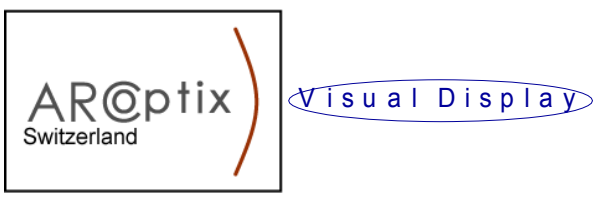
Validation of LCVRs for the Solar Orbiter Polarisation Modulation Package

A proposal for AO/1-5798/08/NL/SFe



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LIST OF ACRONYMS

CSIC	Consejo Superior de Investigaciones Científicas
CSL	Centre Spatial de Liège
ESA	European Space Agency
ESH	Equivalent Sun Hours
HAN	Hybrid Aligned Nematics
HW	Hardware
HWP	Half Wave Plate
IAA	Instituto de Astrofísica de Andalucía
IAC	Instituto de Astrofísica de Canarias
IMaX	Imaging Magnetograph eXperiment
INAF	Instituto Nazionale di Astrofísica
INTA	Instituto Nacional de Técnica Aeroespacial
IL	Institution Leader
IPS	In-Plane Switching
ITO	Indium Tin Oxide
LC	Liquid Crystal
LCVR	Liquid Crystal Variable Retarder
OATo	Osservatorio Astronomico di Torino - Italy
PI	Principal Investigator
PMP	Polarization Modulation Package
QWP	Quarter Wave Plate
R+D	Research and Development
SCORE	Sounding-rocket Coronagraphic Experiment
SO	*Solar Orbiter*
SW	Software
TBD	To be Defined
TBC	To Be Confirmed
UV	Ultraviolet
UVCI	Ultraviolet and Visible-light Coronal Imager
VIM	Visible-light Imaging Magnetograph
WPS	Work Package Structure

1. TECHNICAL PROPOSAL

1.1 INTRODUCTION

This proposal in response to the Announce of Opportunity of *"Validation of LCVRs for Solar Orbtier Polarization Modulation Package" (Ref. AO/1-5798/08/NL/SFe)* is leaded by INTA (Instituto Nacional de Técnica Aeroespacial, Spain) as prime contractor. The subcontractors proposed who participate in this proposal are the CSL (Centre Spatial de Liège, Belgium), INAF (Instituto Nazionale di Astrofísica, Italy), IAC (Instituto de Astrofísica de Canarias, Spain), IAA (Instituto de Astrofísica de Andalucía-CSIC, Spain), Visual Display S.L.L. (Spain) and Arcoptix S. A. (Switzerland).

This consortium has broad experience in LCVR (Liquid Cristal Variable Retarder) manufacturing, characterization, test and use for polarimetric applications as well as in the field of development, qualification and acceptance of components, instruments and systems for space.

In this proposal INTA will carry out the tasks related with the coordination of the activity, the requirement and technology review, the qualification tests including vibration, shock, thermo-vacuum, gamma radiation and outgassing tests, as well as the optical characterization of the components before and after all the tests.

CSL will perform the radiation tests on the LCVRs, including some *in situ* characterizaton and some quick measurements before and after the tests.

INAF will carry out the tasks related to the revision of the scientific requirements, keeping in mind the application of LCVRs as PMP for the coronagraph foreseen in the payload of Solar Orbiter. Therefore INAF will be involved in the activities related to the definition during the design and manufacturing process and characterization of achromatic LCVRs for this purpose.

IAC will mainly participate in the requirements review of the LCVRs taking into account the science requirements of the Visible Imager Magnetograph of Solar Orbiter.

Visual Display S.L.L. will manufacture the different types of nematic LCVRs that will be studied in this activity. Additionaly, it will participate in the evaluation study and definition.

Arcoptix will also provide LCVRs focusing in alternatives designs, components and processes to the Visual Display S.L.L. ones. Specially, it will focus its activity in achromatic LCVRs to be used in the Solar Orbiter coronagraph.

IAA-CSIC will design the support driving electronics and the software associated to control the LCVRs and it will contribute to the science requirements review of the LCVRs.

INTA, IAC, IAA, CSL and INAF has submitted proposals for the different instruments of the payload Solar Orbiter instruments in response to the Announcement of Oportunity published in October 2007, and all these institutions are deeply involved in the development of the mission.

For further information about the work distribution, please see Section 2.5.

1.2 LCVRS PREVIOUS EXPERIENCE

INTA, IAC, IAA and Visual Display S.L. have previously worked together in the IMaX project. The Imaging Magnetograph eXperiment (IMaX) is one of the three payload instruments of the *SUNRISE* balloon mission within the NASA Long Duration Balloon program. SUNRISE is a stratospheric balloon to be flown for 10 days above the Artic in June 2009 to study the solar magnetic fields, resolving the critical length scale of 100 km in the solar photosphere.

The magnetism is studied through measurements of the polarization state of the light. IMaX is an imager, a spectrograph and a polarimeter which employs two LCVRs for modulating the polarization and to analyze the incoming light in terms of the Stokes vector. The polarimetric solutions adopted in IMaX makes use of anti-parallel aligned, positive nematic LCVRs for the polarization modulation.

Figure 1. Left: SUNRISE test flight (October 2007), New Mexico (USA). Right: The Imaging Magnetograph; a polarimeter based on LCVRs as PMP to study the magnetic fields of the Sun

The detailed structure of the LCVRs is shown in *Figure 2*. The substrate is fused silica polished to high optical quality (~λ/10 rms). The inner surface of the substrate is coated with a conductive ITO (Indium Tin Oxide) film, 250 Å thick (resistance < 200 Ω). Over the ITO layer, a polyimide thin layer (200-300 nm) is deposited. The spacers define the thickness of the liquid crystal layer which is inserted into the silica plates subsequently. The spacer used is a non-reactive plastic (Mylar), 6.5 µm thick. The cell is assembled and tacked together with a 90-minutes epoxy cured at 150 ºC (Struct Bond XN-5A). Then, it is filled with the LC and sealed with a slow curing epoxy (ThreeBond 3026 B, UV 300-400nm 10kJ/m^2). Finally, one flexible cable made out of Kapton® material is fixed onto the ITO layers for voltage feeding and fixed to the LCVR with a space-qualified epoxy (Scotch Weld 2216). This type of cable fulfils the outgassing requirements and has the possibility of routing several electrical lines along it, for instance, to install temperature sensors as shown in *Figure 2*.

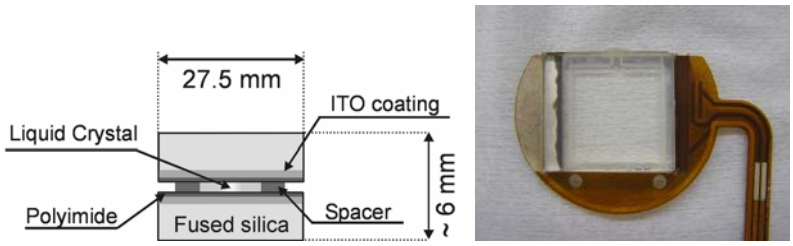

Figure 2. IMaX LCVR structure (left) and an IMaX flight LCVR device (right).

For the confident use of LCVRs in SUNRISE a number of characterizations of these devices simulating the operative environment similar to space conditions were performed. The Solar Orbiter mission environmental conditions were also taken into account in the definition of the test plan, so these tests could serve as a guide to the performance of LCVRs in more general space conditions. This experience paved the way toward future developments like the present proposed activity. The influence of vacuum, temperature, vibration, gamma and ultraviolet radiation was analyzed by measuring the effects of these tests on the optical retardance, the response time, the wavefront distortion and the transmittance, including some *in situ* measurements. Outgassing measurements of the different parts of the LCVRs were also carried out. Table 1 shows a description of the tests performed. All the optical parameters were measured before the start of each test to have a reference measurement. During the thermal-vacuum test, the optical parameters were measured *in situ* for different temperatures. In the rest of the tests, the optical parameters were measured after the test to evaluate the changes. These tests will be performed again to validate the use of the LCVRs for SO PMP according to the environmental conditions of the mission and taking into account the accumulated doses predicted over the whole mission (see *Table 3*). The experience acquired in IMaX with LCVRs will serve much to evaluate and analyse the results of these tests.

Test	Environmental Conditions
Vacuum	P = 10^{-6} mbar
Thermal vacuum	Constant pressure: P = 10^{-6} mbar Operational levels: T = -20 °C to +40 °C Non-operational levels: T = -65 °C to +70 °C
Vibration or dynamic test	T = 22 °C ± 5 °C, RH = 50% ± 10% and ambient pressure Random vibration: Time: 120 s. Flat profile: at 0.5 g2/Hz between 20 and 800 Hz. Decrease profile: 0.5 g2/Hz at 800 Hz until 0.01 g2/Hz at 2000 Hz Shock loads: 10 g (11 ms half-sine shock pulse)
Outgassing	P = 10^{-3} Pa; T = 125 °C, Δt = 24 hours
γ radiation	10, 20, and 54 krad at 0.5 krad/h
UV radiation	~30, ~60, ~150, and ~180 ESH (ESH = 94.6 W/m^2)

Table 1. General Environmental Test Conditions

The results of these tests, which can be found in RD 1, are summarized in the following:

- It could be concluded that the transmittance of the materials that constitute the device decreased (turning yellow) with UV irradiation. Therefore, the sensitivity of these devices to the UV radiation will be an important issue to be considered. This is in agreement to some studies found in the literature describing the effects of the UV radiation on some components of the LCVRs. The polymeric alignment layer (polyimide) undergoes a decrease in transmittance, in accordance with the results observed in our experiments. The LC is the most sensitive component of the devices and more irradiation experiments will allow measuring the modifications in the retardance and the response time induced by the degradation of the LC molecules.

- The LCVRs were irradiated with gamma radiation and showed a linear decrease in the transmittance with the total dose of radiation. After thorough experiments, the drop of the transmittance is attributed to an effect on the polyimide or on the LC. The loss of transmittance is no recovered after two months, pointing out to irreversible degradation processes in the polyimide and/or the LC molecules. There are no clear changes in the wavefront deformation values. The retardance, as well as the response time showed an increase that could be attributed to modifications on the chemical structure of the LC molecules induced by the interaction with the gamma radiation.

- A temperature control for the LCVRs is vital, due to its widely known retardance dependence on temperature, especially at low voltages. It was concluded that a ±0.5º C temperature control is sufficient for a polarimetric application. Response times are sensitive to temperature too, being lower as the LC mixture reaches the isotropic transition temperature, and higher as the mixture reaches the nematic-crystal transition temperature.

- Vacuum does not affect the LCVRs performance.

- The outgassing rates obtained for some LCVR parts analyzed are higher than the ESA standard recommendations. This problem should be solved by changing (or encapsulating) the problematic epoxies with space qualified ones.

As a general conclusion, the LCVRs performance after the tests was acceptable for the IMaX requirements, due to the absence of UV irradiation during the mission. However, the problem with UV radiation has long been known for LCs and polyimide, and therefore the LCVRs should be protected avoid excessive exposure to UV in an instrument. The other components of the LCVRs (as ITO), need further studies.

INAF-Osservatorio Astronomico di Torino is the lead institution of an Italian consortium that has developed the Ultraviolet and Visible-light Coronagraphic Imager (UVCI) for the Sounding-rocket Coronagraphic Experiment (SCORE). SCORE/UVCI is part of the US Naval Research Laboratory payload to be launched on a NASA sounding-rocket in November 2008. The SCORE multi-

wavelength coronagraph will combine UV (HI Lyman-α,122 nm), EUV (HeII, 30 nm) and visible light polarized images of the K-corona to study the solar wind acceleration regions. The solution adopted for the UVCI K-corona polarimeter (KPol) is an electro-opically modulated linear polarization rotator that includes a nematic liquid cristal variable retarder (LCVR). One technological goal of this sounding-rocket mission is to space-qualify liquid crystal devices e to prototype the design for the Solar Orbiter's coronagraph, COR.

Commercially available LCVRs have a wavelength bandpass limited to few nanometers. After their qualification for space use, thus, the broadening of their bandpass is the next logical step in LCVRs development for the Solar Orbiter's coronagraph. One goal of this proposed study is the development and space qualification of achromatic LCVRs, with bandpasses of a few tenths of nm.

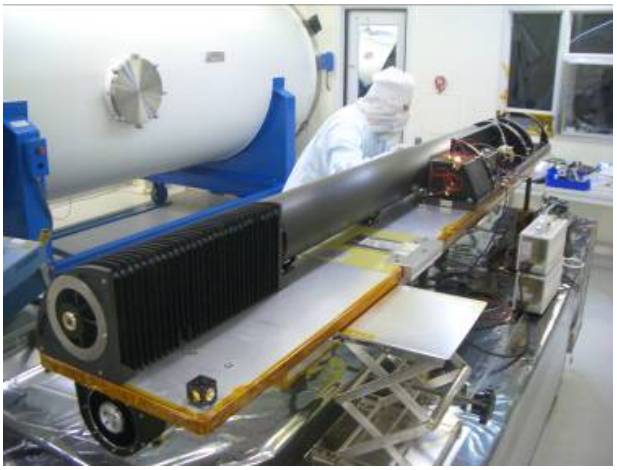

Figure 3. Sounding-rocket Coronagraphic Experiment pre-flight calibration (September 2008).

1.3 UNDERSTANDING OF REQUIREMENTS

1.3.1 Technical requirements overview, problems and solutions

LCVRs have been used extensively in recent years as polarization devices for polarimetric applications. They provide polarization modulation by means of its voltage dependence of retardance. In contrast to traditional rotating waveplates, they have low mass, voltage, and power consumption requirements and they avoid use of complex, moving mechanical parts.

Vector magnetographs as VIM measure the four components of the Stokes vector of the incident light. LCVRs have been used successfully in ground-based solar magnetographs [RD 3-RD 6] as well as in Mueller matrix polarimeters and ellipsometers [RD 7-RD 9]. A typical LCVR cell consists of a pair of optical quality glasses, with an antireflection coating in its outer sides, coated on the inner sides with an ITO layer (approx. 25 nm thick) for the application of an electric field, and an alignment layer. The cell is filled with LC, thus the LC is in contact with the alignment layer of both glasses. This layer provides the LC molecules, which are rod-like molecules with its longitudinal axis known as the director axis, an initial alignment that can be parallel (homogeneous) or perpendicular (homeotropic) to the interfaces.

The alignment layer can be made of several materials, including polyimide (the most common), SiOx, lecithin, polyvinyl alcohol, polystyrene, linearly photo-polymerizable polymer, etc. with several deposition techniques. Depending on the material and/or the deposition technique, homogeneous or homeotropic alignment is achieved.

The electric field inside the cell mimics that of a capacitor, therefore exerting a which tries to align the LC molecules perpendicular to the interfaces. Varying the external electric field, the LC molecules inside reach an equilibrium with some director profile along the cell. This director profile determines the total retardance of the LCVR for a given voltage. The voltage applied to the LCVR should comply with several requirements, being usually an AC square voltage, with frequency of

about 2 kHz, and peak to peak voltage of, maximum, 28 V for a full 360º range of retardance. It should have a very low DC compensation (below ~4 mV), and high repeatability of the voltage applied, to ensure retardance repeatability.

Traditionally, nematic and ferroelectric LCs have been used for polarimetry applications. Nematic LCs have the advantage of a continuous retardance range. Thus, the final retardances can be finely tuned via the voltages applied to achieve an optimum polarization demodulation. However, this high sensitivity to voltage also implies that voltages should be highly repeatable for all the time span of the mission. Nematic LCs have also response times in the region of tens of milliseconds, and thus affect the demodulation process. They are also the most angle sensitive LCVRs. The response time of a particular LCVR will depend on the LC layer thickness, LC viscosities, and specially, the initial and final state. Therefore, by choosing appropriate LC mixtures, response times can be made compliant with those shown in Annex A.1.1 of RD 2, but some transitions will always be slower than others. Some standard transitions should be defined to compare across LCVR types. The same occurs about the angle sensitivity, as it will depend also in the particular LC mixture and layer thickness used.

There are some nematic configurations that address these issues, and have to be taken into account in the review of Task 1 in RD 2. Hybrid Aligned Nematics (HAN) have a homogeneous and a homeotropic alignment layer. This improves the response time of the device [RD 10]. There exists also Nematic LCs with negative dielectric anisotropy, which should also be taken into account. In-plane switching (IPS) nematics consists of a LCVR with in-plane electrodes that apply the electric field parallel to the interfaces. In this configuration, retardance is not changed, but only the fast axis orientation. This kind of LCVRs have greater acceptance angles, but can suffer from non-homogeneities due to the in-plane electrodes. Dual frequency nematics also address the problem of response time, because they use special LC mixtures that have positive dielectric anisotropy at low frequency electric fields (about <10 kHz) and negative dielectric anisotropy at high frequencies. Thus, commanding them with high or low frequency fields depending on the initial and final retardance state, one can greatly reduce the response times. However, thermal stability can be an issue, because the LCs usually heat up when driven with high frequency electric fields.

The other LC phase that can be used to make LCVRs is the smectic phase. The most common application of this phase is the Surface Stabilized Ferroelectric Liquid Crystals (SSFLC). Ferroelectric LCs are bistable, and thus are, in principle, much more robust due to its absence of sensitivity to voltage, once the transition voltage is surpassed. Instead of changing the effective retardance of the LC cell, they change the azimuth axis of the retarder. Therefore, the retardance and the exact azimuth position are defined in the design phase of the LCVR cell and cannot be finely tuned once the LCVR is manufactured. The HWP or QWP retardance specified in Annex A.1.1 of RD 2 are achieved by properly selecting the layer thickness. Ferroelectric LCs are very fast, their response times being in the region of microseconds. However, SSFLCs elements are very difficult to manufacture because of the small cell gap of about 1.5 - 2 μm that have to be controlled, and obtaining a homogenous smectic phase over the whole cell surface is a challenging task. Beside manufacturing challenges one must notice that only a very small selection of Ferroelectric materials are commercially available, and smectic phase are by far less stable than nematic phase. They are also known for they are very high sensitivity to vibrations, which can produce a misalignment of the LC layer and thus results in a non-functional LCVR.

Ferroelectric LCs have alternative configurations too. Deformed Helix Ferroelectrics exploit the fact of having an helical pitch smaller than the wavelength of light. An electric field deforms the helix which then modifies the configuration by rotating the effective optical axis to give a continuous retardance state change with voltage, with the fast response times typical of ferroelectrics. However the pitch is very temperature dependent and this type of ferroelectric structure suffer from the same drawbacks as the bi-stable SSFLCs given above. They work with in-plane electrodes, which can make them less homogeneous than LCVRs that use full-plane ITO electrodes. The endless Smectic A rotator also exists, which uses in-plane electrodes as well, and provides continuous rotation of the retardance azimuth axis.

In principle, LC mixtures usually work in the whole visible spectrum, thus the working wavelengths of the devices are not an issue.

The FoV strongly depends on the type of LCVR. Although the retardance depends, in general, on the incident angle, a full characterization of the FoV performance is only possible in a polarimeter demonstrator. That is because each ray from a given cone of light suffers from a slightly different retardance, hence producing depolarisation. The effect of this depolarization, and its effect on the demodulation process, can only be measured if the Mueller Matrix elements of the PMP are measured in a certain FoV.

Beam deviation requirements are not an issue, because they depend only on the quality of the substrate glasses used, as well as on the LC layer thickness homogeneity.

In the area of optical performance, the effects on the optical components of the space environment hazardous radiation must be taken into account. The effect of gamma rays, proton irradiation, ultraviolet radiation, vacuum and temperature on optical glasses have been studied for sometime [RD 11-RD 13], but very few studies on LCs have been done [RD 1, RD 14-RD 15]. It is known that high-energy radiation affects glasses, with the creation of colour centres. However, for a high spectral resolution instrument, like a polarimeter, this has the only effect of diminishing the overall transmittance, but does not affect the polarization measurements (except for decreasing the signal-to-noise ratio). It is also known in the literature referenced above that fused silica is probably the best candidate for this type of experiment, due to its high resistance to radiation.

However, the effects of radiation in the ITO, in the alignment and in the LC layers can affect the measurements in an unknown manner. First of all, the ITO layer can happen to change its conductance. Then the actual retardance state varies with time, hence degrading the demodulation process. This, however, can be avoided if: a) the effect on the conductance in time is known, and can be corrected for; or b) bistable devices are used, so that small changes in voltage do not affect the retardance state. Secondly, for the alignment layer and the LC, from the reports found in the literature, we can deduce that polymeric materials exhibit transmittance changes (usually turning yellow), due to modifications in their chemical structure, which is in accordance with the results of our experiments (RD 1). Then, the effect of radiation in the alignment layer is important. If the chemical structure of the alignment layer changes, the alignment imposed on the LC layer can be degraded. This can result in a different voltage-retardance curve, or worse, in the formation of micro-domains in which the orientation of the LC molecules change. This effect would create diffraction and scattering, thus affecting its performance. However, there is one alignment material that is not organic and that can, in principle, be less sensitive to radiation: SiOx. We, therefore, think that thorough research about radiation effects in SiOx is important, and that the test of SiOx alignment layer based LCVR can be an important item. Lastly, the LC, being an organic compound and the thickest organic layer in a LCVR, is perhaps the more critical item. However, LCVRs are nowadays made up of LC mixtures, not of pure substances. LC mixtures are needed to have an appropriate index anisotropy, while at the same time having a large operational temperature range. Non-mixture LCs usually have a working temperature range of 20 deg, whereas mixtures can have as much as 70 deg. However, the trade off is that mixtures usually have a large number of components, usually more than 20, and most of them are industrial secrets of its manufacturers. Therefore, it is not feasible to test each compound independently to systematize the search for the best mixture, but some mixtures must be chosen and tested as a whole.

Now, UV radiation is known to degrade LCs. Although in the Visible-light Imaging Magnetograph (VIM) of Solar Orbiter there is a UV filter before the light reaches the LCVRs, and the levels of UV radiation predicted for VIM and COR on the LCVR plane will be very small thanks to it and the glasses that compose the LCVR, of concern are micro-pinholes that are typically present in that kind of filters. For this reason, we are considering an additional rad-hard UV protecting glass in front of the LCVRs as the first element of the Polarization Modulation Package (PMP) or other alternative solutions as UV-protecting coatings based on sol-gel materials, already developed [RD 17] by the Instituto de Ciencia de Materiales de Madrid ICMM-CSIC in collaboration with INTA.

In the case of VIM, the radiation levels the spacecraft will encounter should be considered, and the radiation test will be performed taking into account these levels. Functionality under the cruise + nominal/extended mission conditions should be studied. No LCVR has been in vacuum for a long period of time and put to work after a large lapse of time. But the technology seems to be ready for a full characterization, in particular response to the small amounts of UV light that will reach the LCVRs, as these will be behind the entrance window of the telescope.

For aerospace missions, it is very important to evaluate the durability and operability of the devices during the whole mission. Specific tests should be planned to simulate the aging of the LCVRs even though the analysis will be more quantitative than qualitative. Standard tests performed by companies that produce liquid crystal displays include tests at high and low temperatures together with thermal-shock and degradation with UV. The specific test to be performed in this project for this purpose will be studied during the Phase 1. Nevertheless, it should be taken into account the difficulty of reproducing the aging conditions of the LCVRs due to their continue actuation during the mission. It is not clear that applying an accelerated commutation ratio is equivalent to a longer working time with standard commutation, in a similar way as the problems found in tribologic experiments. Therefore, it could be found after the proper study that a representative test to evaluate the life cycle of the LCVRs would be out of the scope of this project, for example taking a time comparable to that of the SOLO mission. Then estimations based on the ground experience of the industry of LCDs displays would be carried out.

LCVR technology is particularly useful for a space mission which has very strong constrains of mass, power and complexity. The UVC instrument is also considering the use of LCVRs in his visible part. The additional goal, there, is to make the LCVRs response achromatic in the 500 to 600 nm wavelength band. As a conclusion, LCVR technology (basically LCD technology) has been proven on ground instruments and qualified for a suite of space applications. This technology offers the possibility of producing large mass and power savings compared to mechanically driven devices. It also offers a simpler solution for synchronization purposes than rotating devices. LCVRs are commercially available and are being manufactured for optical and space programs in several parts of the world.

One last thing has to be kept in mind: synergy. It is known that chemicals degradation is different when they are isolated than when they are in a compound. Therefore, the degradation of, e.g., isolated polyimide and an isolated LC mixture, is not equal to the degradation when the polyimide and the LC are in contact (like in a LCVR device). Therefore, caution must be taken not to extrapolate previous studies on isolated components to a complete LCVR device, nor to think that a systematized approach, testing each individual component for radiation degradation, can give a meaningful result when translated to a complete LCVR device.

However, it is possible that the sole knowledge of the effect of radiation along time in the LCVR performance is enough to correct these effects and avoid a negative impact on the polarimetric measurements during the mission.

Another critical aspect on the use of LCVRs is temperature control. LCs retardance is sensitive to temperature, and as such, variations of temperature have to be avoided. They are more sensitive at low voltages than at high voltages; thus a modulation scheme should be selected to minimize the sensitivity to temperature. However, it is estimated that a control to within ±0.5º from the nominal temperature is needed for proper modulation repeatability. A system based on the thermal control of the IMaX instrument's LCVRs subsystem will be used for this purpose.

Outgassing is a concern, due to the many materials that involve one LCVR cell. Certain adhesives have high rates of outgassing, and have to be avoided. If it is not possible (due to, e.g., being in contact with the LC and thus have to be known to be non reactive), the problematic points in the LCVR device can be encapsulated with a space qualified adhesive.

Inhomogeneity in the retardance is also a concern. Because the spacers are located outside the clear aperture of the LCVR, it is normal for the glass substrates to bend a bit. This is clearly visible as a series of fringes across the aperture. This obviously affects the retardance across the aperture, and thus has to be taken into account, specially, when making non-imaging characterizations. A LCVR will not give exactly the same retardance across its aperture, and thus a set of points to be characterized for all the LCVRs must be defined. This will permit the confident analysis of pre- and post-test measurements. In the case of LCVRs with in-plane electrodes, the spacing, width, and in general geometry of these electrodes will determine the retardance homogeneity.

In Figure 4, one of the modulation matrix elements of the flight pair of IMaX LCVRs is shown. Clearly, a smooth change in retardance across the aperture exists, along with two problematic points. In the clear aperture of the IMaX LCVRs, air micro-bubbles are known to develop over time.

This is a major concern, if imaging characterizations are not carried out. Therefore, we will perform this kind of imaging polarimetric characterizations of the LCVRs, to track possible air micro-bubbles developing, and to avoid aperture retardance inhomogeneity problems with test analysis.

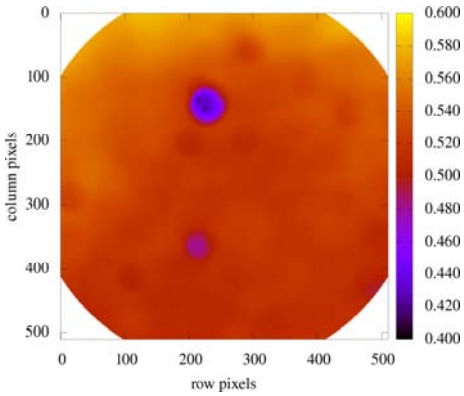

Figure 4. IMaX PMP normalised modulation matrix element M13, showing retardance inhomogeneities.

1.3.2 Achromatic specific requirements

The main performance criteria for the production and validation of the achromatic LCVR is the deviation, as a function of wavelength, of the LCVR retardance from an electro-optically set value (e.g., λ/2, λ/4).

For a given central wavelength (λ_c), Figure 5 shows the goal for the performances of achromatic LCVRs for two electro-optical retardance settings: quarter-wave, λ/4 (left), and half-wave, λ/2 (right). The central wavelength, λ_c, is 550 nm.

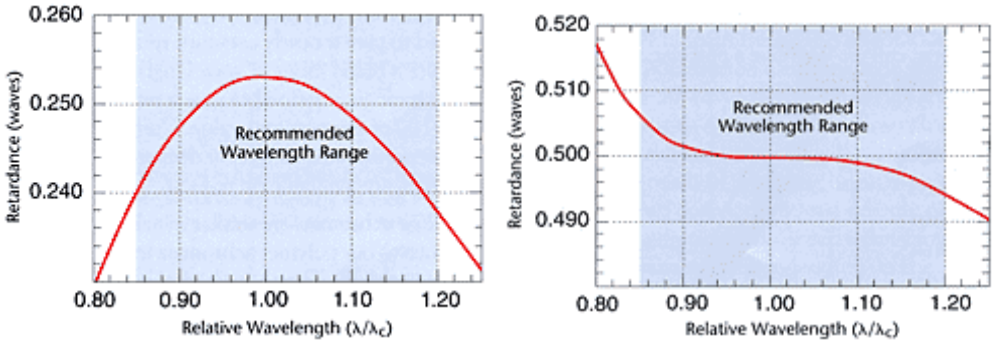

Figure 5. Performance goals for the retardance, as a function of wavelength, of an achromatic LCVR, electro-optically set at λ/4 (left) and λ/2 (right). The central wavelength, λc, is 550 nm

Specifications for Achromatic LCVRs	
Central wavelength, λ_c, (nm)	550
Achromatic wavelength range (λ/λ_c,)	1.25-0.85 (goal); 1.2-0.9 (acceptable)
Retardation range (waves: λ)	0.05λ-0.8λ
Percentage retardance variation in the achromatic range for different settings in the retardation range	≤2% rms (goal) ≤4% rms (acceptable) averaged over the aperture

Table 2. Performances requirements (goal and acceptable) for achromatic LCVRs.

The achromatic LCVRs will be part of the linear polarimeter of COR for the measurement of the K-corona polarized brightness (pB). The performance goal of the polarimeter is a contrast ratio≥98% (≥ 95% acceptable) in the wavelength range. The contrast ratio is defined as the difference between the parallel and perpendicular transmissions to 100% linear polarization divided by their sum:

$$Contrast = \frac{T_{\parallel} - T_{\perp}}{T_{\parallel} + T_{\perp}}$$

Figure 6 shows the calculated contrast ratio, as a function of wavelength bandwidth, of a polarimeter using an achromatic LCVR with the specification summarized in Table 2.

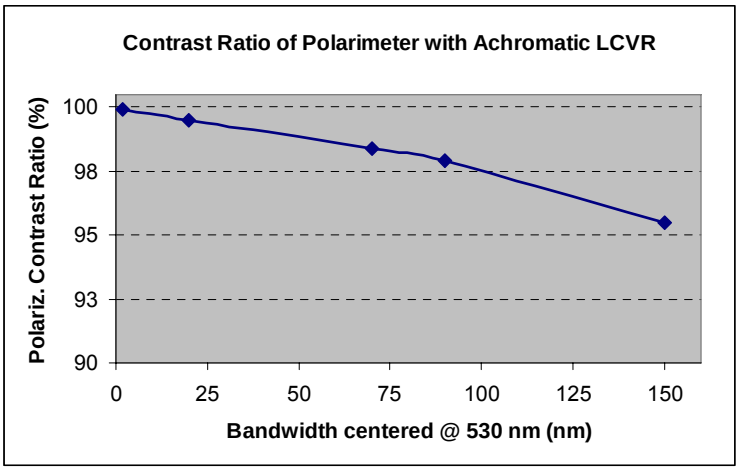

Figure 6. Expected contrast ratio of a linear polarimeter using a LCVR with the achromatic performances resulting from the specifications of Table 1 (see also Figs. 1 and 2)

A polarimeter's contrast ratio of 98% translates in an accuracy of 2%, at best, in the measurements of linear polarization. The typical levels of K-corona fractional linear polarization range between 10% and 60%. Therefore, a polarimeter using an achromatic LCVR with the specifications given in Table 2 would be able to measure the K-corona pB with an accuracy ranging between 20% and 4%. This accuracy is comparable to that of other typical coronagraphic polarimeters (e.g., SOHO/LASCO C2) and it is thus adequate for deriving coronal electron densities from COR's observations.

The 450nm-600nm range is proposed to be changed from the visible-light Channel (VLC) SOHO/UVCS. The polarimeter of UVCS/VLC used a mechanically rotating, fixed half-wave retarder. In the 400nm wavelength range, liquid crystals are:

- more sensitive to UV radiation damage
- more chromatic.

The latter characteristic is exemplified in *Figure 7* that shows the chromatic response, at different voltage settings, of a polarimeter using a commercially available (chromatic) LCVR. The measurements where performed at the OATo optical laboratory.

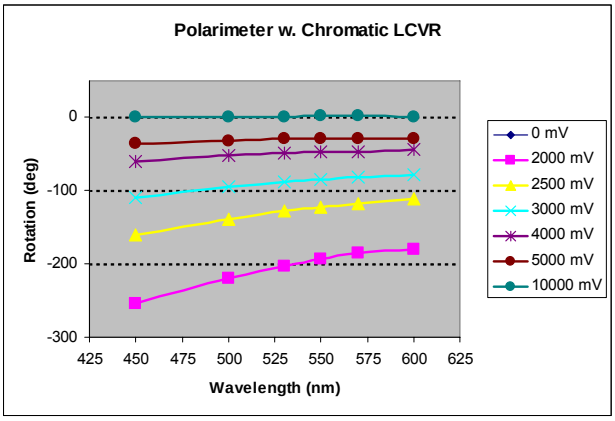

Figure 7. Chromatic response, at different voltage settings, of a polarimeter using a commercially available (chromatic) LCVR. The measurements where performed at the OATo optical laboratory.

Below 500 nm, liquid crystals tend to show an increased chromatic response. For this reason, a conservative approach will be adopted in the development of achromatic LCVRs by initially limiting the bandpass above 480-500 nm. In order to compensate for the band reduction in the 450nm-500 nm range, we will consider extending it in the 600nm – 650nm range. Lliquid crystals show a less severe chromatic response in the red portion of the visible-light spectrum. The K-corona emission is spectrally flat. Therefore, a LCVR with an achromatic response in the 500nm-650nm range will be able to carry out the same pB measurements of an achromatic LCVR in the 450nm-600nm band. This would result in no reduction in the radiometric throughput and in the COR's science return.

1.4 FIRST ITERATION OF THE TASKS

To comply with the objective of creating a European infrastructure that is able to manufacture and qualify for space LCVRs devices, it is necessary to gather a handful of institutions and enterprises that have both experience in LCVR development, manufacture, testing and qualification for space environments, as well as experience in the use of LCVRs in polarimeters and coronagraphs and its associated driving electronics, which will be the ultimate use of the LCVRs in space. Therefore, it is very clear the role of each institution inside de consortium to reach this objective, and the WP have been distributed accordingly (see Section 2.5):

- Design and qualification of optical instrumentation for space applications: INAF, CSL, INTA.
- Polarimetry in solar physics: IAA, IAC, INAF and INTA.
- Use of achromatic LCVRs in coronagraphs: INAF.
- Driving electronics development: IAA.
- LCVR manufacturing: Visual Display and Arcoptix.

In the subsequent sections a brief description of the Tasks, the WP distribution and the general work planning will be given.

1.4.1 Task 1 (WP 0100)

To space qualify the LCVRs and to evaluate their performance, the consolidation of the technical requirements is a previous fundamental goal. In this step, it is crucial to have a previous knowledge on the design and use of ground-based Stokes polarimeters. With this knowledge, it is possible to carry out a thorough critical review of the technical requirements to assure that the LCVRs developed will be useful for the Solar Orbiter mission, and to have an objective reference about the technical objective pursued. A first review have already been done in previous sections (Section 1.3), however some additional comments will be given here.

All the WP included in this task will be coordinated by INTA through WP 0100, which will have as inputs all the outputs of its sub-WPs and will be the core of the main output document, TN1.

1.4.1.1 Task 1.1 (WP 0110)

1.4.1.1.1 WP 0111-0113

LCVRs have, in general, some drawbacks, although both nematic and ferroelectric LCVRs have been used in ground polarimeters (being nematics be much more robust for an applications like VIM and COR). The drawbacks are, mainly, the dependence of retardance on angle of incidence, the slow response times, the temperature dependence of retardance and its chromaticity. In Section 1.9 a preliminary list of candidates have already been chosen bearing in mind the limitations of NLCs. Each one of the types of candidate LCVRs address a different problem to comply with the technical requirements. First, la large angles of incidence indicated in the SoW makes the study of dual cell LCVRs (type V) a necessity. They have already been used successfully in other contexts (see RD 18). For the response time problem, a dual frequency LC (type III) is proposed (see RD 19), as well as a pi-cell (type II), see RD 20, which may be in principle less suitable for our purposes.

However, some of these drawbacks can be minimized by a proper design of the polarimeter, and this knowledge comes from the previous experience that the consortium have with ground solar Stokes polarimeters and IMaX. For example, the retardance non-homogeneity can be addressed by performing a pixel-per-pixel calibration of the system, and therefore the only effect of the inhomogeneity is a slight decrease on the efficiency of the demodulation process for some areas of the FoV. Also, a proper positioning of the LCVRs (near an image plane) can diminish the effects of WFE and depolarization introduced by retardance inhomogeneity. Also, a proper modulation scheme can improve response times, by the use of the common over-shoot and under-shoot method, or by choosing the retardance states sequence that minimize the total response time of the modulation cycle.

Apart from the preceding requirements, the only one left that can pose a problem in this work is the outgassing. We have already determined that the usual adhesives used in the LCD industry does not meet the outgassing requirements, and that, in principle, cannot be changed because they have to have known non-interaction with the LC material. However, from our experience of the design of optical systems for space, we know it is very easy to encapsulate a standard LCVR cell to avoid the contact of these adhesives with the vacuum, and this is the approach intended in the present work. Finally, the use of the well-known Kapton® material in the electrical cables of the device assures the compatibility with vacuum of this part of the device (*Figure 2*).

The environmental requirements will be analyzed in detail by the institutions that have a long experience in this type of qualification studies.

1.4.1.2 Task 1.2 (WP 0120)

1.4.1.2.1 WP 0121-0122

The area of technology review concerning these WPs will be carried out by institutions with expertise in polarimetry, which are the ones able to determine the important characteristics a LCVRs must comply with to be useful for solar polarimetry. The subject of LC based Stokes polarimeters is well known to IAA, IAC, INAF and INTA, and we do not think that any revolutionary concepts can be introduced at these stage to improve the LCVRs with VIM and COR in mind.

1.4.1.2.2 WP 0123-0124

A study of the state of the art of LCVRs manufacturing as well as a study of possible technology improvements taking into account the Solar Orbiter PMP requirements will be carried out.

It is important to point out that both Visual Display and Arcoptix have had a long previous experience with ferroelectric liquid crystals. A typical SSFLC have a very thin layer of LC, of the order of a micron. For them, it has been very difficult to obtain a homogeneous thickness for SSFLCs, in contrast to the homogeneity they can obtain with nematic LCVRs. On the other hand, as its name implies, the structure of a SSFLC is dependent exclusively on the surface that is in contact with the LC layer, because if that surface, for any circumstance, cannot hold the LC molecules in the surface stabilized configuration, the LCVR cell will inevitably be rendered useless. This has been the major drawback for the success of SSFLC in the LCD industry. Therefore, apart from novel

techniques to improve this stability, it is improbable that SSFLC will be suitable candidates for space applications.

Many of the alternative LCVRs for polarimetry make use of in-plane electrodes for its functioning, and will be probably discarded as they carry an implied large non-homogeneity in the retardance along the LCVR aperture.

1.4.2 Task 2 (WP 0200)

With the results of TN1, we are in the position to asses the environmental effects on the LCVR components. INTA will coordinate this activity through WP 0200 and produce TN2 as output.

1.4.2.1 WP0210-0220

INTA have a solid experience in the effects of the space environment on LCVR thanks to the work in IMaX. We already know, as stated in section 1.2, that the primary factor that affects LCVR performance is UV irradiation. Gamma irradiation showed a small effect in retardance transmittance and response times. WFE, for example, is the least sensitive part of the LCVR performance to the space environment. Thus, we already know that transmittance and retardance are the main indicators of performance for these types of tests.

For thermo-vacuum, transmittance can be omitted, while response times are the most important figure.

At this stage INAF should establish specific performance indicators for achromatic LCVRs, but we already presume that retardance at different wavelengths should be the main concern for the COR application.

1.4.3 Task 3 (WP 0300)

Once the requirements (Task 1) and the effects of the space environment (Task 2) are reviewed, a preliminary selection of materials and of designs of the LCVRs will be made. INTA will coordinate this activity through WP 0300 and produce TN3 as output.

1.4.3.1 WP0310-0320

As outlined in section 1.2, a rough selection of materials has already been made. LC mixtures do not play such an important role in this work as the other materials constituent of the LCVR device. This is because the LCD industry have advanced to such extent in the last years, that LC mixtures are very complex and manufactures usually ask its customers about the desired characteristics desired for the LC mixture, and a particular mixture will probably comply with most of the requirements. The main aspects of the LC mixture to be selected are the temperature range, the optical anisotropy, the dielectric anisotropy and the viscosities. These parameters are tightly related to the final layer thickness and response times. However, it is not possible to choose particular ingredients to improve irradiation resistance, because the high number of components makes synergy between different components the determinant factor in the response of a LC mixture to high energy irradiation.

The specific materials that will possibly be used in the LCVR manufacturing are listed below:

- LC mixture :
  - For cells type I and II. for standard cells of type I would recommend Merck ZLI-1132 (stable to UV radiation and good transmission response) Other possibilities : ZLI 3502 or MLC6610, MLC12000,…
  - For cells type III: MLC-2048 (Merck) dual frequency nematics. E44
  - For cells type IV: Felix-018 (from Hoechst).
  - For cells type V and VI :To be defined at design
- Polyimides:
  - Low pretilt: PI2545 (Dupont), SE-2170(Nissan)

  - High pretilt: Nissan SE-610, SE-3510
  - Homeotropic alignment: Nissan RN-783 and RN-722
- Spacers: Glass fibres 2μm, 6 μm, 8 μm, 10 μm, 20 μm diameter
- Adhesives: Sealing LC cells ThreeBond 3025, NOA 68, 61 for UV curing glue
- Glass plates - AR coatings:
  - Substrates: Fused silica polished both sides
  - Electrodes: ITO coating thickness 10nm-150nm
  - AR coating: Broadband AR coating MgF2 layer

1.4.4 Task 4 (WP 0400)

With the results of TN1, TN2 and TN3 we will be able to define the final LCVR types to be manufactured and its materials and subcomponents. Note that as it was stated in Section 11.4.1.2.2 this LCVR type IV could be rejected during the previous studies.

INTA will coordinate this activity and produce TN4 and TN5.

1.4.4.1 Subtask 4.1 (WP 0410)

1.4.4.1.1 WP0411

There are several performance figures that can be estimated from the theoretical figures of the materials to be utilized in the LCVR manufacturing, as well as there are some performance requirements that will not be possible to predict to sufficient degree to make the calculation feasible. In one hand, with the optical anisotropy and our previous experience, it is possible to derive figures for optical retardance and WFE for each cell, as well as retardance homogeneity. Also, the operational temperature range will be completely defined by the LC mixture used. On the other hand, response times are very sensitive to many of the LCVR parameters as well as the actual manufacturing, its interaction with a particular polyimide, and with great dependence on temperature, thus needing a very complex theory to get meaningful results. Thus, we think that we will not be able to predict response times, nor high energy irradiation tolerance, as they will be dominated by the aforementioned synergy problem. Therefore, the performance model will be a simplified model due to the system complexity.

1.4.4.1.2 WP0412

We have already determined that the preliminary functional verification can be performed by a simple crossed polariser test. The LCVRs will be supplied with several voltages, and we will confirm that its effect in polarisation changes with voltage. No preliminary quantified measurements will be carried out, as they are not needed in this stage.

Additionally, a quick phase shifting interferometry measurement developed in INTA could be done to determine the homogeneity of the cell across the aperture .

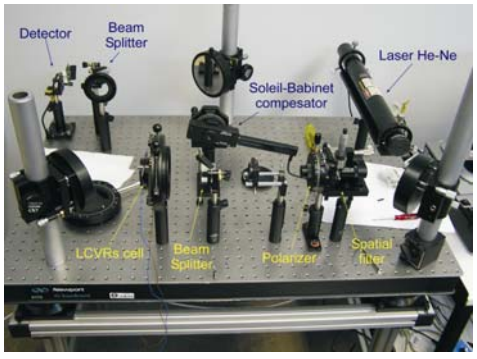

Figure 8. Phase shifting interferometry setup for a quick determination of the LCVRs homogenity.

1.4.4.1.3 WP0413

We have already determined the long lead items for LCVR manufacturing, as stated in section 1.8.

1.4.4.1.4 WP0414

Based on the long experience of Arcoptix and Visual Display in LCVR manufacturing, a manufacturing and procurement plan for LCVRs will be established.

Note that INAF will be involved in all the WPs related to the achromatic LCVRs manufacturing because a continuous feedback will be necessary in this development. INAF will not manufacture LCVR, but test them. However, INAF will directly interact with the manufacturer to ensure that the best manufacture process will be followed to meet the specifications given

The driving electronics design will build upon the IMaX electronics design by IAA-CISC. In spite of the fact that space electronics is not required, the components involved in the design need to have the equivalent ones on space grade since, in the end, this requirement will be demanded for the mission. The following steps are forseen:

A. Validation plan and electronic design / computer simulation from the requirements and technology review analysis.

B. Development of an electronic mockup: PCB design, PCB manufacture, PCB setup, software development.

C. Test the mockup behavior.

D. Check of the requirements fulfillment.

1.4.4.1.5 WP0415-WP0416

For type I, II and IV LCVRs, the same design of IMaX driving electronics must suffice for our purposes, as well as its associated software. A new design should be needed in the case it is decided to manufacture type III and V LCVRs.

1.4.4.2 Subtask 4.2 (WP 0420)

1.4.4.2.1 WP0421

The performance verification plan will include, as a first draft, the following items:

- Rough extraction of retardance curve and cell homogeneity via phase shifting algorithm.
- Thermo-vacuum test to determine the optimum working temperature, using a null ellipsometer setup through the vacuum chamber windows. This is because the main performance requirement that will be used to determine this temperature will be optical retardance range and response times at 632.8 nm.
- Extraction of retardance curve with Variable Angle Spectroscopic Ellipsometer for all wavelengths and angles of incidence, and to extract the dispersion law of the LC mixture optical anisotropy.
- Interferometric extraction of WFE with the use of a ZYGO interferometer.

1.4.4.2.2 WP0422

The preliminary environmental test plan will include all the tests foreseen: thermal-vacuum, tests, vibration/shock test, outgassing test and radiation tests.

A LCVRs mount based on the IMaX experience will be designed as test tool, to be able to carry out the vibration/shock test at INTA since it is a critical issue in this kind of tests. The thermal-vacuum test will be performed at INTA.

