



L'instrument METIS: objectifs
scientifiques, opérations, données

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METIS contribution to SoLo science

SoLo: How and where do the solar wind plasma and magnetic field originate in the corona?

METIS: origin and acceleration of the fast and slow solar wind streams.

SoLo: How do solar transients drive heliospheric variability?

METIS: ejection of CMEs and its evolution in the inner heliosphere

SoLo: How do solar eruptions produce energetic particle radiation that fills the heliosphere?

METIS: origin, acceleration and transport of SEPs

SoLo: How does the solar dynamo work and drive connections between the Sun and heliosphere?

METIS: overall magnetic open/closed configurations of the corona

METIS: Understanding cometary properties and evolution

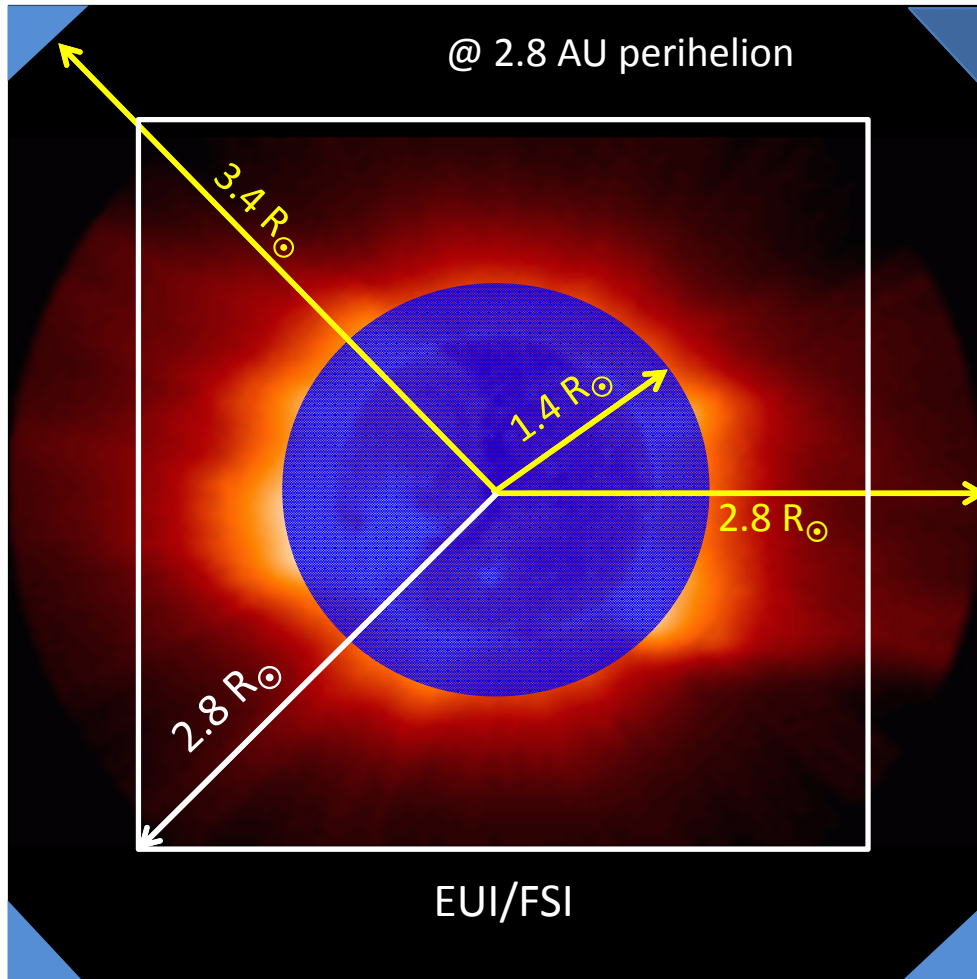
METIS measurements

METIS will perform off-limb and near-Sun coronagraphy

For the first time:

- Simultaneous imaging of the full corona in polarized VL (580-640 nm) and narrow-band UV H I-Ly α (121.6 nm)
 - ➔ Global maps of coronal emission
 - characterization of the major plasma components of the corona and the solar wind, i.e., electrons and protons:
 - ➔ e^- , H density, outflow velocity of H
- Spatial resolution \sim 2000 Km @0.28 AU

