

The evolution of deep traps in the MOS CCDs

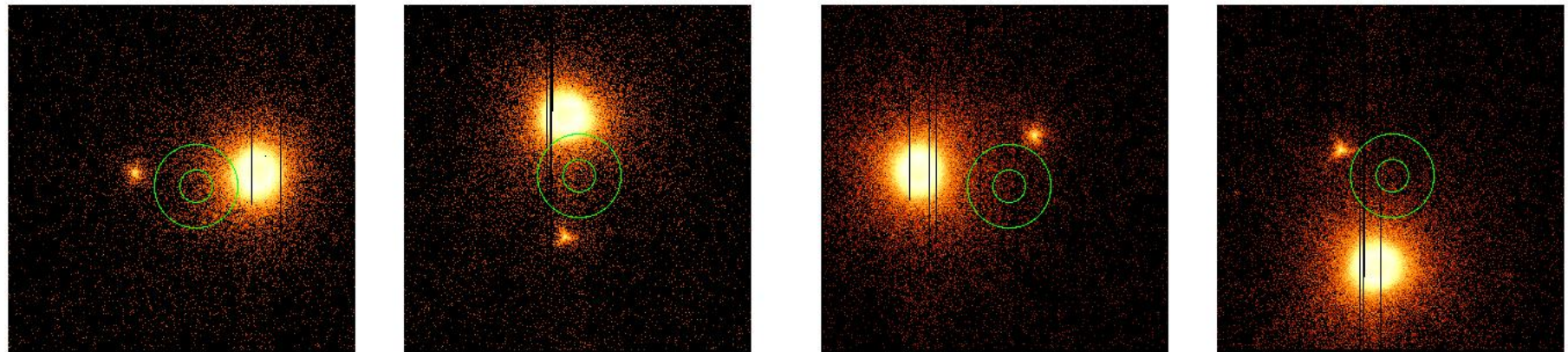
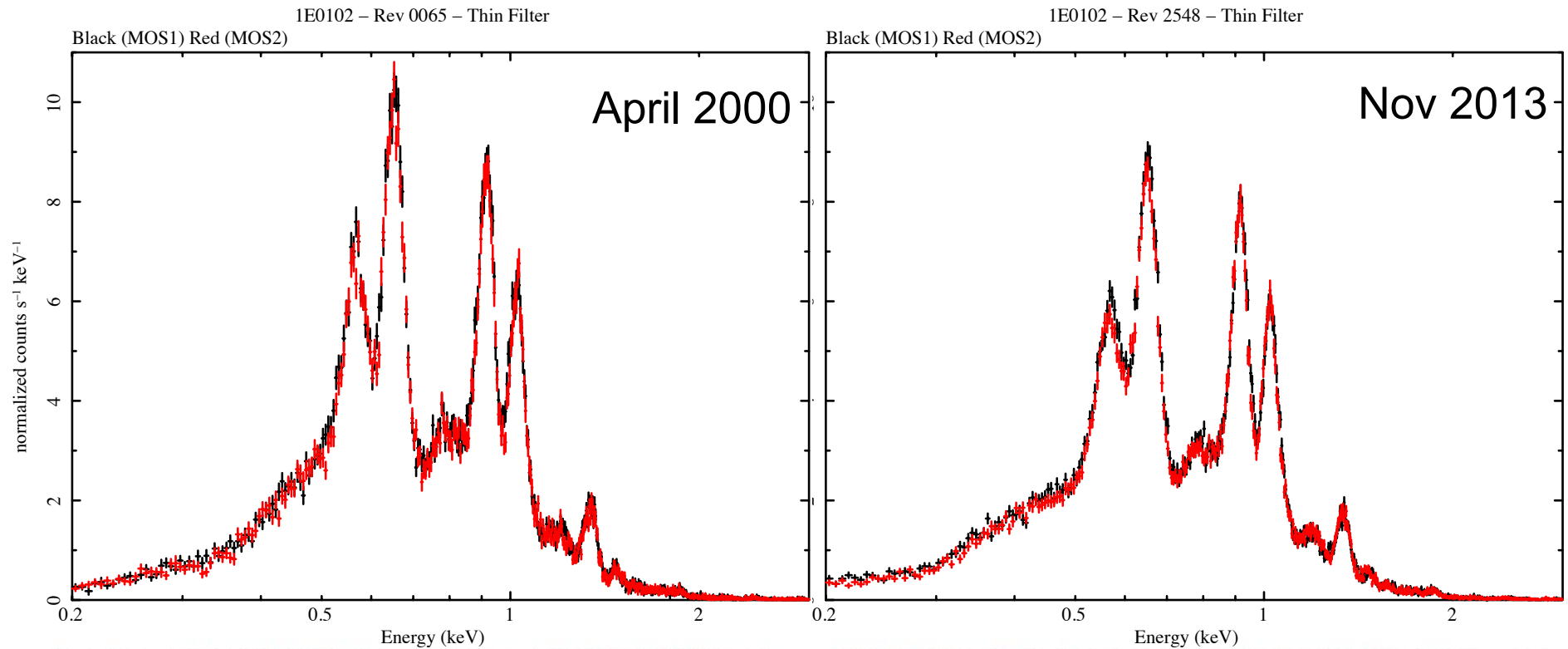


