The GlueX DIRC Project

Massachusetts Institute of Technology

INDIANA UNIVERSITY

Jefferson Lab

GSI

THE CATHOLIC UNIVERSITY of AMERICA

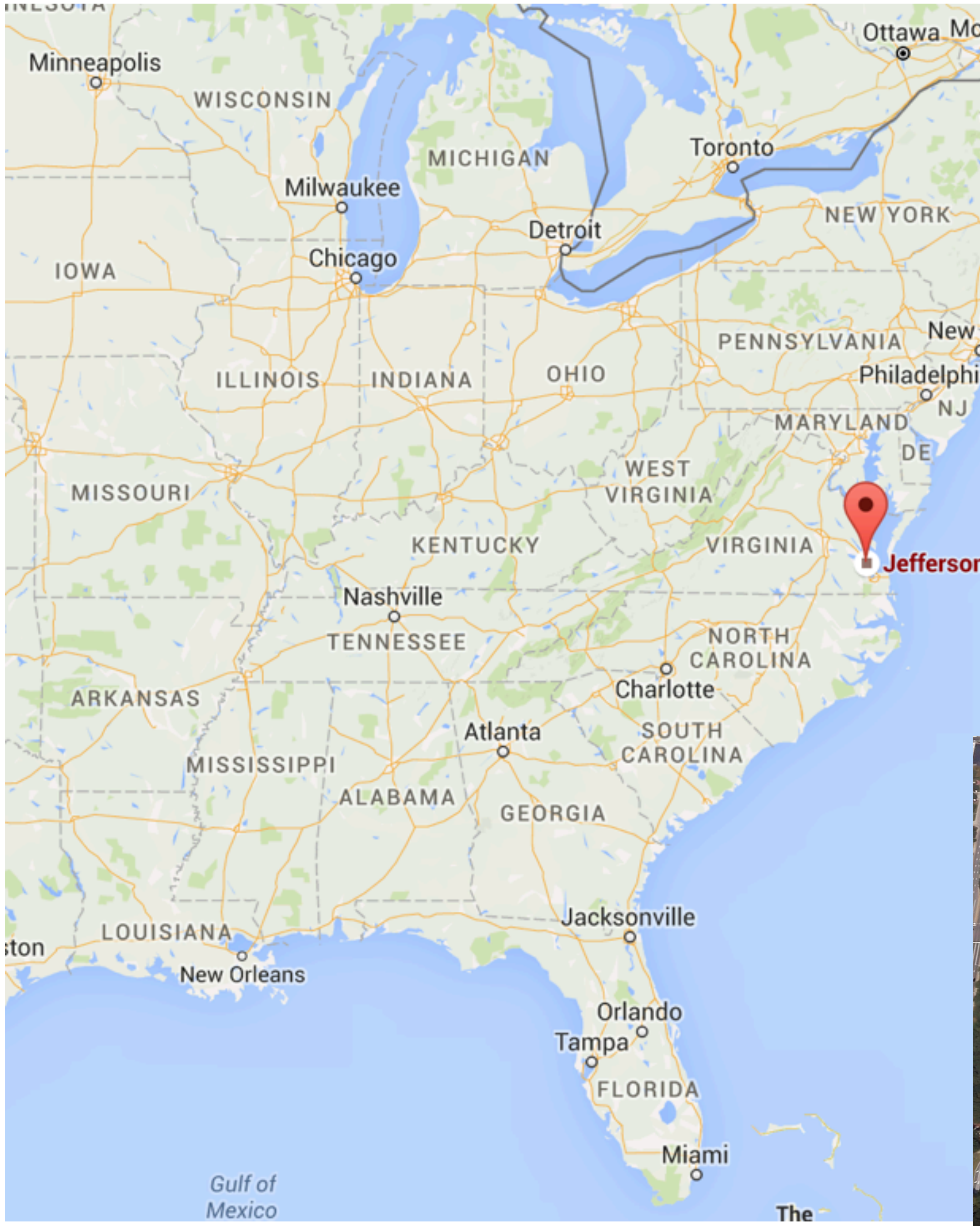
JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

Justin Stevens

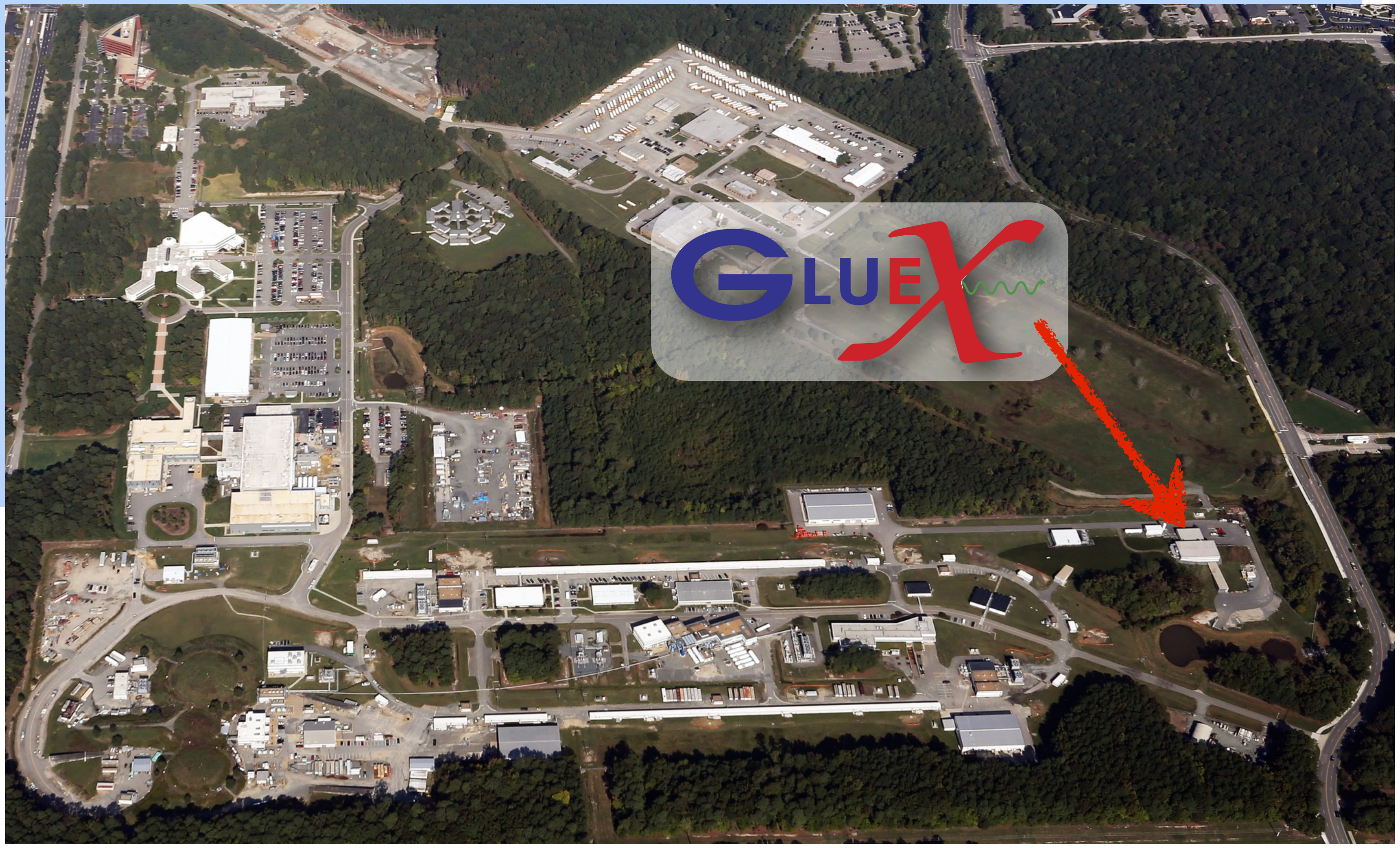
DIRC 2017 Workshop

WILLIAM & MARY
CHARTERED 1693

Jefferson Laboratory (JLab)

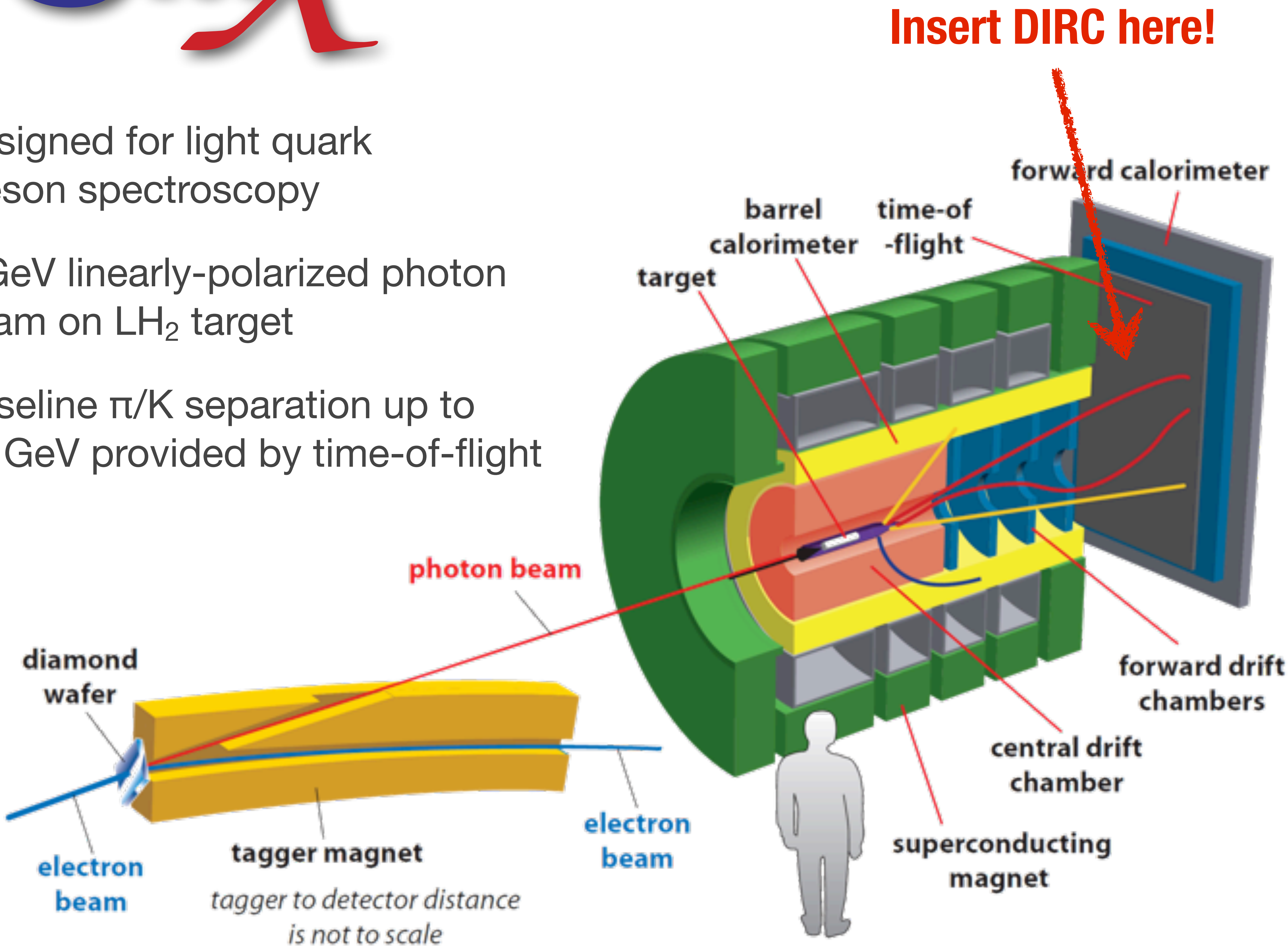


- Newport News, Virginia
- Home to the Continuous Electron Beam Accelerator Facility (CEBAF)



GlueX at JLab

- Designed for light quark meson spectroscopy
- 9 GeV linearly-polarized photon beam on LH_2 target
- Baseline π/K separation up to ~2 GeV provided by time-of-flight



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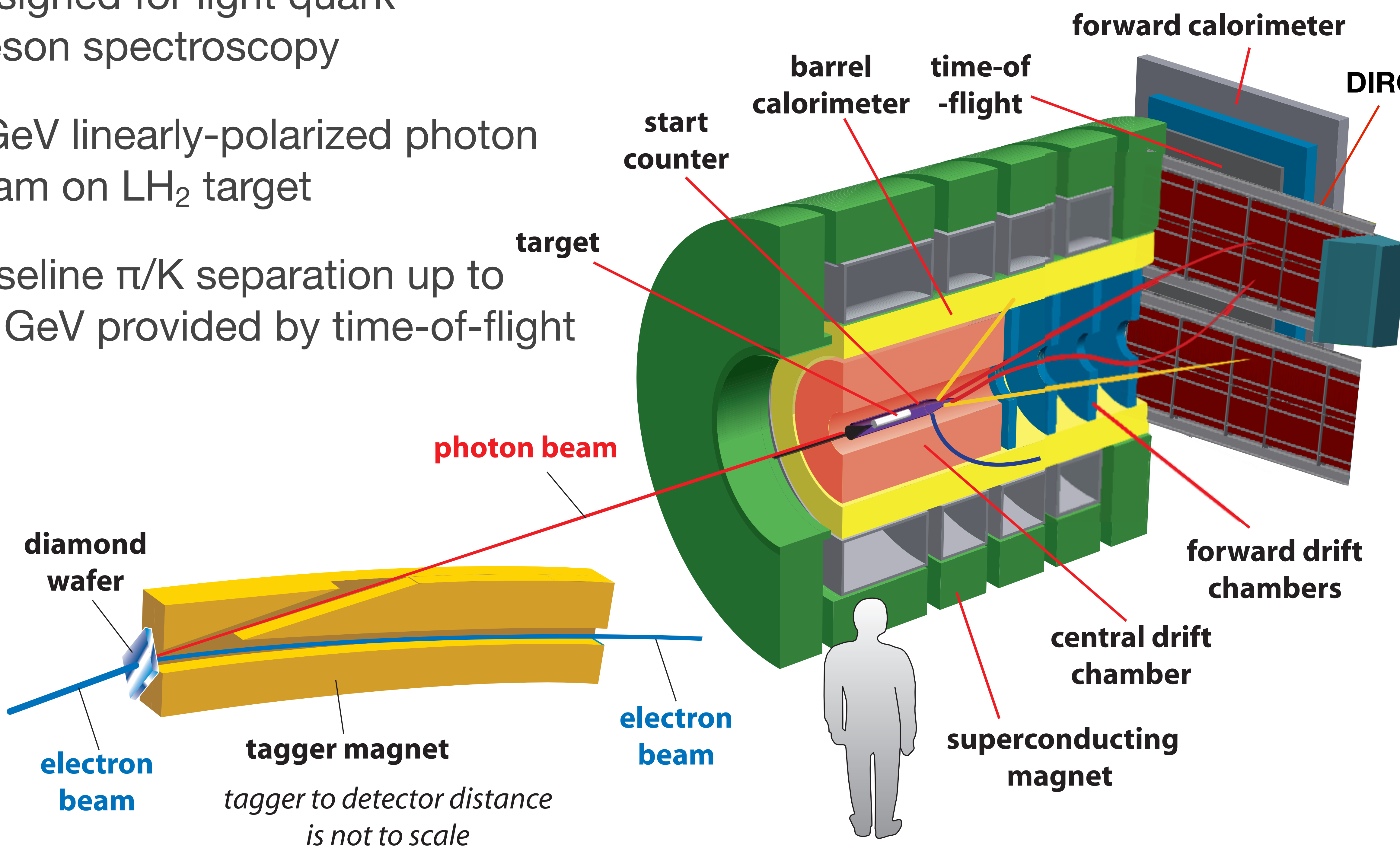
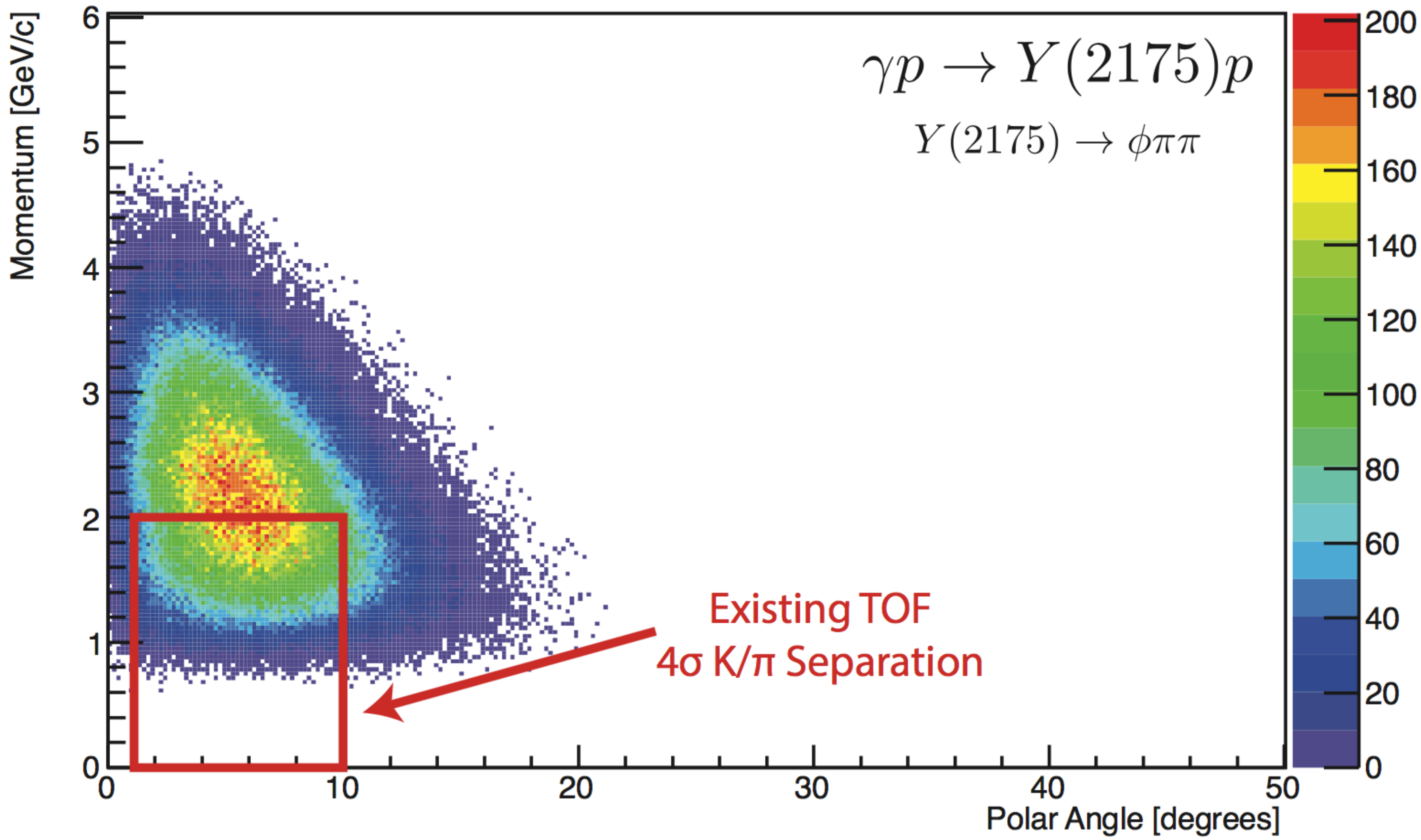
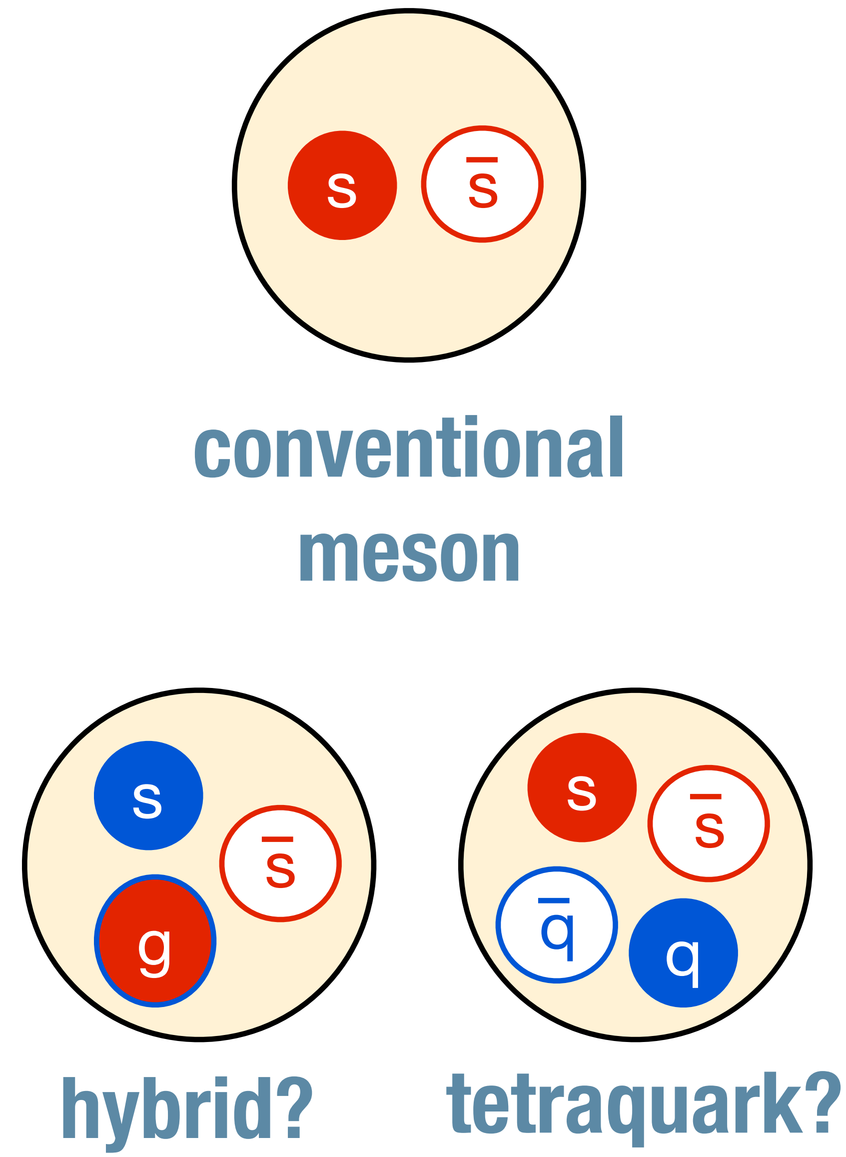


