LYRA status and inter-instrument comparison

M. Dominique

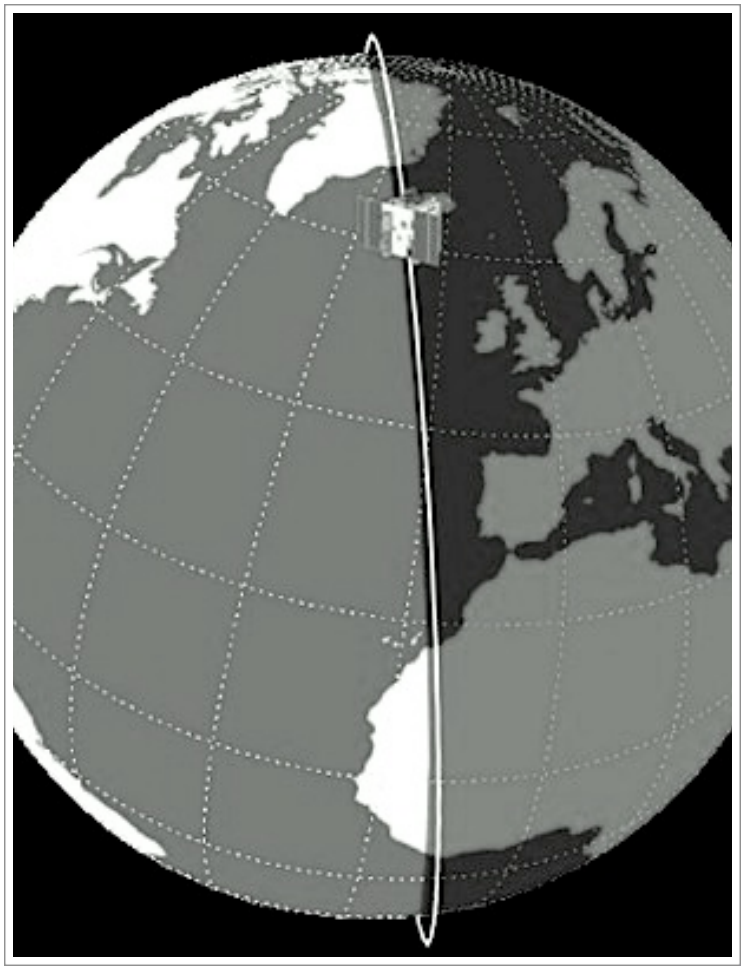
EVE Workshop

Yosemite NP, Oct 30 – Nov 01 2012

PROBA2:
Project for On-Board Autonomy

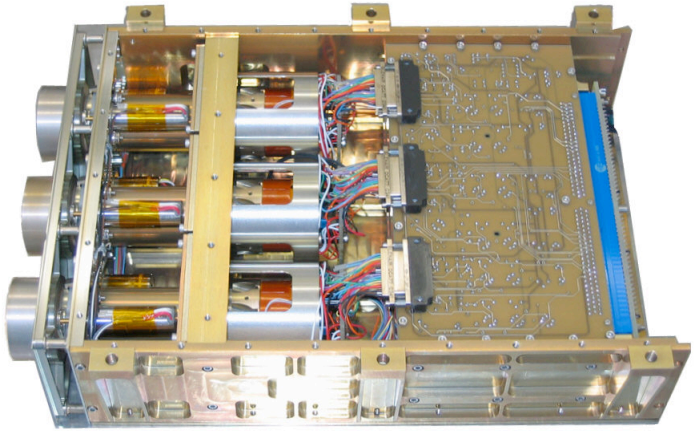
PROBA2 orbit:

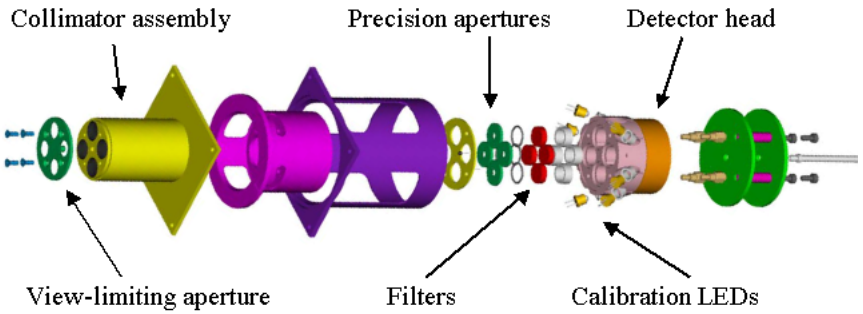
- Heliosynchronous
- Polar
- Dawn-dusk
- 725 km altitude
- Duration of 100 min



launched on November 2, 2009

LYRA highlights

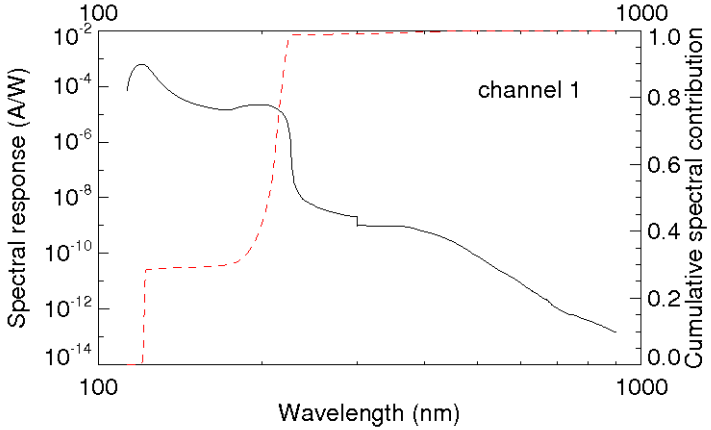




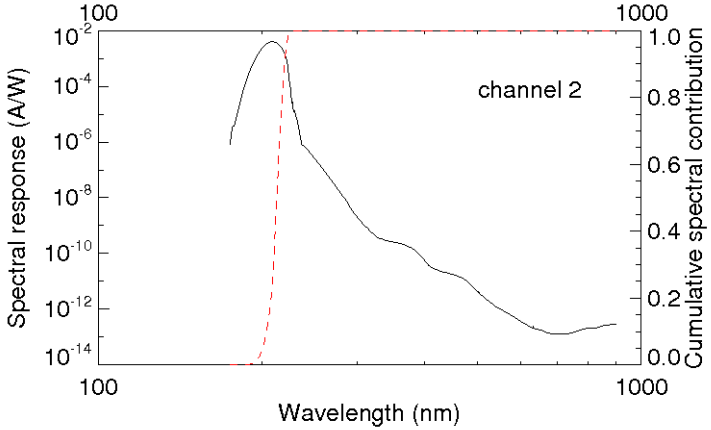
- **3 redundant units** protected by independent covers
- **4 broad-band channels**
- High acquisition cadence: **nominally 20Hz**
- 3 types of detectors:
  - standard silicon
  - 2 types of **diamond detectors**: MSM and PIN
    - radiation resistant
    - blind to radiation > 300nm
- **Calibration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

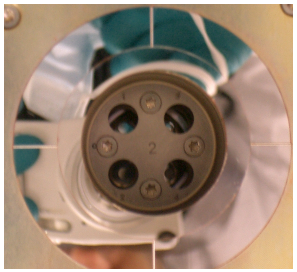
LYRA channels convolved with quiet Sun spectrum

Channel 1 – Lyman alpha
120-123 nm

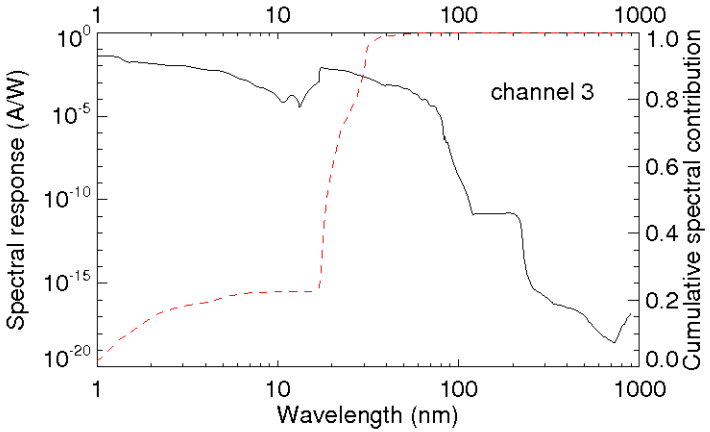


Channel 2 – Herzberg
190-222 nm

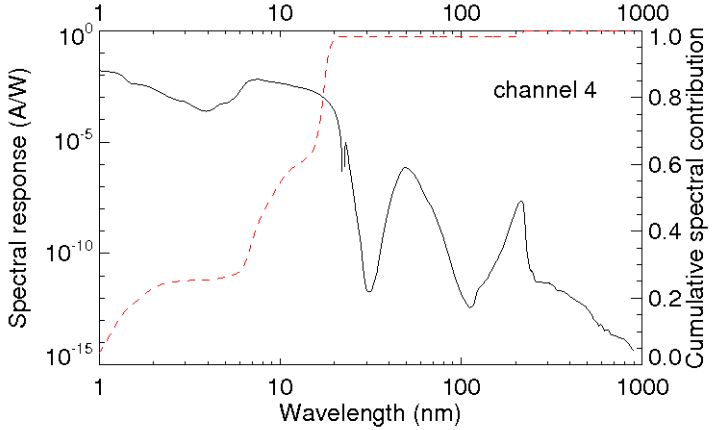




Channel 3 – Aluminium
17-80 nm + < 5nm



Channel 4 – Zirconium
6-20 nm + < 2nm



Calibration

Includes:

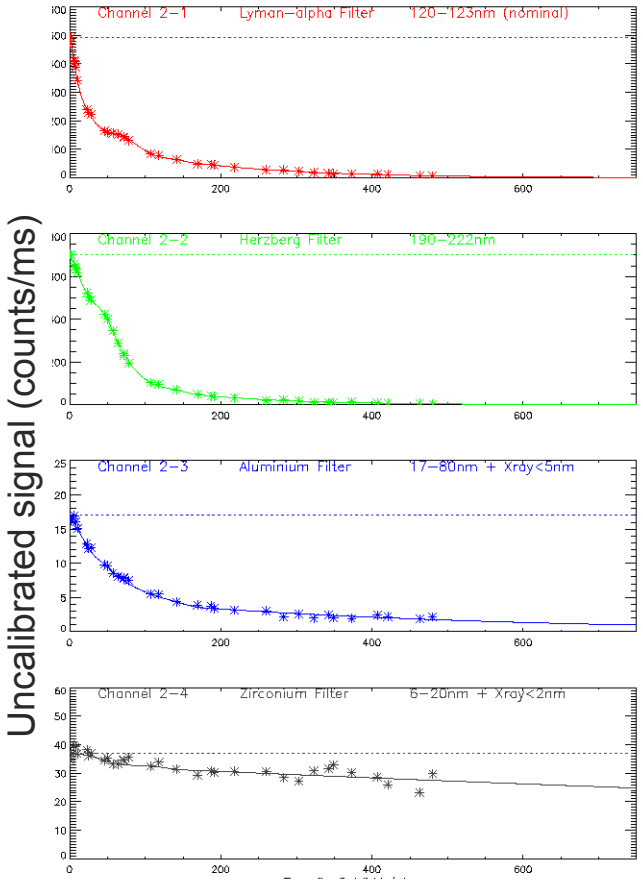
- Dark-current subtraction
- Additive correction of degradation
- Rescaling to 1 AU
- Conversion from counts/ms into physical units (W/m2)

  WARNING: 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

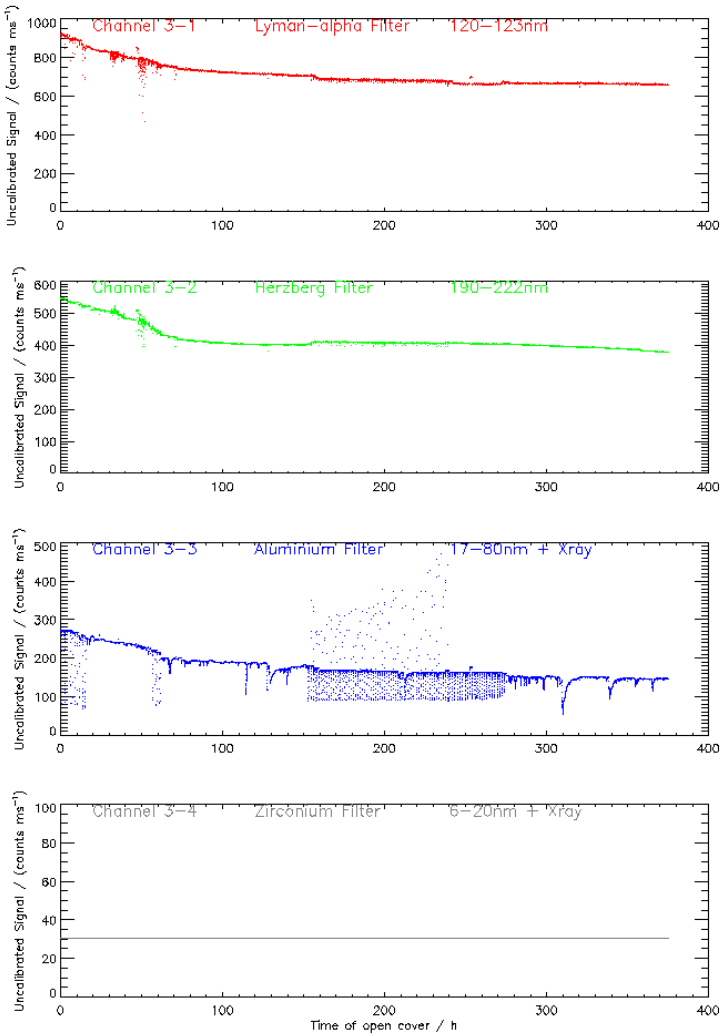
Degradation of unit 2 – the nominal unit



Degradation after 400h vs now:

- Ch1 : 58.3% | >99%
- Ch2 : 32.5% | >99%
- Ch3 : 28.7% | 90%
- Ch4 : 10% | 30%

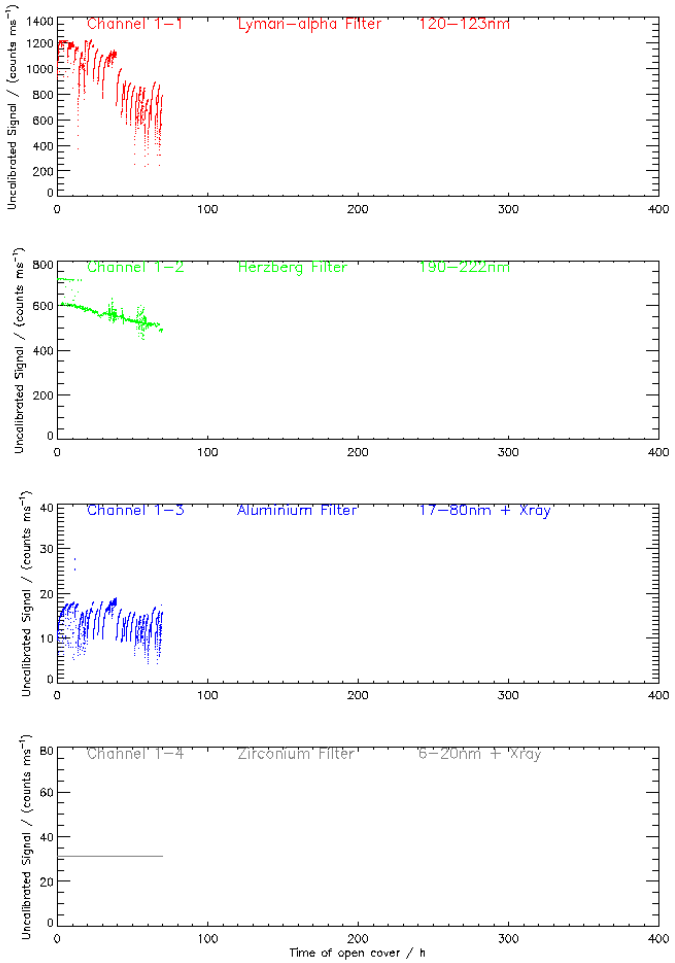
Degradation of unit 3 – dedicated campaigns



- Degradation after 400h vs now:
  - Ch1 : 28.3% | 34%
  - Ch2 : 30.9% | 66%
  - Ch3 : 45.2% | 57%
  - Ch4 : / | 10%

  after removal of the long-term solar variability provided by channel 4

Degradation of unit 1 – calibration



- Current degradation:
  - Ch1 : 50%
  - Ch2 : 15%
  - Ch3 : 20%
  - Ch4 : /
- Approximate values

Long term evolution

Work still in progress …

Various aspects investigated:

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

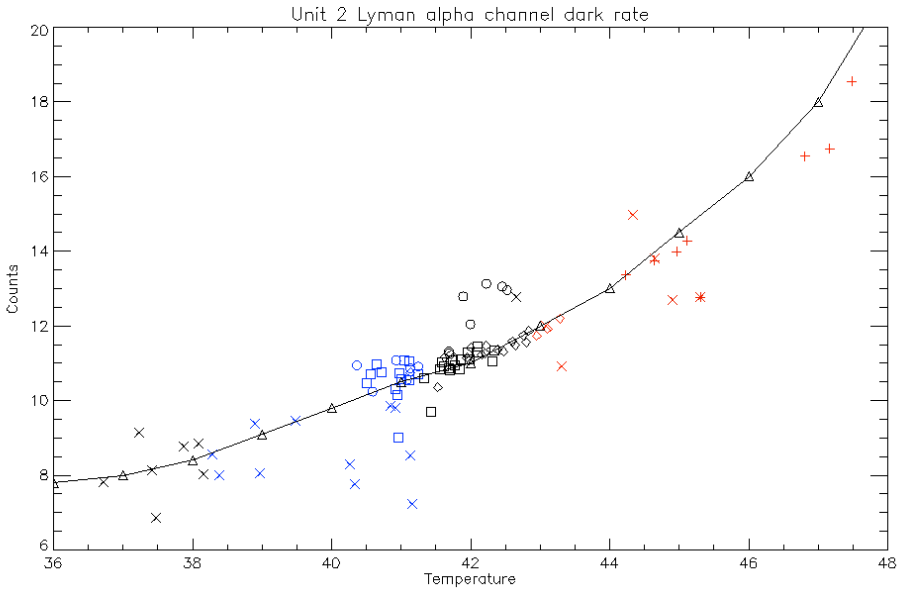
Investigation means:

- 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

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

DC variations correlated with temperature evolution

Dark current in Lyman alpha

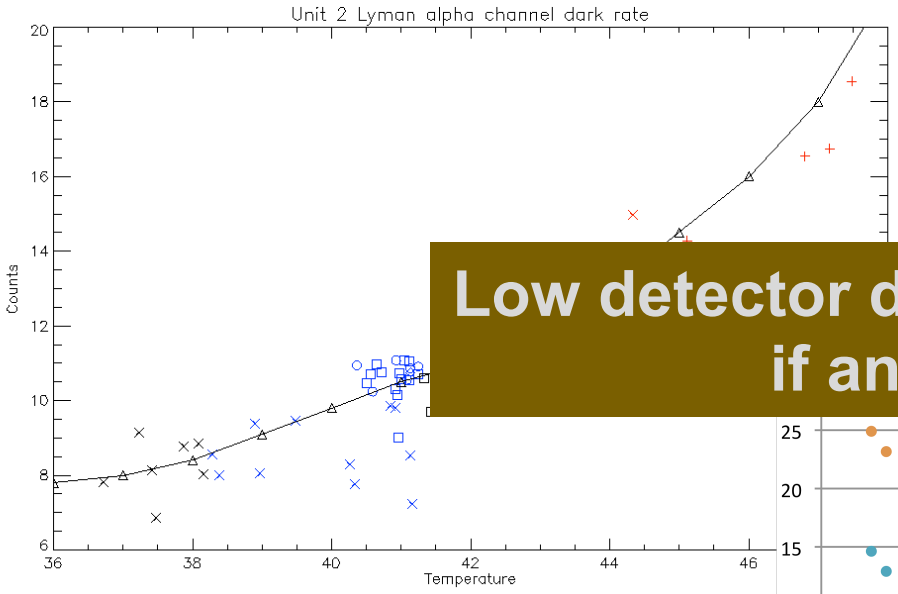


I. Dammasch + M. Snow

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

LED signal constant over the mission

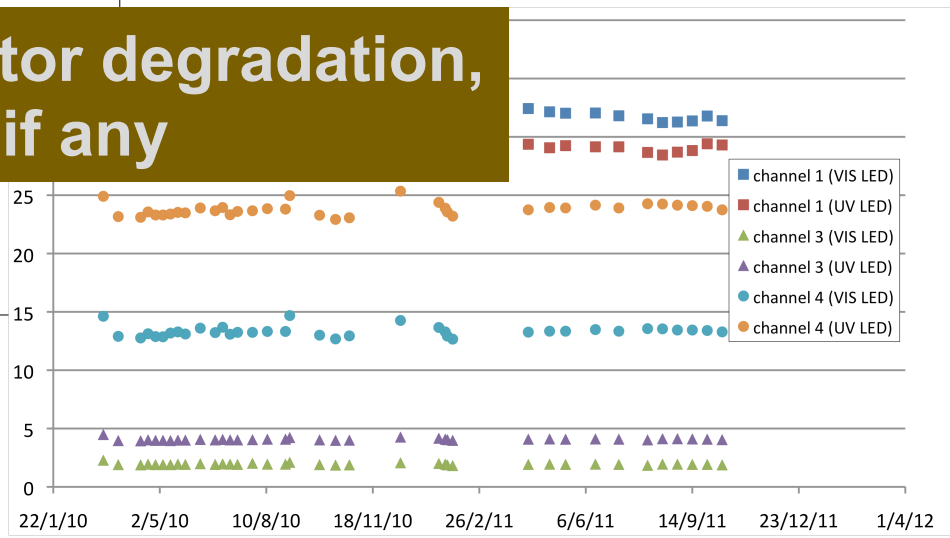
Dark current in Lyman alpha



I. Dammasch + M. Snow

Low detector degradation, if any

LED signal evolution
Unit 2 – dark current subtracted

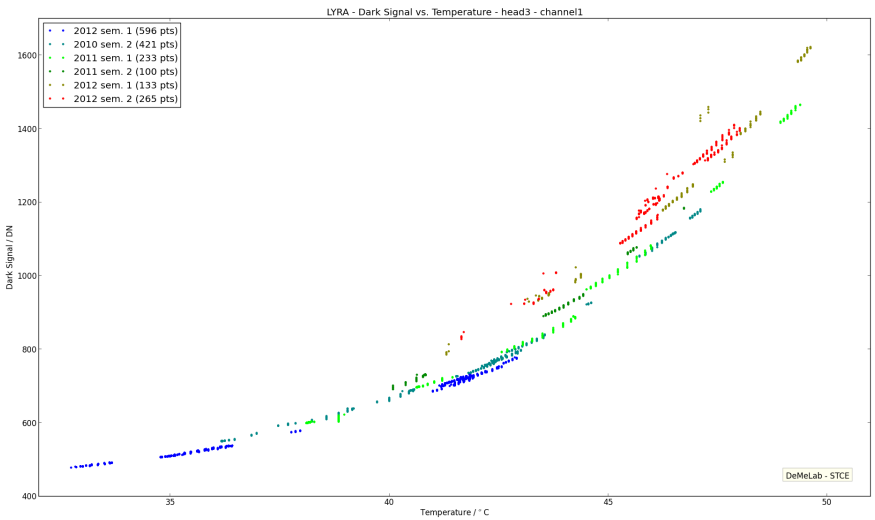


M. Devogele

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

- DC increases slightly with time

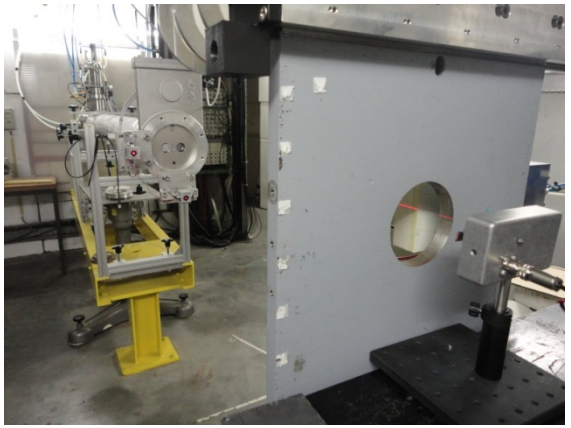
  => Small degradation observed on unit 3



