IUG meeting

ESTEC, 22 January 2013

Analysis of INTEGRAL's Earth observations of 2012

Marc Türler

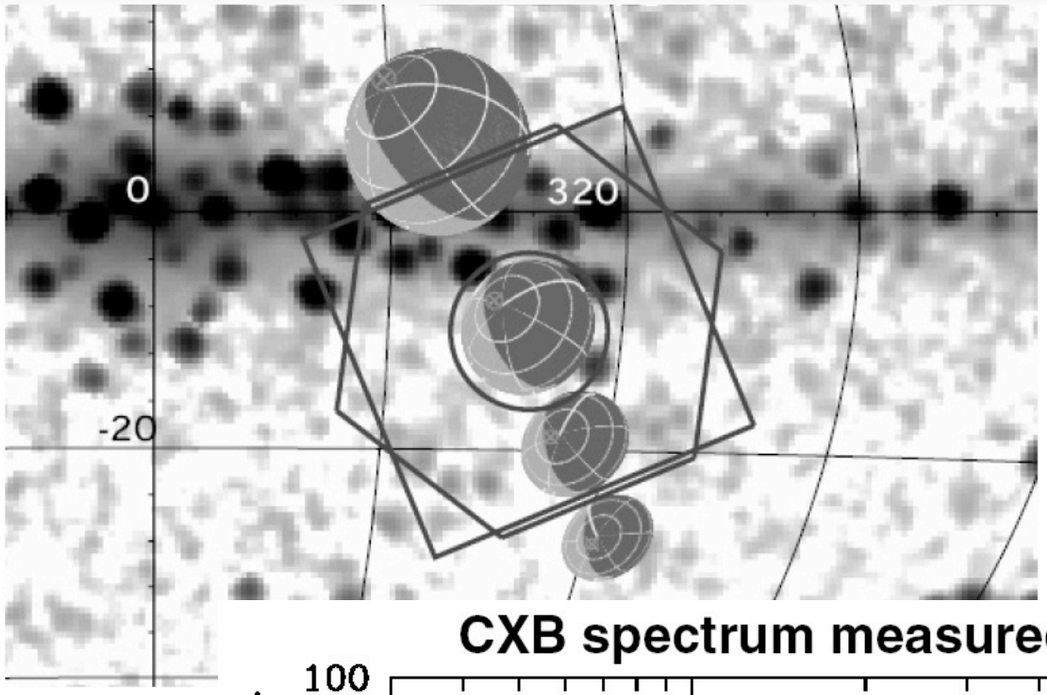
Nicolas Produit, Lucia Pavan, Carlo Ferrigno & Pol Bordas

