Determination of the Pointing Offsets and Beam Pattern for the 4-m Telescope

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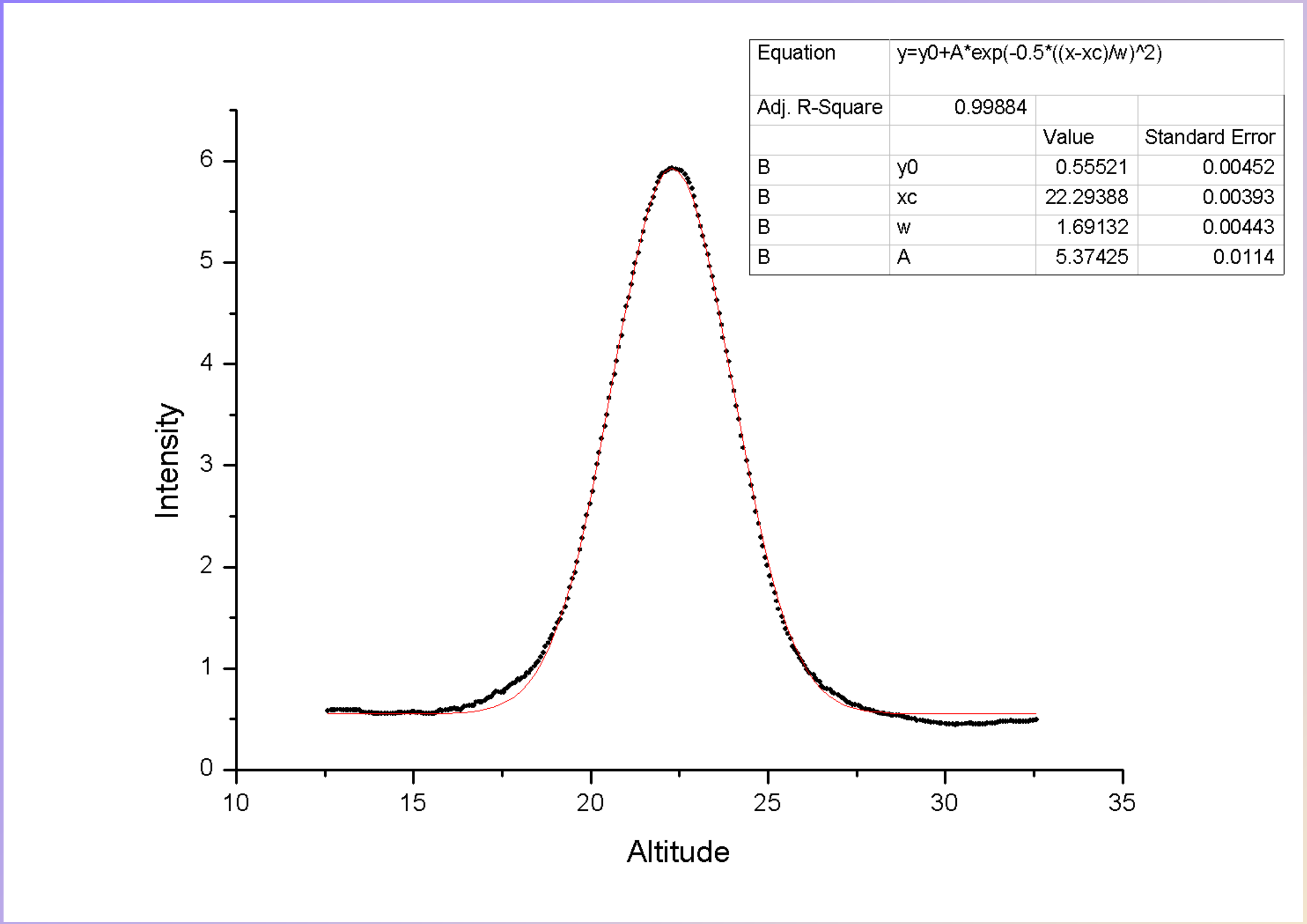
INTRODUCTION

