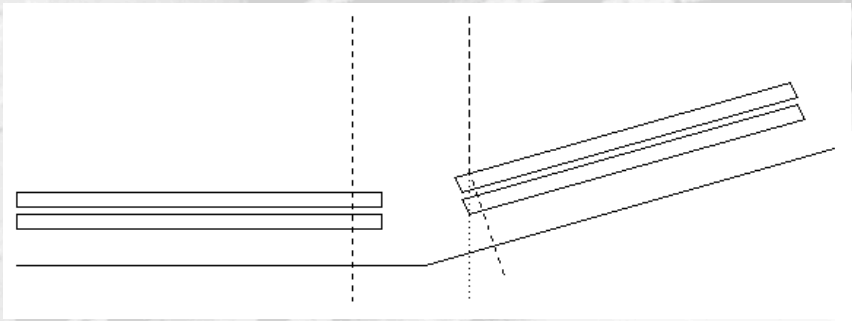
Improving the LETGS Dispersion Relation

Chandra Users' Committee
12/1/04

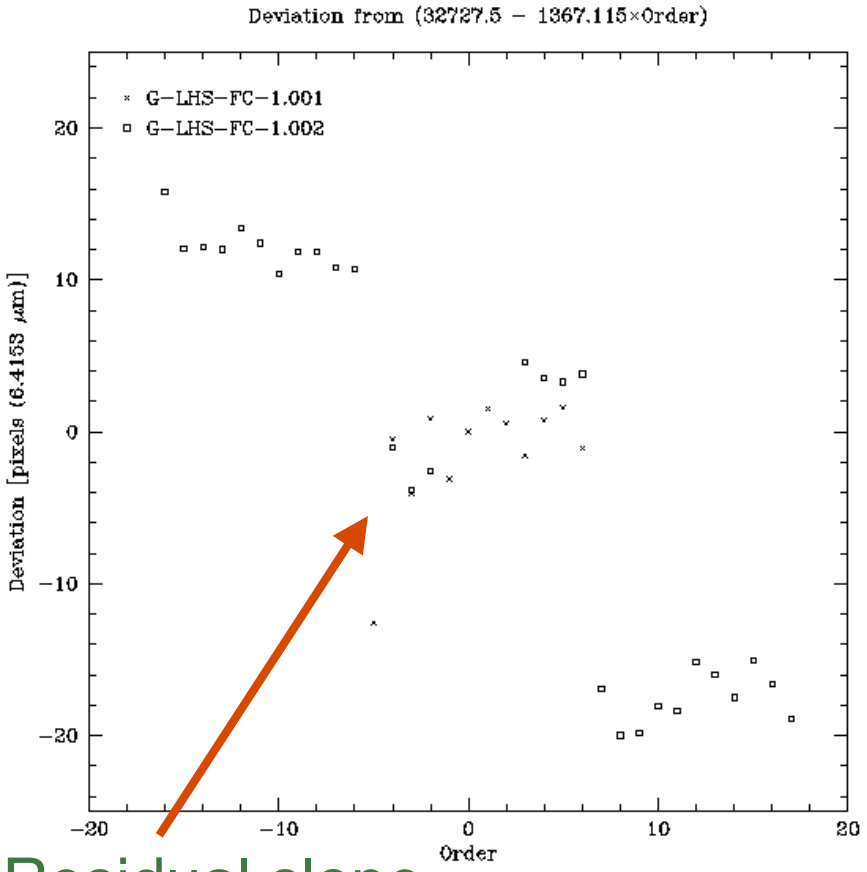
Jeremy Drake & LETG Group (CXC)

1. New plate gap calibration
2. Probing LETG+HRC-S dispersion relation non-linearities
3. Testing an empirical HRC-S degap approach
4. Summary

XRCF Plate Gap Calibration (M.Juda)



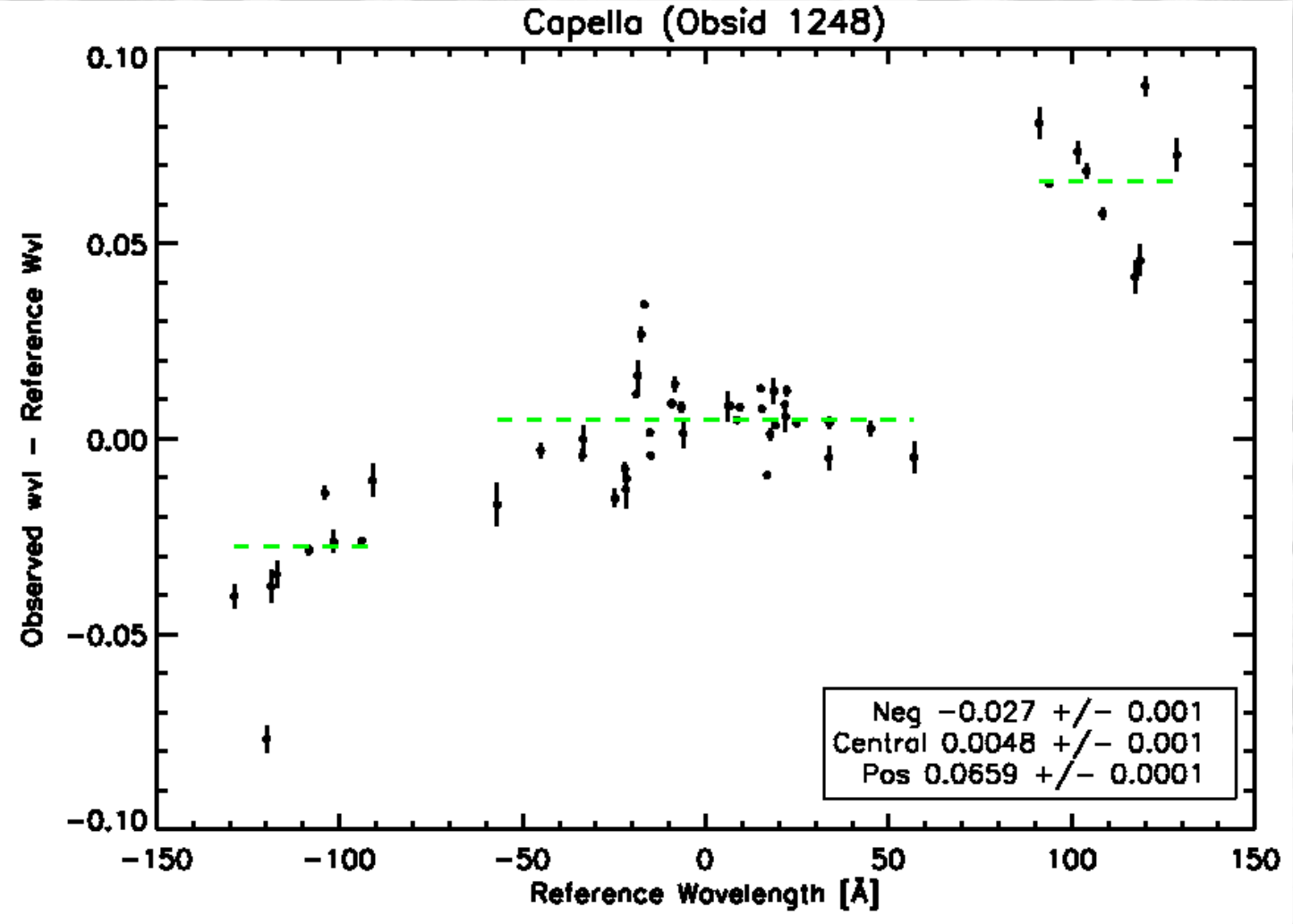
- Geometry of finite thickness HRC-S plates --> position error
- Additional correction arises from different LETG+HRC-S disp rel cf that known at XRCF



