XMM-Newton mission operations (M. Kirsch)

Mission status:
- power generation capabilities are normal; no sign of unexpected degradation
- fuel consumption using 4WD with 65 rpm and VPer will result in fuel-limited operations until ~ 2030 with replenishment limit reached in 2021
- no LCL trips in 2014
- caging reduced from 40% to 3% (due to low speed operations)
- star tracker bad pixel map uploaded and in use since October 2014

MOS operations:
- commissioning of the CDMU patch is ongoing
- on-ground automation increased to free time for handling contingency issues

Fuel migration:
- as the main tank will empty first it will be required to be replenished before that time
- this will be achieved through control of the tank heaters
- several tests already performed; minor commissioning tests to be performed in 2015, full test foreseen in 2016

Orbit evolution:
- orbit evolution controlled through reaction wheel biases; it is being monitored by F/D
- there may be eclipse season gaps in perigee G/S coverage as Goldstone cannot fully commit
- after 2019 - 2020 the perigee gaps will close

Flight dynamics:
- use of variable perigee attitude has reduced fuel consumption by ~ 0.5 kg/yr
- enhanced wheel speed prediction in 4WD results in reduction of wheel speeds

Outlook:
- short term: CDMU patch commissioning and activation of tank 1 and 4 control
- medium term: PER replacement; minor fuel migration checks
- long term: fuel migration check in 2016; Lela migration into SCOS context

Status of instrument operations (P. Calderon)

Routine operations:
RBI clock resynchronisations:
- 03/03/2014 (CDMU reset)
- 13/09/2014 (Nominal wrap around)
- 03/10/2014 (CDMU reset)

Incidents:
CDMU reset on 03/03/2014 and 03/10/2014
cases of NCR#133 (false current limiter activation) on:
- 20/06/2014 (PN extra heating circuit), no impact
- 05/08/2014 (MOS2 FW coil 1 circuit), operations stopped to verify false alarm

MOS1 SEU on 23/03/2014: EMCR voltage drops. Similar to Oct 2011 incident.

Changes in operations:
Several ODB versions uploaded concerning amongst others:
- CDMU thermal control items
- MOS extended BPT reporting,
- preparation for eclipses with G/S gaps
- correction of noisy MOS1 radiation parameter
- 4WD items

Eclipse seasons:
Nominal post-perigee season (18/05 - 19/06/2014).
Pre-perigee season (06/11 - 22/12/2014) with many changes:

- instruments OFF for ~ 2.5 hrs: no thermal control; pre-planned time tagged sequence of heater on/off commanding
- Maspalomas and Goldstone G/S in use reducing the telemetry gap
- MOS focal plane at non-nominal temperature at science start

Future operations:

- MOS noise suppression through new BP / Offset tables
- CDMU TCL commissioning
- future eclipse, esp. pre-perigee: TCL expected to be operational; MOS temperature recovery will impact planning

Status of science operations (M. Santos-Lleo)

AO 13 to be completed end of April
AO 14 to start in May. Oversubscription factor of 5.7.
AO 15 call for proposals 25/08/2015

Smooth instrument operations.

Data analysis and archive:

- SAS 15 planned for Autumn 2015
- PPS based on SAS 14 released in Feb 2015
- 3XMM-DR5 incremental EPIC source catalogue release imminent
- OM catalogue incremental update including all 2013 data ready
- XSA 8.3 released Dec 2014; new release linked to 3XMM-DR5

Workshops:

- No SAS workshop planned for 2015 due to lack of resources
- "X-ray Unverse 2014" symposium hel in Dublin June 2014: 335 participants
- "Extremes of Black Hole Accretion" science workshop to be held June 8-10 at ESAC

SAS status and development (C. Gabriel)

SAS 14.0 was released on 10/11/2014 with several important changes to s/w, calibration and platforms.

Validation performed through:

- standard sets processed with procs and chains
- XCAL DB full reduced to allow comparisons
- standard sets run through the SAS 14 based PPS
- detailed data reduction following threads
- dedicated reduction for new s/w

Several upgrades already envisaged for future SAS releases. Developments are also foreseen for RISA.

