Pointing calibration of 22 GHz multi-beam receiver

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Outline of the talk

- The 22 GHz mbeam receiver
- Why pointing is important @ 22 GHz
- Test measurements
- Subreflector geometry
- Results

    Mechanical Vs Otimized optical alignment

    Subreflector parameters vs elevation

    Antenna gain curve

  - Summary
  - Future plan

22 GHz multi-beam receiver

- 7 feed focal plane array in hexagon geometry working in 18 -26 GHz band
- high sensitivity continuum observations, spectroscopy and polarimetry

Top view

Horn numbered

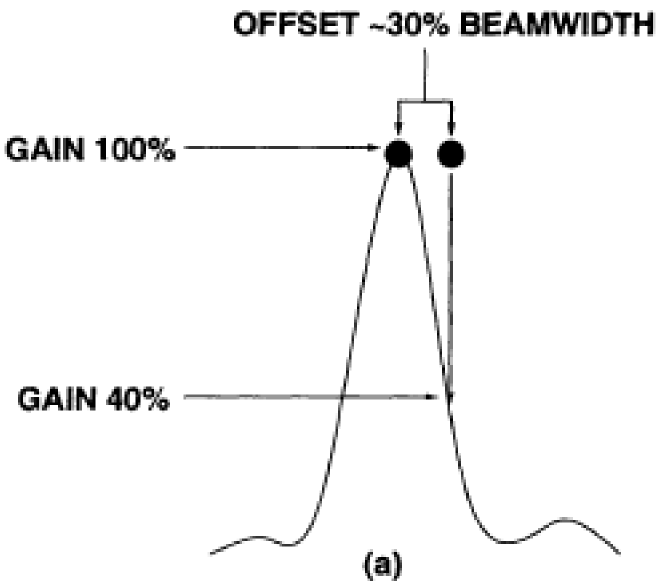
22 GHz.. conti...

Characteristics

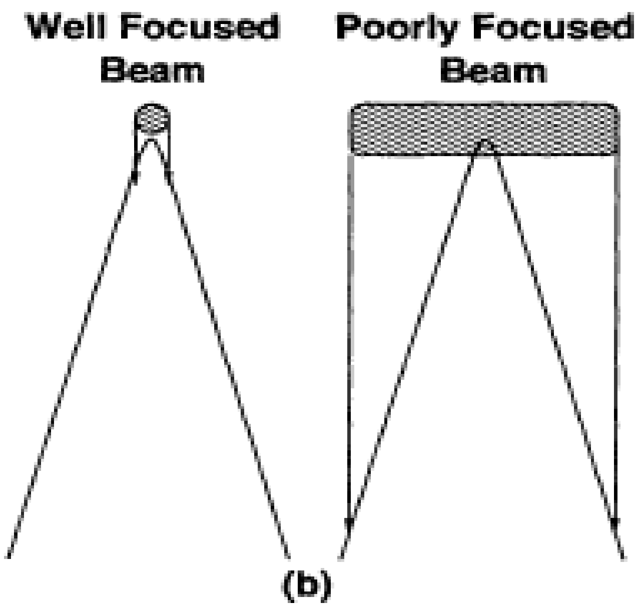
Table 1: 22 GHz multi-feed receiver characteristics

Inner Diameter of the horns	68.8 mm
Outer Diameter of the horns	98.0 mm
Distance between two adjacent horns	100.0 mm
Tsys (El=45°)	75 K (Opacity = 0.1)
Gain (El = 45°)	0.12 K/Jy (Simulated value for central beam)
Gain (El=45°)	0.11 K/Jy (Simulated value for lateral beams)
HPBW	92" (each beam)
Sky distance between two adjacent beams	215"
Output channels	14 (7 LCP + 7 RCP with 2 GHz-wide IF bands)

