

# MONITORING SPACE WEATHER WITH PROBA2

David Berghmans & Royal Observatory of Belgium

ILWS ☀ Bremen ☀ July 16-17, 2010

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# INTRODUCTION TO PROBA2





Plesetsk



SMOS

PROBA2

# EUROCKOT LAUNCH

November 2, 2009, 01:50:51 UTC ☀ Plesetsk, Russia



# SPACECRAFT SEPARATION

November 2, 2009, 04:50:06 UTC ☀ 725 km altitude





# ESA'S PROBA2 PROGRAM

Project for **O**n-**B**oard **A**utonomy



# ESA'S PROBA2 PROGRAM

4 science instruments: SWAP, LYRA, TPMU, DSLP  
17 platform technology experiments





# PROBA2 INSTRUMENTATION

Sun **W**atcher with **A**ctive Pixel System & Image **P**rocessing



# PROBA2 INSTRUMENTATION

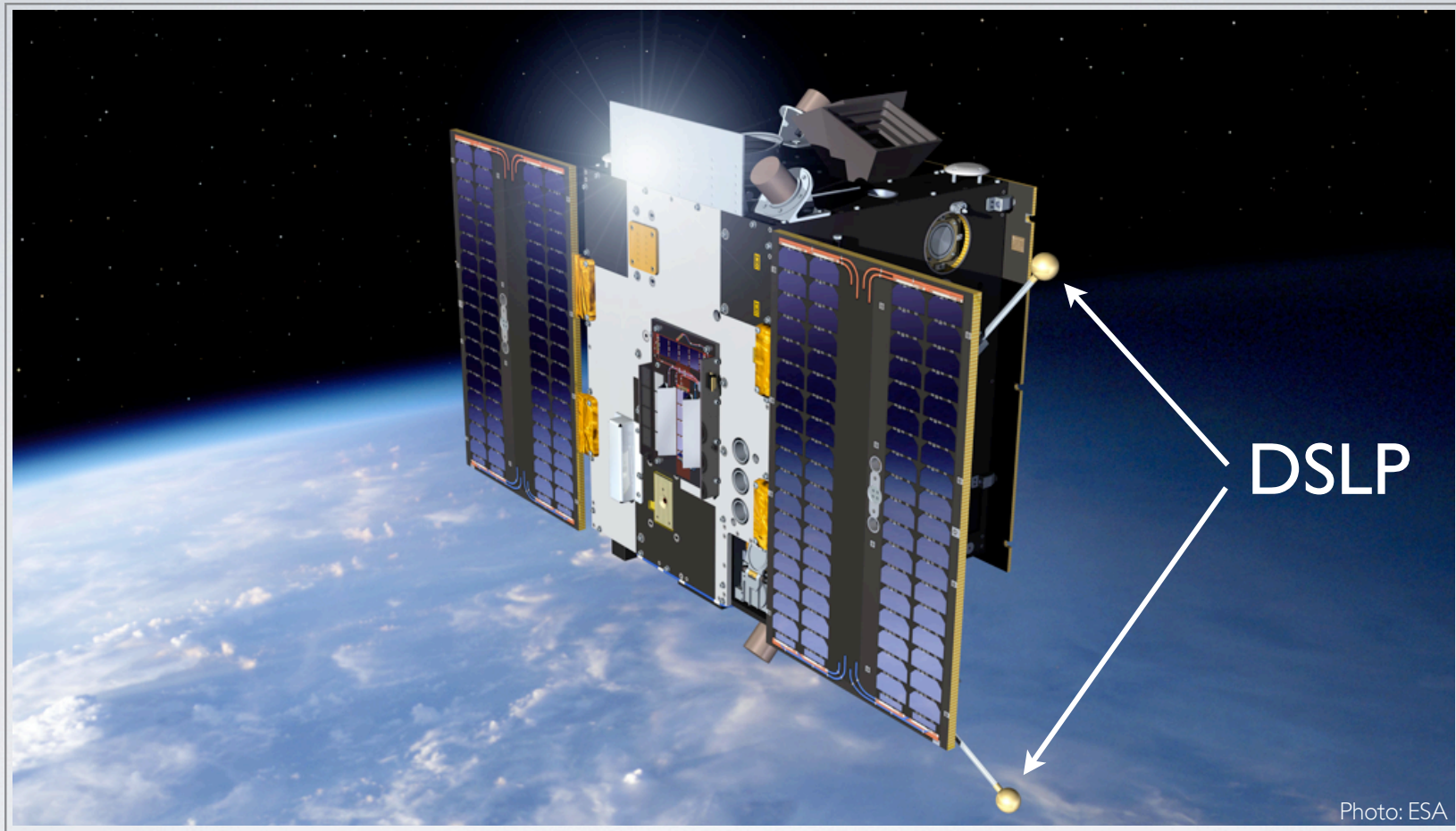
Large Yield Radiometer





# PROBA2 INSTRUMENTATION

Thermal Plasma Measurement Unit



# PROBA2 INSTRUMENTATION

Dual-Segmented Langmuir Probe



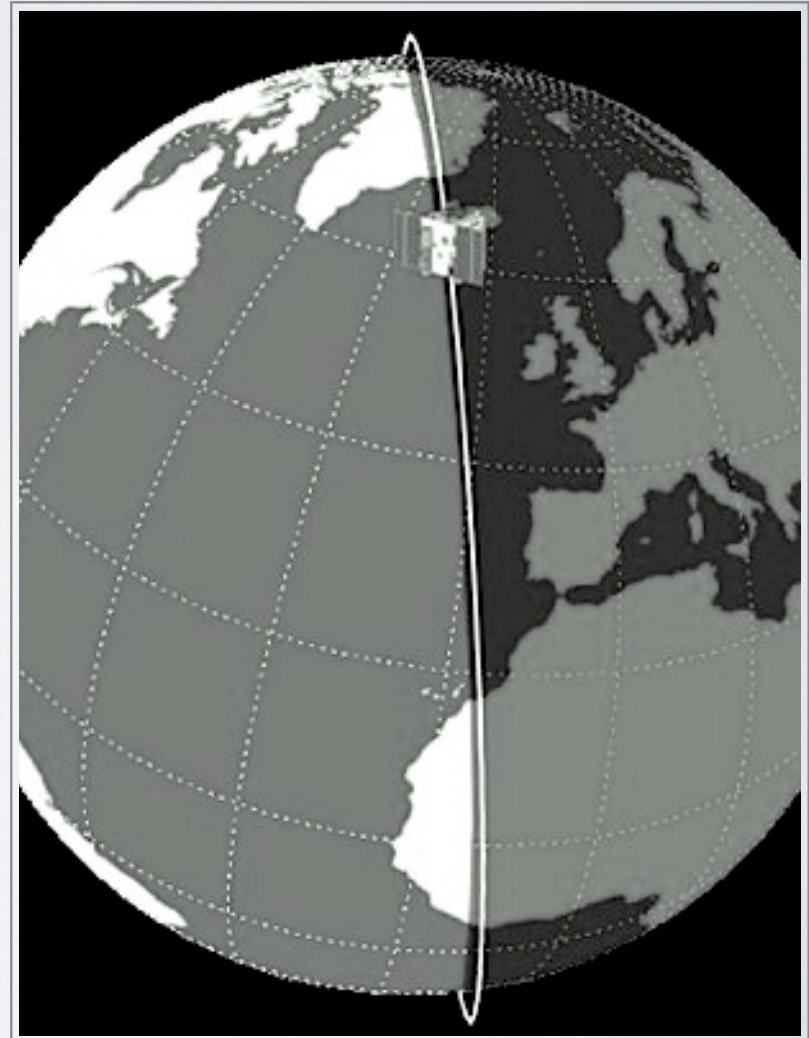
# ORBIT

Polar Sun-Synchronous

725 km altitude

Eclipse season:

- Visible: November-January
- EUV: Slightly longer
- Maximum duration 18 min per orbit







# GROUND STATIONS

Redu (Belgium) & Svalbard (Norway)

$\approx 8$  data downlinks/day





# PROBA2 SCIENCE CENTER

Data processed & stored at ROB  
Available in real time +30 min

# LYRA

PI: Jean-François Hochedez (ROB)

Swiss contribution: W. Schmutz (PMOD-WRC)



# LYRA OVERVIEW

Three detector heads

Four spectral channels per head

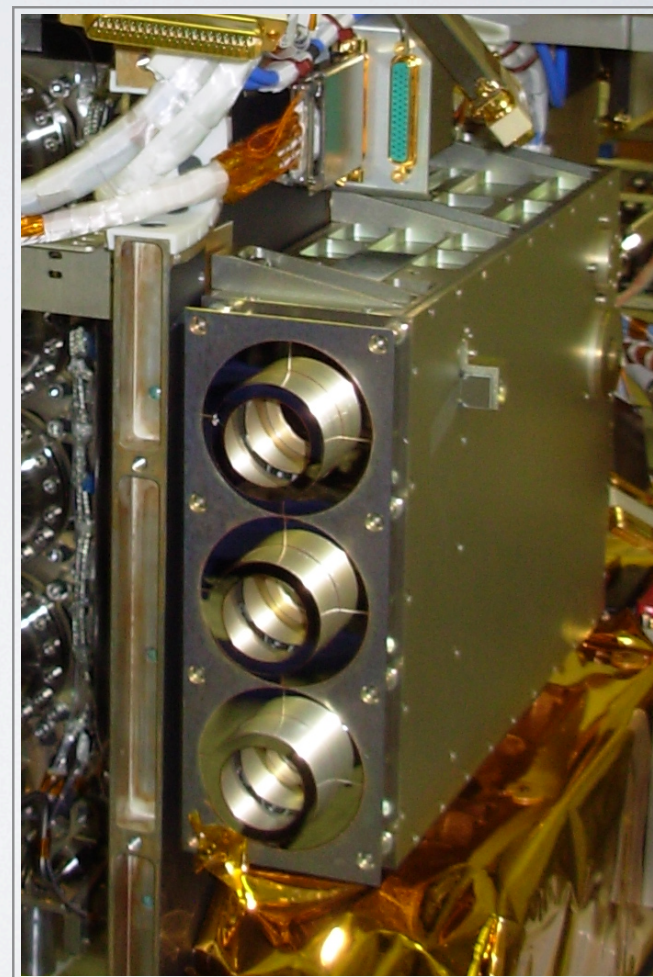
Diamond detectors





# LYRA OVERVIEW

|           | Ly         | Hz         | Al         | Zr         |
|-----------|------------|------------|------------|------------|
| Unit<br>1 | <b>MSM</b> | <b>PiN</b> | <b>MSM</b> | Si         |
| Unit<br>2 | <b>MSM</b> | <b>PiN</b> | <b>MSM</b> | <b>MSM</b> |
| Unit<br>3 | Si         | <b>PiN</b> | Si         | Si         |





