Technical University of Denmark

DTU

JEM-X Status, June 2011

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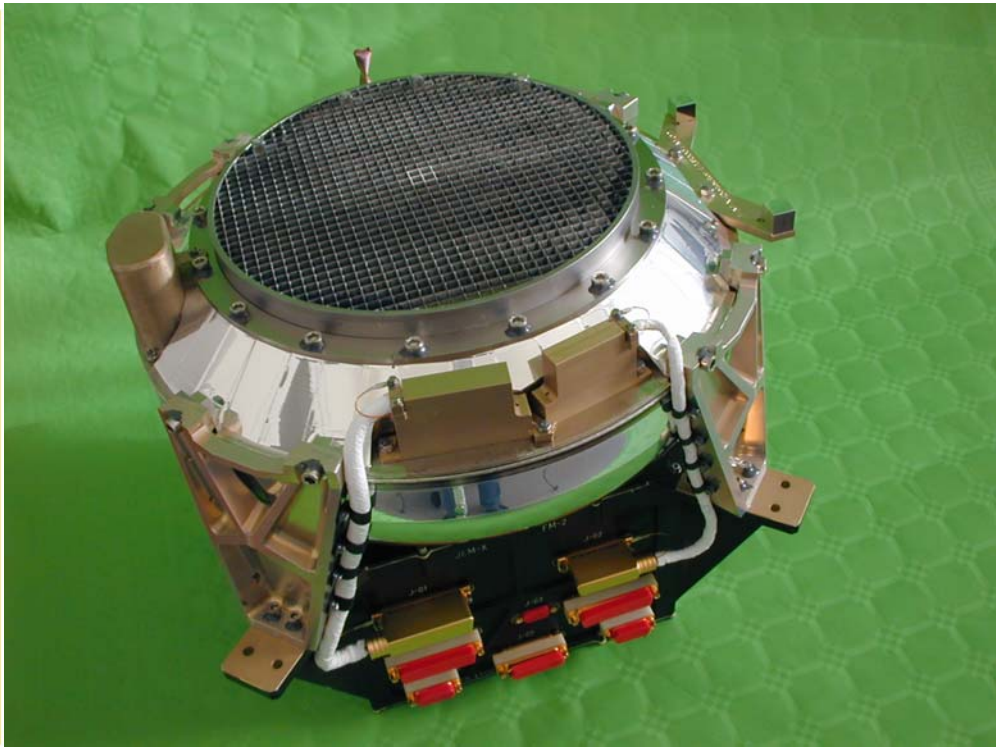
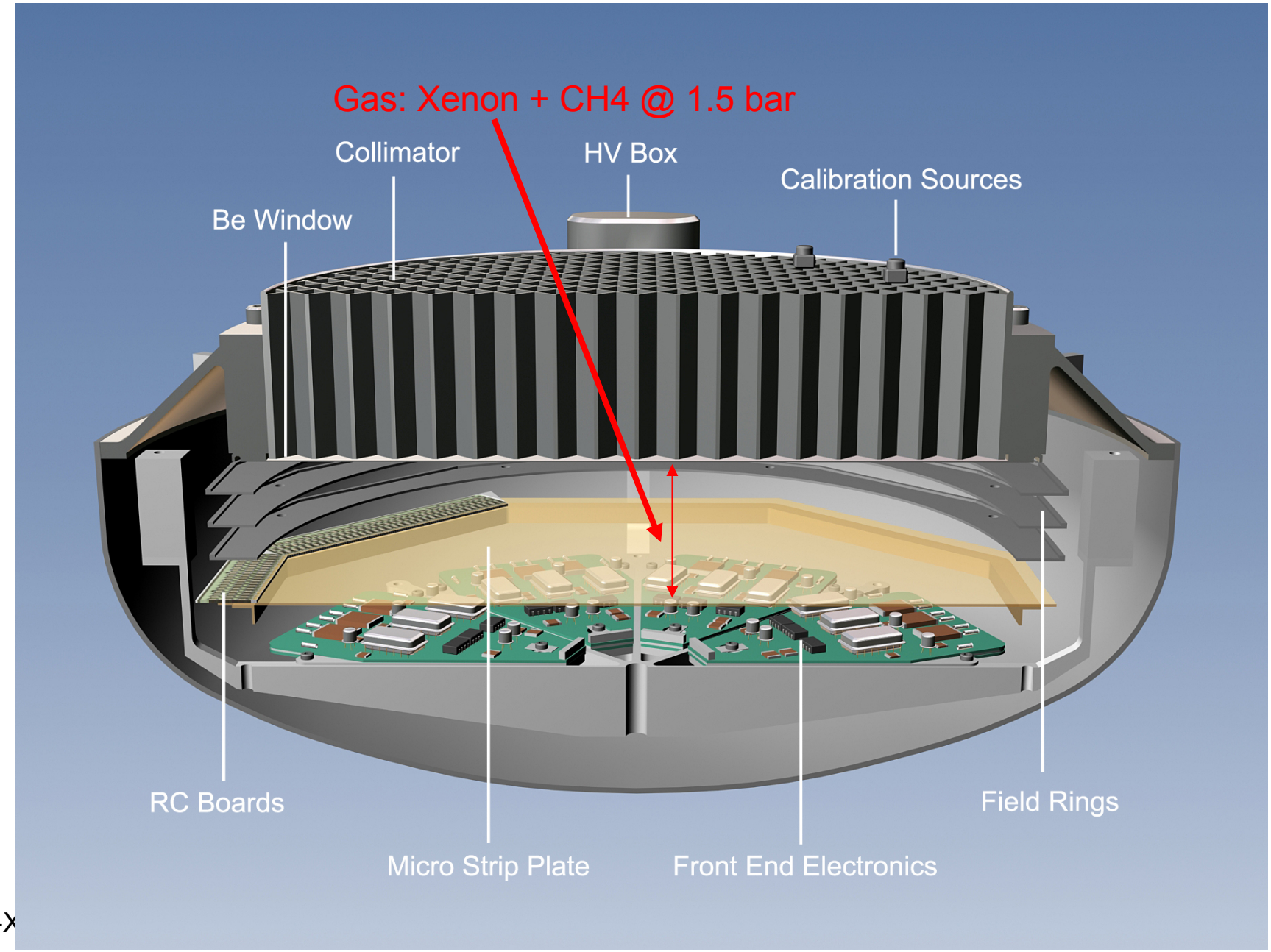
JEM-X X-Ray Telescope on INTEGRAL