XMM
EPIC
MOS

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MPE 25/03/2014



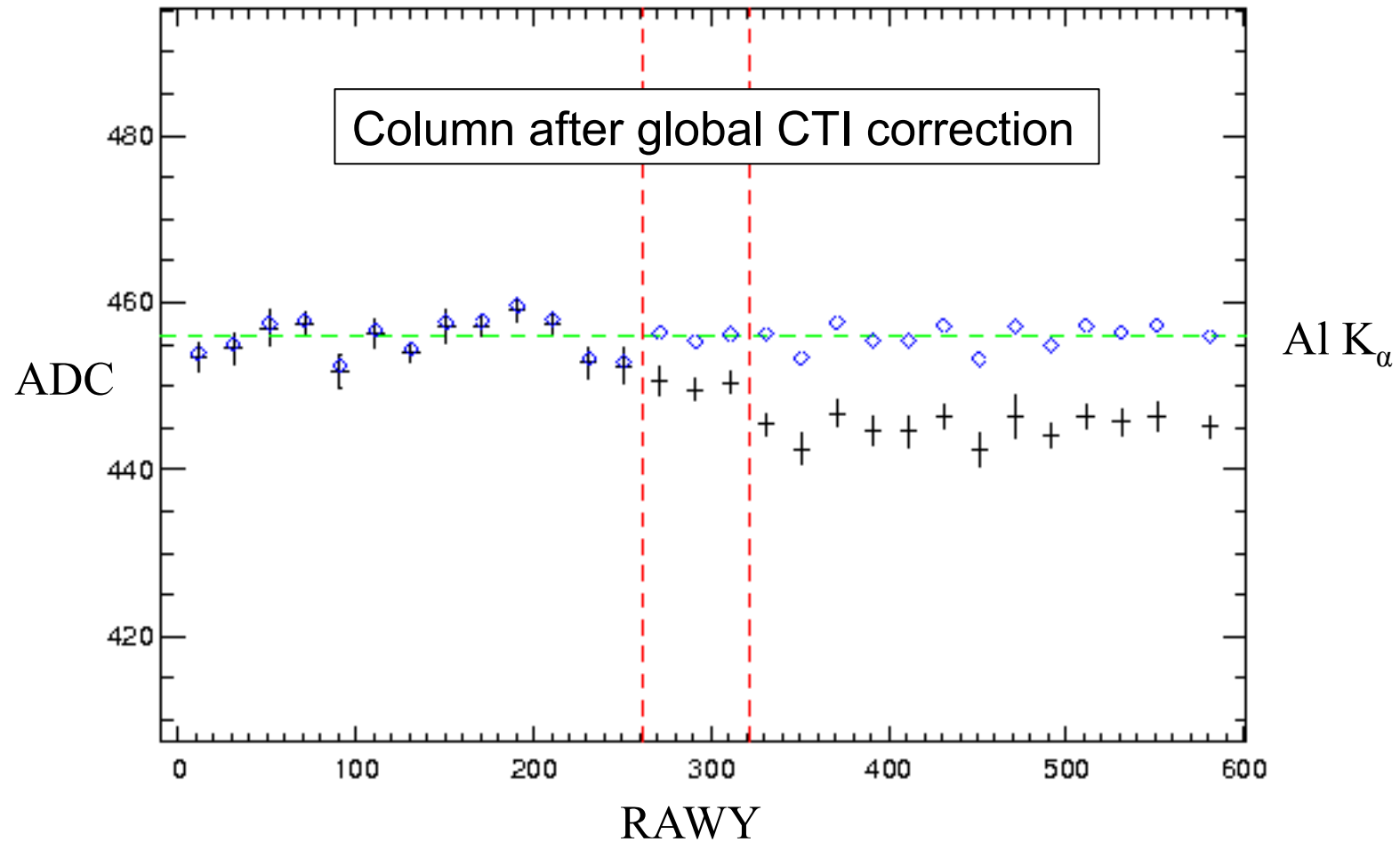
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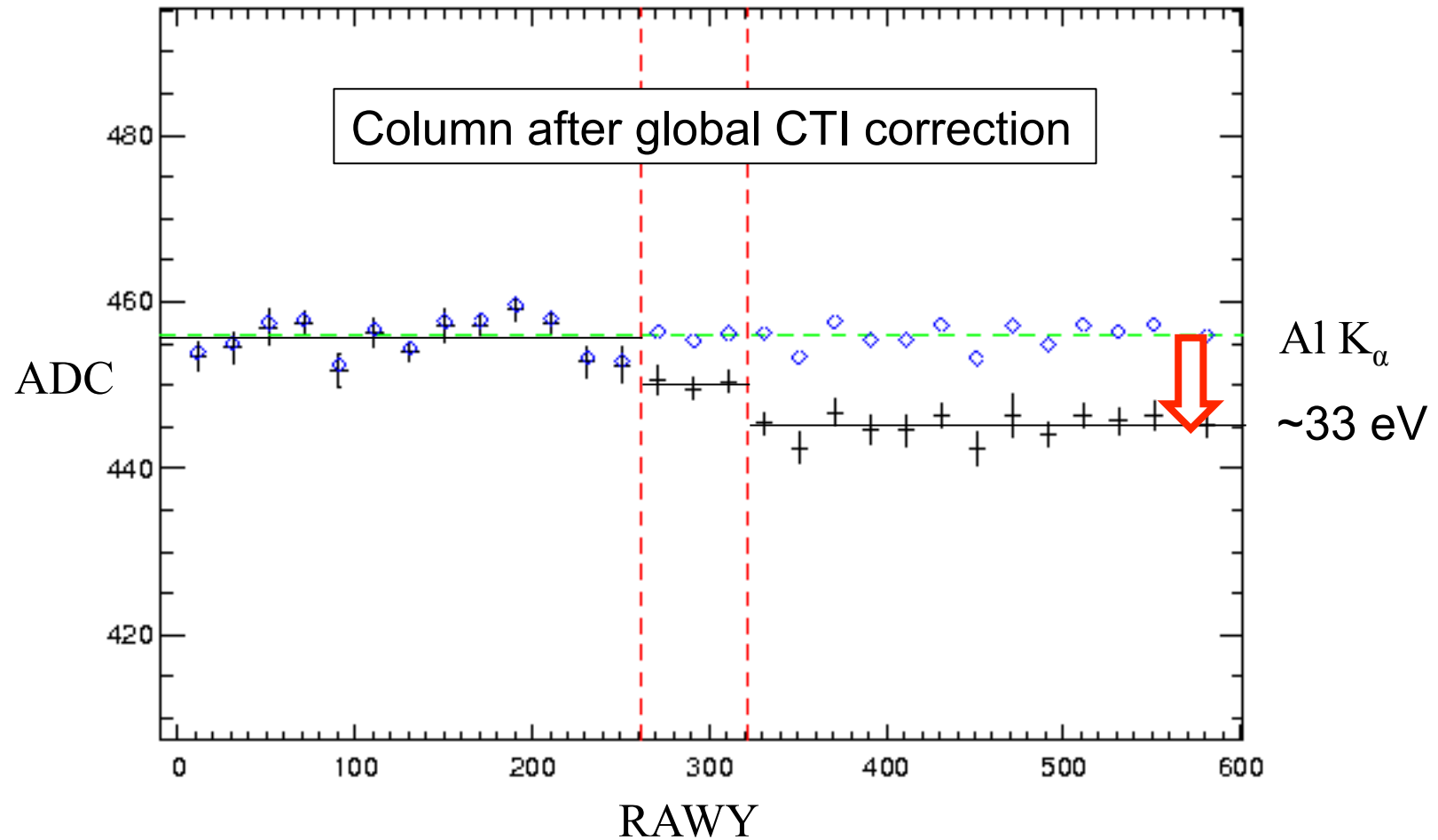
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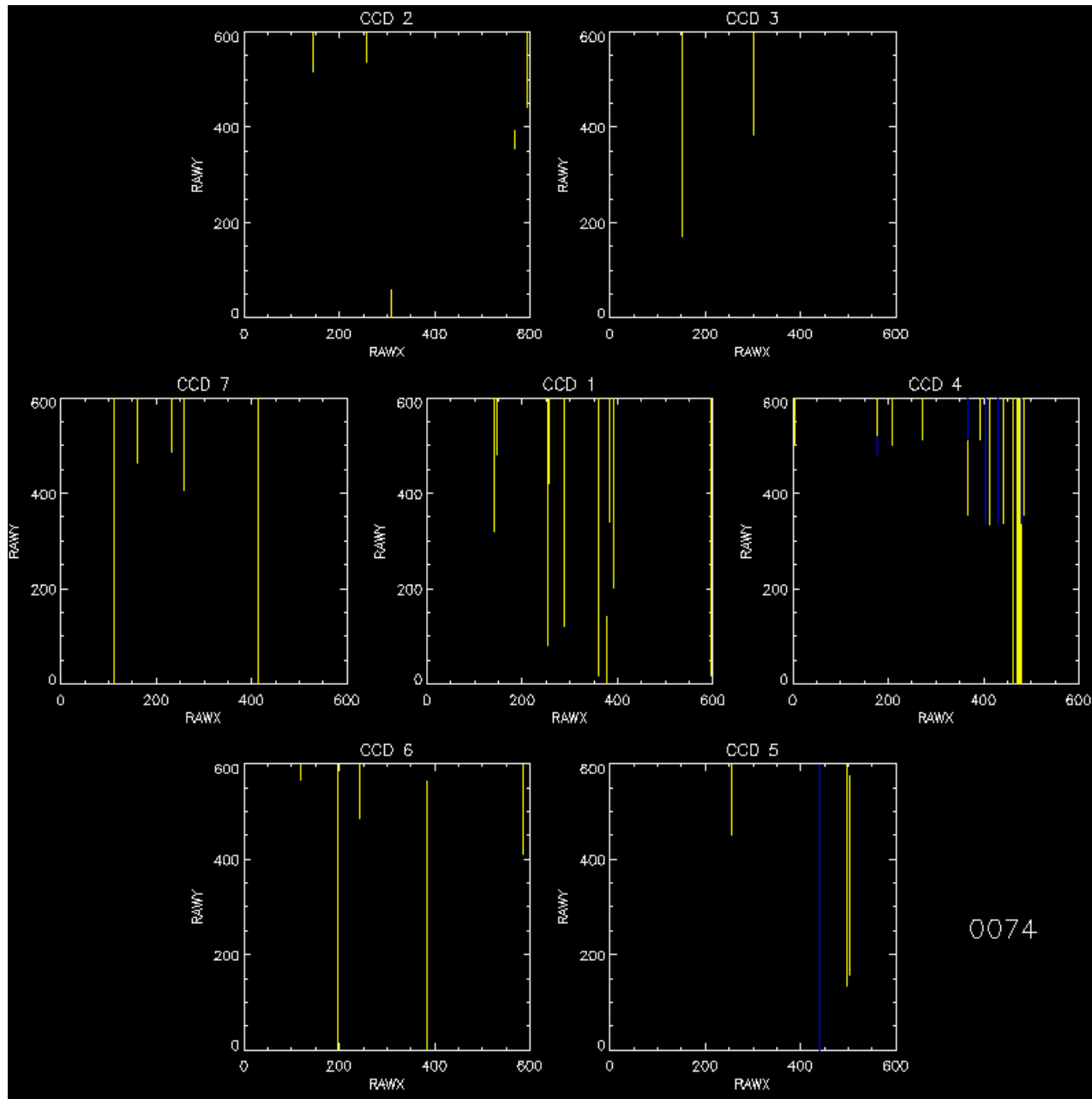


