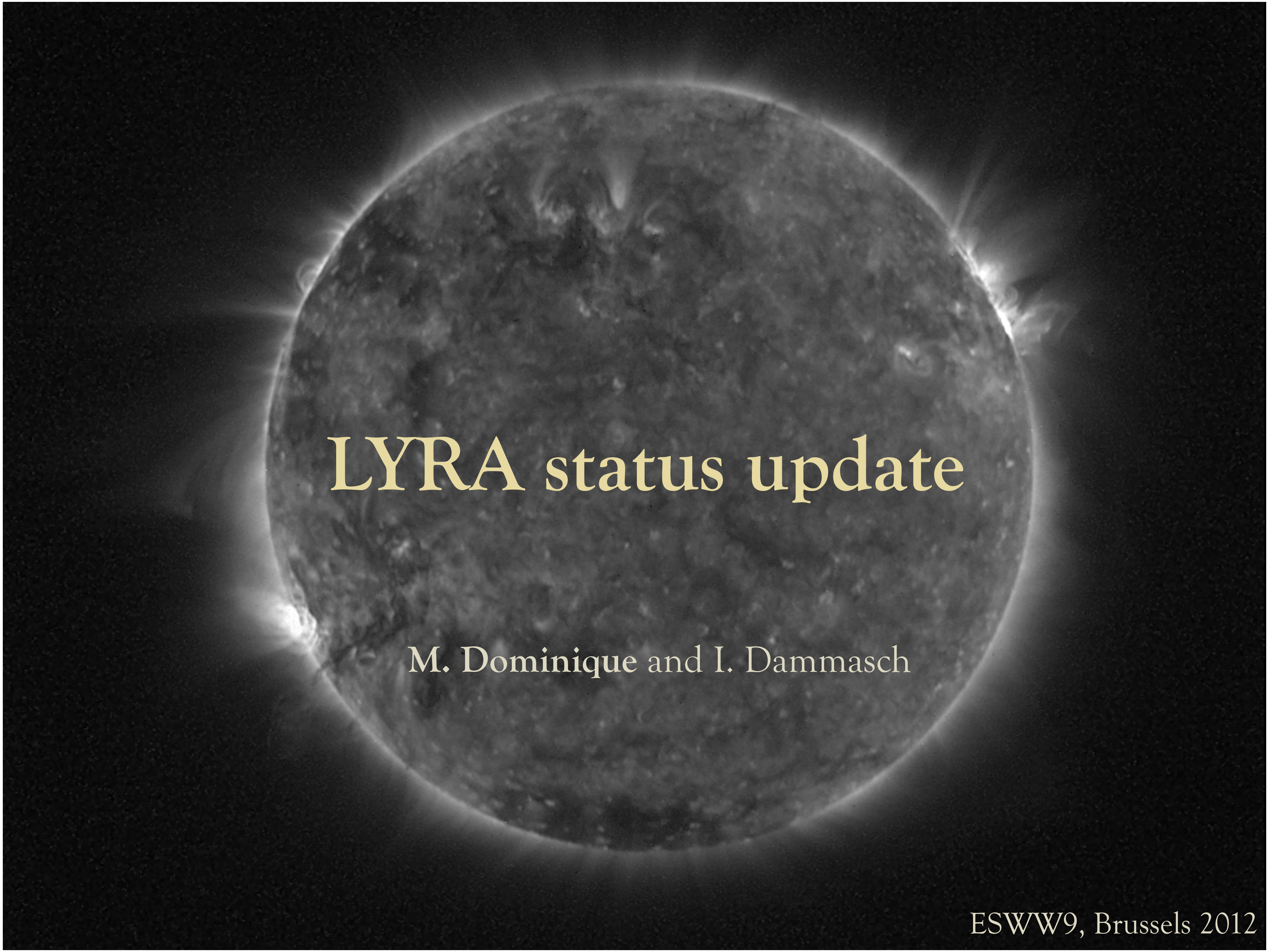
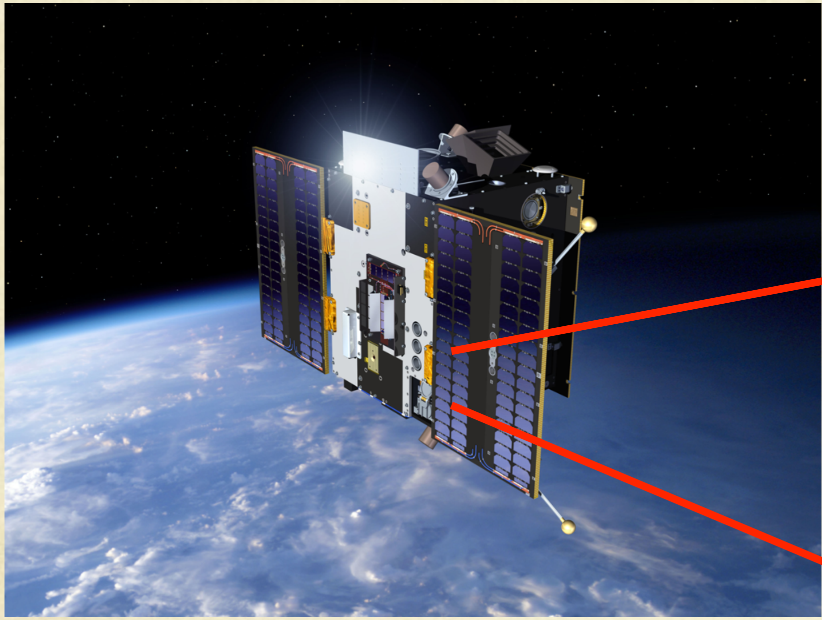


LYRA status update

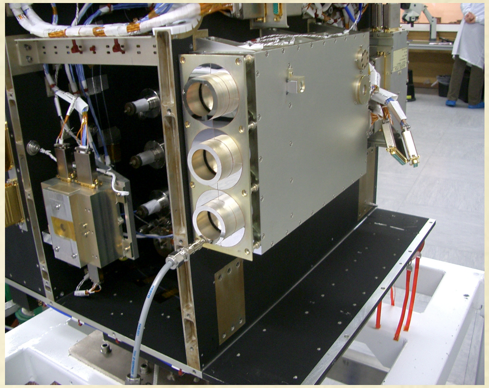
M. Dominique and I. Dammasch

ESWW9, Brussels 2012

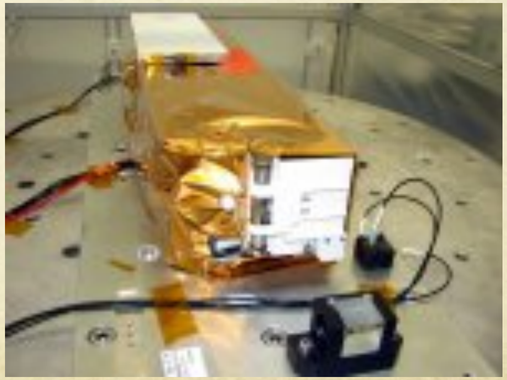
PROBA2: an ESA microsat



LYRA

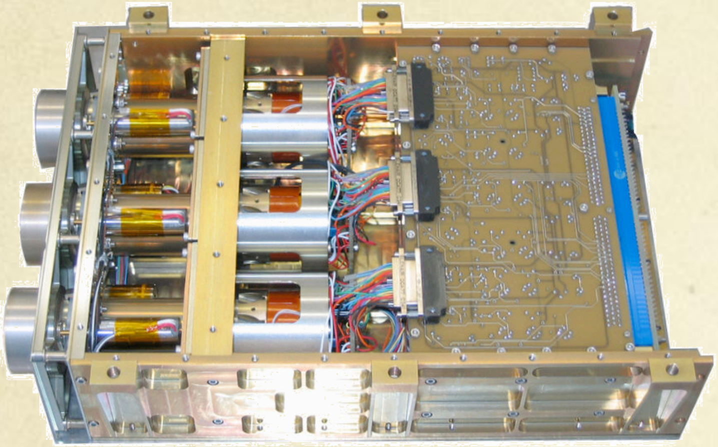


SWAP



- Launched on November 9, 2009
- 17 technology demonstrators + 4 scientific instruments
- LYRA first light on January 6, 2010
- Dawn-dusk heliosynchronous orbit, 700 km altitude