- 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



Inside the JEM-X detector



Both JEM-X units now default configuration

- JEM-X1 was used from rev. 170-855 and has now been used for ~780 revolutions (~7 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 ~400 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

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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 (~720 orbits of use)
  - 63 of 256 anodes affected (almost 25% of area)
    - 39 dead (4 pre-launch, 1 lost during 2010, 1 lost during 2011)
    - 13 neighbor
    - 11 unstable or low
- JEM-X2 (~330 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)

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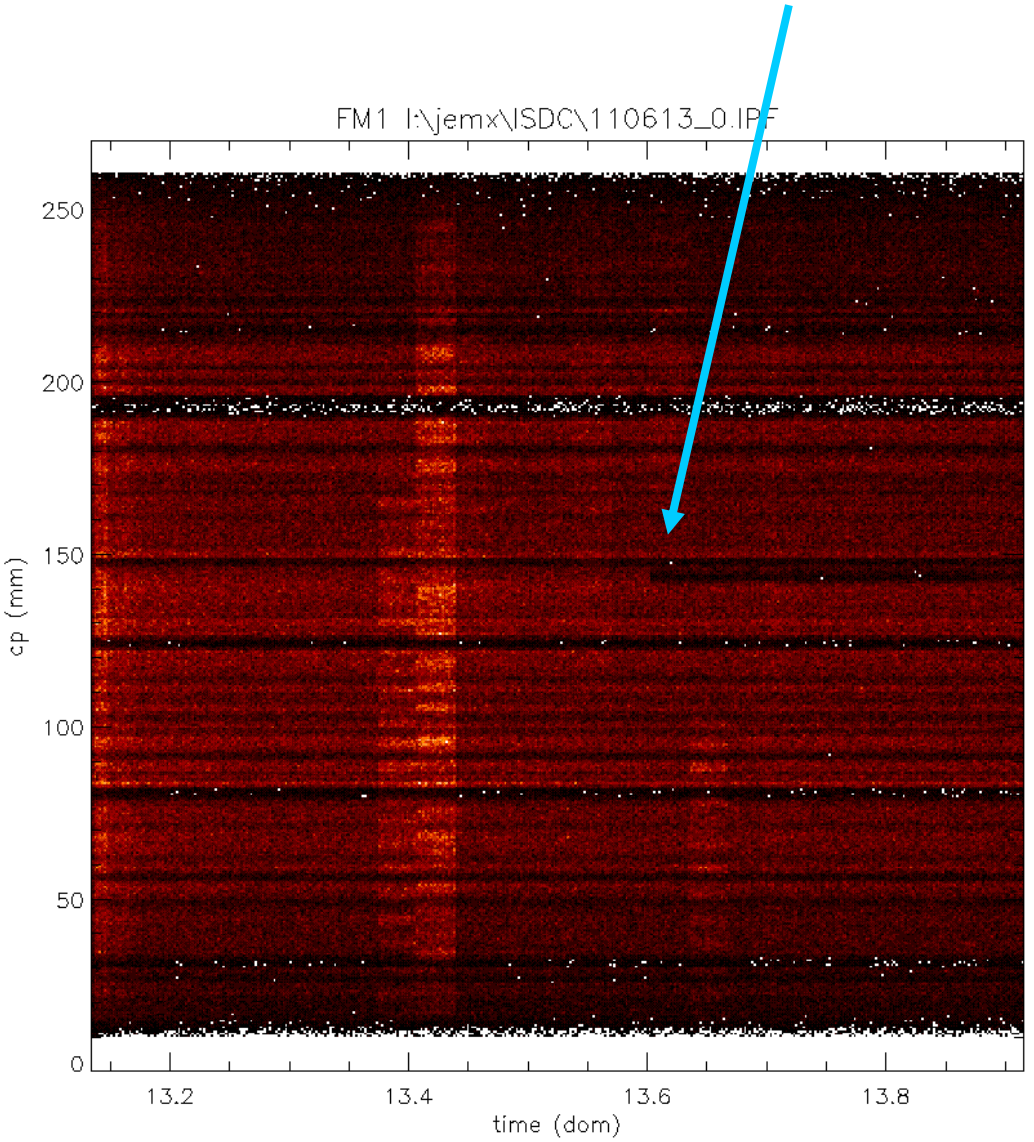
Most recent JEM-X1 anode loss

- One strip in JEM-X1 was lost in April 2011, appears to be briefly active June 12-13, 2011, then dead again….



