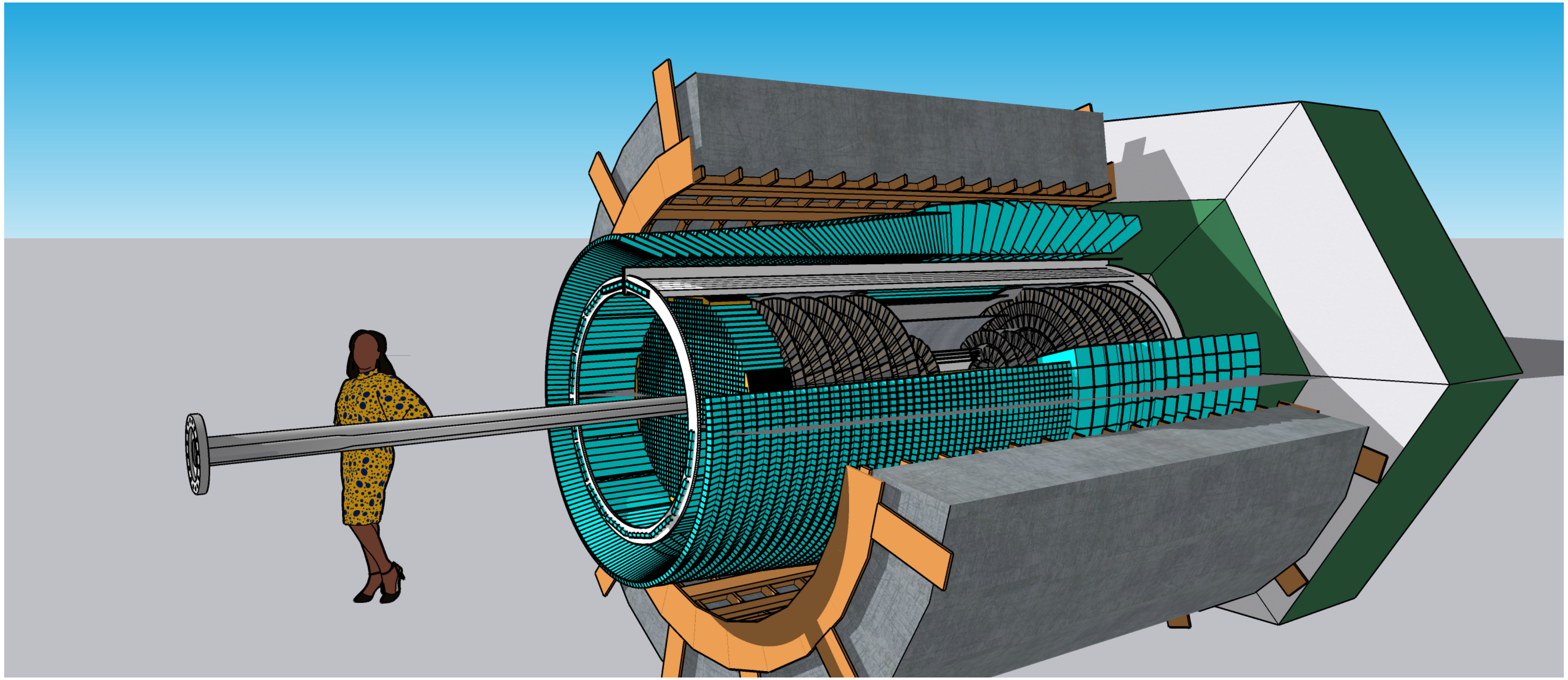
# CORE Tracking

EIC user meeting, August 2-7, 2021



**Pawel Nadel-Turonski**

**Stony Brook University**

for the CORE pre-collaboration

(open to all users)

# CORE and the Generic EIC detector R&D

- The detector proposals were preceded by an R&D program (2011-2021), aiming to support all future EIC detector projects

- The CORE concept was developed by participants of the program, and incorporated many of its findings, in particular with respect to Si-tracking (eRD25) and PID (eRD14).

- CORE members were always well represented in the PID consortium, and S. Bueltmann recently joined the Si-consortium. He will also be leading the CORE tracking effort.

