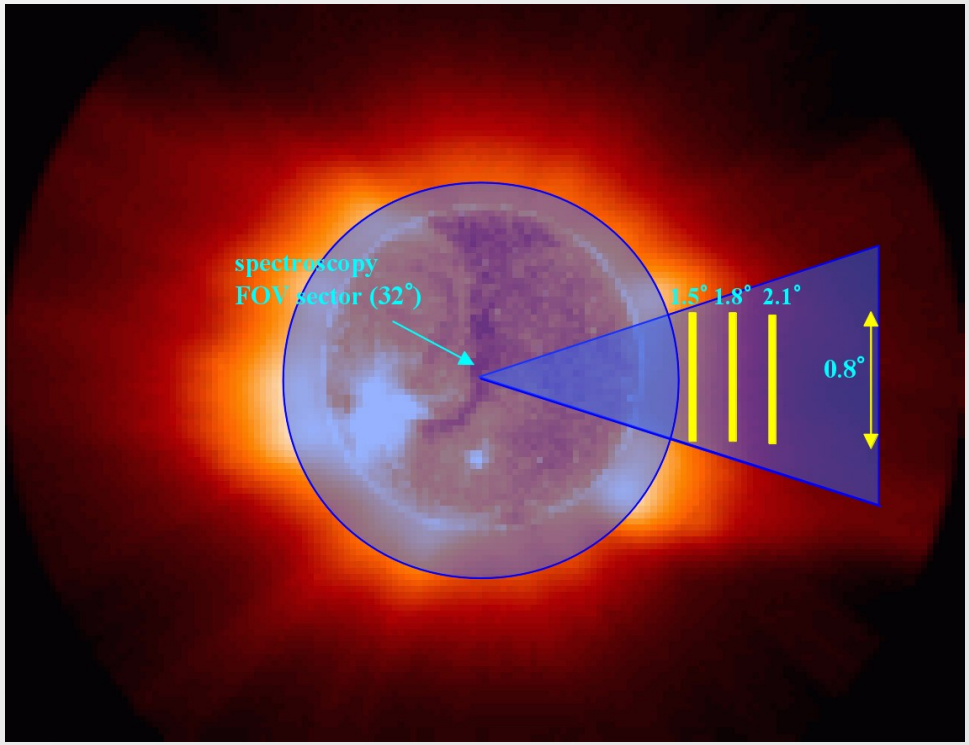
METIS Science Operations

V. Andretta

INAF – Osservatorio Astronomico di Capodimonte

METIS Instrument: Basics

- Three imaging channels:
  - Visible (polarimetry; bandpass: 580-640 nm)
  - UV (Ly-α; bandpass: 121.6 ± 10 nm; N.B.: → First time)
  - EUV (He II 30.4 nm + Si XI 30.3 nm; bandpass: 30.4 ± 2 nm)
- FOV: 1.5-3.0º (~1.6-3.2 R_{Sun} @0.28 AU).
- A spectroscopic sector with three fixed slits.
- Repointing mechanism (S/C off-pointing compensation).



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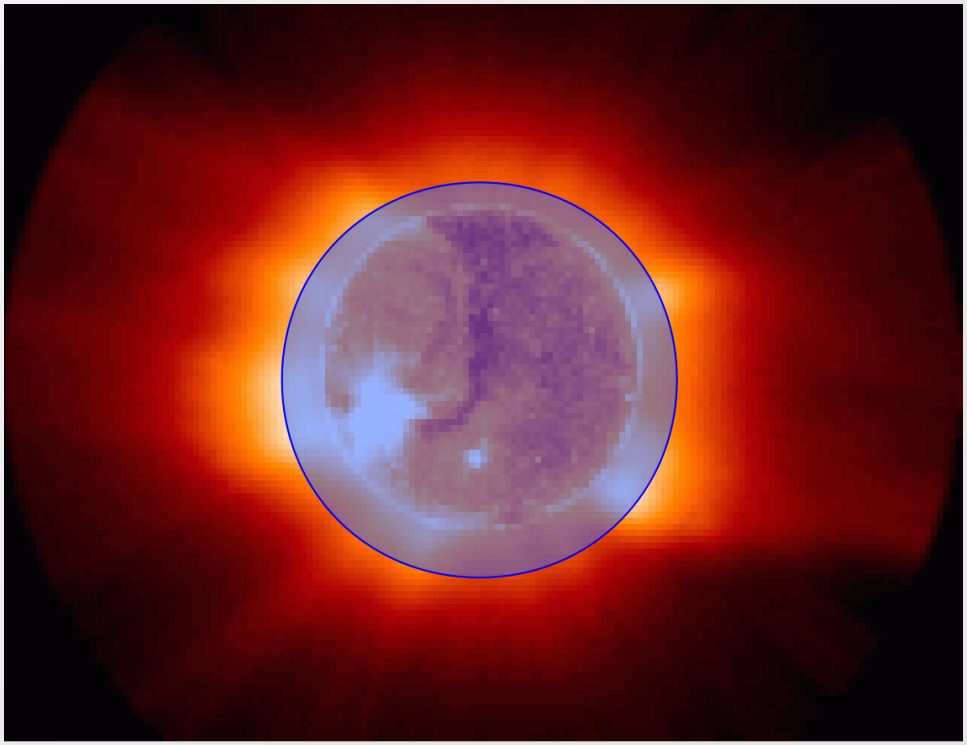