Residual slope

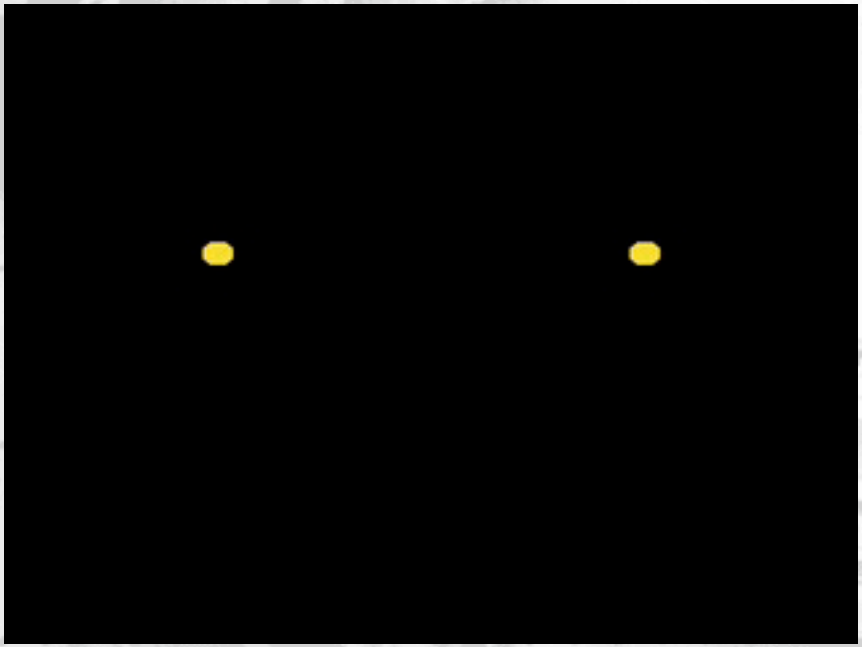
Dispersion Relation Post-Bug Fix

- Clarified apparent plate gap problem
  - Non-linearities not affected



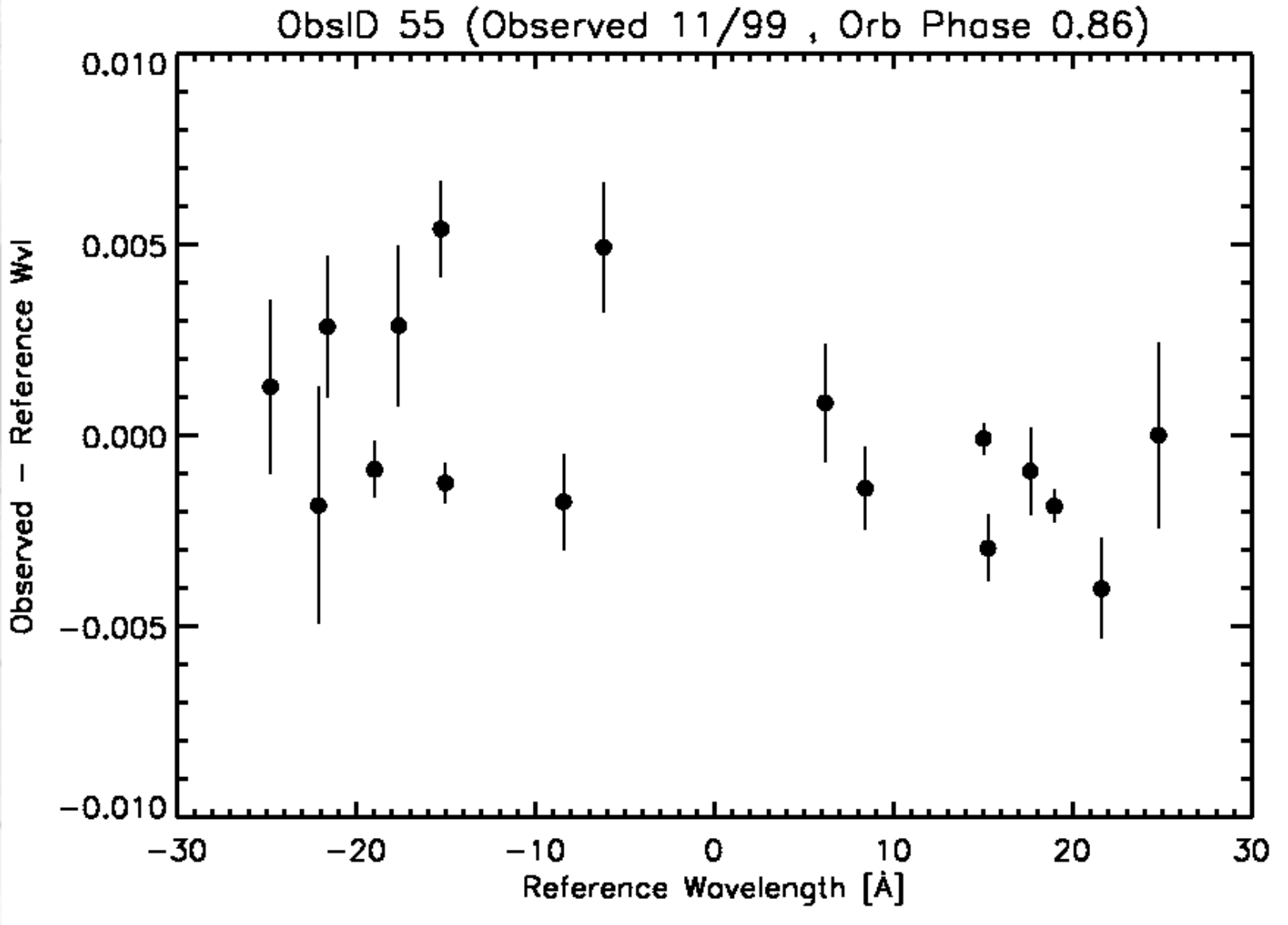
Capella: Wavelength Calibration Standard

