

Recent Quartz Irradiations and dose simulation

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Students involved:

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Outline

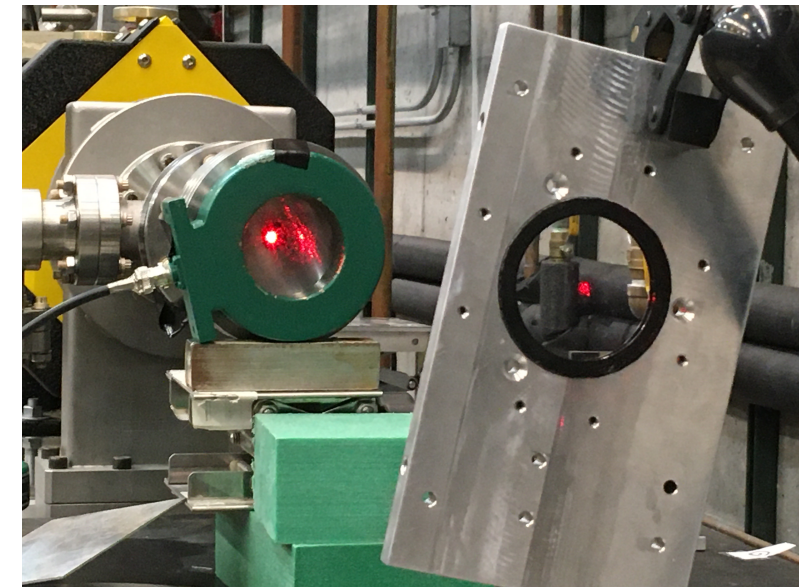
- Beam and sample setup
- Optical transmission measurement apparatus
- G4 dose simulation and benchmarking
- Preliminary Results (relative transmission loss and syst errors)
 - Three Corning samples: 7980 UV Grade F, Eximer, and SK-1300
 - Fused silica LP filter (400 nm)
- Summary and upcoming tests

Beam and Sample Setup

- Very preliminary results from May 19, 2021 quartz irradiation run at Idaho Accel. Center
- Used 25 MeV machine 0 deg port with: 8 MeV peak energy, 45 mA peak current, 700 ns pulse width and 200 Hz rep rate.
- Corning and Ohara samples: 2 cm diameter by 5 cm long; polished on flat ends only
 - Samples are placed 50 cm from beam exit window



