Charge Transfer Inefficiency in the Continuous Clocking Mode

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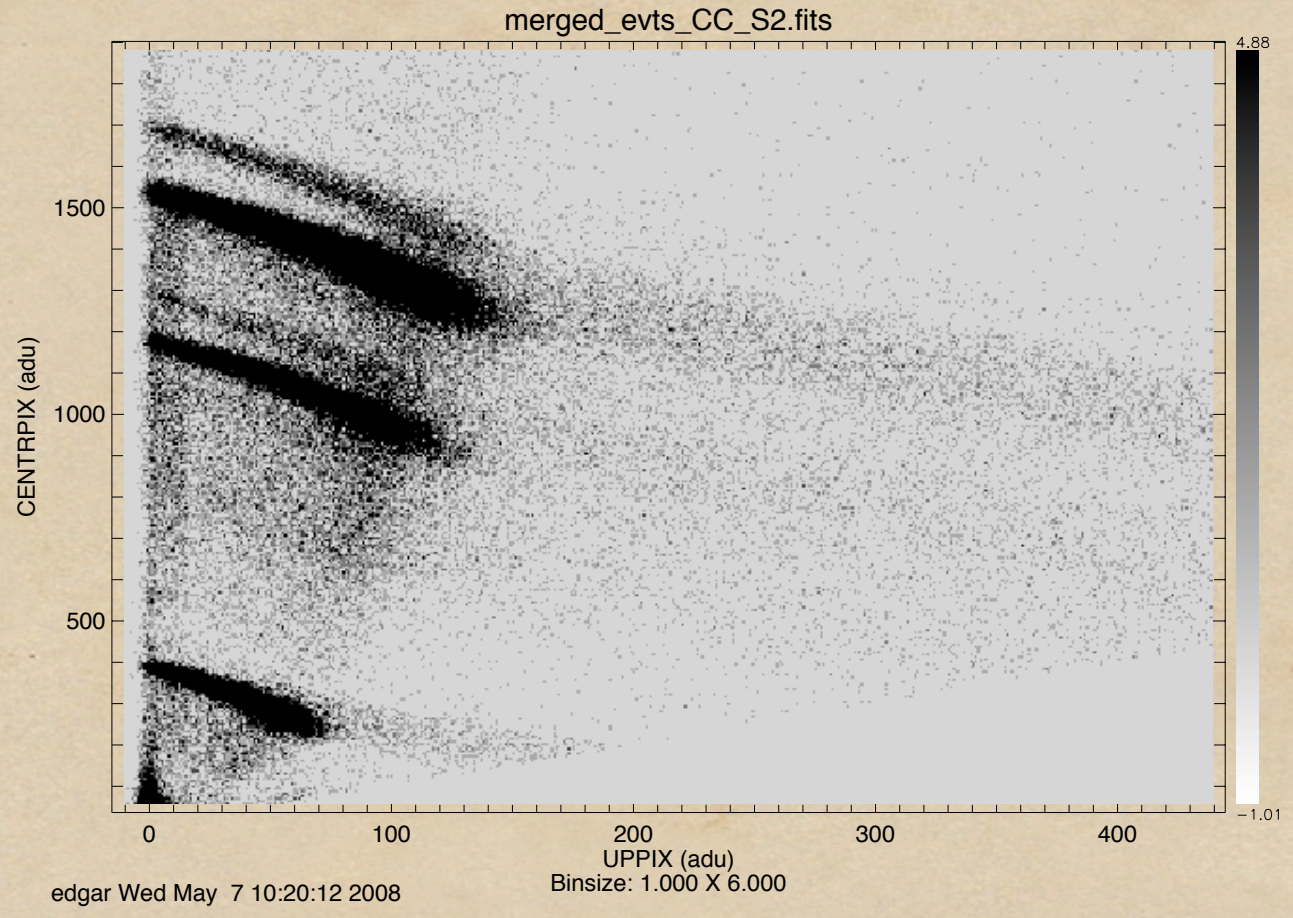
Facts about CC mode

- Row to row clocking time: 2.85 ms (vs. 40 microsec for TE mode).
- This means CTI is due to a different population of traps.
- By default, all ASCA Grade 7 (G7) events are not telemetered.
- There are instrument modes that telemeter all grades but flight grade 255 (all 9 pixels lit).

