č.j: UFP/675/2014

Noordwijk, 4 September 2014

Ing. Petr Krenek, CSc.
Institute of Plasma Physics
ASCR, v.v.i.
Za Slovankou 1782/3
182 00 Praha 8
Czech Republic

Exchange of Letters - PRODEX Experiment Arrangement.

Dear Sir,

With reference to the Institute Agreement signed by ESA on 6 September and by the Institute on 17 September 2013 we hereby send you the conditions of the PRODEX Experiment Arrangement between ESA and your Institute:

Institute of Plasma Physics ASCR, v.v.i.
Phone: [redacted]
Email: [redacted]

related to C4000111353 "ASPIICS". The ESA representative for all administrative and contractual matters is Ms [redacted], and for all technical/scientific matters it is Mr [redacted].

The total price of the present arrangement amounts to € 245,364. All invoices should mention the European standard "IBAN" and "BIC" as bank account identifiers; failing to do so will block the settlement of the payment.

The term of the project shall be the time period 01-06-2014 through 31-12-2015.

I would appreciate if you could sign and approve the present letters and return one original to me at your earliest convenience.

I am looking forward to a fruitful co-operation,

Sincerely Yours, [redacted]

M. Lazerges
Head of the PRODEX Office

Received, accepted and signed by Institute: [redacted]

Place / date:
PRAGUE, 30. 09. 2014

Ing. Petr Křenek, CSc., Director

European Space Agency
Agence spatiale européenne

ESTEC
European Space Research and Technology Centre - Keplerlaan 1 - 2201 AZ Noordwijk - The Netherlands
[redacted]

PRODEX EXPERIMENT ARRANGEMENT

ARTICLE 1: DEFINITIONS - PURPOSE OF THE ARRANGEMENT - APPENDICES

1. Throughout the present Arrangement the terms laid down in the left column below shall have the meaning set out opposite:

"Funds":	An amount of money whose maximum is laid down in Article 2;
"Project":	Institute's project specified in Appendix 1, certified by the Agency's PRODEX Office as - eligible for financial support according to the Financial Plan (Appendix 2) approved by the relevant Participating State,
"Cost":	Allowable cost of these categories: - labour cost - operational cost in the sense defined in Appendix 2 - travel expenses - .... incurred by the Institute in execution of the Project.

2. By entering into the PRODEX Experiment Arrangement the Agency undertakes to reimburse the Institute certain cost incurred in execution of the Project. Purpose of this arrangement is the detailed implementation of said undertaking.

   An obligation on the part of the Institute to carry out the Project is not created by this arrangement. Any other arrangement or agreement by which the Institute undertakes to carry out the Project remains unaffected by the present arrangement, save that the Agency acquires hereunder the rights to access, to audit, and certain licenses in intellectual property rights; details are stipulated in Article 4 and Appendix 4.

3. The Institute may claim the Funds subject to the provisions set forth in Articles 2 through 6 below.

4. The Institute shall utilise the Funds and any part thereof exclusively for defraying, in due time, the Cost incurred during the term of the Project defined in Article 3.1 below.

5. Appendix 1 (Work Description), Appendix 2 (Financial Plan) remain unaffected by this arrangement; Appendices 1 and 2 are appended for information only.
   Appendix 3 (Contract Change Notice procedure and form) and Appendix 4 (General Conditions) shall form an integral part of this arrangement.

ARTICLE 2: FUNDS

1. The Funds available for the present arrangement amount to .....(see cover letter)

2. The above amount is stated to be a limit of liability in the sense defined in Clause 9 of Annex I to the "General Conditions", attached as Appendix 4 hereto.

3. The above amount excludes profit for the Institute (not allowed) and value added tax on the costs charged to the Agency (so far as the Agency is exempted from VAT applied by the Agency's Member States).

4. (Optional)
The above amount is broken down into subtotals per cost category and/or per year as specified in Appendix 2 hereto.

ARTICLE 3: TERM OF THE PROJECT

1. Term of the Project shall be the time period stated in the cover letter.

2. Cost incurred outside said term shall not entitle the Institute to any payment under this arrangement.

ARTICLE 4: OTHER CONDITIONS

"General Conditions" lay down in Appendix 4 shall apply, with the amendments or replacements set forth in the Articles of this arrangement. The applicable General Conditions shall be construed and interpreted with due regard to the specific nature of this arrangement and its Article 1.2 Sentence 3 in particular. The Institute shall be deemed the "Contractor" wherever mentioned in those General Conditions.

CLAUSE 2: APPROVAL

Offers and acceptances with regard to arrangements are not binding on the Agency unless approved in writing by its Director General or his authorised representative.
For the purpose of this arrangement the authorised representative of the Agency's Director General is:
[redacted]
Head of the PRODEX Office.
He is authorised by the Agency to sign the present arrangement on its behalf.

CLAUSE 5: AGENCY'S REPRESENTATIVES - INSPECTIONS

The Agency shall have the right to check the performance of the Project, and for this purpose the Agency nominates its representatives identified in Clause 7 here below.
The Institute shall in this respect, and in accordance with any relevant security regulations, give the representatives of the Agency access to its premises and shall give all other necessary assistance in order that they may fulfil their task.

CLAUSE 7: COMMUNICATIONS

All correspondence for either party shall be sent to the address and the representative in charge identified herein below, with a copy to the other representative(s) where any mixed nature of the matter so requires:

For the Agency to:

ESTEC
P.O. Box 299
NL-2200 AG Noordwijk

Tel/Fax: [redacted] + extension below

For the Institute to:

Institute of Plasma Physics ASCR, v.v.i.
Za Slovankou 1782/3
182 00 Praha 8, Czech Republic

Fax: [redacted]

The Institute's representative(s) is (are) as stated in the cover letter.

CLAUSE 12 - APPLICABLE LAW

The arrangement shall be governed by the laws of the country of residence of the Institute.

CLAUSE 13 - ARBITRATION

The arbitration proceedings referred to in Clause 13 shall take place in the capital of country of the residence of the Institute.

CLAUSE 22 – INVOICES, PLACE AND CURRENCY OF PAYMENT

1. Payments shall be made by the Agency to the account specified by the Contractor. Such information shall clearly indicate the IBAN and BIC/SWIFT codes. Payments shall be considered as effected on time if the Agency's orders of payment reach its bank within the payment period stipulated in Clauses 20 & 21.

2. ESA-P

   2.1. The Contractor undertakes to ensure that all invoices are submitted to the ESTEC Finance Division, Central Invoice Registration office (CIR) by electronic

transmission, using the Agency's ESA-P System.

2.2. The Contractor undertakes to submit complete invoices in adhering strictly to the instructions contained in the standard ESA-P package, e.g. with regard to supporting documentation, information on billing of taxes and duties, etc.

2.3. If the Agency's ESA-P system is not operational with the Contractor, the Contractor may submit invoices in paper format in 5 copies, together with justifying documentation as required by the contract. All other non-ESA-P specific provisions of this cláuse 22 shall however apply.

2.4. As soon as ESA-P is operational with the Contractor, this Clause 22 shall apply in its entirety to all contracts between the Contractor and the Agency.

Any questions arising concerning the operation of ESA-P shall be discussed between the Contractor and ESTEC Finance Division

ARTICLE 5: PAYMENTS

1. Within the limits specified in Article 2 the Institute may claim in arrears payment of the Cost incurred. The Agency shall effect such payment after receipt of the respective invoice, which must identify the cost category/ies concerned and bear a statement by the Institute's financial controller that the invoiced costs are fair and reasonable, do not include profit and have been incurred exclusively in execution of the Project as defined in Article 1.1 and during the term specified in Article 3.1.

2. The Agency can make an advance payment if stated in the cover letter, upon signature of the cover letter by both parties and against submission of an invoice. Any claims for reimbursement of Costs incurred shall be set off against such advance payment; payments in excess of the advance payment shall be effected only once the advance payment has been consumed in the aforesaid manner.

ARTICLE 6: CESSATION, REFUND OF PAYMENTS

1. Notwithstanding any other provision of this Arrangement, the Agency may:

1.1 cease to effect any payments not already fallen due under this arrangement in case of unsatisfactory progress within the Project, provided the Participating State having approved Appendix 2 demands cessation of payments in writing;

1.2 cease to effect any payments in any of the following cases:
- a situation as per Clause 34.1 lit. a) of the General Conditions occurs;
- a situation as specified in Paragraph 2.2 below occurs.

2.1 The Agency may require the Institute to return to the Agency payments effected under this arrangement if and to the extent an audit carried out by the Agency or by the relevant national audit authority reveals any incorrectness of invoices or unauthorised use of Funds.

2.2 The Agency may require the Institute to return to the Agency all payments effected under this arrangement in case a situation as per Clause 34.1 lit. b) of the General Conditions occurs. Within said Clause the words "by deceit concerning the nature, quality or quantity of the supplies, and the methods or processes of manufacture employed" shall be deleted.

PRODEX Experiment Arrangement
Guideline for the preparation of its Appendices 1 (Work Description) and 2 (Financial Plan)

Part I: The Work Description. Appendix 1

1) Work Description:

The Work Description is to identify the Project, i.e. the work in execution of which reimbursable cost will be incurred by the Institute during the term of the Implementation Arrangement.
Length: One page should be sufficient but in no way be regarded as a firm limit.

2) Distinctions as to 'who' and 'when':

The work to be carried by the Institute and to be paid for by ESA under the Implementation PRODEX Experiment Arrangement (the Project) is to be clearly separated from the work to be carried out by others (if the latter is mentioned at all).
Project activities to be carried out during the term specified in the Implementation PRODEX Experiment Arrangement must be clearly separated from work outside said term (if the latter is mentioned at all).

3) Compatibility with other Applicable Documents:

Subject to 1)- 2) above the Work Description must correspond to the work description submitted to the relevant national authority in support of the Financial Plan, and is covered by the Institute Agreement.

Part II: The Financial Plan. Appendix 2 (see figure 1)

1) Content

The Financial Plan's minimum content will encompass:

a) Title of the Project and identification of the Institute
b) Cost categories such as:
   - Salaries (please specify employee(s) name(s)
   - Travel
   - Miscellaneous
   - Overheads: Please note that for Belgium, overheads can only be charged for a **maximum of 5%.**
   - Equipment < 5000 Euros purchased directly by Institute/University
   - etc.
c) Amounts.
   Please note that all figures should be mentioned in Euro and that they should be exclusive of VAT in the Agency's Member States.
d) Time periods

[Ideally this Appendix will be a copy of the document, which was approved by the Delegation.]

2) Procurement of equipment > 5000 Euro (VAT exempt)

This category should not be integrated in the Financial Plan below, but listed separately, seeing that the equipment may be available via PRODEX Office by means of placing a Purchase Order by the Agency (See figure 2). This way of doing would have the advantage of making sure that the equipment purchased for the purposes of the Project will be well exempted from VAT.

Work Description Appendix 1

Overall Objective (mission):

Proba 3 Coronograph System Primary and Relay Optics Lens Objectives & HDD Calibrator Phase C-D-E1 tasks

Proba-3 is a mission devoted to the in-orbit demonstration (IOD) of precise formation flying techniques and technologies for future ESA missions. It is part of the overall ESA IOD strategy and it is implemented by the Directorate of Technical and Quality management (D/TEC) under a dedicated element of the GSTP.

In order to complete the end-to-end validation of the Formation Flying technologies and following the practice of previous Proba missions, Proba-3 includes a primary payload that exploits the features of the demonstration. In this case it is a sun coronagraph, a giant 150 m coronagraph capable of producing a nearly perfect eclipse allowing observing the sun corona closer to the rim than ever before or in any planned mission. The Coronagraph is distributed over the two satellites flying in formation. The so called coronagraph satellite carries the "detector" and the so called occulter satellite carries the sun occulter disk.

The work described concerns the provision of the coronograph optical system compound of Lens Objectives and HDD calibrator.

Role of the Institute (Principal / Co-Investigator for ...):

- *Title and full name:* [redacted]
- *Institute/University:* Institute of Plasma Physics ASCR, v.v.i.
- *Department/Laboratory:* Centre TOPTEC
- *Address:* Sobotecka 1660, 51101 Turnov, Czech republic
- *Tel.:* [redacted]
- *Fax:* [redacted]
- *E-mail:* [redacted]
- *Institute/Department Head, endorsing this Project Proposal:* Ing. Petr Křenek, CSc. - Director of the Institute

Key Personnel

The details of the Key Personnel for this project are given in Table 1.