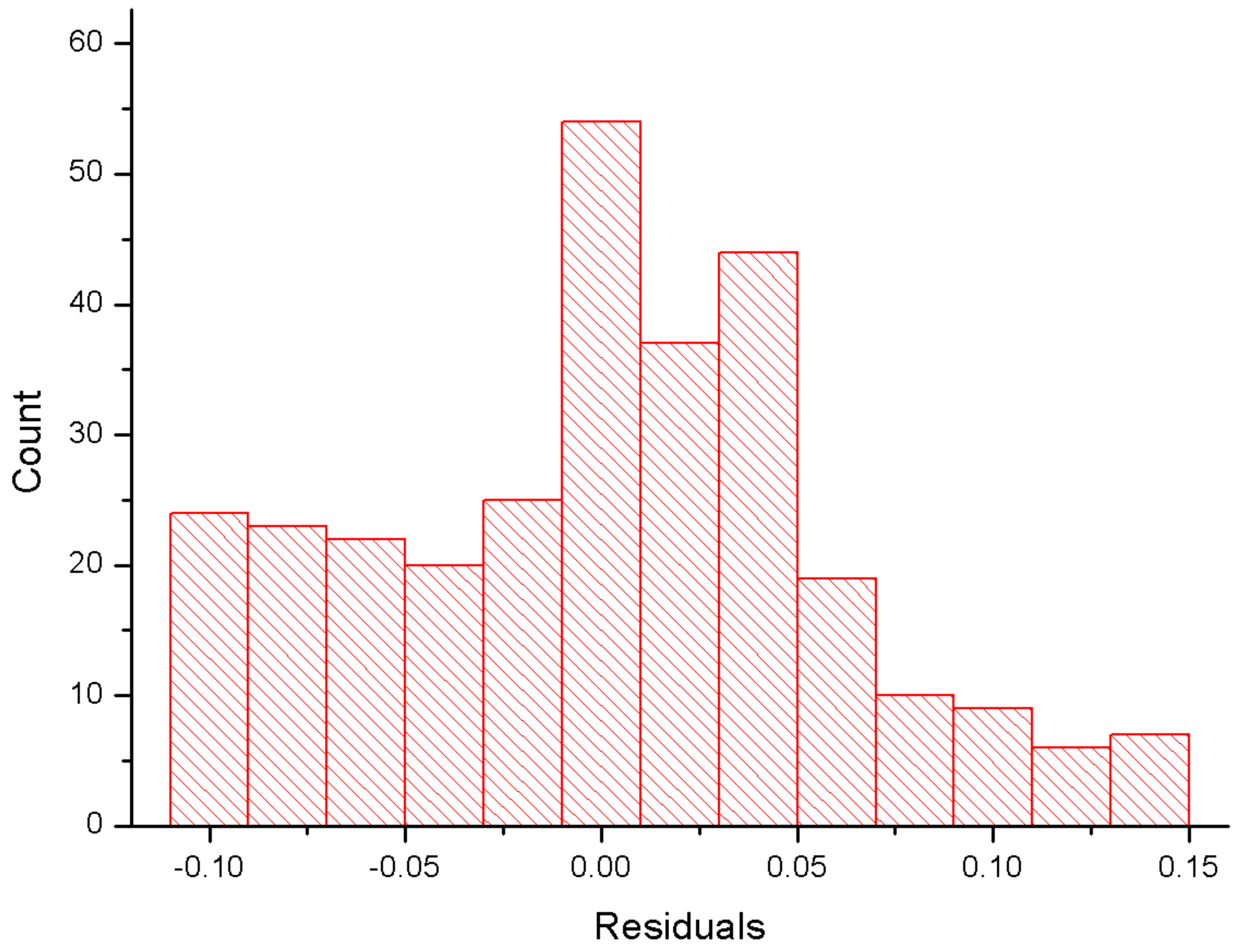
The aim of the experiment is to align the 4-m telescope at NCRA East campus with the proper ALT/AZ coordinate system allowing it to be pointed to a given astronomical source. This requires determining the offsets between the electronic reference of the telescope and the astronomical ALT/AZ coordinate system at the observatory.

