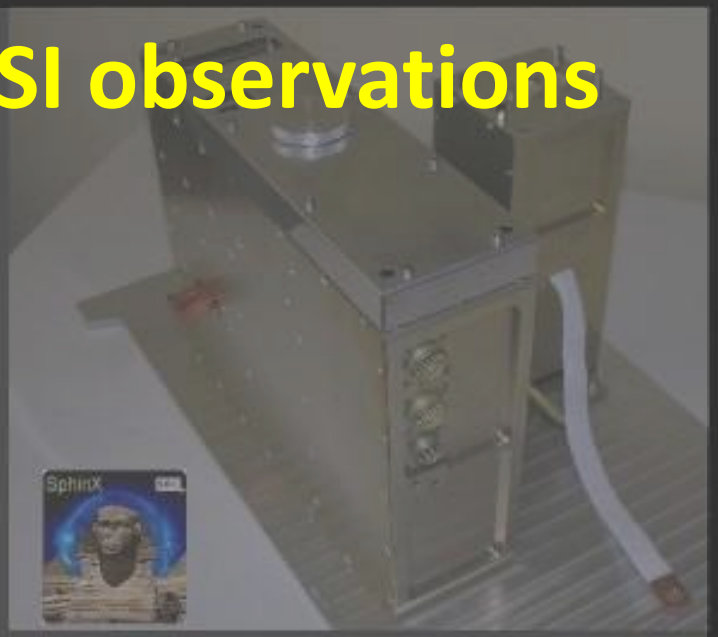
Common SphinX & RHESSI observations of solar flares



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SphinX Team

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- Astronomical Institute, Ondrejov

Frantisek Farnik

- Astronomical Observatory, Palermo

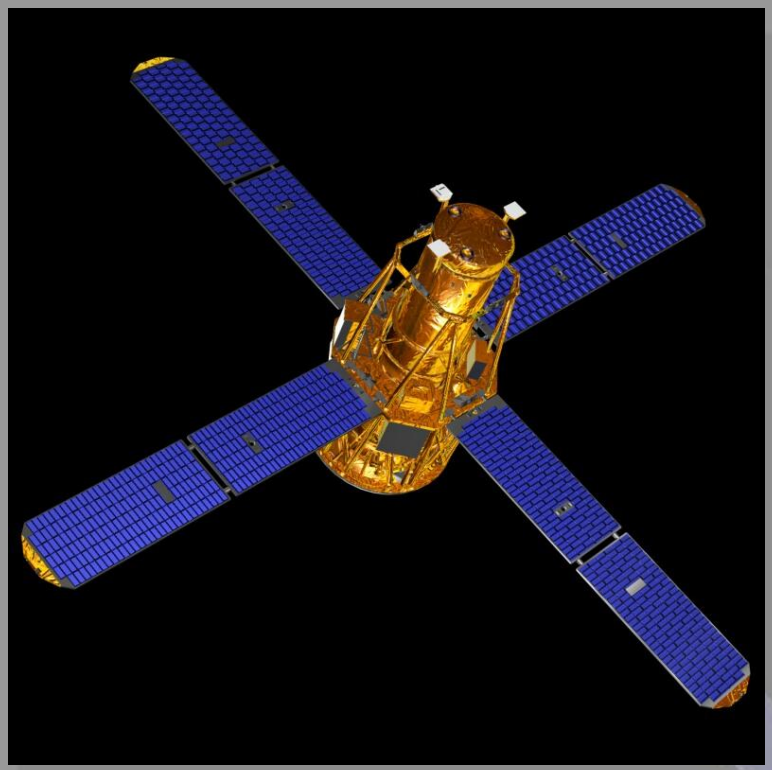
Fabio Reale, Alfonso Collura

- University College, London

Ken Phillips

Motivation

Aim: to compare data obtained by two different instruments



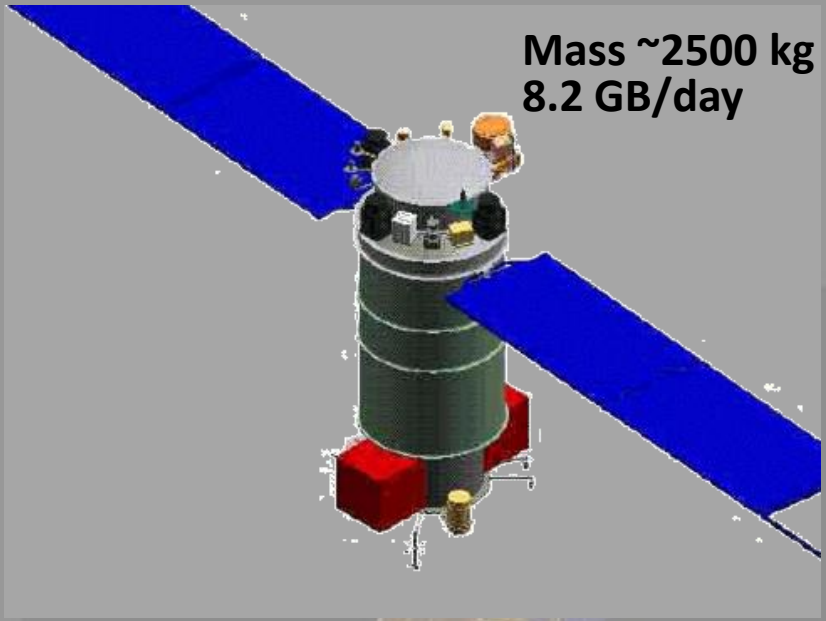
Motivation:

-observations overlap in the energy range 3-15 keV

-SphinX is absolutely calibrated, RHESSI is well explored due to 9 years of observations

-possibility for extending spectral fits to energy of the order of 1 keV – improvement of spectral fits in the lowest energies observed by RHESSI

SphinX & CORONAS-Photon

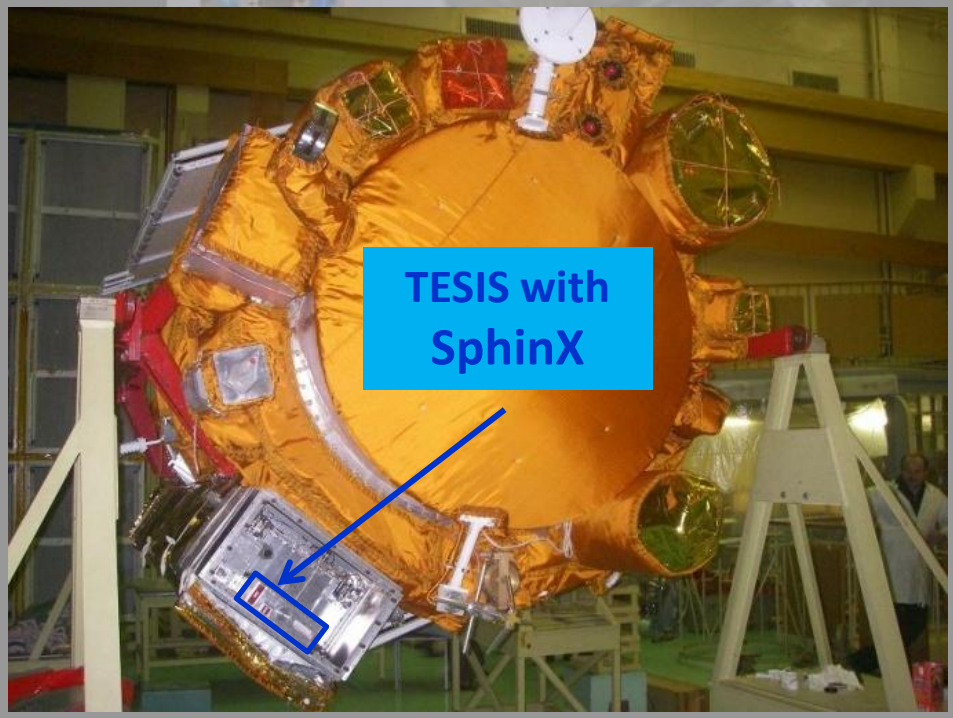


Mass ~2500 kg
8.2 GB/day

Launched
30 Jan. 2009 at 13:30 UT from Plesetsk Cosmodrome
aboard *CORONAS-Photon*

