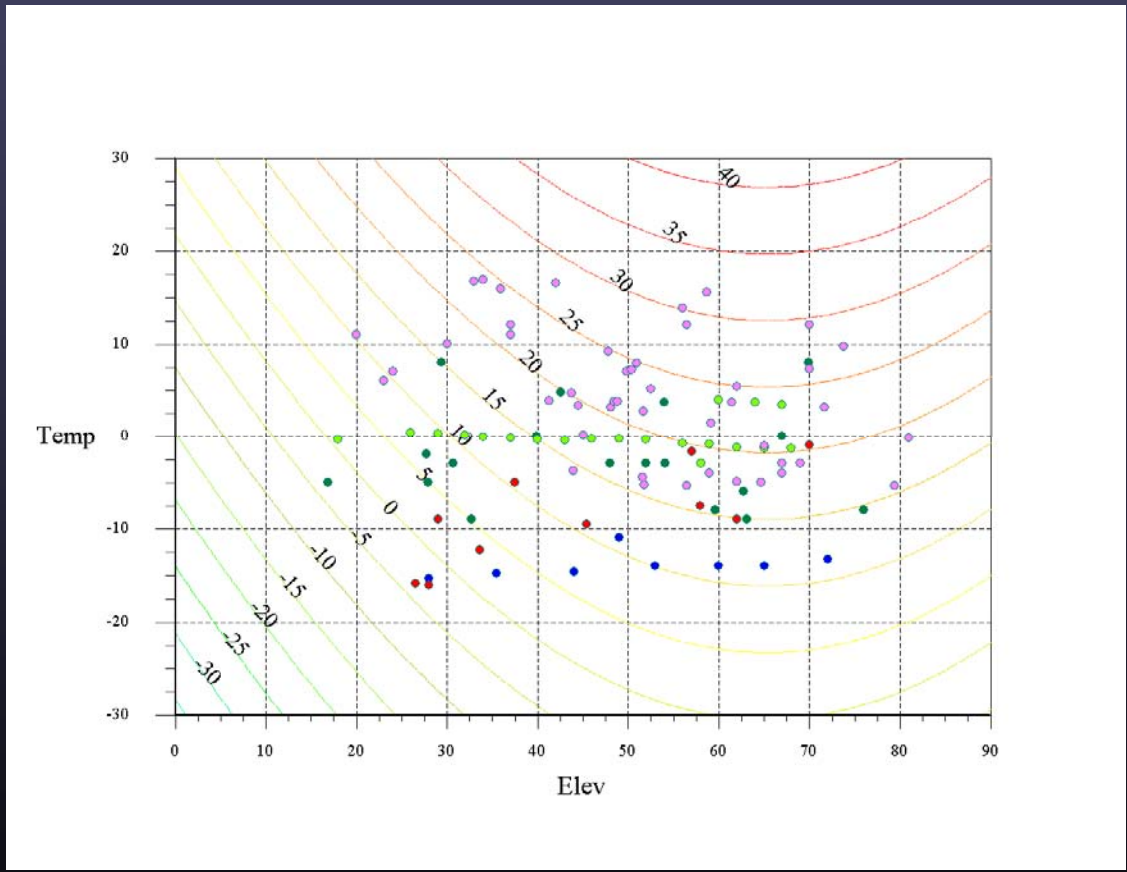
Current GBT Performance

GBT PTCS In-Progress Review

December 3/4, 2003 Green Bank

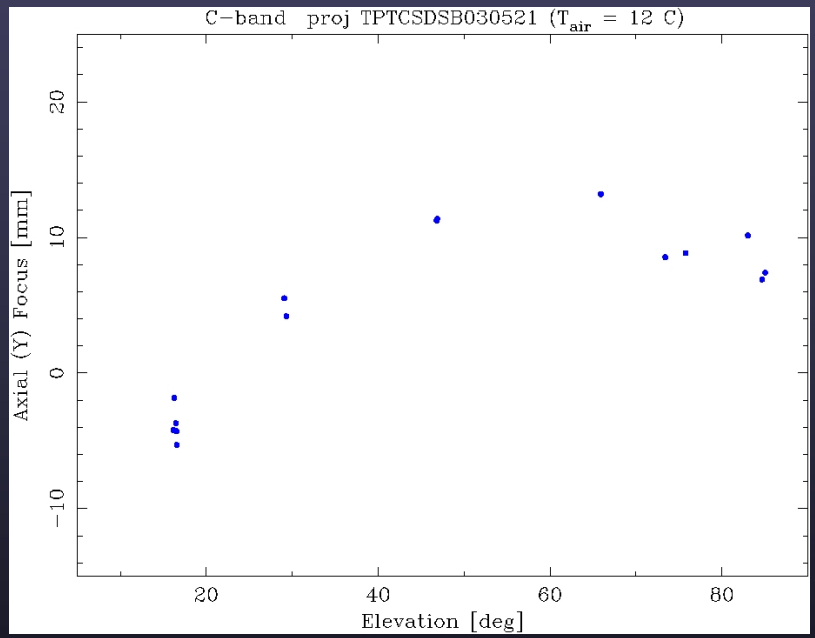
Systematic Focus Errors

Axial Focus Offset: air temperature versus elevation



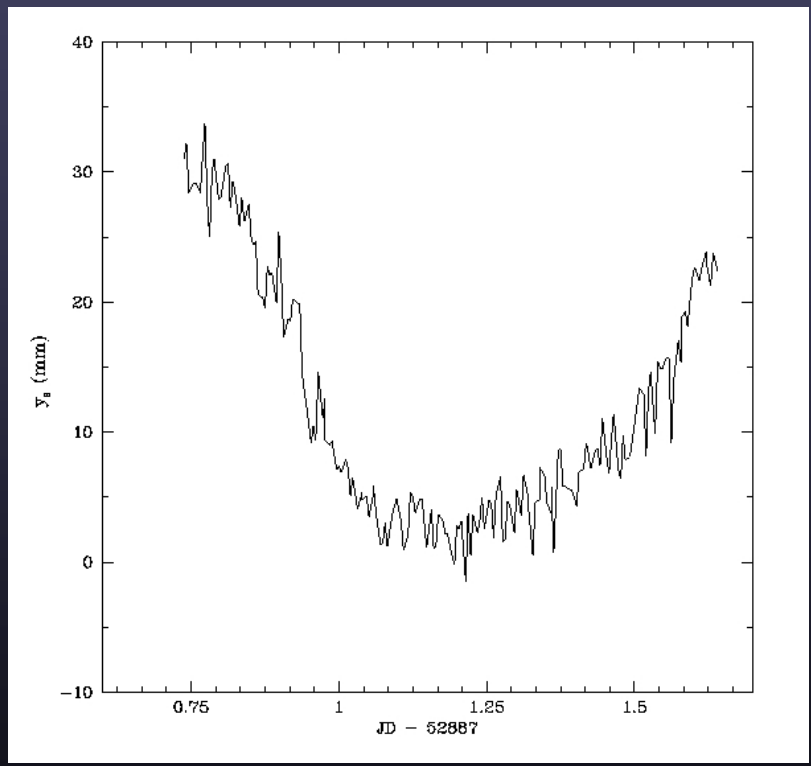
Gravitational & Temperature Focus Effects

