Green Bank Telescope Sub-reflector Stabilization Concepts (Wind)

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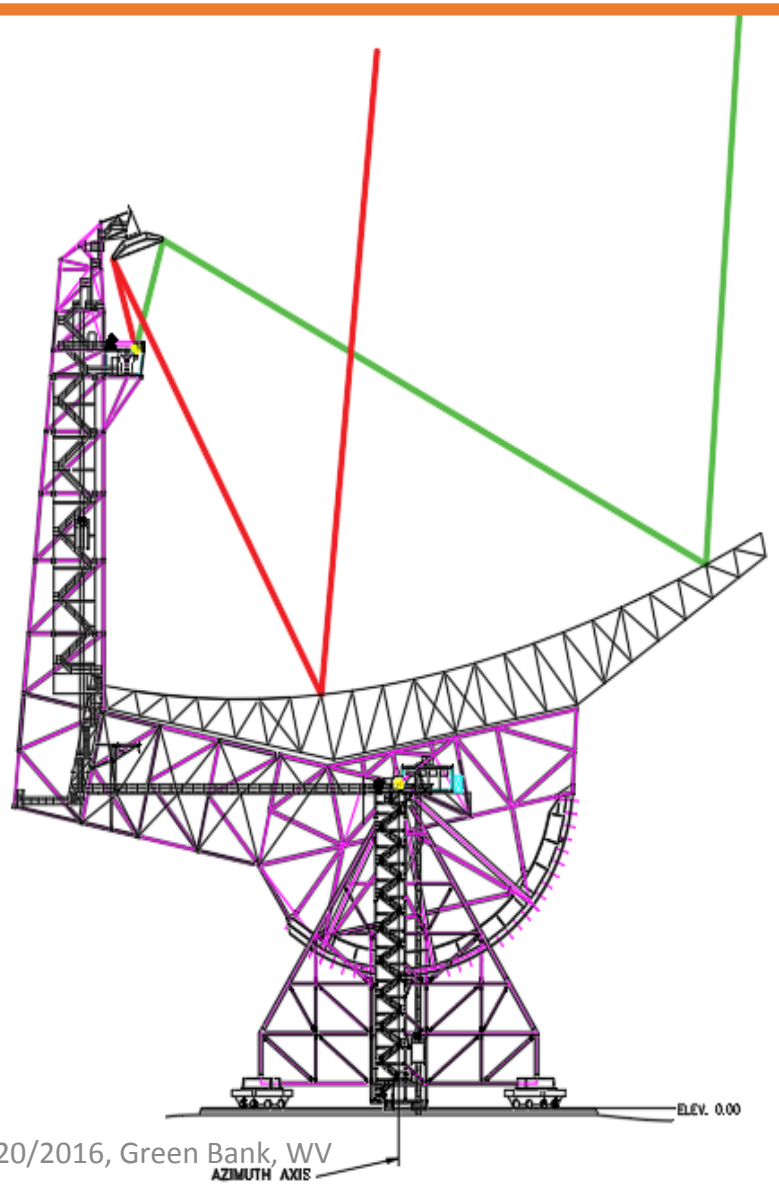
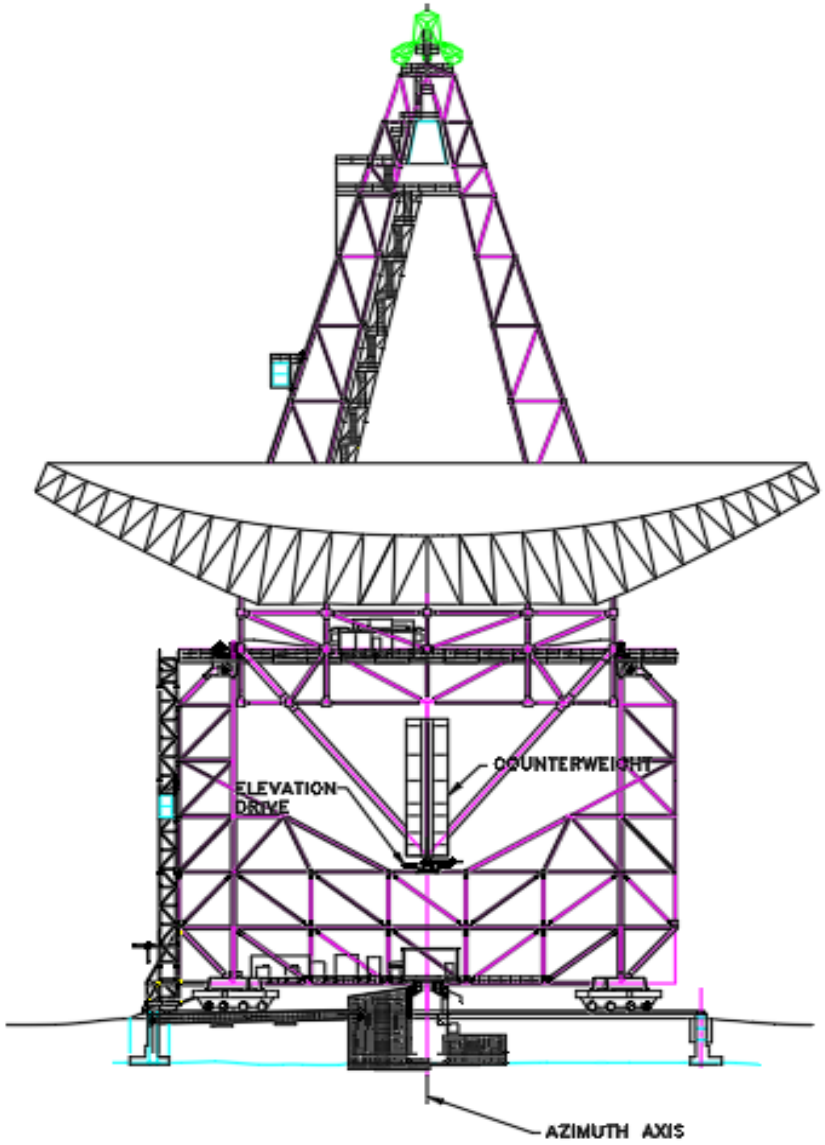
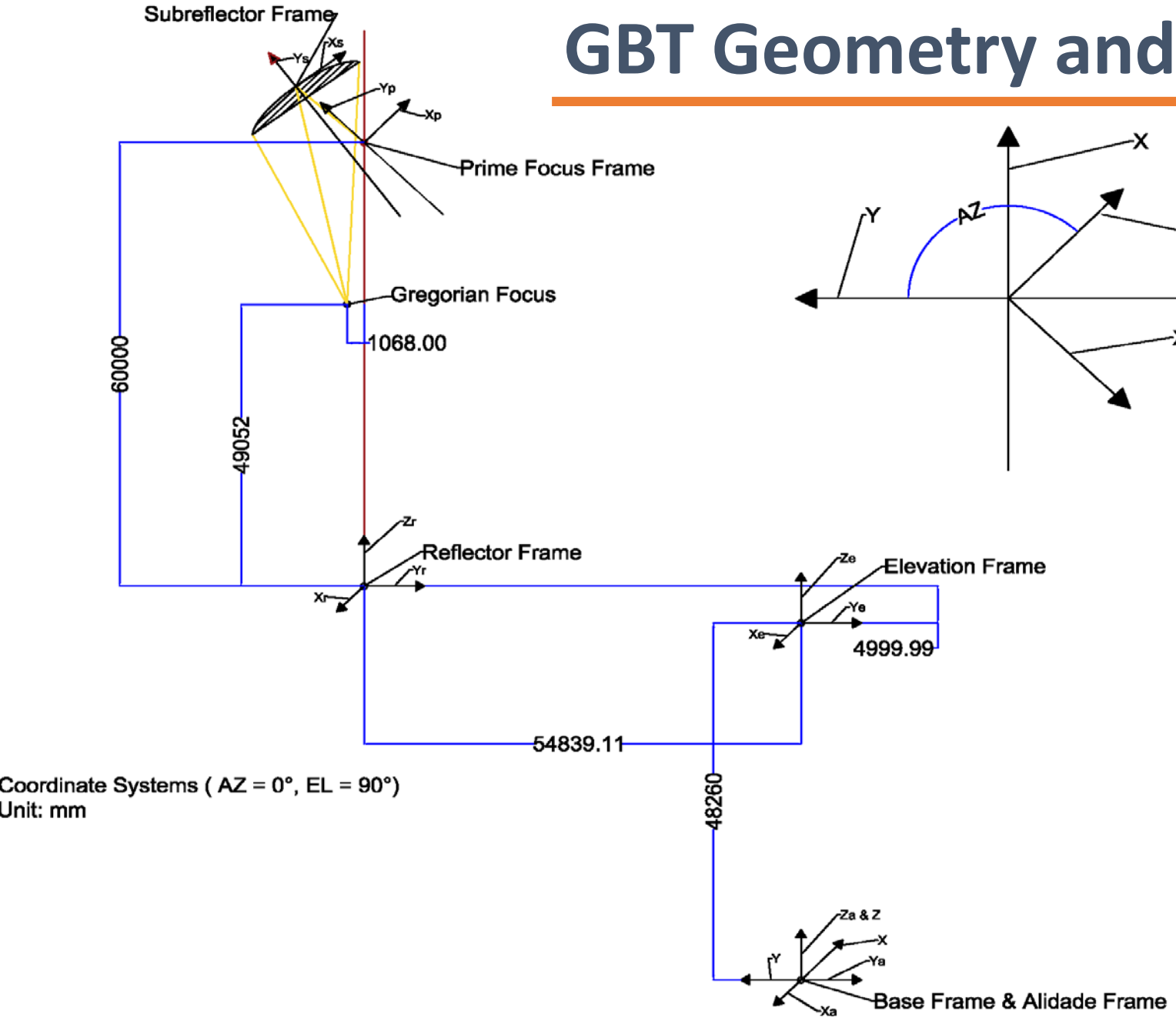
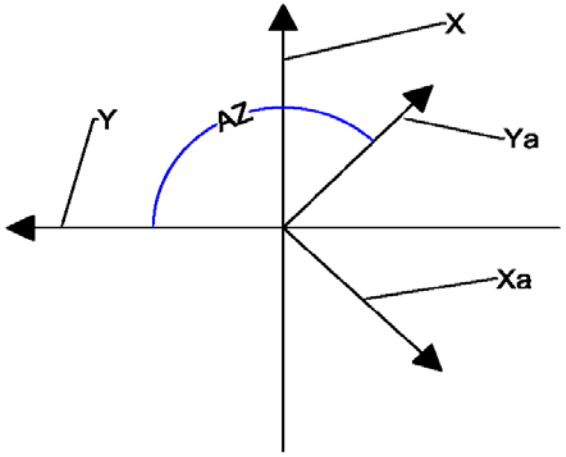
GBT Geometry and Coordinate





