11th Bi-Weekly Meeting

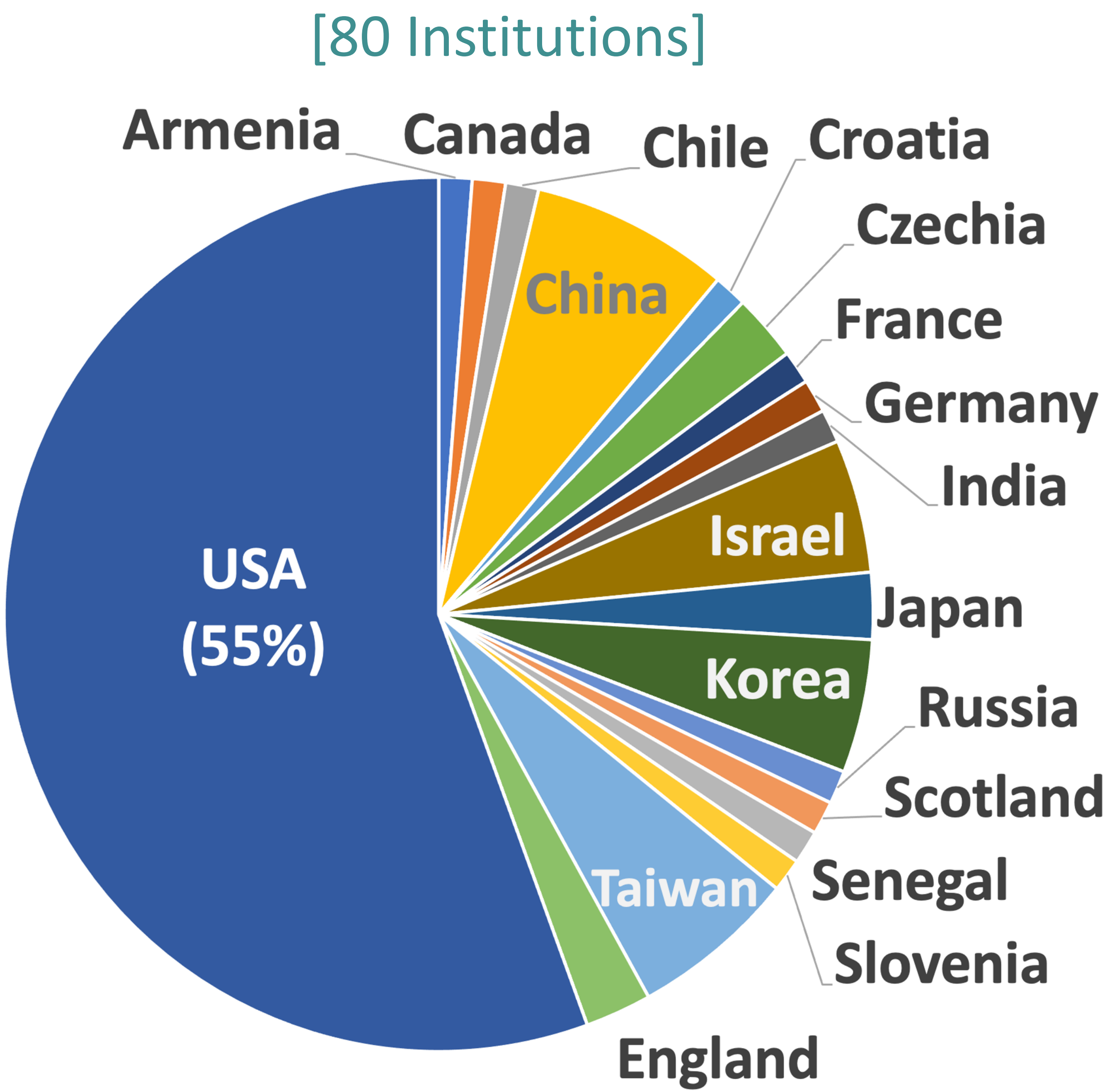
Or Hen, Tanja Horn, John Lajoie

August 16th, 2021.

Outline

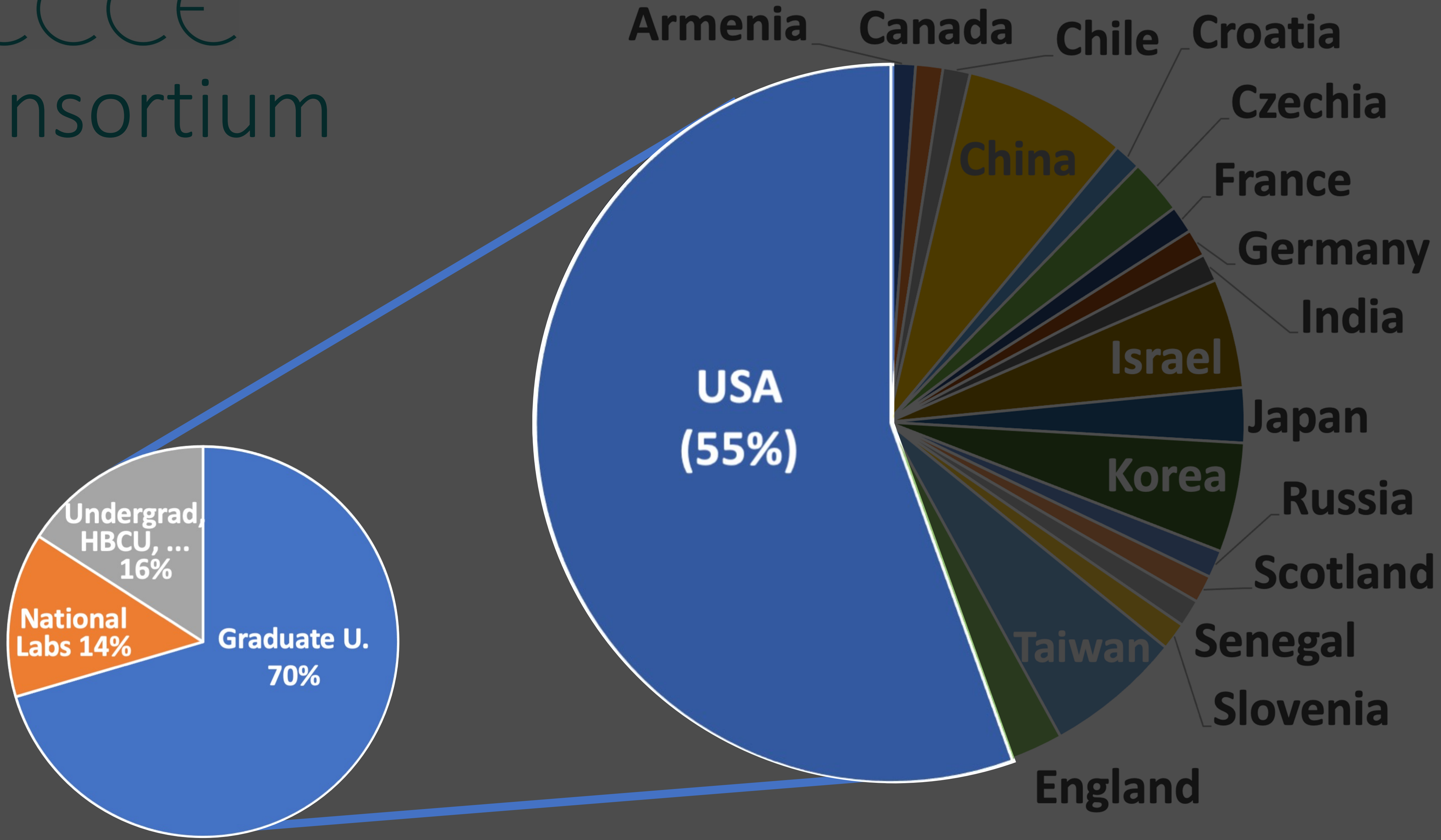
- Consortium status
- Users group meeting summary
- Status updates:
  - Detector
  - Physics
  - DEI
  - Proposal
- Path forward

