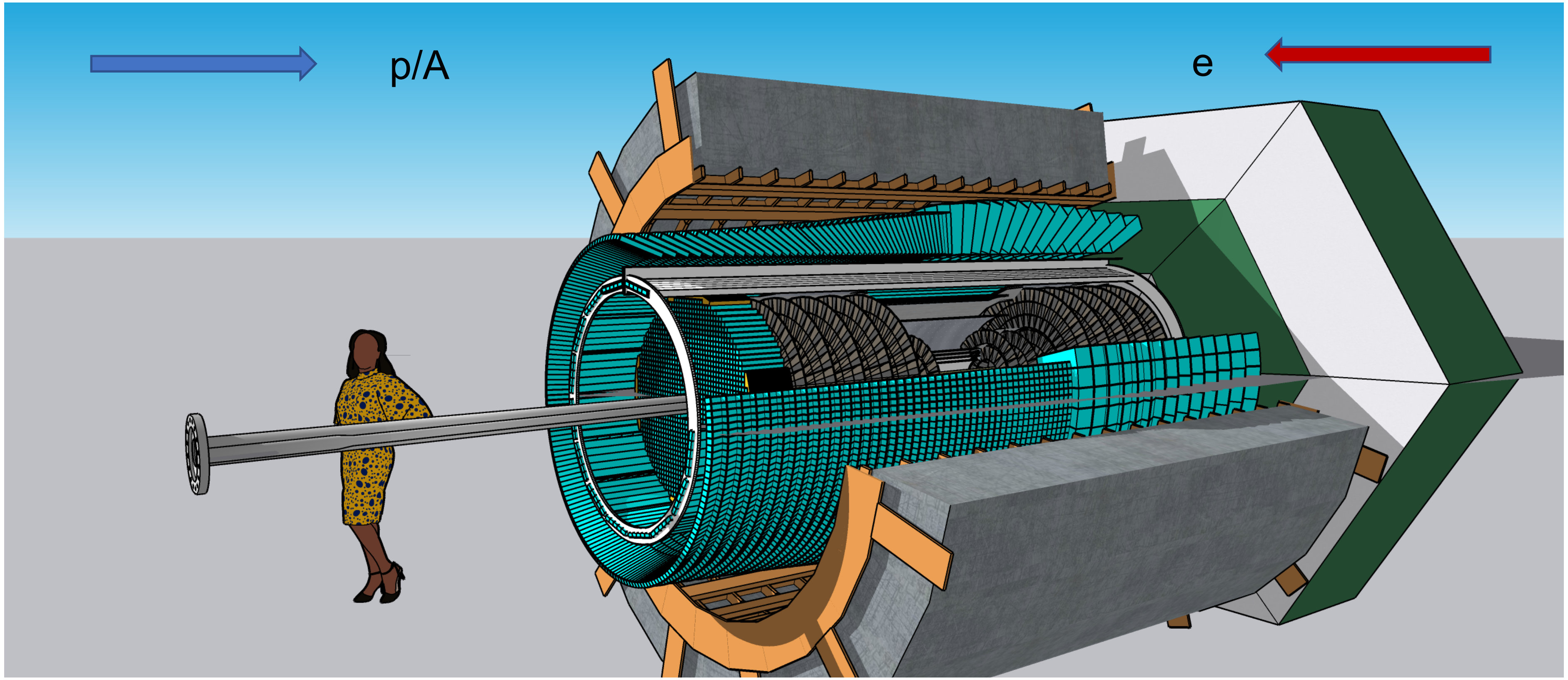
CORE: a COmpact detectoR for the EIC
- August update