METIS performances



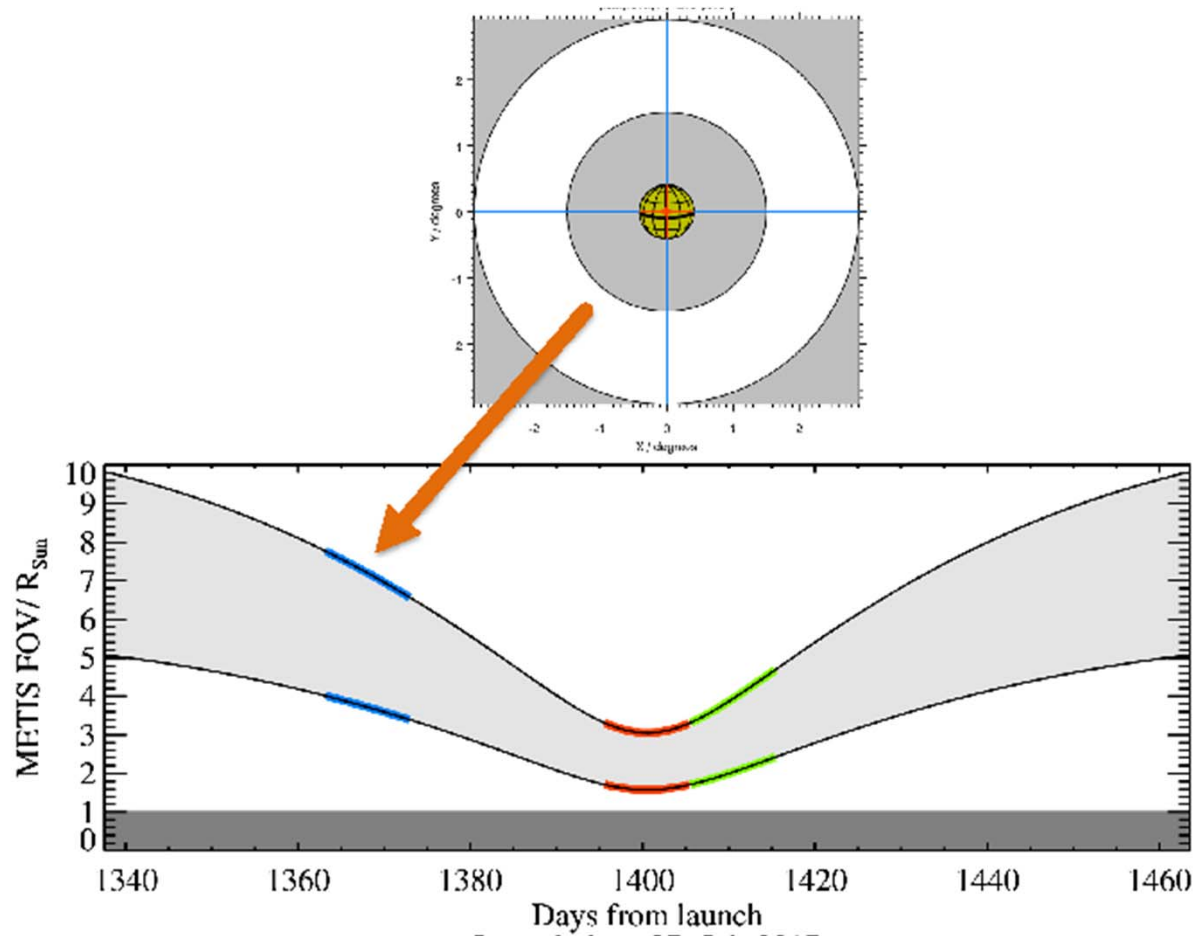
Wavel. range:	VL: 580-640 nm UV: 121.6±10 nm
Spatial Plate Scale	VL: 10'' UV: 20''
Field of view	1.5° - 2.9° annular, off-limb Corona