Gravitational Effect



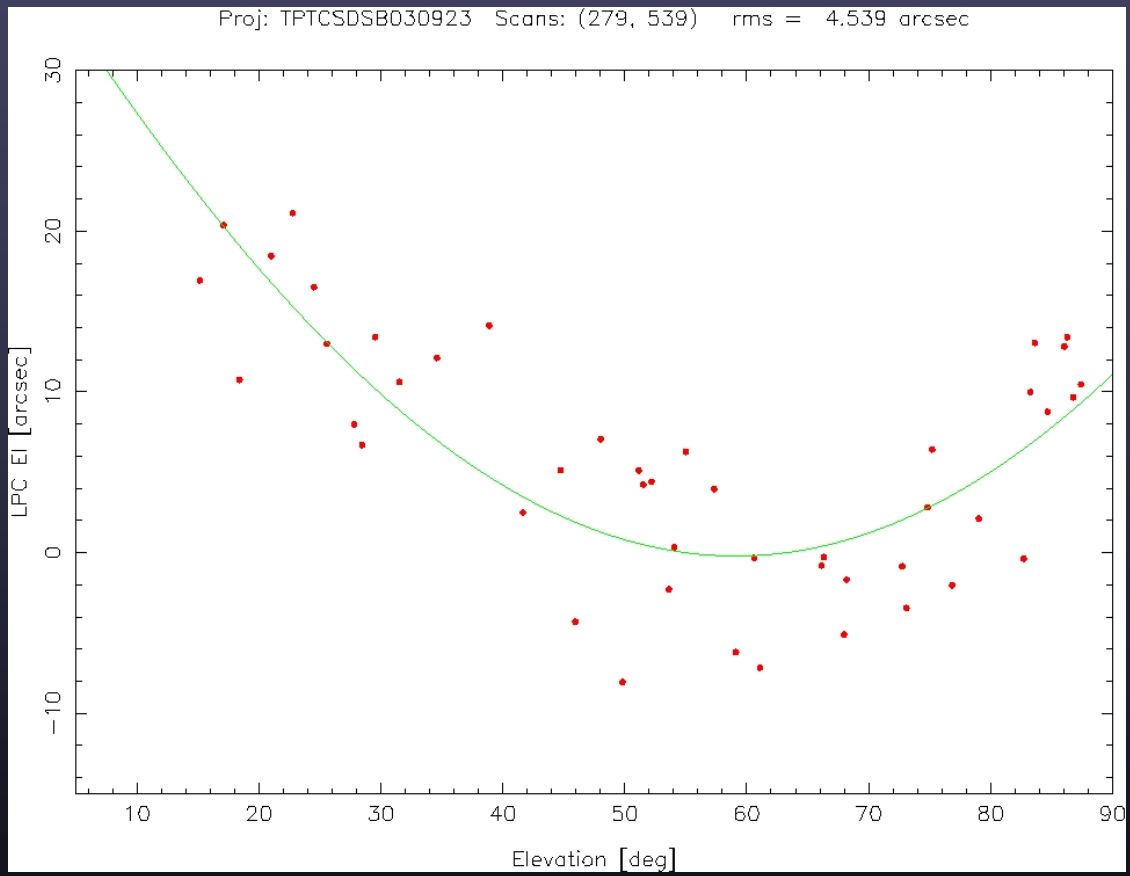
Measure focus over short time period

Temperature Effect



NCP source 0117+8928

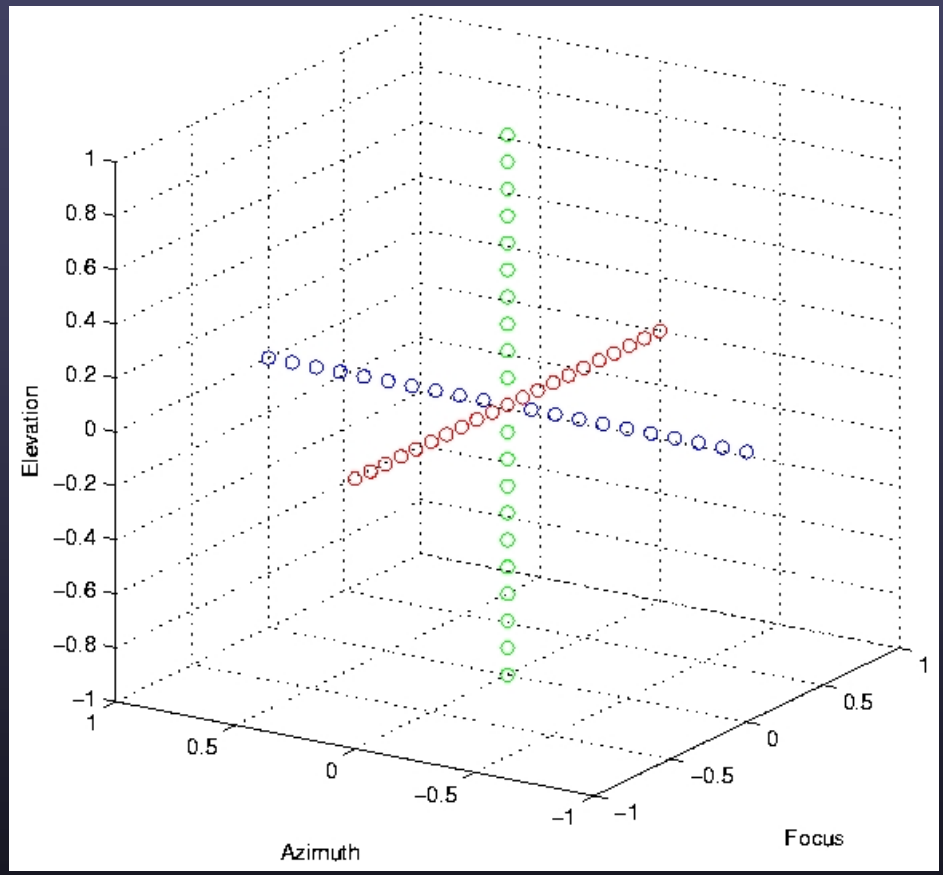
Systematic Pointing Errors



Plan of Attack

- Rationalize data acquisition
- Rationalize data analysis
- Implement temperature sensor system
- Concentrate efforts on pointing and focus
- Characterize performance with X-band (8 -10 GHz)

Data Quality



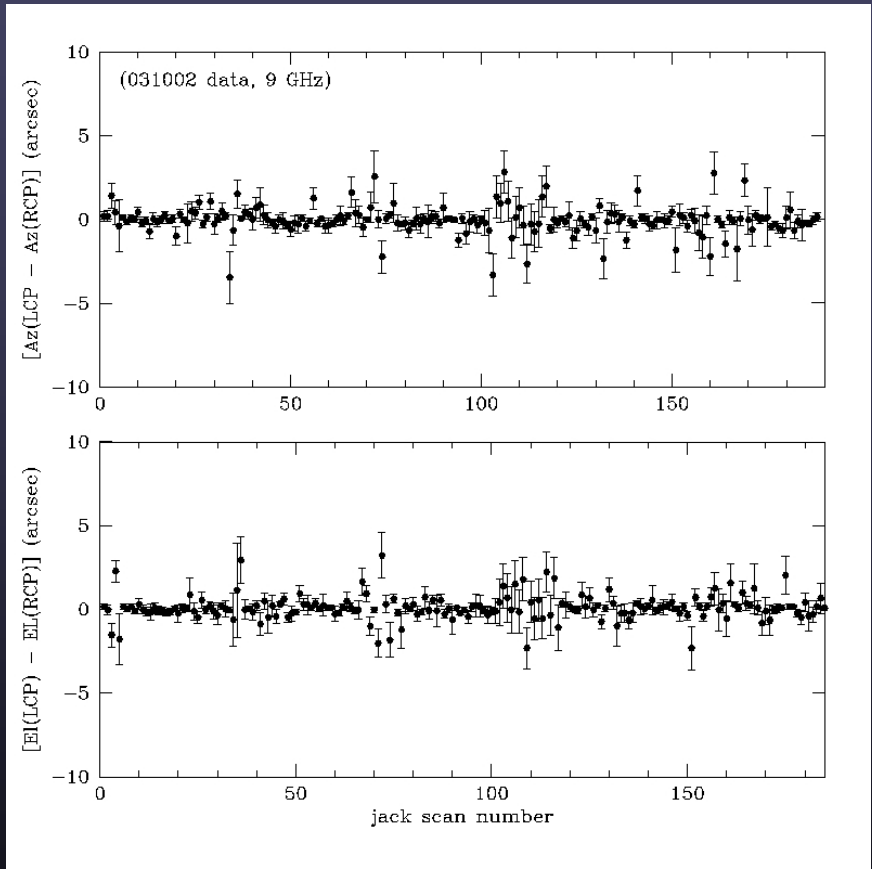
Jack Scan

Gaussian Fits (Az, El, Focus)

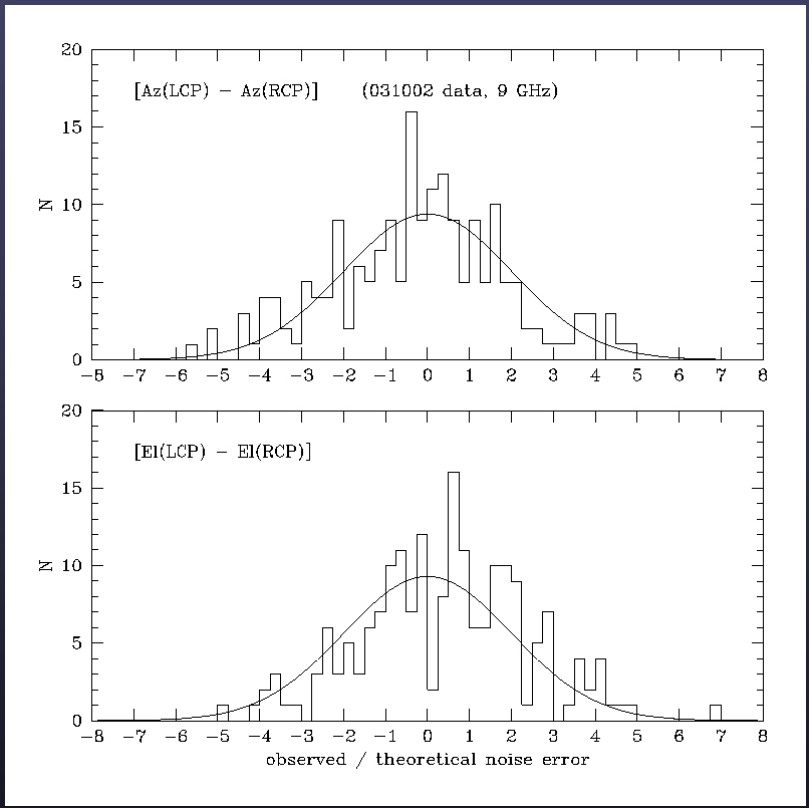
Polarization (LCP – RCP)

Direction (Forward – Backward)

Data Quality: Pointing (LCP – RCP)



Data Quality: Pointing (LCP – RCP)

