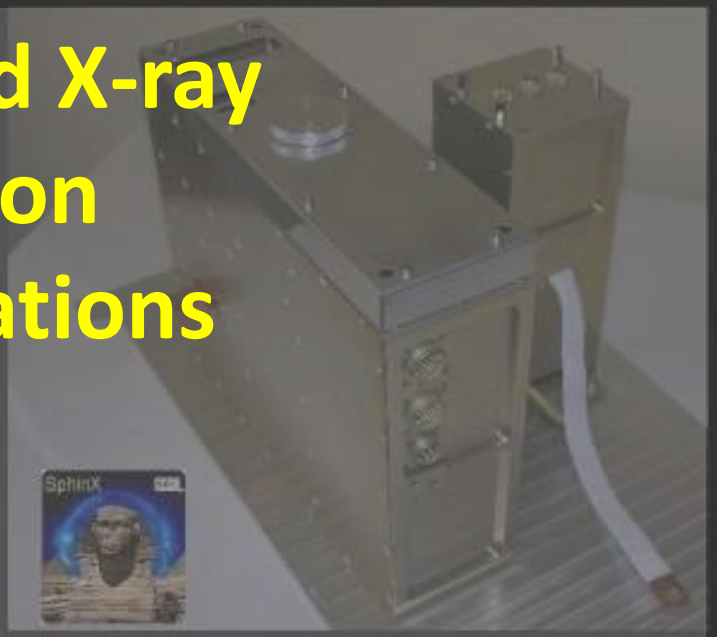
Interpretation of selected X-ray brightenings from common SphinX & RHESSI observations

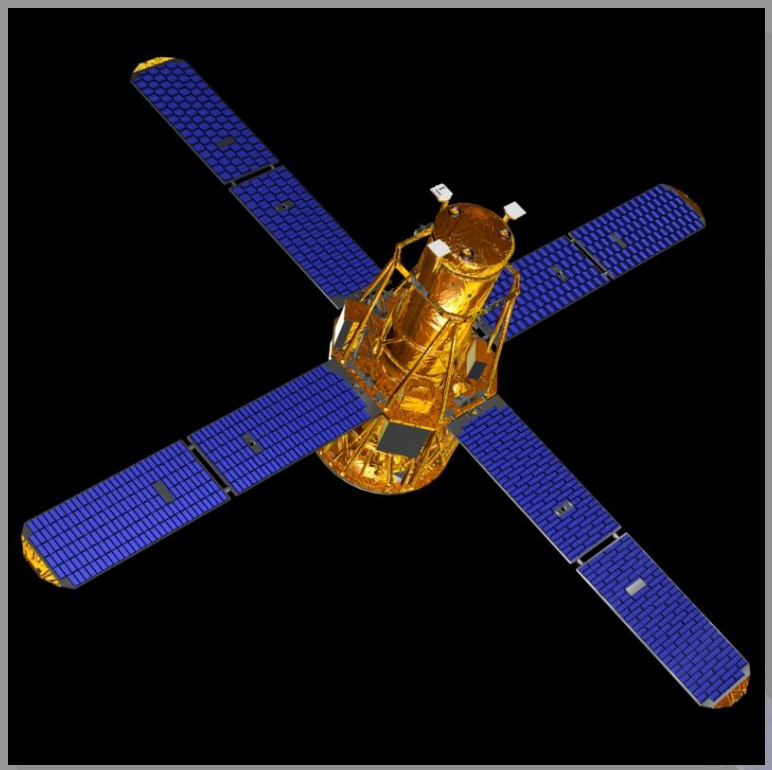


Mrozek, T.[1,2], Siarkowski, M.[1], Sylwester, B.[1], Sylwester, J.[1], Gburek, S.[1], Kępa,A.[1]

[1] Solar Physics Division, Space Research Centre, Polish Academy of Sciences
[2] Astronomical Institute, University of Wrocław

Motivation

Aim: to compare data obtained by two different instruments



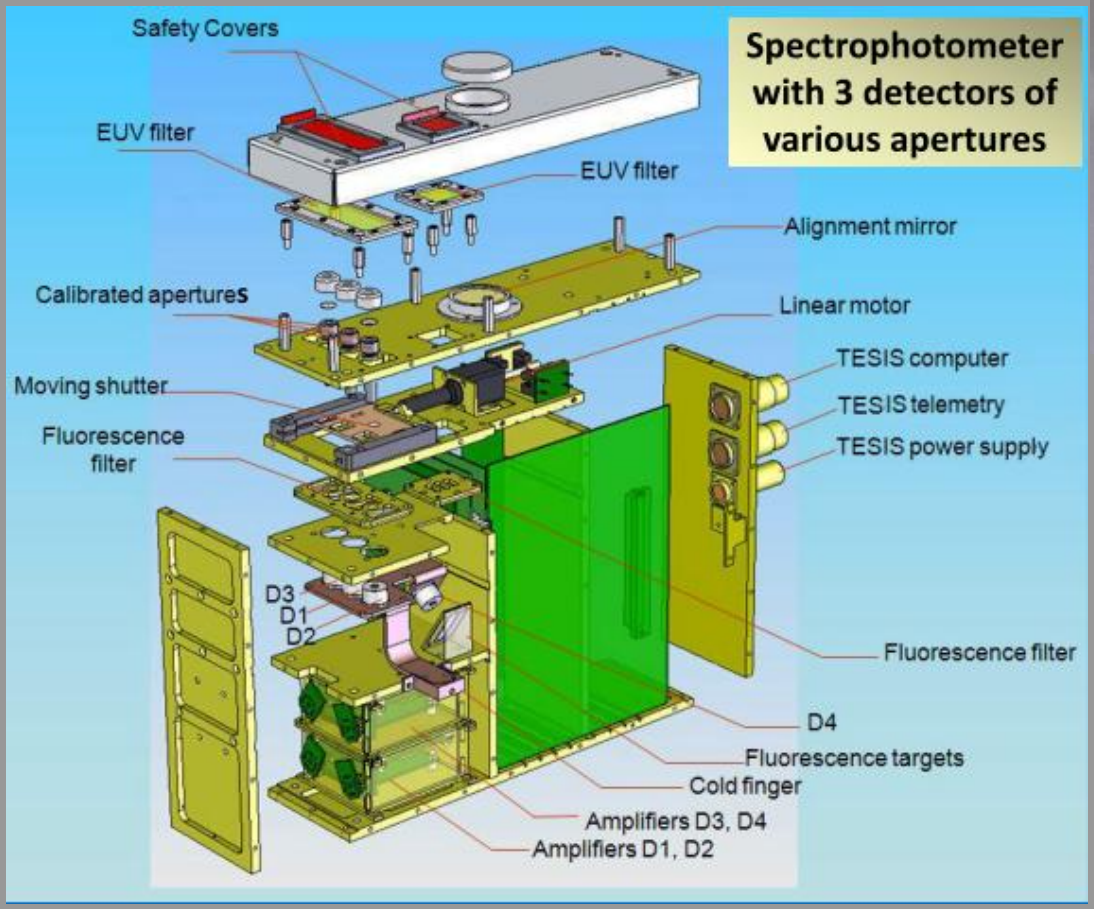
Motivation:

-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

Solar Photometer in X-rays (SphinX)



Spectrophotometer with 3 detectors of various apertures

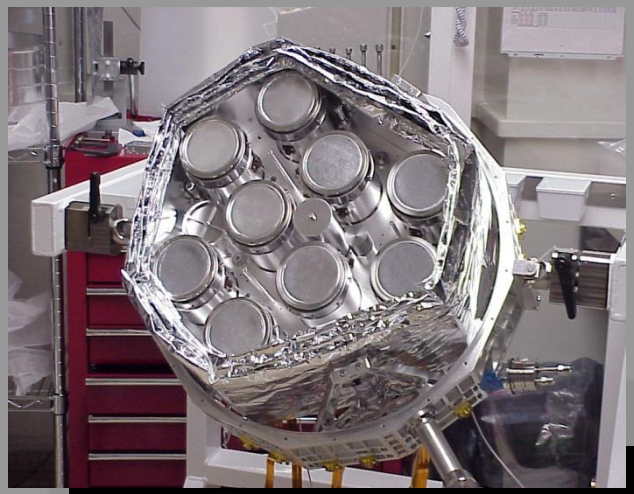
-**energy range: 0.8 – 15 keV**

-**time resolution: ~0.00001 s**

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

-**energy resolution: ~0.4 keV**

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

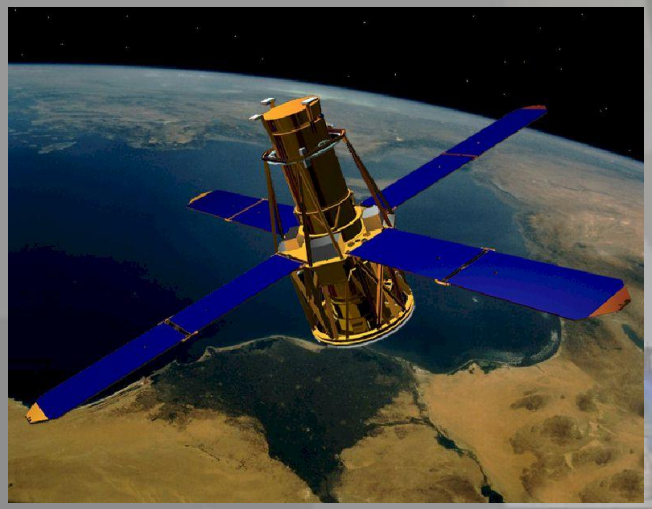
- temporal resolution related to rotation period ~4 s (images), time resolution of lightcurves may be improved by some demodulation methods

-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**)**

RHESSI

Pros:

