# The hpDIRC Detector for the ePIC Experiment

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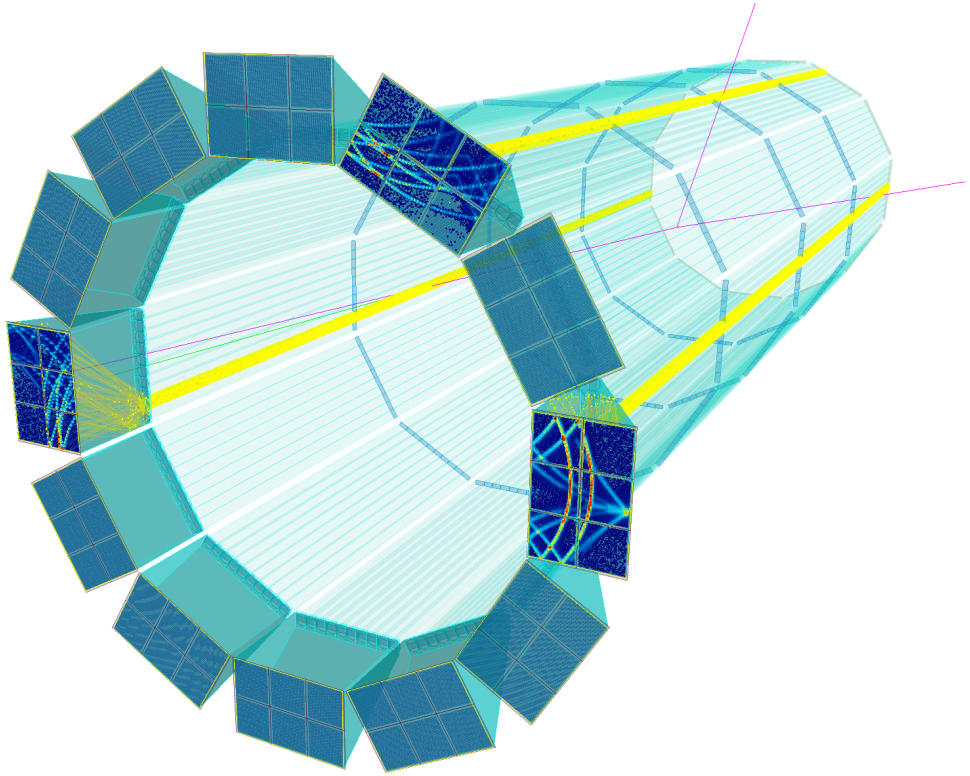
CUA



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

# HPDIRC

## Simulations:

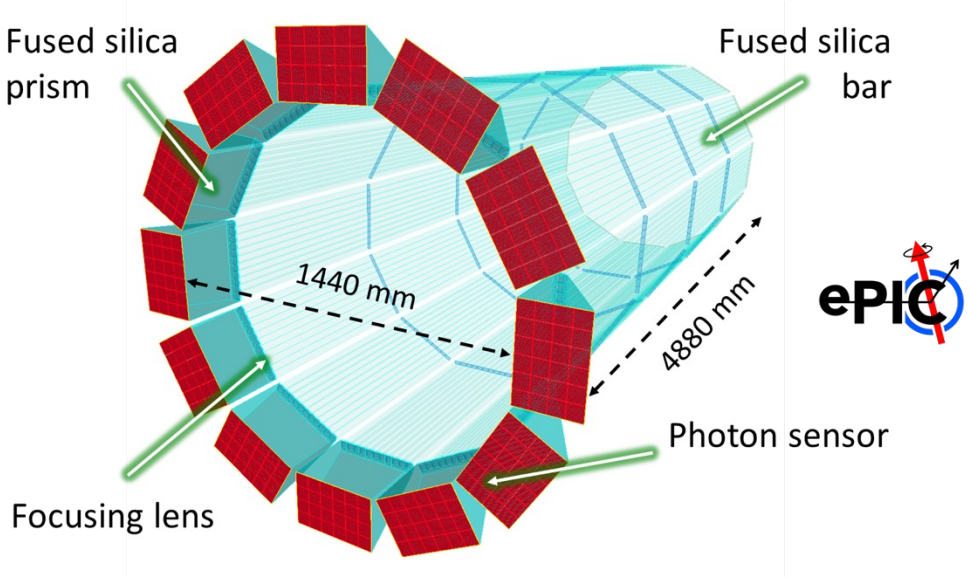
- Detailed stand-alone simulation validated with test beam
- Performance evaluated with magnetic field, Pythia events, multiple trucks in event
- Implementation into full ePIC stack advanced
- Fast sim/parametrisation in progress

