IRAC Centroiding

3.6 μm   4.5 μm   5.8 μm   8.0 μm
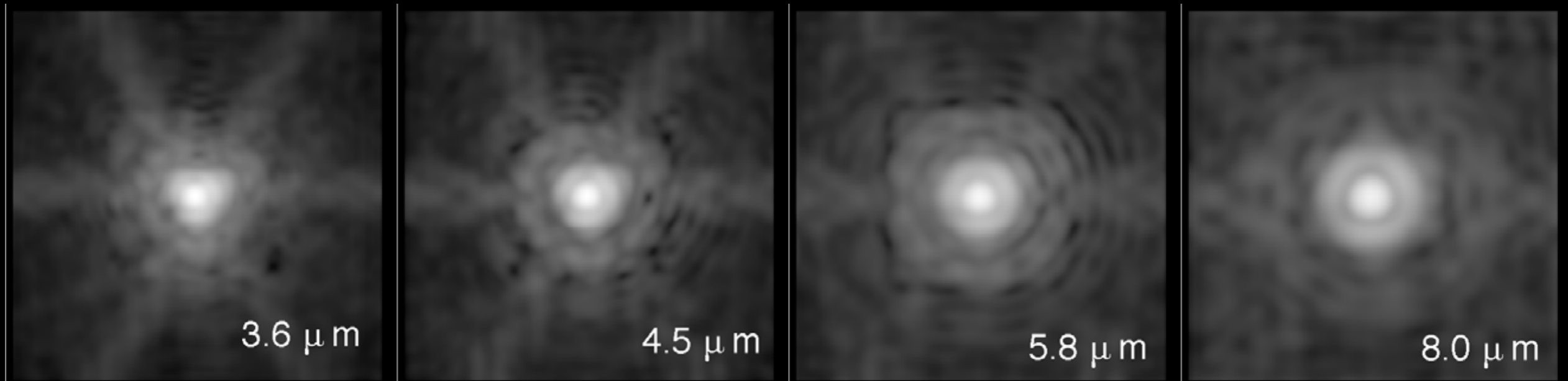
Nikole K. Lewis
Sagan Postdoctoral Fellow
MIT/EAPS

Common Centroiding Methods

- Flux-weighted/Center of Light

$$X = \frac{\Sigma_i m_i x_i}{\Sigma_j m_j}, Y = \frac{\Sigma_i m_i y_i}{\Sigma_j m_j},$$
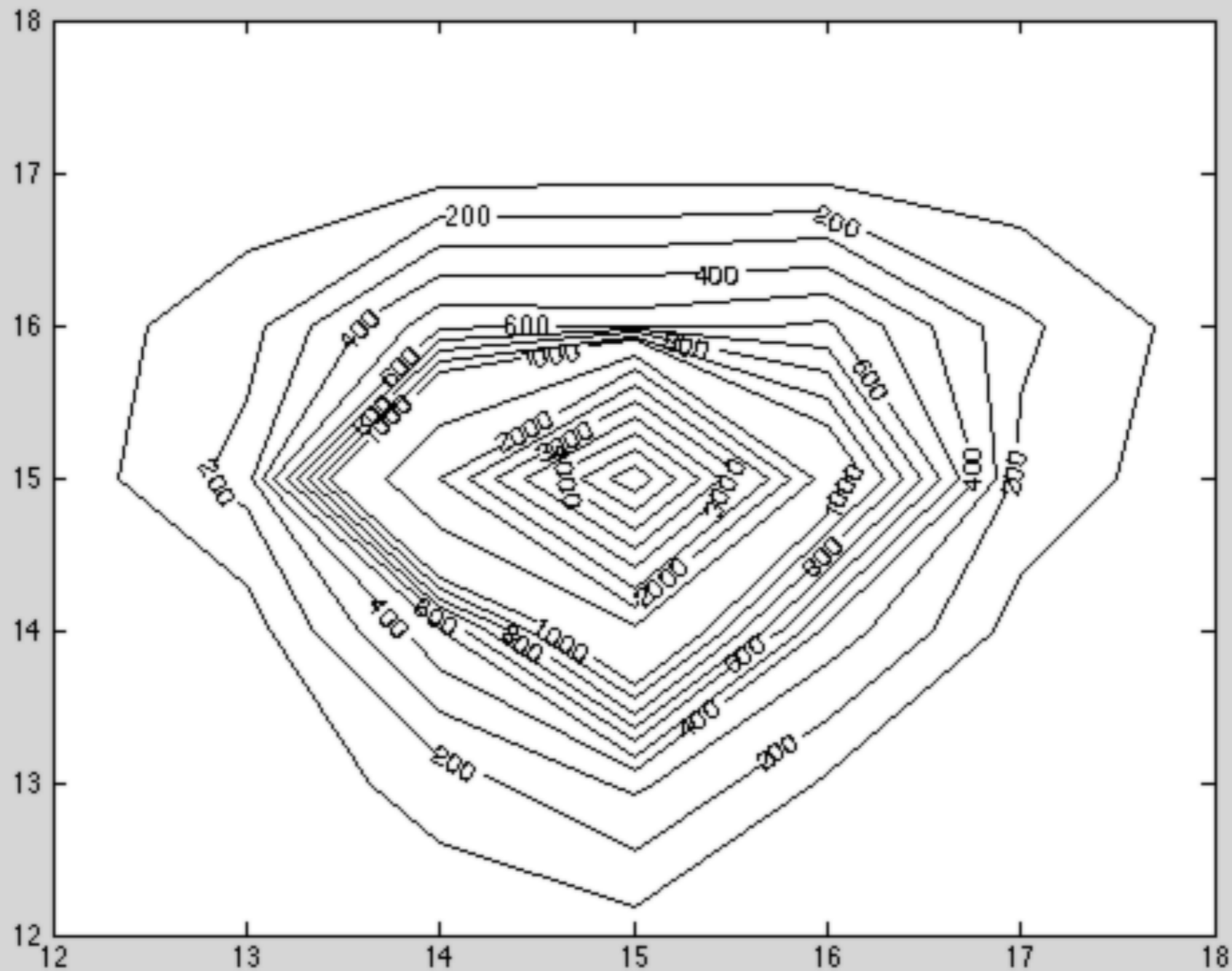
- Fitting 2D Gaussian/Moffat

$$G = Ae^{-\frac{1}{2}(\frac{(x-\mu_x)^2}{\sigma_x^2} + \frac{(y-\mu_y)^2}{\sigma_y^2})}$$
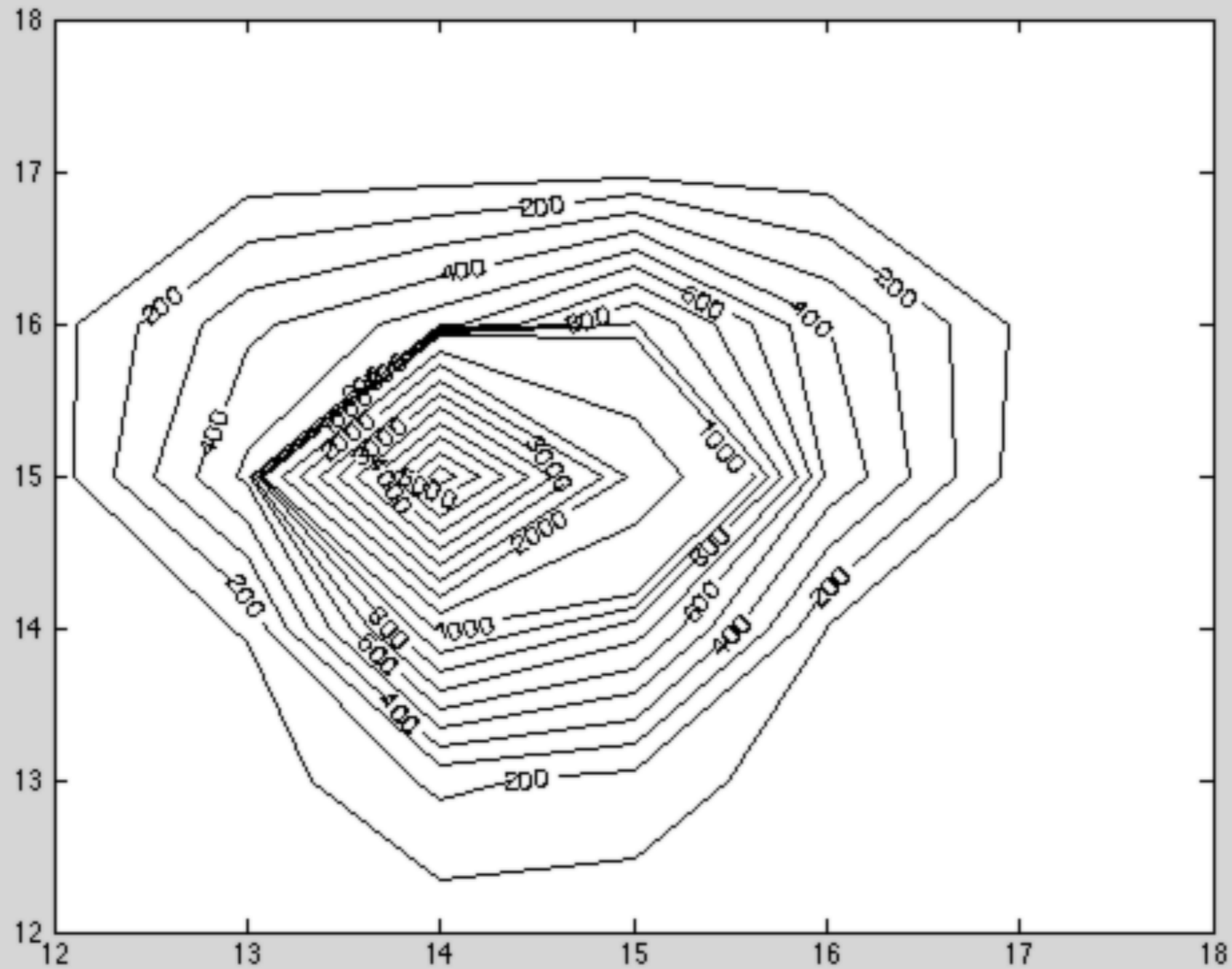
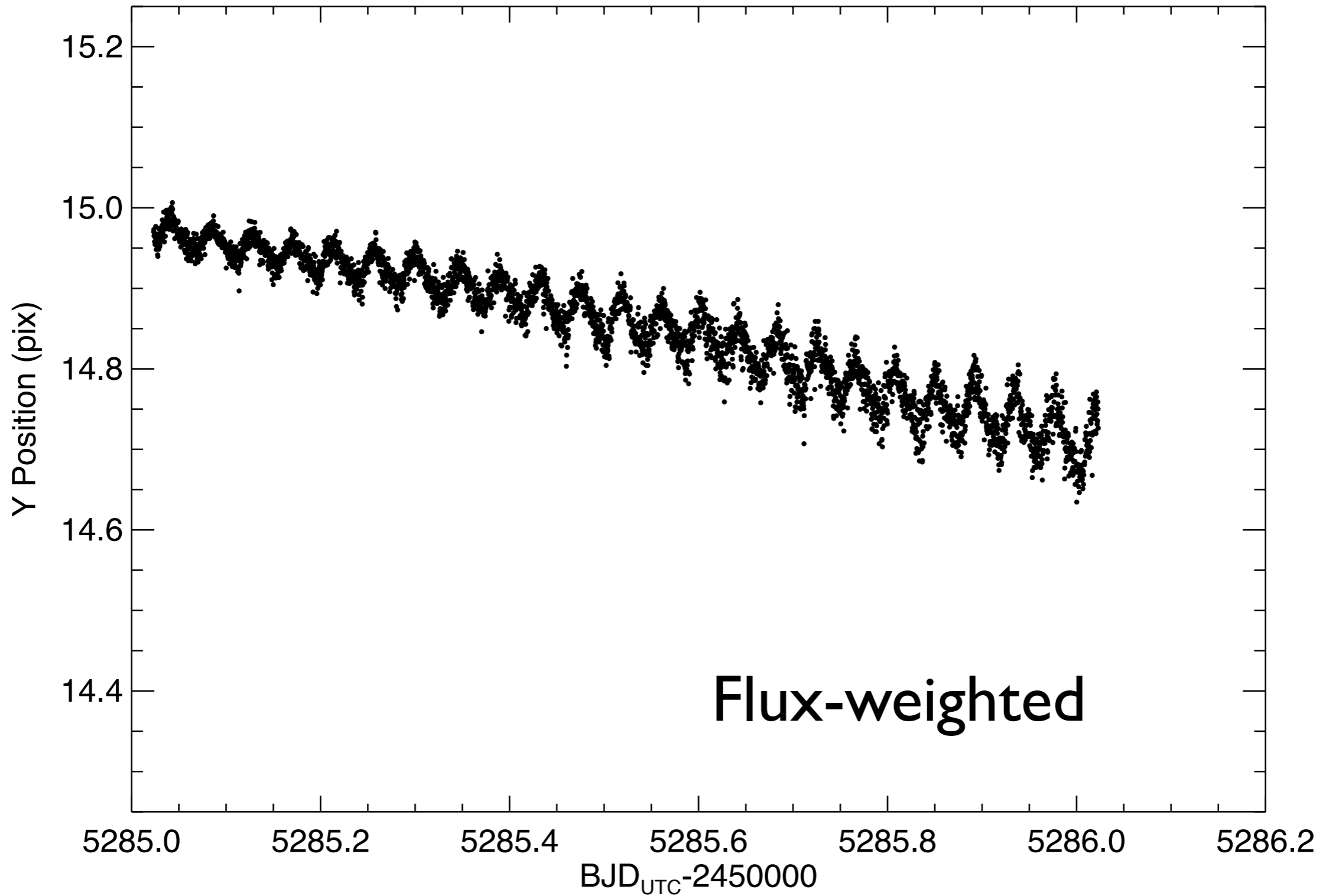- Least Asymmetry