Pawel Nadel-Turonski
Stony Brook University

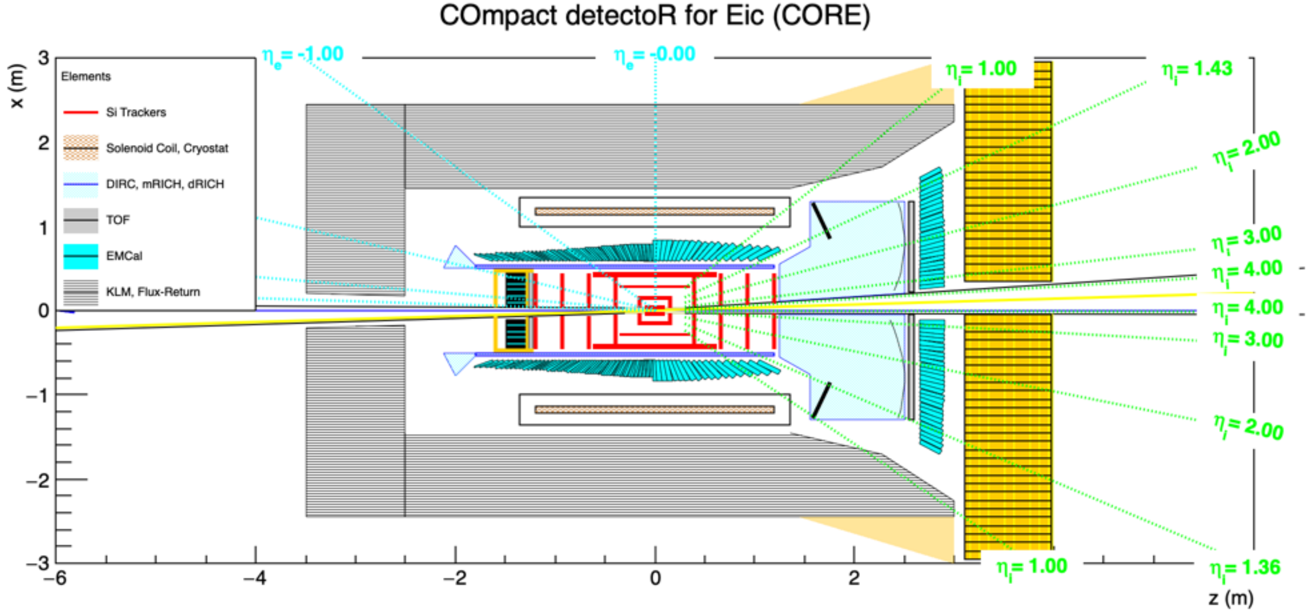
CORE meeting, August 26, 2021

CORE – a high-luminosity EIC detector

- CORE is optimized for the highest possible luminosity at all cm energies
  - Luminosity depends on two key factors: detector *length* and the *asymmetry* of the beam energies

- Beam energy dependence
  - For protons in the 100-275 GeV range (and corresponding ion energies), the luminosity scales with the hadron energy.
  - For electrons, luminosity is constant up to 10 GeV, and drops rapidly at high energy

- Length (l*) dependence
  - The luminosity is to first order proportional to the detector length (β^{max} on the hadron side)
  - Moving beam magnets closer to the IP improves luminosity for *all* energies



A short solenoid is essential for reaching the highest luminosity on day 1, and offers a potential for future upgrades (magnets can be moved in further if optical meta materials can replace dRICH gas)