ECCE
Consortium



ECCE Consortium

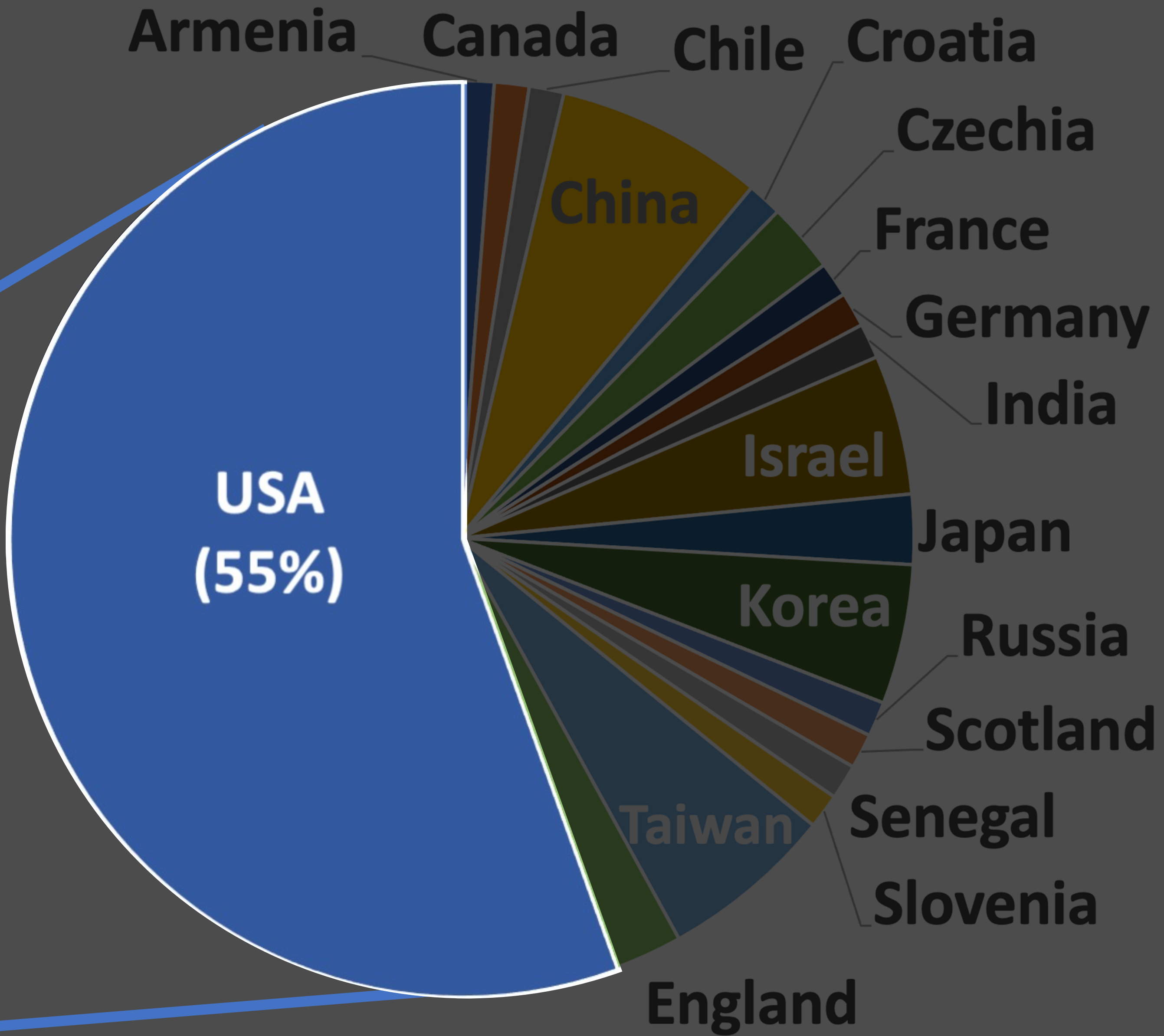
[80 Institutions]

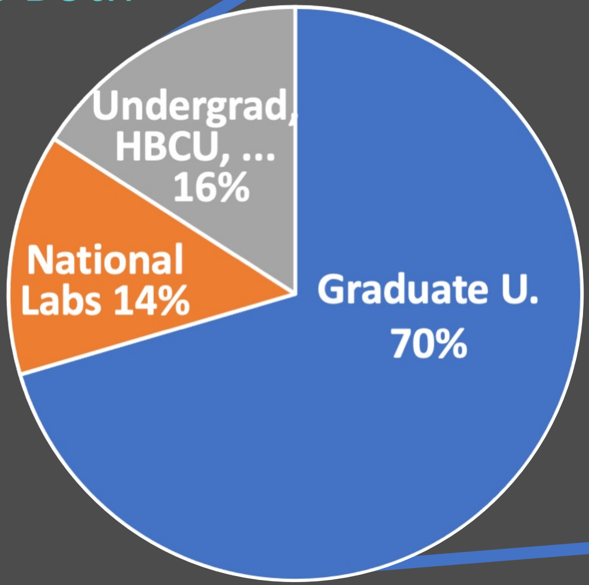


ECCE Consortium

Background / Experience:
- 50% 'RHIC'
- 40% 'JLab'
- 10% Both

[80 Institutions]





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ECCE Talks @ Users Group Meeting

- Overview (Or)
- Calorimetry (Fredi)
- Tracking (Xuan)
- PID (Xiaochun)
- Backward/Forward (Igor)
- Computing (Cameron)
- AI/ML and Detector co-design* (Cristiano)
- Software (Joe)

*covered all activities, but ECCE are clearly leading this front.

ECCE Talks @ Users Group Meeting

- We feel that the meeting went overall well!

  ➔ ECCE is at a very strong position.

- Narratives are being formed and differences between the collaborations are becoming striking.

- Identified a need to:
  - Present more of our electronics work.
  - Better explain our software approach.

ECCE Talks @ Users Group Meeting

- We feel that the meeting went overall well!
  ➔ ECCE is at a very strong position.
- Narratives are being formed and differences between the collaborations are becoming striking.
- Identified a need to:
  - Present more of our electronics work.
  - Better explain our software approach.

Appreciate your thoughts & inputs on what we did well / <u>less well</u> so we can improve in the future!

General ECCE Narrative

ECCE is developing a low-risk, cost-effective, flexible and optimized EIC detector, capable of delivering on the full EIC physics program!

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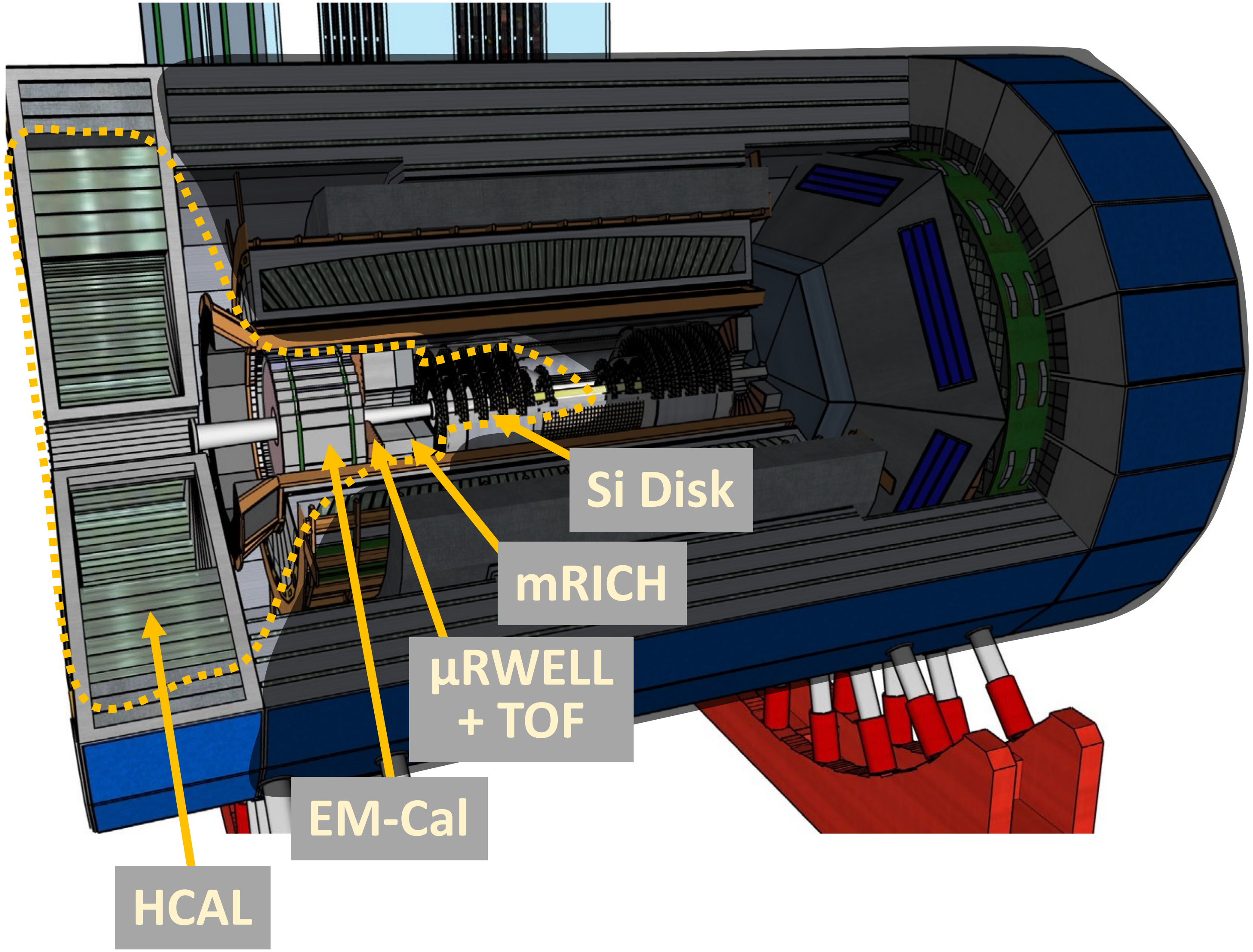
ECCE Detector Status