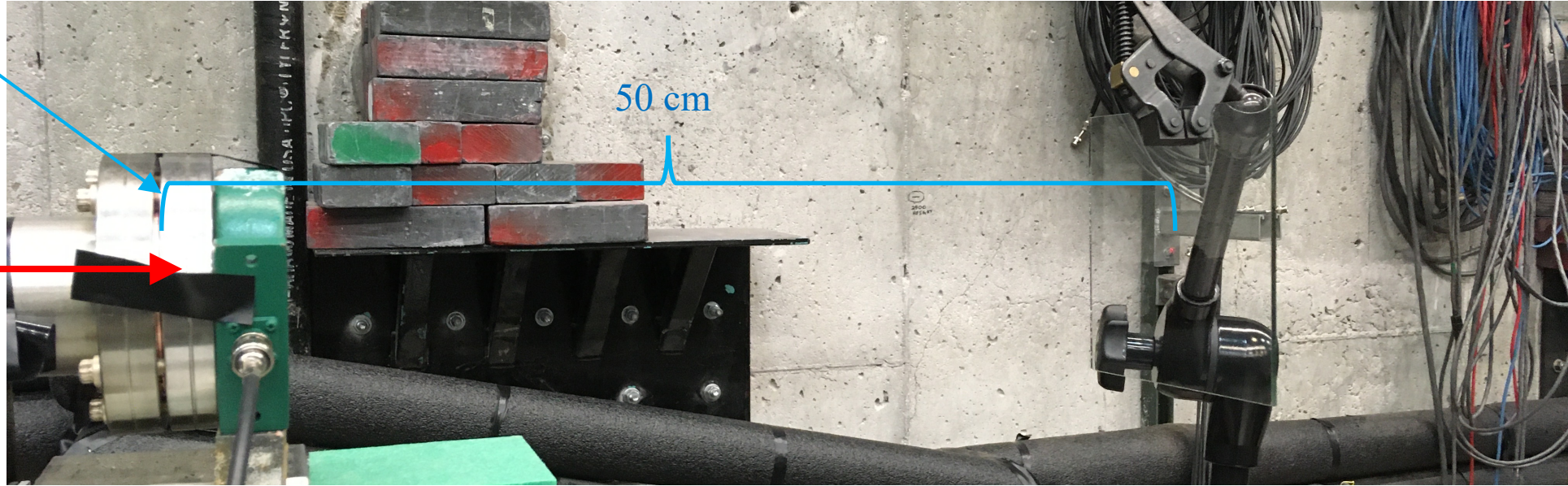
Longpass filter dose test



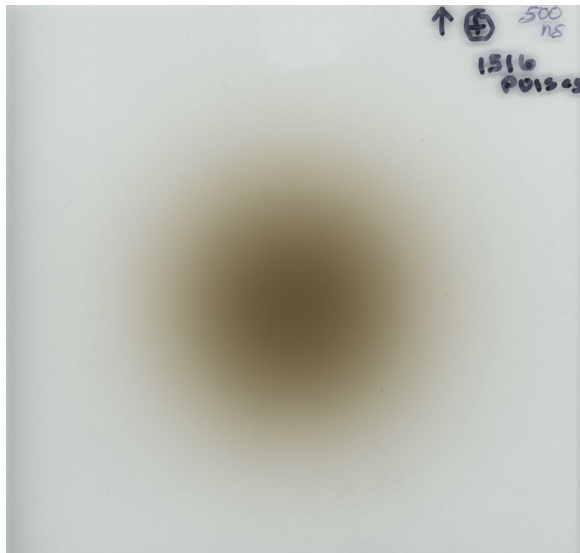
Beam spot size at sample

Titanium window

beam



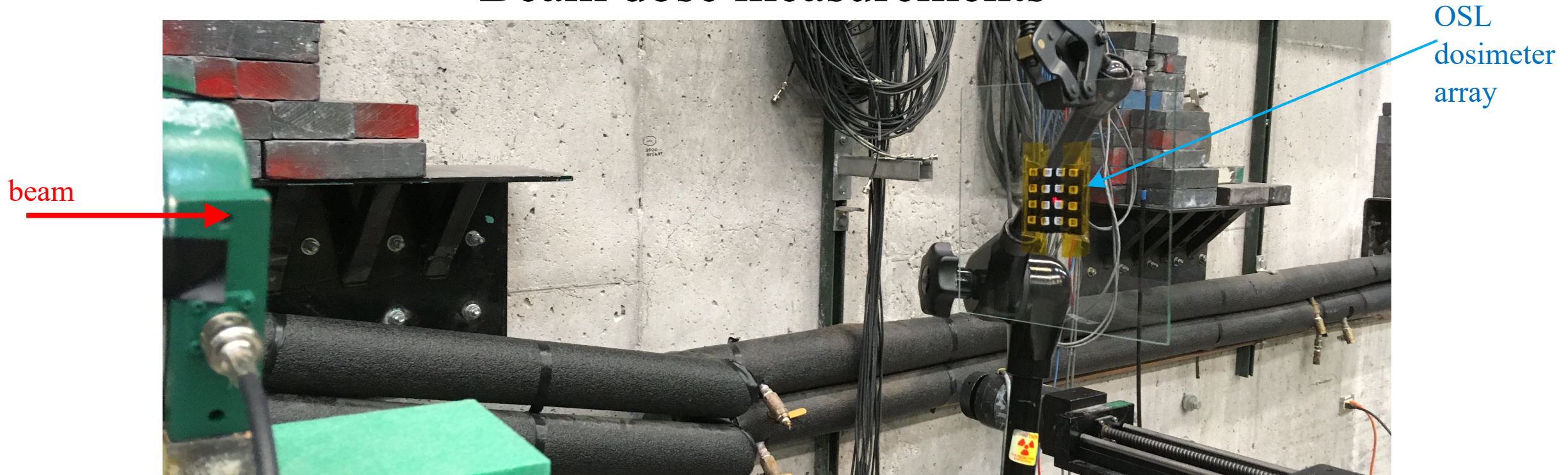
Glass slide



6 in

- Glass slide hit with 1500 beam pulses
- Slide is scanned and used to calibrate the simulated beamspace

Beam dose measurements

