JEM-X SDAST meeting #39, Copenhagen June 9-10, 2008.

Minutes

Participants:
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Simona Soldi, ISDC, Versoix, Switzerland.
Stéphane Paltani, ISDC, Versoix, Switzerland.
Carol Anne Oxborrow, Søren Brandt, Jérôme Chenevez, Niels Jørgen Westergaard, NSI, DTU, Copenhagen, Denmark.

NB! Since NL was not present at the meeting he has added some comments to the first version of these minutes. They can be found and the end of this document.

JEM-X status report (SB):
The gain evolution continues with the pattern that we have usually seen. Intervals between step downs of HV become longer and longer since the gain is proportional to the original gain, so each step counts for more now. The gain increase becomes flatter and flatter, but with corrections for HV changes, the increase in gain is perfectly linear. Next HV lowering will probably not happen earlier than end of 2008.

At instrument cold start after eclipse it takes about 10 hours for gain recovery.

- JEM-X1 has 57 of 256 anodes affected after 600 or so orbits of use
- JEM-X2 has 49 of 256 anodes affected after 175 orbits of use
- JEM-X2 has some better characteristics like electronic efficiency that means it could be advantageous to switch over to this instrument, perhaps in 2009.

The particle trigger rate has passed its maximum due to the solar cycle. The instrument dead time is influenced (higher) by this but not the background.
The temperature sensitivity of the gain has increased from 1% per degree to 3% per degree from 2004 to 2008.

Discussion:
The electronic efficiency is a major issue. It has been measured as a function of pulseheight (PHA) during crab calibration exercises. CBJ notes that the spectrum extraction software can be energy or pulseheight dependent so it is important to derive the electronic efficiency by using the same software as is going to be used in the later data analysis.
Full implementation of the electronic efficiency will be part of new j_ima_iros though whether it's optimal or not is yet to be demonstrated. It will need rigorous tests of this software with the data we already have. Software has been optimized for usual crab calibrations and still needs to be coordinated with CBJ's work.
The source detection sensitivity and absolute calibration of the instrument is still determined by systematics, i.e. a detailed model of the collimator. So on-axis sources are well calibrated (except for a time drift – to be corrected) but when sources (including the

Crab) are off-axis by more than 4.5 degrees problems arise. It appears that the collimator cannot easily be modelled to give consistent fluxes. It's not been possible to model the change in effective area for each off-axis angle.
Unfortunately, each collimator model gets hardwired into the individual pieces of software. The back projection is heavily dependent on the collimator model, and Carl's cross-correlation method deals with this differently and so it's hard to make comparisons.

JEM-X telemetry allocation.
The current default allocation to JEM-X is 8 TM packets per polling cycle (7 science and 1 HK packet) that allows transmission of about 0.6 crab on-axis without grey filtering. For one strong source in FOV useful TM depends on off-axis angle.
More intelligent active allocations methods are being investigated. Currently the mission is running with a 3-packet oversubscription which overrules various very rare packet types. IBIS is often hitting its limit when looking at the galactic centre. SPI has improved their telemetry usage by updating the onboard software to do some compression like the JEM-X data-taking formats.

Manpower situation:
NL is downscaling his JEM-X activities, CBJ is busy with ASIM, JC is on time limited contract and also involved in Planck. CAO also needs to devote some time to the Planck development (launch in 6 months). NuStar will also need some manpower.

Operations Coordination Group Meeting (SB):
Instrument teams still have the obligation to support the mission operations and calibration.
The INTEGRAL OCG is in many ways the successor to the Ground Segment Coordination Group.
MOC operations of XMM-Newton and INTEGRAL are now merged in one room sharing operators but the transition has been very smooth for us (no important anomalies have occurred). Only one person is on duty at night who has to deal with everything, so in theory more downtime may happen.
SPI is doing its 11th annealing. ISGRI has a problem with its noisy pixel algorithm and their background is twice what it was a launch, so they've changed the noisy pixel switch-off procedure. OMC complains about an increase in the average CCD temperature, possibly due to pointing changes.

