Elementary flare profile (EFP) fit to X-ray light curves registered by STIX - Continuation

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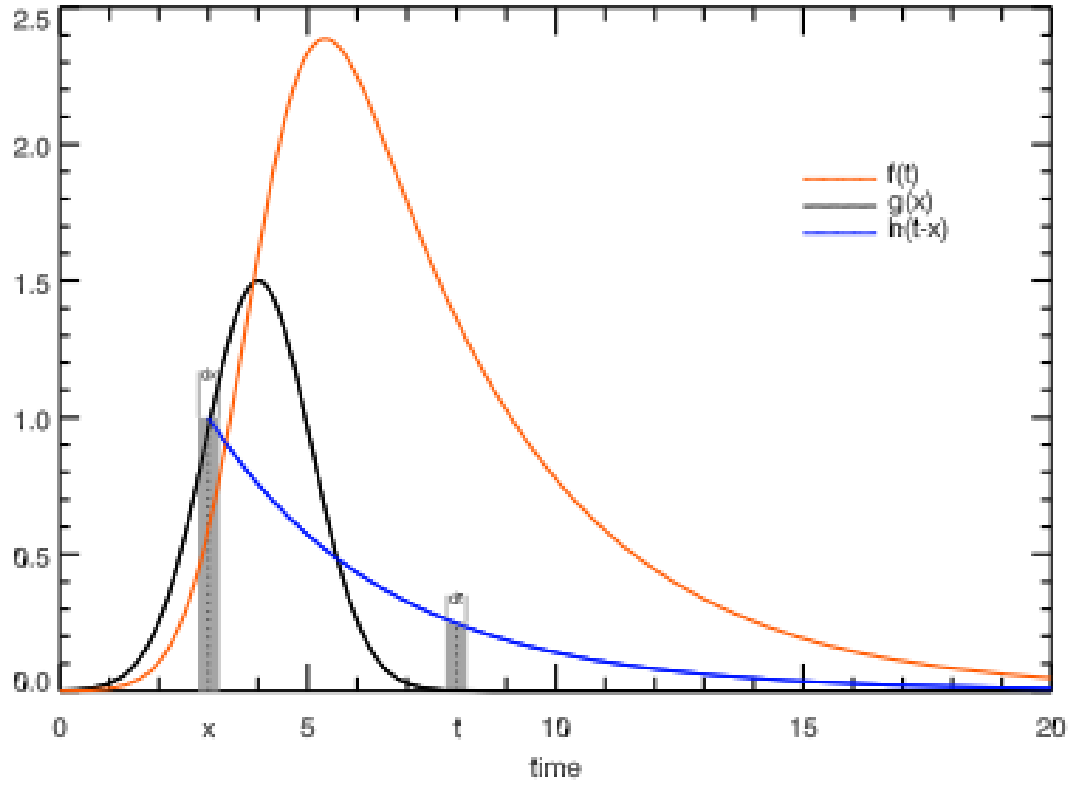
Elementary Flare Profile

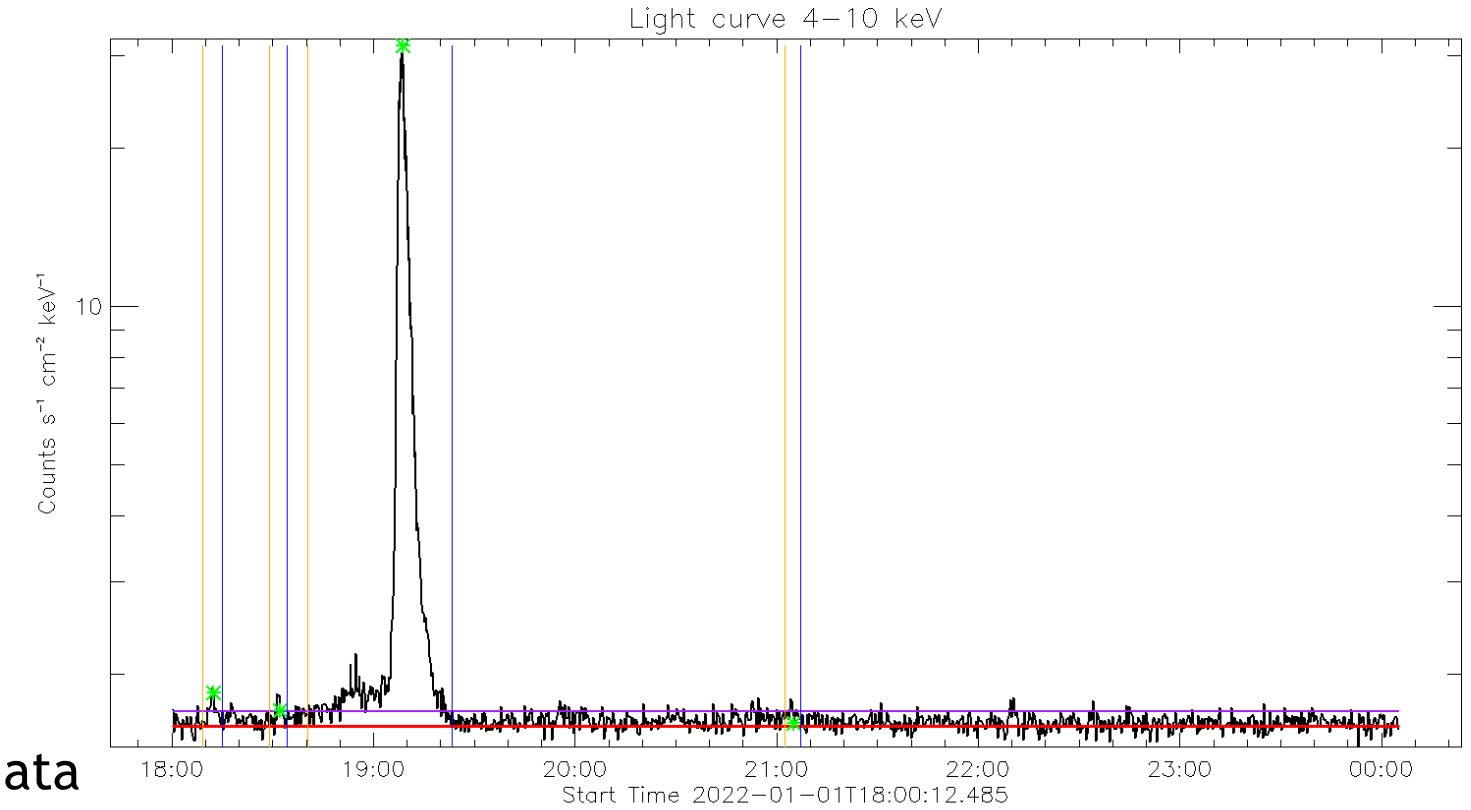
- $$f(t) = \frac{1}{2}\sqrt{\pi}\,A\,C \exp\left[D\,(B-t) + \frac{C^2 D^2}{4}\right]\left[\operatorname{erf}(Z) - \operatorname{erf}\left(Z - \frac{t}{C}\right)\right]$$
- $$f(t) = \int_0^t g(x)h(t-x)\,dx$$
- $$g(x) = A\exp\left(-(x-B)^2/C^2\right)$$
- $$h(x) = \exp(-Dx)$$
- $$Z = \frac{2B + C^2 D}{2C}$$

Figure 3 The model of the soft X-ray flare time profile $f(t)$ results from the convolution of a Gaussian function describing the energy release rate $g(x)$ (Equation (2)) with an exponential decay function $h(x)$ describing energy dissipation (Equation (3)).

