METIS Status

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Science & Technical Meeting II

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Solar Orbiter Coronagraph

METIS

Milestones		Coronagraph/Model Payload
Mission Proposal	January 2000	3 Imaging Channels VL, UV, EUV (VL polarized, HI 121.6, He 30.4 nm)
METIS Proposal coronal *+ disk* instrument	January 2008	3 Imaging Channels VL, UV, EUV & Spectroscopy UV, EUV
METIS Selection	March 2009	*Coronagraph only*

Solar Orbiter Coronagraph

METIS

Milestones		S/C Pointing	Coronagraph - Model Payload
Delta Assessment Study	1999	sun center	
Mission Proposal	January 2000	sun center	•3 Imaging Channels VL, UV, EUV (VL polarized, HI 121.6, He 30.4 nm)
Assessment Study Report	July 2000	sun center	idem
SPC Selection	October 2000		
ESA Remote Sensing Payload WG Report		off-center pointing	*Coronagraph must be able to cope with likely offsets*
Confirmed	June 2004		
Payload Definition Doc. AO	September 2007	off-pointing	
METIS Proposal **corona *+ disk* instrument**	January 2008		•3 Imaging Channels VL, UV, EUV •Spectroscopy *compensation for off-center pointing*
METIS Instrument Selection	March 2009		Selected coronagraph only
Mission Selection	October 2011		