Gain evolution

- JEM-X1 DV setting was lowered in rev. 978 to DV=70 (~700V) and to DV=69 (~690V) in rev. 1010, Jan 20, 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
- Gain evolution is caused by ion conducting glass substrate of the micro-strip plate

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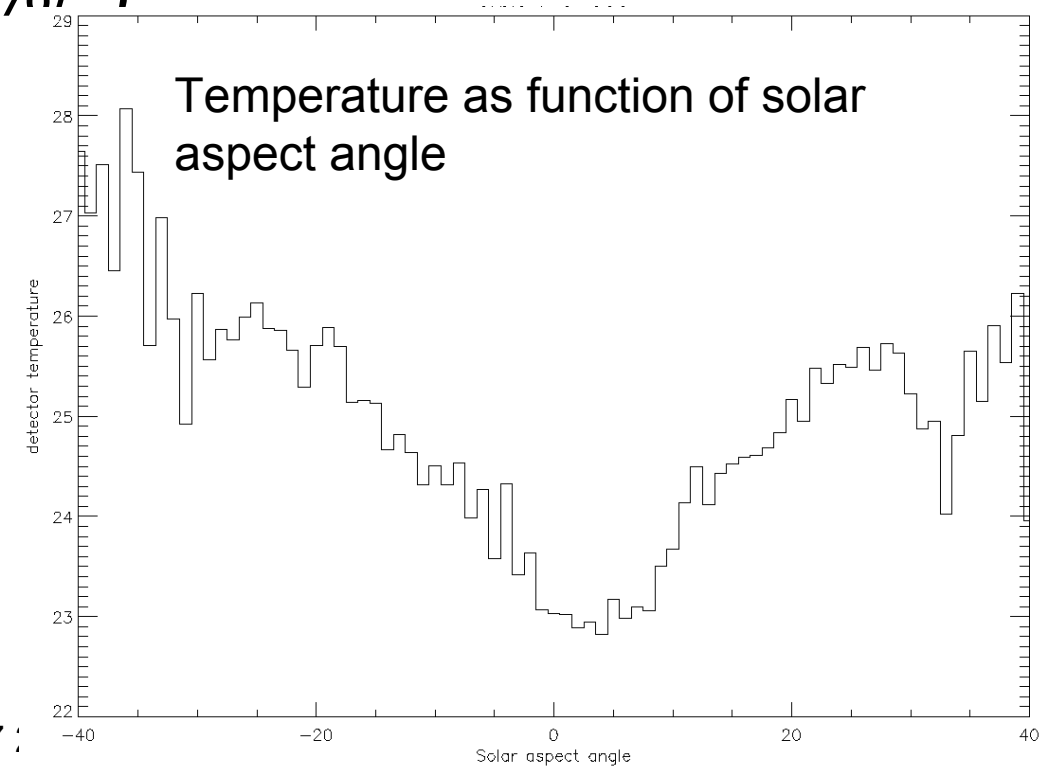
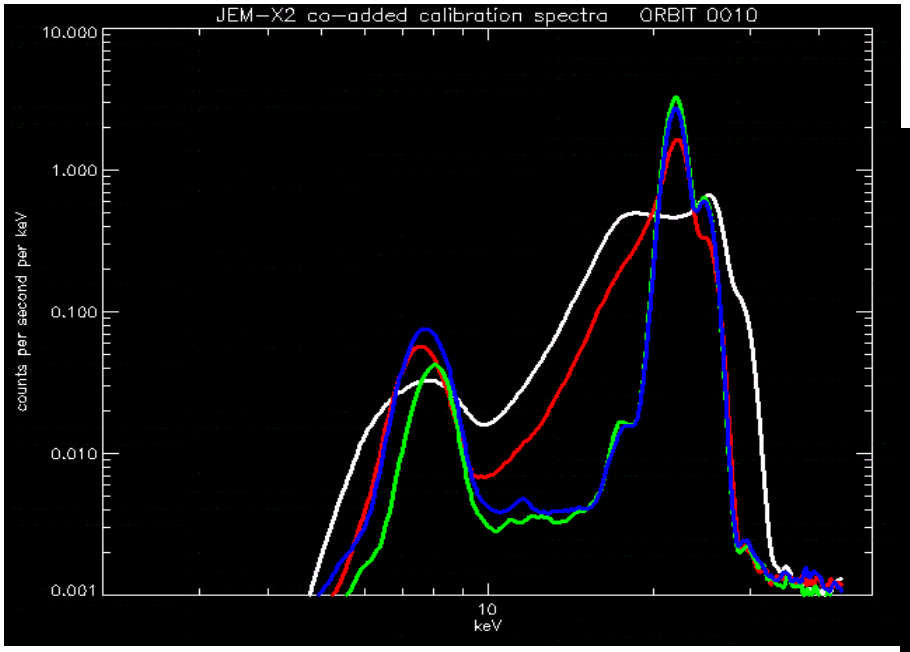
Detector temperature variation

