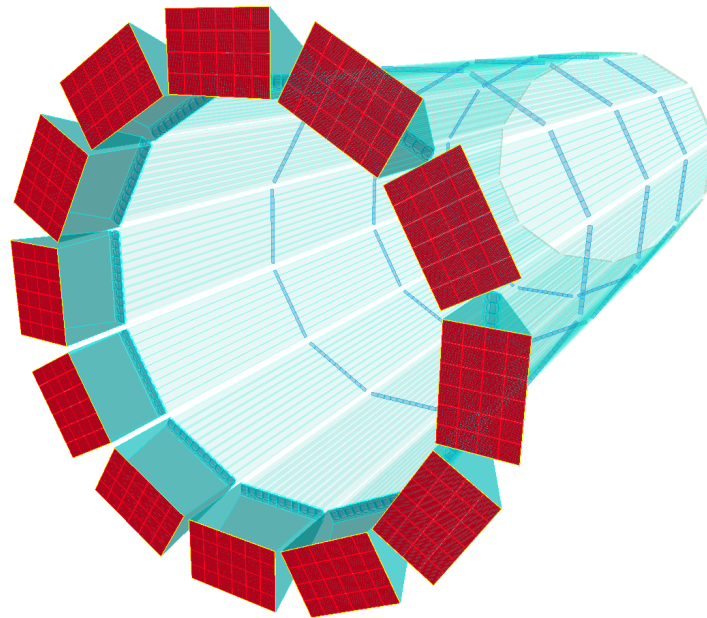
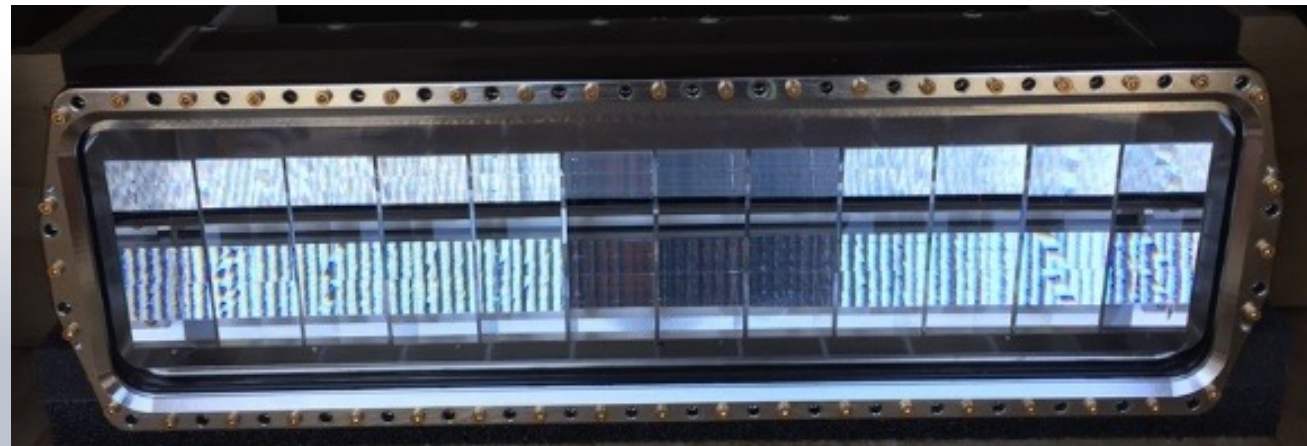


2024 DIRC@EIC ANNUAL WORKSHOP

Greg Kalicy



- Hardware tests in Glasgow, SBU, ODU, and JLab
- Mechanical Design and Integration
- Reuse of BaBar Bars
- Simulation Studies
- Preparations towards TDR

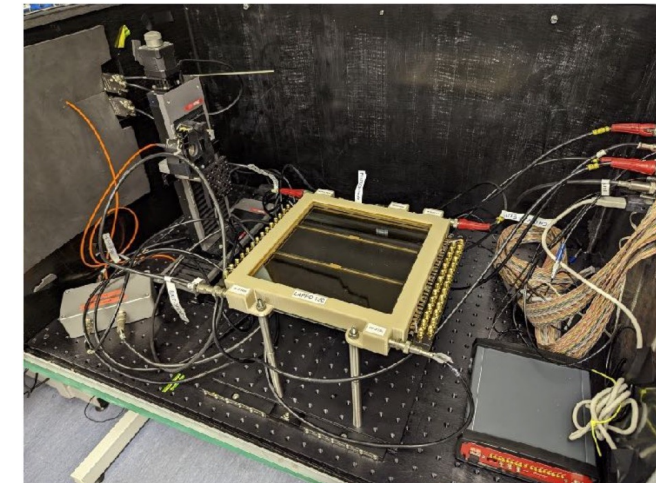


- May 16th – 22nd (<https://indico.bnl.gov/event/23332/>)
- 11 participants in person, 7 participants online (some only for specific sessions)
- All sessions had focus on TDR readiness and overall hpDIRC/ePIC schedule
- Designated TDR sessions used to identify remaining studies, required figures, and write detailed plan
- Several days before and after the meeting were used to work on hpDIRC project planning, schedule, and updating P6 plan

Day	Date	Morning	Afternoon
Thursday	May 16	MCP-PMTs	Sensors SiPMs / TDR
Friday	May 17	Test Besam NIM paper	BaBar bar boxes / eRD103
Saturday	May 18	Simulation Studies	CRT / PicoSec / eRD103
Sunday	May 19	ePIC Simulation	TDR
Monday	May 20	Simulation Studies	BaBar bar boxes / eRD103
Tuesday	May 21	Mechanical Design	TDR
Wednesday	May 22	TDR	BaBar bar boxes / Project Planning

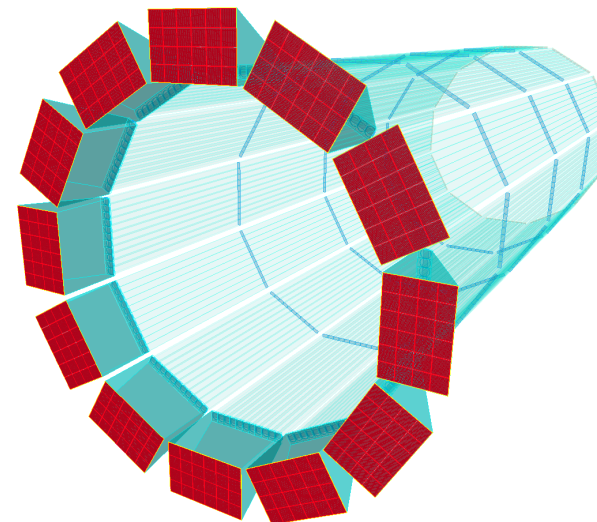
Tests of Photosensors in Glasgow

Setup at Glasgow

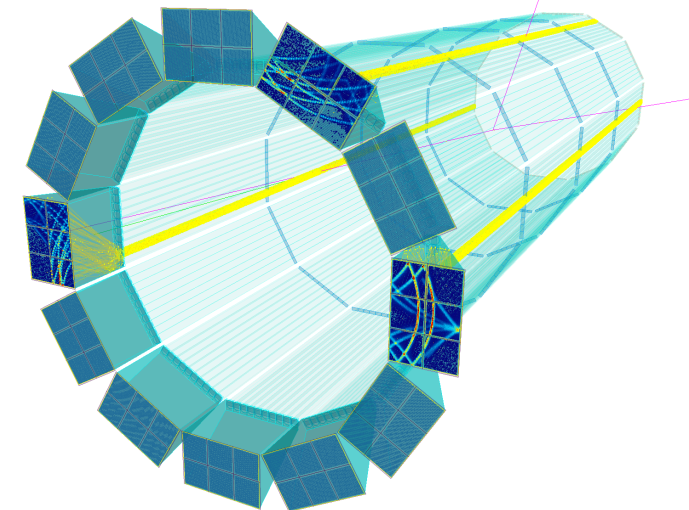


- Setup capable of measurements of all three types of sensors side-by-side is crucial for performance evaluation and is in preparation by Rachel Montgomery
- Long detailed discussion with Albert Lehman to clarify planned studies, procedures, and challenges
- Large pixel Photonis MCP-PMT previously tested in Erlangen was received (on loan from PANDA) and will serve as reference and calibration of setup
- Main short-term goals:
 - Demonstrate that the tubes do not suffer from coherent oscillations at high intensities
 - Single-photon timing precision (both transit time spread and rms timing)
- Future tests:
 - Collection and Quantum efficiency
 - Uniformity
 - Integration with EICROC