METIS Science: Before

Science Objective	Science Question		Cadence	Exposure time	Spatial Resol.	Field of View	Data Volume
A) Origins and acceleration of solar wind streams	A1) What is the mechanism of energy deposition in the fast wind?	**(Imaging)** Global maps of outflow velocities of H^0 and He^+ for determination of the maximum velocity gradients	270 min (VL+UV) 10 h (EUV)	VL 30-270 min UV 15-60 min EUV 9-15 h	40"	1.5°-2.9° annular; off-limb corona	0.19 Gb/ 5 days (VL+UV) 0.02 Gb/ 5 days (EUV)
		(Spectroscopy) Intensity and profile of H^0 and He^+ Ly-α lines for determination of line-of-sight velocity distribution and outflow velocity			45"	1.5°-2.1° 32° sector off-limb corona	Already included in the imaging data volume
	A2) What is the solar origin of solar wind turbulence?	**(Imaging)** Measure time series of velocity and brightness of solar wind features (coronal holes, streamers, etc.) /best during *corotation*	0.5 min	VL 0,5 min UV 0,5 min	20"- 40"	1.5° - 2.9° annular, off-limb corona	4.5 Gb/5h (VL+UV)
	A3) What is the role of magnetic topology in controlling the wind speed?	Global maps of outflow velocities of H^0 and He^+ and He absolute abundance to test velocity composition correlation /best during *corotation*	30 min (alternate VL+UV and EUV)	VL 0.5 min UV 2 min EUV 10-30 min	20"	1.5° - 2.9° annular; off-limb corona	8.6 Gb/ 10 days
	A4) What are the sources of the slow solar wind?	Maps of outflow velocities, and absolute densities of H^0 and He^+ along streamer/hole interfaces, above streamer cusp /best during *corotation*	120 min (alternate VL+UV and EUV)	VL 2 min UV 5 min EUV 120 min	20"	1.5° - 2.9° annular; off-limb corona	2,1 Gb/ 10 days

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Higher SNR / Higher cadence

METIS Science: Before

Science Objective	Science Question		Cadence	Exposure time	Spatial Resol.	Field of View	Data Volume
B) Sources, acceleration mechanism and transport processes of SEPs	B1) How are SEPs produced by CMEs and their associated shocks?	**(Imaging)** Global maps of e^- density in pre-CME coronal ambient, H^0 and He^+ velocities, multi-wavelength UV intensities, combined with radio observations, for deriving ionization states in shocks	10 min	VL 2 min UV 1min EUV 10 min	20"	1.5° - 2.9° annular, off-limb corona	2,6 Gb/1 day
		(Spectroscopy)H^0 Ly-α line profile /best for perihelion ≤ 0.3 AU			45"	1.5°-2.1°-32° sector off-limb corona	
	B2) How are SEPs accelerated in flares?	Detection and timing of CMEs to help distinguishing flare-accelerated SEPs from those associated with CMEs.	10 min	VL 2 min UV 1min EUV 10 min	40"	1.5° - 2.9° annular, off-limb corona	1,3 Gb/ 1 day

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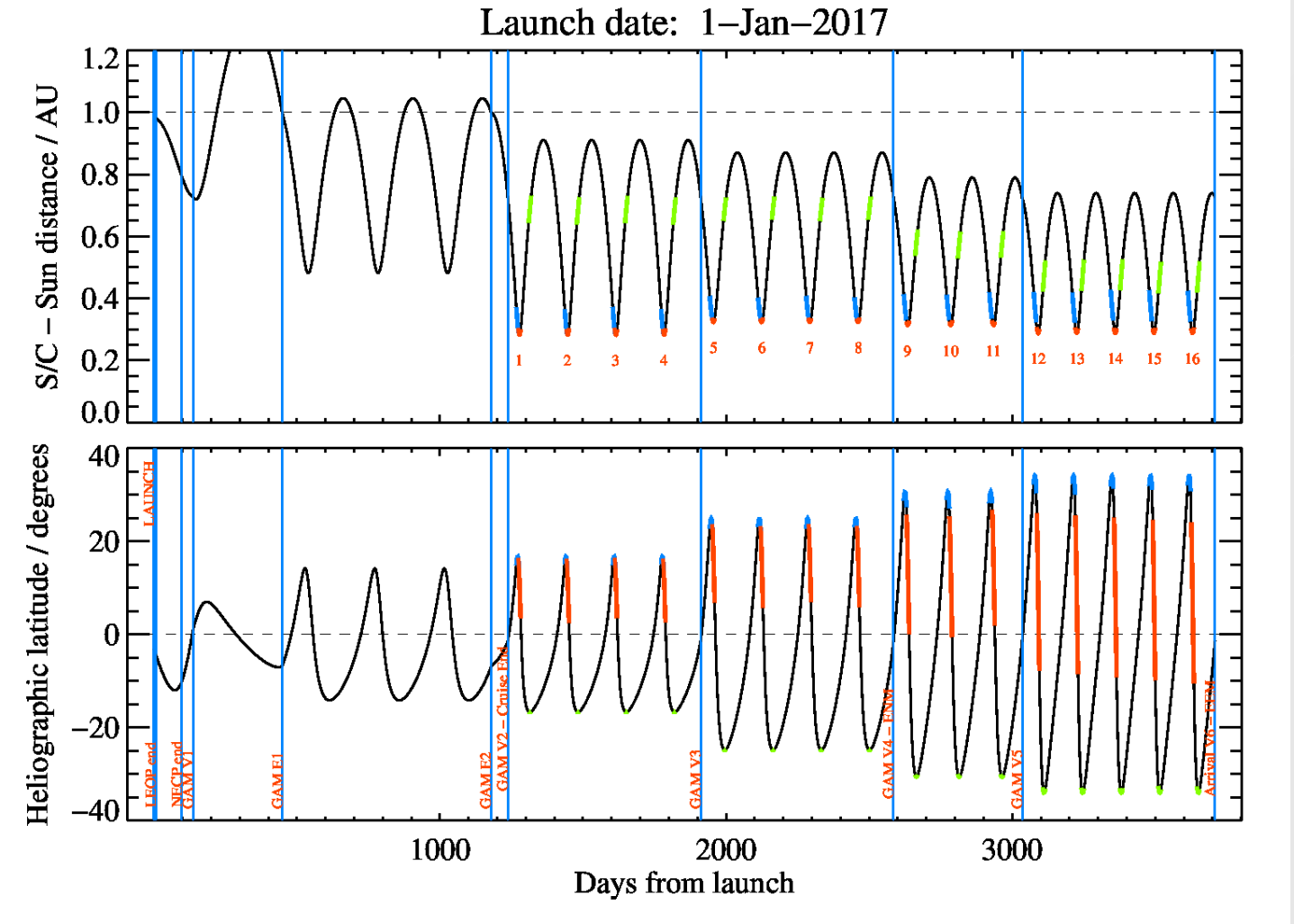
METIS Science Operations: Basics

Like the post-descoping Traceability Matrix
Work in progress...