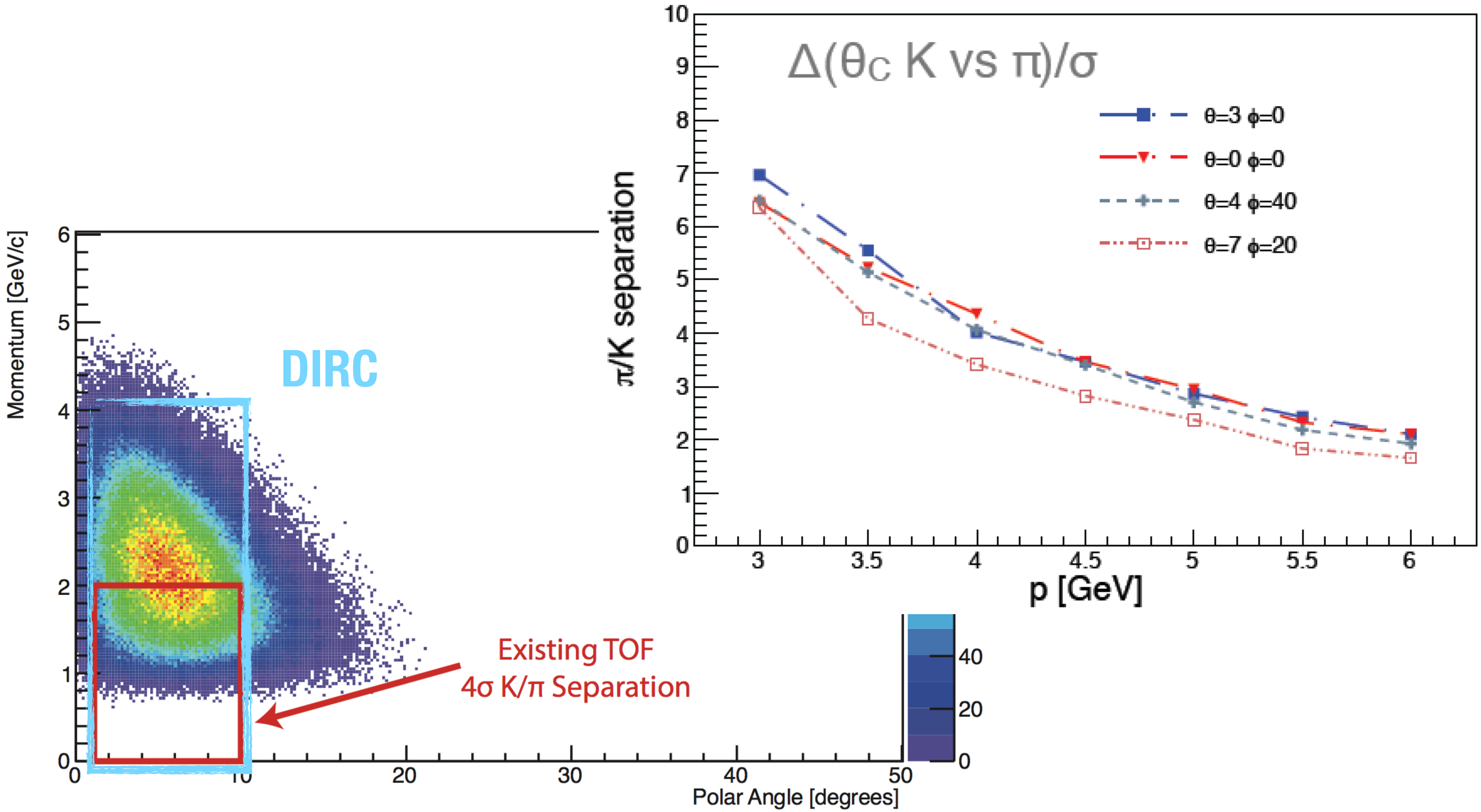
Strange meson spectroscopy

Y(2175): K± momentum vs polar angle



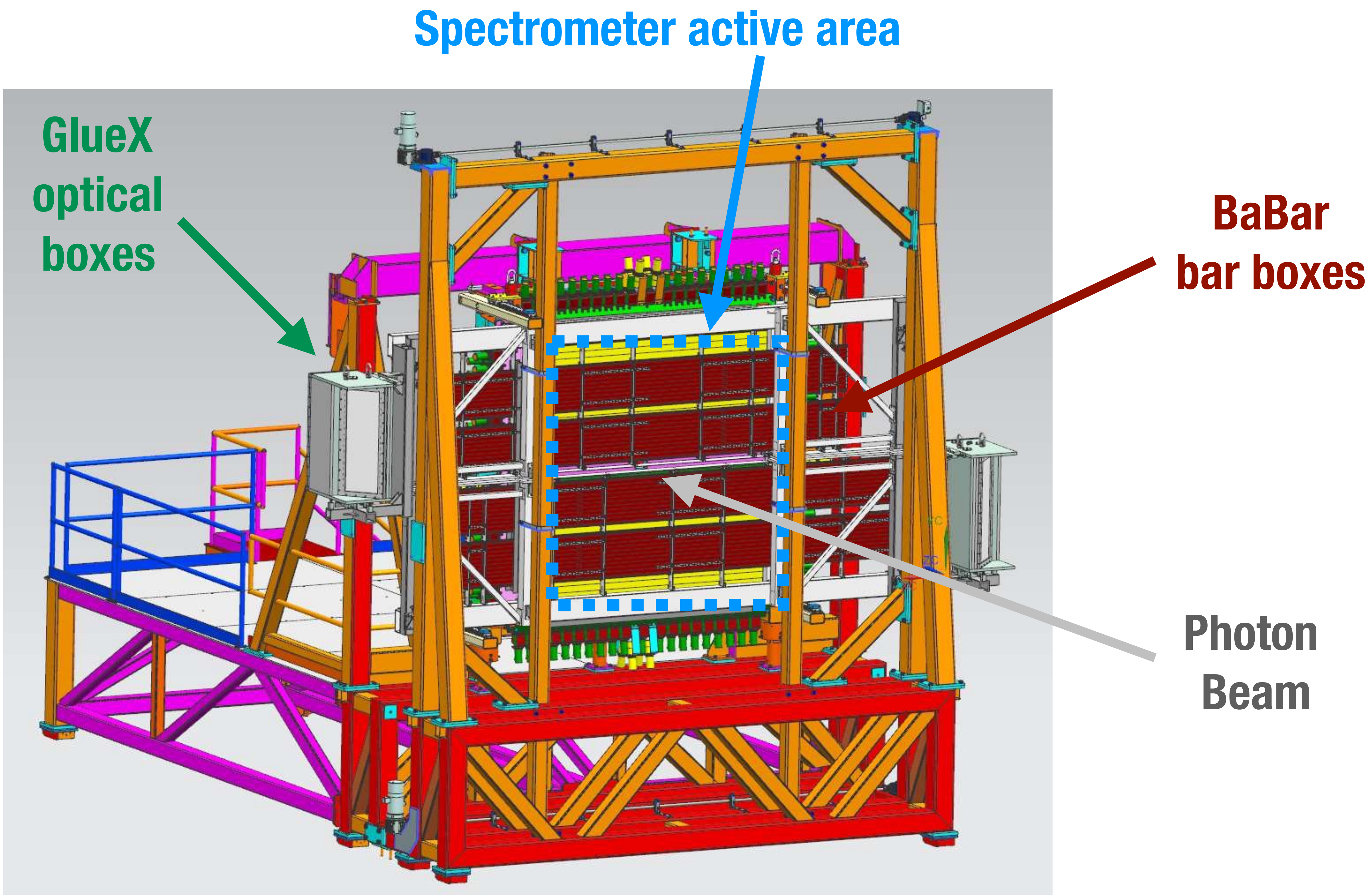


Expected GlueX DIRC performance

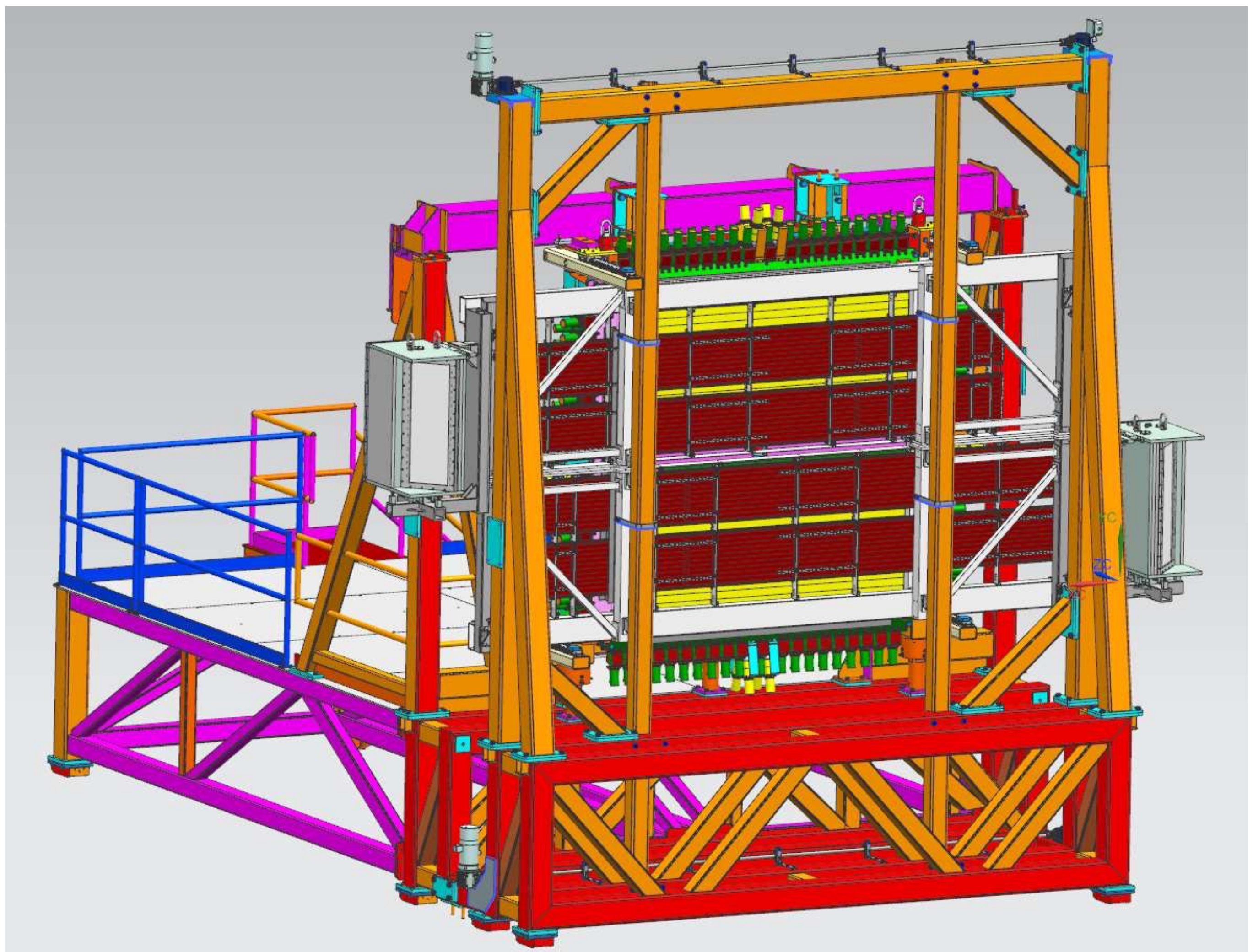


- Significantly extends reach in search for exotic hadrons (hybrid, multi-quark, etc.) containing strange quarks

