Impact of the Particle Environment on SWAP and LYRA Data

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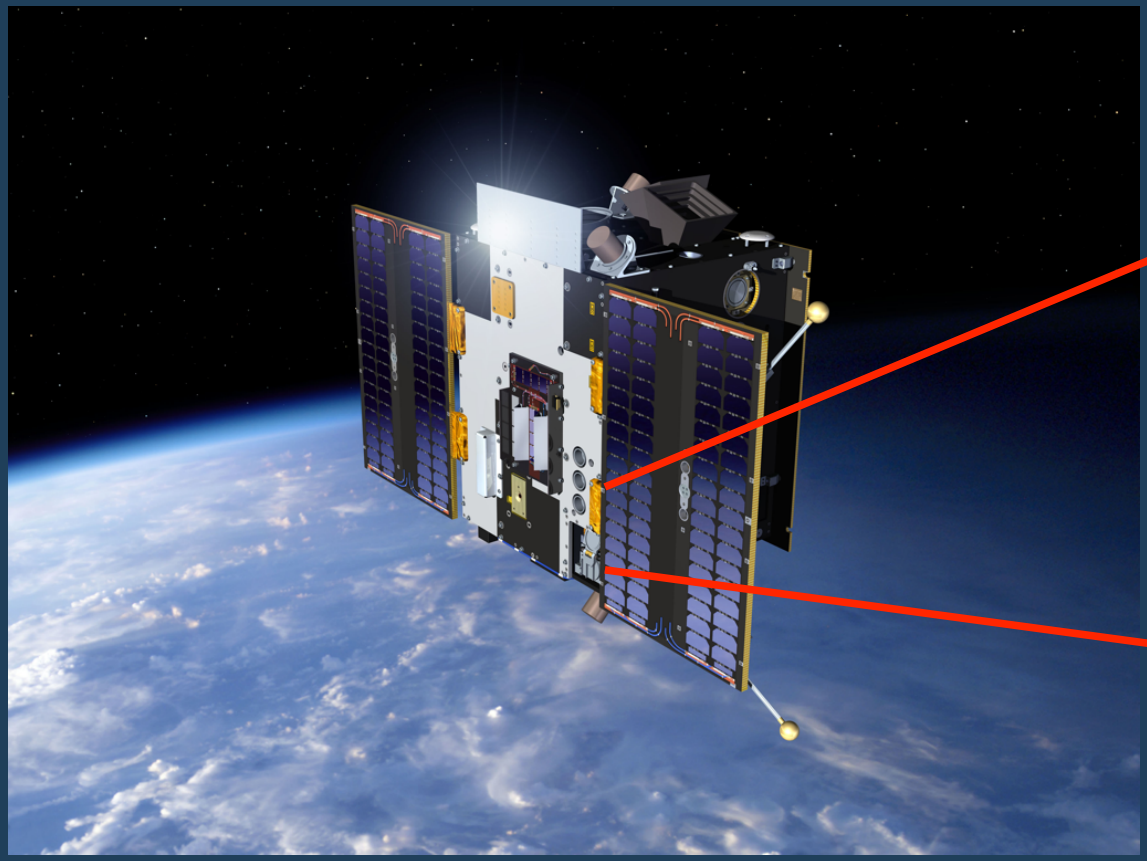
PROBA2: Project for On-Board Autonomy

PROBA2 orbit:

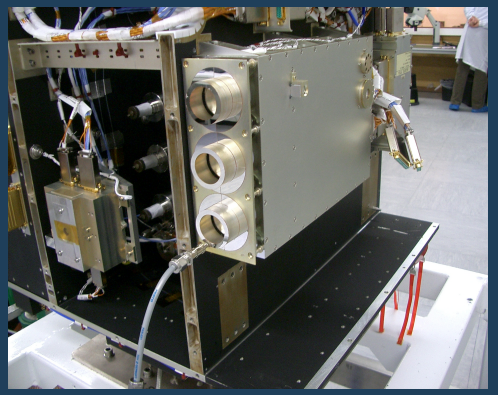
- Heliosynchronous
- Polar
- Dawn-dusk
- 725 km altitude
- Duration of 100 min

