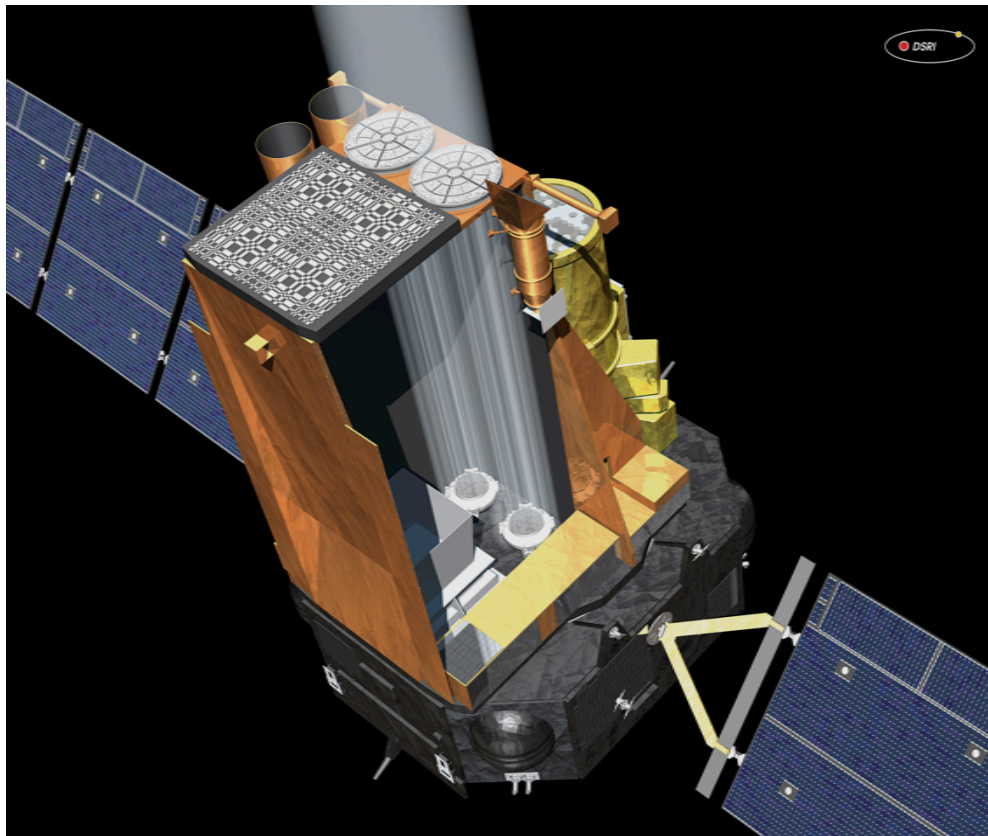


Technical University of Denmark



JEM-X Status, January 2012

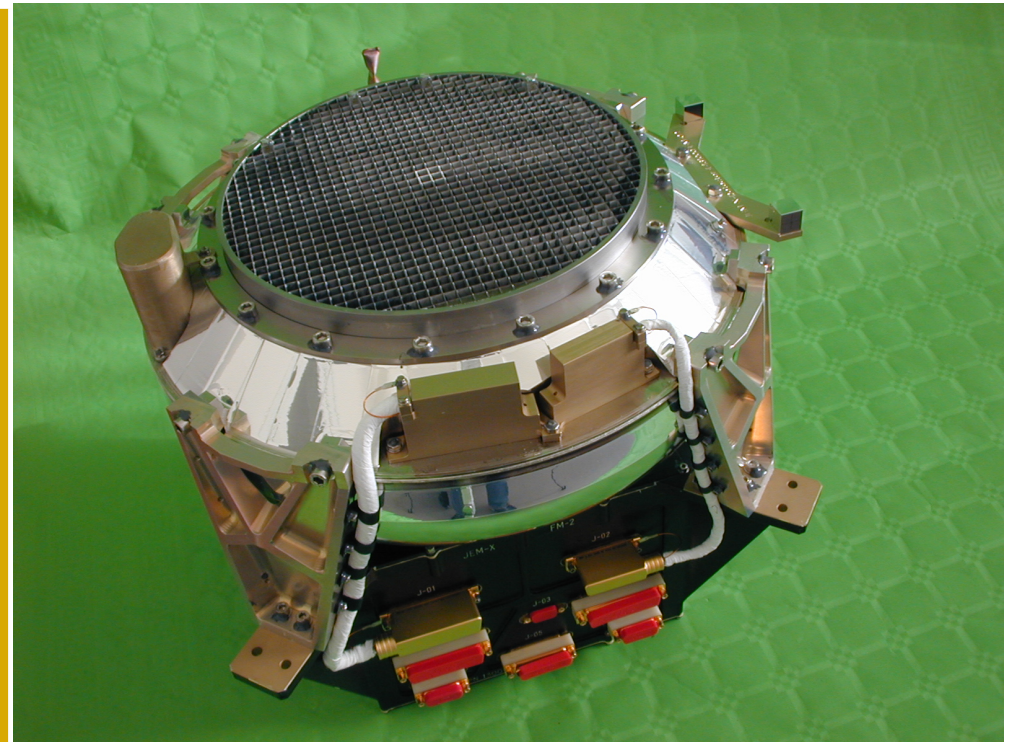
Søren Brandt



 **DTU Space**
National Space Institute

JEM-X X-Ray Telescope on INTEGRAL

- Coded mask camera with ~5000 holes (1/4 open mask)
- Distance between mask and detector: 360 cm
- Energy range: 3-40 keV
- Micro-strip plate and Xenon gas filled proportional counter
 - Analog detector with "pixels" determined by software



Both JEM-X units now default configuration

- JEM-X1 was used from rev. 170-855 and has now been used for ~900 revolutions (~7.4 years of use)
- During revolution 862-975 (Oct 16, 2009) JEM-X2 was the default JEM-X unit
- Since revolution 976 (Oct 10 2010) both JEM-X units have been used (8+8 tm packets allocation)
- JEM-X2 has been used for ~475 revolutions (~4 years of use)
- Both units have been used for all Crab calibrations
- Both units were used during SPI annealing, as TM allocation allowed
- S/N ratio improved by $\sim\sqrt{2}$ with both units