G1 III + G8 III



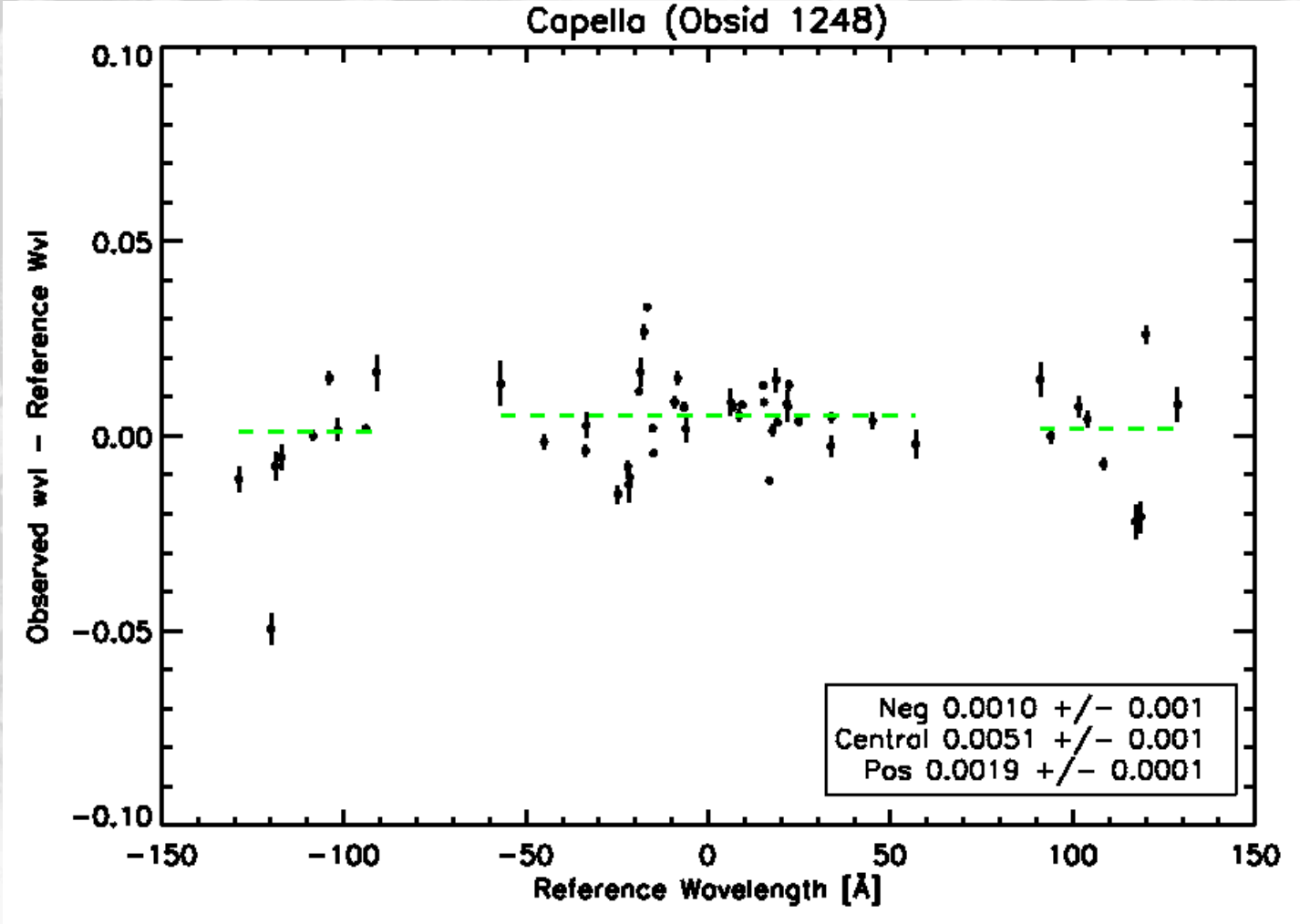
- 108 day orbital period
- Projected orbital speed ~25 km/s
- G1 8 day spin period
  - Equatorial velocity ~36 km/s

