Diagnostics of continuum enhancement during two X1.0 flares observed by IRIS

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OUTLINE

- Continuum emission during Solar flares
- Two X1.0 Flares observed by IRIS

  [29-Mar-2014 & 25-Oct-2014]
  - Overview of IRIS observations
  - Ca II, Si IV and Mg II h & k line profile
    - Temporal and spectral evolution
    - RHESSI spectral and spatial analysis
  - Summary and future work

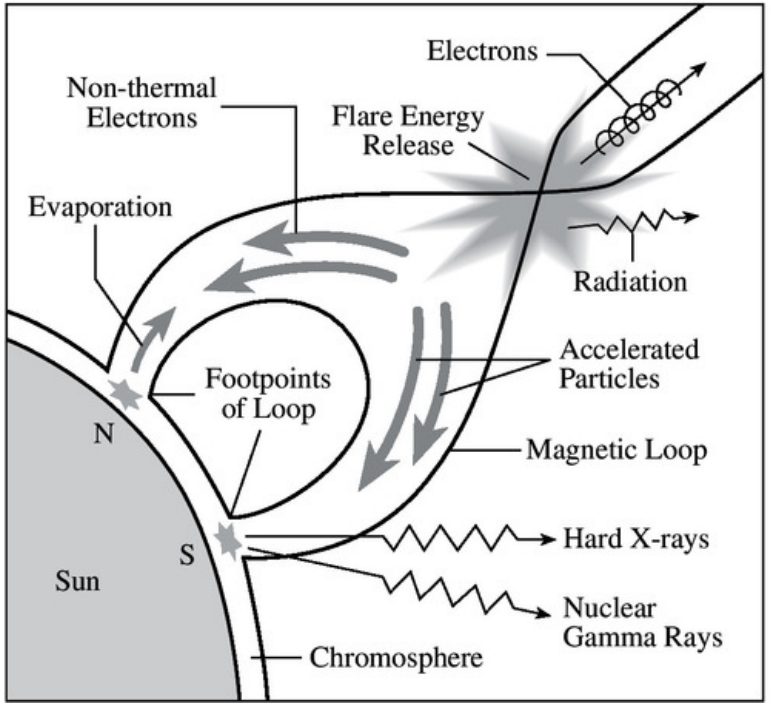
Energy Release processes during a flare

- Solar flare is one of the most impulsive phenomena occurring in the atmosphere of our Sun, releasing typically 10^{27} – 10^{32} ergs of energy in 10^{3} s.

Continuum Emission from Flares

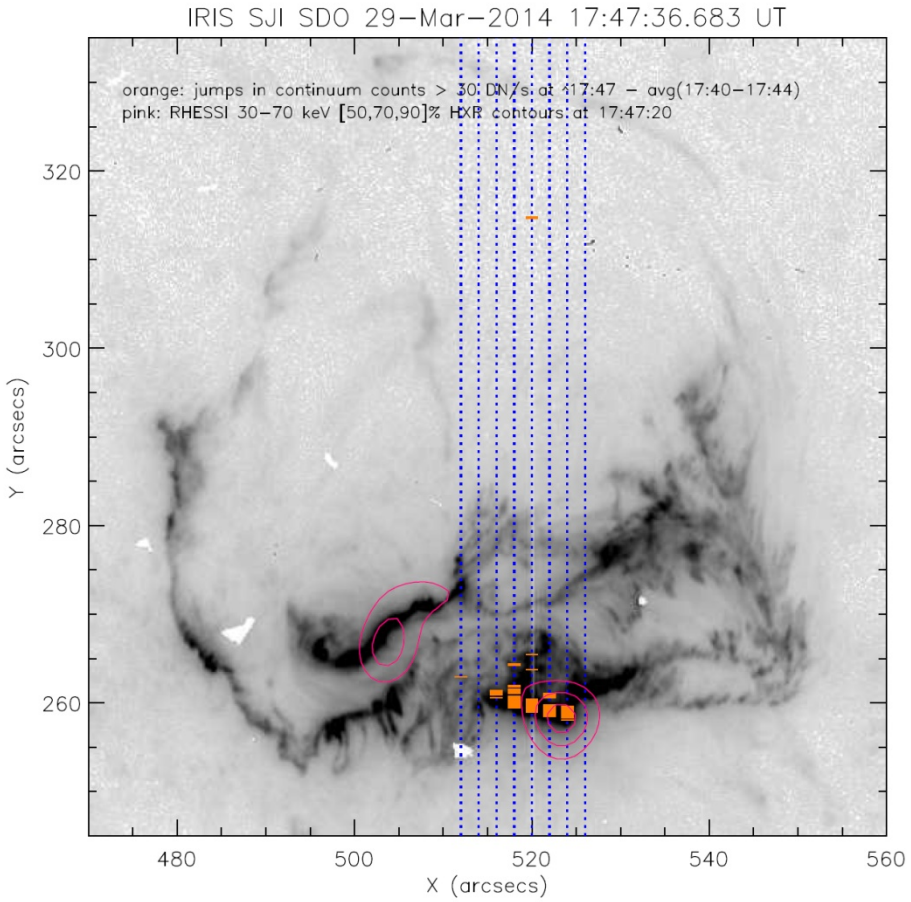
Continuum enhancement during a flare represents significant fraction of the impulsive energy release.

Provides useful diagnostics of the energy deposition and emission processes in the photospheric and chromospheric heights.



IRIS observation overview: 29-March-2014

- An eight-step raster of 2'' steps, yielding a FOV of 14'' × 174''
- In 8 steps, vertical slit was positioned to cover the flare ribbons.
- Complementary slit-jaw images (SJI) were obtained with the filters at 1400 Å, 2796 Å, and 2832 Å.
- A complete raster cadence = 75 s
- Plate scale = 0. 167''/pixel.
- *S*pectral sampling = 0.025 Å /pixel
- Covered: C-II, Si-IV, Mg-II h&k line profile etc.



Heinzel and Klient (2014)

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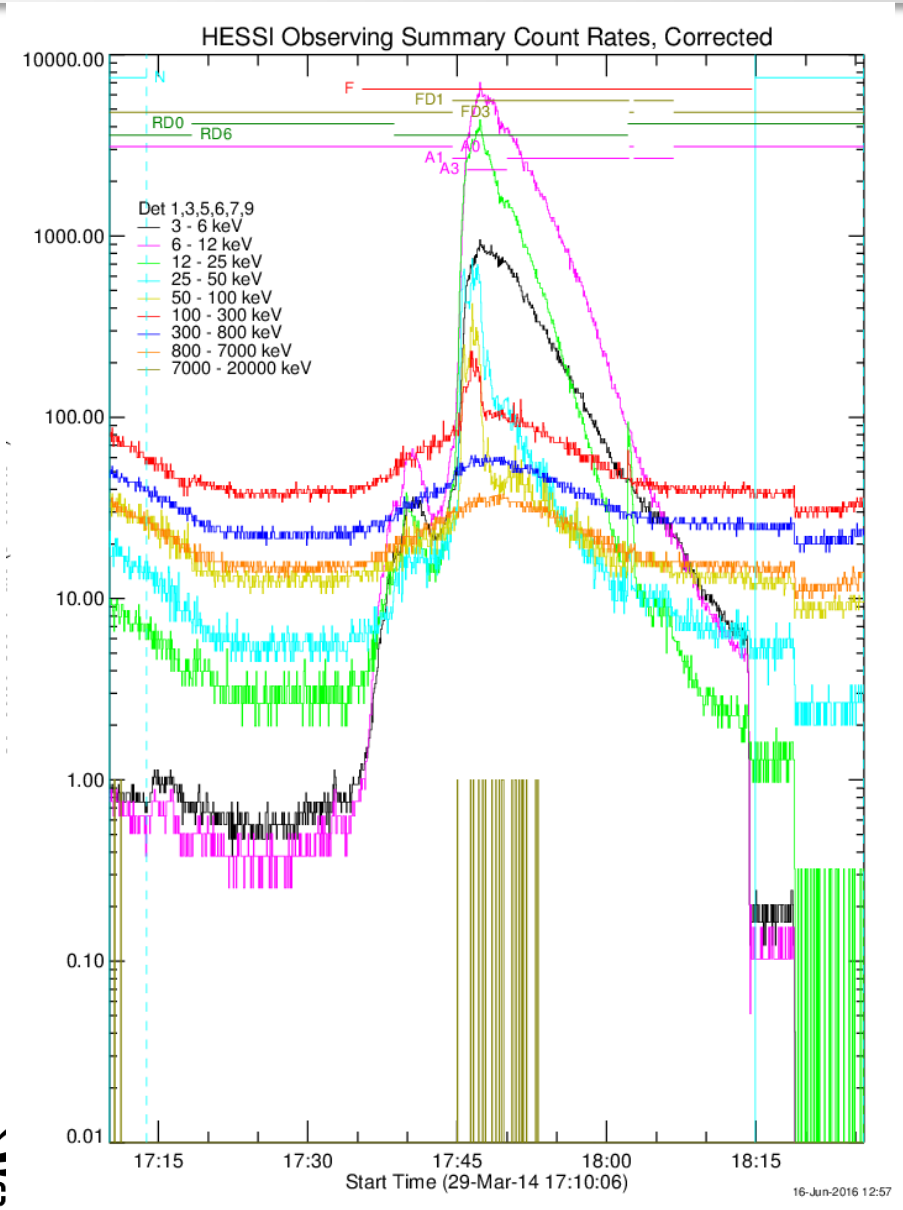
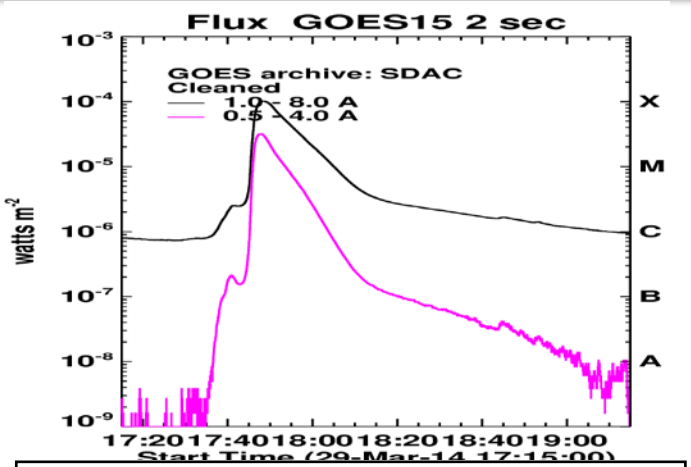
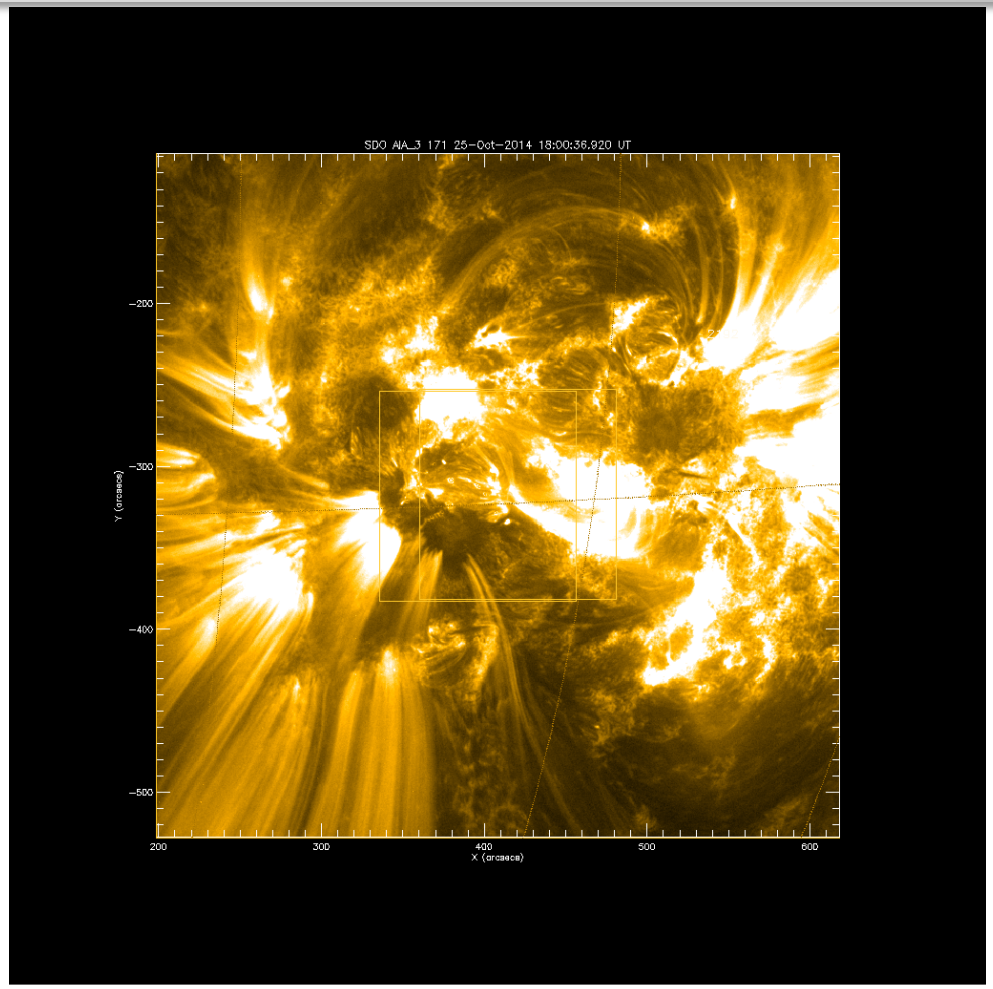
X-ray observation: 29-Mar-2014