http://www.tesis.lebedev.ru/

1 Dec 2009 – end of the mission

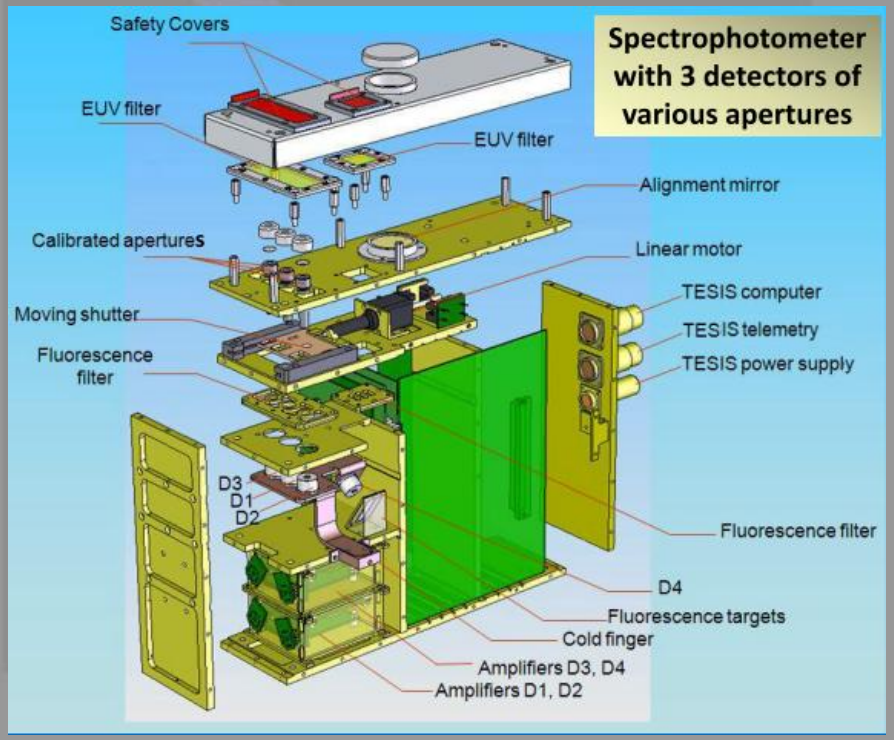


SphinX - Polish concept, design & manufacture

Solar Photometer in X-rays (SphinX)

GOALS: to measure the X-ray emission of the Sun in the ~0.8 – 15 keV band

Method: energy and arrival time are measured for each photon



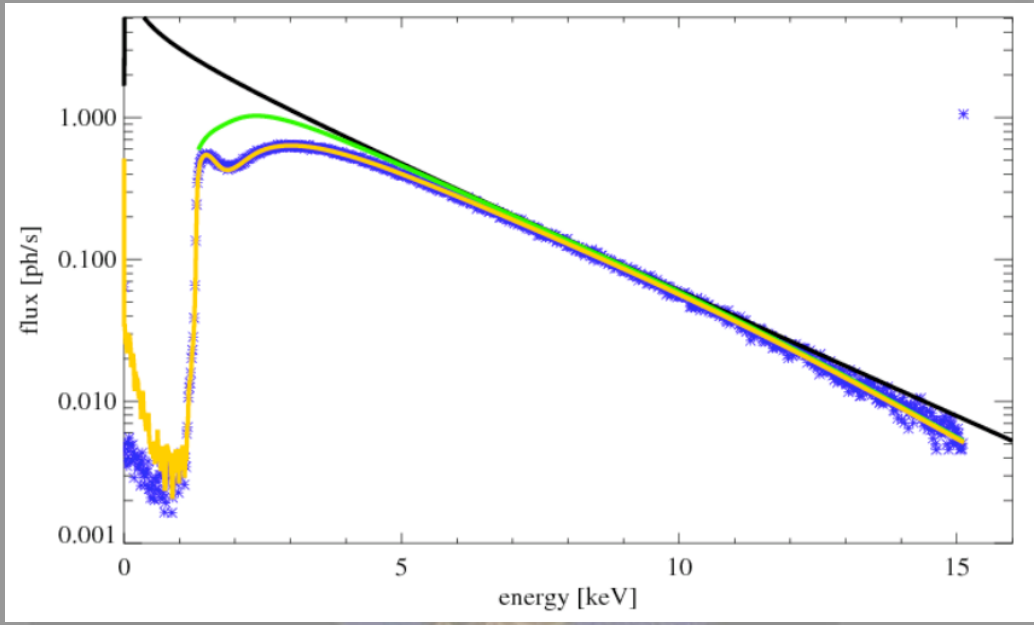
-**energy range: 0.8 – 15 keV**

-**time resolution: ~0.00001 s**

-**sensitivity: 100x better than GOES XRM**

-**energy resolution: ~0.4 keV**

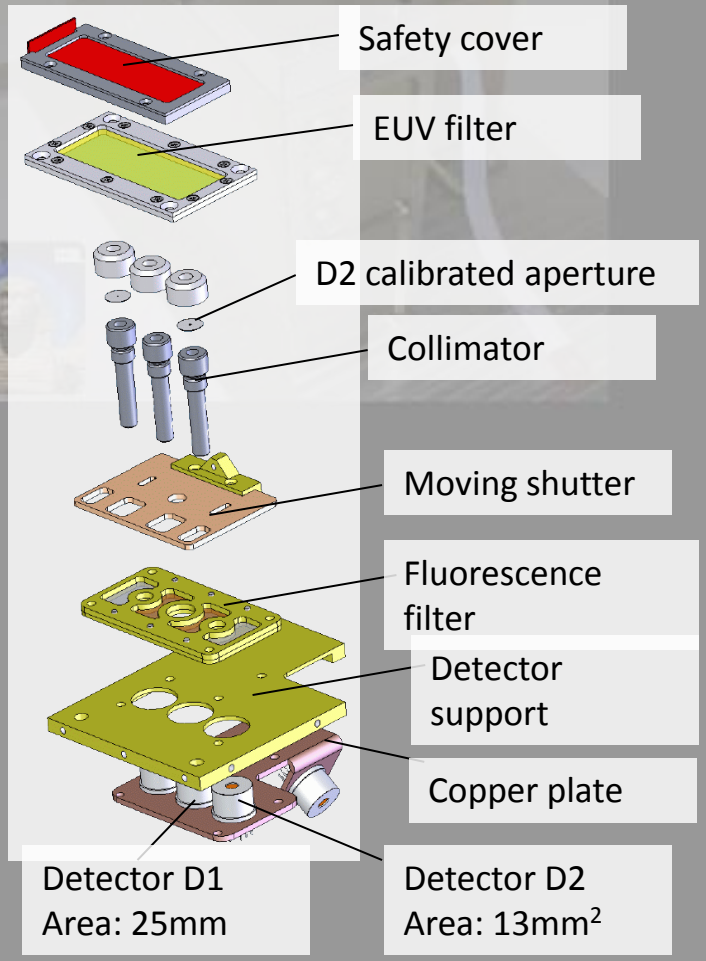
SphinX - Polish concept, design & manufacture



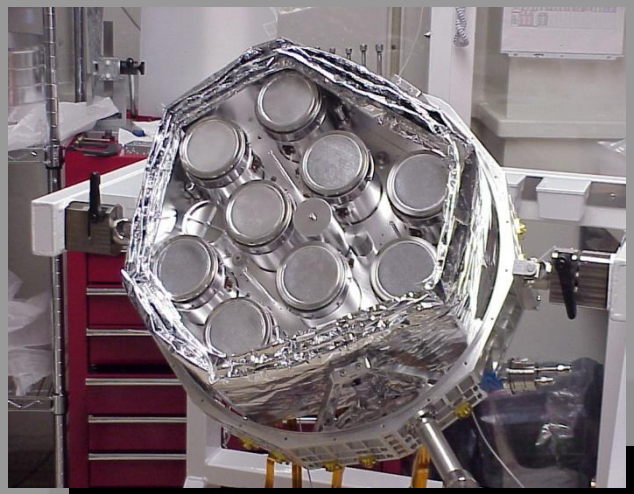
black – the BESSY synchrotron input spectrum
blue – overplotted response of SphinX D1 detector (300 spectra)
green – nominal effective areas
yellow – the optimum theory model

The agreement is better than 5% in the energy band where SphinX detectors are the most sensitive.

