EIC PID in DELPHES

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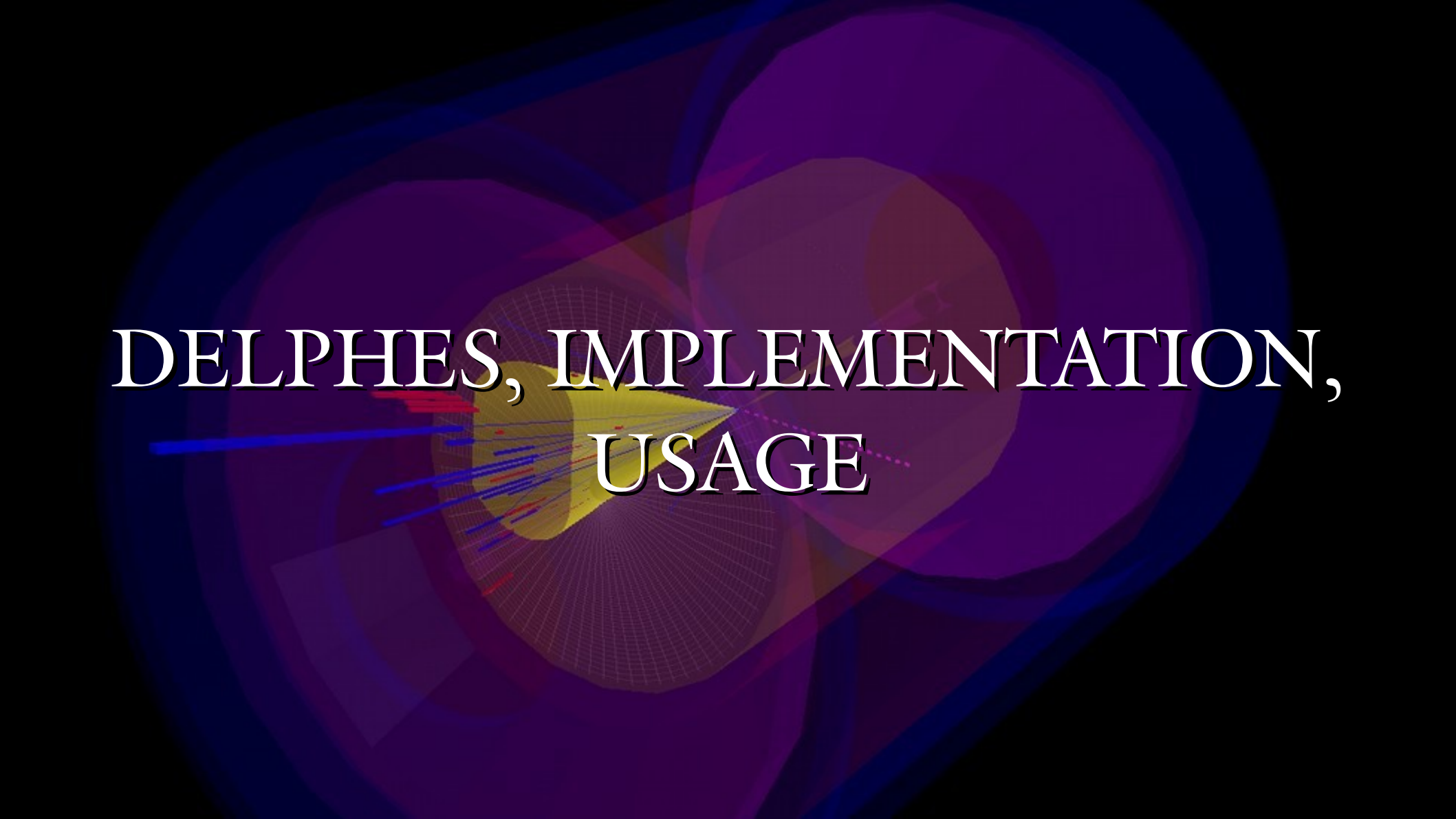
Outline

- DELPHES structure – reminders
- Implementation and usage
- Results – kaons and pions
- Next steps

