Metis data

R. Susino & the Metis team

9th Metis Workshop – Catania – January 25th 2024

Solar Orbiter/Metis observation structure

High latitude window

- Remote-sensing windows (RSWs) → VL + UV
  - observations targeted to address mission science objectives
  - coordination of RS instruments – Solar Orbiter Observing Programs (SOOPs)
- Out of RS-windows
  - synoptic program – coordinated observations at constant cadence → VL + UV (< 0.6 au)

Perihelion window

  - opportunities (comets, conjunctions/quadratures) → VL + UV
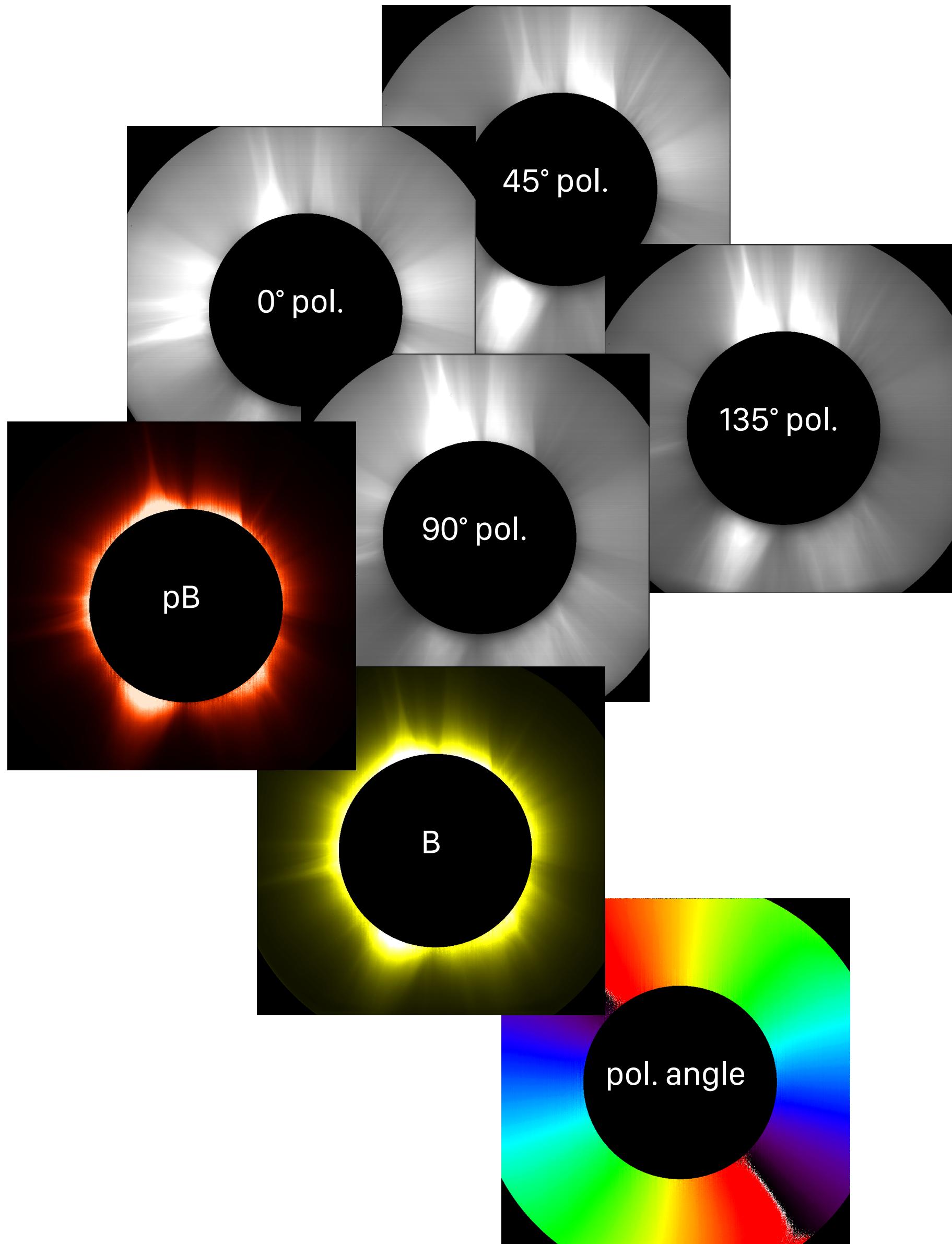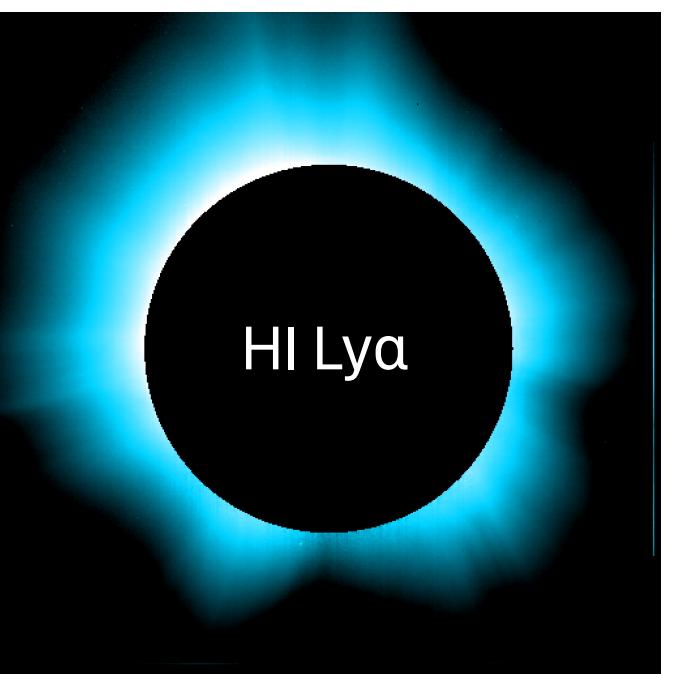
Out of RS-windows
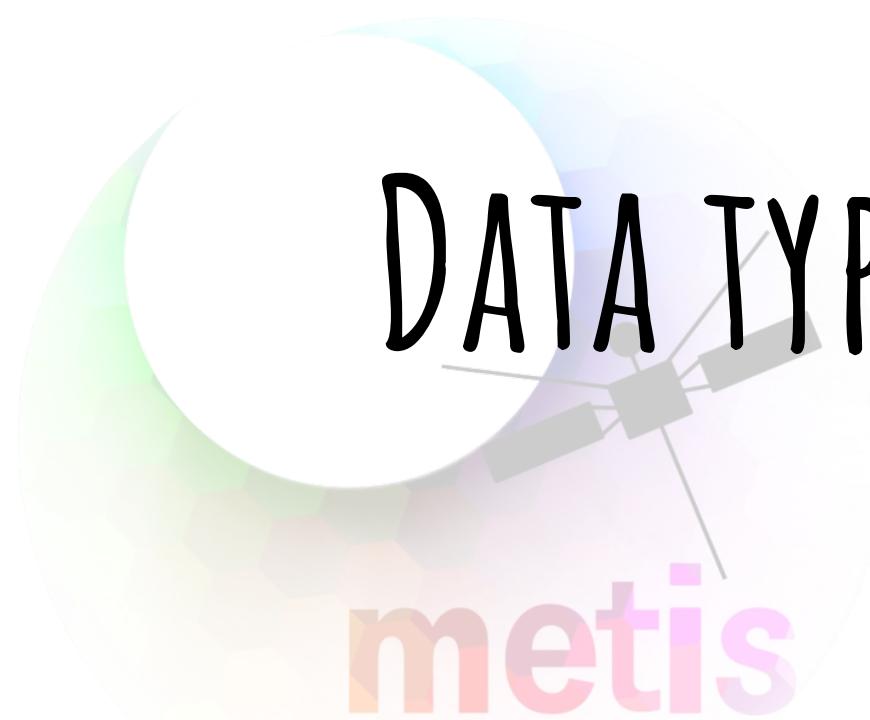
Low latitude window