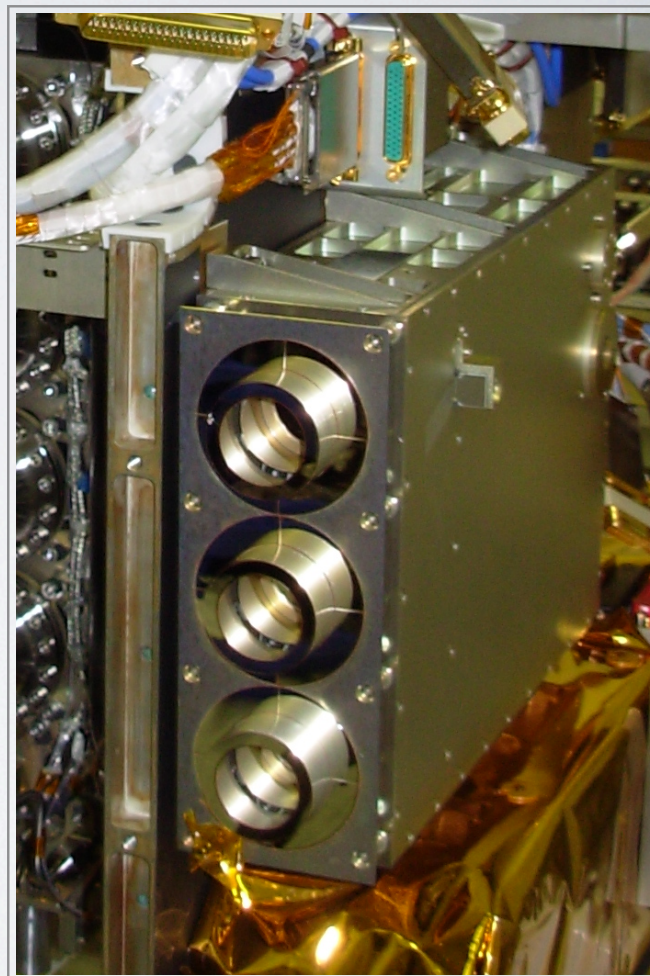
Lyman- $\alpha$ : 120-123 nm

Herzberg 200-220 nm

Aluminum Filter: 17-80 nm

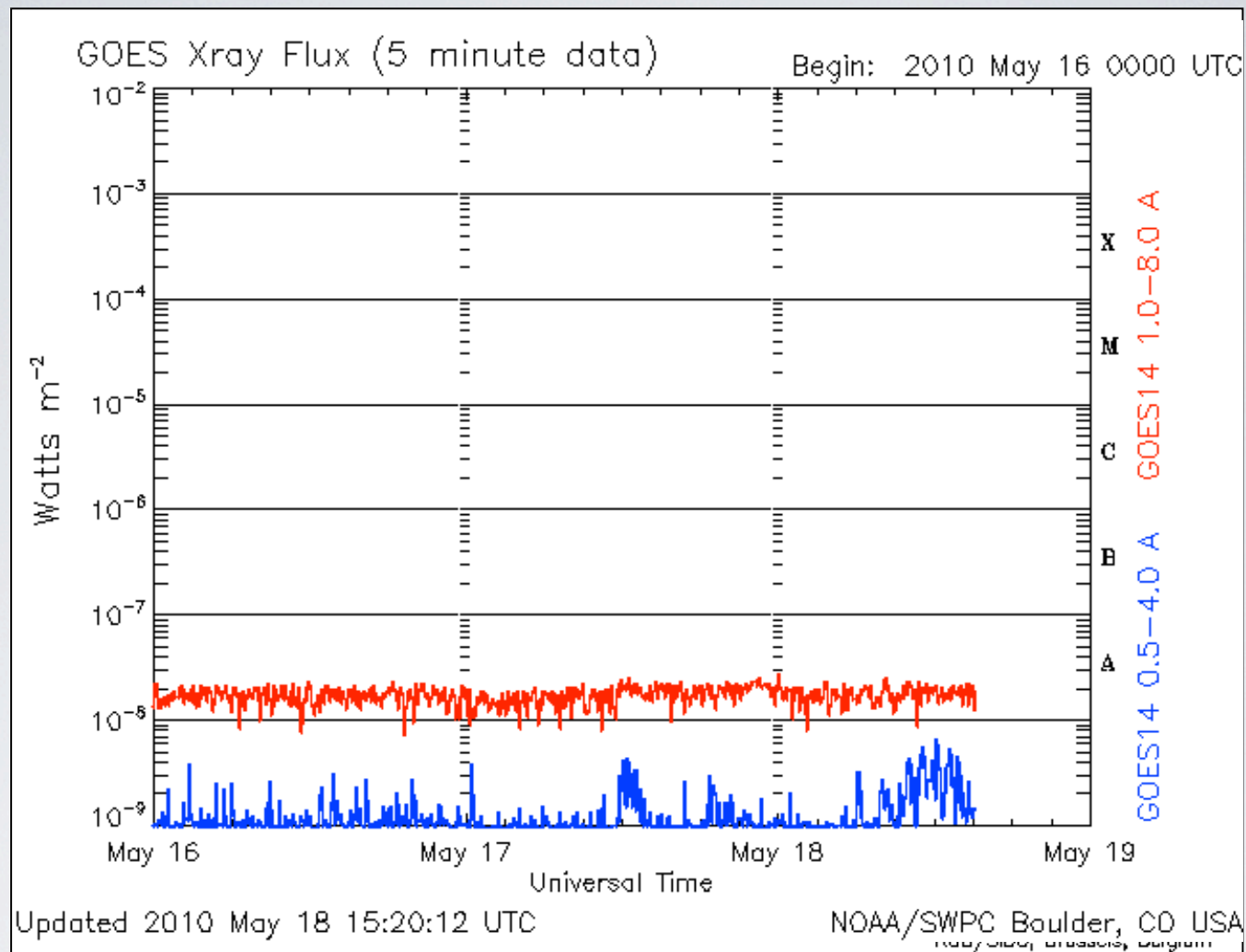
Zirconium Filter: 1-20 nm

|        | Ly  | Hz  | Al  | Zr  |
|--------|-----|-----|-----|-----|
| Unit 1 | MSM | PiN | MSM | Si  |
| Unit 2 | MSM | PiN | MSM | MSM |
| Unit 3 | Si  | PiN | Si  | Si  |