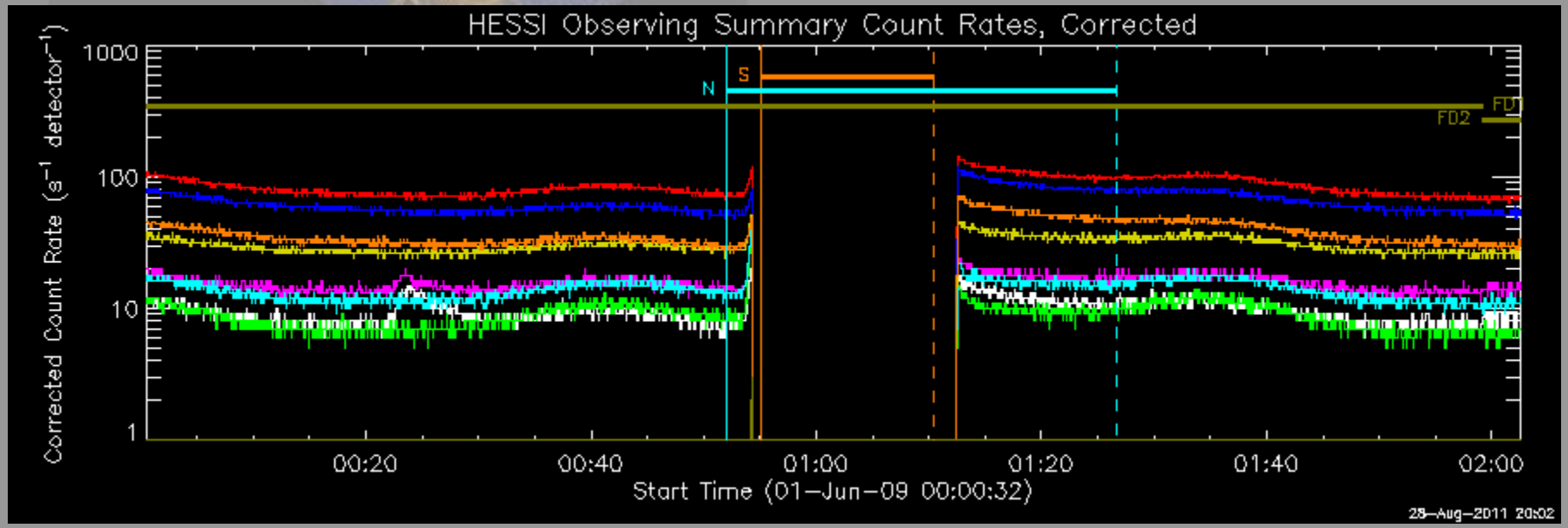
- spatial resolution
- dynamical range
- sensitivity
- spectral resolution



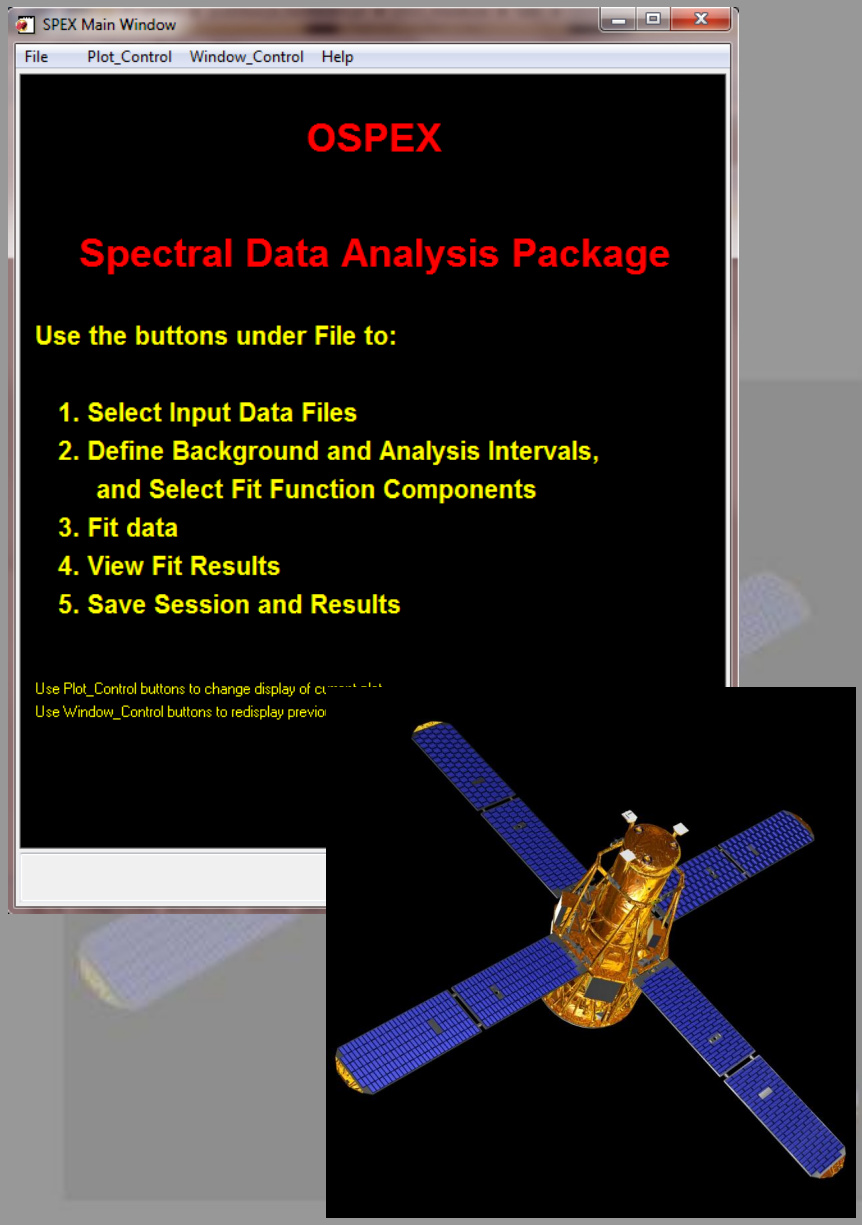
Cons:

- pile-up*
- attenuators*
- orbital background (SAA, radiation belts)

*** not important in a case of weak events analysis**



RHESSI data analysis

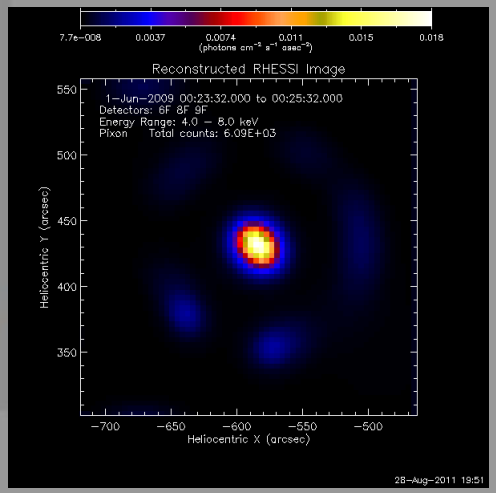


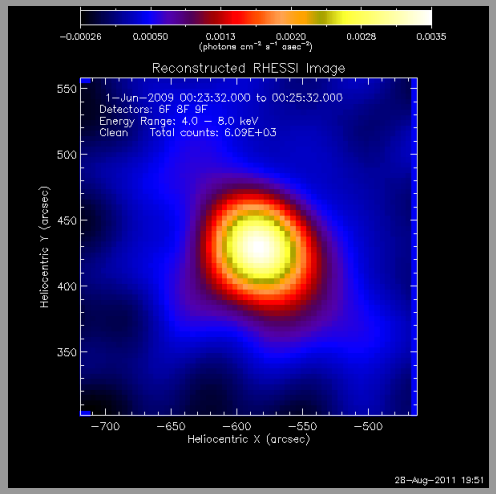
Spectral analysis was performed with the use of standard OSPEX package

Observed spectra were usually fitted with thermal component, two lines and non-thermal represented with a broken power-law function

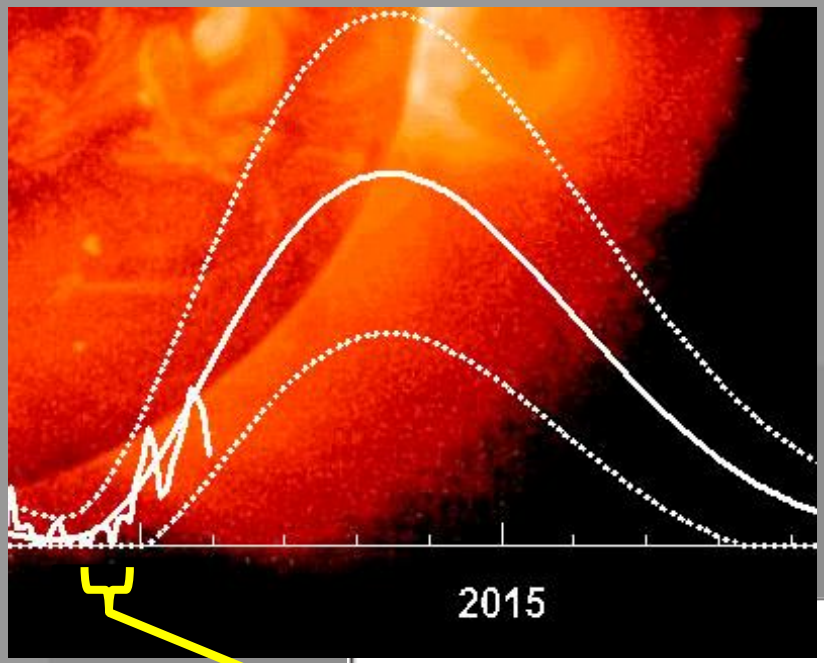
Images were reconstructed using standard CLEAN and PIXON methods.

