

# Coronal EUV imagers: a sunny view thanks to PRODEX

David Berghmans  
Royal Observatory of Belgium





esa ESTEC

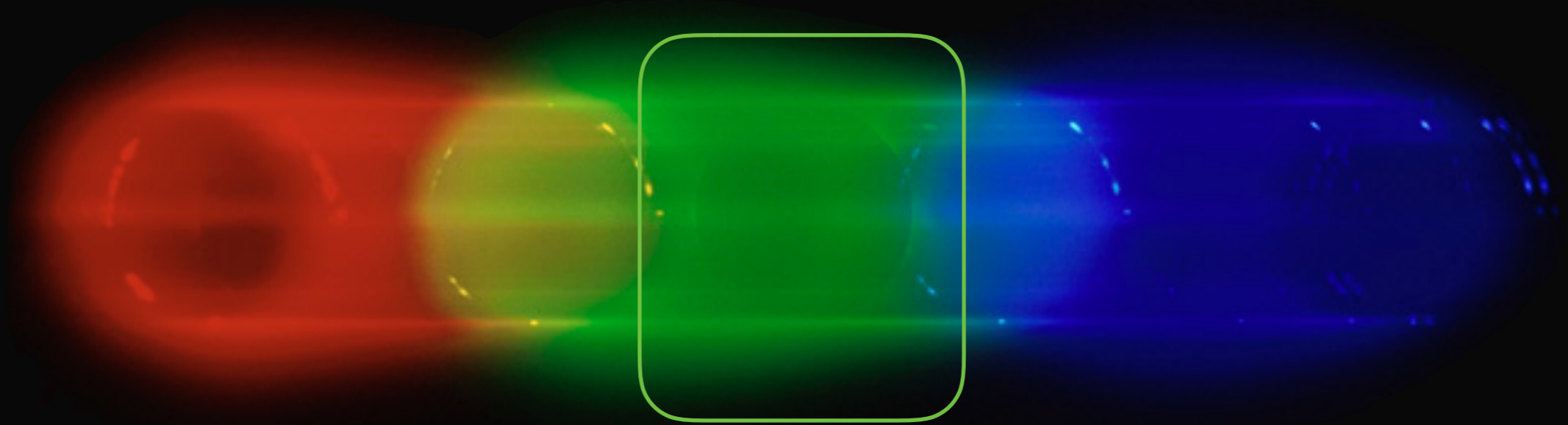
Reception



Svalbard, Norway 2015 April 20

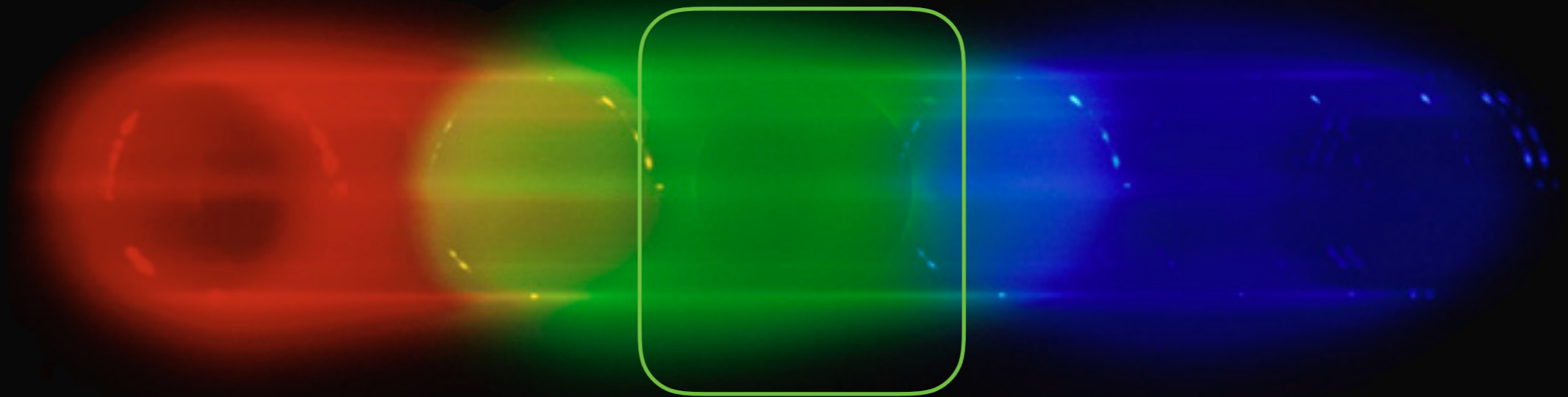


# Eclipse 1999, Hungary



530.3nm  
Coronium

# Eclipse 1999, Hungary



530.3nm

Coronium

Bengt Edlen: Fe XIV

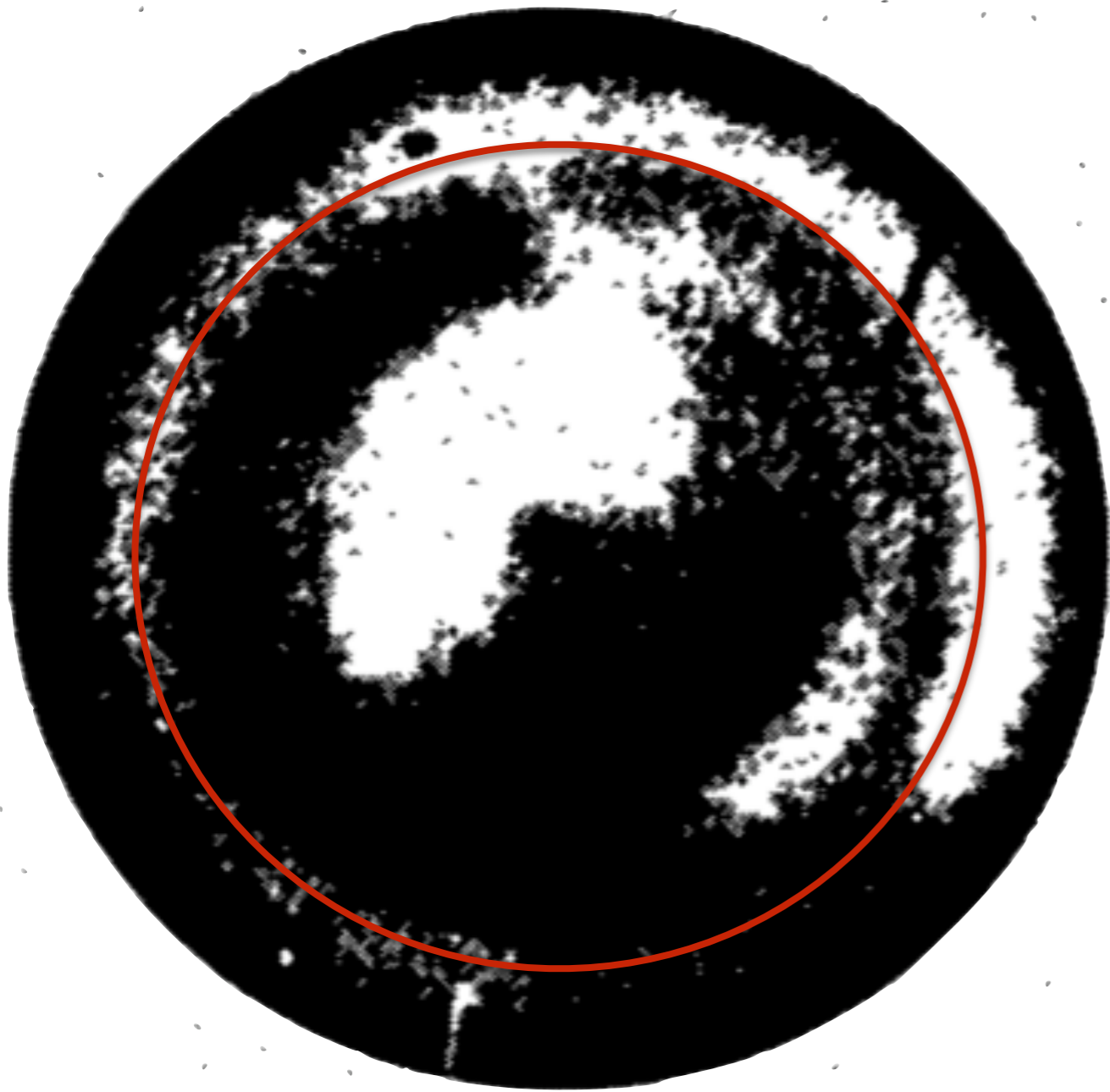
SOLAR X-RAY PHOTOGRAPH  
NRL, APRIL 19, 1960



Pinhole camera  
flown in 1960

[Friedman \(1963\) IAUS, 16, 45](#)

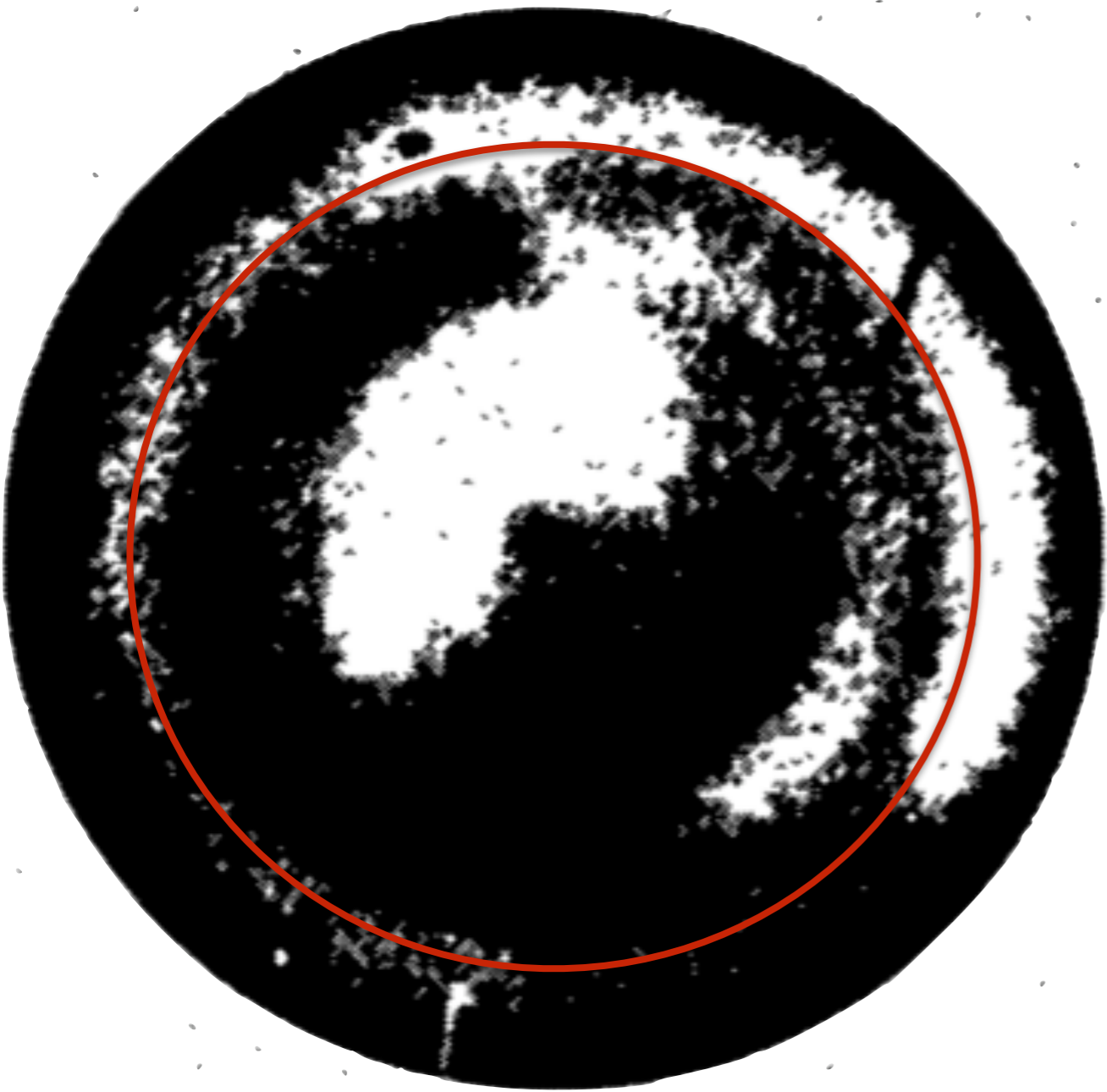
SOLAR X-RAY PHOTOGRAPH  
NRL, APRIL 19, 1960



Pinhole camera  
flown in 1960

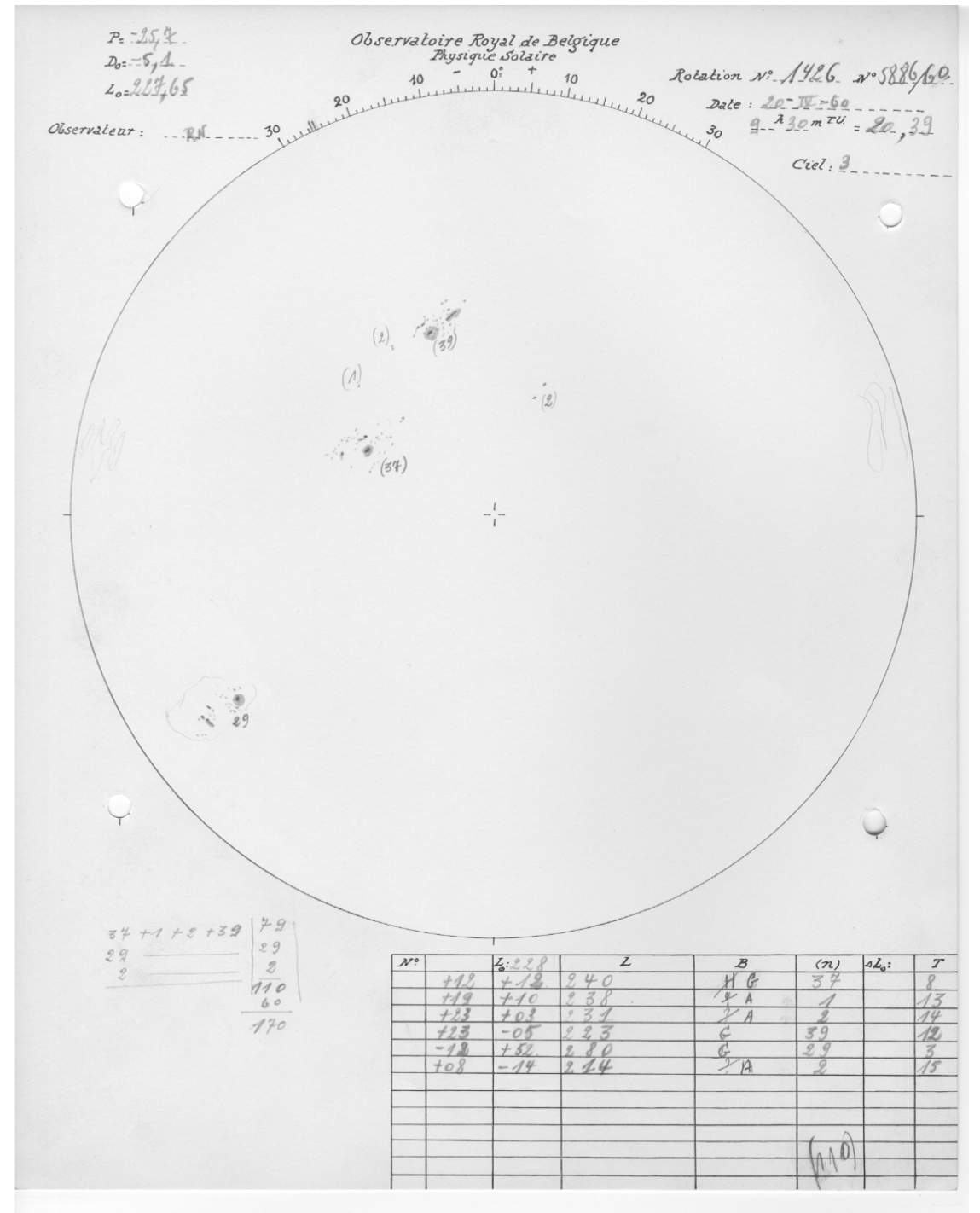
[Friedman \(1963\) IAUS, 16, 45](#)

SOLAR X-RAY PHOTOGRAPH  
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Pinhole camera  
flown in 1960

[Friedman \(1963\) IAUS, 16, 45](#)