The last meeting of the generic R&D for an EIC program

8/3/2021 July 2020 - BNL Conferences

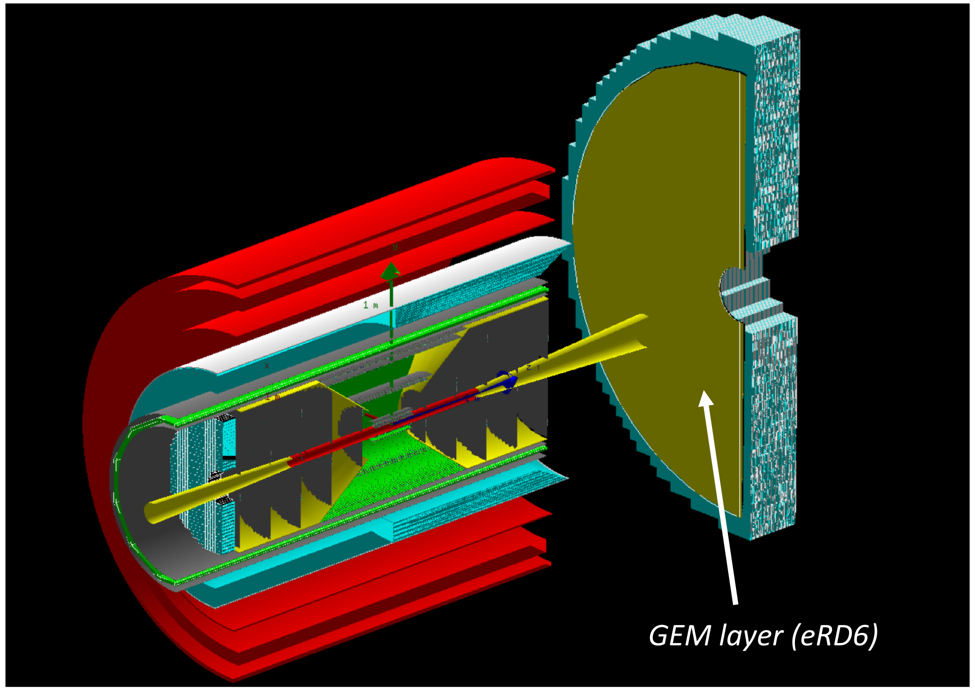
| Thursday, July 23, 2020 | | | |
|---|---|---|---|
| Time | Title | Speaker (Time) | Slides |
| 10:15 | Committee: Executive Session | | |
| 11:00 | Welcome and Overview | Thomas Ullrich (10) | pdf |
| 11:10 | eRD6/Tracking: Progress Report and Proposal | Kondo Gnanvo, Bob Azmoun, Silvia Dalla Torre (40+15) | pdf |
| 12:05 | eRD22/GEM-TRD: Progress Report and Proposal | Yulia Furletova (20+10) | pdf |
| 12:35 | Break | | |
| 12:50 | eRD25/Si: Progress Report and Proposal | Laura Gonella (40+15) | pdf |
| 13:45 | eRD14/DIRC: Progress Report and Proposal | Jochen Schwiening (12+3) | pdf |
| 14:00 | eRD14/mRICH: Progress Report and Proposal | Xiaochun He (12+3)pdf | pdf |
| 14:15 | eRD14/dRICH: Progress Report and Proposal | Marco Contalbrigo (12+3) | pdf |
| 14:30 | eRD14/Electronics & Sensors: Progress Report and Proposal | Gary Varner (12+3) | pdf |
| 14:45 | Committee: Executive Session | | |