Why pointing is so important



Pointing errors



Poor focus of telescope

A pointing offset and poor focus degrades the SNR of object

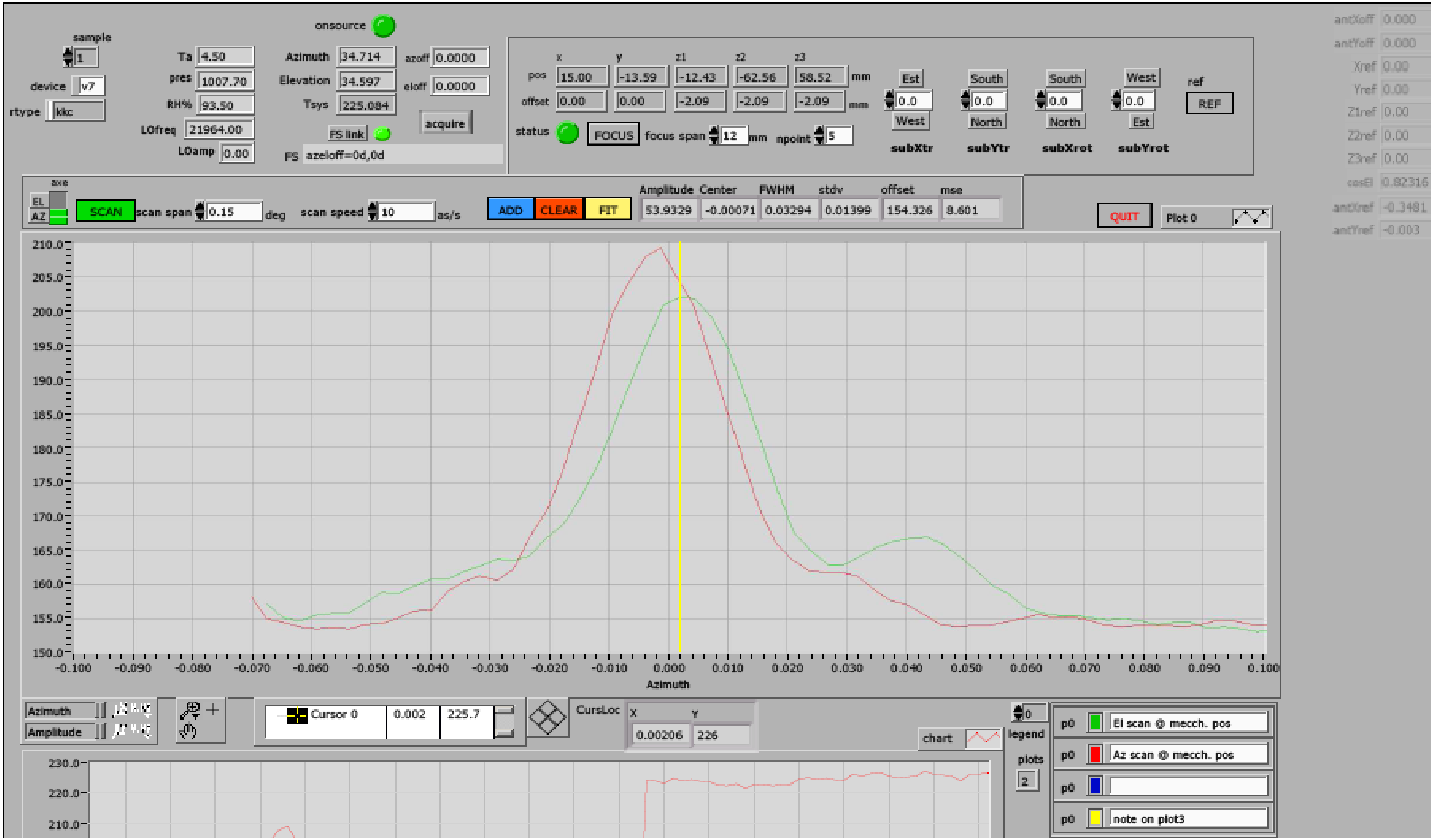
Test measurements

To determine pointing accuracy

- Performed cross scans across W3OH with mechanically determined optical alignment

- W3OH is a maser & bright @ 22 GHz

Conti...



Optics is not aligned properly

Conti...

Questions arises :

- How to maximize the power in main beam
- How to reduce side lobes

Solution :

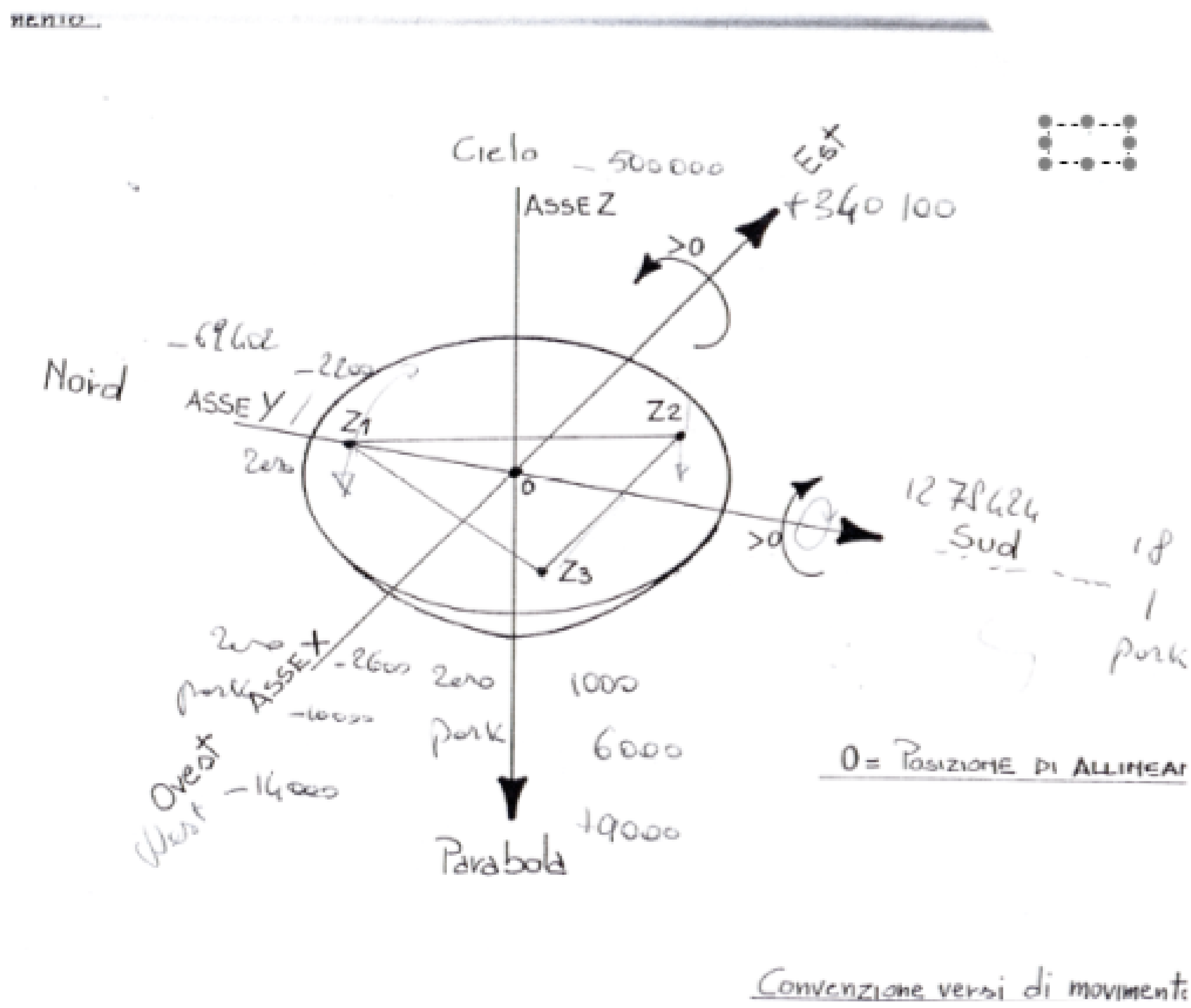
- Align primary mirror, secondary mirror and feed properly

Conti...