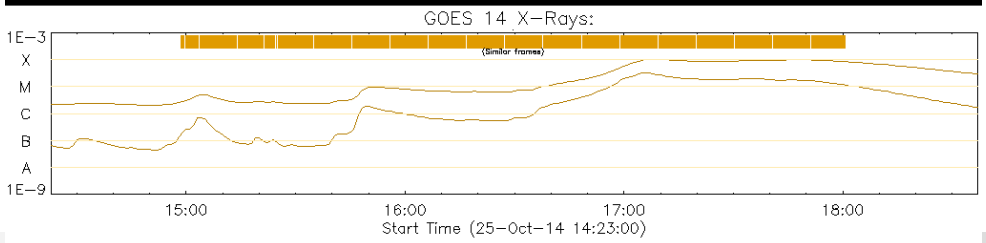




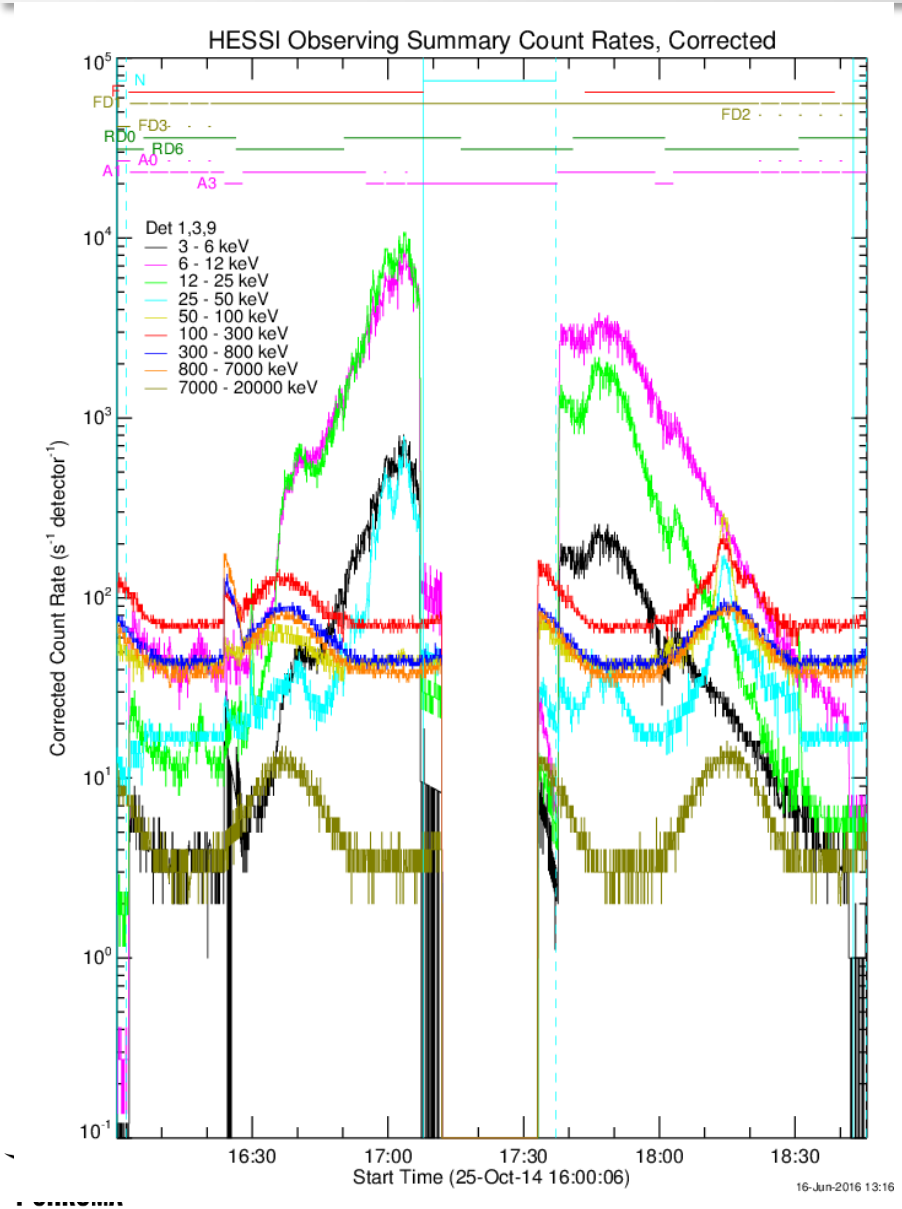
IRIS observation overview: 25-Oct-2014

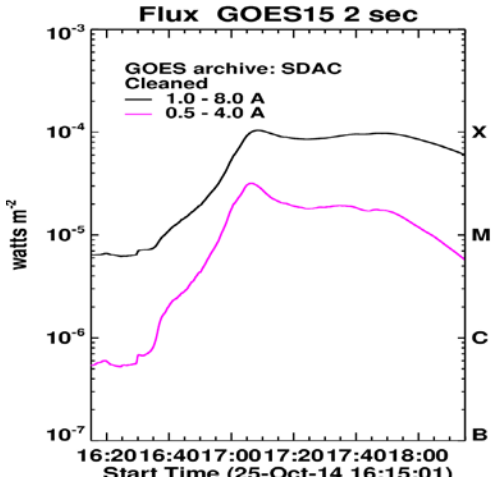
- Large sit-and-stare, yielding a FOV of 0'' × 109''
- Complementary slit-jaw images (SJI) were obtained with the filters at 1400 Å, 2796 Å, and 2832 Å.
- The raster cadence = 5.4 s
- Plate scale = 0. 167''/pixel.
- Spectral sampling = 0.025 Å /pixel
- Covered: C II, Si IV, Mg II h&k line profile etc.





X-ray observation: 25-Oct-2014





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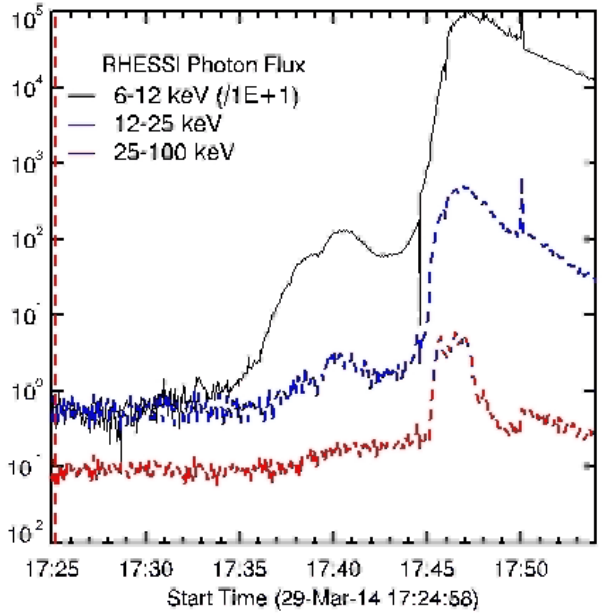
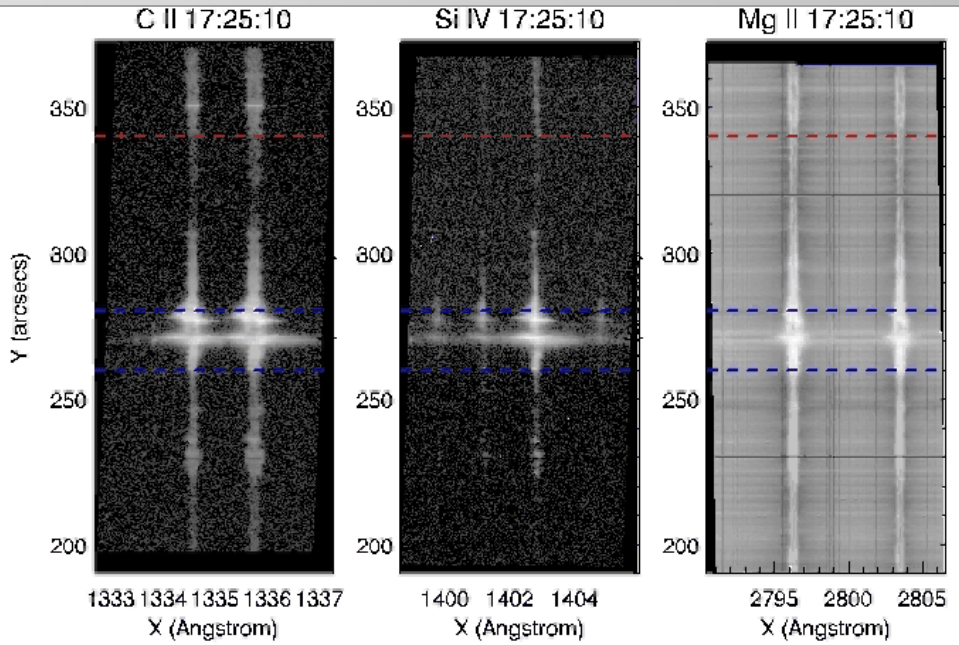
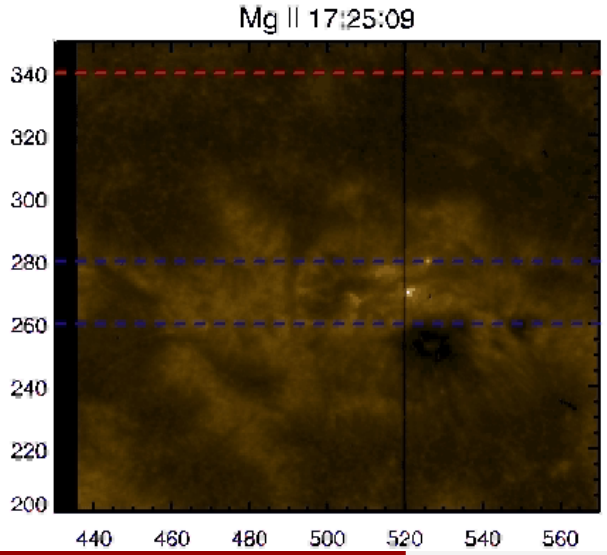
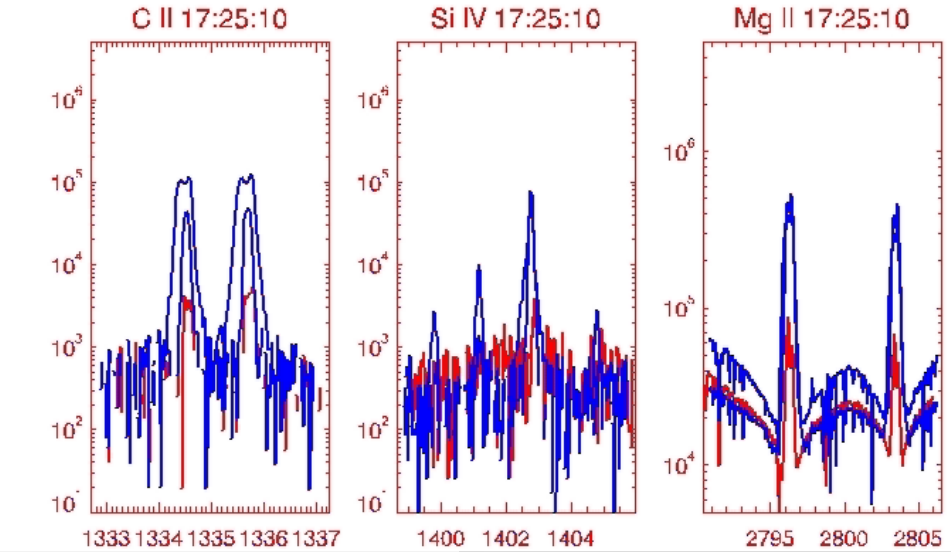
IRIS NUV and FUV observation: 29-Mar-2014