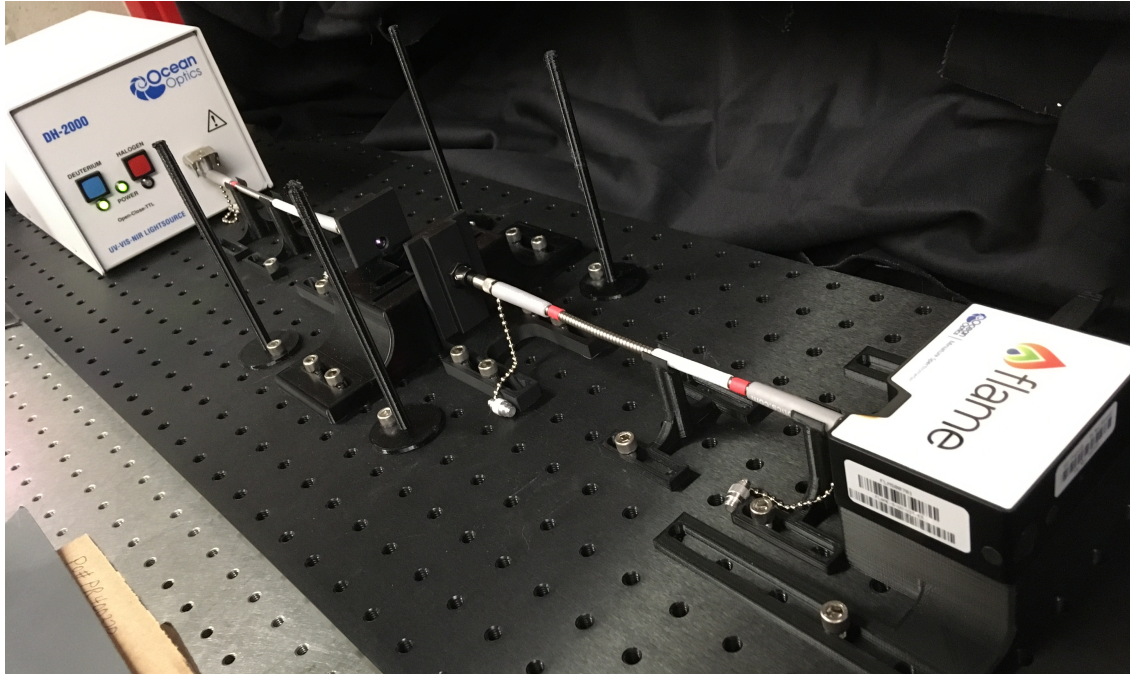


Sample 4x4 OSL array measurement (5 beam pulses)

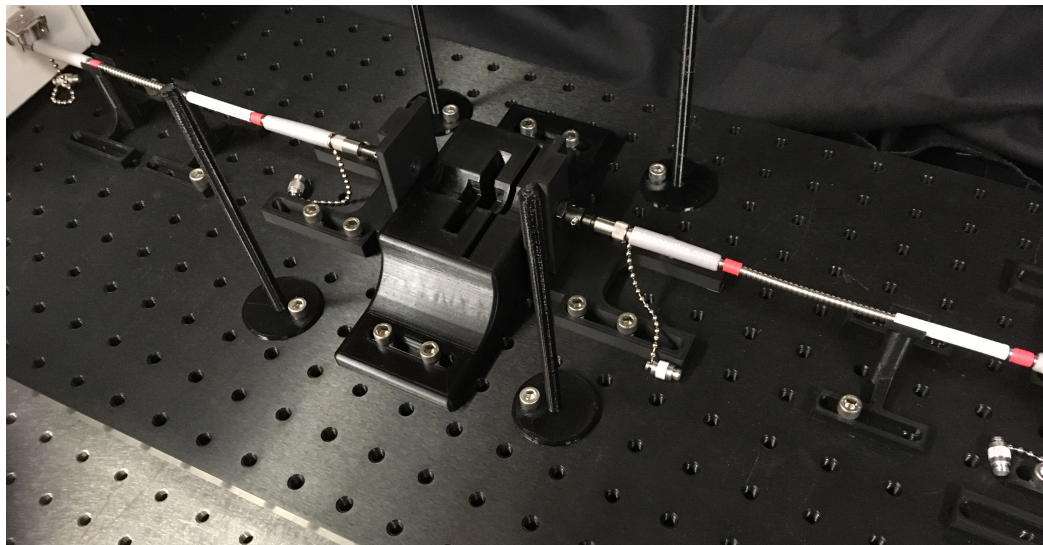
120 rad/pulse	137 rad/pulse	113 rad/pulse	86 rad/pulse
144 rad/pulse	224 rad/pulse	212 rad/pulse	120 rad/pulse
207 rad/pulse	271 rad/pulse	248 rad/pulse	161 rad/pulse
155 rad/pulse	188 rad/pulse	179 rad/pulse	123 rad/pulse