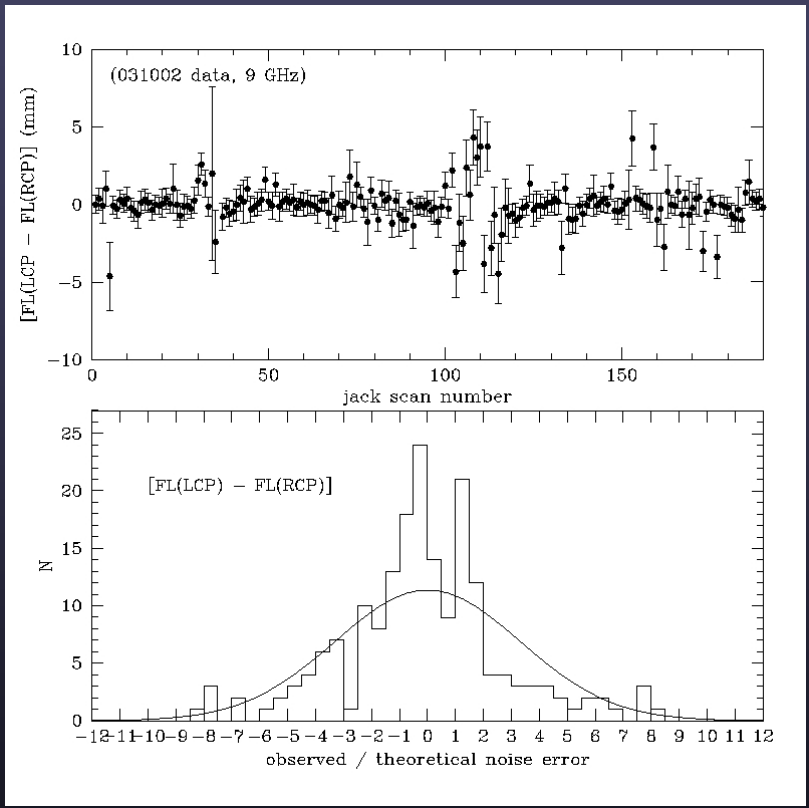


$$\sigma \approx \left[\frac{0.2}{S(Jy)} \right] \; arc\,\sec$$

Flux (9 GHz) > 0.08 Jy

RMS < 2.5 arcsec < 0.03 HPBW

Data Quality: Focus (LCP – RCP)

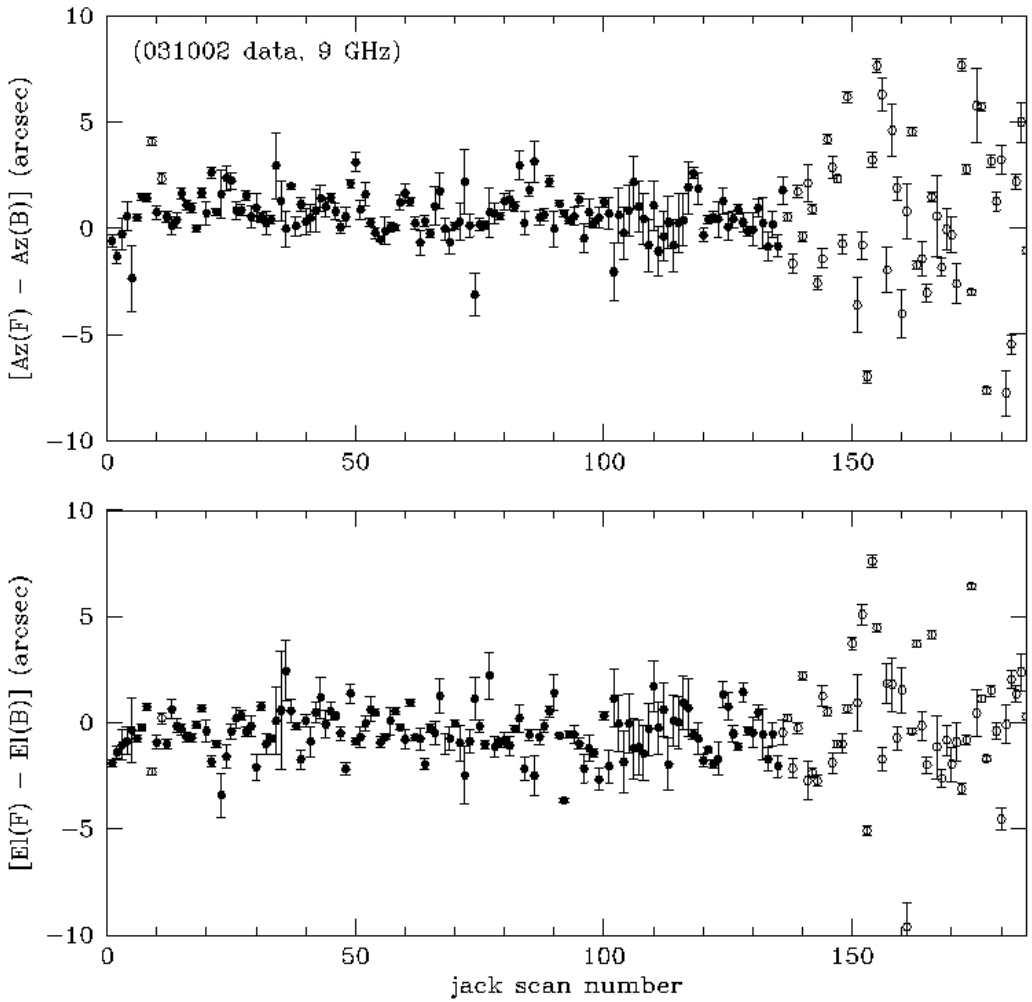


$$\sigma \approx \left[\frac{0.3}{S(Jy)} \right] \quad mm$$

Flux (9 GHz) > 0.08 Jy

RMS < 3.8 mm << focus beamwidth

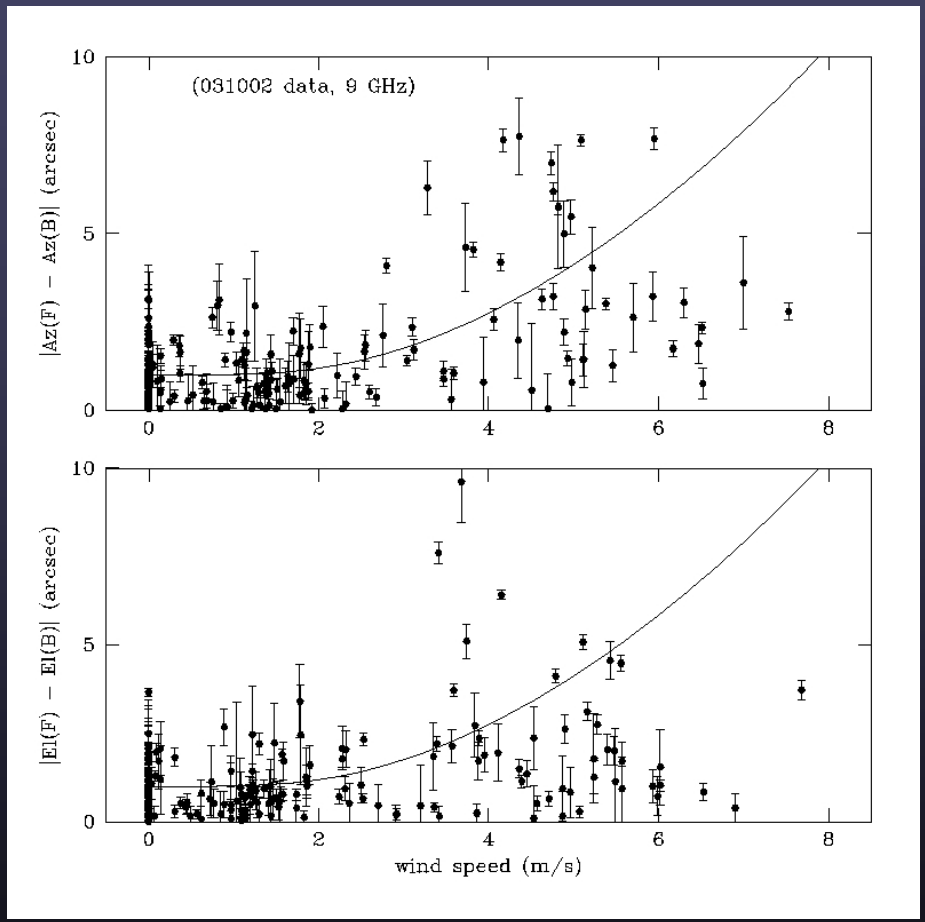
Data Quality: Pointing (F – B)



$$\langle (F-B) \rangle \approx +0.68 \pm 0.1\, arc\,\sec$$

$$\langle (F-B) \rangle \approx +0.54 \pm 0.1\, arc\,\sec$$

Data Quality: Wind



$$\sigma_1(wind) \approx 0.16 \left[\frac{s}{m\ s^{-1}} \right]^2 \quad arc\,\mathrm{sec}$$

$$\sigma_2(wind) \approx \sqrt{2}\,\sigma_1(wind)$$

$$\approx 8'' \ at\ s = 6\ m\ s^{-1}$$

Observational Strategy

- NCP source to probe temperature effects
- Up-down sources at night to probe gravity effects
- All-sky for a combination