LYRA DATA

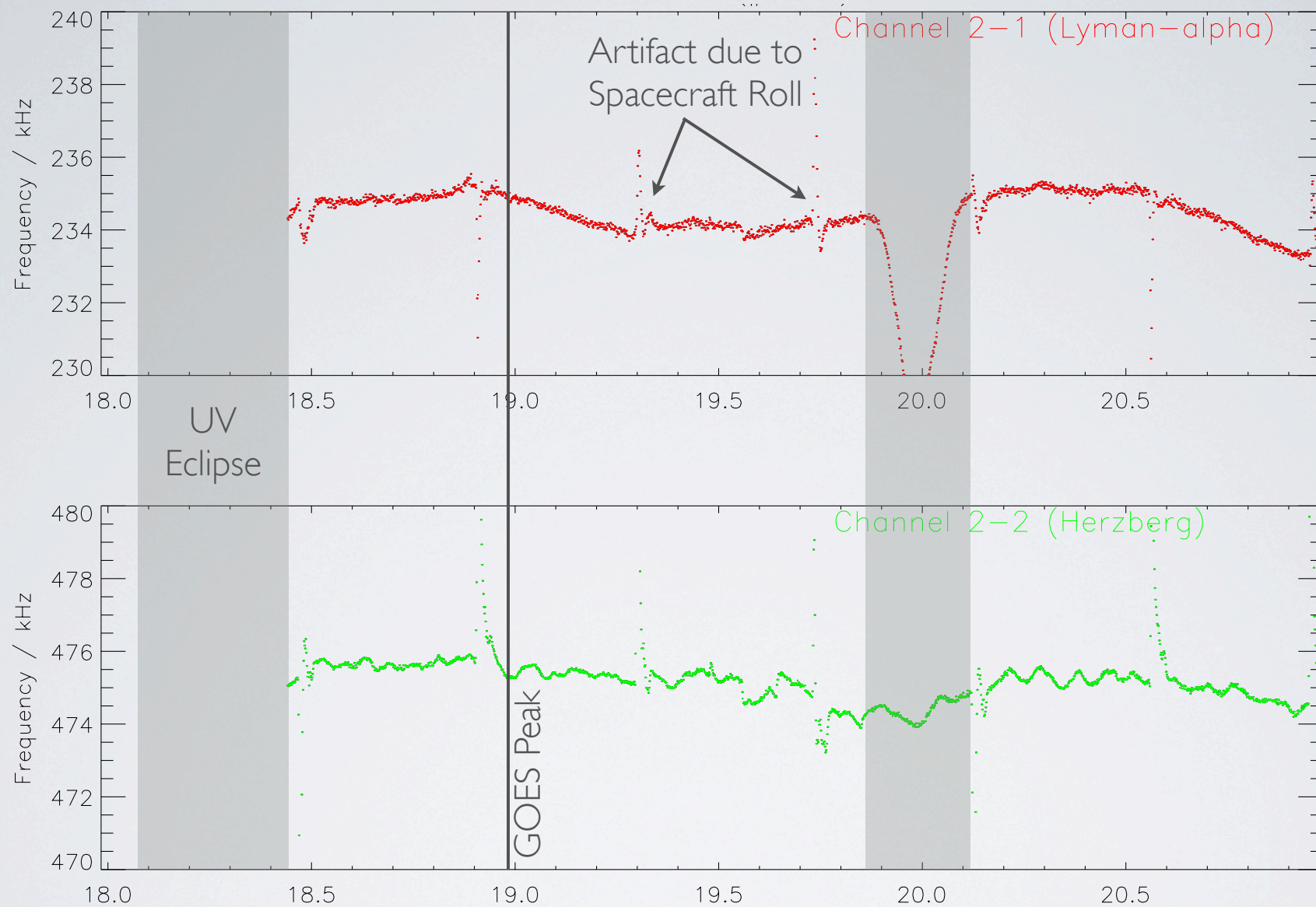




# LYRA DATA PRODUCTS

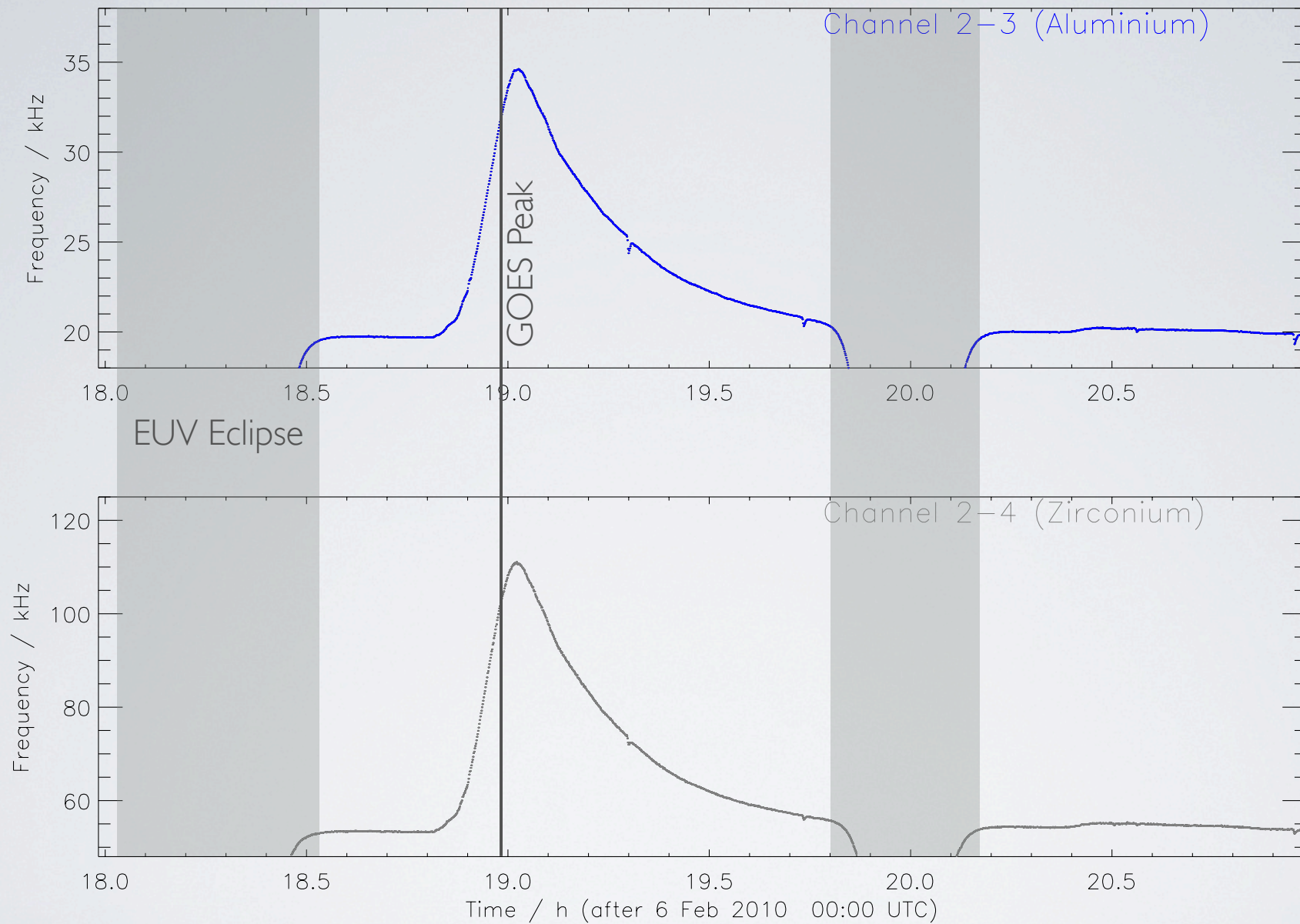
Daily Overview Light Curves

<http://proba2.sidc.be/>

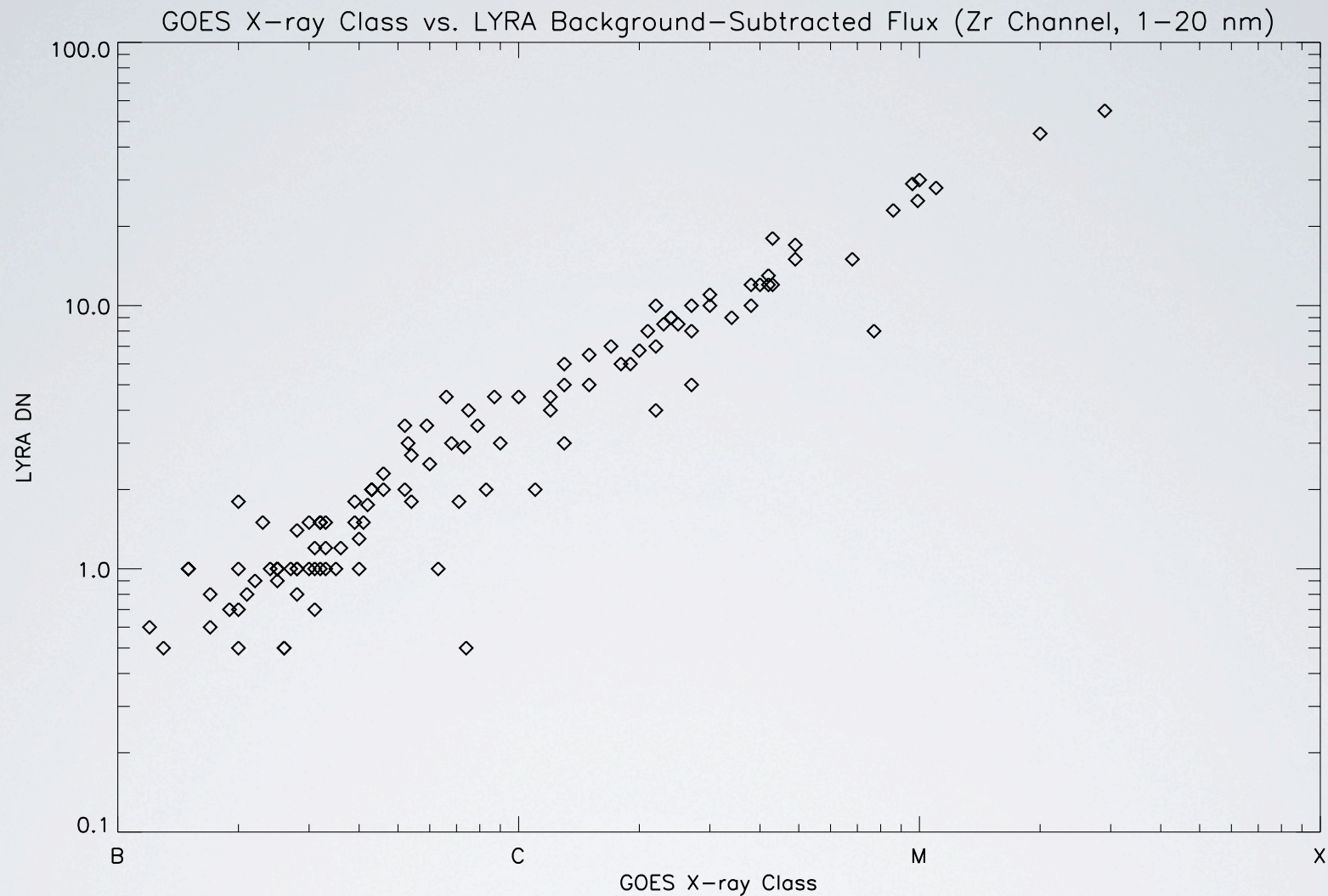


M2.9 Flare, 6 February 2010





M2.9 Flare, 6 February 2010



# LYRA & GOES FLUX

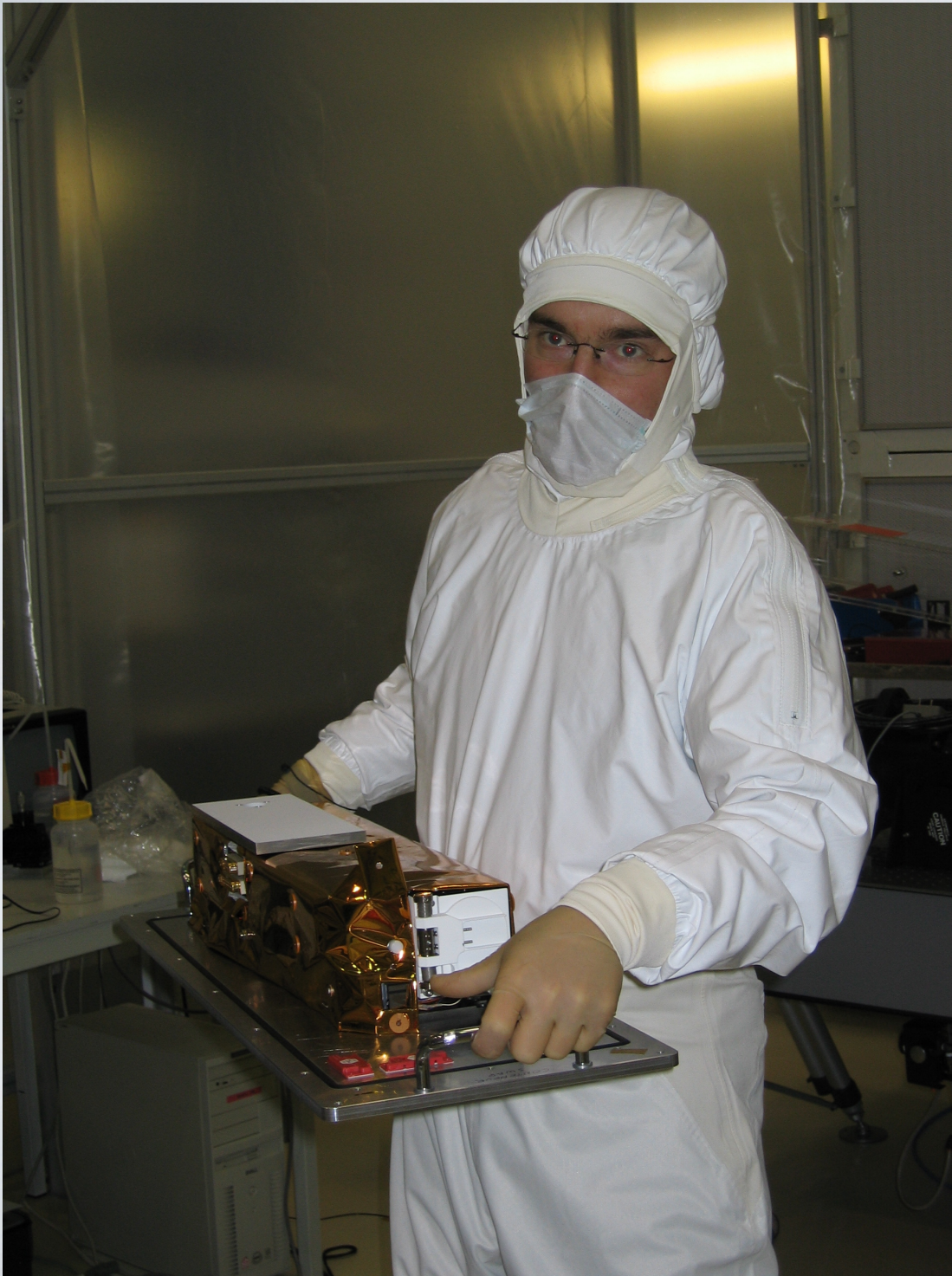
Flares observed in 2010, LYRA Zr Channel



# SWAP

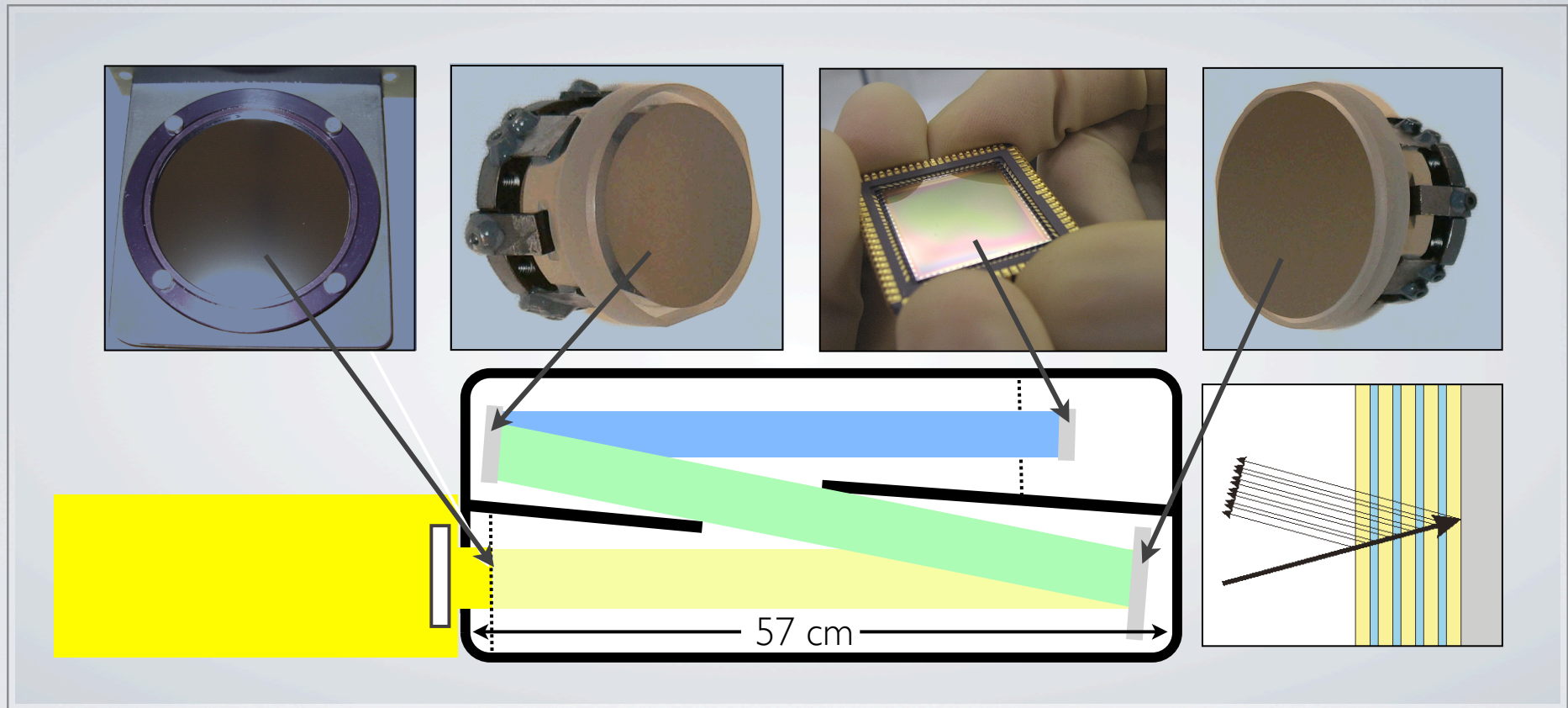
PI: David Berghmans (ROB)  
JM Defise (CSL)





