SphinX

Szymon Gburek & SphinX team

Space Research Centre Polish Academy of Sciences,

SRC-PAS

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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**
Project Manager: **Mirek Kowalinski**
Project Constructor: **Jarek Bąkała**
Project Scientist: **Szymon Gburek**
Co-I: **Marek Siarkowski, Barbara Sylwester, Zbigniew Kordylewski, Piotr Podgórski, Witold Trzebiński, Stefan Płocieniak, Anna Kępa**

FIAN:
Sergey Kuzin, TESIS PI, SphinX Co-I

MEPhI:
Yury Kotov, CORONAS-Photon Project Manager, SphinX Co-I

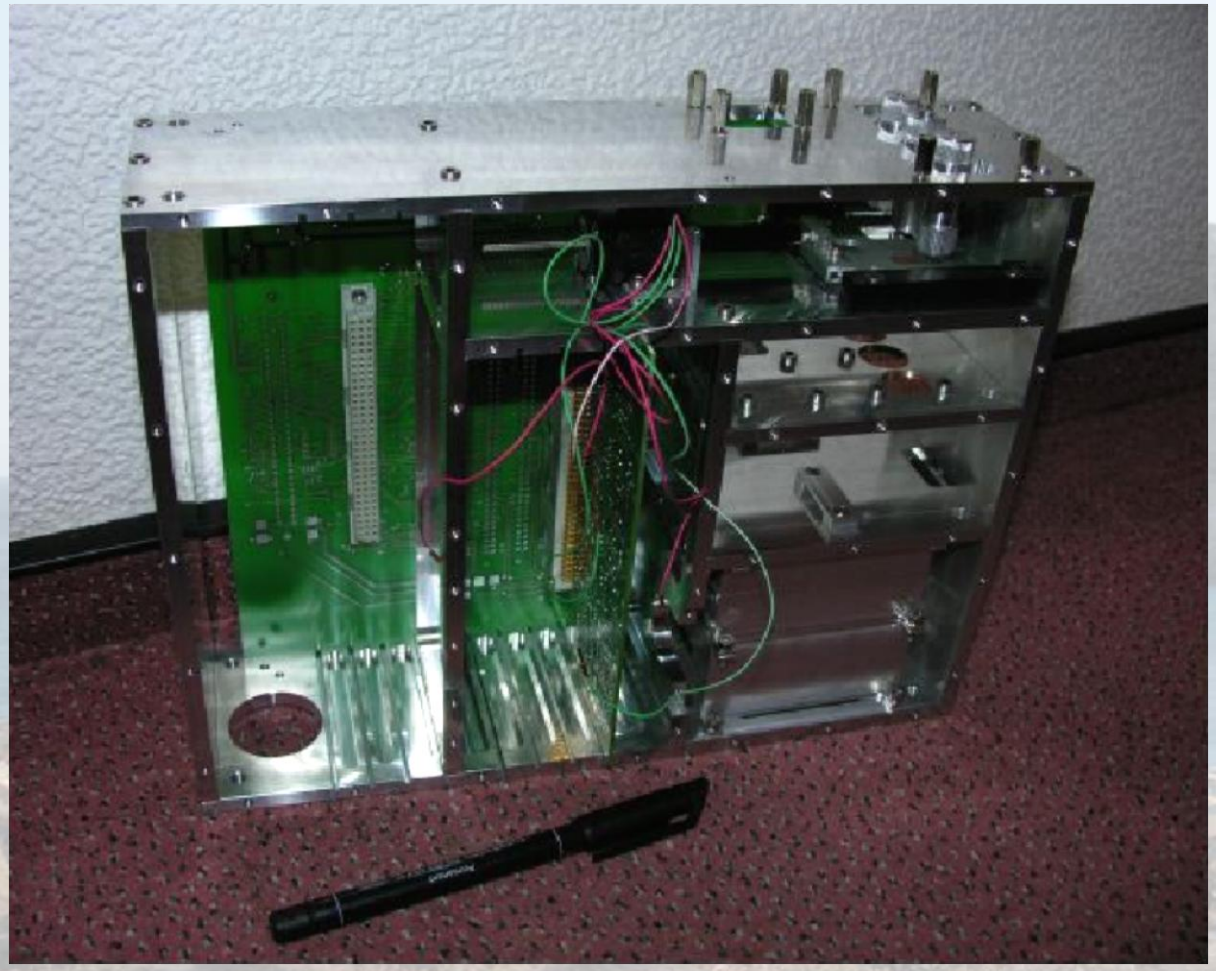
AI CzAS:
Franta Farnik, SphinX Co-I

INAFA, Palermo University:
Fabio Reale, SphinX Co-I

UCL, London:
Ken Phillips, SphinX Scientist Co-I

NASA GSFC:
Brian Dennis, SphinX Scientist Co-I

SphinX **S**olar **Ph**otometer **in X**-rays



~4kg/~10W (peak)

~1 keV - ~15 keV

Time resolution ~6 μs

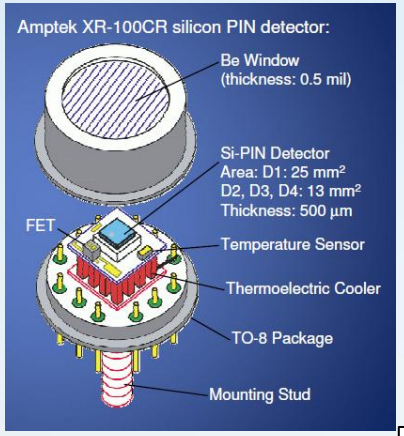
Energy resolution ~400 eV

Launch: January 30, 2009 at 13:30 UT, Plesetsk, Russia
Mission duration: February 20, 2009 – November 29, 2009
CORONAS-Photon satellite

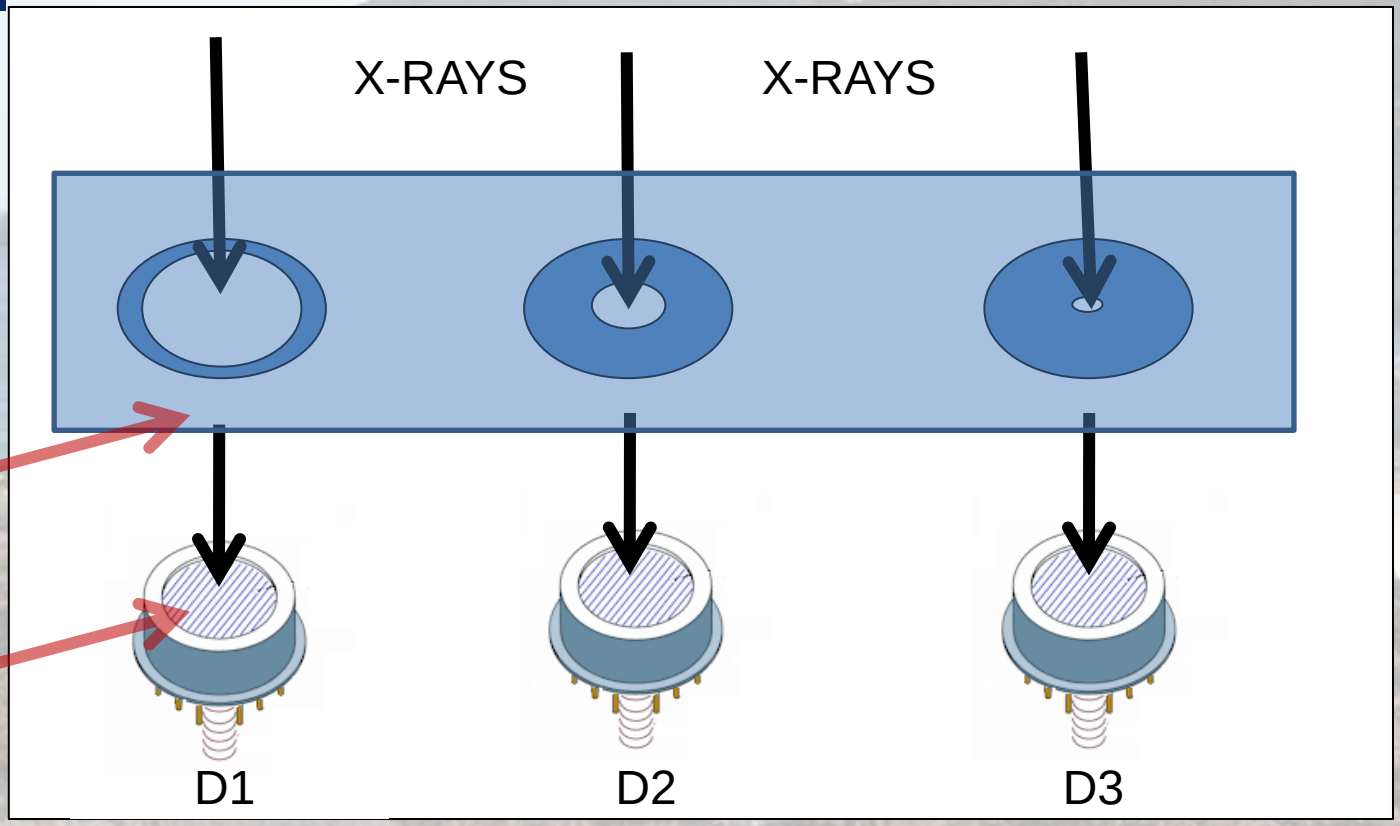
SphinX **S**olar **Ph**otometer **in X**-rays

