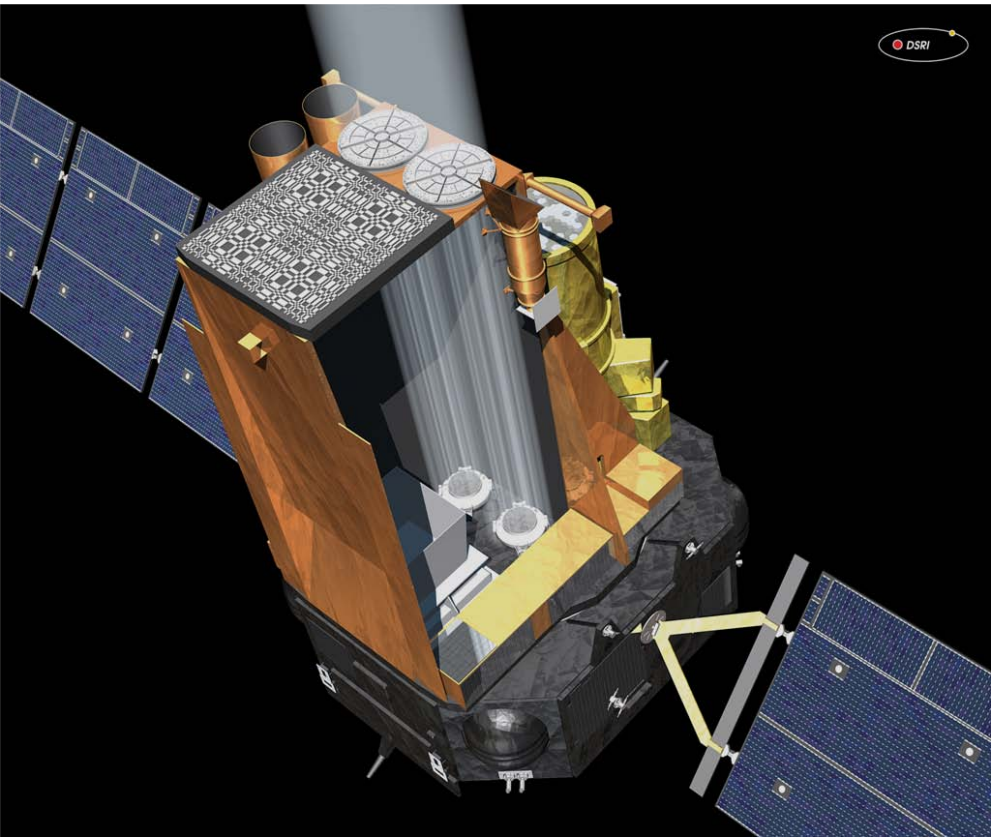
Technical University of Denmark

DTU

JEM-X Status, March 2011

Søren Brandt



DTU Space
National Space Institute

We survived the first 1000 revolutions!

INTEGRAL Status

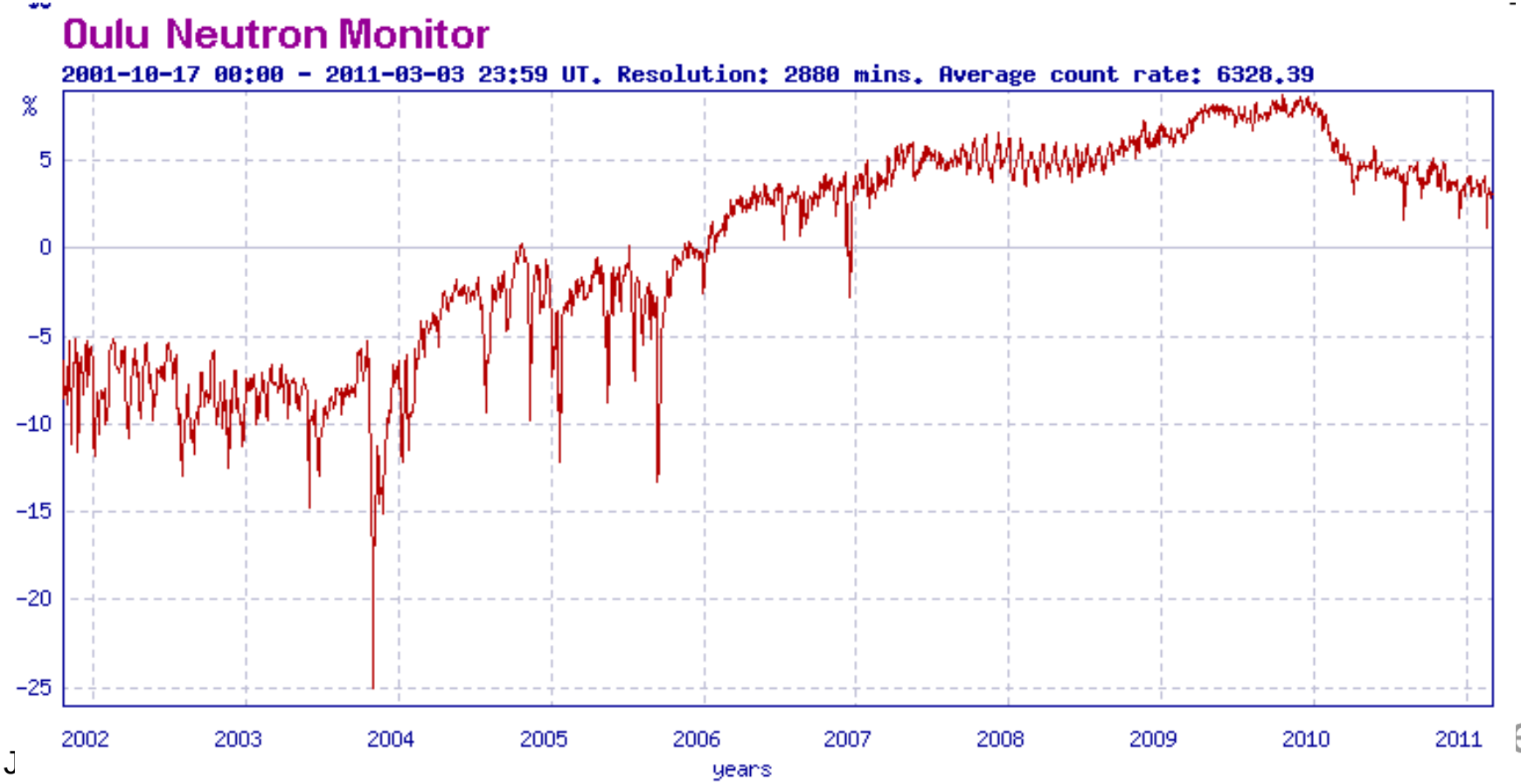
- INTEGRAL is approved by ESA until the end of 2014
  - (pending the “usual” review in 2012)

INTEGRAL continues to provide unique possibilities for studying the high-energy sky, in particular thanks to its imaging, spectral and polarimetric capabilities in the 20 keV to a few MeV range. No mission is planned in the near future to substitute INTEGRAL at energies above a few hundred keV. An extension of the INTEGRAL operations would enable new and interesting science. However, while producing science of high quality, the community making use of INTEGRAL is smaller than for other missions (e.g., XMM-Newton or HST) and the resulting science is of a somewhat less broad nature.

The AWG was impressed by the innovativeness of the INTEGRAL community as shown by recent results. The extension to the end of 2014 will benefit from the low particle background expected around solar maximum and the AWG recommends the extension of the mission.