Talk by P. Brindza

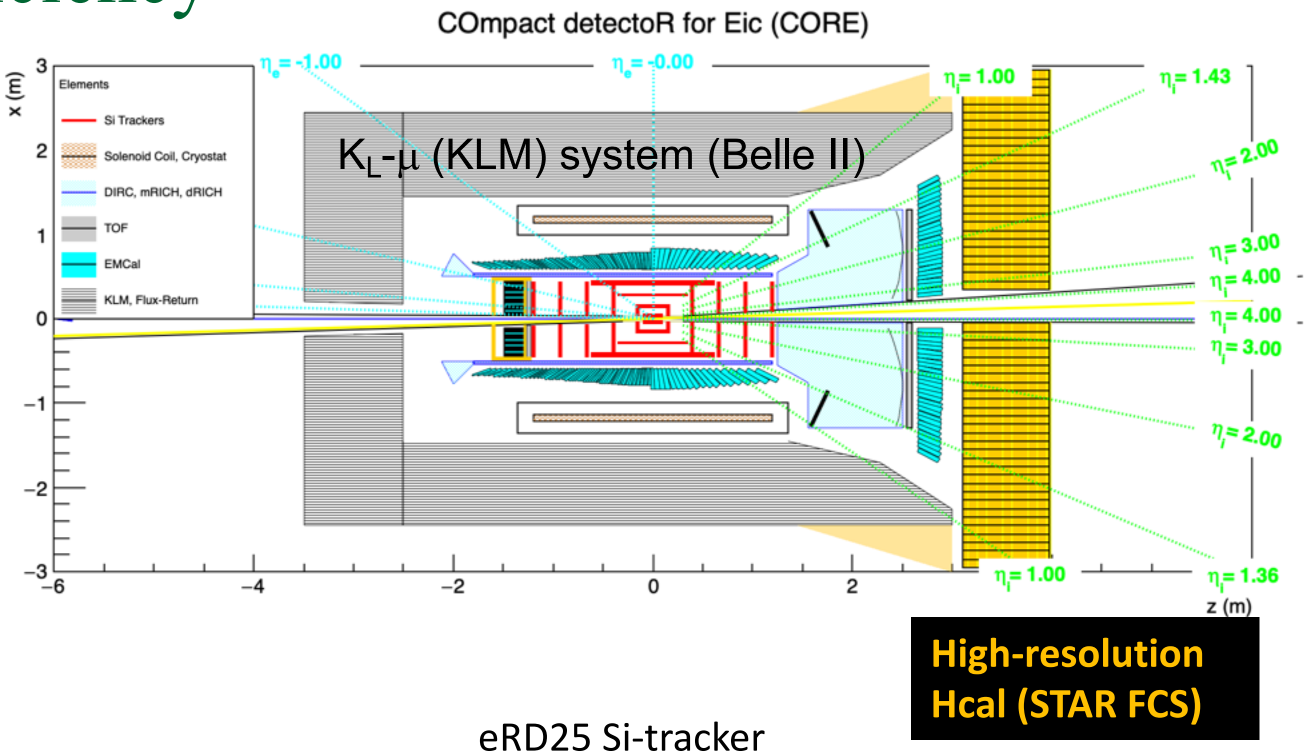
- Two-detector operation
  - Two detectors would have to share certain global limitations (e.g., chromaticity), reducing their luminosity – commonly known as luminosity sharing
  - But a shorter detector creates a smaller chromatic contribution, allowing a higher *combined* luminosity

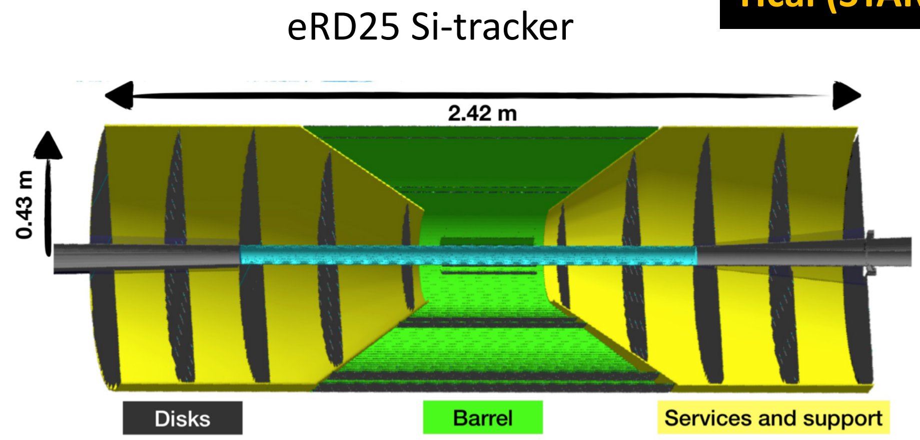
Jets and track reconstruction efficiency

- At the EIC, mid-rapidity jets are best reconstructed from individual tracks
  - Replaces a traditional barrel Hcal
  - However, high-multiplicity final states require a high tracking efficiency

- The Si-tracker developed by the Silicon Consortium (eRD25) is a good geometric match for CORE.
  - L: 2.4 m, D: 0.9 m
  - ALICE ITS3 technology allows for a low mass, air cooling, and an efficient vertex tracker