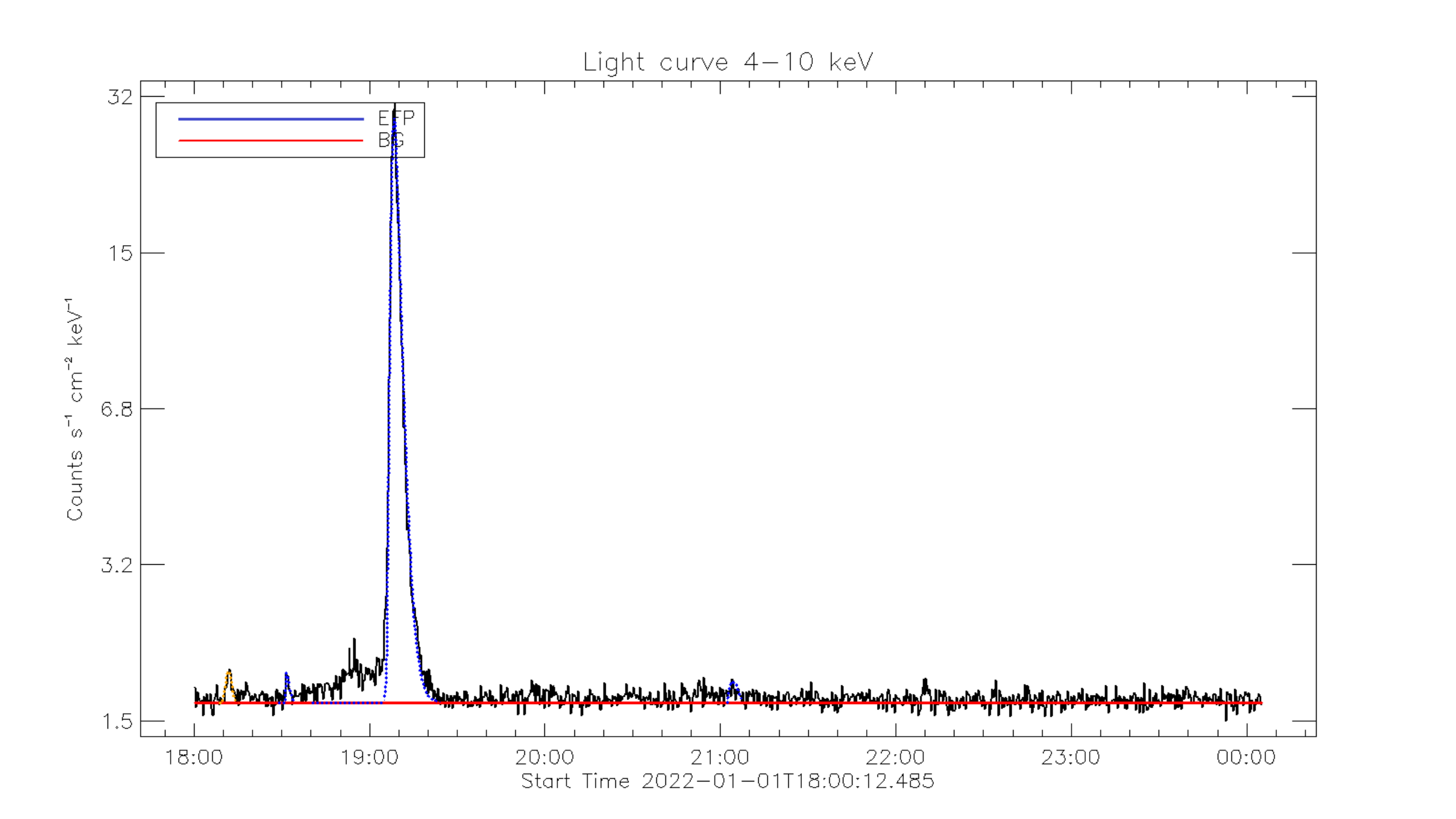


Flare Characteristics from X-ray Light Curves
M. Gryciuk et. al. 2017

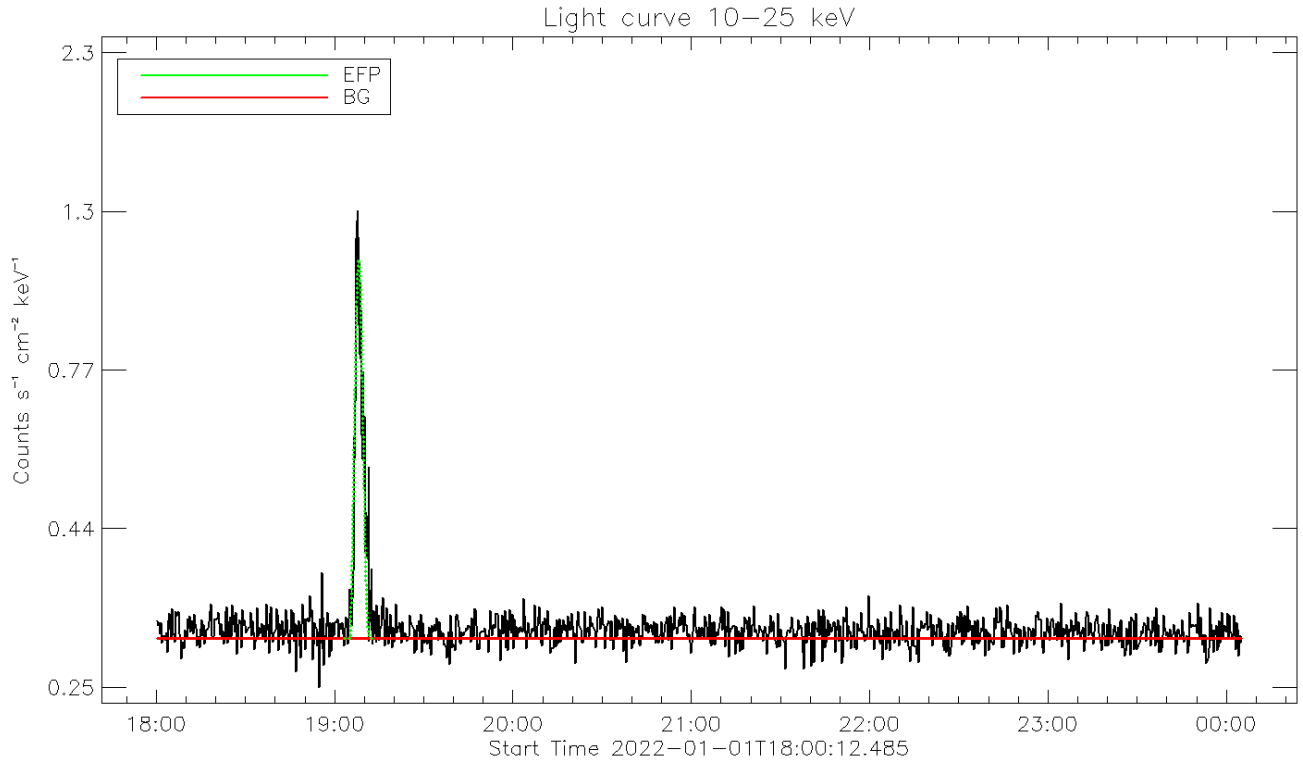
Automatic EFP fit

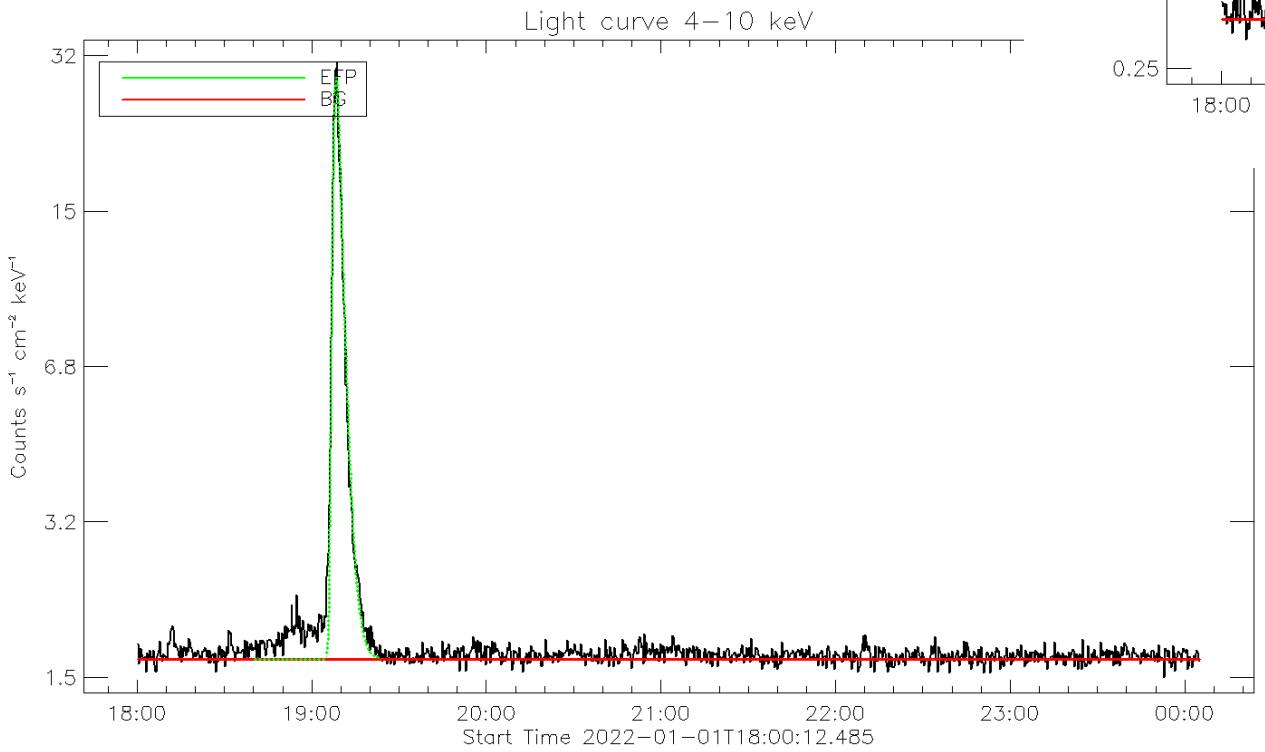


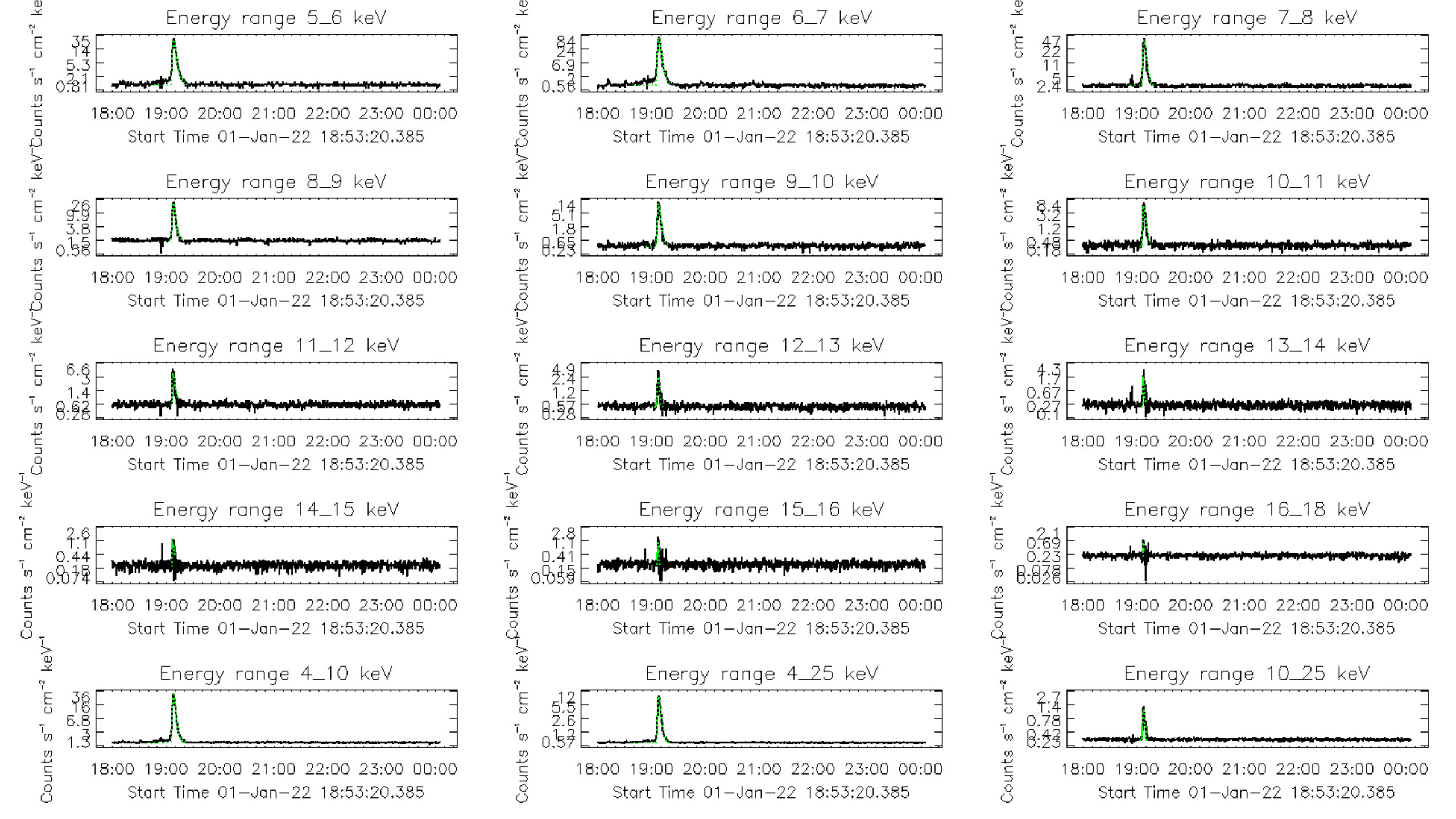
- Compare background level with data
- Smooth with 9 points and again with 3 points
- Searching for extremas
- Checking if found extremas are for this same flare/flares (limit above background)
- Combining extremas if counts are above the limit
- Parameter randomization 150 000 Times and using MpFit