SphinX optical entrance



RHESSI (Ramaty High Energy Solar Spectroscopic Imager)



- launched: February 2002

-9 large germanium detectors

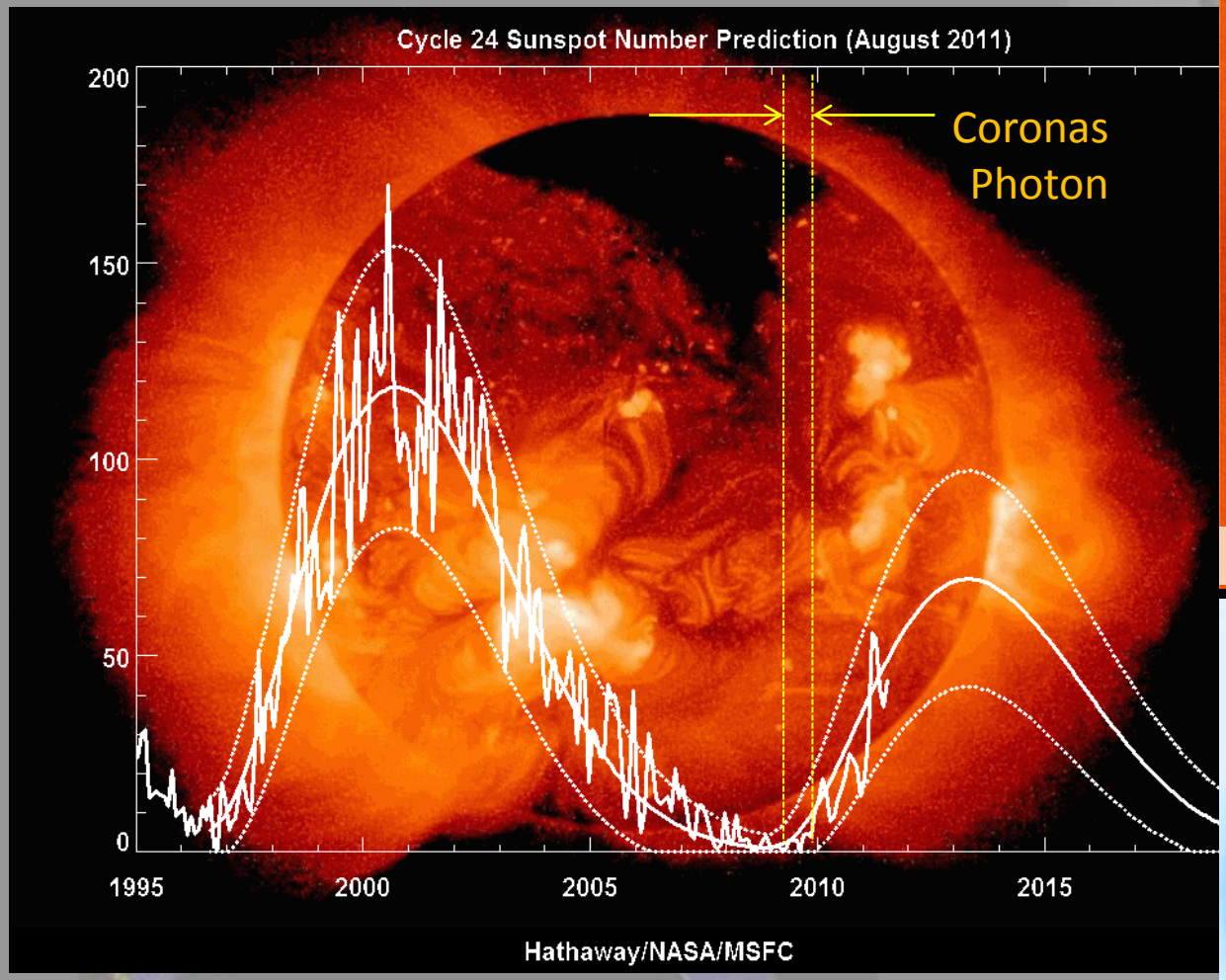
- observations in the 3 keV – 20 Mev energy range

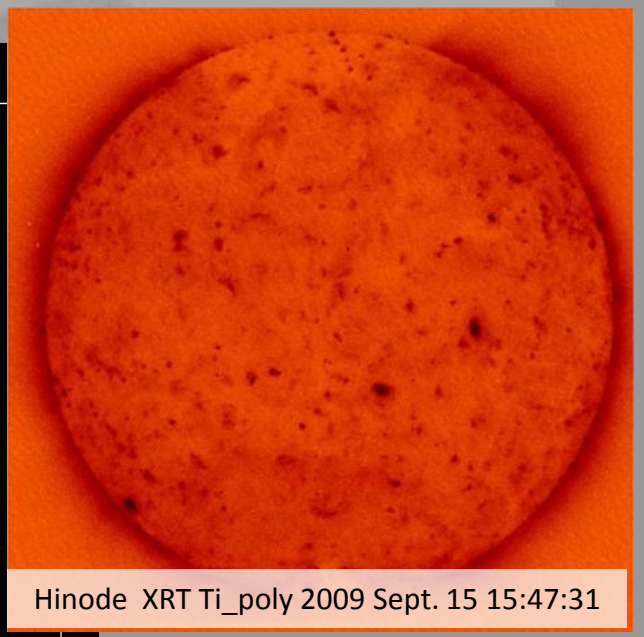
-energy resolution 1 keV - 5keV

- temporal resolution related to rotation period ~4 s (images), time resolution of lightcurves may be improved by some demodulation methods

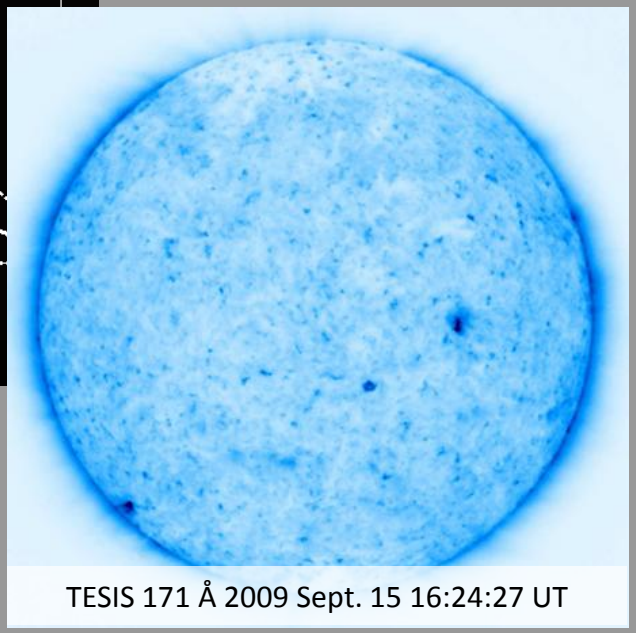
-lower sensitivity (2009) in comparison to first year (2002) due to radiation damage, but still is able to observe even smallest flares (at present the sensitivity is again very high thanks to annealing performed in March 2010**)**