Flight model – just before tests TV tests

SphinX detectors and optics



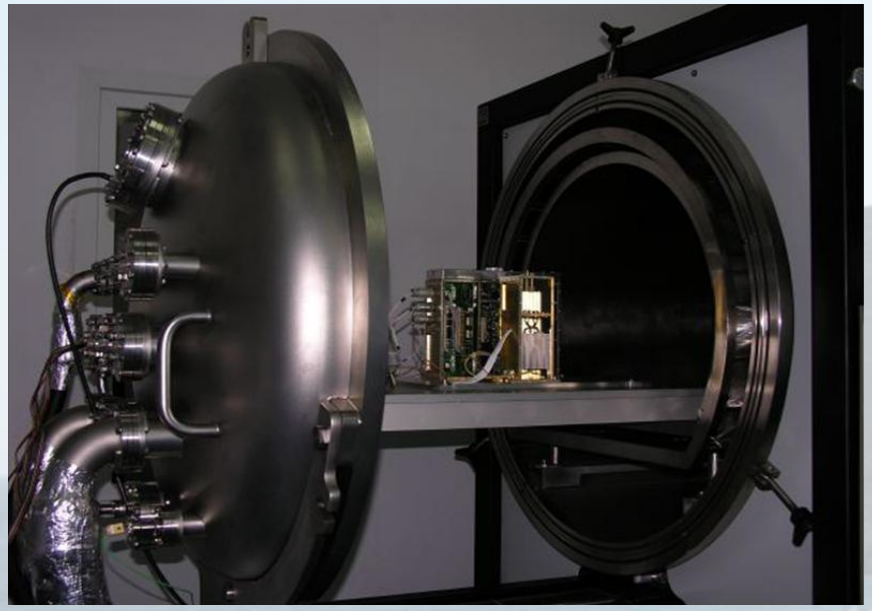
AMPTEK
Si PIN-DIODES
XR-100CR



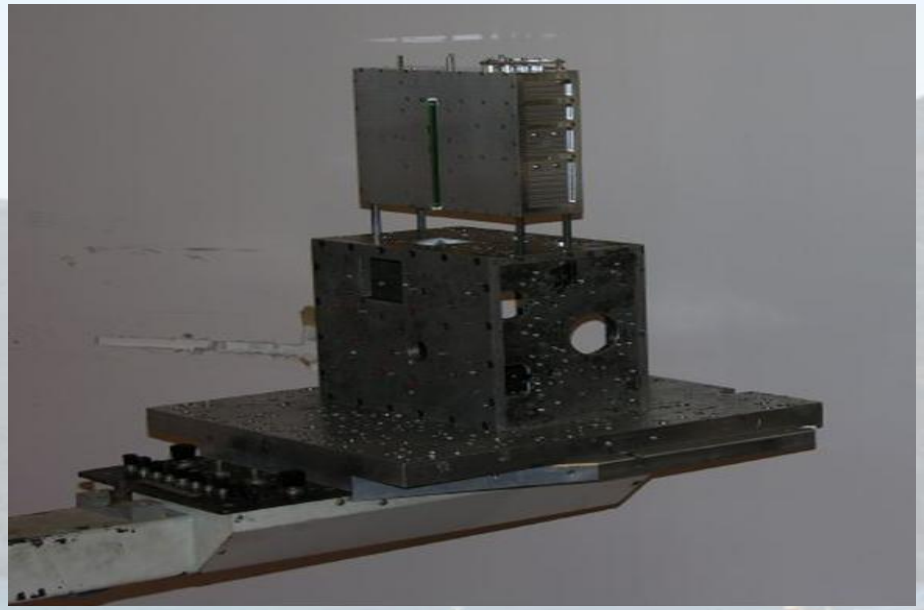
Seven orders of magnitude of solar X-ray flux covered