Light curve 4−10 keV
EFP
BG
32
15
6.8
3.2
1.5
Counts s^{-1} cm^{-2} keV^{-1}
18:00
19:00
20:00
21:00
22:00
23:00
00:00
Start Time 2022−01−01T18:00:12.485

2022-Jan-01 19:08:39

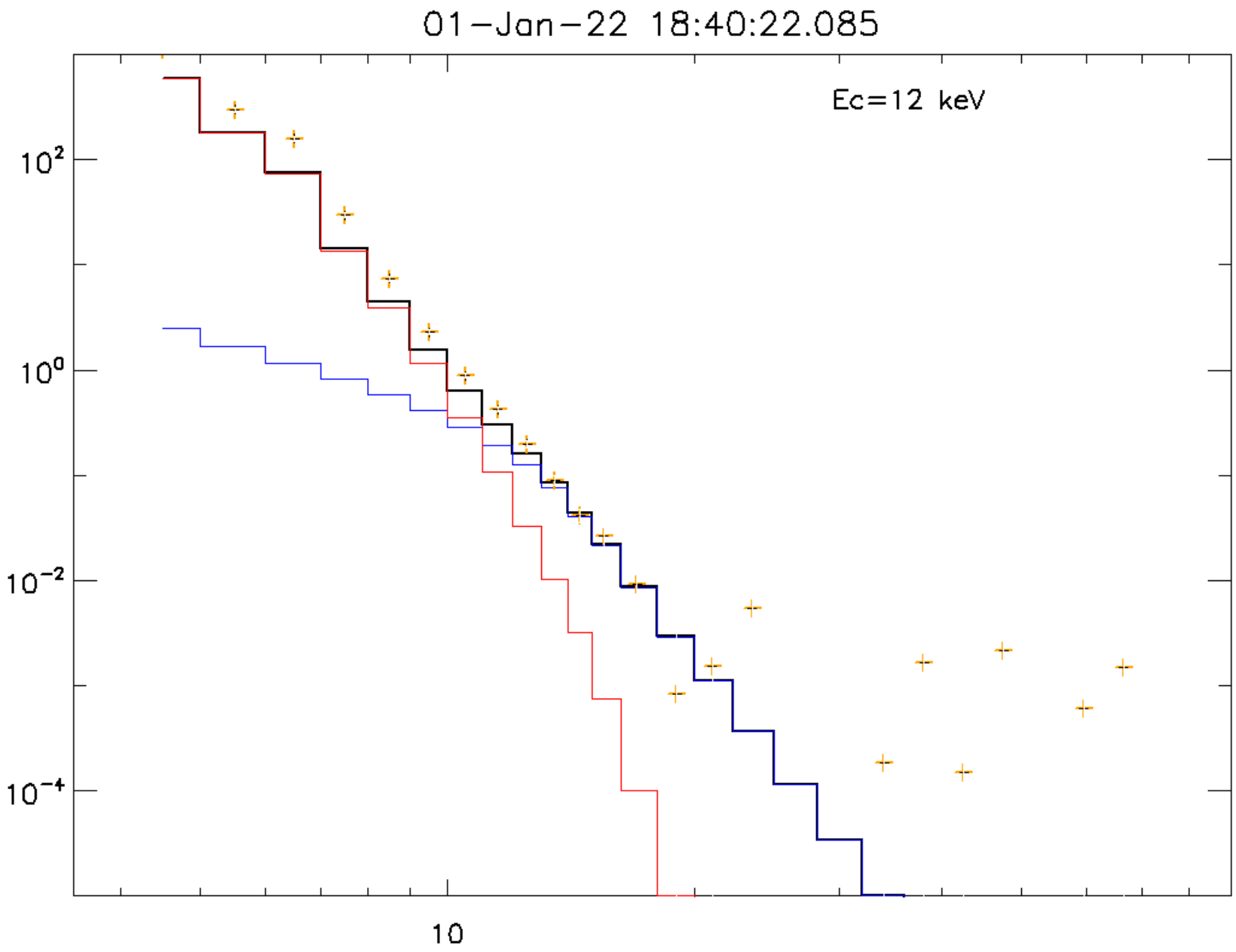


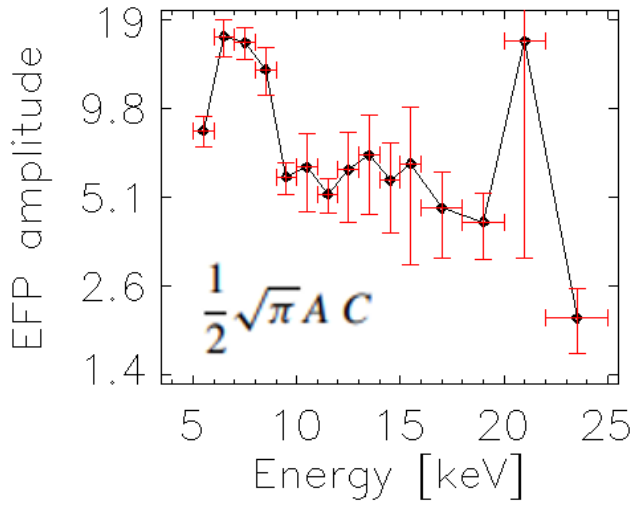


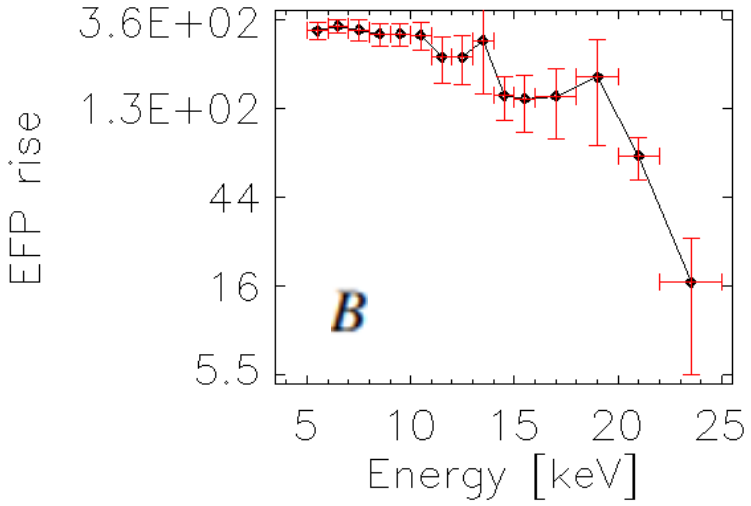

Energy range 5_6 keV
Energy range 6_7 keV
Energy range 7_8 keV
Energy range 8_9 keV
Energy range 9_10 keV
Energy range 10_11 keV
Energy range 11_12 keV
Energy range 12_13 keV
Energy range 13_14 keV
Energy range 14_15 keV
Energy range 15_16 keV
Energy range 16_18 keV
Energy range 4_10 keV
Energy range 4_25 keV
Energy range 10_25 keV
Counts s⁻¹ cm⁻² keV⁻¹
18:00 19:00 20:00 21:00 22:00 23:00 00:00
Start Time 01-Jan-22 18:53:20.385