Table 1: Key personnel details

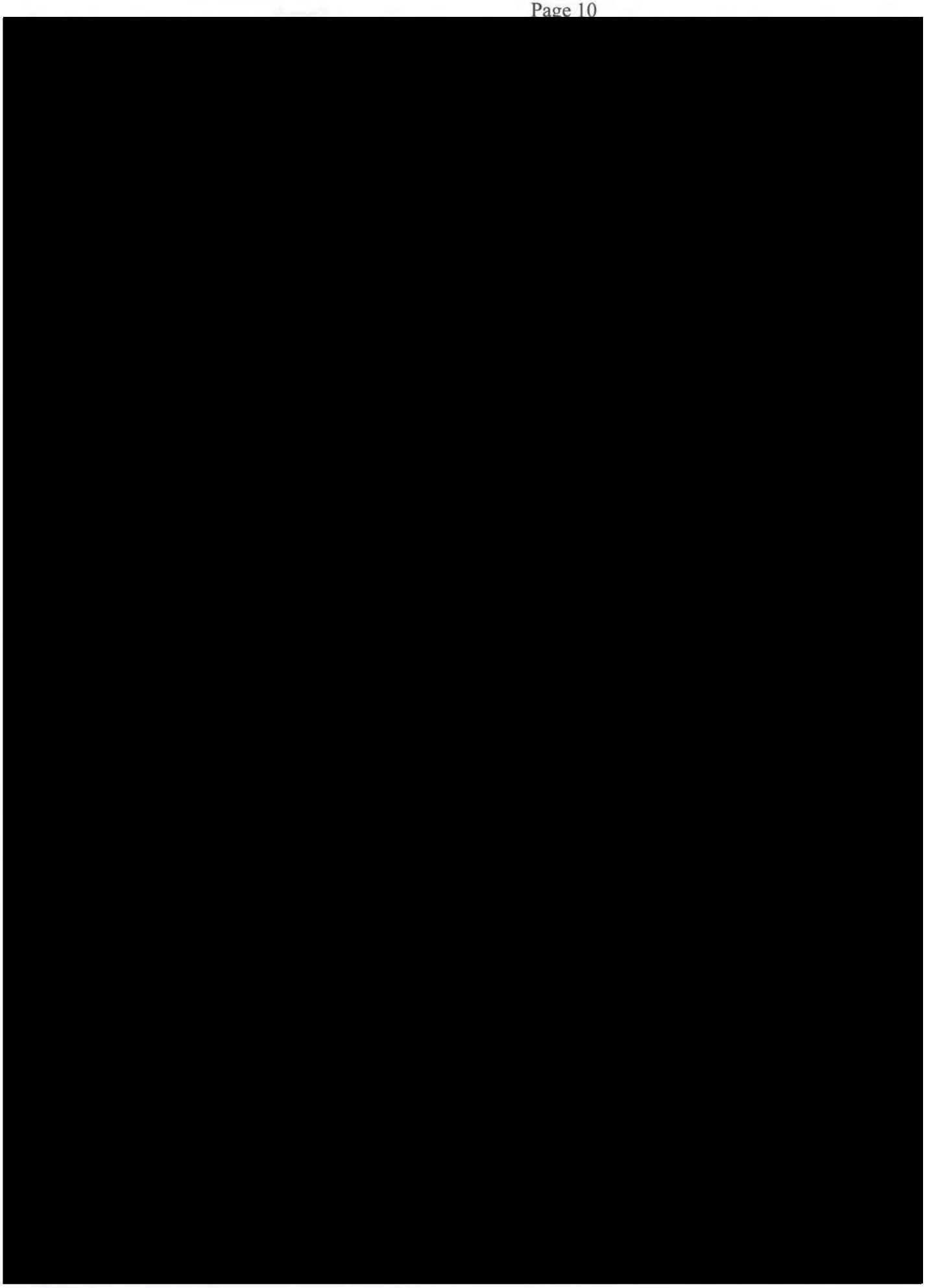
Function	Name	Affiliation	Telephone	E-mail
Project Manager	[redacted]	TOPTEC	[redacted]	[redacted]
PA Manager	[redacted]	TOPTEC	[redacted]	[redacted]
Mechanical Engineer	[redacted]	TOPTEC	[redacted]	[redacted]

Metrology Engineer	[redacted]	TOPTEC	[redacted]	[redacted]
Contract Officer	[redacted]	TOPTEC	[redacted]	[redacted]

The CV's of TOPTEC key personnel are provided below.

Curriculum Vitæ

[redacted]



[redacted]

Project term (to be) covered by the Implementation PRODEX Experiment Arrangement:

Start date: 1 June 2014
End Date: 31 Dec 2015

Brief description of Main Tasks:

2.1 Proposed Design

2.1.1 Overview

The Proba 3 Coronagraph optical design follows the general principles of a classical externally occulted Lyot coronagraph. The external occulter (EO), hosted by the Occulter Spacecraft (OSC), blocks the light from the solar disc while the coronal light passes through the circular entrance aperture of the Coronagraph Optical Box (COB), accommodated on the Coronagraph Spacecraft (CSC).

The Coronagraph optical system consists of a Primary Objective (PO) that forms an image of the external occulter onto the internal occulter (IO), and a Relay Lens (RL) that re-images both the entrance pupil onto the so-called "Lyot Stop" and the corona image onto the detector.

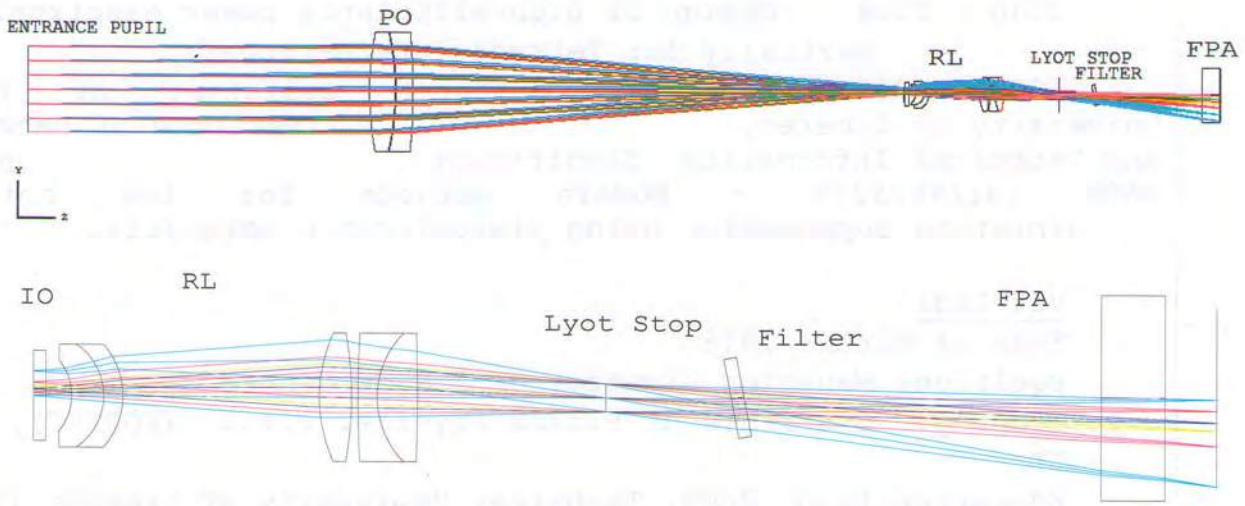


Figure 1: Coronagraph optical design (Phase-B design).

The Lens Objectives consist of 2 main optical parts:

- The Primary Objective (PO), composed of two separated lenses.
- The Relay Lens (RL), composed of 2 sets of lenses:
  - a spherical doublet,
  - an aspherical lens followed by a spherical doublet.

The two lenses of the PO are held together in one barrel. This barrel is held inside the PO tube which is part of the instrument tube.
The first doublet has its own barrel.
The aspherical lens and the second doublet are held together in a third barrel.
Finally the two barrels of the RL are held inside a common tube which is interfaced to the Equipment Box.

2.1.2 Optical requirements

The requirements on the Lens Objectives System are defined in Table 2.

Table 2: Optical requirements specifications.

Reference	Specification	Spec. Value	Design Value	Compliance
Image Scale and Field of View (FOV)				
OPT-1-1	FOV	> 1.6°	1.6°	C

OPT-1-2	Array Size	2048 x 2048 x 15 μm	~ 30.5 mm	C
OPT-1-3	Image Scale	2.8 arcsec/pixel	28 arcsec/pixel	C
OPT-1-4	Distortion	< 5 %	3.4 %	C
Light-collecting power and dynamic range				
OPT-2-1	Pupil Diameter	50 mm	50 mm	C
OPT-2-2	Optical Transmissio	> 75 %	> 76.69	C
Wavelength range ad selection				
OPT-3-1	Wavelength Range	540 - 587.6 nm	540 - 588 nm (optimization)	C
Stray light rejection				
OPT-4-1	Over Occultation	1.02 Rsol	1.02 Rsol	C
OPT-4-2	Internal Occulter Location	Image plane EO	Image Plane EO (ISD = 144 m)	C
OPT-4-3	Entrance Aperture Location	At the front	At the front (pupil)	C
OPT-4-4	Real Lyot Stop	Yes	Yes	C
Image quality				
OPT-5-1	RMS Spot Radius at Focal Plane	< 13.8 μm	~7 theoretical; 9.7 μm toleranced	C
OPT-5-2	EE100 at IO plane for 144 mm object distance	< 4 μm difraction limit	1.68 theoretical; 3.76 μm toleranced	C

2.1.3 Optical system tolerance budget

Results of the phase B optical system design tolerancing are summarized in the Table 3 for PO and Table -4 for RL.

Table 3: Tolerance budget results for the PO.

type of tolerance	surface/element	value	units	notes
radius of curvature	PO_L1_Front	4	fringes	
radius of curvature	PO_L1_Back	4	fringes	
radius of curvature	PO_L2_Front	2	fringes	
radius of curvature	PO_L2_Back	4	fringes	
surface irregularity	PO_L1_Front	0.25	lambda@540nm	
surface irregularity	PO_L1_Back	0.25	lambda@540nm	
surface irregularity	PO_L2_Front	0.25	lambda@540nm	
surface irregularity	PO_L2_Back	0.25	lambda@540nm	
surface thickness	PO_L1	0.1	mm	
surface thickness	PO_L1/L2	0.05	mm	
surface thickness	PO_L2	0.2	mm	
surface tilt	PO_L1_Front	30	arcsec	
surface tilt	PO_L1_Back	30	arcsec	
surface tilt	PO_L2_Front	30	arcsec	
surface tilt	PO_L2_Back	0	arcsec	chosen as a reference
element tilt	PO_L1	30	arcsec	

element tilt	PO_L2	0	arcsec	chosen as a reference
element decenter	PO_L1	0.01	mm	
element decenter	PO_L2	0	mm	chosen as a reference

Table -4: Tolerance budget results for the RL.

type of tolerance	surface/element	value	units	notes
radius of curvature	RL_L1_Front	4	fringes	
radius of curvature	RL_L1\L2	4	fringes	
radius of curvature	RL_L2_Back	4	fringes	
radius of curvature	RL_L3_Front	4	fringes	
radius of curvature	RL_L3_Back	4	fringes	
radius of curvature	RL_L4_Front	4	fringes	
radius of curvature	RL_L4\5	4	fringes	
radius of curvature	RL_L5_Back	4	fringes	
surface irregularity	RL_L1_Front	1	lambda@540nm	
surface irregularity	RL_L1\L2	1	lambda@540nm	
surface irregularity	RL_L2_Back	1	lambda@540nm	
surface irregularity	RL_L3_Front	1	lambda@540nm	
surface irregularity	RL_L3_Back	1	lambda@540nm	
surface irregularity	RL_L4_Front	1	lambda@540nm	
surface irregularity	RL_L4\5	1	lambda@540nm	
surface irregularity	RL_L5_Back	1	lambda@540nm	
surface thickness	RL_L1	0.2	mm	
surface thickness	Rl_L2	0.2	mm	
surface thickness	RL_L2\L3	0.2	mm	
surface thickness	RL_L3	0.2	mm	
surface thickness	RL_L3/L4	0.2	mm	
surface thickness	RL_L4	0.2	mm	
surface thickness	RL_L5	0.2	mm	
surface tilt	RL_L1_Front	0	arcsec	RL_L1/L2 coordination reference
surface tilt	RL_L1\L2	60	arcsec	
surface tilt	RL_L2_Back	60	arcsec	
surface tilt	RL_L3_Front	60	arcsec	
surface tilt	RL_L3_Back	60	arcsec	
surface tilt	RL_L4_Front	60	arcsec	
surface tilt	RL_L4\5	60	arcsec	
surface tilt	RL_L5_Back	0	arcsec	RL_L3/L4/L5 coordination reference
element tilt	RL_L1\L2	60	arcsec	
element tilt	RL_L3	30	arcsec	
element tilt	RL_L4\L5	0	arcsec	RL_L3/L4/L5 coordination reference
element decenter	RL_L1\L2	0.1	mm	
element decenter	RL_L3	0.5	mm	
element decenter	RL_L4\L5	0	mm	RL_L3/L4/L5 coordination reference

Among the technical constraints on the optical system design and development, the following ones are regarded as the most critical:

- Production and assembly tolerances of the Primary Objective

2.1.4 Other requirements

2.1.4.1 Architectural Requirements

The Lens Objectives & HDD Calibrator consists of (*the parts it is made of*):

- The Primary Objective (PO) composed of :
  - A spherical lens made of BK7G18,
  - A spherical lens made of SF6G05, separated from the first lens,
  - The barrel holding the two lenses.
- The Relay Lens (RL) composed of :
  - A spherical doublet made of BK7 and SF2,
  - The barrel holding the first doublet,
  - An aspherical lens made of BK7,
  - A spherical doublet made of SF2 and BK7,
  - The barrel holding the lens and second doublet,
  - The tube holding the two barrels.

The two lenses of the PO are separated by 0.5mm at the edge (i.e. 1.284mm at the center) in order to avoid differential thermal dilation problems and to allow easy assembly of the two lenses in a common barrel. Radiation hard glasses are used for this objective to avoid any darkening effects while the optical performance is equivalent to those achieved by classical glasses (e.g. BK7 and SF6).

Table 5: Primary objective characteristics and layout.

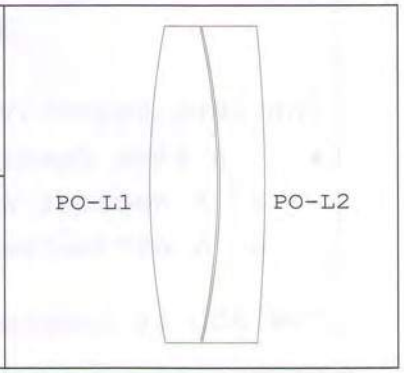
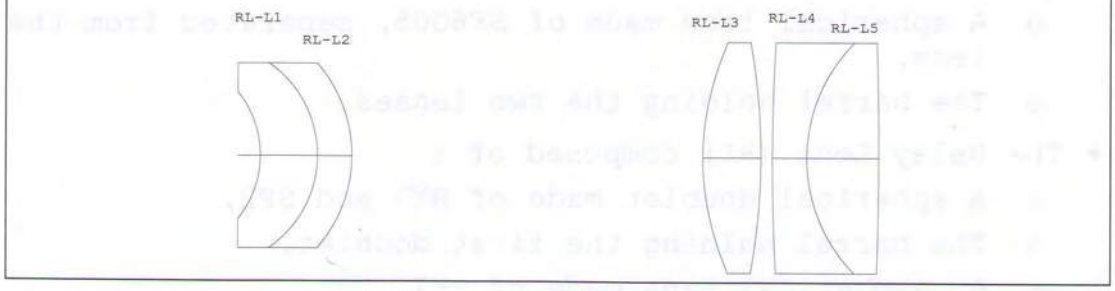
Lens ID	RoC [mm]	Thickness (center) [mm]	CA/Diameter [mm]	Glass	Distance between lenses (center) [mm]	
PO-L1	182.036 -188.321	15	56/70	BK7G18	1.284	
PO-L2	-173.614 -339.080	10	56/70	SF6G05		

Table 6: Relay Lens characteristics and layout.