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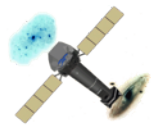
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MOS1 CC

Offsets at Al $K\alpha$ as Calculated by EMOS Package

- Offset < -100 eV
- 100 < Offset < -50
- 50 < Offset < 100
- Offset > 100

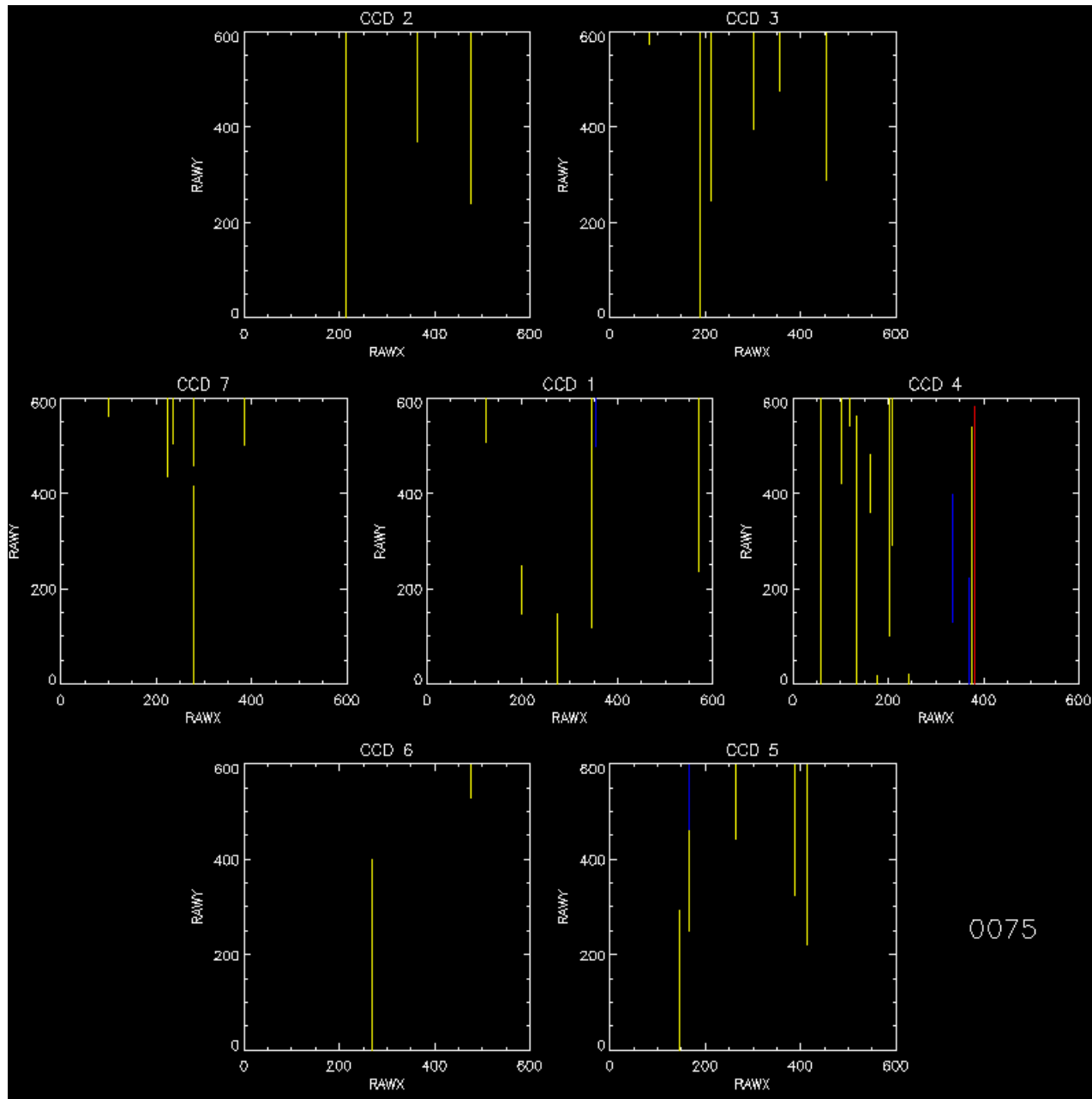


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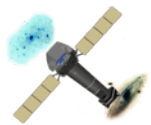
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MOS2 CC