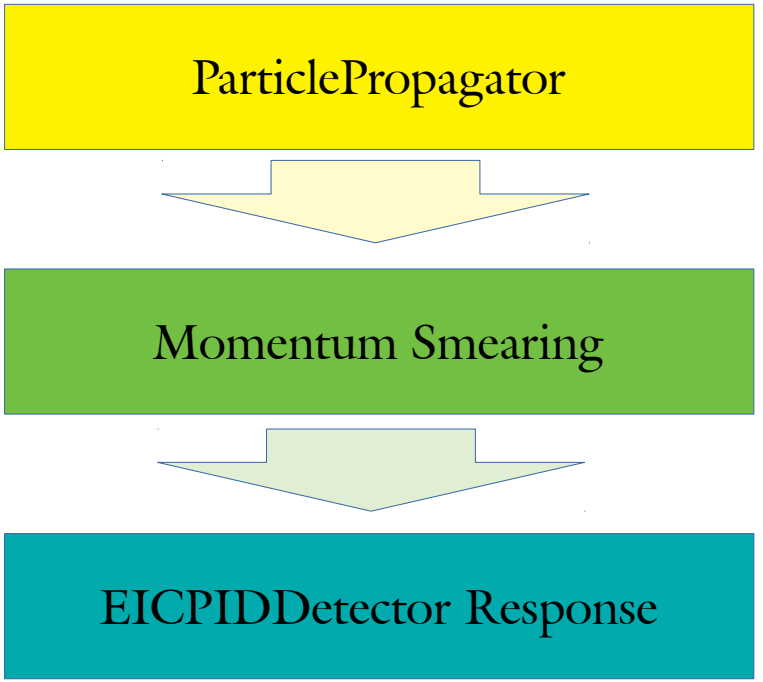


DELPHES, IMPLEMENTATION, USAGE

DELPHES

- Fast parameterized simulation of detector
- Modular
- Forked from main project: created EICPIDDetector module to interface with PID code, updated Makefile

https://github.com/stephensekula/delphes



DELPHES_EIC

- PYTHIA8 and DELPHES configuration of EIC baseline-like detector

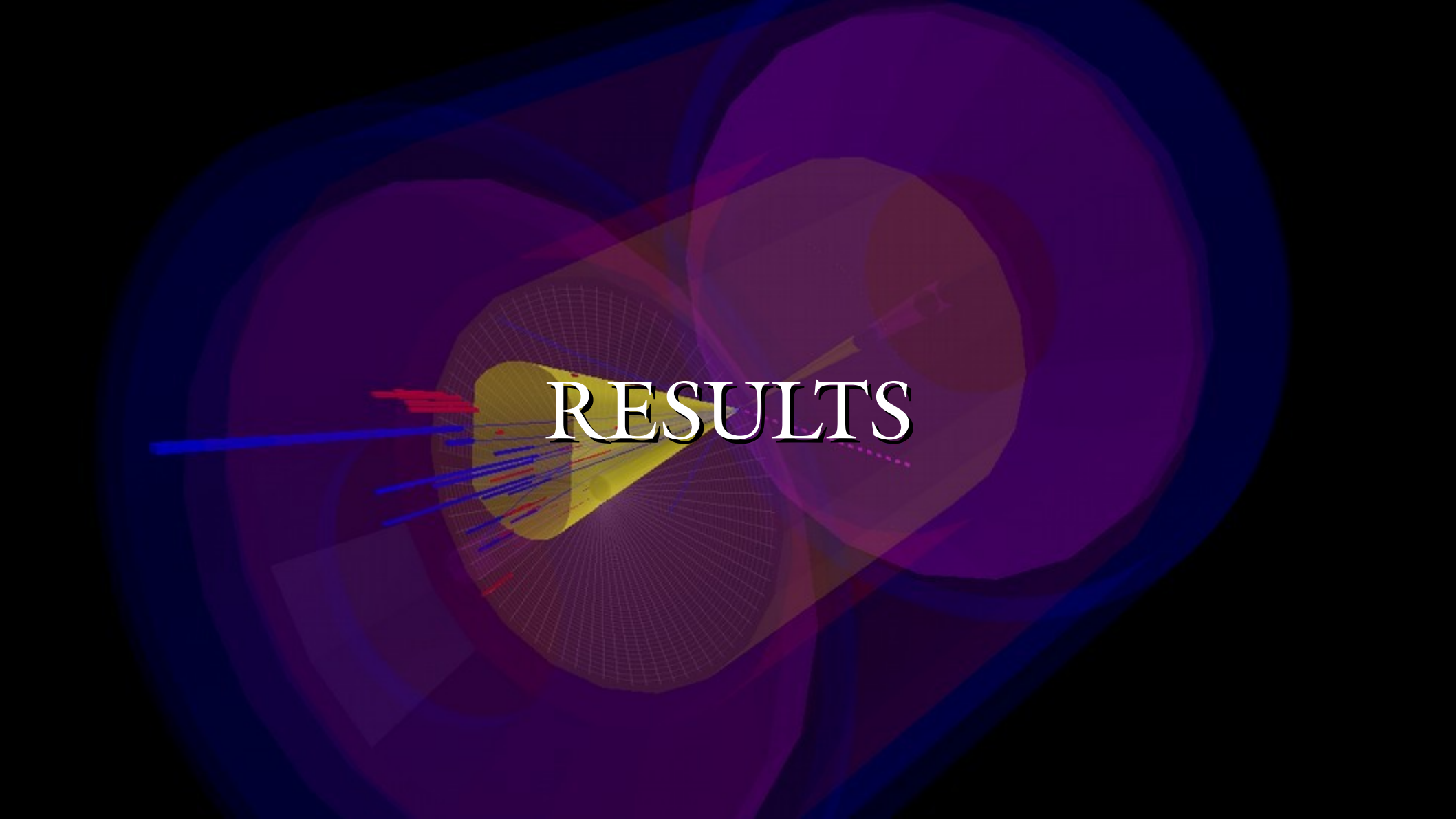
https://github.com/stephensekula/delphes_EIC