July 2012 Descoping

METIS configuration @ PDR

- *5 channels*
- *5 mechanisms*

In order to reduce mass, power, cost, complexity

Cancelled

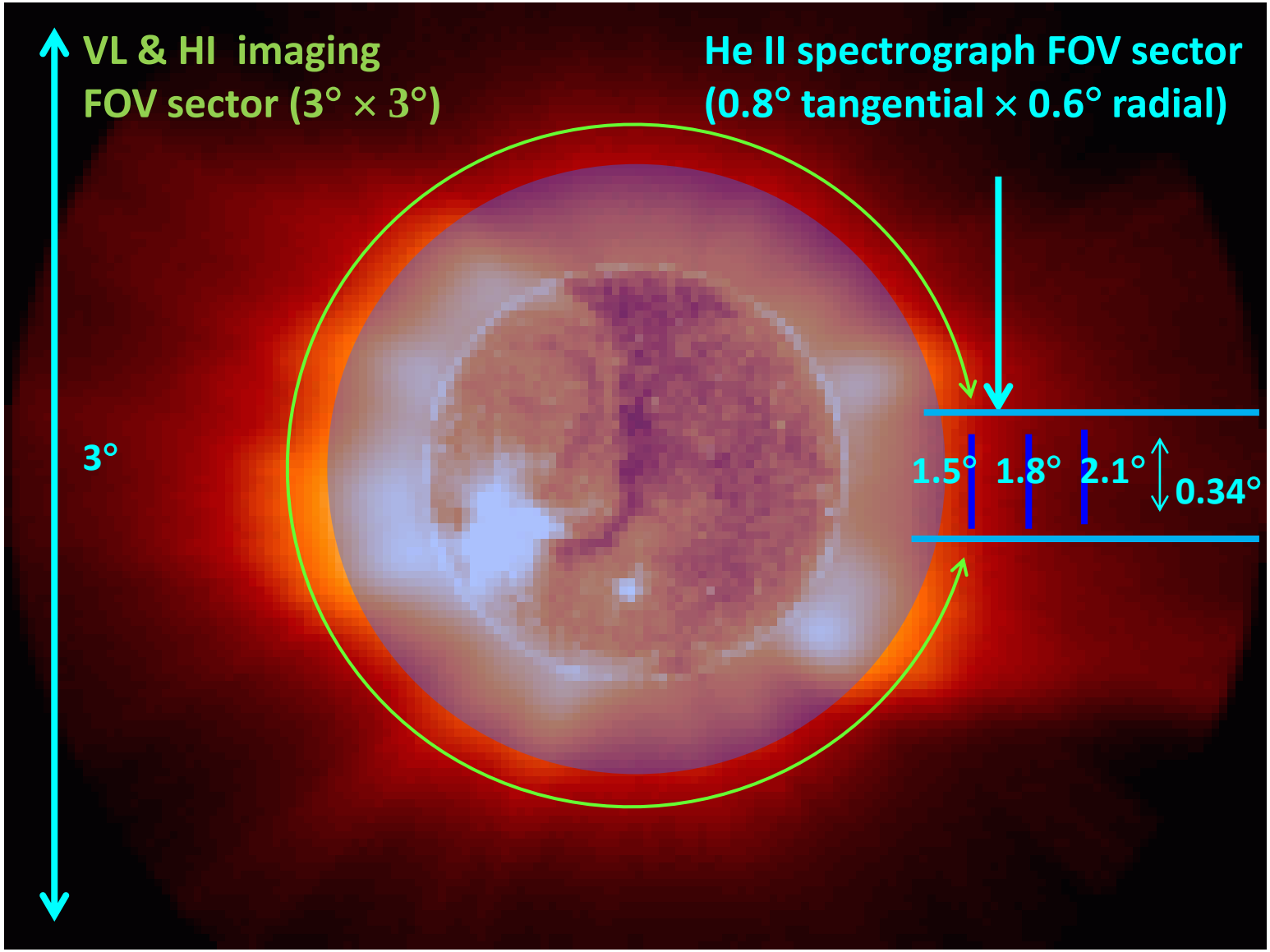
✓*2 channels*

✓*3 mechanisms*

+

✓*QM model*

METIS @ PDR	METIS DESCOPING July 2012
Coronal Imaging	*Coronal Imaging*
• VL imaging	• VL imaging
• UV (H) imaging	• UV (H) imaging
✓ EUV (He) imaging	• -
Coronal spectroscopy	*Coronal spectroscopy*
✓ UV (HI) spectroscopy	• -
• EUV spectroscopy	• EUV (He) spectroscopy
Mechanisms + relative subsystem	*Mechanisms + relative subsystem*
✓ Internal door + mechanism	• -
✓ Repointing mechanism	• -
✓ 2 EUV Al filter + filter mechanism	• -
• Internal occulter mechanism	• Internal occulter mechanism
• (Detector door mechanism)	• (Detector door mechanism)


VL & HI imaging
FOV sector (3° × 3°)
He II spectrograph FOV sector
(0.8° tangential × 0.6° radial)
3°
1.5°
1.8°
2.1°
0.34°

No External Re-Pointing Mechanism

No METIS observations at perihelion and in the southern obs. windows when S/C offpointing > 3 arcmin