SphinX tests and calibrations

TV tests in Warsaw 2007

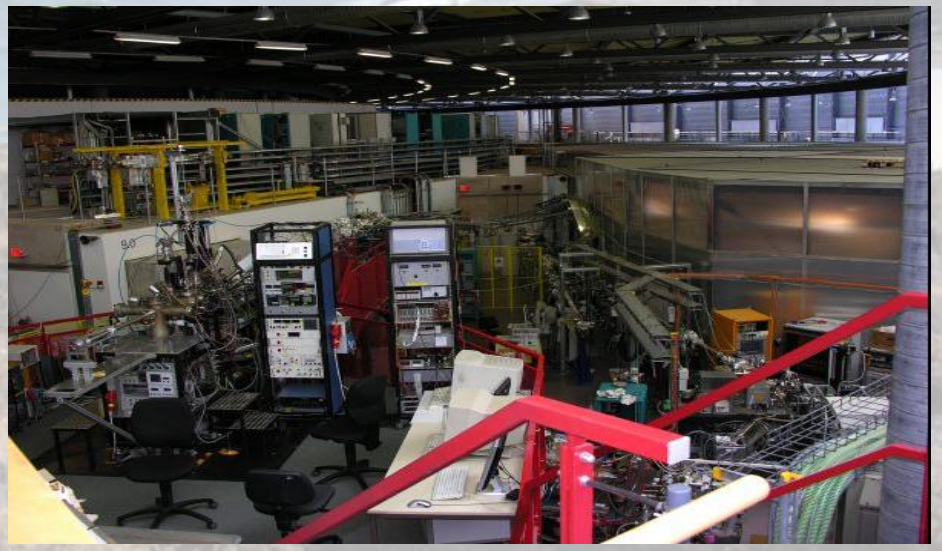


Vibration/Acceleration/Acoustic, Prague 2007

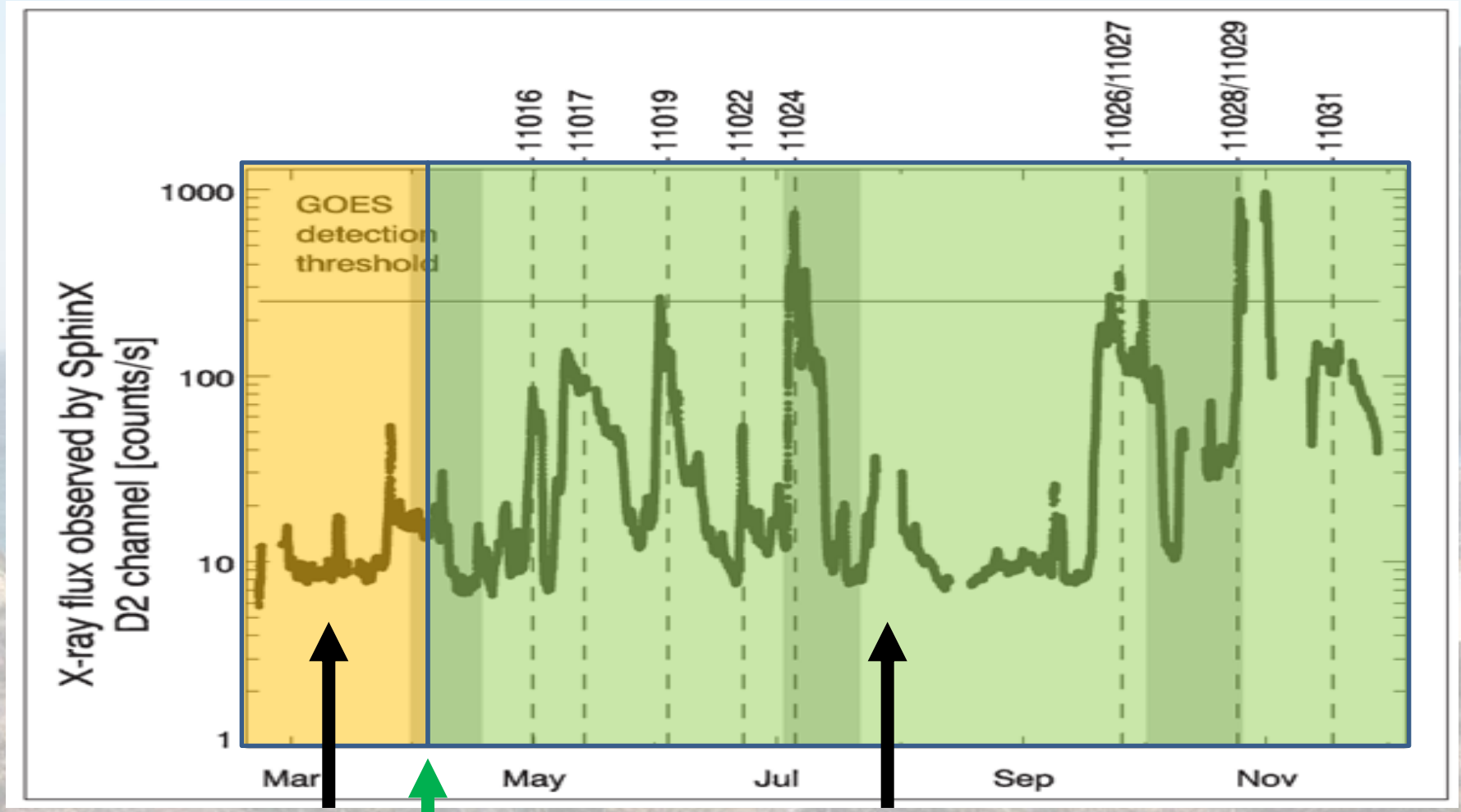


Efficiency and response XACT, Palermo, 2007

Final calibration experiment BESSY II, Berlin 2008



SphinX mission phases

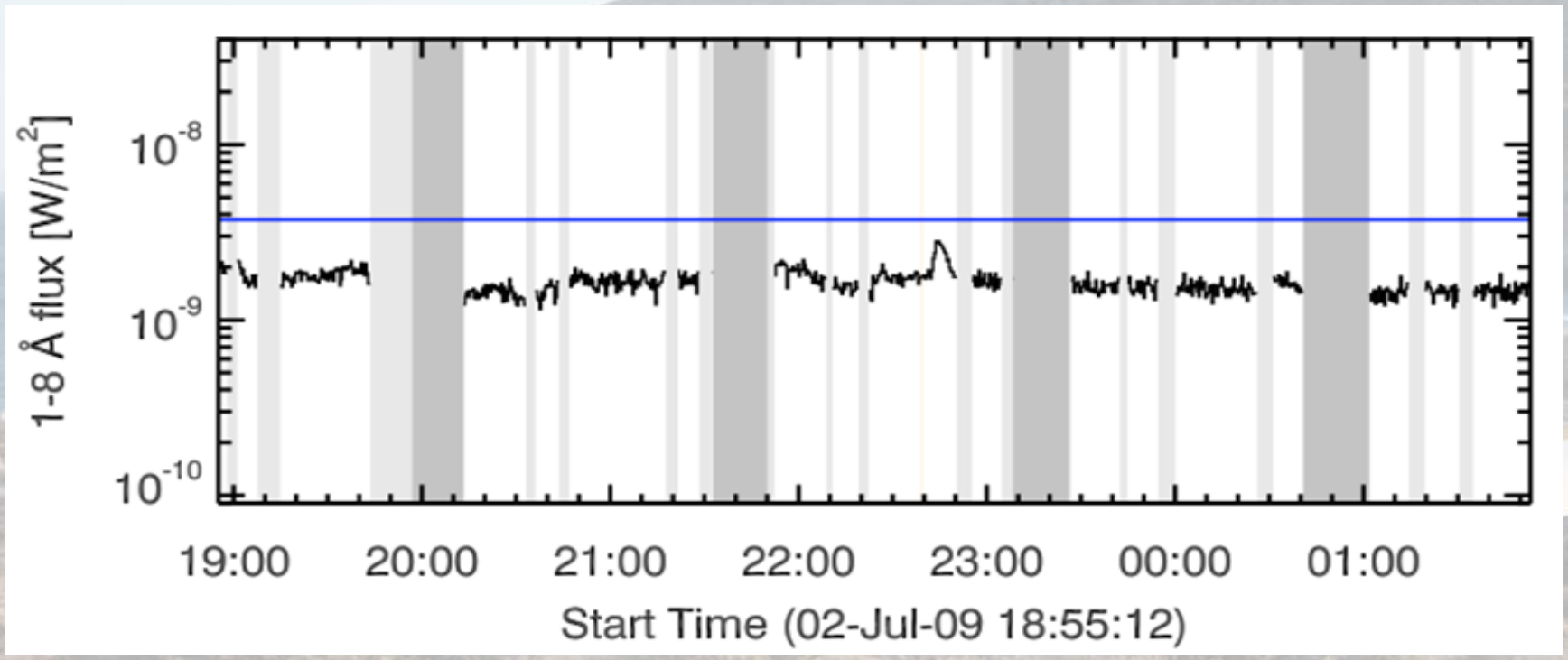


April 6, 2009 optimum on-board operation and data collection strategy achieved

SphinX

The first fully
tested and calibrated
solar spectrometer

Sphinx vs GOES



SphinX data – summary status

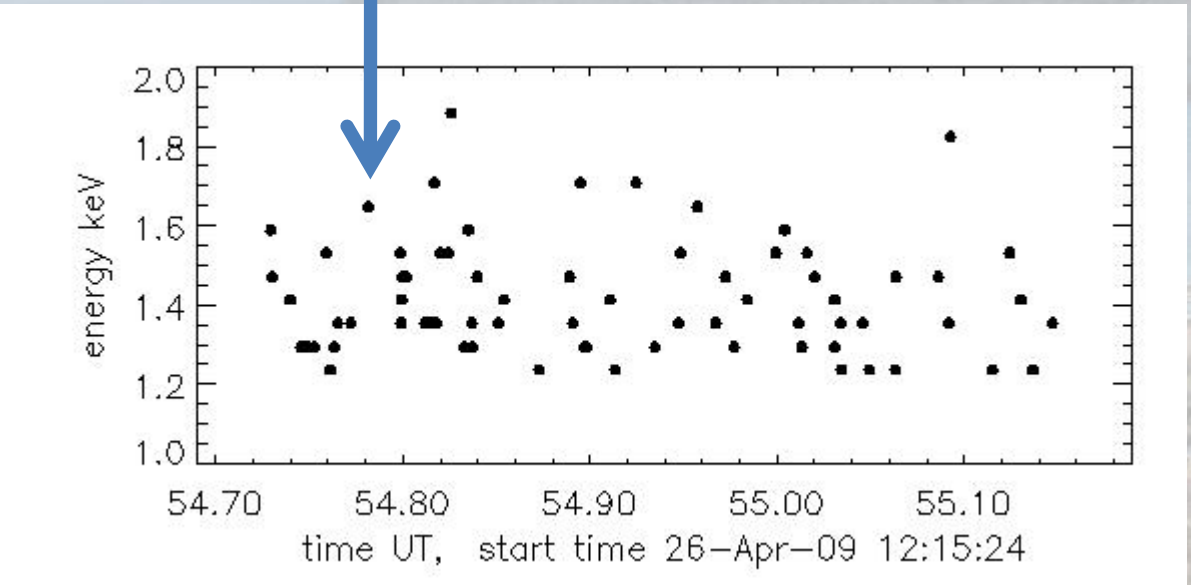
- Measurements for very low solar activity
- February 20, 2009 – November 29, 2009
- Mission phase II reduced to Level - 1