GBT Geometry and Coordinate





- **Frame #1**

The Base Frame.
Unit Frame Vectors: X, Y, Z

- **Frame #2**

The Alidade Frame.
Origin Point-Ad
Unit Frame Vectors: Xad, Yad, Zad

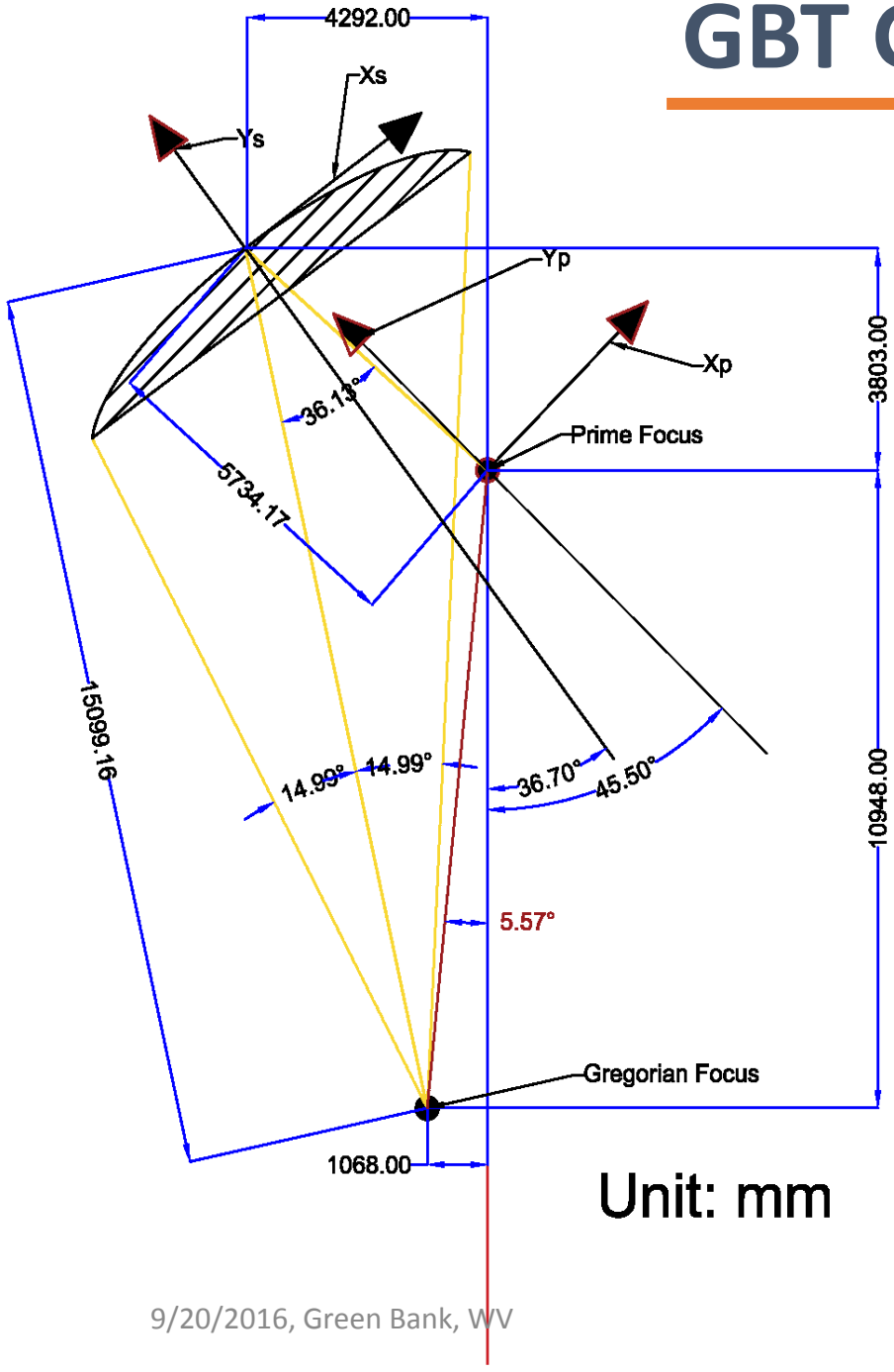
- **Frame #3**

The Elevation Frame.
Origin Point-Ed
Unit Frame Vectors: Xed , Yed , Zed

- **Frame #4**

The Reflector Frame.
Origin Point-Rd
Unit Frame Vectors: Xrd, Yrd, Zrd

GBT Geometry and Coordinate



- **Frame #5**

The Prime Focus Frame.
Origin Point-Pd
Unit Frame Vectors: Xpd, Ypd ,Zpd

- **Frame #6**

The Sub-reflector Frame.
Origin Point-Sd
Unit Frame Vectors: Xsd , Ysd ,Zsd

- **Frame #9**

The Receiver House Frame.
Origin Point-Hd
Unit Frame Vectors: Xhd, Yhd ,Zhd

Sub-Reflector Platform

6 Linear Actuator

- 3 In Ys Axis Direction
- 2 in Xs Axis Direction
- 1 in Zs Axis Direction

Name	Travel Range (mm)
Y1	2540 ~ 3454.4
Y2	2489.2 ~ 3403.6
Y3	2489.2 ~ 3403.6
X1	2819.4 ~ 4013.2
X2	2819.4 ~ 4013.2
Z1	1473.2 ~ 1955.8