- Partial common FOV with EUI/FSI
- SoloHI extends the METIS FOV

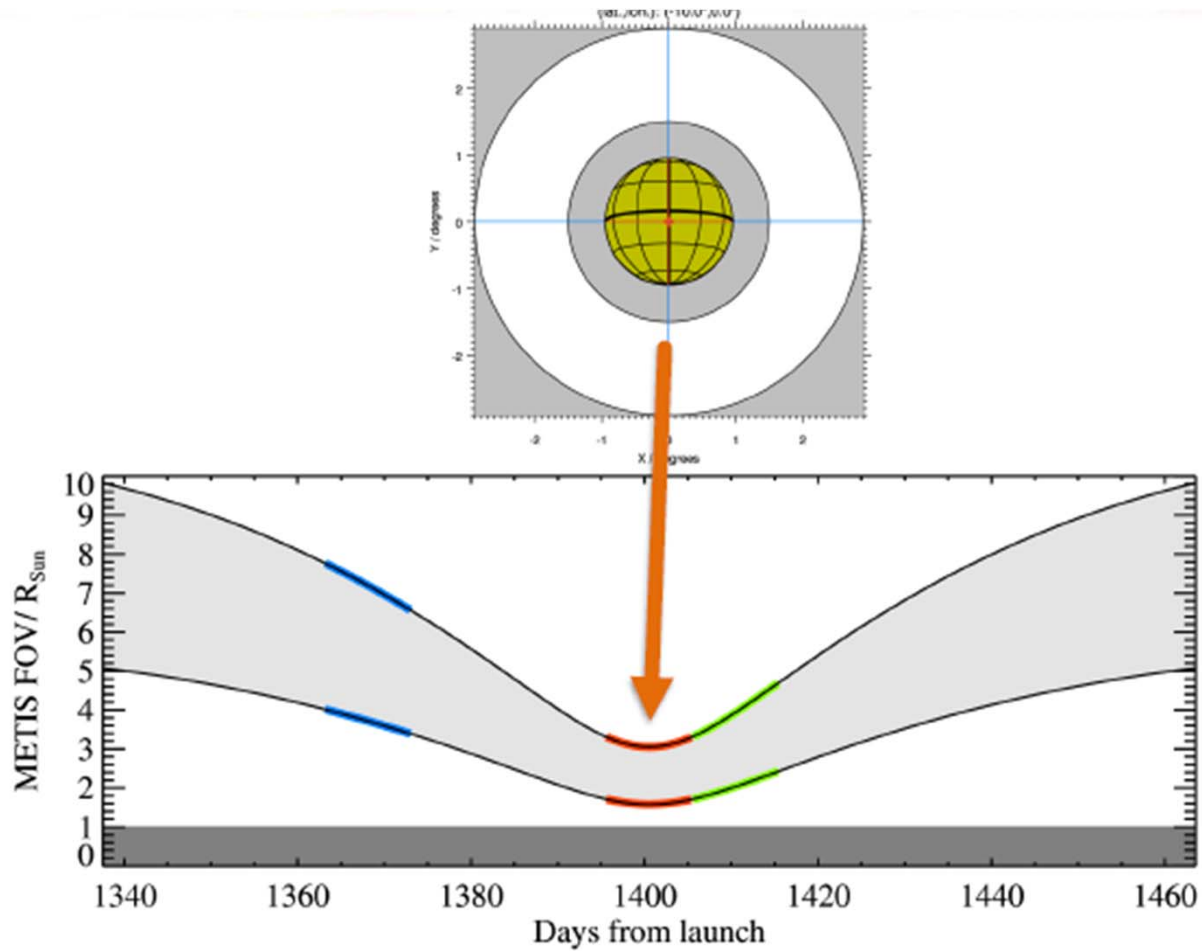


METIS provides key data for the link between the source regions and the heliosphere