# CORE tracking

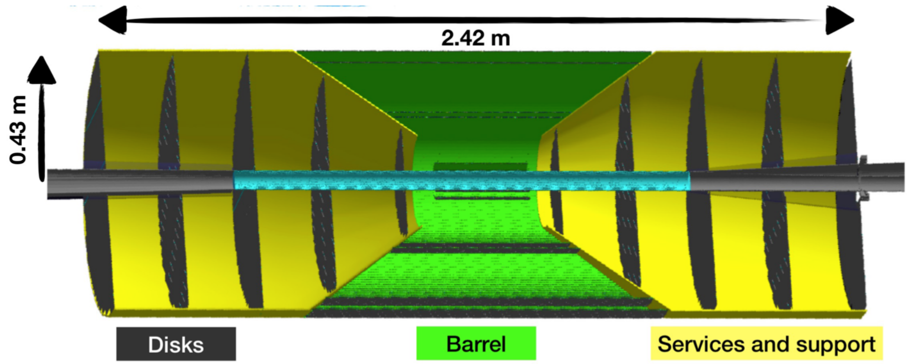
- The Si-tracker developed by the Silicon Consortium (eRD25) is a good geometric match for CORE, and an excellent staring point for simulations.
  - L: 2.4 m, D: 0.9 m
  - ALICE ITS3 technology allows for a low mass, air cooling, and a very efficient vertex tracker geometry

- The main modification for CORE would be an optimization for high-energy $K_S$ decays.
  - *E.g.*, three separated cylindrical layers in the outer 1/3 of the barrel at mid-rapidity
  - Also beneficial for incident angle on the DIRC?

- A GEM behind the dRICH provides additional tracking
  - Helps with reconstruction in the dRICH

