

RESIK spectral atlas for flares: data access and use

Janusz & Barbara Sylwester

Anna Kępa,

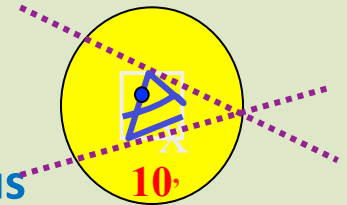
Mirek Kowaliński,

ZFS CBK

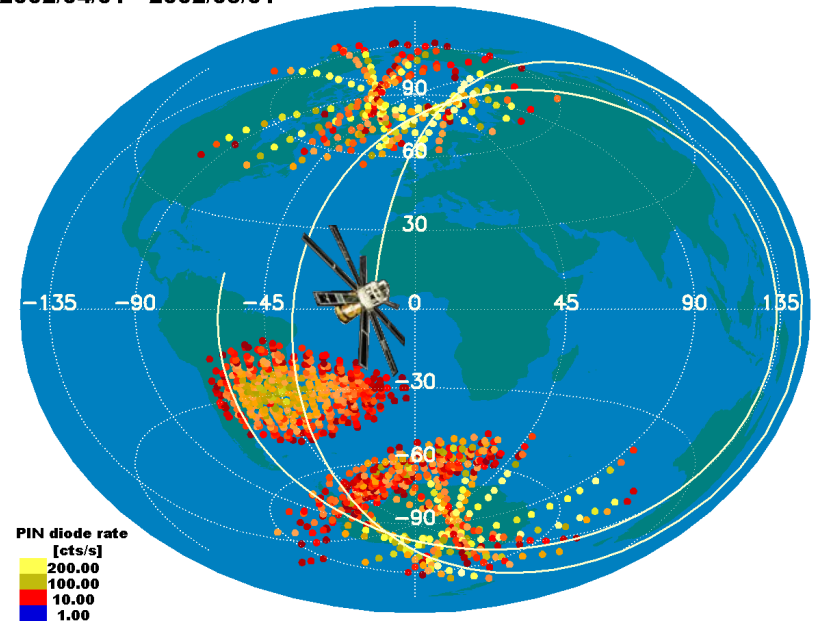
CORONAS-F launch, orbit & pointing



polar orbit, 95min,
~500 km
semi-Sun-synchronous



2002/04/01 - 2002/05/01

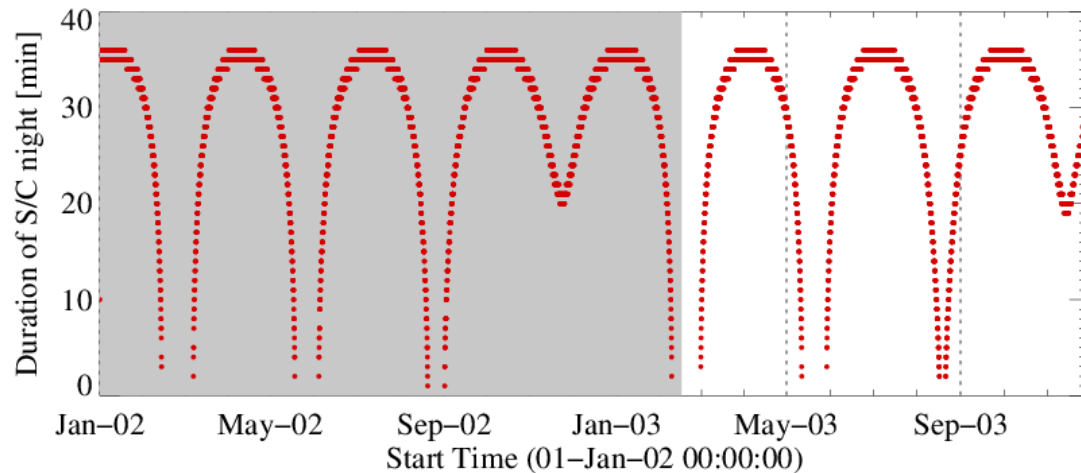


CORONAS-F launch from Plesetsk on 31 July 2001 morning

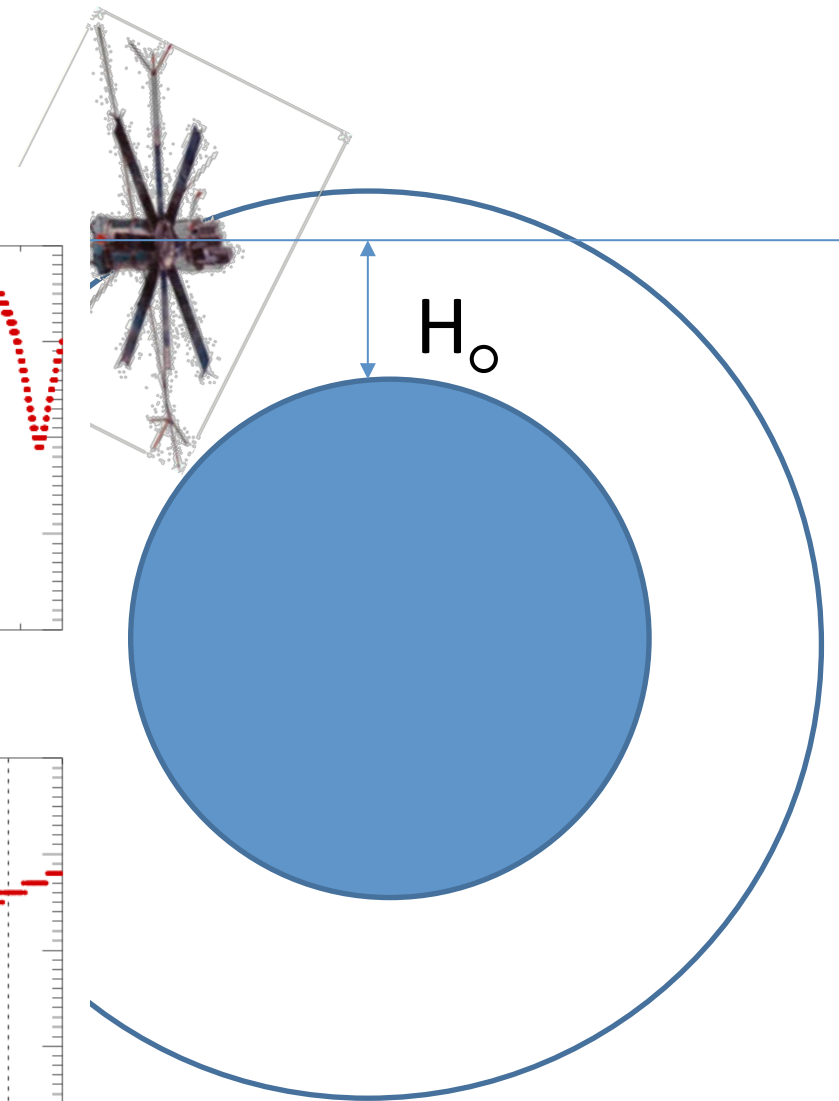
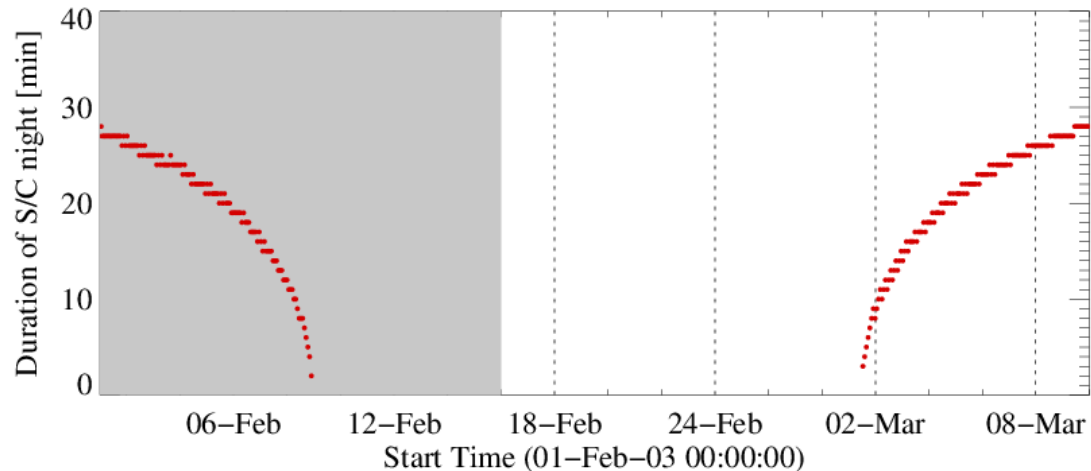
For description of the instruments, visit <http://coronas.izmiran.rssi.ru/F/instruments>.

S/C nights

CORONAS-F NIGHTS over 2002 & 203

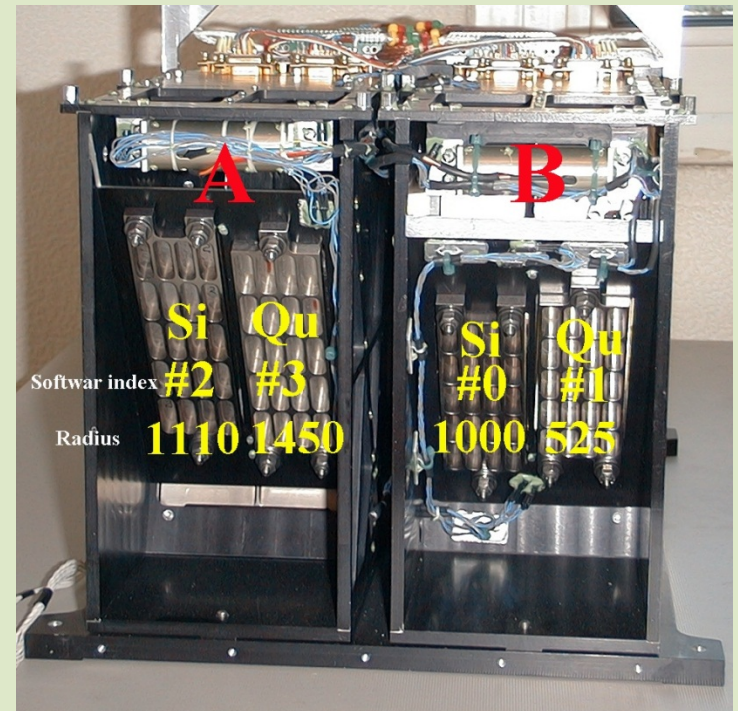
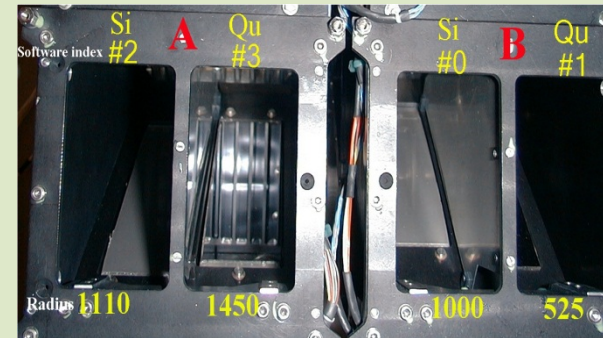
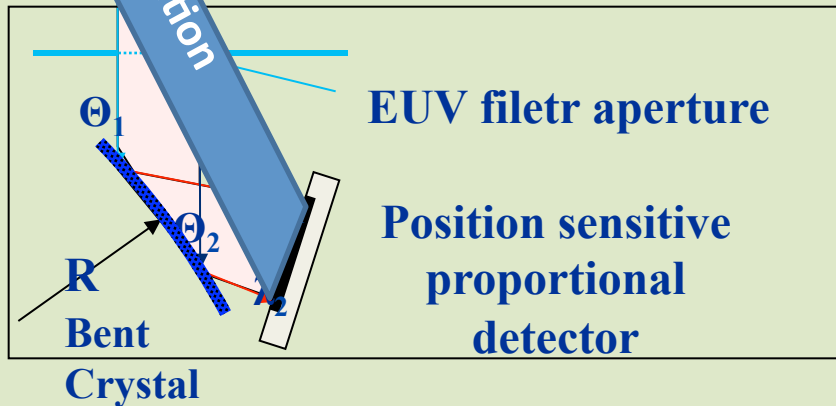


