Technical University of Denmark

JEM-X Status, January 2013

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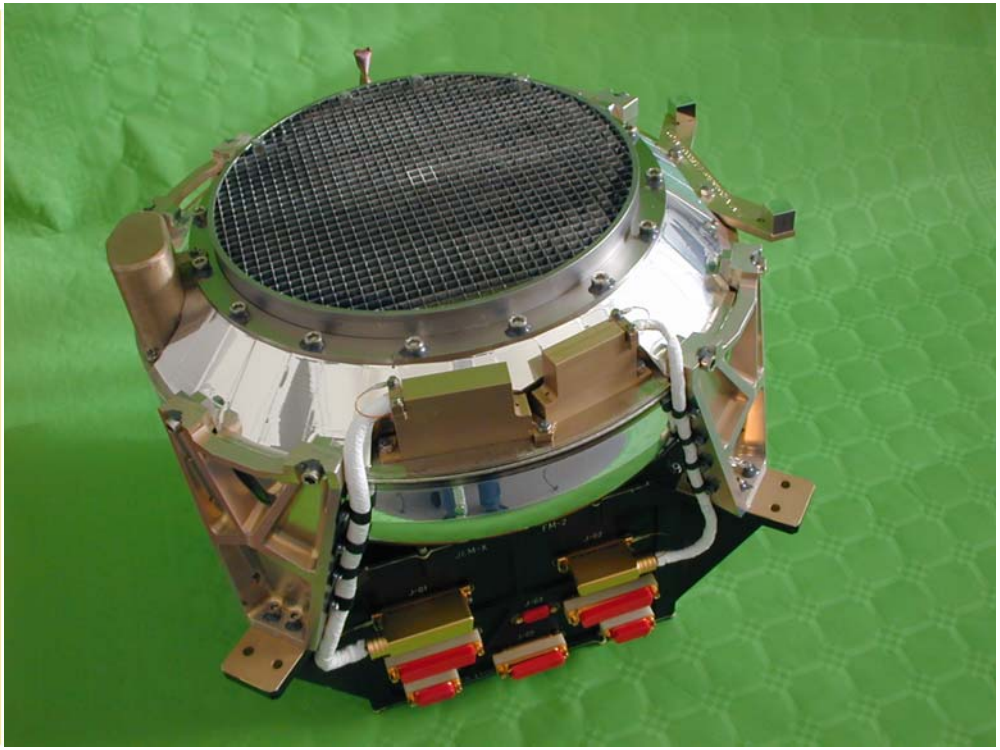
JEM-X X-Ray Telescope on INTEGRAL

- 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



Both JEM-X units on default configuration

- JEM-X1 has now been used for ~1020 revolutions (~8.5 years of use)
- Since revolution 976 (Oct 10 2010) both JEM-X units have been used (8+8 tm packets allocation, since Aug 2012 with 13+13 packets)
- JEM-X2 has been used for ~600 revolutions (~5 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 ~sqrt(2) with both units on
  - Systematics are reduced

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Anode status

- ~So far – on average ~2-3% loss per year (256 anodes in total), but now <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 (~1020 orbits of use)
  - 64 of 256 anodes affected (~25% of area)
    - 36 dead (4 pre-launch, 1 lost during 2010, 2 lost during 2011, 0 lost in 2012)
    - 12 neighbor
    - 16 unstable or low

No anode loss since Dec 2011!

- JEM-X2 (~600 orbits of use)
  - 61 of 256 anodes affected (almost 25% of area)
    - 31 dead (9 pre-launch) (+2 since Oct 2009, none lost in 2012)
    - 15 neighbor
    - 15 unstable or low (+3 since Oct 2009, none lost in 2012)

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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 (~680V) in rev. 1089, Sep 13 2011, June 21 2012 DV=67 (~670V) in rev 1183
- 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 ~4-5% 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, June 21 2012 DV=68 (~680V) in rev 1183
- Gain evolution is caused by ion conducting glass substrate of the micro-strip plate