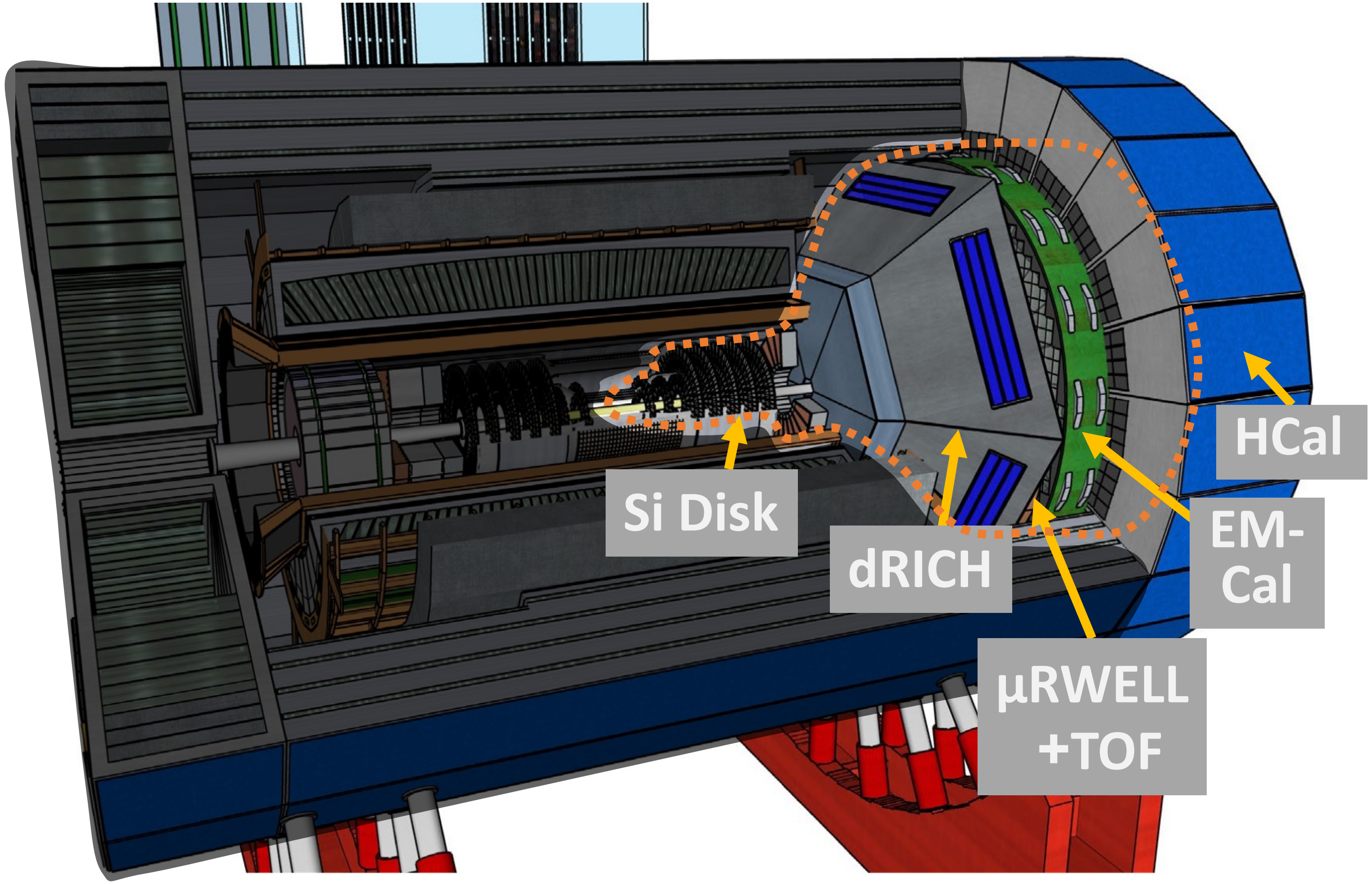
ELECTRON ENDCAP

Tracking: Si discs + Large area µRWELL
Electron Detection:

- Inner: $PbWO_4$ crystals (reuse some)
- Outer: SciGlass (backup PbGl)

h-PID: mRICH & TOF
HCAL: Fe/Sc (STAR re-use)

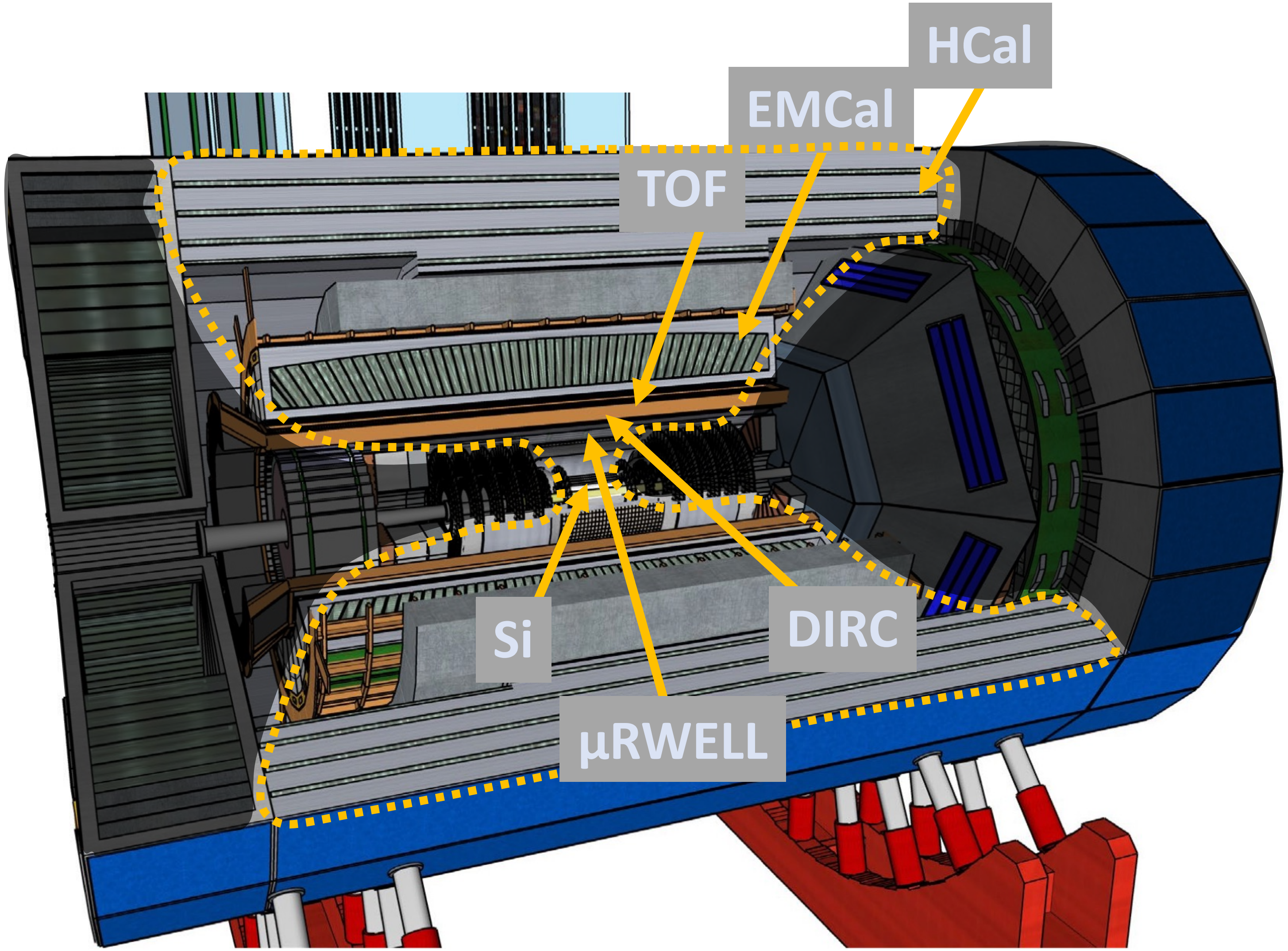
ECCE Detector Status



HADRON ENDCAP

Tracking: Si discs + Large area µRWELL
PID: dual-RICH & TOF
Calorimetry:
standard Pb/ScFi shashlik (PHENIX re-use)
long. sep. HCAL
(other options under study)

ECCE Detector Status



CENTRAL BARREL

Tracking: MAPS Si + µRWELL
Electron PID: SciGlass (alt: PbGl or W(Pb)/Sc shashlik) + instrumented frame
h-PID: hpDIRC & TOF
HCAL: Fe/Sc (sPHENIX re-use)

Three updates today

1. Tracker: Si + MPDG Hybrid.

2. PID: Cerenkov veto mode and impact on TOF requirement.

3. EM-Cal coverage.

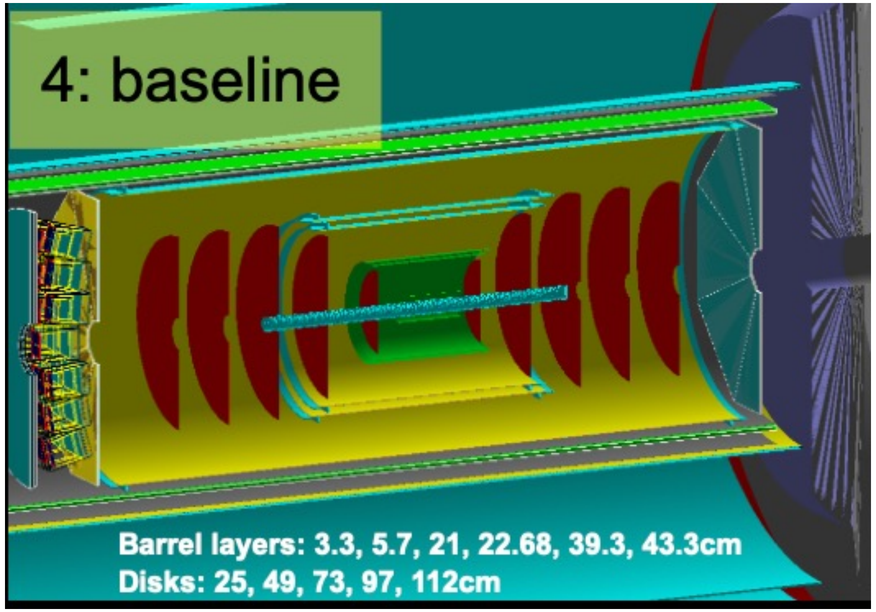
ECCE Tracking

Baseline:

- Barrel: Silicon tracker (2 double layers) + μRWELL around DIRC
- Endcaps: Silicon disks + μRWell after RICH

AI/ML optimization pipeline

Open question: 2 vs. 3 vertex layers.
ACTS study underway.