INTEGRAL

- Particle background is decreasing
  - Less demand for TM
- Perigee will reach down to 2800 km later this year
  - No adverse effects due to the passage of the proton belts



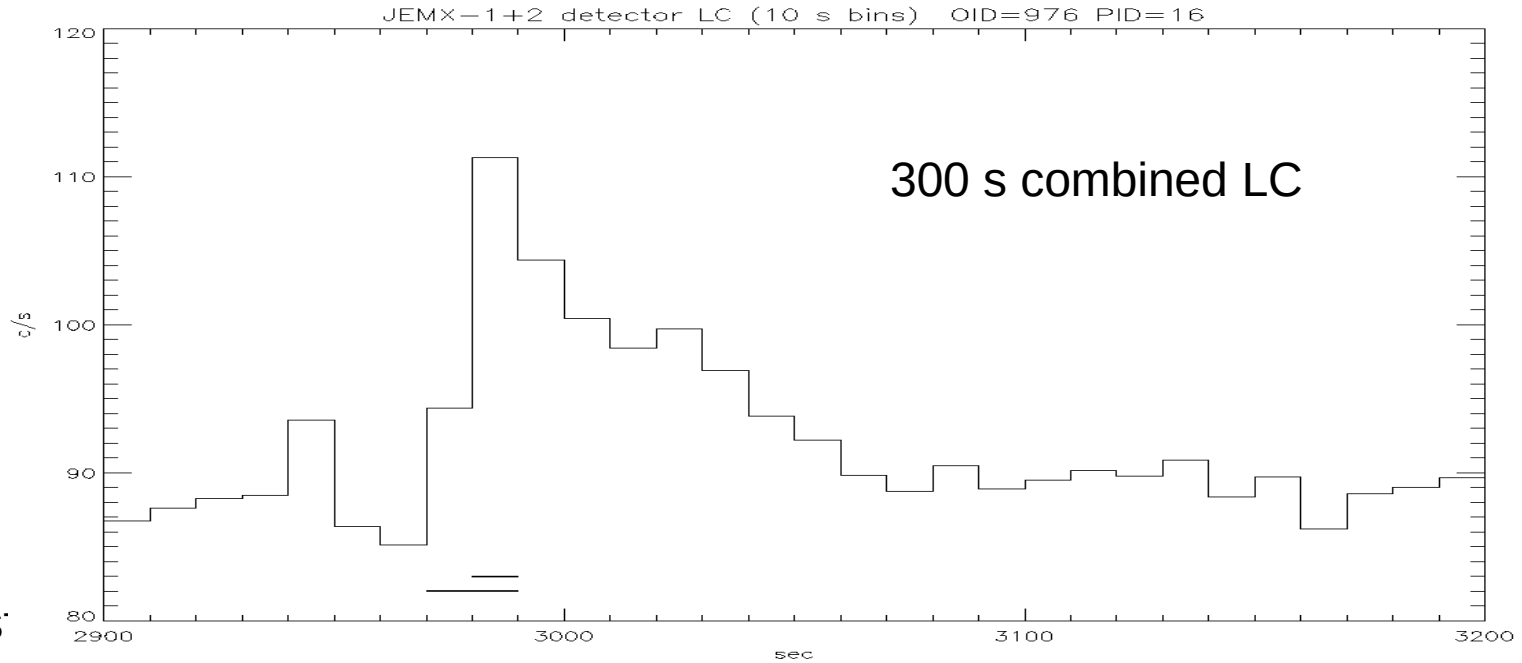
Both JEM-X units new default configuration

- JEM-X1 was used from rev. 170-855 and has now been used for ~750 revolutions (~6 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 had been used for ~350 revolutions
- 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 ~sqrt(2) with both units

Example, both units:Transient in Terzan 5

IGR J17480-2446

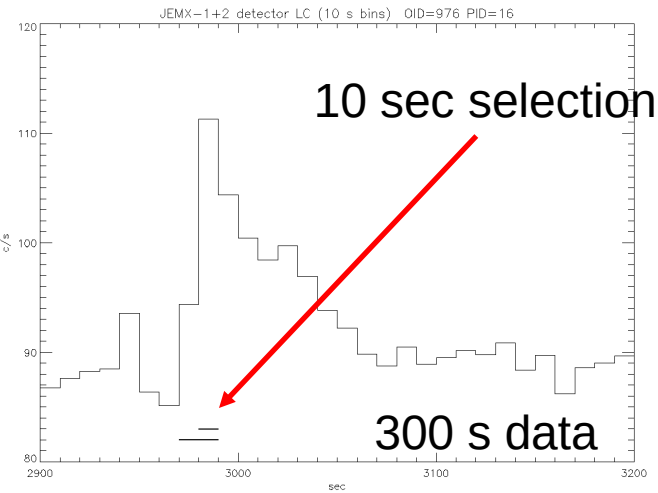
- **“A hard X-ray transient in the direction of Terzan 5 detected by INTEGRAL”, ATEL#2919**, Bordas et al. Oct 10, 2010
  - **Rev. 976, first orbit with both JEM-X units on as default**
- Followed up by 15 other ATELs 2920, 2922, 2924, 2929, 2932, 2933, 2935, 2937, 2939, 2940, 2946, 2952, 2958, 2974, 3000, 3044)
- Long discussions on issue if this source is EXO 1745-248, elclipse? Etc.
- Type I X-ray burst discovered by JEM-X on Oct 11 (ATEL 2924)
  - Both JEM-X units were active, adding to statistics

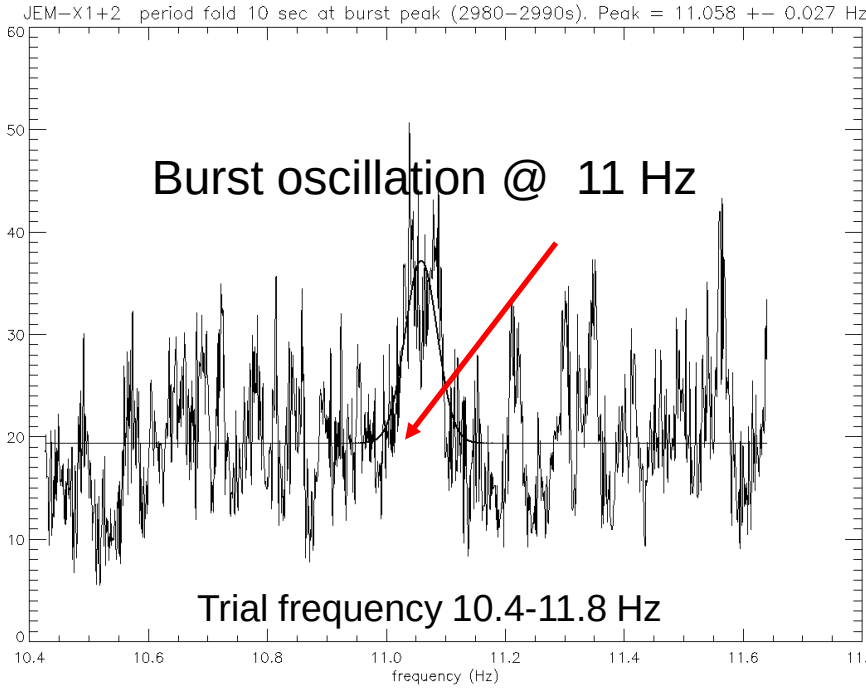


JEM-X SDAS

IGR J17480-2446 cont.

- Shown by XTE to be 11 Hz pulsar
  - Slowest spinning bursting neutron star
- Most X-ray burst neutron star systems do not show pulsations
- Neutron star spin period only revealed very briefly during burs
- Observed by JEM-X





JEM-X operations

- JEM-X is running smoothly
- Only exception is the “eclipse recovery anomaly”
  - During eclipse the JEM-X DFEE is switched off
  - Sometimes the recovery of the DFEE memory configuration fails/stops with a CRC error reported
  - Troubleshooting has shown that there is no real error
  - A procedure to proceed with instrument activation without reboot has been implemented (to prevent loss of observing time)
    - Anomaly was seen in JEM-X2 in 1022, but reboot was performed (less experienced operator and other factors)

