

THE SOLAR CORONA UP TO 2-3 R_☉

AS SEEN THROUGH

PROBA2/SWAP

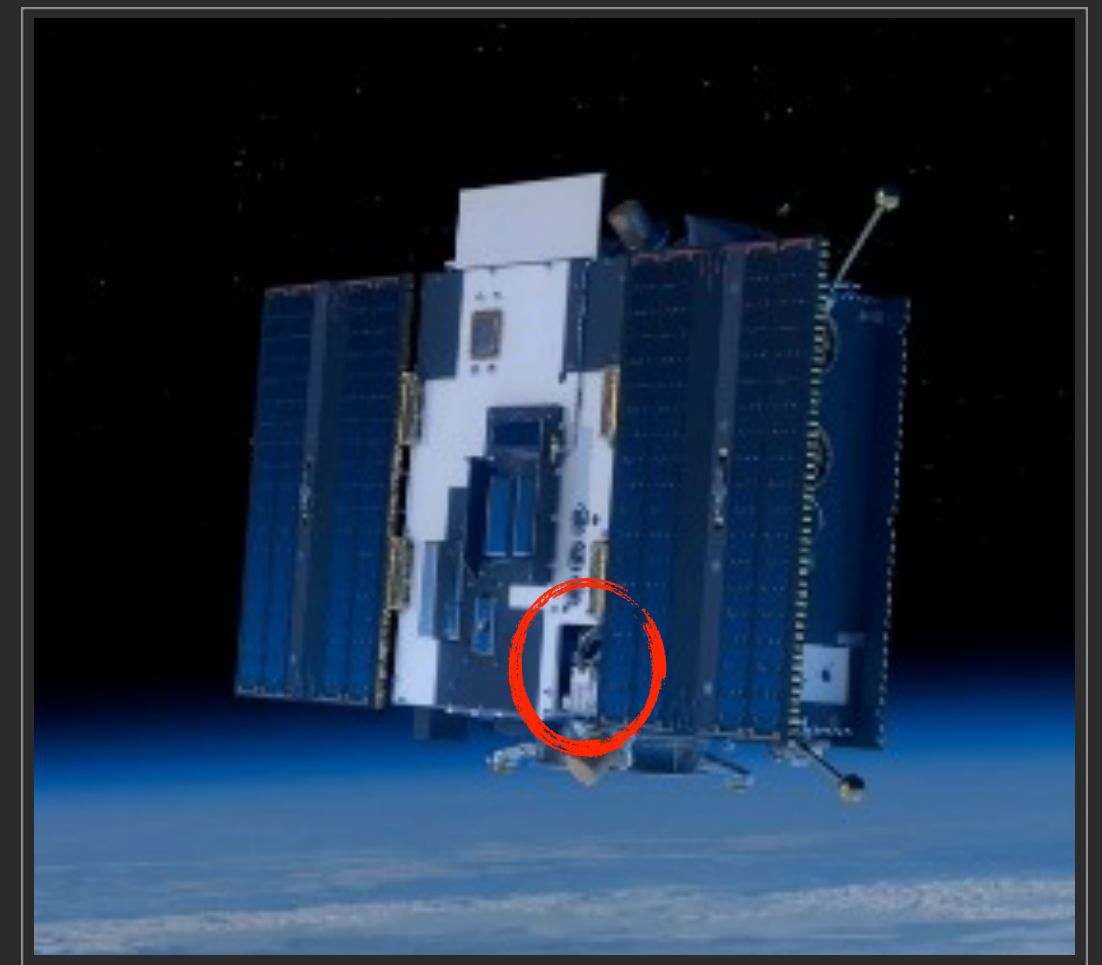
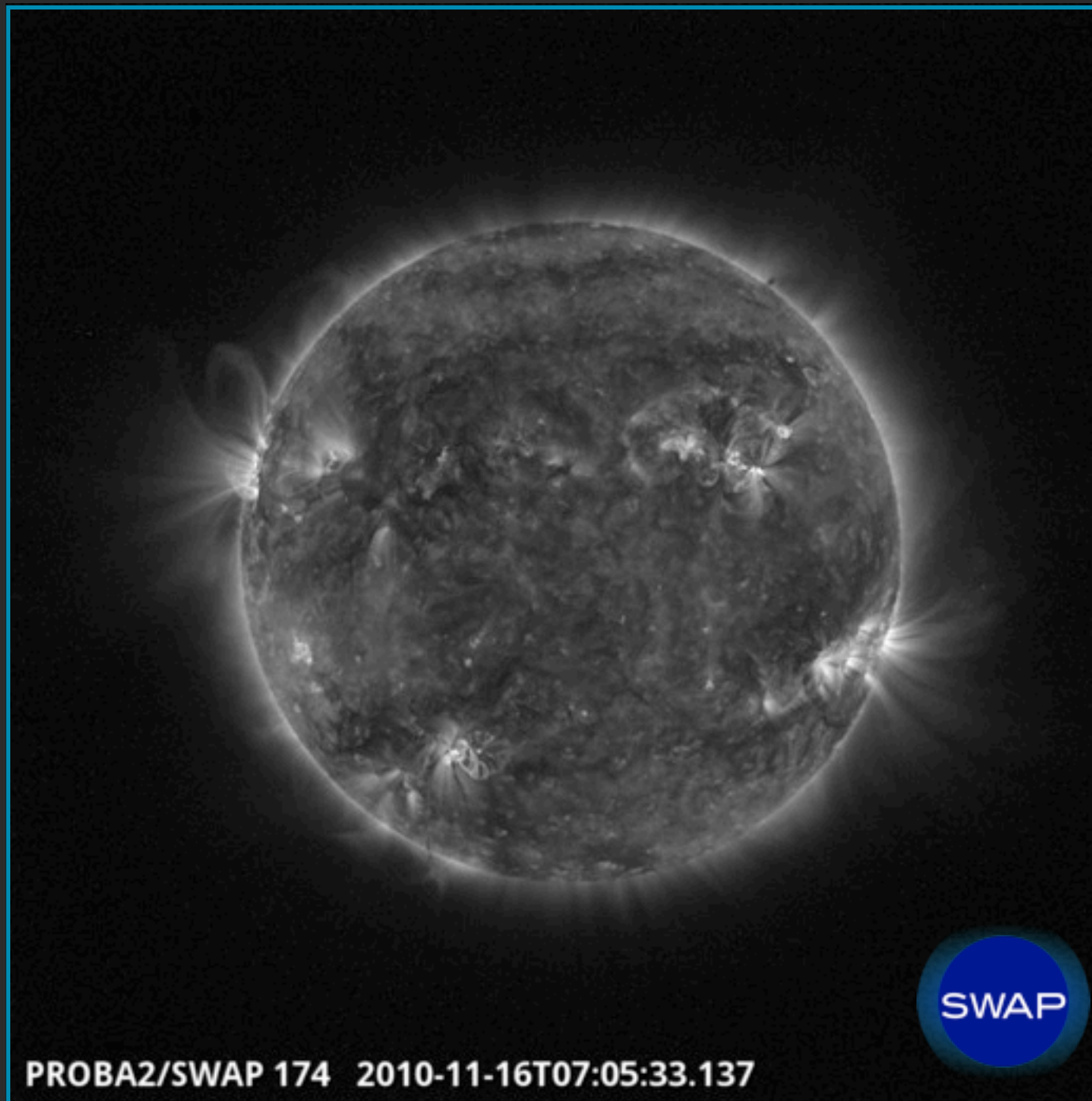
A. De Groof, D. Seaton, D. Berghmans, J. Pasachoff, C. Bazin***

ESA, Royal Observatory of Belgium

* Williams College, MA, US ** IAP, France

Eclipse on the Coral Sea ☀ Palm Cove, QLD Australia ☀ November 12-16, 2012





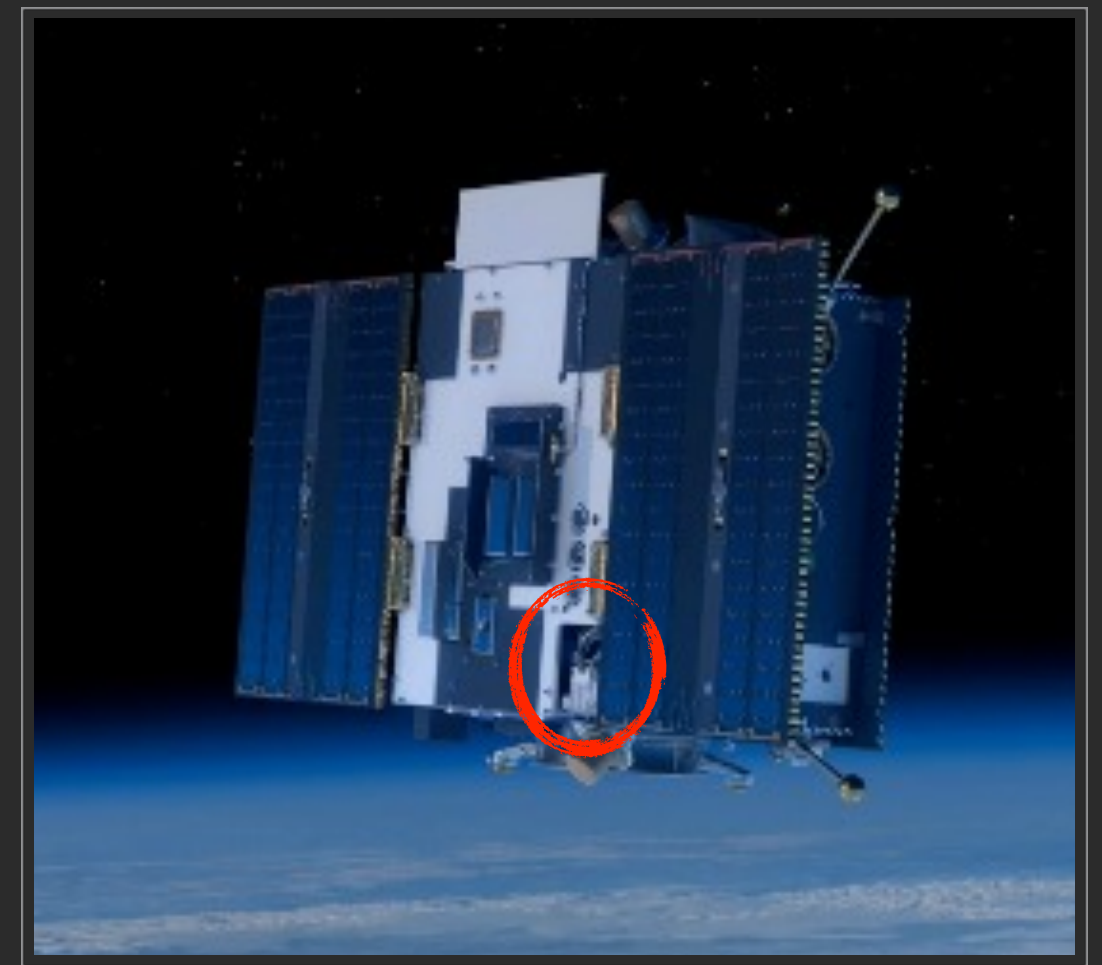
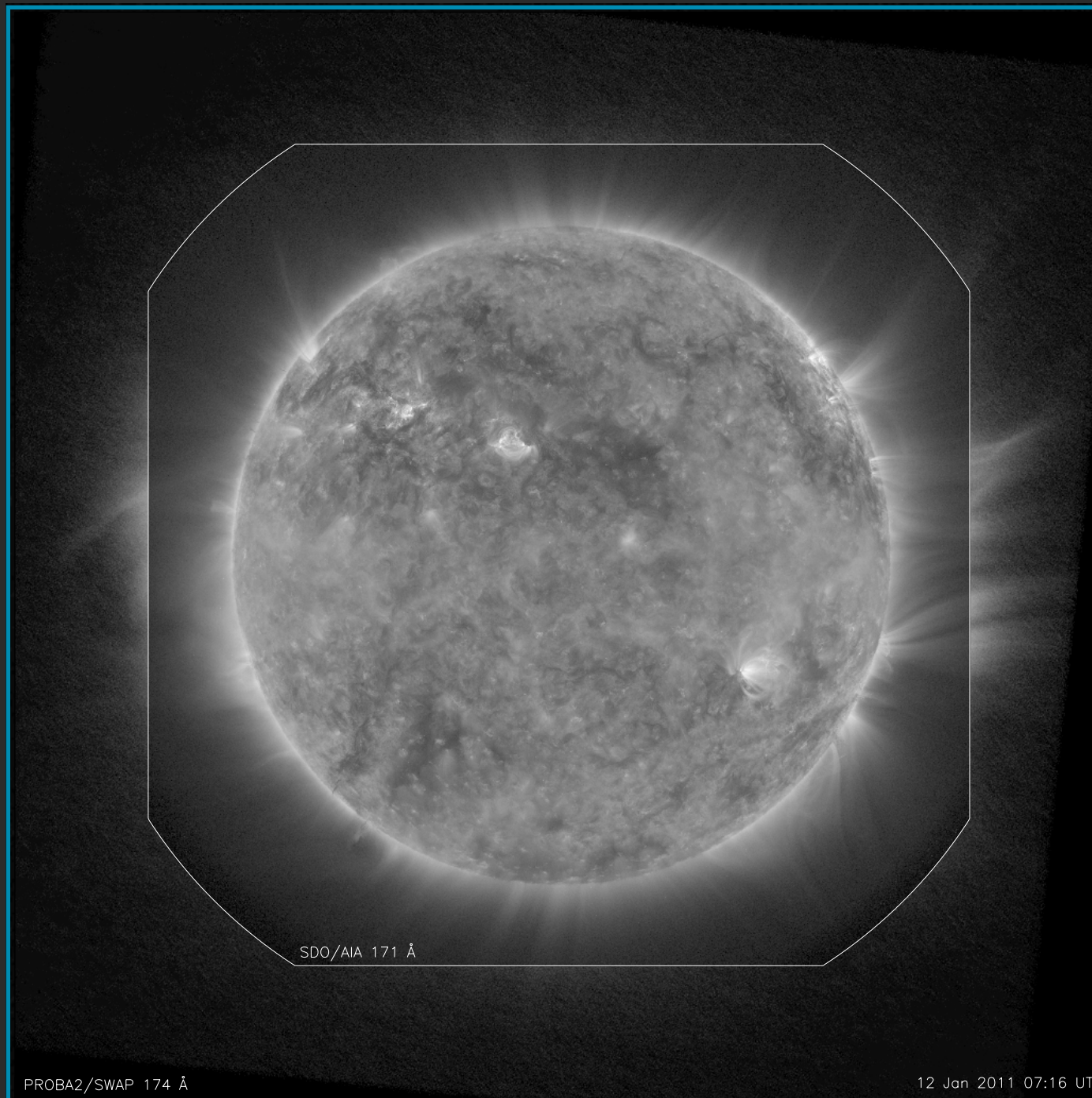
ESA microsatellite PROBA2
sun-synchronous orbit since Nov '09