$$A(x,y) = \sum_0^R Var(\Phi(r)) * N(r)$$

IRAC CH1 - HD 149026

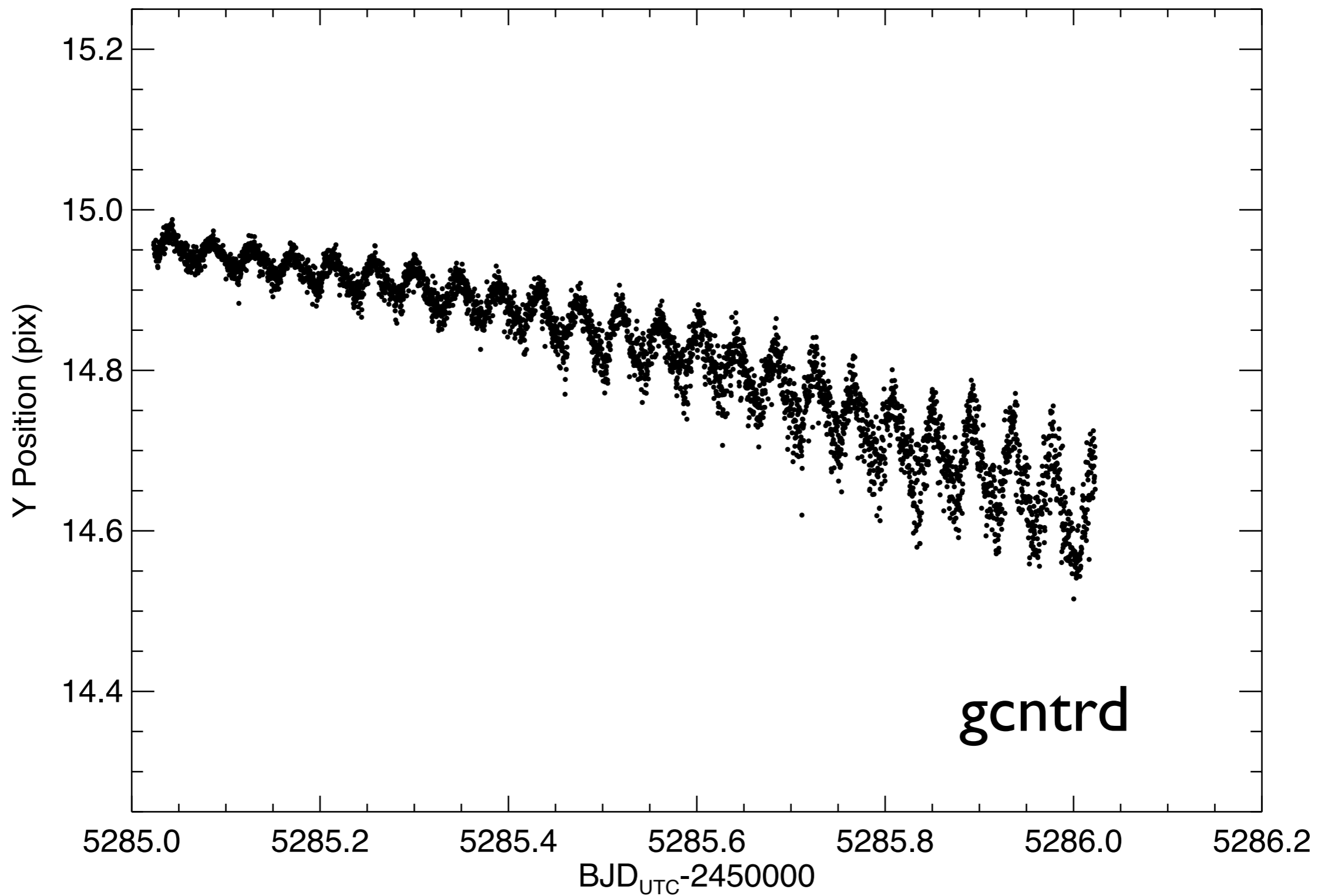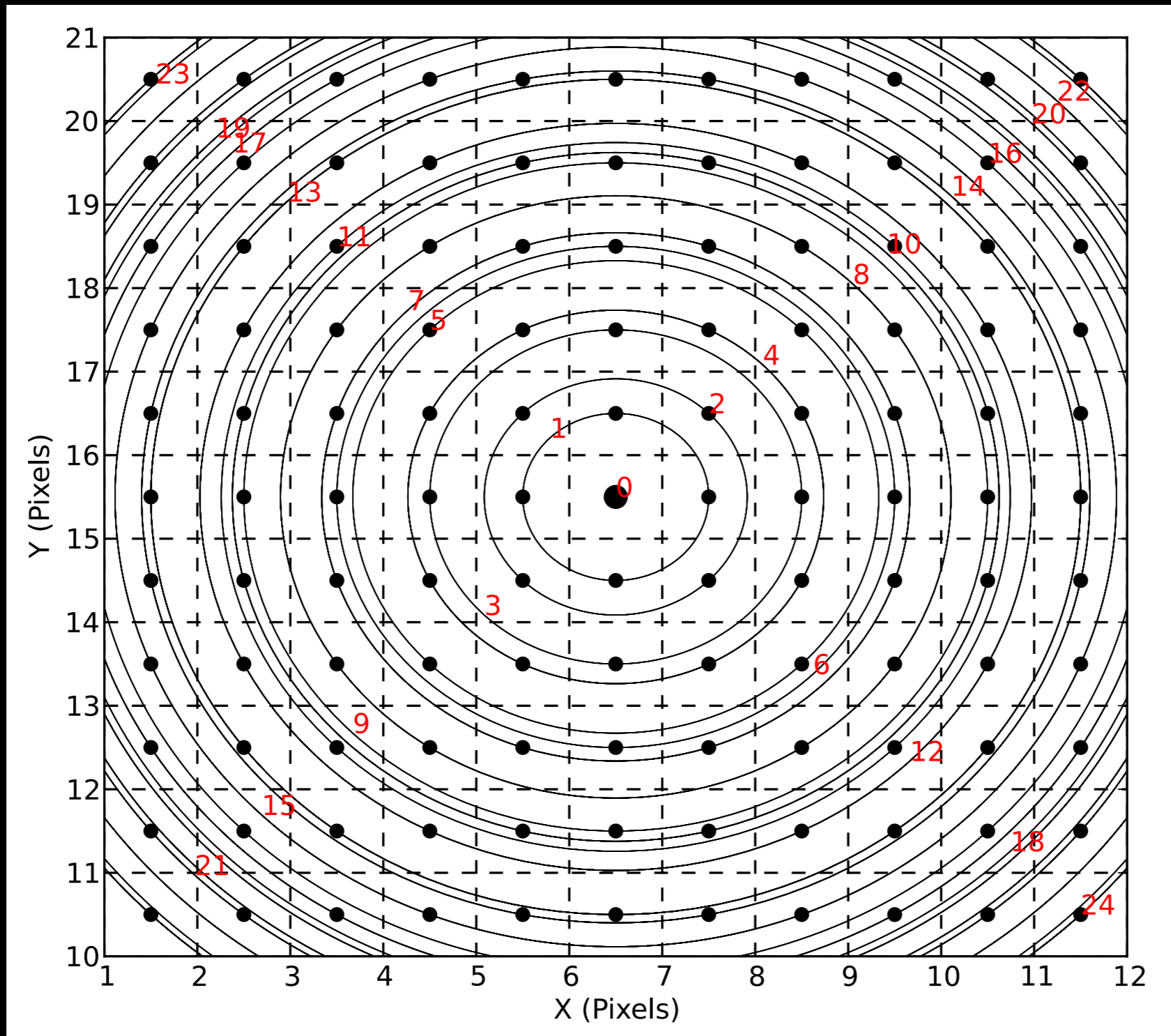# IRAC CH1 - HD 149026

