

# The **GLUE**X DIRC Project

**Justin Stevens**  
**DIRC 2015 Workshop**

 **Jefferson Lab**

# Jefferson Laboratory (JLab)

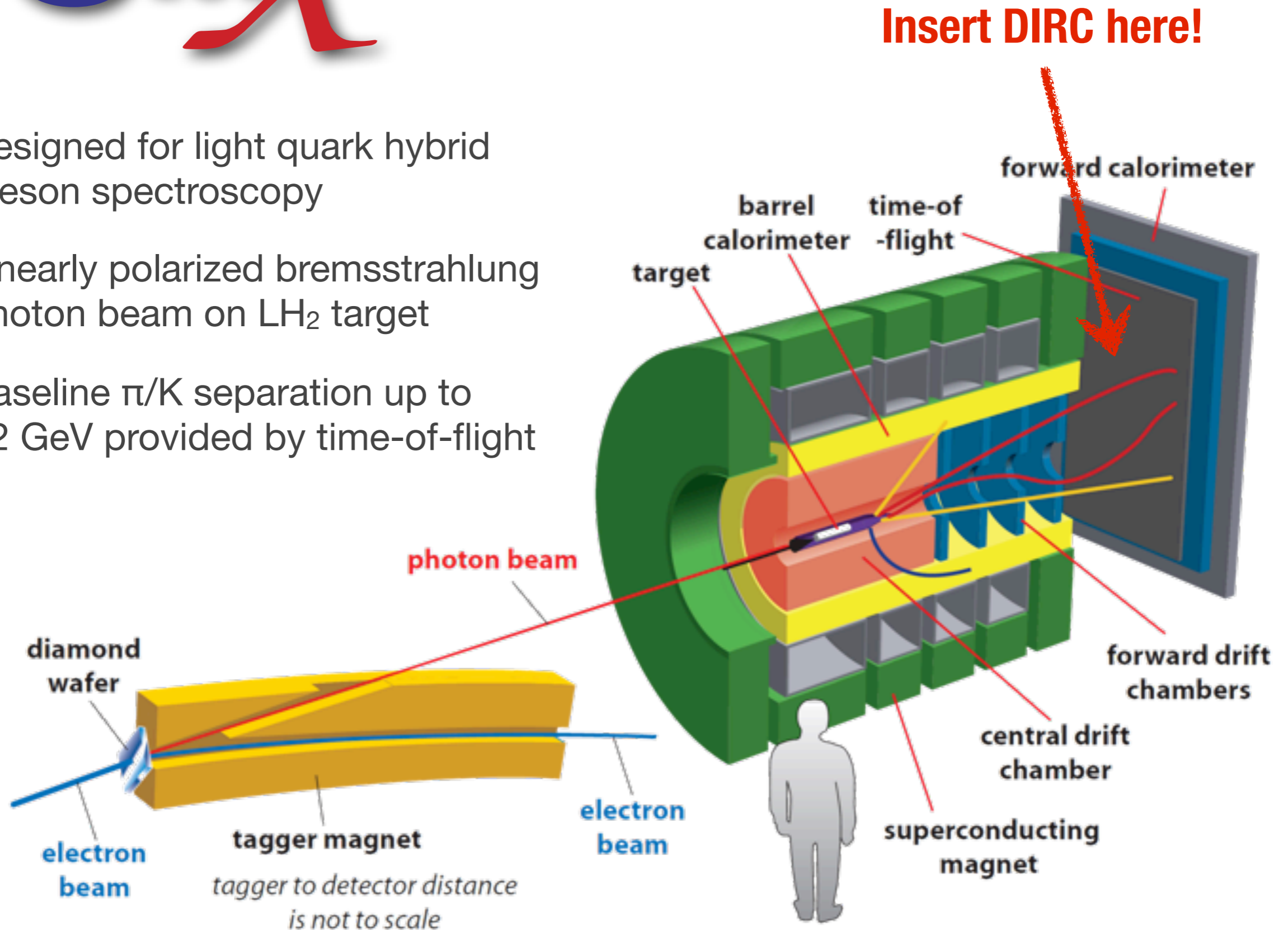


- ✿ Newport News, Virginia
- ✿ Home to the Continuous Electron Beam Accelerator Facility (CEBAF)



# GLUEX at JLab

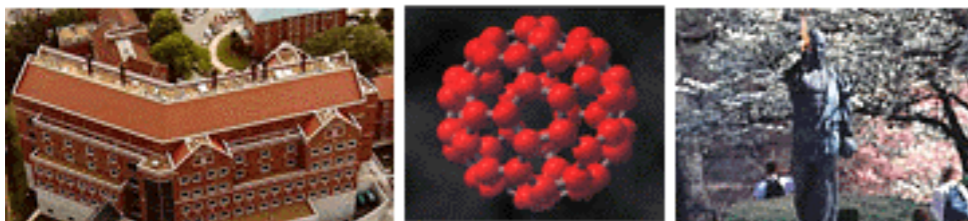
- \* Designed for light quark hybrid meson spectroscopy
- \* Linearly polarized bremsstrahlung photon beam on LH<sub>2</sub> target
- \* Baseline  $\pi/K$  separation up to  $\sim 2$  GeV provided by time-of-flight



# A DIRC for Gluex ?

Stefan M. Spanier  
University of Tennessee, Knoxville

- *The BaBar DIRC*
- *Adaptation to Gluex*



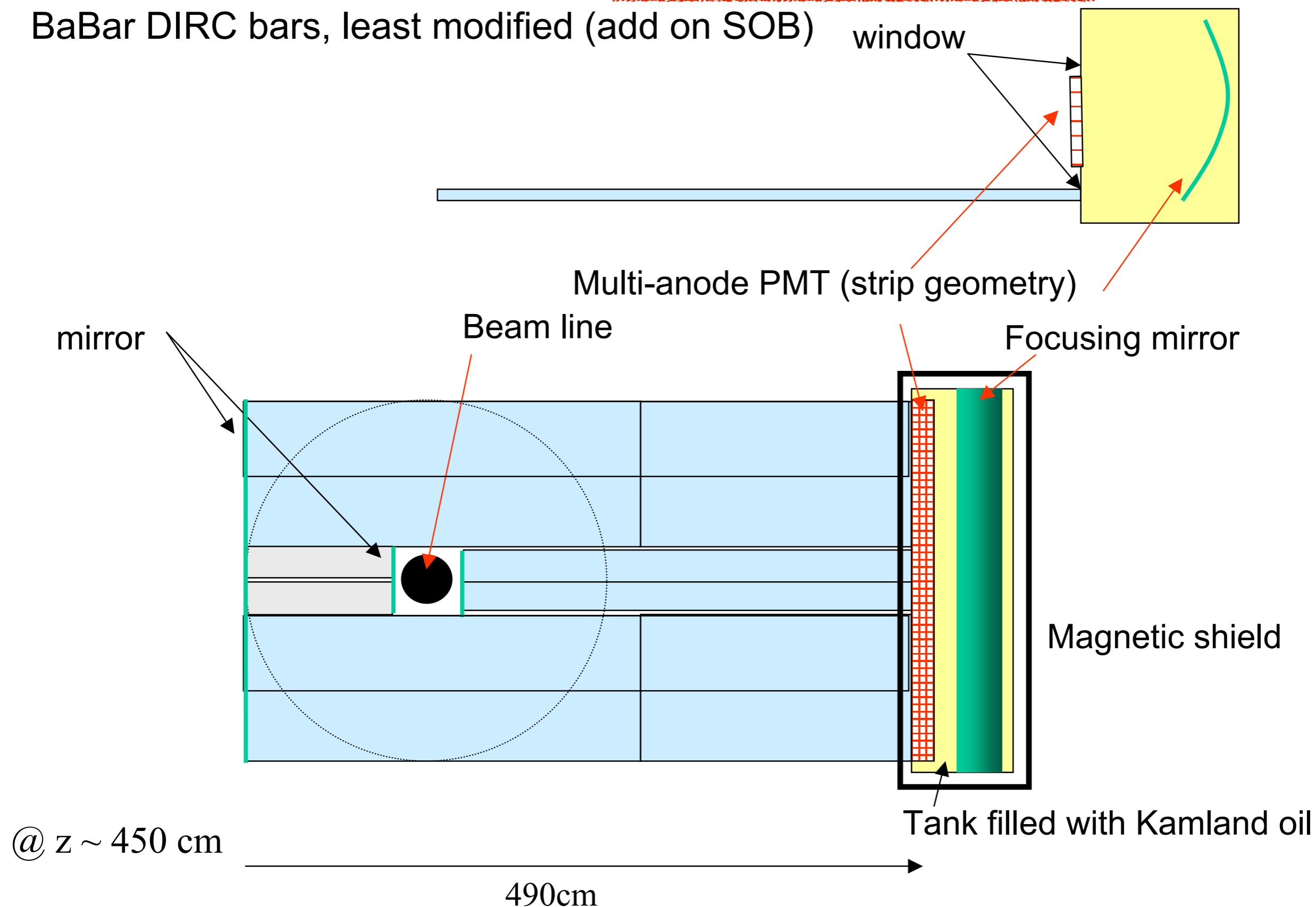
**The University of Tennessee**  
Department of  
**Physics & Astronomy**



