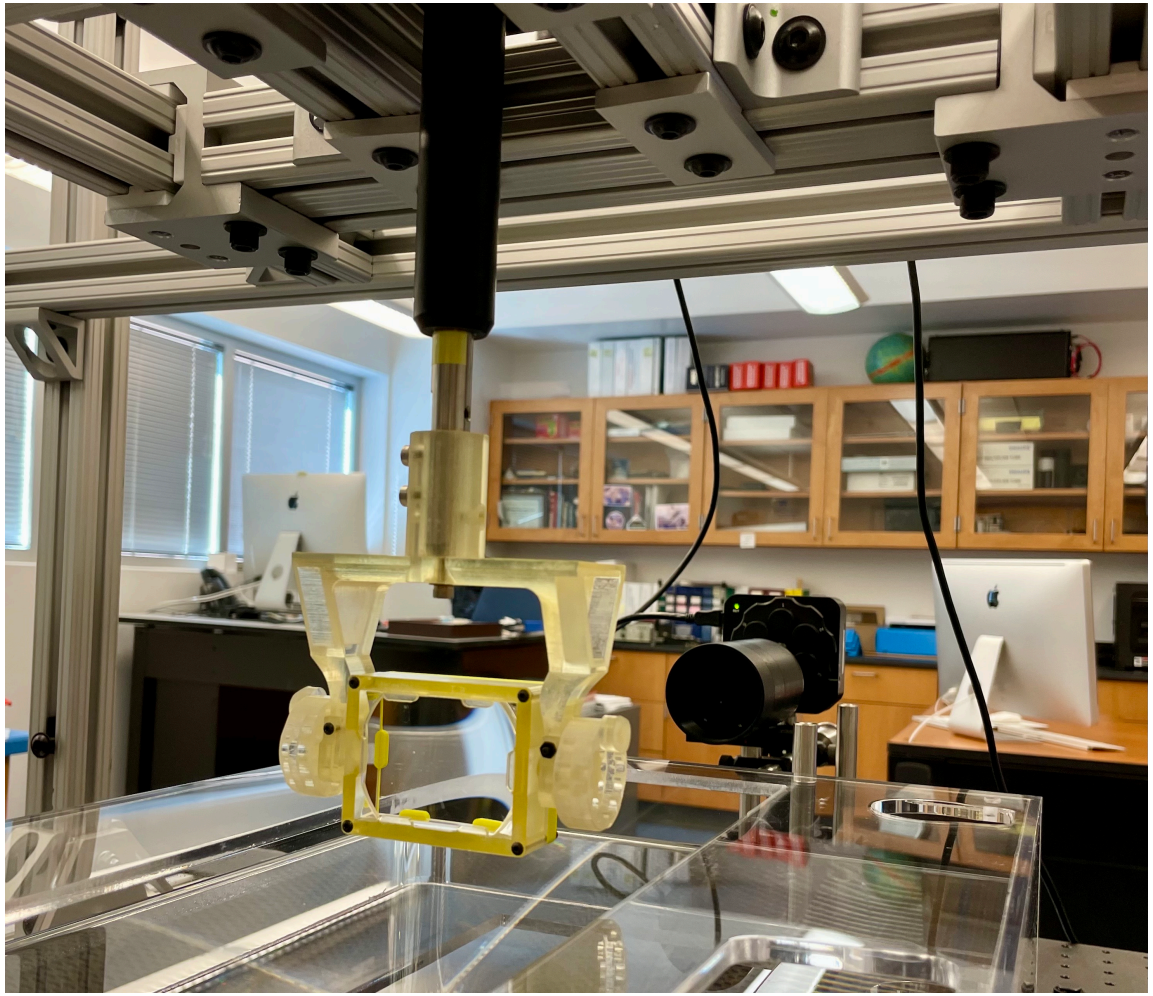
Mapping Fecal Plane of 3-layer Lens ☺

Greg Kalicy

CUA

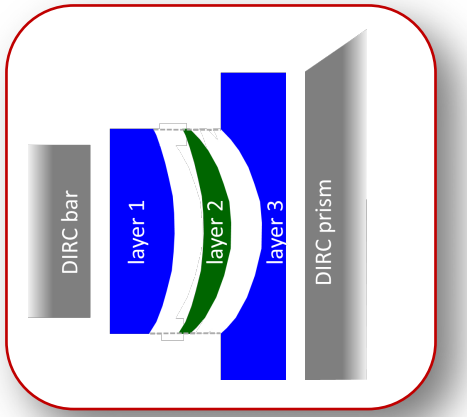


June 4 2026

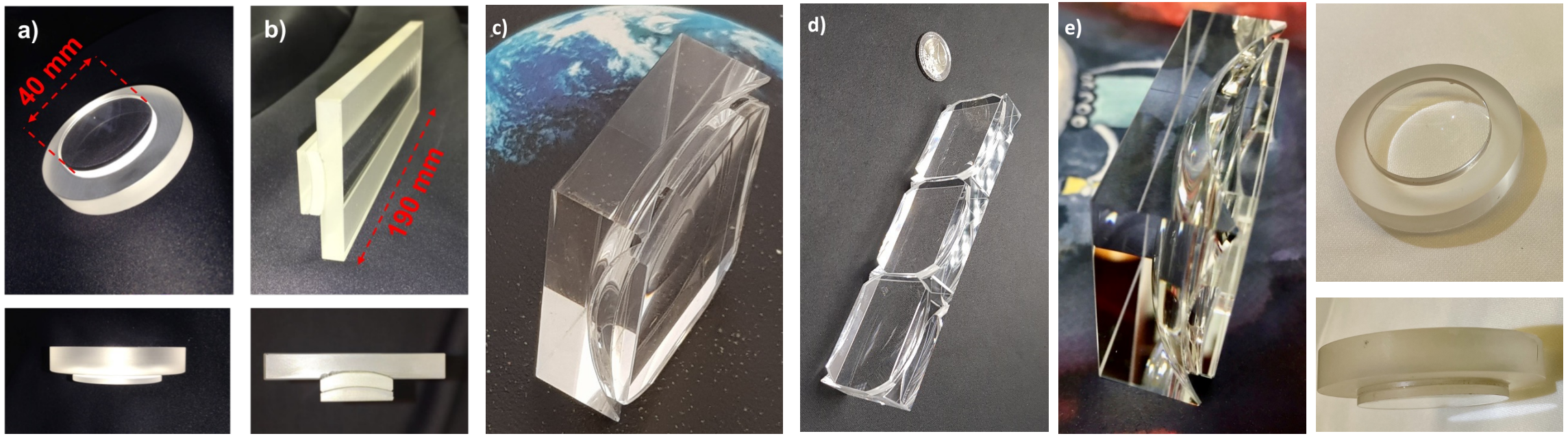

MCP-PMTs
Greg Kalicy
awasly
awasly
Shubham Dutta
Shubham Dutta
Jaydeep Datta
Jaydeep Datta

3-LAYER LENS PROTOTYPES

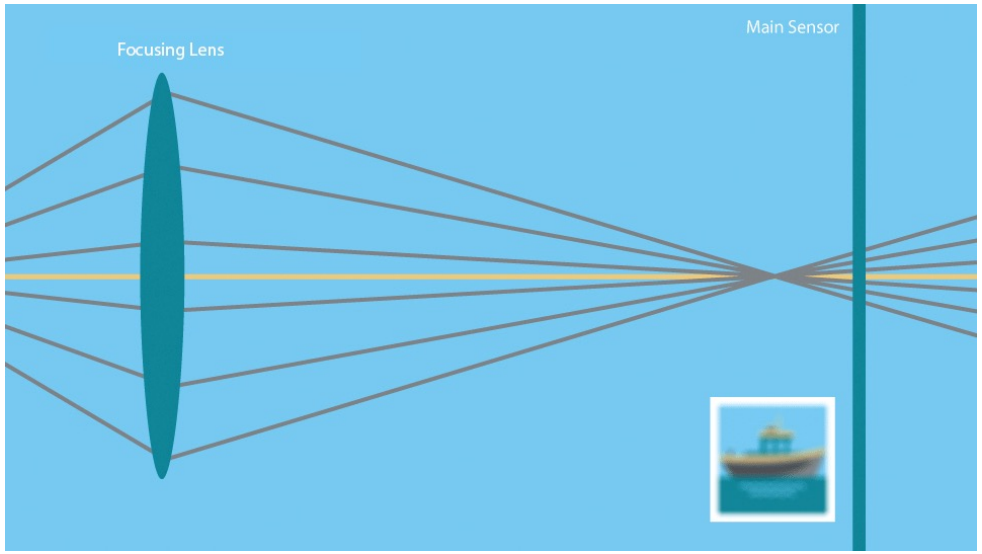
- Several prototypes build for PANDA and EIC R&D programs with different radii ratio and middle layer material