Considering that LCVRs cells do not fit in the INTA outgassing chamber test, which is ESA certified for this kind of measurements, the following plan will be carried out: First, the outgassing rate of the materials and critical subcomponents of the LCVRs devices will be measured in the

certified facility. After that, a test of outgassing rate of the complete LCVRs device (system level) will be performed in an ESA non-certified facility following a traceably and rigorous method.

CSL will carry out the radiation tests that will include UV radiation tolerance tests and the proton and electron irradiation tolerance tests. The electron irradiation will probably be simulated by using gamma irradiation following the advice from ESA Mr. Ali Mohammadzadeh (thanks to secondary electrons produced by gammas).

To characterise the effects of the environmental conditions on the LCVRs will carry out the following steps:

- Measurement of specific performance figure before the environmental test.
- Perform the test.
- Measurement of the specific performance figure after the test.

In order to avoid time relaxation effects, CSL will measure the main indicator at CSL facilities just after testing. A calibration between the different optical testing systems (INTA-CSL) will be performed to be able to compare the measurements (see WP 1211).

INAF will participate including specific characterisation test for the achromatic LCVRs.

1.4.4.2.3 WP0423-WP0426

This will be based on the work done for IMaX, but the precise outputs for these tasks will be known only after the definition of the performance verification and environmental test plan.

1.4.5 Task 5 (WP 1100)

This task has as outputs the actual LCVR prototypes, the driving electronics, the control software and document TN6 of the preliminary functional verification, defined in WP0412.

1.4.6 Task 6 (WP 1200)

All the WPs in this section will be performed as specified in subtask 4.2.

A Polarization Modulation Package Demonstrator for VIM and COR has been included (WP 1230). Using the experimental setups developed previously to this activity by INAF and INTA, we will test a VIM Polarization Modulator Package Demonstrator based on the most promising LCVRs prototypes after testing and characterisation. The results will be included in TN7. This task is not in SoW document, but we think that it will be a very useful verification of the LCVRs final application and the effort is relative low because the optical setup for this purpose has already been developed for COR and IMaX-VIM. However, the demonstrators will not be deliverables.

1.4.7 Task 7 (WP 1300)

All the participants will carry out a critical review of the results after the characterisation and environmental testing, and they will participate in the elaboration of the final technical data package.

INTA will elaborate a technology qualification plan taking into account all the experienced gathered in this project.

1.5 STUDY PLAN

In Figure 9 and Figure 10 the study plan of Phase I and II respectively are presented.

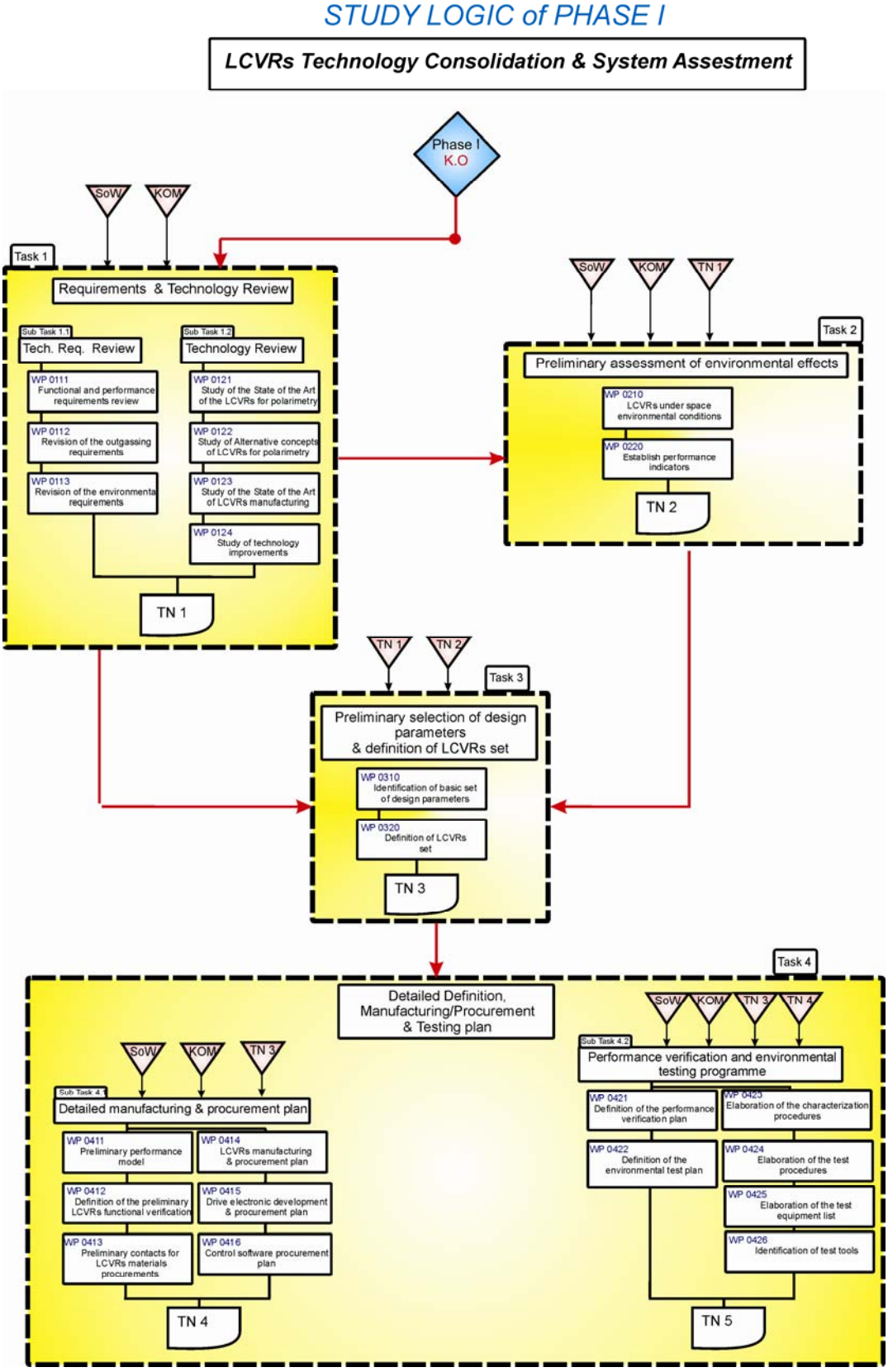

Figure 9. Study Logic of Phase I.

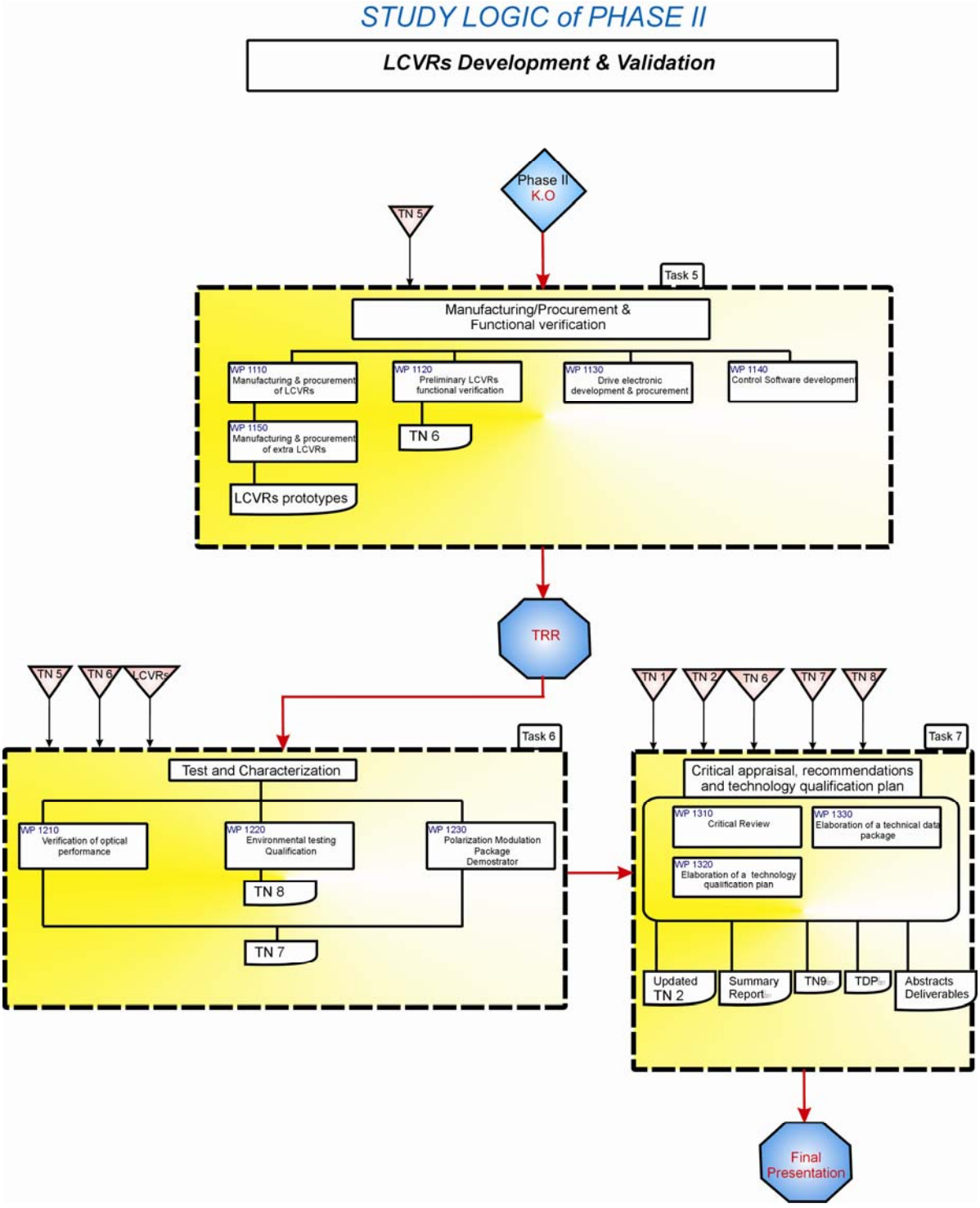

Figure 10. Study Logic of Phase II

1.6 CRITICAL REVIEW OF TECHNICAL REQUIREMENTS

CONFORMANCE MATRIX ESA REQUIREMENTS

C = Conformance PC = Partial Conformance NC= Not Conformance N/A= Not Applicable

	Parameter	Value	ESA Comments	Conformance	Contractor Comments
A 1.1 Functional & Performance Requirements	**Mode of operation / modulation**	In plane or out of plane switching	Both possibilities shall be investigated	C	Both possibilities will be investigated during Task 1, 2 and 3 of Phase 1. After this study, decisions will be made regarding the availability of the materials proposed to be manufactured
	LC Material	FLC / NLC type, Low Birefringence LCs / High Birefringence LCs, Positive Nematics / Negative Nematics	These representative types of LC materials shall be included in the LCVR set as a minimum	C	Several possibilities will be investigated during Task 1, 2 and 3 of Phase 1. After this study, decisions will be made regarding the availability of the materials proposed to be manufactured
	Operational wavelength(s)	617.3 nm 450 – 600 nm	LCVRs shall be optimised for operation at 617.3nm Performance shall be verified at the above wavelength as well as at the following wavelengths: 500nm, 530nm and 600nm. If tests have to be performed at a different wavelength, then performance shall be projected unambiguously to the specified wavelengths.	PC	A new operational wavelength range is proposed (500-650 nm) according to comments in Section 1.3.2. Also, the extended upper part of the range is needed since some tests (at least WFE) will be performed with HeNe laser at 633 nm, and the design wavelength should be inside the operational wavelengths. Different selected wavelengths for testing are proposed [500, 532, 632], to include HeNe wavelength and diode laser wavelength. Extrapolation of the results to different wavelengths will be calculated, based on the ellipsometric models of the LCs.
	Bandwidth	> 1 nm (FWHM)	The performance of the LCVRs shall be verified for the selected wavelengths (see previous point) and for a minimum of 1nm bandwidth in each case.	PC	Some tests (WFE) will be performed with lasers, thus with a smaller bandwidth.
	Retardation Range	[0.05 – 1.5] waves (for NLC), [HWP, QWP] (for FLC)	Continuous phase modulation in the case of Nematic LCVRs, Discrete phase levels in the case of Ferroelectric LCVRs	PC	Optical retardance of 1.5 waves seems very high. In principle, complete 360 º of retardance should be sufficient: [0.05 – 1.05].*See note below* [a].
	Retardance homogeneity	5% (3% goal) over full aperture & FoV	Variation over the average value. To be performed for different driving voltages.	C	If in-plane electrodes LCVRs does not comply, will not be considered for manufacturing.
	FoV	± 4.6 degrees maximum	The performance of the LCVRs shall be evaluated at the following intermediate values: (a) ± 0.28 deg (b) ± 1.35 deg (c) ± 4.6 deg	PC	Measurements of optical retardance at different angles will be measured with an ellipsometer. Performance with an optical beam covering the whole FoV could be achieved when performing Imaging Polarimetry with the polarimeter demonstrator.

	Parameter	Value	ESA Comments	Conformance	Contractor Comments
	Beam Deviation	< 5 arcmin	Assuming collimated input	C	
	Transmission	> 95%		PC	Depending on the LC used, 95 % seems too high value. Redefined to >90 %, with goal >95 %.
	Contrast	500:1 (goal: 1000:1) (over full aperture)	Not a performance requirement. To be used for evaluation of the alignment quality and its degradation with the environment.	C	
	Clear Aperture	4 cm square (goal: 5 cm square)		C	
	Thickness of the LC layer	TBD for each LCVR	To be optimised for each material and chosen operational wavelength	C	
	Response Time	< 50 ms (goal: < 30 ms)		PC	Depending of the transition stages defined and on type of LC
	Optical quality of LCVR	< 100 nm WFE RMS		C	The required accuracy in the retardation value and in the WFE are closely related, *see note below*[b].
	Temperature dependence of retardance	< 0.5 % / °C		PC	< 0.5% /ºC seems a very demanding value and higher values are expected, mainly in the low voltage region of nematics. LC phases are, by its very nature, sensitive to temperature. The use of LCVRs implies control of temperature
A 1.2 Outgassing Requirements	**TML (Total Mass Loss)**	< 0.1 %	[SoW RD 19]	C	
	CVCM (Collected Volatile Condensable Material)	< 0.01 %	[SoW RD 19]	C	
A 1.3 Environmental Requirements	**Operational temperature range**	[0 … +50] °C	The functionality and performance of all LCVRs throughout this temperature range shall be established in a thermal vacuum test. The temperature range of the optimum optical performance for the selected LCVRs shall be determined. [SoW RD 17] & [SoW RD 18]	C	The performance of the LCVRs will be first tested for the whole temperature range during the thermal-vacuum test. The temperature control of the vacuum chamber will be used, as it provides a large range of stabilised temperatures. Depending on the results and the VIM and COR thermal conditions, one temperature for operation will be selected for their optimum performance A very similar temperature control as the one used in IMaX will be used for the rest of optical characterisations at the selected temperature. *See note below*[c].

	Parameter	Value	ESA Comments	Conformance	Contractor Comments
	Non-operational temperature range	[-40 … +70] °C	Survivability of the LCVRs shall be ensured after several thermal cycles through the specified range. [SoW RD 17] & [SoW RD 18]	C	
	Vacuum environment	< 10^{-6} mbar	[SoW RD 17] & [SoW RD 18]	C	
	UV Radiation Tolerance	Equivalent solar flux in the spectral region between 160 nm and 400 nm of 20 ESH (Equivalent Sun Hours at 1 A.U.)	- To be performed in vacuum. - The LCVR shall be kept at operational temperatures during irradiation. - The performance of the cell shall be checked for intermediate irradiation doses up to the specified maximum. - An acceleration factor could be used if necessary. [SoW RD 15] & [SoW AD 1] p.9	C	
	Ionizing Radiation Tolerance	> 75 krad (Si) (as of [AD 1] p.27)	The effects of radiation shall be assessed (as a minimum) after the following intermediate dose steps: 8 krad(Si), 25 krad(Si), & 75 krad(Si) [SoW RD 15] & [SoW RD 16]LCVRs	C	
	Proton & Electron Irradiation Tolerance	[AD 2]	If a full proton irradiation test is performed then a lower fluence of electrons can be used (as stated in [SoW AD 2]) Guidelines in: [SoW RD 15] & [SoW RD 16]	PC	Following advice from ESA Mr Ali Mohammadzadeh, we suggest to simulate electron irradiation by using gamma irradiation (thanks to secondary electrons produced by gammas). For protons irradiation, we suggest to use the worst case of low energy protons at 2 different energies
	Sinusoidal & Random vibration, Shock	Applicable levels are defined in paragraphs 5.1.10, 5.1.11 & 5.1.13 of [RD 17]	[SoW RD 17]	C	

Table 3. Conformance matrix ESA requirements.

Note [a]

In polarimetry, there is no difference between 0 and 1 waves. However, from a practical point of view, having no true retardance is more robust than having 1 wave of retardance, because changes in working wavelength, angle of incidence or temperature can produce a drift in the true retardance value. However, bearing in mind the importance of temperature control, angle of incidence and FOV in this study, it makes no sense to develop a compensator to make the 0.05 wave state a 0 wave state that could only partially compensate deviations in these quantities.

Note [b]

The required accuracy in the retardation value and in the WFE are closely related, and depend almost exclusively on the particular LC mixture used. This comes from the fact that the major part of the WFE is produced by the bending of the glasses when the LCVR if filled with the LC. This bending is, in the IMaX LCVRs, of the order of λ/2 PV (λ/10 rms). The important figure with respect to retardance homogeneity is PV WFE, and omitting the contribution from the negligible WFE of the glasses alone, the maximum error in retardance can be estimated as:

$$Retardance_{\max error} = \Delta n \frac{WFE_{PV}}{n_{effective}}$$

being Δn the optical anisotropy of the LC mixture and $n_{effective}$ the effective refractive index. It is clear also that the maximum of WFE induced retardance error is obtained at zero voltage. If the IMaX WFE figures are taken as a guide, the rms WFE of λ/10 corresponds to a PV WFE of λ/2, which translates to a maximum retardance error of approx. 5%. at zero voltage, taking into account that IMaX LCVRs provided a maximum retardance of ~1.5 waves. Because the WFE requirement for this ITT is approximately λ/5, it is clear that complying with the retardance requirements will, probably, automatically satisfy the WFE requirements. This requirement could be more difficult to comply with in the case of double cell LCVRs.

Note [c]

It consists of a fully flight qualified mount for the LCVR, made of anodized aluminium. It will be thermally isolated from the environment by a Delrin® enclosure, and will be in contact with Kapton® heaters that provide the thermal control. In the case of an operational temperature close or below ambient temperature, a Peltier will provide the cold reservoir. The heaters and/or Peltier are controlled with a PID algorithm to maintain a temperature stability of ±0.1 º C.

1.7 STATEMENT OF COMPLIANCE

COMPLIANCE MATRIX ESA WORK STATEMENT

C = Compliance PC = Partial Compliance NC= Not Compliance N/A Not Applicable

Items with PC are described in Section **¡Error! No se encuentra el origen de la referencia.**.

		Section		Requirement	Compliance
Phase I (WP 0000)	**Task 1 (WP 0100)**	**Review of requirements & Technology review**			
		WP 0110		Review of the technical requirements	C
			WP 0111	Review of functional & performance requirements	C
			WP 0112	Review outgassing requirements	C
			WP 0113	Review of the environmental requirements	C
		WP 0120		Technology review	C
			WP 0121	Study of the state of the Art of LCVRs for polarimetry	C
			WP 0122	Study of Alternative concepts of LCVRs for polarimetry	C
			WP 0123	Study of State of the Art of LCVRs manufacturing	C
			WP 0124	Study of technology improvements	C
	Task 2 (WP 0200)	**Preliminary assessment of environmental effects on LCVRs components**			
		WP 0210		LCVRs components under space environmental conditions	PC
		WP 0220		Establish performance indicators	C
	Task 3 (WP 0300)	**Preliminary selection of design parameters and electro-optical effects**			
		WP 0310		Identification of basic set of design parameters	C
		WP 0320		Definition of LCVRs set	PC
	Task 4 (WP 0400)	**Detailed Definition, Manufacturing/Procurement & Testing Plan**			
		Subtask 4.1 (WP 0410)	**Detailed manufacturing and procurement plan**		
			WP 0411	Preliminary performance model	PC
			WP 0412	Definition of the preliminary LCVRs functional verification	C
			WP 0413	Preliminary contacts to LCVRs materials procurement	C
			WP 0414	LCVRs manufacturing plan	C
			WP 0415	Drive electronic procurement plan	C
			WP 0416	Control software procurement plan	C

Phase I (WP 0000)	**Task 4 (WP 0400)**	**Detailed Definition, Manufacturing/Procurement & Testing Plan**			
		Subtask 4.2 (WP 0420)	**Performance verification and environmental testing programme**		
			WP 0421	Definition of the requirements verification method	C
			WP 0422	Definition of the environmental test plan	C
			WP 0423	Elaboration of the characterisation procedures	C
			WP 0424	Elaboration of the test procedures	C
			WP 0425	Elaboration of the test equipment list	C
			WP 0426	Identification of the test tools	C
Phase II (WP 1000)	**Task 5 (WP 1100)**	**Manufacturing/Procurement & component assembly. Functional verification**			
			WP 1110	Manufacturing and procurement of LCVRs	C
			WP 1120	Preliminary LCVRs functional verification	C
			WP 1130	Driving electronic development and procurement	C
			WP 1140	Control software development	C
			WP 1150	Manufacturing of extra LCVRs	C
	Task 6 (WP 1200)	**Test & Characterization**			
		Subtask 6.1 (WP 1210)	**Verification of optical performance**		
			WP 1211	Design and manufacturing of test tools	N/A
			WP 1212	Calibration between the different optical testing systems	N/A
			WP 1213	Optical performance characterisation	C
			WP 1214	Specific optical performance tests for achromatic LCVRs	C
		Subtask 6.2 (WP 1220)	**Environmental testing and qualification**		
			WP 1221	Thermal vacuum test	C
			WP 1222	Vibration/shock tests	C
			WP 1223	Outgassing test	C
			WP 1224	Radiation tests	C
			WP 1225	Optical characterisation before/after the environmental testing	C
			WP 1226	Specific optical characterisation before/after the environmental testing for achromatic LCVRs	C

Phase II (WP 1000)	**Task 6 (WP 1200)**	*Task proposed (WP 1230)*	**Polarization Modulation Package Demonstrator**	
		WP 1231_A	VIM Polarization Modulation Package Demonstrator	N/A
		WP 1231_B	COR Polarization Modulation Package Demonstrator	N/A
	Task 7 (WP 1300)	**Critical appraisal, recommendations and technology qualification plan**		
		WP 1310	Critical review	C
		WP 1320	Elaboration of a technology qualification plan	C
		WP 1330	Elaboration of a technical Data Package	C

Table 4. Compliance matrix ESA Work Statement.

1.7.1 Critical comments on Activities

With respect to the activities proposed in the Statement of work, we have the following additions and corrections.

- **Task 1:** No questions/comments.
- **Task 2:** As mentioned previously, a component by component LC evaluation is not likely possible (due to manufacturers' limitations) or representative of the performance of LC mixtures (because of synergy between components). Therefore, only mixtures will be considered.
- **Task 3:** There are too many variables. It should be necessary to concentrate only in LCVRs types feasible to be manufactured to a certain quality: whether commercially via any company or custom built with our partners companies. As mentioned previously, LCVRs type IV (SSFLC, see Section 1.4.1.2.2) will be studied but they are candidates to be rejected for the subsequent phase due to their high instability found in the long previous experience of Visual Display and Arcoptix.

  The budget presented in this proposal considers the production of 80 LCVRs (40 Arcoptix and 40 Visual Display). The LCVRs types and the number of devices of each type selected to check the repetibilty shall take into account this limitation. A higher number of devices will increase the cost. Therefore, it should be taken into account to fulfil the ESA requirement of 3 devices per LCVRs type and considering that a number of the same LCVRs type will be also necessary to be dedicated to different environmental tests (gamma radiaton, UV radiation, etc.). A compromise between all these requirements should be achieved taking into account the Performance Verification and Environmental Testing plan (WP 0420).
- **Task 4:** The performance model will be a simplified model due to the system complexity. The possibility of developing a complete model is not clear and out of the scope of this activity.
- **Task 5:** No questions/comments.
- **Task 6:** Based on the results of the review phase (Task 1 and Task 2), it will be decided exactly which type of radiation tests will be carried out. The development of a PMP demonstrator for VIM and COR is proposed to assess the functionally of the most promising LCVRs after testing in the final application.
- **Task 7:** No questions/comments.

The total estimation of the tasks duration exceeds the 14 months described in SoW. We propose a total duration of 16 months as it is showed in the master schedule(Section 2.7).

1.8 LONG LEAD ITEMS

The following long lead items have been preliminary identified:

- ITO coated fused silica glass substrates.
- Polyimide precursor.
- SiOx coated fused silica glass substrates.
- LC mixtures
- Spacers.
- Availability of irradiation facilities (must be checked at project start).

1.9 PRELIMINARY LIST OF CANDIDATES LCVRS CONFIGURATIONS

We propose the following preliminary list of LCVRs configurations to be studied and analyzed:

- Type I: anti-parallel aligned nematic (as IMaX)
- Type II: parallel aligned nematic (also known as pi-cell LCVRs, see RD 16).
- Type III: dual frequency nematic.
- Type IV: Surface Stabilized Ferroelectrics.
- Type V: Dual Type I to improve acceptance angle.
- Type VI: Achromatic LCVRs

All these types are within the manufacturers' capabilities, as they currently manufacture Type I LCVRs on a continuous basis. Type II-III-V are only variations from the design of Type I, because they try to address some possible limitations of traditional nematic LCVRs, and only need a different assembly or different LC mixtures. At the end of Phase I the LCVRs Types to be tested and characterized will be selected from this list in base of the results of the studies carried out (Task 3 and Subtask 4.1). Technical and financial restrictions will determine the total number of types and samples that will be selected.

It has been pointed out that, both Visual Display and Arcoptix have had a long previous experience with ferroelectric liquid crystals and their conclusion is that, apart from novel techniques to improve its stability, it is improbable that SSFLC will be suitable candidates for space applications. So LCVRs Type IV will be studied but they are probable candidates to be rejected for the subsequent phase.

Note: Both polyimide (subtype a) and SiOx (subtype b) alignment layers will be included in the preliminary list. Probably, no in-plane electrodes (Deformed Helix Ferroelectrics) will be included due to possible inhomogeinity of retardance. Negative nematics will also be considered. We note that both Visual Display S.L. and Arcoptix have had a long experience in the past with the production of Type IV LCVRs. Arcoptix and Visual Display S.L. have worked with SiOx alignment layers, and if it is determined that SiOx alignment is to be tested in Phase II, it is within their possibilities.

The preliminary distribution for manufacturing is the following:

- Visual Display S. L. will manufacture the Type I polymide aligned, Type I SiOx aligned and the Type II. The number of LCVRs will be 40.
- Arcoptix will manufacture the Type III, Type V and Type VI. The number of LCVRs will be 40.

Hence, the total number of LCVRs foresees in this activity is 80.

1.10 ACCESS TO MANUFACTURE MATERIALS

The companies Visual Display S. L. and Arcoptix S. A. are providers of LCVRs: they will supply to devices to be characterized and tested. So the access to manufacture materials is guaranteed.

1.11 COMMITMENT TO DISCLOSE ALL INFORMATION DURING THE ACTIVITIES.

All information will be disclosed during the activities.

1.12 SUBTASK 5.2

Extra LCVR prototypes will be produced and delivered to the Agency at the end of the contract. The optical performance of those will be measured during the performance verification campaign, but these prototypes will not undergo any environmental tests.

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2. FINANCIAL, MANAGEMENT AND ADMINISTRATIVE PROPOSAL

2.1 BACKGROUND EXPERIENCE

As mentioned in Section 1.1. the consortium leaded by INTA (Instituto Nacional de Técnica Aeroespacial) and formed by IAC (Instituto de Astrofísica de Canarias), IAA (Instituto de Astrofísica de Andalucía), INAF (Instituto Nazionale di Astrofísica), CSL (Centre Spatial de Liège), Visual Display S.L.L. and Arcoptix S.A. has broad experience in LCVRs (Liquid Cristal Variable Retarder) development, characterization, test and use. Besides this consortium has a wide experience in the field of development, qualification and acceptance of components, instruments and systems for space. Particularly outstanding is the work developed by INTA, IAC, IAA and Visual Display S.L. in the IMaX instrument for the *SUNRISE* mission as it was explained in Section 1.2.

In the following sections, the experience in space and LCVRs related projects of the different institutes forming the consortium is presented.

2.1.1 INTA

The National Institute for Aerospace Technology (INTA) is a public research institution specialised in R+D aerospace technology. It was founded in 1942, within the Air Force, and in 1977 came under the aegis of the Secretary of State for Defence of the Ministry of Defence. With this step, the scope of its activities was expanded, to serve not only all of the Armed Forces, but also the rest of the public administration and Spanish society as a whole.

The approximately 200 activities that INTA carries out simultaneously, and their high technological level, make the National Institute of Aerospace Technology the Defence Ministry's main research and development centre; indeed, the scope of its work often goes beyond the realm of Defence. INTA's staff is comprised of over 1200 individuals, of whom approximately a thousand are dedicated to R+D activities. In addition, the Institute carries out an intense training program for both scientists and technicians, not only its own staff but also for scholarship holders who surpass the hundred mark, and are mainly comprised by university graduates, approximately half having PhD degrees.

A short overview of the most relevant projects carried out in the last years are: MINISAT01 LEO scientific satellite developed at INTA, OMC instrument on board INTEGRAL which was lead and developed by INTA, IRMA active Antenna (to be on board SPAINSAT Telecom Geo satellite) and its Control and Simulator Software, TRIBOLAB ISS payload, IRIS satellite panchromatic camera demonstrator, OSIRIS (a dual Filter Wheel mechanism developed both for WAC and NAC cameras on board ROSETTA) MIRI Telescope Simulator to support the AIV activities of MIRI (one of the JWST instruments) and specially *SUNRISE*/IMaX (Imaging Magnetograph eXperiment, a solar magnetograph) a project deeply related with *Solar Orbiter* in which the optical design, integration and tests is being carried out in INTA.

The Space Instrumentation Laboratory (LINES-Laboratorio de Instrumentación Espacial) in INTA, which will coordinate this activity, is specialised, in space optics. LINES-INTA carries out since 1994 activities of research in optics and optical engineering for aerospace applications. During the last years LINES-INTA is performing a prominent research activity to study the effects of the space environmental on optical materials as glasses (NBK7, SF11…), coatings (SiO_2, TiO_2...) and electro-optics devices (LCVRs and $LiNbO_3$ etalons). Additionally, new nanostructured materials are being investigated as sol-gel photochromic materials and luminescent layers deposited by remote plasma polymerization in collaboration with other research institutes.

Variable Angle Spectroscopic Ellipsometry is the main technique utilized to analyze these materials as well as *in situ* null ellipsometry, spectrometry, Abbe refractometry and interferometry.

An optical bench to carry out polarimetric measurements of PMP in vacuum conditions simulating the optical beam characteristic of real instrument as telecentrity, #f, collimation, etc. has been developed and has been utilized to calibrate the IMaX flight PMP. The optical, optomechanical and thermal design of IMaX as well as the LCVRs characterization has been carried out by LINES-INTA. Currently the assembly, integration and verification phase of IMaX is being performed in INTA.

INTA is the coordinator of the Spanish contribution for the VIM instrument in the proposal presented in response to the Solar Orbiter payload Announcement of Oportunity in October 2007.

2.1.2 INAF

The Solar Group of the Osservatorio Astronomico di Torino (OATo) of the Istituto Nazionale di Astrofisica (INAF), Italy, has been involved since 1990 with the development, integration, mission operation and data analysis of the NASA/Agenzia Spaziale Italiana instrument Ultraviolet Coronagraph and Spectrometer (UCVS) on board of the ESA mission Solar and Heliospheric Observatory (SOHO). The group has participated, in particular, to the development of the Italian visibl-light polarimeter per the measurement of the K-corona polarized brightness.

In 2000, the Solar Group has proposed, in collaboration with the US Naval Research Laboratory)NRL), a multi-wavelength, coronagraph based on a novel design for the observation of the off-limb corona in the EUV (30 nm), UV (122 nm) and visible-light (550 nm) wavelength bands with an all-reflecting, externally-occulted telescope. The visible-light channel includes a LCVR-based polarimeter for the measurement of the polarized brighness of the K-corona. This Sounding-rocket Coronagraphic Experiment (SCORE) has been selected by NASA in March 2003 for the NRL-led HERSCHEL ("HElium Resonant Scattering in the Corona and HELiosphere") sounding-rocket mission. The SCORE coronagraph has been integrated at the OATo Laboratory in view of its launch in 2008.

SCORE is intended as a prototype for the coronagraph, COR, included in the Solar Orbiter's payload. The LCVR-based polarimeter in SCORE will provide a great deal of heritage to the present concept of COR that calls for a electro-optical polarimeter with LCVRs.

The Solar Group successfully tested also a ground-based version of the K-corona polarimeter with LCVRs during a campaign in Lybia for the observation of the March 26th, 2006 eclipse.

2.1.3 CSL

CSL is a Research Centre of the University of Liège and one of the four ESA co-ordinated facilities specialised in space optics, thermal-vacuum tests, and evaluation of instruments and payloads related to optics or optoelectronics. CSL laboratories and offices employ about 94 persons, 60% of whom are engineers or physicists. In spite of the academic nature of CSL, more than 70% of the activities are, since 1975, based on Agency or industrial contracts. Besides the development of some 20 sounding rocket experiments for auroral observations, CSL scientists have participated to series of scientific experiments, linked to astrophysics.

- Design, development and calibration of the Ultraviolet sky-scanning telescope S2/S68 (launched in 1972 on the ESRO/TD1 satellite).
- Development and testing of the Halley Multicolor Camera (launched in 1985 on GIOTTO).
- The Extreme Ultraviolet Imaging Telescope EIT (launched on SOHO in 1995).
- The Optical Monitor of XMM (launched on XMM in 1999).
- The Far Ultraviolet Spectrographic Imager (launched on IMAGE in 2000).
- The Optical Monitor of INTEGRAL (launched on INTEGRAL in 2002)
- The HF1 and HF2 of STEREO mission.
- The COROT telescope.

Presently, CSL is developing in collaboration with various institutes several space instruments :

- The LYRA/SWAP on PROBA II mission.
- Various subsystems of the PACS instrument for the HERSCHEL mission.
- The MIRI on the JWST.
- A subsystem of the UVS instrument on JUNO.

As a coordinated facility of ESA, CSL is equipped with several vacuum chambers equipped with optical benches and cryogenic-thermal systems for vacuum-thermal balance test of space payloads. These facilities are located in class 10000 clean room with possible class 100 sub-areas.

Several satellite payloads were and are currently tested at CSL : Meteosat Radiometer, Faint Object Camera of the Hubble Space Telescope, Hipparcos payload, ISO mirrors and telescope, SILEX optical heads and terminals, XMM mirror module, and later on GOMOS, XMM Optical Monitor, FIRST mirror, HRG, Seviri, Planck S/C, Herschel telescope ….

The activities of CSL have furthermore acquired an international level as a result of its collaborations with European Space Agency as well as with several high level European companies (Dornier, Matra Marconi Space (ASTRIUM EADS), Aérospatiale [Thales Alenia Space], British Aerospace …) and laboratories (IAS, LAS, ONERA, IOTA, MSSL, NRL, LPARL, Los Alamos, TUM, various Max Planck Institutes, U.C. Berkeley…).

CSL has also expertise in development of optical techniques for industry and space. Additionnally to optical, mechanical and electronic aspects, environmental (among which radiation) effects have been considered in a variety of projects.

2.1.4 IAC

The Instituto de Astrofísica de Canarias in La Laguna (Tenerife) has ample experience on the construction of solar polarimeters and in space projects.

IAC has participated in the past in a number of ESA led missions such as ISO (instrument ISOPHOT-S), SOHO (instrument GOLF, LOI) and Herschel/Planck (instrument PACS, SPIRE).

The IAC solar physics group is composed by more than 20 scientists (staff, post-docs, students) with a long tradition in the fields of solar magnetism and helio-seismology. The group has built in the past two grating-based polarimeters for the telescopes located in the Canary Islands observatories: the Tenerife Infrared Polarimeter (TIP) and the La Palma Stokes Polarimeter (LPSP). TIP and LPSP use liquid-crystal-based modulators for the polarization analysis of solar light. As such, the instruments implement fundamental concepts of relevance for VIM like simultaneous polarization modulation states (to measure all four Stokes parameters), image accumulation (to reach the desired S/N), polarization calibration (to minimize instrumental effects), and polarization and image acquisition synchronization (needed in fast polarimeters to minimize artefacts due to solar evolution or pointing errors). More recently, the IAC has led the construction of the Imaging Magnetograph eXperiment (IMaX) for the *SUNRISE* polar balloon project (MPS led). IMaX is being built by a consortium of institutes in Spain, three of which are included in the present proposal. During 2008 the instrument IMaX undergoes its AIV phase including a thorough end-to-end calibration. Conceptually speaking, the IMaX+*SUNRISE* combination is very similar to VIM. On the IMaX side, the use of LCVRs for polarization modulation, $LiNbO_3$ etalons for the spectral analysis and a fast cadence detector with fast readout and on-board accumulation provides a great deal of heritage that has already been applied to the present concept of VIM.

2.1.5 IAA

The Instituto de Astrofísica de Andalucía (IAA) was created as a Consejo Superior de Investigaciones Científicas (CSIC) own center in July, 1975. It belongs to the “Physics Science and Technology” area of the CSIC.

Since its foundation, the IAA is scientifically aimed at contributing to increase our knowledge of the Universe, from the nearest in our Solar System up to a global scale of the Universe as a whole, by improving its description and the physical processes taking place therein. This goal needs to be undertaken from a multi-discipline viewpoint, because of the own nature of the studied object. Hence, theory, observation, and technology in several areas of physics and engineering are needed. Although the IAA is a fundamental science producer, the institute is well aware of the role that astrophysics implies as a new-technology user and producer.

To reach this main aim, a number of scientific programs with various specific goals and terms, encompassing four wide areas of astrophysics are carried out: the Solar System; the Formation, Structure, and Evolution of Stars; the Structure and Evolution of Galaxies; and Cosmology. Fundamental science has been and will continue to be the main driver for training our scientific and technical personnel, while stimulating the development of other disciplines. The IAA history speaks by itself about the observational vocation of the institution.

The IAA manages and operates the Observatorio de Sierra Nevada (OSN). The telescopic facilities at OSN obey to a scientific policy aimed at having continuous, guaranteed access to own observational means that permit plans for long-term projects. This fact adds a special feature to the institution and is both a challenge and a strong stimulus at the same time. Instrument design and construction for the OSN, as well as other space-borne instruments, help as a support for the fundamental science developed within the various research groups and are paramount activities to properly combine research, development, and technological innovation. The 2004 commitments about the co-managing (at 50 % level) of the Centro Hispano Alemán de Calar Alto (CAHA) with the Max-Planck-Institut für Astronomie (MPIA, Heidelberg, Germany) are especially relevant as far as state-of-the-art technology development is concerned.

The IAA is located in Granada, Camino Bajo de Huétor 50, and postal code E-18008.

As of December, 2006, the IAA has 182 staff members of which 110 are scientists (42 permanent positions, 27 pos-doc positions, and 41 PhD students), 56 engineers and technicians, and 16 administrative personnel.

The IAA carries out basic scientific research which is summarized in the following figure. The four research departments (in blue) are structured into research groups (in light yellow); their most important lines of research are specified in the green boxes. In red are the connections and synergies between groups.

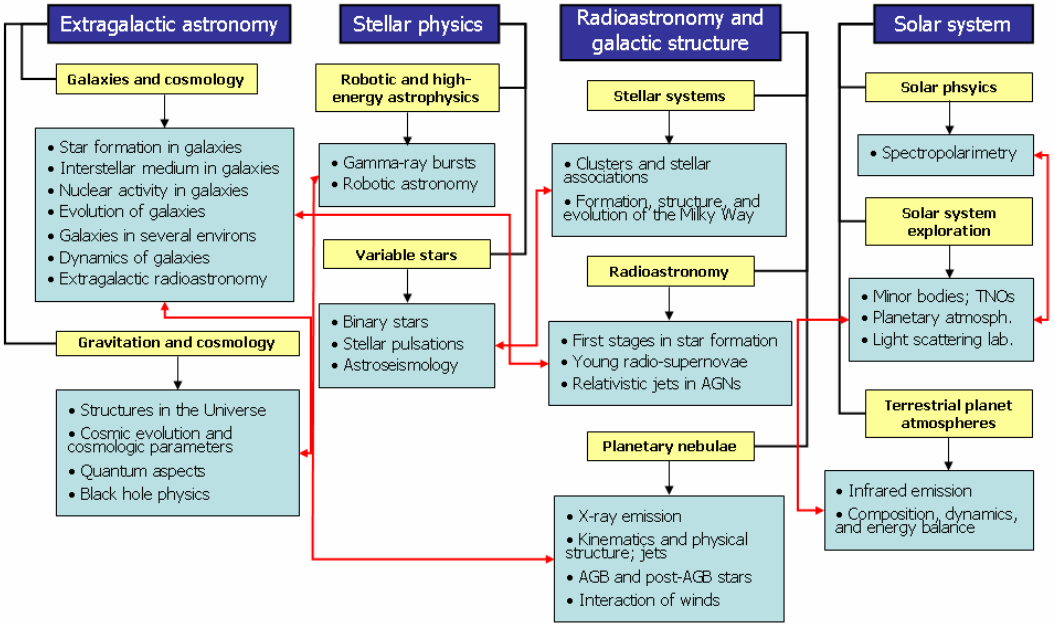


Figure 11. IAA Research Structure

Besides this, the IAA carries out a number of instrumentation development activities both for ground-based and space-borne observatories and missions:

Ground-based instruments: OSN, 1.5 m and 0.9 m OSN telescopes control electronics, Strömgren photometer for the 0.9 m telescope, Spectrograph for the 1.5 m telescope, Robotization of the 0.6 m IR telescope, *Headquarters,* Scattering of light by small particles laboratory, *CAHA,* PANIC (Panoramic IR Camera) for the 2.2 m telescope, GAW (Gamma Air Watch experiment): a three-telescopes Cherenkov radiation observatory, *Roque de los Muchachos Observatory Canary Islands),* SIDE (Super-Ifu Deployable Experiment): a fiber-fed, integral field, multi-spectrograph for the Gran Telescopio Canarias

Space-borne and balloon-borne instruments: FOCCA I & II, FEIROX & FEIROH (atmospheric probes in Spanish rockets), ISOPHOT-S for *ISO* (ESA), PFS, *Mars Express* (ESA), HASI-PWA, *Cassini-Huygens* (ESA), PFS, VIRTIS, Venus Express (ESA), Osiris, *Rossetta* (ESA), Giada, *Rossetta* (ESA), *COROT* (CNES, PNE, ESA, and others), IMaX, *SUNRISE* (DLR, NASA, PNE), BELA, *Bepi-Colombo* (ESA).

2.1.6 VISUAL DISPLAY S.L.L.

Visual Display is a company dedicated to the Design, assembly and distribution of electronic modules for display applications, indicators, interface, control and measurement oriented to customized and innovative solutions. We work very closely with manufacturers and distributors, offering technical advice and customized solutions and also customer service. We design our products according to the customer technical requirements and adapting the product very closely to the customer requirements.

We have a long experience in the display and display modules technologies and we are also interested in the research in this field with new materials as well as in new applications for the already existing products like TFT Panels and Touch Screen Panels to different sectors. We have more than 14 years experience in the design, manufacturing and distribution of electronic modules for Display applications and also in National and European R&D projects.

Presently we collaborate with different University Departments as well as Research Centers:

- Dpto Química Inorgánica - Fac. Ciencias Univ. Valladolid
- Dpto Electricidad y Electrónica - ETSI Telecomunicación Univ. Valladolid
- Dpto Tecnología Fotónica - ETSI Telecomunicación Univ. Politécnica de Madrid
- INTA - Instituto Nacional de Técnica Aeroespacial
- IAC - Instituto Astrofísico de Canarias

Also Visual Display is now leading a National R&D project called: “Liquid Polarizer syntesis and its use for LCD manufacturing” with the Dpt. of Inorganic Chemistry (Fac. Ciencias Univ. Valladolid), the Dpt. of Electricity and Electronics (ETSI Telecomunicación Univ. Valladolid) and the Dpt. of Photonic Technology (ETSI Telecomunicación Univ. Politécnica de Madrid). This Project is founded by the Local and Nacional governments.

Our target is to become a reference supplier in our sector at a global level, changing and adapting ourselves to the market requirements and being actively in all the potential sectors where our technology can be used.

Visual Display is owned by Mr. Manuel López and Mr. Javier Rodríguez, which are ex-employees of Tecdis Displays Ibérica. Tecdis was a company manufacturing Liquid Cristal Displays and Liquid Cristal Display Modules, and Tecdis Displays Ibérica was the spanish branch of Tecdis group. This company stopped its activity at the beginning of 2004 and was definitely closed in summer 2004. Working at Tecdis Displays Ibérica Mr. Manuel López was Engineer Dpt. Manager and Mr. Javier Rodríguez was Design Dpt. Manager. Both ex-employees of Tecdis Displays Ibérica continue in the Liquid Cristal Displays activity, and started with a new company called Visual Display in Boecillo, Valladolid (Spain) with its own capital and not related at all with Tecdis wich dissapeared.

2.1.7 Arcoptix

ARCoptix S.A (Limited company) is a small high tech company established in Neuchâtel (Switzerland). It is a spin-off company of the IMT (Institute of Microtechnology) of the University of Neuchâtel and the Engineering School of Biel (HTI Biel). It has been founded begin 2006 by four experts in the field of optics, liquid crystals and micro-fabrication. The founders are the unique owners of the company.

ARCoptix offer products such as Fourier Transform spectrometers, liquid crystal optical systems for R&D labs, and an inteferometric based velocimeter. We offer also services such as optical system design, micro-optical component fabrication, custom liquid crystal cells fabrication, characterization of birefringent materials and spectral analysis.

The expertise of ARCoptix staff have permitted to develop and commercialize and a set of worldwide unique high tech products such as the liquid crystal radial polarization converter (converts linearly polarized light in radial polarization distribution), the ARCSpectro-NIR and the ARCSpectro-HT (smallest and most sensitive miniature Fourier transform spectrometer in the world) and the unique self-mixing interferometer. ARCoptix fabricates also set of more standard liquid crystal

products optimized for science such as the liquid crystal variable phase retarder and the switchable polarization rotator.