Solar Orbiter Mission Profile

Overview of orbital parameters (January 2017 launch)



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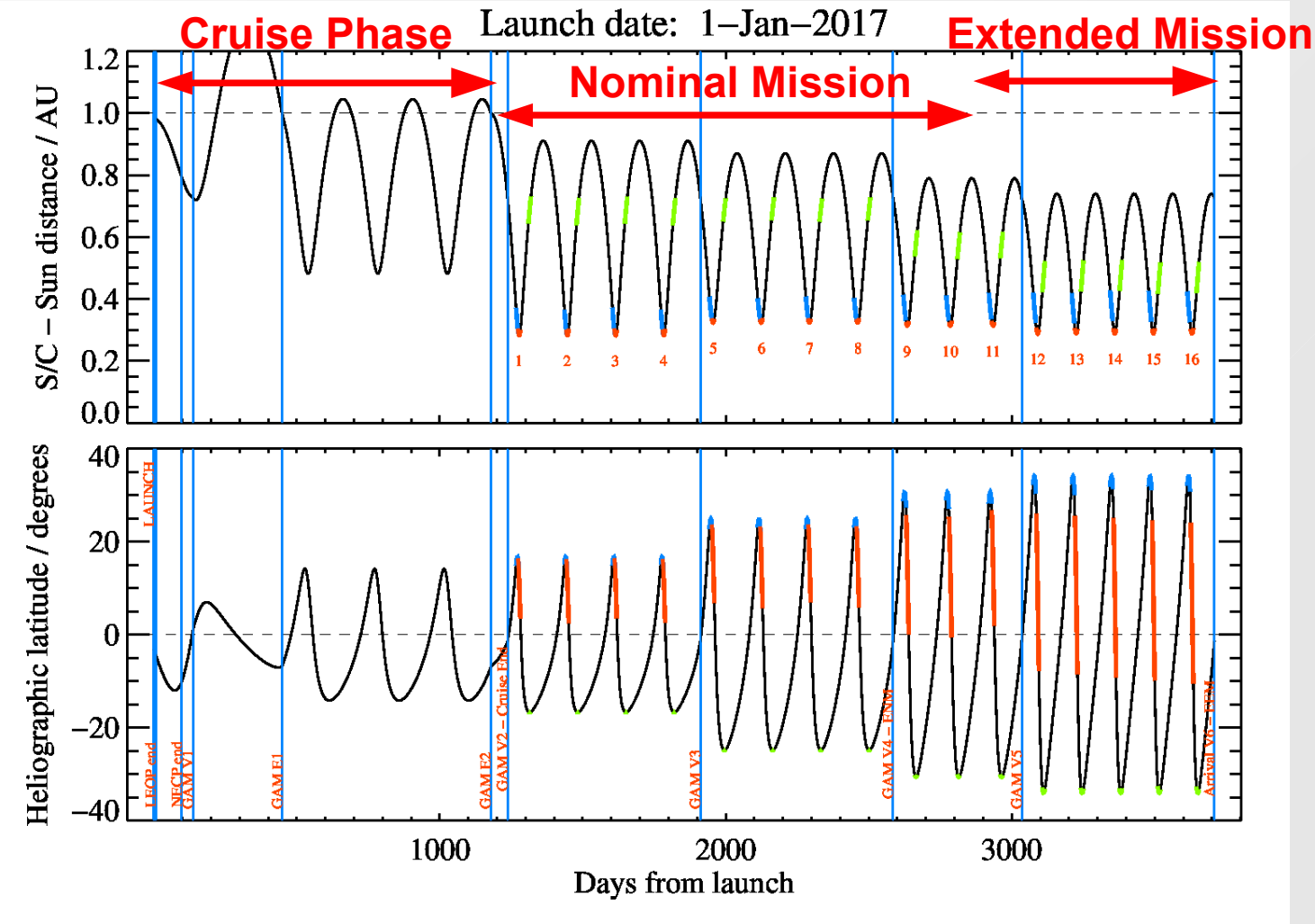
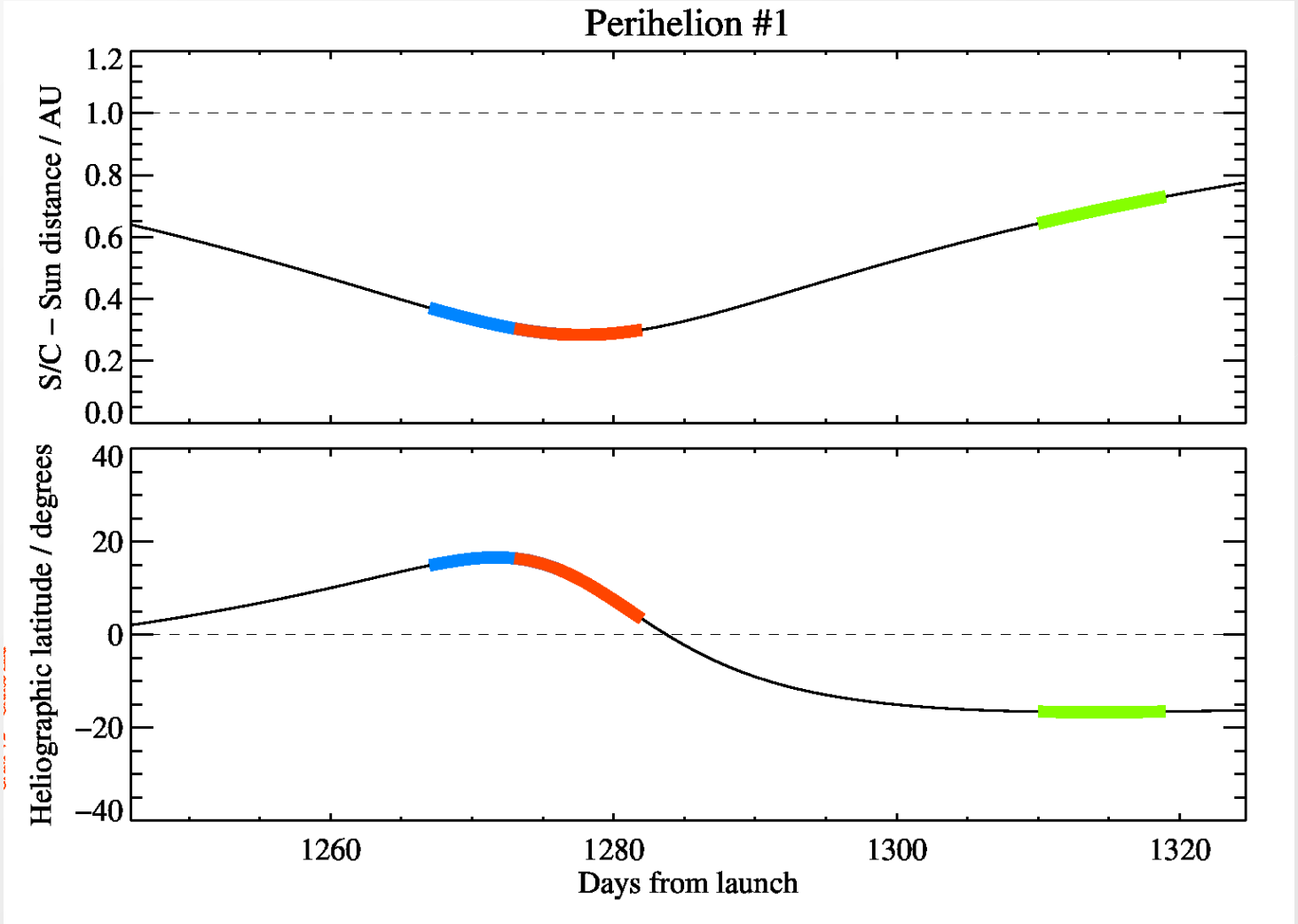