Data types & on-board processing

metis

- Visible-light channel
  - sequences of 4 polarimetric images → polarised and total brightness, polarisation angle, Stokes parameters
  - single total-brightness images
  - fixed-polarisation images

- UV channel
  - analogue-mode images

Data types & on-board processing

- On-board processing
  - frame average
  - binning, masking
  - compression (lossless, lossy)
  - cosmic-ray/SEP correction

- Secondary data products
  - light curves (for each pB sequence)
  - cosmic-ray/SEP correction maps (twice per day)

On-ground processing and calibration

- Level 0 (L0)
  - uncalibrated data (units of DN) obtained from telemetry packets, that are uncompressed and formatted in standard FITS format
  - metadata contain only the information that is available from the telemetry packet headers
- Level 1 (L1)
  - uncalibrated data (units of DN)
  - metadata contain extra engineering data from housekeeping telemetry
  - all the available orbital and attitude information is used and coordinates expressed in scientific coordinate systems (WCS)

On-ground processing and calibration

- Level 2 (L2)
  - calibrated data (physical units) corrected for
    - detector bias/dark current
    - flat-field
    - optical vignetting
    - exposure normalisation
    - radiometric calibration
    - demodulation (applied only to polarimetric acquisitions)
  - the most up-to-date calibration is always applied

# On-ground processing and calibration
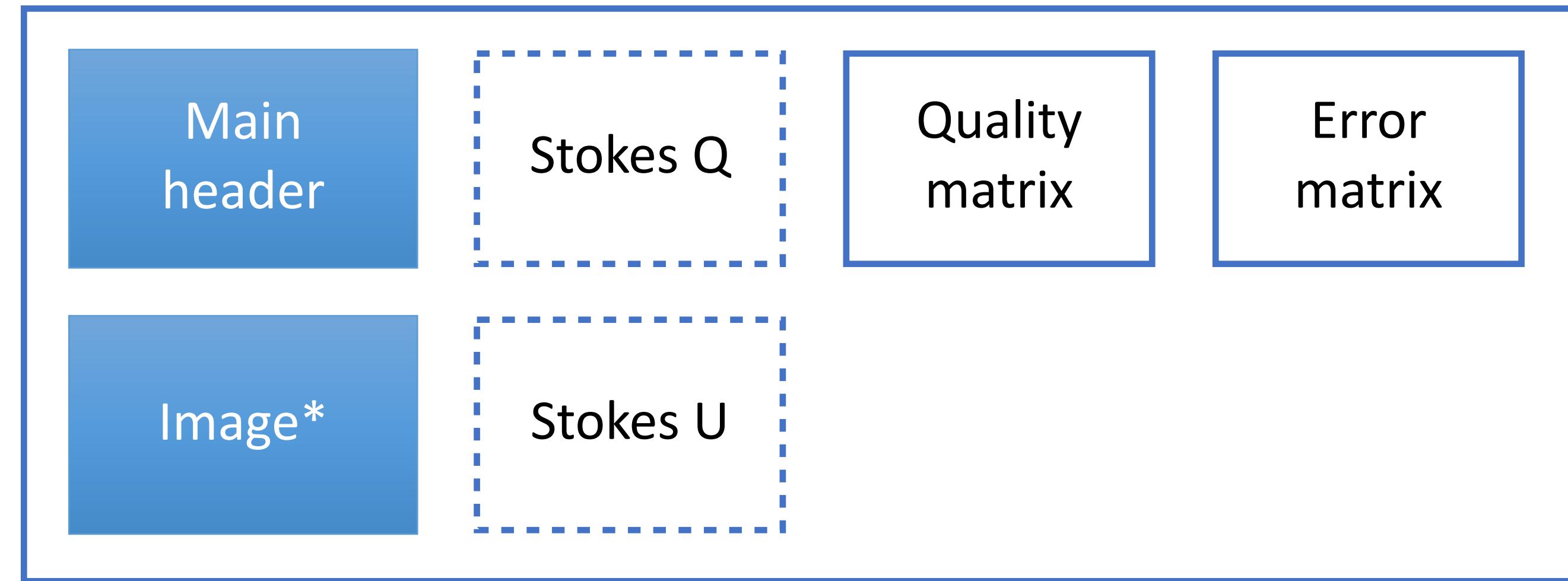
- Level 3 (L3)
  - science-grade data derived from L2 data: movies, Carrington maps; and data obtained after scientific analysis, e.g., electron-density maps, solar-wind outflow velocity maps → available later in the mission