Time correlation:
MOC had a s/w problem that didn't update the predicted orbit which gave a 15 msec light travel time error, where we really should be down to a few microseconds. MOC claims that we are down at the 23 microsec level now with the new s/w, but the Toulouse group has seen funny jumps. Verification will be done on the Crab pulsar by Wim Hermensen et al. at SRON. Orbit updates are now done once per orbit.

Raw telemetry archive:
Storage on CDs is old technology and will not be supported much longer. MOC will only guarantee it has the raw telemetry for 6 months at a time. ISOC is looking at making a

raw telemetry archive for the future. Some JEM-X AIPs are not available through ISDC because they're not part of that software pipeline so they can only be retrieved manually from the raw telemetry.
The Russian telemetry station at Bear Lake has been given up for budget and political reasons. Redu would still have to be kept for some project or other so no real saving for ESA. So Redu/Goldstone configuration remains for now.

News from ISDC (SP):
New people are arriving but mainly attached to other projects (Gaia, CTA (Cerenkov Telescope Array), etc.). The situation of INTEGRAL is less bright. Mark Gaber has left at end of 2007. There will be a new librarian but no one has been appointed yet. The USA has stopped its support for INTEGRAL so Jake Wendt has also left. The situation of Bruce O'Neel is not clear yet. Daniel Ryhchick has left so the hardware team is being reorganized. Tom Payne is now head of the hardware team.
Ingo Kreykenbom has been replaced by Carlo Ferrigno. Simona Soldi (as a JEM-X person) wants to get a post-doc position elsewhere and will be replaced by another post-doc.

No new OSA release is being planned at the moment. On the ISGRI side they have problems finding somebody to work on the software so development is a bit slow. If JEM-X has some important development it can be the driver for a new OSA release.

News from ESAC and … (EK):
SCI has become SRE (Science and Robotic Exploration) with David Southwood as director.
INTEGRAL operations are running smoothly; there is no change in the current staff.
AO-6: 179 proposals with request for 56 Ms observation time were handed in and 12 Ms are available. There will be 6 Key Programs. Results from the TAC meetings will be announced soon. Next step (after approval) will be observations planning.

Phases of j_ima_iros updates (NL, told by NJW):
The electronic efficiency corrections are now included in j_ima_iros as well as corrections for off-axis dependencies (separate for the x-directions and the y-direction). The on-axis Crab count rate shows a time dependence that has not been explained, but corrections for it has been introduced.

The current development version of j_ima_iros is finished in the sense that all known dependencies are included. The proper organization of the extra correction coefficients and constants in to the IMOD file still needs to be done, but this task will probably not take more than a month after which a trial delivery to ISDC will be initiated.

After OSA 7.0 a delivery was made in Feb 2008 (version 2.2.2) which removed a number of bugs and flux determination problems. It also had a flag to indicate the kinds of sources found in the SRCL_RES structure. Normalization of image exposure to 100 cm^2 detector area was also included.

Discussion:
Why not have it in 1 cm^2 and is it too late to change this? In theory Exposure is always measured in seconds, but we're talking about and effective exposure map and is based on the vignetting map. SB says that the natural units for such a map is cm^2 seconds. EXPOSURE keyword is in seconds. JC takes his vignetting map from the BPL map. So unfortunately we're stuck with a rather homegrown standard.

Now j_ima_iros is considered to be functionally complete though some parameters may need to be optimized.

Electronic efficiency in j_ima_iros.
The actual gain values are read from CAO's SCP table and their average is put in the header of the shadowgram as a keyword, for the time interval that the user has chosen. It is not greyfilter weighted. Combining this with the SPAG and the curtain correction term applied onboard creates the pixel gain map. From this the pixel gain efficiency is calculated and the mean efficiency can be applied. The pixel efficiency map is used in two ways, namely to calculate the effective detector area and the PIF. The table of electronic efficiency has been derived by CBJ, but only for the way he uses the EE, so he can't guarantee that his map will work with NL's s/w.
All Crab calibration data up to orbit 666 was used to test and develop the software. This gives 750 useful SCWs for JEM-X1 and 550 SCWs for JEM-X2.
After running the program for each unit, the output crab fluxes are analyzed statistically by NL's own program js4summary. This program can make adhoc corrections for the different Crab observation periods.