IRAC CH1 - HAT-P-2b

Flux-weighted

IRAC CH1 - HAT-P-2b

gcntrd

IRAC CH1 - GJ 436

Stevenson et al. (2010)
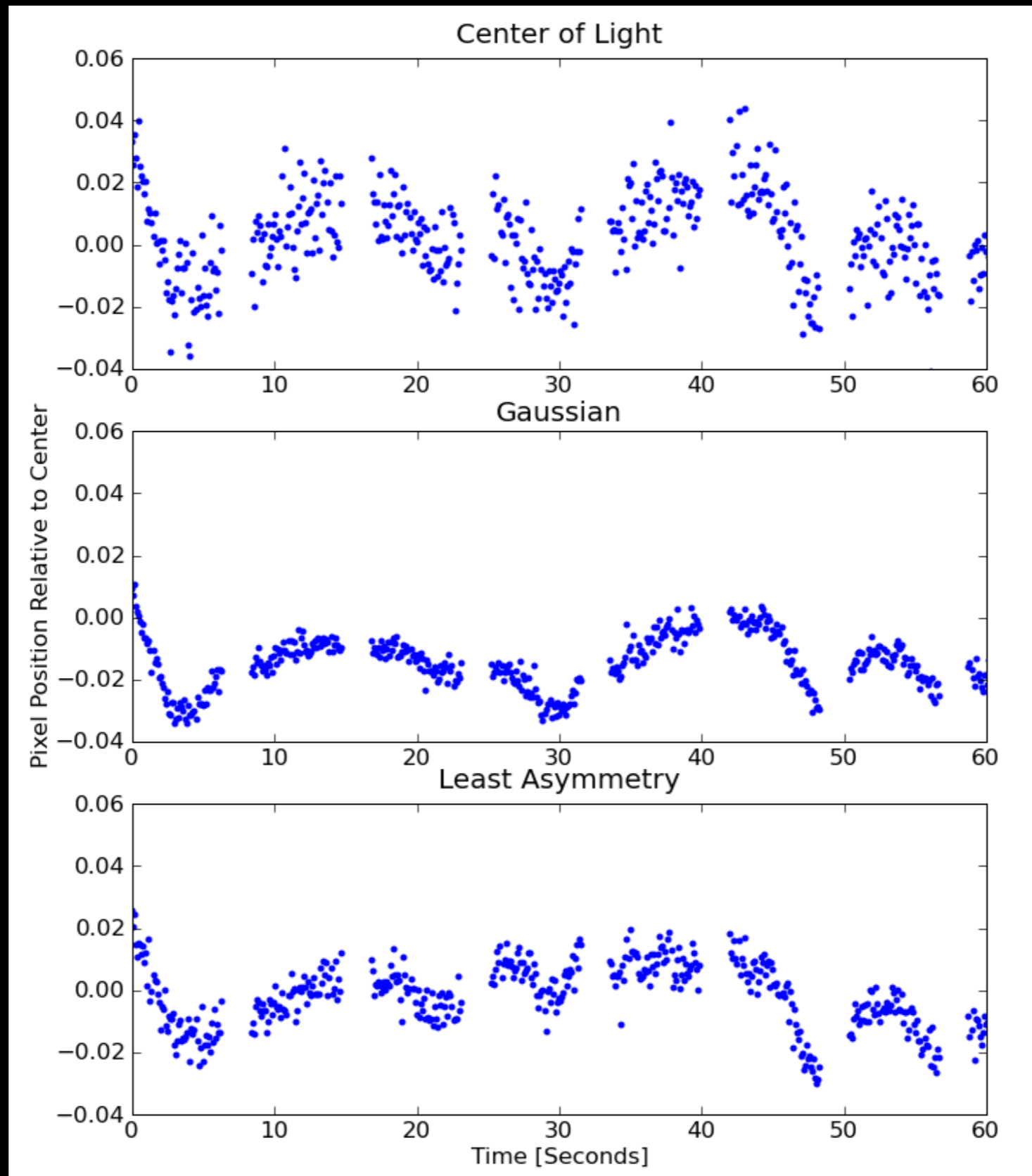
Testing Centroiding Methods
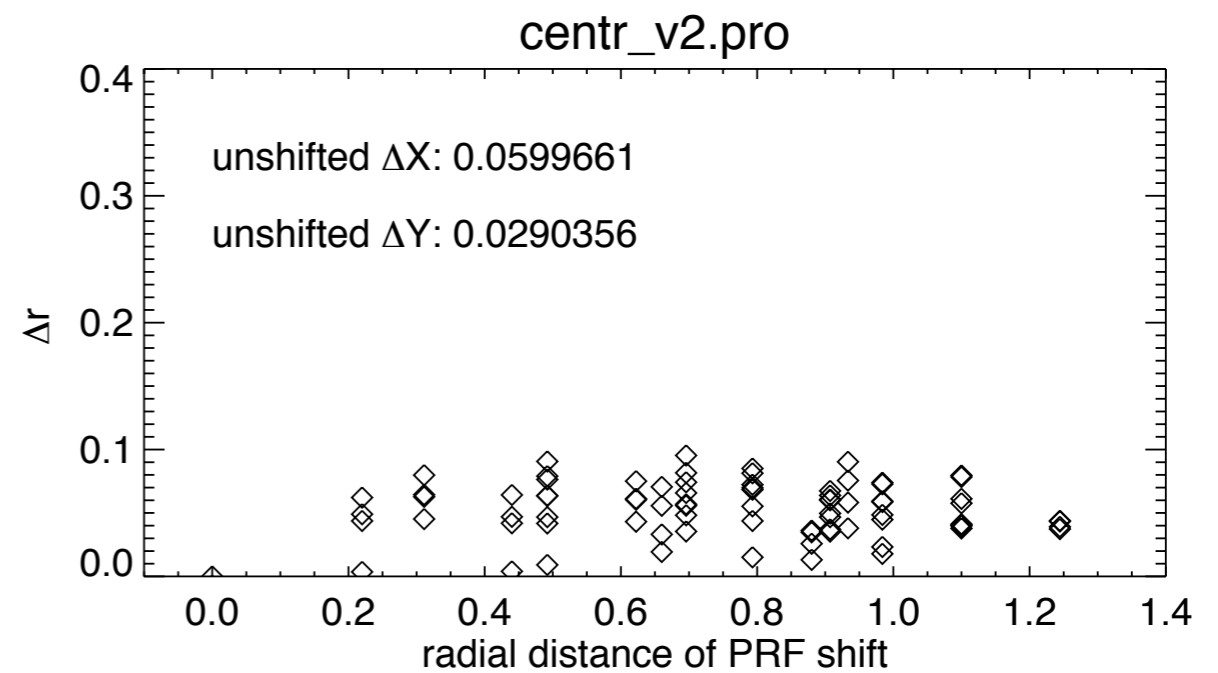
Gaus Chi

Col Chi

Gaus Chi

8 μm PRF Kernel Mean Positional Error (Pixels)

