Instrument Characteristics

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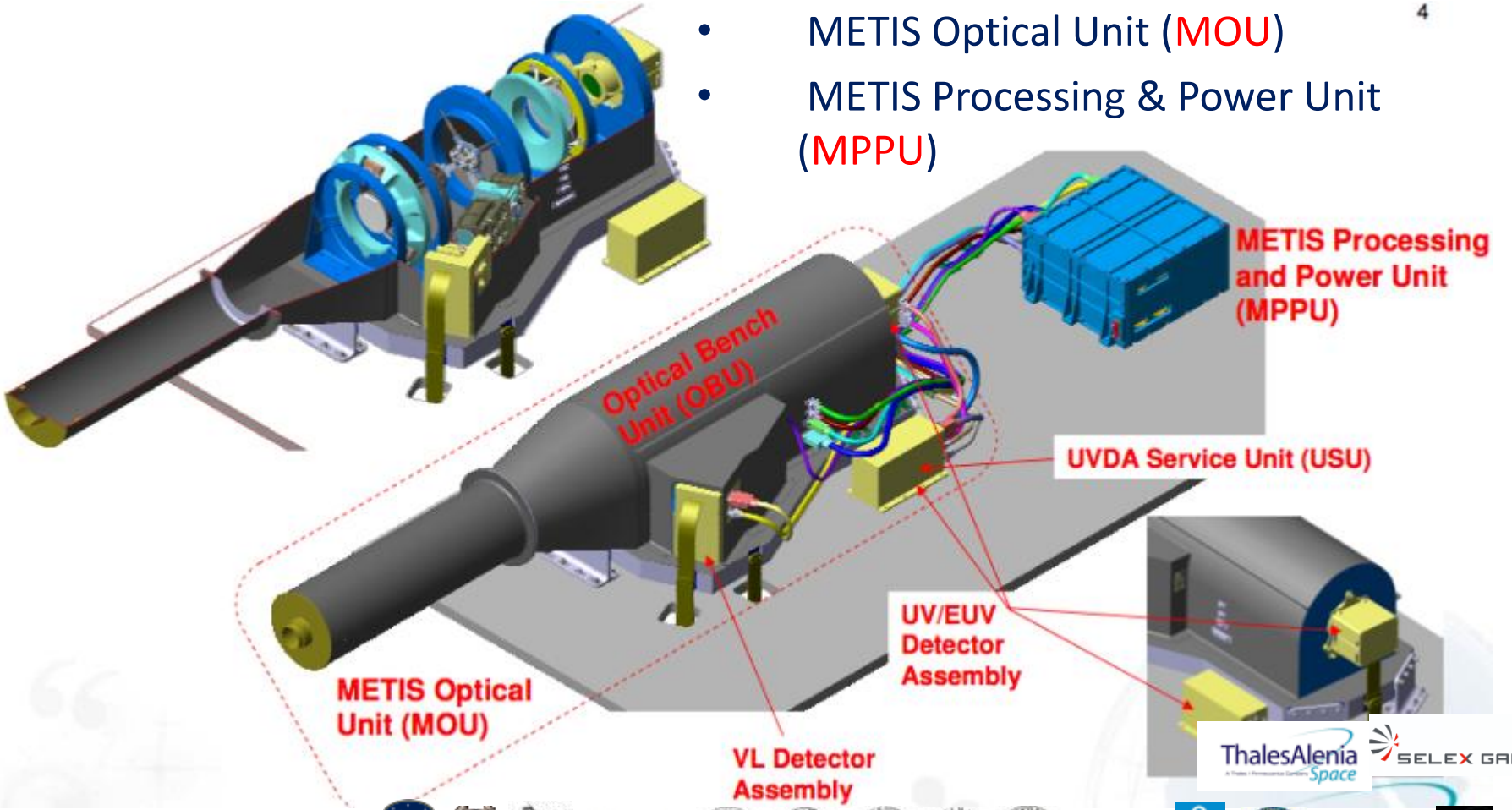
In order to meet the requirements:

Coronal Imaging	
Wavelength range	VL: 580-640 nm UV: 121.6 ± 10.0 nm
Spatial Resolution	20 arcsec
Field-of-view	1.5° - 2.9° annular, off-limb corona
Instrumental Stray Light (Bcor/$B_{\odot}$)	VL $<10^{-9}$ UV $<10^{-7}$

METIS instrument is an externally occulted coronagraph (with inverted occultation) with imaging capabilities.

METIS consists of two units:

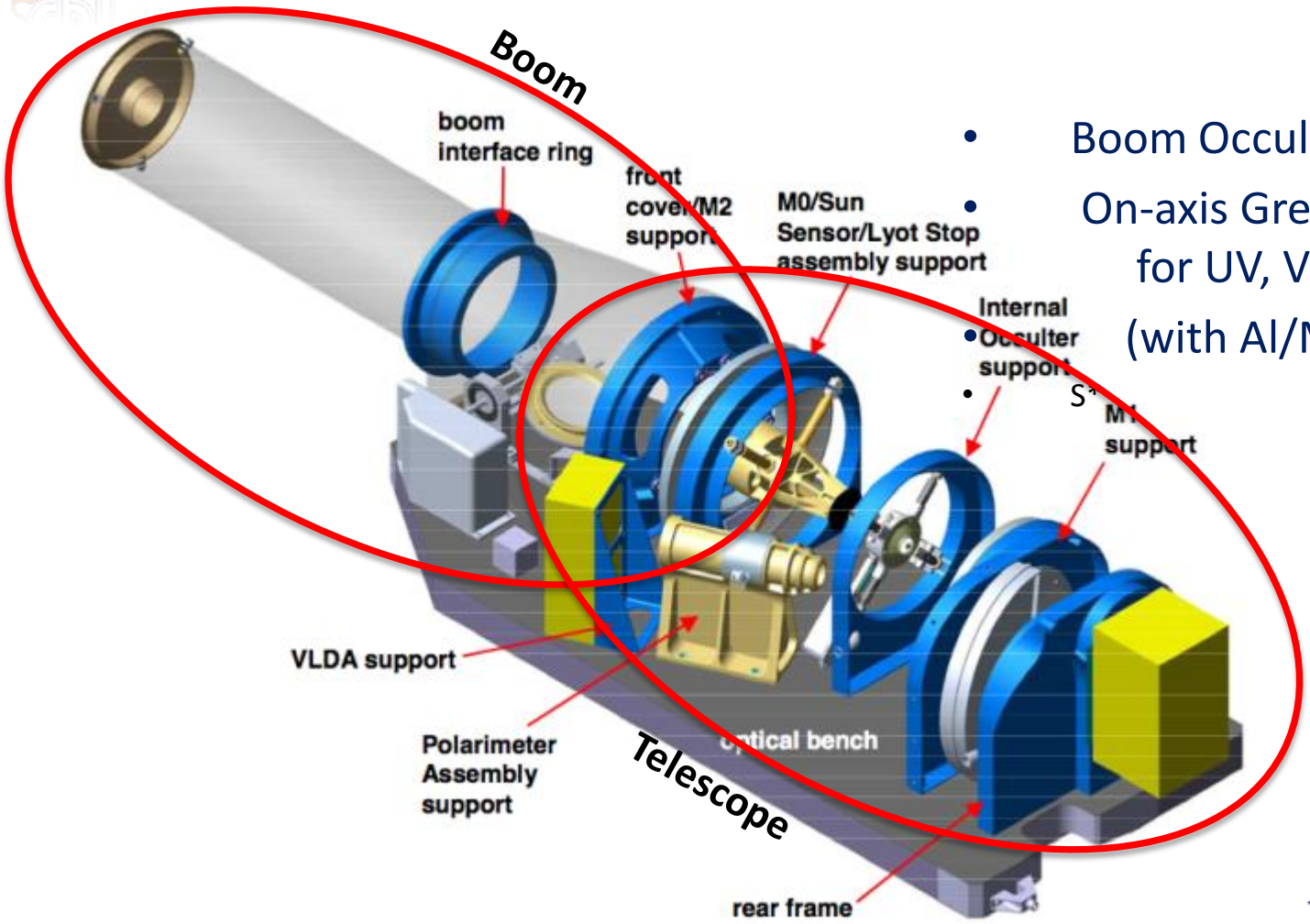
- METIS Optical Unit (MOU)
- METIS Processing & Power Unit (MPPU)



METIS de-scoping from PDR (April 2012) to fulfill mass, cost requirements ant to reduce complexity:

- External Re-pointing Mechanism (ERM)
- Internal Door Mechanism (IDM)
- EUV imaging channel
  - Filter Insertion Mechanism (FIM)
- Spectroscopic channel
  - Filter Insertion Mechanism (FIM)
  - UVD door mechanism
  - Grating
  - Slit assembly
- *(Sun-sensor)*
- *(Internal Occulter Mechanism (IOM))*

METIS Optical Unit (MOU)



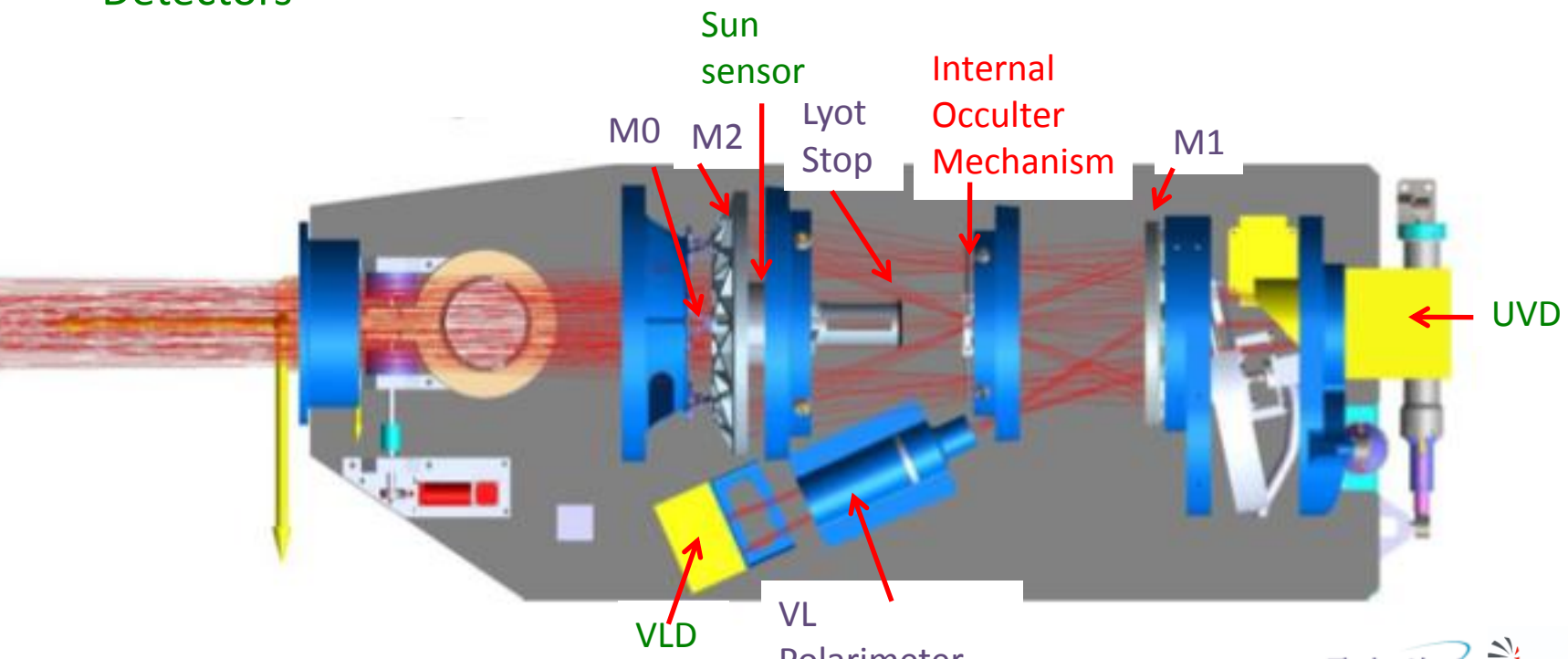
- Boom Occulter Assembly (BOA)
- On-axis Gregorian Telescope for for UV, VL imaging
- (with Al/MgF_2 coated mirrors)