ECS data: cenpix vs uppix

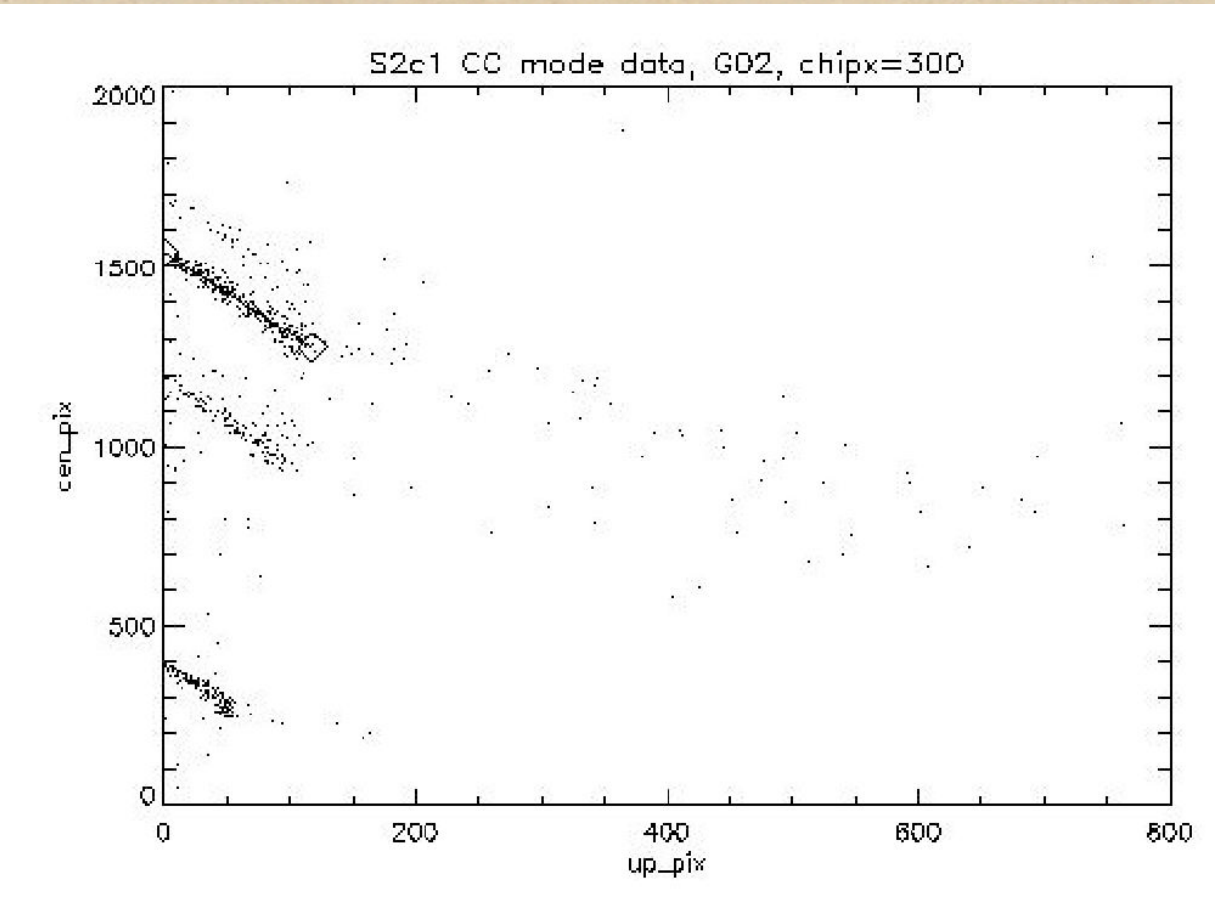


- External cal source data
- Note 5 bright lines.