Offsets at Al $K\alpha$ as Calculated by EMOS Package

- Offset < -100 eV
- 100 < Offset < -50
- 50 < Offset < 100
- Offset > 100

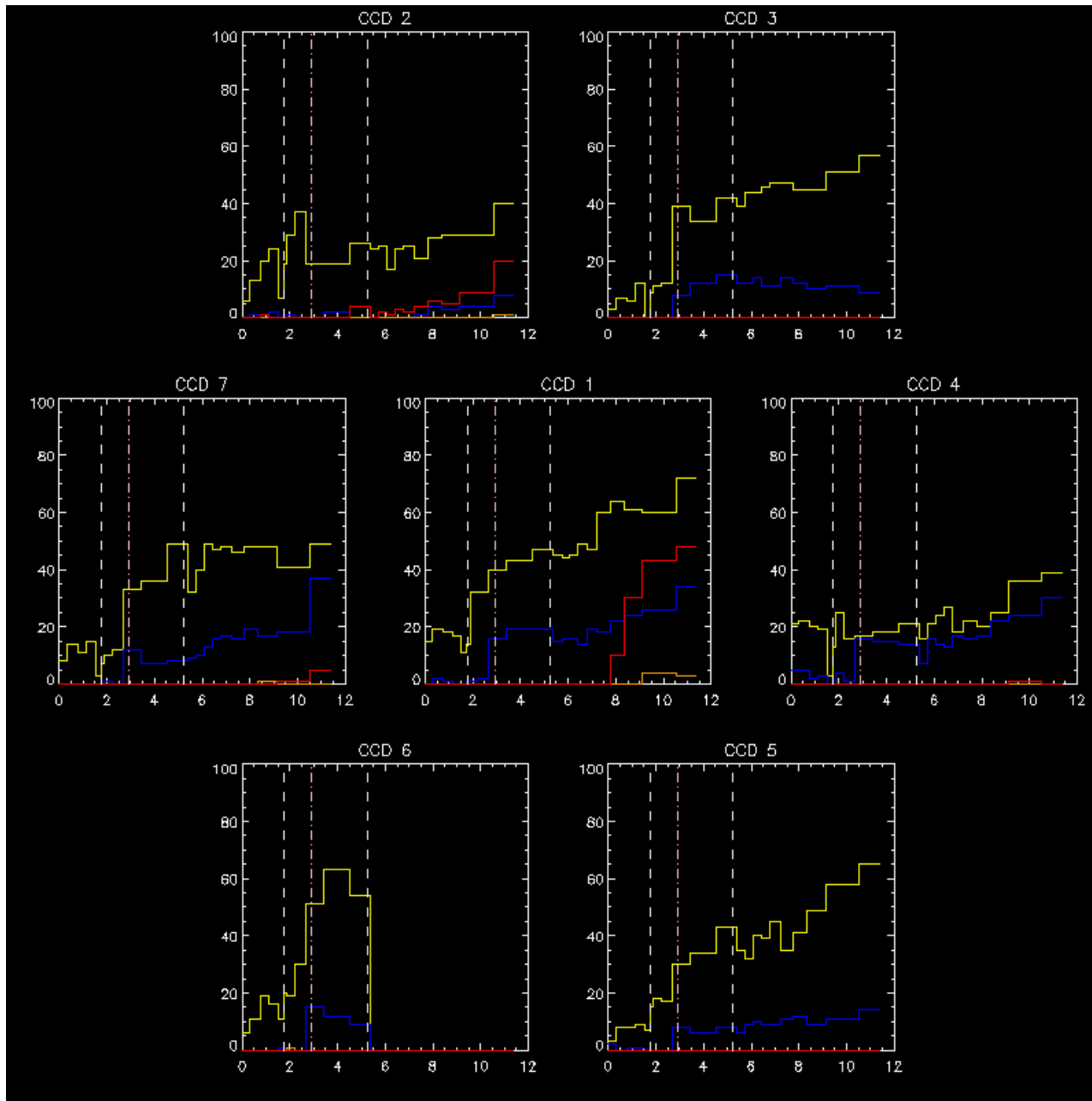


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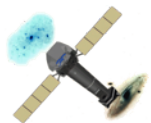
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MOS1 CC
 Offsets at Al K α as
 Calculated by EMOS
 Package