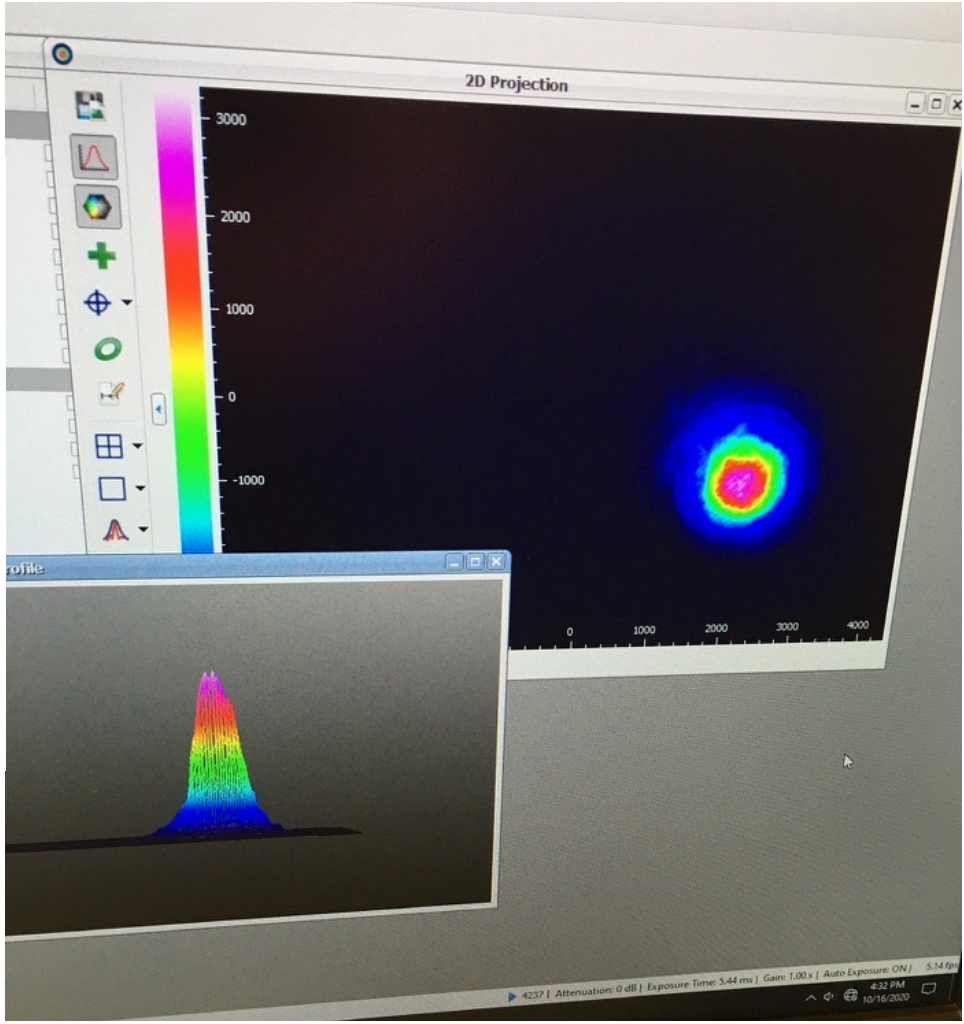
Spherical (NLaK33) | **Cylindrical (S-YGH51)** | **Spherical (S-YGH51)** | **Spherical (LaK33)** | **Spherical (Sapphire)** | **Spherical (PbF_2)**



Measuring Focal Length

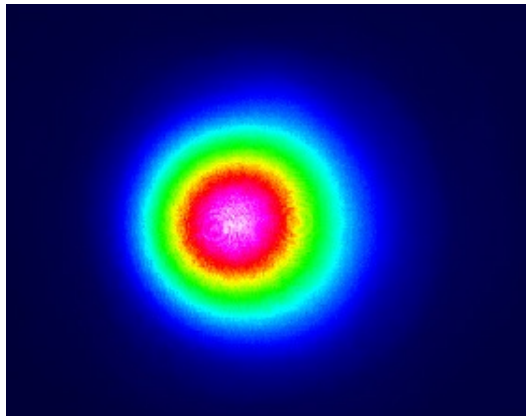


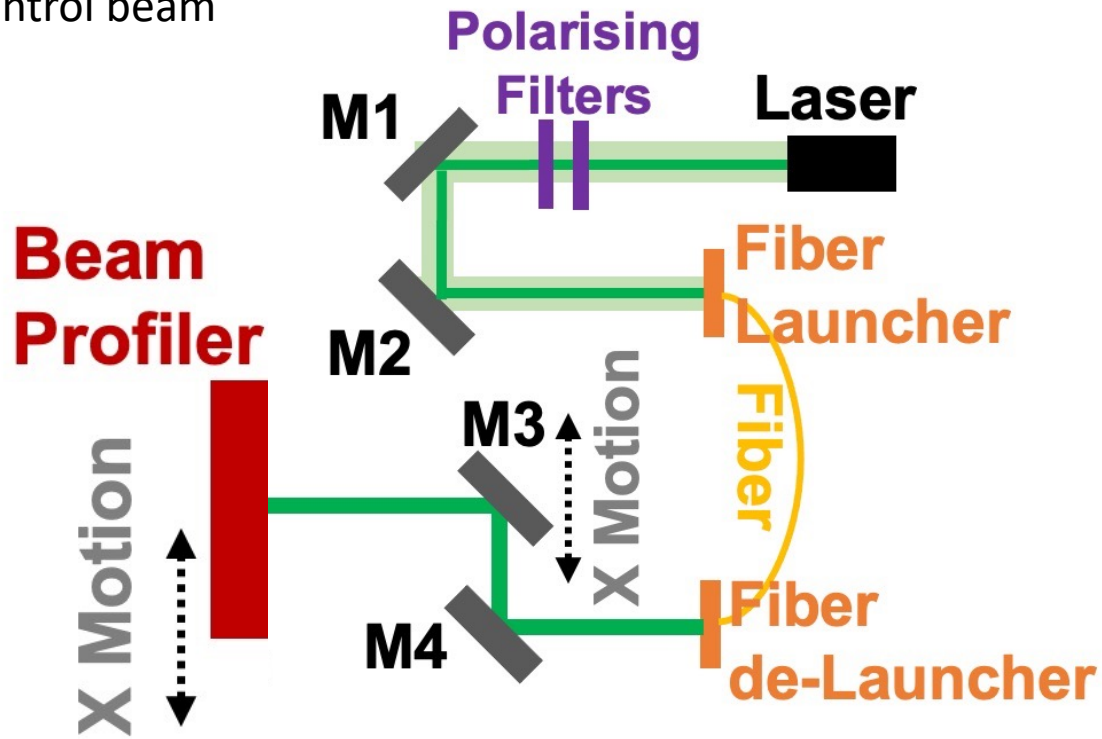
CCD Beam Profiler from Thor Labs as Sensor

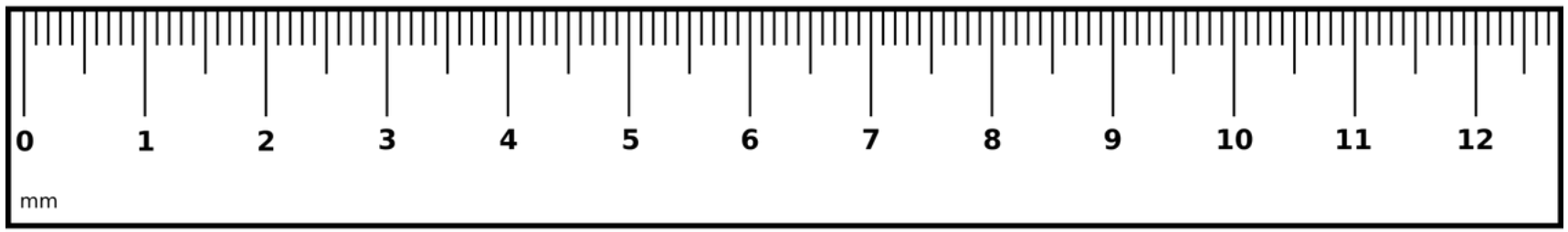


Measuring Focal Length

- Optical fiber used to achieve clean, collimated gaussian laser beam profile
- Polarising Filters used to control beam intensity
- Mirror (M3) on 3D micrometre control stage used to align and control beam

