Cross calibration with Anti-Coincidence System of Spectrometer on INTEGRAL (ACS SPI)

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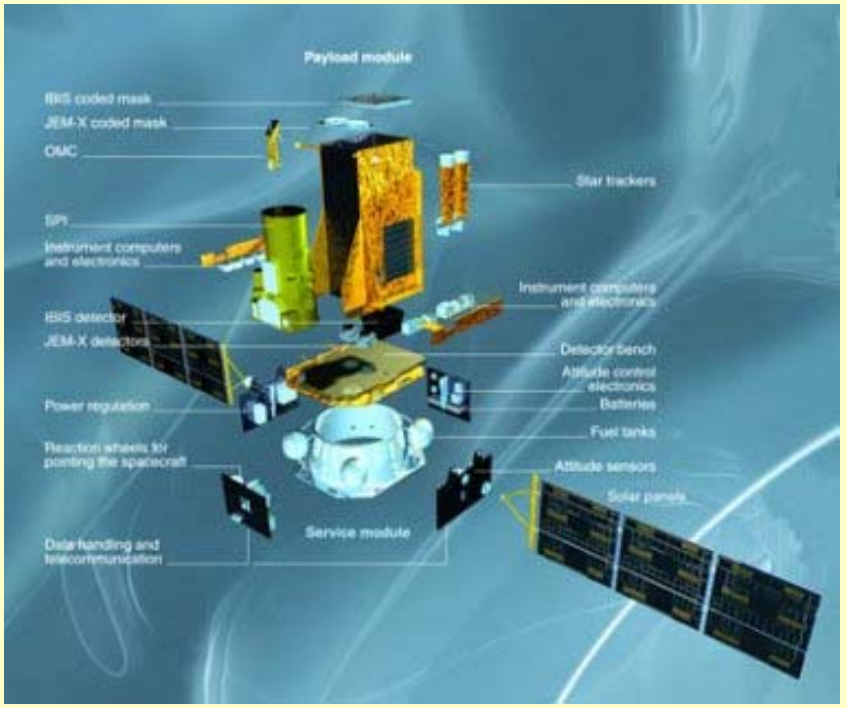
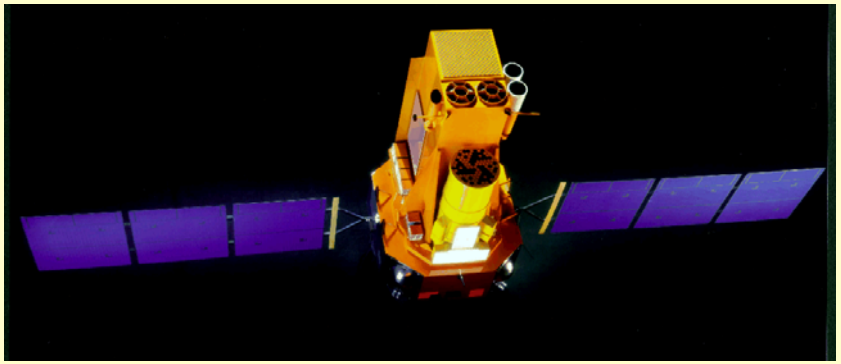
INTEGRAL

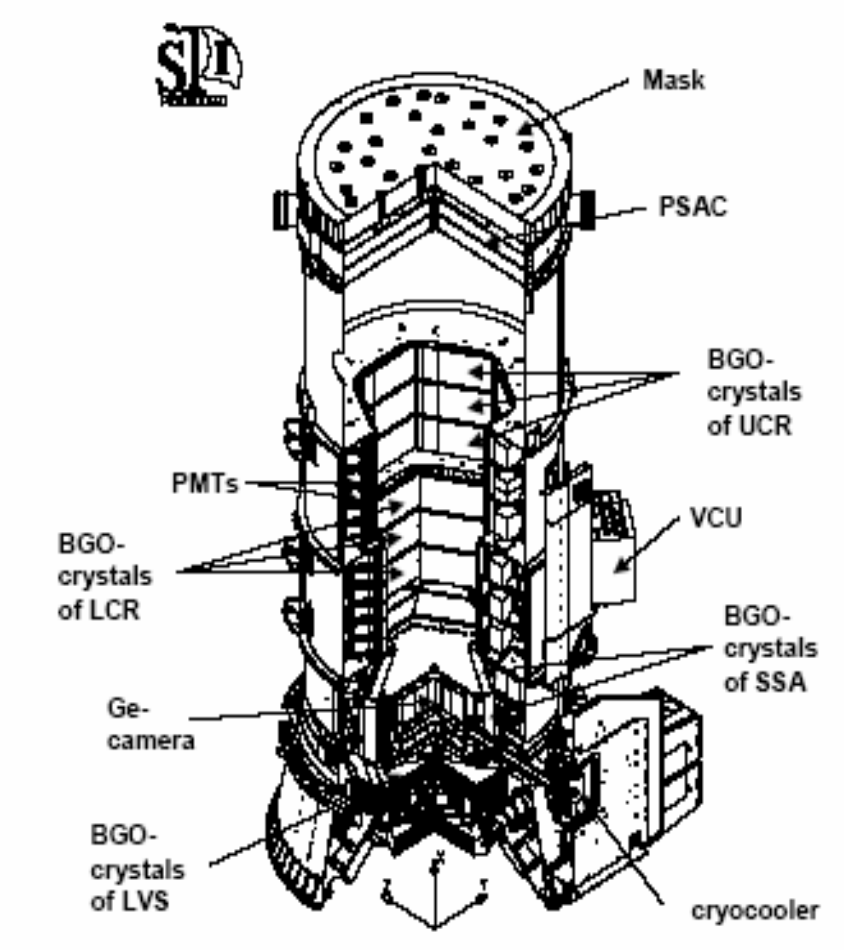
- INTEGRAL is a European (ESA) Gamma-Ray Observatory Satellite Mission for the study of cosmic gamma-ray sources in the keV to MeV energy range.
- INTEGRAL has two main instruments, the Imager "IBIS" and the Spectrometer "SPI".
- It was launched on 17th October 2002 into its 72 hours (85% out of the radiation belts) eccentric operational orbit with an apogee of 153600 km and an inclination of 52.5 degrees. It will be operated till at least 2012.
- The solar event of 2003 Oct 28 (Gros, M., et al., 2004)