LYRA highlights

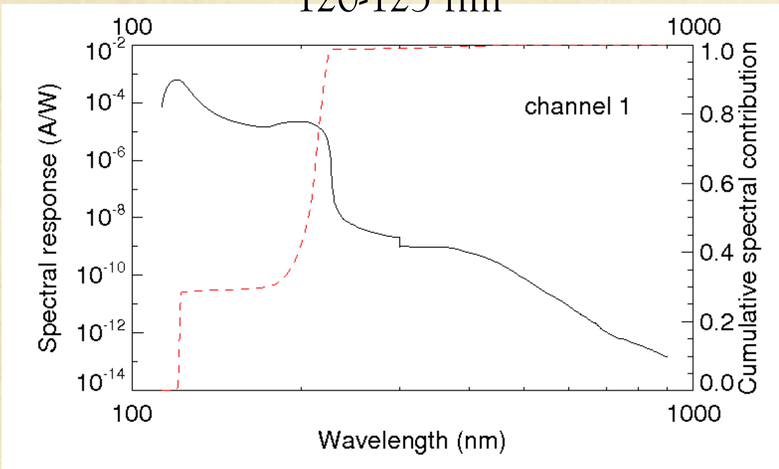


LYRA channels	
Lyman alpha	120-123 nm
Herzberg	190-222 nm
Aluminium	17-80 nm + <5nm
Zirconium	6-20 nm + <2nm

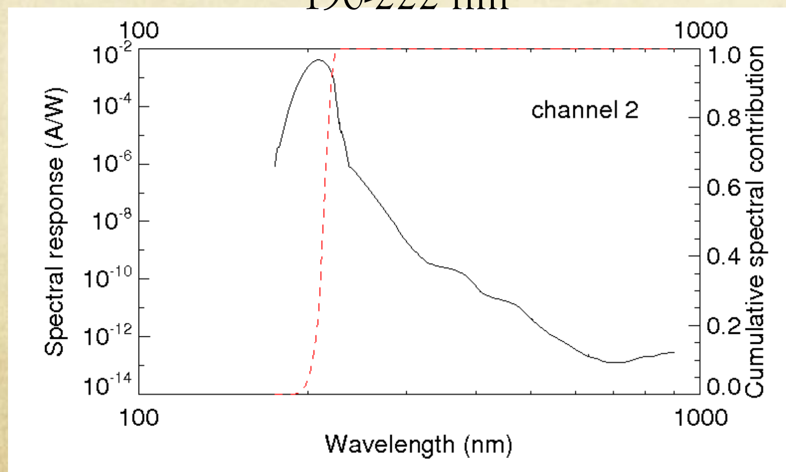
- **3 redundant units** protected by independent covers
- **4 broad-band channels**
- High acquisition cadence: **nominally 20Hz**
- 3 types of detectors:
  - Standard silicon
  - 2 types of **diamond detectors**: MSM and PIN
    - radiation resistant
    - blind to radiation > 300nm
- **Calibration LEDs** with λ of 370 and 465 nm

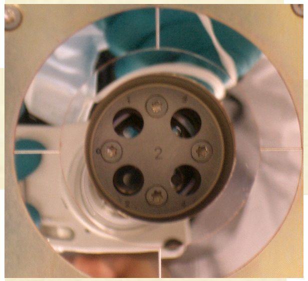
LYRA channels convolved with quiet Sun spectrum

Channel 1 – Lyman alpha
120-123 nm

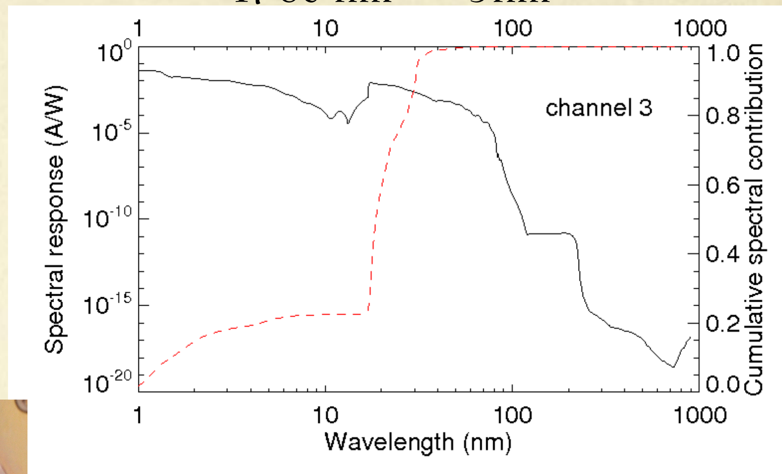


Channel 2 – Herzberg
190-222 nm

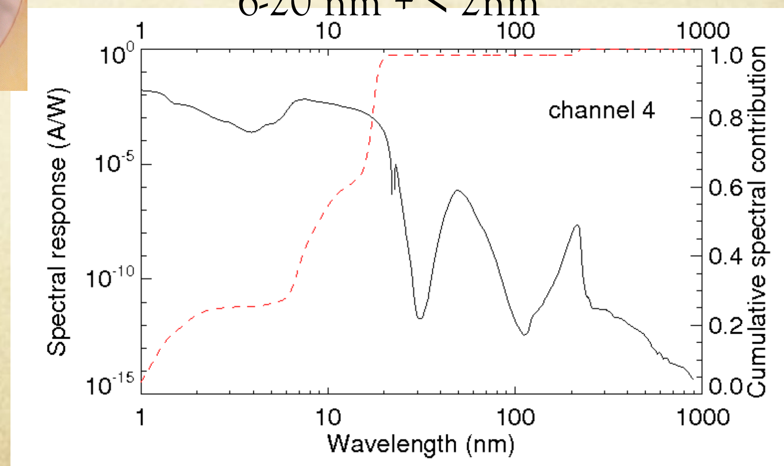




Channel 3 – Aluminium
17-80 nm + < 5nm



Channel 4 – Zirconium
6-20 nm + < 2nm



Mission status

- Mission currently founded till end 2014, funded by ESA science directorate and SSA
- Topical issue released early 2013
- Third Guest Investigator programme ongoing, a fourth call is foreseen this summer
- PROBA2 website: http://proba2.oma.be
- Archiving the data at ESAC

Usual data products: now reprocessed

Product	File extension on LYRA website	Format	Characteristics
Level 1 engineering data	∗_lev1_std(bst).fits	FITS	unprocessed solar irradiance, in *counts/ms*
	∗_lev1_cal(bca).fits	FITS	unprocessed calibration data, in *counts/ms*
	∗_lev1_met.fits	FITS	ancillary data: temperature, pointing . . .
	∗_lev1_rej(bre).fits	FITS	rejected samples (outliers . . .)
Level 2 basic science data	proba2.oma.be		rated solar irradiance, m^{-2}
Level 3 averaged science data	∗_lev3_std.fits	FITS	level 2 averaged over 1 min, in Wm^{-2}
Level 4 A quicklooks	∗.png	image	daily plot of calibrated data for all LYRA channels
Level 4 B quicklooks	∗.png	image	3-days GOES-like plot of calibrated data in Aluminium and Zirconium channels
Level 5 flare list	html	text file	List of flares with links to LYRA and GOES flux profiles

Calibration

Includes:

- Dark-current subtraction
- Additive correction of degradation
- Rescale to 1 AU
- Conversion from counts/ms into physical units (W/m2)

ATTENTION: this conversion uses a synthetic spectrum from
SORCE/SOLSTICE and TIMED/SEE at first light
=> LYRA data are scaled to TIMED/SORCE ones

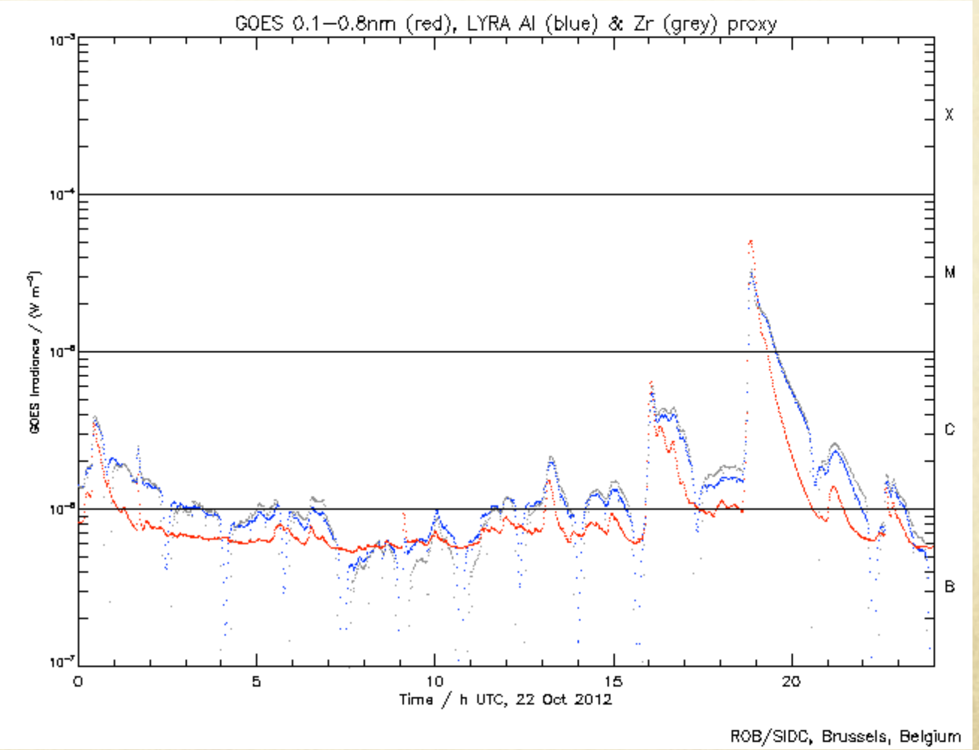
Does not include (yet)

- Flat-field correction
- Stabilization trend for MSM diamond detectors

A new data product!