launched on November 2, 2009

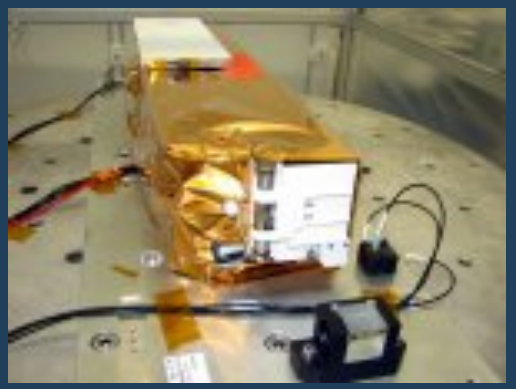
Two solar instruments on-board PROBA2



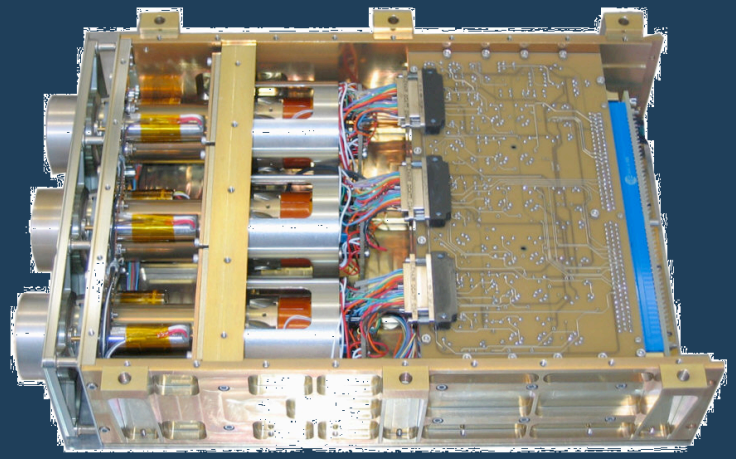
LYRA

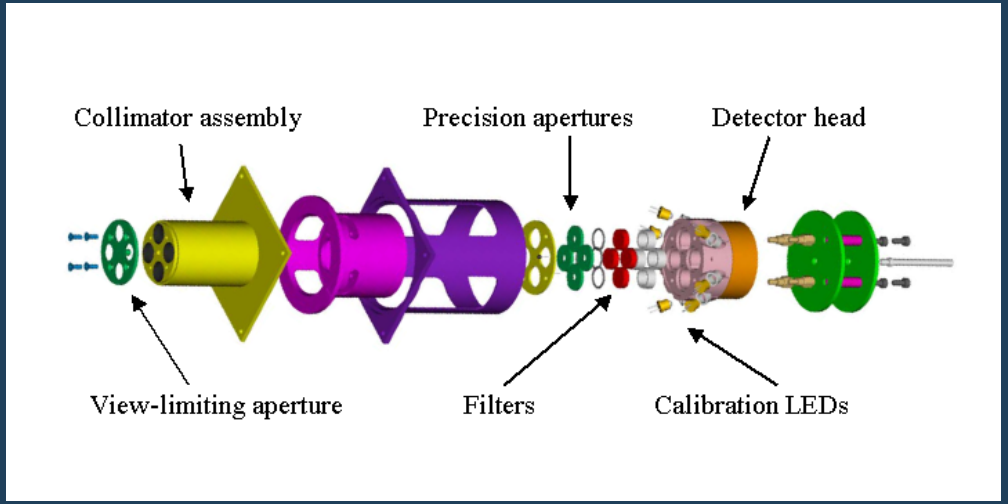


SWAP

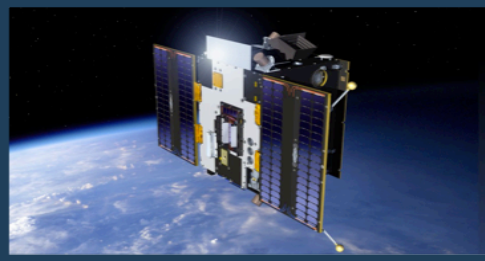


LYRA highlights



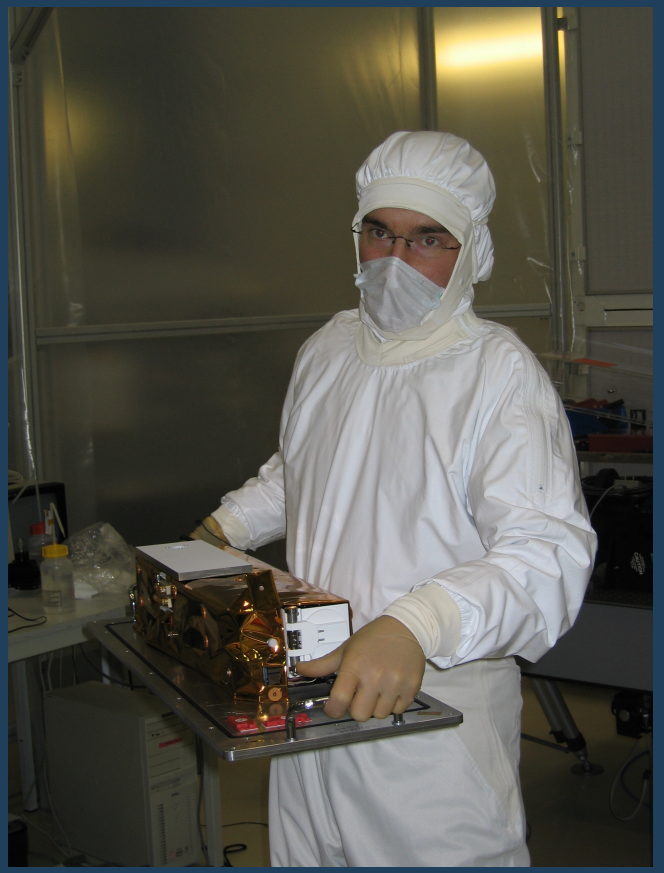


	Ly	Hz	Al	Zr
	120-123 nm	190-222 nm	17-80 nm + <5nm	6-20 nm + <2nm