Seaton et al. 2012, Sol.Phys. online
Halain et al. 2010, SPIE 7732

SWAP EUV IMAGER

1 million° corona in EUV 17.4nm ☼ ~2 mins cadence (upto 20s)

large FOV ☼ 1Kx1K CMOS APS (~EUI, PHI, SoloHI)



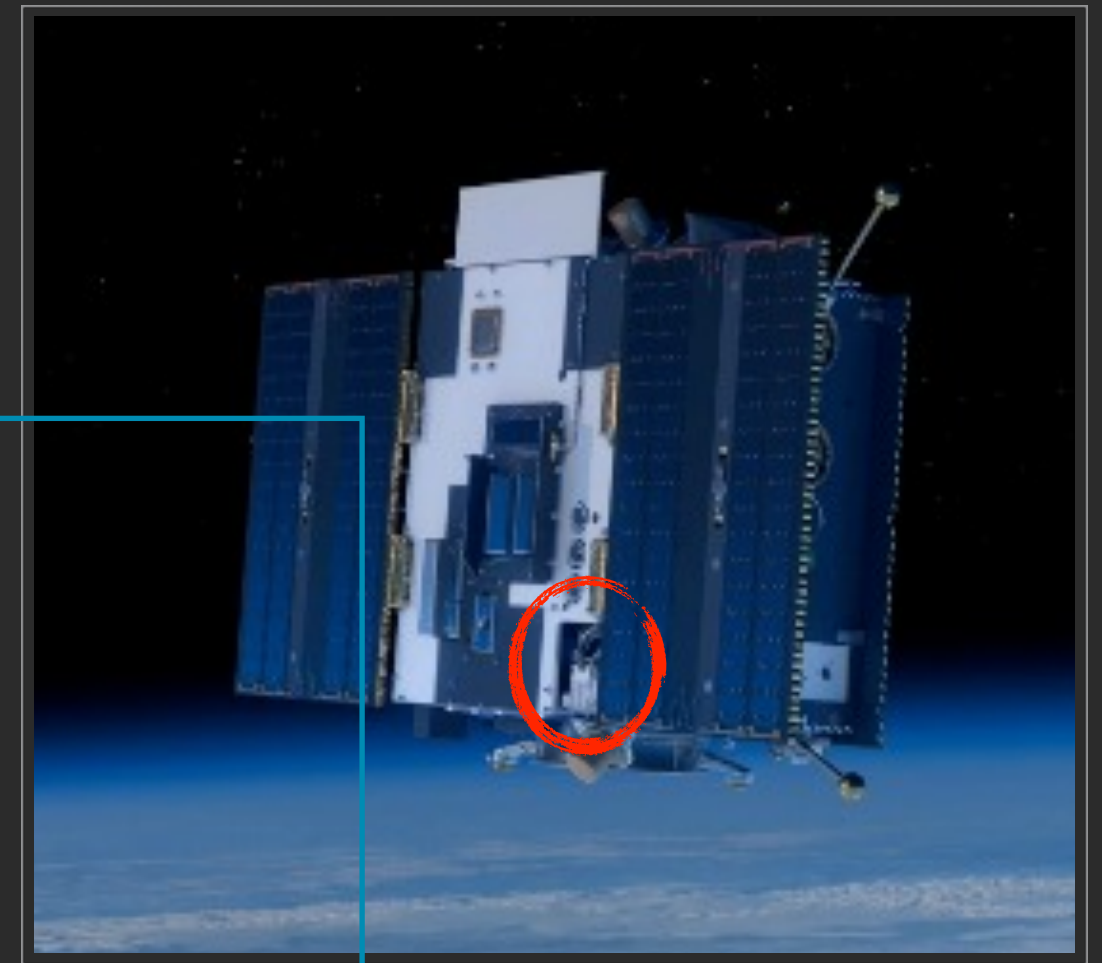
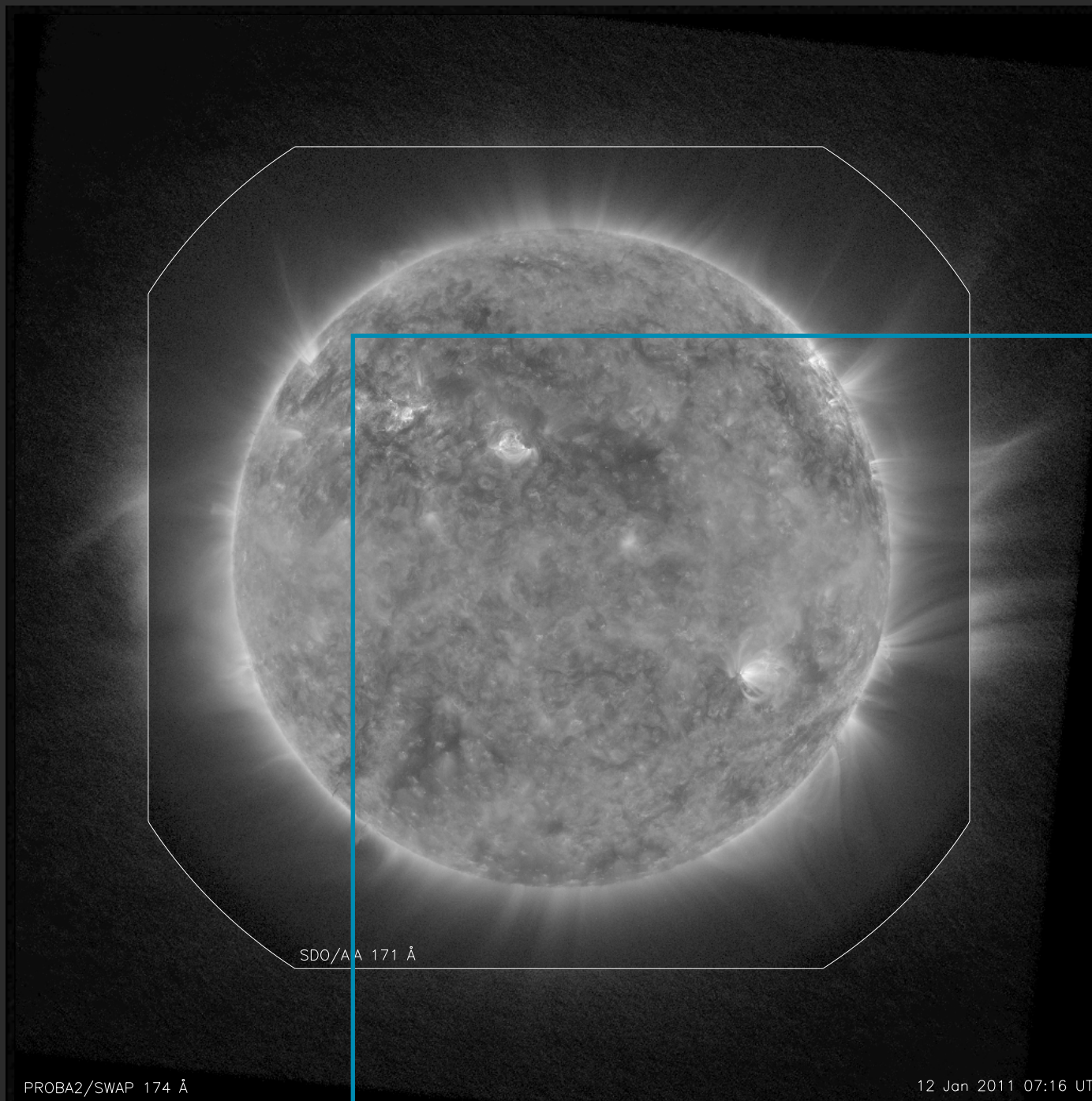
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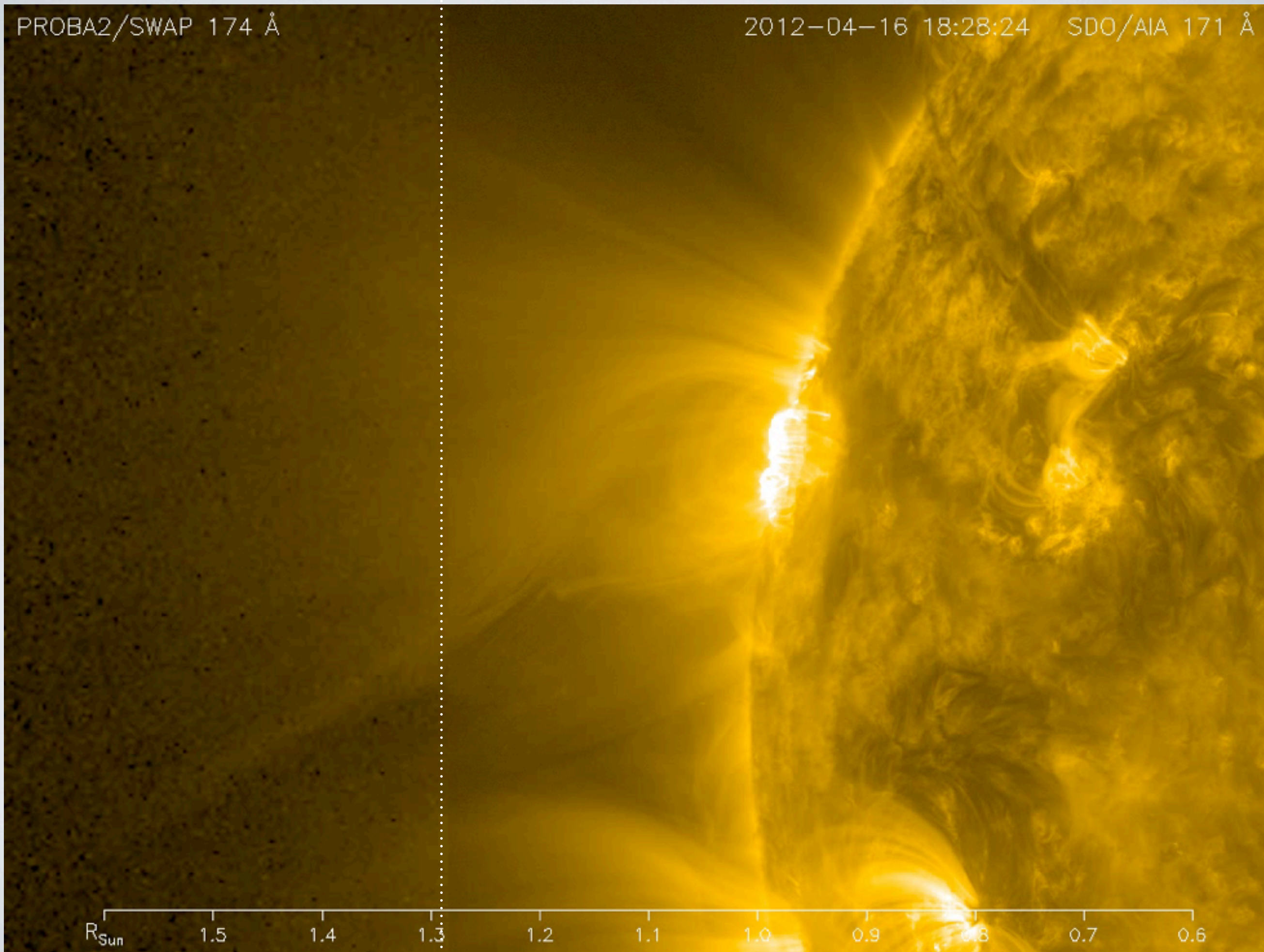
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PROBA2/SWAP 174 Å