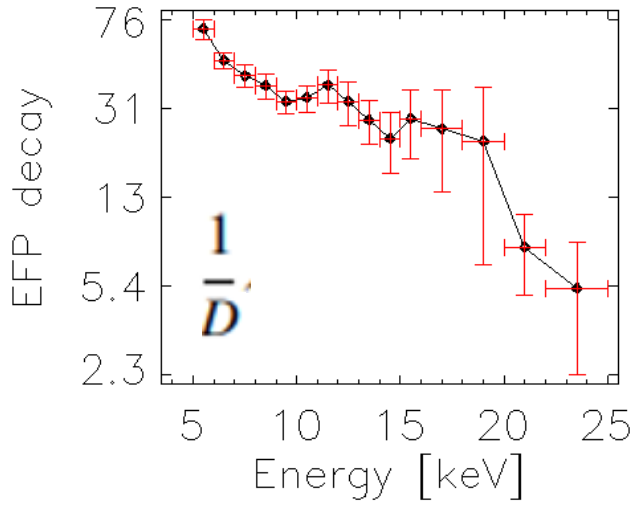
2022-Jan-01 19:08:39

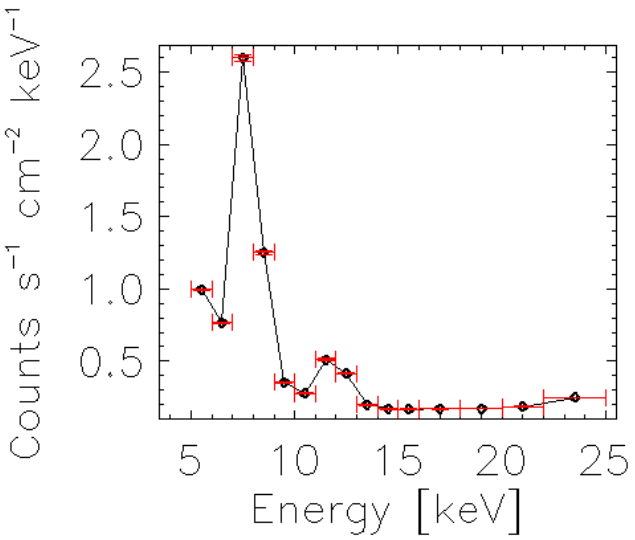
Black – Vth+Thick2
Red – Thermal component (Vth)
Blue – Nonthermal component (Thick2)
Orange – Observed spectrum
Ec – Cutoff energy









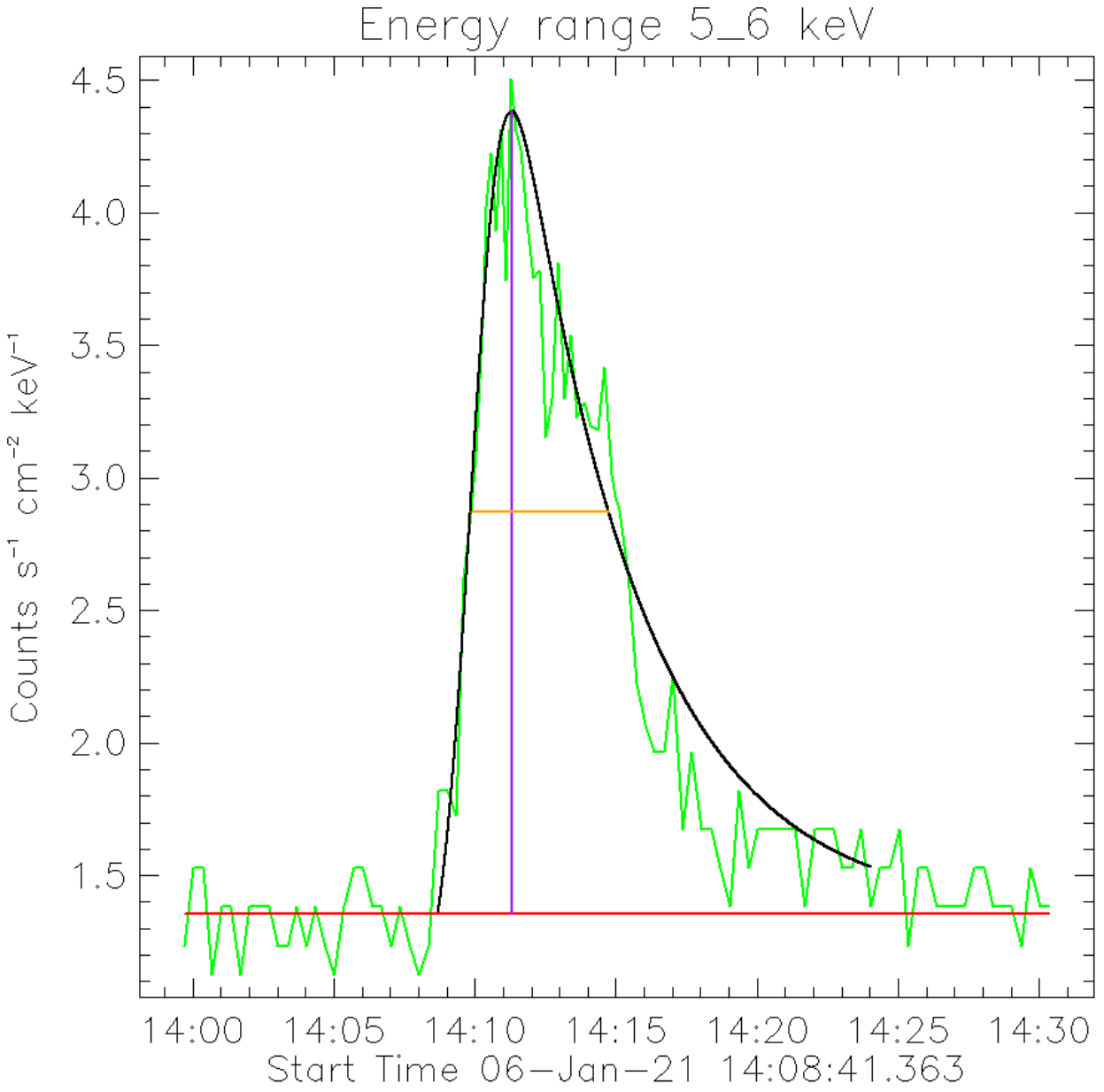


Example for automatic fit from January 2022; 219 EFP and 479 rejected flares (multiple peaks, bad fits)

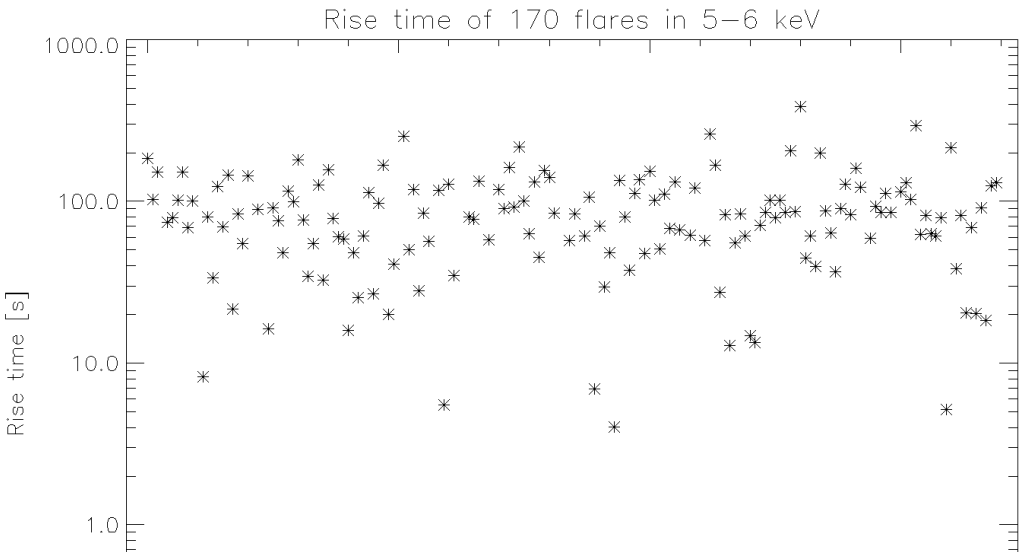
$$f(t) = \frac{1}{2}\sqrt{\pi}\,A\,C\exp\left[D\,(B-t)+\frac{C^2D^2}{4}\right]\left[\mathrm{erf}(Z)-\mathrm{erf}\left(Z-\frac{t}{C}\right)\right]$$