hpDIRC with Photonis MCP-PMTs



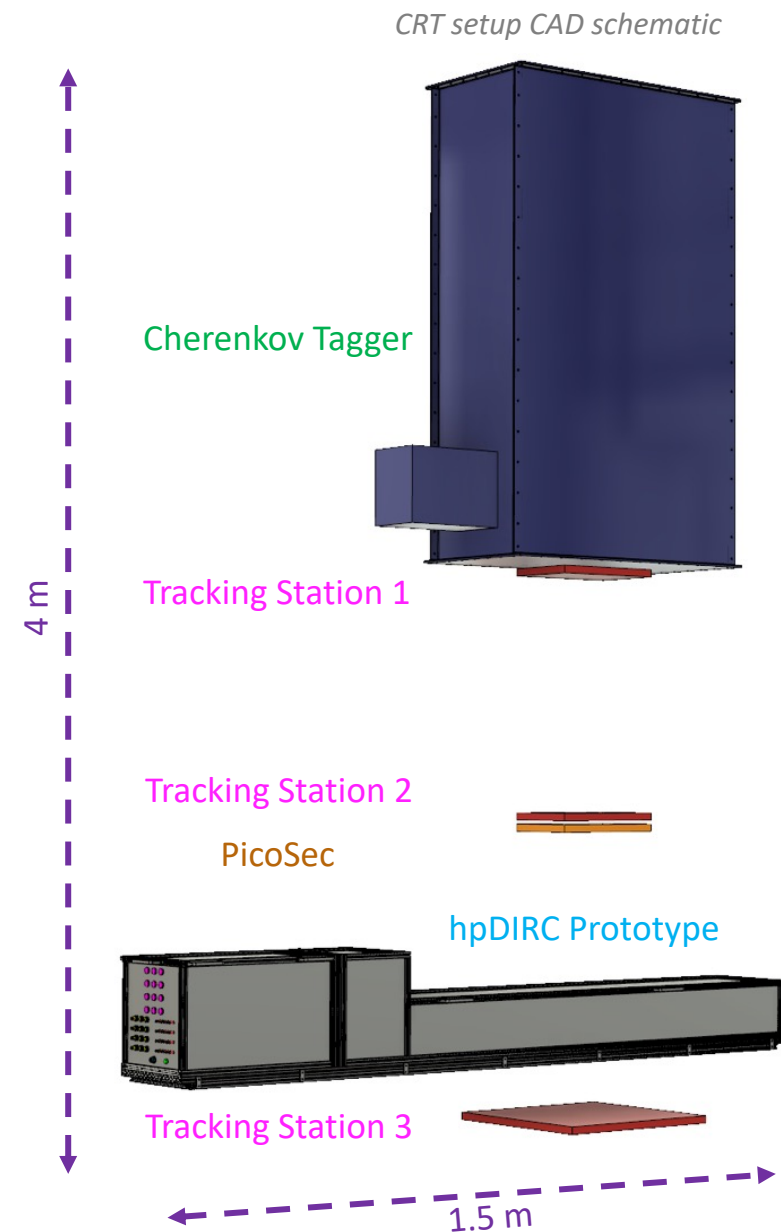
hpDIRC with HRPPDs



Cosmic Ray Telescope (CRT) at SBU

Facility to test incremental upgrades of prototype components, performance evaluation

- Initial **PANDA Barrel DIRC-based prototype** to commission setup
- Modular design will allow to add new ePIC hpDIRC components once they become available
- **Cherenkov Tagger** to select muons above 3.5 GeV/c
- Three **tracking stations** for high-precision 3D-track reconstruction (location optimized with simulations)
- **PicoSec detector** for event timing (Jlab group committed prototype and personnel to project)
- Geant4 simulation used to optimise setup arrangement

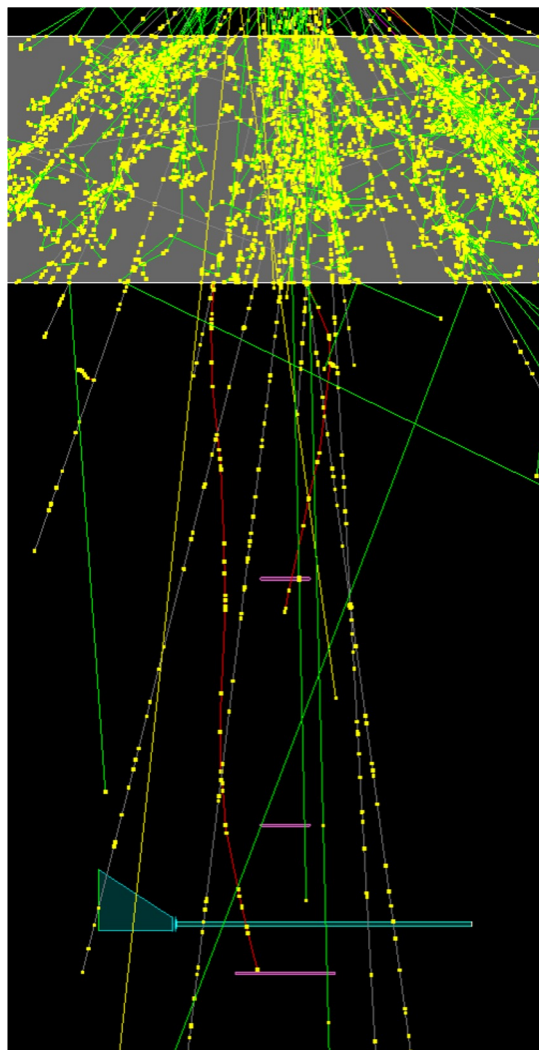


Cosmic Ray Telescope (CRT) at SBU

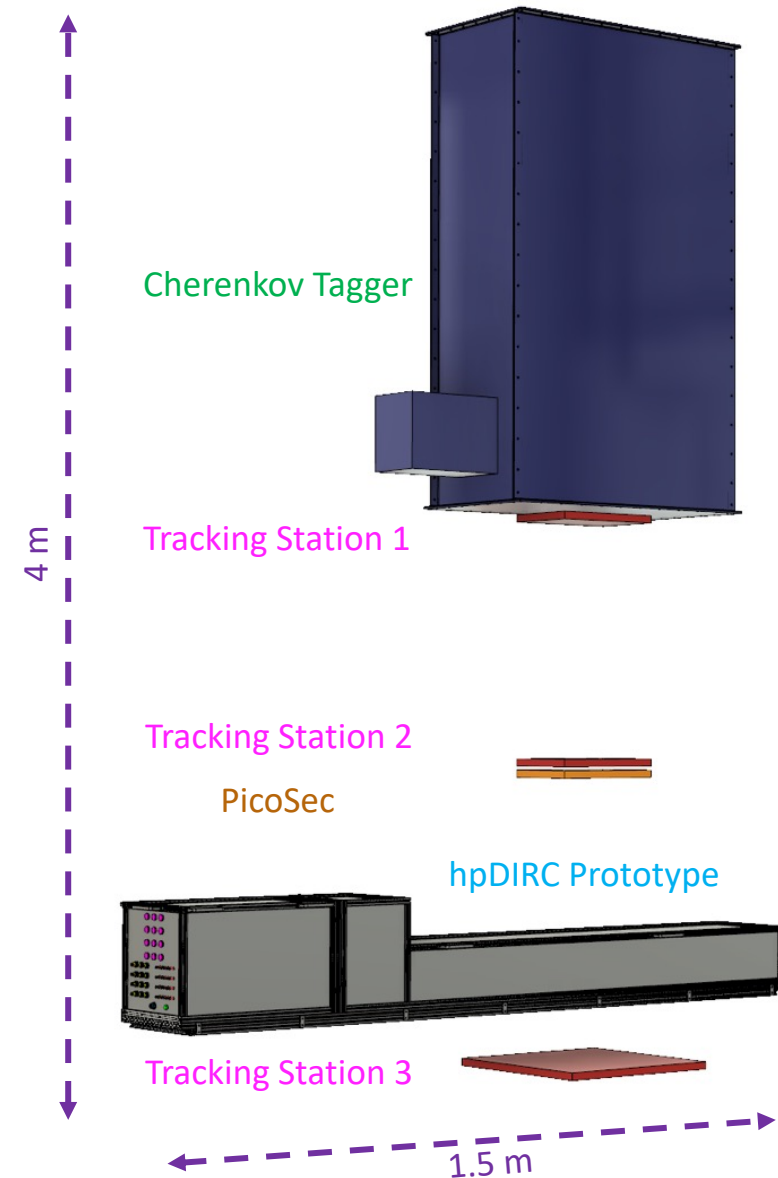
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Geant4 simulation of CRT setup



