



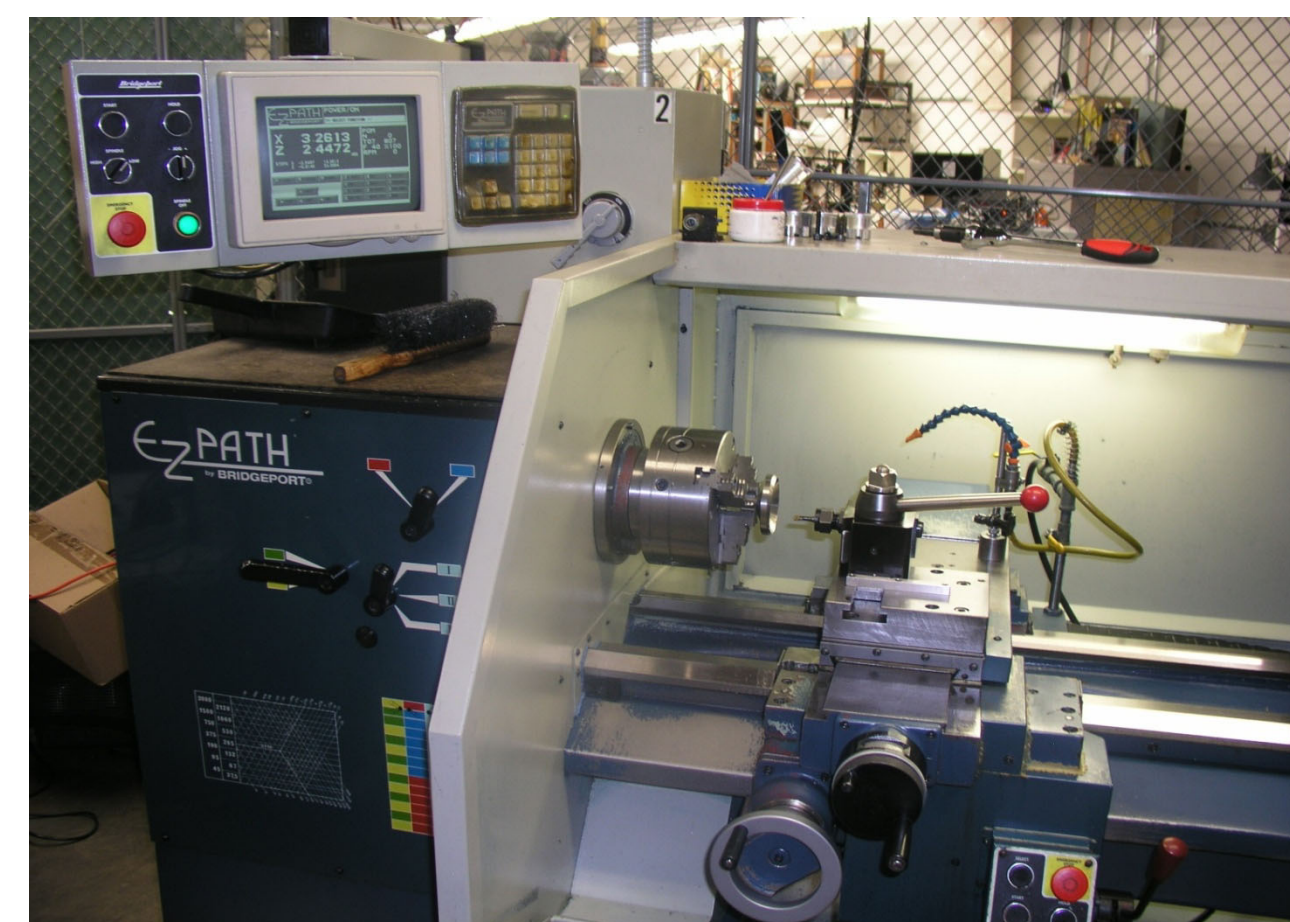
Construction of the Six Ion Gun Fusion Experiment (SIGFE)