- Mostly for steering and production, with some rough analysis tools provided
- Forked from Miguel Arratia's original code to allow for dependency on my forks of DELPHES and PID

https://gitlab.com/stephensekula/pid

PID

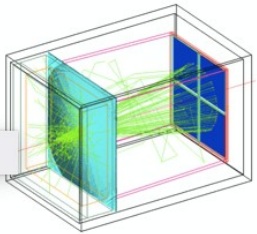
- A fork of the original repository https://gitlab.com/preghenella/pid/
- **Fork allows for standalone compilation** of each PID folder's code (e.g. mRICH, dRICH, quintRICH, etc.) as a library.
  - git clone this into the delphes/external/ folder for compilation by the general DELPHES Makefile.
- **Also some code cleanup** (e.g. one PID script had a for-loop that was repeated for every collision and was computationally expensive, but only needed to be run once, etc.) → small things, but useful to fix.

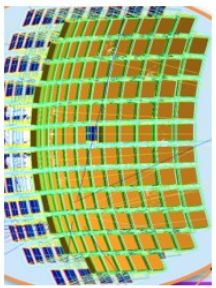

RESULTS

Individual hadrons (π, K, p) identification

Electron end-cap: Modular RICH

•Modular aerogel RICH: compact, using lens-based design to **reduce ring size and sensor plane area**



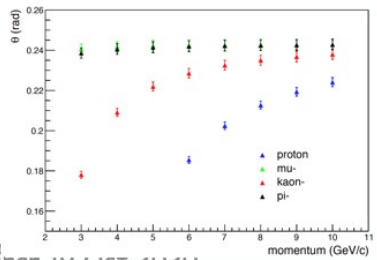


•Separation (3σ):

0.56 GeV < e/π < 2 GeV ,

0.56 (2.0) GeV < π/K < 8 (10) GeV,

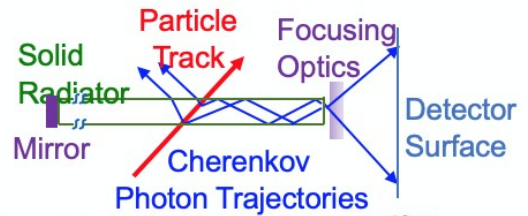
2.0 (3.8) GeV < K/p < 12 GeV



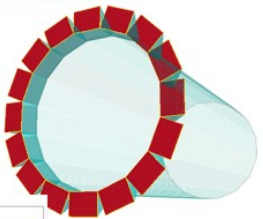
Ping Wong

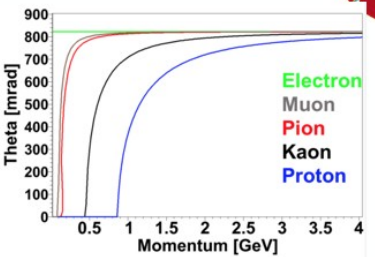
Barrel: DIRC

•radially compact (5 cm)



Current design based on narrow synthetic fused silica bars arranged in 16 barboxes, coupled to solid prisms with custom made 3-layer lens, read out by arrays of MCP-PMTs.





•Simulation for particle identification (3σ):

0.15 < e/π < 1.8 GeV

0.15 (0.45) < π/K < 6 GeV,

0.45 (0.8) < p/K < 10 GeV

Greg Kalicy

Hadron end-cap: dual-radiator RICH

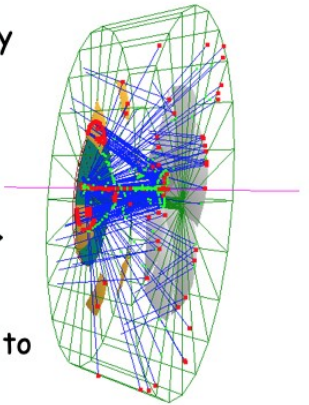
Alessio Del Dotto

• JLEIC design geometry constraint: ~160 cm length

• Aerogel in front, followed by C_2F_6

•Outward reflecting mirror

•Focal plane away from the beam, reduced background



•Sensitive to magnetic field=> New 3T solenoid minimized a field in RICH region

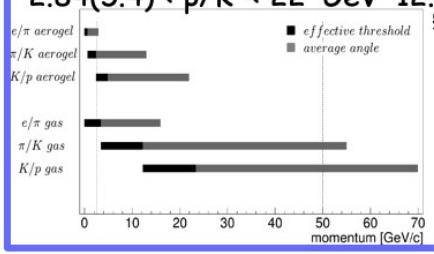
•Aerogel drives the detector to be solid state (e.g. SiPMs, LAPPDs)

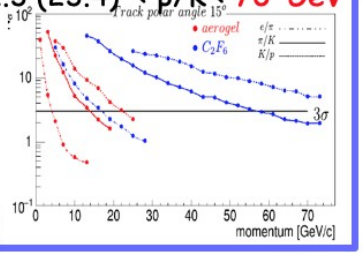
•Particle identification:

0.003(0.8) < e/π < 4 GeV 0.01 (3.48) < e/π < 18 GeV

0.8 (2.84) < π/K < 14 GeV 3.48(12.3) < π/K < 55 GeV

2.84(5.4) < p/K < 22 GeV 12.3 (23.4) < p/K < 70 GeV

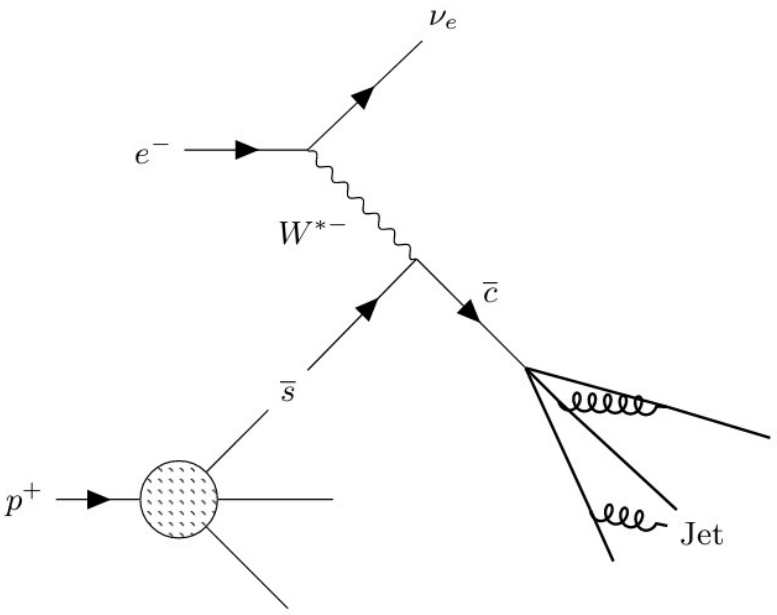


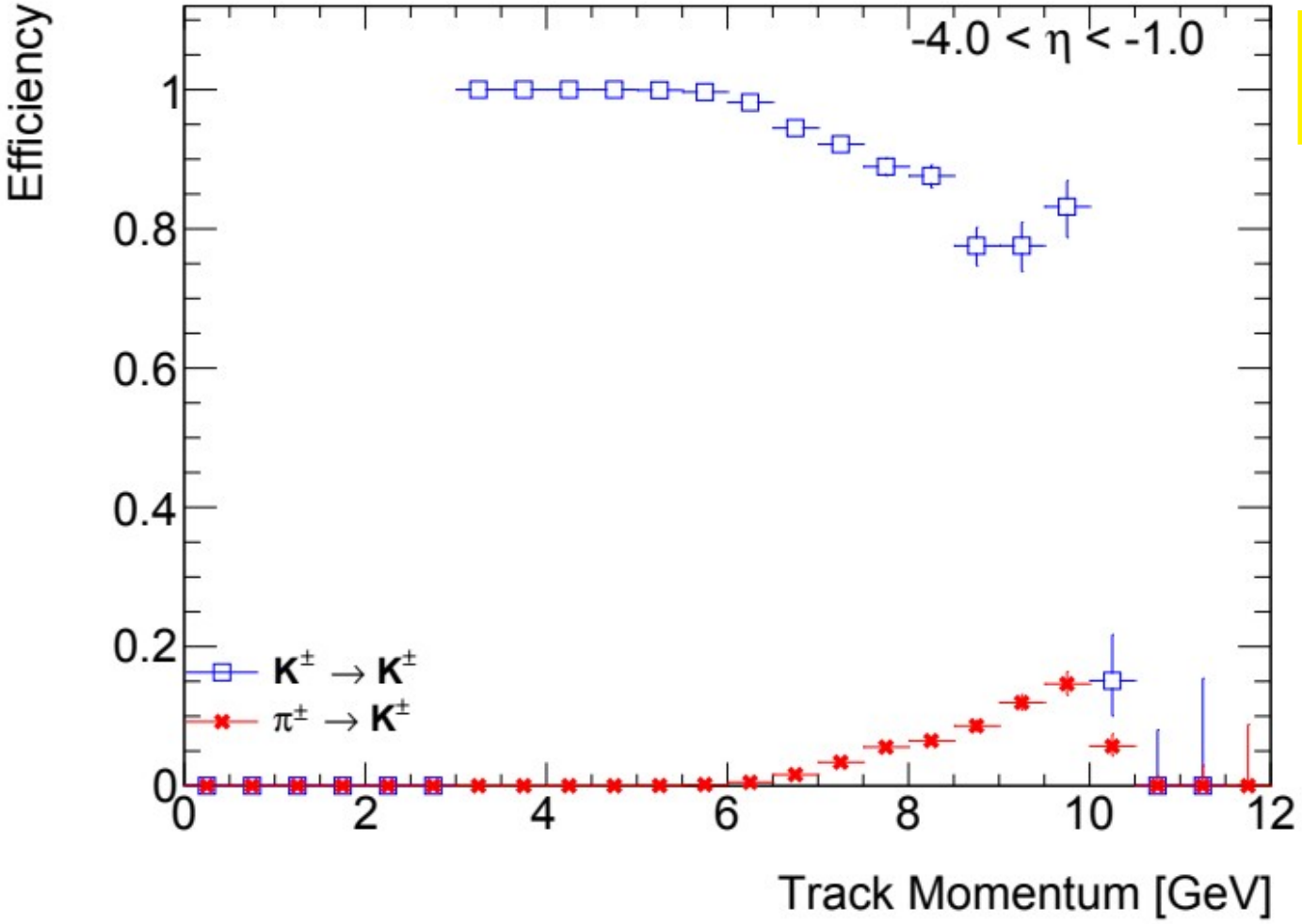


Slide from Y. Furletova

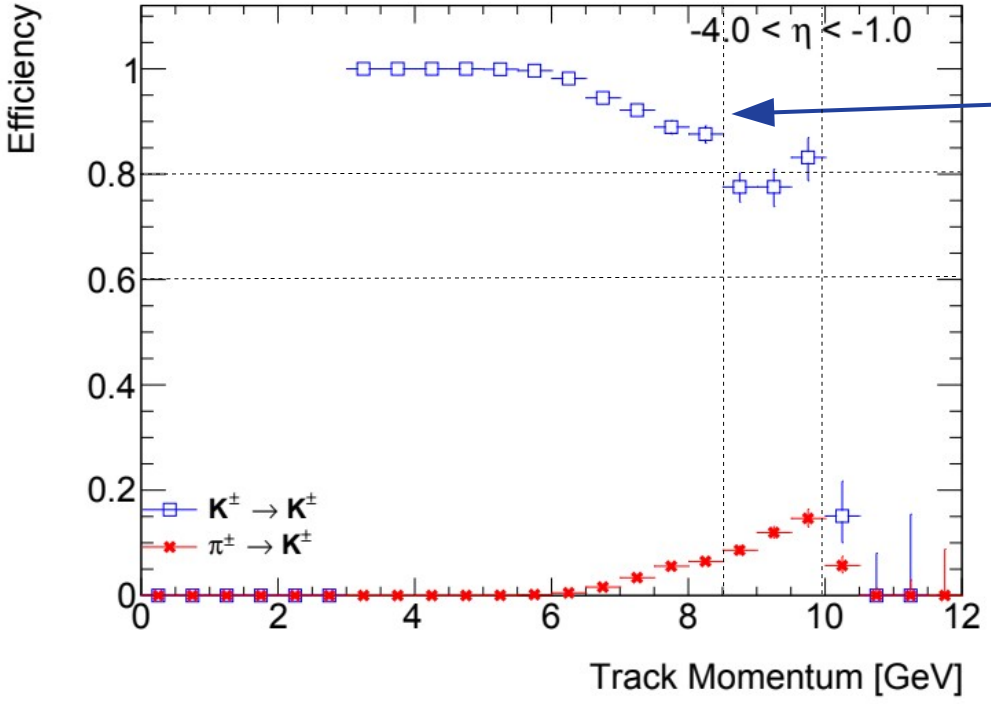
Events Studied

- CC DIS, PYTHIA 8, CT18NNLO PDF
  - *20 million e-p collisions at √s=105 GeV*
  - *Jets mostly forward (hadronic endcap)*
- K/π identified using truth
  - *Classified using PID detector*
- Smeared tracks passed to PID code…
  - *Probably not the right approach, but effectively treats the particles as if their momentum has been smeared by interactions before entering the PID system. No additional smearing due to PID system passage…*