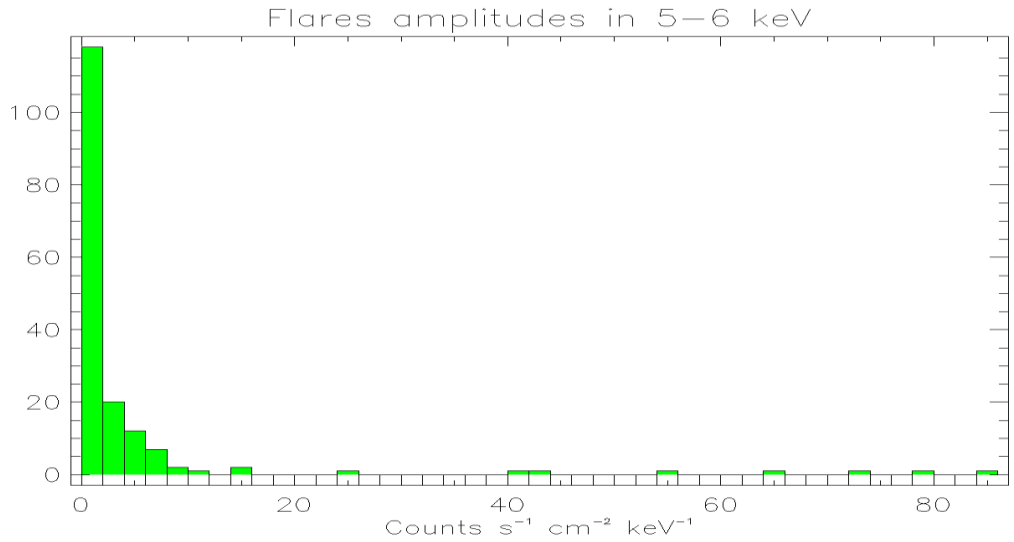
Example of flare with estimated amplitude and FWHM

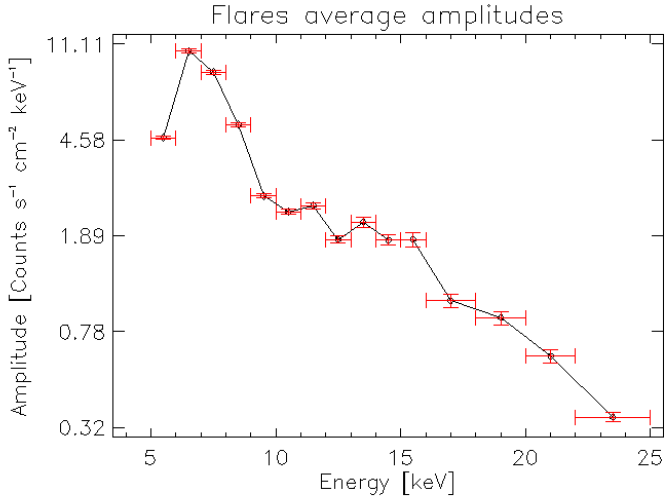
Green - Original Data
Black - Elementary flare profile
Red - Background
Purple - Profile Amplitude
Orange - Flare FWHM

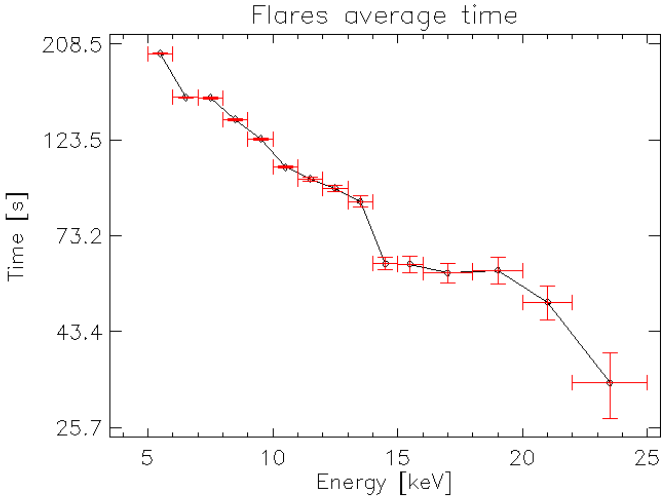


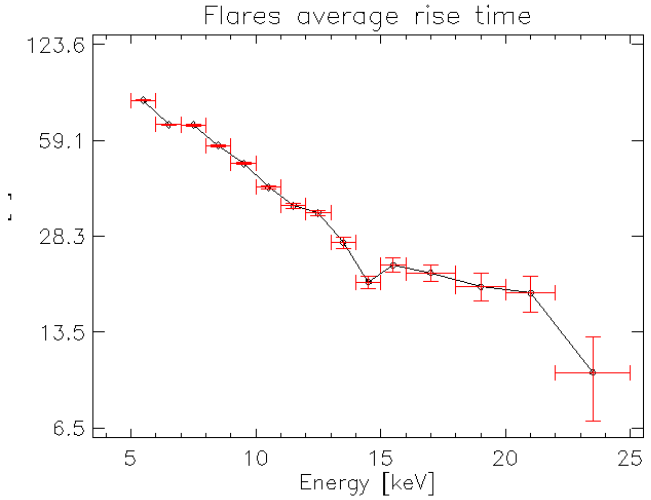
Flare amplitude, duration, rise time and Decay time