S/N	Asymmetry	Gaussian	Center of Light
1.0	0.8081	89.6562	0.4457
2.0	0.4829	0.8983	0.4343
3.0	0.2332	0.2195	0.4233
4.0	0.1637	0.1714	0.4128
5.0	0.1332	0.1556	0.4028
6.0	0.1158	0.1479	0.3932
7.0	0.1047	0.1427	0.3840
8.0	0.0970	0.1373	0.3751
9.0	0.0916	0.1343	0.3681
10.0	0.0876	0.1305	0.3597
20.0	0.0722	0.1253	0.2925
30.0	0.0685	0.1245	0.2442
40.0	0.067	0.1242	0.208
50.0	0.0662	0.1240	0.1799
60.0	0.0657	0.1238	0.1577
70.0	0.0654	0.1238	0.1396
80.0	0.0651	0.1237	0.1247
90.0	0.0649	0.1236	0.1123
100.0	0.0648	0.1236	0.1019
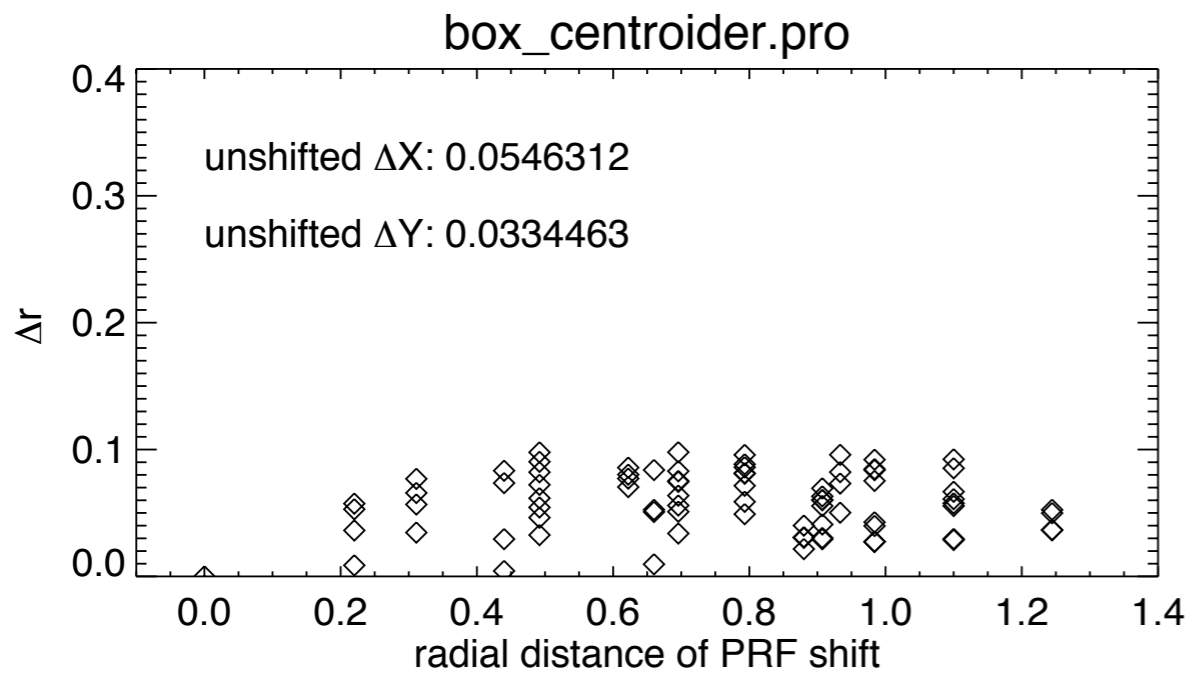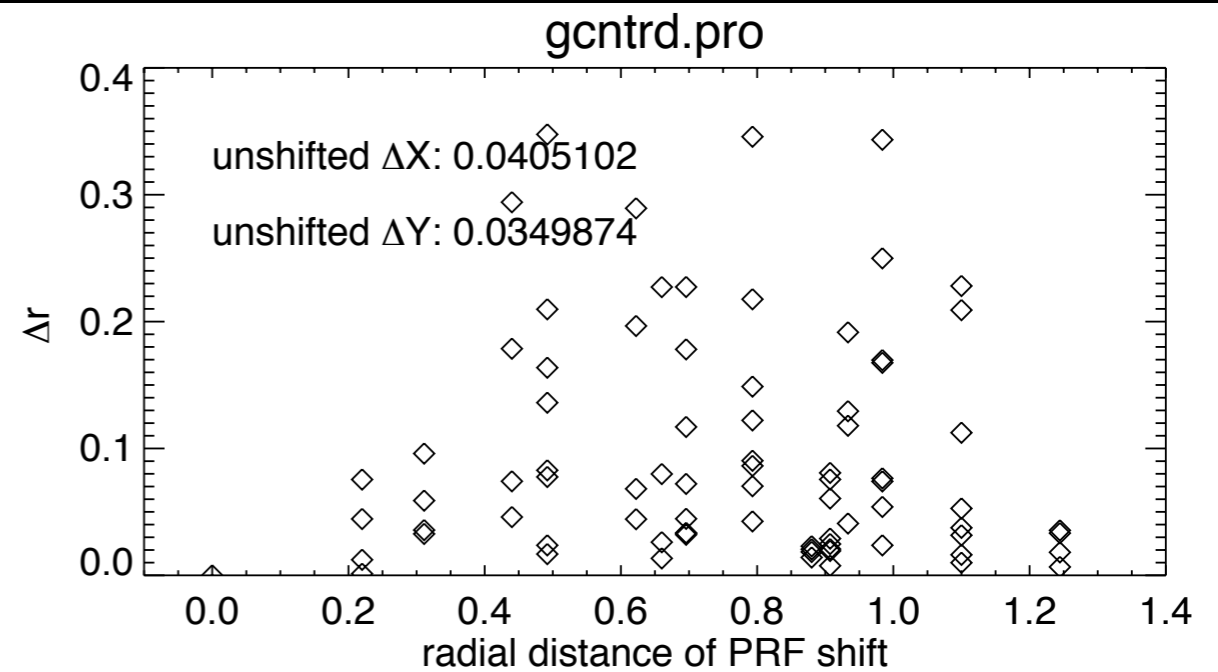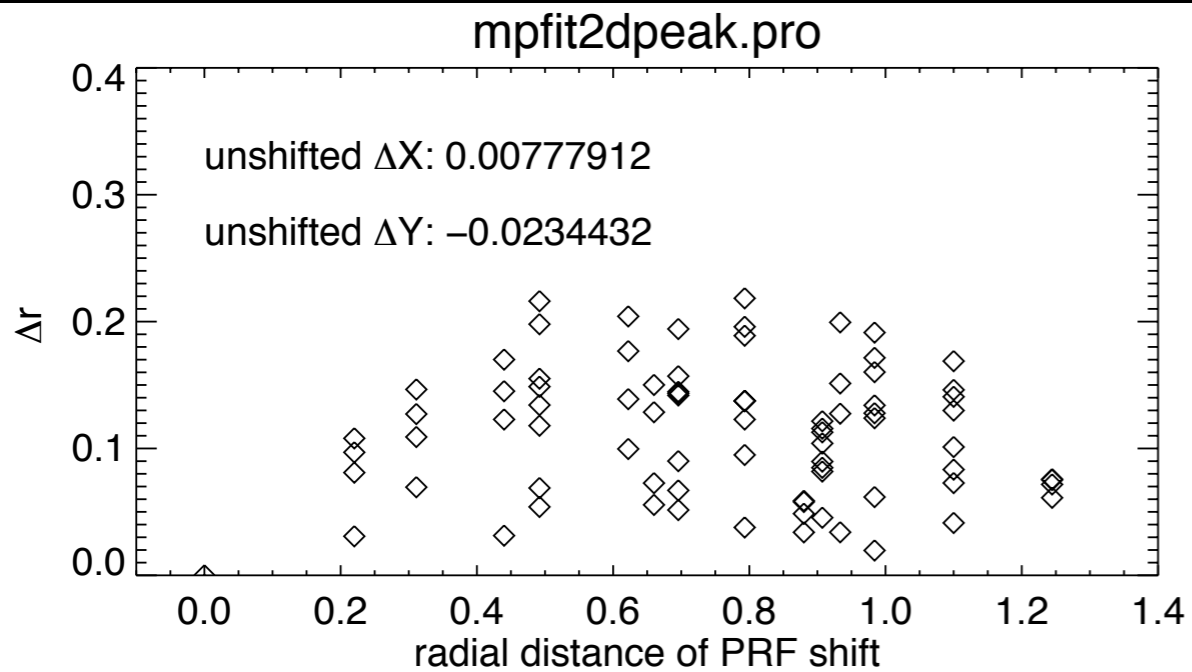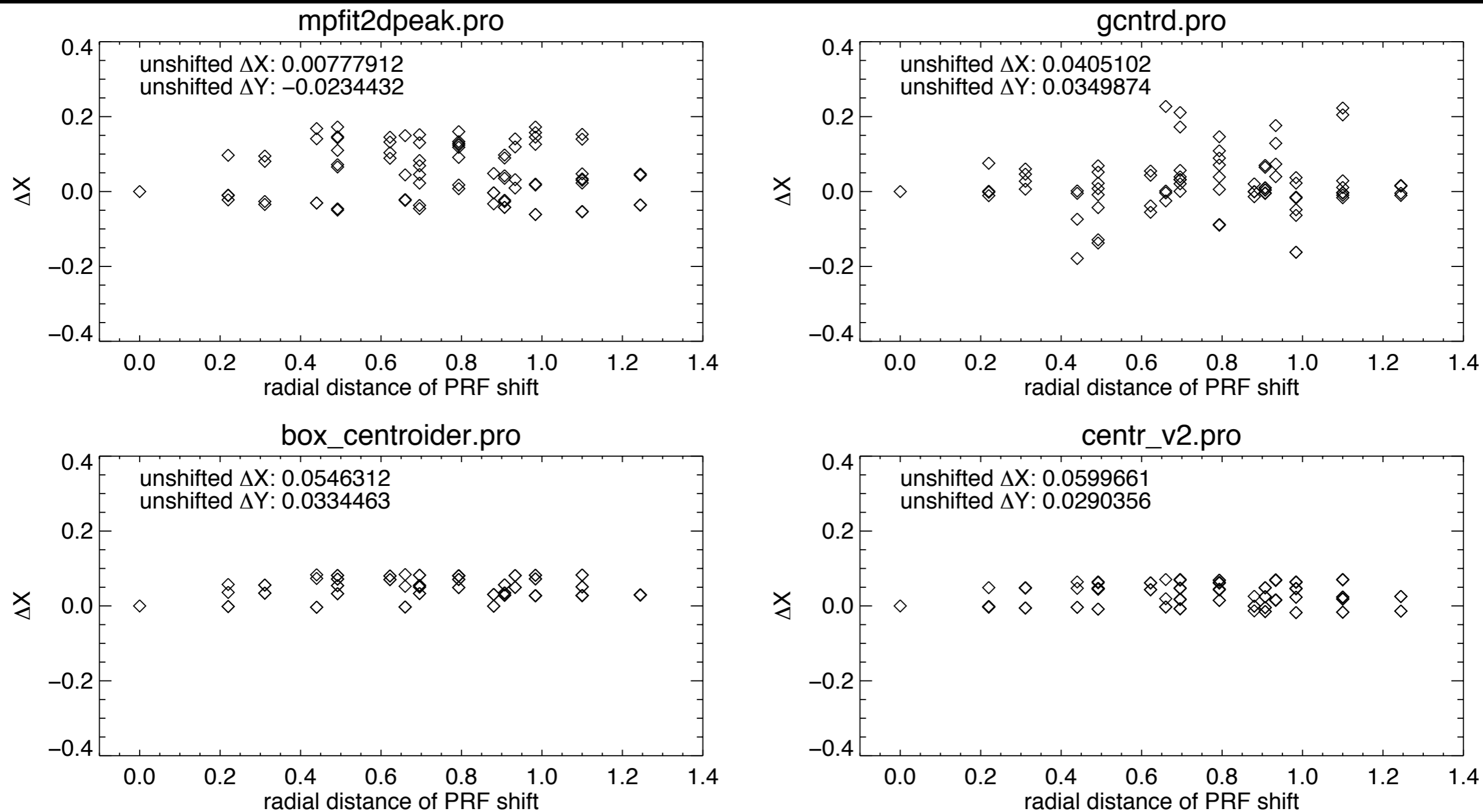
r (Pixels)

