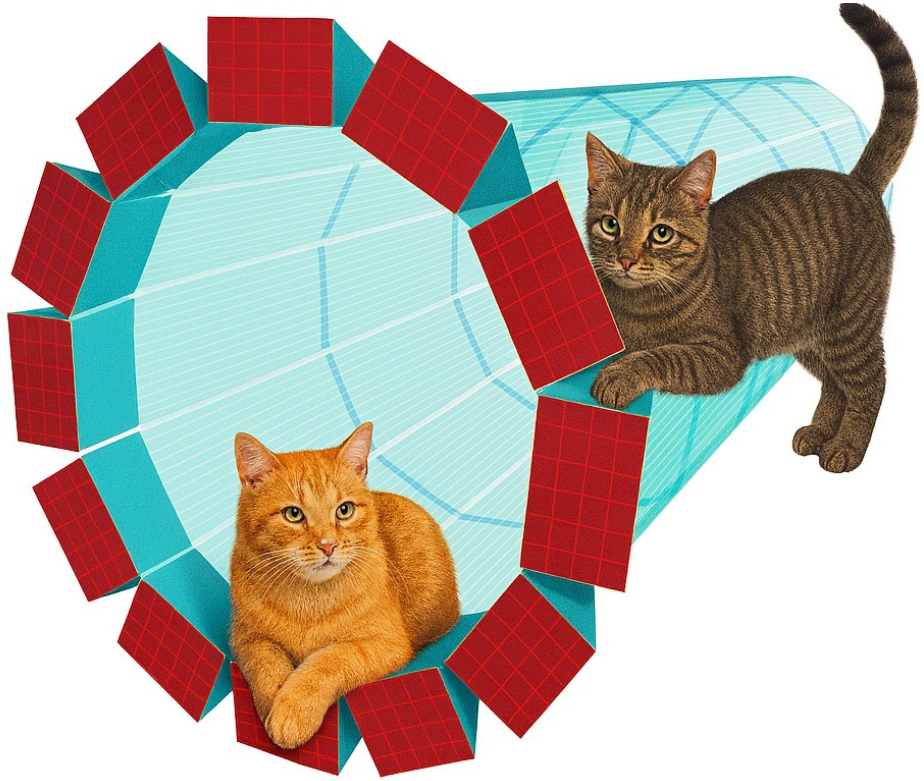
The DIRC@EIC Annual Meeting

Greg Kalicy

CUA



ePIC TIC Meeting

August 4th, 2025

CUA GSI Jefferson Lab Old Dominion Stony Brook University University of South Carolina Wayne State University William & Mary

10TH DIRC ANNUAL MEETING IN JLAB*

The DIRC@EIC Annual Meeting/Workfest: https://indico.bnl.gov/event/28624/

- A total of 29 participants attended, including 19 on-site attendees.
- The pre-TDR and TDR efforts served as central references for all discussions related to the ePIC hpDIRC; a comprehensive review of the current version was done.
- Project were discussed and re-evaluated, leading to updated plans and procedures.
- Dedicated sessions focused on key documentation efforts, including three NIM papers, the BaBar DIRC bar refurbishment strategy, and the sensor selection plan.

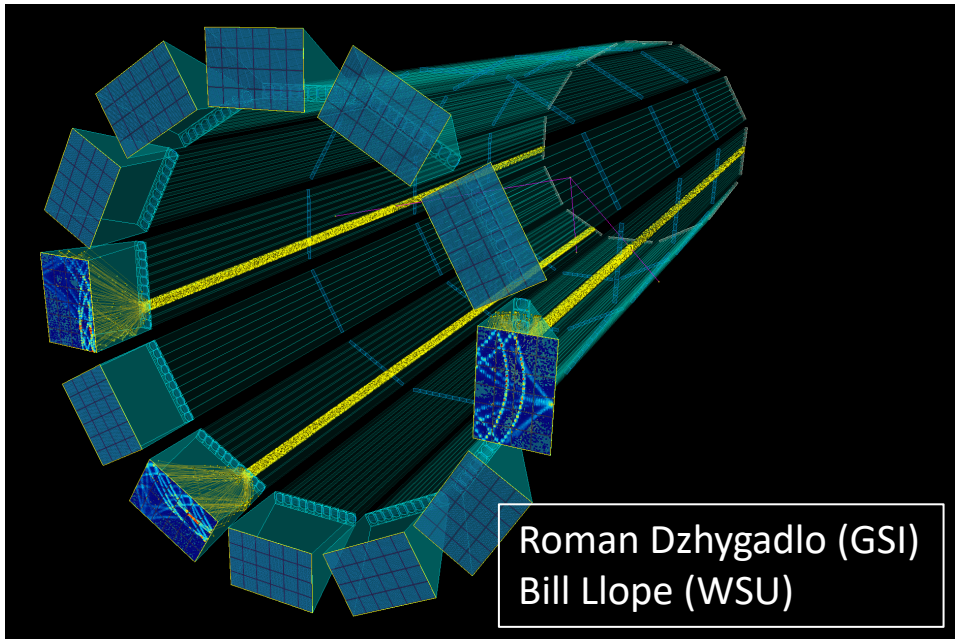
Day	Date	Morning		Afternoon	
Thursday	June 26	TDR		Lens tests at ODU	hpDIRC ePIC simulation
Friday	June 27	Sensors	Machine Learning based Simulations	hpDIRC ePIC simulation	Generic R&D
Saturday	June 28	hpDIRC ePIC simulation	QA and Assembly	CRT	
Sunday	June 29	BaBar bar box		QA and Assembly	
Monday	June 30	NIM paper		Electronocs	BaBar bar box
Tuesday	July 1	ePIC Tracking	Mechanical Design	Papers and documentation	
Wednesday	July 2	miniDIRC		TDR	

HPDIRC SIMULATION

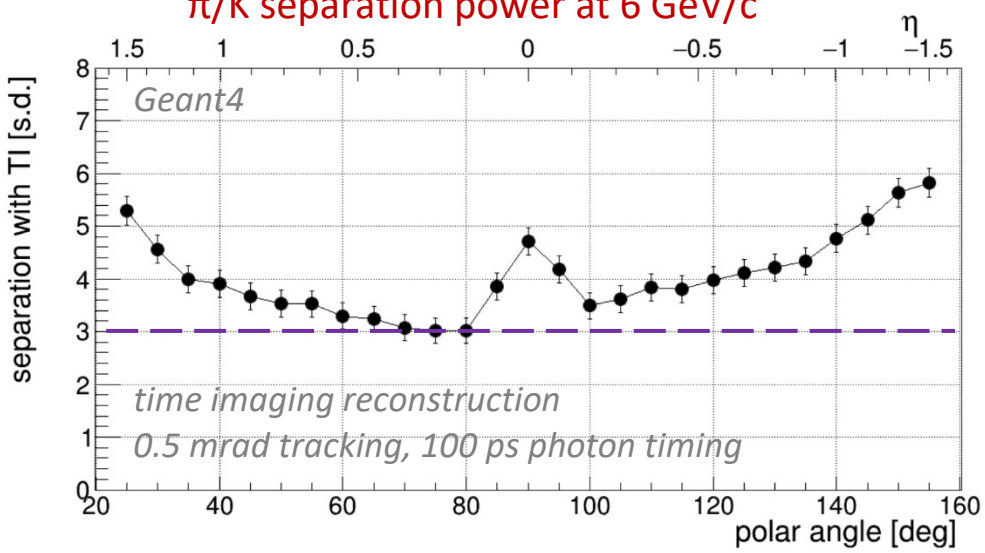
- Overview of key simulation projects and current status
- Confirmed robust performance in magnetic field, using physics events (Pythia) to include backgrounds, multiple tracks per bar
- Ongoing updates to performance studies reflecting recent geometry modifications and incorporating revised component specifications

→ Performance requirements reached: ≥ 3 s.d. π/K separation at 6 GeV/c for all angles