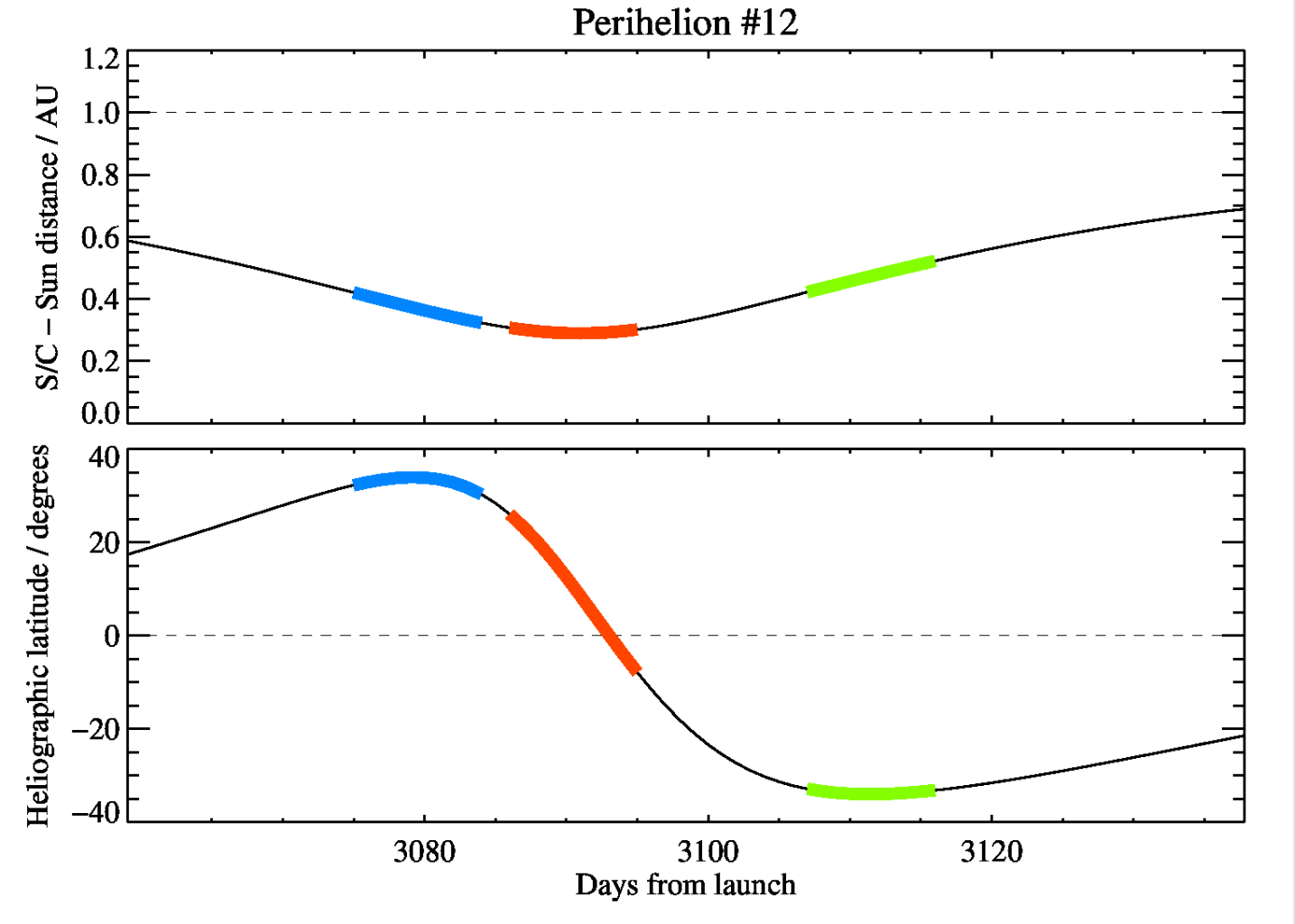
Solar Orbiter Mission Profile

The first science orbit (close perihelion)