Risk and mitigation:
Complex instruments, subject to ageing, contamination and other developments result in a substantial amount of development still required (esp. EPIC). However, manpower is reduced and expertise lost. To mitigate associated risks:

- OM SAS maintenance only
- EPIC and RGS SAS: minimise s/w changes through use of calibration files (using tables whenever possible).
- one SAS release per year

- reduce number of supported platforms

Medium term perspectives strongly depend on the level of resources available.

Pipeline status and plans (P. Rodriguez)

Pipeline based on SAS14.0 released in February 2015. This included:

- global GTIs based on steady pointings
- RGS products in wavelength space
- pn SW mode source detection
- pn TI mode source products
- true colour images for EPIC
- full field mosaic images
- constant background from image window for OM fast mode light curves

Several future developments are foreseen:

- instrumental background, and flaring background thresholds
- SSO observations in target reference frame
- additional source products
- additional catalogue products

EPIC-MOS monitoring (M. Stuhlinger)

Latest MOS CTI/Gain CCF update for current epoch (post Dec 2012) public since July 2014.

Implementation of a significant improvement in column traps correction would require update of all epochs. However, some s/w issues need to be solved. Also some currently defined epochs are too short to allow proper column trap evaluation.

MOS 1 CCD1 "meteorite" column shows substantial offset variations since revolution ~ 2600. This is partly due to diagnostics having been obtained at non-nominal FP temperatures. Nevertheless, some recent diagnostics taken at the nominal temperature also show variability in column offset.

A substantial telemetry load is due to noise in hot columns, esp. in MOS1 CCD2. These columns will be suppressed or blanked in future fixed offset tables.

Several long CalClosed exposures taken in periods of strong solar flare periods suffer a sudden flagging of all events as invalid. Two different event flags were raised: UNDERSHOOT and IN_BAD_FRAME (and IN_SPOILED_FRAME). This always occurs simultaneously for both MOS1 and MOS2.

MOS flashes are interpreted as a light flash due to micro-meteorite impact on the mirrors or detector. MOS flash monitoring has resulted in six flash candidates (4 in MOS1 and 2 in MOS2) of which four resulted in obvious damage (lost CCDs, new bad pixels) and two show no permanent effects.

EPIC-pn monitoring and energy scale (M. Smith)

MOS fixed offset tables to be modified:

- suppress noise in MOS1 CCD2 and CCD5 hot columns
- correct for long-term drift in MOS1 SW and MOS2 LW modes (1 ADU shift required)

PN hot pixels and offsets stable.

Changes to PN energy scale introduced with SAS 14.0:
Energy reconstruction:

- E dependent LTCTI
- Doubles event energy correction (pattern-dependent offset)
- Additional polynomial order in the empirical LTCTI model
- Energy resolution:
- Time dependent RMF

Quiescent background dependent gain correction implementation at advanced stage. SW mode observations and exposures with non-nominal MAXMIP settings still pending.

Monitoring of EPIC-pn timing (J. Ebrero)

Biannual Crab pulsar observations used for relative and absolute timing monitoring.
Observations consist of a pair of Timing and Burst mode exposures.

Update on EPIC-MOS contamination (S. Sembay)

Prime monitoring source is E0102:

- standard spectral model available
- stable
- regularly observed throughout mission

Contaminant is carbon dominated (as RGS).

Depth derived by comparing model and data hardness ratios.

Validation performed on RX J1856 and blazars.

New model derived with SAS 14.0 RMFs shows change in time dependency for MOS2. MOS1 shows
no clear trend (compatible with low energy QE adjustment).

Current MOS2 contaminant depth is ~ 50% of that of RGS.

RX J1856 shows 20% flux difference between MOS2 and PN when contamination is not taken into account.

Temporal and spatial dependences of the EPIC-pn spectral response (F. Haberl)

Degrading energy resolution of PN calibrated and validated on:

- Fe-K emission from the Circinus Galaxy
- Fe-K from Eta Carinae
- 1E0102 (< 2 keV)

The correction has been implemented in SAS 14.0.

A Circinus Galaxy observation where the source is no at the B/S location shows that closer to the CAMEX the energy resolution is worse than that modelled.

A problem encountered in the 1E0102 analysis is that the shape of the low-energy shoulder is not well reproduced with the current RMF. Tests with the parameterised RMF yield better modelling of the shoulder.

1E0102 was observed on several occasions in the centre of the SW and on other occasions at the B/S location. Comparing 0.3-3.0 keV count rates (normalised to effective area) show significant differences between the two locations. Differences are reduced when using effective areas based on a previous telescope axis location (before a 2' shift based on the G21.5 raster pointings). This may point to an issue with the current telescope axis location.

