UNIVERSITÀ DEGLI STUDI DI PADOVA

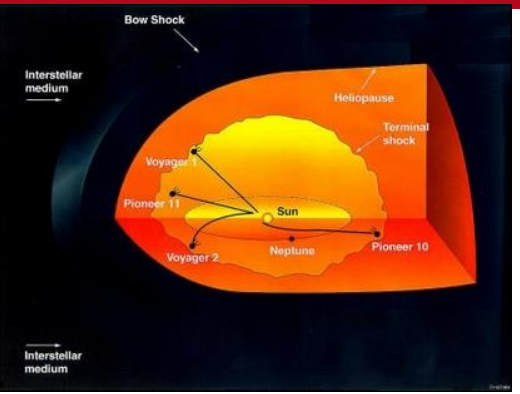
In-flight calibration and performance verification of the Metis instrument for the Solar Orbiter mission

Chiara Casini - 36th Cycle

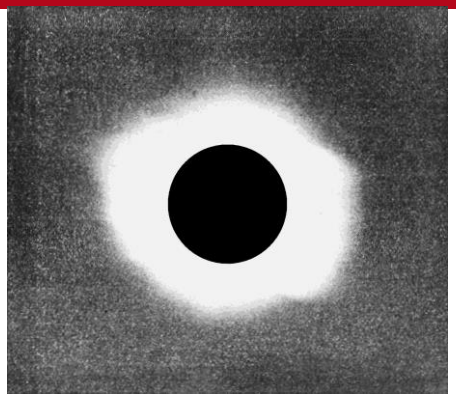
MEETING FOR THE ADMISSIONS OF THE DOCTORAL STUDENTS

06/11/2020

The Solar Corona



The solar corona is the outer part of the solar atmosphere that expands, as solar wind, into the interplanetary space to the border of the solar system (heliosphere).



The 1900 Wadesboro eclipse. Image from the North Carolina Collection

Open Questions:

- How and where do the solar wind plasma and magnetic field originate in the corona?
- How do solar transients drive heliospheric variability?
- How do solar eruptions produce energetic particles radiation that fills the heliosphere? [1]

ESA/NASA Solar Orbiter mission to study also the Solar Corona

Total Solar Eclipse 02/07/2019 up to 5 solar radii, *Druckmüller, http://www.zam.fme.vutbr.cz/~druck/eclipse/*

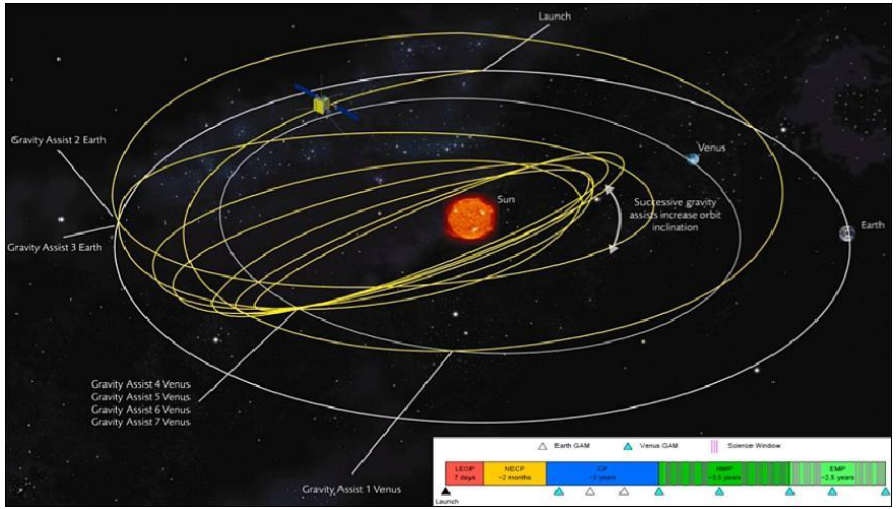
1 Müller D. et al. (2013), Solar Orbiter. Exploring the Sun "Heliosphere Connection". Solar Phys, 285. Pag. 25-70

Solar Orbiter

Launch 09/02/2020 | **06/2020** | **11/2021** | **01/2026** | **2030**

Mission phases

- ***Commissioning***
- ***Cruise***
- ***Nominal***
- **Extended mission time**



ORBIT:

0.28 – 0.32 AU (perihelion)