- Use Optical Stimulated Luminescence (OSL) dosimeters
- Setup 3x3 and 4x4 OSL arrays to map-out incident radiation field
- Uses microStar Reader to measure dose to OSLs
- These measurements used to benchmark G4 sim

Transmission Apparatus



- Ocean Optics Deuterium UV light source
- USB spectrometer
- Straight fiber optics; static arrangement for reduced systematics
- 3D printed nylon sample holder; accommodates all tested samples; also static
- More details in future talk

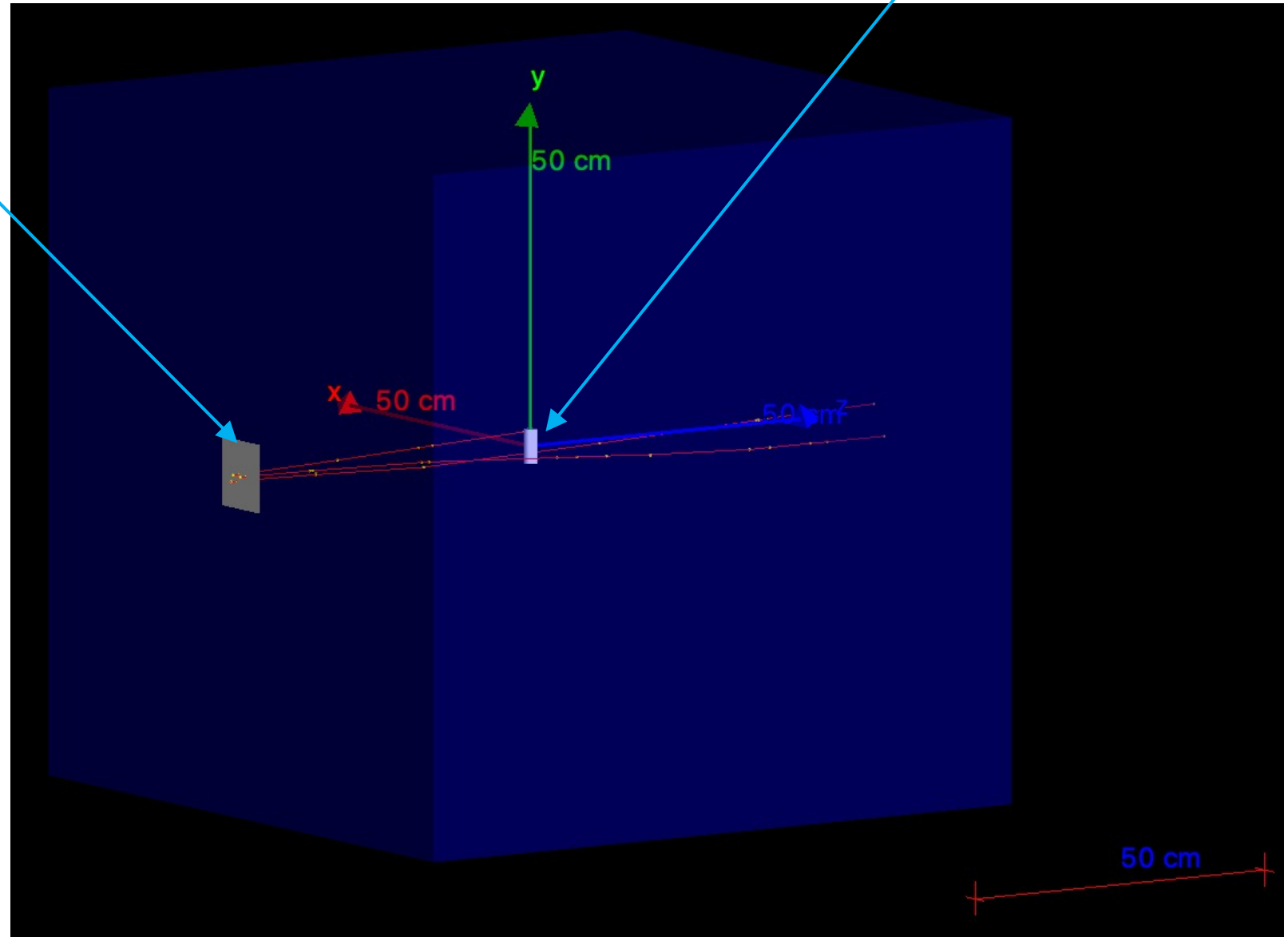


G4 Dose Simulation: geometry

Titanium
window

Sample

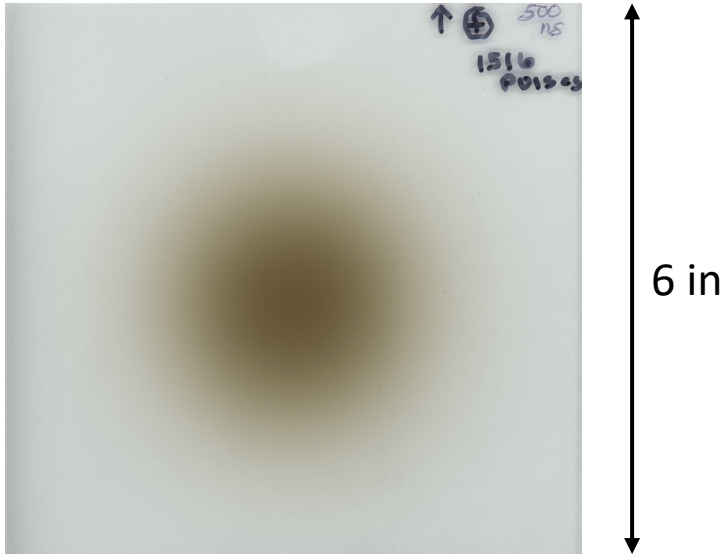
- Event visualization for 3 beam electrons
- Beam source is upstream of window
- Beam source is rastered over position to tune the beamspot size at sample
- Simulation is needed to translate the dose in the OSL to the dose in the sample