2009: the year of low solar activity



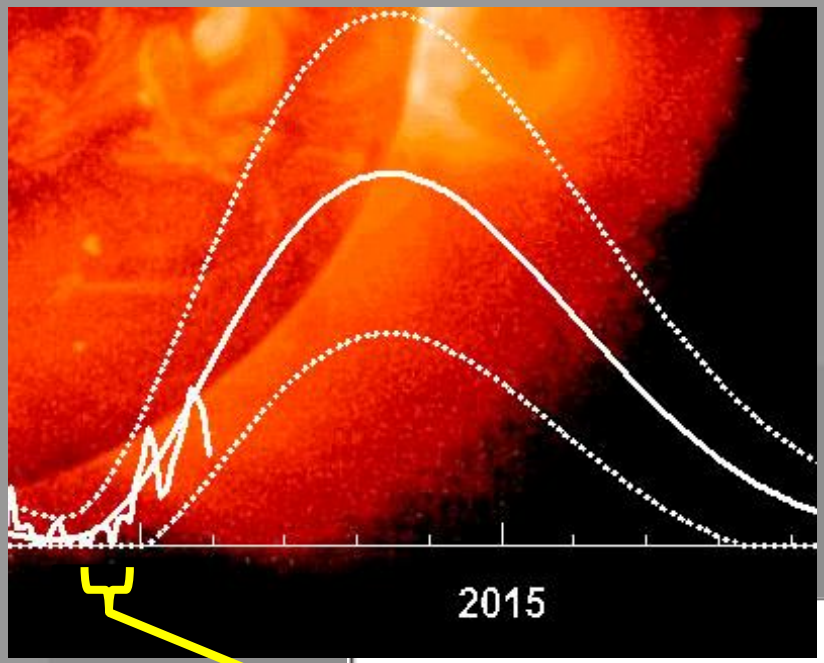


Hinode XRT Ti_poly 2009 Sept. 15 15:47:31



TESIS 171 Å 2009 Sept. 15 16:24:27 UT

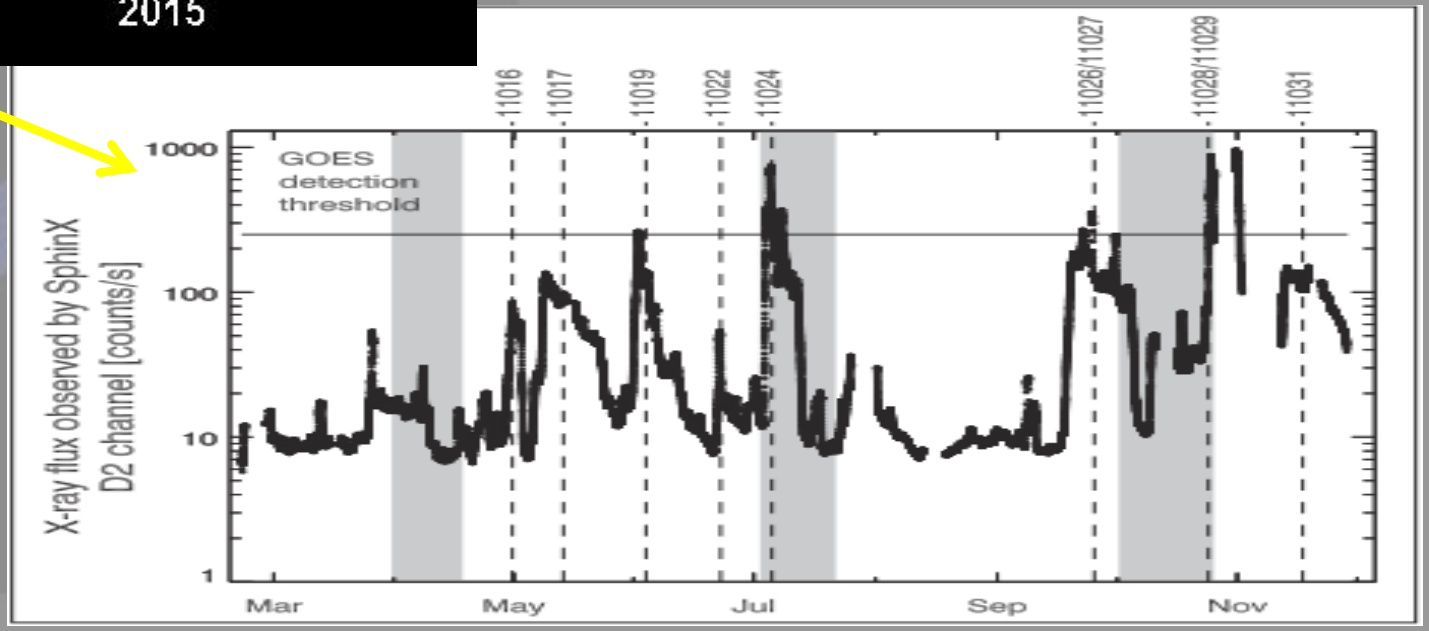
Observational period



-extremely low activity

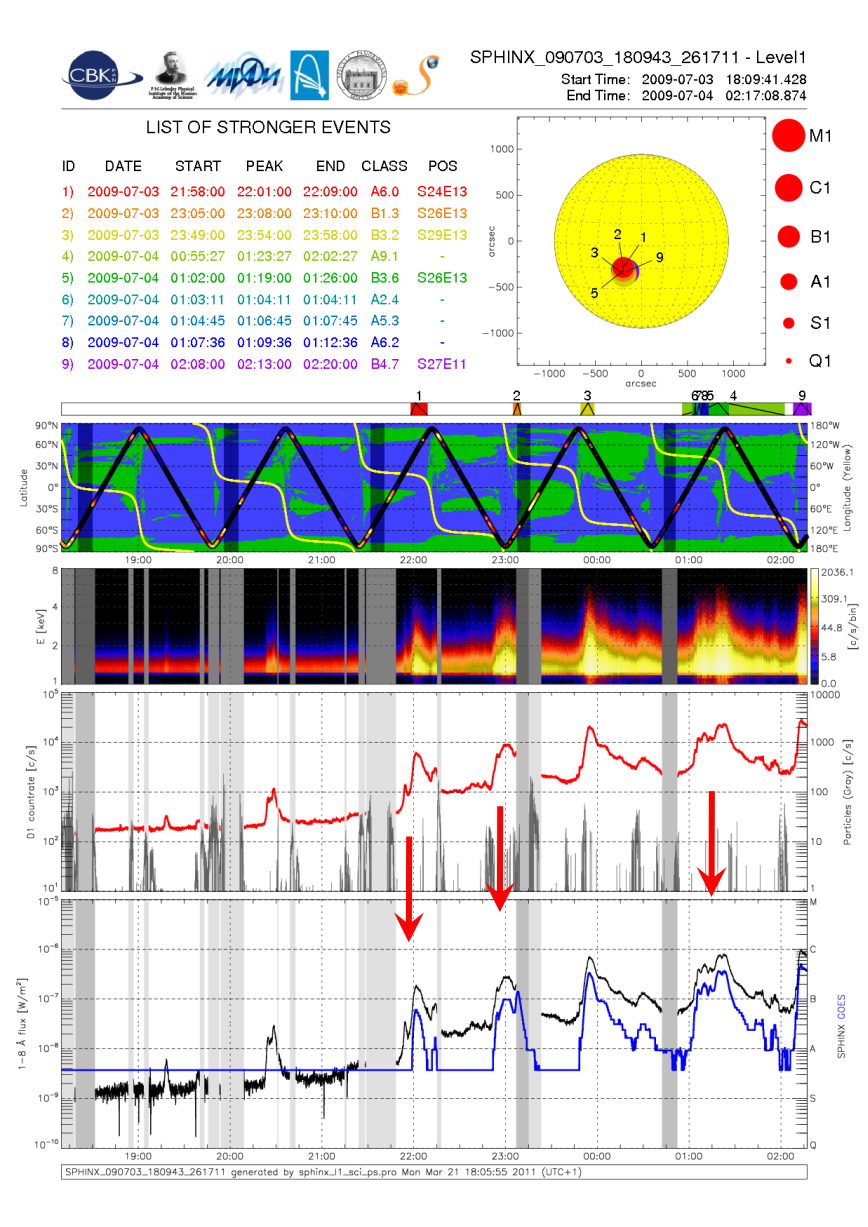
-mainly A,B – class flares, few C-class

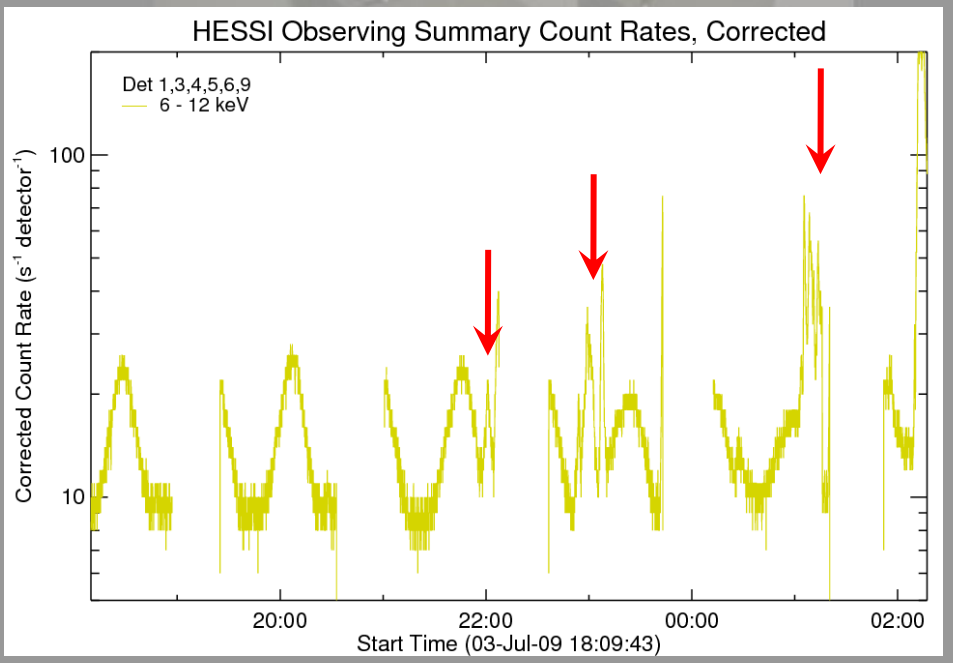
-decreased sensitivity of RHESSI detectors due to radiation damage, but even smallest A-class events are clearly seen in data