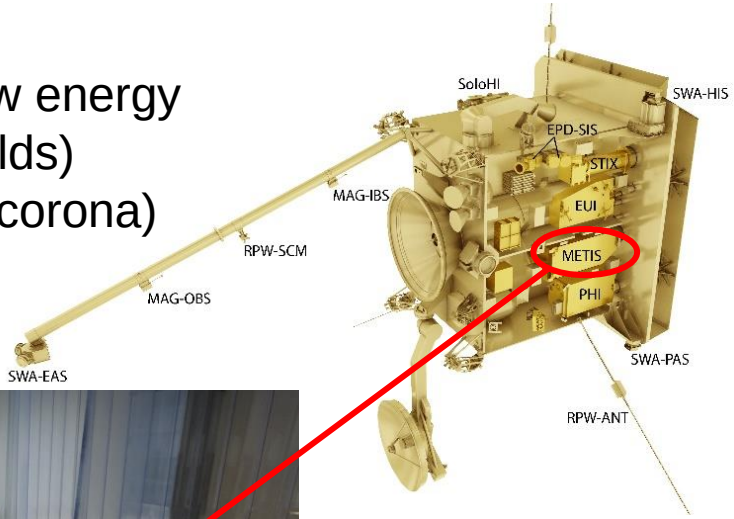
0.74 -- 0.91 AU (aphelion)

Out-of-ecliptic view:
Multiple gravity assists with Venus to increase inclination out of the ecliptic to :
>24° (nominal mission);
>34° (extended mission)

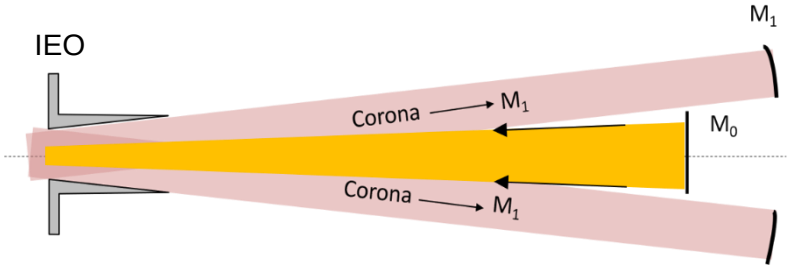
Solar Orbiter & Metis

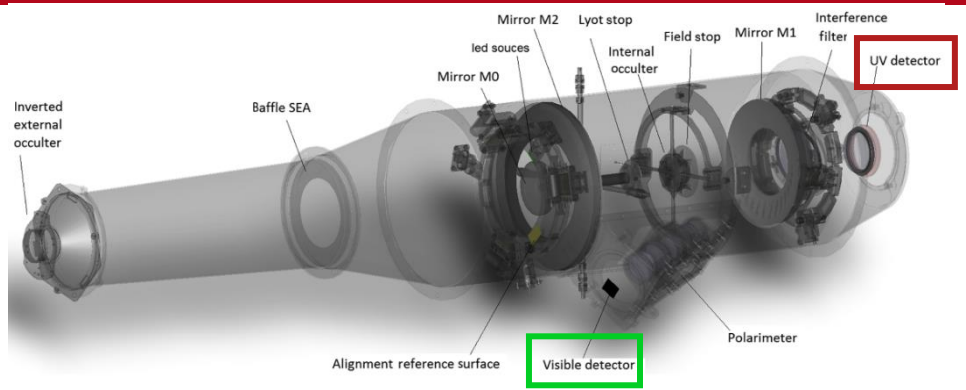
10 Instruments:

- 4 *in-situ* (measurements concerning high and low energy charged particles, magnetic fields and electric fields)
- 6 remote sensing (taking images of the Sun and corona)



METIS is a coronagraph with an innovative occultation system

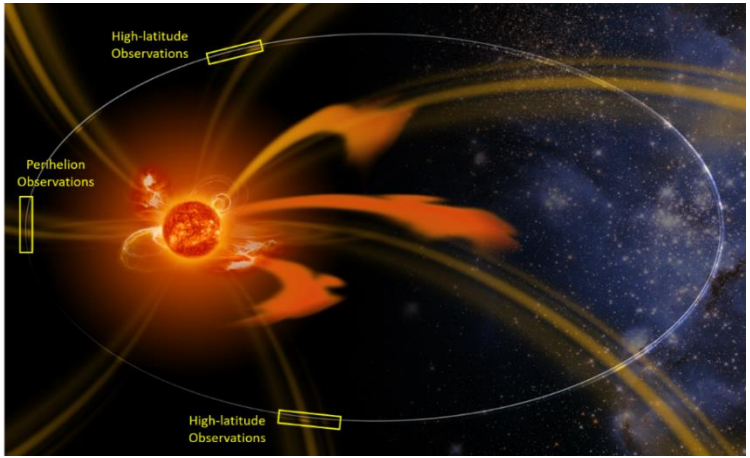




At the **perihelion** (0.28 AU)
Spatial resolution **≤ 4000 km**
Time resolution **≥ 1 sec**
Simultaneous **VL** and **UV** imaging