Lens ID	RoC [mm]	Thickness (center) [mm]	Conic	CA/Diameter [mm]	Glass	Distance RLi & RLi+1 [mm]
RL-L1	-8.684	5	0	10.7/11	BK7	0

	-9.648		0			
RL-L2	-9.648	3	0	12.4/16	SF2	30.7
	-12.061		0			
RL-L3	22.532	5.1	-1.379	18/20	BK7	1
	-55.352		0			
RL-L4	-172.817	3	0	16.7/20	SF2	0
	14.163		0			
RL-L5	14.163	6.3	0	15.3/20	BK7	NA
	-294.06		0			



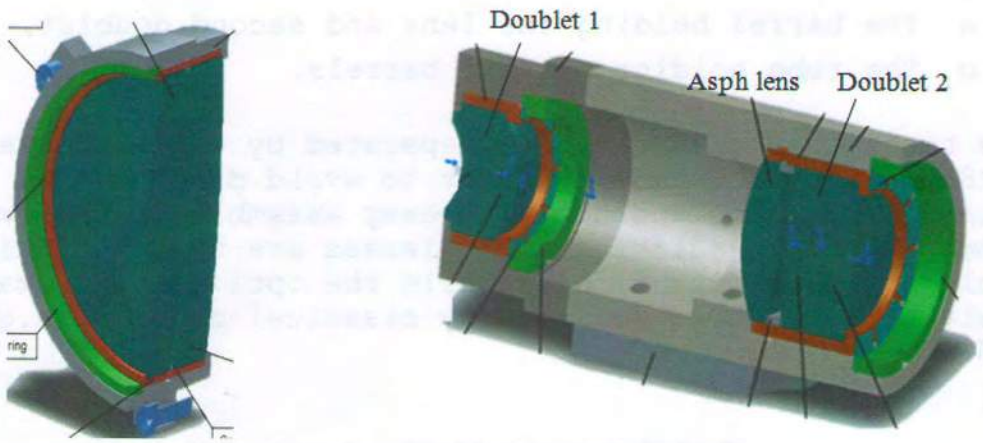


Figure 2: Lens Objectives subsystem architecture.

The Lens Objectives & HDD Calibrator consists of:

- A high density device including
  - A neutral density
  - A diffusive surface

The HDD is located in the lid of the Front Door Assembly.

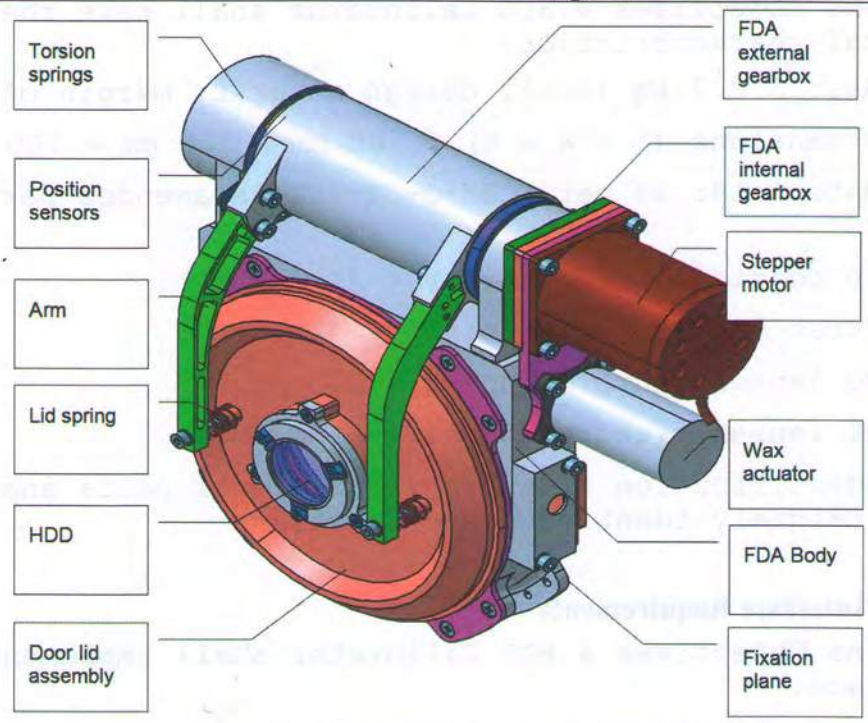


Figure 3: HDD subsystem architecture.

The unit reference axis frame is defined in P3-SEN-ICD-0001.

2.1.4.2 Functional & Performance Requirements

The Lens Objectives & HDD Calibrator shall implement the following functions, modes and states:

The Primary Objectives shall:

- Form an image of the external occulter (EO) onto the internal occulter (IO) with the image quality specified
- Form an intermediate image of the Sun corona in an intermediate focal plane close to the IO.

The Relay Lens shall:

- Re- image the corona image onto the detector with the image quality specified

The Primary Objectives and the Relay Lens shall:

- Image the entrance pupil onto the Lyot Stop.
- Present alignment constraints in compliance with the tolerancing budget in Table 3 and Table -4.
- Verify the following specifications matrix in Table 2

The HDD Calibrator shall:

- Produce a flat field on the detector plane when lighted by the Sun,
    - With a flux compatible with the dynamics of the coronagraph (This dimensions the HDD neutral density).
    - With a spatial uniformity of TBD
- Be interfaced within the lid of the Front Door Assembly,
- Present a useful circular aperture of 25 mm in diameter.

2.1.4.3 Physical Requirements

The Lens Objectives & HDD Calibrator shall have the following physical characteristics:

- Mass ≤ 0.7 kg (incl. design maturity margin of 20%)
- Dimensions (L × W × H) ≤ 700 mm × 100 mm × 100 mm
- Materials: as per ECSS-Q-ST-70C as amended per P3-EST-RS-1005, §.9.1
- AR coatings reflectivity < 2%
- First lens of PO uncoated
- PO lenses microroughness < 0.5 nm RMS
- RL lenses microroughness < 2 nm RMS
- Identification & marking: individual units and connectors shall be uniquely identified and labelled

2.1.4.4 Interface Requirements

The Lens Objectives & HDD Calibrator shall implement the following interface:

- Optical interface to outer Space
  - The field of view is a cone with a half-angle of 0.8 degrees,
  - The unobstructed field of view is a cone with a half-angle of 90 degrees
- Mechanical interface to COB:
  - Primary objective barrel mounted in the PO tube
  - RL barrel attached to Equipment Box
  - HDD mounted in the FDA lid
- Thermal interface:
  - Primary Objective thermally controlled by conductive coupling to the tube
  - Relay Lens thermally controlled by conductive coupling to the EQB
  - HDD thermally controlled by conductive coupling to the FDA
  - Total heat flux (conductive + radiative) toward OBA ≤ 1 W
  - Temperature monitoring by internal sensors

2.1.4.5 Environmental Requirements

The Lens Objectives & HDD Calibrator shall be able to operate in or survive the following environmental conditions without degradation of its functions and performances (*the conditions it has to survive and under which it has to perform its functions*):

- Pressure & humidity:
  - ambient laboratory condition (Class 10,000 / ISO-7 Cleanroom)
  - high vacuum ($P < 10^{-5}$ hPa)
- Temperature:
  - Operational: +20°C to +40°C (TBC)
  - Survival: -50°C to +45°C (TBC)

- Radiation susceptibility:
  - 62 kRad behind 3-mm Al shielding, 25 kRad behind 4-mm Al shielding, 11 kRad behind 5-mm Al shielding
  - immune to destructive and non-destructive SEE (e.g. LET threshold < 60 MeV*cm^2/mgr)
  - Atomic oxygen fluence of 4.25 E17 atoms/cm^2
  - Non-Ionising Energy Loss to be considered for the optical components :

Shielding Thickness [mm]	Non-ionising energy loss [MeV/g(Si)]	Equivalent proton Fluence [#/cm2]		
		10MeV	60MeV	200MeV
0.05	2.15E+10	3.11E+12	6.21E+12	8.95E+12
0.1	6.59E+09	9.54E+11	1.91E+12	2.74E+12
0.2	2.52E+09	3.66E+11	7.30E+11	1.05E+12
0.3	1.68E+09	2.44E+11	4.87E+11	7.01E+11
0.4	1.27E+09	1.84E+11	3.67E+11	5.29E+11
0.5	1.01E+09	1.46E+11	2.92E+11	4.20E+11
0.6	8.42E+08	1.22E+11	2.43E+11	3.51E+11
0.8	6.10E+08	8.84E+10	1.77E+11	2.54E+11
1	4.83E+08	6.99E+10	1.40E+11	2.01E+11
1.5	3.11E+08	4.51E+10	9.00E+10	1.30E+11
2	2.38E+08	3.46E+10	6.90E+10	9.93E+10
2.5	1.85E+08	2.67E+10	5.34E+10	7.69E+10
3	1.55E+08	2.24E+10	4.48E+10	6.45E+10
4	1.13E+08	1.63E+10	3.26E+10	4.69E+10
5	8.66E+07	1.25E+10	2.50E+10	3.61E+10
6	7.25E+07	1.05E+10	2.10E+10	3.02E+10
7	6.21E+07	9.01E+09	1.80E+10	2.59E+10
8	5.31E+07	7.70E+09	1.54E+10	2.21E+10
9	4.76E+07	6.91E+09	1.38E+10	1.99E+10
10	4.29E+07	6.21E+09	1.24E+10	1.79E+10
12	3.51E+07	5.09E+09	1.02E+10	1.46E+10
14	3.03E+07	4.40E+09	8.77E+09	1.26E+10
16	2.61E+07	3.78E+09	7.54E+09	1.09E+10
18	2.33E+07	3.38E+09	6.74E+09	9.71E+09
20	2.05E+07	2.97E+09	5.93E+09	8.55E+09

- Vibration:
  - Design loads: 20 g (TBC)
  - Sine: TBD g (5-100 Hz)
  - Random: TBD g_{RMS} (out-of-plane) ; TBD g_{RMS} (in-plane) (TBC)
- Acoustic: 141 dB (PLSV)
- Shock: see IID-A
- EMC/EMI: see P3-EST-RS-1009

2.1.4.6 Design, Quality & Verification Requirements

The Lens Objectives & HDD Calibrator shall be designed and verified according to the following quality requirements (*how well it has to perform its functions*):

- Life time:
  - On-ground life time ≥ 5 years (TBC)
  - In-orbit life time ≥ 2 years (TBC)
- Workmanship:

- EEE parts quality: ECSS-Q-ST-60C Class 3, as amended per P3-EST-RS-1005, §.8
- Mechanical parts: as per ECSS-Q-ST-70-71A as amended per P3-EST-RS-1005, §.9.2
- Mechanical stiffness: first mode ≥ TBD Hz
- Design safety factors: see P3-EST-RS-7013 and P3-SEN-RS-0014

- Cleanliness, outgassing:
  - Compatible with (i.e. cleanable to) Class 10,000 / ISO-7 cleanroom conditions (TBC)
  - General cleanliness upon delivery: ECSS-Q-ST-70-01C, as amended per P3-EST-RS-1005, §.9.3
  - Outgassing characteristics: TML ≤ 1% and VCM ≤ 0.1% (TBC)
- Safety: ECSS-Q-ST-40C, as amended per P3-EST-RS-1005, §.7
- Verification, testability:
  - All requirements contained in this document shall be verified by a valid method (D, I, A, or T)
  - Specific verification requirements: see P3-SEN-RS-0015

2.2 Project work breakdown structure and work-package description

2.2.1 Project WBS

The Lens Objective and HDD calibration device work breakdown structure trees are presented in Figure 4 and Figure 5.

TOPTEC is also involved in workpackages

- WP11072 - TOPTEC Local Project Management
- WP41271 – HDD Calibration Device Non Recurrent Engineering
- WP41272 - Lens Objective Non Recurrent Engineering

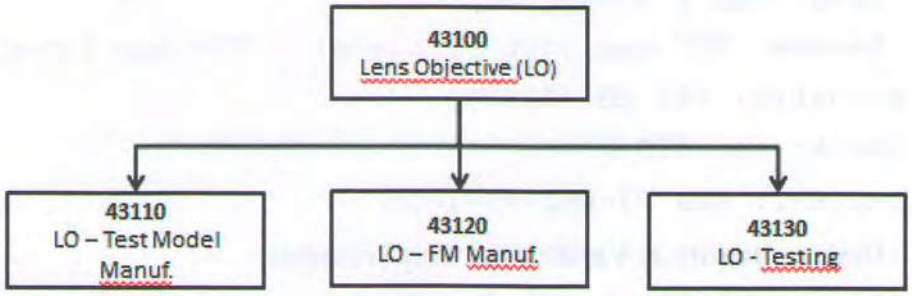


Figure 4: Lens objectives production tree.

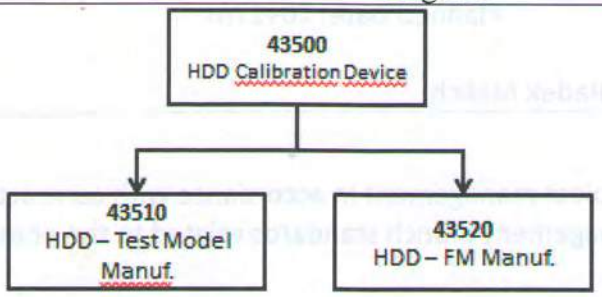


Figure 5: HDD calibrator production tree.

Work Breakdown Structure and Work Packages Description

The Lens Objective and HDD calibration device work breakdown structure trees are presented in Figure 6 and Figure 7.

TOPTEC is also involved in workpackages

- WP11072 - TOPTEC Local Project Management
- WP41271 – HDD Calibration Device Non Recurrent Engineering
- WP41272 - Lens Objective Non Recurrent Engineering

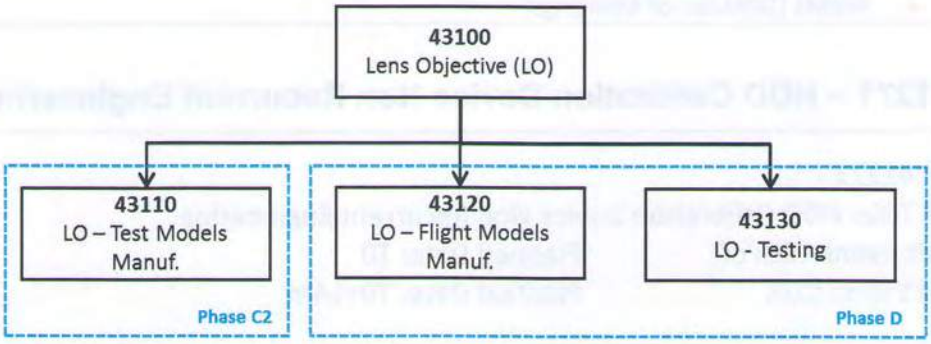


Figure 6: Lens objectives production tree.