Verification with ACIS-S



New Plate Gap Calibration

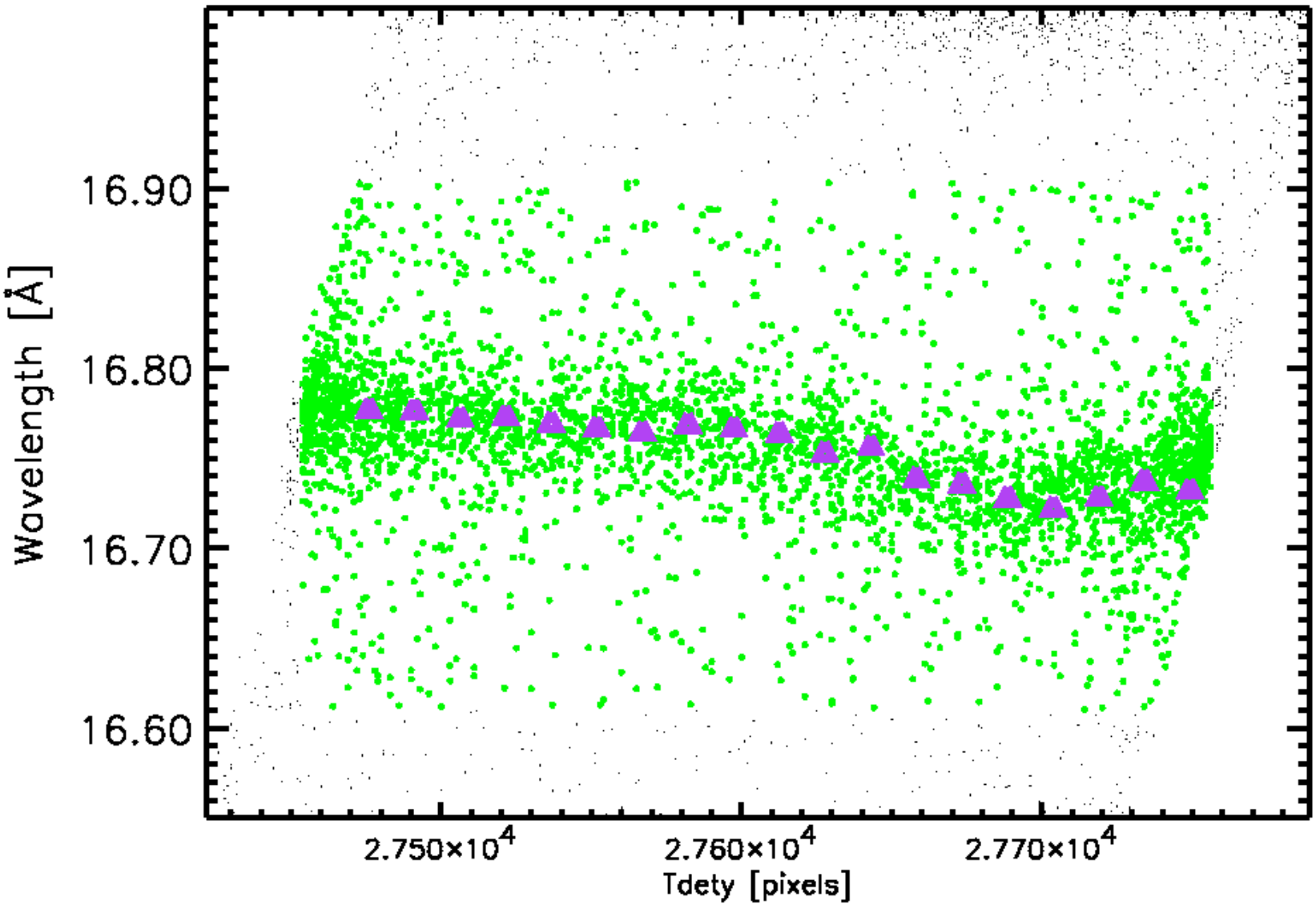
- Removes discontinuities between plates
  - Resulting RMS deviation=0.013 *AA* (~0.01% @100*AA*)