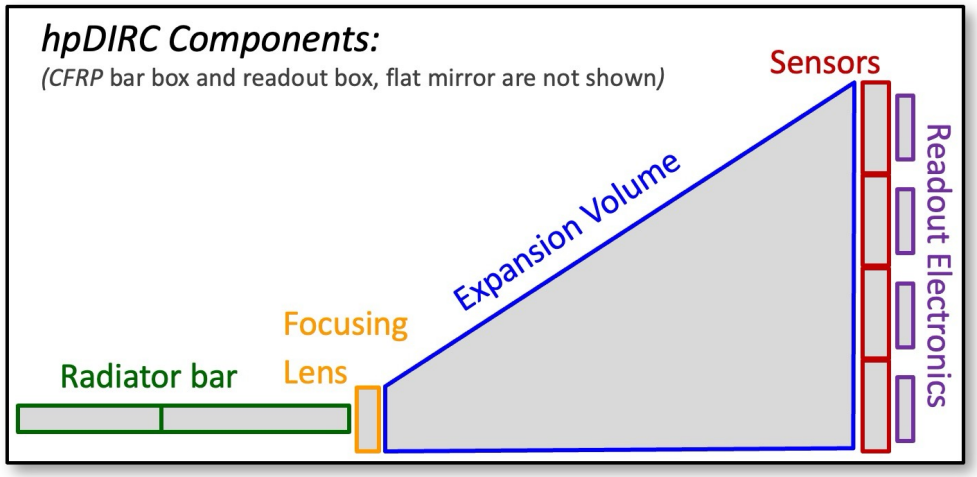
## Hardware:

- No additional prototype tests needed for performance validation
- CRT will be used for QA and integration of components, eventually full modules