Degradation – Proton tests

A. BenMoussa, B Giordanengo and S. Gissot (ROB/STCE)
A. Soltani (IEMN)
U. Schühle (MPS)

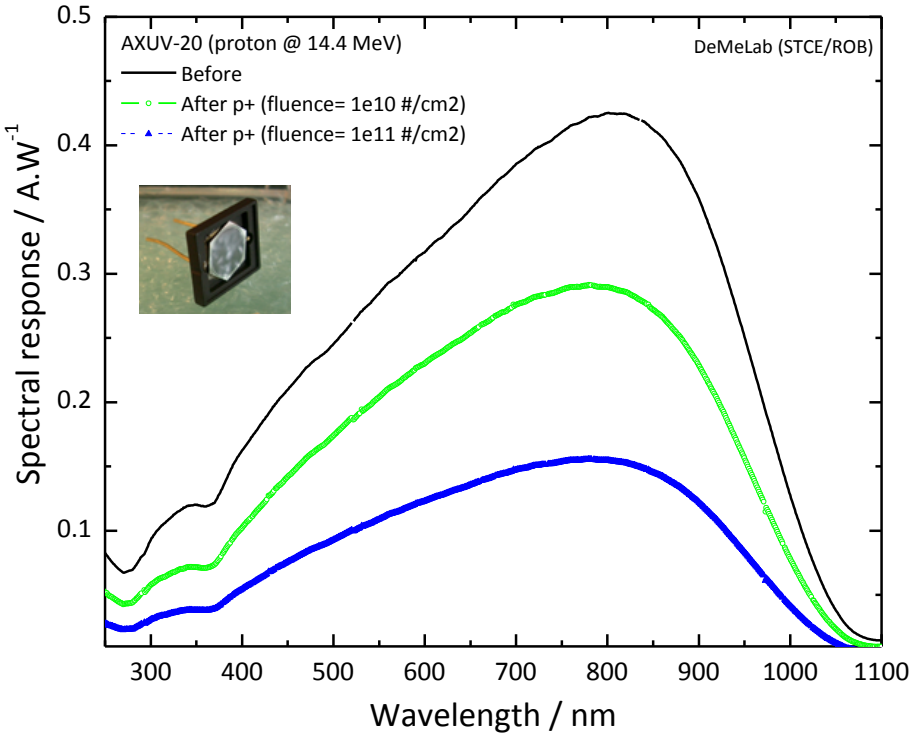
DeMeLab
detector measurements laboratory

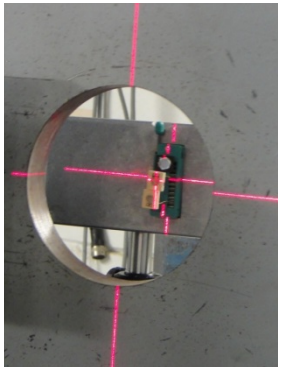


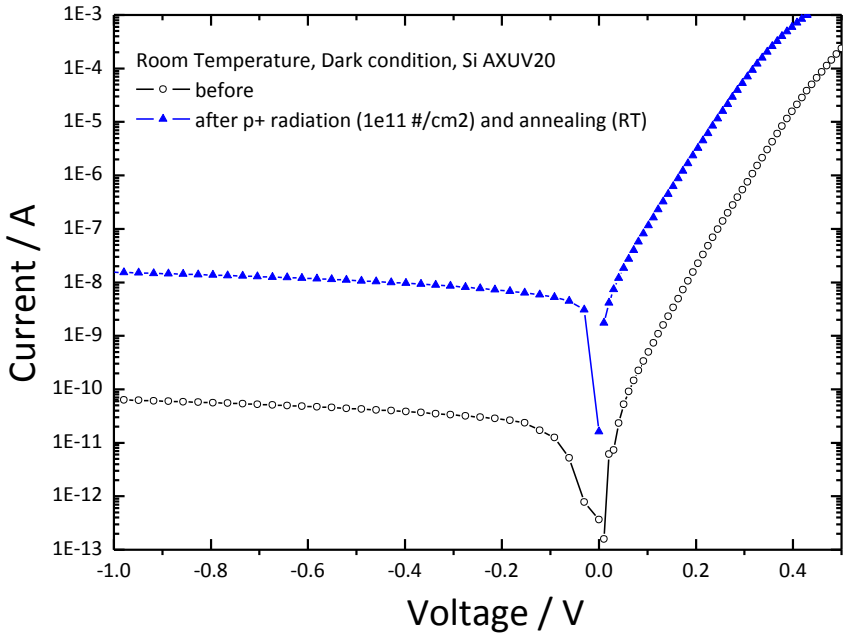
Light Ion Facility @ Cyclotron Research Center in Louvain-La-Neuve, Belgium.

AXUV Si PIN photodiode (LYRA)

NUV-VIS spectral response decreases strongly



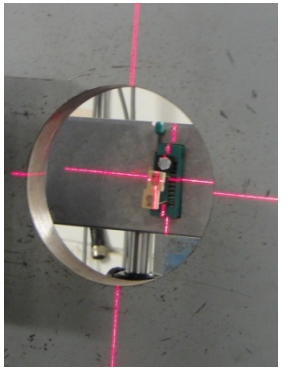


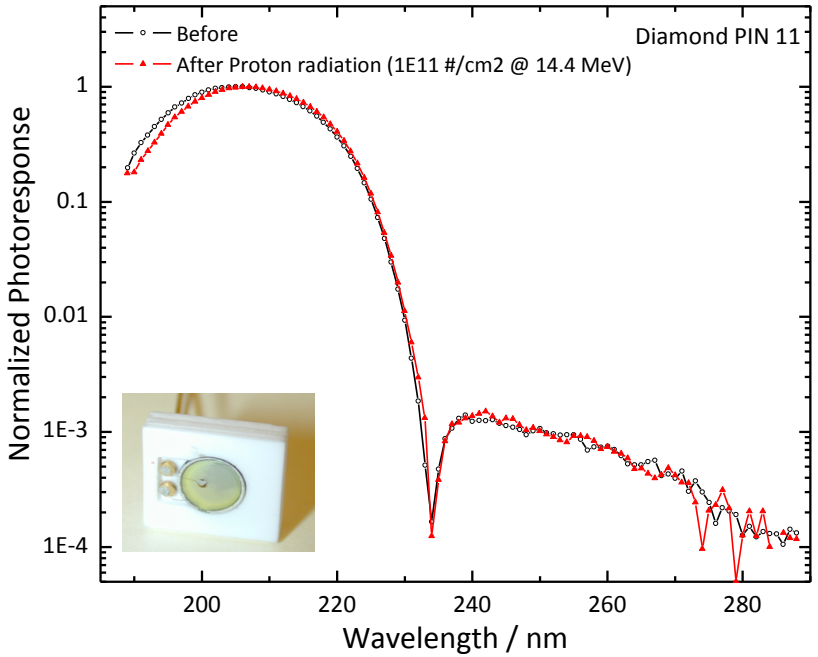


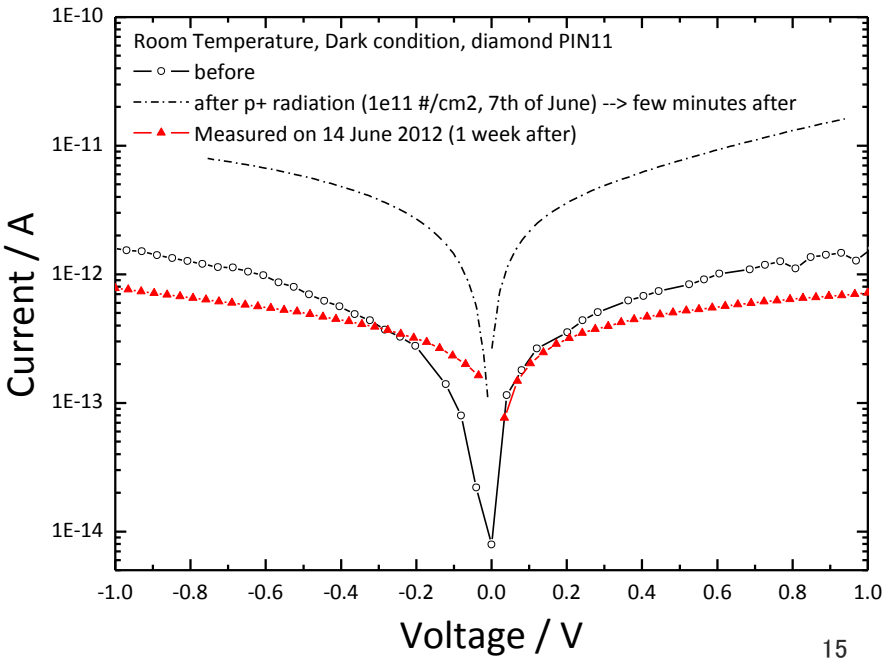
Dark current increases (x100)

→ Permanent degradation (measured several weeks after)→ surface degradation and/or bulk displacement damage