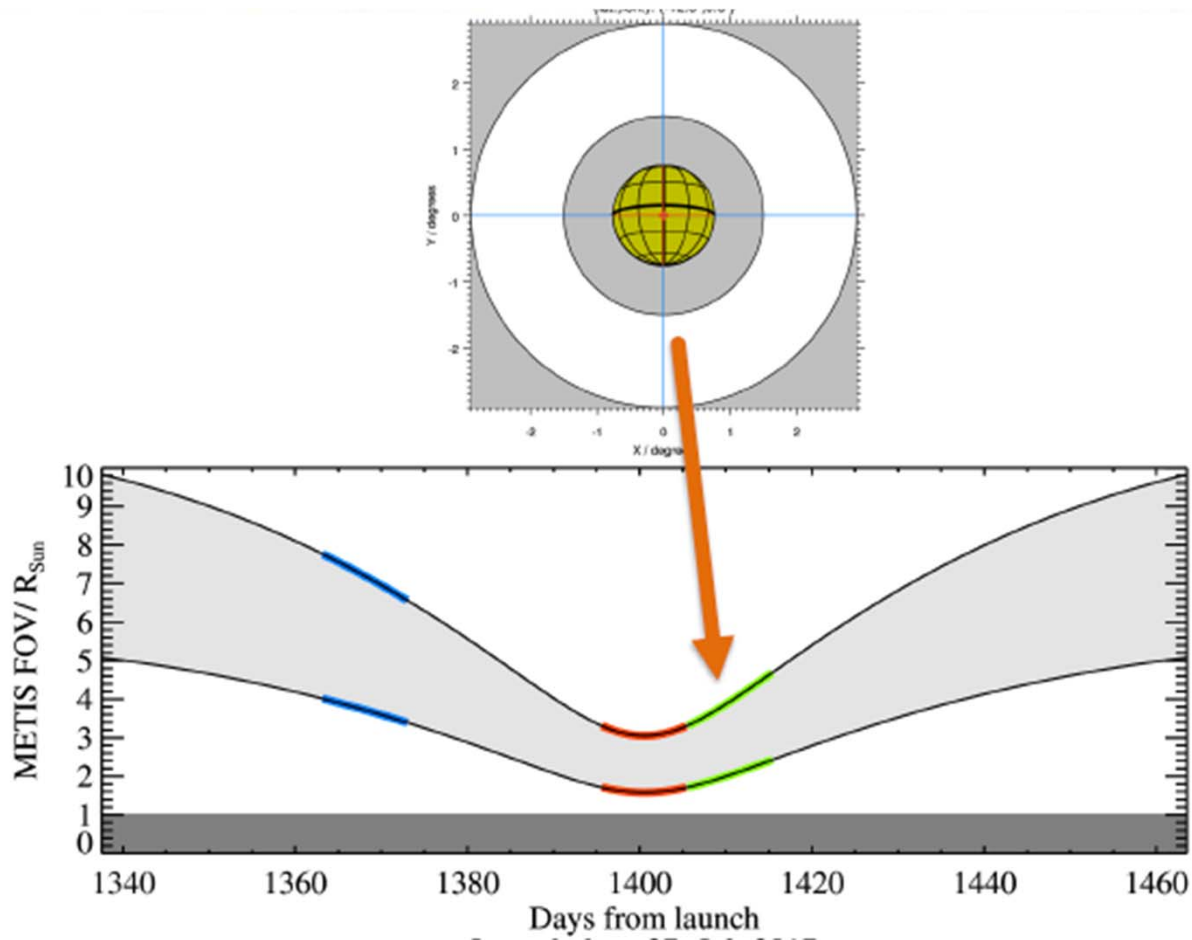
Field of view & zoom effect



Field of view & zoom effect



Field of view & zoom effect



METIS Observing Modes

Name	Purpose
WIND	Measurement of the electron density and the solar wind outward expansion velocity.
MAGTOP	Wind outflow velocity measurements and relationship with the magnetic topology.
GLOBAL	Global corona configuration/evolution measurements before, during and after CME events.
LT-CONFIG	Long-term evolution of the coronal configuration.
FLUCTS	Brightness fluctuations spectra (observations taken at fixed polarization).
CMEOBS	CME propagation, related driven shocks and filamentary structures, SEP accelerated by CMEs.
COMET	Mapping the emission of Sun-grazing comets.
PROBE	Coordinated observations with Solar Probe Plus (SPP).

METIS Observing Modes: STANDARD

Mode	Electron density measurement and solar wind velocity	Slow wind source regions (magnetic topology)	Global corona configuration/ evolution during CME events	Long-term evolution of the coronal configuration	
Name	WIND	MAGTOP	GLOBAL	LT-CONFIG	
Science Sect.	3.1.1 – 3.1.2	3.1.4 – 3.1.5	3.3.1	3.3.2	
Global maps	- UV H I Ly- α emission - polarized VL in the range 580-640 nm				
Spatial Plate Scale	20" – 40"	20"	20" – 40"	40"	
FoV (binning, pxl)	1.6 – 5 R _⊙ (2x2 ≤ 2.5° 4x4 > 2.5°)	1.6 – 5 R _⊙ (2x2)	1.6 – 3.0 R _⊙ (@ 0.28 AU) (2x2 ≤ 2.5° 4x4 > 2.5°) 5.1 – 9.8 R _⊙ (@ 0.9 AU) (2x2 ≤ 2° 4x4 > 2°)	1.6 – 3.0 R _⊙ (@ 0.28 AU) (4x4) 5.1 – 9.8 R _⊙ (@ 0.9 AU) (4x4)	
VLD	T_{ACQ} = DIT	15 – 20 s	15 s	15 – 30 s	15 – 30 s
	T_{EXP}	75 – 450 s	75 – 300 s	75 – 450 s	300 – 450 s
	N_{POL}	4	4	4	4
	T_{CAD}¹	5 – 30 min	5 – 20 min	5 – 30 min	20 – 30 min
UVD	DIT²	1 – 60 s ³			
	T_{ACQ}	1 – 600 s			
	T_{EXP}	5 – 30 min	5 – 20 min	5 – 30 min	20 – 30 min
	T_{CAD}¹	5 – 30 min	5 – 20 min	5 – 30 min	20 – 30 min
CR removal	YES	YES	YES	YES	
CME flag	ON	ON	ON	ON	
Data volume⁴	12.01 Mb	19.83 Mb	12.01 – 8.06 Mb	4.99 – 4.99 Mb	

¹ Time required to get a full set (4) of VL science images plus 1 UV science image.

