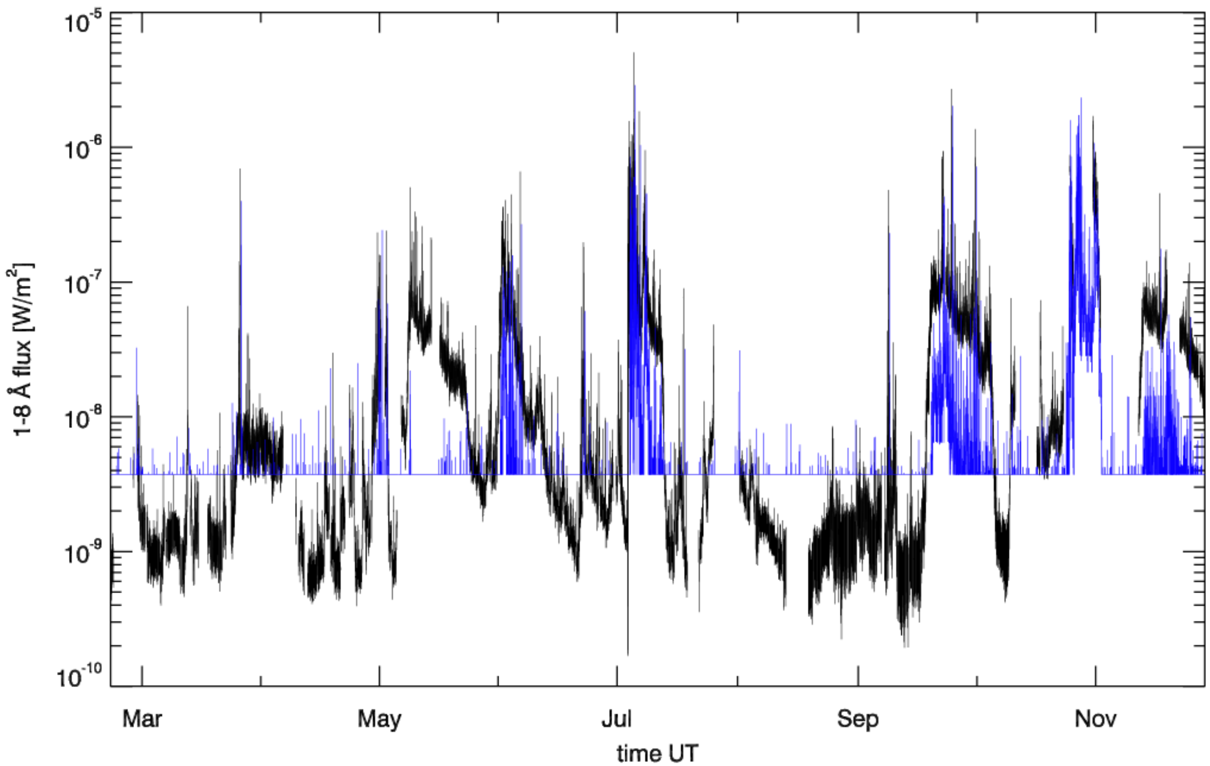
Analiza dwóch wybranych mikro-rozbłysków obserwowanych za pomocą przyrządu SphinX

M. Gryciuk[1,2]
M. Siarkowski[1]

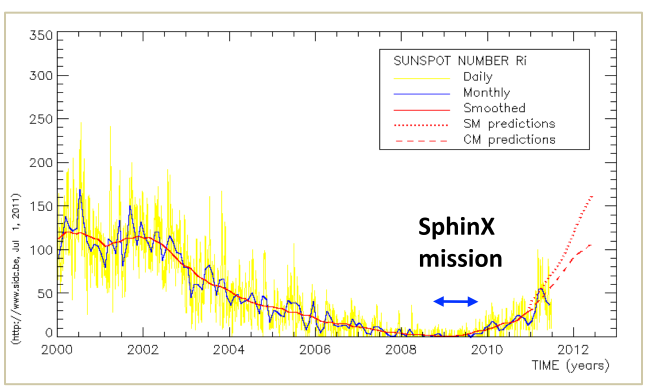
[1]Space Research Centre of the Polish Academy of Sciences, Poland

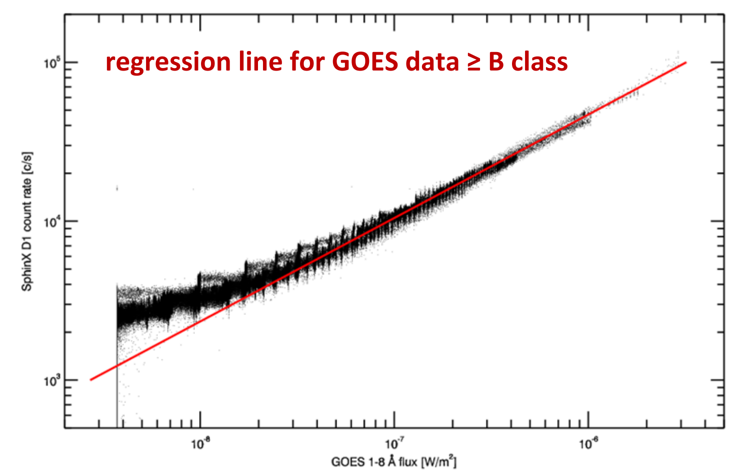
[2]Astronomical Institute, University of Wroclaw, Poland

SphinX observations



The largest SphinX flare:
5th July 2009
C 2.7 GOES class flare

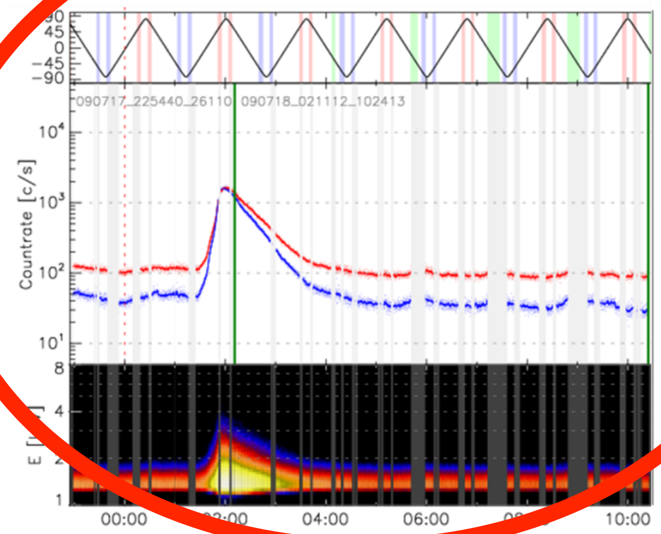




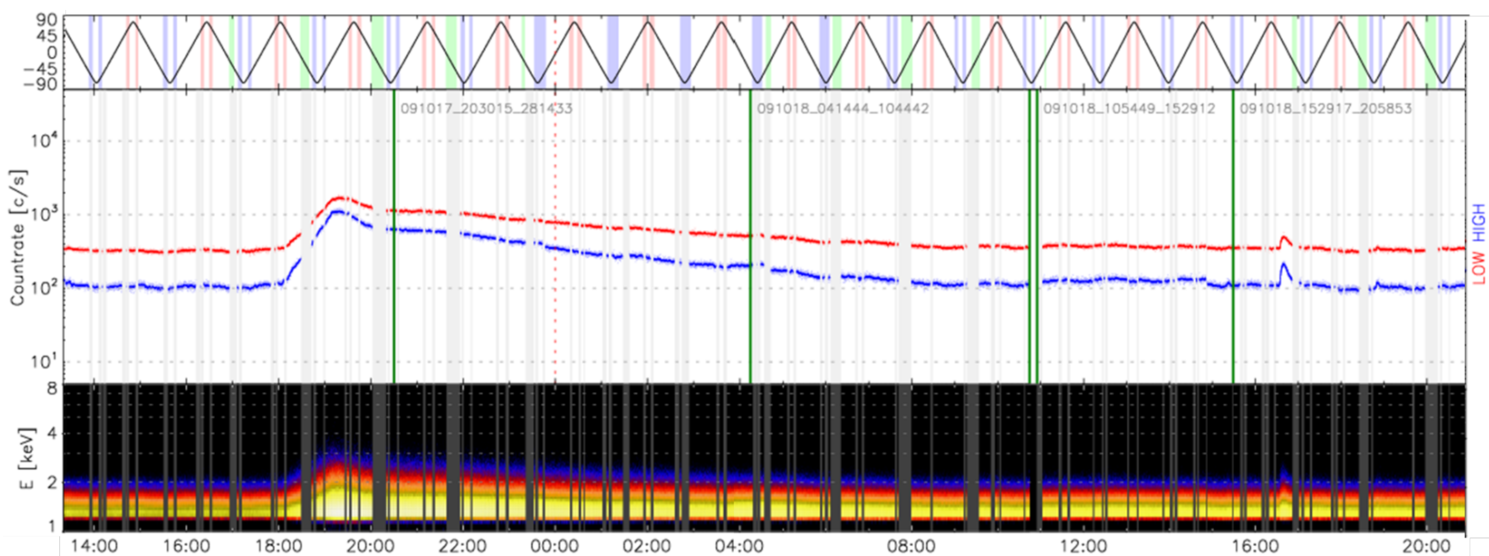
Analysed flares

18 July	**2009**	**A9 class**
17 October 2009		A7 class

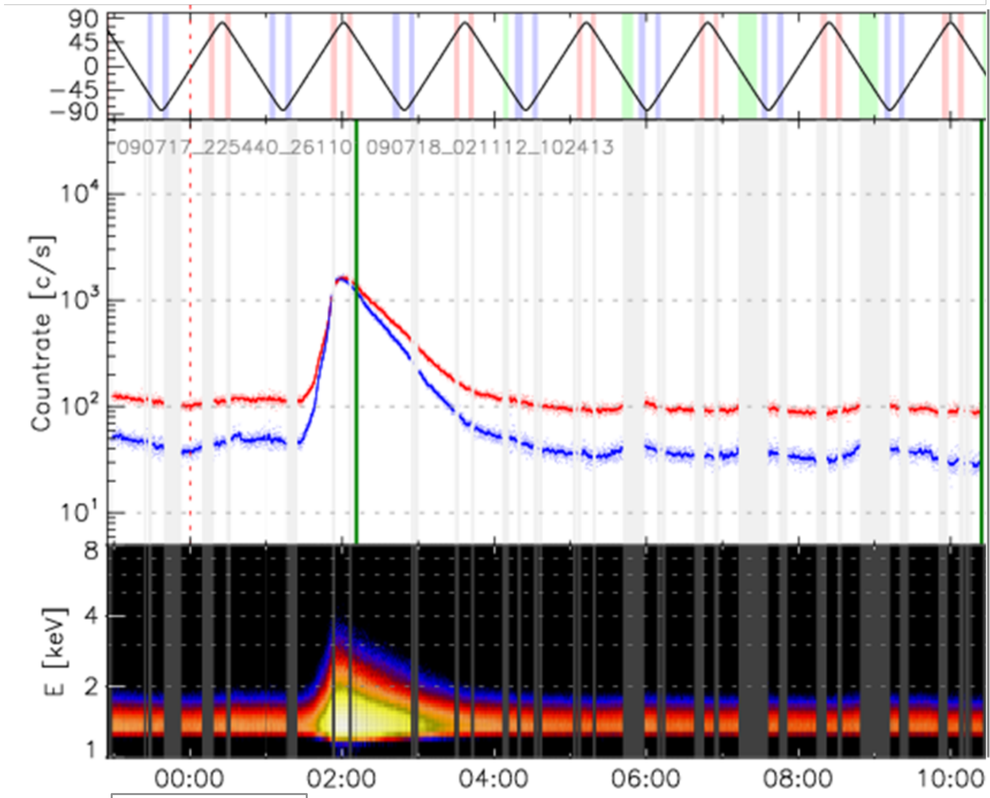
18 July 2009 (A9 class)



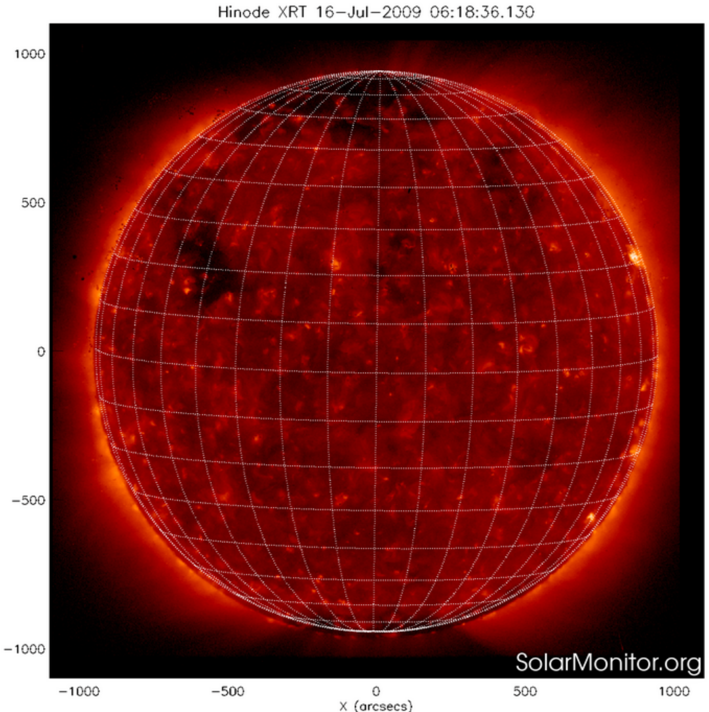
17 October 2009 (A7 class)