- Optimizations for CORE *Talk by S. Bueltmann*
  - Adjustments to the disks and barrel layer layout to improve redundancy / efficiency
  - Improved reconstruction of decaying particles (K_S, Λ/Σ, etc)

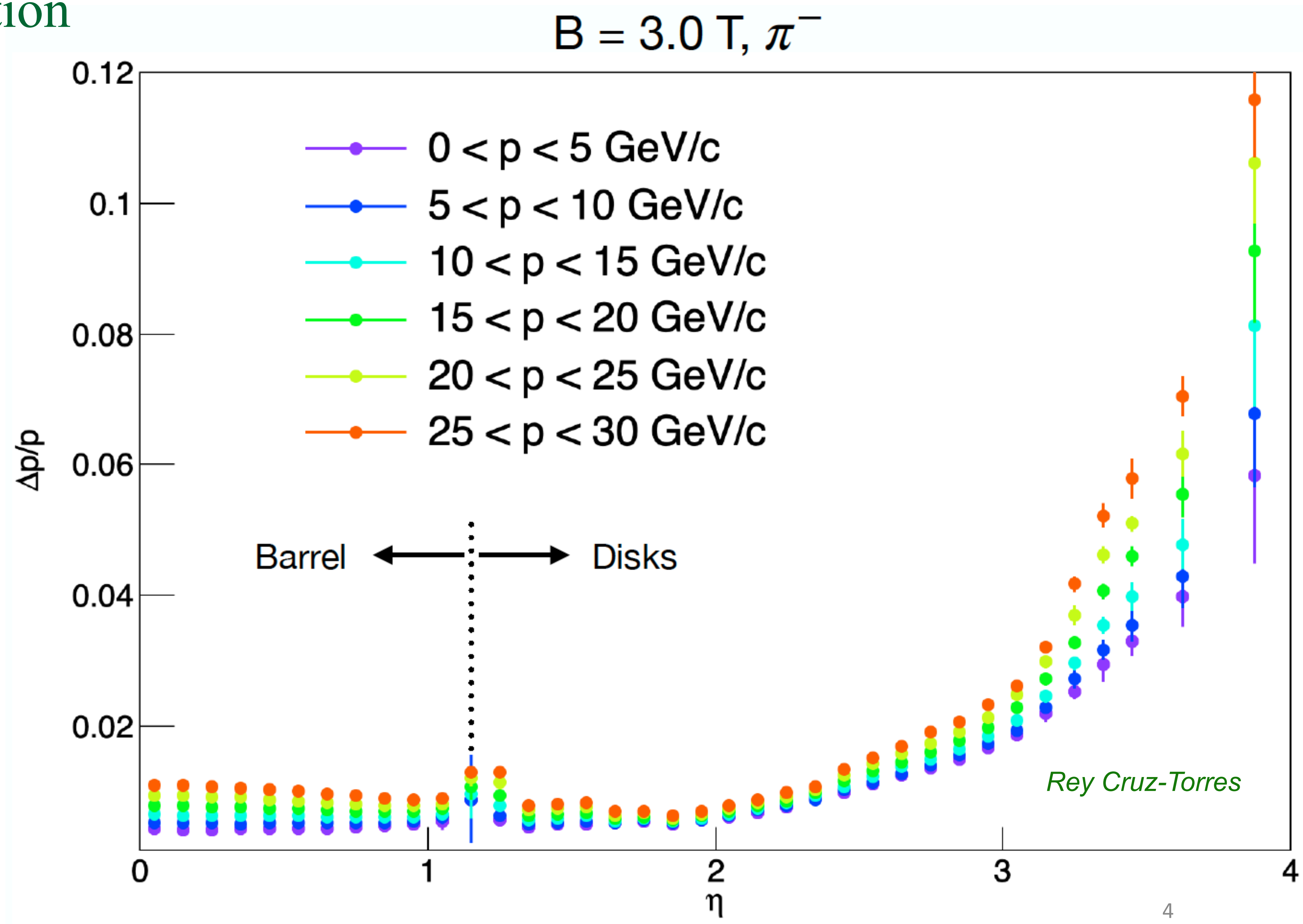




Momentum resolution

- The racking resolution in the barrel is at the sub-percent level.
- A compact radius reduces size and cost of the DIRC and barrel EMcal.
  - The current radius is a good compromise
- Optimizations for efficiency and decaying particles are ongoing.