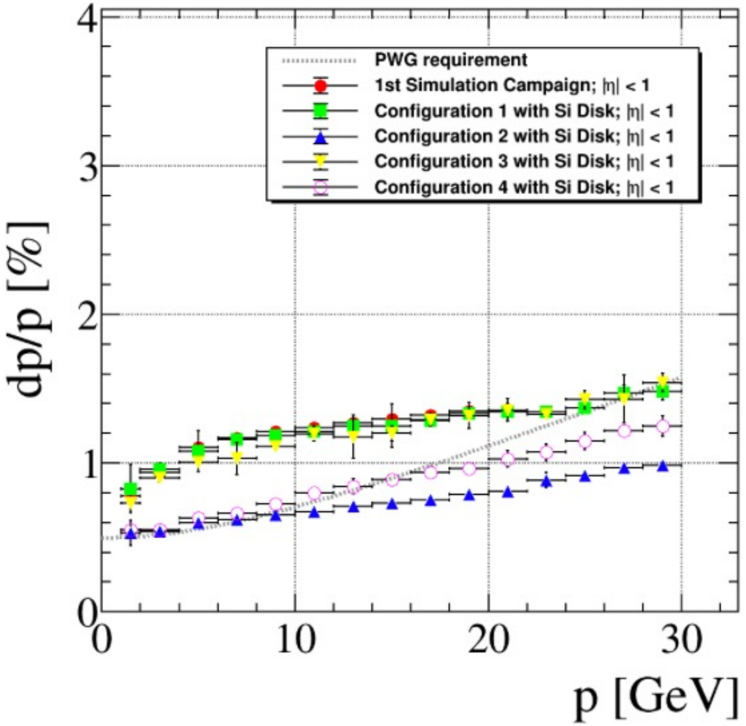


Comparing four configurations:

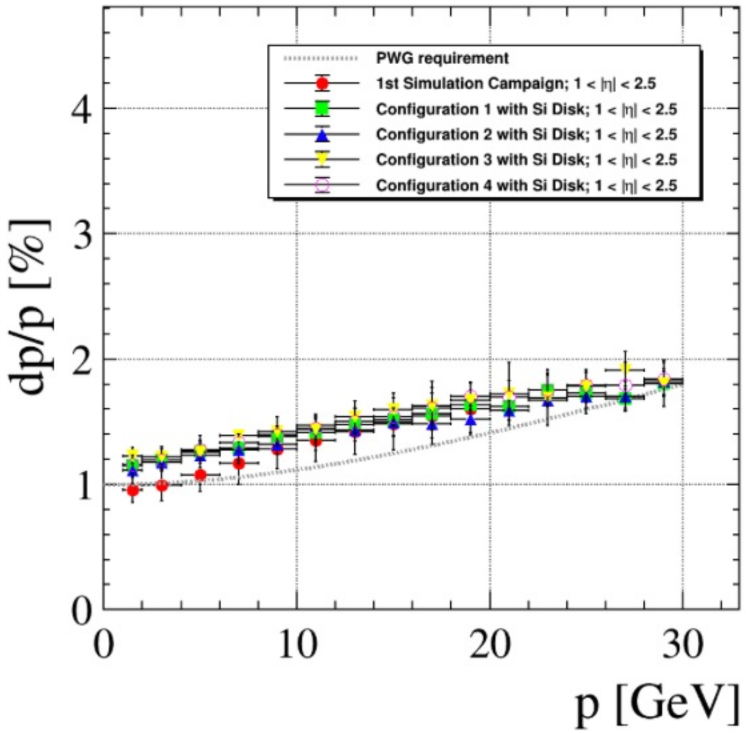
ITS2 vs. ITS3 for sagitta

ITS2 vs. uRWELL for 3rd barrel double layer

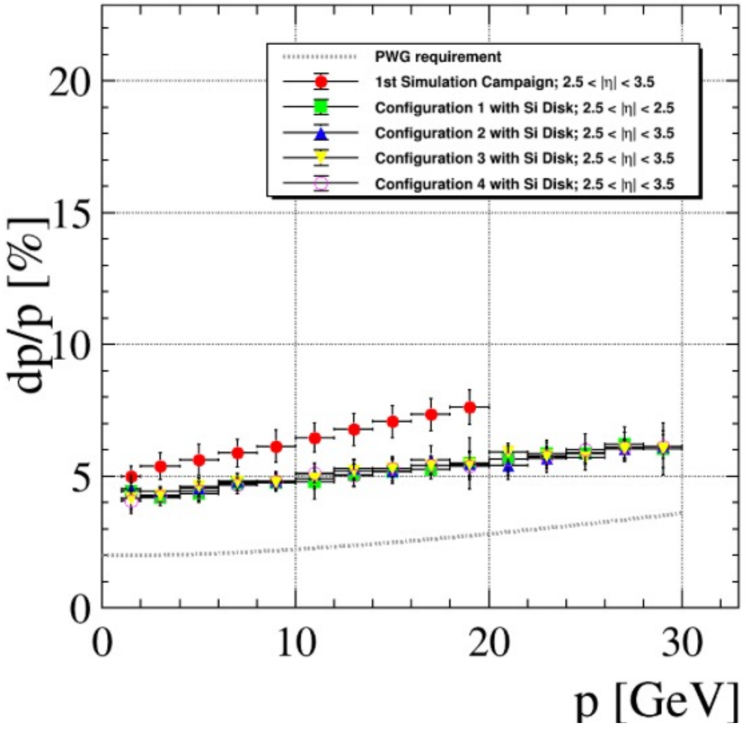
|η| < 1



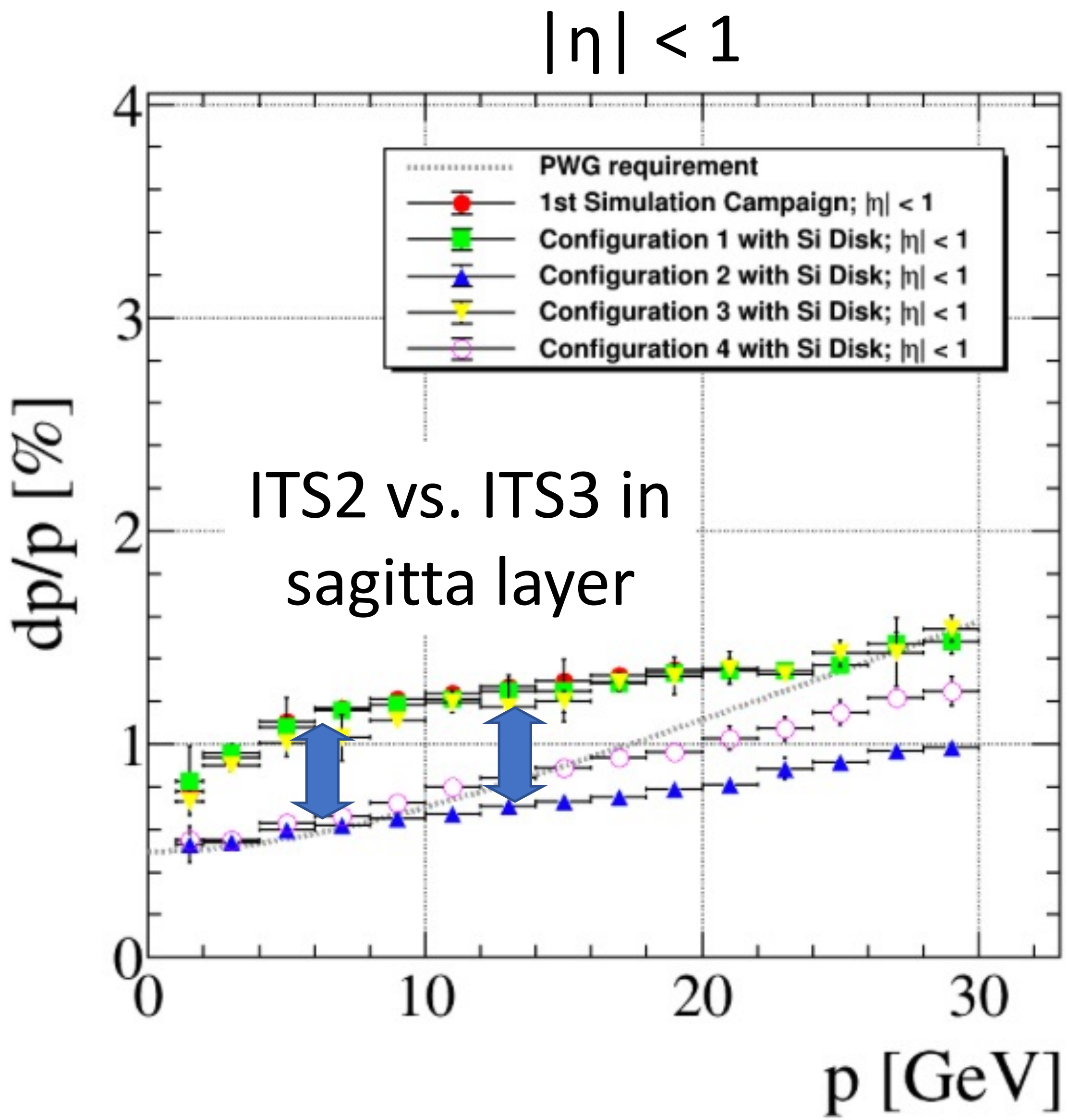
1 < |η| < 2.5



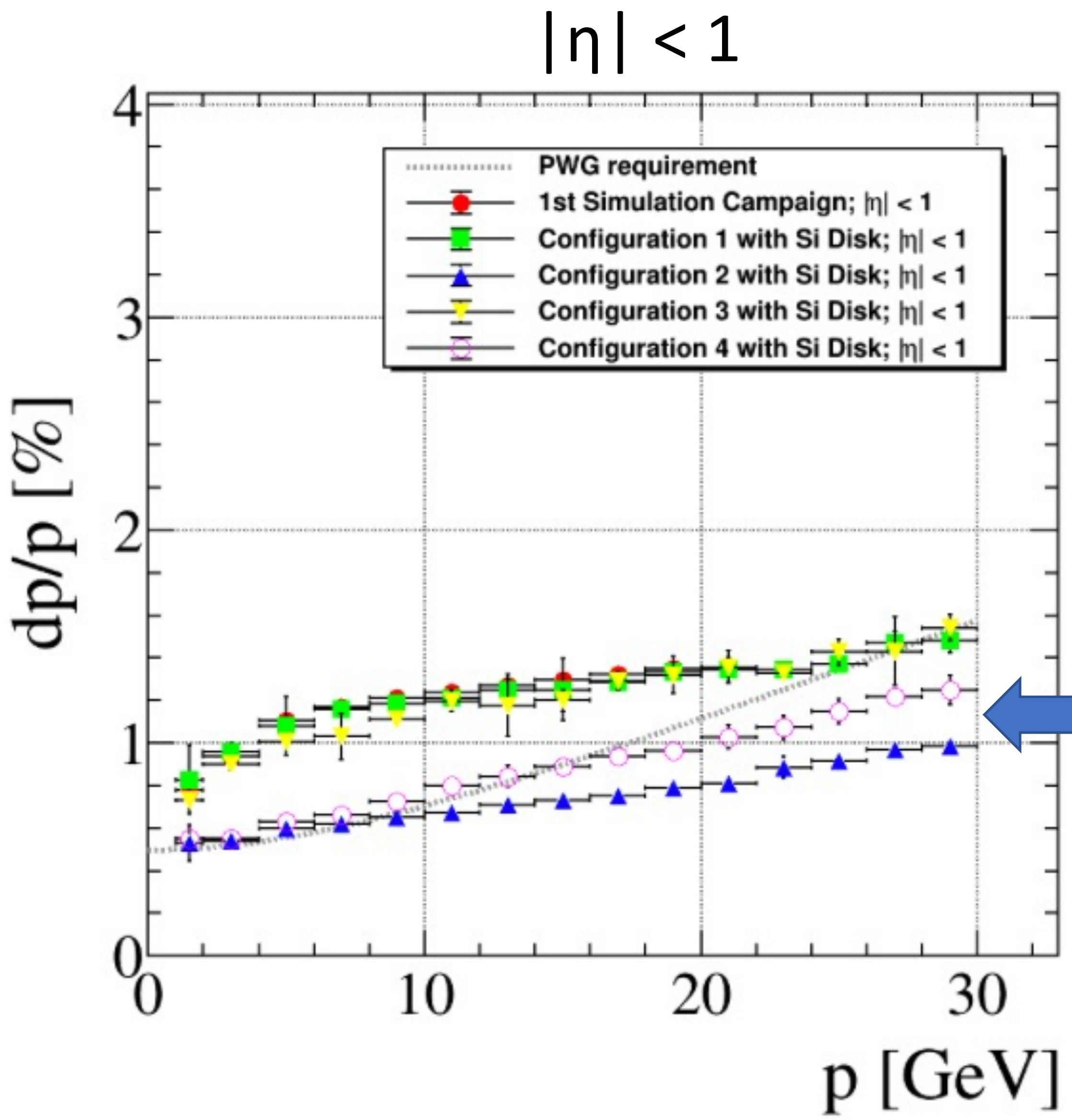
2.5 < |η| < 3.5



ITS3 in Sagitta allows realizing YR spec



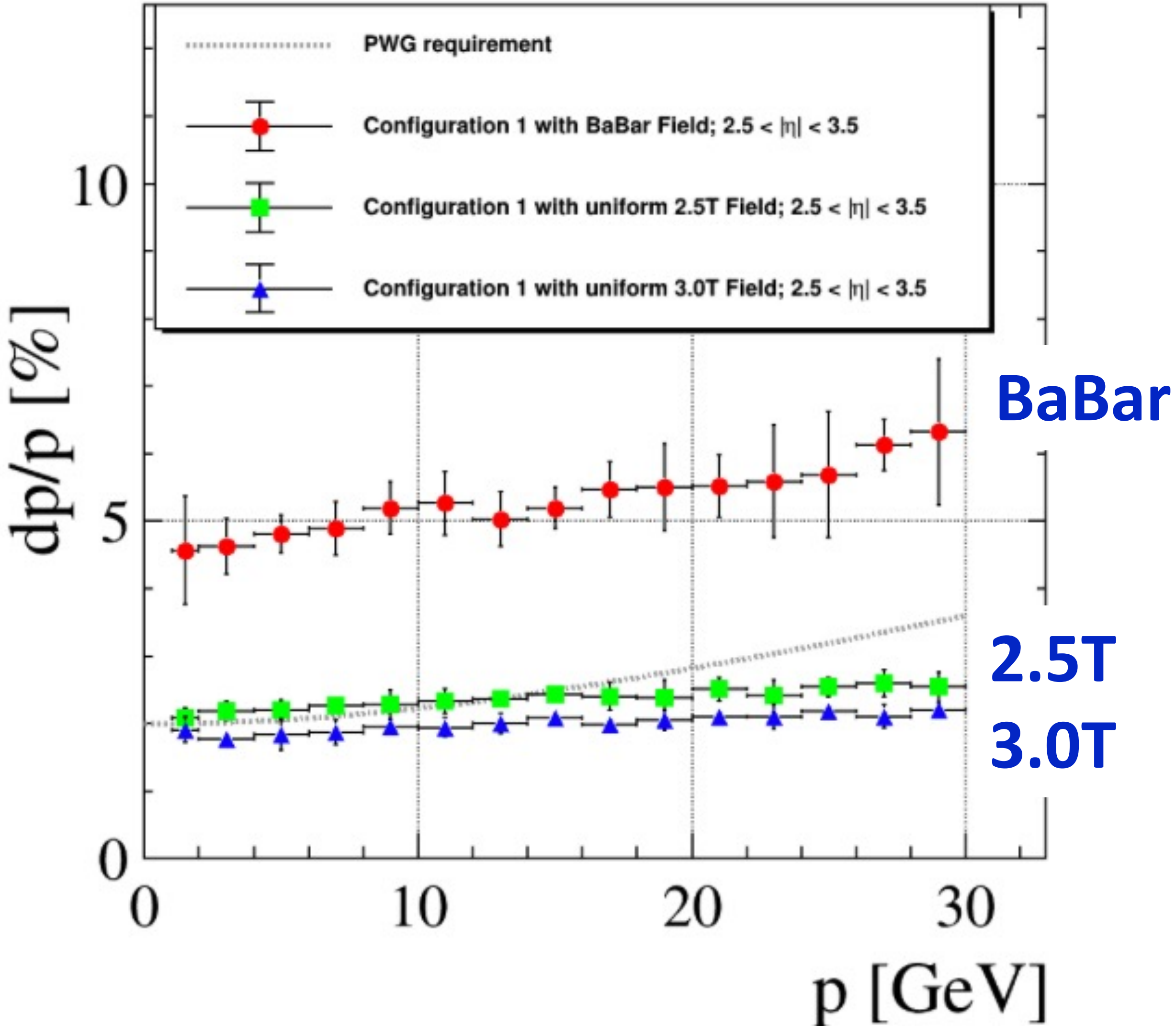
Save cost & service with uRWELL in outer layer



ITS2 vs. uRWELL in 3^{rd} double layer

Hitting magnet limit @ forward region

2.5 < |η| < 3.5



Cherenkov 'Veto' Mode

TOF is needed to supplement Cherenkov PID @ low-momentum.

Cherenkov can perform π/K separation below the kaon threshold in **"veto mode"**:

- If track below kaon threshold, any signal must be from low-mass particles (e.g. pions).
  Used in COMPASS, LHCb, DELPHI.

RICH "veto" mode @ DELPHI:
https://inis.iaea.org/collection/NCLCollectionStore/_Public/27/073/27073494.pdf

Cherenkov Veto helps low-p PID

- **h-endcap: dRICH**

Ring imaging:

- **π/K < 50 GeV/c**
- **e/π <15 GeV/c**

"Veto" mode:

- **e/ π > few MeV/c**
- **π/K,p > 0.7 (1.0) GeV/c**
- **K/p > 2.5 (3.0) Gev/c**

- **e-endcap: mRICH**

Ring imaging:

- ***π/K: 2-9 GeV/c***
- **e/π : 0.6-2.0/2.5 GeV/c**

"Veto" mode:

- **k/π : 0.6-2 GeV/c**
- **e/π <0.6 GeV/c**
- **k/P <3.8 GeV/c**

- **barrel: hpDIRC**

Ring imaging:

- ***π/K <6-7 GeV/c***
- **e/π <1.2 GeV/c**

"Veto" mode:

- **e,k/π >0.2/0.3GeV/c**
- **k/P >1 GeV/c**

Cherenkov Veto ➔ Modest TOF Req.?