# • Focusing DIRC Scenario

**GlueX DIRC circa 2004**

BaBar DIRC bars, least modified (add on SOB)



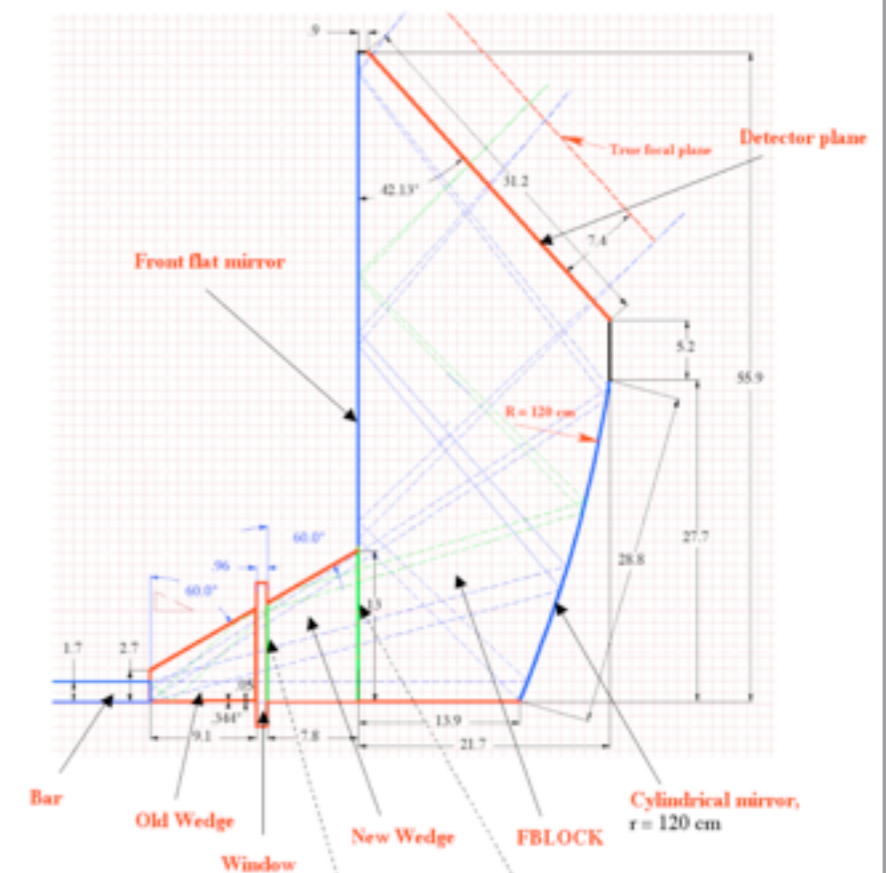
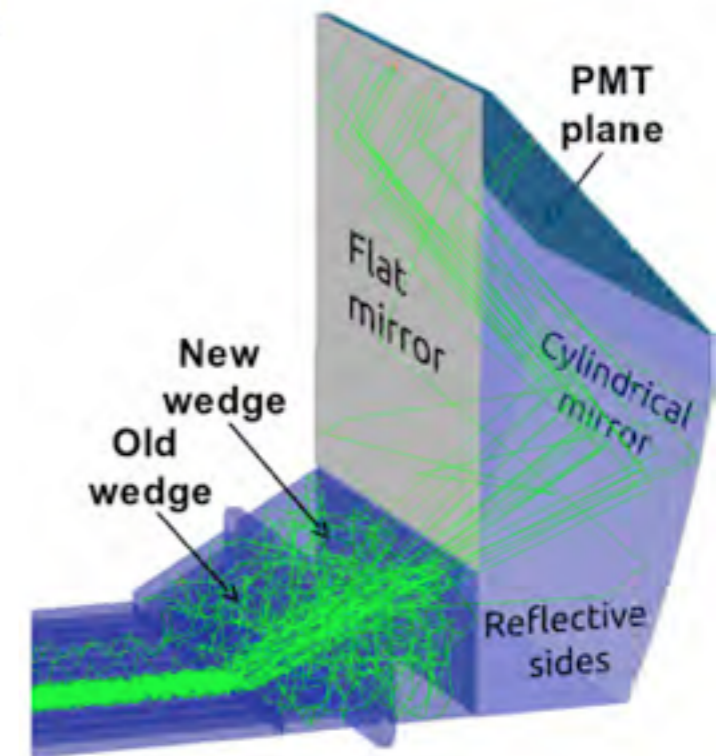
# SLAC FDIRC prototype

[arXiv:1410.0075]

## Design and performance of the Focusing DIRC detector

B. Dey<sup>a,1</sup>, M. Borsato<sup>b</sup>, N. Arnaud<sup>b</sup>, D.W.G.S. Leith<sup>c</sup>, K. Nishimura<sup>c</sup>, D.A. Roberts<sup>d</sup>,  
B.N. Ratcliff<sup>c</sup>, G. Varner<sup>e</sup>, J. Va'vra<sup>c,\*</sup>

- ✱ Developed for SuperB
- ✱ Advantages of FDIRC for SuperB
  - ✱ Modular design
  - ✱ Less sensitive to background
  - ✱ Measure the chromatic dispersion with timing; improves resolution
  - ✱ Reduced size of readout plane and PMT coverage



# BaBar DIRC bar boxes

- ✦ With the cancellation of SuperB, the BaBar DIRC bar boxes became available
- ✦ In December 2013 we submitted a proposal to use four of the BaBar bar boxes for a DIRC at GlueX



## PARTICLE PHYSICS AND ASTROPHYSICS DIRECTORATE

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Menlo Park, CA 94025 USA

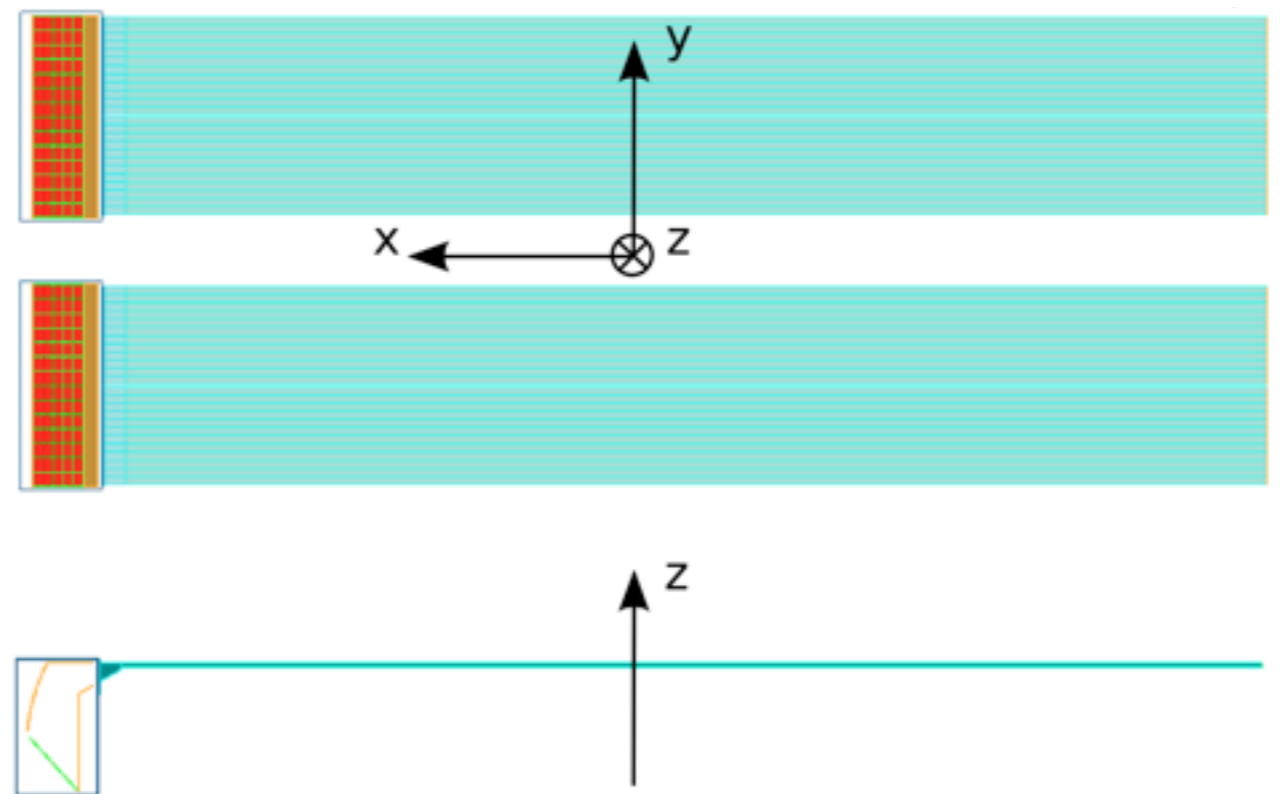
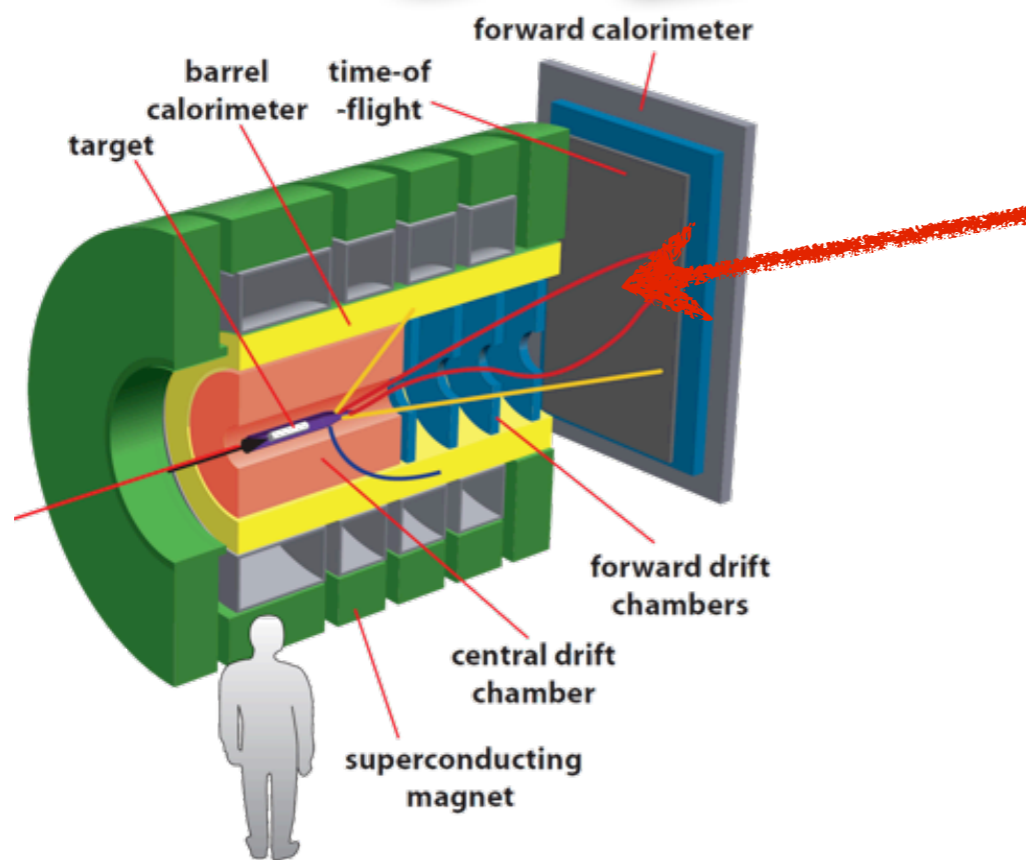
David MacFarlane  
PPA Director