18 July 2009 flare A9 class



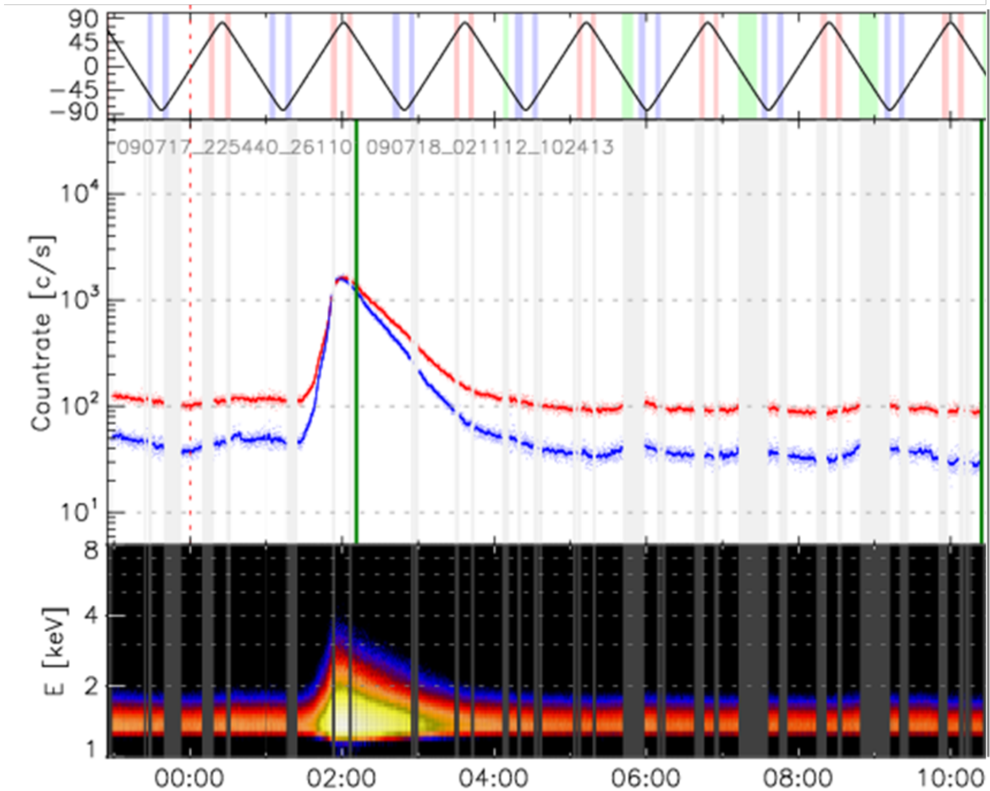
SphinX



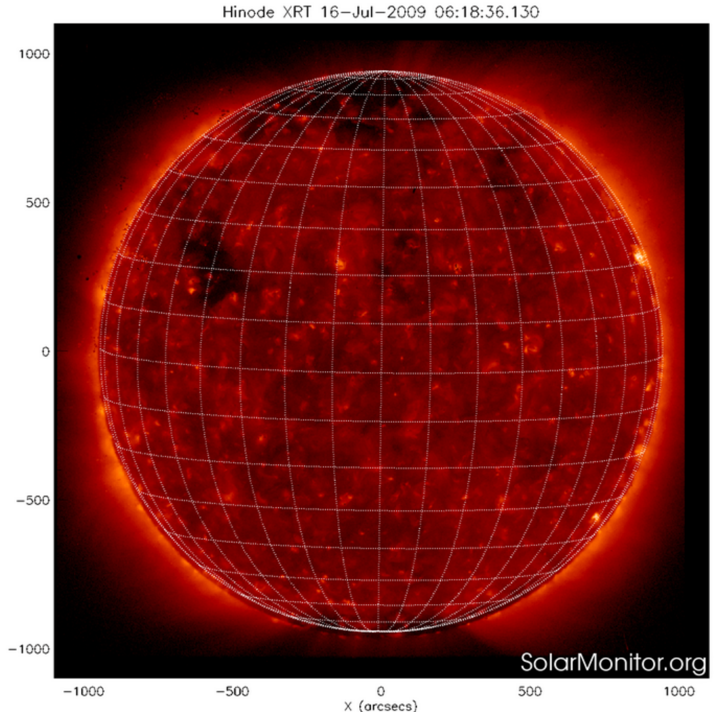
XRT/Hinode

http://156.17.94.1/sphinx_l1_catalogue/SphinX_cat_main.html

18 July 2009 flare A9 class



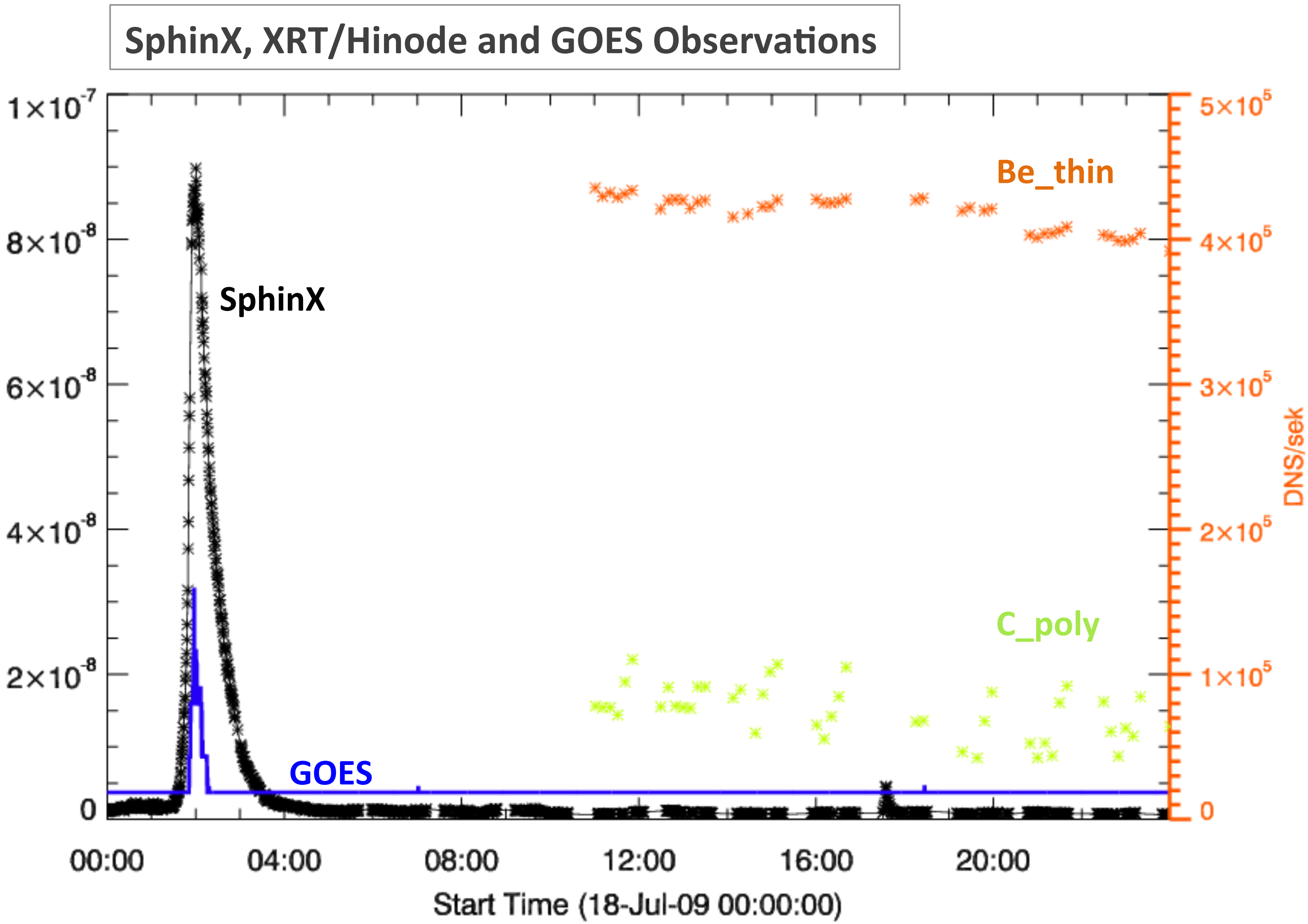
SphinX



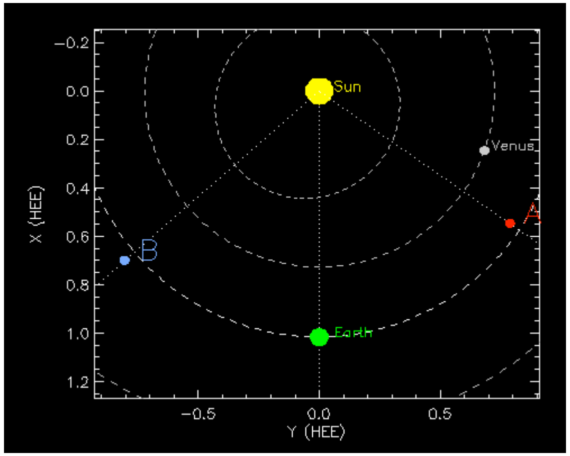
XRT/Hinode

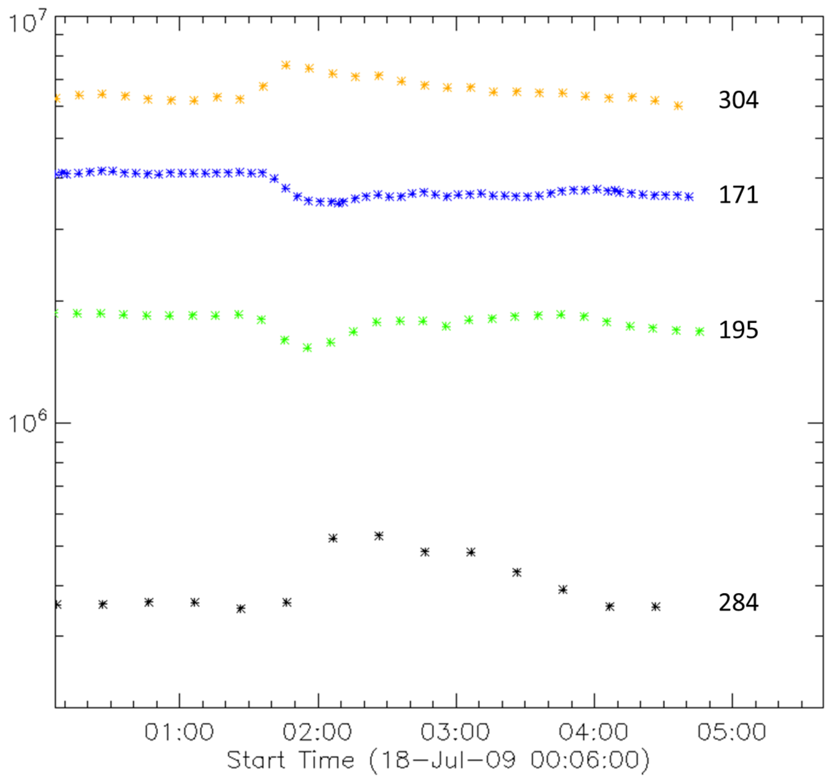
http://156.17.94.1/sphinx_l1_catalogue/SphinX_cat_main.html

