Instrumentation Progress: Alignment, Baselines and Backgrounds

T.A. ten Brummelaar, J. Sturmann & L. Sturmann

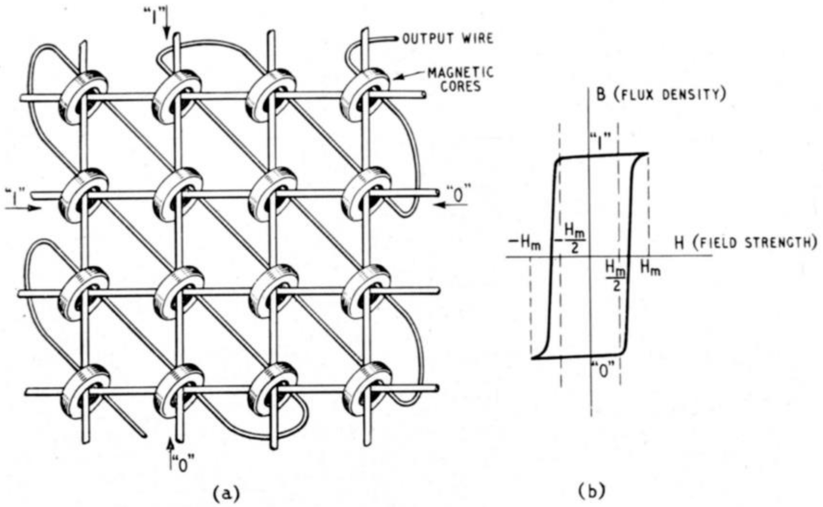
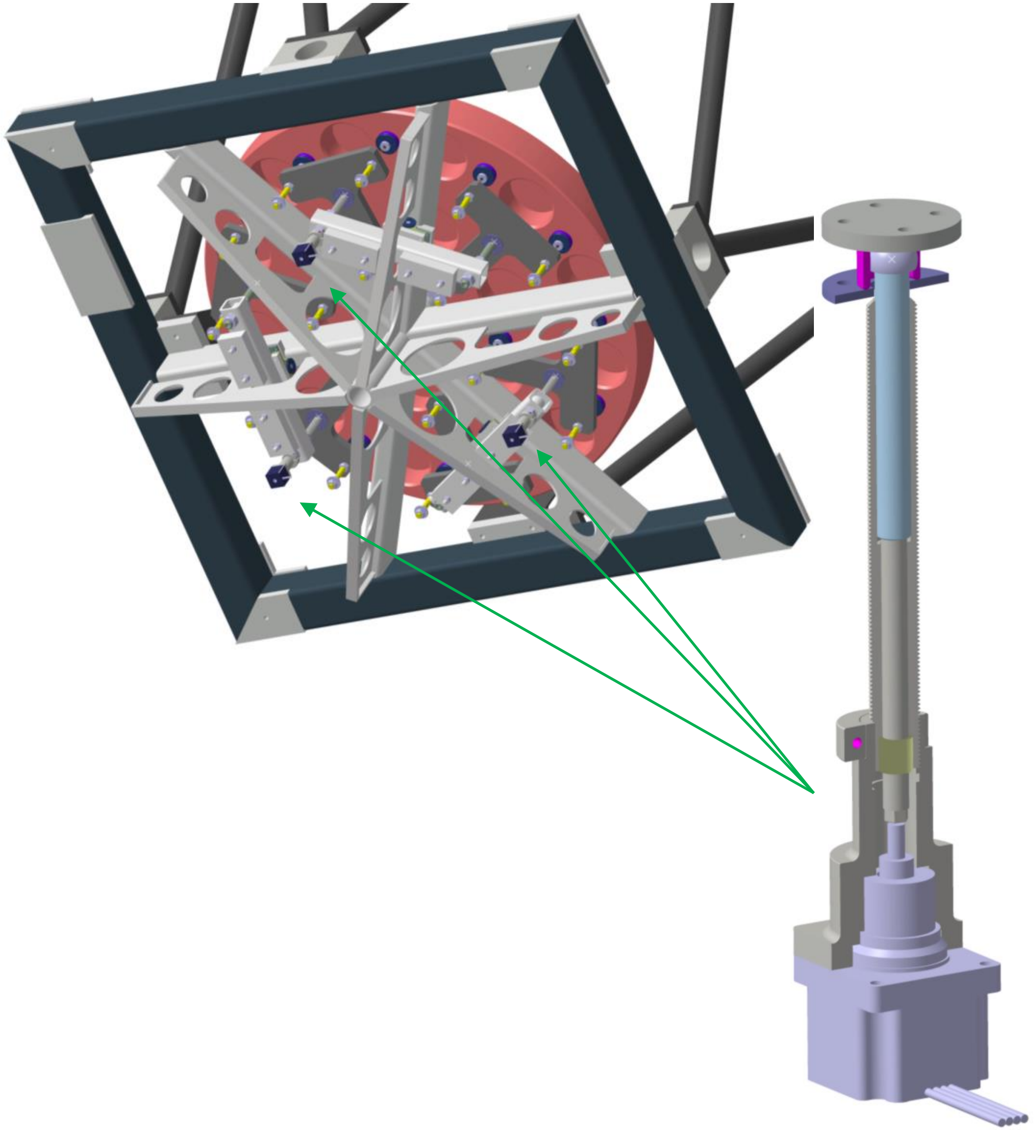


Fig. 9.2—above. Arrangement of magnetic cores in a matrix storage system (a), with (b) rectangular hysteresis loop of the core material. Plate 15—below. One plane of a 32 × 32 magnetic matrix store made by Mullard

Update on the Automated Telescope Alignment: M1 Actuator Revision



The axial force exerted by the first iteration of the actuators was not sufficient to tilt M1 reliably.

A spring was added to lower the axial load on the actuator at high elevation. The spring force that was sufficient at high elevation was too much at low elevation. The mirror started floating.

A more powerful motor is a better solution than a weak motor plus a spring.

E1 will have these more powerful actuators in May

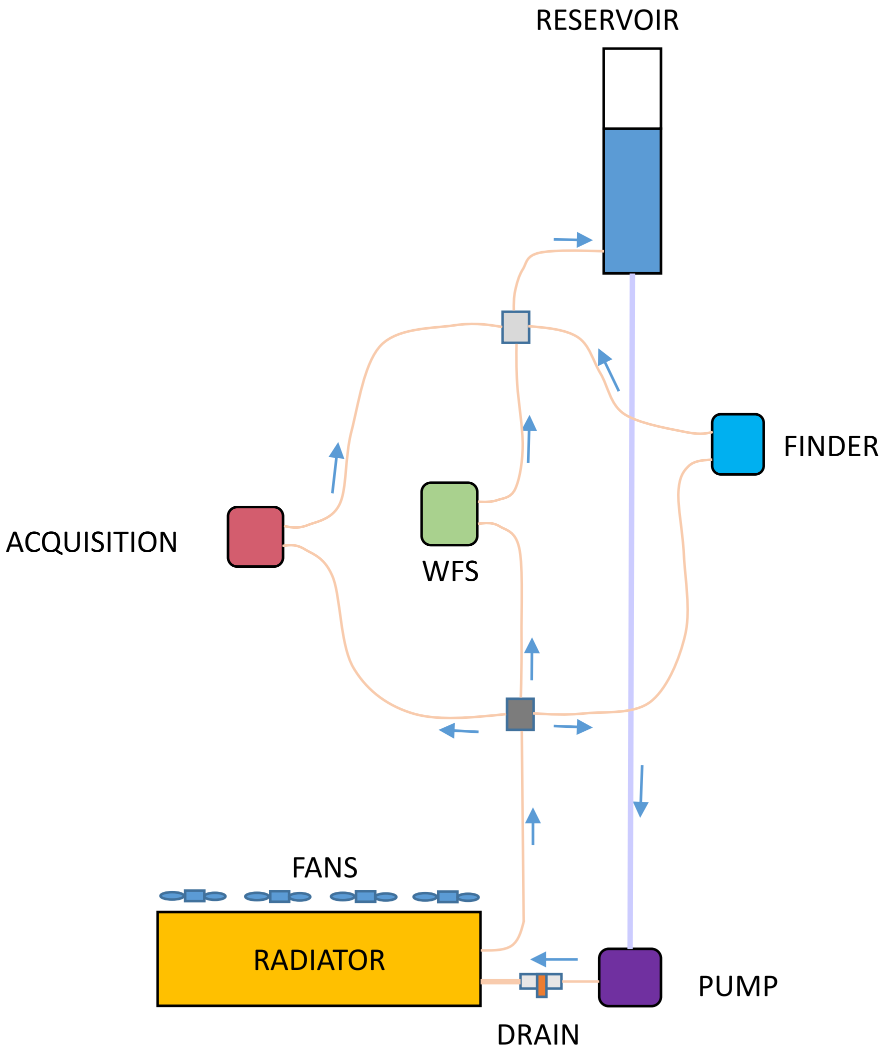
The actuators can now be installed without the need of removing M1

Commissioning the telescope WFS is ongoing. The software is not ready for telescope alignment.

