



TESTING OF THE HALL-D GONIOMETER

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SPECIFICATIONS AND GOALS

| Motion Axis | Stage type | Limits | Minimal increment | Unidirectional Repeatability |
|-------------|------------------------------|------------------|-------------------|------------------------------|
| X | MTM200PE1V6 | -100 to +100 mm | 0.001 mm | 0.0015 mm |
| Y | MTM100PE1V6 | -50 to +50 mm | 0.001 mm | 0.0015 mm |
| rZ (Roll) | URS75BPPV6 | 0 to 360 deg | 0.2 mdeg | 4.0 mdeg |
| rX (Pitch) | BGS80PP-V6 | -45 to +45 deg | 0.1 mdeg | 1.0 mdeg |
| rY (Yaw) | URS150BPP-V6 | -170 to +170 deg | 0.2 mdeg | 10.0 mdeg |

https://halldweb1.jlab.org/wiki/index.php/Motion_Control_Applications#Goniometer_Application

- Verify the goniometer satisfies the requirements on minimal increments and repeatability in [Yaw](#) and [Pitch](#)

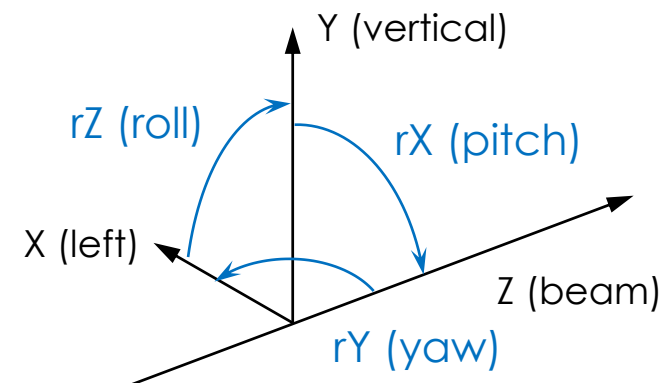
- Logbook <https://halldweb1.jlab.org/elog-halld/Goniometer/>