However METIS best science is at perihelion

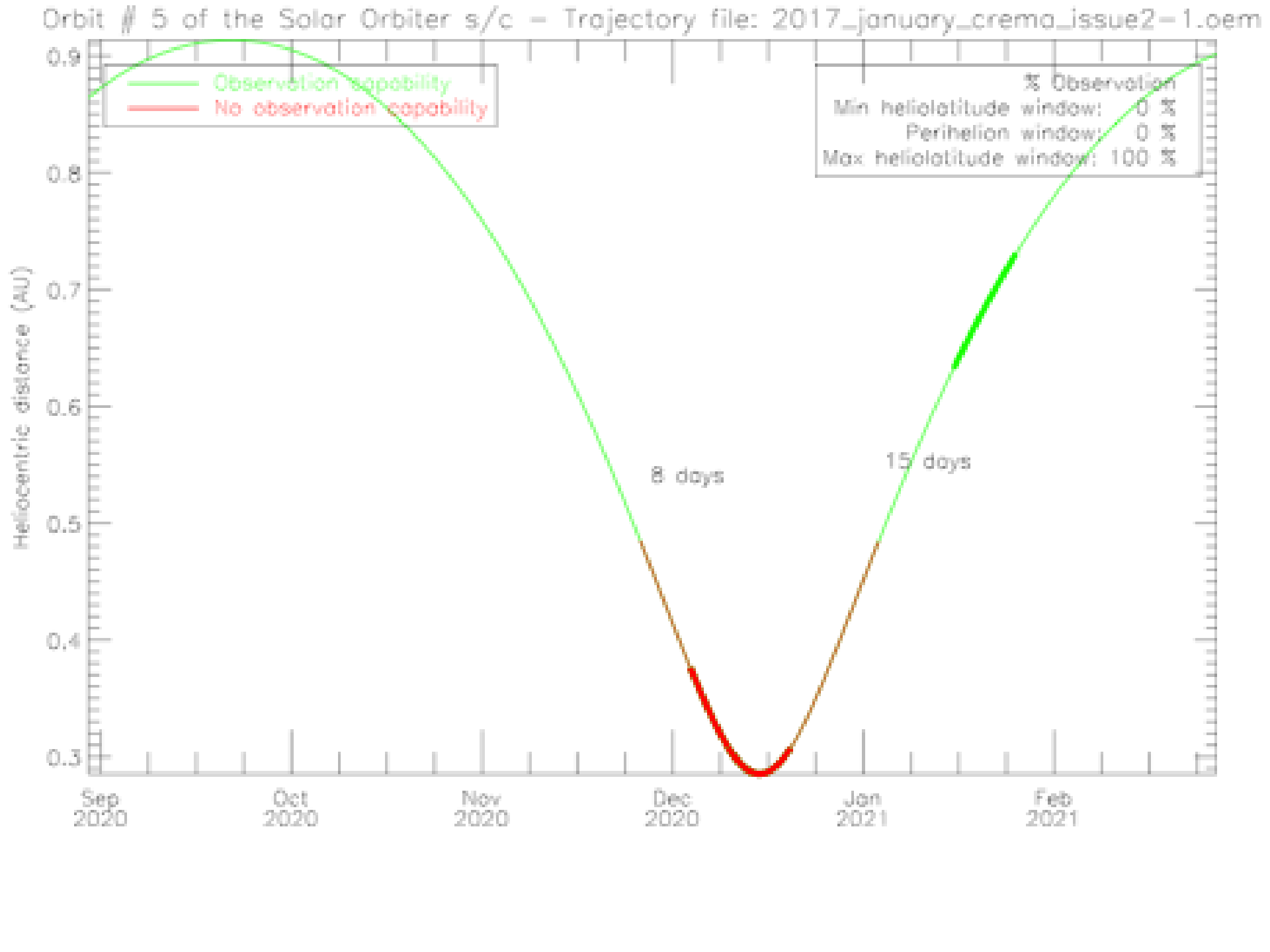
Corotation: unique opportunity for coronagraphic obs.

