A common analysis of RESIK, SPIRIT and RHESSI observations for LDE flare of 15 April 2002

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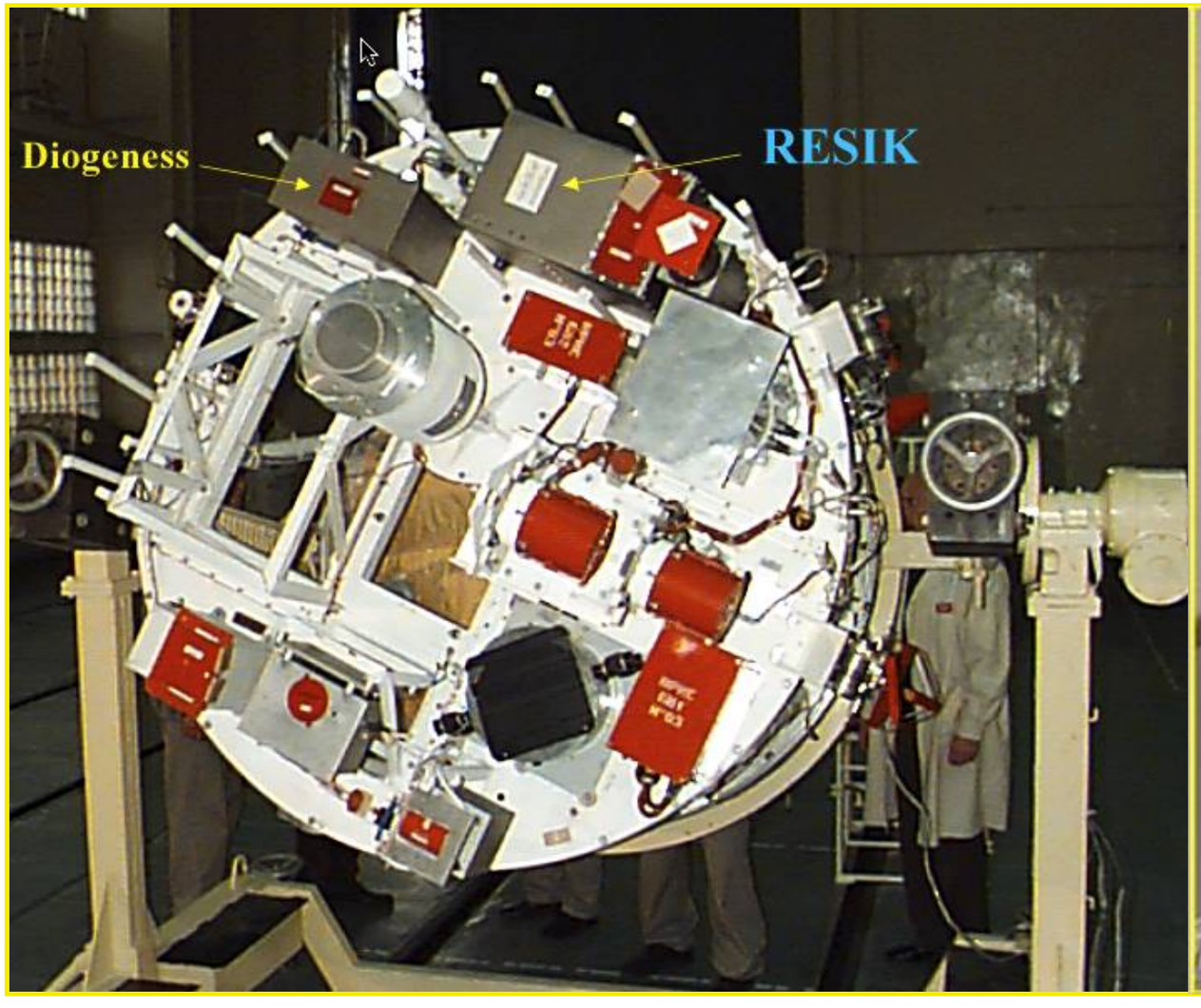
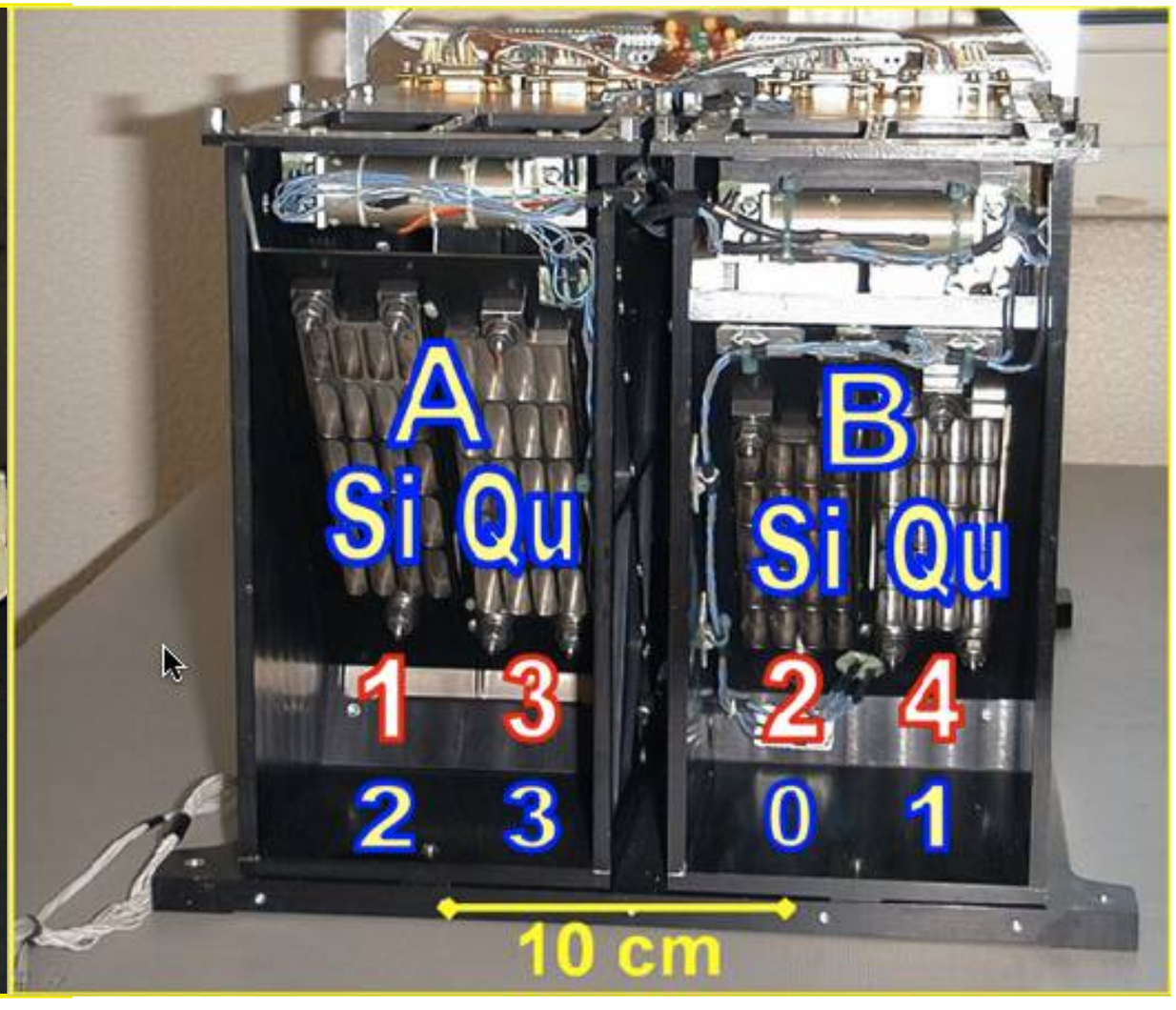
Outline

- Coronas-F
- 15 April 2002 flare
- RESIK, SPIRIT, EIT/SoHO, RHESSI data
- Isothermal analysis & DEM

Coronas-F





Characteristics of RESIK channels

Wavelength				
nominal range[d] [Å]	3.40–3.80	3.83–4.27	4.35–4.86	5.00–6.05
extreme range[e] [Å]	3.33–3.90	3.78–4.32	4.23–4.92	4.90–6.15
Wavelength				
resolution [mÅ]	8	9	12	17
Dispersion[c] [mÅ/bin]	2.49	2.28	2.85	4.99