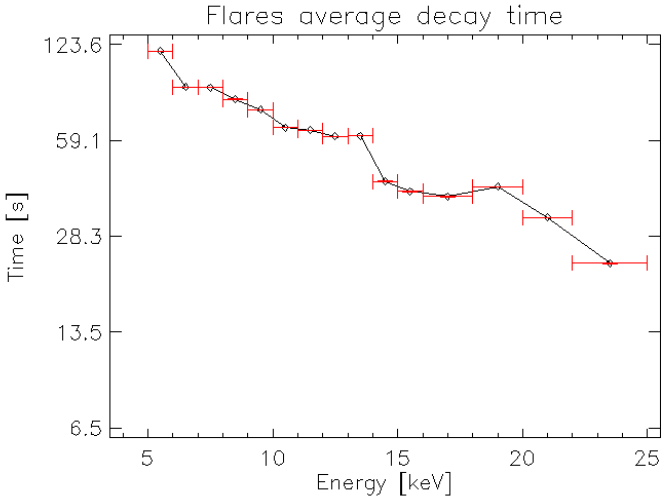








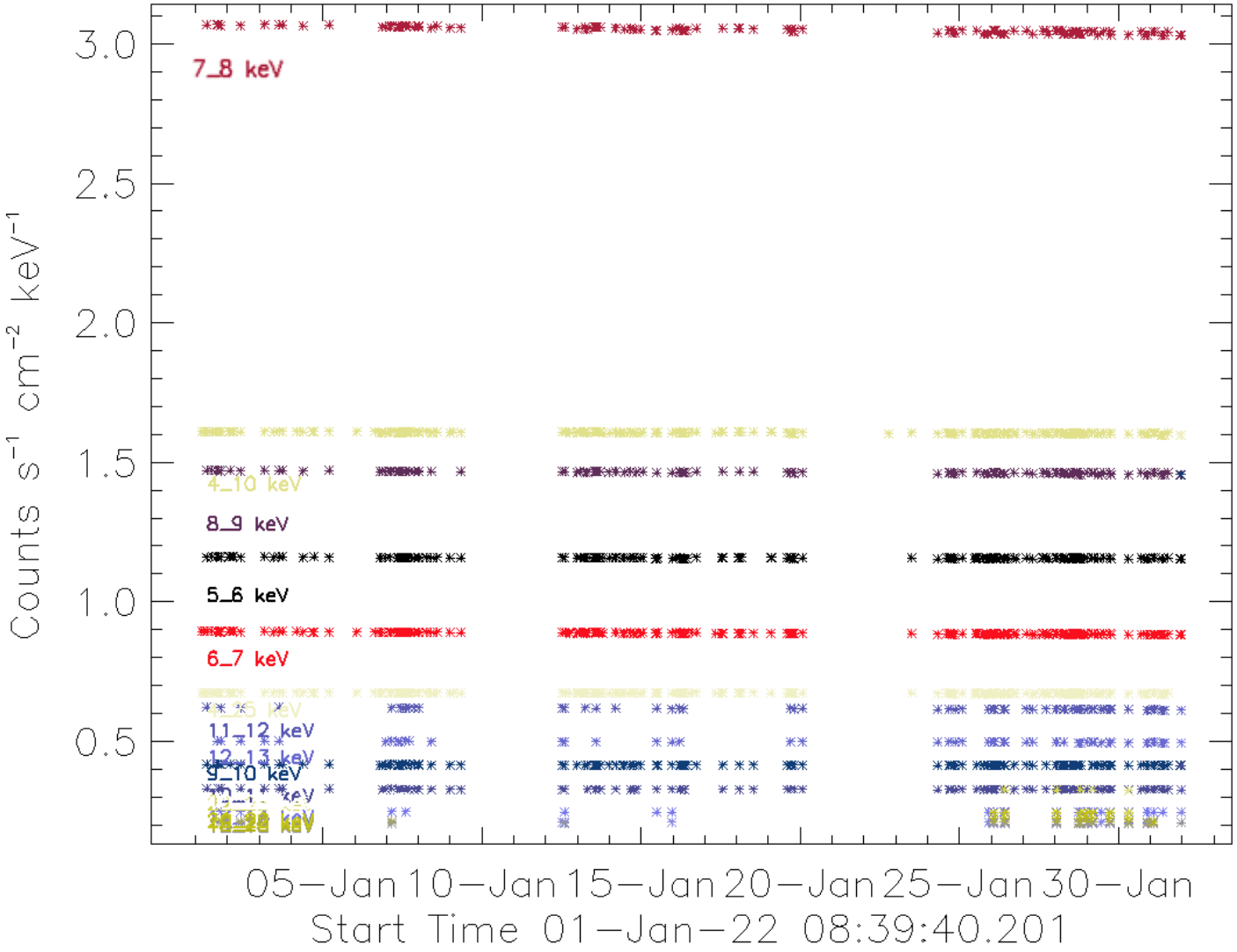




Interpolated background level

Background level is slowly decreasing

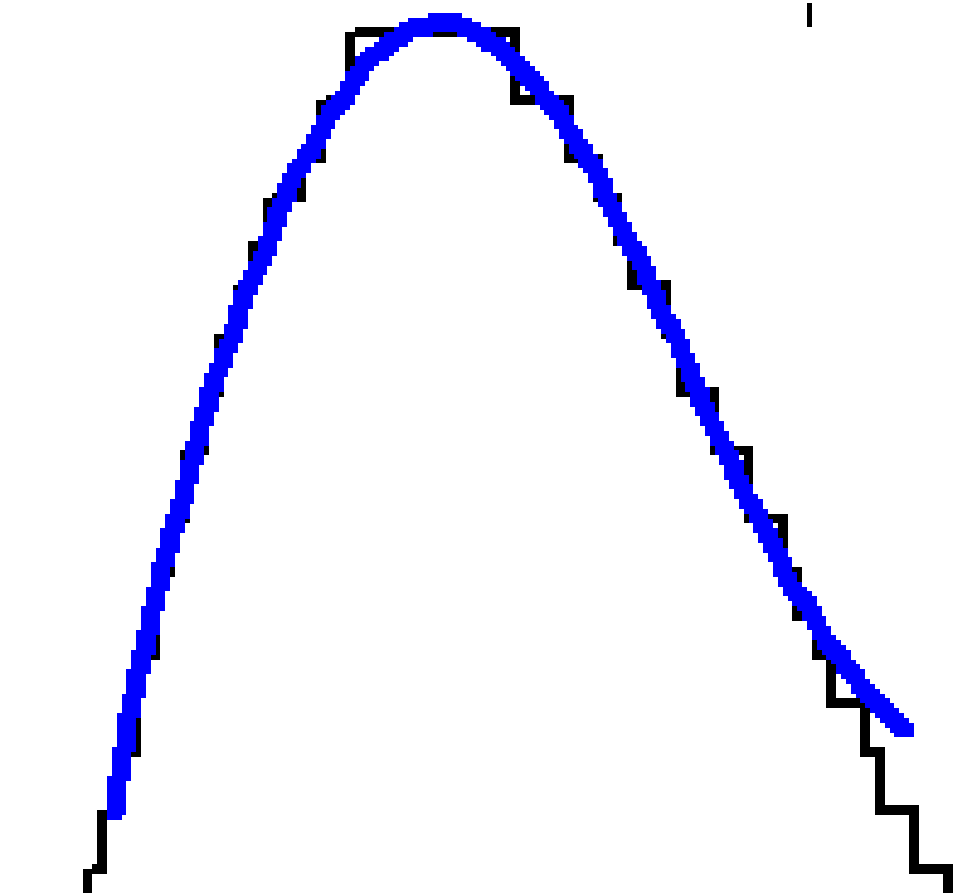
30 detectors and 12 pixels were used to determine background from background files