Diamond PIN detectors (LYRA)



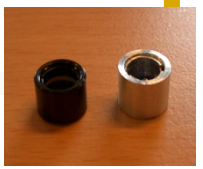




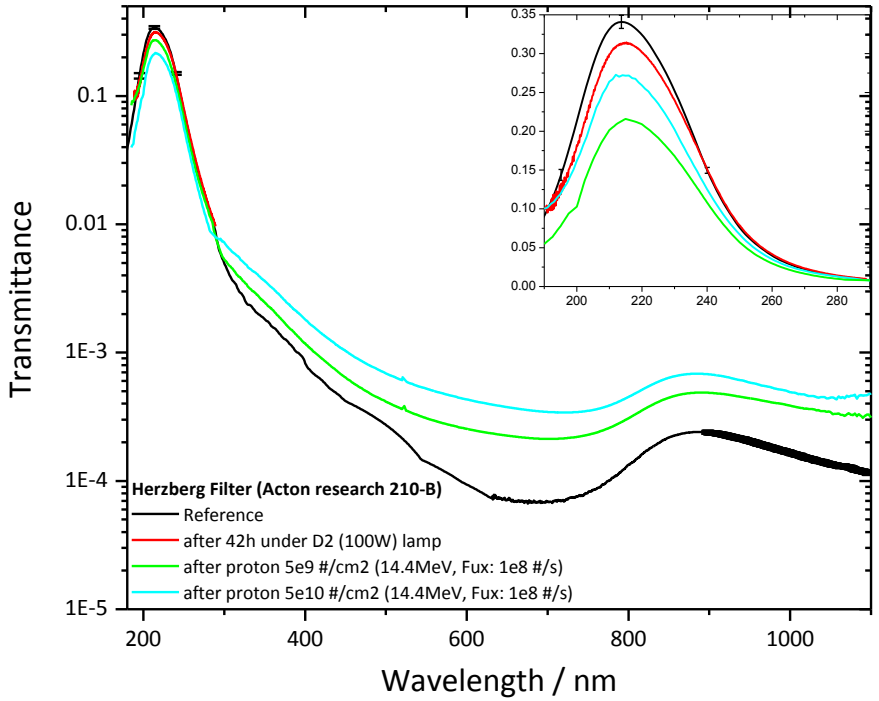
<u>Dark current (PIN11)</u>

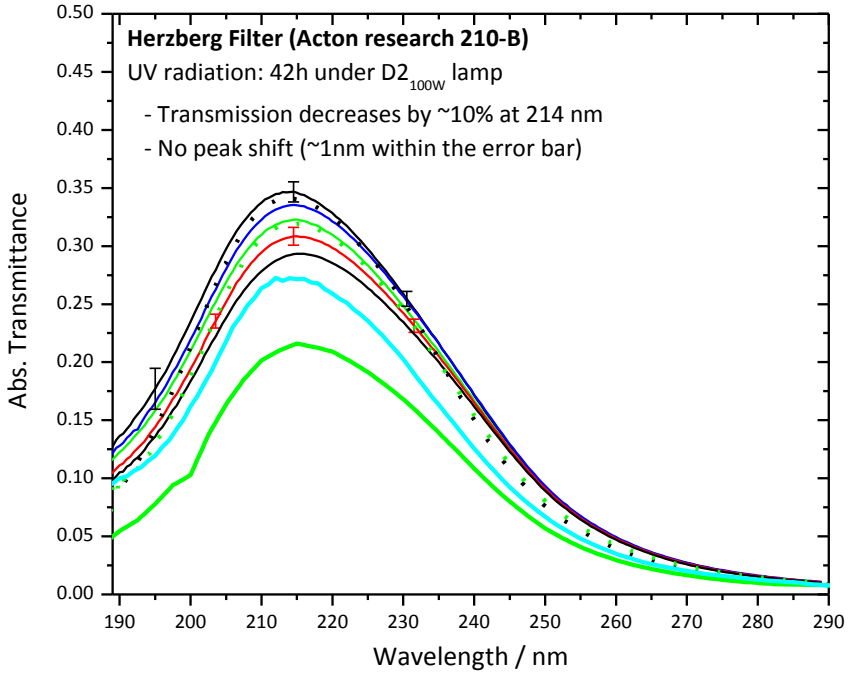
DC increases (x7) due mainly to ionization but it is back to its pre-irradiation value after RT annealing

LYRA's filters (Hz) after proton tests (@14.5MeV)



Acton filters

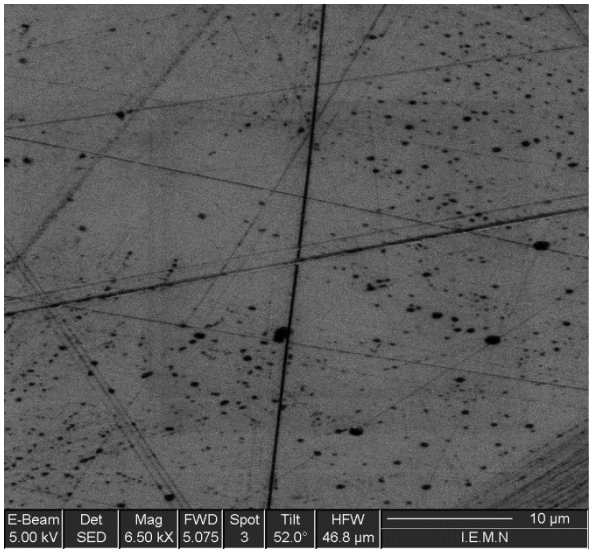


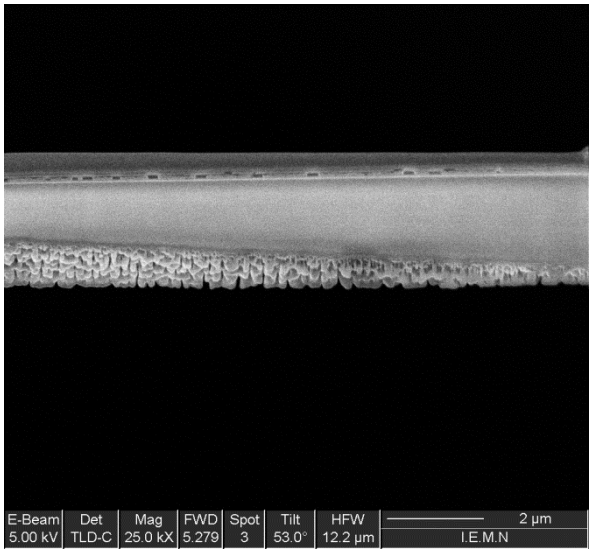


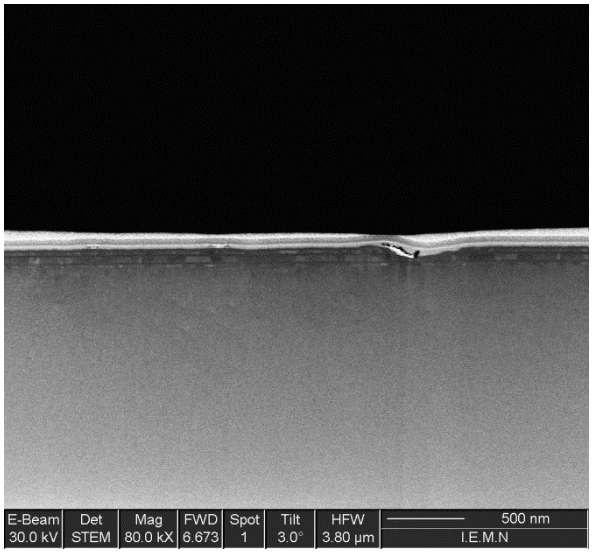
Herzberg filters at 214 nm:

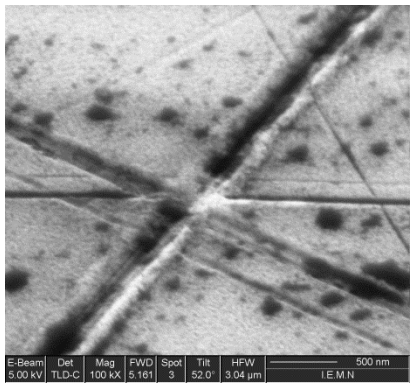
- Transmission decreases by ~10% after UV radiation (observation of interference fringes after 30h irradiation)
- Transmission decreases by ~37% after proton radiation.