We chose as narrow time and energy intervals for reconstruction as possible





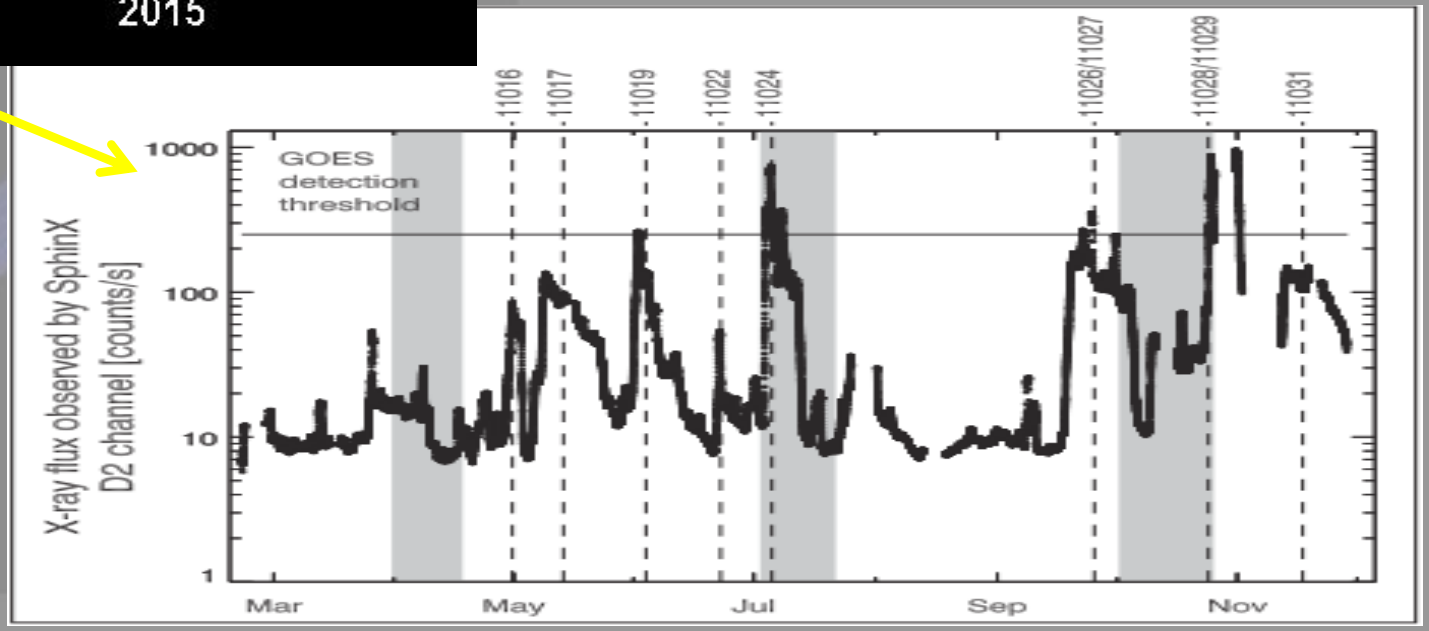
Observational period



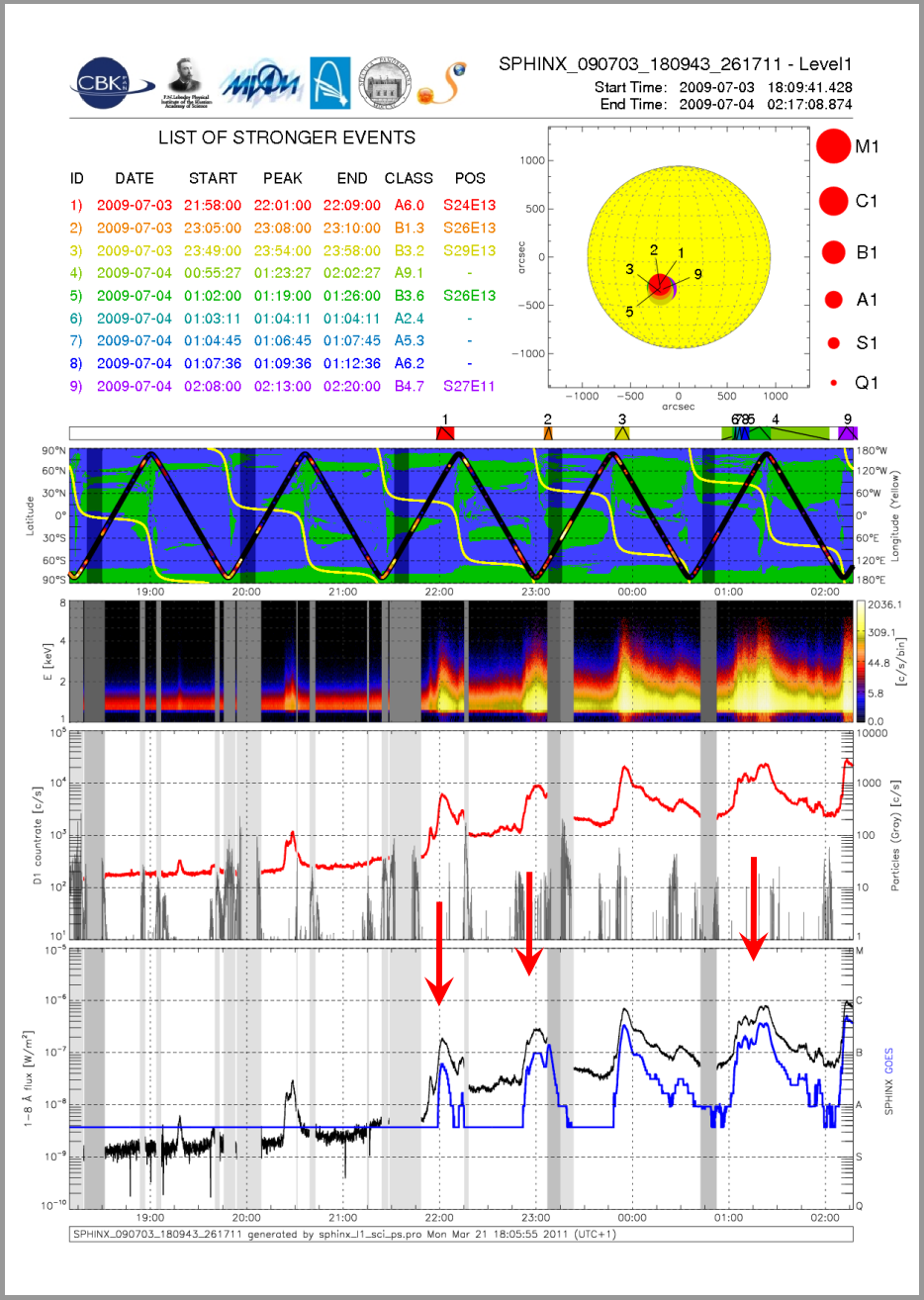
-extremely low activity

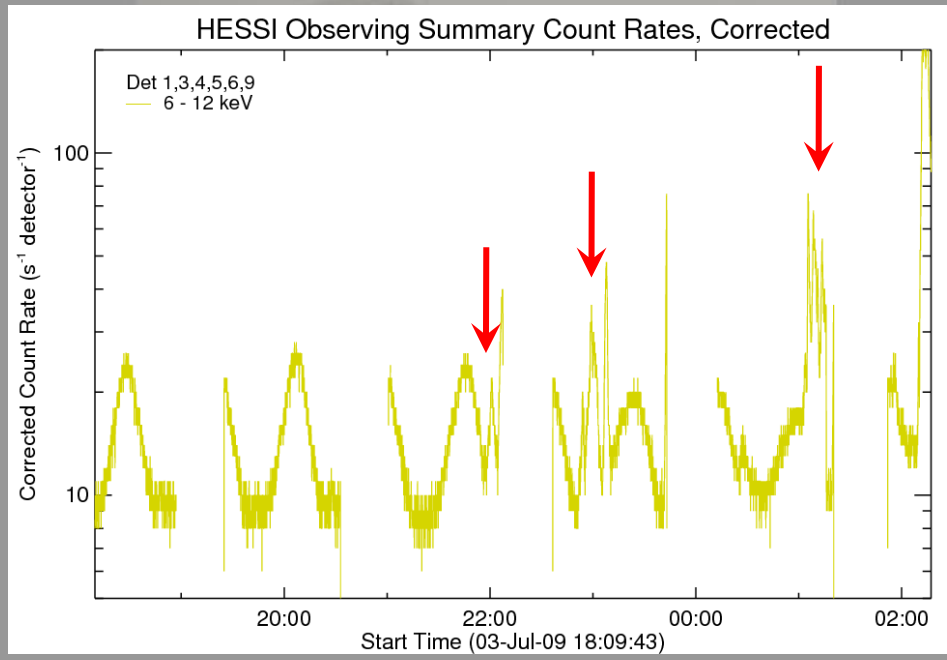
-mainly A,B – class flares, few C-class

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



Flares selection





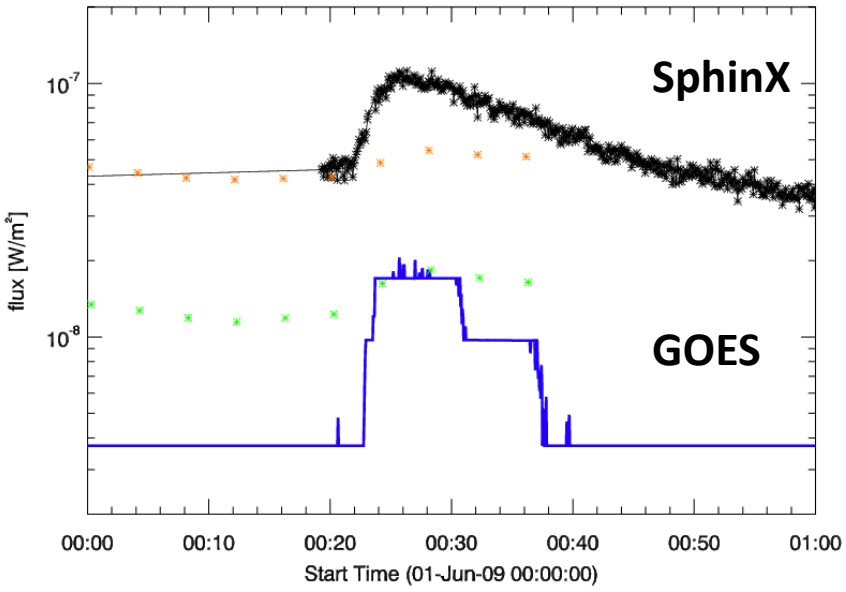
Flares were chosen by the inspection of RHESSI and SphinX data catalogues

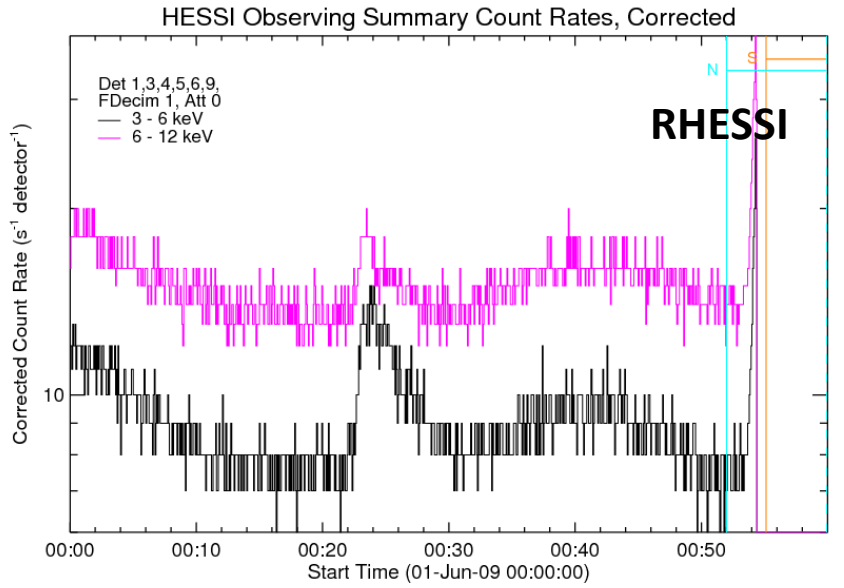
37 common RHESSI and SphinX observations of flares have been found