² In Photon Counting Mode the typical DIT is 0.1 s.

³ Values valid in Analogue Mode only.

⁴ For a full set (4) of VL science images plus 1 UV science image (see Sect. 5.1.1).

METIS Observing Modes: SPECIAL

	Mode	Brightness fluctuations spectra	CME driven shocks and SEP (filamentary structure)	Mapping the emission of Sungrazing comets	Coordinated observations with Solar Probe Plus (SPP)
	Name	FLUCTS	CMEOBS	COMET	PROBE
	Science Sect.	3.1.3	3.2.1 - 3.3.1	3.4.1	3.3.1 – 3.3.2
	Global maps	- UV H I Ly- α emission - polarized VL in the range 580-640 nm			
	Spatial Plate Scale	10'' – 20''	10'' – 20''	20'' – 40''	20'' – 40''
	FoV (binning, pxl)	1.6 – 3.0R _⊙ (@ 0.28 AU) (2x2 ≤ 2° 2° < 1x1 ≤ 2.5° 2x2 > 2.5°)	1.6 – 10 R _⊙ (2x2 ≤ 2° 2° < 1x1 ≤ 2.5° 2x2 > 2.5°)	1.6 – 10 R _⊙ (2x2)	1.6 – 10 R _⊙ (2x2)
VLD	T_{ACQ} = DIT	1 – 10 s	15 s	15 – 20 s	15 – 30 s
	T_{EXP}	1 – 10 s	15 – 75 s	75 – 300 s	75 – 450 s
	N_{POL}	1 (fixed)	4	4	4
	T_{CAD}¹	1 – 10 s	1 – 5 min	5 – 20 min	5 – 30 min
UVD	DIT²		1 – 60 s ³		
	T_{ACQ}		1 – 600 s		
	T_{EXP}	---	1 – 5 min	5 – 20 min	5 – 30 min
	T_{CAD}¹	---	1 – 5 min	5 – 20 min	5 – 30 min
	CR removal	NO	NO if N _{ACQ} = 1 YES if N _{ACQ} > 1	YES	YES
	CME flag	OFF	OFF	ON	ON
	Data volume⁴	8.38 Mb (VL)	35.62 Mb	19.83 Mb	19.83 Mb

¹ Time required to get a full set (4) of VL science images plus 1 UV science image. In the case of the “FLUCTS” mode, to get 1 VL science image only.

² In Photon Counting Mode the typical DIT is 0.1 s

³ Values valid in Analogue Mode only

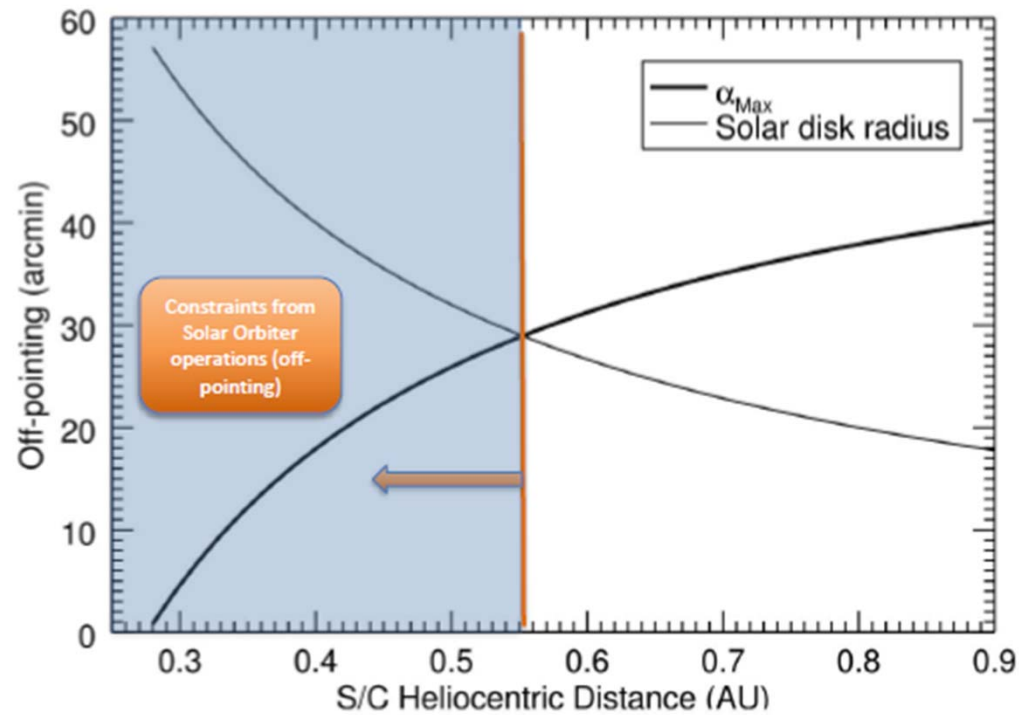
⁴ For a full set (4) of VL science images plus 1 UV science image (see Sect. 5.1.1). In the case of the “FLUCTS” mode, 1 VL science image only.