Thanks to close collaboration with the University of Neuchâtel, the engineering school in Biel and the nearby watch industry, ARCoptix disposes also of an important infrastructure for manufacturing and R&D development.

2.2 ORGANISATION AND MANAGEMENT

2.2.1 Organisation structure

INTA is proposed as prime contractor of this project. Six institutes and companies from Europe are proposed as subcontracts. The involved institutes have a long and rich heritage in space-borne, balloon-borne and ground-based solar and optical instrumentation, with leading roles in numerous space missions as well as LCVRs for polarimetric applications. The following organization chart shows an overview of the organizational structure

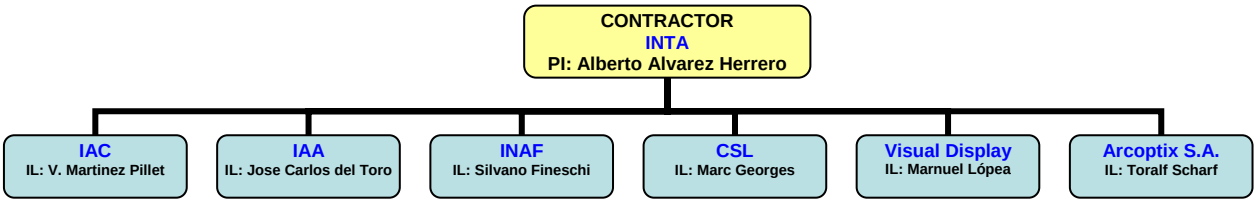


Figure 12. Organization structure.

This consortium is coordinated and managed by the Principal Investigator (PI) Dr. Alberto Alvarez Herrero (INTA).

The institution leader (IL) will manage all the activities assigned to his institute/company and he will be the contact person with the PI in order to coordinate all the project activities. The current distribution of work packages (see Section 2.5) is based on the availability of relevant technological expertise at the respective institutes/companies. Responsibilities of key scientific and technical personnel are laid down in detail in Section 2.4. Each investigator team can count on technical support provided by the institutes of the consortium.

2.2.2 Management plan

2.2.2.1 Communications within the programme

2.2.2.2 Communications with ESA

Formal communications (exchange of information which affects technical standards, deliveries, time schedule, costs, or any other relevant aspect of the project) will take place between the Principal Investigator and the ESA Project Manager, and are binding on both parties. No other party will have formal authority, without written delegation.

As single point interface the PI will coordinate electronic transfer of data (documentation, progress reports including schedule information, changes, technical data, etc.) to the ESA Project Office. The PI as project head and head of the Investigator Team will be in the loop of all interchanged information. All communications will be held using the English language.

Contact information of the activity:

Dr. Alberto Alvarez Herrero Insituto Nacional de tecnica Aeroespacial –INTA Carretera de Ajalvir km4, Torrejón de Ardoz 28850 Madrid (SPAIN)	Tel.+34 91 520 1062 Fax. +34 91 520 6384 alvareza@inta.es

2.2.2.3 Communications within the consortium

The PI is responsible for the overall direction of the project and will agree major policy/strategic decisions concerning the activity development, the system level allocation of tasks, etc.

The PI will have access to the project teams at the participating institutes through the institution leaders. The institution leaders are the formal point of contact for each institute project team. The PI will route all formal communication and provision of documents through the institution leaders, and they will ensure that it is distributed within the teams appropriately.

At working level, direct communication between institution teams is allowed, but the corresponding institution leaders have to be informed of such communications.

2.2.3 Reporting, meetings and reviews

The technical and programmatic aspects will be assessed between the ESA Project Office and the Principal Investigator through:

- Monthly progress reporting,
- Progress meetings,
- Formal reviews

The overall scientific performance will be monitored by the ESA Project Office during the review cycle and through the regular progress reporting supplied by the PI.

2.2.3.1.1 Progress Reports

Progress Reports for the monthly reporting period will be prepared and transmitted to ESA by the Principal Investigator (5 days after the end of the month, TBC). These progress reports may be also produced upon Agency request.

Every institute/company participating in the proposal will contribute through its institution leader to the progress report.

Progress reports will provide a summary of the progress of the project over the period between two consecutive progress meetings or reviews. They will be written in a clear and concise style, presenting a realistic assessment of the actual project status, identifying any problem potentially affecting agreed performances, schedule or cost baselines and providing an evaluation of its criticality, as well as proposing corrective actions aimed at keeping to the planned targets.

The progress report will contain at least the following information:

- Overview: Descriptions of the overall progress made in the period. It shall highlight all important problem areas, their criticality and their anticipated impact. In particular, it shall highlight adverse trends in technical, schedule and cost performance, shall identify potential problems, and shall propose corrective actions.
- Schedule reporting against milestones: overall project charts showing the duration and progress of main phase interface events and milestones. This schedule report shall be constructed starting from the lower-level work package estimations. This report will include a narrative part explaining the overall status of the project execution, the update milestone list, the update barcharts, an analysis of any critical items which may jeopardise the schedule, an indication of any further changes in duration, added or deleted activities or logic changes which may have occurred and the reason for such changes.
- Cost: any changes to the cost of the project shall be provided.
- Action items list: a listing of action items from all previous meetings shall be included showing the status.
- Meetings plan
- Documentation status list: an updated list of the documentation generated
- Deliverable items status list: an updated list of the delivery status for all the deliverable items

Progress reports will be submitted in PDF format. Project status information will be merged into the progress report in graphical or tabular form as appropriate.

2.2.3.2 Meetings

2.2.3.2.1 Progress meetings

The following progress meetings will be conducted between the ESA Project Office and the investigator team with the objective of ensuring the proper development of the activity (also see 2.7):

- Kick-off meeting (KOM): T0
- Progress meeting 1 (PM1): T0+4
- Phase 1 Review: T0+6
- TRR:T0+9
- Progress meeting 2 (PM2): T0+14
- Final presentation: T0+16
- Additional progress and technical meetings as required (TBD)

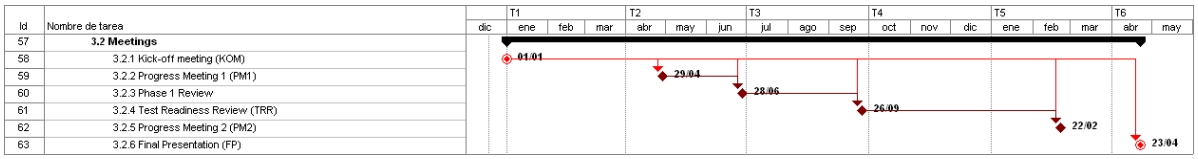


Figure 13. Meetings plan.

PM1, TRR, PM2 and additional progress meetings will be held at INTA (TBC). KOM, Phase 1 Review and Final Presentation will be held in ESTEC. The frequency may be changed on request by the ESA Project Office. Detailed technical problems occurring on either side of the interface will be flagged during these meetings and corrective actions, including their schedule impact, agreed and implemented. The INTA will maintain and publish minutes of meetings to all participants in the activity.

The investigator team will support any additional ad hoc meetings (technical or other, on specific subjects) when requested by the ESA Project Office to address critical subjects at any time. These meetings will have an agreed agenda and will be held at ESA or INTA premises. Meetings may also be held using tele- or video-conference facilities, where possible and appropriate.

2.2.3.2.2 Consortium Meetings

The consortium will hold progress meetings on a regular basis. They will be organised by the PI and the institution leaders. They will support the progress and review meetings with ESA and therefore will be hold generally prior to those.

During a progress meeting the general technical and scientific progress of the development will be reviewed. However, it will mainly concentrate on pending and/or eventual critical areas. The planning and scheduling will always be part of the agenda for these meetings.

2.2.3.2.3 Minutes of Meetings

INTA will be responsible for writing the minutes of scheduled meetings and teleconferences, unless otherwise agreed. INTA will also be responsible for the distribution of the agreed number of copies of the minutes of all meetings, not later than 5 days after the meeting or teleconference. Minutes of meetings or telecoms on short notice are written by the requesting party. Minutes will be distributed to all institutes/companies of the consortium.

2.2.3.3 Reviews

The PI with assistance of the institution leaders will provide the resources to prepare review data packages and support fully the review processes.

The Reviews will be conducted by the ESA Project Office. The objectives of the reviews will be to ensure that the activity will achieve the anticipated objectives and that it complies with the technical requirements. Programmatic aspects like scheduled delivery dates and their compatibility with system level requirements will also be screened. The Documentation to be provided will consist of Review Data Packages in accordance with a dedicated Review Procedure to be issued for every occasion.

The output of the review may provide recommendations for consideration by the ESA Project Manager or the PI in technical or programmatic areas. Where requested, either party will provide a formal response to such recommendations according to the above mentioned review procedure.

The following reviews will be carried out:

- Phase 1 Review: T0+4
- Test Readiness Review (TRR): T0+8
- Final Presentation: T0+14

2.2.4 Monitoring and controlling mechanism

The Master Schedule (Section 2.7) defines the baseline for the project plans and schedule. The actual progress of the project will be monitored with respect to the schedule defined in the Project Management Plan.

The consortium PI will be responsible for monitoring and controlling the status of the project with the continuous support of the others institution leaders.

- **Schedule Control:**

The project schedule will be controlled throughout the course of the project, by updating the plans with the actual progress and by estimation of effort-to-finish for each task. This will help to detect critical paths, or tasks that have slipped and might not be possible to finish on time, allowing the PI to take remedial steps, such as re-planning the tasks or redistributing/increasing the level of resources assigned to tasks. For each milestone, the PI will maintain a record of the baseline achievement date, the forecast achievement date and the actual date achieved.

- **Action Items and Open Points:**

The consortium PI will track the progress and status of the action items raised at the progress and review meetings. Spreadsheets will be used for keeping a record of the action items, and for producing action item status reports for inclusion in the monthly progress reports.

- **Cost Control:**

Each institution leader will collect data on project expenditures, using the monthly timesheets and expense claims submitted by the staff. The actual expenditures will be compared with the planned expenditures in order to assure that the project is in a healthy financial state. Data will be passed to the PI, who will monitor the overall financial state of the project.

2.3 FACILITIES

The most important facilities that can be used to LCVRs study and characterization are presented.

2.3.1 INTA:

INTA possesses the following equipment items, among others:

- Class 10,000 cleanroom with class 100 areas and stable relative humidity and temperature
- High vacuum chamber with temperature control for optical tests.
- Optical benches for analysing and aligning optical instrumentation: interferometry, MTF, autocollimation and polarimetry
- Opto-mechanical workshop: cutting, optical polishing and machining of parts.
- Confocal microscopy.
- Variable Angle Spectroscopic Ellipsometry with and attached cryostat. Spectral range: 200nm-2200nm. T= 5K-400K.
- *In situ* null ellipsometry.
- Imaging polarimeter for *in situ* measurements.

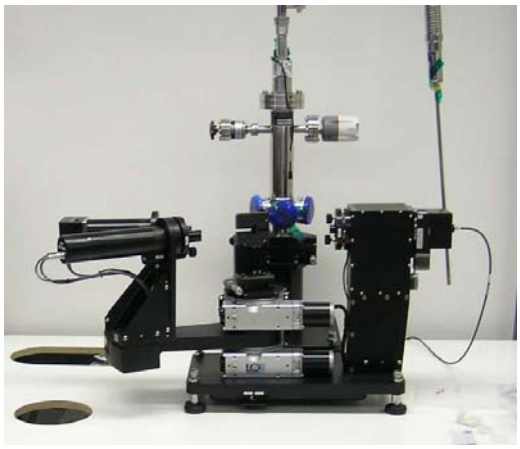


Figure 14. Variable Angle Spectroscopic Ellipsometry.

INTA can perform all the environmental tests (except acoustic noise) required for the qualification of a space unit, and most of the environmental tests needed to qualify a unit in the defence field (normally tests compliant with the MIL-STD-810). Specifically, the following tests can be performed, among others:

- Climatic environmental tests.
- Thermal cycling tests in high vacuum.
- Temperature / humidity tests.
- Mechanical environmental tests.
- Vibration tests.

Figure 15. Thermal Vacuum Chamber for optical measurements.

The following facilities will be available at INTA:

- Thermal Vacuum Chamber for Optical measurements at +100 to -60°C which is being updated to achieve 100 K
- Cryogenic Thermal Vacuum Chamber (20K) class room 1000
- New facilities: Thermal Vacuum Chamber 4x4m
- Thermal Vacuum Chamber 1.3m free diameter
- Mechanical Environment, Electro Dynamic Shakers 16kN to 32 KN. Shock tables, centrifuges machines, Inertial and CoG balance
- Thermal Shock Chamber 1x0.8x0.8 m volume, [-170ºC / + 160 ºC, 20ºC/min]
- Climatic Chamber 1x1x1.5m volume , [-70ºC / + 130 ºC, 1atm to 5mbar]
- Anechoic chamber 24 x 14 x 10 m measurements from 10 m to 1 m. Class room 100000.
- EMC test: Radiated from 20 Hz to 60Ghz, Conducted from 5 Hz to 100 MHz, Susceptibility from 10 Hz to 40 GHz, ESD test until 300 kV

Figure 16. Electro dynamic shakers.

2.3.2 INAF

The Astronomical Observatory of Torino (INAF-OATo) has the following facilities for optical and polarimetric activities of testing and integration, with particular emphasis to Liquid Crystal Variable Retarder characterization:

- Optics laboratory comprising of the following equipment:
  - Two environmentally-controlled rooms.
  - Clean room (10 m^2) class 10.000 (ISO 7).
  - Laminar flux bench.
  - Optical benches for analysing and aligning optical instrumentation (interferometry, MTF, autocollimation and polarimetry): 3.00m x 1.25m x 310mm Ultra Performance, with passive vibration dumping system optical bench; 1.6mx1.2mx100mm and 0.8mx1.8mx100mm optical benches.
  - Mueller spectro-polarimeter assembly for polarimetric measurements and characterization.
  - PixelVision CCD camera, 16-bit, back-illuminated.
  - Czerny-Turner monochromator and spectrograph for visible light (> 200nm).
  - Tungsten and Hg halogen 100 W and 150W sources.
  - Hg (Ne) spectral calibration sources.
- Electronics laboratory.
- Machine shop.

In OATo Laboratories the polarimetric performances of the K-corona polarimeter for the HERSCHEL-SCORE experiment have been studied. The Mueller matrix spectro-polarimeter facility allows to fully characterize the polarimetric properties of a sample at different wavelengths.

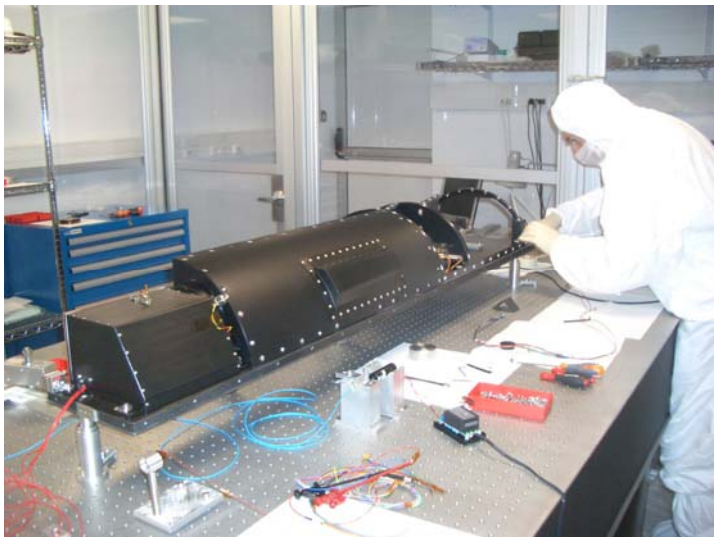


Figure 17. Clean room activity during the HERSCHEL-SCORE integration in OATo laboratories.

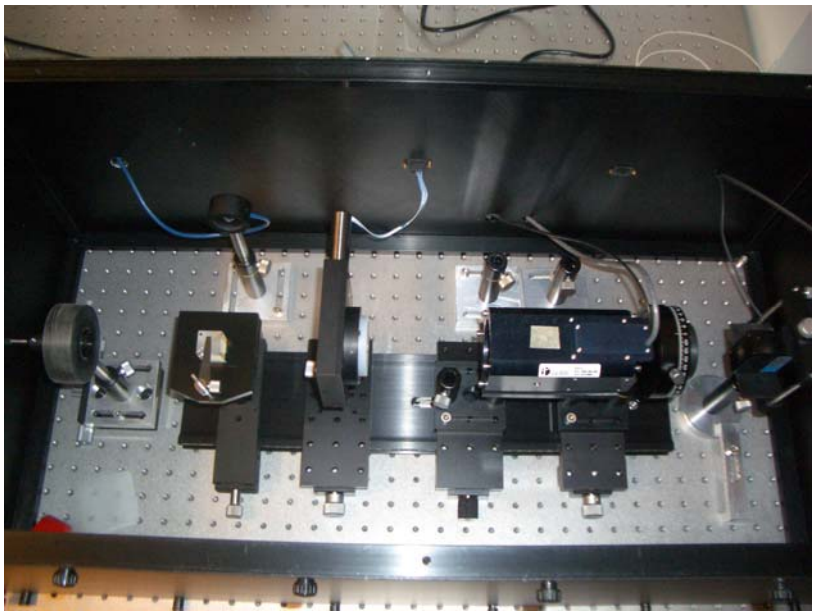


Figure 18. Mueller matrix polarimeter assembly testing the KPol SCORE polarimeter.

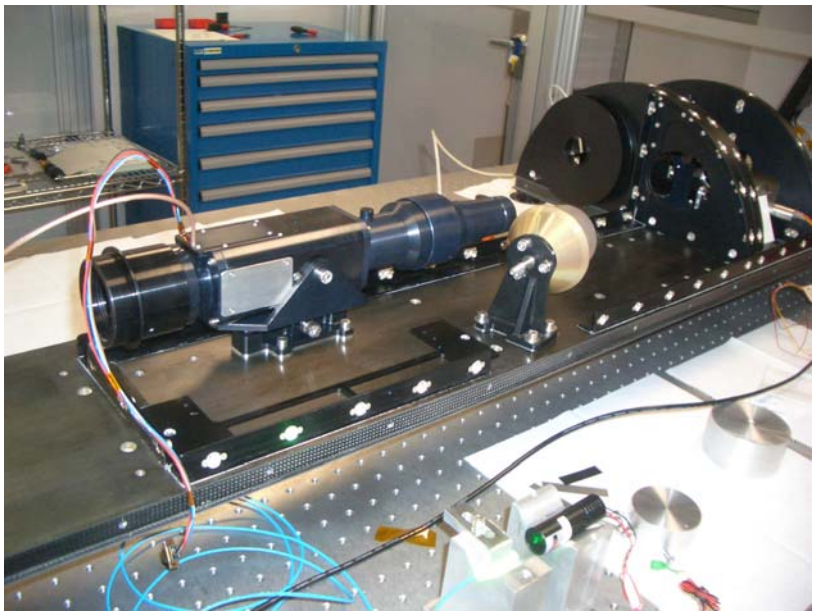


Figure 19. KPol polarimeter assembled on the SCORE bench.

2.3.3 CSL

CSL facilities include 2 large cleanrooms (class 10,000 and, locally, class 100) that contain 5 space simulation chambers respectively of 220m³, 120m³, 21m³, 17m³, and 1.7m³ specially equipped for testing space optical instruments.

Various conditions specific to the space environment (vacuum, temperature variation, light beam...) can be reproduced in those chambers. Additionally CSL operates two shakers allowing tests in three axes (89 kN and 200 kN sine force), one of them being equipped for vibrations under cryogenic conditions. The following figure shows the space simulation chambers of the CSL.

Focal 0.25

Focal 1.5

Focal 2

Focal 3

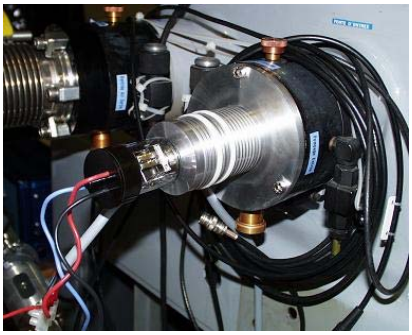
Focal5

Focal 6.5

The CSL special facilities identified in the attached PSS A2 will be used for the execution of the work. Technical descriptions can be made available on request. An overview may be found on CSL's web site (http://www.csl.ulg.ac.be)

Additionnally to vacumm-thermal facilities, CSL runs 9 optical labs with different specialties. They all are equipped with optical tables and a large selection of optical, optomechanical and electronic equipment will be available for the project.

Owing to its participation to various previous projects, CSL is well equipped with varieties of UV lamp, detectors, filters either for air and vacuum operation.



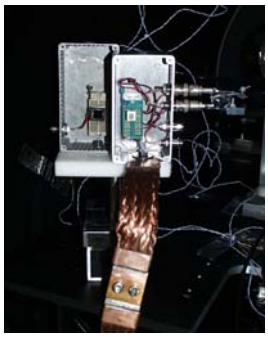


Figure 20. Deuterium lamp and flange attached to vacuum chamber, vacuum compatible UV detectors

For the optical characterization, CSL plans to use clean the SENTCH ellipsometer SE800 able to measure phase retardance from visible to infrared wavelengths and transverse profile. The following picture shows the apparatus located in the clean room optics lab. This ellipsometer can be set in transmission mode for the measurement of transparent samples.

Figure 21. Ellipsometer

2.3.4 IAC

The Instituto de Astrofisica de Canarias is a 350-people institution with about 150 scientists, 100 engineers and maintenance personnel and 50 people dedicated to administrative support. The IAC manages two international astronomical observatories in the islands of Tenerife and La Palma. At its headquarters in La Laguna, the IAC technology Department is structured as follows:

- Project Managenment Department:

Responsible for planning and managing technical projects. In close contact with the Principal Investigator, who has overall responsibility, the project managers coordinate the use of the resources assigned to the project by the various departments or operational services.

- Software Department:

Designs and develops software applications, particularly for data acquisition, mechanism and system control, and data processing and analysis.

- Electronics Department:

Designs and develops electronic systems. Mainly e-boards and digital and analog systems for device control and real-time data acquisition and processing. The Department also develops systems for servo control and for reading, processing, controlling and characterising astronomical sensors. It includes the following facilities:

  - Electronic Design Laboratory: A general purpose facility for developing, integrating and testing electronic parts or instruments.
  - Electromagnetic Compatibility Laboratory: An annex of the electronic design laboratory, this consists of a shielded chamber housing an electromagnetic interference analyser/receiver.

- Optical Department:

Develops optical systems, particularly for telescopes and astronomical equipment for use in the visible spectrum and the infrared.

Experienced in specifying, designing, integrating and testing optical systems including fibre optics applications in astronomy. It includes the following facilities:

  - Optical Laboratory: General purpose facility with cleanliness, humidity and temperature controls, used for assembling and testing visible and infrared optical systems.
  - Optical Coating Laboratory Facility for producing fine film deposits on surfaces (mirrors, filters etc). Has cleanliness, temperature and humidity control systems.

- Mechanics Department:

Designs and develops mechanical systems for astrophysical instruments like telescopes, post-focus and space instruments. Specialises in machine part design, fabrication and quality control systems, structural calculation and design methods, cryogenics, vacuum technology, optomechanics and mechatronics. It includes the following facilities:

- Mechanical Integration and Verification Laboratory General purpose facility for integrating and checking mechanical instruments.
- CAD laboratory: Houses the most powerful hardware and software applications for mechanical design, structural dynamic and thermal analysis and calculation with finite elements.

- Technical Drawing Laboratory:

Responsible for ensuring that technical drawings comply with standard regulations before the production of parts begins.

Produces three-dimensional views, solid models and mechanism and instrument designs.

- Electronics Workshop:

Specialises in the manufacture and assembly of surface-mount technology (SMD) and conventional prototypes. Produces designs for power supplies, PAL and IFL programming, microcontrollers etc. It includes the following facilities:

- Electrical Calibration Laboratory: An ENAC (Entidad Nacional de Acreditación) accredited laboratory which issues Official Calibration Certificates of electrical magnitudes of direct and low frequency current.

- Mechanics Workshop:

Produces parts in steel, stainless steel, aluminium alloy, bronze, teflon and other metals. Also produces material and surface treatments. It includes the following facilities:

- Fibre Optics Laboratory: A facility for the preparation, characterisation and integration of fibre optics for use in astronomical instruments.
- Dimensional Meteorology Laboratory: An annex of the Mechanics Workshop, which measures, calibrates and tests the dimensions, shape and surface quality of parts and components.

- Instrument Maintenance Telescope and astronomical instrument maintenance:

Also designs instrument improvements and has access to a wide range of instruments, enabling it to carry out electronic and mechanical repairs.

- Large Instrument Assembly, Integration and Verification Room:

Facility for mounting and testing large instruments. With a floor area of 540 square metres and 10 metres high, the laboratory is a 100000 class cleanroom and will house two GTC rotator simulators. The AIV room is an annex of the Mechanics Workshop.

2.3.5 IAA-CSIC:

IAA disposes the following equipment items, among others:

- Class 100,000 clean room with stable relative humidity and temperature.

Figure 22. Class 100,000 clean room (left) and optical laboratory (right).

- Osciloscope Tektronix DPO 4054 500MHz, 2.5GS/s. Current probe Tektronix TCP0030 5A-30A
- Oscilloscope /Logic signal analyzer Agilent Infiniium 54832D MSO 1GHz 4GS/s (4 scopes and 16 logic channels inputs)
- High precision Multimeter Hewett Packard 3478A.
- Several DC laboratory power supplies. Whole voltage-current ranges for electronic development.
- Several soldering/desoldering stations Weller with several performances (temperature selectable for lead or unlead soldering process, antistatic pencils, vacuum-pencil).
- A baste number of electronic samples for prototyping.
- Optical laboratory: Optical benches for analyzing and aligning optical instrumentation: MTF, autocollimation and polarimetry
- Electronic benches for development purposes:
- Mechatronic laboratory for tooling (metallic supports, radiators…)

Figure 23. Electronic bench (left) and mechatronic laboratory (right).

2.3.6 Visual Display S.L.L.

Visual Display is a company with R&D research activity in the field of Liquid Crystals. We have strong long term cooperation with the UPM Polytechnic University of Madrid where we develop our research activity in Liquid Crystal Display technologies and materials.

There we have available all the equipments related with the LCD (Liquid Crystal Displays) manufacturing as follow:

- ITO patterning (Mask pattern aligment and UV lamp exposure)
- ITO etching
- Poliimide spin coating for deposition of poliimide (organic) alignment layer
- Thermal evaporation for deposition of silicon monoxide (inorganic) alignment layer
- e-beam system for deposition of silicon monoxide (inorganic) alignment layer
- Rubbing
- Seal printing for seal adhesive deposition onto the substrate
- Spacers sprinkling
- Assembly and Hot Press for substrates assembly and seal adhesive curing
- LC filling
- End seal deposition and UV end seal curing
- Clean room environments (Class 100)
- Utilities: Nitrogen, Vacuum, DI water, compressed air

Also there are equipments for display static and dynamic characterisation:

- Hartman-Shack wavefront analyzer for measuring the spectral and angular response of the devices
- Polarization state and Pretilt angle measurement equipment of VAN (vertically aligned nematic) LC devices

Presently Visual Display is working with the UPM in a national R&D project called “Liquid Crystal Polarizer for its use in Liquid Crystal Displays”

2.3.7 Arcoptix

Arcoptix have the following facilities for the production of LCVRs:

- 60m^2 Clean room area 10’000
- 1 large size rubbing machine with piezo-electric z stage for precise rubbing strength control (custom made machine).
- 1 small size rubbing machine for special demands (custom made machine).
- 1 Liquid crystal Vacuum filling machine (custom made machine) with integrated heater.
- Thermo controlled stage for polarization microscope
- Mach-Zender interferometer for wave distortion characterization
- 2 Leica completely equipped polarization microscopes

- Sealing dispenser.
- Ultrasonic cleaning bath
- Water cascade
- Photolithographic infrastructure (Süss mask aligner)
- Illumination table
- Vacuum system for uniform sealing of LC cells.
- 2 UV polymerization chambers
- 1 UV Gun.
- 1 grating spectrometer compatible with microscope
- Spacer dispensing machine (for equal reparation of the spacers)
- 3 programmable Ovens
- 2 programmable spin-coaters
- 1 Programmable function generator
- 1 Standard function generator.
- 1 oscilloscope.
- Detector mountable on the polarization microscopes.
- 1 programmable heating stage
- 1 classical heating stage.
- Large collection of different types of polyimides, spacers, Liquid crystals and substrates.
- ITO coating machine
- Optical testing bench with HeNe laser and different optical component and custom software for phase retardance characterization of variable phase retarders.

2.4 KEY PERSONAL

The institutes submitting this proposal form a consortium with a strong expertise in solar physics and in long standing experience in ESA and NASA space missions. Members of this consortium have played the lead role in the scientific definition of the Solar Orbiter mission. The consortium has a long and rich heritage in space-borne, balloon borne and ground-based solar instrumentation, playing leading roles in missions like Ulysses, SOHO, *SUNRISE*, Hinode and STEREO.

The team proposed by our consortium is composed of experienced scientists and engineers from the participating institutes providing expertise in all disciplines to an extent necessary for ensuring the success of the project. A summary of the key scientific and technical personnel at each of the institutes contributing hardware or software to the instrument development is given in tabular form in the following sections, along with main responsibilities. A detailed overview of the individual careers, relevant experience and scientific interests is given in Annex 1.

List of participating institutes with lead persons and responsibilities

2.4.1 INTA

NAME	RESPONSIBILITY
A. Álvarez-Herrero	Principal Investigator
R. López Heredero	Test coordination responsible
Marianela Fernandez	Optical charact. responsible
T. Belenguer Dávila	Optical Scientist
S. Esteve Hoyos	Radiation analysis

2.4.2 IAC

NAME	RESPONSIBILITY
Valentín Martinez Pillet	Institution leader

2.4.3 IAA

NAME	RESPONSIBILITY
J.C. del Toro Iniesta	Institution leader
A.C. López Jiménez	Institution head engineer
José Mª Jerónimo Zafra	Electronics
P.J. Mellado Sánchez	Software
María Balaguer Jiménez	Quality assurance
Daniel Álvarez García	Electronics

2.4.4 INAF

NAME	RESPONSIBILITY
Silvano Fineschi	Achromatic LC study Lead
Luca Zangrilli	LC scientist
Giuseppe Massone	Optical Scientist
Gerardo Capobianco	Calibration specialist – post doc
Gianalfredo Nicolini	Doc. /reporting coord. contract

2.4.5 CSL

NAME	RESPONSIBILITY
M. Georges	Project manager-Optical charac
A. Carapelle	Scientist for irradiation test
K. Fleury-Frenette	Scientist for ellipsometric charact.

2.4.6 VISUAL DISPLAY S. L.

NAME	RESPONSIBILITY
Manuel López	Leader
Javier Rodriguez	Logistic Management

2.4.7 Arcoptix S. A.

NAME	RESPONSIBILITY
Dr. Toralf SCHARF	Head of the arcoptix part of the project
Dr. Gerben Boer	Responsible for the engineering and manufacturing LCVRs.

2.5 WORKPACKAGES

2.5.1 Work Breakdown Structure

A Work Breakdown Structure (WBS) will be established, maintained and submitted to the ESA Project Office throughout the project to define the scope of the work and the responsibilities involved.

The WBS of this proposal at the various levels is shown in Figure 24.

The system work package is broken down into Phase I (LCVRs Technology Consolidation and System Assessment), Phase II (LCVRs Development and Validation) and Management, activities. The Work Packages reflect primarily phases I and II and the associated tasks described in thee document Statement of Work. A detailed break down has been carried out.

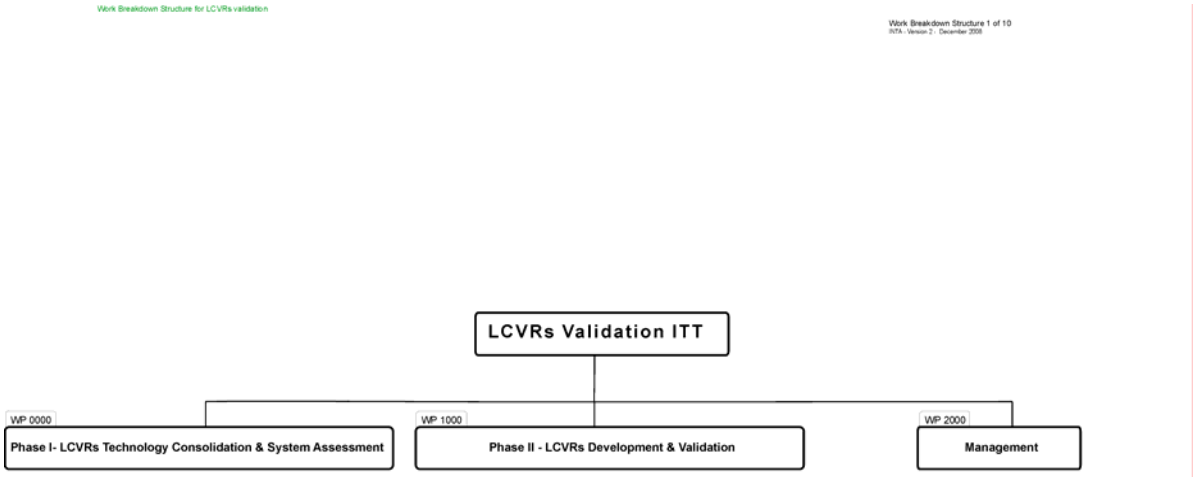
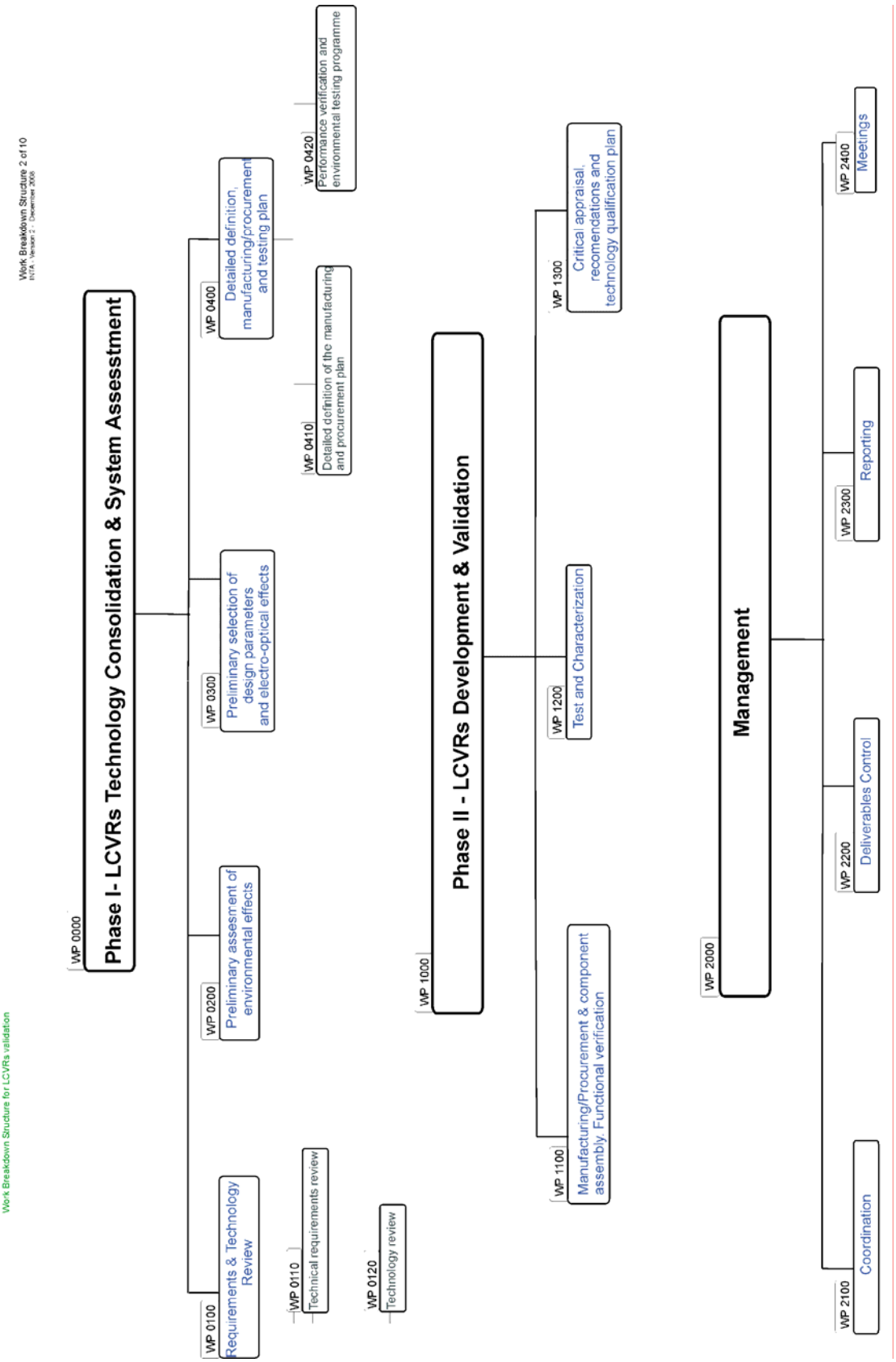
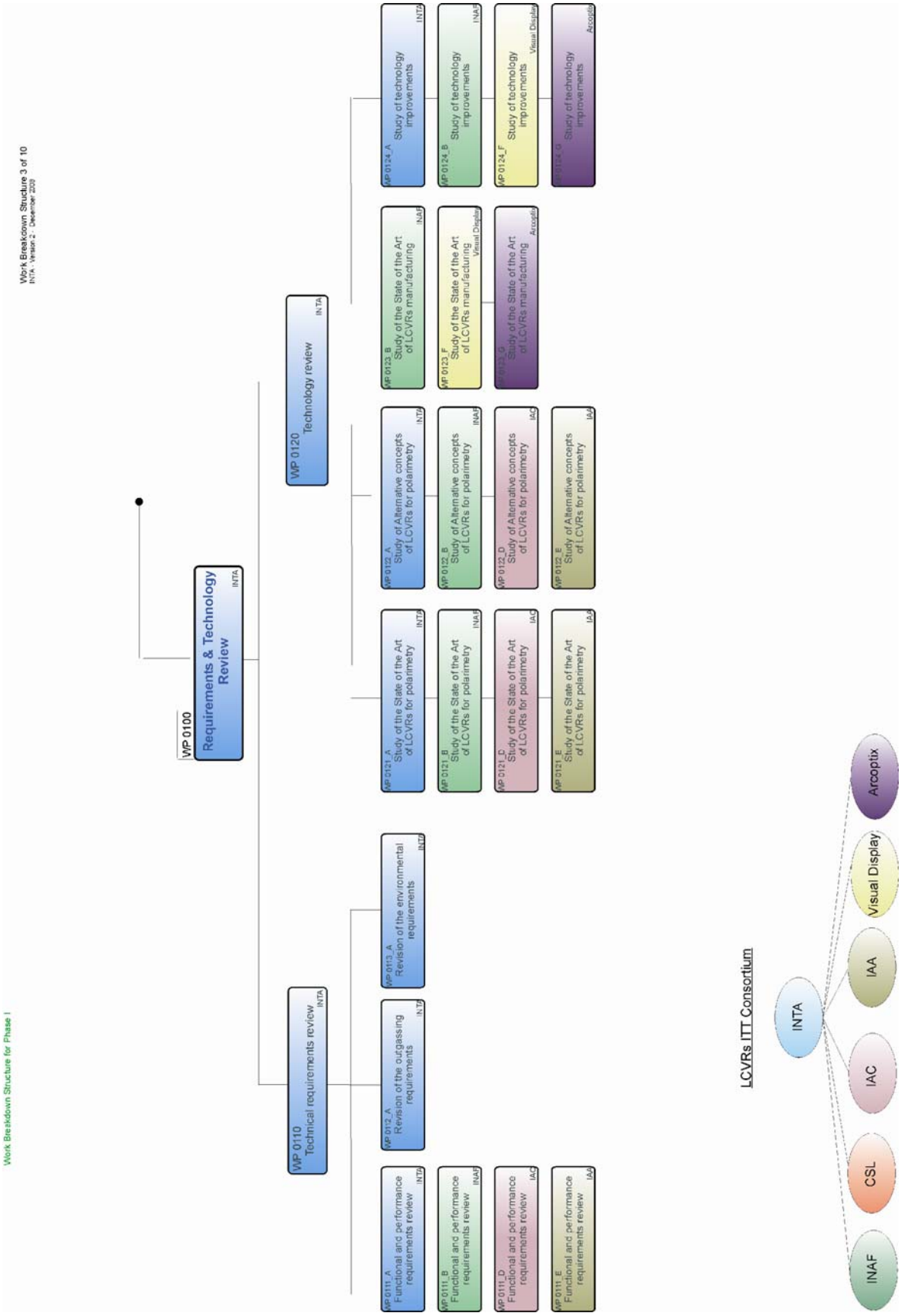


Figure 24. WBS level1.