New Finder (ZWO ASI174) and Acquisition (ASI178) Cameras

2-stage Peltier/air cooled CMOS cameras have been rebuilt to be liquid cooled

The water cooler will also be used to cool the WFS camera on the telescope.



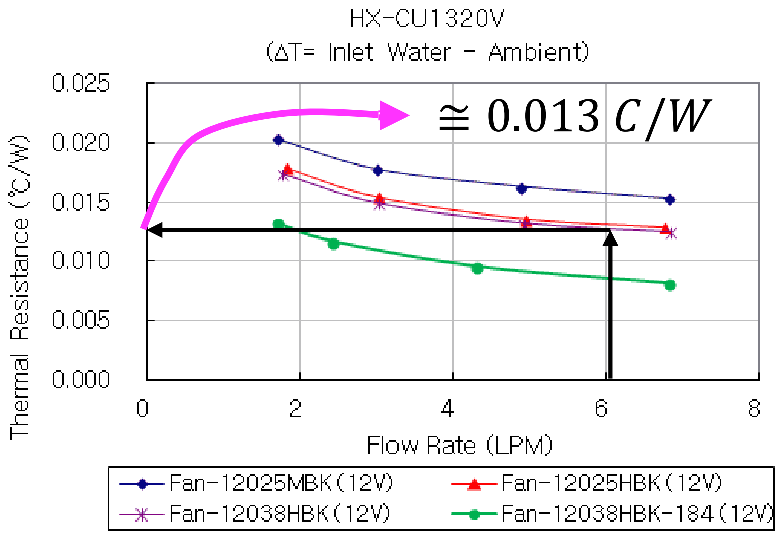
Water Cooler on the Telescopes

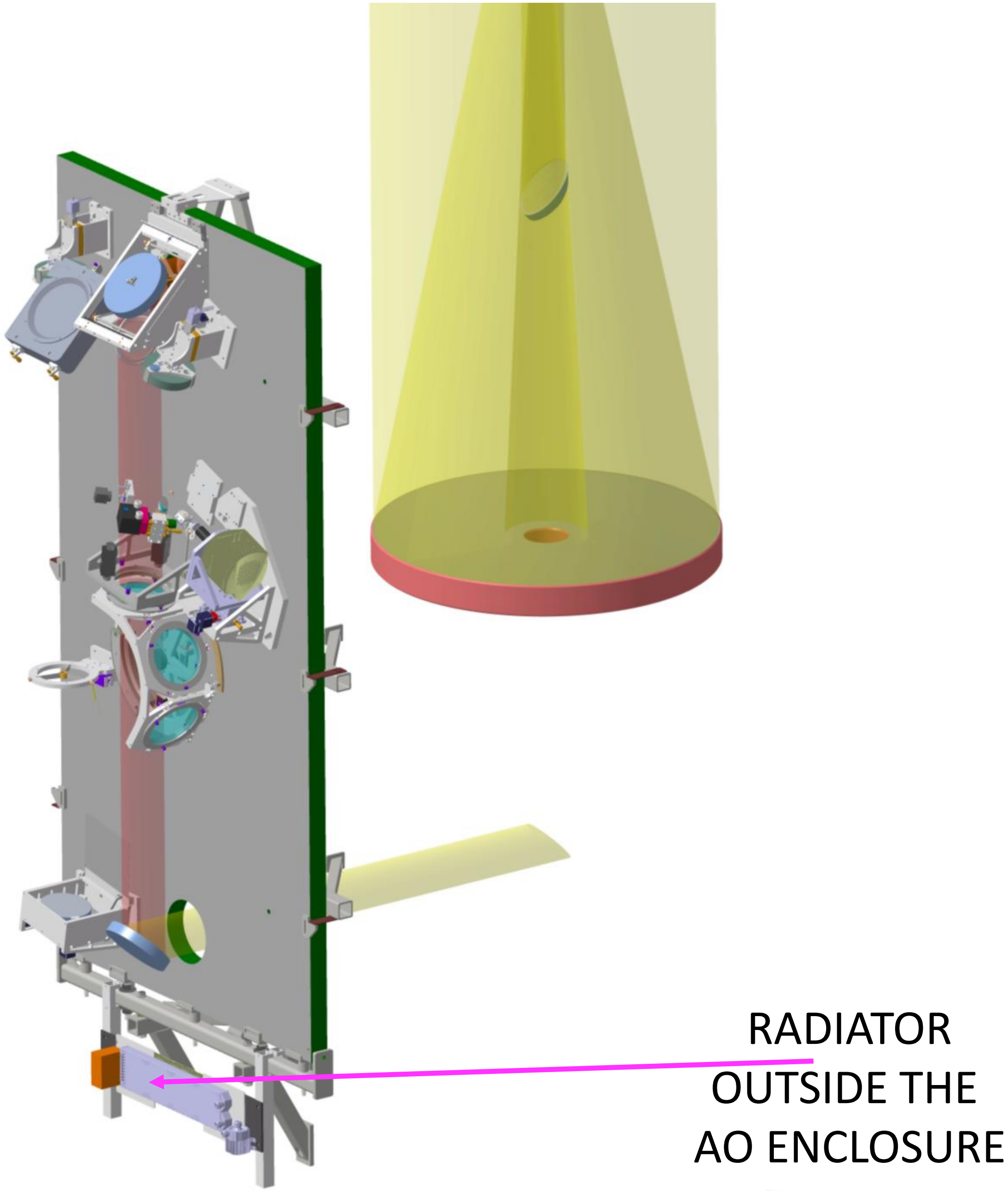
Total power dissipation by the cameras < 75 W

The cameras are in parallel

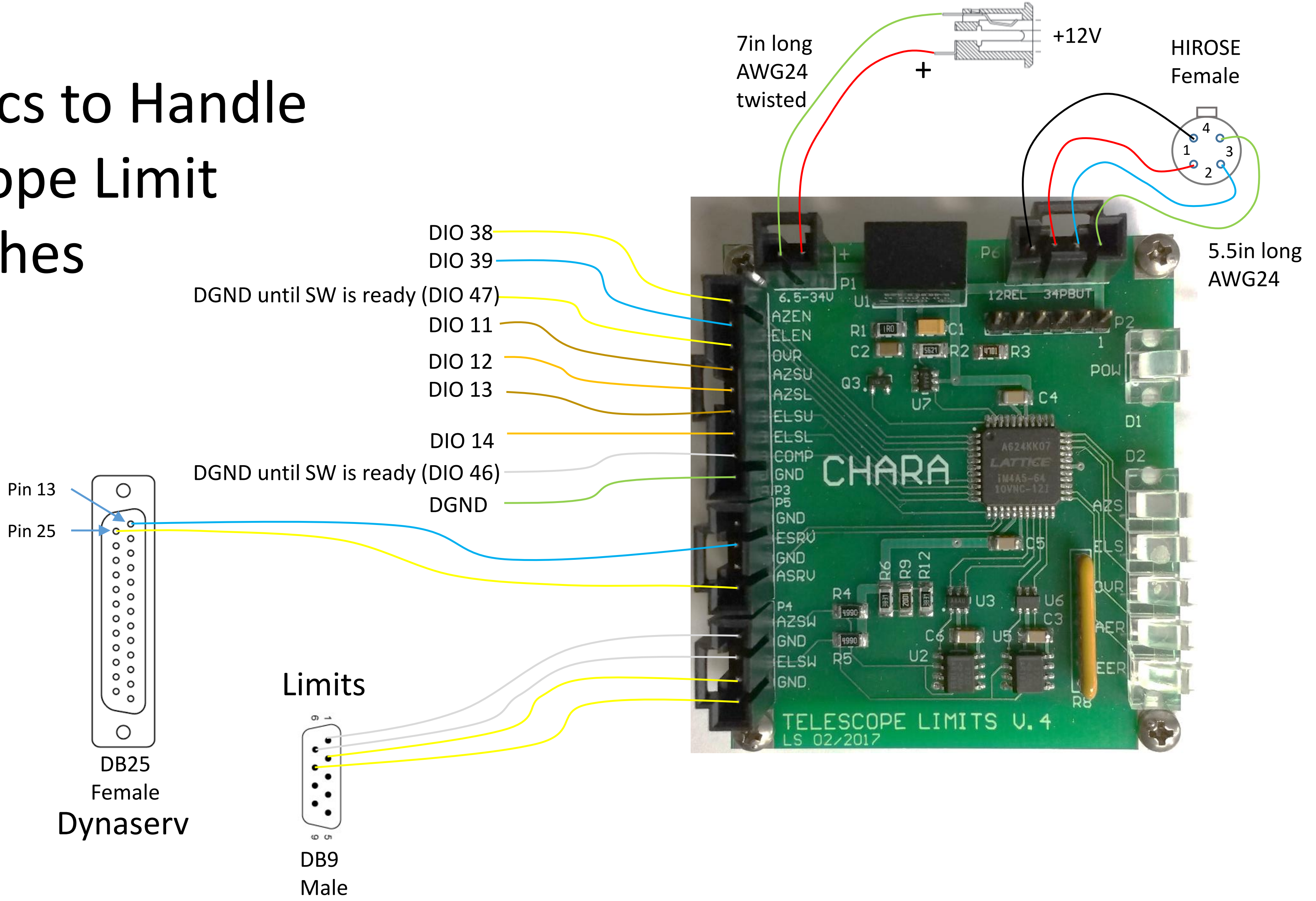
The heat from the three cameras will be dumped to the ambient air through a heat exchanger mounted under the AO enclosure (away from the beams). The expected water temperature will be about 1 C above ambient.

