

SphinX

Szymon Gburek & SphinX team

Space Research Centre Polish Academy of Sciences,
SRC-PAS

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51-622 Wrocław, Kopernika 11

7th Patras Workshop on Axions and WIMPs and WISPs

June 27 – July 1, 2011, Mykonos, Greece

OUTLINE

About SphinX

SphinX database summary and status

SphinX data analysis

SphinX – team



SRC PAS:

Principal Investigator: **Janusz Sylwester**

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MEPhI:

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AI CZAS:

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INAF, Palermo University:

Fabio Reale, SphinX Co-I



UCL, London:

Ken Phillips, SphinX Scientist Co-I



NASA GSFC:

Brian Dennis, SphinX Scientist Co-I

SphinX Solar Photometer in X-rays



~4kg/~10W (peak)

~1 keV - ~15 keV

Time resolution ~6 μ s

Energy resolution ~400 eV

Launch: January 30, 2009 at 13:30 UT, Plesetsk, Russia

Mission duration: February 20, 2009 – November 29, 2009

CORONAS-Photon satellite

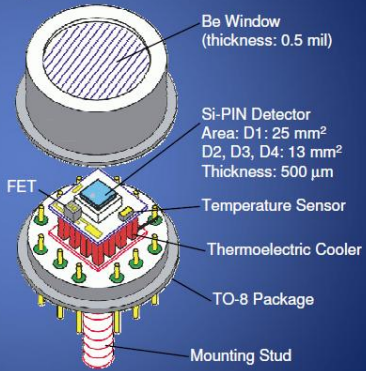
SphinX Solar Photometer in X-rays



Flight model – just before tests TV tests

SphinX detectors and optics

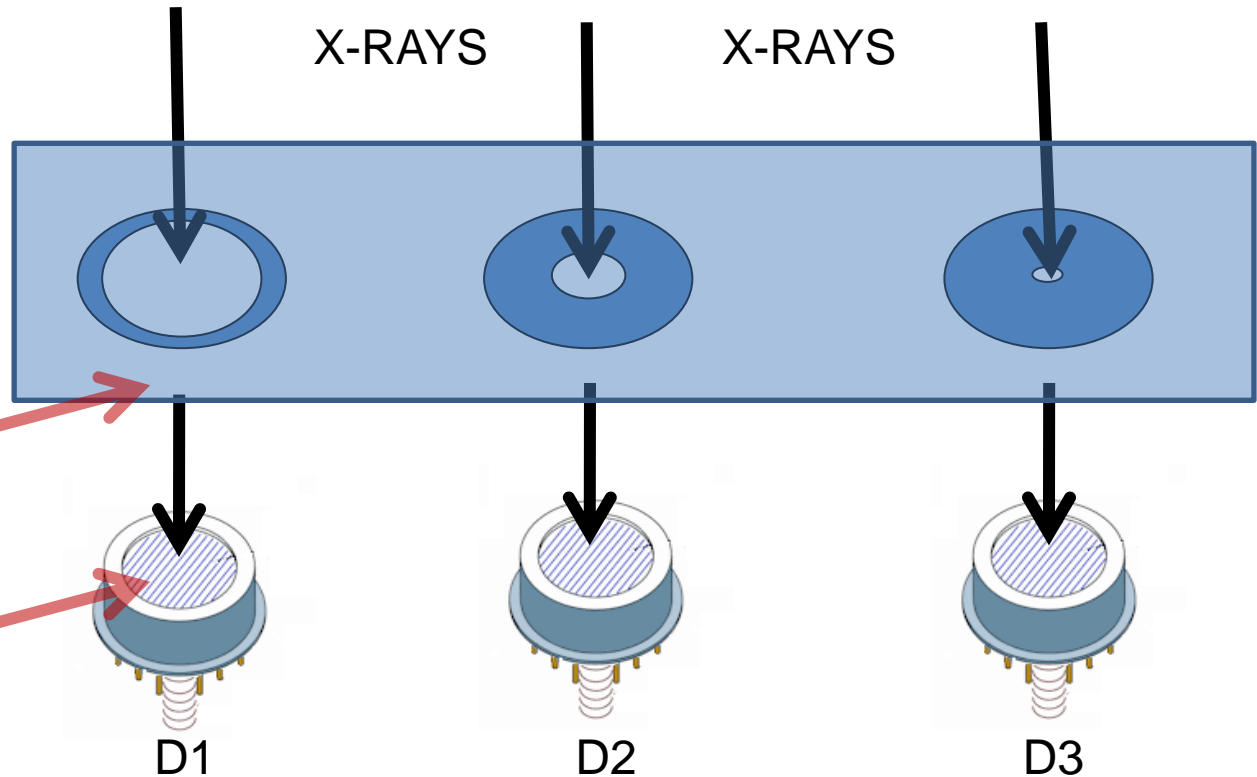
Amptek XR-100CR silicon PIN detector:



AMPTEK
Si PIN-DIODES
XR-100CR

Al entrance filters

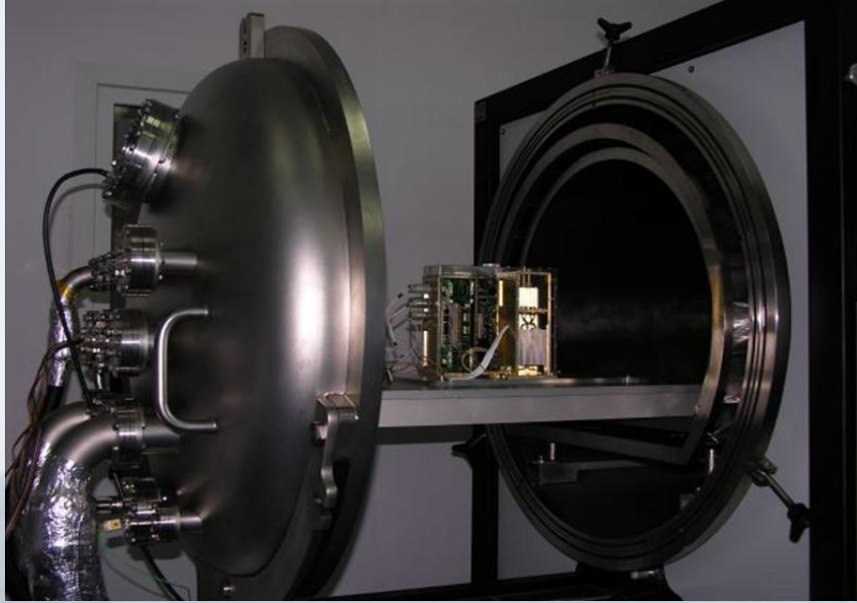
Be detector windows



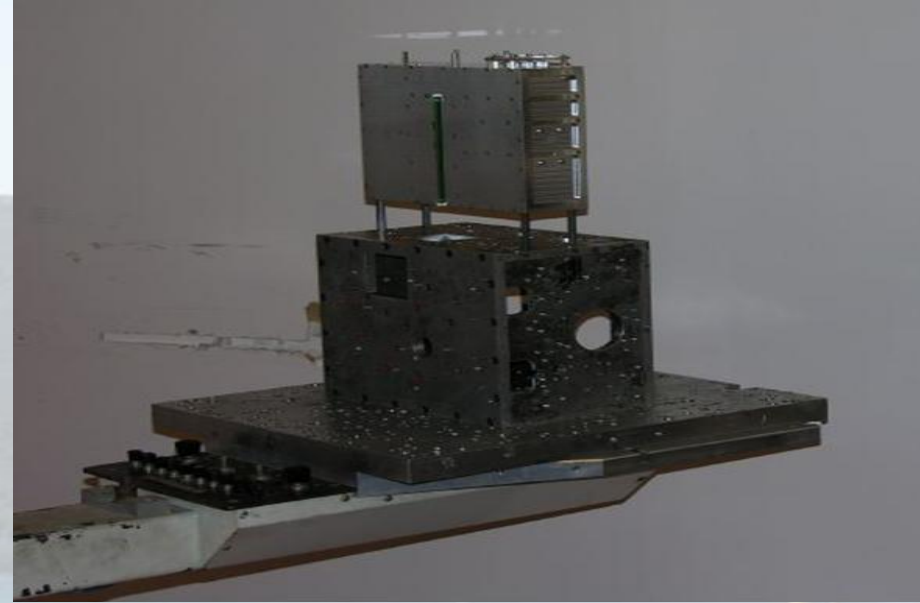
Seven orders of magnitude of solar X-ray flux covered

SphinX tests and calibrations

TV tests in Warsaw 2007



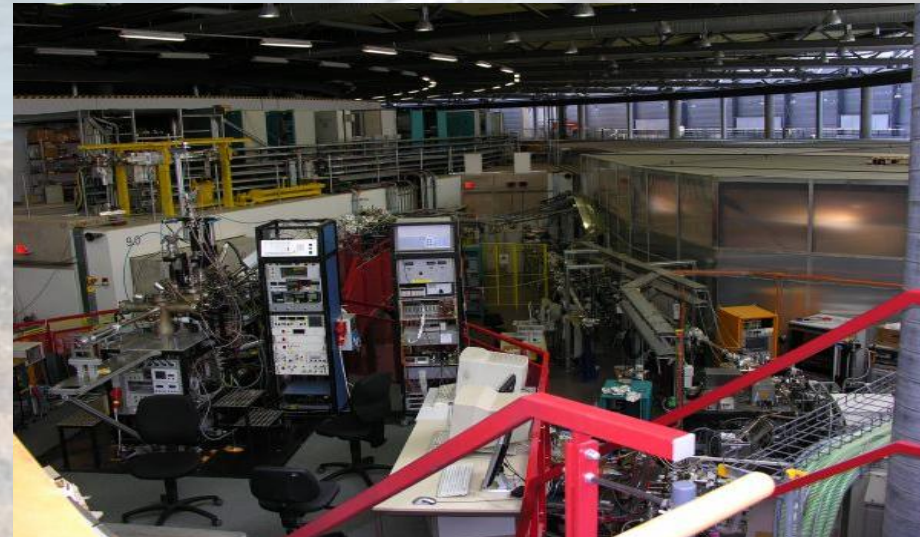
Vibration/Acceleration/Acoustic, Prague 2007