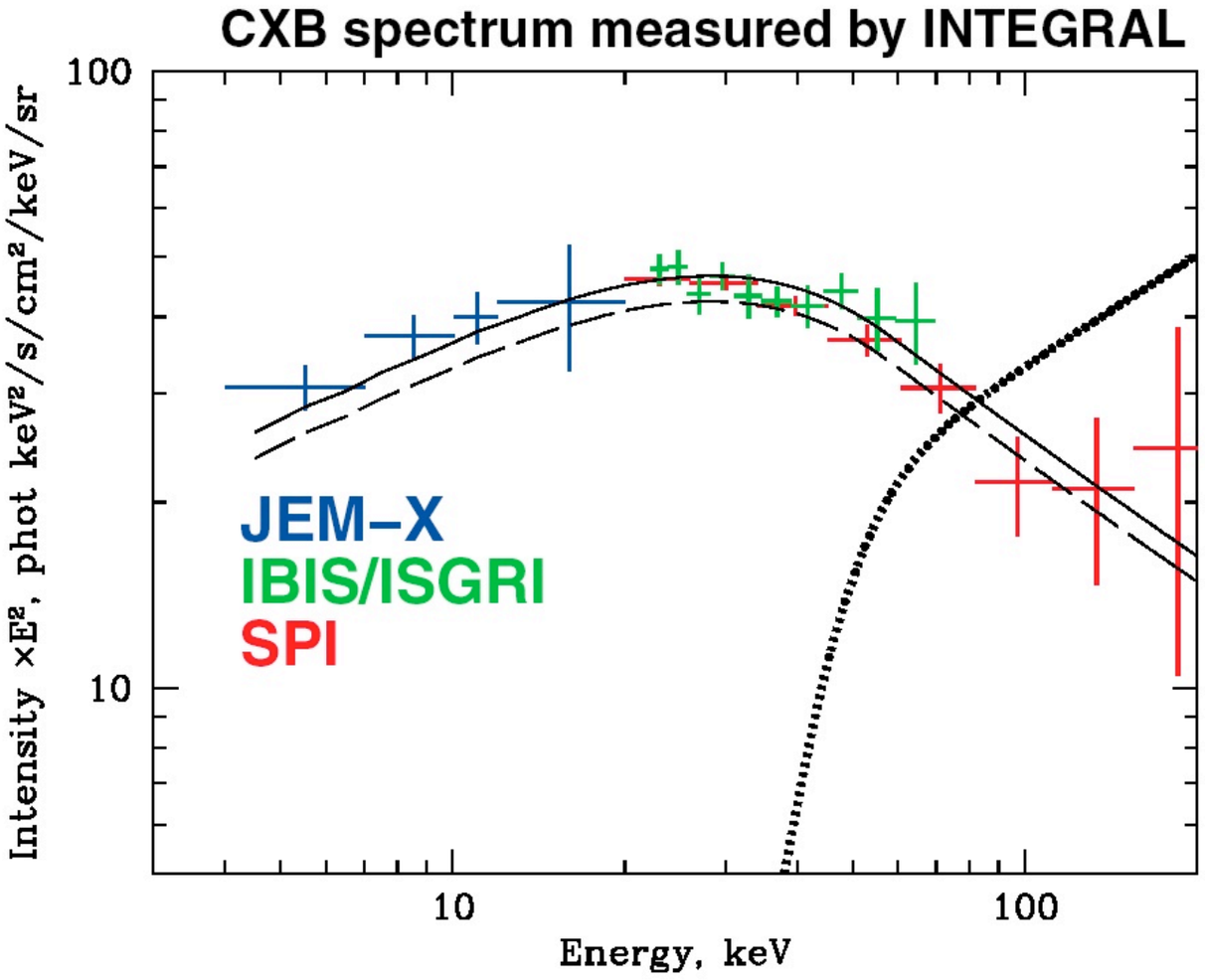
ISDC Data Centre for Astrophysics

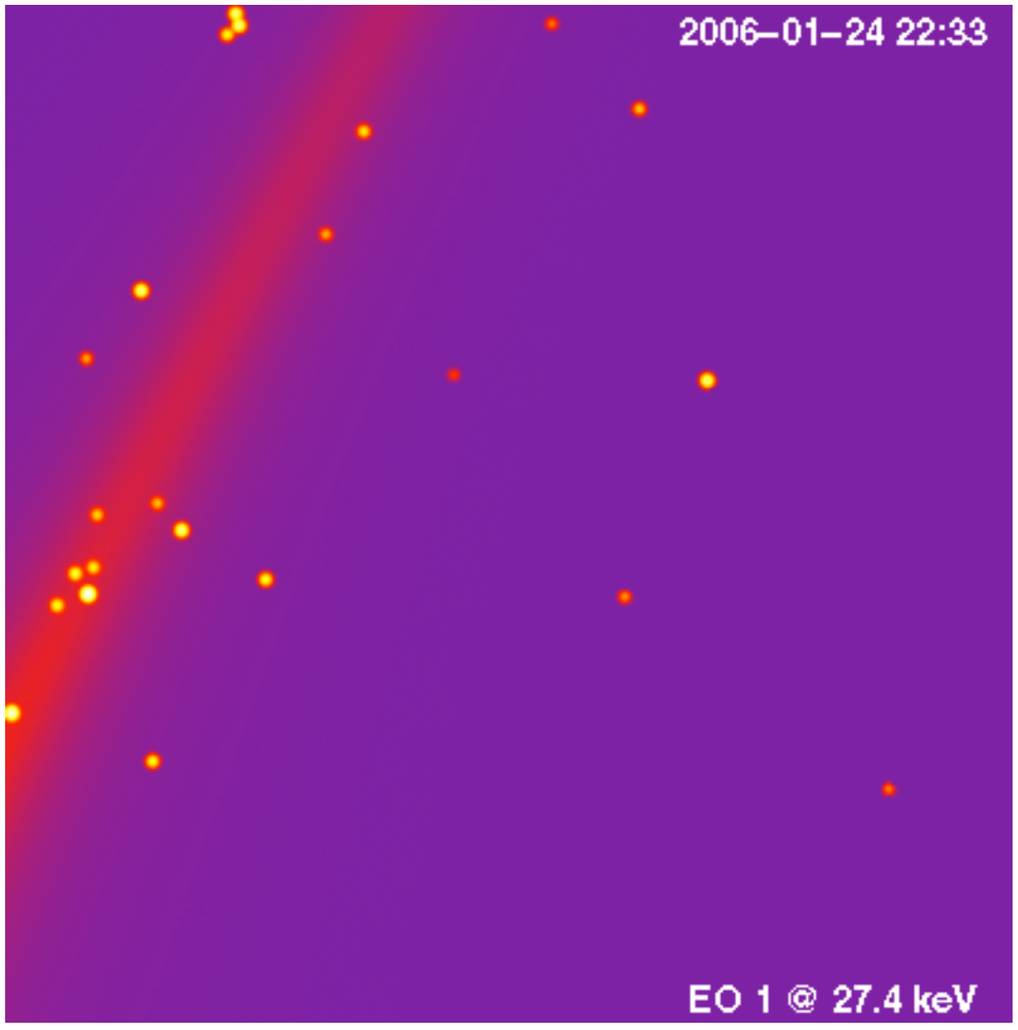
Observatory of the University of Geneva

INTEGRAL's Earth Observations

4 similar CXB occultation observations in Jan-Feb 2006



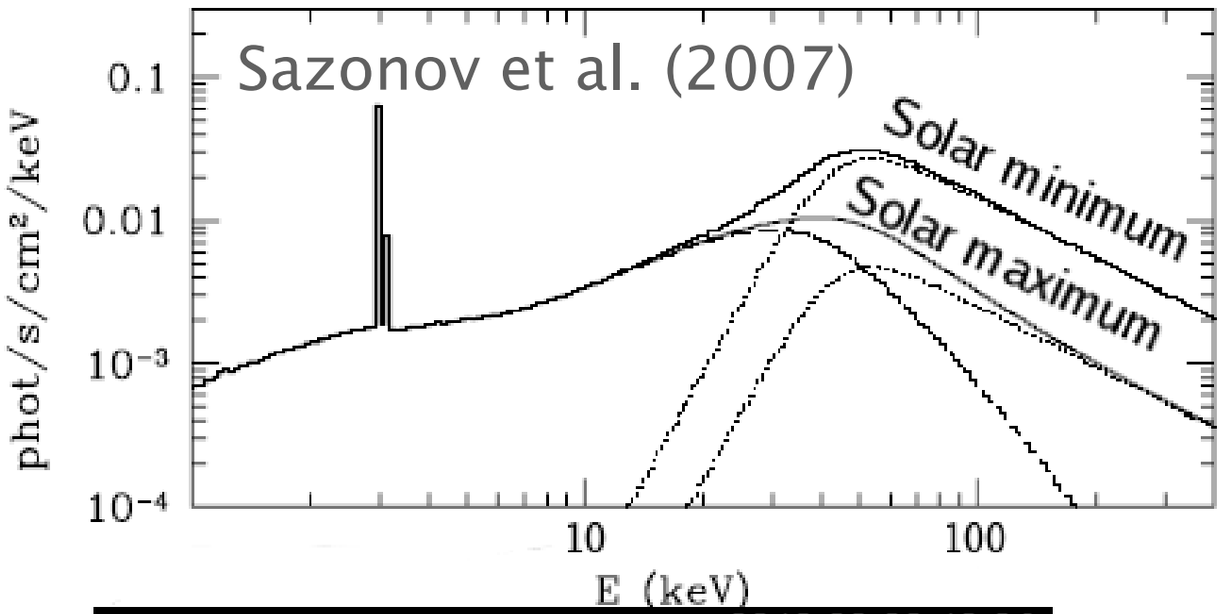


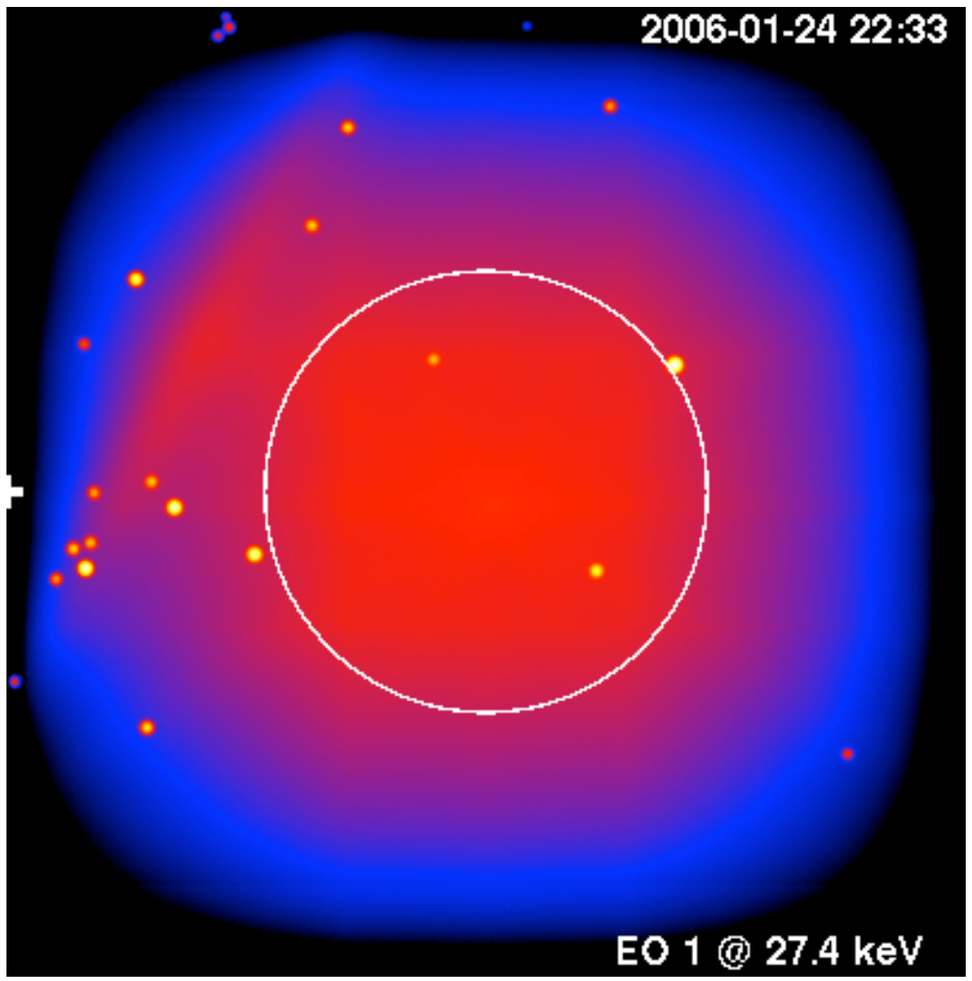