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

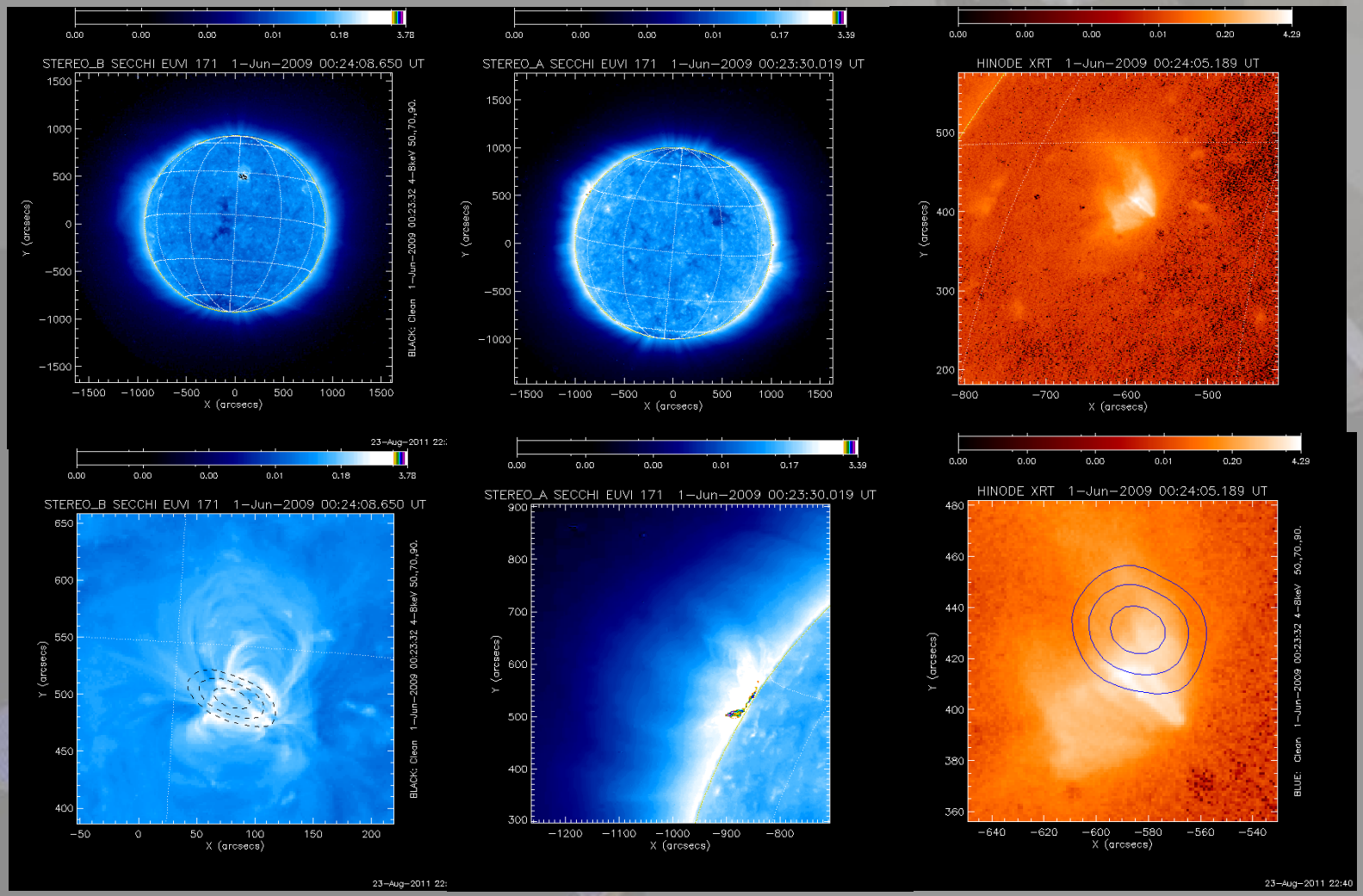
-weak reaction in RHESSI

-entire flare observed by both instruments

-RHESSI outside radiation belts and SAA

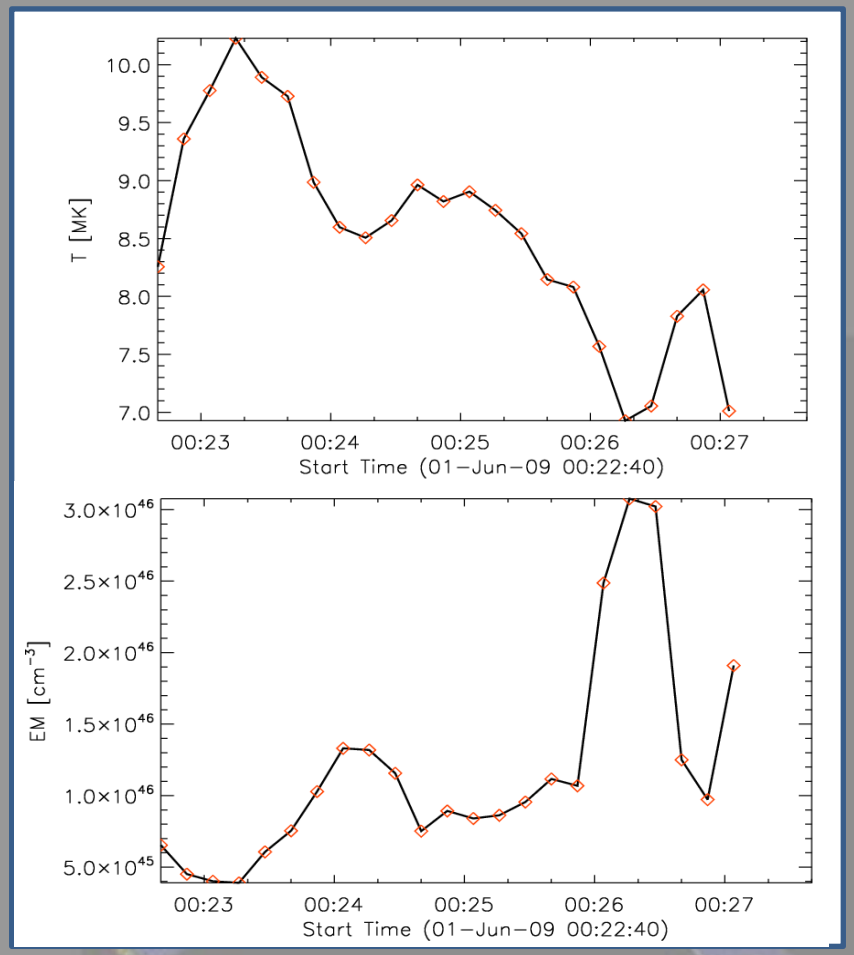
Examples 01-Jun-2009

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



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

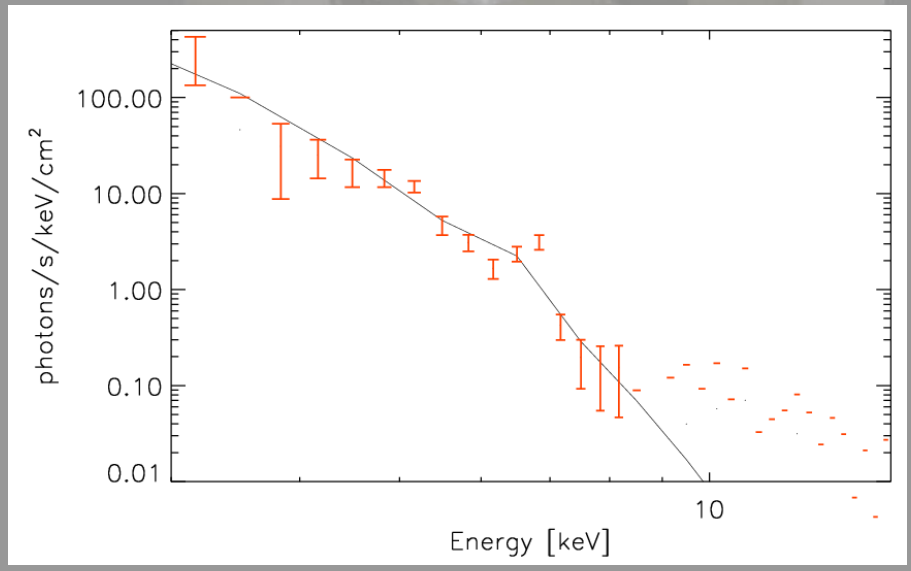
Examples 01-Jun-2009

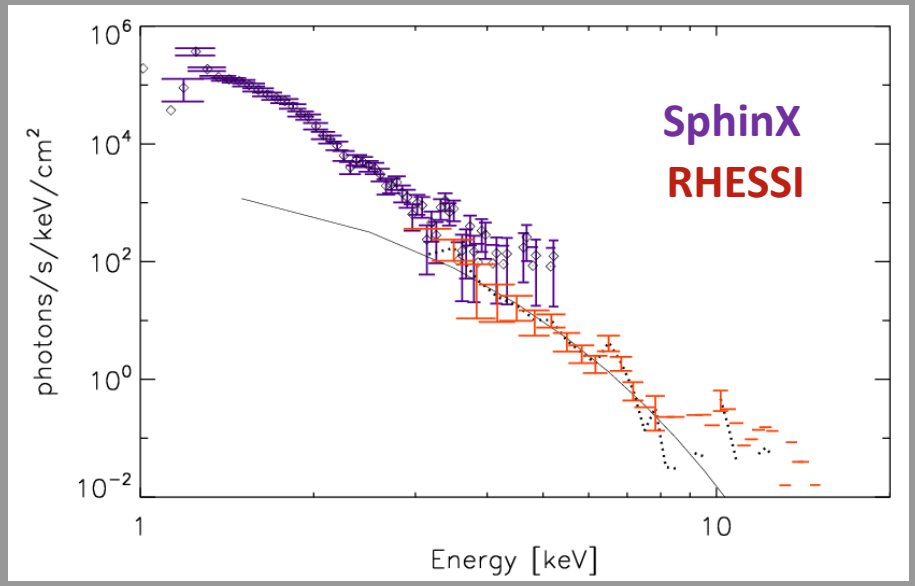


Wery good correlation between spectra.