Anode status

- ~So far – on average 2-3% loss per year (256 anodes in total), but now about 1% per year
- However, no loss during ~12 months period in 2007-08
 - Two strips lost in 2008, one in March 2009, three in 2010, one in 2011
- JEM-X1 (~900 orbits of use)
 - 64 of 256 anodes affected (~25% of area)
 - 38 dead (4 pre-launch, 1 lost during 2010, 2 lost during 2011)
 - 13 neighbor
 - 13 unstable or low
- JEM-X2 (~475 orbits of use)
 - 61 of 256 anodes affected (almost 25% of area)
 - 31 dead (9 pre-launch) (+2 since Oct 2009)
 - 15 neighbor
 - 15 unstable or low (+3 since Oct 2009)

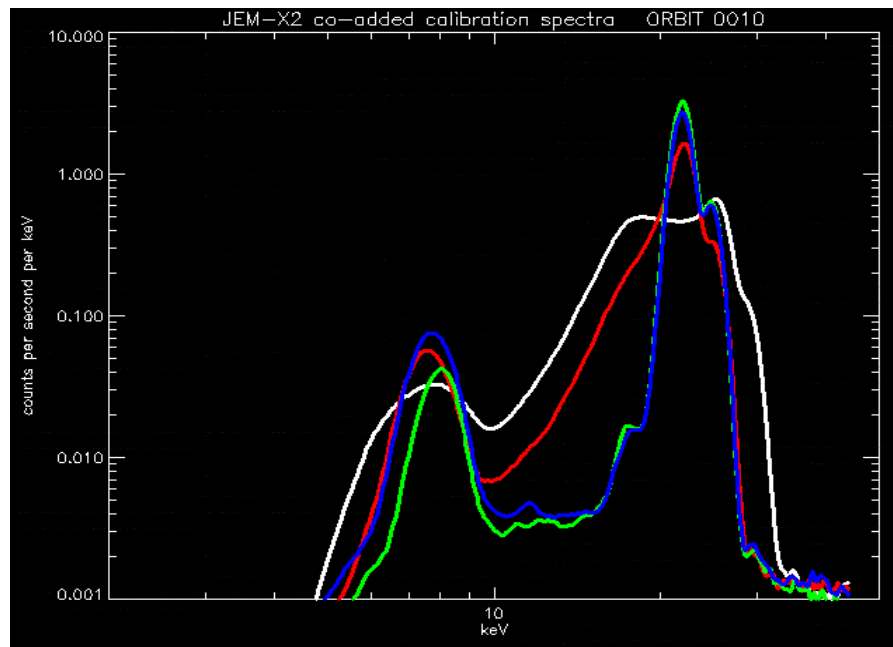
Gain evolution

- JEM-X1 DV setting was lowered in rev. 978 to DV=70 (~700V), to DV=69 (~690V) in rev. 1010, Jan 20, 2011, and to DV=68 (~690V) in rev. 1089, Sep 13 2011
- When JEM-X1 started as default instrument in orbit 170, we had DV=81 (~810 Volts)
- Gain (at constant HV) has increased by a factor of ~4
- Gain dependence on detector temperature has increased from 1% per degree to ~4% per degree
- JEM-X2 DV setting is was lowered to DV=71 in rev. 967 and to DV=70 in rev. 1010, Jan 20, 2011, to DV=69 in rev. 1089, Sep 13 2011
- Gain evolution is caused by ion conducting glass substrate of the micro-strip plate

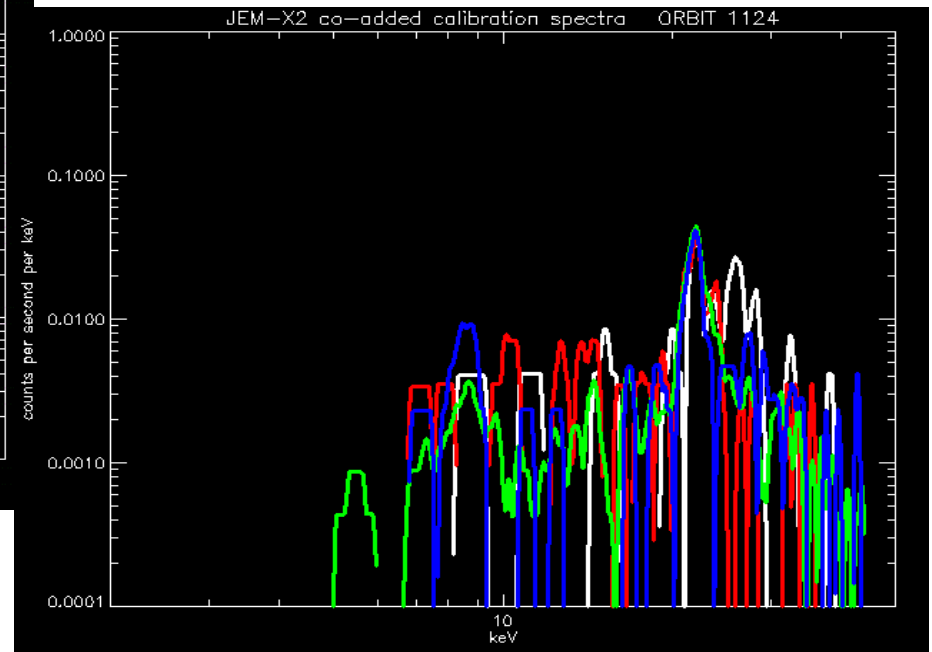
JEM-X2 calibration spectra (rev. 10 and 1124)

- JEM-X2 has 4 Cd sources, which are down by a factor of ~ 100 since launch
- Calibration spectra integrated over longer time to fit the line
- Xe fluorescent line from detector gas at 29.6 keV also used