Flares selection

156.17.94.1/sphinx_l1_catalogue/SphinX_cat_main.htm





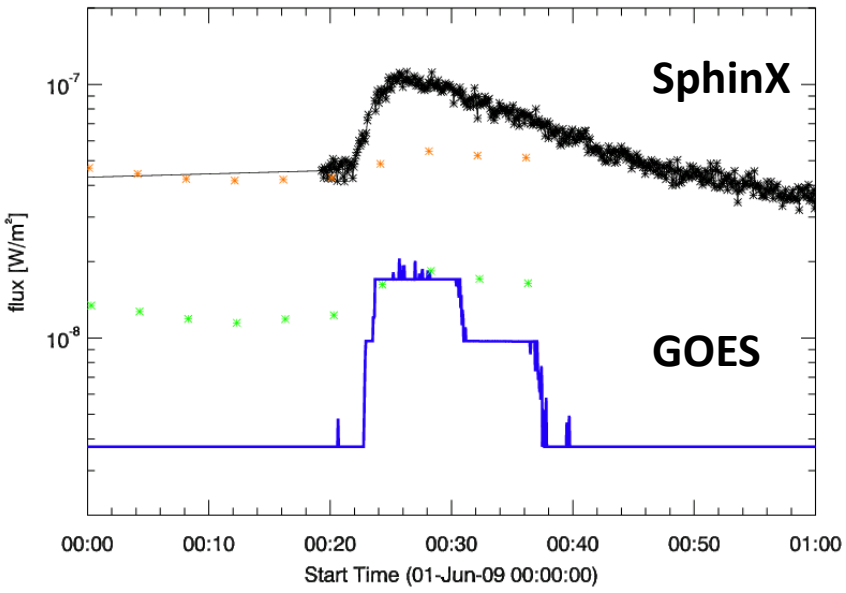
Flares were chosen by the inspection of RHESSI and SphinX data catalogues

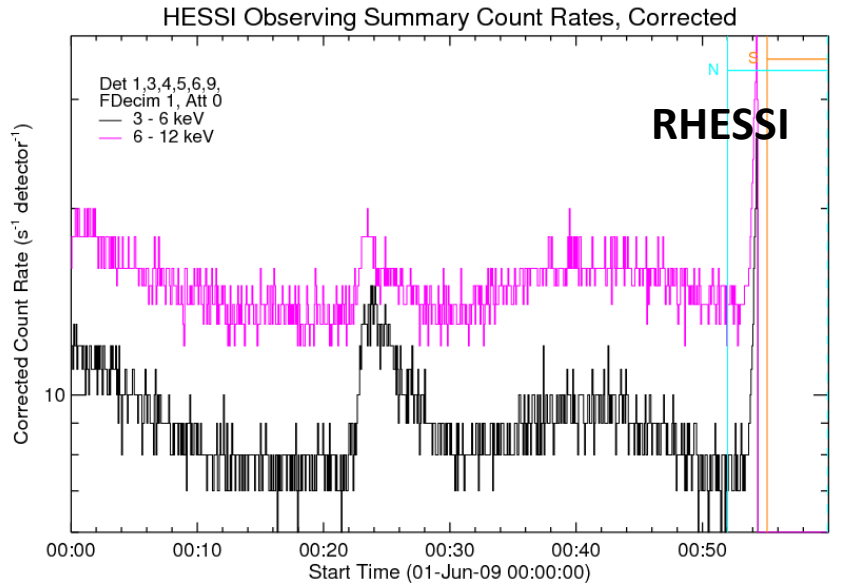
37 common RHESSI and SphinX observations of flares have been found

GOES classes from A1.2 to C1.0

Locations on the disk and on the limb

Examples 01-Jun-2009



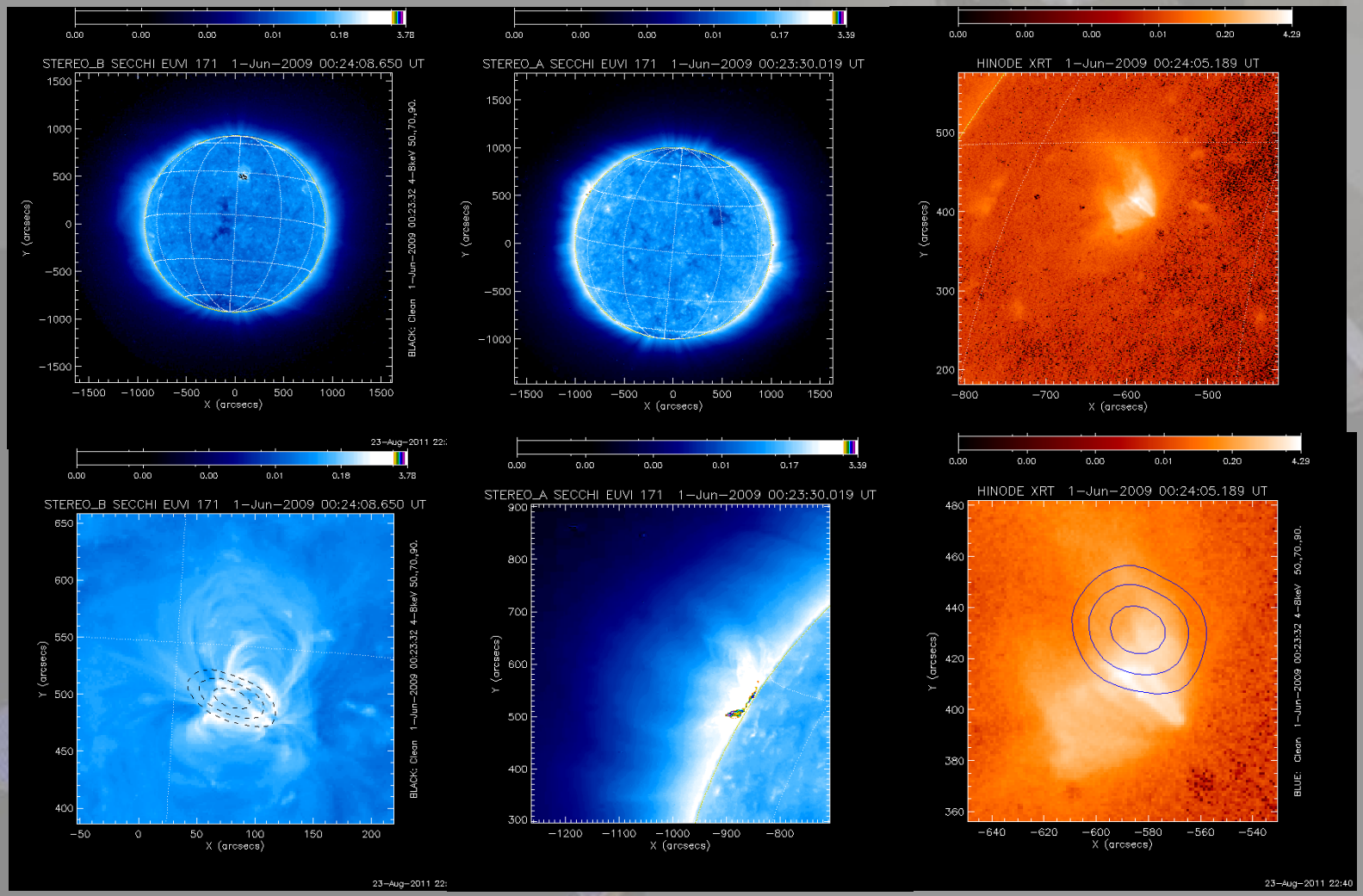


Date:	**1 Jun 2009**
RHESSI (6-12keV) max:	**00:23 UT**
SphinX max:	**00:26 UT**
GOES class:	**A1.3**

- **weak reaction in RHESSI**
- **entire flare observed by both instruments**
- **RHESSI outside radiation belts and SAA**