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Objectives

- Build a precise, symmetric machine
- Stand-off high voltages at close distances
- Align lenses in guns
- Focus guns at center of device

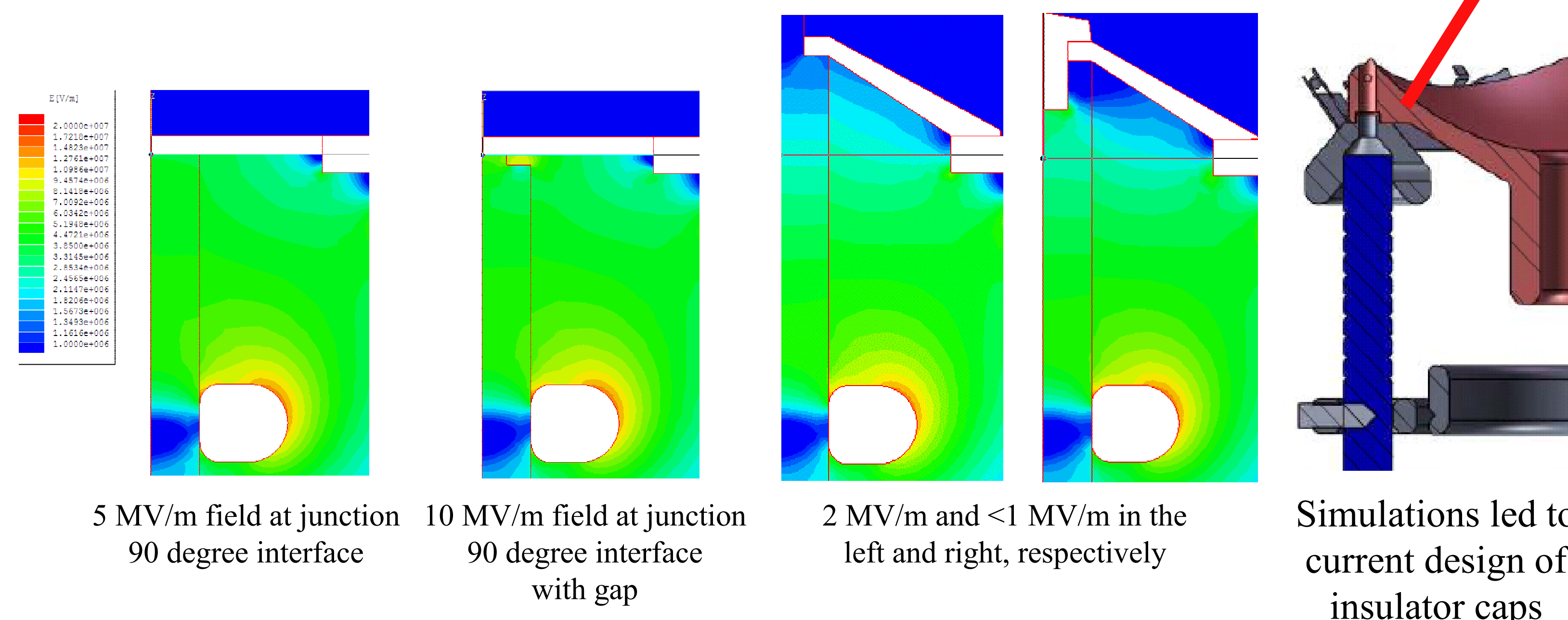