GlueX DIRC design

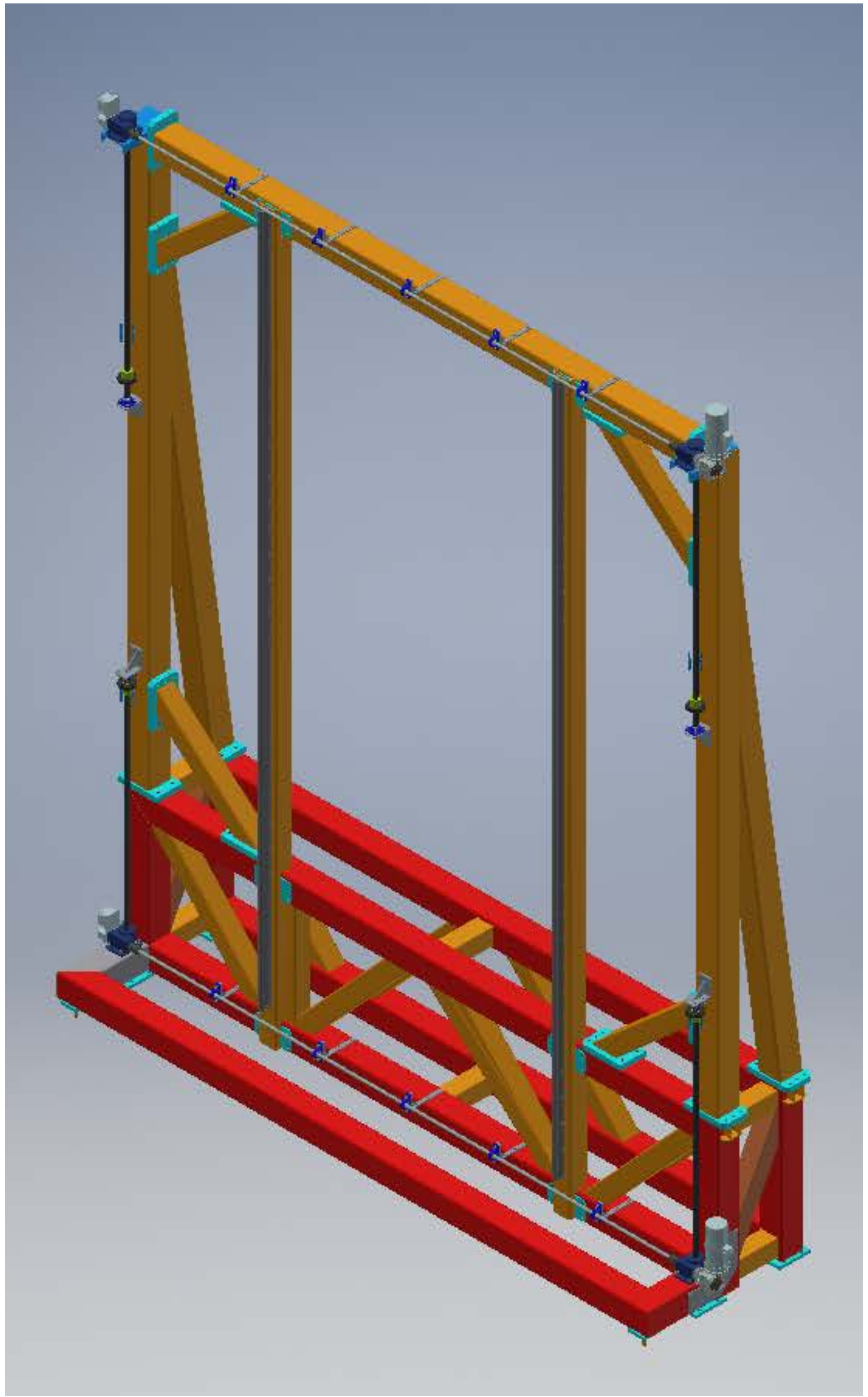


GlueX DIRC design constraints



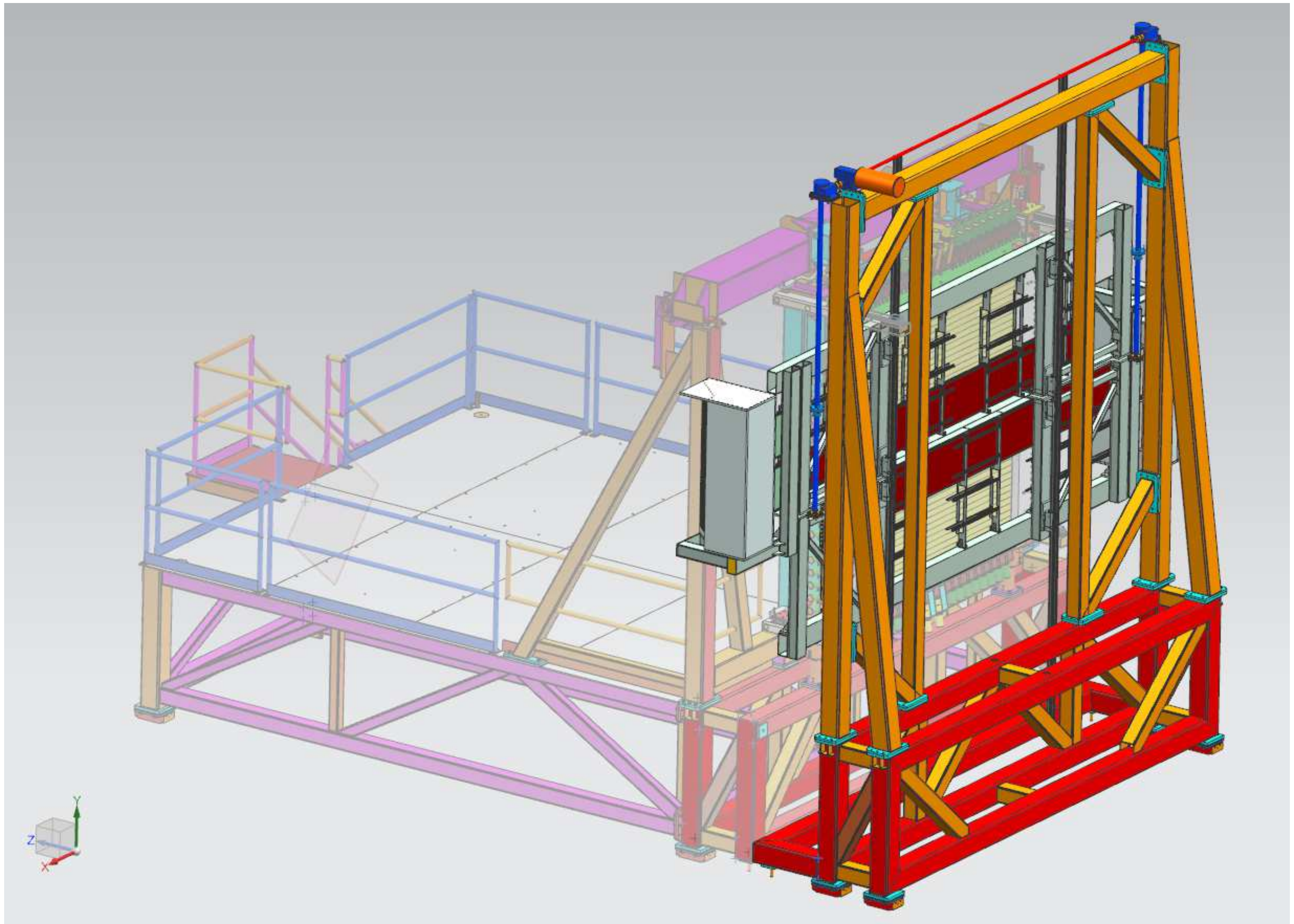
- **Support structure:** radiators retractable, minimize material thickness in active area, non-magnetic materials near solenoid field
- **Optical boxes:** no modifications to bar boxes, DAQ integration (photodetector and electronics choice)