- Control Software

- Hovanes Egiyan and Vanik Kakoyan

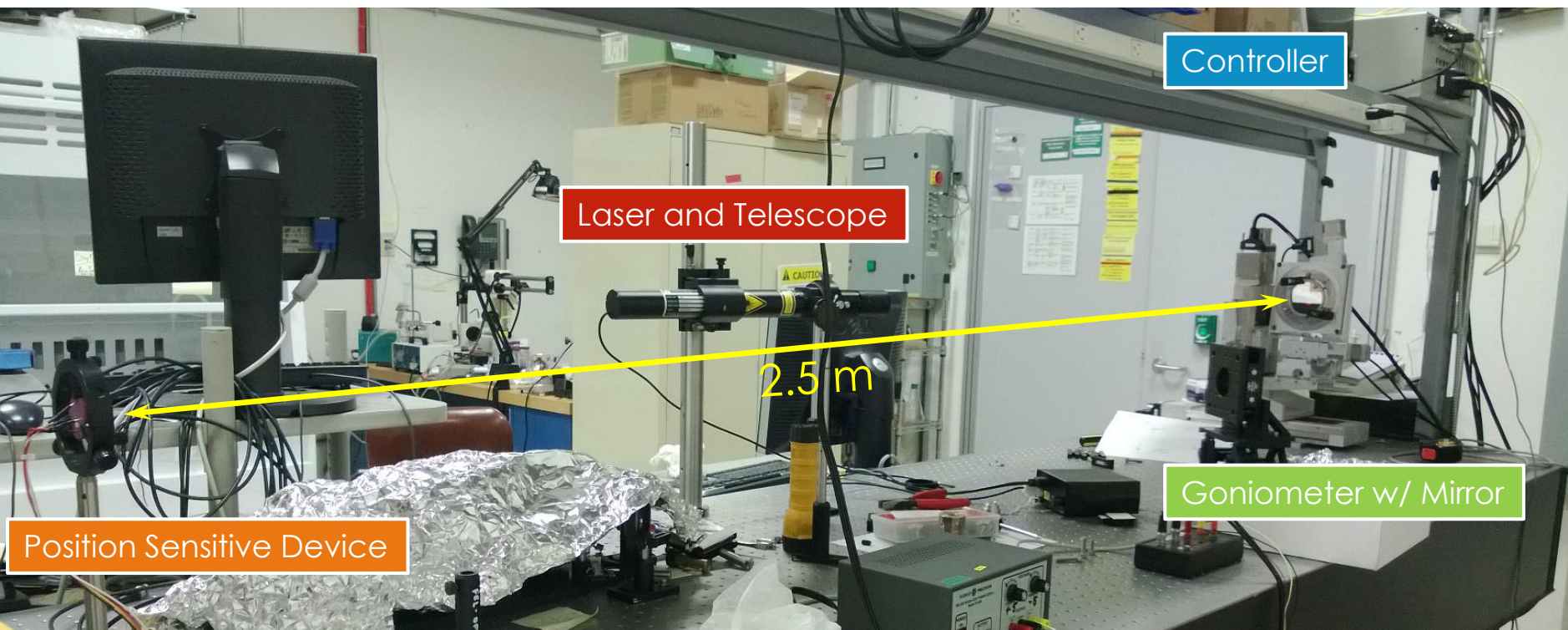
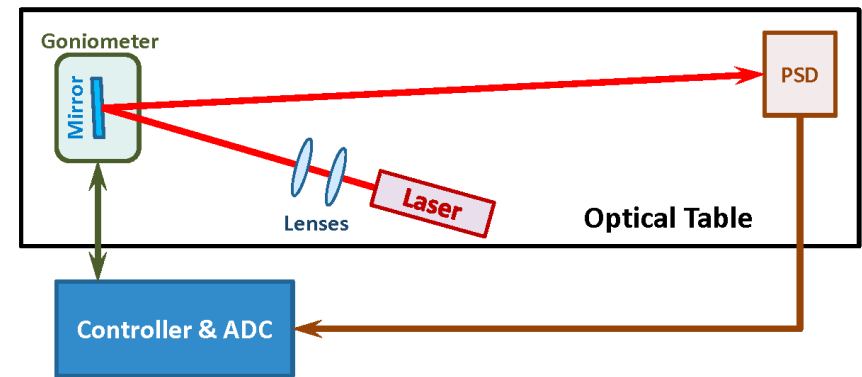
- Optics Setup