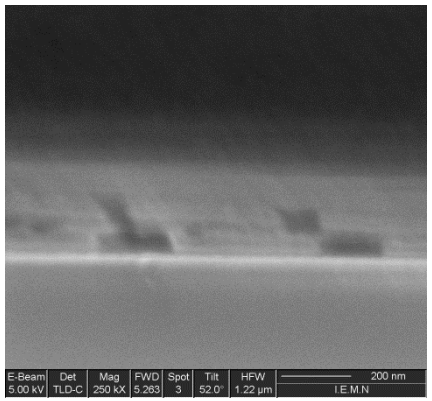
SEM images after proton tests

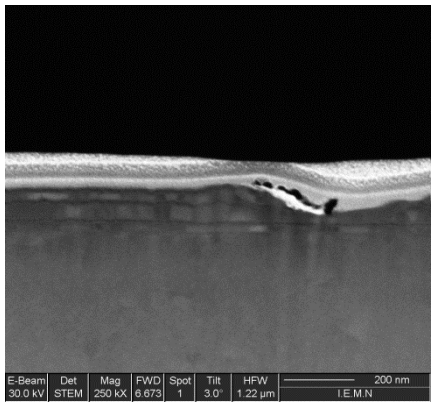




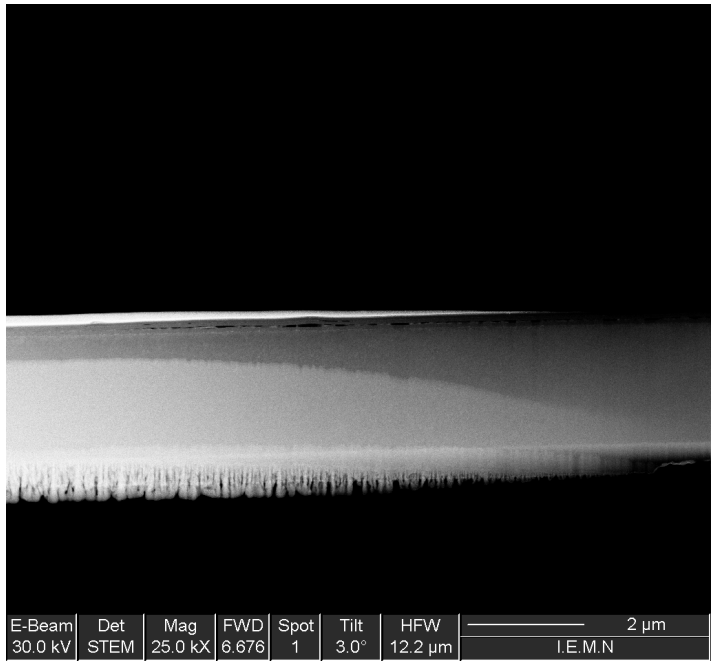


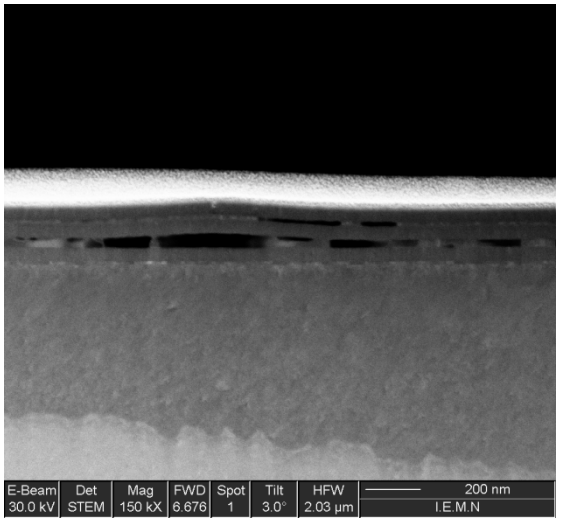


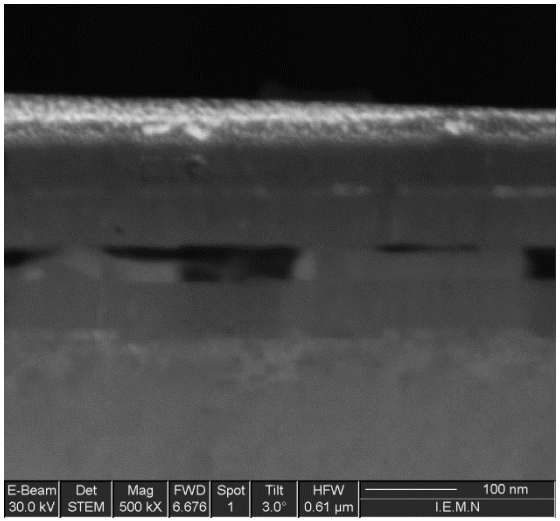


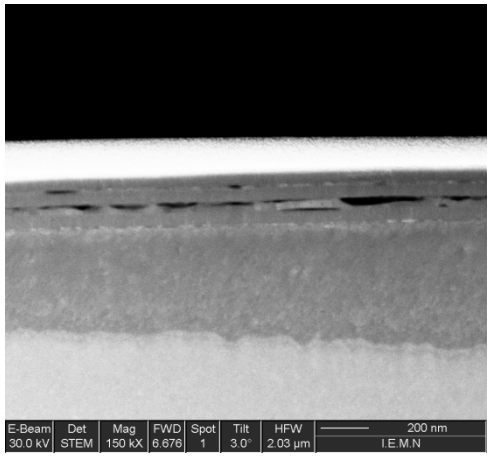


Cross section (Hz filters)



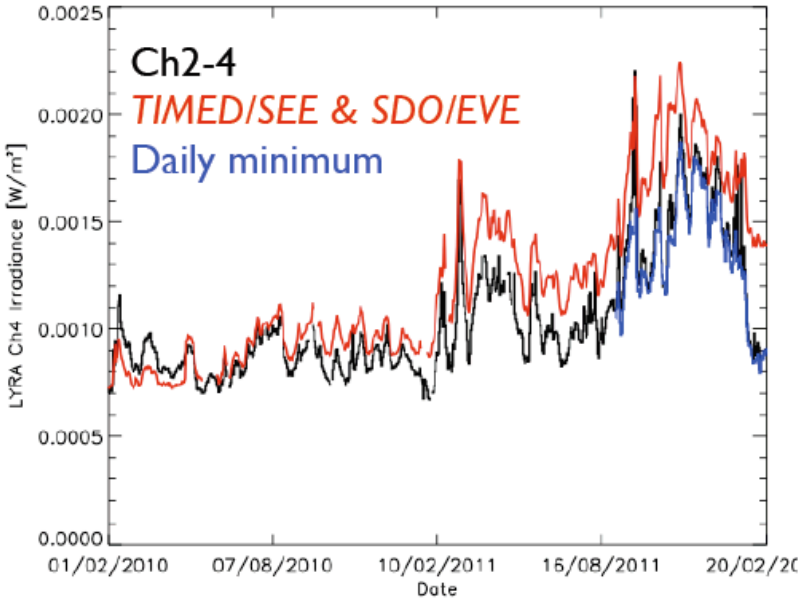






Comparison to other missions: SDO/EVE

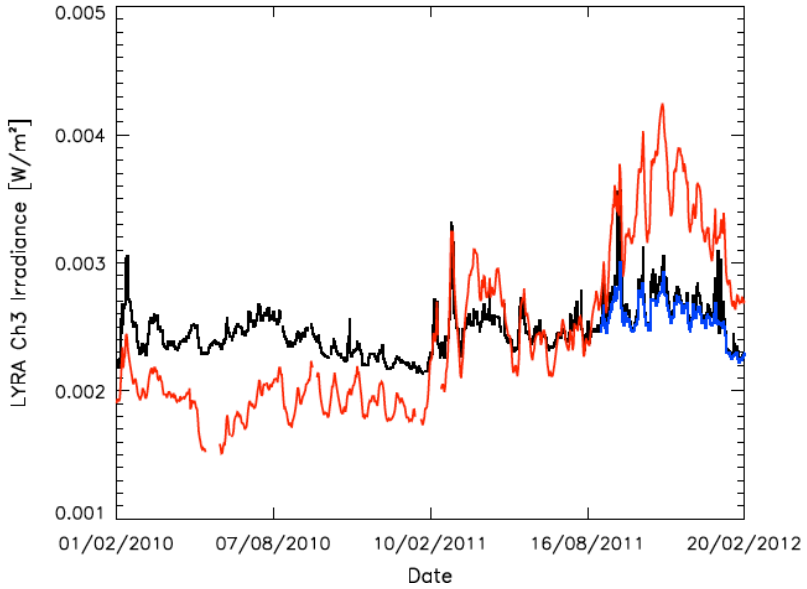
- LYRA channel 4 can be reconstructed from a synthetic spectrum combining SDO/EVE and TIMED/SEE