## Remaining Challenges:

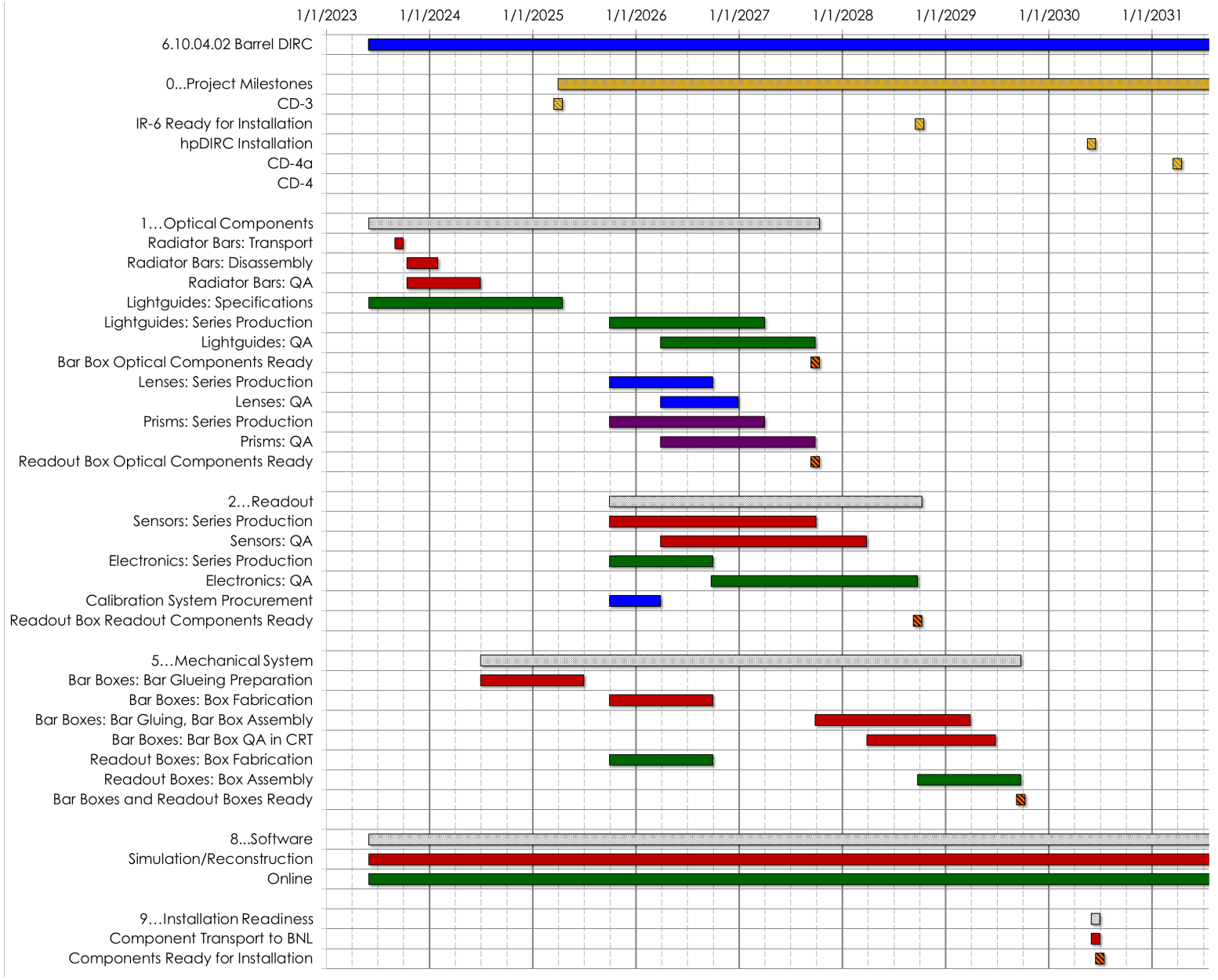
- Decision about the radiator bars
- Lightguides (narrow bars/wide plates)
- Selection of the sensors and readout
- Reliable and realistic tracking angular precision



# SCHEDULE

- hpDIRC technical schedule consistent with project schedule
- On track for TDR readiness
- hpDIRC scheduled for installation into ePIC in June 2030
- More detailed schedule with monthly breakdown is in progress
- In person Workshop/Annual Meeting in May with two days dedicated to TDR



# BaBar Bars

- Validation of reusing BaBar DIRC radiator bars is main remaining step towards TDR readiness
  - Transportation of bar boxes in April 2024
  - Disassembly starting in May 2024
  - Validation of optical quality in summer 2024
  - Decision on reuse of the BaBar bars by fall 2024
- Last modifications to transportation crates are being done in JLab where DIRC labs are being set up for later disassembly and QA
- Invaluable support from Jlab management, DSG group, and EIC technicians!

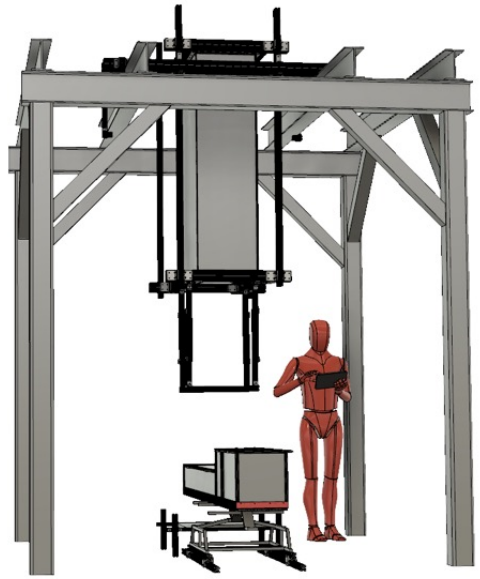
*Test of finished new transportation crate with mock-up box*