- Level - 1 data available in FITS format

OGIP 93/003

SphinX data – summary status

All data available as event lists

Detector EVENT = (arrival time, energy)



Different detector EVENTS are possible

Photon hits

Particle hits

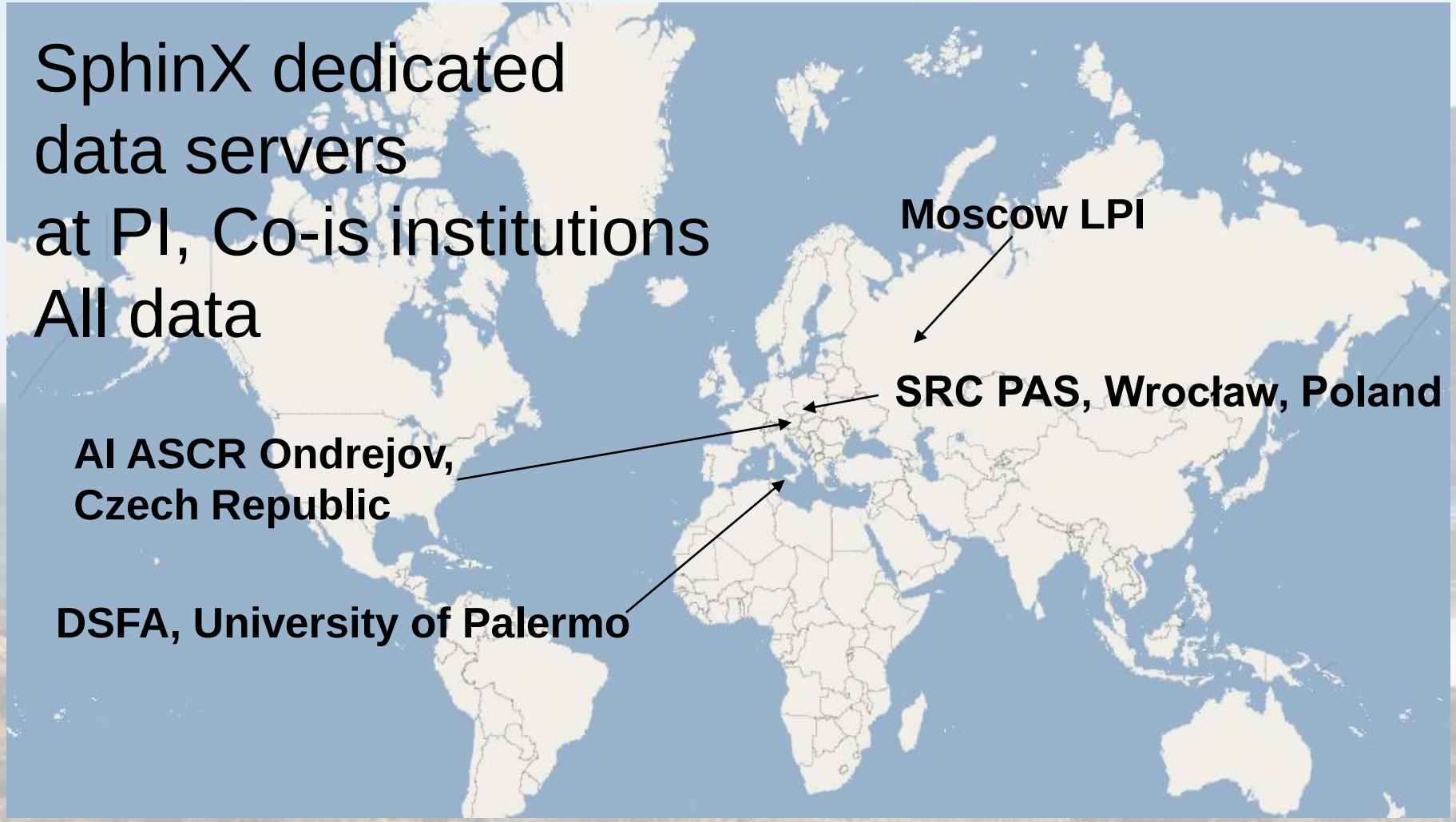
Amplifier resets

FLAG

is given to distinguish events

~5×10^9 EVENTS registered by SphinX during the mission

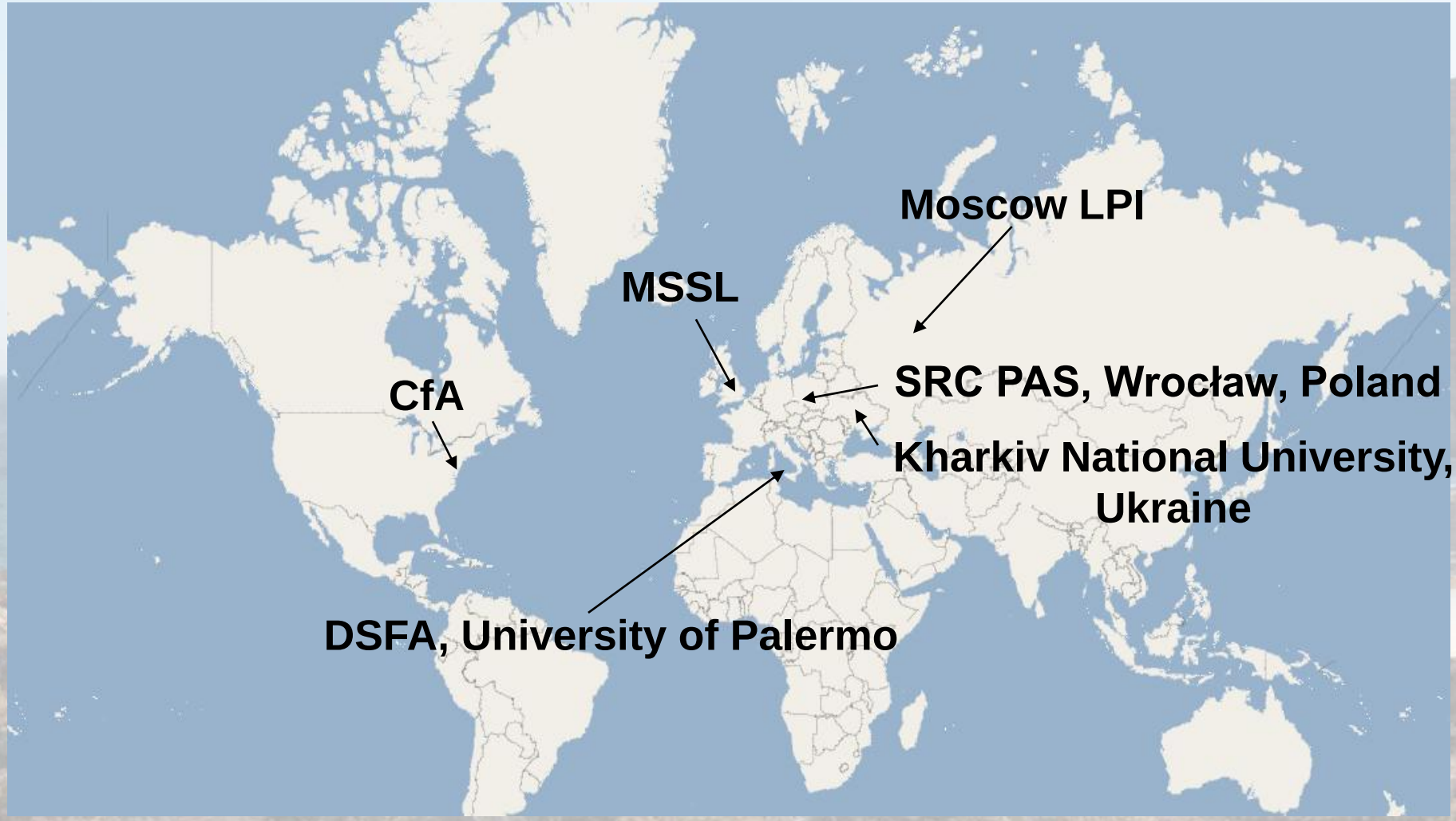
SphinX data distribution map Level - 0



Synchronized Sphinx data servers

http://156.17.94.1/sphinx_catalogue/SphinX_cat_main.html	in Wrocław, Poland
http://147.231.104.188/catalog/SphinX_cat_main.html	in Ondrejov,Czech Republic
http://www-sphinx.astropa.unipa.it/	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.