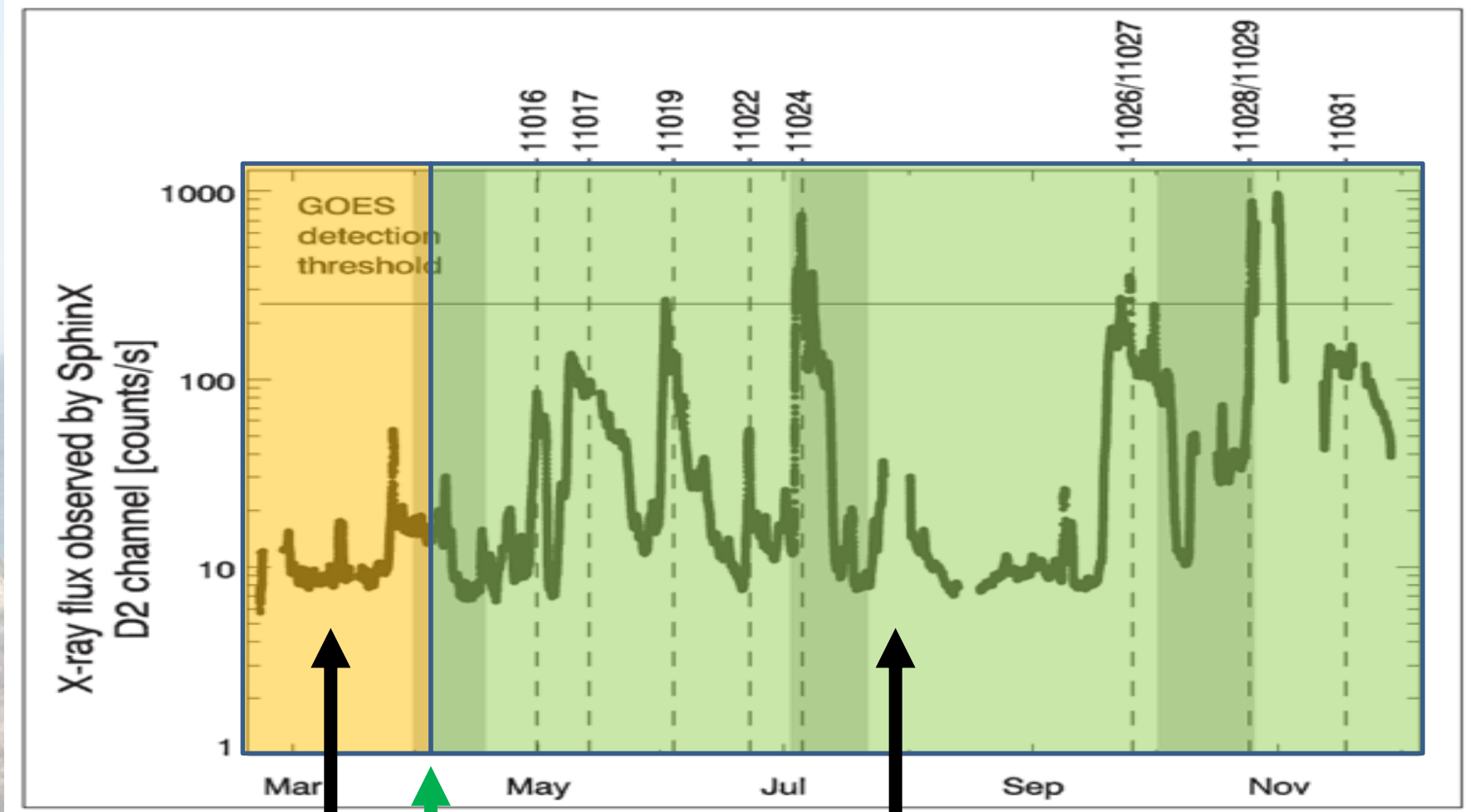
Efficiency and response XACT, Palermo, 2007



Final calibration experiment BESSY II, Berlin 2008



SphinX mission phases

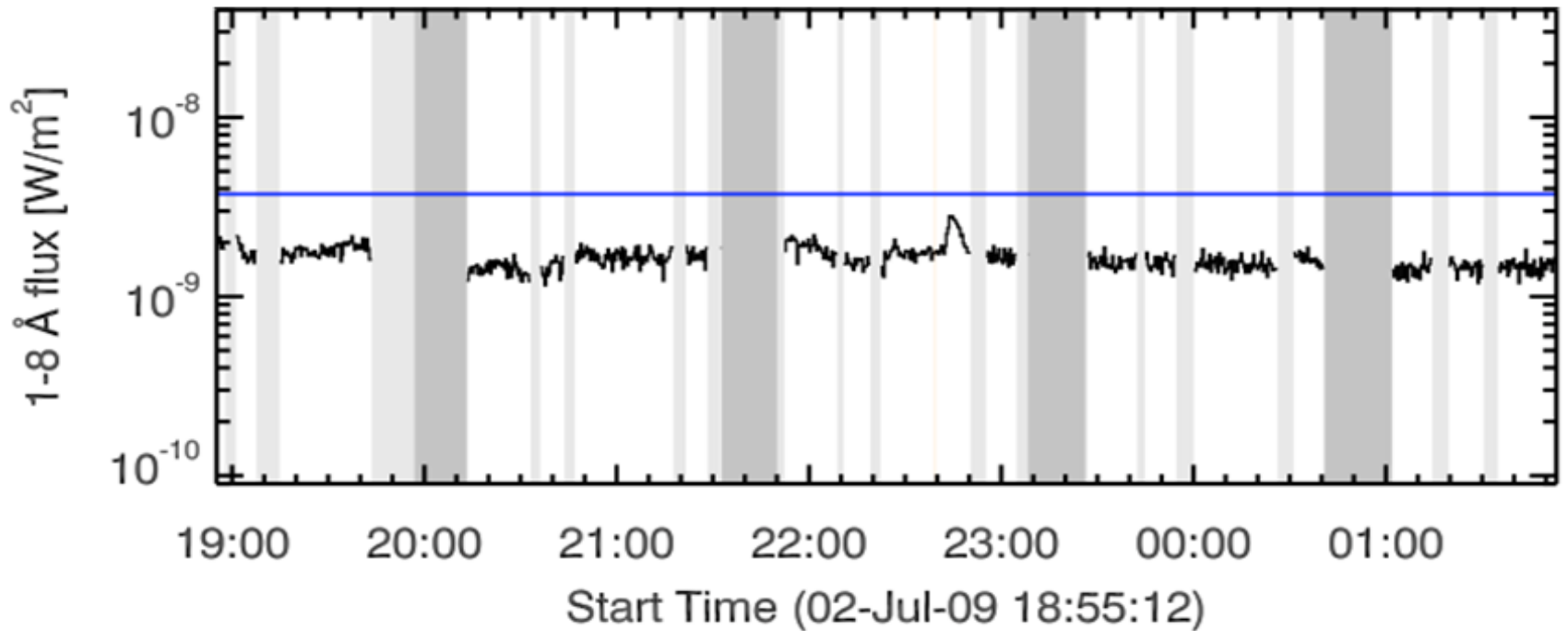


April 6, 2009 optimum on-board operation and data collection strategy achieved

SphinX

The first fully
tested and calibrated
solar spectrometer

Sphinx vs GOES



SphinX data – summary status

- Measurements for very low solar activity
- February 20, 2009 – November 29, 2009
- Mission phase II reduced to Level - 1
- Level - 1 data available in FITS format

SphinX data – summary status

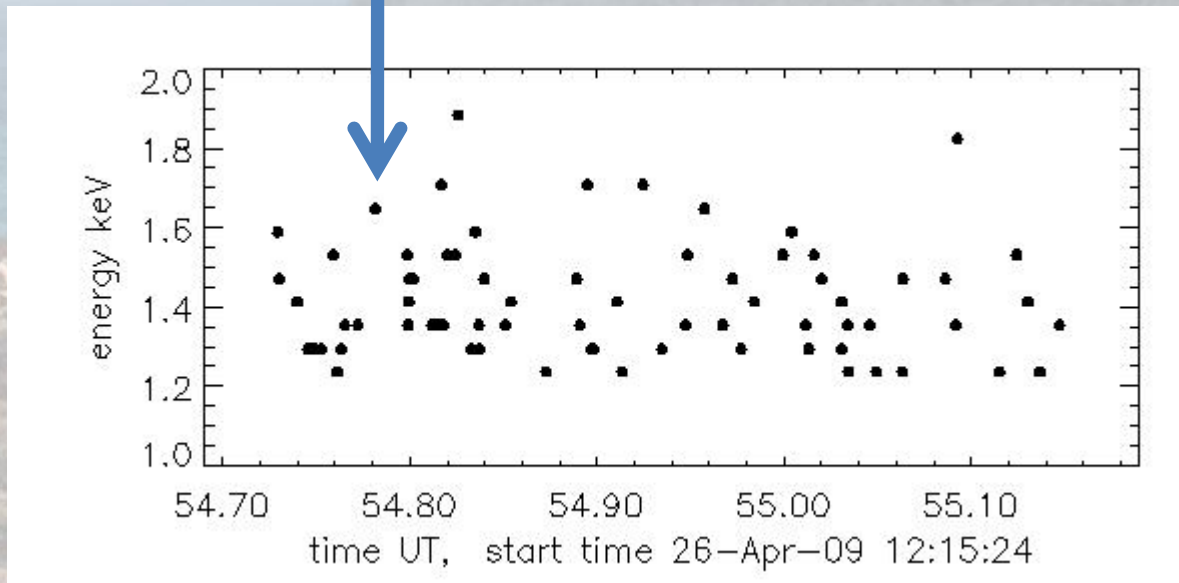
All data available as event lists

Detector EVENT = (arrival time, energy)

Different detector EVENTS
are possible

Photon hits
Particle hits
Amplifier resets

FLAG
is given to distinguish
events



$\sim 5 \times 10^9$ EVENTS registered by SphinX during the mission

SphinX data distribution map Level - 0

SphinX dedicated
data servers
at PI, Co-is institutions
All data

Moscow LPI

SRC PAS, Wrocław, Poland

AI ASCR Ondrejov,
Czech Republic

DSFA, University of Palermo

Synchronized SphinX data servers

http://156.17.94.1/sphinx_catalogue/SphinX_cat_main.html

http://147.231.104.188/catalog/SphinX_cat_main.html

<http://www-sphinx.astro.unipa.it/>

in Wrocław, Poland

in Ondrejov, Czech Republic

in Palermo, Italy

Analysis of SphinX data



SphinX data catalog website **Level – 1** data scientific grade

SphinX data catalogue

All SphinX data available here are Level_1 data.