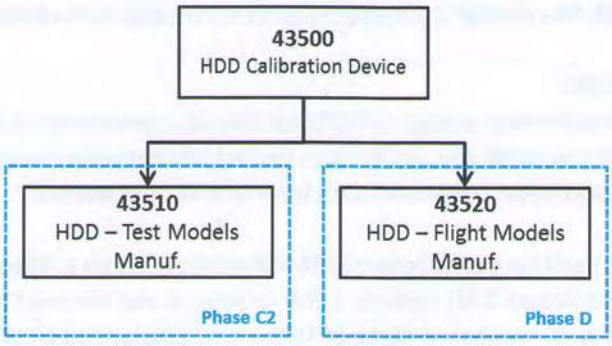


Figure 7: HDD calibrator production tree.

WP11072 - TOPTEC Local Project Management

WP 11072
WP Title: TOPTEC Local Project Management
Start event: Kick off Planned Date: T0

End Event: Planned Date: T0+27m

WP Manager: [redacted]

Objectives:
To perform project management in accordance with contract management requirements and with ECSS management branch standards related to the phase C/D/E1.

Description of Tasks:
This package includes industrial team meetings organization, progress reporting to CSL, final data package preparation, project planning and control. This WP also includes costs and financial flow planning, monitoring and reporting. Within management activities risk management, assessment and control is performed, together with the configuration control management.

Inputs:
- Contractual documents
- ECSS-M-ST standard

Outputs:
- Management Plan
- WP Progress Reports
- MoMs (Minutes of Meetings)

WP41271 – HDD Calibration Device Non Recurrent Engineering

WP 41271
WP Title: HDD Calibration Device Non Recurrent Engineering
Start event: Kick off Planned Date: T0
End Event: CDR Planned Date: T0+14m

WP Manager: [redacted]

Objectives:
The WP deals with the overall opto-mechanical HDD calibration device design.

Description of Work:
The optical and mechanical design of HDD calibration concept (as a result from the phase B) will be studied and optimized with respect to the desired optical performance, mechanical constrains, physical constrains, environmental constrains and interface requirements.

The optical design will be performed in ZEMAX optical design software. The mechanical design will performed in Solid Works CAD system. FEM structural and thermal analysis will be performed. Results will be evaluated with respect to state of stress and displacement of significant parts.
Design and numerical simulations will be carried out in several loops until the optimum result are achieved.

Deliverables:
Design of optical system, CAD data of optical system and mechanical parts, FEM model, Thermal model (ThM), results of FEM and ThM analysis, report summarizing the WP, CDR

Milestones:

T0+14m CDR
Delivery of optical and mechanical concept of HDD (result from phase B)
Final optical HDD design
Final mechanical housing for HDD

Interrelation with other WP:
Input: Optical and mechanical designs of relevant parts from Phase B
Output: final design of HDD opto-mechanical design, CAD files, optical design files (ZEMAX), FEM analysis results, ThM analysis results, WP summarizing report

WP41272 - Lens Objective Non Recurrent Engineering

WP 41272
WP Title: Lens Objective Non Recurrent Engineering
Start event: Kick off Planned Date: T0
End Event: CDR Planned Date: T0+14m

WP Manager: [redacted]

Objectives:
The WP deals with the overall opto-mechanical Lens Objectives (PO and RL) design.

Description of Work:
The optical and mechanical design of LO concept (as a result from the phase B) will be studied and optimized with respect to the desired optical performance, mechanical constrains, physical constrains, environmental constrains and interface requirements.

The optical design will be performed in ZEMAX optical design software. The mechanical design will performed in Solid Works CAD system. FEM structural and thermal analysis will be performed. Results will be evaluated with respect to state of stress and displacement of significant parts.
Design and numerical simulations will be carried out in several loops until the optimum result are achieved.

Deliverables:
Design of optical system, CAD data of optical system and mechanical parts, FEM model, Thermal model (ThM), results of FEM and ThM analysis, CDR.

Milestones:
T0 +3m PCM
Delivery of preliminary versions of deliverables as needed for bridging phase PCM
T0+14m CDR
Delivery of optical and mechanical concept of LO (result from phase B)
Final optical LO design
Final mechanical housing for LO

Interrelation with other WP:
Input: Optical and mechanical designs of relevant parts from Phase B
Output: WP 43110, WP 43120 - final design of LO opto-mechanical design, CAD files, optical design files (ZEMAX), FEM analysis results, ThM analysis results.

WP43100 Lens Objective

WP 43100
WP Title: Lens Objective
Start event Kick off Planned Date: T0
End Event: AR Planned Date: T0 + 27
WP Manager: [redacted]

Objectives:
The WP deals with the overall opto-mechanical Lens Objectives (PO and RL) production, assembly and verification.

Description of Work:
Based on the optical and mechanical design of LO the proper manufacturing process will be chosen so that individual subsystems will satisfy all requirements and constrains.
Based on the optical and mechanical design the proper assembly techniques will be chosed so that individual subsystems can be assembled in a final product that satisfies all requirements and constrains.
Based on the product quality requirement and verification a proper set of tests will be undertaken.

Deliverables:
DM – TBD (WP 43110)
STM – T0+7m (WP 43110)
EGM – T0+14m (WP 43110)
GSE – T0+14m (WP 43110)
CDR – T0+14m (WP 43110)
PFM – T0 + 21m (WP 43120)
FS – T0 + 21m (WP 43120)
QR – T0+22m (WP 43120)
Design of optical system, CAD data of optical system and mechanical parts, FEM model, Thermal model (ThM), results of FEM and ThM analysis, LO as a final product (5 sets of models), reports from individual WP.

Milestones:
CDR – T0+14m
QR – T0+22m
AR – T0+27m
Interrelation with other WP:
Input: Results of WP41272
Output: deliverables

WP43110 LO – Test models manufacturing

WP 43110
WP Title: LO - Test Models manufacturing
Start event: PCR Planned Date: T0+3m
End Event: CDR Planned Date: T0+14m

WP Manager: [redacted]

Objectives:
The WP deals with the overall manufacturing of Lens Objectives (PO and RL) test models.

Description of Work:
Based on the optical and mechanical design of LO the proper manufacturing process will be chosen with respect to the purpose of individual test model so that individual subsystems will satisfy all relevant requirements and constrains.

The process of optical production will implement grinding (OPTOTECH MCG-100 CNC), polishing (OPTOTECH MCP-250 CNC) and superpolishing (OPTEG IBF – 400) processes.

Based on CAD data the mechanical pats will be manufactured using CNC lathe and 5ax milling machine (Roeders). The postprocesors for machines will be prepared using SolidCAM system.
Seating, with the highest demands on accuracy will be machined by ultra-precise lathe Nanotech.
Proces measurements will be performed on Mitutoyo CCM. The measurement protocol will be make for each machined part.
The LO system will be assembled and adjusted with respect to optical properties. Assembling will be performed in clean room. In order to match optical and mechanical axes and manufacture the reference surfaces the SPDT machinery will be used.

This WP includes the preparation of assembling tooling and purchase of necessary connecting material.
This WP includes the manufacturing of test toolings.

Deliverables:
DM - TBD
STM – T0+7m
EGM – T0+14m
GSE – T0+14m
CDR – T0+14m

Milestones:
CDR - T0+14m

Interrelation with other WP:
Input: Results from Phase B, result from WP 41272
Output: WP 43120

WP43120 LO – Flight models manufacturing

WP 43120
WP Title: LO - Flight Models manufacturing
Start event: CDR Planned Date: T0+14m
End Event: QR Planned Date: T0+22m

WP Manager: Radek Melich

Objectives:
The WP deals with the overall opto-mechanical Lens Objectives (PO and RL) production.

Description of Work:
Based on the optical and mechanical design of LO the proper manufacturing process will be chosen so that individual subsystems will satisfy all relevant requirements and constrains.

The process of production will implement:

1. blanks of the lenses production from a designed glass types. For this will be used optical saws and form generators (OPTOTECH MCG-100 CNC)
2. grinding of the lenses – a process where proper radius and proper subsurface damage are both achieved so that polishing process can follow (OPTOTECH MCG-100 CNC form generator and grinding machine)
3. polishing of the lenses – a process where lens surface is polished and designed values and tolerances are achieved (OPTOTECH MCP-250 CNC polishing machine)
4. super-polishing – a process where lens designed values are kept under their tolerance range but microroughness of the lenses is enhanced (classical polishing techniques employing optical pitch or IBF techniques (OPTEG IBF – 400 polishing machine)).
5. coating – enhancement of the lens surfaces with thin film layers with respect to lens transmission

Based on CAD data the mechanical pats will be manufactured using CNC lathe and 5ax milling machine. The postprocesors for machines will be prepared using SolidCAM system.
Seating, with the highest demands on accuracy will be machined by ultra-precise lathe Nanotech.
Proces measurements will be performed on Mitutoyo CCM. The measurement protocol will be make for each machined part.

Assembly approaches:

1. With respect to the optical design and tolerance analysis mechanical parts will be manufactured within designed tolerances so that after the assembly the designed optical performance is achieved. Assembled lenses are controlled interferometrically for their performance.
2. Lenses error measurement (thickness error, radii error, wedge error, surface irregularity error) can be measured and their proper assembly orientation can be simulated and optimized in ZEMAX.
3. In order to match optical and mechanical axes and manufacture the reference surfaces the SPDT machinery will be used.

This WP includes the preparation of assembling tooling and purchase of necessary connecting material.
This WP includes the manufacturing of test toolings.

Deliverables:
PFM – T0+21m
FS – T0+21m
QR – T0+22m
A proper number of Individual lenses of the LO, reports from the WP containing the details of the production and all the production measurement results (production heritage).

Milestones:
QR - T0+22m

Interrelation with other WP:
Input: result from WP 41272, WP 43110
Output: deliverables

WP43130 LO - Testing

WP 43130
WP Title: LO Optics
Start event Planned Date: T0+18m
End Event Planned Date: T0+21m

WP Manager: [redacted]

Objectives:
The WP deals with the overall opto-mechanical Lens Objectives (PO and RL) testing and verification.

Description of Work:
Optical testing:
Lenses diameter (micrometer gauge), Lenses wedges (micrometer gauges),Surfaces radiuses (interferometer), Surface form irregularities (interferometer), surface microroughness (WLI)

Mechanical testing:
It is planned to execute at least following tests:
Visual and ultrasound quality inspection. (This will be mostly done in WP43110 and WP43120)
Dimensional and surface quality measurements. (Done in WP43110 and WP43120)

It will be necessary to design and manufacture tooling to perform tests.
Test results will be correlated with results of numerical simulations.

Tests will be conducted in the TOPTEC workplace (Quality of manufacturing, Dimensional Measurements, Stability at different temperatures).

Deliverables:
Reports of the individual measurements, report summarizing the WP
Milestones:

Interrelation with other WP:
Input: Elements from WP43110 and WP43120.
Output:

WP43500 HDD Calibration Device

WP 43500
WP Title: HDD Calibration Device
Start event Kick off Planned Date: T0
End Event: AR Planned Date: T0 + 27

WP Manager: [redacted]

Objectives:
The WP deals with the overall opto-mechanical HDD Calibration Device production, assembly and verification.

Description of Work:
Based on the optical and mechanical design of HDD the proper manufacturing process will be chosen so that individual subsystems will satisfy all requirements and constrains.
Based on the optical and mechanical design the proper assembly techniques will be chosen so that individual subsystems can be assembled in a final product that satisfies all requirements and constrains.
Based on the product quality requirement and verification a proper set of tests will be undertaken.

Deliverables:
DM – TBD (WP 43510)
STM – T0+5m (WP 43510)
EGM – T0+12m (WP 43110)
GSE – T0+12m (WP 43110)

CDR – T0+14m (WP 43110)
PFM – T0 + 18m (WP 43120)
FS – T0 + 18m (WP 43120)
QR – T0+22m (WP 43120)
AR – T0+27m
Design of optical system, CAD data of optical system and mechanical parts, FEM model, Thermal model (ThM), results of FEM and ThM analysis, HDD as a final product (5 sets of models), reports from individual WP.

Milestones:
CDR – T0+14m
QR – T0+22m
AR – T0+27m
Interrelation with other WP:
Input: Results of WP41271
Output: deliverables

WP43510 HDD – Test models manufacturing

WP 43510
WP Title: HDD - Test Models manufacturing
Start event: PCR Planned Date: T0+3m
End Event: CDR Planned Date: T0+14m

WP Manager: [redacted]

Objectives:
The WP deals with the overall manufacturing of HDD Calibration Device test models.

Description of Work:
Based on the optical and mechanical design of HDD the proper manufacturing process will be chosen with respect to the purpose of individual test model so that individual subsystems will satisfy all relevant requirements and constrains.

The process of optical production will implement grinding (OPTOTECH MCG-100 CNC) and polishing (OPTOTECH MCP-250 CNC) processes.

Based on CAD data the mechanical pats will be manufactured using 5ax milling machine (Roeders). The postprocesors for machines will be prepared using SolidCAM system.
Process measurements will be performed on Mitutoyo CCM. The measurement protocol will be make for each machined part.
The HDD system will be assembled and adjusted with respect to optical properties. Assembling will be performed in clean room.
This WP includes the preparation of assembling tooling and purchase of necessary connecting material.
This WP includes the manufacturing of test toolings.

Deliverables:
DM - TBD
STM – T0+5m
EGM – T0+12m
GSE – T0+12m

CDR – T0+14m

Milestones:
CDR - T0+14m

Interrelation with other WP:
Input: Results from Phase B, result from WP 41271
Output: WP 43520

WP43520 HDD – Flight models manufacturing

WP 43520
WP Title: HDD - Flight Models manufacturing
Start event: CDR Planned Date: T0+14m
End Event: QR Planned Date: T0+22m

WP Manager: [redacted]

Objectives:
The WP deals with the overall opto-mechanical HDD Calibration Device production.

Description of Work:
Based on the optical and mechanical design of LO the proper manufacturing process will be chosen so that individual subsystems will satisfy all relevant requirements and constrains.

The process of production will implement:

1. blanks of the glass production from a designed glass types. For this will be used optical saws and form generators (OPTOTECH MCG-100 CNC)
2. grinding of the glass – a process where proper radius and proper subsurface damage are both achieved so that polishing process can follow (OPTOTECH MCG-100 CNC form generator and grinding machine)
3. polishing of the glass – a process where lens surface is polished and designed values and tolerances are achieved (OPTOTECH MCP-250 CNC polishing machine)
4. coating – enhancement of the glass surfaces with thin film layers with respect to the design values.

Based on CAD data the mechanical pats will be manufactured using CNC lathe and 5ax milling machine. The postprocesors for machines will be prepared using SolidCAM system.
Seating, with the highest demands on accuracy will be machined by ultra-precise lathe Nanotech.
Proces measurements will be performed on Mitutoyo CCM. The measurement protocol will be make for each machined part.