Support structure assembly



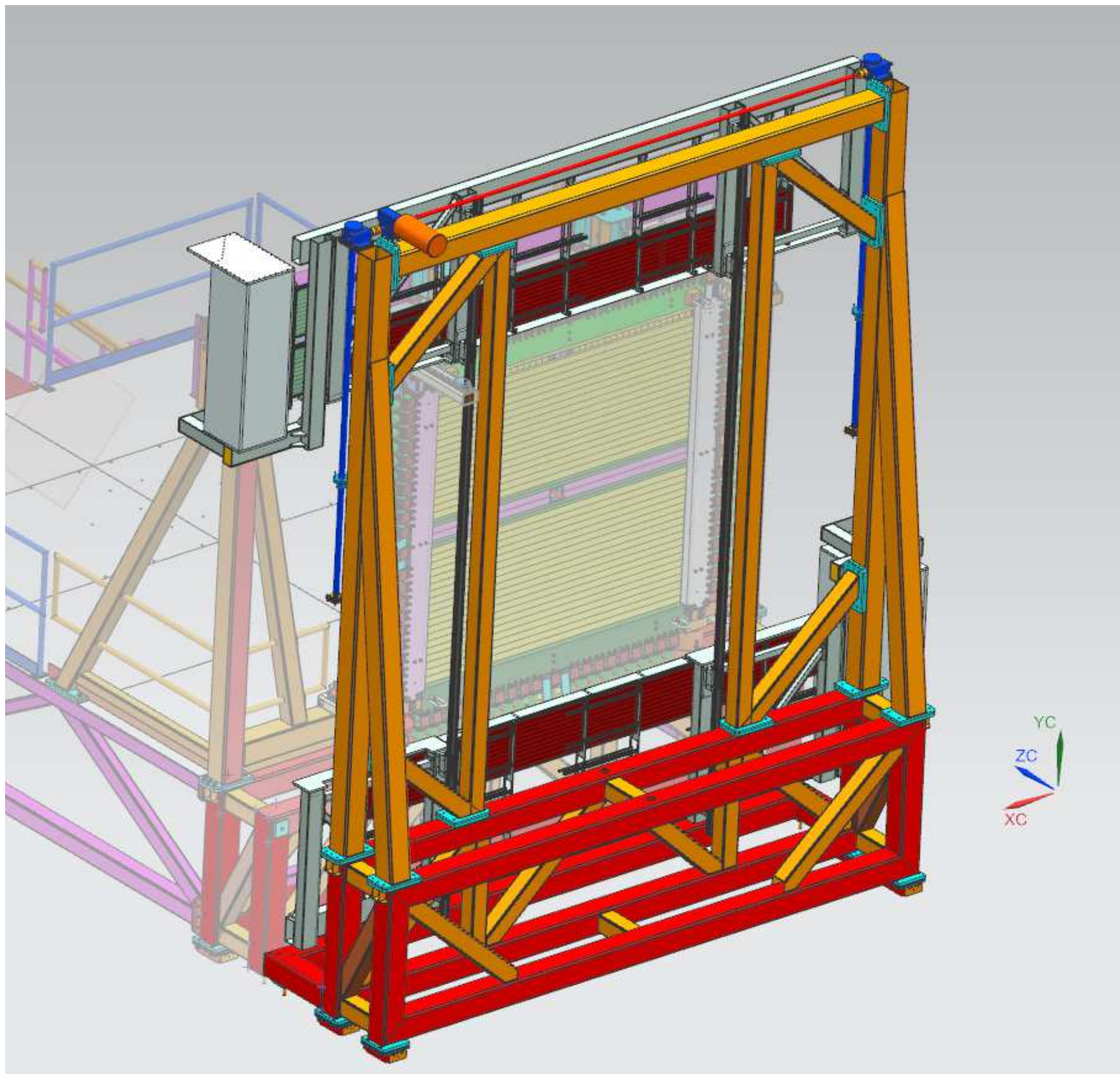
DIRC design constraints

Nominal Postion

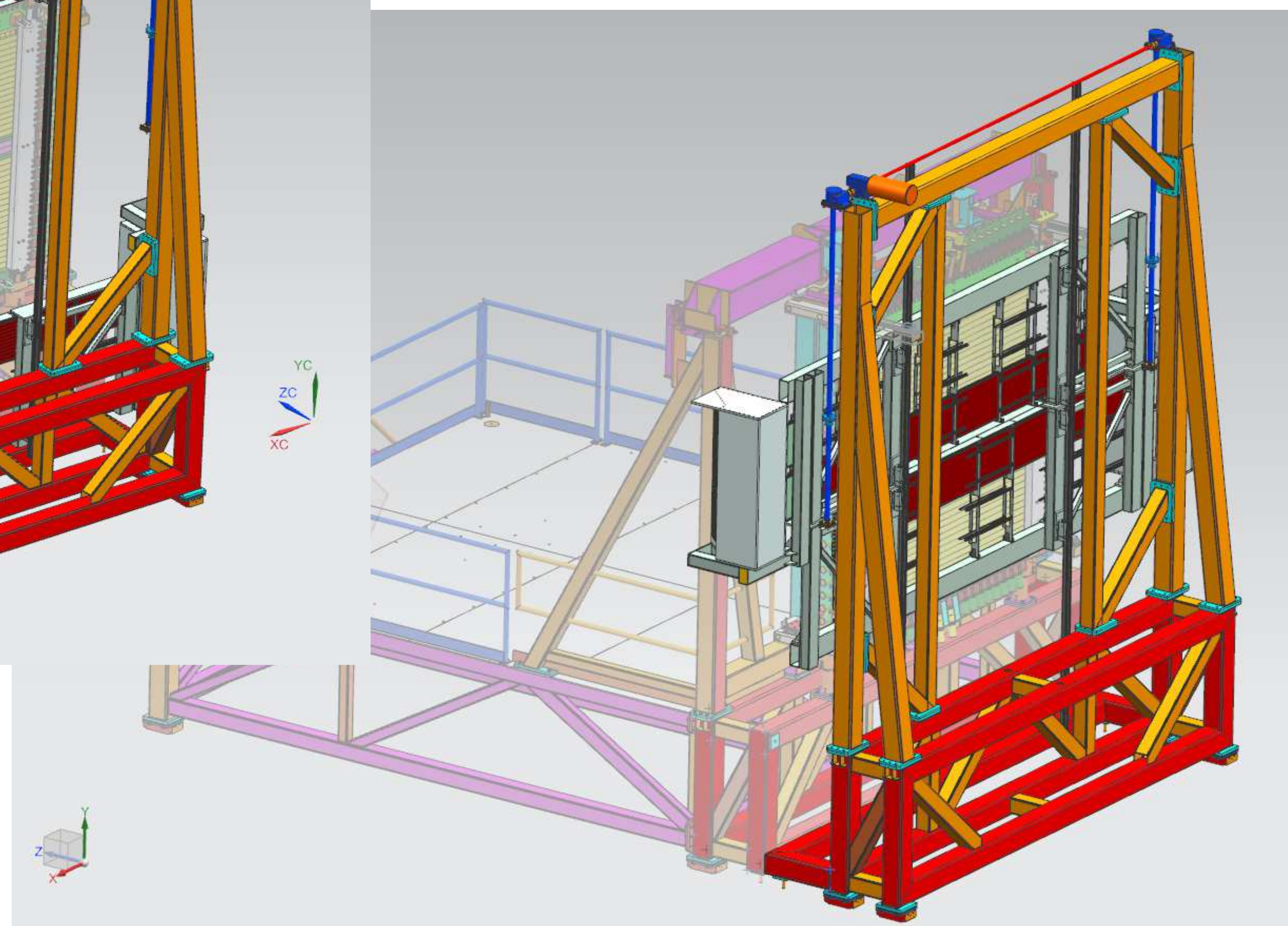


DIRC design constraints

Retracted Position

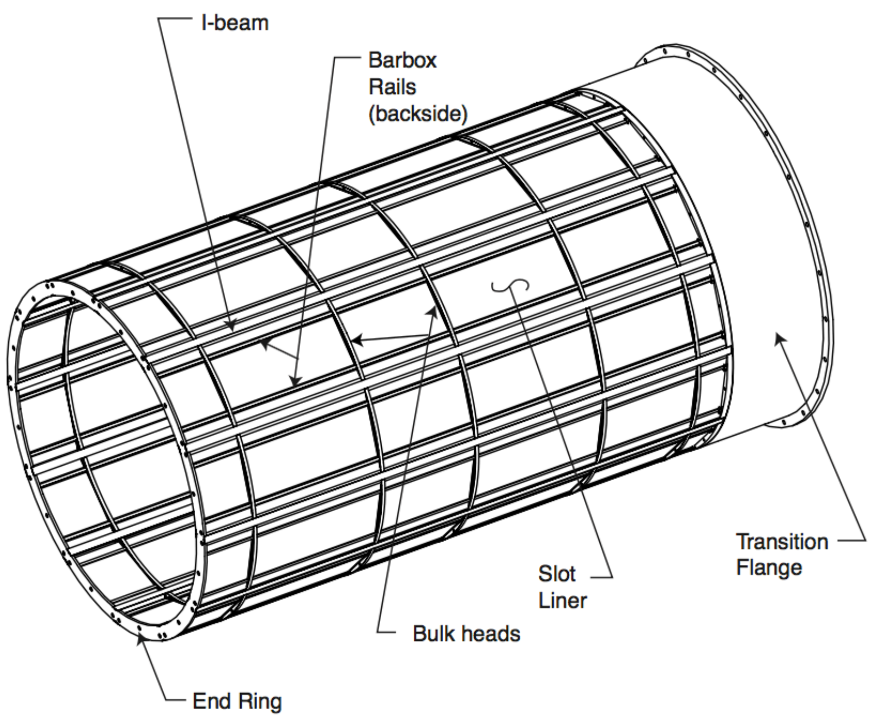


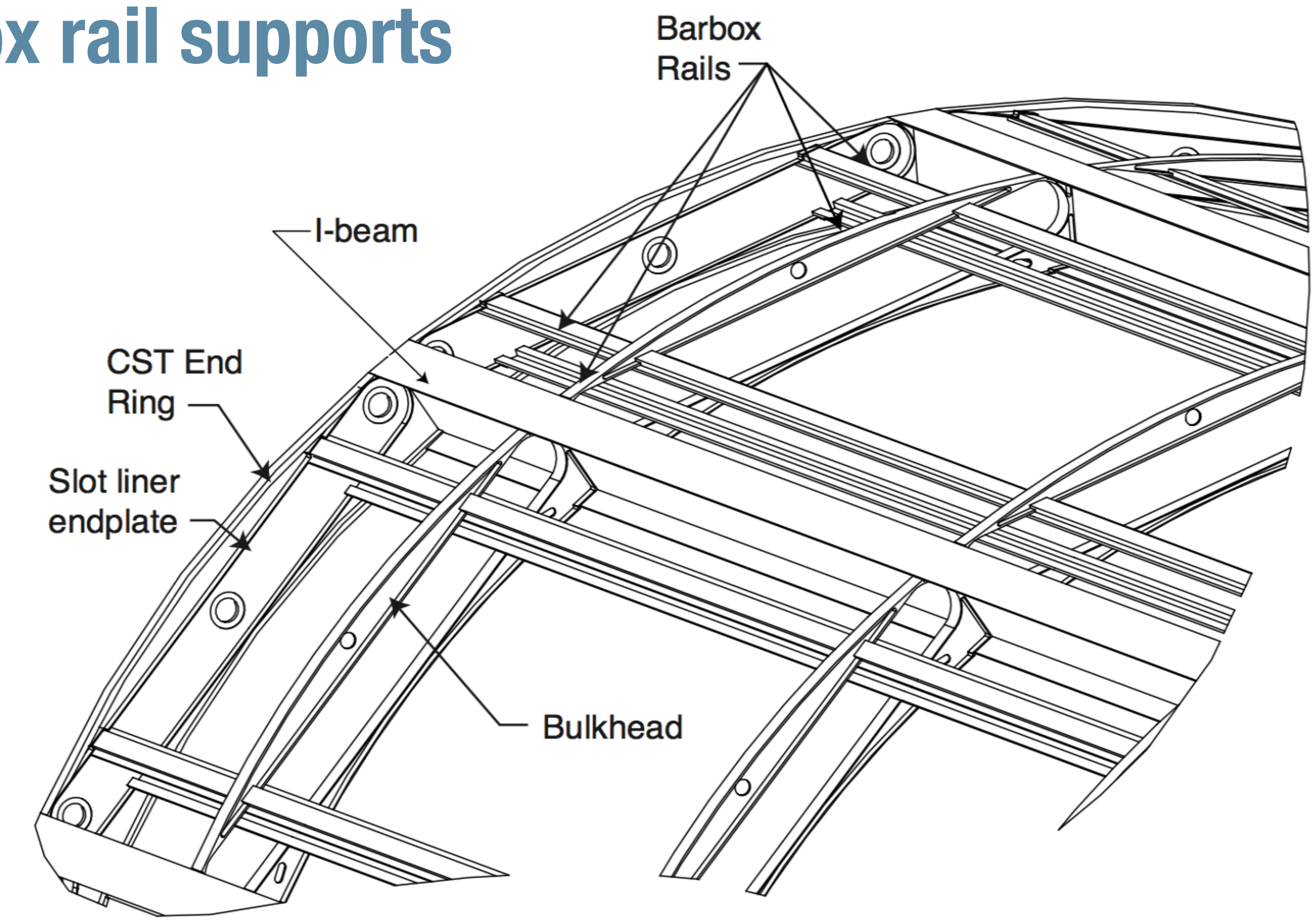
Nominal Postion



Inner support frame design

SLAC Barbox rail supports

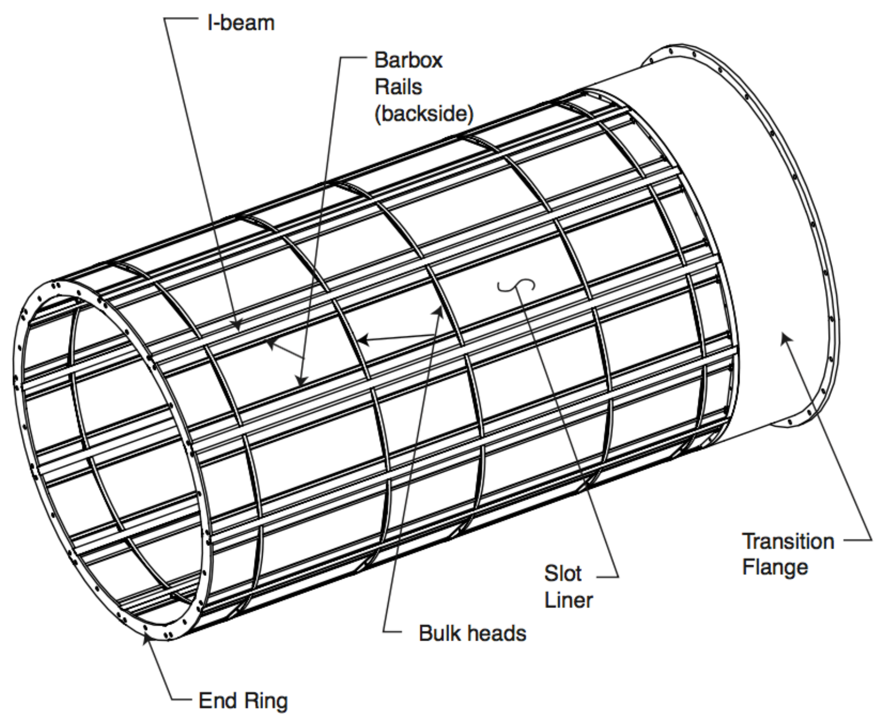


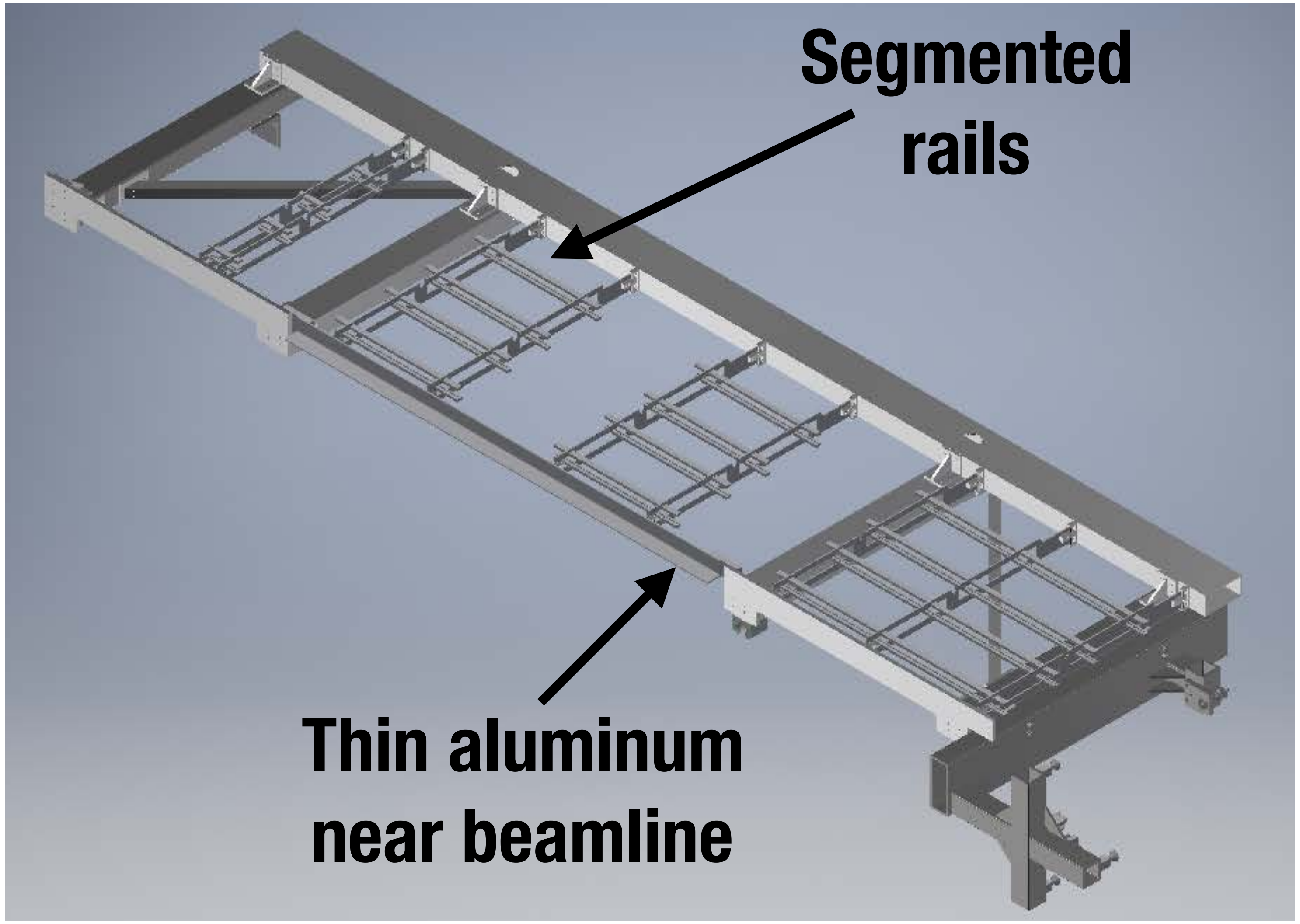


- No I-beam near beamline to minimize material, and limit rails to only required positions on bar boxes
- Non-ferromagnetic requirement near solenoid field

Inner support frame design

SLAC Barbox rail supports





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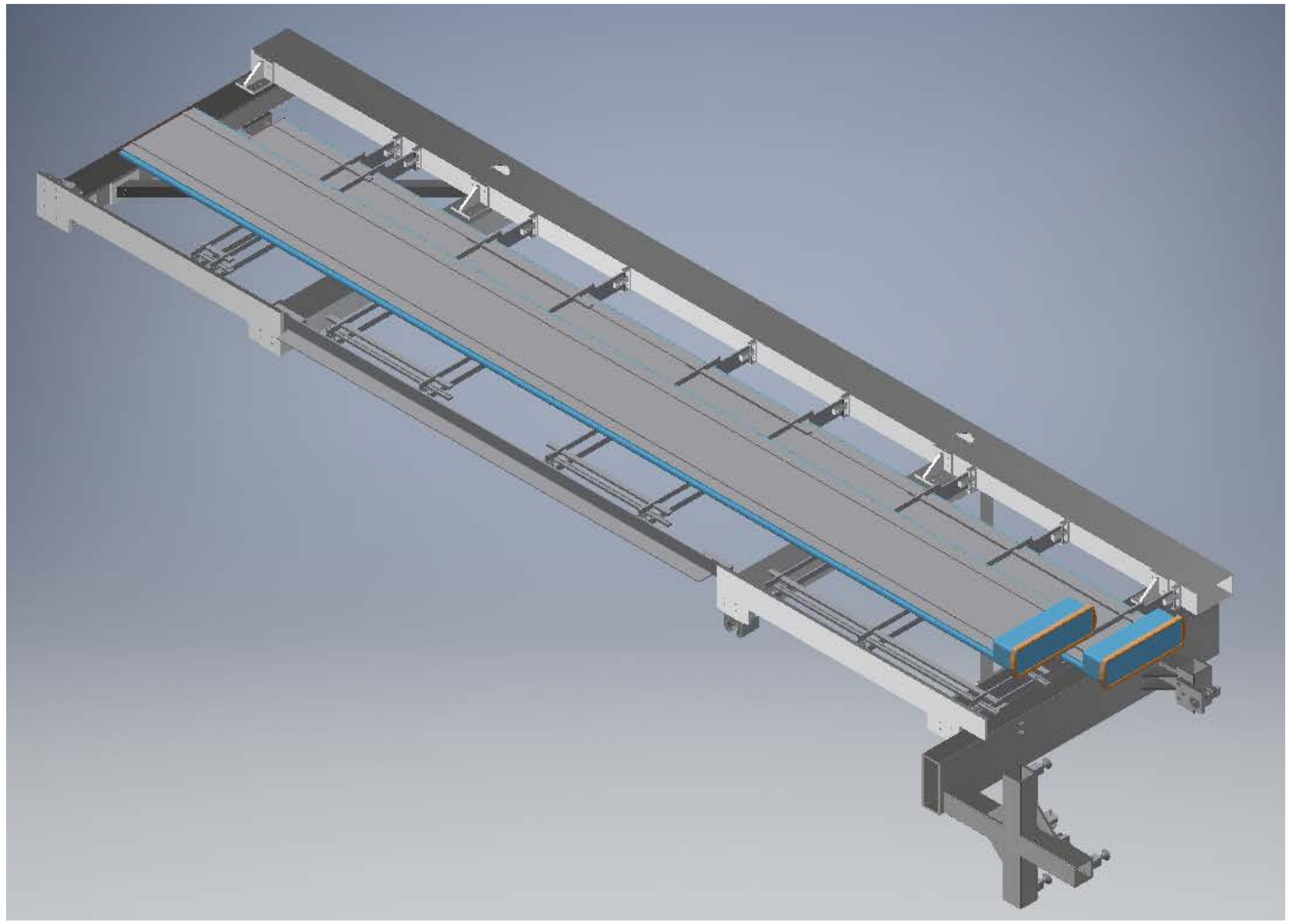
Inner support frame design



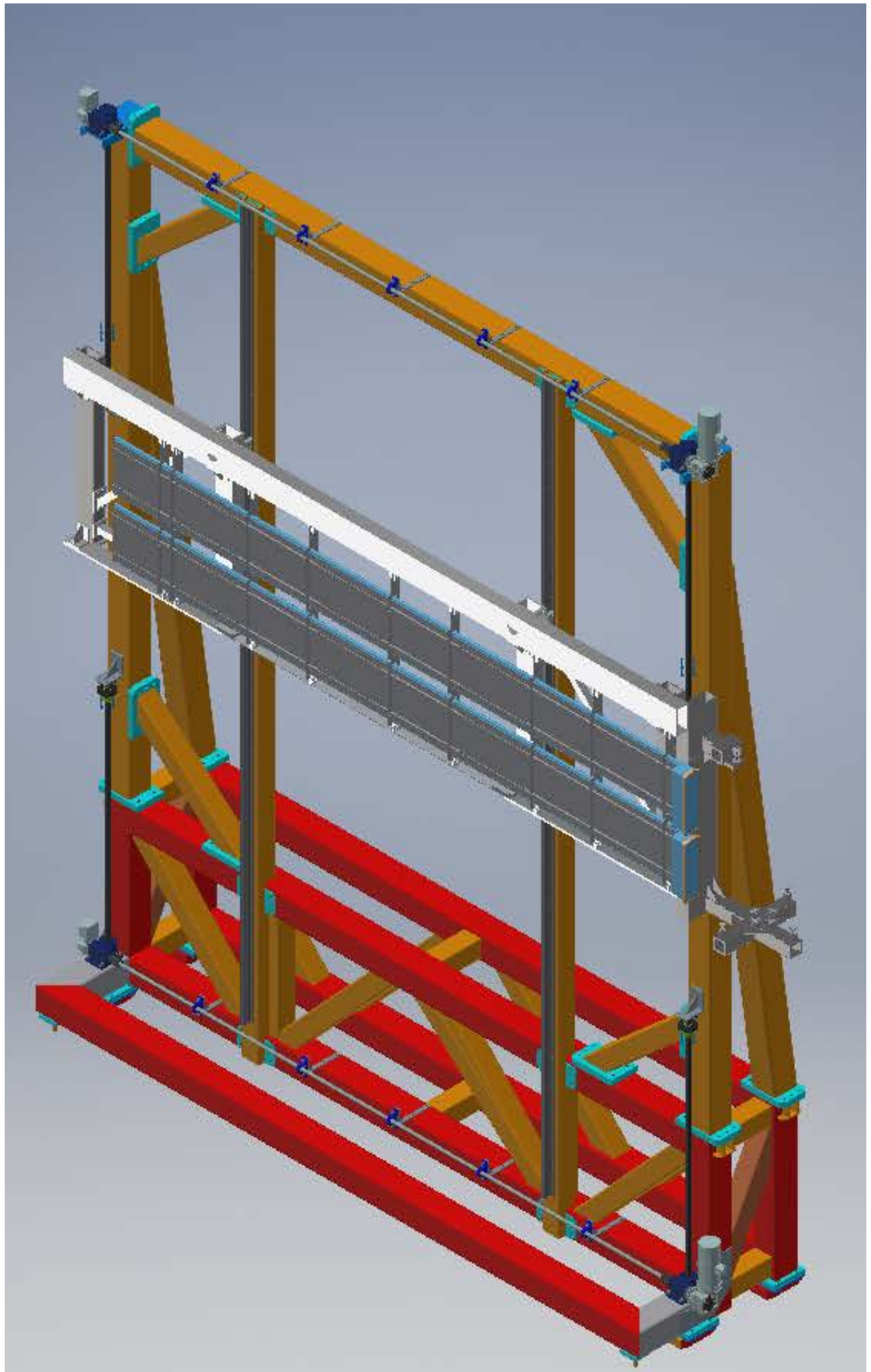
- No I-beam near beamline to minimize material, and limit rails to only required positions on bar boxes
- Non-ferromagnetic requirement near solenoid field

Inner support frame assembly

Segmented rails

- No I-beam near beamline to minimize material, and limit rails to only required positions on bar boxes
- Non-ferromagnetic requirement near solenoid field

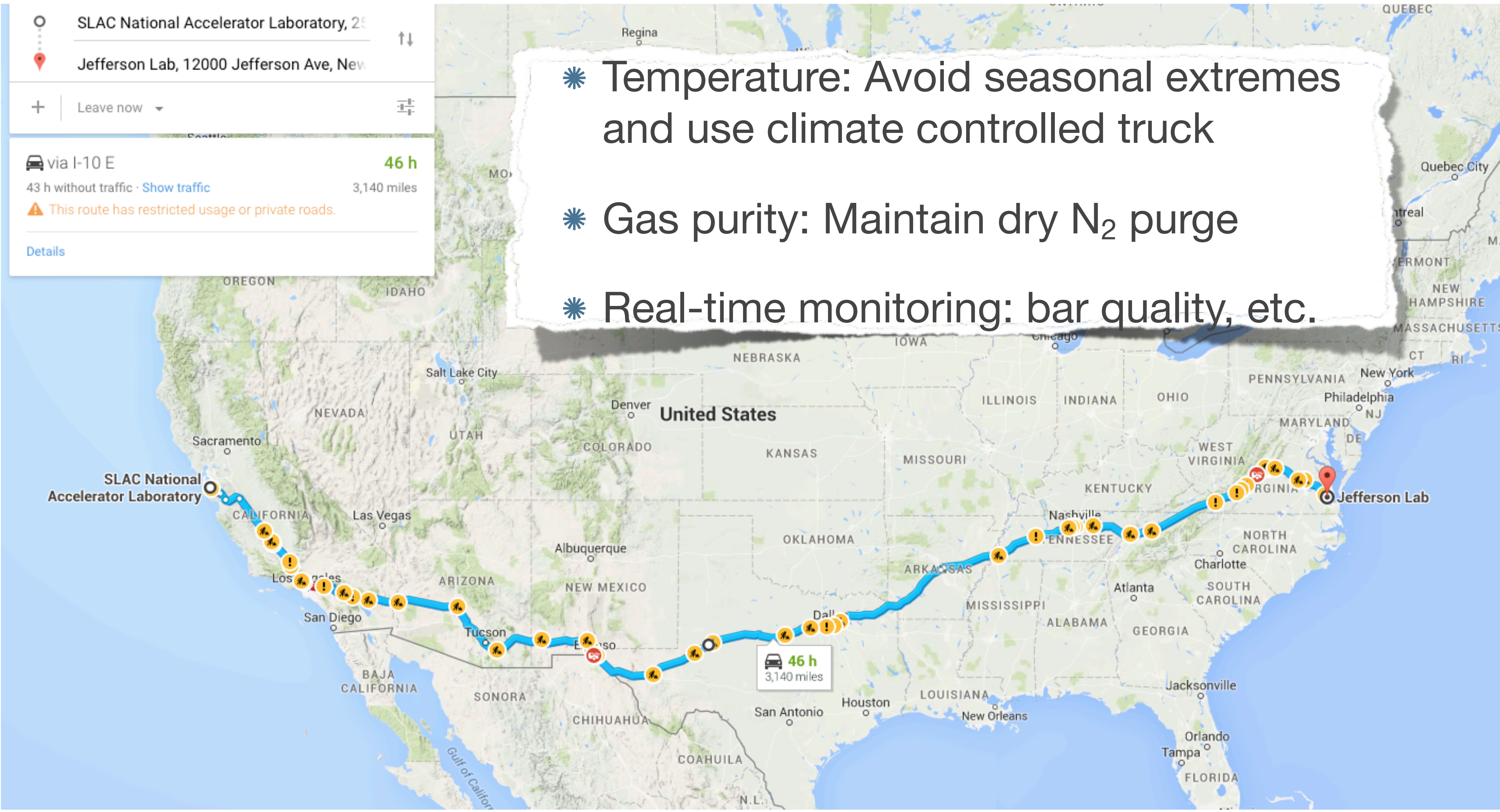
Support structure installation



- Final assembly and testing ongoing now at IU
- Expect delivery to JLab in August and installation soon thereafter
- Requires temporary floor mounts while FCAL carriage is retracted