Simulation studies performed with
- Stand-alone Geant4 simulation
- Single particles from particle gun
- 1.7T magnetic field, no other ePIC subsystems
- 0.5 mrad tracking resolution
- 100ps time resolution



π/K separation power at 6 GeV/c

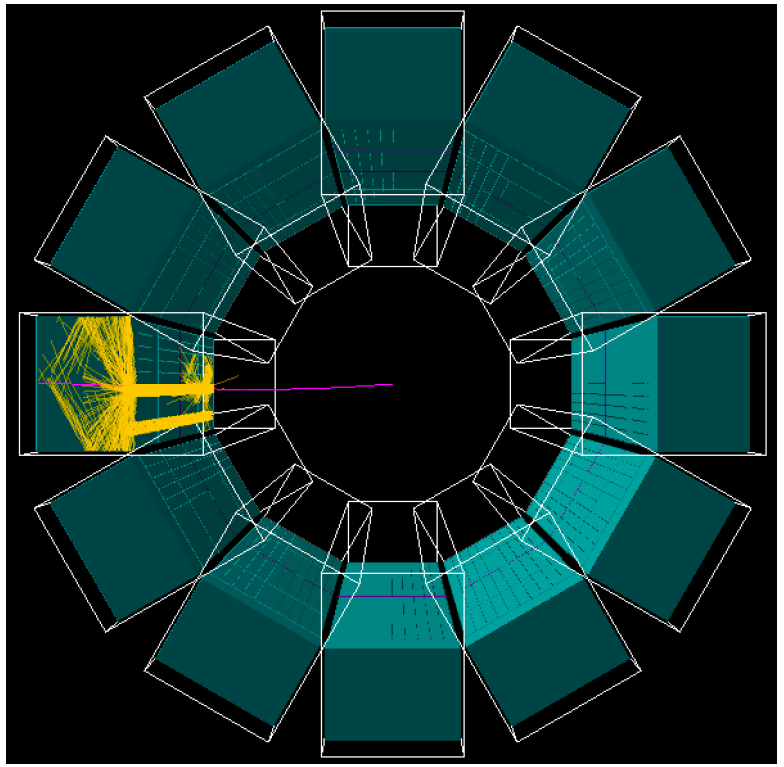


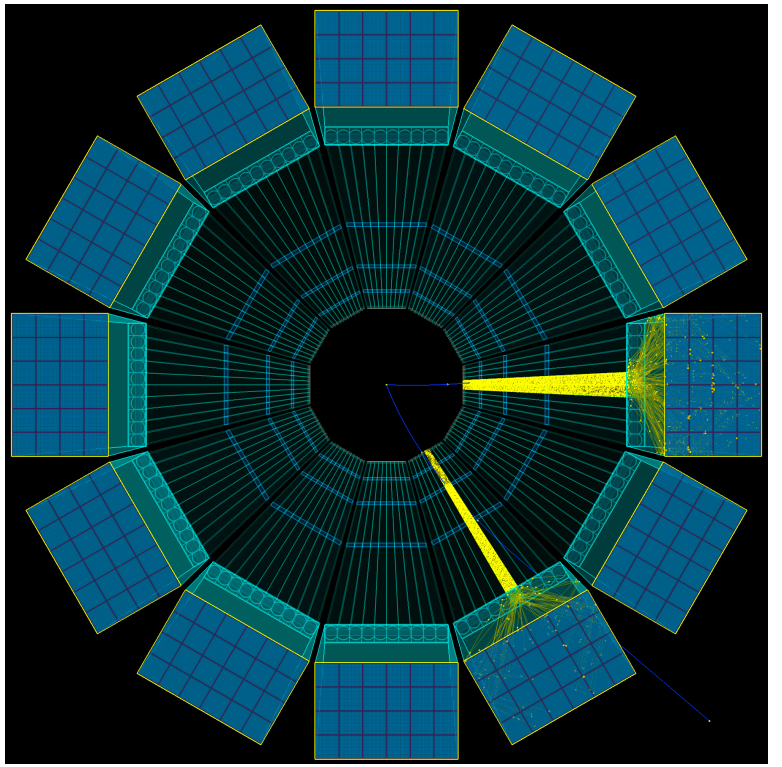
HPDIRC SIMULATION IN EPIC STACK

Bill Llope (WSU)
Shubham Dutta (SBU)
Julio Barrantes (SBU)

- Integration of hpDIRC Reconstruction into Full ePIC Simulation restarted
- Collaborative work between WSU and SBU teams.
- Assessment of the current implementation of hpDIRC geometry and functionality to define a detailed task list for further development.
- Two newly joined members of the hpDIRC group will contribute.