Assembly approaches:

1. With respect to the optical design and tolerance analysis mechanical parts will be manufactured within designed tolerances so that after the assembly the designed optical performance is achieved. Assembled system is controlled interferometrically for their performance.
2. Error measurement (thickness error, radii error, wedge error, surface irregularity error) can be measured and their proper assembly orientation can be simulated and optimized in ZEMAX.
3. In order to match optical and mechanical axes and manufacture the reference surfaces the SPDT machinery will be used.

This WP includes the preparation of assembling tooling and purchase of necessary connecting material.
This WP includes the manufacturing of test toolings.

Deliverables:
PFM – T0+18m
FS – T0+18m
QR – T0+22m

Milestones:
QR - T0+22m

Interrelation with other WP:
Input: result from WP 41271, WP 43210
Output: deliverables

Performance estimates

The proposed design is fully within all the required specifications and requirements.

Engineering budgets

Mass budget

The mass budget of proposed version – final result of the Phase B is in Table 7

Table 7: Mass budget of the LO (final version of the phase B)

system		mass
HDD calibration device		25 g
Lens Objectives	Primary Objective	439 g
	Relay Lens	98 g

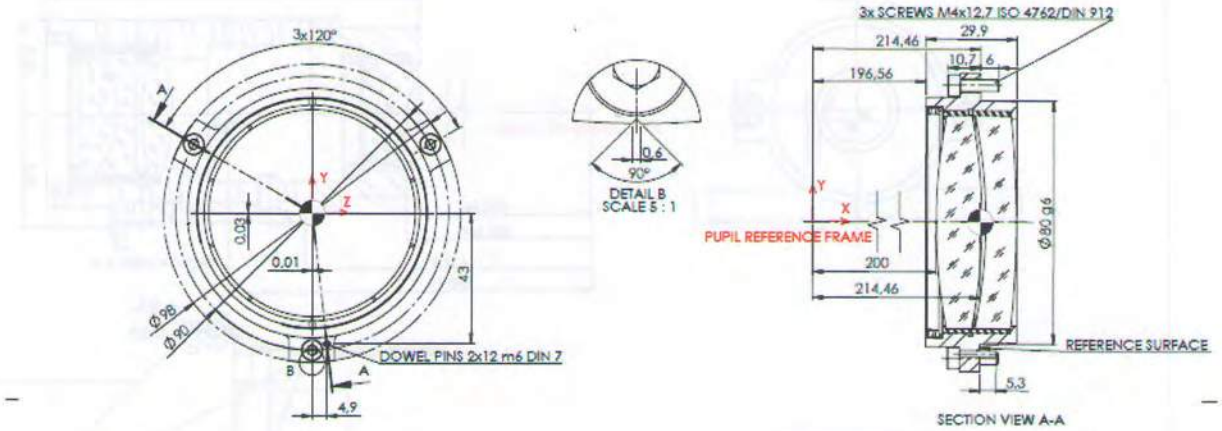
Technical compliance status

The TOPTEC as public research institution do not own any international ISO standards or any other production standards, however has its own standards that lead to sufficient fulfillment of the stated requirements in sections 2.1.2, 2.1.3 and 2.1.4.

Subsystem interfaces

Primary Objective (PO)

The opto-mechanical design of PO can be seen at Figure 8. The PO is fixed to the ASPIICS mechanics using 3 screws (M4x12.7 ISO 4762/DIN 912). Mounting surfaces for assembly are marked as reference surfaces.



PART NUMBER	WEIGHT [g] 1pcs	QTY.
xx_x86_Lens1_D70_BG7G18	112.74	1
xx_x87_Lens2_D70_SF6G05	216.72	1
xx_x05_Spacer_AL	0.48	1
xx_x03_Insert_D73_PTFE	17.20	1
xx_x01_Cell_D70_AL	82.07	1
xx_x04_Flange_D75,4_Steel	0.64	1
xx_x02_RetainingRing_M78x0,5_AL	6.96	1
xx_x92_Pin_D2_Steel	0.30	1
xx_x93_Screw_M4_Titanium	1.326	3

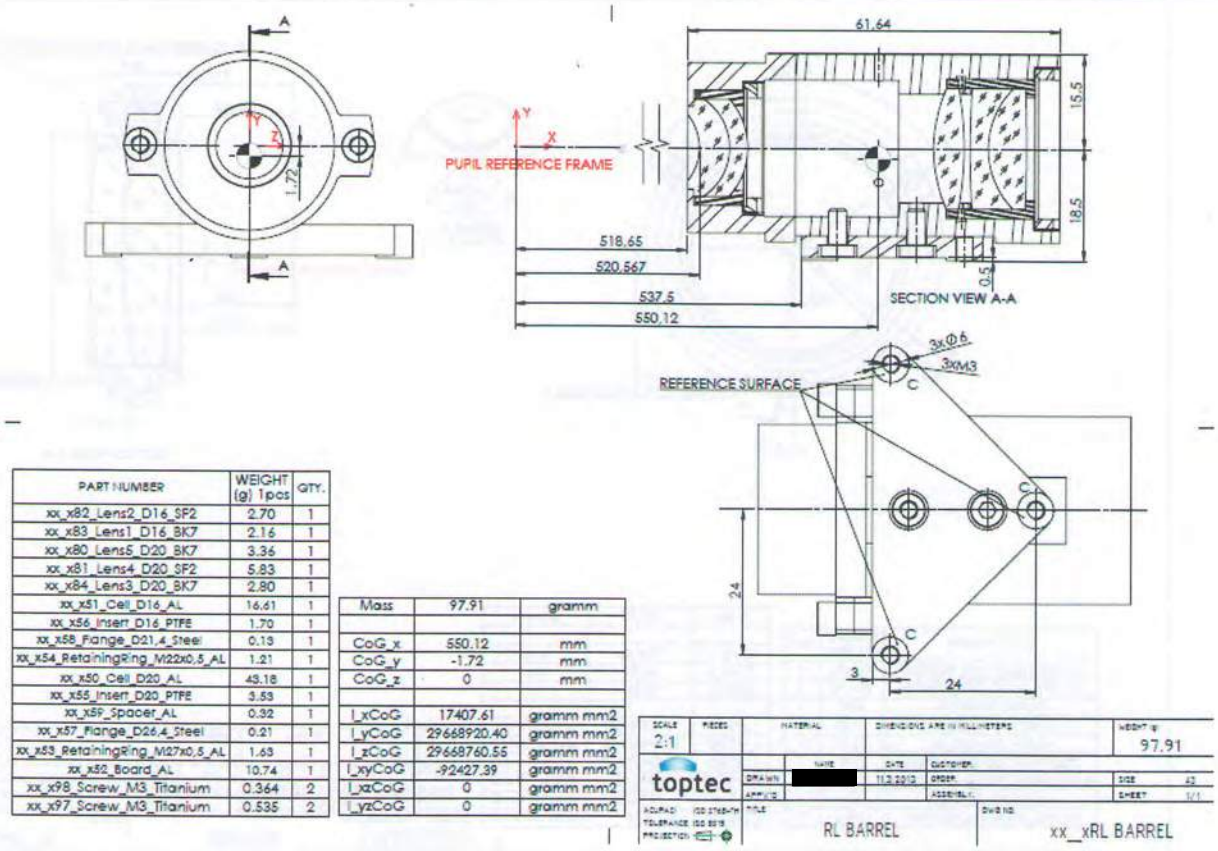
Mass	441.09	gramm
CoG_x	214.46	mm
CoG_y	-0.03	mm
CoG_z	0.01	mm
I_xCoG	365486.65	gramm mm2
I_yCoG	20494089.57	gramm mm2
I_zCoG	20494522.28	gramm mm2
I_xyCoG	-2746.43	gramm mm2
I_xzCoG	1270.72	gramm mm2
I_yzCoG	4.36	gramm mm2

SCALE 1:1	MATERIAL	DIMENSIONS ARE IN MILLIMETERS	WEIGHT [g] 441,09
toptec	DRAWN [redacted]	DATE 11.2.2013	CUSTOMER
	APPV'D		ORDER
			ASSEMBLY
	TITLE P0 BARREL		DWG NO. xx_xP0 BARREL

Figure 8: The opto-mechanical layout of the PO.

Relay Lens (RL)

The opto-mechanical design of RL can be seen at Figure 9. The RL is a female part and is fixed to the ASPIICS mechanics using 3 M3 screws. Mounting surfaces for assembly are marked as reference surfaces.



PART NUMBER	WEIGHT (g) 1pcs	QTY.
xx_x82_Lens2_D16_SF2	2.70	1
xx_x83_Lens1_D16_BK7	2.16	1
xx_x80_Lens5_D20_BK7	3.36	1
xx_x81_Lens4_D20_SF2	5.83	1
xx_x84_Lens3_D20_BK7	2.80	1
xx_x51_Cell_D16_AL	16.61	1
xx_x56_Insert_D16_PTFE	1.70	1
xx_x58_Flange_D21,4_Steel	0.13	1
xx_x54_RetainingRing_M22x0,5_AL	1.21	1
xx_x50_Cell_D20_AL	43.18	1
xx_x55_Insert_D20_PTFE	3.53	1
xx_x59_Spacer_AL	0.32	1
xx_x57_Flange_D26,4_Steel	0.21	1
xx_x53_RetainingRing_M27x0,5_AL	1.63	1
xx_x52_Board_AL	10.74	1
xx_x98_Screw_M3_Titanium	0.364	2
xx_x97_Screw_M3_Titanium	0.535	2

Mass	97.91	gramm
CoG_x	550.12	mm
CoG_y	-1.72	mm
CoG_z	0	mm
I_xCoG	17407.61	gramm mm2
I_yCoG	29668920.40	gramm mm2
I_zCoG	29668760.55	gramm mm2
I_xyCoG	-92427.39	gramm mm2
I_xzCoG	0	gramm mm2
I_yzCoG	0	gramm mm2

Figure 9: The opto-mechanical layout of the RL.

HDD calibration device

In the present time all the HDD calibration device designes are presented at Front Door Assembly Provider, i.e. VZLU/Serenum (CZ). The detailed interface is TBC. The HDD can be seen at Figure 10.

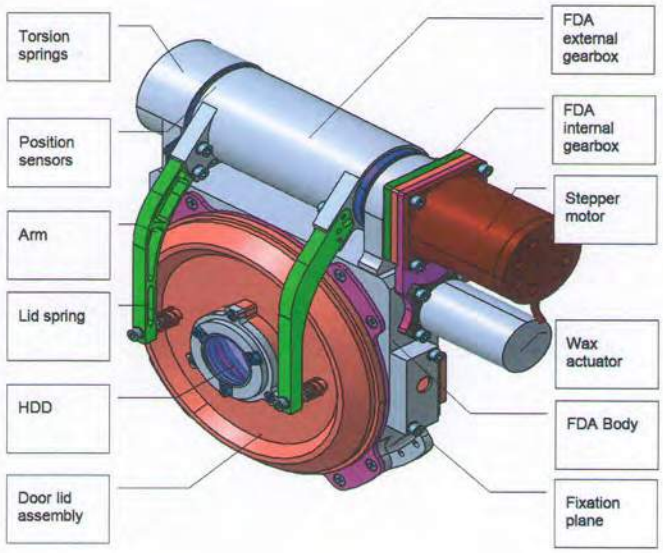


Figure 10: HDD subsystem architecture.

Project realization flowchart

Development, production, assembly and verification approach of the proposed project in a form of flowchart can be seen at figure Figure 11.

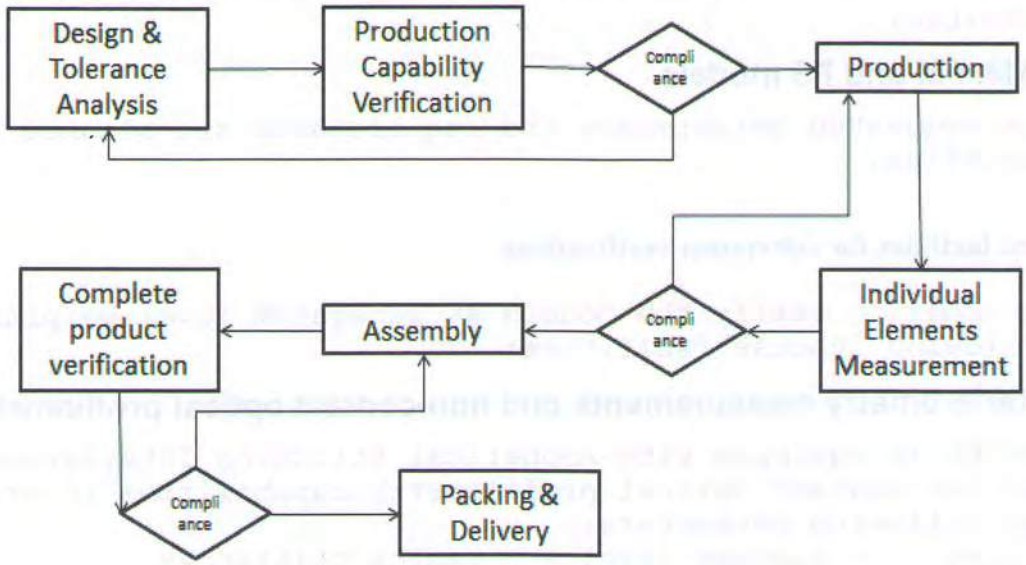


Figure 11: Flowchart of the project realization strategy

Individual model approach at subsystem level

For both LO and HDD the TOPTEC is obliged to deliver 5 model (see table Table 8)

Table 8: Deliverable Hardware.

ID#	Deliverable Item Description	Due Date
DM	1 Elegant breadboard model of the Lens Objectives (see Note 1) 1 breadboard of the HDD Calibrator (TBC)	TBD
STM	1 Structural and Thermal Model of the Lens Objectives (see Note 2) 1 Structural and Thermal Model of the HDD Calibrator (see Note 3)	T0 + 7 months (TBC) T0 + 5 months (TBC)
EQM	1 Engineering/Qualification Model of the Lens Objective 1 Engineering/Qualification Model of the HDD Calibrator (see Note 3)	T0 + 15 months (TBC) T0 + 12 months (TBC)
PFM	1 Flight Model of the Lens Objective 1 Flight Model of the HDD Calibrator (see Note 3)	T0 + 21 months (TBC) T0 + 18 months (TBC)
FS	1 Flight Spare Kit for the Lens Objective 1 Flight Spare HDD Calibrator (see Note 3)	With PFM

Note 1: The elegant breadboard model is an optically representative laboratory model of the Lens Objectives that will be used in conjunction with the Auxiliary Formation Flying Metrology Subsystems for advanced experimental verification to be performed by INAF (IT).