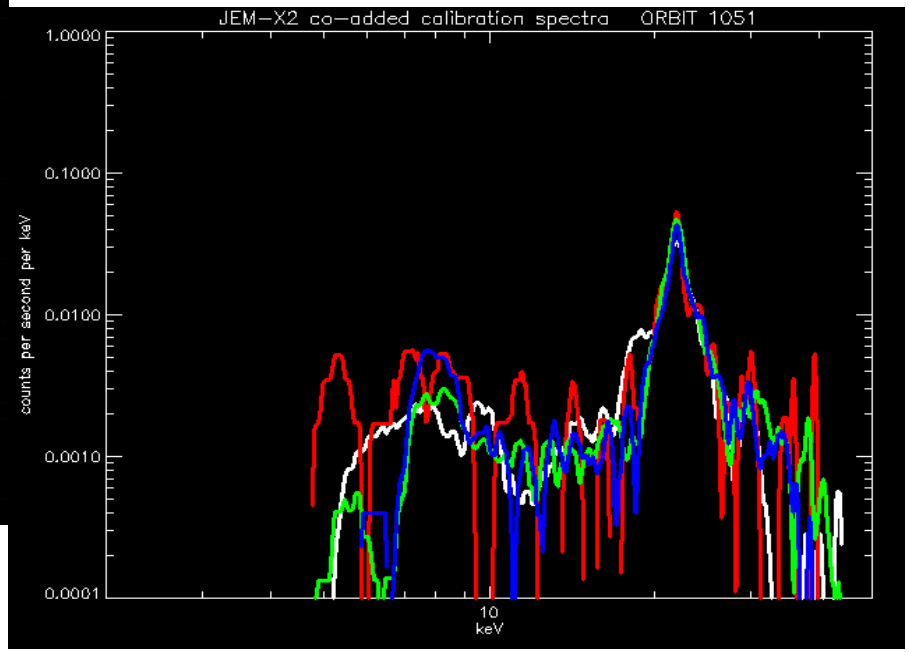
- The JEM-X detector temperature depends on the solar aspect angle
  - +5° to +3° when toward and away from Sun
  - Detector gain has become more dependent on temperature (4%/°)



JEM-X2 calibration spectra (rev. 10 and 1051)

- 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
  - Further complicated by increased dependence on temperature = more variation over an orbit
- 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 and temperature variation modeling

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the cosmic ray flux is coming down…. slowly

Calibration

- Recent Crab calibration in revolution 1019
- JEM-X request for checking electronic efficiency by stepping down the anode HV settings
- Diagnostic (full information) data request to verify the particle rejection criteria
- Increased drift voltage setting to check ”double-trigger” problem