- A proxy of GOES flare curve based on LYRA data is available on http://proba2.oma.be/ssa or on

  http://solwww.oma.be/users/dammasch/GoesVsLyra.html



"Nominal" unit 2

Remaining response
after 1053 *days*:

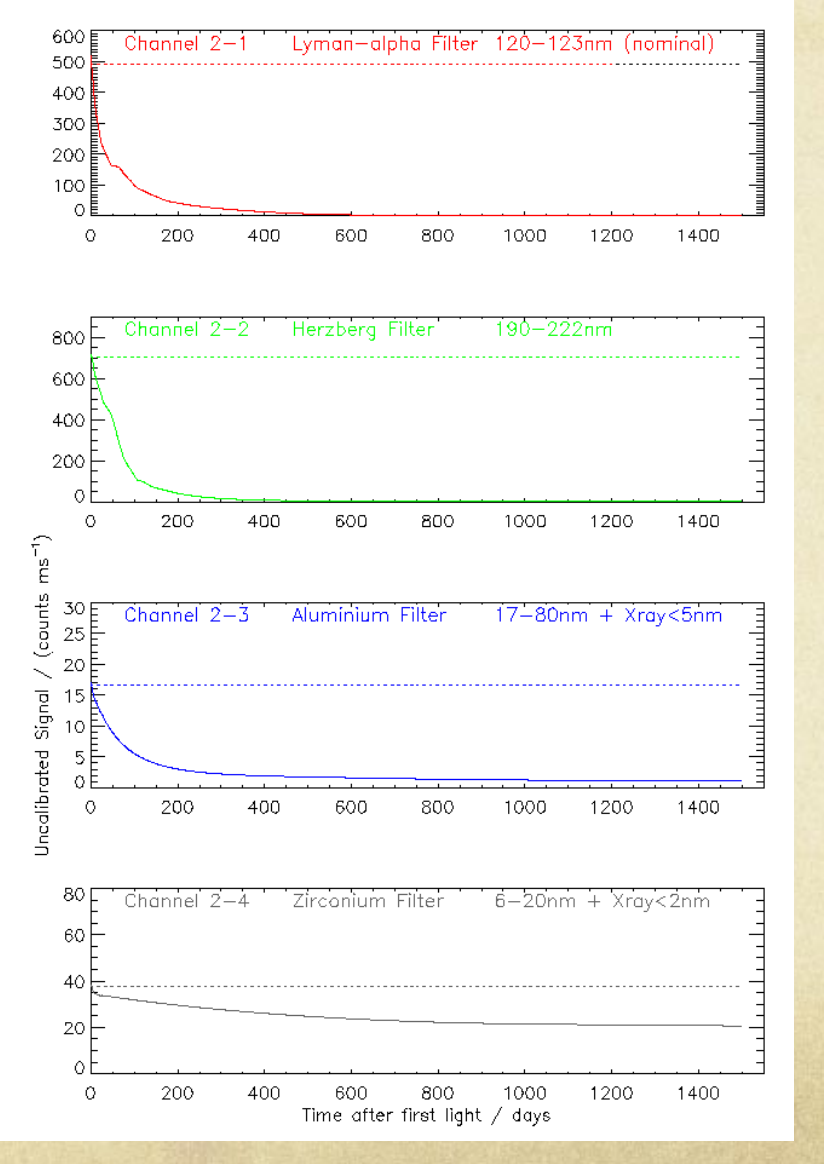
ch2-1 < 0.5%

ch2-1 < 0.5%

ch2-3 7%

ch2-4 56%

(Comparison
for ch2-3 and ch2-4
now based on ch1-4)



“Campaign” unit 3

Remaining response
after 964 *hours*:

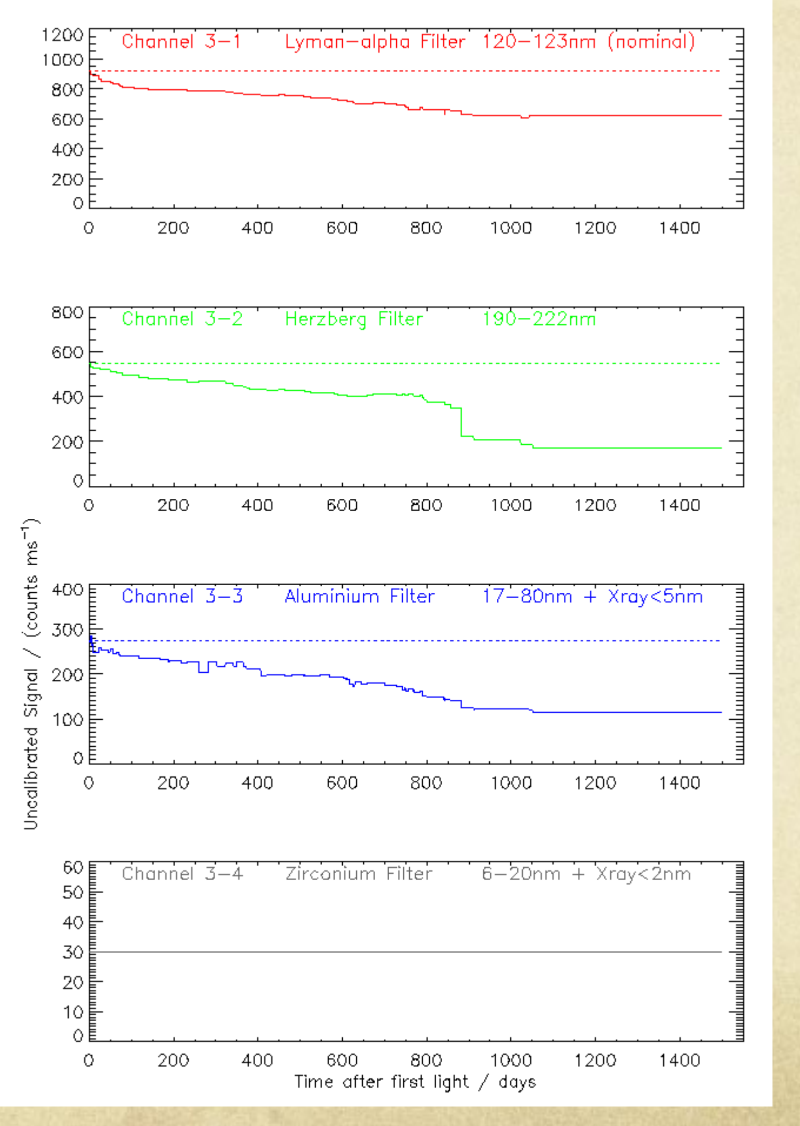
ch3-1 67%

ch3-1 31%

ch3-3 38%

ch3-4 83%

(Comparison
for ch3-3 and ch3-4
now based on ch1-4)



(preliminary)