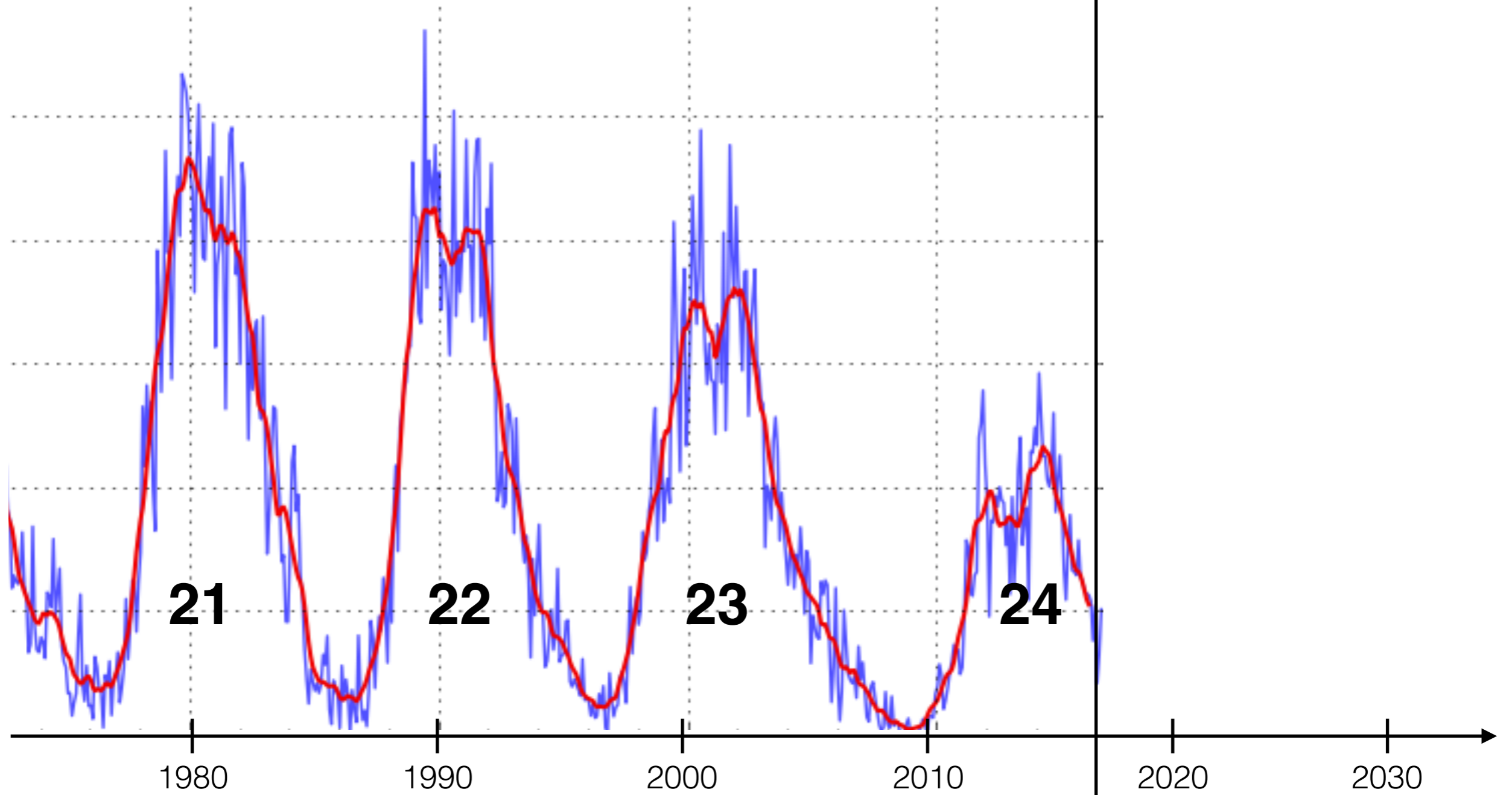


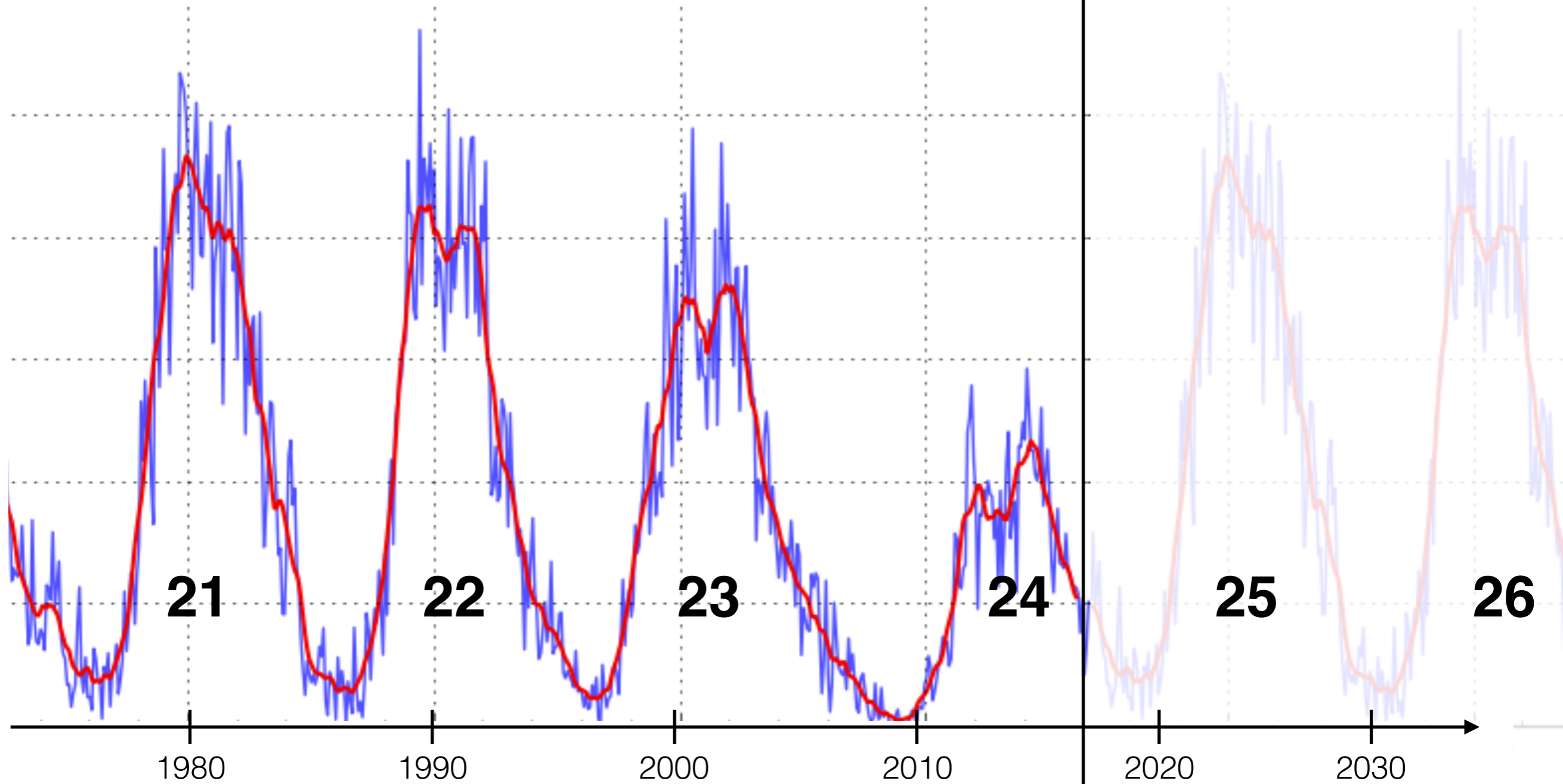
April 20 1960 Sunspot drawing  
from Royal observatory of Belgium

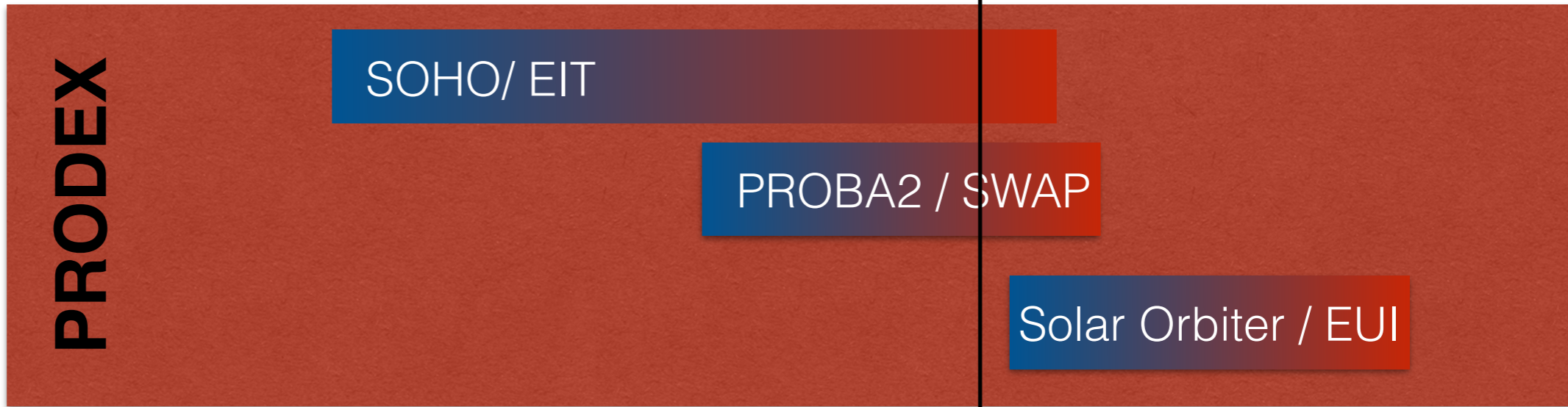
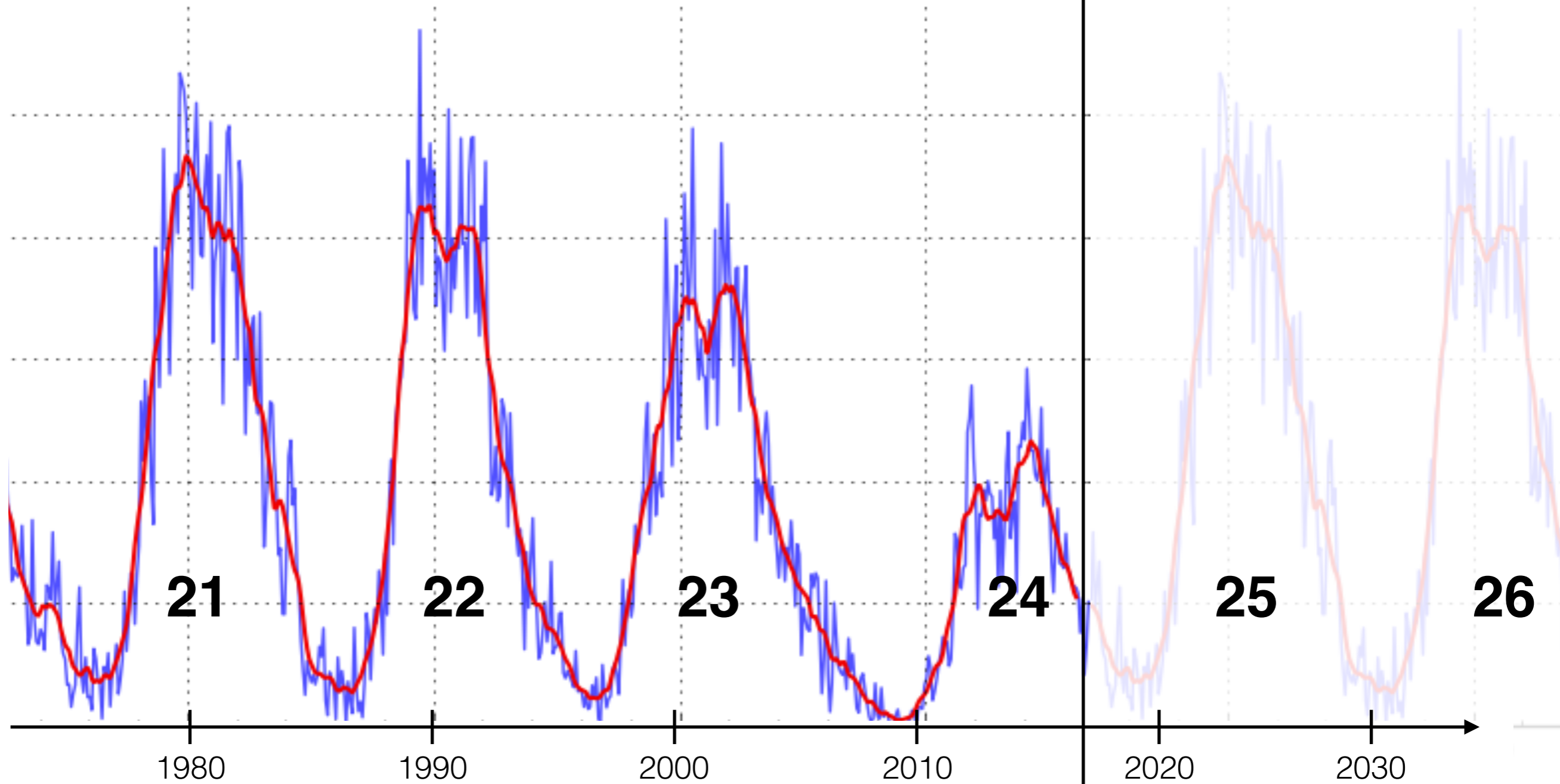




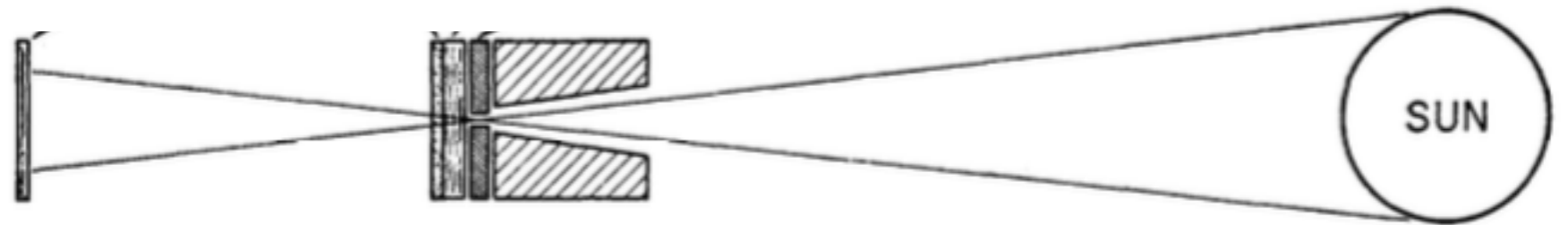
April 20 1960 Sunspot drawing  
from Royal observatory of Belgium



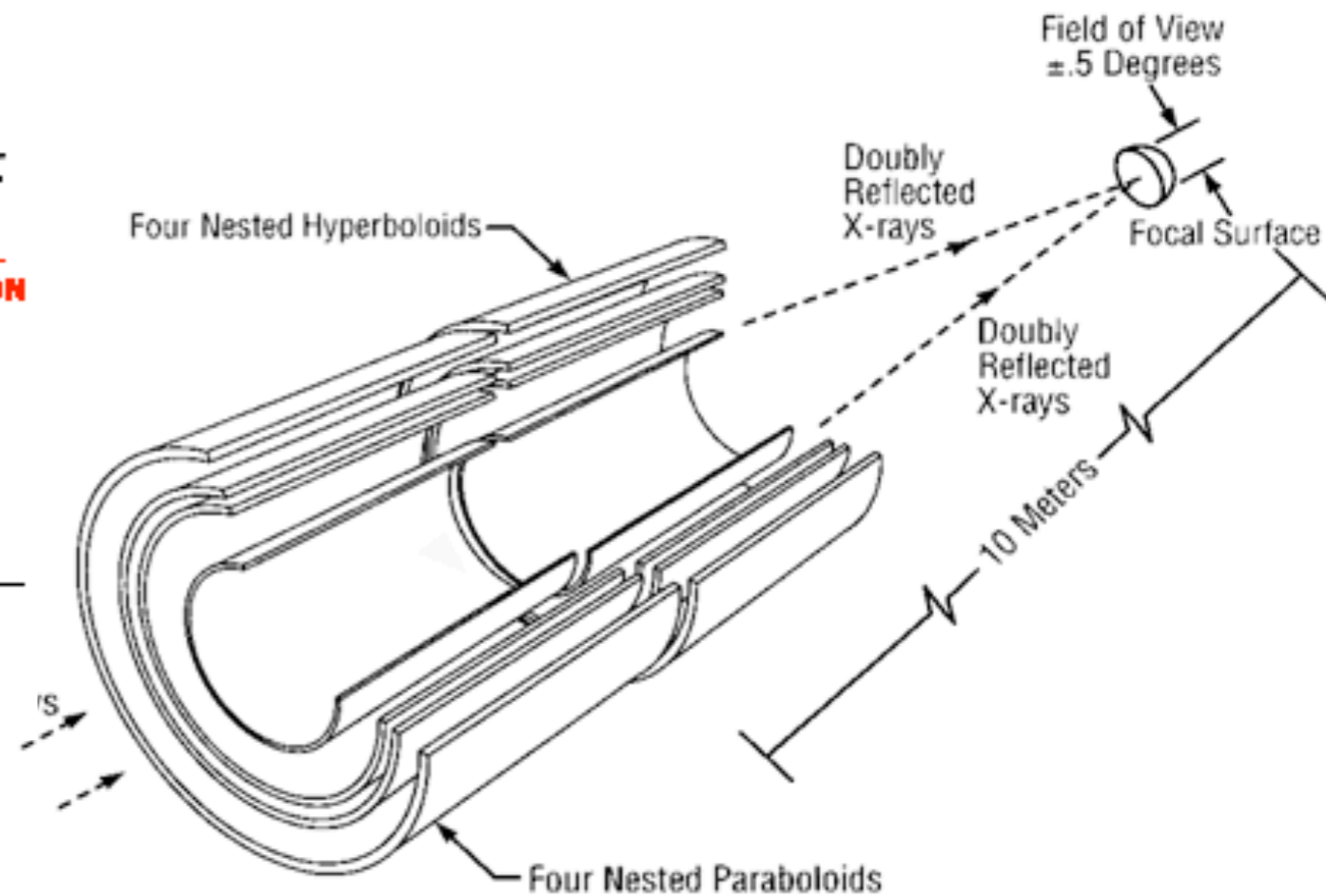
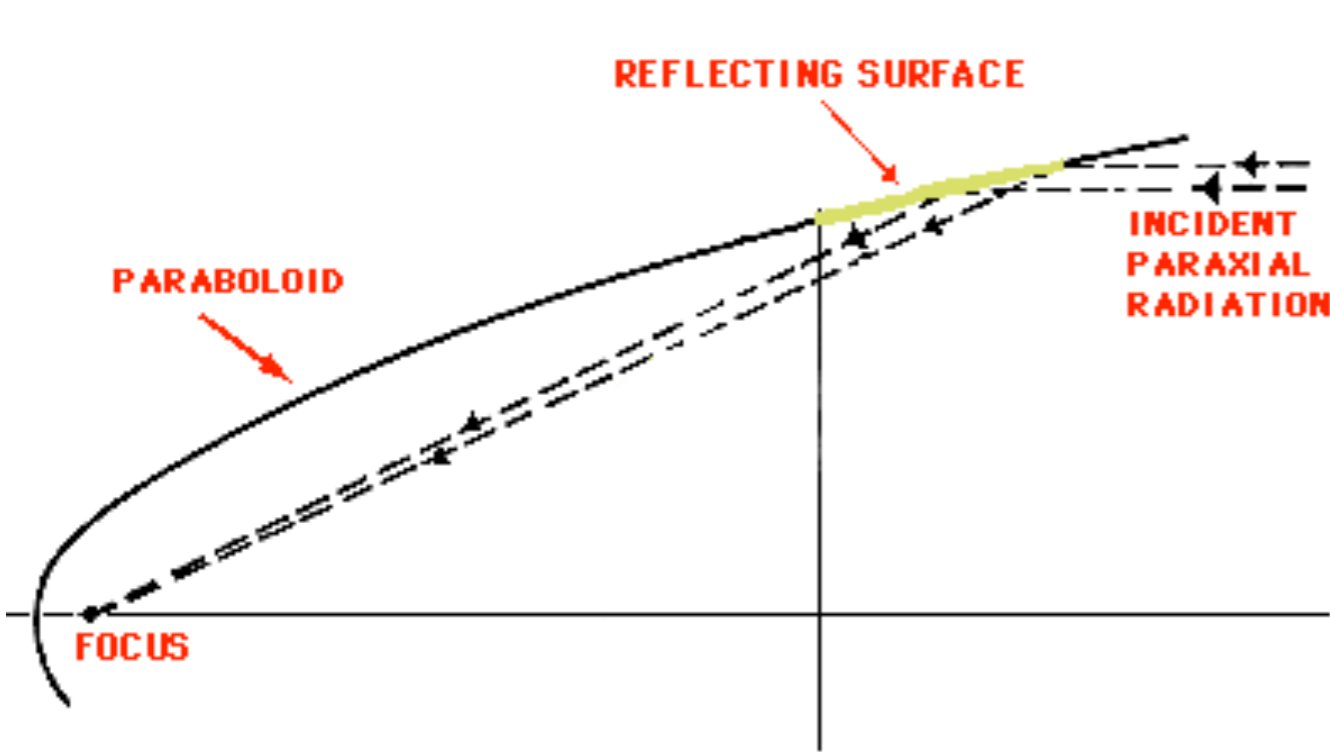
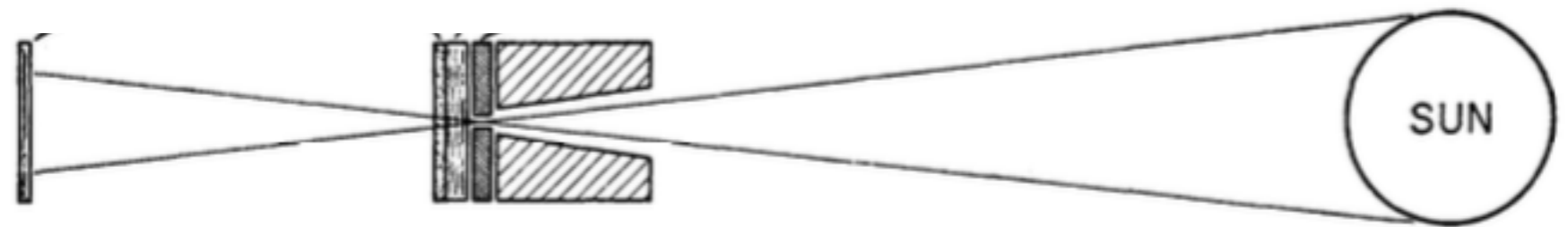