Anode status

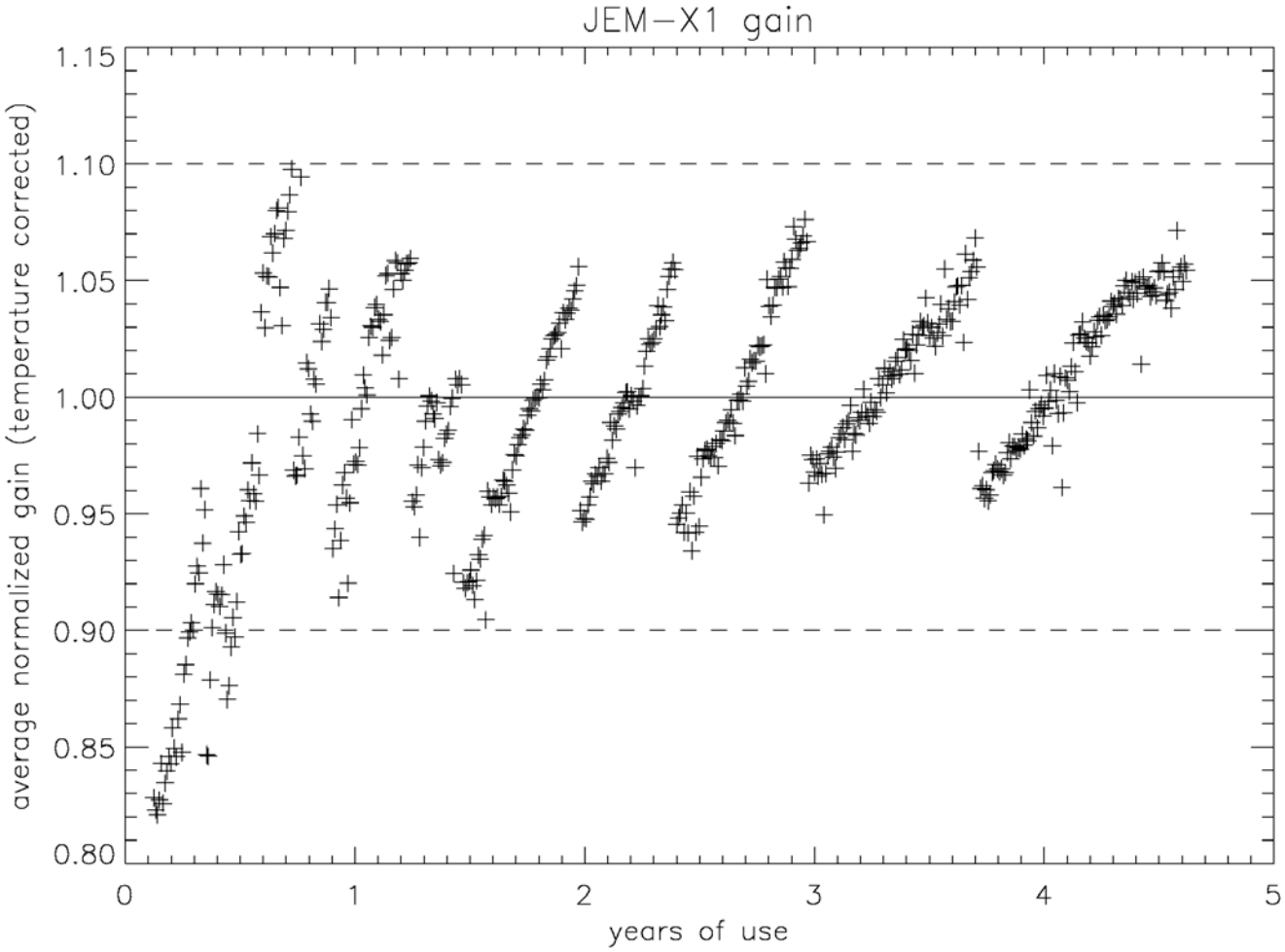
- ~So far – on average 2-3% loss per year (256 anodes in total), but now about 1% per year
- However, no loss during ~12 months period in 2007-08
  - Two strips lost in 2008, one in March 2009, one in Aug 2010
- JEM-X1 (~750 orbits of use)
  - 62 of 256 anodes affected (almost 25% of area)
    - 38 dead (4 pre-launch, 1 lost during 2009, 1 lost during 2010)
    - 13 neighbor
    - 11 unstable or low
- JEM-X2 (~350 orbits of use)
  - 60 of 256 anodes affected (almost 25% of area)
    - 31 dead (9 pre-launch) (+2 since Oct 2009)
    - 18 neighbor
    - 11 unstable or low (+3 since Oct 2009)

Gain evolution

- JEM-X1 DV setting was lowered in orbit 978 to DV=70 (~700 V) and further i orbit 1010 to DV=69 (690 V)
- 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 orbit 1010
- Gain evolution is caused by ion conducting glass substrate of the micro-strip plate