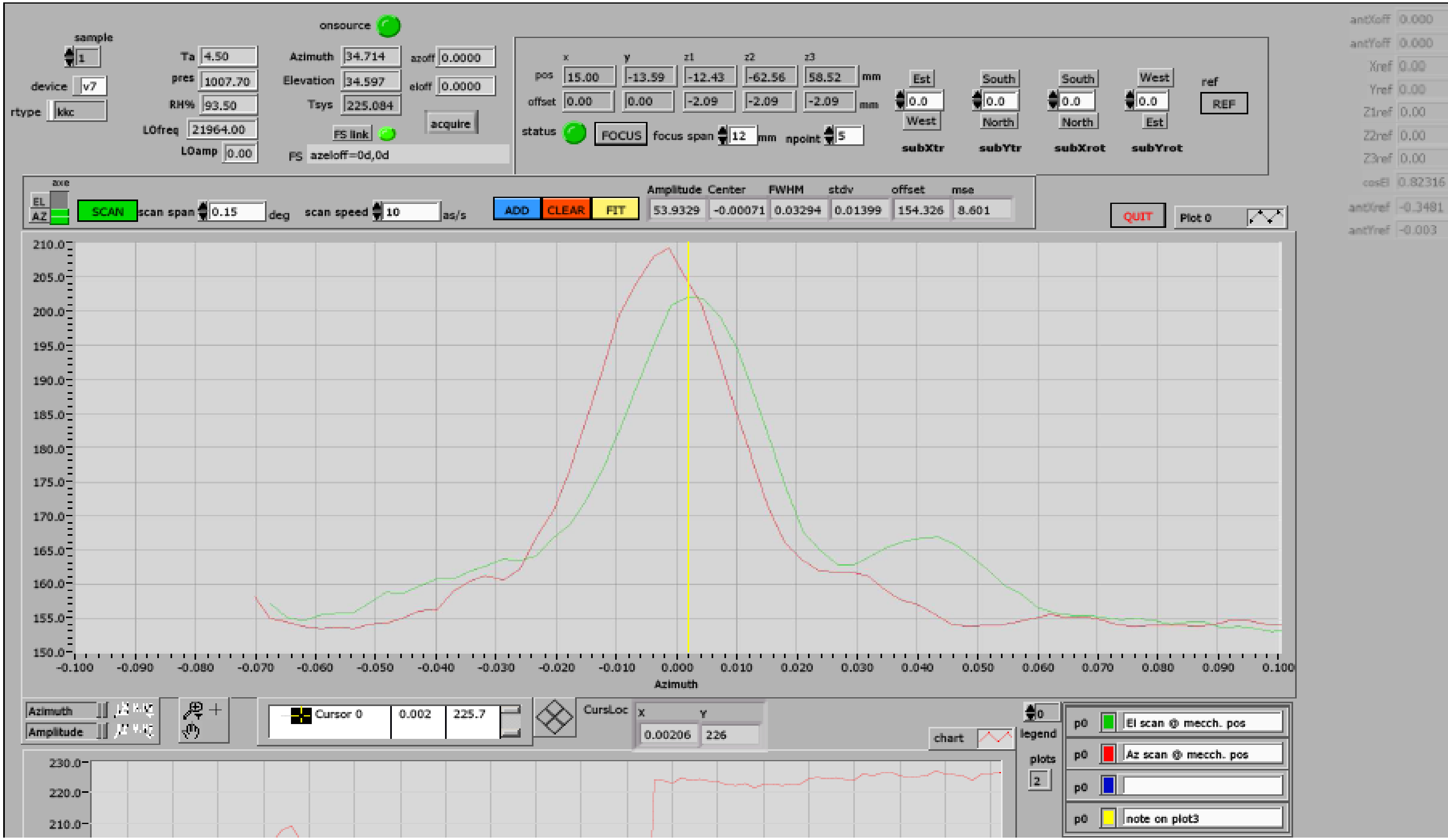
- Mfeed is mounted in the secondary focus
- Adjust subreflector to align optics

  Subreflector 5 degrees of freedom for movement
- 2 degrees in translation (X & Y axes)
- 3 degrees for Tilt & focus (parameters: z1;z2;z3)
- z2 = z3, z1 = -2 z2