Note 2: The STM of the Lens Objective is an opportunity to verify the integrity and robustness of the opto-mechanical design in advance of the flight hardware production. It shall be representative of the mechanical and thermal characteristics of the end product but doesn't require optical quality. If practical, the lenses can be e.g. replaced with glass plates.

Note 3: The HDD Calibrator is to be delivered to the Front Door Assembly Provider, i.e. VZLU/Serenum (CZ)

With respect to the individual models we propose the following strategy:

DM and STM models

The mechanics performance of the DM and STM models will be in

accordance with the design results from WP41271 and WP41272. The optical performance, however, is planned not to satisfy the microroughness requirement and no coating will be applied. The optical tolerances will be about one magnitude looser where possible.

STM, FM and FS models

The requested performance and requirements are planned to be satisfied.

Test facilities for subsystem verifications

In order to verify the models at subsystem level we plan to use the following inhouse facilities:

Interferometry measurements and non-contact optical profilometry

TOPTEC is equipped with Aspherical Stitching Interferometry (ASI) and non-contact optical profilometry capabilities in order to verify the following parameters:

Optics - surface level - radius tolerances
surface form irregularities
mid-spatial frequencies footage
- objective level - wavefront inspection (quality of assembly)

The precision of ASI metrology is achieving $\lambda\backslash 20$.

Clean room assembly

TOPTEC is equipped with:

- laboratory room (12 x 6 m^2) of 100 000 class
- laboratory room (6x6 m^2) of 10 000 class,
- assembly room (3x3 m^2) 10 000/1 000 class
- 2 flowboxes of 100 class.

Within this conditions we plan to inspect the LO and HDD and provide its assembly.

White light interferometry

The surface micro-roughness is planned to be verified on White Light Interferometer (WLI) with resolution of 0.1 nm.

Spectrometers

The coating performance with respect to the transmission is going to be validate on a spectrometric devices calibrated for a region in interest. The intensity resolution of our spectrometers is about 0.3%.

Tactile measurement

Tactile measurement is planned mainly for the mechanics precision verification. TOPTEC is equipped with capability to measure is box of 400 x 400 x 300 mm with a precision of 0.3 µm x L[mm]/1000.

Other measurements

Among other measurements we plan to use classical micrometer gauges mainly for:

Optics - lens thickness
- lens wedges

Mechanics - where relevant

Design options

CSL is proposing a new design of RL objective where two main modifications are applied to the original design

- Make RL telecentric.
- Use a different CCD with 2048 x 2048 pixels of 10 µm (instead of 15 µm).

The design is optimized following the new constraints presented here above and with the minimum modifications in the original design. The first solution requires the addition of one lens after the Relay Lens for the telecentricity and the modification of the aspherical lens in order to achieve a good image quality compatible with the new pixels size. The other optical elements are not modified but the distances between them changed with as consequence a ~ 100 mm longer design. All RMS spots diameter are < 10 µm.

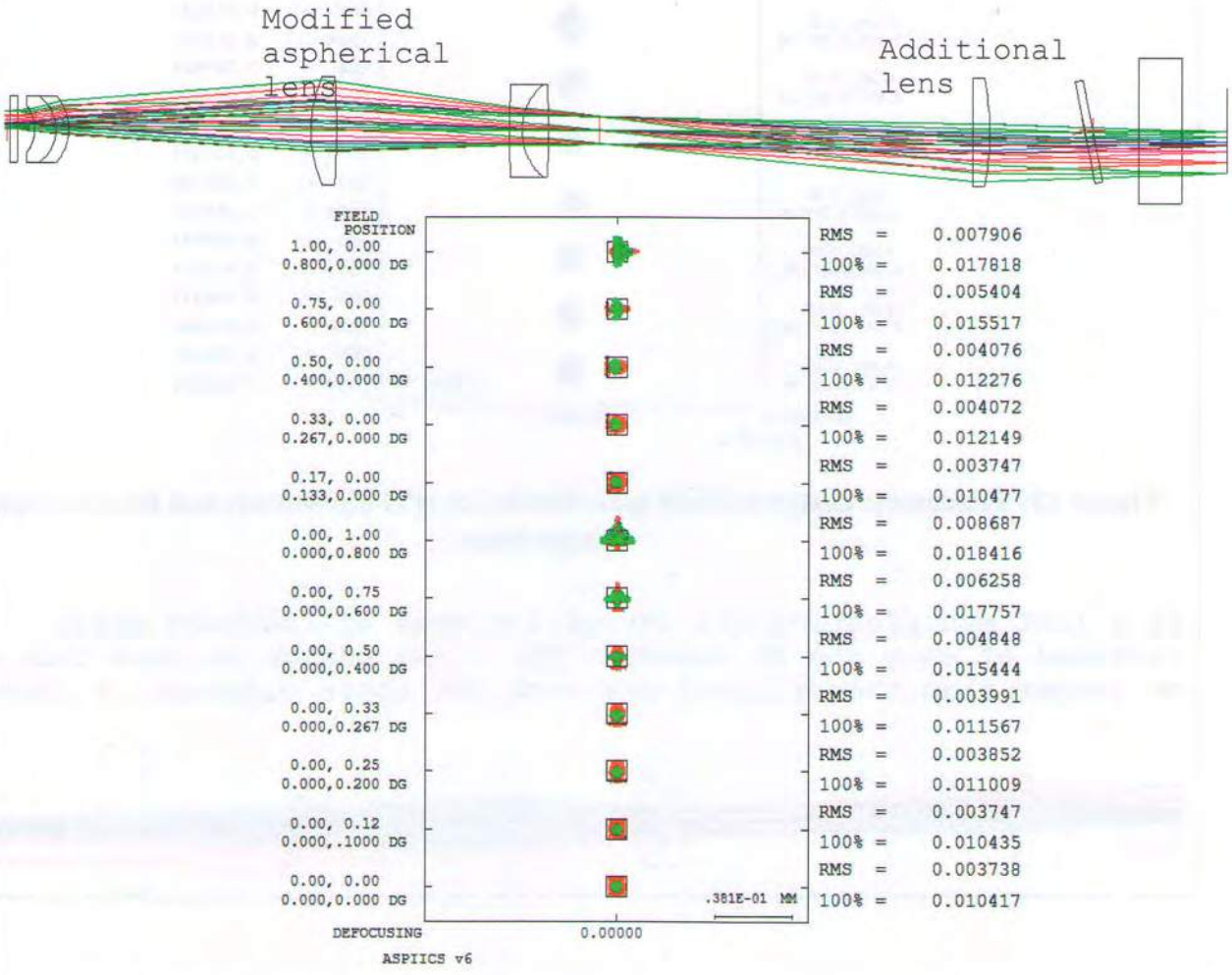


Figure 12: Telecentric design with one additional lens and modified aspherical lens (PO not shown)

and the corresponding image spots.

To avoid the aspherical lens from the new telecentric design, this lens has to be replaced by two spherical lenses. This gives a design ~120 mm longer than the original one where the Lyot stop has moved before the second doublet of the Relay Lens. All RMS spots diameter are ≤ 10 µm.

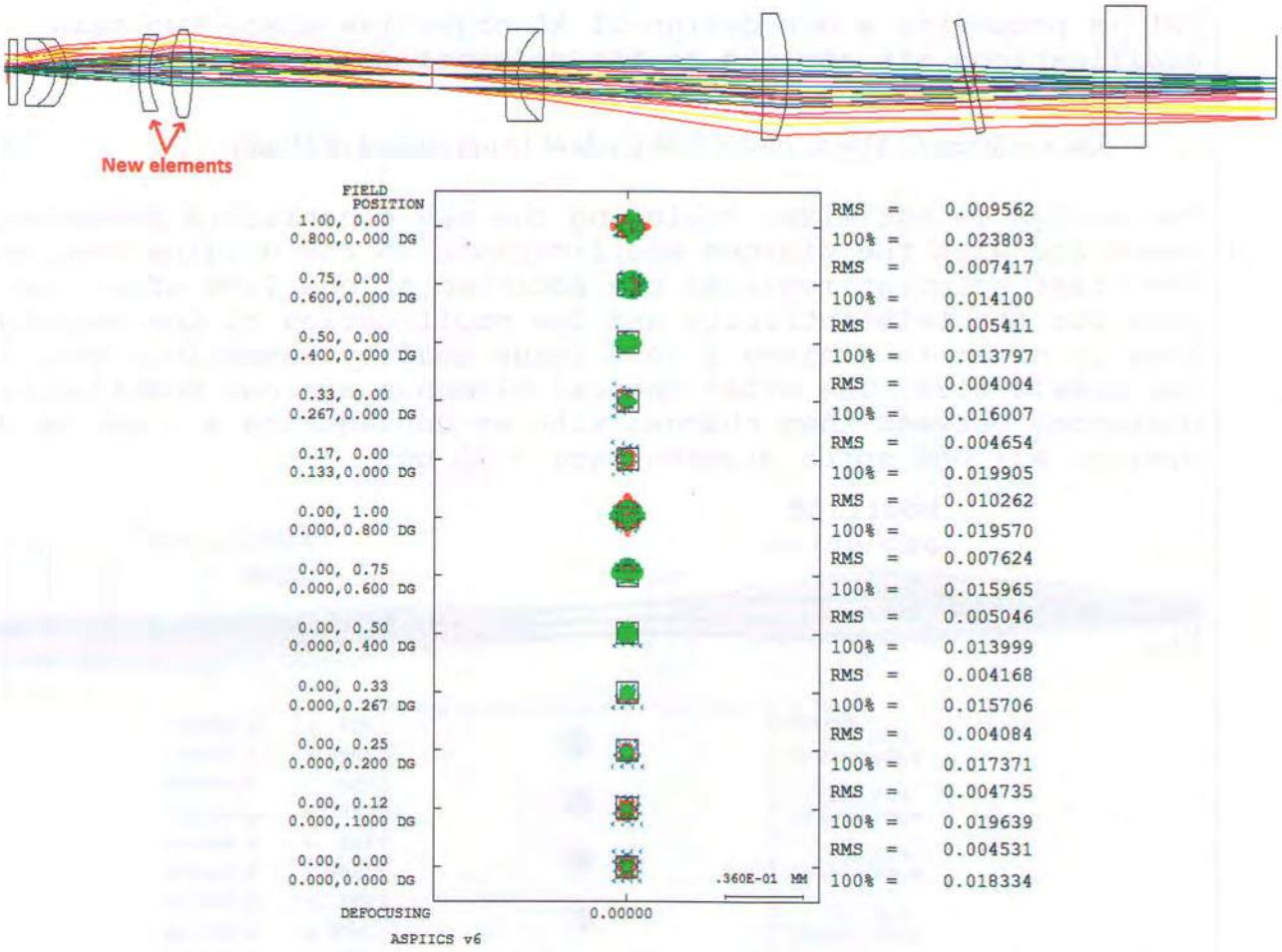
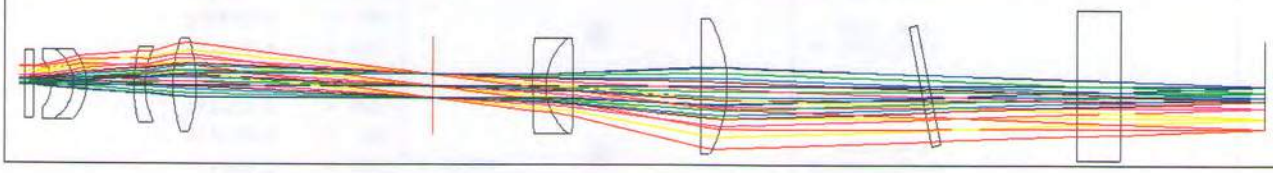


Figure 13: Telecentric design with all spherical lenses (PO not shown) and the corresponding image spots.

As a last modification all lenses are made of rad-hard glass (instead of only the PO lenses). The final design is less than 100 mm longer than the original one with RMS spots diameter ≤ 10µm.



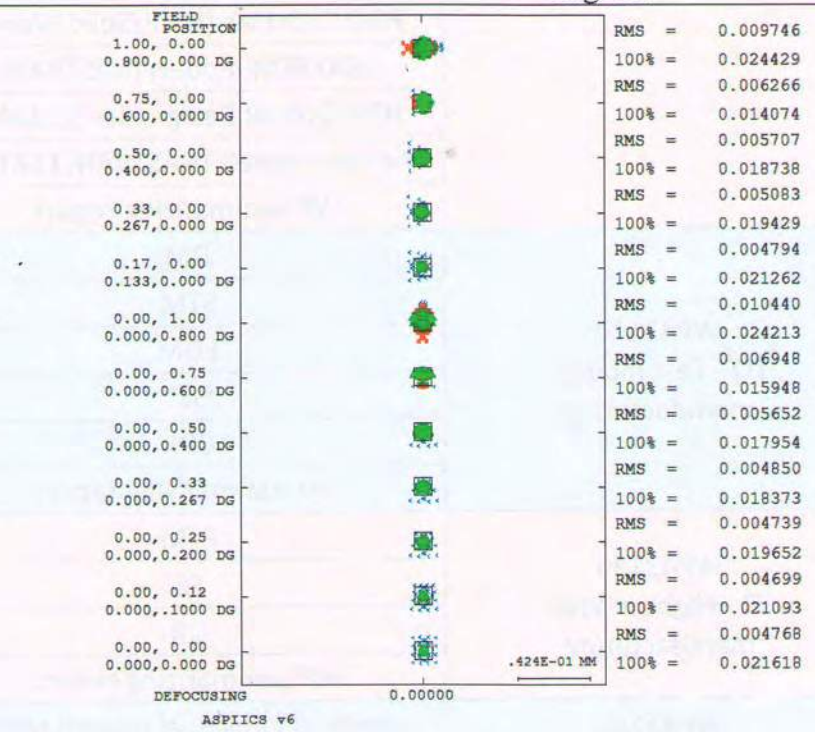


Figure 14: Telecentric design with all spherical and rad-hard glass lenses (PO not shown) and the corresponding image spots.

As a conclusion, it was shown that the new requirements of telecentricity and smaller pixels can be easily achieved with some modifications of the original design and with some additional lenses. The next step would be to try to reduce the number of optics in order to limit the spots degradation from manufacturing and alignment tolerances.

Project output at the end of the term specified in the Implementation PRODEX Experiment Arrangement in terms of :

A summary table giving an overview of individual deliverables in listen in Table 9.