CRT setup CAD schematic

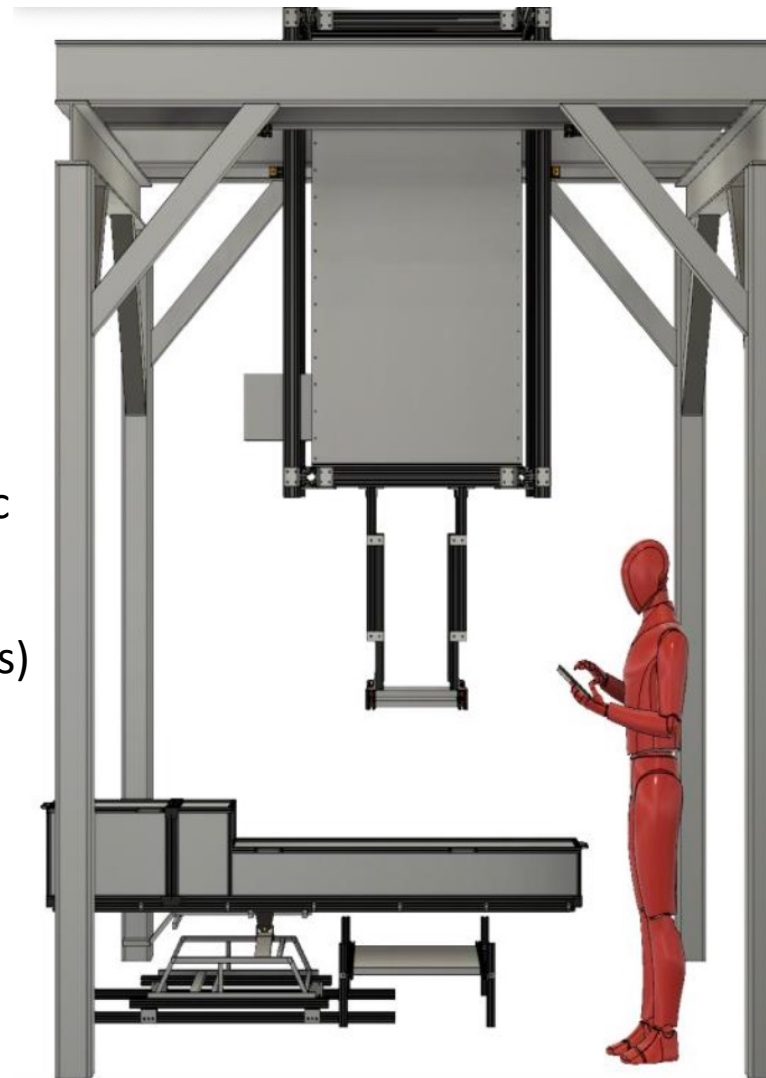


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CAD Model



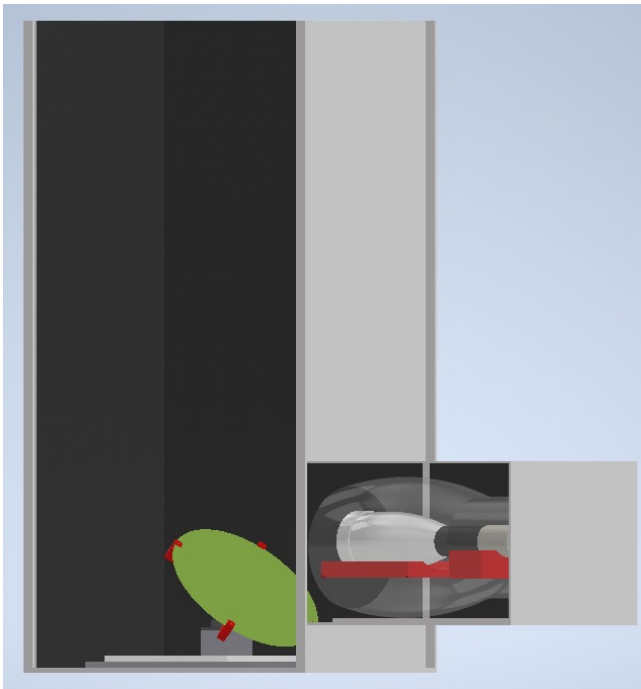
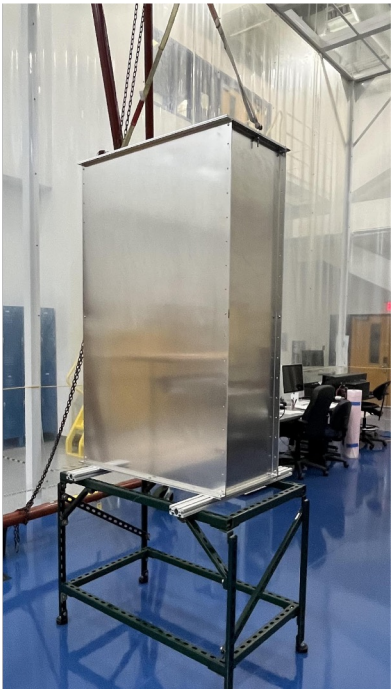
CRT setup CAD schematic



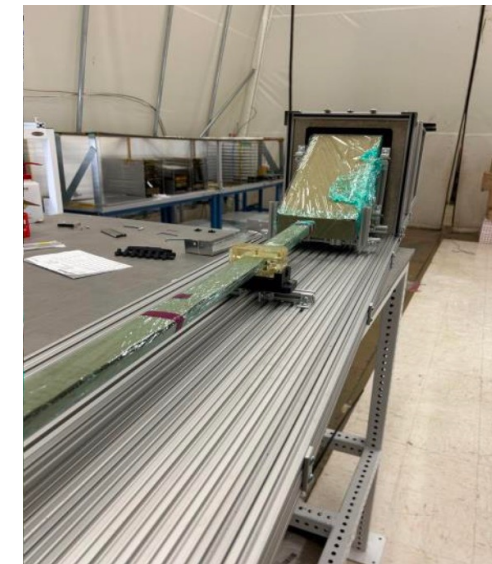
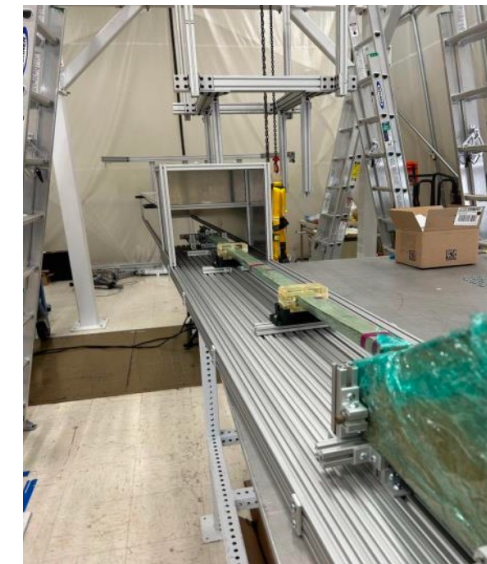
hpDIRC Prototype at SBU Cosmic Ray Telescope