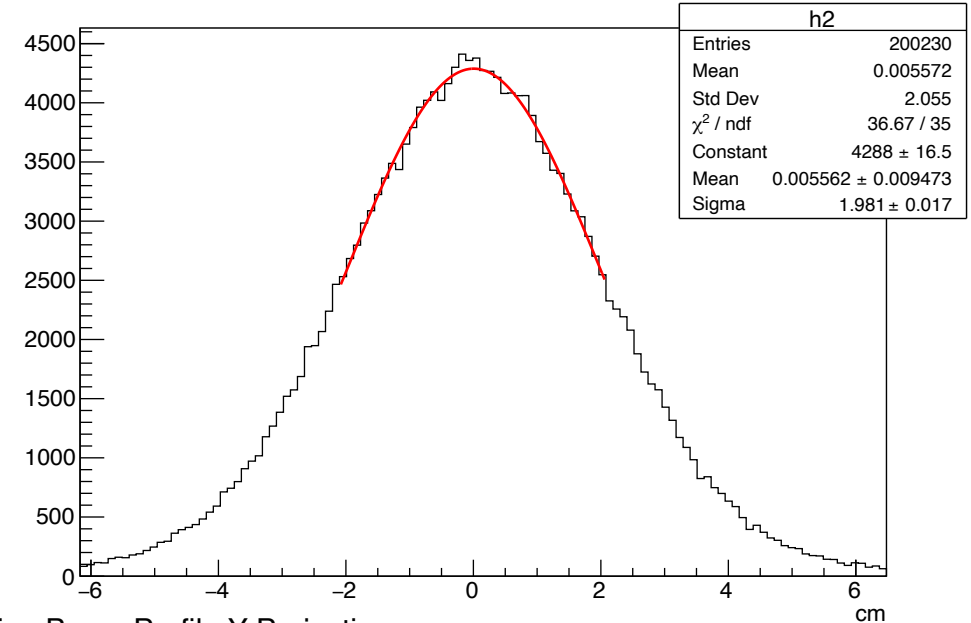
G4 Dose Simulation: beamspot

- Slide is scanned and used to calibrate the simulated beamspot

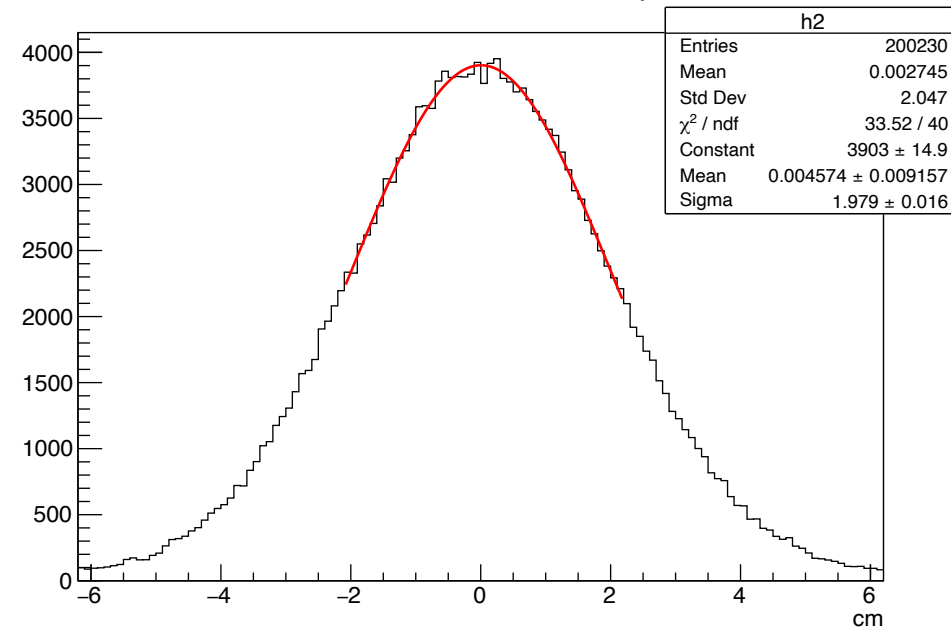
Glass slide



Simulation Beam Profile X Projection

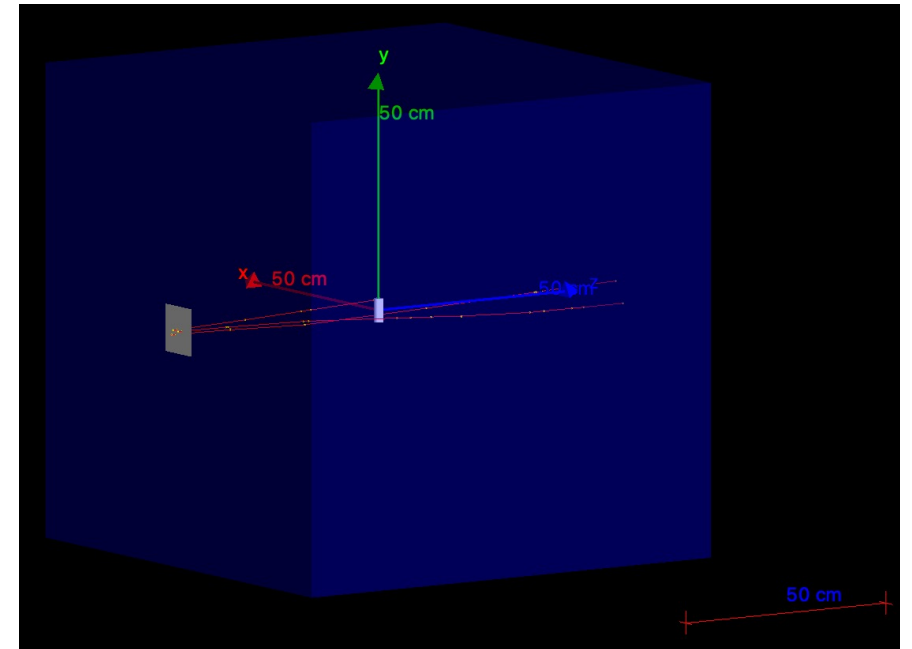


Simulation Beam Profile Y Projection



G4 Dose Simulation: OSL dose benchmarking

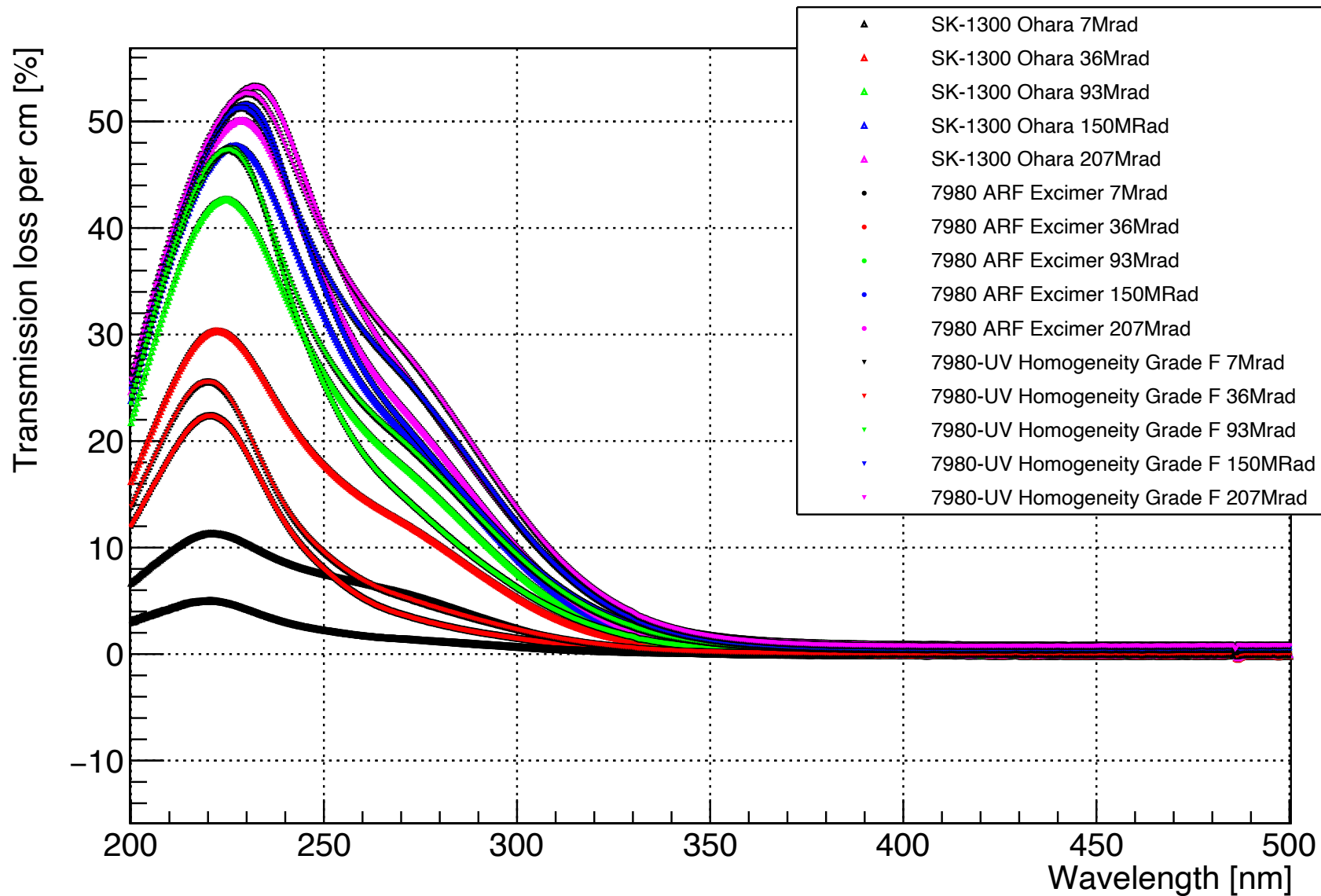
- For benchmarking the beam dose in the simulation, a simulated OSL crystal is centered at the sample location
- Using the calibrated beamspot size from the glass slide data, the simulation is run (few 100k electrons)
- The energy deposited in the crystal is tallied and a dose calculated. The dose is then compared with real data OSL measurements.
- The peak beam current, pulse width, and beamspot size are set to match the real experiment. The difference between the G4 and real data dose estimates gives a handle on our level of uncertainty.



- We are still working on getting this comparison and will acquire more diagnostic data on the accelerator operations during next beamtest -- to get a better handle on the sim parameters