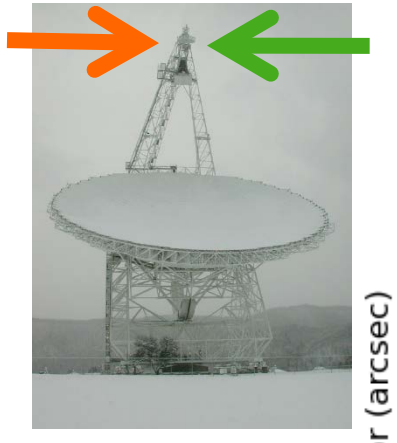
Final Goal

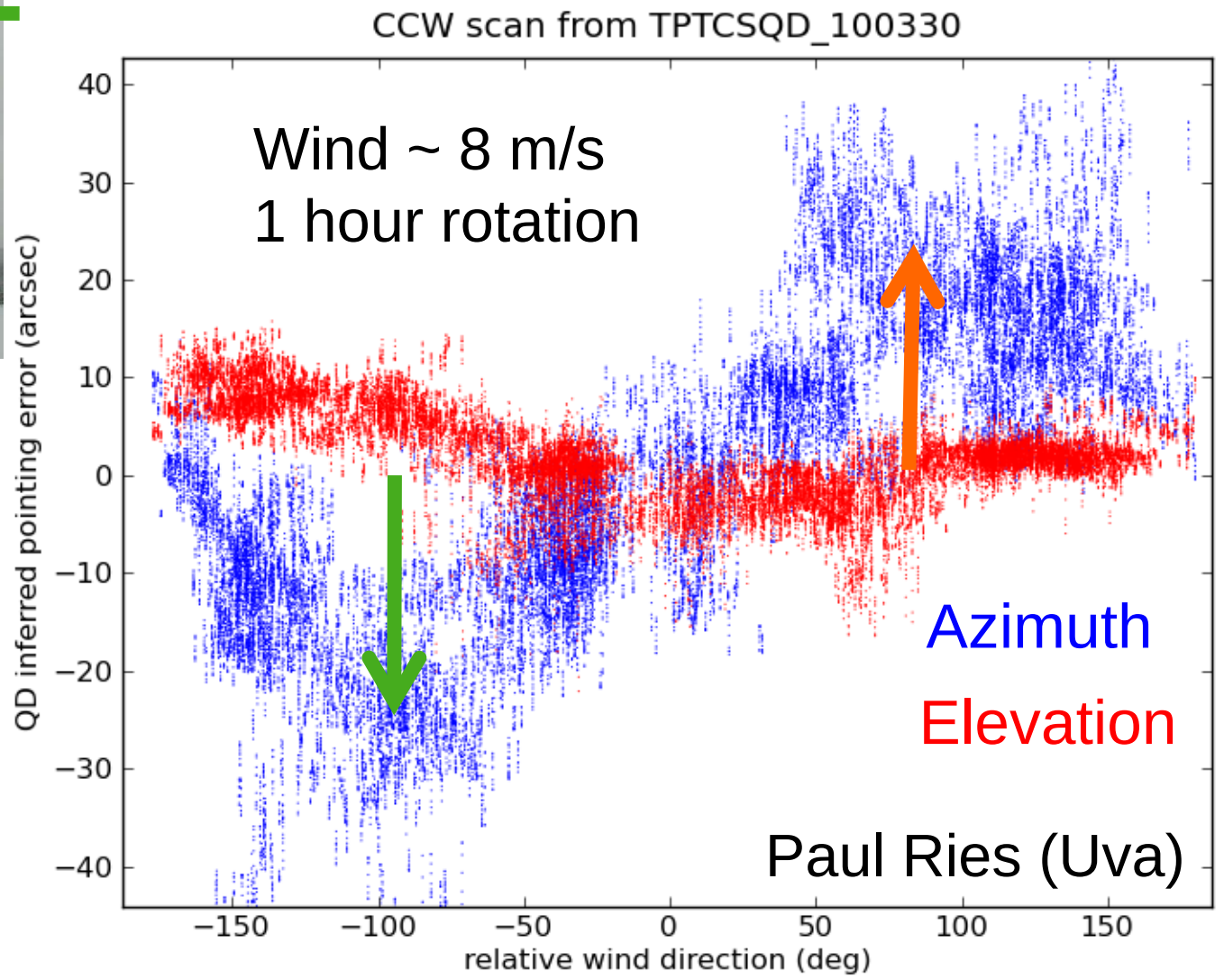
Table.1. Acceptable pointing error.

GBT Point Error	5'' (Useful)	1.83"(Good)	1"(Better)	0.23"(Best)	0.1"(Ultimate)
Xs in EL	1.35 mm	0.49 mm	0.27 mm	0.06 mm	0.030 mm
Zs in Cross EL	1.29 mm	0.47 mm	0.25 mm	0.05 mm	0.026 mm
Zt	28.9"	10.6"	5.8"	1.3"	0.28"
Xt	35.2"	12.9"	7.0"	1.6"	0.70"

- The Frame # 6; Table data are in Sub-reflector frame.
- First Line is the Error of the GBT Point Error
- 5 level Requirement from "Useful" to "Ultimate"
- Unit is mm and arc Second