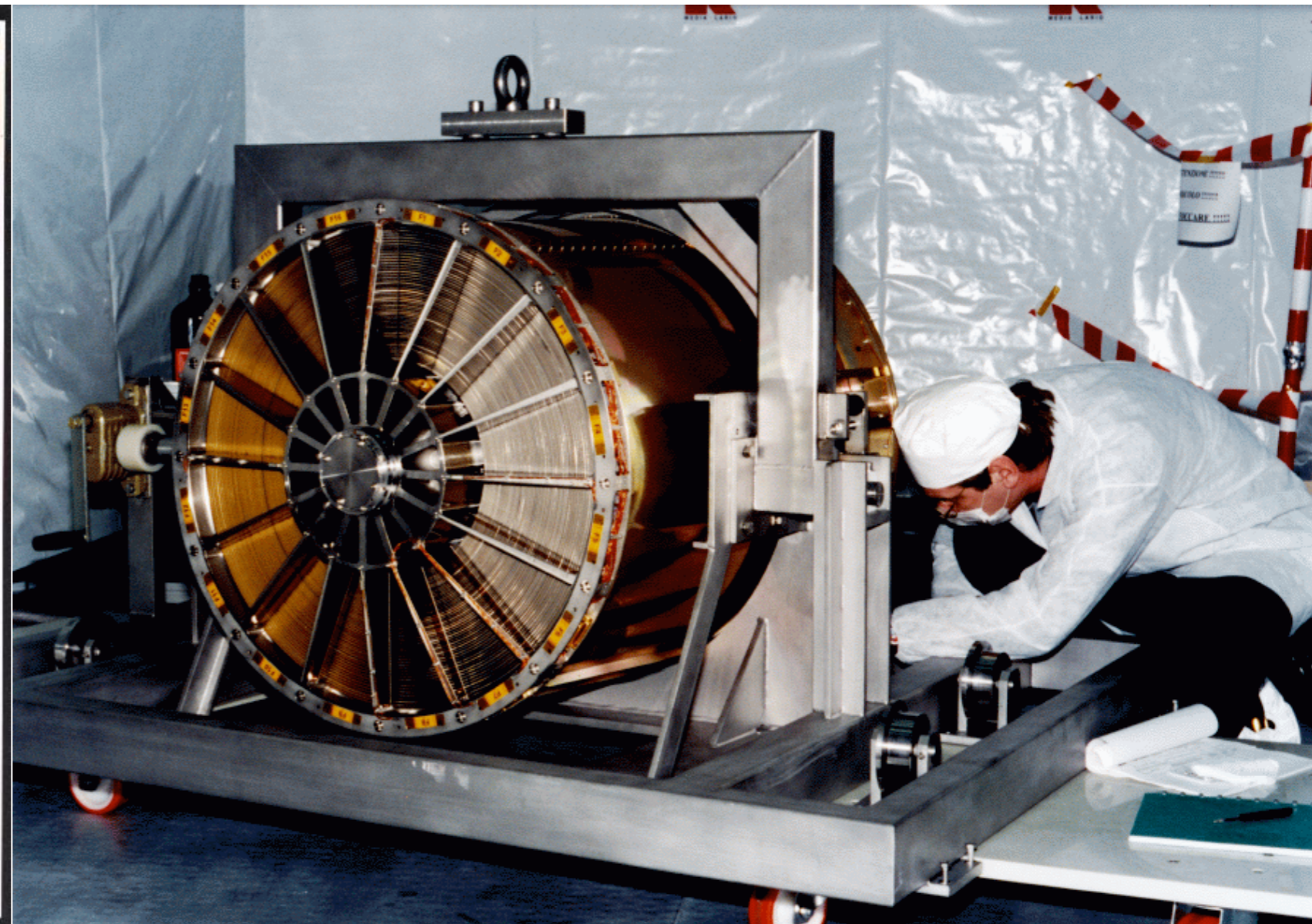
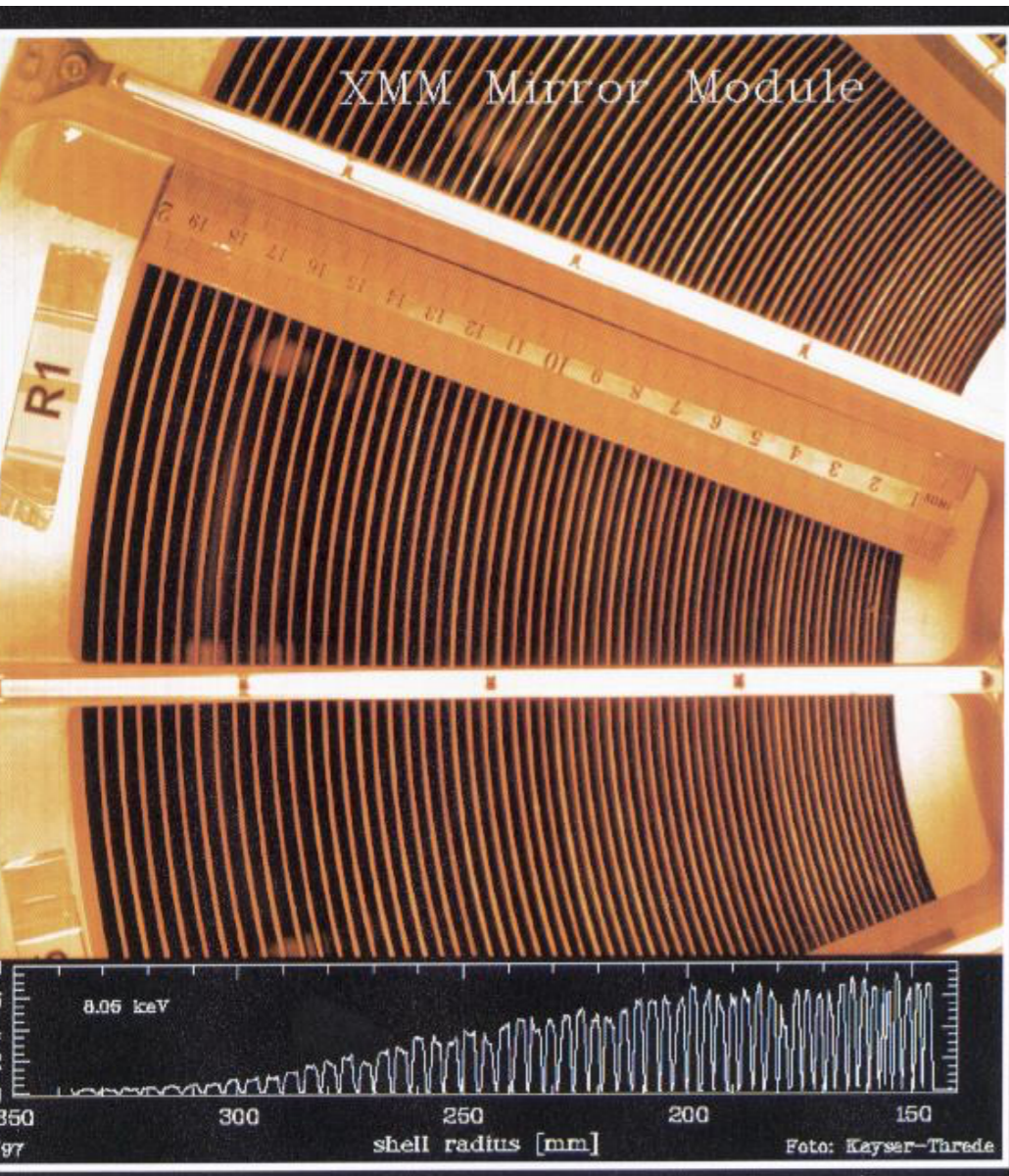
# Focussing X-rays is hard