Manufacturing



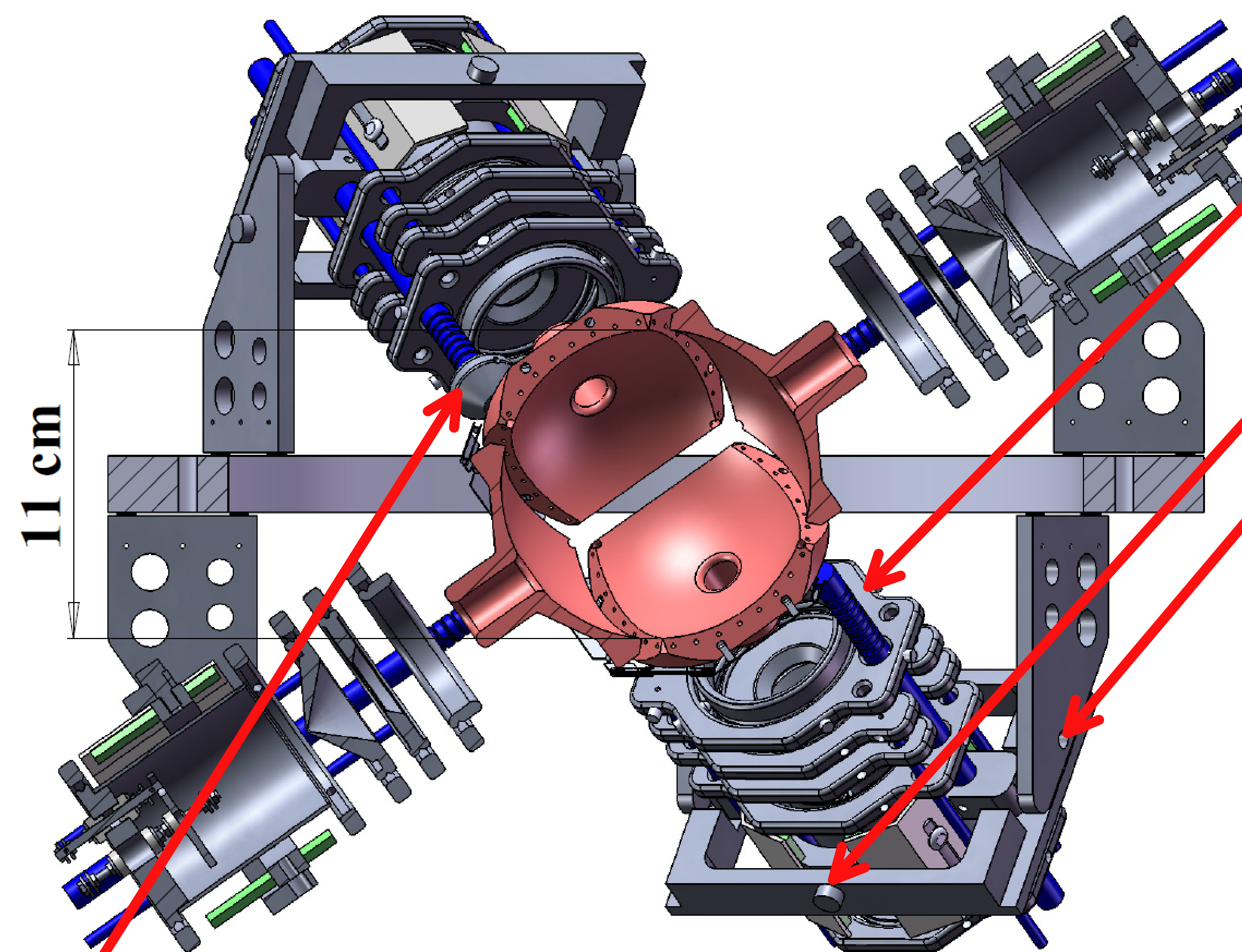
- All lenses manufactured in-house on a computer numerically controlled (CNC) lathe
- Settings on lathe were such that machined surfaces were very smooth
- Variance between lenses was within 0.05 mm