- **h-endcap: dRICH**

Ring imaging:
- **π/K < 50 GeV/c**
- **e/π <15 GeV/c**

“Veto” mode:
- **e/ π > few MeV/c**
- **π/K,p > 0.7 (1.0) GeV/c**
- **K/p > 2.5 (3.0) Gev/c**

TOF PID (3m path):
- π/K < 1.0 GeV/c ➔ ~230ps resolution
- K/p < 3.0 GeV/c ➔ ~80ps resolution

- **e-endcap: mRICH**

Ring imaging:
- ***π/K: 2-9 GeV/c***
- **e/π : 0.6-2.0/2.5 GeV/c**

“Veto” mode:
- **k/π : 0.6-2 GeV/c**
- **e/π <0.6 GeV/c**
- **k/P <3.8 GeV/c**

TOF PID (1.75m path):
- π/K < 0.6 GeV/c ➔ ~330ps resolution

- **barrel: hpDIRC**

Ring imaging:
- ***π/K <6-7 GeV/c***
- **e/π <1.2 GeV/c**

“Veto” mode:
- **e,k/π >0.2/0.3GeV/c**
- **k/P >1 GeV/c**

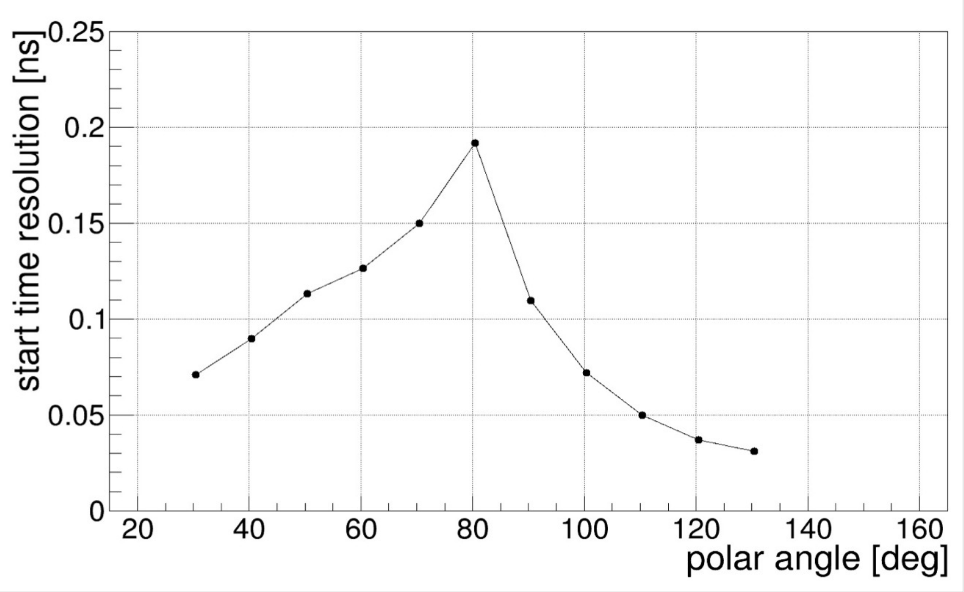
TOF PID (75cm path):
- e/π < 0.3** GeV/c ➔ ~60ps resolution
- π/k < 0.3 GeV/c ➔ ~470ps resolution
- K/p < 1.0 GeV/c ➔ ~155ps resolution

*Track angle & bending will make paths longer.
** 0.3 GeV/c is close to our minimal Pt…

+ TOF from DIRC 'for free'!

- **h-endcap: dRICH**
  - **Ring imaging:**
    - **π/K < 50 GeV/c**
    - **e/π <15 GeV/c**
  - **"Veto" mode:**
    - **e/ π > few MeV/c**
    - **π/K,p > 0.7 (1.0) GeV/c**
    - **K/p > 2.5 (3.0) Gev/c**
- **e-endcap: mRICH**
  - **Ring imaging:**
    - ***π/K: 2-9 GeV/c***
    - **e/π : 0.6-2.0/2.5 GeV/c**
  - **"Veto" mode:**
    - **k/π : 0.6-2 GeV/c**
    - **e/π <0.6 GeV/c**
    - **k/P <3.8 GeV/c**
- **barrel: hpDIRC**
  - **Ring imaging:**
    - ***π/K <6-7 GeV/c***
    - **e/π <1.2 GeV/c**
  - **"Veto" mode:**
    - **e,k/π >0.2/0.3GeV/c**
    - **k/P >1 GeV/c**

DIRC hit time resolution



TOF PID (75cm path):

- e/π < 0.3 GeV/c ➔ ~60ps resolution
- π/k < 0.3 GeV/c ➔ ~470ps resolution
- K/p < 1.0 GeV/c ➔ ~155ps resolution

+ TOF f… DIR… …

- **h-endcap: dRIC…**

Ring imagi…
- π/K …
- e/π <…

- **e-en…**

“Veto…
- **k/π : 0.6-2 Ge…**
- **e/π <0.6 GeV/c**
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- **barrel: hpDIRC**

Ring imaging:
- ***π/K <6-7 GeV/c***
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“Veto” mode:
- **e,k/π >0.2/0.3GeV/c**
- **k/P >1 GeV/c**

Still under PID WG study.
Attend meetings to be part of the discussion!

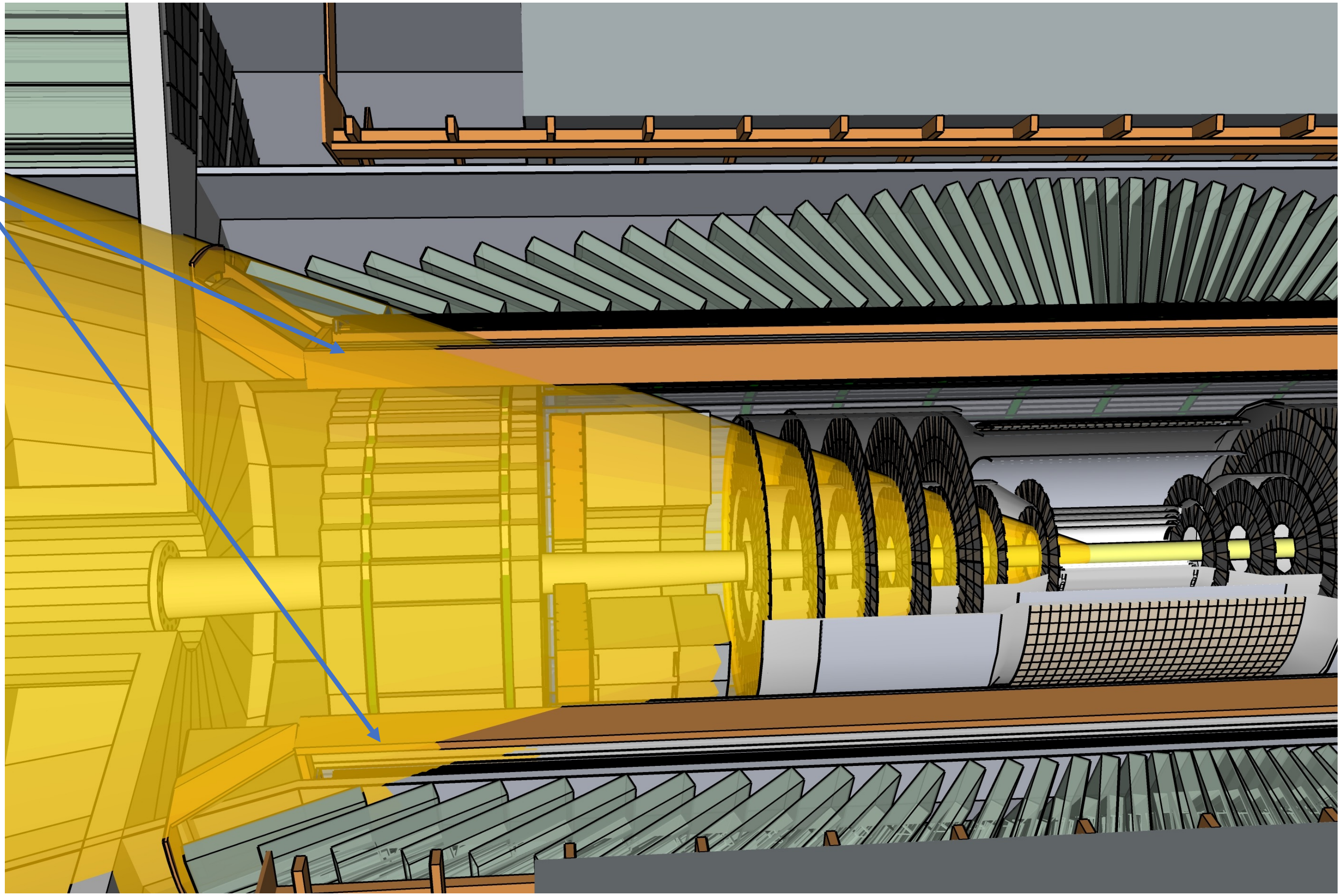
Previously stated AC-LGAD (~25ps) which cost ~$25M for ECCE. Studying alternatives, e.g., crystals in barrel (30 – 60ps), mRPC in endcap (50 – 80ps).