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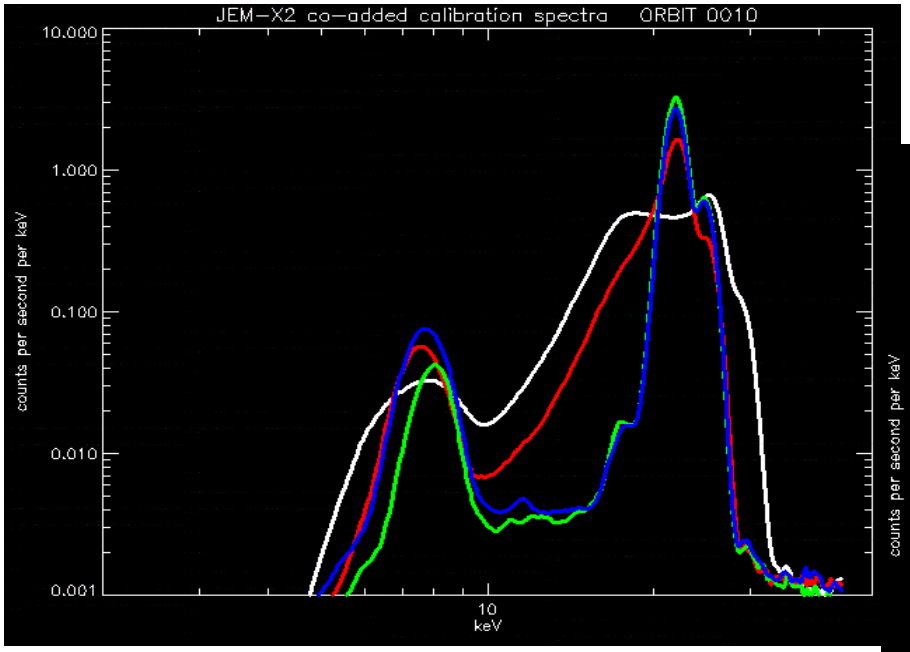
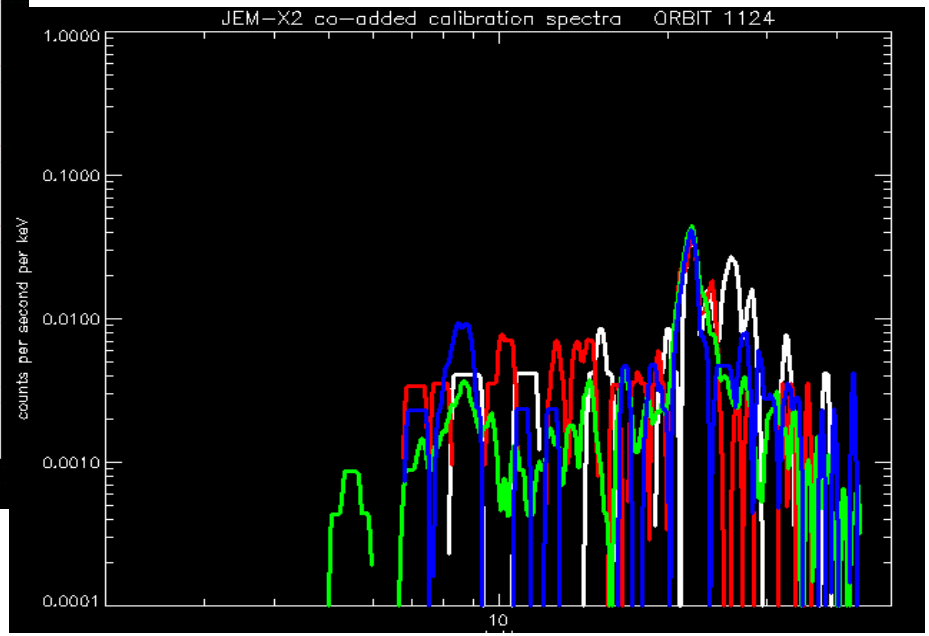
JEM-X2 calibration spectra (rev. 10 and 1124)

- 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
  - However, usually automatic near-real time corrections are not too bad
- Calibration analysis is more difficult in orbits with grey filter
  - More TM has helped 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