Off-axis dependencies.
By adding a tilt to the collimator model NL can improve the agreement of the off-axis flux variations. Tilt is clearly not constant in all parts of the collimator and the lamellae may not even be parallel. Measurements have show that there are changes in the tilt. SB agrees that systematics are dominated by this unmappable collimator. Ad hoc off-axis flux corrections are tabulated for 16 logarithmic ranges from 2.5 to 25.5 keV. Corrections vary the most for high energies and at the large off-axis angles. New delivery will include matrices desribing these empirical corrections and they will be improved as more data accumulates.
This means that the program may well work best with narrow energy bands and this fact should be mentioned in the documentation, so that the actual energy bands will be similar to the vignetting correction energy bands. Using this correction set the fluxes from all Crab observations, including large off-axis angles (up to +/- 5 degrees), are more or less constant. Very early revolutions with selection criteria which were very different from the current ones cannot be dealt with since the empirical corrections would be very difficult to derive for at the beginning of the mission where no Crab observations have been made.
Crab fluxes have a certain time variation in each energy band. SB thinks he can see zigzag effect for Crab in spring and Crab in autumn, in the time-varying adhoc corrections and this could be due to incorrect modeling of the collimator tilt or of the maximum throughput apex of the collimator. So he thinks that the collimator is still

giving problems. Also the time-varying adhoc corrections seem to indicate that there's a decrease in flux steadily throughout the mission. NL claims to have taken anode death into account in the effective area calculation. SB suggests it could be a gas leak effect since it's largest for high energies. Both units show this same decline in flux. Flux droop in JEM-X2 at beginning of rev 666 seems to show that the EE function at low energies is not well determined since the program is clearly not removing the gain stabilization gain changes at low energies.

Extracting spectra using j_ima_iros.
This can be done for strong sources, but a dedicated ARF will be needed for doing this. For weaker sources the spectra should be extracted from mosaics and this too may need another dedicated ARF to get best results.
The next step is to apply the current version of jmx_lib_pif subroutine package to the spectrum and light curve extraction problem in j_src_properties.

Discussion:
SB has his reservations about the completeness of the package since it has no independent test set and no independent testing. All the available crab data has been used to derive these adhoc corrections so there's nothing left to test the results. SB suggests that the events from the engineering windows where the HV was played around with and use these for independent tests. SP suggests splitting the Crab data in two so that only one set is used for the generation of the corrections and the other half is used to test the resulting corrections. NJW suggests looking at the simultaneous observation of XTE to check the intercalibration. This would be nice if it showed that the cross calibration was constant, but meaningless if it isn't, because how and where does the difference arise? CBJ thinks it's important to find out where the steady decrease in flux with time comes from, and he'll look into his results with the cross correlation method to see if he gets the same steady decrease. If not there's a problem in NL's s/w. Otherwise there is a physical effect in the instruments that we really need to understand before just correcting for it.

A flux comparison (JC):
The Crab flux has been derived by mosaic_spec from all the images produced by j_ima_iros (the latest version by Niels Lund) in 16 energy channels. There is considerable scatter and a discussion rose whether the peak width was correctly defined. [After a check it turns out that the correct PSF value has been used.]
In order to derive some conclusions the observations should be sorted in chronological order and w.r.t. off-axis angle.

j_ima_cross status report (NJW): No new development.

IC data updates (NJW):
IMOD to be updated with SPAG and new correction coefficients for j_ima_iros. The trigger for a new IMOD instance would be either a new SPAG map or a new detector map (i.e. mapping bad anodes etc.).
RMF to be updated (in the future) with new ARF, perhaps for j_ima_iros and for j_src_properties.

BPL has no update foreseen after instance 0007 by delivery of j_ima_iros-2.2.2.

Xe line analysis and gain aging, IC gain table and difficult revolutions (CAO):
Xe line position in JMX1 has not changed much in the last year.
A new tool is being made: j_gain_HK that makes the temperature information available for j_gain_fitting and j_gain_correction. j_gain_HK I is to be run once per revolution.