Comparison to other missions: SDO/EVE

- Reconstruction of LYRA channel3 doesn't match the measured time-series

  => To try to use spectrally dependant correction for degradation



Guest Investigator proposal of Andrew Jones and Don Mc Mullin

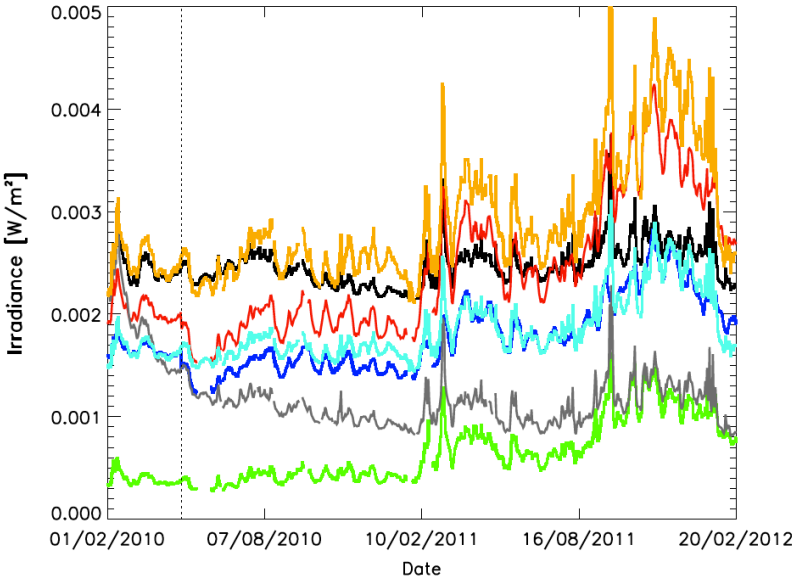
Comparison to other missions: SDO/EVE

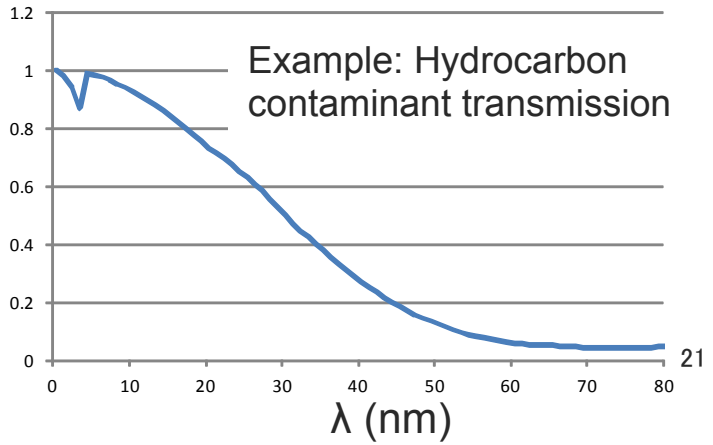
- first attempt: independent correction of the EUV and SXR contributions to Al channel, based on their respective correlations to Zr channel

  => encouraging results

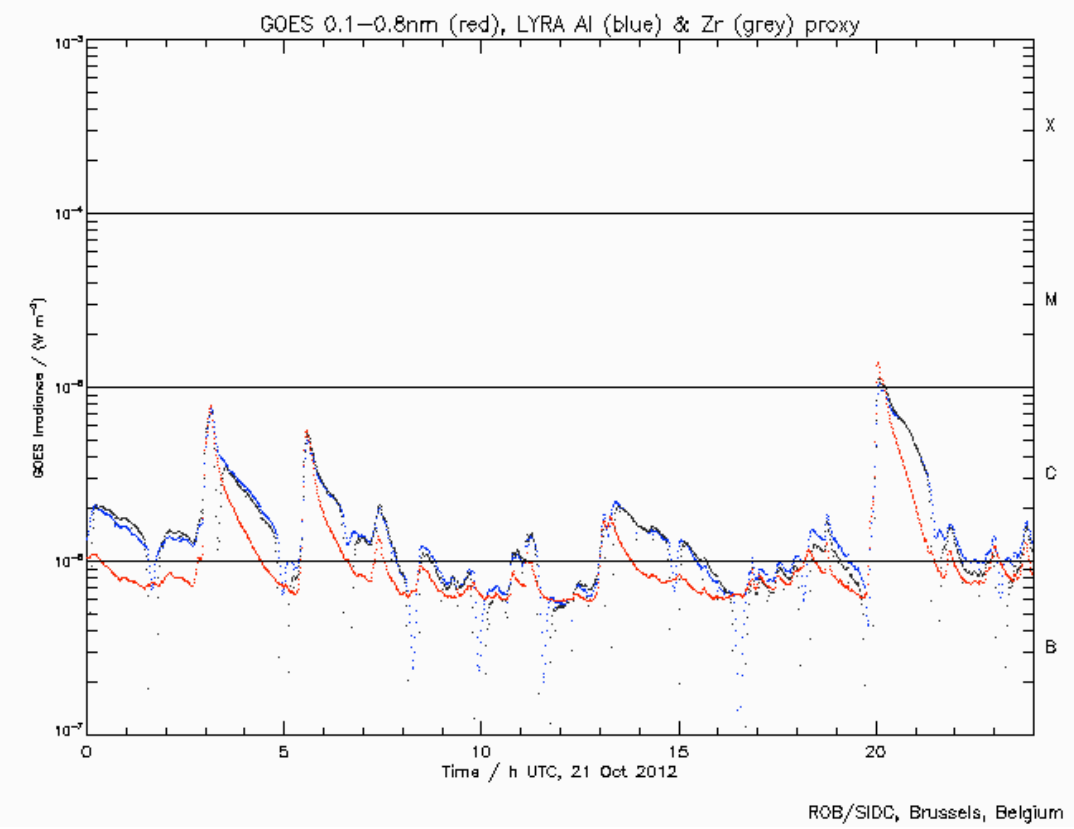
- Next step: build a correction for degradation that is fully spectrally resolved

  => hypothesis on the nature of contaminants





Comparison to other missions : GOES



http://proba2.sidc.be/ssa

- Good correlation between GOES (0.1-0.8nm) and LYRA channels 3 and 4
- For this purpose, EUV contribution has to be removed from LYRA signal