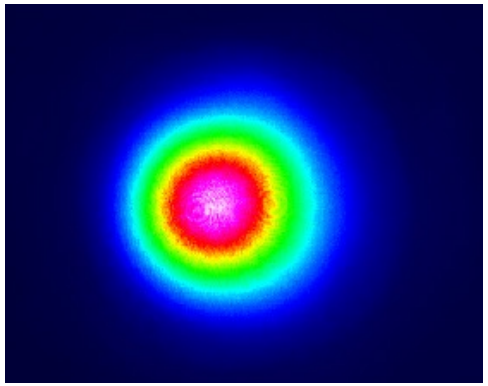




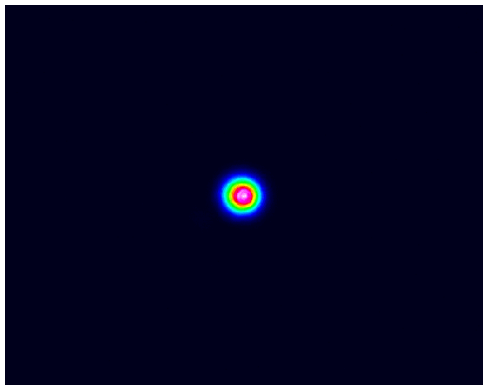


Measuring Focal Length

Unfocussed Beam Profile

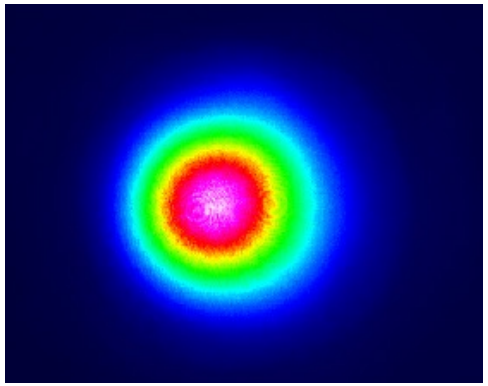


Focussed Beam Profile

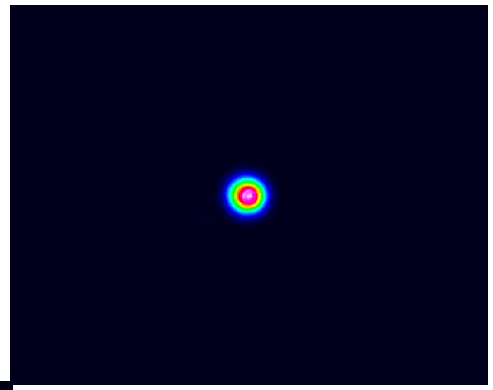


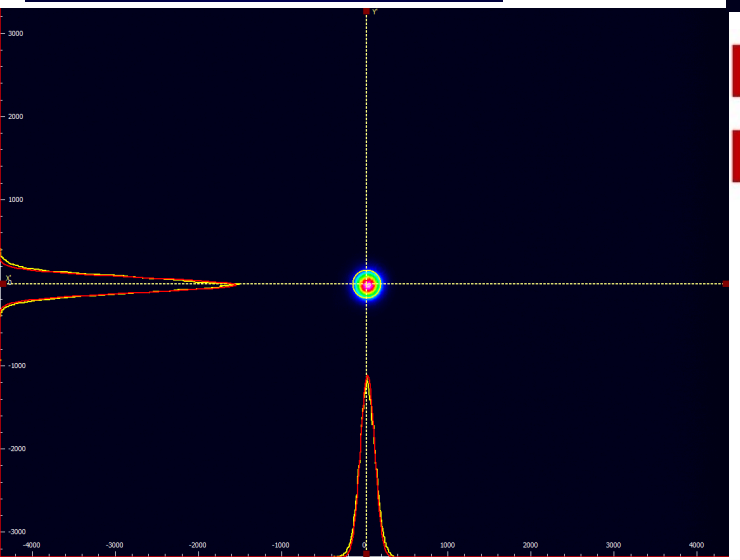
Measuring Focal Length

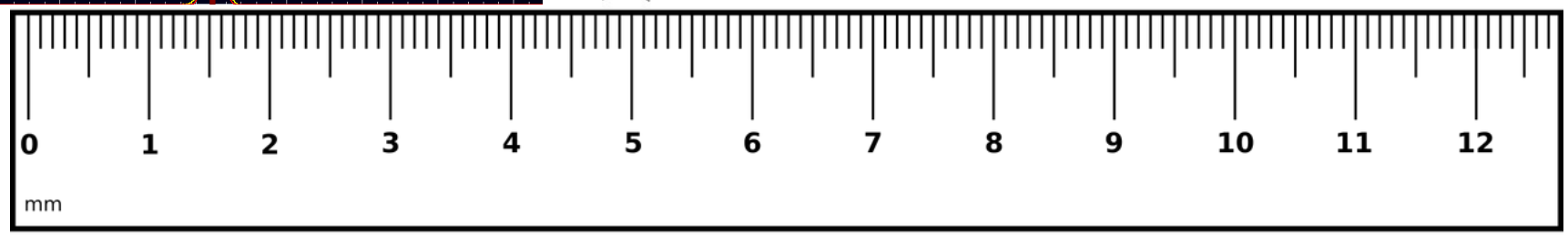
Unfocussed Beam Profile



Focussed Beam Profile

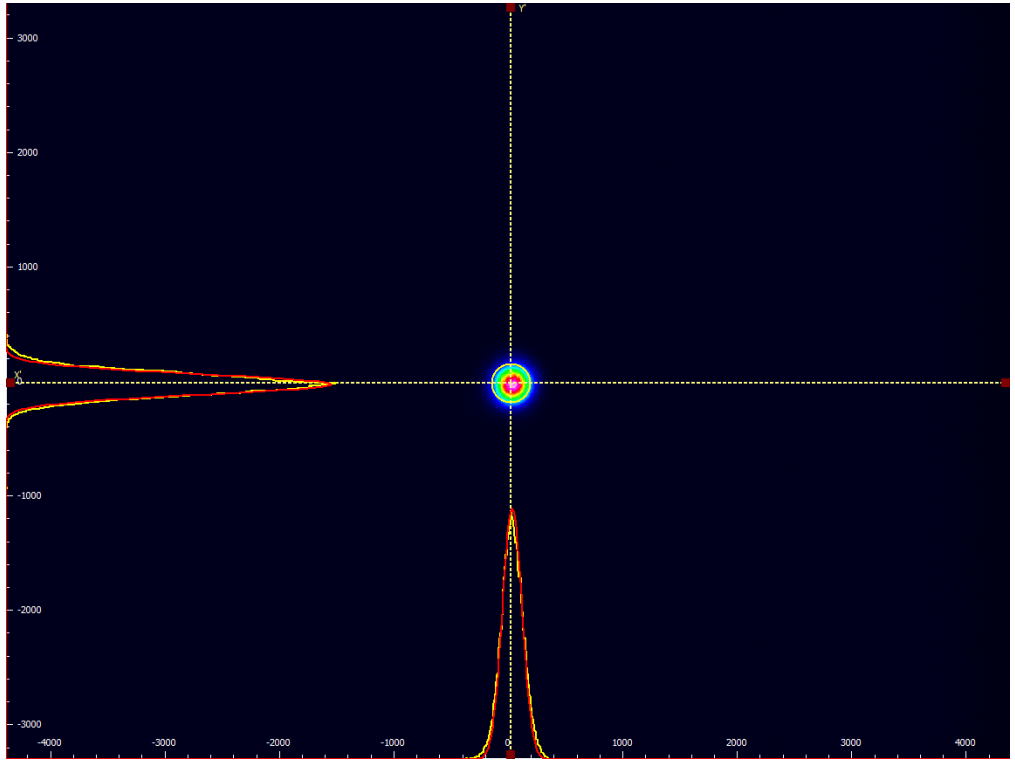


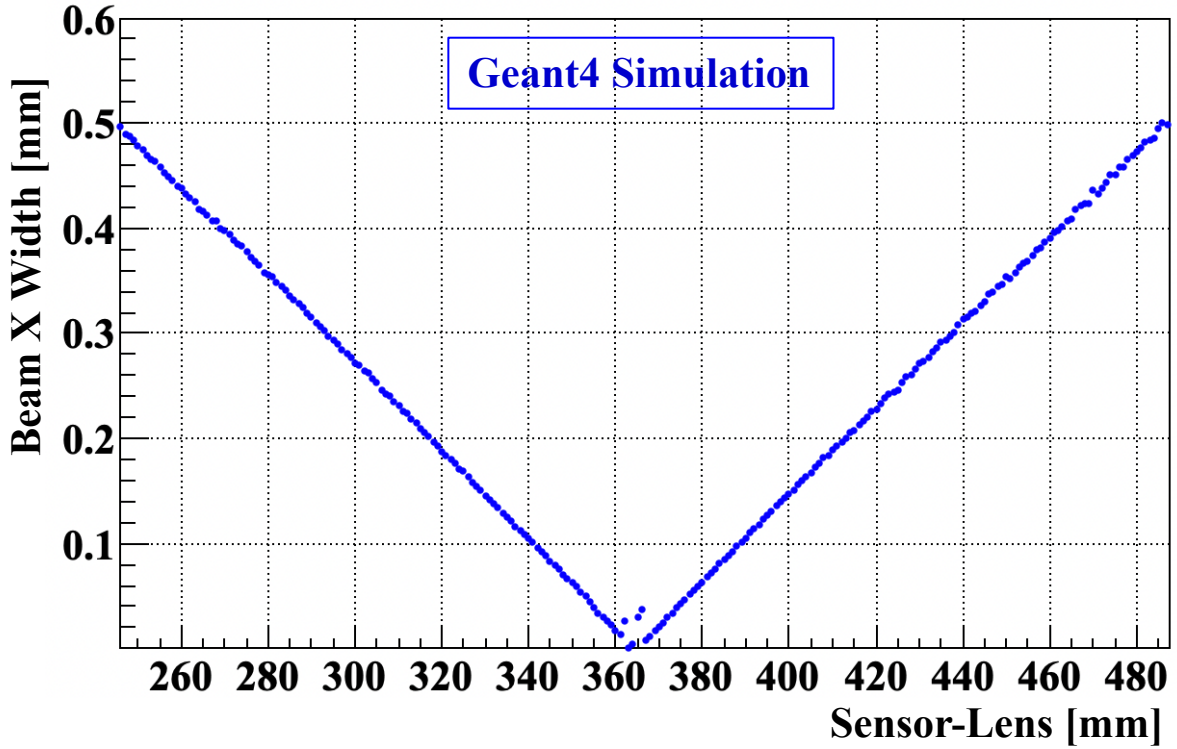




Measuring Focal Length

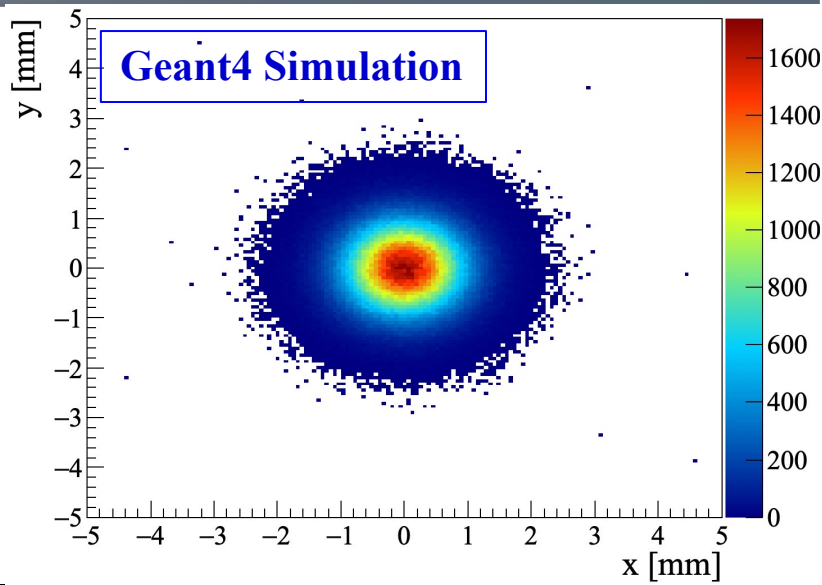
- Moving lens along laser beam towards the sensor and measuring beam width
- Minimum beam width indicates the best focussing position – focal length