2012-04-16 18:28:24 SDO/AIA 171 Å



R_{Sun} 1.5 1.4 1.3 1.2 1.1 1.0 0.9 0.8 0.7 0.6

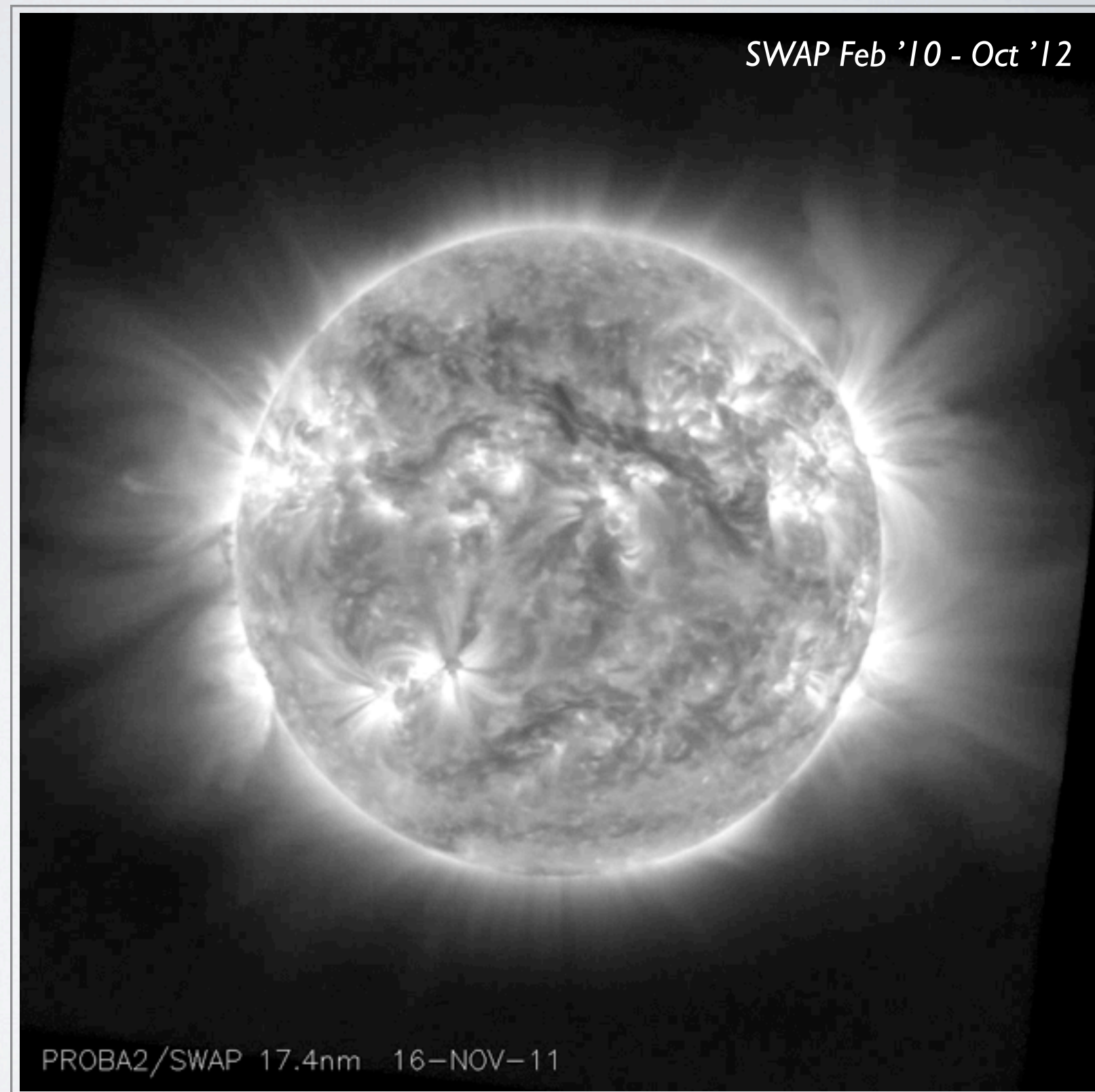
EVOLUTION EXTENDED CORONA

SWAP Feb '10 - Oct '12

- high-quality, deep-exposure SWAP images by stacking up many individual images
- ▶ Carrington rotation movies
<http://proba2.oma.be/swap/movies>
- SWAP monitored the extended corona ($< 2 R_{\text{sun}}$) over 2,5 years (rising phase)
- **Aim of this presentation:**
present preliminary results,
inspire new research on
extended EUV corona
above $1.3 R_{\text{sun}}$

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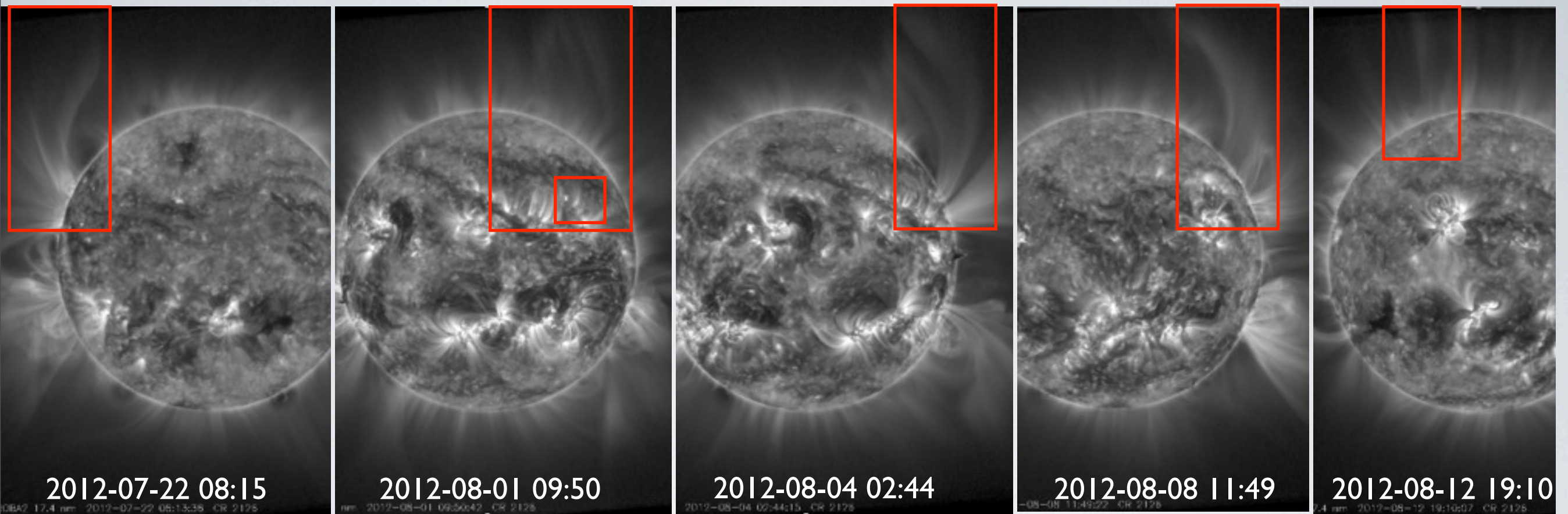
CR 2125-2126
radially enhanced

SWAP 174 Å 2012-06-21 06:10:32 CR 2125

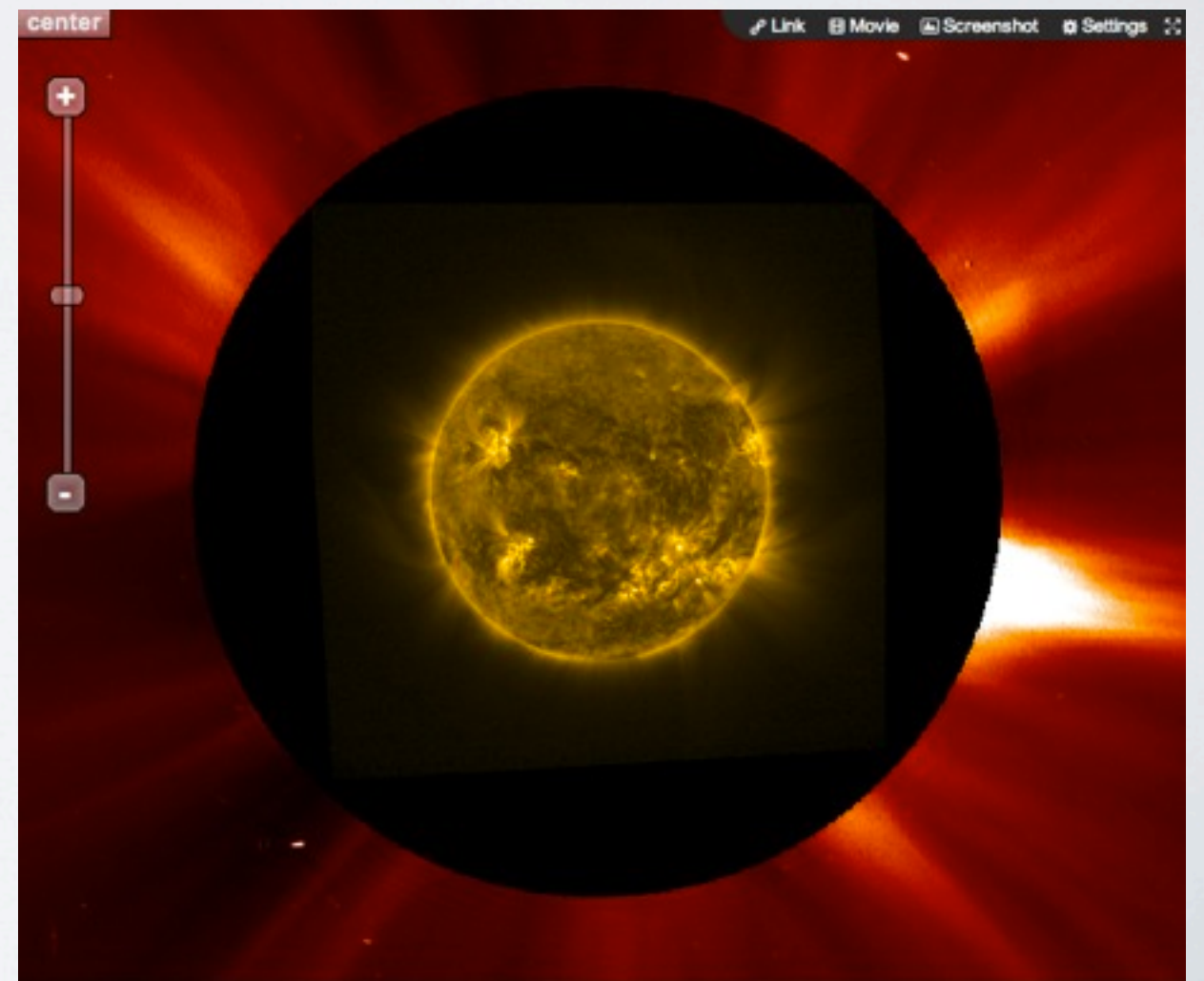
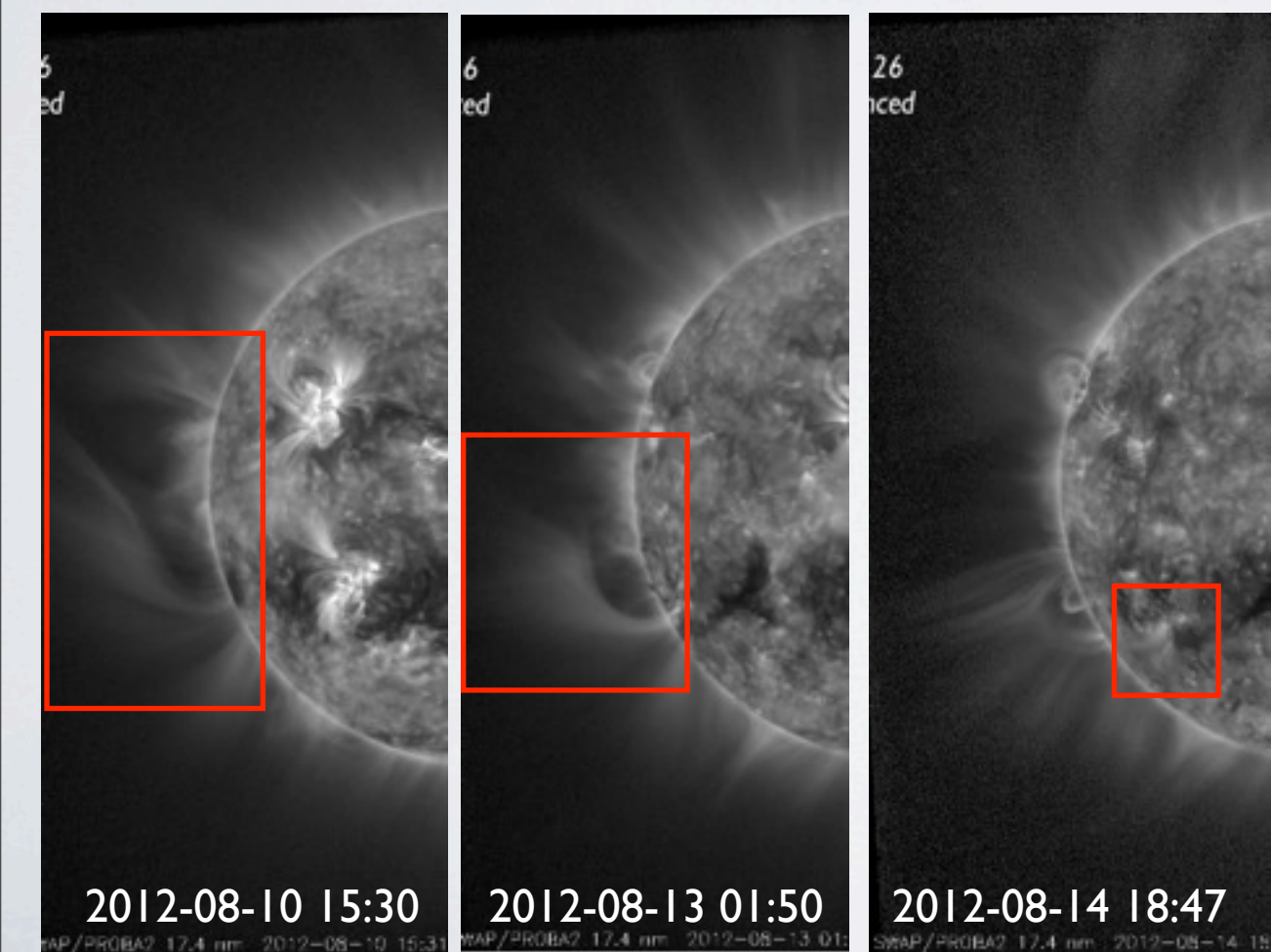
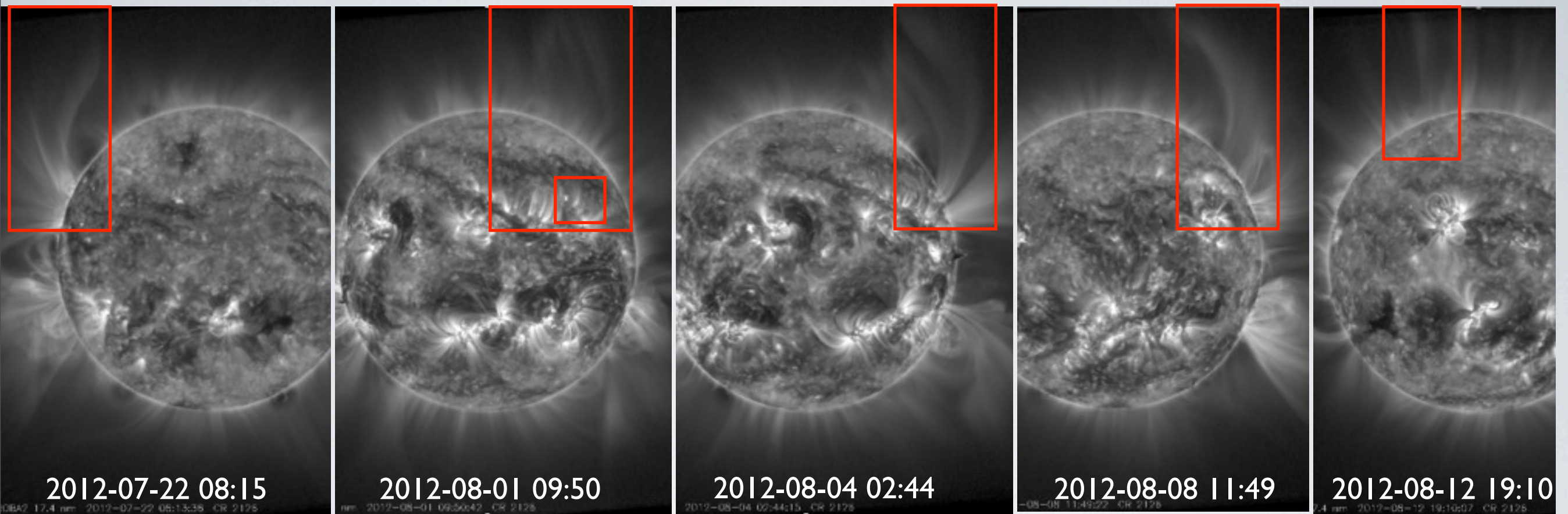