Subreflector geometry

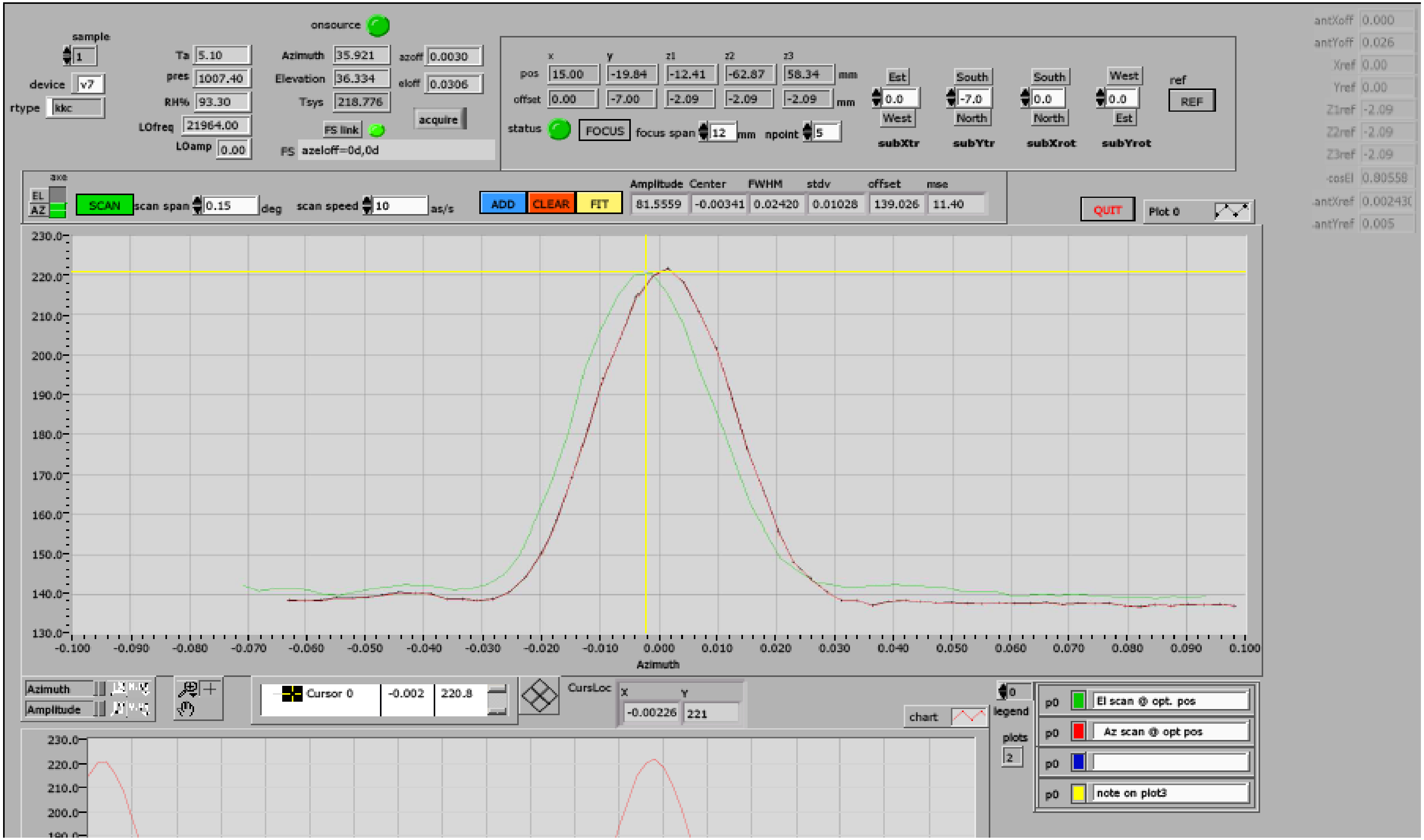


Results



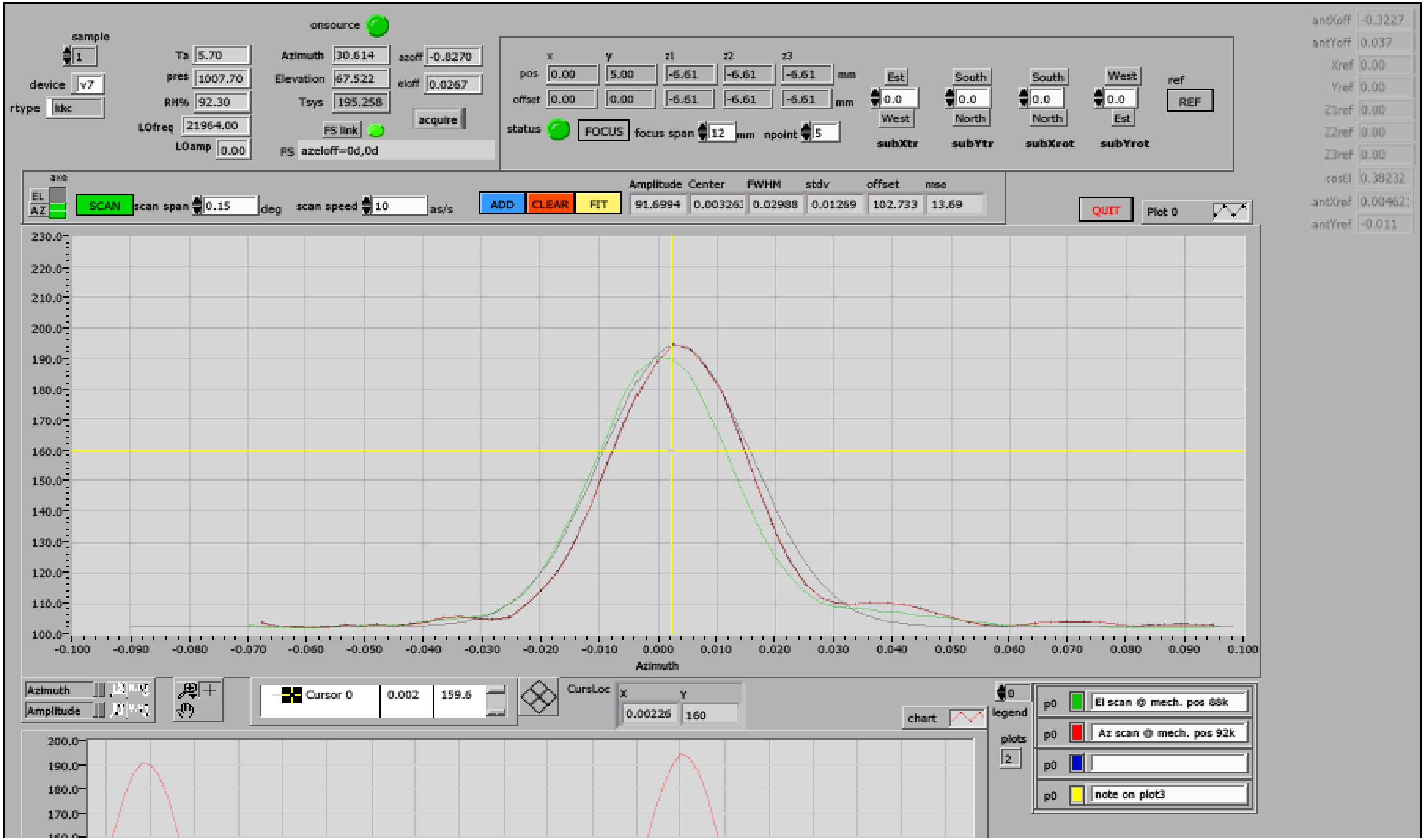
W3OH @ elv = 33 with mechanically determined optical alignment
Tsys = 54K

results conti...