L2 FITS structure

| Main header	Stokes Q	Quality matrix	Error matrix
Image*	Stokes U		

* VL pB, B, pol. angle, or Stokes I or UV Lyα intensity
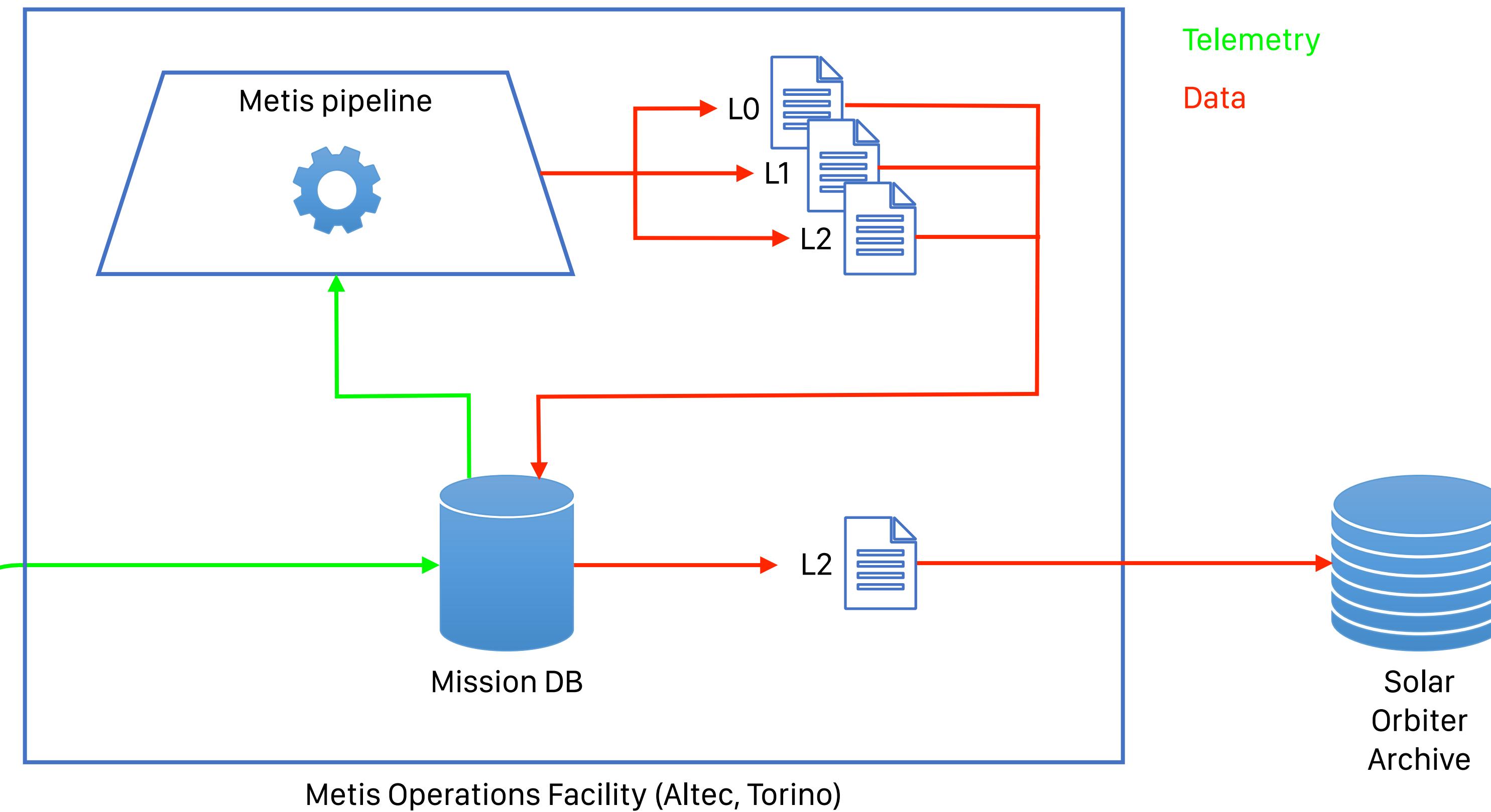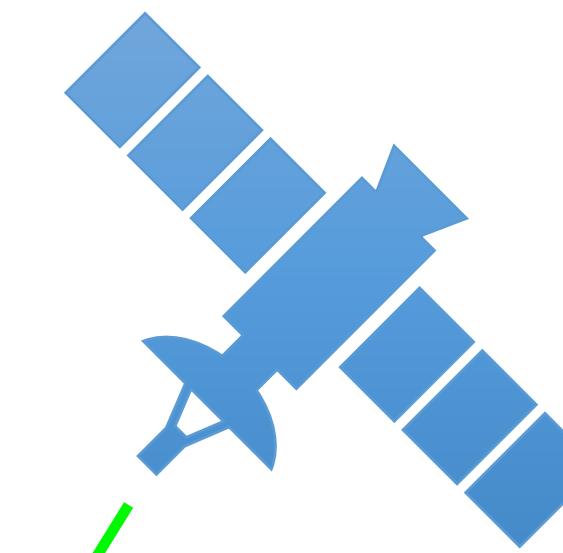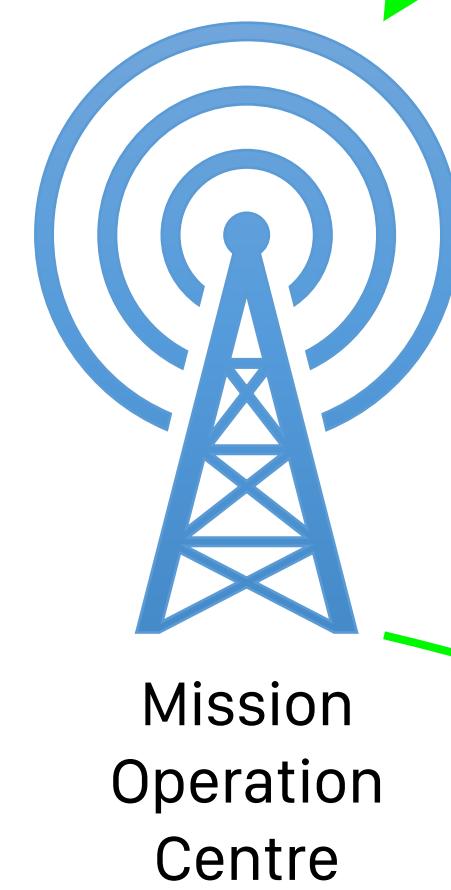
- Quality matrix
  - image mask flagging:
    - saturated/bad pixels (NaN)
    - unreliable pixel values (0)
    - good pixels (1)
- Error matrix
  - uncertainty map derived from measured counts through error propagation → under assessment