2009																															
January	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
February	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			
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
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	
May	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
June	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	
July	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
August	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
September	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	
October	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
November	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	
December	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

Last update: Wed May 25 21:23:23 2011 (UTC+2)

contact:

[Szymon Gburek](#) - Any questions concerning content of data from SphinX catalogue.

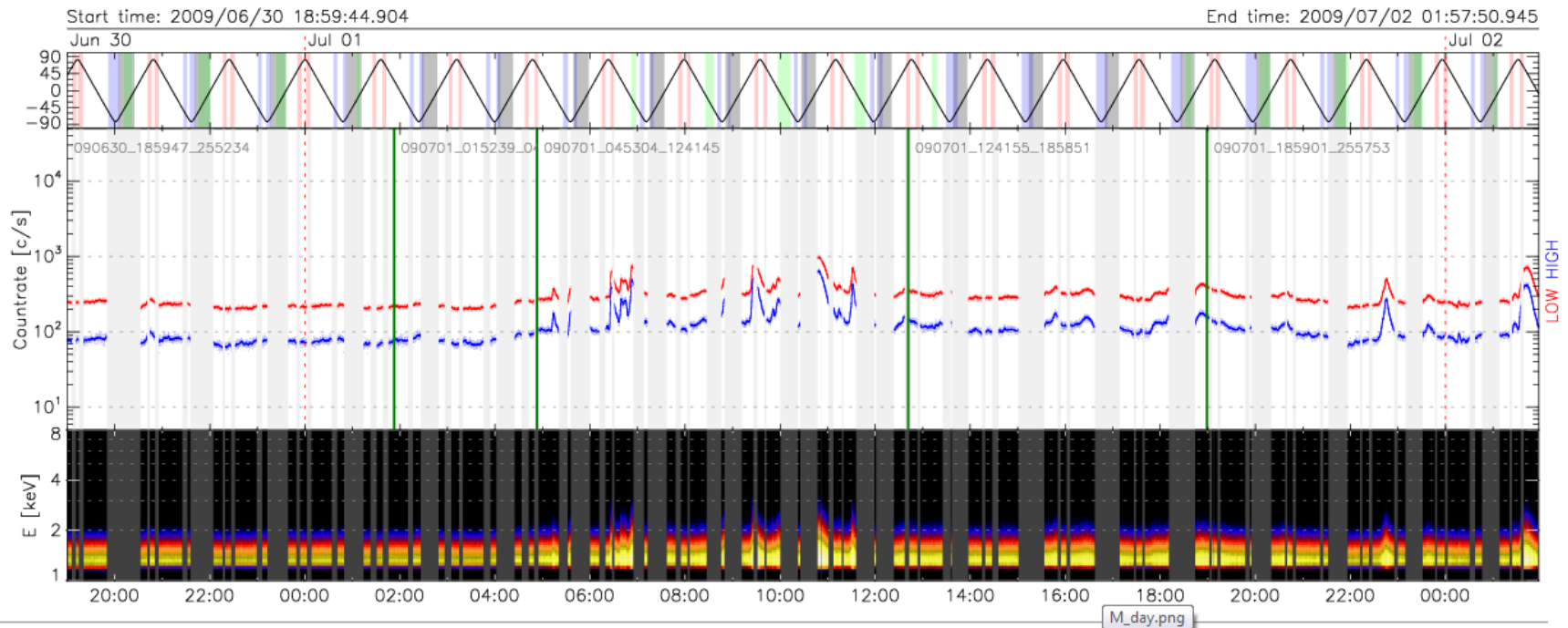
[Piotr Podgorski](#) - Report any technical problems with SphinX data catalogue.

http://156.17.94.1/sphinx_l1_catalogue/SphinX_cat_main.html

Example of SphinX daily summary page

SphinX data catalogue

< 01 July 2009 >



SphinX Level_1 data:

[090630_185947_255234](#) (152.94 MB) [090701_015239_045254](#) (70.109 MB) [090701_045304_124145](#) (184.49 MB) [090701_124155_185851](#) (150.19 MB) [090701_185901_255753](#) (169.01 MB)



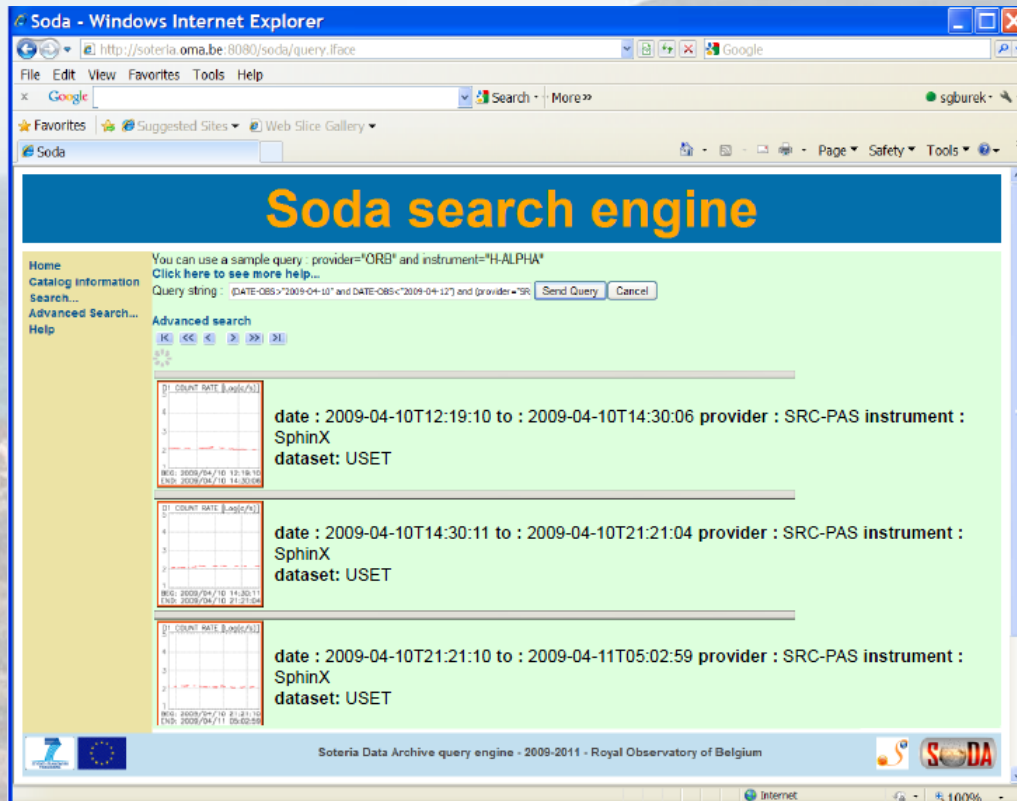
Download FITS files (OGIP format)