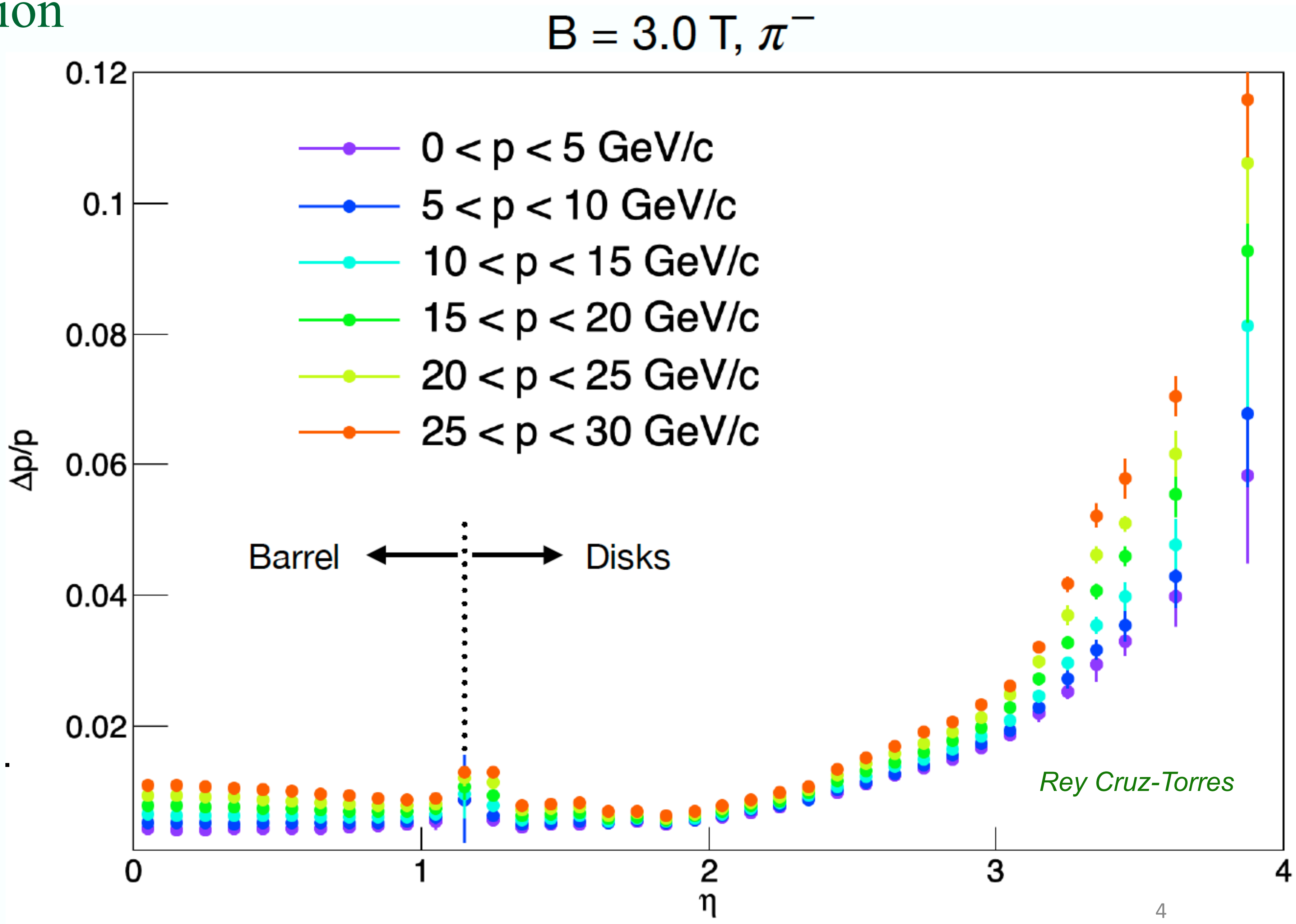



eRD25 Si-tracker

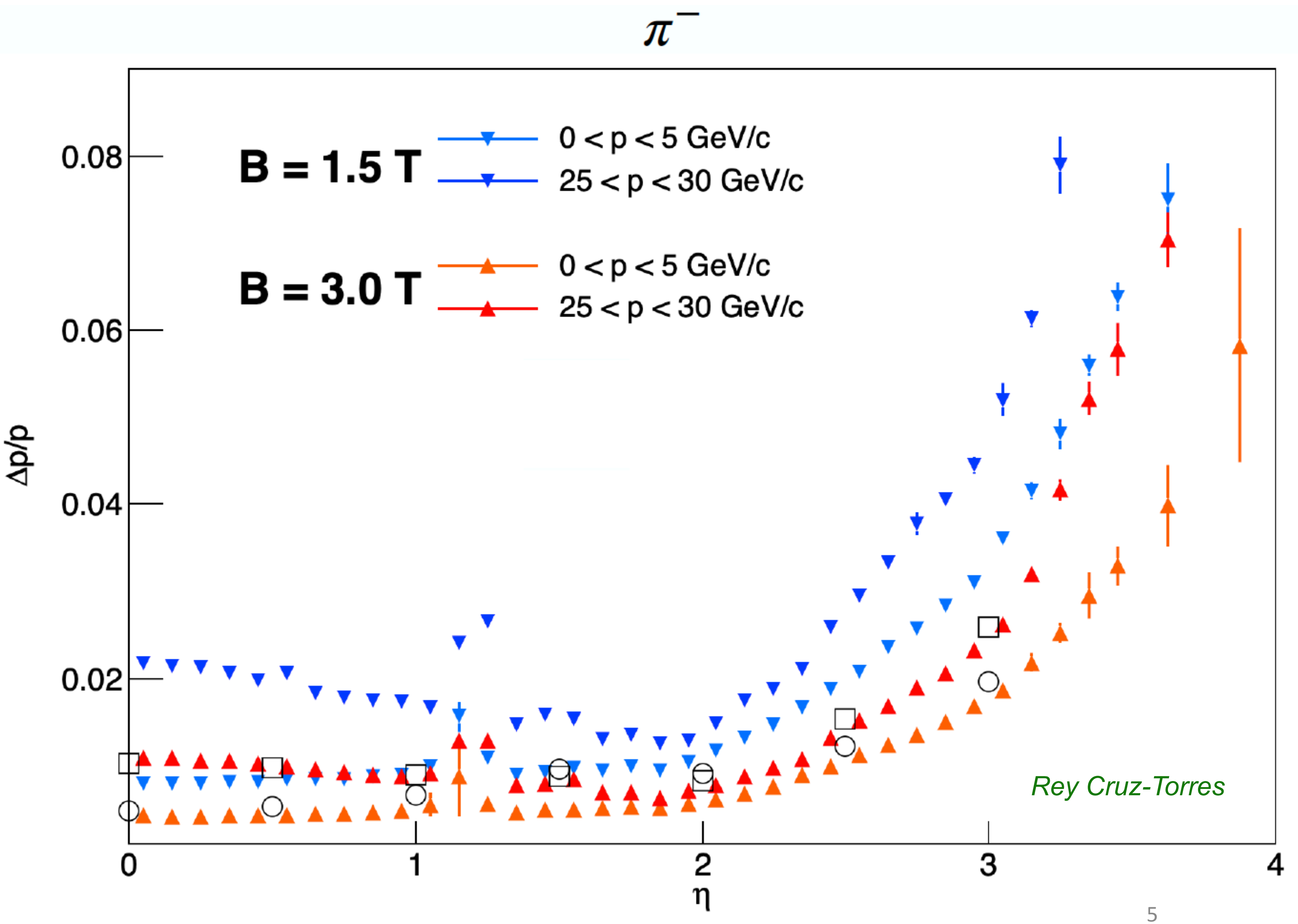


# Momentum resolution

- The racking resolution in the barrel is at the sub-percent level.
- A compact radius reduces size and cost of DIRC and EMcal.
    - The current radius seems to be a good compromise
- An optimization for $K_S$ decays may affect the geometry and resolution.
    - Not necessarily in a negative way