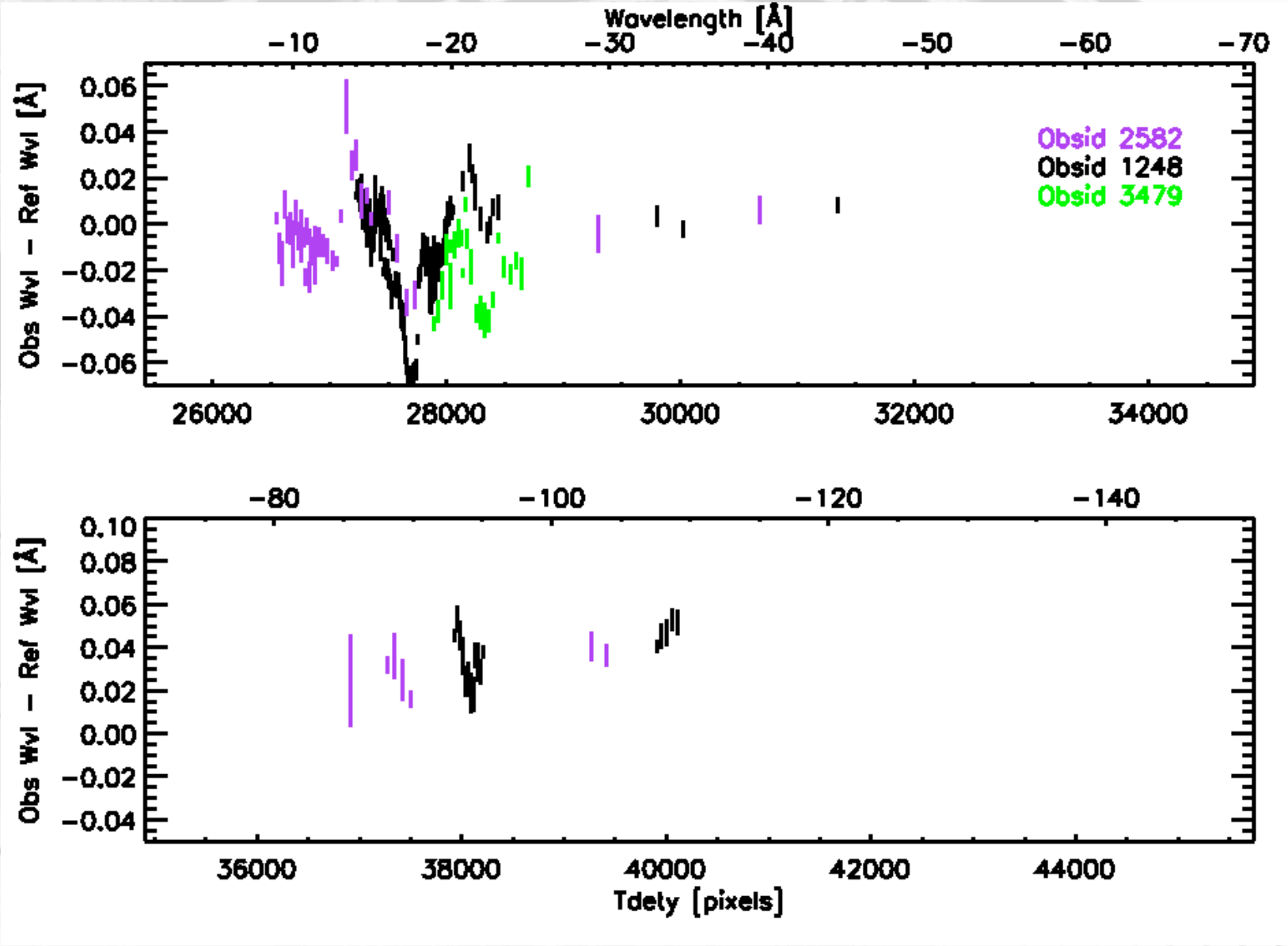
Mapping HRC-S Spatial Non-Linearity

- Examine events from bright well-understood lines in detector coordinates (`tdety`)
  - BUT: Relatively few bright lines - poor coverage
- Cross-correlate spectra in small wavelength intervals extracted from different dither phases
  - At any given wavelength, maps out relative position error between areas of the detector ~1mm apart.
  - Effective for any spectra with significant structure; does not require "high quality" lines