Nov 2002



Dec 2011

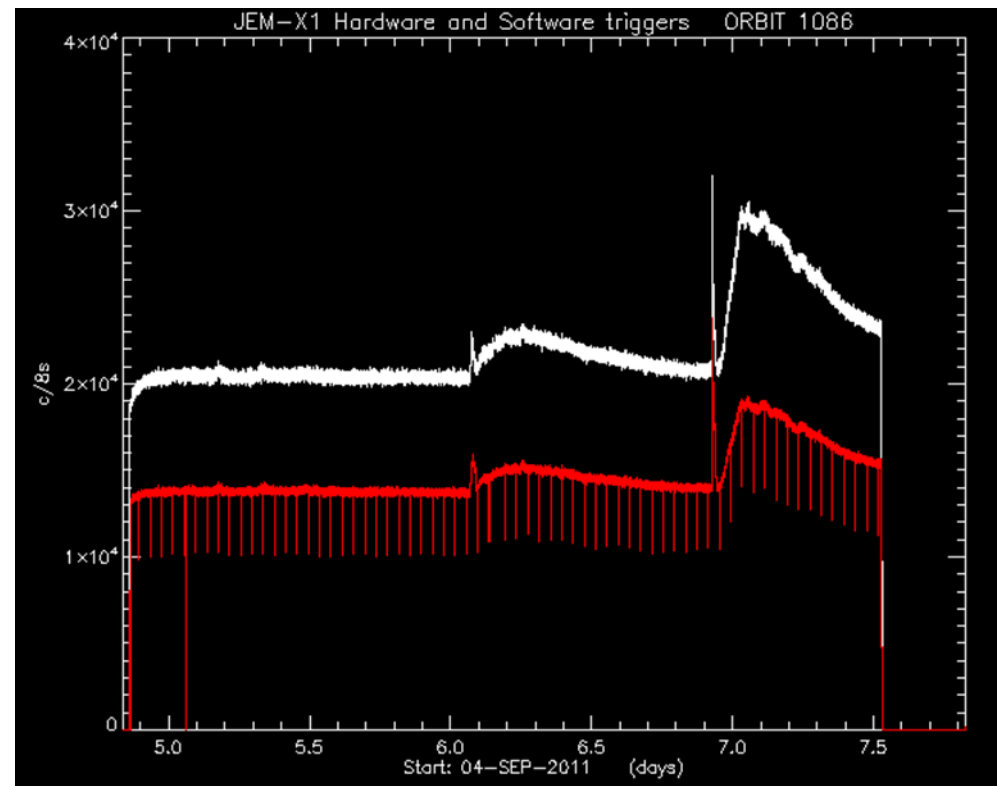
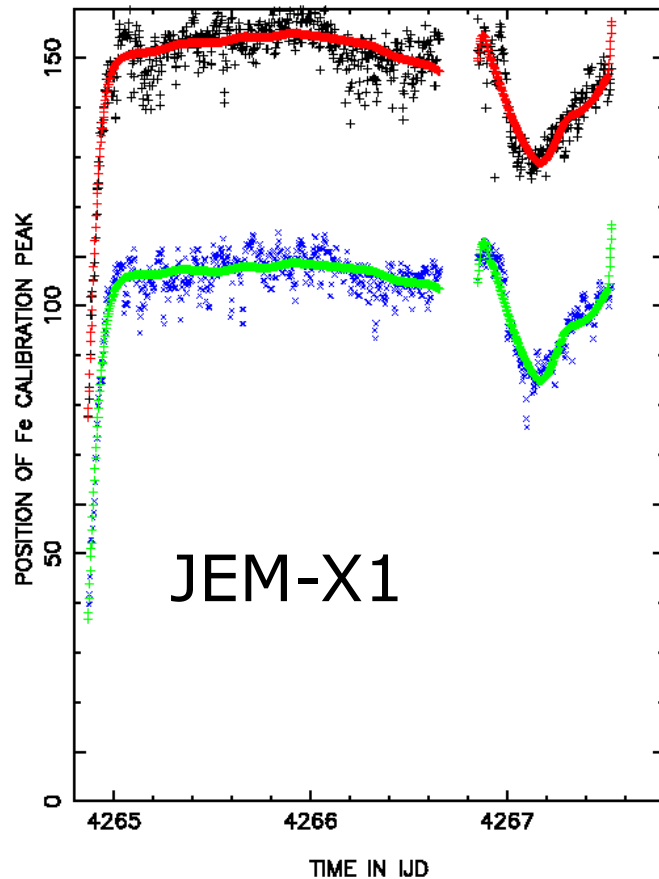


JEM-X Gain Calibration in OSA

- Gain calibration requires continued efforts because of the decaying calibration sources
 - Further complicated by increased dependence on temperature = more variation over an orbit
- Calibration data must be collected in increasing time periods
- offline analysis of gain required to ensure correct results
- Calibration analysis is more difficult in orbits with grey filter
 - More TM would help avoid grey filter “interruptions” in gain curves
- Calibration provided by “Instrument Characteristics” tables delivered to ISDC for each revolution
- Eventually the gain calibration will rely only on the Xe fluorescence background line at 29.6 keV and temperature variation modeling