- SBU team (**Nathan Shankman, Jaydeep Datta**) finished hpDIRC prototype and are ready for installation
- hpDIRC, trackers, PicoSec DAQs integration is in progress
- PicoSec prototype will be ready for July/August (**Kondo Gnanvo, Akash Pandey**)
- Cherenkov Tagger is being finished at ODU (**Charles Hyde, Carlos Gayoso, Alex Garrett**)

Cherenkov Tagger at ODU

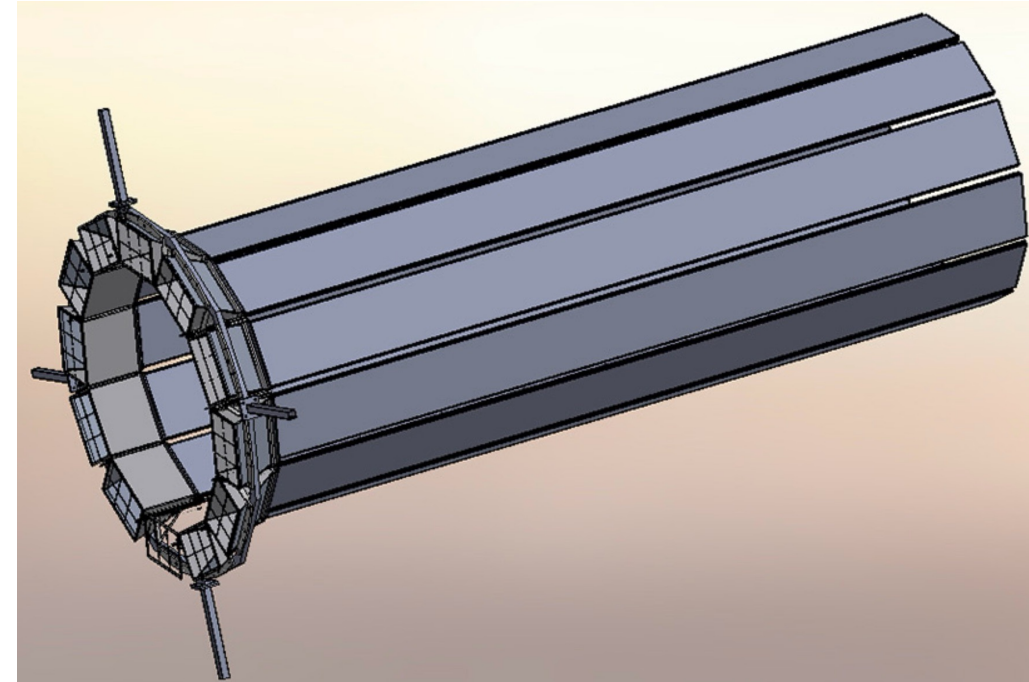


hpDIRC Prototype at SBU

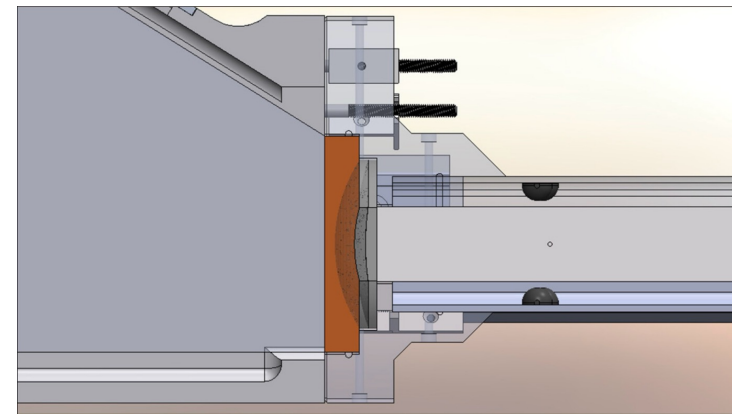


- Engineering/integration support for hpDIRC from EIC project:
Avishay Mizrahi (MIT), Kris Cleveland (Jlab)
- Synergy with PANDA Barrel DIRC continues to help tackling many questions
- Currently focussed on:
 - Compact lens housing integrated with bar box
 - Prism and readout housing
 - Connection between readout and bar box sections
 - Installation procedure

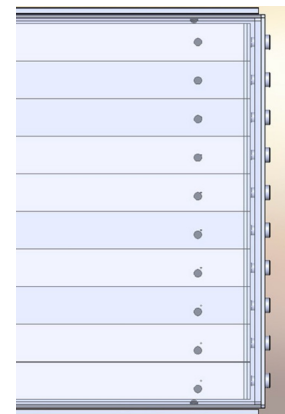
3D CAD Model of hpDIRC



Lens housing, connection of readout and bar box section



Mirror end

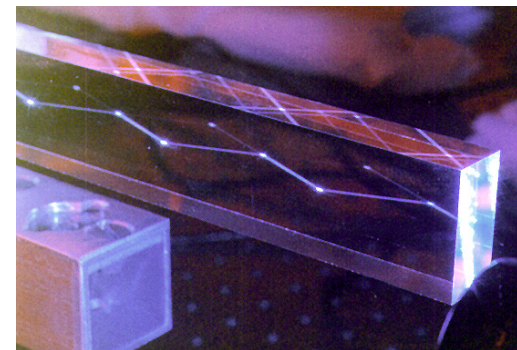
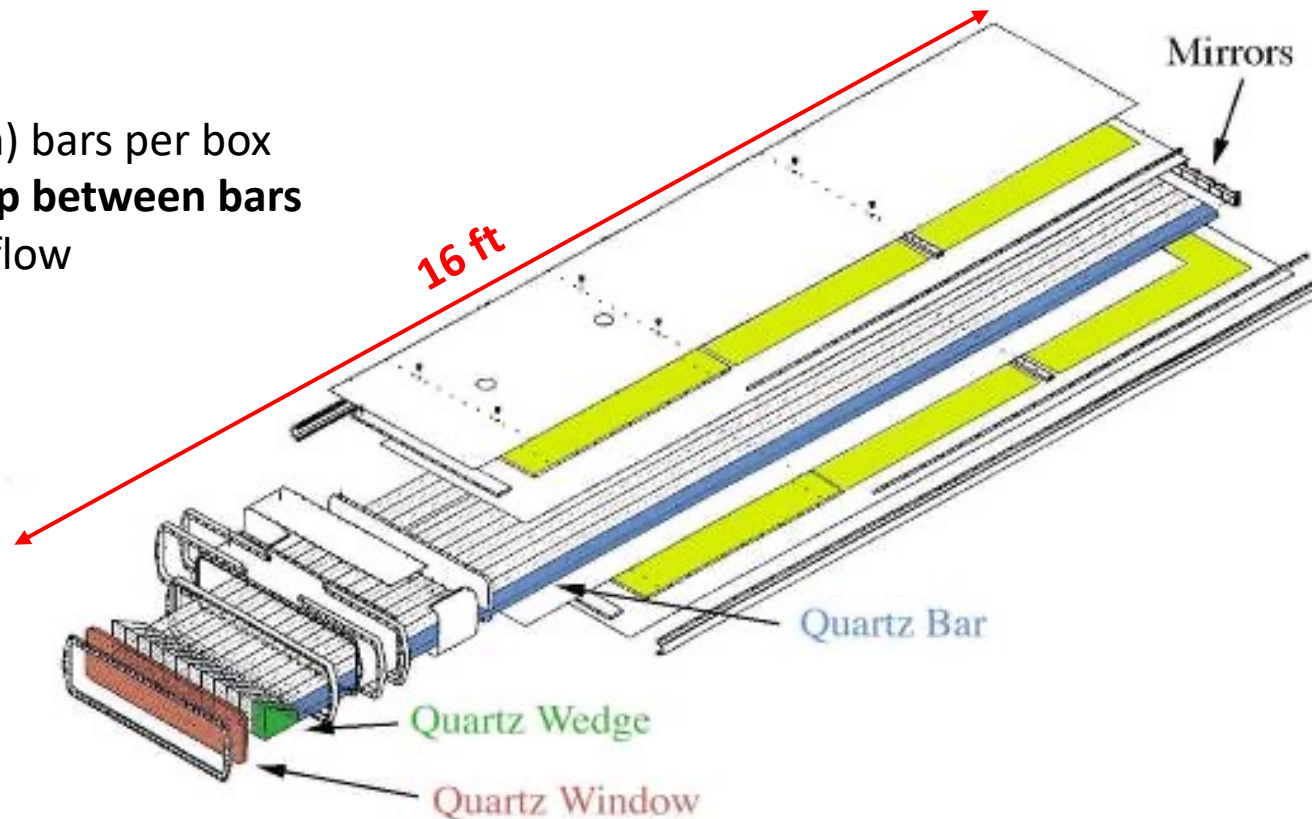