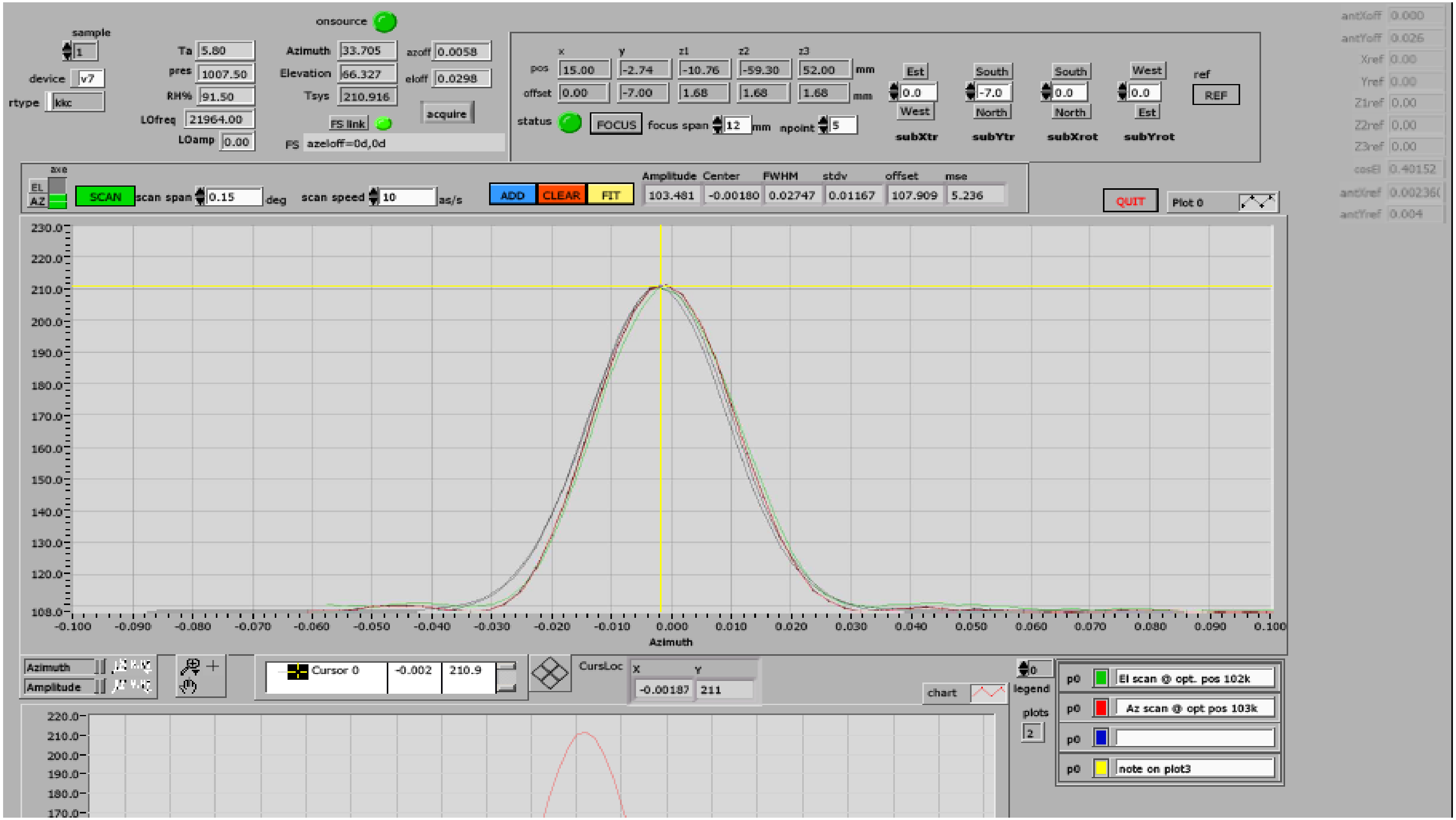
W3OH @ elv = 36 with optimized optical alignment
Tsys = 81K

results conti...



W3OH @ elv = 67 with mechanically determined optical alignment
Tsys = 88K

results conti...