- Ziheng Chen, Yi Qiang and Shukui Zhang

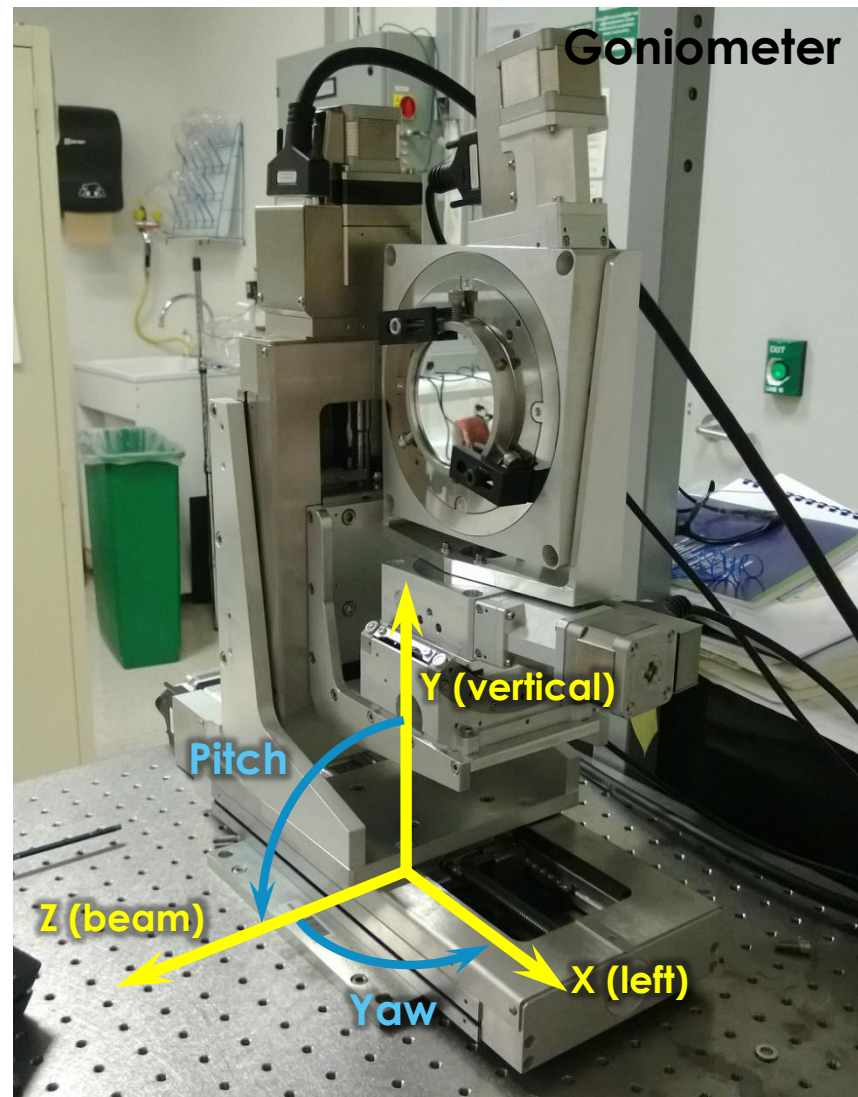


SETUP AT FEL

- Designing Optics
 - Goal: $0.1 \text{ mdeg} = 1.7 \mu\text{rad}$
 - Long path length \sim a few meters
 - Precision position sensor \sim a few μm
 - Focusing optics

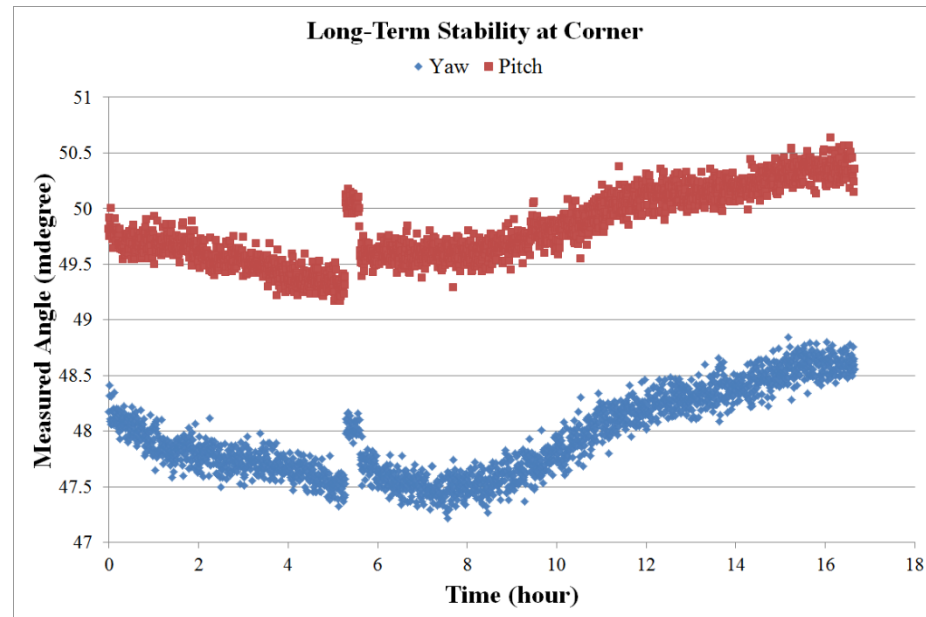
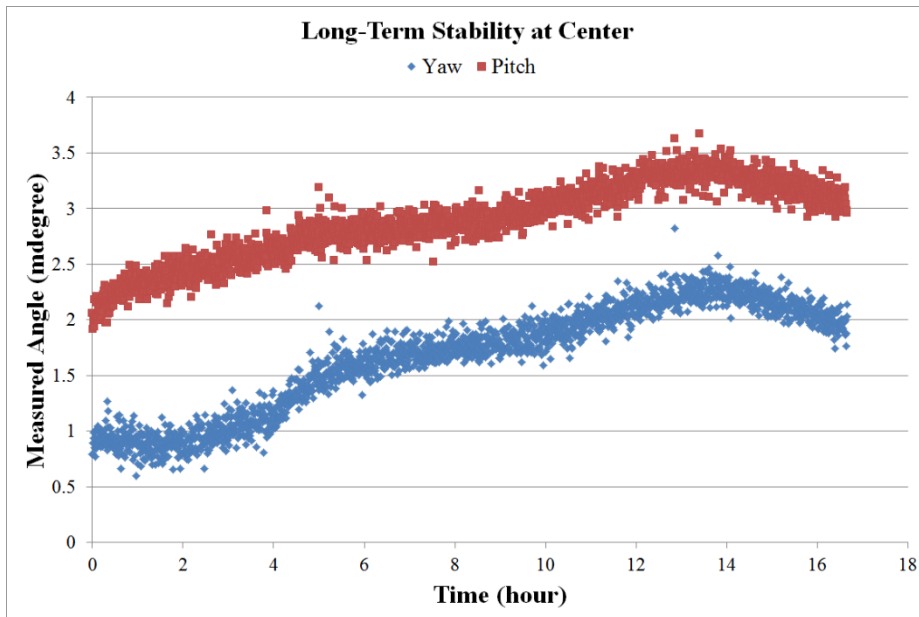