DTU Space
National Space Institute

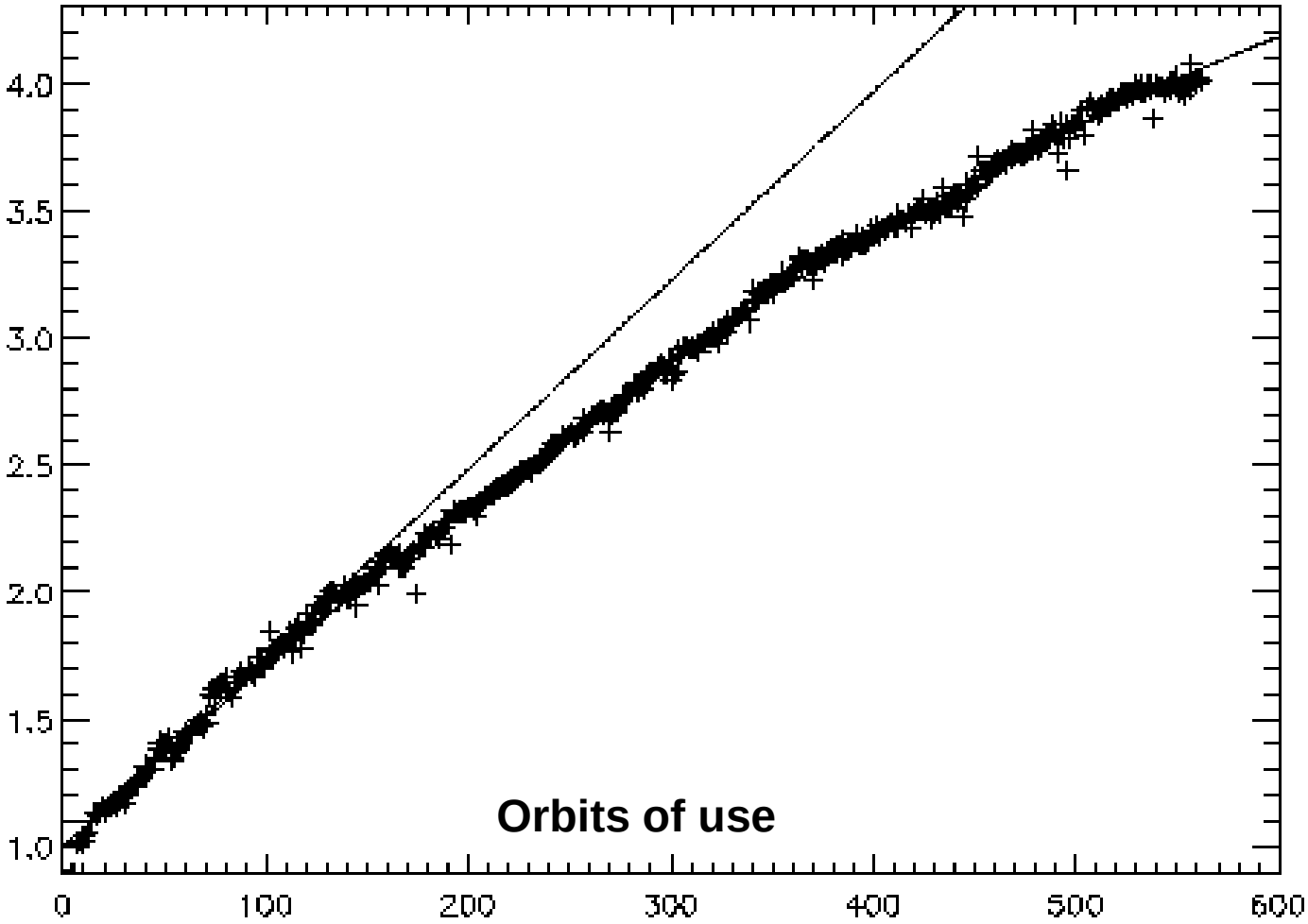
Gain evolution to orbit 735



DTU Space
National Space Institute

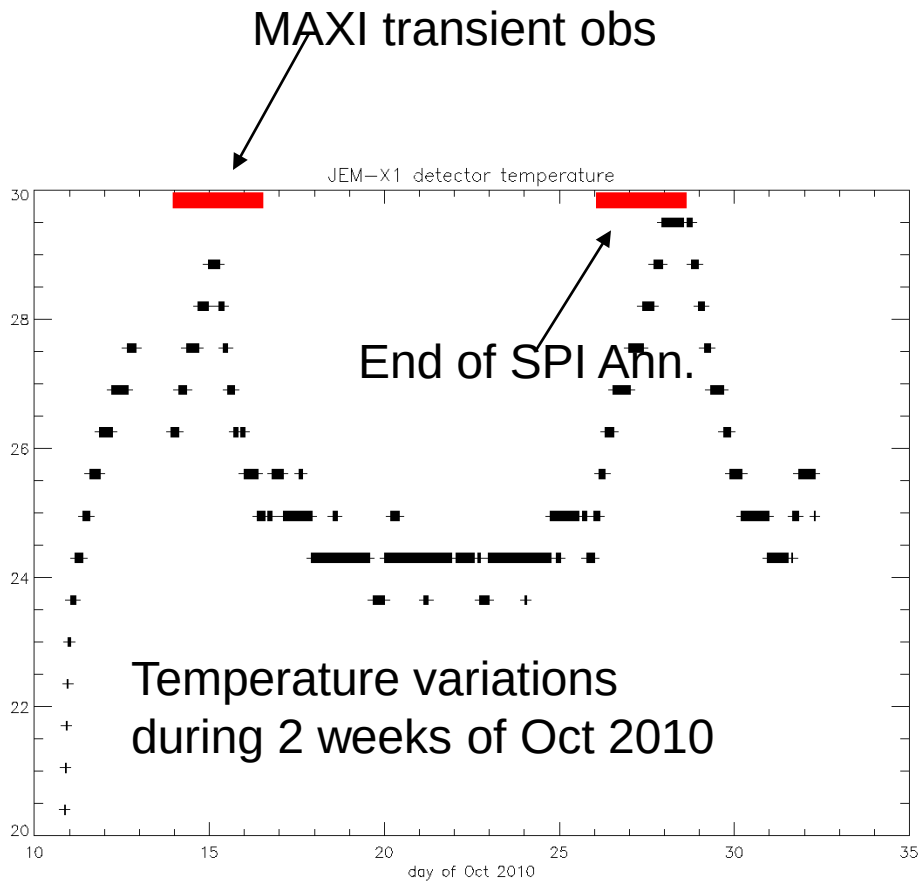
Total gain increase

- Increase is slowing down from 0.8% to 0.4% oer orbit



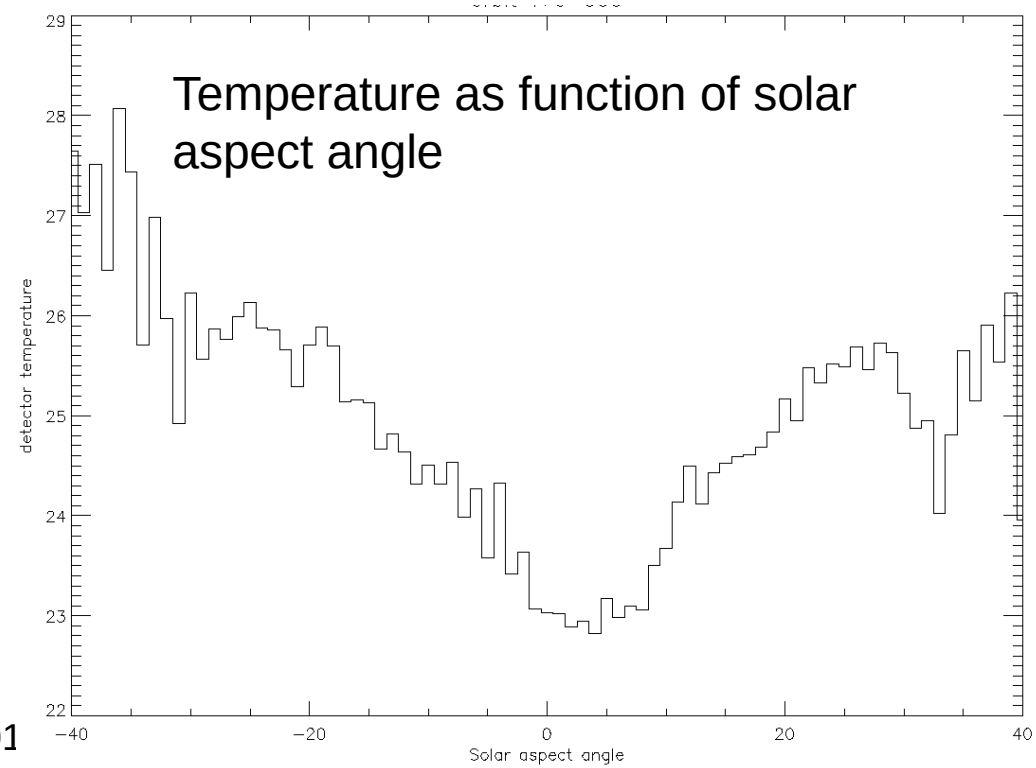
Gain dependence on temperature

- Gain varies as function of temperature
  - ~1%/°C pre-launch
  - JEM-X1 now: ~4%/°C
  - JEM-X2 now: ~2.5%/°C
- ~5°C amplitude
  - 20% gain variation



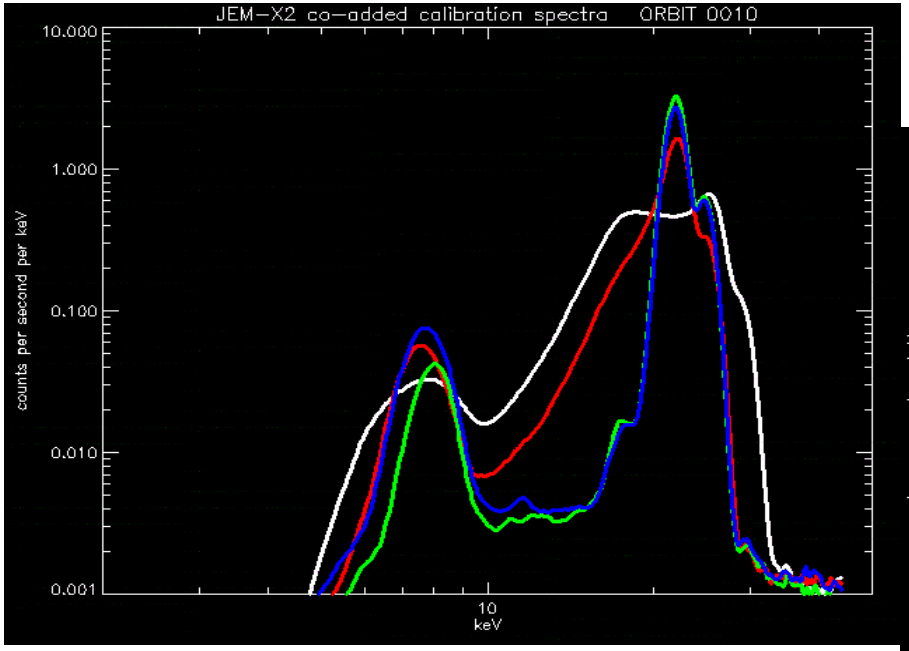
Detector temperature variation

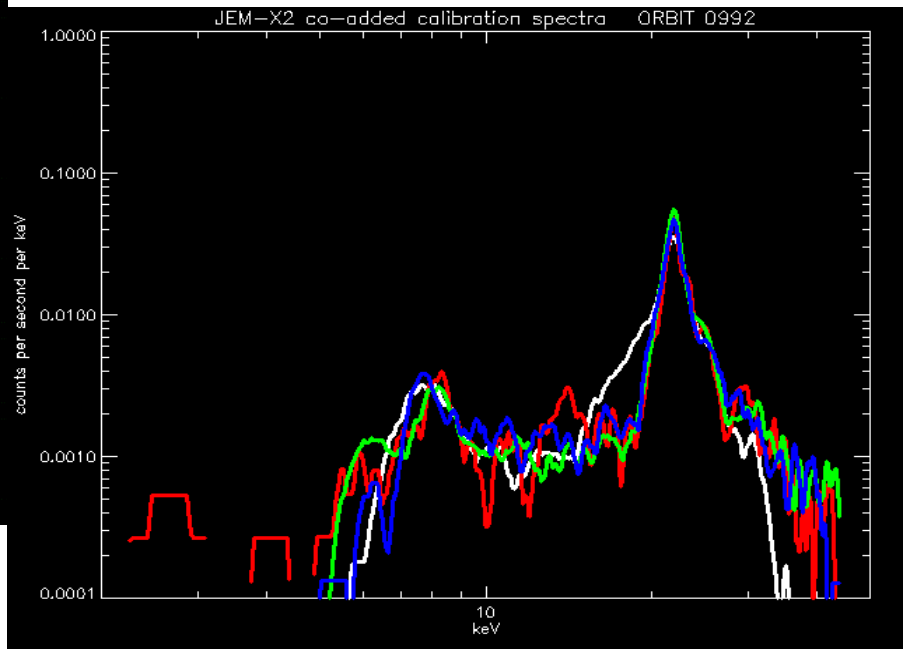
- The JEM-X detector temperature depends on the solar aspect angle
  - +5° to +3° when toward and away from Sun