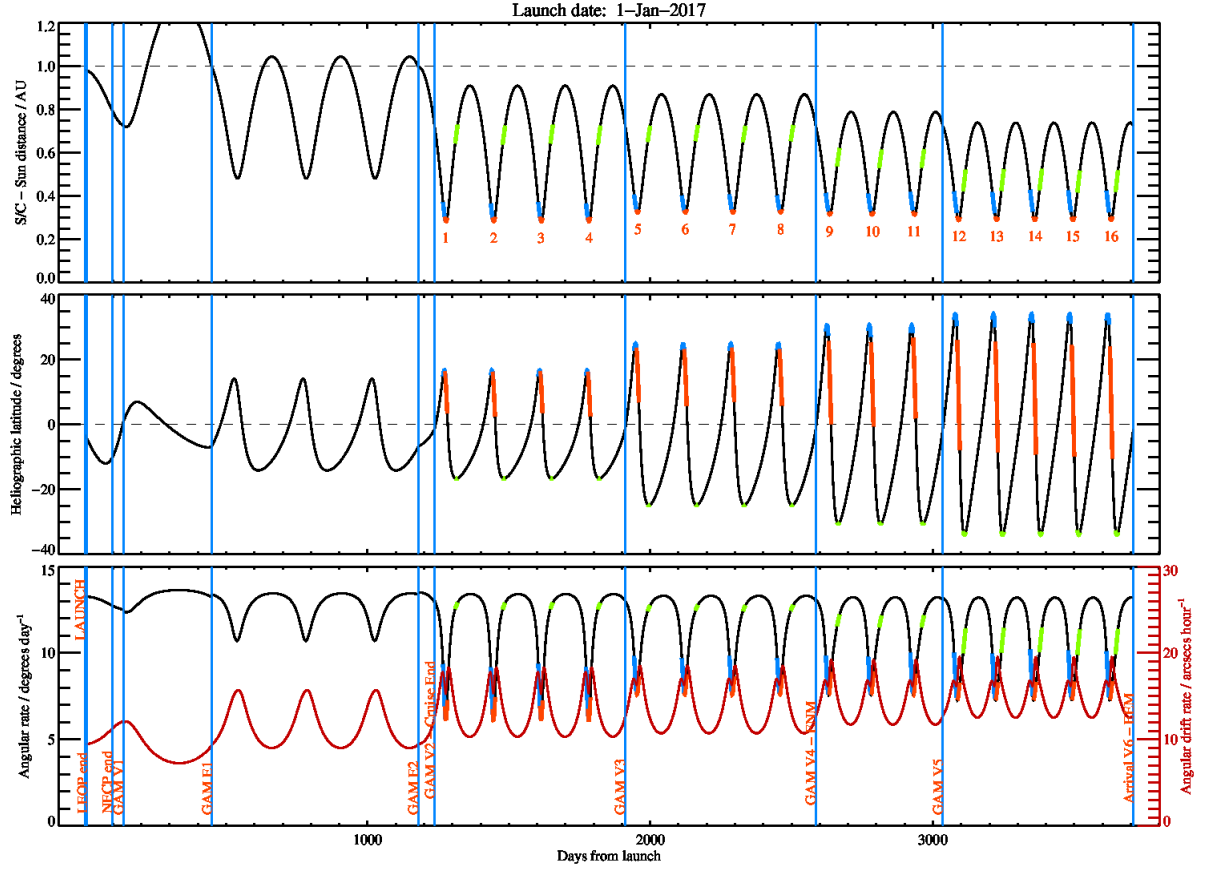
Solar Orbiter Mission Profile

A high inclination orbit (polar view)



Solar Orbiter Mission Profile

(Quasi) Corotation (**N.B.:** Solar internal rotation rate: 14°/day or 13°/day from Earth; equatorial drift from Earth: ~10”/hour.)