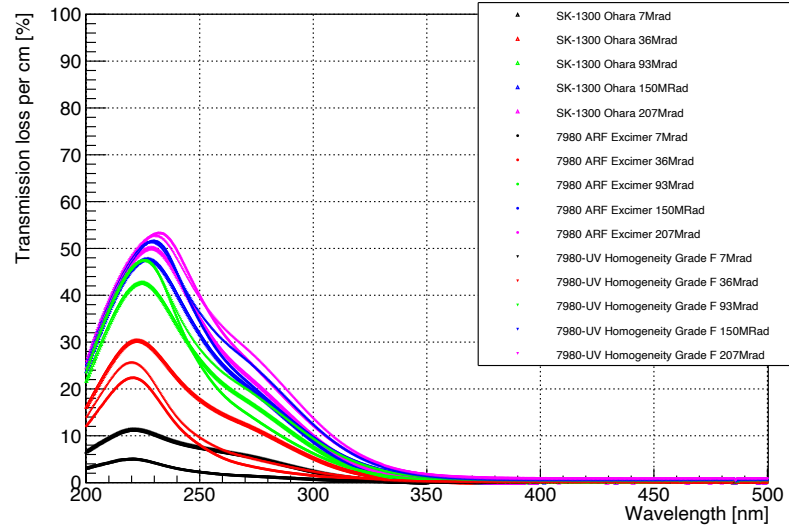
Preliminary Results for Corning samples

Transmission Loss Corning Quartz Samples

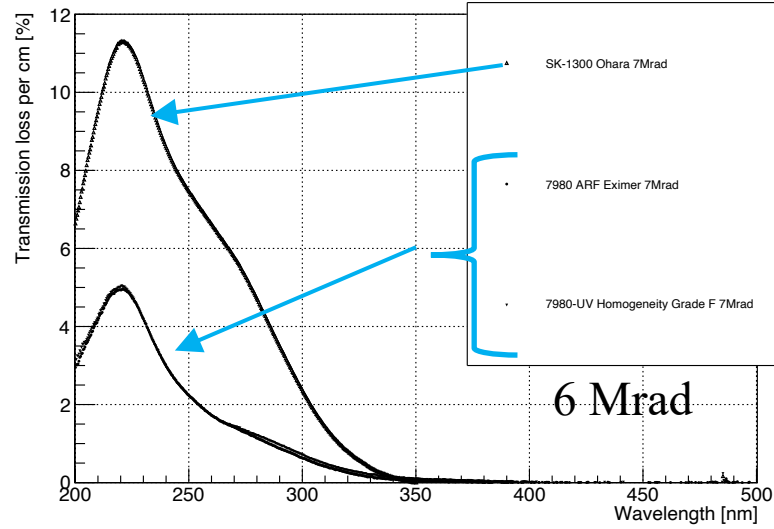


Preliminary Results for Corning samples

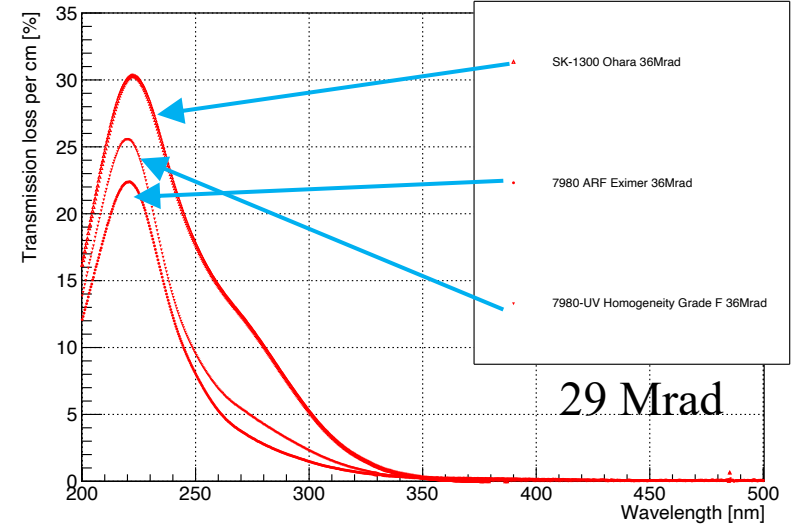
Transmission Loss Corning Quartz Samples



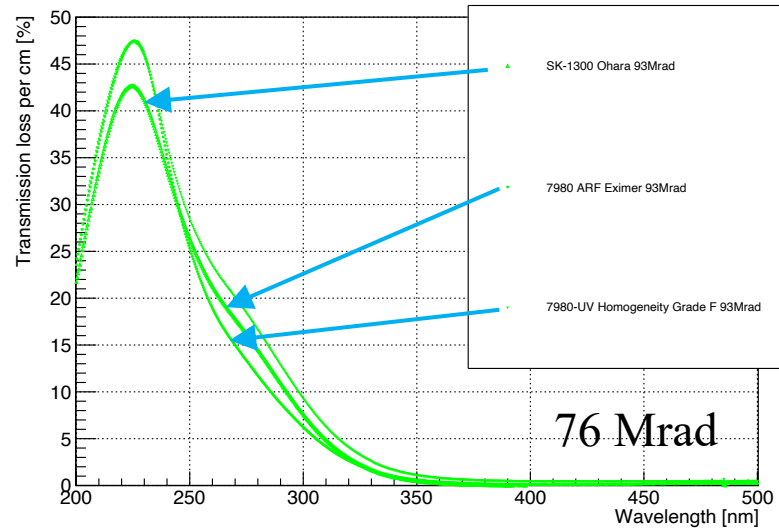
Transmission Loss Corning Quartz Samples



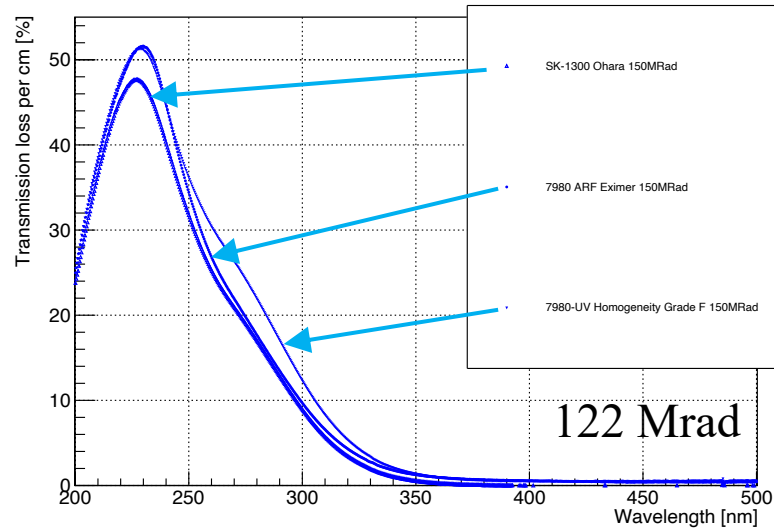
Transmission Loss Corning Quartz Samples