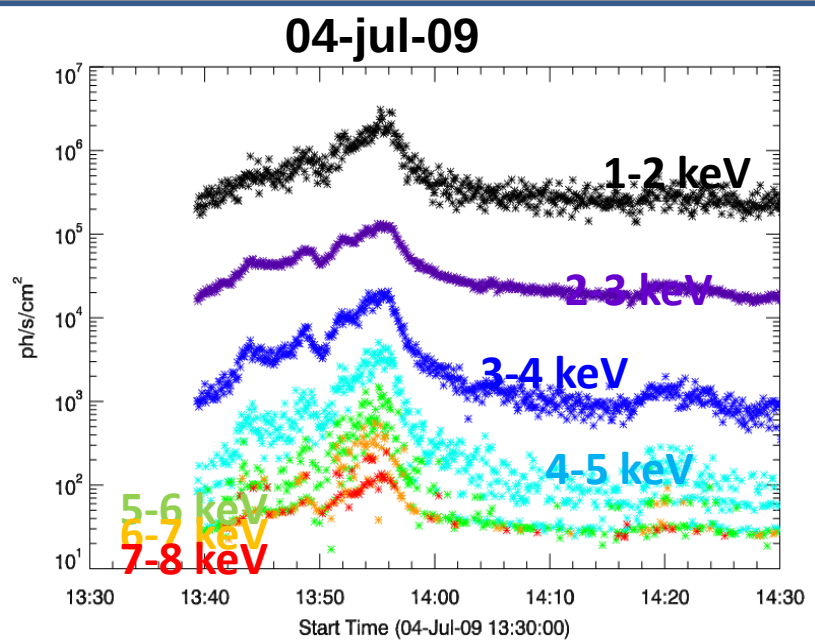
RHESSI spectral fit do not fit the SphinX data

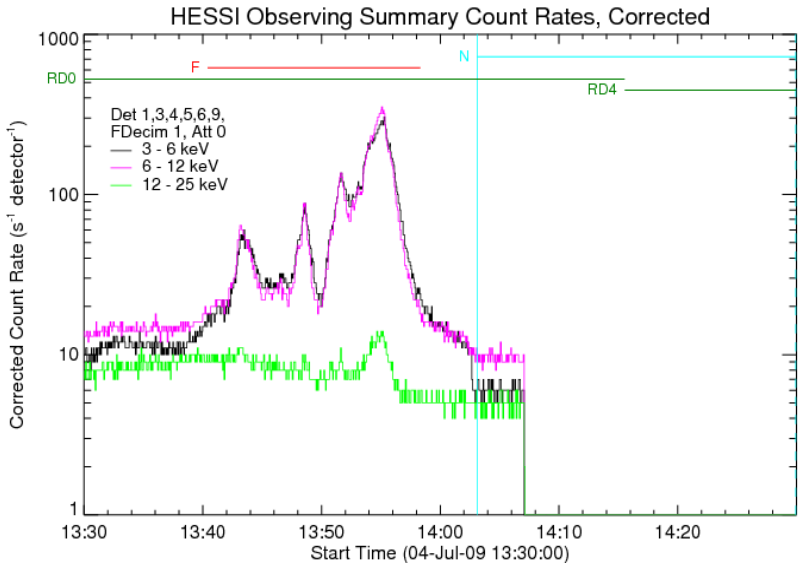
Fit with thermal component + gaussian representing Fe complex at 6.7 keV





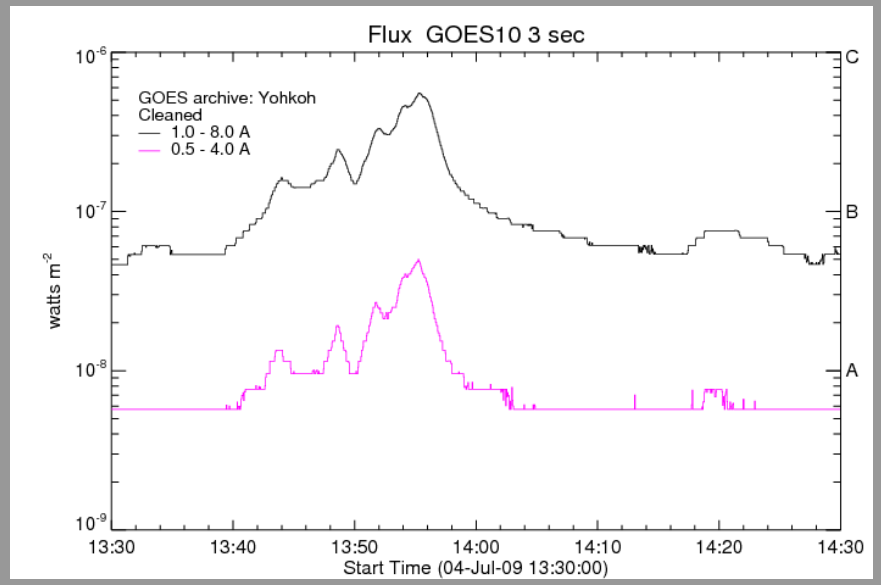
Examples 04-Jul-2009





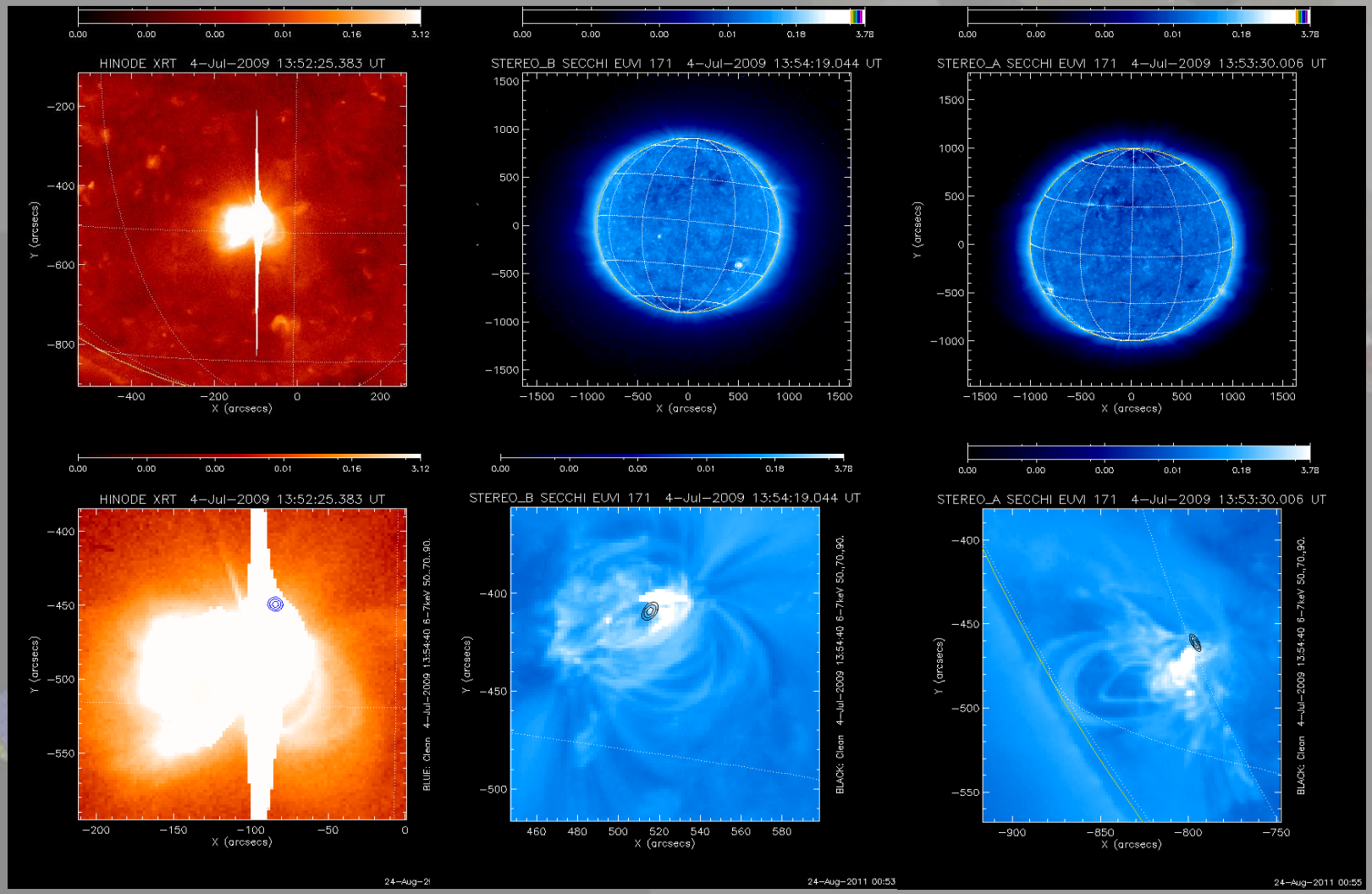
Date	SphinX max [UT]	RHESSI max [UT]	GOES class
4.07.2009	13:44	13:43	B1.6
	13:48	13:48	B2.4
	13:54	13:52	B4.6
	13:55	13:55	B5.3