# THE LAB/TESTBEAM/PROTOTYPING

- Validation of Simulation and several components was done in CERN
- Test Lab tests of sensors and electronics are in preparation (Glasgow, BNL, Jlab)
- Cosmic Ray Telescope (CRT) under construction at SBU to test incremental upgrades of new components
  - Phase1: PANDA Barrel DIRC prototype components used for commissioning (Q3 2024)
  - Phase2: Single and double bar configuration using bars from BaBar DIRC disassembly (Q4 2024)
  - Phase3: Small pixel sensors and EIC readout electronics gradually added (when available)
  - Phase4: Validation of full hpDIRC module (pre-installation)

*DIRC lab/CRT space at SBU*

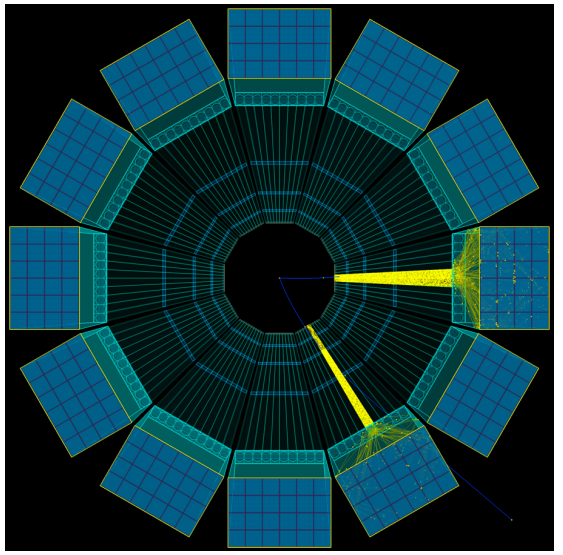
*CRT setup schematic*



# HPDIRC SIMULATION

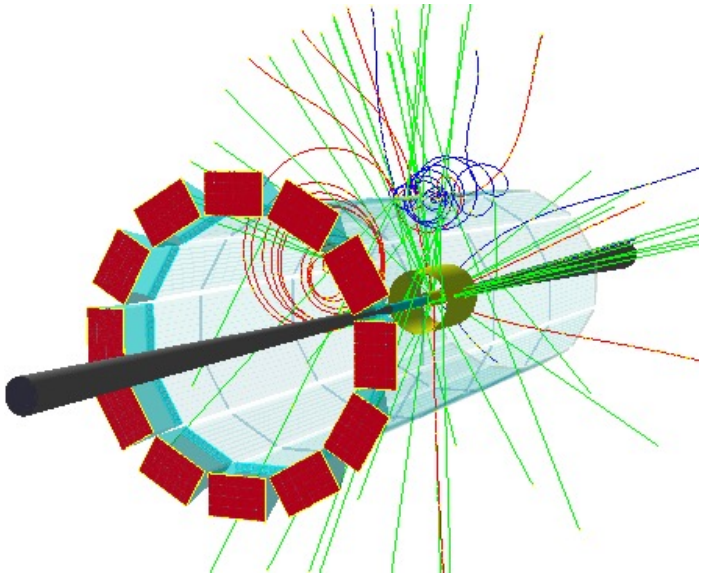
## Stand-alone Geant4 Simulation

- Used for design optimization studies and to test novel design options
- Realistic optics, geometry, and material properties – based on prototypes and experimental data, wavelength-dependent material properties and processes
- Validated with test beam data



## Full ePIC Simulation:

- Enabling full reconstruction chain with all other subsystems is in progress. (modification to digitization and efficiencies, allowing generation of LUTs and PDFs mode)
- Fast SIM/Parametrisation is being adjusted to agreed format, can be gradually improved.
- Alternative reconstruction algorithms are under consideration
- Updated properties of sensors, optical quality of bars can be easily added when become available (eRD110, eRD109, bars studies in summer 2024)