MORE PRETTY PICTURES



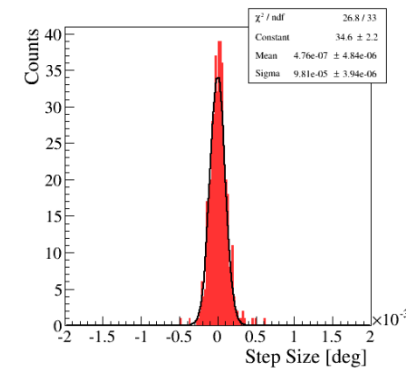
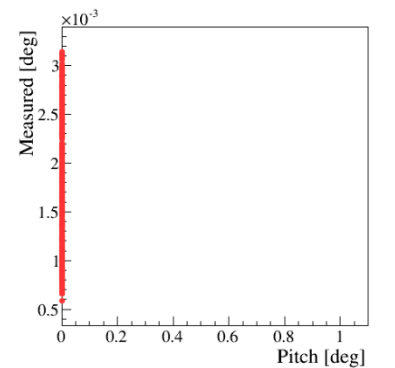
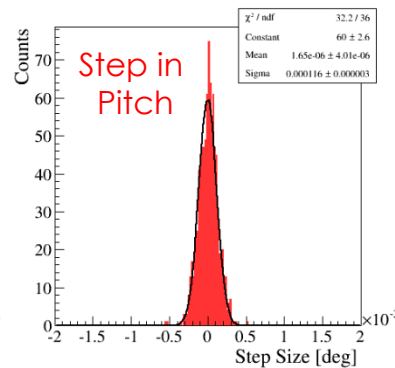
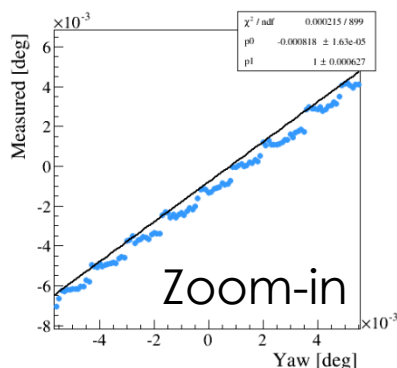
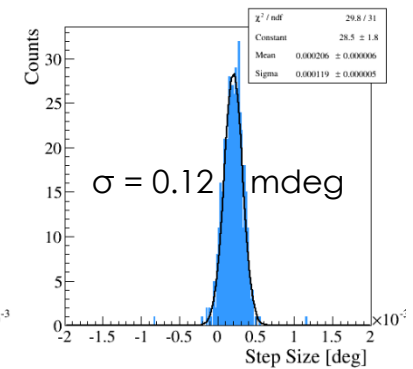
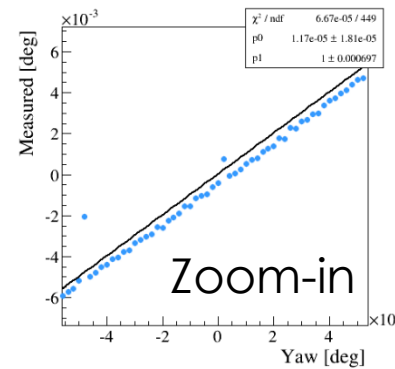
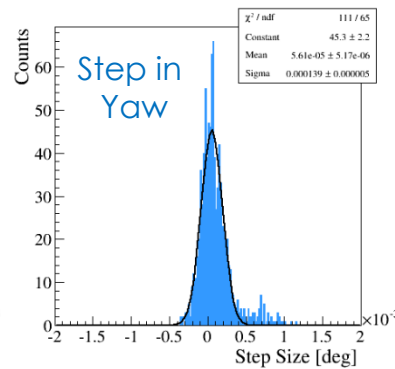
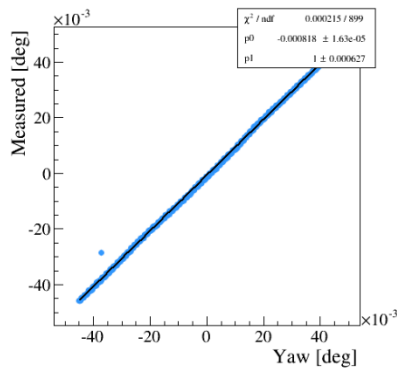
DRIFTING AND UNCERTAINTY OF READOUT