Sun Watcher using APS  
and Image Processing





# OPTICAL PATH

## Off-Axis Ritchey-Chrétien Scheme



# CMOS APS DETECTOR

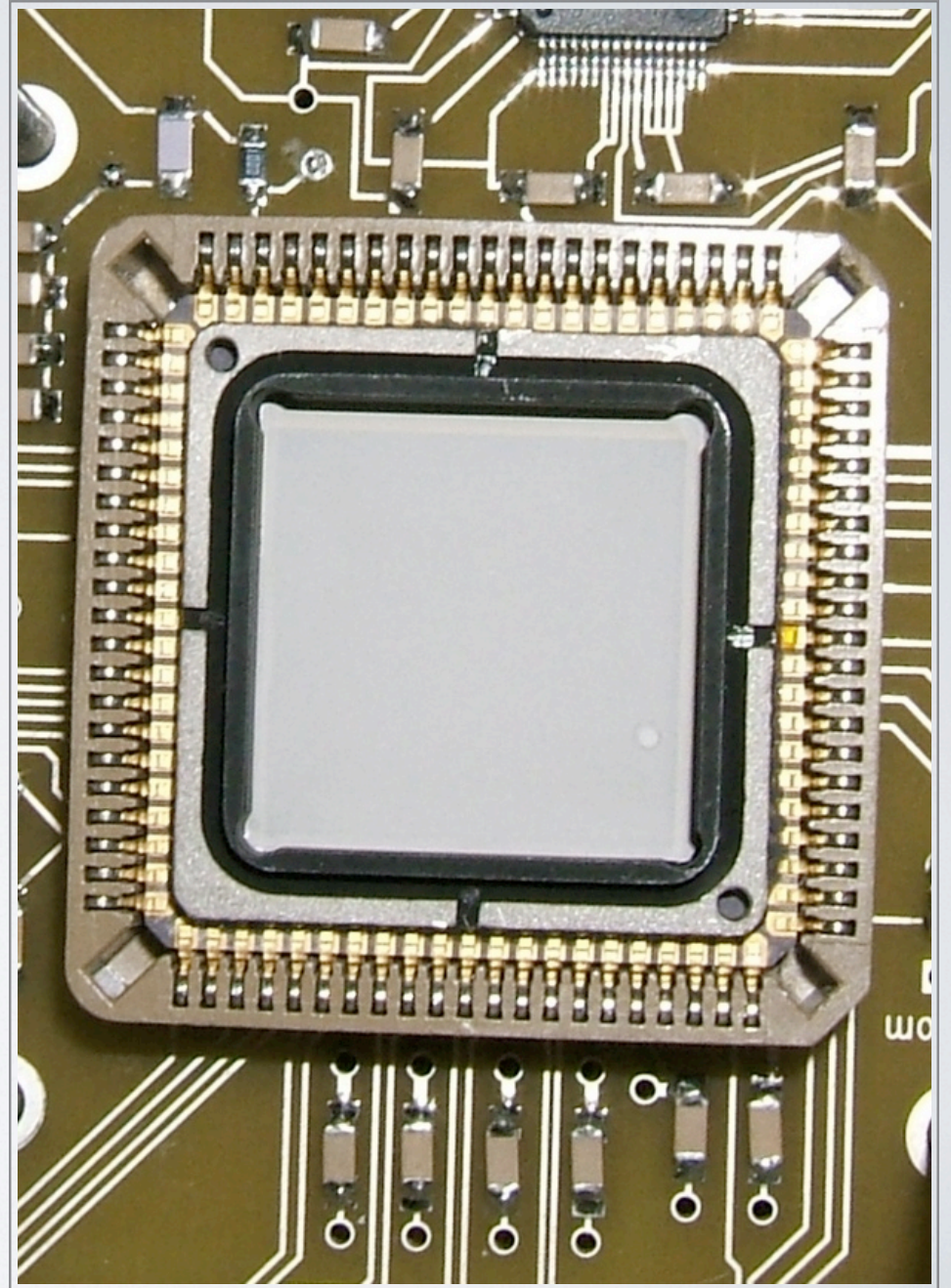
1024×1024 Pixels

P43 coating for EUV sensitivity

First CMOS for solar physics  
in orbit

Low power consumption

No charge transfer as in CCD  
No need for shutter



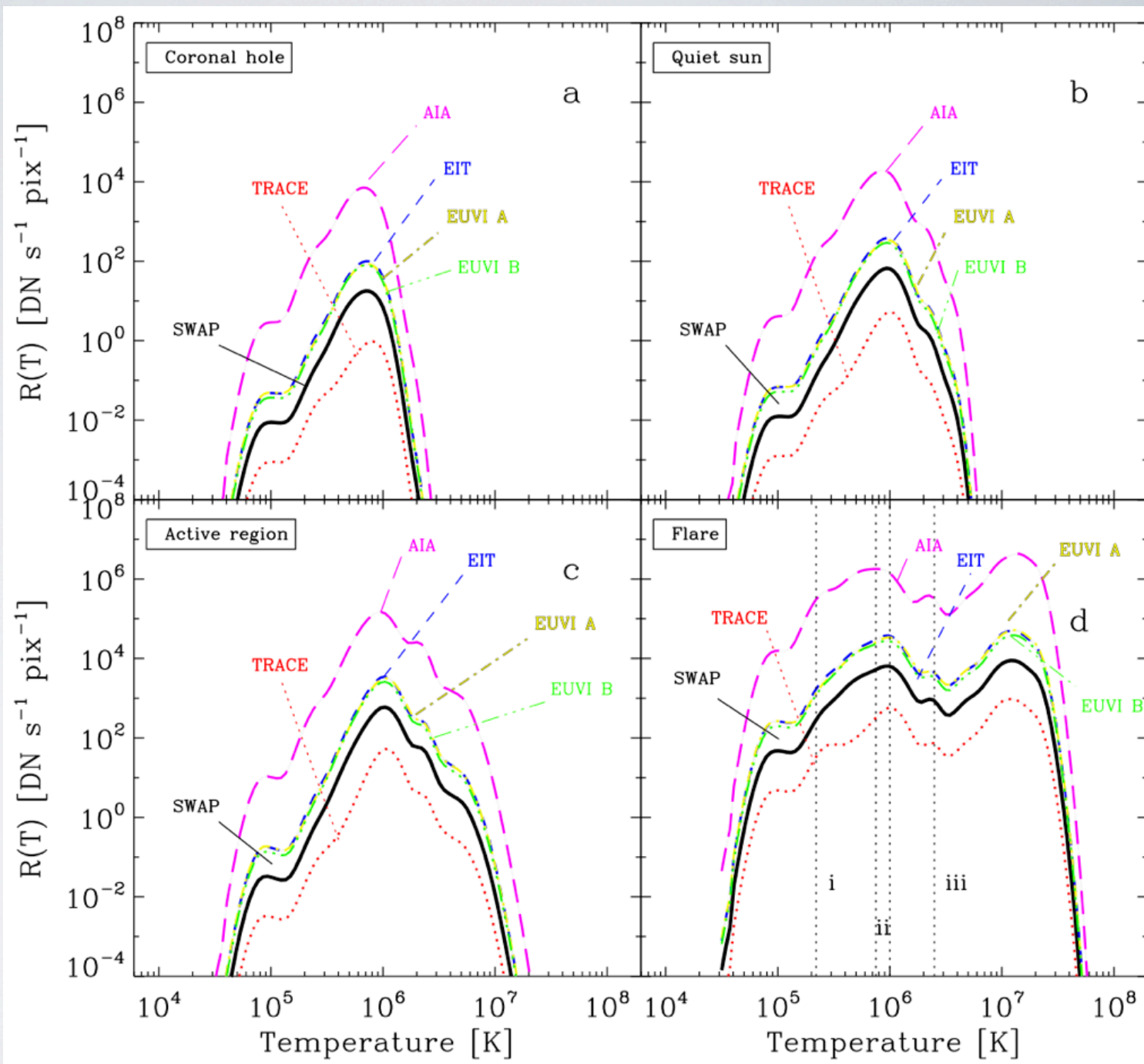


# Bandpass

C. Raftery (TCD)

SWAP was  
calibrated at BESSY/  
PTB synchotron

thanks to support  
by MPAE-Lindua  
(col: U. Schuehle)

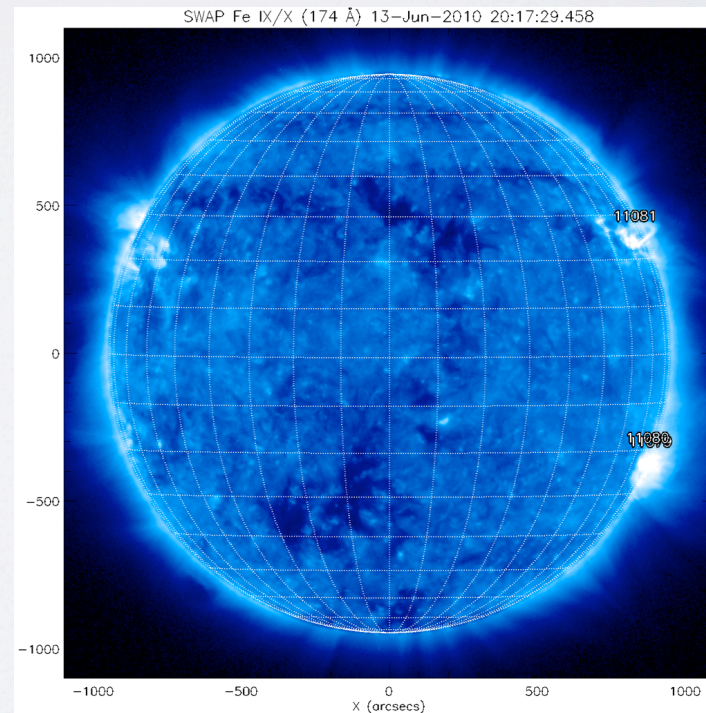
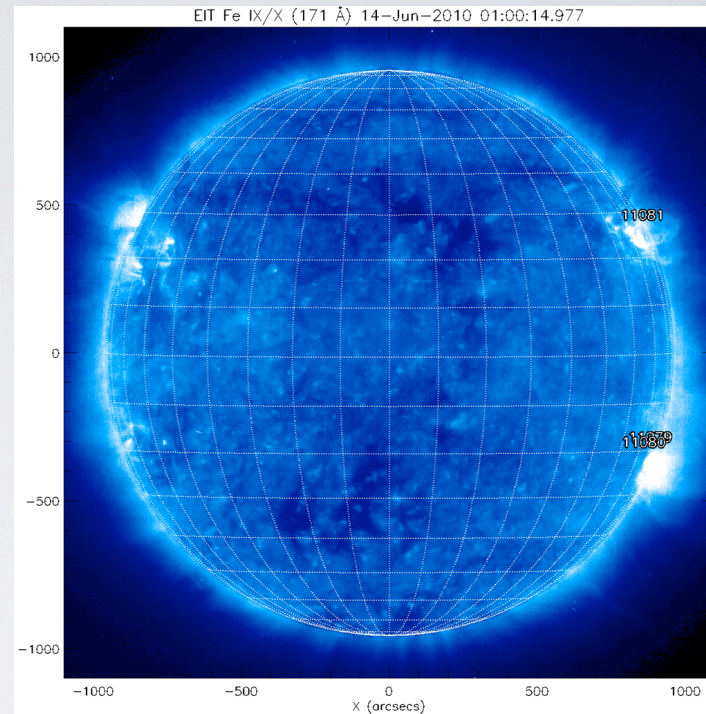


**EIT:** 17.1, 19.5, 28.4, 30.4 nm

- Sun-centered FOV
- 45 arcmin FOV
- $\approx$  12 minute cadence
- Located at L1-point