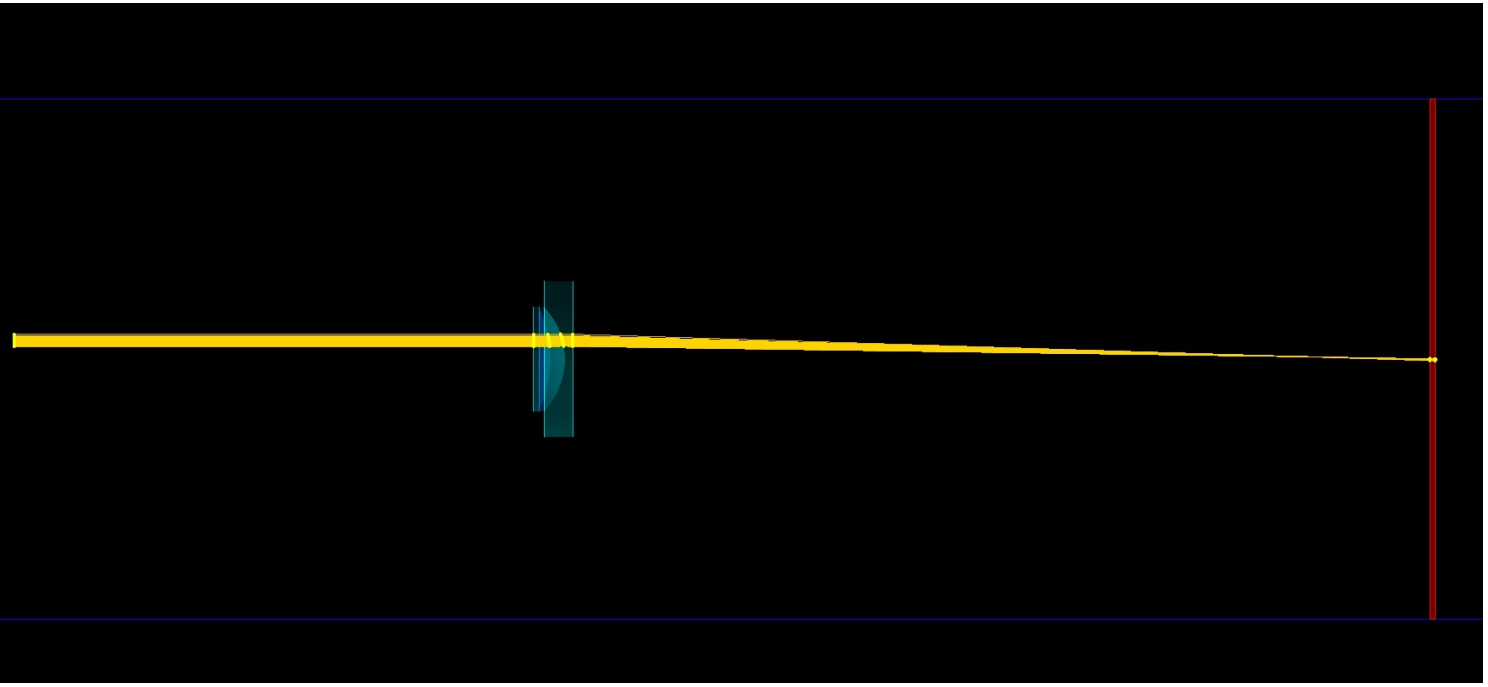


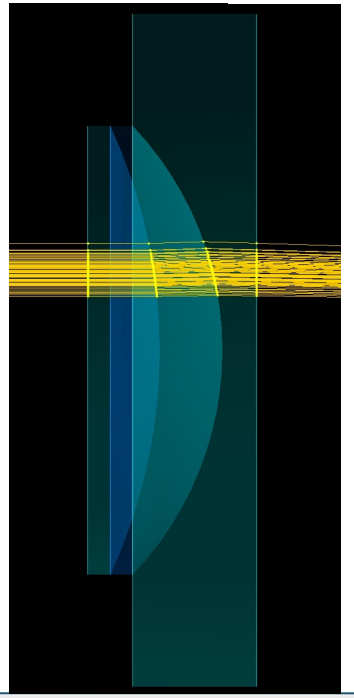


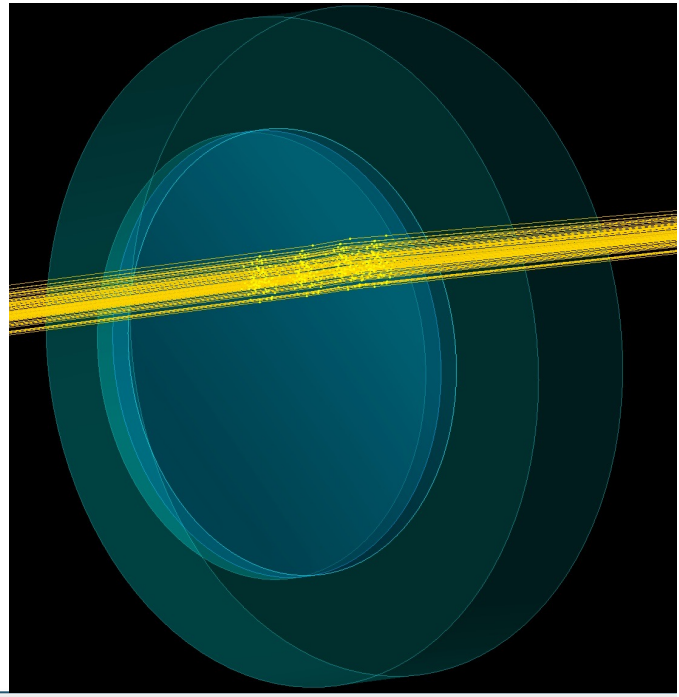
SIMULATION

- Geant4 Simulation package is the same as one used to evaluate PANDA Barrel DIRC performance
- Comparing not only focal length but also shape of beam profile will allow to see how well optical aberrations are represented in simulation