Work Breakdown Structure for LCVRs validation
Work Breakdown Structure 2 of 10
INTA - Version 2 - December 2008
WP 0000
Phase I- LCVRs Technology Consolidation & System Assesstment
WP 0100
Requirements & Technology Review
WP 0110
Technical requirements review
WP 0120
Technology review
WP 0200
Preliminary assesment of environmental effects
WP 0300
Preliminary selection of design parameters and electro-optical effects
WP 0400
Detailed definition, manufacturing/procurement and testing plan
WP 0410
Detailed definition of the manufacturing and procurement plan
WP 0420
Performance verification and environmental testing programme
WP 1000
Phase II - LCVRs Development & Validation
WP 1100
Manufacturing/Procurement & component assembly. Functional verification
WP 1200
Test and Characterization
WP 1300
Critical appraisal, recomendations and technology qualification plan
WP 2000
Management
WP 2100
Coordination
WP 2200
Deliverables Control
WP 2300
Reporting
WP 2400
Meetings


Work Breakdown Structure 3 of 10
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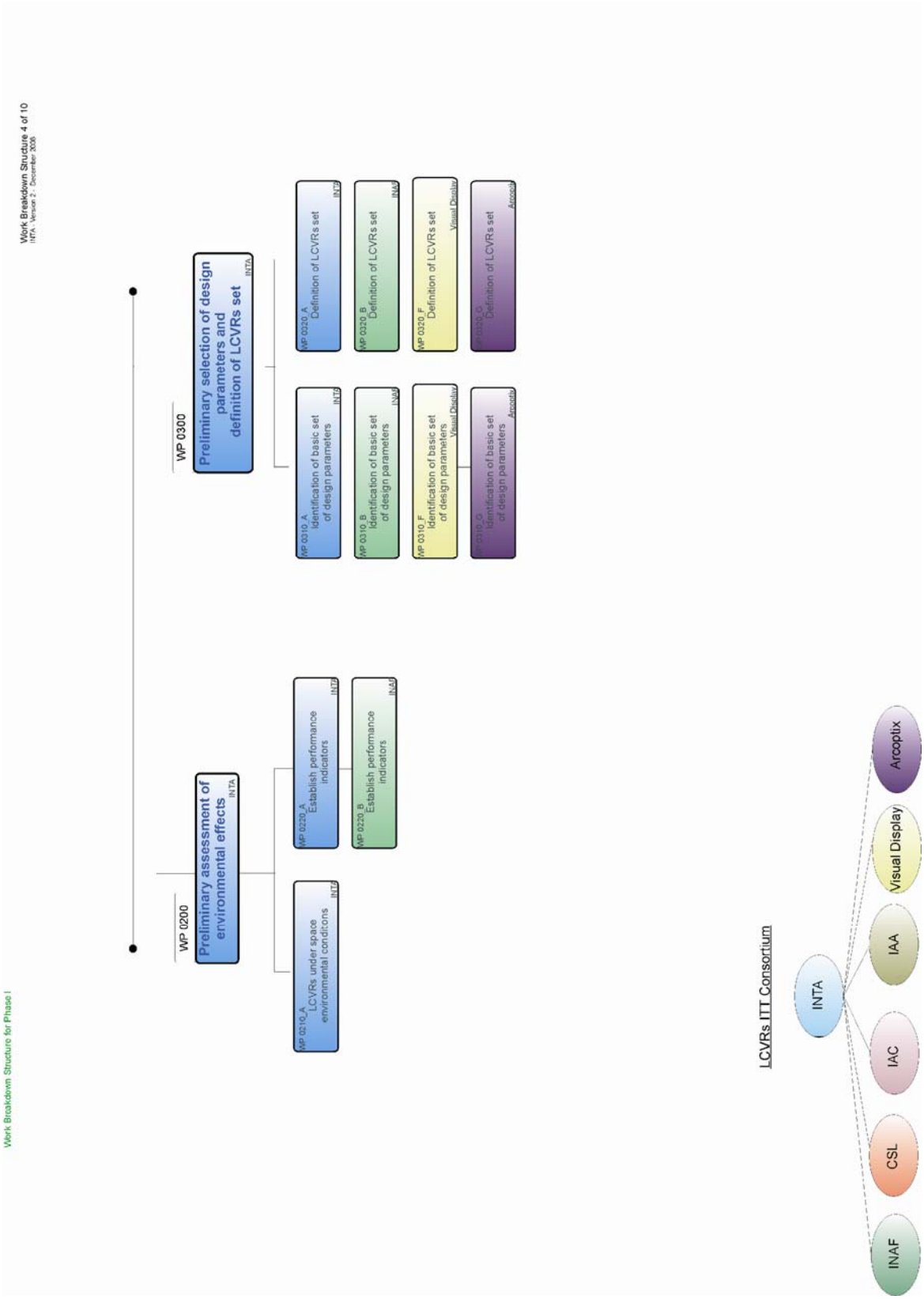
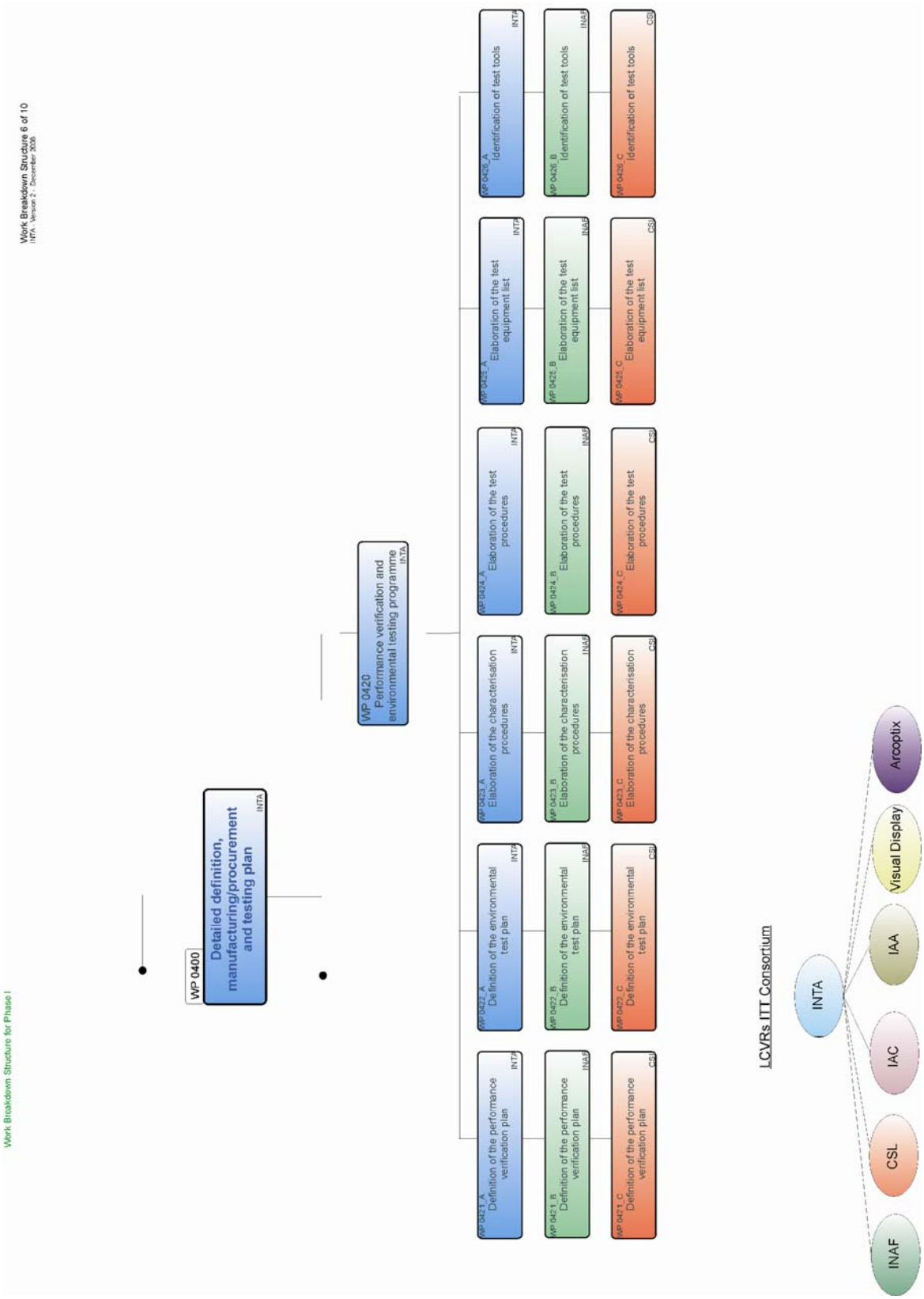
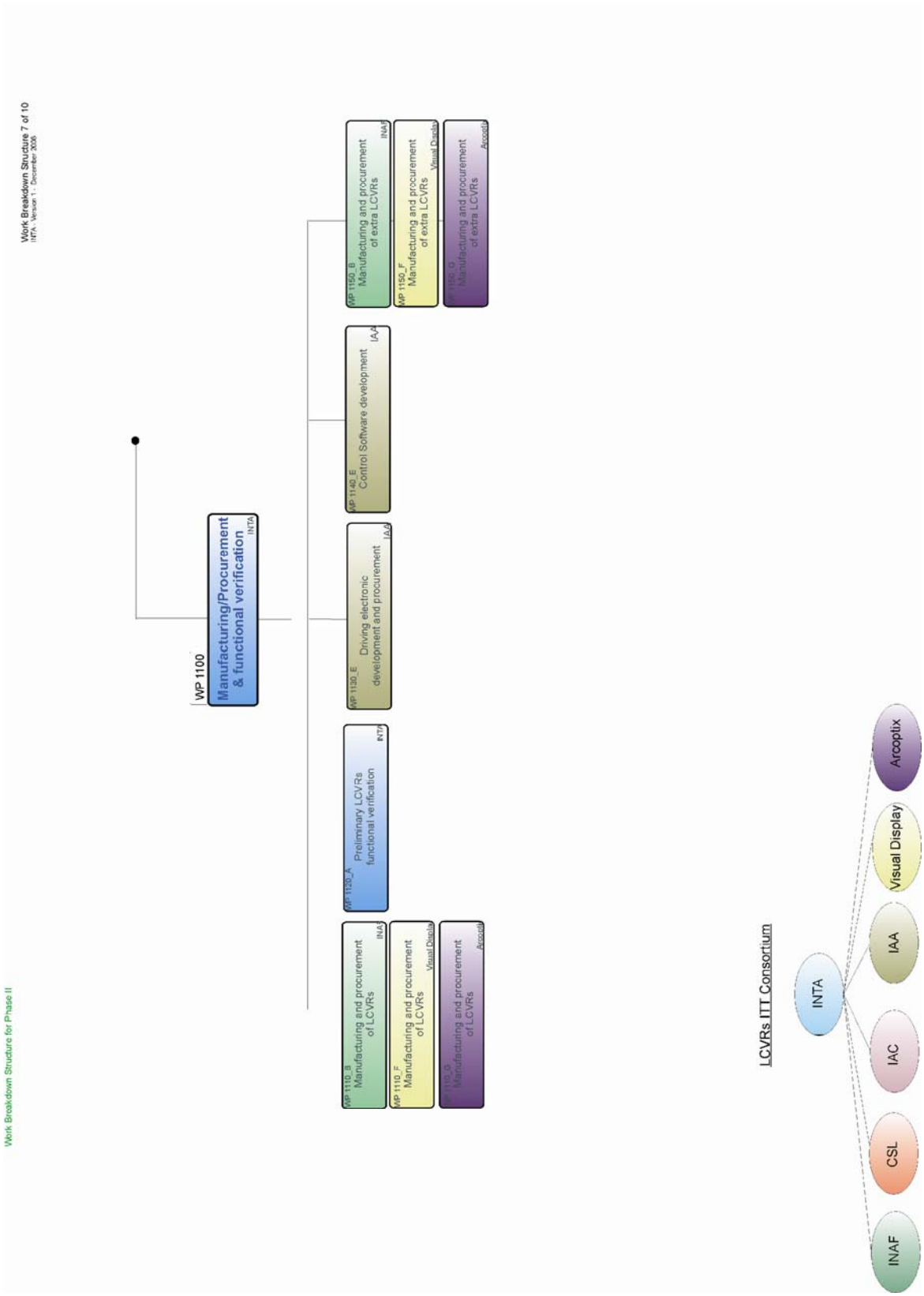
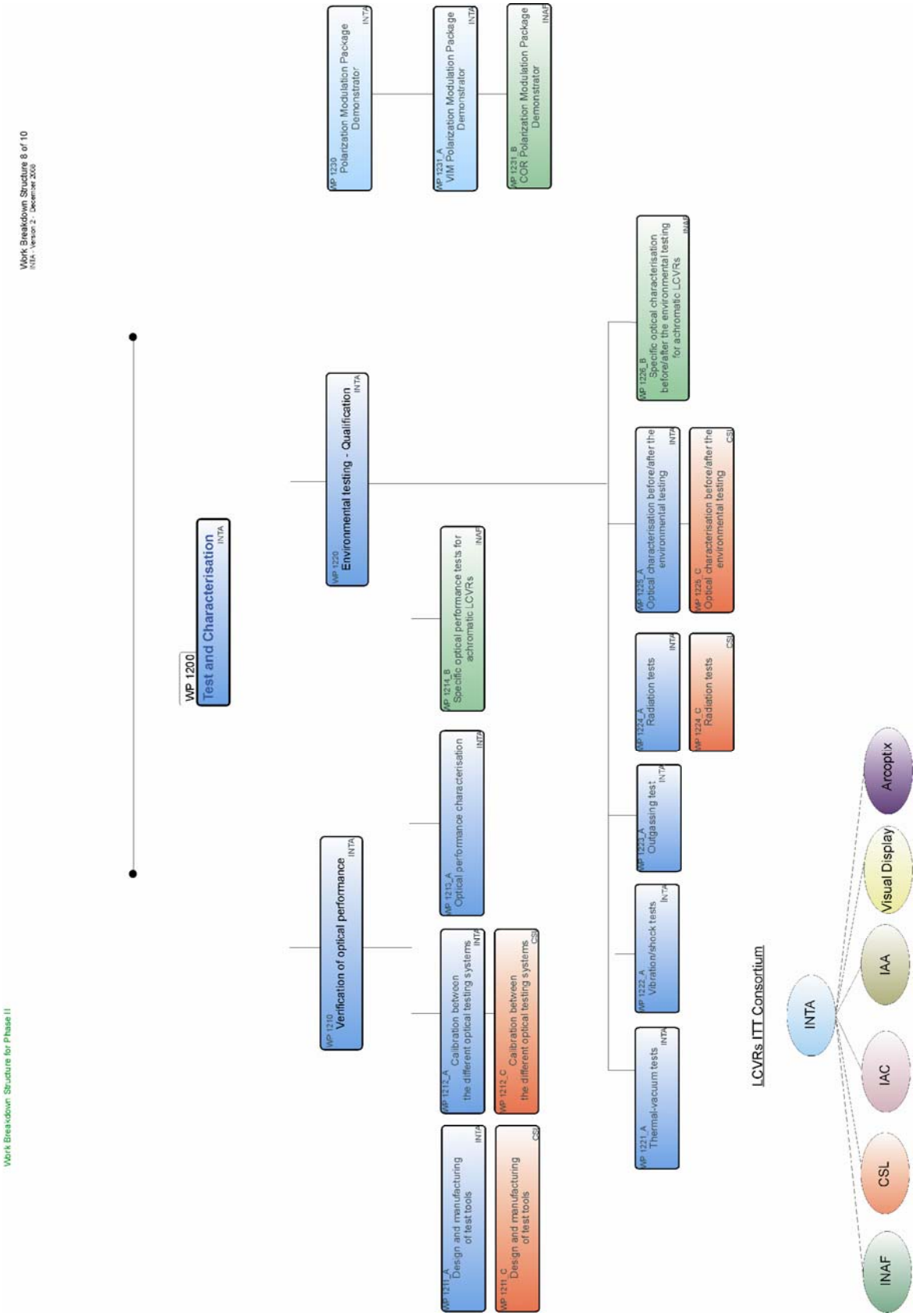
Work Breakdown Structure for Phase I
WP 0100
Requirements & Technology Review
INTA
WP 0110
Technical requirements review
INTA
WP 0111_A
Functional and performance requirements review
INTA
WP 0111_B
Functional and performance requirements review
INAF
WP 0111_D
Functional and performance requirements review
IAC
WP 0111_E
Functional and performance requirements review
IAA
WP 0112_A
Revision of the outgassing requirements
INTA
WP 0113_A
Revision of the environmental requirements
INTA
WP 0120
Technology review
INTA
WP 0121_A
Study of the State of the Art of LCVRs for polarimetry
INTA
WP 0121_B
Study of the State of the Art of LCVRs for polarimetry
INAF
WP 0121_D
Study of the State of the Art of LCVRs for polarimetry
IAC
WP 0121_E
Study of the State of the Art of LCVRs for polarimetry
IAA
WP 0122_A
Study of Alternative concepts of LCVRs for polarimetry
INTA
WP 0122_B
Study of Alternative concepts of LCVRs for polarimetry
INAF
WP 0122_D
Study of Alternative concepts of LCVRs for polarimetry
IAC
WP 0122_E
Study of Alternative concepts of LCVRs for polarimetry
IAA
WP 0123_B
Study of the State of the Art of LCVRs manufacturing
INAF
WP 0123_F
Study of the State of the Art of LCVRs manufacturing
Visual Display
WP 0123_G
Study of the State of the Art of LCVRs manufacturing
Arcoptix
WP 0124_A
Study of technology improvements
INTA
WP 0124_B
Study of technology improvements
INAF
WP 0124_F
Study of technology improvements
Visual Display
WP 0124_G
Study of technology improvements
Arcoptix
LCVRs ITT Consortium
INTA
CSL
INAF
IAC
IAA
Visual Display
Arcoptix

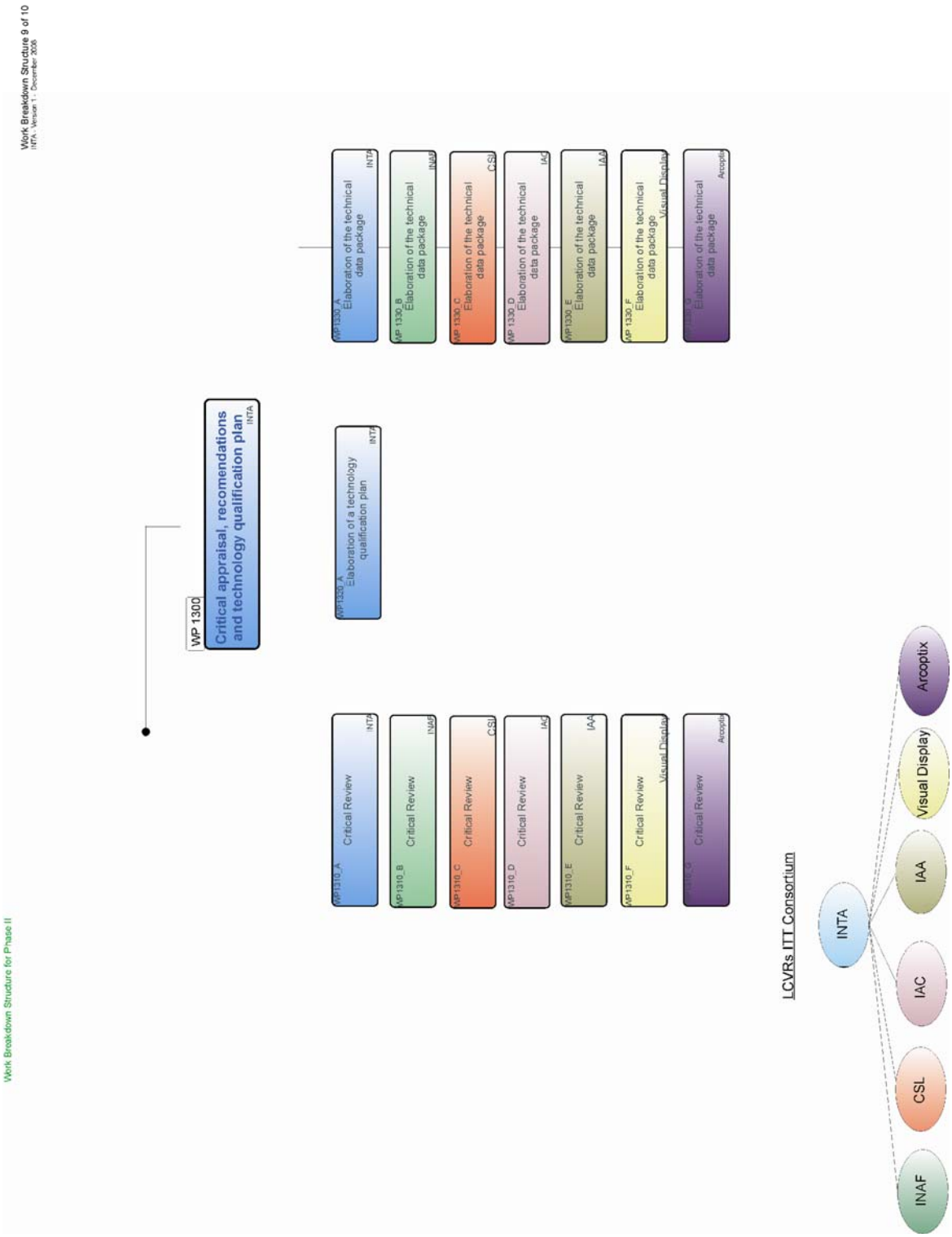

Work Breakdown Structure 4 of 10
INTA. Version 2 - December 2008
WP 0200
Preliminary assessment of environmental effects
INTA
WP 0210_A
LCVRs under space environmental conditions
INTA
WP 0220_A
Establish performance indicators
INTA
WP 0220_B
Establish performance indicators
INAF
WP 0300
Preliminary selection of design parameters and definition of LCVRs set
INTA
WP 0310_A
Identification of basic set of design parameters
INTA
WP 0310_B
Identification of basic set of design parameters
INAF
WP 0310_F
Identification of basic set of design parameters
Visual Display
WP 0310_G
Identification of basic set of design parameters
Arcoptix
WP 0320_A
Definition of LCVRs set
INTA
WP 0320_B
Definition of LCVRs set
INAF
WP 0320_F
Definition of LCVRs set
Visual Display
WP 0320_G
Definition of LCVRs set
Arcoptix
Work Breakdown Structure for Phase I
LCVRs ITT Consortium
INTA
IAA
Visual Display
Arcoptix
IAC
CSL
INAF

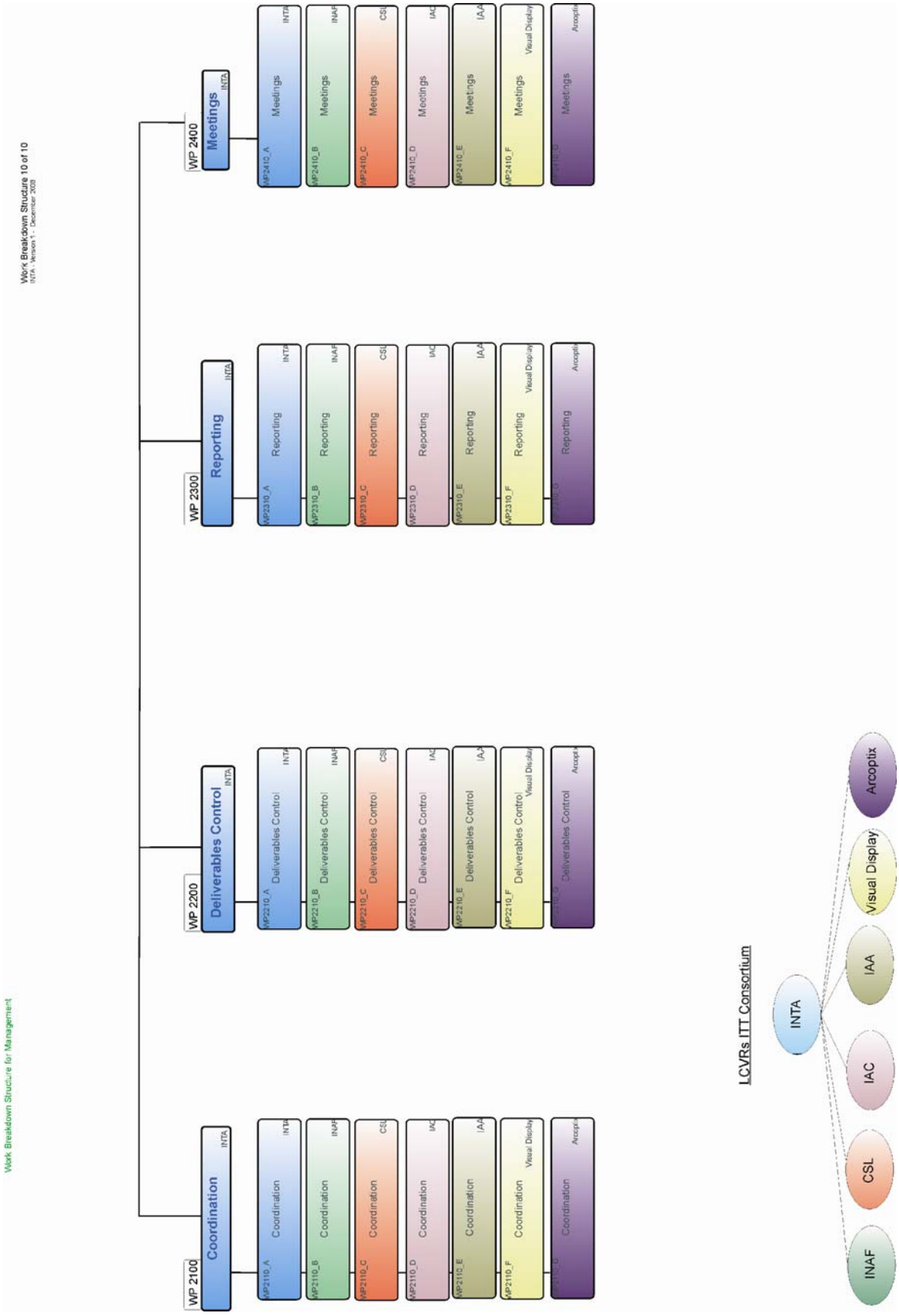
Work Breakdown Structure 5 of 10
INTA - Version 2 - December 2008
Work Breakdown Structure for Phase I
WP 0400
Detailed definition, manufacturing/procurement and testing plan
INTA
WP 0410
Detailed manufacturing and procurement plan
INTA
AP 0410_A
Definition of the preliminary LCVRs functional verification
INTA
AP 0411_A
Preliminary performance model
INTA
AP 0411_B
Preliminary performance model
INAF
AP 0411_F
Preliminary performance model
Visual Display
Preliminary performance model
Arcoptix
AP 0412_B
Preliminary contacts for LCVRs materials procurement
INAF
AP 0413_F
Preliminary contacts for LCVRs materials procurement
Visual Display
Preliminary contacts for LCVRs materials procurement
Arcoptix
AP 0414_B
LCVRs manufacturing & procurement plan
INAF
AP 0414_F
LCVRs manufacturing & procurement plan
Visual Display
LCVRs manufacturing & procurement plan
Arcoptix
AP 0415_E
Drive electronic development and manufacturing plan
IAA
AP 0416_E
Control software development plan
IAA
LCVRs ITT Consortium
INTA
IAA
Visual Display
Arcoptix
IAC
CSL
INAF


Work Breakdown Structure for Phase I
Work Breakdown Structure 6 of 10
INTA - Version 2 - December 2008
WP 0400
Detailed definition, manufacturing/procurement and testing plan
INTA
WP 0420
Performance verification and environmental testing programme
INTA
WP 0421_A
Definition of the performance verification plan
INTA
WP 0421_B
Definition of the performance verification plan
INAF
WP 0421_C
Definition of the performance verification plan
CSL
WP 0422_A
Definition of the environmental test plan
INTA
WP 0422_B
Definition of the environmental test plan
INAF
WP 0422_C
Definition of the environmental test plan
CSL
WP 0423_A
Elaboration of the characterisation procedures
INTA
WP 0423_B
Elaboration of the characterisation procedures
INAF
WP 0423_C
Elaboration of the characterisation procedures
CSL
WP 0424_A
Elaboration of the test procedures
INTA
WP 0424_B
Elaboration of the test procedures
INAF
WP 0424_C
Elaboration of the test procedures
CSL
WP 0425_A
Elaboration of the test equipment list
INTA
WP 0425_B
Elaboration of the test equipment list
INAF
WP 0425_C
Elaboration of the test equipment list
CSL
WP 0426_A
Identification of test tools
INTA
WP 0426_B
Identification of test tools
INAF
WP 0426_C
Identification of test tools
CSL
LCVRs ITT Consortium
INTA
IAC
CSL
INAF
IAA
Visual Display
Arcoptix


Work Breakdown Structure 7 of 10
Work Breakdown Structure for Phase II
WP 1100
Manufacturing/Procurement & functional verification
INTA
WP 1110_B Manufacturing and procurement of LCVRs
WP 1110_F Manufacturing and procurement of LCVRs
Visual Display
WP 1110_G Manufacturing and procurement of LCVRs
Arcoptix
WP 1120_A Preliminary LCVRs functional verification
WP 1130_E Driving electronic development and procurement
IAA
WP 1140_E Control Software development
IAA
WP 1150_B Manufacturing and procurement of extra LCVRs
WP 1150_F Manufacturing and procurement of extra LCVRs
Visual Display
WP 1150_G Manufacturing and procurement of extra LCVRs
Arcoptix
LCVRs ITT Consortium
INTA
Arcoptix
Visual Display
IAA
IAC
CSL
INAF


Work Breakdown Structure 8 of 10
Work Breakdown Structure for Phase II
WP 1200
Test and Characterisation
INTA
WP 1210
Verification of optical performance
INTA
WP 1211_A
Design and manufacturing of test tools
INTA
WP 1211_C
Design and manufacturing of test tools
CSL
WP 1212_A
Calibration between the different optical testing systems
INTA
WP 1212_C
Calibration between the different optical testing systems
CSL
WP 1213_A
Optical performance characterisation
INTA
WP 1214_B
Specific optical performance tests for achromatic LCVRs
INAF
WP 1220
Environmental testing - Qualification
INTA
WP 1221_A
Thermal-vacuum tests
INTA
WP 1222_A
Vibration/shock tests
INTA
WP 1223_A
Outgassing test
INTA
WP 1224_A
Radiation tests
INTA
WP 1224_C
Radiation tests
CSL
WP 1225_A
Optical characterisation before/after the environmental testing
INTA
WP 1225_C
Optical characterisation before/after the environmental testing
CSL
WP 1226_B
Specific optical characterisation before/after the environmental testing for achromatic LCVRs
INAF
WP 1230
Polarization Modulation Package Demonstrator
INTA
WP 1231_A
VIM Polarization Modulation Package Demonstrator
INTA
WP 1231_B
COR Polarization Modulation Package Demonstrator
INAF
LCVRs ITT Consortium
INTA
Arcoptix
Visual Display
IAA
IAC
CSL
INAF


Work Breakdown Structure 9 of 10
INTA. Version 1 : December 2008
WP 1300
Critical appraisal, recomendations and technology qualification plan
INTA
Elaboration of a technology qualification plan
INTA
Critical Review
Elaboration of the technical data package
Work Breakdown Structure for Phase II
LCVRs ITT Consortium
INTA
IAC
CSL
INAF
IAA
Visual Display
Arcoptix


Work Breakdown Structure 10 of 10
INTA - Version 1 - December 2008
Work Breakdown Structure for Management
WP 2100
Coordination
WP 2200
Deliverables Control
WP 2300
Reporting
WP 2400
Meetings
LCVRs ITT Consortium
INTA
CSL
IAC
IAA
Visual Display
Arcoptix
INAF

2.5.2 Work packages distribution

The following Work Packages distribution has been planned considering the scientist and technical expertise of the institution involved:

2.5.2.1 INTA WORK PACKAGES

Consortium project management is at INTA. Work packages at INTA in Table.

INTA	
WP 0000	**Phase I – LCVRs Technology Consolidation & System Assessment**
WP 0100	**Requirements and Technology Review**
WP 0110	**Technical requirement review**
WP 0111_A	Functional and performance requirements review
WP 0112_A	Revision of the outgassing requirements
WP 0113 _A	Revision of the environmental requirements
WP 0120	**Technology review**
WP 0121_A	Study of the State of the Art of LCVRs for polarimetry
WP 0122_A	Study of Alternative concepts of LCVRs for polarimetry
WP 0124_A	Study of technology improvements
WP 0200	**Preliminary assessment of enviromental effects**
WP 0210_A	LCVRs under space environmental conditions
WP 0220_A	Establish performance indicators
WP 0300	**Preliminary selection of design parameter and definition of LCVRs set.**
WP 0310_A	Identification of basic set of design parameters
WP 0320_A	Definition of LCVRs set
WP 0400	**Detailed definition, manufacturing/procurement and testing plan**
WP 0410	**Detailed manufacturing and procurement plan**
WP 0411_A	Preliminary performance model
WP 0412_A	Definition of the preliminary LCVRs functional verification
WP 0420	**Performance verification and environmental testing programme**
WP 0421_A	Definition of the performance verification plan
WP 0422_A	Definition of the environmental test plan
WP 0423_A	Elaboration of the characterisation procedures
WP 0424_A	Elaboration of the test procedures
WP 0425_A	Elaboration of the test equipment list
WP 0426_A	Identification of test tools
WP 1000	**Phase II – LCVRs Development and Validation**
WP 1100	**Manufacturing/procurement and functional verification**
WP 1120_A	Preliminary LCVRs functional verification
WP 1200	**Test and characterisation**
WP 1210	**Verification of optical performance**
WP 1211_A	Design and manufacturing of test tools
WP 1212_A	Calibration between the different optical testing systems
WP 1213_A	Optical performance characterisation
WP 1220	**Environmental testing - Qualification**
WP 1221_A	Thermal-vacuum tests
WP 1222_A	Vibration/shock tests
WP 1223_A	Outgassing test
WP 1224_A	Radiation tests
WP 1225_A	Optical characterization before/after the environmental testing
WP 1230	**Polarization Modulation Package Demonstrator**
WP 1231_A	VIM Polarization Modulation Package Demonstrator

WP 1300	**Critical appraisal, recommendations and technology qualification plan**
WP 1310_A	Critical Review
WP 1320_A	Elaboration of a technology qualification plan
WP 1320_A	Elaboration of the technical data package
WP 2000	**Management**
WP 2100	**Coordination**
WP 2110_A	Coordination
WP 2200	**Deliverables Control**
WP 2210_A	Deliverables Control
WP 2300	**Reporting**
WP 2310_A	Reporting
WP 2400	**Meetings**
WP 2410_A	Meetings

2.5.2.2 INAF WORK PACKAGES

Work packages at INAF in Table.

INAF	
WP 0111_B	Functional and performance requirements review
WP 0121_B	Study of the State of the Art of LCVRs for polarimetry
WP 0122_B	Study of Alternative concepts of LCVRs for polarimetry
WP 0123_B	Study of the State of the Art of LCVRs manufacturing
WP 0124_B	Study of technology improvements
WP 0220_B	Establish performance indicators
WP 0310_B	Identification of basic set of design parameters
WP 0320_B	Definition of LCVRs set
WP 0411_B	Preliminary performance model
WP 0413_B	Preliminary contacts of LCVRs materials procurements
WP 0414_B	LCVRs manufacturing and procurement plan
WP 0421_B	Definition of the performance verification plan
WP 0422_B	Definition of the environmental test plan
WP 0423_B	Elaboration of characterisation procedures
WP 0424_B	Elaboration of the test procedures
WP 0425_B	Elaboration of the test equipment list
WP 0426_B	Identification of test tools
WP 1110_B	Manufacturing and procurement of LCVRs
WP 1150_B	Manufacturing and procurement of extra LCVRs
WP 1214_B	Specific optical performance tests for achromatic LCVRs
WP 1226_B	Specific optical characterisation before/after the environmental testing for achromatic LCVRs
WP 1231_B	COR Polarization Modulation Package Demostrator
WP 1310_B	Critical Review
WP 1330_B	Elaboration of the technical data package
WP 2110_B	Coordination
WP 2210_B	Deliverables Control
WP 2310_B	Reporting
WP 2410_B	Meetings

2.5.2.3 CSL WORK PACKAGES

Work packages at CSL in Table.

CSL	
WP 0421_C	Definition of the performance verification plan
WP 0422_C	Definition of the environmental test plan
WP 0423_C	Elaboration of the characterisation procedures

WP 0424_C	Elaboration of the test procedures
WP 0425_C	Elaboration of the test equipment list
WP 0426_C	Identification of test tools
WP 1211_C	Design and manufacturing of test tools
WP 1212_C	Calibration between the different optical testing systems
WP 1224_C	Radiation tests
WP 1225_C	Optical characterisation before/after the environmental testing
WP 1310_C	Critical Review
WP 1330_C	Elaboration of the Technical Data Package
WP 2110_C	Coordination
WP 2210_C	Deliverables Control
WP 2310_C	Reporting
WP 2410_C	Meetings

2.5.2.4 IAC WORK PACKAGES

Work packages at IAC in Table.

IAC	
WP 0111_D	Functional and performance requirements review
WP 0121_D	Study of the State of the Art of LCVRs for polarimetry
WP 0122_D	Study of Alternative concepts of LCVRs for polarimetry
WP 1310_D	Critical Review
WP 1330_D	Elaboration of a technical data package
WP 2110_D	Coordination
WP 2210_D	Deliverables Control
WP 2310_D	Reporting
WP 2410_D	Meetings

2.5.2.5 IAA WORK PACKAGES

Work packages at IAA in Table.

IAA	
WP 0111_E	Functional and performance requirements review
WP 0121_E	Study of the State of the Art of LCVRs for polarimetry
WP 0122_E	Study of Alternative concepts of LCVRs for polarimetry
WP 0415_E	Drive electronic development and manufacturing plan
WP 0416_E	Control software development plan
WP 1130_E	Driving electronic development and procurement
WP 1140_E	Control software development
WP 1310_E	Critical review
WP 1330_E	Elaboration of the Technical Data Package
WP 2110_E	Coordination
WP 2210_E	Deliverables Control
WP 2310_E	Reporting
WP 2410_E	Meetings

2.5.2.6 Visual Display S.L. WORK PACKAGES

Work packages at Visual Display in Table.

Visual Display	
WP 0123_F	Study of the State of the Art of LCVRs manufacturing
WP 0124_F	Study of technology improvements
WP 0310_F	Identification of basic set of design parameters
WP 0320_F	Defintion of LCVRs set
WP 0411_F	Preliminary performance model
WP 0413_F	Preliminary contacts of LCVRs materials procurements

WP 0414_F	LCVRs manufacturing and procurement plan
WP 1110_F	Manufacturing and procurement of LCVRs
WP 1150_F	Manufacturing and procurement of extra LCVRs
WP 1310_F	Critical Review
WP 1330_F	Elaboration of the technical data package
WP 2110_F	Coordination
WP 2210_F	Deliverables Control
WP 2310_F	Reporting
WP 2410_F	Meetings

2.5.2.7 Arcoptix S.A. WORK PACKAGES

Work packages at Arcoptix S. A. in Table.

Arcoptix	
WP 0123_G	Study of the State of the Art of LCVRs manufacturing
WP 0124_G	Study of technology improvements
WP 0310_G	Identification of basic set of design parameters
WP 0320_G	Defintion of LCVRs set
WP 0411_G	Preliminary performance model
WP 0413_G	Preliminary contacts of LCVRs materials procurements
WP 0414_G	LCVRs manufacturing and procurement plan
WP 1110_G	Manufacturing and procurement of LCVRs
WP 1150_G	Manufacturing and procurement of extra LCVRs
WP 1310_G	Critical Review
WP 1330_G	Elaboration of the technical data package
WP 2110_G	Coordination
WP 2210_G	Deliverables Control
WP 2310_G	Reporting
WP 2410_G	Meetings

2.5.3 Work package description

PSS-A20 forms with the description of the Work Packages at the lowest level identified in the Work Breakdown Structure are available in Annex 4.

2.6 LIST OF DELIVERABLES

	Document			Hardware				Software			
	Identifier	**Title**	**Due**	**Item identifier**	**Description**	**Milestone**	**Quality**	**Item identifier**	**Description**	**Milestone**	**Num Copies**
Phase I	**TN1**	Review of the Requirements & Technology Review Report	PM1 – 6 weeks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TN2	Environmental Assessment Report	First issue: PM1-4weeks Final issue: FP-2weeks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TN3	Preliminary Definition Report	PM1 – 2weeks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TN4	Development, Manufacturing & Procurement Plan	First issue: Phase 1 Review -6 weeks Final issue: Phase 1 Review-2weeks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	-	Material Data (LCs, ITO, alignment layers, AR coatings, Glasses, spacers)	Phase 1 Review – 6weeks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TN5	Test Plan	Phase 1 Review-2weeks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	PR	Progress Report	Monthly	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

	Document			Hardware				Software			
	Identifier	Title	Due	Item identifier	Description	Milestone	Quality	Item identifier	Description	Milestone	Num Copies
Phase II	TN6	Development & Functional Verification Report	TRR – 2 weeks	HW1	All LCVRs manufactured and purchased under this contract	FP		SW1	To operate support driving electronics if	FP	One (1) of each kind including applicable user manual
	TN7	Performance Verification Report	First issue: PM2-2weeks Final issue: FP-2weeks	HW2	Extra LCVRs prototypes for future testing	FP	Two (2) of each kind including calibration and optical performance characterisation				
	TN8	Environmental Test Report	First issue: PM2-2weeks Final issue: FP-2weeks	HW3	Support driving electronics	FP	One (1) of each kind including installation and operation instructions				
	TN9	Technology Quality Plan	FP -2 weeks								
	TDP	Technical Data Package	FP -2 weeks								
	SR	Summary Report + Abstract	FP -2 weeks								
	PR	Progress Report	Monthly								

2.7 OVERALL PROGRAM PLANNING

A master schedule of the activity will be established, maintained and submitted to the ESA Project Office to demonstrate the commitments for the validation of LCVRs for *Solar Orbiter PMP*. This master schedule will show:

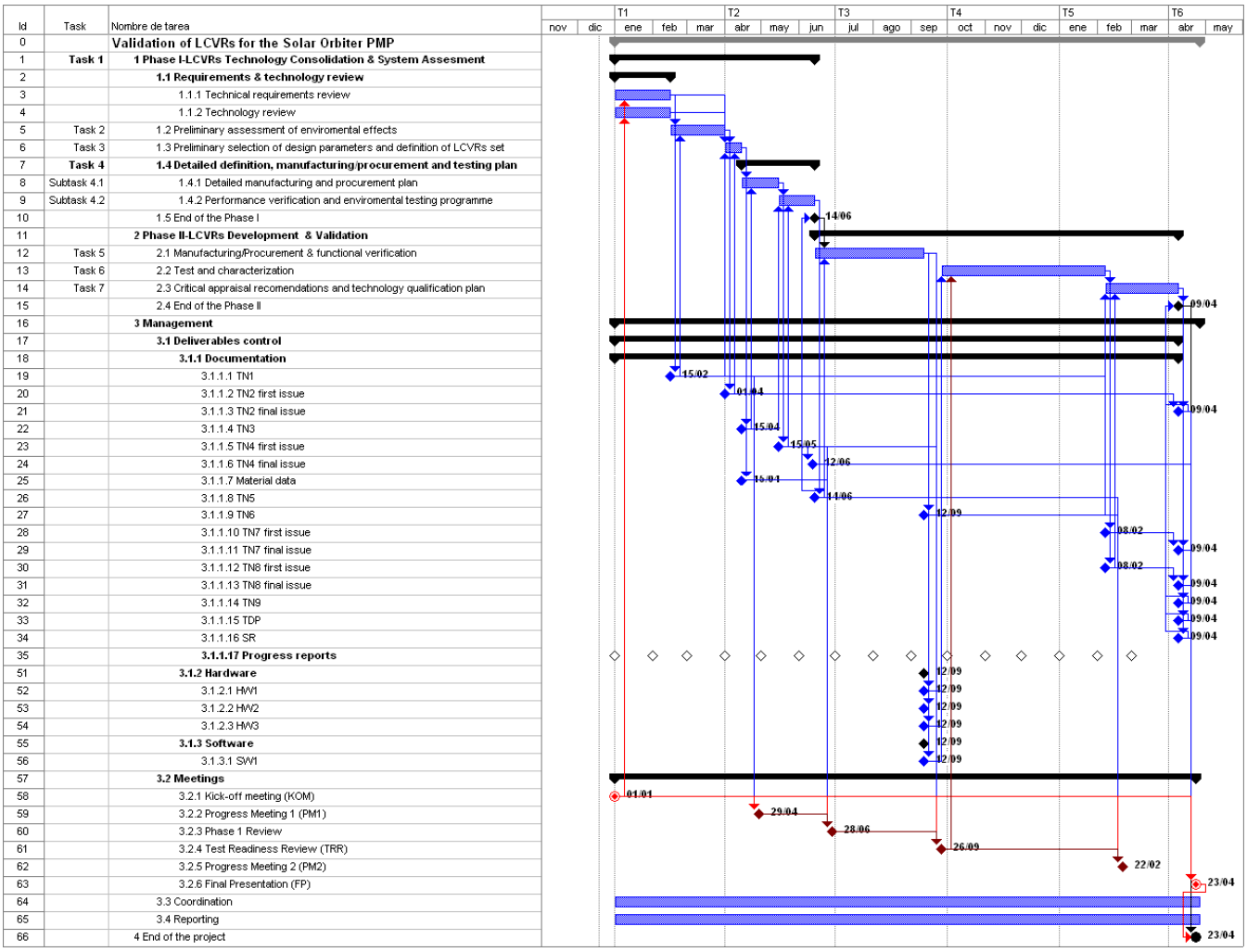
- The overall LCVRs validation programme, including the activities identified in the WBS.
- Project milestones
- Deliverables.
- Bar charts of critical activities.

The master schedule will be delivered to the ESA Project Office on demand. A master schedule for the activity is shown in Figure 25. Only second level of the WBS has been included in this document for clarity. A more detailed master schedule is available under request.

In this master schedule some modifications of the due dates of deliverables and meetings dates are proposed taking into account the estimation of the tasks duration. Note that the total duration of the activity is estimated in 16 months. They are resumed in Table 5 and Table 6.

Meeting	Date
KOM	T0
PM1	T0+4
Phase 1 Review	T0+6
TRR	T0+9
PM2	T0+14
FP	T0+16

Table 5. Meetings dates.



Id	Task	Nombre de tarea
0		**Validation of LCVRs for the Solar Orbiter PMP**
1	**Task 1**	**1 Phase I-LCVRs Technology Consolidation & System Assesment**
2		**1.1 Requirements & technology review**
3		1.1.1 Technical requirements review
4		1.1.2 Technology review
5	Task 2	1.2 Preliminary assessment of enviromental effects
6	Task 3	1.3 Preliminary selection of design parameters and definition of LCVRs set
7	**Task 4**	**1.4 Detailed definition, manufacturing/procurement and testing plan**
8	Subtask 4.1	1.4.1 Detailed manufacturing and procurement plan
9	Subtask 4.2	1.4.2 Performance verification and enviromental testing programme
10		1.5 End of the Phase I
11		**2 Phase II-LCVRs Development & Validation**
12	Task 5	2.1 Manufacturing/Procurement & functional verification
13	Task 6	2.2 Test and characterization
14	Task 7	2.3 Critical appraisal recomendations and technology qualification plan
15		2.4 End of the Phase II
16		**3 Management**
17		**3.1 Deliverables control**
18		**3.1.1 Documentation**
19		3.1.1.1 TN1
20		3.1.1.2 TN2 first issue
21		3.1.1.3 TN2 final issue
22		3.1.1.4 TN3
23		3.1.1.5 TN4 first issue
24		3.1.1.6 TN4 final issue
25		3.1.1.7 Material data
26		3.1.1.8 TN5
27		3.1.1.9 TN6
28		3.1.1.10 TN7 first issue
29		3.1.1.11 TN7 final issue
30		3.1.1.12 TN8 first issue
31		3.1.1.13 TN8 final issue
32		3.1.1.14 TN9
33		3.1.1.15 TDP
34		3.1.1.16 SR
35		**3.1.1.17 Progress reports**
51		**3.1.2 Hardware**
52		3.1.2.1 HW1
53		3.1.2.2 HW2
54		3.1.2.3 HW3
55		**3.1.3 Software**
56		3.1.3.1 SW1
57		**3.2 Meetings**
58		3.2.1 Kick-off meeting (KOM)
59		3.2.2 Progress Meeting 1 (PM1)
60		3.2.3 Phase 1 Review
61		3.2.4 Test Readiness Review (TRR)
62		3.2.5 Progress Meeting 2 (PM2)
63		3.2.6 Final Presentation (FP)
64		3.3 Coordination
65		3.4 Reporting
66		4 End of the project

Figure 25. Master schedule

Document	Date
TN1	PM1 - 6 weeks
TN2 first issue	PM1 – 4 weeks
TN2 final issue	FP – 2 weeks
TN3	PM1 – 2 week
TN4 first issue	Phase 1 Review -6 weeks
TN4 final issue	Phase 1 Review -2 weeks
Material data	Phase 1 Review -6 weeks
TN5	Phase 1 Review -2 weeks
TN6	TRR – 2 weeks
TN7 first issue	PM2 – 2 weeks
TN7 final issue	FP – 2 weeks
TN8 first issue	PM2 - 2 weeks
TN8 final issue	FP – 2 weeks
TN9	FP – 2 weeks
TDP	FP – 2 weeks
SR	FP – 2 weeks

Table 6. Proposed deliverables due dates

2.8 COST PRICE DATA

Our overall price for the work is a **Firm Fixed Price** and it amounts to **249.916€,** excluding taxes and duties.

The price is broken down per Phase and per Contractor as follow:

	Phase 1	Phase 2	Total
Contractor INTA	10.709€	40.559€	51.268€
Subcontractor CSL	8.938€	39.057€	47.995€
Subcontractor INAF	4.329€	33.071€	37.400€
Subcontractor IAC	2.283€	2.497€	4.780€
Subcontractor IAA	5.627€	15.326€	20.953€
Subcontractor Visual Display S. L.	9.716€	32.584€	42.300€
Subcontractor Arcoptix S. A.	10.851€	34.369€	45.220€
TOTAL in EURO	52.453€	197.463€	**249.916€**

No profit has been included in this price and INTA do not charge any overhead amount.

2.9 GEOGRAPHICAL DISTRIBUTION

	Budget	Percentage	Percentage	
INTA	51 268 €	21%	**48%**	**Spain**
IAC	4 780 €	2%		
IAA	20 953 €	8%		
Visual Display	42 300 €	17%		
CSL	47 995 €	19%	**19%**	**Belgium**
INAF	37 400 €	15%	**15%**	**Italy**
Arcoptix	45 220 €	18%	**18%**	**Switzerland**
TOTAL	**249 916 €**			

Table 7. Geographical Distribution.

2.10 MILESTONE PAYMENTS PLAN

INTA proposes to negotiate on the basis of the following Milestones and Payment Plan:

		T0 (Advance Payment)	T0+4 (P1R)	T0+8 (TRR)	T0+14 (FP)
% of the budget	**100%**	**20%**	**40%**	**20%**	**20%**
TOTAL	**249 916 €**	**49 983 €**	**99 966 €**	**49 983 €**	**49 983 €**
INTA	51 268 €	10 254 €	20 507 €	10 254 €	10 254 €
IAC	4 780 €	956 €	1 912 €	956 €	956 €
IAA	20 953 €	4 191 €	8 381 €	4 191 €	4 191 €
Visual Display	42 300 €	8 460 €	16 920 €	8 460 €	8 460 €
CSL	47 995 €	9 599 €	19 198 €	9 599 €	9 599 €
INAF	37 400 €	7 480 €	14 960 €	7 480 €	7 480 €
Arcoptix	45 220 €	9 044 €	18 088 €	9 044 €	9 044 €

Table 8. Milestone payments plan.