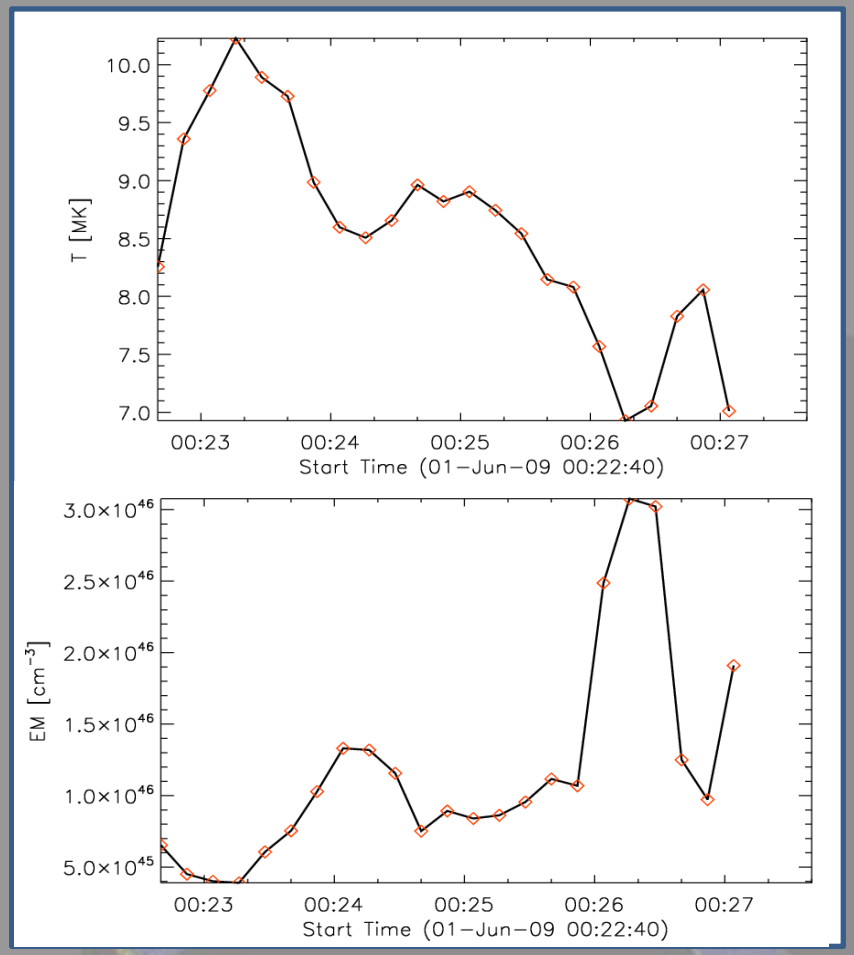
Examples 01-Jun-2009

STEREO B **STEREO A** **HINODE/XRT**

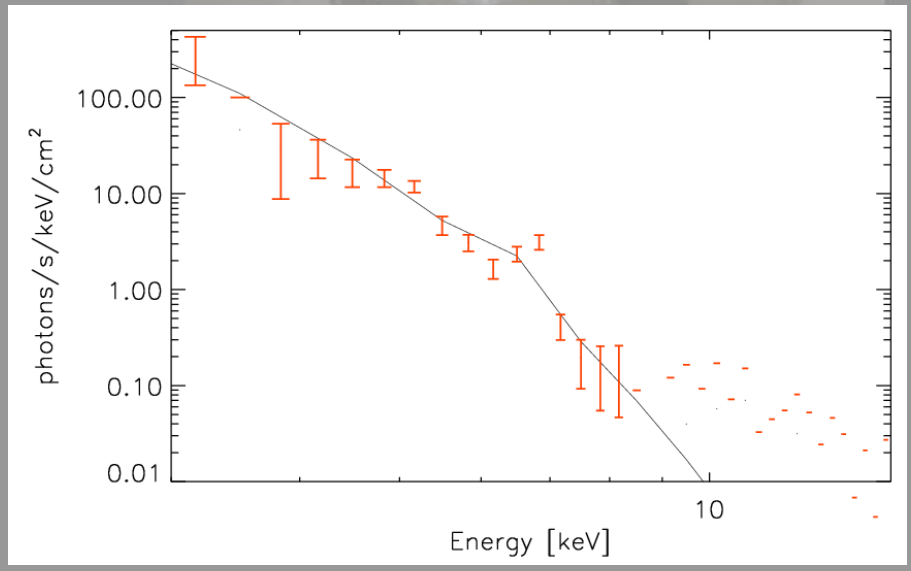


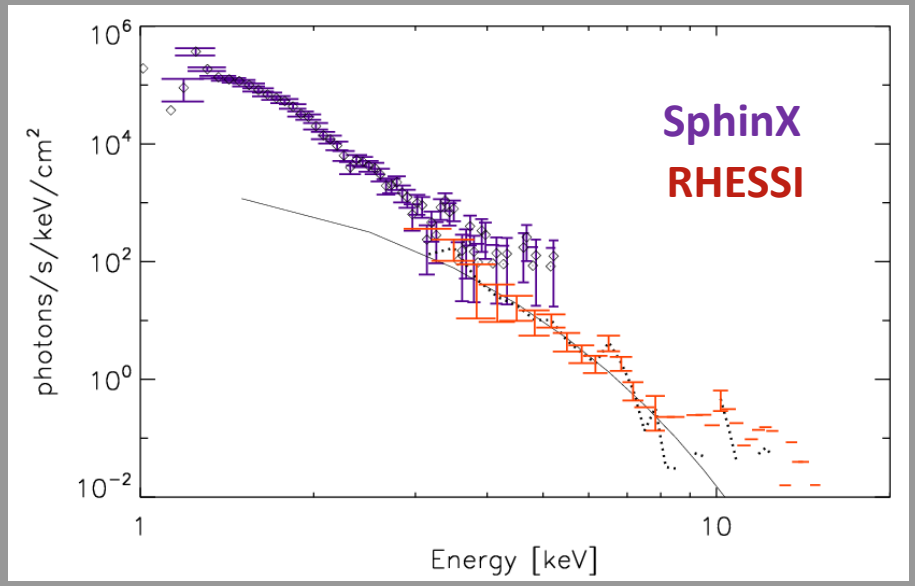
Images from HINODE/XRT and STEREO/EUVI with overlaided RHESSI 4-8 keV sources

Examples 01-Jun-2009



Fit with thermal component + gaussian representing Fe complex at 6.7 keV

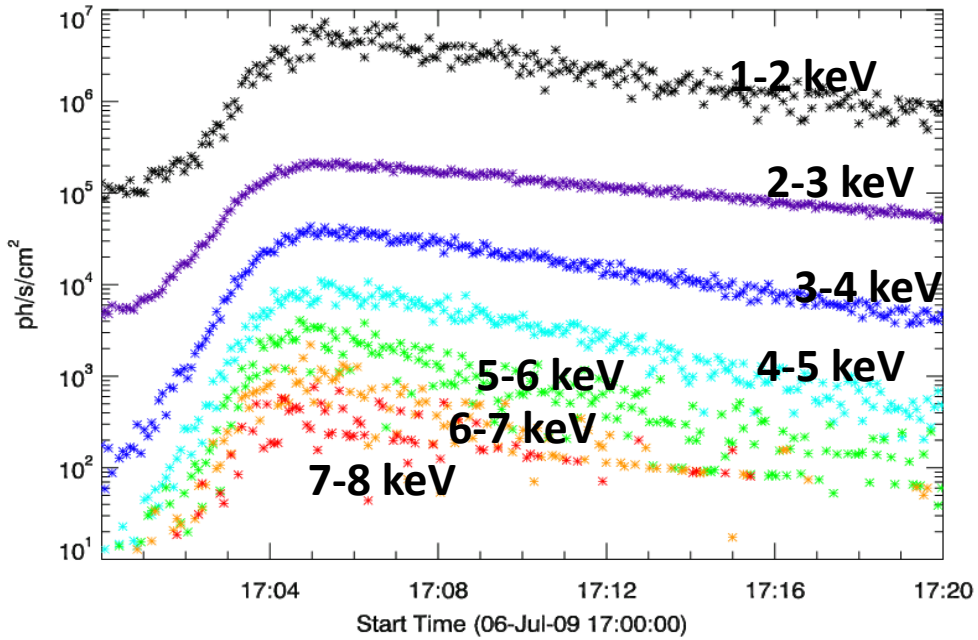


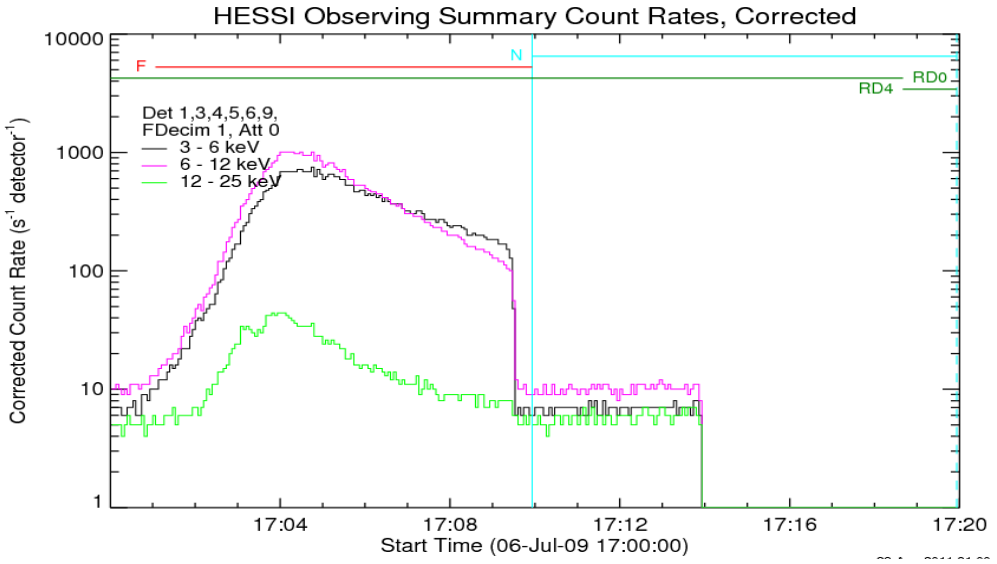


Very good correlation between spectra.