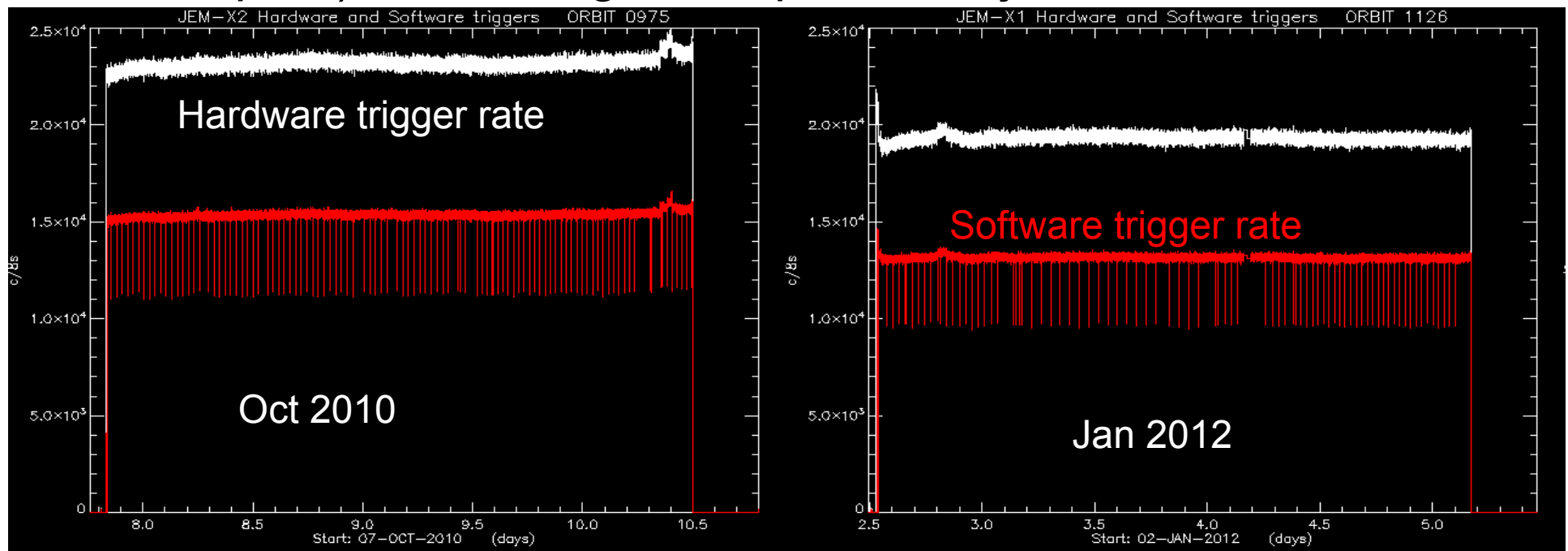
Strong Count Rate Dependent Gain Variations (e.g. rev. 1086)

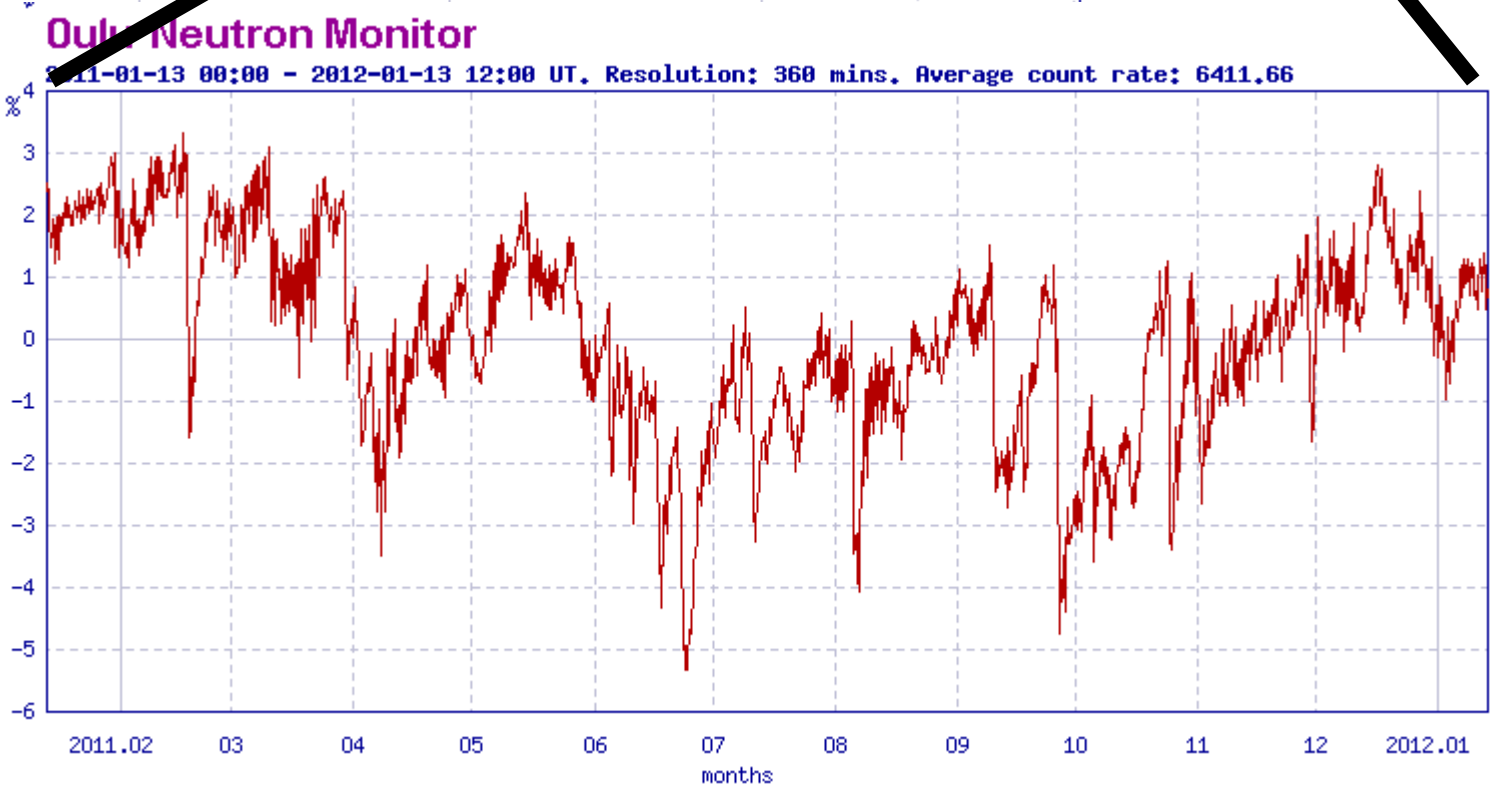
