IBIS/INTEGRAL observation of the LMXB 4U 1812-12 in the ?-ray domain

Detection of its Hard X-ray tail and Type 1 X-ray bursts

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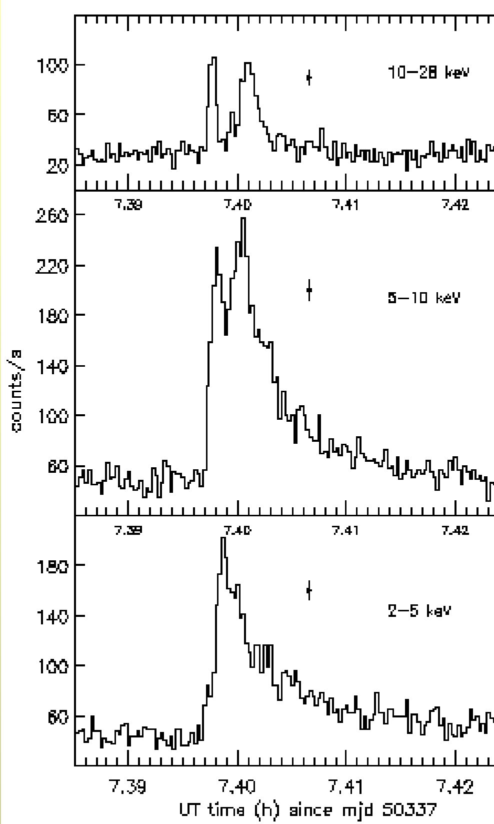
The source 4U 1812-12

- 4U 1812-12 was discovered with Uhuru satellite by Forman et al. (1976), while the first type 1 X-ray bursts were detected with Hacuko by Murakami et al. (1983). Afterwards, several X-ray bursts were detected from 4U 1812-12 with the WFC of BeppoSax by Cocchi et al. (2000). In most of this bursts, clear photospheric radius expansion due to Eddington-limited burst luminosity was detected, allowing to estimate the source distance to ~ 4 Kpc. The presence of bursts of this source established a neutron star as the compact object in 4U 1812-12, and the system to be a likely LMXB.



Cocchi et al. 2000.

- The continuum source emission was preliminary studied by EXOSAT below 20 keV (Warwick et al. 1988). Subsequently this source was detected in the hard X-ray range with BeppoSax and RXTE by Barret et al. (2003).

During 2000 April 20 to April 21, the BeppoSax spectrum (0.5- up 100 keV) was fitted by a black body or a multicolor disk black body plus Comptt component. The best spectral fit gave:

T0= 0.35 keV, KT_e = 36 keV with a very large error bars and t = 3.

Assuming the source at about 4 Kpc distance, the 1-200 keV luminosity was ~ $2 \cdot 10^{36}$ erg s^{-1} .

In 2003 Barret et al. said

"…the location of the source in the galactic plane, its perstistent intensity and hard spectrum mean that it will be repeteadly detected by the IBIS hard X-ray imaging instrument aboard INTEGRAL during its weekly scans. This will provide insights on the long term spectral evolution and timing properties of its hard X-ray tail."

Now……We have the results!