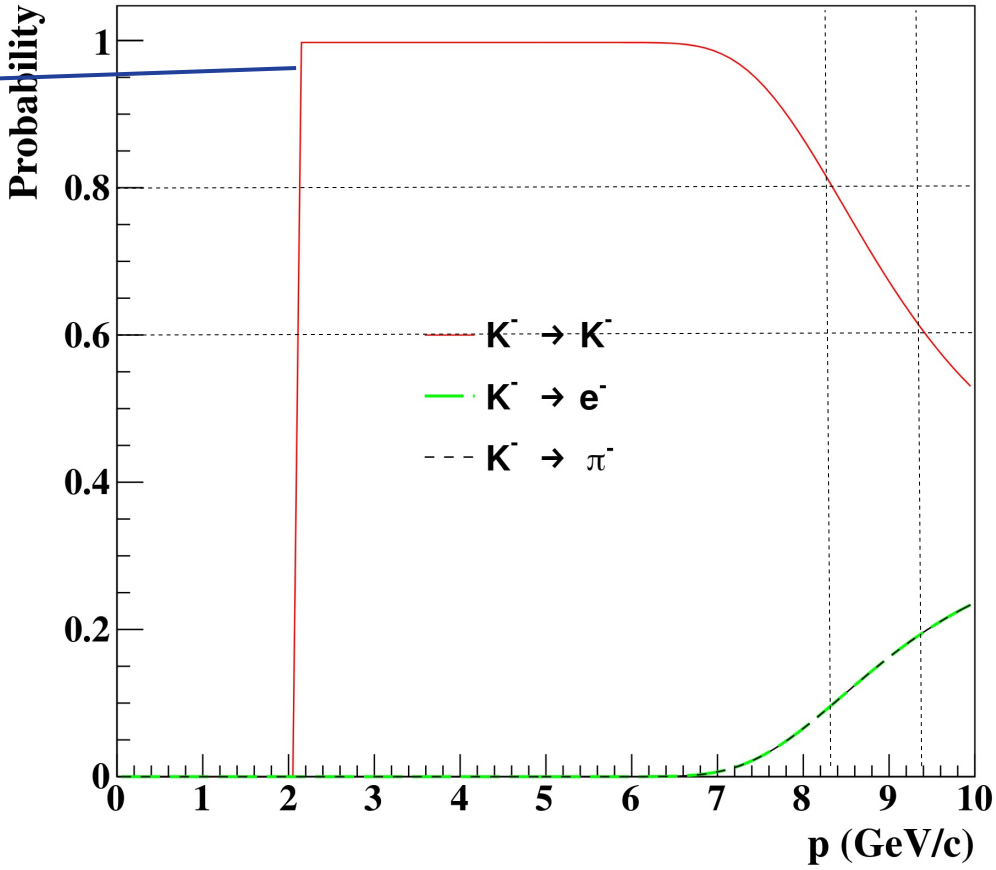


Electron Endcap
(mRICH)



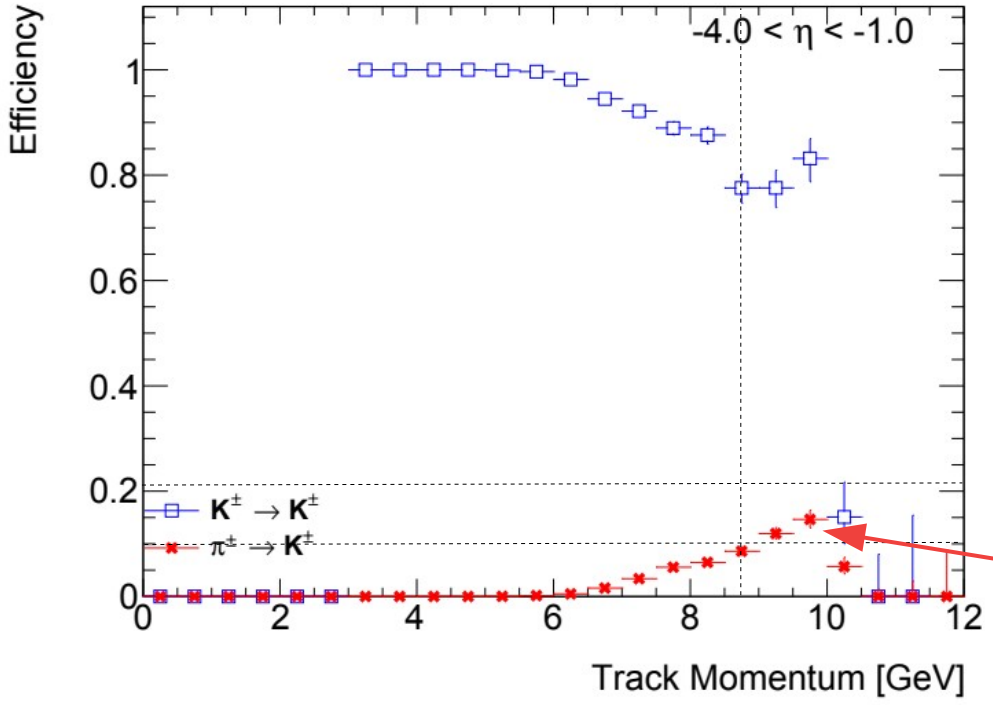
Electron Endcap
(mRICH)