hpDIRC in ePIC and stand-alone simulation



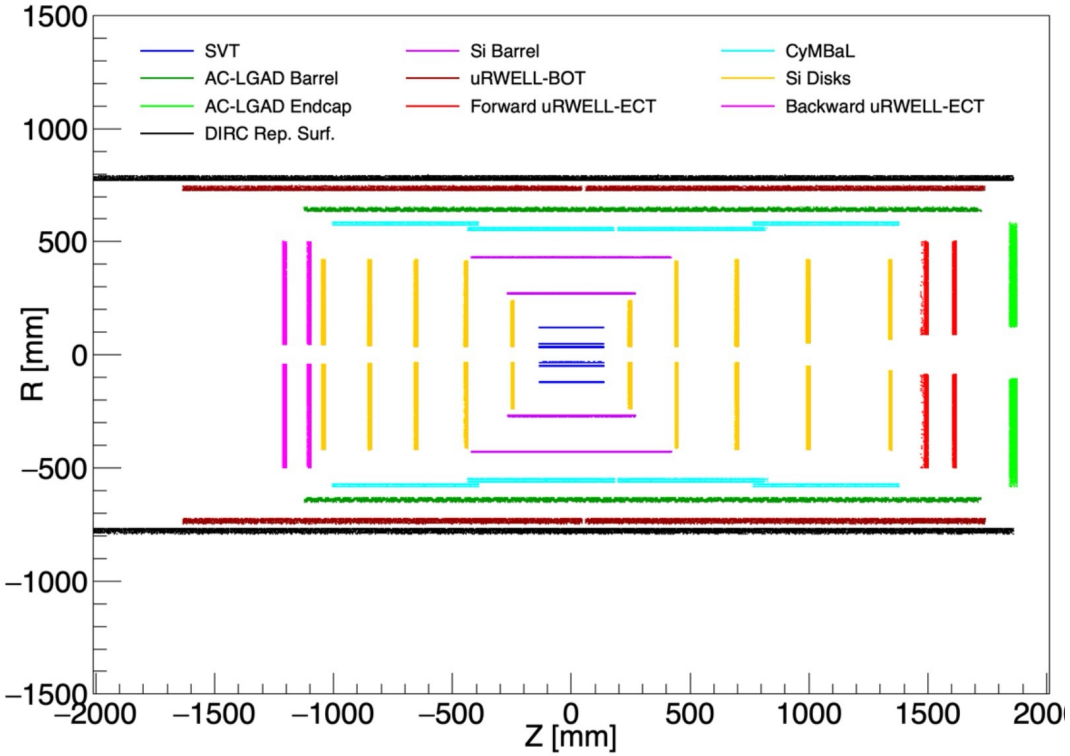


ePIC Tracking Impact on hpDIRC Performance

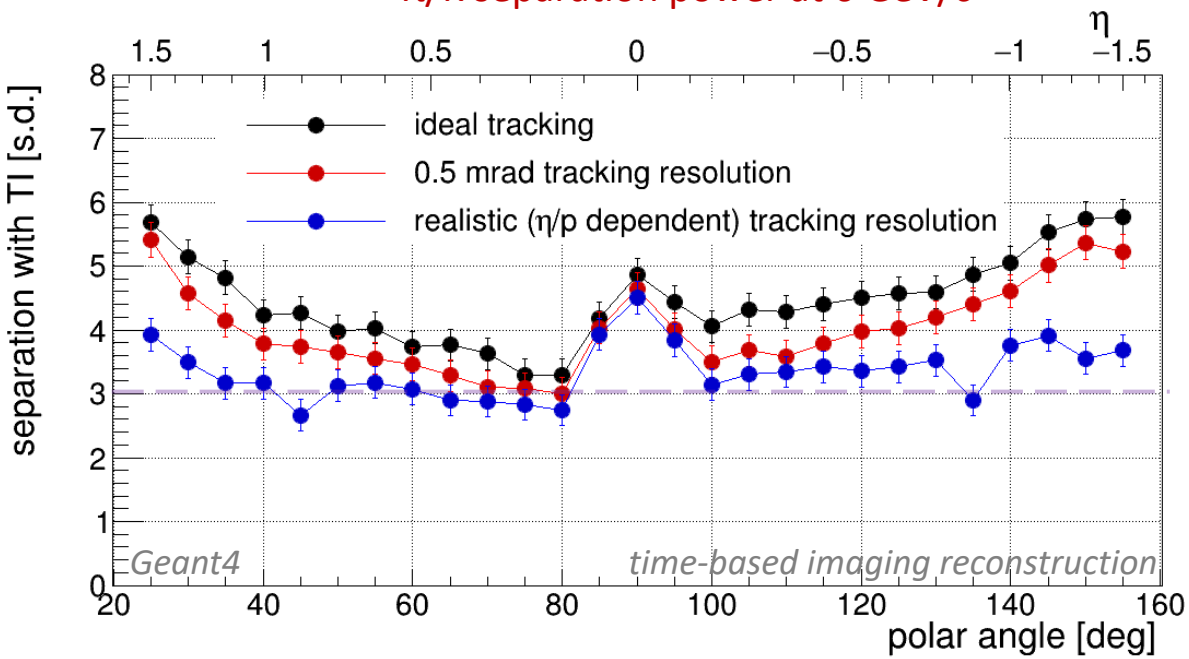
Roman Dzhygadlo (GSI)
Matt Posik (TU)

Performance with latest ePIC angular track resolution maps (June 2025)

- Concerning performance loss
- π/K separation drops close to or below 3 s.d for most polar angles



π/K separation power at 6 GeV/c



Simulation studies performed with

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- 1.7T magnetic field, no other ePIC subsystems
- 100ps time resolution

Sensors and Readout Electronics

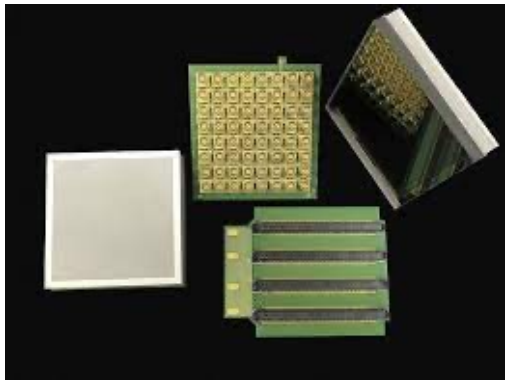
hpDIRC readout: Microchannel-Plate PMTs + ASIC-based electronics

- Baseline sensor for hpDIRC: 2'' Photek MAPMT 253 MCP-PMT
- Potential solution: DC-coupled Incom HRPPD
  Making use of synergy with pfRICH, optimizing cost and workforce
- Setups are ready for side-by-side comparison and evaluation of key performance parameters with clear plan to have initial results and decision on sensor before TDR
- Discussion with Glassgow group and Albert Lehman (Erlangen)

Baseline front-end board: FCFD

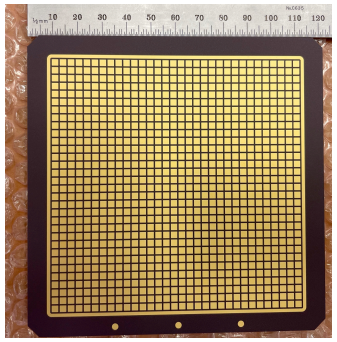
- Synergetic development with ePIC AC-LGAD and pfRICH systems
- Discussion with Fernando with short term goal established to synchronize required tests with FCFD development schedule

Photek MAPMT 253

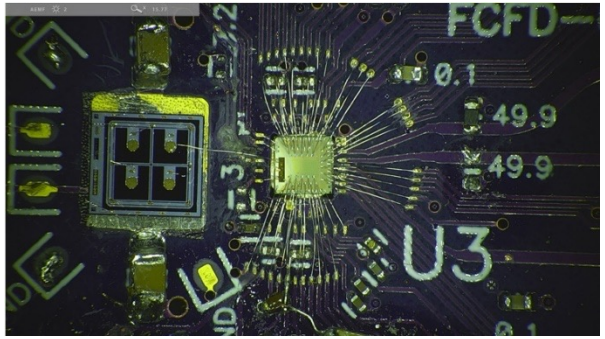


Rachel Montgomery (Glassgow)

INCOM Gen III HRPPD prototype (front/back view)



FCFDv0

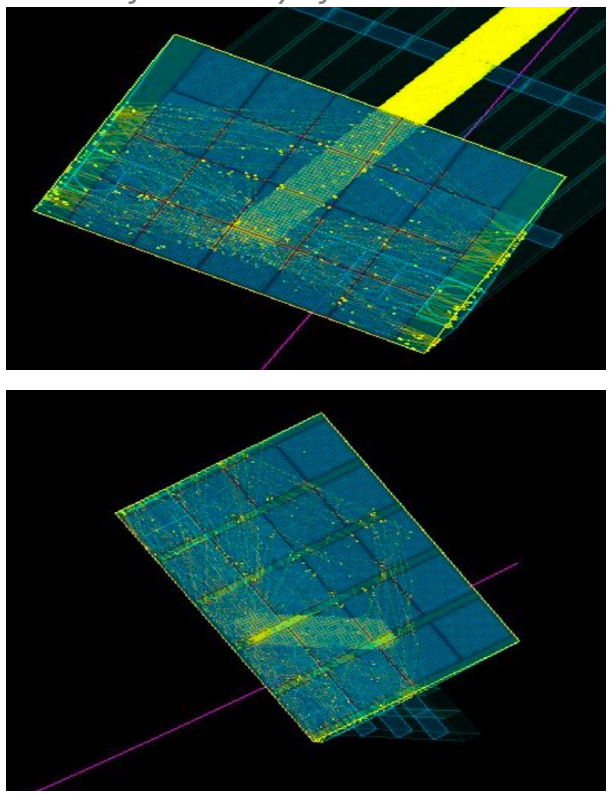


Sensor Coverage

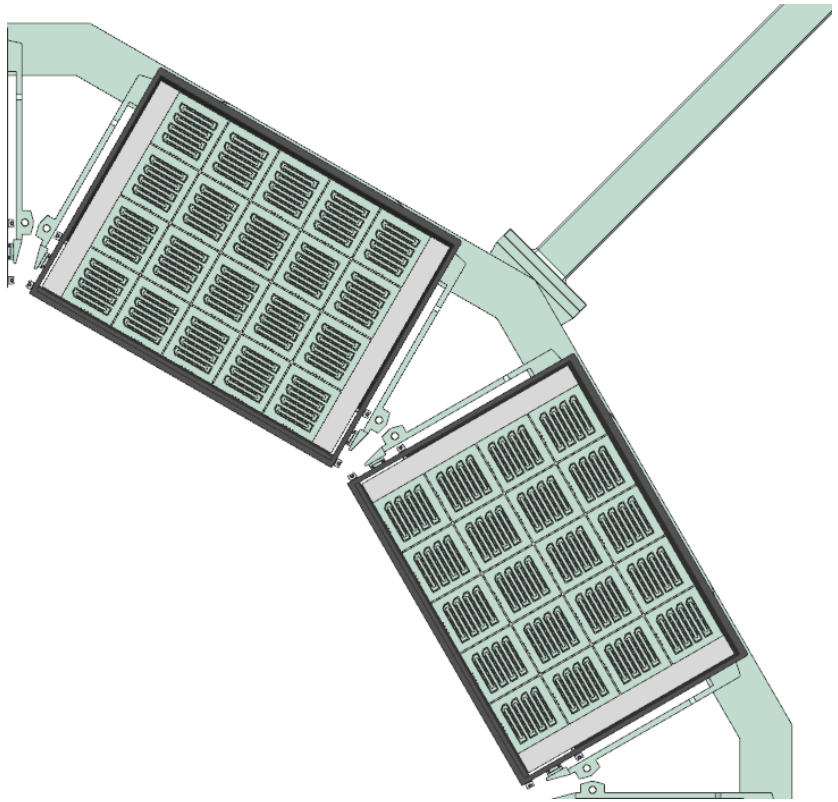
Roman Dzhygadlo (GSI)
Imran Hossain (CUA)
Kris Cleveland (JLab)