Data flow

Telemetry

Data

Metis pipeline

L0

L1

L2

Mission DB

L2

Mission Operation Centre

Metis Operations Facility (Altec, Torino)
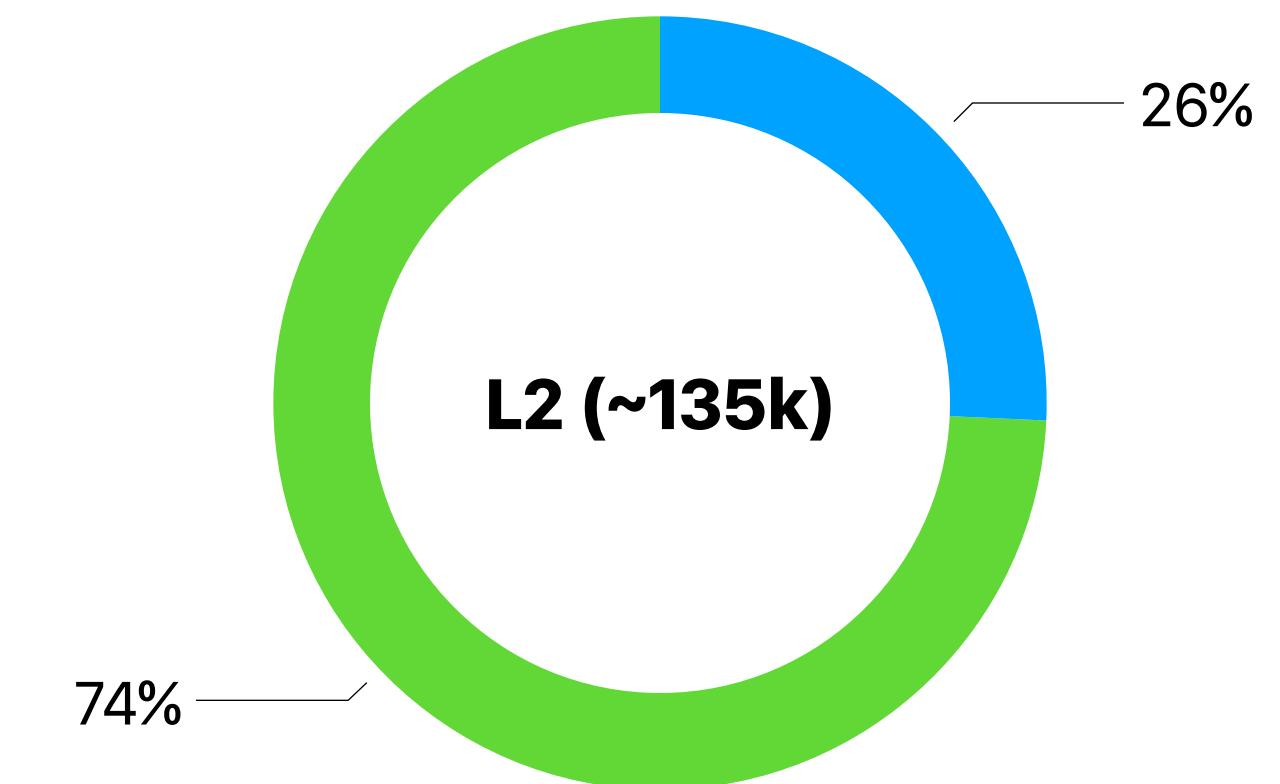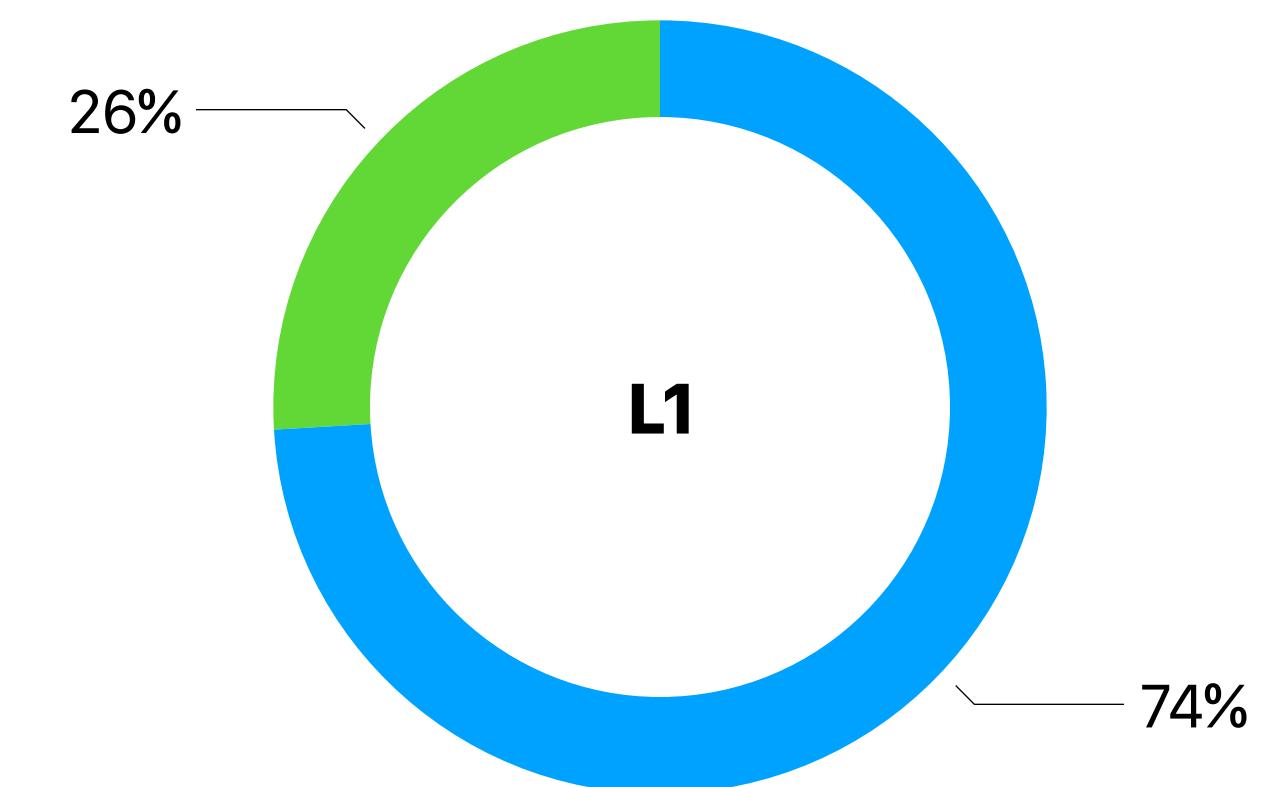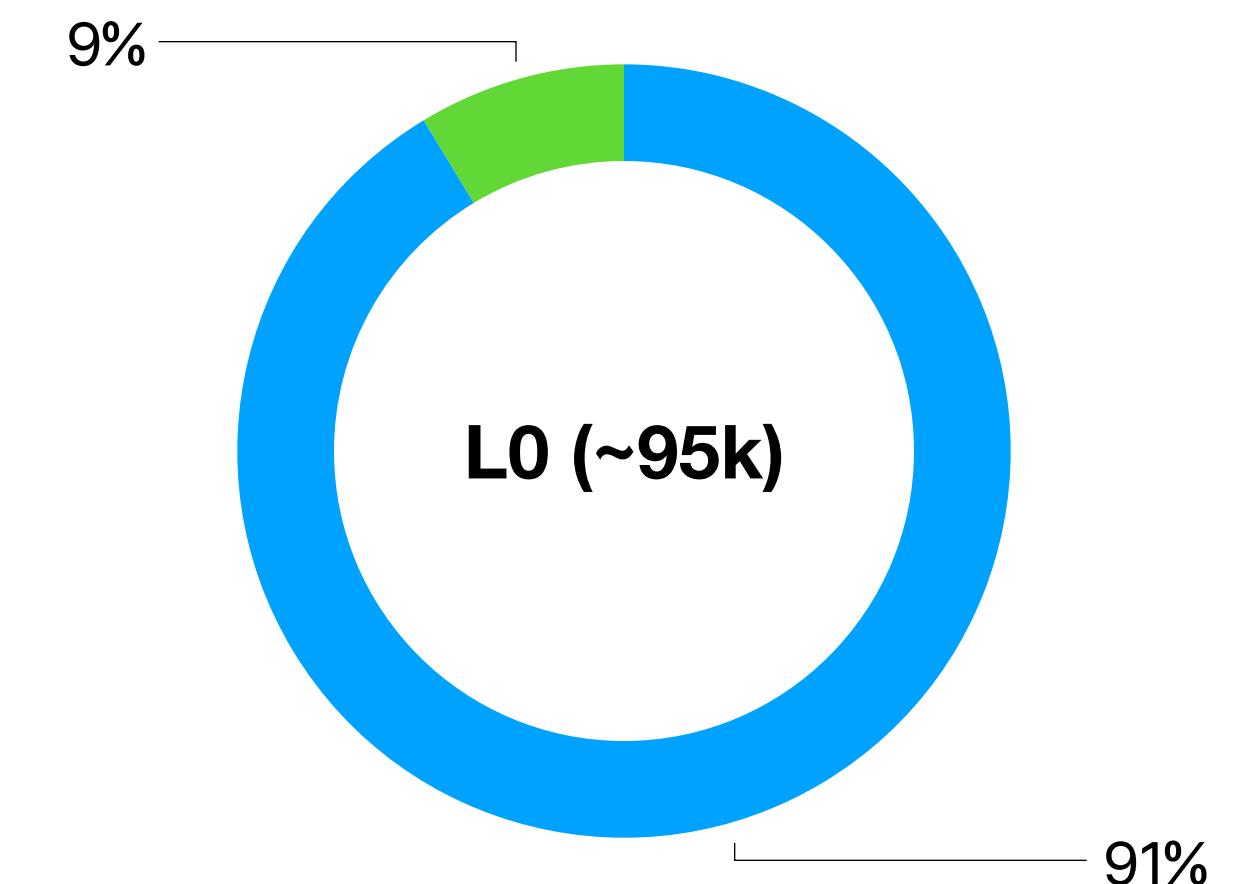