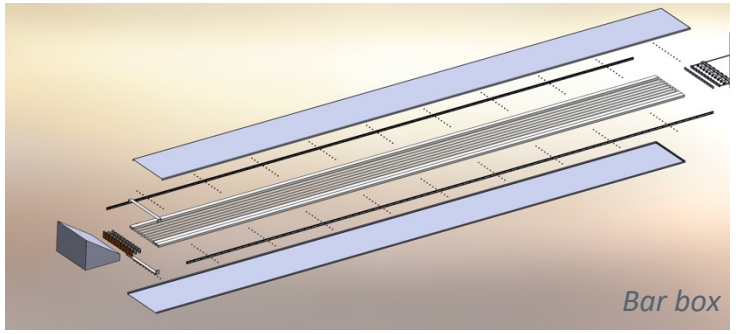
*Event in full ePIC simulation*

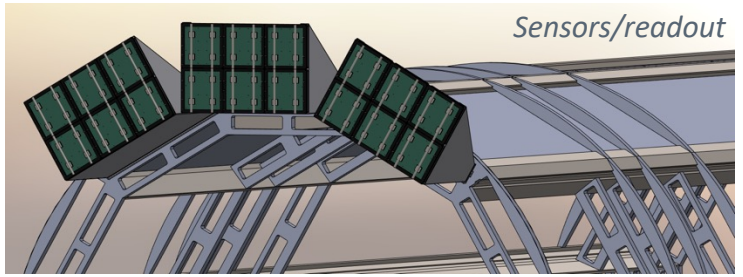
# The required engineering design

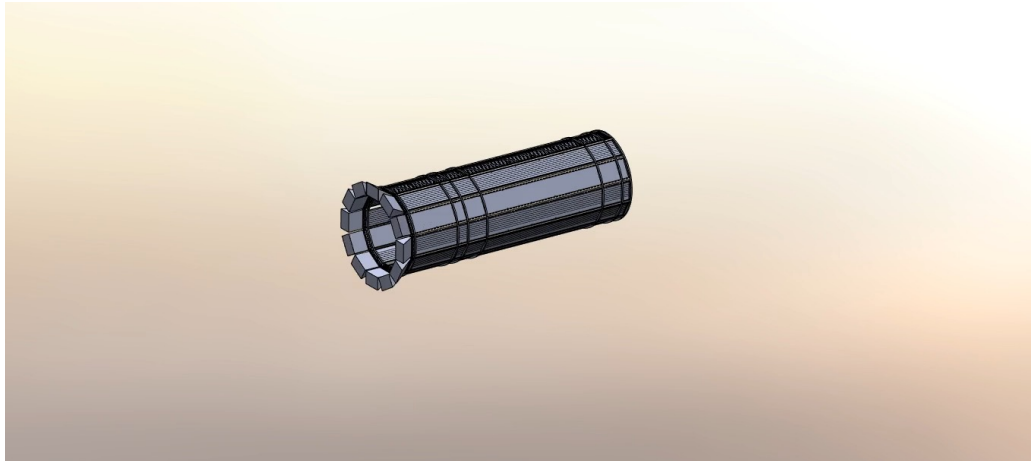
## Synergy with PANDA Barrel DIRC has helped to tackle many questions

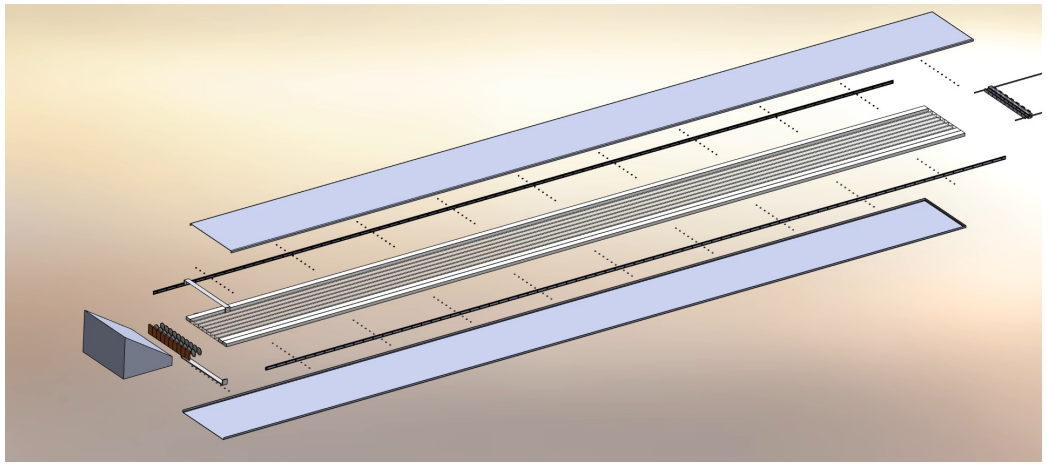
- Working with Avishay Mizrahi (Tel Aviv University) and Kris Cleveland (Jlab) since January
- Mechanical design is progressing, adding details on barboxes, support structure, integration, etc.