SphinX data goes to Virtual Observatories

On-line access + search engine

SODA – SOTERIA DATA ARCHIVE European VSO maintained at ROB

Proposed layout of SphinX interface in SODA

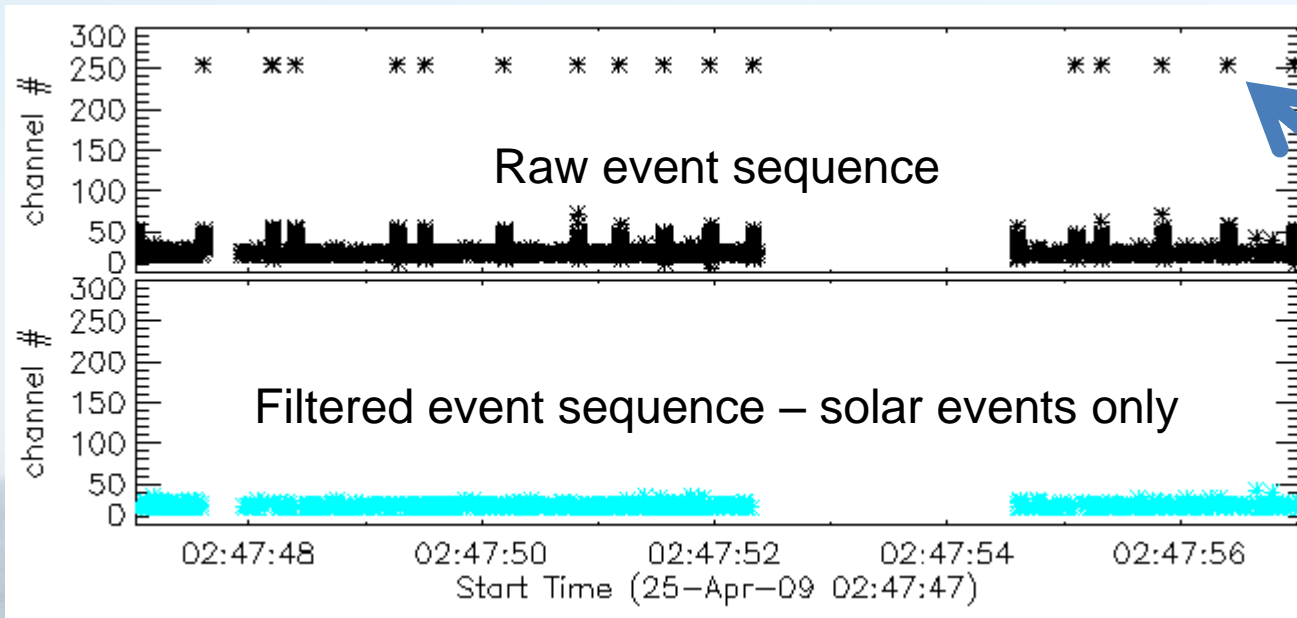


SphinX - SODA READY

- SphinX Level-1 FITS
- Visualisations – LC
- Server & software

US VSO for SphinX – in preparation

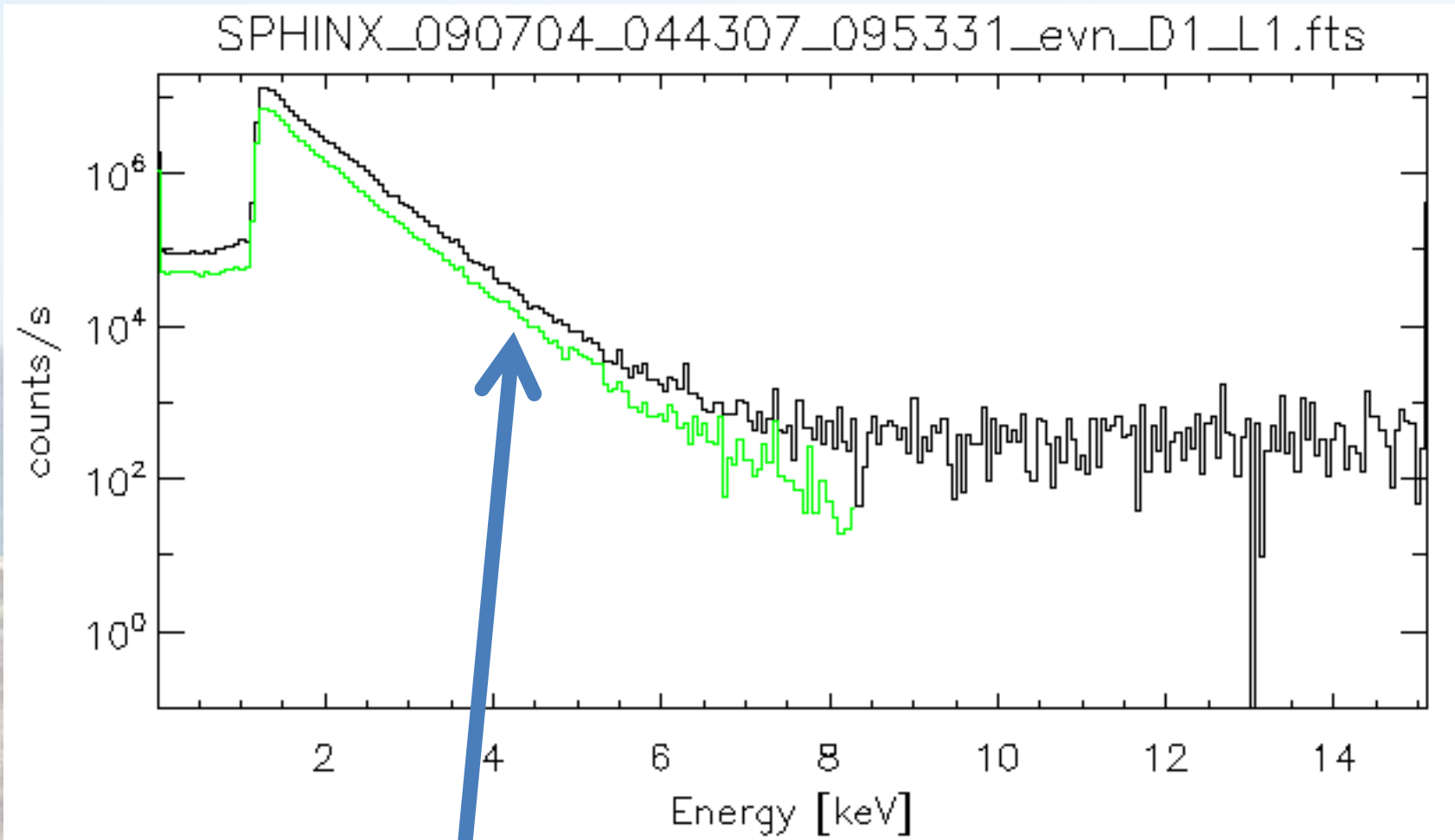
SphinX data analysis strategy



Particle events
Amplifier resets
etc...

- Filter out/select events of interest using **FLAGS**
- Construct higher level data products (spectra, lightcurves)
- Add calibration information (detector response matrix)
- Perform analysis with spectral analysis packages.

SphinX data filtering and analysis - example



Clean filtered spectrum of solar origin

SphinX tools

Existing data analysis tools. For example FTOOLS ...

<http://heasarc.gsfc.nasa.gov/docs/software.html>



The screenshot shows the HEASARC website interface. At the top left, it features the NASA logo and the text "GODDARD SPACE FLIGHT CENTER" and "Smithsonian Astrophysical Observatory". To the right, there are links for "Help/FAQ", "What's New", "Site Map", and "NASA Homepage". A search bar is present with the text "Search enter search terms" and a link to "Advanced Search". Below this is a "HEASARC Quick Links" dropdown menu showing "--Quick Links--". A navigation bar at the bottom contains several tabs: "HEASARC HOME", "OBSERVATORIES", "ARCHIVE", "CALIBRATION", "SOFTWARE" (highlighted in blue), "TOOLS", and "STUDENTS / TEACHERS / PUBLIC" (highlighted in red). The main content area is a collage of images, including a table of data, a plot, and the word "Xanadu" in large, stylized letters. The table data is as follows:

Chi-Squared	Lvl	Fit param #	1	2	3
924.178	-2	5.087	5.076	0.4056	
305.507	-2	4.525	3.791	0.1249	
140.460	-2	2.930	3.367	6.5553E-02	
			2.244	1.4635E-02	
				2.2279E-02	

Below the collage is another navigation bar with tabs for various software tools: "FITSIO", "FTOOLS", "FV", "HEASOFT", "HERA", "MAKI", "PIMMS", "PROFIT", "XANADU", "XSELECT", "XSTAR", "ASTRO-Update", and "FITS".

... or SphinX IDL dedicated software provided by the instrument team

... or Sphinx IDL dedicated software developed at SRC-PAS

sphinx_select.pro – filtering tool

sphinx_lightcurve – event list to lightcurve conversion tool

sphinx_spectrum – event list to spectra conversion tool

Detector Response Matrix DRM is provided in a FITS file

```
IDL> data = mrdfits(filename, i, hdr, status=status)
```



IDL structure



Header – string array with description of data

i=0 - primary header, data =0

i=1 – events HDU

i=2 – exposure HDU

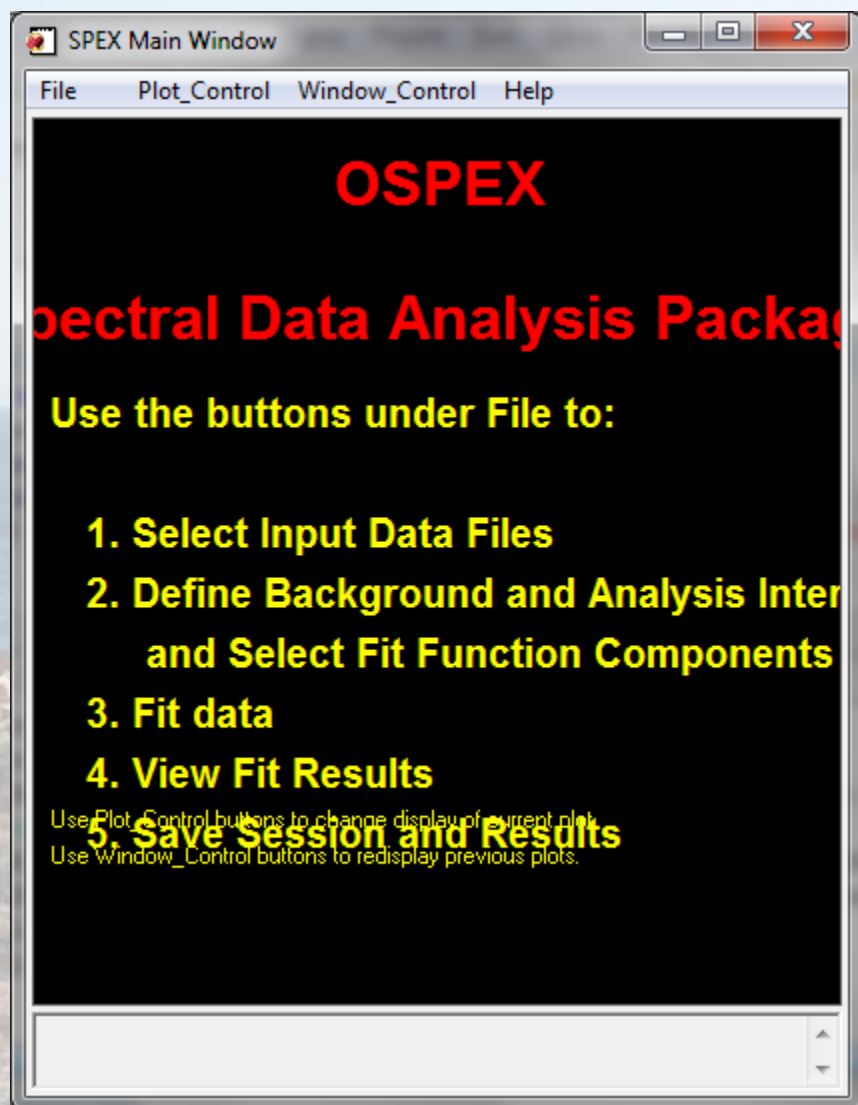
i=3 – GTI HDU

```
IDL> pm, hdr
```

```
IDL> help, data, /st
```

Analysis in OSPEX

(XSPEC can be used as well)