THERMAL RESISTANCE OF THE RADIATOR
vs. LIQUID FLOW RATE AND FANS





New Electronics to Handle the Telescope Limit Switches



AO REQUIRES BETTER CONTROL OF ALIGNMENT

Recent news:

- ✓ **Improved Reference Camera** software allows more precise setting of the origin, and locating the LED targets in the pipes.
- ✓ Confirmed with telescope beacon beams that we could keep the short procedure **for night time pop changes**, if we do the **detailed daytime checks more often** to prevent drifting of the beam paths into obstacles, thus the beams will be free of vignetting.

In progress:

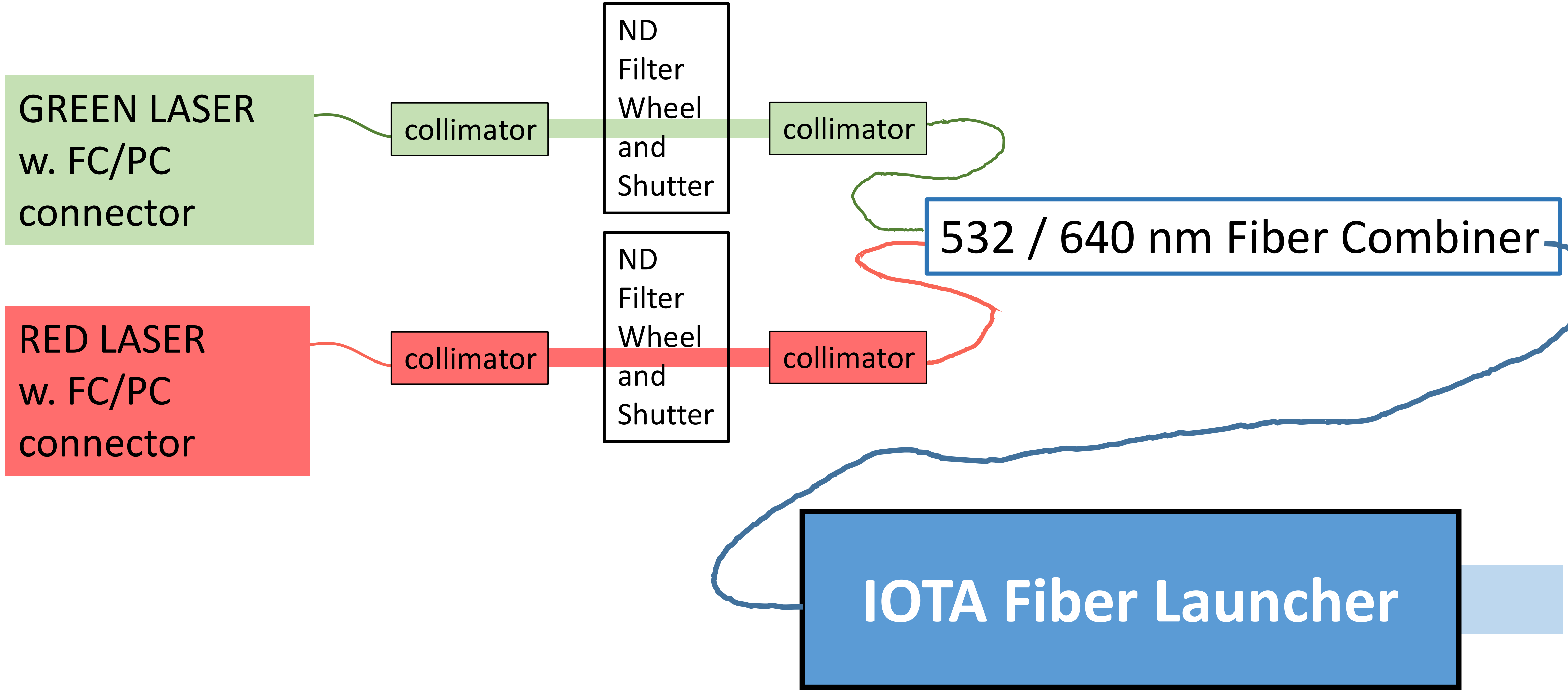
- ❖ **Better** – more objective – **control of the alignment laser** using cameras.
- ❖ **New,** brighter **alignment laser**, quick switch between red and green colors. Ready for use probably later this year. *The schematic is in the next slide.*

Directly AO-related additions to maintenance tasks:

Based on experience so far, here is the top of the list of systems where **more detailed daytime checks are needed more often to correct for known instabilities**

1. Lab-DM + Beam Reducing Telescope systems
2. The paths through the pipes: M7+M10+pops+periscopes
3. Beacon focus (hinges on labao as focus reference affected by Lab-DM + BRT + cart)
4. …