of Light

466
355
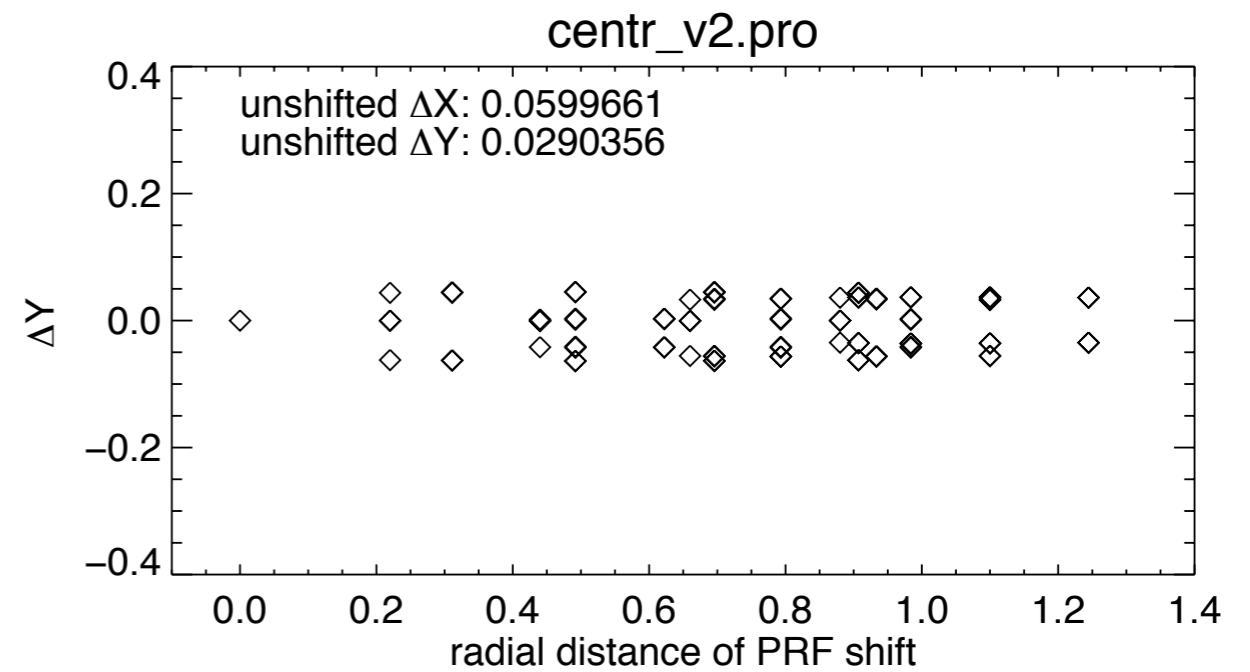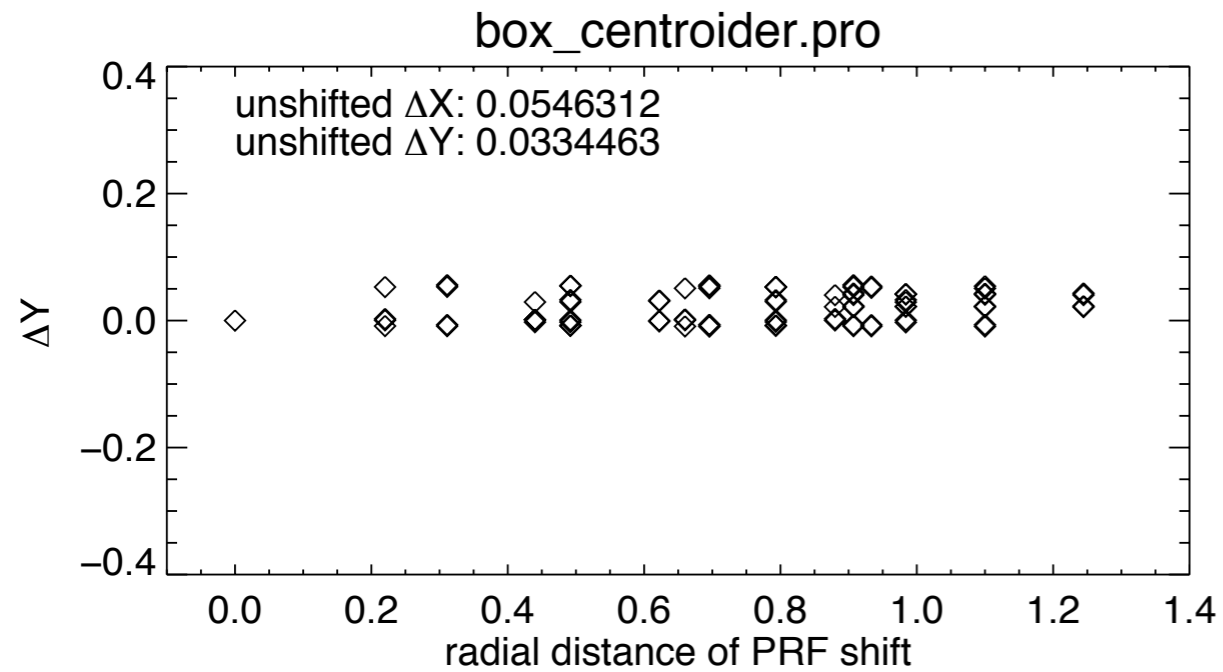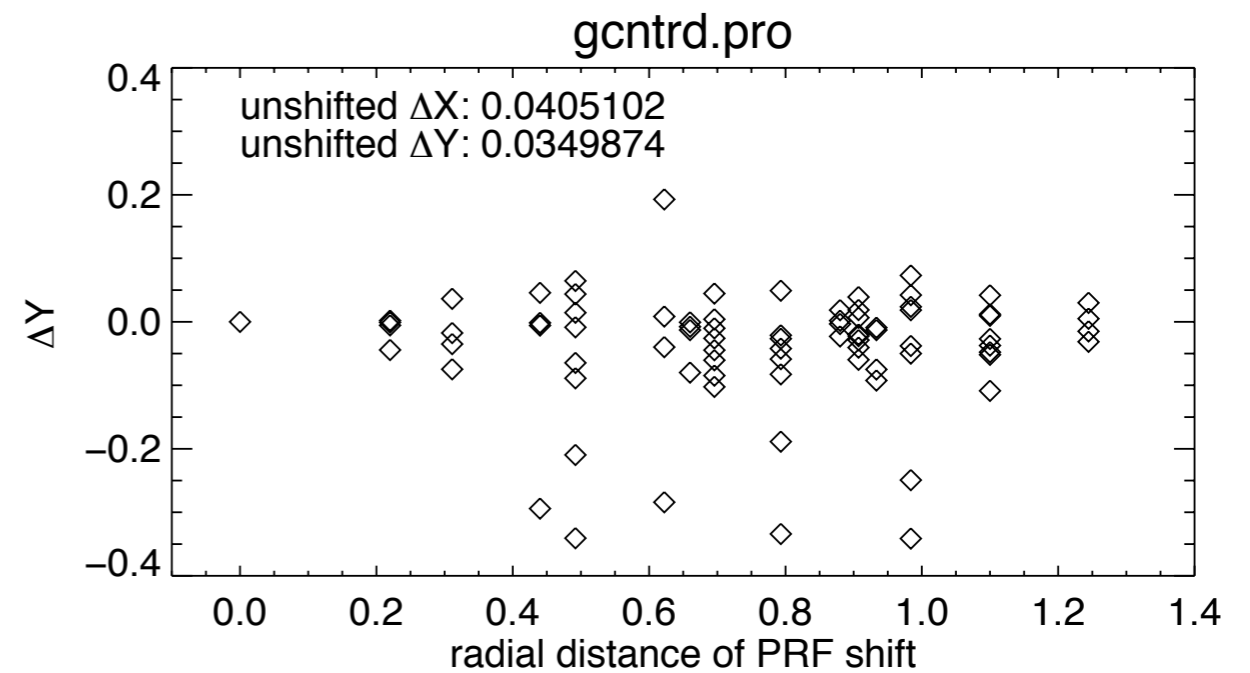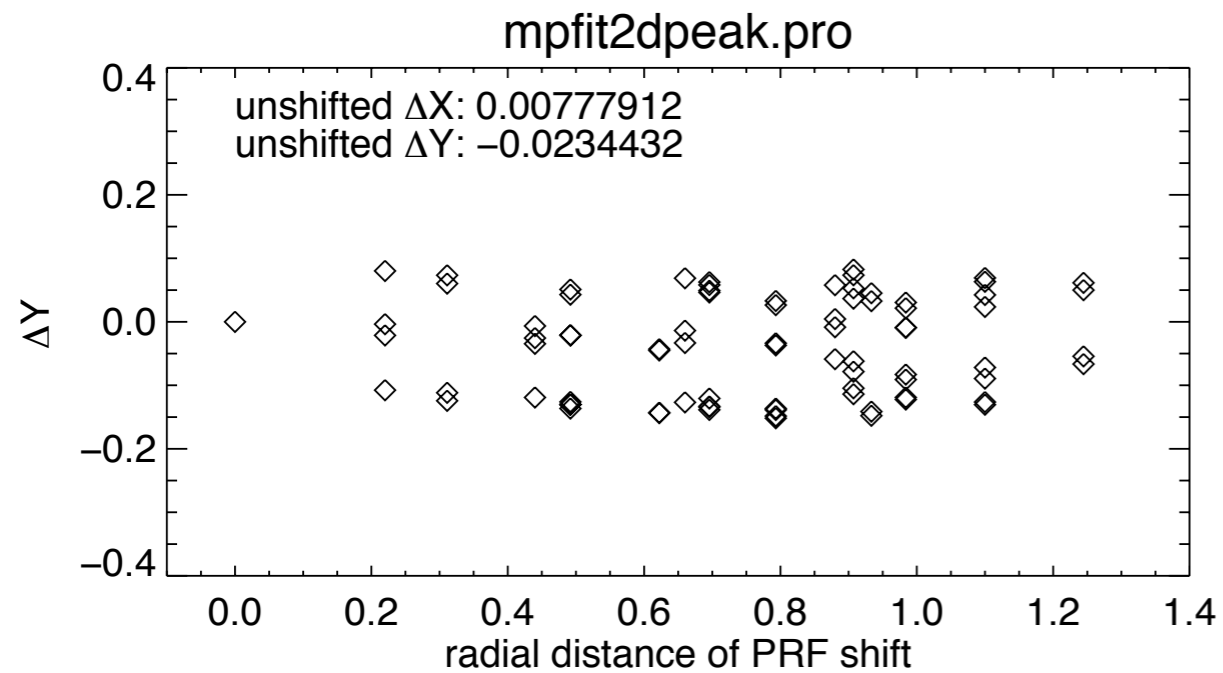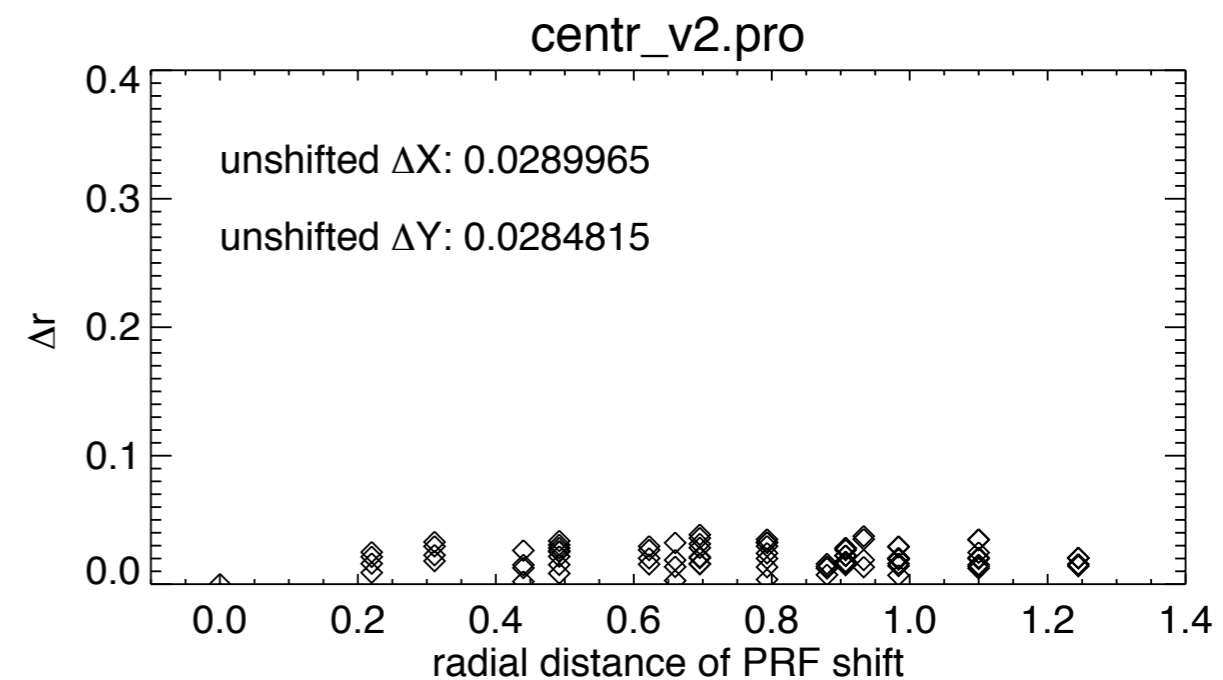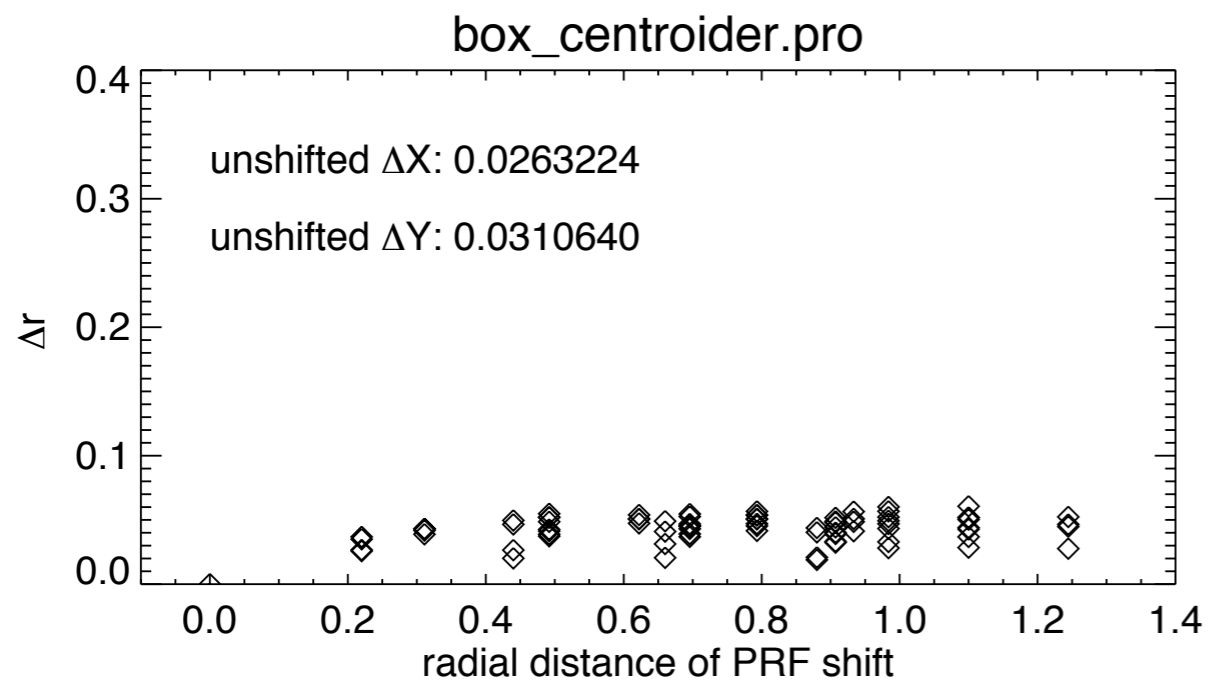249
147
405
957
868
783
701
618
972
509
162
894
682
511
371
255
255