SPEX Main Window

File Plot_Control Window_Control Help

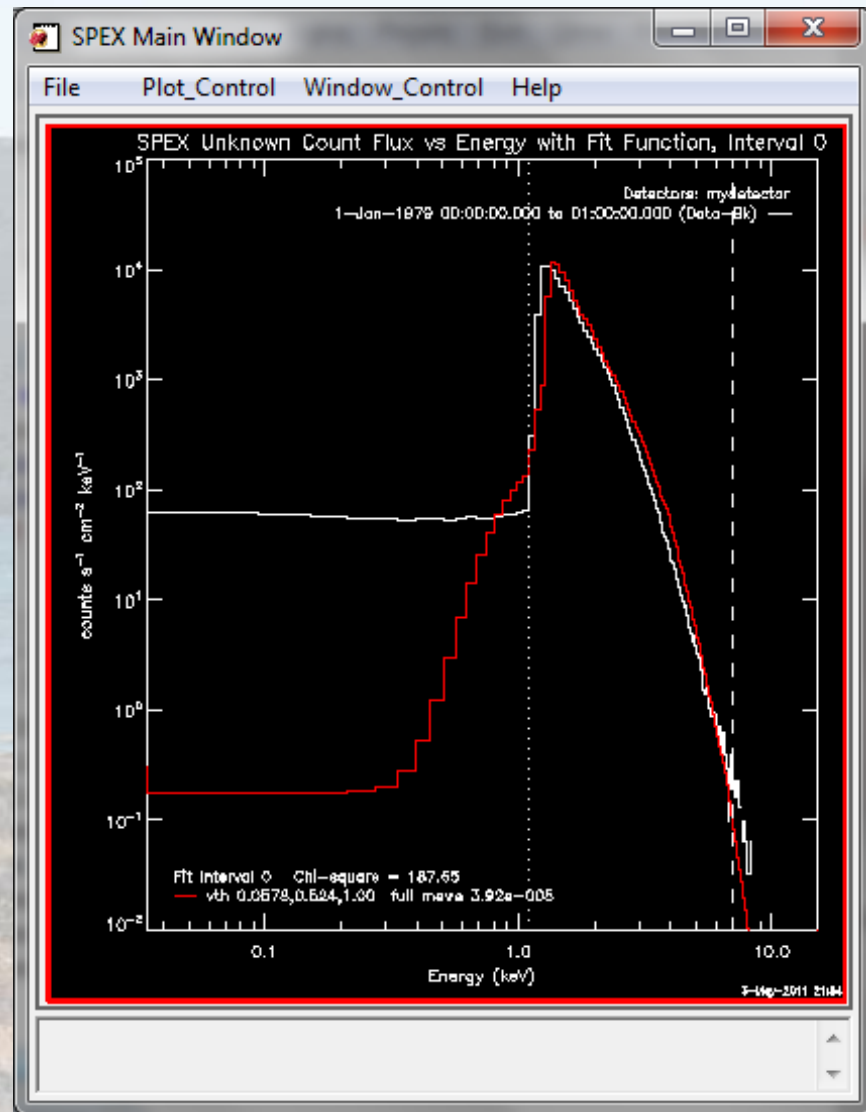
OSPEX

Spectral Data Analysis Package

Use the buttons under File to:

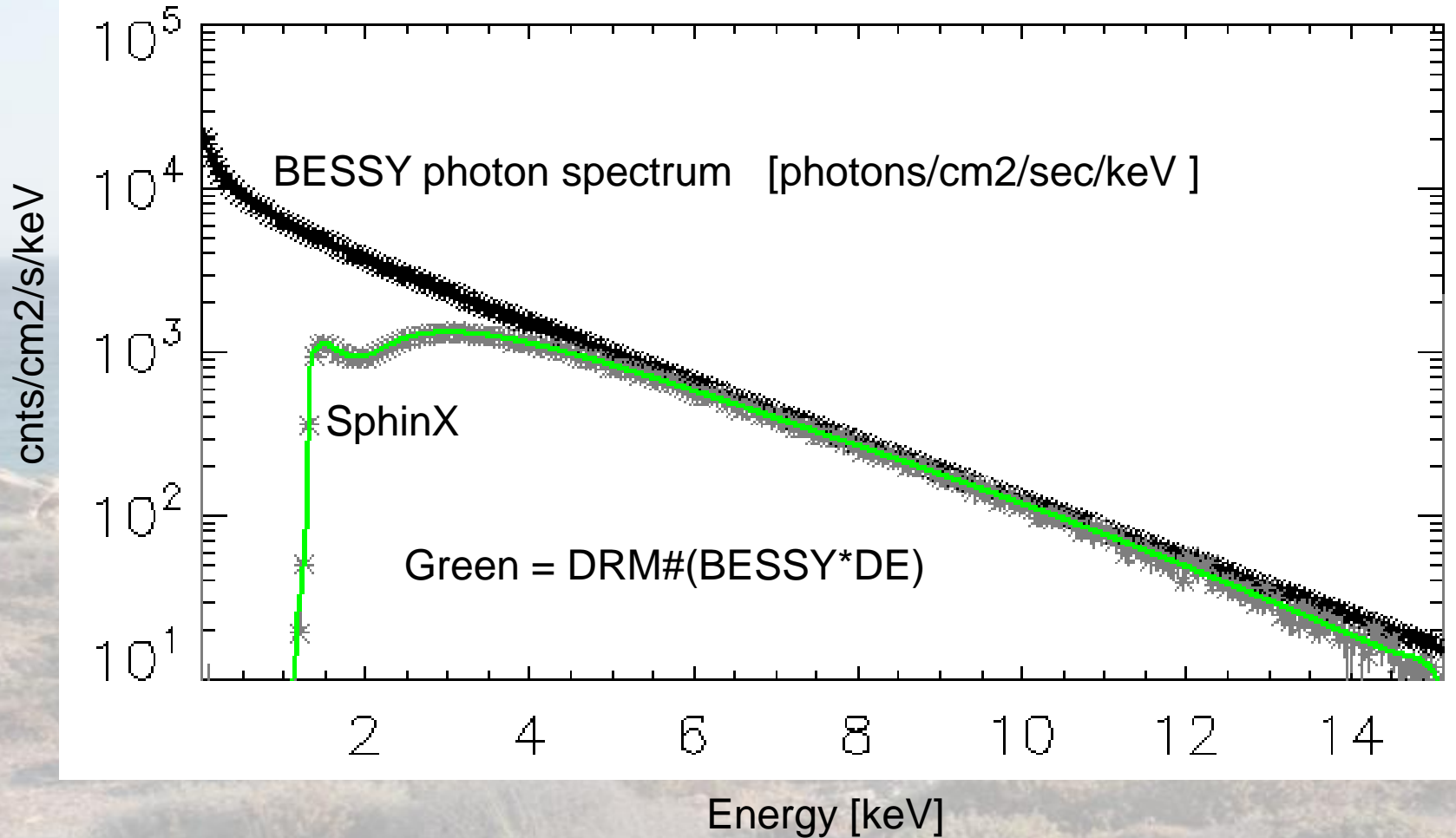
1. Select Input Data Files
2. Define Background and Analysis Interval and Select Fit Function Components
3. Fit data
4. View Fit Results
5. Save Session and Results

Use Plot_Control buttons to change display of current plot.
Use Window_Control buttons to redisplay previous plots.