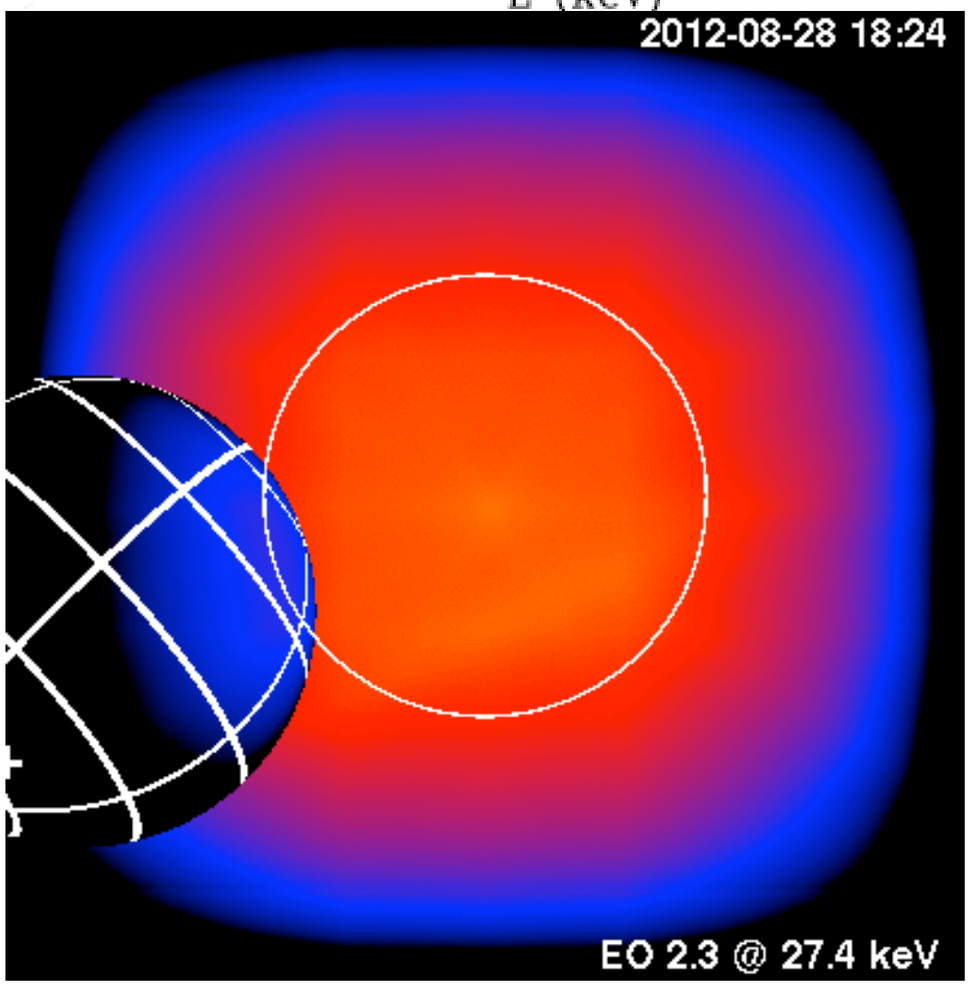
Churazov et al. (2007)

Why redo new Earth observations ?
1) Gain on systematics

- EO of 2006 done near the Gal. bulge at solar minimum
  - degeneracy from presence of the Gal. ridge & point sources
  - max. Earth atmosph. emiss. from cosmic rays (@ > 70 keV)