Unit1	MSM - diamond	PIN- diamond	MSM- diamond	P-N Silicon
Unit2	MSM- diamond	PIN- diamond	MSM- diamond	MSM- diamond
Unit3	P-N Silicon	PIN- diamond	P-N Silicon	P-N Silicon



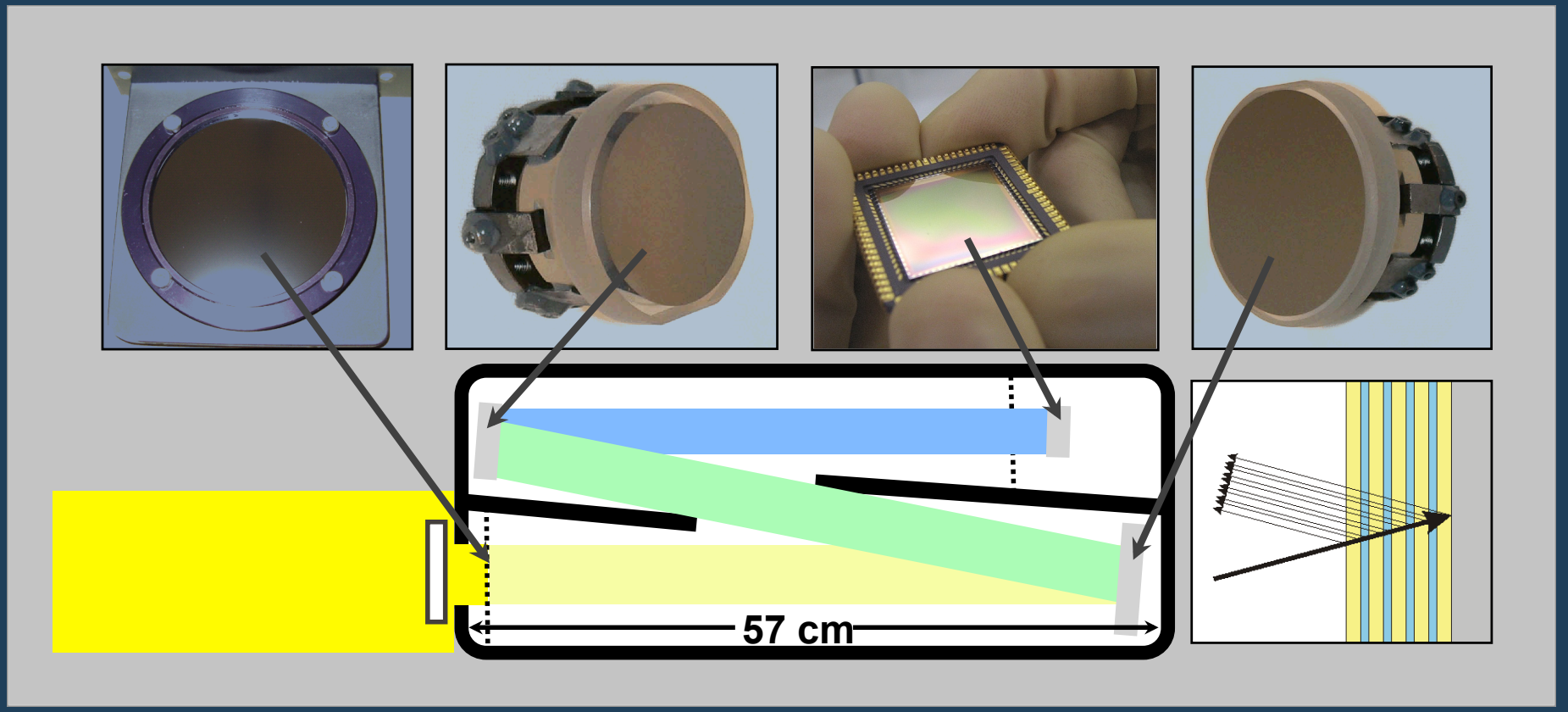
SWAP highlights

- EUV imager – 17.4 nm
- 54 arcmin FOV
- 1 min acquisition cadence
- Flexible off-pointing
- CMOS - Active Pixel Sensor