et al., ApJ submitted

IRAC CH1 - Method Compare

Figure Credit: Syler Wagner

IRAC CH1 - Method Compare

Figure Credit: Syler Wagner
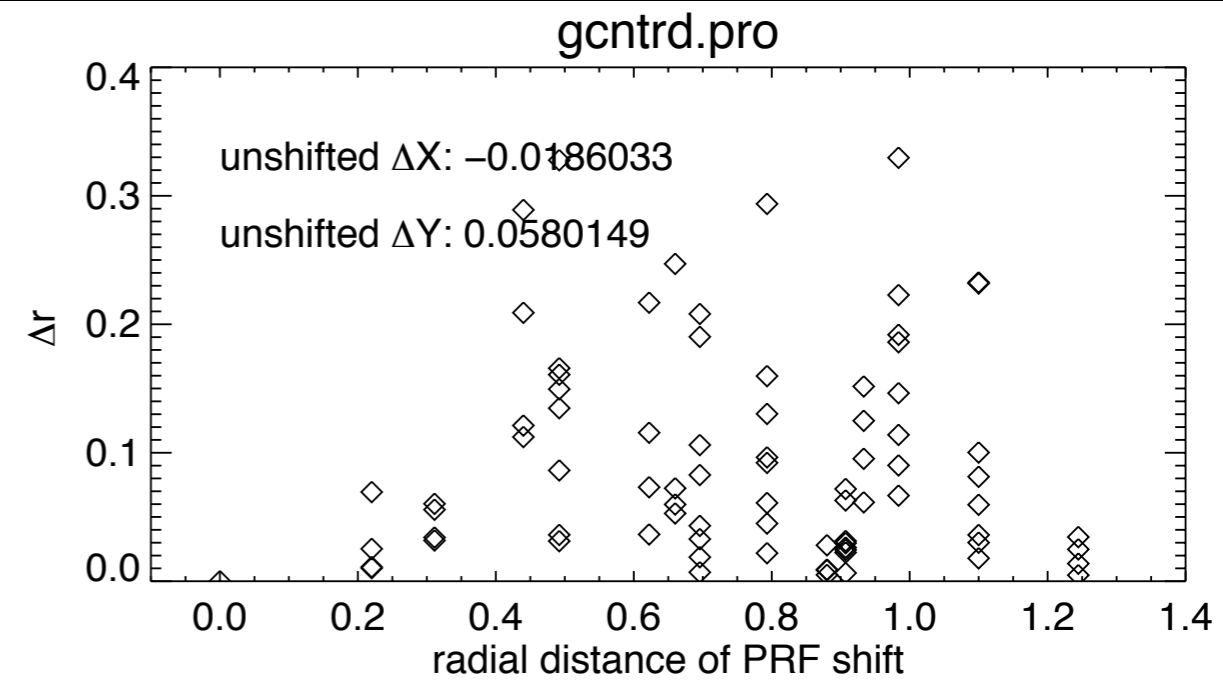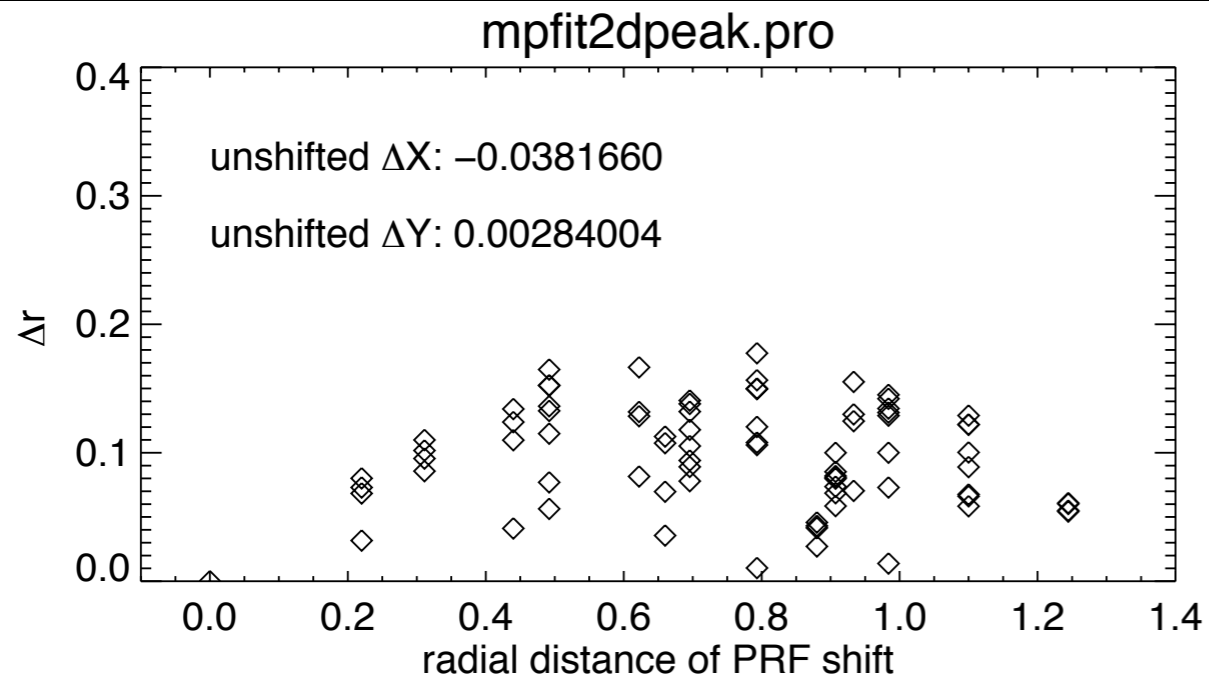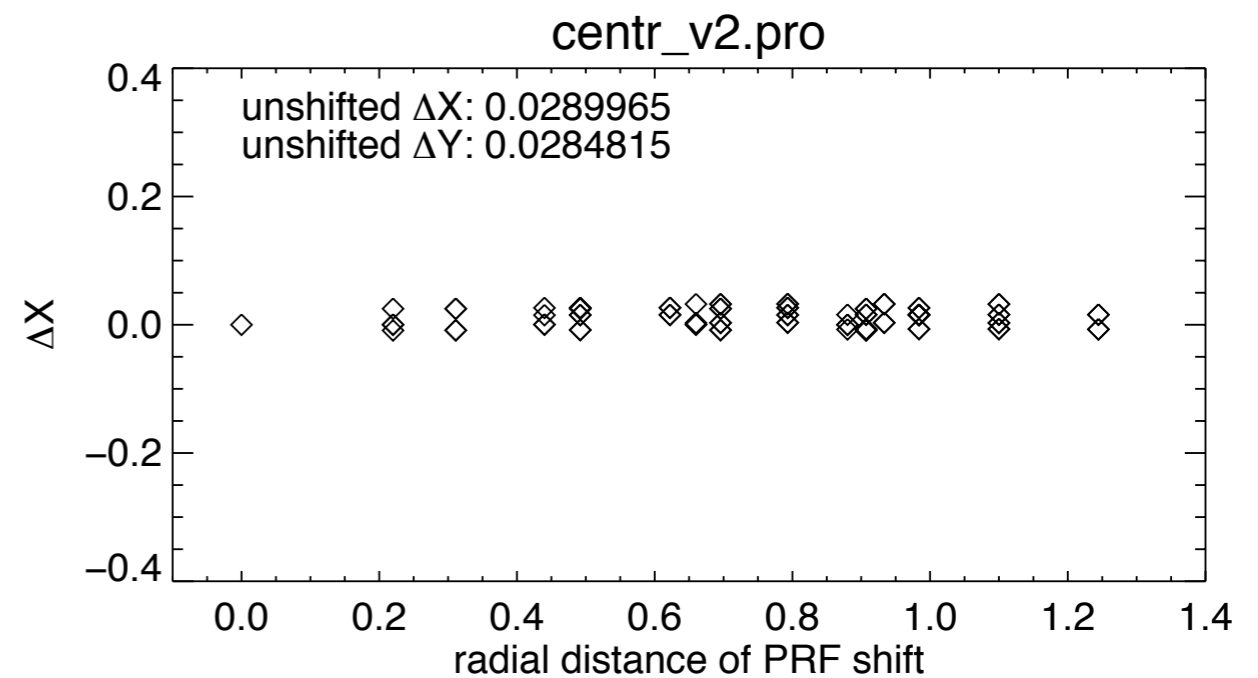
IRAC CH1 - Method Compare