CORONAS-F NIGHTS in Feb./March 2003

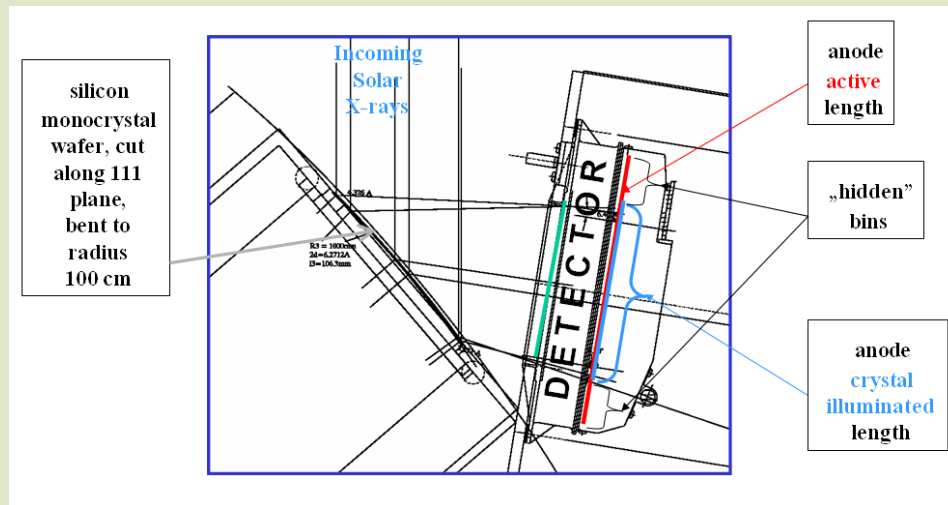


Crystal-detector geometry

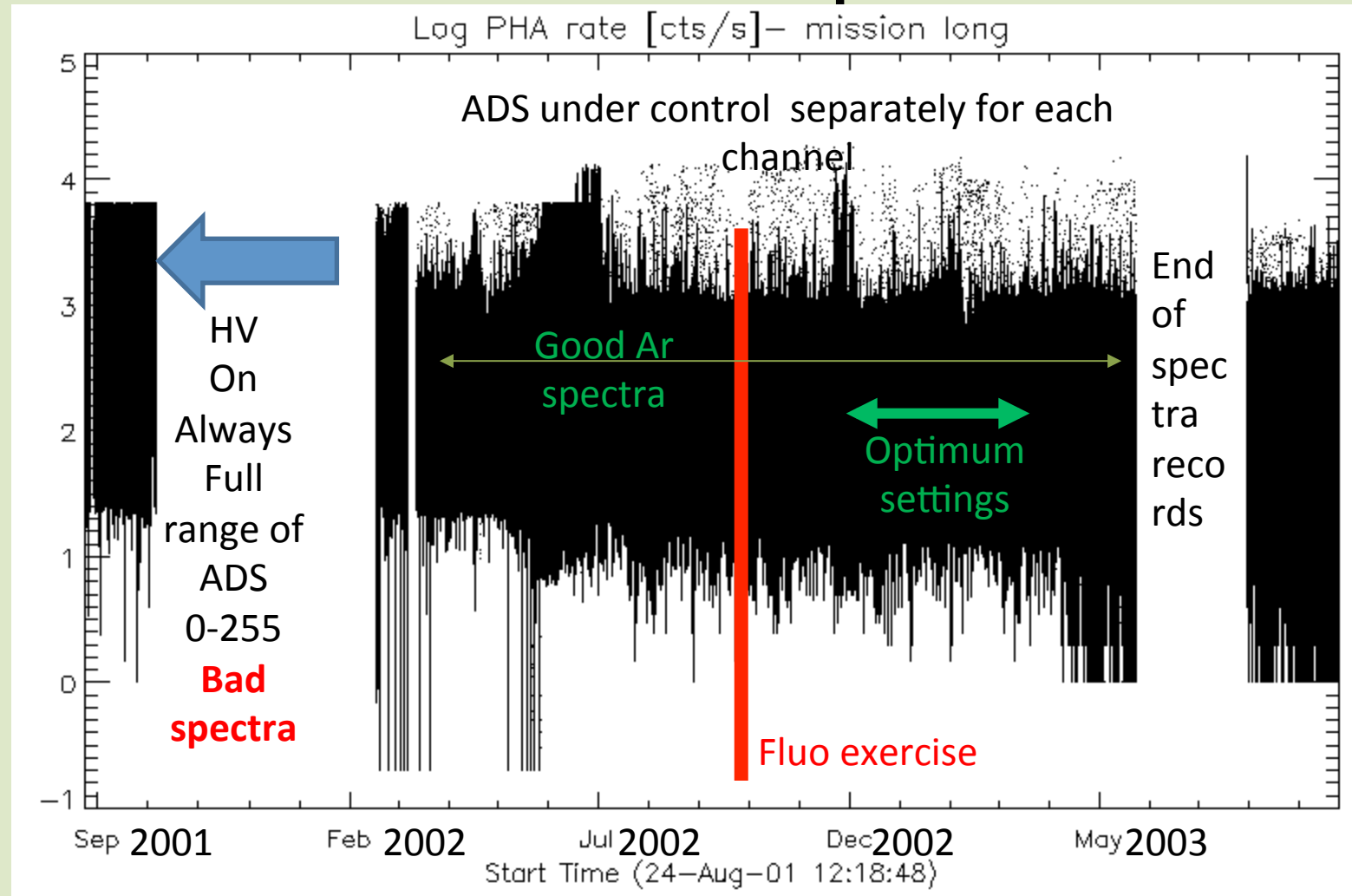
$$n\lambda = 2d \sin(\theta)$$



~30 cm, 20 kg



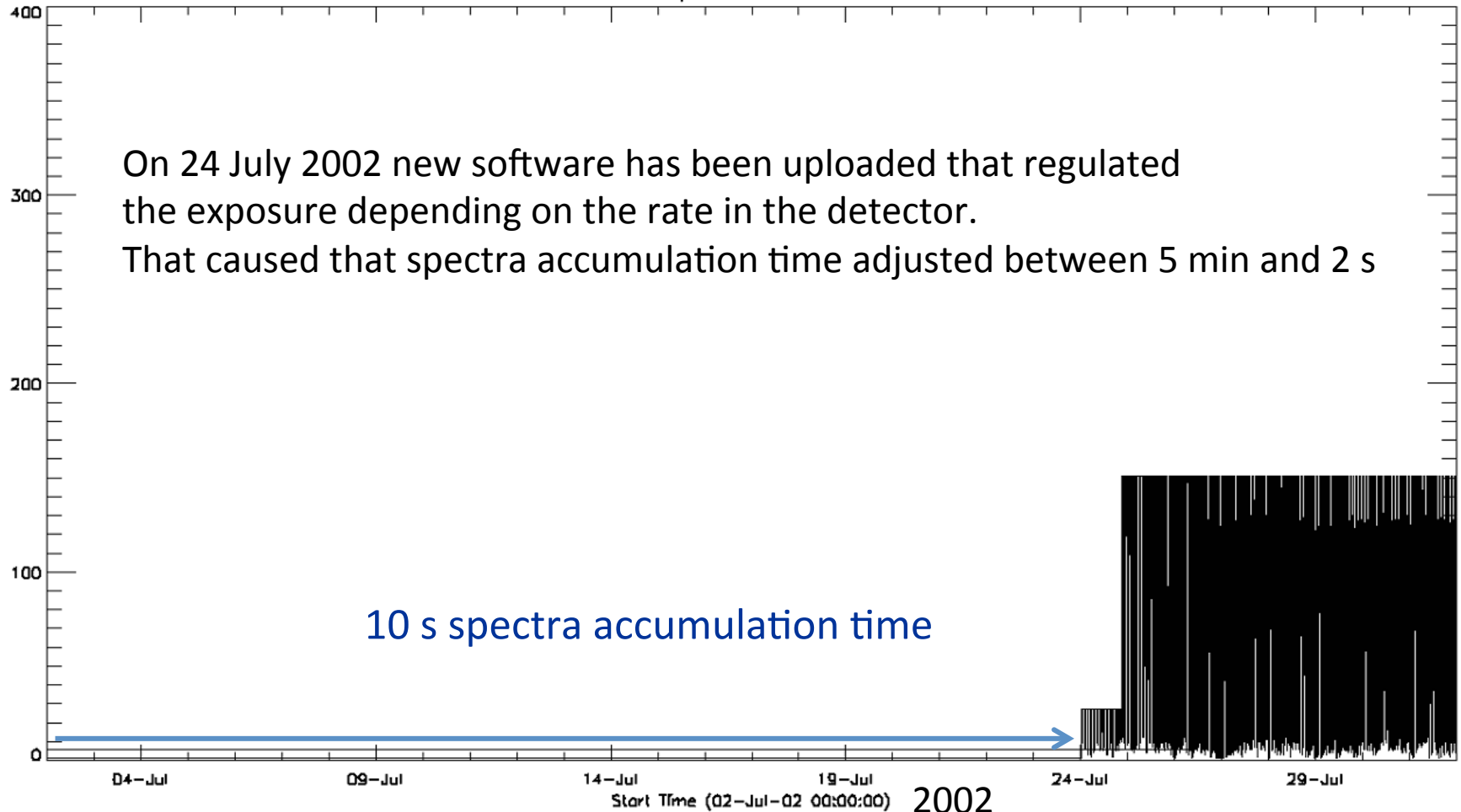
Phases of RESIK operations



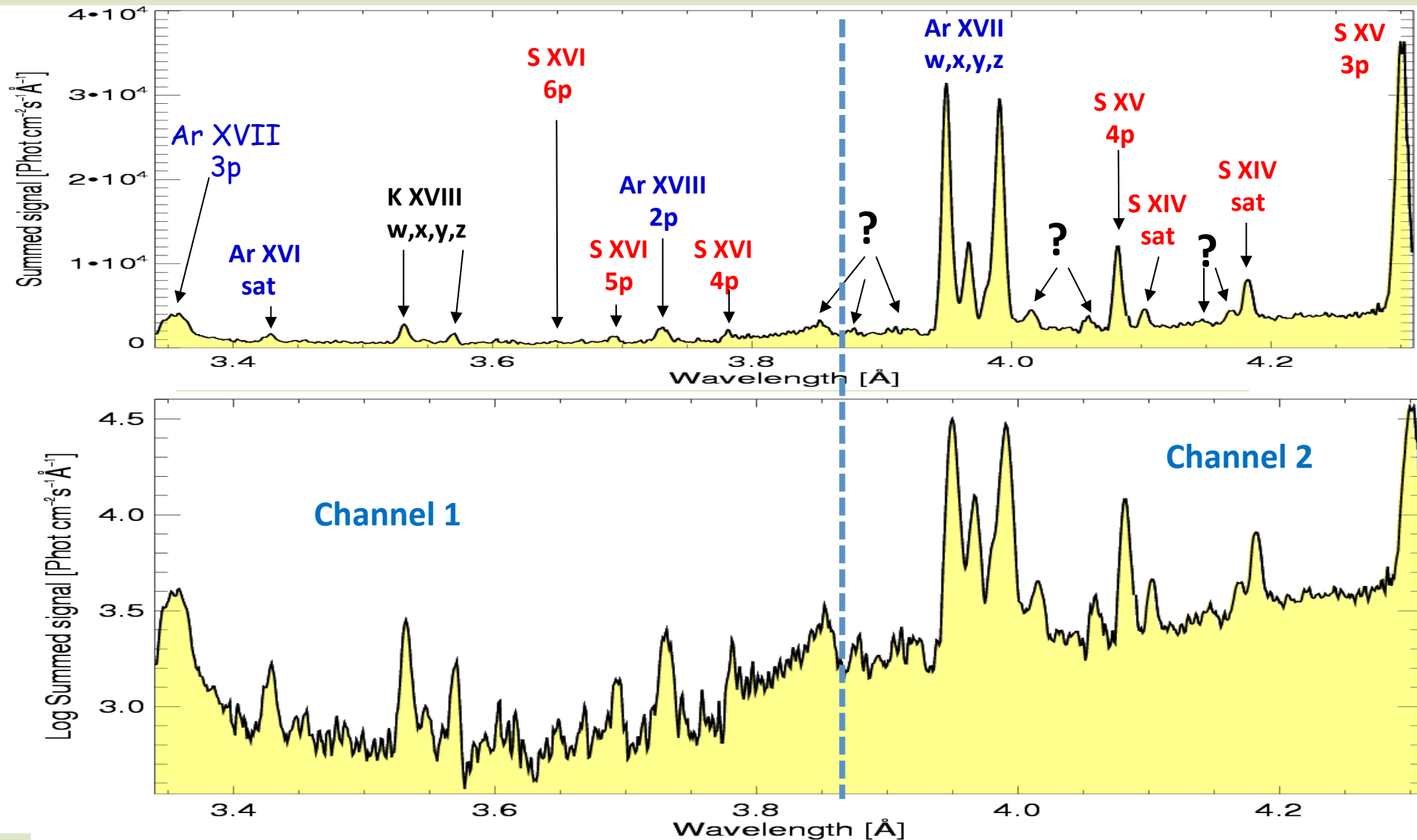
19 mln samples (DGI), 1.8 mln spectra 25 GB, only some (5000) reduced...

Implementation of dynamic spectra collection exposures

Duration of spectra accumulation in DGI



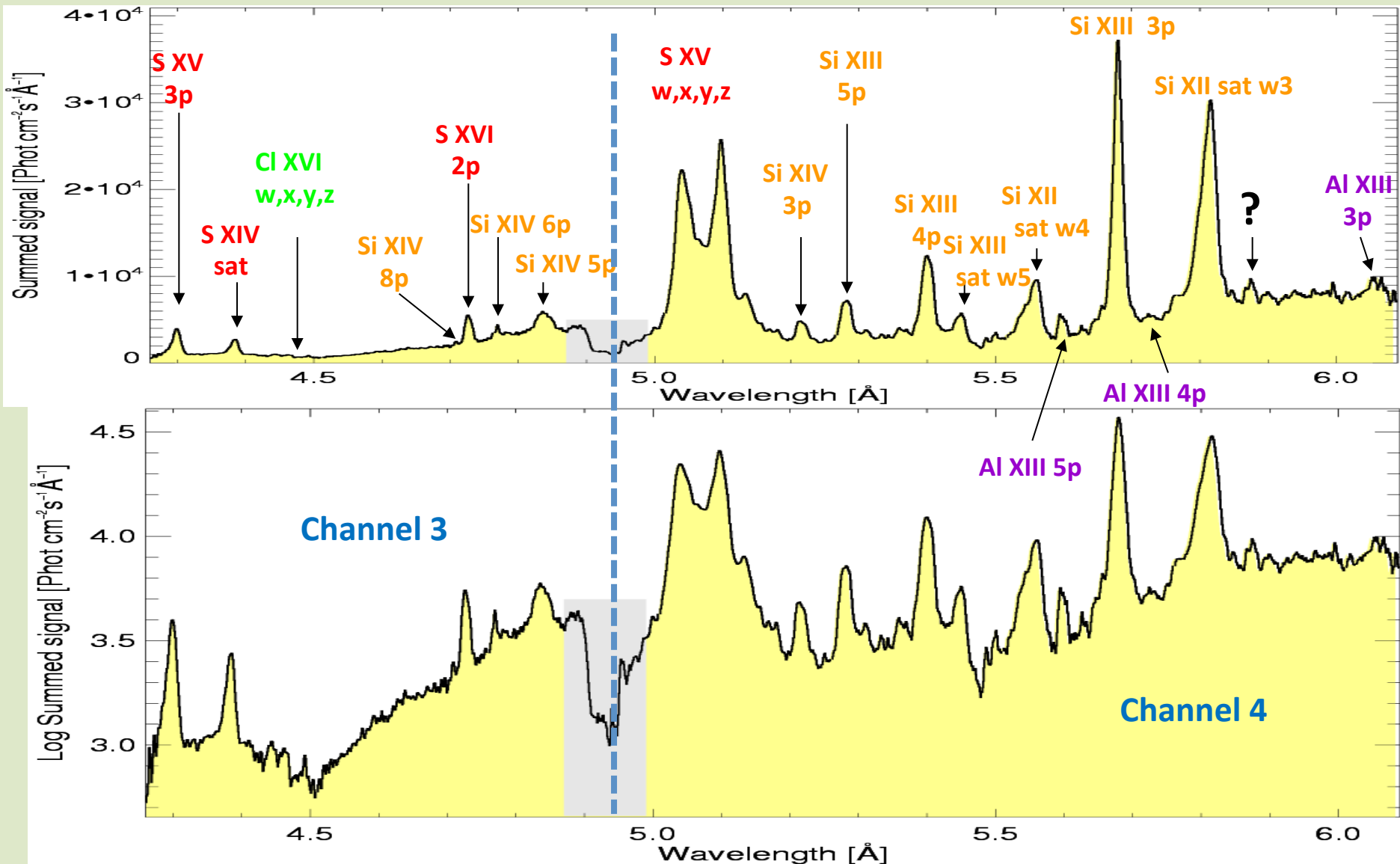
Channel 1 and 2 averaged RESIK spectra



КОРОНАС-Ф: три года
наблюдений активности
Солнца 2001-2004 гг.