RES SPIRIT

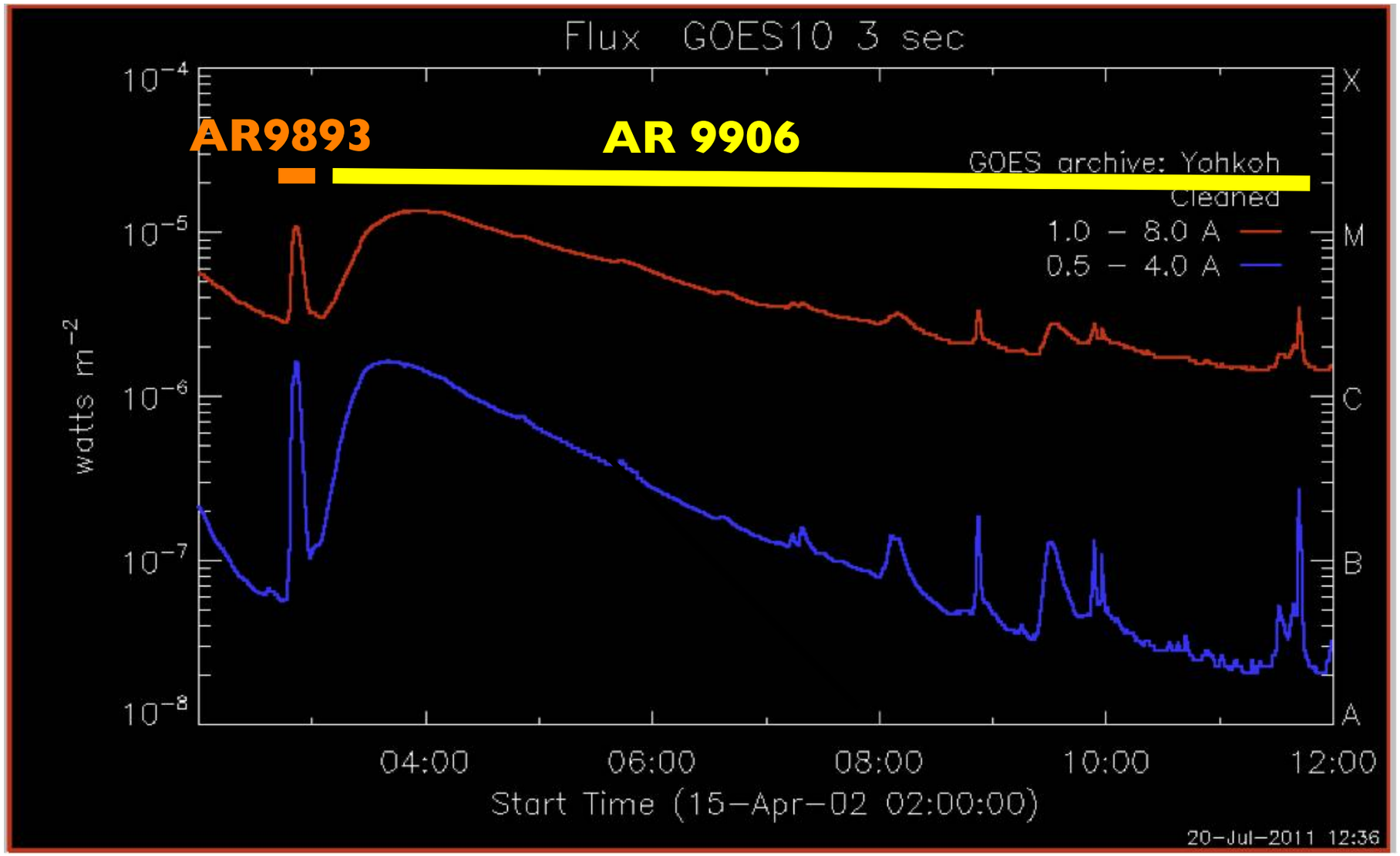
RES spectroheliograph of the SPIRIT instrumentation onboard the CORONAS-F satellite includes:

- X-ray channels to image the Sun in the monochromatic MgXII 8.42 A˚ line
- two channels to obtain monochromatic EUV solar images:176–207Å and 280–330 **Å.**

Wavelength range 280-330 Å includes lines of ions Fe VIII-XXII, Si VIII, XI, VII-VIII, Mg, Ni, Ca XVIII and XVIII, which are emitted in the temperature range from 0.8 MK to more than 20 MK.