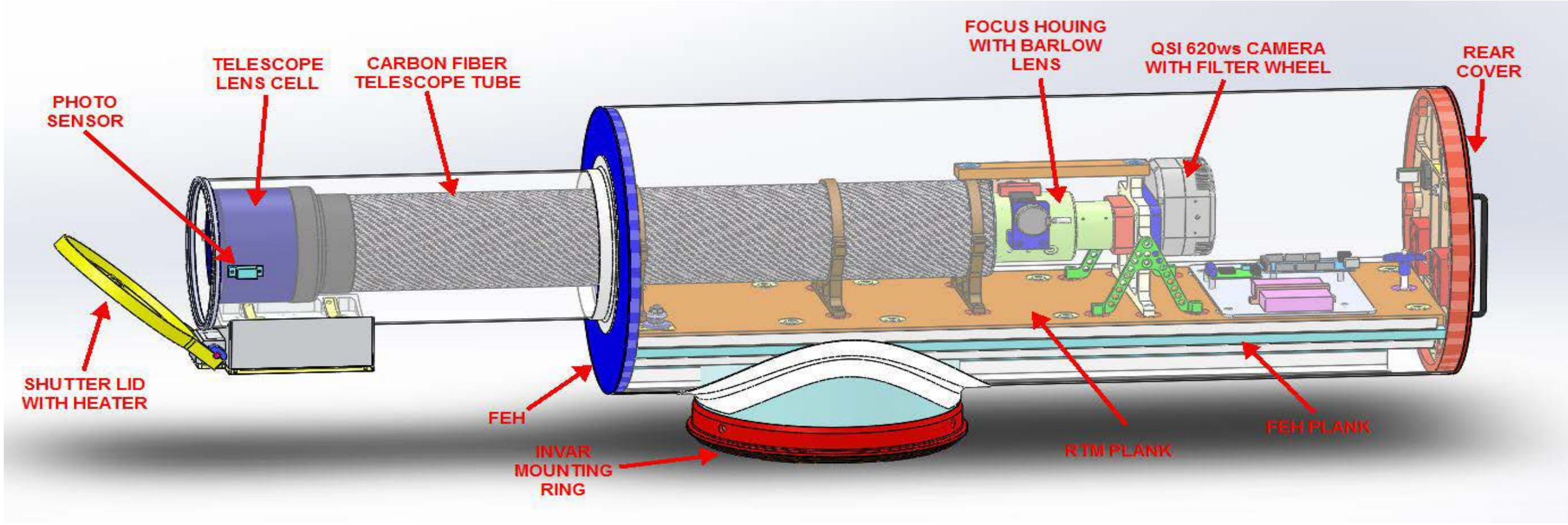
Pointing Error With Azimuth



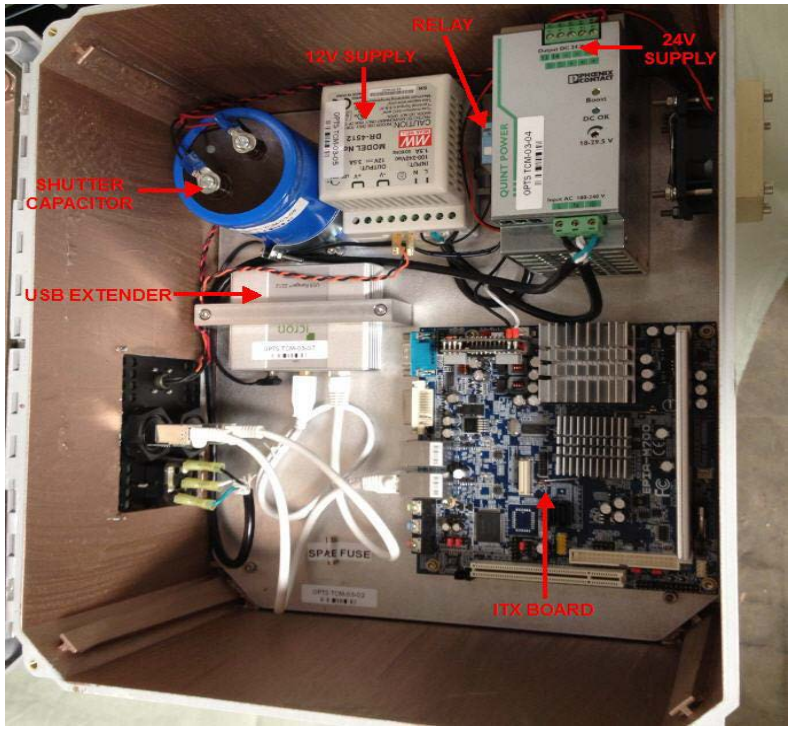


Concept #1 Optical Pointing Telescope

ALMA Optical Pointing Telescope (OPT)