2.11 CONTRACT CONDITIONS

The draft contract conditions proposed in the IT are read, understood and accepted with the following clarifications:

Clause 7: All corresponde for the Contractor shall be addressed to

- For technical and managerial matters: Dr. Alberto Álvarez Herrero

  Tel. (34) 91 520 1062. Fax. (34) 91 520 6384

  Email: alvareza@inta.es

- For commercial and contractual matters: D. Miguel Angel Martín González

  Tel. (34) 91 529 1973. Fax. (34) 01 520 6384

  Email: martingma@inta.es

Clause 12: The Contract shall be governed by the laws of Spain.

Clause 25: INTA request that: "The Agency agrees that part of the work as specified in the Contractor's proposal be subcontracted to Center Spatial de Liège (CSL), INAF–Osservatorio Astronomico di Torino, Instituto de Astrofísica de Canarias (IAC), Instituto de Astrofísica de Andalucía (IAA), Visual Display S.L and Arcoptix S. A.".

Clause 43: Due to the broad experience of the proposal participants about LCVRs, INTA request that the proprietary background information will be identified and clarified previously to the sign of the contract in case of winning the Announce of Opportunity.

2.12 PROPRIETARY BACKGROUND INFORMATION

INTA would like to point out the following information should be consider as proprietary background information:

1) The following paper has been submitted to be published in J. Opt. Soc. Am. B: "*Determination of the molecular tilt profile of a liquid crystal under applied electric field by generalized transmission ellipsometry*", N. Uribe-Patarroyo, A. Alvarez-Herrero.

2) Additionally, we are preparing a manuscript about a system developed to measure the LCVRs inhomogeneity based on phase-shifting interferometry.

3) Currently INTA is working in new designs of substrates used in the LC cells in order to avoid bubbles and to obtain a high homogeneity degree. Potential patents could be developed.

These activities are being performed thanks to internal funding and out of the scope of this ESA activity, although they will be probably applied in this work.

ANNEX 1: CURRICULA VITAE OF KEY PERSONNEL

The Annex gives an overview of the key scientific and technical members of the consortium. The present address and professional position, the role and position in the project, a brief CV with a description of relevant experiences and, where appropriate, a short selection of relevant publications are provided for each of these members.

Name	**Dr. Alberto Alvarez-Herrero**
Address	Instituto Nacional de Técnica Aeroespacial (INTA) Carretera de Ajalvir km4 28850 Madrid (SPAIN) Phone: +34 91 520 1062; Fax: +34 91 520 6384 email: alvareza@inta.es
Position in Project	PI
Present Position	Senior staff member at INTA (since 1994)
CV	Alvarez-Herrero received the degree in fundamental physiscs and the Ph. D. degree from the Universidad Complutense de Madrid, Spain, in 1994 and 2002, respectively. He has been with the Space Instrumentation Laboratory (LINES), National Institute for Aerospace Technology (INTA), Madrid, since 1994. Currently, his main activity is related to the specification, design, integration and qualification of optical instruments for aerospace applications. Additionally, his research interest is ellipsometry, polarimetry, optical characterization of nanostructured materials, holography and optical fiber sensors. He participated in numerous projects to development scientific instrumentation for space missions as MINISAT01, Envisat, NANOSAT, WSO and ROSETTA. Currently, he is the lead of the INTA project of the Imaging Magnetograph eXperiment (IMaX) for the *SUNRISE* mission. Coordinator of the Spanish contribution in a proposal called SO/PHI for the VIM instrument of the Solar Orbiter Mission.
Relevant Publications	*"*IMaX: a polarimeter based on Liquid Crystal Variable Retarders for an aerospace mission*"*, International Conference on Spectroscopic Ellipsometry IV, Stockholm (Sweden), June 2007. Physica Status Solidi C 5, pp 1041 (2008). *"*UV irradiation effects on TiO2 thin films*",* International Conference on Spectroscopic Ellipsometry IV, Stockholm (Sweden), June 2007. Physica Status Solidi 5, pp 1064 (2008). A. Alvarez-Herrero, R. Pardo, M. Zayat, D. Levy, "Ellipsometric analysis of the spectral properties and dynamic transitions of photochromics thin films*"*, J. Opt. Soc. Am. B 24, pp 2097 (2007) R. L. Heredero, N. Uribe-Patarroyo, T. Belenguer, G. Ramos, A. Sánchez, M. Reina, V. Martínez-Pillet, A. Alvarez-Herrero, "Liquid Cristal Variable Retarders for aerospace polarimetry applications", Appl. Opt. 46, pp 689 (2007). M. Fernández-Rodríguez, C. G. Alvarado, A. Nuñez, A. Alvarez-Herrero, "Modeling of absorption induced by space radiation on glasses: a two variable function depending on radiation dose and post-irradiation time", IEEE Trans. Nucl. Sci., 53, pp 2367 (2006). M. Fernández-Rodríguez, G. Ramos, D. Levy, C. G. Alvarado, A. Nuñez, A. Alvarez-Herrero, "Ellipsometric analysis of gamma radiation on Standard optical coatings used in aerospace application", Thin Solid Films 545, pp 455-456 (2004).

Name	**Dr. V. Martínez Pillet**
Address	Instituto de Astrofísica de Canarias c/ Vía Láctea s/n 38200 La Laguna, S/C de Tenerife, Spain Phone: +34 922605237 Fax: +34 922605210 email: vmp@iac.es
Position in Project	Institute leader
Present Position	Senior staff member at IAC (since 1995)
CV	PhD in 1992 from the University of La Laguna 1993-1994 Postdoc at HAO/NCAR (Boulder, USA) Member of the Scientific Advisory Committee of HAO/NCAR (1997-today) Member of the ATST Science Working Group (2001-2005) Member of the ESA Solar System Working Group (2001-2003) Member of the ESA *Solar Orbiter* Payload Working Group (2002-2006) Member of the Editorial Board of the Journal Solar Physics (2004-) Member of the Spanish National Astronomical Commission (2006-2010) President of IAU Commission 12 (2007-2009) Vice-President of IAU Division II (2007-2009) Consultant of Spanish National Funding Agencies (PNE, PNAyA, ANEP) PI of the Imaging Magnetograph eXperimet for the *SUNRISE* balloon program. Co-PI of a proposal called SO/PHI for the VIM instrument of the Solar Orbiter mission. 50 papers in refereed Journals.
Relevant Publications	Martínez Pillet, V., and the IMaX team, 'The imaging magnetograph eXperiment for the *SUNRISE* balloon Antarctica project', Optical, Infrared, and Millimetre Space Telescopes, 2004, SPIE, **5487**, 1152 Mártínez Pillet, V., Aparicio, A., Sánchez, F. (eds.), 'Payload and Mission Definition in Space Sciences', 2005, ISBN 052185802X. Cambridge, UK: Cambridge University Press Sainz Dalda, A. and Martínez Pillet, V., 'Moving Magnetic Features as Prolongation of Penumbral Filaments', 2005, ApJ, **632**, 1176 Jurčák, J., Martínez Pillet, V., Sobotka, M., 'The magnetic canopy above light bridges', 2006, A&A, **453**, 1079 Martínez Pillet, V., 'Instrumental approaches to Magnetic and velocity measurements in and out of the ecliptic', in *Proc. of the Second Solar Orbiter Workshop*, 2007*,* ESA **SP-641** Mathew, S. K., Martínez Pillet, V., Solanki, S. K., Krivova, N. A, 'Properties of sunspots in cycle 23. I. Dependence of brightness on sunspot size and cycle phase', 2007, A&A, **465**, 291 Vargas Domínguez, S., Bonet, J.A., Martínez Pillet, V., Katsukawa, Y., Kitakoshi, Y., and Rouppe van der Voort, L., 'On the □rbi-Penumbra Relation', 2007, ApJ, **660**, L165

Name	**Tomás Belenguer**
Address	INTA, Carretera de Ajalvir Km 4.5 28850 Torrejón de Ardoz MADRID (SPAIN) Phone: +34915201847 FAX: +34915201317 email: belenguer@inta.es
Position in Project	Optical Scientist
Present Position	Head of INTA LINES
CV	MS in physics, optical engineer in1986 from the University of Zaragoza, From 1989 to 1996 responsible of Rangefinder research and development line at ENOSA working as a senior optical engineering; From 1996 to 2005 expert in Optics, working in design integration and testing of optical instrumentation in various spatial missions, INTEGRAL, OSIRIS, MINISOB, IRIS, IMaX (*SUNRISE*), MIRI, SEOSAT, OPTOS, MICROSAT From 2005 up to date, Head of LINES. His research interests include Holography, holographic interferometry, speckle metrology, SolGel Optics, advanced material for space applications and optical design of instruments
Relevant Publications	"The MIRI Telescope Simulator". SPIE Congress. Edinburgh 2004 "Measurements of wood structural features by optical techniques" international agrophysics, 8, pp 653-660 (1994) "Holographic diffraction gratings recording in organically modified silica gels", Opt. Lett. 21(no.22) (1996) "Faraday rotation in magnetic γ-fe2o3/sio2 nanocomposites", Appl. Phys. Lett. "High sensitivity temperature sensor based on overlay on side-polished fibers"/photonics technology letters (2000) "Hydrodynamic Lattice-Boltzman Simulation of a Thermoplastic Fluid Film for Holographic Recording Including the Effect of Electric Forces" ,T. Belenguer, Opt.Spectr.103, pp 898-903 (2007) "Shrinkage Control in a Photopolymerizable Hybrid Sol-Gel Material for Holographic Recording", G. Ramos, A. Álvarez-Herrero, T. Belenguer, F. del Monte y D. Levy ,Appl. Opt (2004) "Photopolymerizable Hyrbid Sol-Gel Materials for Holographic Recording", G. Ramos, A. Álvarez-Herrero, T. Belenguer, A. Núñez, F. del Monte y D. Levy; SPIE's Optics in Information Systems Technical Group Newsletter (Holographic Materials for Data Storage Special Issue), 2004.

Name	**Dr. Raquel López Heredero**
Address	Laboratorio de Instrumentación Espacial - LINES Área de Cargas Útiles e Instrumentación Instituto Nacional de Técnica Aeroespacial - INTA Ctra. Ajalvir km 4, 28850 Torrejon de Ardoz Madrid - SPAIN Phone: + 34 91 520 10 62 FAX: + 34 91 520 63 84 email: lopezhr@inta.es
Position in Project	Key technical personnel
Role in Project	Test coordinator responsible
Present Position	Senior staff member at INTA (since 1997)
CV	PhD in 2002 from the Autónoma University in Madrid (research carried out at LINES-INTA). Optical engineer at INTA. Her research interests include LCs behaviour for their application in optical devices for aerospace missions. She participates in the development and calibration of the IMaX polarization subsystem which is based in nematic LC variable retarders. She has experience in the design and development of fiber optic sensors based in Fabry-Perot cavities and fiber Bragg gratings for aerospace applications (project OPTOS). She collaborates in the activities of optical design and assembly, integration and verification of opto-mechanical integration at INTA (projects IMaX and MIRI Telescope Simulator (MTS)).
Relevant Publications	P.D. Townsend, N. Can, P.J. Chandler, B.W. Farmery, R. López-Heredero, A. Peto, L. Salvin, D. Underdown, B. Yang “Comparisons of tin depth profile analyses in float glass”, J. Non-Cryst. Sol. 223, pp 73-85 (1998) R.L. Heredero, R. Fernández de Caleya, H. Guerrero, P. Los Santos, M.C. Acero, J. Esteve “Micromachined optical fiber sensor”, Appl. Opt. 38, pp. 5298-5305 (1999) Álvarez-Herrero, R.L. Heredero, E. Bernabeu, D. Levy “Adsorption of water on porous Vycor glass studied by ellipsometry”, Appl. Opt. 40, pp. 527-532 (2001) R. L. Heredero, S. Martin, R. Fernández de Caleya, A. B. L. Ribeiro, F. M. Araújo, L. A. Ferreira, J. L. Santos, H. Guerrero “Study of the optical properties of photopolymer Fabry-Pérot microcavities by a dual-wavelength fibre optic architecture”, Measurement Sci. Tech. 13, pp 1094-1099 (2002) R.L. Heredero, J. L. Santos, R. Fernández de Caleya, H. Guerrero “Micromachined low-finesse Fabry-Pérot interferometer for the measurement of DC and AC electrical currents”, IEEE Sensors 3, pp. 13-18 (2003) Heredero R. L., Uribe-Patarroyo N., Belenguer T., Ramos G., Sanchez A., Reina M., Pillet V. M., Alvarez-Herrero A. , “Liquid-crystal variable retarders for aerospace polarimetry applications”, Appl. Opt. 46 pp 689-698 (2007) “The Imaging Magnetograph eXperiment for the *SUNRISE* balloon Antarctica project”, Proc. SPIE 2004-Optical, Infrared, and Millimeter Space Telescopes 5487, 1152-1164 (2004) “The MIRI Cold Telescope Simulator”, Proc. SPIE 2004-Optical, Infrared, and Millimeter Space Telescopes 5487, 804-813 (2004) “Lithium Niobate Fabry-Perot etalons in double-pass configuration for spectral filtering in the visible imager magnetograph IMaX for the *SUNRISE* mission”, Proc. SPIE 2006-Astronomical Telescopes and Instrumentation: 6265, G2652-G2652, Part 1-2 (2006) “Detailed Design of the Imaging Magnetograph eXperiment - IMaX: a visible imager magnetograph for the *SUNRISE* mission”, Proc. SPIE 2006-Space Telescopes and Instrumentation I: Optical, Infrared, and Millimeter: art. no. 62654C

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Position in Project	Institute Leader
Role in Project	Lead of IAA contribution; science support; data analysis
Present Position	CSIC's senior researcher at IAA (from July, 2007)
CV	PhD in 1987 from the University of La Laguna; PostDoc at IAC (1987 – 1990); CSIC's tenure scientist at IAC (1990 – 1992); Visiting scientist at Lockheed Palo Alto Research Labs. (1992 – 1993); CSIC's tenure scientist at IAC (1993 – 1998) and at IAA (1998 – 2004); CSIC's senior researcher at IAA (2007-) Member of the Scientific Advisory Committee of THEMIS (1996-98) Secretary of the Spanish Astronomical Society (2002-2004) Consultant of Spanish National Funding Agencies (PNE, PNAyA, ANEP) Director of the Instituto de Astrofísica de Andalucía (CSIC; 2004-2007) His research interests include solar spectropolarimetric diagnostics and measurements of magnetic fields, and polarization optics. He participates in the development of scientific instrumentation for space missions: he is Co-I of IMaX on *SUNRISE* and of AIA on SDO (NASA). He has experience in ground-based solar observations. He has given undergraduate and post-graduate courses in Spain, Austria, and Japan. Dr. del Toro Iniesta has authored one book, has co-edited two books, and has co-authored 42 papers in refereed journals.
Relevant Publications	Ruiz Cobo, B. & del Toro Iniesta, J.C., 1992, ApJ, 398, 375 Westendorp Plaza, C., del Toro Iniesta, J.C., Ruiz Cobo, B., Martínez Pillet, V., Lites, B.W., & Skumanich, A., 1997, Nature, 389, 47 Westendorp Plaza, C., del Toro Iniesta, J.C. Ruiz Cobo, B., Pillet, V. Martínez, Lites, B.W., & Skumanich, A., 2001, ApJ, 547, 1130 Collados, M., Martínez Pillet, V., Ruiz Cobo, B., del Toro Iniesta, J.C., & Vázquez, M., 1994, A&A, 291, 622 del Toro Iniesta, J. C., Tarbell, T. D., & Ruiz Cobo, B., 1994, ApJ, 436, 400 Ruiz Cobo, B. & del Toro Iniesta, J. C., 1994, A&A, 283, 129 Westendorp Plaza, C., del Toro Iniesta, J. C., Ruiz Cobo, B., & Martínez Pillet, V., 2001, ApJ, 547, 1148 del Toro Iniesta, J.C., Bellot Rubio, L.R.; Collados, M. 2001, ApJ, 549, L139 del Toro Iniesta, J. C. & Ruiz Cobo, B., 1996, Sol. Phys.,164,169 Westendorp Plaza, C., del Toro Iniesta, J. C., Ruiz Cobo, B., Martínez Pillet, V., Lites, B. W., Skumanich, A., 1998, ApJ, 494, 453

Name	**Dr. Antonio C. López Jiménez**
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Position in Project	Insitute head engineer
Role in Project	Insitute head engineer
Present Position	CSIC's tenure scientist at IAA (since 2008)
CV	PhD in 2006 from the University of Granada. Senior staff member of IAA since 1993. His research interests include development techniques in FPGA, algorithm implementation in VHDL, and space scientific instrumentation. He has participated in the development of scientific instrumentation for space missions: Cassini-Huygens(PWA), Mars 96 (PFS), Rosetta (OSIRIS and GIADA). He has experience in instrumentation for ground-based telescopes -- CCD cameras, telescope control-- and in rocket instrumentation. He is responsible for the control electronics and software of the IMaX instrument on-board the *SUNRISE* mission. He is co-author of 8 publications and more than 30 meeting contributions.
Relevant Publications	L. Colangeli et al. (including Lopez-Jimenez, A.) "The Grain Impact Analyser and Dust Accumulator (GIADA) Experiment for the Rosetta Mission: Design, Performances and First Results", Space Sci. Rev. 128, Iss: 1-4 (2007). Keller, H.U. et al. (including Lopez-Jimenez, A.): "OSIRIS – The Scientific Camera System Onboard Rosetta". Space Science Reviews, 128, Iss: 1-4; (2007). L. Colangeli, J.J. López Moreno, et al (including Lopez-Jimenez, A.) "GIADA: The Grain Impact Analyser and Dust Accumulator for the Rosetta space mission". Adv. Space. Research, 39, Issue 3; (2007). Álvarez-Herrero, et al. (including Lopez-Jimenez, A.). "Detailed design of the imaging magnetograph eXperiment-ImaX: a visible imager magnetograph for the *SUNRISE* mission". Space Telescopes and Instrumentation I: Optical, Infrared, and Millimeter. Edited by John C. Mather, Howard A. MacEwen, and Mattheus W. M. de Graauw. Proceedings of the SPIE, Volume 6265, 2006. Martínez Pillet, V. et al. (including Lopez-Jimenez, A.). "The imaging magnetograph eXperiment for the *SUNRISE* balloon Antarctica project". Optical, Infrared, and Millimeter Space Telescopes. Edited by Mather, John C. Proceedings of the SPIE, Volume 5487; 2004. Colangeli, L. et al. (including Lopez-Jimenez, A.). "The GIADA experiment for the Rosetta mission". Astrophysics and Space Science Library*;* Volume 311; 2004. Castro Marín, J.M. et al. (including Lopez-Jimenez, A.C.). "Mechanism controller system for the optical spectroscopic and infrared remote imaging system instrument on board the Rosetta space mission". Rev. Scientific Instruments, Volume 72, Issue 5;(2001). Colangeli, L. et al. (including Lopez-Jimenez, A.). "Experiments for in-situ monitoring of dust environments in the Solar System". Bull. Am. Astron. Soc., Vol. 31, No.4;(1999). Bussoletti, E. et al. (including Lopez-Jimenez, A.). "The GIADA experiment for ROSETTA mission to comet 46P/wirtanen: Design and performances", Adv. Space Research, Volume 24, Issue 9; (1999).

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Position in Project	Achromatic LC study lead
Present Position	Staff Astronomer, Nat. Inst. of Astrophysics. (INAF) - Turin Astronomical Obs., Torino, Italy
CV	**Education:** • ˜ 1994 Ph.D. in Astronomy, Universita' di Firenze, Firenze, Italy • 1988 Doctor in Physics (”Laurea in Fisica”} Univ. di Firenze, Firenze, Italy **Professional:** • 2002 - Co-PI, NASA, UV & Visible-light Coronagraphic Imager (UVCI) for the HERSCHEL sounding-rocket • 2005 – Co-responsible, INAF/Turin Astron. Obs., Optical Payload System Facility. • 1996-2000 - Co-Investigator, Lead Science Operations Scientist, NASA/ASI (Italian Space Agency), Ultraviolet Coronagraph and Spectrometer (UVCS/SOHO) • 1992-2000 - Associate Scientist, NASA, Ultraviolet Coronal Spectrometer for the Space Shuttle Sub-satellite SPARTAN
Relevant Publications	• F. Landini, M. Romoli, S. Fineschi, E. Antonucci, Applied Optics 45, 26, “Stray-light analysis for the SCORE coronagraphs of HERSCHEL” , 6697 (2006) • G. Naletto, S. Fineschi, et al. Applied Optics 44, 24, “Optical design of a high-spatial-resolution extreme-ultraviolet spectro-heliograph for the transition region”, 5046 (2005) • S. Fineschi, J.D. Moses, and R.J. Thomas, Proc. SPIE 5901, “Spectro-imaging of the extreme-UV solar corona”, 289 (2005) • S. Fineschi ,et al, Proc. SPIE 5487, “Solar ultraviolet spectro-coronagraph with toroidal varied line-space (TVLS) grating”, 1165 (2004) • S. Fineschi, et al. Proc. SPIE 4853, “Ultraviolet and Visible-light Corona-graphic Imager (UVCI) ”, 162 (2003) • K. Yuan-Ko, [et al.], S Fineschi, et al., Ap. J. 578, 2, , “SOHO/UVCS and Yohkoh Soft X-Ray Telescope Observations of the High-Temperature Corona above an Active Region Complex”, 979, (2002) • A. Ciaravella, [et al.], S. Fineschi, Ap. J. 575, 2, ” Elemental Abundances and Post-Coronal Mass Ejection Current Sheet in a Very Hot Active Region”, 1116, (2002) • E. Antonucci, S. Fineschi, et al., Porc. SPIE 4139, “Ultraviolet and visible-light coronagraph for the Solar Orbiter mission”, 378 (2000)

Name	**Luca Zangrilli**
Address	INAF - Osservatorio Astronomico di Torino Strada Osservatorio 20 10025 - Torino Italy email:zangrilli@oato.inaf.it
Position in Project	LC scientist
Present Position	Scientific Technician, Nat. Inst. of Astrophysics. (INAF) - Turin Astronomical Obs., Torino, Italy
CV	**Education:** • Laurea degree in Astronomy, University of Padua, Italy, 1993. • Ph.D in Astronomy, University of Padua, Italy, 1998. **Professional:** • Responsible of the laboratory activities related to the integration and calibration of the visible light polarimeters for the EKPol eclipse telescope, and SCORE/UVCI sounding rocket coronagraph. • Member of the alignment and integration team of the SCORE/UVCI sounding rocket coronagraph. • Program manager of the SPECTRE instrument for the Solar Dynamic Observatory.
Relevant Publications	• Fineschi S. et al., KPol: liquid crystal polarimeter for K-corona observations from the SCORE coronagraph, SPIE, Volume 5901, pp. 389-399 (2005). • Naletto G. et al., SPECTRE: a spectro-heliograph for the transition region, ESA Publications Division, 2004, p. 251 - 256 • Gherardi A. et al., CCD camera for ground- and space-based solar corona observations, SPIE, Volume 5171, pp. 247-257 (2004). • Fineschi S., et al., Ultraviolet and Visible-light Coronagraphic Imager (UVCI), SPIE, Volume 4853, pp. 162-171 (2003). • Zangrilli L. et al., Solar and Stellar Polarimetry with Liquid Crystal Retarders, Memorie della Societa Astronomica Italiana, v.74, p.807 (2003).

Name	**Giuseppe Massone**
Address	INAF - Osservatorio Astronomico di Torino Strada Osservatorio 20 10025 - Torino Italy email:massone@oato.inaf.it
Position in Project	Optical scientist
Present Position	Scientific Technician, Nat. Inst. of Astrophysics. (INAF) - Turin Astronomical Obs., Torino, Italy
CV	**Professional:** • March 1, 1982: beginning of the service at Torino Observatory, for activity on visual double star measurement (filar micrometer) and trigonometric parallax determination (photographic); • 1983-1987: continuation of classical astrometry activities, including comets and minor planets astrometry, with observations and development of reduction software; • 1988-1992: start activity on open cluster proper motion determination, photoelectric and CCD photometry, in collaboration with Mario Lattanzi at Space telescope Science Institute for the new project of GSC-II star catalogue. In this respect several times visiting astronomer at European Southern Observatory in La Silla for the photometric calibration of the southern sky fields; • 1992-1993: continuation of above activities and in charge of design a new CCD camera for Torino Observatory; • 1994-1998: staring observation with the new CCD camera for the program of trigonometric stellar parallaxes; design and realization of the automation of Ascorecord plate measuring machine; • 1999: in charge of the organization and implementation of the new optical laboratory for interferometric activities; same year promoted at the position of responsible of the laboratory; • 2000-2001:in charge of the optomechanical design of FINITO, a fringe sensor for VLTI interferometrer built as a collaboration between ESO and Torino Observatory; • 2002-2004: construction and integration of FINITO at ESO Garching and then Paranal; starting of PRIMA project, in charge of design and realization of the cryostat for PRIMA-FSU; • 2004-2006:integration of PRIMA-FSU at ALCATEL ALENIA SPACE and ESO Garching; collaboration with the Torino Observatory Solar Group for design and realization of a liquid crystal polarimeter used for the observation of the total solar eclipse at Waw an Namus (Lybian desert) in March 29, 2006; • 2006: appointed as coordinator of the scientific instrumentation (telescopes and laboratories) of Torino Observatory.
Relevant Publications	

Name	**Dr. Marc GEORGES**
Address	Centre Spatial de Liège - Université de Liège Liege Science Park, Avenue du Pré Aily B-4031 Angleur (Liège) Phone : +32-(0)4-3676668, Fax : +32-(0)4-3675613 e-mail : mgeorges@ulg.ac.be
Position in Project	Project manager at CSL level - Optical characterization
Present Position	Senior staff member at CSL - Head of Laser Techniques Activity
CV	Physicist from Univ. Catholique de Louvain (Louvain-la-Neuve) in 1990, Marc Georges is researcher at CSL since 1990. He first was implied in the optical characterization of photorefractive materials. Then he developed holographic techniques with photorefractive materials, with applications in full-field non destructive testing. He obtained his PhD in this field in 1998. After his pursued his activity in the field, among which characterization of holographic materials for space utilization (including radiation tests). In 2006, he took the leadership of the Laser Techniques activity. Fields of interest : optical and holographic characterization of materials, development of holographic NDT techniques, qualification of laser elements for space utilization, laser spectroscopy (LIBS). • 2005 : Joint award of Optical Society of America and National Science Foundation of China for "Best Application of Photorefractive Materials" for the development and commercialization of photorefractive holographic camera • since 2005 : Member of Scientific Committee of CLEO/Europe, Conference for Laser and Electro-Optics, Symposium CC on "Holography, Adaptive Optics, Optical Storage and Photorefractives" • since 2007 : Member of Scientific Committee of Société Française d'Optique CMOI (Club Mesures Optiques pour l'Industrie) • 12 publications in refereed journals • 1 book chapter • typically 70 papers in conference proceedings • Coordinator of FP7 "FANTOM" project (1st call Transport/Aero)
Relevant Publications	• Ph.C. Lemaire and M.P. Georges, “Correction method of secondary reflection effects in measurement of electro-optic coefficient in optically active media”, Optics Communications, Vol. 91, p. 260-266 (1992) • Ph.C. Lemaire and M.P. Georges, “Electro-optic coefficient measurements : correction of electric-field inhomogeneities in the transverse configuration”, Optics Letters, Vol. 17, N° 20, p. 1411-1413 (1992) • Ph.C. Lemaire and M.P. Georges, “Local measurement system for optical and electro-optic characterization and homogeneity analysis of photorefractive sillenite crystals”, Optical Materials, Vol. 4, p. 182-187(1995) • M. Georges, L. Joannes, C. Thizy, F. Dubois, O. Dupont, Ph. Lemaire, J-C. Legros, "Holographic camera with BSO applied to microgravity fluid experiment onboard ISS", Trends in Optics and Photonics Series, Vol 62 on *Photorefractive Effects, Materials and Devices*, D.Nolte, G. Salamo, A. Siahmakoun, S. Stepanov, eds., p. 18-25 (2001) • M. Georges, O. Dupont, I. Zayer, Ph. Lemaire, Th. Dewandre, "Qualification of BSO crystals for use onboard the International Space Station", Trends in Optics and Photonics Series, Vol 87 on Photorefractive Effects, Materials and Devices, Ph. Delaye, C. Denz, L. Mager, G. Montemezzani, eds., p.456-462 (2003) • A. Brignon, S. Richard, A. Gusarov, F. Berghmans, M. Georges, T. Thibert, and Y. Lien, "Assessment of space radiation effects on solid-state Brillouin phase conjugate mirrors", Applied Optics, Vol. 46 Issue 22, pp.5329-5335 (2007)

Name	**Alain CARAPELLE**
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Position in Project	Scientist responsible of radiation tests
Present Position	Project Manager in Advanced Technologies department. Research scientist in various Activity Groups. Radiation protection responsible for CSL.
CV	Mr Carapelle holds a University Master in Physical Sciences, a University degree for High-School Physical Sciences teaching and a Post-Master University degree in Nuclear Science. Also he is Belgian Federal Nuclear Agency certified Level II Radiation Protection Expert. Prior to joining CSL, he was assistant at the University of Liege and engineer at IBA (world leader company manufacturing particle accelerators). At CSL he worked on the following projects : • FESTIP Phase 2 Technology developments in heat management for reusable launch vehicles, Work Package 4.3, ESA • Development of a photometer for real-time counting of particles, ESA & Belgian Walloon region • ESP (Experimental Solar Panel) Phase I, Solar Array Concentrator, ESA • ESP (Experimental Solar Panel) Phase II, Array Concentrator, ESA
Relevant Publications	• A.Carapelle, J.-P.Collette, "Gamma-ray attenuation for characterization of future space launcher fuels", IEEE Transactions On Nuclear Science, Vol. 53, No. 3 (June, 2006) • A.Carapelle, J.-P.Collette, "Gamma-ray attenuation for measuring cryogenic slush mixture", Nuclear Inst. and Methods in Physics Research, B, 229 111-116 (2005) • A.Carapelle, M.Henrist. "Comparison of a Rutherford Back Scattering signal with a Particle Induced X-Ray emission signal". Patent number: WO2004025285 & EP1391722 • A.Carapelle, K.Fleury-Frenette, J.-P.Collette, H.-P.Garnir and P.Harlet Portable XRF spectrometer for coating thickness measurement, Rev.Sci.Inst, Volume 78, Issue 12 (2007)

Name	**Dr Karl FLEURY-FRENETTE**
Address	Centre Spatial de Liège - Université de Liège Liege Science Park, Avenue du Pré Aily B-4031 Angleur (Liège) Phone : +32-(0)4-3676668, Fax : +32-(0)4-3675613 e-mail : mgeorges@ulg.ac.be
Position in Project	Scientist responsible of ellipsometric characterization
Present Position	Head of the Surface & Nanoengineering Activity
CV	Dr Fleury-Frenette holds a BSc in Physics from Mc Gill University in Canada, MSc in Atomic and Molecular Physics from Université Laval, Québec and a PhD in Science from University of Liege. He has followed complementary trainings in Thin film depositions and application (Uppsala Finland), Advanced Optical Coatings (Tucson US), Ion sources (Moscow) and Surface simulations (Sherbrooke Canada). Prior to join CSL, he made researches in deposition and characterization of magneto-optical thin films (subject of his PhD). In 2000, he joined CSL and has established activities in R&D in surface treatments (coating, ion & plasma,..), surface characterization and optical characterization facilities in clean rooms. His main projects are : • Since 2007 : involved as division leader in *GSTP Carbon Nanotubes for Space Applications* • Since 2005 : involved as specialist in *GSTP Lithographic Manufacturing of Zeroth Order Gratings for Innovative Achromatic Phase Shifters* • Since 2005 : involved as specialist in the *ESP Experimental Solar Pannel program* • Since 2005: involved as specialist in the *MIRIM instrument program* • 2003-2005 : involved as WP manager in TRP *Darwin Optical Delay Lines*
Relevant Publications	• P. Gailly, J. -P. Collette, C. Jamar, K. Fleury-Frenette, P. Médart, Y. Stockman, Roughness evolution of some X-UV reflective materials induced by low energy (<1 keV) ion beam milling, Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, Volume 216, pp 206-212 (2004) • A.Carapelle, K.Fleury-Frenette, J.-P.Collette, H.-P.Garnir and P.Harlet Portable XRF spectrometer for coating thickness measurement, Rev.Sci.Inst, Volume 78, Issue 12 (2007) • D. Mawet, Ch. Hanot, C.Lenaers, P.Riaud, D. Defrère, D. Vandormael, J. Loicq, K. Fleury-Frenette, J-Y. Plesseria, J. Surdej, S. Habraken, "Fresnel rhombs as achromatic phase shifters for infrared nulling interferometry", Optics Express, Vol. 15, Issue 20, pp. 12850-12865 (2007)

Name	**Dr. Toralf SCHARF**
Address	ARCOPTIX S.A. Chemin de Trois Portes 18 Neuchatel - Switzerland Phone: + 41 32 731 0464 FAX: + 41 32 731 0463 email: scharf@arcoptix.com
Position in Project	Head of the arcoptix part of the project (realisation of the various liquid crystal cell types).
Role in Project	Coordination of ARCOPTIX contribution; technology and optical advisor for LC cell realisation.
Present Position	Director
CV	Director of ARCOPTIX (since 2006) Head of research, Applied Optics at the Institute of Microtechnology, University of Neuchatel, Neuchatel (1997-2006) Dr. rer. nat. in Physical Chemistry in 1997 from the Martin Luther University of Halle-Wittenberg (research carried out at Max Planck Research Group) He has done basic research on ferroelectric liquid crystals, applied research on miniaturized liquid crystal devices and application of microoptics.
Relevant Publications	T. Scharf, Polarized light in Liquid Crystals and Polymers, Wiley 2006

Name	**Dr. Gerben Boer**
Address	ARCOPTIX S.A. Chemin de Trois Portes 18 Neuchatel - Switzerland Phone: + 41 32 731 0466 FAX: + 41 32 731 0463 email: boer@arcoptix.com
Position in Project	Principal Engineer in the arcoptix part of the project (realisation of the various LCVRs).
Role in Project	Responsible for the engineering and manufacturing LCVRs.
Present Position	Liquid crystal product Manger
CV	Now: Liquid crystal Product Manger at ARCoptix S.A (since February 2006) 2005-2006: Research scientist at the Institute of Microtechnology in Neuchâtel for development of optical diffractive element for medical applications. 2003-2005: Research scientist at the EPFL in the advanced photonics group for development optical tweezers based on micro-optics for bio-analysis systems on a chip. 1999-2003: PhD student and research assistant in the polymer opto-electronic section of CSEM S.A, for the development of optical liquid crystal devices fro interferometric applications.
Relevant Publications	- G.Boer, T.Scharf, and R.Dändliker, "Static Fourier transform spectrometer with a large field of view based on liquid-crystal technology", Applied Optics, Vol. 41, 7, March 2002. - G.Boer, T.Scharf, "Polarization Ray Tracing in Twisted Liquid Crystal Systems", Molecular Crystals and Liquid Crystals, Vol. 375, pp.301-311, 2002. - G. Boer, P. Ruffieux, T. Scharf, P. Seitz and R. Dändliker, "Compact liquid crystal polymer Fourier transform spectrometer", Applied Optics, Vol.43, 11, April 2004. - G. Boer, *Polarization interferometers using liquid crystal as birefringent elements.* (Thesis director was Prof. Dändliker).

ANNEX 2: COST DESCRIPTION FORMS OF INTA

COMPANY COST ELEMENT DATA SHEET	FORM No. PSS A1 Issue 2	Page no. of
RFQ/ITT no.: AO/1-5798/08/NL/Sfe		COMPANY NAME: INTA
PROPOSAL no.: INTA-LCVRs-001		Name and title: Alberto Alvarez Herrero
NATIONAL CURRENCY *: EURO		Signature:
Period for which agreed rates and overheads are valid : From January To December		
ECONOMIC CONDITIONS: 2008		

1. LABOUR *Direct labour cost centres or categories*	Basic Labour *hourly rate (NC)*	Labour OH% *(or NC)*	GROSS HOURLY RATE *in National Currency*
1 Engineer	90.51		90.51
2 Technician	51.15		51.15
3 Management	90.51		90.51

2. INTERNAL SPECIAL FACILITIES	Type of Unit	UNIT RATE (NC)
Thermal Vacuum TVC1	Hour	51.15
Vibration-shock test facility	Hour	51.15
Outgassing facility	Hour	51.15
Clean area 1000	Hour	51.15
Optical measurement equipment	Hour	51.15

3. OTHER COST ELEMENTS			OVERHEADS
According to ESA type		*According to normal company type*	*%*
3.1	Raw materials		
3.2	Mechanical parts		
3.3	Semi-finished products		
3.4	Electric & electronic components		
3.5	Hirel parts		
	a) procured by company		
	b) procured by 3rd party		
3.6	External major products		
3.7	External services		
3.8	Transport, insurance		
3.9	Travels		
3.1	Miscellaneous		
3.11	Subcontracts		

GENERAL EXPENSES			OVERHEADS
According to ESA type	*According to normal company type*	*Applicable on cost element no.*	*%*
5. General & Admin. expenses			
6. Research & Developm. expenses			
7. Other (specify)			

12. COST WITHOUT ADDITIONAL CHARGE

Agreed by

Status
(x when appl.)

COMPANY PRICE BREAKDOWN FORM — ***Form No. PSS A2*** — ***Issue 4***

Page No. 1 No. of Pages 1

RFQ/ITT No. **AO/1-5798/08/NL/Sfe**	COMPANY NAME: **INTA**
Proposal/Tender No.: **INTA-LCVRs-001**	Name and Title: **Alberto Alvarez Herrero**
Economic Condition: **sep-08** Type of Price: **Firm Fixed Price**	Signature

SUPPLIES AND/OR SERVICES TO BE FURNISHED

LABOUR *Direct Labour cost centres or categories*	Manpower effort *in Manhours*	Gross Hourly Rates *in NC**		National Currency (NC)	Total EURO *€*
1 Engineer	200	91			18 102
2 Technician	55	51			2 813
3 Administrative	60	91			5 431
1 Total Direct Labour Hours and Cost			*A*		*26 346*

INTERNAL SPECIAL FACILITIES	Type of unit	No. of units	Unit rates in NC			
1 Thermal Vacuum TVC1	hour	60	51			3 069
2 Vibration-shock test facility	hour	48	51			2 455
3 Outgassing facility	hour	12	51			614
4 Clean area 10000	hour	60	51			3 069
5 Optical measurement equipment	hour	100	51			5 115
2 Total Internal Special Facilities Cost				*B*		*14 322*

OTHER COST ELEMENTS	Base amounts in NC	OH%	OH amounts in NC			
3.1 Raw materials	4 000					4 000
3.2 Mechanical parts						
3.3 Semi-finished products						
3.4 Electrical & electronic components						
3.5 Hirel parts						
a) procured by company						
b) procured by third party						
3.6 External Major Products						
3.7 External Services	198 648					198 648
3.8 Transport/Insurance						
3.9 Travels	6 600					6 600
3.10 Miscellaneous						
3 Total Other Direct Cost	*209 248 C*		*D*	*E*		*209 248*
4. SUB TOTAL COST			**(A+B+E)**	**F**		**249 916**

GENERAL EXPENSES	Cost items to which % applies	Base in NC to which % applies	%			
5. General & Admin. Expenses				G		
6. Research & Develop. Exp.				H		
7. Other (to be specified)				J		
8. Total Cost of All Work Packages			***(F+G+H+J)***	***K***		***249 916***
9. Overheads on Subcontractors (Base in NC on which % applies:)			%	L		
10. Sub-total			**(K+L)**	**M**		**249 916**
11. Profit (% on Base Amount in NC:)				N		
12. Cost without additional charge (to be itemised on Exhibit A)				P		
13. Financial Provision for escalation, if applicable (justification and details to be stated on Exhibit A)				Q		
14. Total			**(M+N+P+Q)**	**R**		**249 916**
15. Reduction for company contribution (if applicable)				S		
16. TOTAL PRICE FOR ESA			**(R-S)**	**T**		**249 916**

If insufficient space is available to identify all required information, please use additional sheet or insert lines

* The Euro is to be used as the NC where the cost accounting system is in Euro.