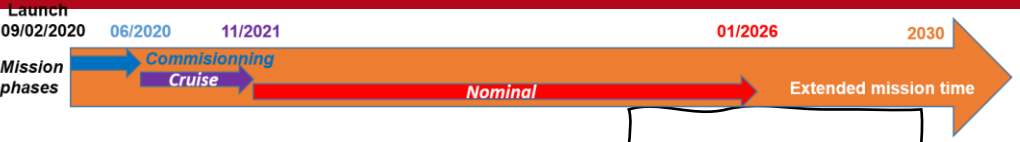
Full Imaging of the corona (1.7 - 9 $R_{\odot}$):

- UV (121.6±10 nm)
- visible light (580-640nm) in total and polarized brightness
- depending on the science goal and the instantaneous field of view (FoV): different spatial resolution and detector exposure time,



The CNR-IFN of Padua is participating to the project and the calibration of Metis

Map of the project



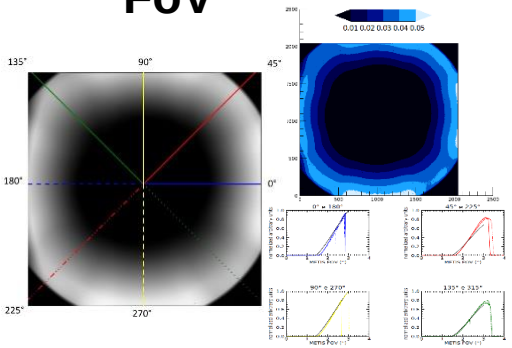
- Solar Orbiter phase
  - Commissioning phase
    - processing and comparing
    - verifying performances
    - perform simulations
  - Cruise phase
    - define the procedures and analyze the data to complete the characterization tests
  - Nominal phase
    - Starting the concrete analysis of data acquired

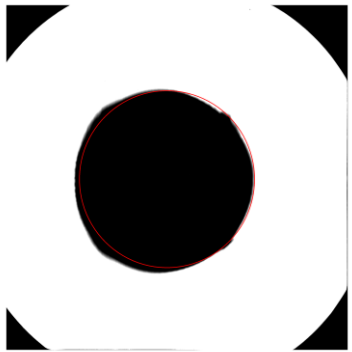
Scientific Image Calibration 1

On- ground

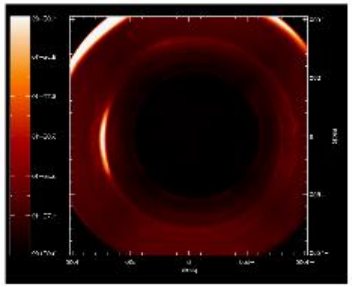
In-flight[1]