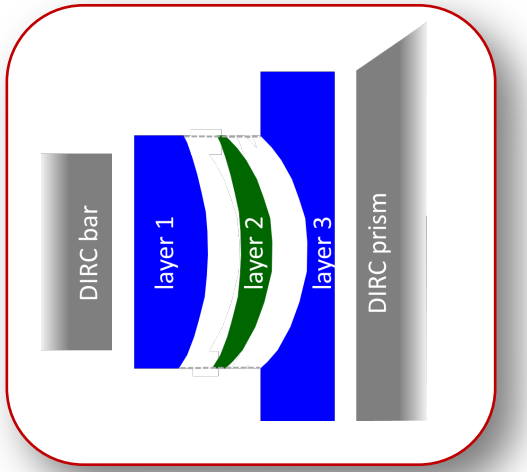


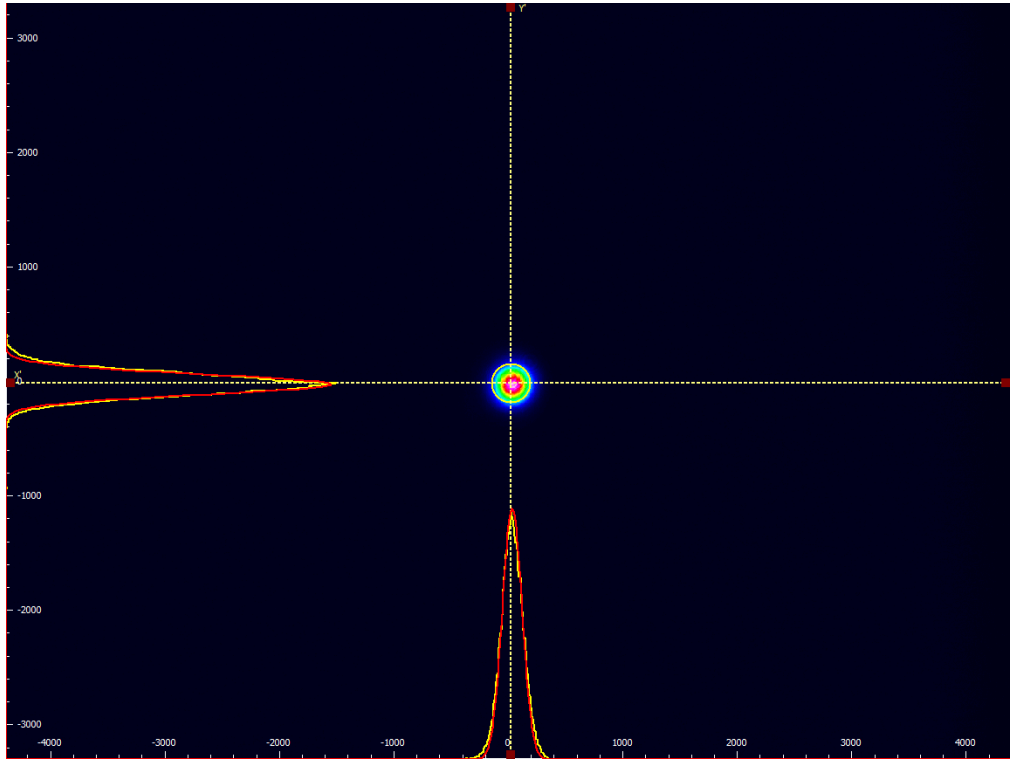


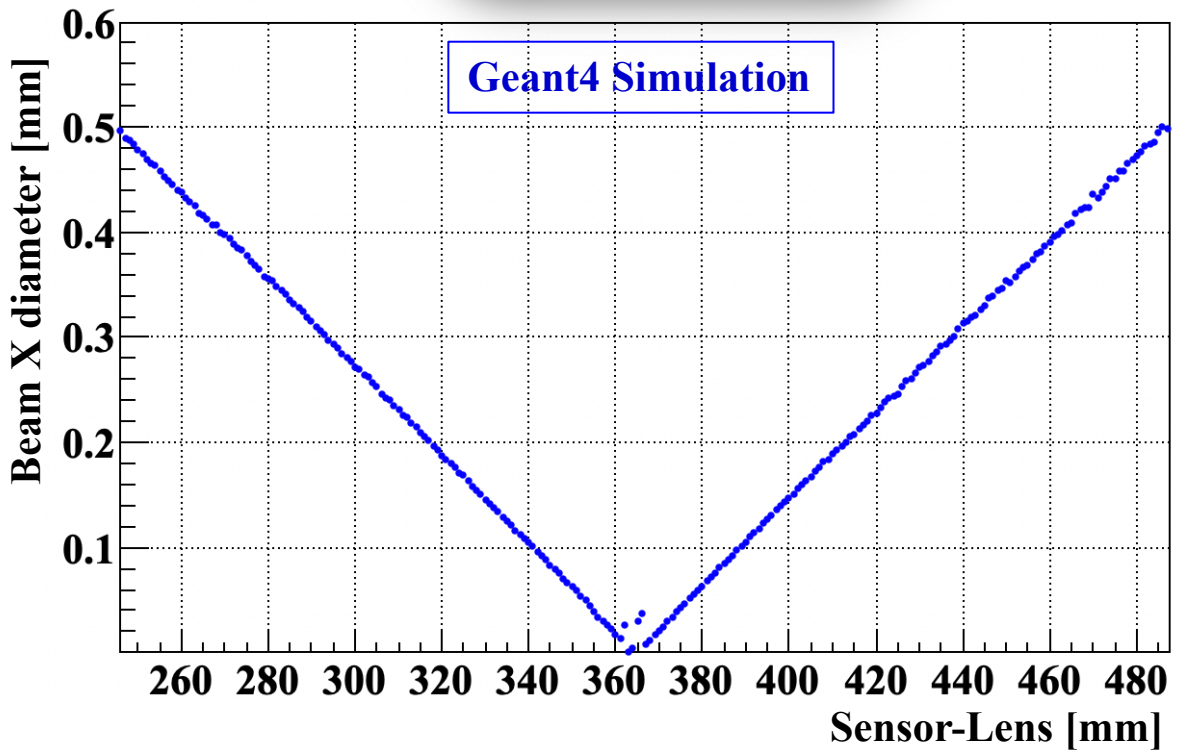


Measuring Focal Length

- Moving lens along laser beam towards the sensor and measuring beam width
- Minimum beam width indicates the best focussing position – focal length
- But in the DIRC detector lens is placed in between fused silica pieces not air – significant refractive index difference

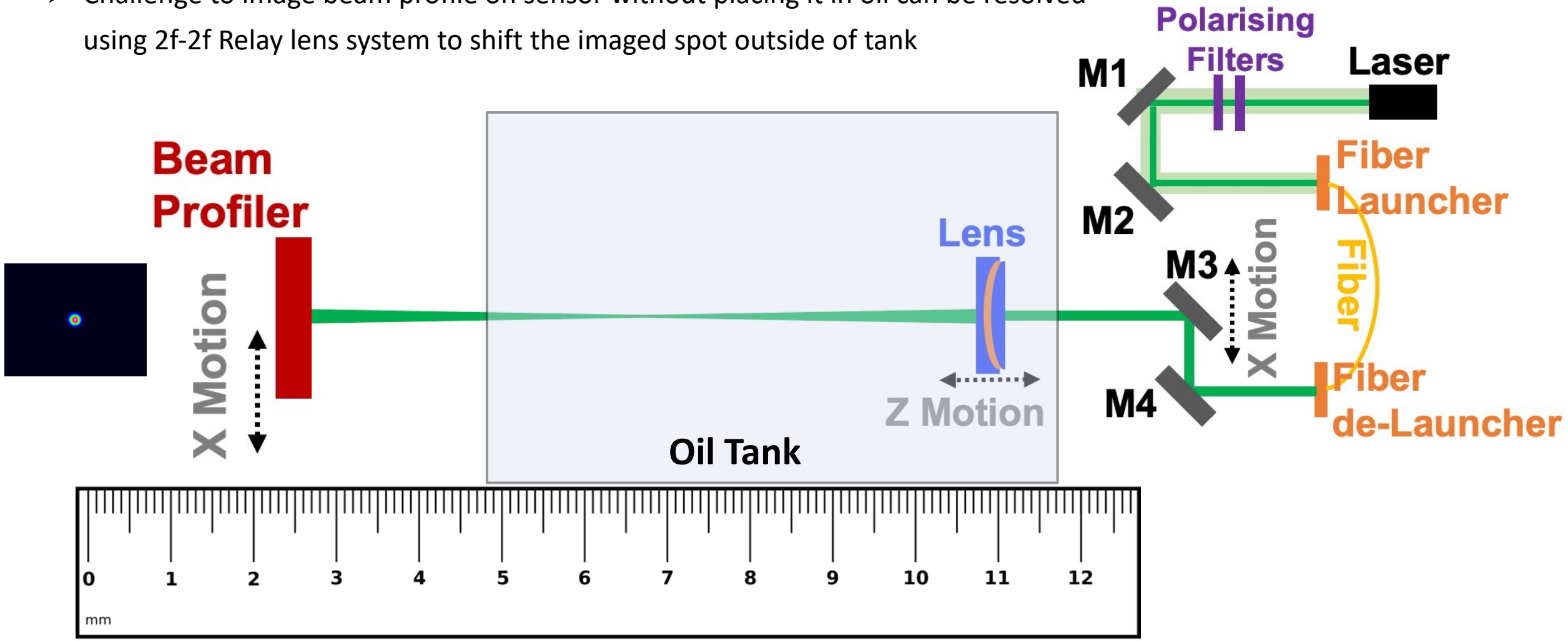






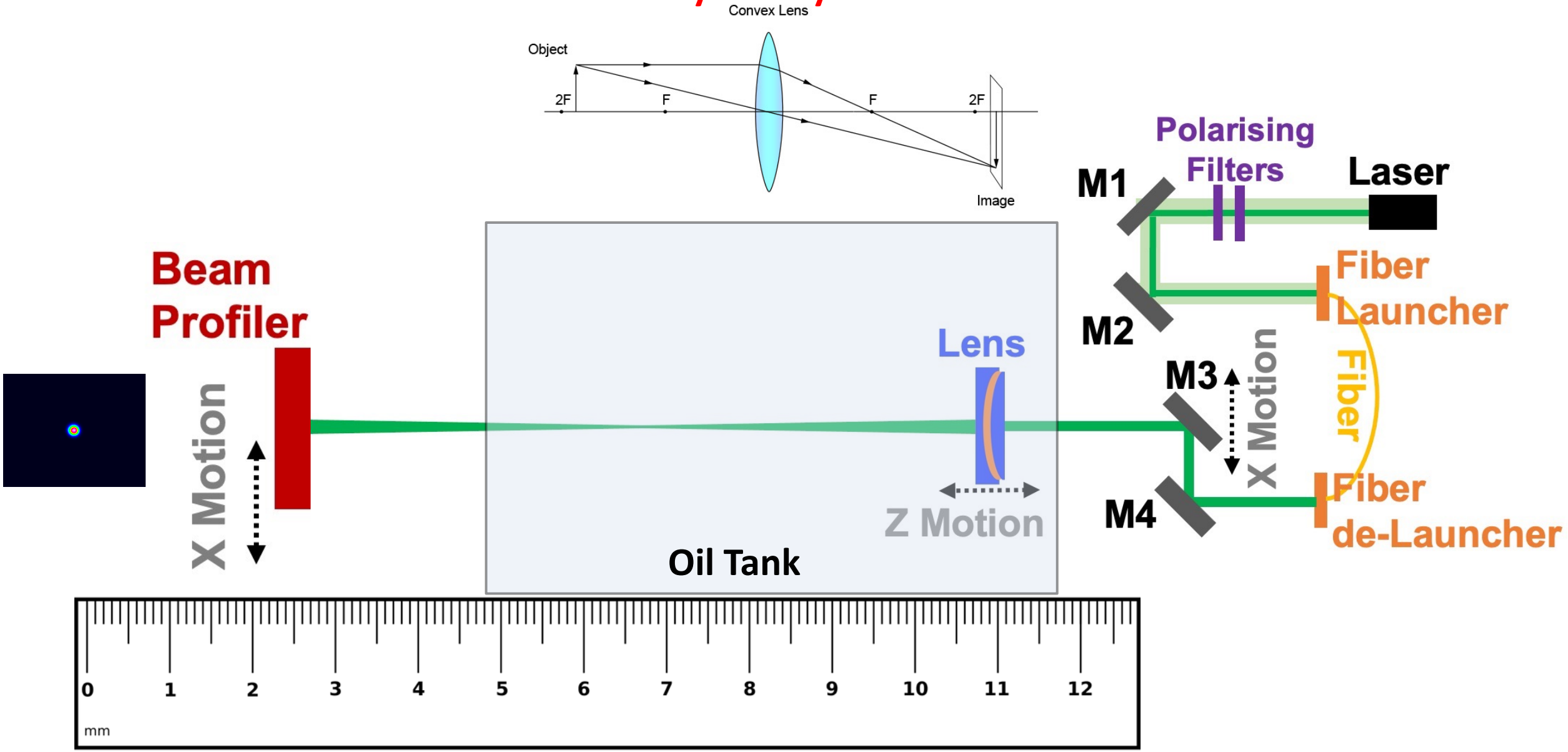
Measuring Focal Length

- Mineral oil has matching refractive index with fused silica and can simulate detector environment
- Challenge to image beam profile on sensor without placing it in oil can be resolved using 2f-2f Relay lens system to shift the imaged spot outside of tank