Reuse of BaBar Bars

- BaBar DIRC finished operation in 2010 SLAC/DOE made DIRC bars available for reuse
- 4 bar boxes awarded to us and installed as GlueX DIRC in 2018
- Remaining 8 boxes awarded to us to be used as EIC DIRC, could yield up to 384 short bars (360 needed for ePIC hpDIRC active area)

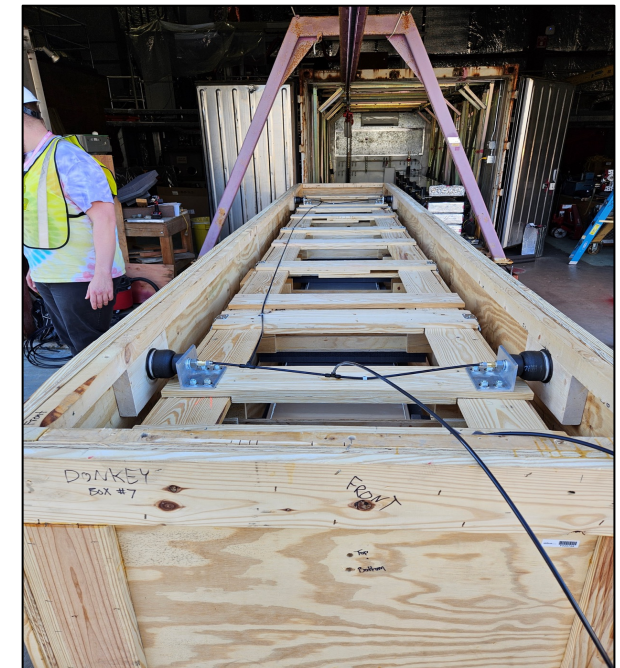
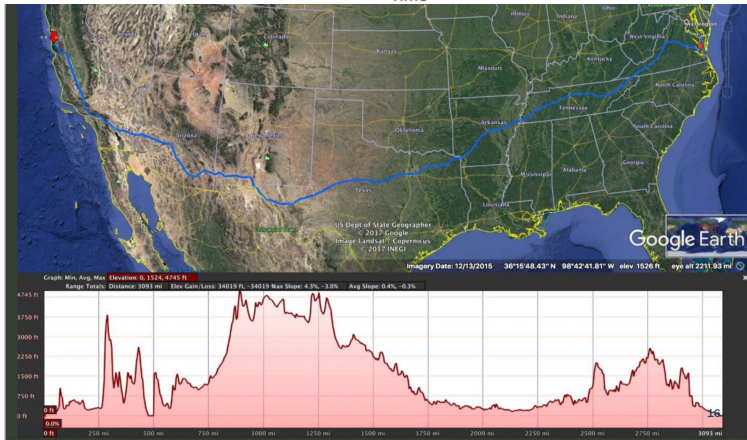
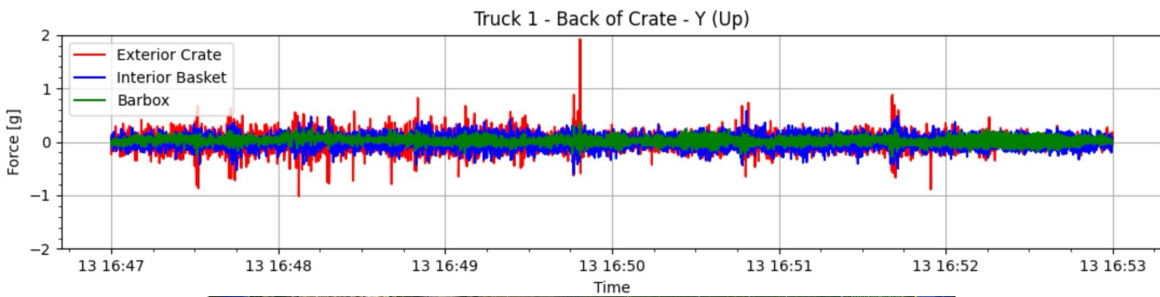
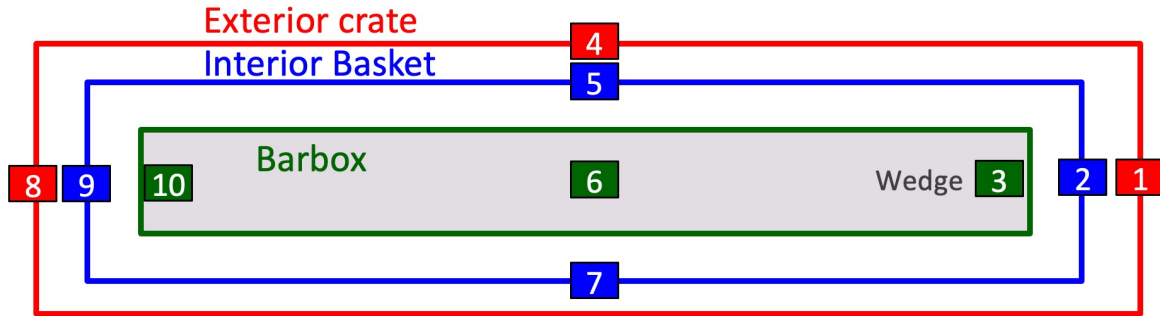
Babar Bar box:

12 long (4.9m) bars per box
150 μ m air gap between bars
dry nitrogen flow



Transport of BaBar Bar Boxes from SLAC to JLab

- Used similar approach to successful GlueX bar box transport in 2017/2018: wooden crates with shock absorption trays, air-ride and temperature controlled trailers



Transport of BaBar Bar Boxes from SLAC to JLab

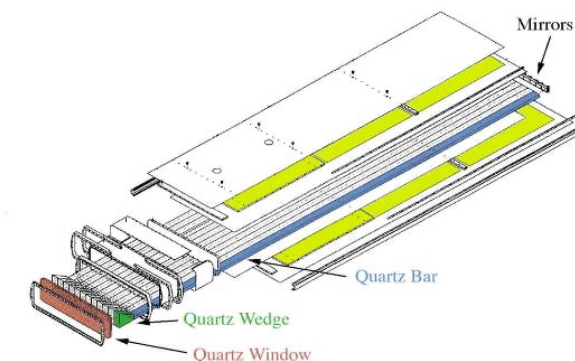
- JLab-CUA-GSI crew prepared and with SLAC crew executed transport of 8 BaBar DIRC Bar Boxes in April (Andrew Lumanog, Tyler Lemon, Joe Schwiening, Greg Kalicy, Matt McCulloch)



Disassembly of BaBar Bar Boxes

- Bar boxes will be disassembled into individual bars at JLab (starting in July/August 2024)
 - Never done before, working on detailed plan
 - Aluminum covers will need to be "open", glue joints between bars dissolved
- Optical quality of bars after disassembly will be evaluated in QA DIRC lab, located next to disassembly tent
- QA DIRC lab close to ready for commissioning
- Reference DIRC bars (never used in BaBar) from SLAC available for commissioning and as reference
- QA Lab will consist of three parts:
 - Cleaning/inspection station
 - Darkroom with laser setup to measure quality of DIRC bars
 - Storage (long and short-term)
- Reflection coefficient measurement to evaluate surface quality