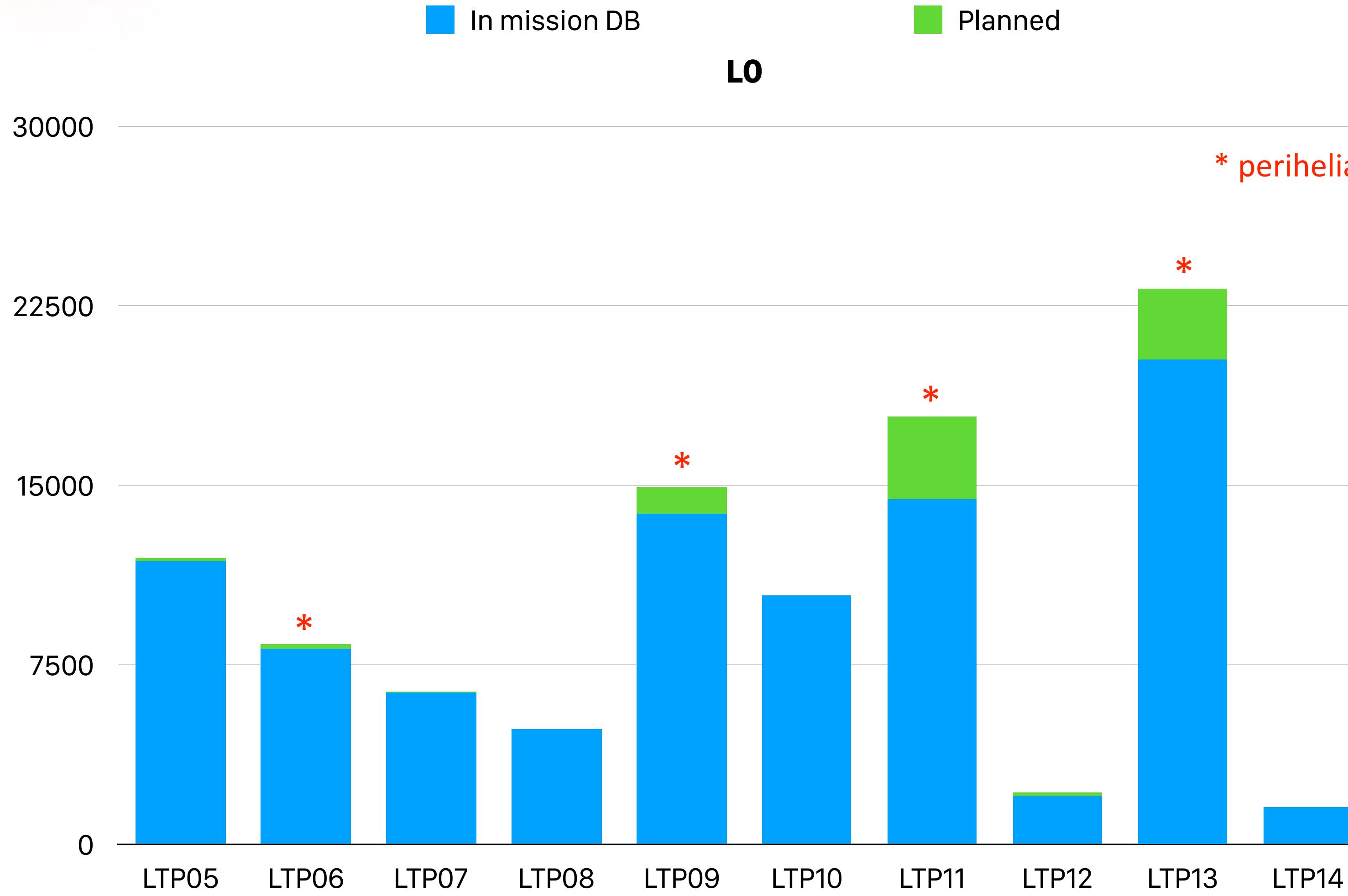
Solar Orbiter Archive
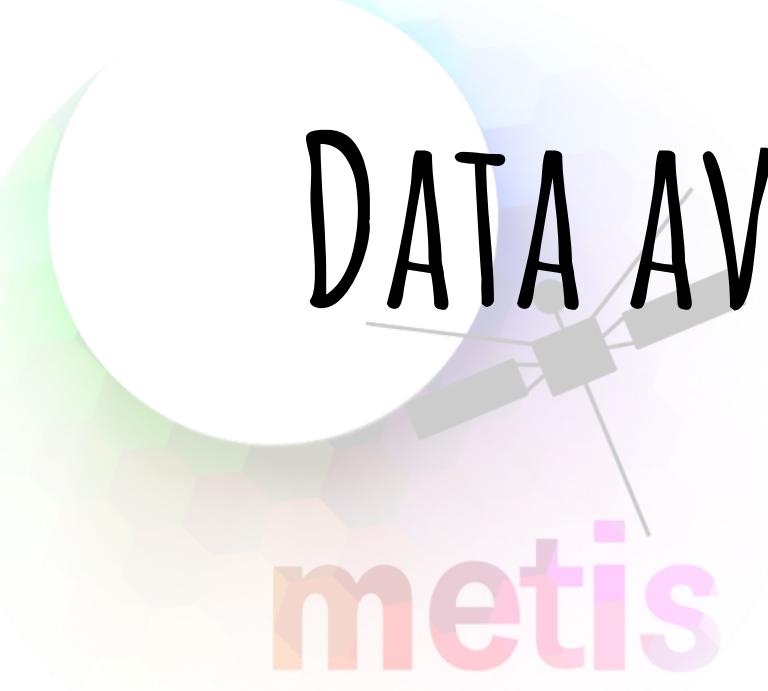
Statistics for the nominal phase