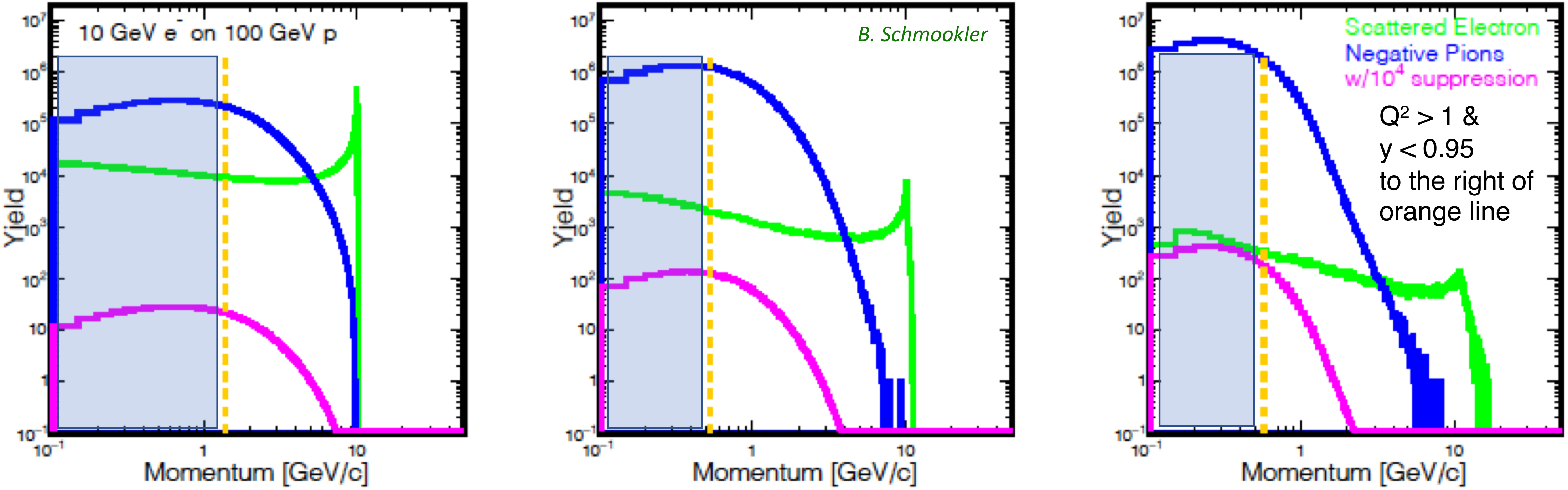
Talk by S. Bueltmann



e/π identification in the electron hemisphere

$\eta = -\ln(\tan(\theta/2))$

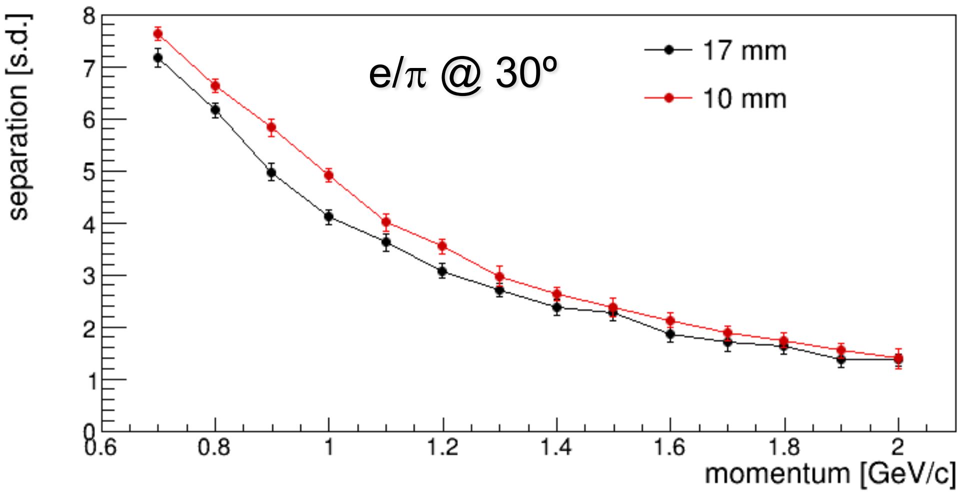
CORE endcap $-3.5 < \eta < -2.0$ $\quad$ $-2.0 < \eta < -1.0$ $\quad$ CORE barrel $\quad$ $-1.0 < \eta < 0.0$