- Offset < -100 eV
- 100 < offset < -50
- 50 < Offset < 100
- Offset > 100

Number of offsets
 versus year since
 launch

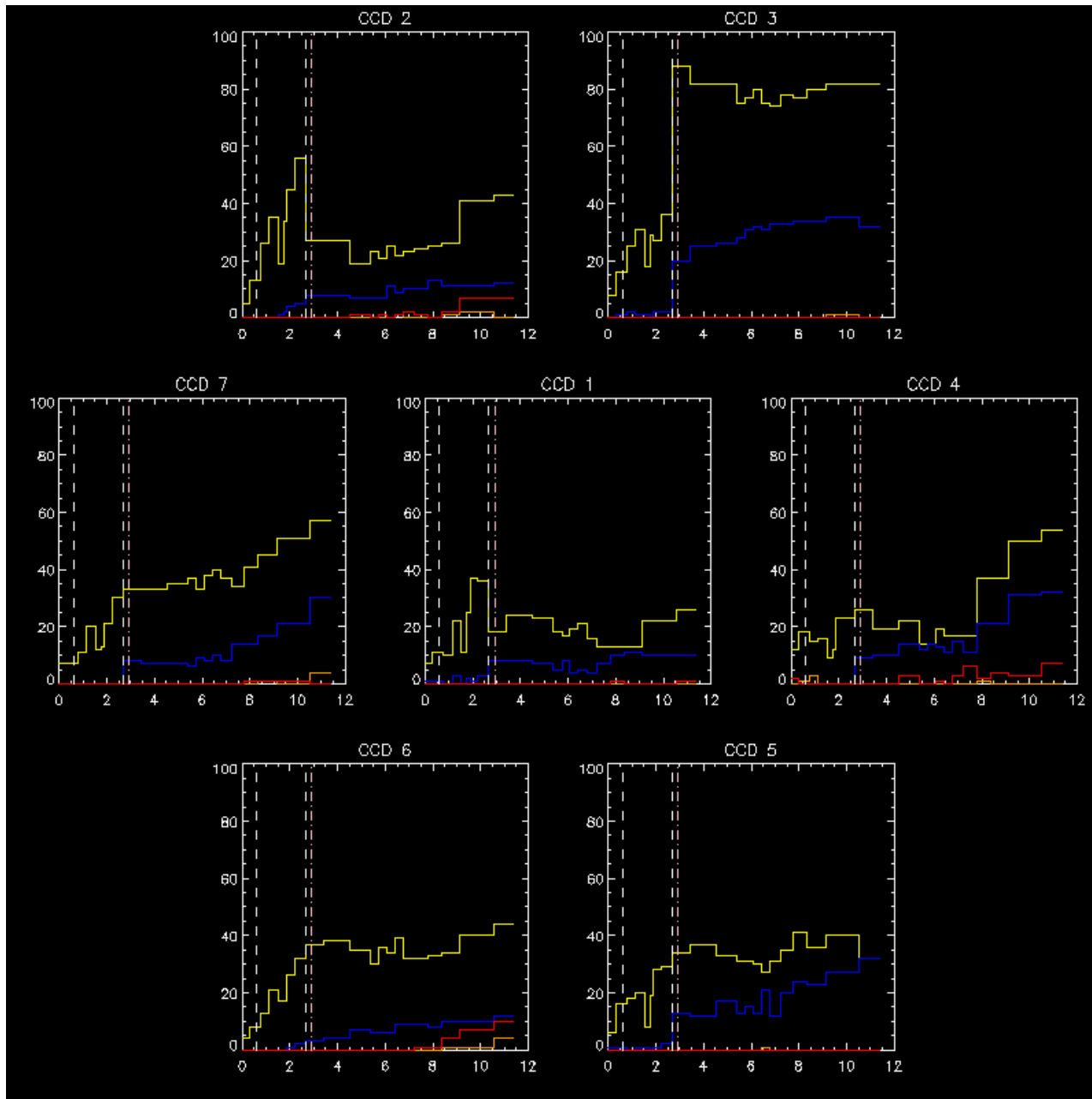


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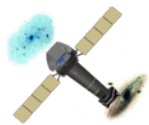
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MOS2 CC
 Offsets at Al K α as
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 Package

Offset < -100 eV
 -100 < offset < -50
 50 < Offset < 100
 Offset > 100

Number of offsets
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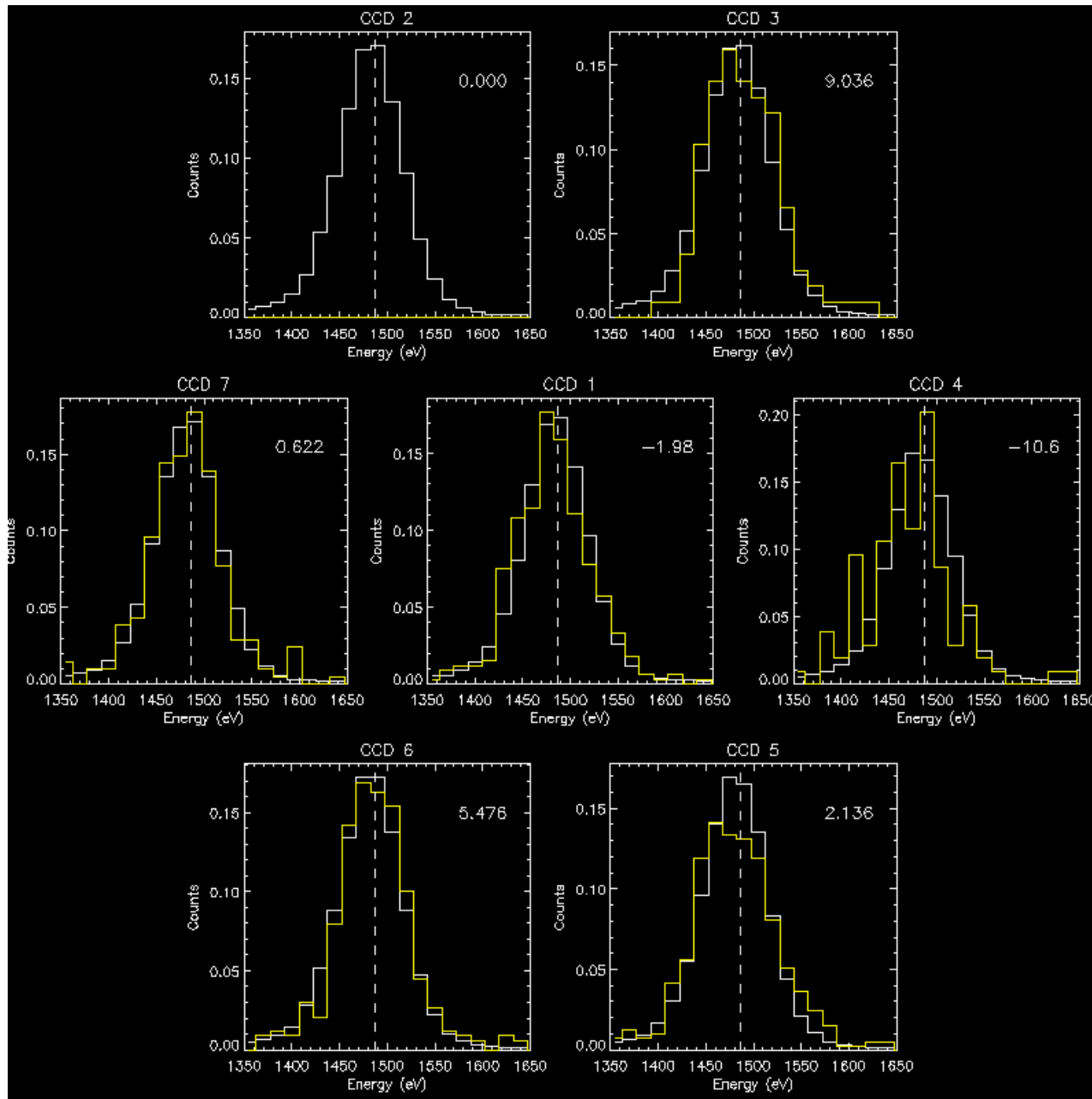


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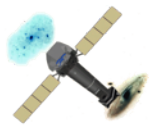
MOS1 CC
 0709/0160362701
 Al
 Pattern 0