High Voltage

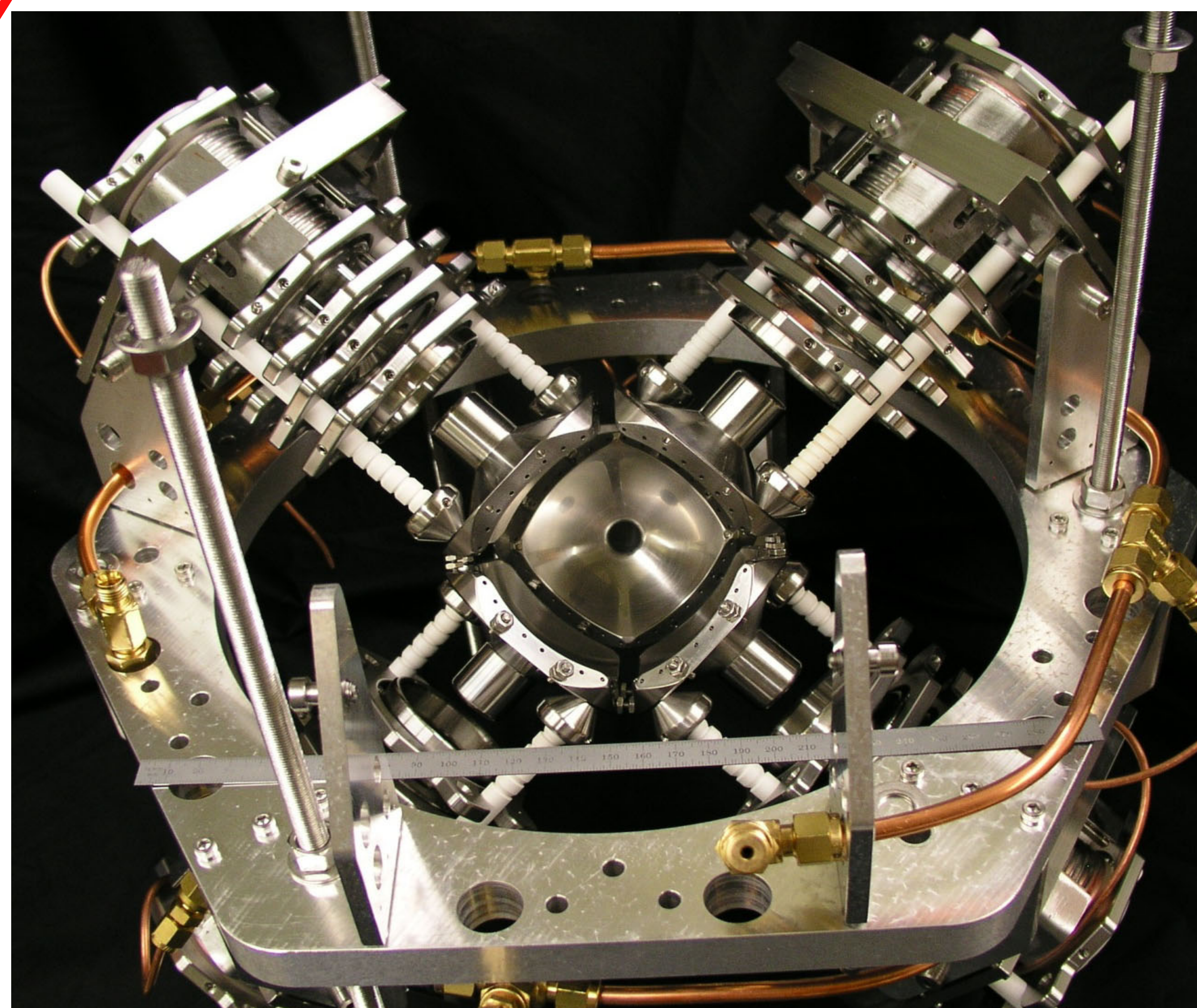
- Special design considerations were taken to stand-off the high electric fields between lenses
- Angling electrode-insulator-vacuum junction, reduced the electric field at the cathode triple point by approximately a factor of 5