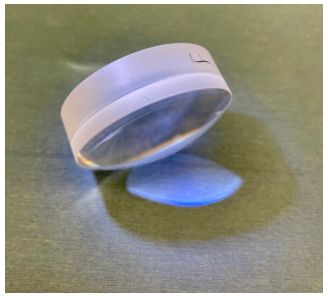
Measuring Focal Length

2f – 2f Relay lens system



Measuring Focal Length

- 75mm Achromat lens used to shift the beam image by around 300mm, outside of oil tank

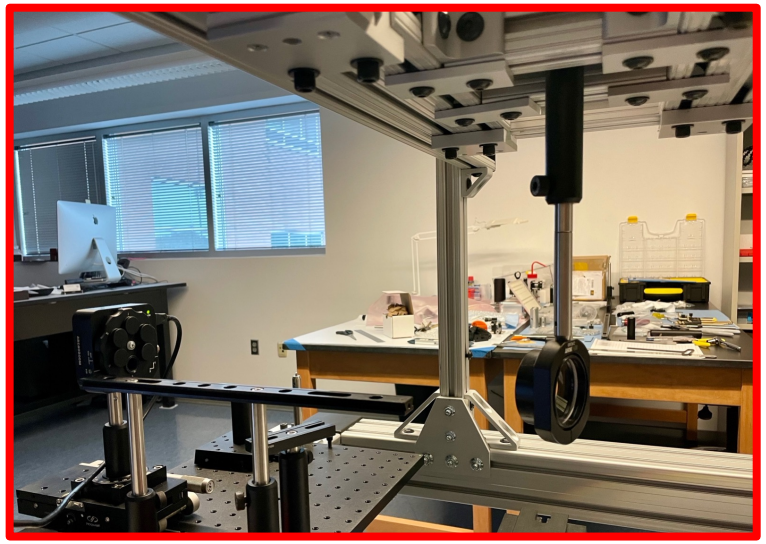


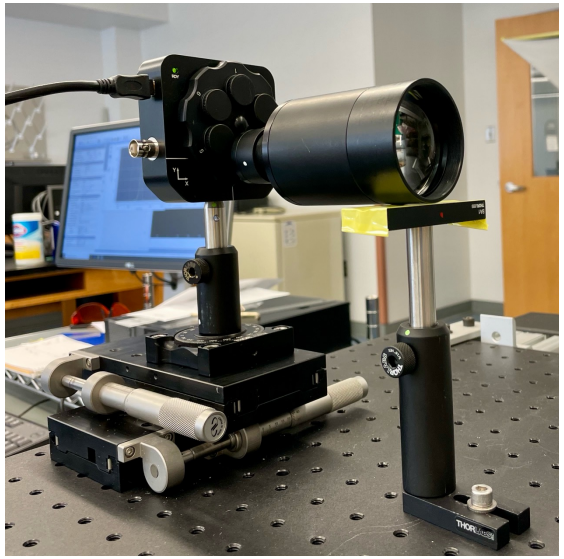
Measuring Focal Length

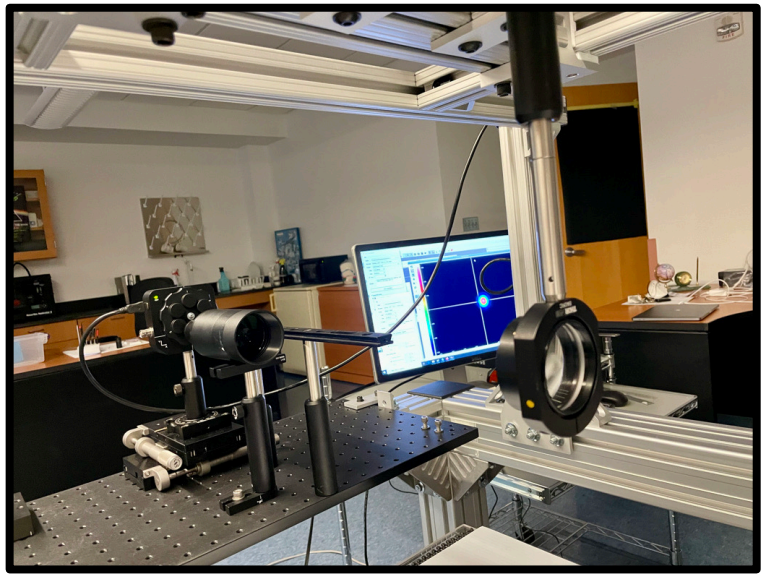
- 75mm Achromat lens used to shift the beam image by around 300mm, outside of oil tank
- Oil tank on X-table to make lens changes and air measurements easier
- Two Achromat lenses used to validate setup. One as measured lens, one as Relay lens

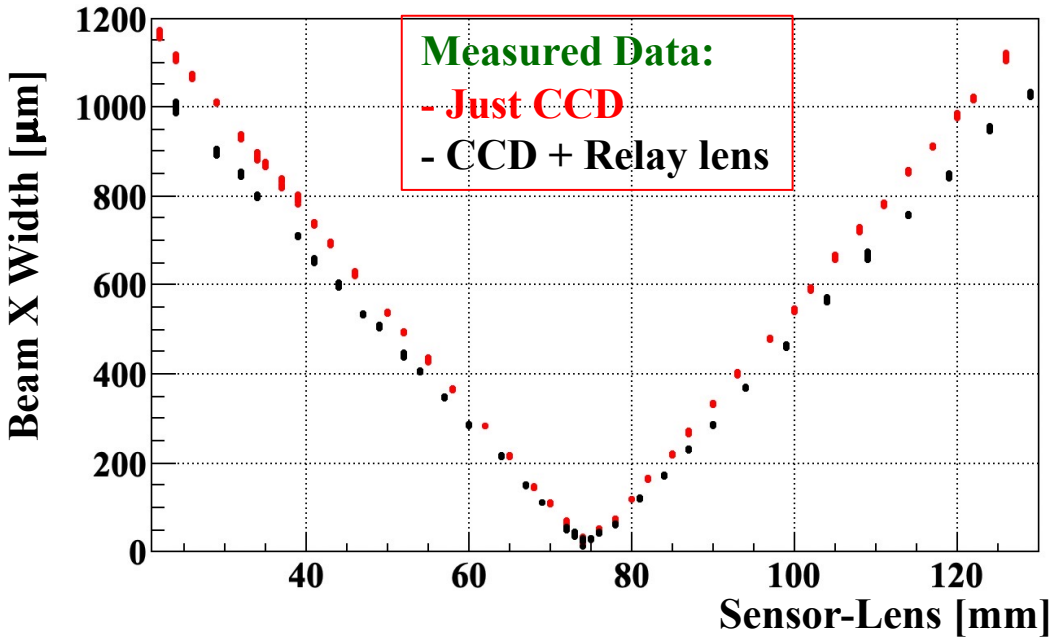
Measuring Focal Length

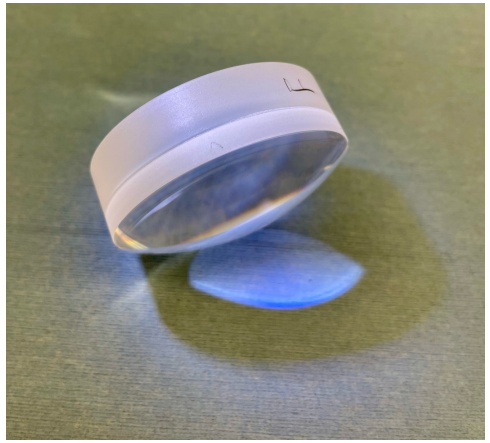
- **Perfect match of focal length measurement directly on CCD beam profiler and measurement with Relay lens shift.**