METIS MOU sub-systems

Optics

Mechanisms

Detectors



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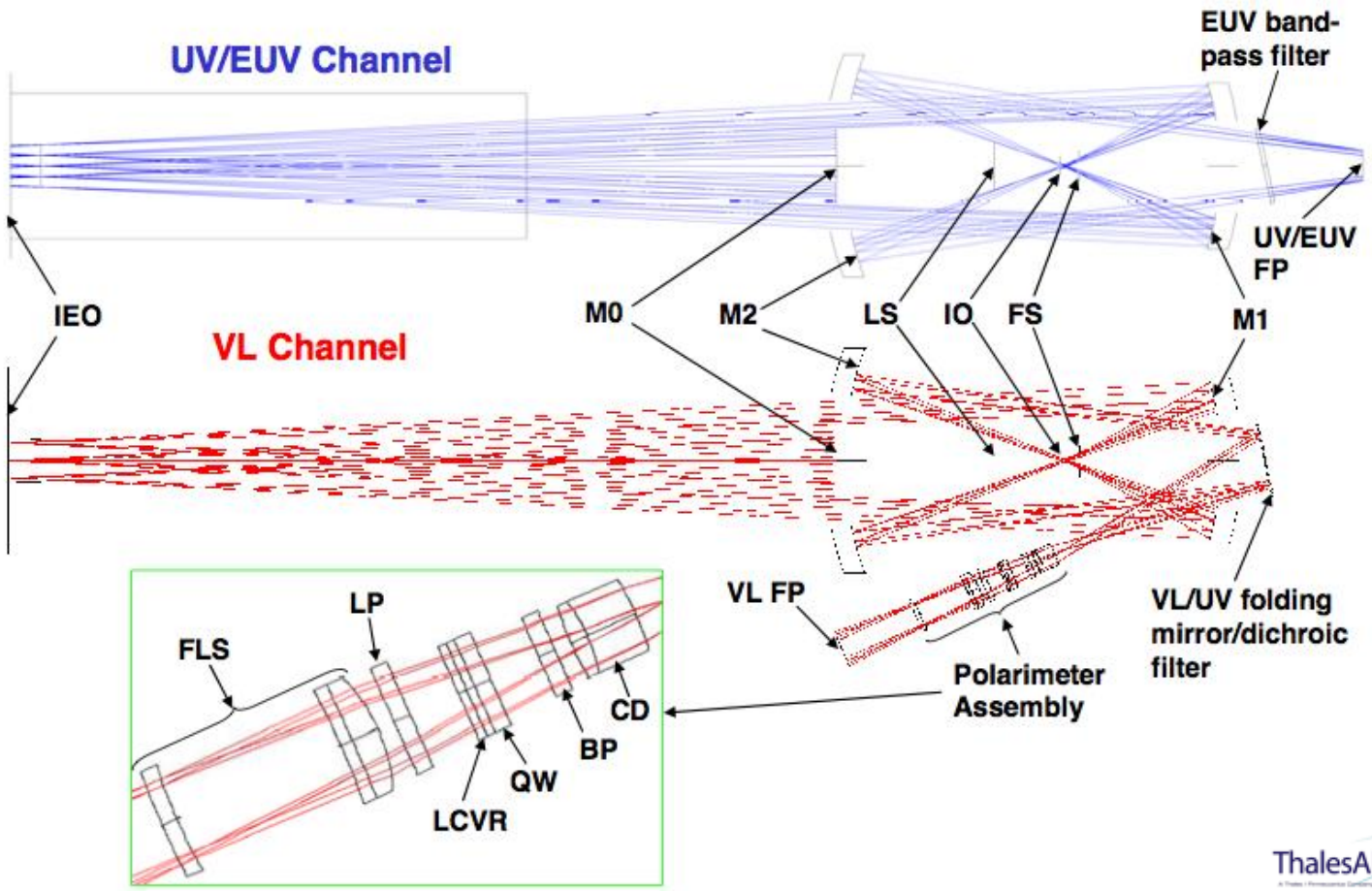
METIS Optical Design: IMAGING