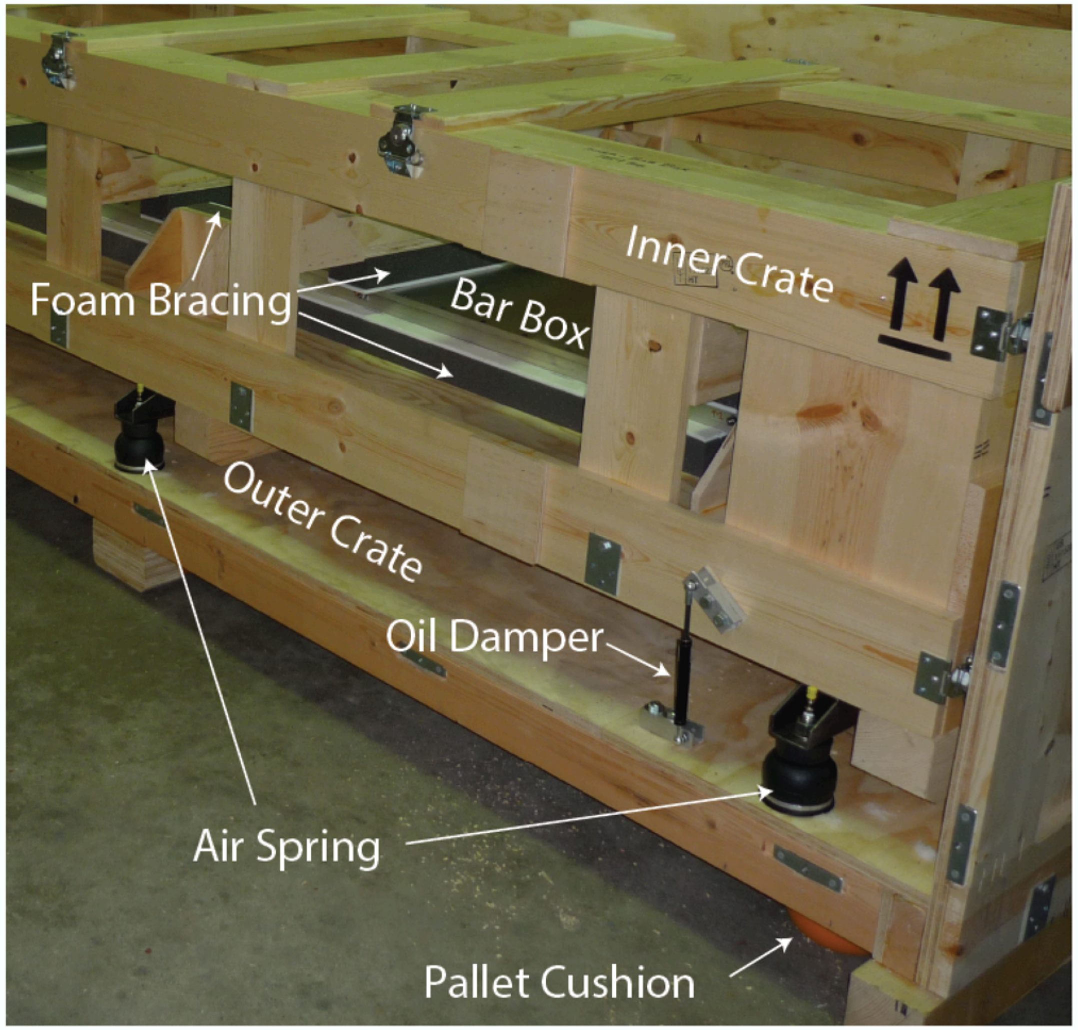
Bar box transportation

- Temperature: Avoid seasonal extremes and use climate controlled truck
- Gas purity: Maintain dry N_2 purge
- Real-time monitoring: bar quality, etc.



Transportation strategy

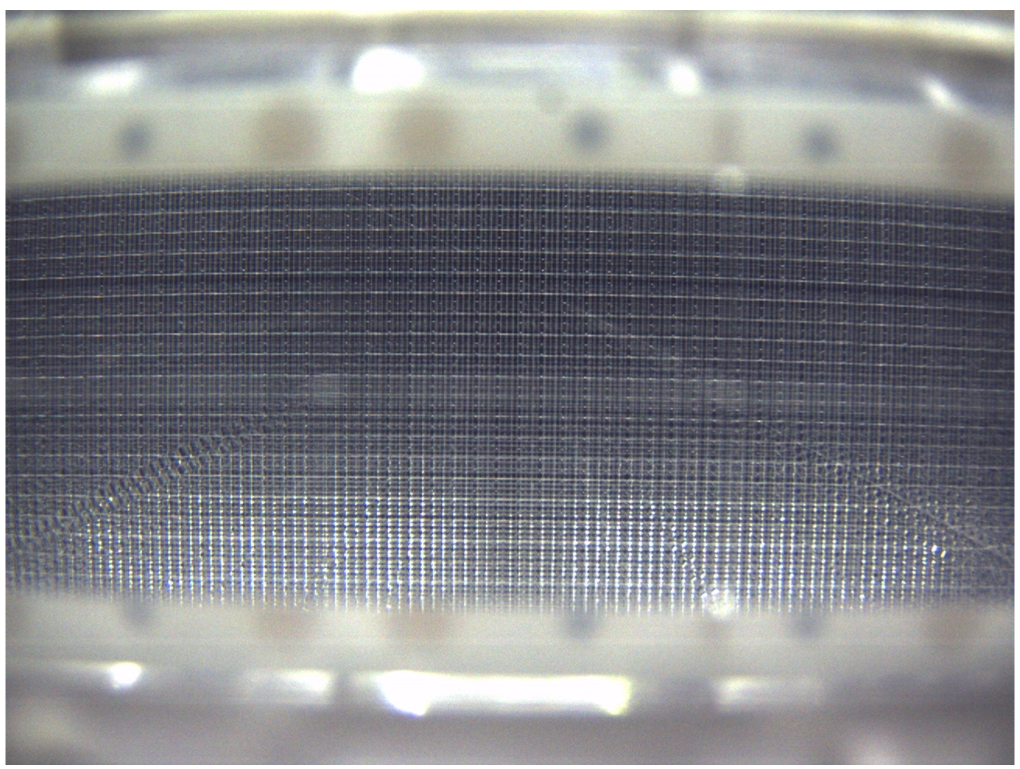
- Transport 4 bar boxes from SLAC to JLab in two separate shipments
- First bar box shipment in Fall 2017, second shipment of remaining three soon thereafter

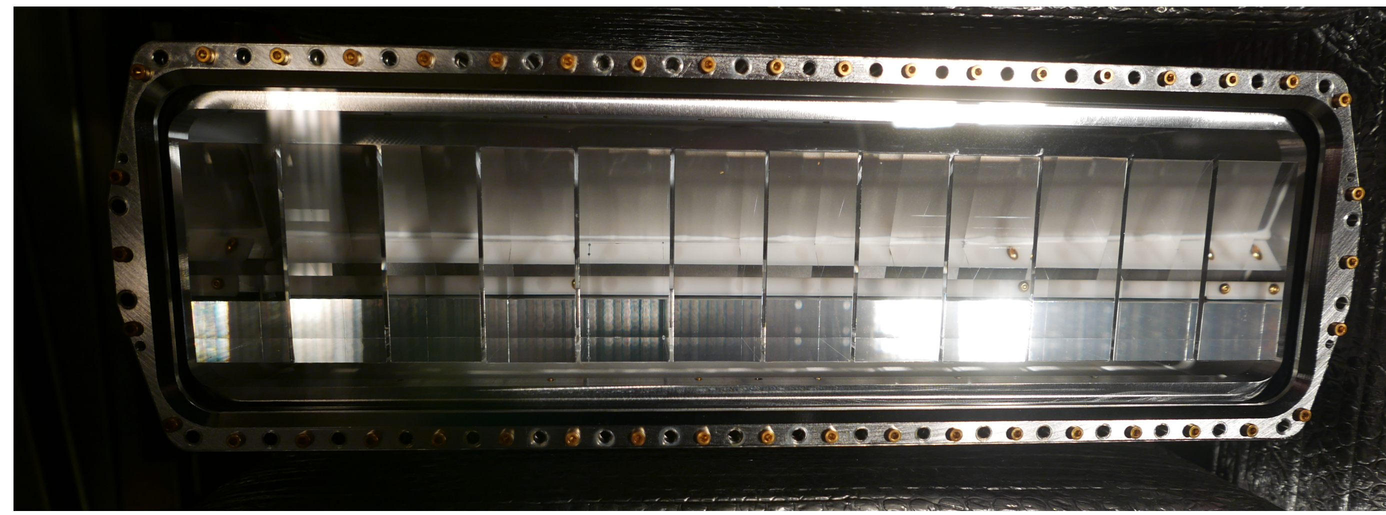


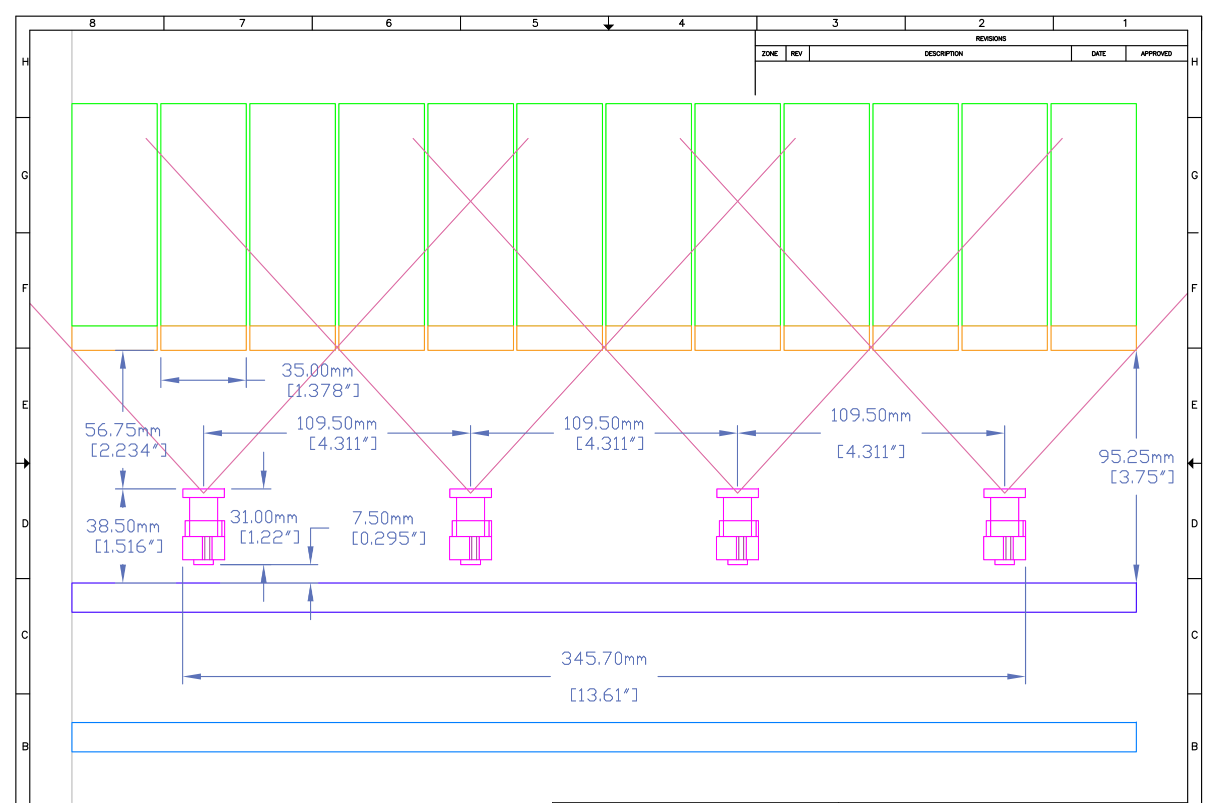
- Real-time monitoring system for bar boxes in transit
  - Multiple cameras for viewing bars
  - N_2 flow sensors, accelerometers, etc.

Monitoring system development

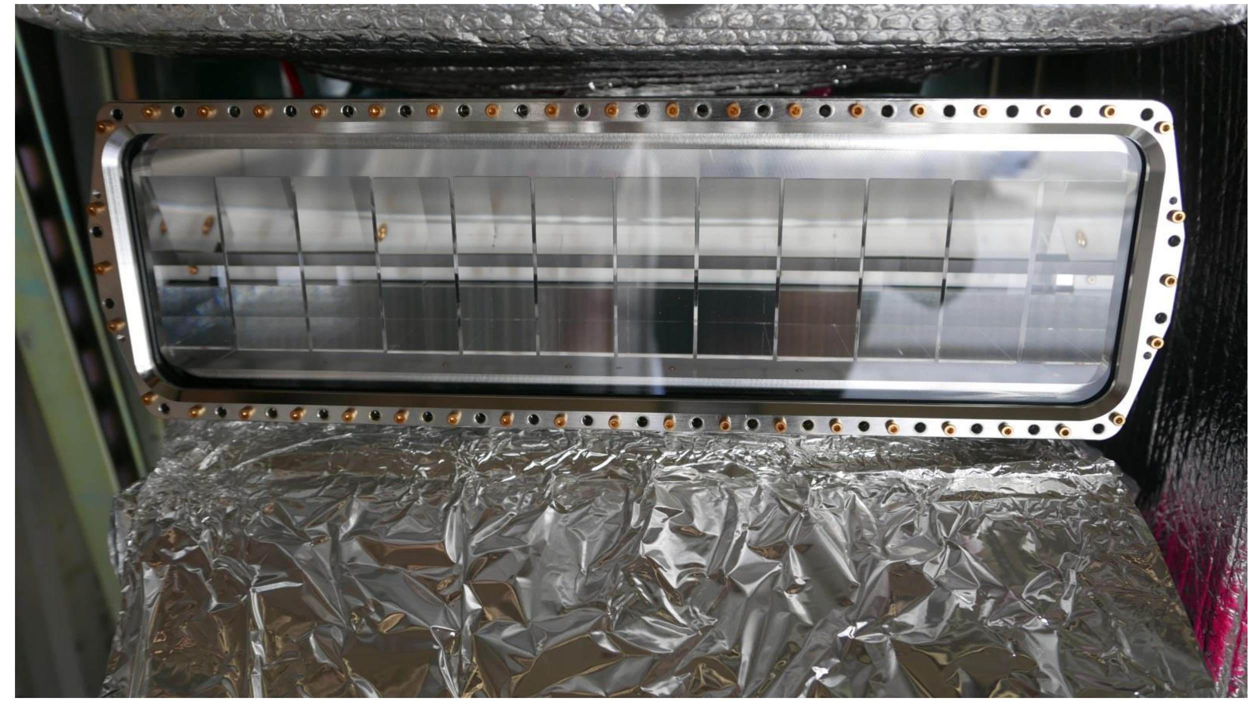
- Distinct kaleidoscope pattern when viewing bar from window which can be monitored in ~real time