TOF PID (75cm path):
- e/π < 0.3 GeV/c ➔ ~60ps resolution
- π/k < 0.3 GeV/c ➔ ~470ps resolution
- K/p < 1.0 GeV/c ➔ ~155ps resolution

ECCE Mechanical Integration

Working to achieve hermetic EM-Cal coverage, e.g., moving the backward EMCal inward.

Too soon to discuss details (e.g. impact on other detectors etc.)



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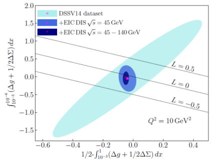
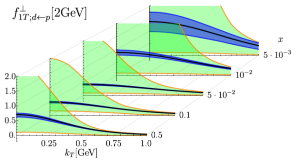
ECCE Physics Studies [Analyzing 150M Events]

Studies to demonstrate EIC NAS Study, Yellow Report physics

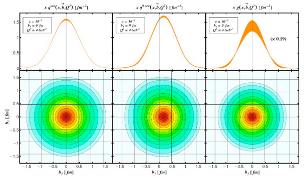
- Origin of Nucleon Spin



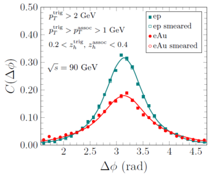
- Confined motion of partons



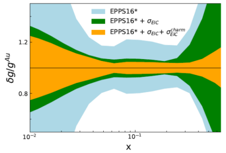
- 3D imaging of quarks and gluons



- Nucleon mass
- High gluon densities in nuclei

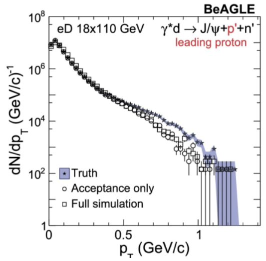


- Quarks and gluons in the nucleus

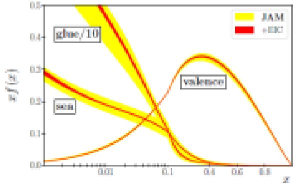


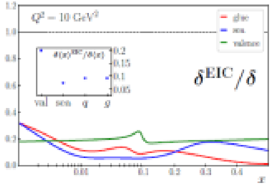
Studies to show unique ECCE strengths

- Light-ion tagging



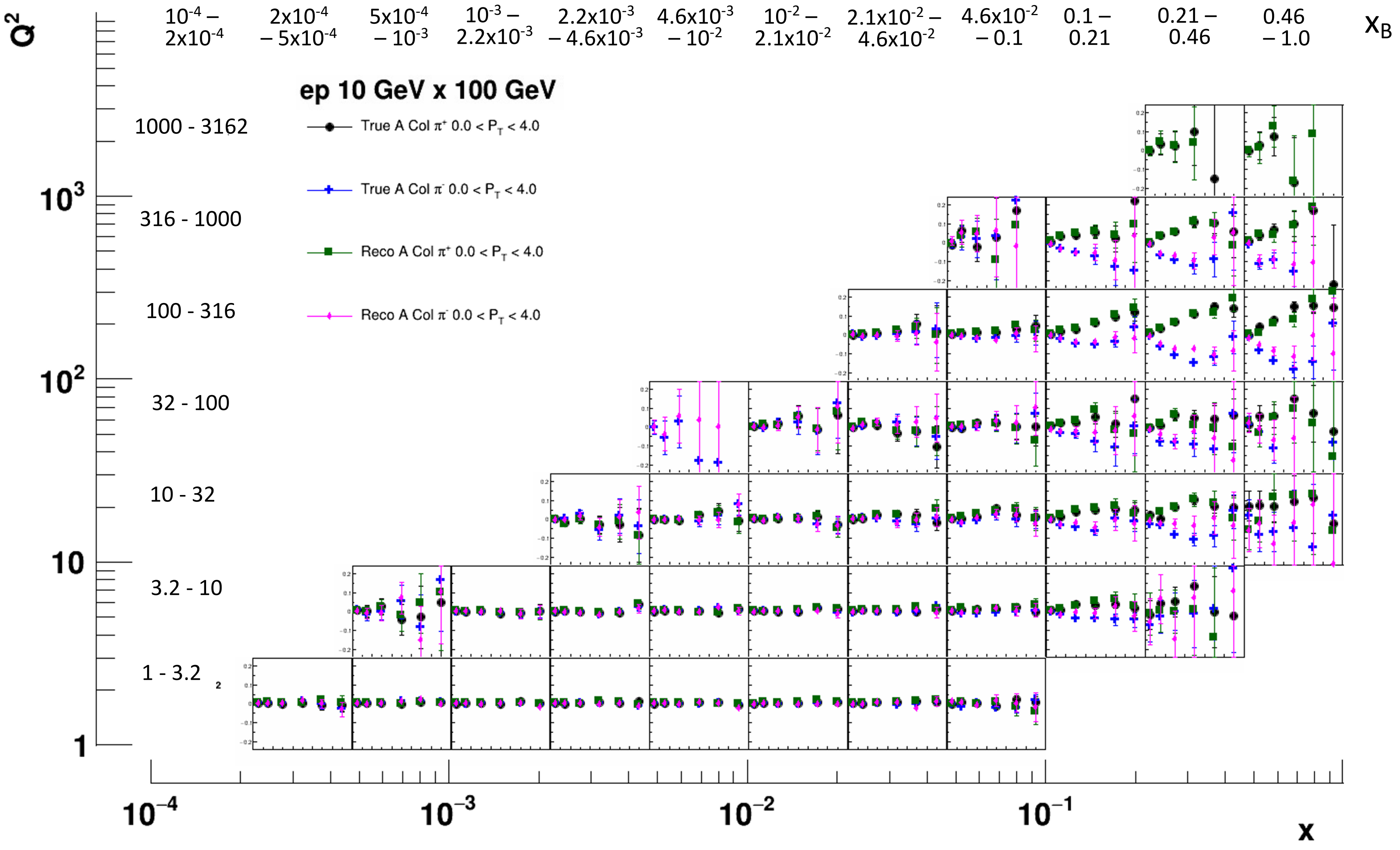
- Pion/Kaon structure



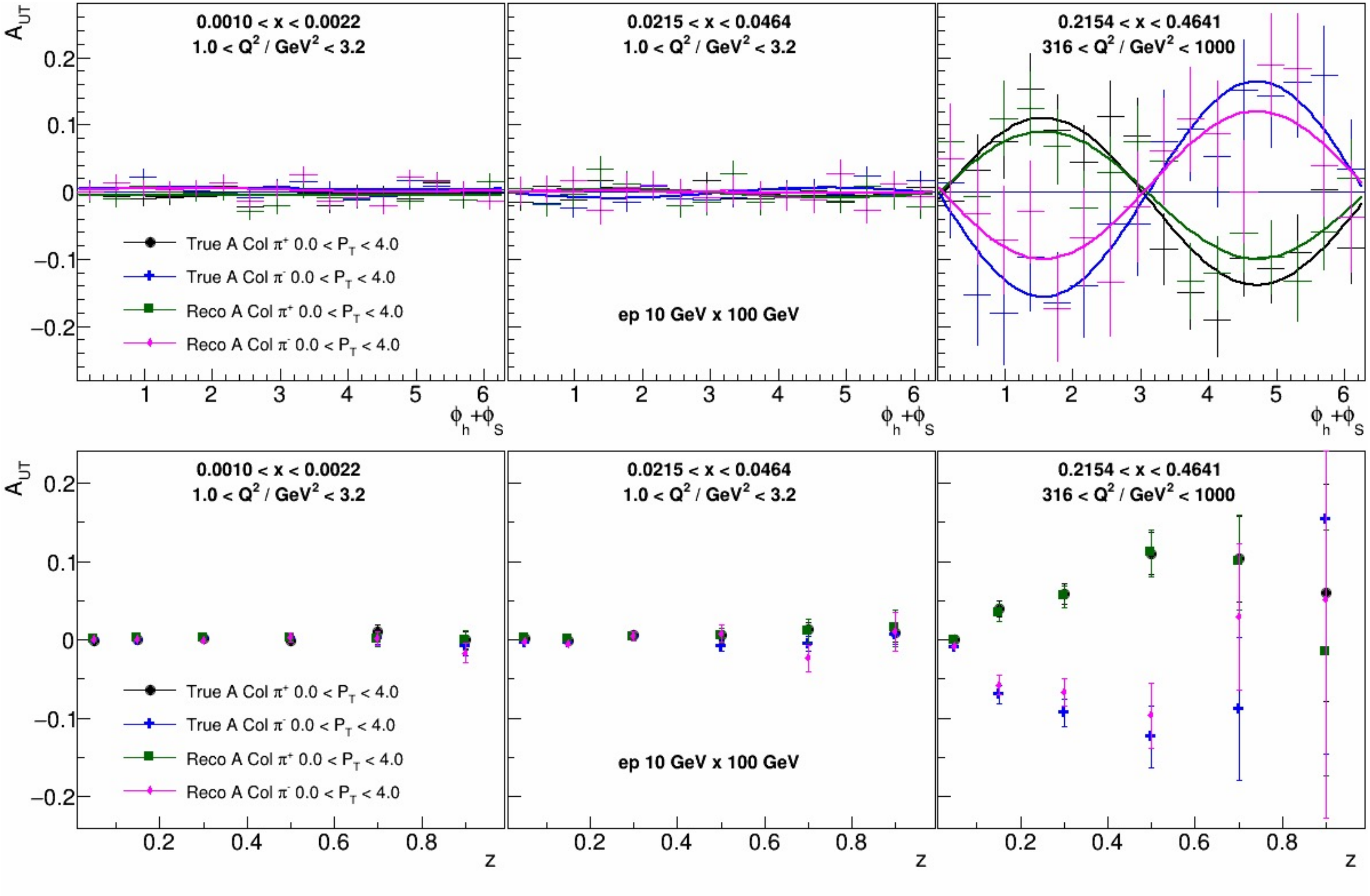


- Diffractive jets?
- Nuclear modifications and in-medium evolution
  - D/D* reconstruction and heavy-flavor in jets.