METIS optical design: IMAGING



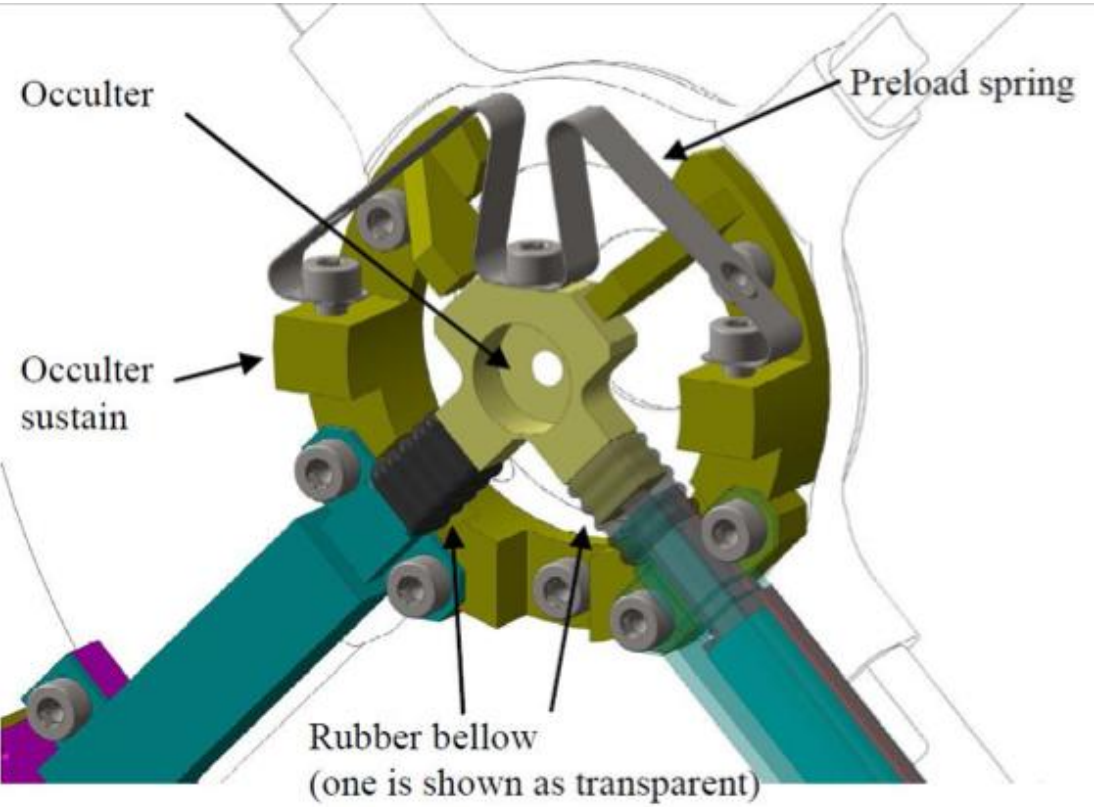
Mechanisms: IOM

Internal Occulter Mechanism (IOM)

- IO stops diffraction from IEO edge

IEO – IO re-alignment

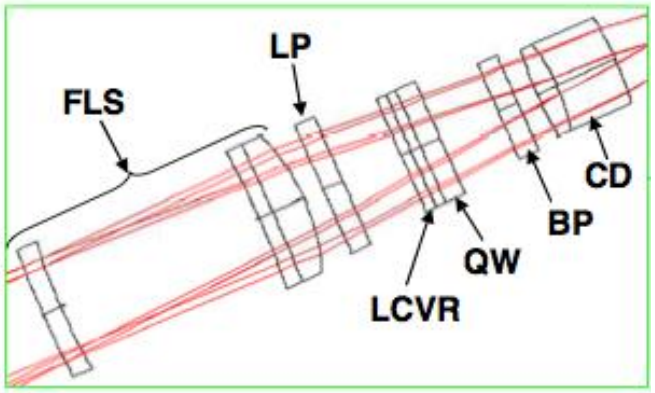
If IOM is descoped IO will change size (smaller radius) increasing the lower edge of FOV by 0.15 $R_{\odot}$ @ 0.28 AU



Polarimeter assembly

METIS

The polarimeter consists of:



- **_Polarimetric Optical System (POS)**

The POS electro-optically modulates the intensity
of the linearly polarized K-corona.
The POS is a polarization optics in “Senarmont configuration”:

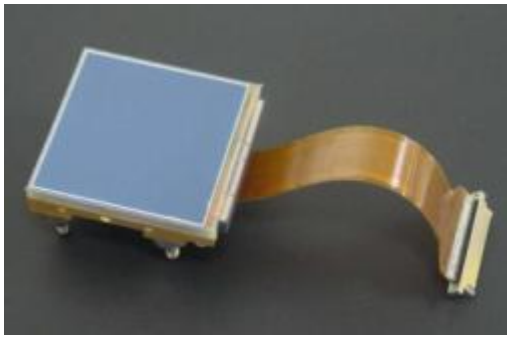
- Bandpass (BP) filter (580-640 nm);
- Fixed Quarter-Wave (QW) retarder;
- Polarization Modulation Package (PMP) with a LCVR cell (Liquid Crystal Variable Retarder);
- Linear Polarizer (LP).

- **_Relay-Optics System (ROS)**

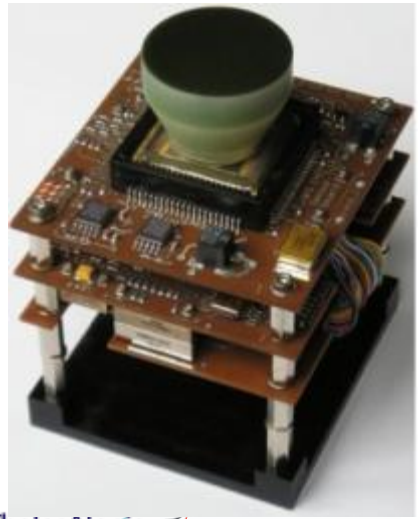
The ROS gives a 1:1.2 magnification ratio to match the telescope plate scale with the APS pixel size.