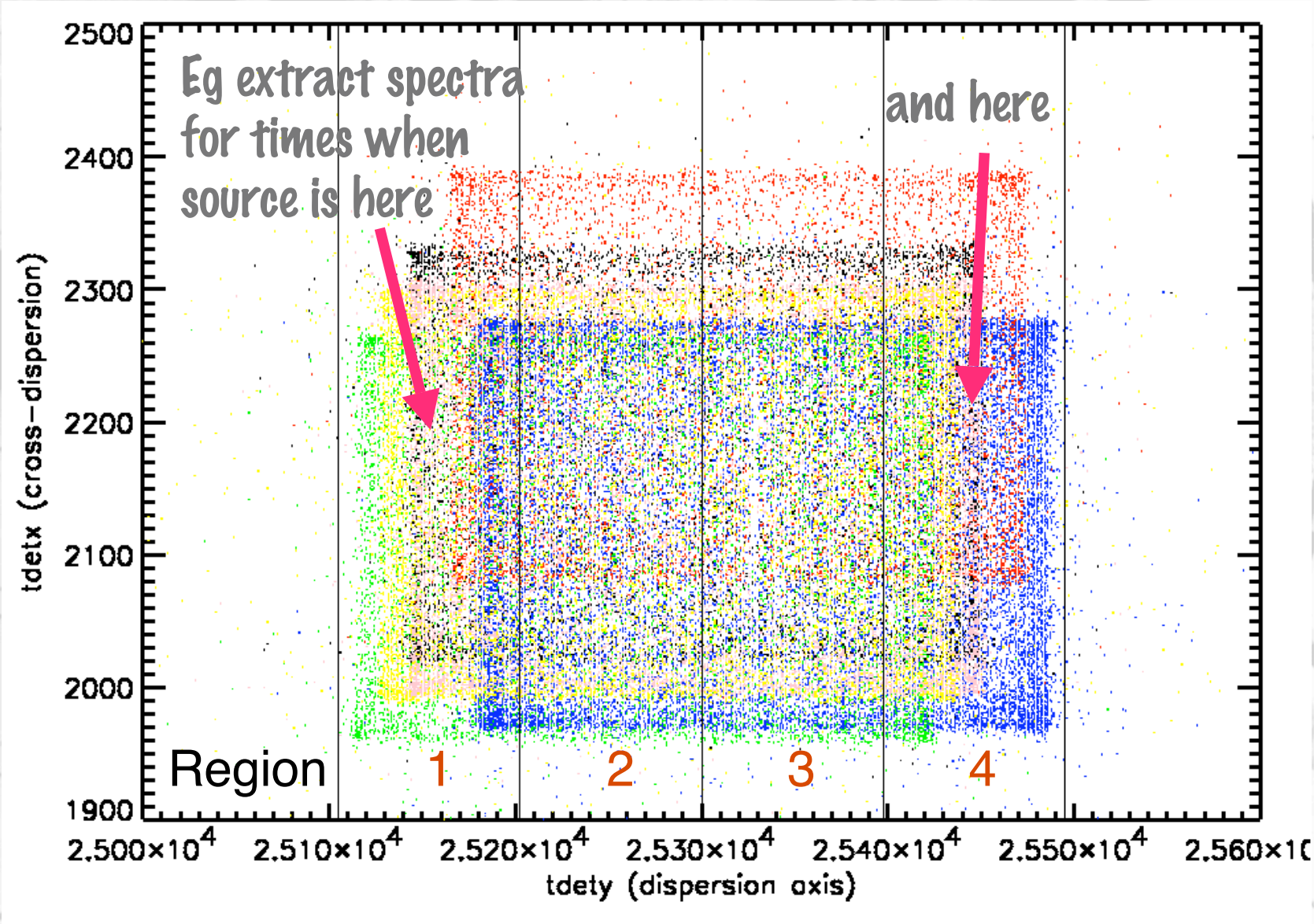
Mapping Non-Linearity in tdety



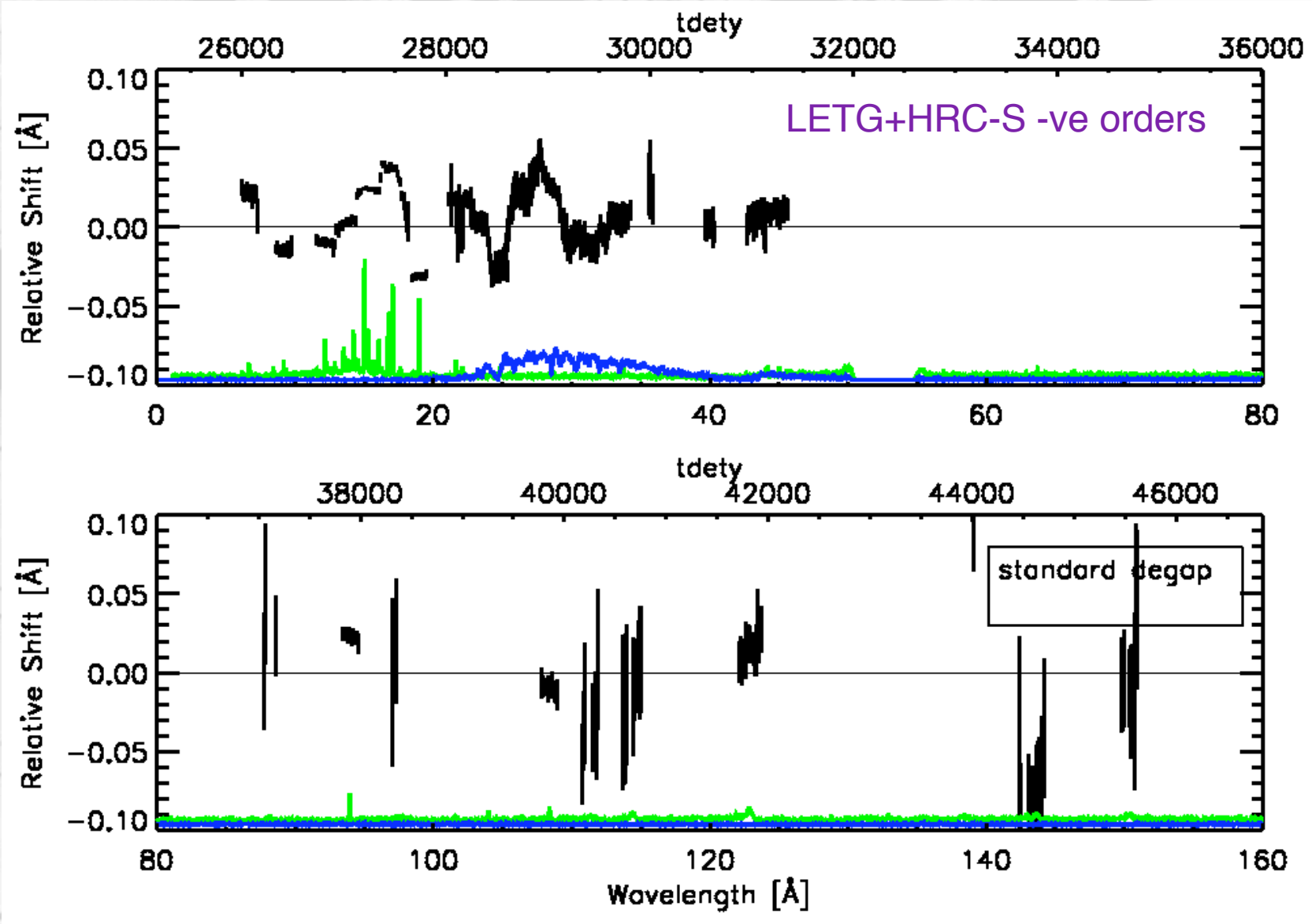
Mapping Non-Linearity in tdety



Dither-Split Cross-Correlation



Dither-Split Cross-Correlation



Testing an Empirical Degap

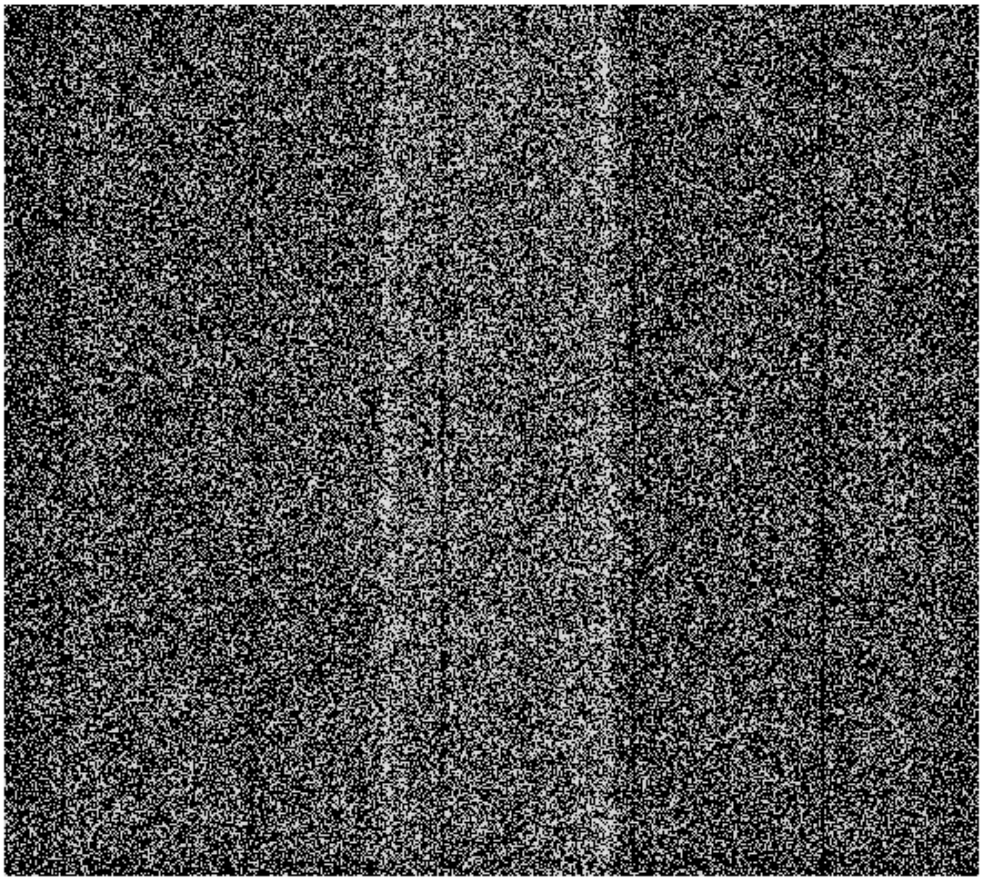
- Is non-linearity caused by degap deficiencies?
- Empirical degap correction derived for "dispersion strip" of HRC-S based on bright continuum source (PKS2155-304)
  - Basically, enforce a smooth continuum
- Applied to observations
  - Analysed using cross-correlation and tdety techniques