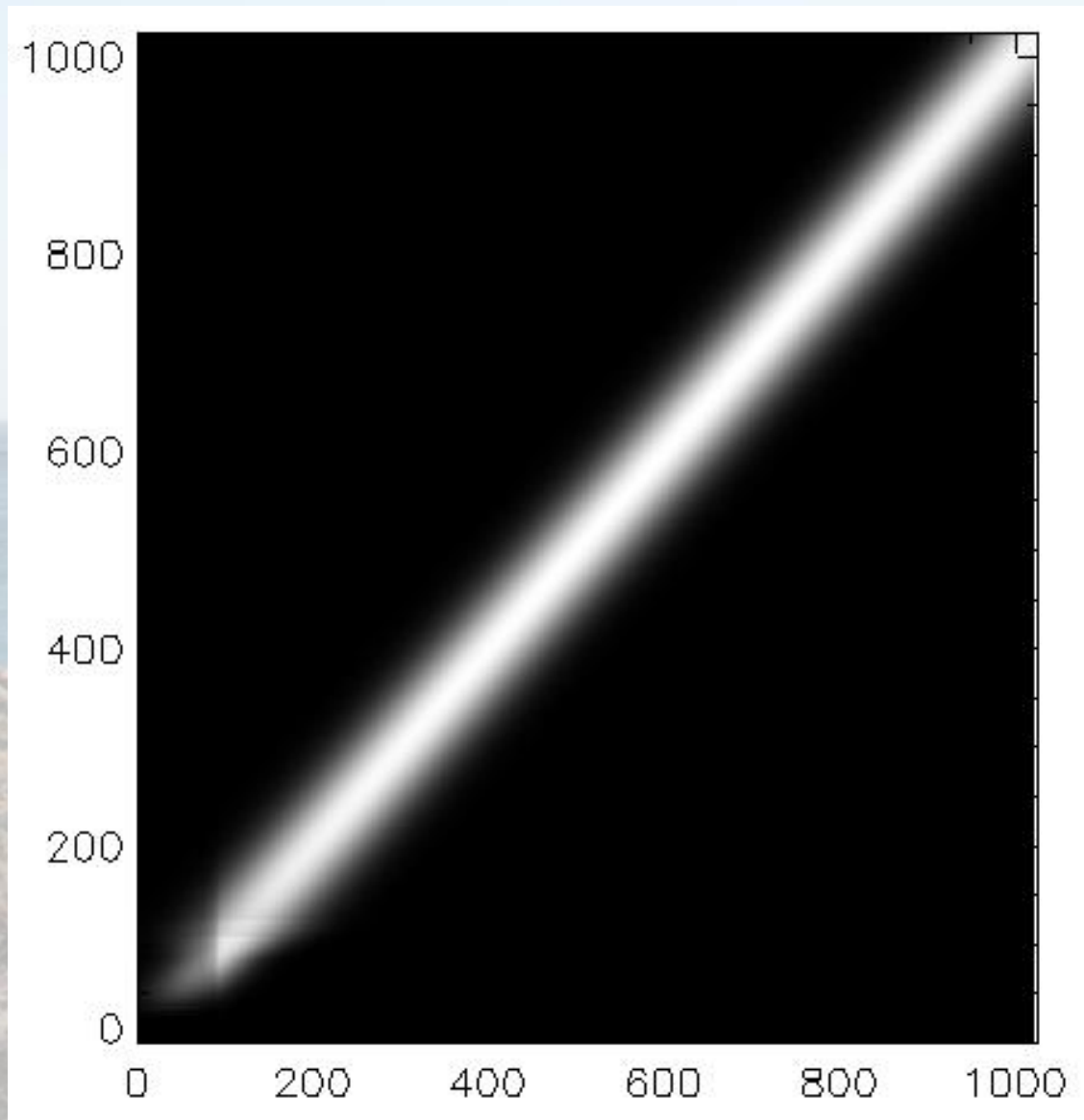


SphinX detector response matrix

DRM for spectral analysis



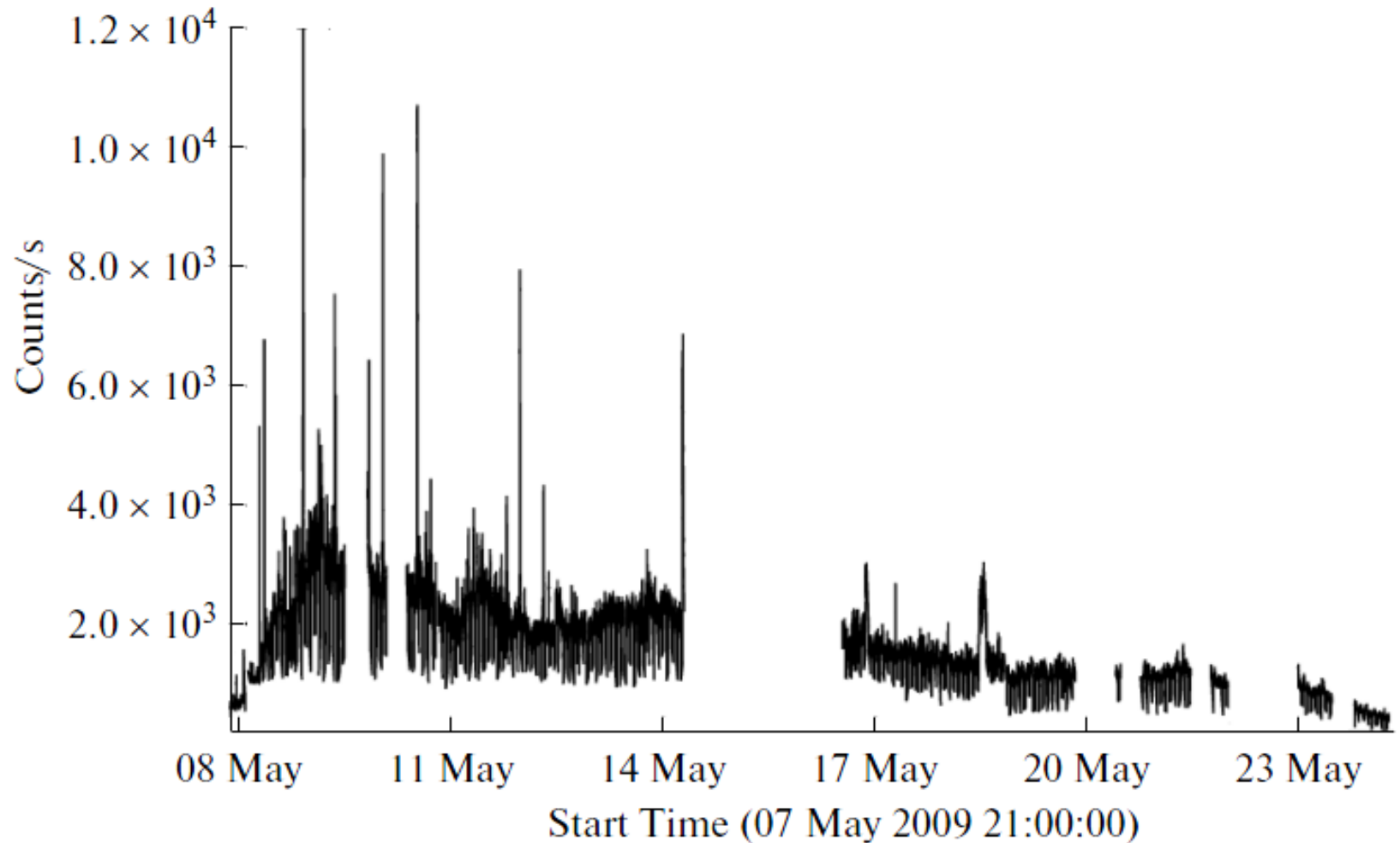
SphinX DRM



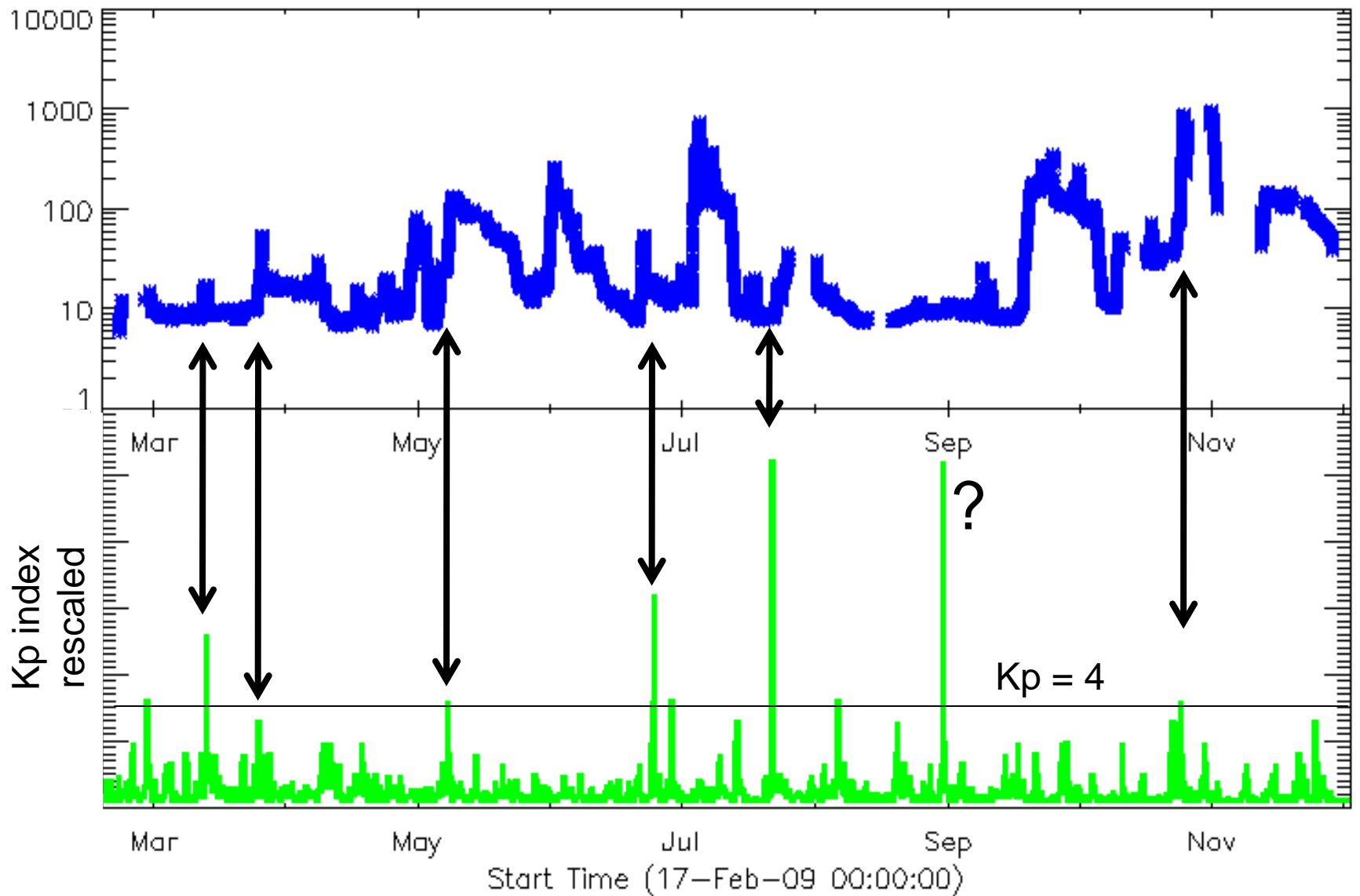
SphinX data analysis

A scenic view of a coastal area. In the background, a large, dark, rocky hillside rises from the sea. The sea is a deep blue, with a small boat visible in the distance. In the foreground, there is a building with a white facade and a blue roof, with a Greek flag flying on a pole. The foreground is covered in dry, scrubby vegetation. The overall scene is bright and clear, suggesting a sunny day.

Active regions investigations

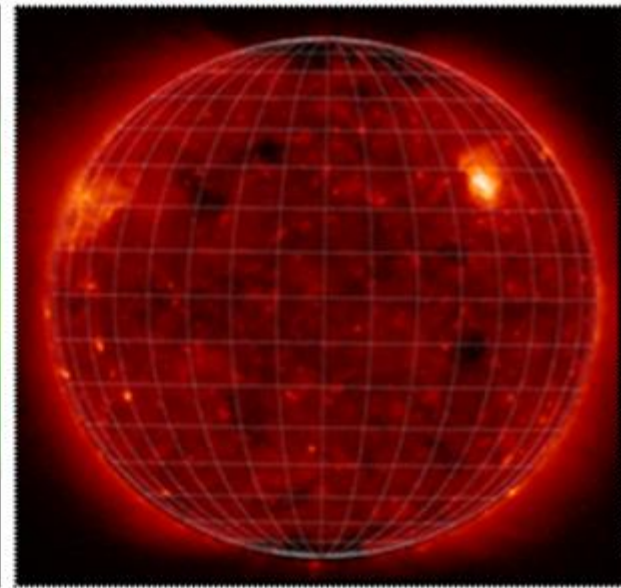
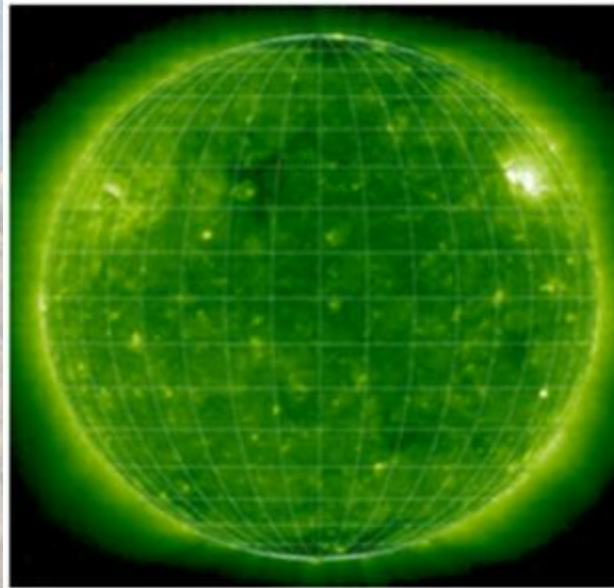
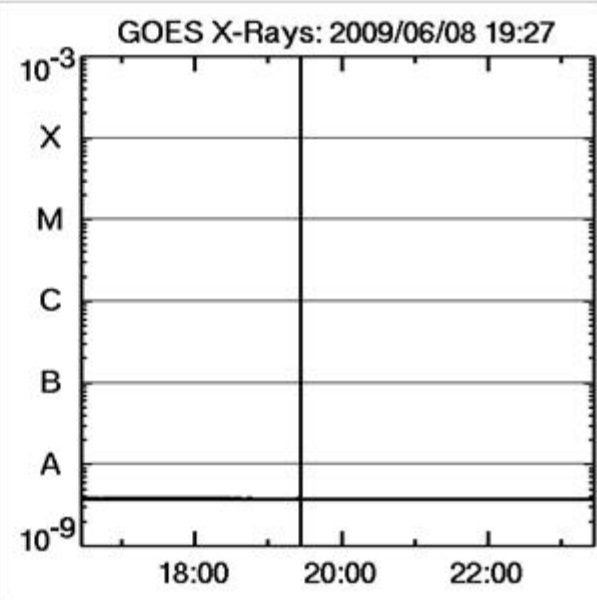
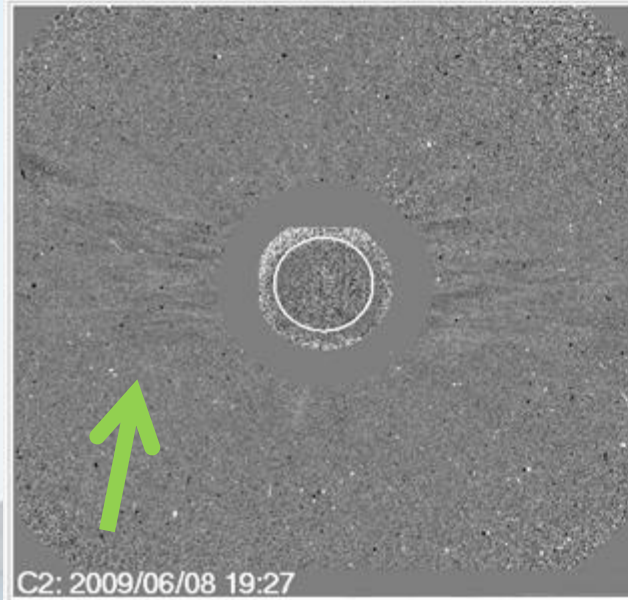