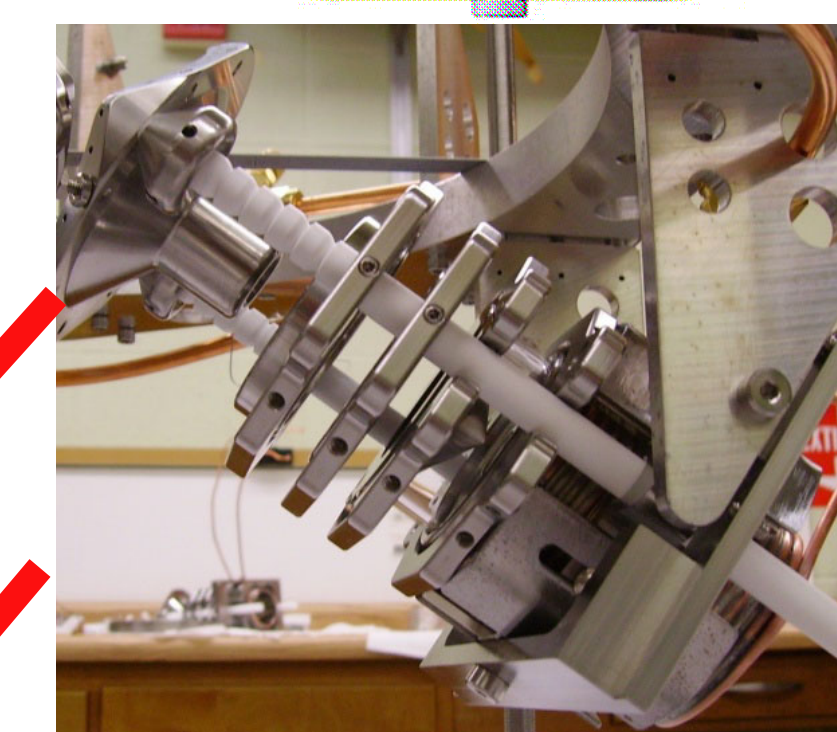
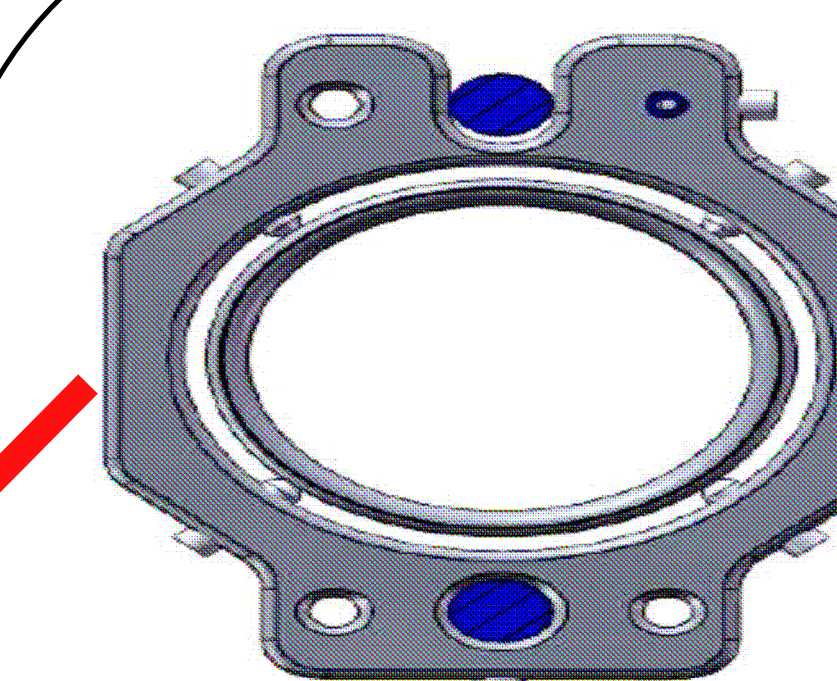
- All metal surfaces were sanded to 600 grit and then polished with abrasive cloth to eliminate electric field enhancements at sharp points on the electrodes