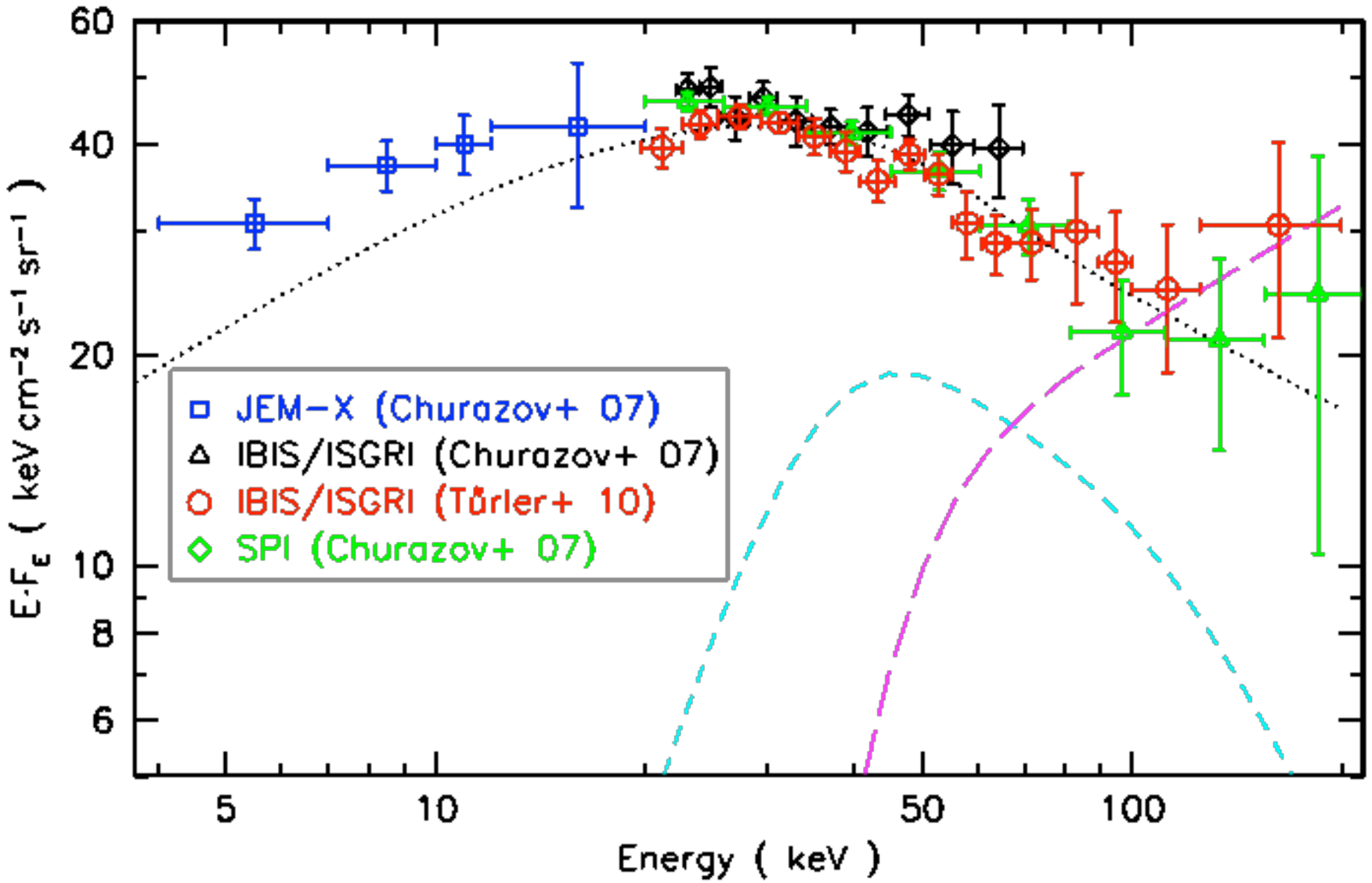






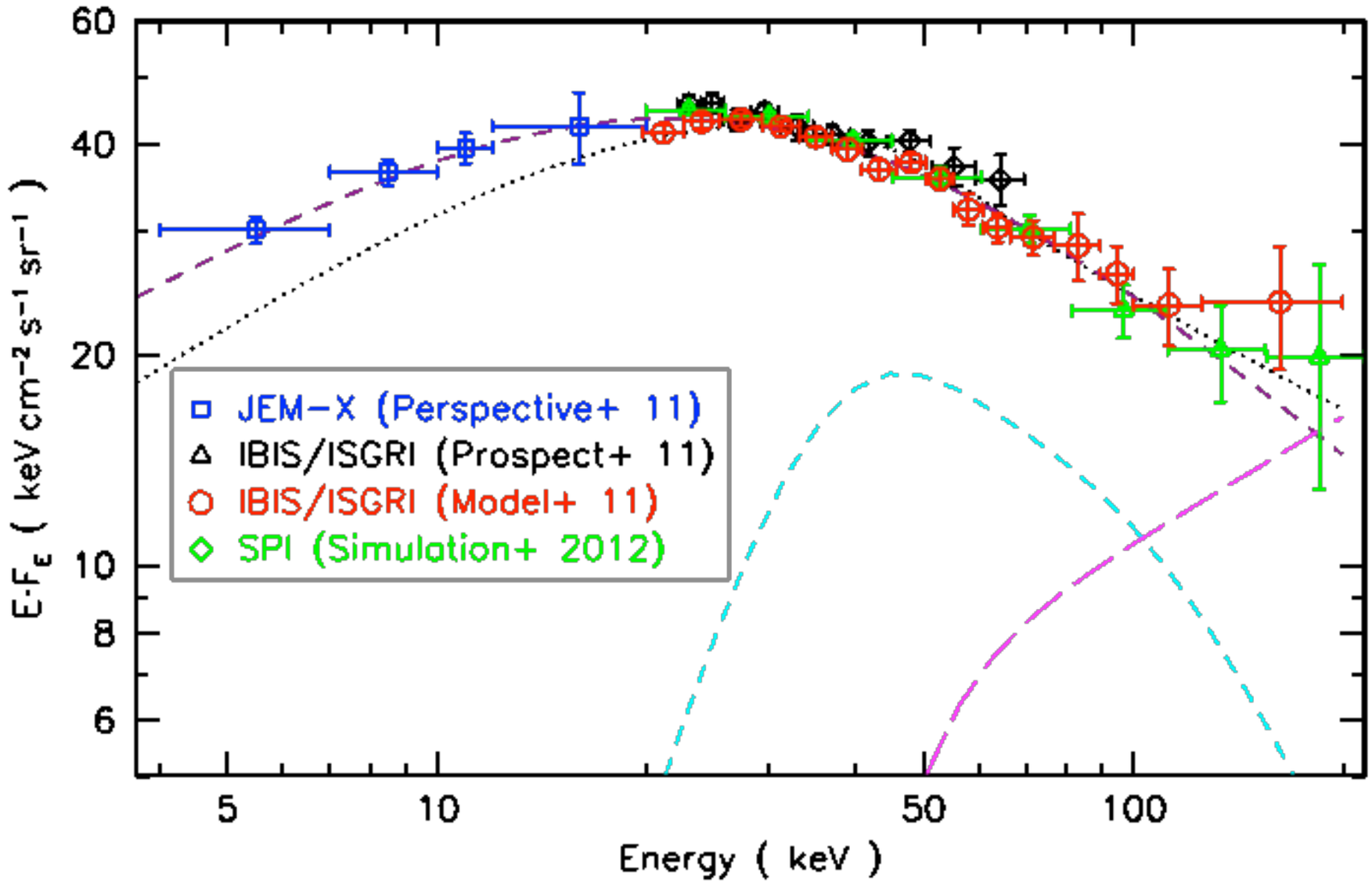
Why redo new Earth observations ?
2) Gain on statistics with 4x more observations