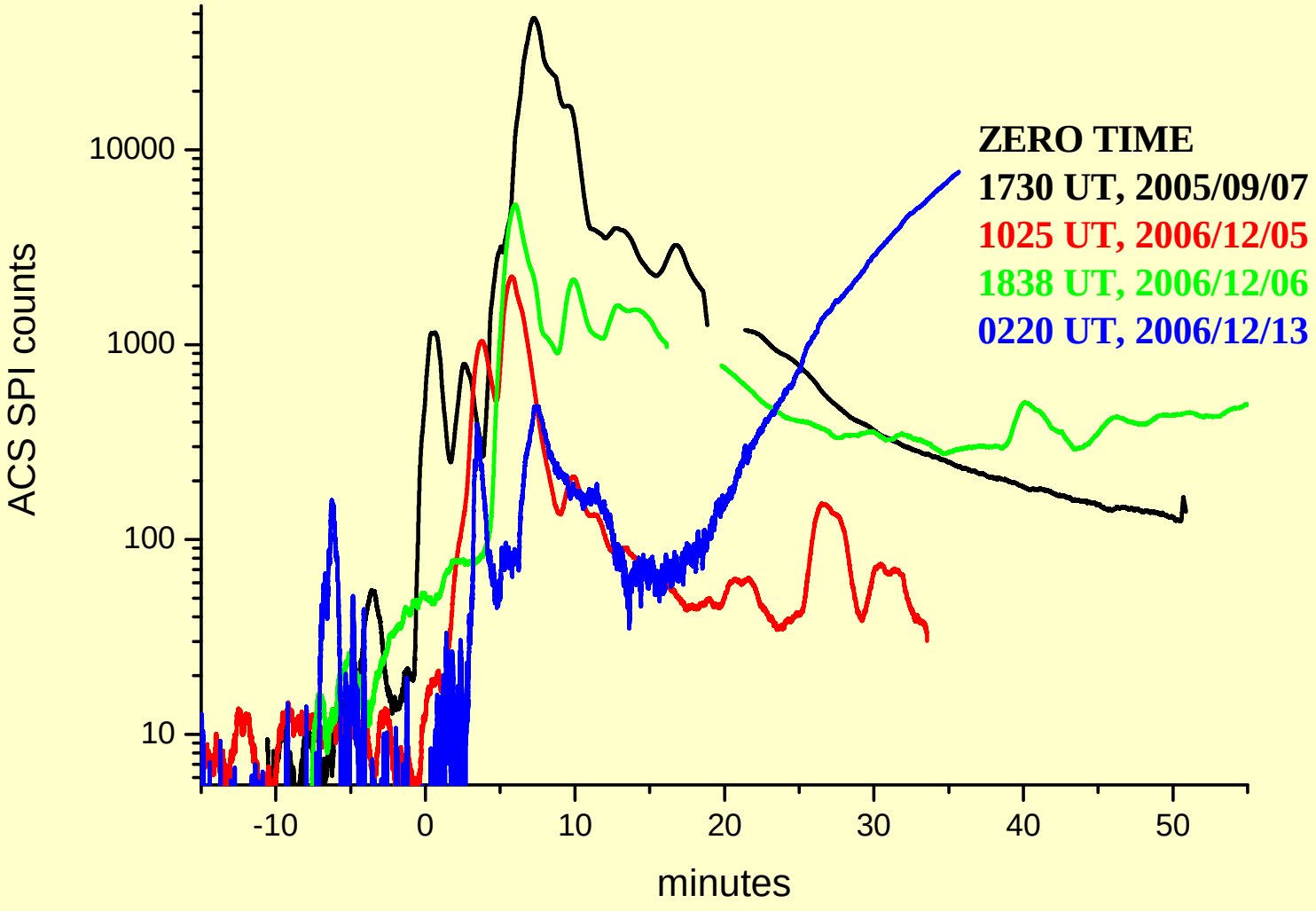


ACS SPI

- The anti-coincidence system1 of SPI consists of 91 Bismuth Germanate (BGO) crystals with a total mass of ***512 kg***. The thickness of the individual crystals ranges from 16 to 50mm. They are positioned in two rings (the upper and lower collimator ring) whose axes are along the viewing direction of the spectrometer, between the coded mask and the detector plane of SPI; in addition, there are side-shield and rear-shield assemblies.
- The ACS SPI provides a quasi omni directional field of view with a large (***0.3m²***) effective area for the detection of gamma-rays. The burst data consist only of the total event rate from all the crystals with a time resolution of ***50ms***.
- The only spectral information which is avaiable is that the energy of the interacting photon ***must be above the threshold energy of 80 keV*** Due to the different properties of the individual crystals, this energy threshold can only be estimated very coarsely (A. Rau, et al., 2005).
- ***>100 keV***, (Gros, M., et al., 2004)