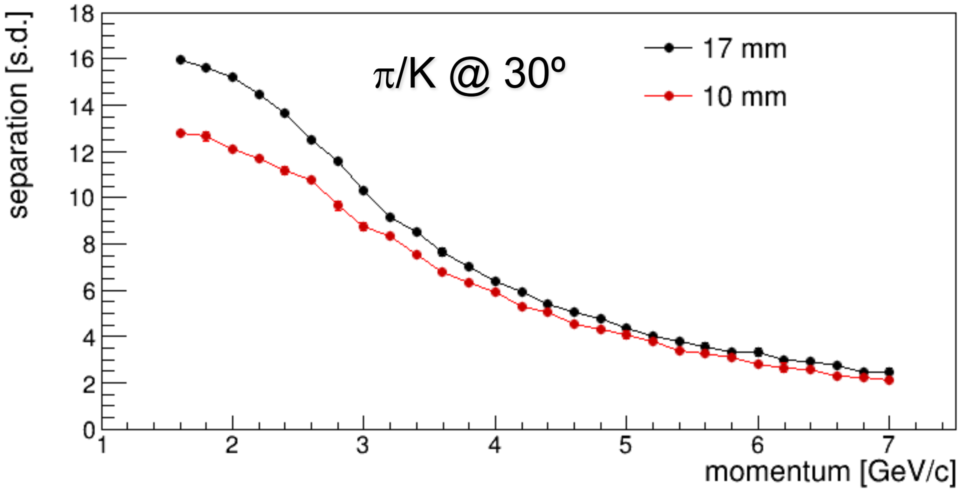
- For the EIC, a clean identification of the scattered electron is essential.
- The barrel region poses the greatest challenge and requires the best electron ID.
- CORE addresses this issue by extending the PWO EMcal coverage up to $\eta < 0$ (or possibly -0.5)
- Additional low-momentum e/π suppression is also provided by the DIRC.