“Spare” unit 1

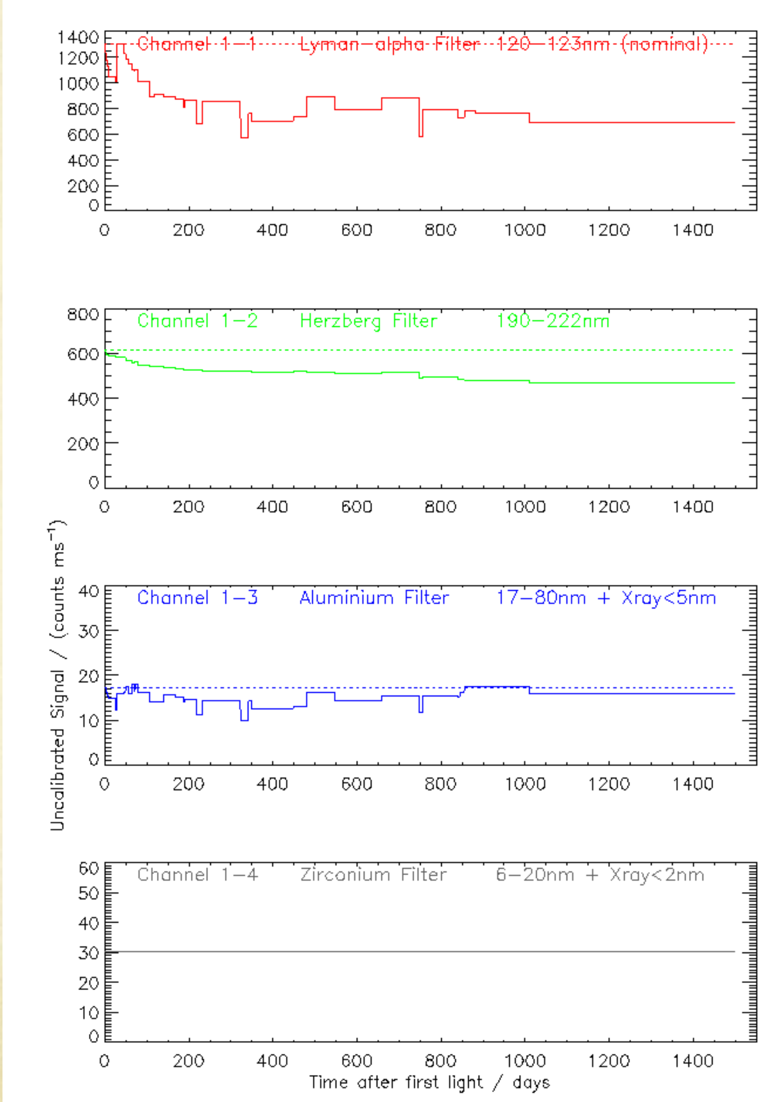
Remaining response after 90 *hours*:

ch1-1 53%

ch1-1 77%

ch1-3 ~100%

ch1-4 ~100%



(preliminary)

Degradation: long term evolution

Work still in progress …

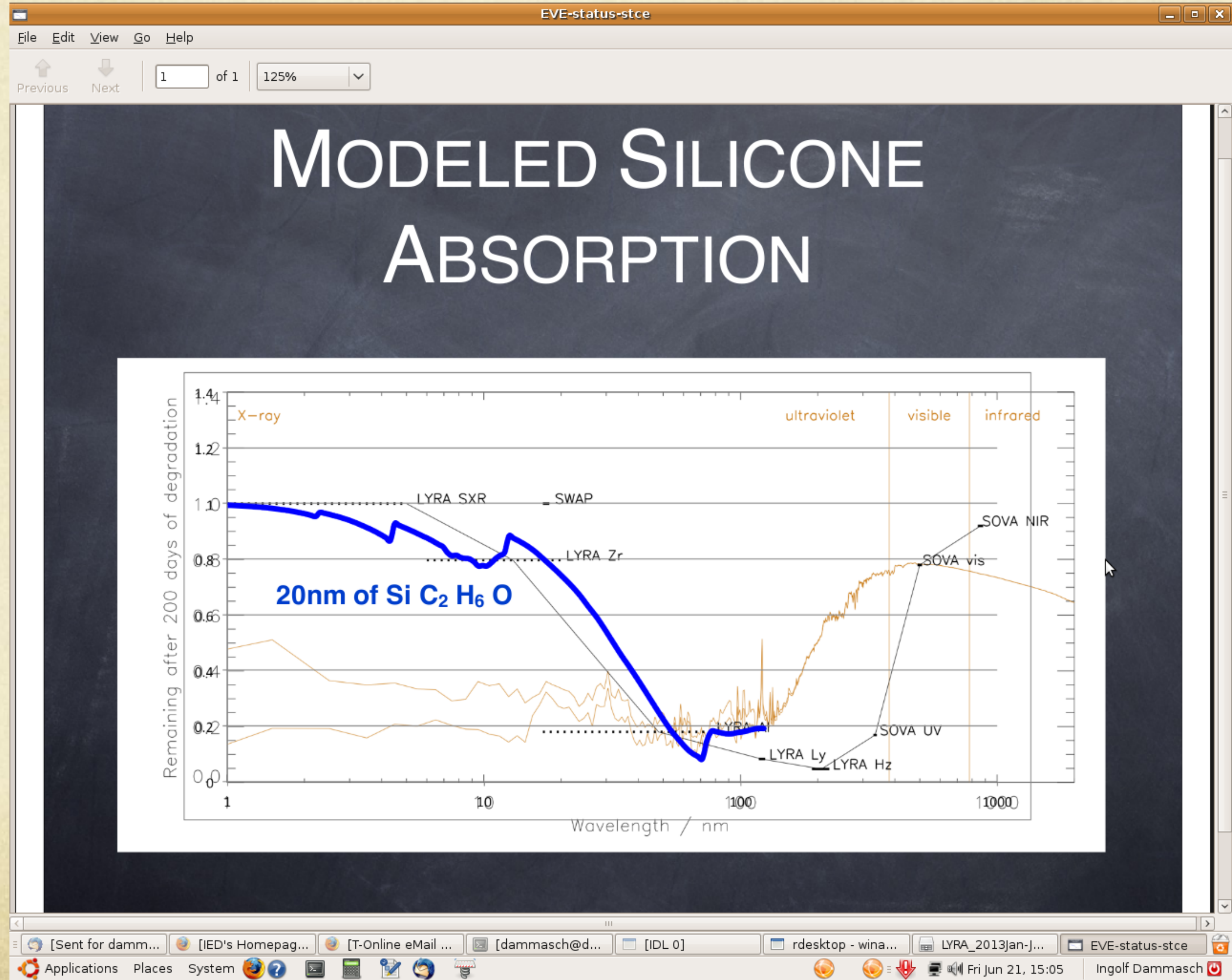
Various aspects investigated:

- Degradation due to a contaminant layer
- Ageing caused by energetic particles

Investigation means:

- Dark current evolution (detector ageing)
- Response to LED signal acquisition (detector spectral evolution)
- Spectral evolution (detector + filter):
  - Occultations
  - Cross-calibration
  - Response to specific events like flares
- Measurements in laboratory on identical filters and detectors

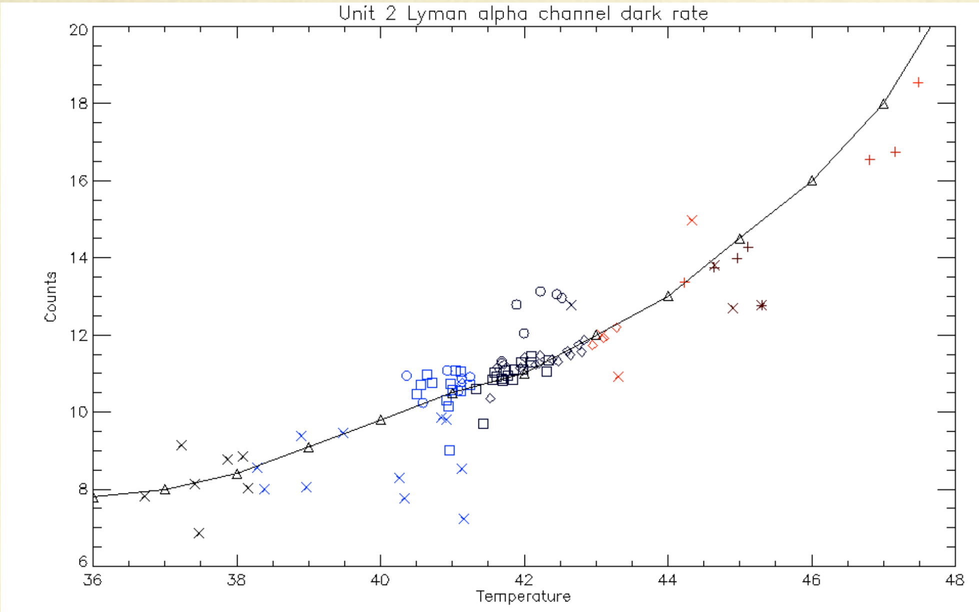
Possible cause of degradation



Dark current + LED signal evolution: unit2 (nominal, all diamond)