JEM-X2 calibration spectra (rev. 10 and 992)

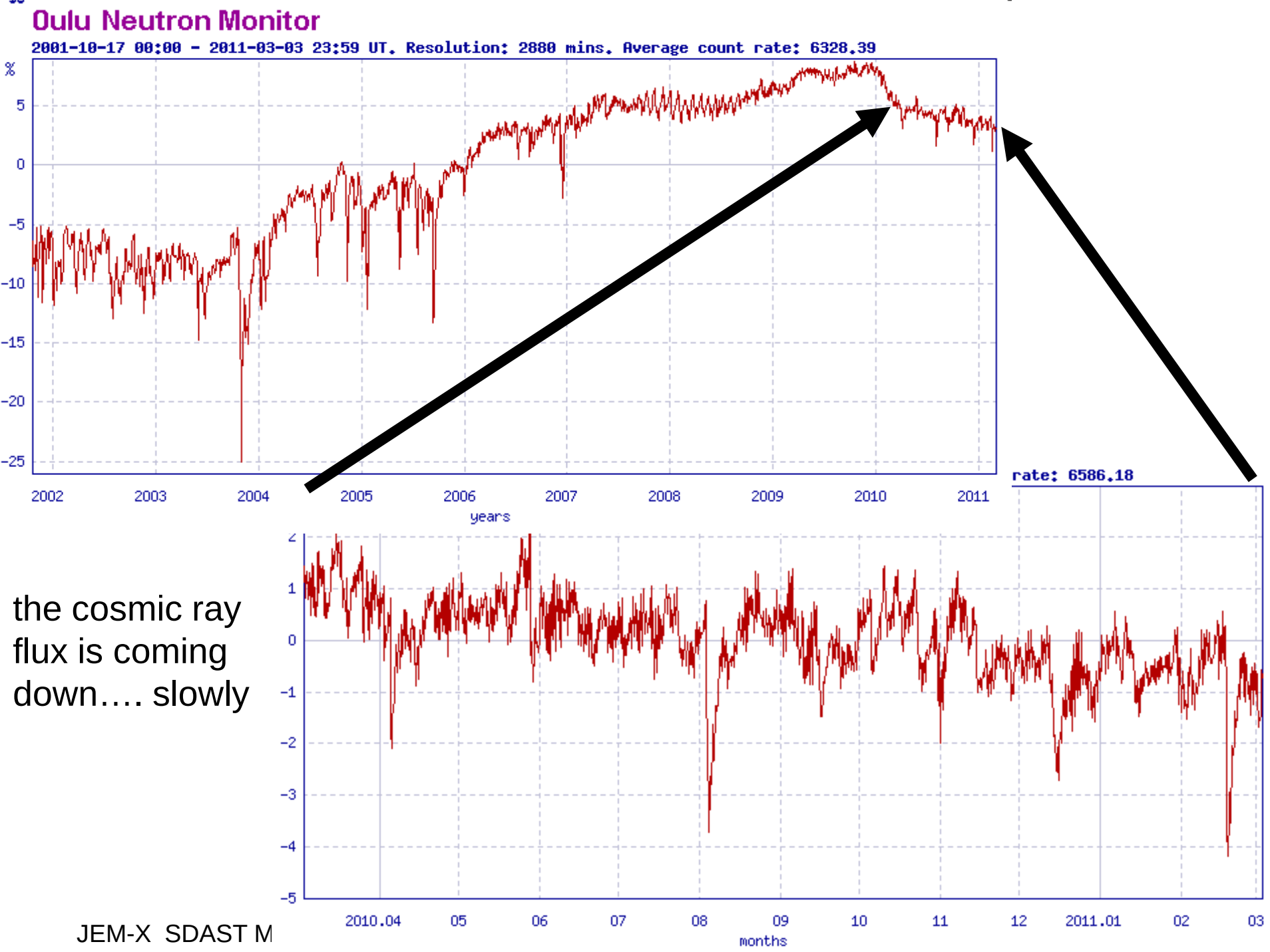
- JEM-X2 has 4 Cd sources, which are down by a factor of ~90 since launch
- Calibration spectra integrated over longer time to fit the line
- Xe fluorescent line from detector gas at 29.6 keV also used





JEM-X Gain calibration in OSA

- Gain calibration requires continued efforts because of the decaying calibration sources
- data must be collected in increasing time periods
- offline analysis of gain to ensure correct results
- Calibration provided by “Instrument Characteristics” tables delivered to ISDC for each revolution
- Eventually the gain calibration will rely on the Xe fluorescence background line at 29.6 keV



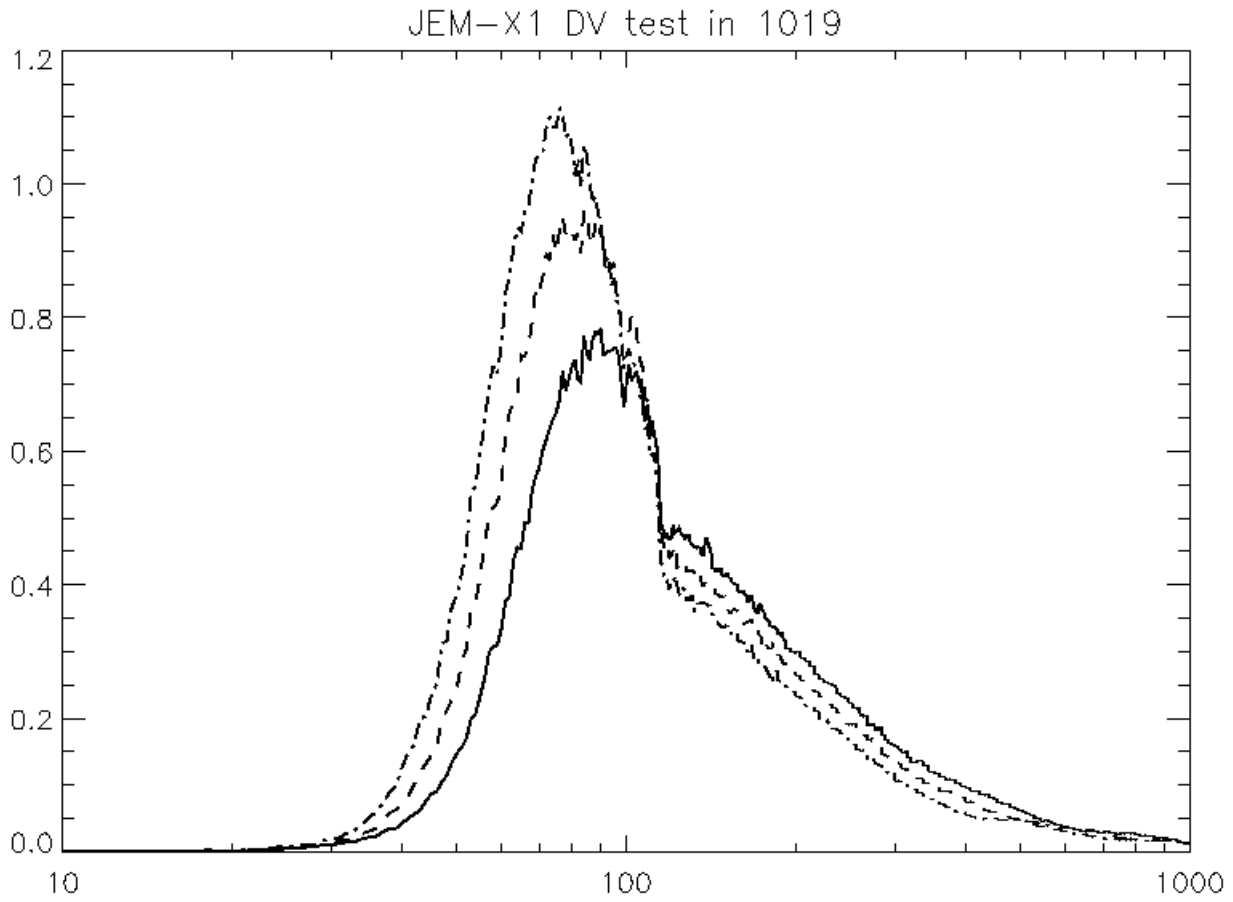
the cosmic ray flux is coming down…. slowly