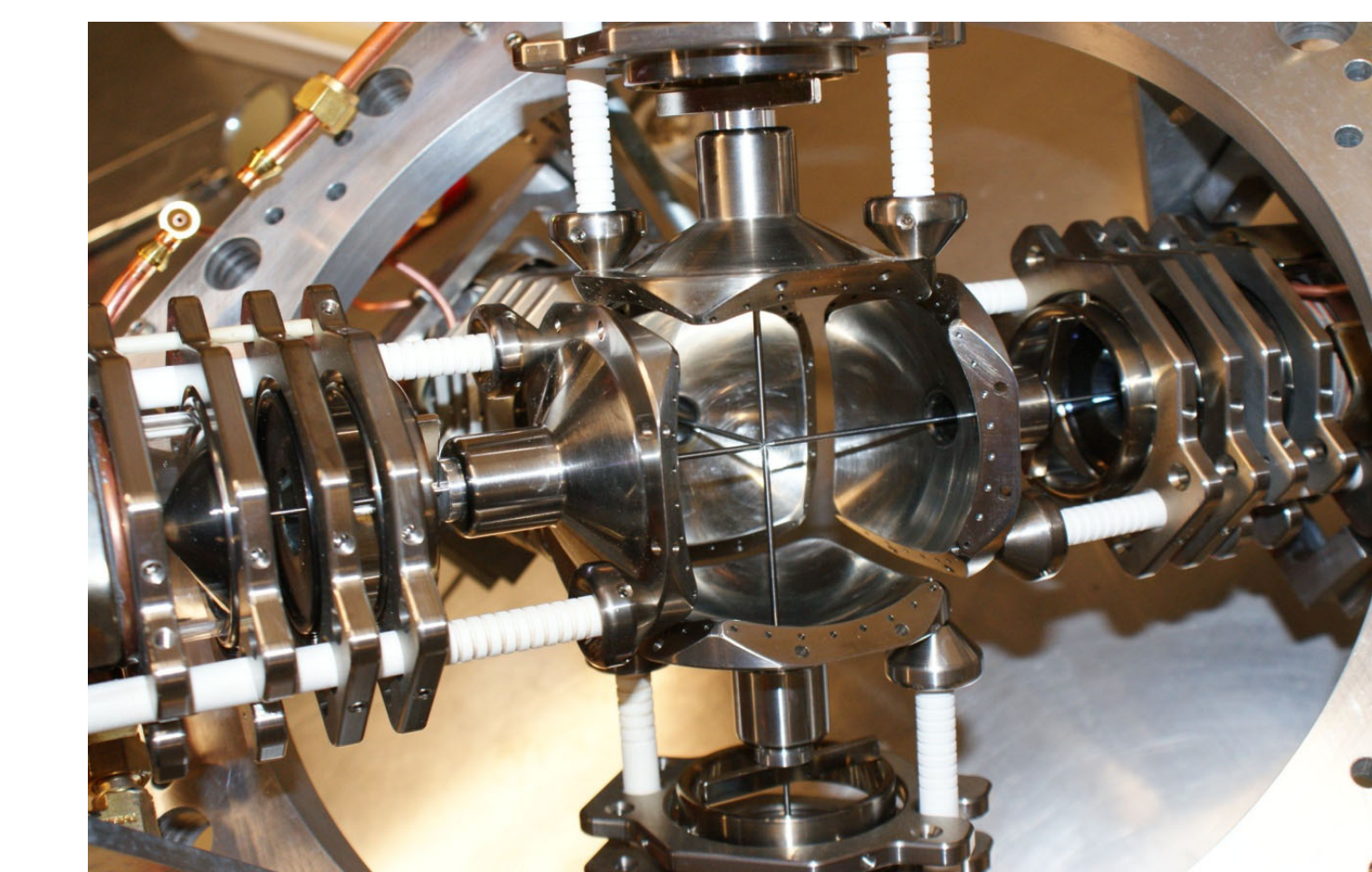
Above: Cross sectional CAD drawing of the SIGFE
Below: Completed SIGFE with one gun removed