Figure Credit: Syler Wagner

IRAC CH2 - Method Compare

Figure Credit: Syler Wagner

IRAC CH2 - Method Compare

Figure Credit: Syler Wagner

IRAC CH2 - Method Compare

Figure Credit: Syler Wagner
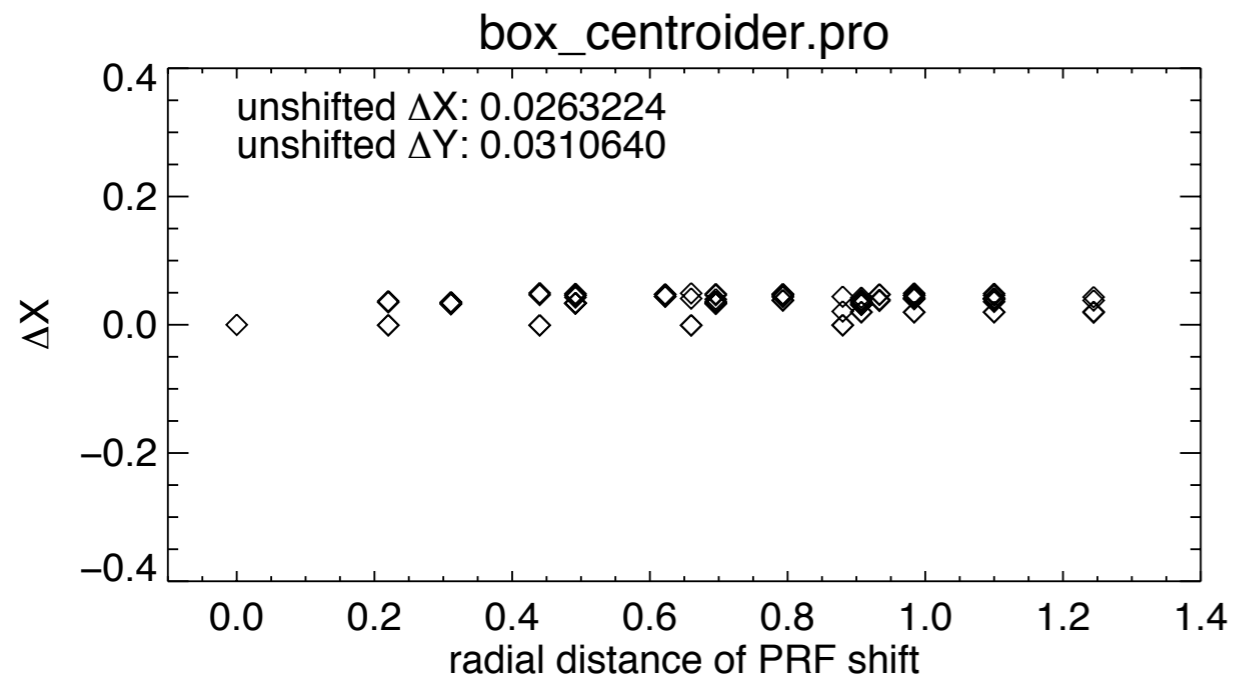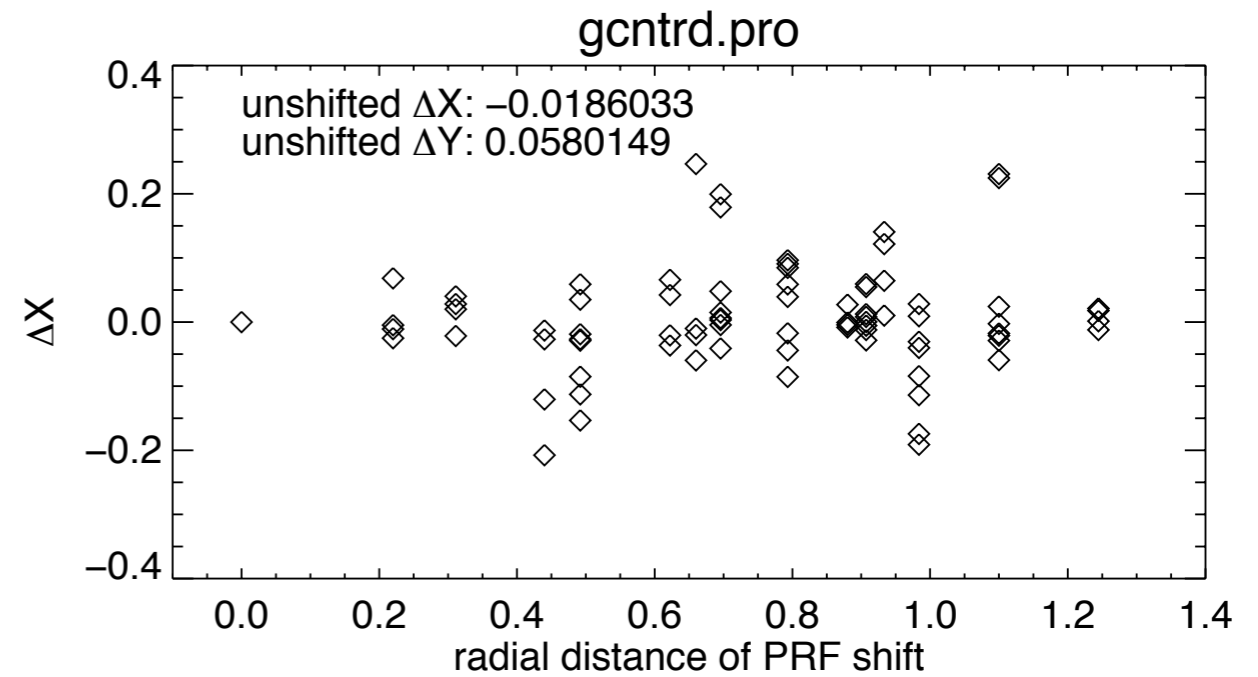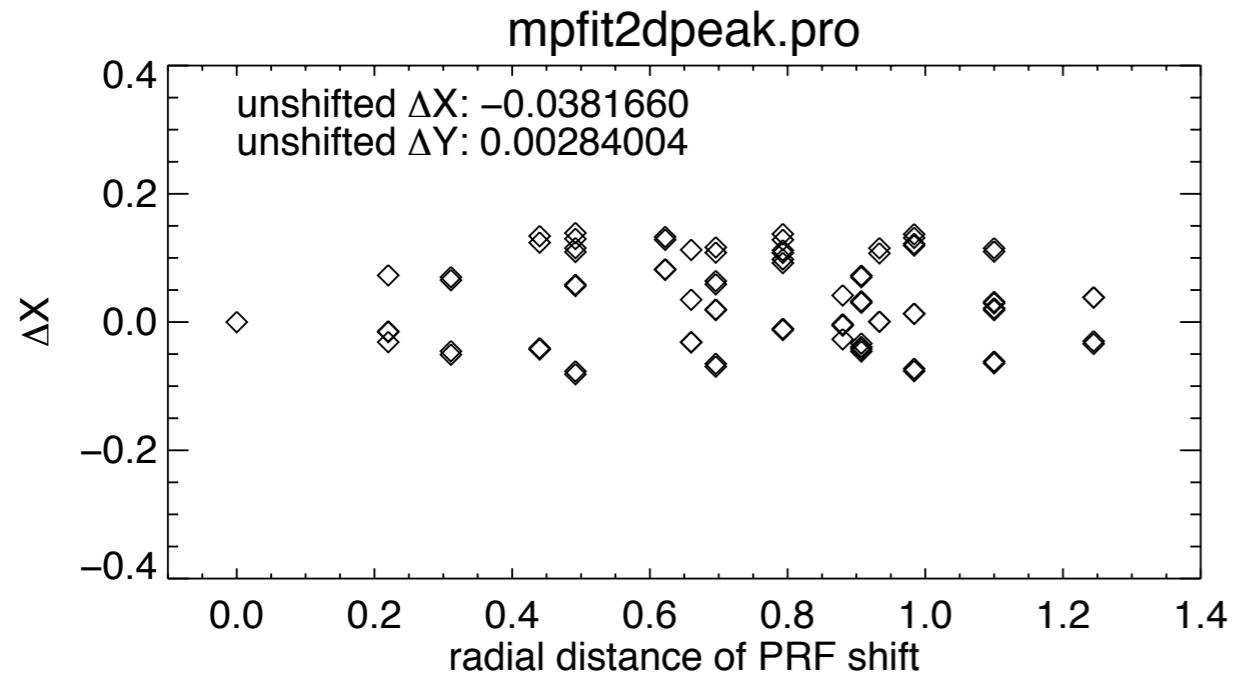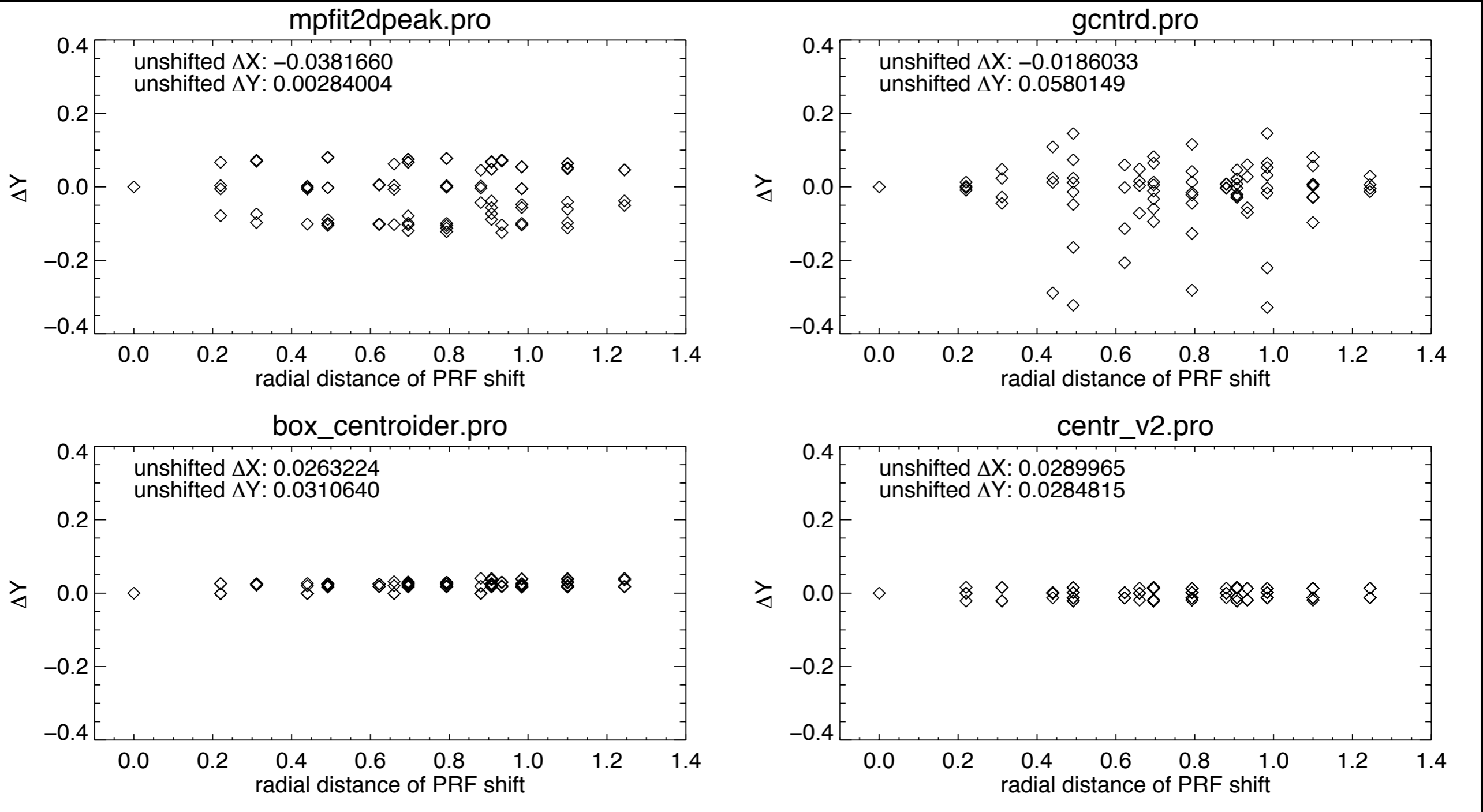
IRAC CH1 - Centroid Errors