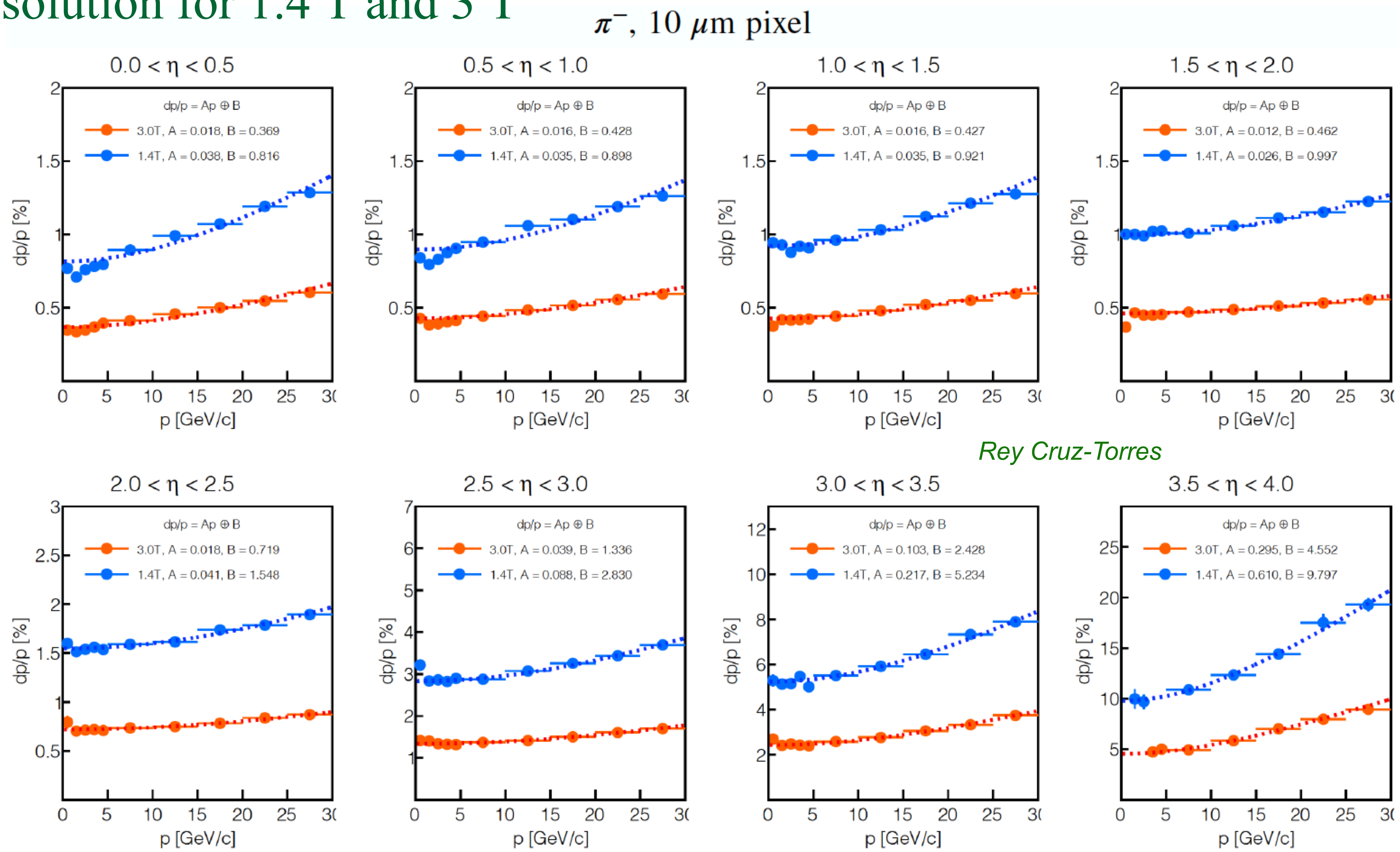


# B-field dependence



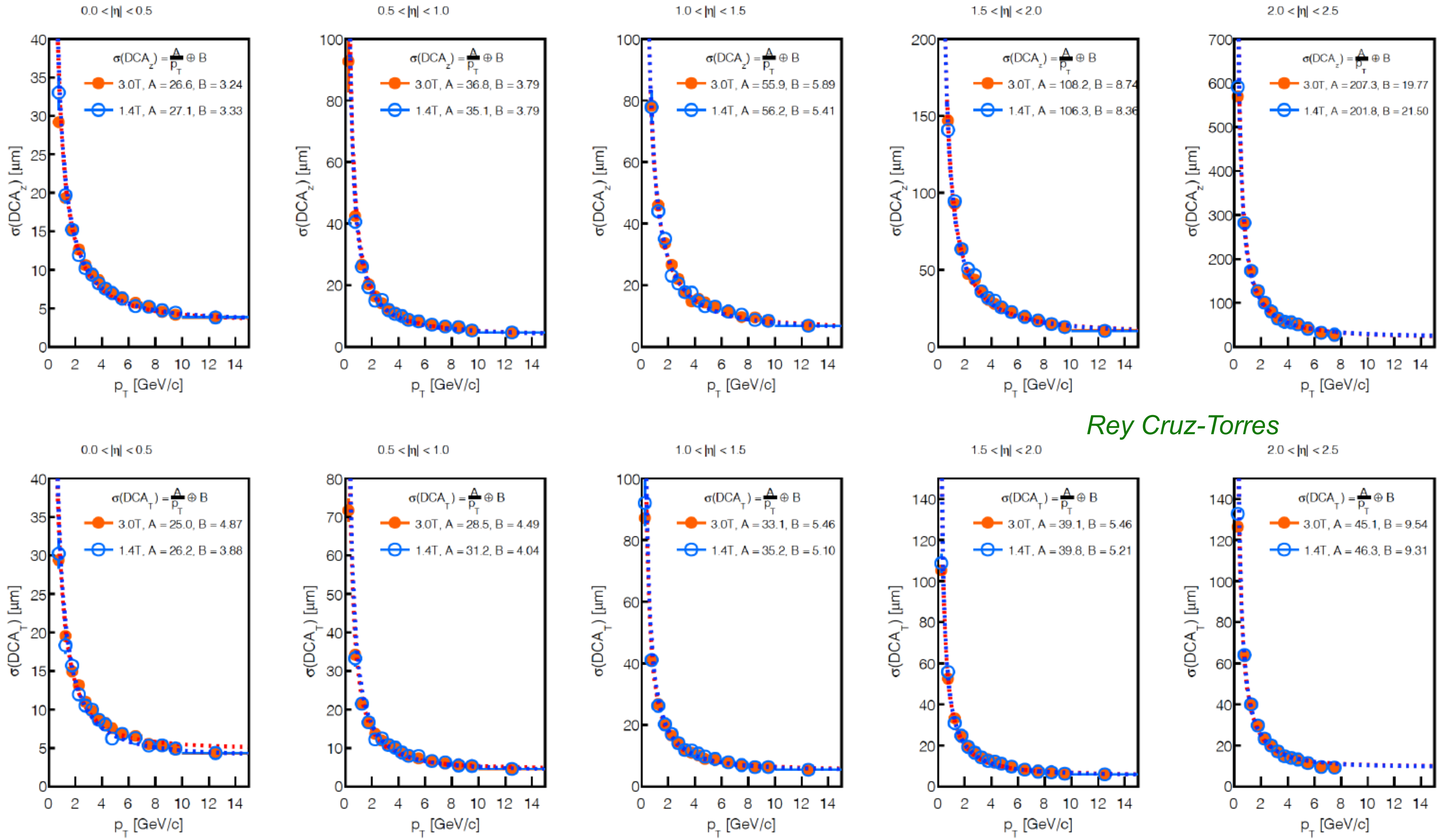

- A field of 1.5 T may be acceptable, but a 3 T field is clearly better.