SIDIS Collins Asymmetries



Raw asymmetries in med. z bin



Note: These are 1D Collins angle projections for visualization only, actual Sivers and Collins asymmetries are fit simultaneously in 2D distributions!

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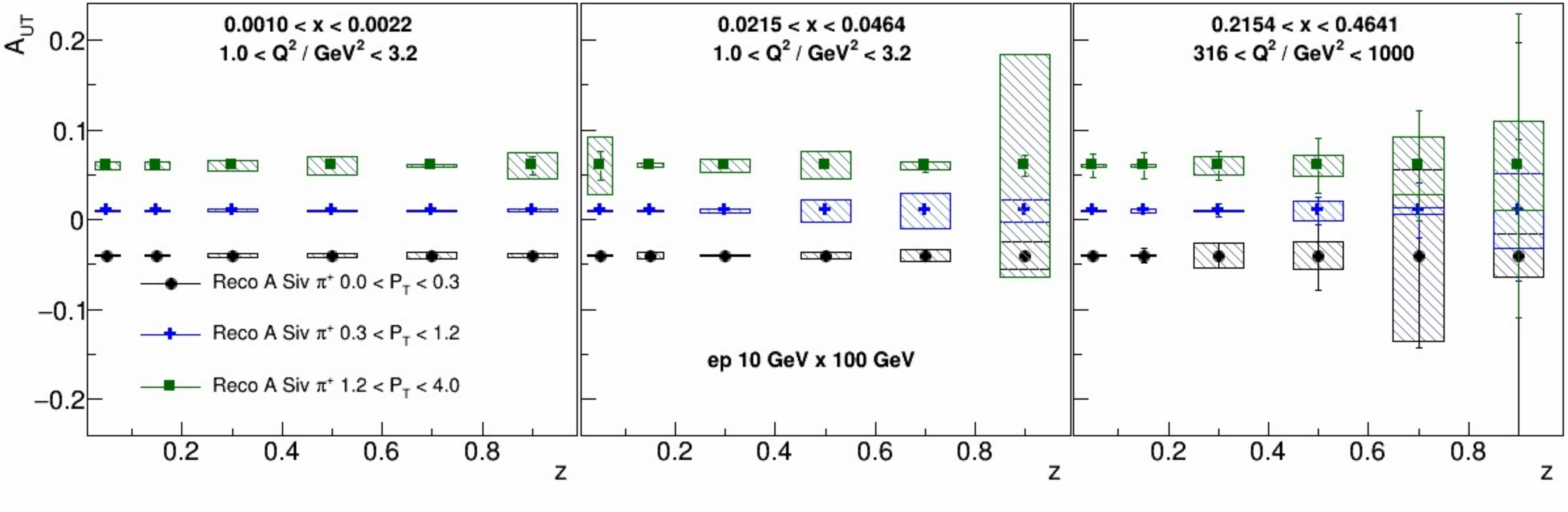

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Diversity Equity and Inclusion

- Circulated Code of Conduct.

https://docs.google.com/document/d/1yWBw47xXJNLXV3zRgOmYzmDOB2rcVE3RWghghZGfuDM/edit?usp=sharing

- Requesting feedback as we plan to bring it to IB vote next week.

- Feedback doc:

https://docs.google.com/document/d/1HHa6Isgz-EKYnvg_JkmRjarmBfh3Yve-T3nqixvBjB0/edit?usp=sharing

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Cost & Schedule

- ORNL working w/DWG convenors on cost, schedule and risk estimates
  - Detailed input requested by August 13th
- Communication w/Project:
  - Polarimetry not costed as part of detector
  - Luminosity monitor should be costed
    - *Need effort on this*
  - Good communication on infrastructure:
    - Detector vs. IR clarified
    - Working w/sPHENIX on cradle, racks, etc.
- Meeting between SC and ORNL cost/schedule in near future.

Table 1: The cost breakdown for the global detector systems.

EIC Reference Detector Cost Estimate	
WBS	**$M**
Detector Management	7.4
Detector R&D	12.1
Tracking	31.1
PID	26.5
Electromagnetic Calorimetry	36.2
Hadronic Calorimetry	33.1
Magnet	29.7
Electronics	17.1
DAQ Computing	8.7
Detector Infrastructure	26.4
IR Integration & Auxiliary Detectors	8.1
Detector Pre-Ops & Commissioning	8.7
TOTAL	**245.1**

Costs shown in $US(2021).
In-kind of ~$90M assumed in total.

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Path Forward

- Aug. 1st - Sep. 15th   [1.5 months]:
  - Simulated data analysis & physics performance demonstration.
  - 2nd Large-scale simulations production
- Sep. 15th - Nov. 1st   [1.5 months]:
  - All ‘physics plots’ are ready.
  - Final technology evaluation based on physics studies results.
  - Proposal narrative composition around simulation results & selected technologies.
- Nov. 1st - Nov. 30th   [1 month]:
  - Proposal review by external colleagues.
  - Final edits

Keep it up! ☺

Software Narrative

Must

Should

Want

ECCE Software Narrative

Must	Mature software to implement ECCE in full G4 simulation with analysis tools that enable *physics informed* decisions. ➔ Fun4All
Should	
Want	

ECCE Software Narrative

Must	Mature software to implement ECCE in full G4 simulation with analysis tools that enable *physics informed* decisions. → Fun4All
Should	Advanced, specialized, tools that can significantly impact the detector design. → AI/ML; ACTS
Want	

ECCE Software Narrative

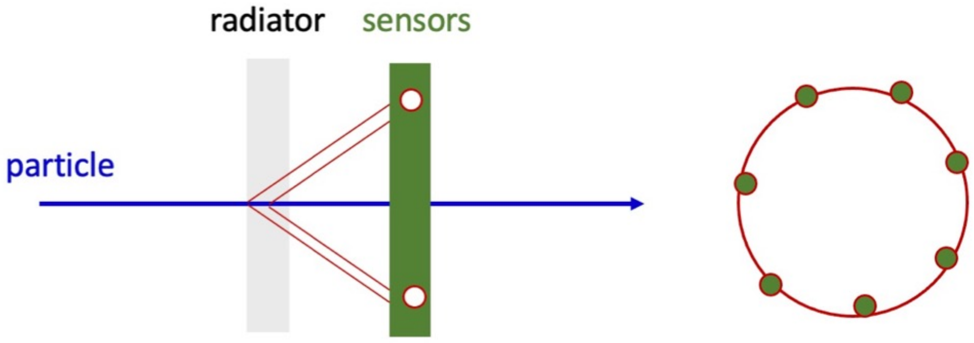
Must	Mature software to implement ECCE in full G4 simulation with analysis tools that enable *physics informed* decisions. ➔ Fun4All
Should	Advanced, specialized, tools that can significantly impact the detector design. ➔ AI/ML; ACTS
Want	'Forward looking' software tools that *do not* significantly impact the detector design (e.g. DD4hep). ➔ Not at this stage...

Cherenkov 'Veto' Mode

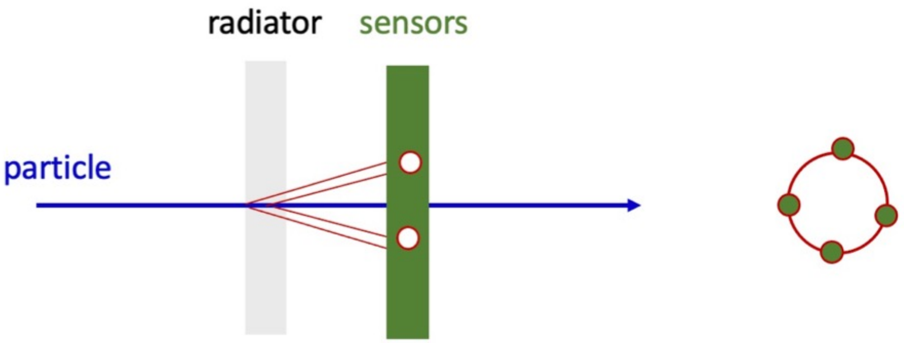
Standard RICH: photons detected when particle above threshold and hit the sensor plane

DIRC: photons still need to survive the total internal reflection limit

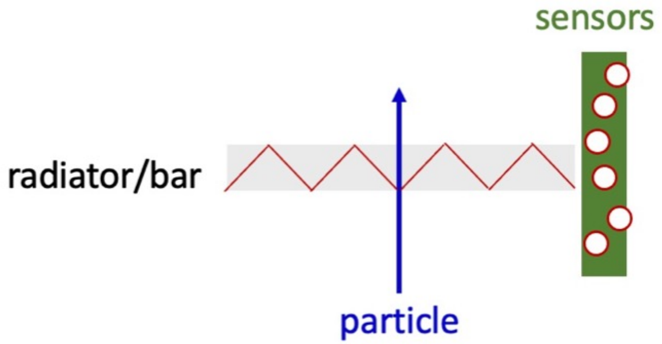
gaseous RICH, p >> p_{thresh}



gaseous RICH, p = p_{thresh} + Δp



DIRC, p >> p_{thresh}



DIRC, p = p_{thresh} + Δp