DC variations correlated with temperature evolution

Dark current in Lyman alpha

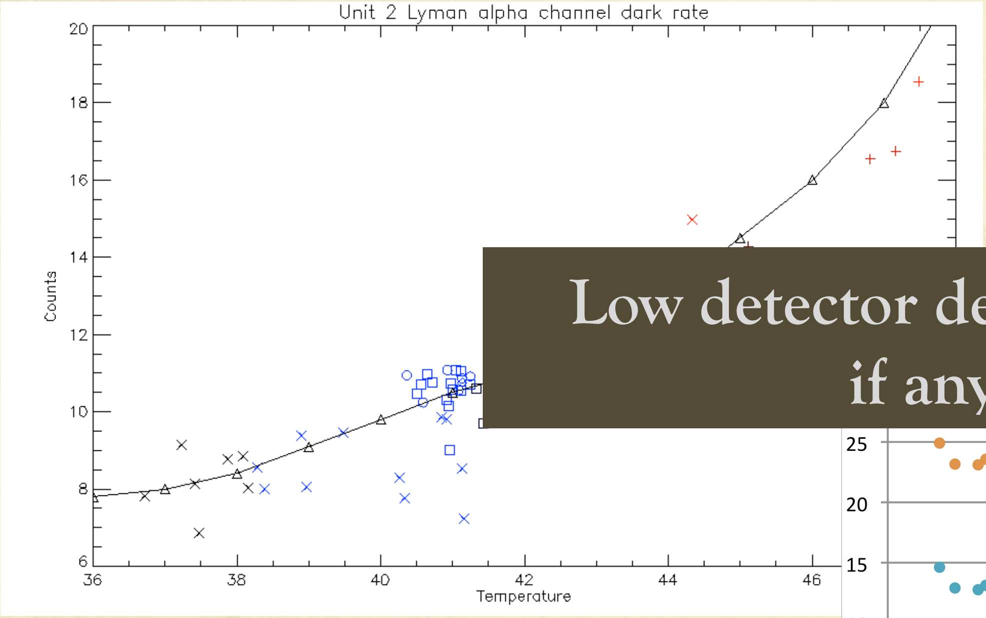


I. Dammasch + M. Snow

Dark current + LED signal evolution: unit2 (nominal, all diamond)

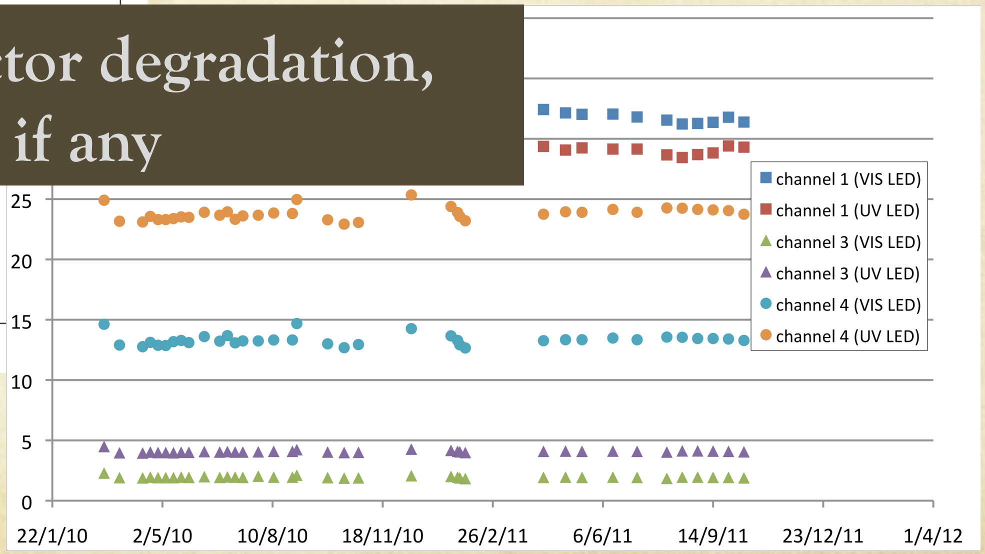
LED signal constant over the mission

Dark current in Lyman alpha



I. Dammasch + M. Snow

LED signal evolution
Unit 2 – dark current subtracted



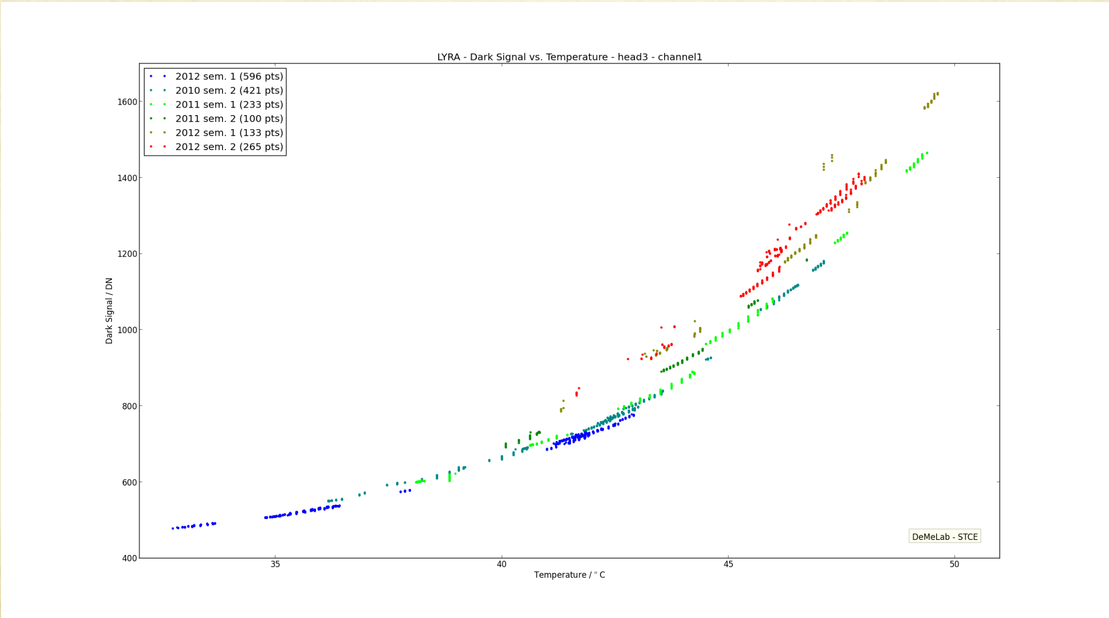
Low detector degradation, if any

M. Devogele

Dark current evolution - unit 3 (back-up, Si)