Schematic of BaBar bar box



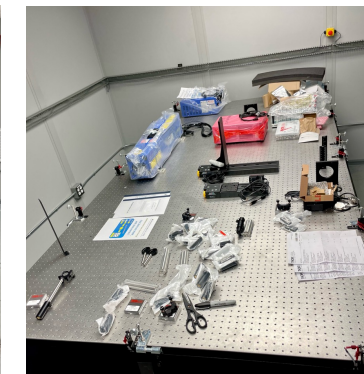
DIRC labs under construction at JLab



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Laser Lab (Installation in progress)



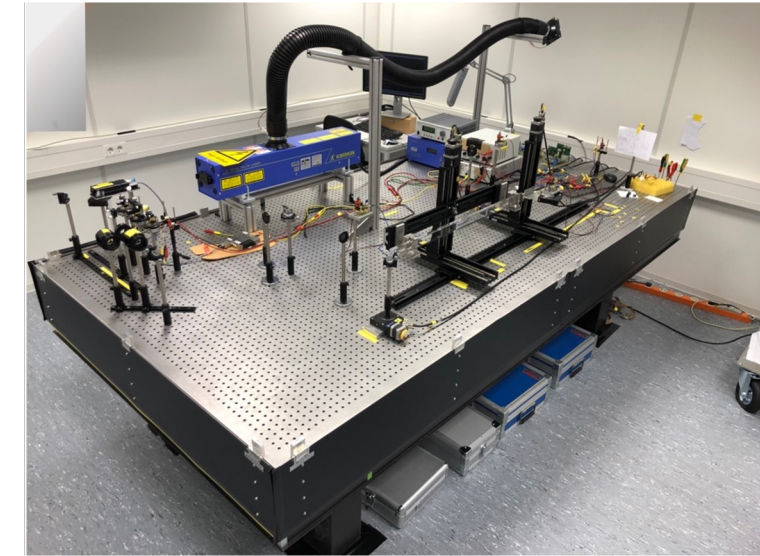
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Disassembly of BaBar Bar Boxes

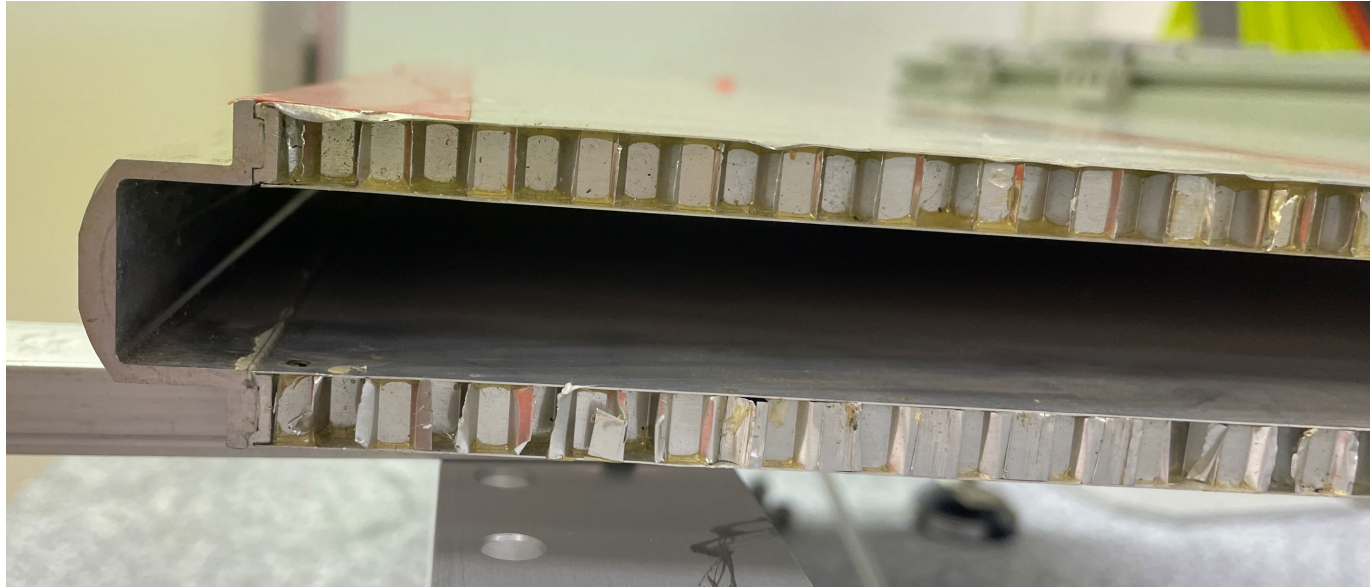
Laser lab at GSI

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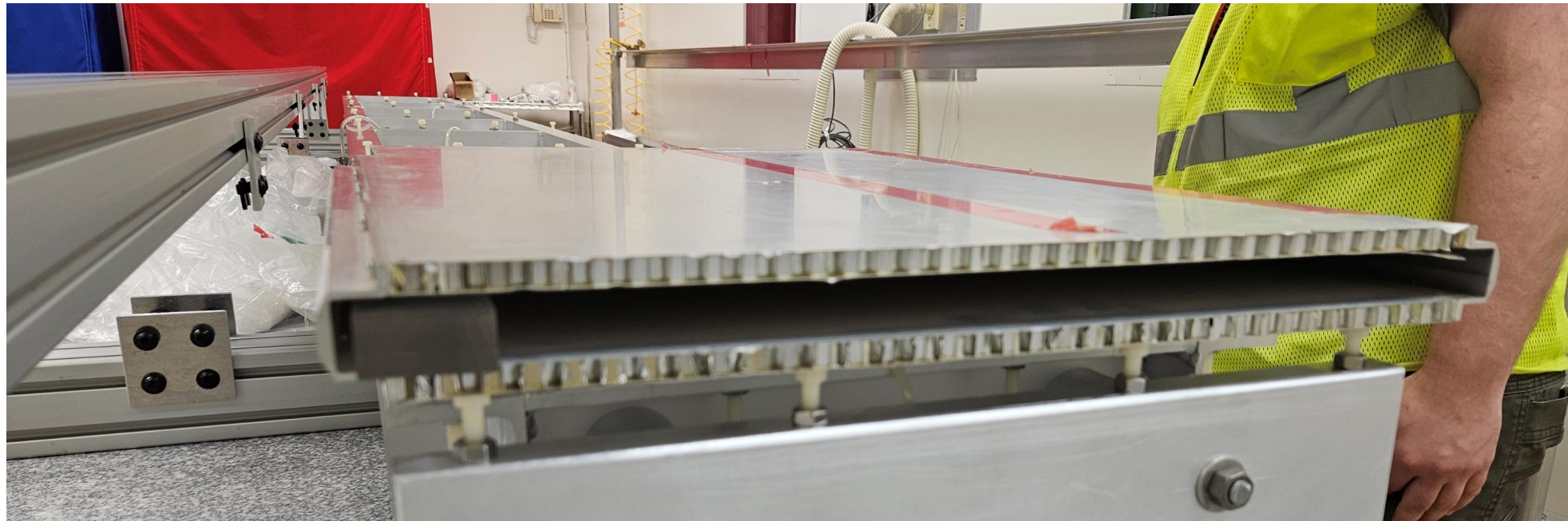