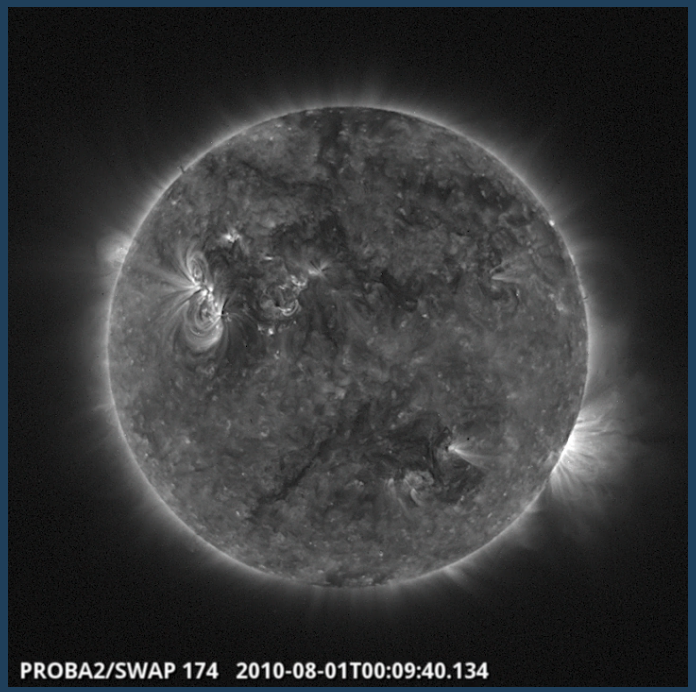


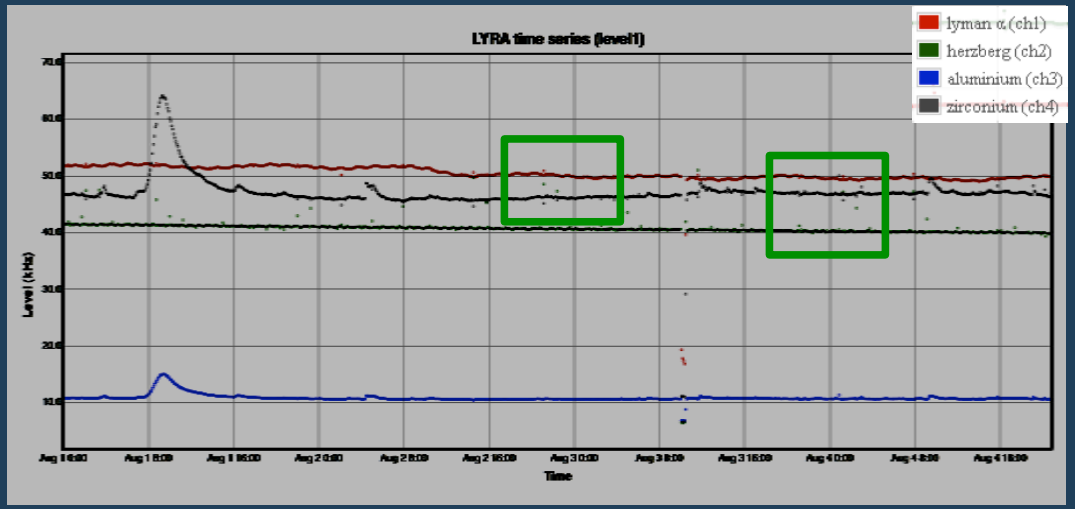
SWAP Optical Path

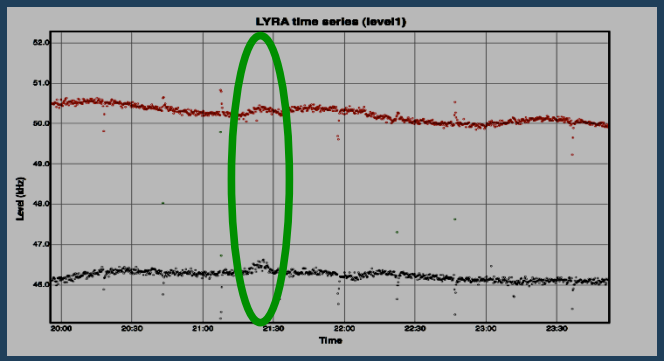
- Off-Axis Ritchey-Chrétien Scheme

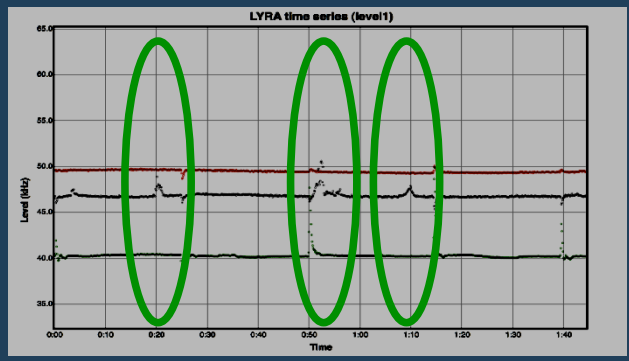


SWAP and LYRA data