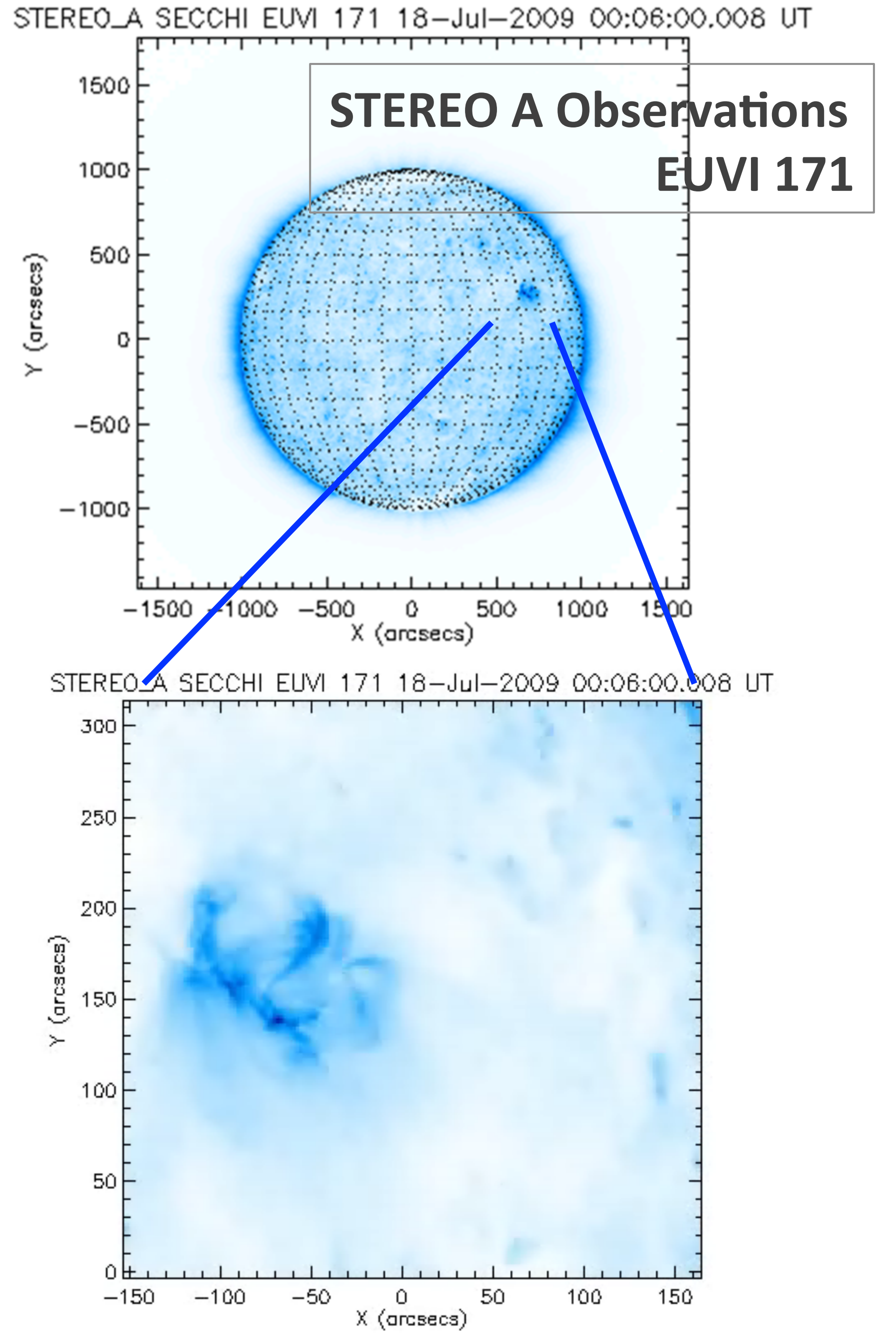
18 July 2009 flare A9 class



18 July 2009 flare





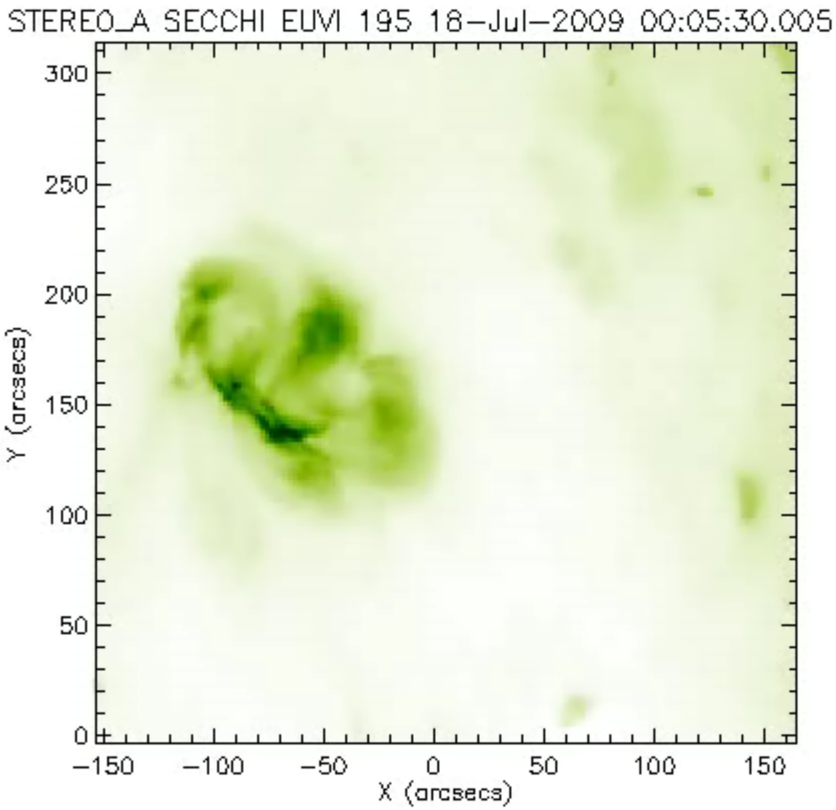


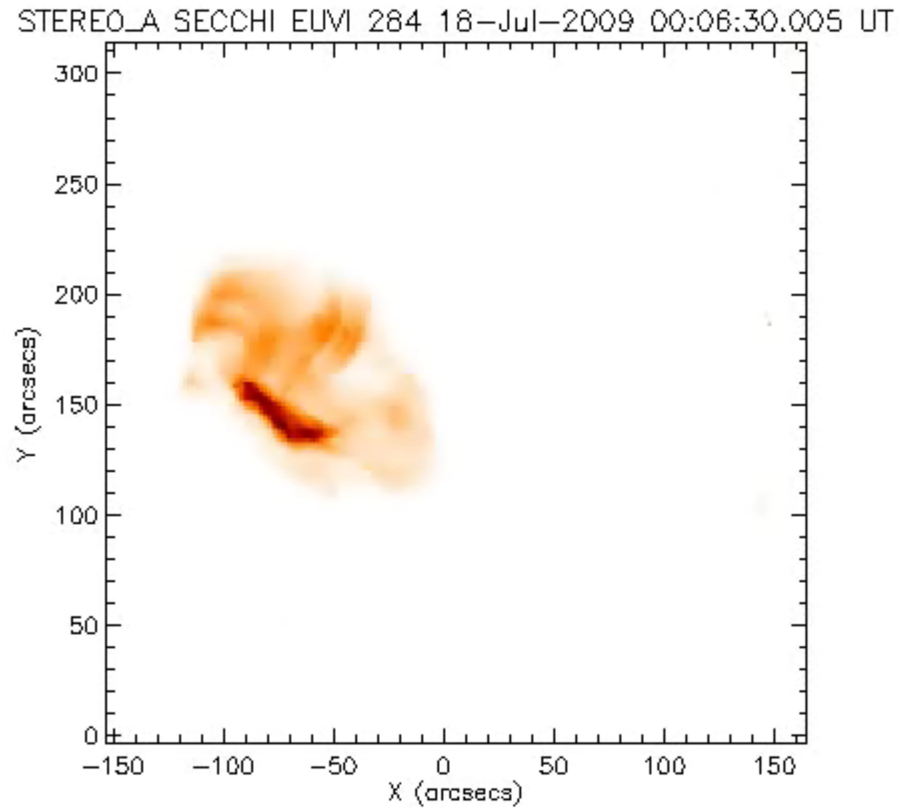
18 July 2009 flare

STEREO A Observations

EUVI Extreme Ultraviolet Imager

195	1.4 MK
284	2.2 MK



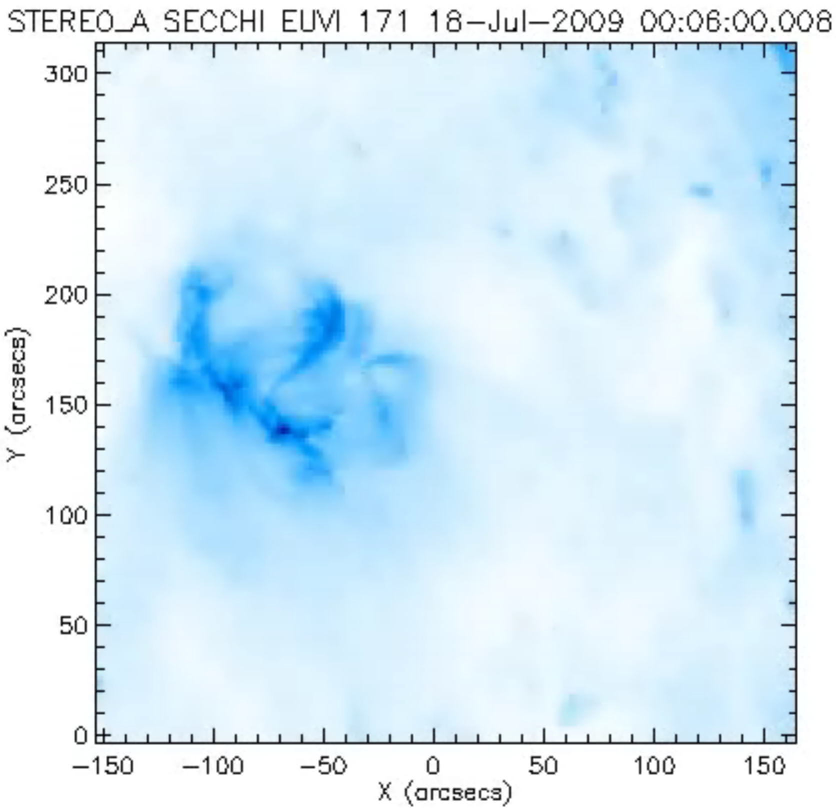


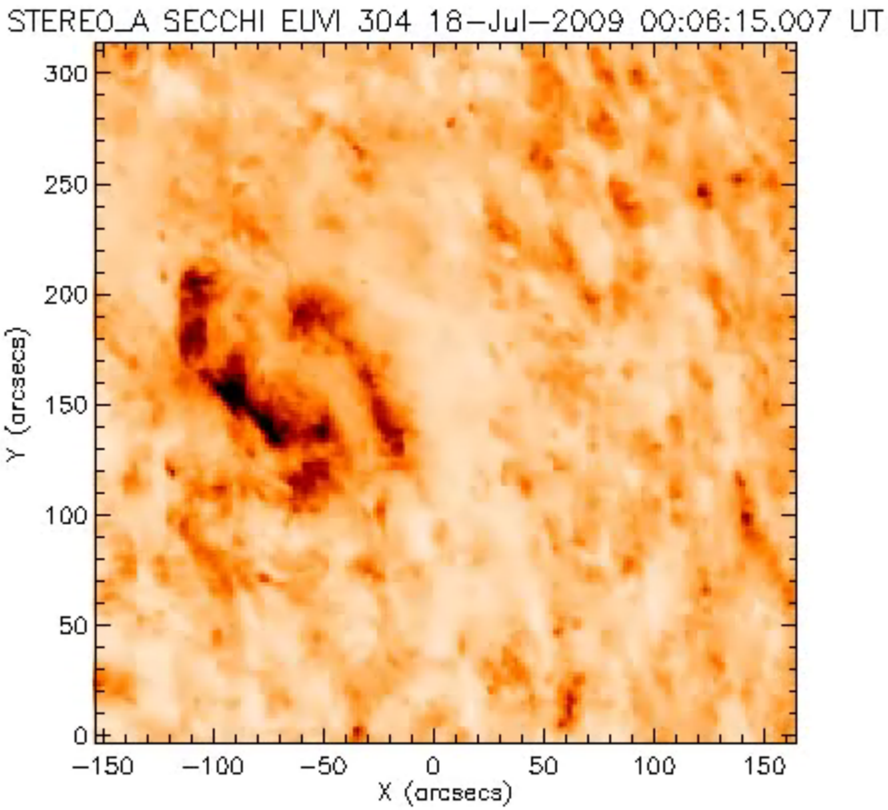
STEREO A Observations

18 July 2009 flare

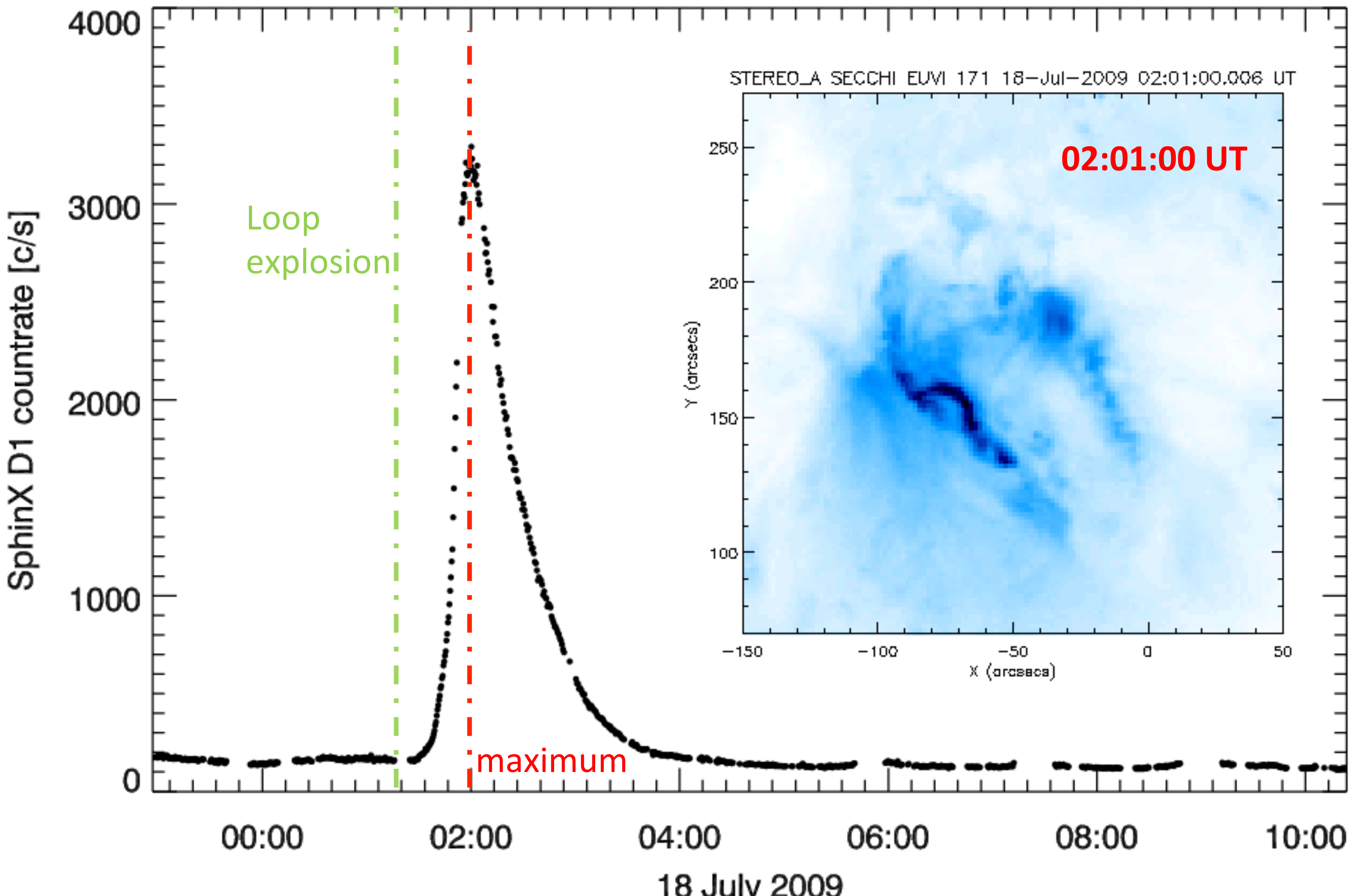
EUVI Extreme Ultraviolet Imager
171 1.0 MK
304 80000 K

Loop explosion ~ 01:40 UT

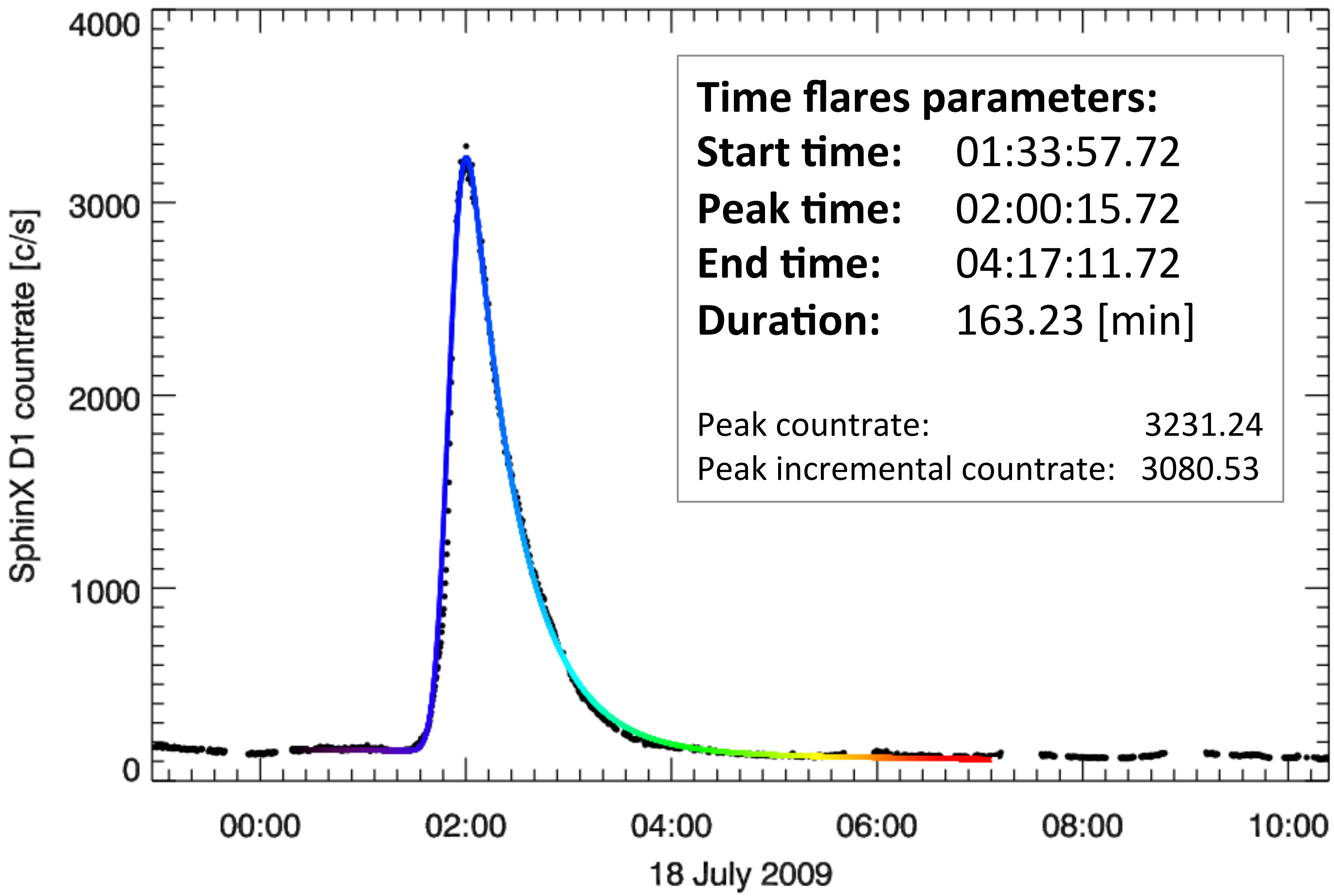




18 July 2009 flare



18 July 2009 flare



Flaring plasma diagnostics with SphinX data

- ✓ Background subtracted method
- ✓ Isothermal approximation

Elementary soft X-ray flare profile

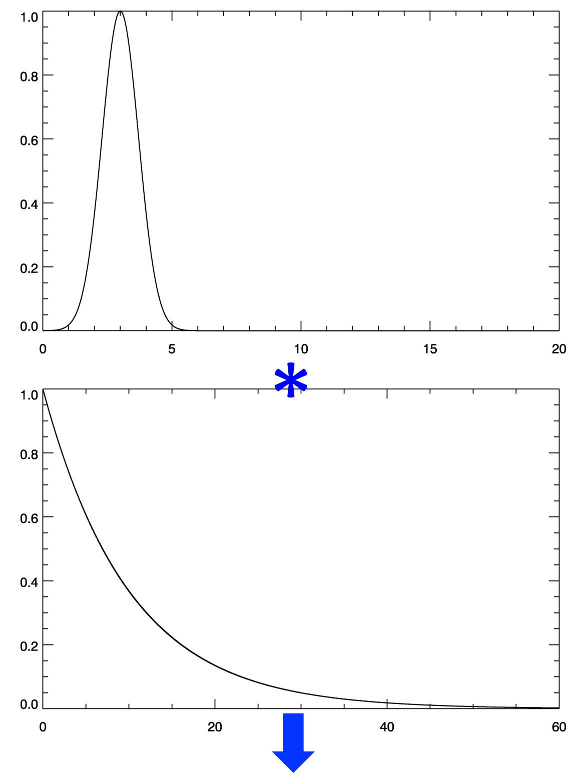
Convolution of two functions

Gauss function:

$$f(t) = Ae^{(-(t-B)^2/C^2)}$$

Exponential function:

$$f(t) = e^{(-Dt)}$$



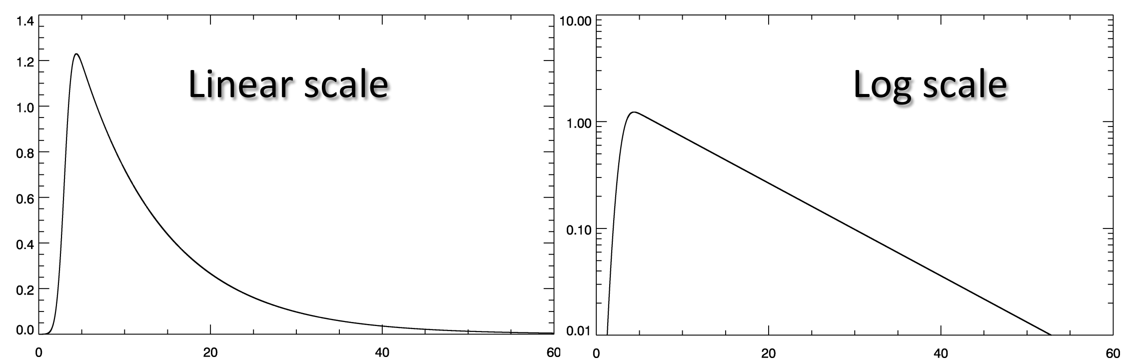
FLARE PROFILE FORMULA:

EFP (t) $= 0.5\ \sqrt{\pi}\ A\ C\ exp(D(B-t) + (C^2D^2)/4)\cdot$
$[erf((2B + C^2D)/2C) - erf((2(B-t) + C^2D)/2C)] +$
$+Et + F$

Linear background

$$f_{bg}(t) = Et + F$$

4 parameters (flare) +
2 parameters (linear background-attributable) = 6 PARAMETERS



Elementary soft X-ray flare profile

FLARE AFTER BACKGROUND SUBTRACTION

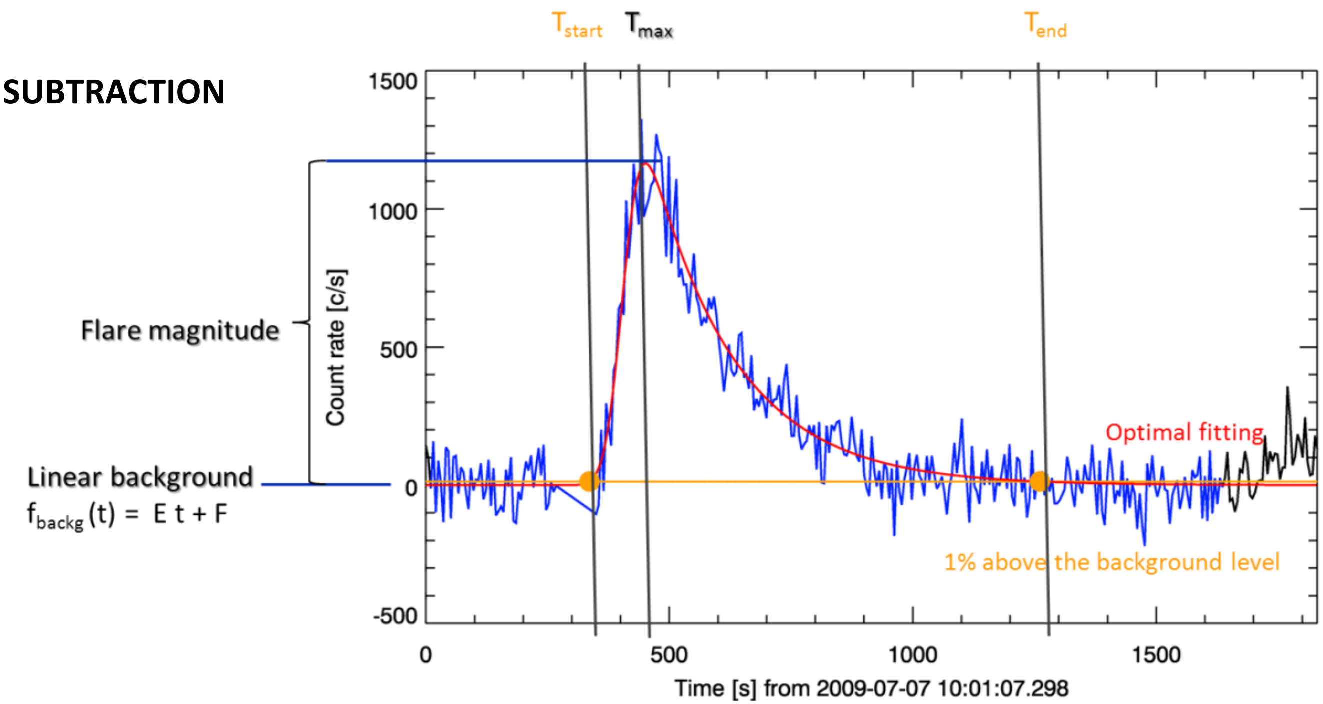
PARAMETERS:

T_{start} time of start

T_{end} time of end

T_{max} time of maximum

Flare magnitude

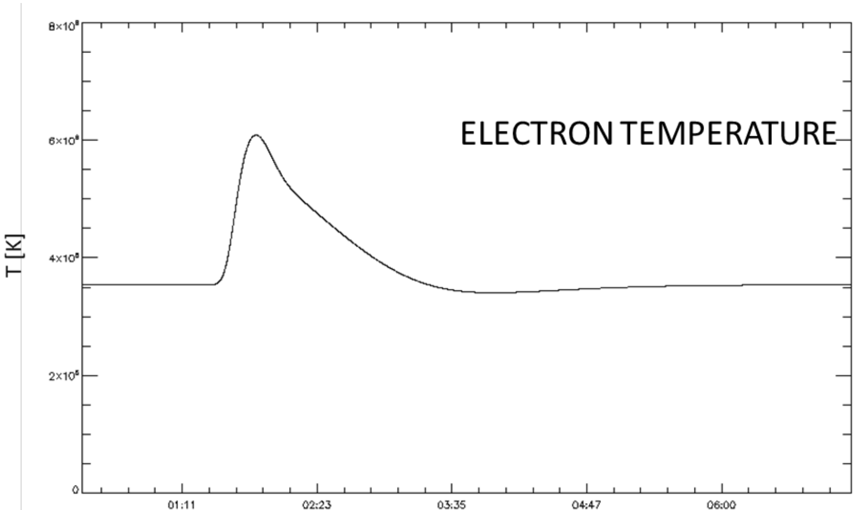


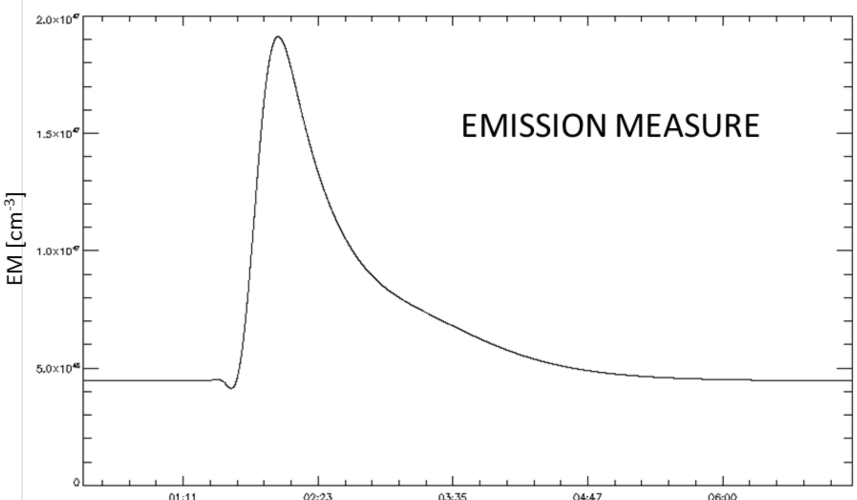
FLARE PROFILE FORMULA:

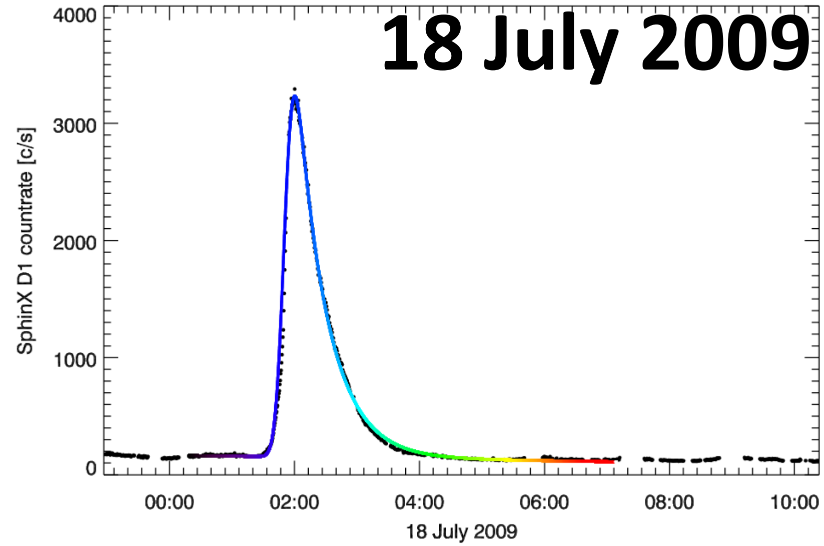
$$f(t) = 0.5\,\sqrt{\pi}\;A\;C\;exp(D(B-t)+(C^2D^2)/4)\cdot$$
$$[erf((2B+C^2D)/2C)-erf((2(B-t)+C^2D)/2C)]+$$
$$+Et+F$$

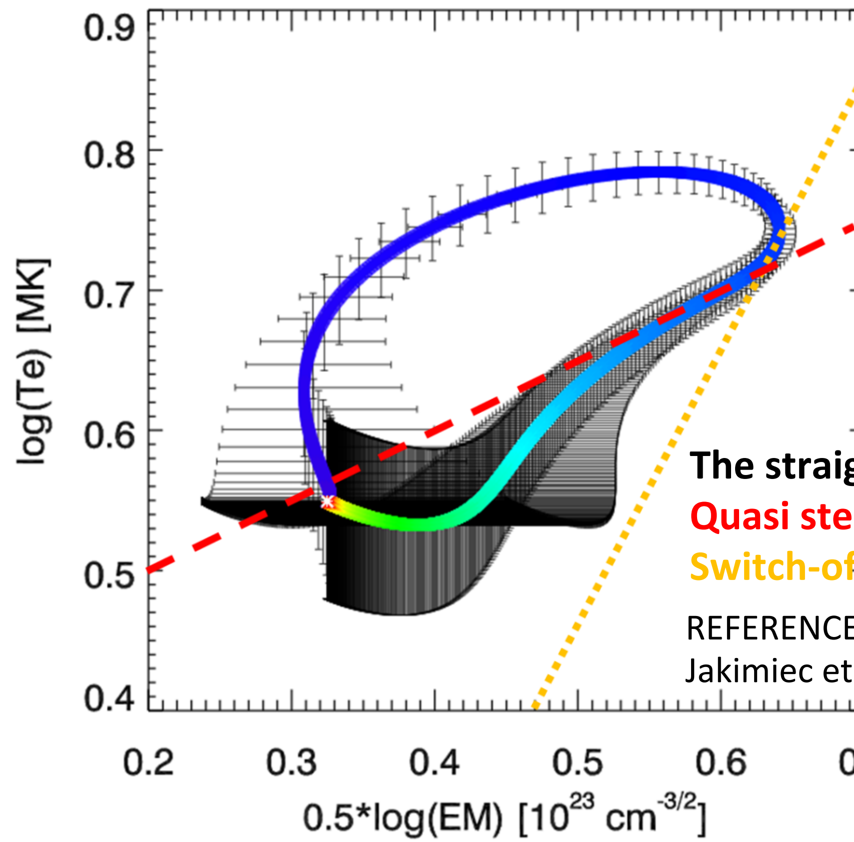
18 July 2009 flare

Evolution of flaring plasma









The straight lines:

Quasi steady state

Switch-off heating

REFERENCE:
Jakimiec et al., (1992)

RESULTS:

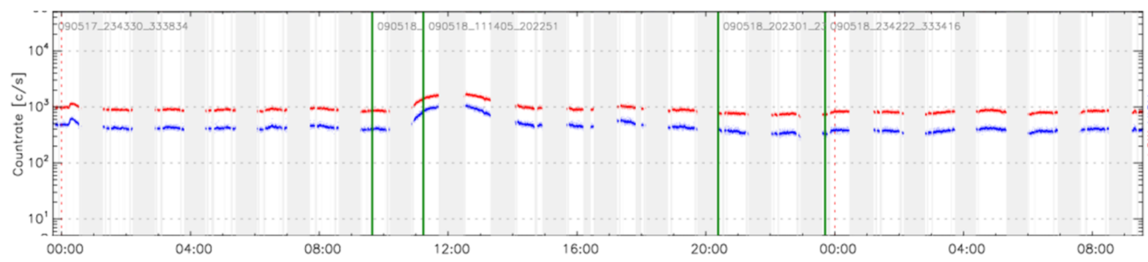
max T **6.09 [MK]**

max EM **1.9 x 10^{47} [cm^{-3}]**

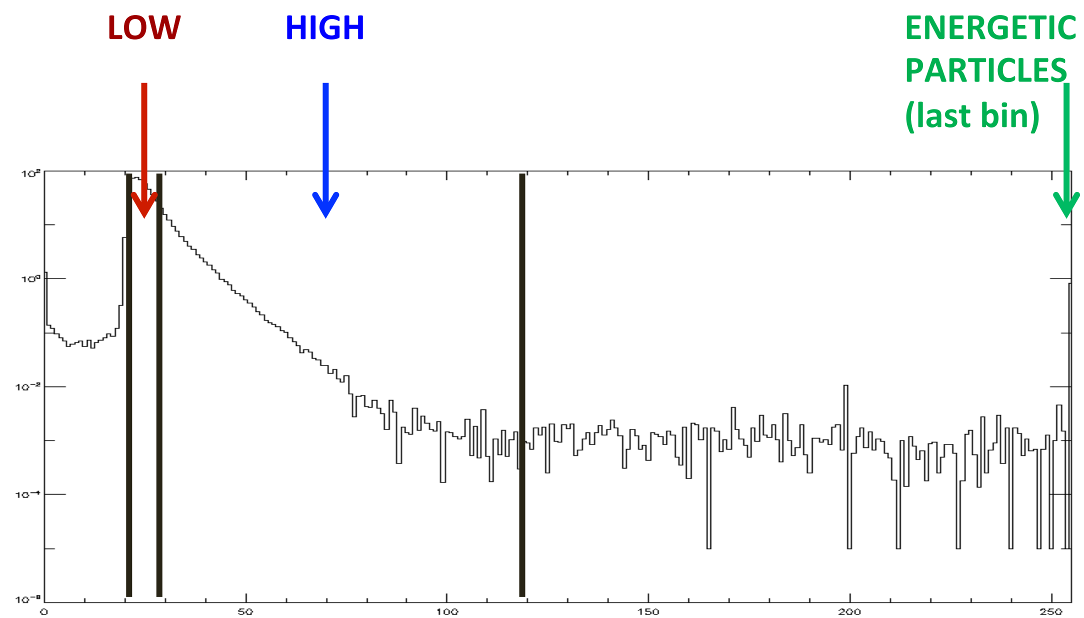
SphinX – plasma diagnostics

SphinX lightcurves in two channels:

Low (red curve): countrates of photons within energy range 1.16 - 1.5 keV.
High (blue curve): countrates of photons within energy range 1.5 - 15.07 keV.