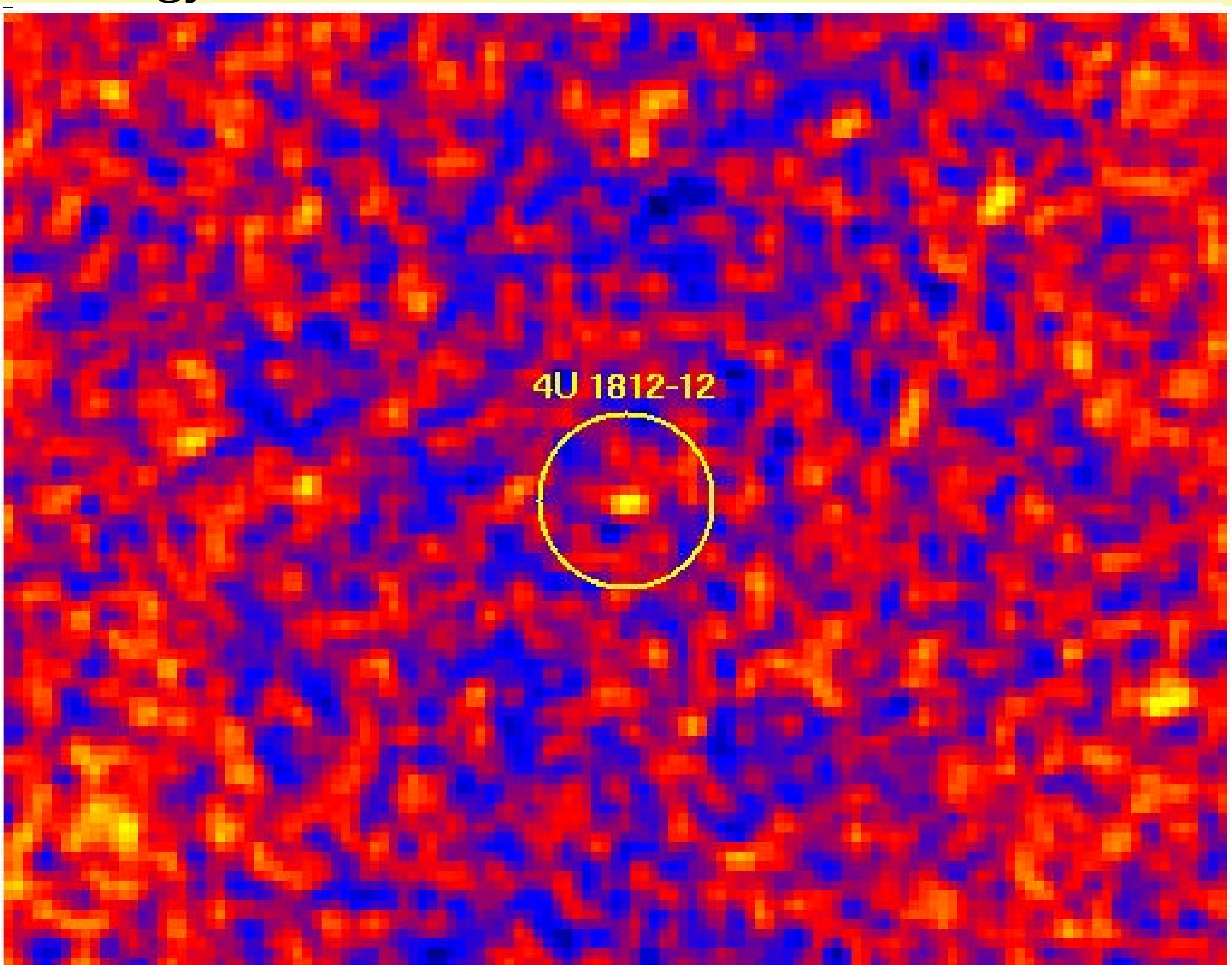
What we have done:

- We analaysed more than 1 year of observations.
- Temporal analysis of whole period of observation.
- Temporal behaviour of 4 bursts detected during the observations.
- Extracted the hard spectrum of the persistent emission.

Mosaic Images

The mosaic consists of 96 Scw images for a total of 174 ks (rev 55 to 122), in different energy bands.