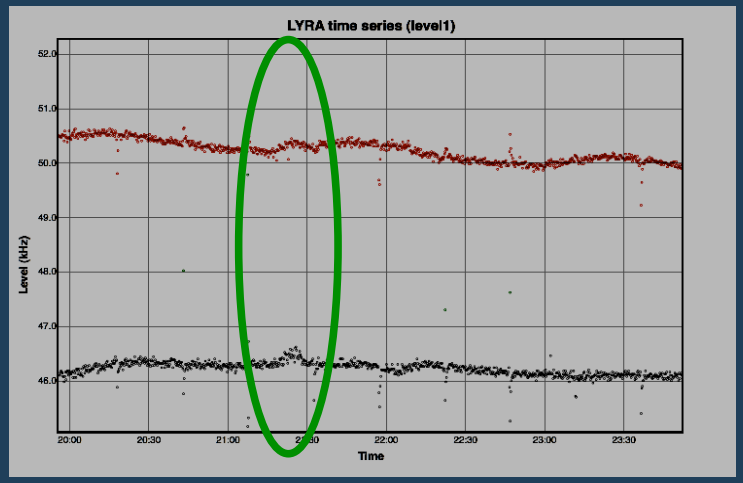




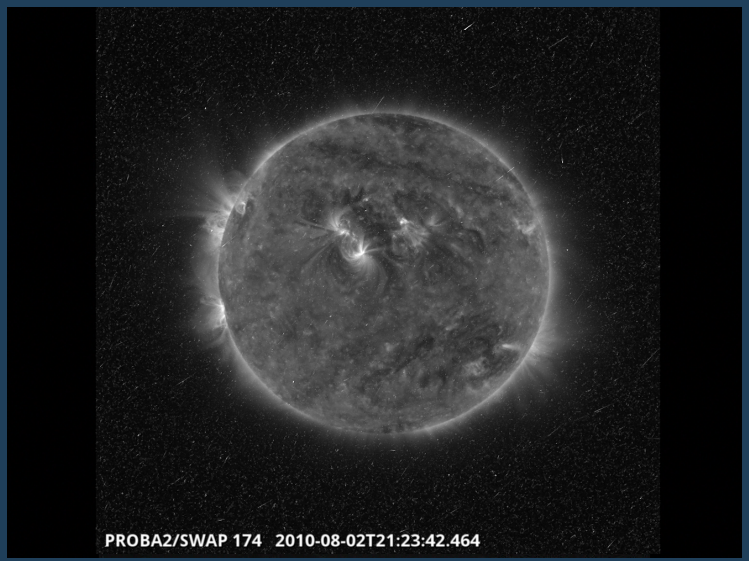


SAA

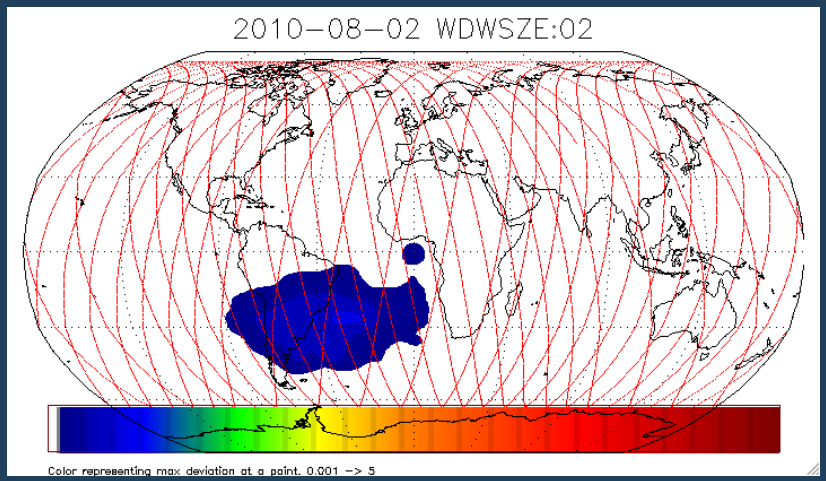
- Independent on the pointing direction and on the covers status
- Independent on the wavelength
- Dependent on the detector material