Zhitnik et al. 2005

15 April 2002 flare

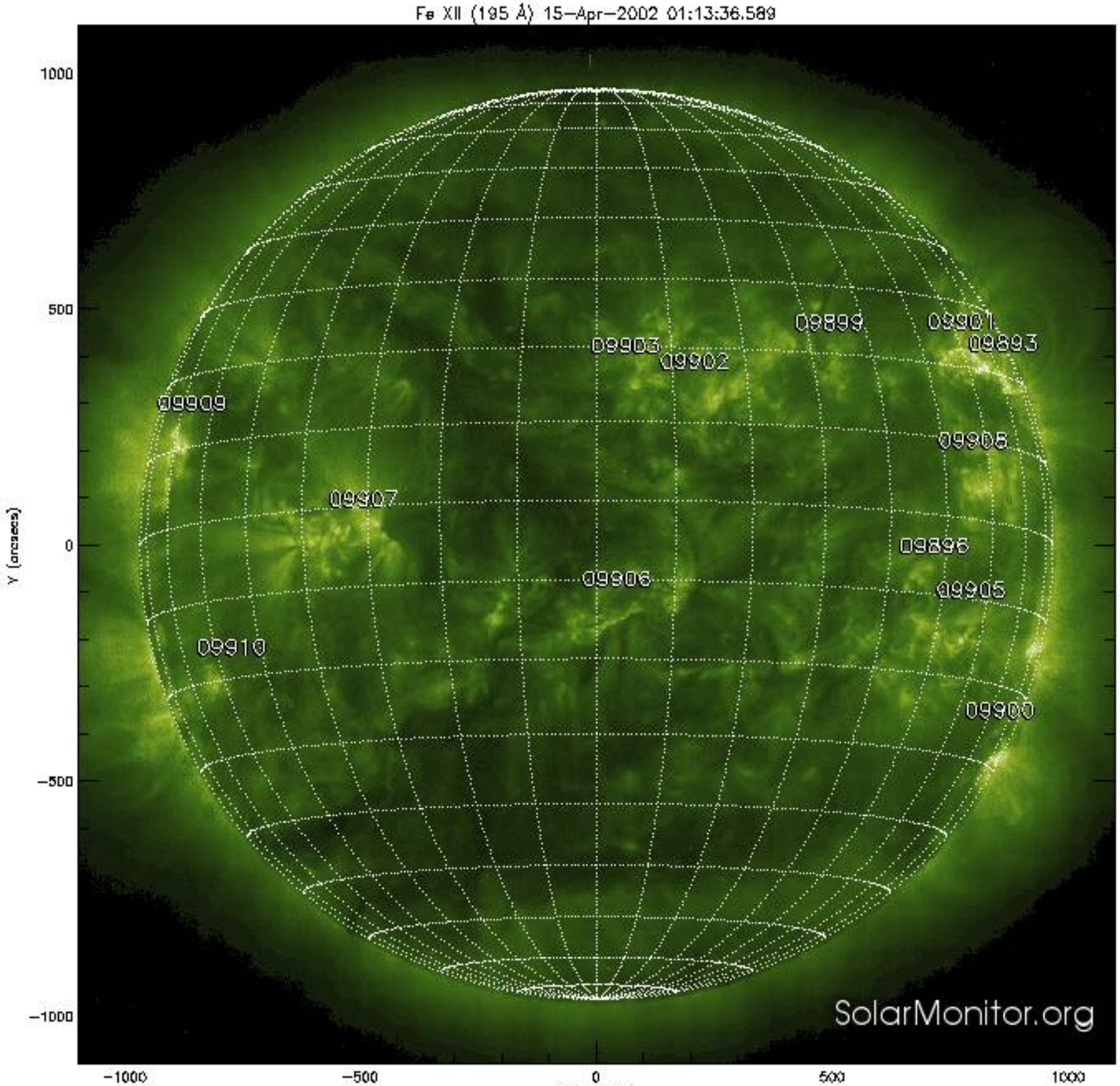


start: 2002-04-15 03:05:00 location: S15W01

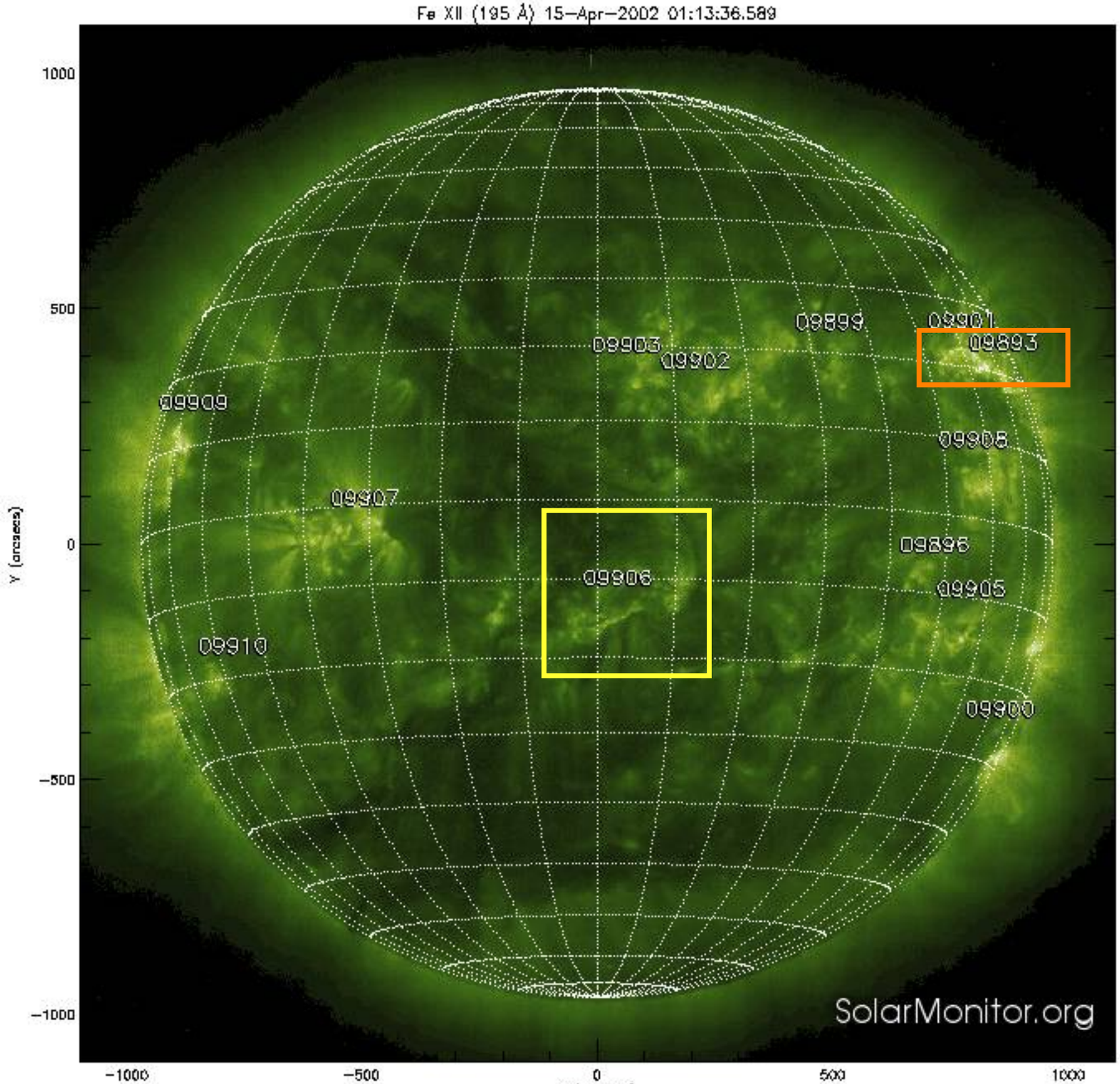
max: 2002-04-15 03:55:00 AR: 9906

stop: 2002-04-15 05:06:00 GOES class: M1.2

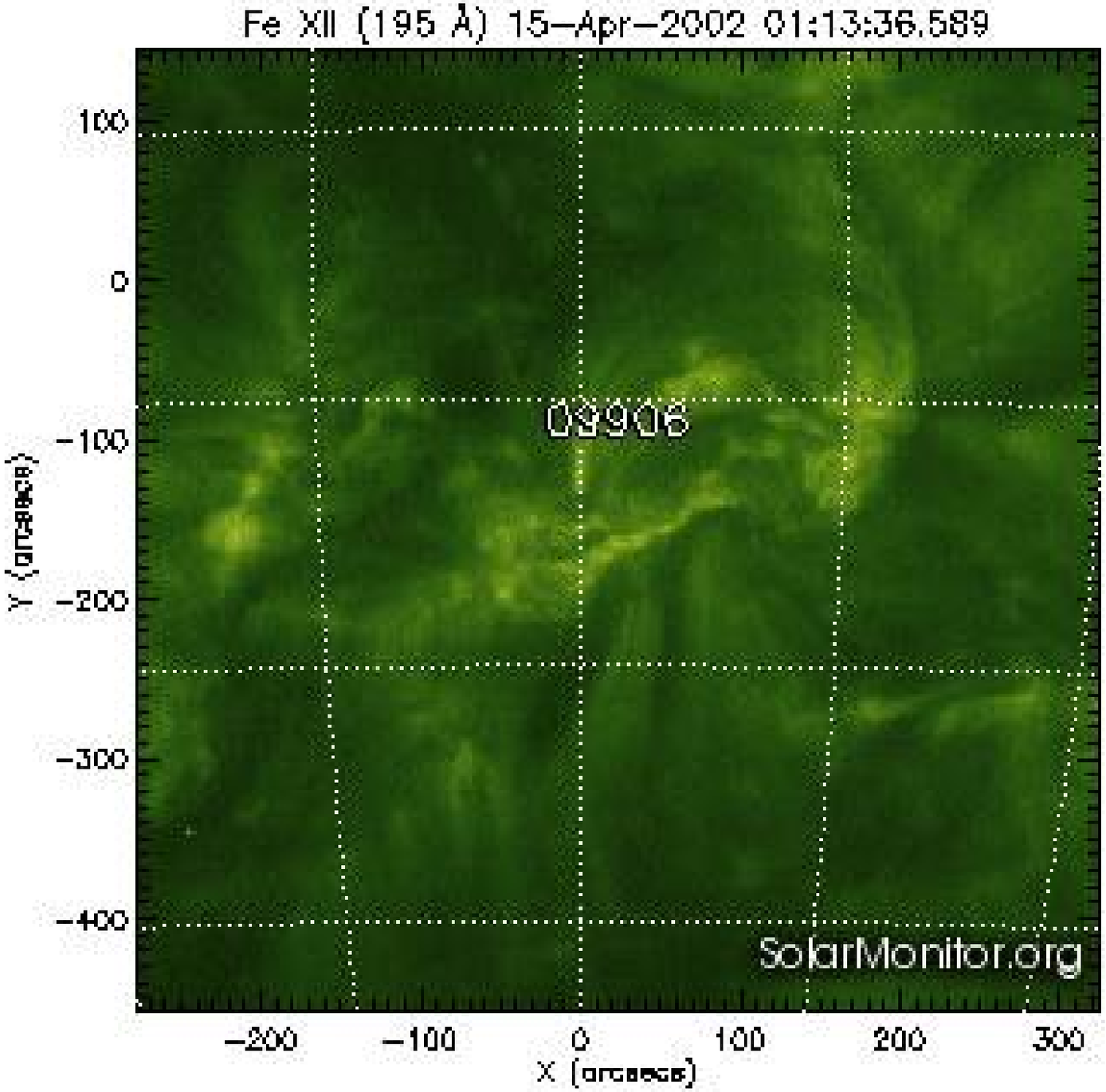
15 April 2002 flare

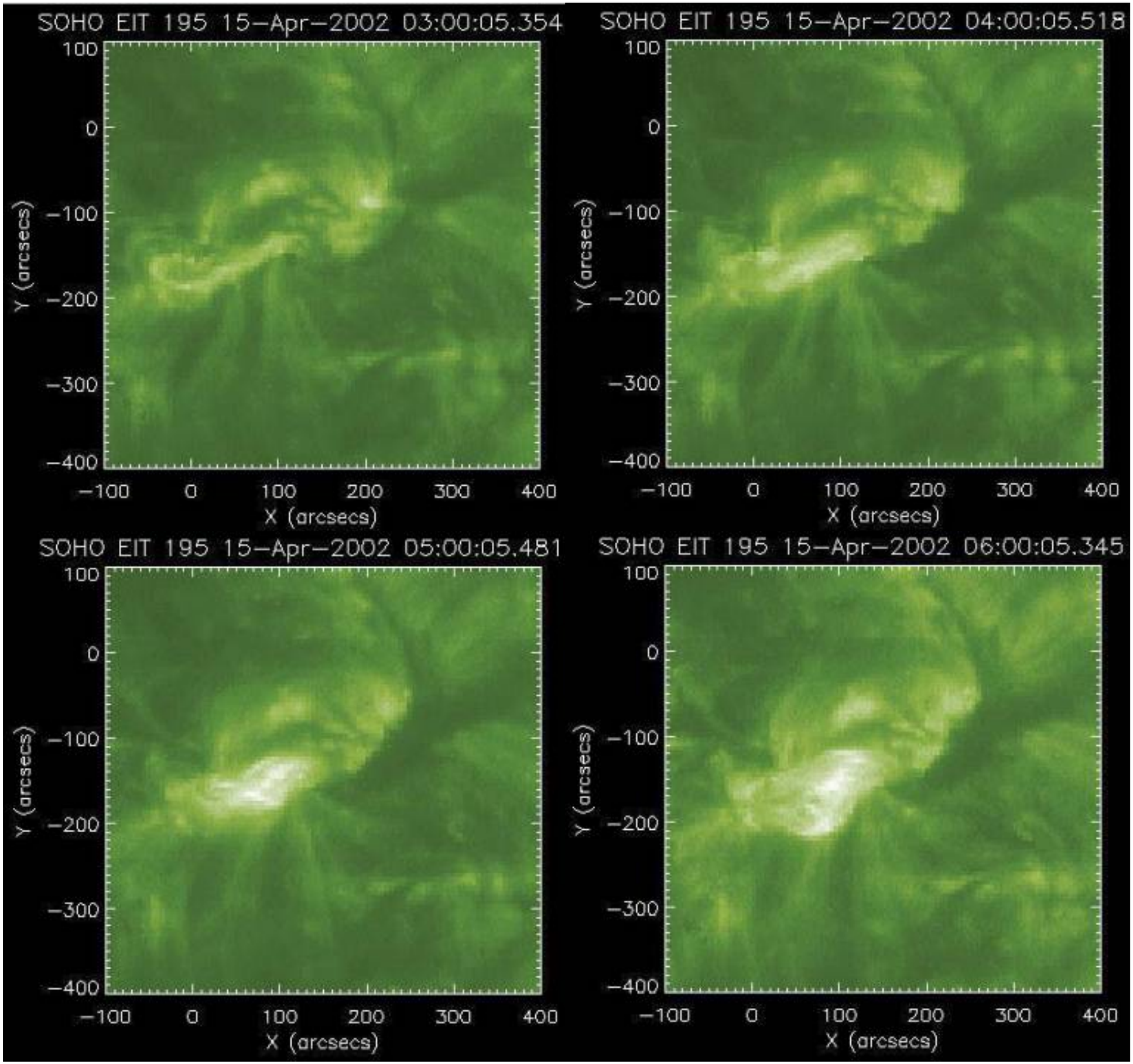


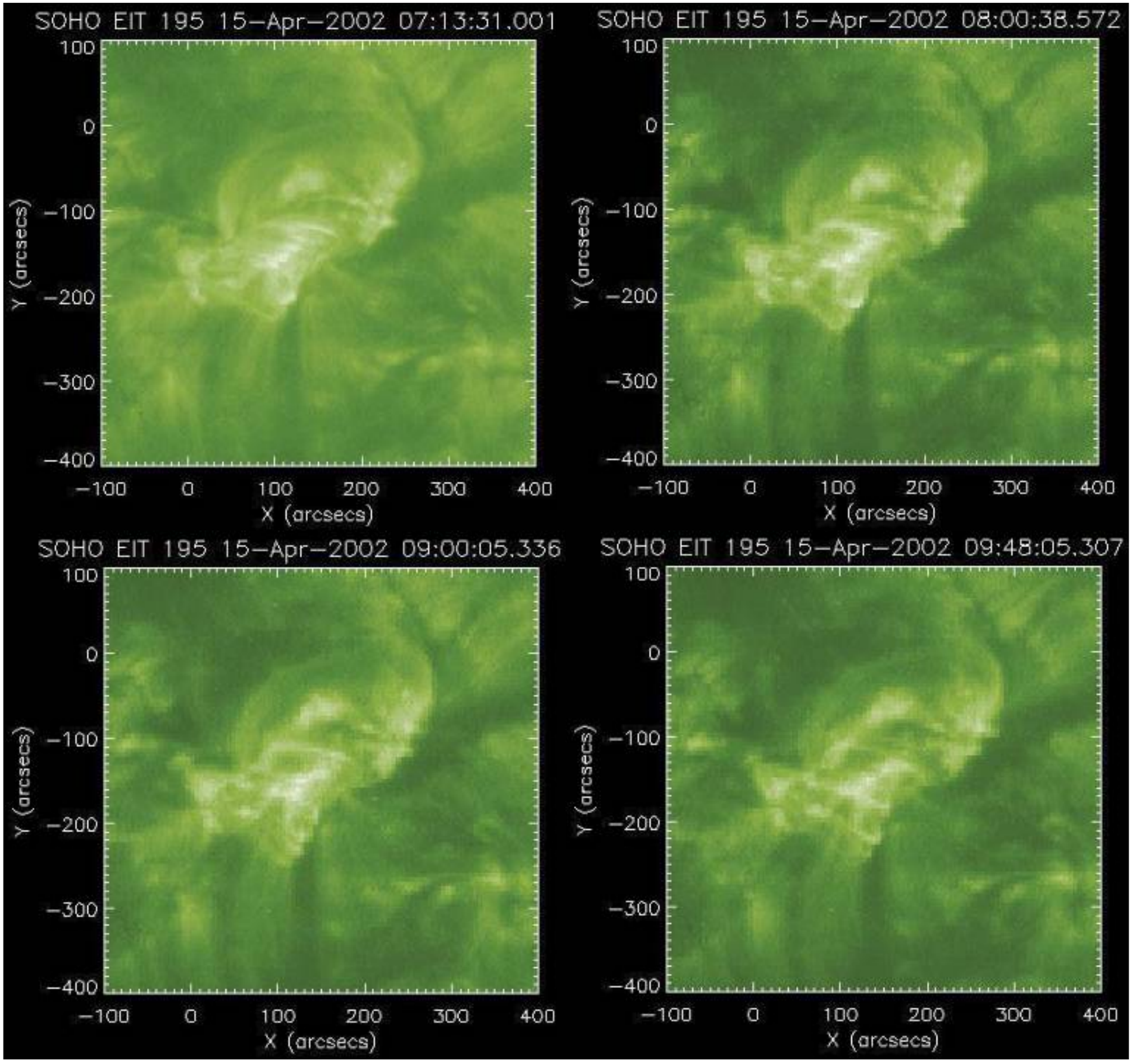
15 April 2002 flare

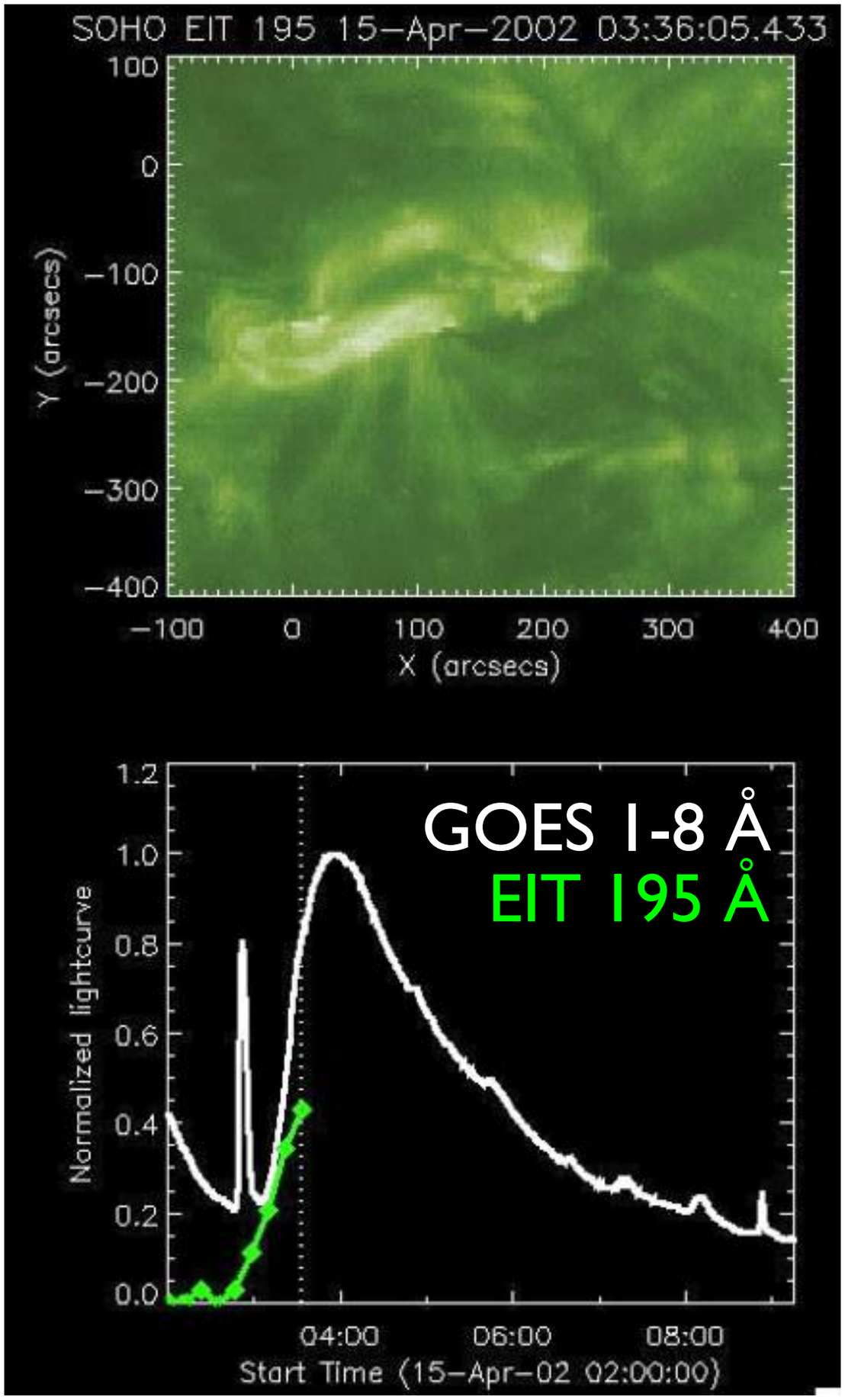


15 April 2002 flare

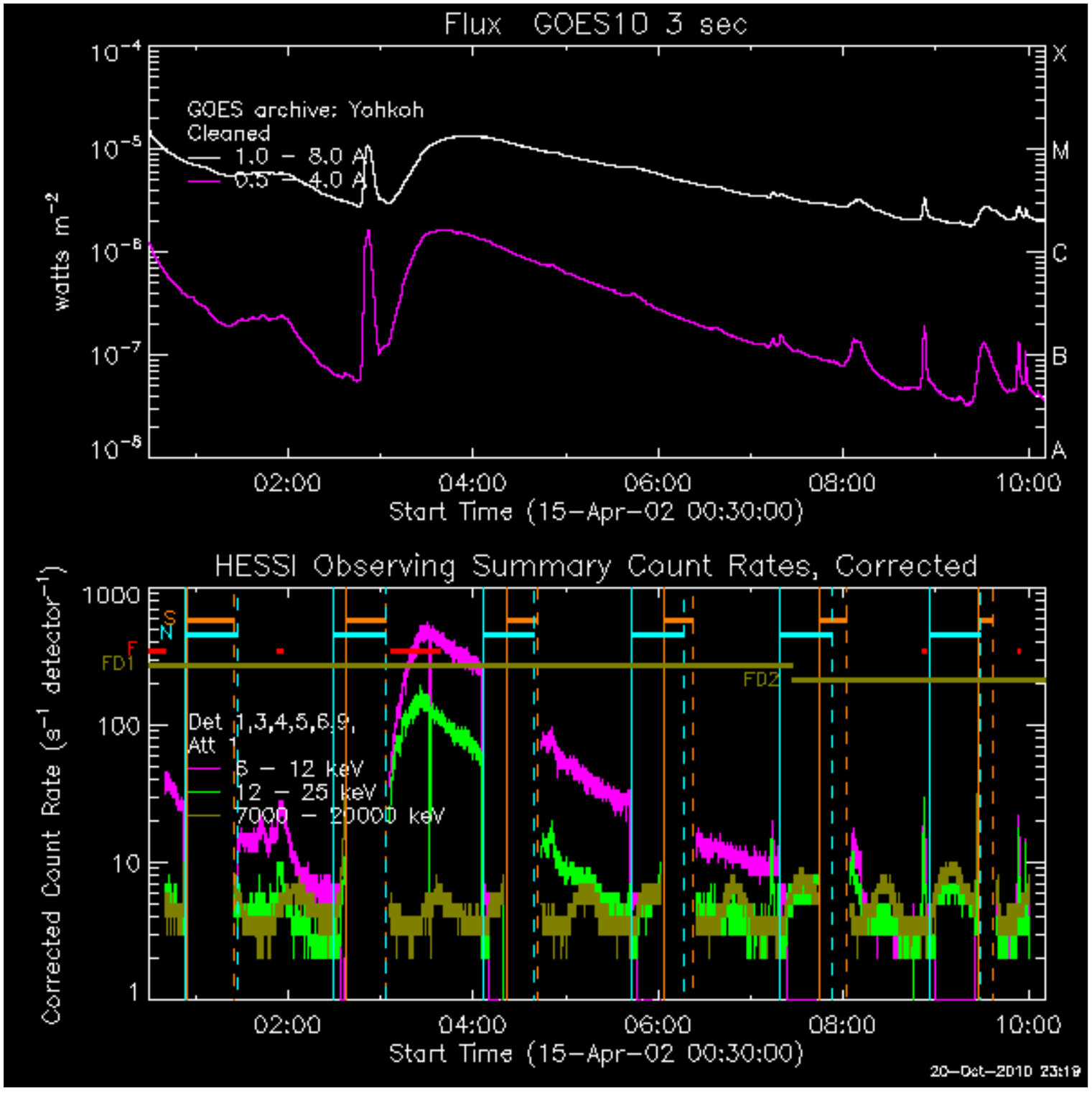



SOHO EIT 195 15-Apr-2002 03:00:05.354
SOHO EIT 195 15-Apr-2002 04:00:05.518
SOHO EIT 195 15-Apr-2002 05:00:05.481
SOHO EIT 195 15-Apr-2002 06:00:05.345
Y (arcsecs)
X (arcsecs)
100
0
-100
-200
-300
-400
-100
0
100
200
300
400


SOHO EIT 195 15-Apr-2002 07:13:31.001
SOHO EIT 195 15-Apr-2002 08:00:38.572
SOHO EIT 195 15-Apr-2002 09:00:05.336
SOHO EIT 195 15-Apr-2002 09:48:05.307
Y (arcsecs)
X (arcsecs)
100
0
-100
-200
-300
-400
-100
0
100
200
300
400


SOHO EIT 195 15-Apr-2002 03:36:05.433
Y (arcsecs)
X (arcsecs)
100
0
-100
-200
-300
-400
-100
0
100
200
300
400
Normalized lightcurve
1.2
1.0
0.8
0.6
0.4
0.2
0.0
04:00
06:00
08:00
Start Time (15-Apr-02 02:00:00)
GOES 1-8 Å
EIT 195 Å