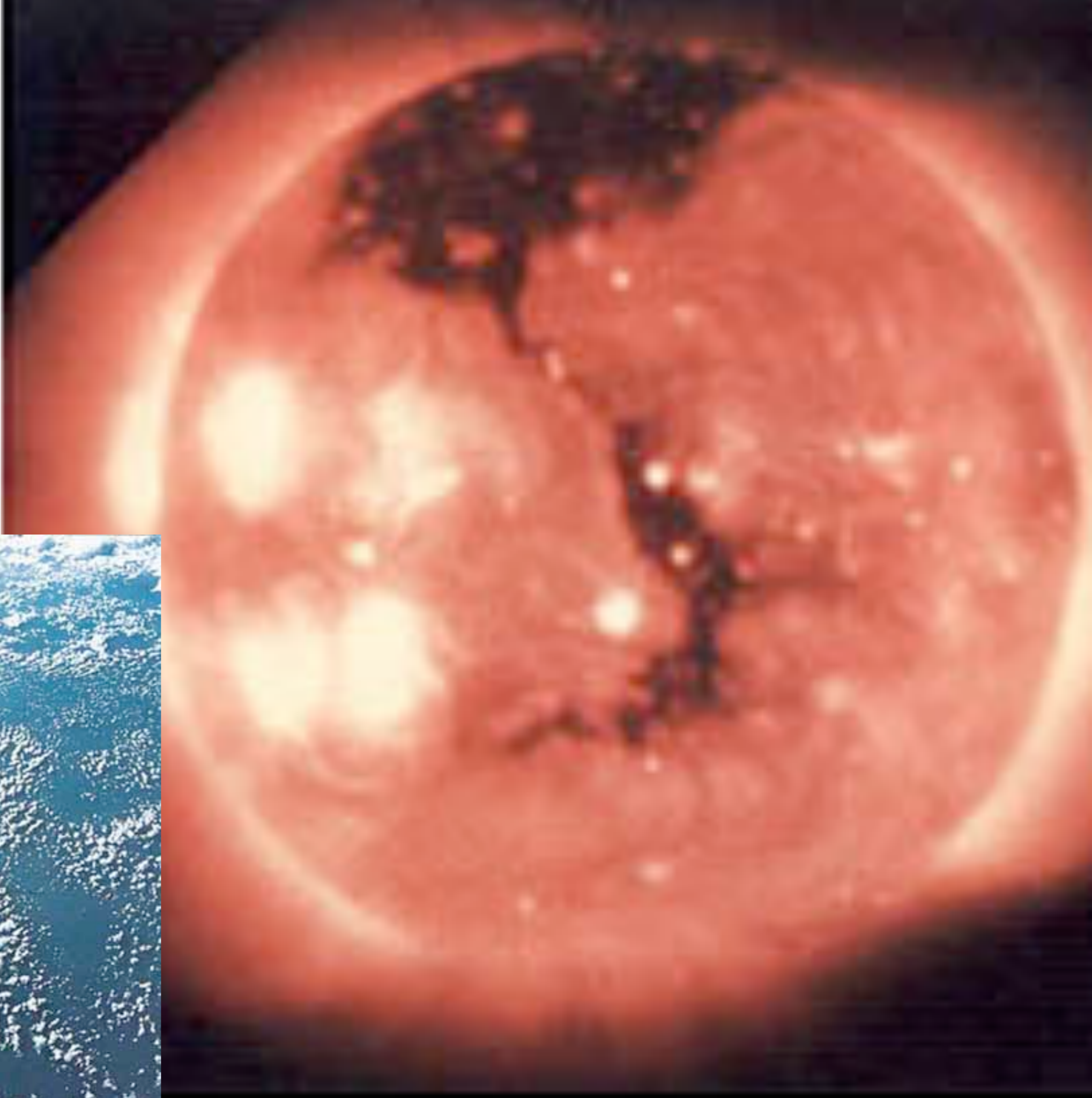
# Focussing X-rays is hard



# XMM mirrors during tests at Centre Spatial de Liege

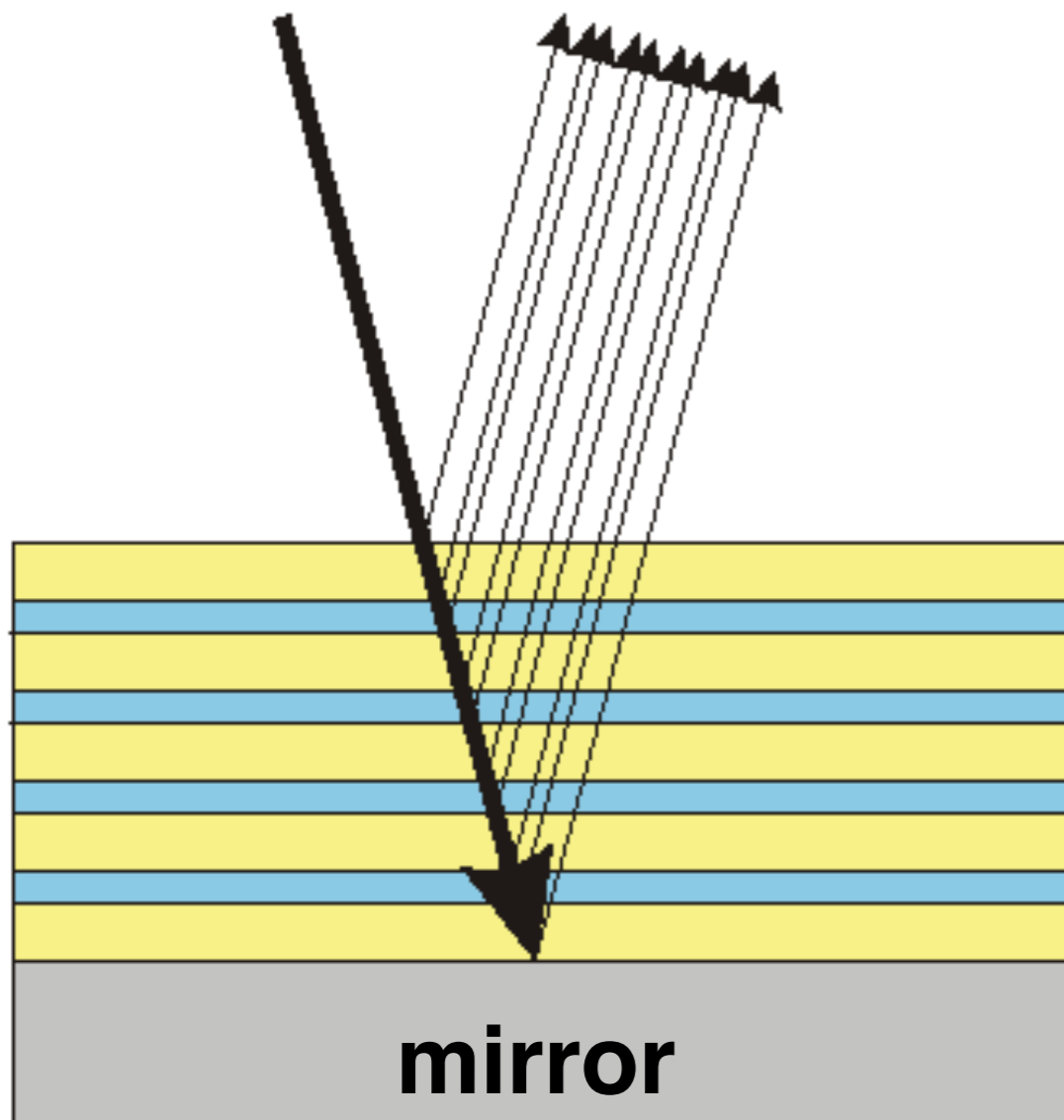


# Skylab (1973-74)

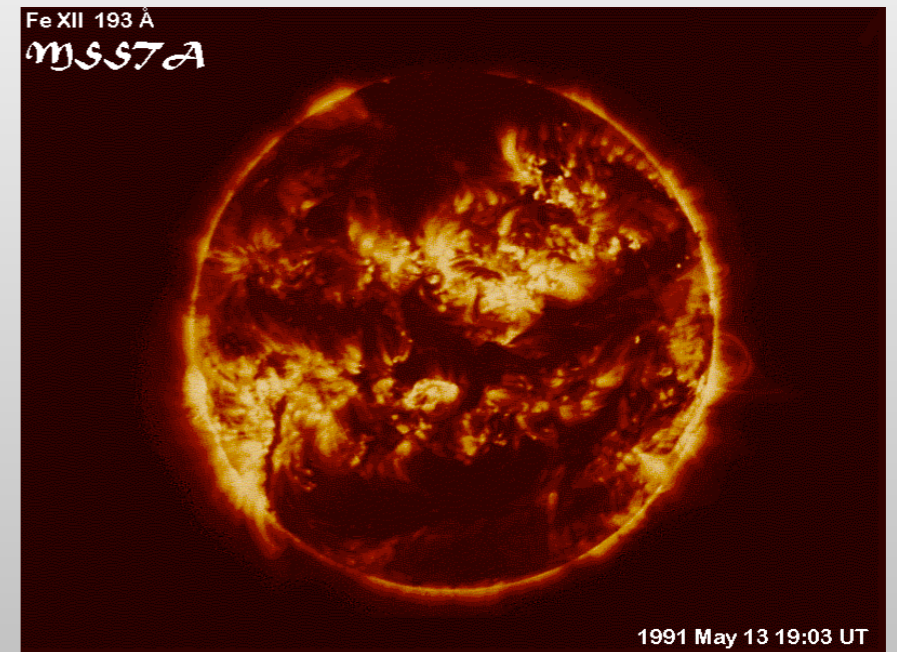




# New multilayer technology: normal incidence EUV reflection



1990's: prototypes on  
sounding rockets

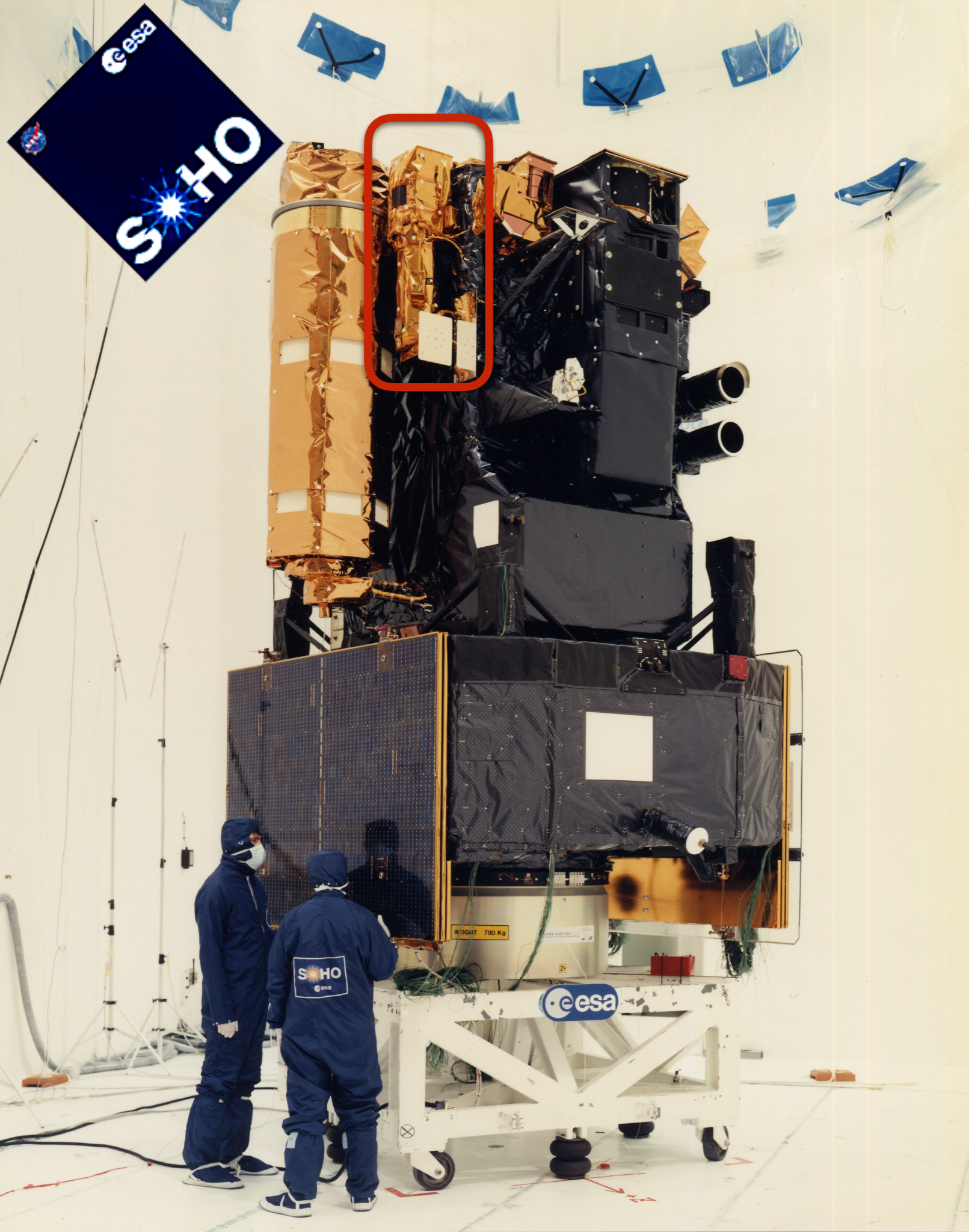


## **Molybdenum:**

heavy scatter element that absorbs EUV strongly

## **Silicon:**

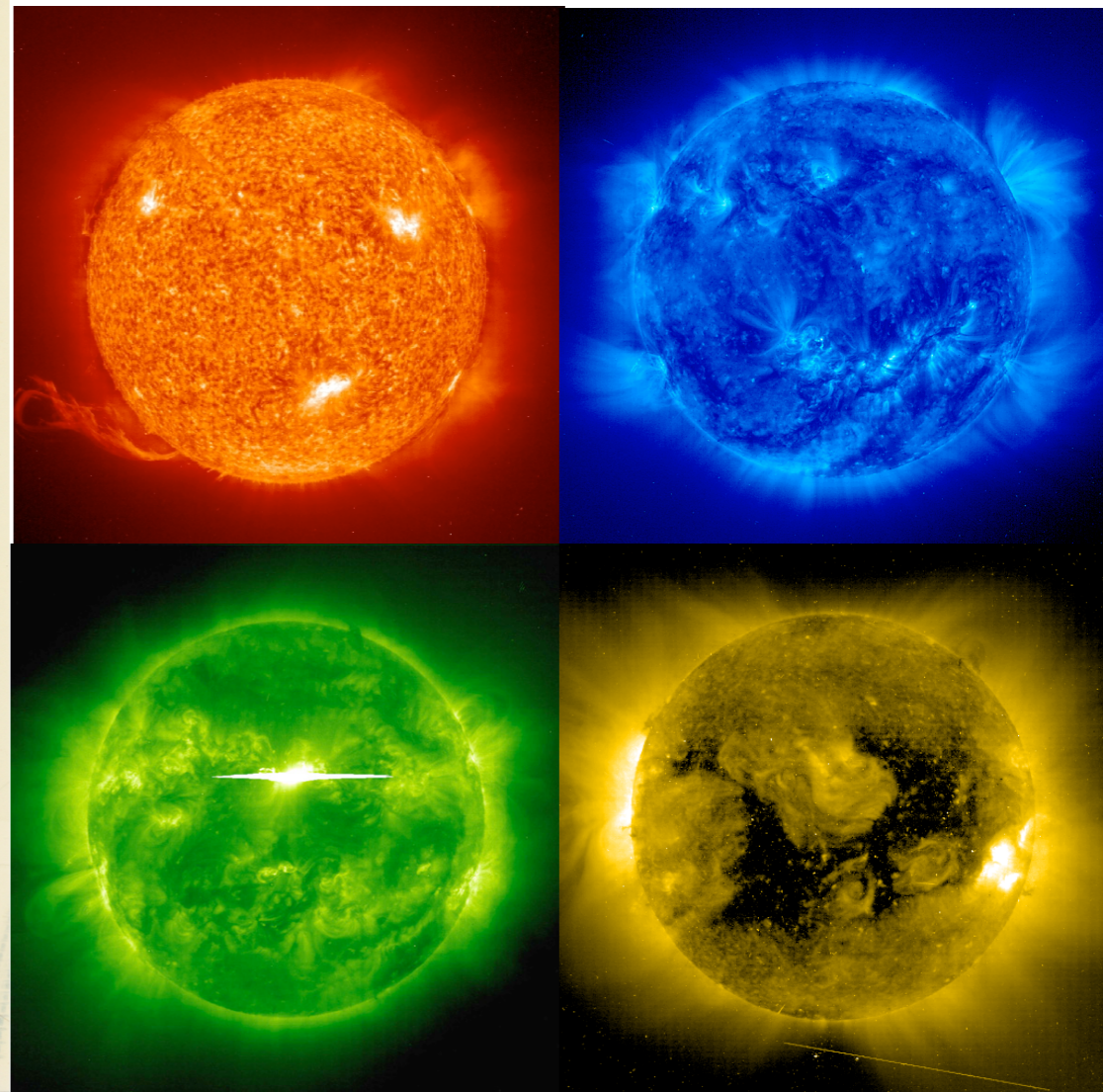
light element that absorbs EUV only weakly



# EIT

Extreme Ultraviolet  
Imaging Telescope

*“SOHO’s finderscope”*





# EIT

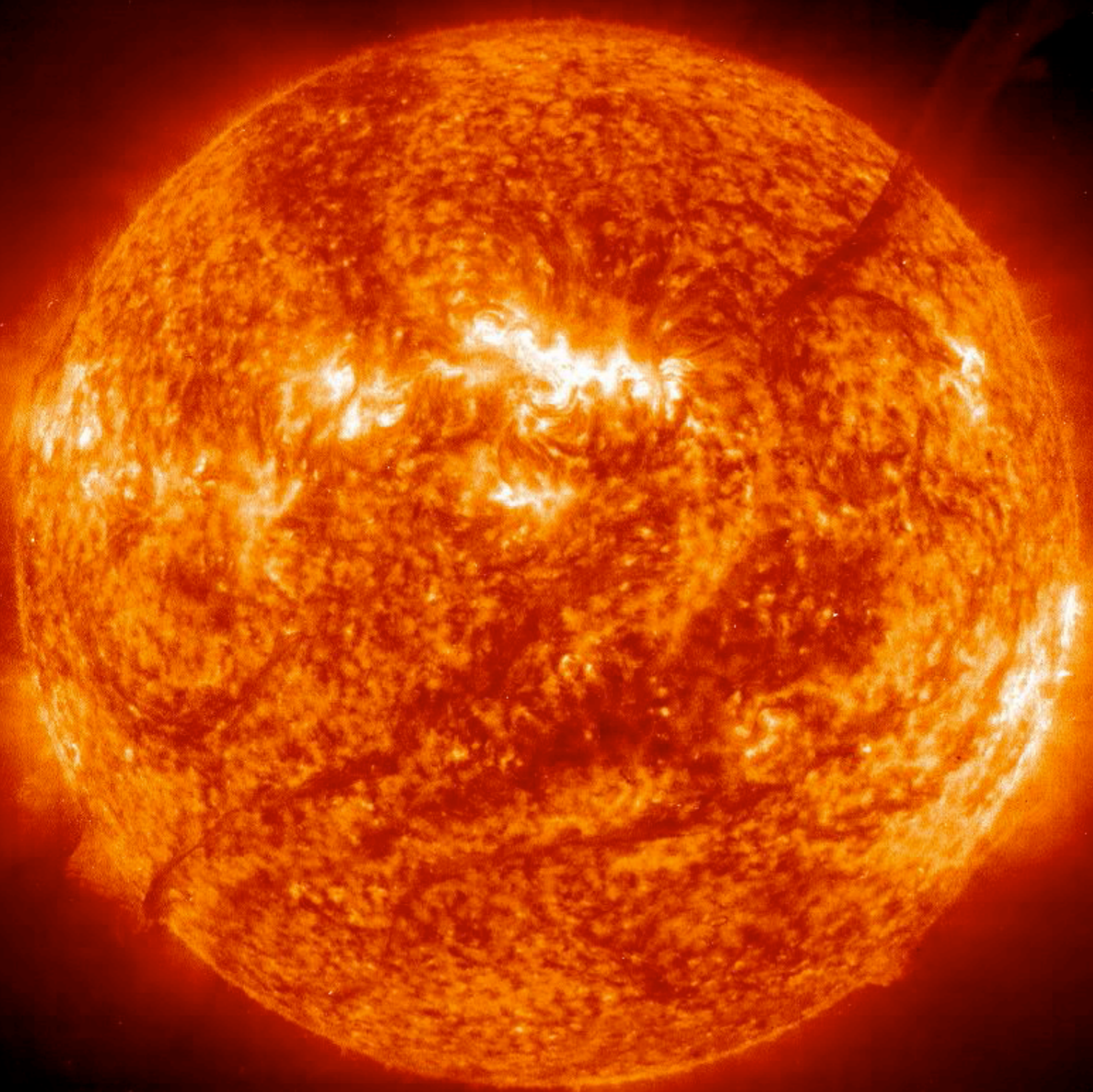
Jean-Pierre Delaboudinière  
† 2016 June