Data availability
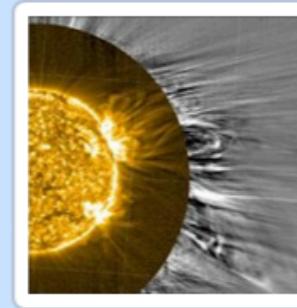
- Nominal-phase L2 data
  - publicly available through the Solar Orbiter Archive (SOAR) at https://soar.esac.esa.int/soar/ (~ 90 days after download)
- L2 data not yet available on the SOAR, L0, L1, or cruise-phase data
  - available upon request, please write to metis@inaf.it
- For the Metis team (authentication required)
  - data available on the Metis mission DB (maintained by Altec) at http://mission-db-pro.metis.altecspace.it:8888

Metis data description
Observation summary
Metis data access
Publication policy

«

May 18, 2022
Solar Orbiter closer than ever to the Sun

»

Metis: the multi-wavelength coronagraph for the Solar Orbiter mission

Metis is the coronagraph of the scientific payload of Solar Orbiter, the first mission of the European Space Agency (ESA) program Cosmic Vision 2015-2025. Solar Orbiter has been conceived to explore for the first time the poles of the Sun and the circumsolar region.

The Metis experiment is an international collaboration led by the Italian National Institute for Astrophysics (INAF) and supported by the Italian Space Agency (ASI), involving several Universities in Italy and research institutes in the world.
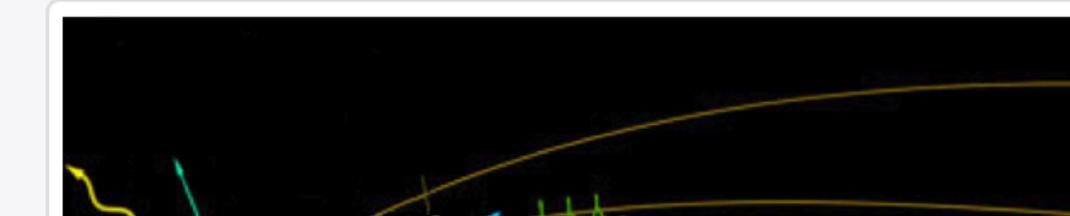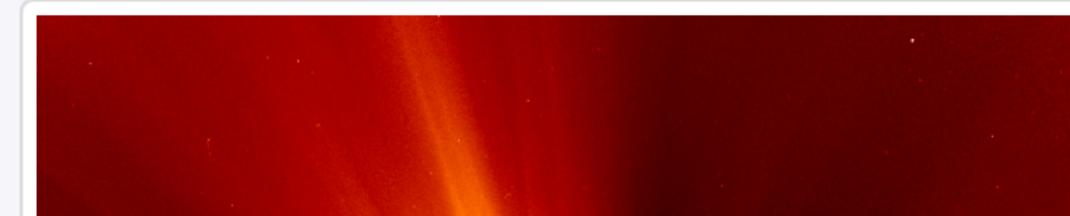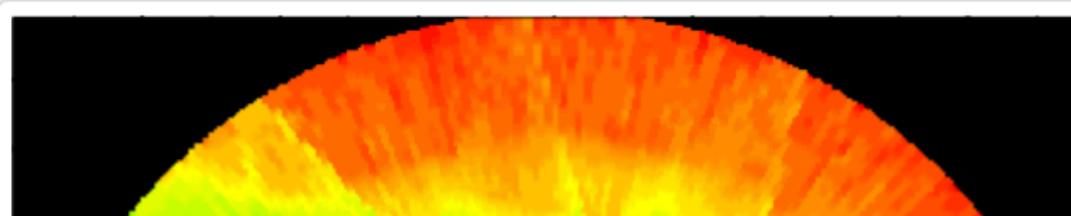
The innovative instrument design has been conceived for simultaneously imaging the visible and ultraviolet emission of the Sun's corona. Observations obtained with Metis will enable us to diagnose, with unprecedented temporal coverage and spatial resolution, the structures and dynamics of the full corona.

Find out more »

metis

Metis science objectives

Data

- Metis data description
- **Observation summary**
- Metis data access
- Publication policy

Observation summary

2024 **2023** **2022** **2021** **2020**

JAN 2023

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

FEB 2023

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

MAR 2023

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

APR 2023

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

MAY 2023

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

JUN 2023

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

JUL 2023

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

AUG 2023

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

SEP 2023

OCT 2023

NOV 2023

DEC 2023

Legend

- 🟩 Solar Orbiter perihelion
- 🟦 Remote-Sensing Window (RSW)
- 🟨 Special observations (targets of opportunity, PSP quadratures, etc.)
- — UV data available
- ✖ No data available