pixel = 3 mm / Track Resol = 1 mrad



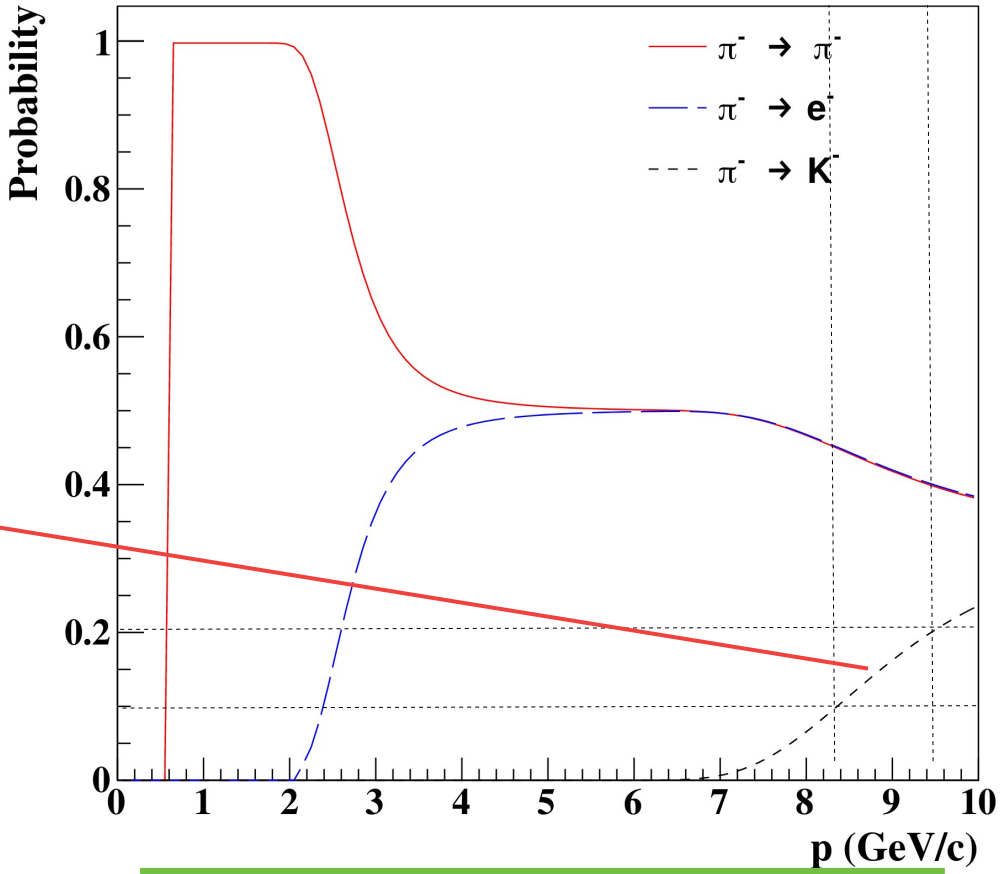
Plot from M. Sarsour

Dotted lines mark where particles reach 80% or 60% efficiency...



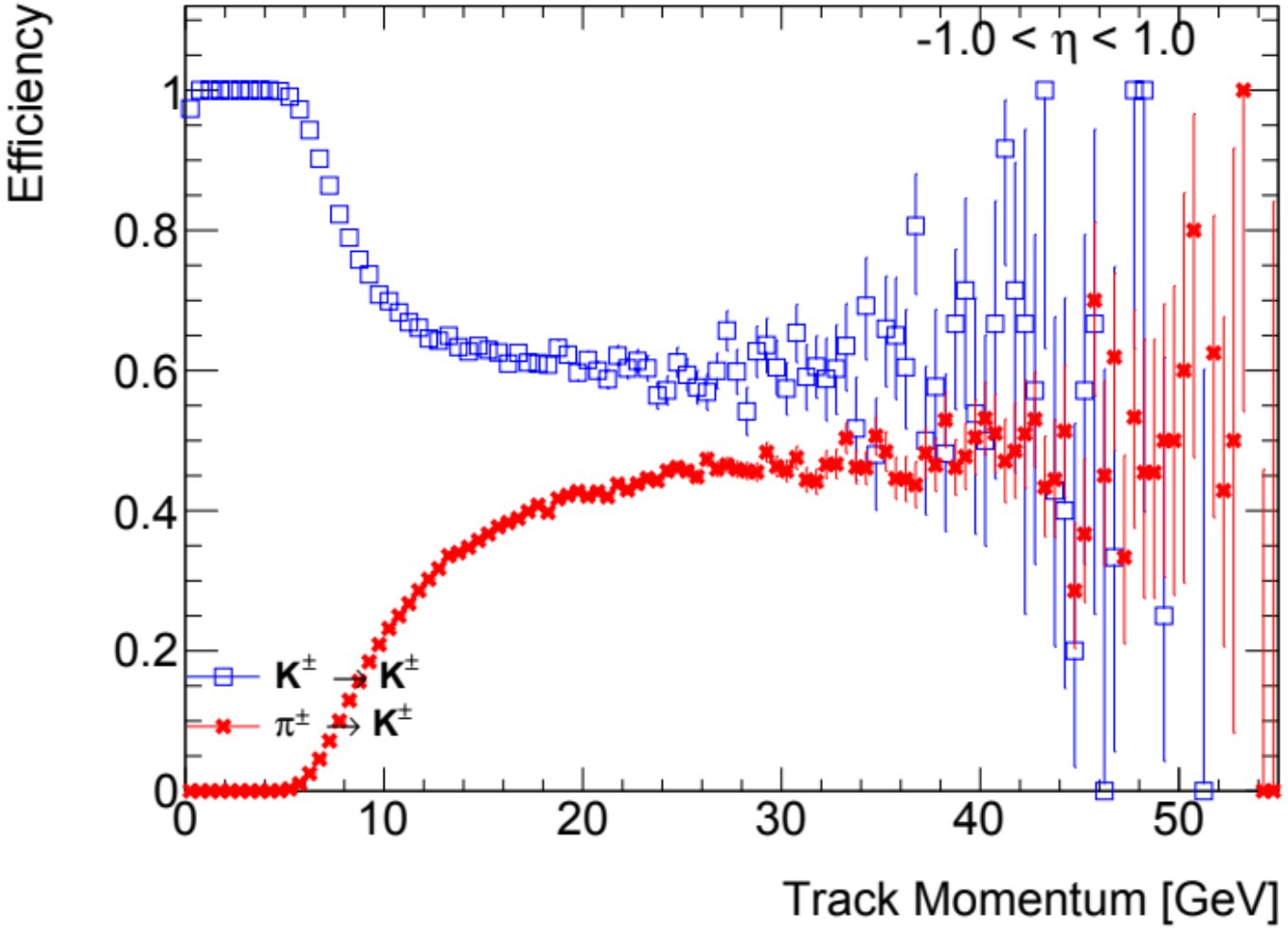
Electron Endcap
(mRICH)