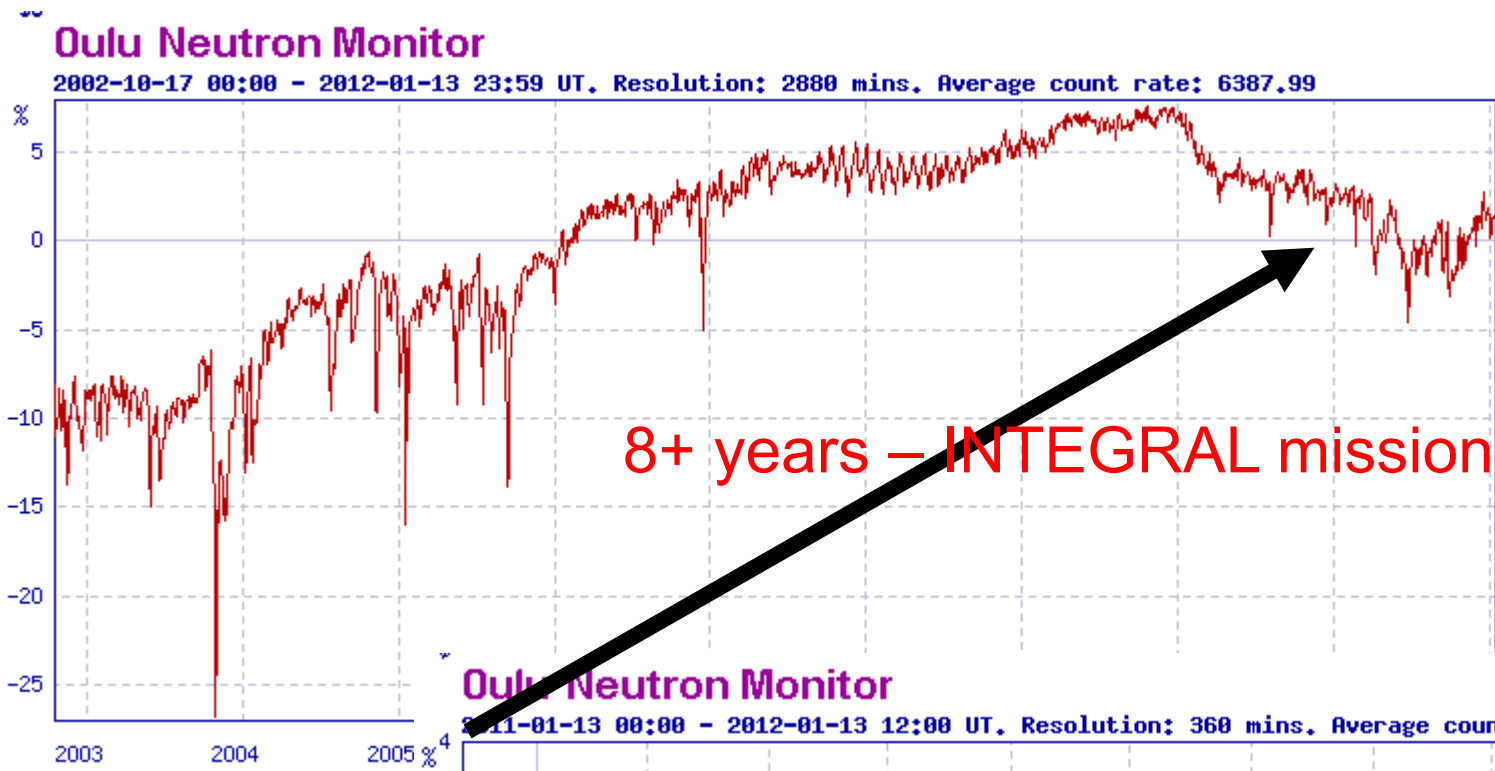
Worst case example: Strong solar particle event introduces strong gain variation