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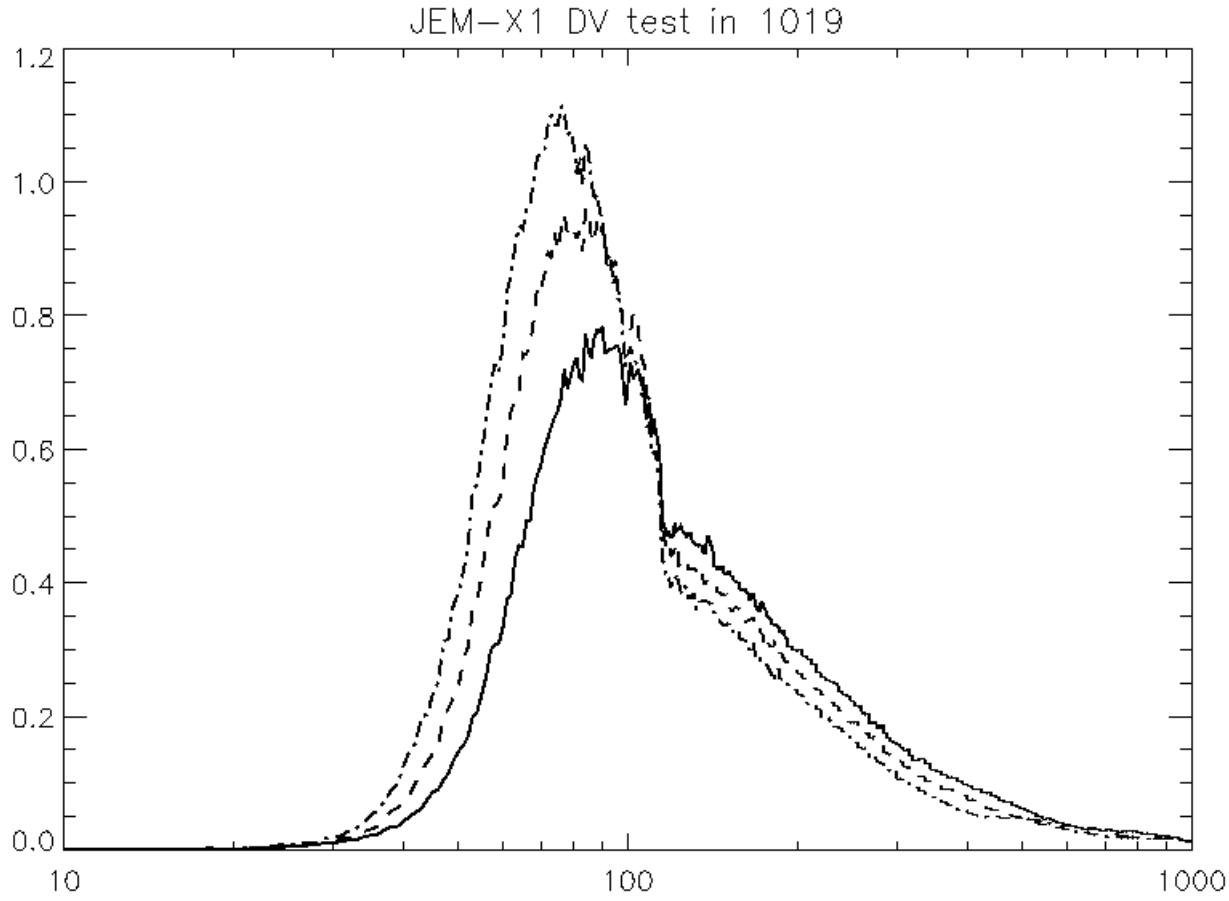
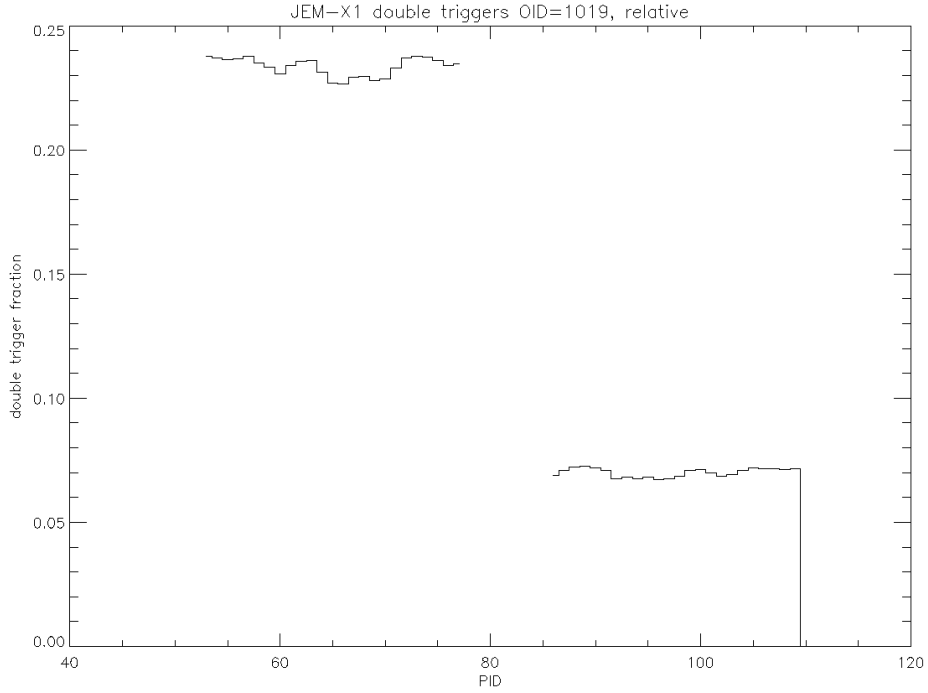
DV-test: observing the same Crab spectrum at different gain

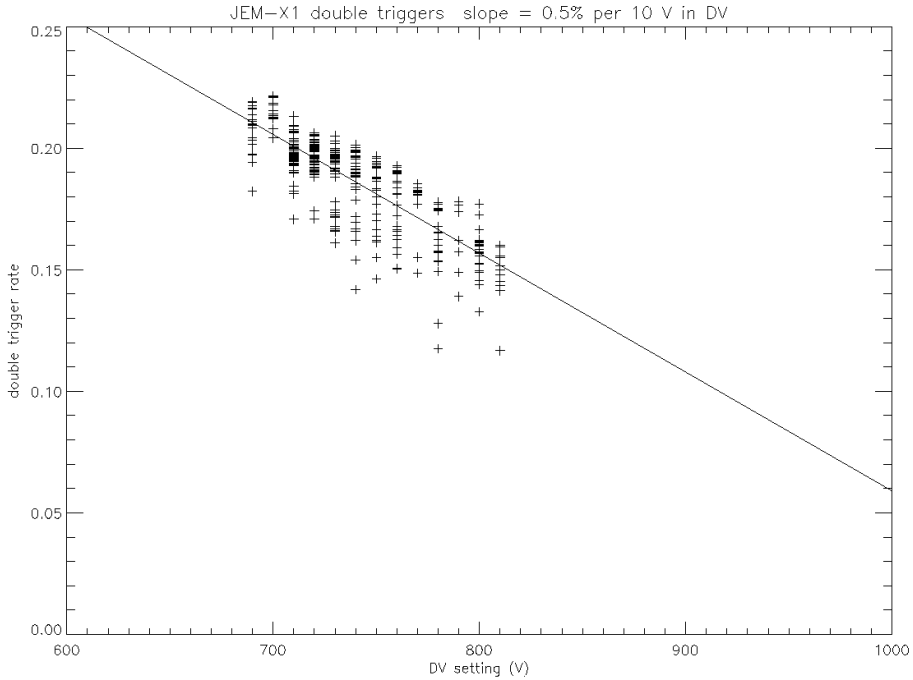
- Relative measurement gives electronic efficiency