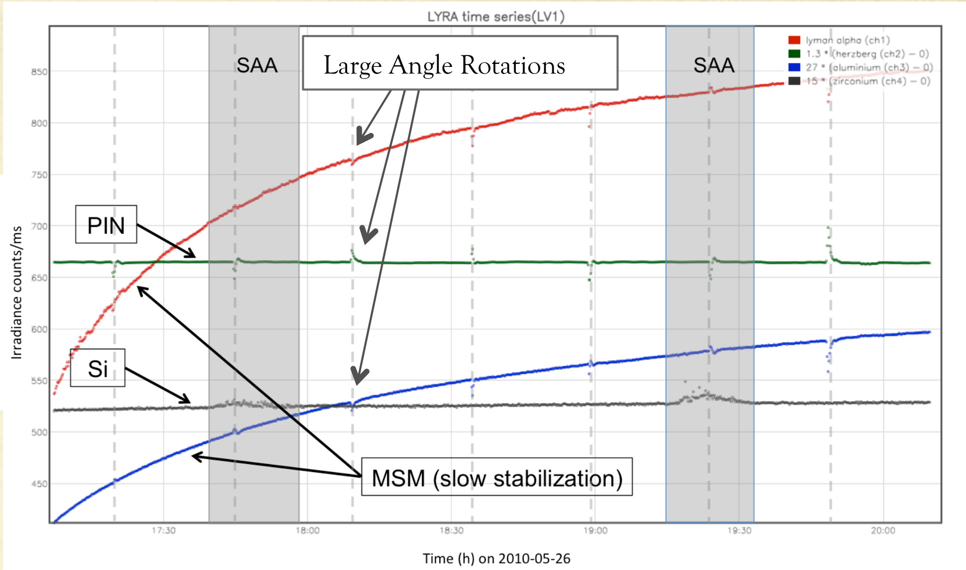
- DC increases slightly with time

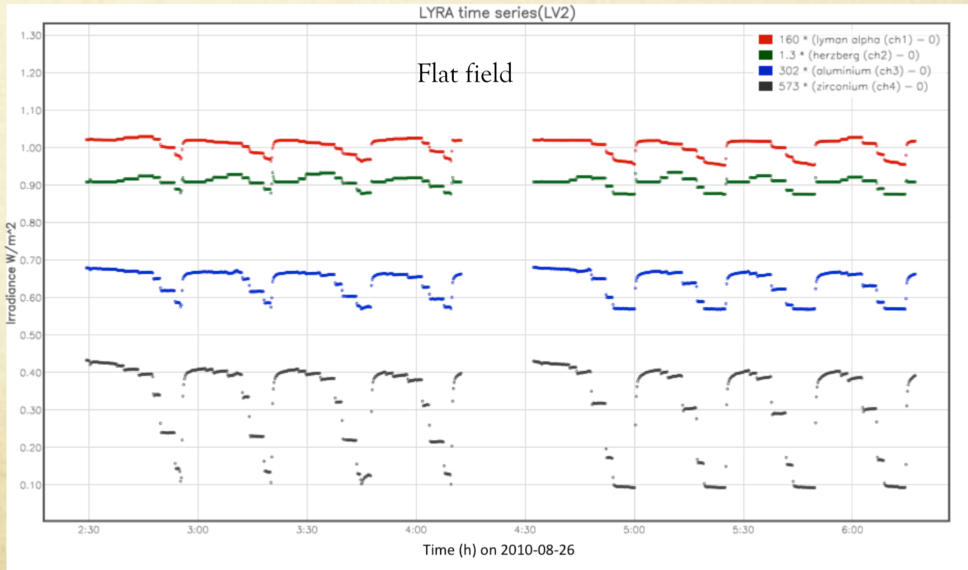
  => Small degradation observed on unit 3



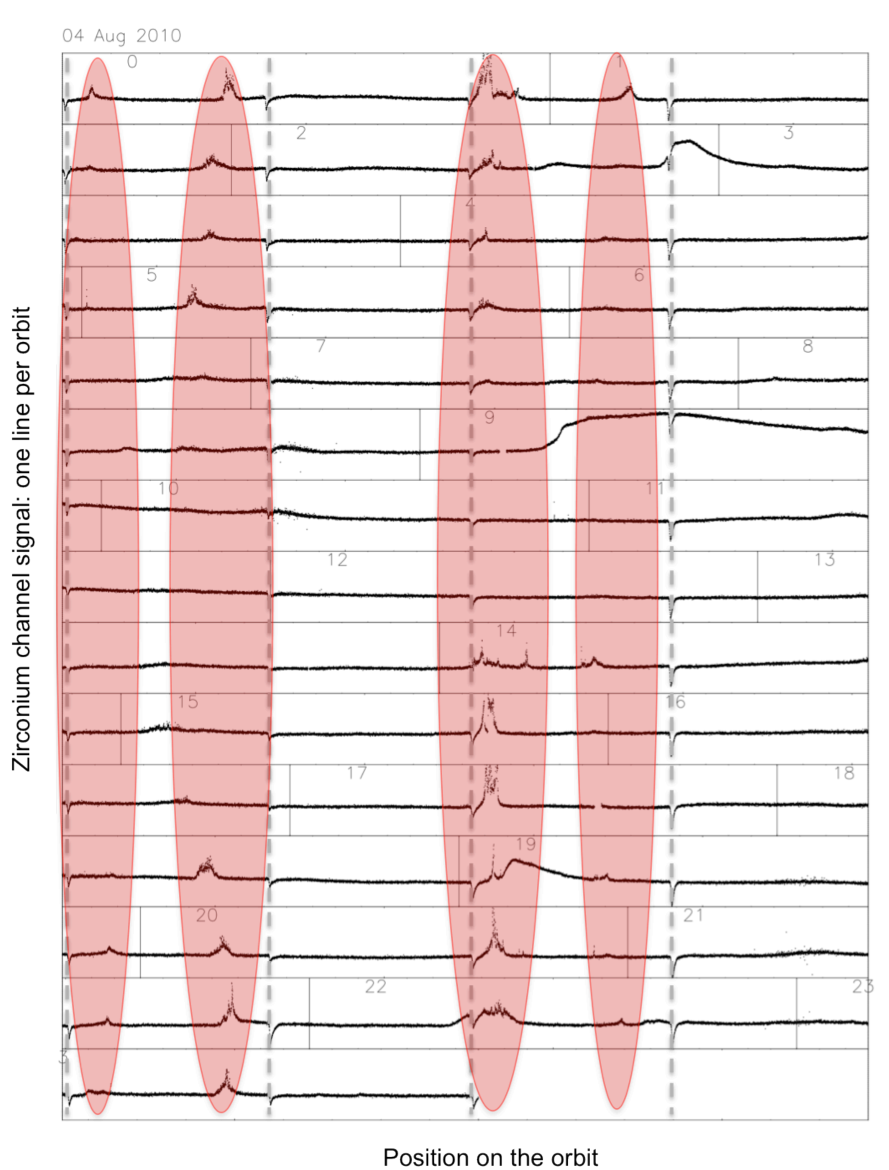
Non-solar features in LYRA data

1. LAR: four times an orbit
2. SAA affects more Si detectors independently of their bandpass
3. Flat-field: Proba2 pointing is stable up to 5arcsec /min (from SWAP). Jitter introduces fluctuations in the LYRA signal of less than 2%.

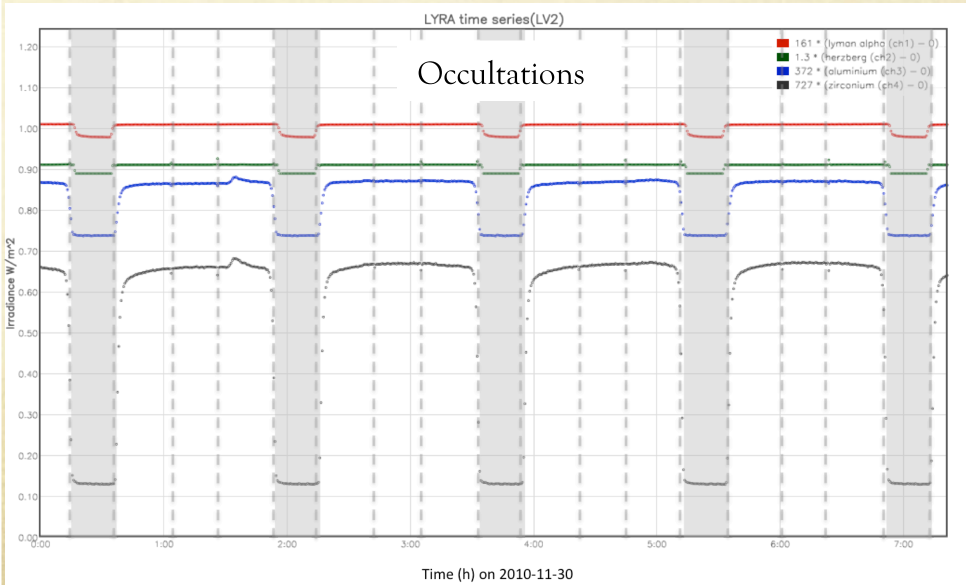




Non-solar features in LYRA data



1. Occultation: from mid-October to mid-February
2. Auroral perturbation
   - Only when Kp > 3
   - Only affects Al and Zr channels independently of the detector type
   - Does not affects SWAP (though observing in the same wavelength range)