JEM-X particle trigger rate is lowered

- JEM-X HW and SW trigger rate (dominated by particles) is lowered by $\sim 20\%$ since Oct 2010
 - Now ~ 2500 triggers/sec
- Processing dead time is reduced from $\sim 18\%$ to $\sim 16\%$
- Background (dominated by CXB, direct + induced Compton) is unchanged, as particle rejection is efficient



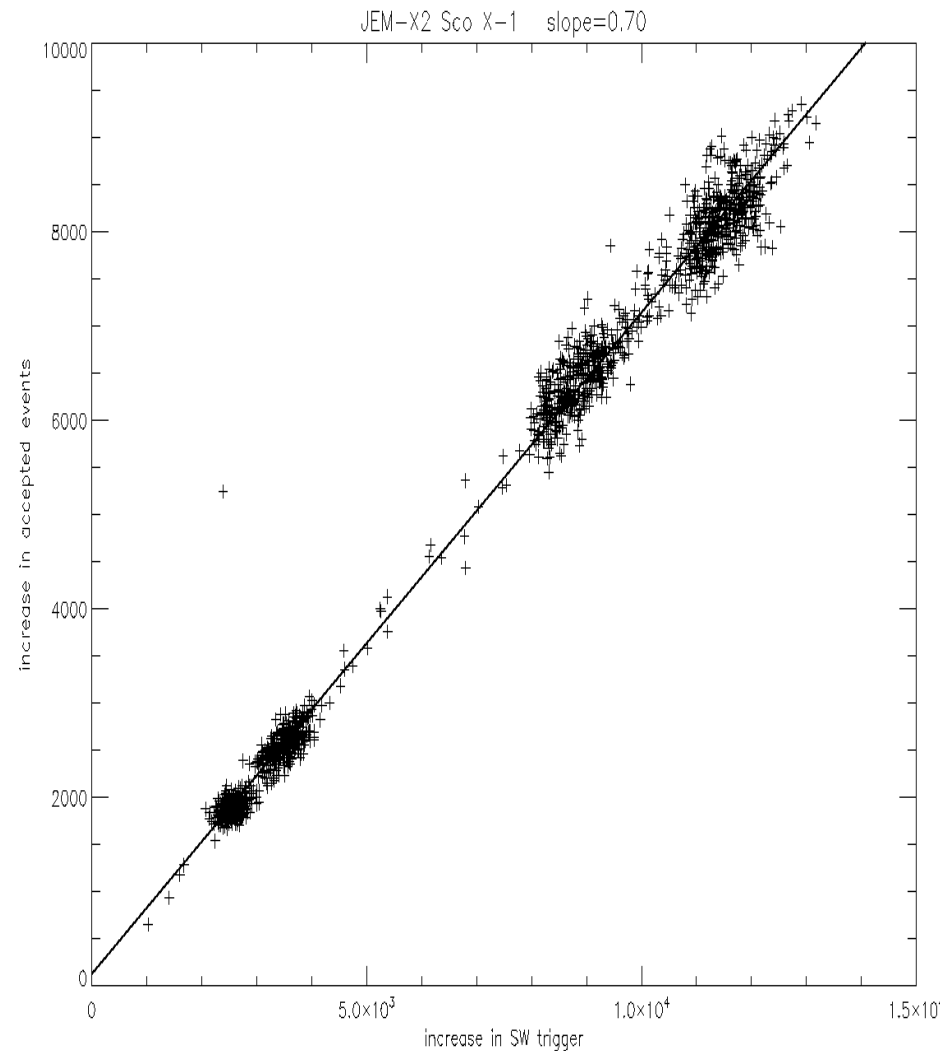


the cosmic ray flux is coming down.... slowly.

Not much variation over 2011...

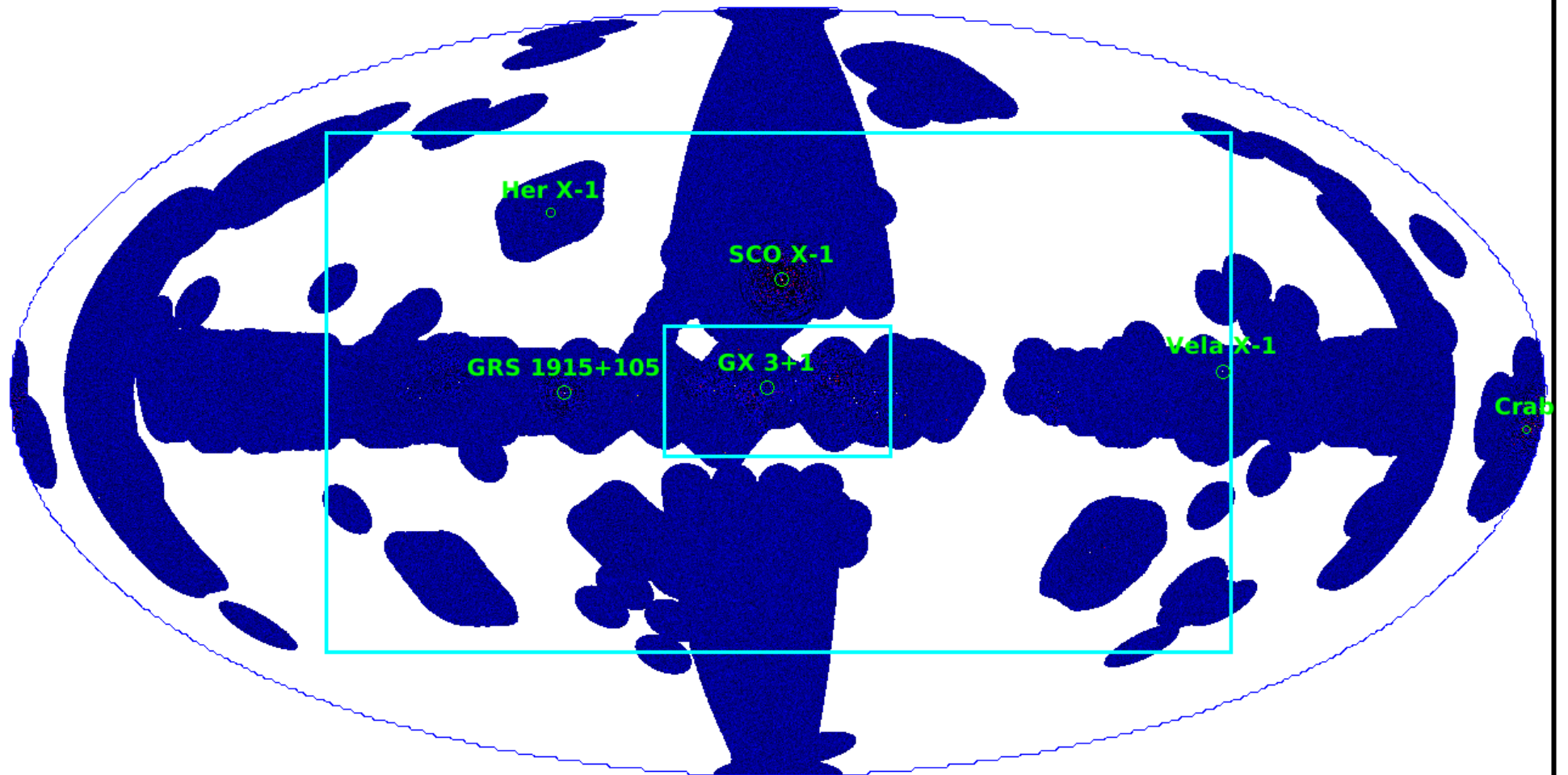
Under-estimated dead time?