SphinX LC vs Kp index

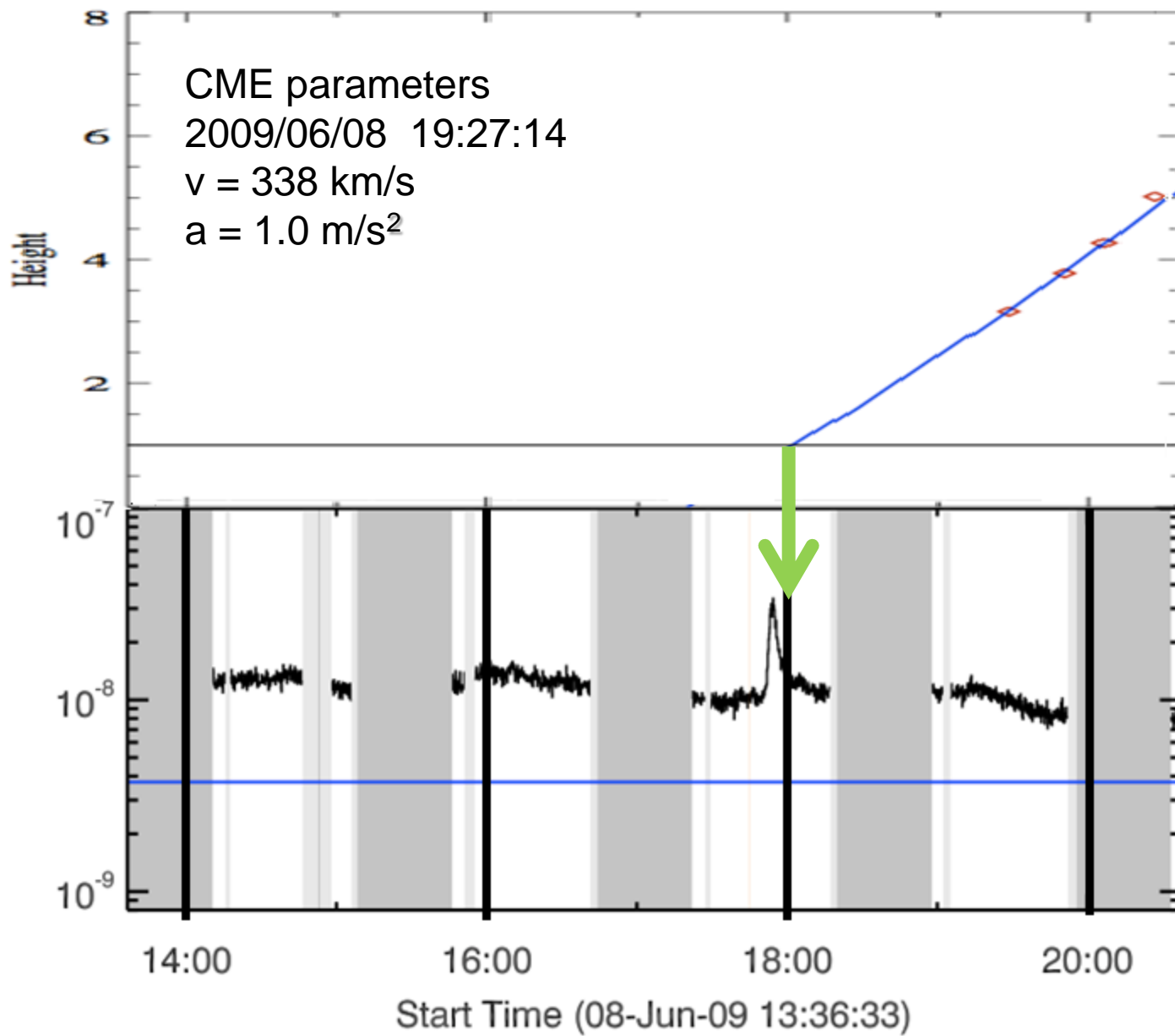


SphinX vs LASCO observations...(several tens of events)

2009-06-08 CME event
C2 start at 19:27:14



2009-06-08 CME event
C2 start at 19:27:14

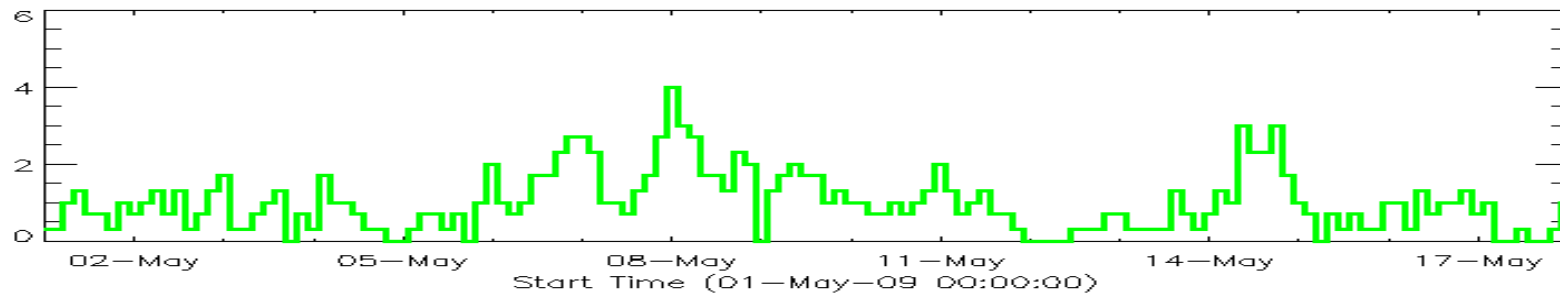
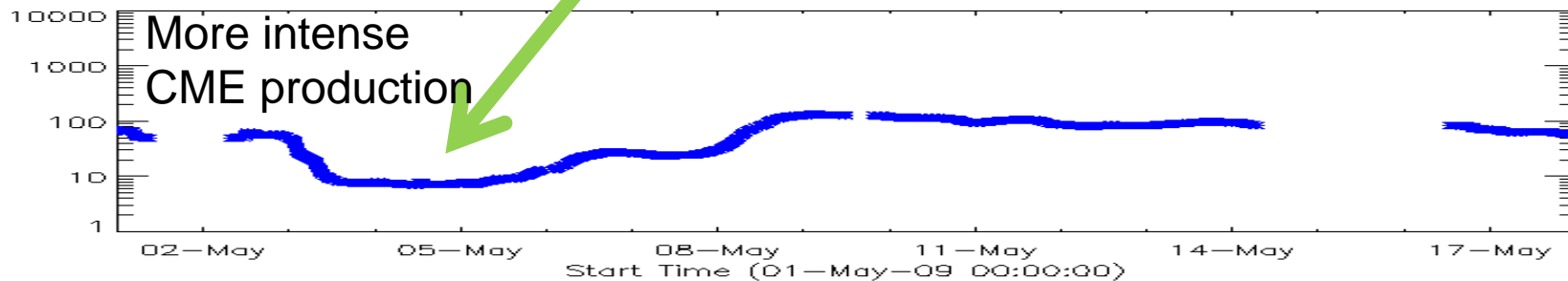
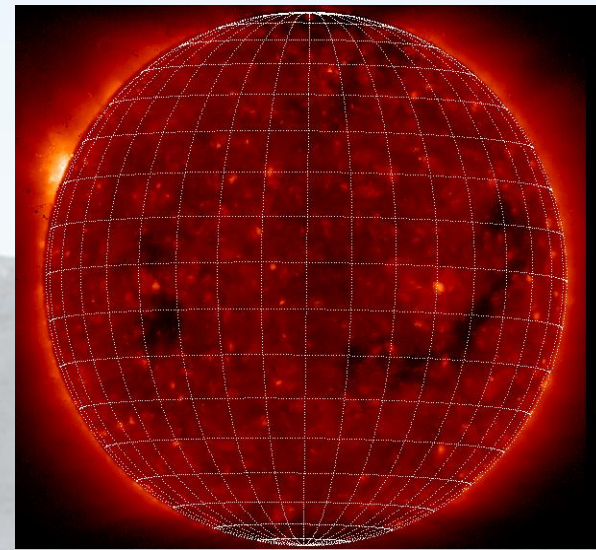
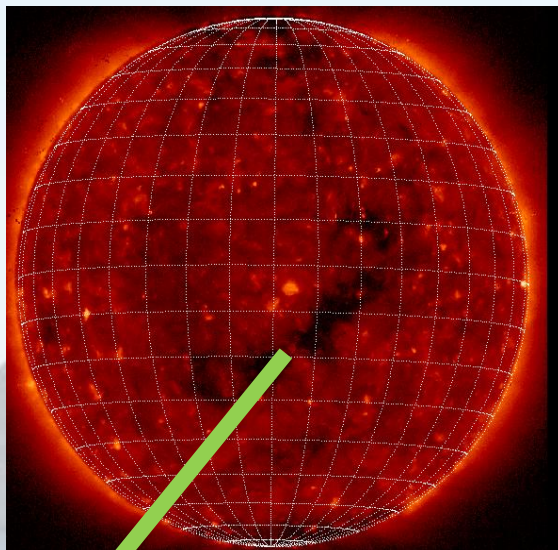
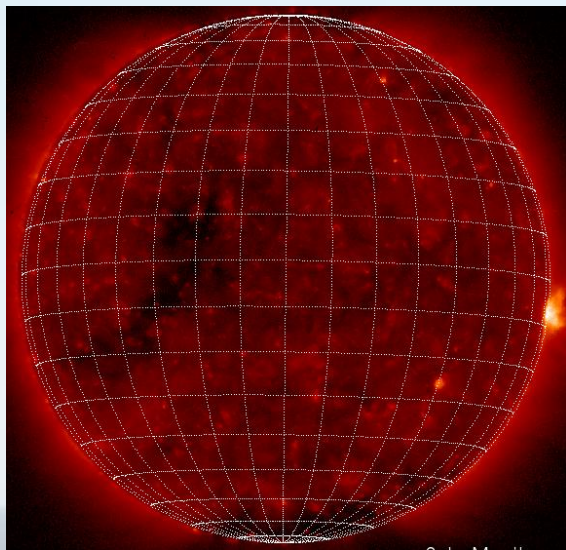