- Verifying optimal sensor coverage
- Baseline design of 6x4 for MCP-PMTs and 3x2 for HRPPDs is not possible due to mechanical constrains -> at least one sensor has to be removed

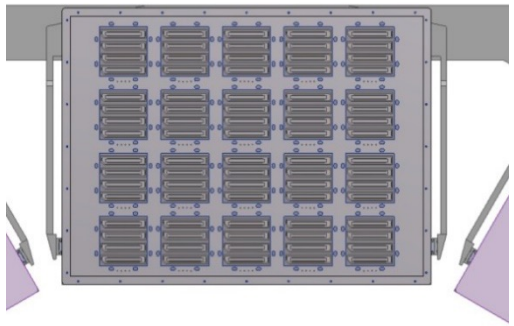
Two arrangements of 5x4 array of sensors



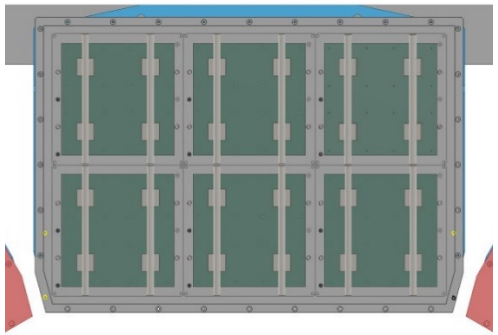
Backplane of hpDIRC readout box



MCP-PMT



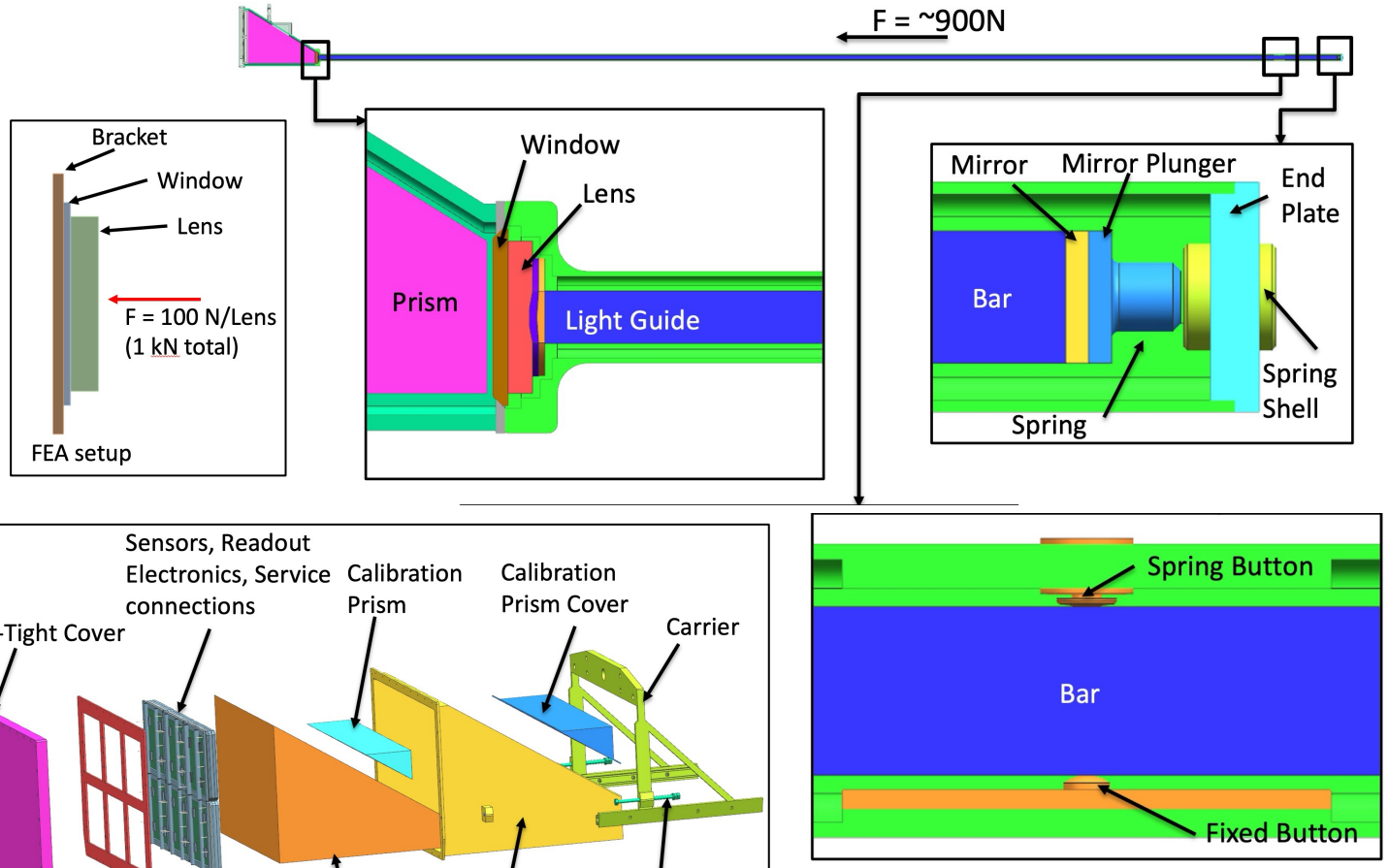
HRPPD



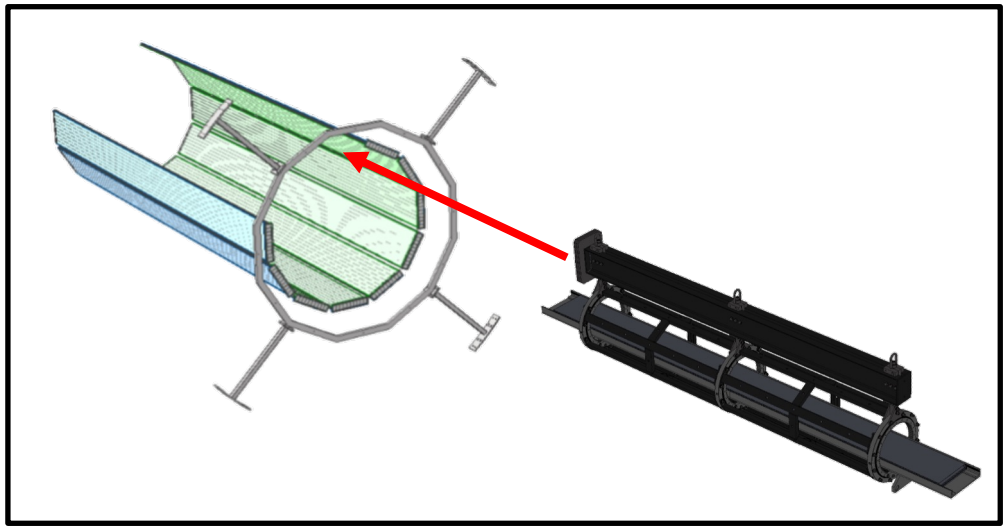
Mechanical Support and Integration

Kris Cleveland (JLab)