Detectors

The METIS **visible detector** (VLD)will be a 2kx2k hybrid Active Pixel Sensor (APS) H2RG ROIC+HyViSI PIN array produced by Teledyne with 18 µm pixel size



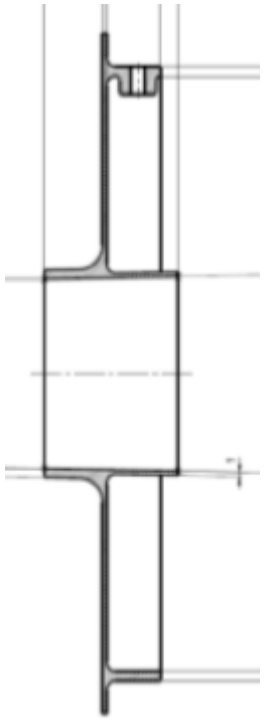
The METIS **UV detector** (UVD) will be a photon counting Intensified Active Pixel Sensor (IAPS) with a 2k × 2k format, 15 µm pixel size, with the capability of working also in integration/analog mode under high flux though with a reduced spatial resolution (30 µm pixel size, 1kx1k)

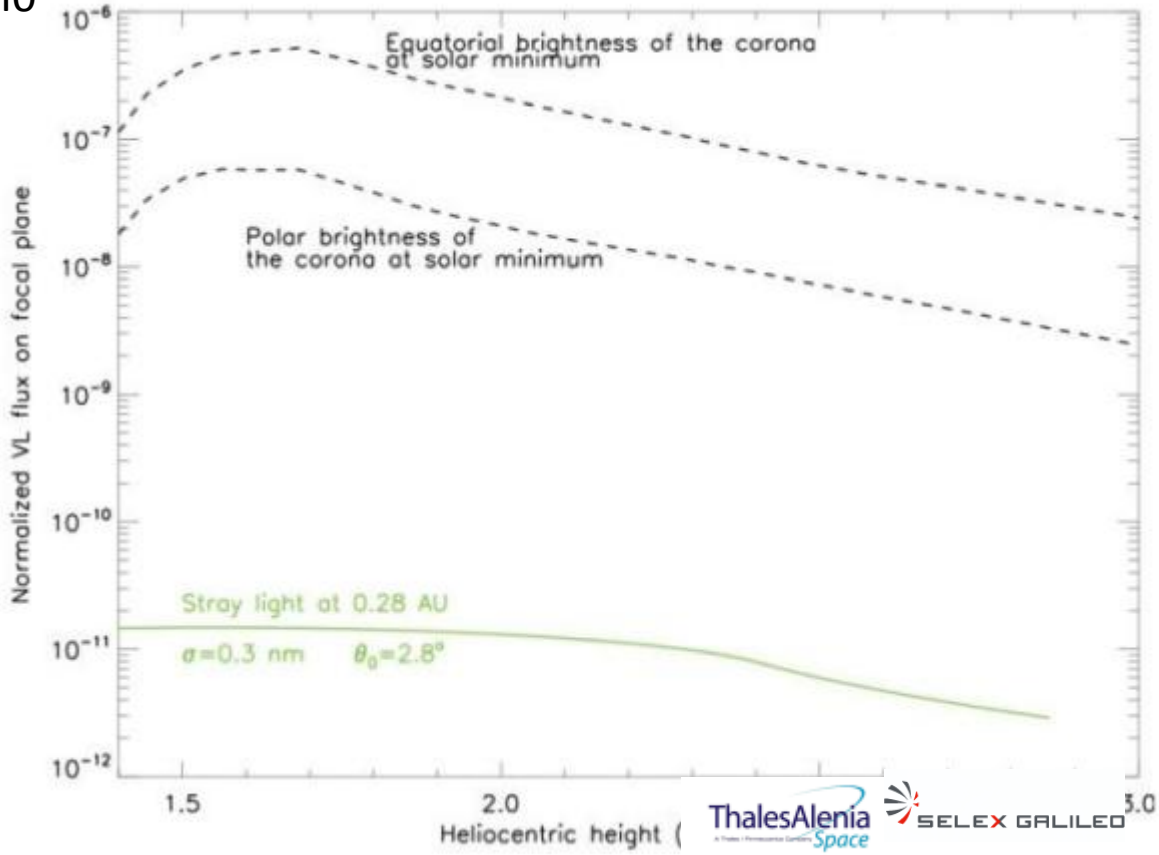


METIS stray light rejection

Sources of stray light:

1. **Disk light entering IEO**:
   Reflected back through IEO by M0
2. **Disk light diffracted by IEO**:
   Blocked by IO and by LS