METIS & SOLOHI

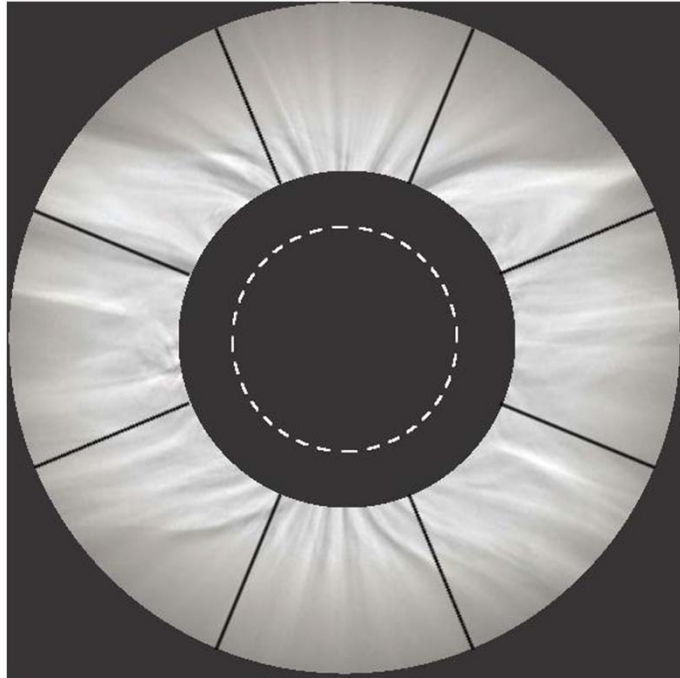
METIS & SOLOHI

(courtesy A. Vourlidas & S. Fineschi)

S/C off-pointing angles



METIS CME flag



METIS reaction to the flag:
CMEOBS replaces the ongoing plan

- Running differences of images
- Re-binned to single values in pre-determined sectors
- Threshold in Intensity
- Selection rules based on the polarization angle set when taking that images
- The relevant packet is sent to the other instruments through service 20
 - Information: sector, time, halo CME
- No use of other instruments flag (TBD)

Data products: METIS quick-look data

METIS low-latency (quick look) data normally consists (TBC) in:

- VL polarized images, at two orthogonal LCVR polarization angles;
- UV image.

Only if a selective downlink mechanism is implemented for the mission, and an event is detected :

- 4 VL polarized images, at four different LVCR polarization angles;
- 1 UV image.
- 1 or two CME “snapshots”, consisting in:
 - VL image taken during the event;
 - CME light curves, 1 for each sector of the FOV, for the duration of the event observations.

These data are processed by a special pipeline (“proxy pipeline”)