Four peaks observed by all instruments



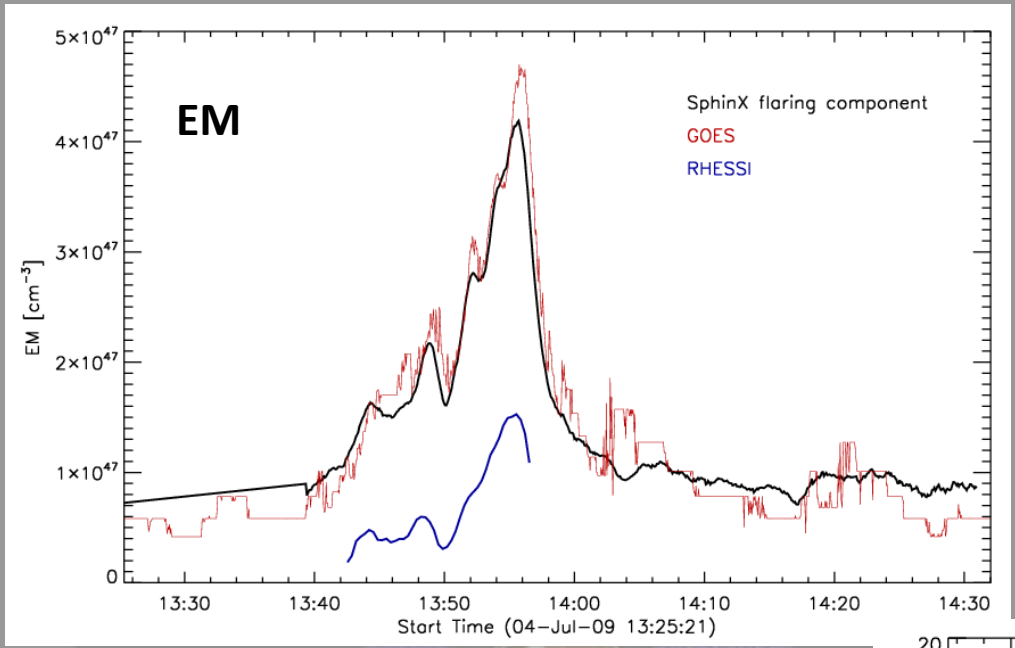
Examples 04-Jul-2009

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



Small structure observed in the range 6-8 keV

Examples 04-Jul-2009



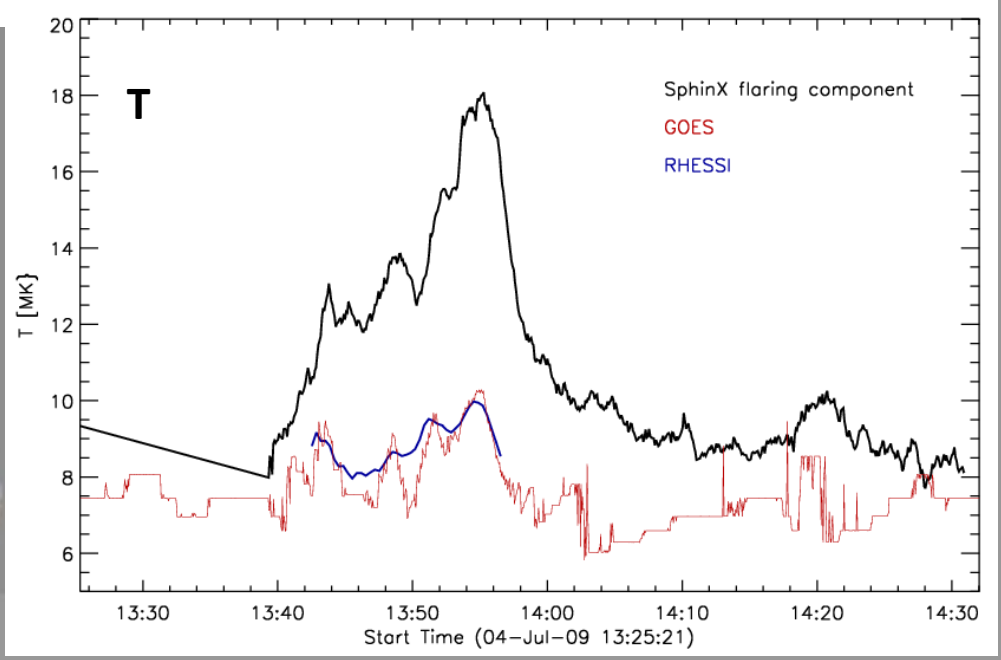
SphinX and GOES gives very similar estimations of the emission measure

RHESSI is significantly lower

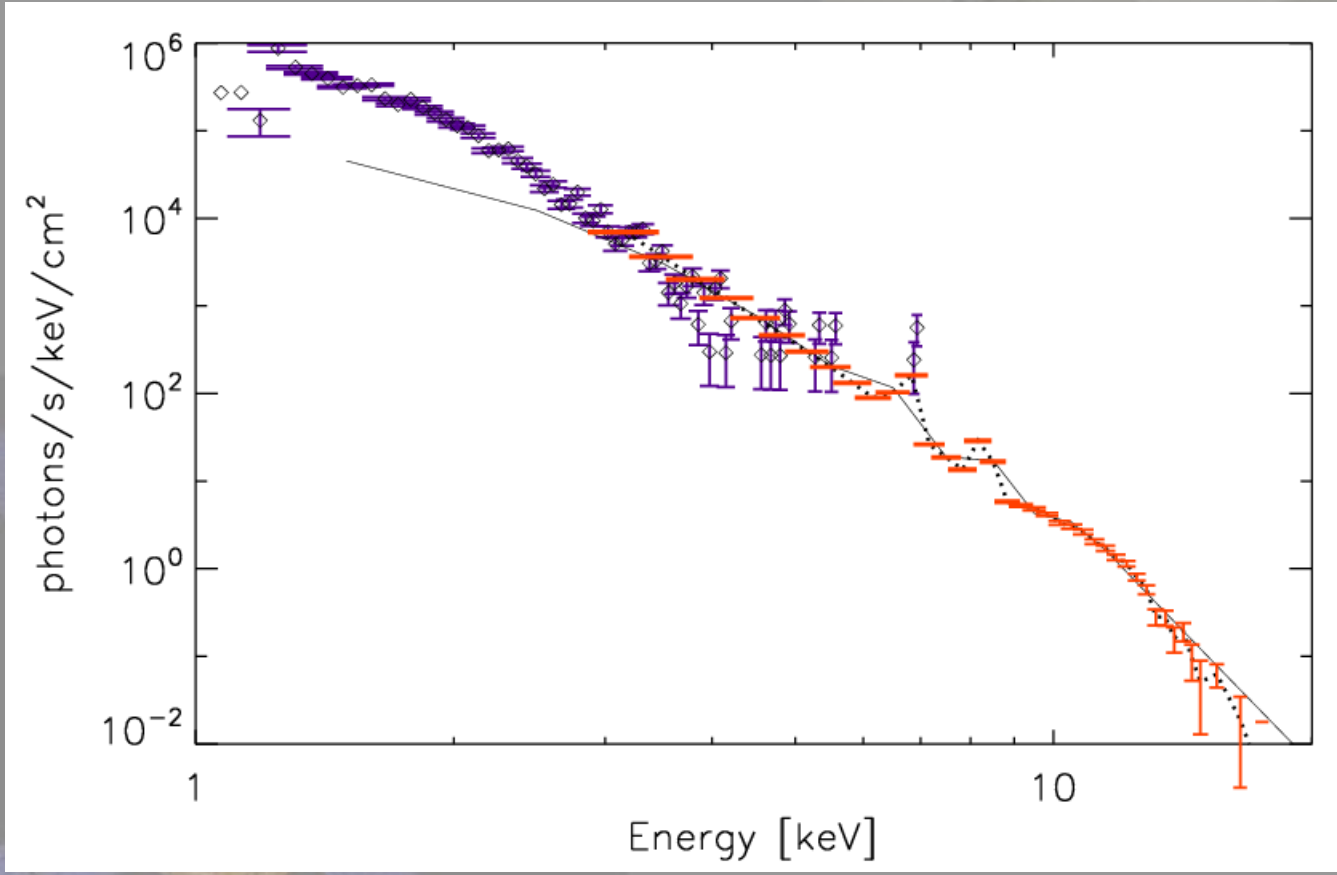
Temperature is largest for SphinX (at the maximum reaches value of 16 MK)

RHESSI is slightly above values estimated from GOES data

The effect is connected with the method of calculating T and EM from SphinX data. In this example only pure flaring component was calculated.