TWO-COLOR FIBER LASER SETUP SCHEMATICS

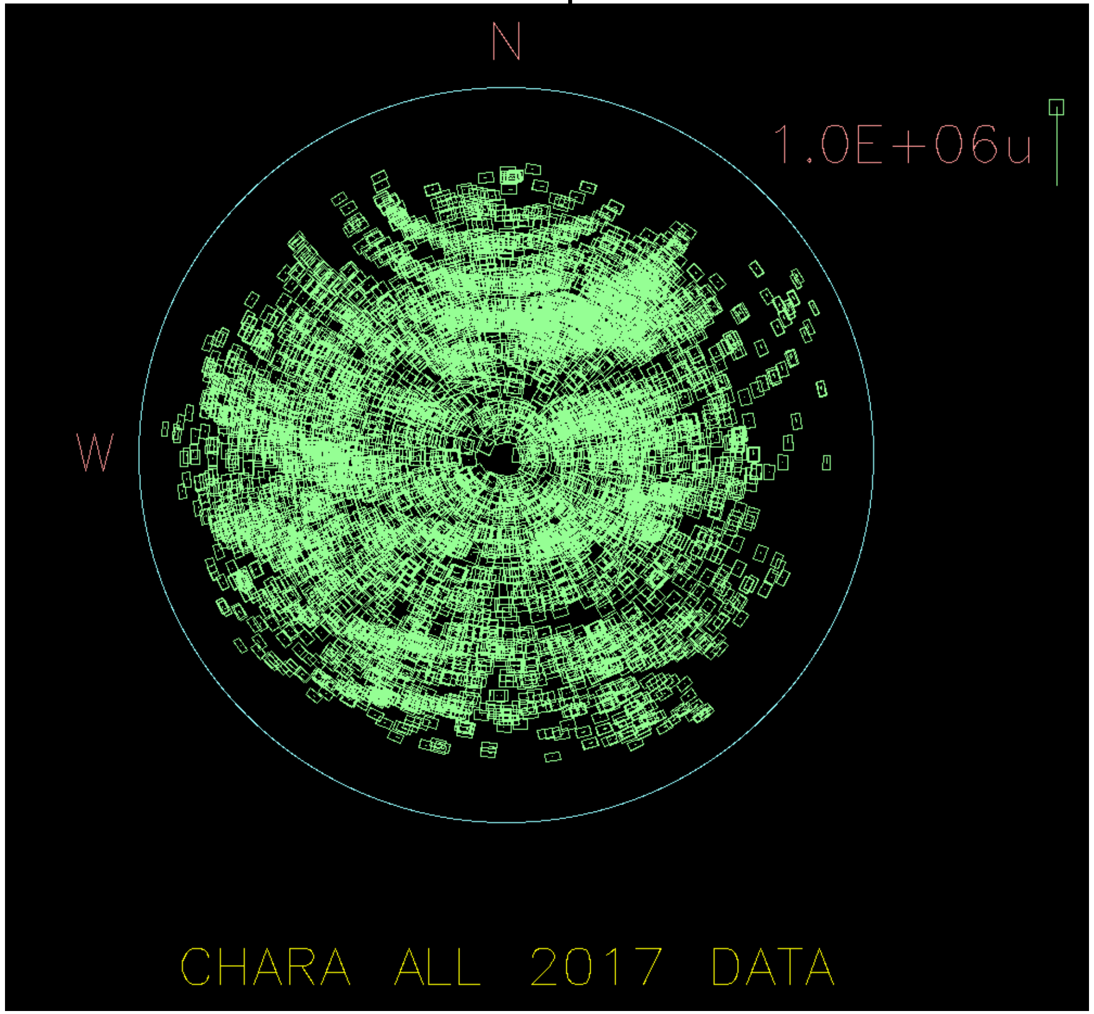


Baseline Solution

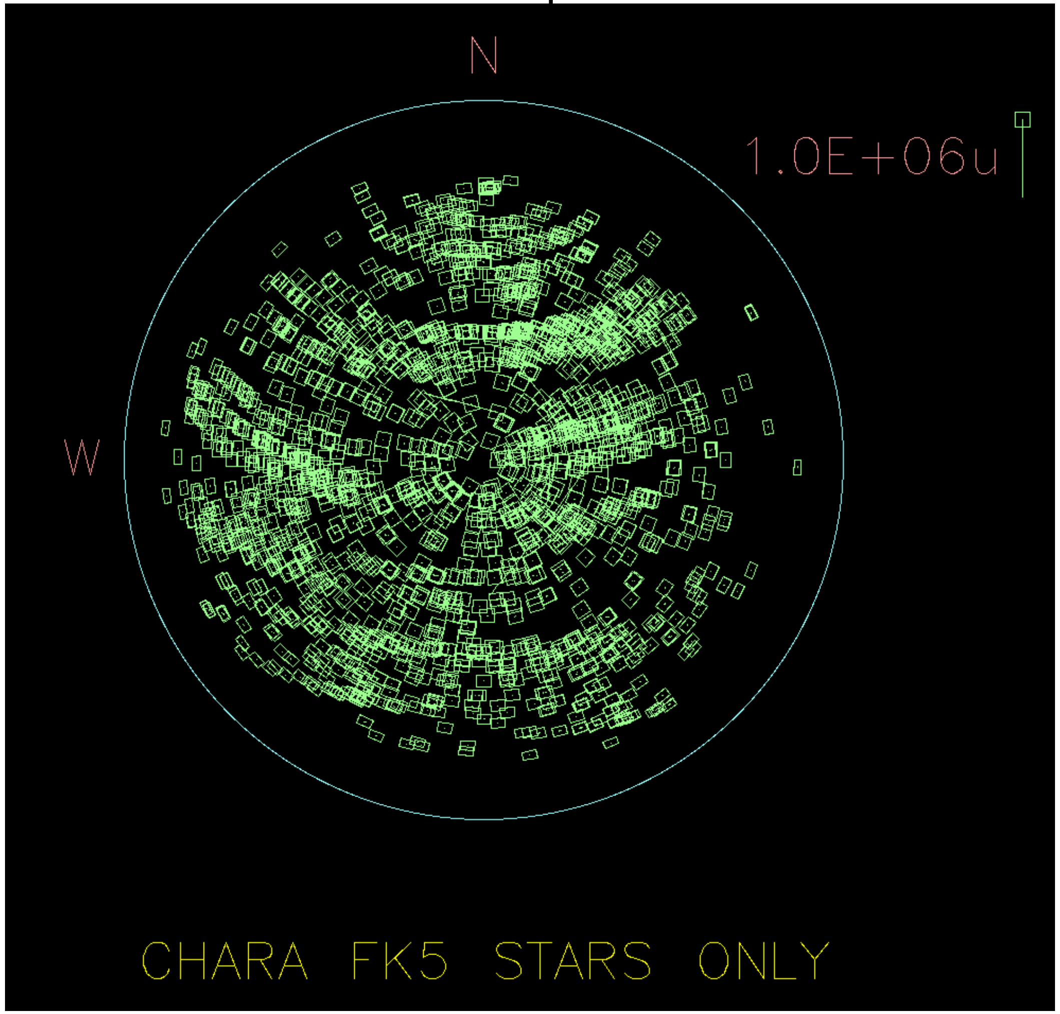
Analysis or Data?

Data is collected “Automatically”. We save cart demand positions and the Alt/Az of the object.
We have now introduced a way to edit the data stream based on SIMBAD information on the object.