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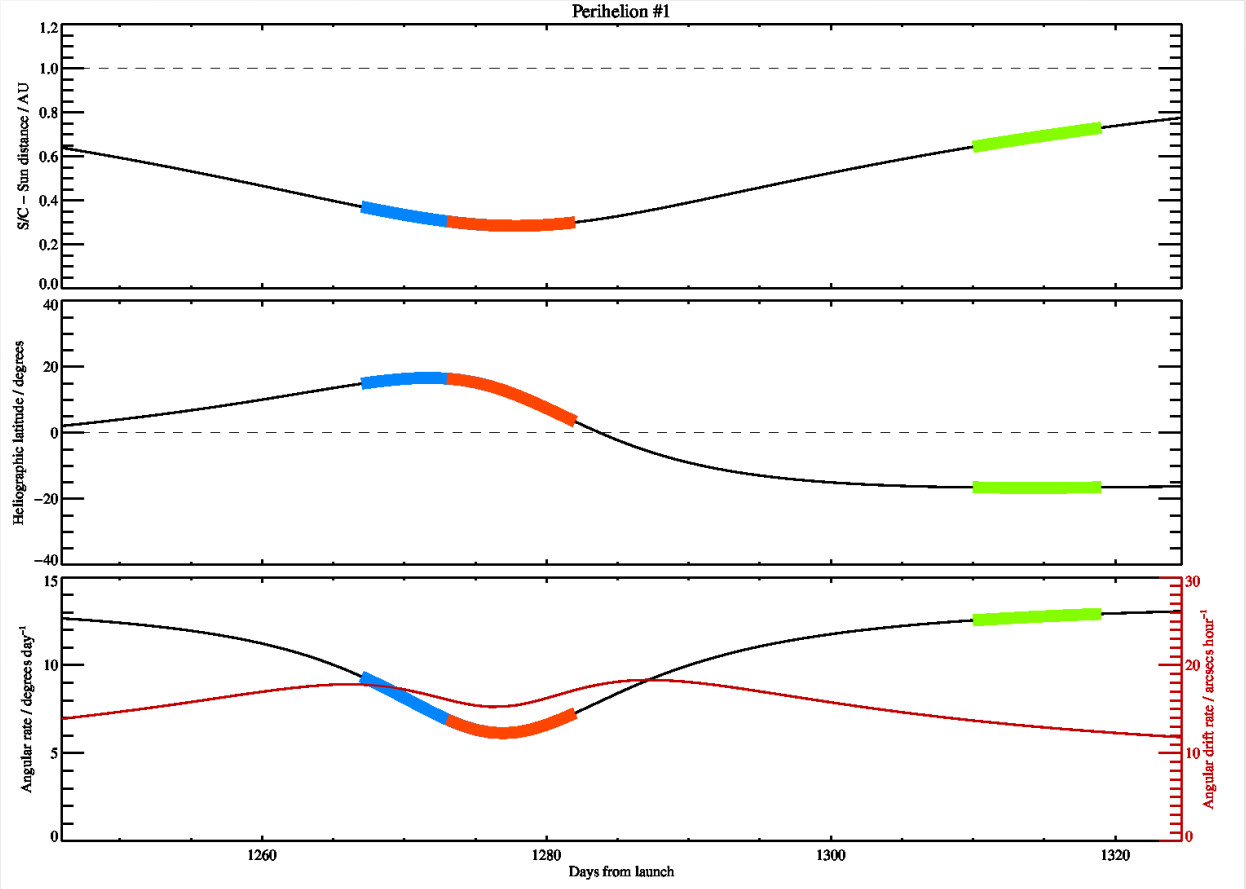
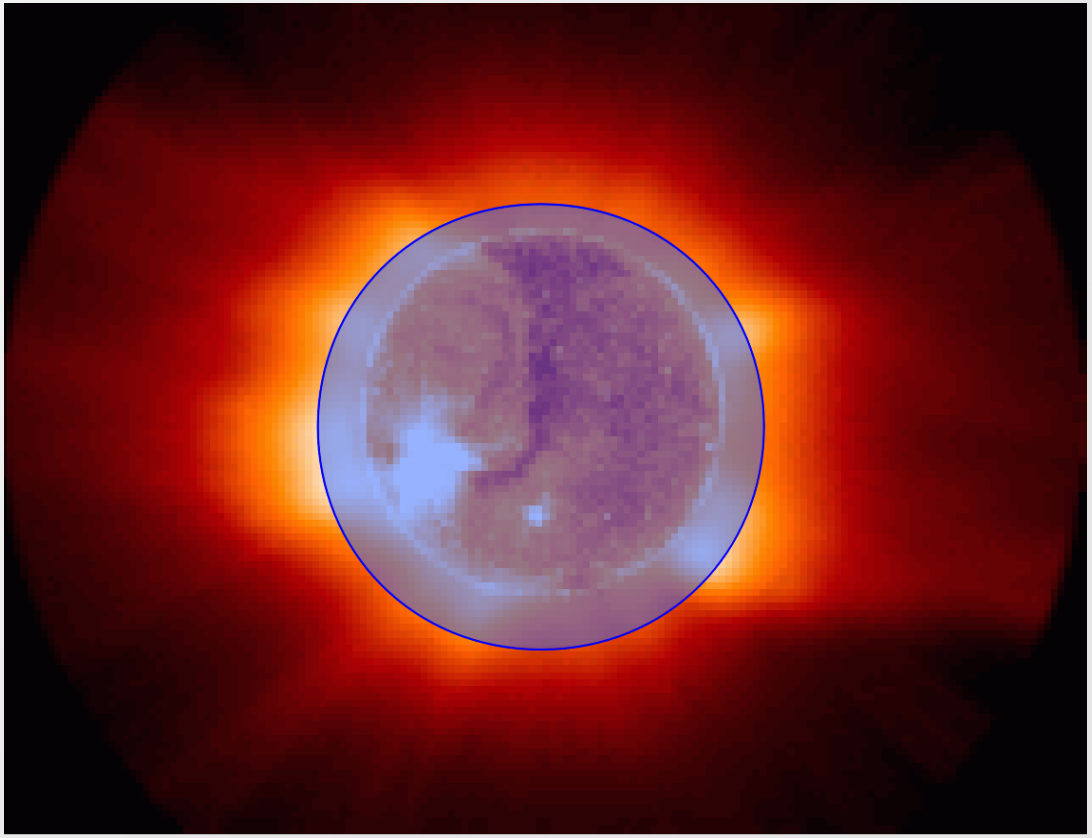