Constructing CC mode trapmaps

- Fit slope, intercept, endpoint
- Endpoint gives max trap density
- Assume integrated trap density linear vs chipy, and zero at readout
- Slope gives charge trailing fraction
- Only for FI chips (so far)

Single-column fitting

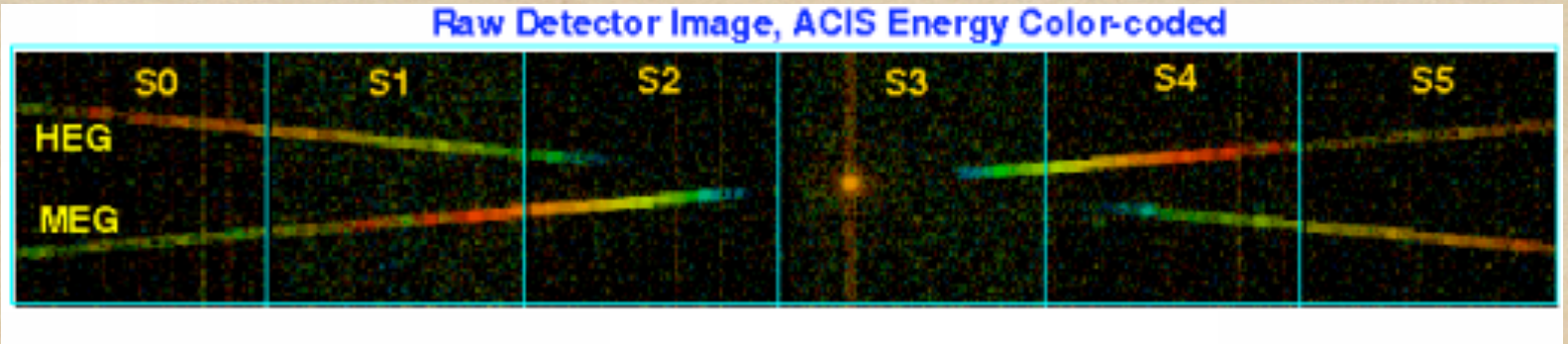


- Allows trapmap to fix column-to-column variations

However, comma...

- Need chipy. For bright sources, HETG observations, etc. this comes from RA_TARG and DEC_TARG (user-supplied target coords)

Resolving chipy coord



- For HETG observations (ciao 4.1+), tg_resolve_events estimates chipy coord of each event after order sorting.
- We will use this in data processing.