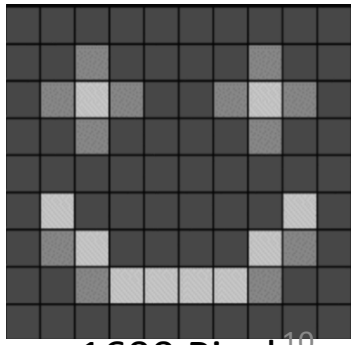


Concept #1 Optical Pointing Telescope

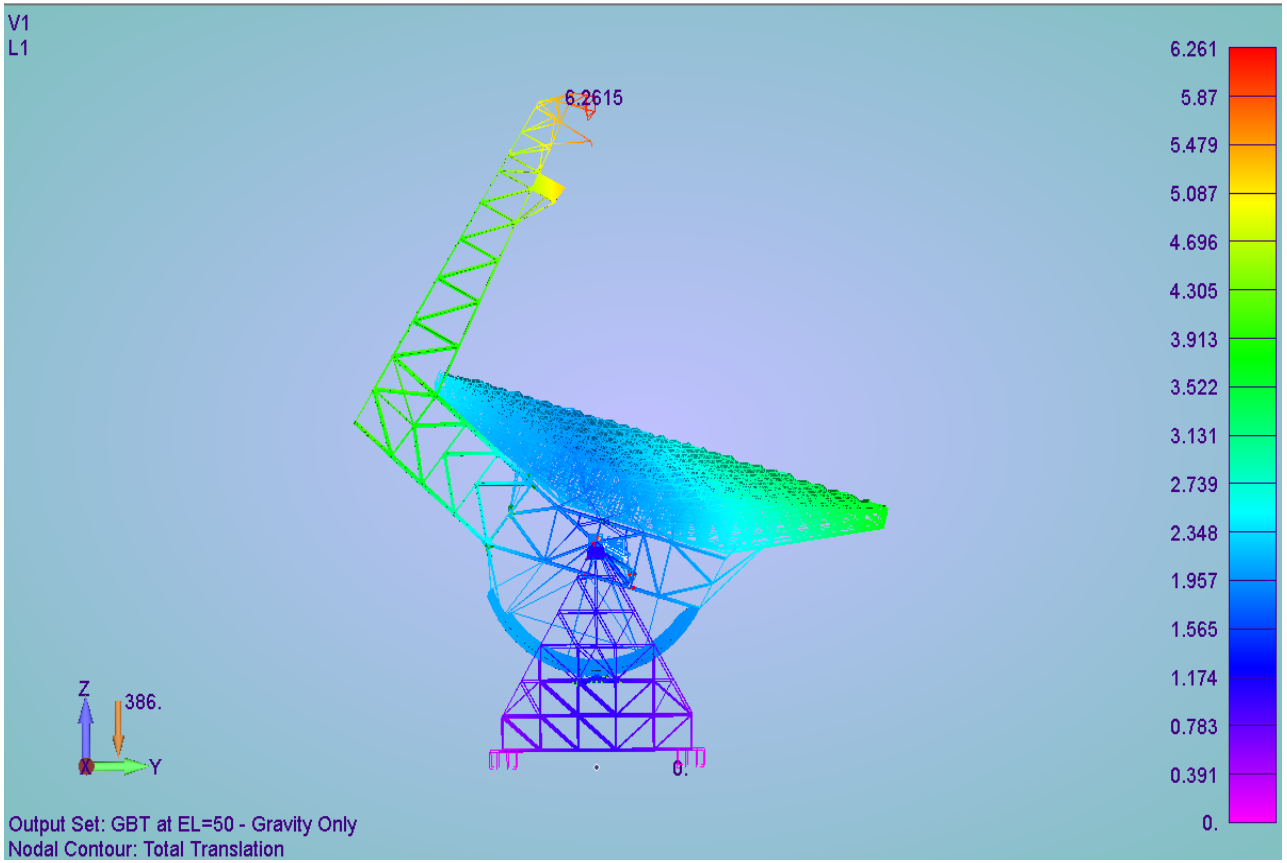


QSI 620ws
Imaging Area: 11.84 mm *8.88 mm
Pixel Size: 7.4μm*7.4μm

$$\frac{ArcSec}{Pixel} = \frac{4500\ mm}{7.4\ \mu m} * 206.3 = 0.34"/Pixel$$

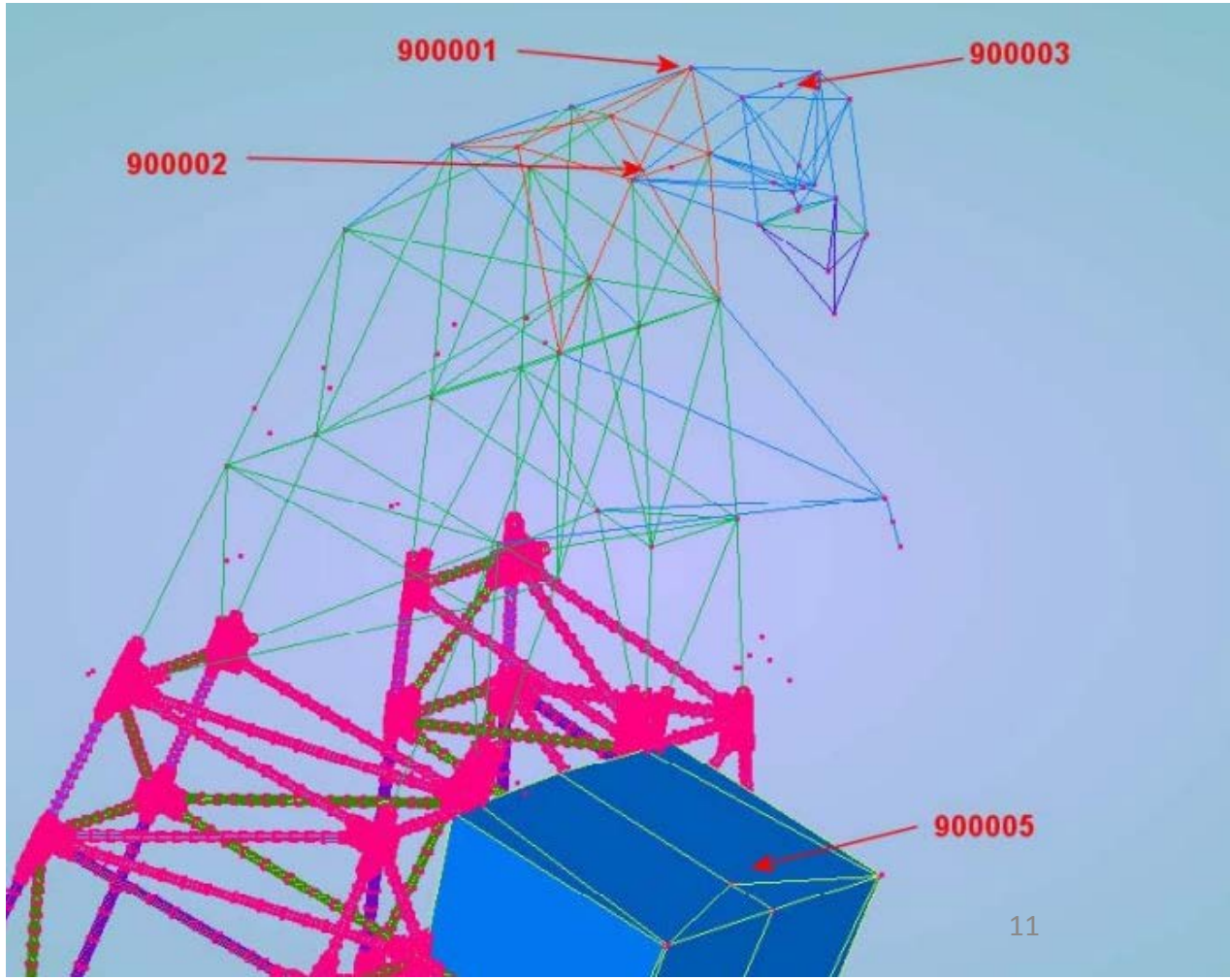


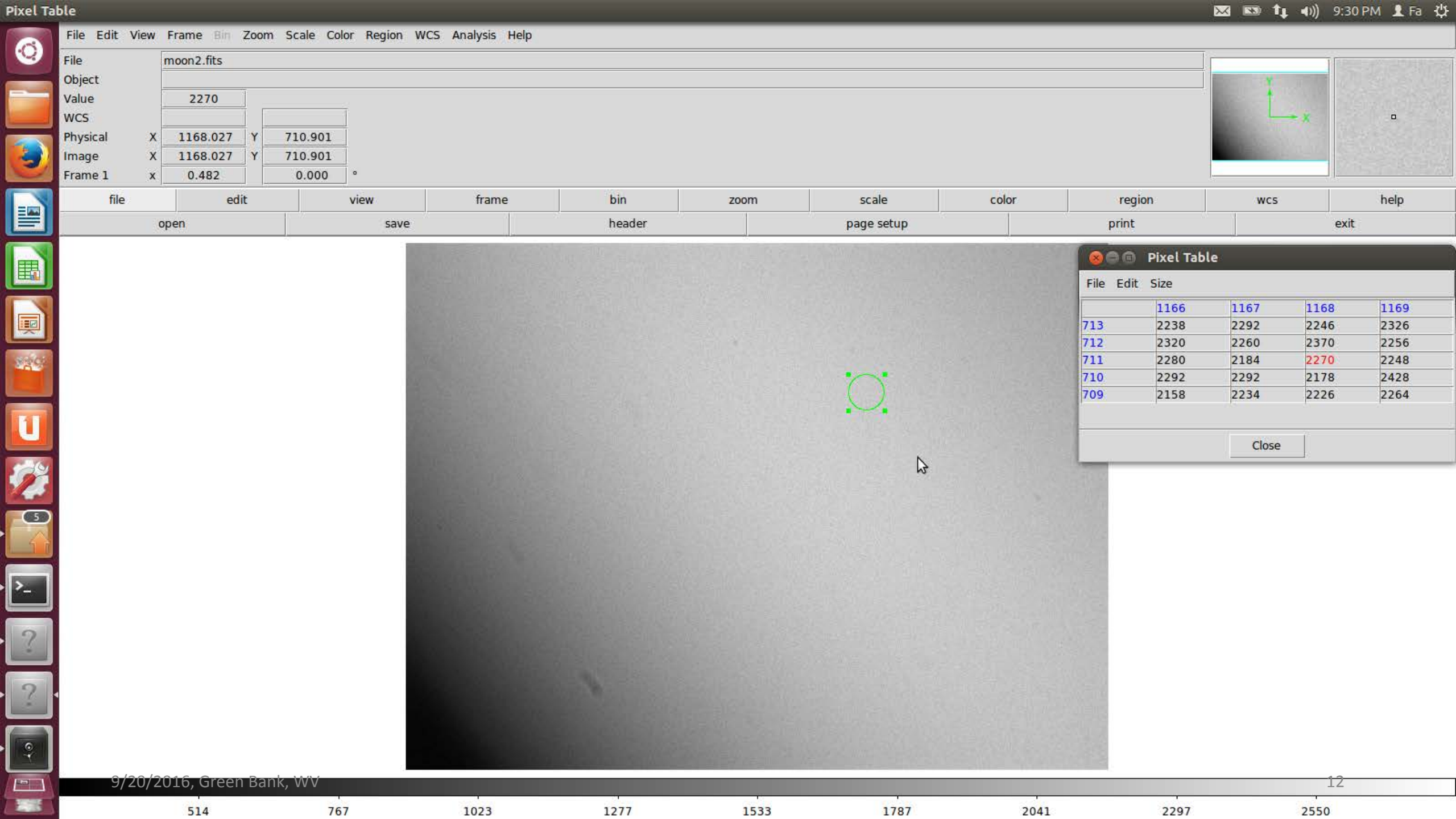
Concept #1 Optical Pointing Telescope



- GBT FE Model: Deflection on Gravity at EL =50 degree. (Unit: Inch)