Tel: +1 650 926- 3406  
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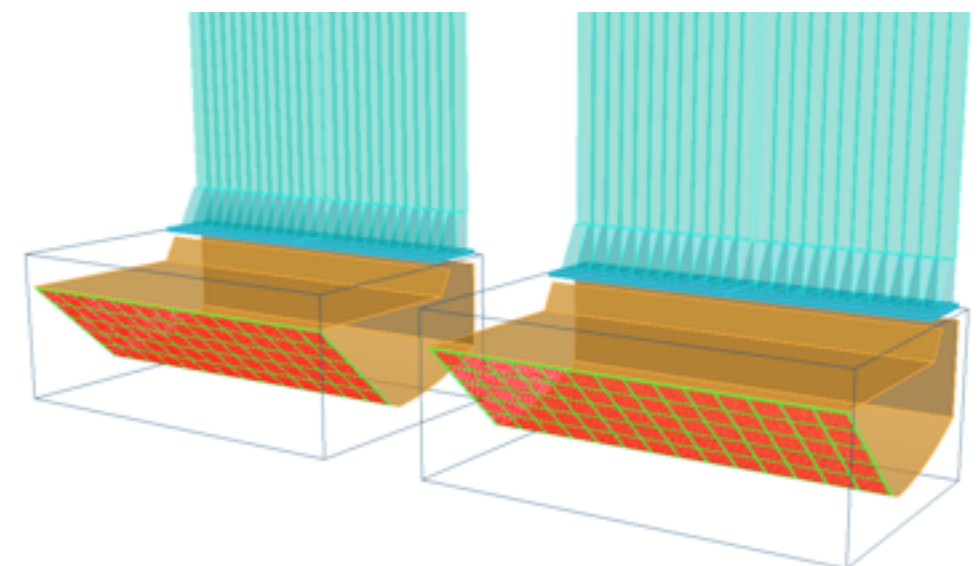
July 10, 2014

Based on these recommendations and comments, with the concurrence of DOE, SLAC will provide four bar boxes to GlueX for the program described in your proposal as soon as it can be arranged. We encourage you to begin discussions with appropriate members of the committee

# GLUEX DIRC



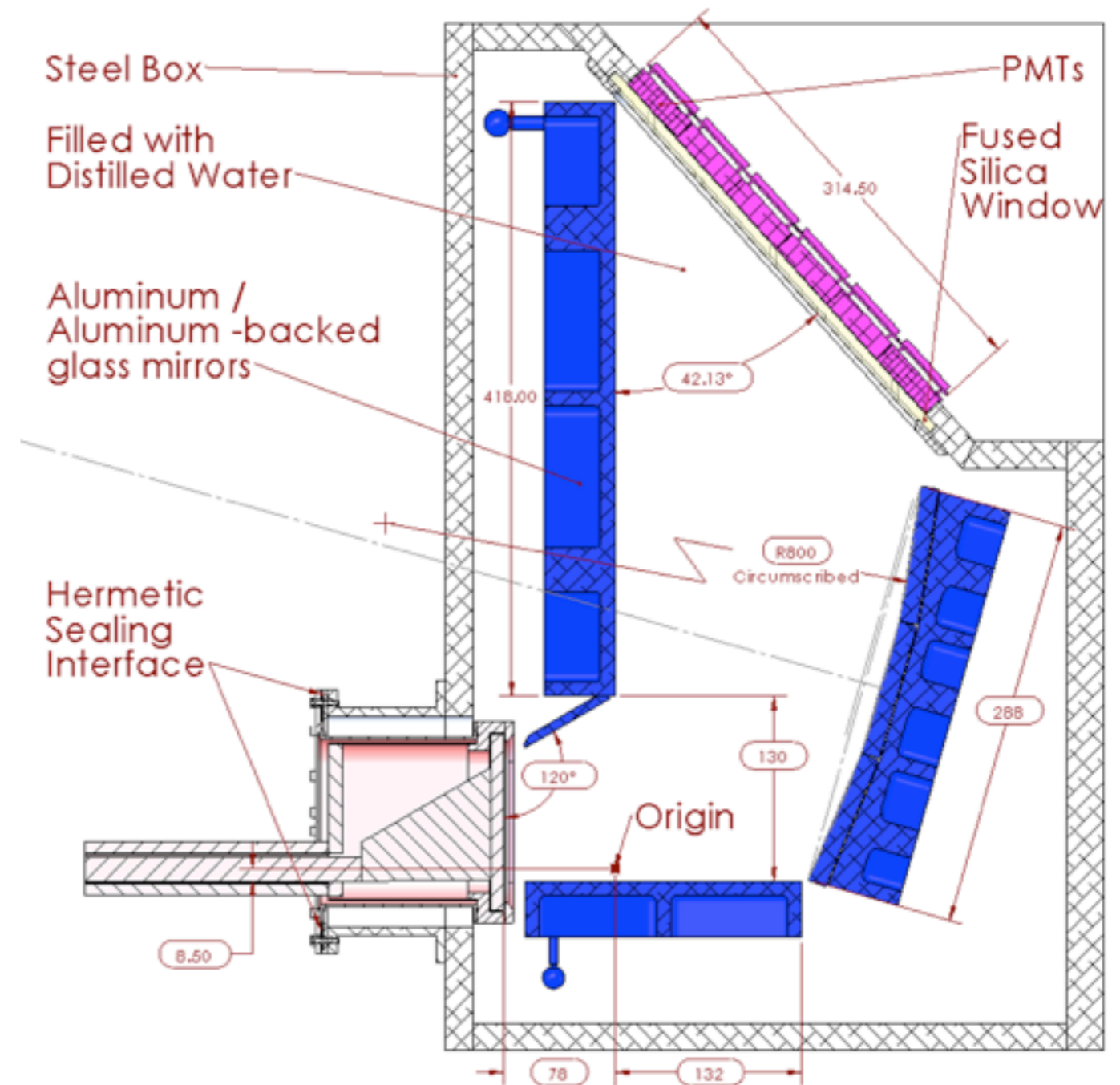
- \* Bar boxes in a plane orthogonal to beam direction, so tracks enter at near perpendicular angles
- \* Two separate expansion volumes, which each couple to 2 BaBar bar boxes (reduces reflections)