Calibration

- Circle of 4 degree off axis completed in 774 and 839 Crab calibrations
  - Systematics in light curves on the order of 5% due to the collimator
- In 902 Crab staring during start of orbit to check the gain correction and electronic efficiency after HV activation
- Recent Crab calibration (1019):
  - JEM-X request for checking electronic efficiency by stepping down the DV (3 different levels with each 6 ks Crab on-axis)
  - Diagnostic data request with and without increased drift voltage
    - Purpose: Verification of event selection criteria
  - The 2 5x5 dithers on the Crab were performed with different drift voltage settings
    - Double triggers due to particle tracks is reduced
    - Analysis of data is ongoing
- Big question: do we have “pile-up” problems that introduce a reduced efficiency as function the particle rate??

DTU Space
National Space Institute

DV-test: observing the same Crab spectrum at different gain

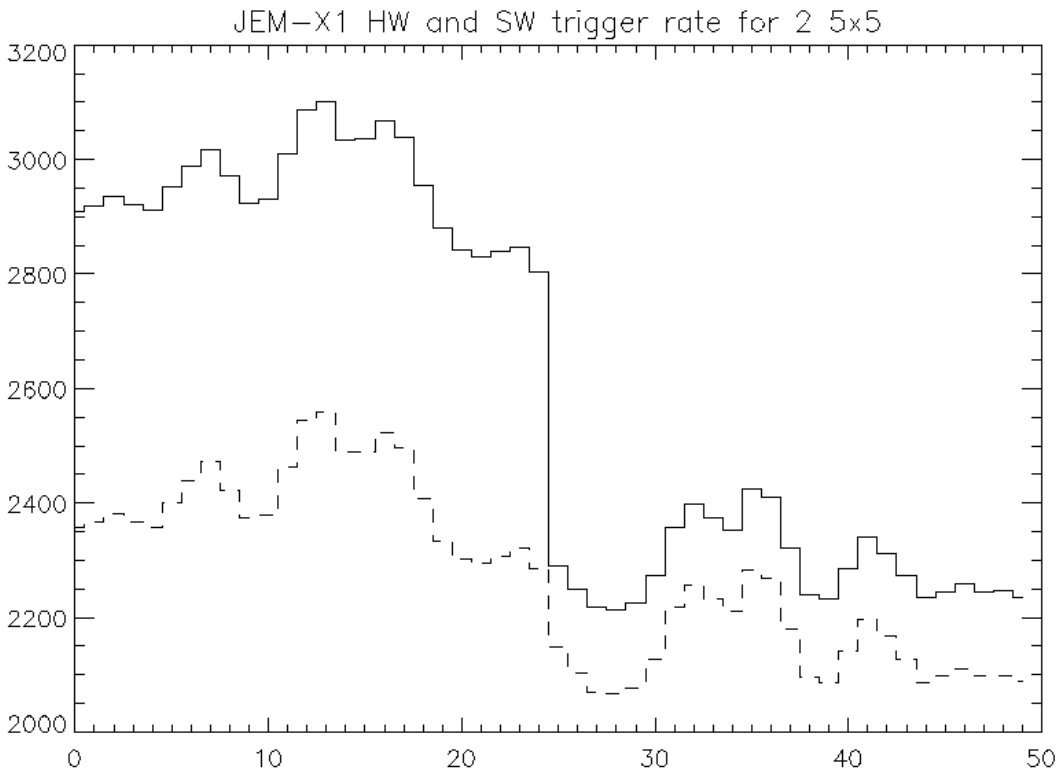


ace

National Space Institute

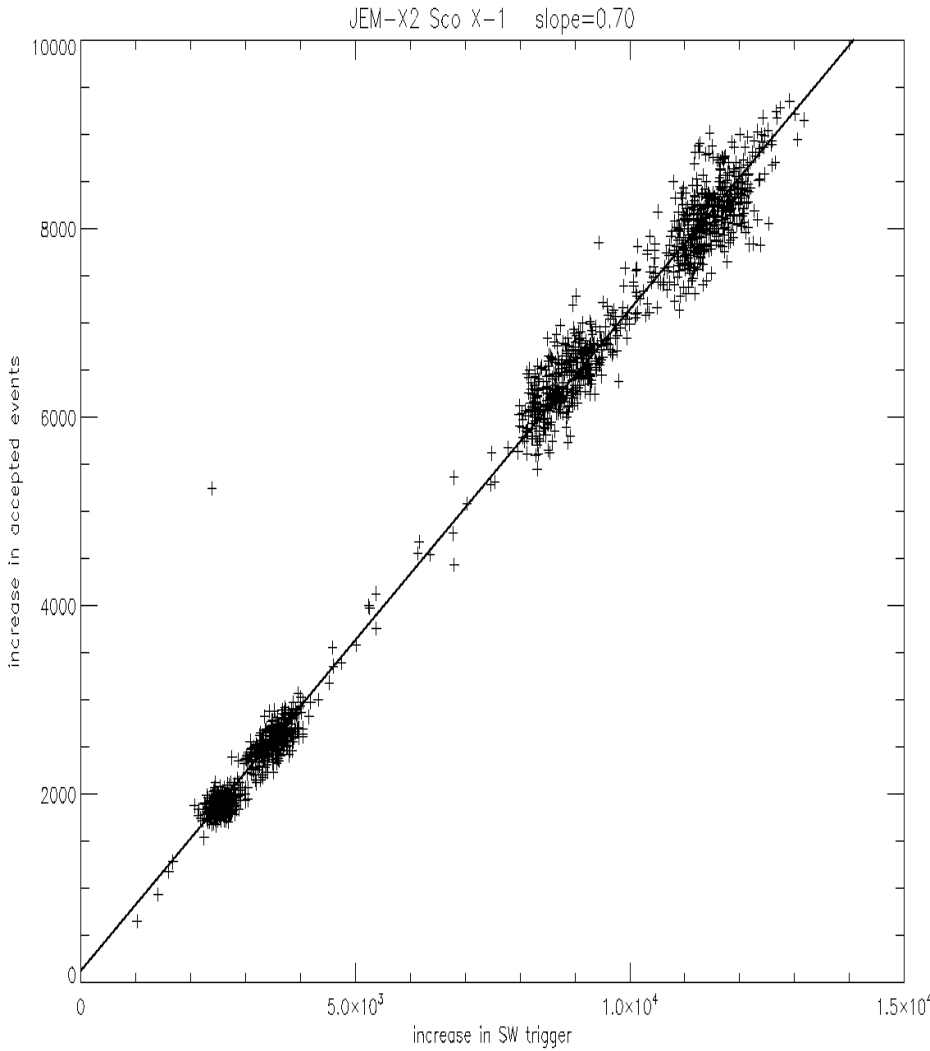
Drift voltage test on 5x5 dither

- Double trigger rate is reduced from ~20% to <5%



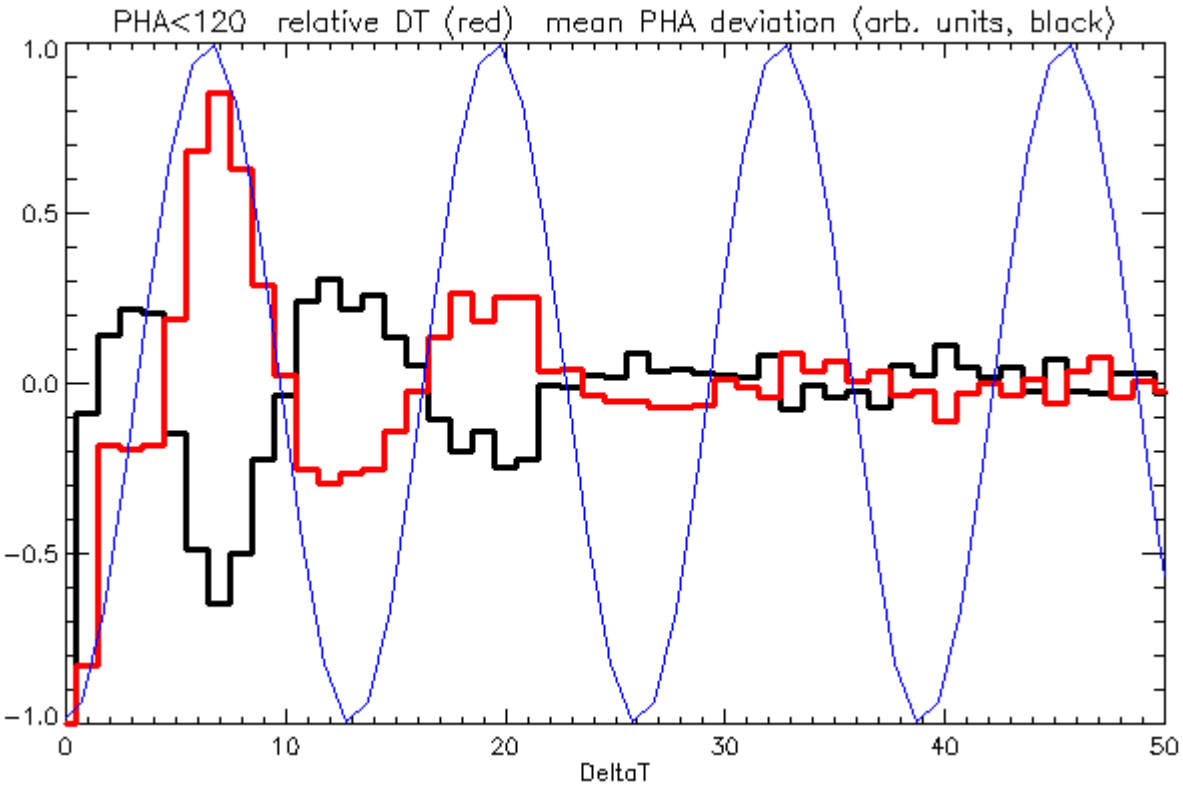
Under-estimated dead time?

- 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?
  - Recent Crab exercises may help find an answer



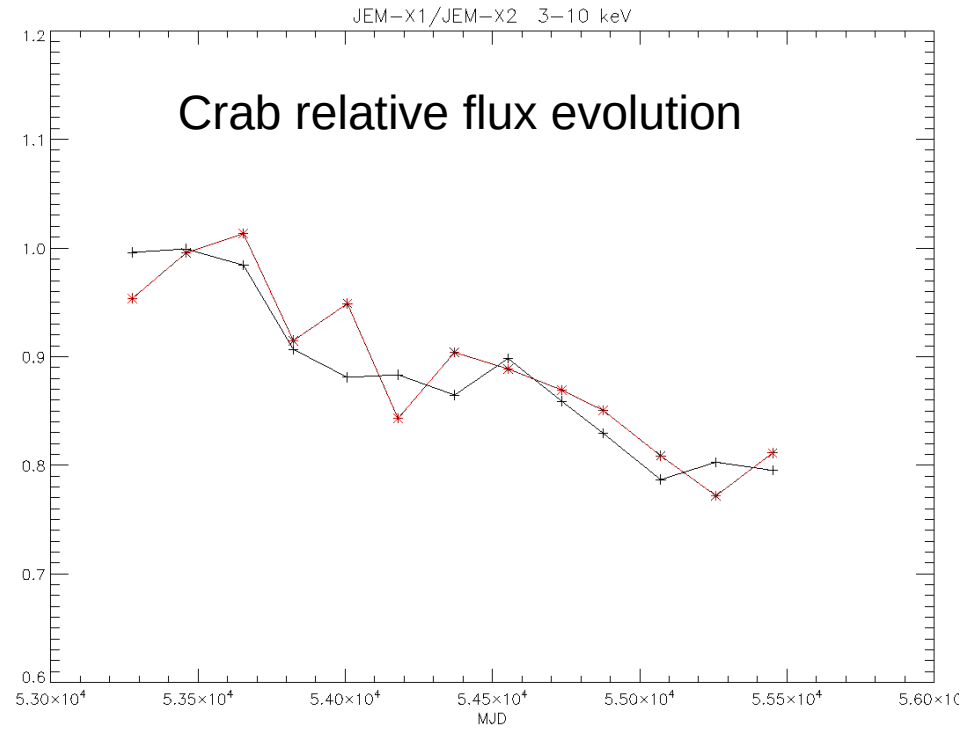
Delta-time distribution deviations

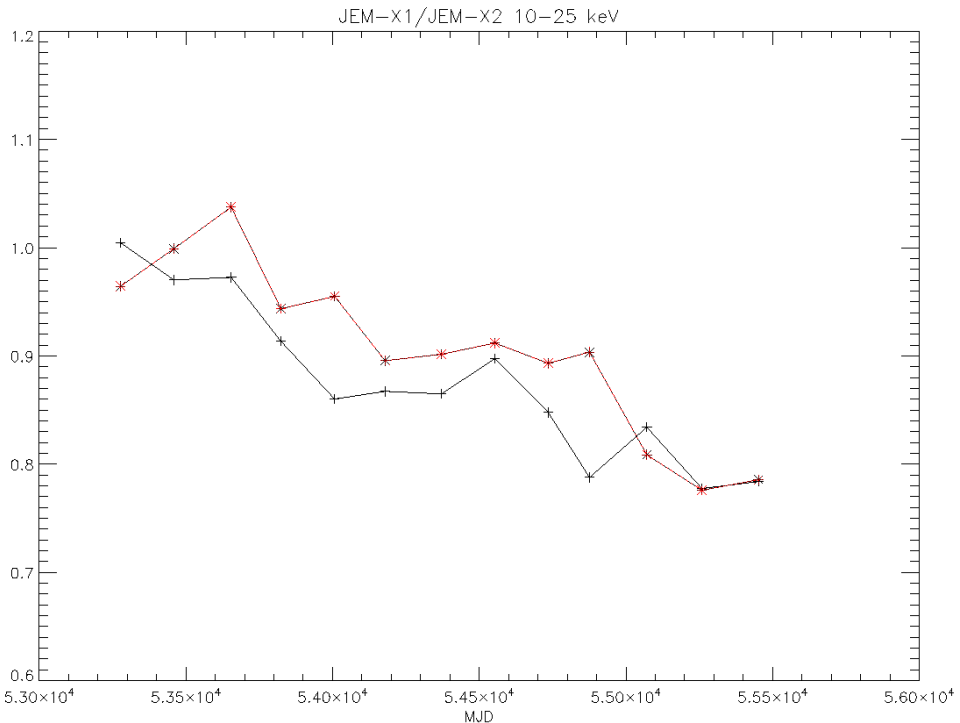
- Deviation from Poisson distribution at small delta-times