- 900001 & 900002 node: OPT Mounting

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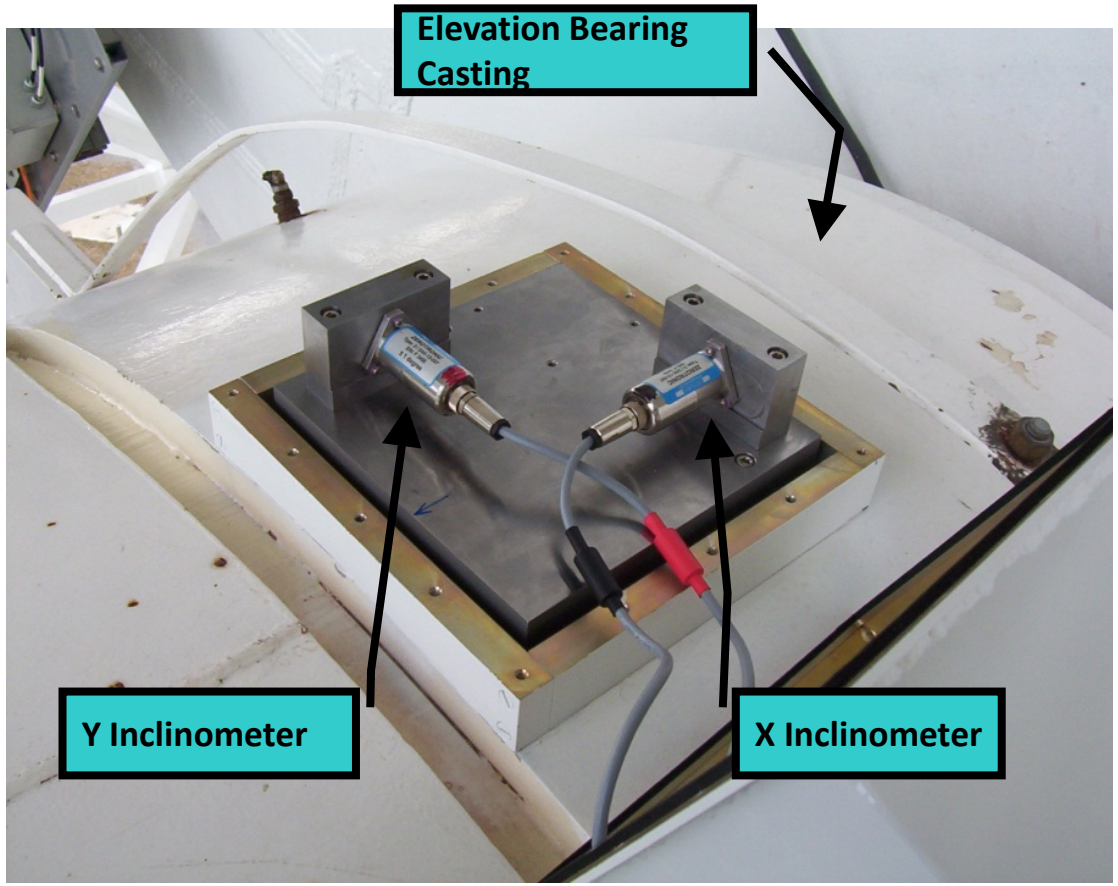
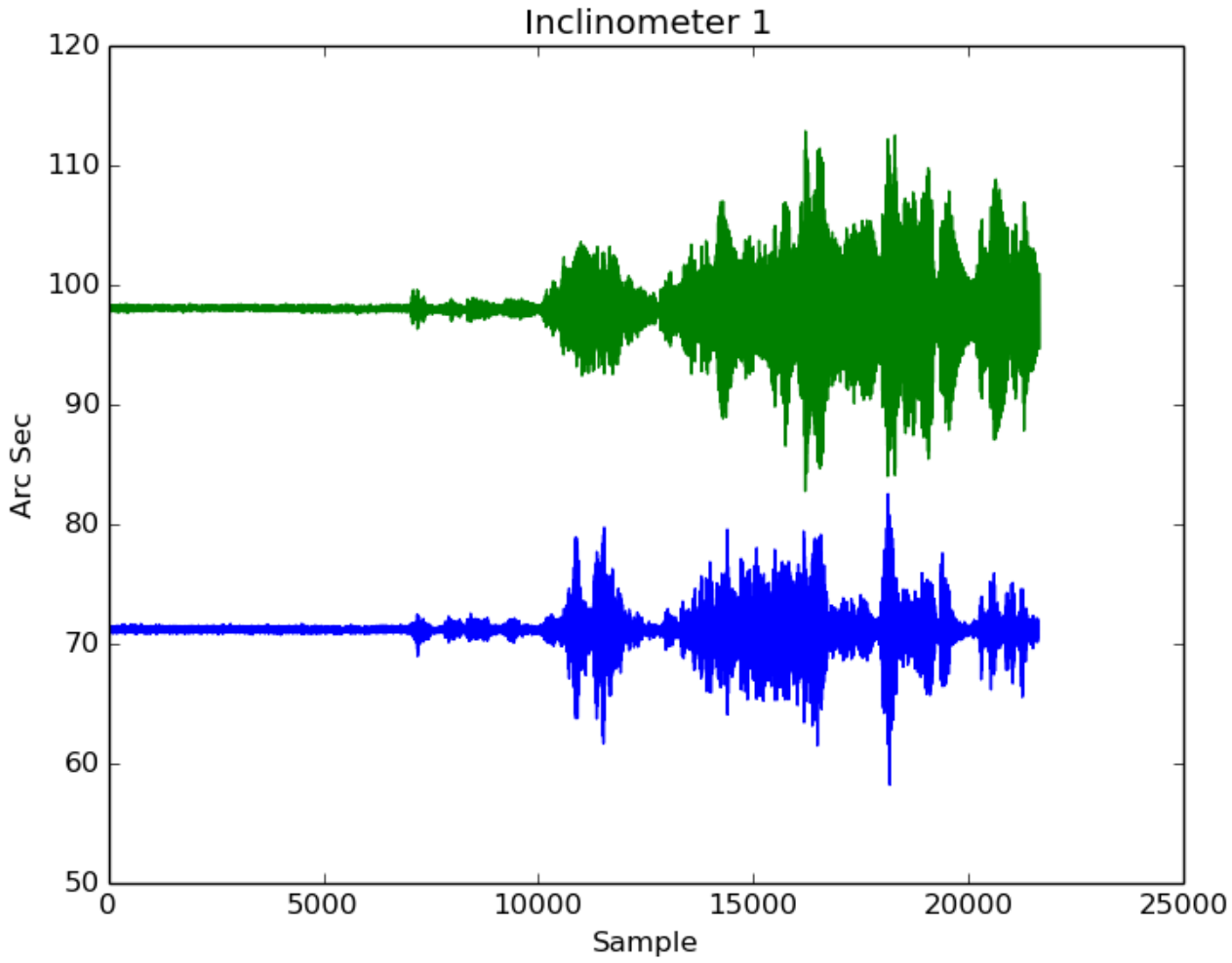
File Edit View Frame Bin Zoom Scale Color Region WCS Analysis Help
File moon2.fits
Object
Value 2270
WCS
Physical X 1168.027 Y 710.901
Image X 1168.027 Y 710.901
Frame 1 x 0.482 0.000 °
file edit view frame bin zoom scale color region wcs help
open save header page setup print exit
Pixel Table
File Edit Size
1166 1167 1168 1169
713 2238 2292 2246 2326
712 2320 2260 2370 2256
711 2280 2184 2270 2248
710 2292 2292 2178 2428
709 2158 2234 2226 2264
Close
514 767 1023 1277 1533 1787 2041 2297 2550