IAS; Orsay, France  
IOTA; Orsay, France  
LAS; Marseilles, France

LPARL; Palo Alto CA, USA  
GSFC; Greenbelt MD, USA

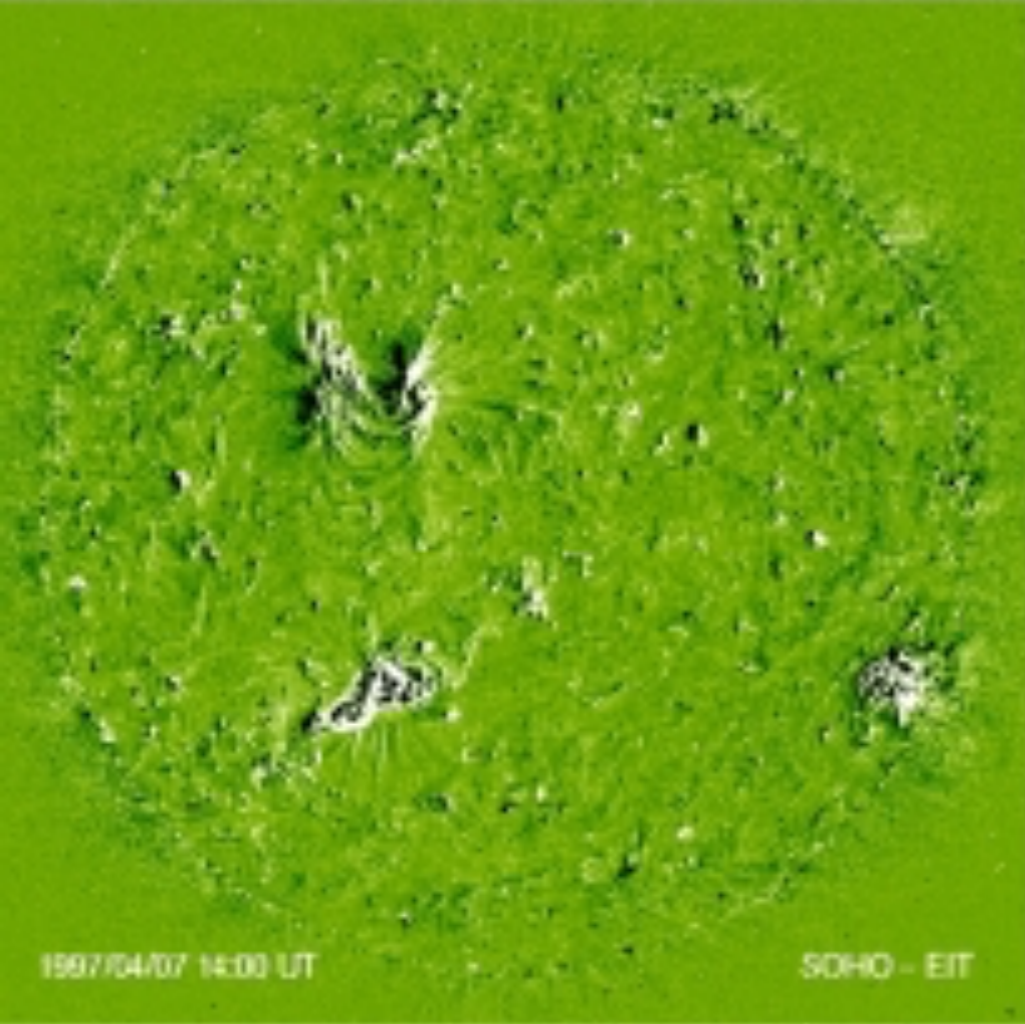
ROB, Brussels, Belgium  
CSL; Belgium

Picture taken during  
EIT Steering Committee meeting



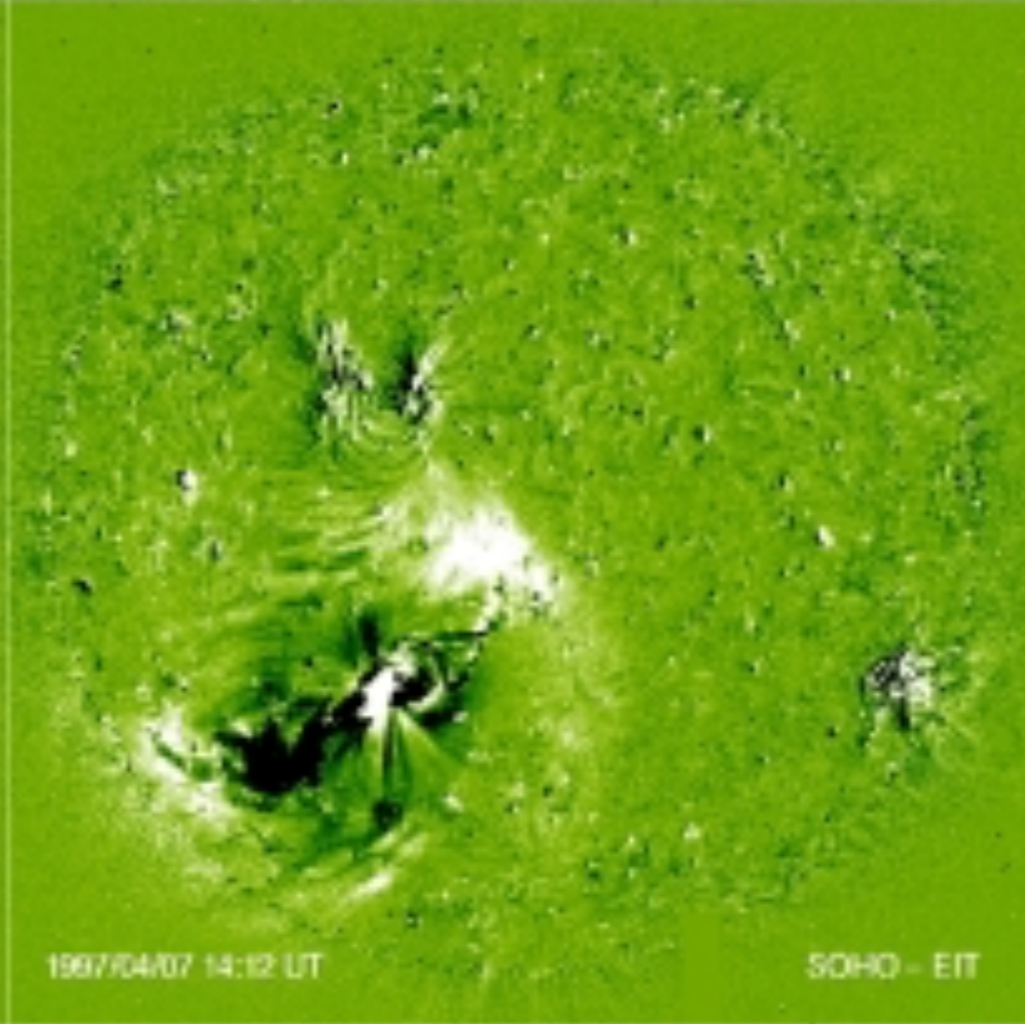
ENT

***“EIT waves”***



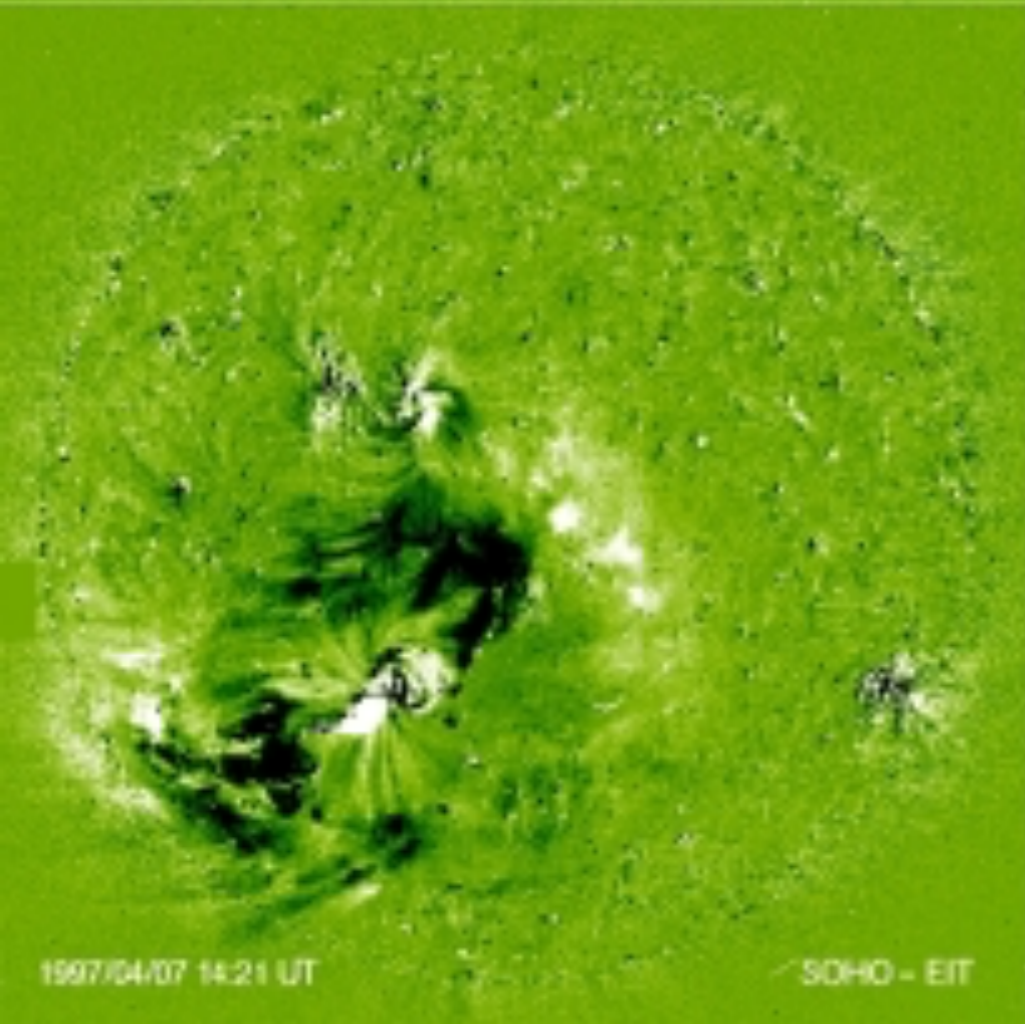
1997/04/07 14:00 UT

SOHO - EIT



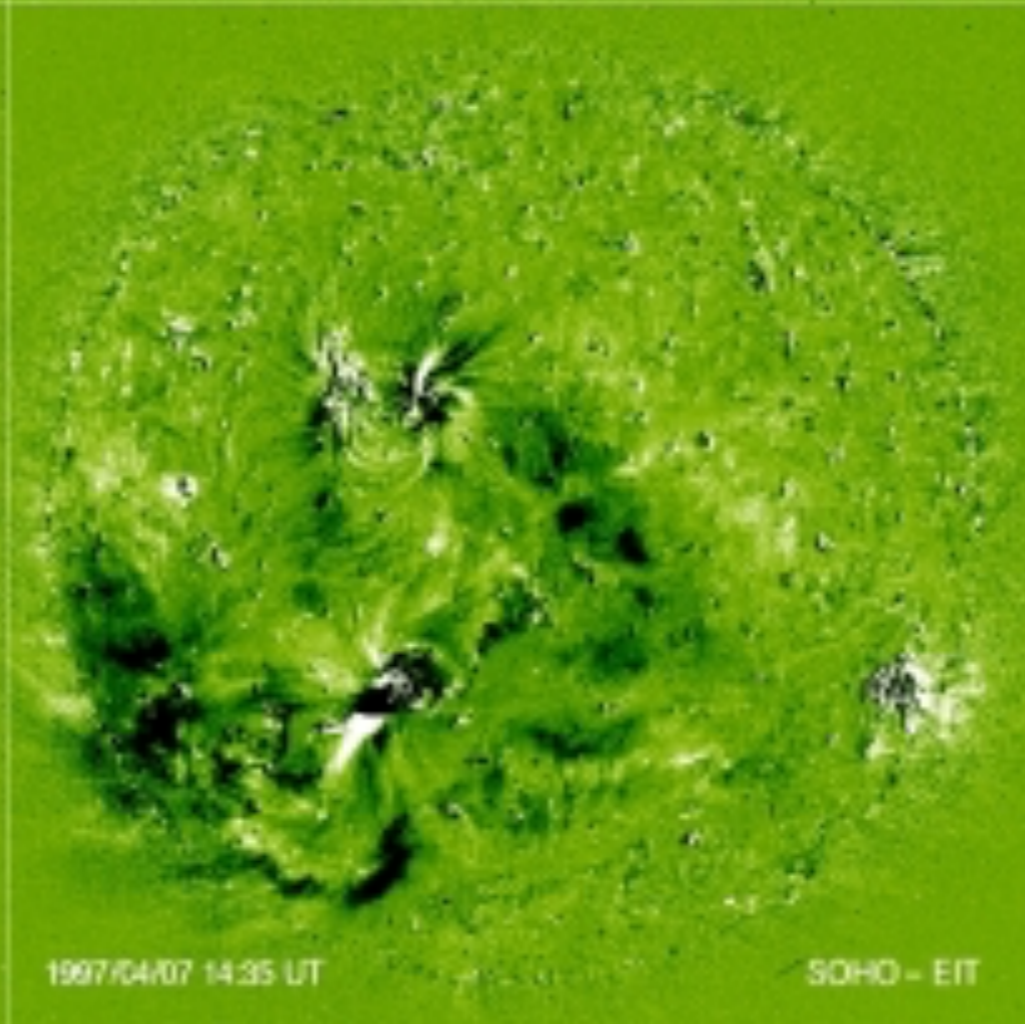
1997/04/07 14:12 UT

SOHO - EIT



1997/04/07 14:21 UT

SOHO - EIT



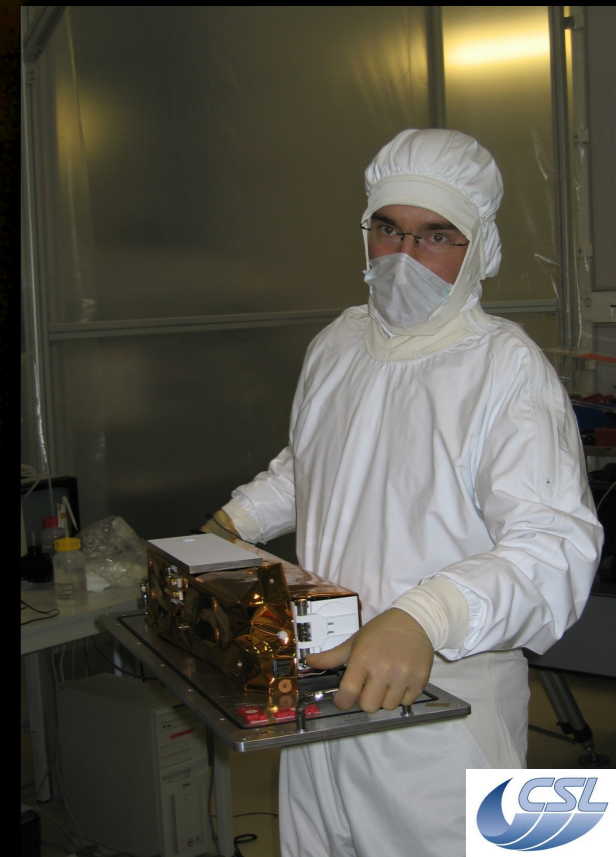
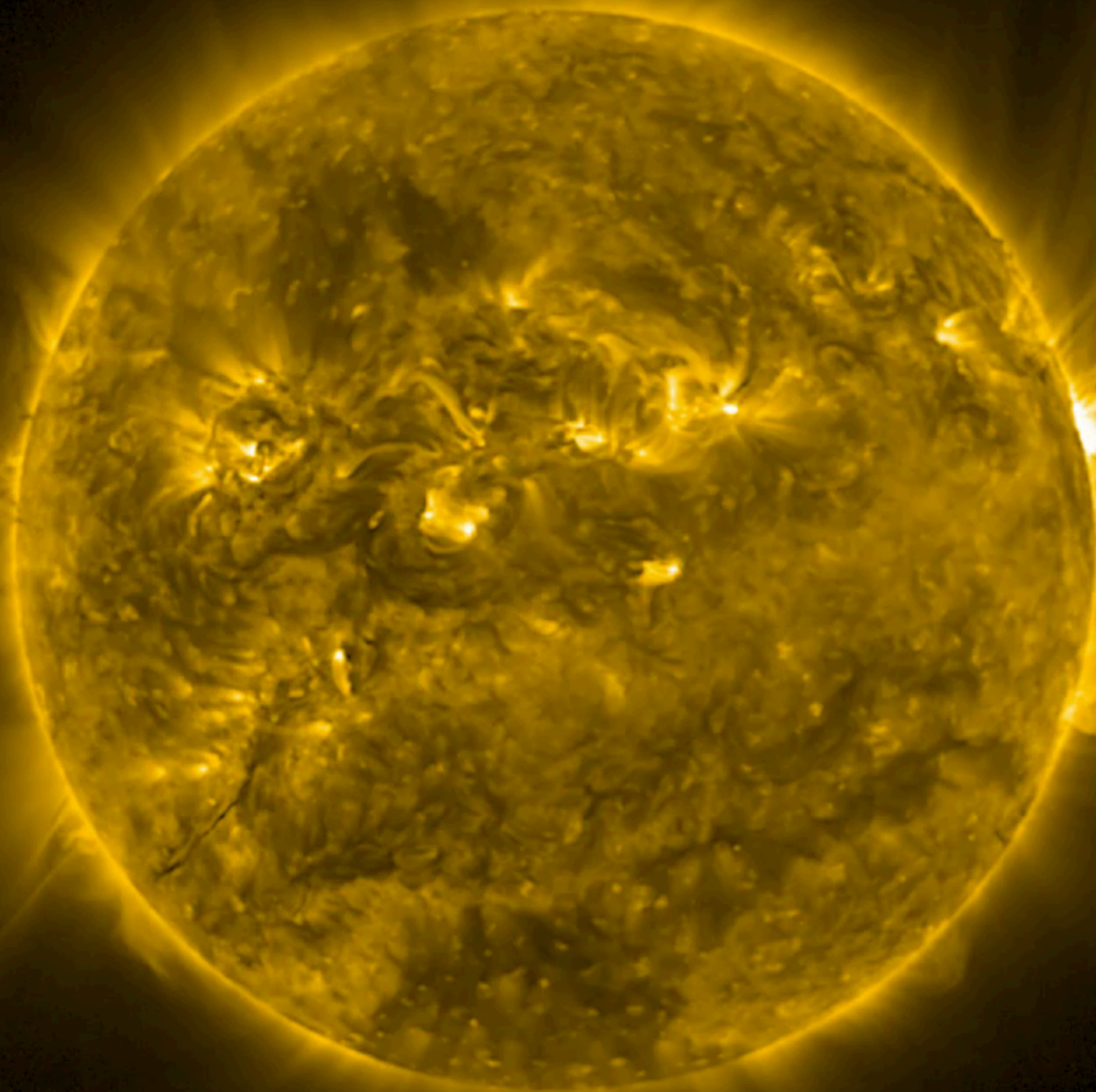
1997/04/07 14:35 UT

SOHO - EIT

# Microsatellite PROBA2



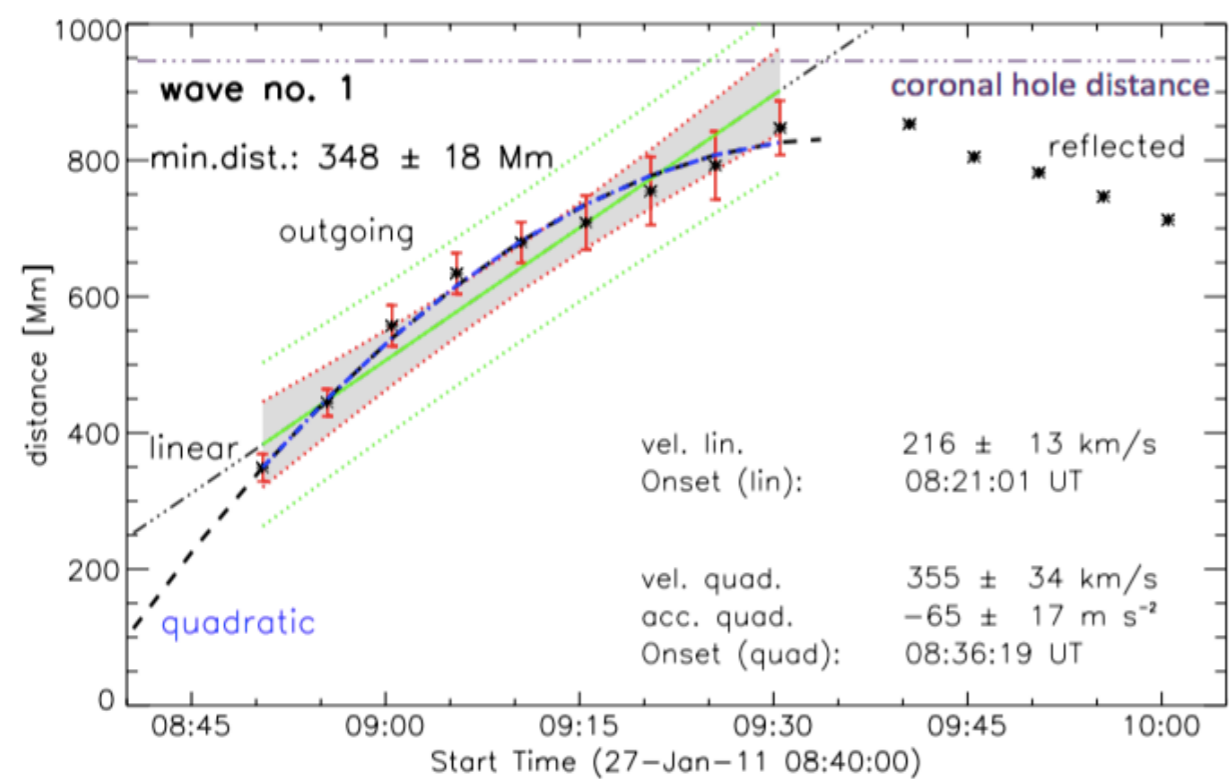
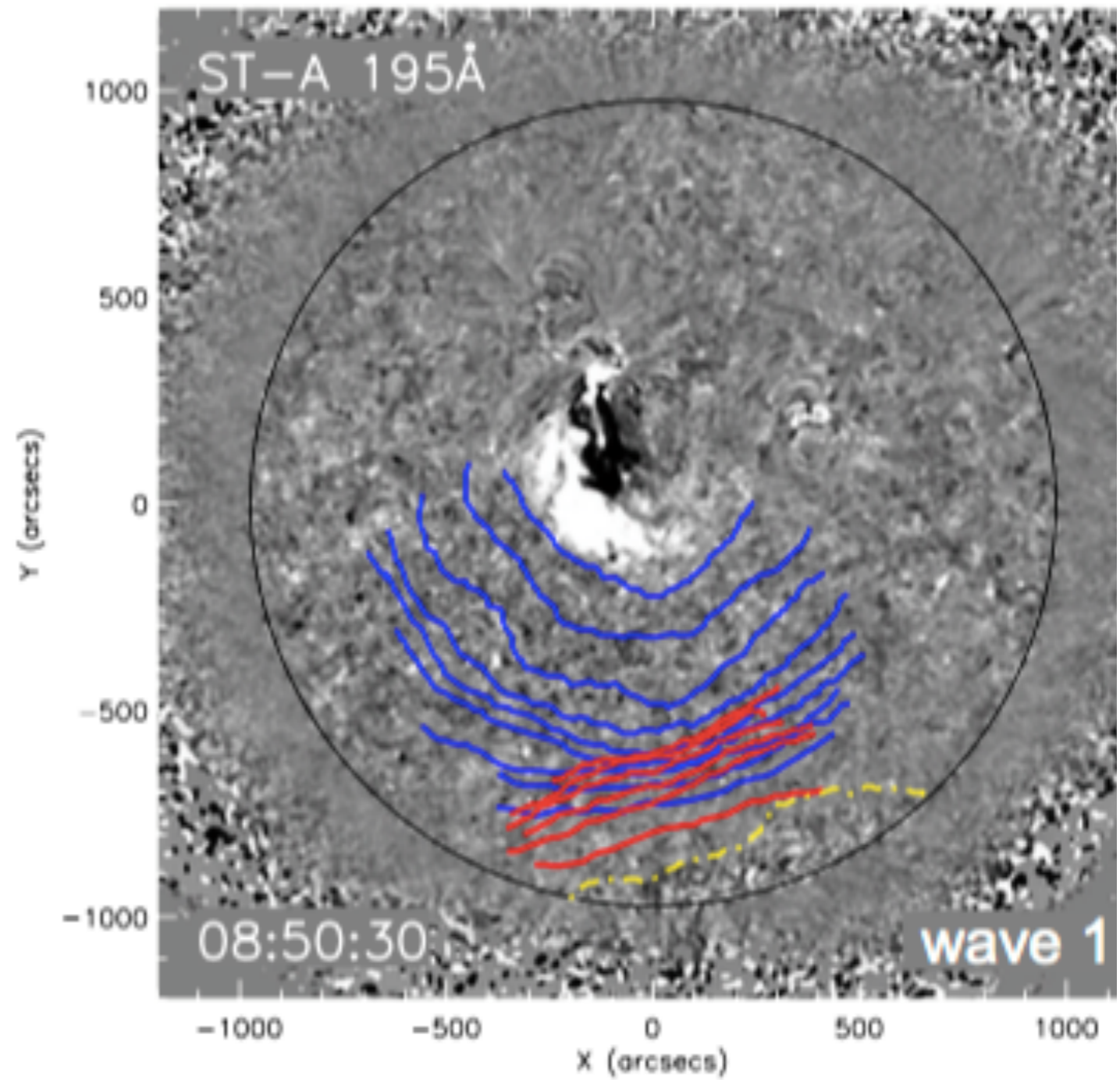
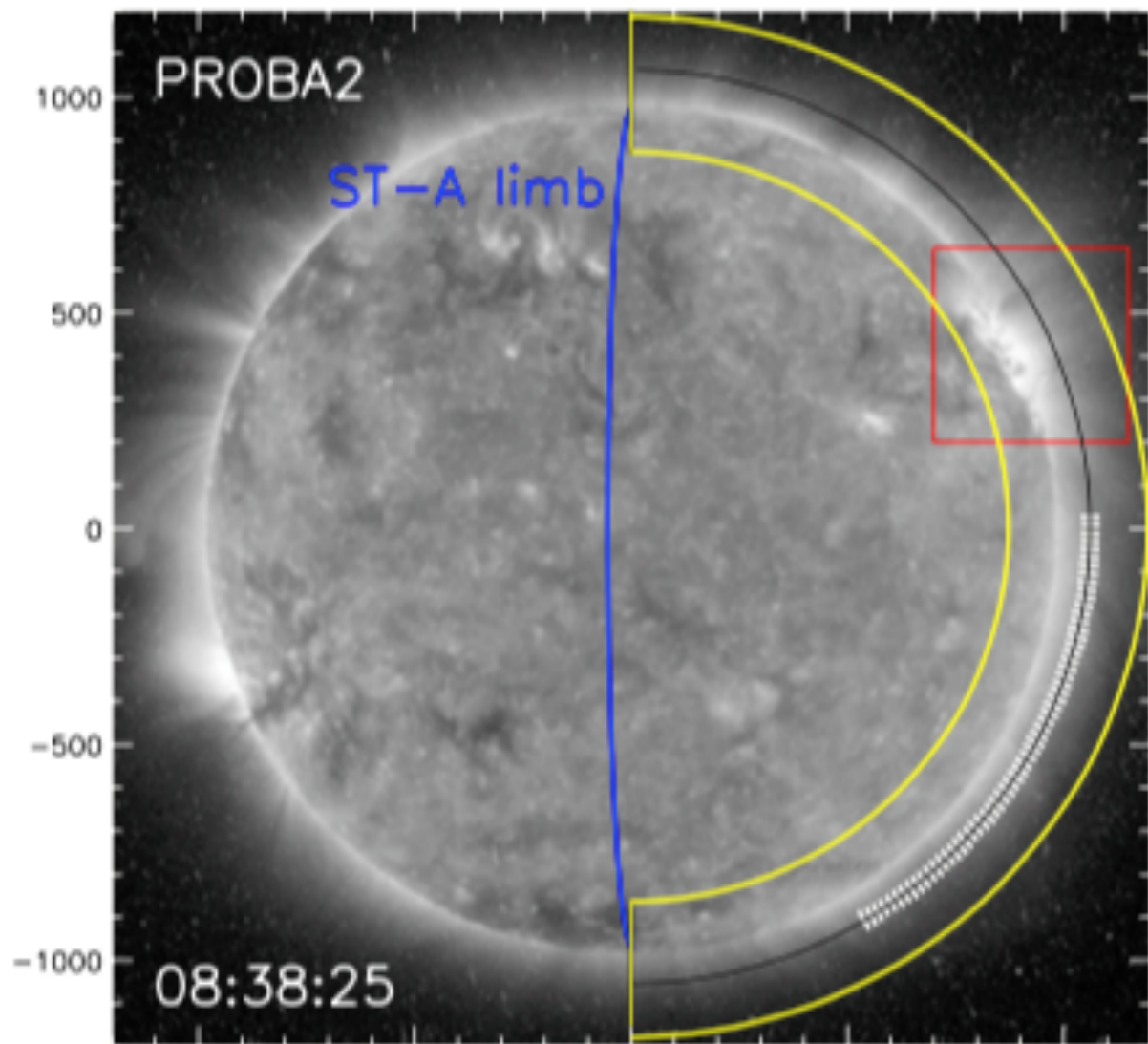
# “Sun Watcher using APS and Image Processing” (SWAP) onboard PROBA2



PROBA2/SWAP 174 2016-02-18T04:38:04



# Coronal Seismology



PROBA2/SWAP (ESA) and STEREO/EUVI (NASA)

Kienreich et al (2013)