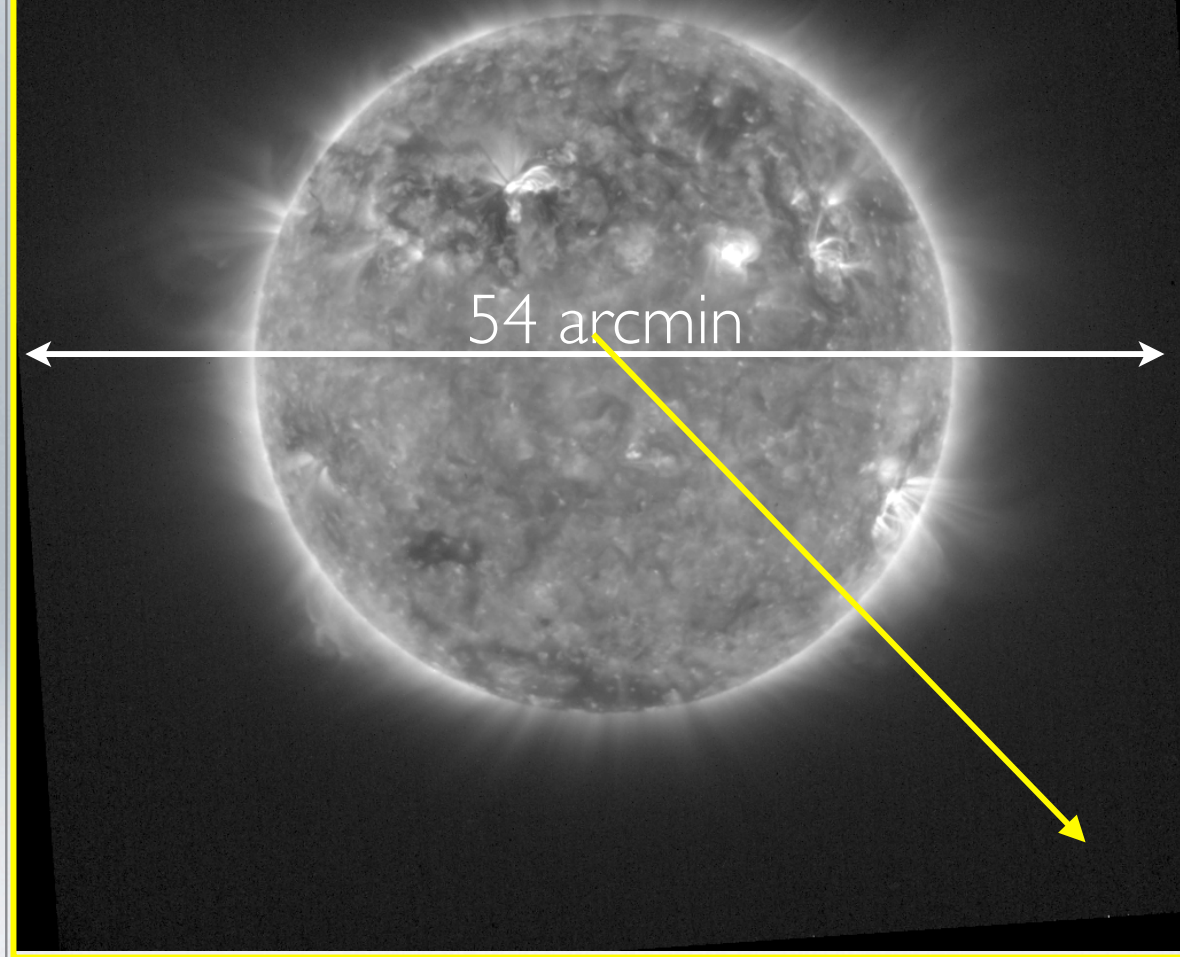
**SWAP:** 17.4 nm

- Flexible off-pointing
- 54 arcmin FOV
- $\approx$  1 minute cadence
- Inside magnetosphere