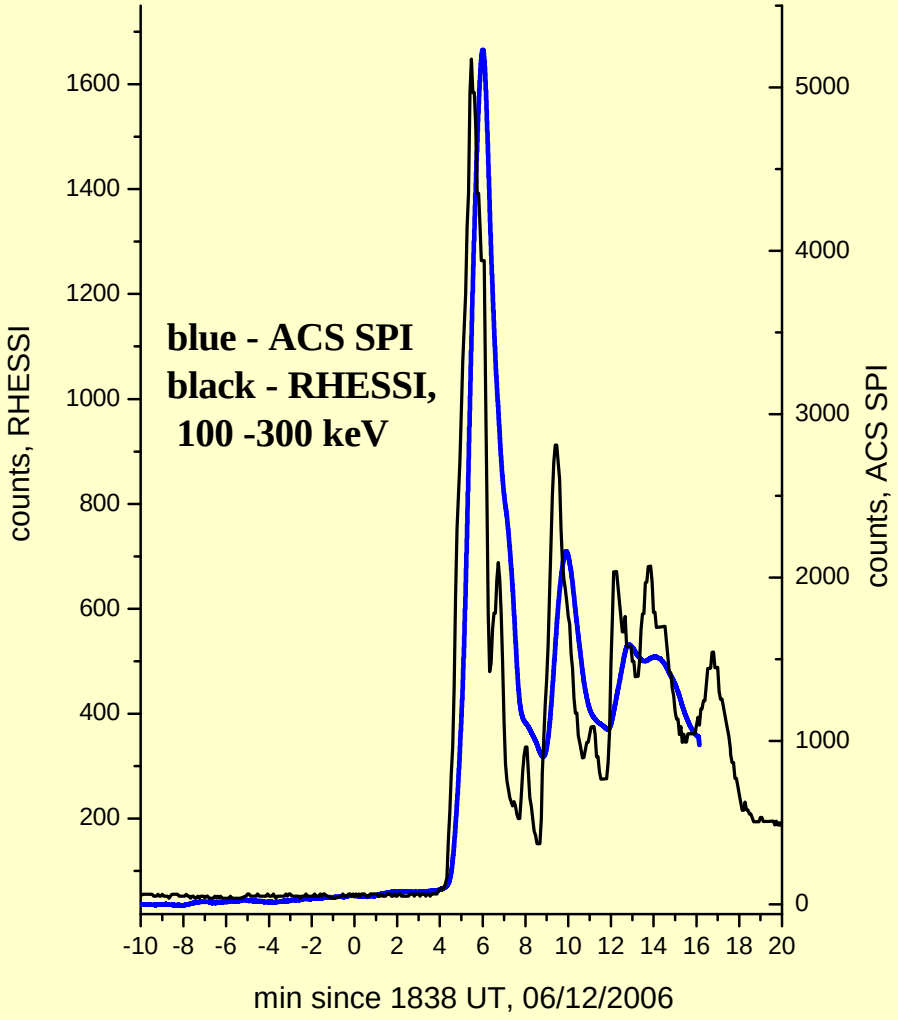


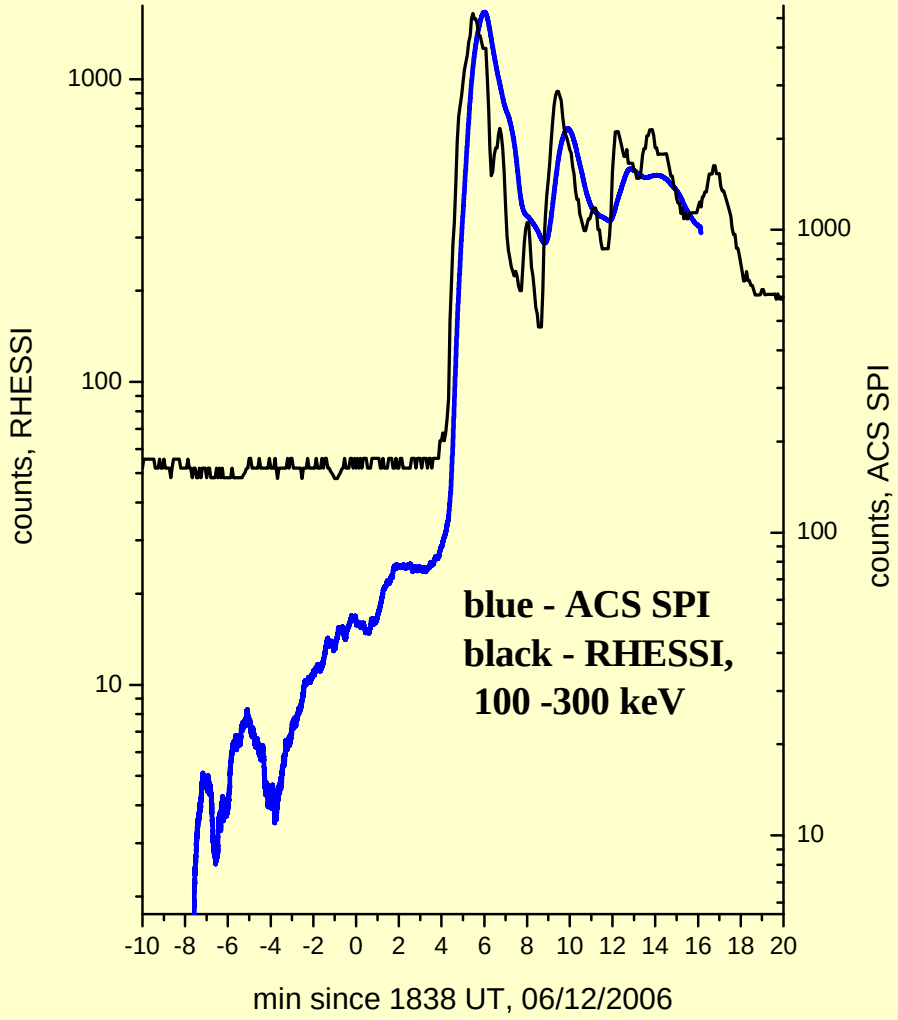
ACS SPI observations



Running average of 1000 points (50 ms*1000=5 s)