Examples 04-Jul-2009

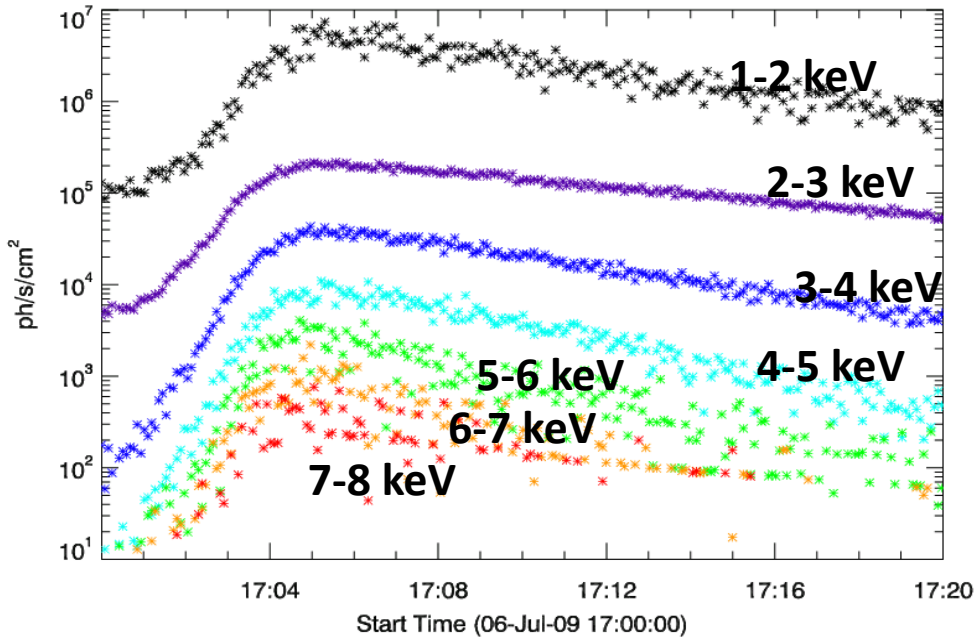


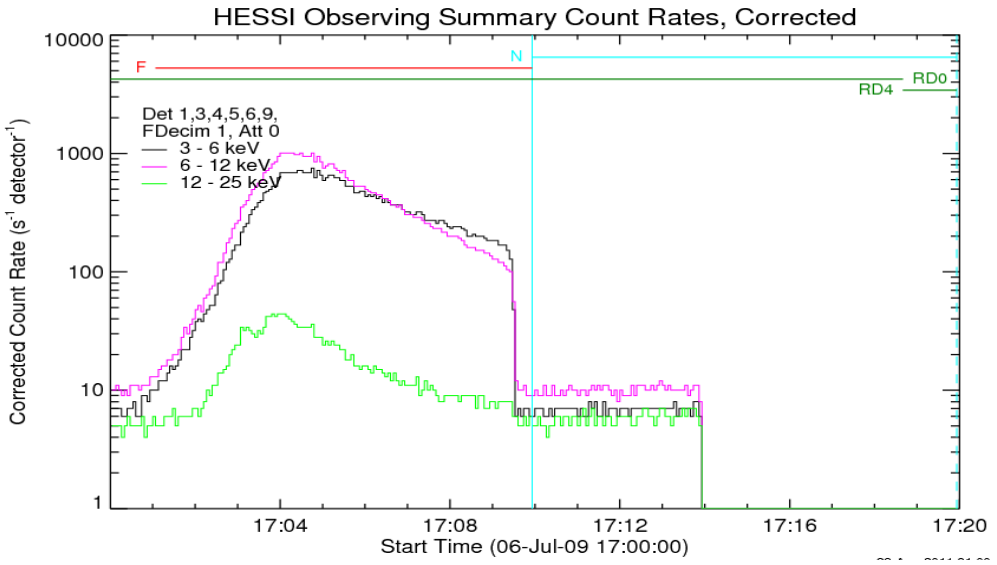
Spectra agrees excelent

Probably in the SphinX data we observe the Fe complex at 6.7 keV

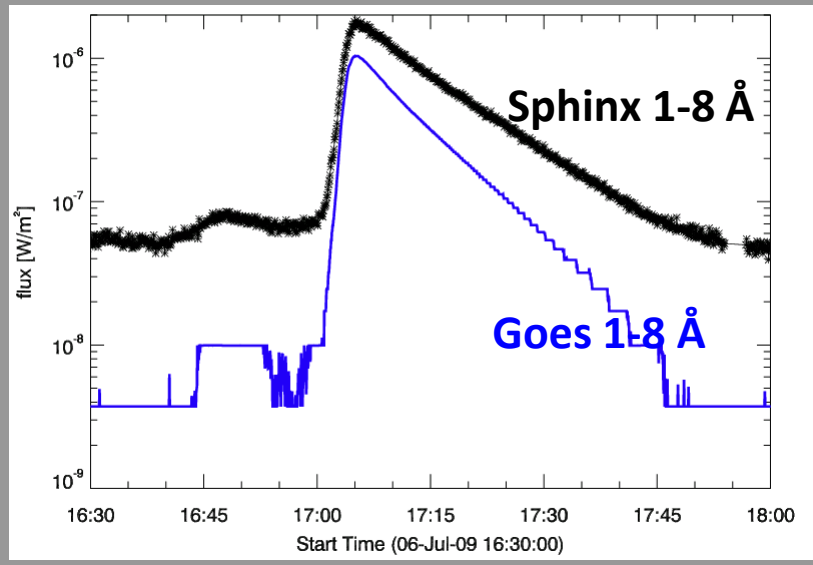
RHESSI spectral fit do not describe SphinX part of spectrum

Examples 06-Jul-2009



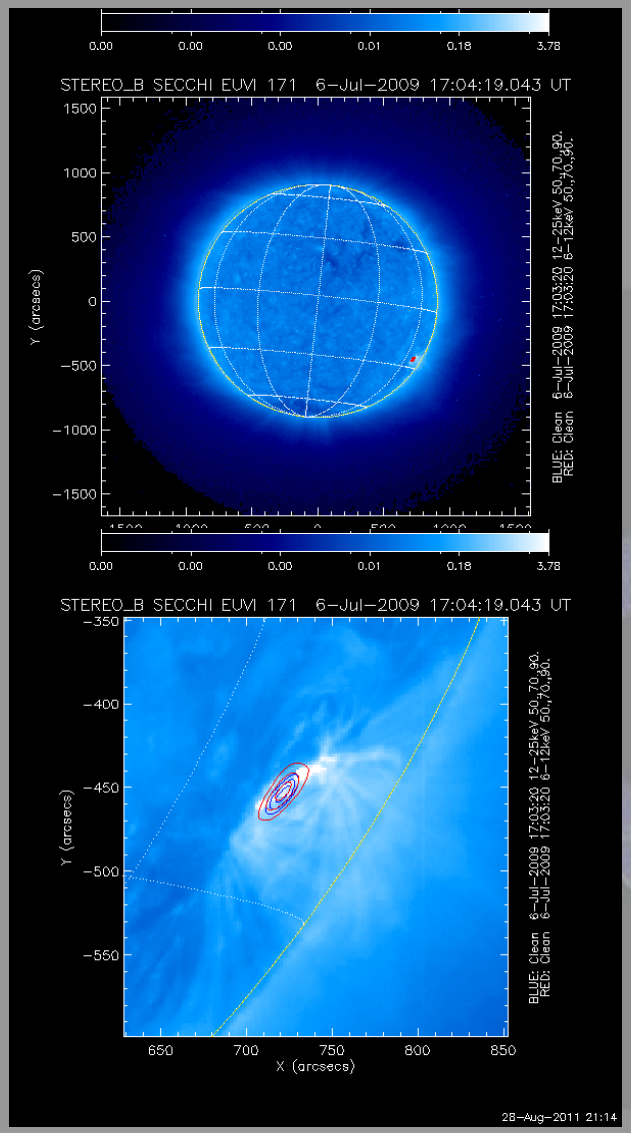


Date:	**6 Jul 2009**
RHESSI (6-12keV) max:	**17:04 UT**
SphinX max:	**17:05 UT**
GOES class:	**C1.0**