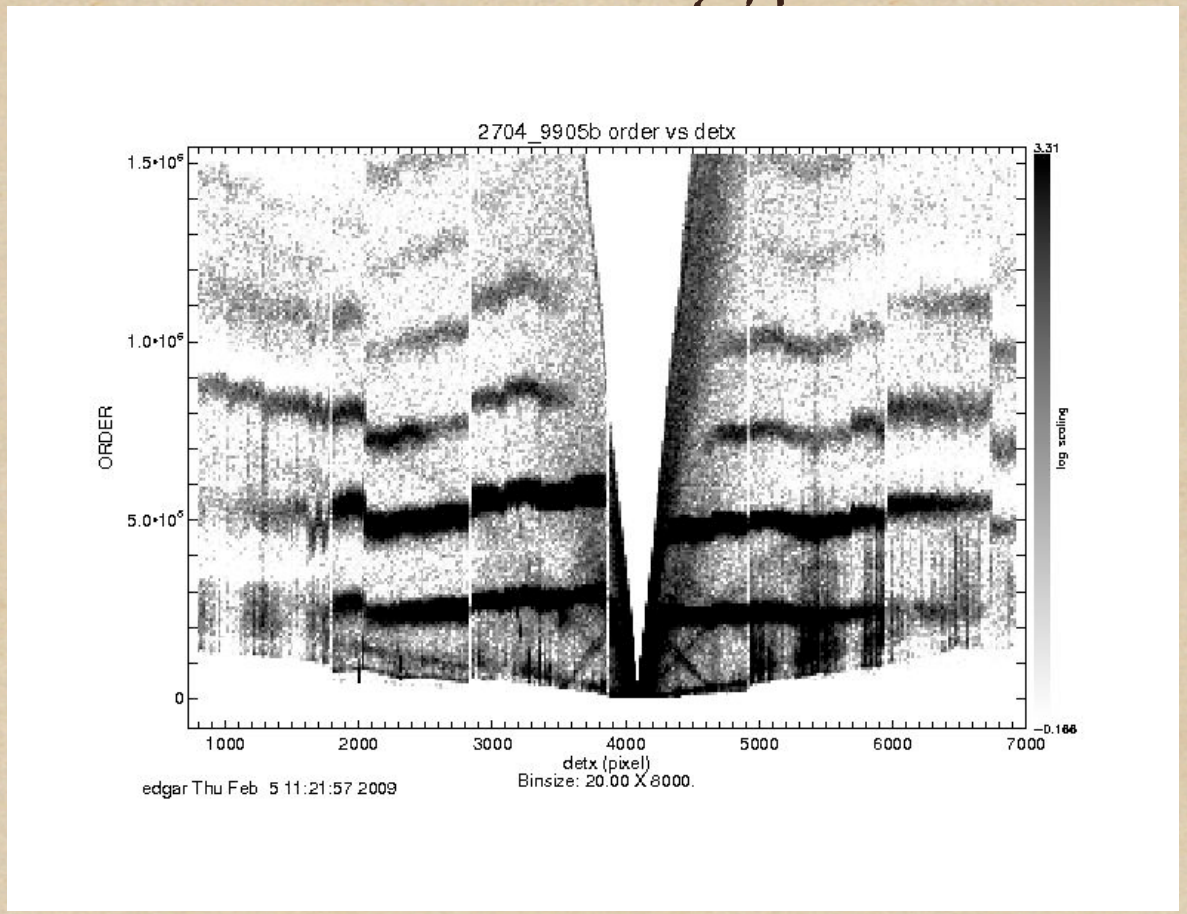
Data prep: Uses existing CIAO tools

- Remove existing CTI correction: a_p_e
- Get chipy coords from target coords: tg_r_e
- Hack header to mock-up TE mode: dmhedit
- Apply cc-mode CTI correction, gain, etc.: a_p_e
- Grating processing as usual.

Testing: HETG obs of HER X-1

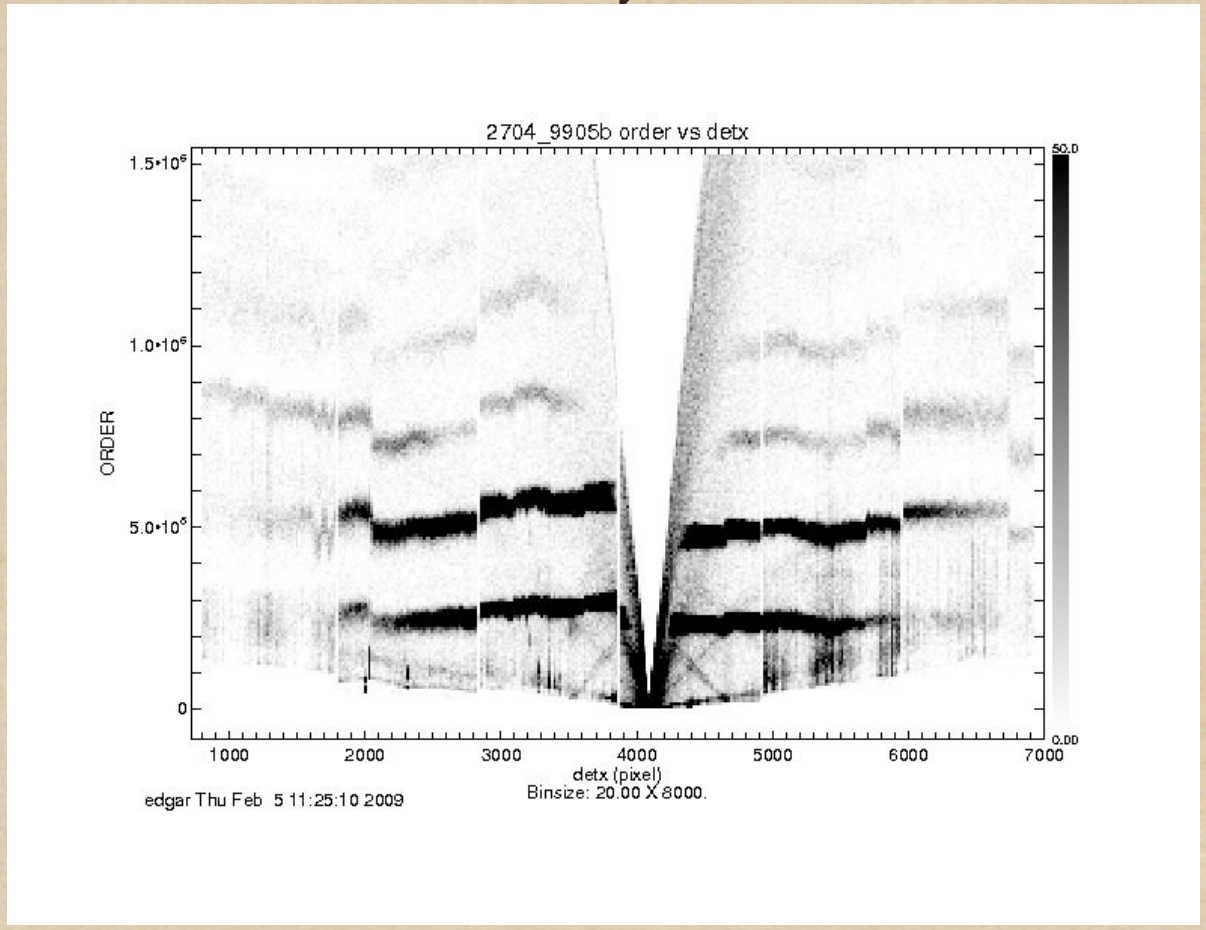
- obsid 1702: HETG/CC mode
- Data prepared as above
- Raw order-sorting plots (PHA times the distance in detx pixels from the zero order image)
- Extract spectra for 32-column slices, and fit