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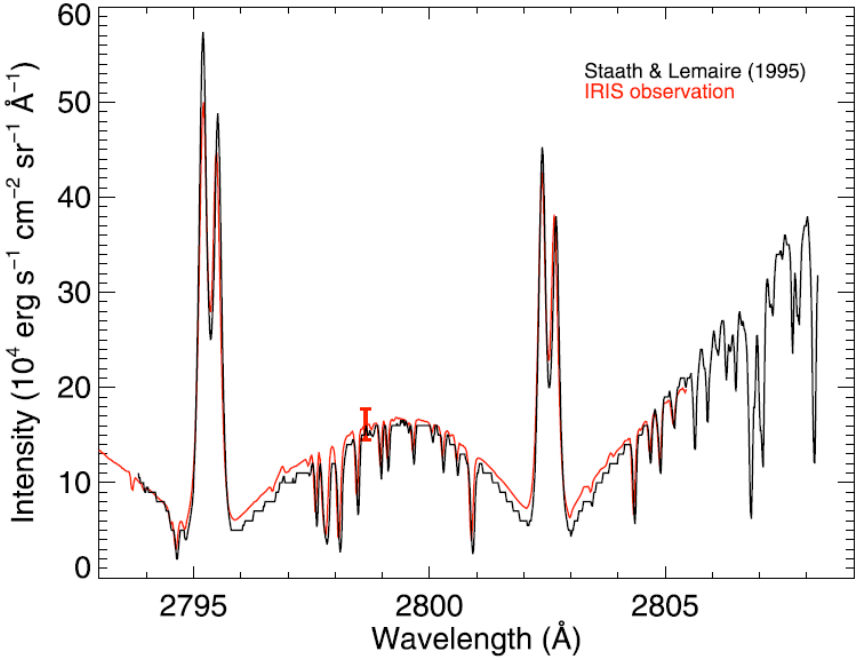
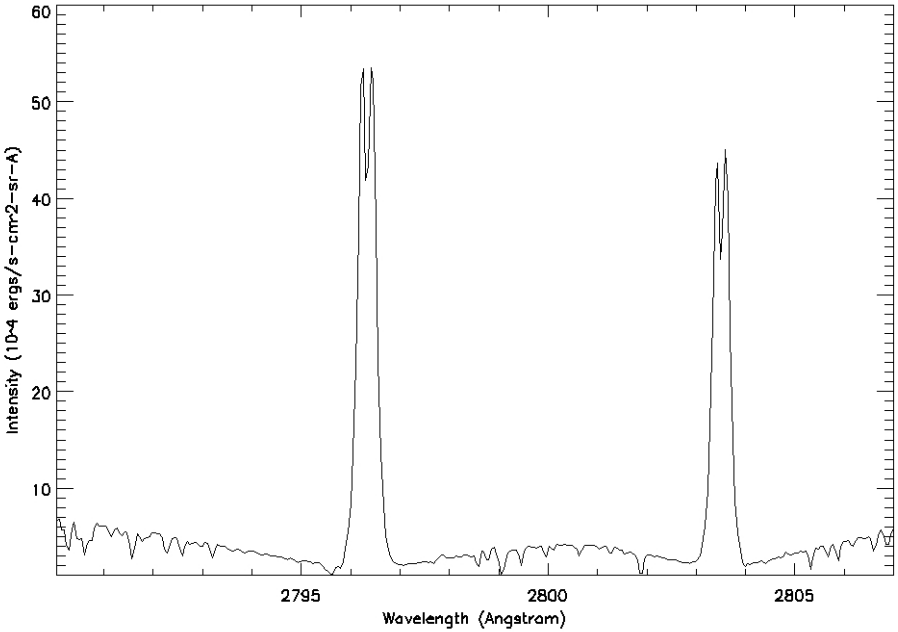
IRIS NUV and FUV observation: 29-Mar-2014



Liu et al. (2015)



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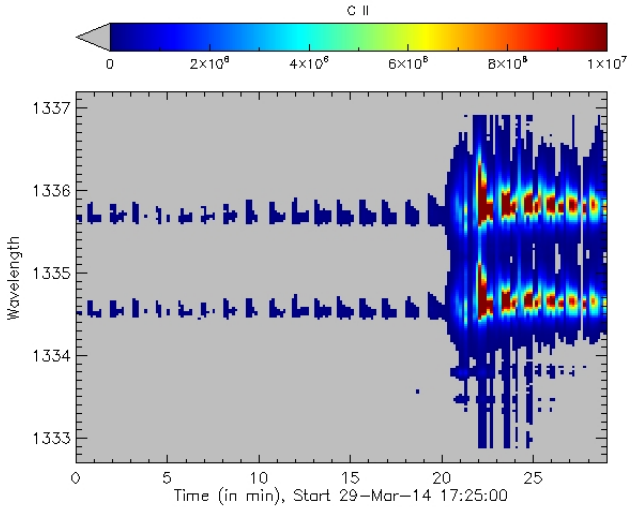
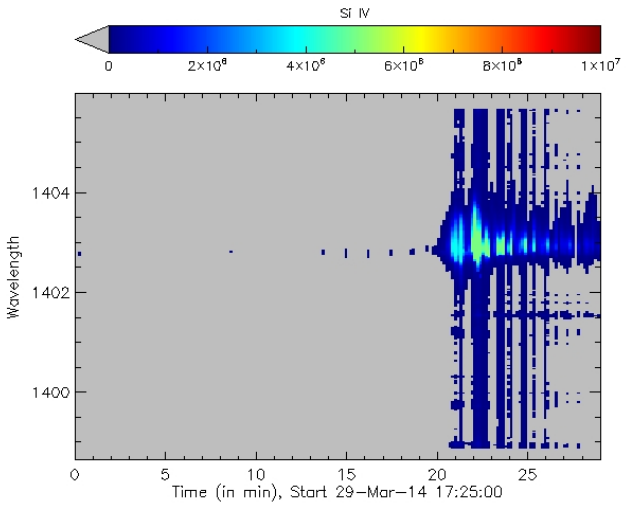
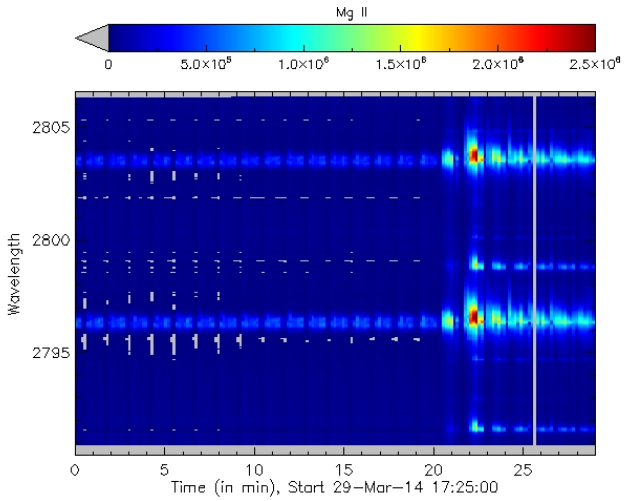
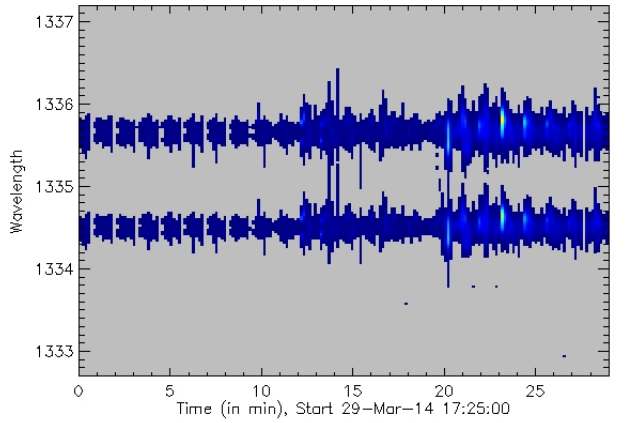
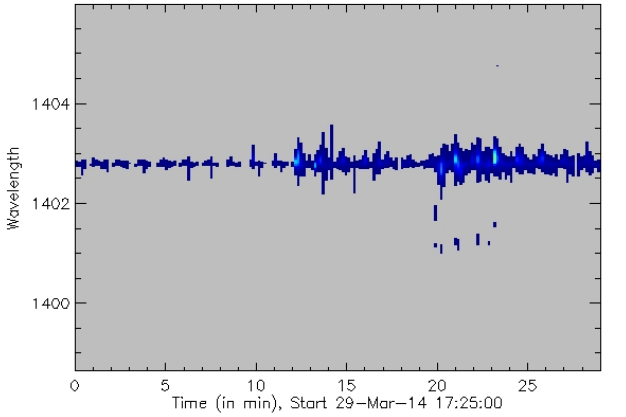
Intensity evolution of the line profiles