RMF studies (K. Dennerl)

In the context of the eROSITA calibration, an attempt is underway to derive an empirical based on measured spectra. The aim is to compute the spectral response between 0.1 and 11 keV. To this end, a mathematical model has been developed which describes the spectra, taking into account detector noise, pile-up etc. The relevant energy dependencies of the various components also need to be modelled. Separate RMFs will be derived for singles up to quadruples. The results are checked by fitting laboratory spectra with the derived responses.

The empirical modelling of the RMF is also being applied to the PN. The model parameters are optimised by fitting to to a spectrum using an assumed spectral model. This has been tested on an observation of 1E0102 using the IACHEC model with promising results (e.g. resulting in a better fit in the emission line wings). Further testing on a larger number of sources and modes is required.

EPIC-pn Burst Mode X-ray loading and rate-dependent CTI calibration (J.-U. Ness)

The BU mode RDCTI correction has been recalibrated taking into account the effects of X-ray loading. The X-ray loading correction parameters are identical to those used in TI mode. The rate dependent energy shifts are determined from fits to the instrumental Si and telescope Au edges of sufficiently non-variable sources.

After applying the correction, the residual gain shifts are very much reduced. A validation at higher energies (~ 6.5 keV) was performed on observations of GRO J1655-50 and 4U 1700-37, where the new calibration yields improved results. A similar validation on Cas A shows slightly worse results, although this source has a very low count rate and is not representative of typical BU mode targets.

EPIC-pn Burst Mode rate-dependent PHA calibration (S. Migliari)

A RDPHA correction will be implemented and calibrated for BU mode, similar to that currently used as default for PN TI mode. The RDPHA correction has an advantage over the RDCTI correction as the former is derived from gain shifts in PHA space, and does not require any a priori astrophysical assumptions.

A suitable sample of sufficiently constant sources has been defined.

Implementation of the RDPHA correction will require modifications to SAS and the CCF structure.

Flagging the anomalous CCDs in MOS: in continuation to the path of emtaglenoise (C. Maitra)

A time-variable component of the MOS background complicates analysis of large extended sources, and interferes with PPS source detection. Characteristics of the low-energy noise are:

- enhanced rate below 1 keV (low hardness ratio)
- most affected are MOS2 CCD5 and MOS1 CCD4, although other CCDs are also affected
- no correlation with HK parameters or RadMon found; cause remains unknown

The SAS tool emtaglenoise flags noise occurrences using out of FOV events for each CCD individually.

Another method, based in inter-CCD comparisons (of out-of-FOV events), uses criteria which are independent of the noise characteristics. Although this method is less sensitive than emtaglenoise it does allow flagging of CCDs with noise in a different spectral ranges. However, this type of noise appears to be limited to very early observations.

Standard processing beyond standards: NCR-138 (M. Freyberg)

Observations affected by NCR-138 ("PN CCD currents OoL Low Low, possible EPCE s/w corruption") required manual editing of the ODFs to perform processing up to the incident.

The epframes and epchain switches "witheventmap=Y" and "withphotonmap=Y" require access to HK info and therefore do not work when running from the final events file only.

Offset maps are used by SAS for several purposes:

- correction of offset shifts due to MIPs
- correction for X-ray loading

However, not all ODFs contain their respective offset maps (especially in the case of older observations), nor do SDFs. There are also instances where only a subset of offset maps are available (usually of the inner CCDs).

SAS-SCR-7284 has been submitted to address these issues. It may involve extending the SDF and AOL to accept the relevant offset maps in a way consistent with SAS. Or allow an input list of file names to be used to associate the correct offset maps.

Lessons learnt from EPIC data analysis within the EXTraS project (A. Tiengo)

EXTraS explores EPIC data (3XMM-DR4) in the time domain for serendipitous signals:

- new transients
- variability in all sources
- variability over multi-epoch observations

New sources will be classified. A variable source catalogue will be released.

Few-pixel events in PN, possibly due to MIP afterglows or bright pixels, result in spurious detections. Additional spurious sources due to counting modes when using pre-SAS 14 PPS products. Satellite drift or attitude glitches also result in spurious sources.

New sources have been detected, and more are expected after full archive processing with optimised pipeline and careful screening.