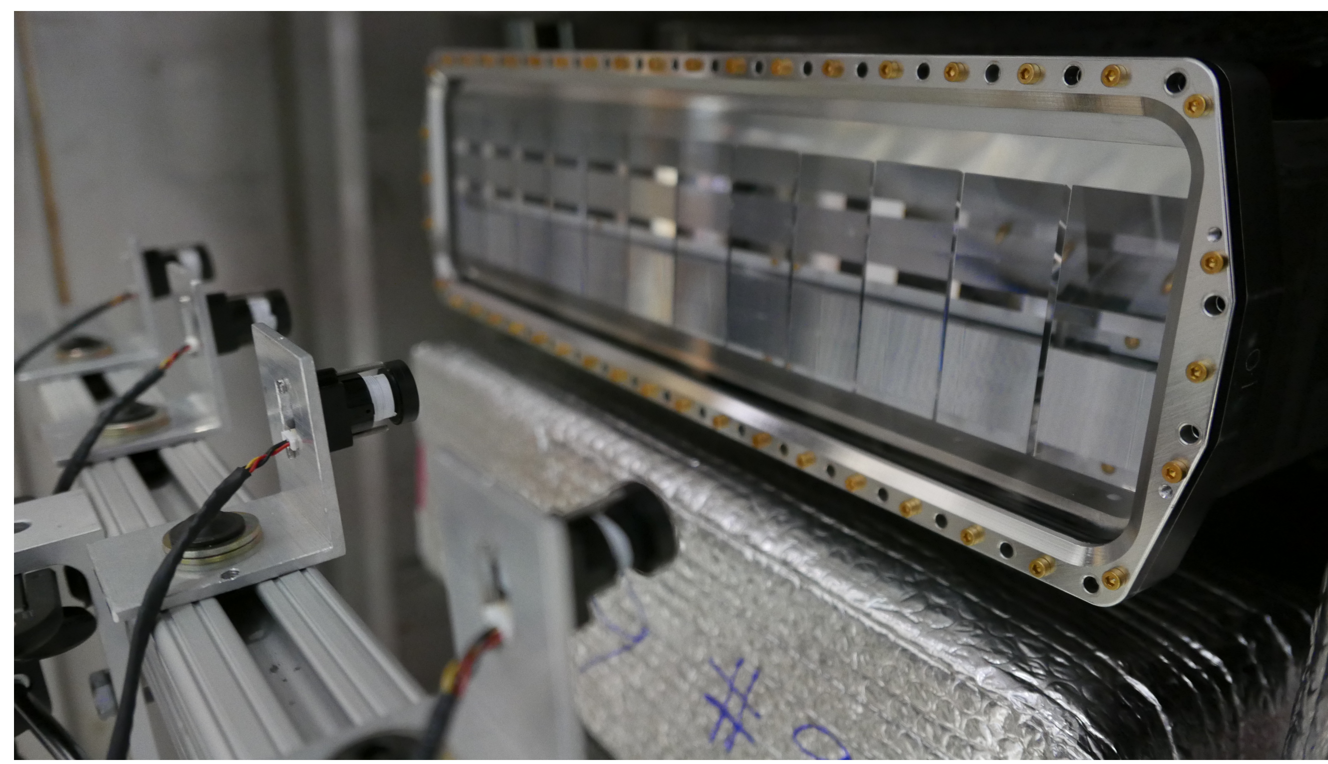






Camera tests at SLAC

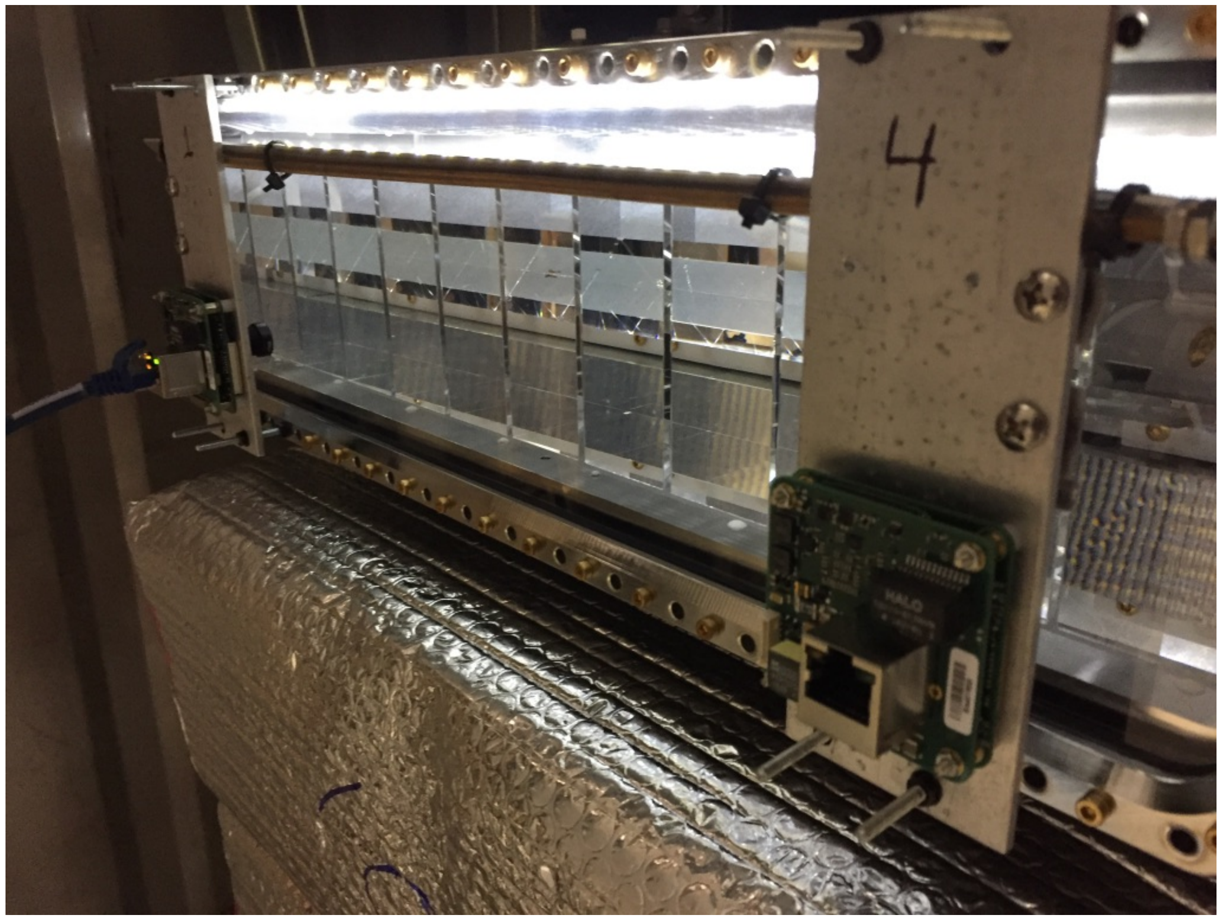




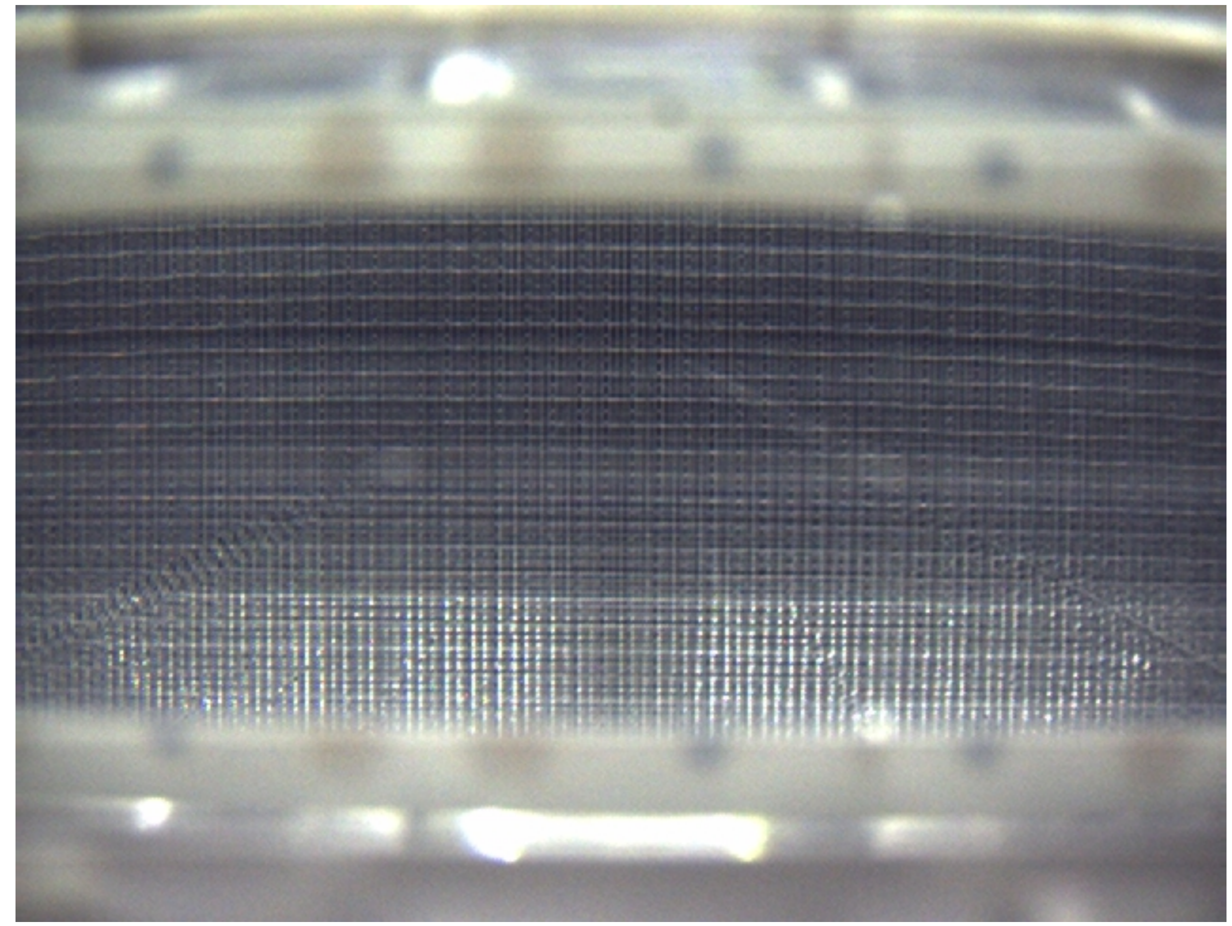
- LED light source for use inside shipping crate
- Tested various mounting schemes for cameras for image quality and stability

Camera tests at SLAC

Mount plates directly to bar box



Too close to see full bar

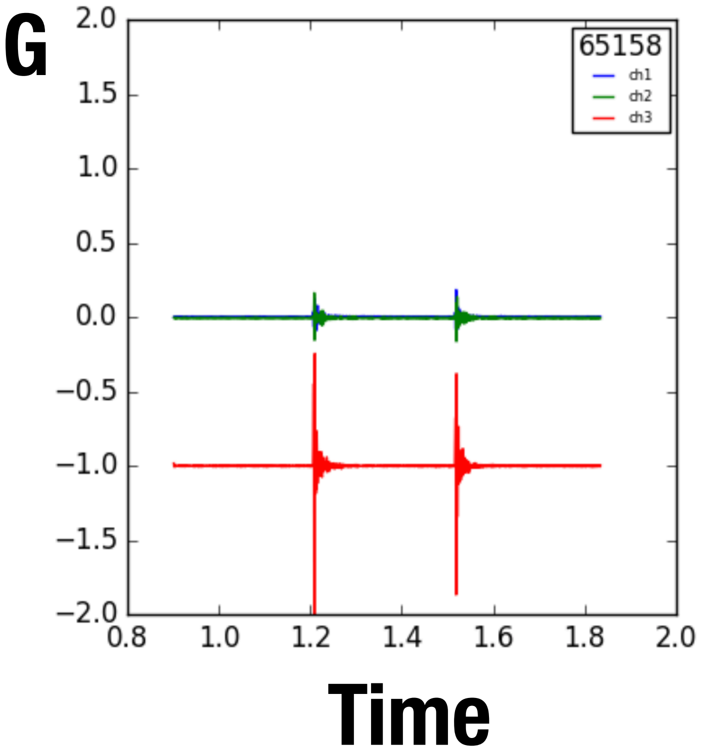


- Will use 4 (6) cameras on plates directly mounted to bar box with larger stand off distance to view 3 (2) bars per camera

Monitoring system logistics

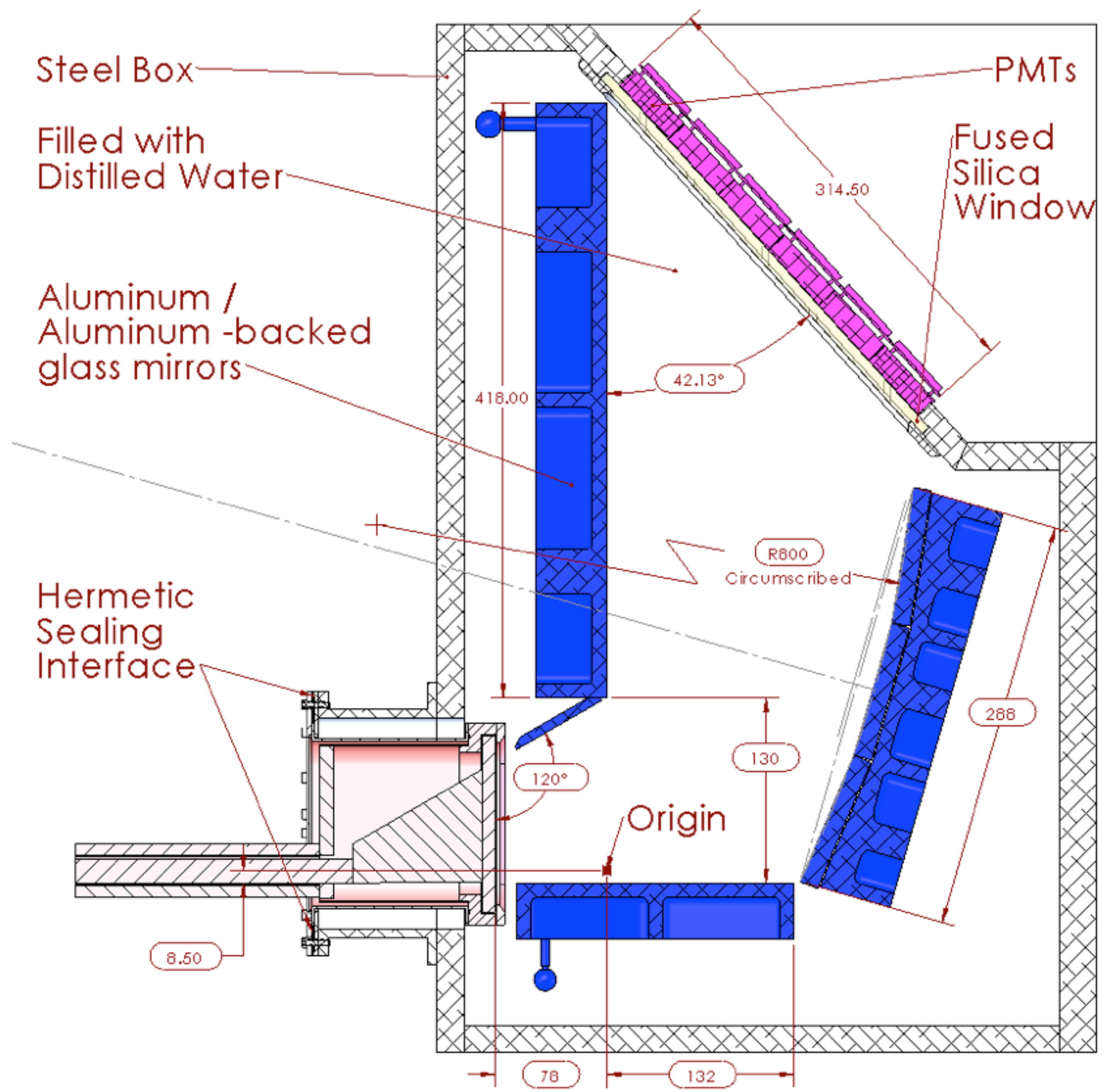
- Many sensors, cameras, etc. needed in transit, which provide input to central computer and broadcasts wireless signal to trail car
- Wireless interface for accelerometers, temp sensors, flow meters, etc.
- Limit power consumption to that available in refrigerated truck
- Full test run in September to install all components in crate and test the system before shipping to SLAC