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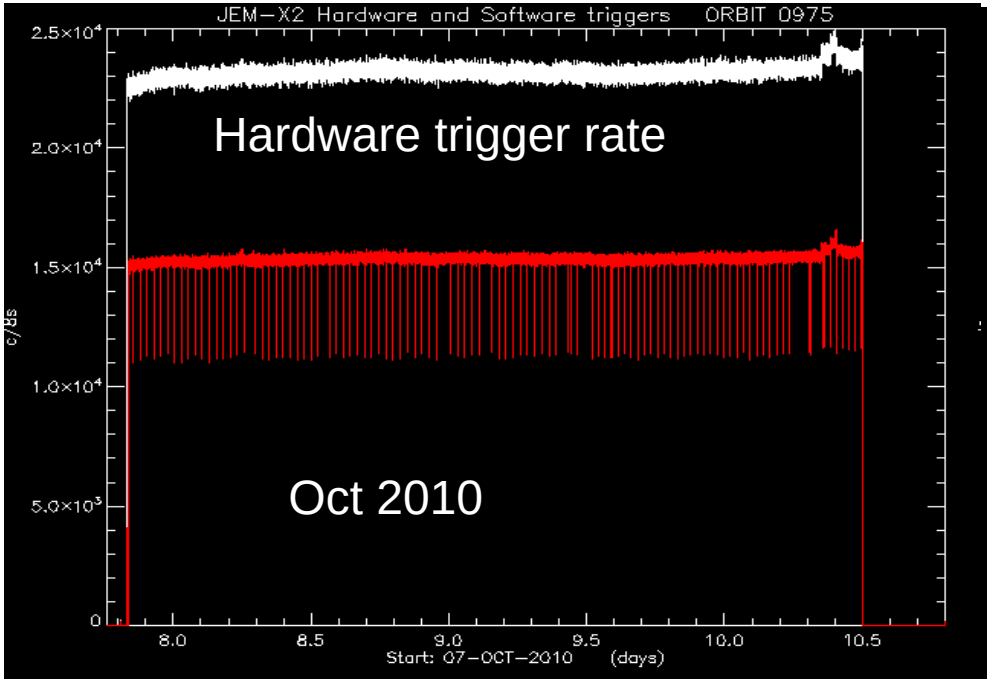
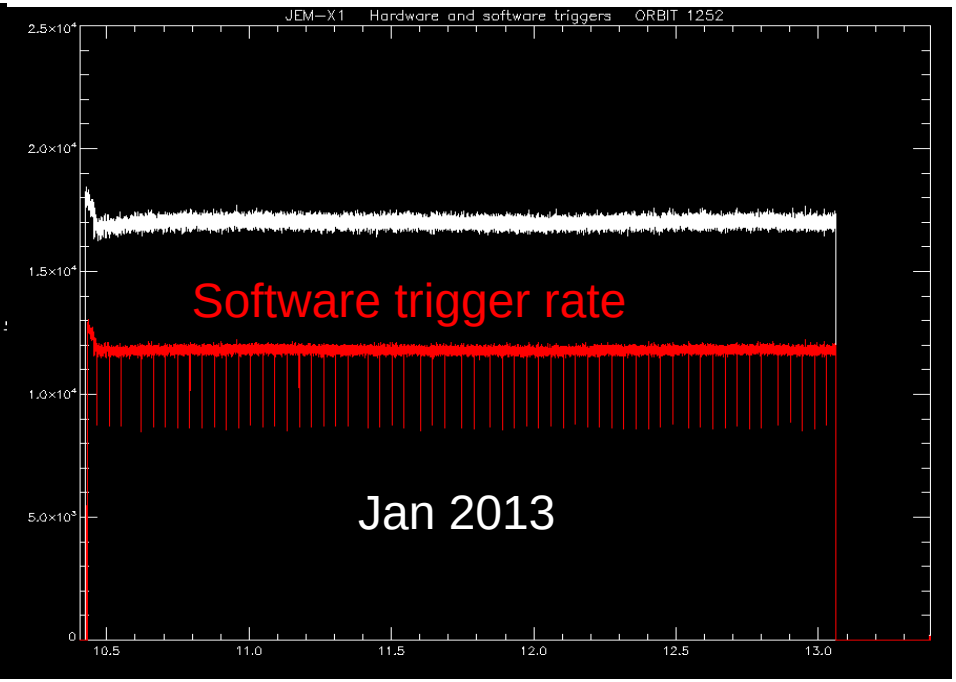
JEM-X particle trigger rate is lowered