Триумф ИЗМИРАН

Channel 3 and 4 averaged RESIK spectra



RESIK catalogue Aug 2001- May 2003

http://www.cbk.pan.wroc.pl/experiments/resik/resik_catalogue.htm

Provide access to catalogue pages

RESIK CATALOGUE

Planned telemetry sessions



RESIK is the Bragg bent crystal spectrometer aboard Russian CORONAS-F Solar Observatory

Detector
Calibration
Instrument
switch off



Discriminator calibration



GOES class



-M GOES class



-X Higher orders-ORD3



LEGEND 2002

LEGEND 2003

2003

May

01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22

April

01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

March

01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

RESIK spectra reduction progress

- **Effects considered**

- All factors discussed in the instrument paper
- Removed fluorescence from the crystal support (semi-empirically) <http://www.cbk.pan.wroc.pl/body/publikacje/2005/rip.html>
- Saturation (electronic dead-time) effects correction performed
- Wavelengths converted to centre of the disk source location

- **36 flares reduced ~5000+ spectra**

- 16 new flares added from last year
- Cases identified with time dependent offset for limb events (source transversal motion)

- **Further steps – mission long approach**

Accessing Level_2 catalogue fits files (Szymon & Anna)

http://www.cbk.pan.wroc.pl/experiments/resik/RESIK_Level2/index.html

RESIK data - level 2

README

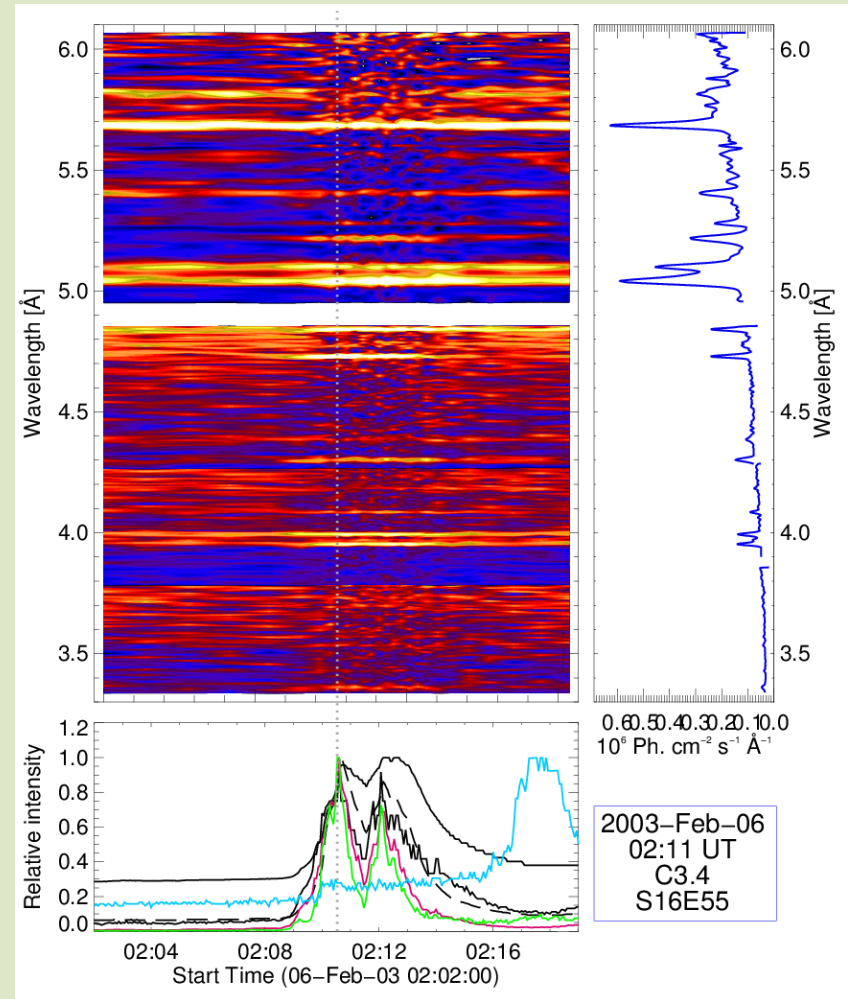
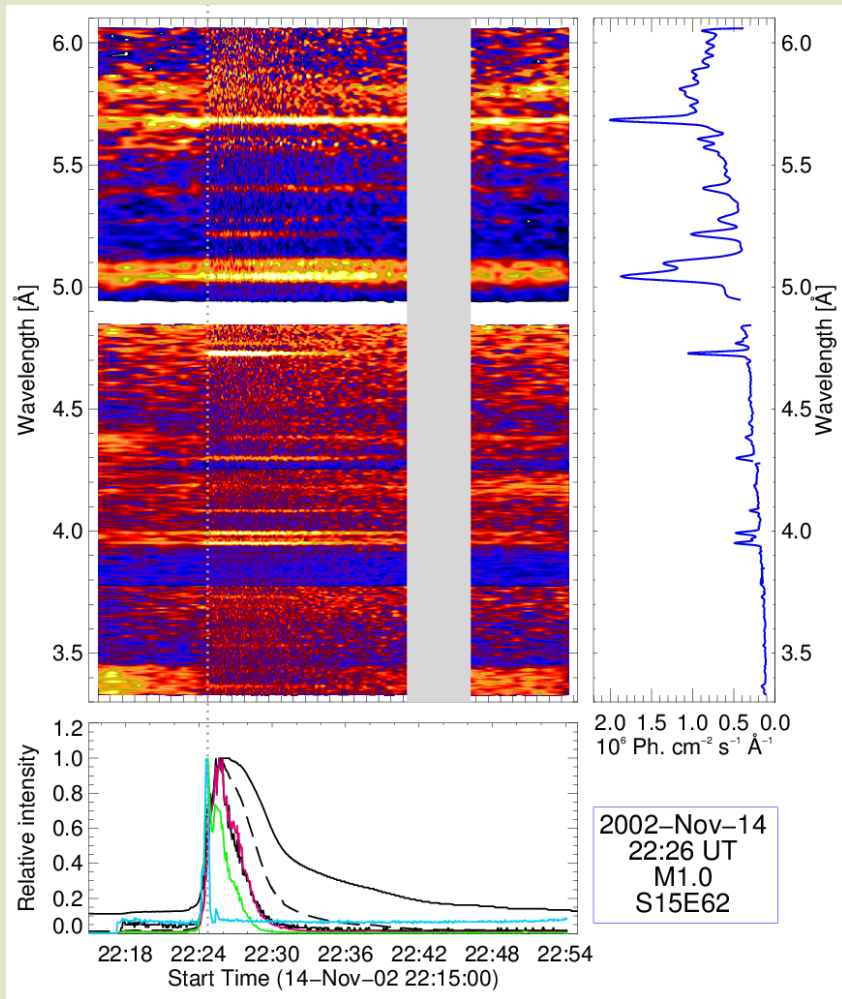
[resik_read_fits_fast.pro](#) - program for reading RESIK fits files (8 kB)

Please click the appropriate date in order to get access to RESIK data of the selected flare

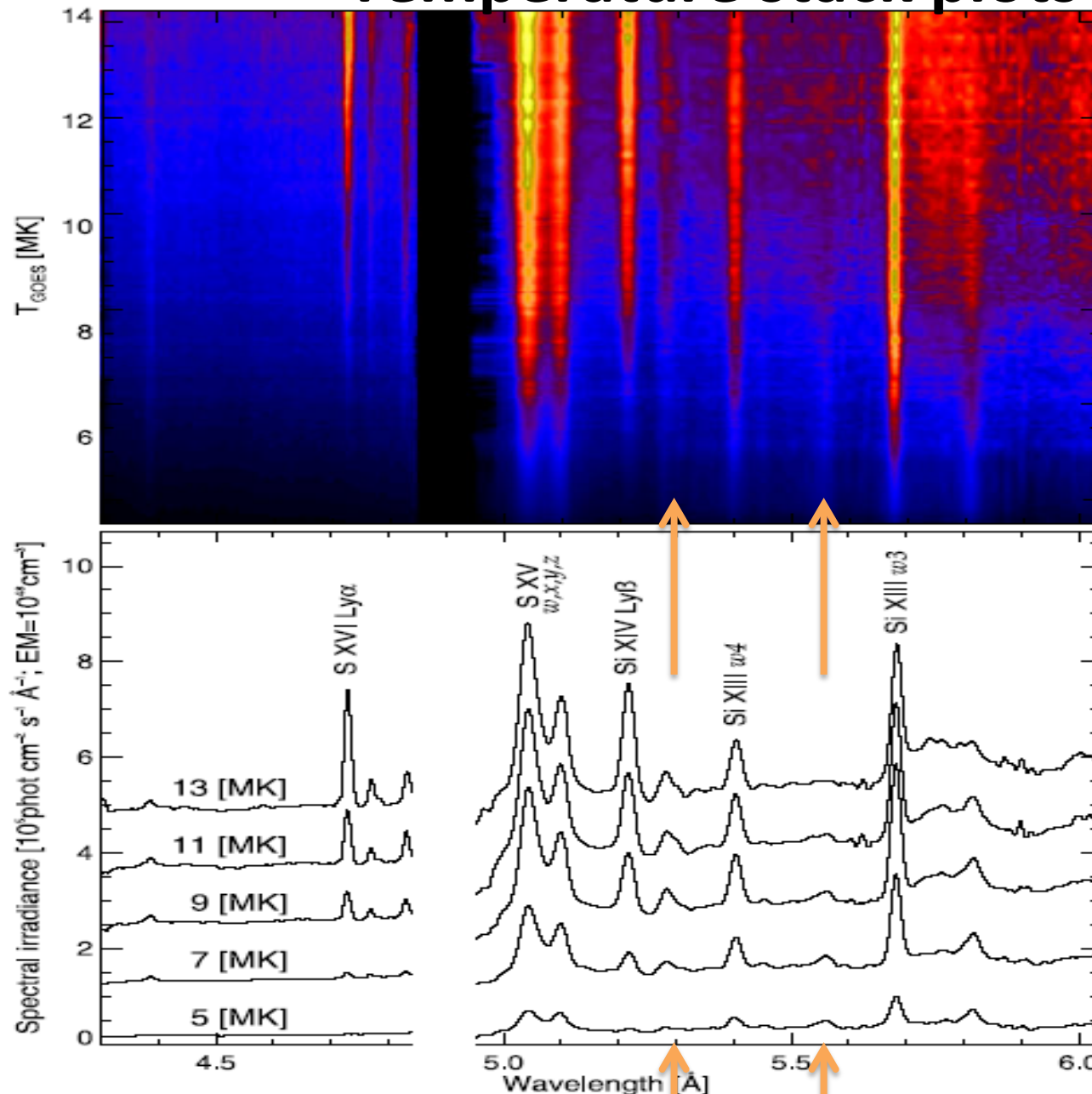
Date	GOES class	Location	Date file created
↓ ↑	↓ ↑	↓ ↑ ← →	↓ ↑
Quiet (312 individual spectra)			21 Feb. 2008
11 March 2003 (max ~ 05:50 UT) *	B7.3	N16W28	14 Apr. 2012
25 December 2002 (max ~ 23:10 UT)	B8.0	S15W91	23 Apr. 2013
22 February 2003 (max ~ 04:50 UT) *	B9.6	N16W02	28 Apr. 2008
25 December 2002 (max ~ 10:41 UT)	C1.0	S20W01	6 May 2013
7 January 2003 (max ~ 23:30 UT)	M4.9	S11E89	25 Apr. 2008
3 August 2002 (max ~ 19:07 UT)	X1.0	S16W87	4 Jun. 2008
17 March 2003 (max ~ 19:05 UT)	X1.5	S14W38	28 Apr. 2012

* - some pre- or post-event spectra are available in the respective FITS file

Two examples of events from Level_2 catalogue page



Temperature stack plots



**RESIK solar
flare spectra: Si
XIII + satellites**

RESIK solar flare
spectra stacked in
ascending order of
temperature (from
GOES).

*Done:
Abundance
estimates:
K, Ar, Cl, S and Si*

*Orange arrows mark
 $n=3$ and $n=4$
satellites to Si XIII w_3
and w_4 lines.*

Direction of future analyses

- **Investigations of solar plasma**
 - Further kappa-distribution diagnostics (Ar lines & their satellites)
 - Kappa effects on elemental abundance determinations
 - DEM- dependent S & Si abundance studies (now in progress)
 - Calibration of PHA signal with energy (rate dependence of gain)-2s lightcurves at several energies from 0.5 – 10 keV
 - Further reduction of selected flares to Level_2 (AK, BS, JS)
 - Systematic automatic reduction of every recorded S/C day spectrum (~2 mln.)
- **Investigation of magnetosperic & aeronomic effects PIN & PHA 1-2 s time resolution**
 - Crossings of polar van Allen belts geomagnetic storms and disturbances
 - SAA variability
 - Night portion emission
 - Analysis of hidden-bin emissions
 - Studies of X-ray auroral illumination & spectra
 - Studies of Height profiles of X-ray absorption