2010



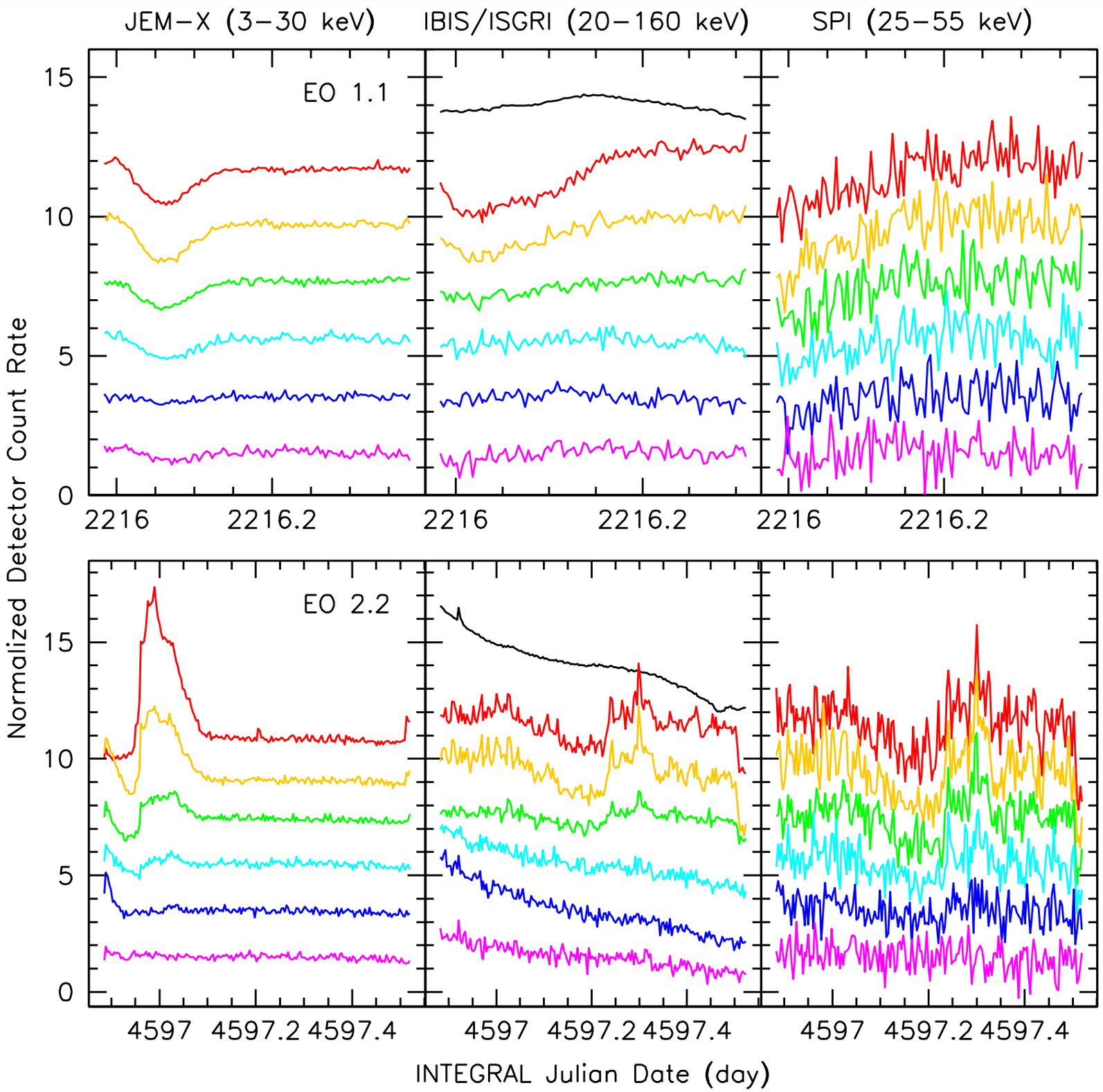
Why redo new Earth observations ?
2) Gain on statistics with 4x more observations

2014



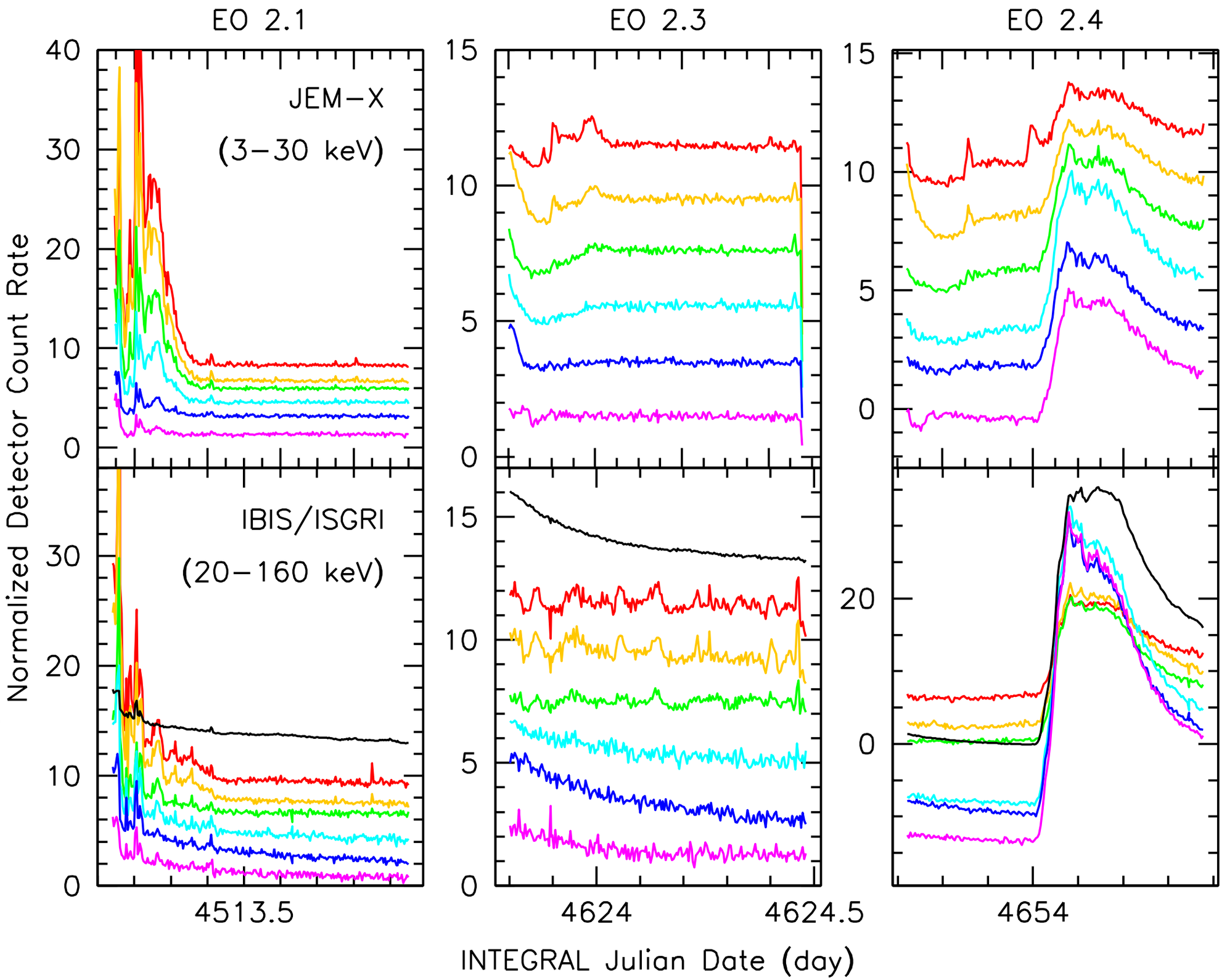
Comparison of EOs of 2012 vs. 2006

- We extracted detector lightcurves of all 3 high-E inst. for all 5 EOs of 2012
  - Unlike for EOs of 2006, the CXB occultation is not seen in the data
  - JEM-X has auroral emission sometimes also seen in ISGRI and SPI
  - SPI/ACS shows now a decay also seen in IBIS counts above ~60 keV



EOs of 2012 are all different !