December 6, 2006

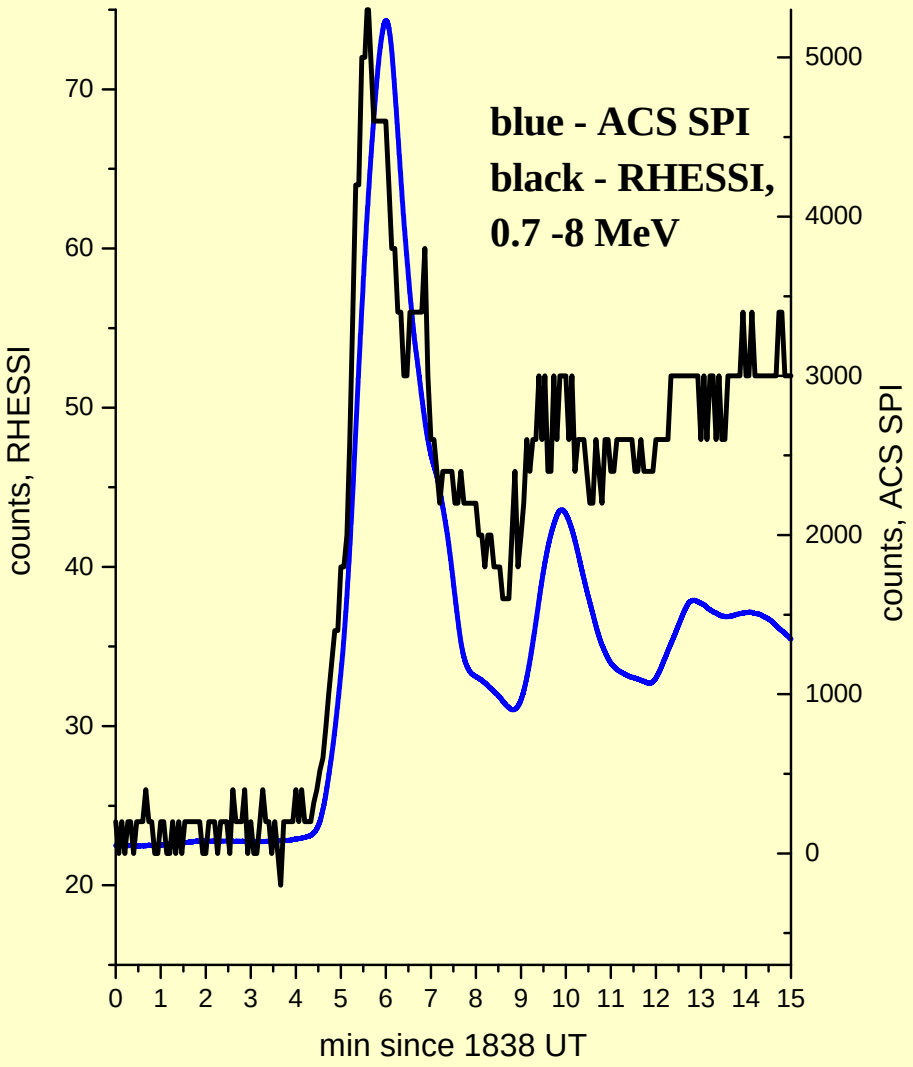




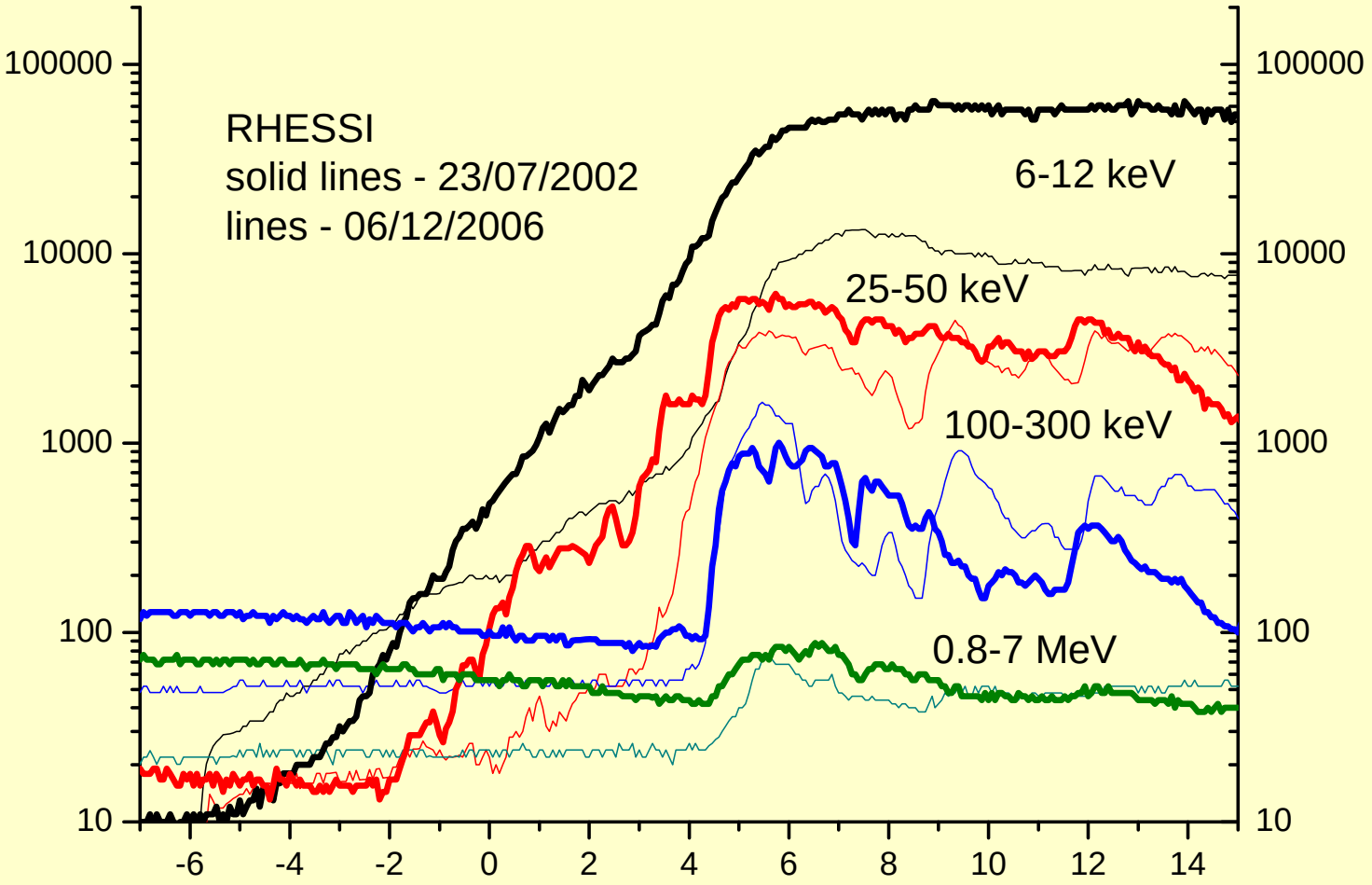
•ACS SPI was the only instrument with necessary statistical accuracy for observations of HXR emission during impulsive and late gradual phases of the 2006 December 6 event.

December 6, 2006

- Maximums of the RHESSI 100-300 keV curve were observed earlier than the corresponding ACS SPI count rate peaks.
- A coincidence is better comparing the ACS SPI count rate with count rate of the RHESSI 0.8 – 7 MeV for the first peak, but the RHESSI statistics is poor during the decay phase.
- Photons of >1 MeV energies are mainly registered by ACS SPI (at least during the 2006 December 6 event).
- ACS SPI was the only instrument with necessary statistical accuracy for observations of the gradual >1 MeV gamma-emission during the 2006 December 6 event.