Focus of the software development (ALL):
Should we continue developing j_ima_cross? SB: Yes, at least as a test for the validity of all the corrections introduced in j_ima_iros. CBJ: Agrees . SP: Do we have the manpower? There is a large investment of work ahead of us to keep j_ima_cross up to speed.
Conclusion: First job is to conclude j_ima_iros and then do a check against j_ima_cross to see if there are any advantages here.
What is the timescale for finishing j_ima_iros and do a delivery? Perhaps August 2008.
SP proposes to do spectral extraction from j_ima_iros produced SRCL-RES by a new ftool in e.g. 64 energy bins. The rebinning of RMF can be done on the fly.
j_src_spectra/j_src_lc may be kept for special cases i.e. removed from the OSA scripts but not from the OSA package. j_ima_mosaic needs a review but not necessarily a change.

Common cookbook for JEM-X and ISGRI? (SB):
SP: This is not required, but a clear statement what cross-calibration factor is acceptable should appear somewhere. Remember that sources are variable so users should be careful only to fit together time overlapping data. CAO: We should not generate yet another document. SP: We could produce a section that can go into both the JEM-X and the ISGRI cookbook to explain how to analyze the two together.

Science contributions (EK, JC):
EK: Strange change of flux determination by one analysis compared to another one.
JC: Intermediate long burst from SLX 1737-282 is burning of thick layer of He on NS.

JC:
A&A has selected JC's and EK's paper as a highlight. First author is Maurizio Falanga (CEA Saclay).
SLX 1737-282: a long burst. One known XRB by BeppoSAX and then 3 by INTEGRAL. All bursts were about 1/2 an hour long (intermediate long bursts). In second burst JEM-X saw a sharp precursor peak about 50 seconds before the main burst. This indicates a radius expansion burst corresponding to expansion from about 20 km to about 50 km, and the radius after the burst was about 10 km. Using Cumming and MacBeth's model you can show that there is a decrease in the thick helium layer on the NS due to burning. Conclusion was that the source was a compact binary with a white dwarf in which accretion of pure He at a very slow rate allows a thick layer of He to develop (about 100 m thick), which suddenly burns and that takes about half an hour to complete once the threshold is reached. This is a medium long Type-I Xray burst. Longer bursts are known as superlong. Normal Xray bursts are about 100 secs long at most and make up 99% of

all bursts. Very short He bursts can happen when acretion rate is very high and make the shortest short bursts, whereas the longer short bursts are a combination of H and He. Long and super bursts make up only 1% of known Xray bursts. Bursts of different duration from the same source can be accounted for by a change in regime from H-rich burning to pure He burning. Of 14 known intermediate bursts 6 were discovered with JEM-X.
SAX J1810.8-2609: JC and SB together on a paper to be submitted soon to ApJL. Shows a possible precursor but it was 4.7 degrees off-axis, so not clear how significant this was. Three other bursts presented which show very similar lightcurves using JEM-X data in 3-25 keV range. They are weaker than the first burst and do not show a precursor burst. SuperAGILE found Xray burst from J1747.3-2721. First known burst from this source. But other instruments have found other bursts, including JEM-X from galactic bulge data and Key programme. So that 11 bursts have been seen with INTEGRAL, one of which was also seen by XTE.

Science Results EK: POM of Rapid Burster.
Type-II bursts, acretion instabilities. SB made these plots. Binning is 2 seconds in lower plots and 4 secs in upper plot. This is data from the Key Programme. In this data there are no type-I bursts though this source does do Type I bursts. Bursts tend to have an inverse size and frequency relationship, so many little Type-II bursts will follow each other rapidly, while there will be a longer wait between large bursts, some of which may be Type-I.

Science Results, SP: JEM-X spectrum of which disagreed with SWIFT results, but were proved to be right. Presented his result at the Granada meeting. The community does not appear to be aware that we can make reliable spectra with JEM-X. However Stefan Larsson's software seems much less reliable above 10 keV. JC has seen the same effect but at 15 or 20 keV.

Spectral extraction (SP):
j_src_spectra displays a deficiency of flux above 10 keV for faint sources, a feature that is not found in the flux extraction from mosaic_spec applied to a mosaic of images made by j_ima_mosaic. More tests for faint sources are clearly needed.