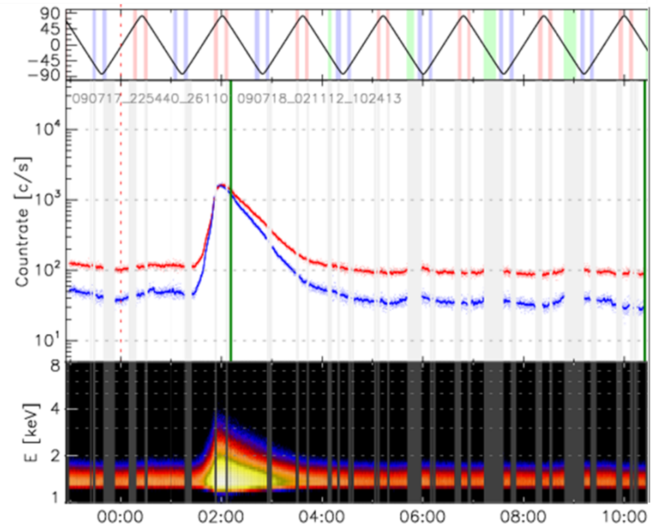


ISOTHERMAL APPROXIMATION USED FOR PLASMA TEMPERATURE AND EMISSION MEASURE CALCULATIONS



Low/high = f (T, EM)

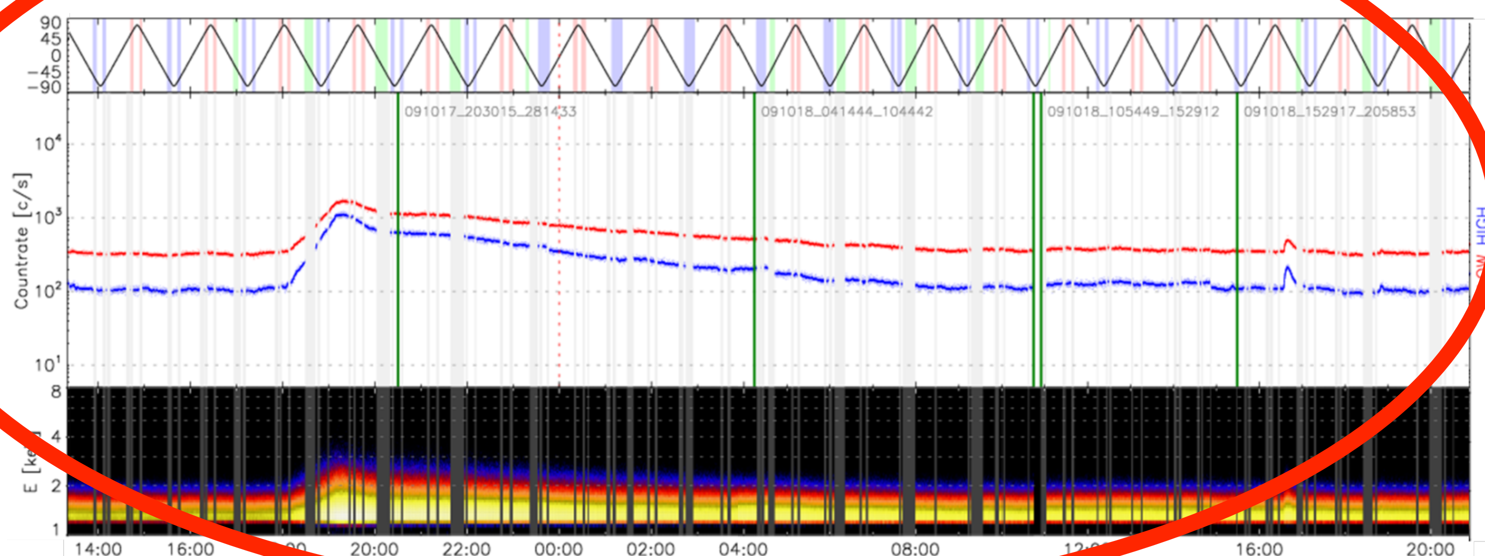
18 July 2009 (A9 class)



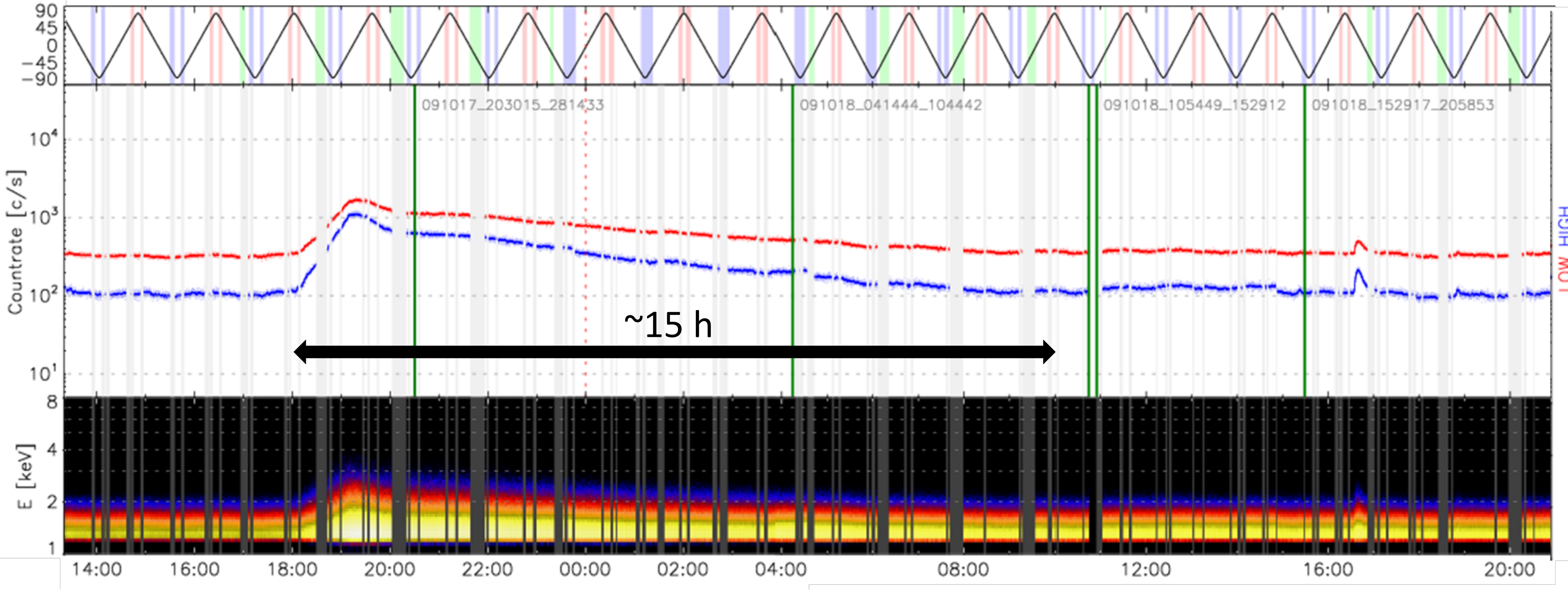
Selected flares

18 July	2009	A9 class
17 October 2009		**A7 class**

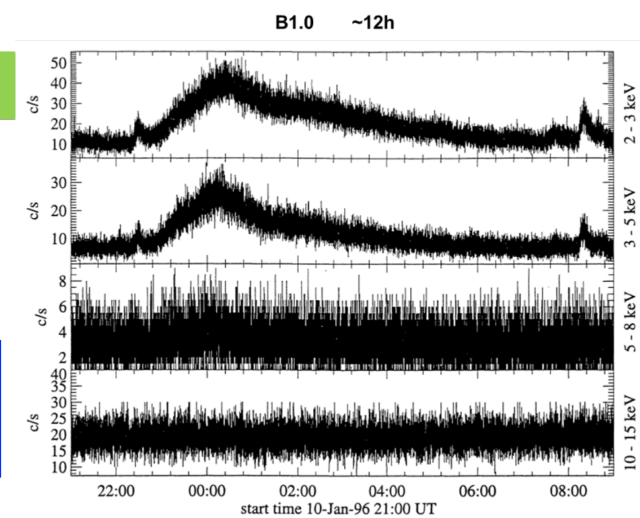
17 October 2009 (A7 class)



17 October 2009 flares   A7 class



http://156.17.94.1/sphinx_l1_catalogue/SphinX_cat_main.html



LONG DURATION EVENT

LDE, Hybrid flare ?
Svestka, Solar Phys. 1989, 121, 399

Interball RF15I
11-Jan-96 LDE

Hybrid flares (confined & dynamic)

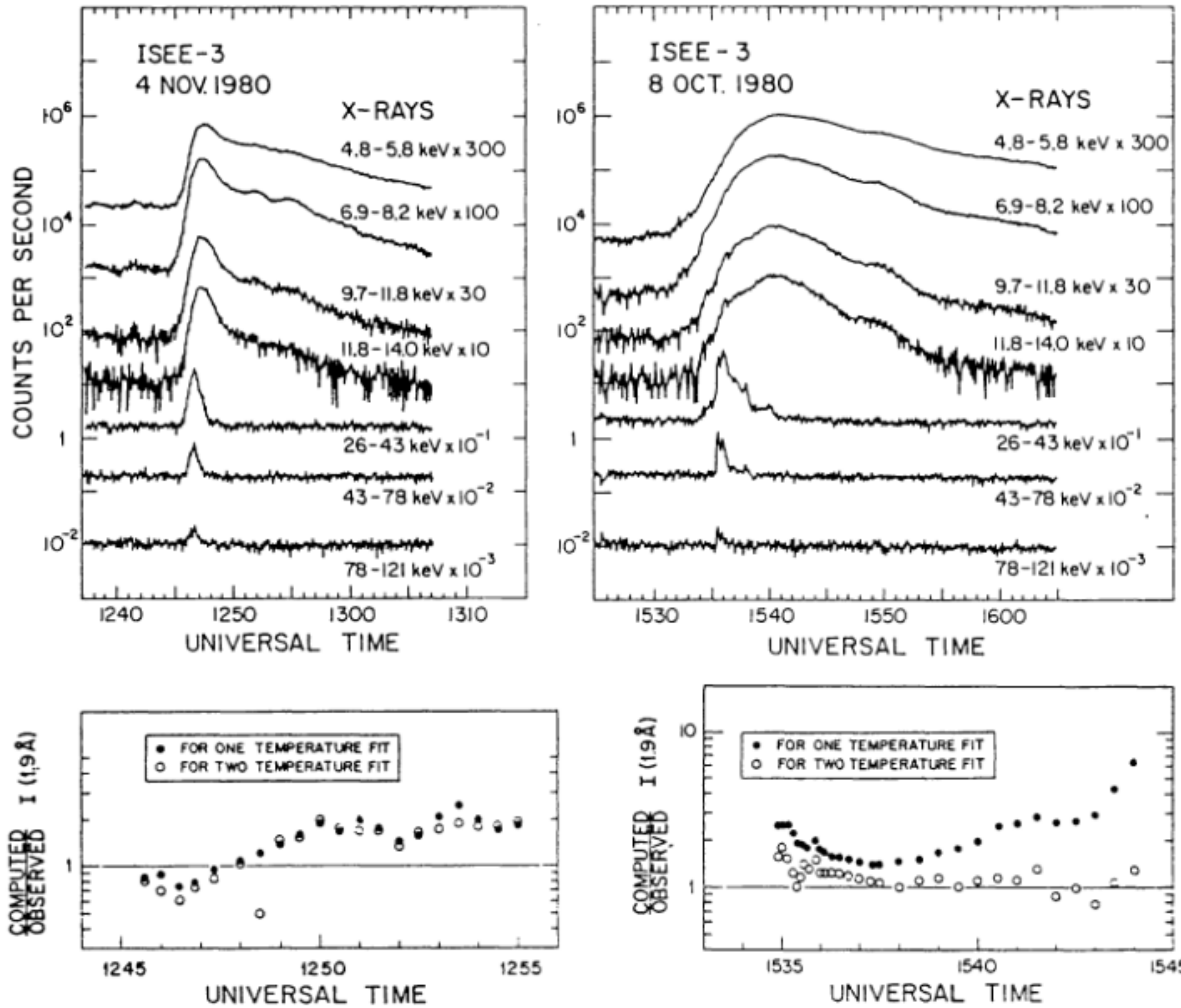
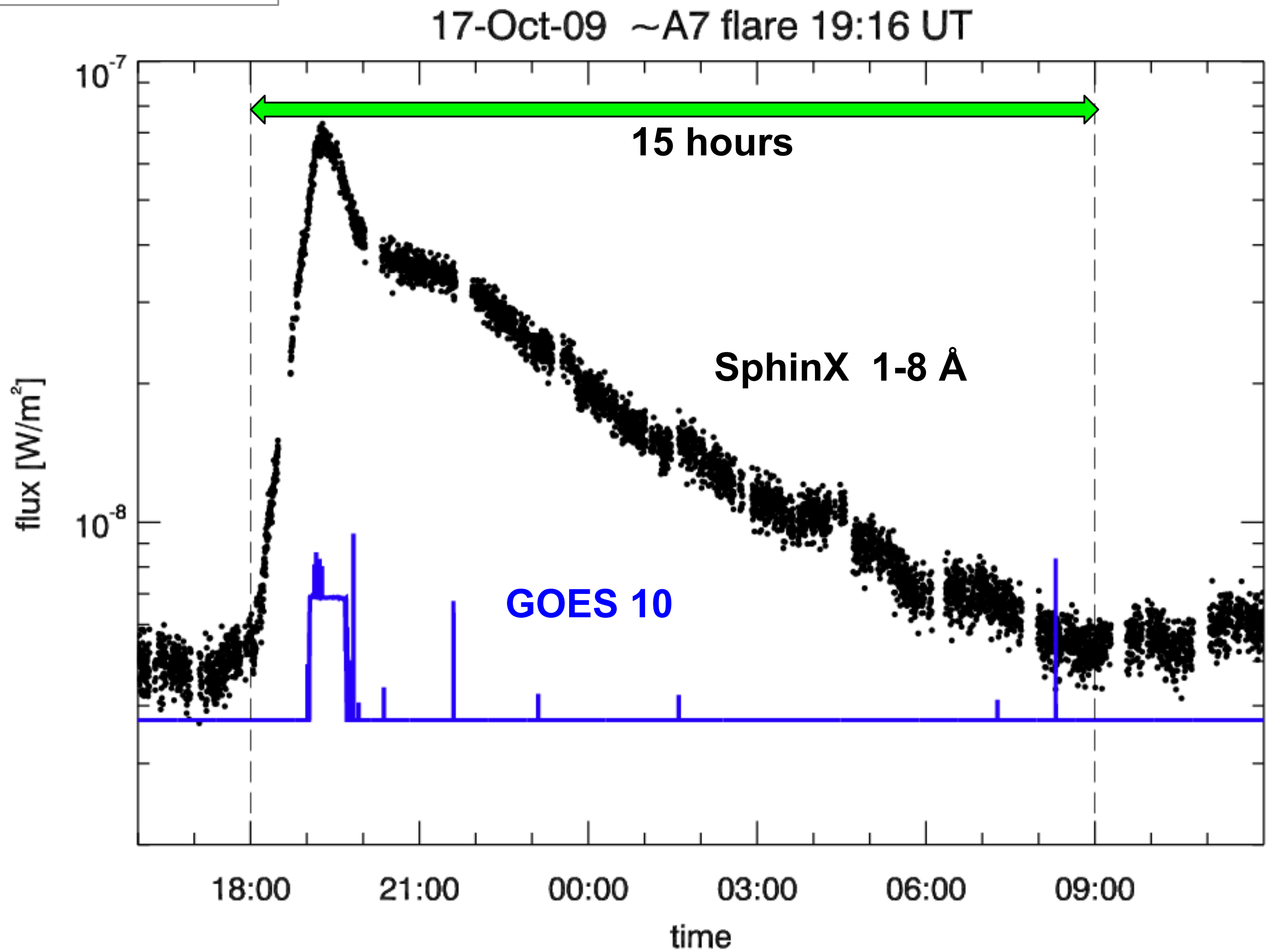