120-200 keV

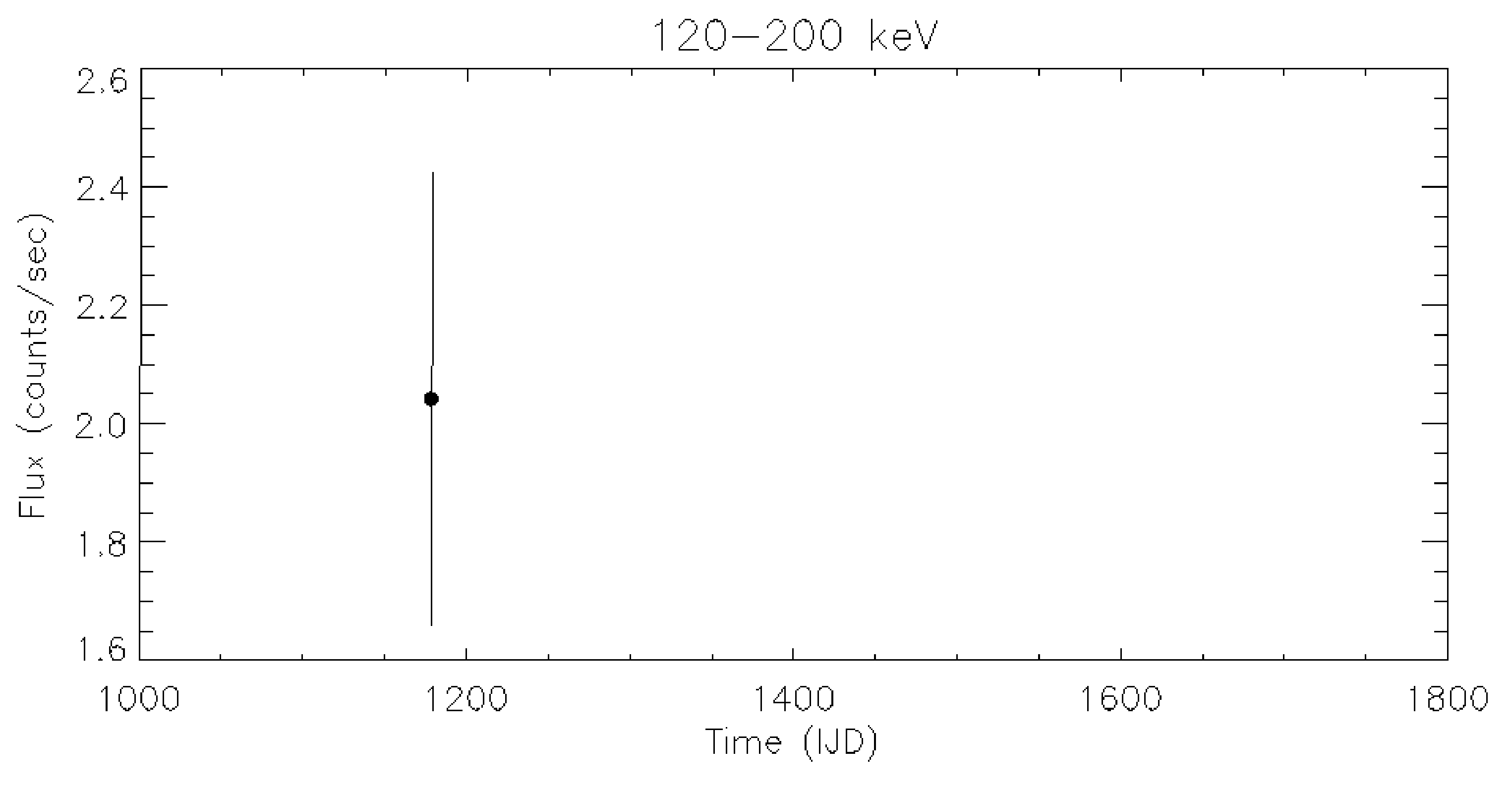


Temporal analysis

Period of observation: March 11th 2003 – October 20th 2004.

Light curves in 5 energy bands: 20-40, 40-60, 60-80, 80-120, 120-200 keV. With s > 3

Tempora bin = 1 Sc (~2200 s



The source shows a persistent flux of ~26 mCrab in the 20-40 keV bar

Type 1 X-ray bursts detection

During the observation period the IBIS Burst Alert System revealed 4 type 1 X-ray bursts:

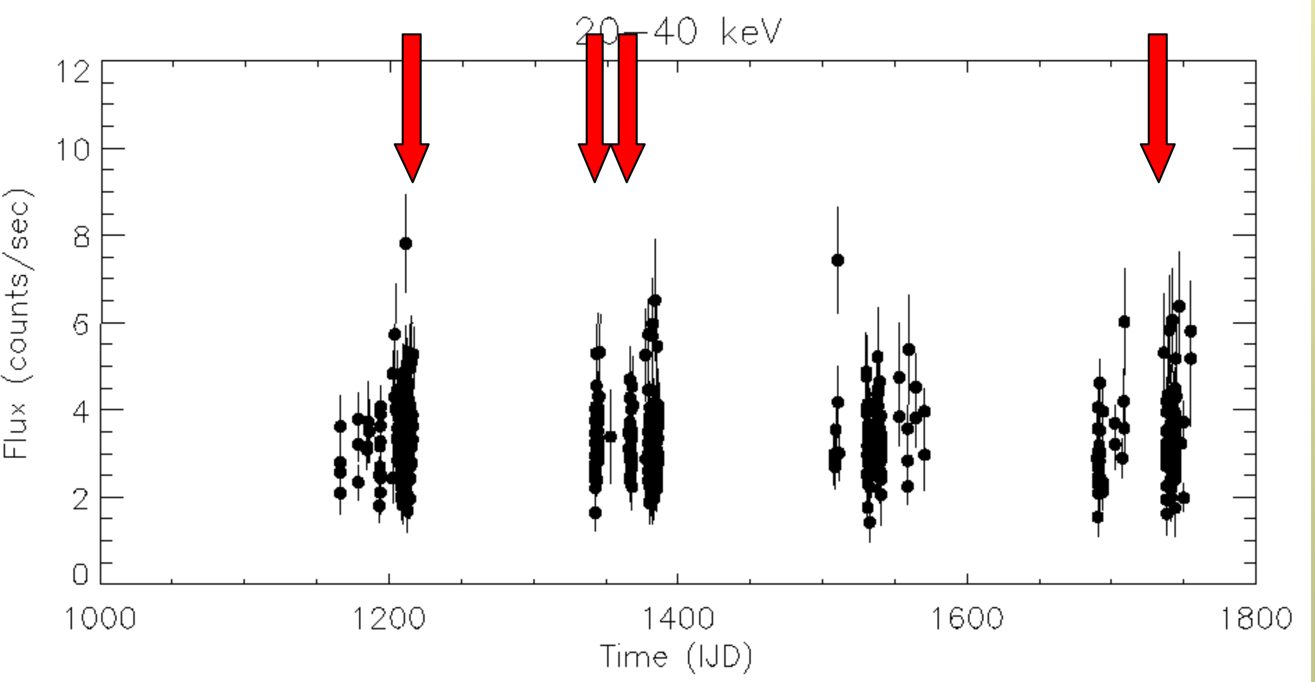
2003-04-25 UT 10:54:28 → during Scw 006401120010

2003-09-06 UT 00:23:49 → during Scw 010900410010

2003-09-27 UT 16:08:52 → during Scw 011601000010

2004-10-04 UT 03:15:53 → during Scw 024100290010

Where are the bursts in the 20-40 light curve?