Is a fixed ARF a possibility (NJW):
The on-axis Crab detector spectra have been extracted for a number of Crab calibration observations. The part of the detector consists of the anodes that have been active throughout the mission. An ARF has been calculated based on the physical properties of the detector. An electronic efficiency has been deduced by the method prescribed by CBJ. It is demonstrated that the Crab spectrum can be well fitted in the gain range 17 – 24 with out additional assumptions.

Crab Calibration and Cross Calibration (NJW):
Presented a summary of the report for IUG compiled by Elisabeth Jourdain. There are spectral fits for both JEM-X1 and JEM-X 2. Latter is very nice, but former has a slight rise at the low energy end of the spectrum. SPI finds a break energy at 100 keV.

Intercalibration factors range from 0.99 to 1.06 which all seem nice (SPI fixed at 1.0) and reasonable.
International Astronomical Consortium for High Energy Calibration.
NJW attended the meeting, number 3, at Schloss Ringberg. He showed his map of dead anode evolution. Also showed the electronic efficiency derived by Carl. ARF is an energy-dependent effect of the instrument, whereas the EE is an electronic effect by passing all the signals through the onboard processing. For Crab we get a spectral slope of 2.08 for JEM-X1 in revolution 605.

Detector position calibration (SB):
Do we still need to adjust the position event algorithm. This could be one of the effects that contribute to the slow decay of flux that NL sees over time. A second issue is the sensitivity since NL thought he saw fewer sources with the new j_ima_iros. It would be nice to have a number for the sensitivity. What is the faintest source that can be found by the new software? There is at least no evidence that the S/N has decreased during the mission according to SP. If we really do have a loss of sensitivity then there's a real problem. If we really have better software, we should have better sensitivity too. Could it be due to NL's rejection criteria.

Update of SPAG tables (SB):
A derivation of the SPAG (spatial gain) table based on the Xe line done some time ago showed that there are changes in the relative gain as a function of position in the detector. The SPAG must therefore be updated from time to time and the derivation of it must be done in a more semi-automatic way.
SB has a program that works well for most of the detector, though is uncertain around the dead anodes. The times of high event rates are not that critical when you integrate data over a half year. Every six months would fit in with the time scale of the Crab calibrations. The time consuming part is accumulating the spectra, and so SB is fine with every 6 months since it's no harder than every year. His procedure still needs some checking and determining what to do with the pixels where the spectral fitting failed.

JEM-X observer's manual update (EK):
Before Christmas 2008 a new version must be prepared. (Put on agenda next time).

Action items defined (CAO):
(1) NL and CBJ: to do the comparison of their physical parameters used in their methods.
(2) NL: to provide a physical description of his model and parameters.
(3) NJW: to check with NL whether BPL file has changed recently and find out whether it should be updated.
(4) JC and SP: to draft this cross-instrument section for the current cookbooks.
(5) NL: to look into the sensitivity question and be encouraged to go back to the previous level of sensitivity.
(6) SP: to check that the OSM file is available in the SCW pipeline and to OSA for temperature housekeeping to be used by j_cor_gain.
(7) ISDC: to make a tool to extract intensities from j_ima_iros and re-bin RMF

(8) NJW: to define standard bins for the rebinning. Default will be 4 coarse bins. NJW to supply sets of 4, 12, 32, and 64 bins.
(9) EK: to compare JEM-X and XTE bulge data.
(10) SP: to write agreed SCREWs on the s/w.

Next meeting.
Meet during INTEGRAL workshop, where we discuss the new deliveries and the next ordinary meeting.

/CAO+NJW

Comments to the Draft Minutes from the JEM-X SDAST meeting no 39
June 17, 2008, Niels Lund

Page 1: Discussion after JEM-X status report:

It is stated that "on-axis sources are well calibrated but as soon as sources (including the Crab) are slightly off axis problems arise".

*** I find this a very non-quantitative statement. What does it mean that "on-axis sources are well calibrated"? And how much is "slightly off axis" which caused what problems?