Constraints on METIS Operations

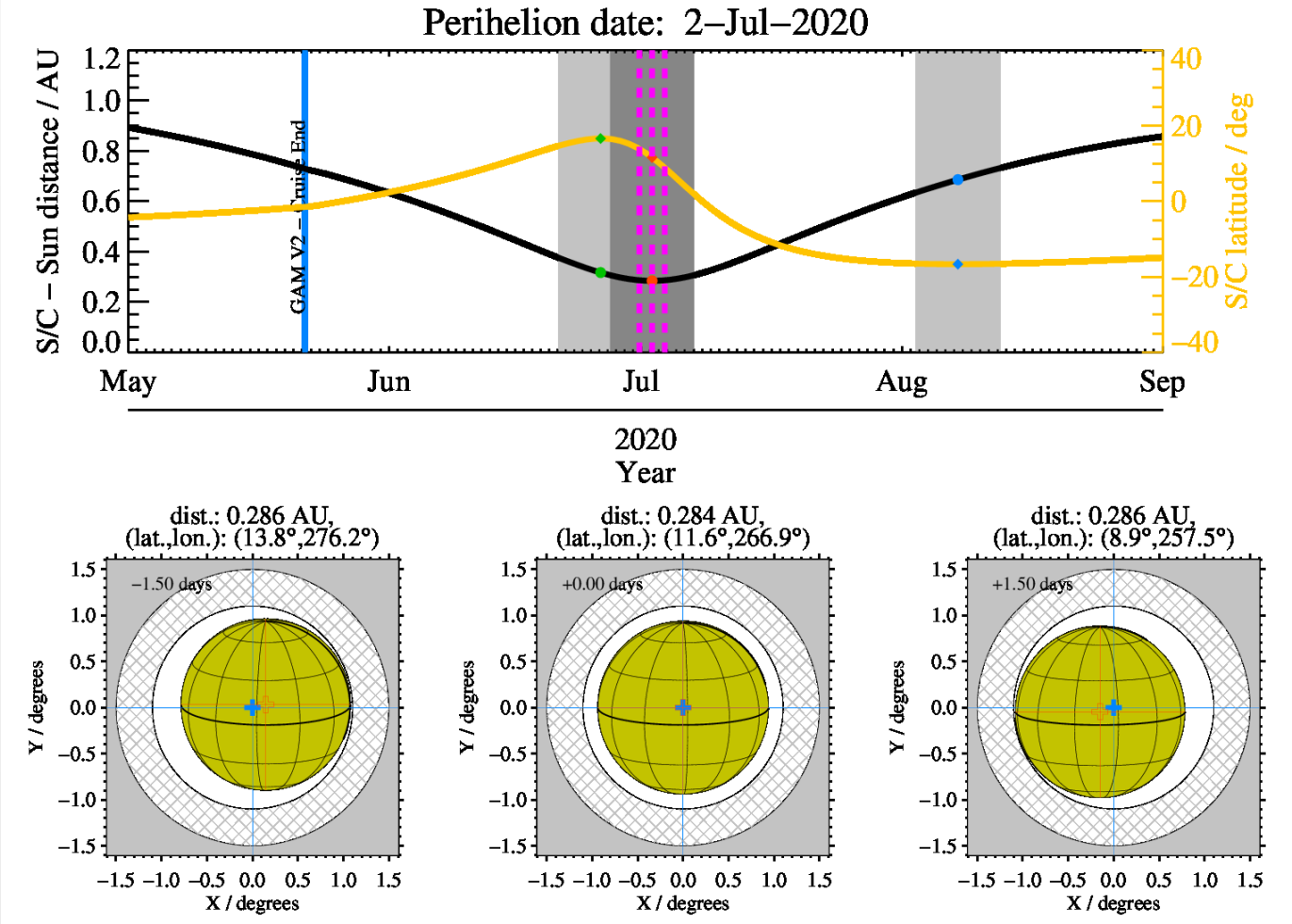
No pointing compensation mechanism: METIS can operate only when S/C pointing at disk center. At perihelion, even small offsets can produce excessive / asymmetric straylight, or even damage the instrument.



N.B.: Must take into account also the size of the occulter (1.1º), and the S/C pointing parameters, particularly the Absolute Pointing Error requirement (<3.5')

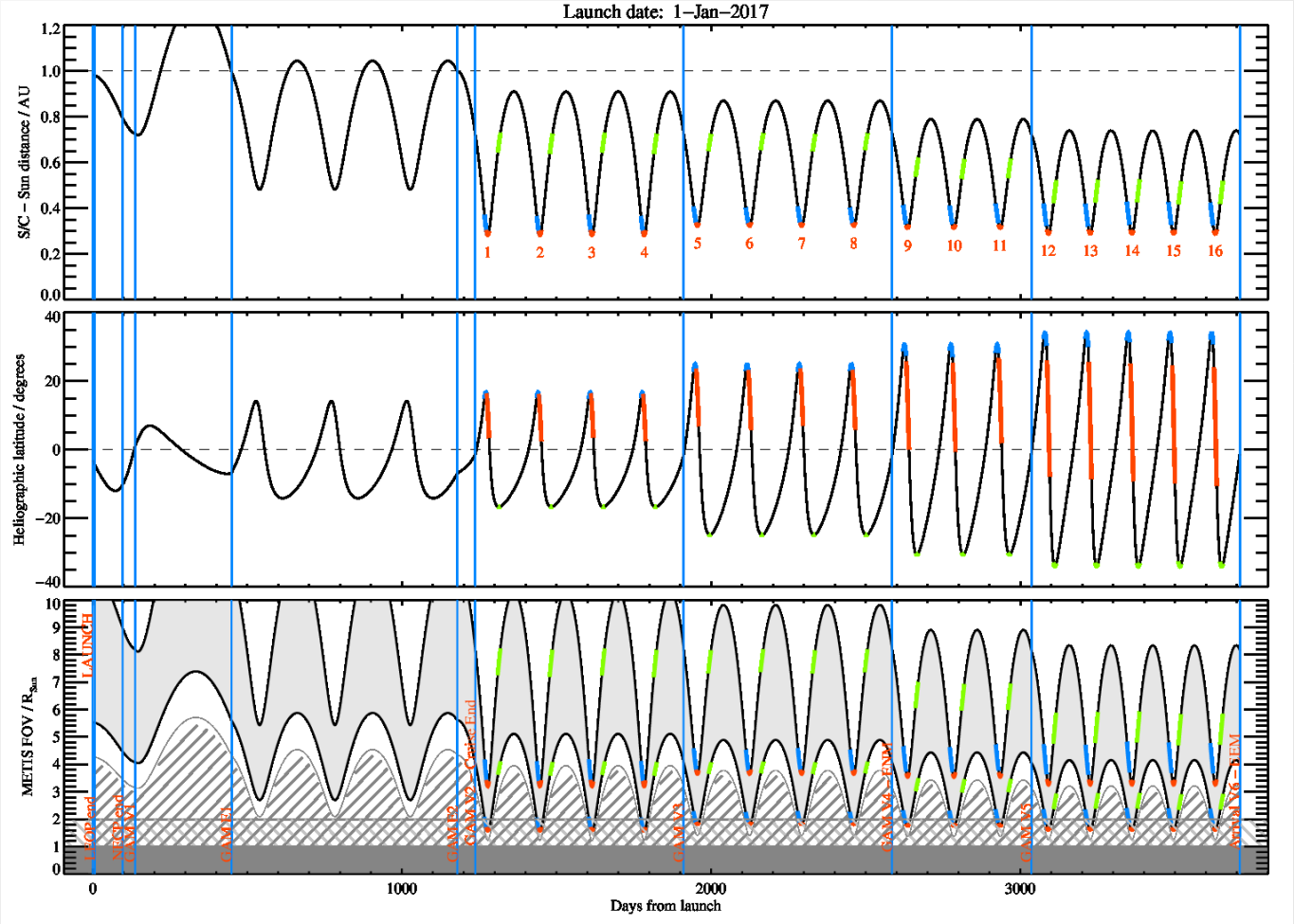
Constraints on METIS Operations: Feature Tracking