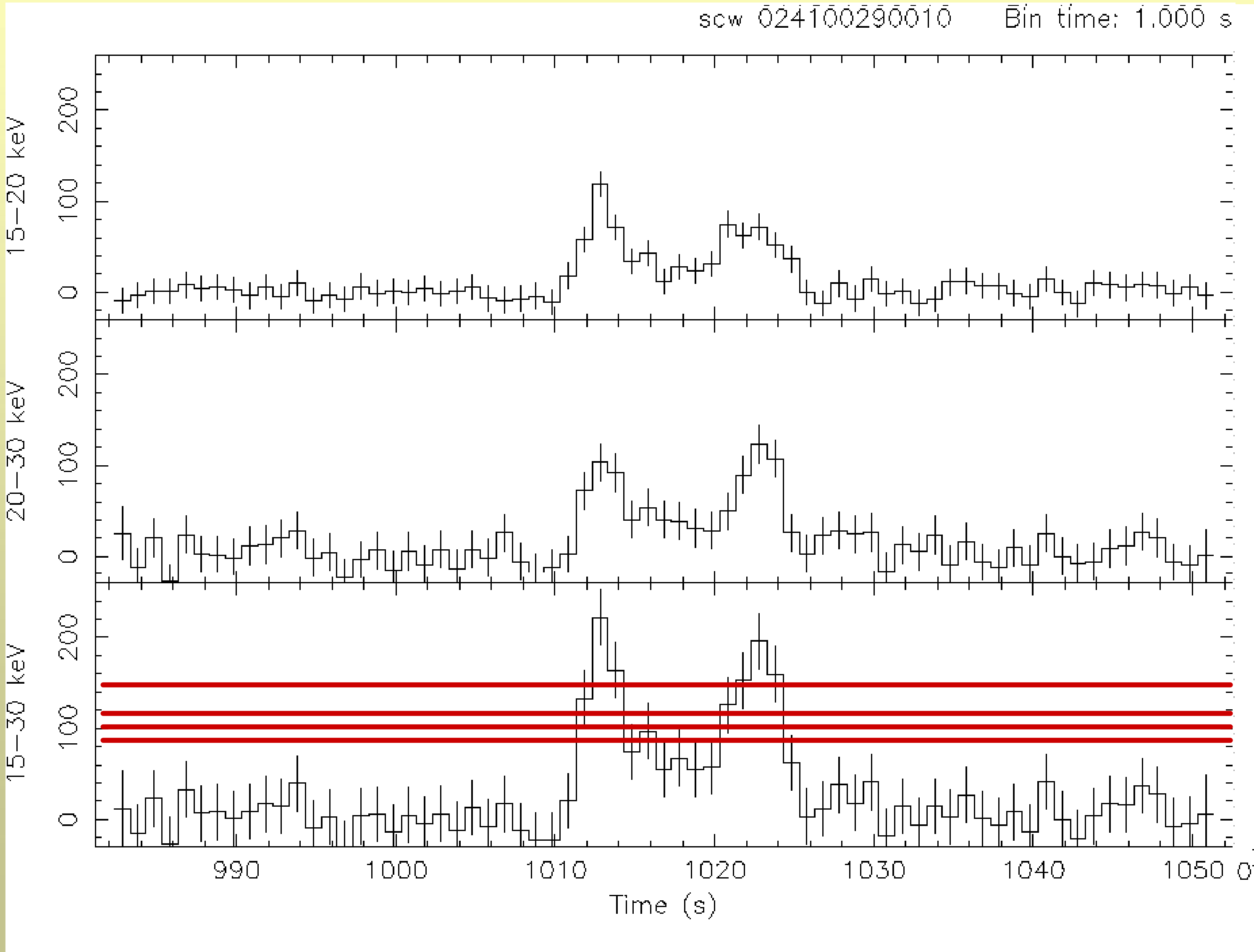
Obviously in t
light curves with b
temporal of 1 Sc
the Bursts are n
visible, so lig
curves with
smaller temporal b
is necessary.