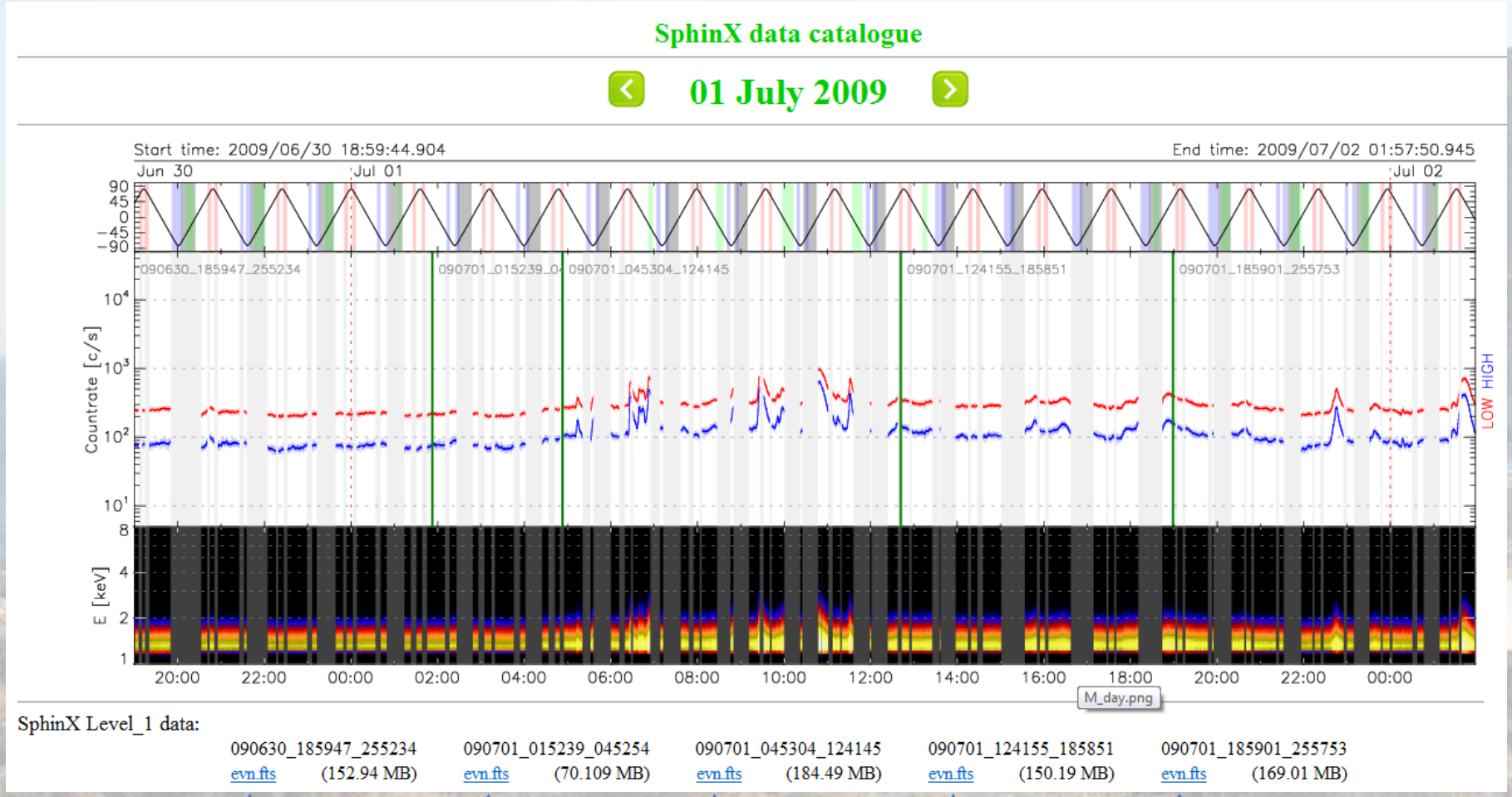
2009	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
January	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
February	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28			
March	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



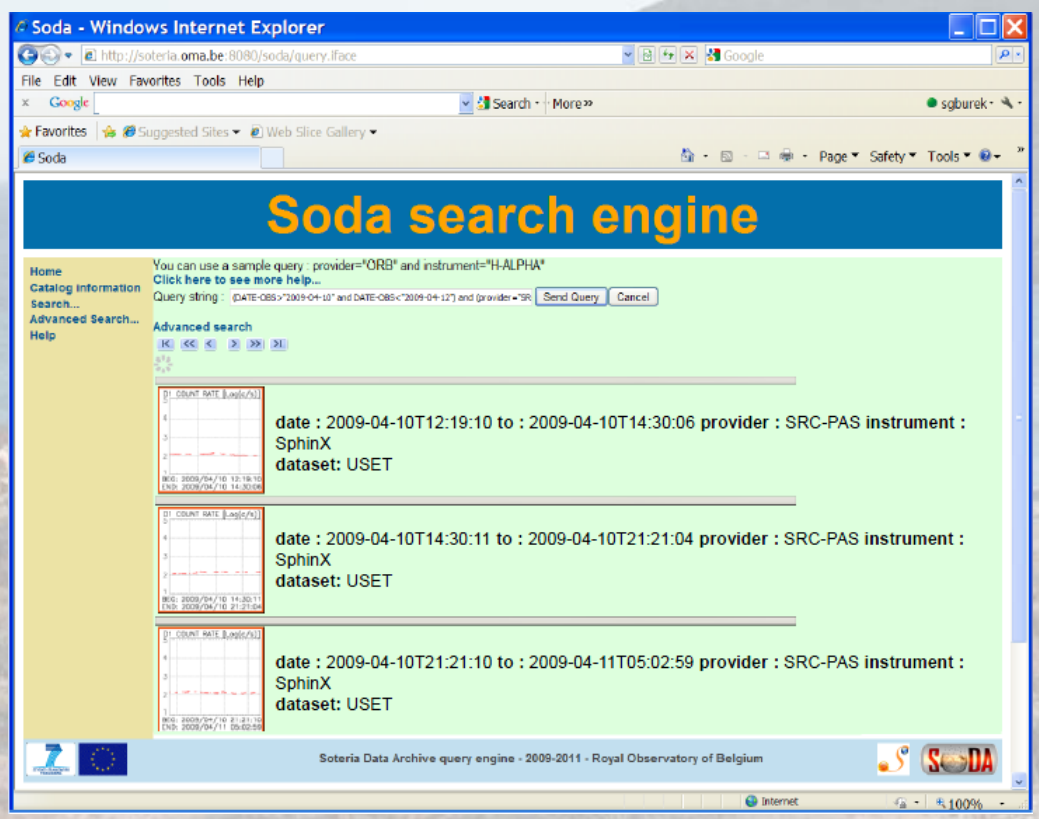
Download FITS files (OGIP format)