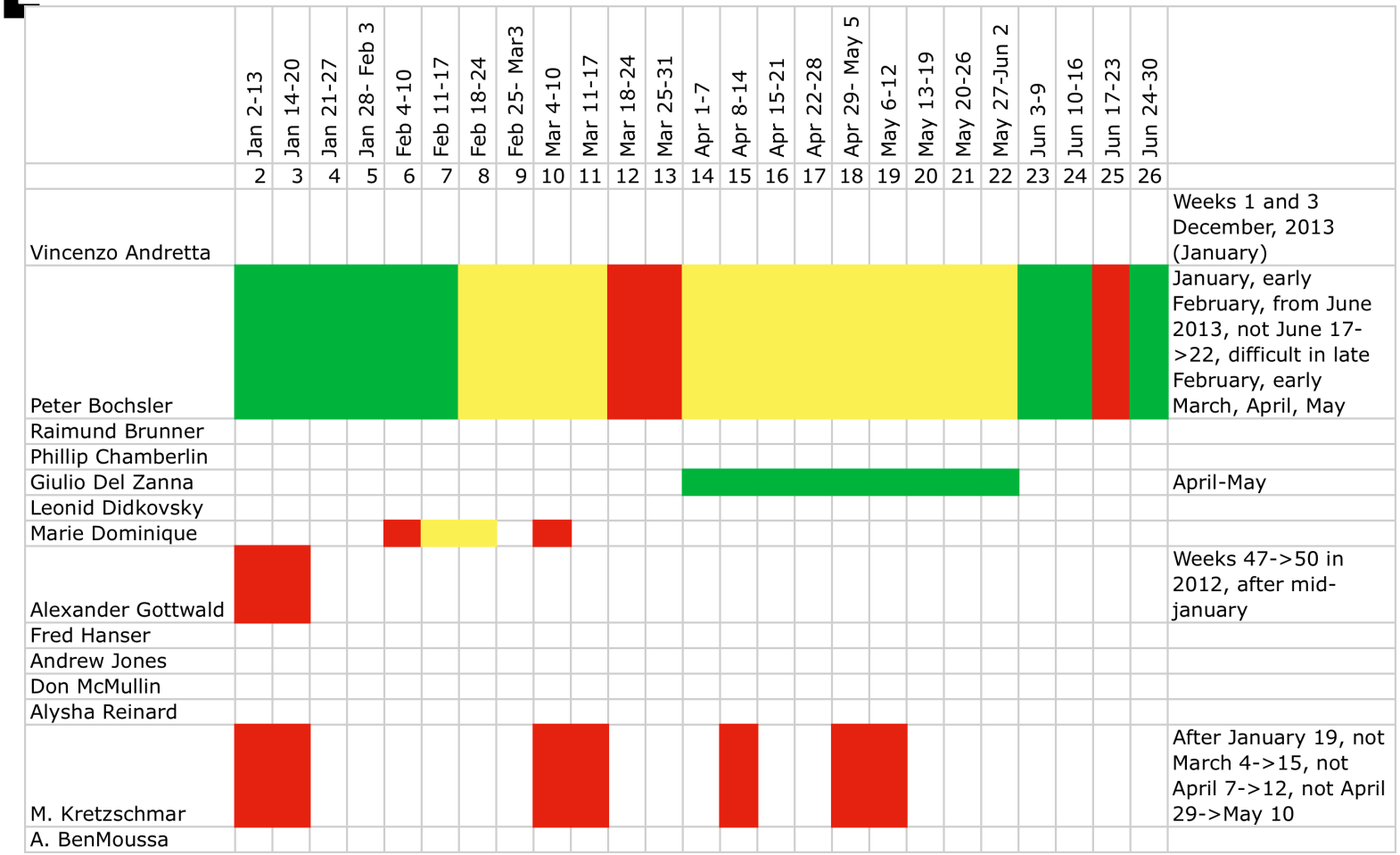
=> LYRA can constitute a proxy for GOES

Thank you!

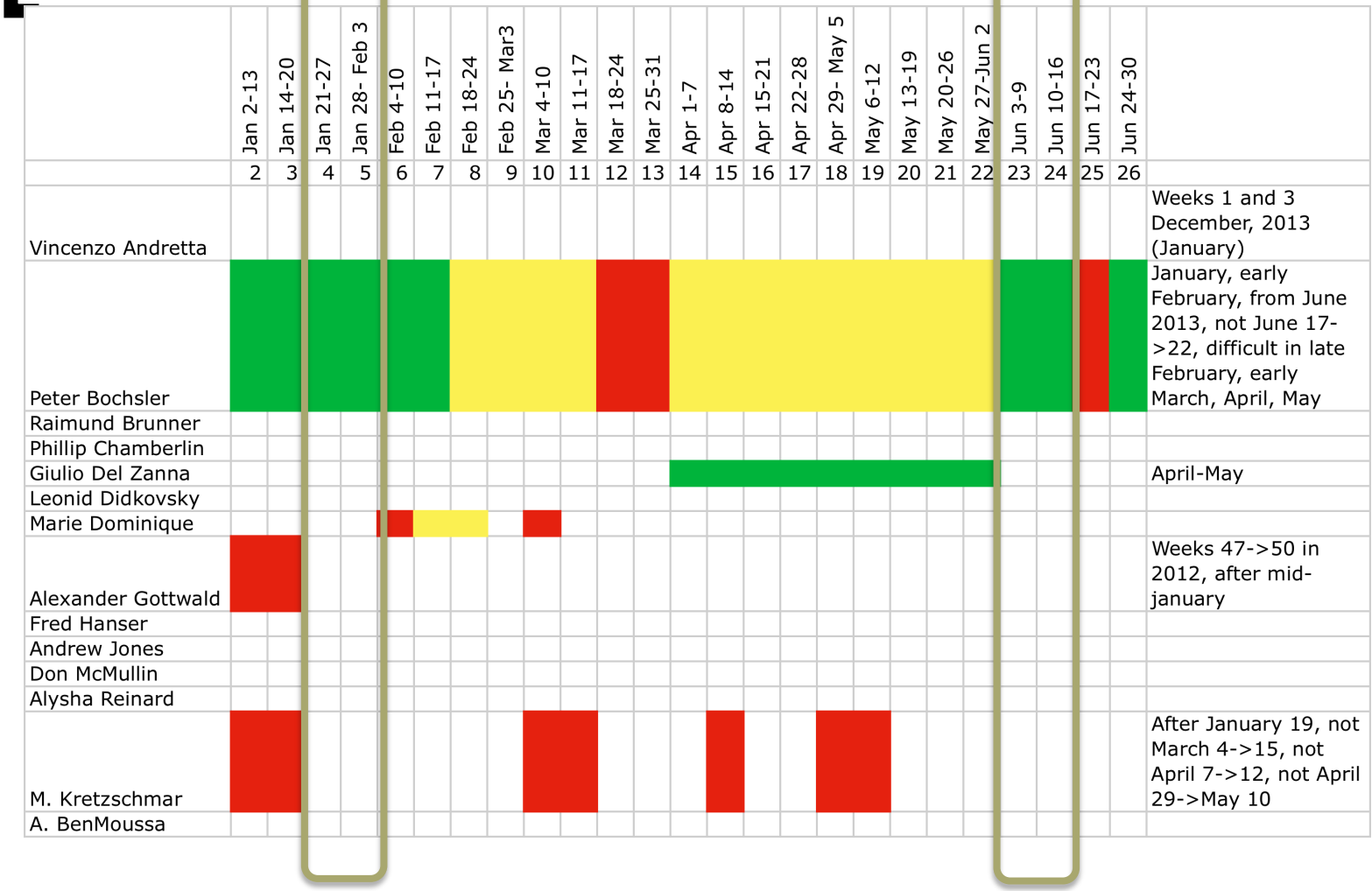
STCE proposal : Inter-calibration and Validation of Solar Extreme Ultraviolet Spectral Irradiance Measurements

- Team composed of Vincenzo Andretta, Peter Bochsler, Raimund Brunner, Phillip Chamberlin, Giulio Del Zanna, Leonid Didkovsky, Marie Dominique, Alexander Gottwald, Fred Hanser, Andrew Jones, Don McMullin, Alysha Reinard + M. Kretzschmar and A. BenMoussa
- For each: per diem (40€) + lodging expenses for two one-week meetings
- Capped budget of 3500€ for travel
- Meeting open to other people, without financial participation of STCE

Next meeting



Next meeting



Objectives for the next meeting

Action Items from 1 st. Solar EUV Irradiance Inter-Calibration and Validation Workshop

1. **ISSI Proposal Effort**
   a. Every team will select a representative to work on the proposal team. Send contact information to Frank by Nov. 7
   b. Frank will schedule a Skype telecon to start coordinating the proposal process before the end of November.

2. **Broadband Comparison Effort**
   a. Tom will send out a template by Oct 31 for collecting information about instruments and every team will respond Nov 30.
   b. Tom will come up with reference spectra (0-300 nm, 0.1 nm res., min, max, X7 flare) for teams to use in processing their broadband measurements by Nov. 11
   c. Every team will provide ascii files and plots of their un-degraded spectral responses by Nov. 11, and those responses multiplied by the reference spectra, and determinations of how much signal is coming from what bandpasses for each channel and each reference spectrum, what are 1%, 2%, and 5% contribution levels by Dec. 16.
   d. Every team will determine irradiances in specified bands (?) using the reference spectra by Dec 16.
   e. Schedule a telecon sometime in early 2012 to go over results.

3. **SolACES and LASP Comparison Effort**
   a. SolACES will provide high resolution spectra to LASP by Nov. 11
   b. SolACES and LASP will share observation times with MEGS-B to look for overlaps with SolACES observations in the past by Nov. 11.
   c. SolACES and LASP will coordinate a campaign to exactly overlap MEGS-B measurements with SolACES measurements in the future
   d. LASP will provide MEGS-XPS composite spectra for SolACES calibration times (need to get those times) by Nov 11
   e. SolACES will give LASP the lines they use for their wavelength scale by Nov 11 and both teams will calculate irradiances for those lines from their measurements by Nov 28.
   f. LASP and SolACES will have a telecon on Wed. November 30, 2011 at 8:00 am Mountain Time (4:00 pm Central European Time) to go discuss comparisons

4. **Flare Campaigns**
   a. Phil will provide statistics on flare occurrences during past MEGS-B 3-hour and 24-hour campaigns by Nov 11.
   b. Create a new mailing list for irradiance campaign announcements. Andrew and Don will work out the details by Nov. 30.

5. **TIGER Symposium at COSPAR2012 (July in Mysore, India)**
   a. Organizing committee needs to get on it!