pixel = 3 mm / Track Resol = 1 mrad

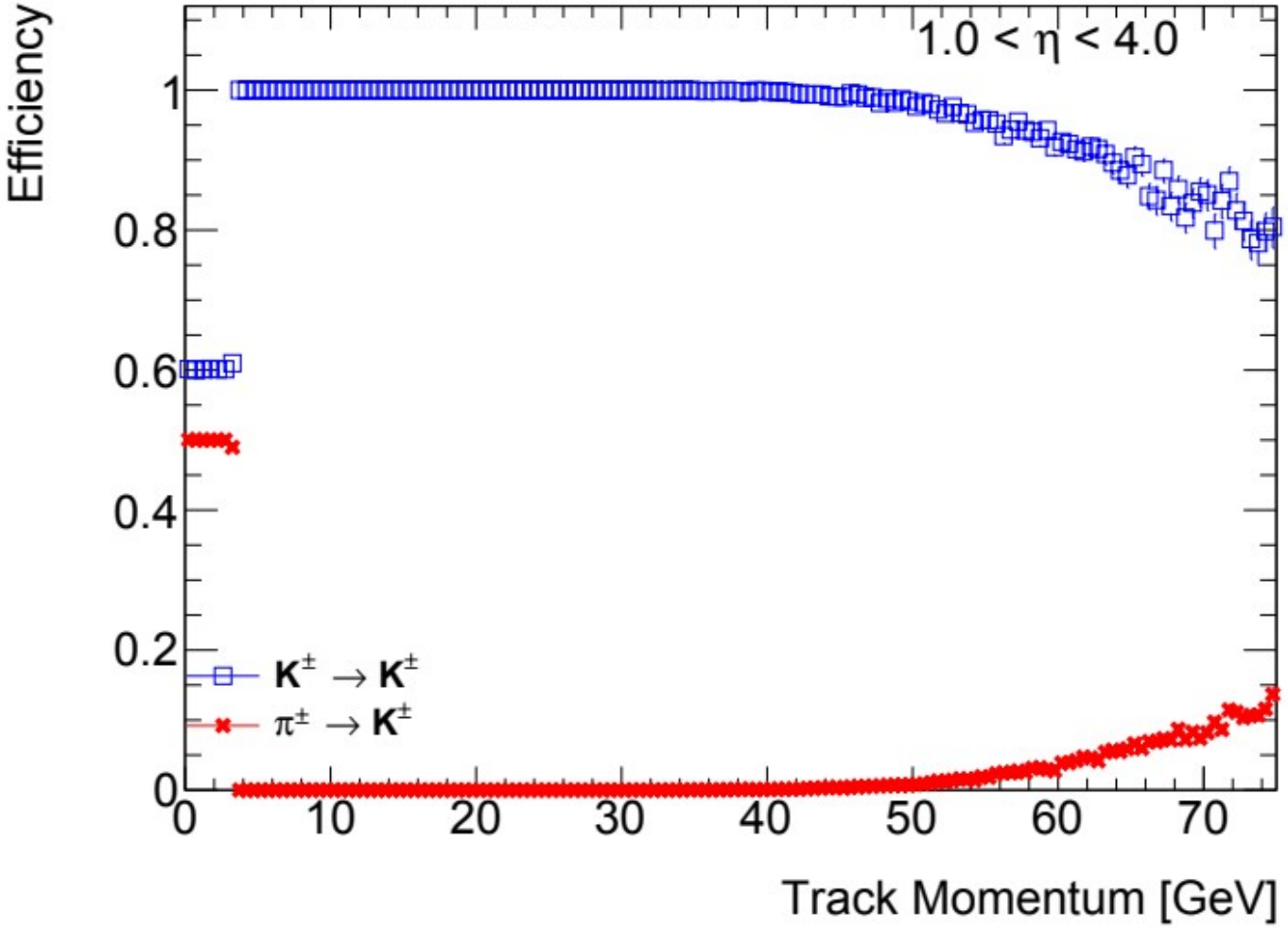


Plot from M. Sarsour

Dotted lines mark where particles reach 10% or 20% efficiency...



Barrel
(barrelDIRC)



Hadron Endcap
(dual RICH)


NEXT STEPS

Next Steps

- Feedback from PID group → does the performance look "as expected"?
- From my physics analysis side of things:
  - *Incorporate PID label as input to multivariate charm jet flavor tagger (e.g. MLP neural network)*
    - ***Preliminary look:*** *a dedicated Kaon-based Charm Tagger MLP using pT and PID flag for two highest p_T jet tracks has a 20% signal efficiency for a 0.4% light-jet mis-tagging rate, benchmarked to what we found from a cut-based signed impact parameter (sIP3D) approach in arXiv:2006.12520*
      - *sIP3D + Kaon tagger leads to only small overall gain in combination.*