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

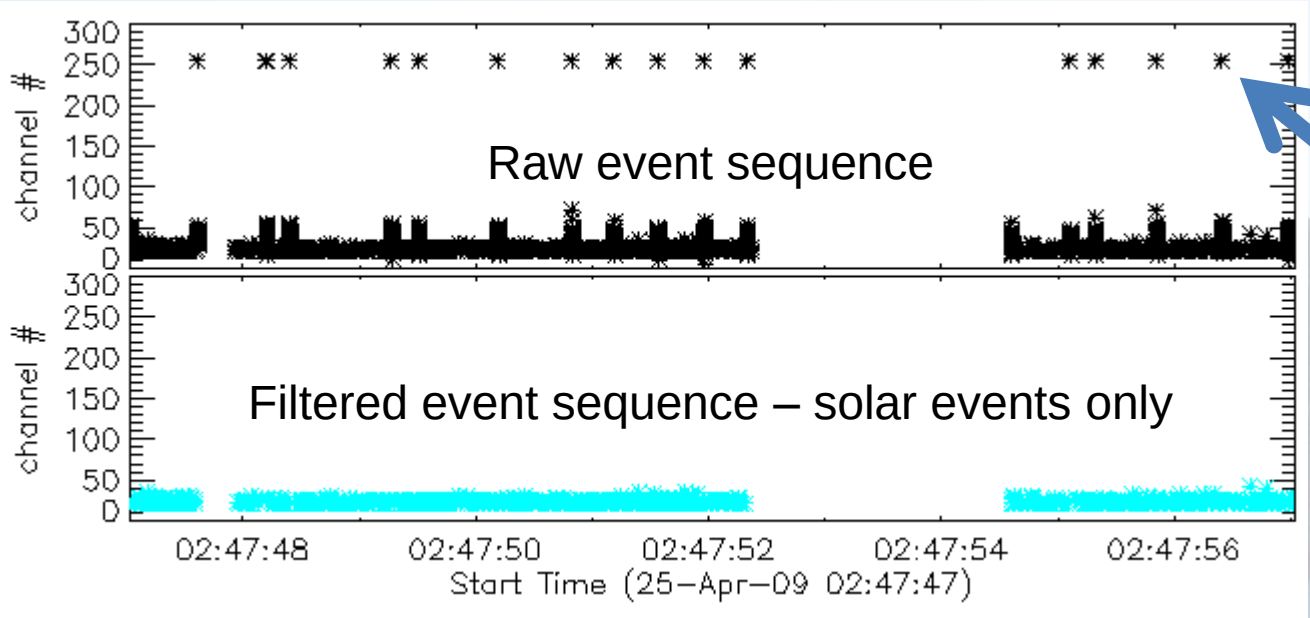


SphinX - SODA READY

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

US VSO for SphinX – in preparation

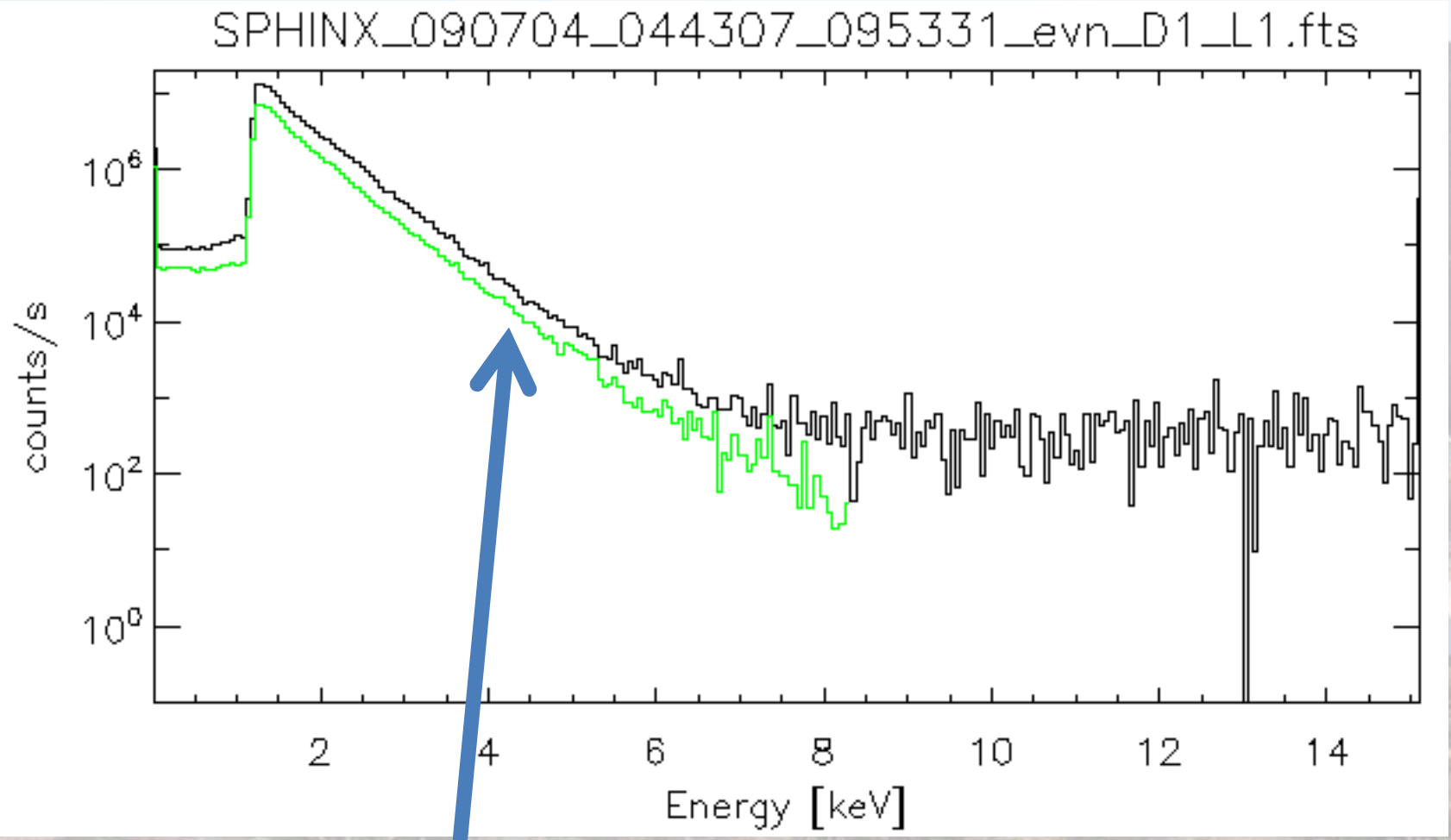
SphinX data analysis strategy



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

… 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

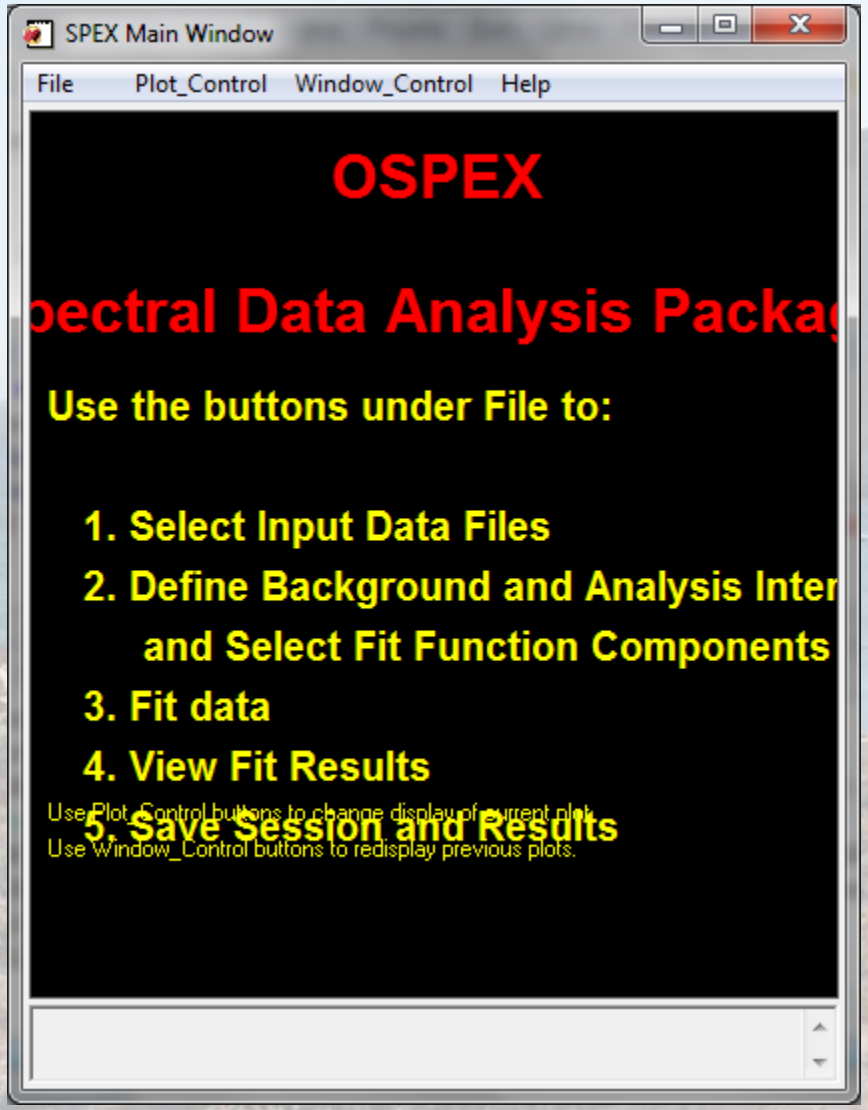
Header – string array with description of data

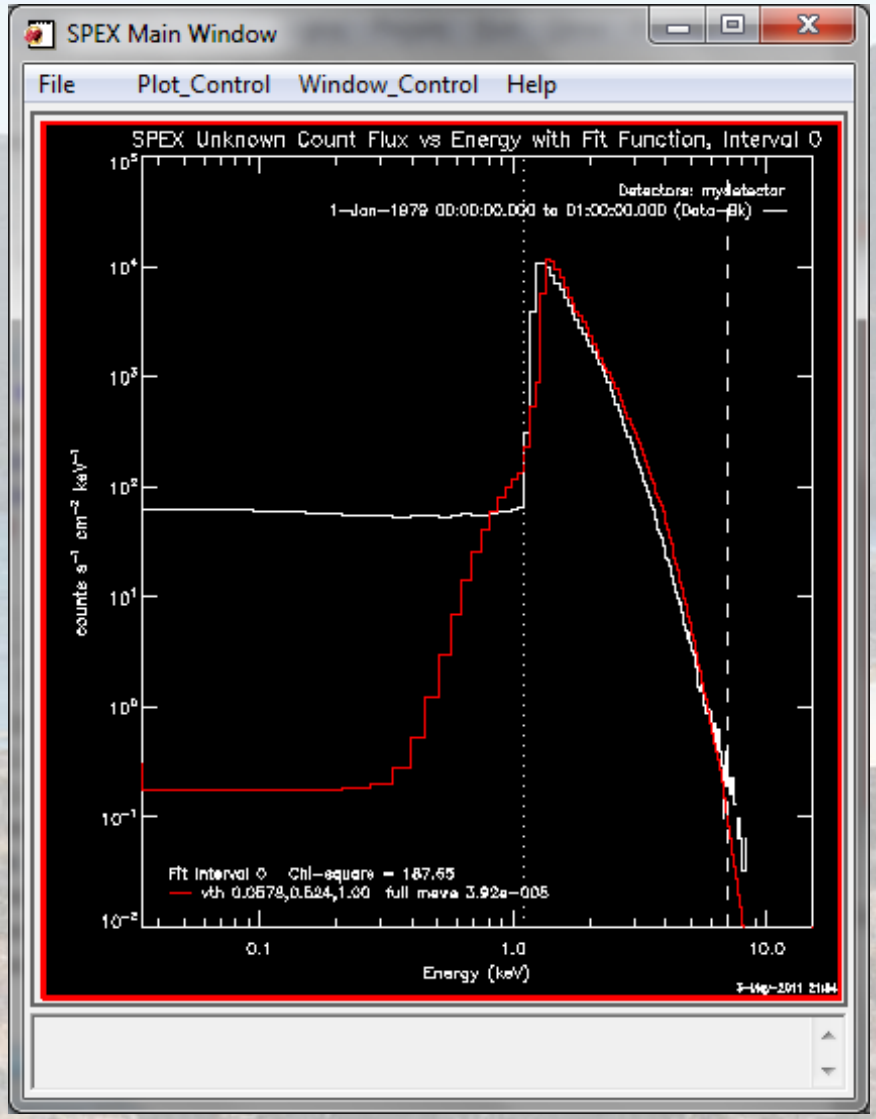
i=0 - primary header, data =0
i=1 – events HDU
i=2 – exposure HDU
i=3 – GTI HDU

IDL> pm, hdr
IDL> help, data, /st

Analysis in OSPEX

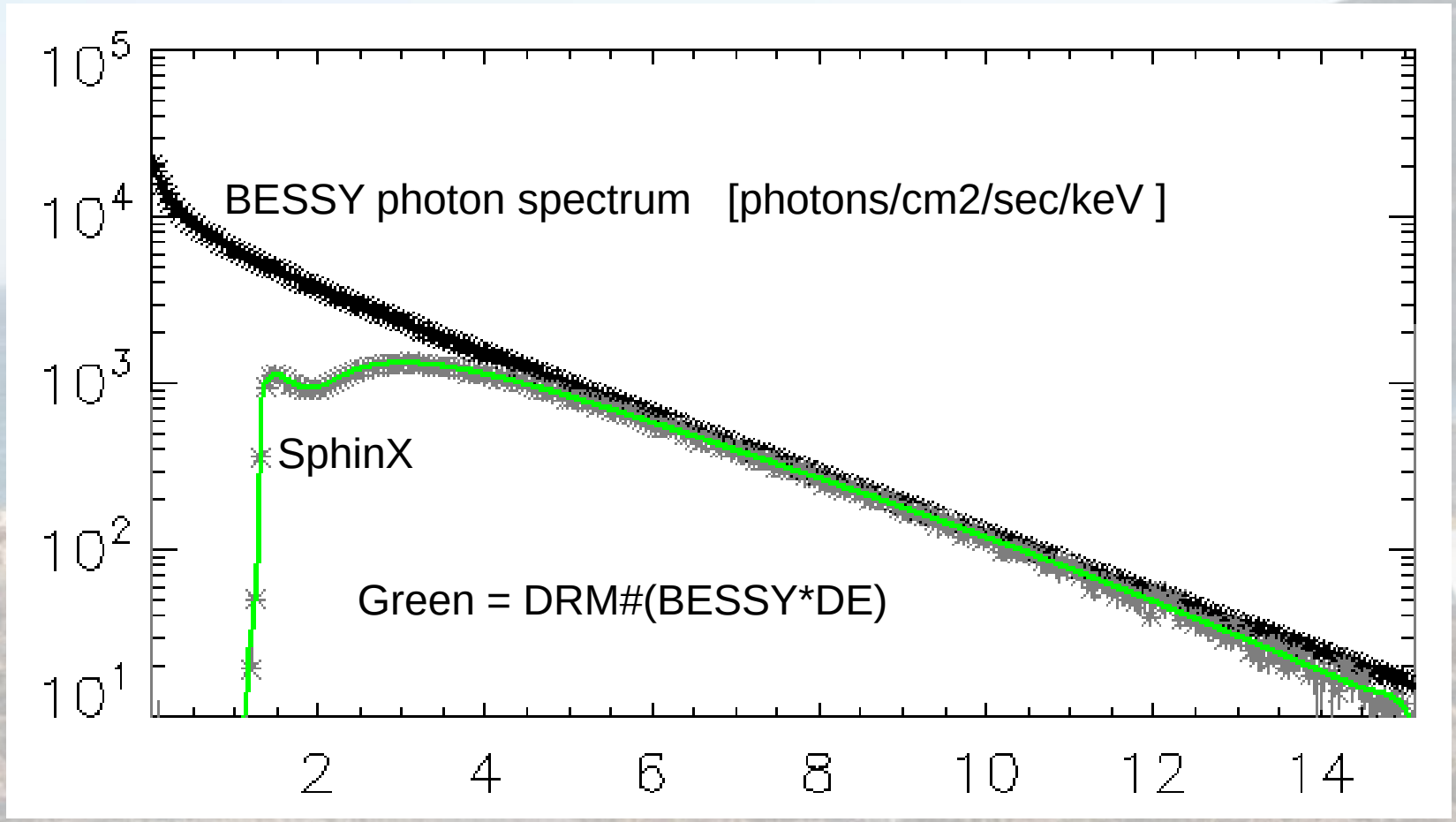
(XSPEC can be used as well)