Faux Order-sorting plot



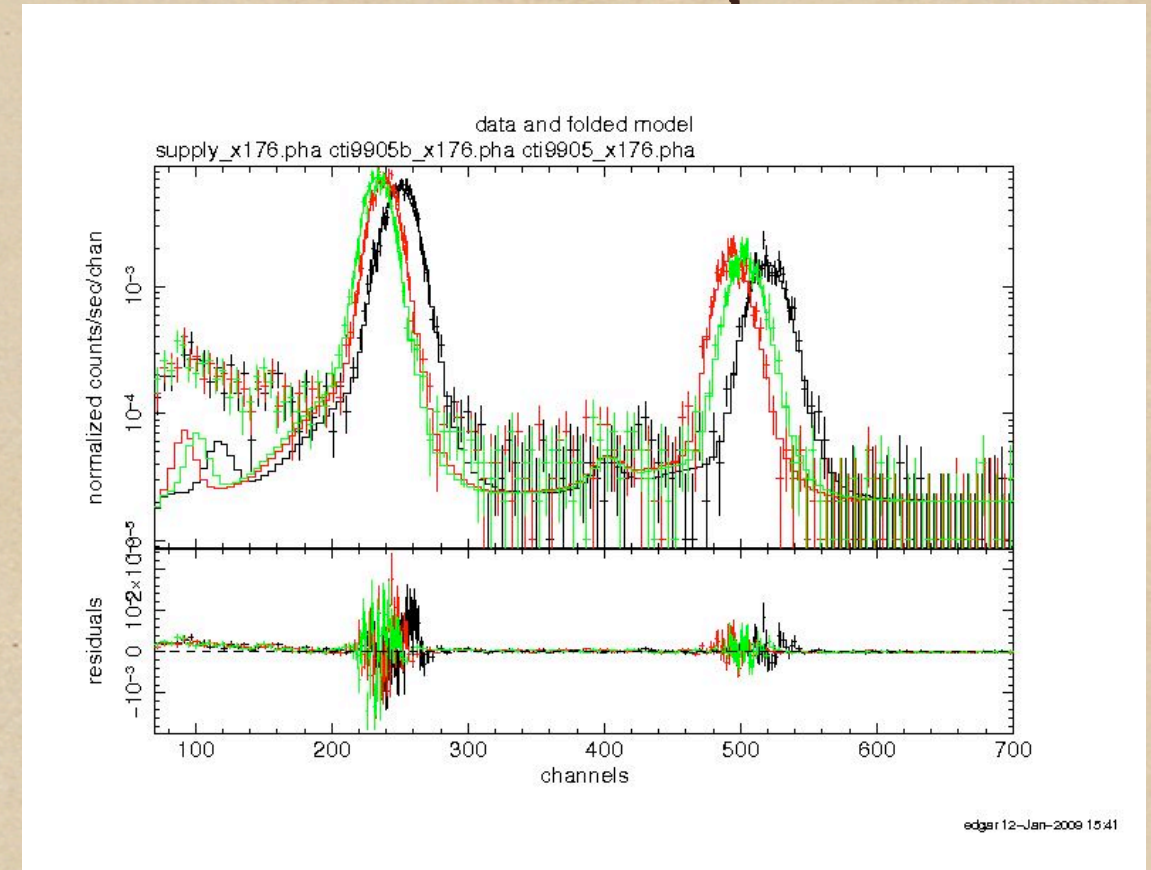
- PHA*(detx-detx0), log stretch
- Note gain "features" esp. S0c3