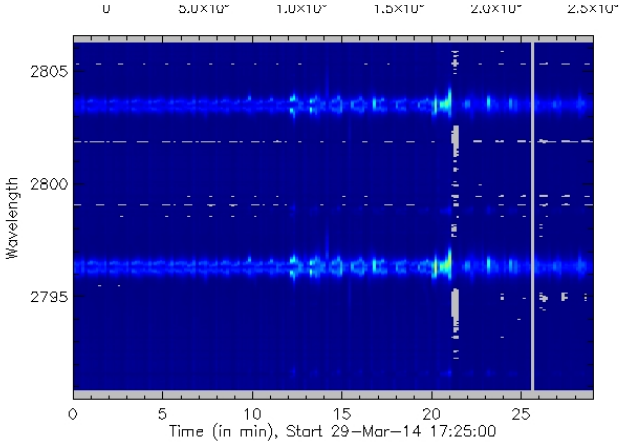












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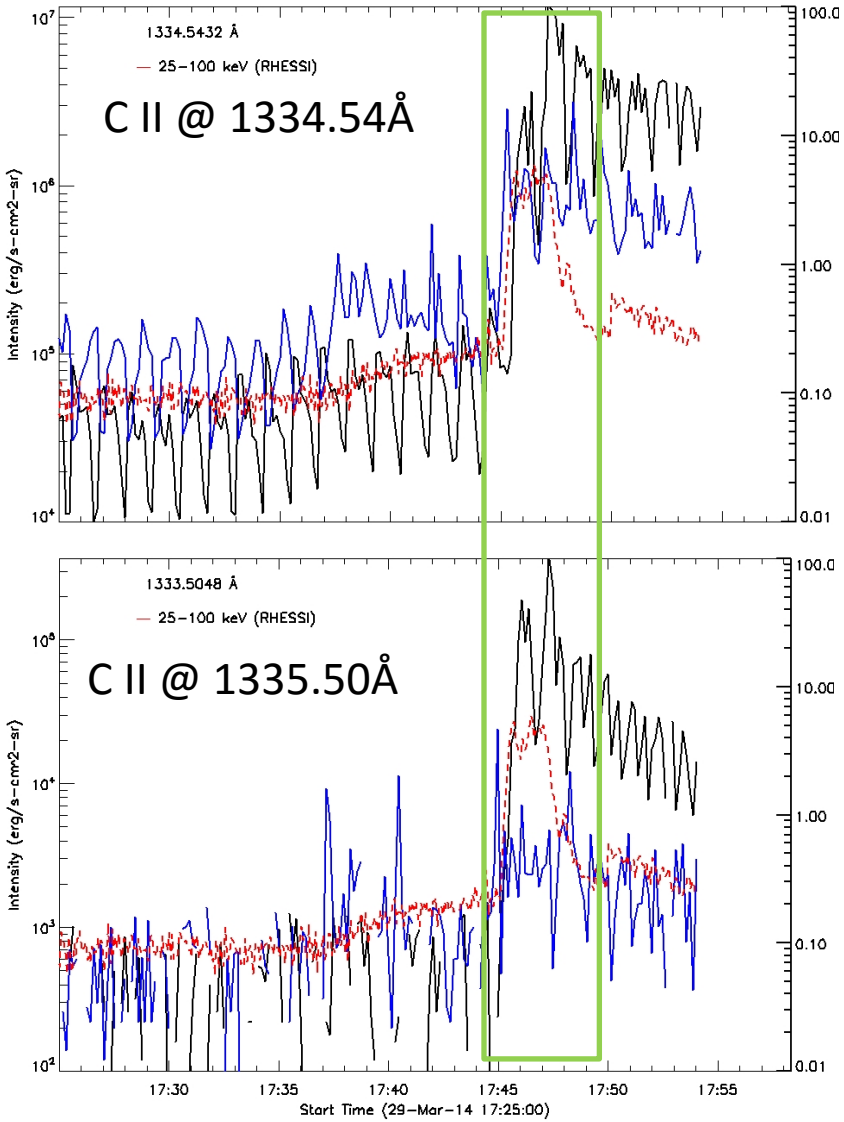
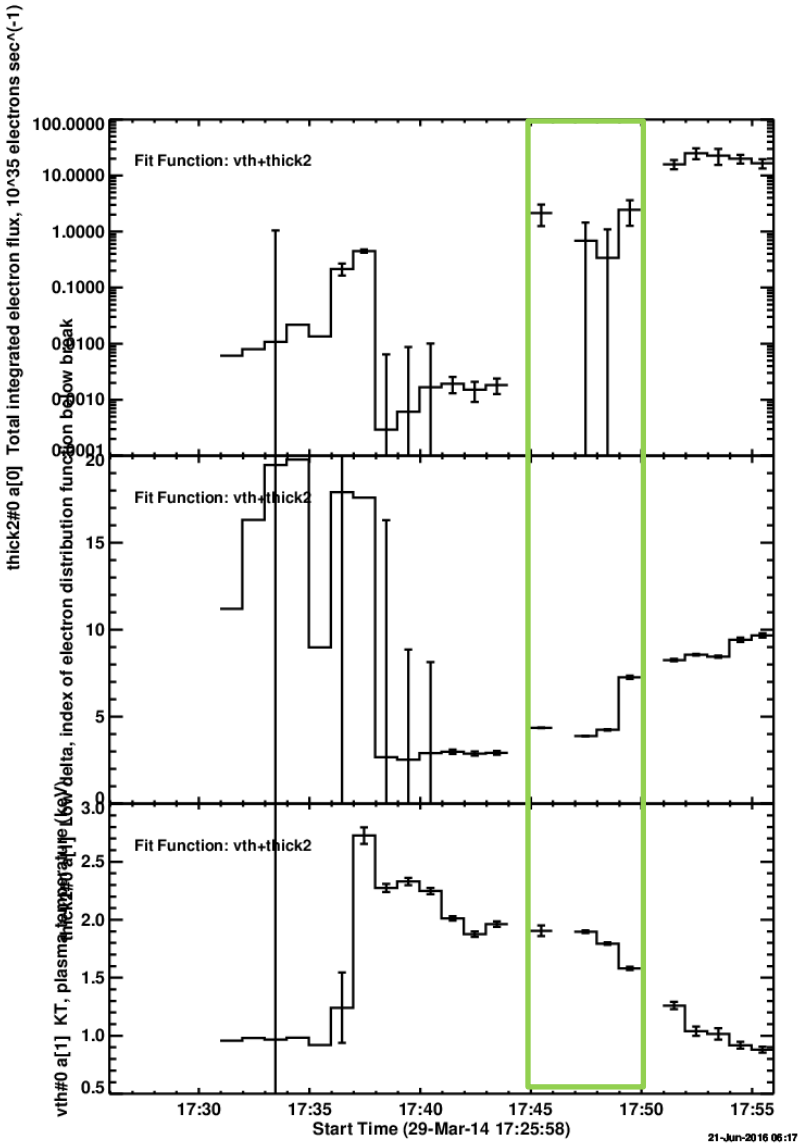
Time Profile evolution of the emission





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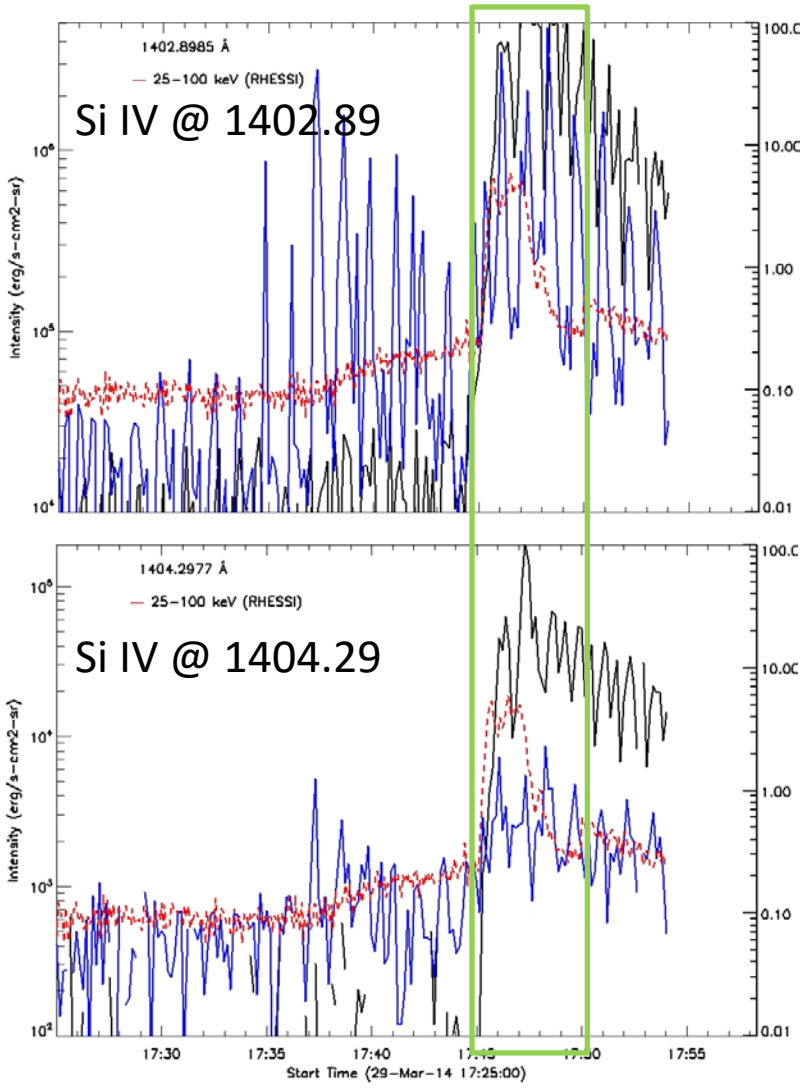
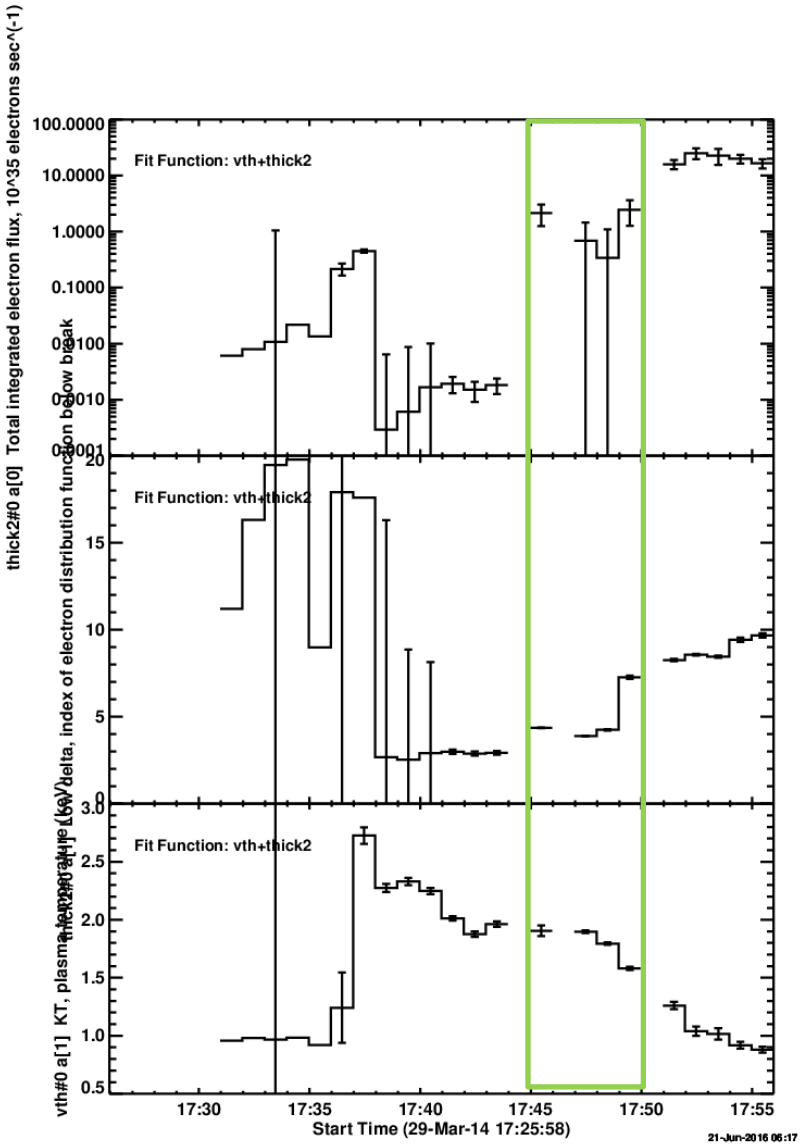
Time Profile evolution of the emission