Fig. 9. The X-ray counting rate versus time profiles (*above*) and results of fitting procedure for one-temperature and two-temperature fit (*below*) for a tentatively confined (*left*) and dynamic (*right*) flare. (Examples taken from Lin, Lin, and Kane, 1985.)

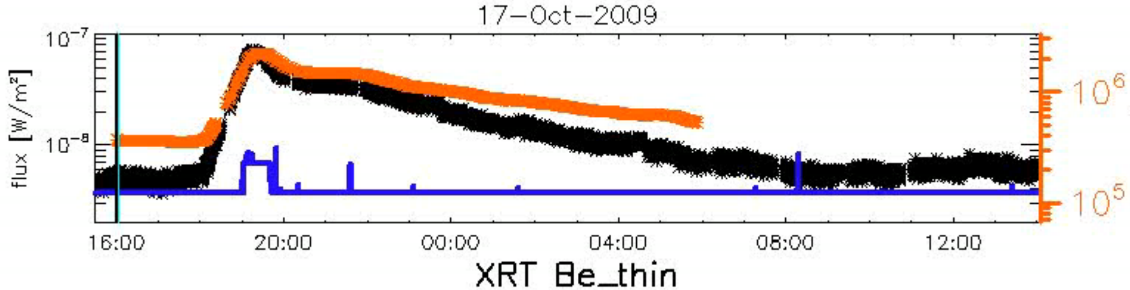
Svestka, Solar Phys. 1989, 121, 399

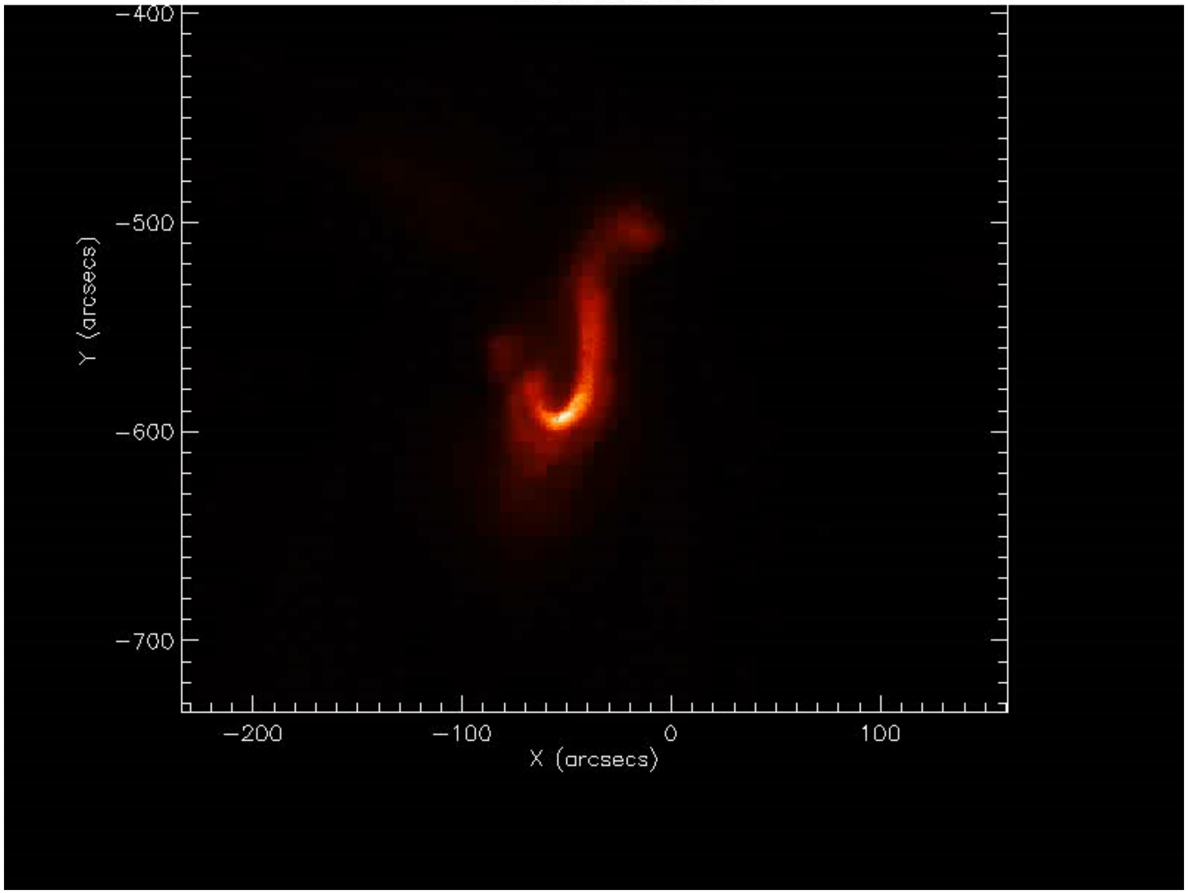
17 October 2009 flares A7 class

GOES Observations

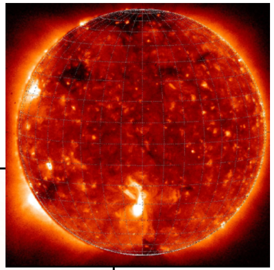


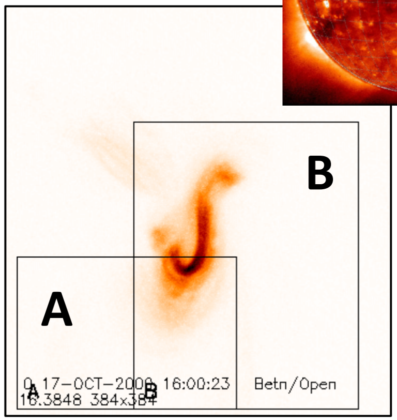
17 October 2009 flares

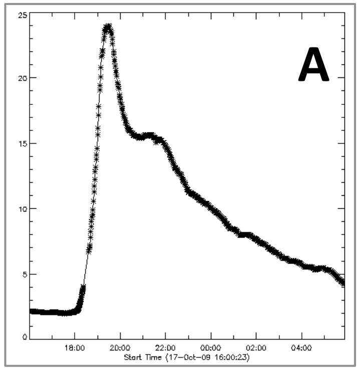


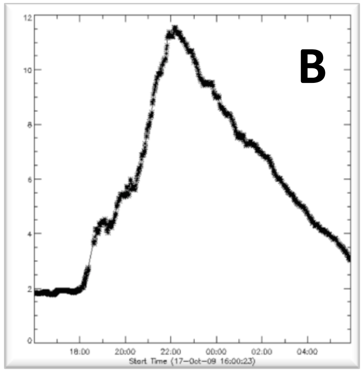


Be_thin filter