Table 9: Summary table of individual WP deliverables

WP	Delivery	Date
WP41271 HDD Calibration Device Non-recurrent Engineering	HDD CAD files (STEP/Solid Works)	T0+14m
	HDD FEM models (NASTRAN)	T0+14m
	HDD Optical Design files (ZEMAX)	T0+14m
	Thermal models (NASTRAN, ESATAN)	T0+14m
	WP summarizing report	T0+14m
WP41272 LO Non-recurrent Engineering	Preliminary versions of WP deliverables as needed for bridging phase PCM	T0+3

	HDD CAD files (STEP/Solid Works)	T0+14m
	HDD FEM models (NASTRAN)	T0+14m
	HDD Optical Design files (ZEMAX)	T0+14m
	Thermal models (NASTRAN, ESATAN)	T0+14m
	WP summarizing report	T0+14m
WP43110 LO - Test models manufacturing	DM	TBD
	STM	T0+7m
	EGM	T0+14m
	GSE	T0+14m
	CDR	T0+14m
	WP summarizing report	T0+22m
WP43120 LO - Flight models manufacturing	PFM	T0+21m
	FS	T0+21m
	QR	T0+22m
	WP summarizing report	T0+22m
WP43230 LO - Testing	reports of individual models testing	T0+22m
	WP summarizing report	T0+22m
WP43510 HDD - Test models manufacturing	DM	TBD
	STM	T0+5m
	EGM	T0+12m
	GSE	T0+14m
	CDR	T0+14m
	WP summarizing report	T0+14m
WP43520 HDD - Flight models manufacturing	PFM	T0+18m
	FS	T0+18m
	QR	T0+22m
	WP summarizing report	T0+22m

Major Milestones (if any):

With a respect to the project WBS we plan and CSL requested delivery date we plan the following schedule (see Figure 16: Project schedule and milestones.

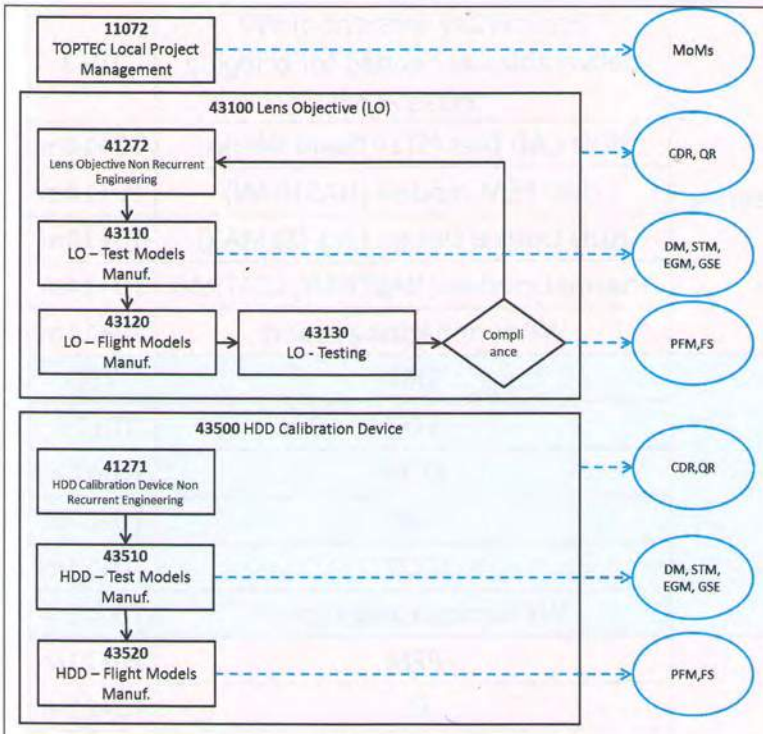


Figure 15: Proposed activity (described in particular WP description) flow

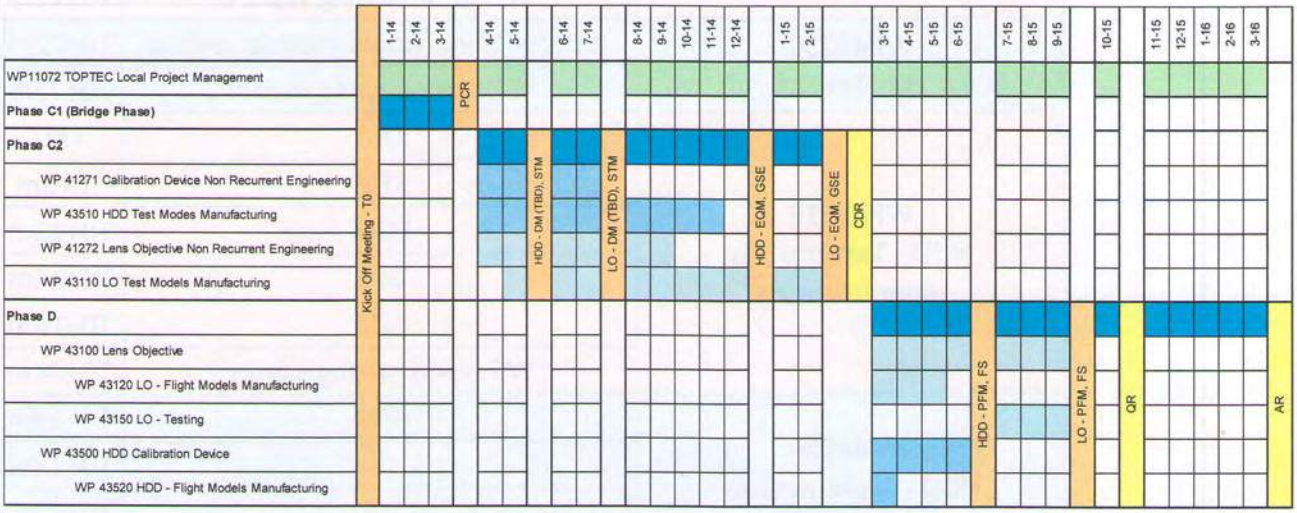


Figure 16: Project schedule and milestones

A summary table giving an overview of individual deliverables in listen in Table 10.

Table 10: Summary table of individual WP deliverables

WP	Delivery	Date
WP41271 HDD Calibration Device Non-recurrent Engineering	HDD CAD files (STEP/Solid Works)	T0+14m
	HDD FEM models (NASTRAN)	T0+14m
	HDD Optical Design files (ZEMAX)	T0+14m
	Thermal models (NASTRAN, ESATAN)	T0+14m
	WP summarizing report	T0+14m

WP41272 LO Non-recurrent Engineering	Preliminary versions of WP deliverables as needed for bridging phase PCM	T0+3
	HDD CAD files (STEP/Solid Works)	T0+14m
	HDD FEM models (NASTRAN)	T0+14m
	HDD Optical Design files (ZEMAX)	T0+14m
	Thermal models (NASTRAN, ESATAN)	T0+14m
	WP summarizing report	T0+14m
WP43110 LO - Test models manufacturing	DM	TBD
	STM	T0+7m
	EGM	T0+14m
	GSE	T0+14m
	CDR	T0+14m
	WP summarizing report	T0+22m
WP43120 LO - Flight models manufacturing	PFM	T0+21m
	FS	T0+21m
	QR	T0+22m
	WP summarizing report	T0+22m
WP43230 LO - Testing	reports of individual models testing	T0+22m
	WP summarizing report	T0+22m
WP43510 HDD - Test models manufacturing	DM	TBD
	STM	T0+5m
	EGM	T0+12m
	GSE	T0+14m
	CDR	T0+14m
	WP summarizing report	T0+14m
WP43520 HDD - Flight models manufacturing	PFM	T0+18m
	FS	T0+18m
	QR	T0+22m
	WP summarizing report	T0+22m

Activity is endorsed up to a total maximum of 252 kEuro. Remaining activity to be placed post-2015.

FINANCIAL PLAN

Institute of Plasma Physics ASCR, v.v.i.
Za Slovankou 1782/3, 182 00 Praha 8, Czech Republic

Project: Proba 3 Coronograph System Phases C/D/E1
LENS OBJECTIVE & HDD CALIBRATORS

Starting date: 1 June 2014
Ending date: 31 Dec 2015

	2014	2015	Total [EUR]
Direct Labour Cost	**23,870**	**45,729**	**69,599**
Internal Special Facilities	**36,860**	**74,650**	**111,510**
Other Direct Cost	**25,559**	**38,696**	**64,255**
Raw materials	8,284	9,100	17,384
External Major Products	1,576	1,680	3,256
External services	2,340	6,207	8,547
Transport/Insurance	3,485	3,230	6,715
Travels	7,540	14,899	22,439
Miscellaneous	2,334	3,580	5,914
TOTAL	**86,289**	**159,075**	**245,364**

Figure 17-1: Financial Plan in Euros

Grand total:	245,364 euros

Appendix 3

PRODEX EXPERIMENT ARRANGEMENT CHANGE PROCEDURE

A PRODEX Experiment Arrangement change procedure shall apply at least to any modifications of the Agency's financial commitment (Articles 2 or/and 5 of the Arrangement) and of the Term (Article 3 of the Arrangement).

1. INTRODUCTION OF A CHANGE

For all changes, whether requested by the Agency or initiated by the Institute, the latter shall submit a proposal for a PRODEX Experiment Arrangement Change Notice (ACN) on the form attached hereto. The ACN shall be filled in completely, and boxes or lines which are not applicable shall be so designated by use of the letters "NA". The form shall be signed by the Institute's authorised representative(s) and be submitted to the Agency's representative for contractual and administrative matters.

The Institute shall ensure that each change proposal is fully co-ordinated with Appendices 1 and 2 to the arrangement and that all reasonably foreseeable implications of the change have been considered. If the space on the form is not sufficient to describe the change and its consequences, the additional information shall be annexed to the form. The Institute shall, on request of the Agency, provide additional documentary evidence.

2. APPROVAL OR REJECTION OF THE ARRANGEMENT CHANGE NOTICES

Upon receipt of a ACN signed by the Institute the Agency shall consider it as regards its acceptability. Should the ACN be approved, it will be signed by the ESA Prodex Office's authorised representative and a copy be returned to the Institute. Should a ACN be rejected for any reason, the Institute shall be informed accordingly, together with the reasons for the rejection.

3. IMPLEMENTATION AND STATUS OF APPROVED ARRANGEMENT CHANGE NOTICES

Upon signature of a ACN by both parties, the ACN has immediate effect and constitutes a binding contractual agreement.

PRODEX EXPERIMENT ARRANGEMENT CHANGE NOTICE - SPECIMEN

Institute:

PEA No: CN No: Supplier Code:

Contract:

Title of area affected	Article(s) of the Arrangement: Initiator of change:
Description of change	
Reason for change	
Funds *in addition to / in replacement of* those stipulated in Article 2.1: EURO: Breakdown of Funds *in addition to / in replacement of* the one stipulated in Article 2.2 - labour cost: - operational cost: - travel expenses: -.....:	
Effect on other Arrangement provisions	Commencement of Term End of Term
Institute	
Institute's representative(s):	Date
ESA	
PRODEX Office representative:	Date

Appendix 4

GENERAL CONDITIONS

Complementary to Article 4 of the arrangement the General Conditions applicable to all PRODEX Experiment arrangements are included in their original version hereafter (therefore, the word "contract(s)" and "contractor(s)" are to be read "arrangement(s)" and "institute(s)" respectively in the following provisions) :

PART I OF THE GENERAL CONDITIONS :

CLAUSE 1 - APPLICABLE CLAUSES AND RULES

The following general clauses and conditions shall apply to contracts placed by the Agency insofar as not stated otherwise in the relevant contract. Furthermore, specific clauses and conditions may be set out or invoked in a contract and its annexes. The annexes form an integral part of the contract.

CLAUSE 2 - APPROVAL

Offers and acceptances with regard to contracts are not binding on the Agency unless approved in writing by its Director General or his authorised representative. Unless otherwise stated in the contract the date of such approval shall be the commencing date of the contract.

CLAUSE 4 - ORIGINALS OF THE CONTRACTS

The number of originals of a contract shall be equal to the number of parties to the contract and this number shall be stated in the contract. These originals are intended for the parties to the contract.

CLAUSE 5 - AGENCY'S REPRESENTATIVES - INSPECTIONS

The Agency shall have the right to check the technical performance of the contract, and for this purpose, and for the general purpose of collaboration, the Agency shall nominate a representative(s) whose name(s) shall be notified in writing to the Contractor. Any information made available by the Contractor to such representative(s) shall be regarded as commercially confidential.

The Contractor shall, in this respect, and in accordance with any relevant security regulations, give the representative(s) of the Agency access to his premises and shall give all other necessary assistance in order that he (they) may fulfil his (their) task.

CLAUSE 7 - COMMUNICATIONS

All communications affecting the terms and conditions of the contract and concerning its execution shall be made or confirmed in writing.

CLAUSE 12 - APPLICABLE LAW

The law governing the contract shall be specified in the contract itself.

CLAUSE 13 - ARBITRATION

13.1 Any dispute arising out of the interpretation or execution of the contract shall, at the request of either party, be submitted to arbitration.

13.2 The contract shall specify the country where the Arbitration Tribunal shall sit; normally the Arbitration Tribunal shall have its seat in the country where the Contractor has his legal seat or where the contract is to be executed.

13.3 If no other arbitration is foreseen in the contract, any dispute arising out of the contract shall be finally settled in accordance with the Rules of Conciliation and Arbitration of the International Chamber of Commerce by one or more arbitrators designated in conformity with those rules.

13.4 When arbitration other than in accordance with the Rules of Conciliation and Arbitration of the International Chamber of Commerce is provided for in the contract, the procedure of the Arbitration Tribunal shall be that of the country mentioned in subclause 13.2.

13.5 The award shall be final and binding on the parties; no appeal shall lie against it. The enforcement of the award shall be governed by the rules of procedure in force in the state / country in which it is to be executed.

CLAUSE 14 - INFRINGEMENTS OF THE LAW

The Agency shall not be responsible if the Contractor infringes the laws or statutes of his country or of any other country whatsoever.

CLAUSE 15 - INFRINGEMENTS OF THIRD-PARTY RIGHTS

15.1 Unless otherwise stipulated in Part II of this document, the Contractor shall indemnify the Agency from and against all claims, proceedings, damages, costs and expenses arising from the infringement of patent rights and intellectual property rights of third-parties with respect to the subject of the contract - excluding any infringement resulting from the use of documents, patterns, drawings or goods supplied by the Agency - which may be made, or brought against the Agency, or to which the Agency may be put by reason of such infringement or alleged infringement.