Effects of ERM descoping

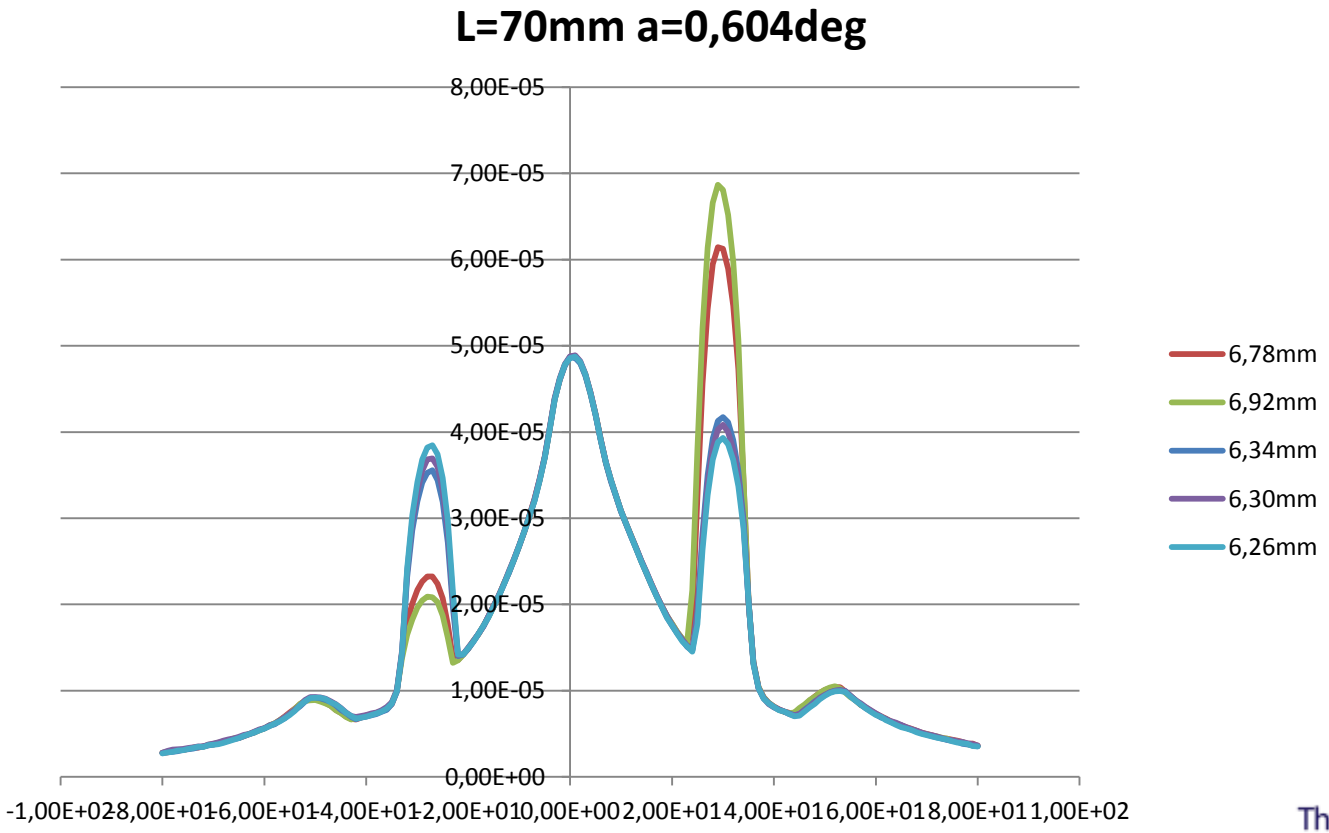
Loss of repointing capabilities consequences:

- METIS in unsafe conditions when offset pointing > 9 arcmin (= 0.15 $R_\odot$ @0.28 AU)
  (= 0.2 $R_\odot$ @0.35 AU)
  (= 0.28 $R_\odot$ @0.5 AU)

- Total APE requirement (S/C + METIS) : < 4.5 arcmin
  - ➔ Non-symmetric vignetting function + non-symmetric stray light pattern
  - ➔ Decrease of S/N in pB measurements
  - ➔ Need of pointing knowledge to be characterized (better than 1 arcmin TBD)

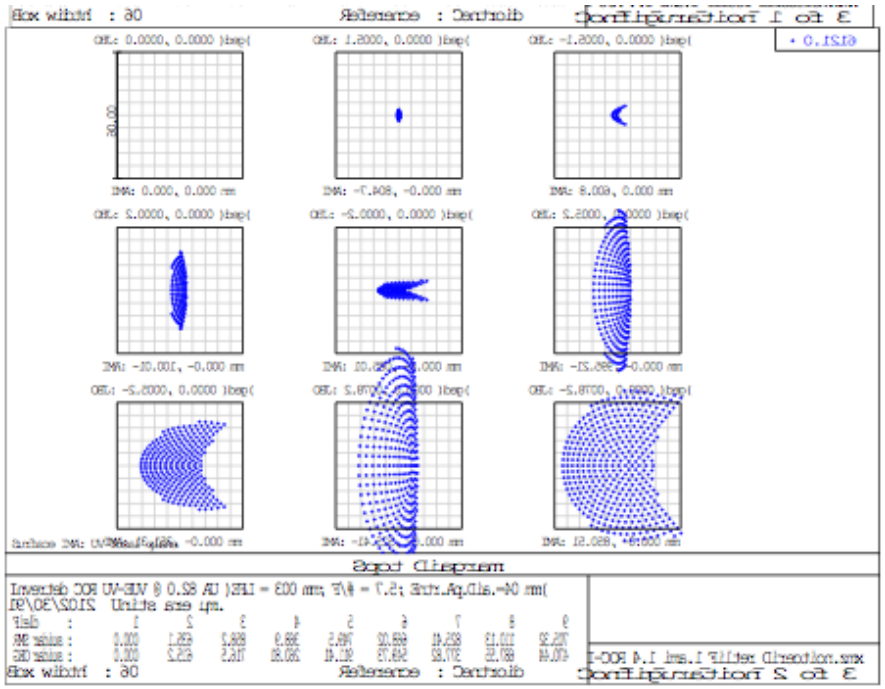
Effects of ERM descoping

Effects of offset pointing or offset error on stray light:
Figure shows a ratio of 3 between lateral lobes of stray light pattern at 2.7arcmin offpointing



Imaging performances

No change of imaging performances in UV and VL channel after descoping



Sunsensor descoping

Sunsensor has two functions:

- Provide pointing information
- Safety

If sunsensor is descoped:

- Pointing information given by S/C and stray light pattern (TBD)
- Safety given by UVD MCP current monitoring

Cleanliness

Particle contamination open issue

METIS cleanliness budget can be met with the exception of the IEO cleanliness.