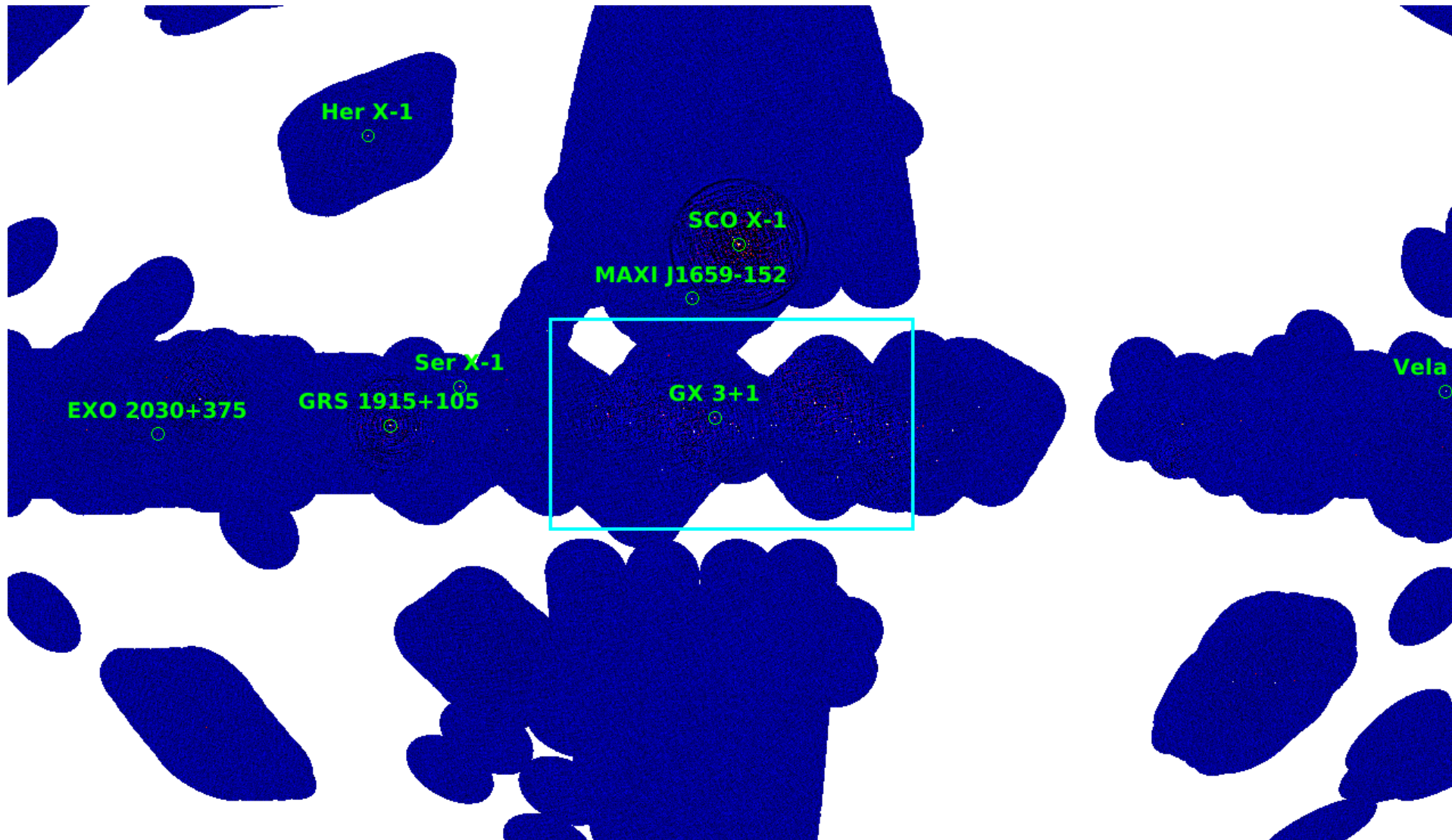
- During Sco X-1 observations increase in number of SW triggers and accepted events show a 0.7 correlation
- Does this mean that we loose 30% of good X-rays?
- And why are they lost?
 - “Pile-up”?
 - Too strict selection criteria?
 - Still under investigation