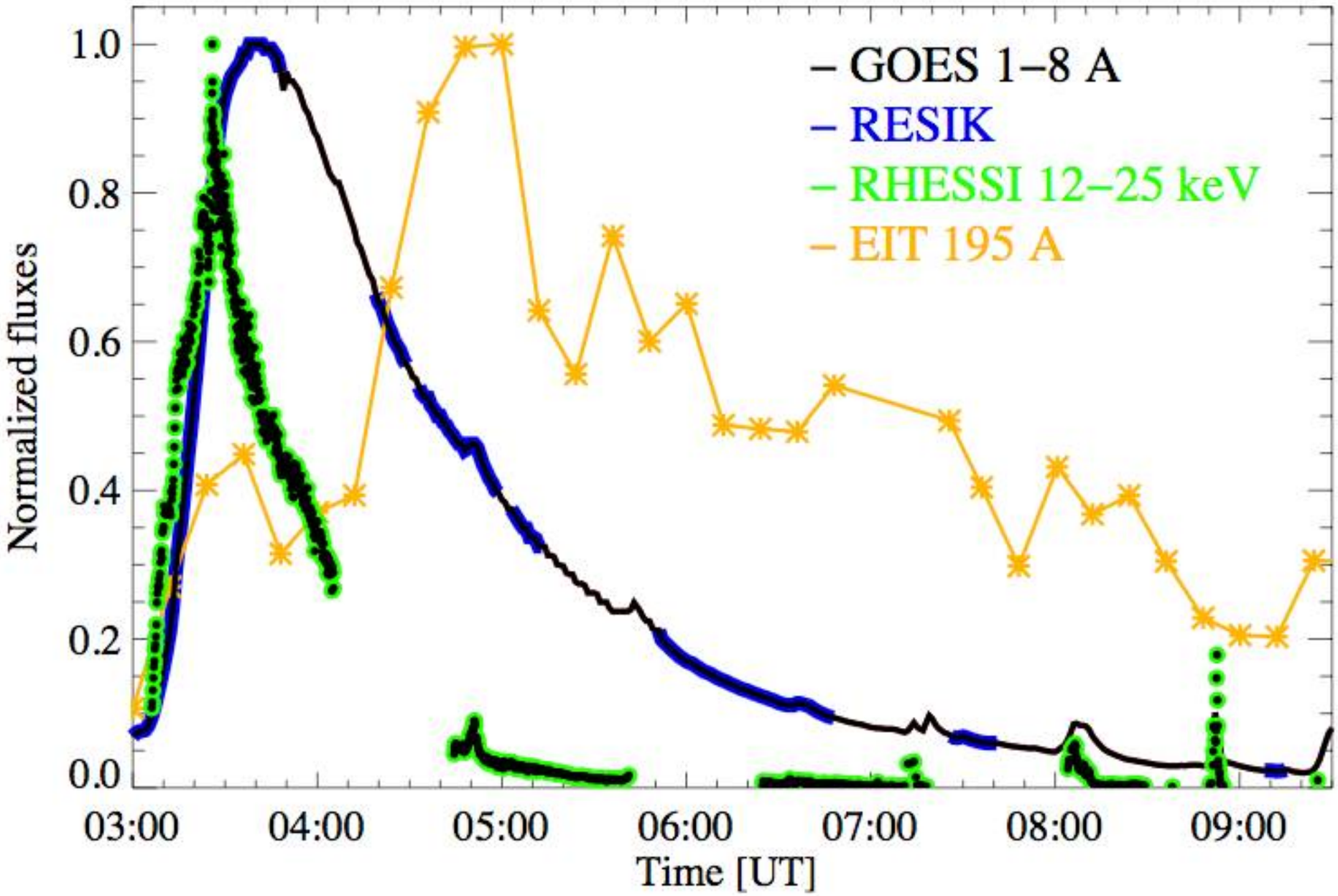
RHESSI - 15 April 2002 flare



Almost entire rising phase

About 5 hours of decay in an energy range of 6-12 keV

GOES, RHESSI and EIT/SoHO light curves

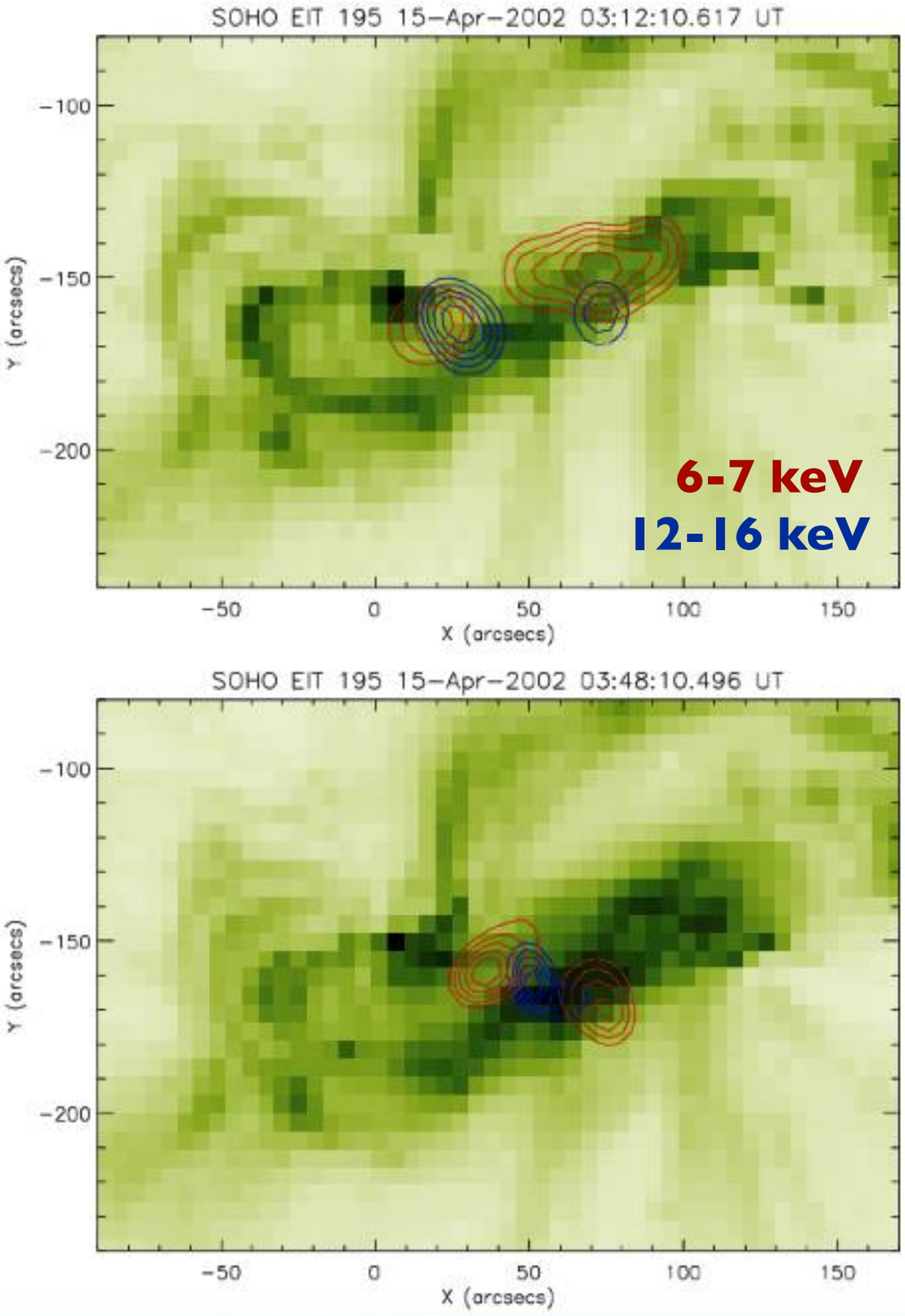


t_{RHESSI_GOES} ~ 20 min

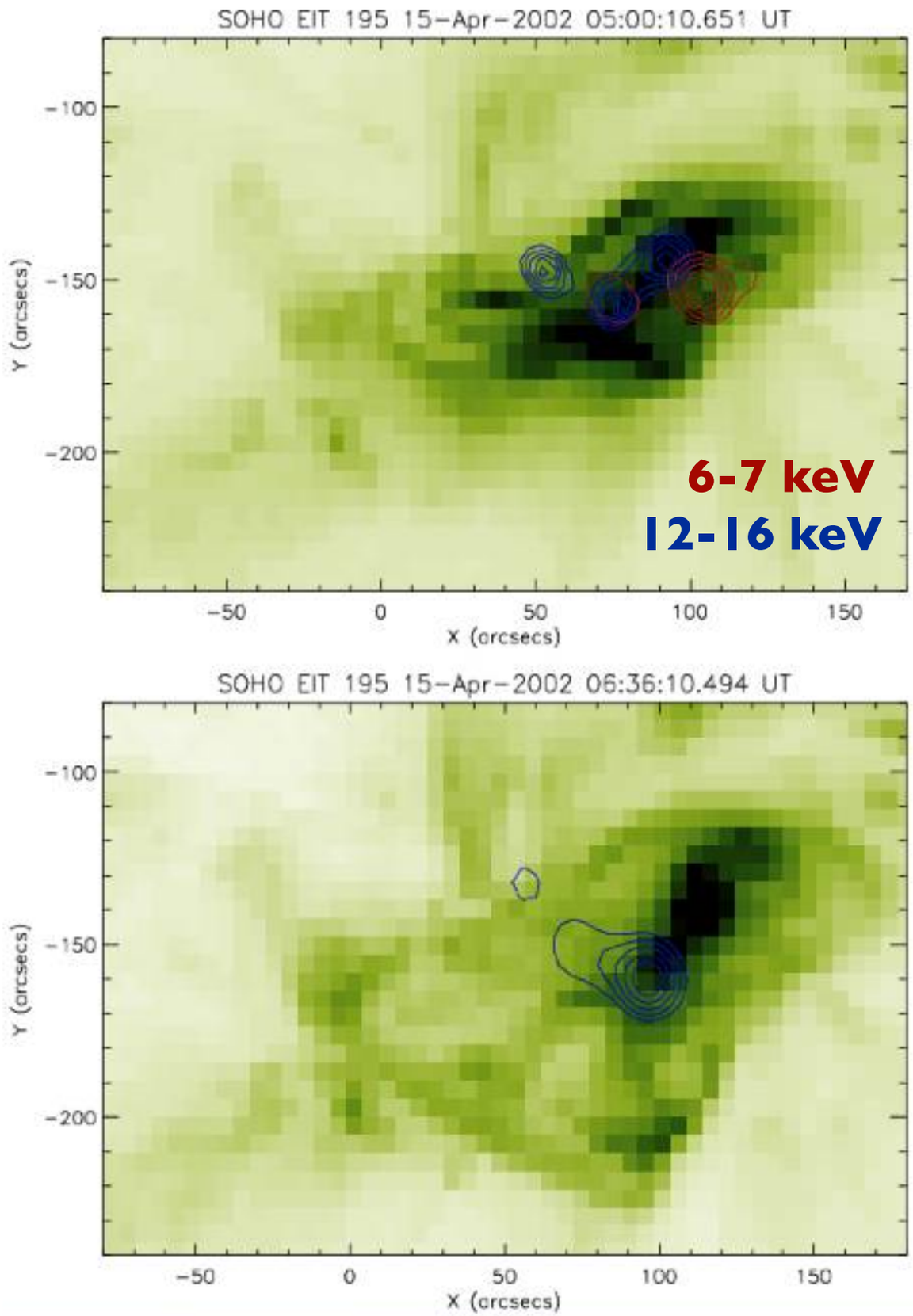
t_{RHESSI_EIT} ~ 1h 30 min

t_{GOES_EIT} ~ 1h 10 min

RHESSI - 15 April 2002 flare

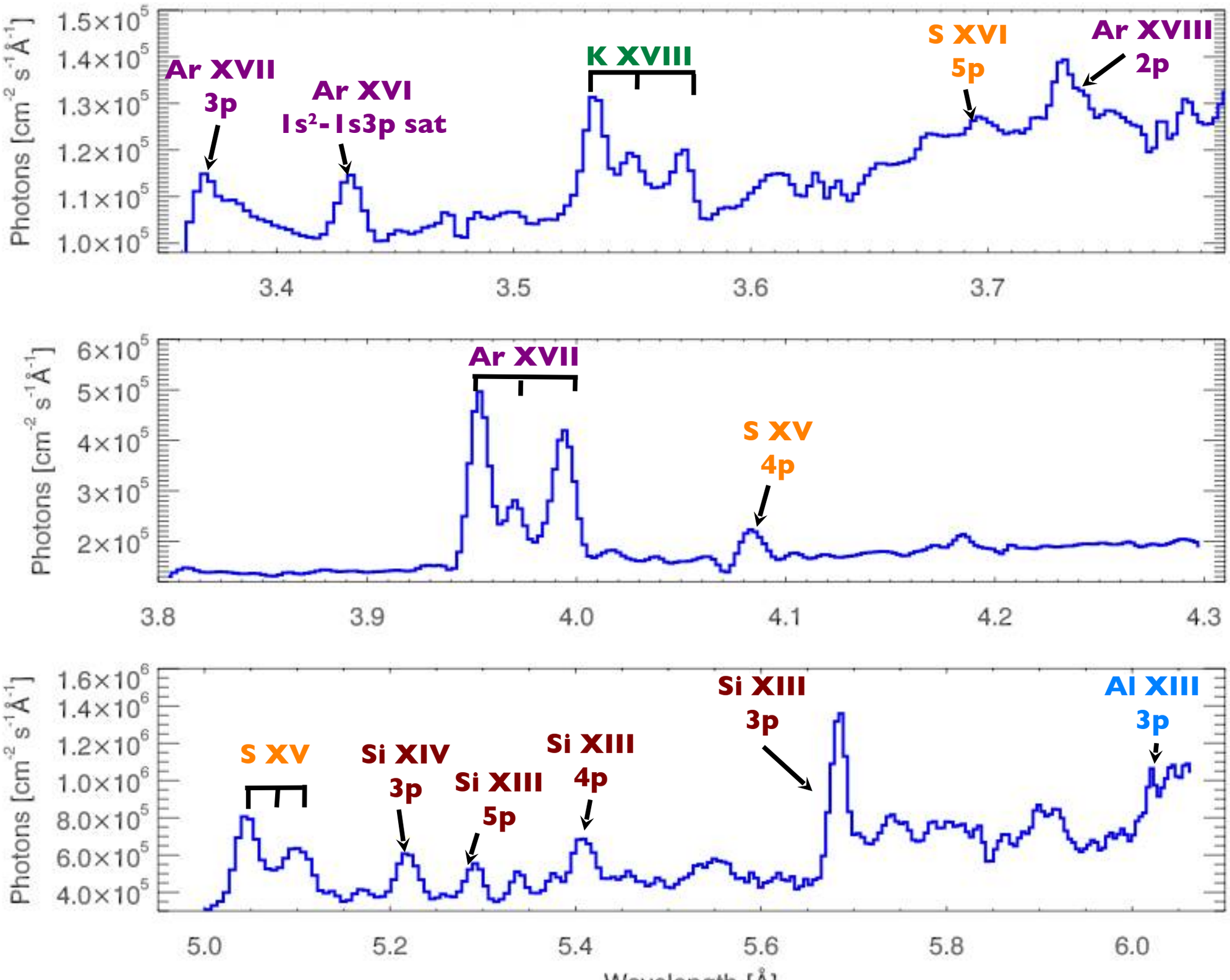


RHESSI - 15 April 2002 flare



RESIK - 15 April 2002 flare

No record on channel 3 is associated with instrumental problems.



DEM - Withbroe-Sylwester method