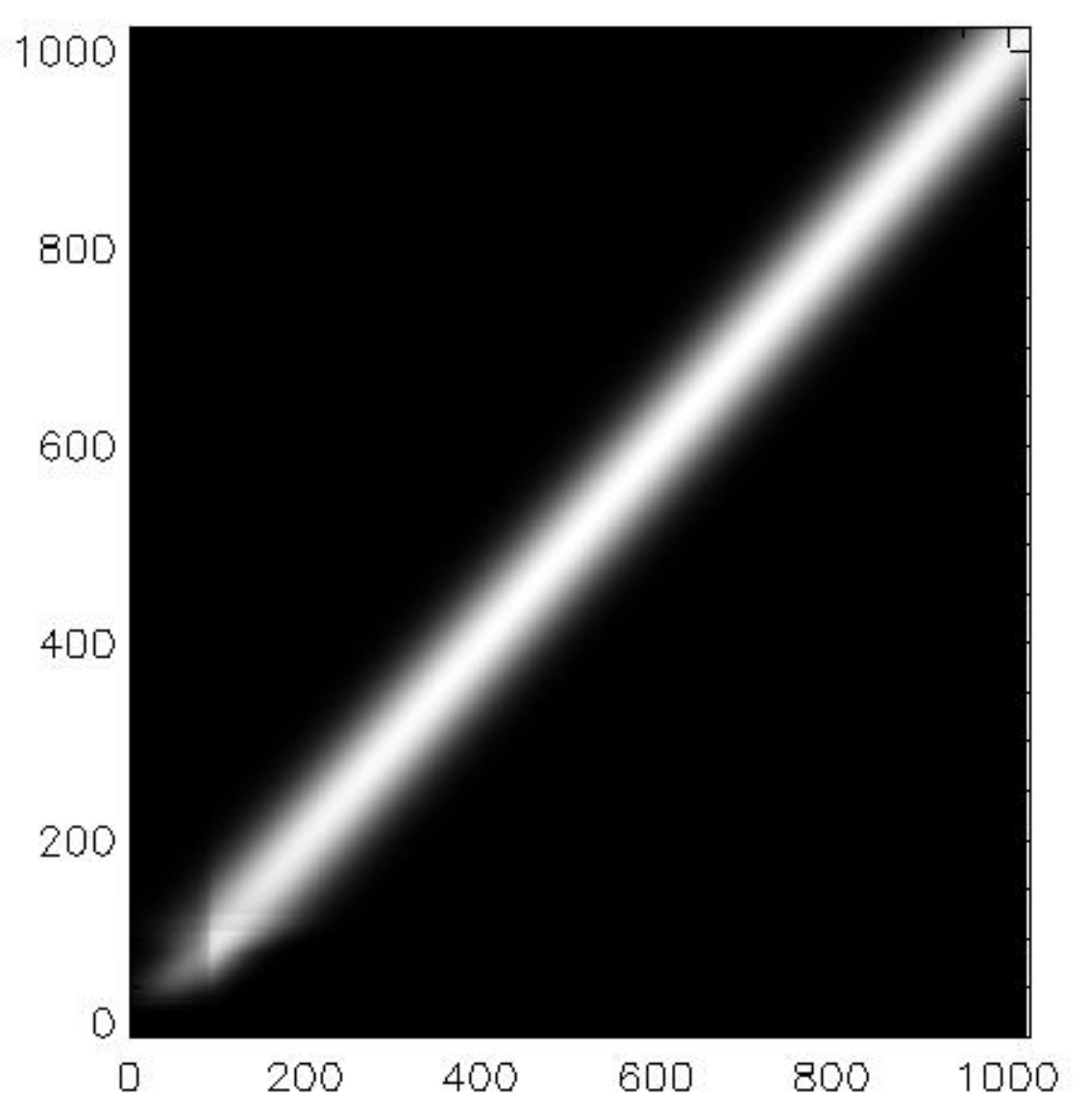


SphinX detector response matrix

DRM for spectral analysis

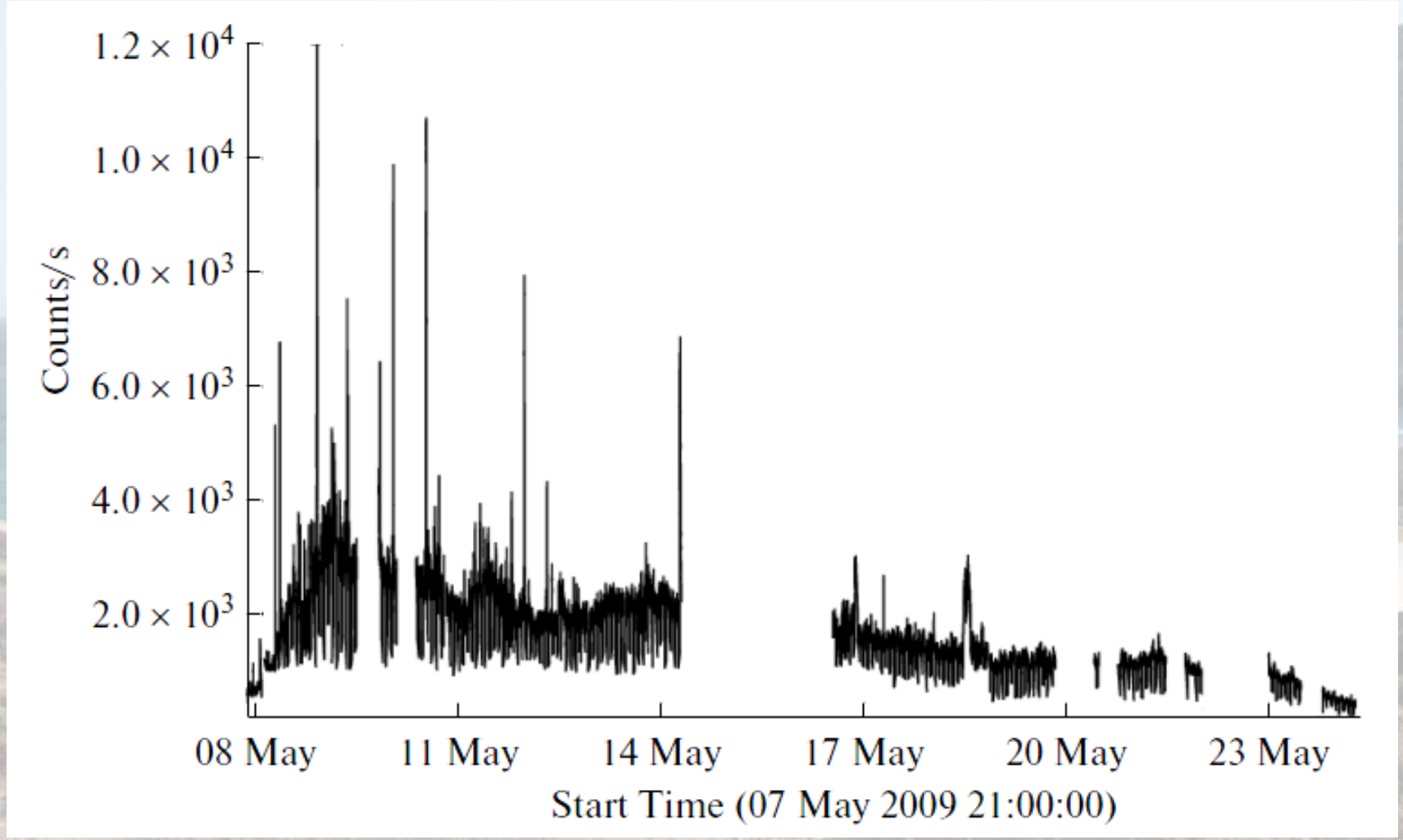


SphinX DRM

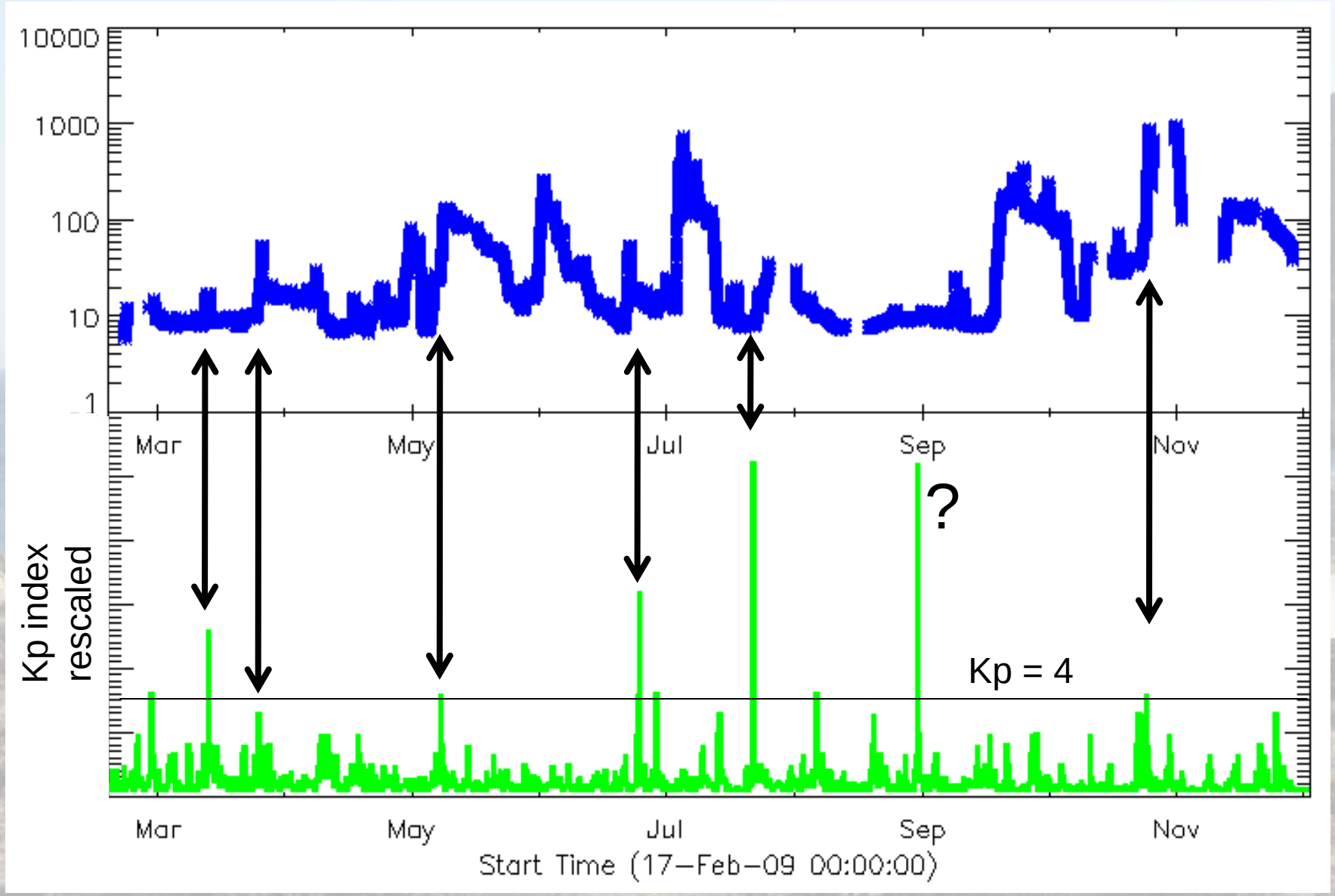


SphinX data analysis

Active regions investigations

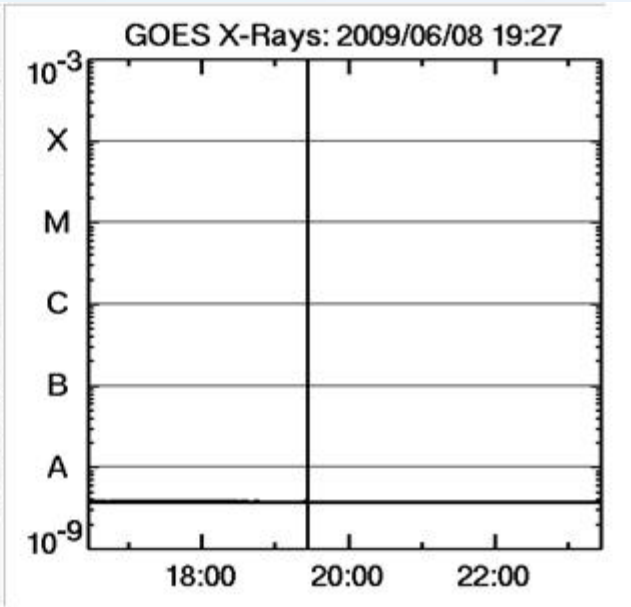


SphinX LC vs Kp index

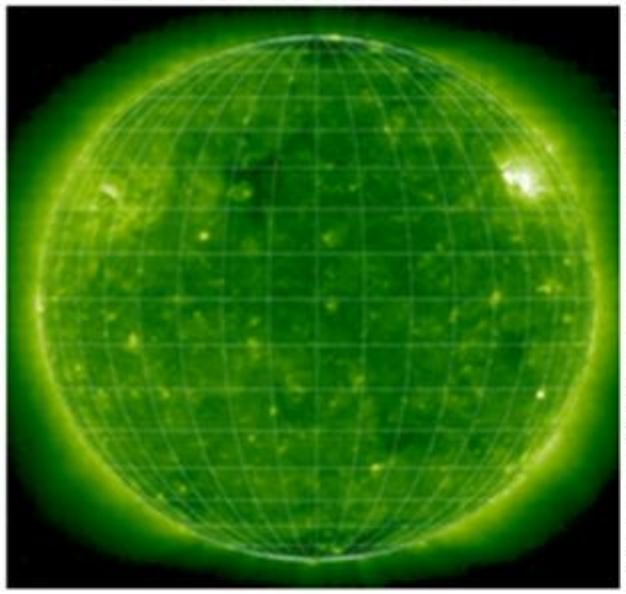


SphinX vs LASCO observations…(several tens of events)

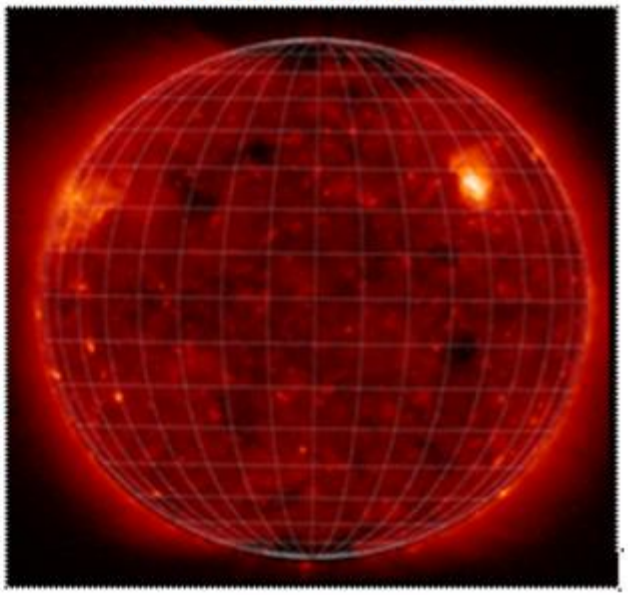
2009-06-08 CME event
C2 start at 19:27:14