IDM descoping brings in also a molecular contamination issue

The IEO cleanliness effort is based on comparison with UVCS, LASCO, and SECCHI. All three instruments had a sealed door.

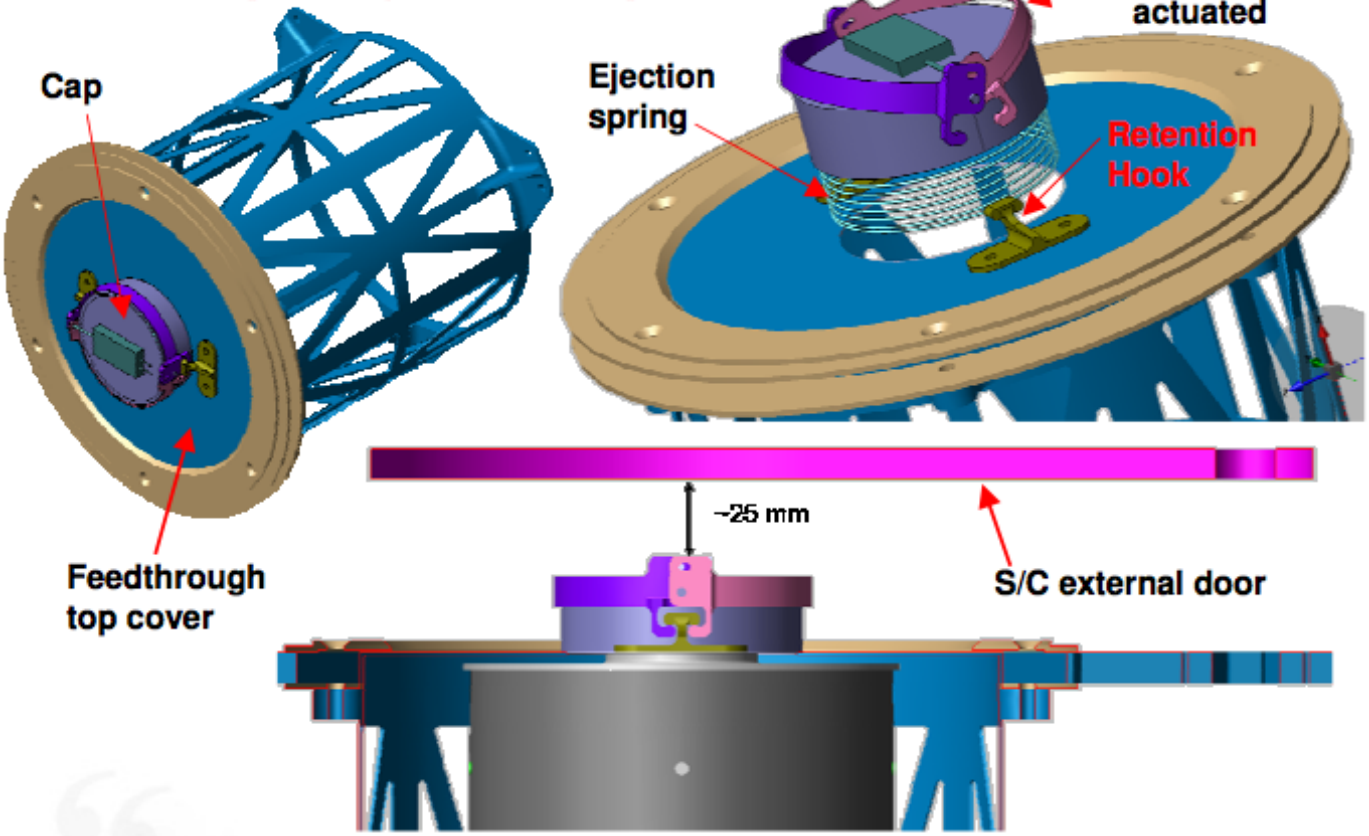
The accommodation of the current METIS instrument design on Solar Orbiter will not satisfy the critical particle cleanliness requirement during launch.

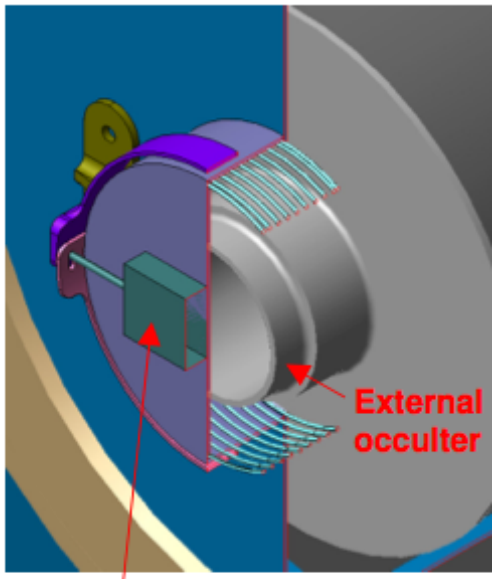
Mitigation of the launch environment will be achieved with a one-shot door that seals the feedthrough aperture combined with the recloseable heat shield door.

