EPIC pn-CCD background summary

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- pattern distribution: invalid patterns
- energy dependence
- monitoring
- discarded lines
### EPIC-pn event pattern: 150 μm pixel: valid types

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Representation</th>
<th>Legend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single event</td>
<td>. X .</td>
<td>X = maximum charge</td>
</tr>
<tr>
<td>Double pattern</td>
<td>. X X x X</td>
<td>x = smaller charge</td>
</tr>
<tr>
<td>Triple pattern</td>
<td>x X X x X</td>
<td>m = minimum charge</td>
</tr>
<tr>
<td>Quadruple</td>
<td>m x x x m</td>
<td></td>
</tr>
</tbody>
</table>

*Note: The patterns represent the charge distribution in a pixel, with `X`, `x`, and `m` indicating different charge levels.*
EPIC-pn event pattern: 150 μm pixel: other types

"GOOD"

.. ..
.. X.
.. ..

2 singles

"BAD": all other types

.. .. .. .. .. ..
.. .. .. .. .. ..
.. .. .. .. .. ..

triple pattern

.. x X x .. X m x .. X x ..
.. .. .. .. .. .. .. x ..
.. .. .. .. .. .. .. .. ..

.. .. .. .. .. .. .. .. ..
.. .. .. .. .. .. .. .. ..
.. .. .. .. .. .. .. .. ..

quadruple pattern

.. x X .. .. X x .. X m .. x X x ..
.. x .. .. .. .. x x .. .. .. ..
.. x .. .. .. .. .. .. .. .. ..
Filter wheel "Closed"

singles, doubles, 313 ks, FF mode
Al-K, Ni-K, Cu-K, Zn-K, Mo-K
Ti-K, Cr-K, Fe-K, Au-L
Mo-K only in doubles, line position better than 0.3%

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MPE Garching

EPIC Calibration Meeting, CEA Saclay, France, 25-September-2003
Filter wheel “CalClosed”

singles, doubles, 2031 ks

additional calibration lines: Al-K, Mn-K\( \alpha \), Mn-K\( \beta \)

and: Ti-K, Mn-EP, V-K, Si-K
“CalClosed” → “Closed” → “Thin1”

singles only, FLAG == 0, one selected exposure
spectra become comparable above 7 keV

 Closed = CalClosed, Closed ∼ Thin1 (Oph)

Rev.59 = Rev.80, Rev.355 ∼ Rev.321
Camera design:
not fully equipped on image
Cu-K (7.8 – 8.2 keV)
Ni-K (7.3 – 7.6 keV)
Mo-K (17.1 – 17.7 keV)
Pattern distribution + fraction: eFF + FF modes

solid lines in right panels: models for mirrored X-rays; invalid patterns dominate between 0.3 – 1.2 keV

singles + doubles + triples + quadruples + invalid patterns
Pattern distribution + fraction: LW + SW modes

Note the deficiency in Ni-K and Cu-K lines compared to FF/eFF mode because of the ventilation hole at the center.

Singles more abundant, doubles less abundant than for mirrored X-rays.
Pattern distribution + fraction: TI + BU modes

lower threshold for TI mode is higher, also TI mode shows the overabundance, but not BU mode
Pattern distribution + fraction: FF spatial: close to CAMEX

labelled Y# with
# = INT(RAWY/20)
as for response matrices
here: # = 0,1,2,3
Pattern distribution + fraction: FF spatial: away from CAMEX

labelled Y# with 
# = INT(RAWY/20)
as for response matrices 
here: # = 4,6,8,9
Pattern distribution + fraction: SW + FF(SW)

SW mode window extracted from FF mode, compared with SW mode different exposure times (FF = 3*SW)!
noise + invalid pattern enhanced in SW
on-axis: less Ni, less Cu
Temporal effects: Cal source

SW mode window extracted from all modes at Mn-Kα

$^{55}\text{Fe}$ internal calibration source: \((T_{1/2} \sim 2.7a)\)

no out-of-time event correction applied
Temporal effects: external

Rev. 80: low background CalClosed

Rev. 242: high background CalClosed

$^{55}\text{Fe}$ internal calibration source: $(T_{1/2} \sim 2.7a)$
Temporal effects: FF mode