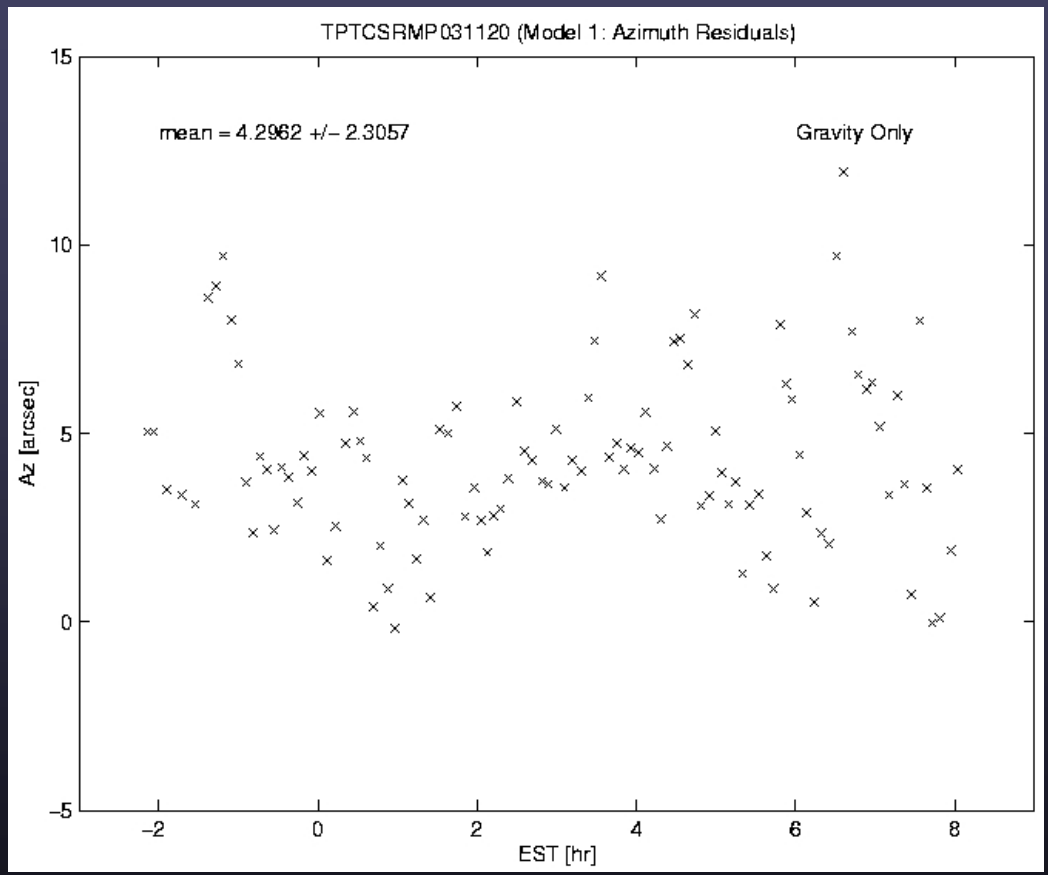
Initial Results

- All-sky (Az, El) pointing
  - Removed systematic pointing residuals
- Simultaneous fits to gravity and temperature
  - Separate two effects
  - Refine focus and pointing models

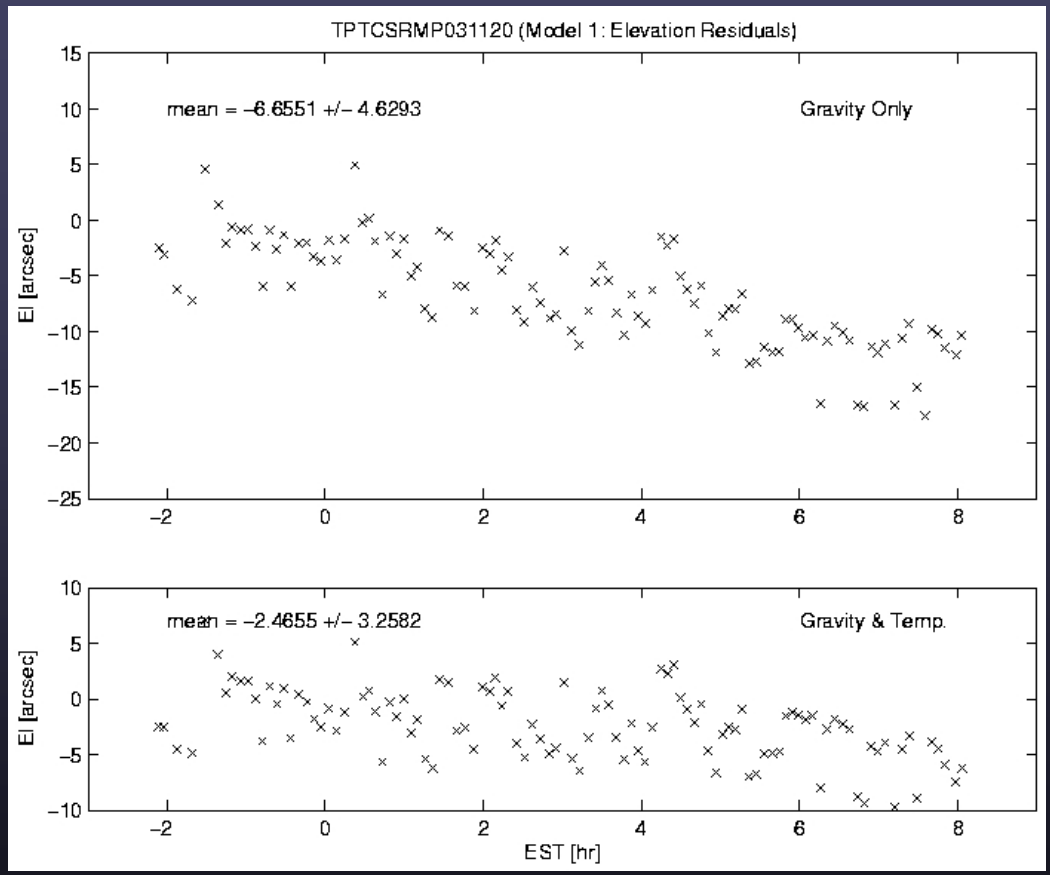
Current Performance

- Model:
  - Simultaneous solution to temperature and gravity effects
- Datasets:
  - All-sky pointing run (2003 Nov 20)
  - Half-power tracking (2003 Nov 20)
- Metrics
  - Blind pointing
  - Offset pointing
  - Continuous Tracking