- Long-term drifting < 0.15 mdeg/hour



- Uncertainty of the readout measured at different positions of the sensor by repeating reading for many times
 - Uncertainty = 0.12 mdeg
 - Negligible position dependence

- Performed several fine scans with different step sizes:
 - 0.1, 0.2, 0.4 and 0.8 mdeg between -50 to 50 mdeg
 - Clear stepping structure with 0.1 mdeg ~ every 1.25 mdeg
 - Smooth movement with step size equal or larger than 0.2 mdeg
 - Variation in step size: 0.12 mdeg, independent on step size



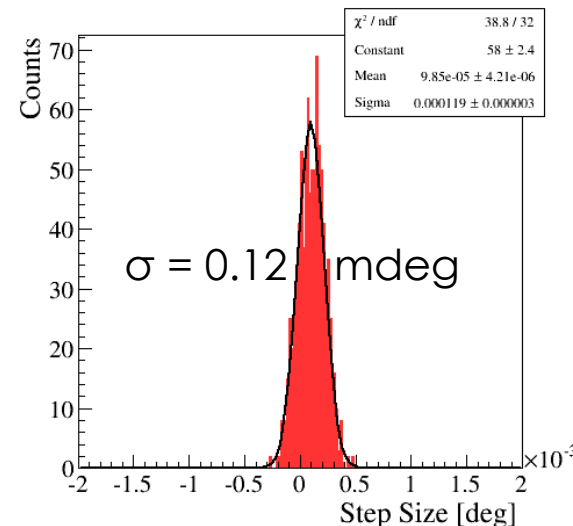
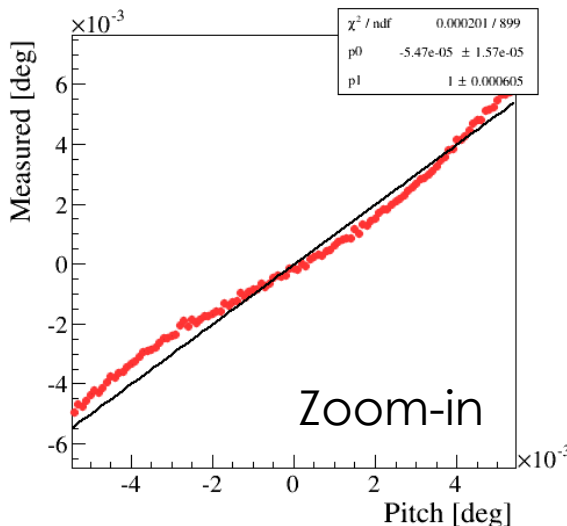
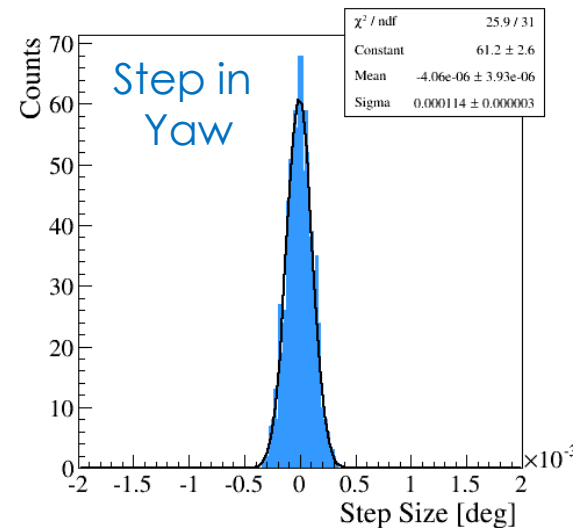
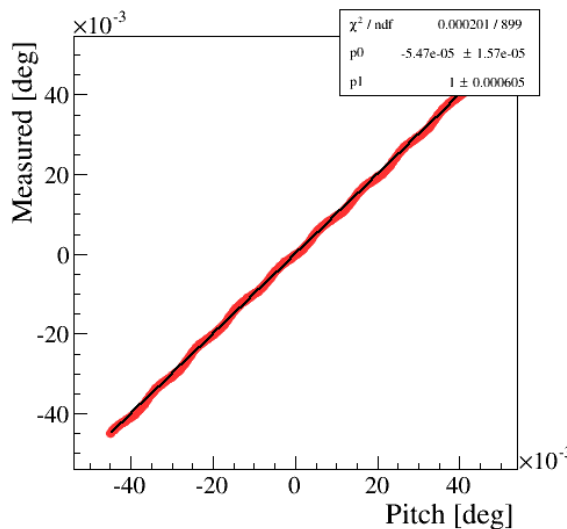
Step = 0.1 mdeg