servations and Analysis

Fitting Gaussian to the intensity plots

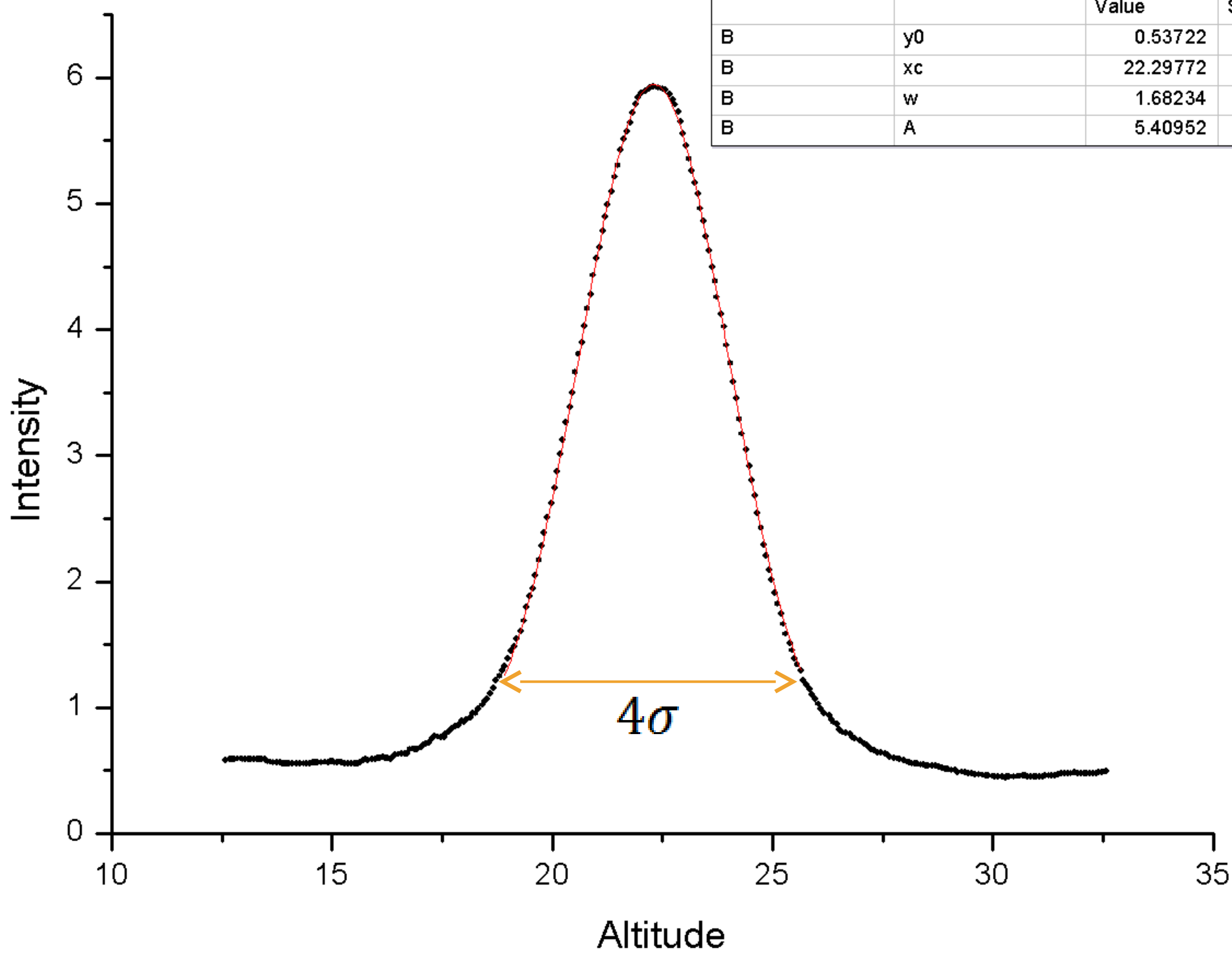


Plotting the distribution of residuals

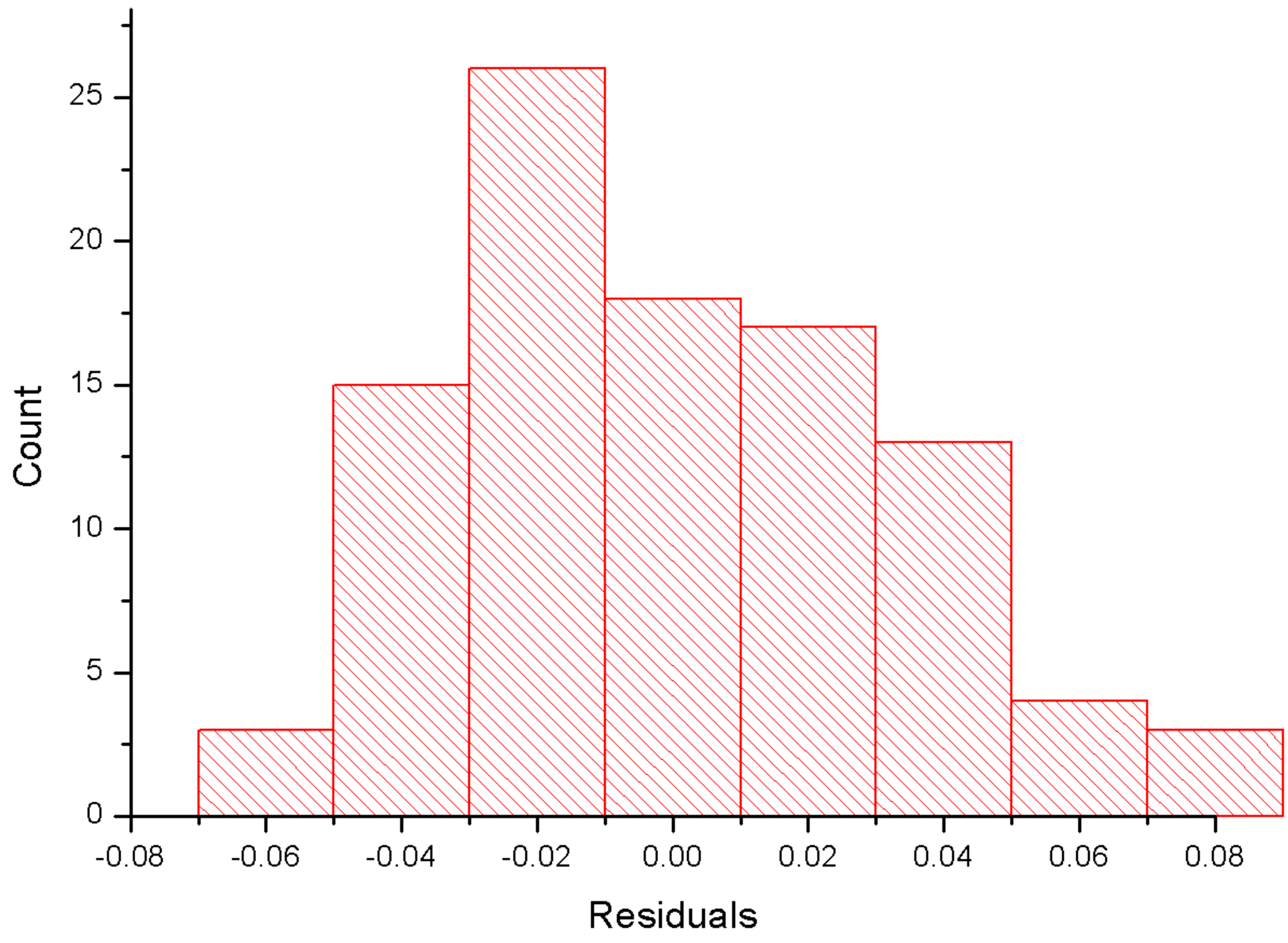


Plotting with data points in $mean \pm 2\sigma$

Equation	y=y0+A*exp(-0.5*((x-xc)/w)^2)		
Adj. R-Square	0.99956		
		Value	Standard Error
B	y0	0.53722	0.02587
B	xc	22.29772	0.00224
B	w	1.68234	0.00838
B	A	5.40952	0.02356



A better plot of residuals...



We have measured the altitude and azimuth of some at specific times. Now we need to find the actual altitude and azimuth to get the offset…

Calculations in Mathematica

```
<< Calendar`

JD1 := DaysBetween[{2009, 2, 1}, {2012, 12, 21}, Calendar → Gregorian] + 2 454 863.5

(* az1→ 3.60583, az2→ 3.64528, az4→ 4.22944, el1→ 3.83222, el2→ 3.86194, el3→ 4.11167, el4→ 4.12*)

UT = 4.22944;                                                RAS = 18.0208;
                    ϕ = (18.5607 × π)/180;                   DECS = (-23.4353) * Pi / 180;

GMST1 := Mod[6.656306 + 0.0657098242 * (JD1 - 2 445 700.5) + 1.0027379093 * UT, 24]

LMST1 := Mod[GMST1 + 73.82/360 × 24, 24]

HAS := Module[{temp = LMST1 - RAS},
   If[temp ≤ -12, temp = temp + 24, temp = temp]; If[temp > 12, temp = temp - 24, temp = temp];
   temp] * Pi / 12

ALTS := ArcSin[Sin[DECS] Sin[ϕ] + Cos[DECS] Cos[ϕ] Cos[HAS]] * 180 / Pi

AZMS := Module[{tempALT = (ALTS × π)/180},
       sinVals = -(Sin[HAS] Cos[DECS])/(Cos[tempALT]);
       cosVals = (Sin[DECS] - Sin[ϕ] Sin[tempALT])/(Cos[ϕ] Cos[tempALT]);

          invVals = If[cosVals < 0, π - ArcSin[sinVals], ArcSin[sinVals]];
          invVals = If[invVals < 0, 2 π + invVals, invVals];
          invVals
          ] × 180 / π
```