Wireless Accelerometers

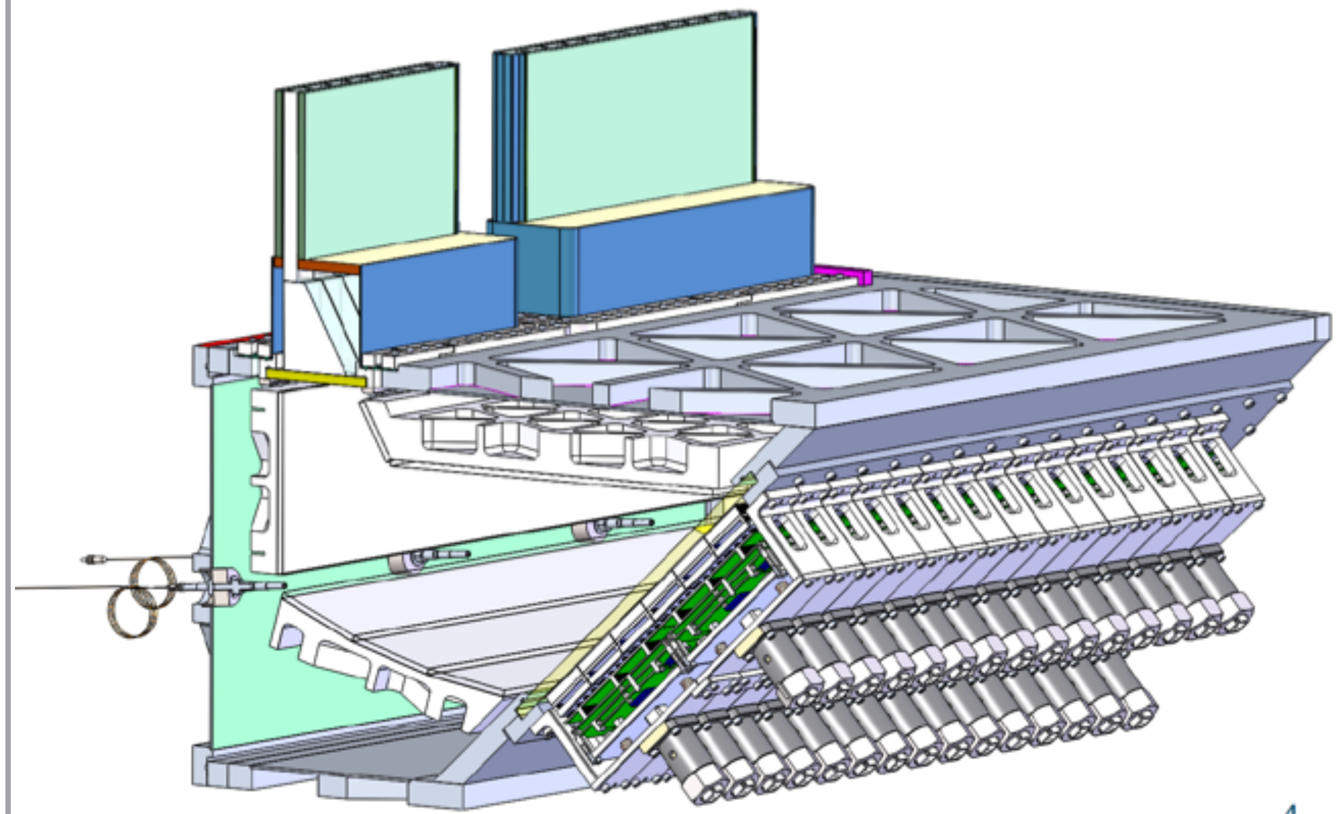


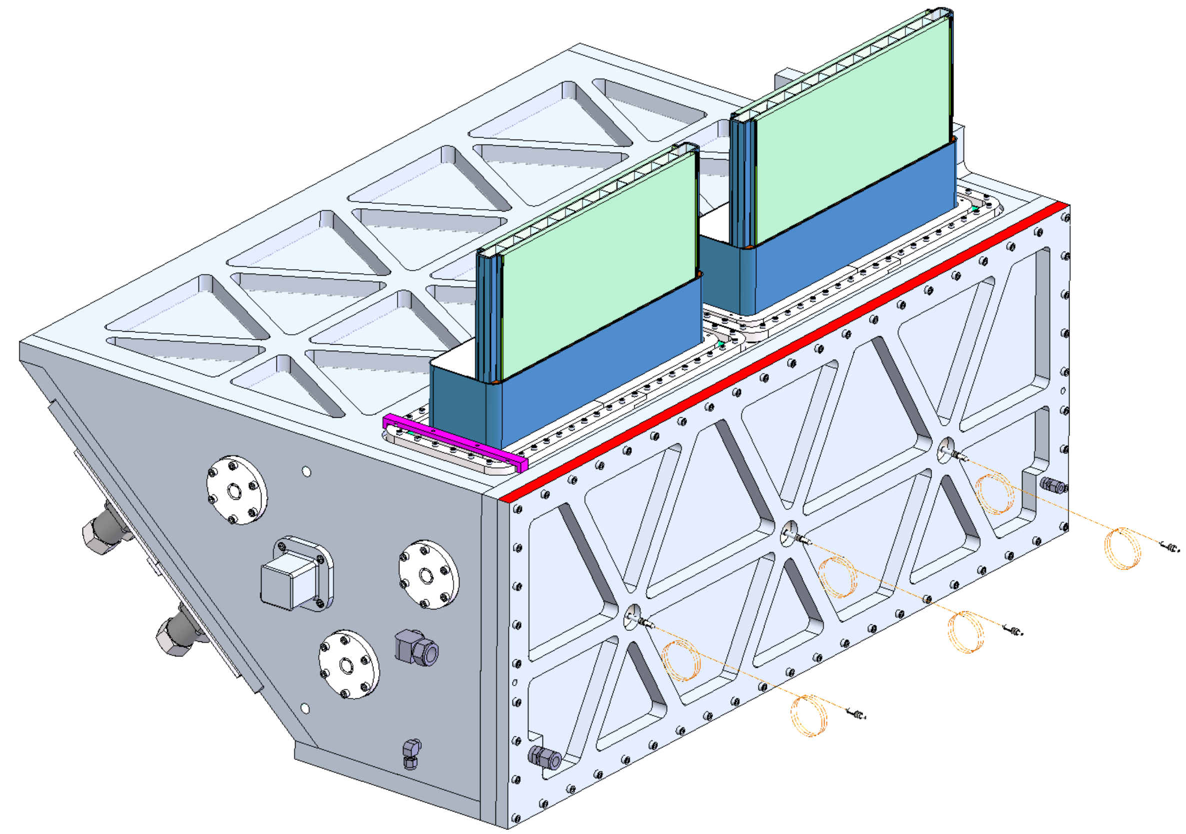
Optical box design

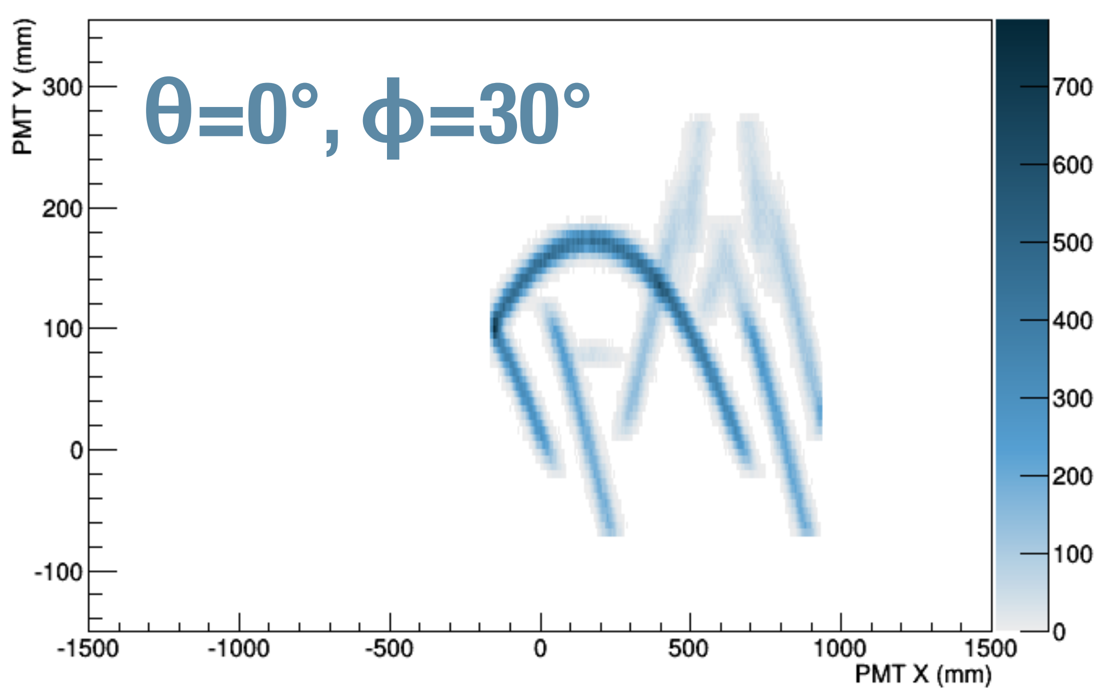
- Design based on SLAC FDIRC prototype
  - Replace fused silica block from FDIRC prototype with mirrors contained in distilled water
  - Replace of cylindrical mirror with 3-segment flat mirror
- Similar coupling of bar boxes to water volume as used at BaBar

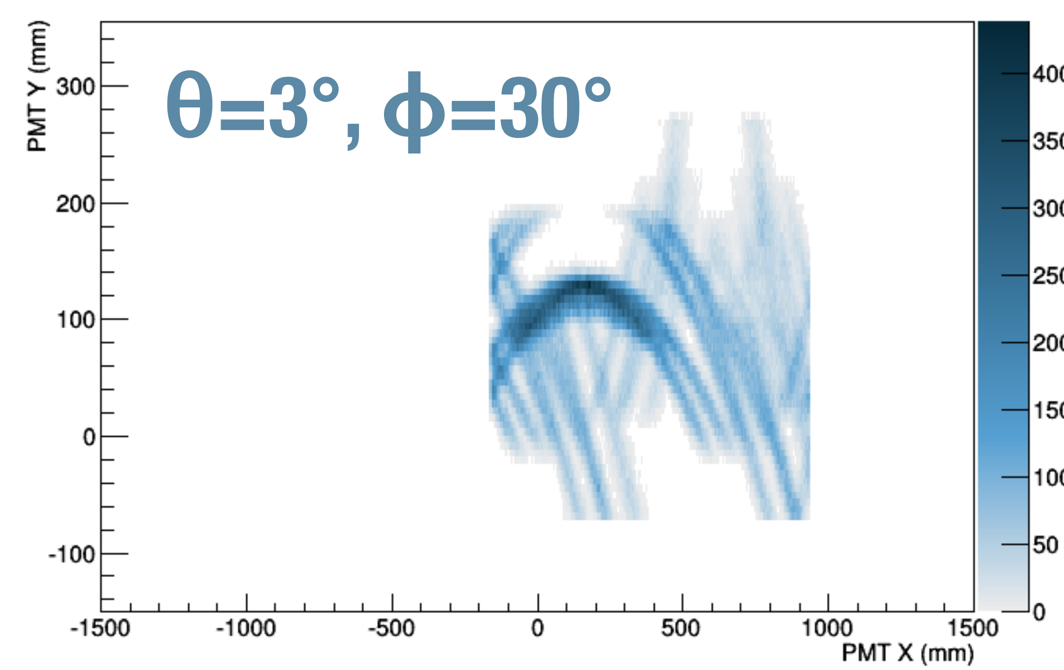


Optical box design



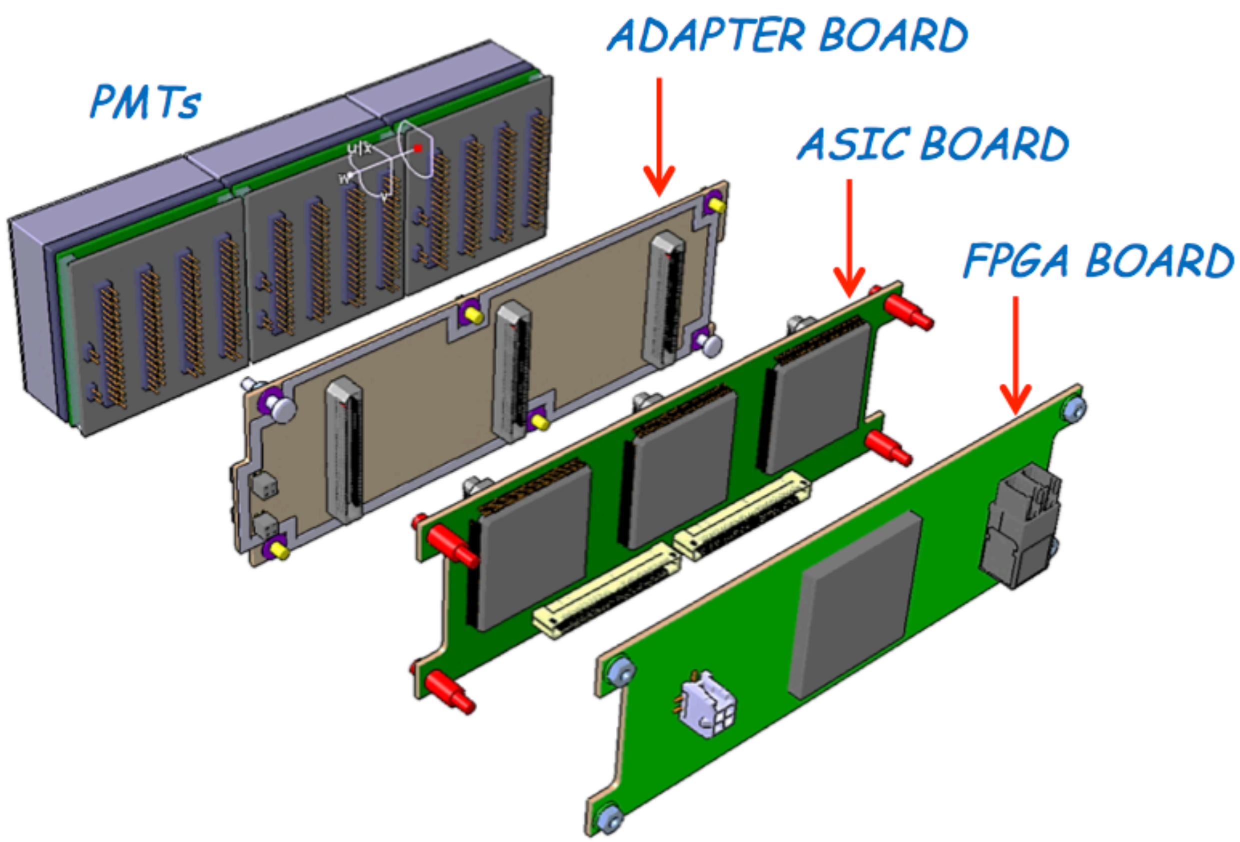






MAPMT readout

See talk by Ilaria Balossino

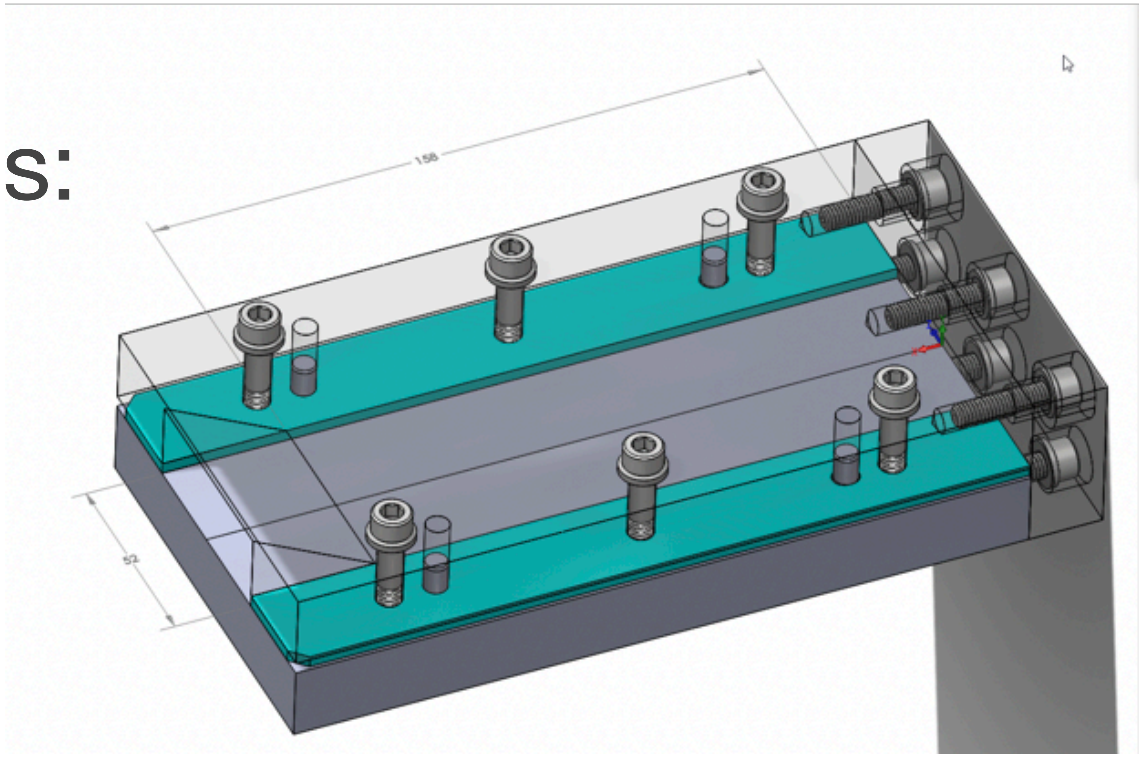


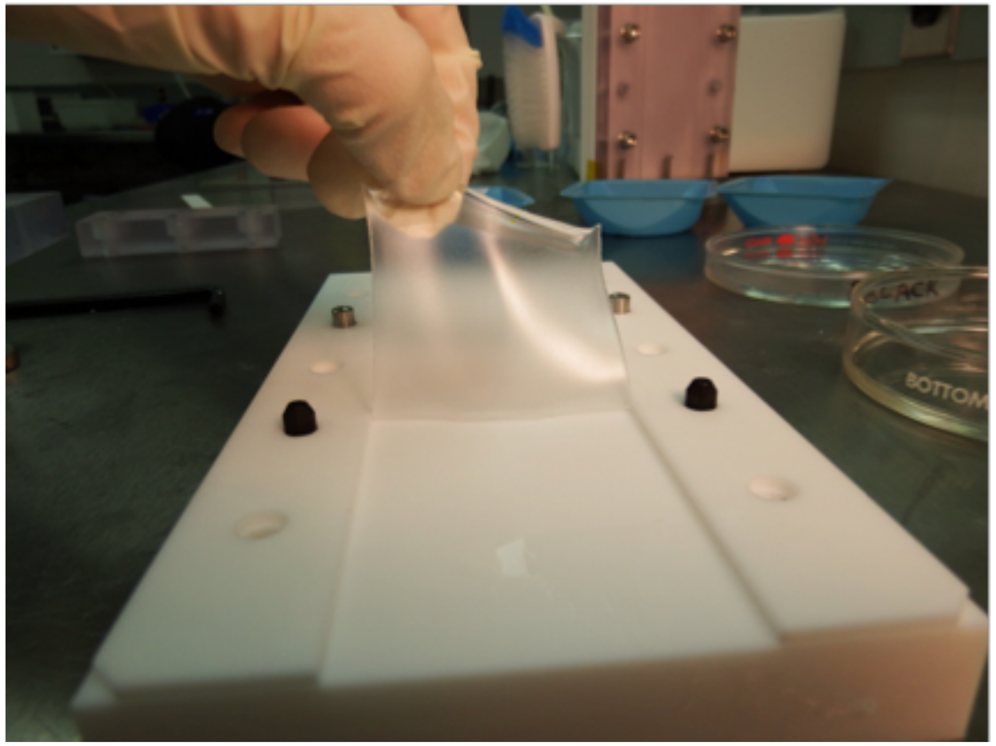
- Need existing solution, since limited time for electronics development
- CLAS12 RICH has very similar requirements for single photon detection
- Limited timing resolution compared to other DIRCs
- All boards in house at JLab, tests ongoing