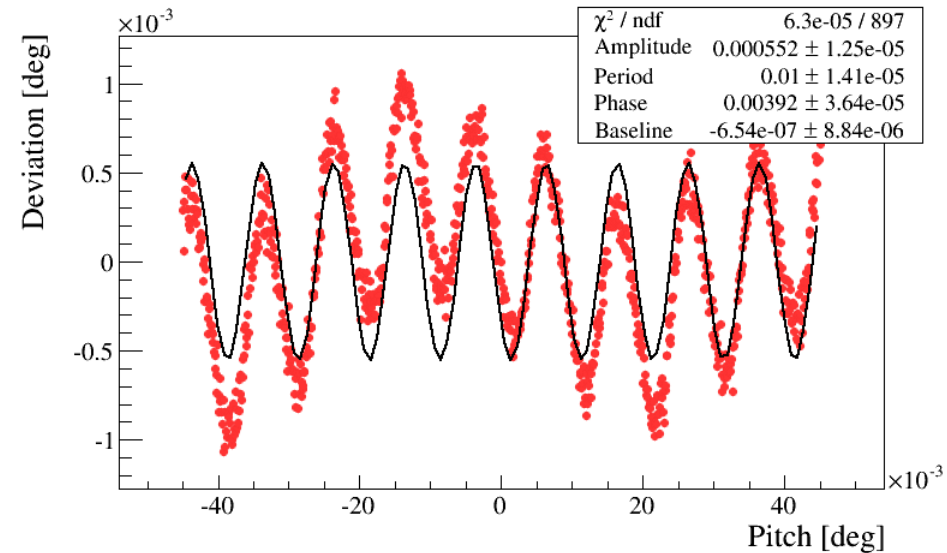
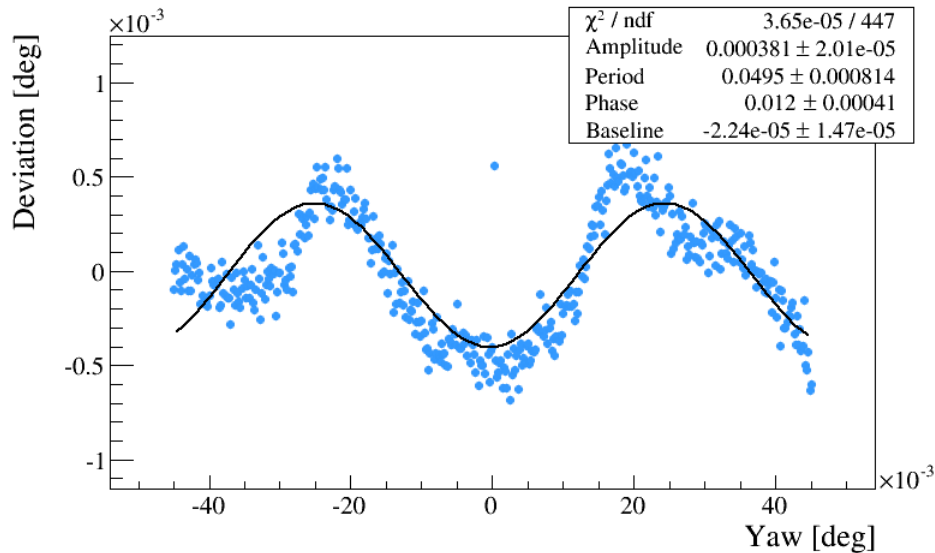
Step = 0.2 mdeg