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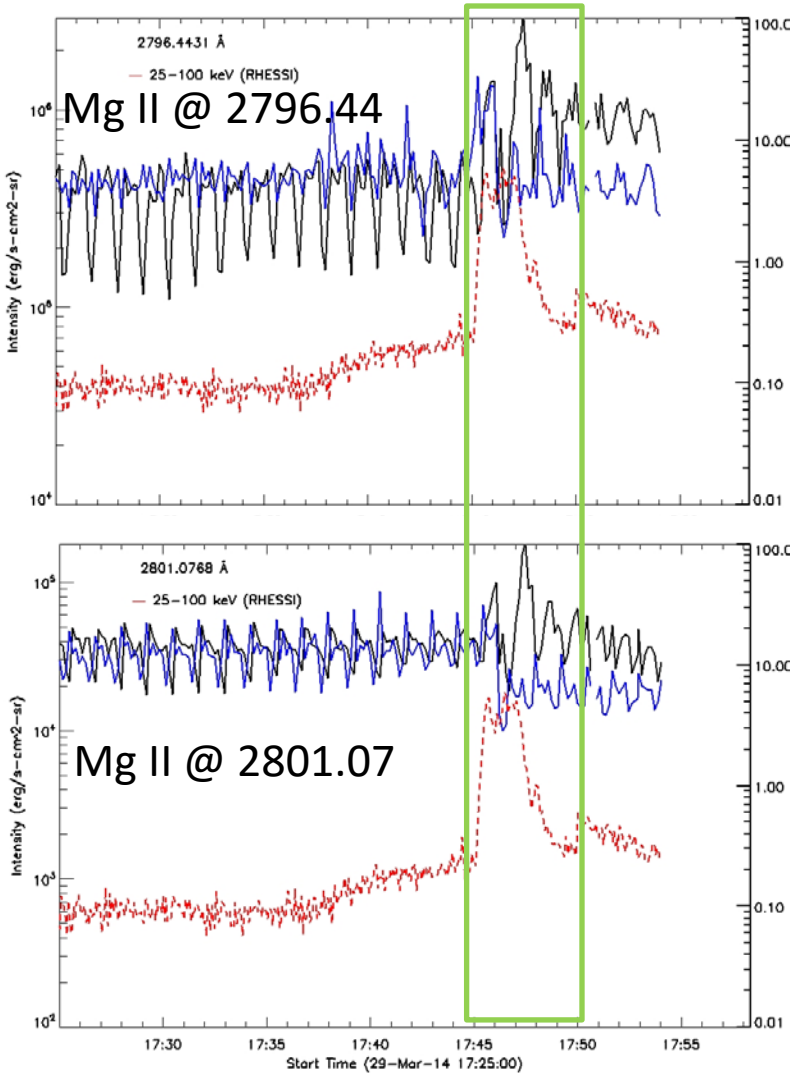
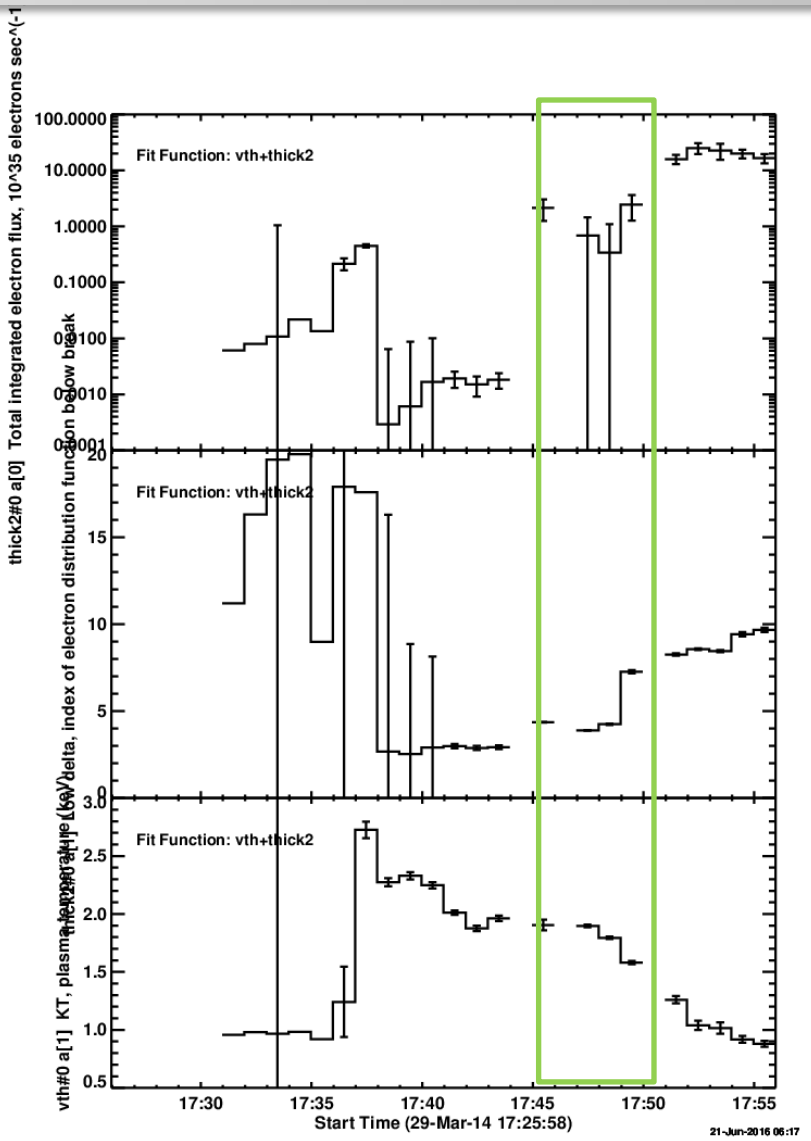
Time Profile evolution of the emission





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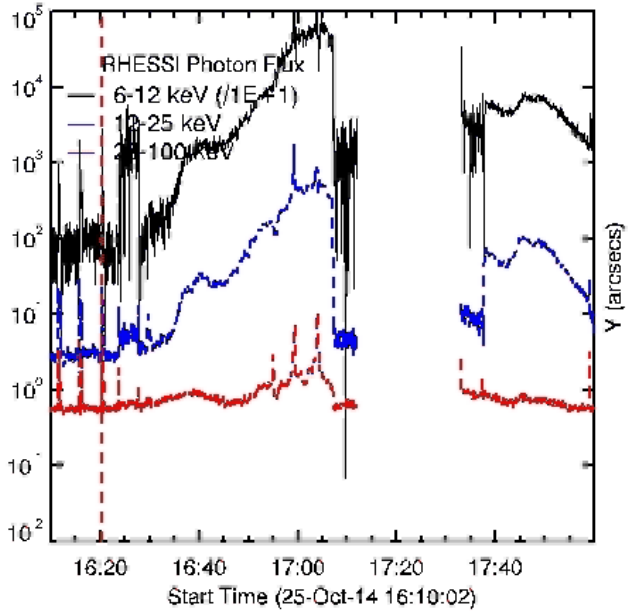
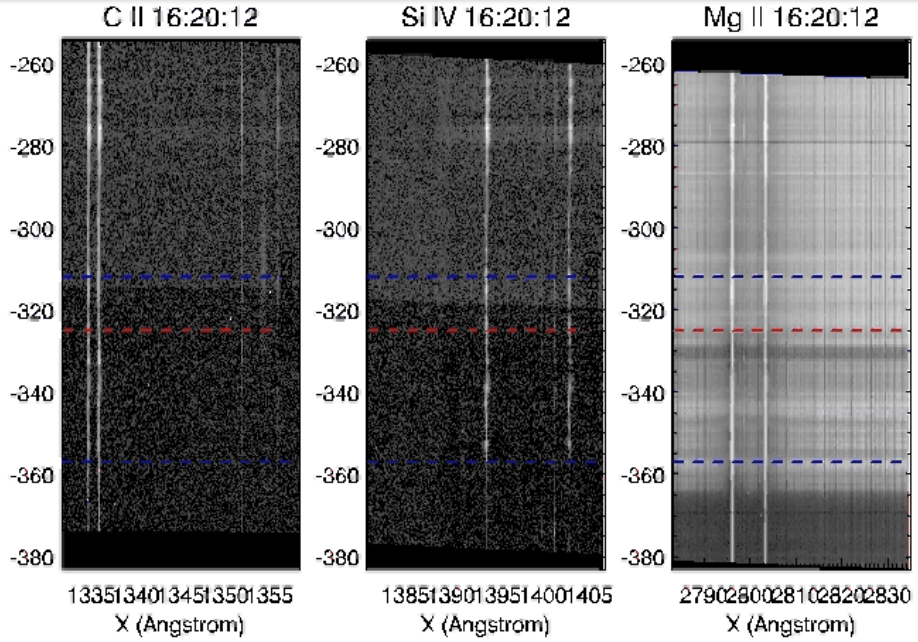
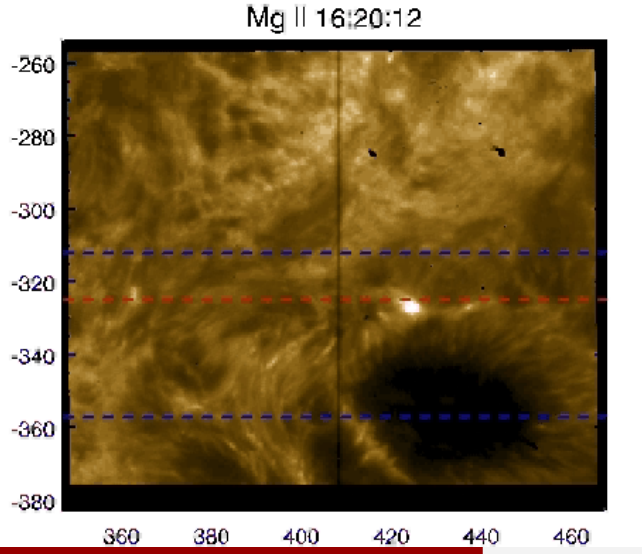
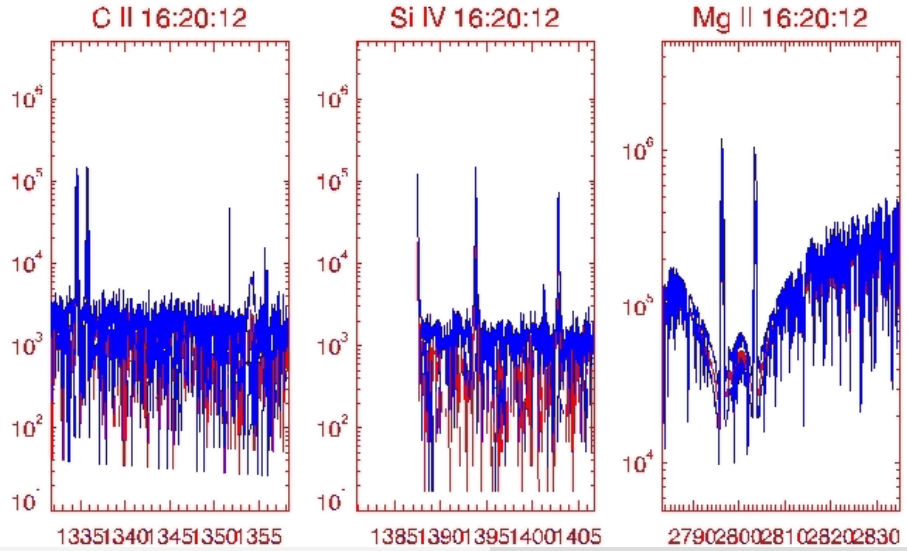
IRIS NUV and FUV observation: 25-Oct-2014