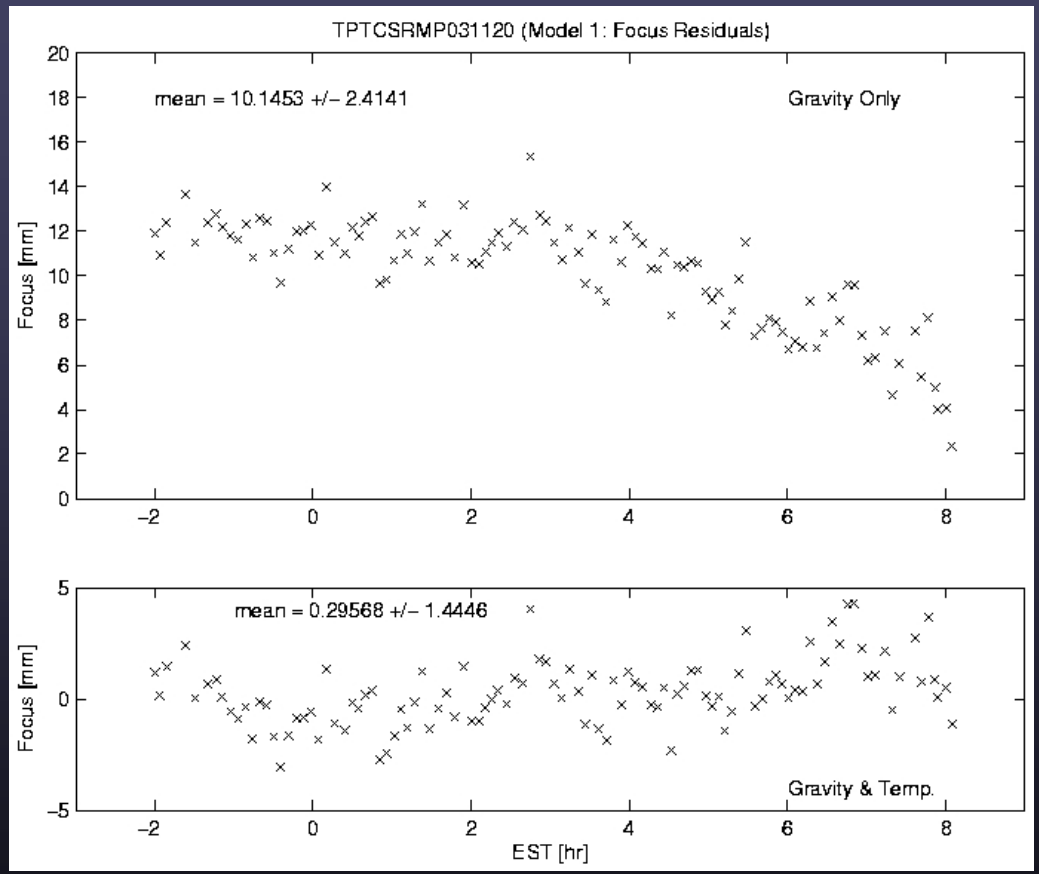
Blind Pointing: Azimuth



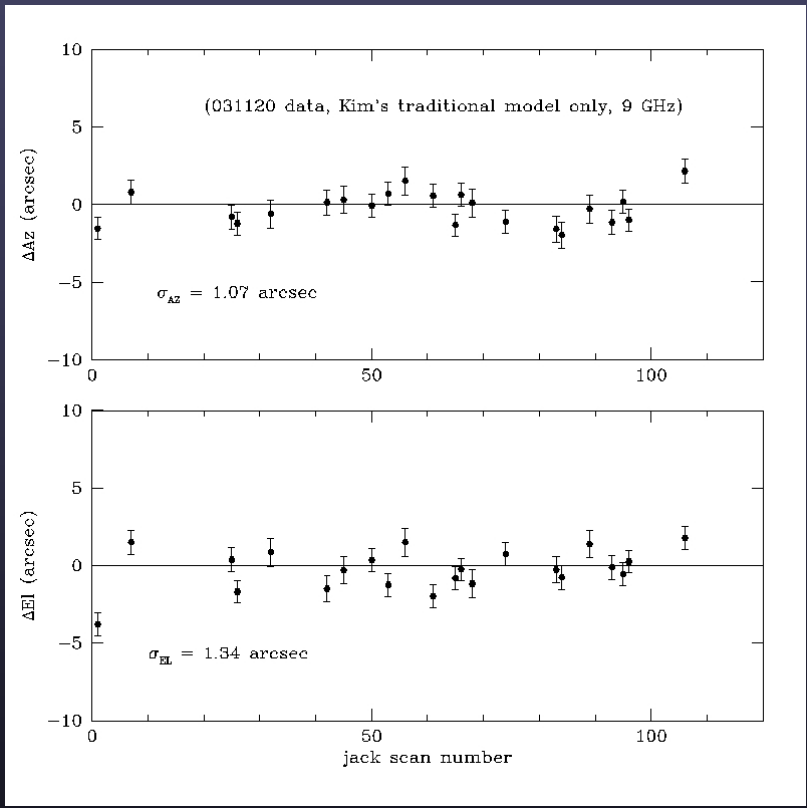
Blind Pointing: Elevation

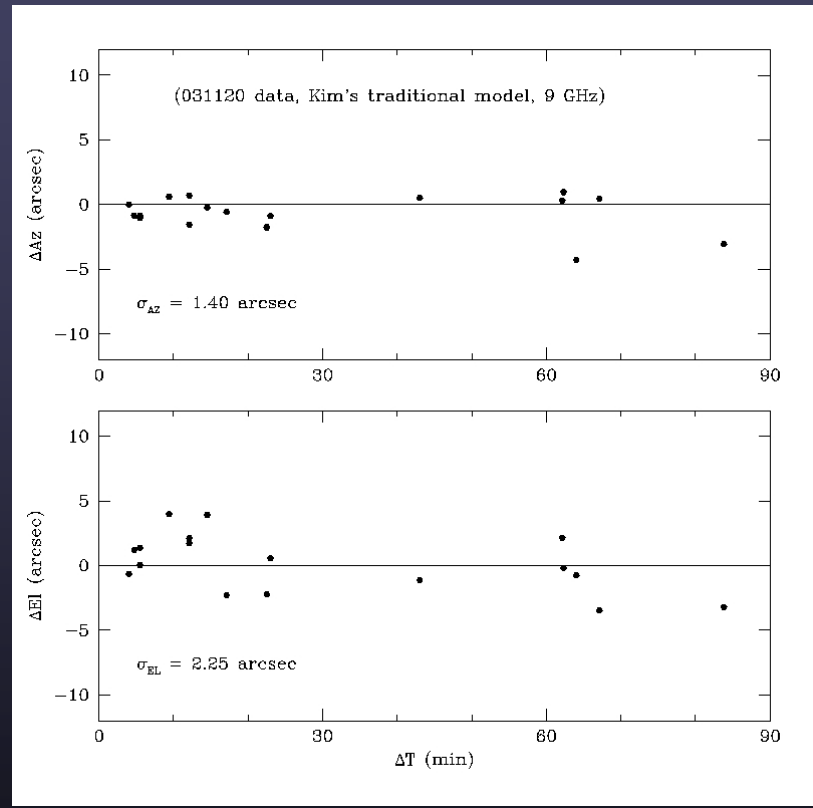


Blind Focus

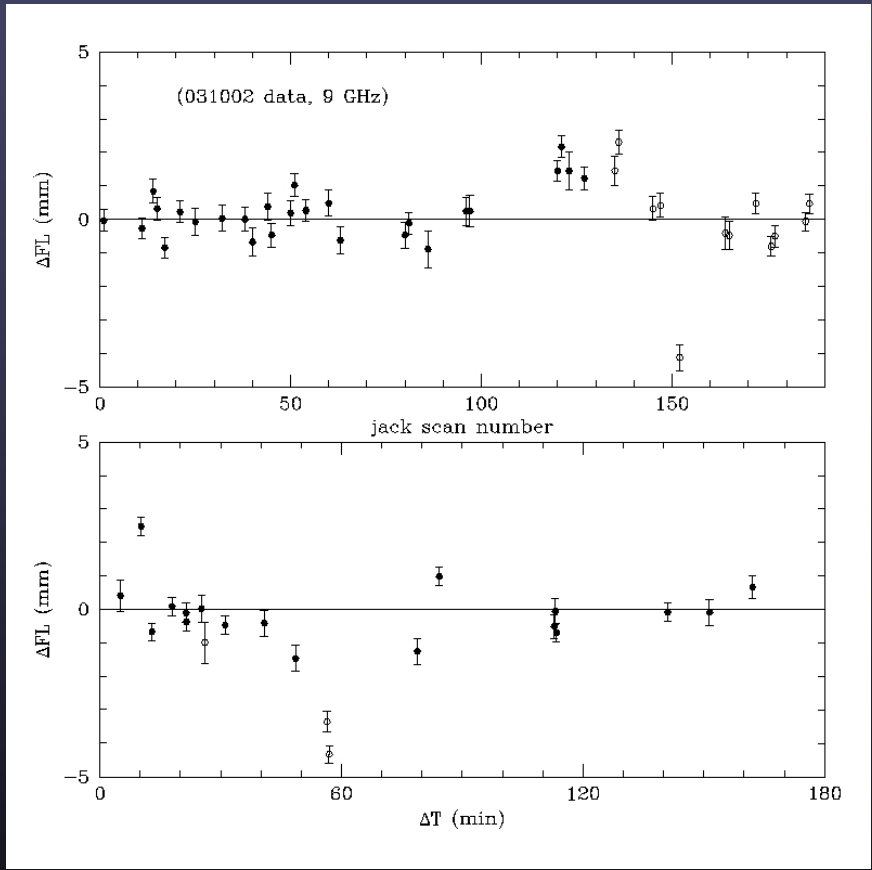

TPTCSRMP031120 (Model 1: Focus Residuals)
mean = 10.1453 +/– 2.4141
Gravity Only
Focus [mm]
mean = 0.29568 +/– 1.4446
Gravity & Temp.
Focus [mm]
EST [hr]

Offset Pointing: Azimuth and Elevation

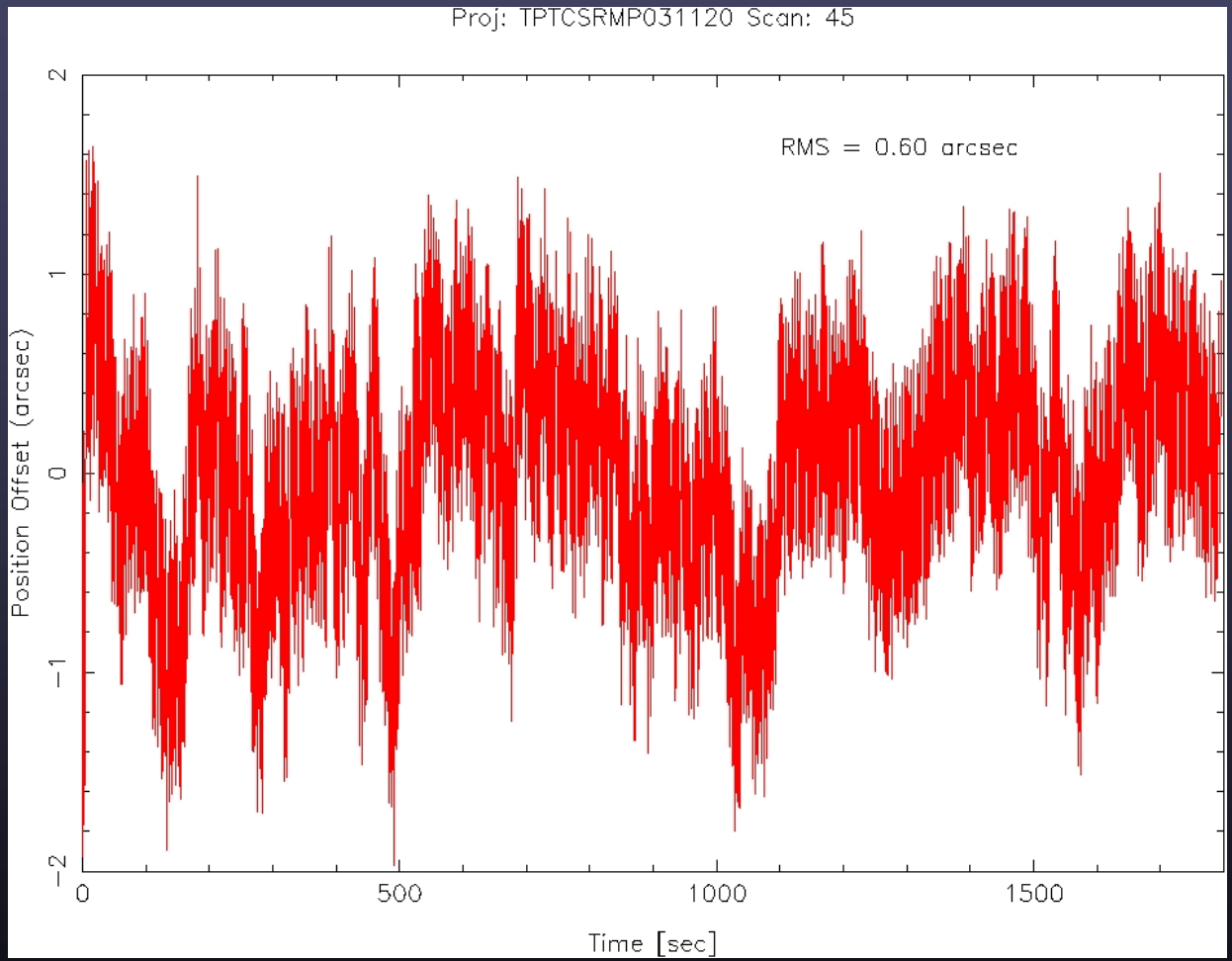




Offset Focus



Tracking: Ku-band (14 GHz) El half-power track



$$\sigma_2 \approx 1 \quad arc\,\mathrm{sec}$$

$$(Az, El) \approx (290^\circ, 58^\circ)$$

$$(\Delta Az, \Delta El) \approx (1^\circ, 5^\circ)$$

$$\left(\frac{\Delta Az}{\Delta t}, \frac{\Delta El}{\Delta t}\right) \approx (2'/m, 10'/m)$$