PITCH SCAN

- 0.1 mdeg step size
- Smooth movement
- Variation in step size:
 - 0.12 mdeg
- Clear wobbling seen

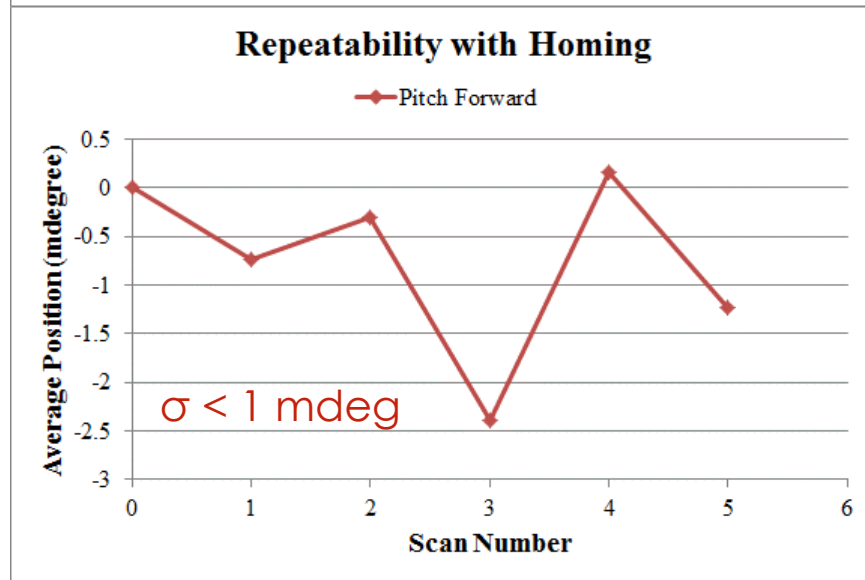
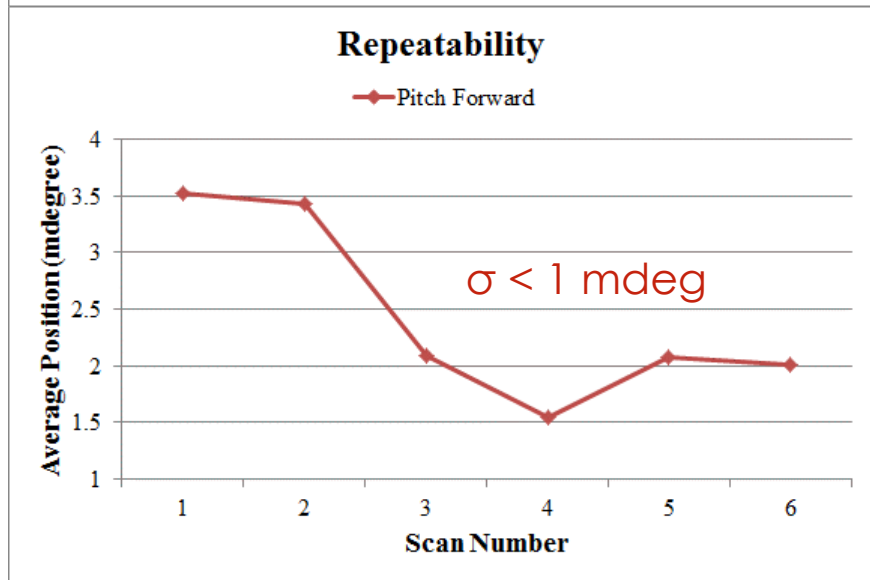
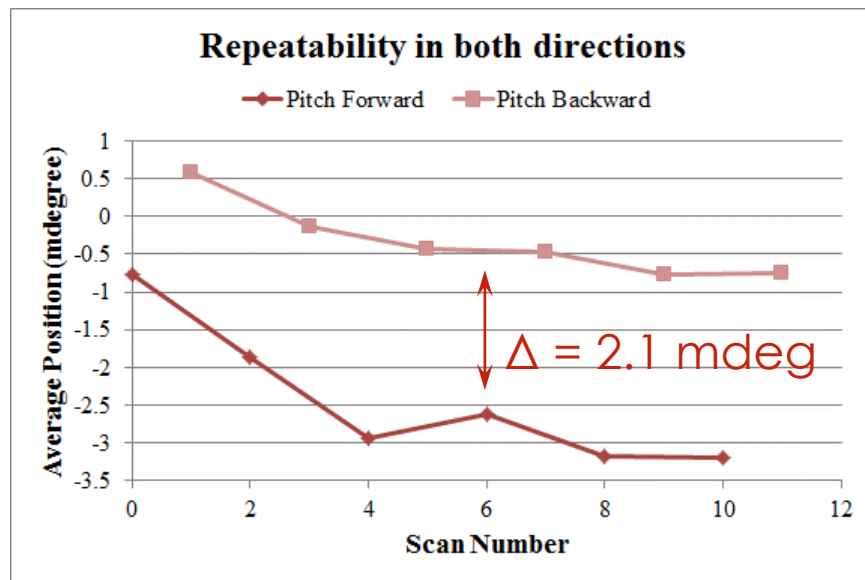
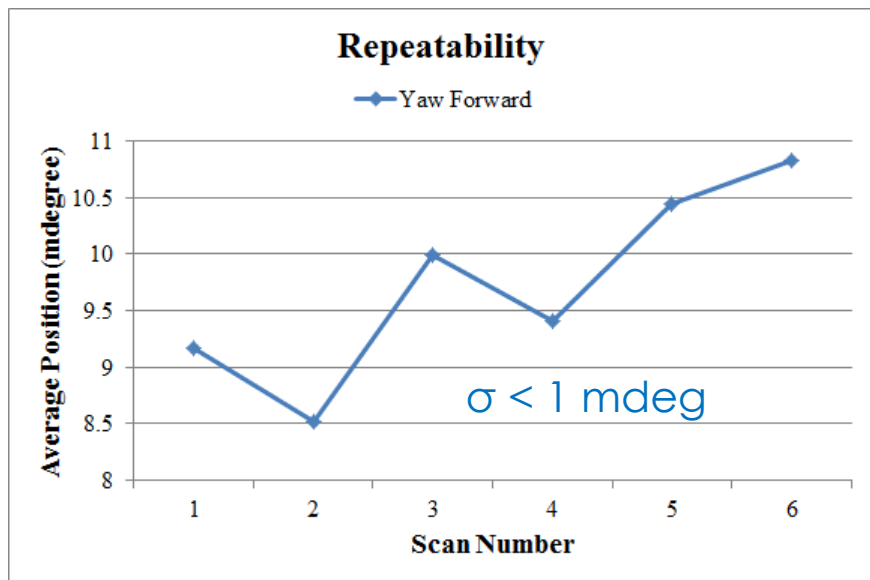
Step = 0.1 mdeg





- Both Axes show wobbling
- Yaw: amplitude 0.4 mdeg, period 50 mdeg
- Pitch: amplitude 0.6 mdeg, period 10 mdeg

REPEATABILITY



- The Yaw and Pitch movement of the Goniometer have been tested and satisfy our specification
- Minimum Step Size
 - Yaw: 0.1 mdeg (1.7 μ rad), Pitch: 0.2 mdeg (3.4 μ rad)
 - Uncertainty better than 0.12 mdeg
- Repeatability
 - < 1 mdeg in one direction regardless of homing, 2 mdeg offset with opposite directions
- Wobbling
 - Yaw 0.4 mdeg and Pitch 0.5 mdeg with different periods
- Recommendation to operation
 - Coherent peak should still be visible in microscope after resetting the motor position to previous value, but re-tuning is needed to precisely restore the peak position