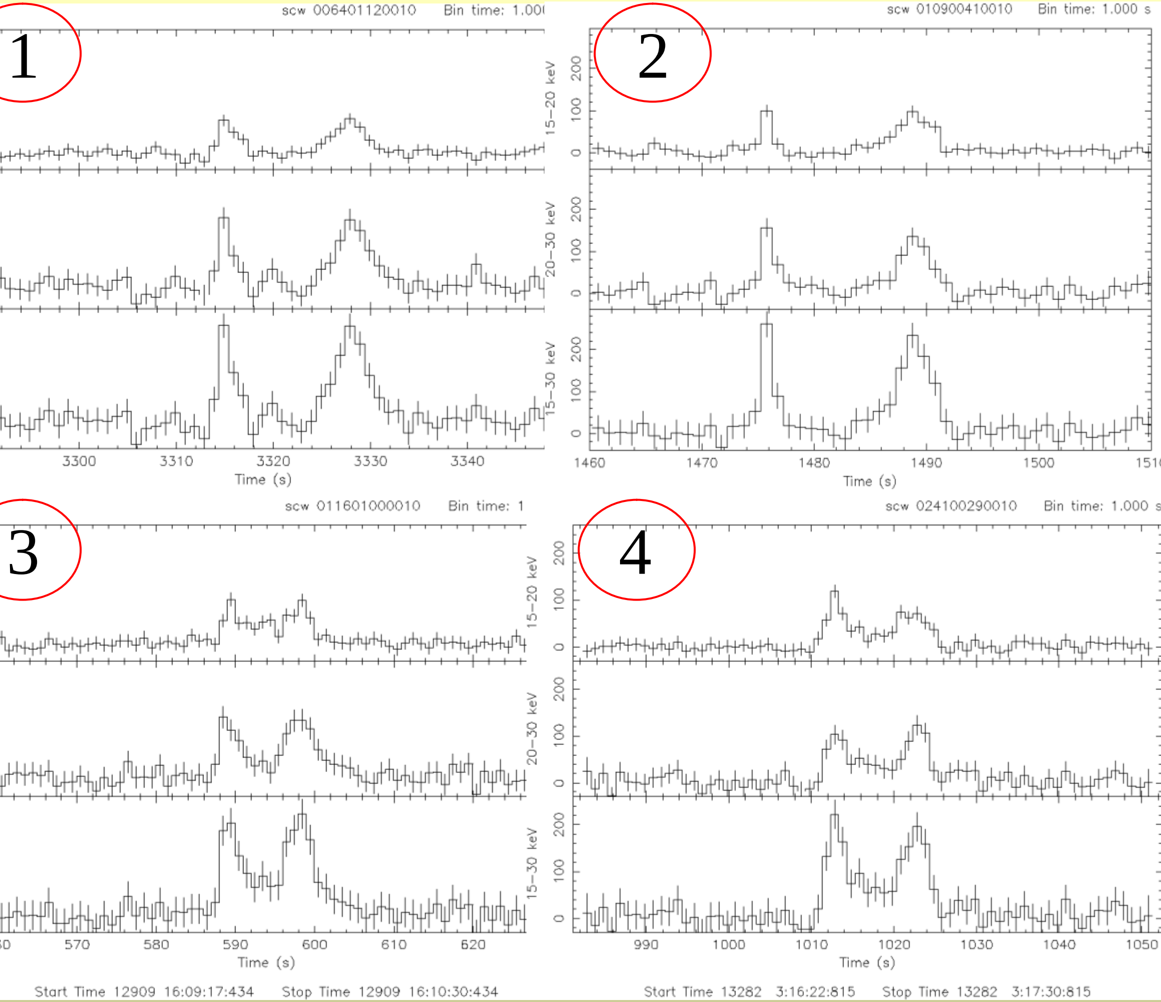
Type 1 X-ray bursts detection

We made the light curves whit a temporal bin of 1 second in 3 energ
bands.

004-10-04

Flux Pick:
220-275 ct/s





Note that:

1) It's evident the high-energ
   double picked profile.
2) Fast rise time about 1 s.
3) The structure of the bursts
   are not precisely the same.