Current Performance: (NO temperature corrections)

Benign Conditions: (1) Exclude 10:00 → 18:00
(2) Wind < 2.5 m/s

Blind Pointing:
(1 point/focus)

$$\sigma_2 \approx 5 \ \ arc\,\mathrm{sec}$$
$$\sigma(\,focus) \approx 2.5 \ \ mm$$

Offset Pointing:
(90 min)

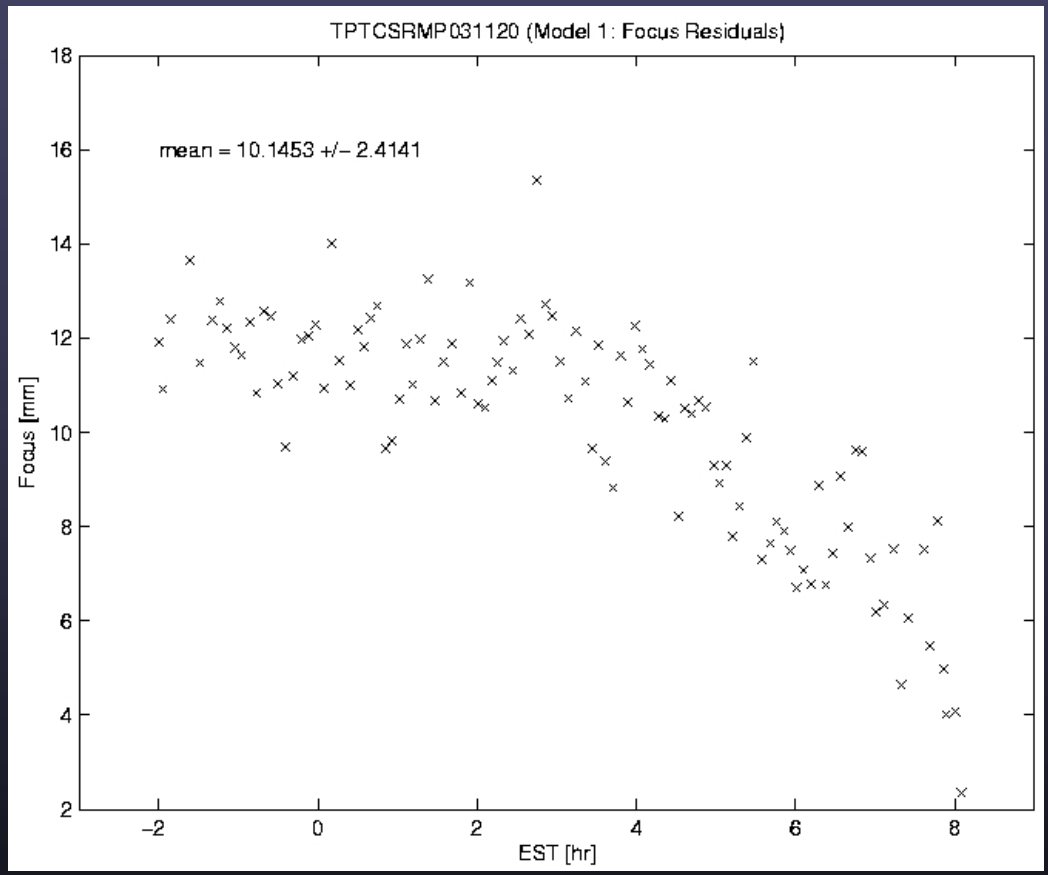
$$\sigma_2 \approx 2.7 \ \ arc\,\mathrm{sec}$$
$$\sigma(\,focus) \approx 1.5 \ \ mm$$

Continuous Tracking:
(30 min)

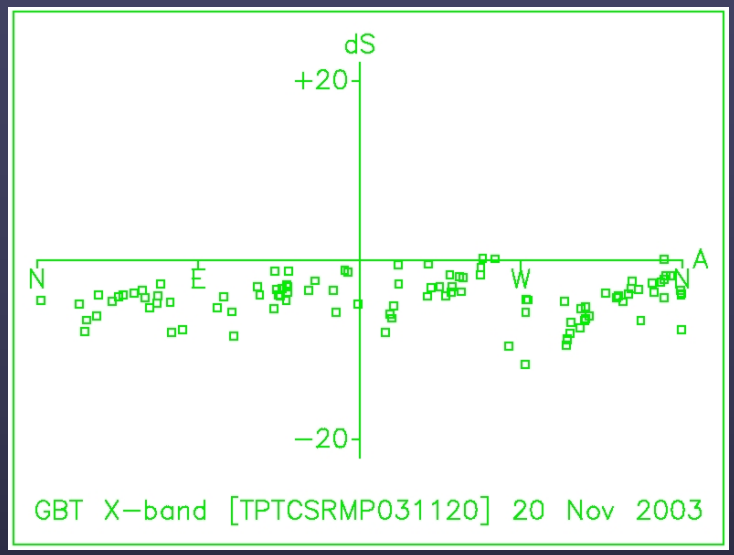
$$\sigma_2 \approx 1 \ \ arc\,\mathrm{sec}$$

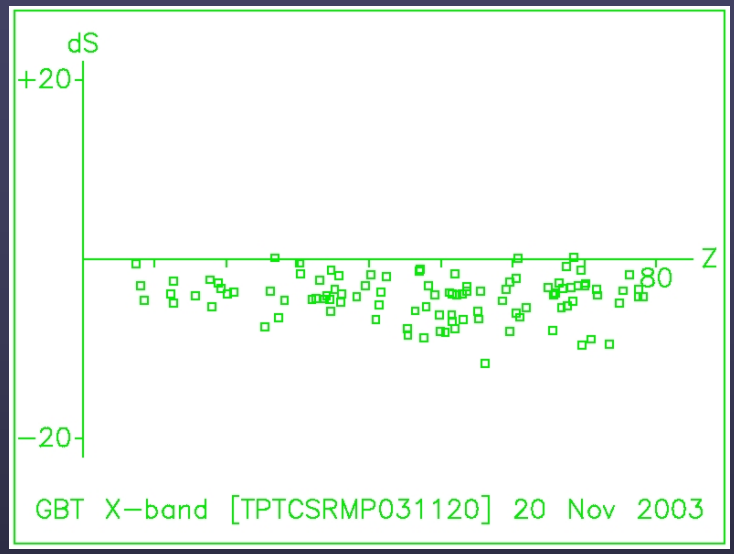
Supplemental Material

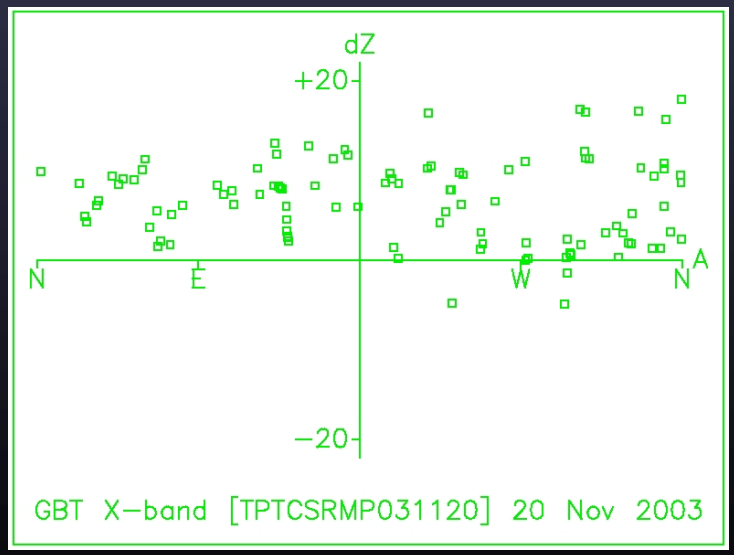
Blind Focus

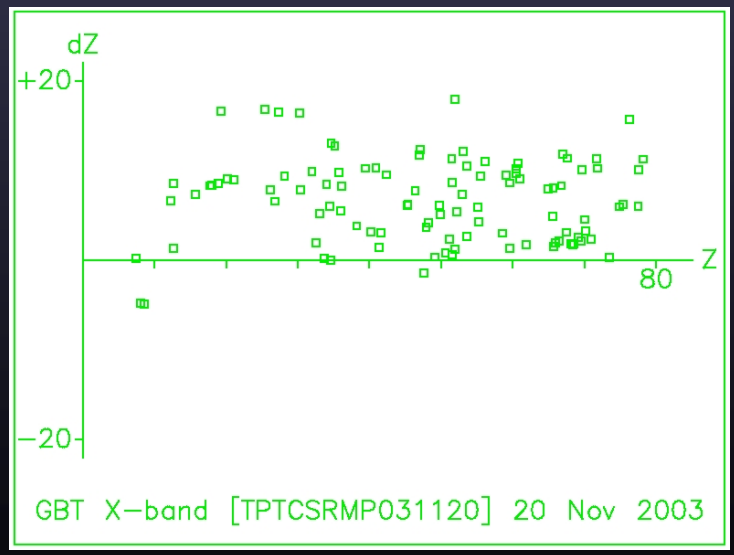

TPTCSRMP031120 (Model 1: Focus Residuals)
mean = 10.1453 +/– 2.4141
Focus [mm]
EST [hr]
18
16
14
12
10
8
6
4
2
–2
0
2
4
6
8

Blind Pointing: residuals versus (A, Z)