# Expansion volume

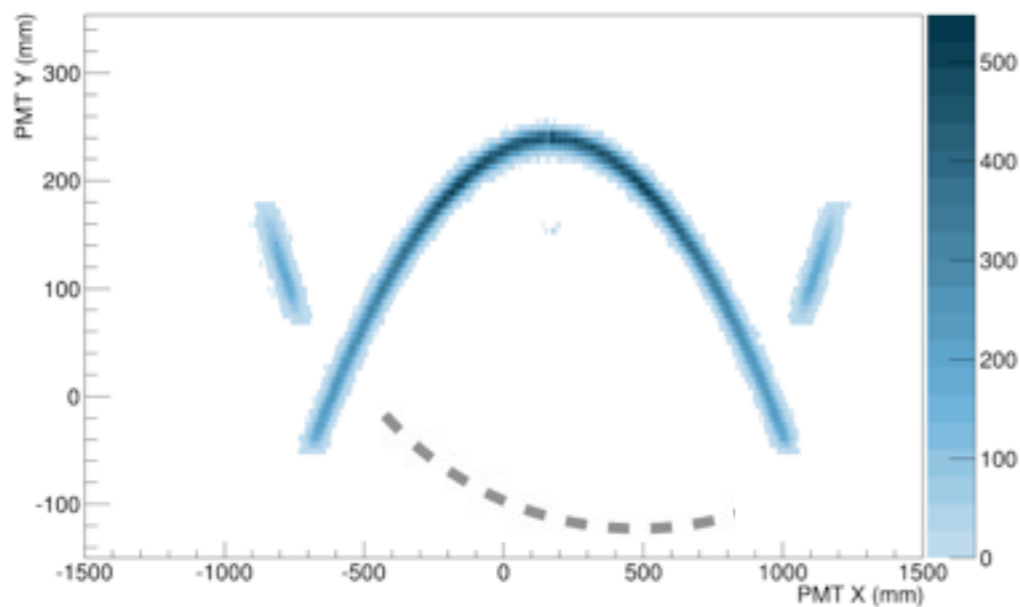
- ✱ Design based on SLAC FDIRC prototype
- ✱ Replace fused silica block from FDIRC prototype with mirrors contained in distilled water
- ✱ Replace of cylindrical mirror with 3-segment flat mirror
- ✱ Similar coupling of bar boxes to water volume as used at BaBar



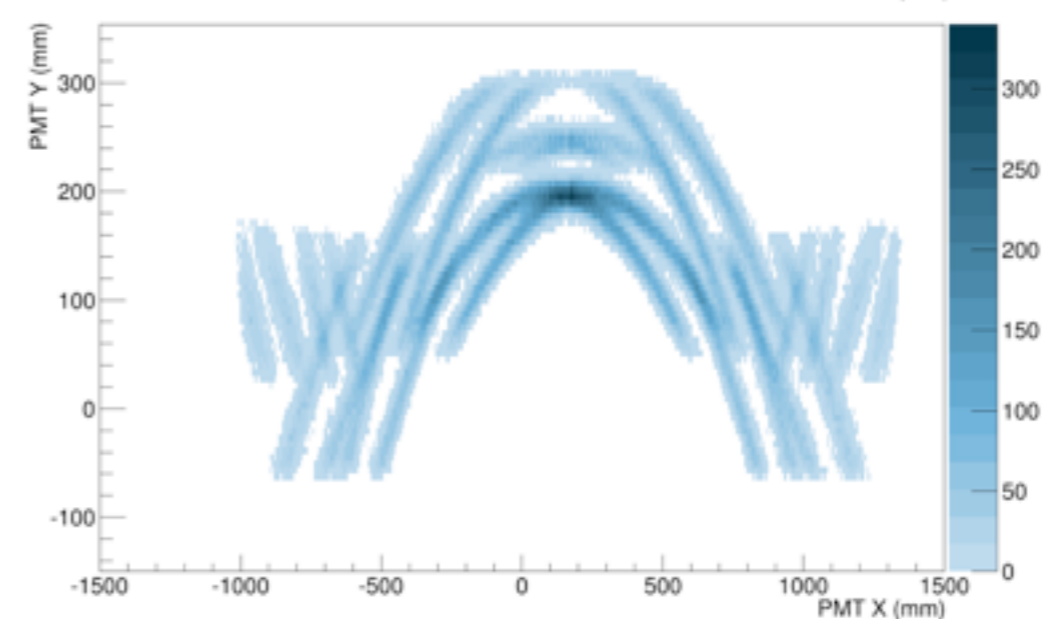
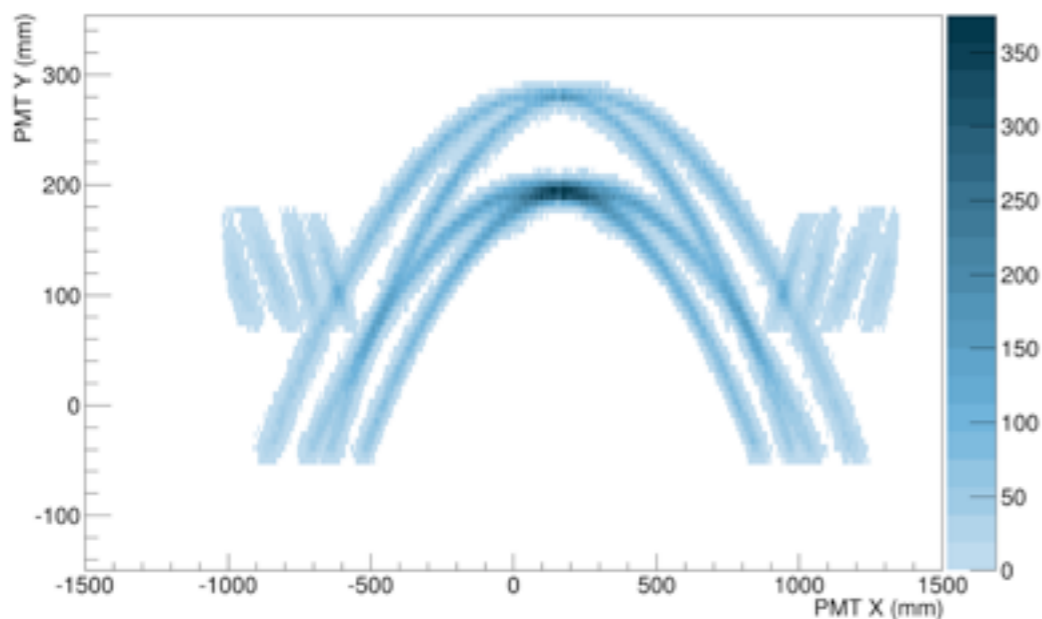
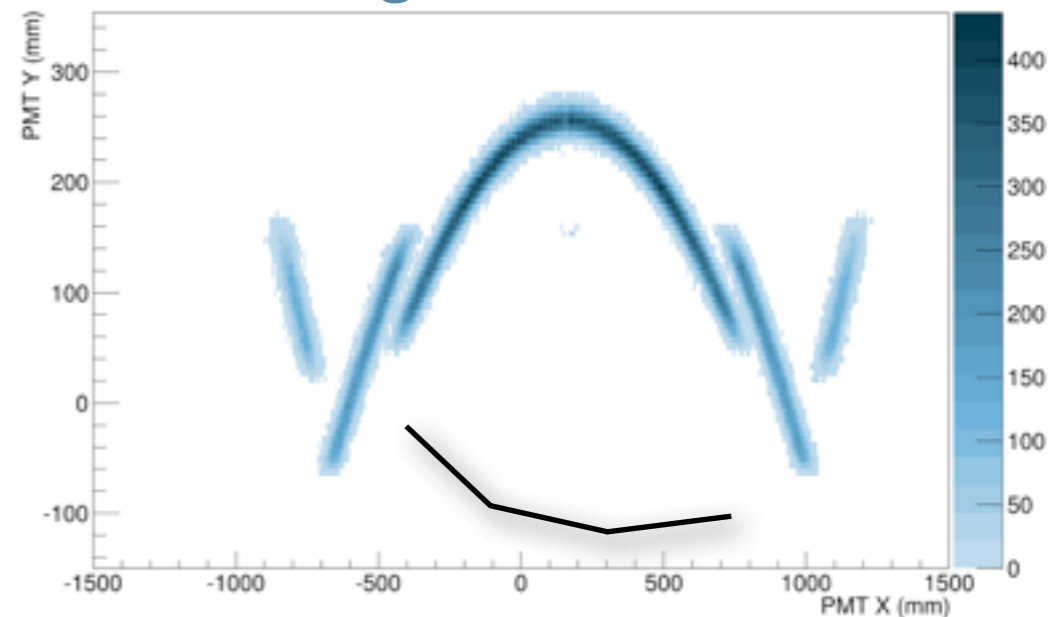
# “Focusing” mirror

- ✦ Cylindrical mirrors are non-trivial and can be expensive to build
- ✦ What happens if we approximate cylindrical with a 3-segment flat mirror?