DEM distribution $\varphi_{j+1}(T)$ calculated from preceding one $\varphi_j(T)$ using the following expression:

$$\varphi_{j+1}(T) = \varphi_j(T) \frac{\sum_{i=1}^{k} c_i w_i(T)}{\sum_{i=1}^{k} w_i(T)}$$

$w_i(T)$ is the weight function defined by the following relationship:

$$w_i(T) = f_i(T)\varphi_j(T) \frac{\int_0^\infty f_i(T)\varphi_j(T)dT}{\int_0^\infty [f_i(T)\varphi_j(T)]^2 dT} \left[\frac{|F_{oi} - F_{ci}|}{\sigma_i} + 1\right]^a$$

c_i is the correction factor taken as $c_i = F_{oi}/F_{ci}$

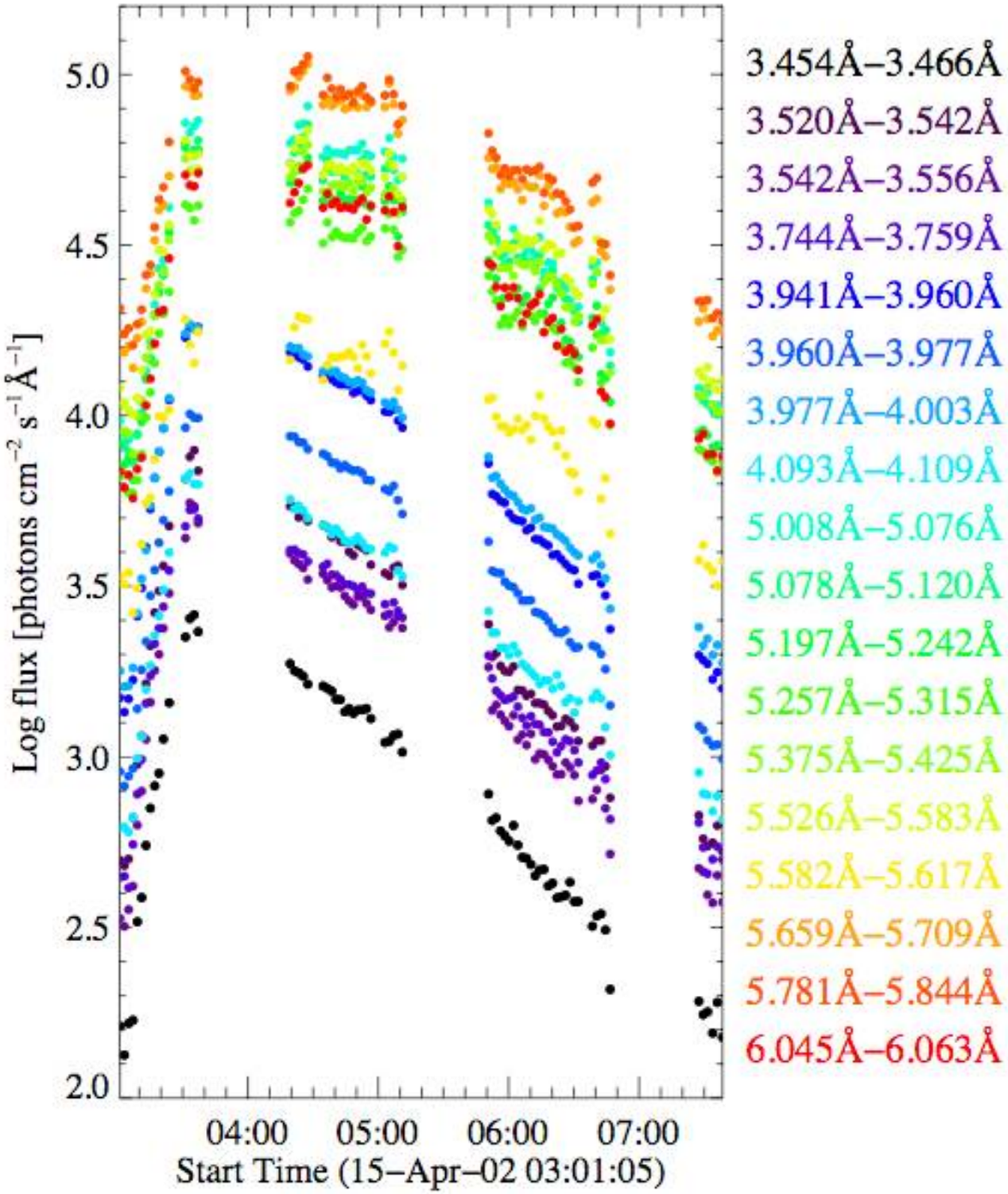
$f_i(T)$ is the emission function in line/band i