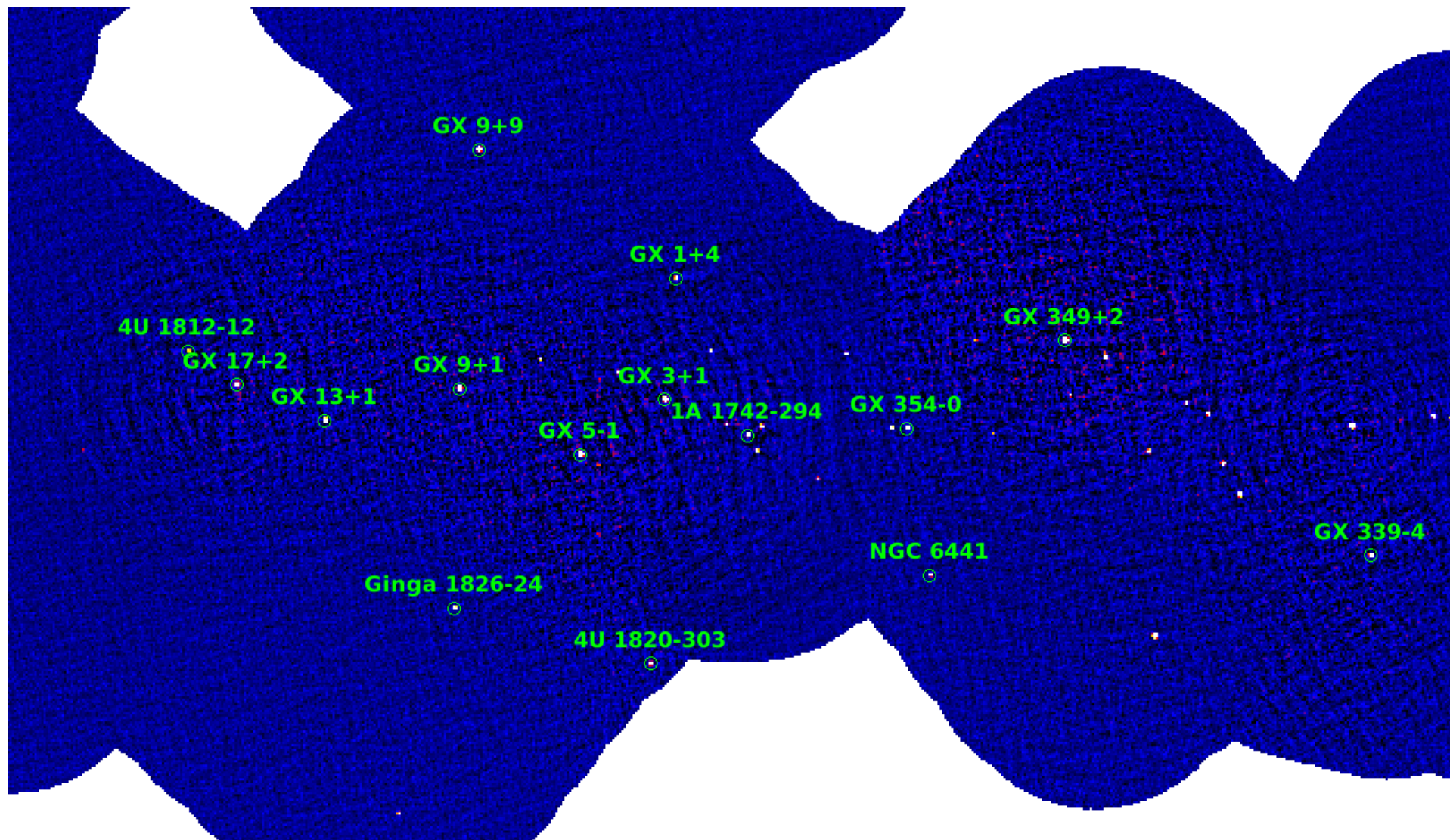


JEM-X Mosaic in Aitoff projection

- JEM-X mosaic tool now supports all WCS projections
- 5-25 keV significance map of 11353 ScWs with JEM-X2 revolutions 861-1054, ~20 Ms, 10^9 photons

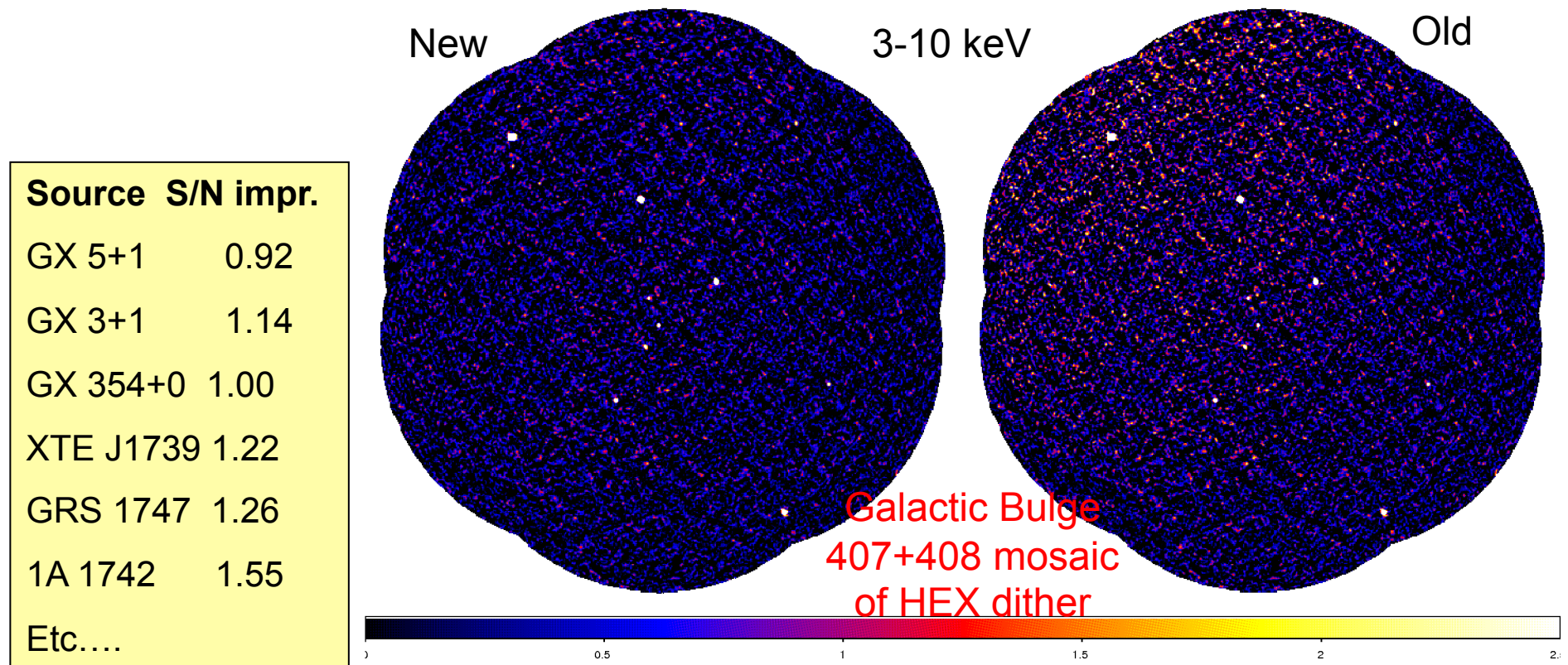






SW development: PIF weighted imaging

- Find and fit the brightest sources
- Assign weights to detector pixels according to expected illumination by brighter sources
- Redo back projected image with better S/N



JEM-X Support of Mission Extension

- DTU Space will support the INTEGRAL extension in 2015-16
 - Main routine work is related to gain calibration, general performance monitoring, OSA support, and Crab calibration
 - Some team members will retire – but some will stay on – transfer of knowledge needed
 - Expected support in 2015-16 at the level of 2 FTE (TBC by end of Jan 2012)

Conclusion

- JEM-X is running smoothly
- JEM-X is not affected by lowered perigee
- Gain evolution is progressing (as expected)
- Switch from JEM-X1 to JEM-X2 was implemented by start AO7 (Oct 2009) to even the “wear” on the detectors
- Running both JEM-X1 and JEM-X2 was implemented in Oct 2010, as sufficient telemetry became available
 - Improved statistics and reduction of systematics
 - Increased TM allocation would reduce number of cases with grey filter and also improve stability of gain fitting
- Team is still intact – but also busy with other projects
- We expect JEM-X and INTEGRAL to operate through 2014, and also in the next extension 2015-2016
 - Performance is monitored to ensure that running both units will not endanger the future use