## Cylindrical Mirror



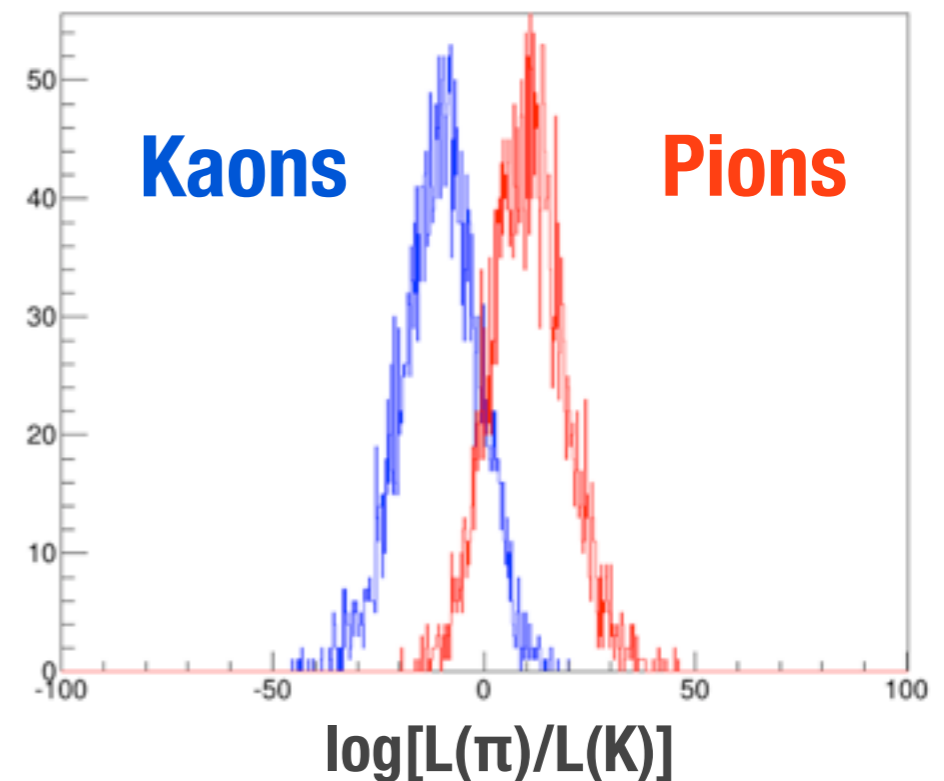
## 3-segment Mirror



# Simulation

John Hardin, 

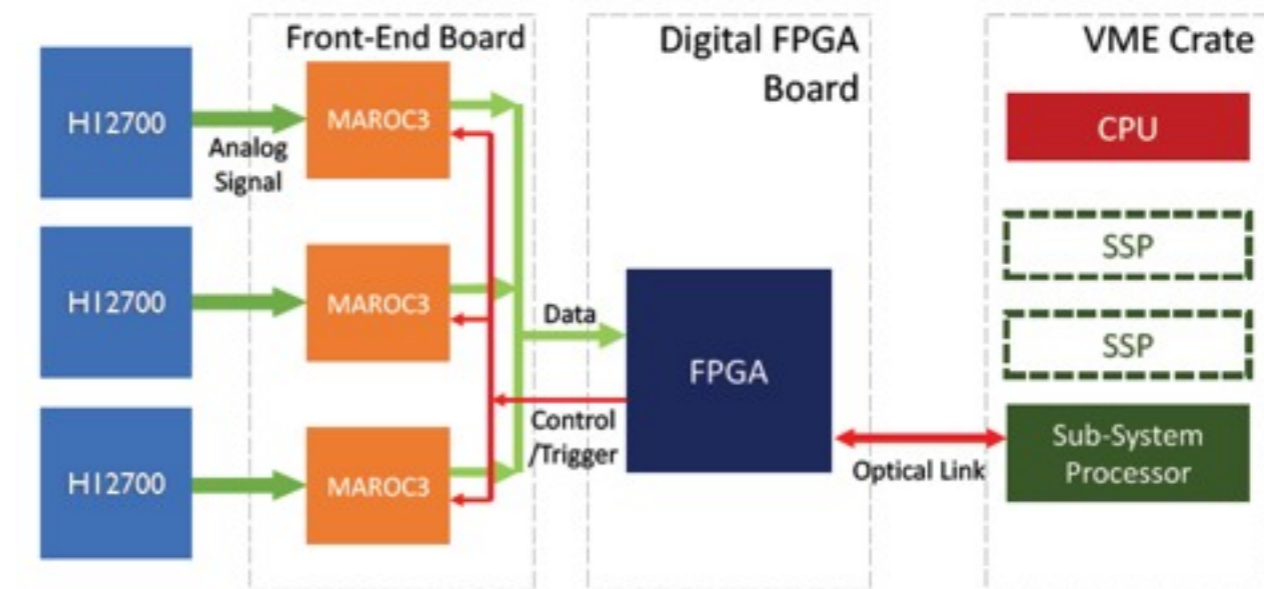
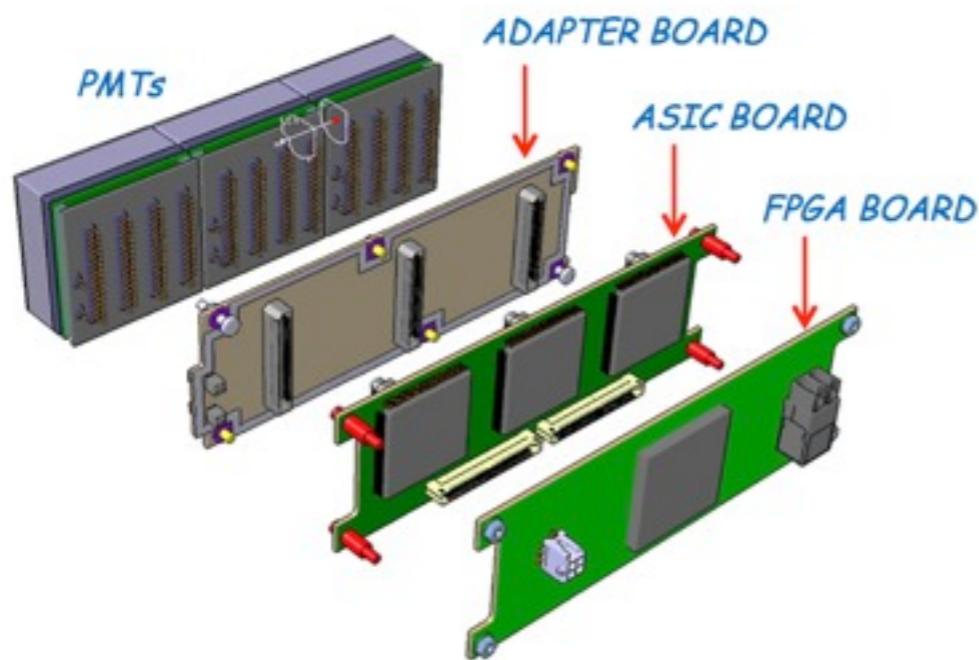
- \* Fast simulation where charged particles are propagated through the bar (including multiple scattering) and emit Cherenkov photons randomly along its path
- \* Analytically trace each photon to the PMT plane, accounting for 3 mrad smearing from transport in the bar seen by BaBar
- \* Photon yield is normalized to that achieved by the SLAC FDIRC, with modifications (quartz vs water) and MAPMTs (H8500 vs 12700)
- \* Generate expected PDF for particle hypothesis on the photosensor plane for each track “on the fly” using analytical tracing
- \* Compute 3D (x, y, t) likelihood using Kernel Density Estimation (KDE) and take ratio,  $L(\pi)/L(K)$ , to evaluate  $\pi/K$  separation
- \* GSI group (Roman) also implementing Look-up-table algorithm (used at BaBar) for GlueX