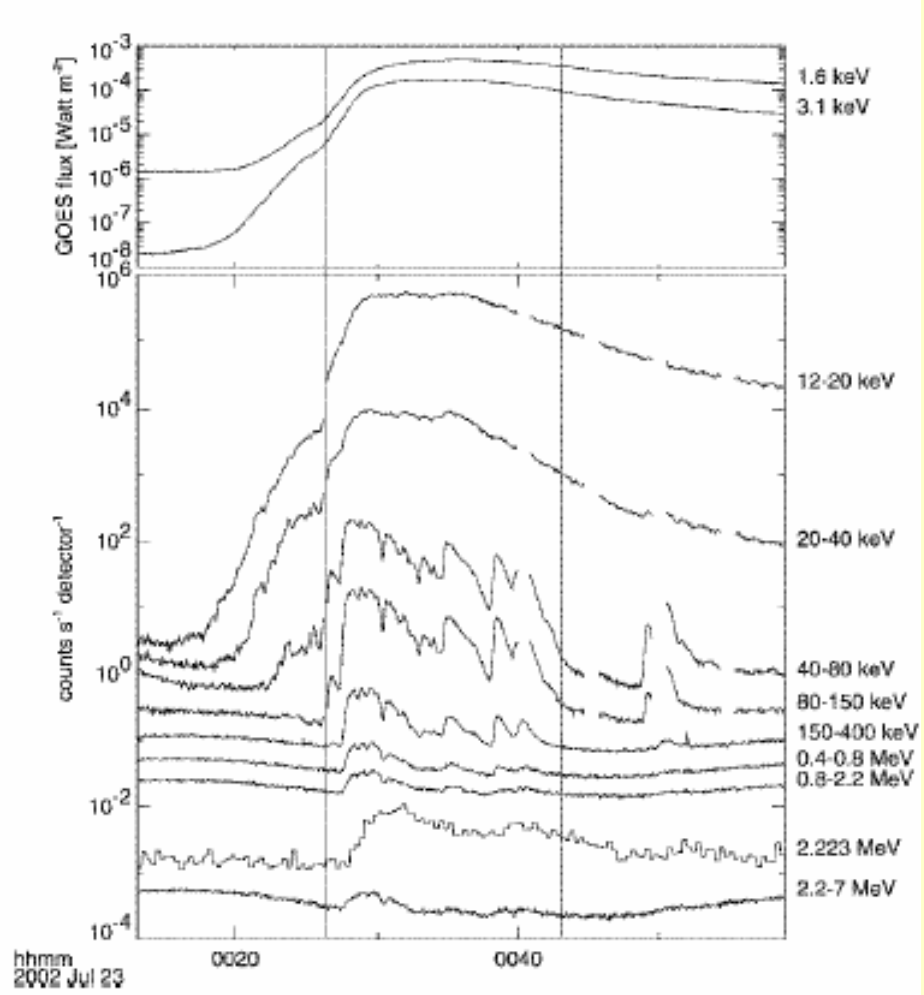
23.07.2002&06.12.2006



- Non-thermal emissions of the 2002 July 23 and 2006 December 06 events are very similar!
- The 100-300 keV RHESSI channel was under background till +5 min.
- Electron spectrum has became harder between 4-5 min!

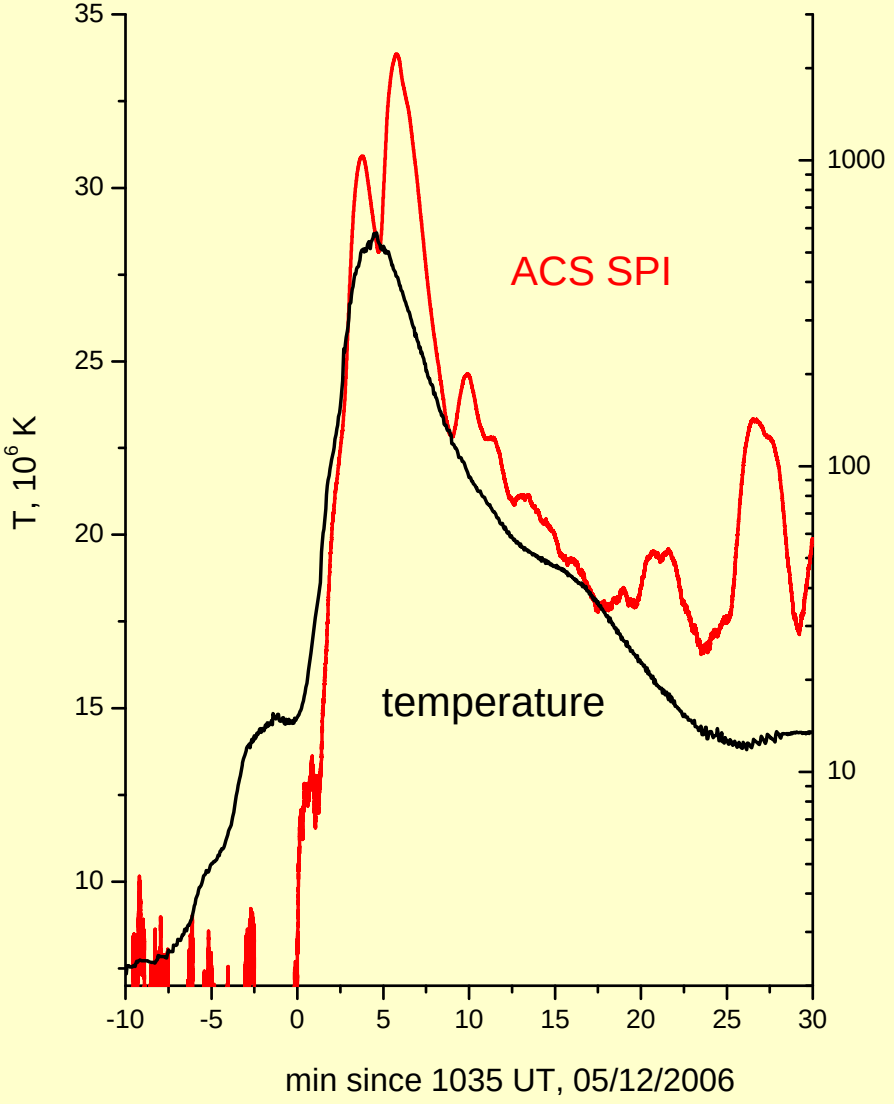
2002 July 23 (Lin et al., 2003)