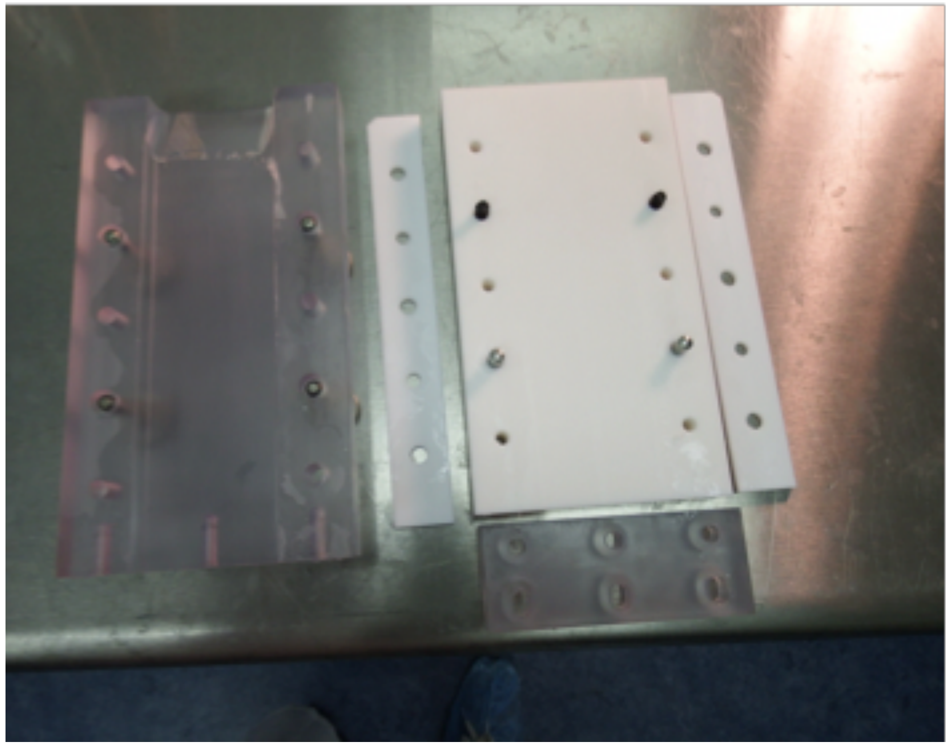
Optical cookie development

- Belle II experience for materials: TSE3032 and RTV615

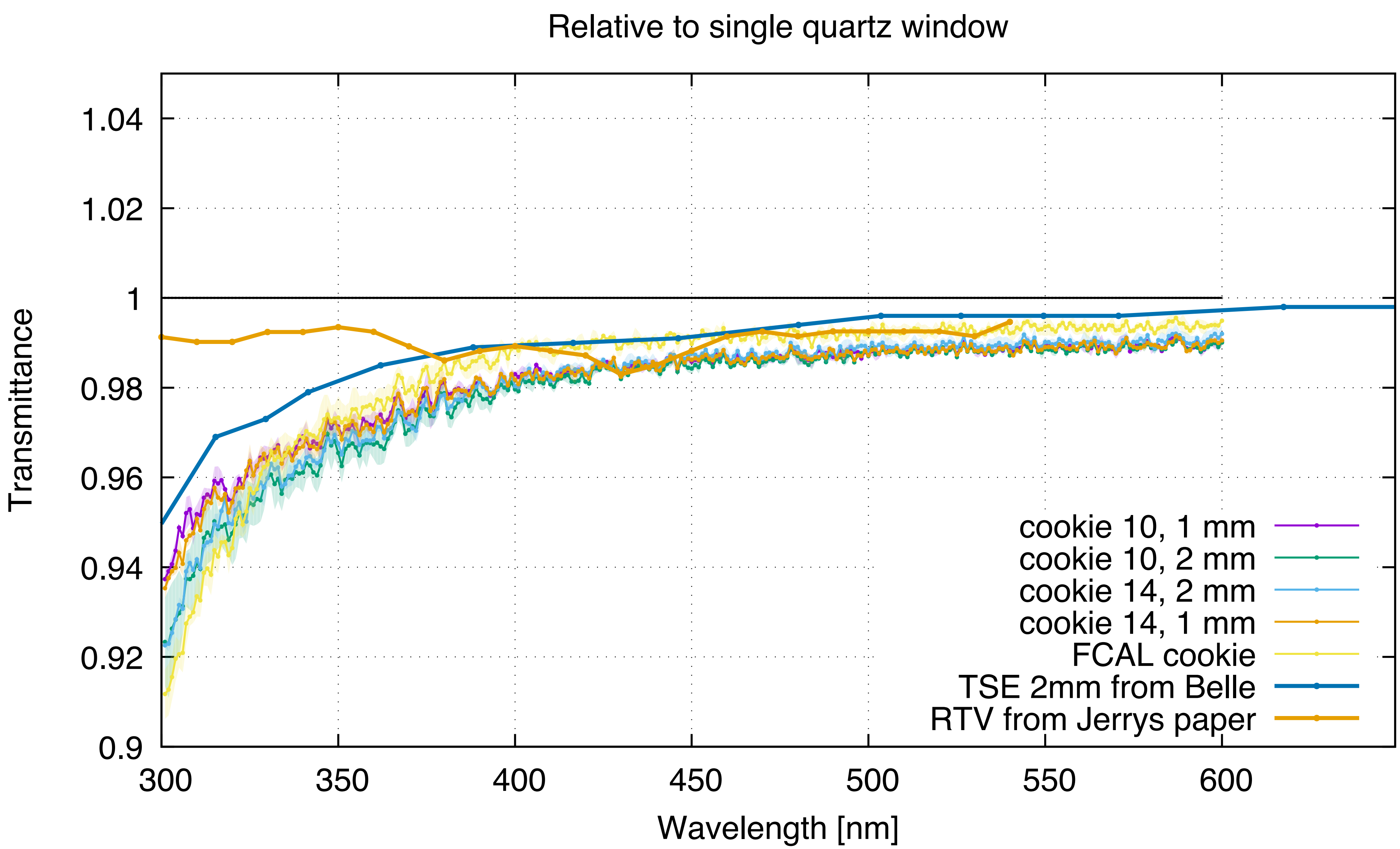
- Custom molds to produce various thickness cookies







Optical cookie performance

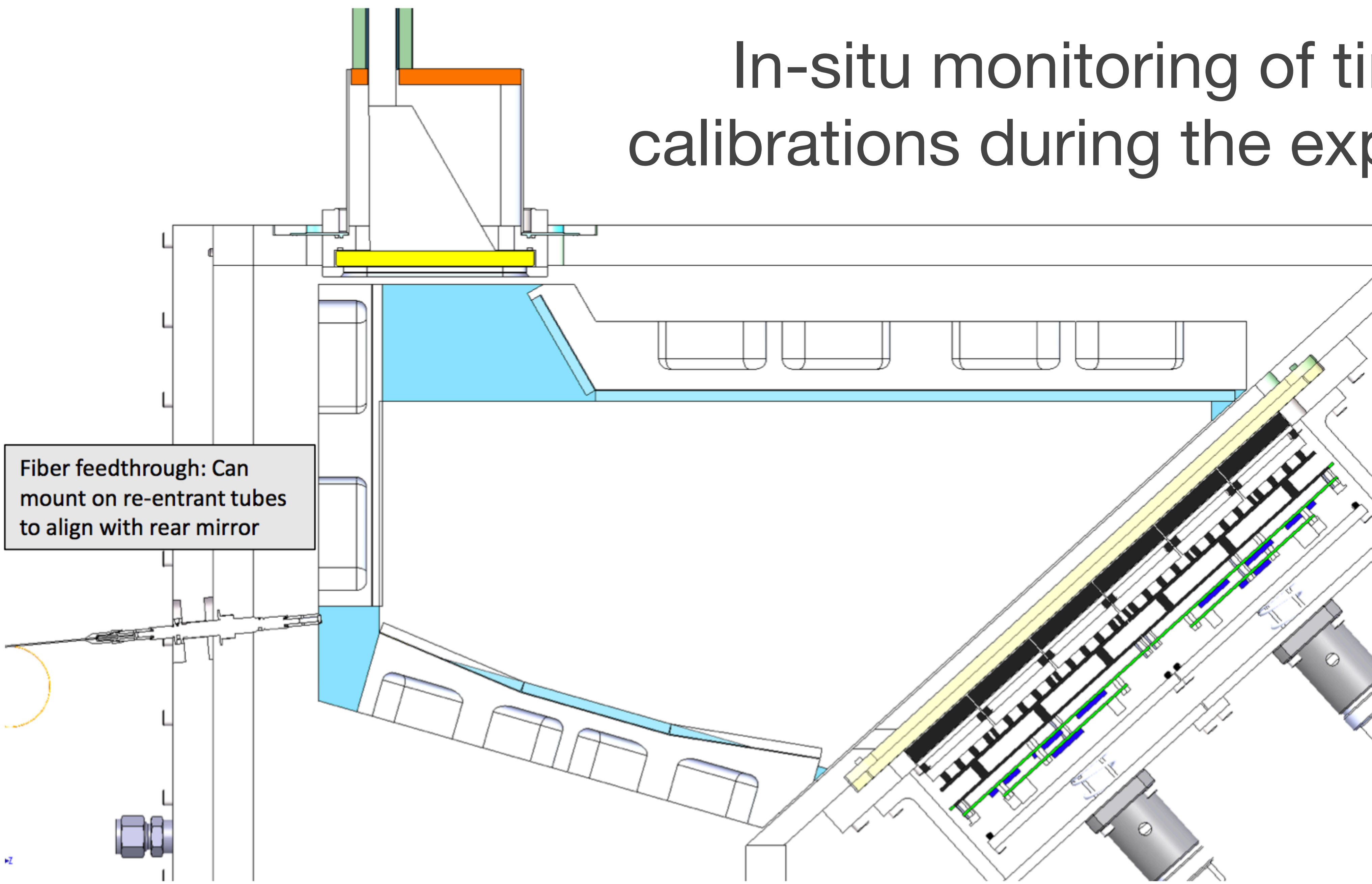


- Quantified transmission of various thickness cookies and materials
- Ongoing studies of application force will determine final thickness

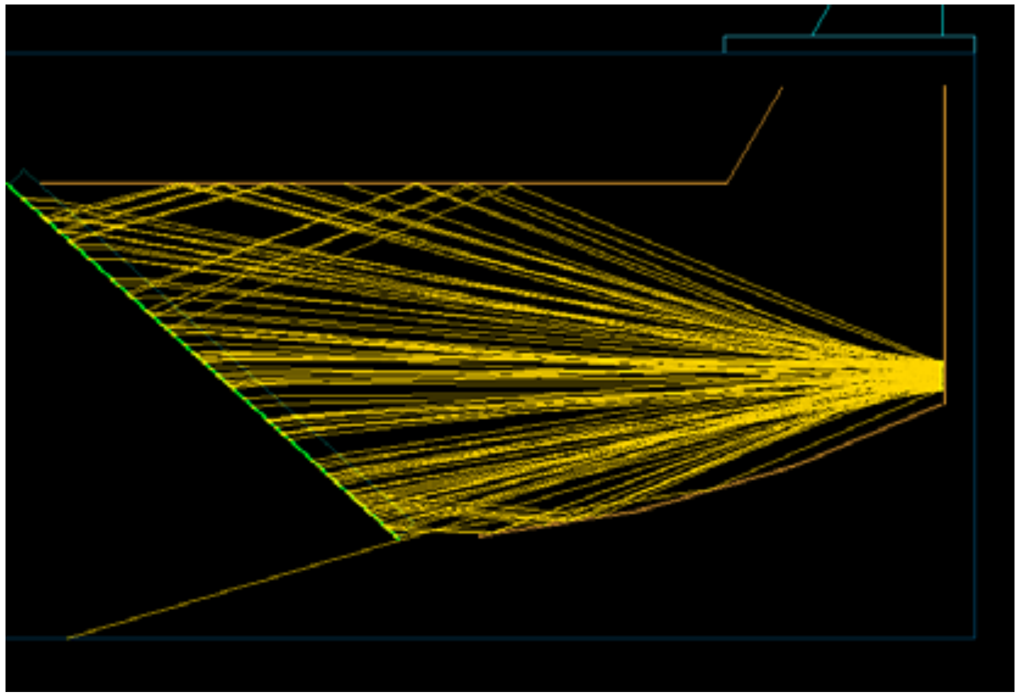
Calibration system

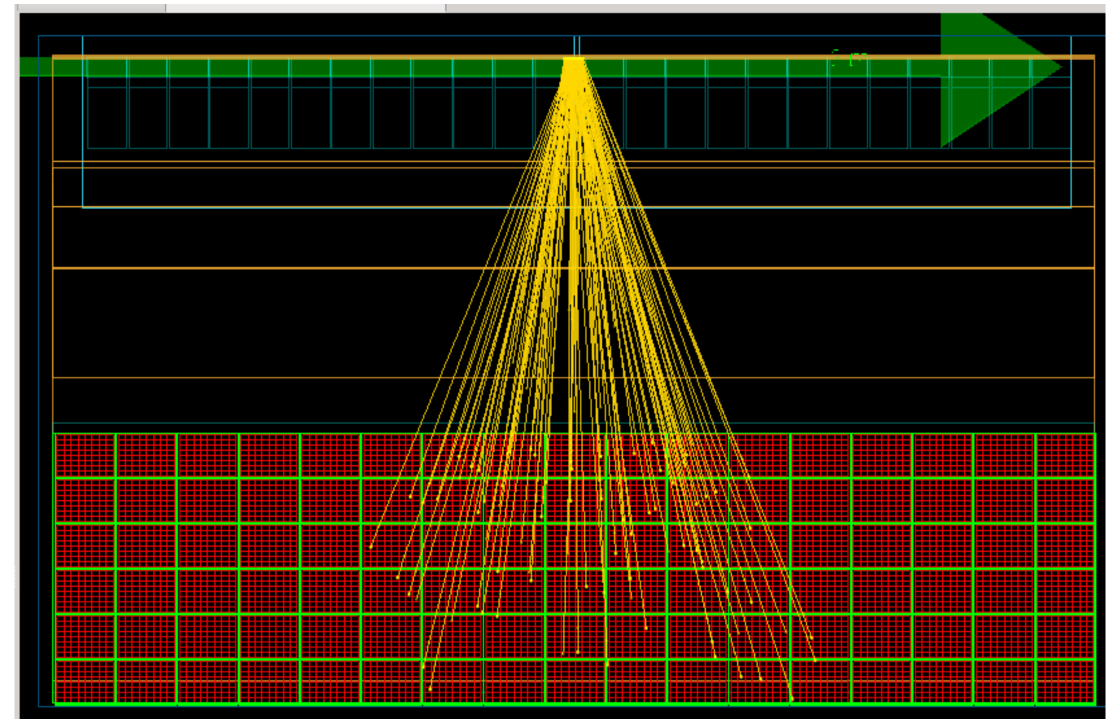
Initial MAPMT characterization with independent laser setup

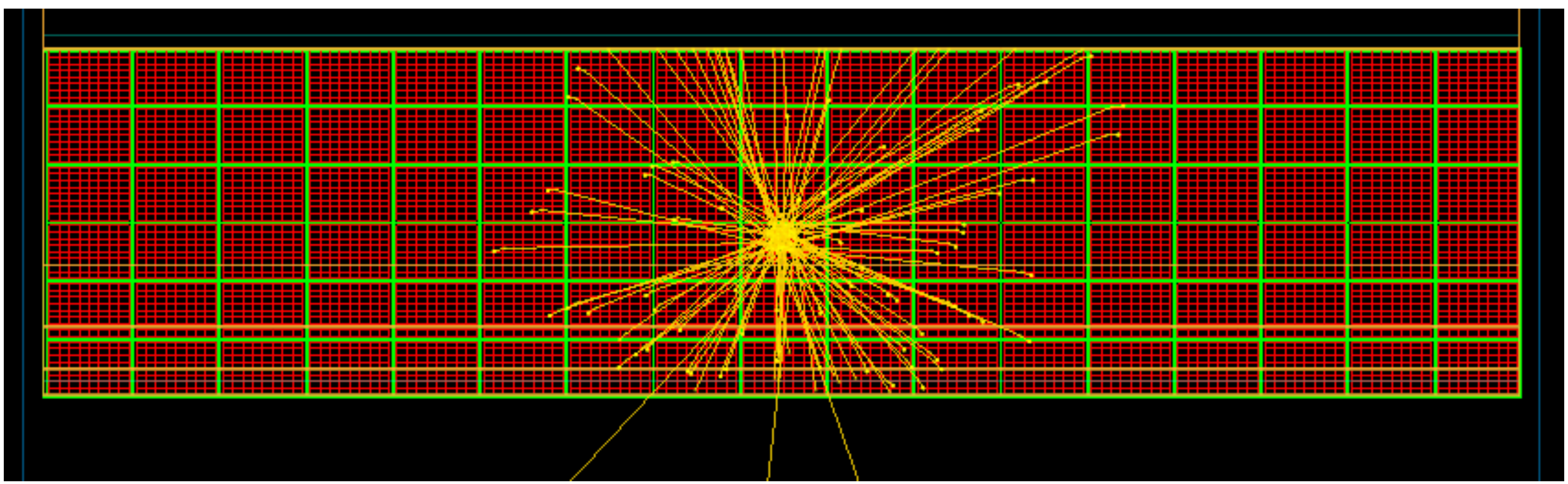
In-situ monitoring of timing calibrations during the experiment



Calibration source optimization







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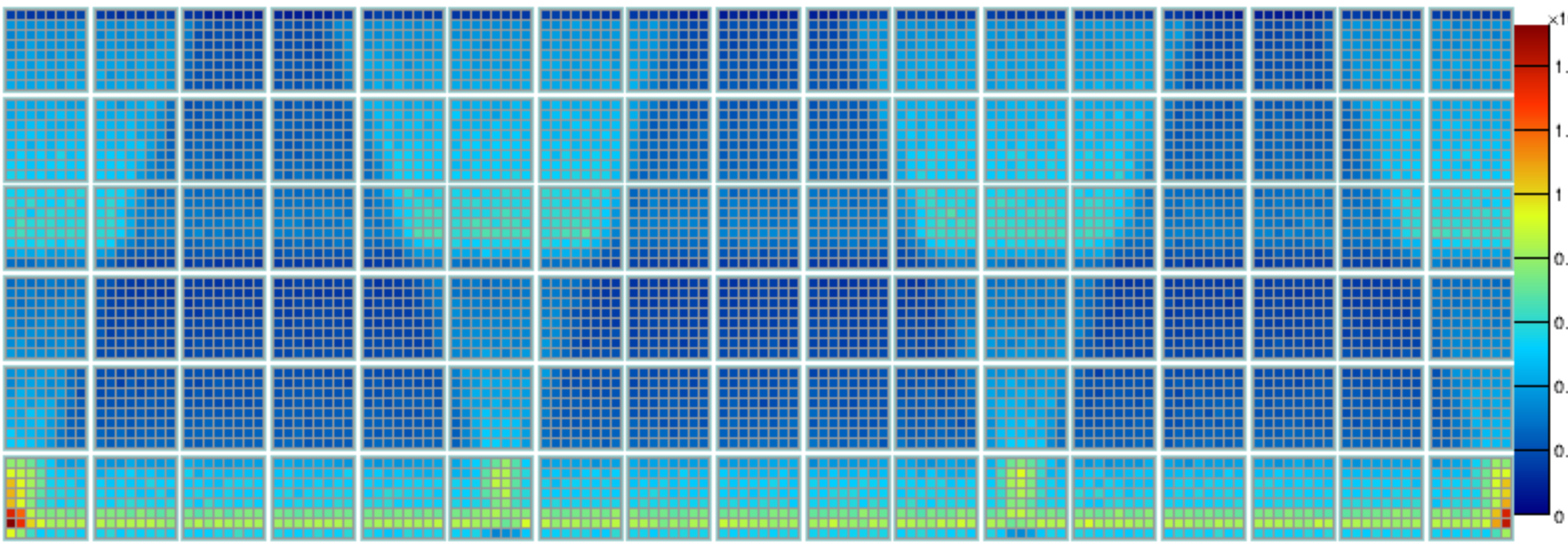

- 3 fibers with a lens or square diffuser provides full illumination of the MAPMT plane
- Studying timing characteristics and requirements of laser vs LED light sources in simulation

GlueX DIRC timeline

- **2017:**
  - Transport BaBar bar boxes from SLAC to JLab
  - Install support structure and services for first optical box
- **2018:**
  - Install first optical box and available MAPMTs and begin commissioning detector with available beam time
- **2019:**
  - Complete installation and commission complete detector
- **Looking forward to exciting results for DIRC2019 workshop**