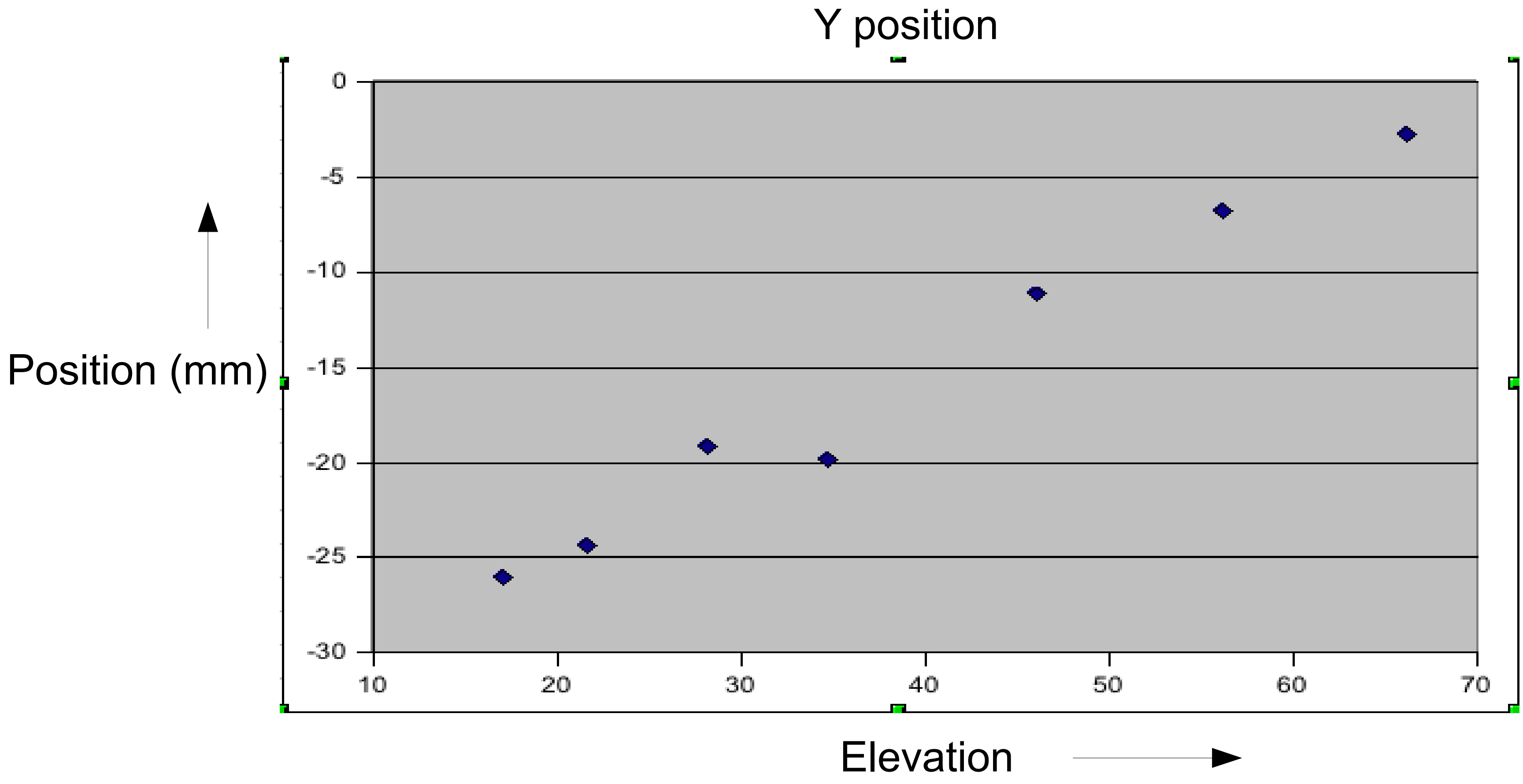


W3OH @ elv = 66 with optimized optical alignment

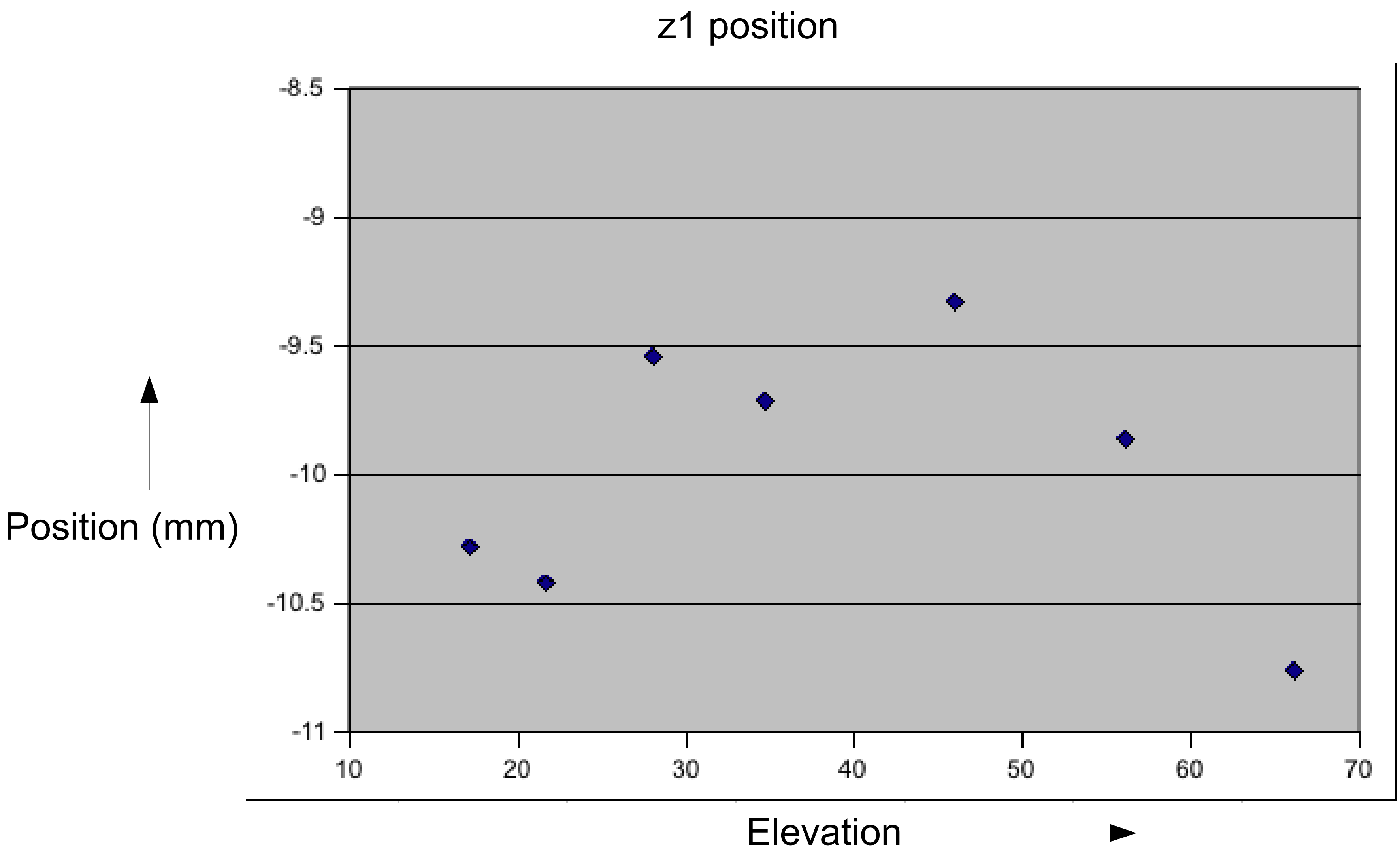
Tsys = 102K

Subreflector parameters

- User will be provided with subreflector parameter vs elevation for optimized optical alignment
- X = 15mm (constant)