-20 < Offset < 20 eV

Offset < -100 eV

Post-Cooling

CCD = -120°C

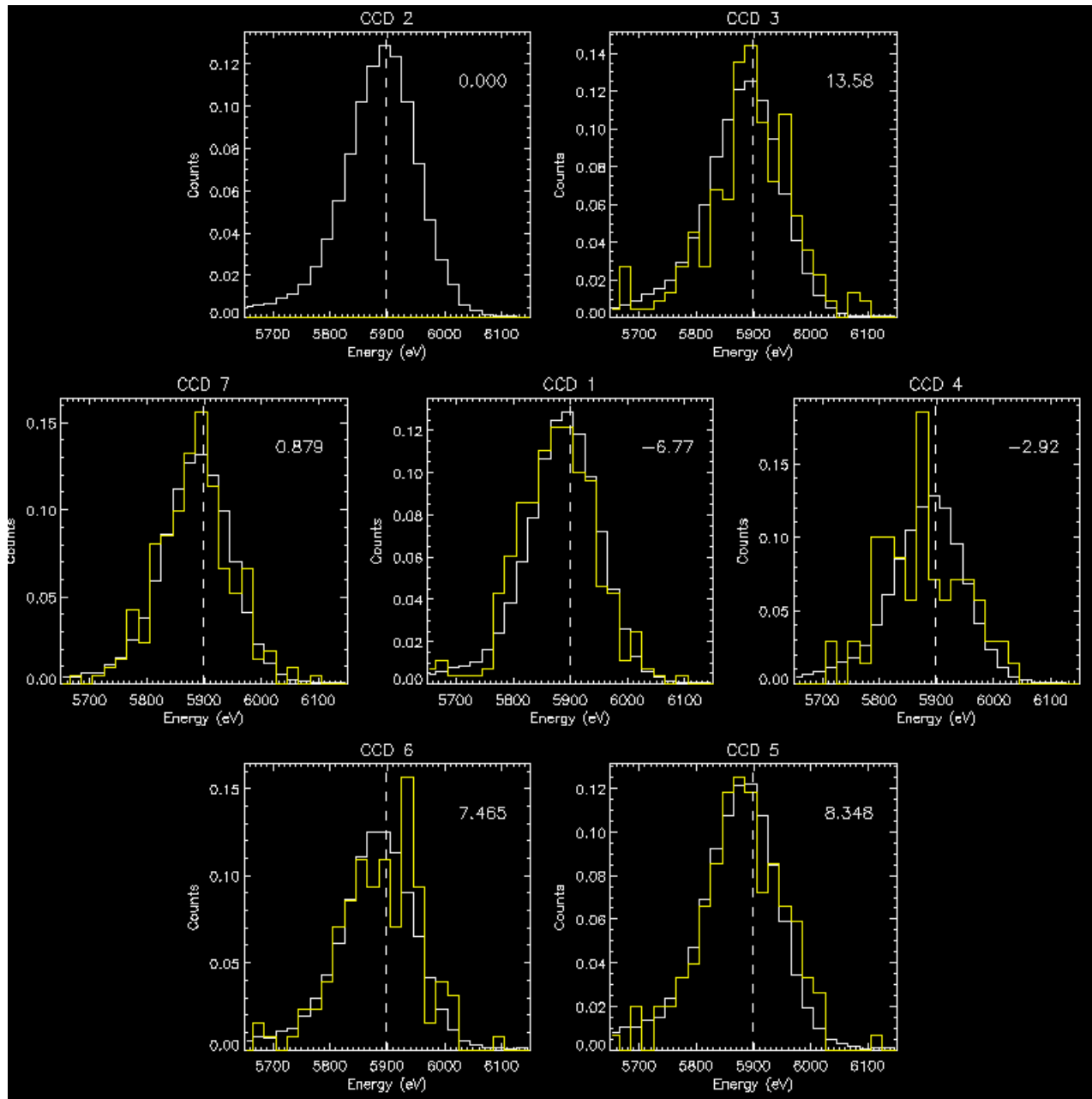


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MOS1 CC
 0709/0160362701
 Mn
 Pattern 0

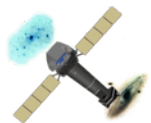
-20 < Offset < 20 eV

Offset < -100 eV

Post-Cooling

CCD = -120°C

Note: No strong
 Energy dependence!



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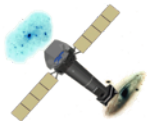
SWIFT XRT energy dependent traps:
(same CCD as MOS, run warmer by ~50-70°C)

$$\text{Off}(E) = \text{Off}(E_{\text{REF}}) \times (E / E_{\text{REF}})^{\alpha}$$

$$E_{\text{REF}} = 1.856 \text{ keV}$$

$$\alpha = \begin{cases} 0.80, & E < E_{\text{REF}} \\ 0.75, & E > E_{\text{REF}} \end{cases}$$

Using this formula, a 50 eV trap at Al K_{α} (1.49 keV) would have a depth of 142 eV at Mn K_{α} (5.9 keV),
a difference of 92 eV! – Not observed in EPIC-MOS

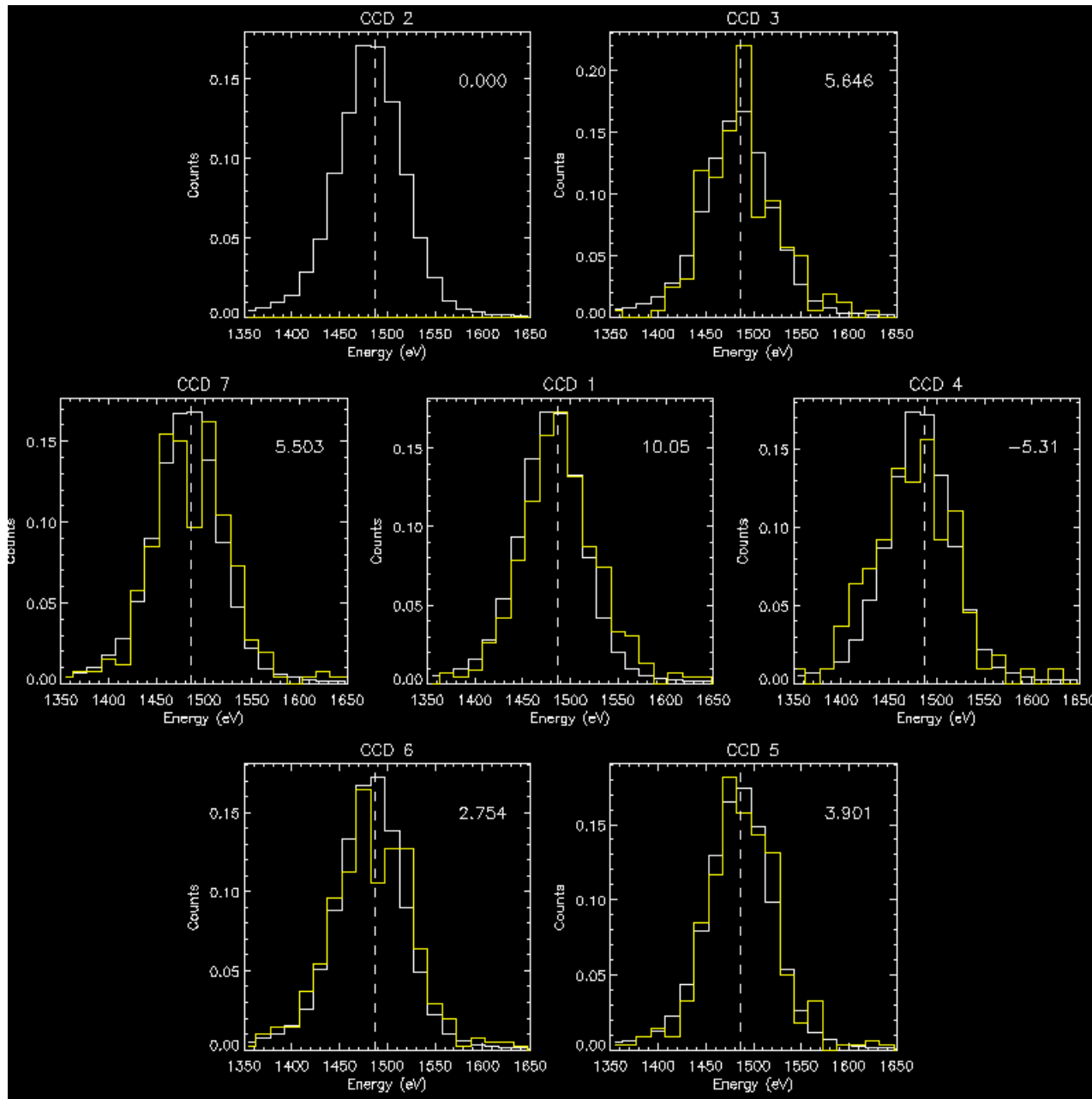


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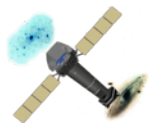
MOS1 CC
 0533/0156960501
 Al
 Pattern 0