SWAP	LYRA		
	Diamond PIN	Diamond MSM	SI
✔	X	Low sensitivity	✔

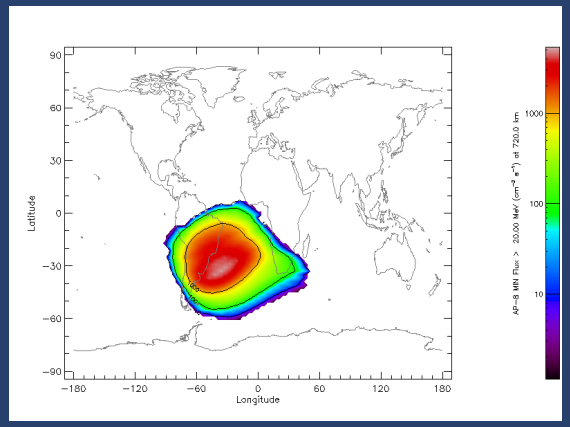


SAA

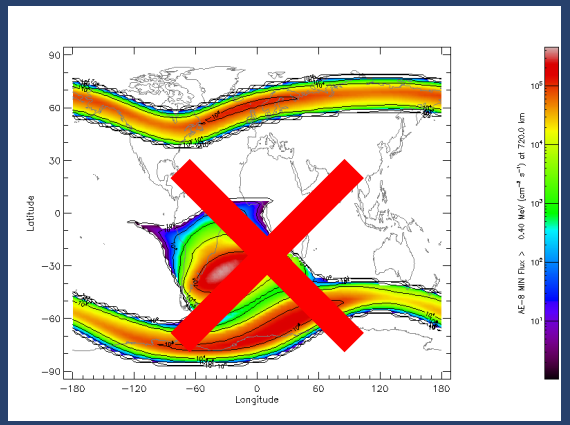


NASA AP-8/AE-8 Trapped radiation particle flux (SPENVIS)

Protons > 20MeV



Electrons > 0.4 MeV

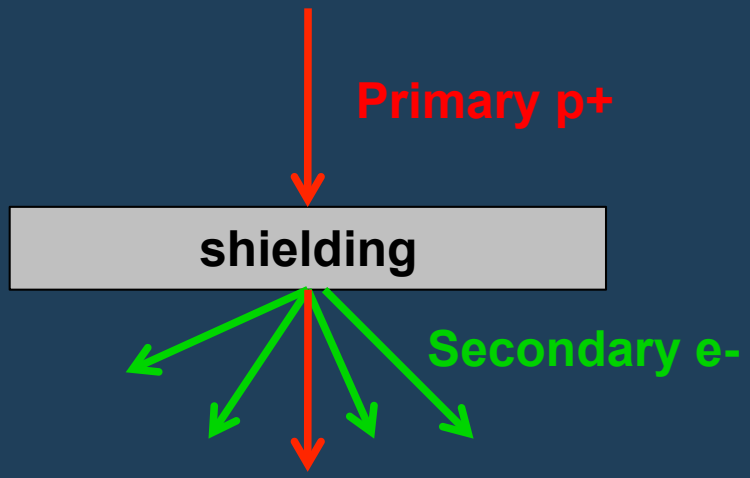


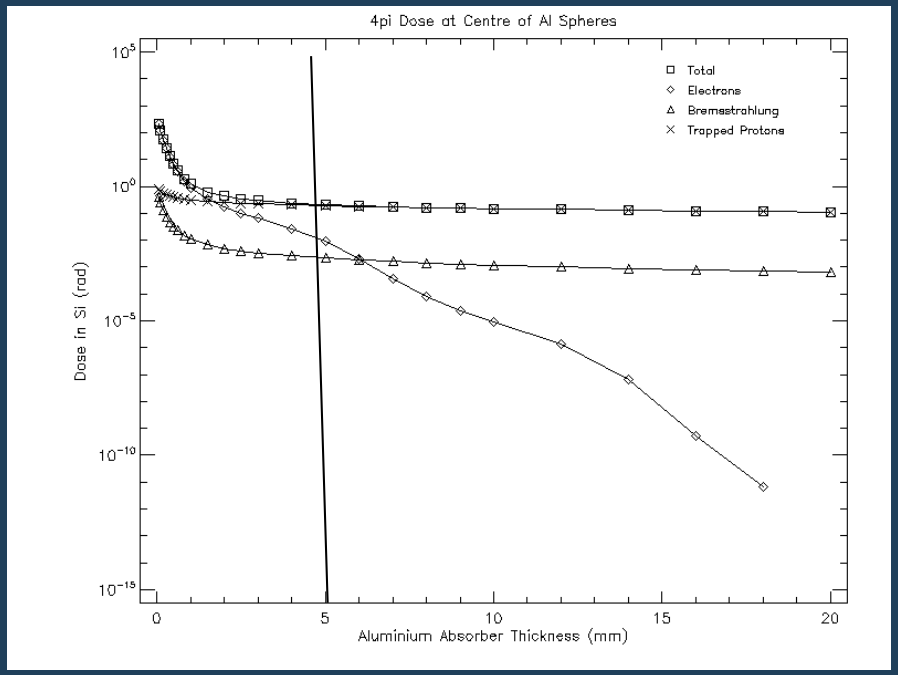
SAA

Energy deposition due to energetic protons

The surrounding shielding causes:

- ❑ slowdown the protons
- ❑ generation of secondary electrons





Energy deposition in Si behind a spherical Al shielding
SHIELDOSE-2 (SPENVIS)