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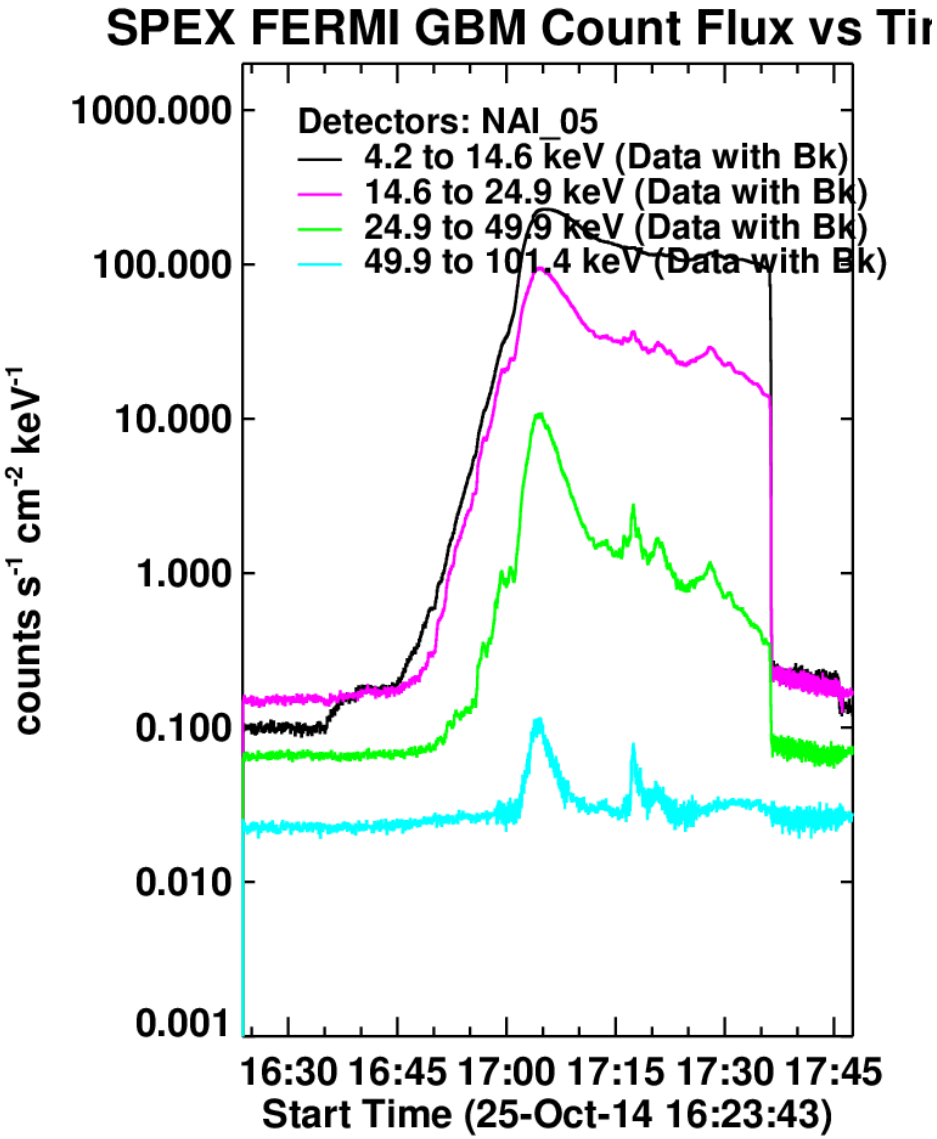

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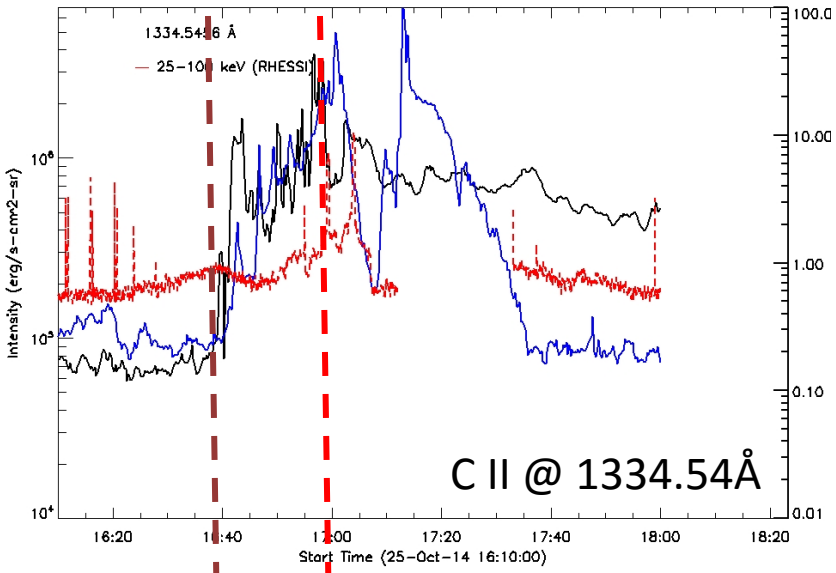
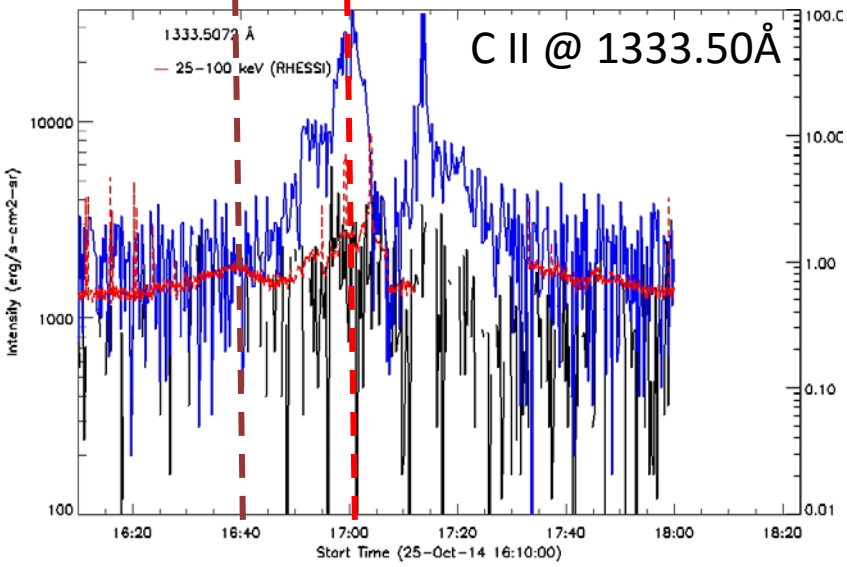
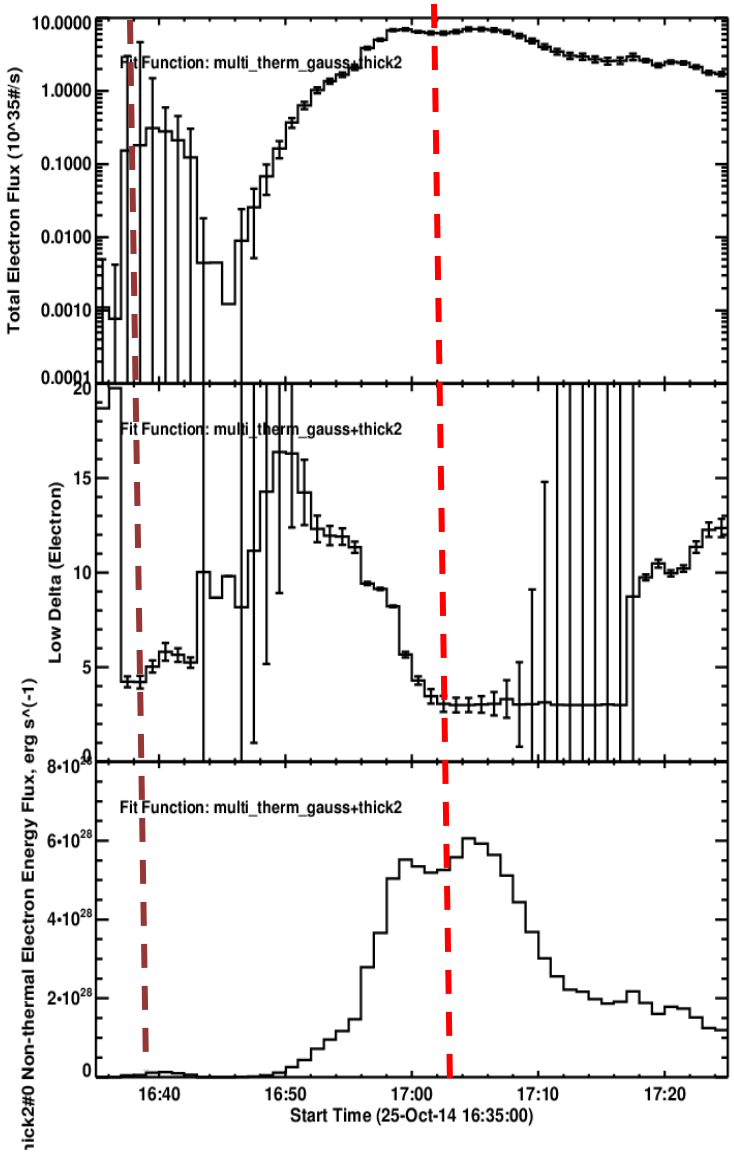
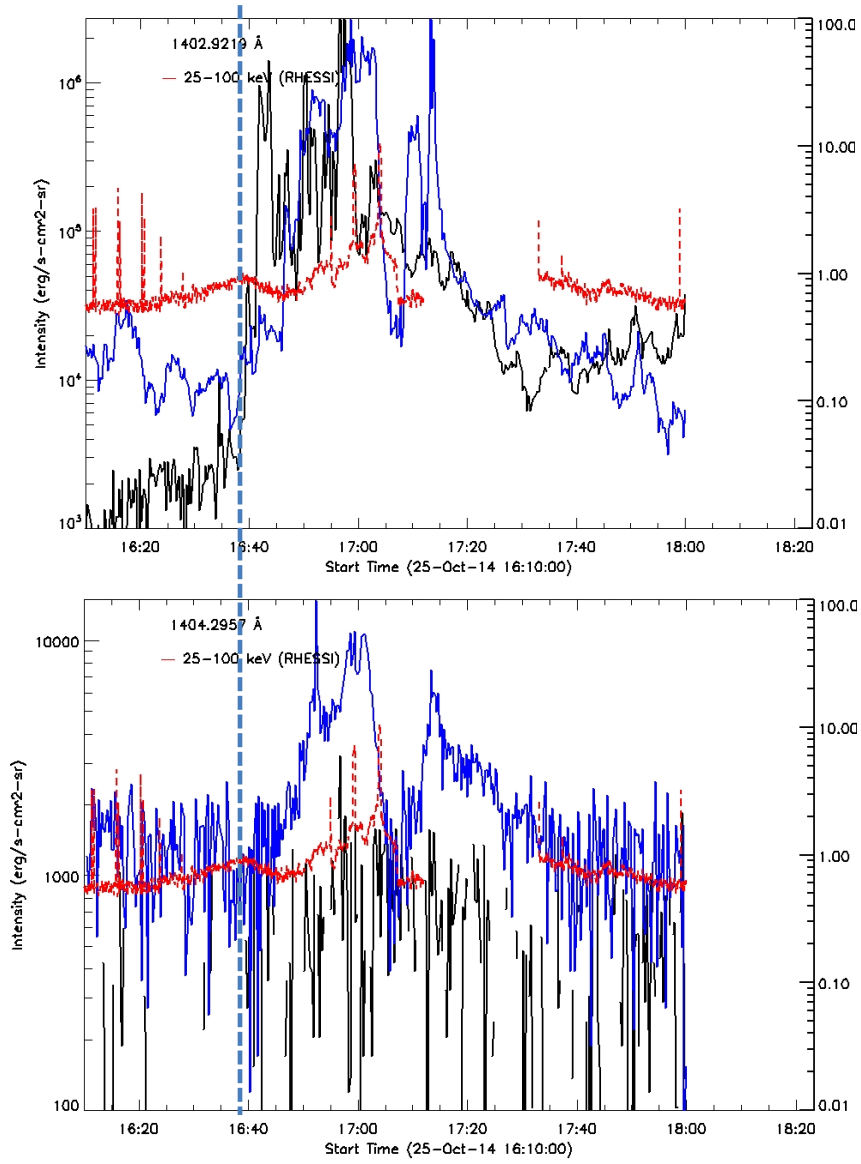
Time Profile evolution of the emission