- EO 2.1 has strong early instr. bkg. + aurorae
- EO 2.3 has moderate variability, but still no CXB occult.
- EO 2.4 starts well, but has then a big particle event (also in SPI/ ACS and IREM)



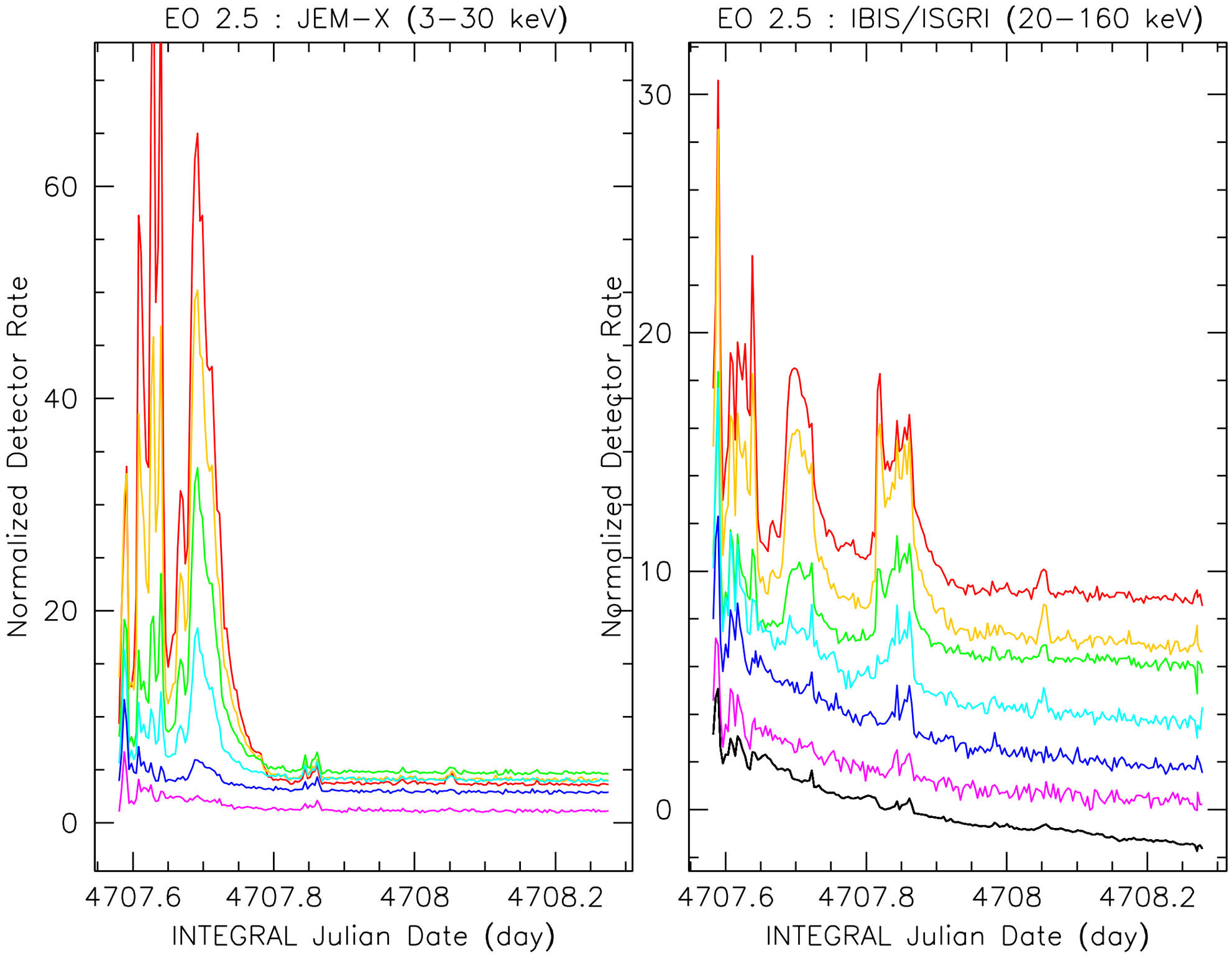
Origin of the problem ?

- The new Earth observations were supposed to give a clearer signal away from the Galactic plane, at solar maximum, **BUT**:
  - The change of the **spacecraft orbit** over time imply now about twice longer observations starting later when the Earth is already near the centre of the FoV, i.e. at max. occultation
    - the Earth passage will give rising count rates that can be blended by radioactive decay of s/c material excited in the radiation belts
  - A **perturbed space weather** affects strongly the 4 first new EO
    - Our attempt to subtract the background by computing the difference of two parts of the ISGRI detector was not successful
  - The **higher solar activity** results also in more likely **aurorae** affecting JEM-X and likely also IBIS & SPI observations
    - although likely interesting in itself, it alters CXB measurements

EO 2.5 (Nov.) is interesting

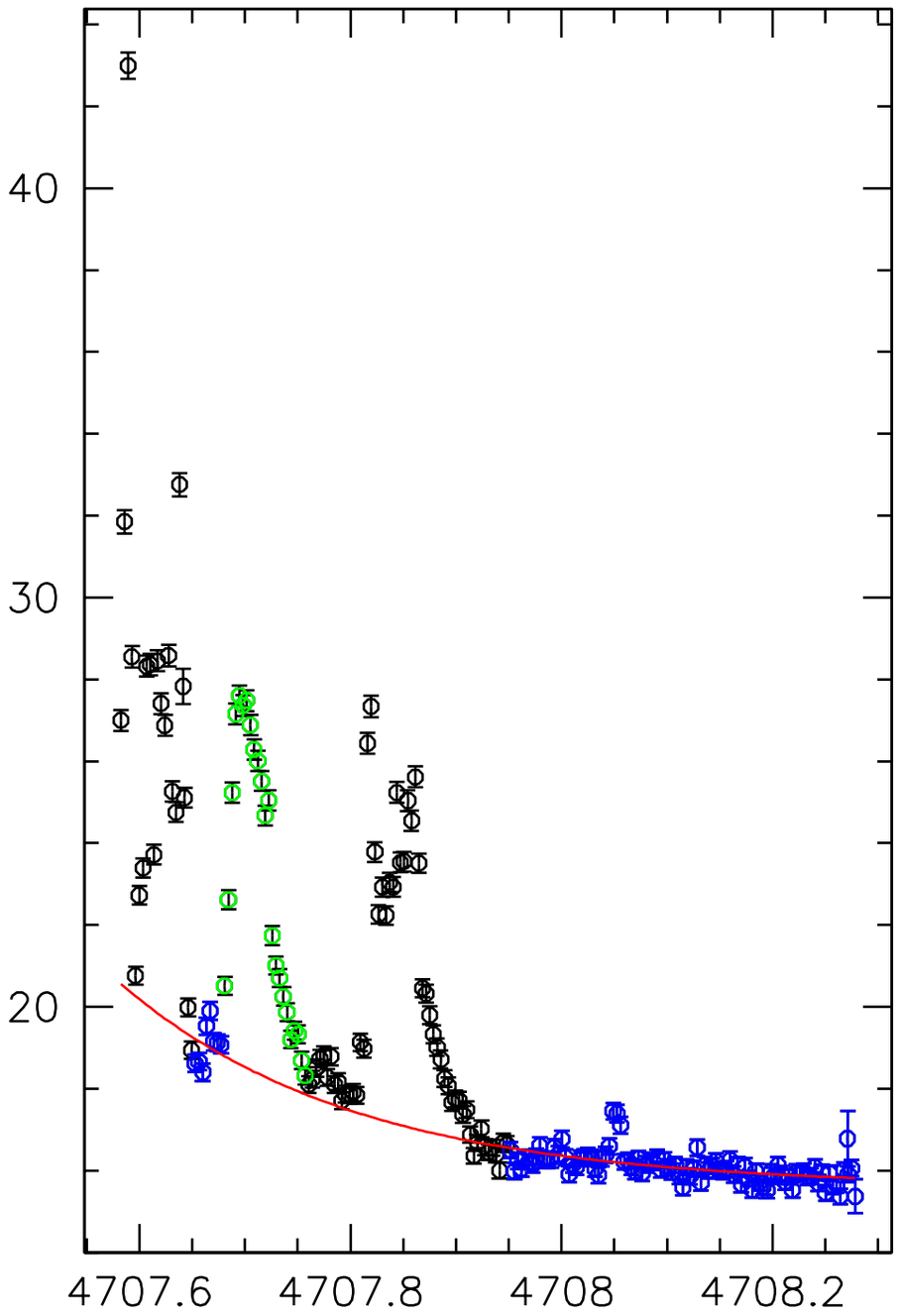
- Strong variability *not* in SPI/ ACS and IREM
- Very strong in JEM-X when Earth in FoV
- Only in one part of ISGRI detector when in PCFoV