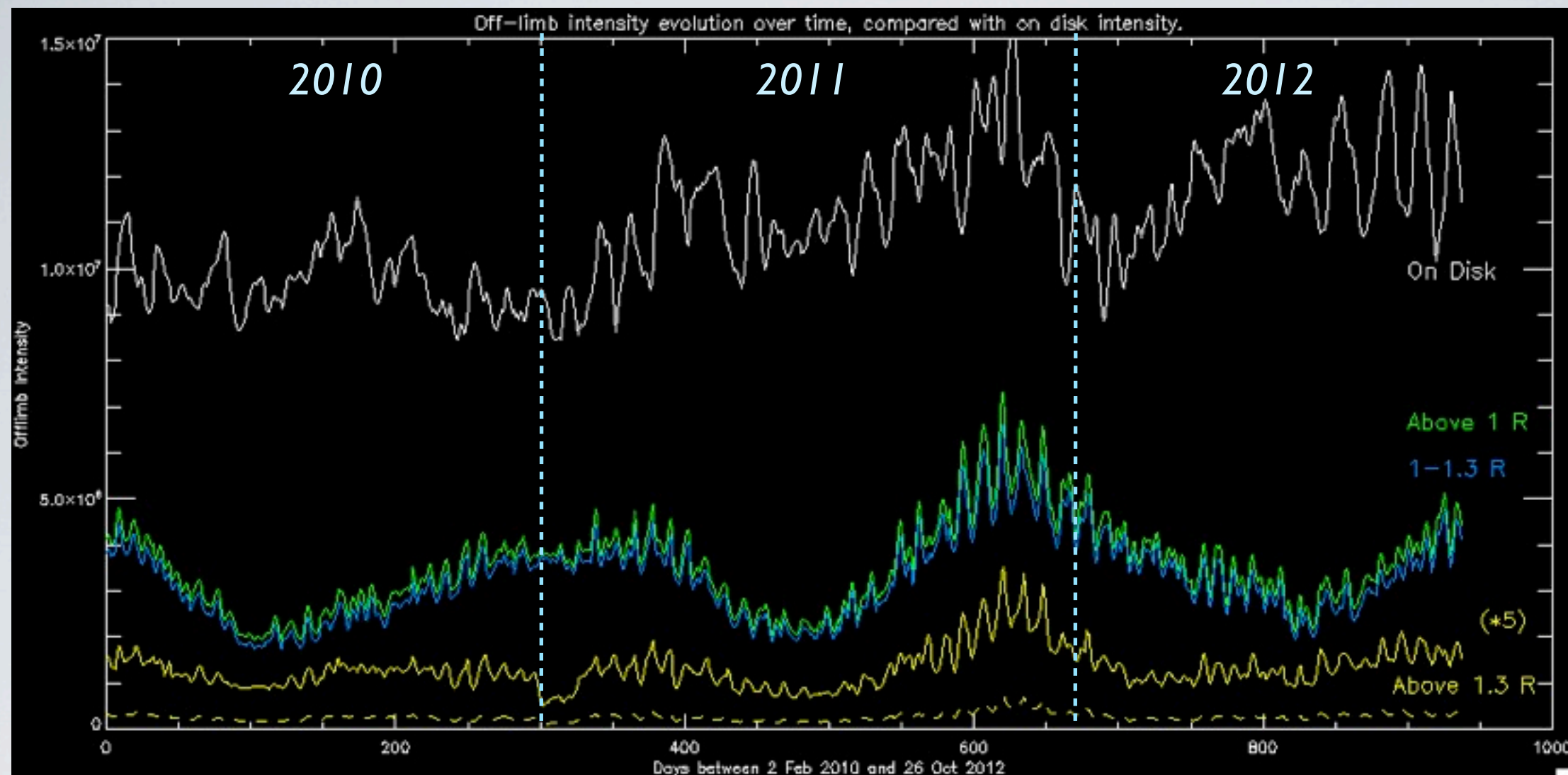
CORONAL 'FAN RAYS'

- Extended, EUV bright structures
- Raise along open field lines
- Seem rooted in the fan loops close to the edges of the AR
- Stable & persistent over several rotations - despite AR closeby
- Often bending above closed field



2012-08-10 15:30 2012-08-13 01:50 2012-08-14 18:47



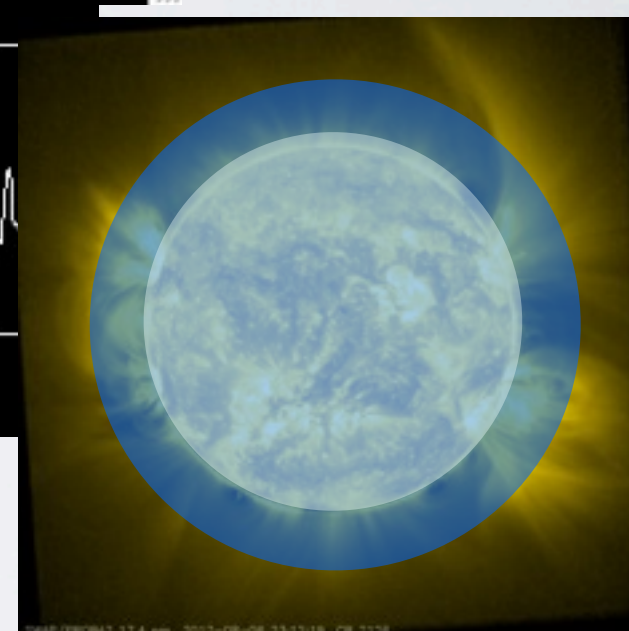
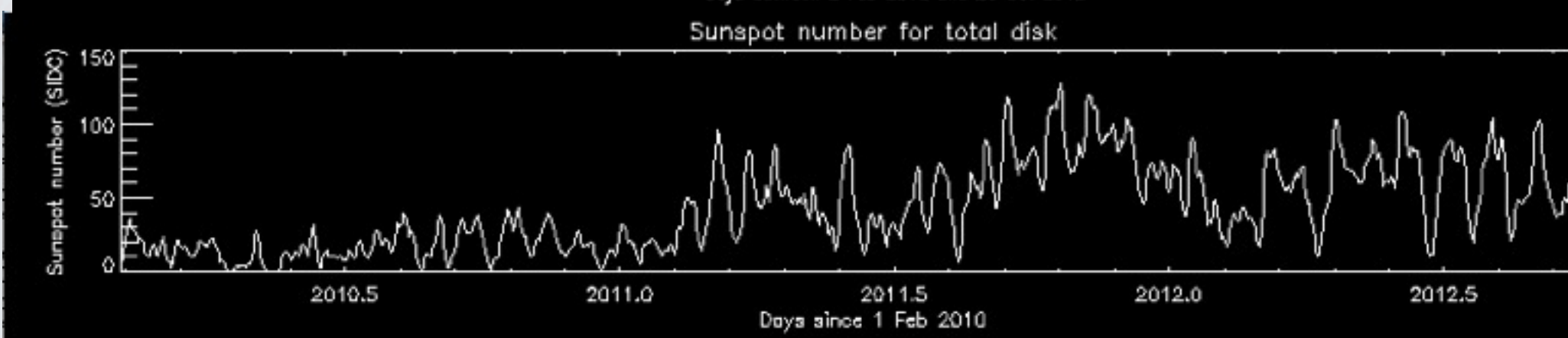