# MAPMT readout

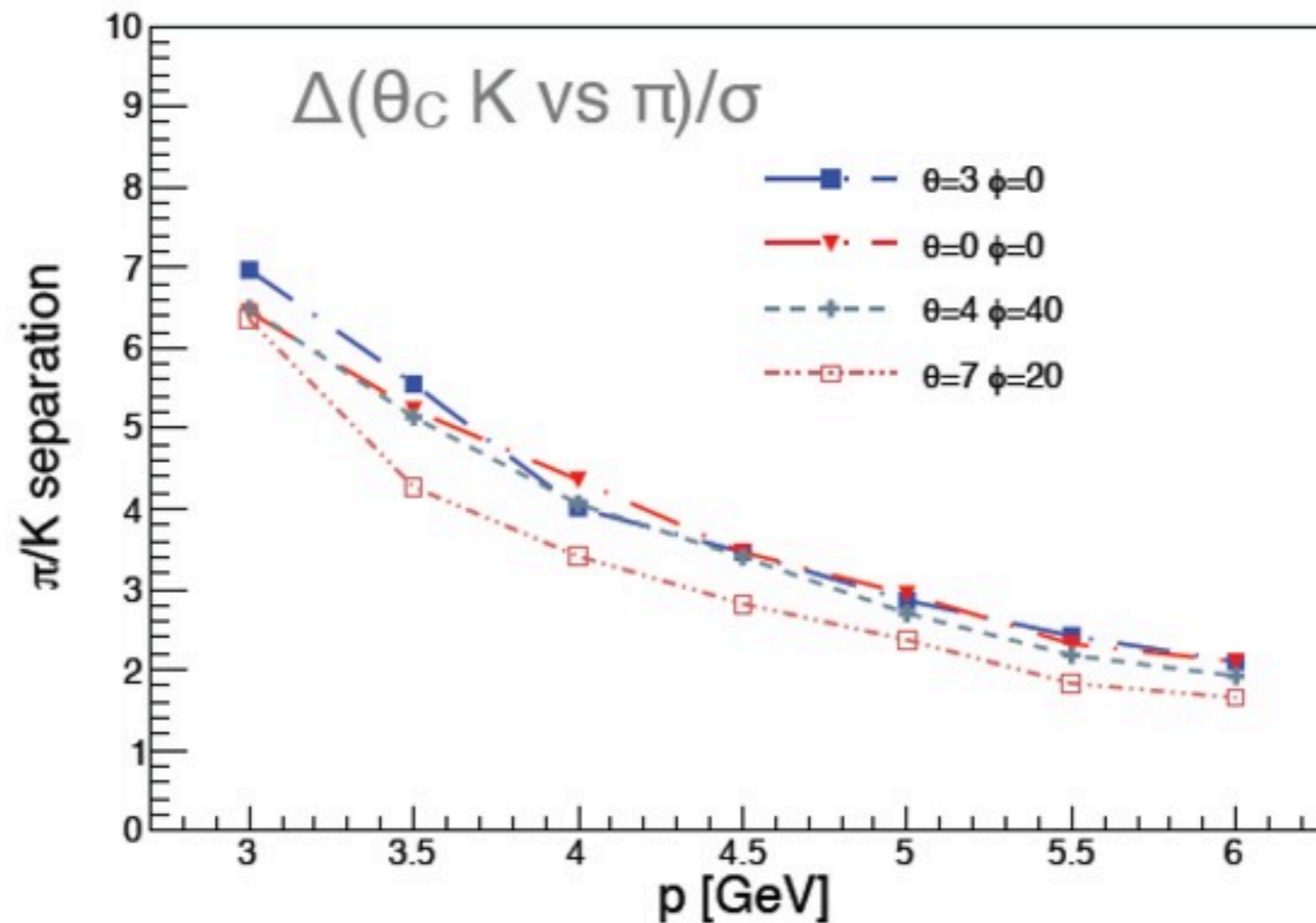
See talk by Matteo Turisini

- ✱ Due to the limited time for electronics development we looked for existing readout solutions which fit our needs
- ✱ CLAS12 RICH in Hall B: very similar requirements to GlueX DIRC
- ✱ We will use 216 Hamamatsu H12700 MAPMTs
- ✱ Suitable electronics already developed and compatible with generic JLab DAQ systems!



# Expected performance

- ✱ Early (conservative) performance estimate: improved Kaon channel selection efficiencies by factors of x2, and allowed access to very high purity event selections (99%) which were not possible without DIRC



- ✱ Now with our more realistic simulations we expect even better performance, and the DIRC's impact on the GlueX physics program should be even larger than previously expected

# Road trip!

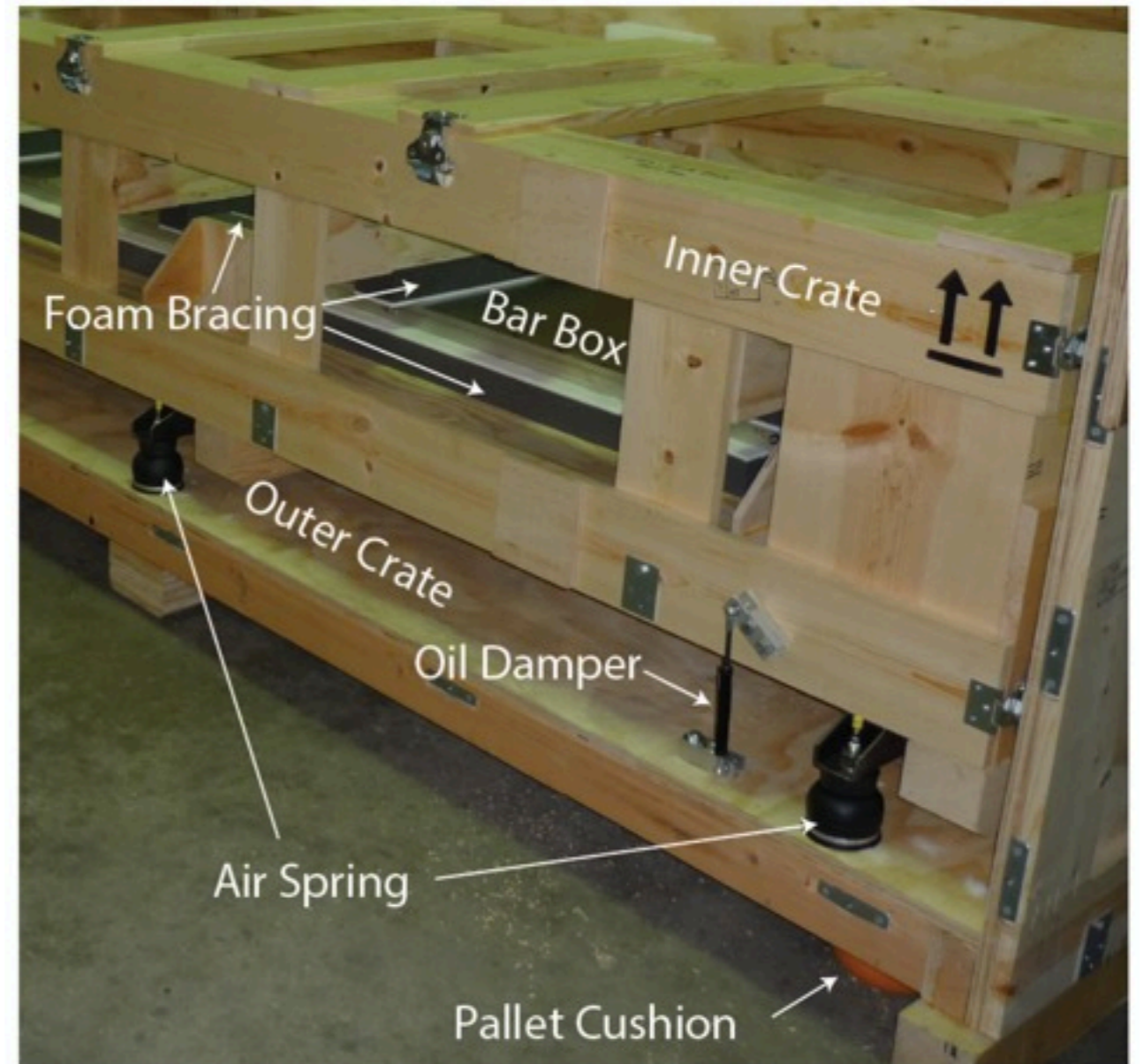


# Shipping tests



# Shipping tests

- \* Instrument bar box, inner and outer crates with accelerometers
- \* Optimized spring pressure and oil damping using “drop tests” onto concrete floor
- \* 4 hour road test in Indiana with additional accelerometers on crate and truck bed