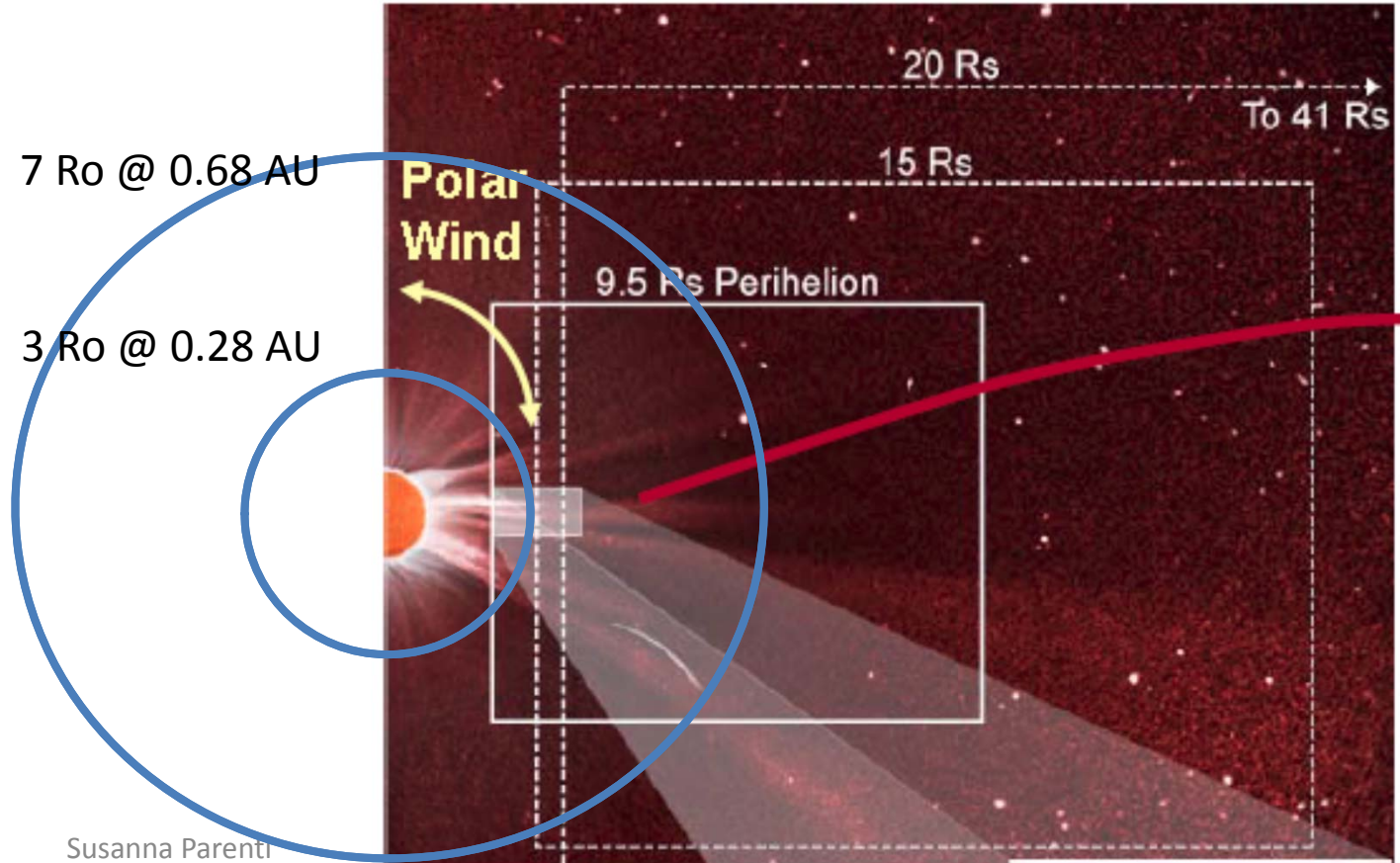
Scientific data products

Scientific and calibration products will be processed by the science data pipeline and published using the following scheme:

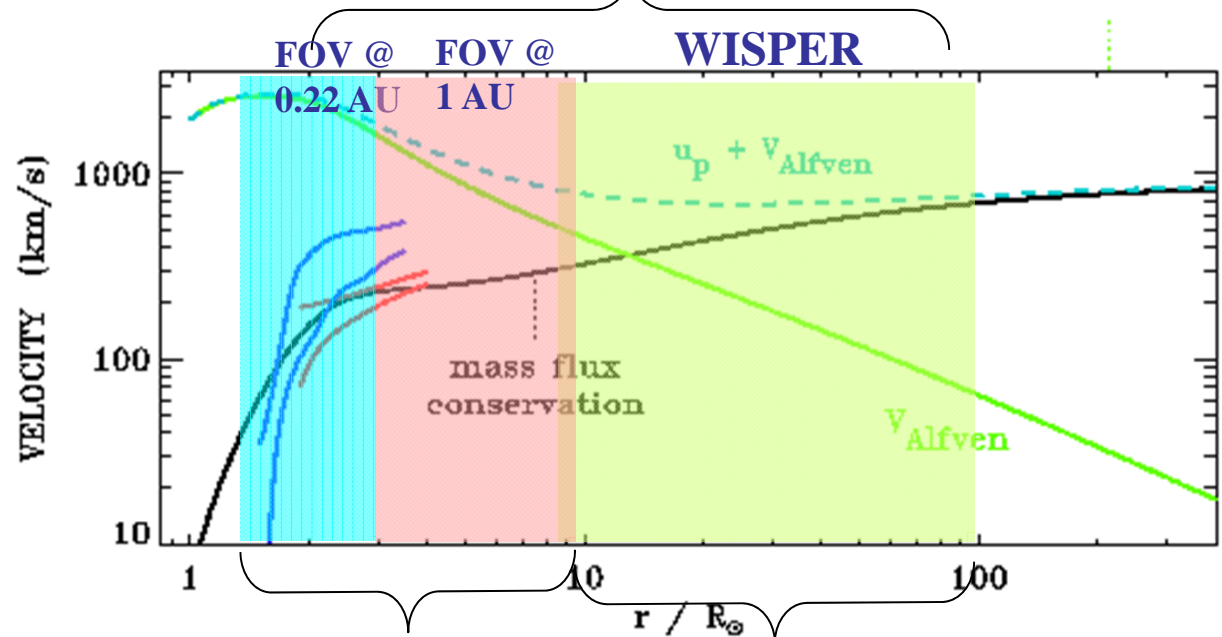
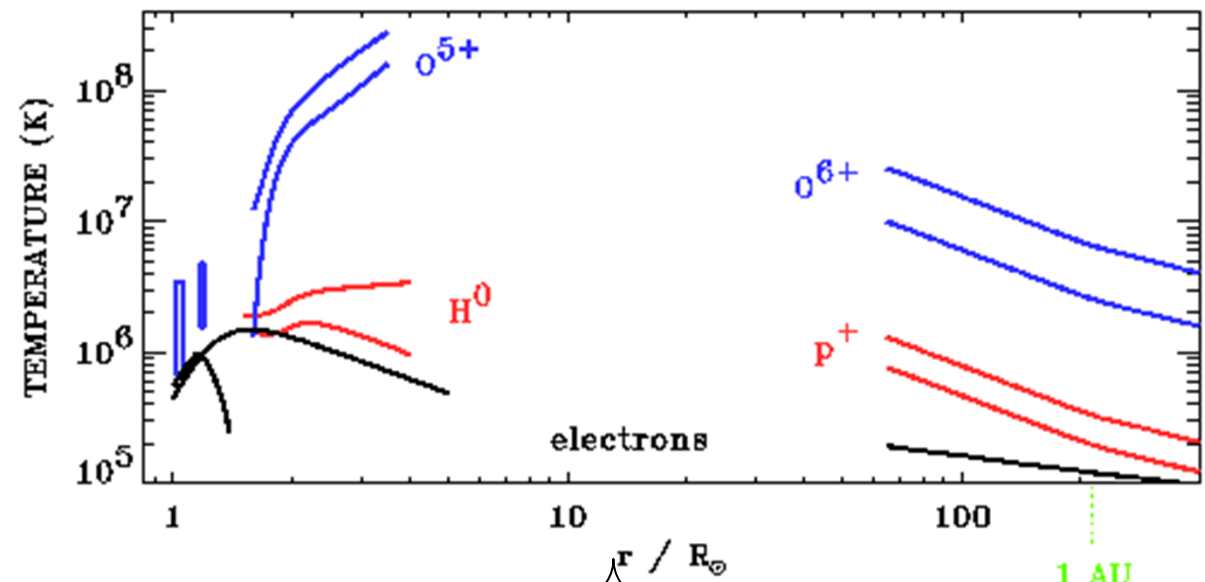
- **Level-0:** uncalibrated data, unpacked from telemetry and decompressed; HK and calibration data (for internal use)
- **Level-0.5:** data after simplified calibration to SI units; pointing information relative to instrument boresight (see LL pipeline)
- **Level-1:** data after calibration to SI units; pointing information relative to instrument boresight
- **Level-1.5:** calibrated data products after transformation to WCS system
- **Level-2:** derived observables (e.g. pB)
- **Level-3:** derived physical parameters (e.g. electron densities, outflow velocities)

SOLO & SPP

WISPR & METIS FOVs



Physical Parameters of the Fast Solar Wind & Heliosphere



Mutual support of SoLo instruments

- p velocity maps: EUI/FSI 304 for Ly α on disc
- Large scale magnetic corona and link with the *in-situ* instruments: PHI, EUI
- Mechanisms driving CMEs: EUI
- SEP associated to CMEs shocks or flares: EUI, STIXS, RPW (radio II burts), EPD

Telescope	Heliocentric distance (AU)	FOV (R_s AU _{eq})	Spatial Resolution (arcsec AU _{eq})	Cadence (min.)
WISPR	0.044	2.2 - 20	17	0.05 - 1
	0.1	4.0 - 41	26	7
	0.25	9.5 - 83	94	60
SOLOHI	0.28	6.3 - 27	45	0.2 - 6
LASCO/C2	1	2.2 - 6	24	24
SECCHI/COR2	1	2.5 - 15	30	15
SECCHI/HI1	1	15 - 90	108	40
SECCHI/HI2	1	74 - 337	250	120
SMEI	1	74 - >337	1440	102

Spatial resolution is only an upper limit!

A. Vouridas (2011)

	Helioctr. distance (AU)	FOV (R_o)	Spat. Res. (arcsec AU _{eq})	Cadence (min.)
METIS	0.28	1.6 - 2.9	7	< 1 - 20
	0.32	1.8 - 3.5	8	5 - 20
	0.68	3.9 - 7.2	14	20 - 30

METIS contribution to SOLO science

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