Figure Credit:
Ken Mighell

IRAC CH1 - Compare Results
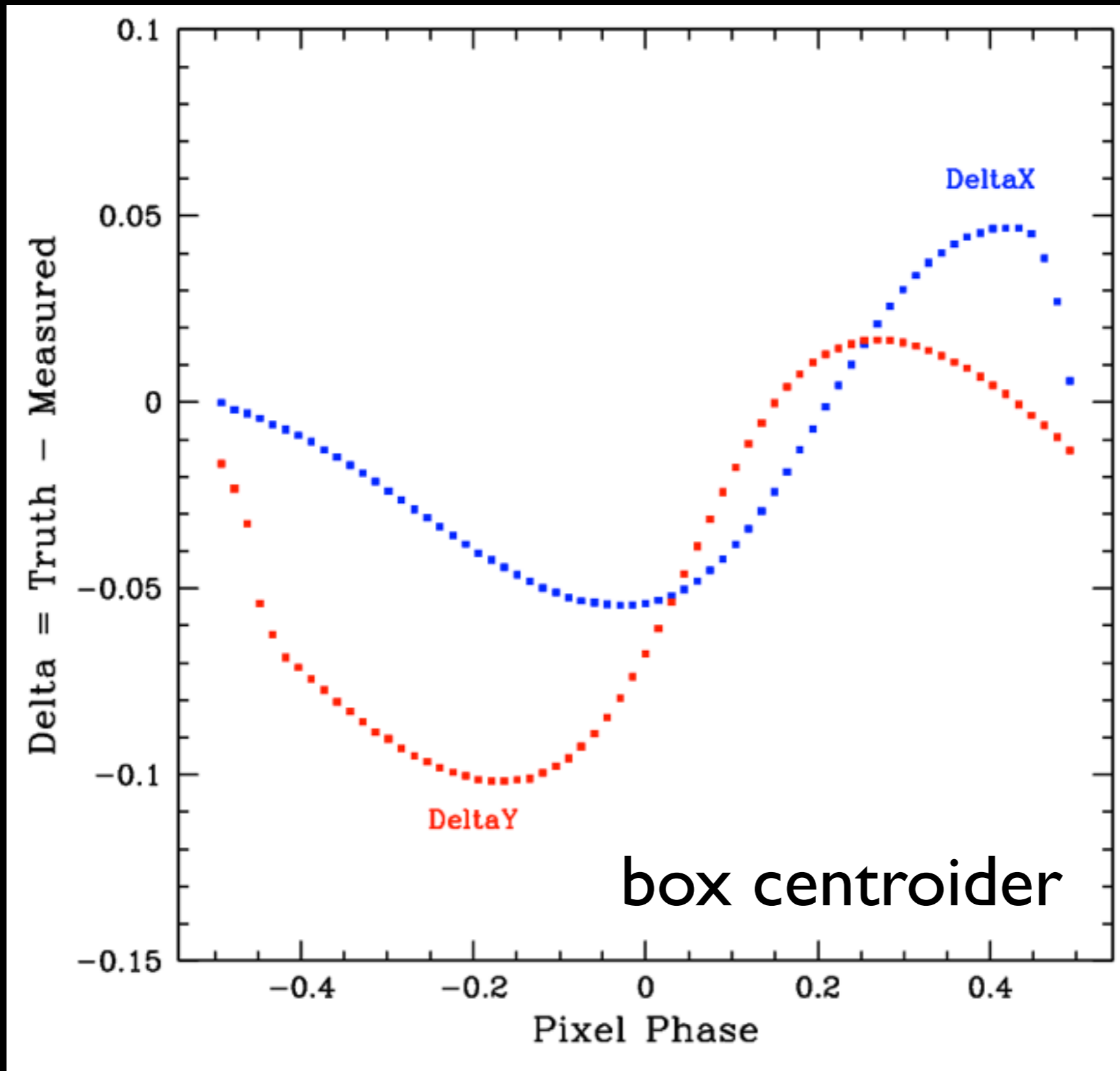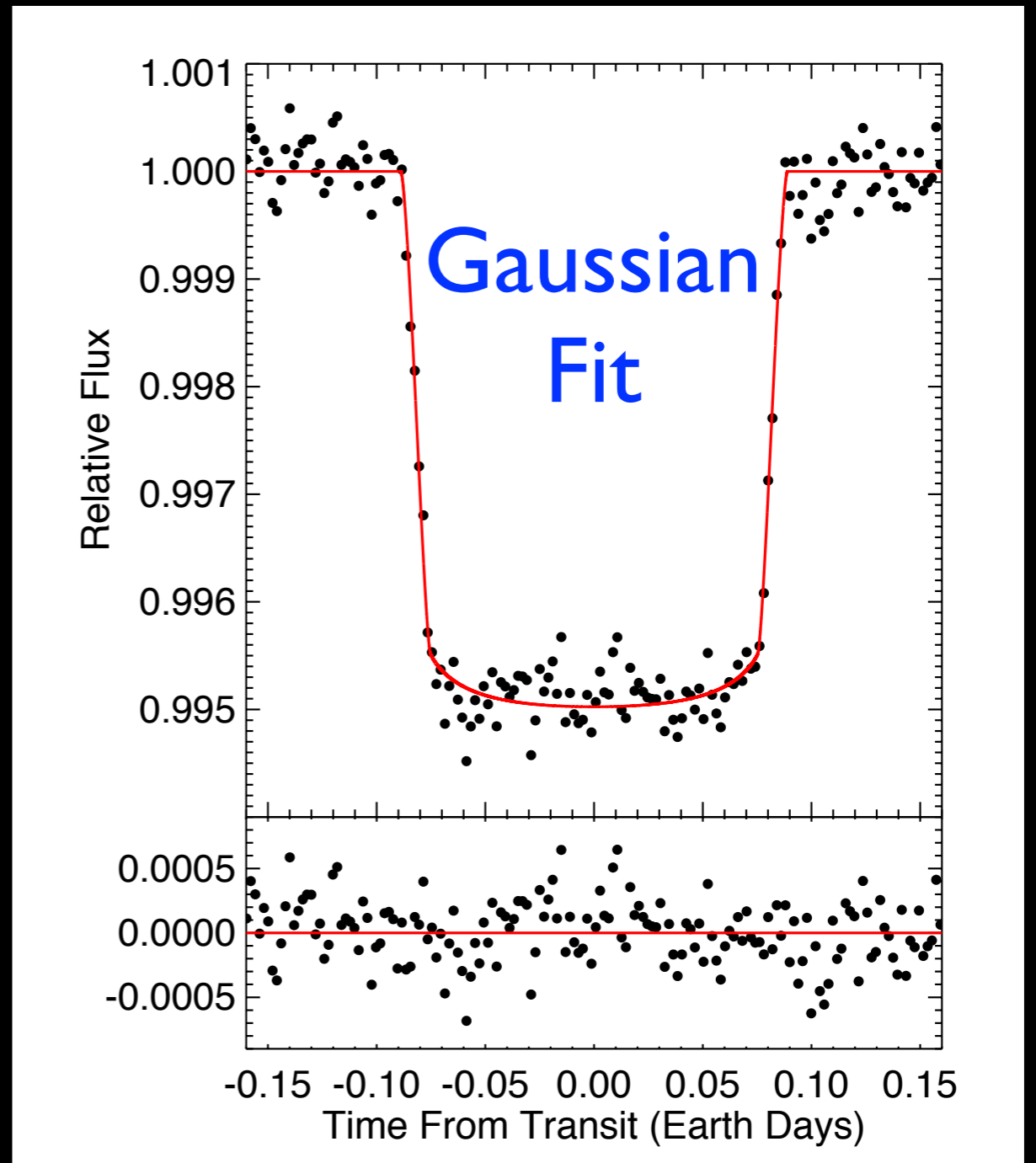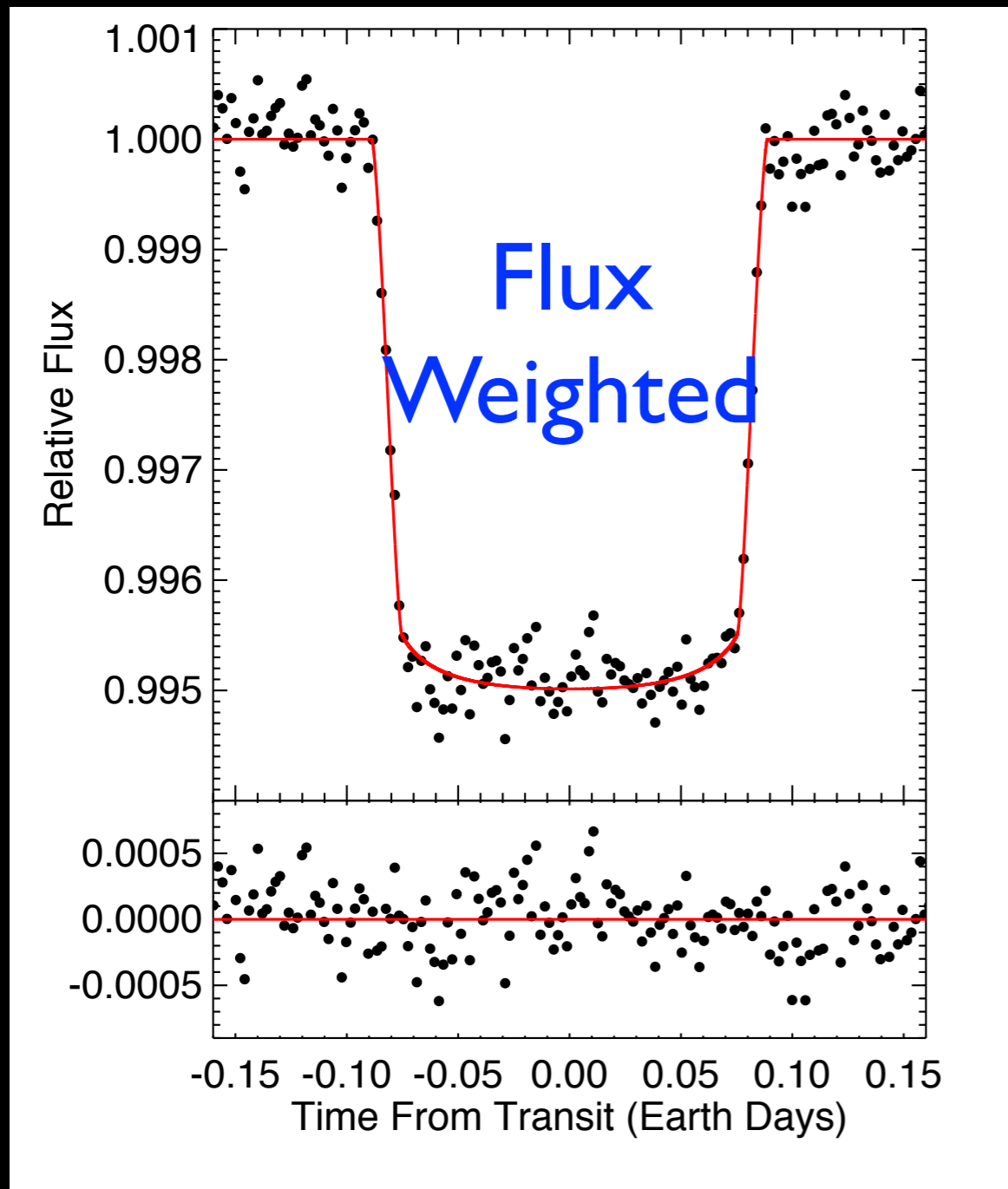
Concluding Thoughts

• Choice of centroiding method generally affects error budget at the few percent level

• Choice of centroiding method generally does not affect retrieved system parameters (within errors)

• Flux-weighted methods appear most 'stable' over a variety datasets (centroid location, S/N, etc.)

•Implementation between groups varies ...

3.6 μm   4.5 μm   5.8 μm   8.0 μm