On-axis I find unexplained time drifts of the Crab flux so I do not think that we can claim to have ain absolutely perfect calibration here. And regarding the off-axis situation I think we can go several degrees off axis without encountering flux variations larger than a few percent. So I find the second part of the above statement much too pessimistic.

Page 3: Phases of j_ima_iros updates:

It is not only the on-axis Crab count rates which exhibit the downward trend with time it is the Crab count rates from all observations, on-axis and off-axis alike. At the time of the SDAST meeting I had not yet corrected for this effect, but now I am a bit further and can be more quantitative regarding the magnitude of the effect:

The time evolution is energy dependent, it starts out with a positive slope of 1.5% per 100 orbits for my lowest energy channel (2.5 to 3.0 keV), but for all energies above 5 keV it is negative, about -5 % per 100 orbits. This means we have now lost about 25 % of the JEM-X1 efficiency. For JEM-X2 the effect is smaller, about -3.5 % per 100 orbits above 5 keV. (see attached plot). The fact that JEM-X2 is also affected despite being dormant is surprising and ominous. The energy dependence of the variation does not match my naive expectations for a gas leak problem.

The zigzag effect noted by Soren has a peak to peak amplitude of 3 to 4%.

Applying an ad-hoc correction for the time slope removes a very significant part of the residual count rate variations from the j_ima_iros results.

For JEM-X1 the count rate variations are reduced from 10.7 % to 6.2 %, for JEM-X2 from 9.4 % to 7.0 %.

The linear correction term has now been implemented in j_ima_iros.

Page 4: Dicussion on off-axis dependencies:

I disagree with the remark that the (user defined) actual energy bands shoud be close to the energy bands I have used in the determination of the vignetting correction. I very much hope that I have used sufficiently fine steps in my mapping of the various effects that the user should not worry about where to place their energy boundaries. Clearly, if you want accurate results (and if your statistics permit) you should use narrow energy channels, because the systematic effects unfortunately are energy dependent. But I am anxiously looking forward to the more complete and independent (independent from me) tests of the new j_ima_iros, where it will show up if I have not been careful enough.

Also, I must stress, when the user defines an energy band, j_ima_iros will try to interpolate in my parameter tables to match the user requirements.

Page 5: SB reservations:

The comment that the package does not have independent testing I fully agree to and I urge all members of the SDAST team to subject the new j_ima_iros to all the testing they can invent once it gets ready for use. Regarding SB's comment that there is nothing left to test the results I will argue that the proof of the pudding is in the eating, and the dramatic reduction in the overall scatter of 10000 points derived from the introduction of 1000 fitting parameters is a proof in itself. Every new Crab calibration in the future will provide additional test samples and other (weaker) tests may be based on observations of alternative sources

*** Comments on the number of fit parameters introduced

The 16 channel energy scale used during the development of the latest j_ima_iros version was chosen to map possible peculiarities around the iron, cadminum and Xenon lines. It is not a logarithmic scale, the boundaries are given here:

channel	lower limit (keV)	upper limit (keV)
0	2.5	3.0
1	3.0	3.5
2	3.5	4.5
3	4.5	5.5
4	5.5	6.0
5	6.0	6.5
6	6.5	7.0
7	7.0	7.5
8	7.5	8.0
9	8.0	8.5
10	8.5	9.0

11	9.0	12.0
12	12.0	16.0
13	16.0	20.0
14	20.0	25.0
15	25.0	35.0

It is important to realize that the number of new fitting parameters which are introduced is limited compared to the number of 'trial cases' in the fits. As mentioned above we have about 600 observations in 16 independent energy bands.

For each energy band we have 16 parameters in X and 16 in Y describing the ad-hoc off-axis corrections. We also have one parameter giving the time slope of the efficiency.

Common for all energies and time periods are the collimator tilt and collimator jitter parameters.

To this should be added about 16 parameters describing the variations of the electronic efficiency for each of the three distinctive operations periods:

Period	Orbit start	Orbit stop
1	38	44
2	45	168/173
3	168/173	-

But the electronic efficiency compensation is based on all the data, taken during a given observation period i.e. the 16 energy points times the numer of science windows available.