An example of the effect on METIS of S/C tracking of a solar feature during the first science window:



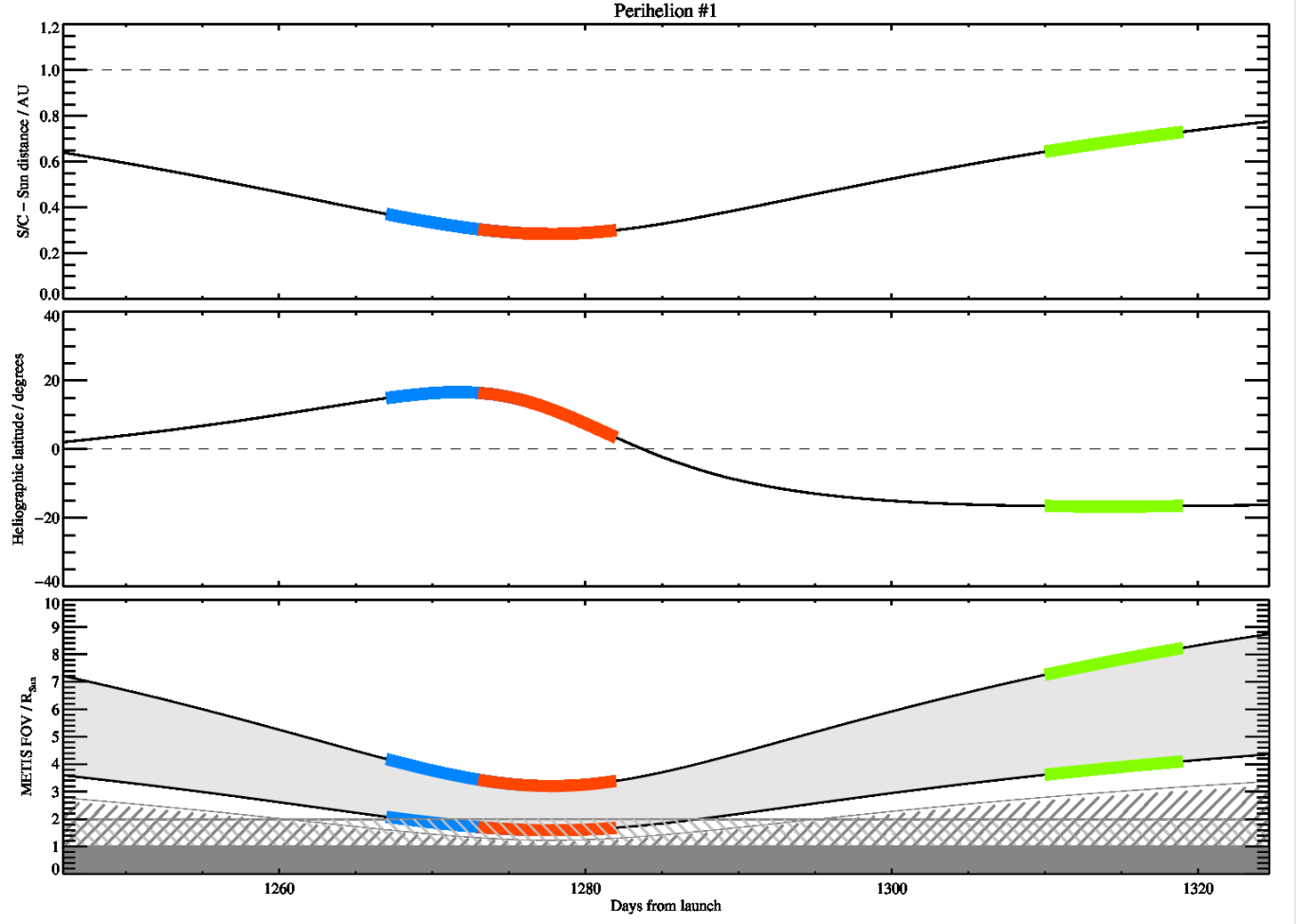
Constraints on METIS Operations: Safe Operations

Variation of the METIS FOV during the mission (hatched area: METIS occulter size+S/C APE and r=2 R_{Sun}):



Constraints on METIS Operations: Safe Operations

Variation of the METIS FOV during the the first science windows:



METIS Science and Operations in the New Configuration

Implications of the loss of He II imaging and of the spectroscopic channel:

- An obvious loss of science, in new, discovery space, as well as lost opportunities for joint science with other instruments (EUI, for instance).
- However, the instrument can be optimized to enhance the performances of the surviving channels (higher SNR further away in the corona, higher cadences).
- *(Note: in a broad sense, the lost channels did not critically depend on the some of peculiar Solar Orbiter mission profile: some of the lost science could be recovered by other near-Earth or even sub-orbital instruments.)*

METIS Science and Operations in the New Configuration

The loss of the off-pointing compensating mechanism has on the other hand heavy consequences on the possibility of exploiting some of the unique opportunities afforded by the Solar Orbiter mission profile, especially at perihelia:

- Observations close to the Sun and, simultaneously, quasi-corotation

Such opportunities will never be available again from any other mission in the foreseeable future. Hence, coordination with other RS instruments is becoming even more crucial than before.

Coordinated Observations: Flags

- Event flags via Service 20 Instrument intercommunication link:
  - Input: Flare/Eruptive prominence flag (STIX, EUI): would trigger a CME tracking, higher cadence sequence
  - Output: CME flag, issued for other Remote Sensing (RS) instruments
- Details of foreseen information to be provided to other instruments:
  1) Flag description and detection algorithm:
     - *Broadcasting two flags: the first one to signal a CME entering METIS FOV, the second to signal CME exiting METIS FOV.*
     - *Adaptation of currently employed algorithms (from e.g. SOHO/LASCO or STEREO/SECCHI)*
  2) Flag information provided in the Service-20 link
  3) Total size: 35 bits