MOS CTI correction

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Current MOS CTI

- In current SAS (v5.2, MOS CTI CCF v5) the CTI is under-corrected ==> line centroid is shifted to lower energies

- Discrepancy increasing with time (rev #)
  - By now (rev 340) it is about 25-30 eV at Mn energies
MOS CTI algorithm

- $X =$ serial loss, $Y$: parallel loss
- $\text{CTI} = \text{CTIX} \cdot \text{RAWX} + \text{CTIY} \cdot \text{RAWY}$

**Current CTI correction:**
- $\text{CTIX} = \delta T \cdot \text{rate}_x + (a_{0x\text{CCDi}} + b_{0x\text{CCDi}} \cdot \text{PHA})$
- $\text{CTIY} = \delta T \cdot \text{rate}_y \cdot (\text{PHA})^{1/2} + (a_{0y\text{CCDi}} + b_{0y\text{CCDi}} \cdot \text{PHA})$
  - with $(a,b)_{0X,Y}$ from ground-based test and $\delta T = T - T_0$

**New CTI correction:**
- $\text{CTIX} = a_{1x\text{CCDi}} + b_{1x\text{CCDi}} \cdot \text{PHA}$
- $\text{CTIY} = \delta T \cdot \text{rate}_{Y\text{CCDi}} \cdot (\text{PHA})^{\alpha_{\text{CCDi}}} + (a_{1Y\text{CCDi}} + b_{1Y\text{CCDi}} \cdot \text{PHA})$
  - with $(a,b)_{1X,Y}$ from ground-based test and $\delta T = T - T_{\text{launch}}$

- 6 parameters per CCD (4 for parallel loss and 2 for serial)
  - degradation rate and power index (0.55 to 0.7) CCD dependant!
- All parameters derived from a linear fit of MOS CTI plots.
MOS CTI new algo tests

- **New algorithm tested in:**
  - CCF MOS CTI **version 6**
  - combined with **cal-3.120**

- **Some slight over-correction for MOS1**

- **Still some under-correction for MOS2**
  - CTI underestimated because of high MOS2 calibration source?

- **Proposed for SAS v5.3**
Temperature-dependence of the gain?

- CTI correction does not work for cal-closed during the eclipse seasons, because of the EMAE $T_{re}$ variations.

- EMAE $T_{re}$ colder ==> CTI is less ==>over-correction in SAS.

- Effect worse for MOS2 than MOS1 and energy-dependent. $\delta$PHA = a . E/K1311 + b + c. PHA

- From rev 242 long calclosed : $\delta$PHA / $\delta T_{re}$ ~1

- Effect worse in autumn eclipses, as $T_{re}$ excusions are larger.

- Science observation less affected, but $T_{re}$ stabilized at ~ 2 degrees lower in last eclipse season, ==> ~ 7 eV shift.
Comparison MOS/ pn

- Comparison MOS/pn on the hot spot of CasA observed in rev 306.
- MOS shifted by $> 20$ eV compared to pn in both LW and full-frame at high energies.
- Note: no mode-dependent CTI correction.
- Future: make a systematic comparison MOS/pn/RGS on N132D for soft energies.
MOS energy resolution

- Negligible line width increase after CTI correction at Mn energies

- \( \sim <1\% \quad \text{sigma} = 64\text{eV} \)

- No change or decrease at Al energies ! (35 eV)
Conclusions

• **Status:**
  – As the linear fit CTI degradation is a good approximation, the new refined CTI algo is appropriate.
  – Give rather good results when the temperature is stabilized.
  – **Suggest to implement it in SAS v5.3**

• **Future:**
  – work on a temperature correction
  – parameters to be refined in the future with more time leverage and new CTI plots from Andrea.
    • Tune the under-correction for MOS2
  – Understand shifts with PN and compare positions with RGS at low energies (cross-calibration)