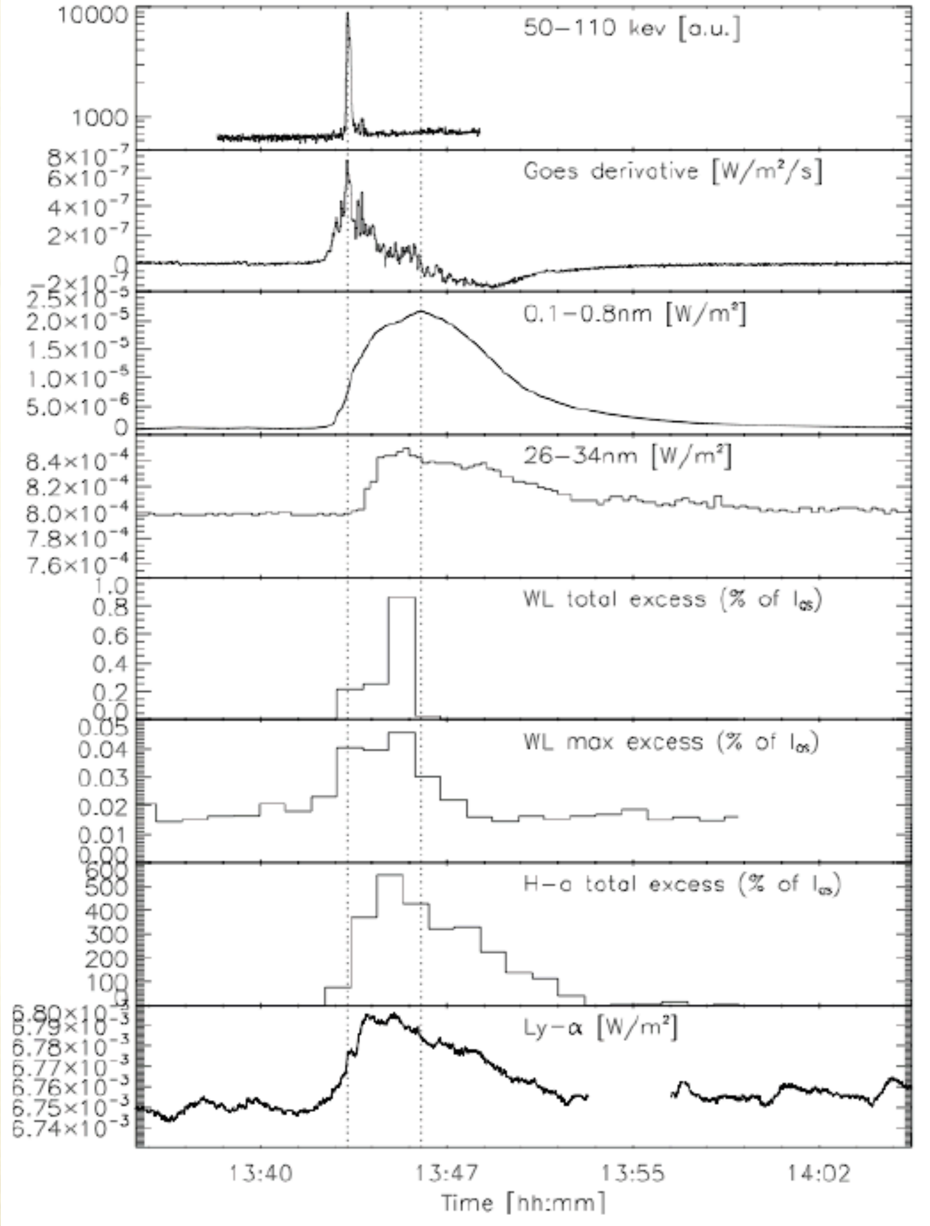


Main fields of investigation

- Flares
  - Detection of Lyman-alpha flares
  - Multi-wavelength analysis of flares
  - Short time-scale events, especially quasi-period pulsations
- Variability of long term solar spectral irradiance
- Sun-Moon eclipses
- Occultations
- Analysis of the degradation process and of ageing effects caused by energetic particles
- Performances of wide-bandgap detectors
- Comparison to other instruments (GOES, EVE ...)

Solar flares with LYRA: Ly-α flare

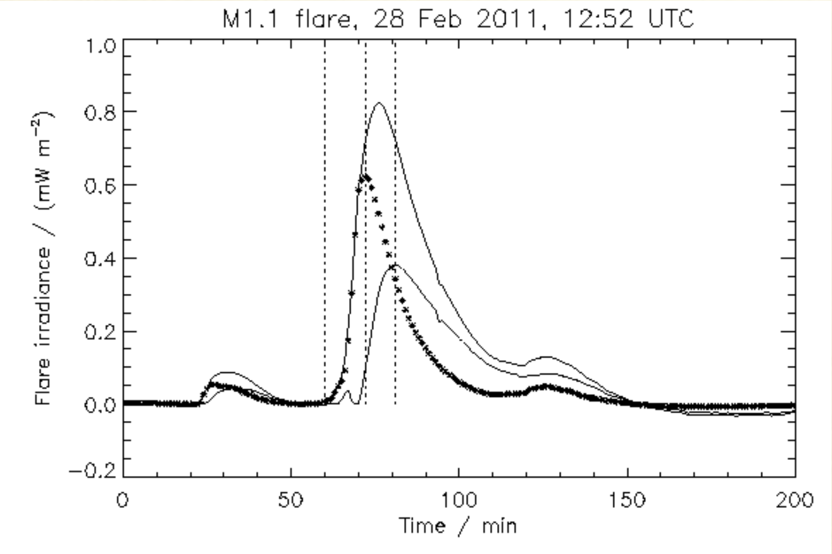
- LYRA has observed about 10 flares in Ly-α
- Attention: to take into account the low purity of the channel
- Degradation rapidly prevents for any new flare detection in this channel
- Occasional campaigns with unit 3

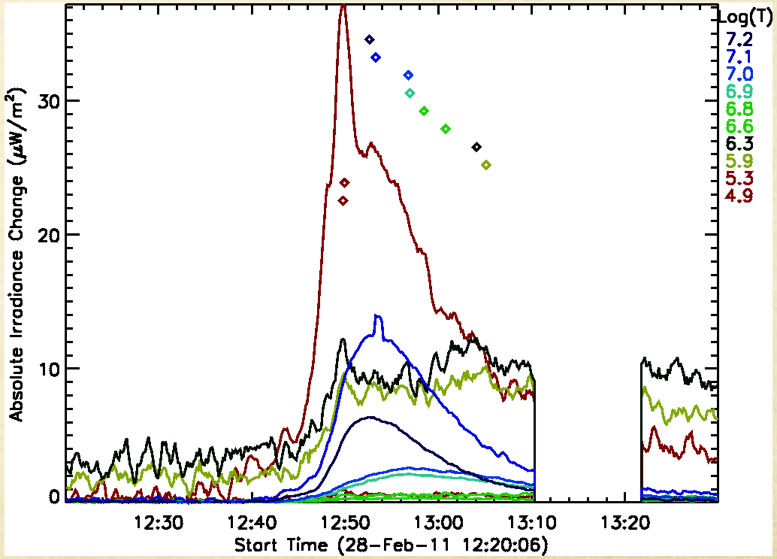


Kretzschmar et al. (2012, topical issue)

Multi-wavelength analysis of flares

- Comparing with other instruments (e.g. SDO/EVE)
  - Separate the SXR from EUV component
  - Build a plot of the thermal evolution of flare