Calculated Offsets

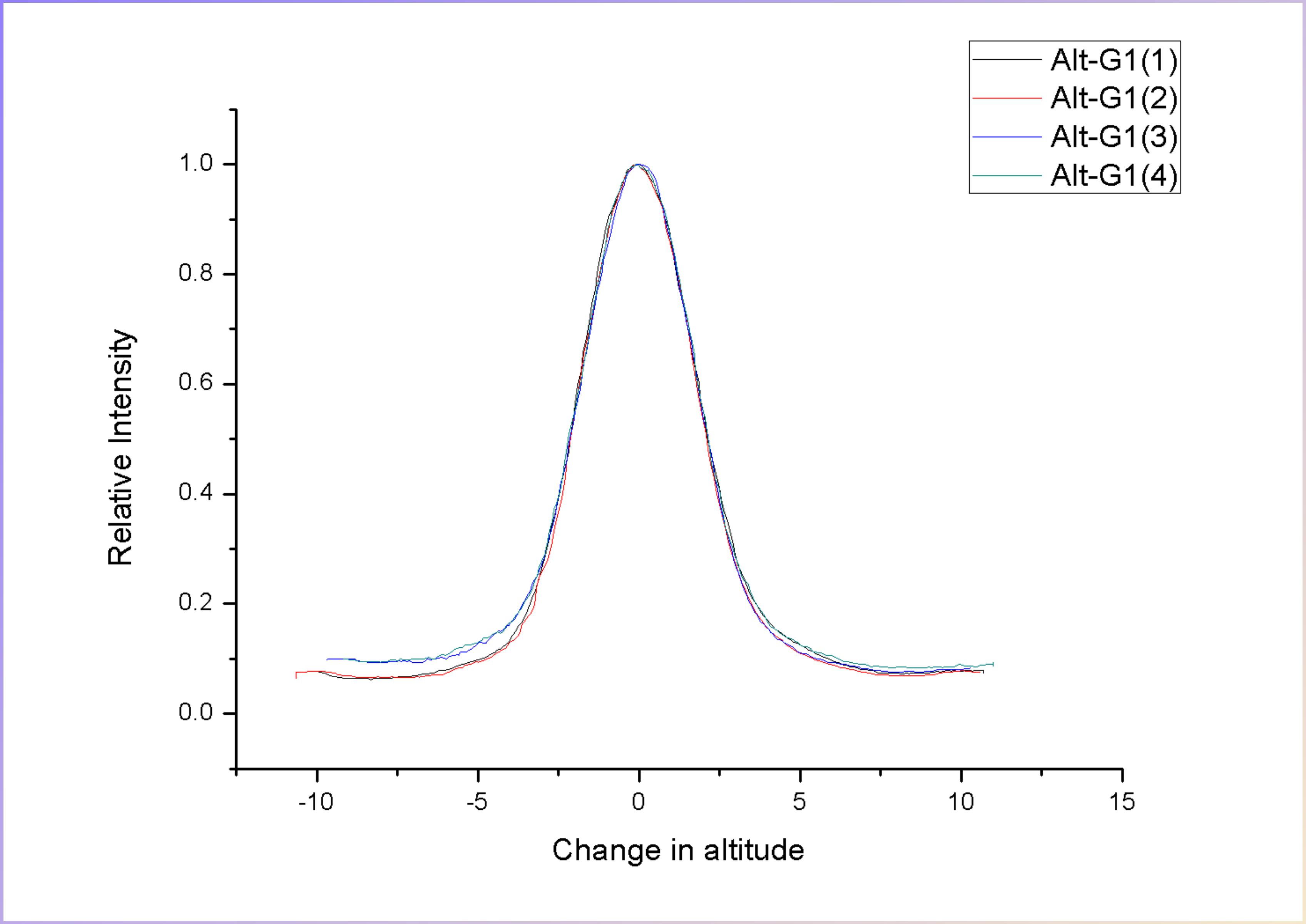
Results:		Actual	Measured	Offset	Avg	Deviation	Squared Deviation	Standard Deviation
Az	1	123.31	127.43	4.12	4.4833	0.3633	0.1320	0.4252
	2	123.53	127.78	4.25		0.2333	0.0544	
	3	128.33	133.41	5.08		-0.5967	0.3560	
Alt	1	26.44	22.30	-4.14	-4.5175	-0.3775	0.1425	0.4296
	2	26.77	21.73	-5.04		0.5225	0.2730	
	3	29.46	25.41	-4.05		-0.4675	0.2186	
	4	29.55	24.71	-4.84		0.3225	0.1040	