*ePIC hpDIRC preliminary mechanical design*



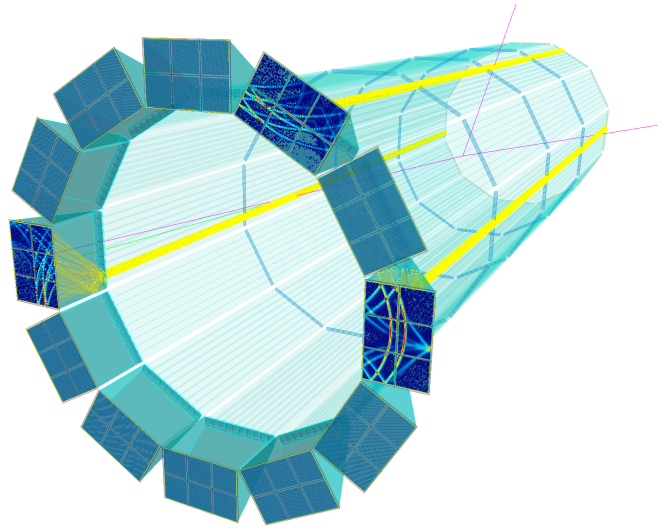





*Two short MEC movies (only in Powerpoint version)*

# Plan Towards TDR, production and installation

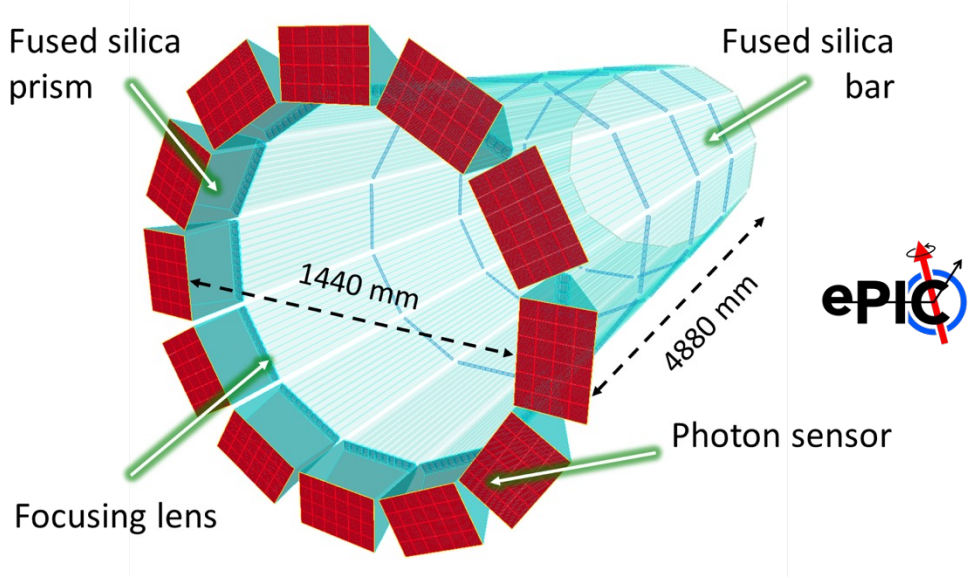
- Precise definition of 60% and 90% is needed
- hpDIRC design is advanced, several options can potentially lower cost, improve performance (lightguides, sensor coverage)
- Simulation validated with testbeam used for parametrisation and adopted to ePIC stack
- Decision on reuse of BaBar bars is expected in fall 2024
- Sensor and readout electronics decisions, realistic tracking are needed
- Study of baseline sensor will start soon in Glasgow, HRPPD and readout electronics development are in progress
- CRT will be used for QA and validation f new components
- May 2024: hpDIRC workshop/annual meeting (this time with additional two days focused on TDR preparations)