SphinX coronal hole observations

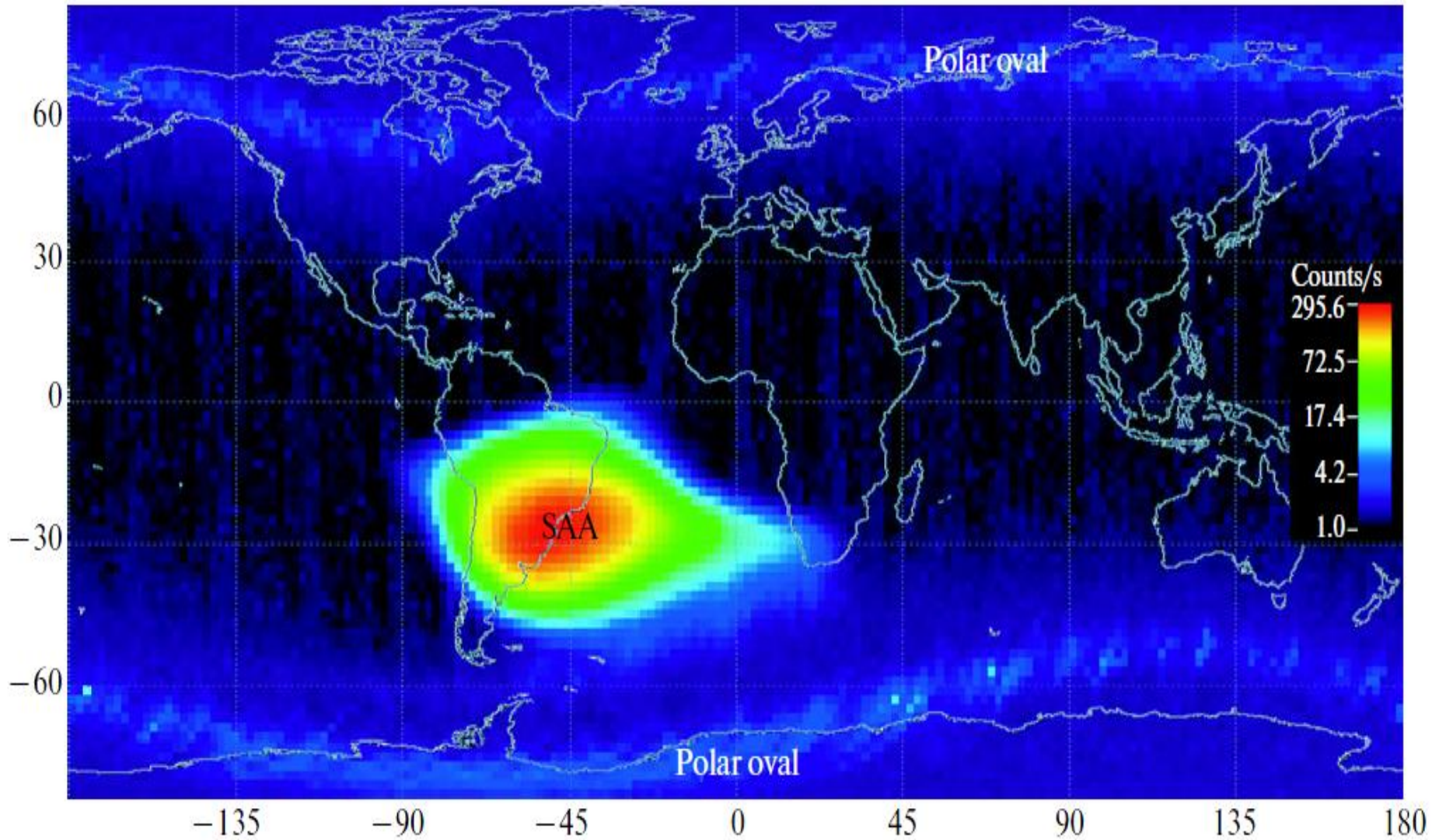
XRT 2009-05-01T18:11:00

XRT 2009-05-04T18:25:00

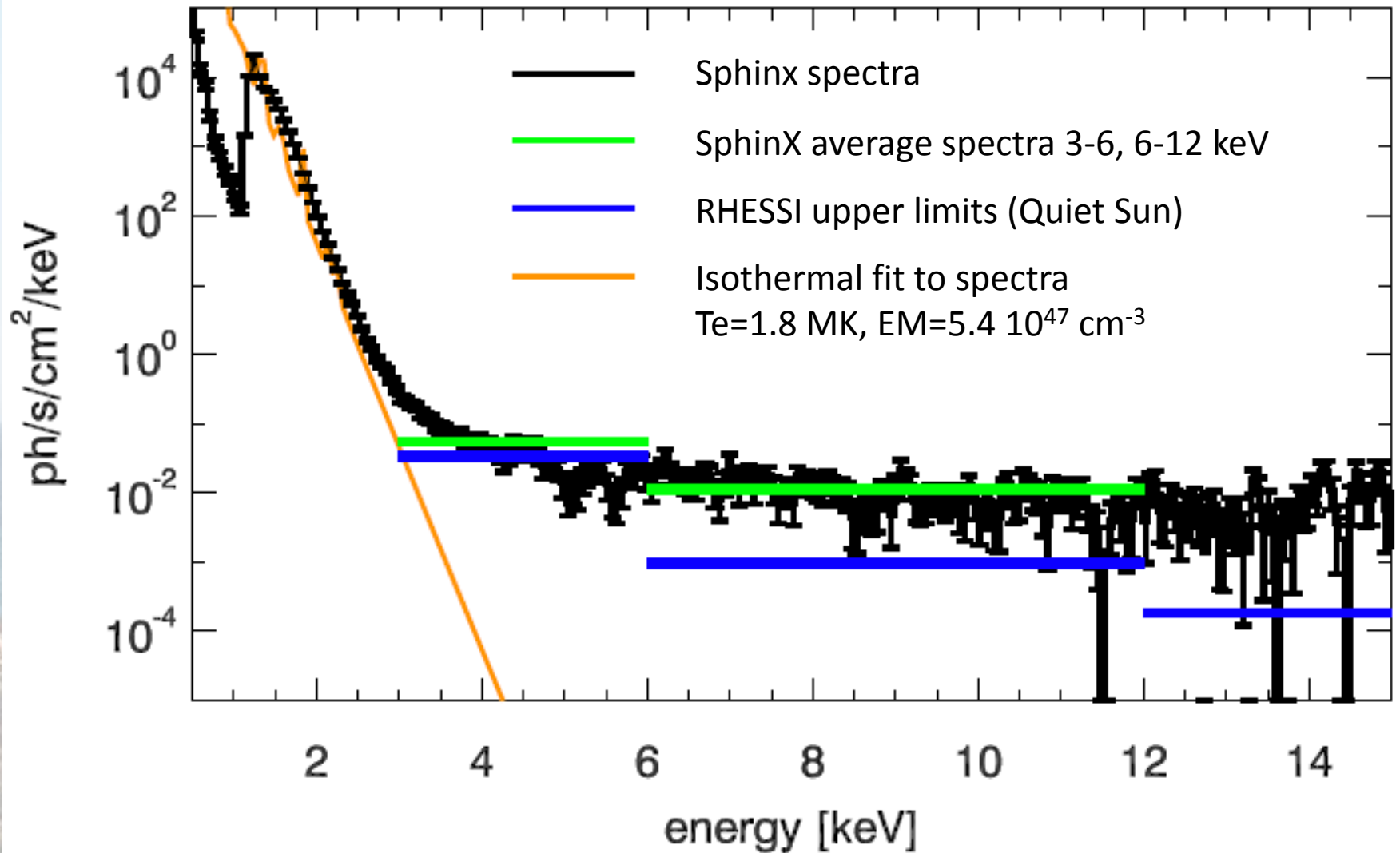
XRT 2009-05-06T18:03:00



In orbit energetic particle distribution studies



SphinX spectra properties – quiet Sun, no AR on disk



$g_{\text{a}\gamma\gamma} \sim 10^{-10} \text{ GeV}^{-1}$ GUT or DFSZ axions
 $g_{\text{a}\gamma\gamma} \ll 10^{-15} \text{ GeV}^{-1}$ KK axions

Estimated from 3 – 6 keV
 mean spectrum value

SphinX – scientific analysis areas

Quiet Sun analysis in X-rays (observed as a star)

Investigations of active regions

Small events investigations (GOES A-C class)

Determination of T, EM

Relationship between solar X-ray flux variability and CME

Identification and analysis of very small solar flares/brightenings

Monitoring of Earth energetic particle distribution

Cross-comparison with other instruments measurements

Determine upper limits for coupling constant - Axions

Thank You

