EPIC-MOS: CTI & gain calculations, emos package

Jenny Carter, Steve Sembay & Kristiina Byckling
University of Leicester
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Need for new CTI & gain software

• Why:
  • CTI & gain IDL procedures delivered to SOC in ~2006
  • Code does not complete when using SAS 11.0.0 processed event files
  • Documentation sparse

• How:
  • write IDL procedures to calculate CTI, gain and offset parameters - decided October 2011, University of Leicester team to write EMOS IDL package, but this will again be handed back to the SOC when complete
  • produce additional code to evaluate the energy reconstruction selection of the calibration over time
  • write comprehensive documentation to accompany the resulting software package
EMOS package: flow of procedure

- Four phases:
  - Global CTI
  - Gain
  - Offsets
  - Trends

- No changes made to the SAS, must work within the existing setup

- Note: re-writing from scratch as very hard to understand and re-work the old code

Second call to SAS (emproc): correctgain=N, offsets column in temporary CCF set to 0
Advantages over old procedures

- Advantages include:
  - able to install a consistent style
    - for example, use of common keywords throughout
    - embedded test harness, therefore only one path name to change on delivery to SOC
  - opportunity to write comprehensive documentation with an aim to make the process transparent and easily transportable
  - opportunity to provide standardised diagnostic output
  - write the package with a modular approach in case the methods for calculating the calibration parameters change (e.g. C. Pagani’s talk)
    - for example, gain profile (see later in this talk)
  - opportunity to add the trends analysis
EMOS package: global CTI

- For a given epoch, instrument and CCD
- First serial (left panels), then parallel (right panels) global CTI calculated
EMOS package: gain

- Per epoch, per instrument, per CCD
- Profiles for Al-K\(\alpha\), Ti-K\(\alpha\), Mn-K\(\alpha\), Mn-K\(\beta\)
- Profile fitted currently with a model consisting of a linear slope plus a Gaussian
- Fitting using a routine in the Markwardt IDL library
- Possible improvement of using a more informed profile (i.e. through Steve Sembay’s rmf work)
EMOS package: gain

- Both linear and quadratic terms as output
- Pattern migration seen (see Steve Sembay’s talk). More motivation for writing the EMOS software package
EMOS package: offsets

- Per epoch, per instrument, per CCD
- Each column (RAWX) split into segments, depending on method chosen:
  - fixed length
  - variable length based on a minimum no. counts
- Spectrum from each segment around line of interest; Al-Kα
- Gaussian profile fitted to each to obtain a set of centroid energies for each column
- Fit profile of centroids for each column to find where traps occur
EMOS package: trends

- Per instrument, per CCD, for a set of closed event lists extract spectra for a chosen pattern type: either \texttt{PATTERN==0} or \texttt{PATTERN<=12}, in FOV region
- Either supply or generate RMFs
- Fit each spectrum with a model (continuum + set of Gaussians, some fixed, others free), obtain line energies of free lines (Al, Si, Ti, V, Cr, Mn all-K\textalpha and also Mn-K\textbeta)
- Plot all found line energies vs time, including several plotting options
- **Possible improvement** of adding an option to generate spectra from the core, wings or outer region of CCD1
EMOS package: trends

Mn Ko1 M1 p0

CCD1

CCD2

CCD3

CCD4

CCD5

CCD6

CCD7

0 500 1000 1500 2000

MOS1 p0 CCD1

Al Ka1

Si Ka1

Ti Ka1

V Ka1

Cr Ka1

Mn Ka1

Mn Kb1

0 500 1000 1500 2000

Energy (eV)

XMM revolution
Differences from old procedures:

- Global CTI: no difference
- Gain: allows switch between linear & quadratic fitting
- Offsets:
  - old version used column-by-column differences from global GTI versions (~all columns had a non-zero correction)
  - this version, only traps located
  - fixed segment size per column (5)
- Trends:
  - new, not included in the old version
## EMOS package: current status & testing

<table>
<thead>
<tr>
<th>Component</th>
<th>Status Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global CTI</td>
<td>general code and wrapper written</td>
</tr>
<tr>
<td>Gain</td>
<td>general code and wrapper written</td>
</tr>
<tr>
<td>Offsets</td>
<td>general code and wrapper written</td>
</tr>
<tr>
<td>Trends</td>
<td>code almost complete</td>
</tr>
<tr>
<td>Generic code</td>
<td>generation of SAS compatible CCFs to be tested</td>
</tr>
<tr>
<td>Documentation</td>
<td>draft of technical note written</td>
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<tr>
<td>Phases 1-3</td>
<td>test harness, 5 event lists, 1 x inst., 7 x CCD</td>
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<tr>
<td>Phase 4</td>
<td>independent testing, awaiting testing with new CCFs</td>
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<tr>
<td>Delivery to SOC</td>
<td>expected early summer 2012</td>
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