On disk

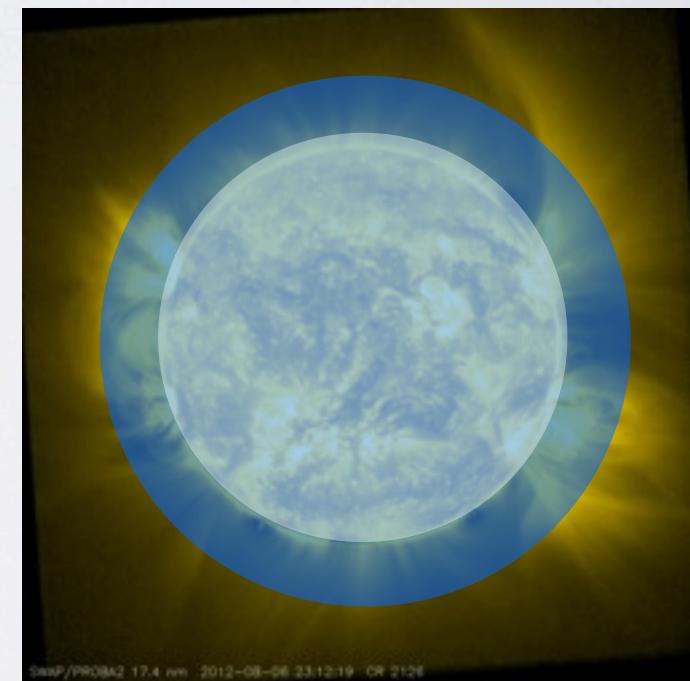
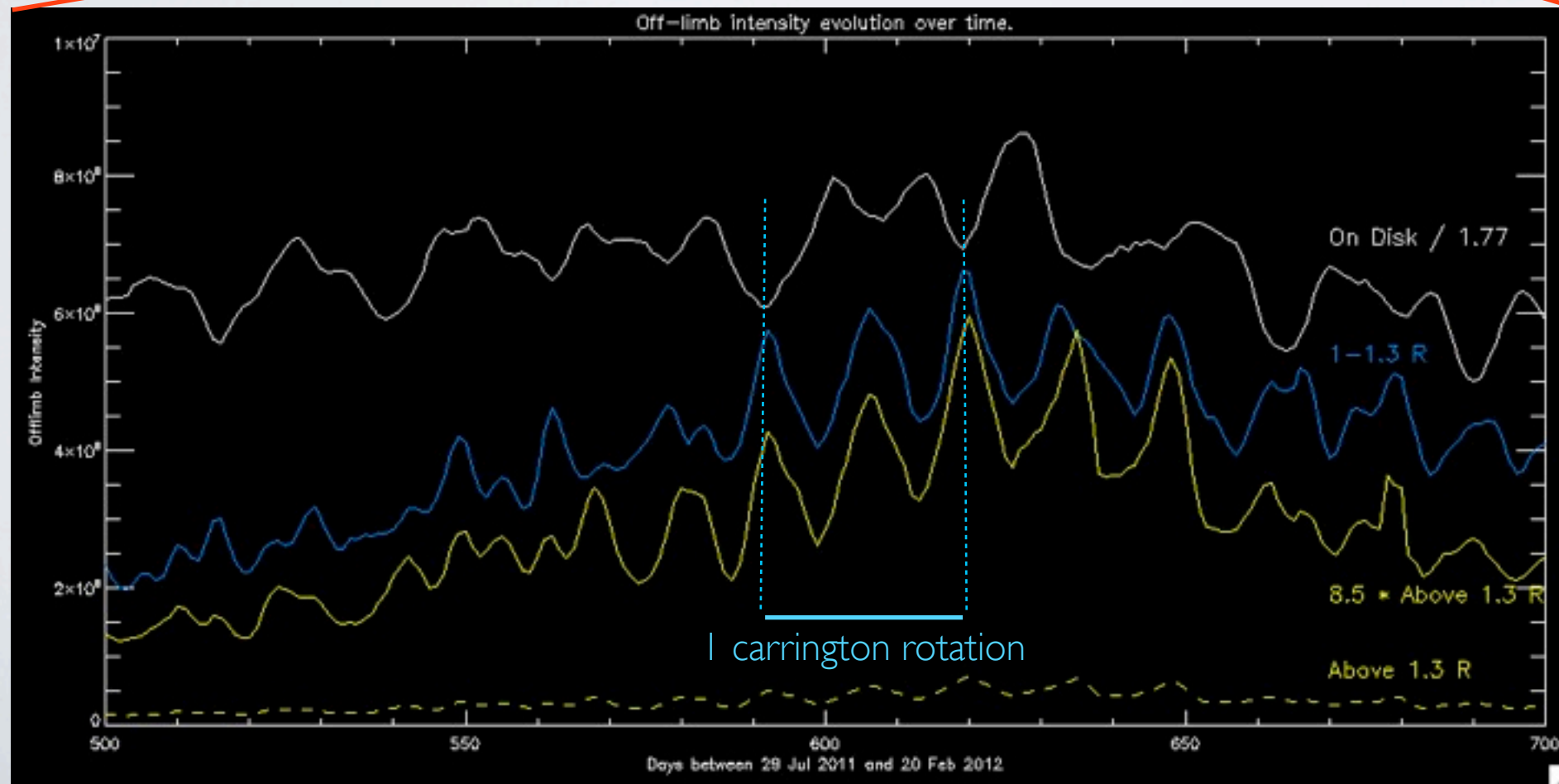
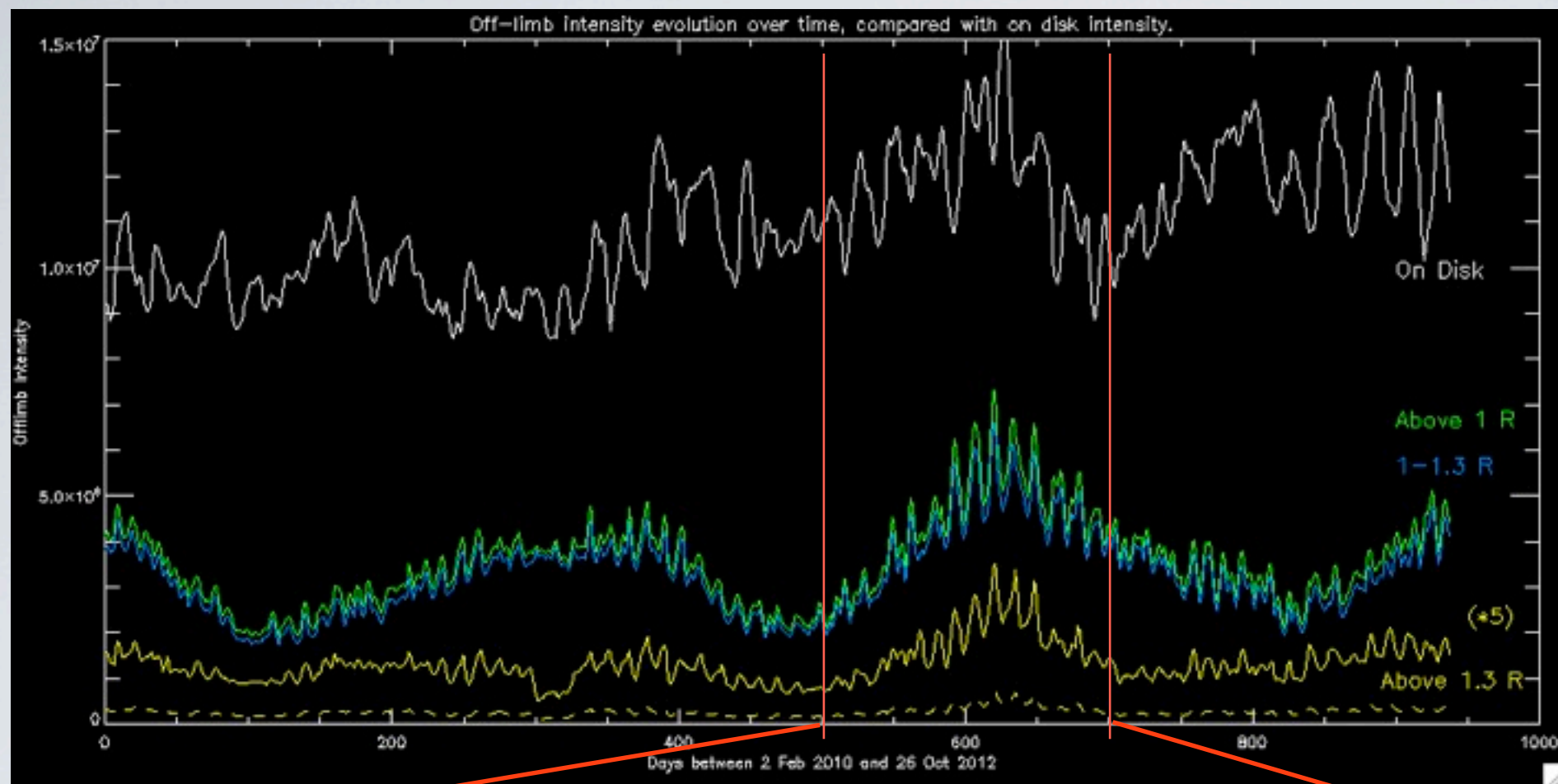
$> 1 R_{\text{SUN}}$

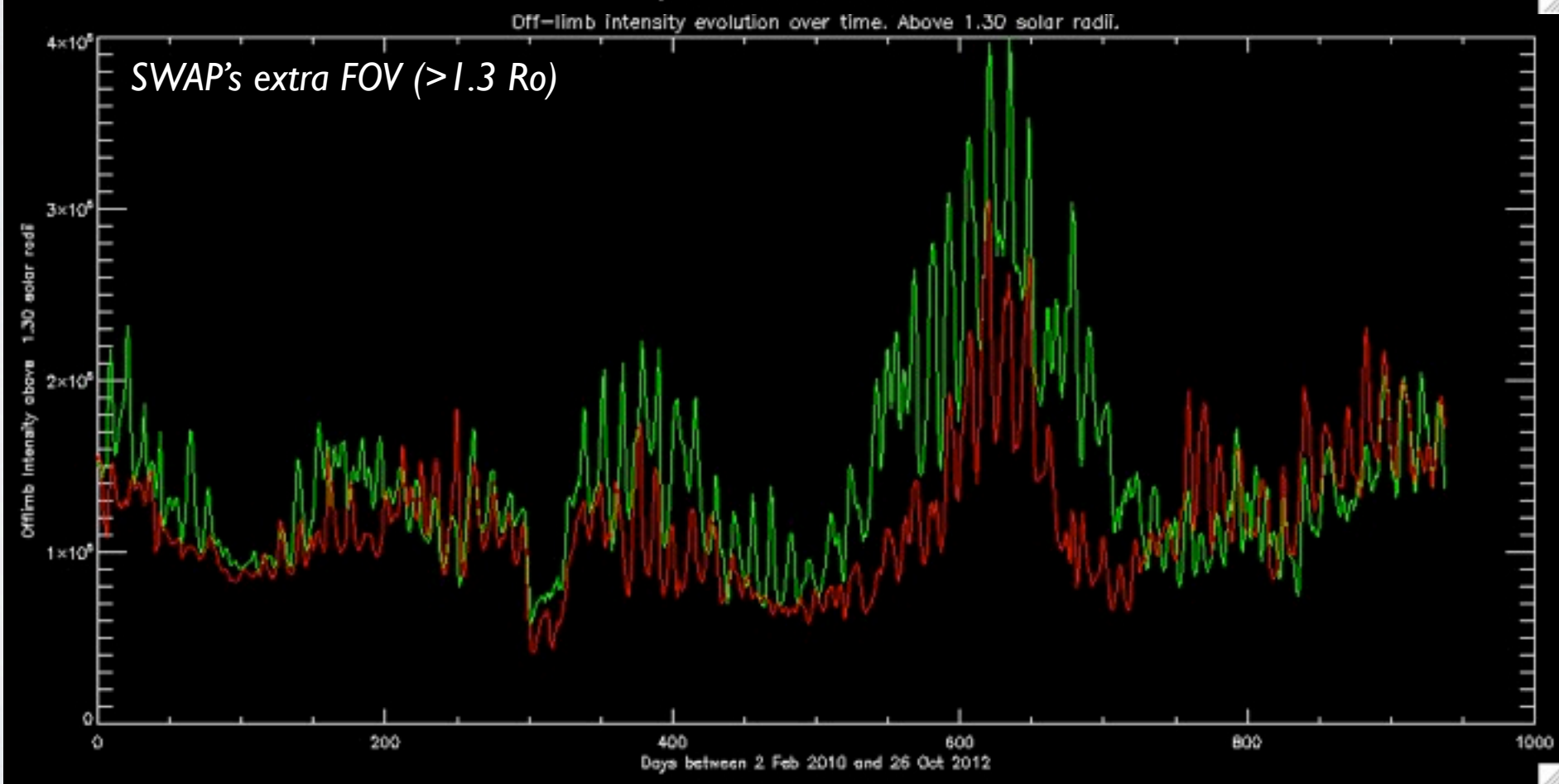
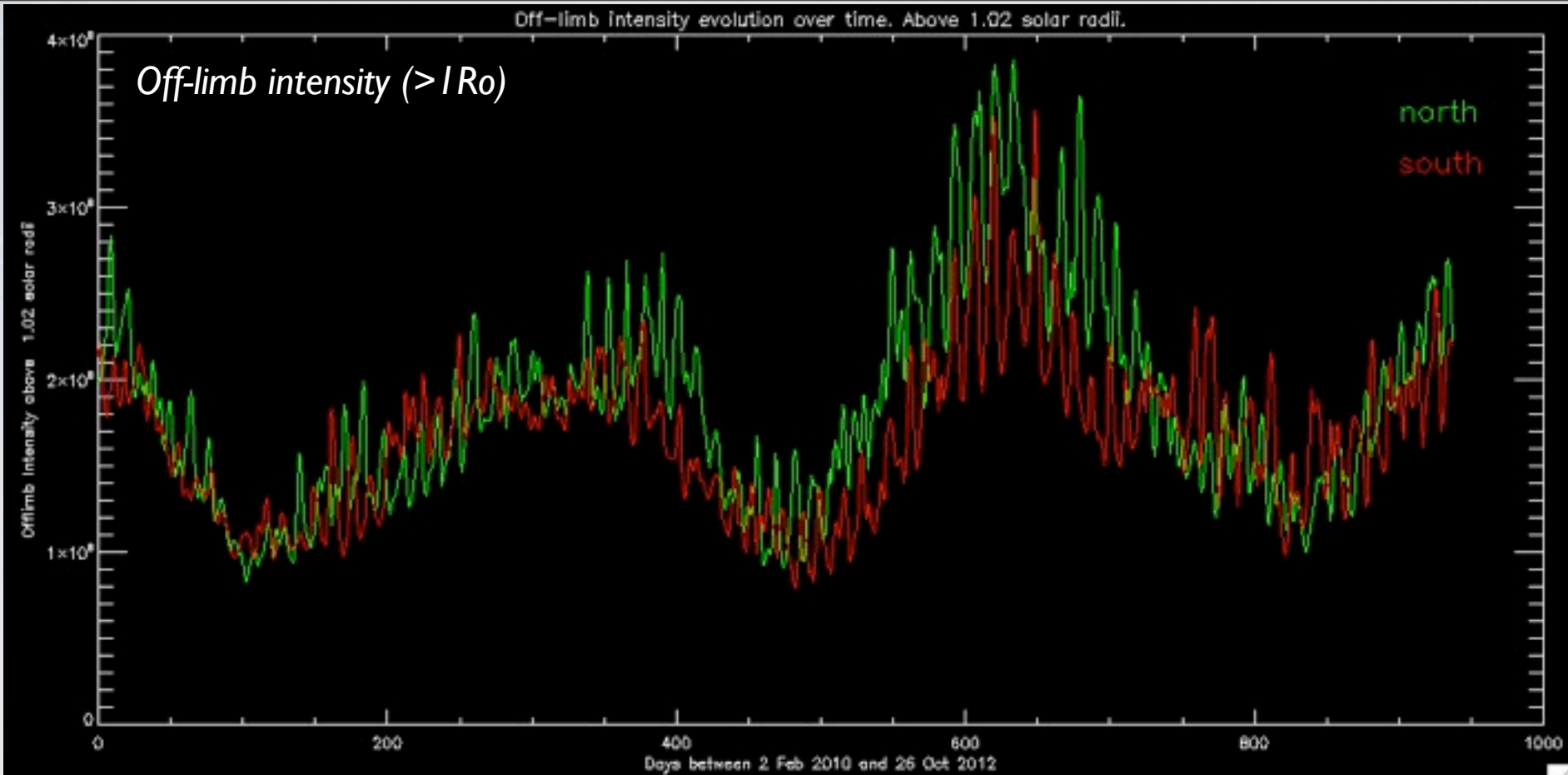
$1-1.3 R_{\text{SUN}}$