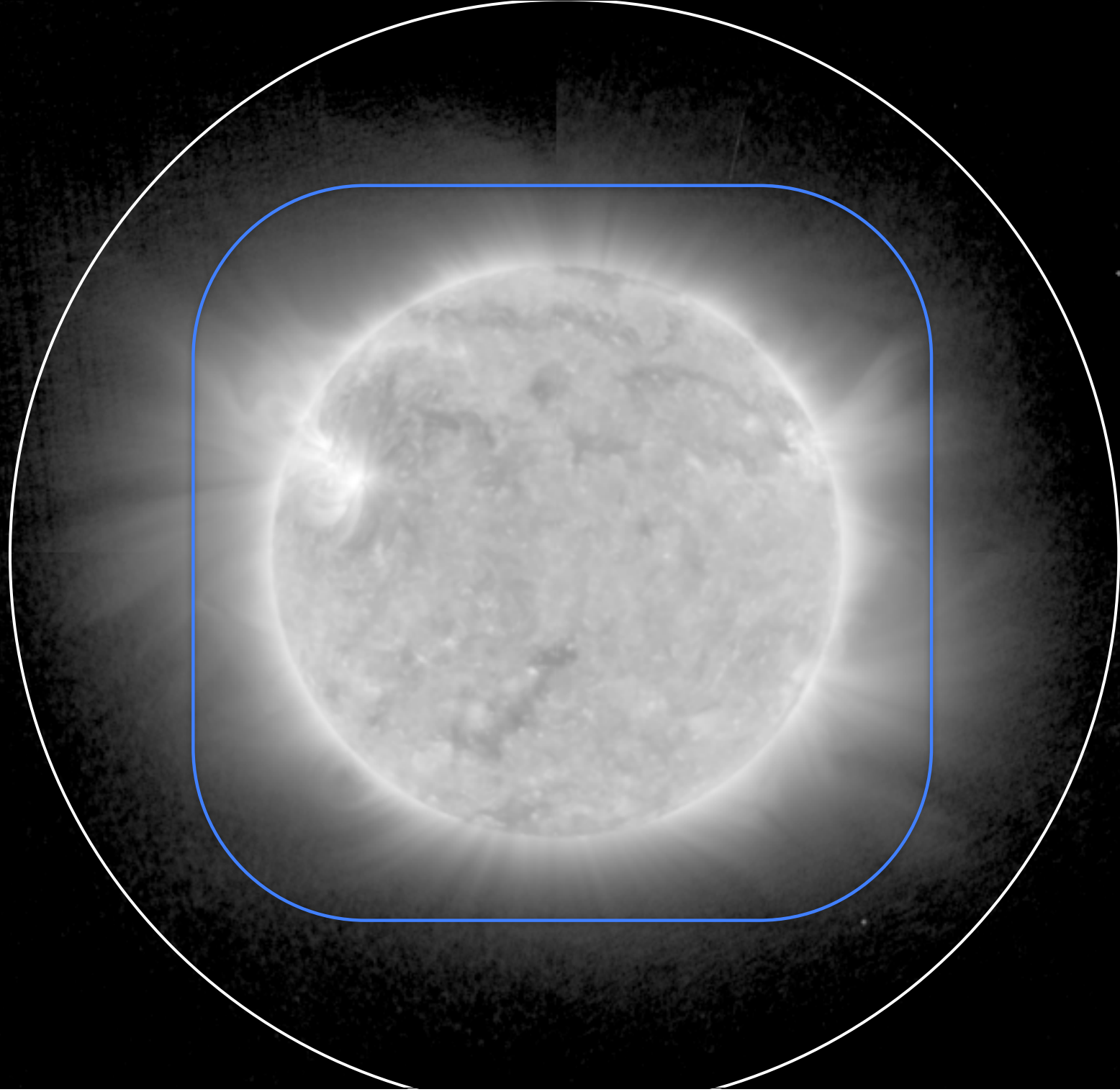


Up to 1 degree off-pointing  
CME Tracking

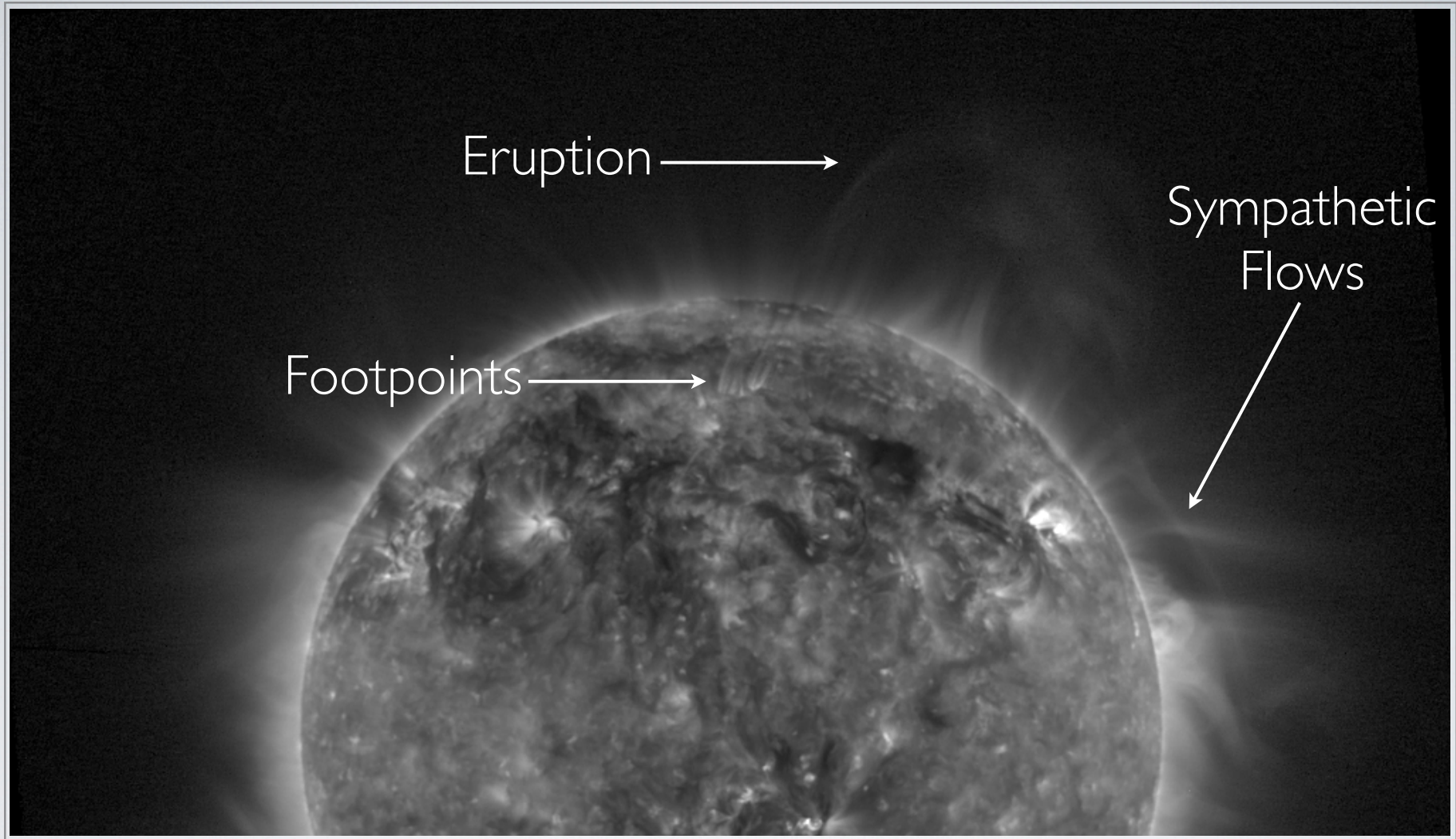


SWAP VS. AIA ON SDO

Work by Vladimir Slemzin (Lebedev) 11 July



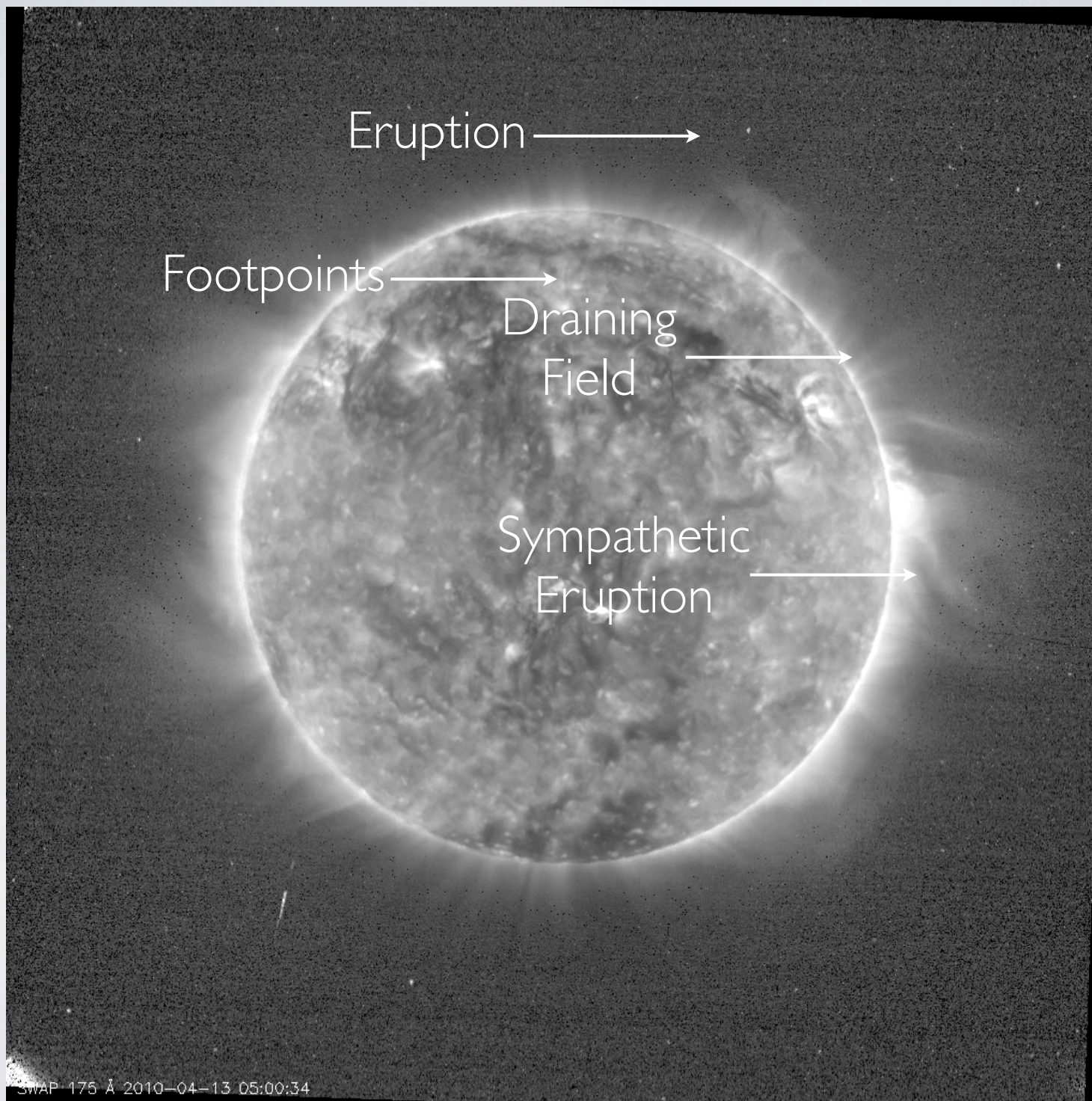




# PROMINENCE ERUPTION

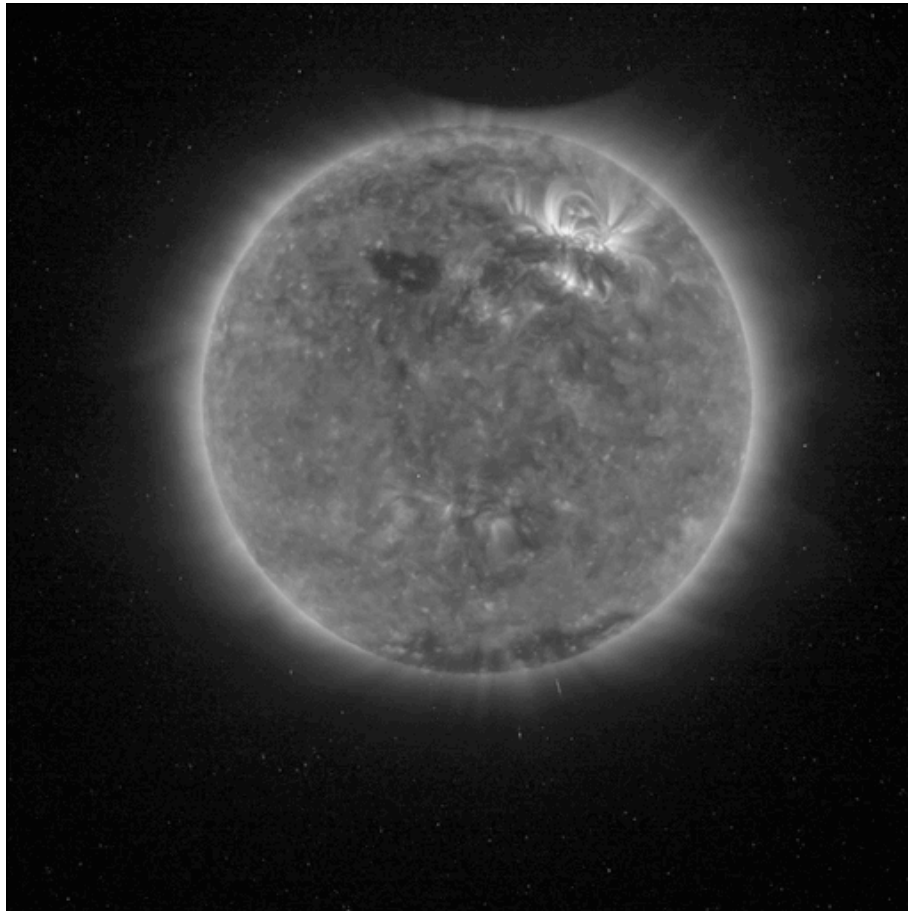