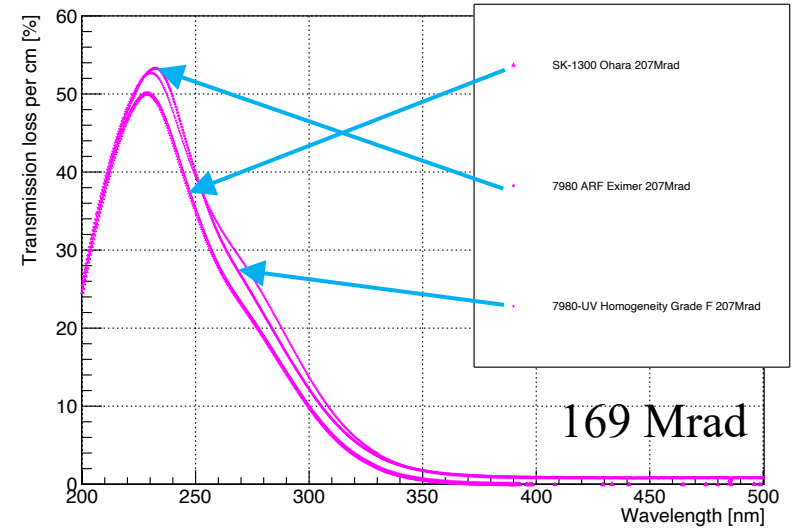
Transmission Loss Corning Quartz Samples



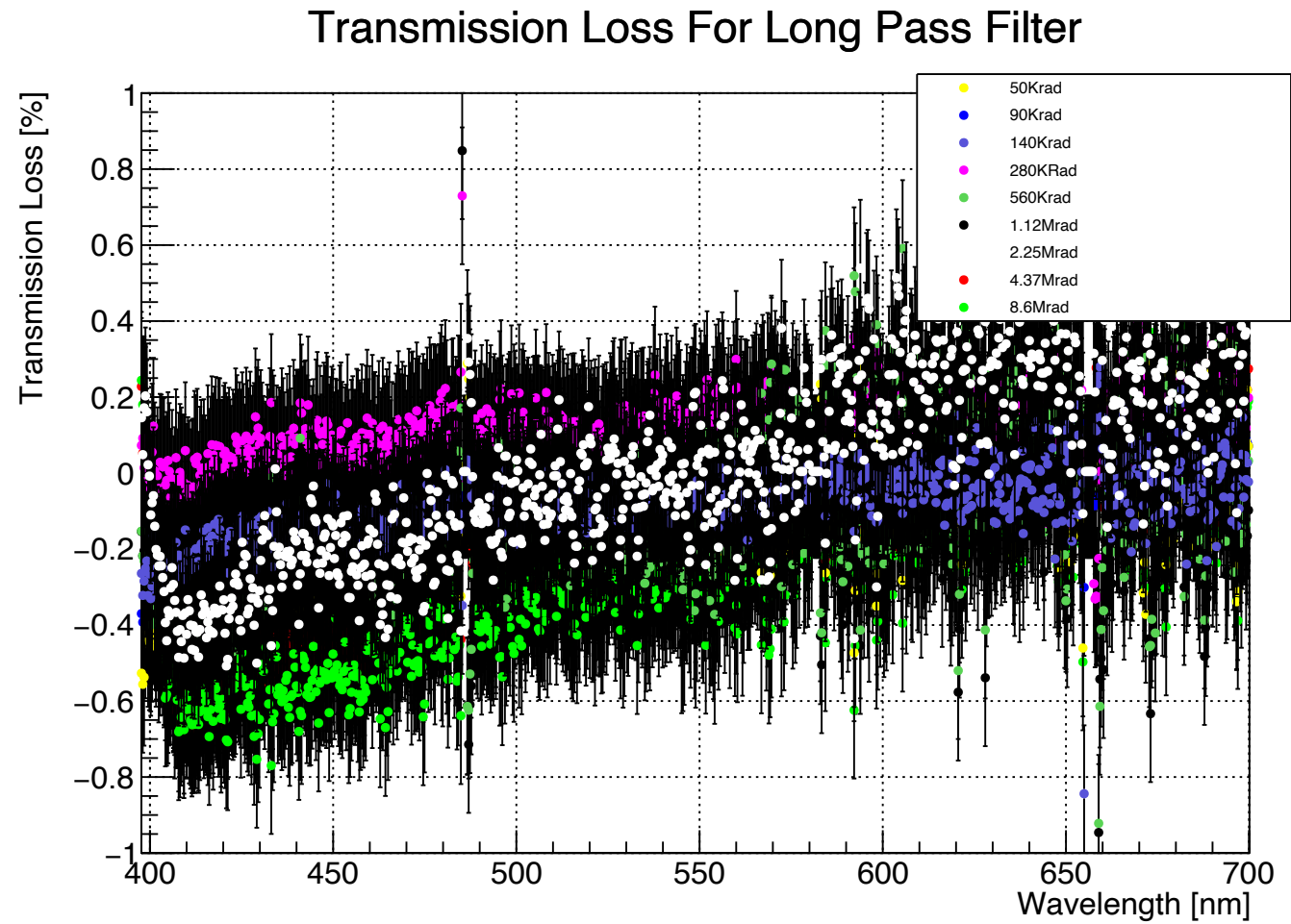
Transmission Loss Corning Quartz Samples