2003-Feb-22 09:29:39 UT

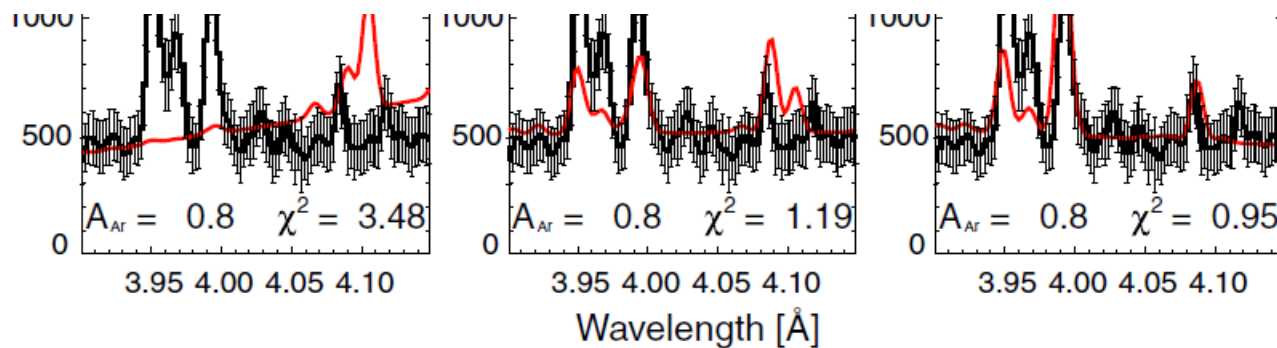
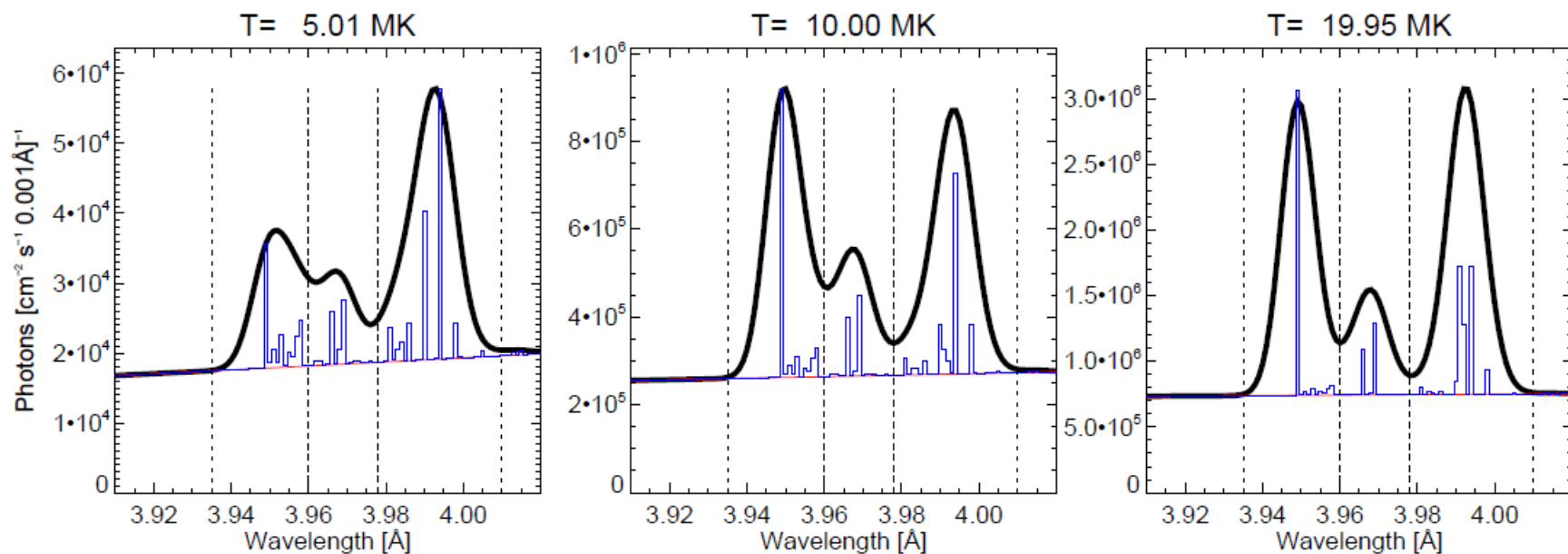
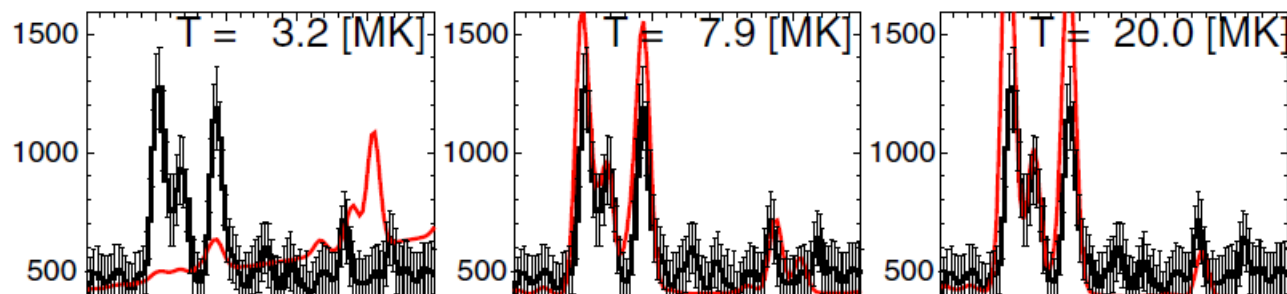
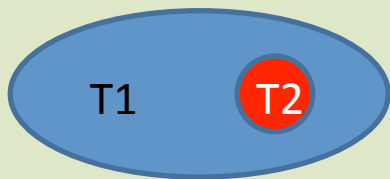
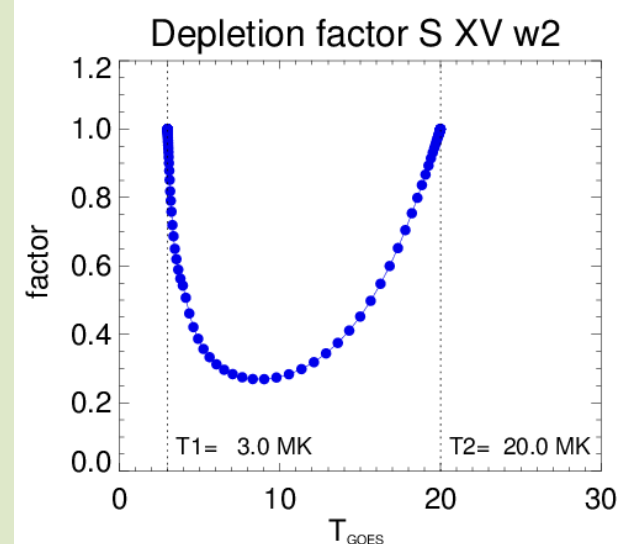
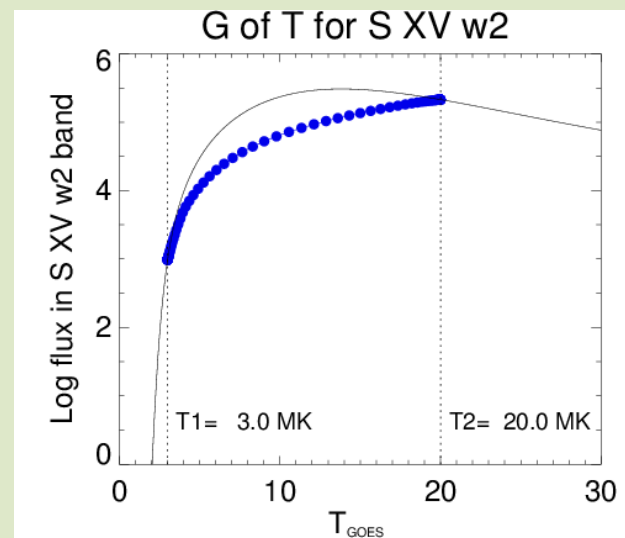
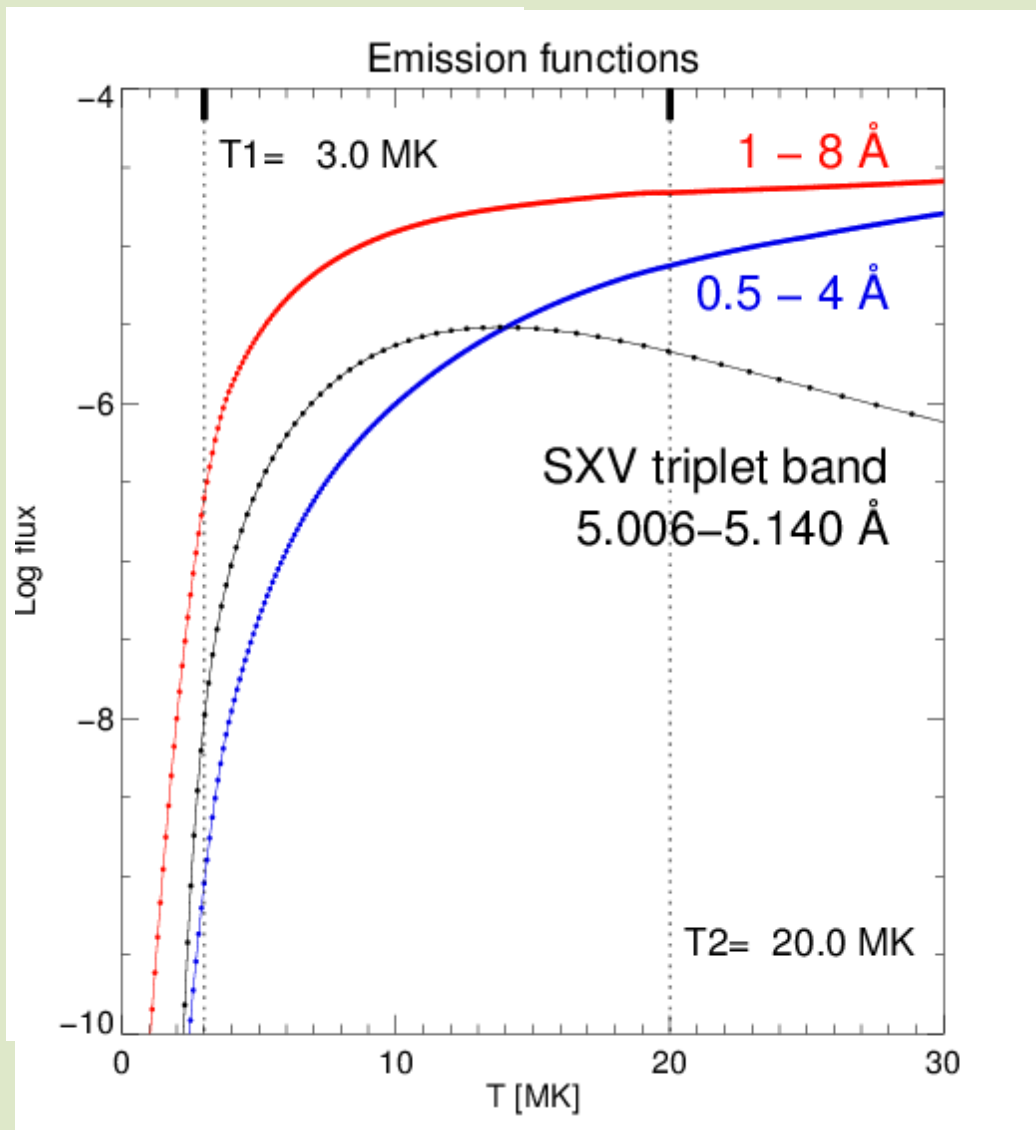


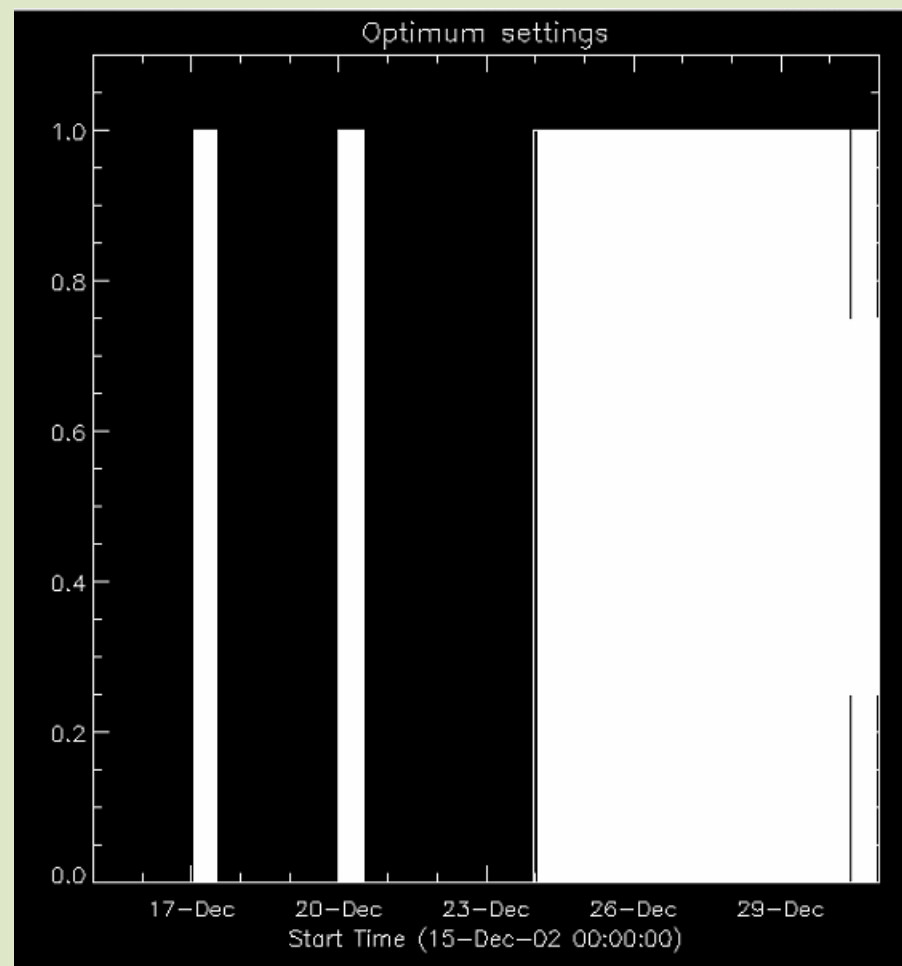
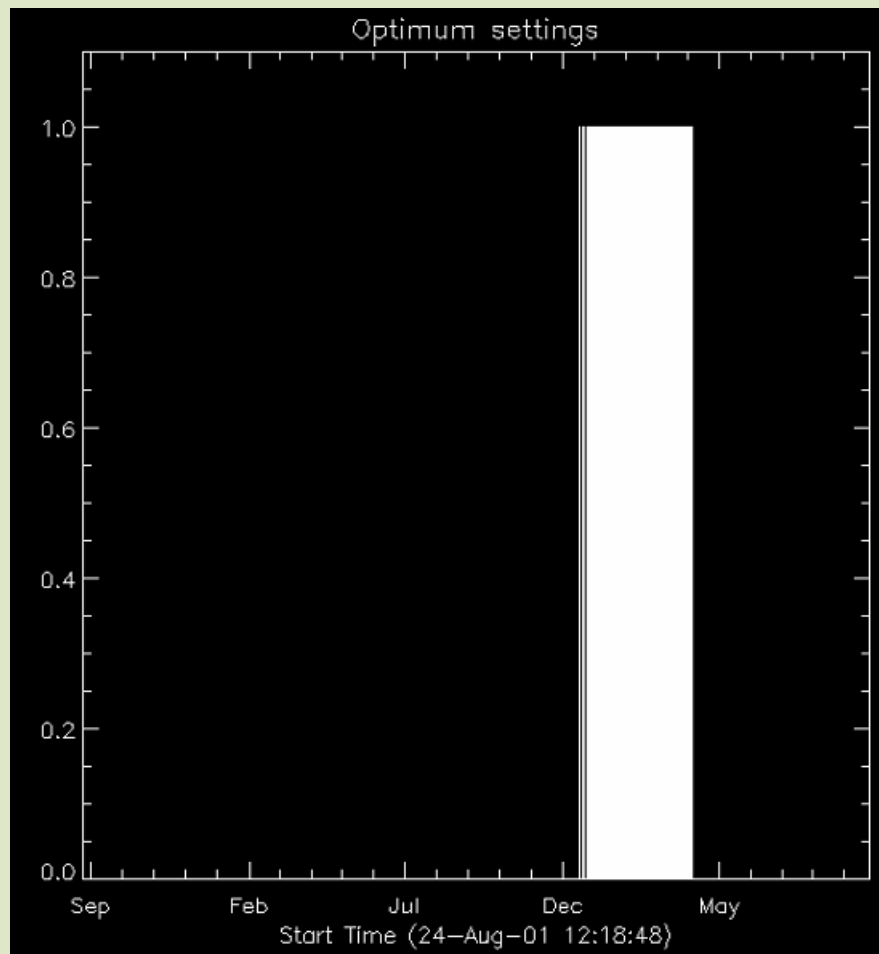
Fig.
of the
 $x+y$
princ