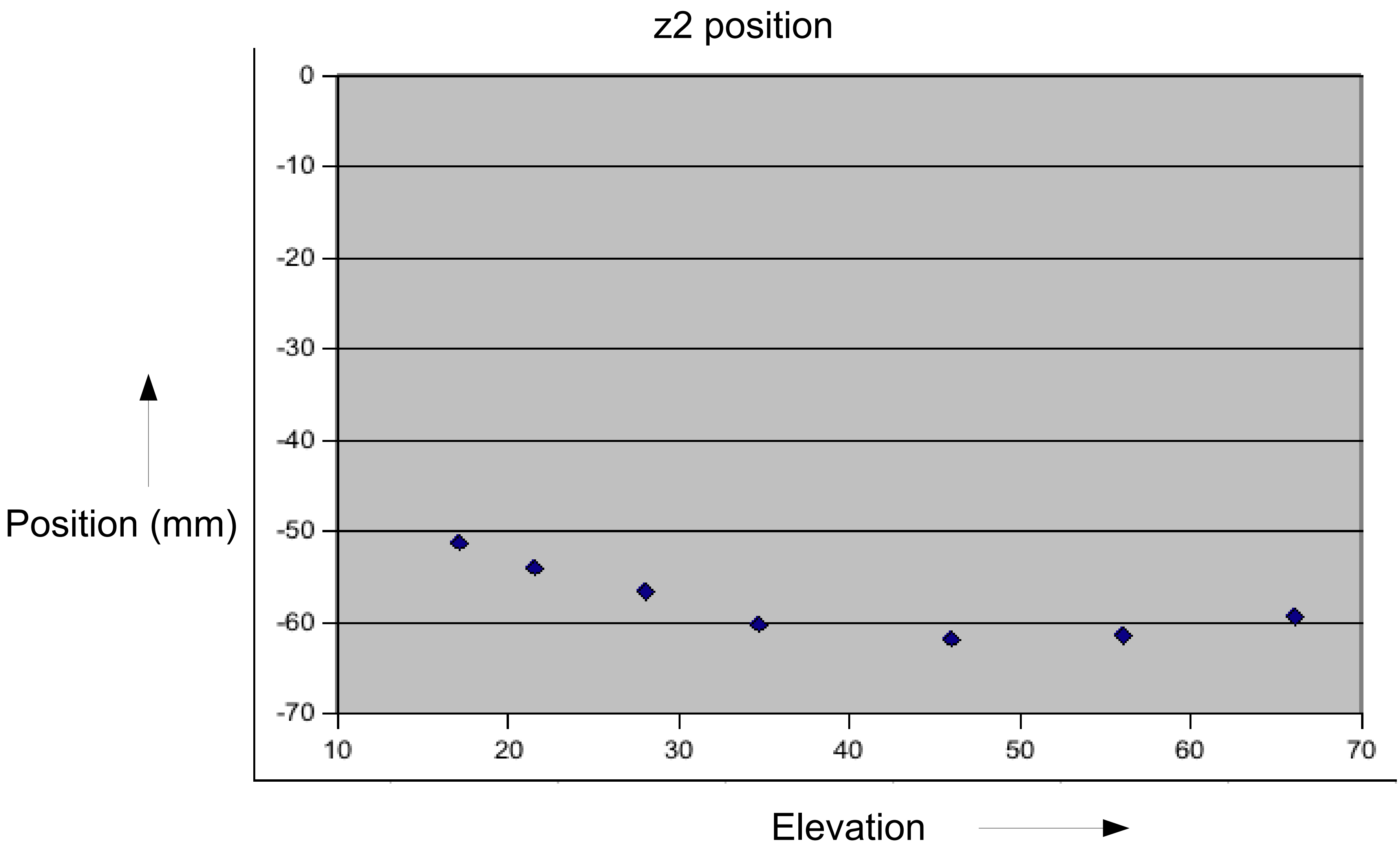


Conti...