Manpower and Price Summary

Issue 4

Subject: Validation of LCVRs for the Solar Orbiter Polarisation Modulation Package

ITT/RFQ: Validation of LCVRs for the Solar Orbiter Polarisation Modulation Package

(*) National Currency (NC) :

(**) Conversion

Economic 2008

Company	INTA	INTA	INTA	INTA	INTA	INTA	INTA	INTA	INTA	INTA	INTA	
WP Title	Requirements & Technology Review	Preliminary assesment of environmental effects	Preliminary selection of design parameters and definition of LCVRs set	Detailed definition, manufacturing/ procurement and testing plan	Manufacturing/Procurement & functional verification	Test and Characterisation	Critical appraisal, recomendations and technology qualification plan	Coordination	Deliverables Control	Reporting	Meetings	
WP Number	WP 0100	WP0200	WP 0300	WP 0400	WP 1100	WP 1200	WP 1300	WP 2100	WP 2200	WP 2300	WP 2400	Total WBS-Level
Labour hours as per PSS A2 (*)												
Engineer	15	15	10	20	25	85	30	0	0	0	0	200
Technician	0	0	0	0	10	45	0	0	0	0	0	55
Management	0	0	0	0	0	0	0	20	10	20	10	60
...												0
...												0
...												0
...												0
...												0
Total Labour Hours	15	15	10	20	35	130	30	20	10	20	10	315
1. Total Labour Cost	1 358	1 358	905	1 810	2 774	9 995	2 715	1 810	905	1 810	905	26 346
2. Internal Special Facilities	0	0	0	0	0	14 322	0	0	0	0	0	14 322
3.1-3.4 Material Costs						4 000						4 000
3.5 High Rel Parts Costs												0
3.6 External major products Cost												0
3.7 External Services Cost												198 648
3.8 Transport/Insurance Cost												0
3.9 Travel and Subsistance Cost	2 000			800	800		1 000	2 000				6 600
3.10 Miscellaneous Cost												
3. Total Other Costs	2 000	0	0	800	800	4 000	1 000	2 000	0	0	0	209 248
4. Subtotal Cost	3 358	1 358	905	2 610	3 574	28 317	3 715	3 810	905	1 810	905	249 916
5.- 7. General expenses												
8. Total Cost of WPs	3 358	1 358	905	2 610	3 574	28 317	3 715	3 810	905	1 810	905	249 916
9. Overhead on Subcontractors												
10. Subtotal (8+9)	3 358	1 358	905	2 610	3 574	28 317	3 715	3 810	905	1 810	905	249 916
11. Profit	0	0	0	0	0	0	0	0	0	0	0	0
12. Cost without additional charge												
13. Financial Provision for escalation												
14. Total	3 357.65	1 357.65	905.10	2 610.20	3 574.25	28 317.10	3 715.30	3 810.20	905.10	1 810.20	905.10	249 915.85
15. Reduction for company contribution (if applicable)												
16. Total Price	3 357.65	1 357.65	905.10	2 610.20	3 574.25	28 317.10	3 715.30	3 810.20	905.10	1 810.20	905.10	249 915.85

(*) for PSS A8 of a single company. (**) The EURO is to be used as the NC where the cost accounting system is in EURO

Manpower and Price Summary

Subject: Validation of LCVRs for the Solar Orbiter Polarisation Modulation Package

(*) National Currency (NC) : (**) Conversion

Company	INTA	INTA	
WP Title	Technical requirements review	Technology review	
WP Number	WP 0110	WP 0120	
			Total WBS-Level
Labour hours as per PSS A2 (*)			
Engineer	7	8	15
Technician	0	0	0
Management	0	0	0
...			
...			
...			
...			
...			
Total Labour Hours	7	8	15
1. Total Labour Cost	634	724	1 358
2. Internal Special Facilities			
3.1-3.4 Material Costs			
3.5 High Rel Parts Costs			
3.6 External major products Cost			
3.7 External Services Cost			
3.8 Transport/Insurance Cost			
3.9 Travel and Subsistance Cost	1 000	1 000	2 000
3.10 Miscellaneous Cost			
3. Total Other Costs	1 000	1 000	2 000
4. Subtotal Cost			3 358
5.- 7. General expenses			
8. Total Cost of WPs	1 634	1 724	3 358
9. Overhead on Subcontractors			
10. Subtotal (8+9)	1 634	1 724	3 358
11. Profit	0	0	0
12. Cost without additional charge			
13. Financial Provision for escalation			
14. Total	1 633.57	172 408.00	3 357.65
15. Reduction for company contribution (if applicable)			
16. Total Price	1 633.57	1 724.08	3 357.65

(*) for PSS A8 of a single company. (**) The EURO is to be used as the NC where the cost accounting system is in EURO

Manpower and Price Summary

Subject: Validation of LCVRs for the Solar Orbiter Polarisation Modulation Package

(*) National Currency (NC) : (**) Conversion

Company	INTA	INTA	INTA	
WP Title	Functional and performance requirements review	Revision of the outgassing requirements	Revision of the environmental requirements	
WP Number	WP 0111_A	WP 0112_A	WP 0113_A	
				Total WBS-Leve
Labour hours as per PSS A2 (*)				
Engineer	2	3	2	7
Technician	0	0	0	0
Management	0	0	0	0
...				
...				
...				
...				
...				
Total Labour Hours	2	3	2	7
1. Total Labour Cost	181	272	181	634
2. Internal Special Facilities				
3.1-3.4 Material Costs				
3.5 High Rel Parts Costs				
3.6 External major products Cost				
3.7 External Services Cost				
3.8 Transport/Insurance Cost				
3.9 Travel and Subsistance Cost	334	333	333	1 000
3.10 Miscellaneous Cost				
3. Total Other Costs	334	333	333	1 000
4. Subtotal Cost	515	695	515	1 634
5.- 7. General expenses				
8. Total Cost of WPs	515	695	515	1 634
9. Overhead on Subcontractors				
10. Subtotal (8+9)	515	695	515	1 634
11. Profit	0	0	0	0
12. Cost without additional charge				
13. Financial Provision for escalation				
14. Total	515.02	694.53	515.02	1 633.57
15. Reduction for company contribution (if applicable)				
16. Total Price	515.02	694.53	515.02	1 633.57

(*) for PSS A8 of a single company. (**) The EURO is to be used as the NC where the cost accounting system is in EURO

Manpower and Price Summary

Subject:	Validation of LCVRs for the Solar Orbiter Polarisation Modulation Package			
(*) National Currency (NC) :				(**) Conversion
Company	INTA	INTA	INTA	
WP Title	Study of the State of the Art of LCVRs for polarimetry	Study of Alternative concepts of LCVRs for polarimetry	Study of technology improvements	
WP Number	WP 0121 A	WP 0122 A	WP 0124 A	
				Total WBS-Leve
Labour hours as per PSS A2 (*)				
Engineer	2	3	3	8
Technician	0	0	0	0
Management	0	0	0	0
...				
...				
...				
...				
...				
Total Labour Hours	2	3	3	8
1. Total Labour Cost	181.02	271.53	271.53	724
2. Internal Special Facilities				
3.1-3.4 Material Costs				
3.5 High Rel Parts Costs				
3.6 External major products Cost				
3.7 External Services Cost				
3.8 Transport/Insurance Cost				
3.9 Travel and Subsistance Cost	666	667	666	2 000
3.10 Miscellaneous Cost				
3. Total Other Costs	666	667	666	2 000
4. Subtotal Cost	847	939	938	2 724
5.- 7. General expenses				
8. Total Cost of WPs	847	939	938	2 724
9. Overhead on Subcontractors				
10. Subtotal (8+9)	847	939	938	2 724
11. Profit	0	0	0	0
12. Cost without additional charge				
13. Financial Provision for escalation				
14. Total	847	939	938	2 724.08
15. Reduction for company contribution (if applicable)				
16. Total Price	847	939	938	2 724.08

(*) for PSS A8 of a single company. (**) The EURO is to be used as the NC where the cost accounting system is in EURO

Manpower and Price Summary Issue 4

Subject: Validation of LCVRs for the Solar Orbiter Polarisation Modulation Package ITT/RFQ: Validation of LCVRs for th

(*) National Currency (NC) : (**) Conversion Economic

Company	INTA	INTA		INTA	INTA	
WP Title	LCVRs under space environmental conditions	Establish performance indicators		Identification of basic set of design parameters	Definition of LCVRs set	
WP Number	WP 0210_A	WP 0220_A	Total WBS-Level	WP 0310_A	WP 0320_A	Total WBS-Level
Labour hours as per PSS A2 (*)						
Engineer	7	8	15	7	3	10
Technician	0	0	0	0	0	0
Management	0	0	0	0	0	0
…						
…						
…						
…						
…						
Total Labour Hours	7	8	15	7	3	10
1. Total Labour Cost	634	724	1 358	634	271.53	905
2. Internal Special Facilities			0			0
3.1-3.4 Material Costs						
3.5 High Rel Parts Costs						
3.6 External major products Cost						
3.7 External Services Cost						
3.8 Transport/Insurance Cost						
3.9 Travel and Subsistance Cost						
3.10 Miscellaneous Cost						
3. Total Other Costs	0	0	0	0	0	0
4. Subtotal Cost	634	724	1 358	634	272	905
5.- 7. General expenses						
8. Total Cost of WPs	634	724	1 358	634	272	905
9. Overhead on Subcontractors						
10. Subtotal (8+9)	634	724	1 358	634	272	905
11. Profit	0	0	0	0	0	0
12. Cost without additional charge						
13. Financial Provision for escalation						
14. Total	634	724	1 357.65	634	271.53	905.10
15. Reduction for company contribution (if applicable)						
16. Total Price	634	724	1 357.65	634	271.53	905.10

(*) for PSS A8 of a single company. (**) The EURO is to be used as the NC where the cost accounting system is in EURO

Manpower and Price Summary

Subject:	Validation of LCVRs for the Solar Orbiter Polarisation Modulation Package		
(*) National Currency (NC) :		(**) Conversion Rate:	
Company	INTA	INTA	
WP Title	Detailed manufacturing and procurement plan	Performance verification and environmental testing programme	
WP Number	WP 0410_A	WP 0420_A	Total WBS-Level
Labour hours as per PSS A2 (*)			
Engineer	10	10	20
Technician	0	0	0
Management	0	0	0
...			
...			
...			
...			
...			
Total Labour Hours	10	10	20
1. Total Labour Cost	905	905	1 810
2. Internal Special Facilities			
3.1-3.4 Material Costs			
3.5 High Rel Parts Costs			
3.6 External major products Cost			
3.7 External Services Cost			
3.8 Transport/Insurance Cost			
3.9 Travel and Subsistance Cost	400	400	800
3.10 Miscellaneous Cost			
3. Total Other Costs	400	400	800
4. Subtotal Cost	1 305	1 305	2 610
5.- 7. General expenses			
8. Total Cost of WPs	1 305	1 305	2 610
9. Overhead on Subcontractors			
10. Subtotal (8+9)	1 305	1 305	2 610
11. Profit	0	0	0
12. Cost without additional charge			
13. Financial Provision for escalation			
14. Total	1 305.10	1 305.10	2 610.20
15. Reduction for company contribution (if applicable)			
16. Total Price	1 305.10	1 305.10	2 610.20

(*) for PSS A8 of a single company. (**) The EURO is to be used as the NC where the cost accounting system is in EURO

Subject:	Validation of LCVRs for the Solar Orbiter Polarisation Modulation Package		
(*) National Currency (NC) :			(**) Conversion Rate:
Company	INTA	INTA	
WP Title	Preliminary performance model	Definition of the preliminary LCVRs functional verification	
WP Number	WP 0411_A	WP 0412_A	Total WBS-Level
Labour hours as per PSS A2 (*)			
Engineer	5	5	10
Technician	0	0	0
Management	0	0	0
...			
...			
...			
...			
...			
Total Labour Hours	5	5	10
1. Total Labour Cost	453	453	905
2. Internal Special Facilities			
3.1-3.4 Material Costs			
3.5 High Rel Parts Costs			
3.6 External major products Cost			
3.7 External Services Cost			
3.8 Transport/Insurance Cost			
3.9 Travel and Subsistance Cost	800	0	800
3.10 Miscellaneous Cost			
3. Total Other Costs	800	0	800
4. Subtotal Cost	1 253	453	1 705
5.- 7. General expenses			
8. Total Cost of WPs	1 253	453	1 705
9. Overhead on Subcontractors			
10. Subtotal (8+9)	1 253	453	1 705
11. Profit	0	0	0
12. Cost without additional charge			
13. Financial Provision for escalation			
14. Total	1 252.55	452.55	1 705.10
15. Reduction for company contribution (if applicable)			
16. Total Price	1 252.55	452.55	1 705.10

(*) for PSS A8 of a single company. (**) The EURO is to be used as the NC where the cost accounting system is in EURO

Manpower and Price Summary

Subject:	Validation of LCVRs for the Solar Orbi	
(*) National Currency (NC) :		
Company	INTA	
WP Title	Preliminary LCVRs functional verification	
WP Number	WP 1120 A	Total WBS-L
Labour hours as per PSS A2 (*)		
Engineer	25	25
Technician	10	10
Management	0	0
...		
...		
...		
...		
...		
Total Labour Hours	35	35
1. Total Labour Cost	2 774	2 774
2. Internal Special Facilities		
3.1-3.4 Material Costs		
3.5 High Rel Parts Costs		
3.6 External major products Cost		
3.7 External Services Cost		
3.8 Transport/Insurance Cost		
3.9 Travel and Subsistance Cost	800	800
3.10 Miscellaneous Cost		
3. Total Other Costs	800	800
4. Subtotal Cost	3 574	3 574
5.- 7. General expenses		
8. Total Cost of WPs	3 574	3 574
9. Overhead on Subcontractors		
10. Subtotal (8+9)	3 574	3 574
11. Profit	0	0
12. Cost without additional charge		
13. Financial Provision for escalation		
14. Total	3 574.25	3 574.25
15. Reduction for company contribution (if applicable)		
16. Total Price	3 574.25	3 574.25

(*) for PSS A8 of a single company. (**) The EURO is to be used as the NC where tl

Manpower and Price Summary

Subject:	Validation of LCVRs for the Solar Orbiter Polarisation Modulation Package					
(*) National Currency (NC) :						(**) Conversion
Company	INTA	INTA	INTA	INTA	INTA	
WP Title	Thermal-vacuum tests	Vibration/shock tests	Outgassing tests	Radiation tests	Optical characterisation before/after the environmental testing	
WP Number	WP 1221 A	WP 1222 A	WP 1223 A	WP 1224 A	WP 1225 A	Total WBS-Leve
Labour hours as per PSS A2 (*)						
Engineer	9	9	9	9	9	45
Technician	4	4	4	4	4	20
Management	0	0	0	0	0	0
...						
...						
...						
...						
...						
Total Labour Hours	13	13	13	13	13	65
1. Total Labour Cost	1 019	1 019	1 019	1 019	1 019	5 096
2. Internal Special Facilities	3 580	3 580	3 580	3 580	3 580	14 322
3.1-3.4 Material Costs	400	400	400	400	400	2 000
3.5 High Rel Parts Costs						
3.6 External major products Cost						
3.7 External Services Cost						
3.8 Transport/Insurance Cost						
3.9 Travel and Subsistance Cost						
3.10 Miscellaneous Cost						
3. Total Other Costs	400	400	400	400	400	2 000
4. Subtotal Cost	4 999	4 999	4 999	4 999	4 999	21 418
5.- 7. General expenses						
8. Total Cost of WPs	4 999	4 999	4 999	4 999	4 999	21 418
9. Overhead on Subcontractors						
10. Subtotal (8+9)	4 999	4 999	4 999	4 999	4 999	21 418
11. Profit	0	0	0	0	0	0
12. Cost without additional charge						
13. Financial Provision for escalation						
14. Total	4 999.19	4 999.19	4 999.19	4 999.19	4 999.19	21 417.95
15. Reduction for company contribution (if applicable)						
16. Total Price	4 999.19	4 999.19	4 999.19	4 999.19	4 999.19	21 417.95

(*) for PSS A8 of a single company. (**) The EURO is to be used as the NC where the cost accounting system is in EURO

Manpower and Price Summary

Subject:	Validation of LCVRs for the Solar Orbiter Polarisation Modulation Package			
(*) National Currency (NC) :				
Company	INTA	INTA	INTA	
WP Title	Design and manufacturing of test tools	Calibration betwwen the different optical testing systems	Optical performance characterisation	
WP Number	WP 1211_A	WP 1212_A	WP 1213_A	Total WBS-Lev
Labour hours as per PSS A2 (*)				
Engineer	5	10	5	20
Technician	5	5	5	15
Management	0	0	0	0
...				
...				
...				
...				
...				
Total Labour Hours	10	15	10	35
1. Total Labour Cost	708	1 161	708	2 577
2. Internal Special Facilities	0	0	0	0
3.1-3.4 Material Costs	0	250	250	500
3.5 High Rel Parts Costs				
3.6 External major products Cost				
3.7 External Services Cost				
3.8 Transport/Insurance Cost				
3.9 Travel and Subsistance Cost				
3.10 Miscellaneous Cost				
3. Total Other Costs	0	250	250	500
4. Subtotal Cost	708	1 411	958	3 077
5.- 7. General expenses				
8. Total Cost of WPs	708	1 411	958	3 077
9. Overhead on Subcontractors				
10. Subtotal (8+9)	708	1 411	958	3 077
11. Profit	0	0	0	0
12. Cost without additional charge				
13. Financial Provision for escalation				
14. Total	708.30	1 410.85	958.30	3 077.45
15. Reduction for company contribution (if applicable)				
16. Total Price	708.30	1 410.85	958.30	3 077.45

(*) for PSS A8 of a single company. (**) The EURO is to be used as the NC where the cost accounting system is in EURO

Manpower and Price Summary

Subject:	Validation of LCVRs for the Solar Orbiter Polarisation Mod	
(*) National Currency (NC) :		
Company	INTA	
WP Title	Polarisation Modulation Package Demonstrator	
WP Number	WP 1231_A	Total WBS-Level
Labour hours as per PSS A2 (*)		
Engineer	20	20
Technician	10	10
Management	0	0
...		
...		
...		
...		
...		
Total Labour Hours	30	30
1. Total Labour Cost	2 322	2 322
2. Internal Special Facilities	0	0
3.1-3.4 Material Costs	2 000	1 500
3.5 High Rel Parts Costs		
3.6 External major products Cost		
3.7 External Services Cost		
3.8 Transport/Insurance Cost		
3.9 Travel and Subsistance Cost		
3.10 Miscellaneous Cost		
3. Total Other Costs	2 000	1 500
4. Subtotal Cost	4 322	3 822
5.- 7. General expenses		
8. Total Cost of WPs	4 322	3 822
9. Overhead on Subcontractors		
10. Subtotal (8+9)	4 322	3 822
11. Profit	0	0
12. Cost without additional charge		
13. Financial Provision for escalation		
14. Total	4 321.70	3 821.70
15. Reduction for company contribution (if applicable)		
16. Total Price	4 321.70	3 821.70

(*) for PSS A8 of a single company. (**) The EURO is to be used as the NC where the cost accounting s

Manpower and Price Summary

Subject:	Validation of LCVRs for the Solar Orbiter Polarisation Modulation Package			
(*) National Currency (NC) :			(**) Conversion	
Company	INTA	INTA	INTA	
WP Title	Critical Review	Elaboration of a technology qualification plan	Elaboration of the technical data package	
WP Number	WP 1310 A	WP 1320 A	WP 1330 A	Total WBS-Level
Labour hours as per PSS A2 (*)				
Engineer	15	7	8	30
Technician	0	0	0	0
Management	0	0	0	0
...				
...				
...				
...				
...				
Total Labour Hours	15	7	8	30
1. Total Labour Cost	1 358	634	724	2 715
2. Internal Special Facilities	0	0	0	0
3.1-3.4 Material Costs				
3.5 High Rel Parts Costs				
3.6 External major products Cost				
3.7 External Services Cost				
3.8 Transport/Insurance Cost				
3.9 Travel and Subsistance Cost	400	300	300	1 000
3.10 Miscellaneous Cost				
3. Total Other Costs	400	300	300	1 000
4. Subtotal Cost	1 758	934	1 024	3 715
5.- 7. General expenses				
8. Total Cost of WPs	1 758	934	1 024	3 715
9. Overhead on Subcontractors				
10. Subtotal (8+9)	1 758	934	1 024	3 715
11. Profit	0	0	0	0
12. Cost without additional charge				
13. Financial Provision for escalation				
14. Total	1 757.65	933.57	1 024.08	3 715.30
15. Reduction for company contribution (if applicable)				
16. Total Price	1 757.65	933.57	1 024.08	3 715.30

(*) for PSS A8 of a single company. (**) The EURO is to be used as the NC where the cost accounting system is in EURO

Manpower and Price Summary

Subject:	Validation of LCVRs for the Solar Orbiter Polarisation Modulation Package				IT
(*) National Currency (NC) :				(**) Conversion	E
Company	INTA	INTA	INTA	INTA	
WP Title	Coordination	Deliverables control	Reporting	Meetings	
WP Number	WP 2110 A	WP 2210 A	WP 2310 A	WP 2410 A	Total WBS-Leve
Labour hours as per PSS A2 (*)					
Engineer	0	0	0	0	30
Technician	0	0	0	0	0
Management	20	10	20	10	0
...					
...					
...					
...					
...					
Total Labour Hours	20	10	20	10	30
1. Total Labour Cost	1 810	905	1 810	905	2 715
2. Internal Special Facilities	0	0	0	0	0
3.1-3.4 Material Costs					
3.5 High Rel Parts Costs					
3.6 External major products Cost					
3.7 External Services Cost					
3.8 Transport/Insurance Cost					
3.9 Travel and Subsistance Cost	2 000	0	0	0	1 000
3.10 Miscellaneous Cost					
3. Total Other Costs	2 000	0	0	0	1 000
4. Subtotal Cost	3 810	905	1 810	905	3 715
5.- 7. General expenses					
8. Total Cost of WPs	3 810	905	1 810	905	3 715
9. Overhead on Subcontractors					
10. Subtotal (8+9)	3 810	905	1 810	905	3 715
11. Profit	0	0	0	0	0
12. Cost without additional charge					
13. Financial Provision for escalation					
14. Total	3 810.20	905.10	1 810.20	905.10	3 715.30
15. Reduction for company contribution (if applicable)					
16. Total Price	3 810.20	905.10	1 810.20	905.10	3 715.30

(*) for PSS A8 of a single company. (**) The EURO is to be used as the NC where the cost accounting system is in EURO

ANNEX 3: COST DESCRIPTION FORMS OF SUBCONTRACTORS

CSL

LCVRs

COMPANY COST ELEMENT		FORM PSS A2		PAGE N° : 1	of	1	ISSUE : 1
RFQ/ITT Nr. : TEC-MMO/2008/55				COMPANY NAME : Centre Spatial de Liège (CSL)			
PROPOSAL : CSL-OFF-ESA-08102		DATE	29-sept-08	NAME : J.P. COLLETTE Contract Officer			
ECONOMIC CONDITION : 2008 - ESA audited rates				SIGNATURE :			
type of price :							
PROJECT NAME :							
Validation of LCVRs for the Solar Orbiter Polarisation Modulation Package							
LABOUR				MANPOWER	GROSS HOURLY		AMOUNT
DIRECT LABOUR COST CENTERS OR CATEGORIES				hrs	RATE (€)		(€)
ENG/SCI				273,00	86,00		23.478,00
TECHNICIAN				130,00	52,00		6.760,00
1. TOTAL DIRECT LABOUR HOURS AND COST				403,00		A	30.238,00
INTERNAL SPECIAL FACILITIES				USE (hrs)	RATE (€)		AMOUNT (€)
Clean room class 10.000 (per unit) and airlock							
Laminar flow class 100 (per unit of 2,5*2,5 m²)							
Thermal vacuum chamber FOCAL 0.25							
Thermal vacuum chamber FOCAL 1.5							
Turbomolecular pumping system for FOCAL 1.5							
Cryopumping system for FOCAL 1.5							
Thermal group for FOCAL 1.5							
Thermal vacuum chamber FOCAL 2							
Turbomolecular pumping system for FOCAL 2							
Cryopumping system for FOCAL 2							
Thermal group for FOCAL 2							
Thermal vacuum chamber FOCAL 3							
Turbomolecular pumping system for FOCAL 3							
Cryopumping system for FOCAL 3							
Thermal group for FOCAL3							
Thermal vacuum chamber FOCAL 5							
Turbomolecular pumping system for FOCAL 5							
Cryopumping system for FOCAL 5							
Thermal group for FOCAL 5							
Thermal vacuum chamber FOCAL 6.5							
Turbomolecular pumping system for FOCAL 6.5							
Cryopumping system for FOCAL 6.5							
Thermal group for FOCAL 6.5							
Stabilized power supply							
Regulated LN2 line (per unit)							
Full LN2 line (per unit)							
Lhe+Ghe liquefier (KOCH - spare)							
Lhe+Ghe liquefier (LINDE - nominal)							
Liquefiers - vacuum chamber interface							
Shaker 87 kN vibration & shock mode)							
Shaker 87 kN (fatigue mode)							
Shaker 200 kN (vibration & shock mode)							
Shaker 200 kN (fatigue mode)							
Cryo-vibration vacuum chamber (for ESA contract)							
Cryo-vibration vacuum chamber (for non ESA contract)							
Control room for cryo-vibration vacuum chamber							
Control room for FOCAL1.5 / 2 / 3 / 5 & 6.5 (per unit)							
Control room for shaker 87 kN							
Control room for shaker 200 kN							
Chek out equipment room (COE) (per unit)							
Customer room (ESA 1 to 3) - (per unit)							
Interferometer ZYGO MARK IV							
Interferometer BRO (infrared @ 10.2µm)							
FTIR (per unit)							
Interferometer WYKO							
Interferometer HP							
UV imager							
Mass spectrometer							
Spectrophotometer							
Atomic Force microscope							
Scanning Electron Microscope							
IR ellipsometer				40	10,17		406,80
Climatic Chamber							
Ion beam facility							
IBS coating facility							
RF sputtering coating facility							
Evaporation coating facility							
e-beam evaporation coating facility							
Direct Laser Writing							
Excimer laser 248 nm							
Excimer laser 193 nm							
3"Quartz photolithographic plate							
Ni electrodeposition							
Hot embossing press							
Dry etching facility							
[1] : all direct cost (phone & fax bills, dedicated requested services) will be paied on a cost reimbursement basis on presentation of vouchers							
2. TOTAL INTERNAL SPECIAL FACILITIES COST						B	406,80
OTHER COST ELEMENTS							
ACCORDING TO ESA TYPE		AMOUNTS (€)		OVERHEAD(%)	x AMOUNTS =		AMOUNT (€)
3. 1. RAW MATERIALS				8			
3. 2. MECHANICAL PARTS		500,00		8	40,00		540,00
3. 3. SEMI FINISHED PRODUCTS		2.000,00		8	160,00		2.160,00
3. 4. ELECTRONIC COMPONENTS		250,00		8	20,00		270,00
3. 5. HIRED PARTS							
a) procured by company				8			
b) procured by third party							
3. 6. EXTERNAL MAJOR PRODUCTS				8			
3. 7. EXTERNAL SERVICES		8.000,00		8	640,00		8.640,00
3. 8. TRANSPORT, INSURANCE		450,00		8	36,00		486,00
3. 9. TRAVELS & SUBSISTENCE		1.900,00		8	152,00		2.052,00
3.10. MISCELLANEOUS				8			
3.11. SUB-CONTRACTS				8			
3. TOTAL OTHER DIRECT COSTS	C	13.100,00			D 1.048,00	E	14.148,00
4. SUB-TOTAL COST					(A+B+E)	F	44.792,80
GENERAL EXPENSES		COST ITEMS TO WHICH % APPLIES		BASE IN €	%		
5 GENERAL & ADMIN. EXPENSES		1		30.238,00	8	G	2.419,04
		2		406,80	8	G	32,54
6 R&D EXPENSES		1 + 5		32.657,04	2,3	H	751,11
7 OTHER						J	
8. TOTAL COST OF ALL WORKPACKAGES					(F+G+H+J)	K	47.995,50
9. OVERHEADS ON SUB-CONTRACTS (BASE IN € ON WHICH 4% APPLIES)						L	
10. SUB-TOTAL					(K+L)	M	47.995,50
11. PROFIT	0	% on item		M		N	0,00
12. COST WITHOUT ADDITIONAL CHARGE						P	
13. TOTAL COMPANY PRICE					(M+N+P)	R	47.995,50
					ROUNDED TO :		

CSL-OFF-ESA-08102 15-Dec-08 Issue :1.0 Rev : 0

LCVRs

MANPOWER & PRICE SUMMARY PSS A8 page : 1 of 1

SUBJECT : Validation of LCVRs for the Solar Orbiter Polarisation Modulation Package	RFQ/ITT Nr.: TEC-MMO/2008/55	Economic conditions: 2008 - ESA approved rates
CURRENCY : €		

WBS title :											
WBS number :	421_C	422_C	423_C	424_C	425_C	426_C	1211_C	1212_C	1224_C	1225_C	1310_C
Level :											
Total Direct labour hours	8,00	8,00	16,00	16,00	8,00	8,00	130,00	35,00	50,00	40,00	8,00
1.- Total direct labour cost	688,00	688,00	1.376,00	1.376,00	688,00	688,00	8.800,00	2.330,00	3.620,00	2.760,00	688,00
2.- internal special facilities cost	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	406,80	0,00
3.1. to 3.4.- material cost	0,00	0,00	0,00	0,00	0,00	0,00	2.750,00	0,00	0,00	0,00	0,00
3.5.- hirel parts cost	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3.6.- external major products	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3.7.- external services cost	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	8.000,00	0,00	0,00
3.8.- transport/insurance cost	0,00	0,00	0,00	0,00	0,00	0,00	0,00	150,00	300,00	0,00	0,00
3.9- travel & subsitence cost	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	300,00	0,00	0,00
3.10.- miscellaneous cost	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3.11.- Sub-contract	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3.- Total other direct cost	0,00	0,00	0,00	0,00	0,00	0,00	2.750,00	150,00	8.600,00	0,00	0,00
5. to 7.- general expenses	72,13	72,13	144,26	144,26	72,13	72,13	1.142,59	256,28	1.067,52	321,90	72,13
8.- total cost of WP	760,13	760,13	1.520,26	1.520,26	760,13	760,13	12.692,59	2.736,28	13.287,52	3.488,70	760,13
9.- Profit	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
10.- PRICE OF THE WORKPACKAGE	760,13	760,13	1.520,26	1.520,26	760,13	760,13	12.692,59	2.736,28	13.287,52	3.488,70	760,13

AMOUNT (€) :	760,13	760,13	1.520,26	1.520,26	760,13	760,13	12.692,59	2.736,28	13.287,52	3.488,70	760,13

WBS title :						
WBS number :	1330_C	2110_C	2210_C	2310_C	2410_C	SUMS
Level :						
Total Direct labour hours	4,00	8,00	4,00	40,00	20,00	403,00
1.- Total direct labour cost	344,00	688,00	344,00	3.440,00	1.720,00	30.238,00
2.- internal special facilities cost	0,00	0,00	0,00	0,00	0,00	406,80
3.1. to 3.4.- material cost	0,00	0,00	0,00	0,00	0,00	2.750,00
3.5.- hirel parts cost	0,00	0,00	0,00	0,00	0,00	0,00
3.6.- external major products	0,00	0,00	0,00	0,00	0,00	0,00
3.7.- external services cost	0,00	0,00	0,00	0,00	0,00	8.000,00
3.8.- transport/insurance cost	0,00	0,00	0,00	0,00	0,00	450,00
3.9- travel & subsitence cost	0,00	0,00	0,00	0,00	1.600,00	1.900,00
3.10.- miscellaneous cost	0,00	0,00	0,00	0,00	0,00	0,00
3.11.- Sub-contract	0,00	0,00	0,00	0,00	0,00	0,00
3.- Total other direct cost	0,00	0,00	0,00	0,00	1.600,00	13.100,00
5. to 7.- general expenses	36,06	72,13	36,06	360,65	308,32	4.250,70
8.- total cost of WP	380,06	760,13	380,06	3.800,65	3.628,32	47.995,50
9.- Profit	0,00	0,00	0,00	0,00	0,00	0,00
10.- PRICE OF THE WORKPACKAGE	380,06	760,13	380,06	3.800,65	3.628,32	47.995,50

AMOUNT (€) :	380,06	760,13	380,06	3.800,65	3.628,32	47.995,50

Economic conditions 2008 - ESA approved rates

INAF

COMPANY COST ELEMENT DATA SHEET	FORM No. PSS A1 Issue 2	Page no. of
RFQ/ITT no.: AO/1-5798/08/NL/Sfe		COMPANY NAME: INAF-Osservatorio Astronomico di Torino
PROPOSAL no.: INTA-LCVRs-001		Name and title: Silvano Fineschi - Associate Astronomer
NATIONAL CURRENCY *: EURO		Signature:
Period for which agreed rates and overheads are valid : From January To December		
ECONOMIC CONDITIONS: 2008		

Agreed by

Status *(x when appl.)*

1. LABOUR *Direct labour cost centres or categories*	Basic Labour *hourly rate (NC)*	Labour OH% *(or NC)*	GROSS HOURLY RATE *in National Currency*
1 Staff Associate Astronomer	33.96		33.96
2 Technician	33.96		33.96
3 Management	71.63		71.63

2. INTERNAL SPECIAL FACILITIES	Type of Unit	UNIT RATE (NC)
Clean area 10000	Hour	40
Optical measurement equipment	Hour	51.15

3. OTHER COST ELEMENTS *According to ESA type*		*According to normal company type*	OVERHEADS %
3.1	Raw materials		
3.2	Mechanical parts		
3.3	Semi-finished products		
3.4	Electric & electronic components		
3.5	Hirel parts		
	a) procured by company		
	b) procured by 3rd party		
3.6	External major products		
3.7	External services		
3.8	Transport, insurance		
3.9	Travels		
3.1	Miscellaneous		
3.11	Subcontracts		

GENERAL EXPENSES *According to ESA type*	*According to normal company type*	*Applicable on cost element no.*	OVERHEADS %
5. General & Admin. expenses			
6. Research & Developm. expenses			
7. Other (specify)			

12. COST WITHOUT ADDITIONAL CHARGE

* No mention of the EURO is required unless the cost accounting system is in EURO in which case the EURO shall be used as the N.C.

COMPANY PRICE BREAKDOWN FORM ***Form No. PSS A2*** *Issue 4*

Page No. No. of Pages

RFQ/ITT No. **TEC-MMO/2008/55**	COMPANY NAME: **INAF - OATo**
Proposal/Tender No.:	Name and Title: **Dr. Silavano Fineschi**
Economic Condition: Type of Price:	Signature

SUPPLIES AND/OR SERVICES TO BE FURNISHED

LABOUR *Direct Labour cost centres or categories*	Manpower effort *in Manhours*	Gross Hourly Rates *in NC**		National Currency (NC) *Euro*	Total EURO *€*
Staff Astronomer	320	48		15 229	15 229
Scientific Technicians	1 600	22		35 584	35 584
Post Doc	1 000	14		14 000	14 000
Cofin on INAF staff				-50 813	-50 813
1 Total Direct Labour Hours and Cost			*A*	*14 000*	*14 000*

INTERNAL SPECIAL FACILITIES	Type of unit	No. of units	Unit rates in NC			
Clean Room Class ISO 7	month	7	1 500		10 500	10 500
Spectropolarimeter setup	month	7	100		700	700
2 Total Internal Special Facilities Cost				*B*	*11 200*	*11 200*

OTHER COST ELEMENTS	Base amounts in NC	OH%	OH amounts in NC			
3.1 Raw materials						
3.2 Mechanical parts						
3.3 Semi-finished products						
3.4 Electrical & electronic components						
3.5 Hirel parts						
a) procured by company						
b) procured by third party						
3.6 External Major Products	20 097	0.00	0		20 097	20 097
3.7 External Services						
3.8 Transport/Insurance						
3.9 Travels	2 500	0.00	0		2 500	2 500
3.10 Miscellaneous						
3 Total Other Direct Cost	*22 597 C*		*0 D*	*E*	22 597	22 597
4. SUB TOTAL COST			**(A+B+E)**	**F**	**47 797**	**47 797**

GENERAL EXPENSES	Cost items to which % applies	Base in NC to which % applies	%			
5. General & Admin. Expenses		14 000	6.00	G	840	840
6. Research & Develop. Exp.				H		
7. Other				J		
(to be specified)						
8. Total Cost of All Work Packages			***(F+G+H+J)***	***K***	***48 637***	***48 637***
9. Overheads on Subcontractors (Base in NC on which % applies:)			%	L		
10. Sub-total			**(K+L)**	**M**	***48 637***	**48 637**
11. Profit (% on Base Amount in NC:)				N		
12. Cost without additional charge (to be itemised on Exhibit A)				P		
13. Financial Provision for escalation, if applicable (justification and details to be stated on Exhibit A)				Q		
14. Total			**(M+N+P+Q)**	**R**	***48 637***	**48 637**
15. Reduction for company contribution (if applicable)				S	***11 200***	11 200
16. TOTAL PRICE FOR ESA			**(R-S)**	**T**	***37 437***	**37 437**

If insufficient space is available to identify all required information, please use additional sheet or insert lines

* The Euro is to be used as the NC where the cost accounting system is in Euro.

Manpower and Price Summary

Form no. **PSS A8**

Subject:

ITT/RFQ:

(*) National Currency (10³):

(*) Conversion Rate:

Economic condition:

Company / WP Title / WP Number	WP 1111_R	WP 0121_R	WP 0122_R	WP 0123_R	WP 0124_R	WP 0220_R	WP 0310_R	WP 1020_R	WP 0411_R
Labour hours as per PSS A2 (*)									
Staff Astronomer	951.8	951.8					951.8		
Scientific Technicians	444.8	667.2	667.2	667.2	667.2		444.8	444.8	444.8
[illegible]									
Post Doc						2800			
Total Labour Cost									
Costs	-1396.6	-1619.0	-667.2	-667.2	-667.2	0	-1396.6	-444.8	-444.8
.									
Total Labour Hours									
1. Total Cost for PSA (Labour-Costs)									
2. Internal Special Facilities						1200			
3.1-3.4 Material Costs									
3.5 High Rel Parts Costs									
3.6 External major products Cost									
3.7 External Services Cost									
3.8 Transport/Insurance Cost									
3.9 Travel and Subsistence Cost									
3.10 Miscellaneous Cost									
3. Total Other Costs									
4. Subtotal Cost									
5.-7. General expenses						168			
8. Total Cost of WPs									
9. Overhead on Subcontractors									
10. Subtotal (8+9)									
11. Profit									
12. Cost without additional charge									
13. Financial Provision for escalation NC									
14. Total NC									
14. Total EUROs									
15. Reduction for company contribution (if applicable) NC						1200			
15. Reduction for company contribution (if applicable) EUROs									
16. Total Price NC									
16. Total Price EUROs									

Company / WP Title / WP Number	WP 0413_R	WP 0414_R	WP 0421_R	WP 0422_R	WP 0423_R	WP 0424_R	WP 0425_R	WP 0426_R	WP 1110_R
Labour hours as per PSS A2 (*)									
Staff Astronomer									
Scientific Technicians	444.8	444.8							6672
[illegible]									
Post Doc			1000						3000
Total Labour Cost									
Costs	-444.8	-444.8	0						-9672
.									
Total Labour Hours									
1. Total Cost for PSA (Labour-Costs)									
2. Internal Special Facilities									1200
3.1-3.4 Material Costs									
3.5 High Rel Parts Costs									
3.6 External major products Cost									2000
3.7 External Services Cost									
3.8 Transport/Insurance Cost									
3.9 Travel and Subsistence Cost									
3.10 Miscellaneous Cost									
3. Total Other Costs									
4. Subtotal Cost									
5.-7. General expenses									180
8. Total Cost of WPs									
9. Overhead on Subcontractors									
10. Subtotal (8+9)									
11. Profit									
12. Cost without additional charge									
13. Financial Provision for escalation NC									
14. Total NC									
14. Total EUROs									
15. Reduction for company contribution (if applicable) NC									
15. Reduction for company contribution (if applicable) EUROs									
16. Total Price NC									
16. Total Price EUROs									

Company / WP Title / WP Number	WP 1150_R	WP 1214_B	WP 1231_B	WP 1310_R	WP 1320_R	WP 2110_R	WP 2210_R	WP 2310_R	WP 2410_R	Total WBS-Level
Labour hours as per PSS A2 (*)										0
Staff Astronomer		**1903.6**	**1903.6**	951.8				951.8	951.8	9518
Scientific Technicians		**11120**	**11120**		444.8		444.8	444.8		35584
[illegible]	10000									10000
Post Doc		**3200**								10000
Total Labour Cost										65102
										0
Costs	-10000	**-13023.6**	-13023.6	-951.8	-444.8	0	-444.8	-1396.6	-951.8	-65102
.										0
Total Labour Hours										0
1. Total Cost for PSA (Labour-Costs)										10000
2. Internal Special Facilities		**3000**	**3000**							8400
3.1-3.4 Material Costs										0
3.5 High Rel Parts Costs										0
3.6 External major products Cost		**5000**	**5000**							12000
3.7 External Services Cost						500		500	500	1500
3.8 Transport/Insurance Cost										0
3.9 Travel and Subsistence Cost						2500			2500	5000
3.10 Miscellaneous Cost										0
3. Total Other Costs										0
4. Subtotal Cost										0
5.-7. General expenses		189								537
8. Total Cost of WPs										0
9. Overhead on Subcontractors										0
10. Subtotal (8+9)										0
11. Profit										0
12. Cost without additional charge										0
										0
13. Financial Provision for escalation NC										0
14. Total NC										0
14. Total EUROs										0
15. Reduction for company contribution (if applicable) NC										
15. Reduction for company contribution (if applicable) EUROs										0
16. Total Price NC										0
16. Total Price EUROs										37437

(*) for PSS A8 of a single company (**) The EURO is to be used as the NC where the cost accounting system is in EURO

IAC

COMPANY PRICE BREAKDOWN FORM *Form No. PSS A2* *Issue 4*

Page No. 1 No. of Pages 1

RFQ/ITT No. **AO/1-5798/08/NL/Sfe**	COMPANY NAME: **IAC**
Proposal/Tender No.: **INTA-LCVRs-001**	Name and Title: **Valentín Martínez Pillet**
Economic Condition: **sep-08** Type of Price: **Firm Fixed Price**	Signature

SUPPLIES AND/OR SERVICES TO BE FURNISHED

LABOUR *Direct Labour cost centres or categories*	Manpower effort *in Manhours*	Gross Hourly Rates *in NC**		National Currency (NC)	Total EURO €
1 Scientist	12	90			1 080
1 Total Direct Labour Hours and Cost			*A*		*1 080*

INTERNAL SPECIAL FACILITIES	Type of unit	No. of units	Unit rates in NC			
1 Thermal Vacuum TVC1						
2 Vibration-shock test facility						
3 Outgassing facility						
4 Clean area 10000						
5 Optical measurement equipment						
2 Total Internal Special Facilities Cost				*B*		

OTHER COST ELEMENTS	Base amounts in NC	OH%	OH amounts in NC			
3.1 Raw materials						
3.2 Mechanical parts						
3.3 Semi-finished products						
3.4 Electrical & electronic components						
3.5 Hirel parts						
a) procured by company						
b) procured by third party						
3.6 External Major Products						
3.7 External Services						
3.8 Transport/Insurance						
3.9 Travels	3 700					3 700
3.10 Miscellaneous						
3 Total Other Direct Cost	*3 700* *C*		*D*	*E*		*3 700*
4. SUB TOTAL COST			**(A+B+E)**	**F**		**4 780**

GENERAL EXPENSES	Cost items to which % applies	Base in NC to which % applies	%			
5. General & Admin. Expenses				G		
6. Research & Develop. Exp.				H		
7. Other				J		
(to be specified)						
8. Total Cost of All Work Packages			***(F+G+H+J)***	***K***		***4 780***
9. Overheads on Subcontractors (Base in NC on which % applies:)			%	L		
10. Sub-total			**(K+L)**	**M**		**4 780**
11. Profit (% on Base Amount in NC:)				N		
12. Cost without additional charge (to be itemised on Exhibit A)				P		
13. Financial Provision for escalation, if applicable (justification and details to be stated on Exhibit A)				Q		
14. Total			**(M+N+P+Q)**	**R**		**4 780**
15. Reduction for company contribution (if applicable)				S		
16. TOTAL PRICE FOR ESA			**(R-S)**	**T**		**4 780**

If insufficient space is available to identify all required information, please use additional sheet or insert lines

* The Euro is to be used as the NC where the cost accounting system is in Euro.

Manpower and Price Summary

Issue 4

Subject: Validation of LCVRs for the Solar Orbiter Polarisation Modulation Package

ITT/RFQ: Validation of LCVRs for the Solar

(*) National Currency (NC) :

(**) Conversion

Economic condition::AO/1-

Company	IAC	IAC	IAC	IAC	IAC	IAC	IAC	IAC	IAC	
WP Title	Functional and performance requirements review	Study of the State of the Art of LCVRs for polarimetry	Study of Alternative concepts of LCVRs for polarimetry	Critical Review (TRB)	Elaboration of a technical data package	Coordination	Deliverables Control	Reporting	Meetings	
WP Number	WP 0111_D	WP 0121_D	WP 0122_D	WP 1310_D	WP 1340_D	WP 2110_D	WP 2210_D	WP 2310_D	WP 2410_D	Total WBS-Level
Labour hours as per PSS A2 (*)										
Scientist	2	1	1	1	1	1	1	1	1	10
...										0
...										0
...										0
...										0
...										0
Total Labour Hours	2	1	1	1	1	1	1	1	3	12
1. Total Labour Cost	180	90	90	90	90	90	90	90	270	1.080
2. Internal Special Facilities										
3.1-3.4 Material Costs										
3.5 High Rel Parts Costs										
3.6 External major products Cost										
3.7 External Services Cost										
3.8 Transport/Insurance Cost										
3.9 Travel and Subsistance Cost	1.100			400					2.200	3.700
3.10 Miscellaneous Cost										
3. Total Other Costs	1.100	0	0	400	0	0	0	0	2.200	3.700
4. Subtotal Cost	1.280	90	90	490	90	90	90	90	2.470	4.780
5.- 7. General expenses										
8. Total Cost of WPs	1.280	90	90	490	90	90	90	90	2.470	4.780
9. Overhead on Subcontractors										
10. Subtotal (8+9)	1.280	90	90	490	90	90	90	90	2.470	4.780
11. Profit	0	0	0	0	0	0	0	0	0	0
12. Cost without additional charge										
13. Financial Provision for escalation										
14. Total	1.280.00	90.00	90.00	490.00	90.00	90.00	90.00	90.00	2.470.00	4.780.00
15. Reduction for company contribution (if applicable)										
16. Total Price	1.280.00	90.00	90.00	490.00	90.00	90.00	90.00	90.00	2.470.00	4.780.00

COMPANY COST ELEMENT DATA SHEET	FORM No. PSS A1 Issue 2	Page no. 1 of 1
RFQ/ITT no.: AO/1-5798/08/NL/Sfe		COMPANY NAME: IAC
PROPOSAL no.: INTA-LCVRs-001		Name and title: Valentin Martinez Pillet
NATIONAL CURRENCY *: EURO		Signature:
Period for which agreed rates and overheads are valid : From January To December		
ECONOMIC CONDITIONS: 2008		

Agreed by

Status *(x when appl.)*

1. LABOUR *Direct labour cost centres or categories*	Basic Labour *hourly rate (NC)*	Labour OH% *(or NC)*	GROSS HOURLY RATE *in National Currency*
1 Scientist	90		90

2. INTERNAL SPECIAL FACILITIES	Type of Unit	UNIT RATE (NC)

3. OTHER COST ELEMENTS			OVERHEADS
According to ESA type		*According to normal company type*	%
3,1	Raw materials		
3,2	Mechanical parts		
3,3	Semi-finished products		
3,4	Electric & electronic components		
3,5	Hirel parts		
	a) procured by company		
	b) procured by 3rd party		
3,6	External major products		
3,7	External services		
3,8	Transport, insurance		
3,9	Travels		
3,1	Miscellaneous		
3,11	Subcontracts		

GENERAL EXPENSES			OVERHEADS
According to ESA type	*According to normal company type*	*Applicable on cost element no.*	%
5. General & Admin. expenses			
6. Research & Developm. expenses			
7. Other (specify)			

12. COST WITHOUT ADDITIONAL CHARGE

* No mention of the EURO is required unless the cost accounting system is in EURO in which case the EURO shall be used as the N.C.

IAA

COMPANY COST ELEMENT DATA SHEET	FORM No. PSS A1 Issue 2	Page no. of
RFQ/ITT no.: AO/1-5798/08/NL/Sfe		COMPANY NAME: IAA (CSIC)
PROPOSAL no.: IAA-LCVRs-001		Name and title: Jose Carlos del Toro Iniesta, Dr.
NATIONAL CURRENCY *: EURO		Signature:
Period for which agreed rates and overheads are valid : From January To December		
ECONOMIC CONDITIONS: 2008		

Agreed by

Status *(x when appl.)*

1. LABOUR *Direct labour cost centres or categories*		Basic Labour *hourly rate (NC)*	Labour OH% *(or NC)*	GROSS HOURLY RATE *in National Currency*
1	Engineer	90.51		90.51
2	Technician	51.15		51.15
3	Management	90.51		90.51

2. INTERNAL SPECIAL FACILITIES	Type of Unit	UNIT RATE (NC)

3. OTHER COST ELEMENTS			OVERHEADS
According to ESA type		*According to normal company type*	%
3.1	Raw materials		
3.2	Mechanical parts		
3.3	Semi-finished products		
3.4	Electric & electronic components		
3.5	Hirel parts		
	a) procured by company		
	b) procured by 3rd party		
3.6	External major products		
3.7	External services		
3.8	Transport, insurance		
3.9	Travels		
3.1	Miscellaneous		
3.11	Subcontracts		

GENERAL EXPENSES			OVERHEADS
According to ESA type	*According to normal company type*	*Applicable on cost element no.*	%
5. General & Admin. expenses			
6. Research & Developm. expenses			
7. Other (specify)			

12. COST WITHOUT ADDITIONAL CHARGE

* No mention of the EURO is required unless the cost accounting system is in EURO in which case the EURO shall be used as the N.C.

COMPANY PRICE BREAKDOWN FORM ***Form No. PSS A2*** *Issue 4*

Page No. No. of Pages

RFQ/ITT No. **AO/1-5798/08/NL/Sfe**	COMPANY NAME: **IAA (CSIC)**
Proposal/Tender No.: **IAA-LCVRs-001**	Name and Title: **Jose Carlos del Toro Iniesta, Dr.**
Economic Condition: Type of Price:	Signature

SUPPLIES AND/OR SERVICES TO BE FURNISHED

LABOUR *Direct Labour cost centres or categories*	Manpower effort *in Manhours*	Gross Hourly Rates *in NC**		National Currency (NC)	Total EURO €
1 Engineer	70	91			6 336
2 Technician		51			
3 Management	34	91			3 077
1 Total Direct Labour Hours and Cost			*A*		*9 413*

INTERNAL SPECIAL FACILITIES	Type of unit	No. of units	Unit rates in NC			
2 Total Internal Special Facilities Cost				*B*		

OTHER COST ELEMENTS	Base amounts in NC	OH%	OH amounts in NC			
3.1 Raw materials						
3.2 Mechanical parts						
3.3 Semi-finished products						
3.4 Electrical & electronic components	10 200					10 200
3.5 Hirel parts						
a) procured by company						
b) procured by third party						
3.6 External Major Products						
3.7 External Services						
3.8 Transport/Insurance						
3.9 Travels	1 300					1 300
3.10 Miscellaneous						
3 Total Other Direct Cost	*C*		*D*	*E*		*11 500*
4. SUB TOTAL COST			**(A+B+E)**	**F**		**11 500**

GENERAL EXPENSES	Cost items to which % applies	Base in NC to which % applies	%			
5. General & Admin. Expenses				G		
6. Research & Develop. Exp.				H		
7. Other (to be specified)				J		
8. Total Cost of All Work Packages			***(F+G+H+J)***	***K***		***20 913***
9. Overheads on Subcontractors (Base in NC on which % applies:)			%	L		
10. Sub-total			**(K+L)**	**M**		**20 913**
11. Profit (% on Base Amount in NC:)				N		
12. Cost without additional charge (to be itemised on Exhibit A)				P		
13. Financial Provision for escalation, if applicable (justification and details to be stated on Exhibit A)				Q		
14. Total			**(M+N+P+Q)**	**R**		**20 913**
15. Reduction for company contribution (if applicable)				S		
16. TOTAL PRICE FOR ESA			**(R-S)**	**T**		**20 913**

If insufficient space is available to identify all required information, please use additional sheet or insert lines

* The Euro is to be used as the NC where the cost accounting system is in Euro.