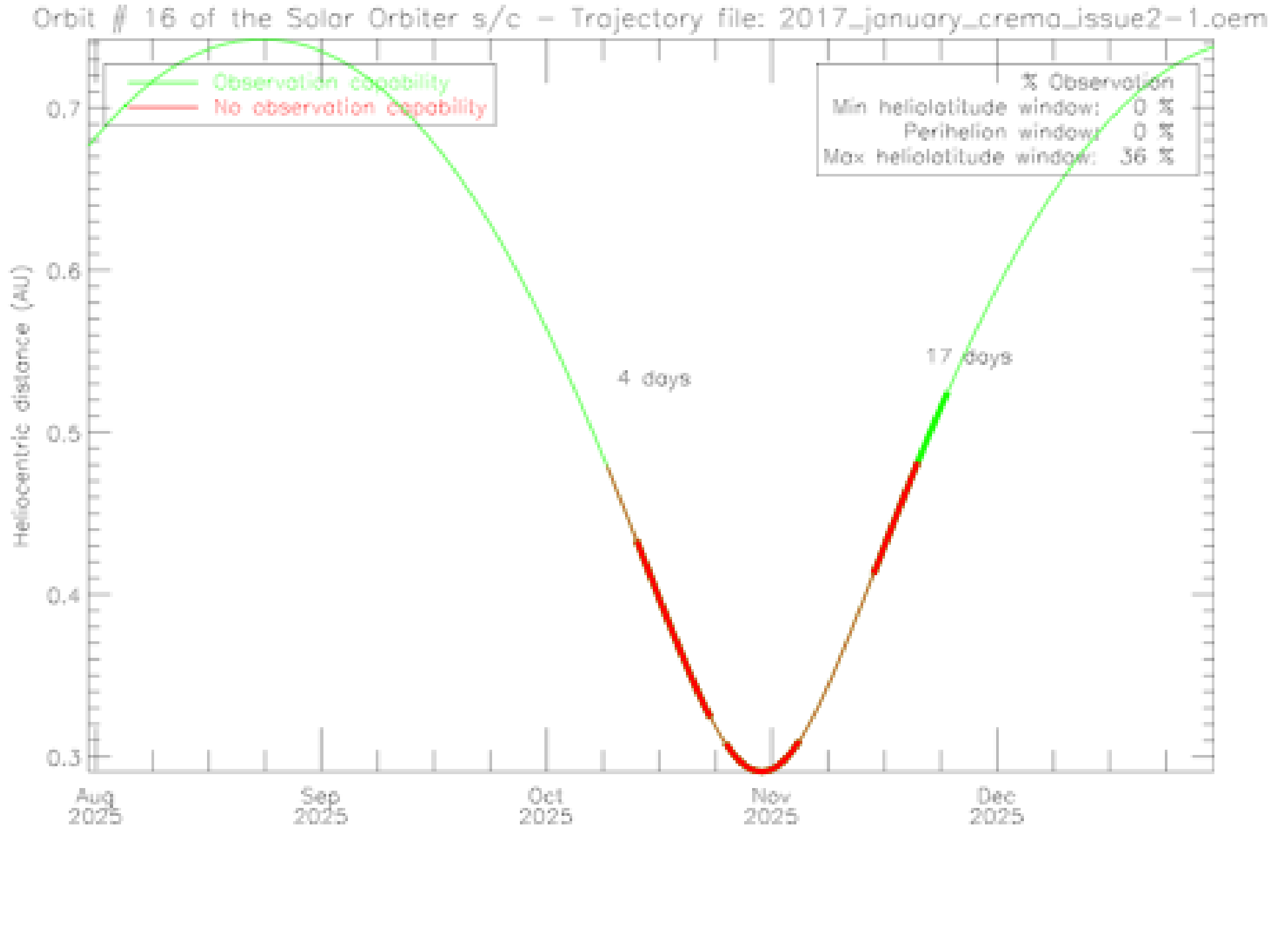
- Medium-term evolution of the corona (pre-CME evolution, etc.)
- Turbulence study

Joint SO science:

- CME flags (halo CMEs obs.in corona and detected by the in situ instruments)
- complementarity of the SO instruments: METIS observes the region linking the base of the solar atmosphere to the inner heliosphere.

CME science: without coronagraphic measurements??


Orbit # 5 of the Solar Orbiter s/c - Trajectory file: 2017_january_crema_issue2-1.oem
Observation capability
No observation capability
% Observation
Min heliolatitude window: 0 %
Perihelion window: 0 %
Max heliolatitude window: 100 %
8 days
15 days
Heliocentric distance (AU)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
Sep 2020
Oct 2020
Nov 2020
Dec 2020
Jan 2021
Feb 2021


Orbit # 16 of the Solar Orbiter s/c - Trajectory file: 2017_january_crema_issue2-1.oem
Observation capability
No observation capability
% Observation
Min heliolatitude window: 0 %
Perihelion window: 0 %
Max heliolatitude window: 36 %
4 days
17 days
Heliocentric distance (AU)
0.7
0.6
0.5
0.4
0.3
Aug 2025
Sep 2025
Oct 2025
Nov 2025
Dec 2025