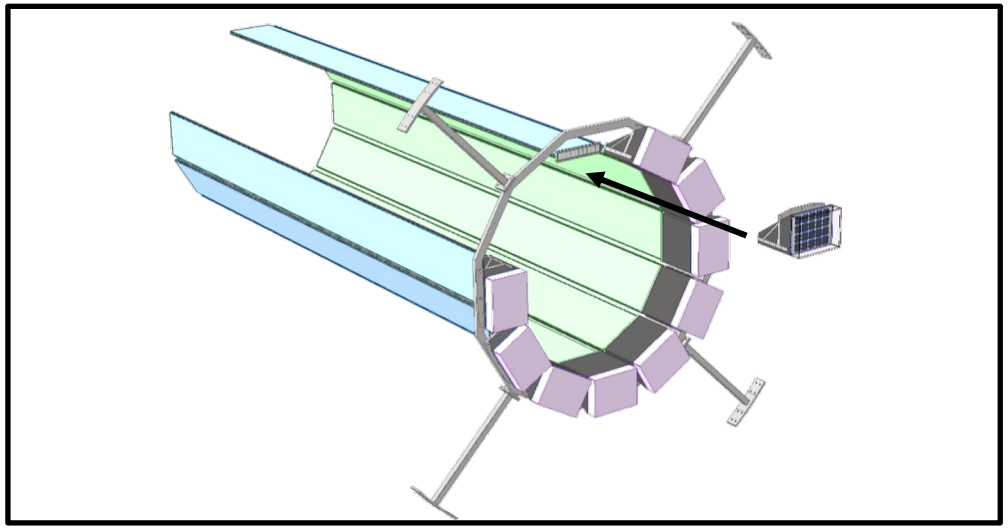
Mechanical design of bar box and readout box



Bar boxes installation



Readout boxes installation

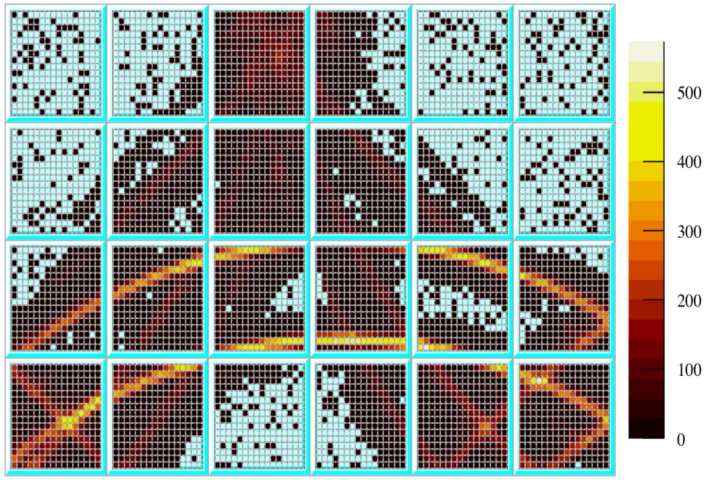


POTENTIAL HPDIRC MISALIGNMENTS

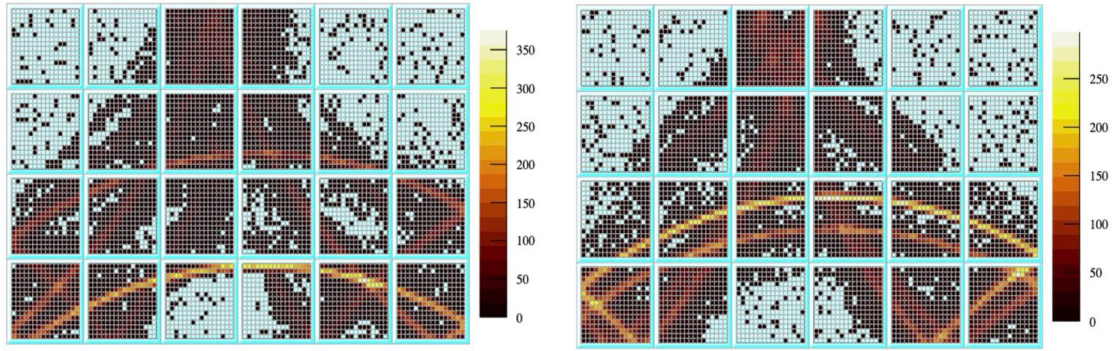
Afaf Wasili (Jazan)

- Impact of bar/lens misalignments on performance
- Establishing limits and mitigation methods in progress

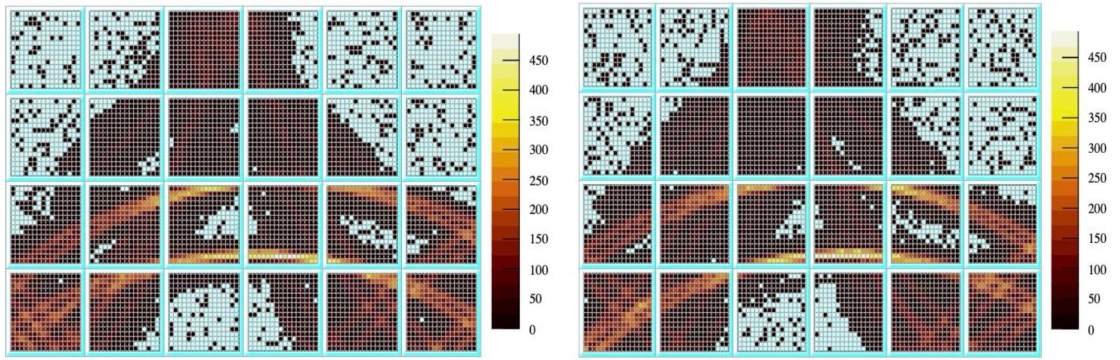
Nominal Detector



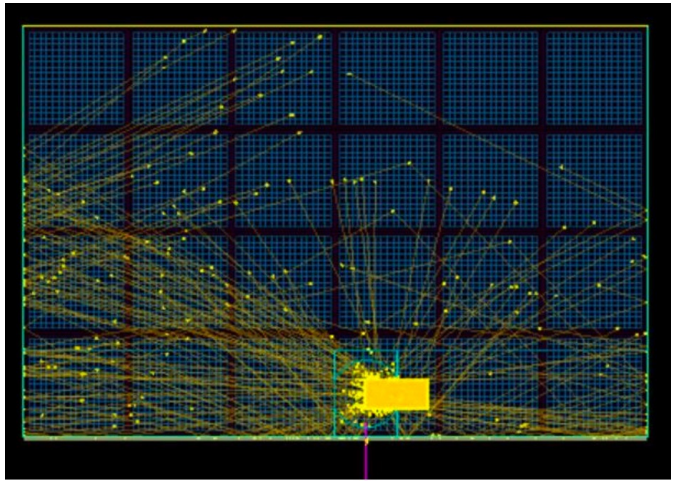
***Offset lens** around the **X-axis** +/- 14.4 mm*



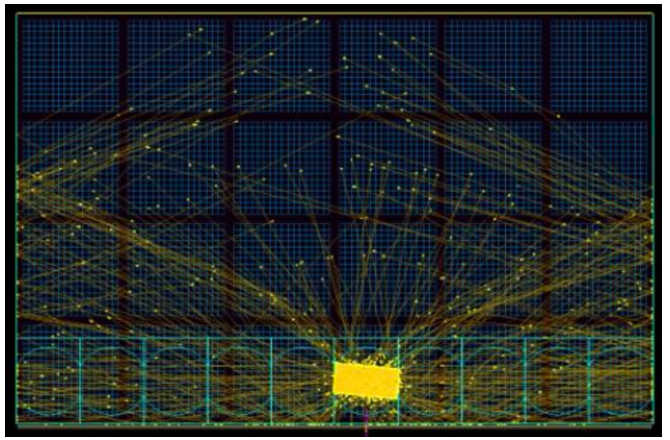
***Rotational bar** around the **z-axis** +/-0.04 [rad]*