Alignment

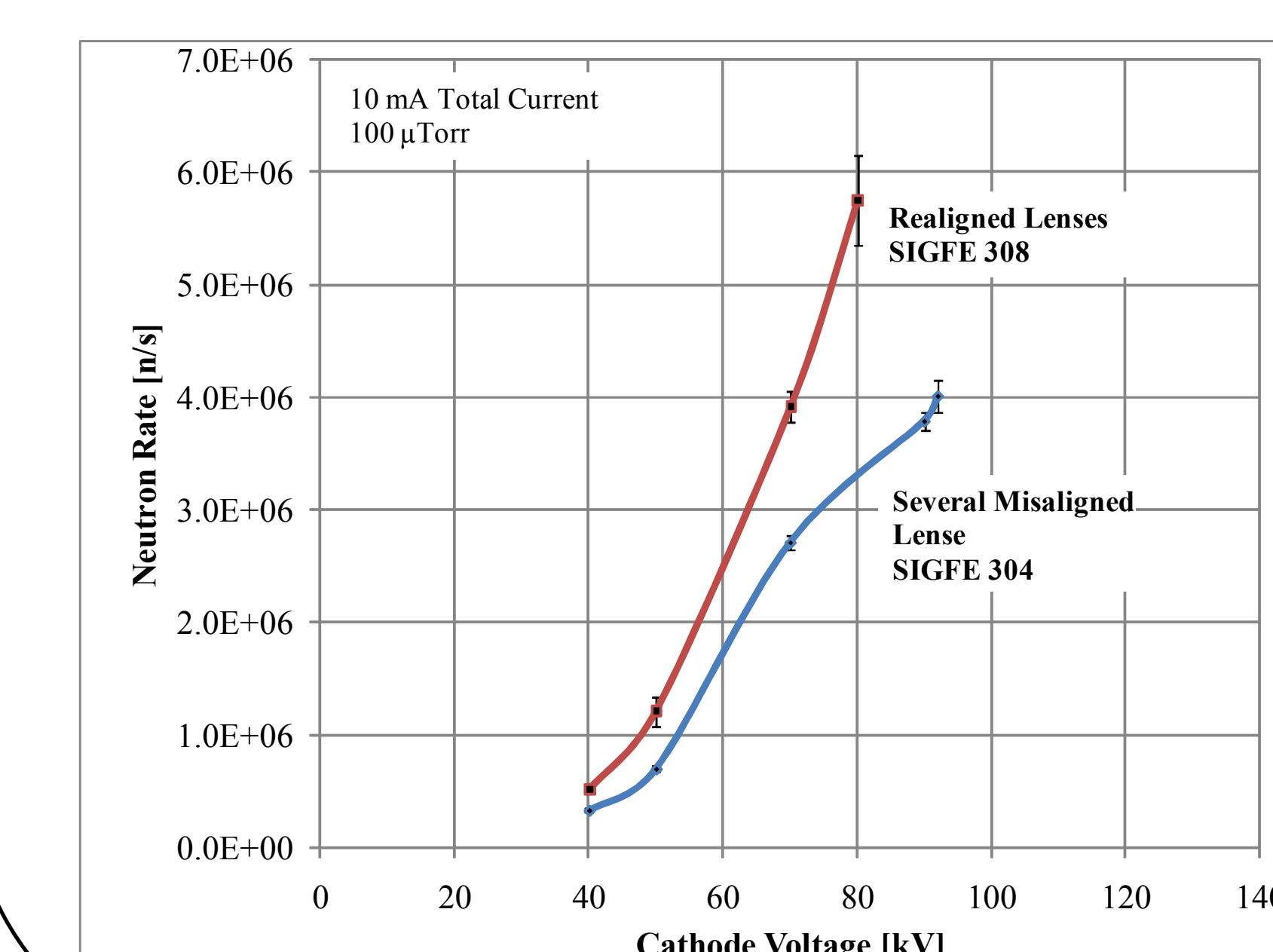
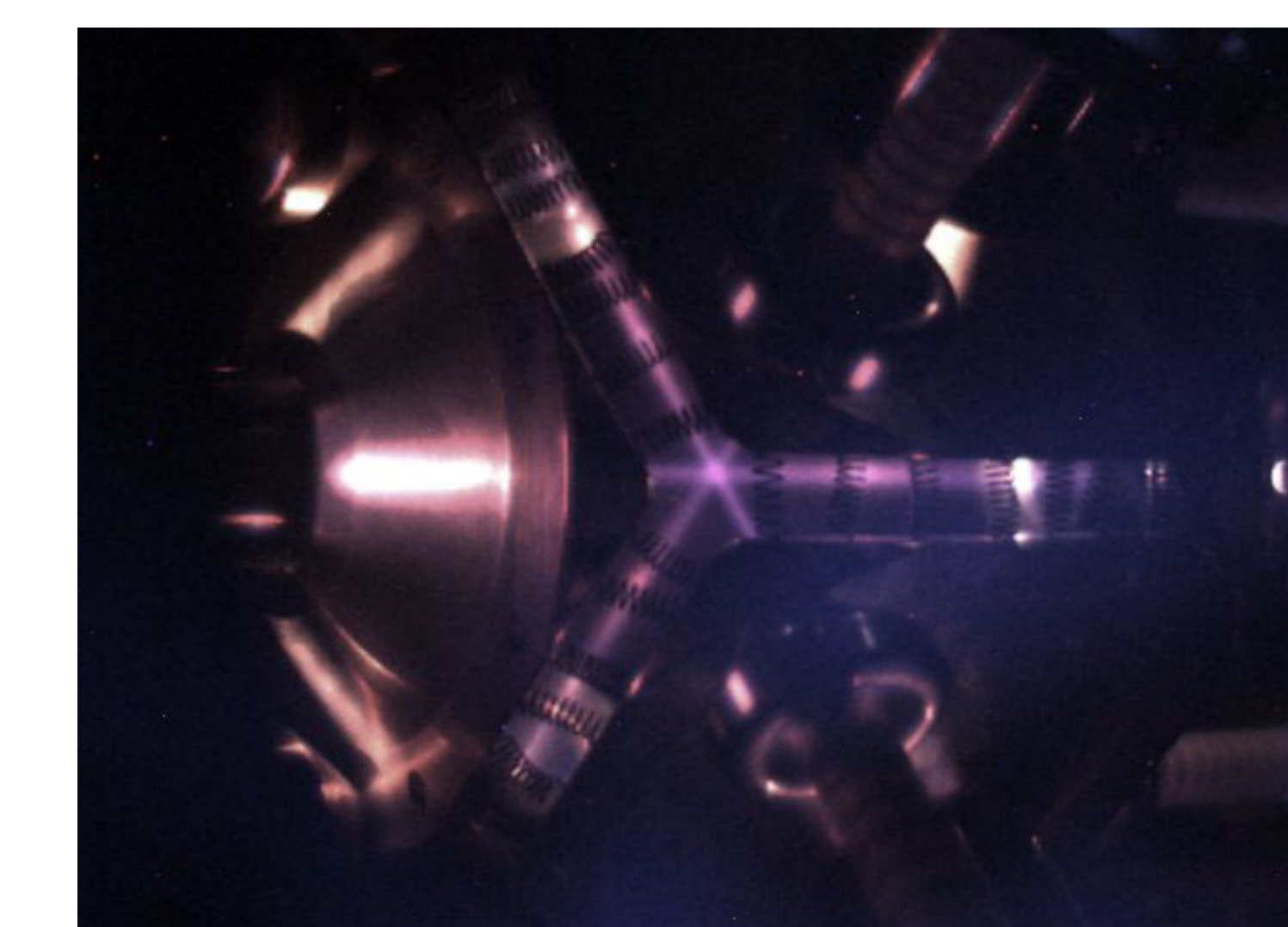


- Individual lenses are able to be adjusted using 4 set screws in the optic mount to make lens axes concentric
- Guns are pivoted on two axes with the gun mount swivel plate to focus ion beams at the center
- Ground steel rods were used to align lenses in each gun
- These same rods were used to focus each gun to the center



Results

- Achieved visible focused beam that converged at the center of the device



- Neutron rates vary distinctly for aligned and misaligned lenses

Summary

- Lenses were machined to tolerances of ± 0.05 mm
- Stable device operation at cathode voltage of 150 kV with insulator standoff distances of 40 mm
- Lenses aligned to within 0.4 mm on center
- Visible ion beams focused at center of device