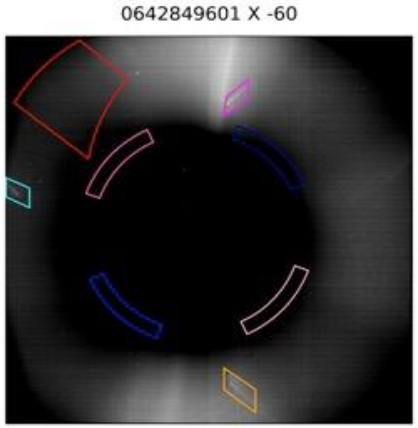
FoV



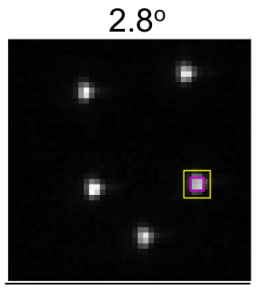


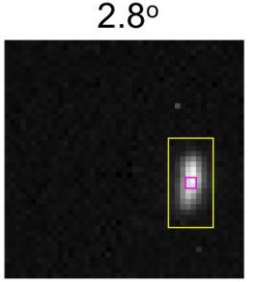
Straylight

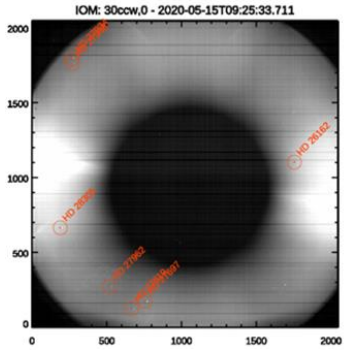




PSF

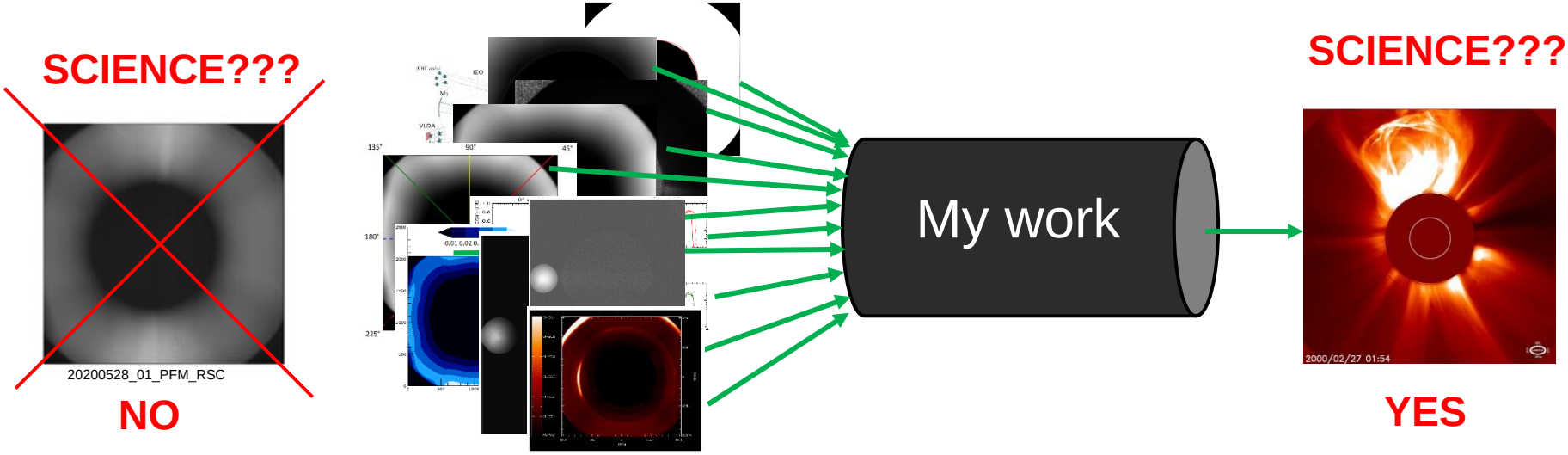






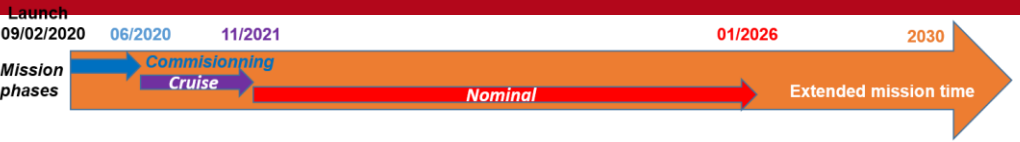
1 Metis Commissioning Activity Report

Scientific Image Calibration 2



My research activity will serve to acquire a deep and detailed knowledge of the Metis instrument in one of the most critical and important phase of a space experiment, and it's essential to obtain scientific useful images.

Conclusions



WBS NUMBER	TASK TITLE	FIRST YEAR												SECOND YEAR												THIRD YEAR											
		T1			T2			T3			T4			T1			T2			T3			T4			T1			T2			T3			T4		
		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
1	Commissioning phase																																				
1.1	Review of state of the art of the Solar Orbiter mission timeline																																				
1.2	Metis calibration actvities: comparison with on ground results																																				
1.3	Optical performances																																				
2	Cruise Phase																																				
2.1	Calibration sequence planning																																				
2.2	Performances validation																																				
2.3	Straylight																																				
3	Nominal Phase																																				
3.1	Calibration input for the pipeline																																				
3.2	Data analysis supprt																																				
4	Phd Thesis Writing																																				
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Thanks for the attention

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