Status of EPIC cross-calibration (M. Stuhlinger)

EPIC observations with increasing pile-up (and extraction regions with larger annular inner radii) show increasing MOS versus PN discrepancies above ~3.5 keV, of up to 25% at ~8 keV. This is suspected to be due to the XRT3 XPSF change (which affects PN data).

Analysis of 1E0102 shows an dependence of extraction radius for PN data-to-model ratios, the off-patch results (with 75" radius) being significantly better than the on-patch results (40" radius).

Except for the high energy band there is no significant change in instrumental cross calibration between SAS 13.5 and SAS 14 (with the most recent calibration files).

Recalibrating the XRT PSF wings (M. Smith)

Bright on-axis sources which are analysed using annular extraction radii show increased MOS-to-PN flux discrepancies above 3.5 keV since the introduction of XRT3_XPSF_0016.CCF. The discrepancies are up to 30% at the highest energies.

XRT3_XPSF_0016.CCF was derived from PN timing mode data and optimised the parameters describing PSF wings in order to obtain constant measured flux independent of number of excised columns.

A sample of 30 on-axis non-piled-up sources was used to measure the affect of annular extraction radii of varying inner radius on the PN flux. For imaging mode data it is confirmed that XRT3_XPSF_0016 yields more consistent results.

In order to investigate whether MOS requires a similar modification the PSF parameter alpha was varied stepwise, and the annular inner radius versus flux consistency was tested. For MOS2 the flux consistency may be significantly improved by changing alpha. MOS1, however, cannot be improved by a change in alpha.

Further investigation is required to see if changes in other PSF parameters may yield better results, especially for MOS1.

Investigating the XMM vignetting and optical axis (N. de la Calle)

EPIC flux cross calibration from 2XMM Sources (Matteos et al. 2009) shows that the MOS cameras show ~10% higher flux than pn with a strong off-axis and azimuthal dependence at higher energies (>4.5keV) (the MOS cameras agree with each other to better than 4% at all energies). This has prompted a reinvestigation of the vignetting calibration by revisiting the raster scan observations of G21.5 and 3C58 performed in 2000-2002.

The results show PN and MOS rates follow the current offset angle effective area curves. The comparison of PN with MOS cameras show ~10% differences with no strong off-axis or energy dependence. The MOS cameras are also within 10% of each other.

Reported analysis of 1E0102 normalised count rates comparing on- with off-axis observations indicated that more consistent results were obtained with the 2002 definition of the optical axis, as opposed to those obtained after the modification made in 2007.

The optical axis location was investigated using various datasets of diffuse emission:

- all EPIC-pn FF Thin/Medium filter in the archive
- all EPIC-pn FF Thin/MEdium filter from a science program
- all blank sky FF Thin filter (ghosted)

Unfortunately, results from the different datasets give inconsistent results.

RGS - EPIC-pn cross-calibration (R. Gonzalez)

RGS contamination is derived from observations of the isolated NS RX J1856. The model remains valid, with only minor parameter changes required to accommodate the most recent data.

The RGS-to-EPIC rectification factors may require recalculation due to:

- new RGS contamination model parameters
- different source sample
- inclusion of all recent EPIC calibration changes
- different source extraction region definitions for some EPIC observations

Differences of ~ 3% may be expected.

Cross-calibration investigations - straylight (and others) (M. Smith OBO D. Lumb)

An extensive investigation of straylight is being undertaken. The method is:

- Select archival observations with single reflection arcs (mostly LMC X-1, Cyg X-3 and Galactic Bulge binaries).

- Compare measured flux with best estimate of source flux (from MAXI or RXTE ASM data), which then gives the straylight fraction.
- Replicate each observation with the SciSim ray tracer.
- Compare measured with simulated straylight fractions.

Complicated analysis; systematic errors dominated by uncertainty in source flux (up to 30%).

Preliminary conclusions following the analysis of ~ 50 observations:

- Measured and simulated straylight versus radial distance not grossly discrepant.
- Indications of camera dependent azimuthal variations which could be explained by baffle shift and/or rotation.

Investigations of the ARF versus extraction radius shows what appears to be aphysical behaviour towards higher energies. Between 2 - 8 keV the encircled energy is increasing with energy, whereas one would expect a decrease due to mirror scattering. This is most evident in the PN EEF.