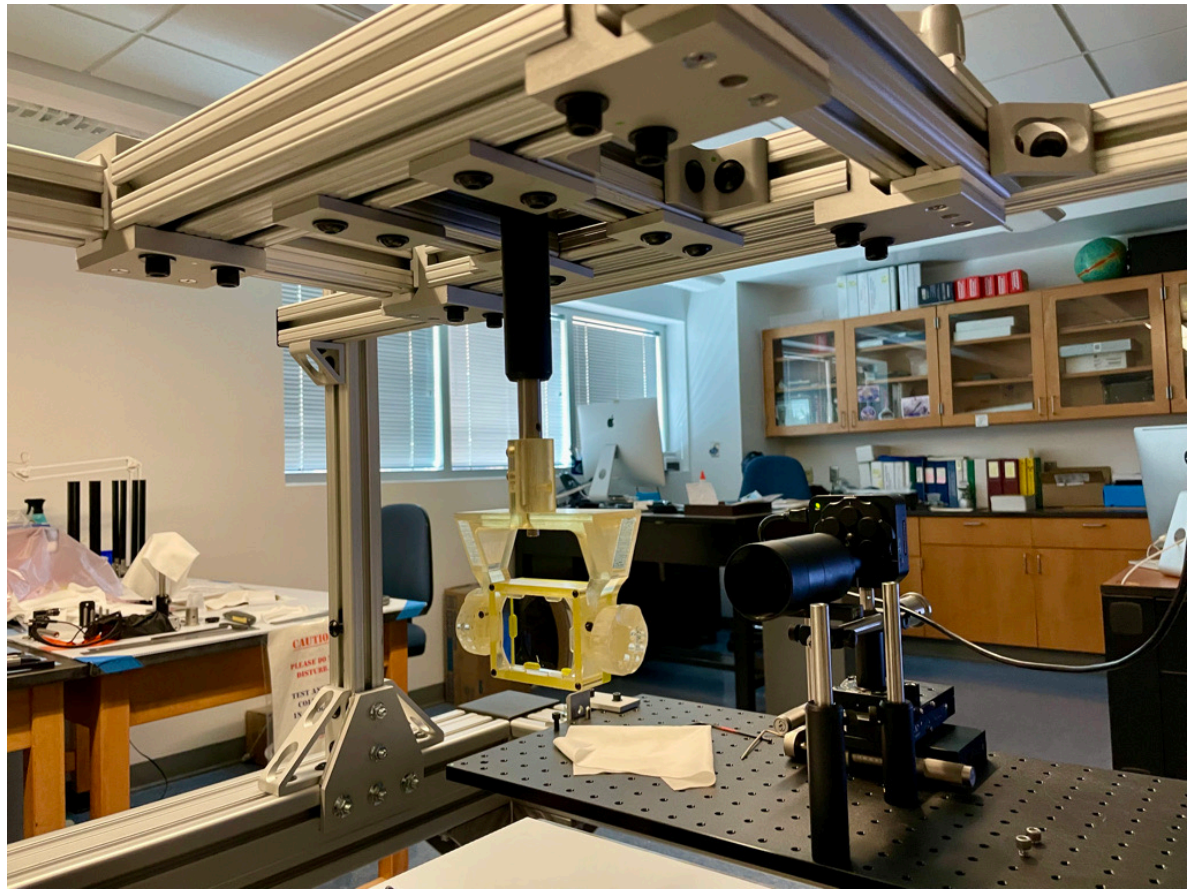


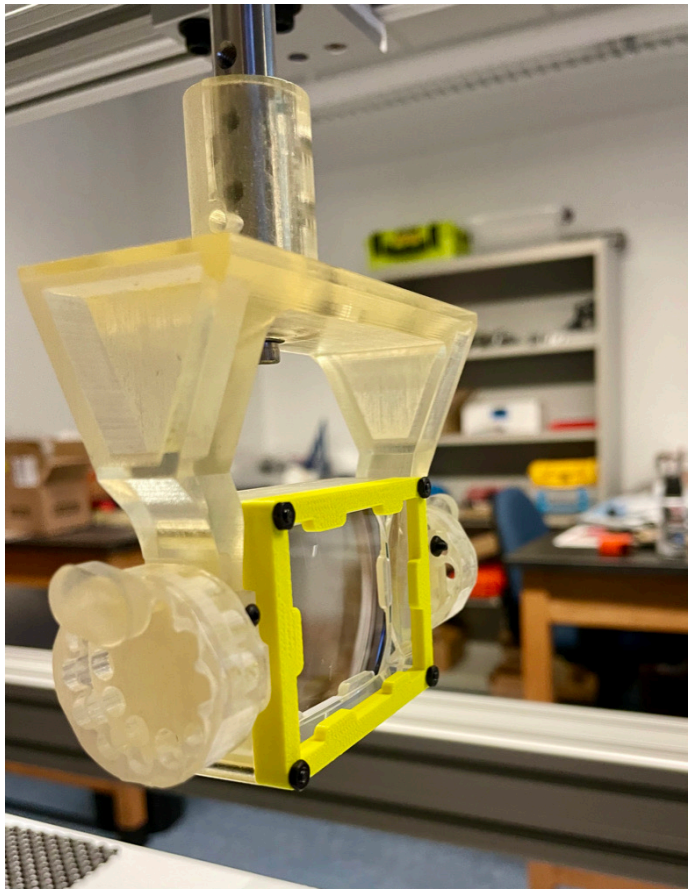






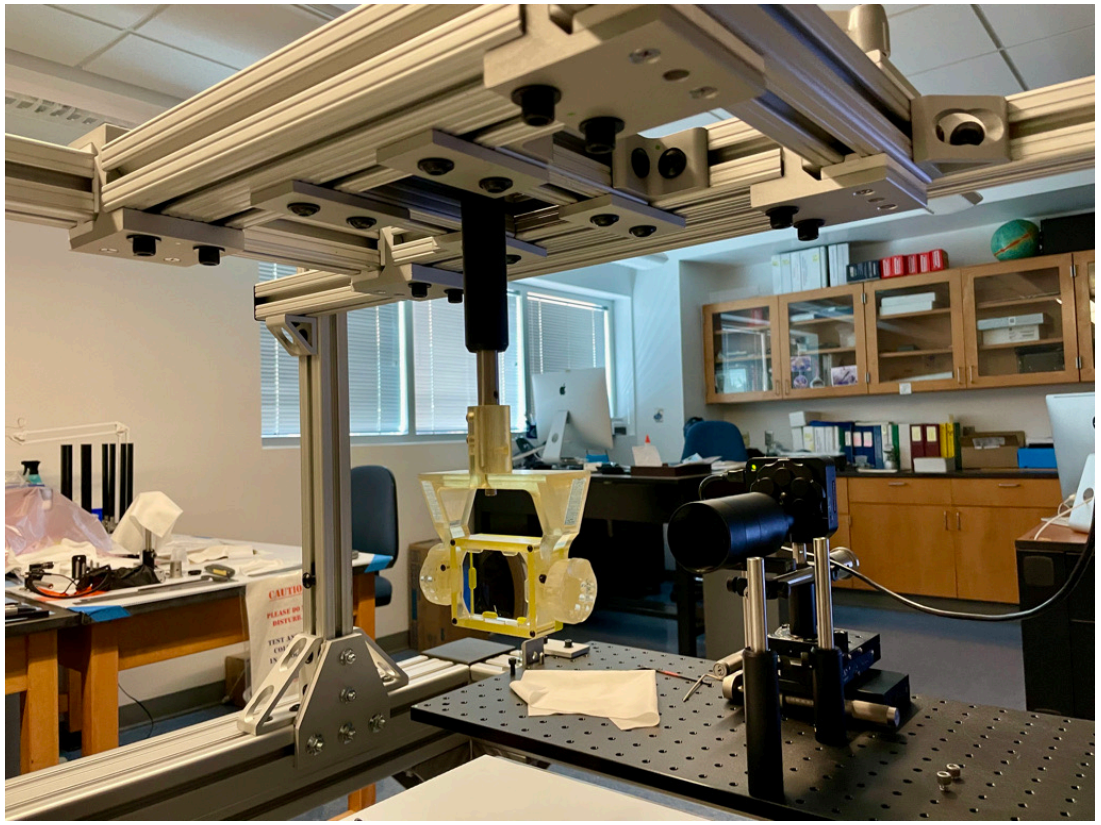
BEFORT PROTOTYPE

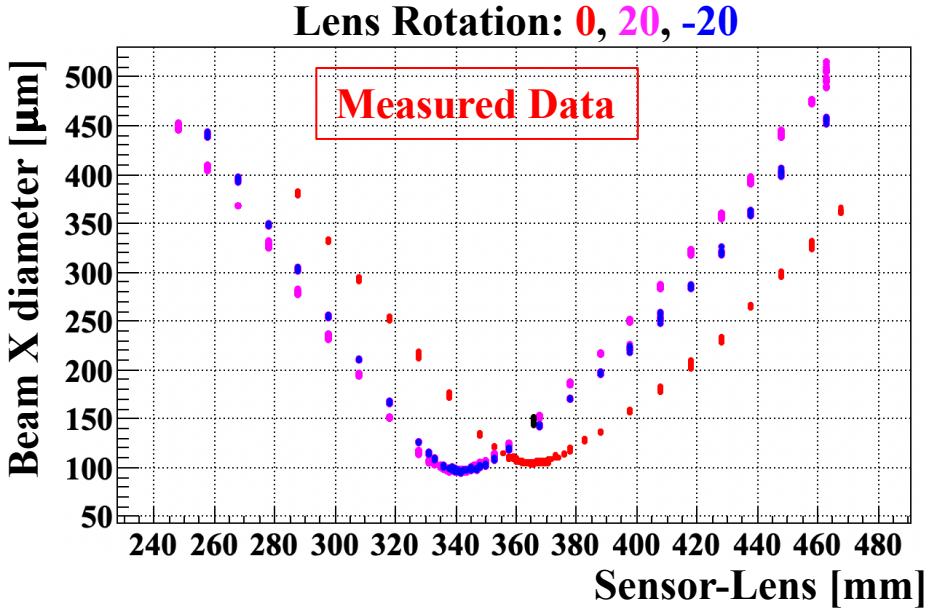


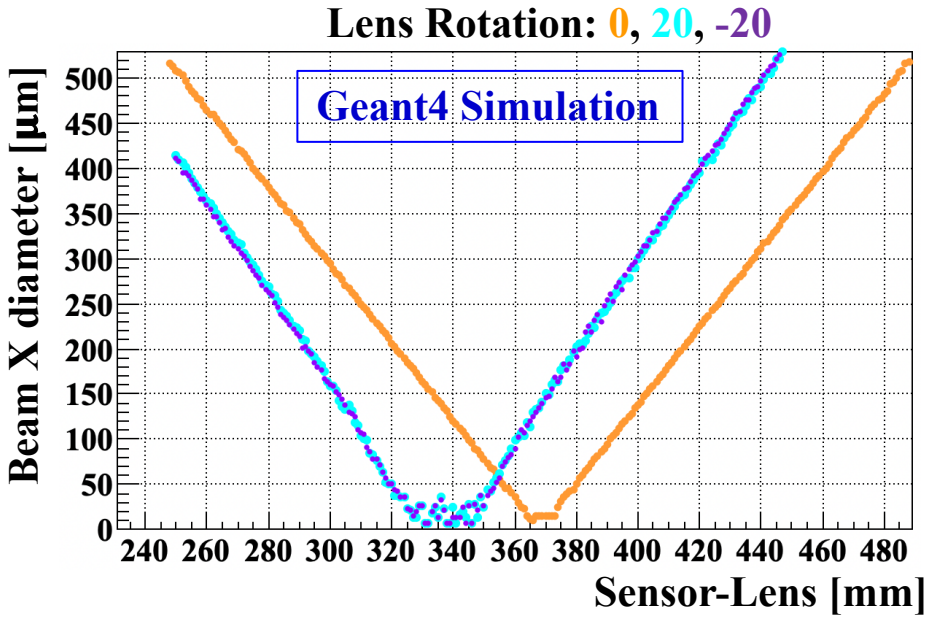


BEFORT PROTOTYPE

- Very well match of measured and simulated data for laser beam cantered on the **lens in air** and three incidence angles.

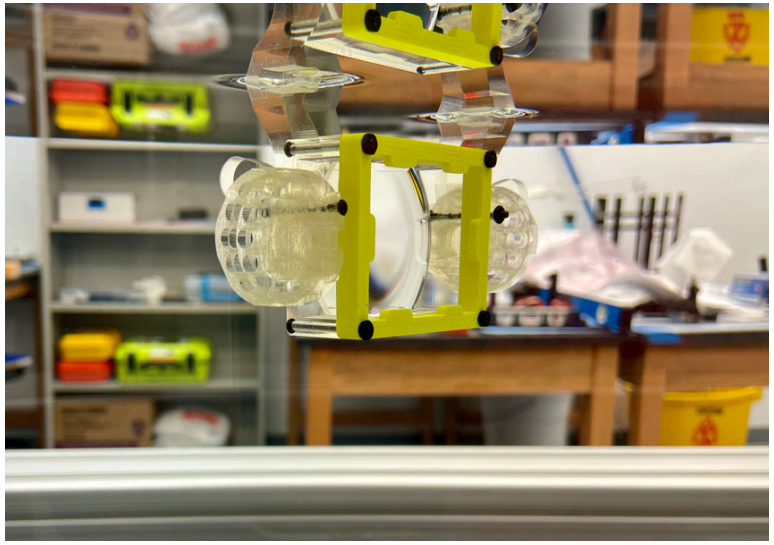