November 2012Further Descoping

In view of a 30th of November approval by part of the ASI CdA

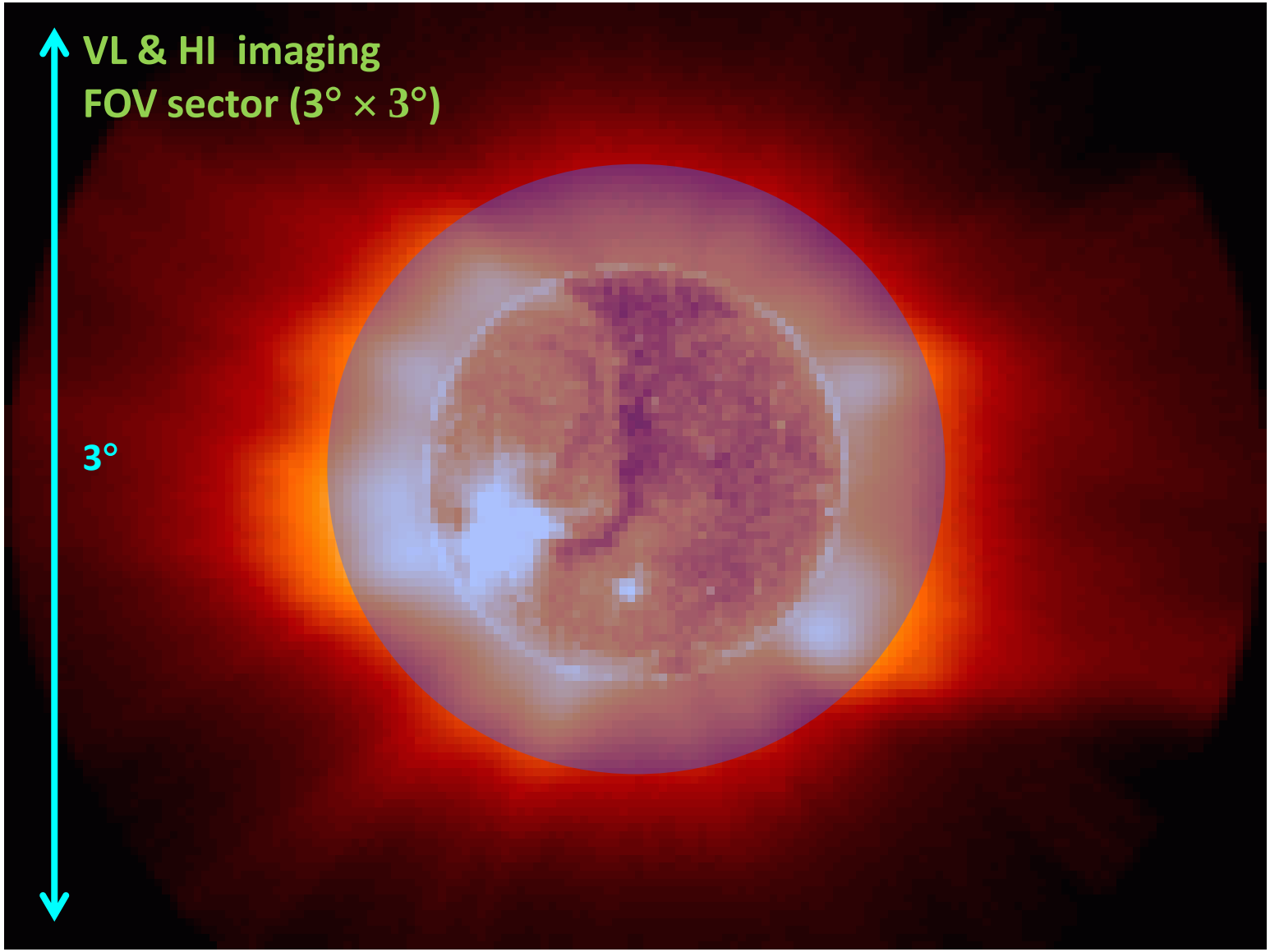
METIS configuration @ PDR
- *5 channels*
- *5 mechanisms*

in order to further reduce cost

Cancelled in order to reduce cost, complexity, mass and power
- ✓*2 channels + 1 channel*
- ✓*3 mechanisms (including ERM)*

+
- ✓*QM model*
- ✓*structural and thermal model*

METIS @ PDR	METIS DESCOPING 13 November 2012
Coronal Imaging	*Coronal Imaging*
• VL imaging	• VL imaging
• UV (H) imaging	• UV (H) imaging
• EUV (He) imaging	• -
Coronal spectroscopy	*Coronal spectroscopy*
• UV (HI) spectroscopy	• -
✓ **EUV spectroscopy**	• -
Mechanisms + relative subsystem	*Mechanisms + relative subsystem*
• Internal door + mechanism	• -
• Repointing mechanism	• -
• 2 EUV Al filter + filter mechanism	• -
• Internal occulter mechanism	• Internal occulter mechanism
• Detector door mechanism	• -