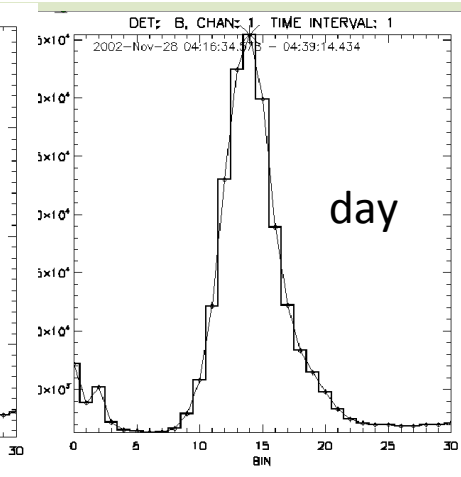
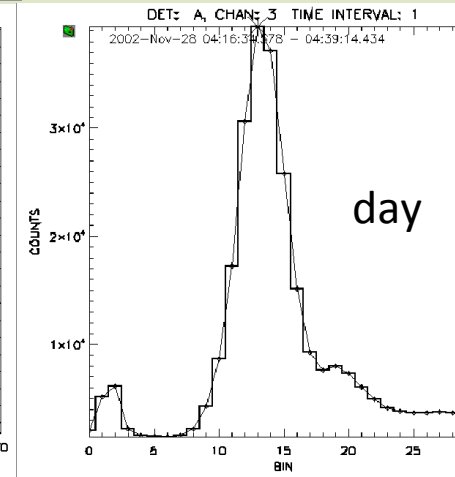
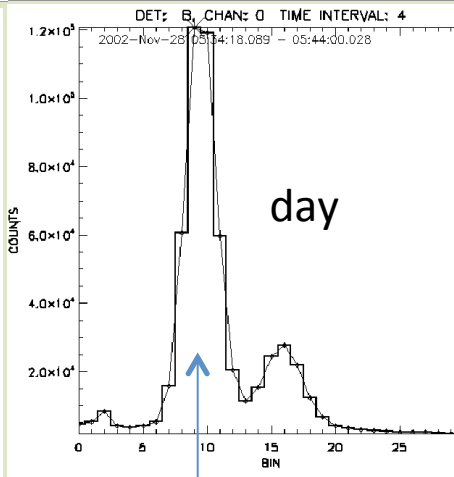
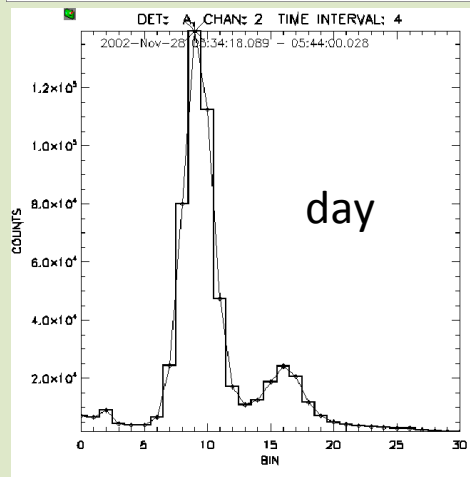
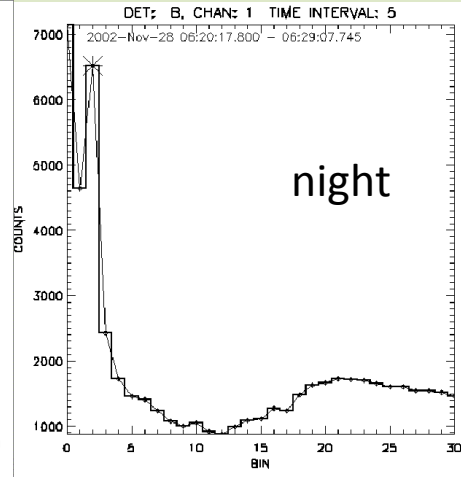
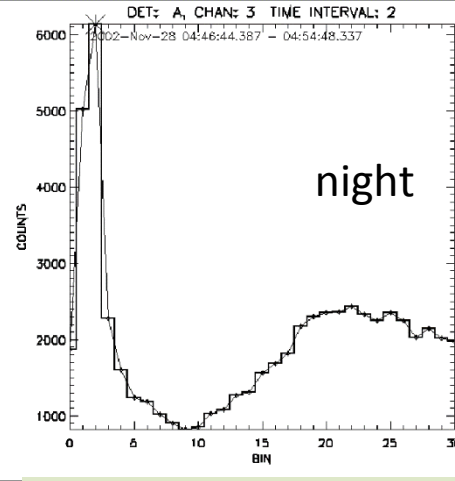
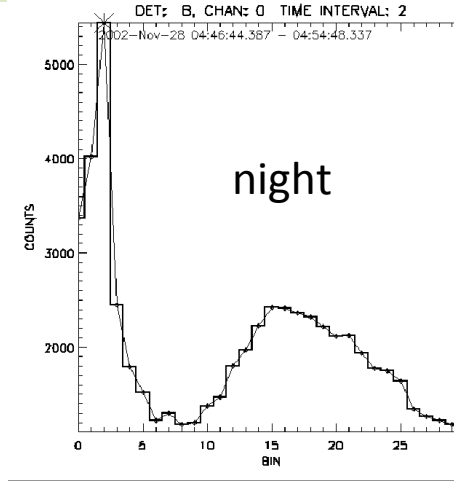
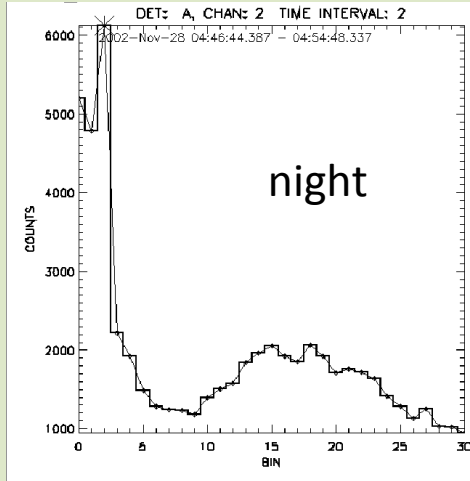
DEM-abundance: S



„Discovered” optimum settings



PHA spectra (~20 mln available each 2s)



#1

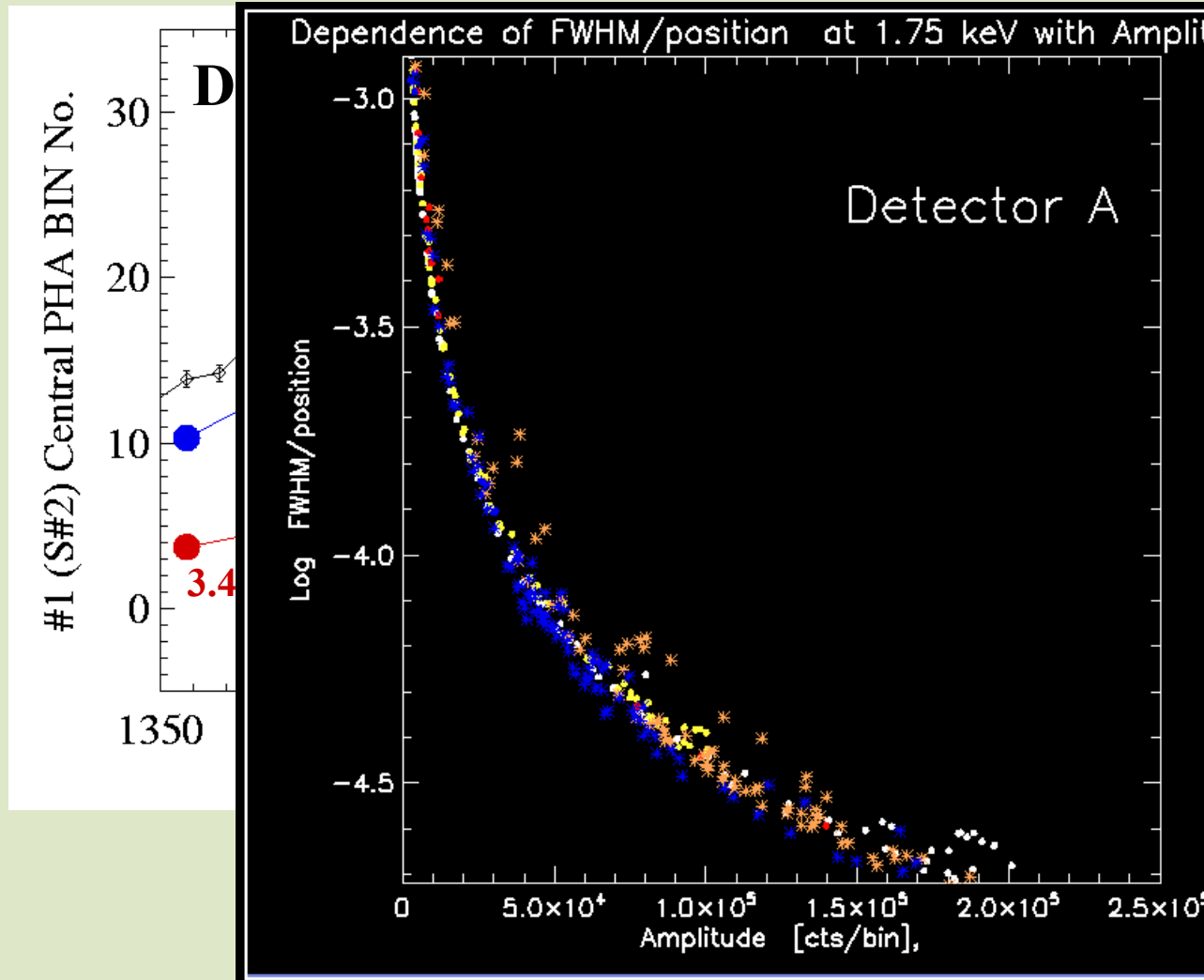
#2

#3

#4

Si fluorescence @ 1.75 keV

Overlaying in-flight & lab. PHA bin energy calibration



ponds
= 9.89 keV)

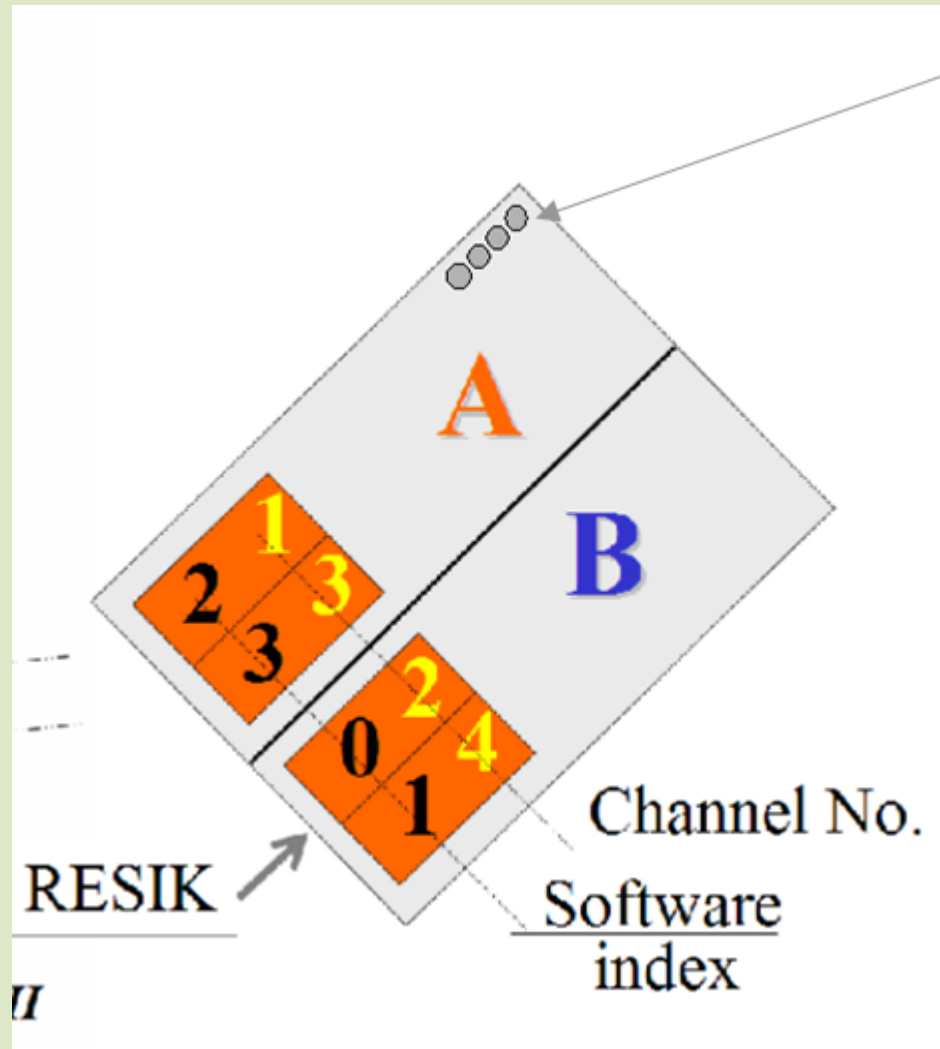
(= 2.29 keV)

fst

amplifier was
to have Fe55
in the centre of
e.