JEM-X1+2 Crab offline analysis

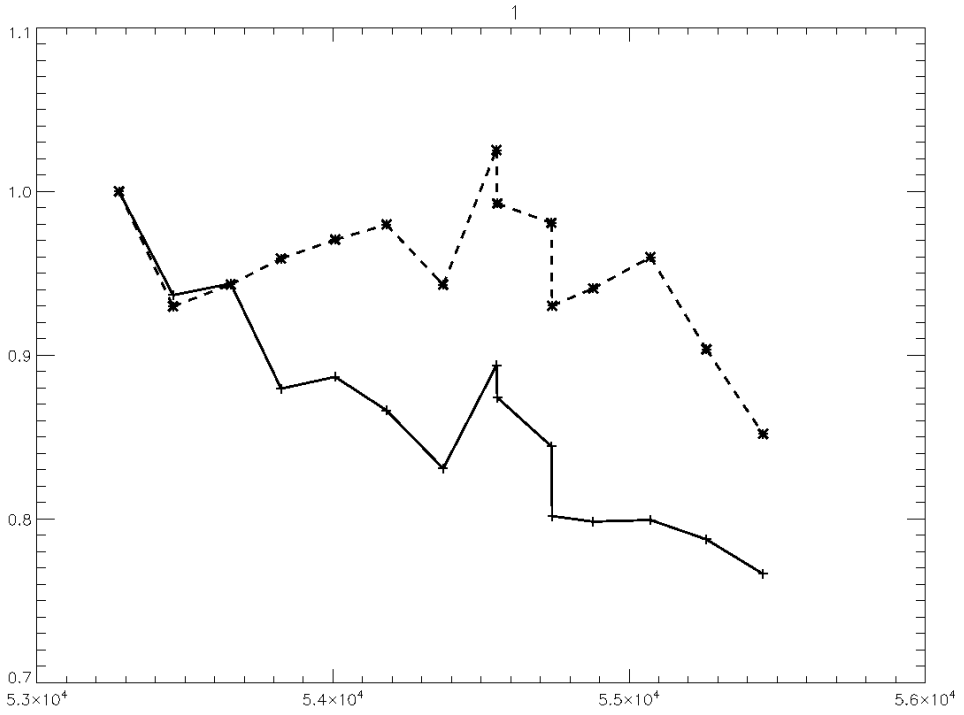
- Standard analysis generally confirm the Crab variability results
- First attempt at “first principle” analysis show general decay trend with variability
  - correlation with cosmic ray flux

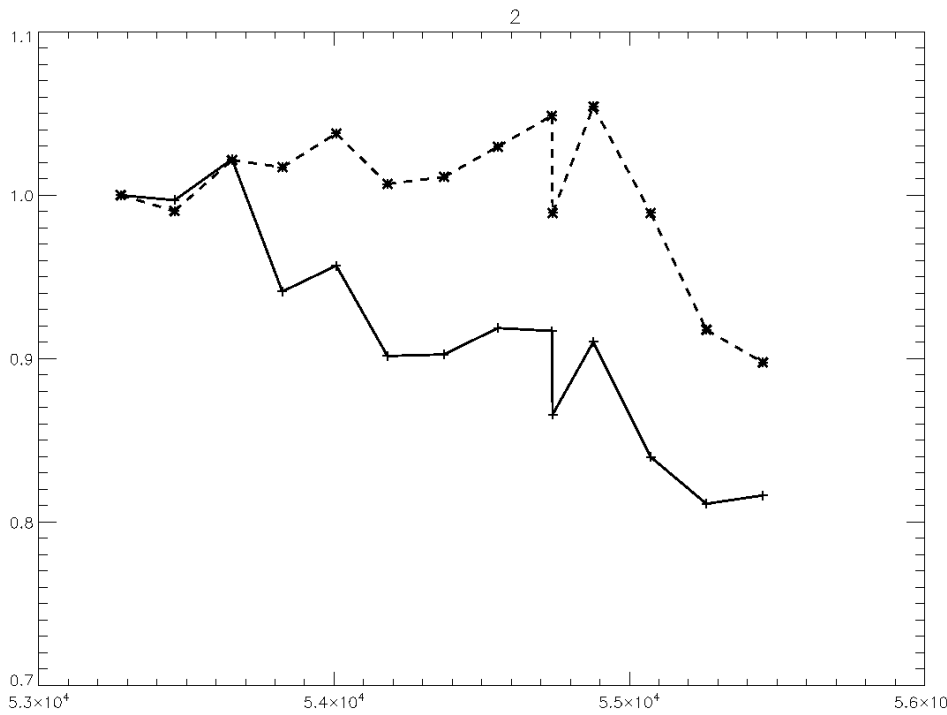




JEM-X Crab trend

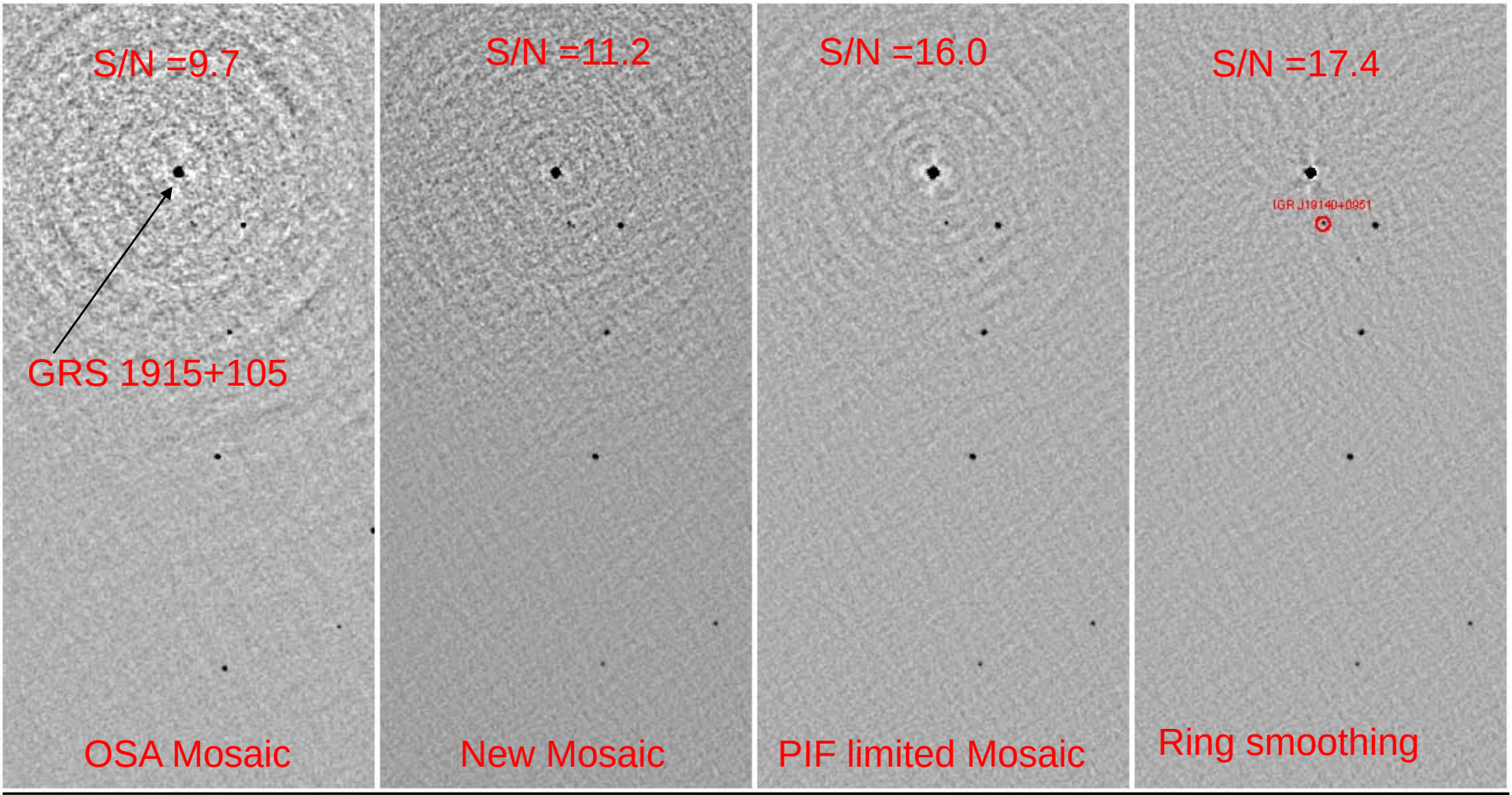
- Work in progress: The overall trend may include unknown dead-time effects due to increased particle rate?
- Further discussion by Carl





Improving imaging – direct fitting

- GRS 1915+105 field example (8°x16° field), 3-7 keV band
- JEM-X1 1800, science windows (rev 170-735)
- IGR J19140+0951 as example of weaker source close to strong



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
- OSA 9 has improved flux stability
- Team is still intact (Silvia Martinez, UA, re-joined!)
- We expect JEM-X and INTEGRAL to operate through 2014 (and longer?)
  - Performance is monitored to ensure that running both units will not endanger the future use

DTU Space
National Space Institute