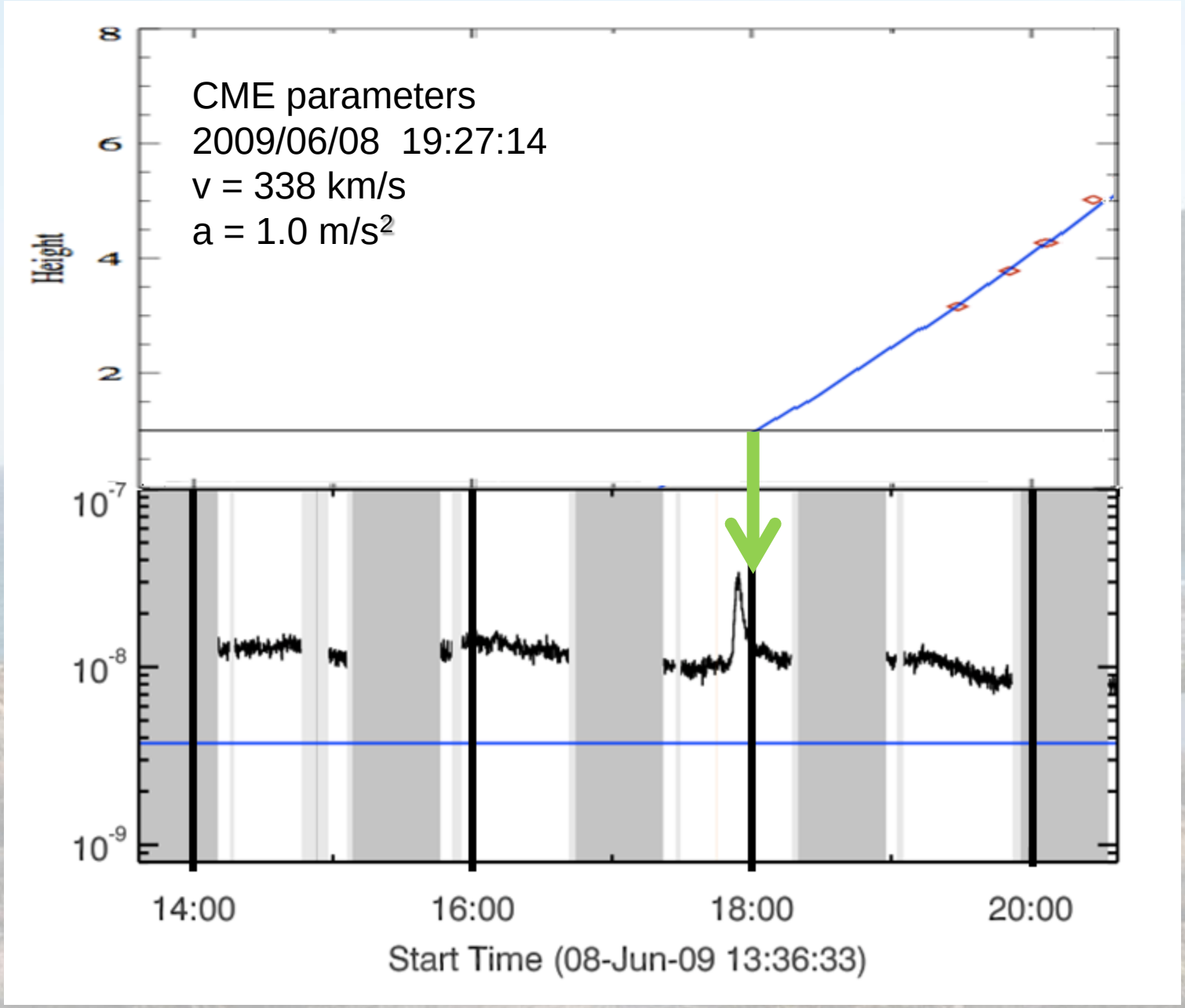
EIT 195Å 20090608 05:48



XRT 20090607 06:39

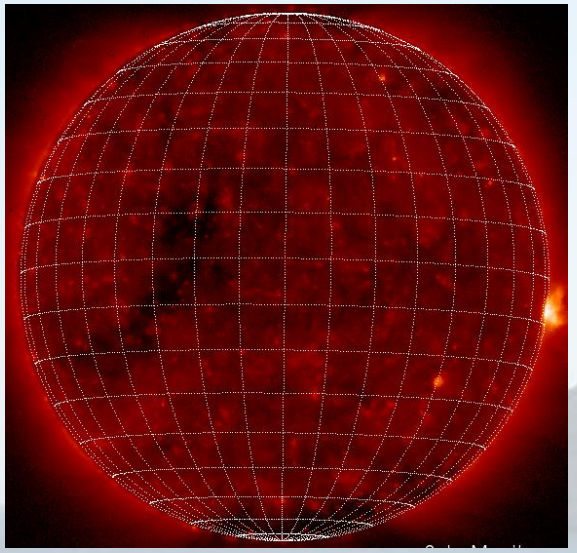


2009-06-08 CME event
C2 start at 19:27:14

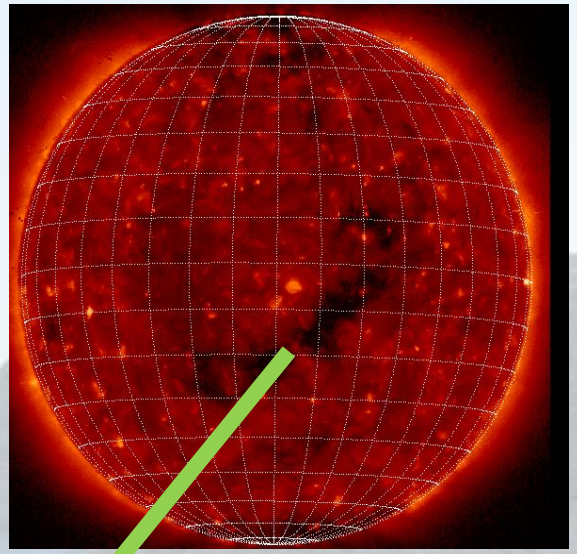


SphinX coronal hole observations

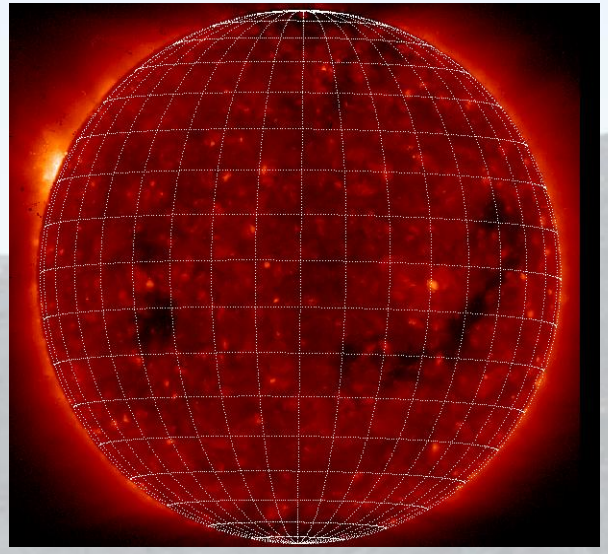
XRT 2009-05-01T18:11:00

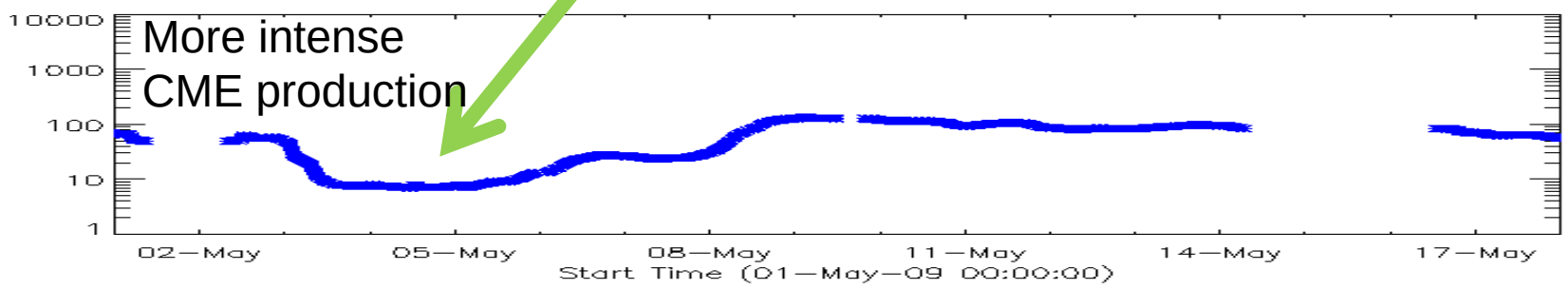


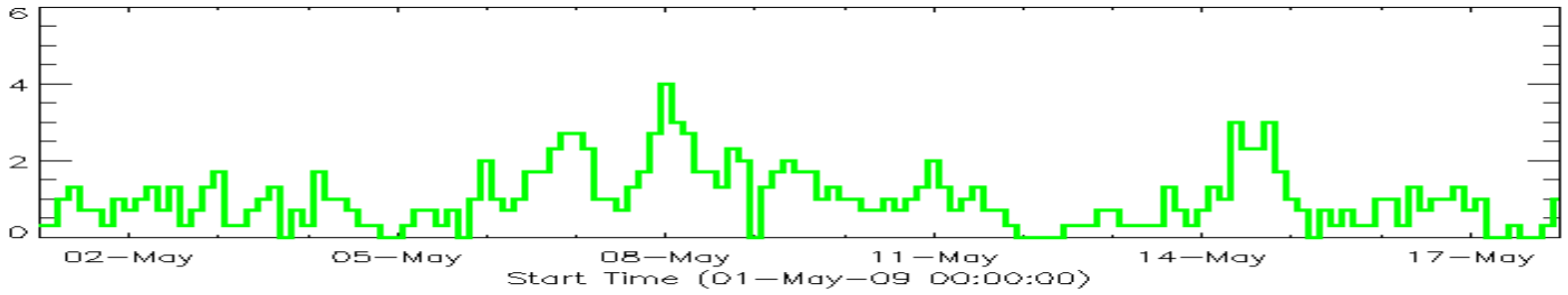
XRT 2009-05-04T18:25:00



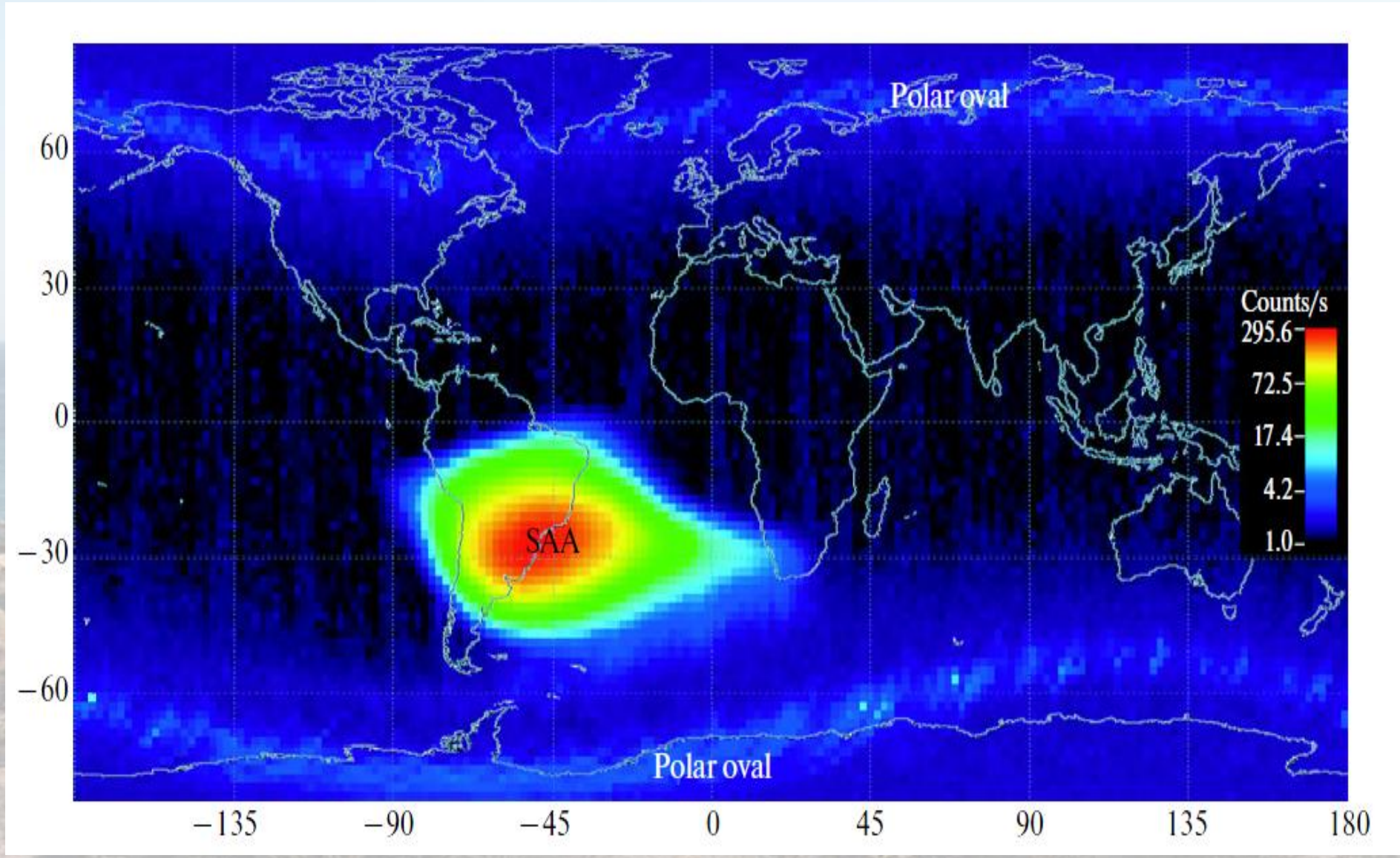
XRT 2009-05-06T18:03:00



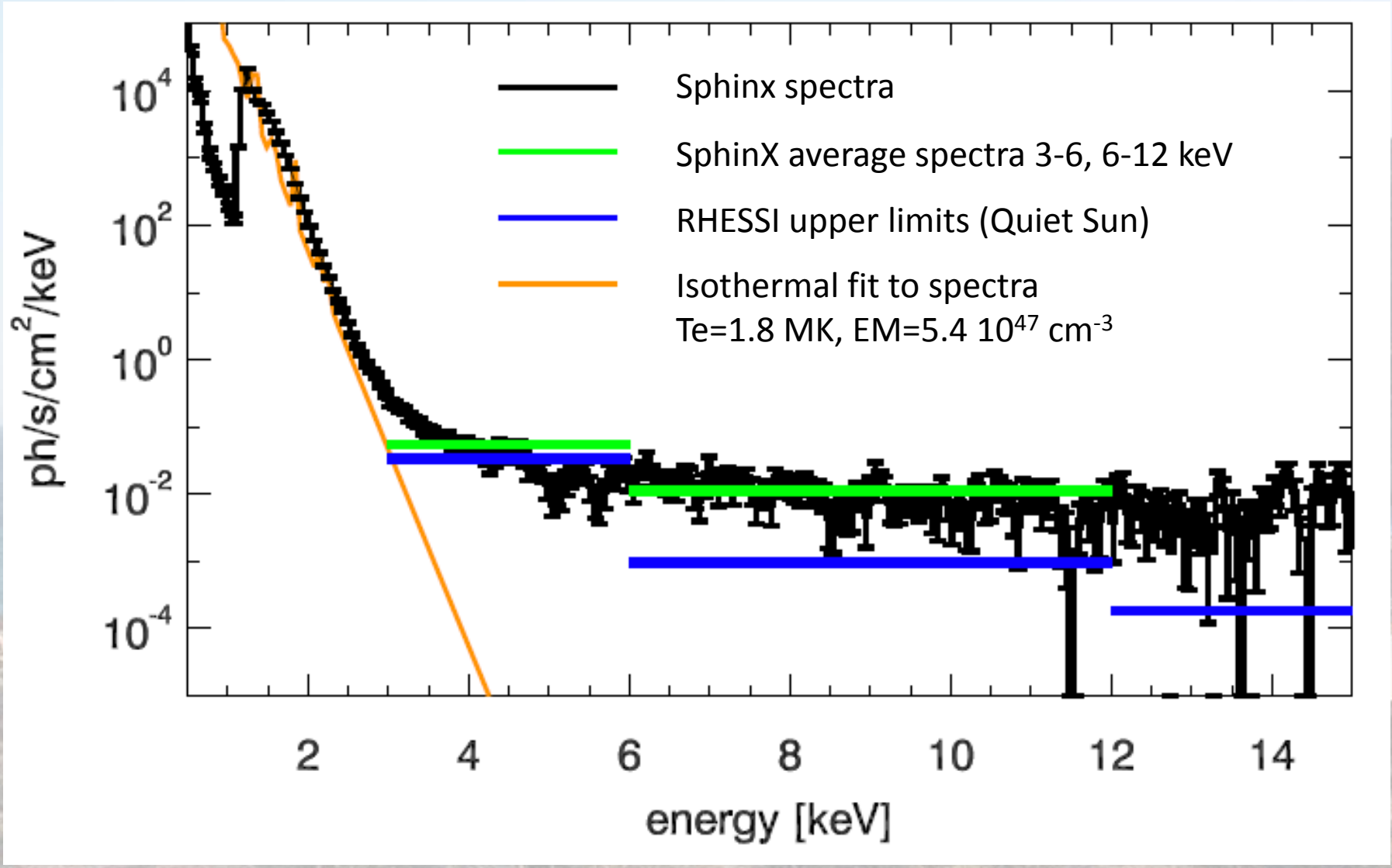




In orbit energetic particle distribution studies



SphinX spectra properties – quiet Sun, no AR on disk



$g_{a\gamma\gamma}$ ~10^{-10} GeV^{-1} GUT or DFSZ axions

$g_{a\gamma\gamma} << 10^{-15}$ 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