# hpDIRC Preliminary Baseline Design

## Radiator bars:

- Barrel radius: 720 mm, 12 sectors
- 10 long bars per sector, 4880 mm x 35 mm x 17 mm (L x W x T)
- Long bar: 4 bars, glued end-to-end,
- Short bars made from highly polished synthetic fused silica
- Flat mirror on far end




## Focusing optics:

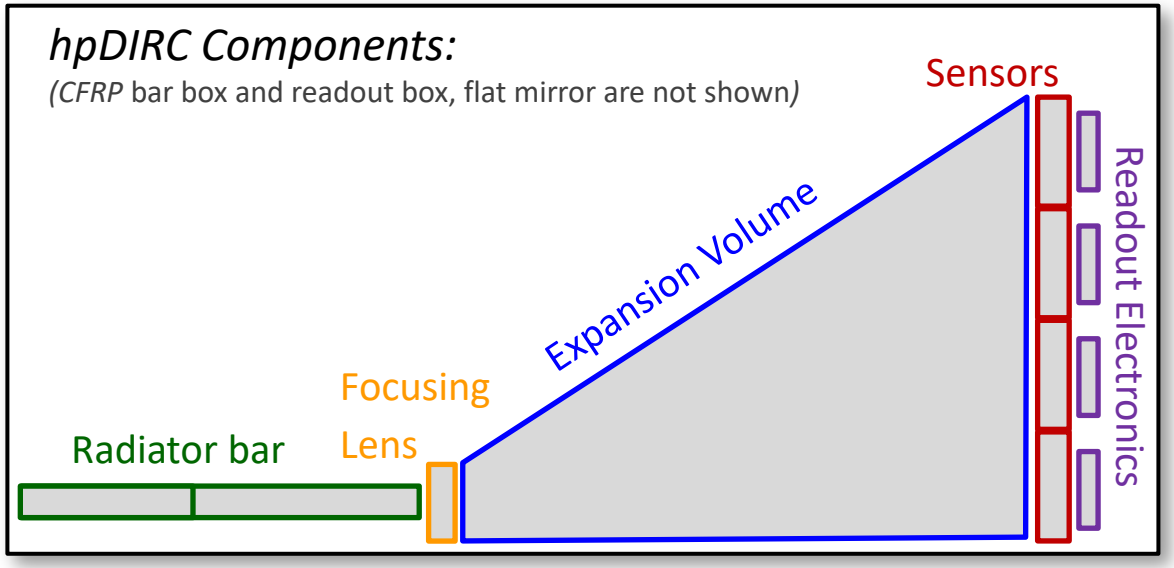
- Radiation-hard 3-layer spherical lens (sapphire or $PbF_2$)

## Expansion volume:

- Solid fused silica prism: 24 x 36 x 30 $cm^3$ (H x W x L)

## Readout system:

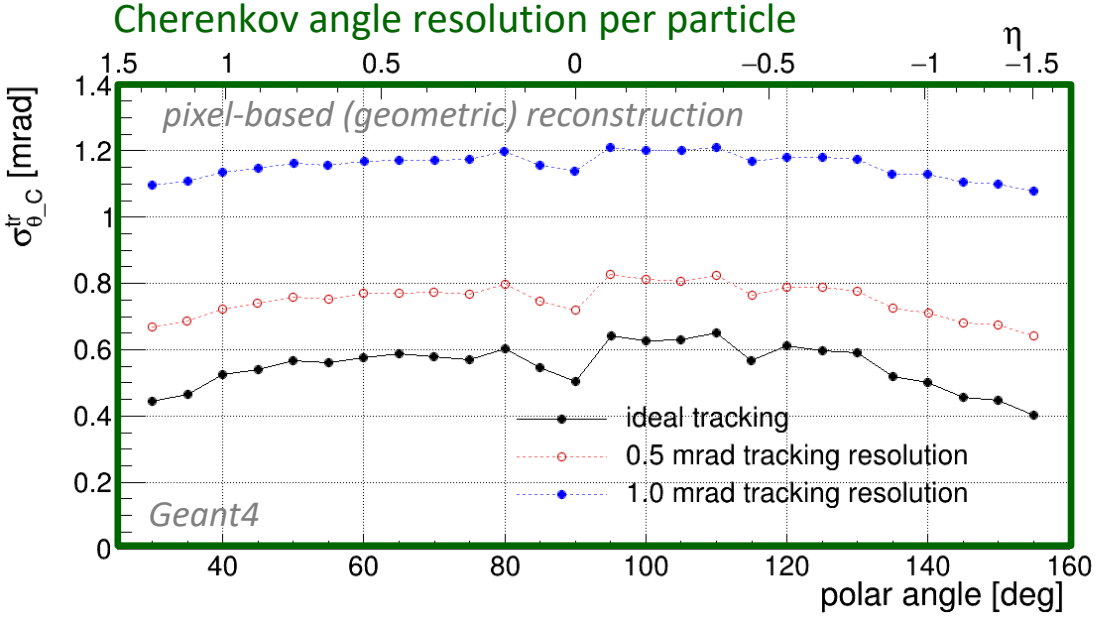
- MCP-PMT Sensors (e.g. Photek/Photonis/Incom)
- ASIC-based Electronics (e.g EICROC)