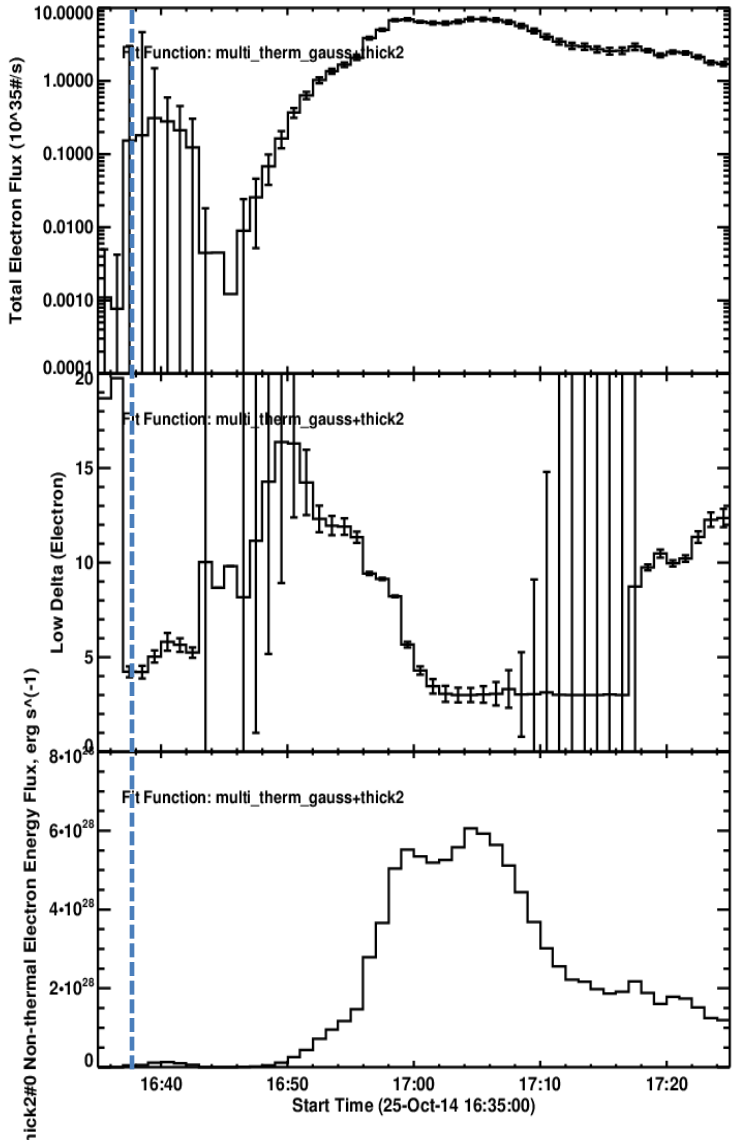




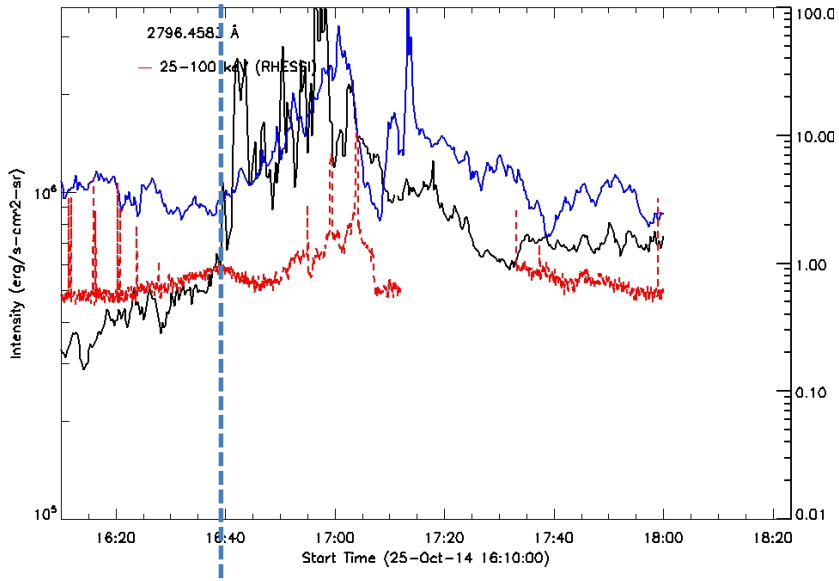


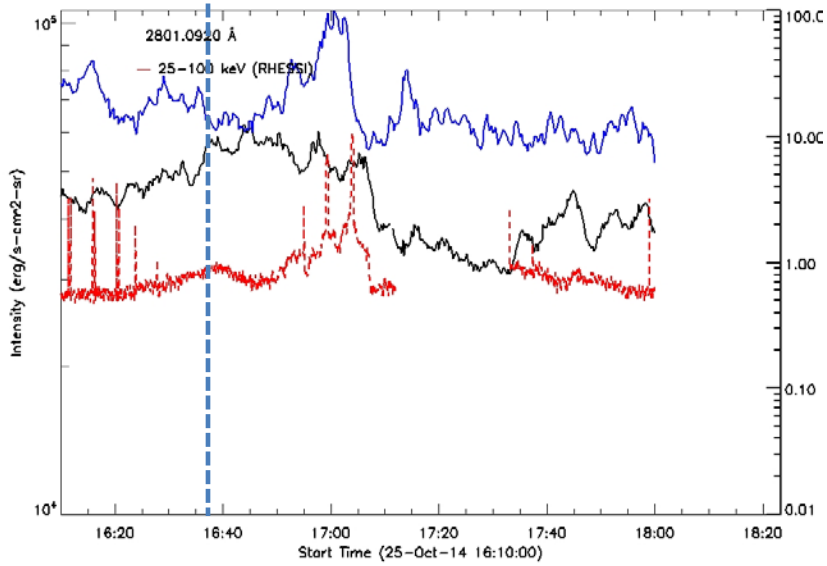
Time Profile evolution of the emission

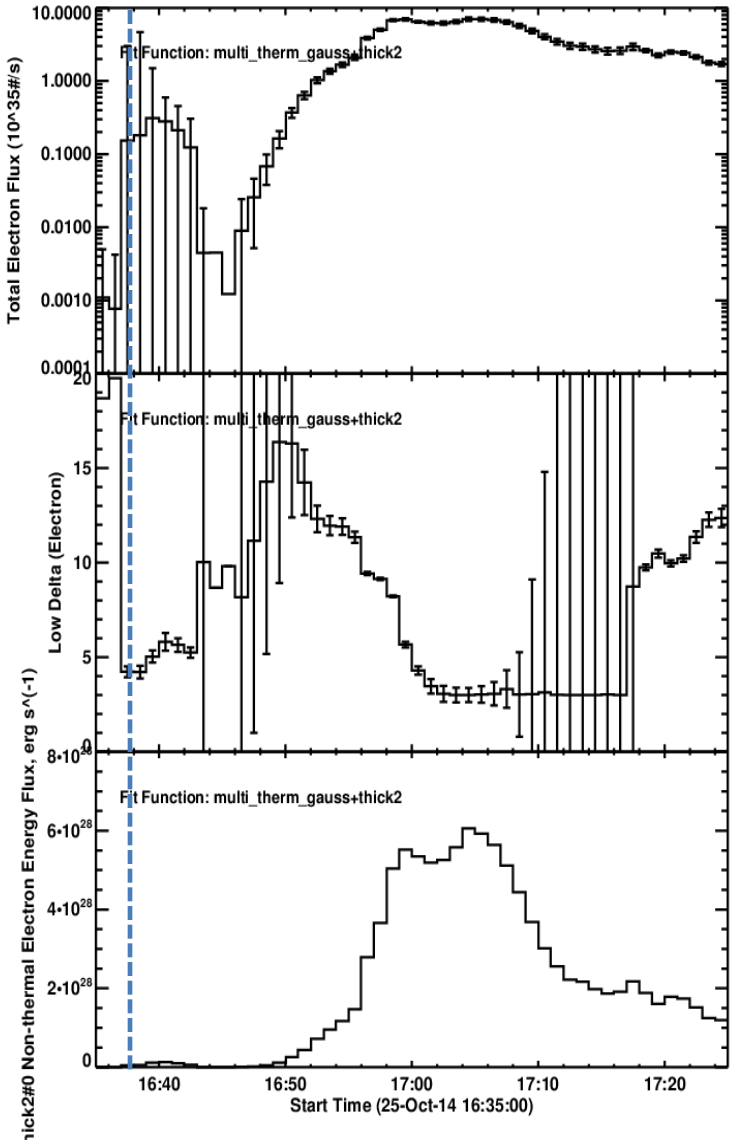




Time Profile evolution of the emission





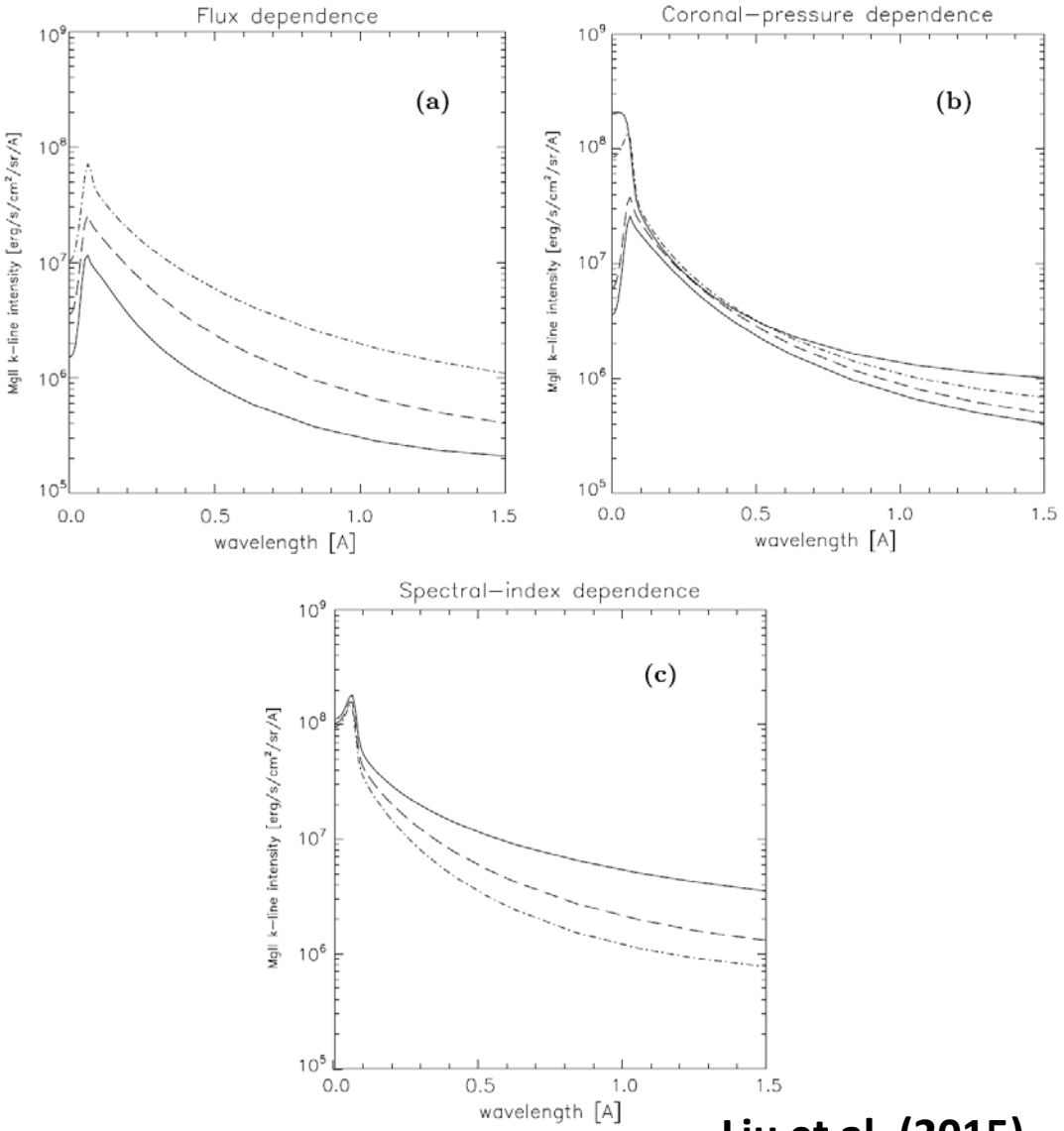


IRIS NUV and FUV emission evolution

Mg II *k* line profiles computed from RC models with different parameters. (a) δ = 5, coronal pressure 1 dyncm−2 and three electron-beam fluxes 109 (solid), 1010 (dashed) and 1011 erg s−1 cm−2 (dashdotted).

(b) δ = 5, flux 1010 erg s−1 cm−2 and four different values of the coronal pressure 1 (solid), 10 (dashed), 100 (dash-dotted) and 1000 dyncm−2 (dash-three-dots).

(c) The electron-beam flux 10^{11} erg s−1 cm−2, coronal pressure 100 dyncm−2 and three spectral indexes of the electron beam δ = 3 (solid), δ = 5 (dashed) and δ = 7 (dash-dotted).



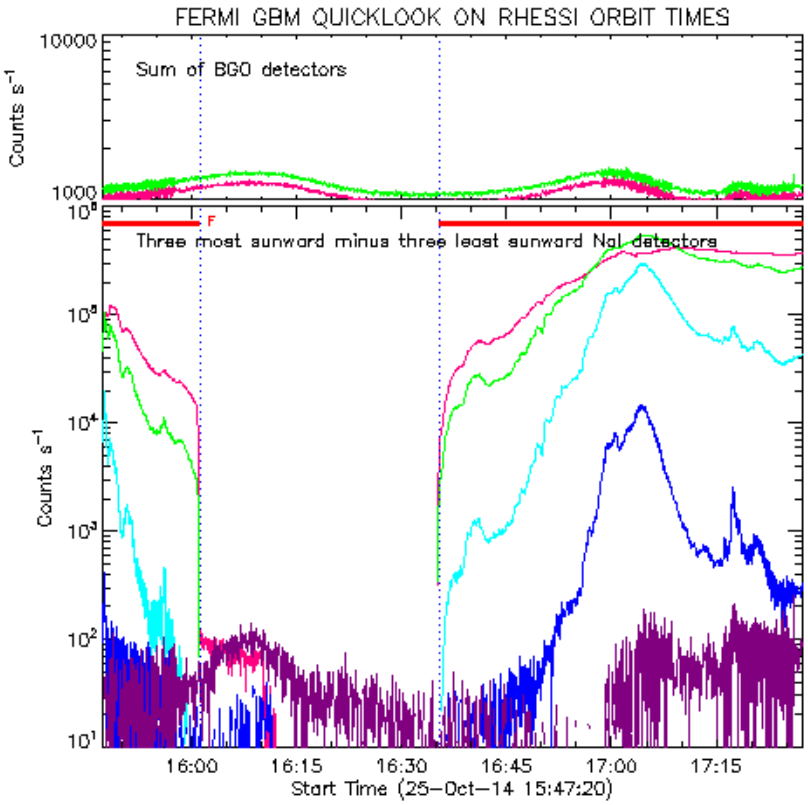
Liu et al. (2015)

Summary and Future Work

- Two X1.1 class flares observed by *IRIS* and *RHESSI* have been analysed.
- In particular, we studied the evolution of CII, Si IV and Mg II line profiles, observed by *IRIS*.
- We note that:
  - Non-thermal spectral index is a key proxy of the continuum enhancement.
  - Line-center intensities are found to be in good correlation with the HXR flux.
  - Continuum flux for both the flares at their peak is in close agreement in respective lines.
- We would like to:
  - Compare the continuum intensity observed with that synthesized for different models.
  - Correlate the NT parameters with the continuum contrast.


Thank you for the attention.

IRIS NUV and FUV emission evolution



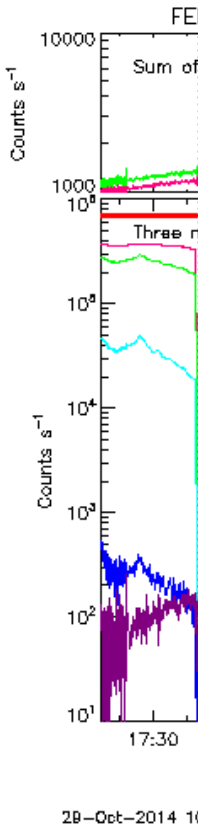


TABLE XIII

Important lines in the EUV region of the flare spectrum

Wavelength (Å)	Identification	I/I_0 [a]	I/I_0 [b]	k [c]	h ($\times 10^3$ km)[e]
1394	Si IV	(1.5)			
1335	C II	2.0			10.9 ± 1.3
1305	O I	2.0/1.5			
1243	N V	(1.7)			
1238.8	N V	2.5	1.3		
1215.7	H I (Lyα)		1.3	0.3	
1206.7	Si III		1.2	2.4 var	
1176	C III	7.2/2.0	3.0		
1085	N II	7.8/1.6	1.6		
1031.9	O VI	6.0/1.7	1.4	2.8	
1025.7	H I (Lyβ)	(1.3)	1.1	0.5	3.6 ± 2.4
991	N III	3.2/2.6	2.0		3.5 ± 2.1
977.0	C III	(3.5)	1.7	0.9	3.1 ± 2.0
972.5	H I (Lyγ)	(1.3)	1.1	0.7	
949.7	H I (Lyδ)	(1.2)	1.1		
834	O II, III		1.9		
791	O IV	2.7/1.6	1.8		5.1 ± 1.0
770.4	Ne VII	2.3/1.5	1.1[d]	1.0	8.8 ± 1.4
765.1	N IV	2.2	1.4		
758	O V	(1.4)	1.8		
718	O II	(1.5)			
703	O III	1.4/1.4			
629.7	O V	1.9/1.7	1.1	1.2	
625.3	Mg X	3.2/1.3	1.1[d]	0.3	10.6 ± 1.6