➡ Most likely auroral emission

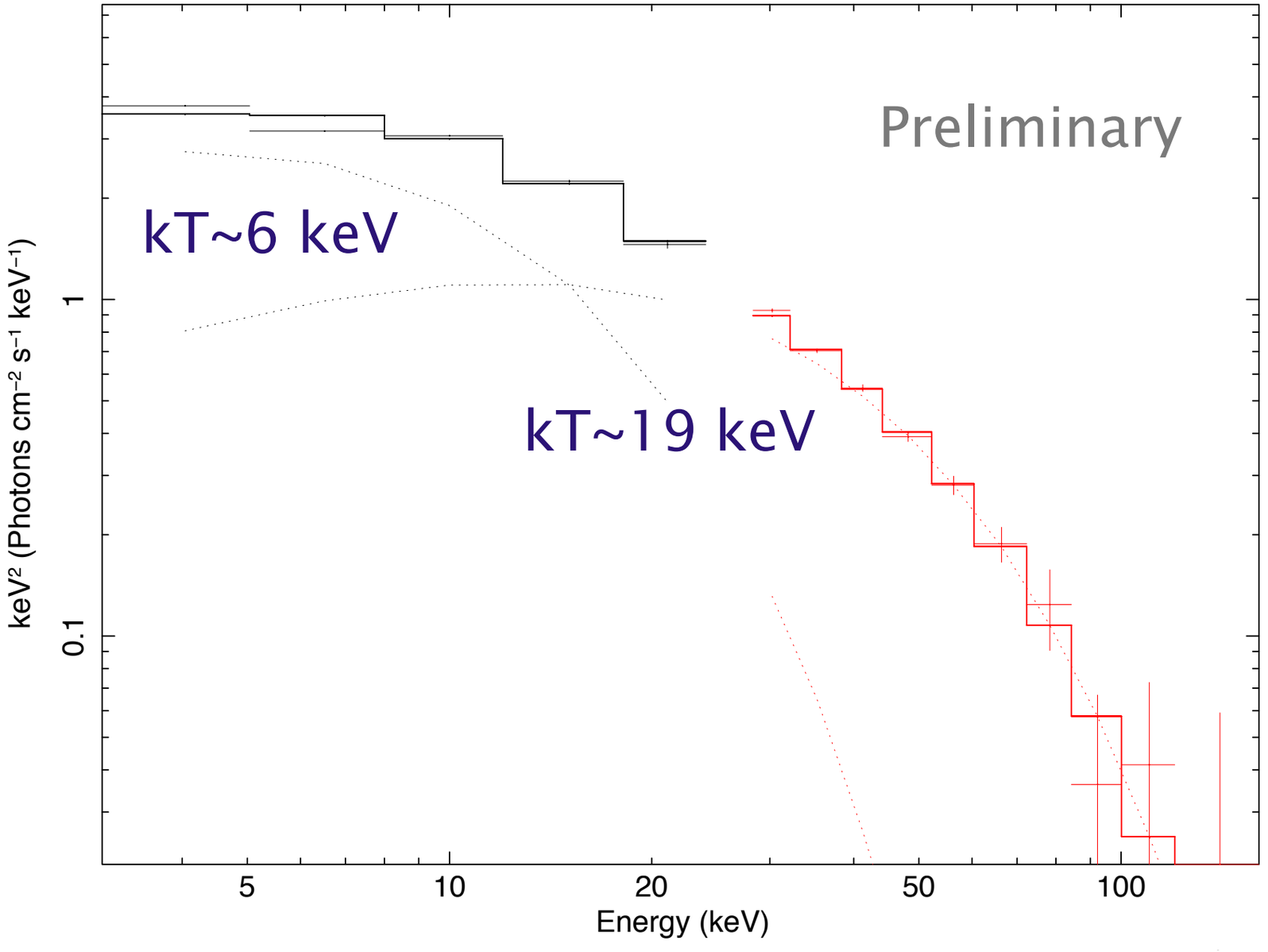


First (?) auroral spectrum 3-100 keV from space

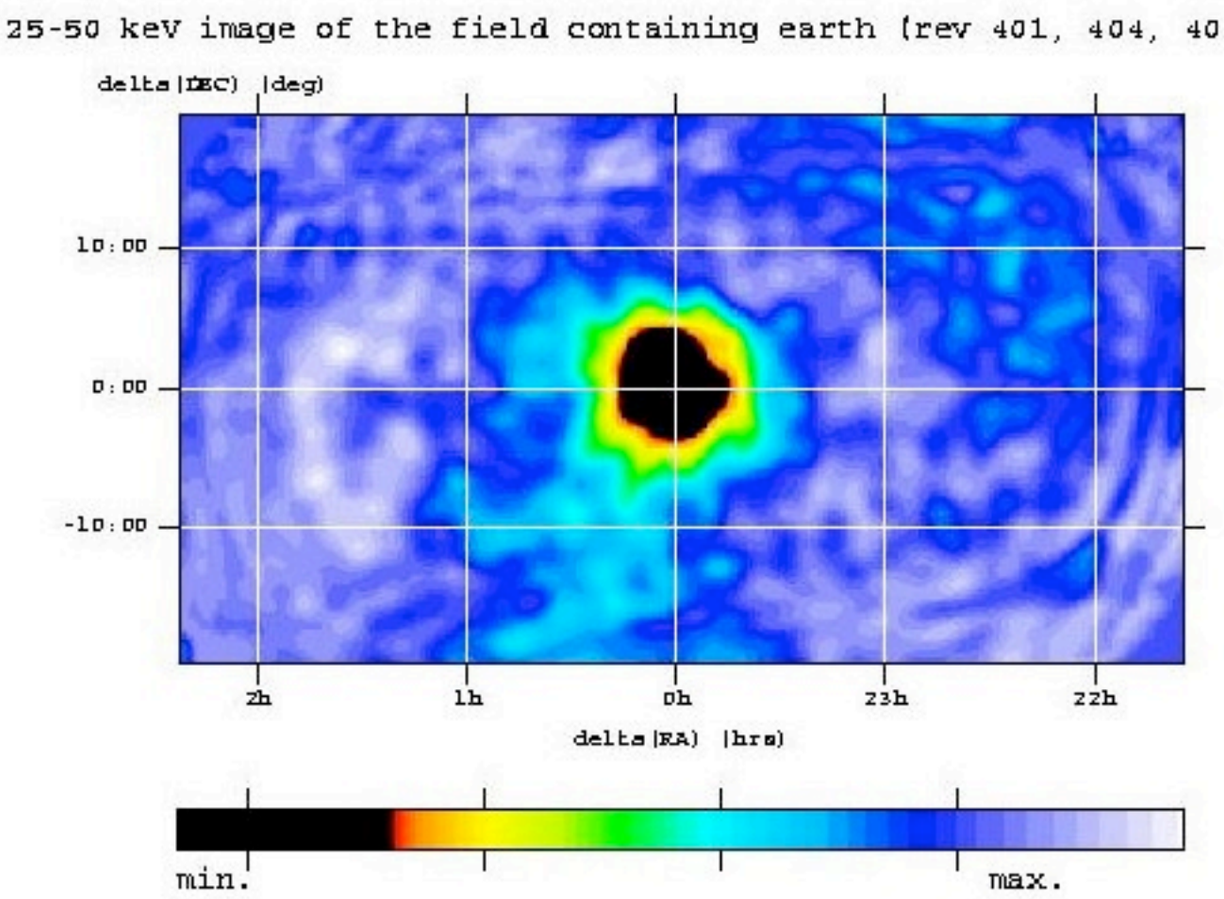
- Just extracting the excess outburst flux yields a high S/N spectrum up to ~100 keV with JEM-X and IBIS.



Two bremsstrahlung spectra fit well:

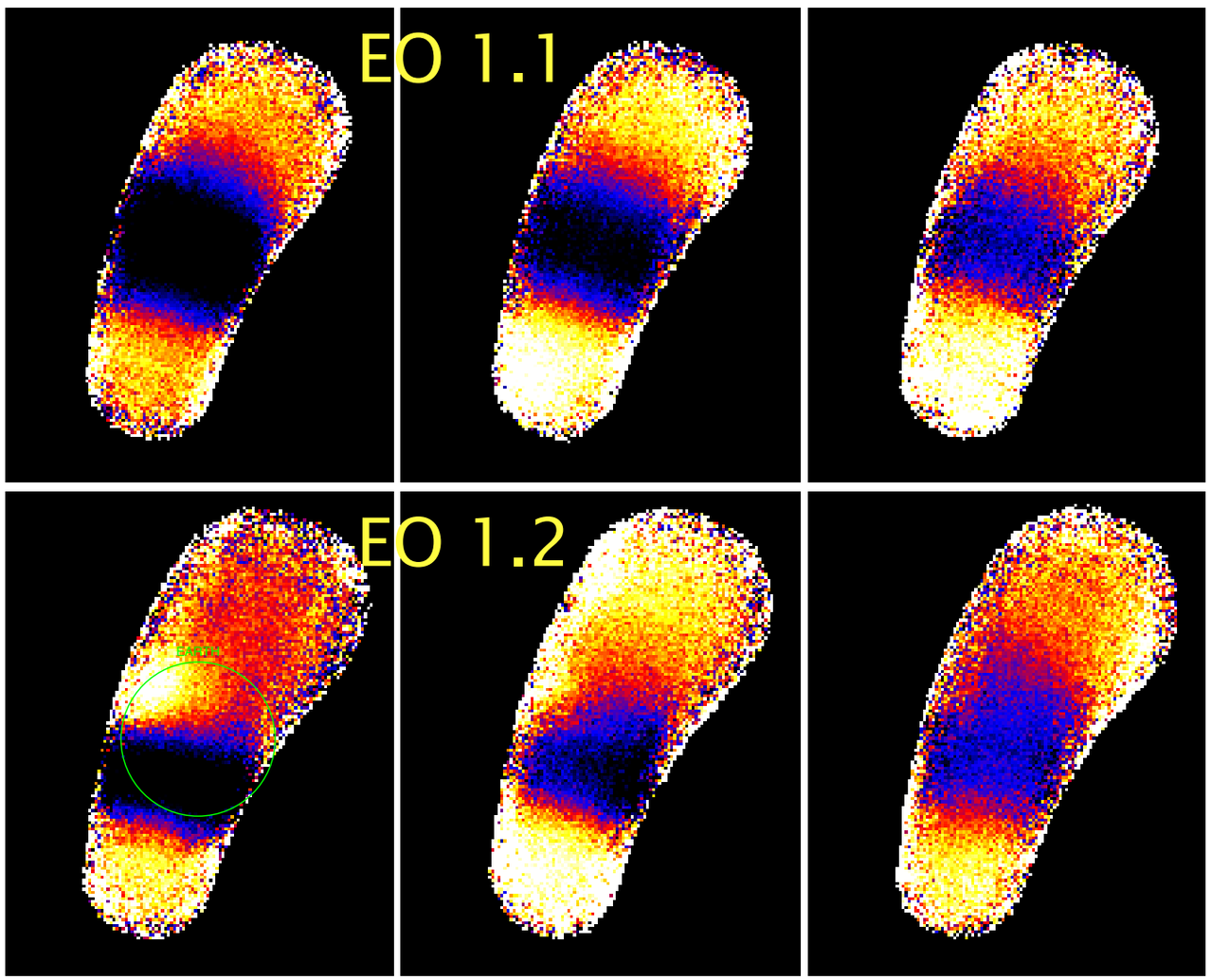


Imaging aurorae *is* possible



←SPI Earth "hole" in CXB

CESR & SPI Team (Feb. 2006)



JEM-X Earth "images" with weak aurora in EO 1.2 of 2006 →

Niels Lund for JEM-X Team (Feb. 2006)

How to continue ?

- Performing **pre-perigee observations would be much better**
  - bigger Earth in FoV & shorter obs. time
  - and no radioactive decay from s/c material affecting the post-perigee detector counts of JEM-X, ISGRI and SPI
- BUT: it looks like the **major show stoppers are now aurorae**
  - Measuring accurately Earth occultation of CXB with a variable occultator will be (very?) difficult, especially because:
    - Aurorae vary on very different timescales from few seconds to several hours (Known from *in situ* obs. with balloons in the 1960s)
    - Are not limited to soft X-rays, but can emit to >~100 keV
- Are we interested in **Earth ~~occultation~~ observations** ?
  - Aurorae are an exciting "new source" for INTEGRAL
  - INTEGRAL has unique capabilities: high orbit, JEM-X, ISGRI, SPI
  - Interesting subject for outreach ? Link with Clusters mission ?

Anyway, a great **THANK YOU** to the ISOC & MOC Team
for all their efforts in preparing and performing these critical observations!