13 April 2010, 09:30 UTC



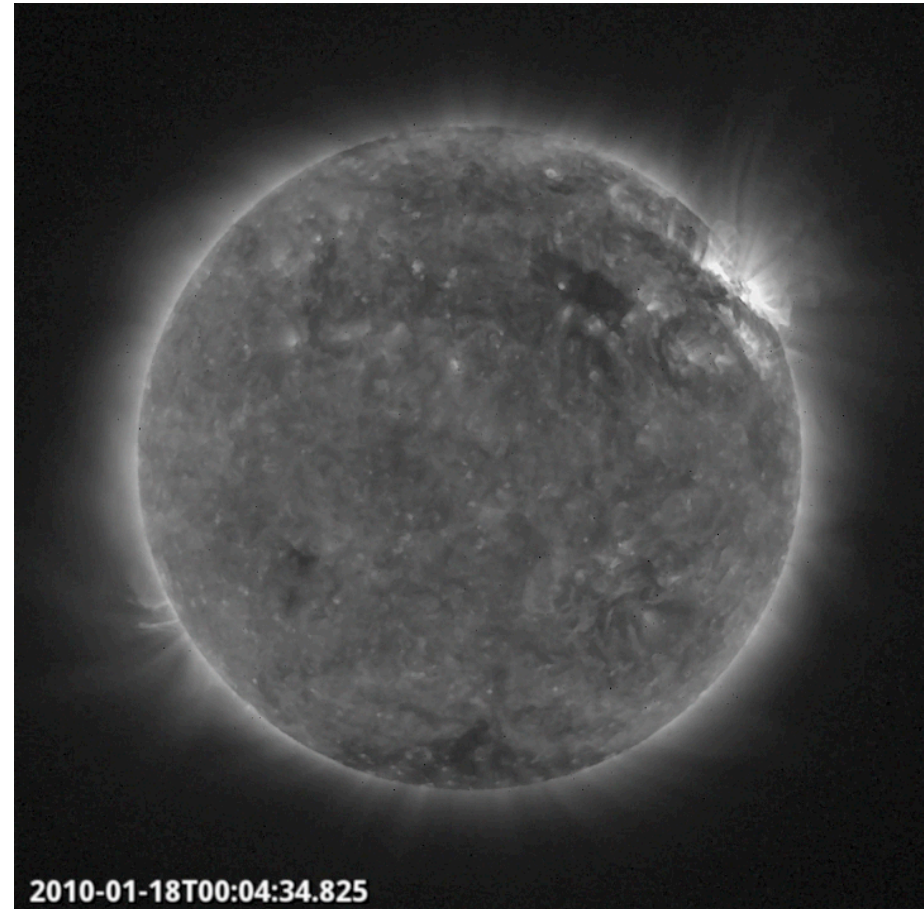




January 15 eclipse

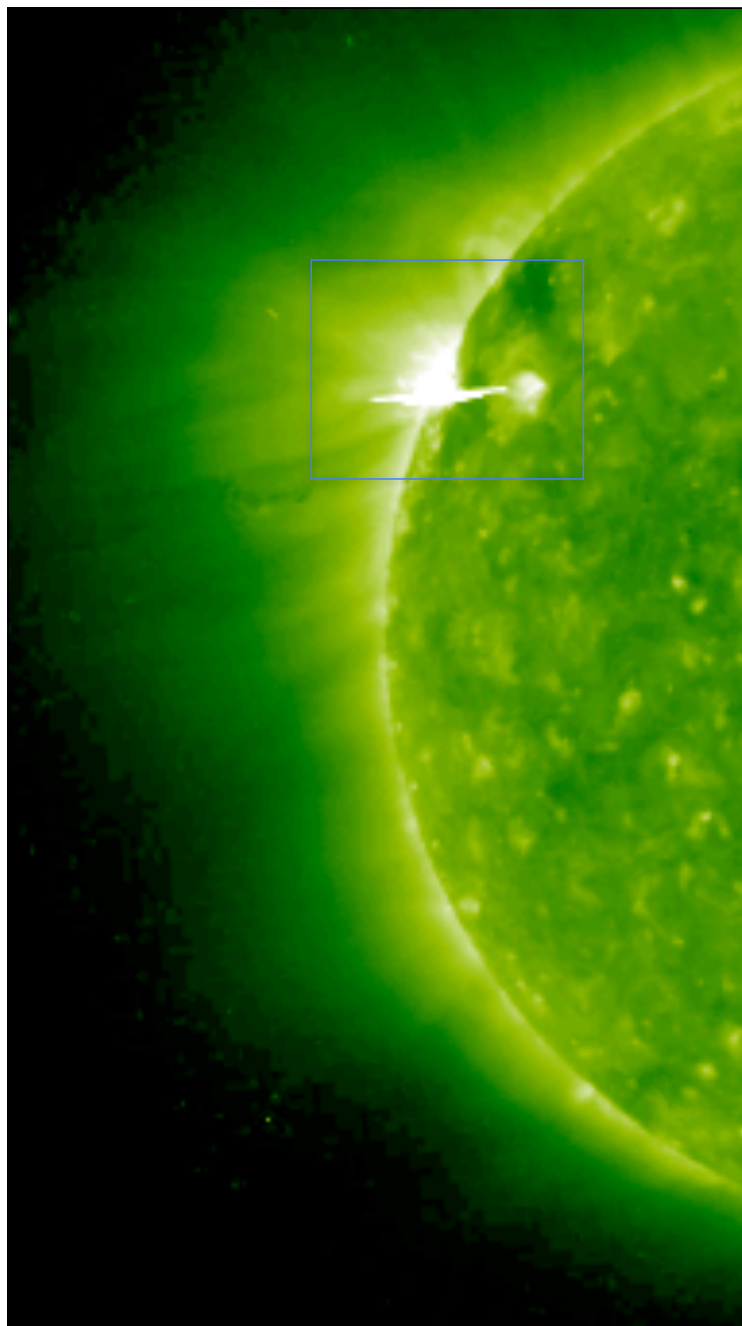


First M flare of new cycle

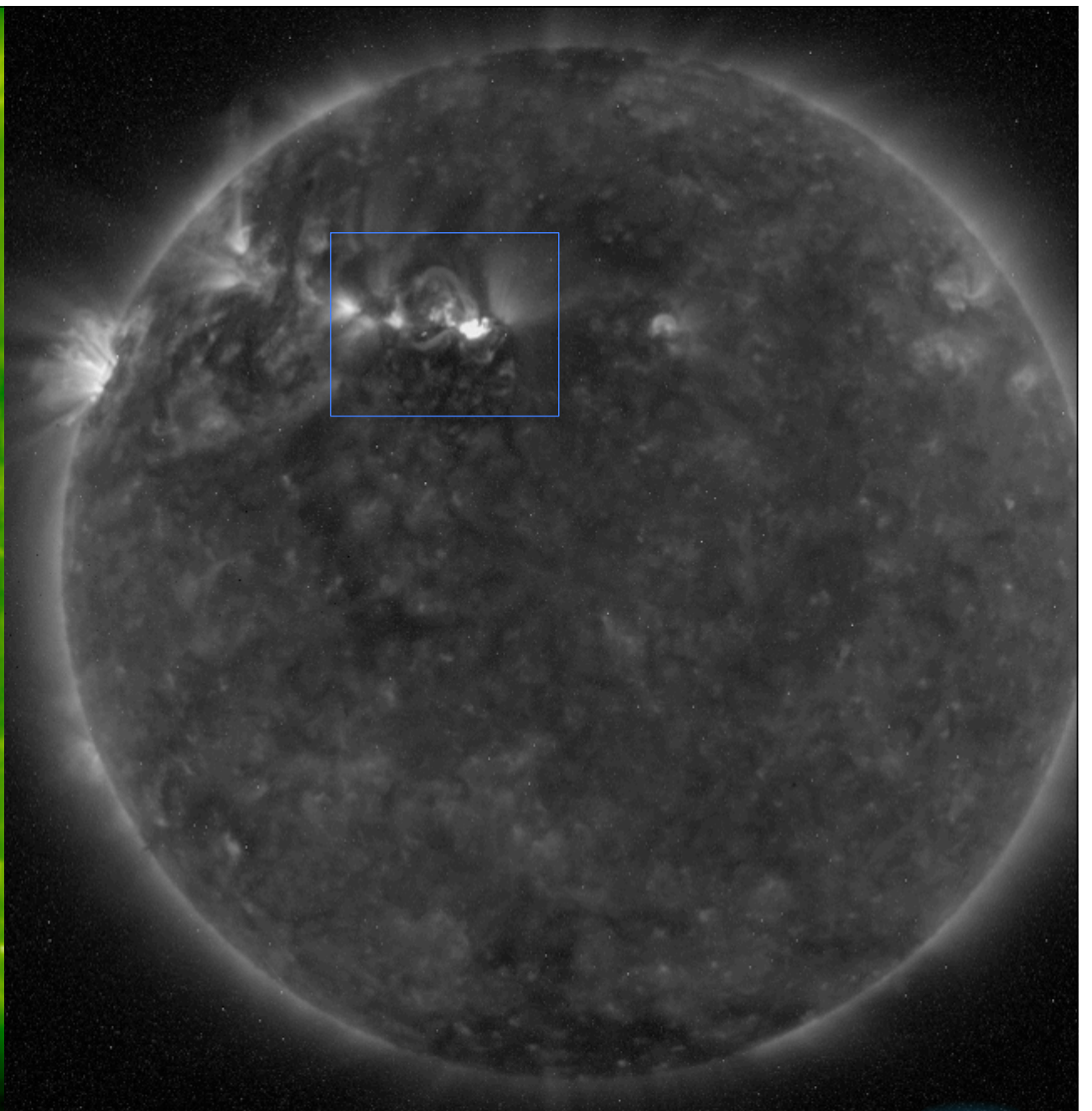


**Space Weather Monitoring with PROBA2**  
David Berghmans – Royal Observatory of Belgium  
ILWS - Bremen 16-17 july 2010