- JEM-X HW and SW trigger rate (dominated by particles) is lowered by ~25% since Oct 2010
  - Now ~2150 triggers/sec
- Processing dead time is reduced from ~18% to ~15%
- Background (dominated by CXB, direct + induced Compton) is unchanged, as particle rejection is efficient



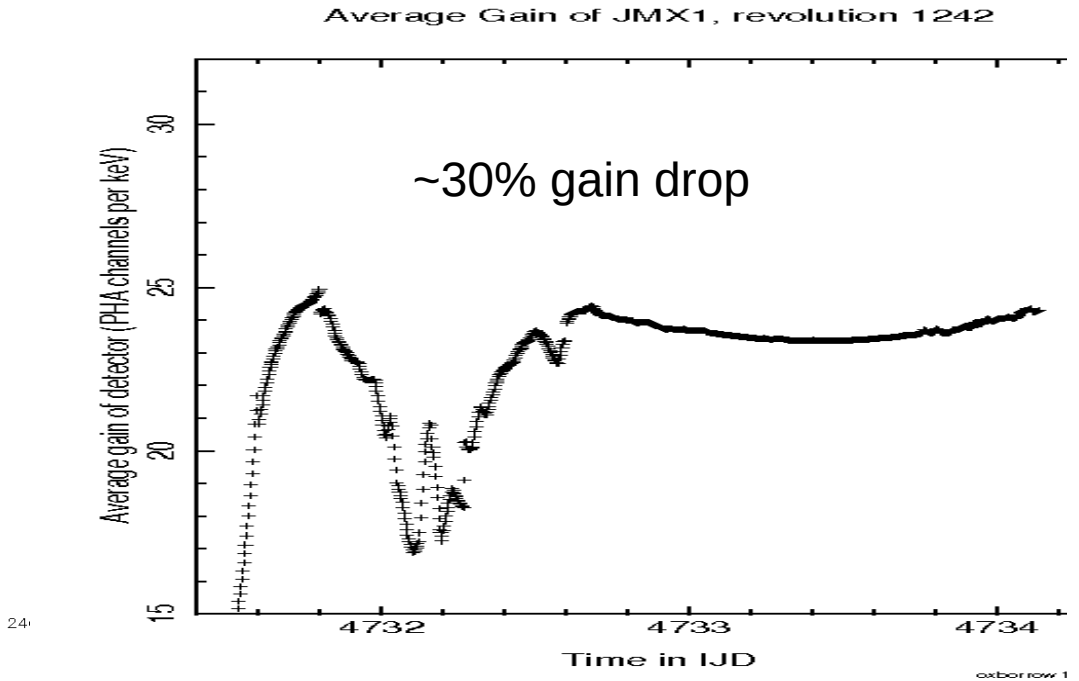


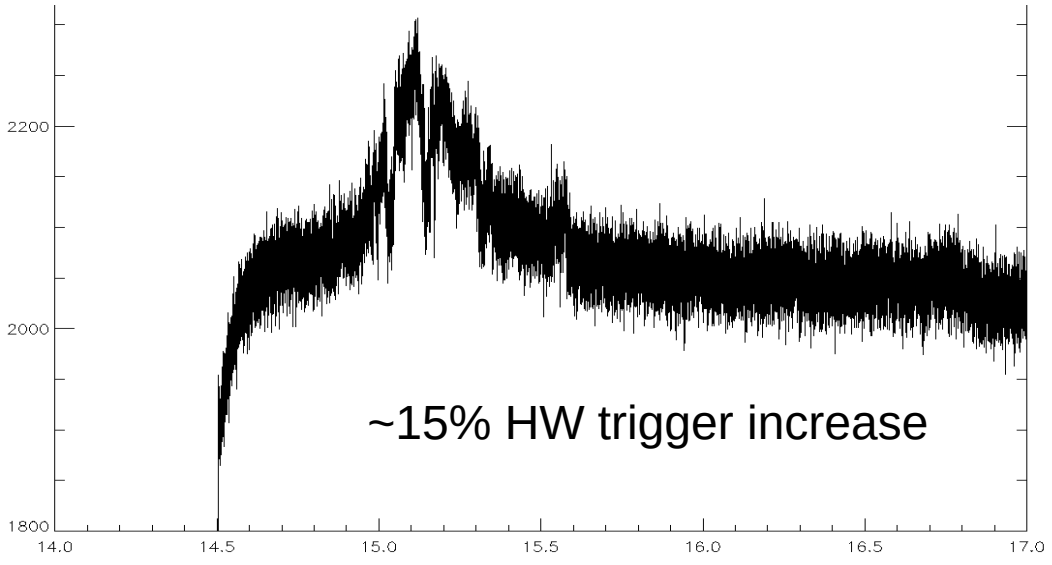
the cosmic ray flux is going down…. slowly.