Seem to be a similarity betwe
Burst 1-2 and between burst

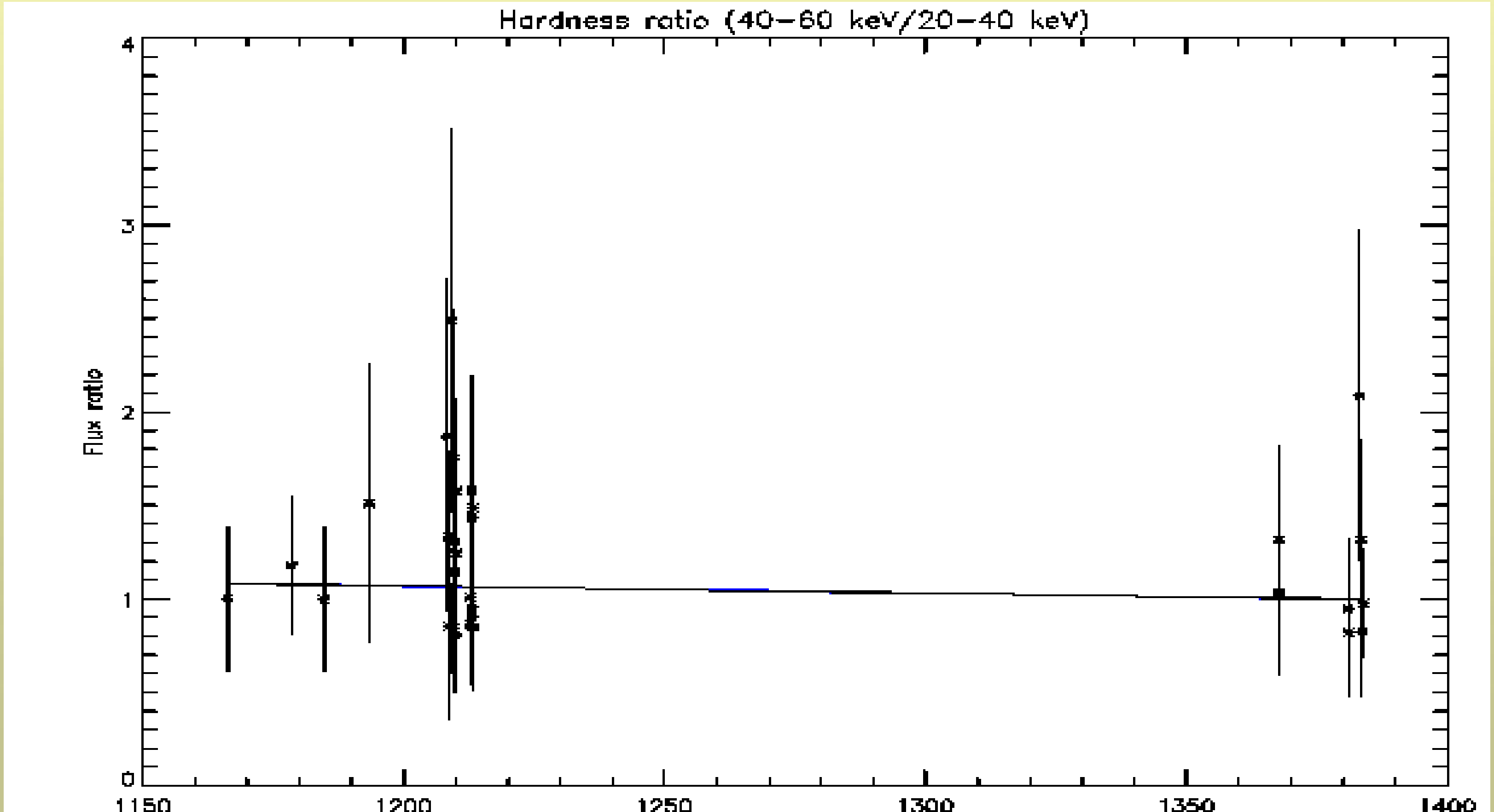
Burst	Duration	? t
1	20 s	12 s
2	18 s	12 s
3	19 s	8 s
4	16 s	9 s

Why?

The first and second burst are lickely more energetic, possibly due to more H available at ignition time.

Spectral analysis

No spectral change is visible so we can add the spectra of all pointings (a total of 93 spectra, ~122 Ks).
The flux source shows a persistent behaviour in different energy bands.