Moving to beam-width of the telescope

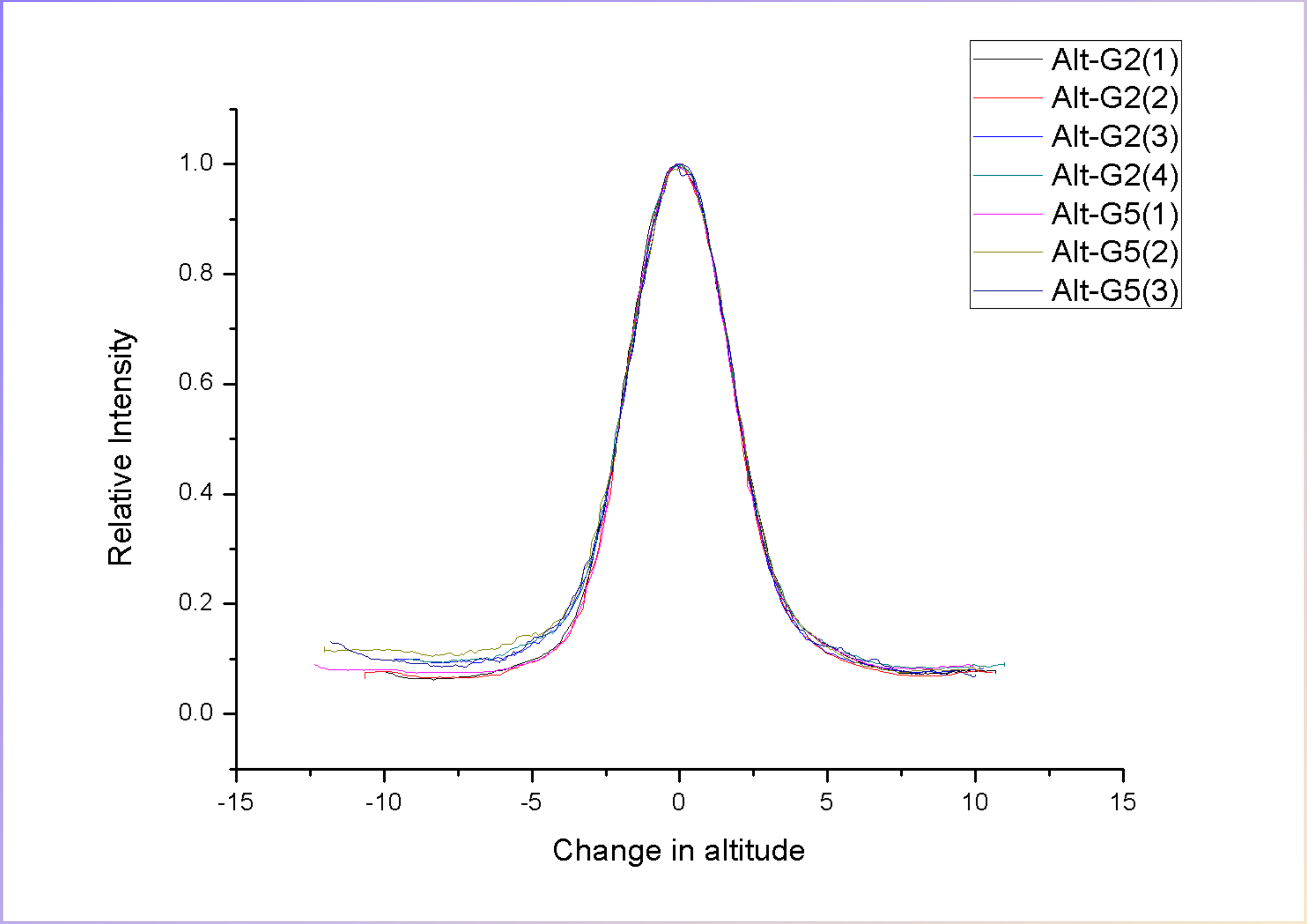
- Beamwidth = FWHM ~ 2.35 σ

- But how do we know our data is consistent?