PANDA DIRC bar in GSI laser lab

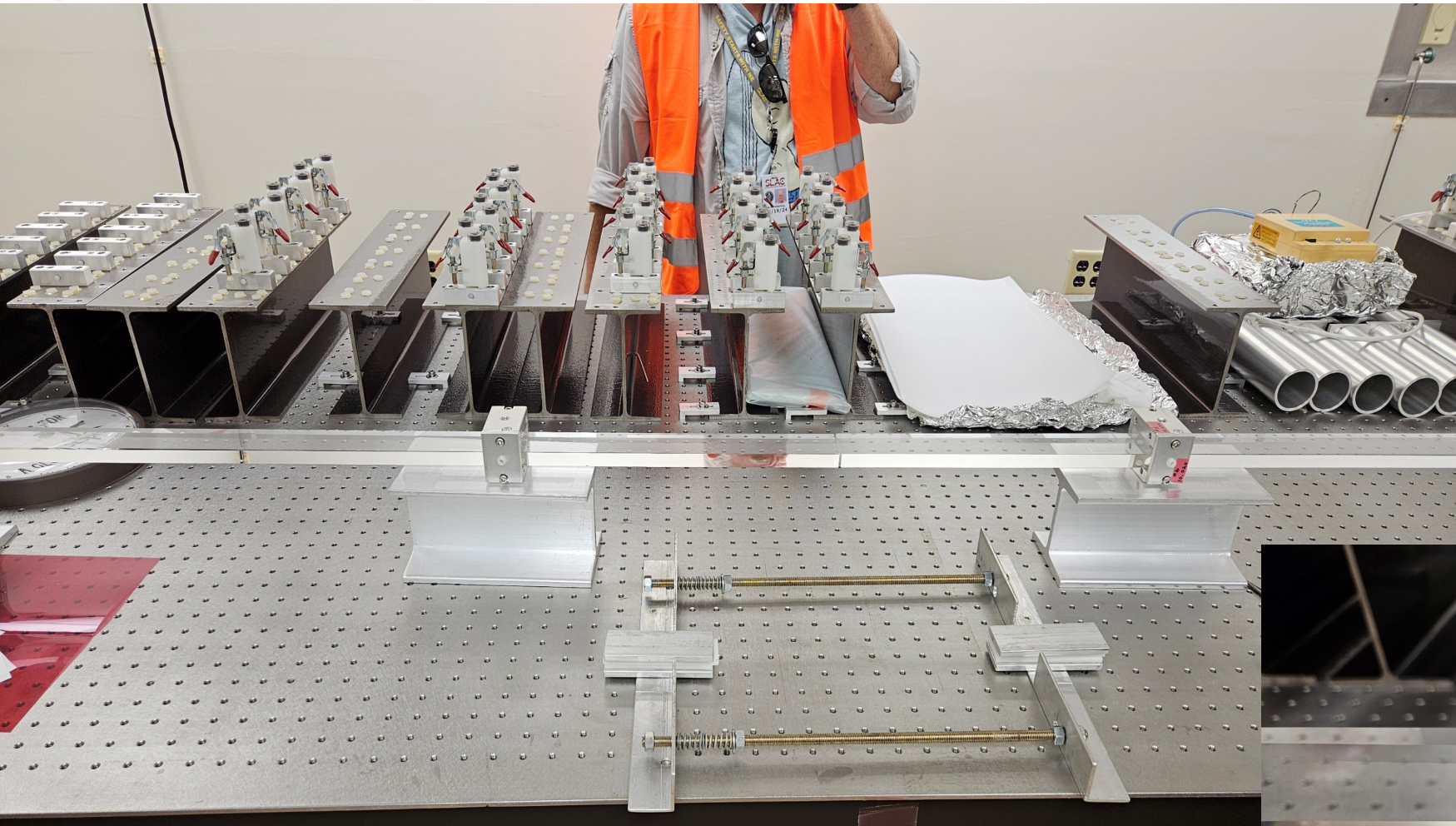




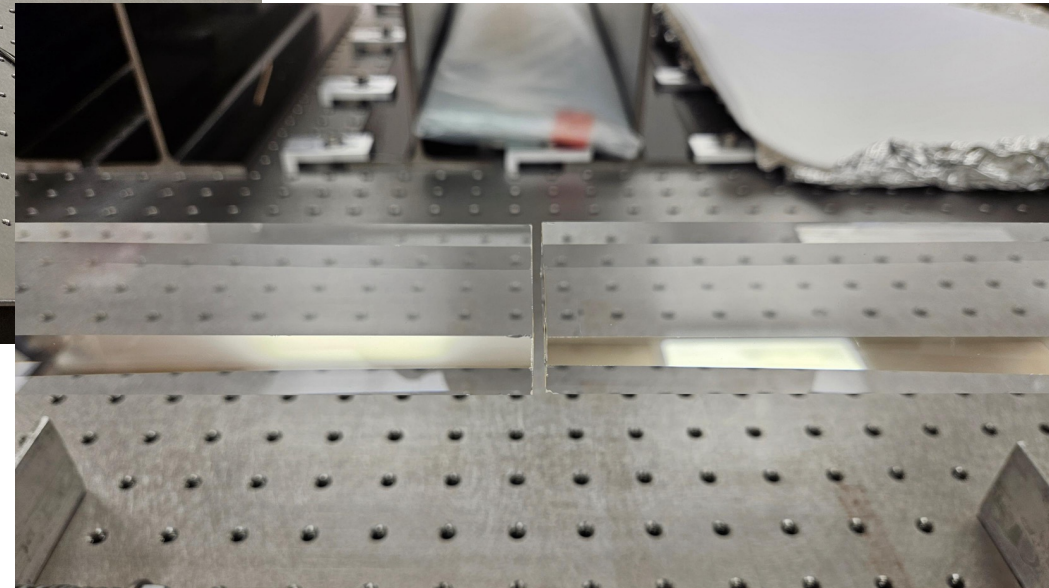
Aluminum DIRC bar box skin



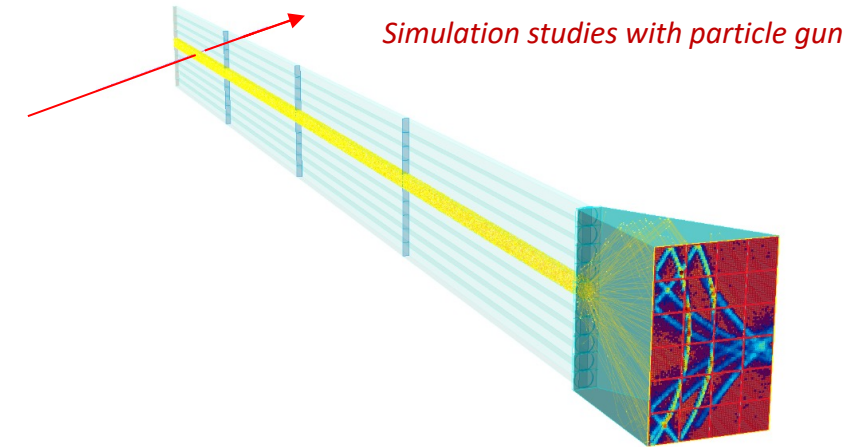
Lessons Learned from SLAC Expert



Separated bars with heat gun

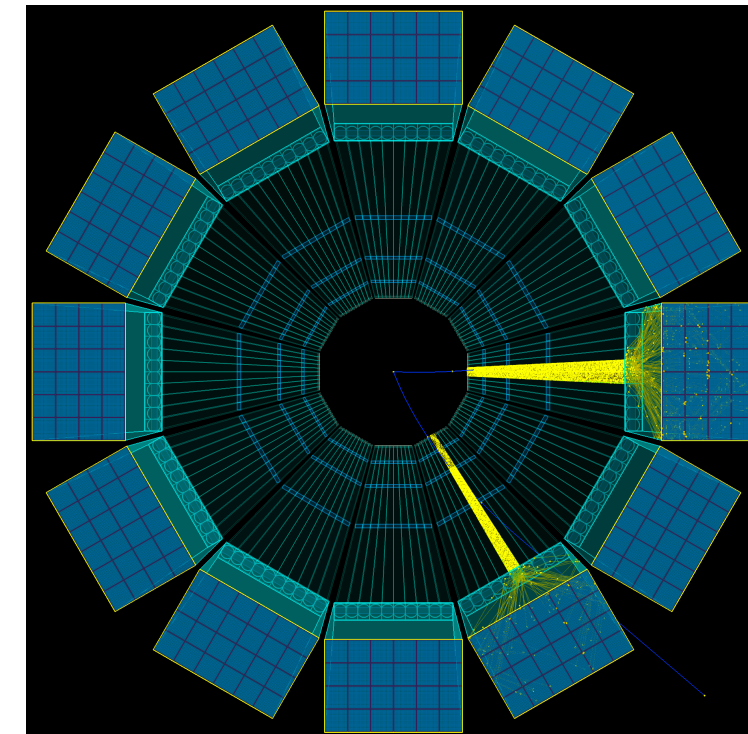


- Studies of hpDIRC performance were done with **test beam validated simulation** (Roman Dzhygadlo, Imran Hossain, Bill Llope)
 - Realistic **ePIC magnetic field** map was used
 - Studies with **Pythia physics events** were done
 - **Multiple tracks per event in single bar** showed very small impact on performance
 - Most studies **assumed 0.5 mrad angular tracking resolution** but software ready to import and include detailed parametrization of tracking
- **New group members** are getting familiar with software, will pick up work packages in near future (Afaf Wasly, Mustafa Schmidt)
- Starting new **weekly technical meeting** focused on hpDIRC simulations