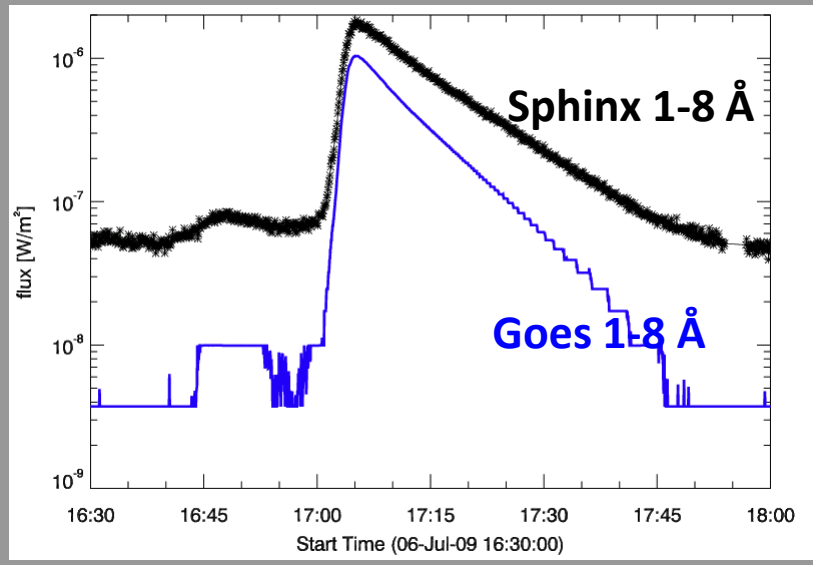
RHESSI spectral fit do not fit the SphinX data

Examples 06-Jul-2009



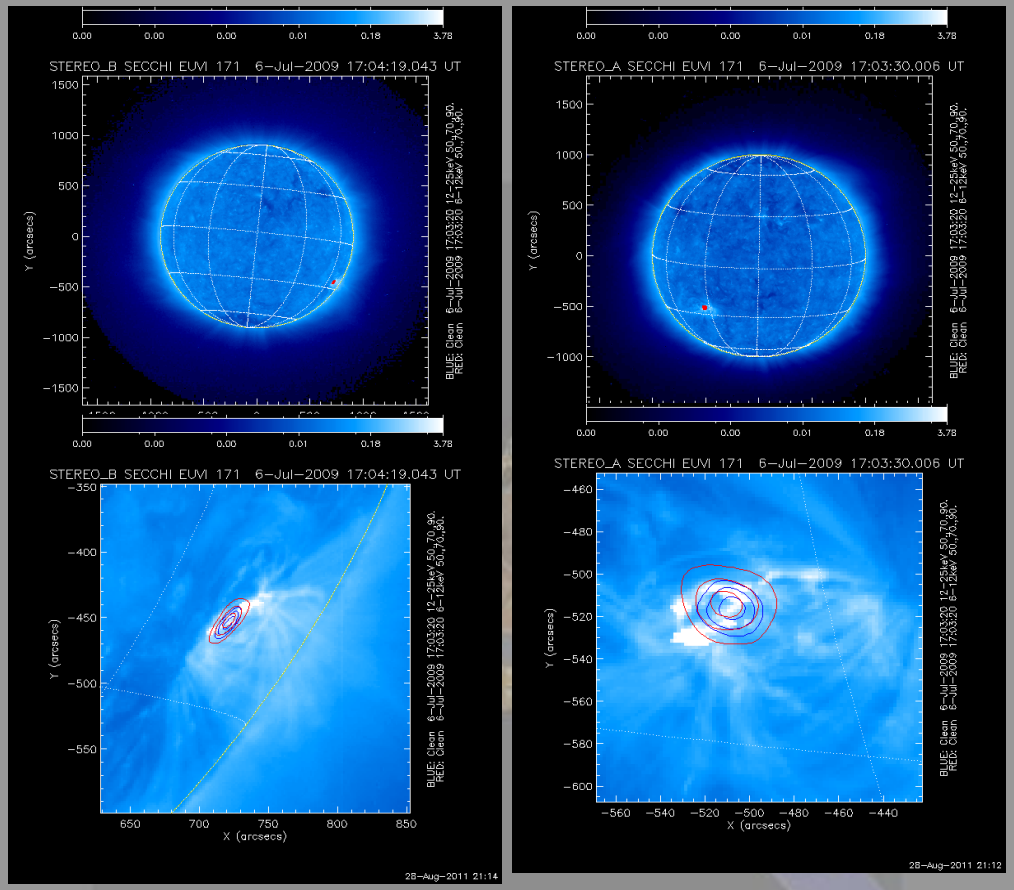


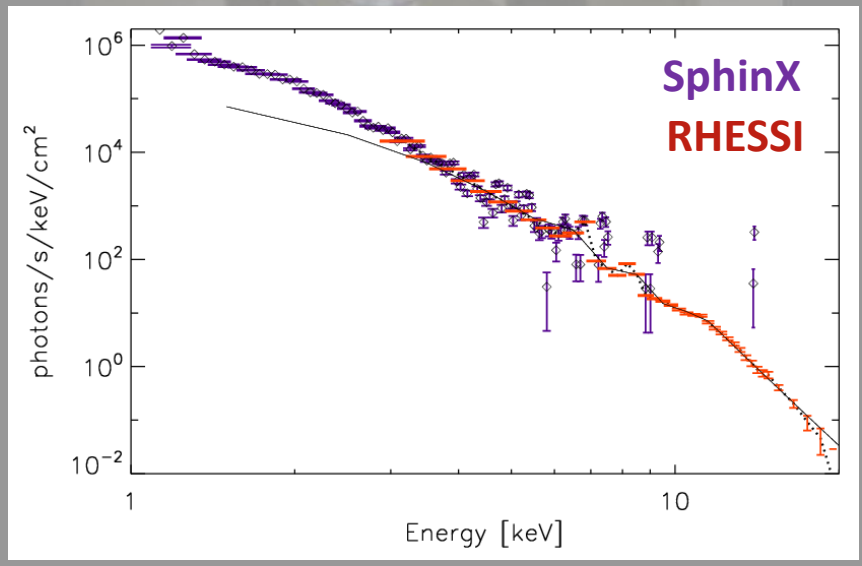
Date:	**6 Jul 2009**
RHESSI (6-12keV) max:	**17:04 UT**
SphinX max:	**17:05 UT**
GOES class:	**C1.0**