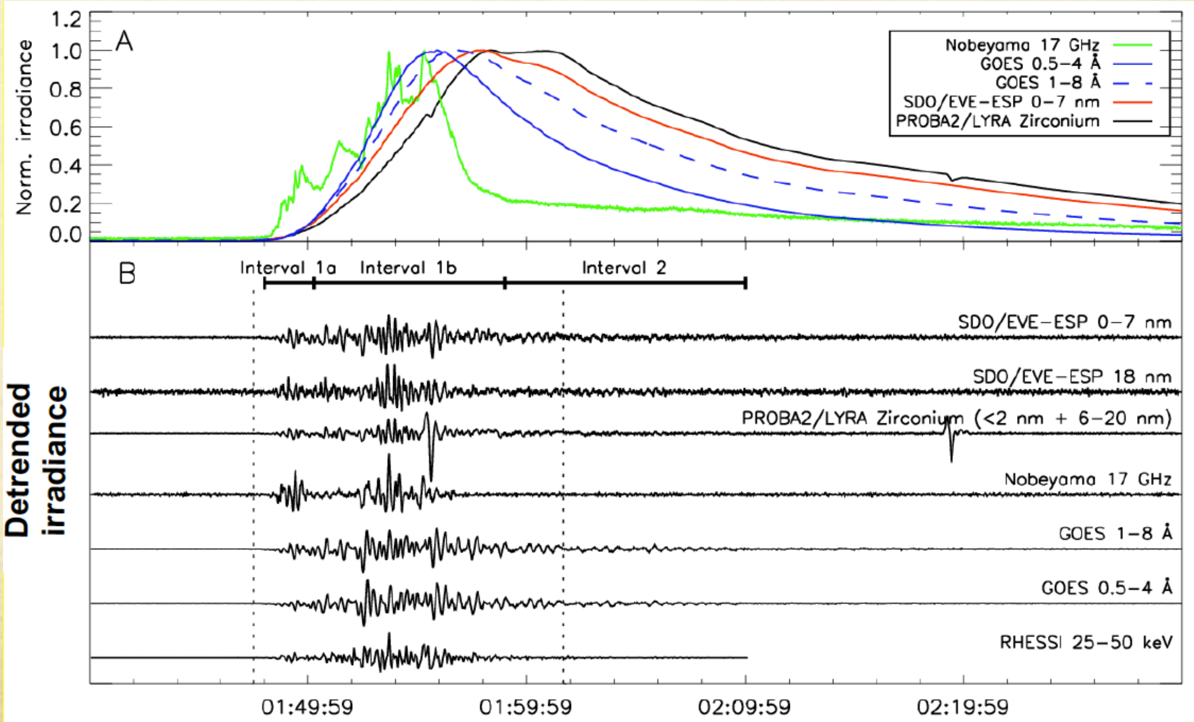




P. C. Chamberlin (NASA/GSFC)

Solar flares with LYRA: QPP

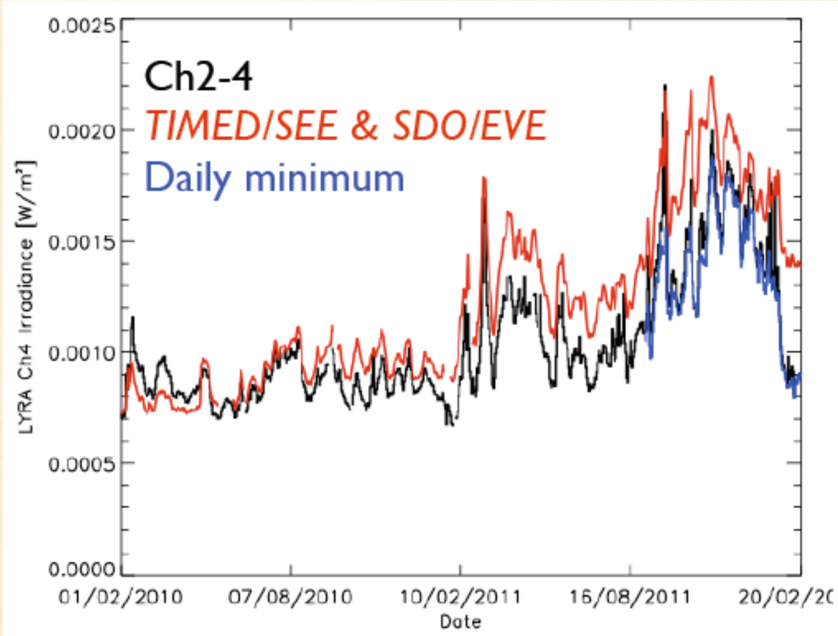
- QPP = quasi-periodic pulsations of solar irradiance observed during the impulsive phase of solar flares
- Detection of periods as short as a few seconds
- Comparison with other instruments from radio to HXR
- Heliosismology: might provide information about the magnetic environment in the coronal loop



Van Doorsselaere et al. (2011), Dolla et al. (2012)

Comparison to other missions: SDO/EVE

- LYRA channel 4 can be reconstructed from a synthetic spectrum combining SDO/EVE and TIMED/SEE

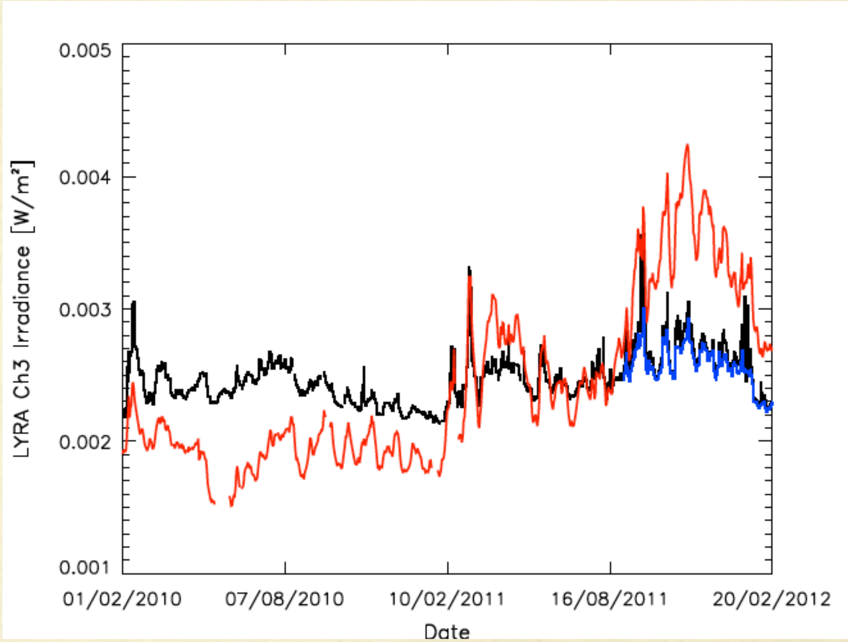


Kretzschmar et al. (2012, SWSC)

Comparison to other missions: SDO/EVE

- Reconstruction of LYRA channel 3 doesn't match the measured time-series

  => To use a spectrally dependant correction for degradation



Kretzschmar et al. (2012, SWSC)

Guest Investigator proposal of Andrew Jones and Don Mc Mullin

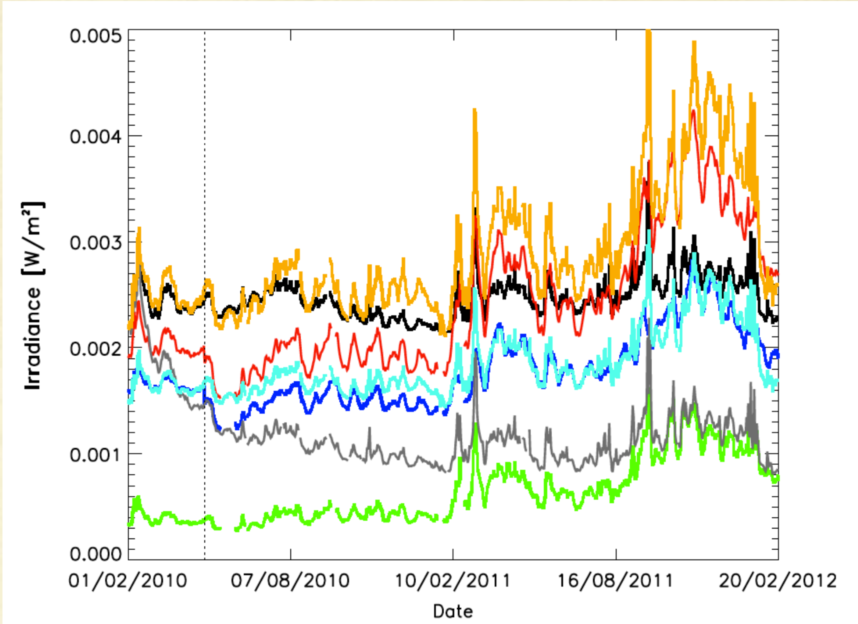
Comparison to other missions: SDO/EVE

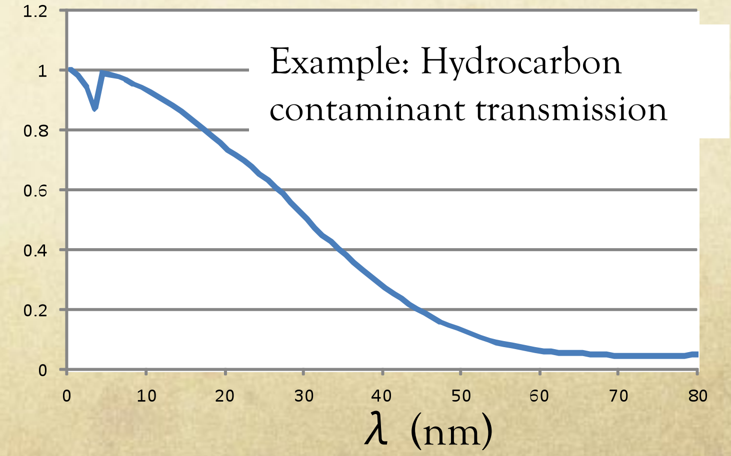
- first attempt: independent correction of the EUV and SXR contributions to Al channel, based on their respective correlations to Zr channel

  => encouraging results

- Next step: build a correction for degradation that is fully spectrally resolved

  => hypothesis on the nature of contaminants





Collaborations

ORB – KSB

wrc pmod

esa

CSL

IMO

THANK YOU!

NIMS

LASP

P.N.Lebedev Physical Institute of the Russian Academy of Science

LPC2E

belspo

MPS

Max-Planck-Institut für Sonnensystemforschung