SAA

Energy needed to create 1 electron-hole pair is

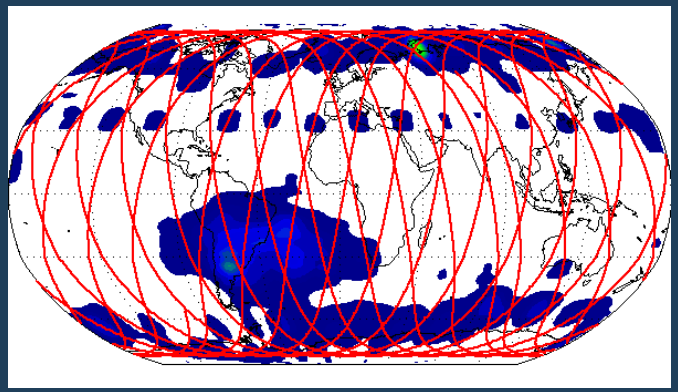
- 3.65eV for Silicon
- 13.2 eV for diamond

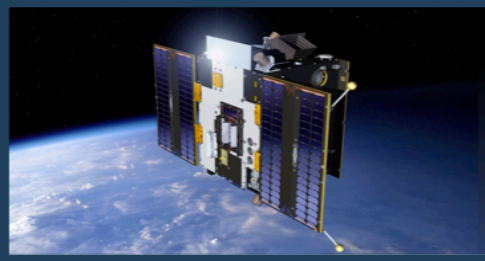
⇩

Diamond has a 4 times better SAA rejection than silicon

Auroral Oval

- Perturbations appearing around 75° latitude
- 2-3 days after a CME, flare ...
- Associated to geomagnetic perturbations of Kp >= 4





Possible origins of the auroral effect

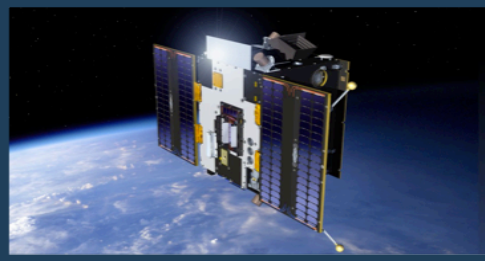
- Galactic Cosmic Rays
- Protons or ions ejected by the Sun (SEP)
- Photons
- Highly energetic electrons
- ???

GCR

- The region in which the GCR are sensed is slightly wider after a geomagnetic storm, but it exists all the time
- GRC should be detected all over the polar caps

↓

Incompatible with the zero-detection under normal geomagnetic conditions



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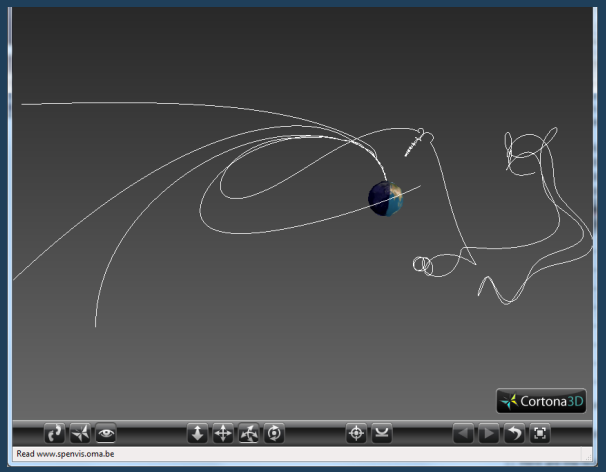
SEP

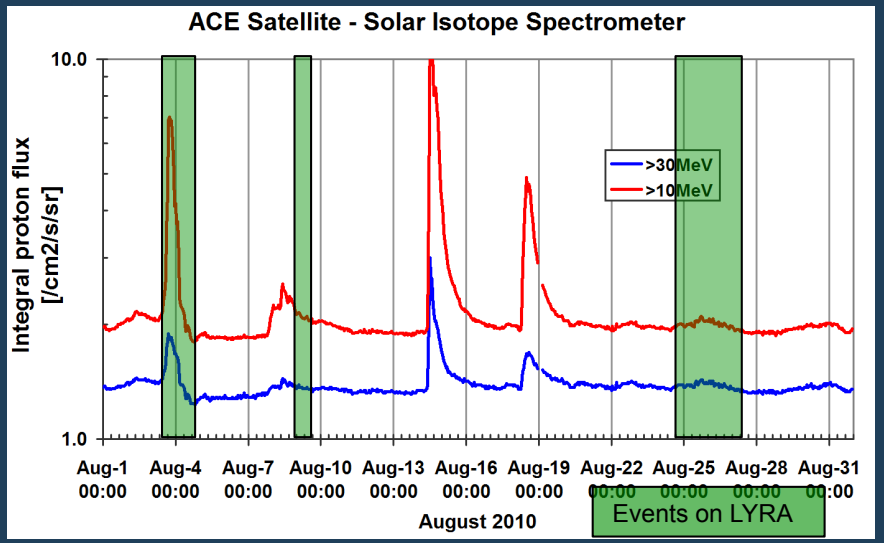
Simulation with Magnetocosmics (SPENVIS):