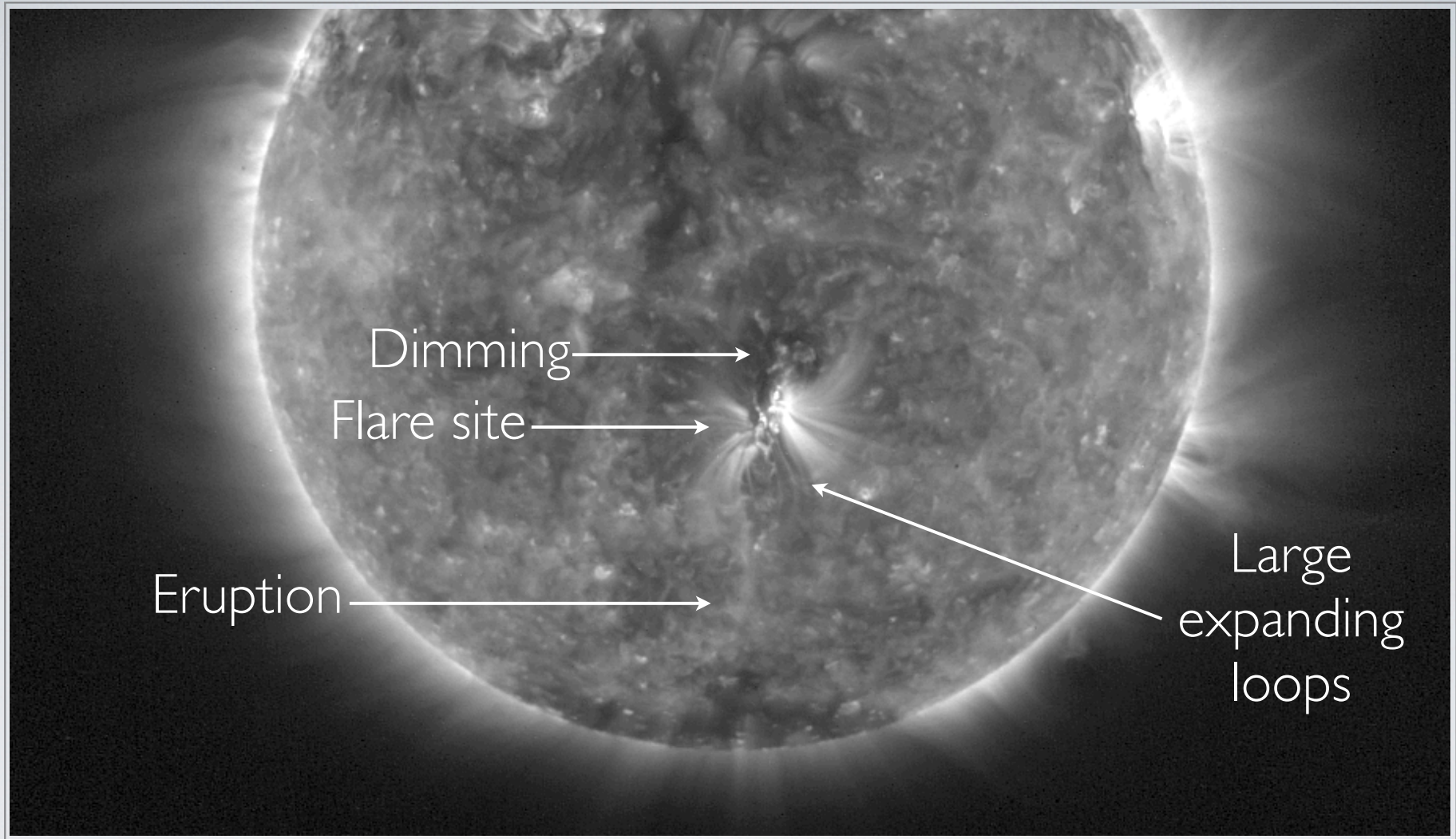




**EUVI-A**  
**2010/02/07 02:40:30**

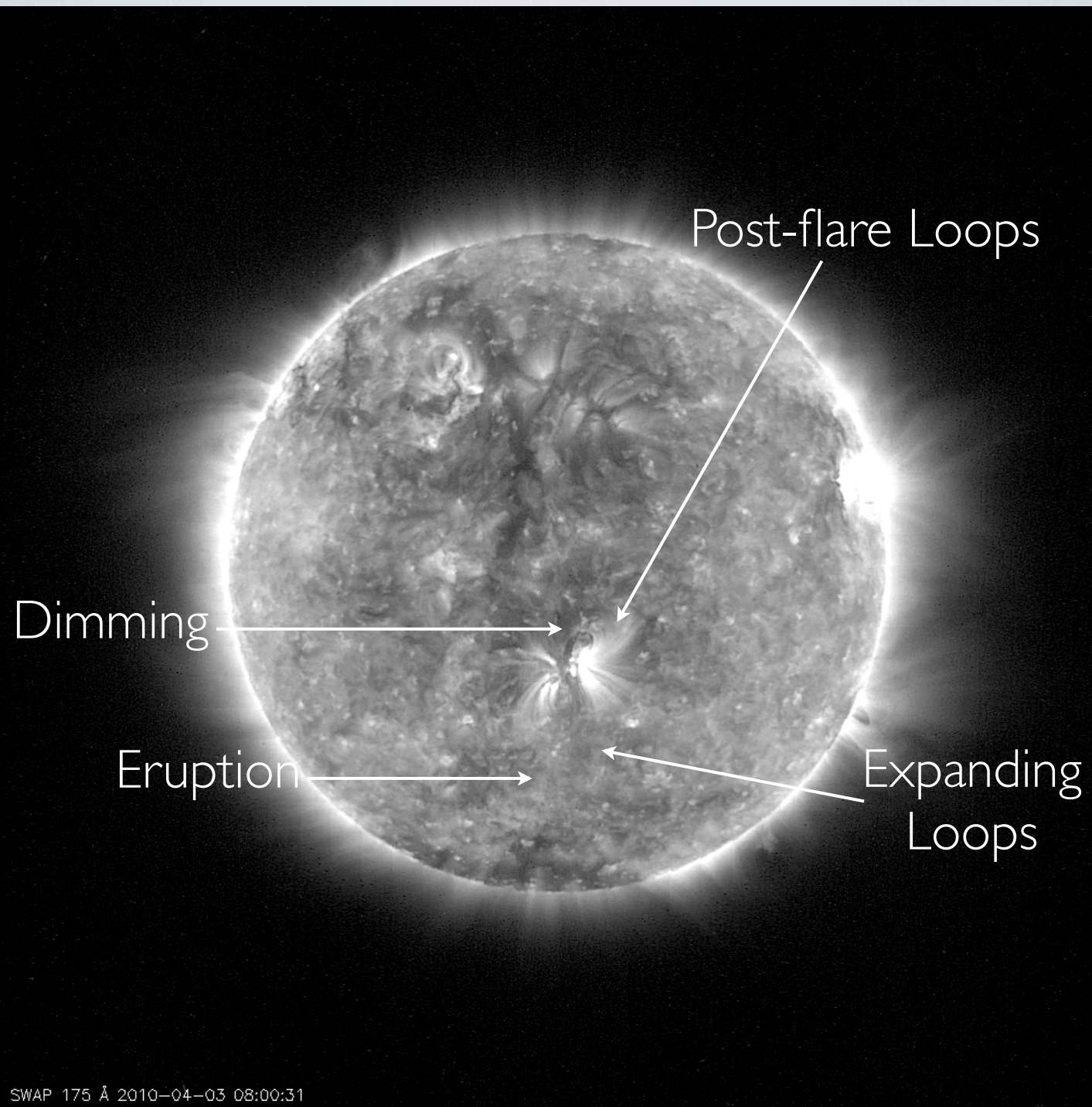




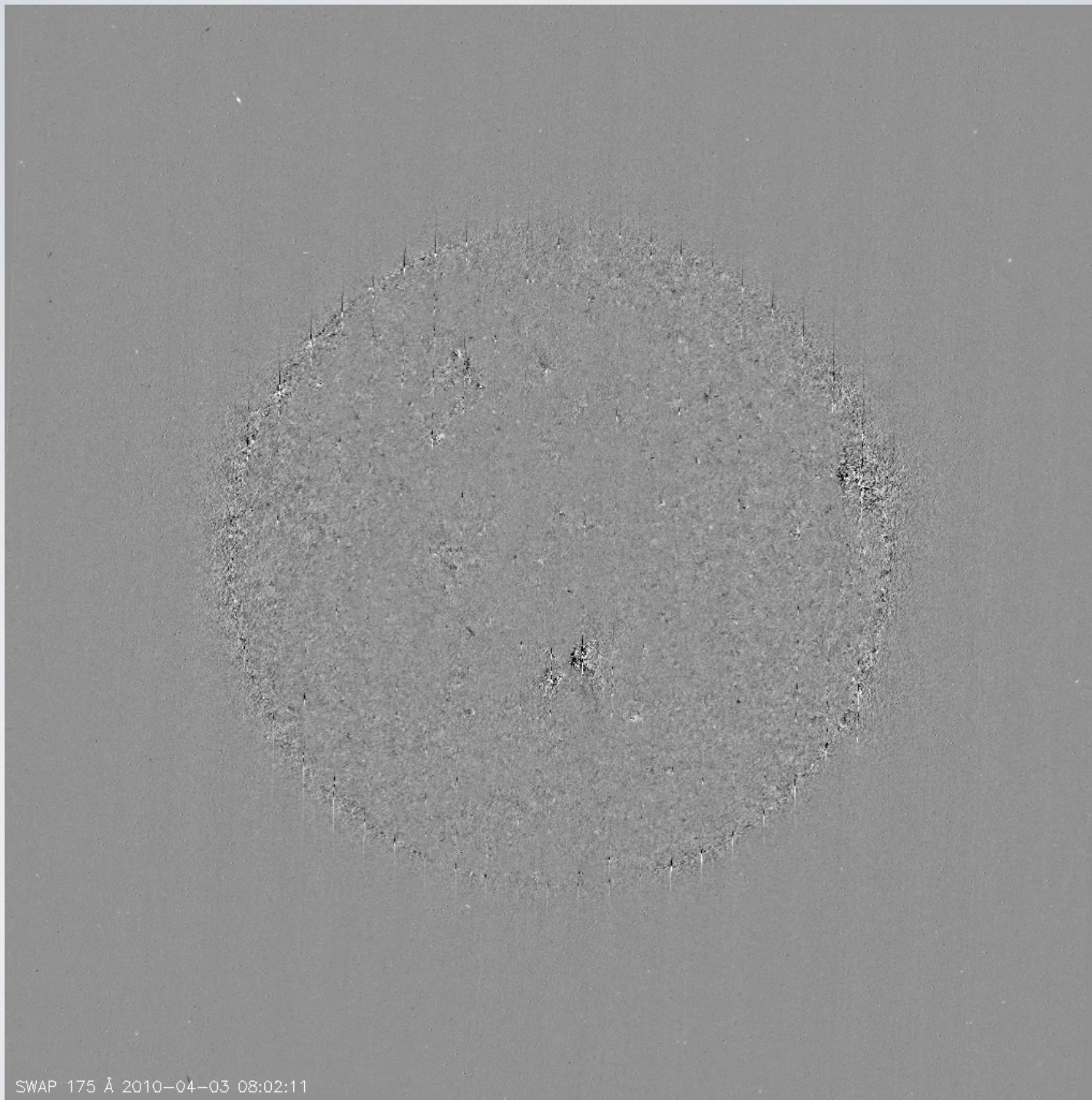


# ERUPTION & FLARE

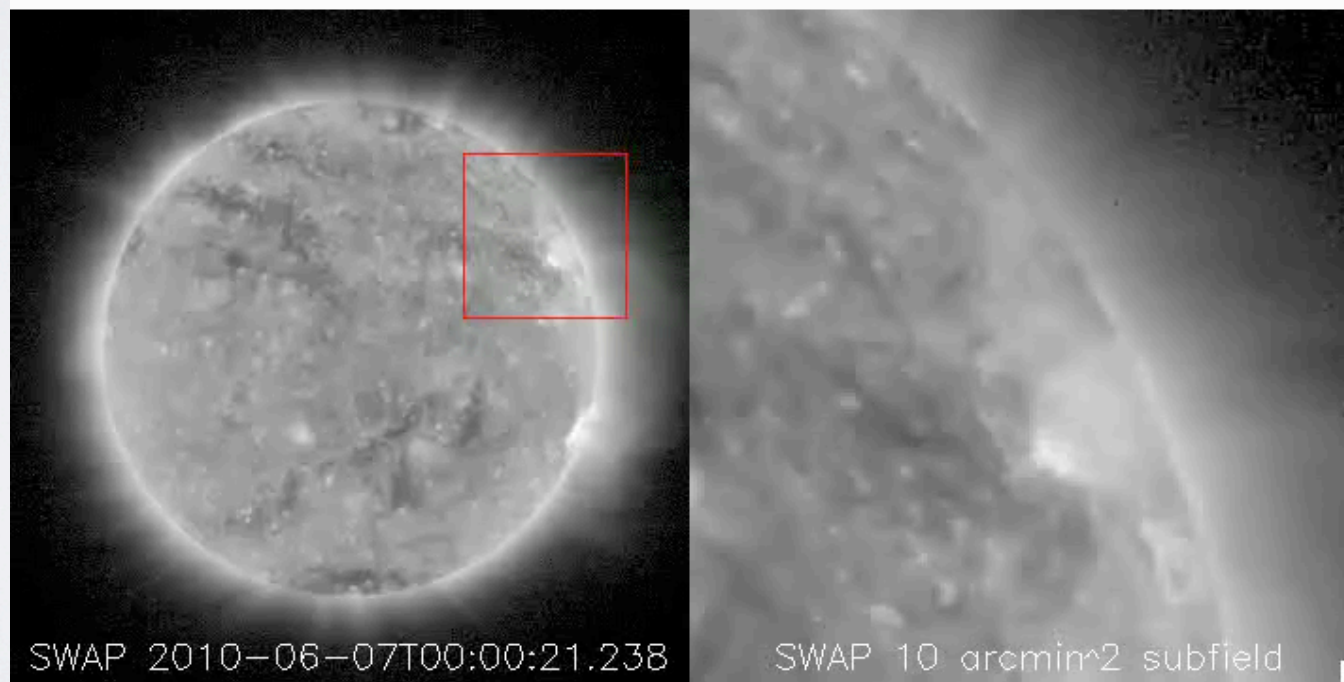
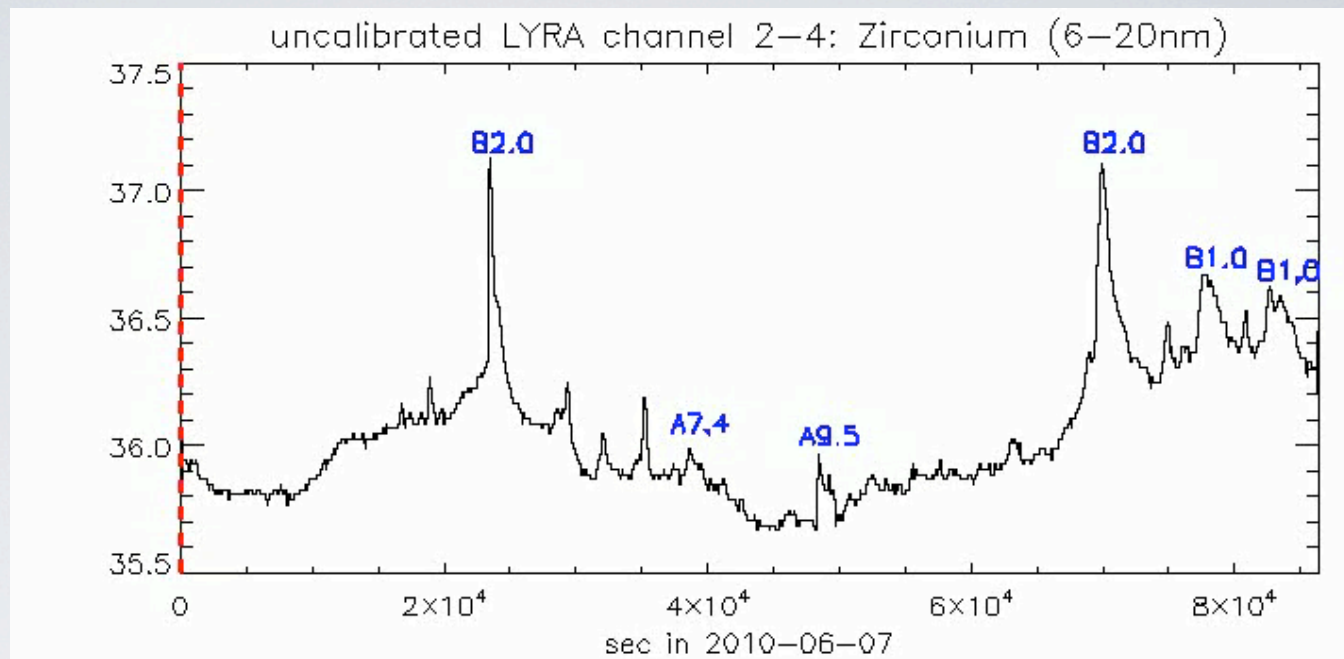
3 April 2010, 09:30 UTC ☀ B7.4 Flare ☀ Geoeffective CME







SWAP 175 Å 2010-04-03 08:02:11



SWAP 2010-06-07T00:00:21.238

SWAP 10 arcmin<sup>2</sup> subfield



COMMUNITY

# OPEN DATA POLICY

Data is freely available to all users

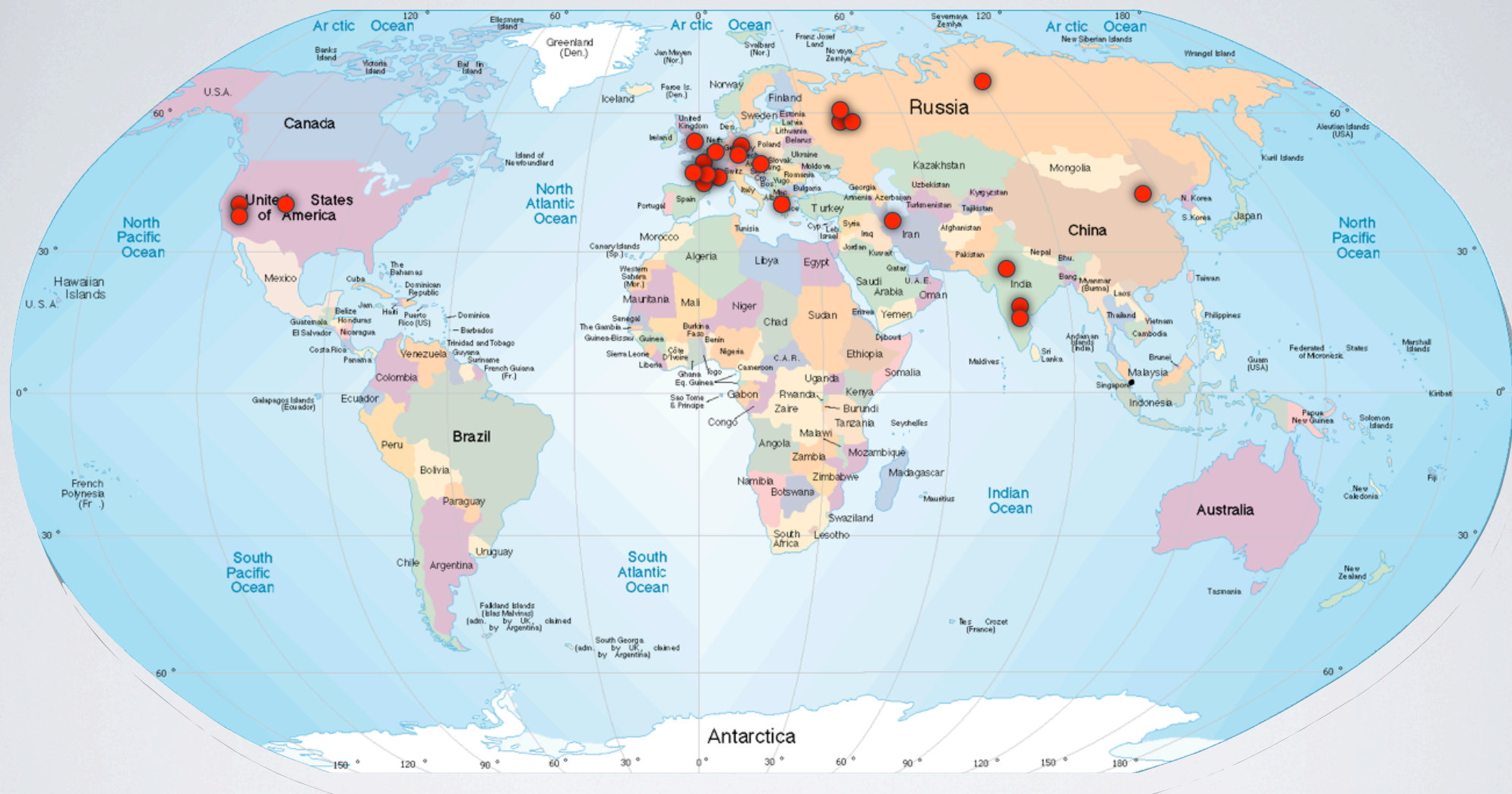
**<http://proba2.sidc.be/>**

All data ordered in year/month/day folders  
Fancy data browser & VO distribution to come

SSW will have software trees SWAP & LYRA



# GUEST INVESTIGATORS



- Austria: 1
- Belgium: 1
- China: 1
- France: 5

- Germany: 2
- Greece: 1
- India: 3
- Iran: 1

- Russia: 4
- UK: 1
- US: 1

# SPECIAL CAMPAIGNS

Commanding from Royal Observatory of Belgium

[swap\\_lyra@oma.be](mailto:swap_lyra@oma.be)

Off-pointing on request within few hours  
Time-resolution, subfields, signal/noise



# PROBA2 NEEDS ILWS HELP

*In the past years:*

- Sun-synchronous orbit
- SWAP and LYRA as community instrument

*Now*

- PROBA2 mission extension

# THANKS



Centre Spatial de Liege



European Space Agency



Belgian Science  
Policy Office



You!