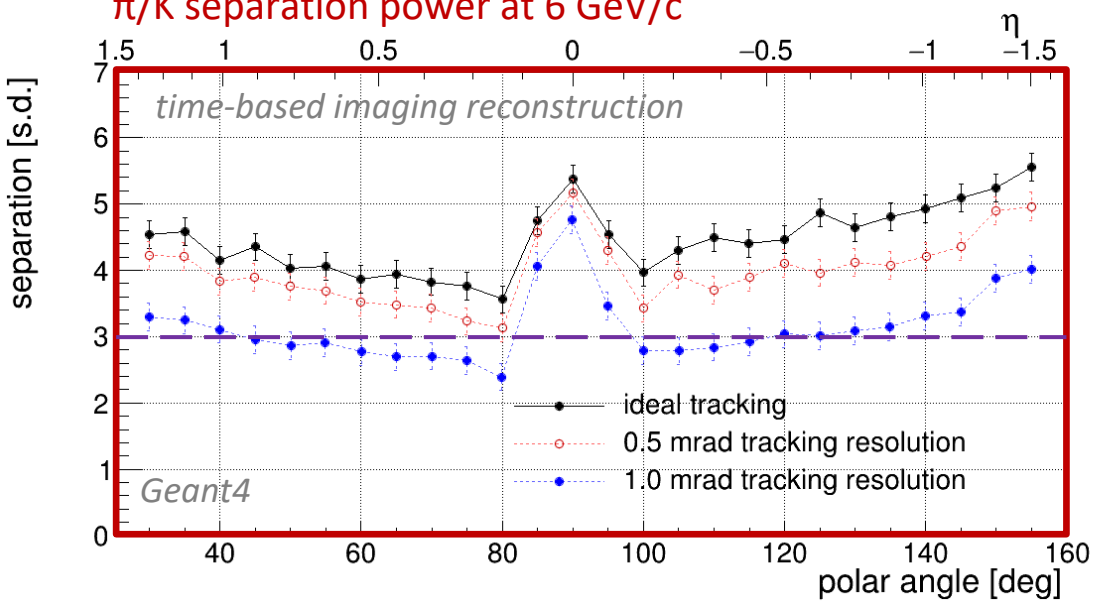
# EXPECTED HPDIRC PERFORMANCE VS. TRACKING

## Impact of tracking angular resolution on hpDIRC performance

Cherenkov angle resolution per particle




π/K separation power at 6 GeV/c




*Note:*

- *π/K Cherenkov angle difference at 6 GeV/c: $\Delta\Theta_c \approx 3$ mrad*
- *Yellow Report tracking requirement: 0.5 mrad resolution at 6 GeV/c*

Simulation studies performed with

- Stand-alone Geant4 simulation
- Single particles from particle gun
- 6 GeV/c momentum
- No magnetic field, no other ePIC subsystems

→ High-precision angular resolution crucial for reaching required hpDIRC performance