The two doors bring both particulate and molecular contamination under control

Cleanliness

Concept 1: ejectable cap





Pin puller

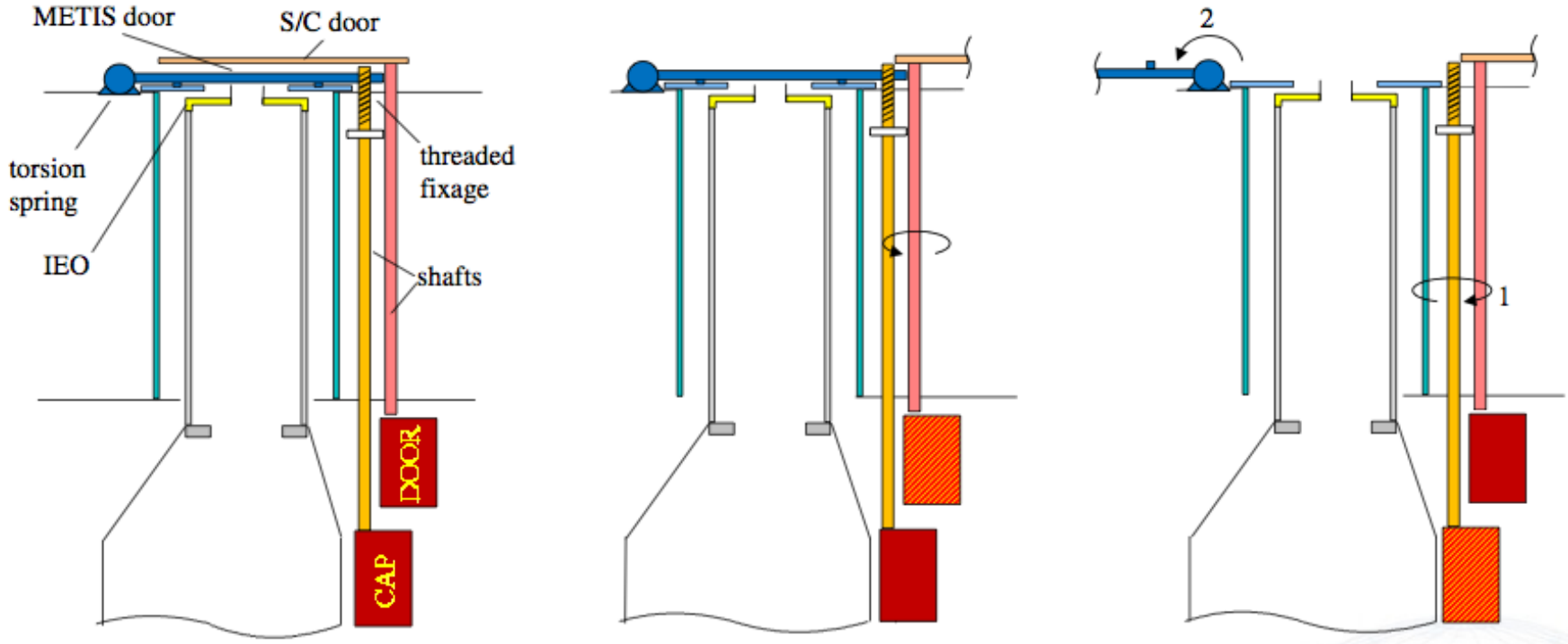
Powering/command options:

- Solar cell(s) on the cap / activated by the sun when external door opens.
- Battery on the cap / timer or telecommand.

Impacts on the spacecraft: modification of the feedthrough top cover (addition of retention hooks, reinforcement); external door height above heat shield increased.

Cleanliness

Concept 2: additional door



Closed position | S/C door open, METIS door closed | Open position

Impacts on the spacecraft: modification of the feedthrough top cover (addition of METIS door hinge); accommodation of an additional shaft of an additional motor; external door height above heat shield increased. Note: an internal motor + shaft could be used also for retaining/releasing the ejectable cap in place of the pin puller.

METIS

Summary of METIS optical specifications

Field of view	Annular Sun-centered: 1.5° - 2.9° 1.6 – 3.1 $R_\odot$ @ 0.28 AU 2 – 4 $R_\odot$ @ 0.35 AU
Telescope type	Externally occulter on-axis telescope
Effective focal length	296mm UV – 360 mm VL
Inverted External Occulter (IEO) Stop aperture at heat shield	Circular hole (Diam.): 40 mm
Sun-light Rejection Mirror (M0)	Spherical (Diam.): 71 mm; Curv. Radius: 1600 mm
Primary mirror (M1)	On axis ellipsoidal: outer (Diam.): 160 mm, inner (Diam.): 88mm Curvature radius: 272 mm, conic: -0.662
Secondary mirror (M2)	On axis ellipsoidal: outer (Diam.): 216 mm, inner (Diam.): 125 mm Curvature radius: 312.385 mm, conic: -0.216
Lyot stop	Circular obscuration (Diam.): 46 mm
Spatial resolution	VL: 20 arcsec UV: 20 arcsec < 2.5 $R_\odot$; > 20 arcsec at > 2.5 $R_\odot$
Wavelength band-pass	VL: 580-640 nm; UV HI (121 ± 10) nm
Detectors	UV: APS Scale factor 10.1 arcsec/pxl Image size: 30.7 mm (2048x2048) with 15 µm pixel size VL: APS Scale factor 10.7 arcsec/pxl Image size: 36.7 mm (2048x2048) with 18 µm pixel size

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