Concept #2 Inclinometer

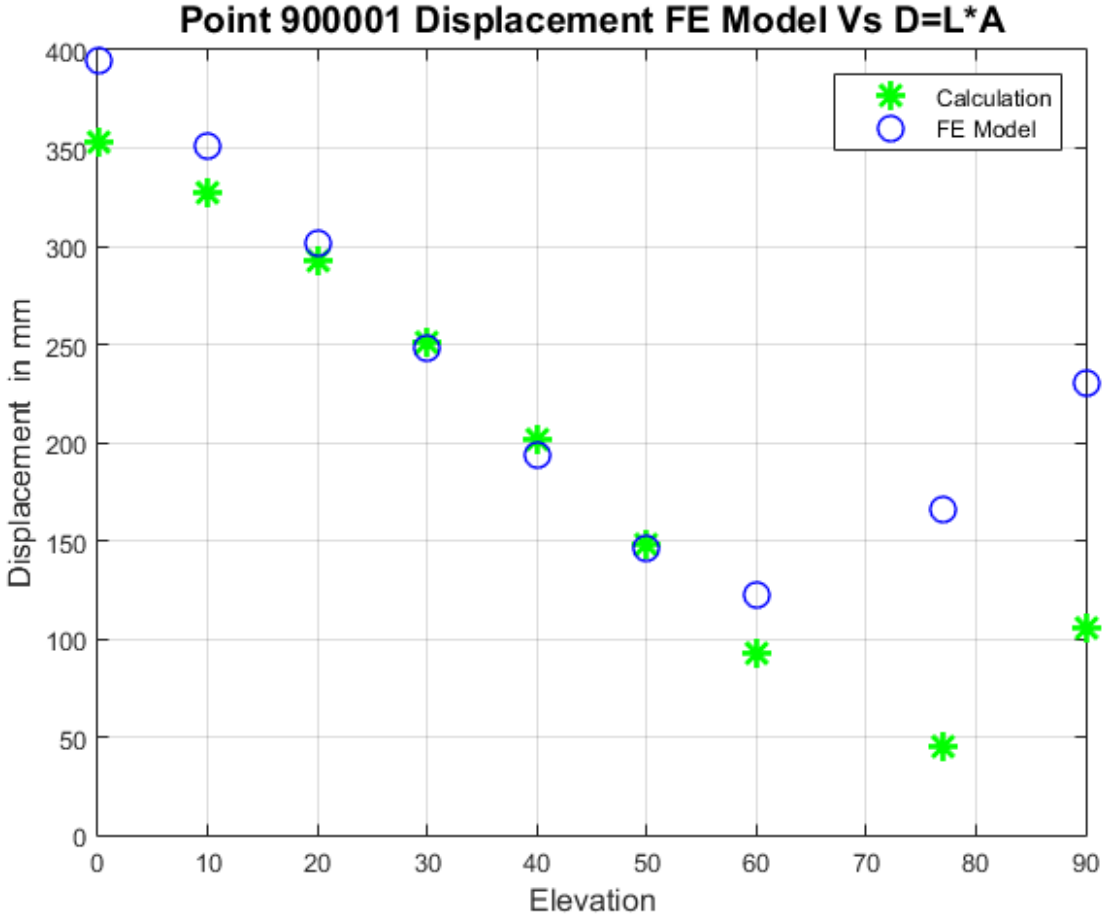


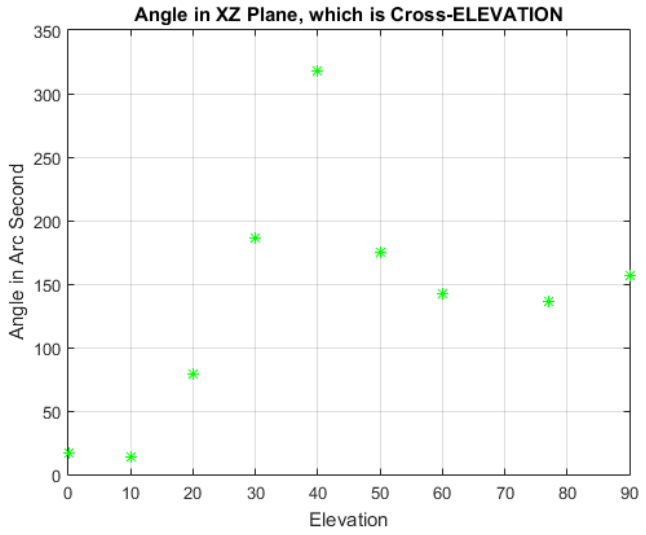
- 0.1” Short term Accuracy
- 0.01” Resolution
- ±1 degree Range

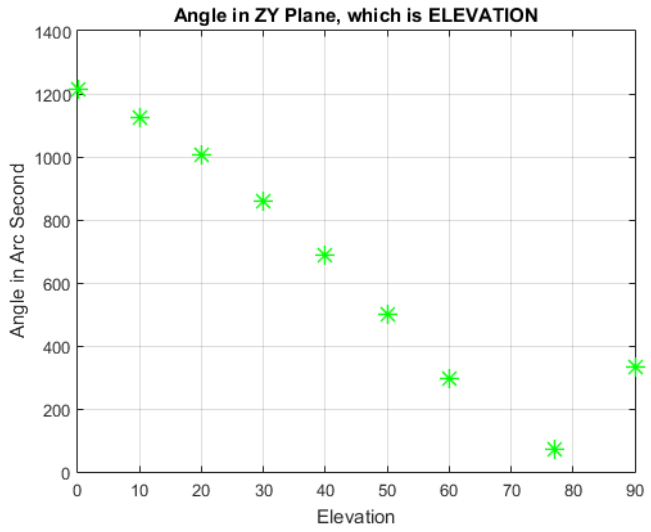
Inclinometer Data in One Hour.

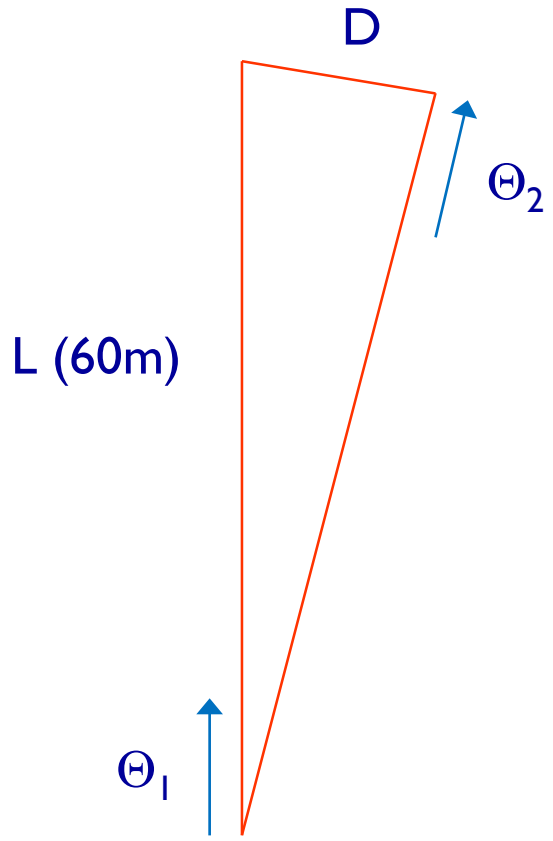


Concept 1&2 Mathematic Calculation









- $D \approx L * \alpha$
- L is the Length of the feed arm, ~60 m
- Lookup table to combine wind, gravity and thermal.

Concept 1 & 2 Summary

Two Ideas to Measure the tilt angle

- ALMA OPT: Mount on the top of the GBT feed arm.
- Inclinometer: Mount in the receiver room with a rotate platform.