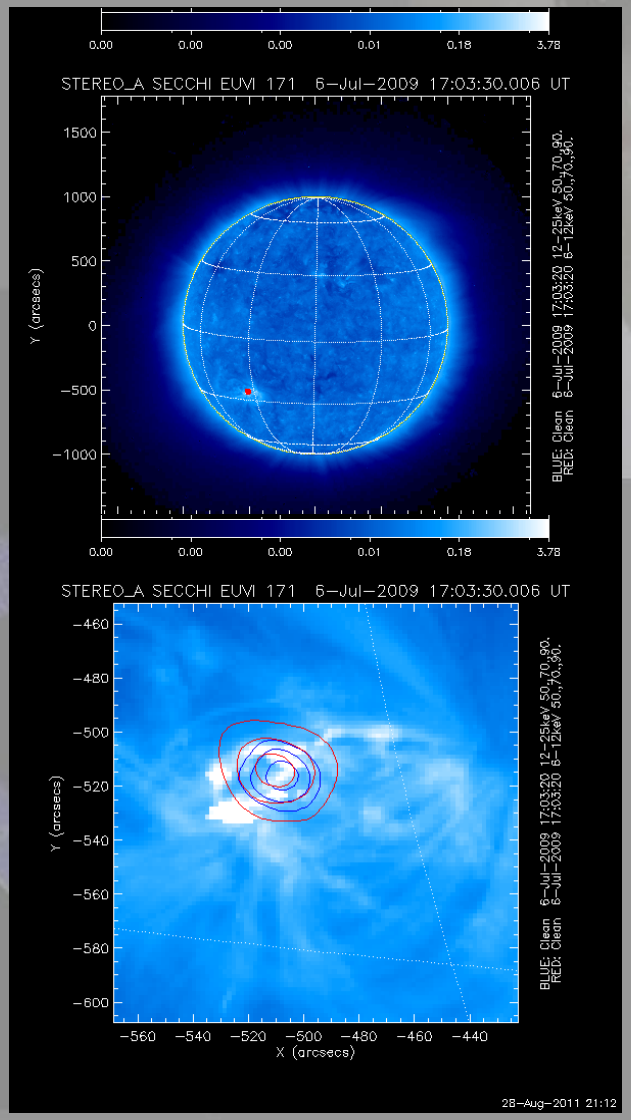


Examples 06-Jul-2009

STEREO B



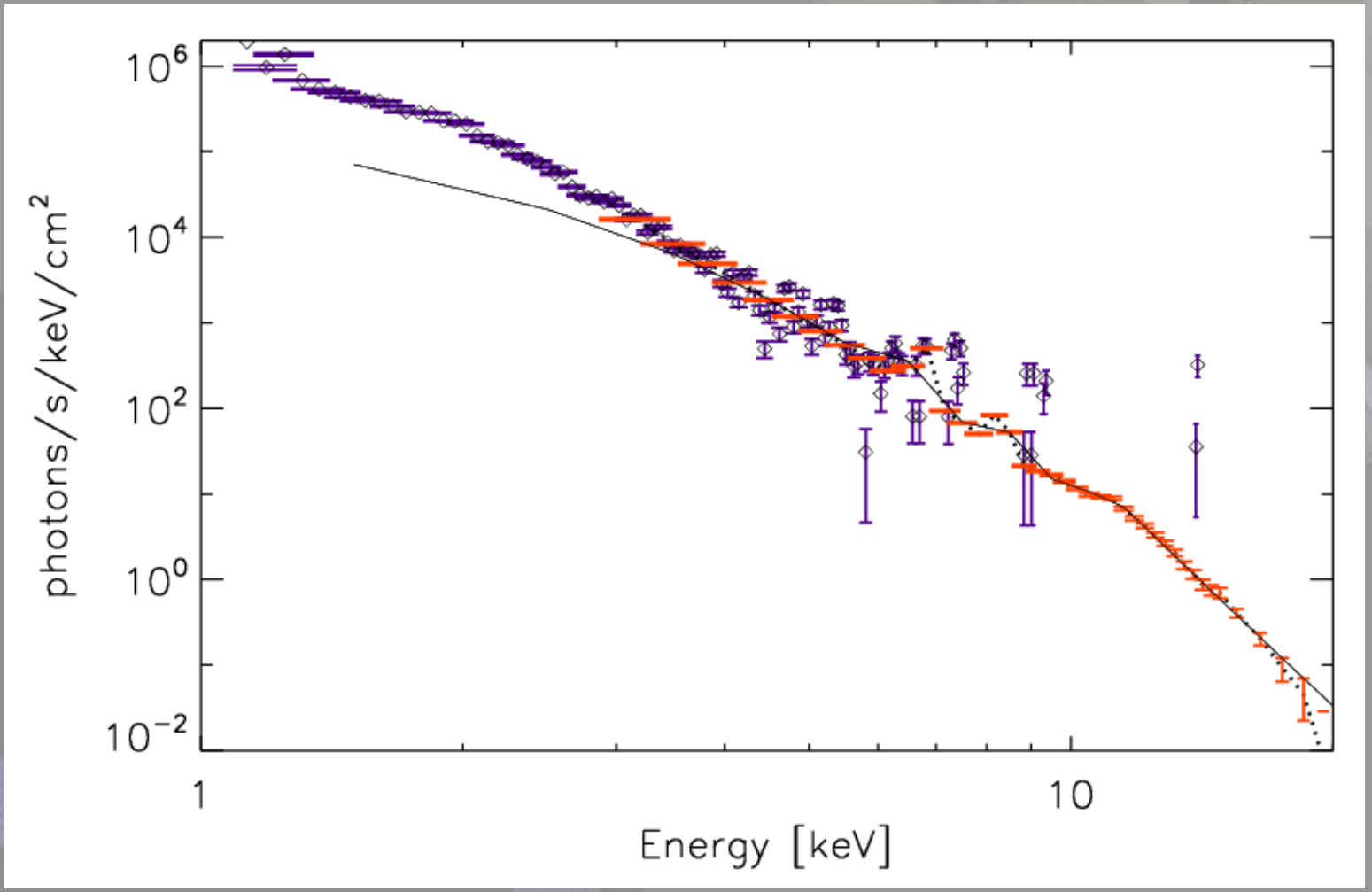
STEREO A



The strongest of analysed flares

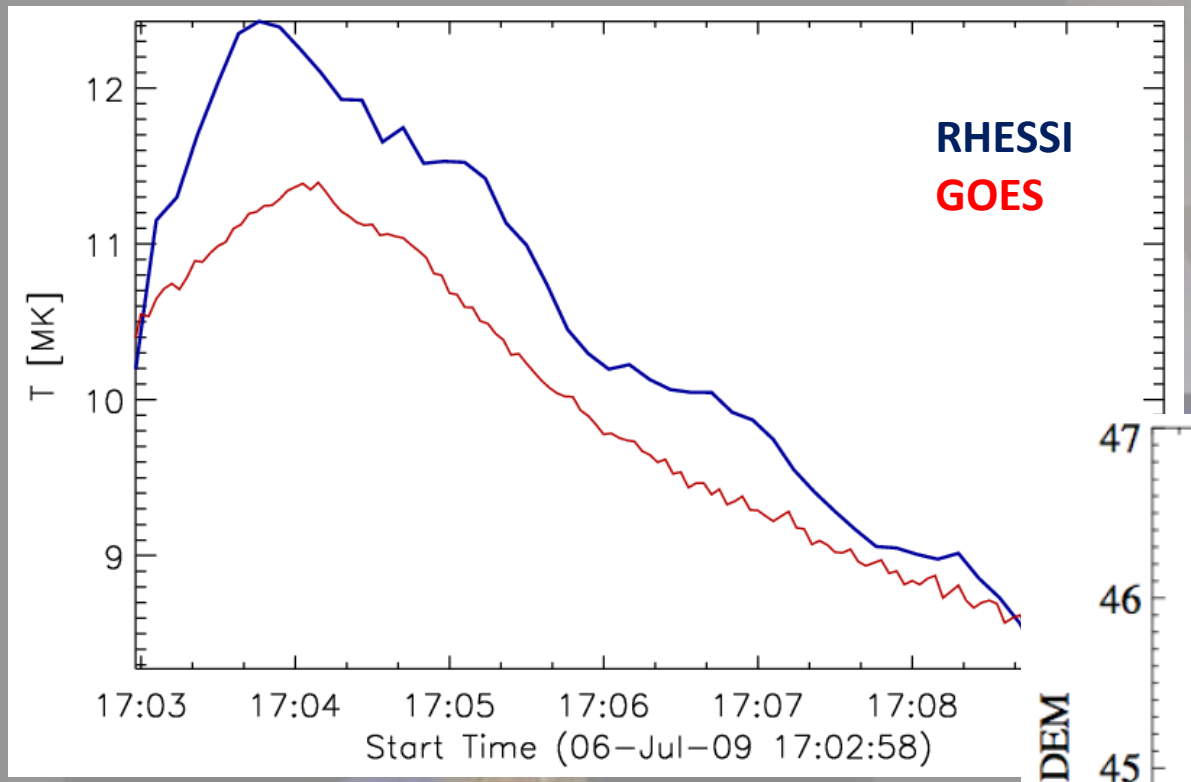
During impulsive phase emission is localized close to flare foot points

Examples 06-Jul-2009

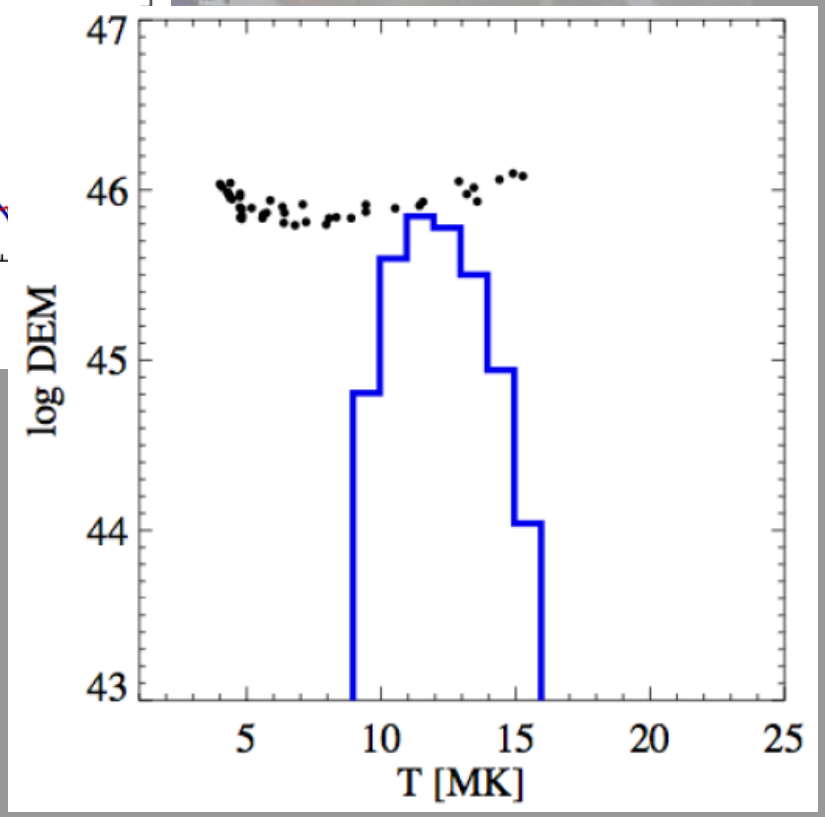


Again we observe excellent agreement between spectra

Examples 06-Jul-2009



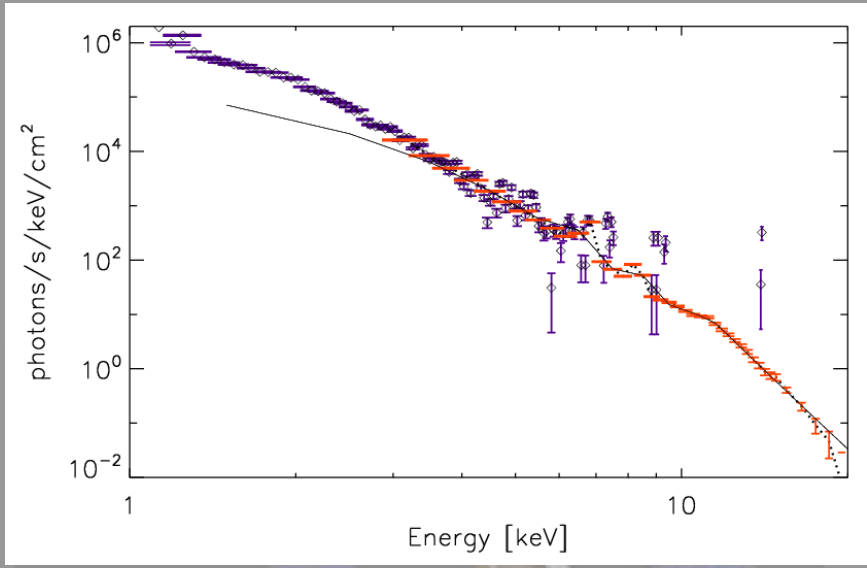
Temperatures estimated with the use of RHESSI and GOES data behaves as we expect – RHESSI is slightly higher.

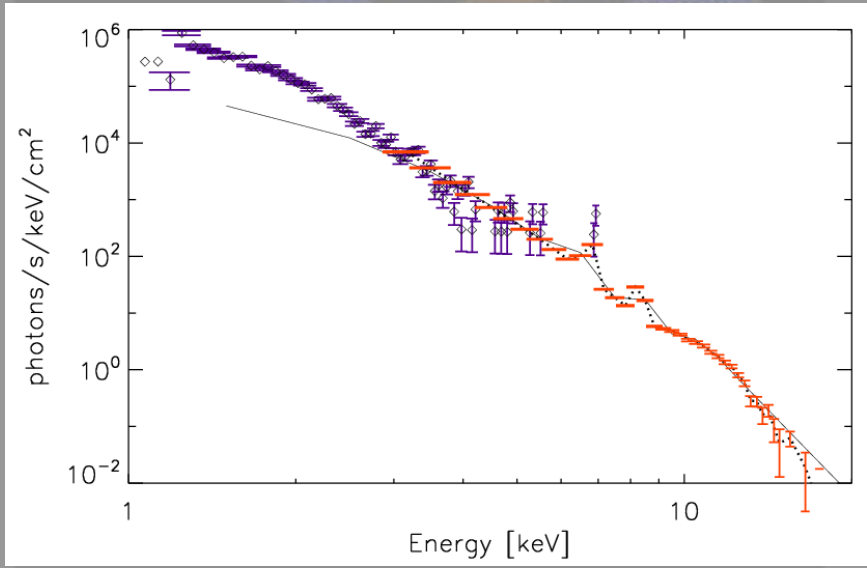


DEM was calculated from SphinX data with the use of Withbroe-Sylwester method. Time interval: 17:02-17:03:30

RHESSI and SphinX temperatures are closer now, but SphinX is still above

Conclusions





Present:

SphinX and RHESSI data are complementary

Nice agreement between light curves, time characteristics.

Spectra show excellent agreement

Physical parameters may differ mainly due to the method which is used for calculating them, problems with background etc.

Future:

Use OSPEX for SphinX data analysis (almost finished)

Statistical analysis of common observations