$> 1.3 R_{\text{SUN}}$



OFF-LIMB INTENSITY EVOLUTION



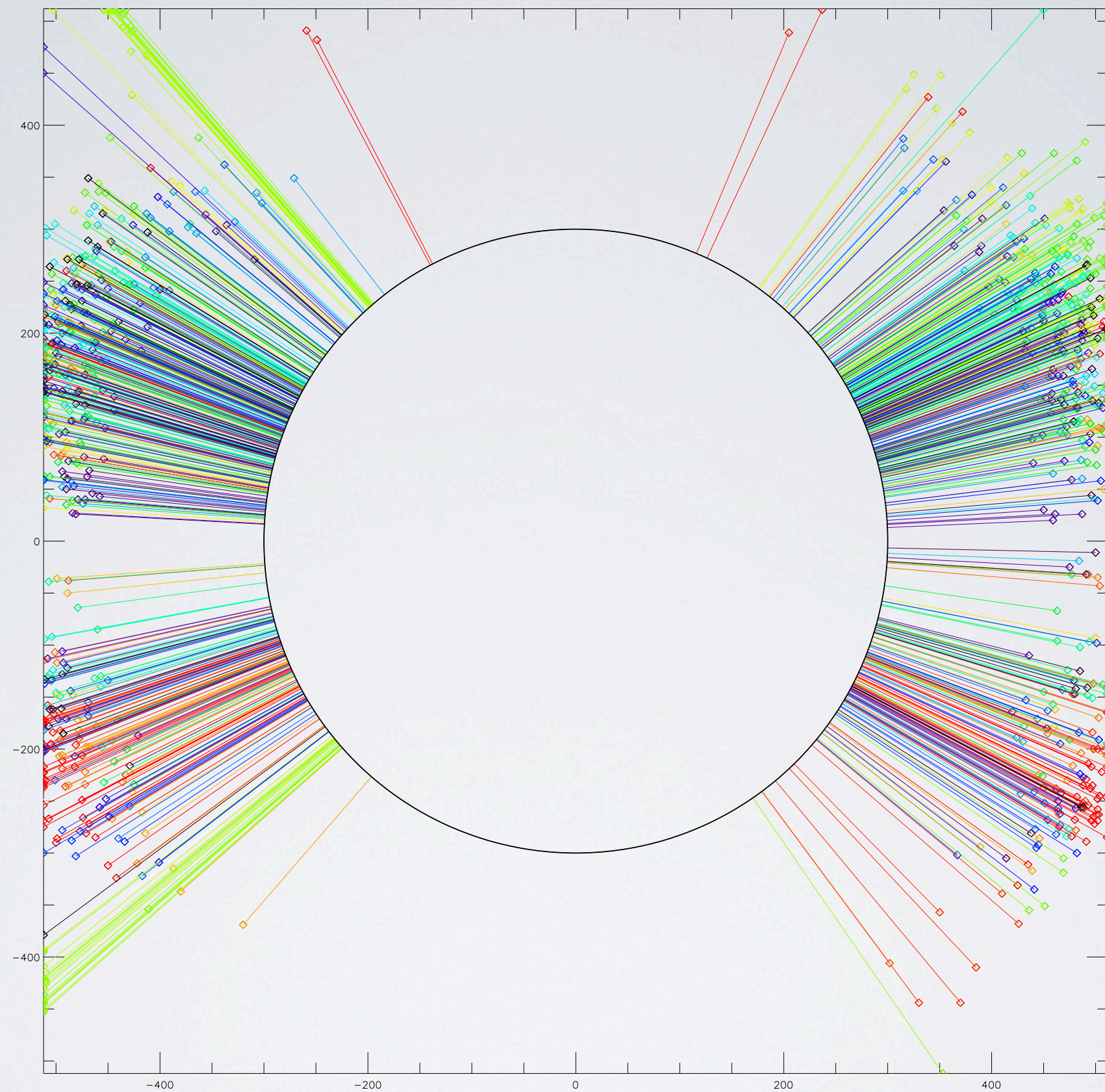


North
South

INTENSITY PER HEMISPHERE

QUESTIONS

- Link with WL streamers?
- Why are they so persistent? Continuous heating?
- Link with solar wind? (e.g. V. Slemzin, L. Harra, et al., *Sol. Phys. Online* 2012)
- How can they stay so stable?
- Where exactly are the footpoints?
- ▶ 3D reconstruction using SWAP only or with STEREO/EUVI
- ▶ Comparison EUV rays with WL, using MLSO or **total eclipses**



old  *recent*

FAN RAY EXTENSION

LINK WITH STREAMERS

Morgan & Habbal 2010, ApJ 710, 1

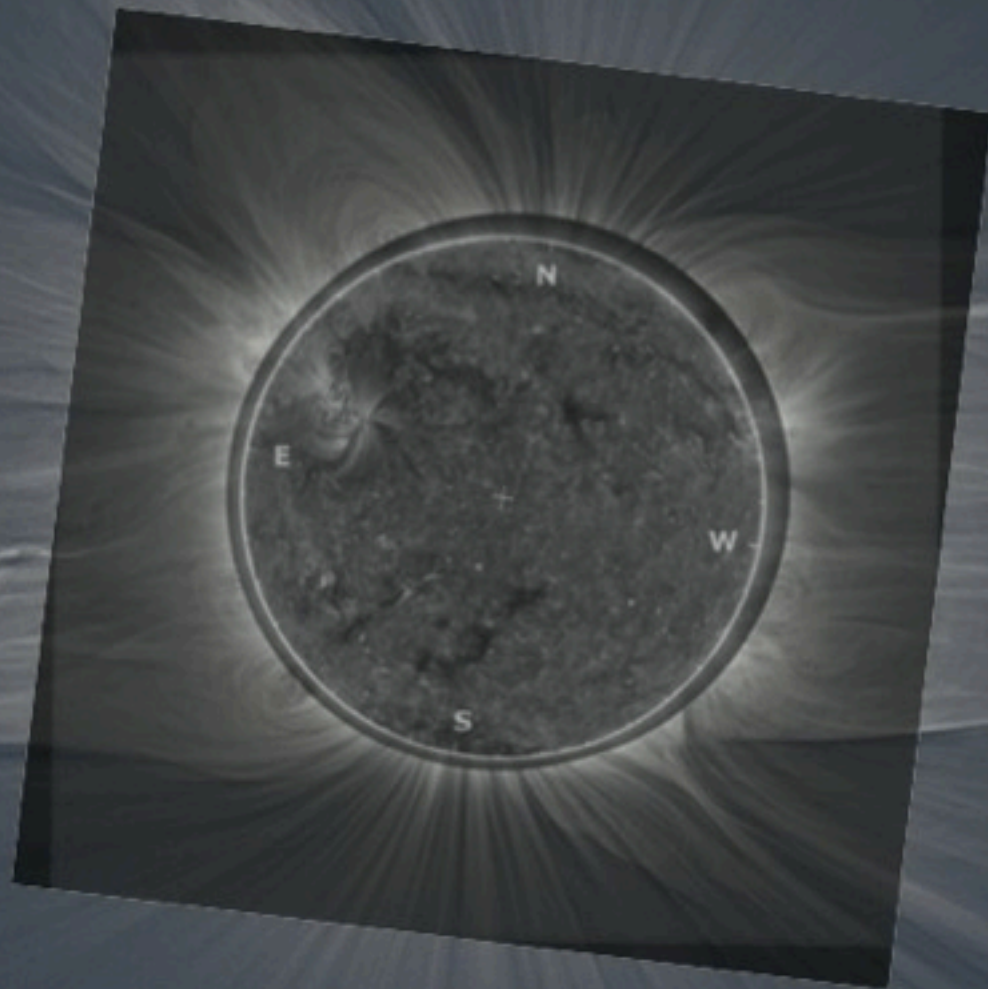
Streamers (WL)	Coronal Fan Rays (EUV)
high-density structures Intensity $\sim r^{-1}$	high-temperature structures Intensity $\sim r^{-2}$
rise radially	fan out, bend over closed loops?
same latitude as filaments & AR belts	higher latitudes? footpoints at polar edge of ARs
not necessarily associated with polar reversal	related to polar reversal ??


results of tomography on full solar cycle of LASCO data 4 R_{SUN}

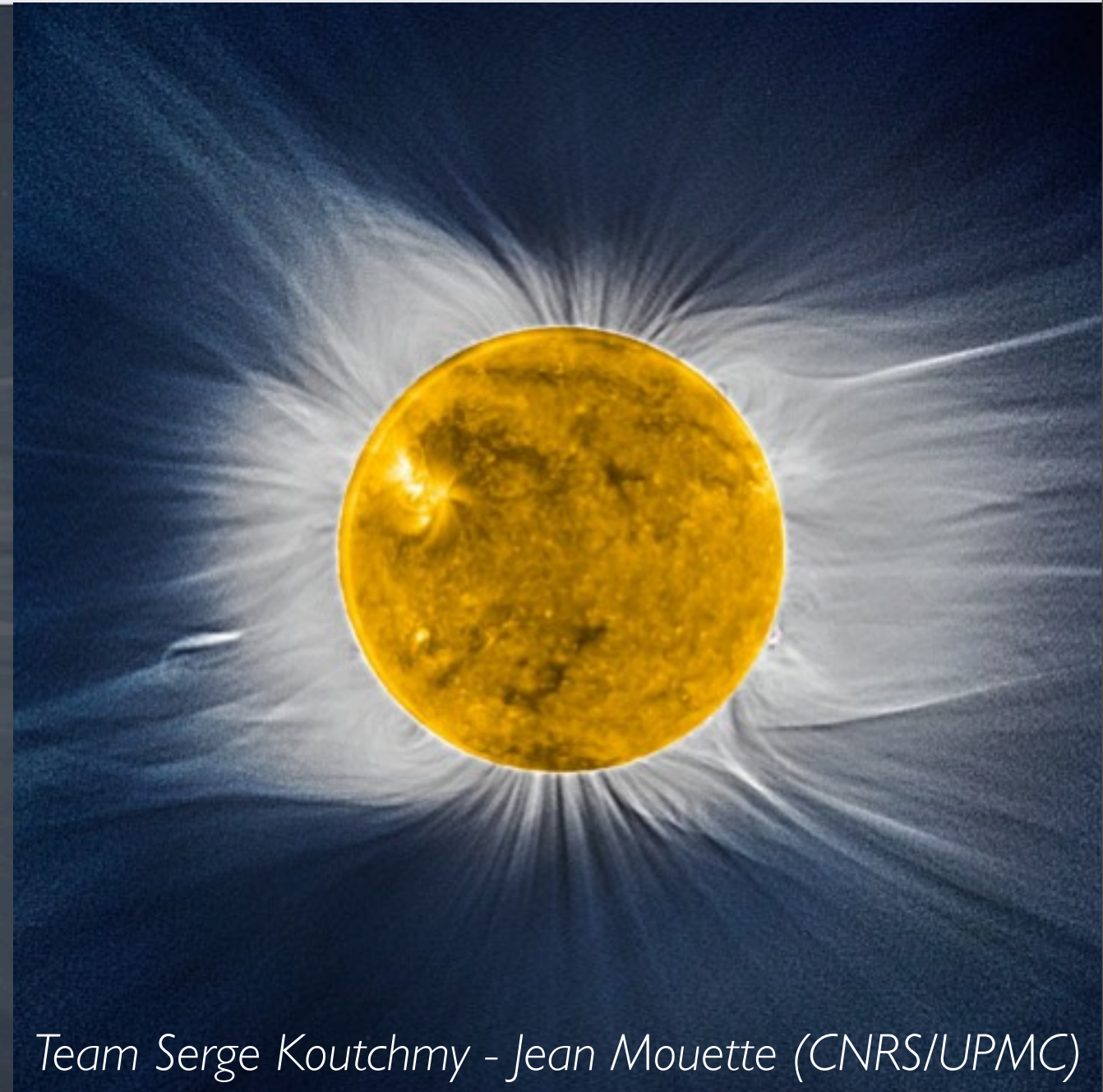
TOTAL SOLAR ECLIPSE

= Ideal opportunity to compare WL streamers with EUV fan rays

Example 11 July 2010 eclipse:



Pasachoff et al. 2010 ApJ. 734(2), 114

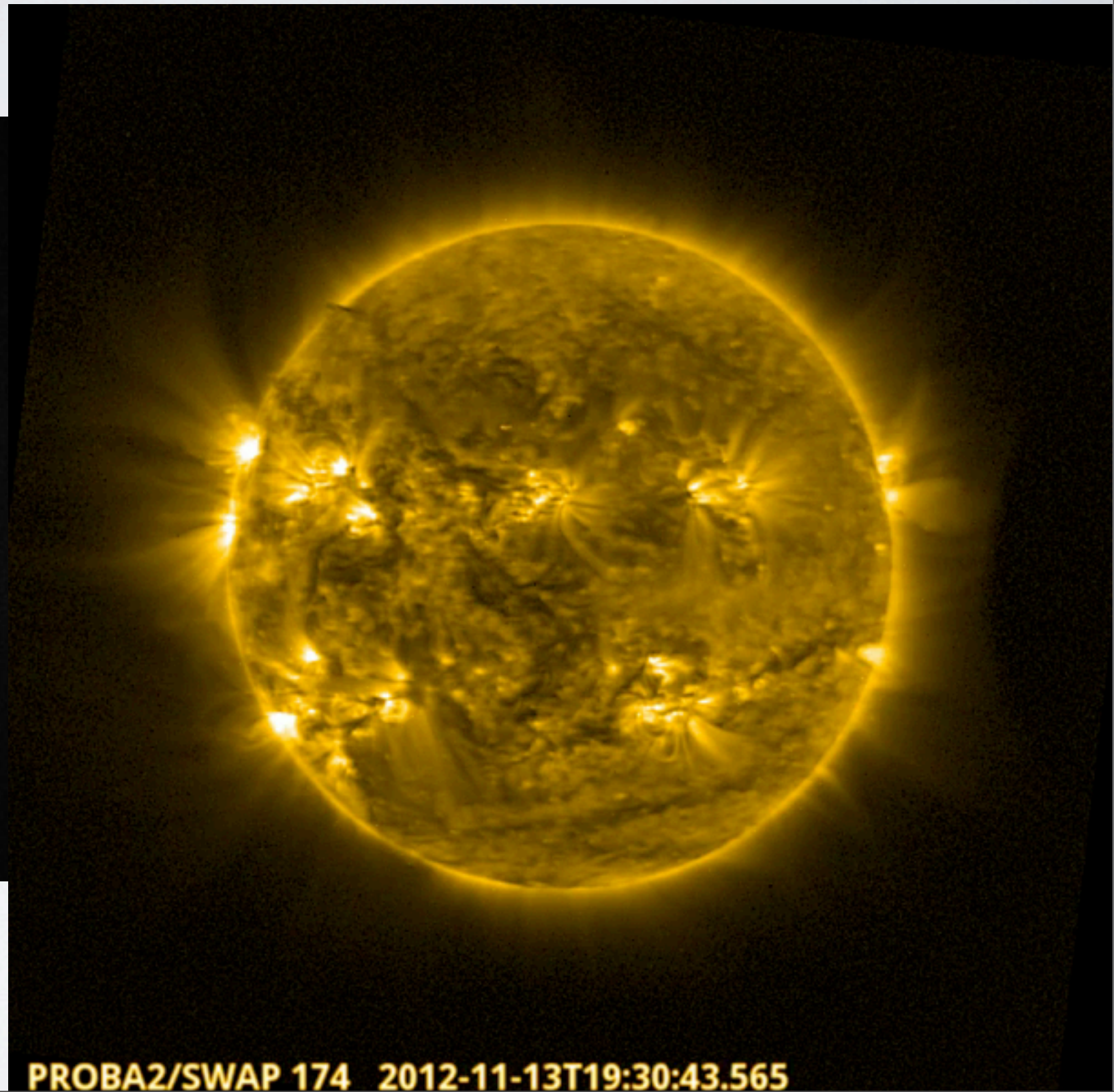
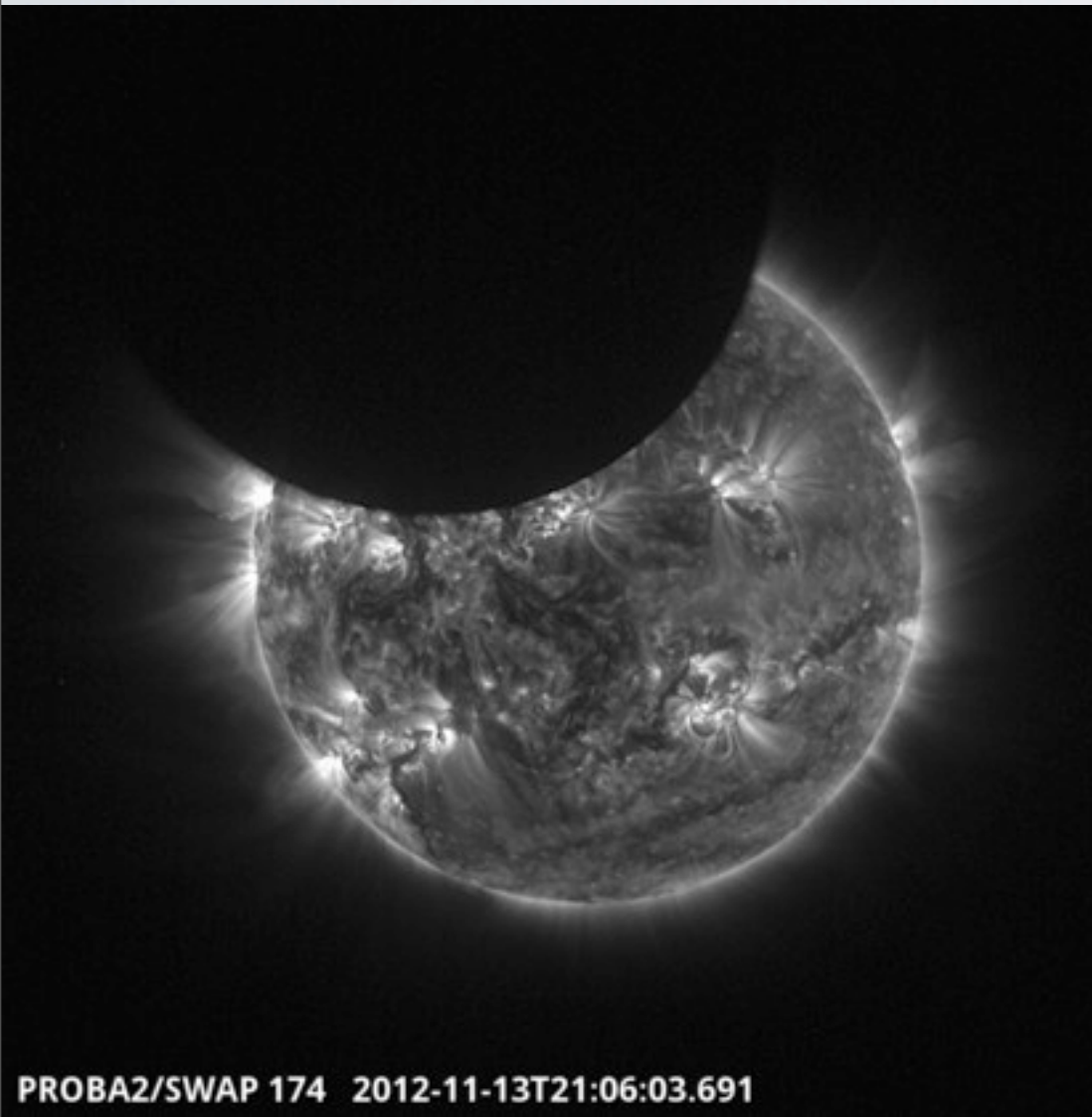


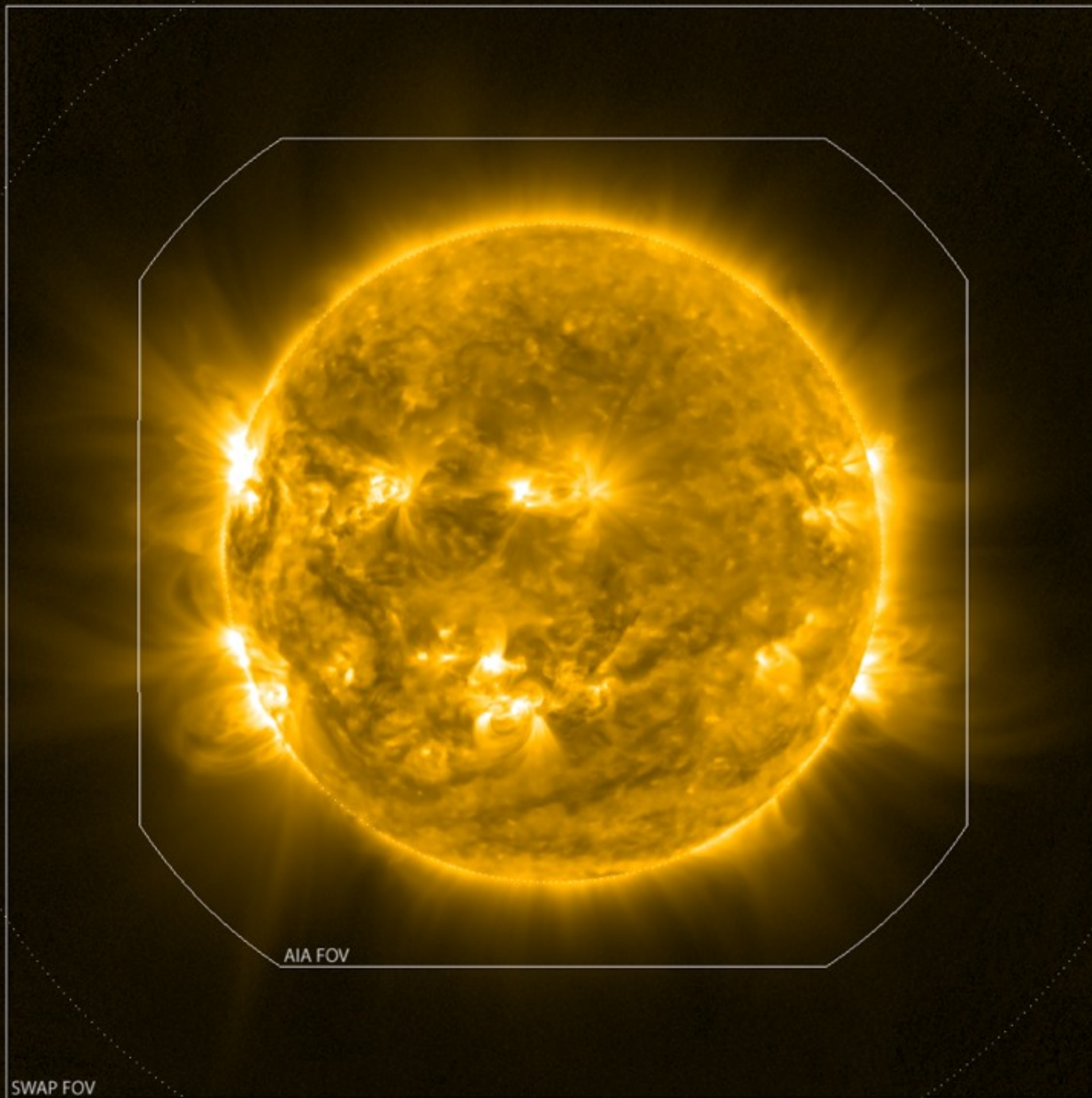
Team Serge Koutchmy - Jean Mouette (CNRS/UPMC)

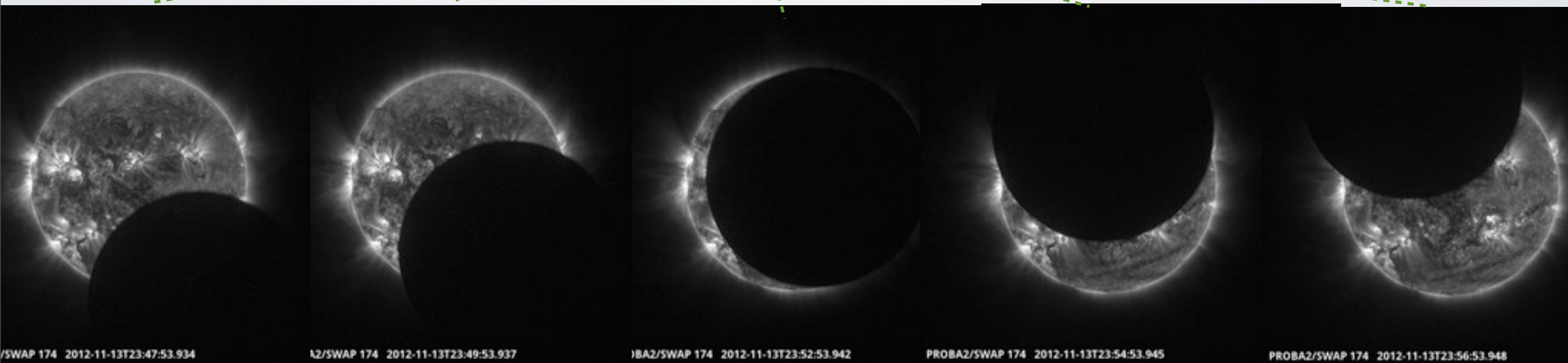
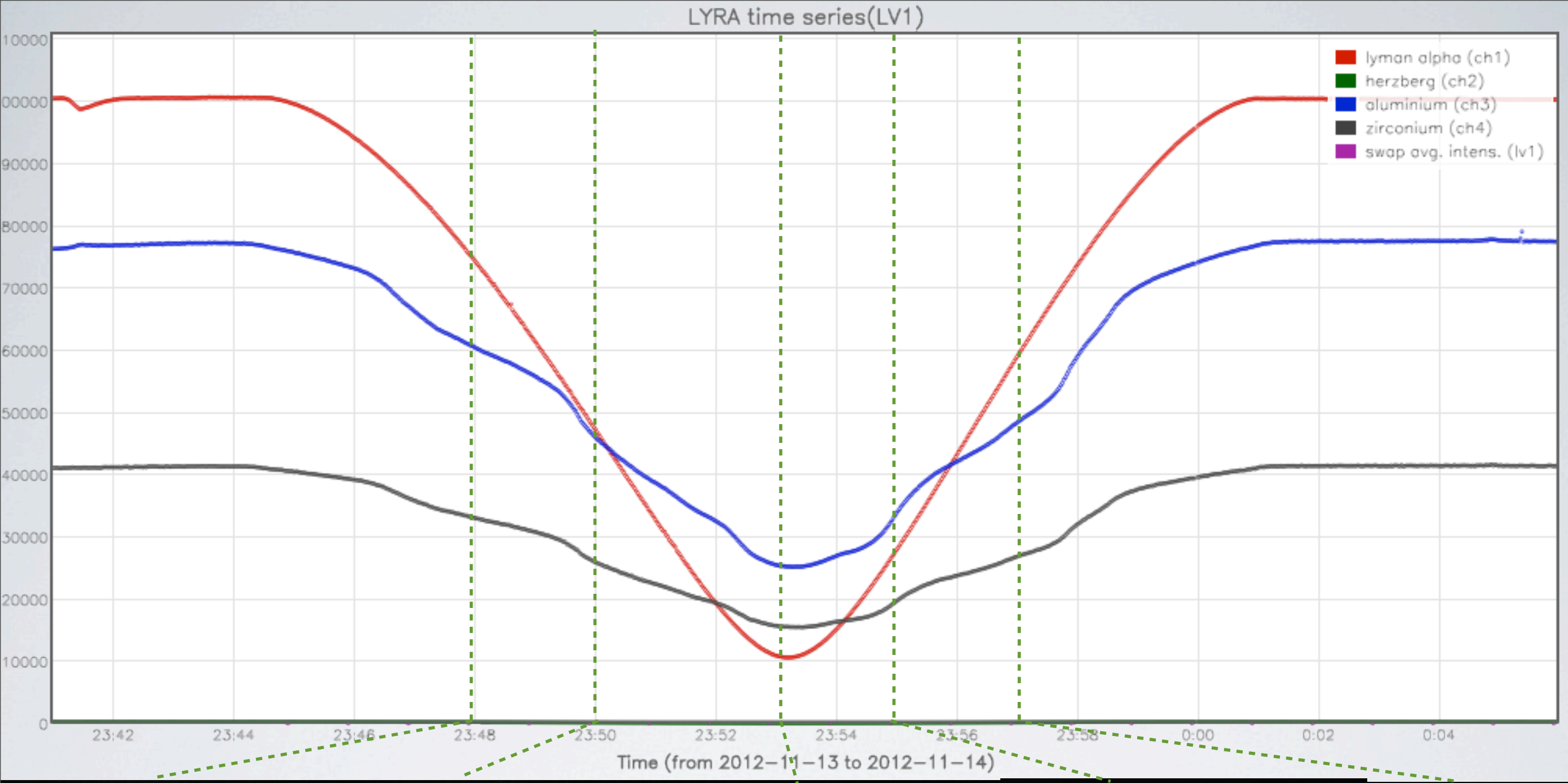
TODAY'S TOTAL SOLAR ECLIPSE