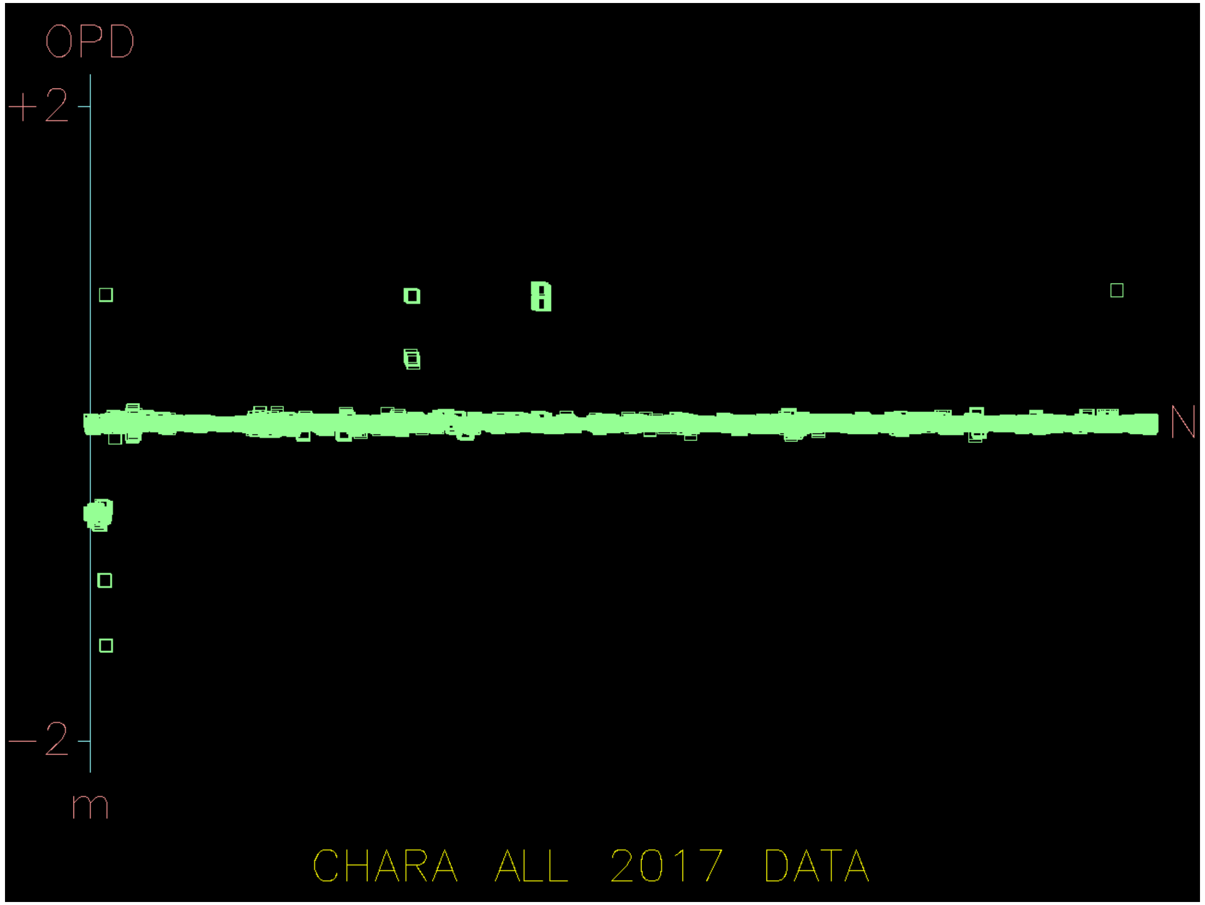
15000 data points

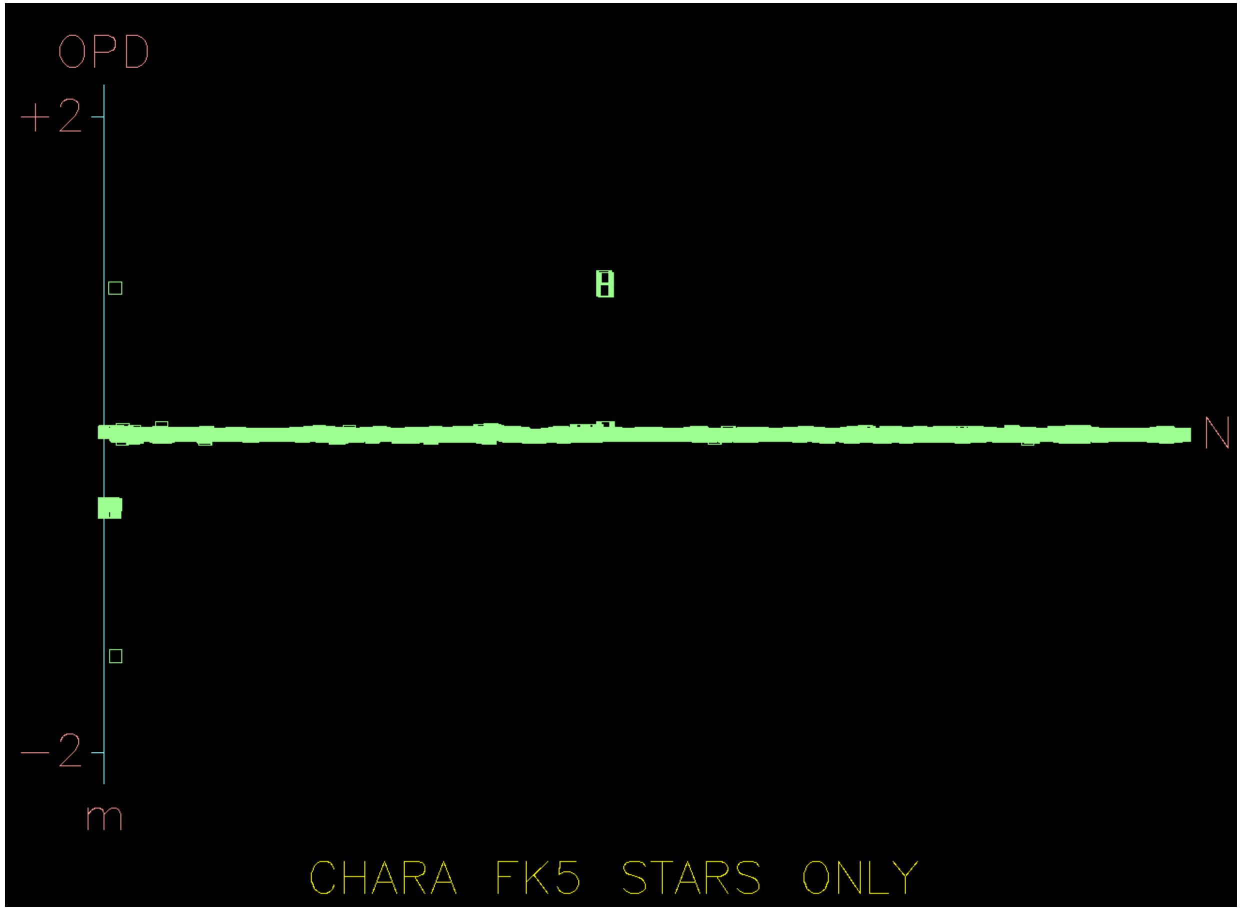


4000 data points



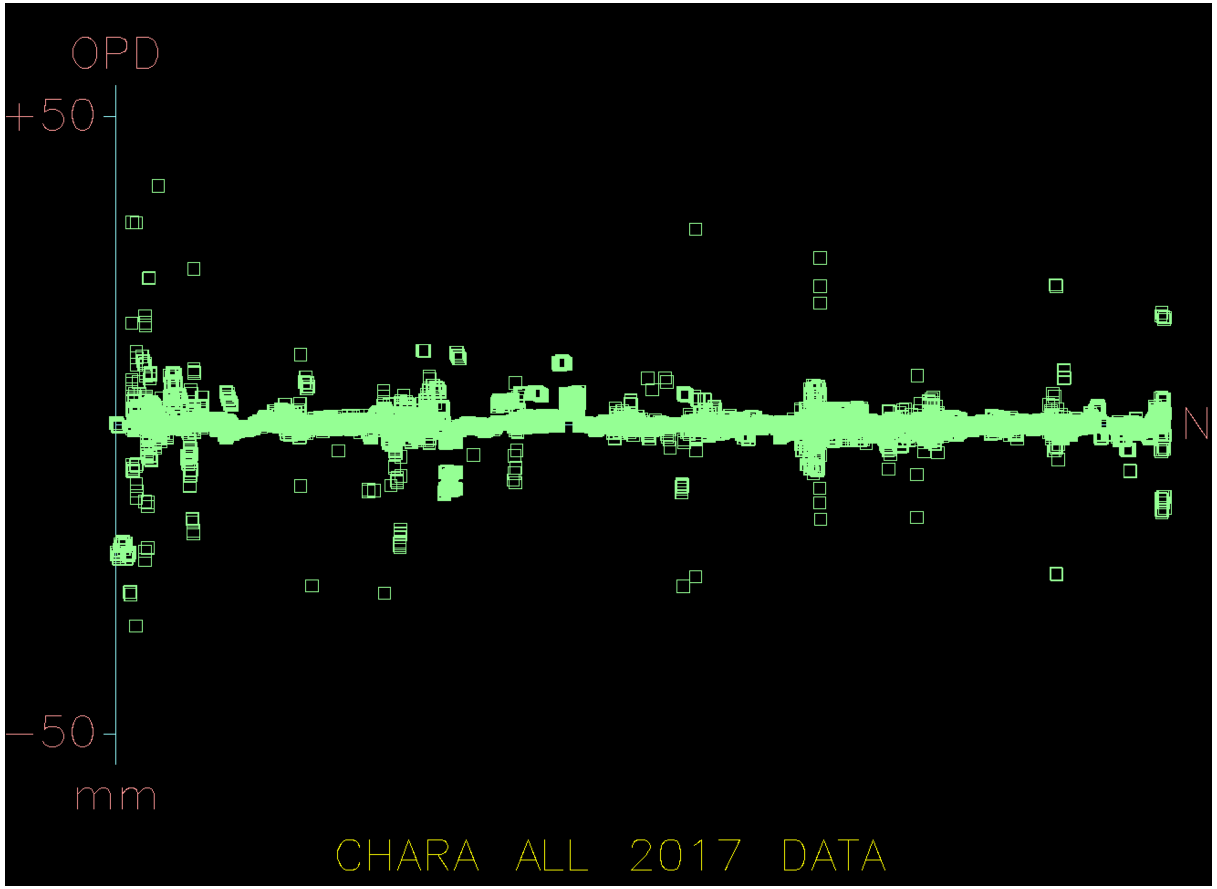
We use IPhase to fit the (x,y,z) position of each telescope across all data.
Internal paths are calculated independently for each POP/BEAM/SCOPE combination.



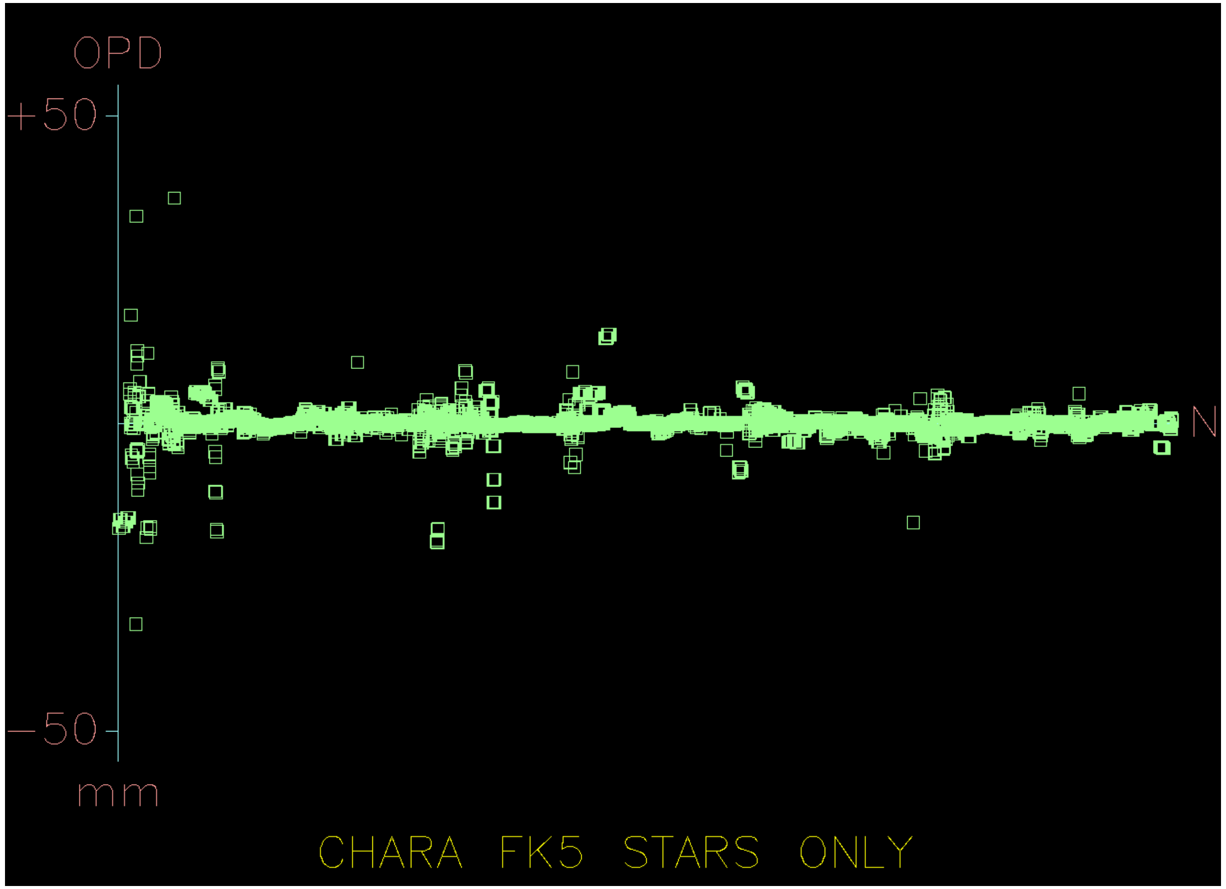


Restricting the data to low proper motion stars helps, as one expects. The question is, what is the best approach to improve objective data editing?