PID in the barrel – low-mass (thin) DIRC

Talk by G. Kalicy



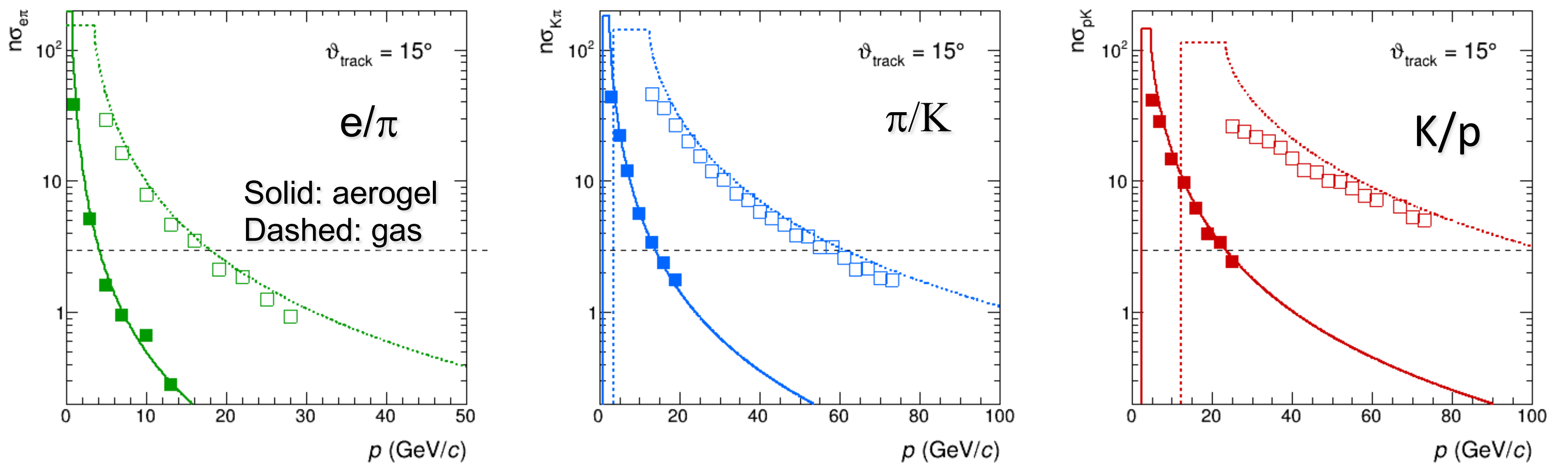
conservative estimates shown

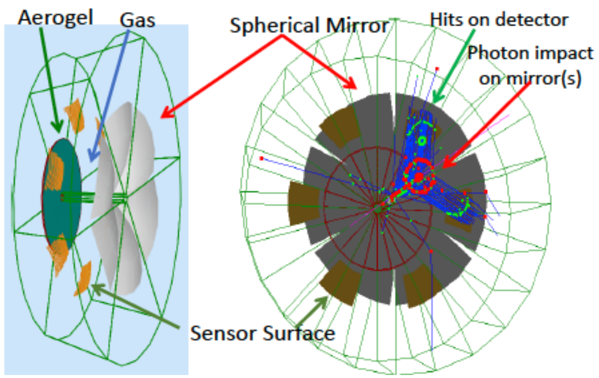


- While CORE is compatible with a re-use of the BaBar bars, the baseline is to make new ones
  - Performance can be optimized
  - A small radius makes new bars affordable
  - There may not be enough bars for two detectors
- A low-mass DIRC has several advantages
  - 40% reduction in mass benefits the EMcal
  - e/π ID around 1 GeV/c range is improved, without significantly affecting π/K ID above 4 GeV/c
  - The lower weight allows for simpler supports
- General DIRC features are retained
  - π/K separation can be extended down to 0.2 GeV/c using in threshold mode (signal from π but not K).
  - A good time resolution can be provided in offline reconstruction (30 - 100 ps, depending on angle)

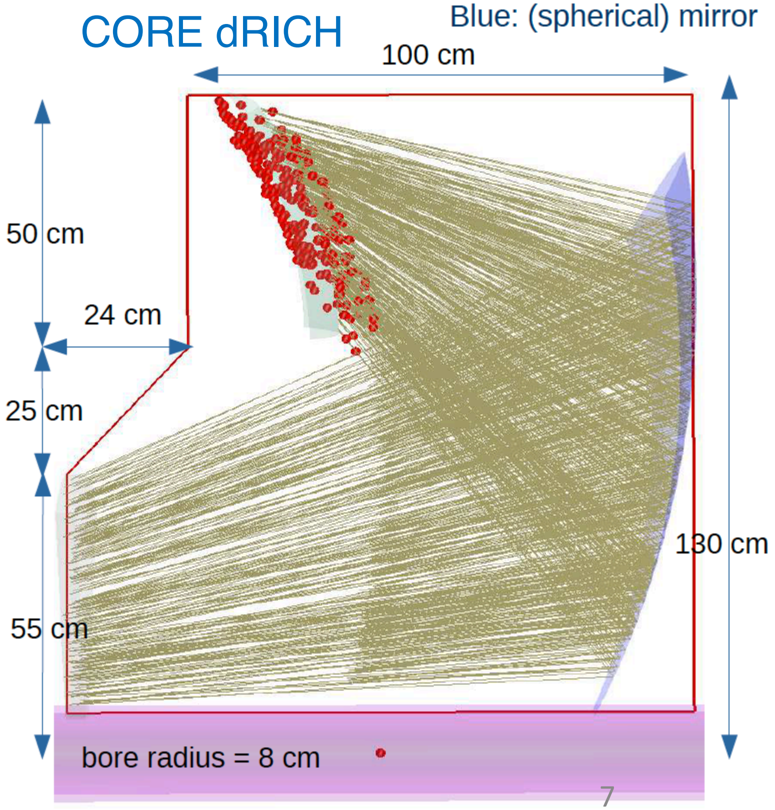
PID in the hadron endcap – dual-radiator RICH