Drift voltage test on 5x5 dither

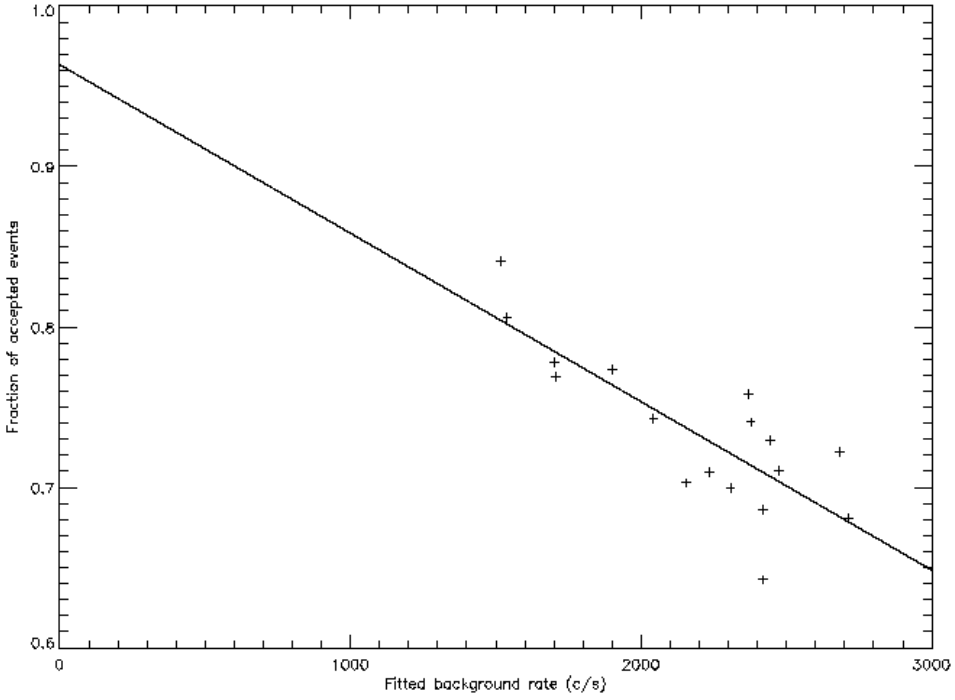
- Particle tracks in the 50 mm thick detector gas volume are able to trigger the HW, if not “cleaned-up” in less than ~6 μs
- Double trigger rate is reduced from ~20% to <5% when drift voltage is increased from 1120V to 1280V
- Drift voltage is coupled to the anode voltage, DV, which has been reduced over the years to counteract gain increase.





Background induced dead time

- Under study:
  - Extra “dead time” may be introduced by particles disturbing the slow anode signal, causing true X-ray events to fail the selection criteria



Crab Calibration

- Ongoing work (Niels Jørgen Westergaard and Niels Lund) to re-analyze all Crab data
  - Update time/energy dependent corrections factors by spectral fitting
  - Described in tech-note by NJW
- Derive updated IMOD IC files with efficiency as function of energy and time
  - Cross calibration work with IBIS and SPI
- Updated IC files to be delivered soon to ISDC

Revolution	JMX1	JMX2
170	20	20
177	1	-
225	1	-
239	61	52
242	1	-
300	30	30
352	16	-
365	17	-
422	99	99
468	1	-
483	34	-
541	54	35
605	43	35
665	41	-
666	45	37
727	41	-
728	44	44
834	7	-
835	5	-
836	4	-
839	48	48
902	21	21
966	15	15
967	24	26
1019	11	11
Total number:	684	484