Horizontal bar misalignment



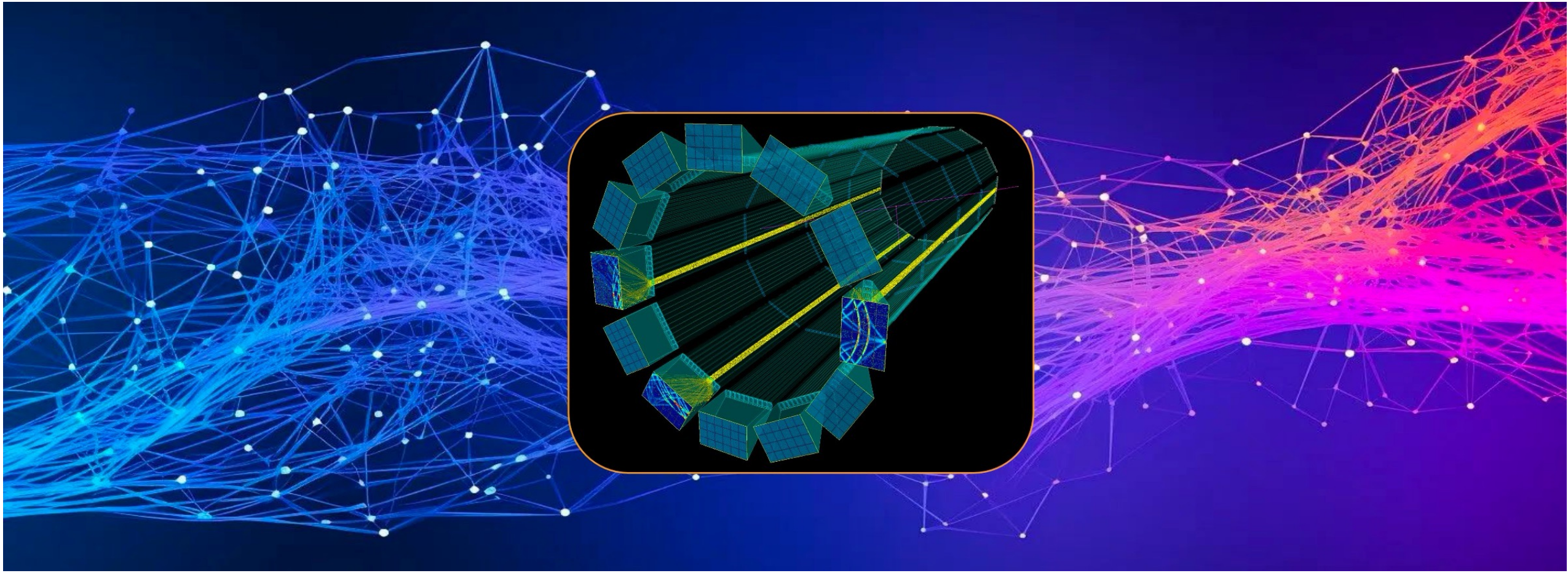
Bar rotation



ML-BASED HPDIRC SIMULATION

James Giroux (W&M)
Cristiano Fanelli (W&M)

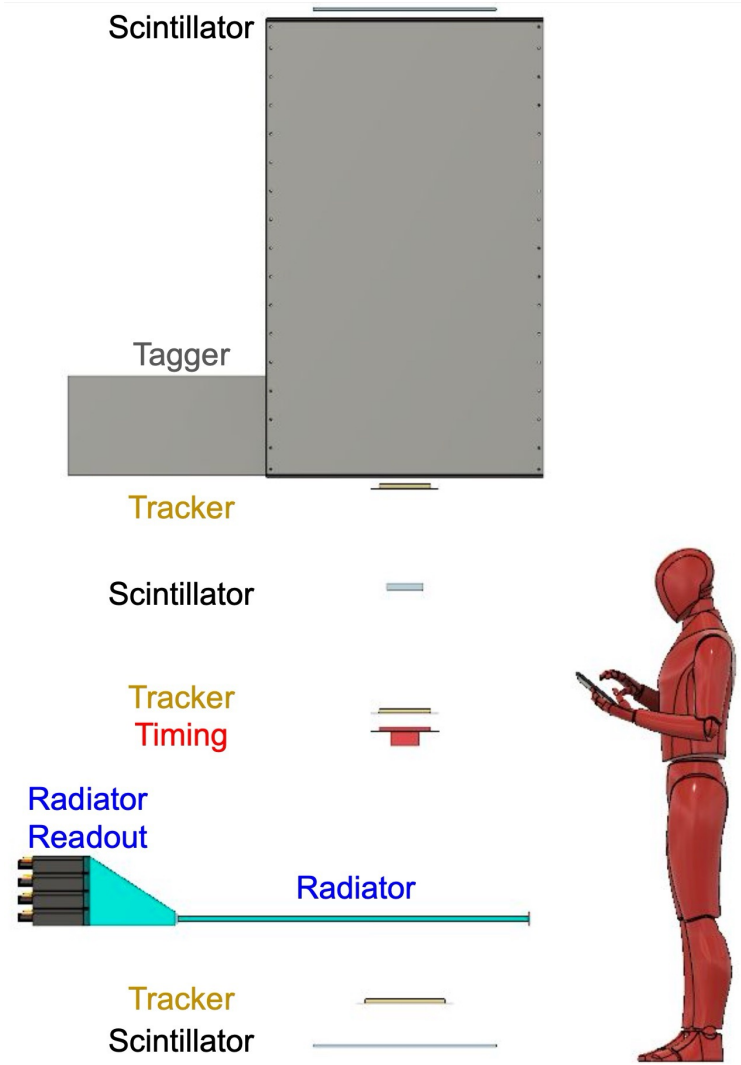
- Machine Learning approach:
  - Serving as independent reconstruction method
  - Fast generation of PDFs to assist time-based reconstruction

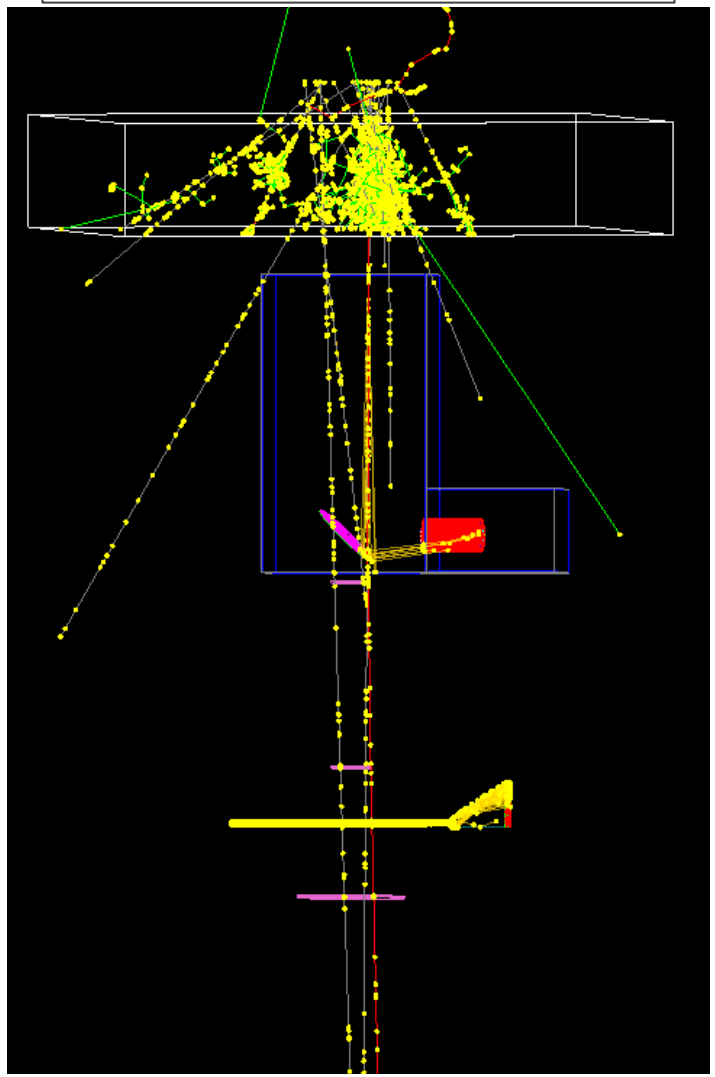


HPDIRC AT CRT

Nathan Shankman (SBU)
Jaydeep Datta (SBU)
Carlos Ayerbe Gayoso (ODU)