-20 < Offset < 20 eV

Offset < -100 eV

Pre-Cooling

CCD = -100°C

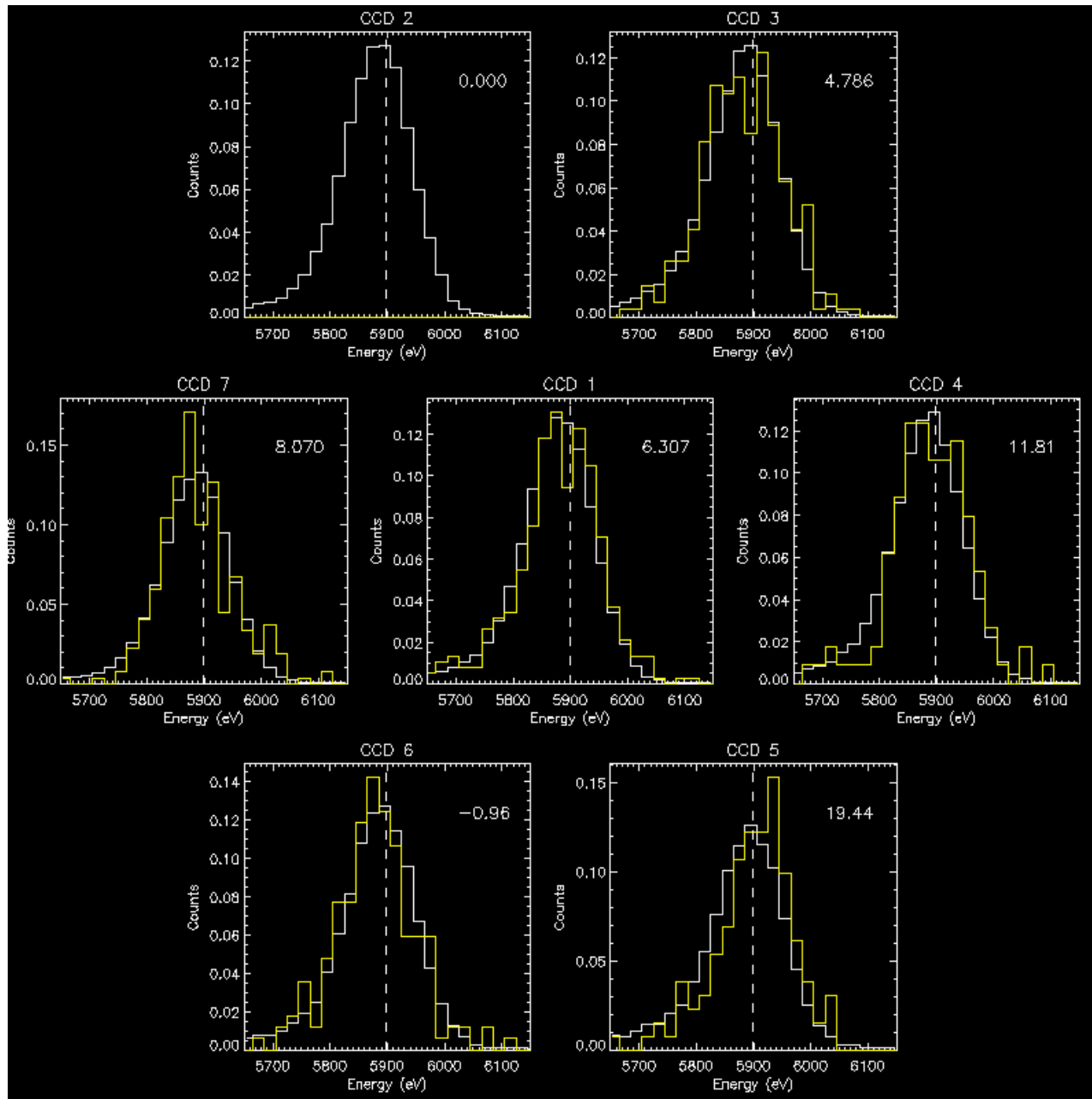


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MOS1 CC
 0533/0156960501
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 Pattern 0

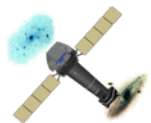
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Pre-Cooling

CCD = -100°C

Note: No strong
 Energy dependence!