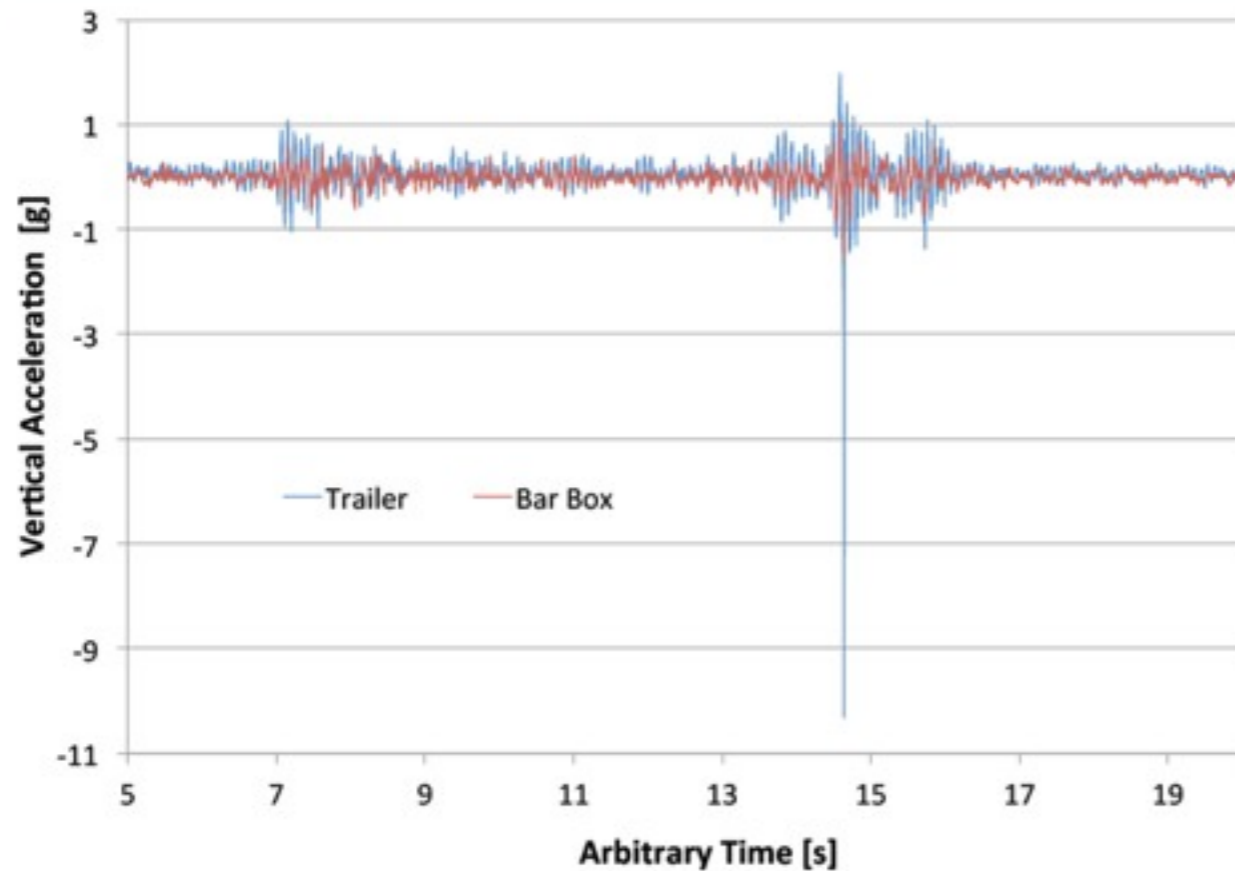


## USB stick Accelerometers





# Shipping test results and plans

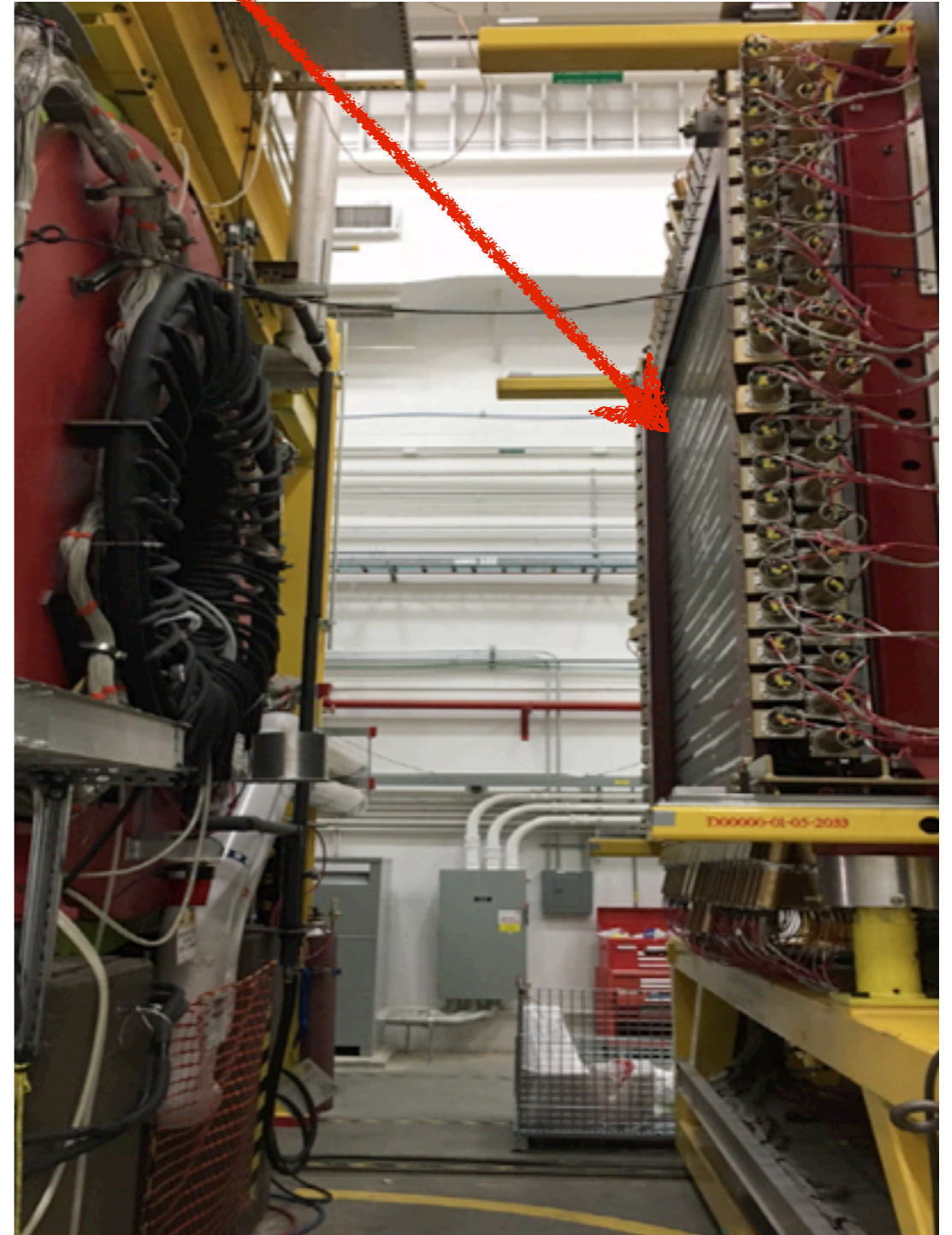
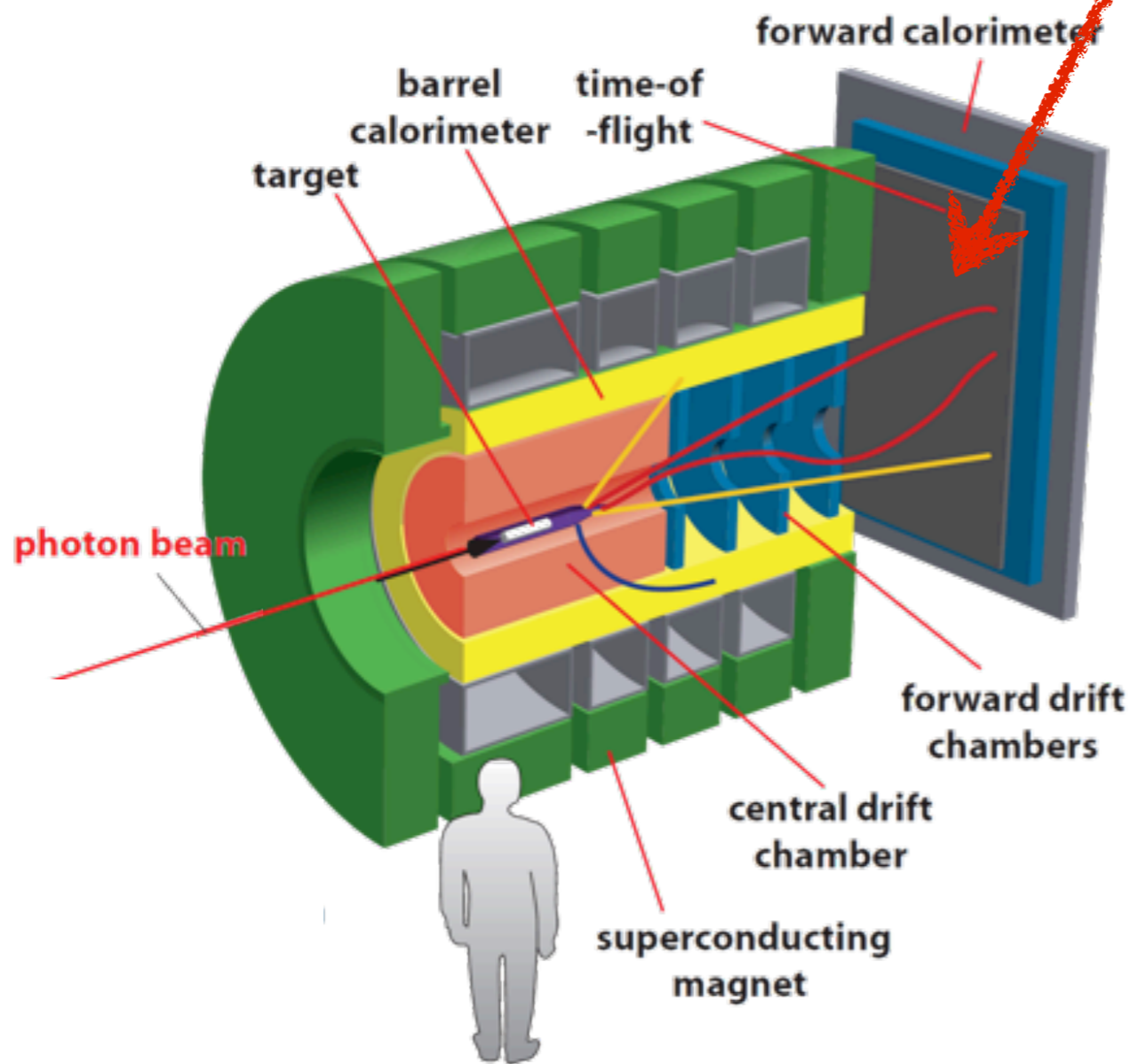