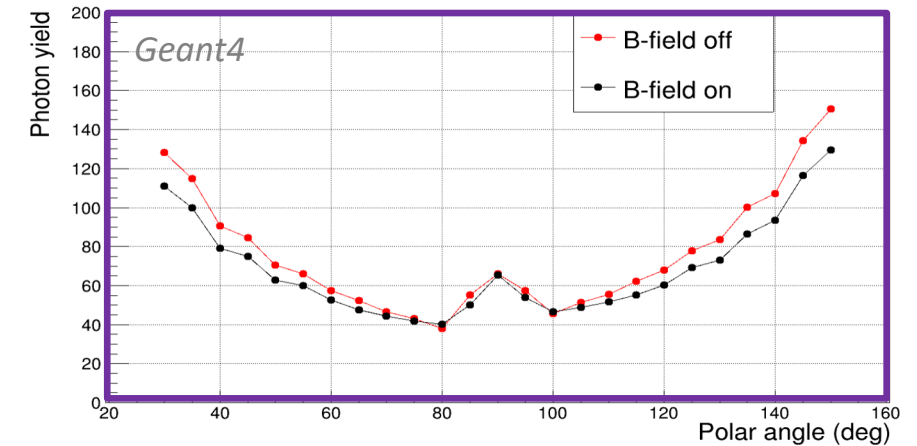
Simulation studies with particle gun

Simulation studies with Pythia events

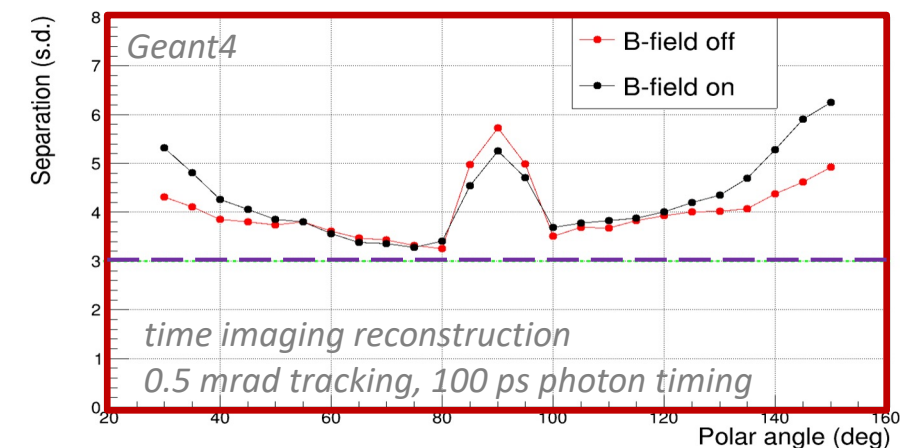


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Photon yield per particle



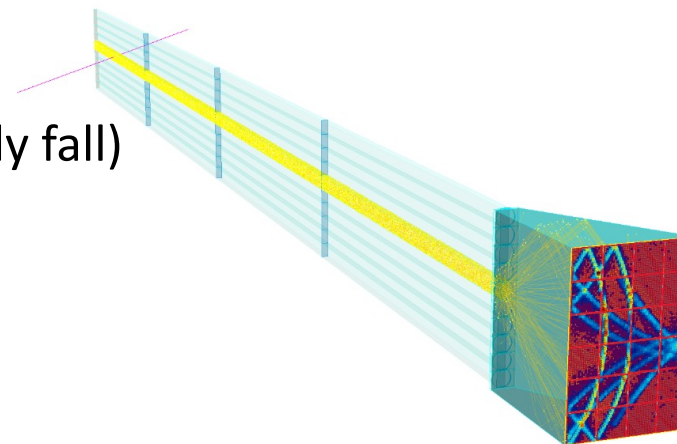
π/K separation power at 6 GeV/c



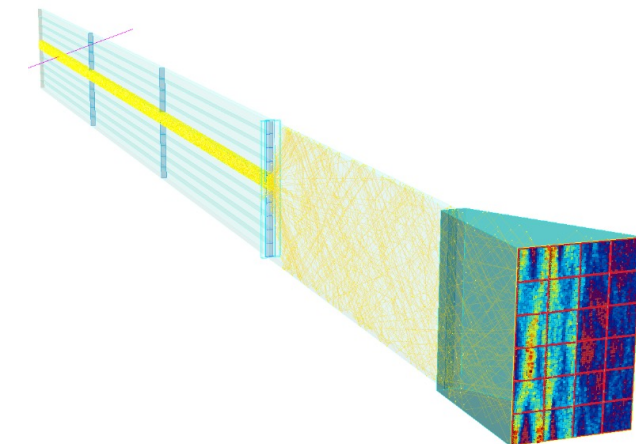
- **Remaining Questions/Studies** (expected time for answers)
 - Possibility of reusing BaBar DIRC bars (late fall)
 - Decision on plate vs narrow bars for lightguide section (late summer/early fall)
 - Optimal bar width in case new are needed (late summer/early fall)
 - "Split-Prism" expansion volume option as part of cost/risk mitigation (late summer/early fall)
 - Potential software-based multiple scattering mitigation (late summer/early fall)



Geant4 visualization of the two light-guide options



Narrow bars in each sector
(baseline for ePIC)



Hybrid of bars and plate

- **hpDIRC TDR section outline prepared**
 - Relevant needed figures identified
 - Some needed figures will be referenced (B field, radiation map, etc.), might include them in paper with ZOOM to hpDIRC region
 - **Detailed breakdown of needed content – ready to write!**
 - Remaining questions/studies identified and assigned
 - Performance plots will be updated for final geometry and are easy to adjust to uniformly agreed representation and style with other systems

Section	Subsecion	Content
Requirements/Motivation		
	Performance	
	Integration	
System Description		
	Concept	hpDIRC unique aspects
	Design	description of components, how the required performance (KPP) will be achieved
	Performance	description of simulation and reconstruction method, CERN validation
	Calibration	alignment - survey marks, experimental data for calibration
Implementation		
	Mechanical	Design and integration, Assembly of modules, Installation
	Services	nitrogen, cooling, voltage, controls and monitoring, laser calibration
	Other activities needed	
	QA	CRT (Full module), Readout (Sensors + Front-end Electronics), Bars/Mirrors (Laser Lab in JLab), Prisms (?), Lenses (ODU setup)
	Timeline, workforce, work packages	
	ES&H	
	Risk mitigation	Readout electronics, Sensor (Whatever is not tested)

Summary

- 2024 DIRC@EIC Annual Workshop was held in Jlab in hybrid form
- Discussed all hardware and software projects with focus on TDR readiness
- Performance studies and preparation of needed plots are in good shape
- Detailed plan for hpDIRC TDR section prepared, remaining tasks identified and assigned
- Potential new members interested in joining hpDIRC group
- Validation of reusing BaBar DIRC radiator bars is main remaining step towards TDR readiness
 - Successful transportation of bar boxes done in April 2024
 - Preparations for disassembly are in progress
 - Decision on reuse of the BaBar bars expected by late fall 2024