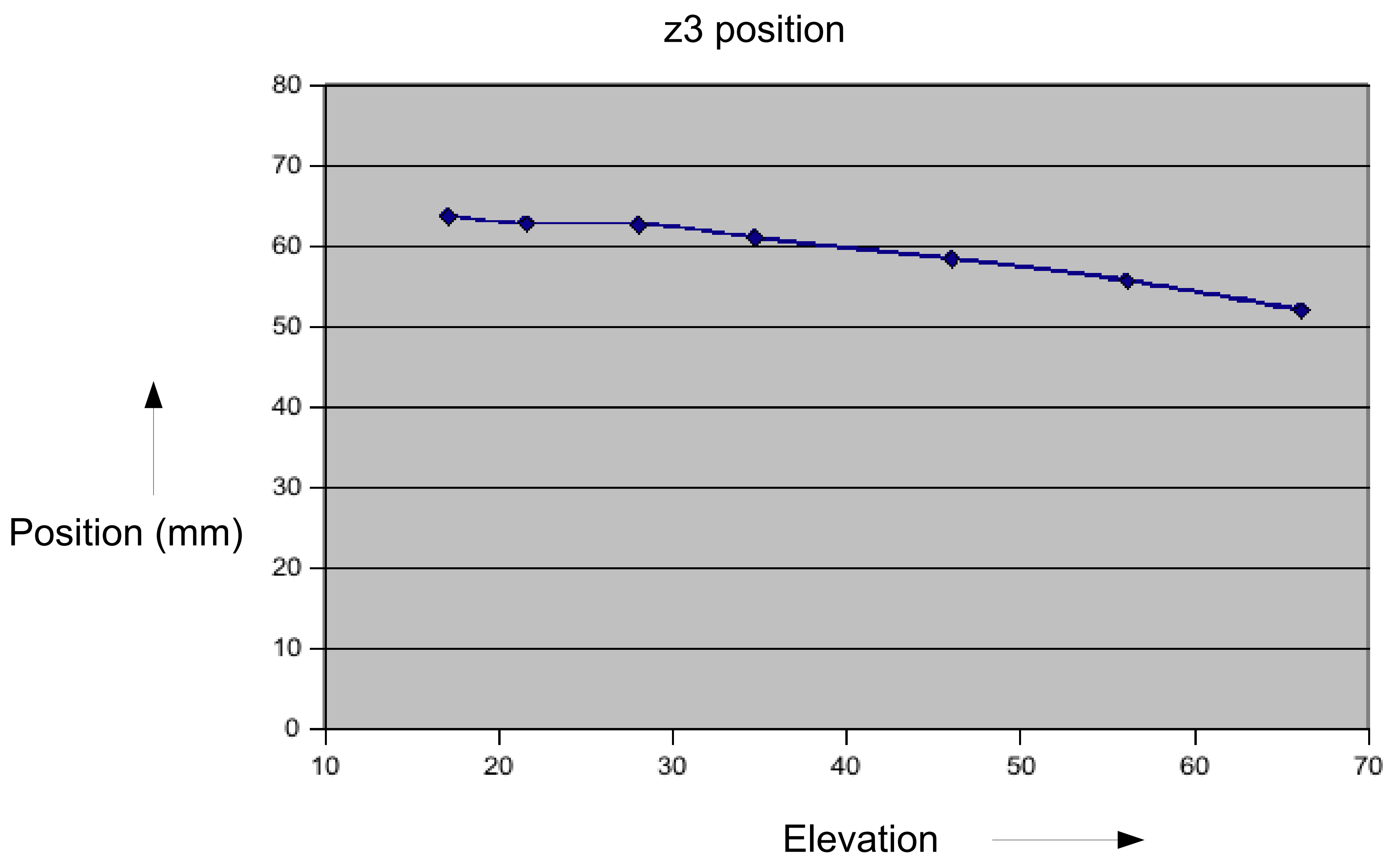


z1 position
-8.5
-9
-9.5
-10
-10.5
-11
10
20
30
40
50
60
70
Position (mm)
Elevation

Conti...


z2 position
0
-10
-20
-30
-40
-50
-60
-70
10
20
30
40
50
60
70
Position (mm)
Elevation

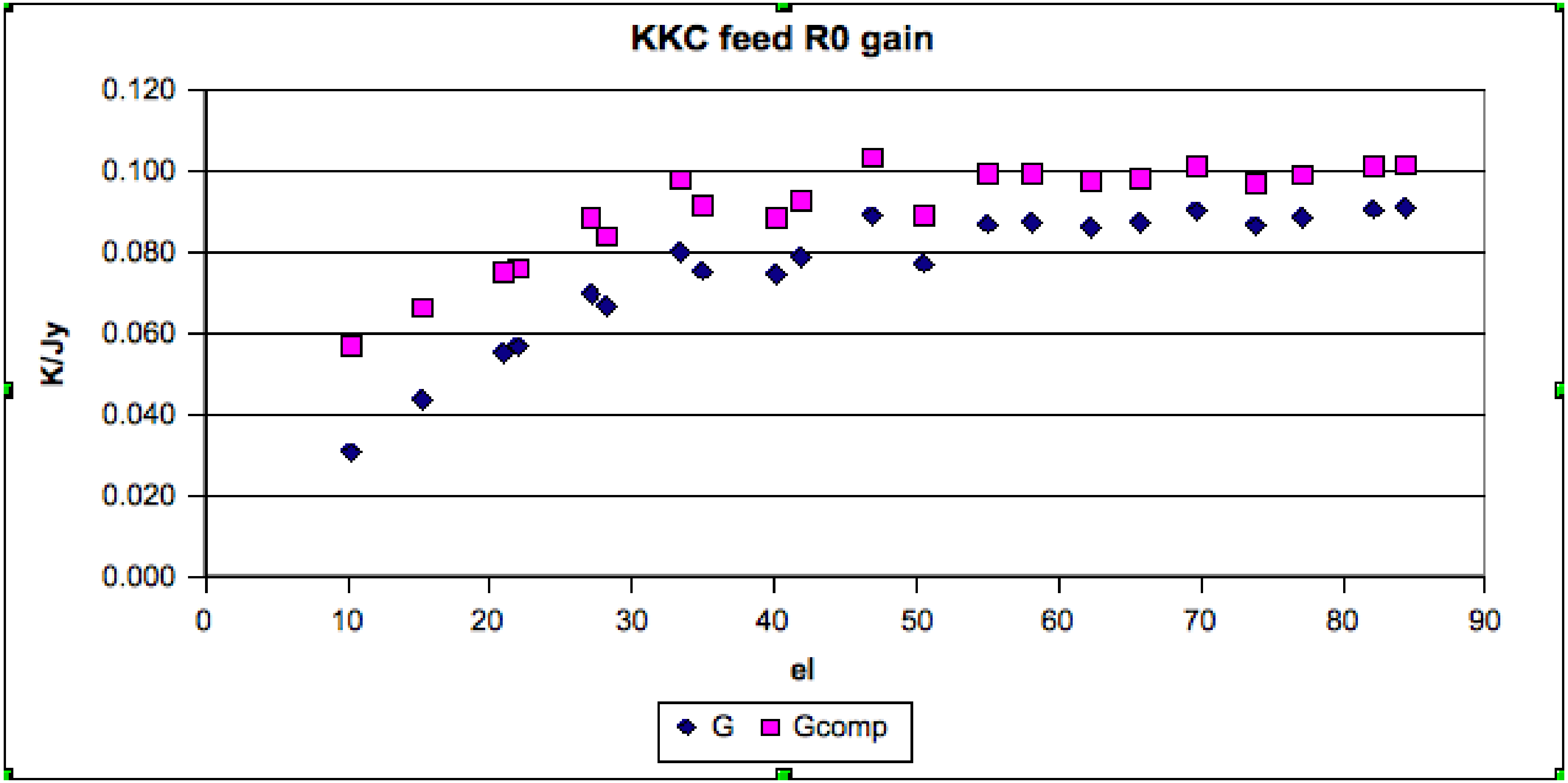
Conti...



z3 position
80
70
60
50
40
30
20
10
0
10
20
30
40
50
60
70
Position (mm)
Elevation

Results conti...

- Antenna gain measured on DR21 for central feed



Blue diamonds : raw data
Pink squares: corrected for opacity

Summary

- 15 – 20 % increase in total power relative to mechanically determined optical alignment
- Reduced side lobes
- New sub reflector model
- Refined the existing pointing model
- Antenna gain @ elevation 45 = 0.1K/Jy for central beam (in agreement with the simulated value)

Future plan

- Some more observation to get sub reflector parameter polynomials
- Calibrate lateral feeds