Data

Metis data descripti

Observation summa

Metis data access

Publication policy
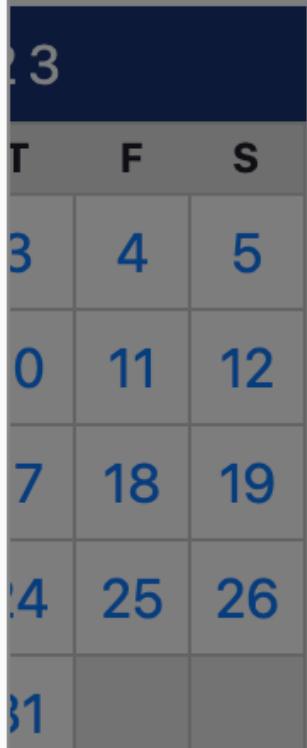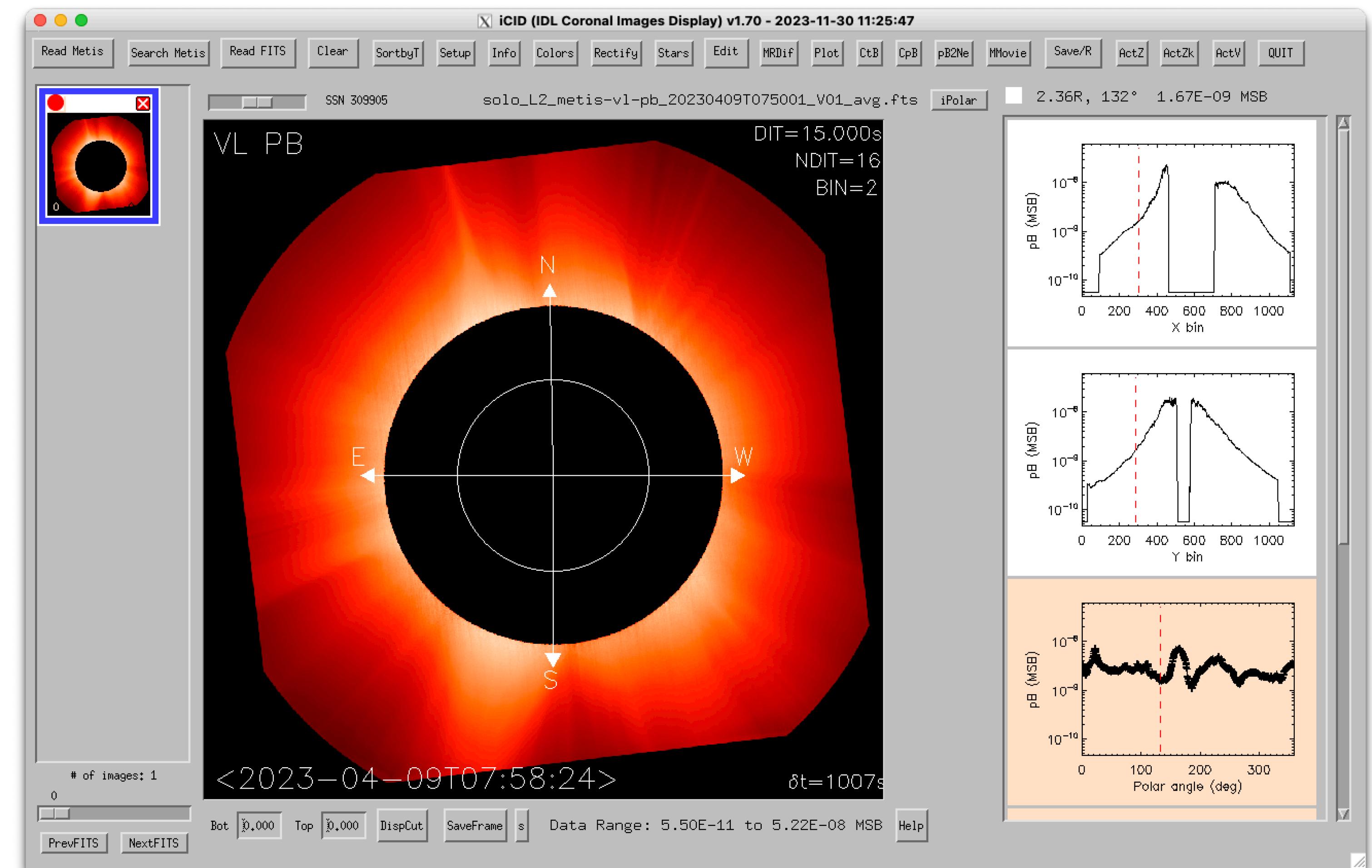
STP251

Start	Stop	Observing program	Description	Solar Orbiter Observing Plan (SOOP)	VL/bin DIT/NDIT/CAD	UV/bin DIT/NDIT2/CAD
03/04/2023 13:24:00	03/04/2023 21:54:29	METIS_SYNOPTIC	Synoptic observations		pB/2x2 15s/28/7200s	UV/4x4 30s/28/7200s
03/04/2023 23:34:00	03/04/2023 23:55:00	LOW_LATENCY	Quick look data		pB/4x4 15s/14/960s	UV/4x4 30s/7/240s
04/04/2023 00:00:00	04/04/2023 01:12:15	METIS_FLUCTS_TBF	Brightness fluctuations spectra		FP/None 1s/None/None tB/2x2 20s/1/20s	
04/04/2023 01:14:00	04/04/2023 22:26:51	METIS_MAGTOP	Relationship of wind with magnetic topology		pB/None 15s/8/720s	UV/2x2 30s/15/720s
04/04/2023 22:34:00	04/04/2023 23:40:22	LOW_LATENCY	Quick look data		pB/4x4 15s/14/960s	UV/4x4 30s/7/240s
07/04/2023 09:00:00	07/04/2023 10:20:18	METIS_FLUCTS_TBF	Brightness fluctuations spectra	L_FULL_HRES_HCAD_Coronal-Dynamics	FP/None 1s/None/None tB/2x2 20s/1/20s	
07/04/2023 10:29:00	07/04/2023 22:24:13	METIS_WIND	Measurement of e⁻–density and wind velocity	L_FULL_HRES_HCAD_Coronal-Dynamics	pB/2x2 15s/16/1800s	UV/2x2 30s/16/900s
07/04/2023 22:34:00	07/04/2023 22:59:00	LOW_LATENCY	Quick look data	L_FULL_HRES_HCAD_Coronal-Dynamics	pB/4x4 15s/14/960s	UV/4x4 30s/7/240s
07/04/2023 23:00:00	08/04/2023 00:12:15	METIS_FLUCTS_TBF	Brightness fluctuations spectra	L_FULL_HRES_HCAD_Coronal-Dynamics	FP/None 1s/None/None tB/2x2 20s/1/20s	

How to look into Metis data?

- With any tool that can handle FITS files...

- Recommended: iCID (IDL Coronal Images Display, developed and maintained by Silvio G.) or the python version pyCID (developed and maintained by Aleksandr B.)

Reference documents and useful links

- Metis Data Product Description Document: http://metis.oato.inaf.it/docs/METIS-OATO-SPE-021_2.2_Solar_Orbiter_Metis_Data_Product_Description_Document.pdf

- Metis Instrument Paper: https://www.aanda.org/articles/aa/pdf/2020/10/aa35338-19.pdf

- Metis website: http://metis.oato.inaf.it

- iCID: https://drive.google.com/drive/folders/1BESI7qkb2PQ_44RjmCOmapFPL93IYSCL?usp=drive_link and pyCID: https://www.ict.inaf.it/gitlab/metis/utilities/pycid.git