- Software preparation for hpDIRC full chain test setup operation at Cosmic Ray Telescope (SBU, GSI, ODU)
- Validation of tracking resolution at CRT
- Establishing muon rates
- Integration of DAQs





HPDIRC AT CRT

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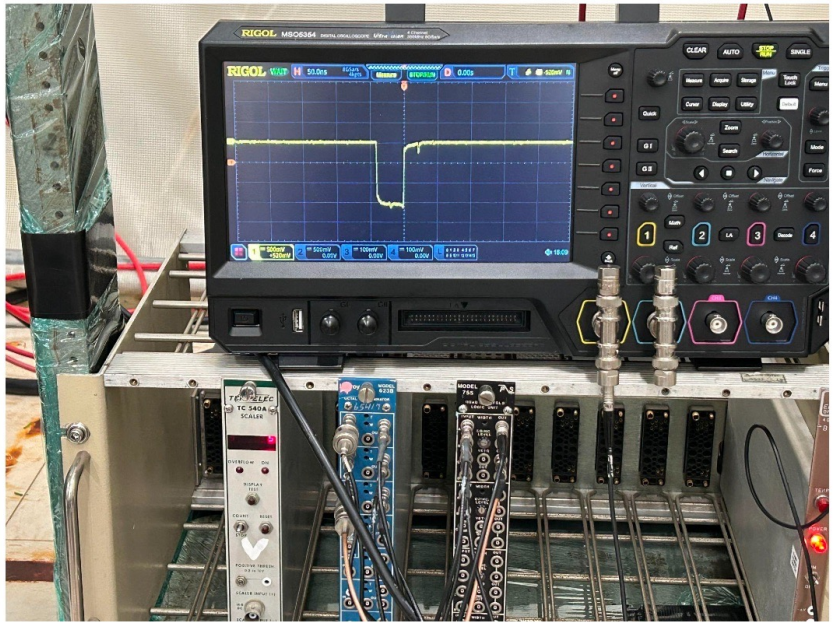
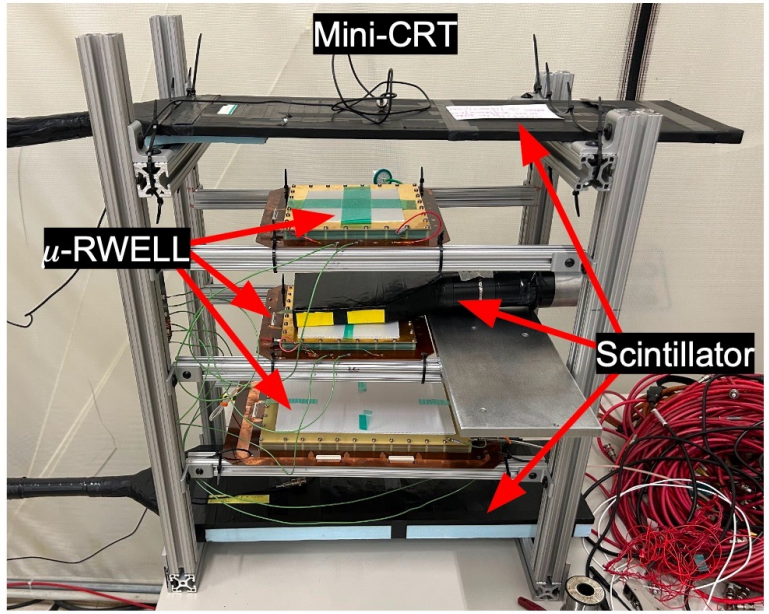
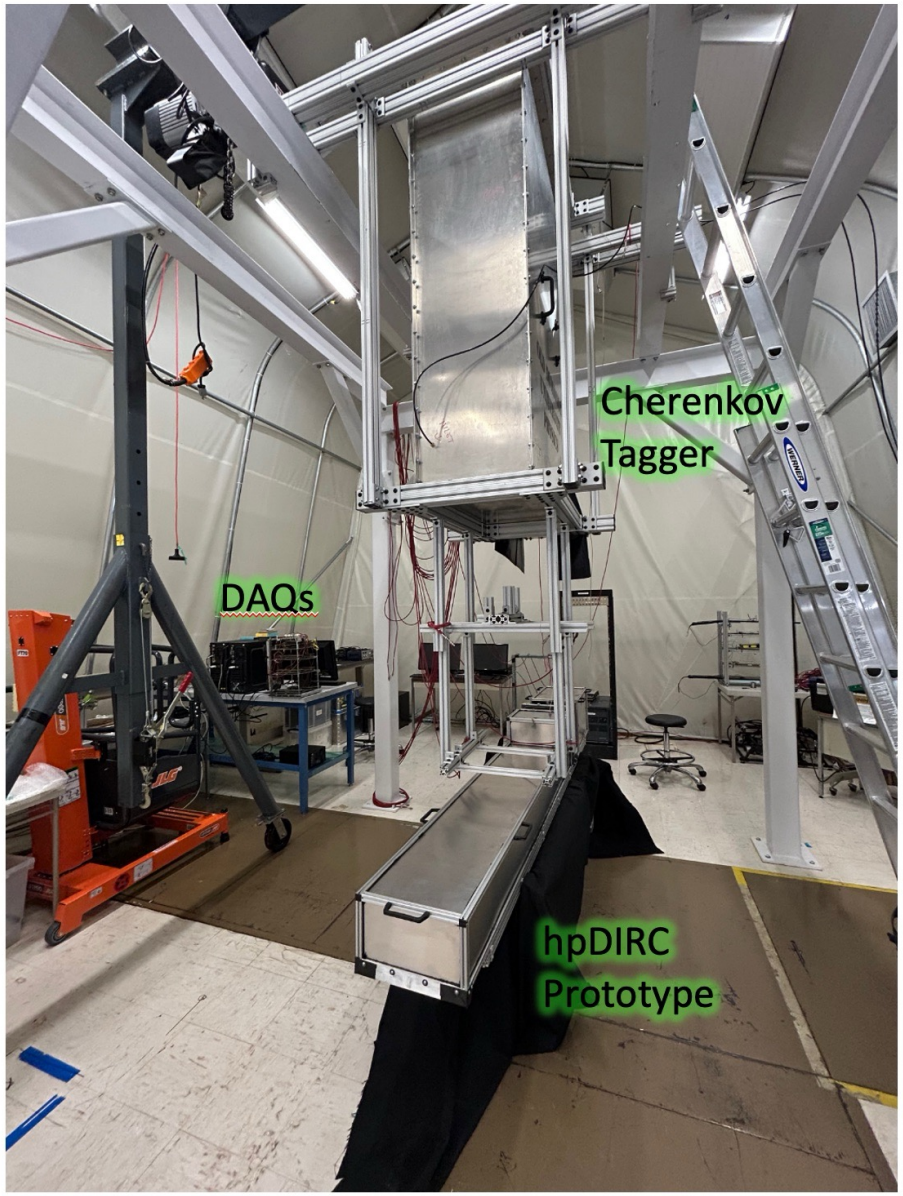
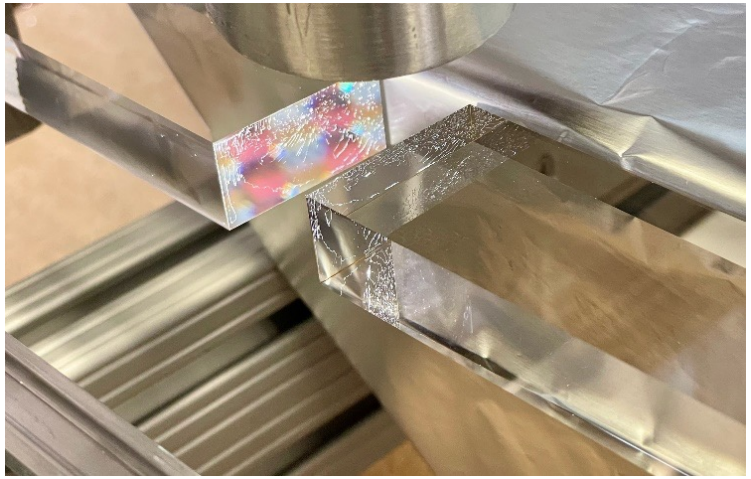