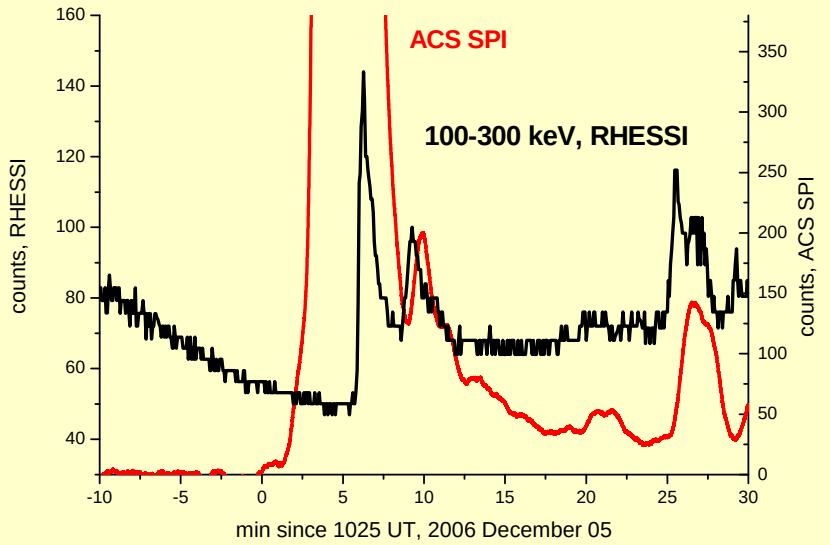
- In the initial rise, a new type of coronal HXR source dominates that has a steep double-power-law X-ray spectrum and no evidence of thermal emission above 10 keV, indicating substantial electron acceleration to tens of keV early in the flare
- An intense impulsive phase with continuum and gamma-line emission extending up to greater than ~7 MeV lasted 16 min from ~00:27 to ~00:43 UT.