Manpower and Price Summary Issue 4

Subject: LCVRs Electronic Control ModuleDevelopment for Solar Orbiter ITT/RFQ: Orbiter Polarisation Modulation Package

(*) National Currency (NC) : Euro (**) Conversion Economic 2008

Company	IAA (CSIC)	IAA (CSIC)	IAA (CSIC)	IAA (CSIC)	IAA (CSIC)	IAA (CSIC)	IAA (CSIC)	IAA (CSIC)	IAA (CSIC)	IAA (CSIC)	IAA (CSIC)	IAA (CSIC)	IAA (CSIC)	
WP Title	Functional and performance requirements review	Study of the State of the Art of LCVRs for polarimetry	Study of Alternative concepts of LCVRs for polarimetry	Drive electronic procurement plan	Control software procurement plan	Driving electronic manufacturing	Control software manufacturing	Critical Review	Elaboration of a technical data package	Coordination	Deliverables control	Reporting	Meetings	
WP Number	WP 0111 E	WP 0121 E	WP 0122 E	WP 0415 E	WP 0416 E	WP 1130 E	WP 1140 E	WP 1310 E	WP 1330 E	WP 2110 E	WP 2210 E	WP 2310 E	WP 2410 E	Total WBS-Level
Labour hours as per PSS A2 (*)														
Engineer	15	10	10	2	1	15	4	5	3	0	0	0	6	71
Technician	0	0	0	0	0	0	0		0	0	0	0		0
Management	3	3	4	1	1	4	1	1	1	5	2	5	2	33
...														
...														
...														
...														
...														
Total Labour Hours	18	13	14	3	2	19	5	6	4	5	2	5	8	104
1. Total Labour Cost	1 629	1 177	1 267	272	181	1 720	453	543	362	453	181	453	724	9 413
2. Internal Special Facilities	0	0	0	0	0	0	0	0	0	0	0	0		0
3.1-3.4 Material Costs						8000	2240							10240
3.5 High Rel Parts Costs														0
3.6 External major products Cost														0
3.7 External Services Cost														0
3.8 Transport/Insurance Cost														0
3.9 Travel and Subsistance Cost			500			800								1 300
3.10 Miscellaneous Cost														0
3. Total Other Costs	0	0	500	0	0	8 800	2 240	0	0	0	0	0	0	11 540
4. Subtotal Cost	1 629	1 177	1 767	272	181	10 520	2 693	543	362	453	181	453	724	20 953
5.- 7. General expenses														
8. Total Cost of WPs	1 629	1 177	1 767	272	181	10 520	2 693	543	362	453	181	453	724	20 953
9. Overhead on Subcontractors														
10. Subtotal (8+9)	1 629	1 177	1 767	272	181	10 520	2 693	543	362	453	181	453	724	20 953
11. Profit	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12. Cost without additional charge														
13. Financial Provision for escalation														
14. Total	1 629.18	1 176.63	1 767.14	271.53	181.02	10 519.69	2 692.55	543.06	362.04	452.55	181.02	452.55	724.08	20 953.04
15. Reduction for company contribution (if applicable)														
16. Total Price	1 629.18	1 176.63	1 767.14	271.53	181.02	10 519.69	2 692.55	543.06	362.04	452.55	181.02	452.55	724.08	20 953.04

(*) for PSS A8 of a single company. (**) The EURO is to be used as the NC where the cost accounting system is in EURO

Visual Display

COMPANY COST ELEMENT DATA SHEET	FORM No. PSS A1 Issue 2	Page no. 1 of 1
RFQ/ITT no.:	AO/1-5798/08/NL-Sfe	COMPANY NAME: VISUAL DISPLAY
PROPOSAL no.:	INTA-LCVRs-001	Name and title: Manuel López - Technical Manager
NATIONAL CURRENCY *:	EUROS	Signature:
Period for which agreed rates and overheads are valid : From	oct-08 To nov-09	
ECONOMIC CONDITIONS:	oct-08	

1. LABOUR *Direct labour cost centres or categories*	Basic Labour *hourly rate (NC)*	Labour OH% *(or NC)*	GROSS HOURLY RATE *in National Currency*
Engineering	36		36
Manufacturing	21		21

2. INTERNAL SPECIAL FACILITIES	Type of Unit	UNIT RATE (NC)
Clean Room LCDs manufacturing facilities and equipment	3 batches / 20days per batch	100 €/day

3. OTHER COST ELEMENTS			OVERHEADS
According to ESA type		*According to normal company type*	%
3.1	Raw materials	6000	0%
3.2	Mechanical parts		0%
3.3	Semi-finished products		0%
3.4	Electric & electronic components		0%
3.5	Hirel parts		
	a) procured by company		
	b) procured by 3rd party		
3.6	External major products		0%
3.7	External services		
3.8	Transport, insurance		
3.9	Travels	1500	0%
3.1	Miscellaneous		0%
3.11	Subcontracts		

GENERAL EXPENSES			OVERHEADS
According to ESA type	*According to normal company type*	*Applicable on cost element no.*	%
5. General & Admin. expenses			
6. Research & Developm. expenses			
7. Other (specify)			

12. COST WITHOUT ADDITIONAL CHARGE

Agreed by

Nat Aut

Status
(x when appl.)

* No mention of the EURO is required unless the cost accounting system is in EURO in which case the EURO shall be used as the N.C.

COMPANY PRICE BREAKDOWN FORM — ***Form No. PSS A2*** — *Issue 4*

Page No. 1 No. of Pages 1

RFQ/ITT No. **AO/1-5798/08/NL-Sfe**	COMPANY NAME: VISUAL DISPLAY
Proposal/Tender No.: **INTA-LCVRs-001**	Name and Title: Manuel López - Technical Manager
Economic Condition: oct-08 Type of Price: Fixed firm	Signature

SUPPLIES AND/OR SERVICES TO BE FURNISHED

LABOUR	Manpower effort	Gross Hourly Rates		National Currency (NC)	Total EURO
Direct Labour cost centres or categories	*in Manhours*	*in NC**			€
Engineering	520	36		18 720	18 720
Manufacturing	480	21		10 080	10 080
1 Total Direct Labour Hours and Cost	*1 000*		*A*	*28 800*	*28 800*

INTERNAL SPECIAL FACILITIES	Type of unit	No. of units	Unit rates in NC			
Clean Room LCDs manufacturing					0	0
facilities and equipment	cost per day	60	100		6 000	6 000
					0	0
					0	0
					0	0
					0	0
2 Total Internal Special Facilities Cost				*B*	*6 000*	*6 000*

OTHER COST ELEMENTS	Base amounts in NC	OH%	OH amounts in NC			
3.1 Raw materials	6 000	0.00	6 000			6 000	6 000
3.2 Mechanical parts		0.00	0			0	0
3.3 Semi-finished products		0.00	0			0	0
3.4 Electrical & electronic components		0.00	0			0	0
3.5 Hirel parts			0			0	0
a) procured by company			0			0	0
b) procured by third party			0			0	0
3.6 External Major Products		0.00	0			0	0
3.7 External Services			0			0	0
3.8 Transport/Insurance			0			0	0
3.9 Travels	1 500	0.00	1 500			1 500	1 500
3.10 Miscellaneous		0.00	0			0	0
3 Total Other Direct Cost	*C*			*D*	*E*	*7 500*	7 500
4. SUB TOTAL COST				**(A+B+E)**	**F**	**42 300**	**42 300**

GENERAL EXPENSES	Cost items to which % applies	Base in NC to which % applies	%			
5. General & Admin. Expenses	0	0	0.00	G		0	0
6. Research & Develop. Exp.	0	0	0.00	H		0	0
7. Other				J		0	0
(to be specified)							
8. Total Cost of All Work Packages			***(F+G+H+J)***	***K***		***42 300***	***42 300***
9. Overheads on Subcontractors (Base in NC on which % applies: 0)			%	L		***0***	0
10. Sub-total			**(K+L)**	**M**		***42 300***	**42 300**
11. Profit (8.00 % on Base Amount in NC:)				N			
12. Cost without additional charge (to be itemised on Exhibit A)				P		***0***	0
13. Financial Provision for escalation, if applicable (justification and details to be stated on Exhibit A)				Q		***0***	0
14. Total			**(M+N+P+Q)**	**R**		***42 300***	**42 300**
15. Reduction for company contribution (if applicable)				S		***0***	0
16. TOTAL PRICE FOR ESA			**(R-S)**	**T**		***42 300***	**42 300**

If insufficient space is available to identify all required information, please use additional sheet or insert lines

* The Euro is to be used as the NC where the cost accounting system is in Euro.

Manpower and Price Summary

Issue 4

Subject: Proposal INTA-LCVRs-001 ITT/RFQ: AO/1-5798/08/NL-Sfe

(*) National Currency (NC) : Euro (**) Conversion Rate: Economic condition:

Company	Visual Display													
WP Title	Study of State of th	Study of Techn	Identification of	Selection of ma	Preliminary perf	Preliminary con	LCVRs manufa	Manufacturing a	Critical Review	Elaboration of a	Coordination	Deliverables co	Reporting	
WP Number	WP0123_F	WP0124_F	WP0310_F	WP0320_F	WP0411_F	WP0413_F	WP0414_F	WP1110_F	WP1310_F	WP1330_F	WP2110_F	WP2210_F	WP2310_F	Total WBS-Level
Labour hours as per PSS A2 (*)														
...														
...														
...														
...														
...														
...														
...														
...														
Total Labour Hours	24	24	36	36	20	36	32	536	56	56	52	44	48	1000
1. Total Labour Cost	864	864	1296	1296	720	1296	1152	12096	2016	2016	1872	1584	1728	28800
2. Internal Special Facilities								6000						
3.1-3.4 Material Costs								6000						
3.5 High Rel Parts Costs														
3.6 External major products Cost														
3.7 External Services Cost														
3.8 Transport/Insurance Cost														
3.9 Travel and Subsistance Cost											1500			
3.10 Miscellaneous Cost														
3. Total Other Costs														
4. Subtotal Cost								12000			1500			
5.- 7. General expenses														
8. Total Cost of WPs	864	864	1296	1296	720	1296	1152	24096	2016	2016	3372	1584	1728	42300
9. Overhead on Subcontractors														
10. Subtotal (8+9)														
11. Profit														
12. Cost without additional charge														
13. Financial Provision for escalation	NC													
14. Total	NC	42300												
	EUROs	42300												
15. Reduction for company contribution	NC													
(if applicable)	EUROs													
16. Total Price	NC	42300												
	EUROs	42300												

(*) for PSS A8 of a single company. (**) The EURO is to be used as the NC where the cost accounting system is in EURO

Arcoptix

COMPANY COST ELEMENT DATA SHEET	FORM No. PSS A1 Issue 2	Page no. of
RFQ/ITT no.: AO/1-5798/08/NL/Sfe		COMPANY NAME: ARCOPTIX
PROPOSAL no.: INTA-LCVRs-001		Name and title: Gerben Boer-Liquid crystal product manager
NATIONAL CURRENCY *: CHF		Signature:
Period for which agreed rates and overheads are valid : From January To December		
ECONOMIC CONDITIONS: 2008		

Agreed by

Status *(x when appl.)*

1. LABOUR *Direct labour cost centres or categories*	Basic Labour *hourly rate (NC)*	Labour OH% *(or NC)*	GROSS HOURLY RATE *in National Currency*
1 Engineer	120		120
2 Technician	100		100
3 Administration	100		100

2. INTERNAL SPECIAL FACILITIES	Type of Unit	UNIT RATE (NC)
clean area (10'000)	Day	100
liquid crystal fabrication facilities	Day	35
optical measurement equipment	Day	10

3. OTHER COST ELEMENTS			OVERHEADS
According to ESA type		*According to normal company type*	%
3.1	Raw materials		0
3.2	Mechanical parts		
3.3	Semi-finished products		
3.4	Electric & electronic components		
3.5	Hirel parts		
	a) procured by company		
	b) procured by 3rd party		
3.6	External major products		
3.7	External services		
3.8	Transport, insurance		0
3.9	Travels		
3.1	Miscellaneous		
3.11	Subcontracts		

GENERAL EXPENSES			OVERHEADS
According to ESA type	*According to normal company type*	*Applicable on cost element no.*	%
5. General & Admin. expenses			
6. Research & Developm. expenses			
7. Other (specify)			

12. COST WITHOUT ADDITIONAL CHARGE

* No mention of the EURO is required unless the cost accounting system is in EURO in which case the EURO shall be used as the N.C.

COMPANY PRICE BREAKDOWN FORM — ***Form No. PSS A2*** — *Issue 4*

Page No. 1 No. of Pages 1

RFQ/ITT No. **A0/1-5798/08/NL/Sfe** | COMPANY NAME: **ARCOPTIX S.A**

Proposal/Tender No.: | Name and Title: **Gerben Boer- Liquid crystal prodcut manager**

Economic Condition: **ene-08** Type of Price: fixed firm | Signature

SUPPLIES AND/OR SERVICES TO BE FURNISHED

LABOUR			Manpower effort	Gross Hourly Rates		National Currency (NC)	Total EURO
Direct Labour cost centres or categories			*in Manhours*	*in NC**		*CHF*	*€*
Engineering			240	120		28 800	18 113
Manufacturing			240	100		24 000	15 094
Administration			24	100		2 400	1 509
1 Total Direct Labour Hours and Cost					*A*	*55 200*	*34 716*
INTERNAL SPECIAL FACILITIES	Type of unit		No. of units	Unit rates in NC			
clean area (10'000)	cost per day		30	100		3 000	1 886
liquid crystal fabrication facilities	cost per day		30	35		1 050	660
optical measurement equipment	cost per day		5	10		50	31
2 Total Internal Special Facilities Cost					*B*	*4 100*	*2 577*
OTHER COST ELEMENTS	Base amounts in NC	OH%	OH amounts in NC				
3.1 Raw materials	12 200	0.00	0			12 200	7 672
3.2 Mechanical parts							
3.3 Semi-finished products							
3.4 Electrical & electronic components							
3.5 Hirel parts							
a) procured by company							
b) procured by third party							
3.6 External Major Products							
3.7 External Services							
3.8 Transport/Insurance	400	0.00	0			400	251
3.9 Travels	0						
3.10 Miscellaneous							
3 Total Other Direct Cost	*C*			*D*	*E*	*12 600*	*7 923*
4. SUB TOTAL COST				**(A+B+E)**	**F**	**71 900**	**45 220**
GENERAL EXPENSES	Cost items to which		Base in NC to which	%			
	% applies		% applies				
5. General & Admin. Expenses	0		0		G	0	0
6. Research & Develop. Exp.	0		0		H	0	0
7. Other (to be specified)					J	0	0
8. Total Cost of All Work Packages				***(F+G+H+J)***	***K***	***71 900***	***45 220***
9. Overheads on Subcontractors (Base in NC on which % applies:)				%	L	***0***	0
10. Sub-total				**(K+L)**	**M**	***71 900***	
11. Profit (0.00 % on Base Amount in NC:)					N	***0***	0
12. Cost without additional charge (to be itemised on Exhibit A)					P	***0***	0
13. Financial Provision for escalation, if applicable (justification and details to be stated on Exhibit A)					Q	***0***	0
14. Total				**(M+N+P+Q)**	**R**	***71 900***	**45 220**
15. Reduction for company contribution (if applicable)					S	***0***	0
16. TOTAL PRICE FOR ESA				**(R-S)**	**T**	***71 900***	**45 220**

If insufficient space is available to identify all required information, please use additional sheet or insert lines

* The Euro is to be used as the NC where the cost accounting system is in Euro.

Manpower and Price Summary Form no. **PSS A8** Issue 4

Subject: Validation of LCVRs for the Solar Orbiter ITT/RFQ: A0/1-5798/08/NL/Sfe

(*) National Currency (NC) : CHF (**) Conversion Rate: 1.59 Economic condition: 2008

Company		ARCOPTIX	ARCOPTIX	ARCOPTIX	ARCOPTIX	ARCOPTIX	ARCOPTIX	ARCOPTIX	ARCOPTIX	ARCOPTIX	ARCOPTIX	ARCOPTIX	ARCOPTIX	ARCOPTIX	ARCOPTIX	
WP Title		Study of the State of the Art of LCVRs manufacturing	Study of technology improvements	Identification of basic set of design parameters	Definition of LCVRs set	Preliminary performance model	Preliminary contacts of LCVRs materials procurements	LCVRs manufacturing plan	Manufacturing and procurement of LCVRs	Critical Review (TRB)	Elaboration of the technical data package	coordination	Deliverable control	Reporting	Meetings	
WP Number		WP 0123_G	WP 0124_G	WP 0310_G	WP 0320_G	WP 0411_G	WP 0413_G	WP 0414_G	WP 1110_G	WP 1310_G	WP 1330_G	WP2110_G	WP 2210_G	WP 2310_G	WP 2410_G	
																Total WBS-Level
Labour hours as per PSS A2 (*)																
Engineering		16	24	20	12	16	16	8	32	8	16	16	8	24	24	240
Manufacturing									240							240
Administration																
...																
...																
...																
...																
...												12		12		24
Total Labour Hours		16	24	20	12	16	16	8	272	8	16	28	2408	10832	25	436
1. Total Labour Cost		1920	2880	2400	1440	1920	1920	960	27840	960	1920	3120	960	4080	2880	55200
2. Internal Special Facilities									4100							4100
3.1-3.4 Material Costs									12200							12200
3.5 High Rel Parts Costs																
3.6 External major products Cost																
3.7 External Services Cost																
3.8 Transport/Insurance Cost																
3.9 Travel and Subsistance Cost															400	400
3.10 Miscellaneous Cost																
3. Total Other Costs									12200						400	13600
4. Subtotal Cost		1920	2880	2400	1440	1920	1920	960	44140	960	1920	3120	960	4080	3280	71900
5.- 7. General expenses																
8. Total Cost of WPs		1920	2880	2400	1440	1920	1920	960	44140	960	1920	3120	960	4080	3280	71900
9. Overhead on Subcontractors																
10. Subtotal (8+9)																
11. Profit																
12. Cost without additional charge																
13. Financial Provision for escalation	NC															
14. Total	NC	1 920.00	2 880.00	2 400.00	1 440.00	1 920.00	1 920.00	960.00	44 140.00	960.00	1 920.00	3120	960	4080	3280	64 540.00
	EUROs	1 207.55	1 811.32	1 509.43	905.66	1 207.55	1 207.55	603.77	27 761.01	603.77	1 207.55	1 962.26	603.77	2 566.04	2 062.89	40 591.19
15. Reduction for company contribution (if applicable)	NC															
	EUROs															
16. Total Price	NC	1 920.00	2 880.00	2 400.00	1 440.00	1 920.00	1 920.00	960.00	44 140.00	960.00	1 920.00	3120	960	4080	3280	71 900.00
	EUROs	1 207.55	1 811.32	1 509.43	905.66	1 207.55	1 207.55	603.77	27 761.01	603.77	1 207.55	1 962.26	603.77	2 566.04	2 062.89	45 220.13

(*) for PSS A8 of a single company. (**) The EURO is to be used as the NC where the cost accounting system is in EURO

ANNEX 4: WORK PACKAGES DESCRIPTION (PSS-A20)

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0000**
WP Title: **Phase I – LCVRs Technology Consolidation and System Assessment** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs: SoW, KOM minutes

Tasks:

This is a root WP and includes the tasks described in the following WPs:

WP 0100

WP 0200
WP 0300
WP 0400

Outputs:
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan
TN5 Test Plan

PROJECT:	**Validation of LCVRs for the Solar Orbiter Polarization Modulation Package**	WP REF: **0100**
PHASE:	Phase 1	
WP Title: **Requirements & technology review** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)		Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs: SoW, KOM minutes

Tasks:

This is a root WP and includes the tasks described in the following WPs:

WP 0110

WP 0120

Outputs: TN1 Review of the Requirements & Technology Review Report

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0110**
WP Title: **Technical Requirements Review** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:

SoW, KOM minutes, Technical requirements of the LCVRs (ANNEX 1 of the SoW)

Tasks:

This is a root WP and includes the tasks described in the following WPs:

WP 0111_A

WP 0111_B

WP 0111_D

WP 0111_E

WP 0112_A

WP 0113_A

Outputs:

Updated Technical Requirements

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0111_A**
WP Title: **Functional and performance requirements review** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Raquel Lopez Heredero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Consolidation of the technical requirements

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Scientific literature
Previous Group Background

Tasks:
- Review of the functional & performance technical requirements of LCVRs (ANNEX1 of SoW)

Outputs:
Updated technical requirements of the LCVRs to be included in TN1.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0112_A**
WP Title: **Revision of the outgassing requirements** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Raquel Lopez Heredero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Consolidation of the technical requirements

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Scientific literature
Previous Group Background

Tasks:
- Review of the outgassing requirements of LCVRs (ANNEX1 of SoW)

Outputs:
Updated technical requirements of the LCVRs to be included in TN1.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0113_A**
WP Title: **Revision of the environmental requirements** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Raquel Lopez Heredero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Consolidation of the technical requirements

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Scientific literature
Previous Group Background

Tasks:
- Review of the environmental requirements of LCVRs (ANNEX1 of SoW)

Outputs:
Updated technical requirements of the LCVRs to be included in TN1.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0120**
WP Title: **Technology review** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:

SoW, KOM minutes, Technical requirements of the LCVRs (ANNEX 1 of the SoW)

Tasks:

This is a root WP and includes the tasks described in the following WPs:

WP 0121_A WP 0123_B
WP 0121_B WP 0123_F
WP 0121_D WP 0123_G
WP 0121_E WP 0124_A
WP 0122_A WP 0124_B
WP 0122_B WP 0124_F
WP 0122_D WP 0124_G
WP 0122_E

Outputs:

Technology Review Report to be included in TN1.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0121_A**
WP Title: **Study of the State of the Art of LCVRs for polarimetry** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Marianela Fernández (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To asses the current state of the art of polarimetry employing LCVRs to perform full Stokes vector measurements, including ground systems.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Scientific literature
Previous Group Background

Tasks:
- To study the technology of Stokes imaging polarimetry using LCVRs, including different existing techniques and technologies involving LCVRs devices.

Outputs:
Study report to be included in TN1

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0122 _A**
WP Title: **Study of alternative concepts of LCVRs for polarimetry** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Marianela Fernández (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To study different techniques and technologies involving LCVRs devices as alternatives for polarimetry, with a view in the SoW requirements.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Scientific literature
Previous Group Background

Tasks:
- To perform a critical comparison of polarimetry concepts based on the most common electro-optical effects, including nematic and ferroelectric switching.
- To study the applicability of alternative concepts based on advanced LC electro-optic effects, alignment method, electrode configurations as well as configurations deploying multiple cascade LCVRs in order to improve achromatic behaviour within the context of polarimetry.

Outputs:
Study report of a critical comparison of alternative concepts for polarimetry using LCVRs to be included in TN1.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0124_A**
WP Title: **Study of technology improvements** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Tomás Belenguer (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To asses the technology improvements to be expected in terms of material engineering and processes development.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Scientific literature
Previous Group Background
Currently commercial available LCVRs components
Currently commercial available polarimetry designs

Tasks:
- To study the technology improvements to be expected in terms of material engineering and processes development
- To estimate the relevant effort and associated development risk

Outputs:
Study report to be included in TN1 establishing the technology improvements to be performed

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0200**
WP Title: **Preliminary assessment of environmental effects** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 1.5 Planned Date: TBD End event: T0 + 3 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:

SoW, KOM minutes, TN1 Review of the Requirements & Technology Review Report

Tasks:

This is a root WP and includes the tasks described in the following WPs:

WP 0210_A

WP 0220_A

WP 0220_B

Outputs:

TN2 Environmental Assessment Report

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0210_A**
WP Title: **LCVRs under space environmental conditions** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 1.5 Planned Date: TBD End event: T0 + 3 Planned Date: TBD WP Manager: Tomas Belenguer (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Preliminary assessment of environmental effects to foresee degradation phenomena and potential failure mechanisms on the different constituting parts of the relevant LCVRs.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
TN1 Review of the Requirements & Technology Review Report
Scientific literature
Previous Group Background

Tasks:
- Preliminary study of the vibration and thermal vacuum exposure effects over the variety of LC materials associated electro-optical effects and relevant fabrication methods selected from Task 1.
- Preliminary study of the radiation environment of space effects (UV, X-ray, gamma irradiation and energetic particle effects over the variety of LC materials, associated electro-optical effects and relevant fabrication methods selected from Task 1.
- Try to establish links between the chemical structure of the LC and their sensitivity to the space radiation environment.

Outputs:
Preliminary assessment of environmental effects report to be included in TN2

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0220_A**
WP Title: **Establish performance indicators** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 1.5 Planned Date: TBD End event: T0 + 3 Planned Date: TBD WP Manager: Marianela Fernandez (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Establish performance indicators that can be used to quantify and monitor the degradation of the LCVRs as a result of their exposure to the environment

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
TN1 Review of the Requirements & Technology Review Report
Scientific literature
Previous Group Background

Tasks:
- To establish potential performance indicators to quantify the degradation of LCVRs to exposure to vibration effects.
- To establish potential performance indicators to quantify the degradation of LCVRs to exposure to thermal vacuum effects.
- To establish potential performance indicators to quantify the degradation of LCVRs to exposure radiation environment of space effects (UV, X-ray, gamma irradiation and energetic particle effects).
- To identify possible technical areas that deserve specific consideration.

Note: The work in this task should take into account the selection of materials, fabrication processes and control schemes to be determined in Task 3.

Outputs:
List of performance indicators to be included in TN2

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0300**
WP Title: **Preliminary selection of design parameters and electro-optical effects** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 3 Planned Date: TBD End event: T0 + 3.5 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:

TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report

Tasks:

This is a root WP and includes the tasks described in the following WPs:

WP 0310_A

WP 0310_B

WP 0310_F

WP 0310_G

WP 0320_A

WP 0320_B

WP 0320_F

WP 0320_G

Outputs:

TN3 Preliminary Definition Report

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0310_A**
WP Title: **Identification of basic set of design parameters** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 3 Planned Date: TBD End event: T0 + 3.5 Planned Date: TBD WP Manager: Tomás Belenguer (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Detailed trade-off that allows the selection of the most promising materials, fabrication methods and control schemes to be selected n order to meet the specified performance and at same time reduce the risk of device degradation due to exposure to the environment.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment report

Tasks:
- To identify a basic set of design parameters that will be used to procure/manufacture.

Outputs:
Report to be included in TN3.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0320_A**
WP Title: **Definition LCVRs set** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 3 Planned Date: TBD End event: T0 + 3.5 Planned Date: TBD WP Manager: Marianela Fernandez (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Selection of the most promising materials and sub-components for the realisation of the LCVR cells in order to ensure optimal performance and durability against the specified environment and identification of a representative set of LCVRs.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment report

Tasks:

- Selection the most promising materials and sub-components
- To identify a representative set of LCVRs,

Note: this set shall be selected with a view to maximise the output from the tests planned for *WP 1200: Test & characterisation and t*o produce a well informed input for the technology qualification plan scheduled for *WP 1300: Critical appraisal, recommendation and technology qualification plan*. As a minimum, the following cases shall be considered:

1: NLC and FLC materials
2: Materials with high birefringence and materials with low birefringence
3: Positive nematics and negative nematics
4: Different alignment agents / methods

Outputs:
Report to be included in TN3

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0400**
WP Title: **Detailed definition, manufacturing/procurement and testing plan** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 3.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:

SoW, KOM minutes,
TN3 Preliminary Definition Report,
TN4 Development, Manufacturing & Procurement plan

Tasks:

This is a root WP and includes the tasks described in the following WPs:

WP 0410

WP 0420

Outputs:

TN4 Development, Manufacturing & Procurement plan

TN5 Test Plan

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0410**
WP Title: **Detailed manufacturing and procurement plan** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 3.5 Planned Date: TBD End event: T0 + 4.5 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:

SoW, KOM minutes
TN3 Preliminary Definition Report

Tasks:

This is a root WP and includes the tasks described in the following WPs:

WP 0411_A

WP 0411_B

WP 0411_F

WP 0411_G

WP 0412_A

WP 0413_B

WP 0413_F

WP 0413_G

WP 0414_B

WP 0414_F

WP 0414_G

WP 0415_E

WP 0416_E

Outputs:

TN4 Development, Manufacturing & Procurement plan

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0411_A**
WP Title: **Preliminary performance model** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 3.5 Planned Date: TBD End event: T0 + 4.5 Planned Date: TBD WP Manager: Marianela Fernandez (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To stablish a preliminary performance model for each type of LCVRs cell and compare its predicted performance to the technical requirements.

Inputs:
SoW, KOM minutes
TN3 Preliminary Definition Report

Tasks:
To elaborate an analytical performance model for each type of LCVR cell.
To compare the LCVR cells predicted performance to the requirements of ANNEX1

NOTE: A simplified model will be elaborated since LCVRs are very complex systems. Therefore, the prediction capabilities of the model can not be guaranteed. A complex simulation is beyond the goal of this project

Outputs:
Report to be included in TN4.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0412_A**
WP Title: **Definition of the preliminary LCVRs functional verification** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 3.5 Planned Date: TBD End event: T0 + 4.5 Planned Date: TBD WP Manager: Raquel Lopez Heredero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To define a preliminary verification plan to be followed upon procurement/manufacturing of the device

Inputs:
SoW
KOM minutes
TN3 Preliminary Definition Report

Tasks:
To define a preliminary verification plan including the necessary tests to be performed immediately at the end of the LCVRs manufacturing for a preliminary verification of the LCVRs performance.

Outputs:
Report to be included in TN4.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP: **REF: 0420**
WP Title: **Performance verification and environmental testing programme** Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:

SoW, KOM minutes,
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement plan

Tasks:

This is a root WP and includes the tasks described in the following WPs:

WP 0421_A WP 0424_A
WP 0421_B WP 0424_B
WP 0421_C WP 0424_C
WP 0422_A WP 0425_A
WP 0422_B WP 0425_B
WP 0422_C WP 0425_C
WP 0423_A WP 0426_A
WP 0423_B WP 0426_B
WP 0423_C WP 0426_C

Outputs:

TN5 Test Plan

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0421_A**
WP Title: Definition of the performance verification plan Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Marianela Fernandez (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:

To produce a detailed verification test plan to demonstrate the performance of all LCVRs devices.

Inputs:

SoW

KOM minutes

TN3 Preliminary Definition Report

TN4 Development, Manufacturing and Procurement Plan

Tasks:

To define the performance verification tests. It will include a complete optical performance characterization of the LCVRs devices to be carried out previously to the environmental tests (WP 1213_A, WP 1214_B) as well as the optical characterization tests to be carried out before/after the environmental testing (WP 1225_A, WP 1225_C, WP 1226_B).

To define a verification plan

Outputs:

Report to be included in TN5

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0422 _A**
WP Title: Definition of the environmental test plan Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Raquel Lopez Heredero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To produce a detailed LCVRs environmental test plan to demonstrate that the requirements presented in ANNEX1 of the SoW are reached.

Inputs:
SoW
KOM minutes
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan

Tasks:
- To establish the requirements verification methods and the environmental tests to be performed.
- To produce a well structured test time schedule, taking under consideration accessibility to facilities and equipment, proximity as well as possible downtimes.

Outputs:
Report to be included in TN5.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0423_A**
WP Title: Elaboration of the characterisation procedures Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Marianela Fernandez (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
The elaboration of the characterization procedures of the LCVRs

Inputs:
SoW
KOM minutes
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan

Tasks:
Characterization procedures shall be elaborated specifying:
· The relevant performance parameters to be measured
  · The methodology behind the extraction of those parameters
  · The test equipment and the configuration necessary for their measurement
  · The pass/fail criteria

Outputs:
Report to be included in TN5.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0424_A**
WP Title: Elaboration of the test procedures Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Raquel Lopez Heredero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
The elaboration of the test procedures of the LCVRs under space environmental conditions

Inputs:
SoW
KOM minutes
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan

Tasks:

- To elaborate the procedures of the environmental tests including the test parameters levels (total dose, pressure, vibratin levels, etc.), necessary equipment, tools and verification methods.

Outputs:
Report to be included in TN5.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0425_A**
WP Title: Elaboration of the test equipment list Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Raquel Lopez Heredero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
The elaboration of the test equipment list

Inputs:
SoW
KOM minutes
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan

Tasks:
- Compile a list of the test equipment available at the Consortium premises together with a description of its performances as well as its intended use for the tests planned.

Outputs:
Report to be included in TN5..

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0426 _A**
WP Title: Identification of test tools Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Raquel Lopez Heredero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Identification of test tools

Inputs:
SoW
KOM minutes
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan

Tasks:
- To identify any additional material necessary for the tests as mechanical tools (i.e.: holders).
- To establish specifications and a procurement plan.

Outputs:
Report to be included in TN5.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1000**
WP Title: Phase II – LCVRs Development and Validation Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 5.5 Planned Date: TBD End event: T0 + 16 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:
SoW, KOM minutes, TN1, TN2, TN3, TN4, TN5

Tasks:

This is a root WP and includes the tasks described in the following WPs:

WP 1100

WP 1200
WP 1300

Outputs:
TN6 Development & Functional Verification Report
TN7 Performance Verification Report
TN8 Environmental Test Report
TN9 Technology Qualification Plan

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1100**
WP Title: Manufacturing/Procurement and functional verification Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 5.5 Planned Date: TBD End event: T0 + 8.5 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:

TN4 Development, Manufacturing & Procurement Plan

Phase 1 Review minutes

Tasks:

This is a root WP and includes the tasks described in the following WPs:

WP 1110_B

WP 1110_F

WP 1110_G

WP 1120_A

WP 1130_E

WP 1140_E
WP 1150_B
WP 1150_F
WP 1150_G

Outputs:

LCVRs prototypes, TN6 Development & Functional Verification Report

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1120_A**
WP Title: Preliminary LCVRs functional verification Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 5 Planned Date: TBD End event: T0 + 8.5 Planned Date: TBD WP Manager: Raquel Lopez Heredero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To perform preliminary functional tests and calibration of control systems s

Inputs:
TN4 Development, Manufacturing & Procurement Plan
Phase 1 Review minutes

Tasks:
Preliminary functional tests and calibration of control systems shall be performed
This task consists of the necessary tests to be performed immediately at the end of the LCVRs manufacturing for a preliminary verification of the LCVRs performance

Outputs:
Report to be included in TN6

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1200**
WP Title: Test and Characterisation Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:

LCVR prototypes

TN5 Test Plan

TN6 Development & Functional Verification

Tasks:

This is a root WP and includes the tasks described in the following WPs:

WP 1210 WP 1223_A

WP 1211_A WP 1224_A
WP 1211_C WP 1224_C
WP 1212_A WP 1225_A

WP 1212_C WP 1225_C

WP 1213_A WP 1226_B

WP 1214_B WP 1230

WP 1220 WP 1231_A

WP 1221_A WP 1231_B

WP 1222_A

Outputs:

TN7 Performance Verification Report

TN8 Environmental Test Report

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1210**
WP Title: Verification of optical performance Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:

LCVR prototypes

TN5 Test Plan

TN6 Development & Functional Verification

Tasks:

This is a root WP and includes the tasks described in the following WPs:

WP 1211_A
WP 1211_C
WP 1212_A

WP 1212_C

WP 1213_A

WP 1214_B

Outputs:

TN7 Performance Verification Report

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1211 _A**
WP Title: Design and manufacturing of test tools Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Raquel Lopez Heredero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Design and manufacture all necessary test set-up to perform the posterior LCVRs tests

Inputs:
TN5 Test Plan
TN6 Development & Functional Verification Report

Tasks:
- To design and to manufacture the additional material necessary for the tests as mechanical tools (i.e.: holders).

Outputs:

Test tools

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1212 _A**
WP Title: Calibration between the different optical testing systems Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Marianela Fernandez (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To calibrate the different optical testing set-ups to be able of compare results between them

Inputs:
TN5 Test Plan
TN6 Development & Functional Verification Report

Tasks:
To calibrate the CSL and INTA optical testing systems (i.e: ellipsoemters) to guarantee the right comparison between measurements. This task is necessary because CSL will measure the LCVRs immediately after radiation tests to avoid relaxation effects. INTA will also measure the devices but after transporting to Spain.

Outputs:
Report to be included in TN7.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1213_A**
WP Title: Optical performance characterisation Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Marianela Fernandez (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Verification of the optical performance of all LCVR prototypes

Inputs:
LCVRs prototypes
TN5 Test Plan
TN6 Development & Functional Verification Report

Tasks:
The performance of all LCVR prototypes shall be fully tested against performance specified in ANNEX 1 hereto
It will include a complete optical performance characterization of the LCVRs devices to be carried out previously to the environmental tests.

Outputs:
Report to be included in TN7

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1220**
WP Title: Environmental testing and qualification Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:

LCVR prototypes

TN5 Test Plan

TN6 Development & Functional Verification Report

Tasks:

This is a root WP and includes the tasks described in the following WPs:

WP 1221_A

WP 1222_A

WP 1223_A

WP 1224_A

WP 1224_C

WP 1225_A

WP 1225_C

WP 1226_B

Outputs:

TN8 Environmental Test Report

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1221_A**
WP Title: Thermal-vacuum tests Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Raquel Lopez Heredero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Verification of LCVRs performance against thermal-vacuum environment specified in ANNEX 1 hereto

Inputs:
LCVRs prototypes
TN5 Test Plan
TN6 Development & Functional Verification Report

Tasks:
To test the performance of the all LCVRs prototypes against thermal-vacuum environment specified in ANNEX1 hereto

Outputs:
Report to be included in TN8

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1222_A**
WP Title: Vibration/shock tests Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Raquel Lopez Heredero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Verification of all LCVRs performance against vibration/shock environment specified in ANNEX 1 hereto

Inputs:
LCVRs prototypes
TN5 Test Plan
TN6 Development & Functional Verification Report

Tasks:
To test the performance of all LCVRs prototypes against vibration/shock environment specified in ANNEX1 hereto

Outputs:
Report to be included in TN8

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1223_A**
WP Title: Outgassing test Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Raquel Lopez Heredero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Verification of all LCVRs outgassing against environment specified in ANNEX 1 hereto

Inputs:
LCVRs prototypes
TN5 Test Plan
TN6 Development & Functional Verification Report

Tasks:
To test the outgassing of all LCVRs prototypes against environment specified in ANNEX1 hereto.
Note: The LCVRs cells do not fit in the INTA outgassing chamber test, which is ESA certified for this kind of measurements. The following plan will carried out: First, the outgassing rate of the materials and subcomponents of LCVRs devices will be measured in the certified facility. After that, a test of outgassing rate of the complete LCVRs device (system level) will be performed in a ESA non-certified facility following a traceably and rigorous method.

Outputs:
Report to be included in TN8

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1224_A**
WP Title: Radiation tests Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Raquel Lopez Heredero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Verification of all LCVRs performance against gamma radiation environment specified in ANNEX 1 hereto

Inputs:
LCVRs prototypes
TN5 Test Plan
TN6 Development & Functional Verification Report

Tasks:
To test performance of all LCVRs prototypes against the gamma radiation environment specified in ANNEX1 hereto.

Outputs:
Report to be included in TN8

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1225_A**
WP Title: Optical characterisation before/after the environmental testing Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Marianela Fernandez (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Detect any possible change in the LCVR optical performance caused by the test

Inputs:
LCVRs prototypes
TN5 Test Plan
TN6 Development & Functional Verification Report

Tasks:
To test the optical performance of LCVRs before and after each environmental test against performance specified in ANNEX 1 hereto. The baseline is a reduced version of the tests carried out in the optical performance characterisation in WP 1213_A.

Outputs:
Report to be included in TN8

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1230**
WP Title: Polarization Modulation Package Demonstrator Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:

TN1 Review of the Requirements & Technology Review Report

TN2 Environmental Assessment Report

TN3 Preliminary Definition Report

TN4 Development, Manufacturing & Procurement Plan

TN5 Test Plan

TN6 Development & Functional Verification Report

TN7 Performance Verification Report

TN8 Environmental Test Report

Tasks:

This is a root WP and includes the tasks described in the following WPs:

WP 1231_A

WP 1231_B

Outputs:

Report of the VIM Polarization Modulator Package Demonstrato to be included in the updated TN7r

Report of the COR Polarization Modulator Package Demonstrator to be included in the updated TN7

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1231_A**
WP Title: VIM Polarization Modulation Package Demonstrator Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Marianela Fernandez (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Elaboration of a VIM Polarization Modulator Package Demonstrator based on the LCVRs prototypes

Inputs:
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan
TN5 Test Plan
TN6 Development & Functional Verification Report
TN7 Performance Verification Report
TN8 Environmental Test Report

Tasks:
To develop a VIM Polarization Modulator Package Demonstrator based on the most promising LCVRs prototypes after testing and characterisation..

Outputs:
Report of the VIM Polarization Modulator Package Demonstrator to be included in the updated TN7

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1300**
WP Title: Critical appraisal, recommendations and technology qualification plan. Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 13.5 Planned Date: TBD End event: T0 + 15.5 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:

TN1 Review of the Requirements & Technology Review Report

TN2 Environmental Assessment Report

TN6 Development & Functional Verification Report

TN7 Performance Verification Report

TN8 Environmental Test Report

Tasks:

This is a root WP and includes the tasks described in the following WPs:

WP 1310_A	WP 1310_F	WP 1330_C
WP 1310_B	WP 1310_G	WP 1330_D
WP 1310_C	WP 1320_A	WP 1330_E
WP 1310_D	WP 1330_A	WP 1330_F
WP 1310_E	WP 1330_B	WP 1330_G

Outputs:

Updated TN2 Environmental Assessment Report, TN9 Technology Qualification Plan,

Technical Data Package (TDP), Summary Report (SR) & Abstract, Deliverables (HW1, HW2, HW3, SW1).

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1310 _A**
WP Title: Critical review Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 13.5 Planned Date: TBD End event: T0 + 15.5 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Critical review of the results obtained during the optical verification and environmental test campaign.

Inputs:
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report
TN6 Development & Functional Verification Report
TN7 Performance Verification Report
TN8 Environmental Test Report

Tasks:
To perform a critical review of the results obtained during the optical verification and environmental test campaign. The performance reached with the LCVRs prototypes and control systems shall be critically evaluated and their theoretical performance limits determined

Outputs:
Report to be included in the updated TN2

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1320 _A**
WP Title: Elaboration of a technology qualification plan Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 13.5 Planned Date: TBD End event: T0 + 15.5 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To elaborate a technology qualification plan

Inputs:
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report
TN6 Development & Functional Verification Report
TN7 Performance Verification Report
TN8 Environmental Test Report

Tasks:
- To elaborate a technology qualification plan.
- To identify relevant objectives, a description of the programme work, the current technological status and timeframe and associated effort (cost and schedule)

Outputs:
Report to be included in TN9

Task Excluded:
None

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1330_A**
WP Title: Elaboration of the technical data package Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 13.5 Planned Date: TBD End event: T0 + 15.5 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Elaboration of a technical data package (TDP)

Inputs:
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan
TN5 Test Plan
TN6 Development & Functional Verification Report
TN7 Performance Verification Report
TN8 Environmental Test Report

Tasks:
To elaborate of a technical data package including the final versions of all technical notes as well as a summary report and abstract summarising the activities of the contract and the results obtained

Outputs:
Technical data package (TDP)

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **2000**
WP Title: Management Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 16 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:
N/A

Tasks:

This is a root WP and includes the tasks described in the following WPs:

WP 2100

WP 2200
WP 2300
WP 2400

Outputs:
TN1, TN2, TN3, TN4, TN5, TN6, TN7, TN8, TN9, TDP, SR, PR, HW1, HW2, HW3, SW1

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2100**
WP Title: Coordination Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:
N/A

Tasks:

This is a root WP and includes the tasks described in the following WPs:

WP 2110_A
WP 2110_
WP 2110_C
WP 2110_D

WP 2110_F

WP 2110_G

Outputs: N/As

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2110_A**
WP Title: Coordination Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Coordination of the activities of the INTA team and the coordination with the subcontractors.

Inputs:

N/A

Tasks:

To coordinate of the activities of the INTA team and the coordination with the subcontractors.

Outputs:
N/A

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2200**
WP Title: Deliverables control Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:

N/A

Tasks:
This is a root WP and includes the tasks described in the following WPs:
WP 2210_A
WP 2210_B

WP 2210_C

WP 2210_D

WP 2210_F

WP 2210_G

Outputs: TN1, TN2, TN3, TN4, TN5, TN6, TN7, TN8, TN9, TDP, SR, PR, HW1, HW2, HW3, SW1.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2210_A**
WP Title: Deliverables Control Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:

To control the deliverables

Inputs:

N/A

Tasks

To control the deliverables

Outputs: TN1, TN2, TN3, TN4, TN5, TN6, TN7, TN8, TN9, TDP, SR, PR, HW1, HW2, HW3, SW1

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2300**
WP Title: Reporting Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:
N/A

Tasks:
This is a root WP and includes the tasks described in the following WPs:
WP 2310_A
WP 2310_B
WP 2310_C
WP 2310_D
WP 2310_F
WP 2310_G

Outputs: TN1, TN2, TN3, TN4, TN5, TN6, TN7, TN8, TN9, TDP, SR, PR.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2310_A**
WP Title: Reporting Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To write the reports to deliver

Inputs:
N/A

Tasks:
To write the report to deliver.

Outputs: TN1, TN2, TN3, TN4, TN5, TN6, TN7, TN8, TN9, TDP, SR, PR.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2400**
WP Title: Meetings Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Inputs:
N/A

Tasks:
This is a root WP and includes the tasks described in the following WPs:

WP 2410_A

WP 2410_B

WP 2410_C

WP 2410_D

WP 2410_F

WP 2410_G

Outputs: N/A

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2410_A**
WP Title: Meetings Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Alberto Alvarez-Herrero (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To attend to the planned meetings.

Inputs:

N/A

Task
To attend to the planned meetings.

Outputs:
N/A

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0111_B**
WP Title: Functional and performance requirements review Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: S. Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 15-12-08

Objectives:
Consolidation of the technical requirements

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Scientific literature
Previous Group Background

Tasks:
- Review of the functional & performance technical requirements of LCVRs (ANNEX1 of SoW)

Outputs:
Updated technical requirements of the LCVRs to be included in TN1.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0121_B**
WP Title: Study of the State of the Art of LCVRs for polarimetry Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To asses the current state of the art of polarimetry employing LCVRs to perform full Stokes vector measurements, including ground systems.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Scientific literature
Previous Group Background

Tasks:
- To study the technology of Stokes imaging polarimetry using LCVRs, including different existing techniques and technologies involving LCVRs devices.