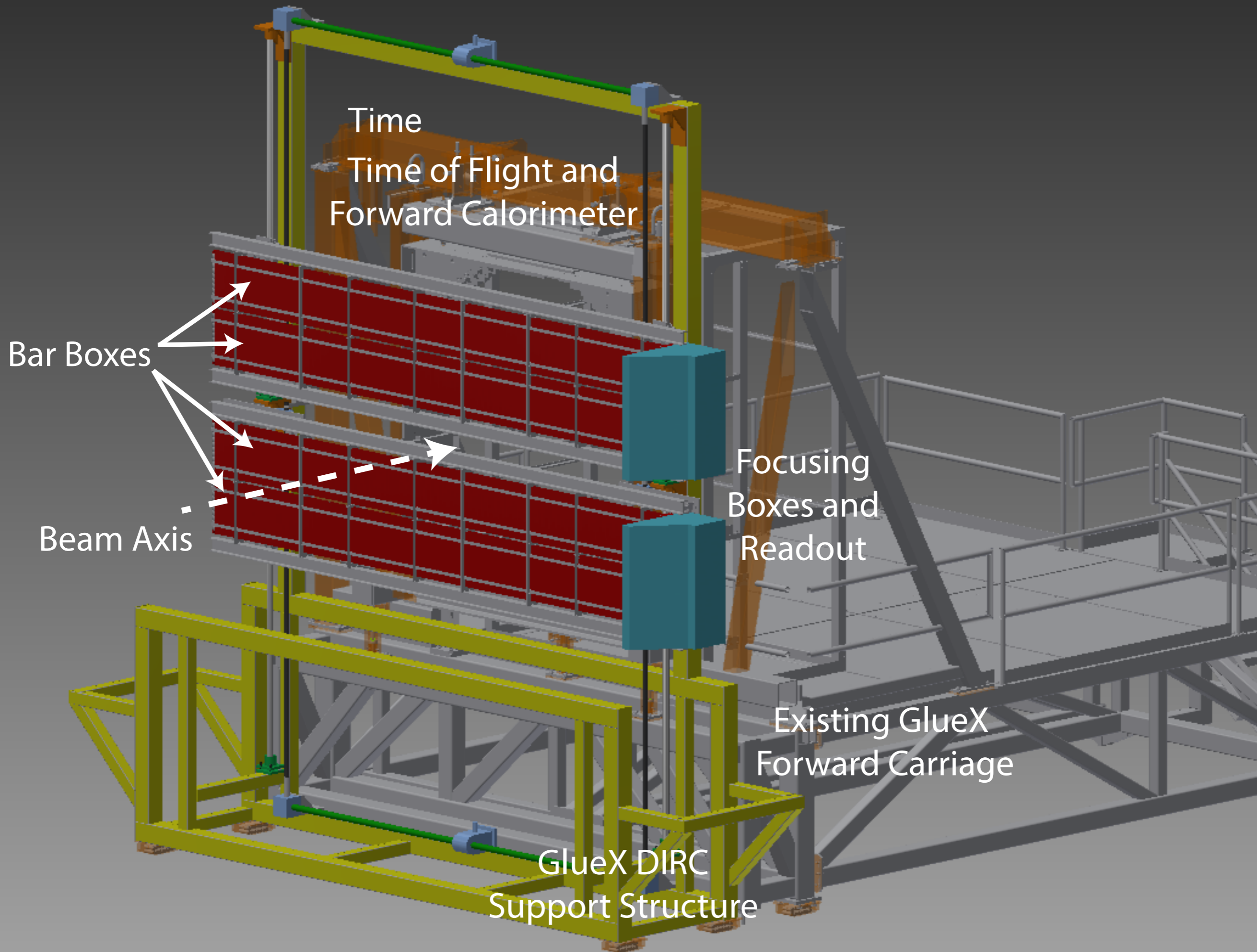
**Quantitative limits:**  
3g vertical  
1.5g horizontal

- \* Crate provided adequate damping of both vertical and horizontal accelerations during the road test according to our ALARA limits, but we can't be too careful
- \* Some suggestions from recent JLab review we're considering:
  - \* Road test with mock bar box on planned route from SLAC to JLab
  - \* Road test at SLAC with actual bar box to assess the crate's performance
  - \* Real time monitoring of bar quality while in transport

# Where does the DIRC go again?

**Insert DIRC  
here!**





Time  
Time of Flight and  
Forward Calorimeter

Bar Boxes

Beam Axis

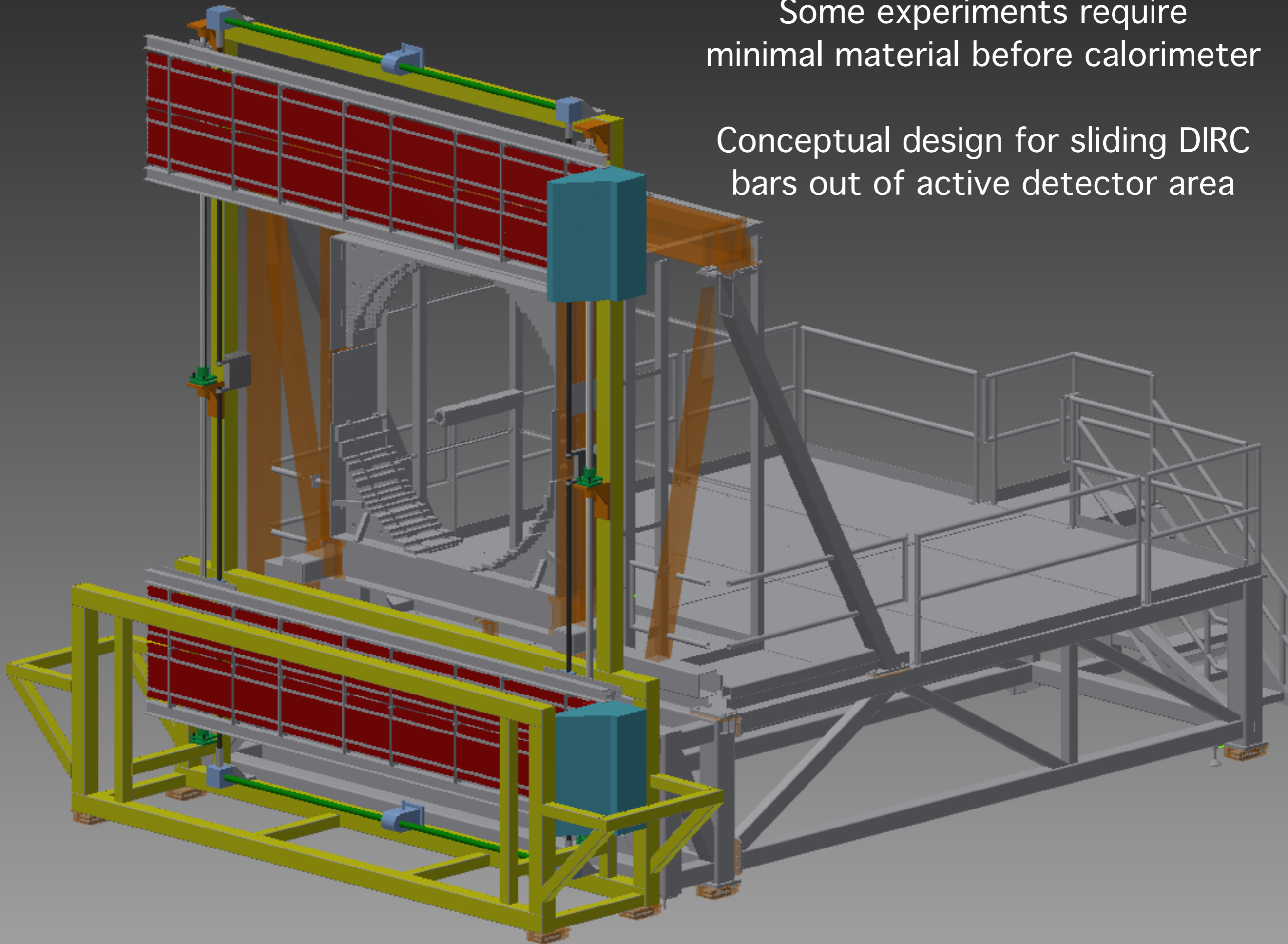
Focusing  
Boxes and  
Readout

Existing GlueX  
Forward Carriage

GlueX DIRC  
Support Structure

Some experiments require minimal material before calorimeter

Conceptual design for sliding DIRC bars out of active detector area



# GLUEX DIRC timeline

## \* **October 2015:**

- \* Submitted technical design report (available if you're interested in some light reading)
- \* JLab project review with several external experts (Jerry Va'Vra, Tom Hemmick, etc); positive feedback from the committee and expect to officially start project in early 2016

## \* **2016:**

- \* Complete additional shipping test runs and finalize crate design
- \* Complete designs and fabricate support structure and optics box

## \* **2017:**

- \* BaBar bar boxes shipped from SLAC to JLab
- \* Install and begin commissioning first optics box coupled to 2 bar boxes

## \* **2018:**

- \* Install and commission complete detector; begin GlueX strangeness program in earnest