Examples 06-Jul-2009

STEREO B **STEREO A**



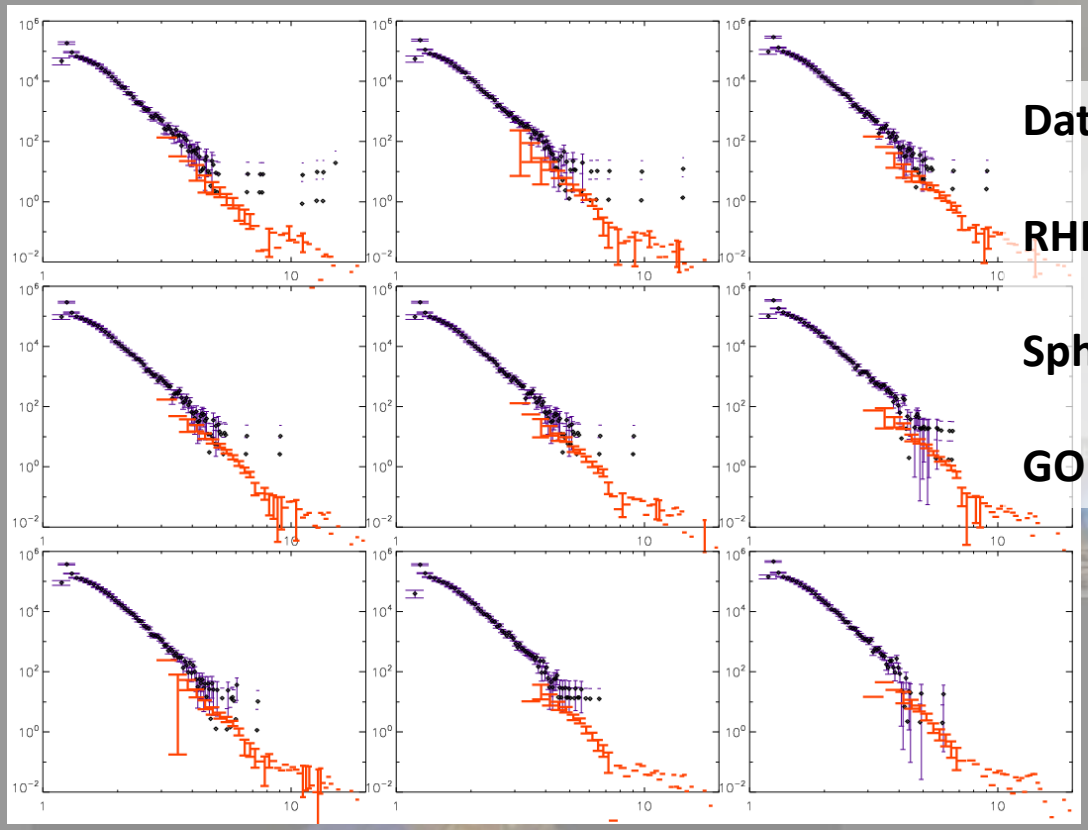


The strongest of analysed flares

Spectra obtained close to the maximum

Excellent agreement

Examples 18-Jul-2009

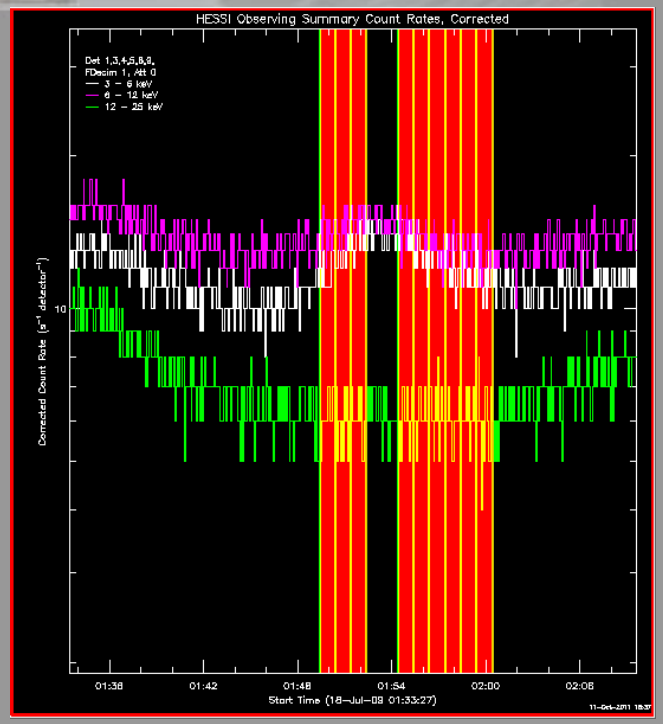


Date: **18 Jul 2009**

RHESSI (6-12keV) max: **1:53 UT**

SphinX max: **2:00 UT**

GOES class: **A2.3**



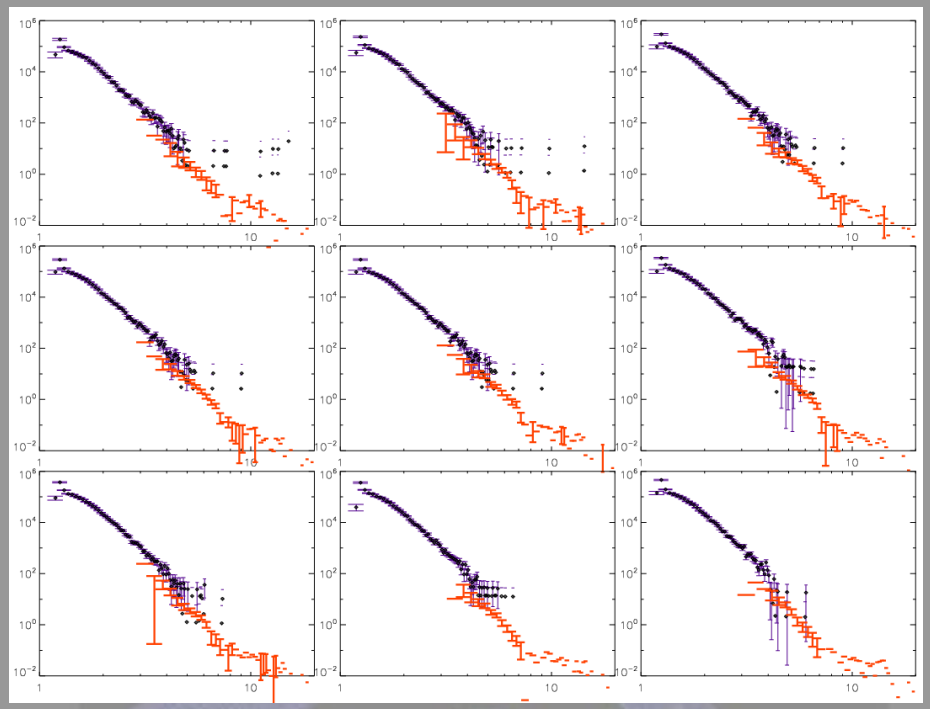
Sequence of spectra for 9 selected, 1 minute intervals

Some inconsistency within overlap region:

- fast decrease of RHESSI response below 6 keV
- low statistics for SphinX above 5 keV

Nevertheless agreement is more than satisfactory

Summary



Present:

SphinX and RHESSI data are complementary

Nice agreement between light curves, time characteristics.

Spectra show good or excellent agreement

Future:

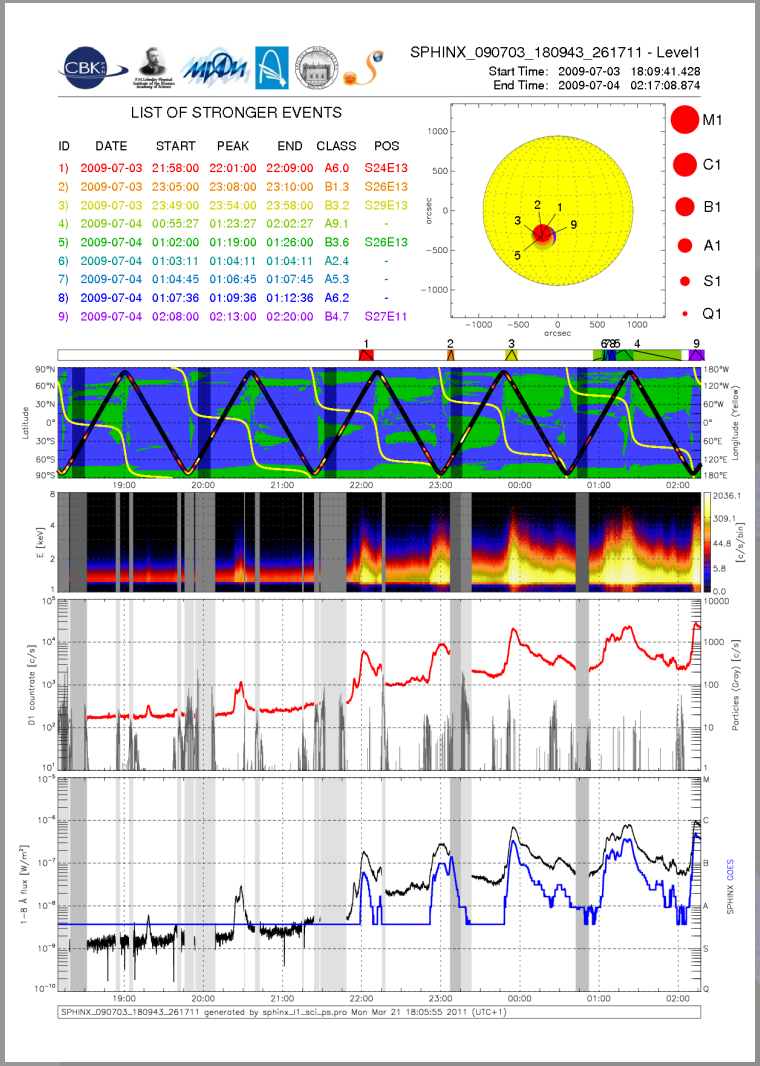
Use OSPEX for SphinX data analysis (almost finished)

Statistical analysis of common observations

Improvement of the RHESSI response function in the low energy range

SphinX catalogue

156.17.94.1/sphinx_l1_catalogue/SphinX_cat_main.htm



SphinX data access is public

All data reformatted and converted to Level_1

Time interval 20 February – 29 November 2009

Most instrumental problems resolved

Diagonal part of detector matrix used for now

CHIANTI 6.1 used to model the synthetic spectra