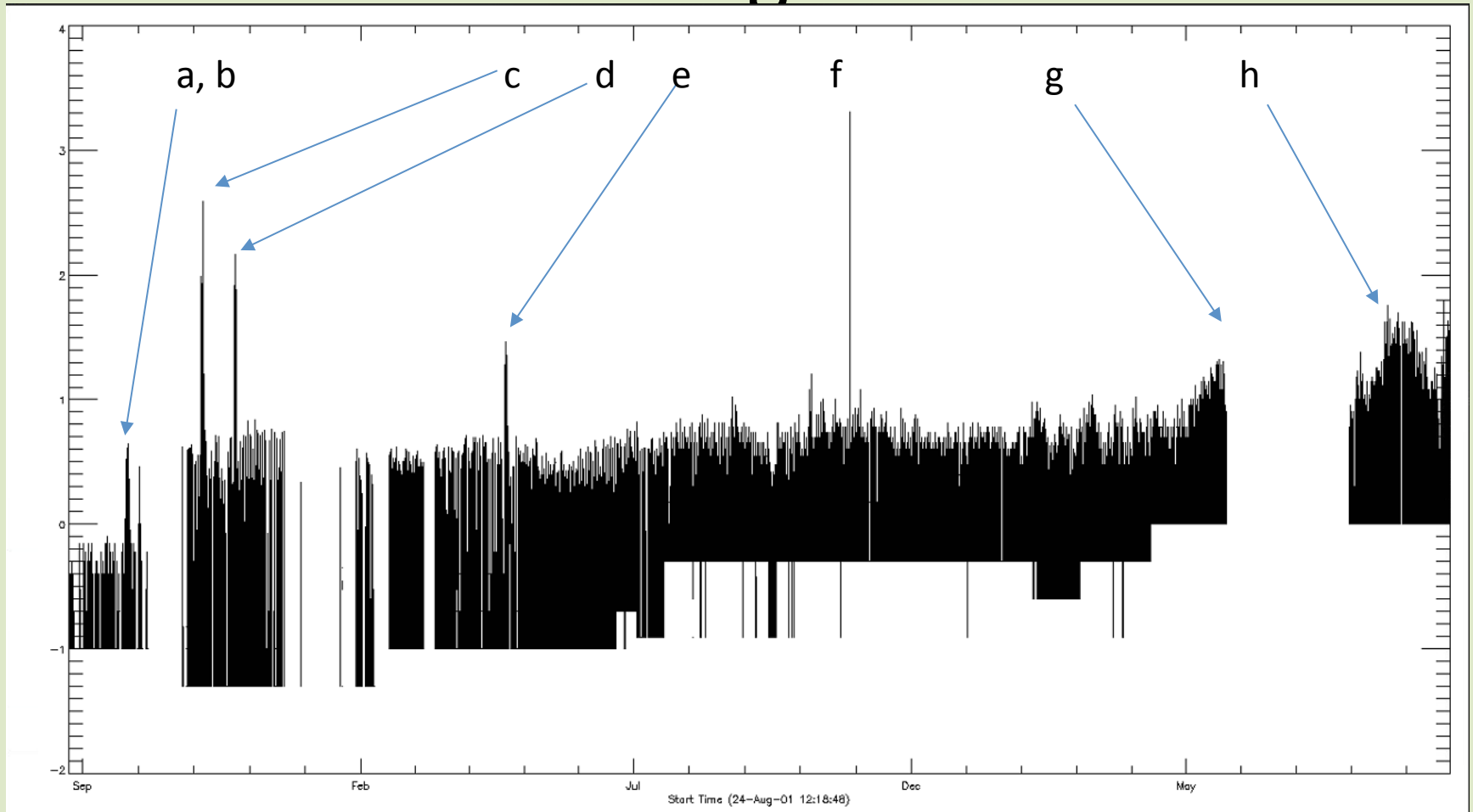
on was made
same
flight.

Records of PIN detectors



- Four PIN detectors mounted behind the 100μ Al foil. No X-rays, but particle –sensitive
- Idea of Witold Trzebinski

RESIK particle environment through PIN averaged rates



Several periods of enhanced geomagnetic activity

Period „c”

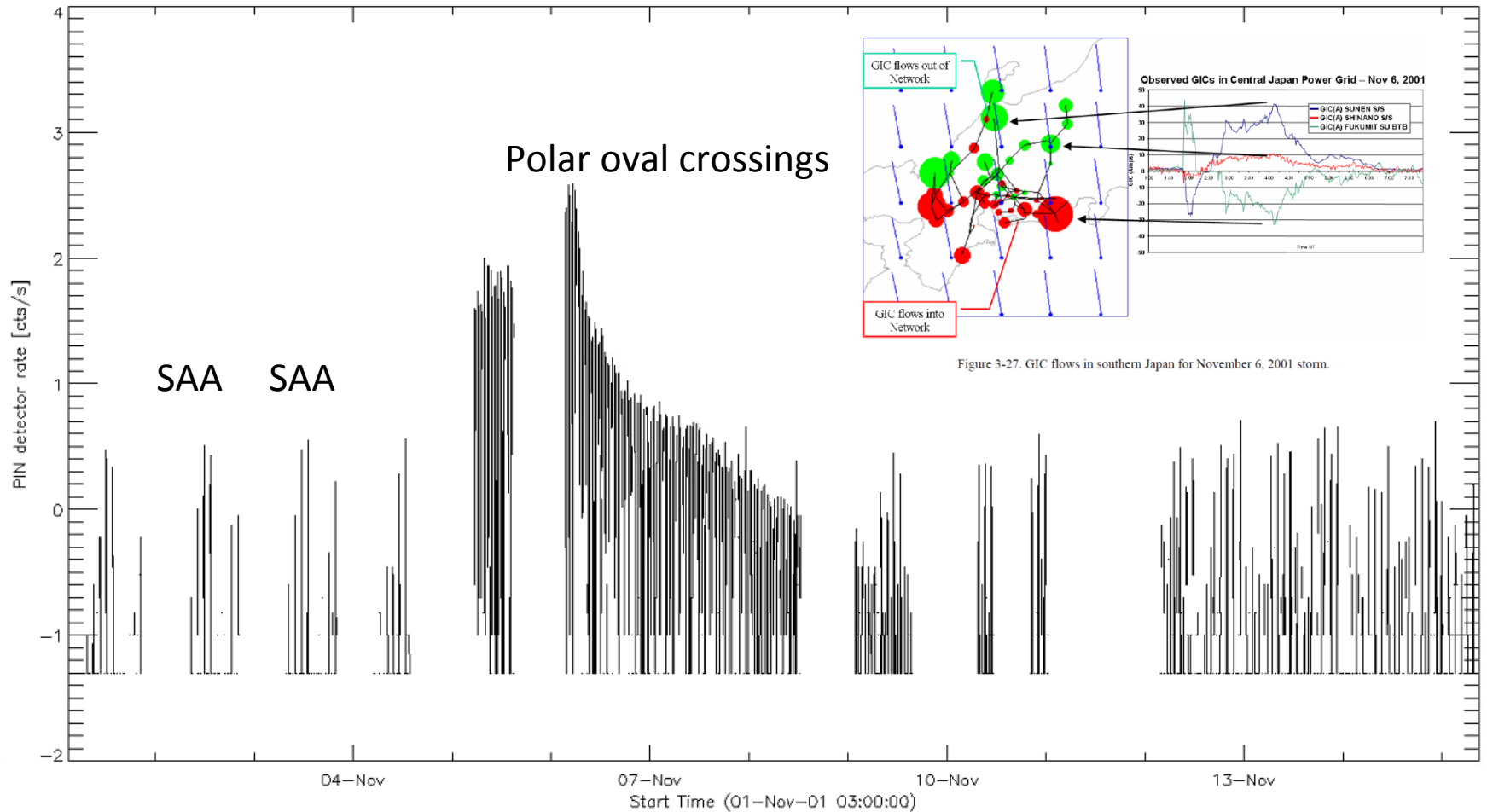


Figure 3-27. GIC flows in southern Japan for November 6, 2001 storm.

Conclusions

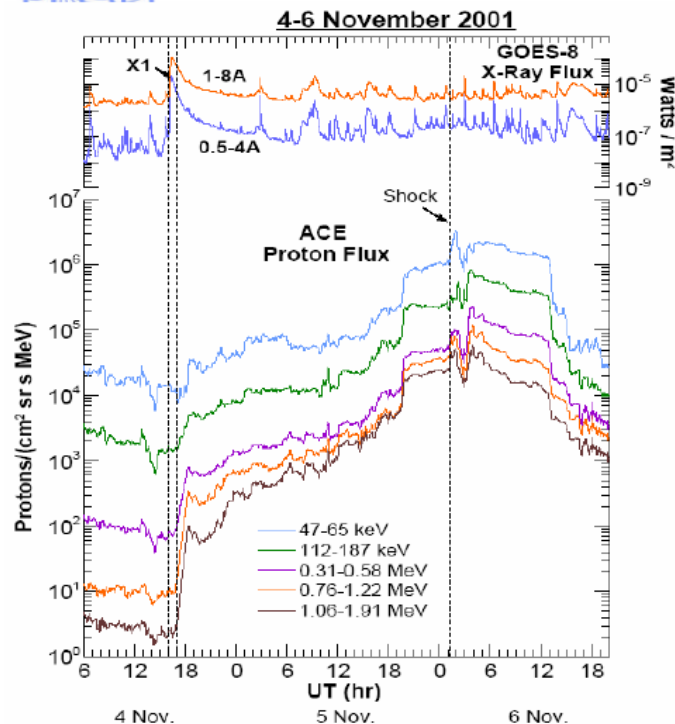
- A lot of new work to be done
- Collaboration with Elena and Marian's groups highly desired
- Results **are important for planning ChemiX**
- There is some **funds available** to support one person FTE (full time equivalent) job: „as soon as possible” - pass the info **to interested (PhD) students. In addition visitors from abroad can be supported for month-long visits.**

Examples of spectra: hot & cool

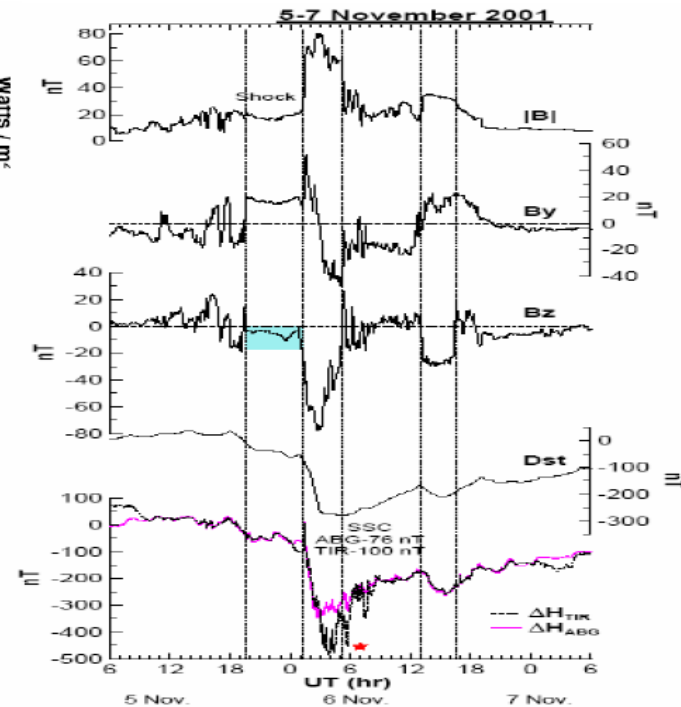
Related SEP event



4 November 2001 SEP Event

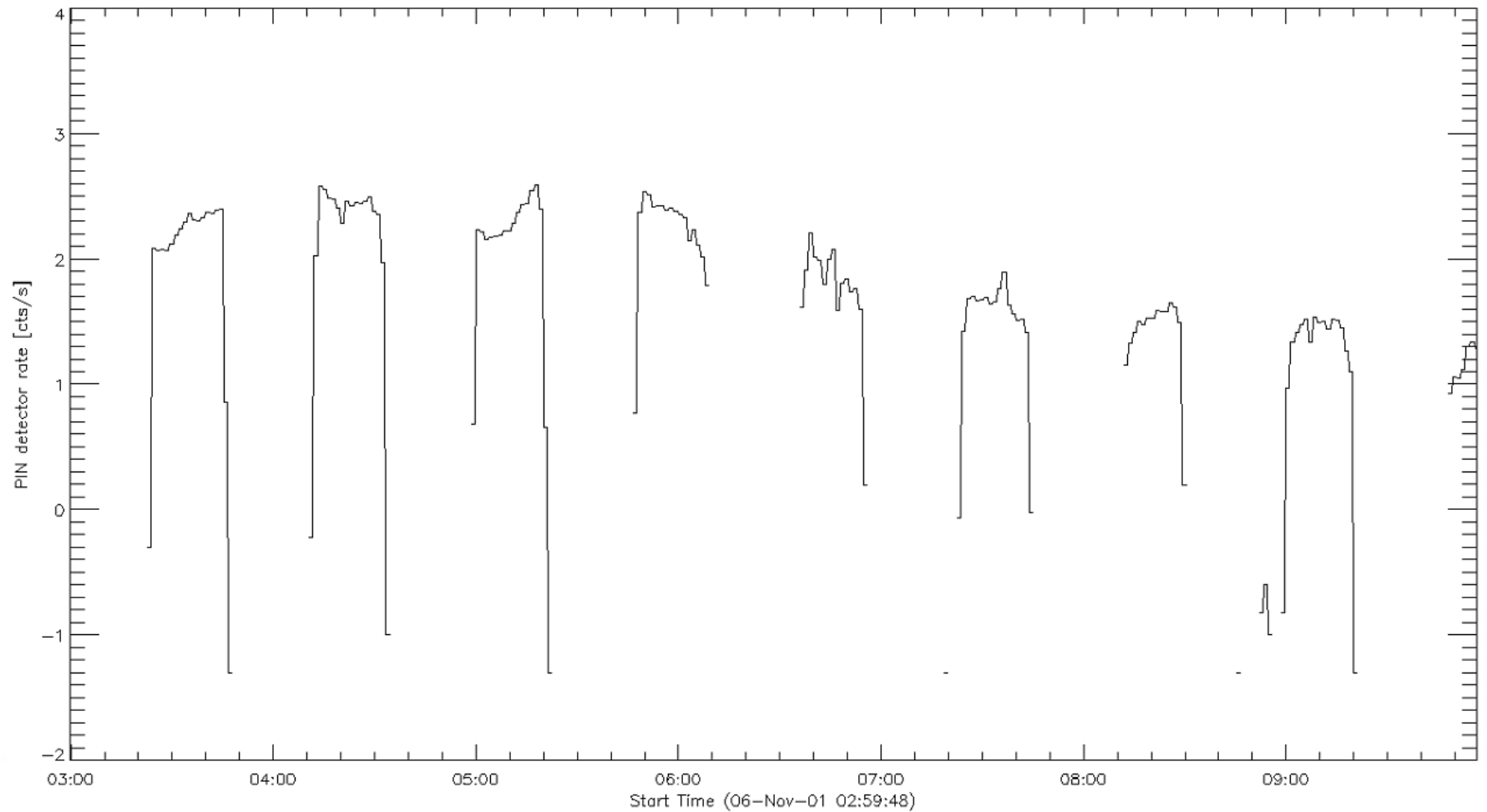


Upper panel shows X-ray flux at two wavelengths 0.5-4 Å and 1-8 Å GEOS-8.
Lower Panel shows Proton flux in various energy levels from ACE.