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Crab normalization factor

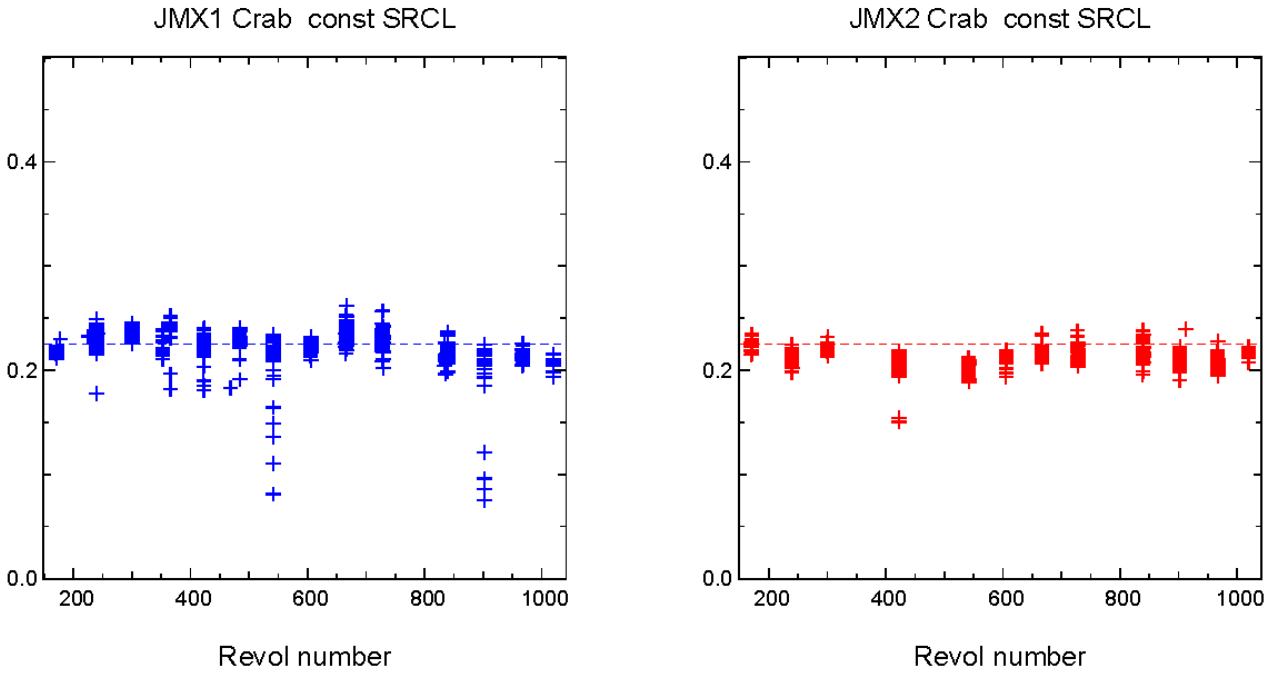


Figure 6: Fitted k_6 (normalization) as a function of revolution number. **Left panel:** JMX1 **Right panel:** JMX2