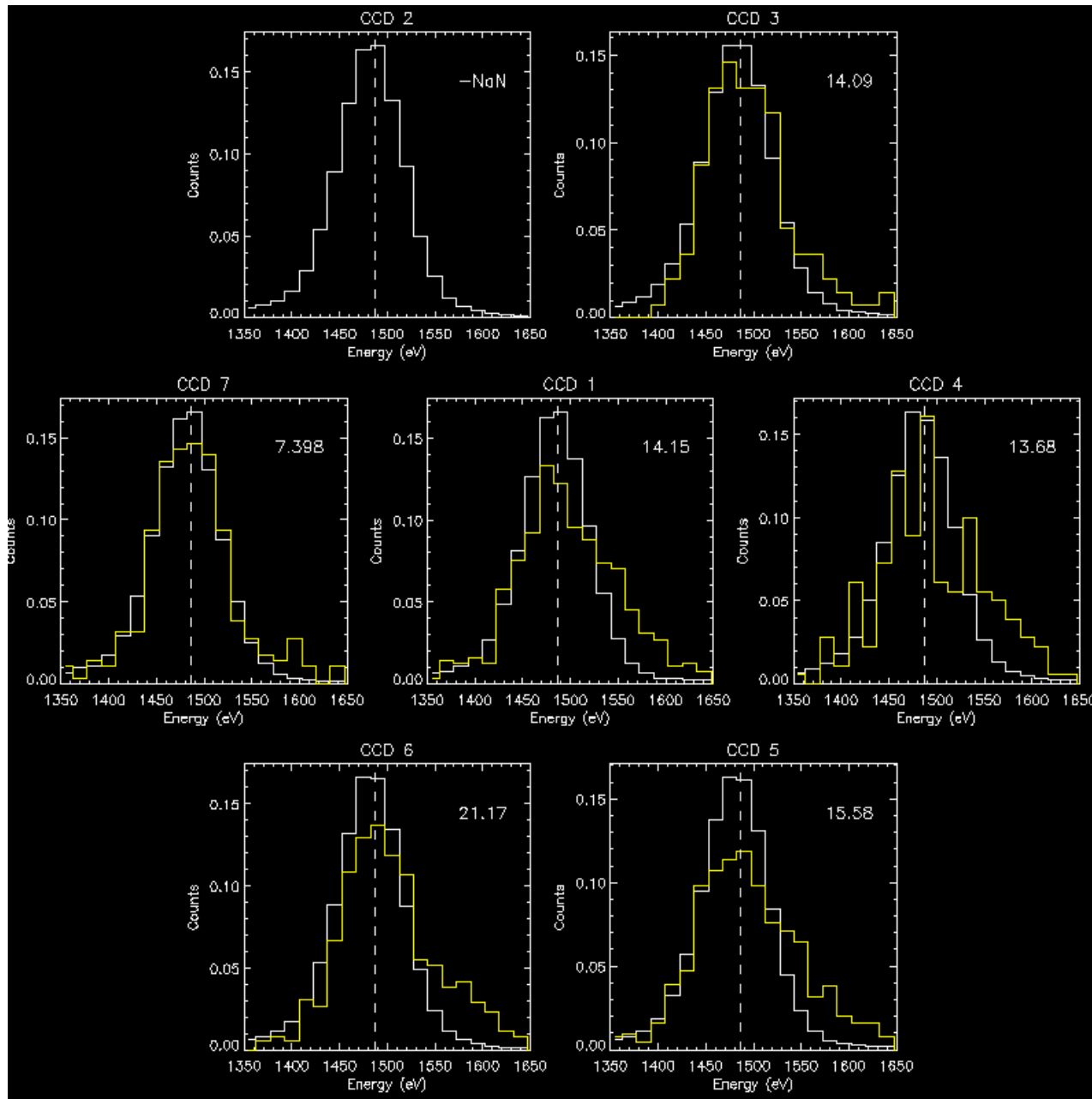


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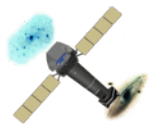
MOS1 CC
 0709/0160362701
 Al
 Pattern 0-12

-20 < Offset < 20 eV

Offset < -100 eV

Post-Cooling
 CCD = -120°C

Note: Reconstruction
 for multi-pixel events
 not so good

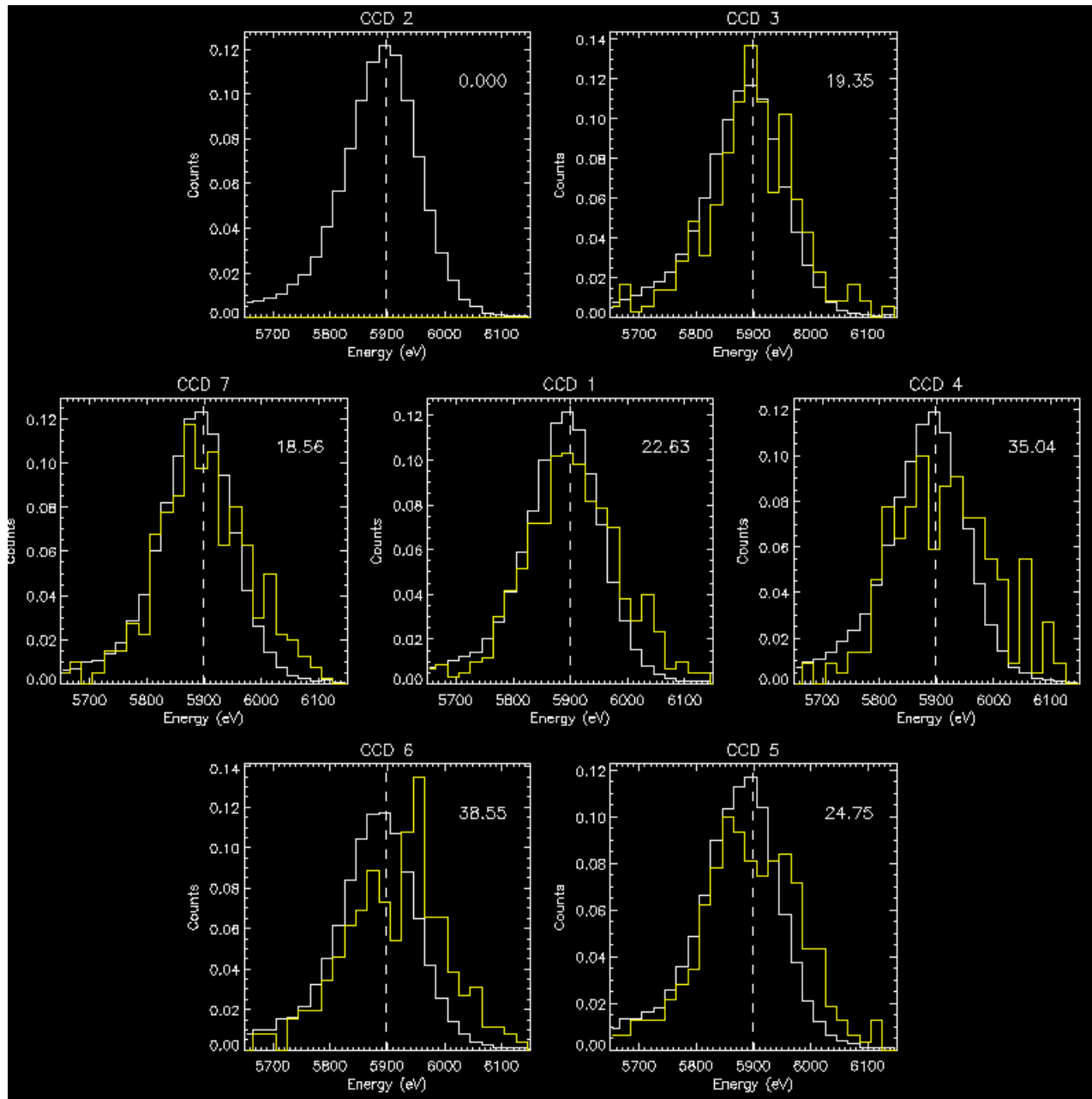


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MOS1 CC
 0709/0160362701
 Mn
 Pattern 0-12

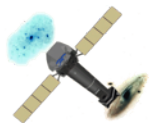
-20 < Offset < 20 eV

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Post-Cooling

CCD = -120°C

Note: Reconstruction
 for multi-pixel events
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Summary:

Rate of generation of traps on central CCDs very different.
MOS1 CCD1 >> MOS2 CCD1

Currently around ~10% of columns of MOS1, CCD1
affected by a deep trap

Good news: no strong energy dependence between Al and
Mn. Need to check at low energies

But “single pixel energy trap model” breaks down for multi-
pixel events...what to do about this??