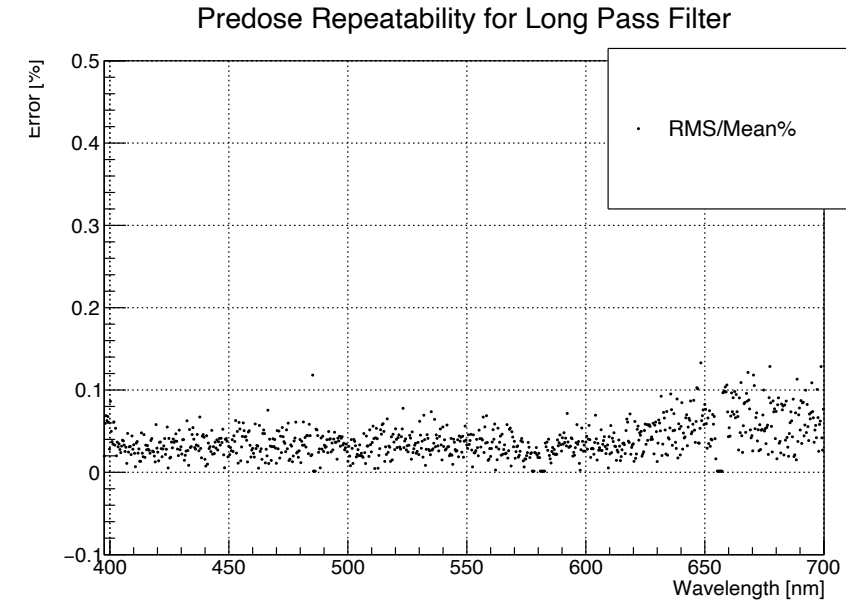
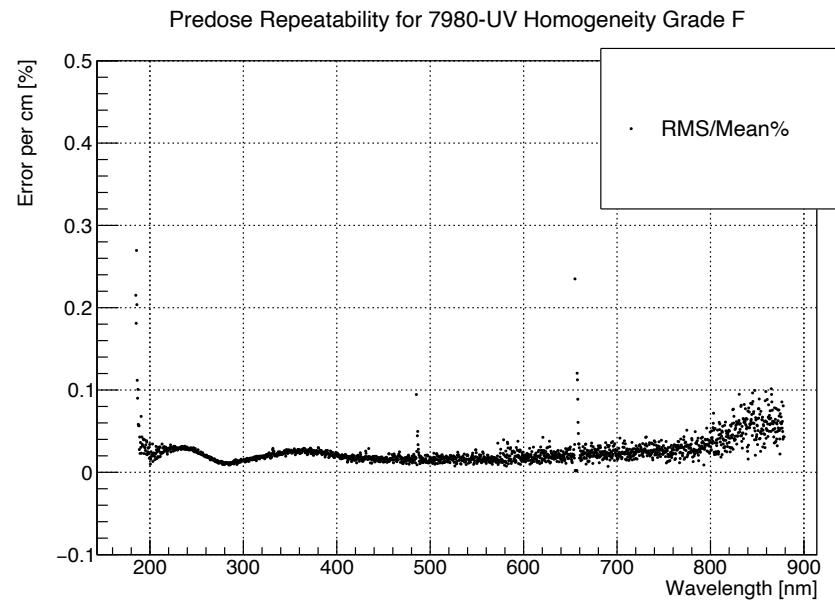
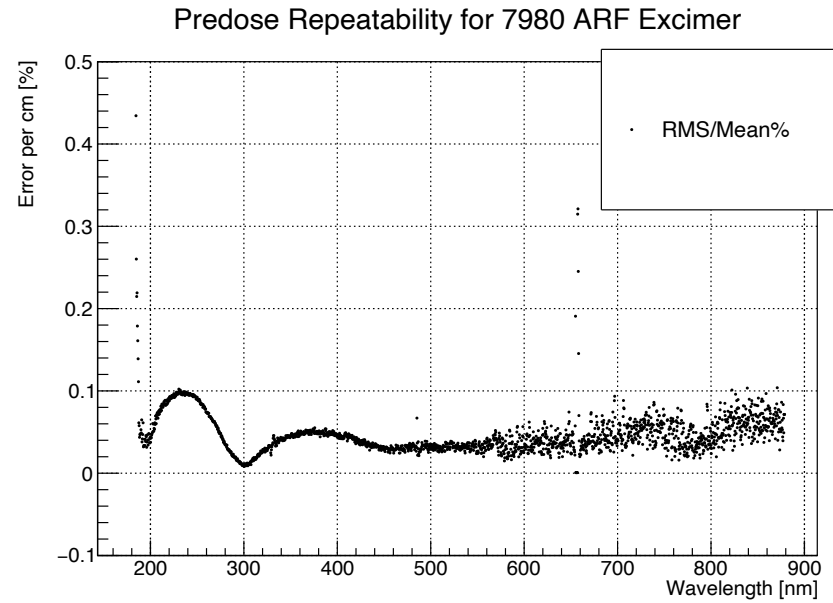
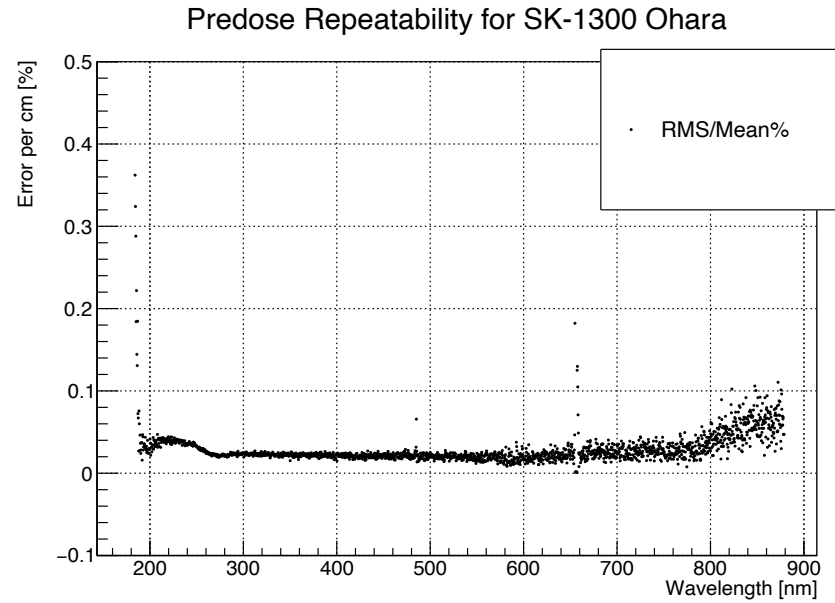
Transmission Loss Corning Quartz Samples



Preliminary Results for LP filter (400 nm)



Reproducibility Tests (not dominant error)



Summary

- Light source drift error (dominant) and possible correction are under investigation, but expected to be at $\sim 0.1\%$ level
- New apparatus (static arrangement) has greatly reduced repeatability systematics
- Corning transmission losses all fairly similar; at higher doses Ohara SK-1300 was best and at lower doses, Corning Eximer is best, and Corning UV Homogeneity Grade F is closest to Eximer; Note Ohara SK-1300 worst performer at low (~ 10 Mrad) dose; SK-1300 becomes better at ~ 100 Mrad
- Edmund Optics 2" longpass filter did not show any signs of losses up to the max tested which was ~ 8 Mrad (~ 2.5 Mrad peak/ $5 \times 5 \text{mm}^2$)
- Future dedicated dose calibration run is coming soon; recent measurements will be simulated to get better dose/pulse estimate for this data.