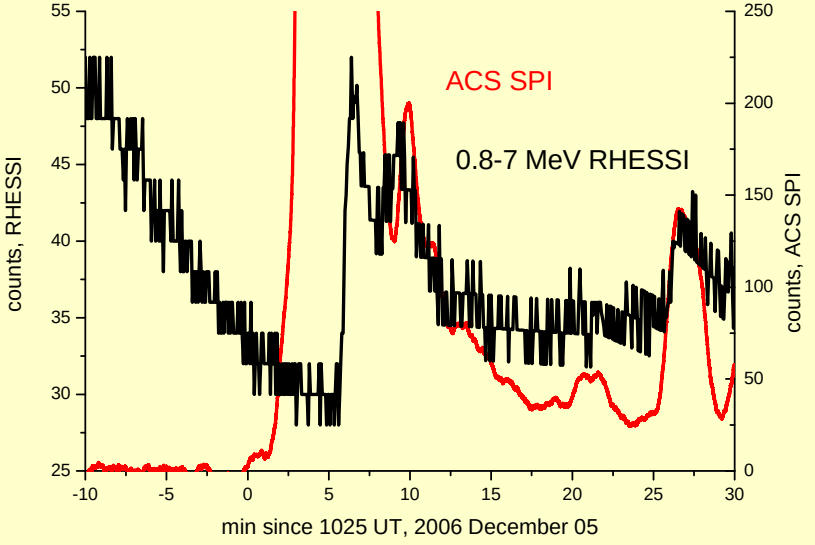


RHESSI

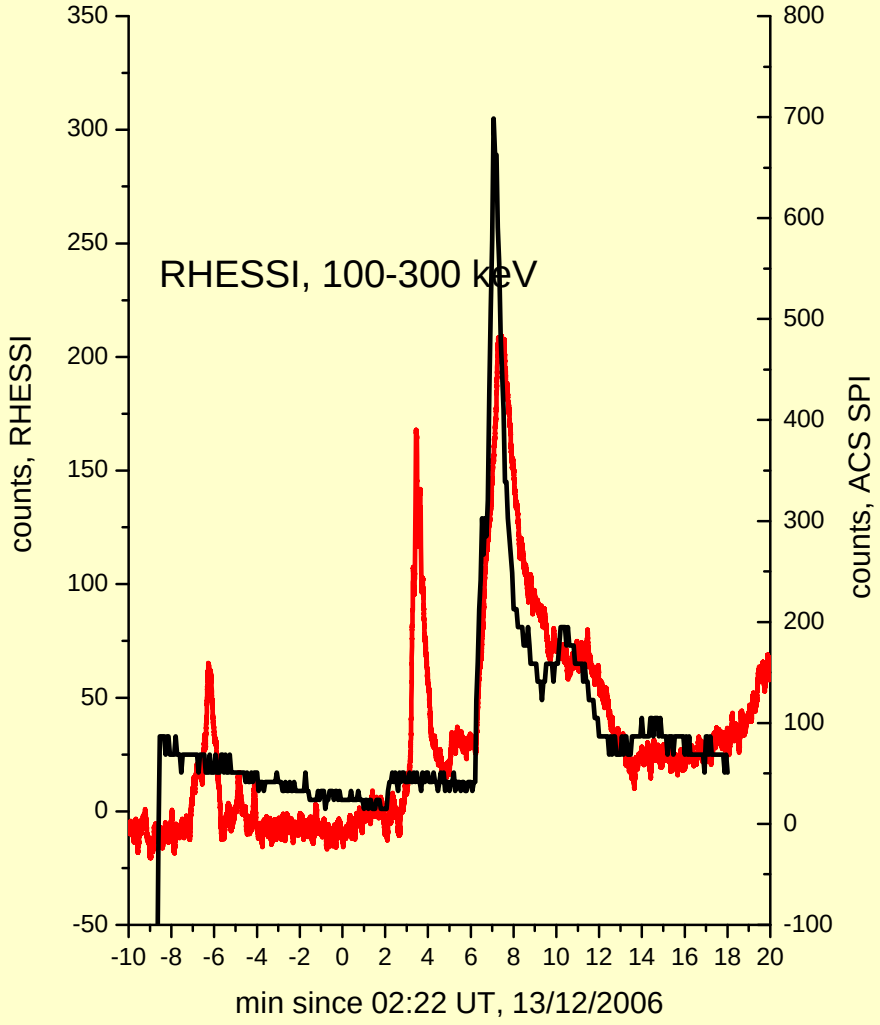
2006 December 5

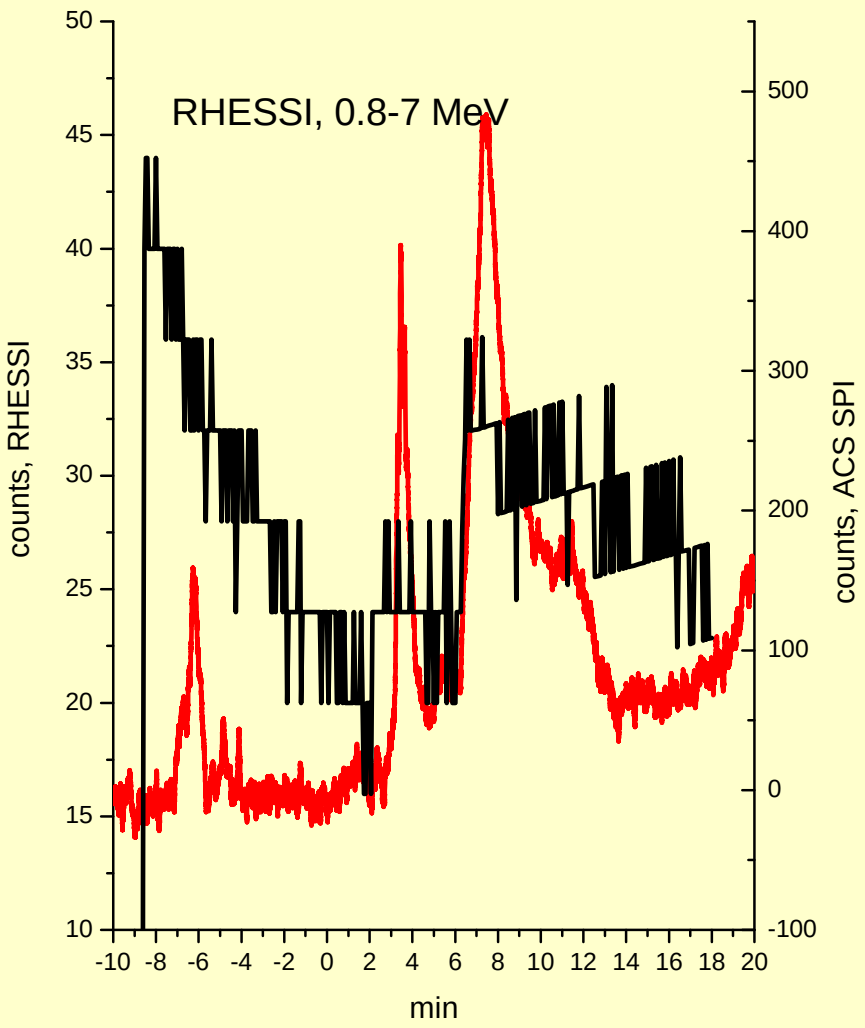




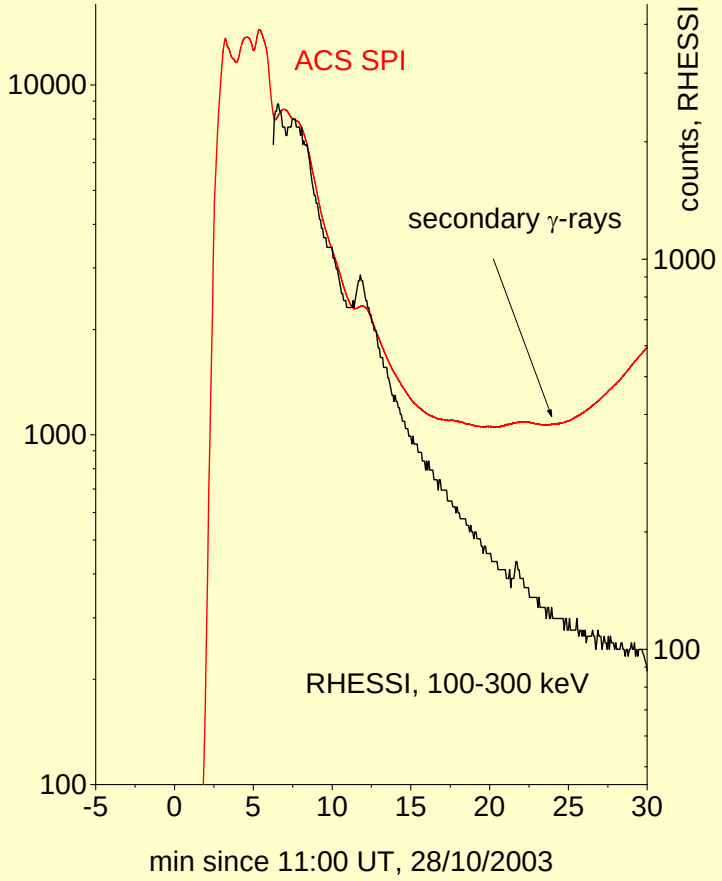


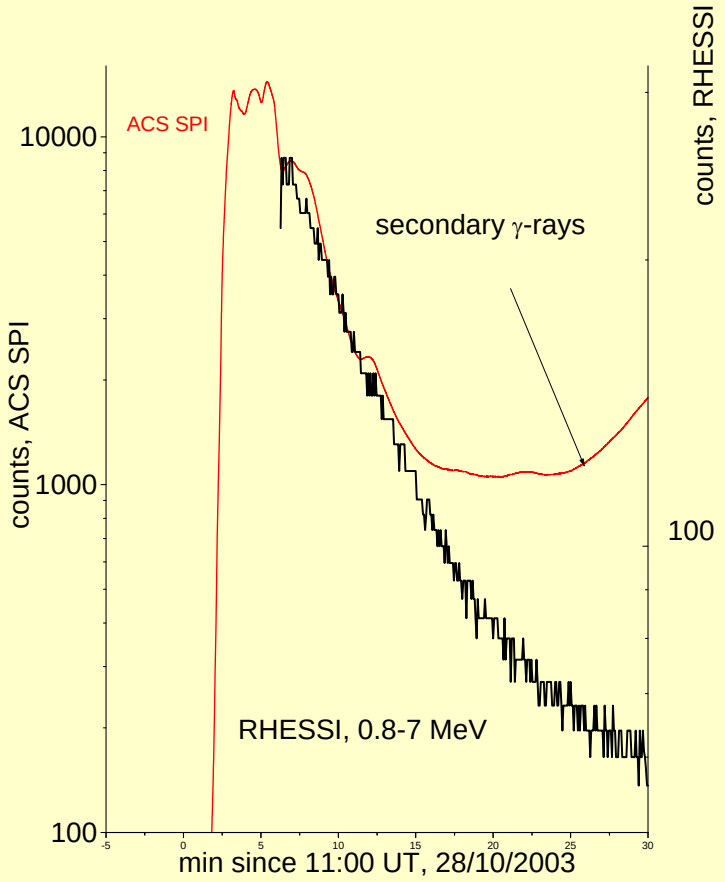
2006 December 13





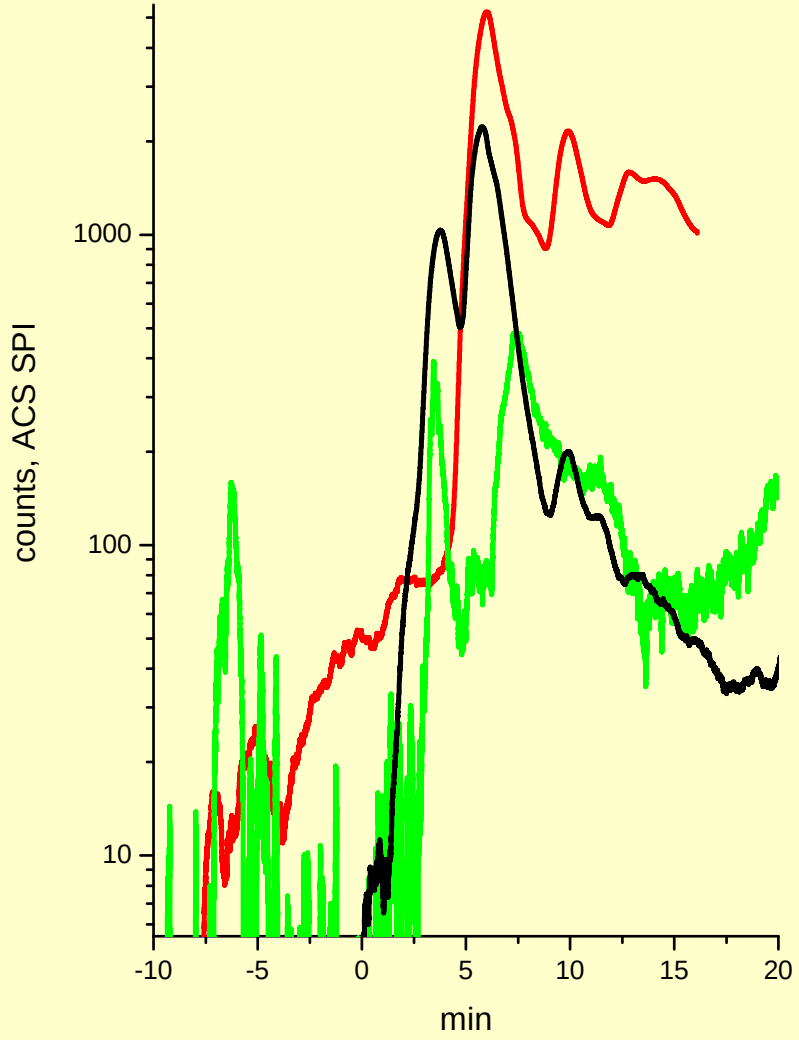
2003 October 28

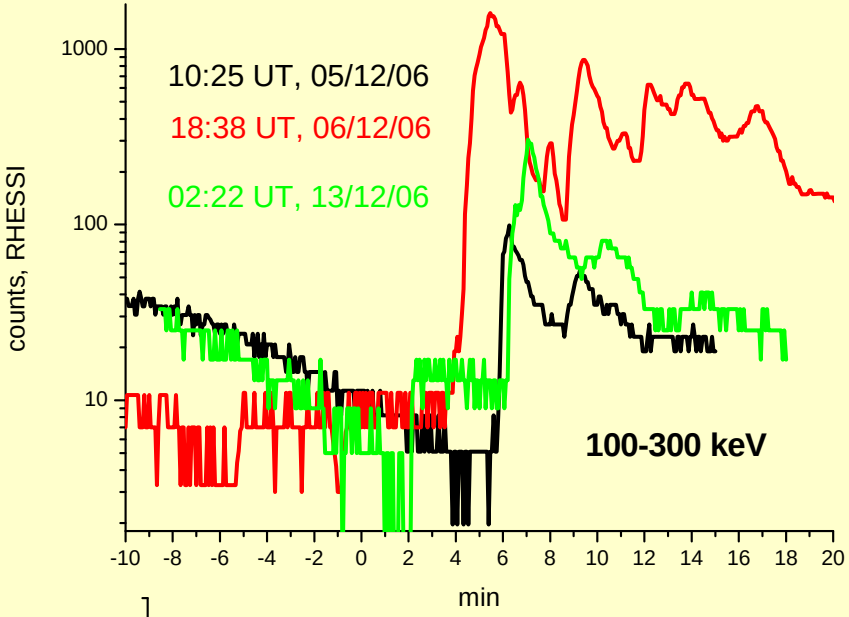


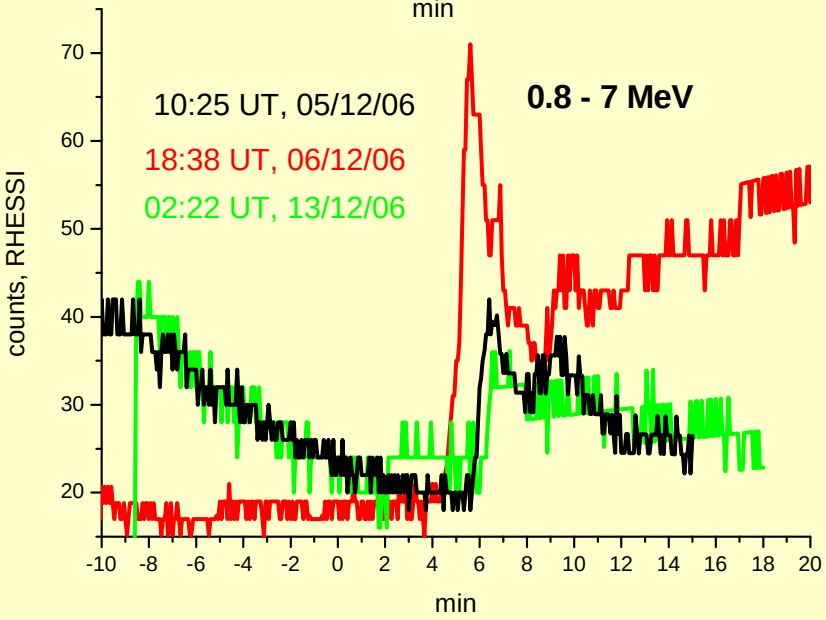


RHESSI is in the magnetosphere, high cut-off rigidities

Three flares







CONCLUSION

- The mean energy registered by ACS SPI ~ 1 MeV
- The statistics accuracy of the RHESSI detector is not sufficient within ranges of hundred keV and several MeV during pre-flare and gradual phases.
- The new generation of gamma-ray and charged particles detectors with low background and high statistics mounted aboard spacecrafts in L1-L2 or high elliptic orbits are necessary to answer the basic questions of solar flare physics.
- **Unfortunately a launch of such spacecrafts is not scheduled.**