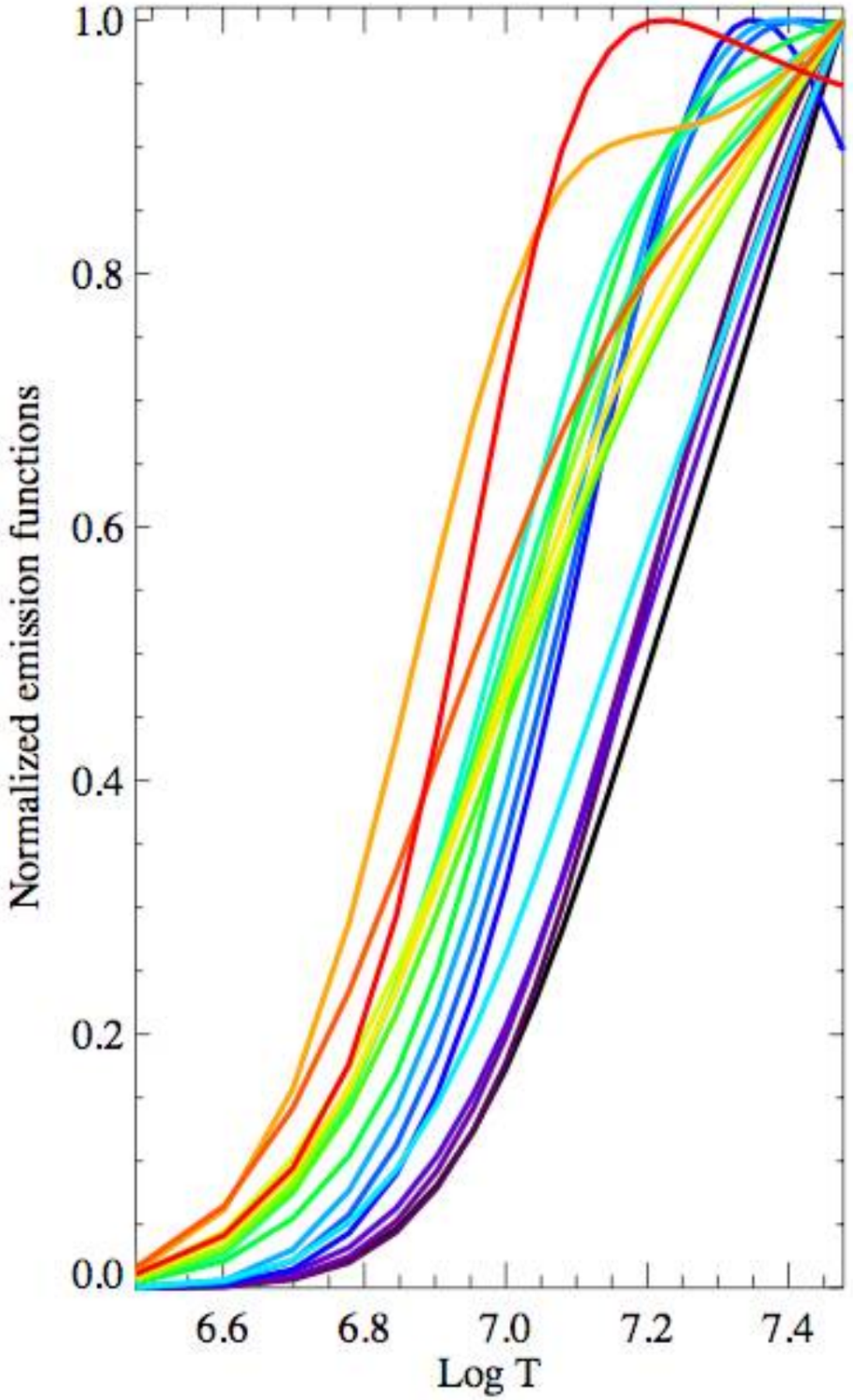
F_{ci} is the flux calculated (in j^{th} iteration) as:

$$F_{ci} = \int_0^\infty f_i(T)\varphi_j(T)dT$$

Sylwester J., Schrijver J. & Mewe R. 1980 Solar Physics 67, 285-309.

DEM - input data

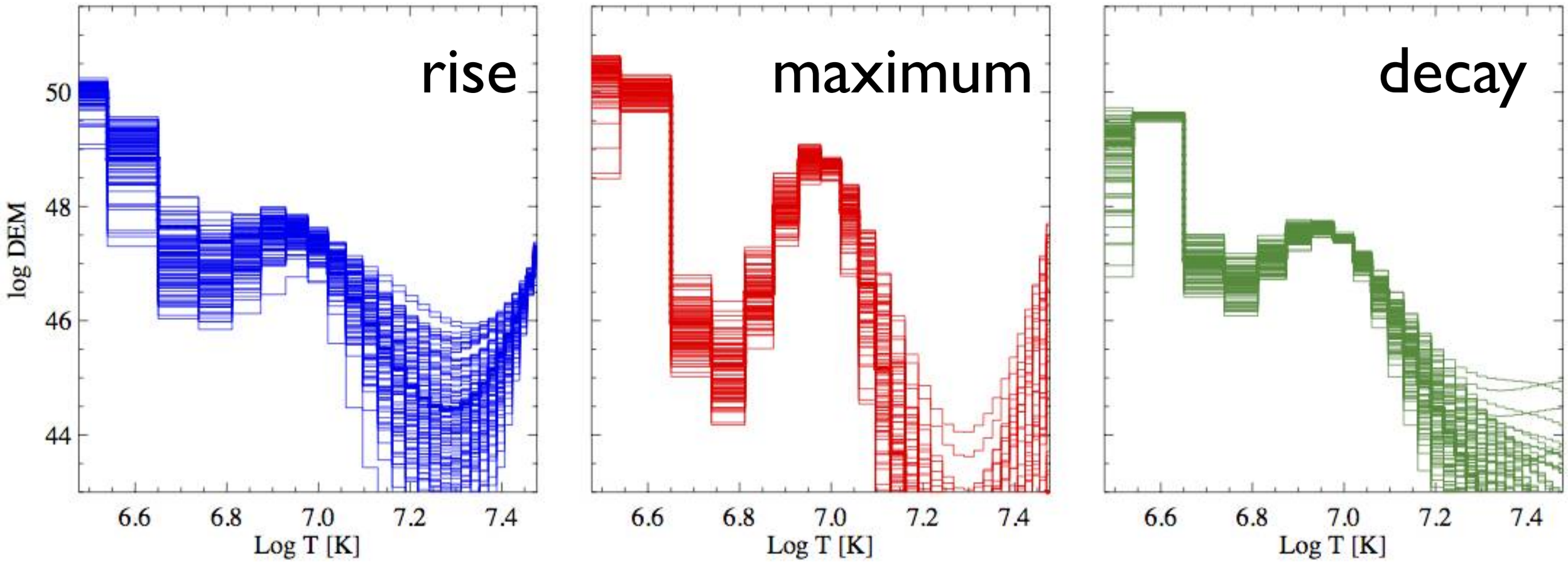




DEM - input data

- Temperature range = 3MK - 30 MK
- 3000 iterations
- CHIANTI package ver. 6.0.1
- ionization equilibrium by Mazzotta et al. 1998
- coronal abundances by Feldman
- new abundances for S, Si, K