584.3	He I	1.4/1.2	1.1	0.3	3.0 ± 1.6
553	O IV	(1.6)	2.2		
537	He I	(4.7)			
521.0	Si XII	(1.2)			
499.3	Si XII	3.3/1.2	1.2[d]	0.5	9.4 ± 1.7
465.2	Ne VII	2.9/2.1	1.2		
417	Fe XV	2.6/1.8			12.8 ± 2.2
368.1	Mg IX	(1.7)	1.1	0.5	
361	Fe XVI	2.1/1.6			15.2 ± 2.3
335.4	Fe XVI	1.4	1.2[d]	0.4	
303.8	He II (Lyα)	2.7/1.8	1.1[f]	1.4	
284.1	Fe XV		1.1[d]	0.4	

[a] Relative line enhancement in flares, after Wood *et al.* (1972). The first number gives the mean of the three highest enhancements measured, the second one the median of all measurements. If only two flares were observed, no second number is given. If only one measurement was obtained, the value is in brackets.

[b] Relative enhancement of the integrated light in the line, in the spectrum of the imp. 2+ flare of 1967, March 22. I/I_0 at long wavelengths represents the flux close to

10:51

IRIS NUV and FUV emission evolution

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Wavelength (Å)	Identification	I/I_0 [a]	I/I_0 [b]	k [c]	h ($\times 10^3$ km) [e]
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1243	N V	(1.7)			
1238.8	N V	2.5	1.3		
1215.7	H I (Lyα)		1.3	0.3	
1206.7	Si III		1.2	2.4 var	
1176	C III	7.2/2.0	3.0		
1085	N II	7.8/1.6	1.6		
1031.9	O VI	6.0/1.7	1.4	2.8	
1025.7	H I (Lyβ)	(1.3)	1.1	0.5	3.6 ± 2.4
991	N III	3.2/2.6	2.0		3.5 ± 2.1
977.0	C III	(3.5)	1.7	0.9	3.1 ± 2.0
972.5	H I (Lyγ)	(1.3)	1.1	0.7	
949.7	H I (Lyδ)	(1.2)	1.1		
834	O II, III		1.9		
791	O IV	2.7/1.6	1.8		5.1 ± 1.0
770.4	Ne VII	2.3/1.5	1.1 [d]	1.0	8.8 ± 1.4
765.1	N IV	2.2	1.4		
758	O V	(1.4)	1.8		
718	O II	(1.5)			
703	O III	1.4/1.4			
629.7	O V	1.9/1.7	1.1	1.2	
625.3	Mg X	3.2/1.3	1.1 [d]	0.3	10.6 ± 1.6
584.3	He I	1.4/1.2	1.1	0.3	3.0 ± 1.6
553	O IV	(1.6)	2.2		
537	He I	(4.7)			
521.0	Si XII	(1.2)			
499.3	Si XII	3.3/1.2	1.2 [d]	0.5	9.4 ± 1.7
465.2	Ne VII	2.9/2.1	1.2		
417	Fe XV	2.6/1.8			12.8 ± 2.2
368.1	Mg IX	(1.7)	1.1	0.5	
361	Fe XVI	2.1/1.6			15.2 ± 2.3
335.4	Fe XVI	1.4	1.2 [d]	0.4	
303.8	He II (Lyα)	2.7/1.8	1.1 [f]	1.4	
284.1	Fe XV		1.1 [d]	0.4	

[a] Relative line enhancement in flares, after Wood *et al.* (1972). The first number gives the mean of the three highest enhancements measured, the second one the median of all measurements. If only two flares were observed, no second number is given. If only one measurement was obtained, the value is in brackets.

[b] Relative enhancement of the integrated light in the line, in the spectrum of the imp. 2+ flare of 1967, March 22. I/I_0 at long wavelengths represents the flux close to