











## Commissioning and In-Flight Calibration

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### ✓METIS commissioning activity

### ✓ METIS in-flight calibration summary





#### Launch February 2020

#### LEOP Launch and Early Orbit Phase (~7 days)

#### CVP/NECP Check Out and Verification Phase/Near Earth Cruise Phase (~90 days TBC) -> ~end May 2020 Commissioning and first Performance verification

#### Cruise Cruise phase ~450 days -> Dec 2021 Performance Verifications





Solar Latitude [deg]

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# **WETIS** Commissioning Intro



The Metis commissioning phase will take place entirely in the NECP. The outgassing phase will last at least 20 days, a period during which the contamination/protection doors must be kept closed. Any functional checks involving observations of the Sun will need to take place after the first opening of the HS door and the subsequent release of the ejectable cap.

After the release of the ejection cap a phase of faster outgassing of Metis cavity will follow (5 day length).





#### **Functional and SW tests**

HK, TM checks, VLDA annealing heater. Open Mcap.

#### Tests with Door closed (with/without Mcap)

• UV and VL Darks and flats. UVD offset map.

#### Tests with door open

- VL alignment and stray light, Sun disk monitoring
- VL Alignment/PSF check with stars (linearity with variable t<sub>exp</sub>)
- VL polarimeter characterization
- VL and UV radiometric calibration
- Check IOM alignment

OAC

SASE GISI

VL cosmic ray algorithm





(T<sub>0</sub>+T<sub>LEOP</sub>+1d - Length: 4h )

#### 1) Switch ON

2) Basic HK, commanding and TM checks (SFT, detailed check of procedure)





(T<sub>0</sub>+T<sub>LEOP</sub>+18d - Length: 6h (TBC) )

Req. to S/C: None

- 1. VL Dark [VL\_DA]
- 2. Test VLDA Annealing Heater [VL\_AH]
- 3. UV dark (Analog; HVPS off) [UV\_DA1]
- 4. UV bias (Photon counting; HVPS off) [UV\_BIA]
- 5. Offset map #1 [UV\_OMAP]

End of Commissioning Block #2.0

OACt

#### **Off-line**

- 1. Check UV\_OMAP algorithm by comparing offset map #1 and UV\_BIA generated offset map
- 2. Check the offset map #1 and prepare patch for the upload (Conditional)











#### (T<sub>0</sub>+T<sub>LEOP</sub>+ T1 (20d) - Length: 2h + 5 days )

Req. to S/C: Open door, close door

#### 1. Metis cap ejection

Allow Metis cavity outgas with door closed for at least 5 days

Starts 19 days after end of LEOP. Time of cap release (T1) to be determined under the following conditions:

1. at least one delta-v burn away from the first big set of component deployments (i.e. the solar panels and HGA);

- 2. Cap ejection no earlier than 20 days after launch to avoid contamination
- 3. Within the NECP, such that METIS can be commissioned (with current plan that means cap release at least 15 days prior to end of NECP (5-day post-release outgassing followed by 10 days subsequent METIS NECP activities))
- 4. Cap ejection before reaching a spacecraft-Sun distance of 0.6 AU (due to METIS cap design)
- 5. Cap ejection requires Sun center pointing or off-pointing > 6°



(T<sub>0</sub>+T<sub>LEOP</sub>+T1+5d - Length: 4h <duration< 10h )

Req. to S/C: Upload UVD offset maps [Conditional]

- 1. Upload offset map #1 [Conditional]<sup>1</sup> Duration < 6h
- 2. Offset map #2 [UV\_OMAP]
- 3. Patch and upload offset map #2 [Conditional]<sup>1</sup>
- 4. UV ramp up [UV\_RAMPU] (requires interactive monitoring of HK)
- 5. UV ramp down [UV\_RAMPD] (requires interactive monitoring of HK)
- 6. VL Bias+Flat [VL\_BFF]
- 7. UV dark (Analog HVPS off) [UV\_DA1]
- 8. UV dark (Analog HVPS on) [UV\_DA2]
- 9. UV dark (PC: HVPS on) [UV\_DPH]
- 10. Open door

11. FIRST LIGHT: VL alignment check with star [VL\_FOV\*]

12. Close door







(T<sub>0</sub>+ T<sub>LEOP</sub>+ T1 + N days (N>6) - Length: 1.5h ) Req. to S/C: Open door and Close door

- 1. Open door
- 2. VL Total Brightness test [VL\_TB]
- 3. VL cosmic ray algo test [VL\_CR]

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- 4. VL alignment check with star [VL\_FOV\*]
- 5. Close Door

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(T<sub>0</sub>+ T<sub>LEOP</sub>+ T1 + N days - Length: 2d ) Req. to S/C: Open door and Close door S/C rolls

- 1. Open Door
- 2. VL diffraction characterization [VL\_SL1] (requires S/C rolls)
- 3. IOM characterization in VL or UV [VU\_IOM] {TC to IOM)
- 4. Close Door





(T<sub>0</sub>+ T1 + N days - Length: 1d (TBC)) Req. to S/C: Open door and Close door

S/C rolls and slews

- 1. Open Door
- 2. VL\_alignment [VL\_ALI] (requires S/C slews)
- 3. VL polarimeter characterization (and VL background characterization [ex VL\_SL2]) [VL\_POL] (requires S/C rolls)
- 4. VL alignment check with star [VL\_FOV\*]
- 5. Close door





(T<sub>0</sub>+ T1 + M days - Length: TBD ) Req. to S/C: Open door and Close door

Backup window





## S/C Rolls



- Characterization of the asymmetric component of stray light (IOM): The procedure requires taking an image of the solar corona at nominal S/C attitude and another one after a 180° roll.
- Characterization of the diffraction pattern: The procedure requires taking an image of the solar corona after a 90° roll, best if in presence of a well-developed polar coronal hole.
- Characterization of instrumental polarization: The procedure requires taking an image of the solar corona at four roll angles, each corresponding to a LCVR polarization angle (0°, 45°, 90°, 135°).
- Characterization of the internal occulter alignment during planned rolls.





## S/C Slews and offsets

- The determination of the boresight, scheduled once in the NECP, is performed first using VL stars positions then through a series of small slews (step size TBD) both in the E-W and in the N-S directions relative to the solar disk. The total excursion of these slew manoeuvres will be within the smallest between 1 R<sub>Sun</sub> and the maximum offset that is safe for Metis,  $\beta_{max}$ .
- Definition of the Sun monitoring algorithm
- UV Radiometric calibration using stellar targets may also require in some circumstances a S/C pointing offset below the smallest between 1 R<sub>Sun</sub> and β<sub>max</sub>.
- No UV calibration stars have been identified during NECP.









- After the launch those curves may not be a reference anymore.
- A procedure to retrieve new curves and a new optimal IO position shall be defined.
- The procedure has to be carried out during the commissioning phase.





## 180° Roll Everything aligned













### 180° Roll IO aligned, Metis not Sun centered



metis



solar orbiter































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 Once Acq1 and Acq2 are downloaded, Acq2 is first rotated 180 deg, then subtracted from Acq1.











#### **UV** Analog





 ✓ Commissioning and performance verification in NECP require detailed procedures to be written