Order-sorting plot, linear stretch



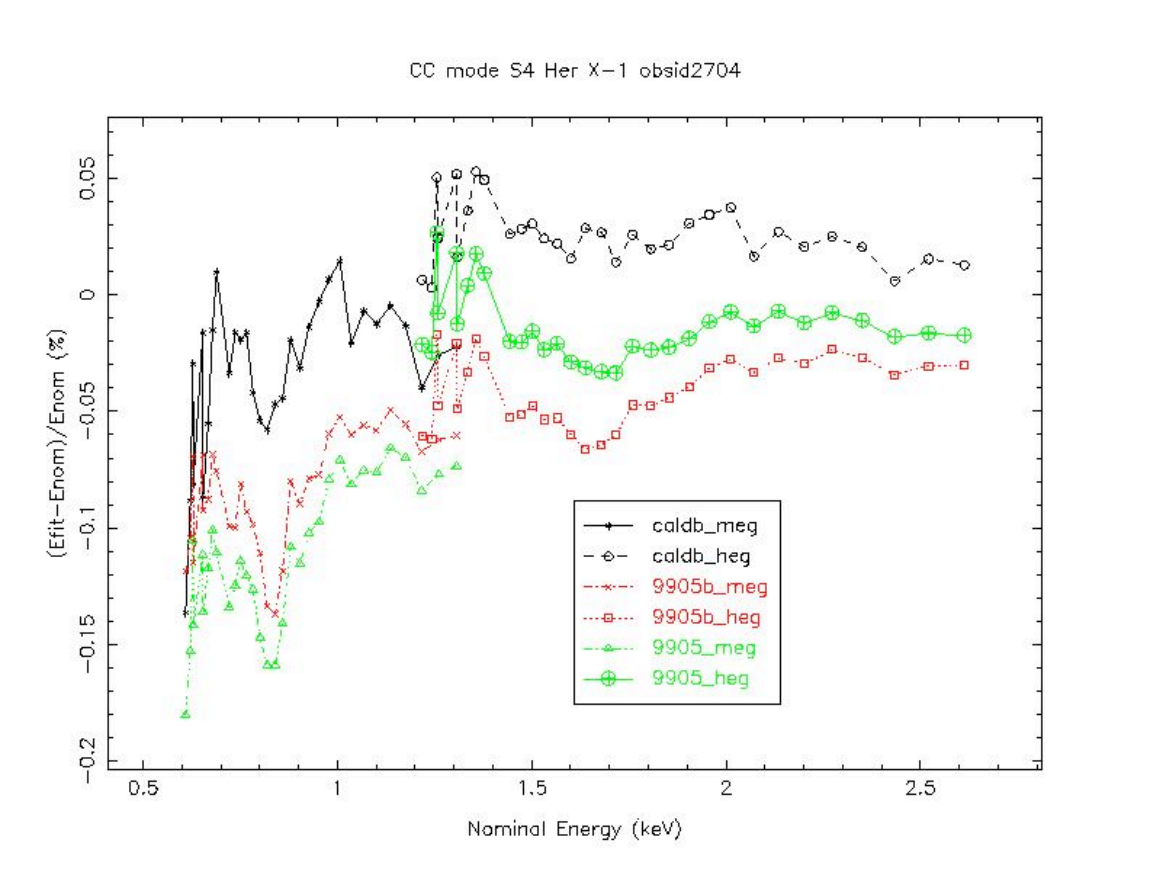
- Same plot, linear stretch
- Gain map can fix most of this