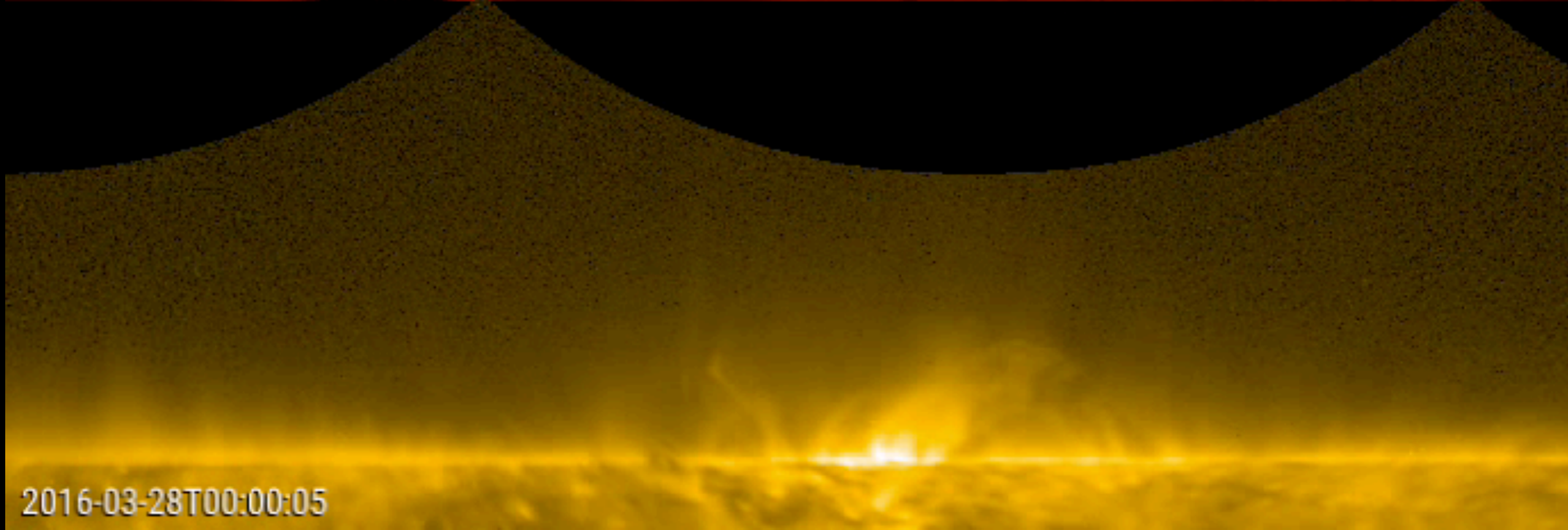
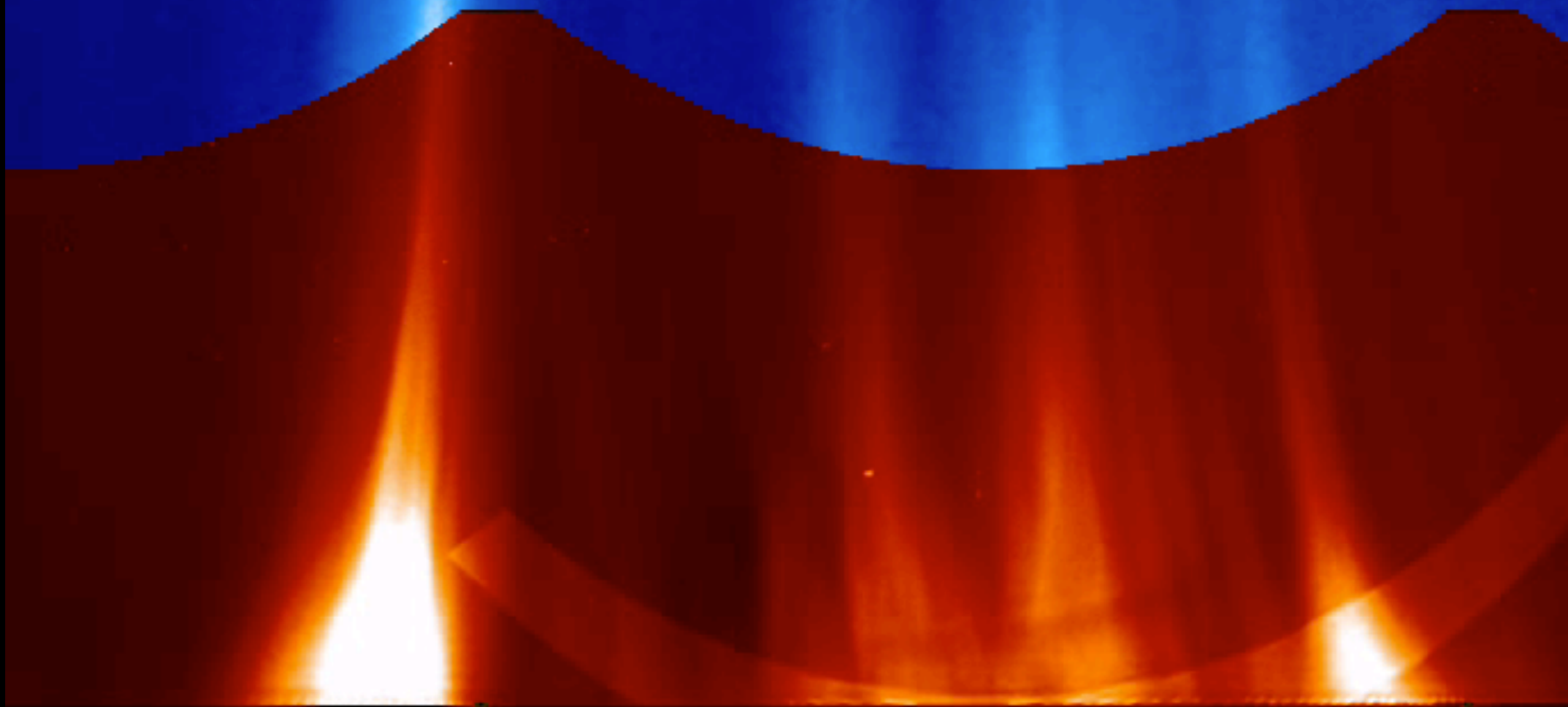
# Venus transit

SWAP 174

2012-06-05 19:01:10



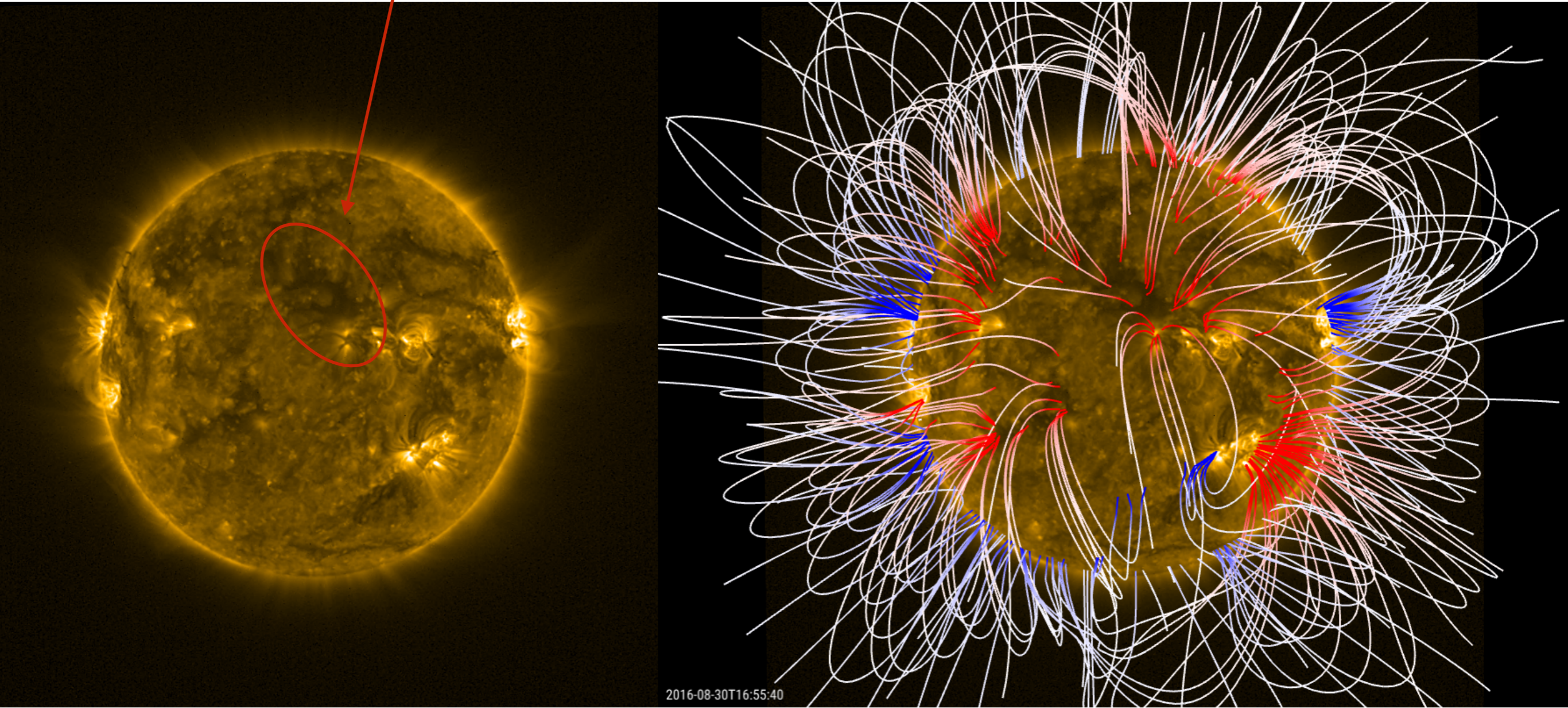
***Tracking CMEs from the solar surface***



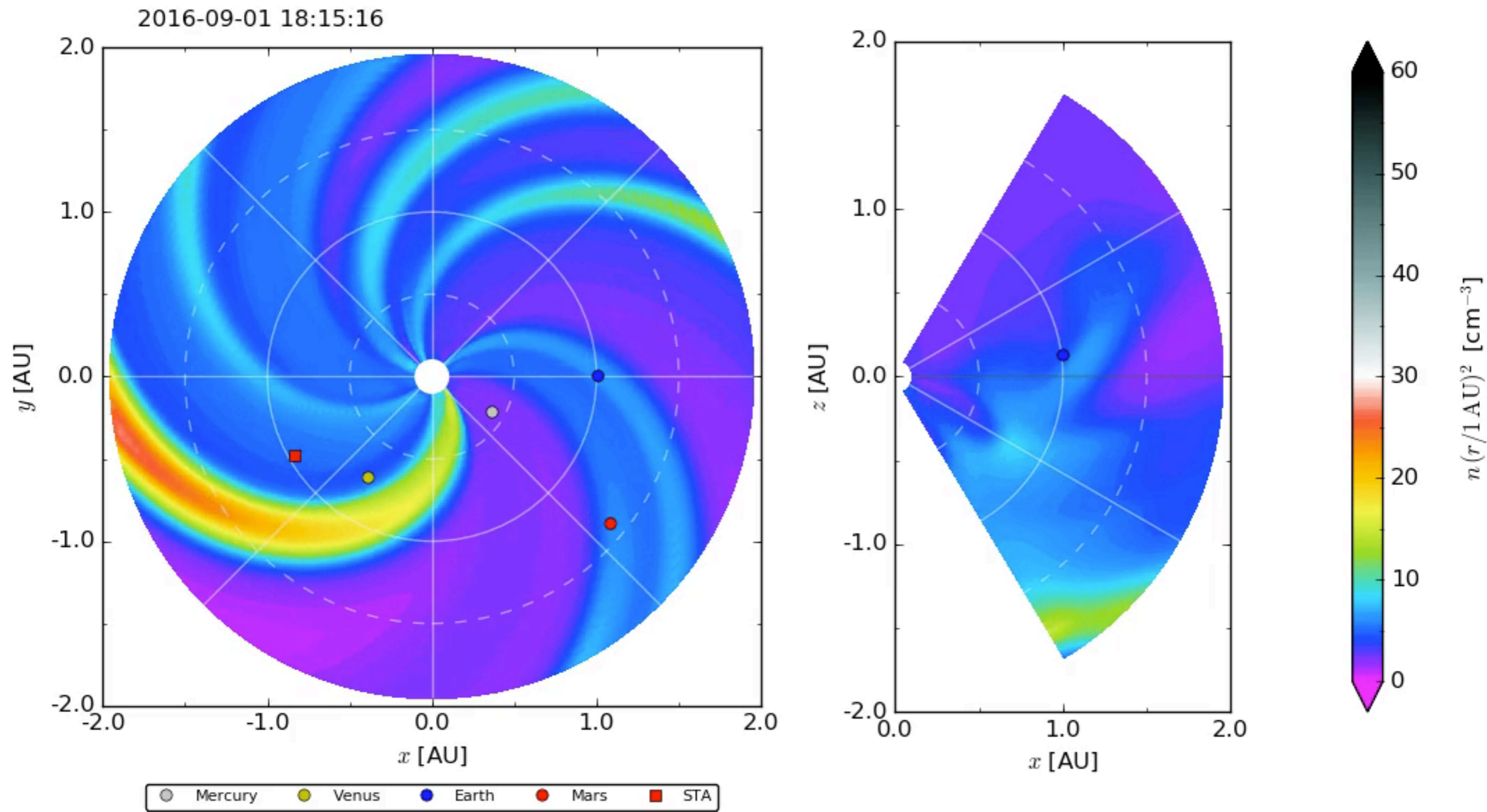
2016-03-28T00:00:05

# ***Coronal holes as the source of geomagnetic storms***

coronal hole



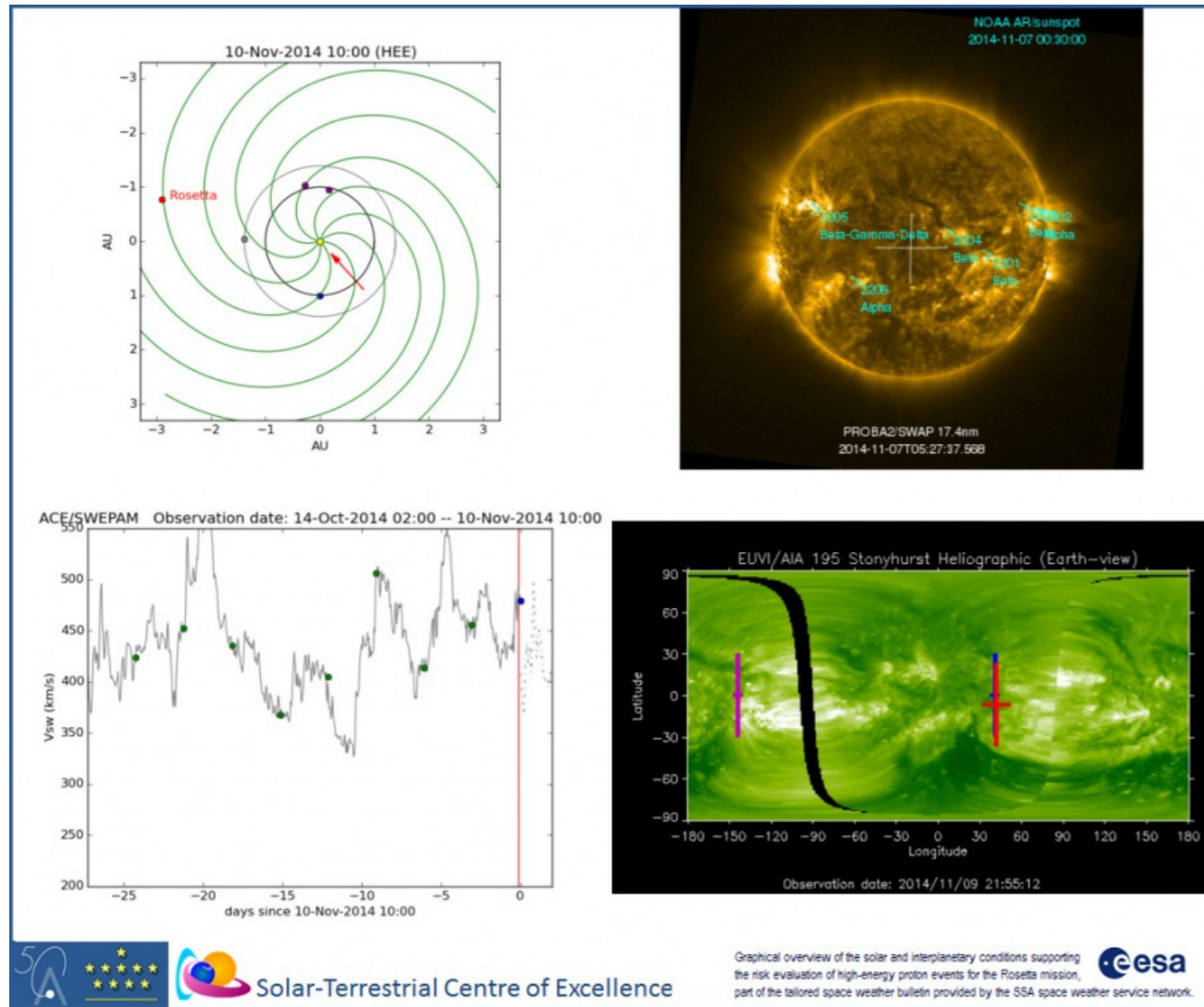
Aug 31, last Wednesday



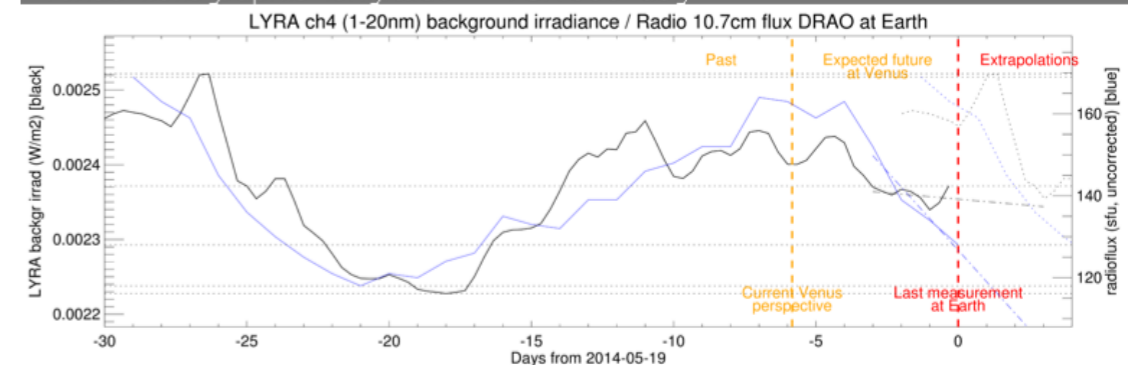
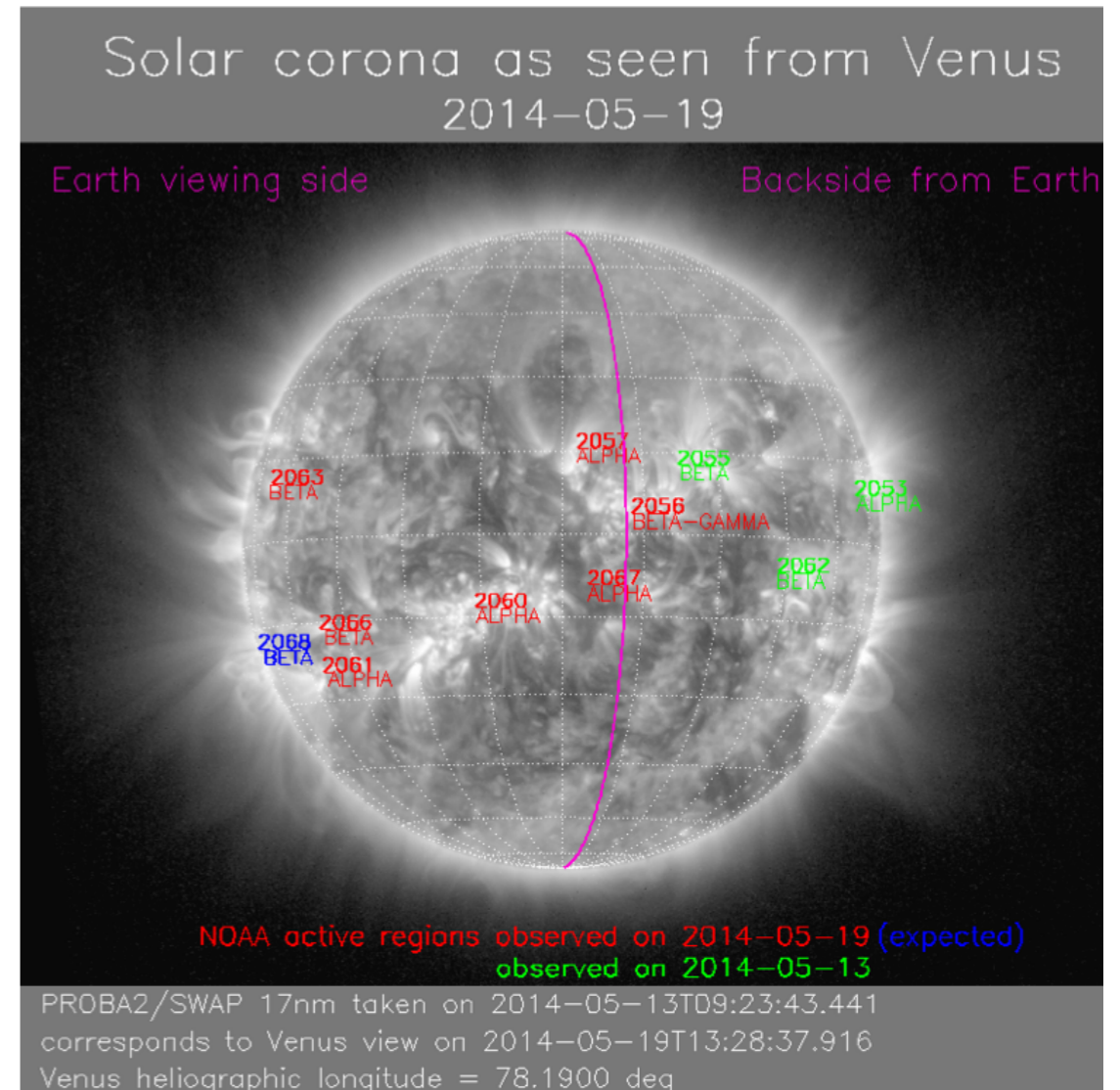
EUHFORIA, realtime simulations of the inner heliosphere