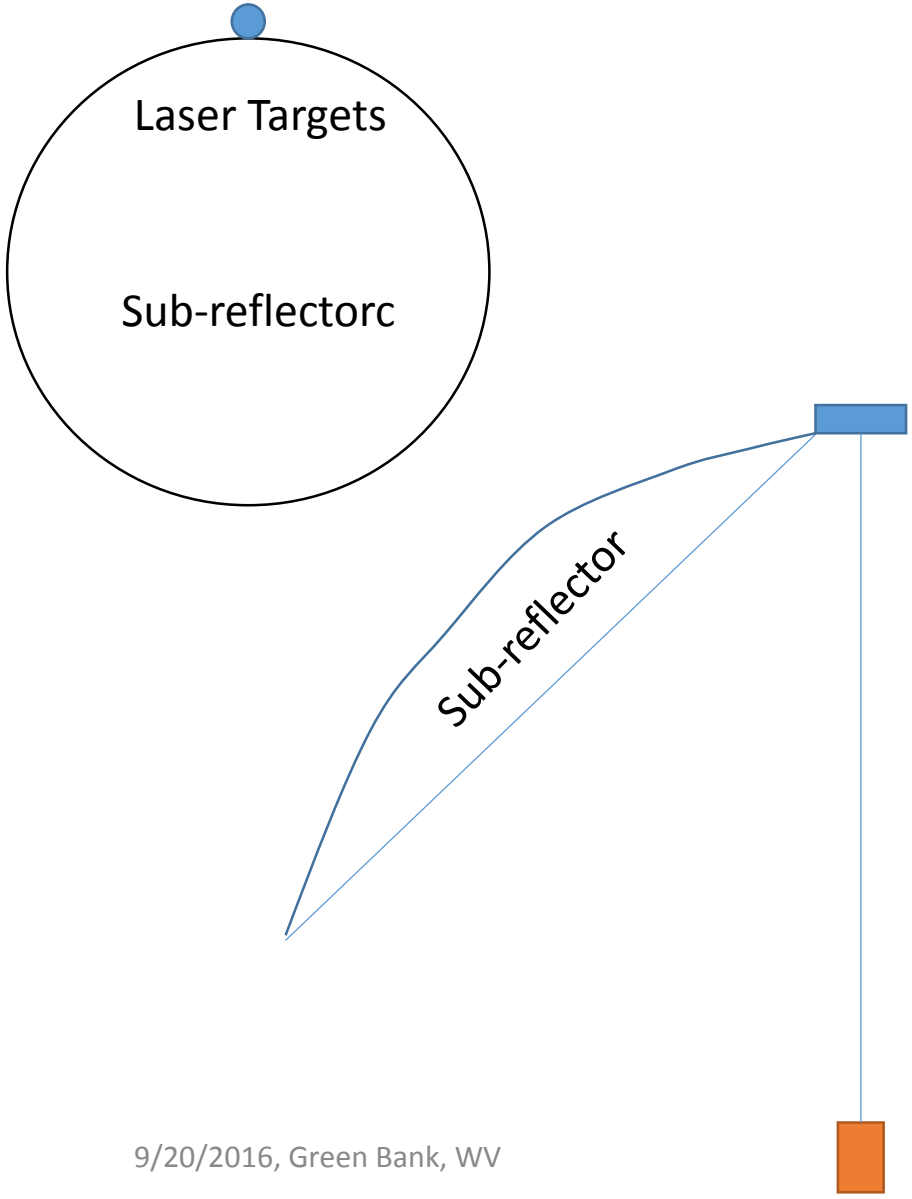
Advantage:

- Straight idea.
- Green bank has Inclinometer & OPT.

Disadvantage:

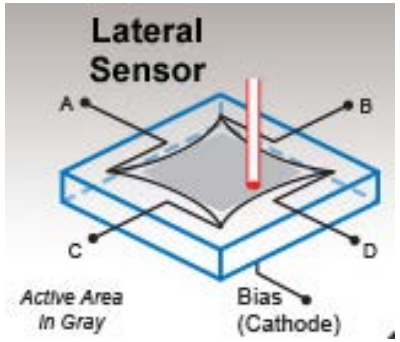
- Open loop.
- Error increases. (Need other device to clean the error).

Concept #3 Laser Ranger



Assume sub-reflector movement is only translation.

- One Position Sensing Detector (Laser on reflector frame (~60 m) or receiver room (~15m))



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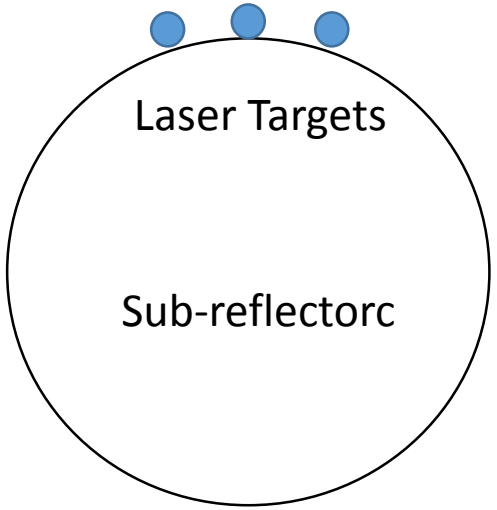
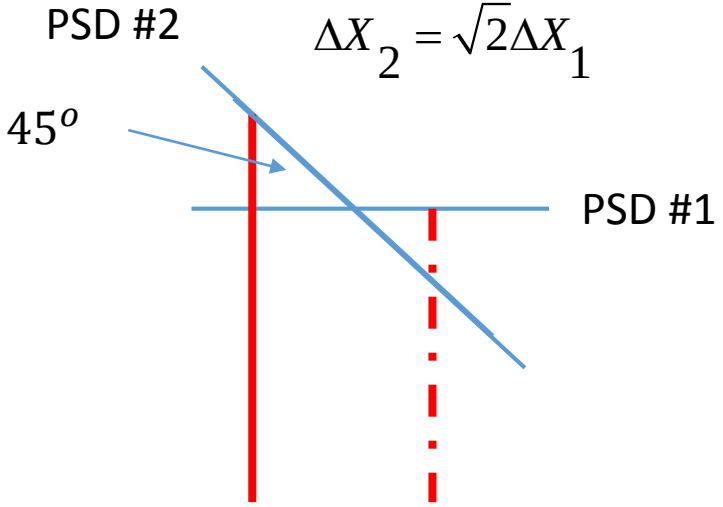
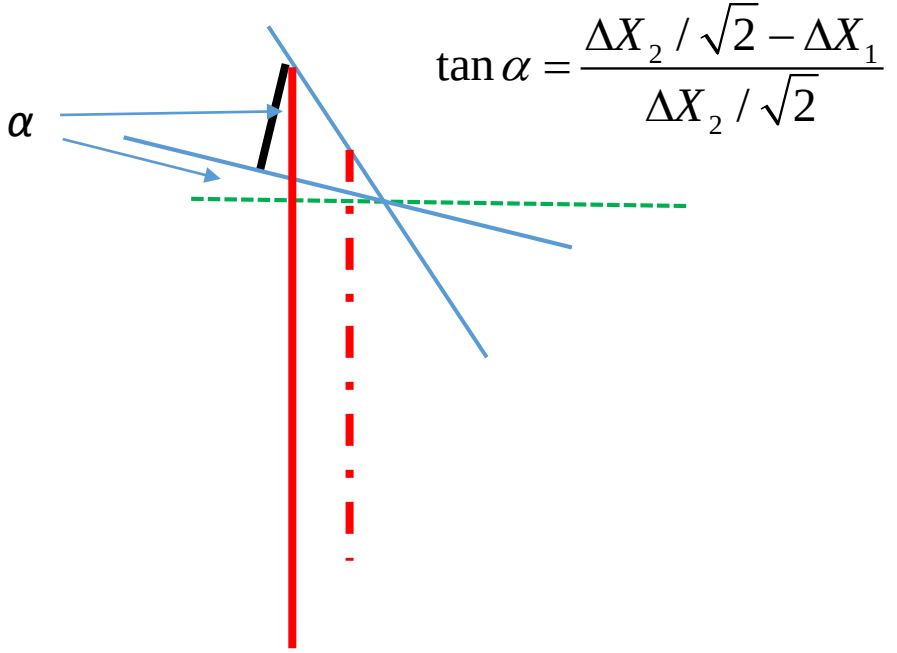


Otherwise

- Three Position Sensing Detectors.
- Mount at a 45 degree different.
- By iteration to calculate the tilt and translation





Summary

- *Is my idea possible?*
- *Do you have a better one?*

Thank You!

Q & A