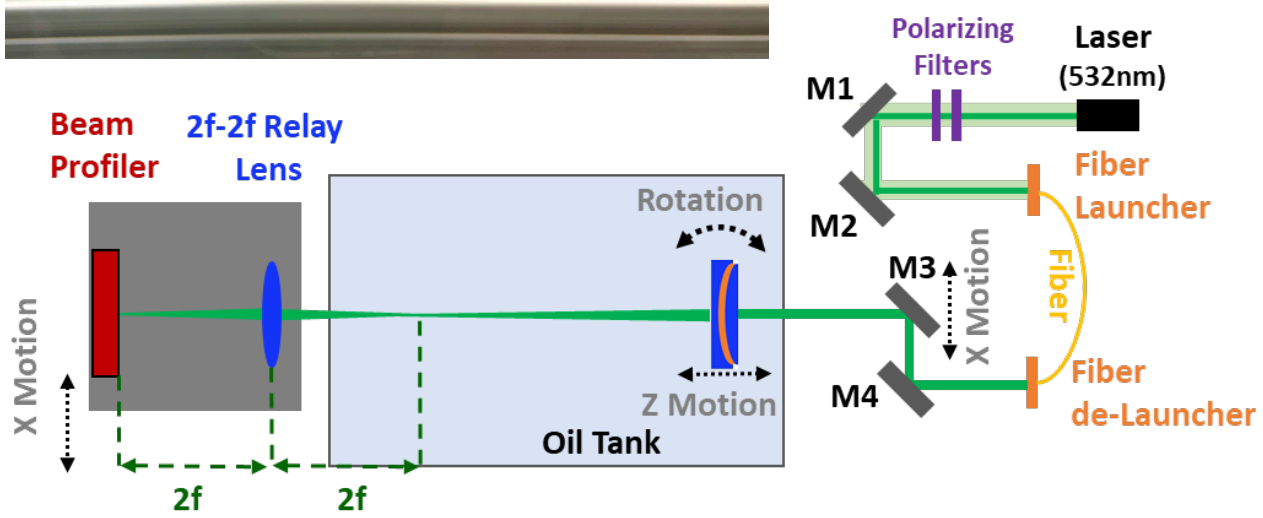


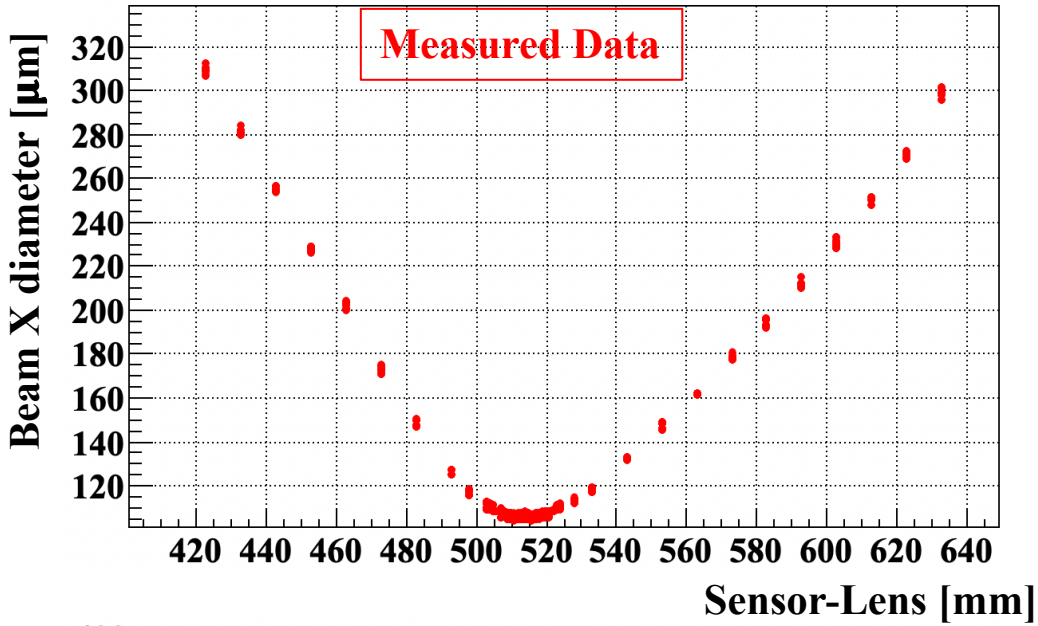


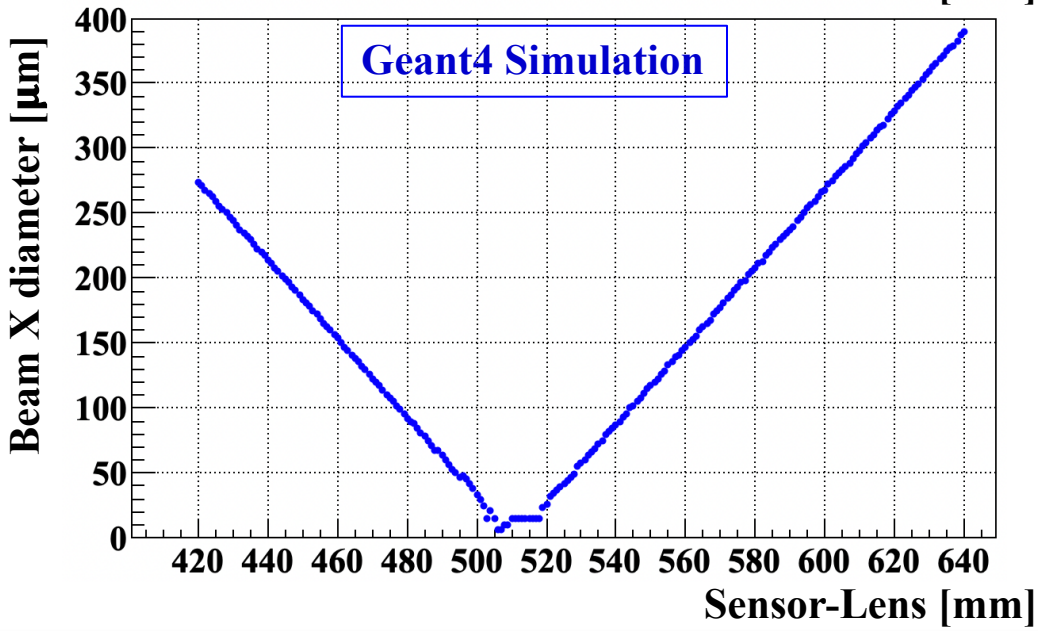
BEFORT PROTOTYPE

- Very well match of measured and simulated data for perpendicular laser beam cantered on the **lens in oil**









BEFORT PROTOTYPE

- Very well match of measured and simulated data for perpendicular laser beam cantered on the **lens in oil**