Outputs:
Study report to be included in TN1

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0122 _B**
WP Title: Study of alternative concepts of LCVRs for polarimetry Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To study different techniques and technologies involving LCVRs devices as alternatives for polarimetry, with a view in the SoW requirements.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Scientific literature
Previous Group Background

Tasks:
- To perform a critical comparison of polarimetry concepts based on the most common electro-optical effects, including nematic and ferroelectric switching.
- To study the applicability of alternative concepts based on advanced LC electro-optic effects, alignment method, electrode configurations as well as configurations deploying multiple cascade LCVRs in order to improve achromatic behaviour within the context of polarimetry.

Outputs:
Study report of a critical comparison of alternative concepts for polarimetry using LCVRs to be included in TN1.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0123 _B**
WP Title: Study of the State of the Art of LCVRs manufacturing Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 15-12-08

Objectives:
To study the state of the art of the manufacturing technologies of LCVRs devices.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Scientific literature
Previous Group Background

Tasks:
- To get in touch with the major industries producing the LCVRs
- to keep constantly up to date about the LCVRs manufacturing technologies.
- To compare and analyse the different applied technologies used by the major industries.

Outputs:
Study report of a critical comparison of alternative technologies used in the manufacturing process to be included in TN1.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0124_B**
WP Title: Study of technology improvements Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: S. Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To asses the technology improvements to be expected in terms of material engineering and processes development and its application to the achromatic LCVRs..

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Technical literature
Previous Group Background
Currently commercial available LCVRs components
Currently commercial available polarimetry designs

Tasks:
- To study the technology improvements to be expected in terms of material engineering and processes development
- To estimate the relevant effort and associated development risk
- To study its applications to achromatic LCVRs.

Outputs:
Study report to be included in TN1 establishing the technology improvements to be performed

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0220_B**
WP Title: Establish performance indicators Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 + 1.5 Planned Date: TBD End event: T0 + 3 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Establish performance indicators that can be used to quantify and monitor the degradation of the achromatic LCVRs as a result of their exposure to the environment

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
TN1 Review of the Requirements & Technology Review Report
Scientific literature
Previous Group Background

Tasks:
- To establish potential performance indicators to quantify the degradation of achromatic LCVRs to exposure to vibration effects.
- To establish potential performance indicators to quantify the degradation of achromatic LCVRs to exposure to thermal vacuum effects.
- To establish potential performance indicators to quantify the degradation of achromatic LCVRs to exposure radiation environment of space effects (UV, X-ray, gamma irradiation and energetic particle effects).
- To identify possible technical areas that deserve specific consideration.

Note: The work in this task should take into account the selection of materials, fabrication processes and control schemes to be determined in Task 3.

Outputs:
List of performance indicators to be included in TN2

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0310_B**
WP Title: Identification of basic set of design parameters Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 + 3 Planned Date: TBD End event: T0 + 3.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Detailed trade-off that allows the selection of the most promising materials, fabrication methods and control schemes to be selected n order to meet the specified performance and at same time reduce the risk of device degradation due to exposure to the environment.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment report

Tasks:
- To identify a basic set of design parameters that will be used to procure/manufacture achroamtic LCVRs.

Outputs:
Report to be included in TN3.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0320_B**
WP Title: Definition LCVRs set Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 + 3 Planned Date: TBD End event: T0 + 3.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Selection of the most promising materials and sub-components for the realisation of the LCVR cells in order to ensure optimal performance and durability against the specified environment and identification of a representative set of LCVRs.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment report

Tasks:

- Selection the most promising materials and sub-components
- To identify a representative set of achromatic LCVRs,

Outputs:
Report to be included in TN3

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0411_B**
WP Title: Preliminary performance model Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 + 3.5 Planned Date: TBD End event: T0 + 4.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To establish a preliminary performance model for achromatic LCVRs cell and compare its predicted performance to the technical requirements.

Inputs:
SoW, KOM minutes
TN3 Preliminary Definition Report

Tasks:
- To elaborate an analytical performance model for achromatic LCVR cell.
- To compare the achromatic LCVR cells predicted performance to the requirements of ANNEX1

NOTE: A simplified model will be elaborated since LCVRs are very complex systems. Therefore, the prediction capabilities of the model can not be guaranteed. A complex simulation is beyond the goal of this project

Outputs:
Report to be included in TN4.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0413_B**
WP Title: Preliminary contacts of LCVRs materials procurements Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 + 3.5 Planned Date: TBD End event: T0 + 4.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 15-12-08

Objectives:
To establish preliminary contacts finalised to the LVCRs material procurement in order to fulfill the specification given by the technical requirements.

Inputs:
SoW, KOM minutes
TN3 Preliminary Definition Report

Tasks: TBD

Outputs:
Report to be included in TN4.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0414_B**
WP Title: LCVRs manufacturing and procurement plan Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 + 3.5 Planned Date: TBD End event: T0 + 4.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To elaborate a procurement and manufacturing plan for the achromatic set of LCVRs agreed in WP 0300.

Inputs:
SoW, KOM minutes
TN3 Preliminary Definition Report

Tasks:
- To elaborate a procurement and manufacturing plan for the specific set of LCVRs agreed in WP 0300.
- To elaborate a report with information regardsing the manufacturing and the assembly process as well as control schemes adopted.

Outputs:
Report to be included in TN4

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0421_B**
WP Title: Definition of the performance verification plan Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:

To produce a detailed verification test plan to demonstrate the performance of the achromatic LCVRs devices.

Inputs:

SoW

KOM minutes

TN3 Preliminary Definition Report

TN4 Development, Manufacturing and Procurement Plan

Tasks:

To define the performance verification tests. It will include a complete optical performance characterization of the achromatic LCVRs devices to be carried out previously to the environmental tests (WP 1213_A, WP 1214_B) as well as the optical characterization tests to be carried out before/after the environmental testing (WP 1225_A, WP 1225_C, WP 1226_B).

To define a verification plan

Outputs:

Report to be included in TN5

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0422 _B**
WP Title: Definition of the environmental test plan Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To produce a detailed LCVRs environmental test plan to demonstrate that the requirements presented in ANNEX1 of the SoW are reached.

Inputs:
SoW
KOM minutes
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan

Tasks:
- To establish the requirements verification methods and the environmental tests to be performed.
- To produce a well structured test time schedule, taking under consideration accessibility to facilities and equipment, proximity as well as possible downtimes.

Outputs:
Report to be included in TN5.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0423_B**
WP Title: Elaboration of the characterisation procedures Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
The elaboration of the characterization procedures of the achromatic LCVRs

Inputs:
SoW
KOM minutes
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan

Tasks:
Characterization procedures shall be elaborated specifying:
· The relevant performance parameters to be measured
  · The methodology behind the extraction of those parameters
  · The test equipment and the configuration necessary for their measurement
  · The pass/fail criteria

Outputs:
Report to be included in TN5.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0424_B**
WP Title: Elaboration of the test procedures Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
The elaboration of the test procedures of the LCVRs under space environmental conditions

Inputs:
SoW
KOM minutes
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan

Tasks:

- To elaborate the procedures of the environmental tests including the test parameters levels (total dose, pressure, vibratin levels, etc.), necessary equipment, tools and verification methods.

Outputs:
Report to be included in TN5.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0425_B**
WP Title: Elaboration of the test equipment list Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
The elaboration of the test equipment list

Inputs:
SoW
KOM minutes
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan

Tasks:
- Compile a list of the test equipment available at the Consortium premises together with a description of its performances as well as its intended use for the tests planned.

Outputs:
Report to be included in TN5..

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0426 _B**
WP Title: Identification of test tools Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Identification of test tools

Inputs:
SoW
KOM minutes
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan

Tasks:
- To identify any additional material necessary for the tests as mechanical tools (i.e.: holders).
- To establish specifications and a procurement plan.

Outputs:
Report to be included in TN5.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1110_B**
WP Title: Manufacturing and procurement of LCVRs Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 + 5.5 Planned Date: TBD End event: T0 + 8.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To control and to interact during the manufacturing and to procurement process of the specific set of achromatic LCVRs agreed in WP300.

Inputs:
SoW, KOM minutes
Phase 1 review minutes
TN3 Preliminary Definition Report
TN4 Development, manufacturing and procurement plan.

Tasks:
To control and to interact during the manufacturing and to procurement process of the specific set of achromatic LCVRs agreed in WP300 following the Development, manufacturing and procurement plan (TN4)

Outputs:
HW1

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1150_B**
WP Title: Manufacturing and procurement of extra LCVRs Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 + 5.5 Planned Date: TBD End event: T0 + 8.5 Planned Date: TBD WP Manager: Silavano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To control and to interact during the manufacturing and to procurement process of the extra achroamtic LCVRs prototypes

Inputs:
SoW, KOM minutes
Phase 1 review minutes
TN3 Preliminary Definition Report
TN4 Development, manufacturing and procurement plan.

Tasks:
To control and to interact during the manufacturing and to procurement process of the extra LCVRs prototypes for ESA use.

Outputs:
HW2

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1214_B**
WP Title: Specific optical performance tests for achromatic LCVRs Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Specific measurements to verify the optical performance of the achromatic LCVRs

Inputs:
LCVRs prototypes
TN5 Test Plan
TN6 Development & Functional Verification Report

Tasks:
The performance of all LCVR prototypes shall be fully tested against performance specified in ANNEX 1 hereto. This WP includes the specific measurements necessary to characterize the achromatic LCVRs.

Outputs:
Report to be included in TN8

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1226_B**
WP Title: Specific optical characterisation before/after the environmental testing for achromatic LCVRs Contractor: INTA Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To detect any possible change in the achromatic LCVR optical performance caused by the test

Inputs:
LCVRs prototypes
TN5 Test Plan
TN6 Development & Functional Verification Report

Tasks:
To test the optical performance of the all LCVRs before and after each environmental test against performance specified in ANNEX 1 hereto. The baseline is a reduced version of the tests carried out in the optical performance characterisation in WP 1213_A. This WP includes the specific measurements necessary to characterize the achromatic LCVR

Outputs:
Report to be included in TN8

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1231_B**
WP Title: COR Polarization Modulation Package Demonstrator Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Elaboration of a COR Polarization Modulator Package Demonstrator based on the LCVRs prototypes

Inputs:
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan
TN5 Test Plan
TN6 Development & Functional Verification Report
TN7 Performance Verification Report
TN8 Environmental Test Report

Tasks:
To develop a COR Polarization Modulator Package Demonstrator based on the most promising LCVRs prototypes after testing and characterisation..

Outputs:
Report of the COR Polarization Modulator Package Demonstrator to be included in the updated TN7

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1310 _B**
WP Title: Critical review Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 + 13.5 Planned Date: TBD End event: T0 + 15.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Critical review of the results obtained during the optical verification and environmental test campaign.

Inputs:
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report
TN6 Development & Functional Verification Report
TN7 Performance Verification Report
TN8 Environmental Test Report

Tasks:
To perform a critical review of the results obtained during the optical verification and environmental test campaign. The performance reached with the LCVRs prototypes and control systems shall be critically evaluated and their theoretical performance limits determined

Outputs:
Report to be included in the updated TN2

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1330_B**
WP Title: Elaboration of the technical data package Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 + 13.5 Planned Date: TBD End event: T0 + 15.5 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Elaboration of a technical data package (TDP)

Inputs:
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan
TN5 Test Plan
TN6 Development & Functional Verification Report
TN7 Performance Verification Report
TN8 Environmental Test Report

Tasks:
To elaborate of a technical data package including the final versions of all technical notes as well as a summary report and abstract summarising the activities of the contract and the results obtained

Outputs:
Technical data package (TDP)

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2110_B**
WP Title: Coordination Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +14 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Coordination of the activities of the INAF team and the coordination with the contractor.

Inputs:

N/A

Tasks:
To coordinate of the activities of the INAF team and the coordination with the contractor.

Outputs:
N/A

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2210_B**
WP Title: Deliverables Control Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:

To control the deliverables

Inputs:

N/A

Tasks

To control the deliverables

Outputs: Reports to be included in TN1, TN2, TN3, TN4, TN5, TN6, TN7, TN8, TDP, SR, PR and HW1, HW2.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2310_B**
WP Title: Reporting Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Silvano Fineschi (INTA)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To write the reports to deliver

Inputs:
N/A

Tasks:
To write the report to deliver.

Outputs: Reports to be included in TN1, TN2, TN3, TN4, TN5, TN6, TN7, TN8, TN9, TDP, SR, PR.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2410_B**
WP Title: Meetings Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Silvano Fineschi (INAF)	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To attend to the planned meetings.

Inputs:

N/A

Task
To attend to the planned meetings.

Outputs:
N/A

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0421_C**
WP Title: Definition of the performance verification plan Contractor: CSL Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Marc GEORGES	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:

To produce a detailed verification test plan to demonstrate the performance of all LCVRs devices.

Inputs:

SoW
KOM minutes
TN3 Preliminary Definition Report
TN4 Development, Manufacturing and Procurement Plan

Tasks:

To define the performance verification tests. It will include a complete optical performance characterization of the LCVRs devices to be carried out previously to the environmental tests (WP 1213_A, WP 1214_B) as well as the optical characterization tests to be carried out before/after the environmental testing (WP 1225_A, WP 1225_C, WP 1226_B).
To define a verification plan

Outputs:

Report to be included in TN5

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0422 _C**
WP Title: Definition of the environmental test plan Contractor: CSL Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Marc GEORGES	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To produce a detailed LCVRs environmental test plan to demonstrate that the requirements presented in ANNEX1 of the SoW are reached.

Inputs:
SoW
KOM minutes
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan

Tasks:
- To establish the requirements verification methods and the environmental tests to be performed.
- To produce a well structured test time schedule, taking under consideration accessibility to facilities and equipment, proximity as well as possible downtimes.

Outputs:
Report to be included in TN5.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0423_C**
WP Title: Elaboration of the characterisation procedures Contractor: CSL Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Marc GEORGES	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
The elaboration of the characterization procedures of the LCVRs

Inputs:
SoW
KOM minutes
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan

Tasks:
Characterization procedures shall be elaborated specifying:
· The relevant performance parameters to be measured
  · The methodology behind the extraction of those parameters
  · The test equipment and the configuration necessary for their measurement
  · The pass/fail criteria

Outputs:
Report to be included in TN5.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0424_C**
WP Title: Elaboration of the test procedures Contractor: CSL Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Marc GEORGES	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
The elaboration of the test procedures of the LCVRs under space environmental conditions

Inputs:
SoW
KOM minutes
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan

Tasks:

- To elaborate the procedures of the environmental tests including the test parameters levels (total dose, pressure, vibratin levels, etc.), necessary equipment, tools and verification methods.

Outputs:
Report to be included in TN5.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0425_C**
WP Title: Elaboration of the test equipment list Contractor: CSL Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Marc GEORGES	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
The elaboration of the test equipment list

Inputs:
SoW
KOM minutes
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan

Tasks:
- Compile a list of the test equipment available at the Consortium premises together with a description of its performances as well as its intended use for the tests planned.

Outputs:
Report to be included in TN5..

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0426 _C**
WP Title: Identification of test tools Contractor:CSL Major Constituent: N/A (eg Subsystem) Start event: T0 + 4.5 Planned Date: TBD End event: T0 + 5.5 Planned Date: TBD WP Manager: Marc GEORGES	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Identification of test tools

Inputs:
SoW
KOM minutes
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan

Tasks:
- To identify any additional material necessary for the tests as mechanical tools (i.e.: holders).
- To establish specifications and a procurement plan.

Outputs:
Report to be included in TN5.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1211 _C**
WP Title: Design and manufacturing of test tools Contractor: CSL Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Marc GEORGES	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Design and manufacture all necessary test set-up to perform the posterior LCVRs tests

Inputs:
TN5 Test Plan
TN6 Development & Functional Verification Report

Tasks:
- To design and to manufacture the additional material necessary for the tests as mechanical tools (i.e.: holders).

Outputs:

Test tools

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1212 _C**
WP Title: Calibration between the different optical testing systems Contractor: CSL Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Marc GEORGES	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To calibrate the different optical testing set-ups to be able of compare results between them

Inputs:
TN5 Test Plan
TN6 Development & Functional Verification Report

Tasks:
To calibrate the CSL and INTA optical testing systems (i.e: ellipsometers) to guarantee the right comparison between measurements. This task is necessary because CSL will measure the LCVRs immediately after radiation tests to avoid relaxation effects. INTA will also measure the devices but after transporting to Spain.

Outputs:
Report to be included in TN7.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1224_C**
WP Title: Radiation tests Contractor: CSL Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Alain CARAPELLE	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Verification of all LCVRs performance against gamma radiation environment specified in ANNEX 1 hereto

Inputs:
LCVRs prototypes
TN5 Test Plan
TN6 Development & Functional Verification Report

Tasks:
To test performance of all LCVRs prototypes against the gamma radiation environment specified in ANNEX1 hereto.

Outputs:
Report to be included in TN8

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1225_C**
WP Title: Optical characterisation before/after the environmental testing Contractor: CSL Major Constituent: N/A (eg Subsystem) Start event: T0 + 9 Planned Date: TBD End event: T0 + 13.5 Planned Date: TBD WP Manager: Karl FLEURY	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Detect any possible change in the LCVR optical performance caused by the test

Inputs:
LCVRs prototypes
TN5 Test Plan
TN6 Development & Functional Verification Report

Tasks:
To test the optical performance of LCVRs before and after each environmental test against performance specified in ANNEX 1 hereto. The baseline is a reduced version of the tests carried out in the optical performance characterisation in WP 1213_A.

Outputs:
Report to be included in TN8

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1310 _C**
WP Title: Critical review Contractor: CSL Major Constituent: N/A (eg Subsystem) Start event: T0 + 13.5 Planned Date: TBD End event: T0 + 15.5 Planned Date: TBD WP Manager: Marc GEORGES	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Critical review of the results obtained during the optical verification and environmental test campaign.

Inputs:
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report
TN6 Development & Functional Verification Report
TN7 Performance Verification Report
TN8 Environmental Test Report

Tasks:
To perform a critical review of the results obtained during the optical verification and environmental test campaign. The performance reached with the LCVRs prototypes and control systems shall be critically evaluated and their theoretical performance limits determined

Outputs:
Report to be included in the updated TN2

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1330_C**
WP Title: Elaboration of the technical data package Contractor: CSL Major Constituent: N/A (eg Subsystem) Start event: T0 + 13.5 Planned Date: TBD End event: T0 + 15.5 Planned Date: TBD WP Manager: Marc GEORGES	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Elaboration of a technical data package (TDP)

Inputs:
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan
TN5 Test Plan
TN6 Development & Functional Verification Report
TN7 Performance Verification Report
TN8 Environmental Test Report

Tasks:
To elaborate of a technical data package including the final versions of all technical notes as well as a summary report and abstract summarising the activities of the contract and the results obtained

Outputs:
Technical data package (TDP)

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2110_C**
WP Title: Coordination Contractor: CSL Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Marc GEORGES	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Coordination of the activities of the CSL team and the coordination with the contractor.

Inputs:

N/A

Tasks:

To coordinate of the activities of the CSL team and the coordination with the contractor..

Outputs:
N/A

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2210_C**
WP Title: Deliverables Control Contractor: CSL Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Marc GEORGES	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:

To control the deliverables

Inputs:

N/A

Tasks

To control the deliverables

Outputs: Reports to be included in TN5, TN7, TN8, TDP, SR, PR.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2310_A**
WP Title: Reporting Contractor: CSL Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Marc GEORGES	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To write the reports to deliver

Inputs:
N/A

Tasks:
To write the report to deliver.

Outputs: Reports to be included in TN5, TN7, TN8, TDP, SR, PR.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2410_C**
WP Title: Meetings Contractor: CSL Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Marc GEORGES	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To attend to the planned meetings.

Inputs:

N/A

Task
To attend to the planned meetings.

Outputs:
N/A

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0111_D**
WP Title: Functional and performance requirements review Contractor: IAC Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Valentín Martínez Pillet	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Consolidation of the technical requirements

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Scientific literature
Previous Group Background

Tasks:
- Review of the functional & performance technical requirements of LCVRs (ANNEX1 of SoW)

Outputs:
Updated technical requirements of the LCVRs to be included in TN1.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0121_D**
WP Title: Study of the State of the Art of LCVRs for polarimetry Contractor: IAC Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Valentín Martínez Pillet	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To asses the current state of the art of polarimetry employing LCVRs to perform full Stokes vector measurements, including ground systems.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Scientific literature
Previous Group Background

Tasks:
- To study the technology of Stokes imaging polarimetry using LCVRs, including different existing techniques and technologies involving LCVRs devices.

Outputs:
Study report to be included in TN1

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0122 _D**
WP Title: Study of alternative concepts of LCVRs for polarimetry Contractor: IAC Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Valentín Martínez Pillet	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To study different techniques and technologies involving LCVRs devices as alternatives for polarimetry, with a view in the SoW requirements.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Scientific literature
Previous Group Background

Tasks:
- To perform a critical comparison of polarimetry concepts based on the most common electro-optical effects, including nematic and ferroelectric switching.
- To study the applicability of alternative concepts based on advanced LC electro-optic effects, alignment method, electrode configurations as well as configurations deploying multiple cascade LCVRs in order to improve achromatic behaviour within the context of polarimetry.

Outputs:
Study report of a critical comparison of alternative concepts for polarimetry using LCVRs to be included in TN1.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1310 _D**
WP Title: Critical review Contractor: IAC Major Constituent: N/A (eg Subsystem) Start event: T0 + 13.5 Planned Date: TBD End event: T0 + 15.5 Planned Date: TBD WP Manager: Valentín Martínez Pillet	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Critical review of the results obtained during the optical verification and environmental test campaign.

Inputs:
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report
TN6 Development & Functional Verification Report
TN7 Performance Verification Report
TN8 Environmental Test Report

Tasks:
To perform a critical review of the results obtained during the optical verification and environmental test campaign. The performance reached with the LCVRs prototypes and control systems shall be critically evaluated and their theoretical performance limits determined

Outputs:
Report to be included in the updated TN2

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1330_D**
WP Title: Elaboration of the technical data package Contractor: IAC Major Constituent: N/A (eg Subsystem) Start event: T0 + 13.5 Planned Date: TBD End event: T0 + 15.5 Planned Date: TBD WP Manager: Valentín Martínez Pillet	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Elaboration of a technical data package (TDP)

Inputs:
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan
TN5 Test Plan
TN6 Development & Functional Verification Report
TN7 Performance Verification Report
TN8 Environmental Test Report

Tasks:
To elaborate of a technical data package including the final versions of all technical notes as well as a summary report and abstract summarising the activities of the contract and the results obtained

Outputs:
Technical data package (TDP)

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2110_D**
WP Title: Coordination Contractor: INAF Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Valentín Martínez Pillet	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Coordination of the activities of the IAC team and the coordination with the contractor.

Inputs:

N/A

Tasks:
To coordinate of the activities of the IAC team and the coordination with the contractor.

Outputs:
N/A

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2210_D**
WP Title: Deliverables Control Contractor: IAC Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Valentín Martínez Pillet	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:

To control the deliverables

Inputs:

N/A

Tasks

To control the deliverables

Outputs: TN1, TN9, TDP, SR, PR.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2310_D**
WP Title: Reporting Contractor: IAC Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Valentín Martínez Pillet	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To write the reports to deliver

Inputs:
N/A

Tasks:
To write the report to deliver.

Outputs: TN1,TN9, TDP, SR, PR.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2410_D**
WP Title: Meetings Contractor: IAC Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Valentín Martínez Pillet	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To attend to the planned meetings.

Inputs:

N/A

Task
To attend to the planned meetings.

Outputs:
N/A

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0111_E**
WP Title: Functional and performance requirements review Contractor: IAA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Antonio C. López Jiménez	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Consolidation of the technical requirements

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Scientific literature
Previous Group Background

Tasks:
- Review of the functional & performance technical requirements of LCVRs (ANNEX1 of SoW)

Outputs:
Updated technical requirements of the LCVRs to be included in TN1.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0121_E**
WP Title: Study of the State of the Art of LCVRs for polarimetry Contractor: IAA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Antonio C. López Jiménez	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To asses the current state of the art of polarimetry employing LCVRs to perform full Stokes vector measurements, including ground systems.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Scientific literature
Previous Group Background

Tasks:
- To study the technology of Stokes imaging polarimetry using LCVRs, including different existing techniques and technologies involving LCVRs devices.

Outputs:
Study report to be included in TN1

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0122 _E**
WP Title: Study of alternative concepts of LCVRs for polarimetry Contractor: IAA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Antonio C. López Jiménez	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To study different techniques and technologies involving LCVRs devices as alternatives for polarimetry, with a view in the SoW requirements.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Scientific literature
Previous Group Background

Tasks:
- To perform a critical comparison of polarimetry concepts based on the most common electro-optical effects, including nematic and ferroelectric switching.
- To study the applicability of alternative concepts based on advanced LC electro-optic effects, alignment method, electrode configurations as well as configurations deploying multiple cascade LCVRs in order to improve achromatic behaviour within the context of polarimetry.

Outputs:
Study report of a critical comparison of alternative concepts for polarimetry using LCVRs to be included in TN1.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0415 _E**
WP Title: Drive electronic development and manufacturing plan Contractor: IAA Major Constituent: N/A (eg Subsystem) Start event: T0 + 3.5 Planned Date: TBD End event: T0 + 4.5 Planned Date: TBD WP Manager: Antonio C. López Jiménez	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
From the functional and electrical requirements, the WP target is to define a development plan for the LVCRs drive electronic including the electronic manufacturing process.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
TN1 Review of the Requirements & Technology Review Report

Tasks:
To elaborate a drive electronic development and manufacturing plan taking into account the LCVRs technical requirements

Outputs:
Report to be included in TN4

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0416 _E**
WP Title: Control software development plan Contractor: IAA Major Constituent: N/A (eg Subsystem) Start event: T0 + 3.5 Planned Date: TBD End event: T0 + 4.5 Planned Date: TBD WP Manager: Antonio C. López Jiménez	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
From the functional and electrical requirements, the WP target is to define a development plan for the LVCRs control software..

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
TN1 Review of the Requirements & Technology Review Report

Tasks:
To elaborate a software development plan taking into account the LCVRs technical requirements

Outputs:
Report to be included in TN4

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **1130 _E**
WP Title: Driving electronic development and procurement Contractor: IAA Major Constituent: N/A (eg Subsystem) Start event: T0 + 5.5 Planned Date: TBD End event: T0 + 8.5 Planned Date: TBD WP Manager: Antonio C. López Jiménez	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Following the electronic manufacturing and procurement plan defined in WP 0415_E, the LVCRs' electronic circuit must be designed, manufactured and delivered.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
TN1 Review of the Requirements & Technology Review Report
TN4 Development, manufacturing &Procurement Plan

Tasks:
To design and to manufacture the LCVRs drive electronic

Outputs:
HW3 Support driving electronics

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **1140 _E**
WP Title: Control software development Contractor: IAA Major Constituent: N/A (eg Subsystem) Start event: T0 + 5.5 Planned Date: TBD End event: T0 + 8.5 Planned Date: TBD WP Manager: Antonio C. López Jiménez	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Following the control software development plan defined in WP 0416_E, the LVCRs' control software must be developed.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
TN1 Review of the Requirements & Technology Review Report
TN4 Development, manufacturing &Procurement Plan

Tasks:
To develop the LCVRs control software

Outputs:
SW1 Control software

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1310 _E**
WP Title: Critical review Contractor: IAA Major Constituent: N/A (eg Subsystem) Start event: T0 + 13.5 Planned Date: TBD End event: T0 + 15.5 Planned Date: TBD WP Manager: Antonio C. López Jiménez	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Critical review of the results obtained during the optical verification and environmental test campaign.

Inputs:
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report
TN6 Development & Functional Verification Report
TN7 Performance Verification Report
TN8 Environmental Test Report

Tasks:
To perform a critical review of the results obtained during the optical verification and environmental test campaign. The performance reached with the LCVRs prototypes and control systems shall be critically evaluated and their theoretical performance limits determined

Outputs:
Report to be included in the updated TN2

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1330_E**
WP Title: Elaboration of the technical data package Contractor: IAA Major Constituent: N/A (eg Subsystem) Start event: T0 + 13.5 Planned Date: TBD End event: T0 + 15.5 Planned Date: TBD WP Manager: Antonio C. López Jiménez	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Elaboration of a technical data package (TDP)

Inputs:
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan
TN5 Test Plan
TN6 Development & Functional Verification Report
TN7 Performance Verification Report
TN8 Environmental Test Report

Tasks:
To elaborate of a technical data package including the final versions of all technical notes as well as a summary report and abstract summarising the activities of the contract and the results obtained

Outputs:
Technical data package (TDP)

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2110_E**
WP Title: Coordination Contractor: IAA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Antonio C. López Jiménez	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Coordination of the activities of the IAA team and the coordination with the contractor.

Inputs:

N/A

Tasks:

To coordinate of the activities of the IAA team and the coordination with the contractor.

Outputs:
N/A

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2210_E**
WP Title: Deliverables Control Contractor: IAA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Antonio C. López Jiménez	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:

To control the deliverables

Inputs:

N/A

Tasks

To control the deliverables

Outputs: Reports to be included in TN1, TN4, TN6, TDP, SR, PR and HW3 and SW1

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2310_E**
WP Title: Reporting Contractor: IAA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Antonio C. López Jiménez	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To write the reports to deliver

Inputs:
N/A

Tasks:
To write the report to deliver.

Outputs: Reports to be included in TN1, TN4, TN6, TDP, SR, PR.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2410_A**
WP Title: Meetings Contractor: IAA Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Antonio C. López Jiménez	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To attend to the planned meetings.

Inputs:

N/A

Task
To attend to the planned meetings.

Outputs:
N/A

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0123_F**
WP Title: Study of the State of the Art of LCVRs manufacturing Contractor: Visual Display S. L. Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Manuel López	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To study the existing manufacturing technology, with a view in the SoW requirement

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Technical literature
Previous Group Background

Tasks:
- To study the different materials and processes, fabrication methods, operational requirements, reliability, characteristics and optical performance.
- To evaluate the existing technology in terms of criticality, complexity, practicability, maturity and space qualifiability

Outputs:
Study report to be included in TN1

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0124_F**
WP Title: Study of technology improvements Contractor: Visual Display S. L. Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Manuel López	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To asses the technology improvements to be expected in terms of material engineering and processes development.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Scientific and Technical literature
Previous Group Background
Currently commercial available LCVRs components
Currently commercial available polarimetry designs

Tasks:
- To study the technology improvements to be expected in terms of material engineering and processes development
- To estimate the relevant effort and associated development risk

Outputs:
Study report to be included in TN1 establishing the technology improvements to be performed

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0310_F**
WP Title: Identification of basic set of design parameters Contractor: Visual Display S. L. Major Constituent: N/A (eg Subsystem) Start event: T0 + 3 Planned Date: TBD End event: T0 + 3.5 Planned Date: TBD WP Manager: Manuel López	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Detailed trade-off that allows the selection of the most promising materials, fabrication methods and control schemes to be selected n order to meet the specified performance and at same time reduce the risk of device degradation due to exposure to the environment.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment report

Tasks:
- To identify a basic set of design parameters that will be used to procure/manufacture.

Outputs:
Report to be included in TN3.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0320_F**
WP Title: Definition of LCVRs set Contractor: Visual Display S. L. Major Constituent: N/A (eg Subsystem) Start event: T0 + 3 Planned Date: TBD End event: T0 + 3.5 Planned Date: TBD WP Manager: Manuel López	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Selection of the most promising materials and sub-components for the realisation of the LCVR cells in order to ensure optimal performance and durability against the specified environment and identification of a representative set of LCVRs.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment report

Tasks:

- Selection the most promising materials and sub-components
- To identify a representative set of LCVRs,

Note: this set shall be selected with a view to maximise the output from the tests planned for *WP 1200: Test & characterisation and t*o produce a well informed input for the technology qualification plan scheduled for *WP 1300: Critical appraisal, recommendation and technology qualification plan*. As a minimum, the following cases shall be considered:

1: NLC and FLC materials
2: Materials with high birefringence and materials with low birefringence
3: Positive nematics and negative nematics
4: Different alignment agents / methods

Outputs:
Report to be included in TN3

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0411_F**
WP Title: Preliminary performance model Contractor: Visual Display S. L. Major Constituent: N/A (eg Subsystem) Start event: T0 + 3.5 Planned Date: TBD End event: T0 + 4.5 Planned Date: TBD WP Manager: Manuel López	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To establish a preliminary performance model for each type of LCVRs cell and compare its predicted performance to the technical requirements.

Inputs:
SoW, KOM minutes
TN3 Preliminary Definition Report

Tasks:
To elaborate an analytical performance model for each type of LCVR cell.
To compare the LCVR cells predicted performance to the requirements of ANNEX1

NOTE: A simplified model will be elaborated since LCVRs are very complex systems. Therefore, the prediction capabilities of the model can not be guaranteed. A complex simulation is beyond the goal of this project

Outputs:
Report to be included in TN4.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0413_F**
WP Title: Preliminary contacts of LCVRs materials procurements Contractor: Visual Display S. L. Major Constituent: N/A (eg Subsystem) Start event: T0 + 3.5 Planned Date: TBD End event: T0 + 4.5 Planned Date: TBD WP Manager: Manuel López	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To initiate component and/or material sourcing

Inputs:
SoW, KOM minutes
TN3 Preliminary Definition Report

Tasks:
- To initiate contacts with suppliers
- To identify the items with long lead times in order to ensure availability during *Manufacturing/procurement and functional verification (WP 1100)*

Outputs:
Report to be included in TN4

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0414_F**
WP Title: LCVRs manufacturing and procurement plan Contractor: Visual Display S. L. Major Constituent: N/A (eg Subsystem) Start event: T0 + 3.5 Planned Date: TBD End event: T0 + 4.5 Planned Date: TBD WP Manager: Manuel López	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To elaborate a procurement and manufacturing plan for the specific set of LCVRs agreed in WP 0300.

Inputs:
SoW, KOM minutes
TN3 Preliminary Definition Report

Tasks:
- To elaborate a procurement and manufacturing plan for the specific set of LCVRs agreed in WP 0300.
- To elaborate a report with information regardsing the manufacturing and the assembly process as well as control schemes adopted.

Outputs:
Report to be included in TN4

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1110_F**
WP Title: Manufacturing and procurement of LCVRs Contractor: Visual Display S. L. Major Constituent: N/A (eg Subsystem) Start event: T0 + 5.5 Planned Date: TBD End event: T0 + 8.5 Planned Date: TBD WP Manager: Manuel López	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To manufacture and to procure the specific set of LCVRs agreed in WP300.

Inputs:
SoW, KOM minutes
Phase 1 review minutes
TN3 Preliminary Definition Report
TN4 Development, manufacturing and procurement plan.

Tasks:
To manufacture and to procure the specific set of LCVRs agreed in WP300 following the Development, manufacturing and procurement plan (TN4)

Outputs:
HW1

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1150_F**
WP Title: Manufacturing and procurement of extra LCVRs Contractor: Visual Display S. L. Major Constituent: N/A (eg Subsystem) Start event: T0 + 5.5 Planned Date: TBD End event: T0 + 8.5 Planned Date: TBD WP Manager: Manuel López	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To manufacture and to procure extra LCVRs prototypes

Inputs:
SoW, KOM minutes
Phase 1 review minutes
TN3 Preliminary Definition Report
TN4 Development, manufacturing and procurement plan.

Tasks:
To manufacture and to procure extra LCVRs prototypes for ESA use.

Outputs:
HW2

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1310 _F**
WP Title: Critical review Contractor: Visual Display S. L. Major Constituent: N/A (eg Subsystem) Start event: T0 + 13.5 Planned Date: TBD End event: T0 + 15.5 Planned Date: TBD WP Manager: Manuel López	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Critical review of the results obtained during the optical verification and environmental test campaign.

Inputs:
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report
TN6 Development & Functional Verification Report
TN7 Performance Verification Report
TN8 Environmental Test Report

Tasks:
To perform a critical review of the results obtained during the optical verification and environmental test campaign. The performance reached with the LCVRs prototypes and control systems shall be critically evaluated and their theoretical performance limits determined

Outputs:
Report to be included in the updated TN2

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1330_F**
WP Title: Elaboration of the technical data package Contractor: Visual Display S. L. Major Constituent: N/A (eg Subsystem) Start event: T0 + 13.5 Planned Date: TBD End event: T0 + 15.5 Planned Date: TBD WP Manager: Manuel López	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Elaboration of a technical data package (TDP)

Inputs:
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan
TN5 Test Plan
TN6 Development & Functional Verification Report
TN7 Performance Verification Report
TN8 Environmental Test Report

Tasks:
To elaborate of a technical data package including the final versions of all technical notes as well as a summary report and abstract summarising the activities of the contract and the results obtained

Outputs:
Technical data package (TDP)

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2110_F**
WP Title: Coordination Contractor: Visual Display S. L. Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Manuel López	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Coordination of the activities of the Visual Display S. L. team and the coordination with the contractor.

Inputs:

N/A

Tasks:
To coordinate of the activities of the Visual Display S. L. team and the coordination with the contractor.

Outputs:
N/A

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2210_F**
WP Title: Deliverables Control Contractor: Visual Display S. L. Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Manuel López	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:

To control the deliverables

Inputs:

N/A

Tasks

To control the deliverables

Outputs: Reports to be included in TN1, TN3, TN4, TN6, TDP, SR, PR and HW1, HW2.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2310_F**
WP Title: Reporting Contractor: Visual Display S. L. Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Manuel López	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To write the reports to deliver

Inputs:
N/A

Tasks:
To write the report to deliver.

Outputs: Reports to be included in TN1, TN3, TN4, TN6, TN9, TDP, SR, PR.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2410_F**
WP Title: Meetings Contractor: Visual Display S. L. Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Manuel López	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To attend to the planned meetings.

Inputs:

N/A

Task
To attend to the planned meetings.

Outputs:
N/A

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0123_G**
WP Title: Study of the State of the Art of LCVRs manufacturing Contractor: Arcoptix S. A. Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Toralf Scharf	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To study the existing manufacturing technology, with a view in the SoW requirement

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Technical literature
Previous Group Background

Tasks:
- To study the different materials and processes, fabrication methods, operational requirements, reliability, characteristics and optical performance.
- To evaluate the existing technology in terms of criticality, complexity, practicability, maturity and space qualifiability

Outputs:
Study report to be included in TN1

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0124_G**
WP Title: Study of technology improvements Contractor: Arcoptix S. A. Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 + 1.5 Planned Date: TBD WP Manager: Toralf Scharf	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To asses the technology improvements to be expected in terms of material engineering and processes development.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
Scientific and Technical literature
Previous Group Background
Currently commercial available LCVRs components
Currently commercial available polarimetry designs

Tasks:
- To study the technology improvements to be expected in terms of material engineering and processes development
- To estimate the relevant effort and associated development risk

Outputs:
Study report to be included in TN1 establishing the technology improvements to be performed

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0310_G**
WP Title: Identification of basic set of design parameters Contractor: Arcoptix S. A. Major Constituent: N/A (eg Subsystem) Start event: T0 + 3 Planned Date: TBD End event: T0 + 3.5 Planned Date: TBD WP Manager: Toralf Scharf	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Detailed trade-off that allows the selection of the most promising materials, fabrication methods and control schemes to be selected n order to meet the specified performance and at same time reduce the risk of device degradation due to exposure to the environment.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment report

Tasks:
- To identify a basic set of design parameters that will be used to procure/manufacture.

Outputs:
Report to be included in TN3.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0320_G**
WP Title: Definition of LCVRs set Contractor: Arcoptix S. A. Major Constituent: N/A (eg Subsystem) Start event: T0 + 3 Planned Date: TBD End event: T0 + 3.5 Planned Date: TBD WP Manager: Toralf Scharf	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Selection of the most promising materials and sub-components for the realisation of the LCVR cells in order to ensure optimal performance and durability against the specified environment and identification of a representative set of LCVRs.

Inputs:
Technical requirements of the LCVRs (ANNEX 1 of the SoW)
KOM minutes
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment report

Tasks:

- Selection the most promising materials and sub-components
- To identify a representative set of LCVRs,

Note: this set shall be selected with a view to maximise the output from the tests planned for *WP 1200: Test & characterisation and t*o produce a well informed input for the technology qualification plan scheduled for *WP 1300: Critical appraisal, recommendation and technology qualification plan*. As a minimum, the following cases shall be considered:

1: NLC and FLC materials
2: Materials with high birefringence and materials with low birefringence
3: Positive nematics and negative nematics
4: Different alignment agents / methods

Outputs:
Report to be included in TN3

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0411_G**
WP Title: Preliminary performance model Contractor: Arcoptix S. A. Major Constituent: N/A (eg Subsystem) Start event: T0 + 3.5 Planned Date: TBD End event: T0 + 4.5 Planned Date: TBD WP Manager: Toralf Scharf	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To establish a preliminary performance model for each type of LCVRs cell and compare its predicted performance to the technical requirements.

Inputs:
SoW, KOM minutes
TN3 Preliminary Definition Report

Tasks:
To elaborate an analytical performance model for each type of LCVR cell.
To compare the LCVR cells predicted performance to the requirements of ANNEX1

NOTE: A simplified model will be elaborated since LCVRs are very complex systems. Therefore, the prediction capabilities of the model can not be guaranteed. A complex simulation is beyond the goal of this project

Outputs:
Report to be included in TN4.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0413_G**
WP Title: Preliminary contacts of LCVRs materials procurements Contractor: Arcoptix S. A. Major Constituent: N/A (eg Subsystem) Start event: T0 + 3.5 Planned Date: TBD End event: T0 + 4.5 Planned Date: TBD WP Manager: Toralf Scharf	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To initiate component and/or material sourcing

Inputs:
SoW, KOM minutes
TN3 Preliminary Definition Report

Tasks:
- To initiate contacts with suppliers
- To identify the items with long lead times in order to ensure availability during *Manufacturing/procurement and functional verification (WP 1100)*

Outputs:
Report to be included in TN4

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 1	WP REF: **0414_G**
WP Title: LCVRs manufacturing and procurement plan Contractor: Arcoptix S. A. Major Constituent: N/A (eg Subsystem) Start event: T0 + 3.5 Planned Date: TBD End event: T0 + 4.5 Planned Date: TBD WP Manager: Toralf Scharf	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To elaborate a procurement and manufacturing plan for the specific set of LCVRs agreed in WP 0300.

Inputs:
SoW, KOM minutes
TN3 Preliminary Definition Report

Tasks:
- To elaborate a procurement and manufacturing plan for the specific set of LCVRs agreed in WP 0300.
- To elaborate a report with information regardsing the manufacturing and the assembly process as well as control schemes adopted.

Outputs:
Report to be included in TN4

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1110_G**
WP Title: Manufacturing and procurement of LCVRs Contractor: Arcoptix S. A. Major Constituent: N/A (eg Subsystem) Start event: T0 + 5.5 Planned Date: TBD End event: T0 + 8.5 Planned Date: TBD WP Manager: Toralf Scharf	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To manufacture and to procure the specific set of LCVRs agreed in WP300.

Inputs:
SoW, KOM minutes
Phase 1 review minutes
TN3 Preliminary Definition Report
TN4 Development, manufacturing and procurement plan.

Tasks:
To manufacture and to procure the specific set of LCVRs agreed in WP300 following the Development, manufacturing and procurement plan (TN4)

Outputs:
HW1

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1150_G**
WP Title: Manufacturing and procurement of extra LCVRs Contractor: Arcoptix S. A. Major Constituent: N/A (eg Subsystem) Start event: T0 + 5.5 Planned Date: TBD End event: T0 + 8.5 Planned Date: TBD WP Manager: Toralf Scharf	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To manufacture and to procure extra LCVRs prototypes

Inputs:
SoW, KOM minutes
Phase 1 review minutes
TN3 Preliminary Definition Report
TN4 Development, manufacturing and procurement plan.

Tasks:
To manufacture and to procure extra LCVRs prototypes for ESA use.

Outputs:
HW2

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1310 _G**
WP Title: Critical review Contractor: Arcoptix S. A. Major Constituent: N/A (eg Subsystem) Start event: T0 + 13.5 Planned Date: TBD End event: T0 + 15.5 Planned Date: TBD WP Manager: Toralf Scharf	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Critical review of the results obtained during the optical verification and environmental test campaign.

Inputs:
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report
TN6 Development & Functional Verification Report
TN7 Performance Verification Report
TN8 Environmental Test Report

Tasks:
To perform a critical review of the results obtained during the optical verification and environmental test campaign. The performance reached with the LCVRs prototypes and control systems shall be critically evaluated and their theoretical performance limits determined

Outputs:
Report to be included in the updated TN2

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **1330_G**
WP Title: Elaboration of the technical data package Contractor: Arcoptix S. A. Major Constituent: N/A (eg Subsystem) Start event: T0 + 13.5 Planned Date: TBD End event: T0 + 15.5 Planned Date: TBD WP Manager: Toralf Scharf	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Elaboration of a technical data package (TDP)

Inputs:
TN1 Review of the Requirements & Technology Review Report
TN2 Environmental Assessment Report
TN3 Preliminary Definition Report
TN4 Development, Manufacturing & Procurement Plan
TN5 Test Plan
TN6 Development & Functional Verification Report
TN7 Performance Verification Report
TN8 Environmental Test Report

Tasks:
To elaborate of a technical data package including the final versions of all technical notes as well as a summary report and abstract summarising the activities of the contract and the results obtained

Outputs:
Technical data package (TDP)

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2110_G**
WP Title: Coordination Contractor: Arcoptix S. A. Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Toralf Scharf	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
Coordination of the activities of the Arcoptix S. A. team and the coordination with the contractor.

Inputs:

N/A

Tasks:
To coordinate of the activities of the Arcoptix S. A. team and the coordination with the contractor.

Outputs:
N/A

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2210_G**
WP Title: Deliverables Control Contractor: Arcoptix S. A. Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Toralf Scharf	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:

To control the deliverables

Inputs:

N/A

Tasks

To control the deliverables

Outputs: Reports to be included in TN1, TN3, TN4, TN6, TDP, SR, PR and HW1, HW2.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2310_G**
WP Title: Reporting Contractor: Arcoptix S. A. Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Toralf Scharf	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To write the reports to deliver

Inputs:
N/A

Tasks:
To write the report to deliver.

Outputs: Reports to be included in TN1, TN3, TN4, TN6, TN9, TDP, SR, PR.

PROJECT: **Validation of LCVRs for the Solar Orbiter Polarization Modulation Package** PHASE: Phase 2	WP REF: **2410_G**
WP Title: Meetings Contractor: Arcoptix S. A. Major Constituent: N/A (eg Subsystem) Start event: T0 Planned Date: TBD End event: T0 +16 Planned Date: TBD WP Manager: Toralf Scharf	Sheet of 1 of 1 Issue Ref: 1.0 Issue Date: 1-12-08

Objectives:
To attend to the planned meetings.

Inputs:

N/A

Task
To attend to the planned meetings.

Outputs:
N/A