Crab spectral index

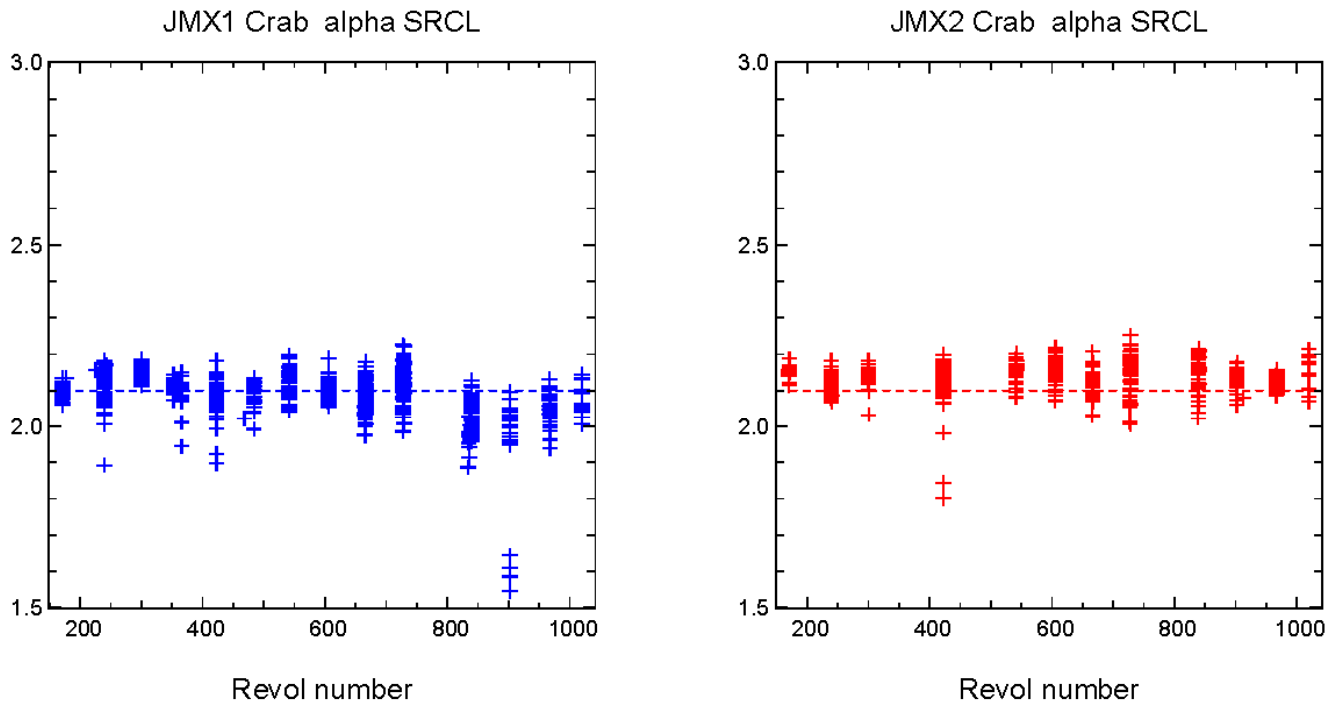
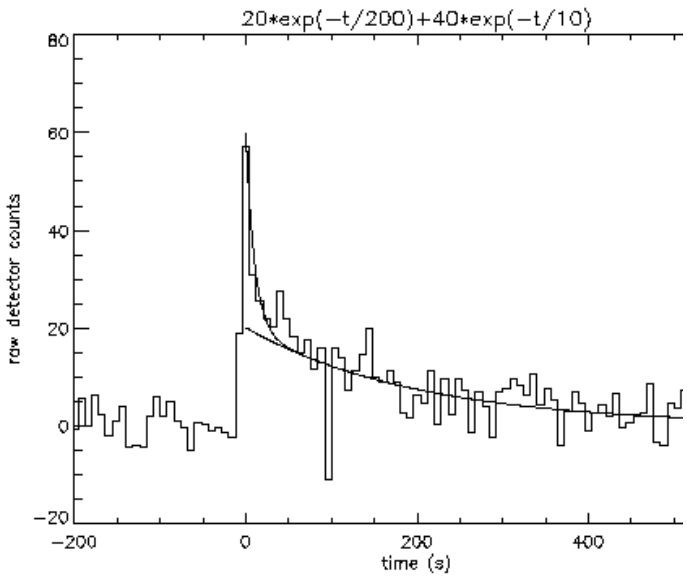
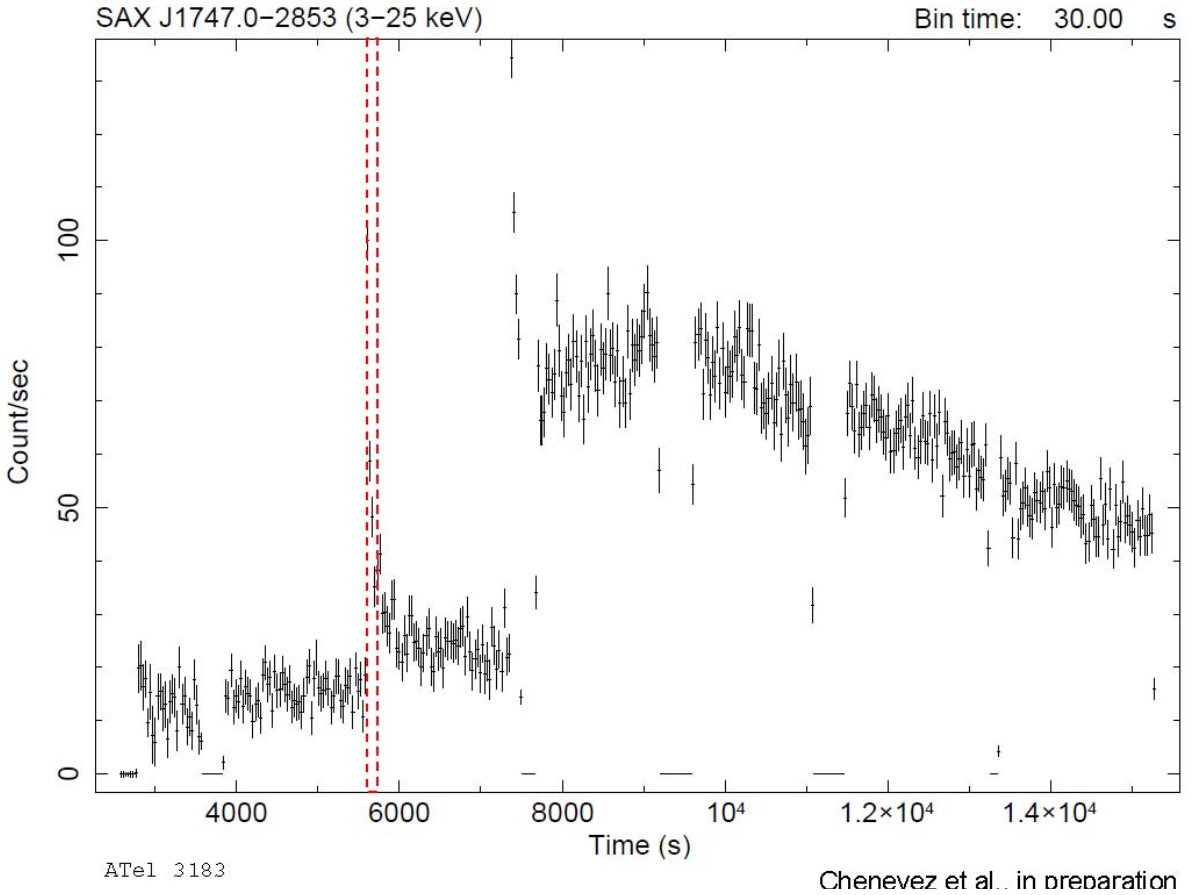


Figure 7: Fitted photon index (α) as a function of revolution number. **Left panel:** JMX1 **Right panel:** JMX2

First superburst observed by INTEGRAL, from SAX J1747.0-2853

- ATEL 3183, Chenevez et al.
  - Triggered by normal type-I burst?





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
  - Updates to IC files expected soon
- Team is still intact
- 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

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