Reuse of BaBar DIRC Bars

- BABAR bar boxes are too long for the ePIC barrel, existing wedges at readout end are incompatible with lens focusing: need to disassemble bar boxes and separate single bars
- Facility, setups, and tools developed, disassembly of first bar box almost done
- hpDIRC barrel requires total of 360 short bars (1.225 m length)
- Eight bar boxes currently located at JLab could yield up to 384 short bars, sufficient to cover rapidity range $-1.65 \leq \eta \leq +1.65$
  (Additional 120 new bars required for the light guide section)
- Study of the impact of bar imperfections on the hpDIRC performance relevant for qualifying BaBar bar refurbishment (GSI)



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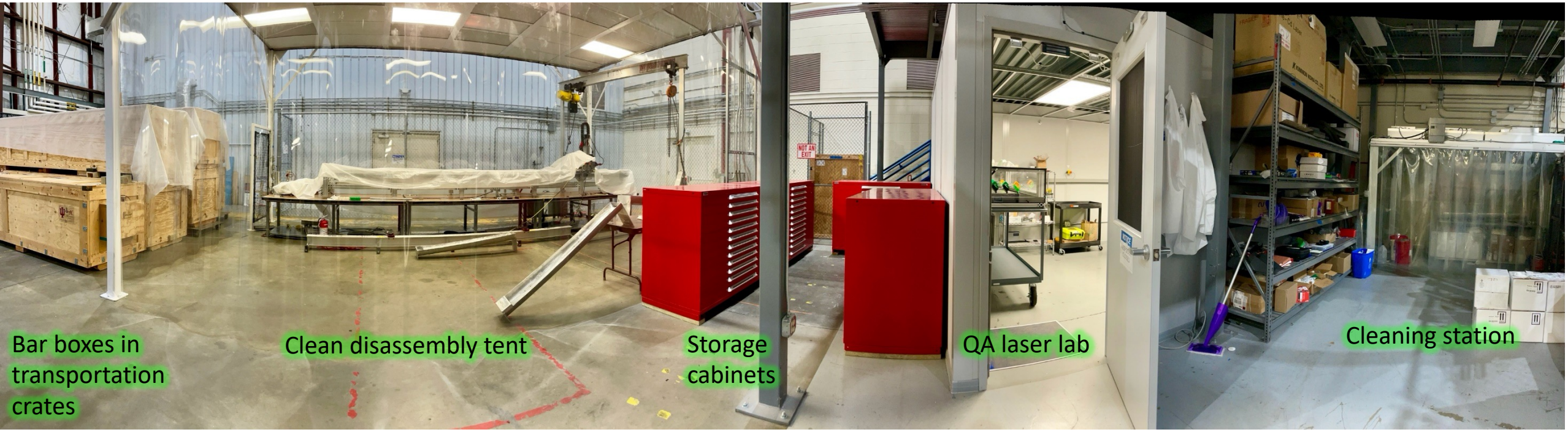

Disassembly process in JLab:

- Bar boxes are disassembled and bars are separated in clean tent
- Cleaning station to remove residue glue, visually inspect bars
- QA laser lab to inspect quality of the bars after disassembly
- Measured bars are wrapped, tagged and stored in cabinets

Team working on disassembly:

- 3 JLab Technicians: Andrew Lumanog, Caleb Graham, David Edwards
- 2 Scientists: Greg Kalicy (CUA), Sourav Tarafdar (JLab)
- JLab DSG Group: Tyler Lemon, George Jacobs, Mindy Leffel
- Graduate Students: Shelby Arrigo (W&M)

REUSE OF BABAR DIRC BARS

Roman Dzhygadlo (GSI)

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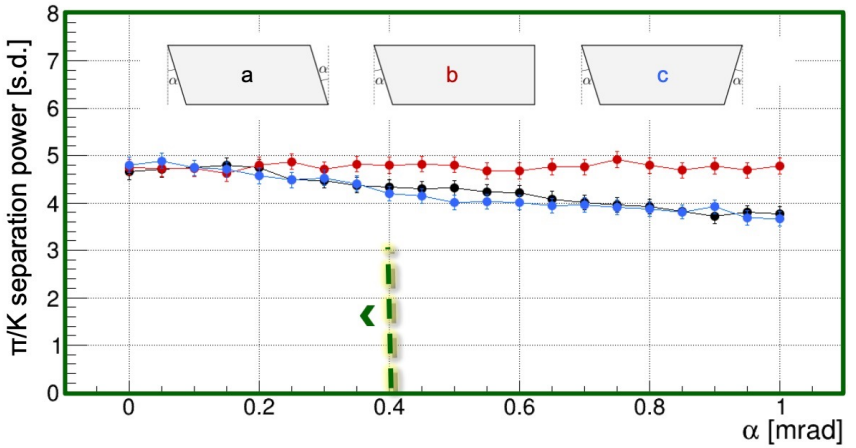
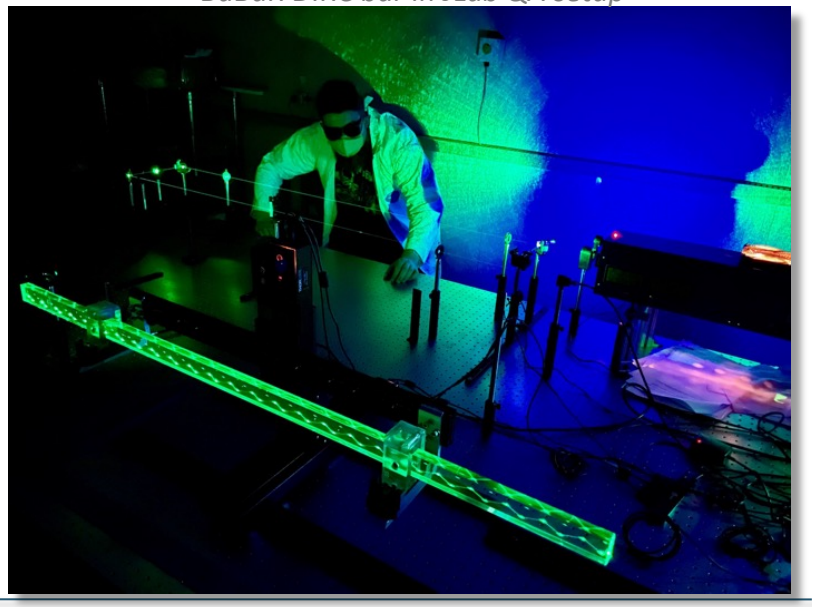
Example: π/K separation power
for 30° polar angle at 6 GeV/c momentum



BaBaR DIRC bar in JLab QA setup



SUMMARY

- 10th DIRC@EIC Annual Meeting – JLab, Summer 2025
- Held at Jefferson Lab during a busy summer schedule; marked the 10th DIRC@EIC group meeting.
  - Successfully completed the 60% Design Review in April.
  - Final Design Review of the BaBar DIRC bar refurbishment process also passed in April.
  - DAC review conducted in June.
- Using the pre-TDR and TDR as guiding references, reviewed the current status and established forward plans for all software and hardware efforts.
- The meeting hosted 29 participants, including 19 attending in person.
- The DIRC@EIC team continues to grow, strengthening capacity to complete outstanding tasks and maintain the project schedule.