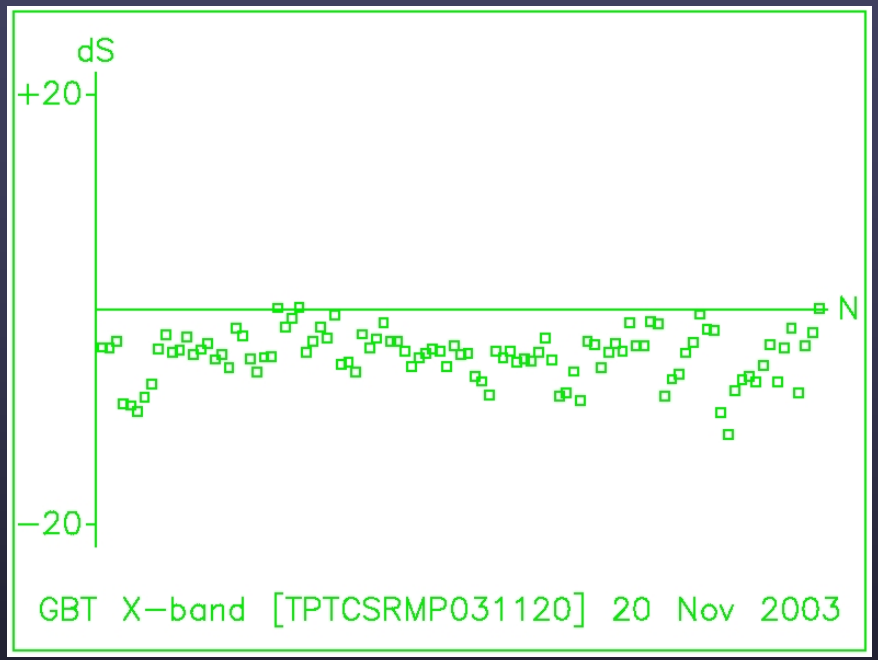


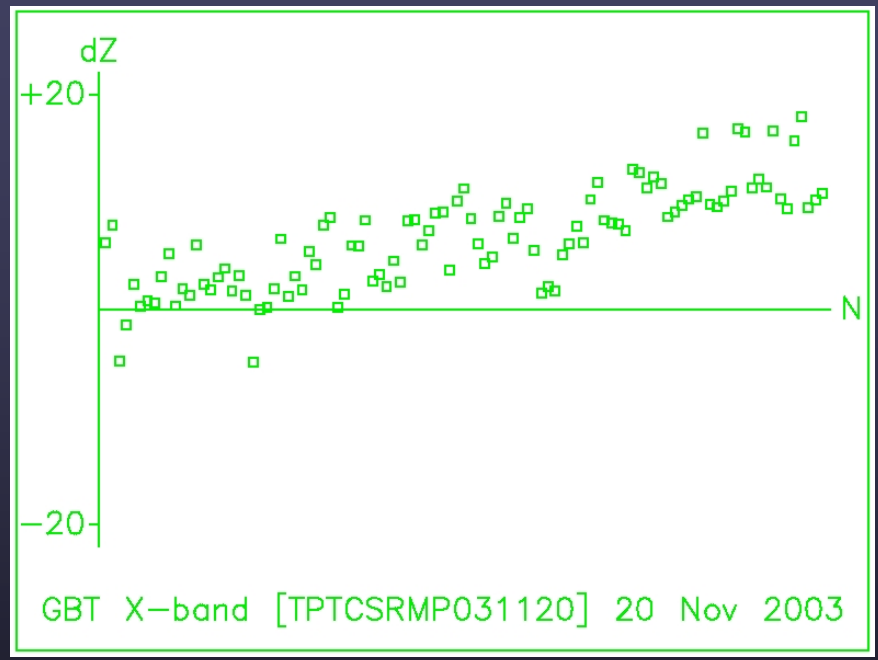




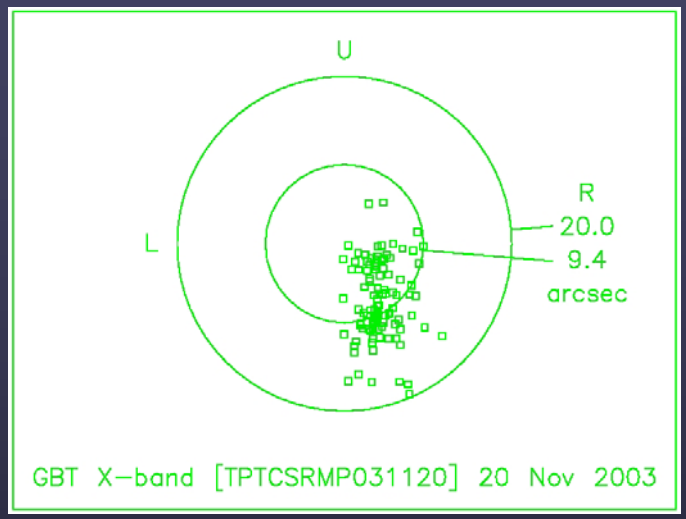


Blind Pointing: residuals versus time

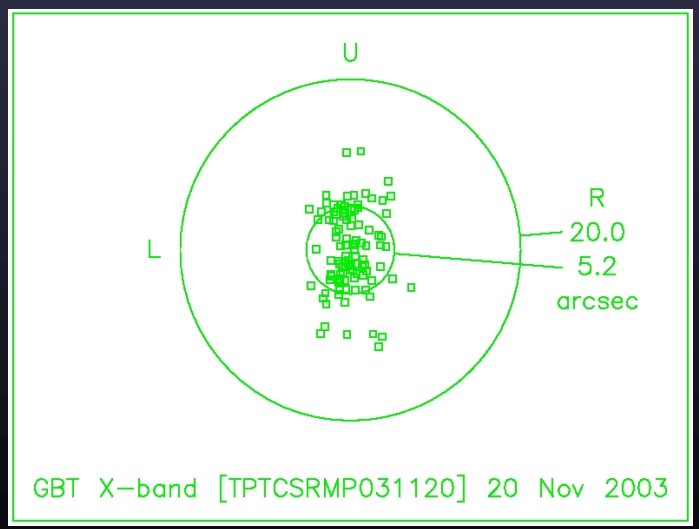




Blind Pointing: 2-D RMS

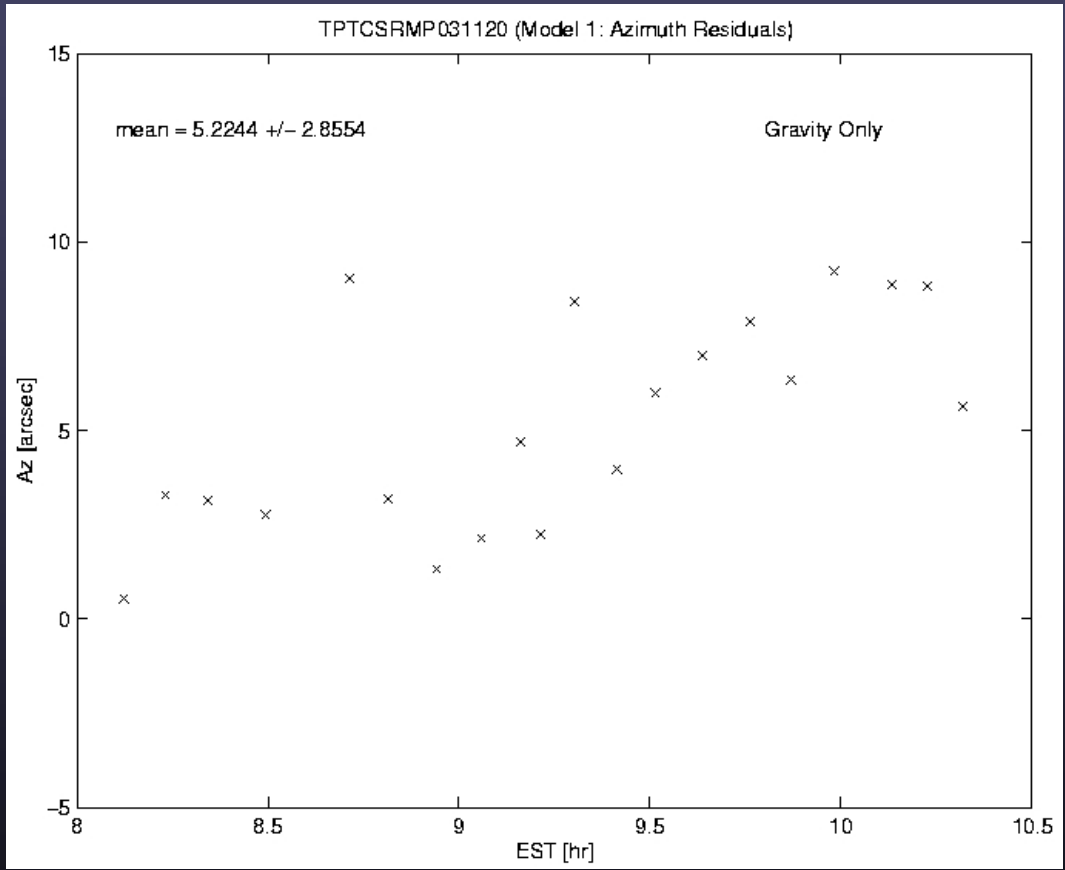


Raw Residuals

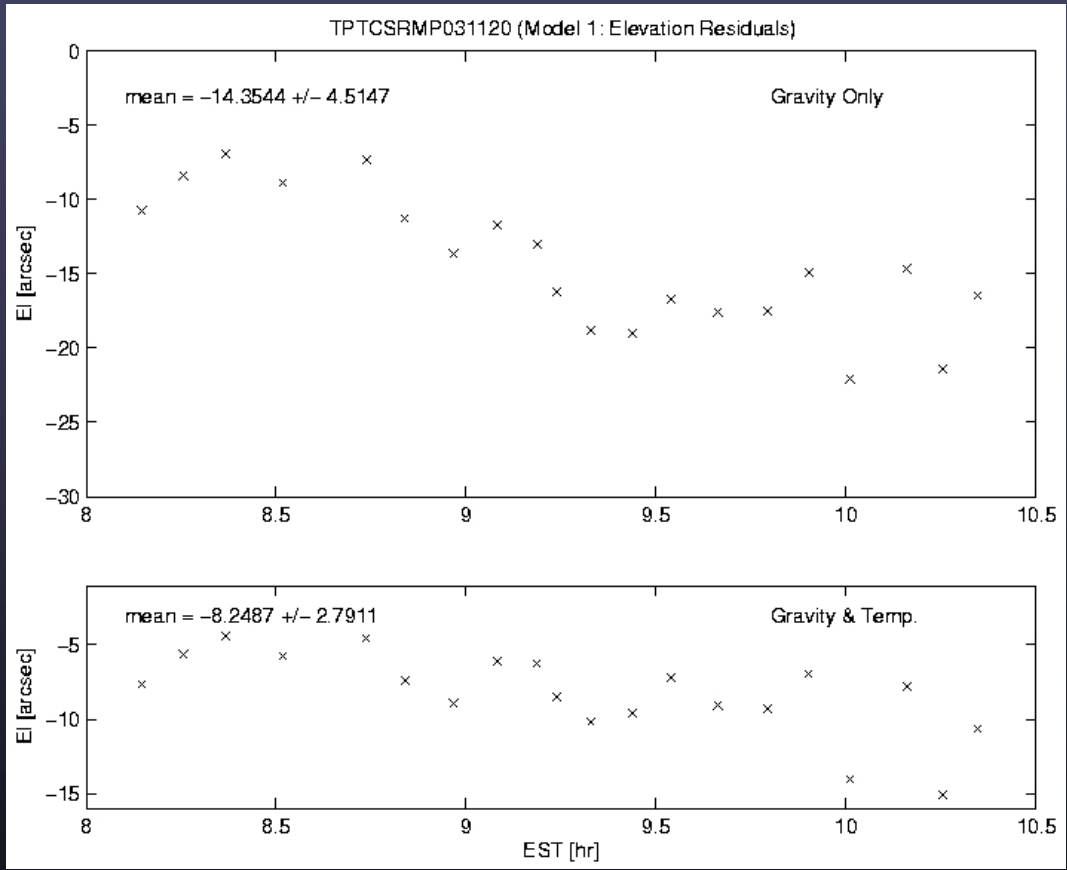


One PEAK at the start of the evening

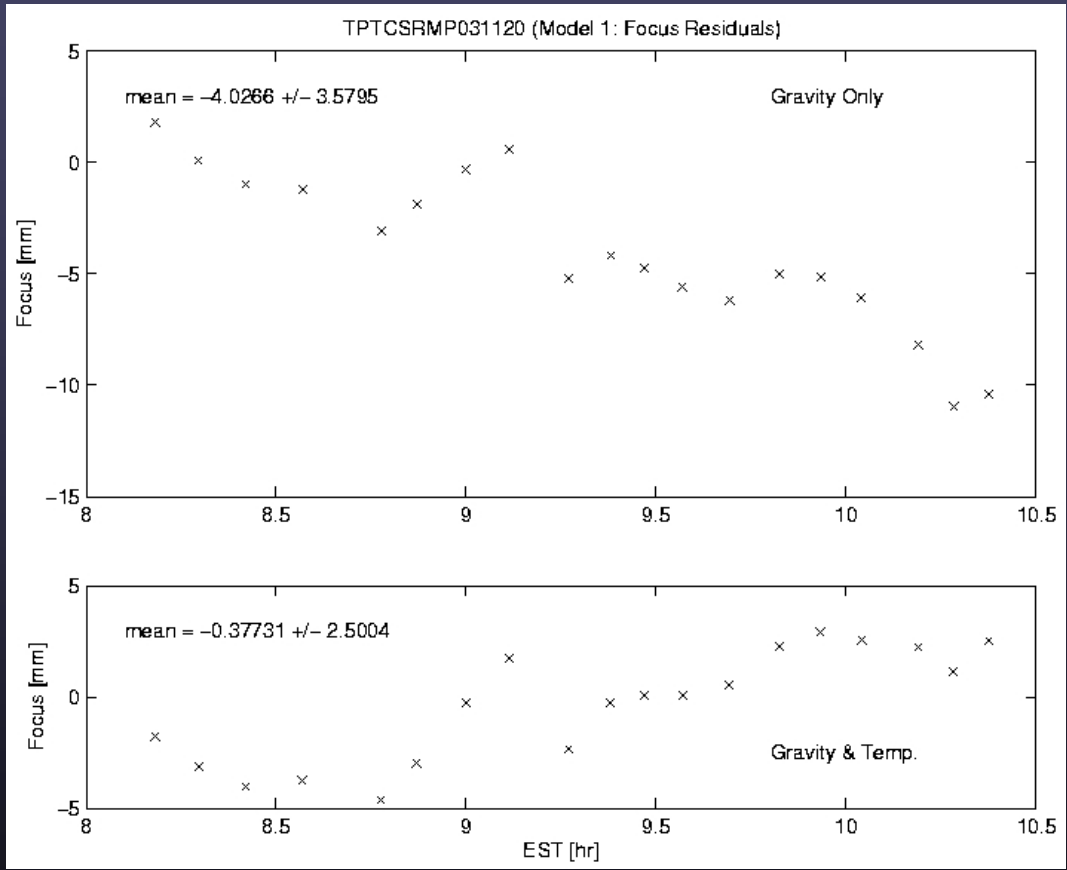