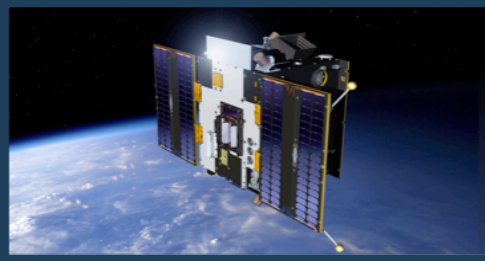
protons form outside the magnetosphere should be able to reach the altitude of the spacecraft for energy > 30 MeV



BUT

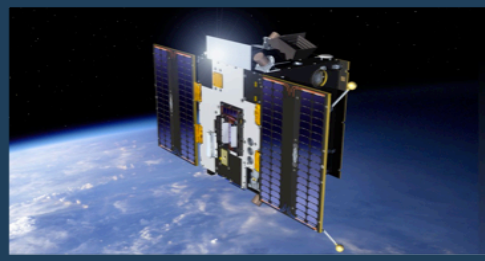
The occurrence of SEP is not always correlated with the auroral perturbations observed by LYRA





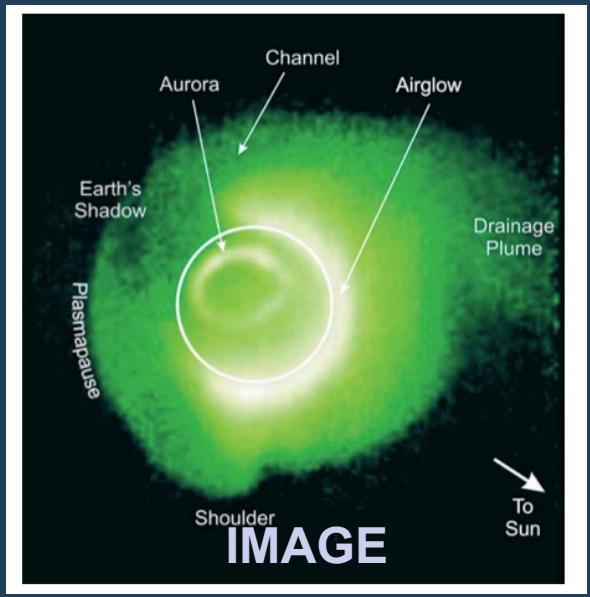
Possible origins of the auroral effect

- Galactic Cosmic Rays ✗
- Protons or ions ejected by the Sun (SEP) ✗
- Photons
- Highly energetic electrons
- ???

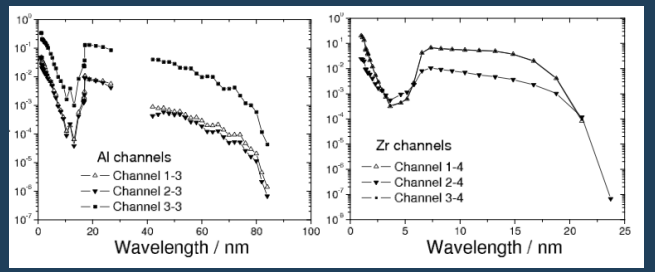


Photons

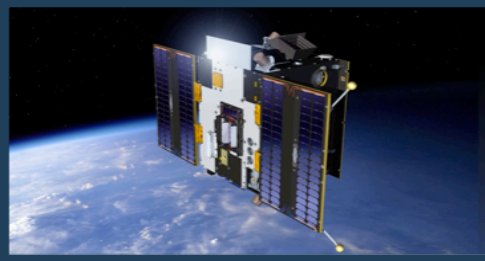
- Auroral:
  - O+ line at 53.9 nm
  - emission in the F layer, mostly below the altitude of PROBA2
- Airglow:
  - He+ 30.4-nm, He 58.4-nm, O+ 53.9-nm
  - emission region up to 1.25 ER



From Sandel, B. R., et al., Space Sci. Rev., 109, 25, 2003.)



⇨ Inside the Al channel but outside Zr channel



Possible origins of the auroral effect

- Galactic Cosmic Rays ✗
- Protons or ions ejected by the Sun (SEP) ✗
- Photons ✗
- Highly energetic electrons
- ???

Highly energetic electrons

- stopped by shielding
  except in the line of sight
- not seen SWAP because of off line axis conf.
- not seen by all sensors of LYRA
- impact of Al (158nm) & Zr (148 or 300nm) filters
- needs more investigation

Conclusions

- Both SWAP and LYRA sense energetic trapped protons in SAA
- LYRA senses an auroral signature in its two shorter wavelength channels. The underlying process is still not clear to us.
- Work still in progress …

Thanks

European Space Agency

Belgian Science Policy Office

http://proba2.sidc.be/

SPENVIS
The Space Environment Information System