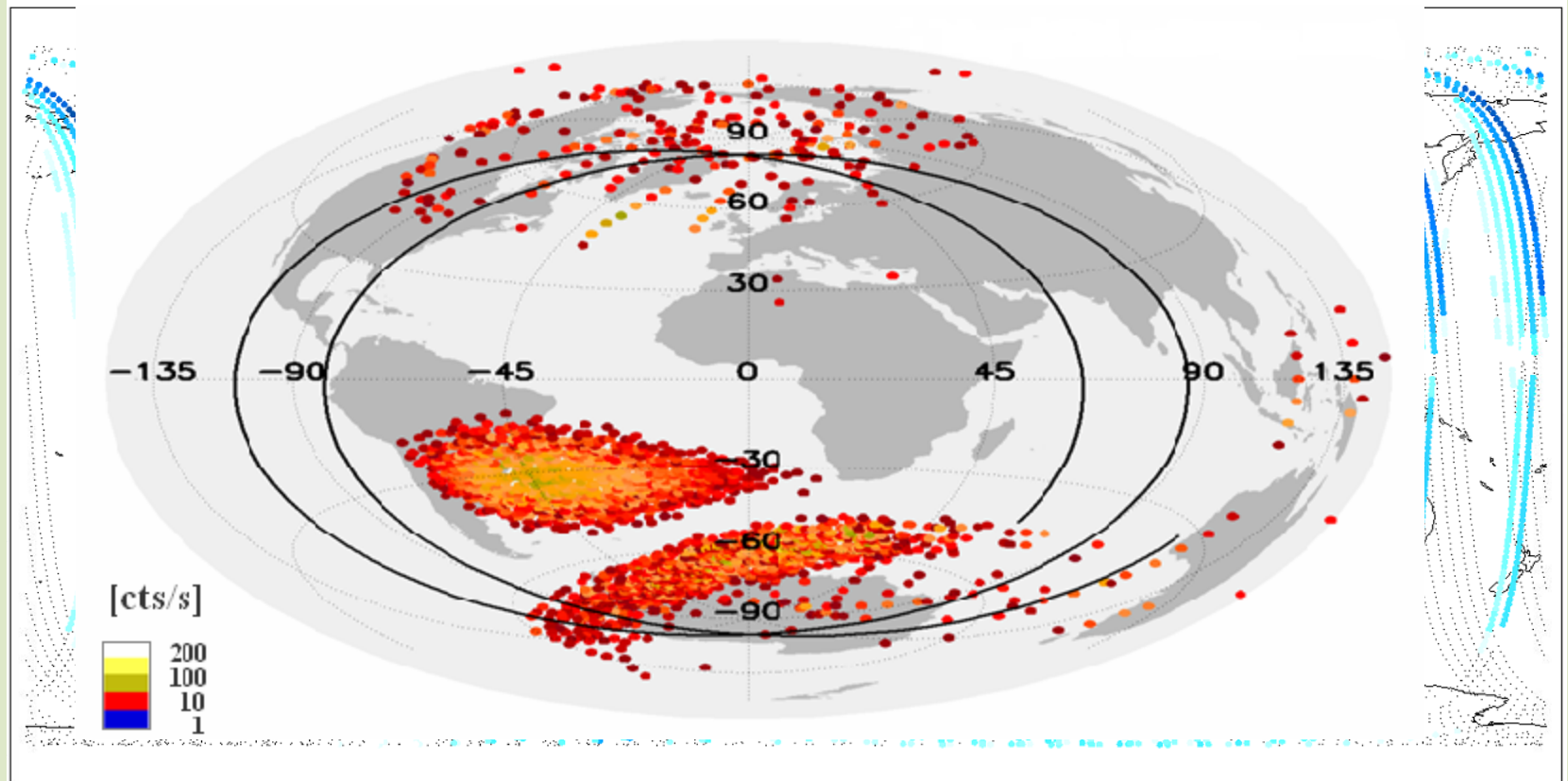


From top to bottom: IMF |B|, By, Bz, hourly averaged *Dst* index, 1-minute digital magnetic data ? HABG and ? HTIR for 4-5 November 2001 18

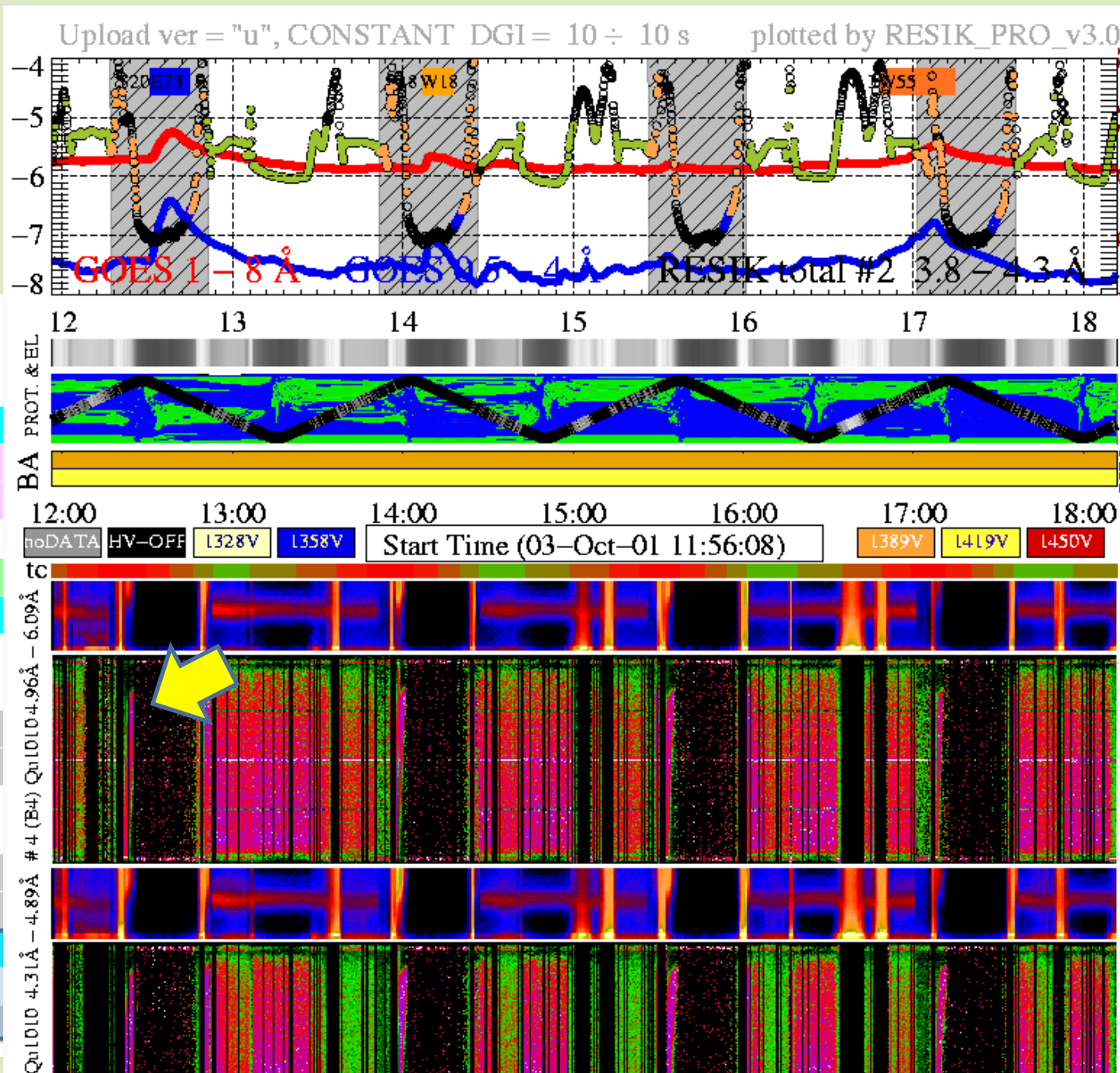
Period „c”



From where the high rates come

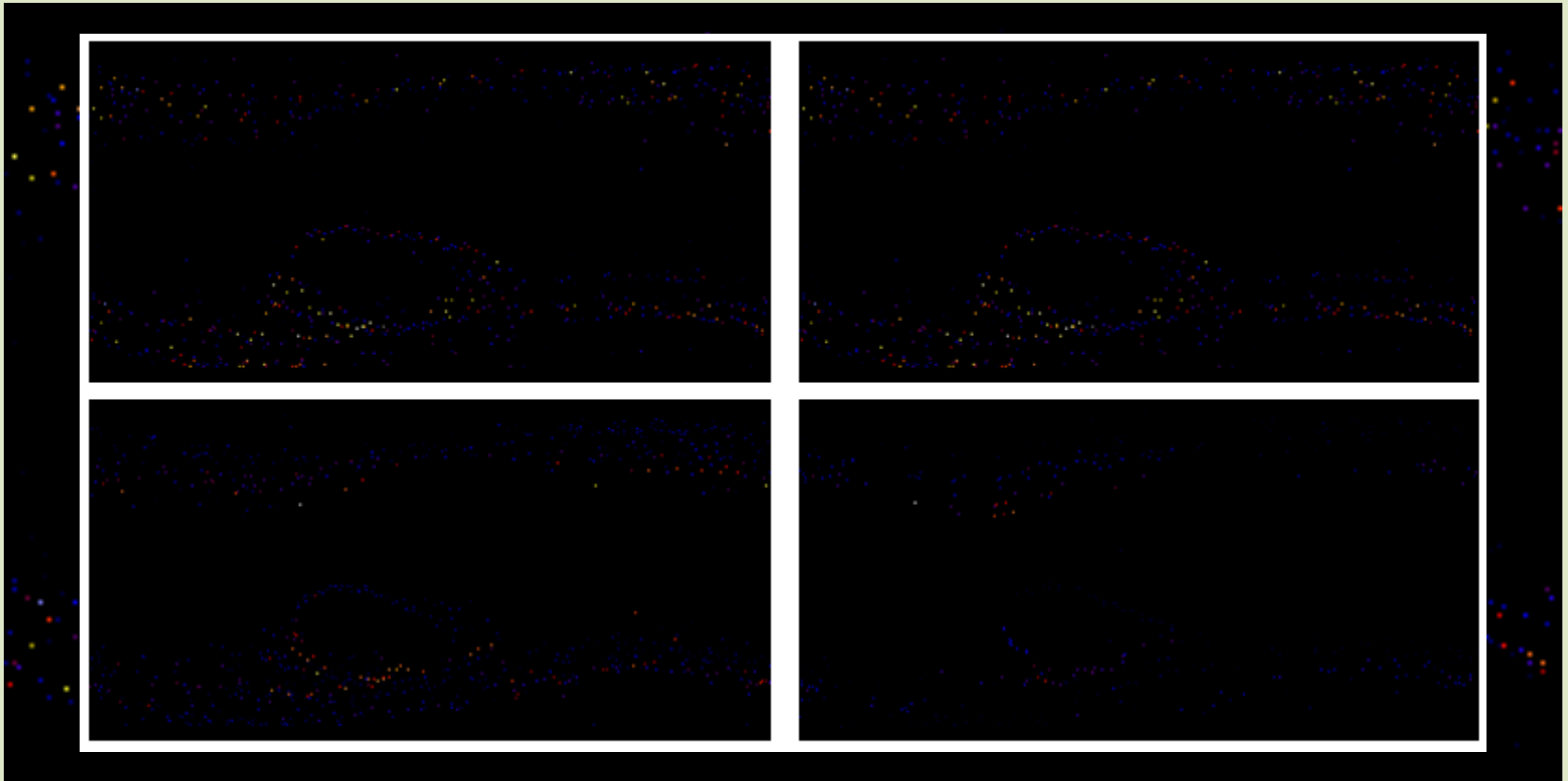


Period

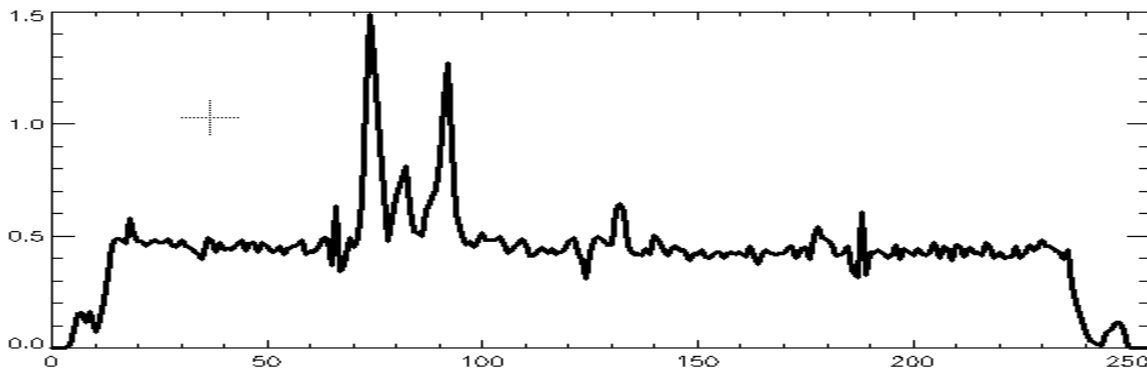


Map from PHA0 for February 2002

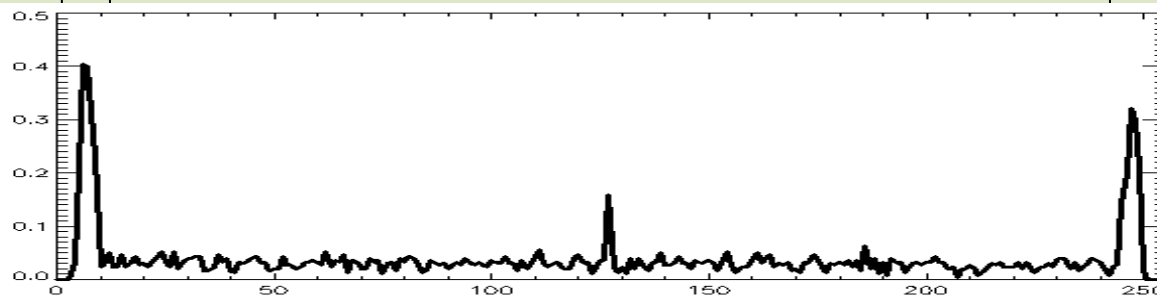
Mirek Kowaliński



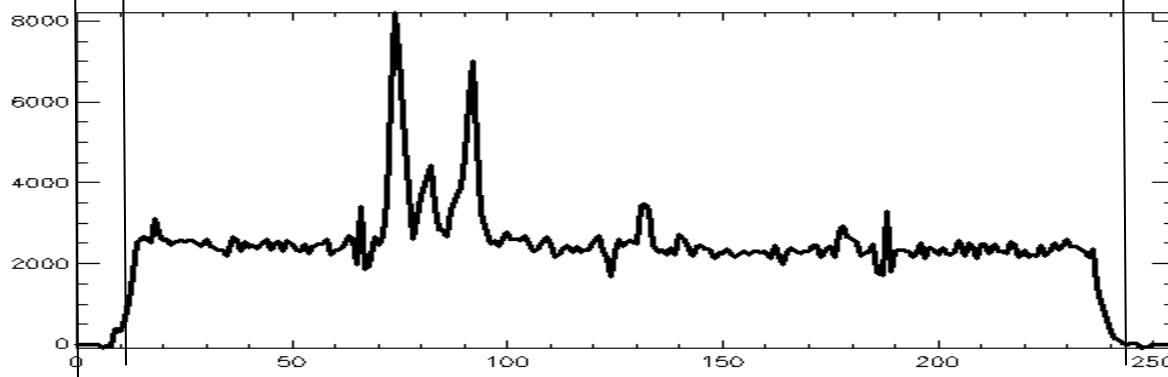
Removing orbital background



measured



Taken during
Night close
To Equator



Difference
Normalized
Through
Hidden bins
flux

Orbital background removal

how it is done?