Blind Pointing: Azimuth



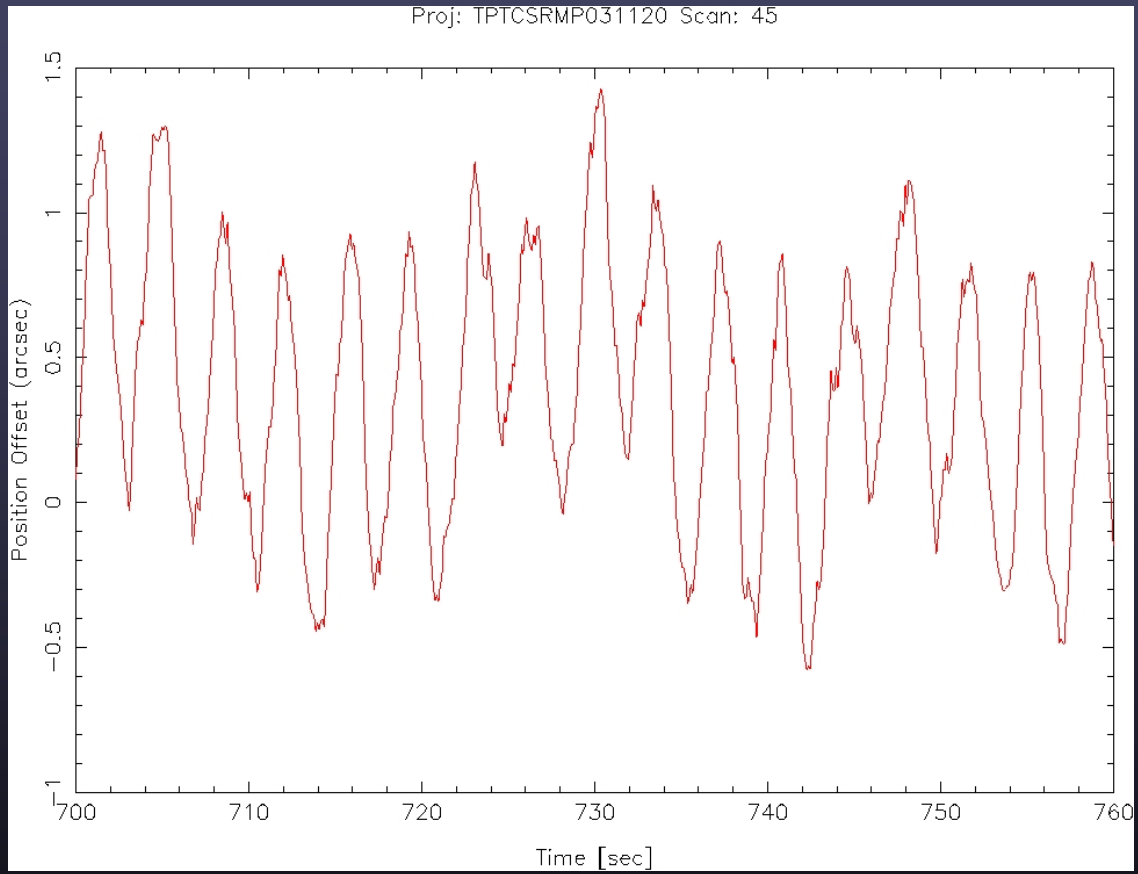
Blind Pointing: Elevation



Blind Focus


TPTCSRMP031120 (Model 1: Focus Residuals)
mean = −4.0266 +/− 3.5795
Gravity Only
Focus [mm]
5
0
−5
−10
−15
8
8.5
9
9.5
10
10.5
mean = −0.37731 +/− 2.5004
Gravity & Temp.
Focus [mm]
5
0
−5
8
8.5
9
9.5
10
10.5
EST [hr]

Tracking: Ku-band (14 GHz) El half-power track



Tracking: Ku-band (14 GHz) El half-power track