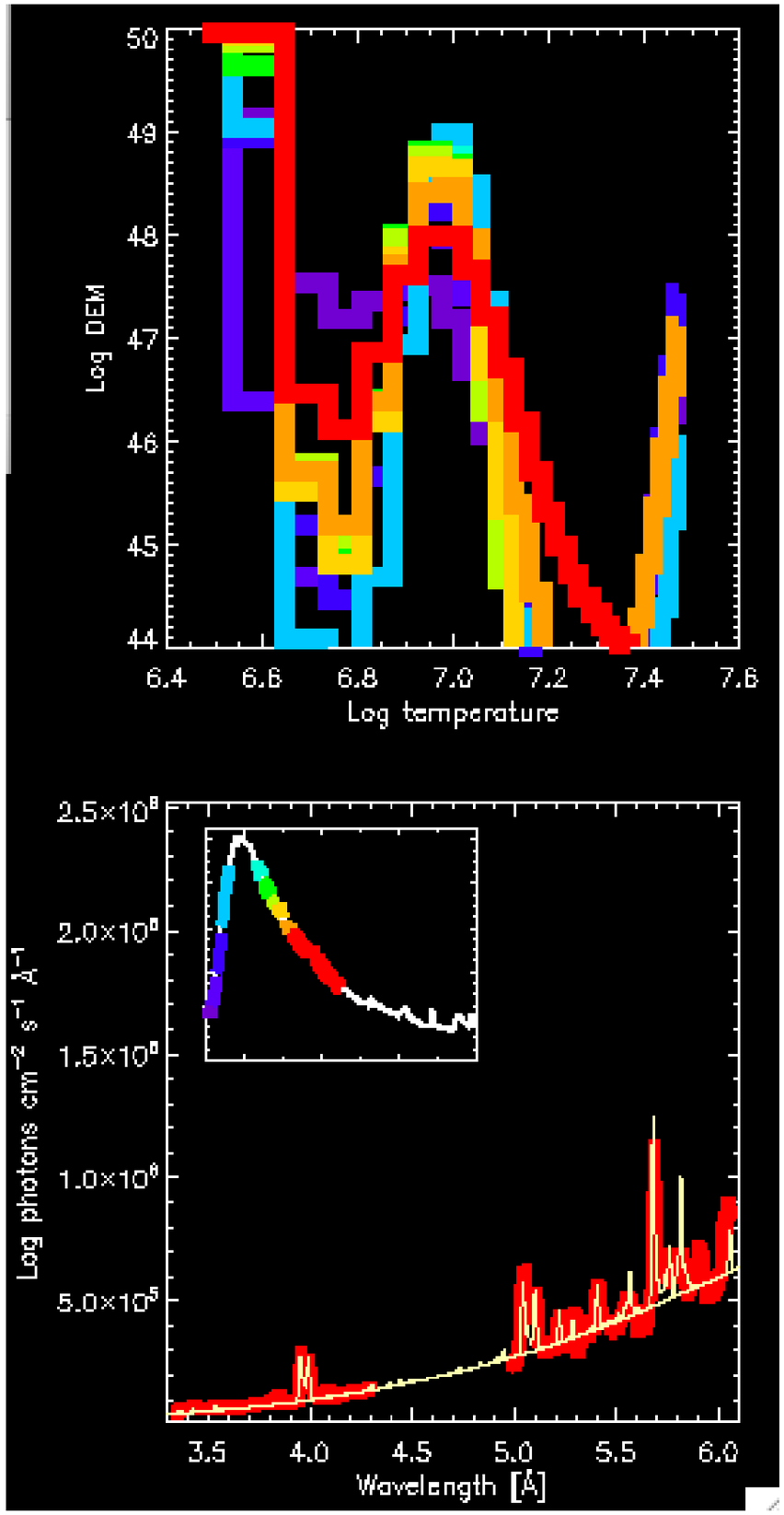
DEM - results



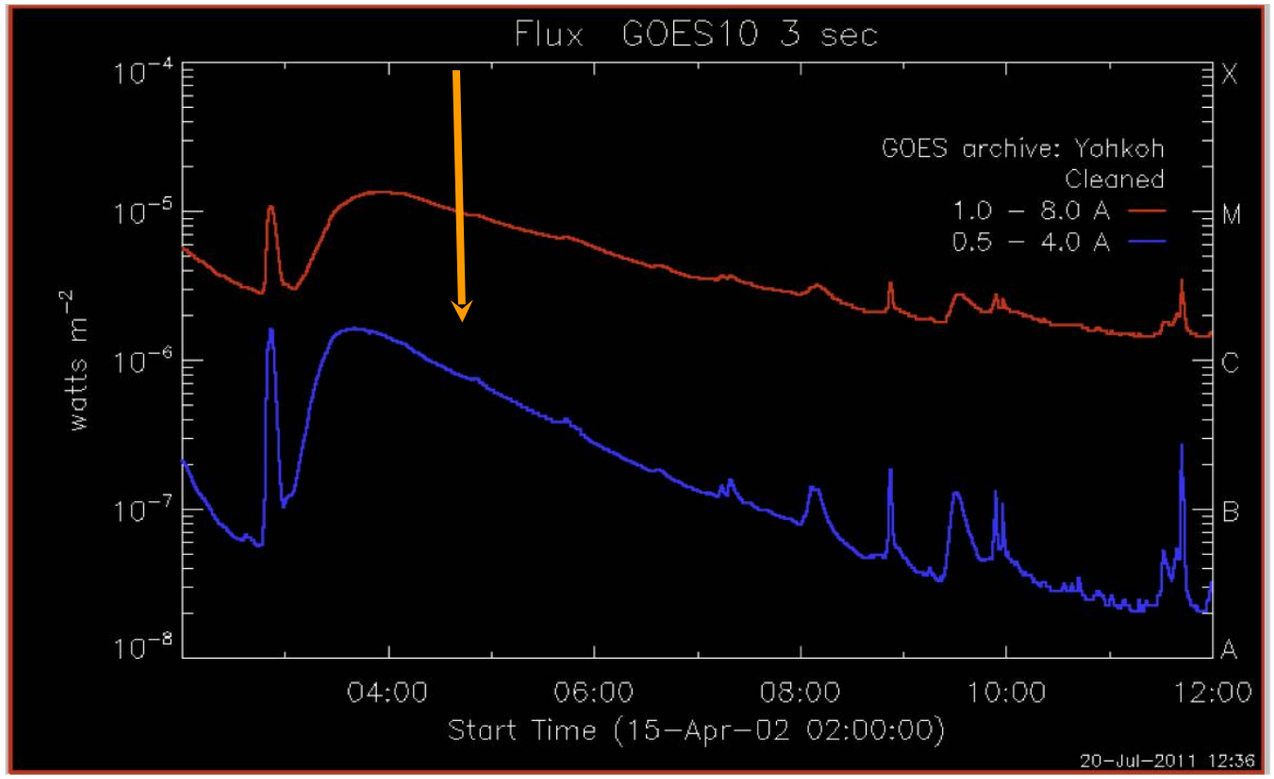
The DEM distributions as calculated for rise, maximum and decay phase of 15 April 2002 flare. They have been obtained from 100 Monte-Carlo realizations of DEM calculations.

The calculated DEM distributions are two- component independent on the evolutionary phase.

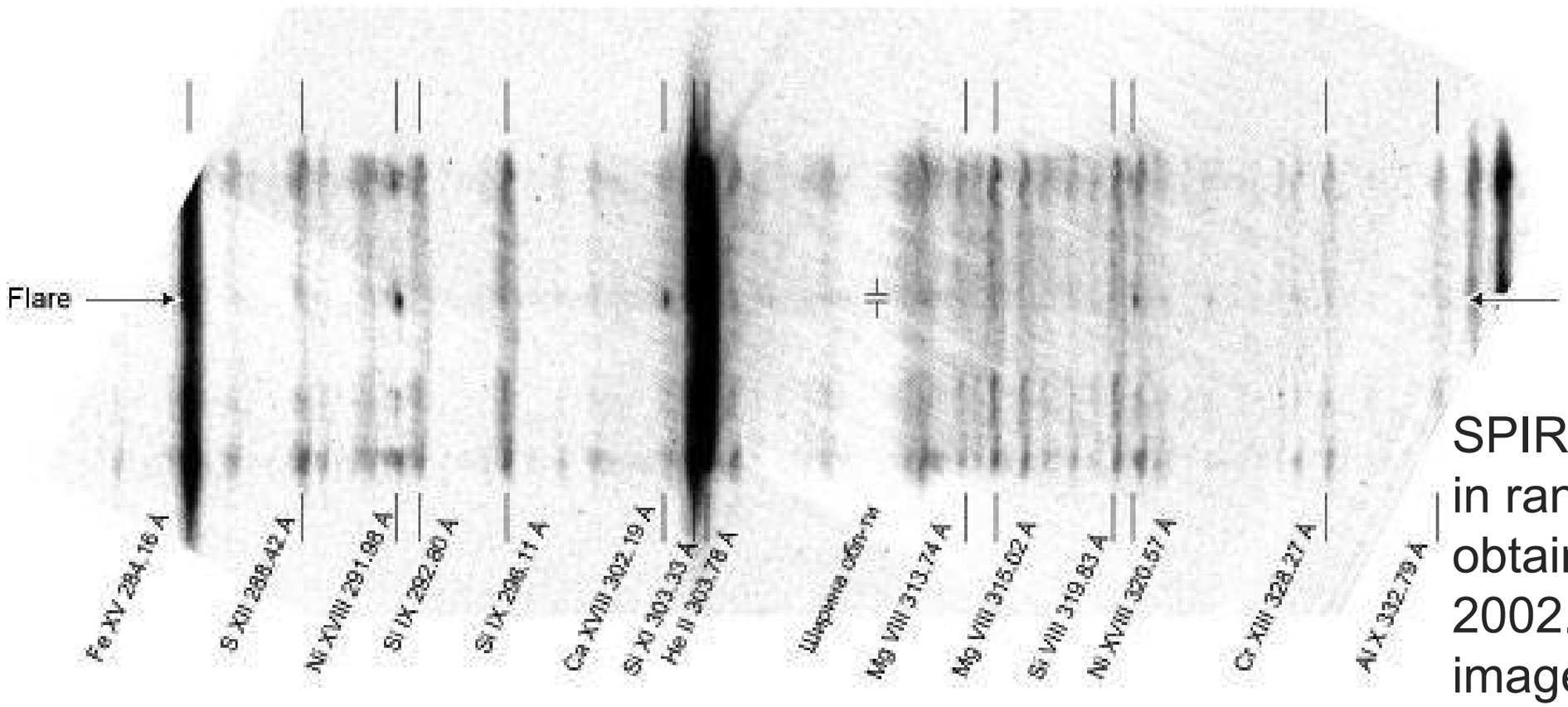
DEM - results


Log DEM
50
49
48
47
46
45
44
6.4
6.6
6.8
7.0
7.2
7.4
7.6
Log temperature
2.5×10⁸
2.0×10⁸
1.5×10⁸
1.0×10⁸
5.0×10⁷
Log photons cm⁻² s⁻¹ Å⁻¹
3.5
4.0
4.5
5.0
5.5
6.0
Wavelength [Å]

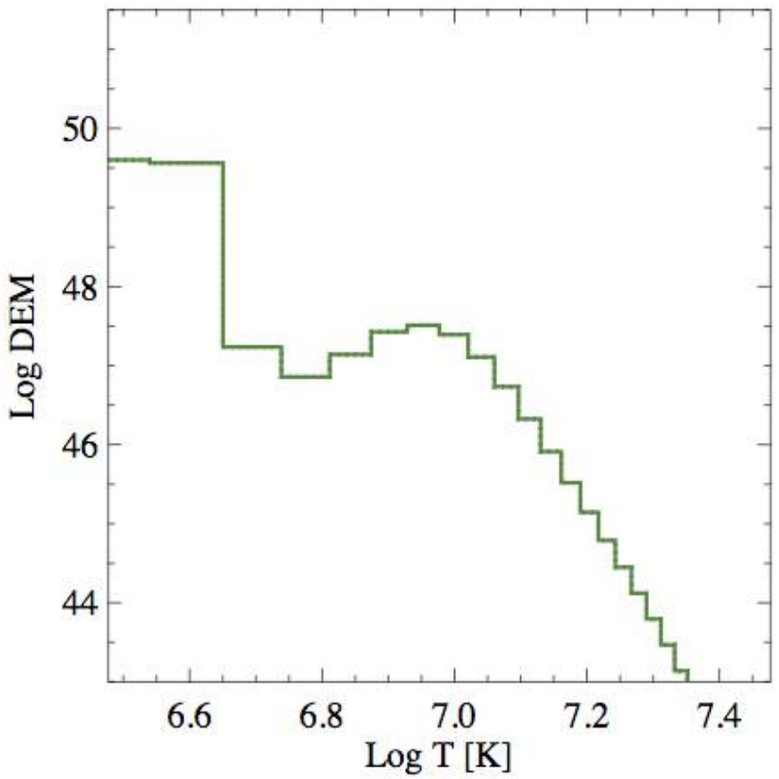
SPIRIT



Simultaneous observations RESIK and SPIRIT were made on the flare decay starting at 4:24 until 4:26. This period was marked by an arrow on GOES light curve.



SPIRIT spektroheliogram in range 280-330 Å, obtained for 15 April 2002. Individual spectral images are marked.



DEM distribution obtained based on RESIK spectra for time period observed by SPIRIT

Comparison synthetic and observed SPIRITspectrum

Plans on the future

The simultaneous use of data from SPIRIT and RESIK instruments will allow to determine differential emission measure distributions in wide temperature range from 0.8 MK to 30 MK. The first obtained results are promising.

Work is in progress.

Thank you for your attention