# Resolution for 1.4 T and 3 T



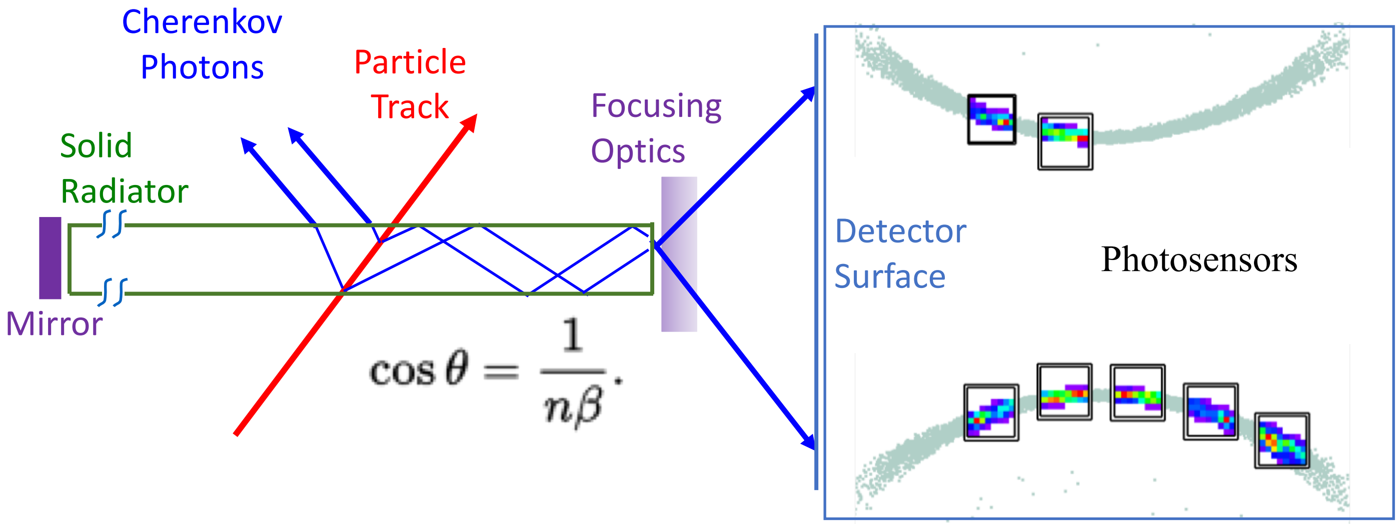
# Vertex resolution

$\pi^-$, 10 $\mu$m pixel




*Rey Cruz-Torres*

# Angular resolution requirements for PID

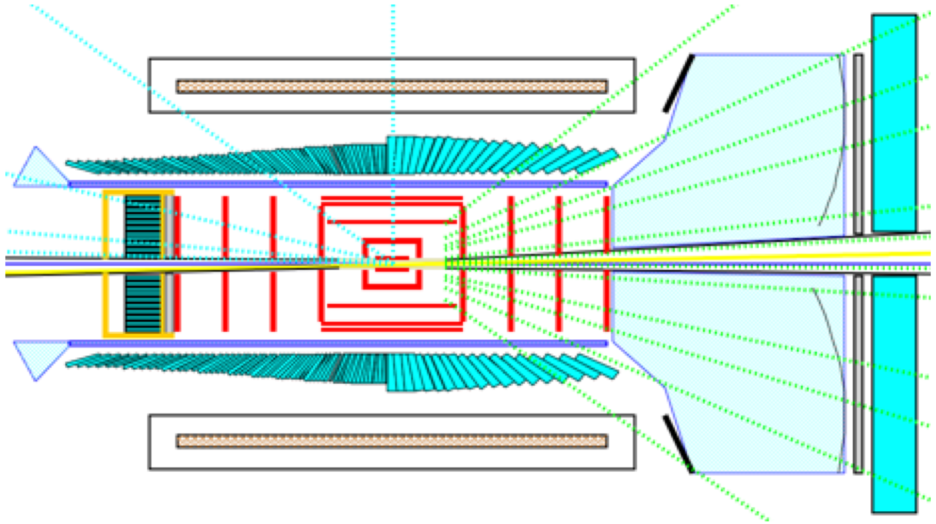



- Cherenkov-based PID systems like the DIRC can measure the angle of the Cherenkov photons with mrad precision using the image on the focal plane and the time of propagation, but the uncertainty in the polar angle of the incoming track will affect this measurement.
  - The next generation of photosensors may have better QE and timing, but the extent to which the momentum reach of the DIRC can be improved will ultimately depend on the tracker.

- eRD25 early on folded the requirement on polar angle resolution into their design.
  - Nevertheless, if it would still be interesting to explore if this could be improved further

# Kaons

In the endcaps, 18 GeV/c $K_S$ can be reconstructed with high efficiency.



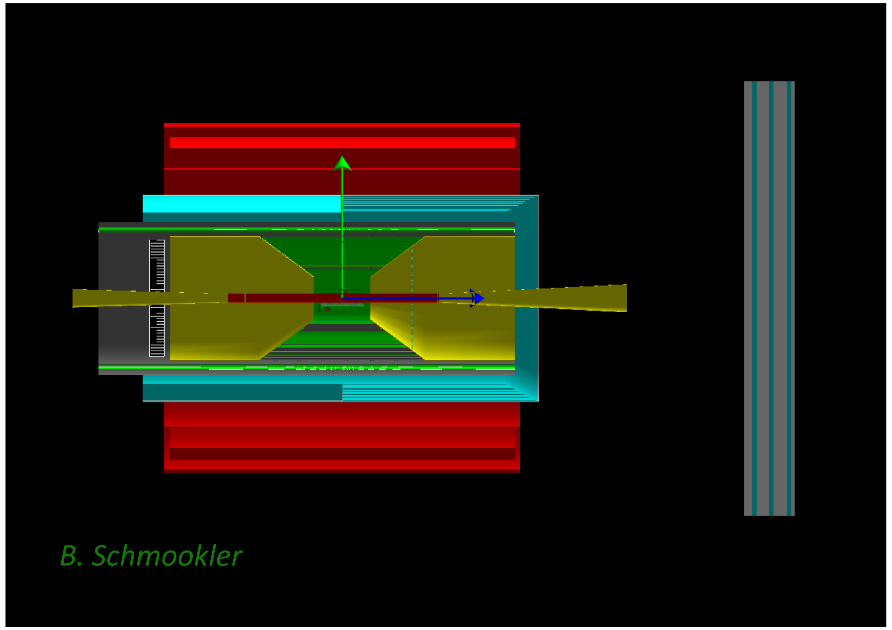
- Charged kaons ($K^{+/-}$) are identified in the PID systems (dRICH, DIRC, TOF)
  - The reconstruction *efficiency* is high, but the separation power (*purity*) drops with momentum.
  - The tracker can improve charged kaon ID though better polar angle resolution on the DIRC

- $K_S \rightarrow \pi^+\pi^-$ decays ($c\tau$ = 2.68 cm) can be measured direclty in the tracker.
  - Since the decays are statistical, $K_S$ with *any* momentum can be measured, but the *efficiency* will drop at higher momenta. The *purity* will be unaffected.
  - $p/\pi^+$ ID will enhance separation of $K_S \rightarrow \pi^+\pi^-$ from $\Lambda \rightarrow p\pi^-$.
  - Separated tracking planes in the outer part (1/3 ?) of the tracker at mid rapidity should improve $K_S$ reconstruction. Could it also improve the polar angle measurement?

# 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.