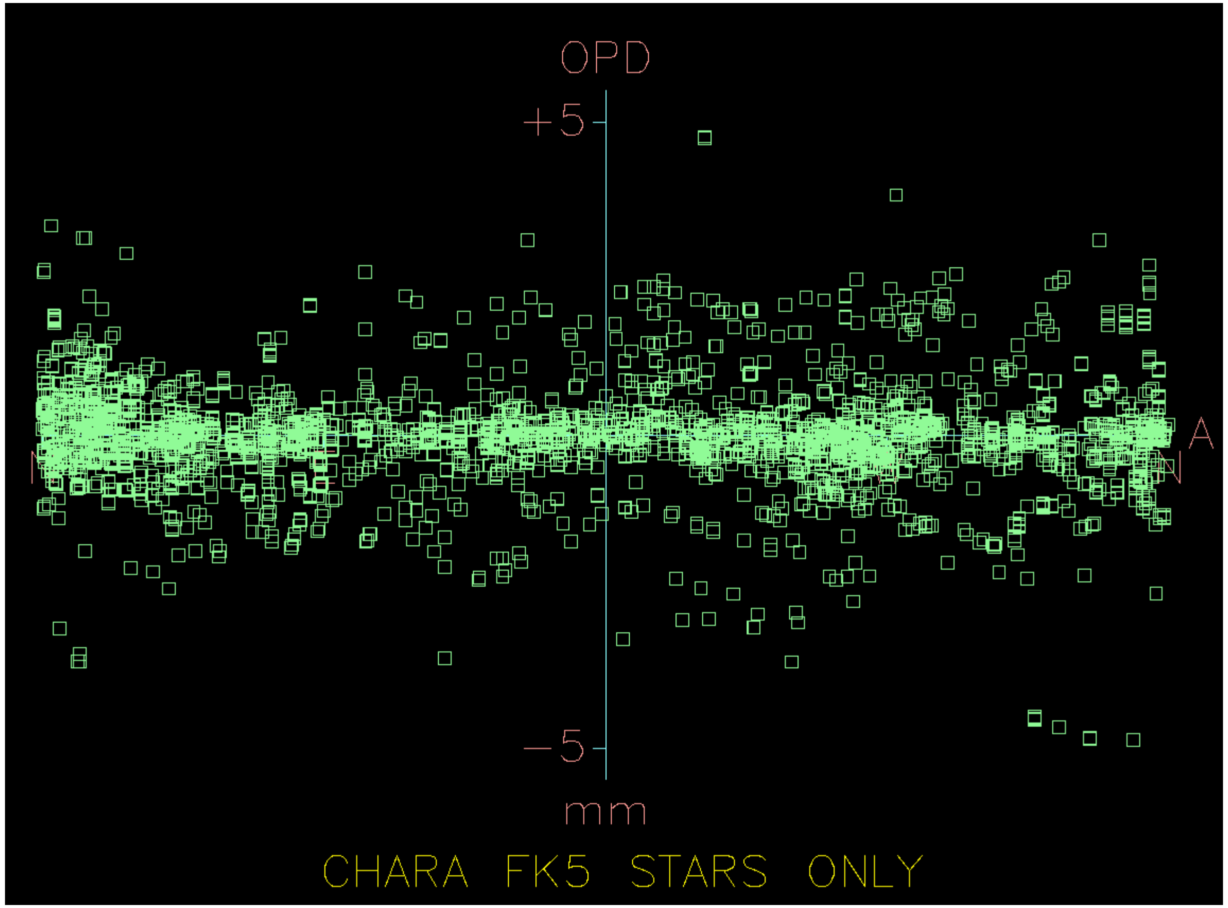
RMS Fit error 2865 microns

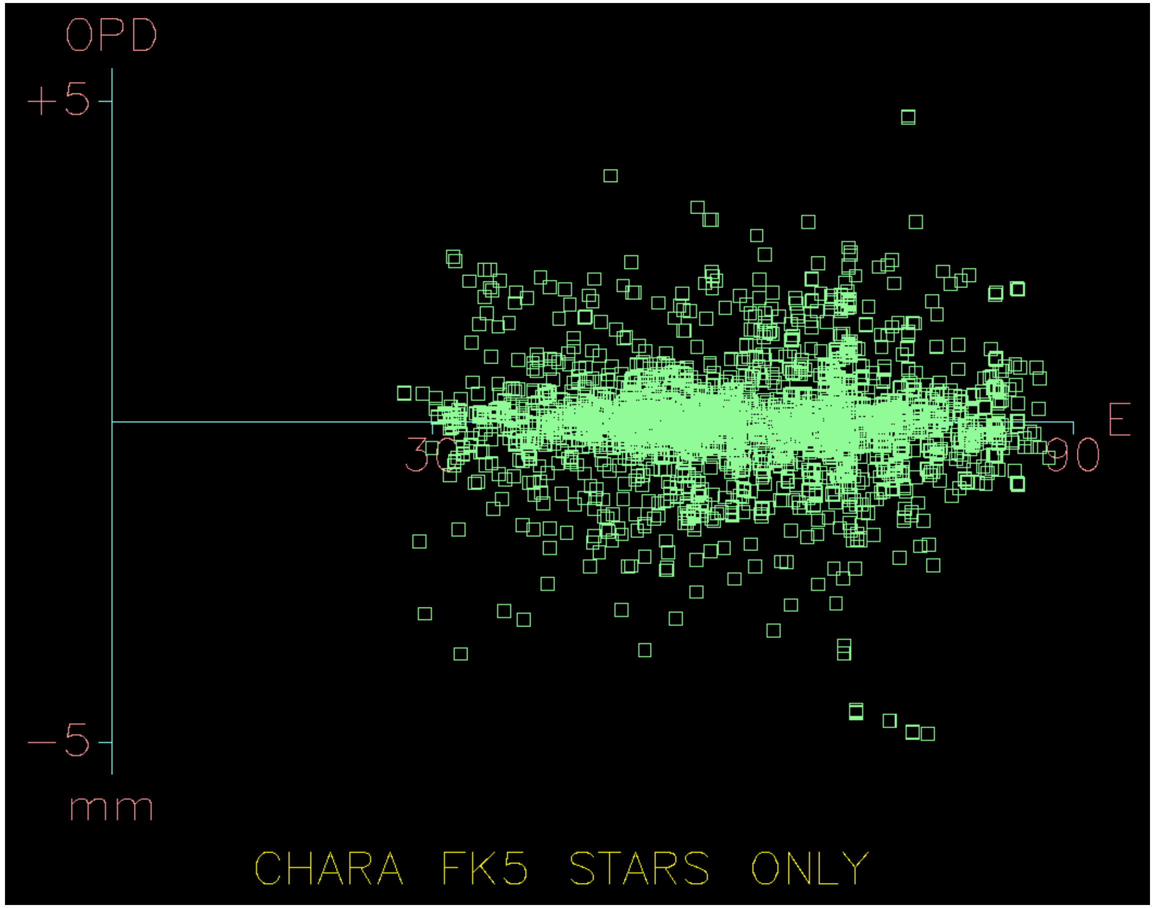


RMS Fit error 2308 microns



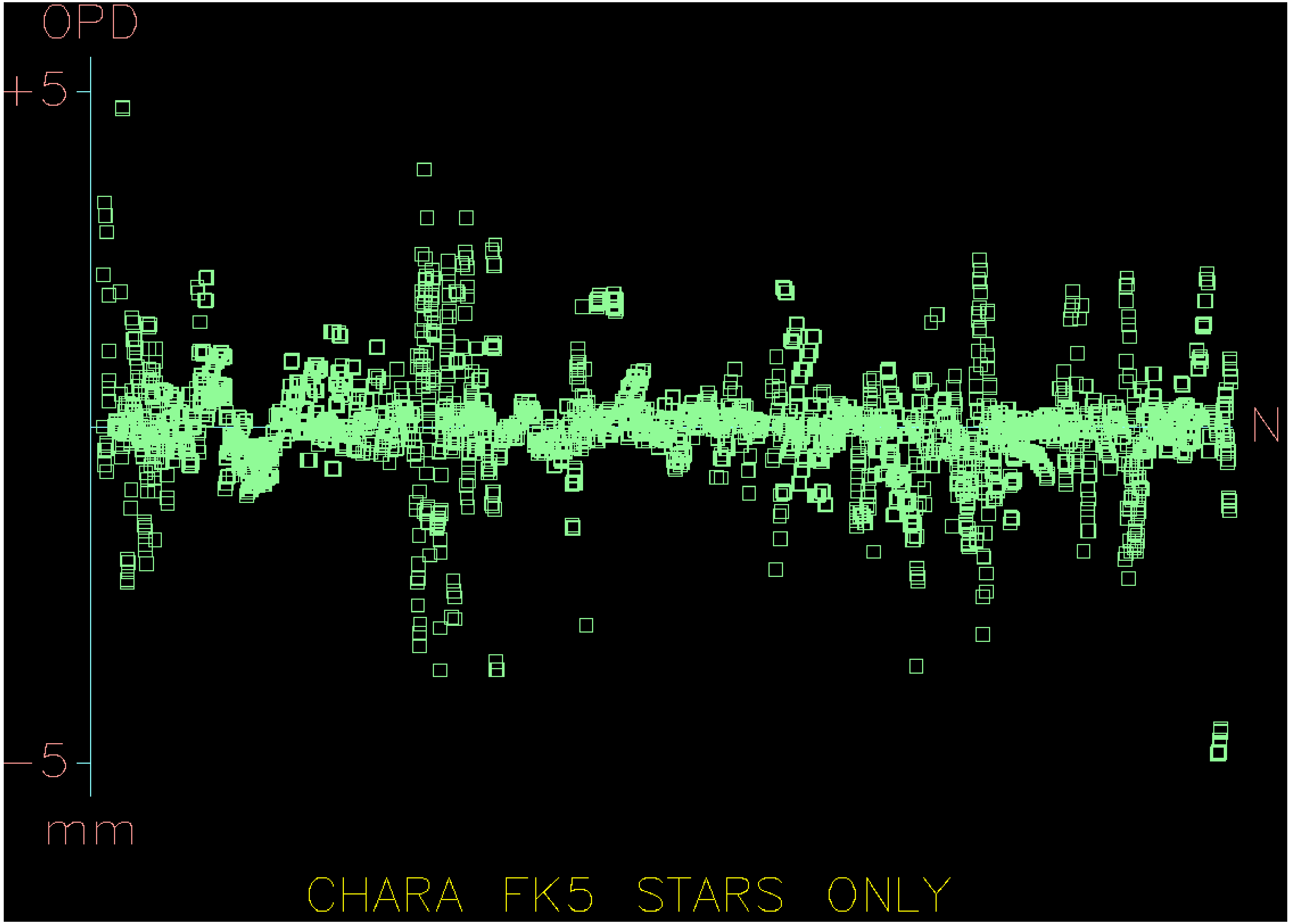
While adding "swash" terms helps a little, it is not clear that there are large dependencies on either Azimuth or Elevation



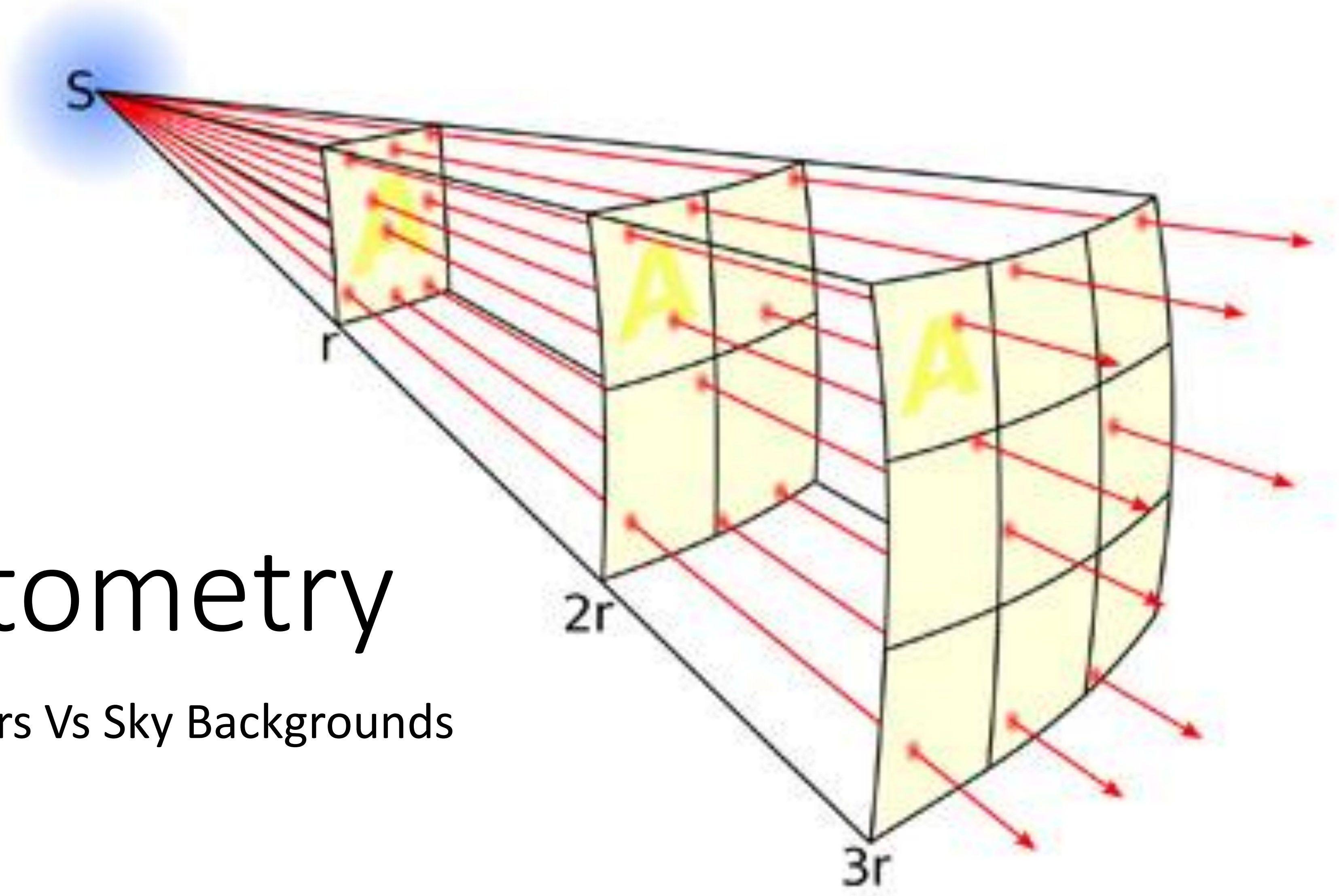


```
# For telescope S1: value stddev delta (total delta 0.000)
XOFFSET            0.000     0.000     0.000
YOFFSET            0.000     0.000     0.000
ZOFFSET            0.000     0.000     0.000
LIGHT              0.000     0.000     0.000
# For telescope S2: value stddev delta (total delta 3404.601)
XOFFSET     -5746282.897   170.985  -573.993
YOFFSET     33578980.283   238.286  2581.163
ZOFFSET       637663.785   427.495 -2144.630
LIGHT        4078278.214  1769.452  3491.311
# For telescope E1: value stddev delta (total delta 6229.556)
XOFFSET    125335734.230    99.278 -3256.357
YOFFSET    305929590.878   171.231  4661.947
ZOFFSET     -5908834.423   285.708 -2543.572
LIGHT       11249956.445  2876.298 11567.467
# For telescope E2: value stddev delta (total delta 5472.118)
XOFFSET     70395896.102   151.534 -1048.116
YOFFSET    269713038.236   196.700  2294.672
ZOFFSET     -2794190.855   418.089 -4855.925
LIGHT       22688283.053  3195.580 11070.420
# For telescope W1: value stddev delta (total delta 1453.717)
XOFFSET   -175072037.612   139.893   109.630
YOFFSET    216320138.656   194.197   800.512
ZOFFSET    -10792256.870   400.503  1208.493
LIGHT       27318223.500  1274.803 -15874.790
# For telescope W2: value stddev delta (total delta 3275.323)
XOFFSET    -69091731.276   151.752   468.339
YOFFSET    199332188.502   198.549  3229.720
ZOFFSET       464921.082   378.222   278.042
LIGHT      -10871813.885  2242.693 15193.786
```

- The "best" solution from 2017 data moves each scope by a few mm.
- Some internal paths changed by cm.
- In particular W1 got shorter and W2 got larger and both E1 and E2 got longer.