Not much variation over 2012…

Understanding gain depression events

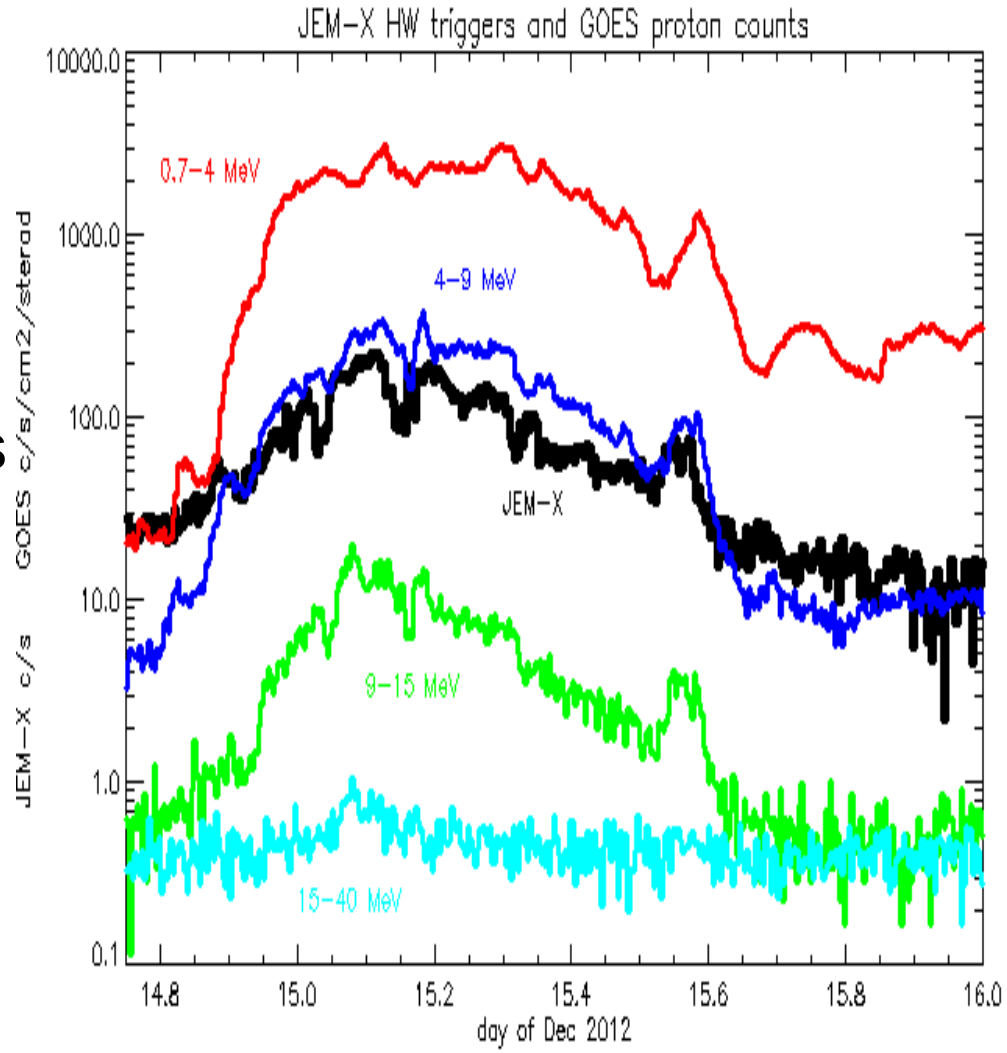
- Example: Solar CME event on Dec 15 2012
- Moderate solar event induced ~30% gain depression in JEM-X
- HW trigger rate increased by ~15%