Fit to PHA spectra



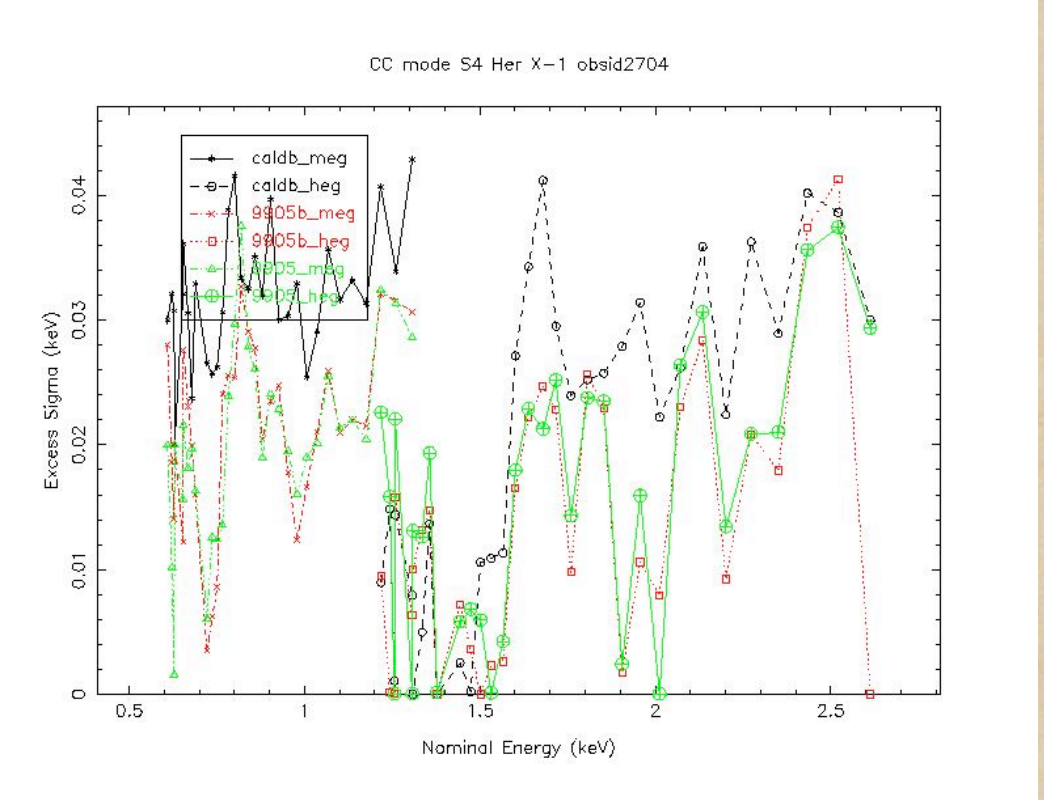
- Fit to x~=176 slice on S4, MEG & HEG 1st order
- black: TE; green: no chipy correction; red: this work

Fit params vs energy



- Fitted vs nominal energy; colors as before
- Red curve more consistent, HEG vs MEG