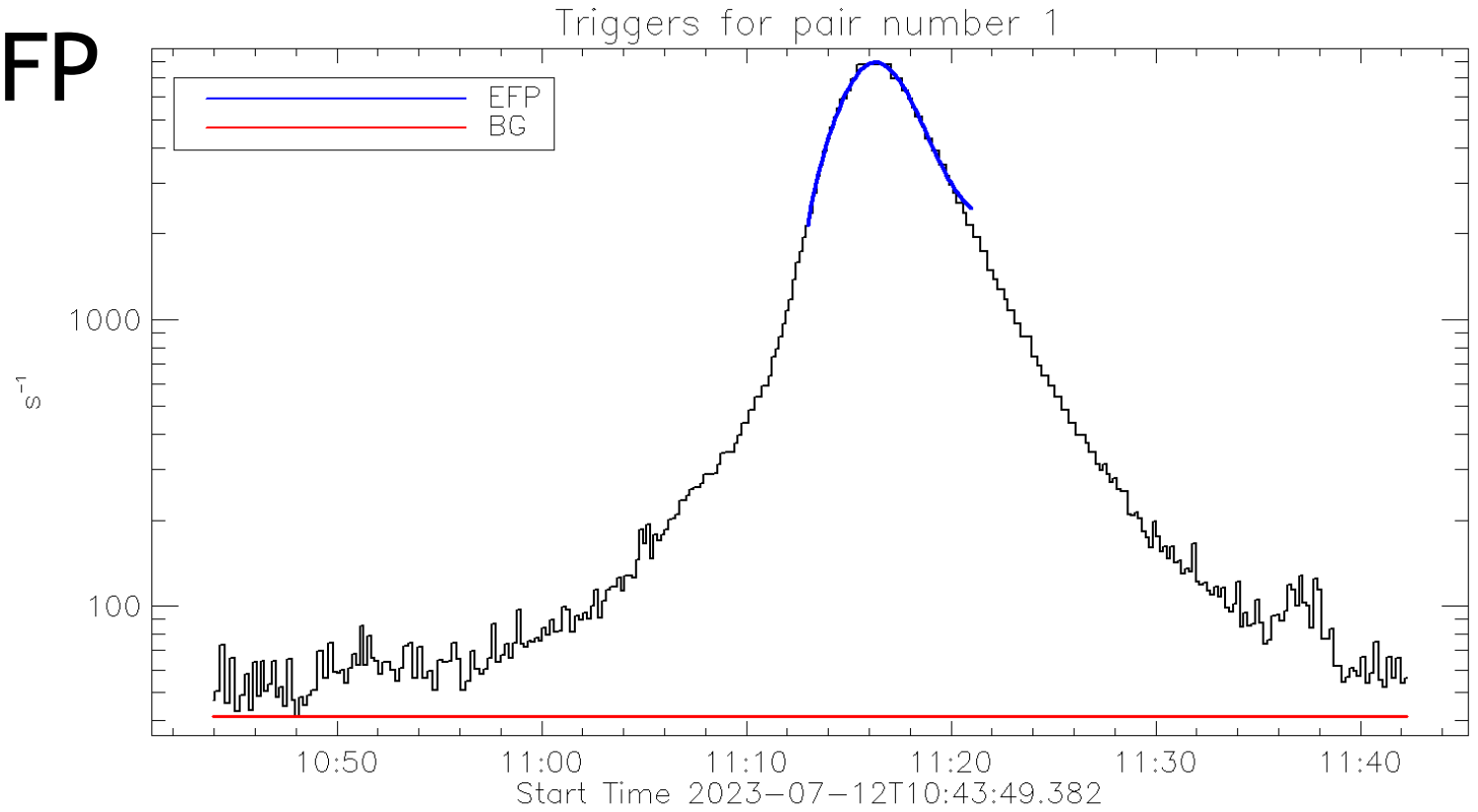


Summary

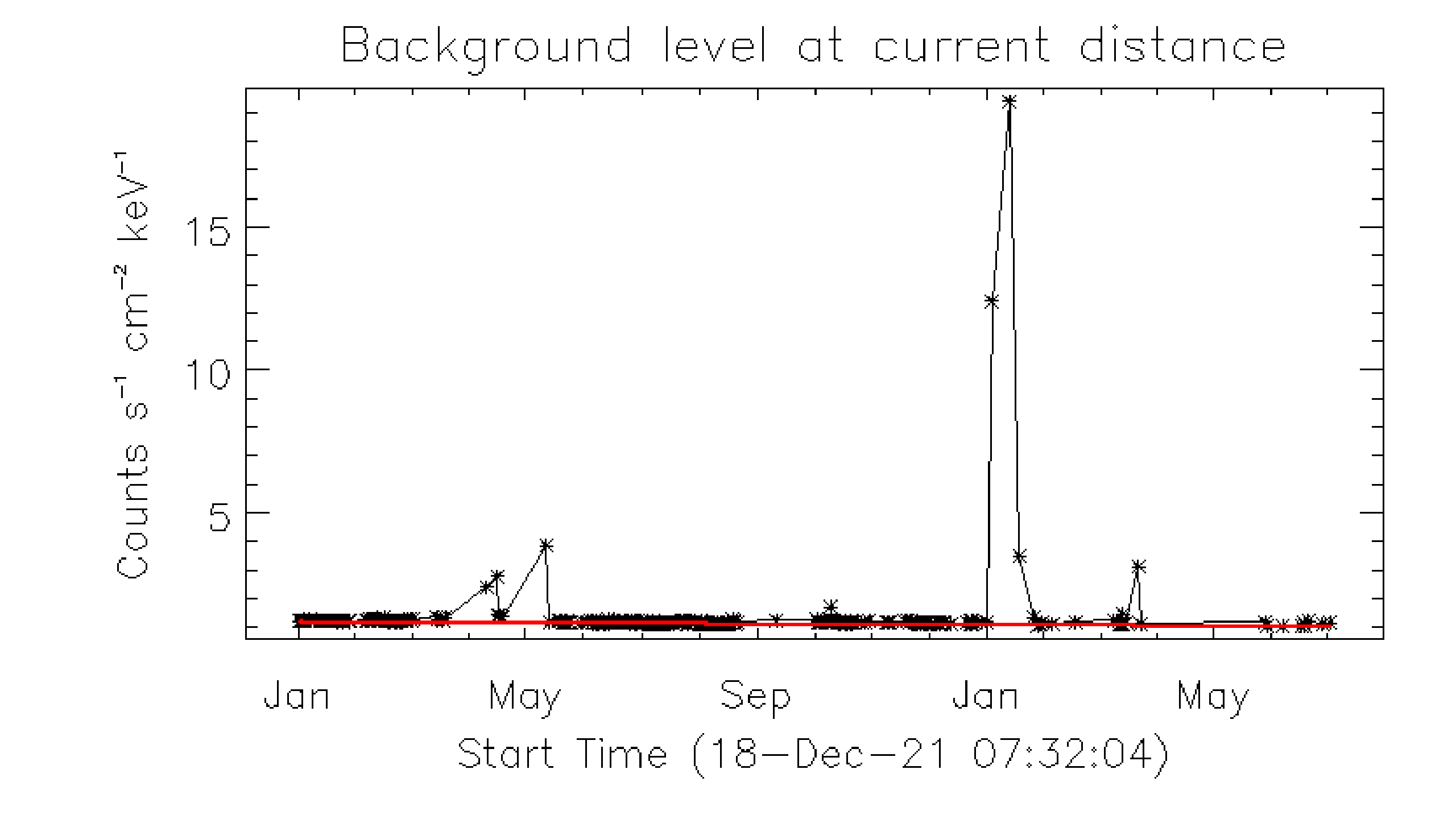
- Almost 30% of automatic found flares are EFP (Jan. 2022)
- Algorithm will search for flares from January 2022 to July 2023
- Simple flares (EFP) will be selected from found events to future work

Triggers fitted with EFP at 3/4 amplitude





Thank You for the attention


Background level at current distance
Counts s^{-1} cm^{-2} keV^{-1}
15
10
5
Jan
May
Sep
Jan
May
Start Time (18-Dec-21 07:32:04)