Performance of the dRICH developed by the EIC PID consortium (eRD14)





eRD14 dRICH

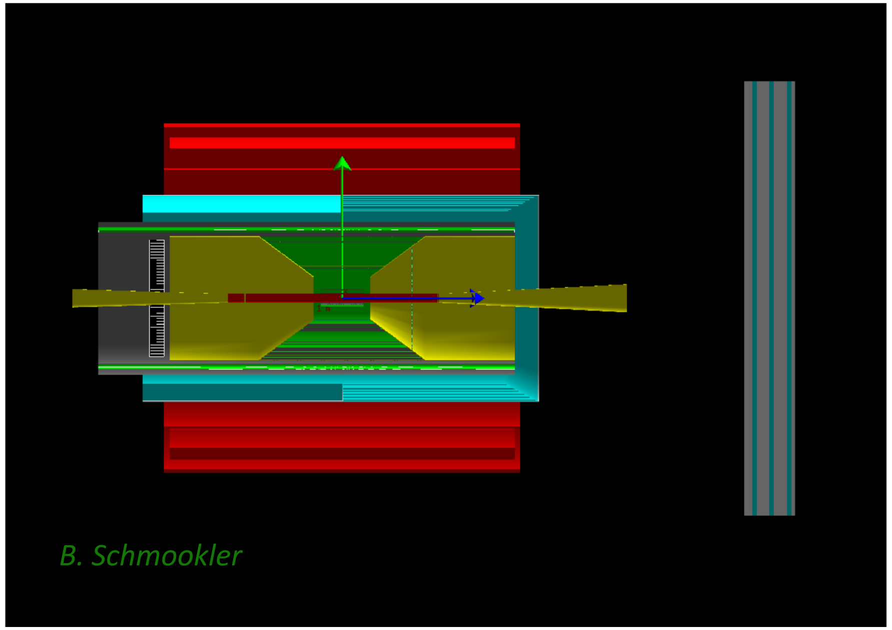


- The CORE dRICH is about half the size of the eRD14 one
  - Good geometric match to smaller photosensor plane
  - Gas length of 1.2 m is only 25% smaller than in the original
  - 55 cm aperture (with aerogel) matches barrel EMcal
- CORE performance should be close to the eRD14 original
  - Note the excellent e/π separation (10σ at 10 GeV/c)
  - In threshold mode (indicated by a flat top), the dRICH aerogel can cover very low momenta (middle plot)

Thank you!

CORE solenoid

- Coil: 2.5 m long
- Cryostat: 1 m inner radius, 2.8 m long
- Magnetic field at IP: 3 T (baseline)
- Note: with a magnetic volume of only 7.8 m^3, any field in the 2 - 4 T range would be affordable, but 2.5 - 3 T seems to offer the best balance between cost and performance.



- A 1 m inner radius leaves 50 cm between the DIRC and solenoid

cost (2020 M$) = 1.8 x 0.458 x (stored energy)$^{0.7}$

M. A. Green and S. J. St. Lorant, Adv. Cryo. Eng. **39**

solenoid	field (T)	volume (m^3)	2020 cost (M$)
Large 3T	3	29	21
CORE	**3**	**7.8**	**8.5**
CORE	2.5	7.8	6.6
CORE	2	7.8	4.8

- The smaller radii of the tracker, DIRC, and barrel EMcal make it possible to take full advantage of a high magnetic field while minimizing the penalty in low-p_T acceptance.
  - To extend the low-p_T acceptance even further, the magnet can be operated below maximum field.