Fit params vs energy



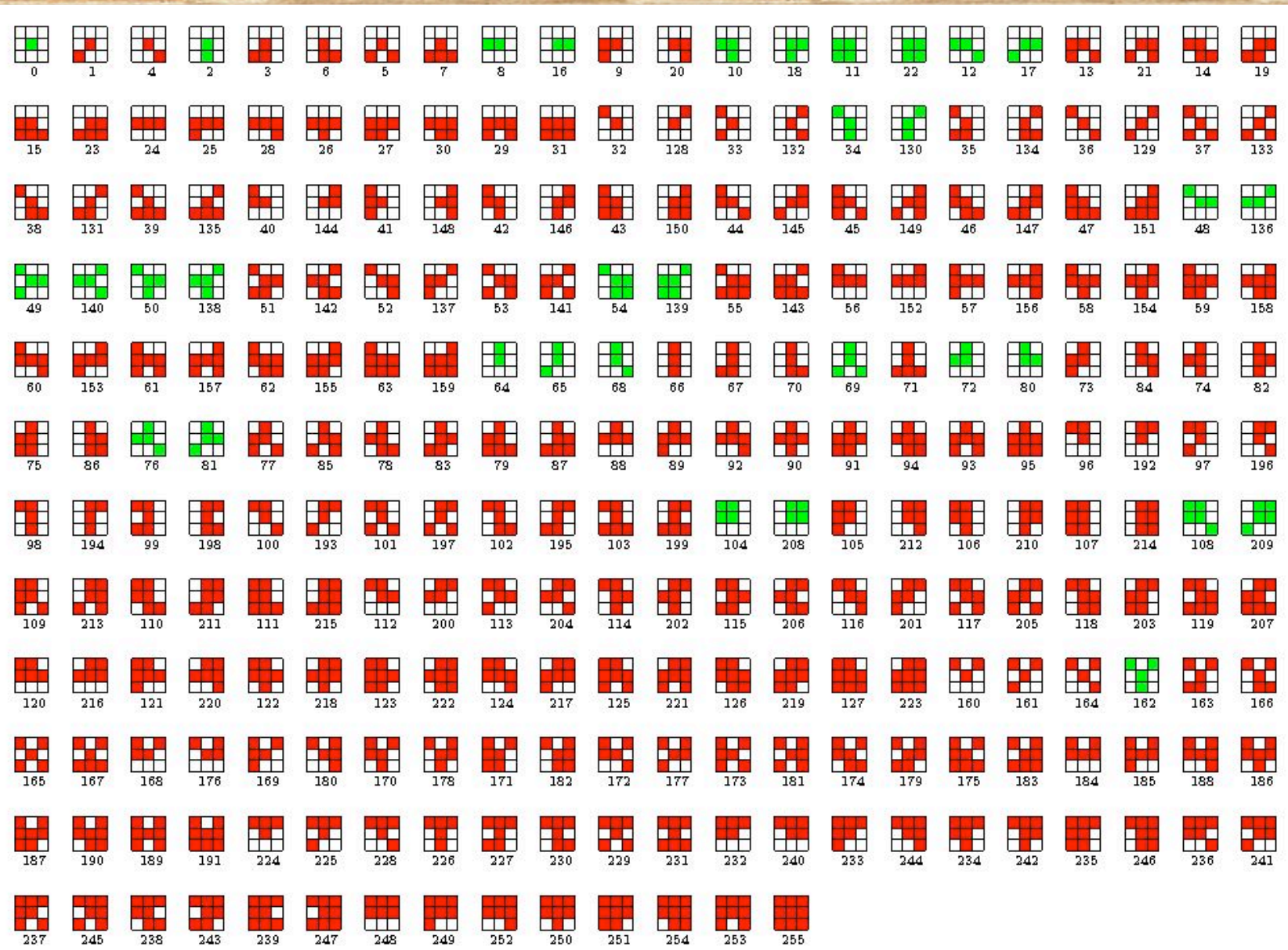
- excess line width, colors as above.
- CC mode trap map often much better than TE

Caveat emptor

- Can't use this on diffuse sources (e.g. external cal source)
- Further calibration using HETG and LETG sources at various SIM-Z
- QE effects: rescuing rejected grades if telemetered (see Norbert Shultz)
- Further work needed on response with this trapmap

Conclusions

- We have a trapmap suitable for use with CC mode data for bright, isolated sky sources
- It can be applied with existing ciao4.1 tools
- Still need a gain map (and tgain?)
- Lines often narrower than with TE trapmap
- response, if desired, could be created by reducing the width of the TE mode scatter matrix.


0 1 4 2 3 6 5 7 8 16 9 20 10 18 11 22 12 17 13 21 14 19
15 23 24 25 28 26 27 30 29 31 32 128 33 132 34 130 35 134 36 129 37 133
38 131 39 135 40 144 41 148 42 146 43 150 44 145 45 149 46 147 47 151 48 136
49 140 50 138 51 142 52 137 53 141 54 139 55 143 56 152 57 156 58 154 59 158
60 153 61 157 62 155 63 159 64 65 68 66 67 70 69 71 72 80 73 84 74 82
75 86 76 81 77 85 78 83 79 87 88 89 92 90 91 94 93 95 96 192 97 196
98 194 99 198 100 193 101 197 102 195 103 199 104 208 105 212 106 210 107 214 108 209
109 213 110 211 111 215 112 200 113 204 114 202 115 206 116 201 117 205 118 203 119 207
120 216 121 220 122 218 123 222 124 217 125 221 126 219 127 223 160 161 164 162 163 166
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