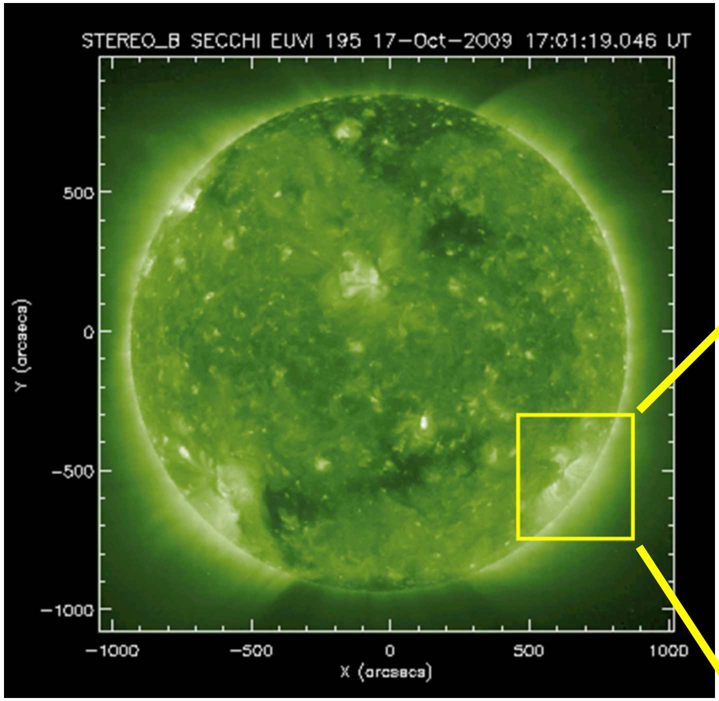




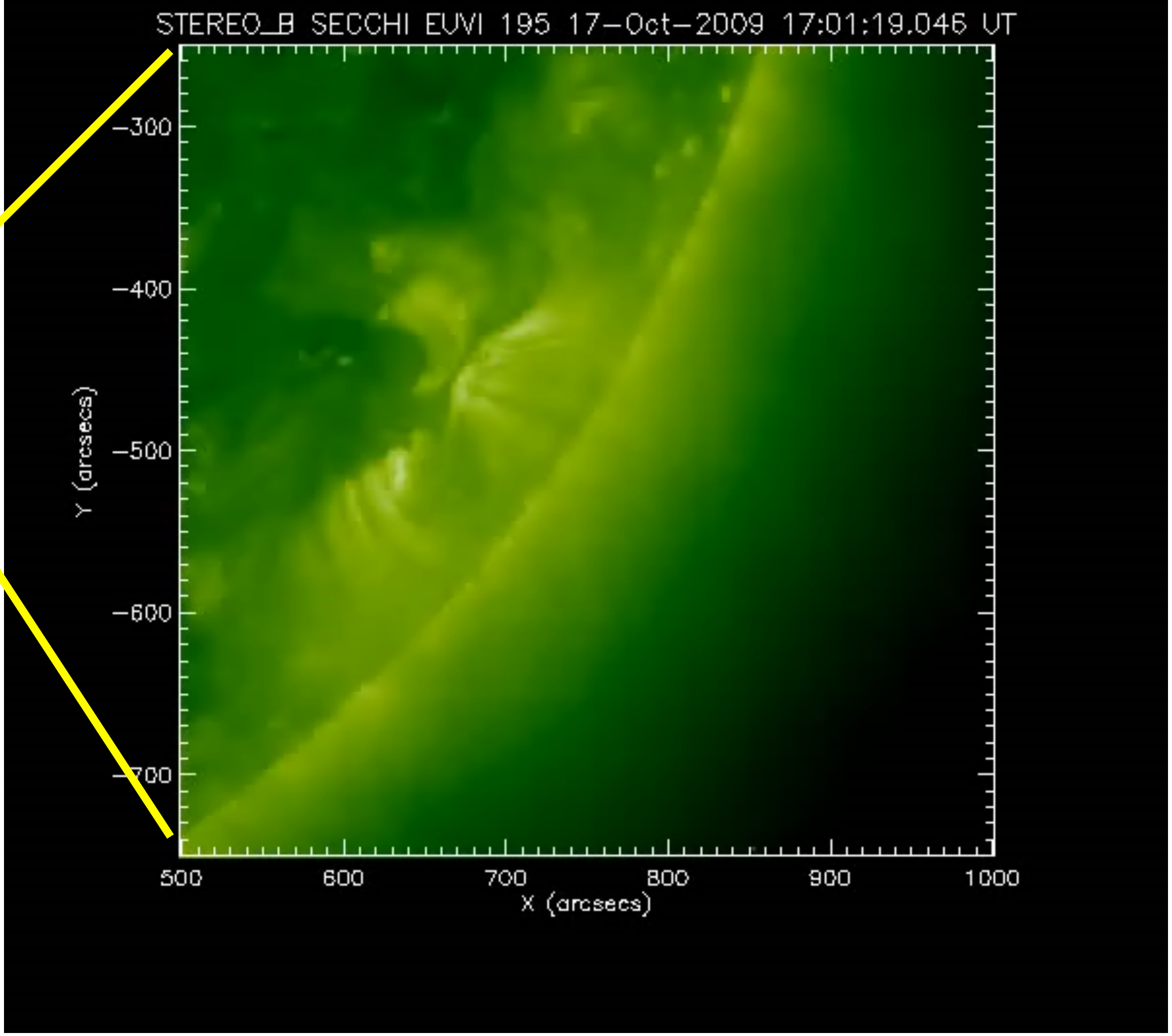


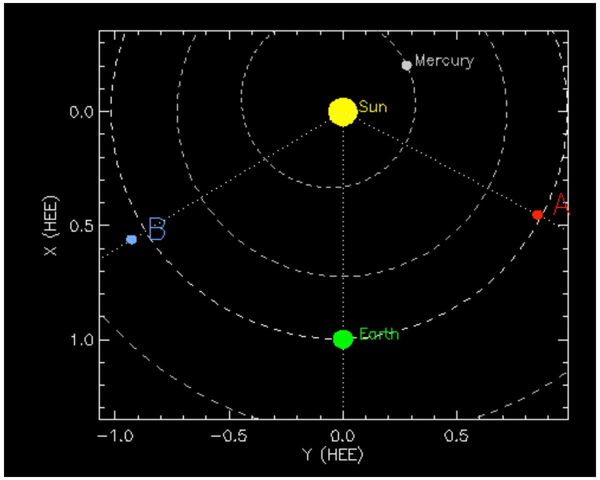


17 October 2009 flares

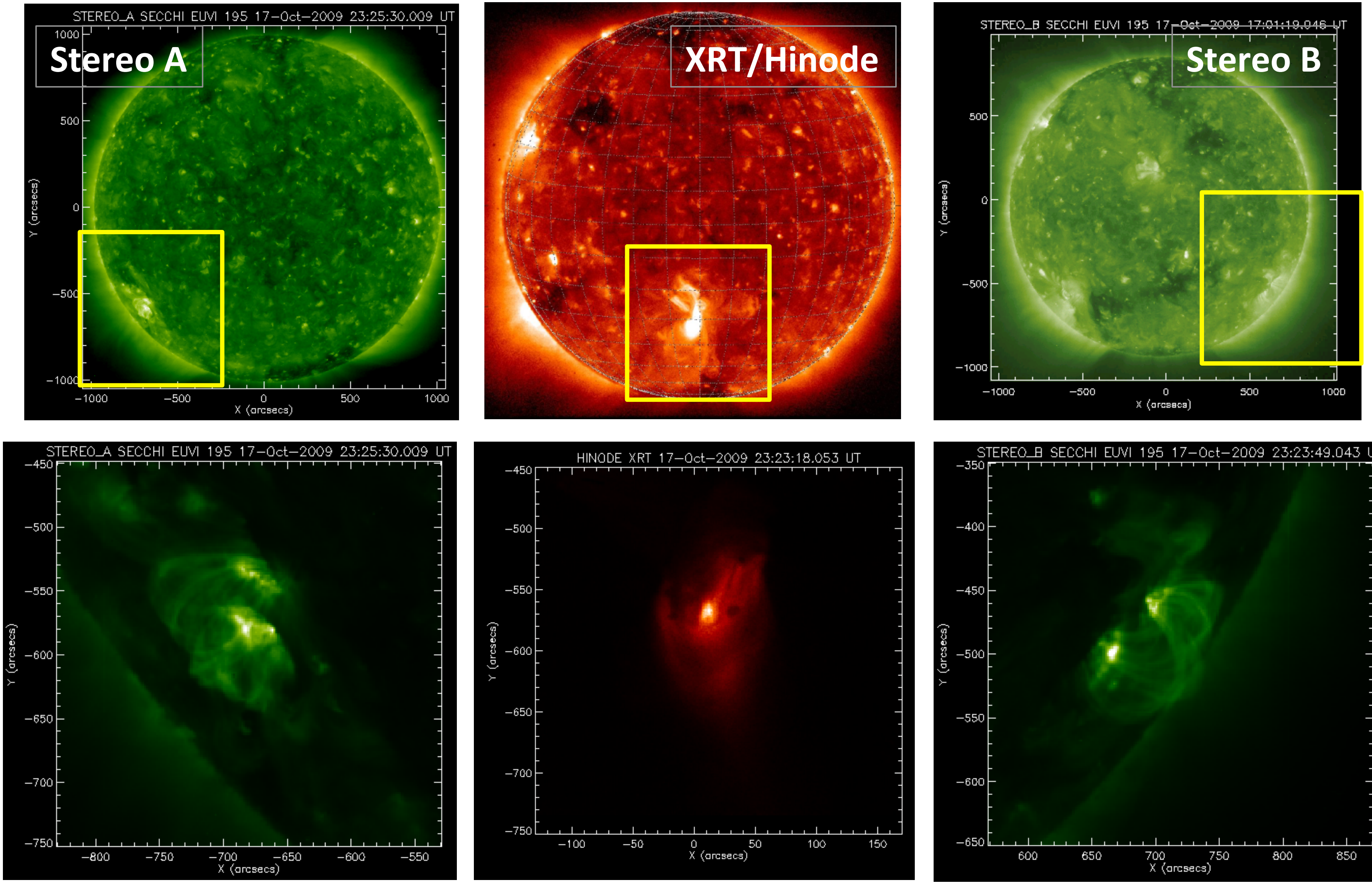


Stereo B Observations



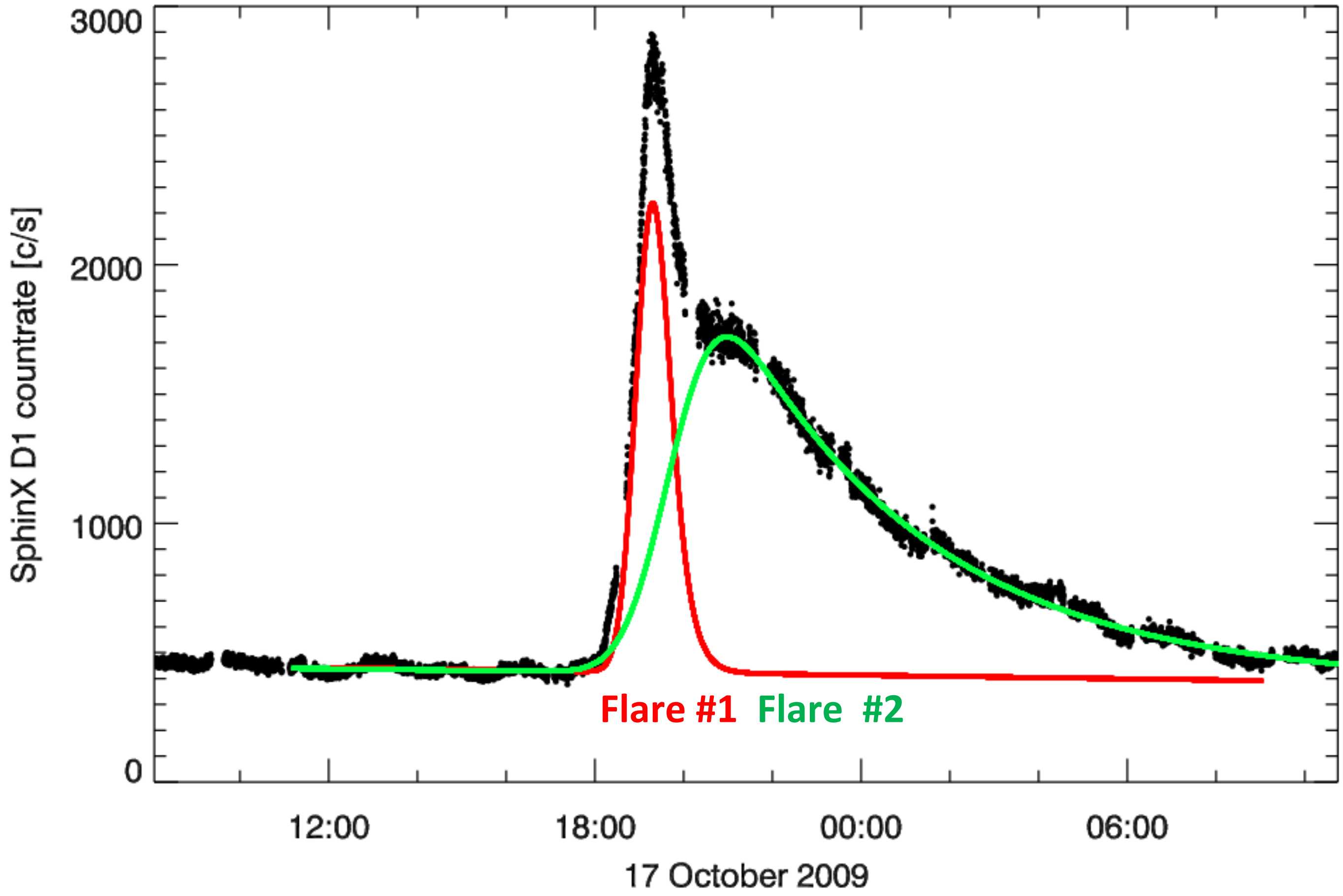


17 October 2009 flares – complex view



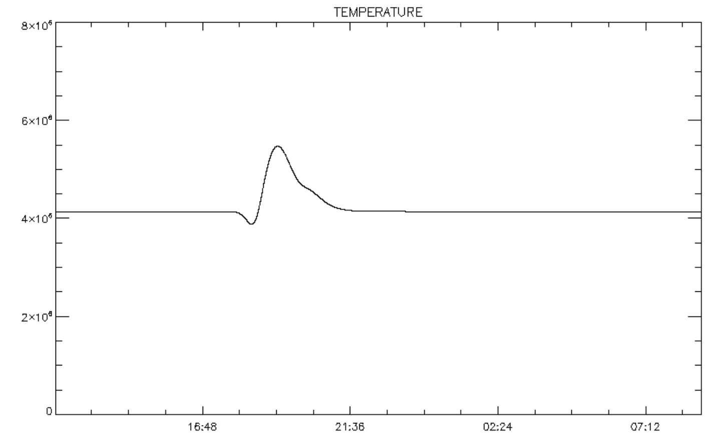
17 October 2009 flares

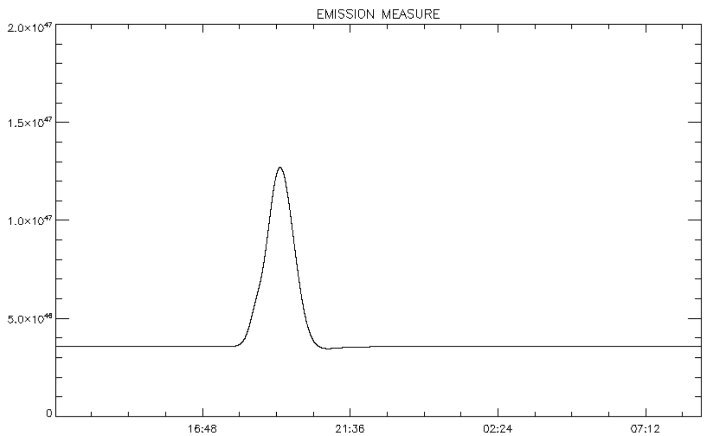
Elementary flare time profile optimal fits

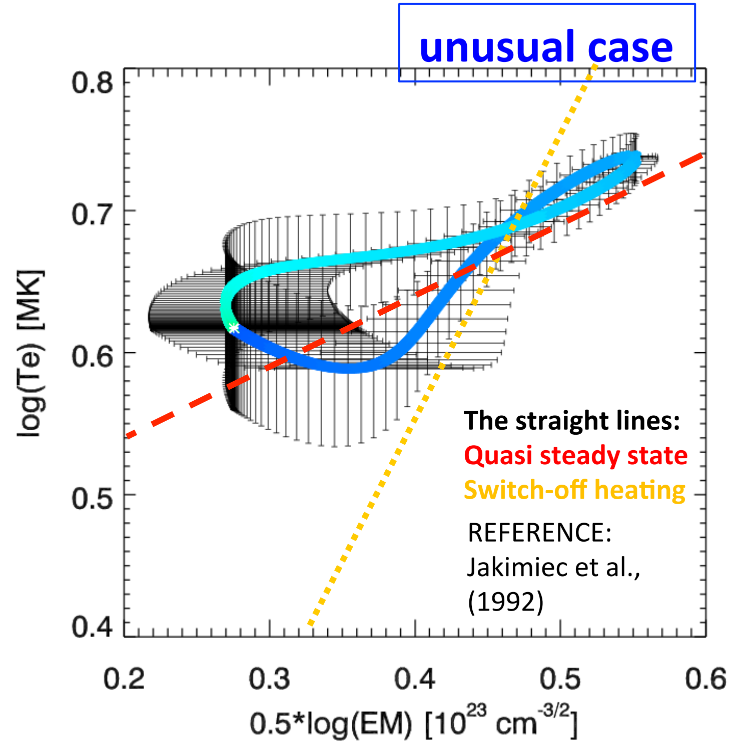


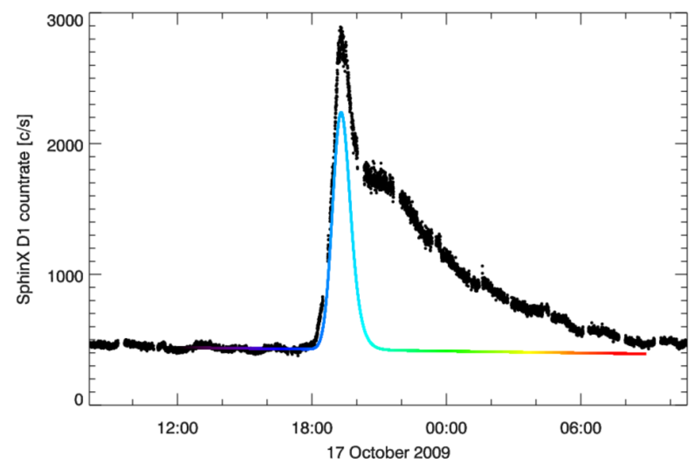
17 October 2009 flares

Flare #1







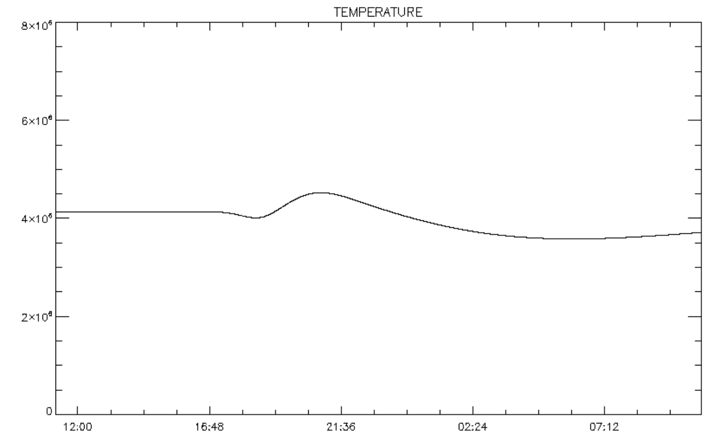


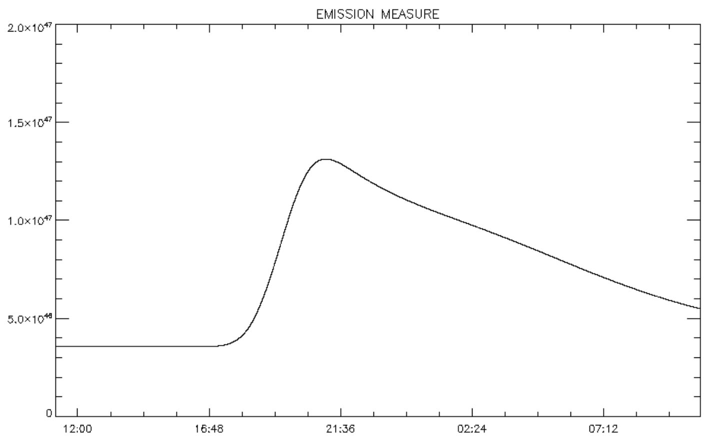
RESULTS:

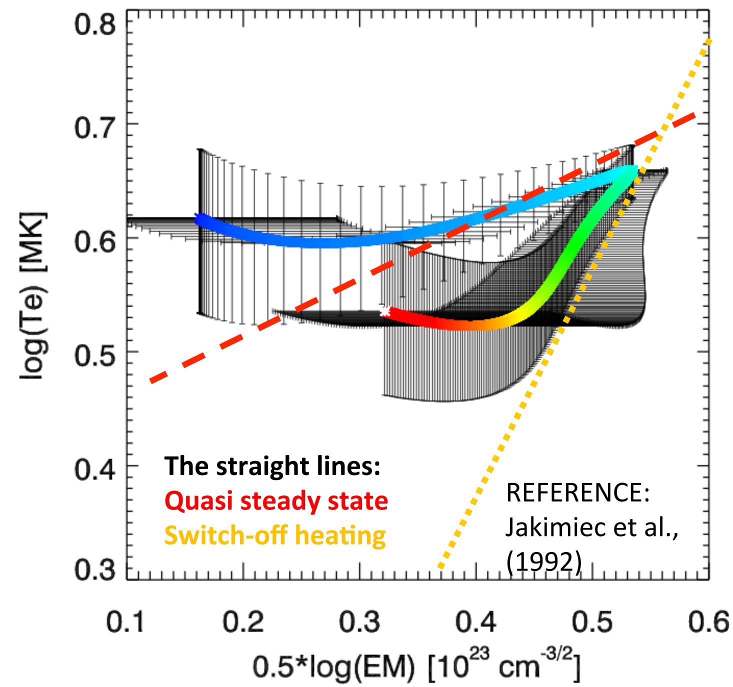
max T	**5.48 [MK]**
max EM	**1.23 x 10^{47} [cm^{-3}]**

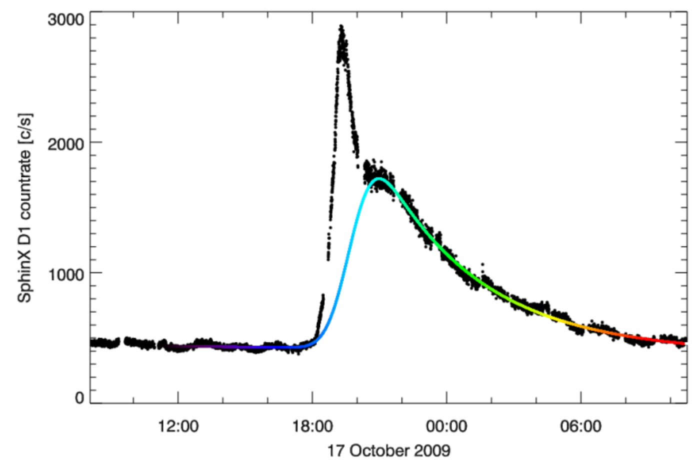
17 October 2009 flares

Flare #2







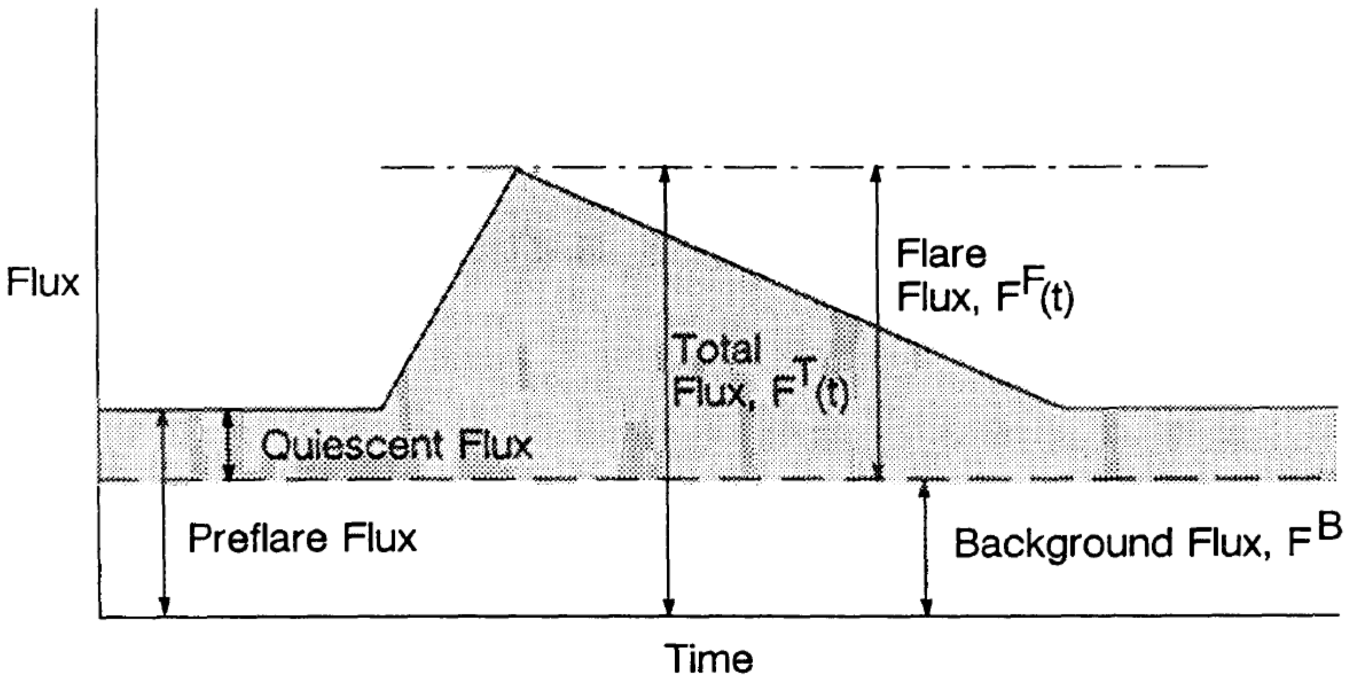


RESULTS:

max T	**4.57 [MK]**
max EM	**1.17 x 10^{47} [cm^{-3}]**

Flares Background determination

BACKGROUND LEVEL SUBTRACTION ESPECIALLY CRITICAL FOR SMALL EVENTS!



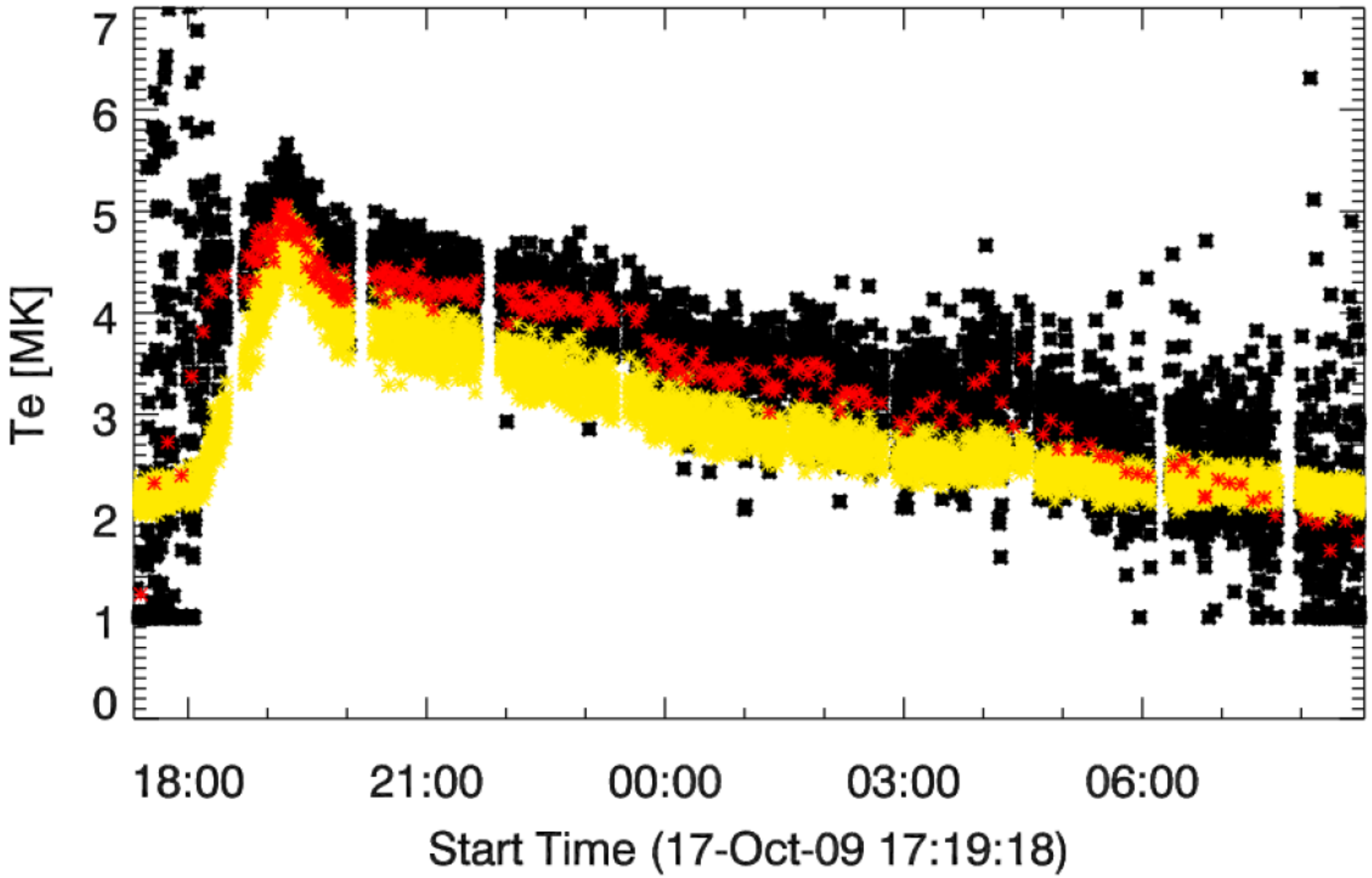
BACKGROUND LEVEL

DEFINITION PROBLEM

Bornmann, P. L. 1990, ApJ, 356, 733

FLARING PLASMA EMISSION

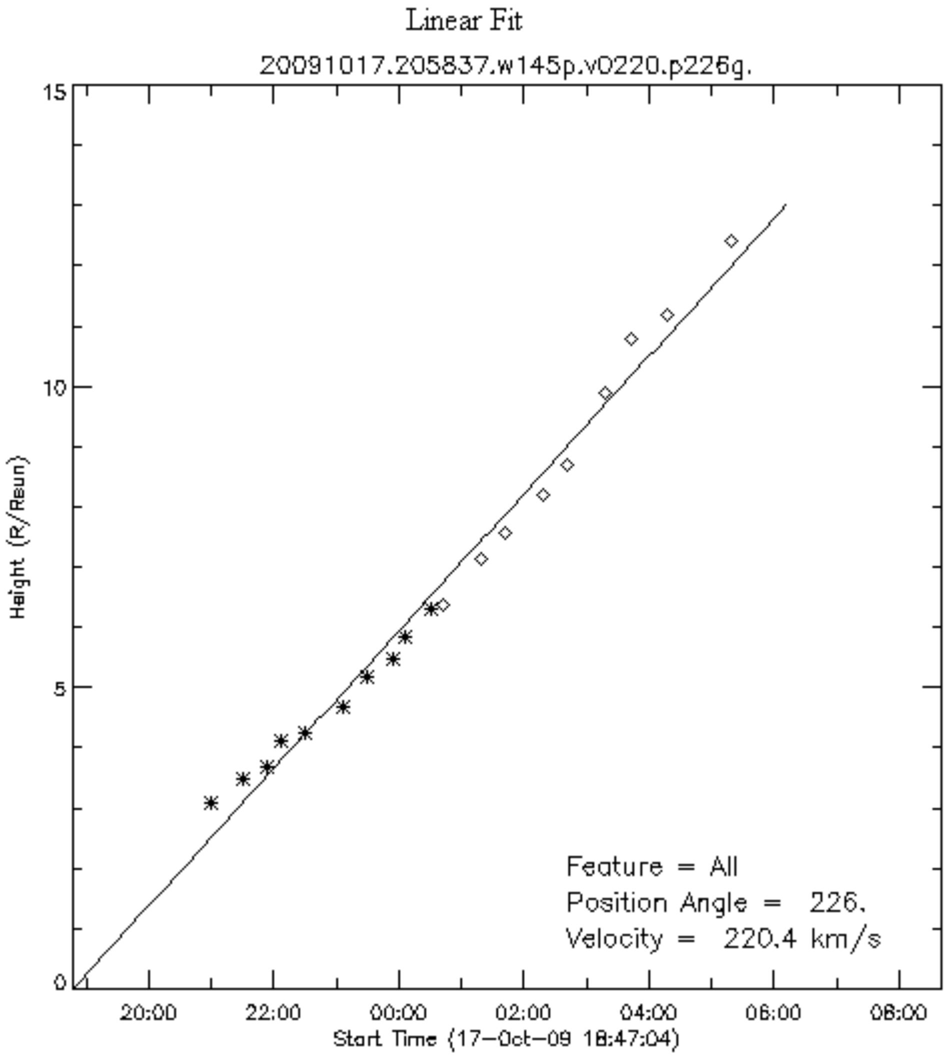
17 October 2009 flares



17 October 2009 flares & CME asocciated with

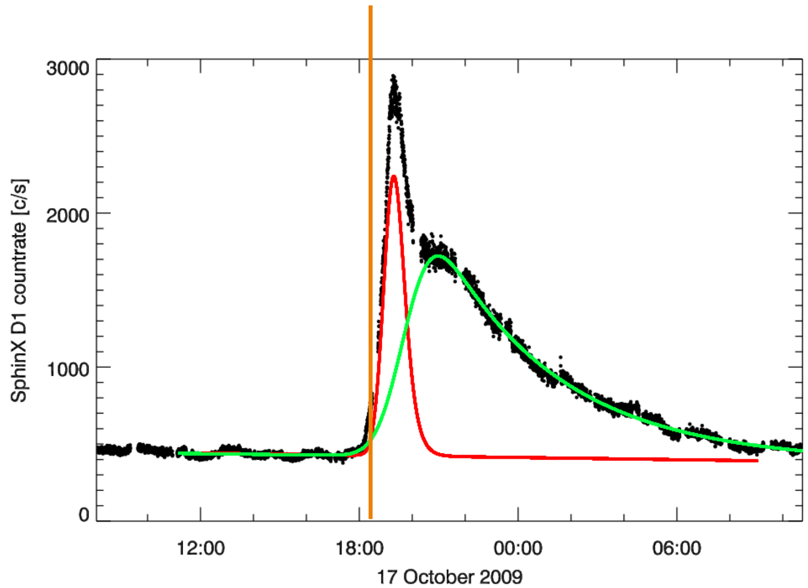
CME event

'Very Poor Event; Partial Halo' (SOHO LASCO CME CATALOGUE)



Determinations based on **LASCO data**

~ 18:47



Conclusions

Analysed flares:
18 July 2009 A9 class
17 October 2009 A7 class

- Small flares differ from large ones only on scales (of size, Te, EM etc.)
- Morphology of small flare can be as complicated as larger ones
- Even small flares can be associated with ejection phenomena (CME) - flares lightcurves deconvolution allow for determination of exact start and end times of event

COSPAR MOSCOW 2014
COSMOS
40th SCIENTIFIC ASSEMBLY
Russia, Moscow, 2-10 August 2014

Thank You
for your kind attention