Taken as average of many night portions of the records over entire bin band

0 – 255 in four detectors

Out of auroral ovals

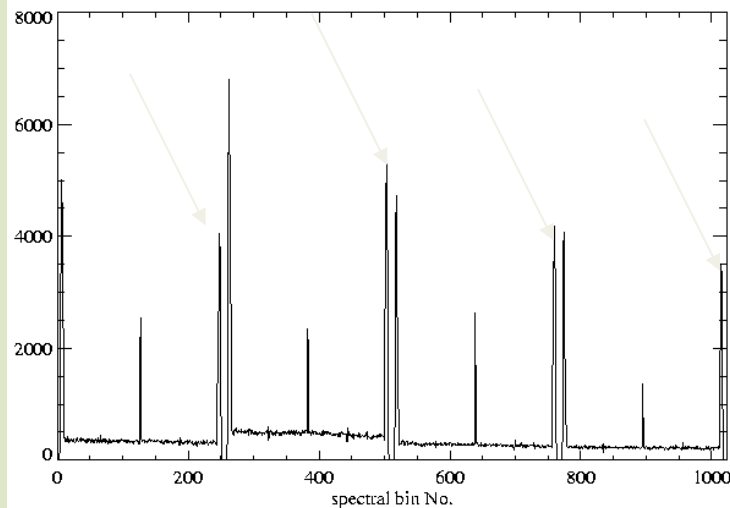
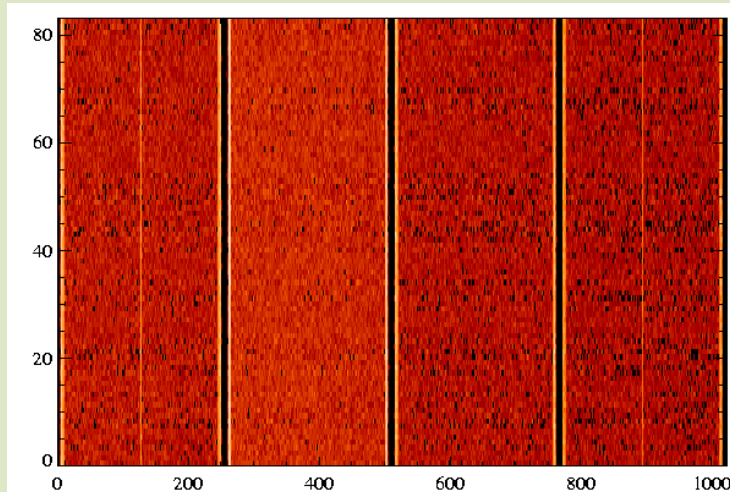
Out of SAA

Distinctive “hidden bin” peaks, where the 45 spectral bins are compressed to 10 bins (higher level)

Assymetry due to instrument construction: particles “easier” penetrate the lower-wavelength portion of the detector.

By the height of the indicated peak, the entire background profile is removed from the “real” spectrum.

Caution: No auroral correction yet available



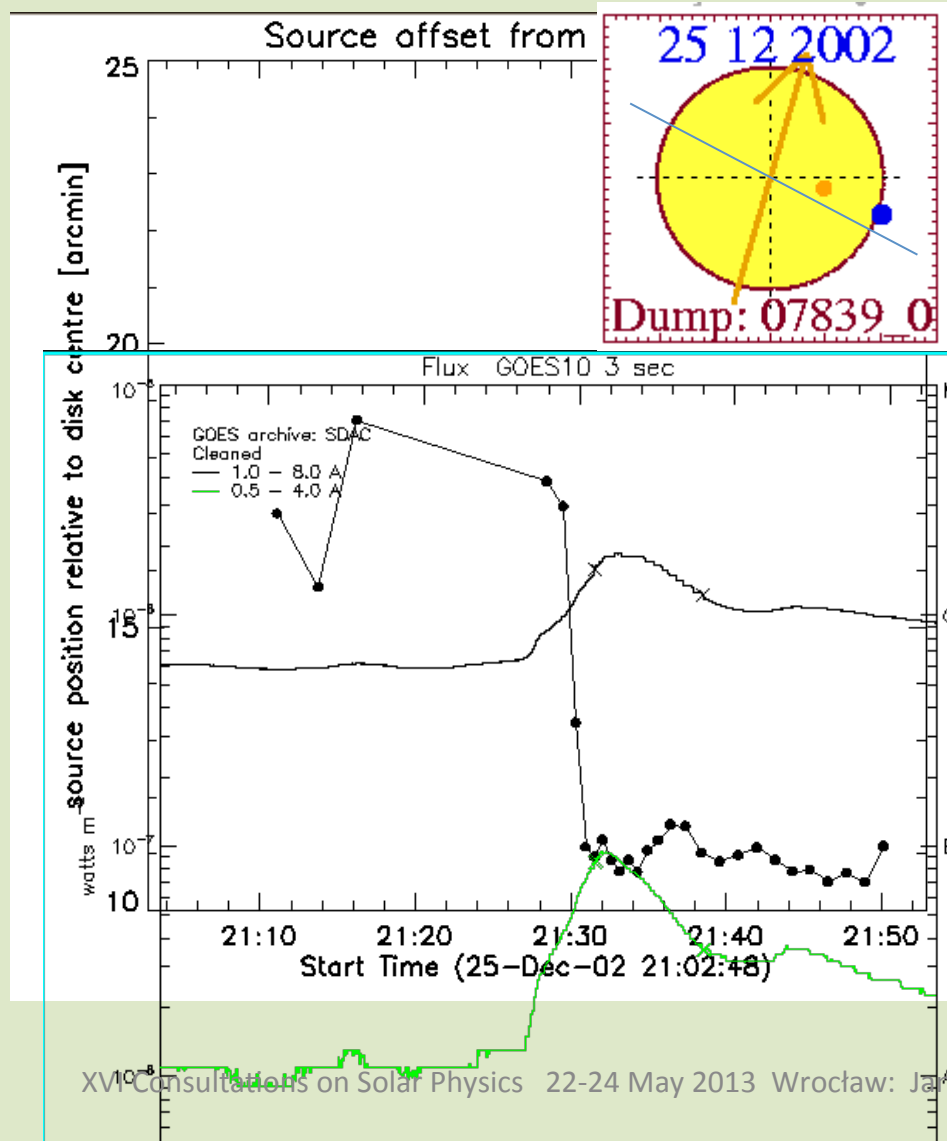
Rate dependence of gain

Enhance particle emission from PHA courtesy Mirek Kowaliński

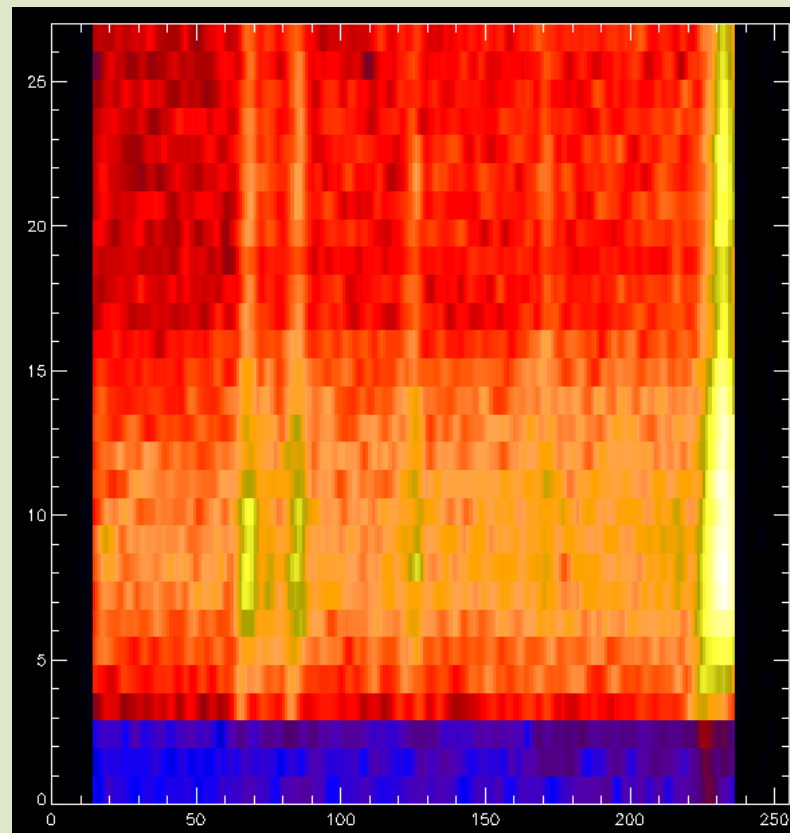
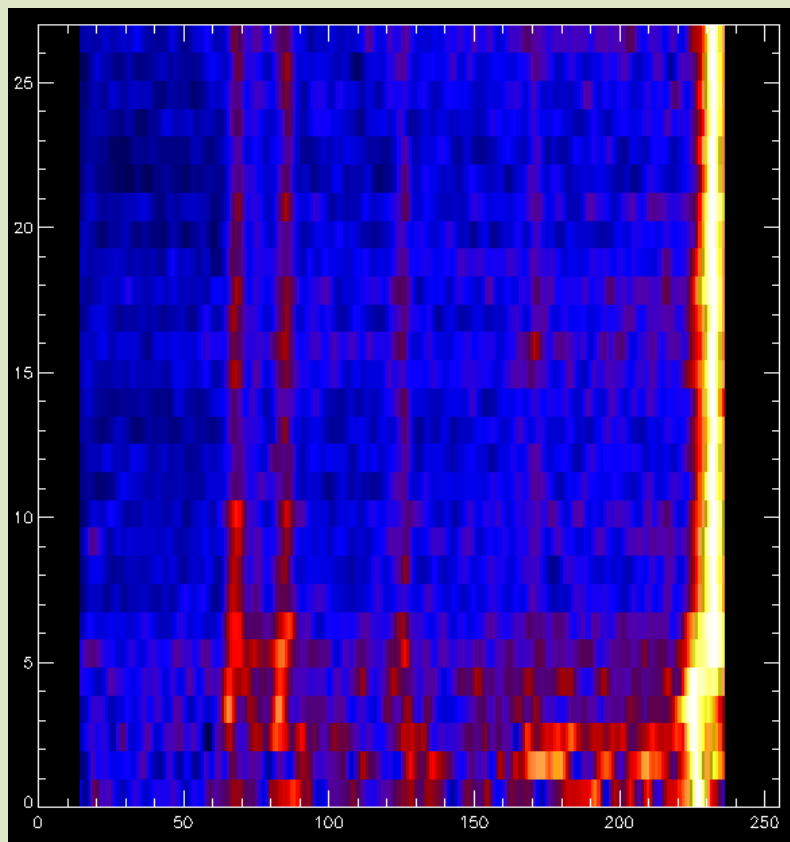
Future analyses 2

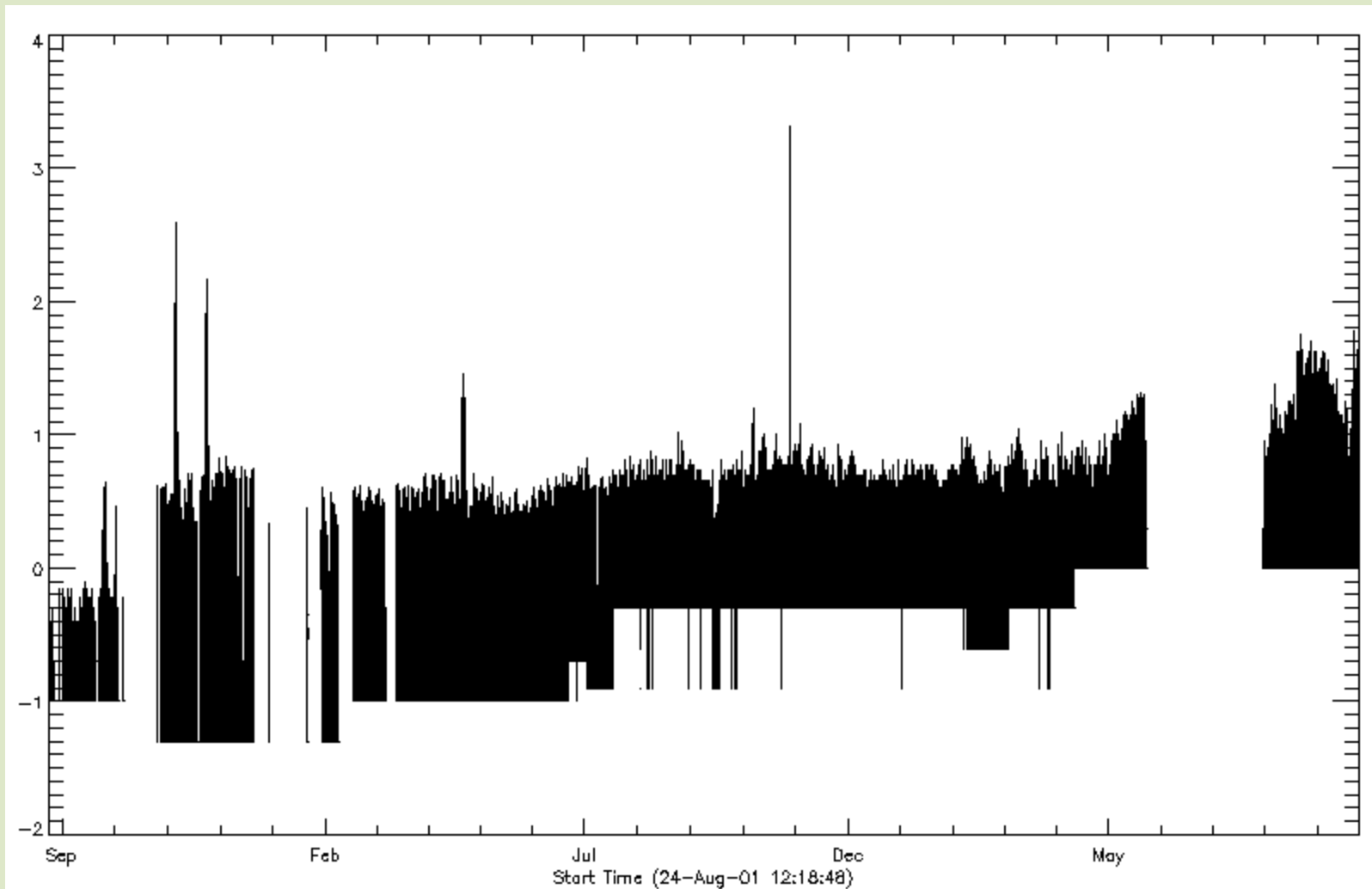
- Investigations of ambient X-ray emission
 - S/C night-PHA and spectra
 - Systematic reduction of every recorded spectrum (~1mln)
 - Auroral emission & spectra collection
- Investigation of magnetospheric effects PIN & PHA
 - Crossings of polar van Allen belts geomagnetic storms and disturbances
 - SAA variability
 - Night portion emission

Examples of offset variability



- Source initially above the limb
- Flare starts on the disc





Instrument settings plot HV

Instrument settings plot ADS