GOES proton data

- Protons entering through the JEM-X mask
  - FoV 0.01 sterad
  - Area ~100 cm2
  - JEM-X: **~1 cm2 sterad**
- JEM-X excess triggers correlate very well with GOES 4-9 MeV band
- But does it make sense?



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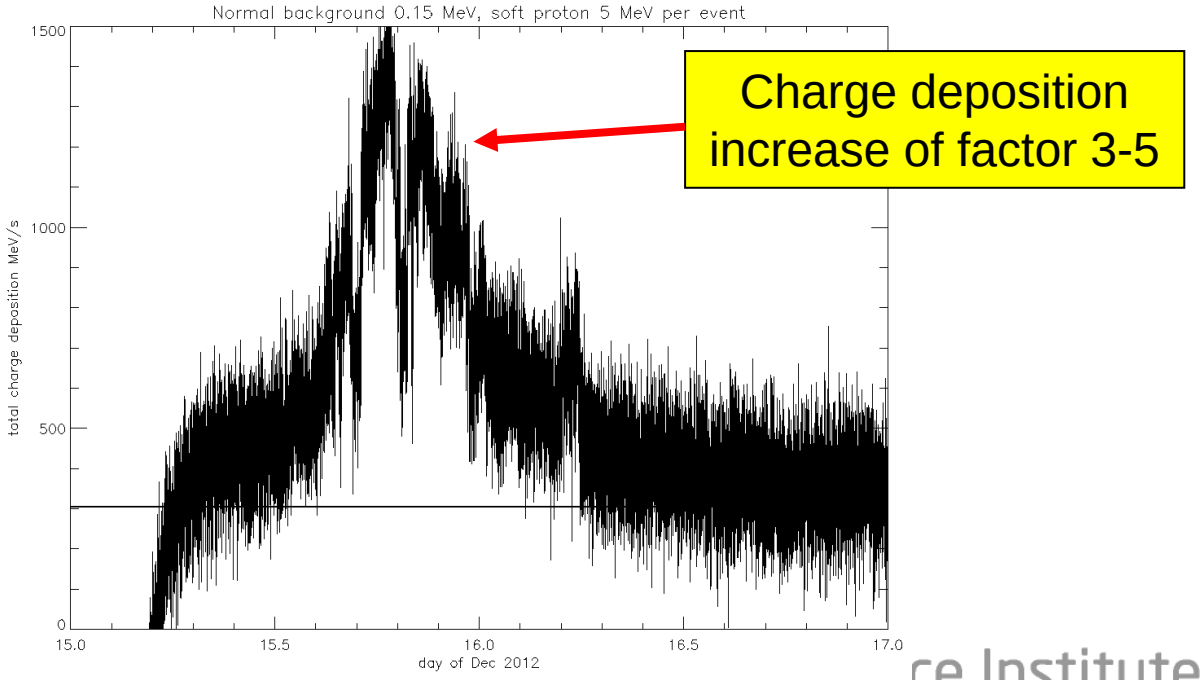
Charge deposition

- 5 MeV protons can penetrate the 250 µm Be window
- Each may deposit ~3 MeV in the Xe gas
- Minimum ionizing cosmic ray particles deposits ~150 keV
- Therefore each 4-9 MeV proton results in ~20 times more charge deposition on the glass plate
- Charge load on micro-strip plate is dominated by “soft” protons

Total charge deposition rate MeV/s



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 in 2012 has reduced number of cases with grey filter and thus improved the stability of gain fitting
- Team is still intact – but also busy with other projects
  - Updated LC SW in the works in Alicante
- 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

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