VL & HI imaging
FOV sector (3° × 3°)
3°

METIS @ PDR	METIS DESCOPING 6 December 2012
In view of 20 December CdA meeting	
Coronal Imaging	*Coronal Imaging*
• VL imaging • UV (H) imaging • EUV (He) imaging	✓ VL + UV imaging vs. VL imaging
Coronal spectroscopy	*Coronal spectroscopy*
• UV (HI) spectroscopy • **EUV spectroscopy**	• - • -
Mechanisms + relative subsystem	*Mechanisms + relative subsystem*
• Internal door + mechanism • Repointing mechanism • 2 EUV Al filter + filter mechanism ✓ Internal occulter mechanism • Detector door mechanism	• - • - • - • -

VL + UV Channels

Solar Orbiter Top-level Science Questions	**Unique METIS contribution (A+B)** The only Solar Orbiter instrument observing the:
How and where do the *solar wind plasma* and *magnetic field* originate in the corona	region where the solar wind is accelerated from ≈100 km/sec to near its asymptotic value
How do *solar transients* drive heliospheric variability	region where the first, most dramatic phase of the propagation of coronal mass ejections occurs
How do solar eruptions produce *energetic particle radiation* that fills the heliosphere	path of the shock front accelerating particles in the solar corona
How does the *solar dynamo* work and drive *connections between the Sun and the heliosphere*	overall magnetic configuration and discrimination of closed and open field regions of the corona

VL Channel

Solar Orbiter Top-level Science Questions	Unique METIS contribution (A)
How and where do the *solar wind plasma* and *magnetic field* originate in the corona	*No* information on the solar wind in corona
How do *solar transients* drive heliospheric variability	Observation of the region where the first, most dramatic phase of the propagation of coronal mass ejections occurs, however *no* information on the directionality of the eruption
How do solar eruptions produce *energetic particle radiation* that fills the heliosphere	Observation the path of the shock front accelerating particles in the solar corona, however *no* information on the directionality of the shock front
How does the *solar dynamo* work and drive *connections between the Sun and the heliosphere*	*No* information to discriminate closed and open magnetic field lines

METIS	Achievable Scientific Objectives	Solar Orbiter Core Science	METIS Contribution
UV&VL channel (A+B)	-Measure the electron density in the solar corona and its longitudinal distribution *Solar wind:* -Identify the coronal wind and measure its parameters: • velocity to discriminate fast and slow wind • acceleration to locate energy deposition in corona • mass and energy flux • longitudinal distribution -Observe the coronal density fluctuations, and assess their role in the acceleration of the solar wind -Trace, through the flows, the open coronal magnetic field and the overall magnetic topology *Coronal mass ejection:* -Measure the • timing • mass content • overall dynamics • directionality to infer its geo-effectiveness • longitudinal distribution of the plasma erupted from the Sun. -Identify the shock front where particles can be accelerated	Solar wind origin and acceleration Solar Coronal Mass Ejections origin and propagation Acceleration of energetic particles Solar dynamo (coronal magnetic configuration)	Unique, major new core science
VL channel (A)	-Measure the electron density in the solar corona and its longitudinal distribution *Coronal mass ejections:* -Measure the • timing • mass content • overall dynamics (partial) • longitudinal distribution of the plasma erupted from the Sun. -Identify the shock front where particles can be accelerated	Solar Coronal Mass Ejections origin and propagation Acceleration of energetic particles	Mainly context instrument moderate new science, mainly in late mission phase
UV channel (B)	As the VL channel but only in the static regions of the corona, which however *cannot be unambiguously identified* in UV coronal images		Negligible scientific return

Hypothesis.: No External Re-Pointing Mechanism

Best science at perihelion

High space resolution:

- *pxl = 5.6” (3.8” in VL) METIS* as from Earth orbit, compared to
- 3.75” COR-1
- 14.7” COR-2 STEREO
- 11.4” C2
- 56” C3 LASCO
- 7” UVCS (110 kg instrument)