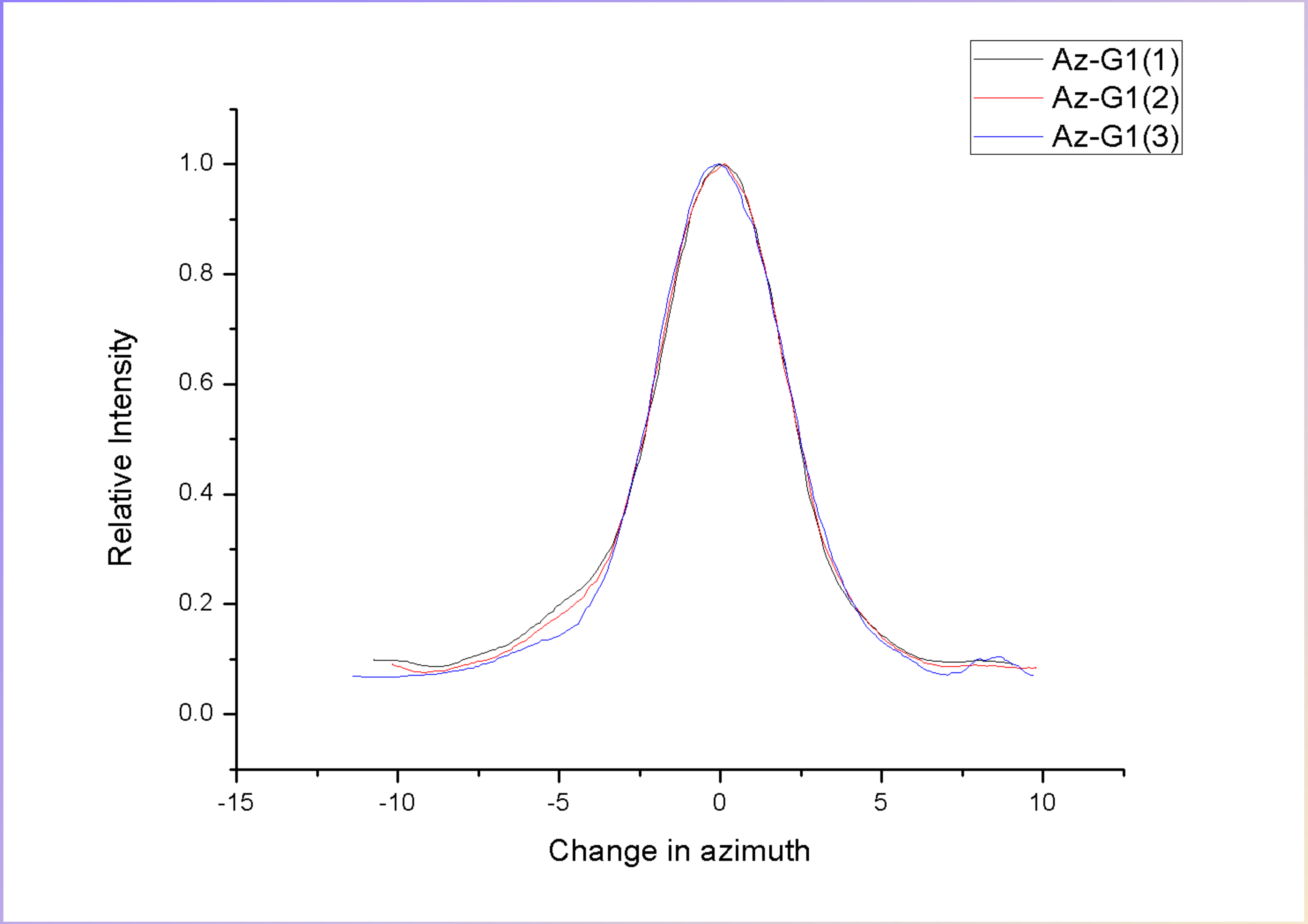
Overlapping the altitude scans



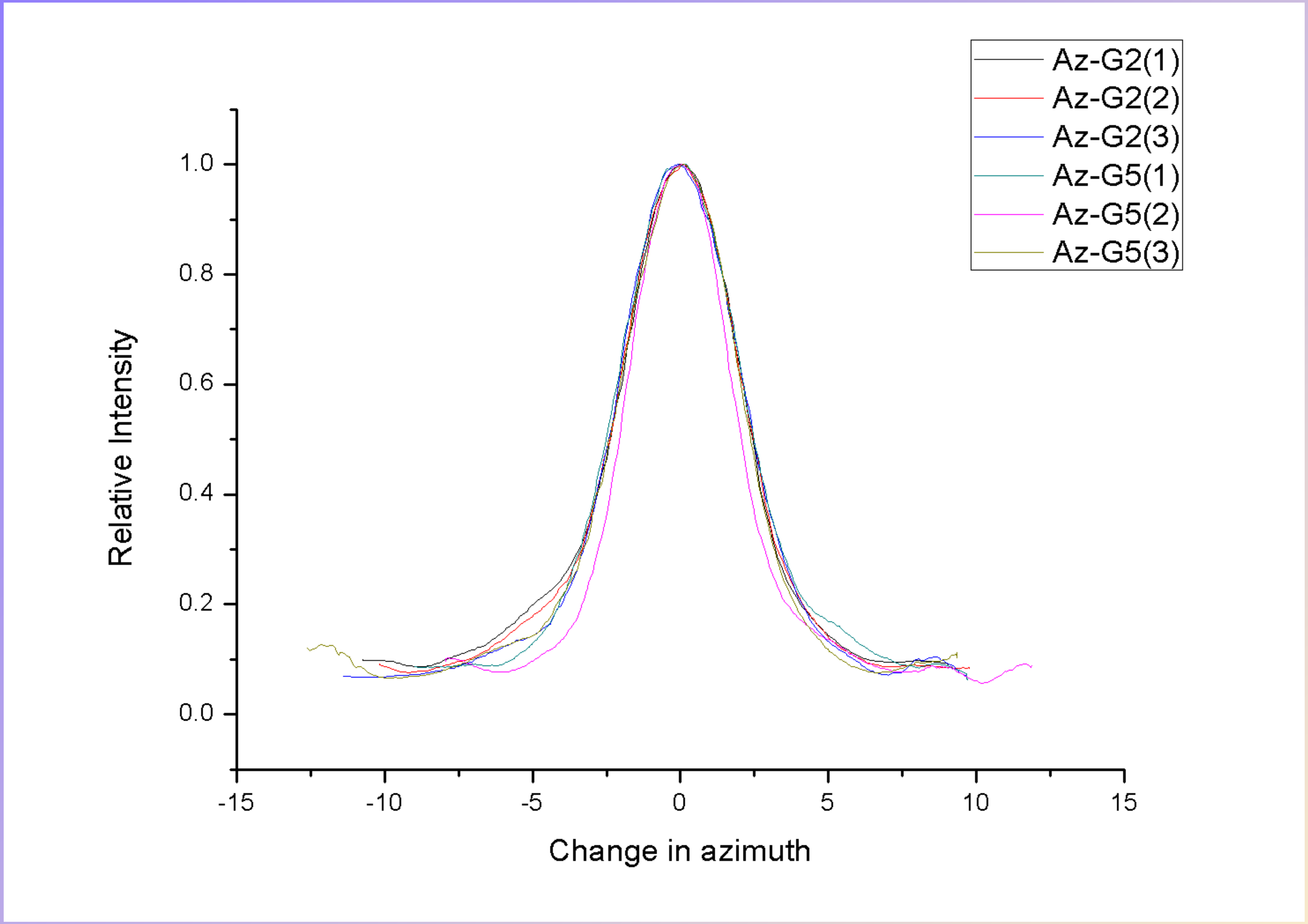
Even further !!



Repeating for azimuth scans...



Repeating for azimuth scans...



Calculating FWHM (Beam Width)

FWHM	1	2	3	Average	Standard Deviation
Azimuth	4.5326	4.6099	4.6650	4.6025	0.0941
Altitude	3.9746	3.9487	4.0505	3.9913	0.0748

Results from group 5 –

- FWHM for azimuth scan: 4.6120
- FWHM for altitude scan: 3.9995

$$Expected\ value\ of\ beam\ width = \frac{\lambda}{D} = \frac{21}{400} \times \frac{180}{\pi} = 3.0080$$

Sources of Errors

- Nearby radio sources in the sky.
- Radio signals from man made sources nearby the telescope.
- Reflected radio wave from the surface of earth/ walls/ trees.
- Non uniform/ broken wire mesh.

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