# SSA Space Weather bulletins

## Arrival of Rosetta at Comet 67P/C-G

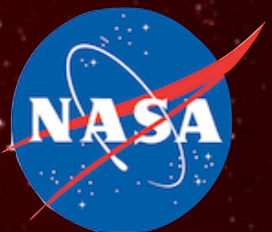


## 2014 Venus express aerobreaking manœuvre

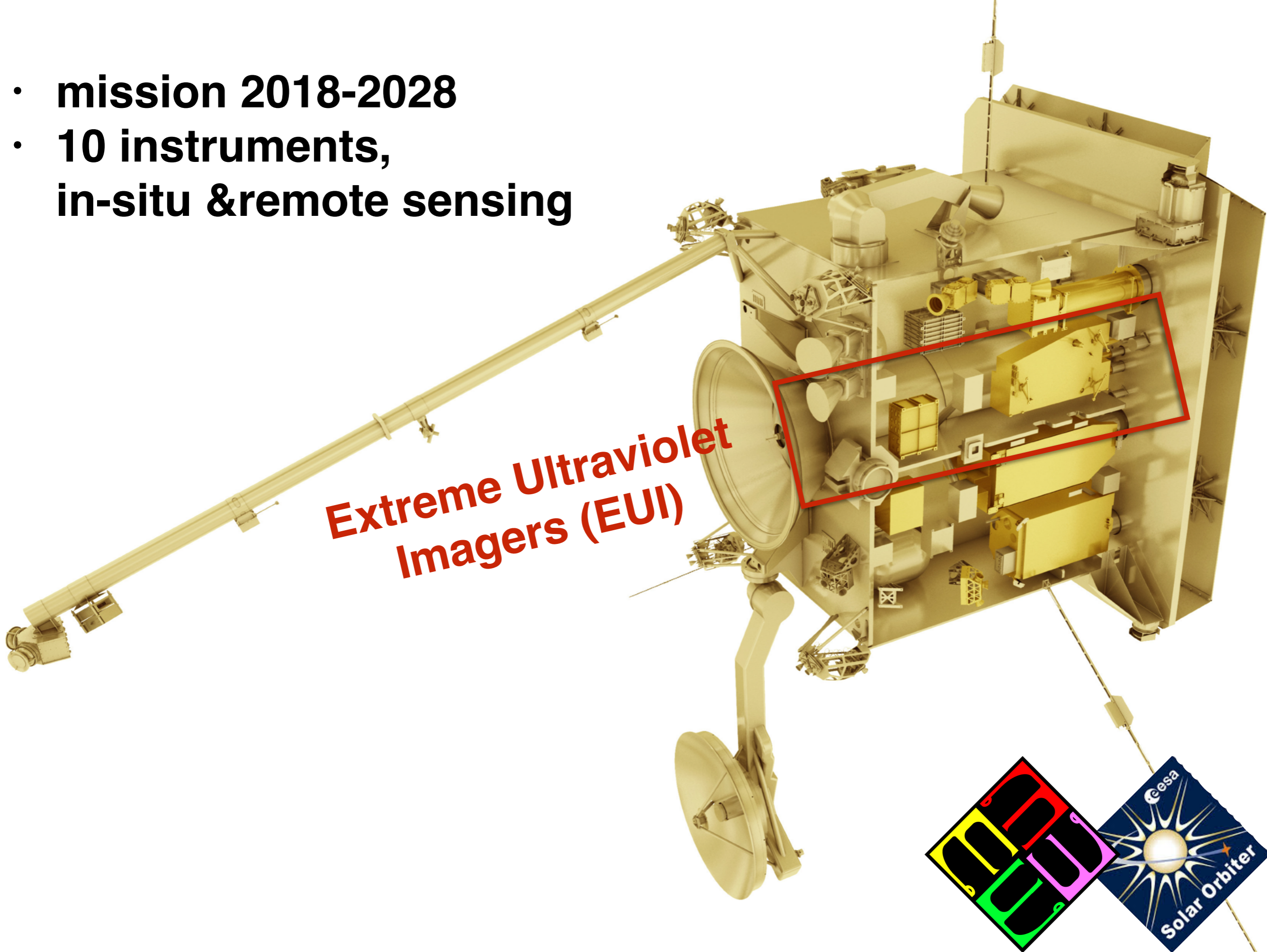


# Solar Orbiter

• will reach  $<0.3\text{AU}$   
• will reach  $>30$  deg latitude  
• reduced relative rotation



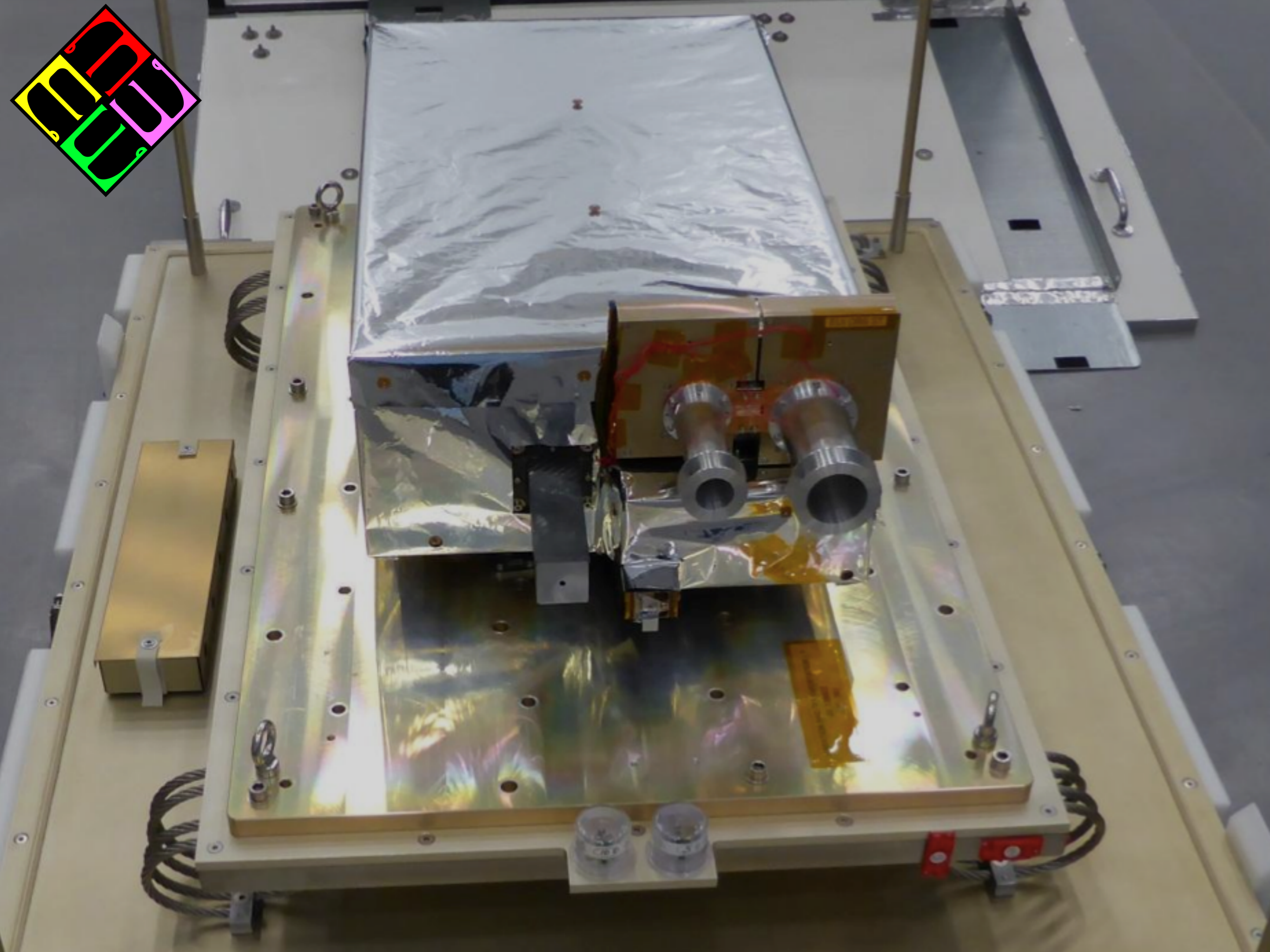
- mission 2018-2028
- 10 instruments,  
in-situ & remote sensing



# The EUI team

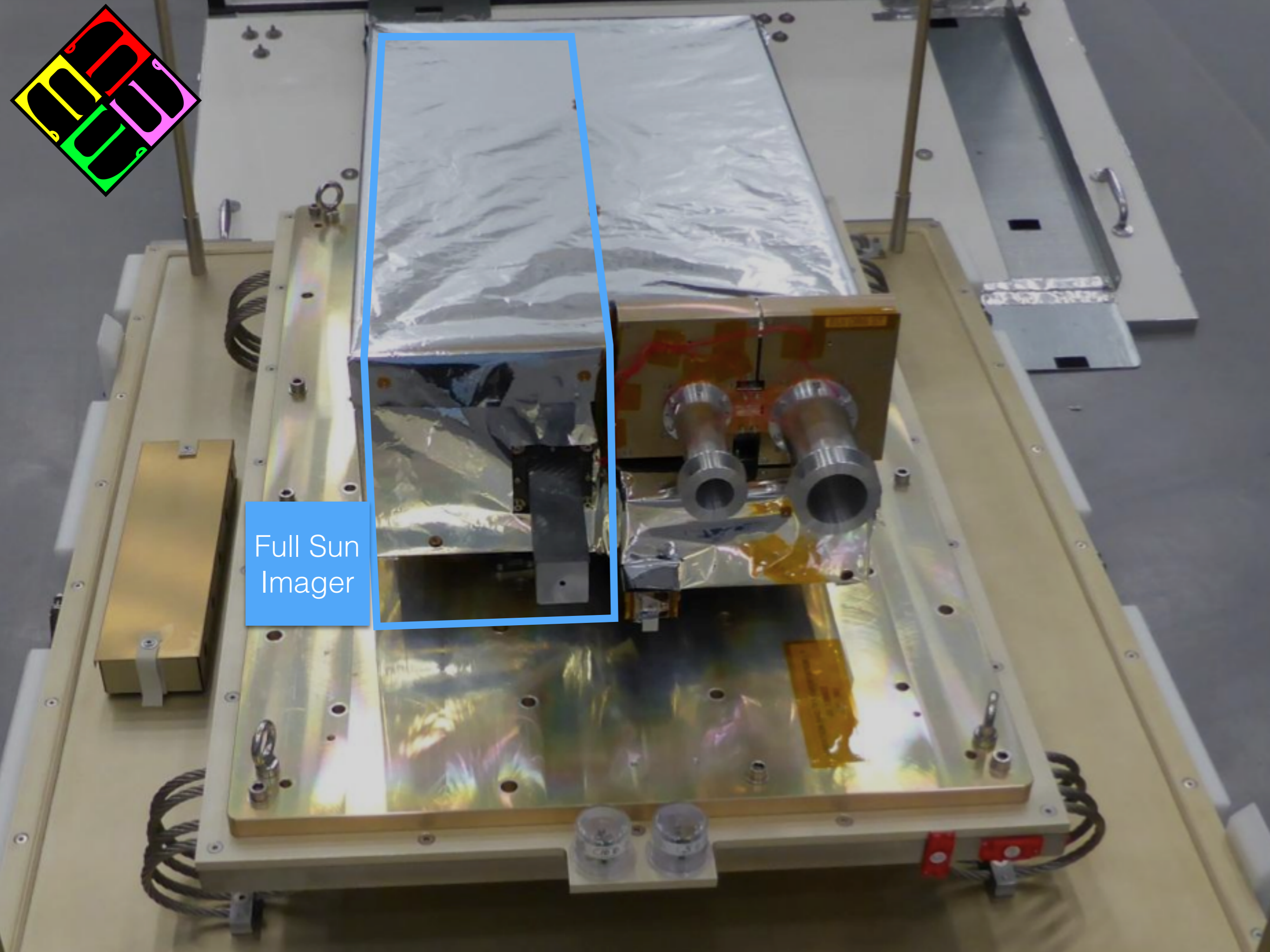








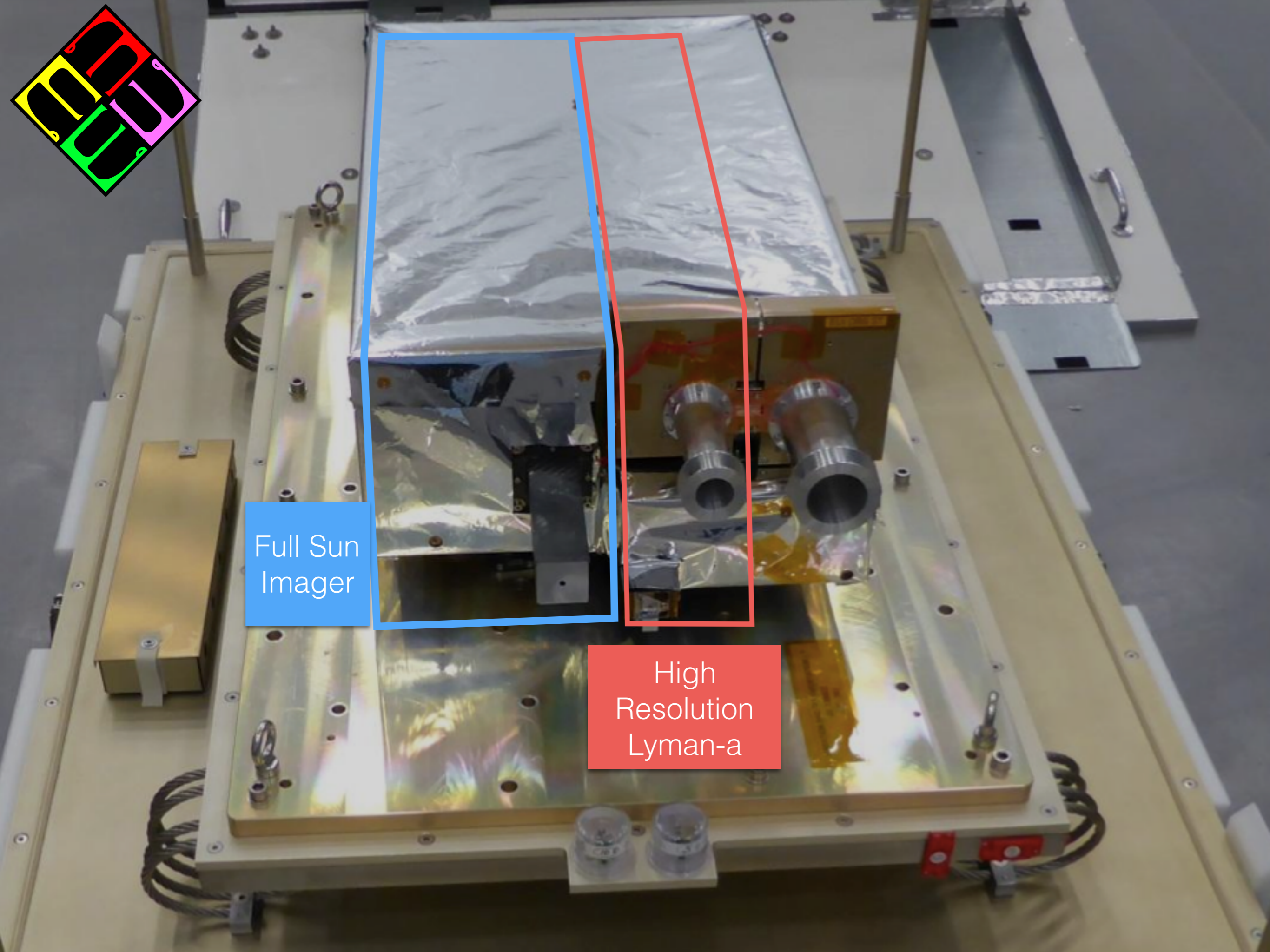
Full Sun Imager





Full Sun Imager

High Resolution Lyman-a

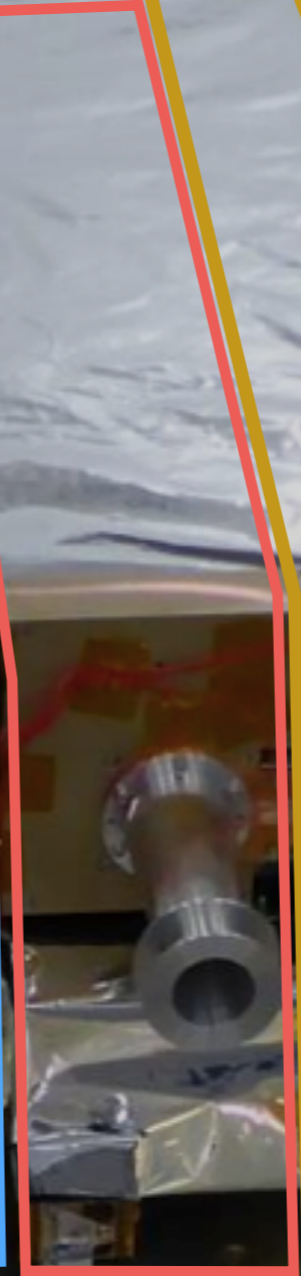




Full Sun Imager



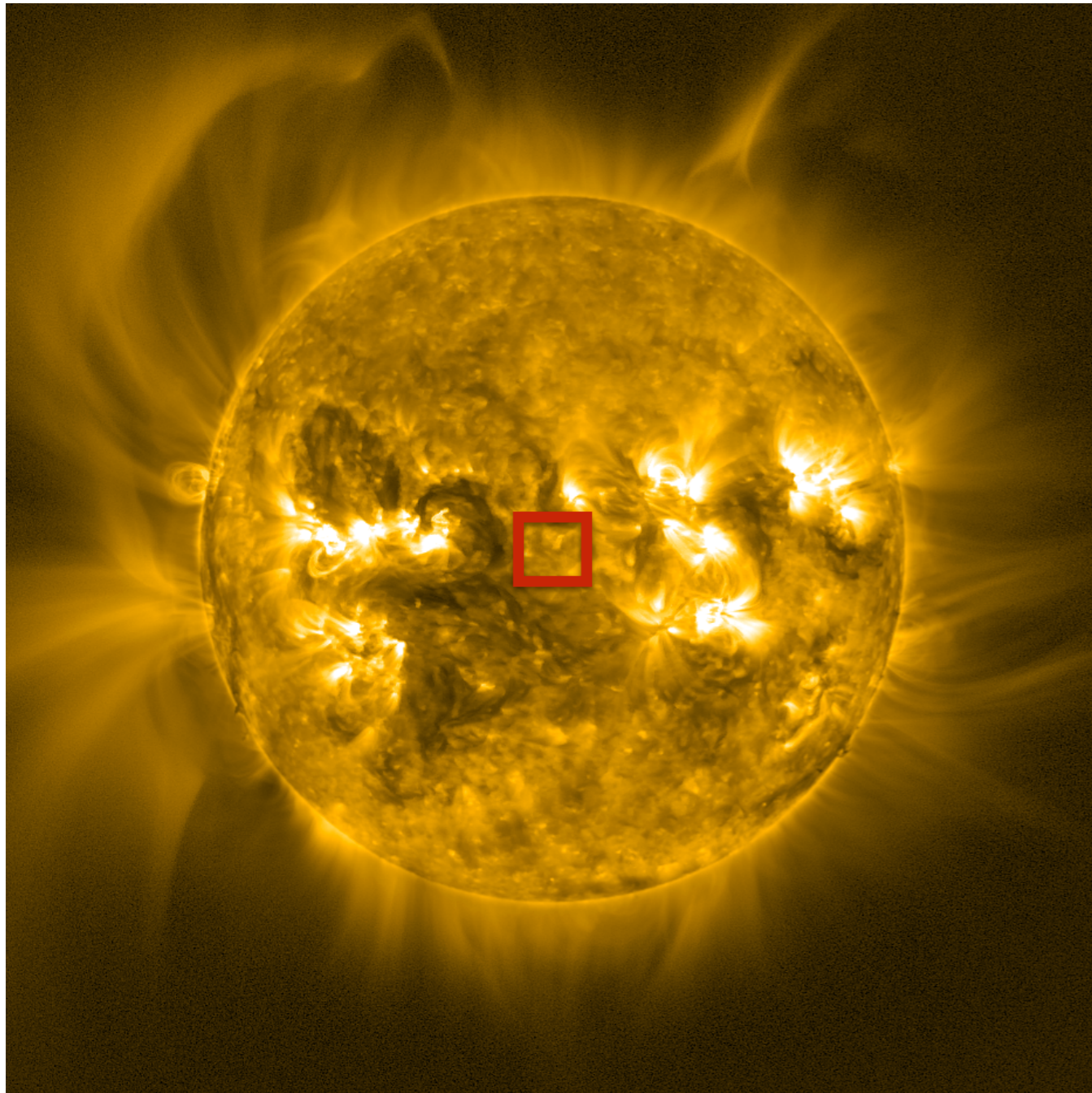
High Resolution Lyman-a



High Resolution EUV



# HRI: High Resolution Imagers



field of view:

17'x17'

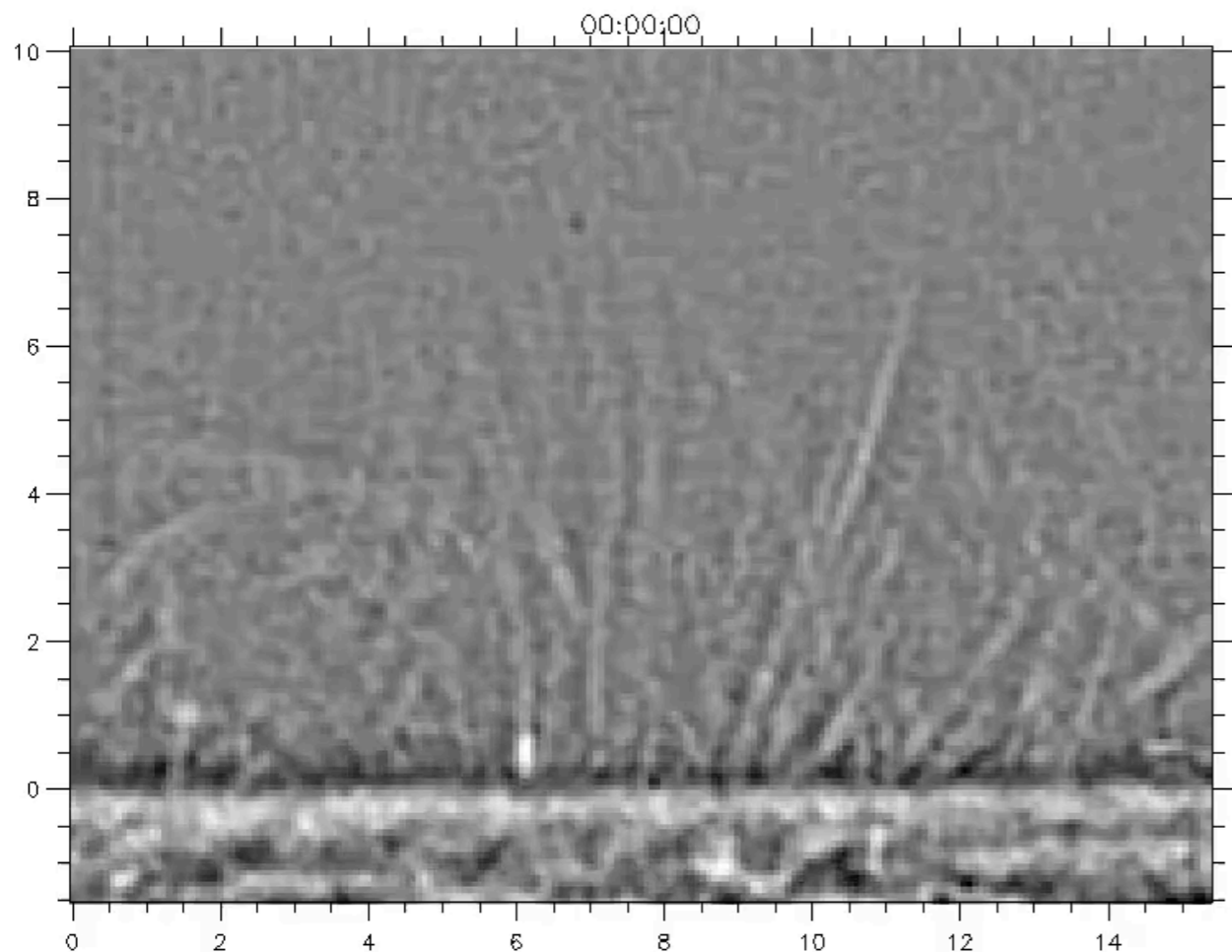
@ 0.28 AU =  $(0.16 R)^2$

resolution:

1 arcsec on 2 pixels

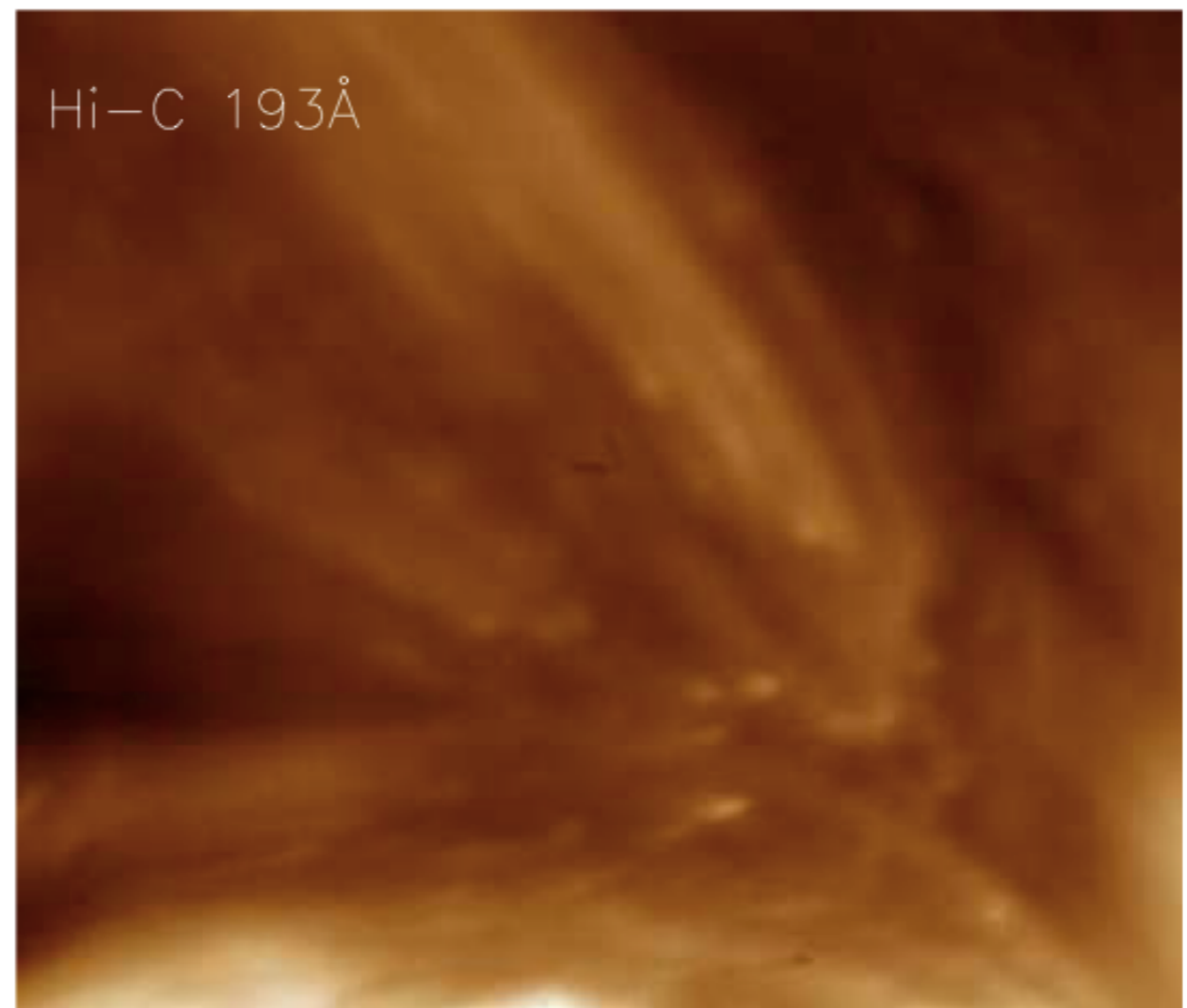
@ 0.28 AU = 200km

## Oscillations & waves?



Hinode SOT Difference movie  
of Type II spicules  
De Pontieu et al, 2007 Science

## Smallest loops and brightenings

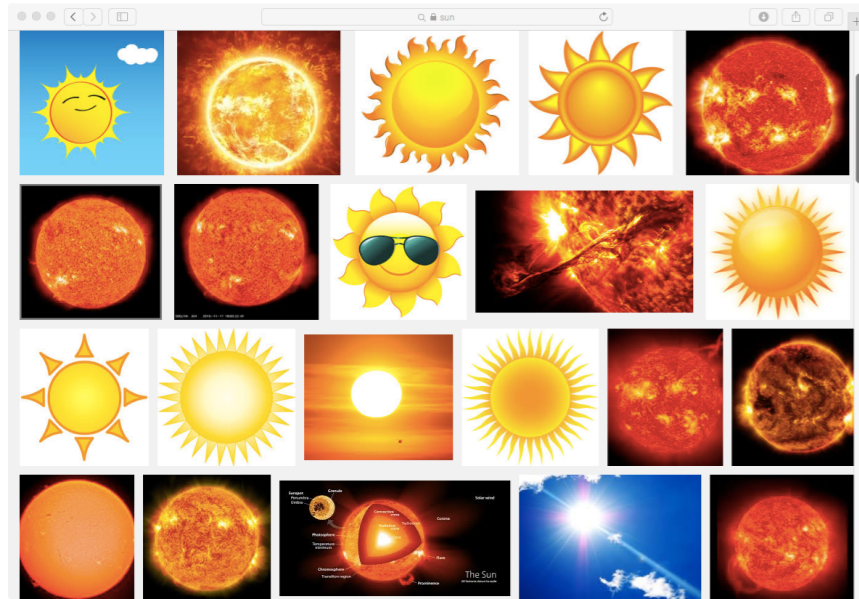


EUV Bright Dots (EBDs)  
at base of large loops  
Regnier et al, ApJ, 2014



Who cares?

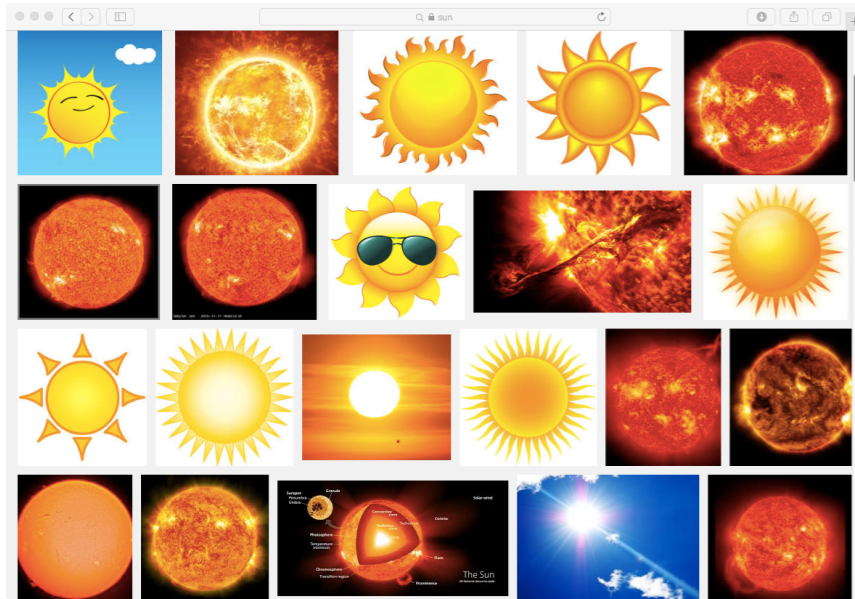
# Google Image Search “Sun”



8 cartoons  
**11 science**  
2 common



Google Image Search  
“Sun”



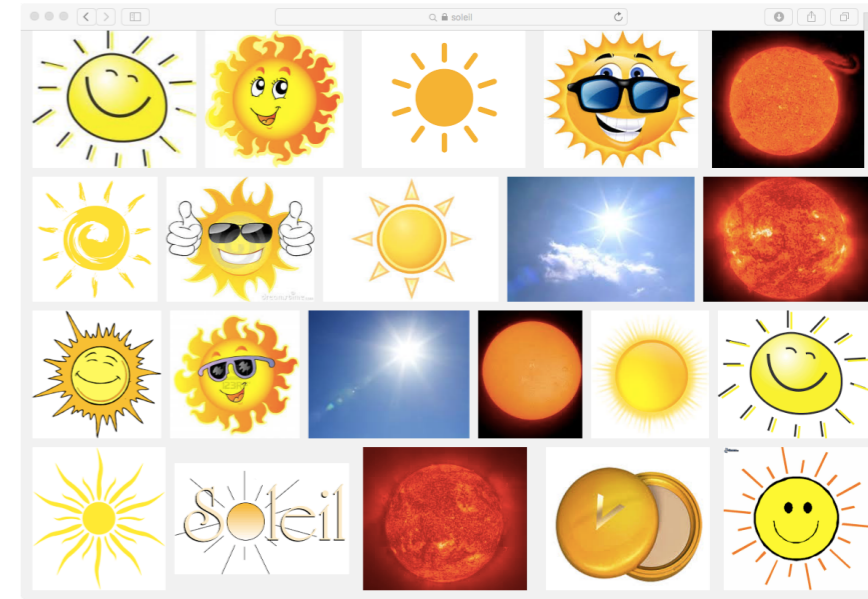
8 cartoons  
**11 science**  
2 common

Google Image Search  
“Zon”



**14 cartoons,**  
2 science  
4 common

Google Image Search  
“Soleil”



**15 cartoons,**  
4 science,  
2 common

Are we reaching out enough?

space for europe



HOME



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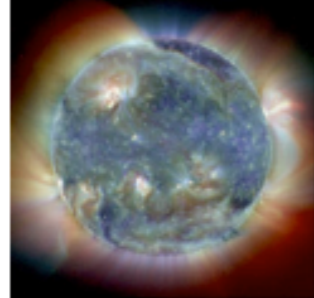
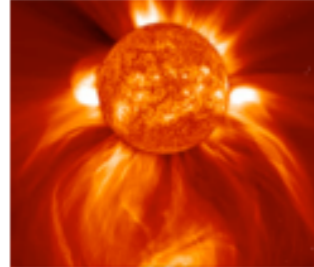
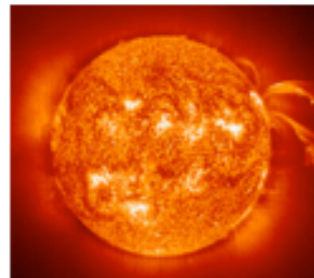
SCIENCE JOURNAL By ROBERT LEE HOTZ



Digital Age Means We Must Care More About Space Weather

September 28, 2007 | Page B1

A moody, middle-age star, our sun has an explosive temperament. Power surges that flare from its roiling magnetic fields send outbursts of charged particles, radio static and X-rays across the 93 million miles to Earth.



Space weather forecasters are bracing for a new season of intense sunspot activity that could begin by March and peak in 2012 -- and they worry that outages and damage could be even greater this time because the world has become increasingly dependent on wireless and cellular electronic networks.

"We are set up for a nasty surprise," said Thomas Bogdan, director of the federal Space Environment Center in Boulder, Colo., the largest of 13 international space weather warning centers.

Worries about solar storms are as old as the telegraph. When 19th-century entrepreneurs first started stringing long-distance wires across the U.S., they discovered that the lines attracted so much electricity during peak solar activity that the system could run without batteries and telegraph operators risked electrocution.

FORUM

'UFO' on NASA camera

By TIM UPTON

WASHINGTON: The object is certainly unidentified and appears to be flying.

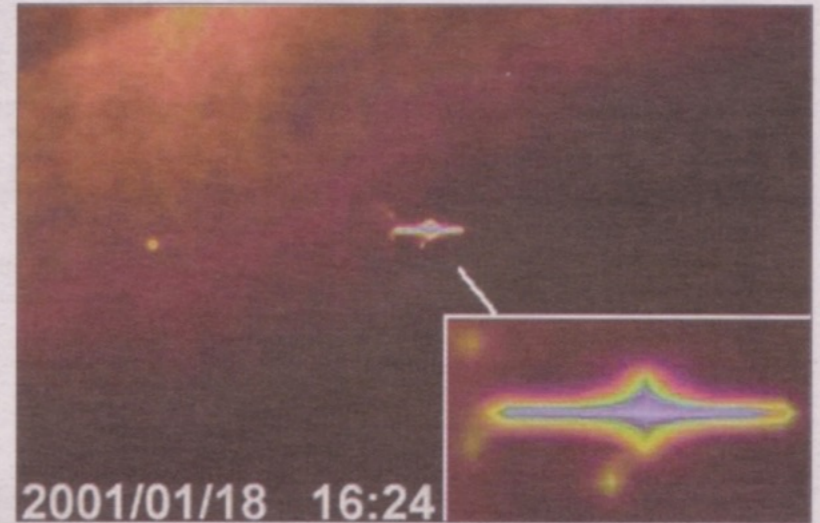
Whether this enlarged image really shows a UFO piloted by aliens remains to be seen. But according to the people who released it this photo and hundreds like it are the best evidence yet of the existence of spacecraft from other worlds.

UFO investigators say the image was captured by the Solar and Heliospheric Observatory (SOHO), a NASA satellite that was launched in 1996 to

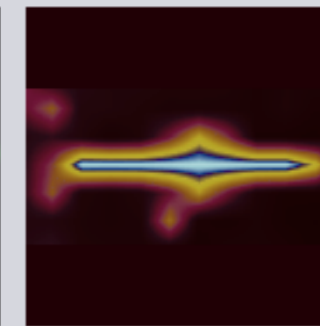
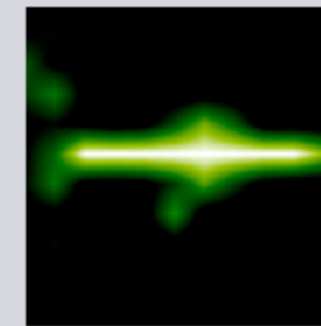
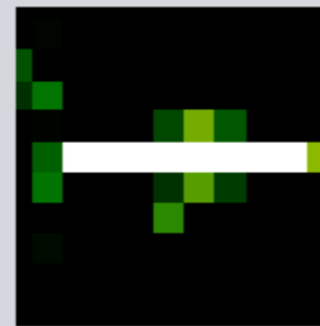
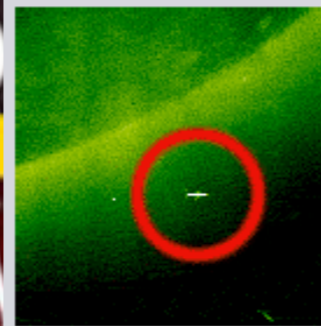
observe the sun. Since then, it is said, SOHO has captured hundreds of images of UFOs moving along a kind of alien superhighway.

SOHO is more than 1.5 million kilometres from Earth, with its camera trained towards the sun. Experts say the photographed objects are likely to be only hundreds of kilometres from its lenses.

Graham Birdsall, editor of UFO magazine, said: "The images are irrefutable in that they are from official satellites owned by NASA. They resemble the kind of spacecraft we used to see in sci-fi films like Star Trek."



UTTERLY ALIEN: The image investigators say shows a UFO.



En cadeau le CD-Rom du Soleil vu par Soho

CIEL & espace

400 images 100 vidéos

L'événement de l'année Les Rencontres du ciel et de l'espace

Colères du Soleil

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Spaceflight The Magazine of Astronautics and Outer Space

**PRODEX, please keep on going!**