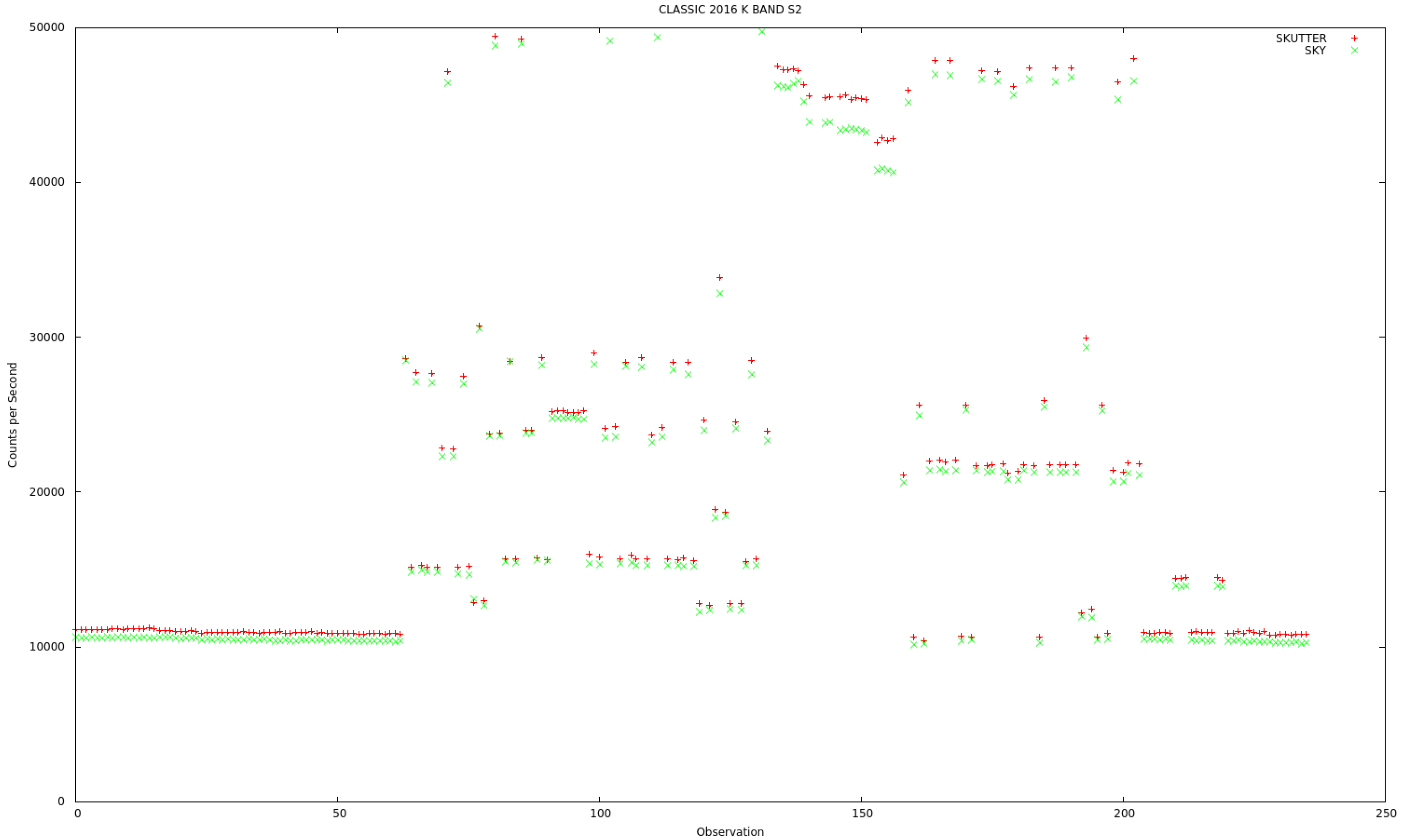
- Restricting the data to errors < 5mm gives a fit with an RMS error of 1471 microns.
- There are places where metrology has obviously failed.
- What are the vertical areas?
- What's causing the "wiggles"
- We need a more sophisticated approach to editing the data.

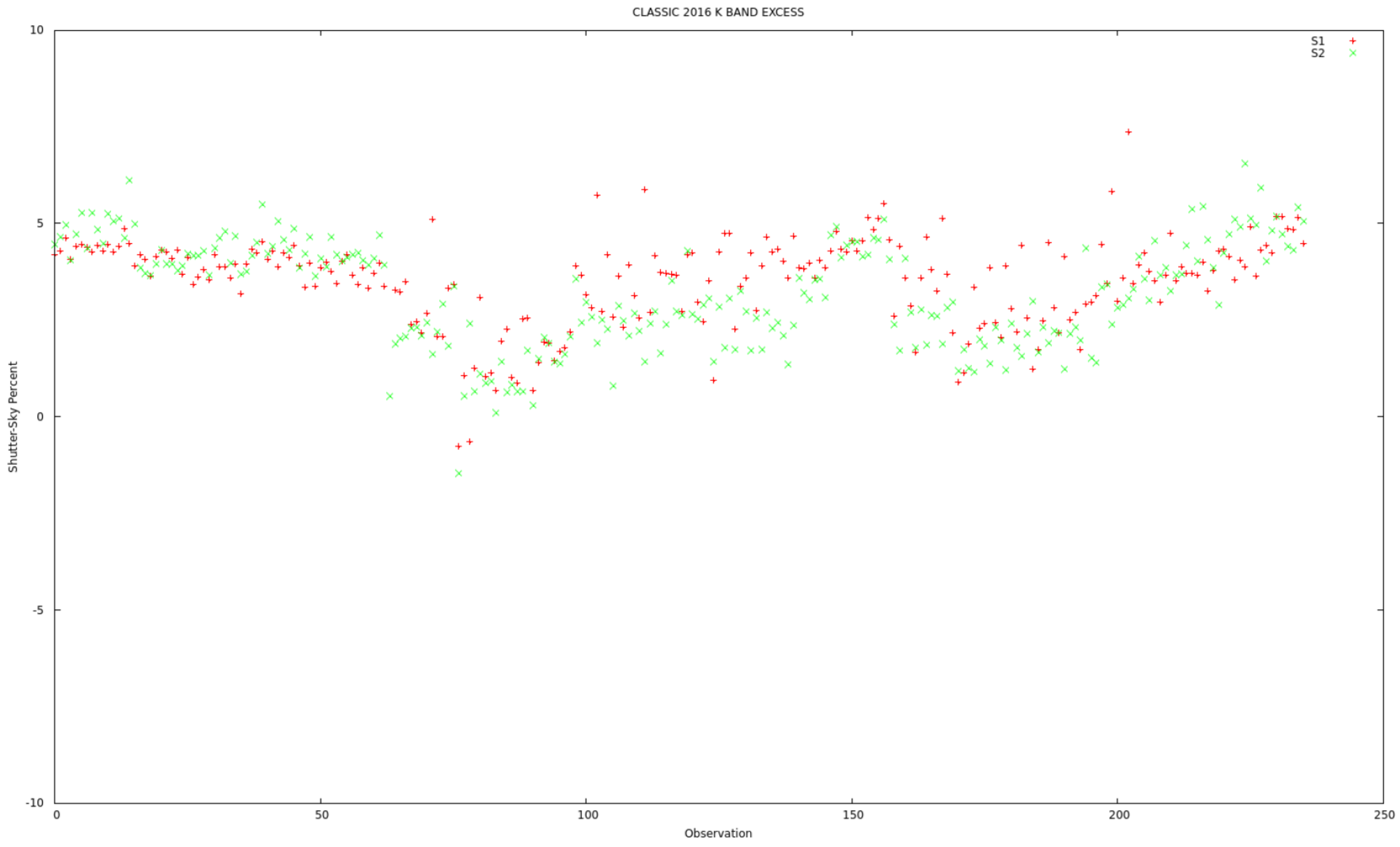


Photometry

Warm Shutters Vs Sky Backgrounds


CLASSIC 2016 H BAND S2
SHUTTER
SKY
Counts per Second
Observation
0
1000
2000
3000
4000
5000
6000
0
200
400
600
800
1000
1200


CLASSIC 2016 K BAND S2
SKUTTER
SKY
Counts per Second
Observation
0
10000
20000
30000
40000
50000
0
50
100
150
200
250



- It should not surprise us that there is background light in K band.
- Nor is it strange that our shutters are warmer than the sky.
- The excess from the shutters appears to be consistently about 4%.
- For very faint calibrators this can cause a systematic bias making stars appear larger than they are.
- How important is this in fiber based beam combiners?
- Classic/Climb/Fluor reduction software can now use the “off-star” data, or if that isn’t there estimate the excess.