HRC-S Residual Gaps

Obsid 1248

Capella

LETG+HRC-S



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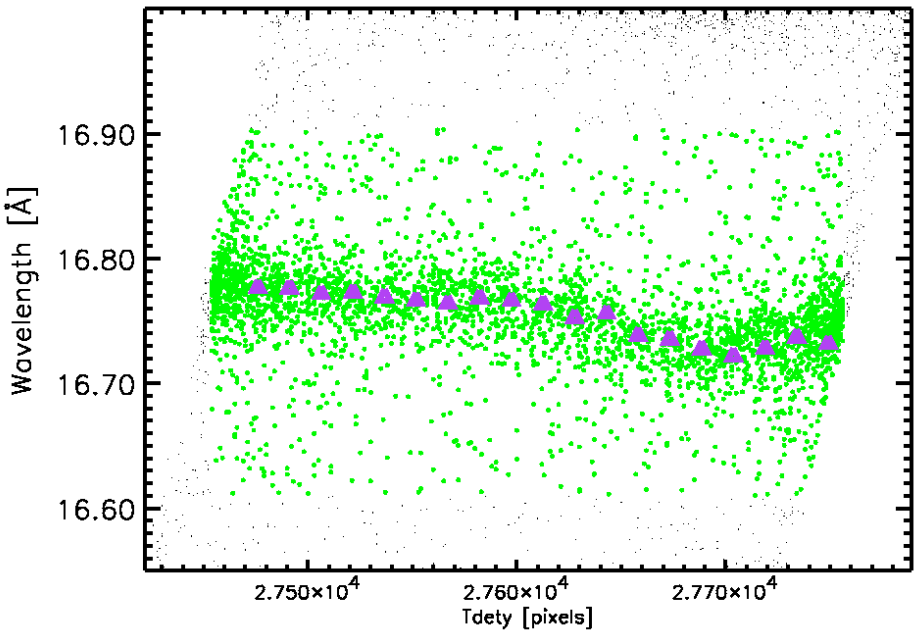
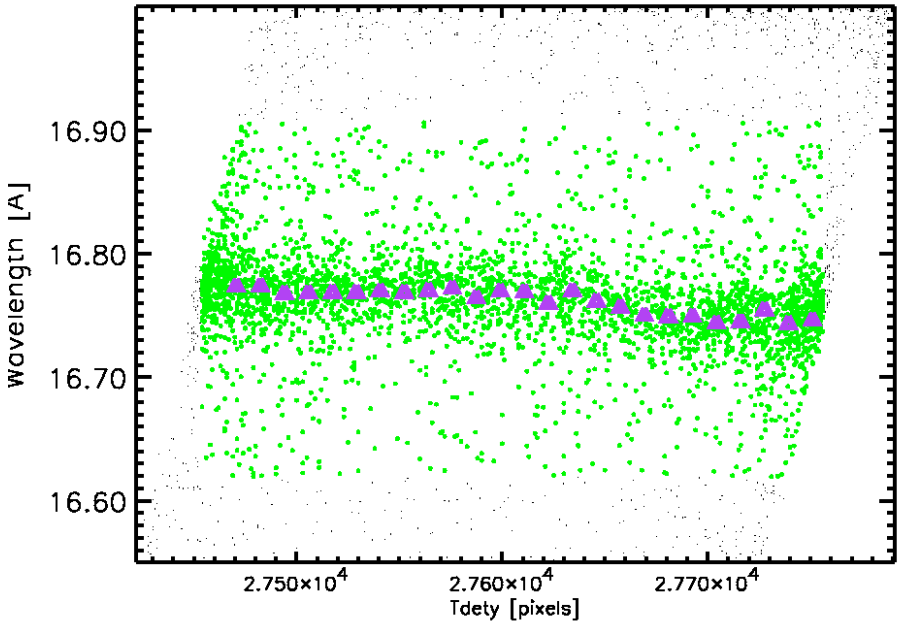
In tdety