15.2 The Agency shall notify the Contractor immediately of any written claim or notice of infringement of third-party rights which it received concerning the contract.

The Contractor shall immediately take all necessary steps within his competence to prevent or end a dispute and shall assist the Agency to defend against, or make settlement in respect of, any claim or notice of infringement or suit for infringement. Written claims or notices of infringement of third-party rights will be accepted or met by the Agency only in agreement with the Contractor.

15.3 The parties shall notify each other of any known intellectual property rights connected with the use of documents, patterns, drawings and goods supplied by the one party to the other or connected with the execution of the specifications laid down by the other party.

CLAUSE 21 - FINAL SETTLEMENT

21.1 The Contractor shall be allowed to claim final settlement when all his obligations under the contract have been fulfilled. For the application of this clause, these obligations shall not include those of guarantee. The Contractor shall, in addition, certify whether or not any inventions as defined in Part II hereof, were made in the course of the contract.

He shall submit a final statement in five copies.

If the contract provides for several batches of settlement, each batch is to be paid and settled separately.

21.2 The Contractor shall supply the Agency with all documents specified in Annex I and necessary for payment, without explicit request by the Agency.

21.3 Unless otherwise provided for in the contract, a period of one month shall be granted to the Agency for the execution of the final payment. This period shall begin on a date to be stated in the contract.

21.4 Whenever any sum of money shall be recoverable from, or payable to, the parties, the sum may be deducted from the sum due, or thereafter becoming due, to the parties under any other contract between the parties.

CLAUSE 34 - CANCELLATION IN SPECIAL CASES

Contrary to all other General Conditions listed in this Appendix 4, Clause 34 as such is not applicable; certain situations described therein however do have the consequences laid down in Article 6 of the contract. Therefore the text of Clause 34.1 is repeated hereafter for convenience :

34.1 The Agency may at any time cancel the contract by giving written notice with immediate effect in any of the following events:

a) if the Contractor becomes insolvent or if his financial position is such that within the framework of his national law, legal action leading towards bankruptcy may be taken against him by his creditors;

b) if the Contractor resorts to fraudulent practices in connection with the contract, especially by deceit concerning the nature, quality or quantity of the supplies, and the methods or processes of manufacture employed or by the giving or offering of gifts or remuneration for the purpose of bribery to any person in the employ of a Member State or of the Agency or acting on its behalf, irrespective of whether such bribes or remuneration are made on the initiative of the Contractor or otherwise.

PART II OF THE GENERAL CONDITIONS (CLAUSES 36, 37, 38 and 39) :

Unless otherwise agreed with all parties to arrangements concluded for the purpose of "co-operative activities" as planned in the PRODEX Programme Declarations and provided that appropriate provisions are then included in the special conditions of the arrangement in question (Article 4, Clauses 37, 38 & 39), the following general provisions 36, 37, 38 & 39 shall apply.

CLAUSE 36 GENERAL

General Rule

36.1 These Part II (Option A) Clauses and Conditions apply to Contracts which are also governed by the Clauses and Conditions set out in Part I. In the event of conflict between the General Clauses and Conditions in Part I and Part II (Option A) the clauses in Part II (Option A) shall prevail.

Definitions for Part II (Option A)

36.2 **"Agency's Own Requirements"** means the activities and programmes undertaken by the Agency in the field of space research and technology and space applications in accordance with Article V 1(a) and (b) of the European Space Agency Convention;
"Agency Technology and Product Transfer Board" means the body established by the Agency Council to consider the transfer or licence

of any Intellectual Property Rights or product, process, application or result arising from the Contract to an entity not Located in a Member State or to an international organisation;
"Background Intellectual Property Rights" means all Intellectual Property Rights not developed under contract with the Agency either prior to or during execution of the Contract which are used by the Contractor and/or the Agency to complete the Contract or required for use of any product, application or result of the Contract; "
Contractor" means the legal person or body who is party to the Contract; ESA/C/290, rev. 6
"Disclose" means the distribution or supply of information or Documentation to a third party without prior authorisation from the proprietor of the information/Documentation;
"Documentation" means all media on which information or data of any description is recorded including all paper documents, and electronic communications whether in electronic or hard copy form;
"Favourable Conditions" means conditions a seller is willing to sell on and a purchaser willing to accept which are more favourable to the purchaser than Market Conditions (and which normally allow reasonable profit for the seller);
"Intellectual Property Rights" means all Registered Intellectual Property Rights, and all unregistered intellectual property rights granted by law without the need for registration with an authority or office including all rights in information, data, blueprints, plans, diagrams, models, formulae and specifications together with all copyright, unregistered trade marks, design rights, data base rights, topography rights, know how and trade secrets or equivalent rights or rights of action anywhere in the world;
"Legitimate Commercial Interest" means an interest the Contractor can demonstrate which is important to its ability to commercially exploit Intellectual Property Rights arising from work performed under the Contract for a defined period of time which includes but is not limited to an economic position vis-à-vis a competitor, loss of profits or survival of an undertaking;
"Located" means belonging to a State according to the criteria set out in Article II (3) of Annex V of the European Space Agency Convention;
"Market Conditions" means conditions a seller is willing to sell on and a purchaser is willing to accept without restrictions or influence by the Agency;
"Member State" means a State which is party to the European Space Agency Convention in accordance with Article XX and XXII of the said Convention;
"Object Code" means the code for a computer programme expressed in machine readable form usually automatically compiled from Source Code by machine;
"Open Source Code" means Source Code for computer software developed under the Contract which the Contract specifies as Source Code which the Agency will distribute to members of the public free of charge;
"Operational Software" means computer programs used or required on the ground to validate and control a space mission, for calibration of data derived from a space mission or for any other Agency purpose including all updates, modifications and enhancements of such programmes which (1) are developed (or are in the process of being developed), modified, enhanced or maintained by more than one party and (2) which have an expected use for the Agency's essential purposes over a period of more than 5 years;
"Participating State" means a Member or non-Member State participating in a given Agency programme according to Article V.1 (a) and (b) of the European Space Agency Convention;
"Participating State's Own Public Requirements" means a public programme in the field of space research and technology and their space applications fully funded or funded to a substantial extent by the Participating State;
"Persons and Bodies" means any individual, partnership, company, research organisation or legal entity under the jurisdiction of a Participating State which, when relevant, meets the criteria set out in Article II (3) of Annex V to the European Space Agency Convention;
"Registered Intellectual Property Rights" means all rights granted by law through registration with an authority or office (whether actually registered or in the form of applications) including all registered patents, utility models, designs, topography rights, domain names and trade marks or equivalent rights and rights of action anywhere in the world;
"Source Code" means the code for a computer programme expressed in human intelligible form which can be compiled automatically into Object Code by machine;
"Source Code Agent" means the Agency or an independent body which the parties agree can hold software Source Code secure for release upon the events specified in clause 42;
"Subcontractor" means a third party who enters into a written agreement with the Contractor for a defined research and development task required for completion of the Contract.

Interpretation

36.3 If an issue arises over the interpretation of Favourable Conditions, Market Conditions and/or Legitimate Commercial Interest any party requiring access and use of Intellectual Property Rights arising from work performed under the Contract may request a reasoned binding opinion from a forum agreed by the parties (and if the parties cannot agree on a forum the matter shall be referred to the Agency).

Contractor Employees/Service Providers

36.4 The Contractor shall ensure that all work to be performed under the Contract is carried out by persons who have a written agreement with the Contractor and that when lawful the agreement includes provisions that ensure:

(a) all Intellectual Property Rights in results, information, data or Documentation arising from work performed during the course of their engagement shall be owned by the Contractor; and
(b) all results information, data and Documentation obtained for the purpose of the Contract will only be circulated under terms which comply with the Contract.

Subcontract Clauses

36.5 If the Contractor requires the services of a Subcontractor for the purposes of fulfilling obligations under the Contract the Contractor may enter into subcontracts with the approval of the Agency unless otherwise specified in the Contract. Each subcontract shall provide:

(a) the Subcontractor with the same rights and obligations in relation to work performed under the subcontract that the Contractor has agreed to in relation to work performed under this Contract and in particular shall ensure that only the Subcontractor has the rights and obligations set out under clause 36.3 (Interpretation), clause 36.4 (Contractor Employees/Service Providers), clause 39 (Ownership of Intellectual Property Rights), clause 40 (Registration of Intellectual Property Rights), clause 41 (Use of Intellectual Property Rights), clause 42 (Software), clause 43 (Background Intellectual Property Rights), clause 44 (Exploitation), clause 46 (Fees) and clause 49 (Transfer outside Member States);

(b) for the exceptional case when work is carried out jointly by the Contractor and one or more Subcontractors, the parties will agree to normally vest the ownership of the intellectual property rights in the principal contributor to the development, provided the principal contributor is able and willing to exploit such rights and compensation in form of a licence and/or payment is agreed. In such case, the assignment shall be notified to the Agency and the subcontract shall be drafted to comply with these provisions of this Part II (Option A).

36.6 To assist in the identification of Intellectual Property Rights created and owned by the Subcontractor each subcontract shall define in writing the product, application or results arising from work performed under the subcontract.

CLAUSE 37 INFORMATION TO BE PROVIDED

Contract Reports

37.1 The Contractor shall provide regular reports detailing all work performed under the Contract as specified in the Contract. The reports shall provide details of all work undertaken and completed, any current or anticipated problems in completing the Contract, the progress achieved and whether any results or Intellectual Property Rights arising from work performed under the Contract have been (or are expected to be) exploited.

37.2 The Contractor shall draft a final report detailing all results of the Contract as specified in the Contract. The Agency may make the report available to Participating States and Persons and Bodies. For the purpose of the report the Contractor shall provide the Agency with relevant commercially sensitive information, data, results and Documentation which shall be included in a separate part of the report marked "Proprietary Information" only to be circulated with prior written consent from the Contractor (such consent not to be unreasonably withheld taking into account the Contractor's Legitimate Commercial Interest).

37.3 If requested by the Agency, and at the Agency's reasonable expense, the Contractor shall provide the Agency with any additional information, results, data or Documentation arising from work performed under the Contract not included in reports provided to the Agency together with any related information the Agency may reasonably require for the Agency to use or make available in accordance with the Contract.

Access to Information

37.4 Information, data and results arising from work performed under the Contract shall be reported to the Agency who may make such information, data and results available for Participating States and Persons and Bodies to use on the condition that Participating States and Persons and Bodies comply with the terms on Use of Intellectual Property Rights (set out in clause 41) and on Disclosure (set out in clause 38).

CLAUSE 38 DISCLOSURE

38.1 The Contractor shall not Disclose any Documentation obtained from the Agency which is marked as "Proprietary Information". The Contractor shall only circulate such Documentation to its employees that require that Documentation for the purposes of complying with the Contract. The Contractor shall never circulate such Documentation to those not employed by the Contractor (other than in compliance with these Clause and Conditions) without prior written consent from the Agency in which case the Agency may require the recipient to sign a non-disclosure agreement.

38.2 The Agency shall not Disclose any Documentation obtained from the Contractor which is marked "Proprietary Information". The Agency shall only circulate such Documentation to its employees that require that Documentation for the purpose of complying with the Contract or for using, modifying or maintaining any product, application or result of the Contract and the Agency shall never circulate such Documentation to those not employed by the Agency (other than in compliance with these Clauses and Conditions) without prior written consent from the Contractor in which case the Contractor may require the recipient to sign a non-disclosure agreement.

38.3 The obligations in clauses 38.1 and 38.2 shall not apply to Documentation:

(a) which at the time of circulation has already entered the public domain or which after circulation enters the public domain other than through a breach of this Contract;
(b) which at the time of circulation is already known by the receiving party (as evidenced in writing) and is not hindered by any obligation not to circulate;
(c) which is later acquired by the receiving party from another source and is not hindered by any obligation not to circulate;
(d) which is required to be circulated by law or order of a court of competent jurisdiction.

CLAUSE 39 OWNERSHIP OF INTELLECTUAL PROPERTY RIGHTS

39.1 The Contractor shall own all Intellectual Property Rights and have the right to apply for and to own any Registered Intellectual Property Rights arising from work performed under the Contract. At the Contractor's request and expense the Agency shall carry out all reasonable tasks including executing any document required to vest such title in the Contractor.

39.2 The Agency shall be granted the rights, including the access, to Intellectual Property Rights set out in clauses 39 to 44 and reserves the right to require the Contractor to assign Intellectual Property Rights arising from work performed under the Contract in the case of:

(a) the Contractor's failure to apply for registration or the Contractor's abandonment of Registered Intellectual Property Rights arising from work performed under the Contract (as set out in clause 40.4 and 40.5);
(b) the Contractor's failure to exploit (as set out in clause 44.2);
(c) Operational Software (as set out in clause 42.7);
(d) Open Source Code (as set out in clause 42.9).

39.3 When the Contractor assigns any Intellectual Property Rights arising from work performed under the Contract he shall give notification to the Agency within 4 weeks of the date of assignment.

39.4 The Contractor shall ensure that any assignee of Intellectual Property Rights arising from work performed under the Contract complies with the same obligations (including the obligation to exploit the Intellectual Property Rights) and grants the Agency, Participating States, Persons and Bodies the same rights that the Contractor has agreed to under this Contract.

ANNEX I TO THE GENERAL CONDITIONS

CLAUSE 9 - LIMITATION OF LIABILITY

9.1 The limit of liability is an amount to be stated in the contract, which shall be the maximum amount to which the Agency is committed and which can only be increased by a written agreement of the Agency.

9.2 If at any time the Contractor has reason to believe that the commitments which he will incur in the performance of the contract in the next succeeding sixty (60) days, when added to all costs previously incurred, will exceed seventy-five percent (75%) of the limit of liability, the Contractor shall notify the Agency in writing to that effect, giving the revised estimate of the total cost.

9.3 The Agency shall not be obliged to reimburse the Contractor for costs incurred in excess of the limit of liability and the Contractor shall not be obliged to continue performance under the contract or to incur costs in excess of the limit of liability, unless and until the Agency shall have notified the Contractor in writing that such limit has been increased up to a revised amount. Any costs incurred by the Contractor in excess of such limit prior to the approval of the increase shall be allowable to the same extent as if such costs had been incurred after the increase.

CLAUSE 10 - RIGHT TO AUDIT

The Agency reserves the right to audit, either itself or through an authorised representative, the claim of the Contractor, for cost incurred in the execution of any cost-reimbursement type contract or any contract with ceiling price to be converted into a fixed price which according to the provisions of Clause 3.4 is to be treated as a cost reimbursement contract.