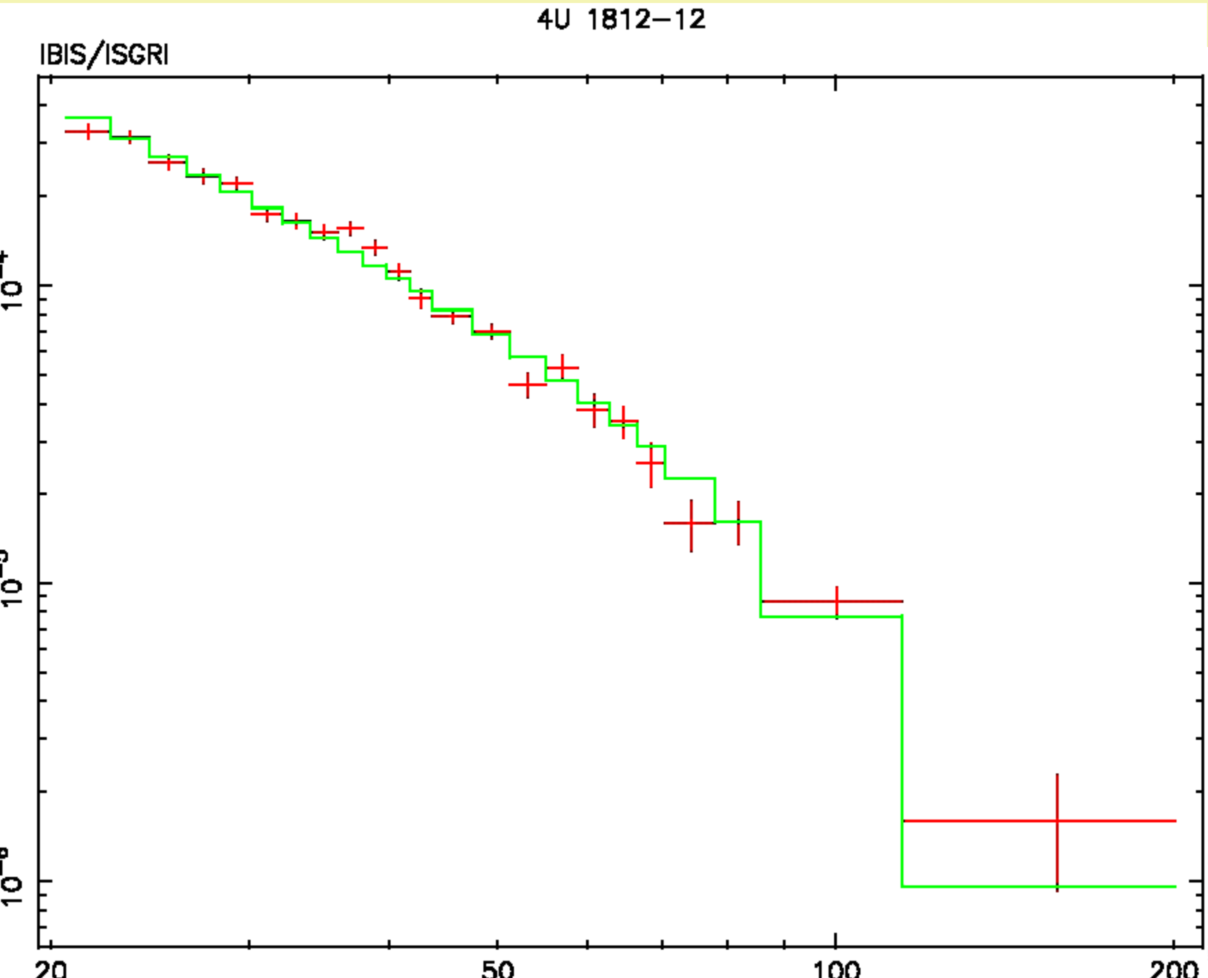


Spectral analysis

The spectral model that better fit the data is the Comptt model.

The 20-200 keV flux is F=4.25·10^{-10} erg s^{-1} cm^{-2} (~ 24 mCrab).

Assuming a distance of 4 Kpc the luminosity is L=1·10^{36} erg s^{-1} (~1% L Edd).



Parameter	Comptt
T0 (keV)	0.37
KT_e(keV)	17 .4 $^{+2}_{-3}$
t	2 .3 $^{+}_{-}$
$?_{rid}^{2}$	1.41

With systematic error = 0.05

Interpretation and conclusion

- We confirm 4U1812-12 is a high energy emitter (up to 200 keV)
- The source is a persistent ($F=4.25 \cdot 10^{-10}$ erg s^{-1} cm^{-2}), low luminosity (1% L Edd) NS-LMXB, with no evident spectral variability during the observations.
- The average 20-200 keV spectrum is consistent with Comptonised emission (KT_e =15-20 keV)
- According to the standard model of Type 1 X-ray bursts, the observed (Eddington-limited) events are likely He-triggered bursts in a mixed H-He environment.
- Slightly different H concentration (and/or burning geometry) could explain the observed differences in the burst profiles.

Future target

- Spectral analysis of the data below 15 keV whit JEM-X.
- Detection of future bursts from 4U1812-12 to analyse the profile.
- Spectral analysis of the bursts.

Moreover…… study other burster sources.