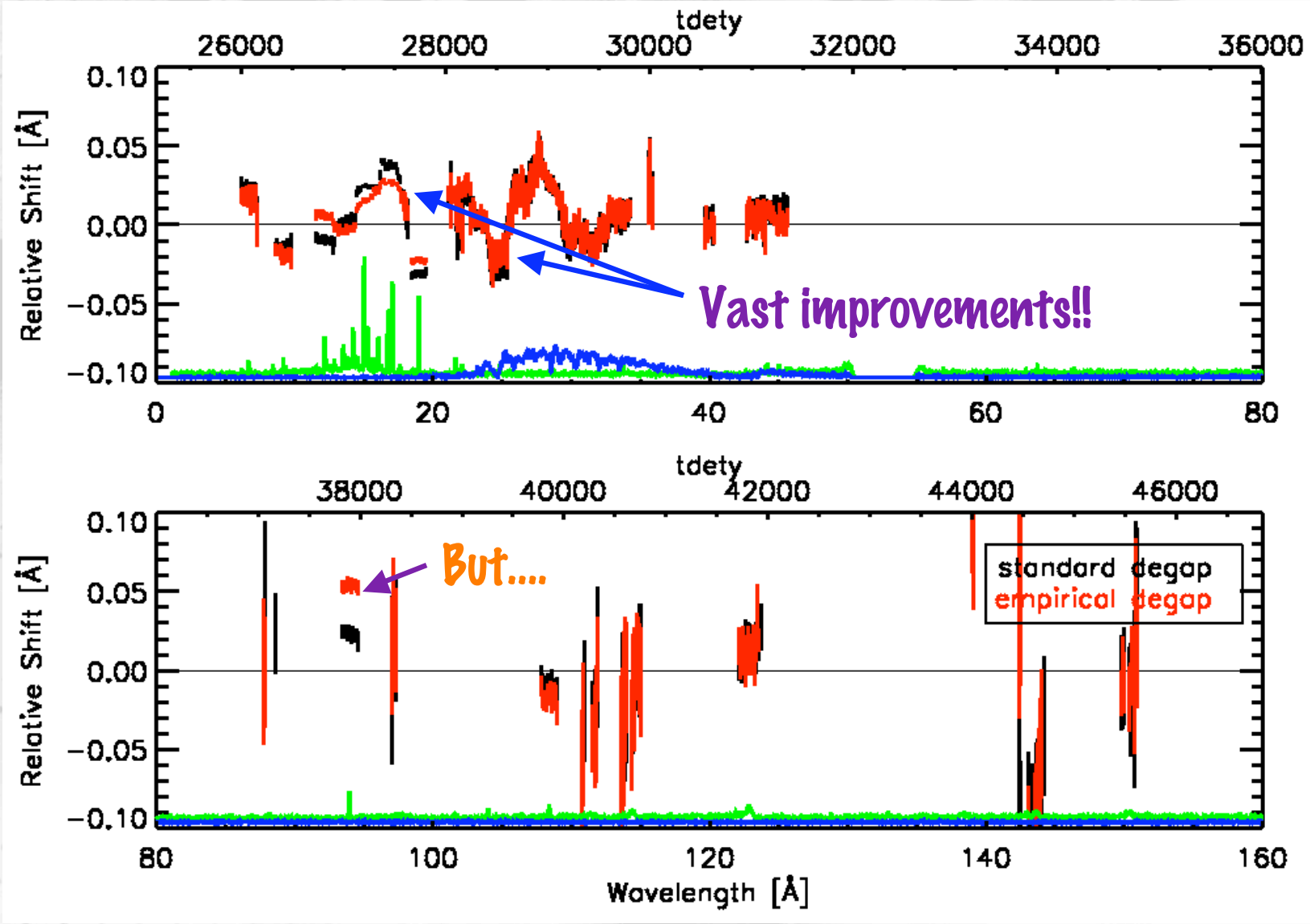
Standard degap



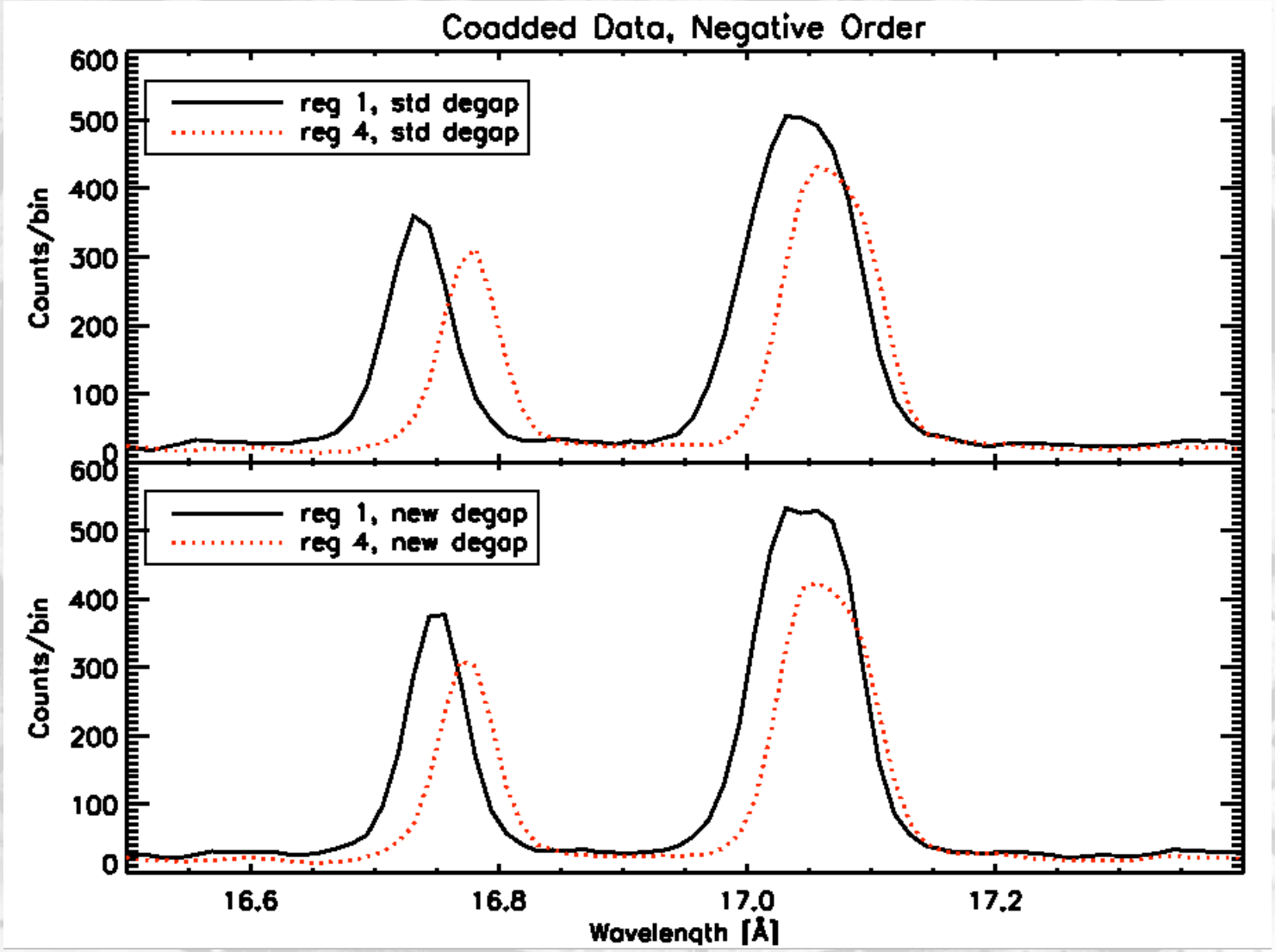
In-flight degap



Dither-Split Cross-Correlation



By Eye


Coadded Data, Negative Order
reg 1, std degap
reg 4, std degap
reg 1, new degap
reg 4, new degap
Counts/bin
Counts/bin
0
100
200
300
400
500
600
16.6
16.8
17.0
17.2
Wavelength [Å]

Summary and Future

- RMS devations in LETG+HRC-S now down to 0.013 AA (0.01% @ ~100 AA)
- Have developed methods to probe dispersion non-linearity
  - In-flight degap helps but does not seem to go far enough; some development/testing still needed here
- Now also looking at semi-empirical correction approaches
- "ab initio" hrc electronics-based study also ongoing (M. Juda)