Discarded Line Counter

10 – 12 keV count rates, FF CalClosed

EPEA setup change at about Rev.216

XMM timeline changed: CalClosed preferentially at start of revolution
Temporal effects: eFF mode

Discarded Line Counter

10 – 12 keV count rates, eFF CalClosed

EPEA setup change at about Rev.216

XMM timeline changed: CalClosed preferentially at start of revolution
DLI analysis

inhomogeneities
Summary

still: in $2 - 7 \text{ keV}$ range: $10^{-1} \text{ cts s}^{-1} \text{ keV}^{-1}$
serendipitous calibration lines
spatial inhomogeneities of fluorescence lines
event pattern fractions dependence on mode, position, energy
decay of calibration source: longer exposures needed
discarded line counter vs. background rate
archive reprocessing: DLI map analysis, ...
EPIC pn-related summary/outlook SAS-6.0

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- reprocess all MPE data (CalClosed + CalPV + et al)
- SAS-6.0-pre (devtrack)
- identify problems within infrastructure and PN tasks
- problems could be weak or rare
- test of new PN task features
calpnalgo 2.43.1 → 2.44

epevents 6.32.4 → 6.39

epatplot 1.1.8 → 1.12

spatial selection via parameter
pile-up quantification (file, keywords, plot)
background subtraction (1 iteration)
pattern fraction calibration values added to qdp output
pile-up diagnostic numbers on plot
also written to event file (needs write access)
pattern fraction calibration values added to qdp output
pile-up diagnostic numbers on plot
also written to event file (needs write access)
badpixfind 1.28 → 1.36

allow also search on “final” (multi-chip) event files

epchain 8.30.5 → 8.50

calls to epreject (future) and epexposure
epreject needs offset map files (ODI)
badpixfind on broad band: background spectrum
“optical loading” image < 150 eV, events removed later
no default rejection via #XMMEA_EP (ebadpixupdate)
epexposure 0.6

removal of columns in EXPOSUnn extensions (dsrm)
analysis of DLI files (epframes) (→ eexpmap)
needs discarded line files (DLI) (overflow problem)
randomization of event arrival times within readout frame (future)

epframes 8.46.12 → 8.63

CAL: all event time CCF entries in REAL*8 (EPN.TIMECORR_*.*.CCF)
early mission phase: eFF mode F1294=5 (EPN.TIMECORR_*.*.CCF)
offset map computation quantities, UNKNOWN filter
OAL: AUX event time jumps (problems!)
<table>
<thead>
<tr>
<th>Sequence</th>
<th>FRAME</th>
<th>CYCLE</th>
<th>FTCOARSE</th>
<th>FTFINE</th>
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epframes:-- Statistics on auxiliary data from `/xmm/public/data/0131/0112380101//.0131_0112380101_PNS00300A'
epframes:--
  spurious 32767-frames: 419
  late-reset frames : 0
  missing frames    : 37235
  normal resets     : 1 [32389/48189(10.07)]
  premature increments : 0
  negative jumps    : 0
  positive jumps    : 1 [7925/20943(26.29-10)]
  wrong quadrant/CCD: 0
  unverifiable deltas : 0
  unidentified deltas : 1 [7942/21956(-25.33)]

  minimum delta      : -25.33s
  maximum delta      : 16.29s

** epframes: warning (UnidentifiedTimeGaps), Time intervals were found whose duration appear not to be integer
epframes:-- . . . . . determine AUX1 GTIs . . .
epframes:--
epframes:-- Start time       = 83720559.92347
epframes:-- End time         = 83763200.43635
epframes:-- Number of frames = 581215.94908
epframes:-- Frame time [ms]  =  73.3643200
epframes:-- Best match [ms]  =  73.3643136
epframes:-- AUX1 gap between 83728485.27160 and 83728501.55881 =  16.28721 [s] = 222.004 [frames]
epframes:-- AUX1 gap between 83752949.97435 and 83752960.04777 =  10.07342 [s] = 137.307 [frames]
epframes:-- AUX1 gap between 83754753.46013 and 83754760.28310 =   6.82297 [s] =  93.001 [frames]
one jump of about 26 s two frames after FFFF frame
SAS corrects only 16 s
0131_0112380101_PNS00300AUX.FIT: PNAUX1

Q2 off by 32 s

current OAL cures 1 s-jumps, creates occasionally 10-100 s-jumps

SOC-SPR-2473