= Ideal opportunity to compare WL streamers with EUV fan rays

Today's eclipse:







[HTTP://PROBA2.OMA.BE](http://PROBA2.OMA.BE)



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- Mission
- Spacecraft
- Launch and Orbit
- Operations Calendar
- Science Payload

Science

- Guest Investigator Program
- Publications

Data

- LYRA Data
- SWAP Data
- Data analysis software
- Spacecraft Ancillary Data
- Terms of use

Community

- Scientific community involvement
- Meetings
- Outreach

Highlights

- Latest News

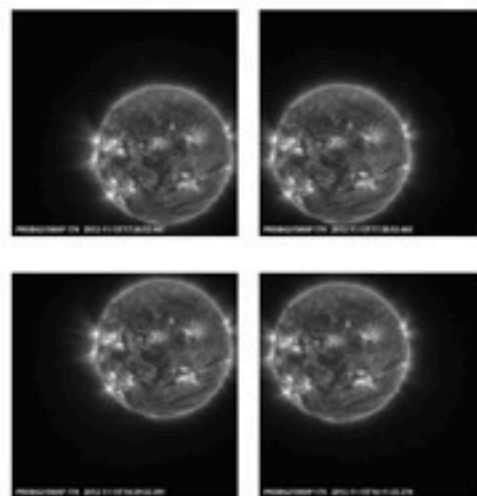
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Solar eclipse on November 13th, 2012

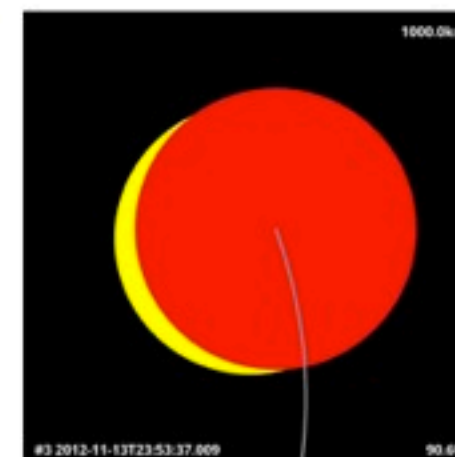
Tue, 11/13/2012 - 22:12 — Koen Stegen

On 13th and 14th of November, PROBA2 observes the solar eclipse from orbit. During the eclipse, the instruments SWAP and LYRA are performing special observation campaigns. The simulation on the right shows the Moon entering the field of view of SWAP four times.

Before and after the eclipse, SWAP will do an offpointing campaign where the Sun is positioned in the four corners of the image.



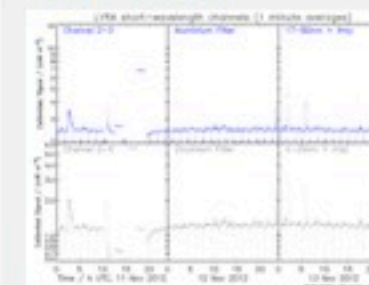
The combination of a series of such offpointed images allows to compose a mosaic image, that shows the corona beyond the normal field of view:



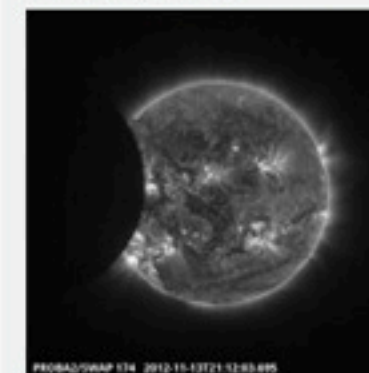
Solar eclipse

Both SWAP and LYRA perform special observation campaigns during the eclipse. [Read more...](#)

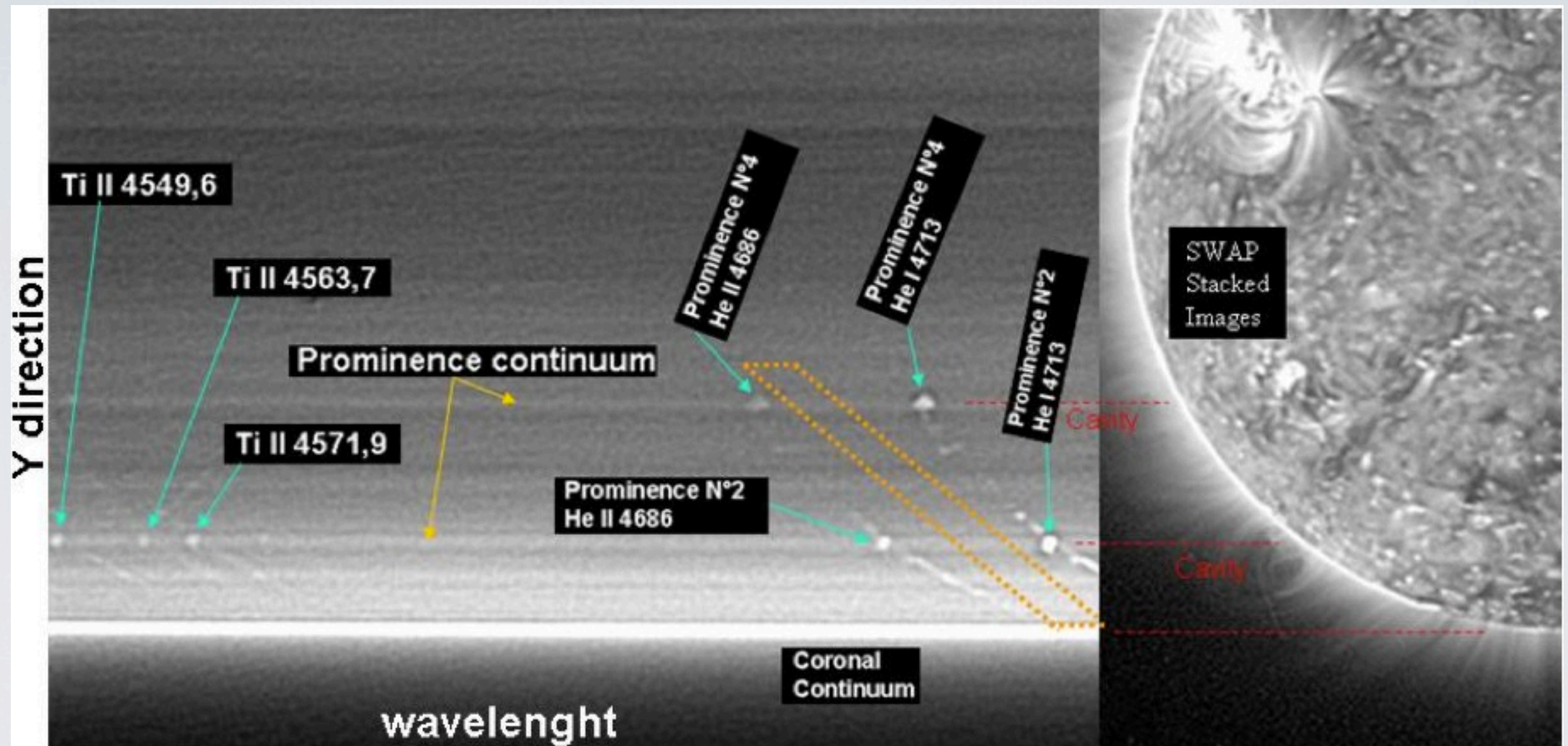
LYRA Latest



SWAP Latest



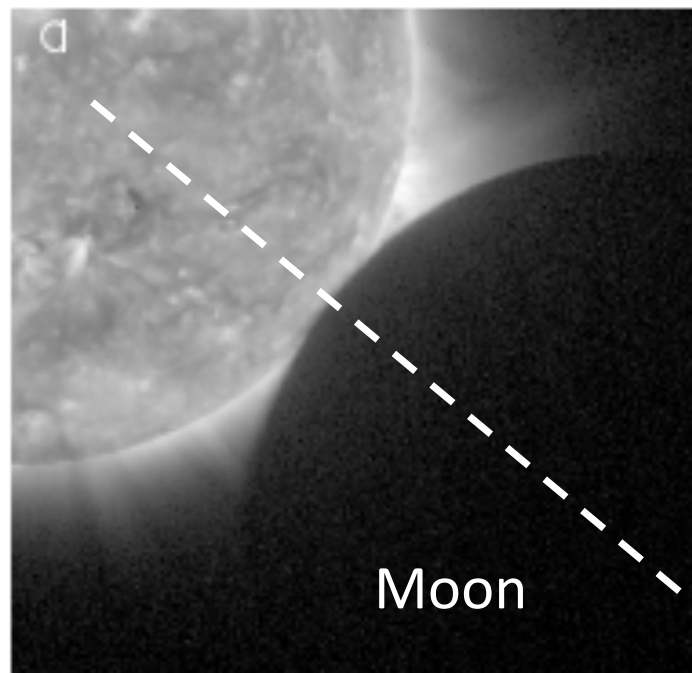
COMPARISON TO WL CORONA



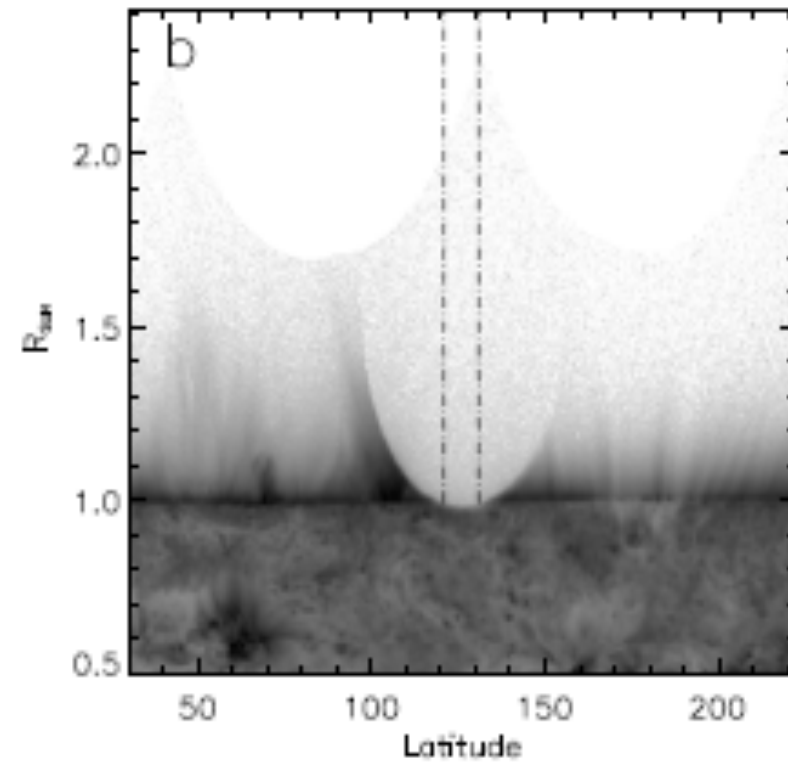
11 July 2010 eclipse - Bazin et al. 2012, Solar Phys. Online

Photometry of EUV streamers observed by SWAP

Eclipse image original



In polar coordinates



Straylight along the strip

