TPC dE/dx Performance

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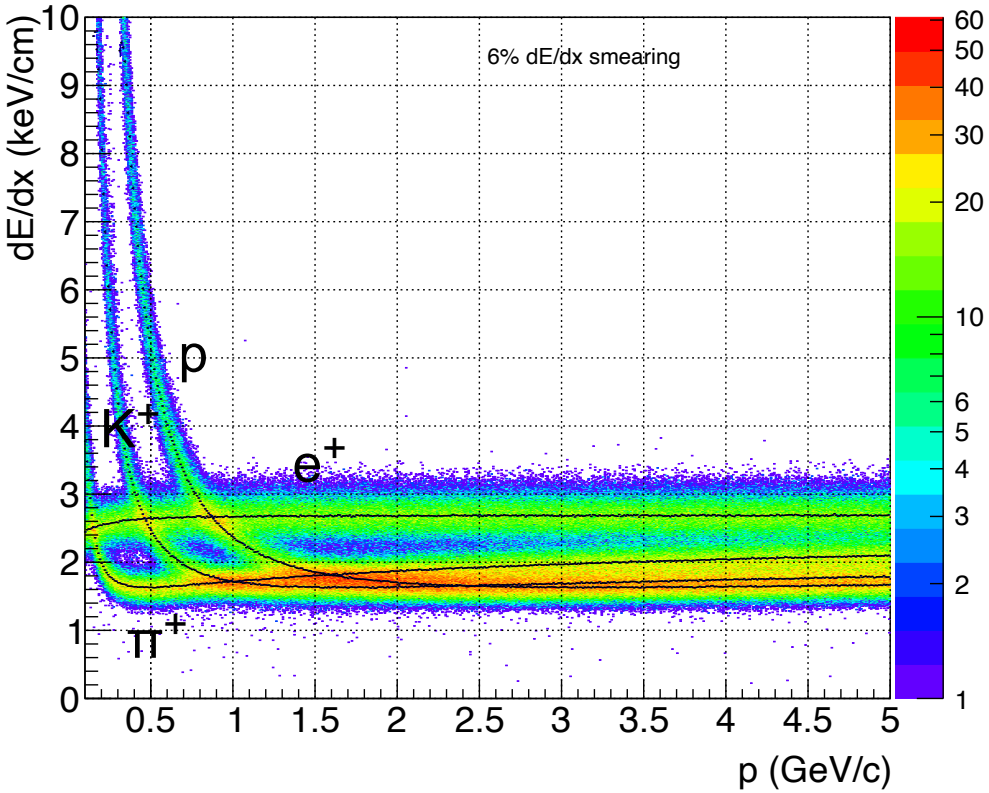
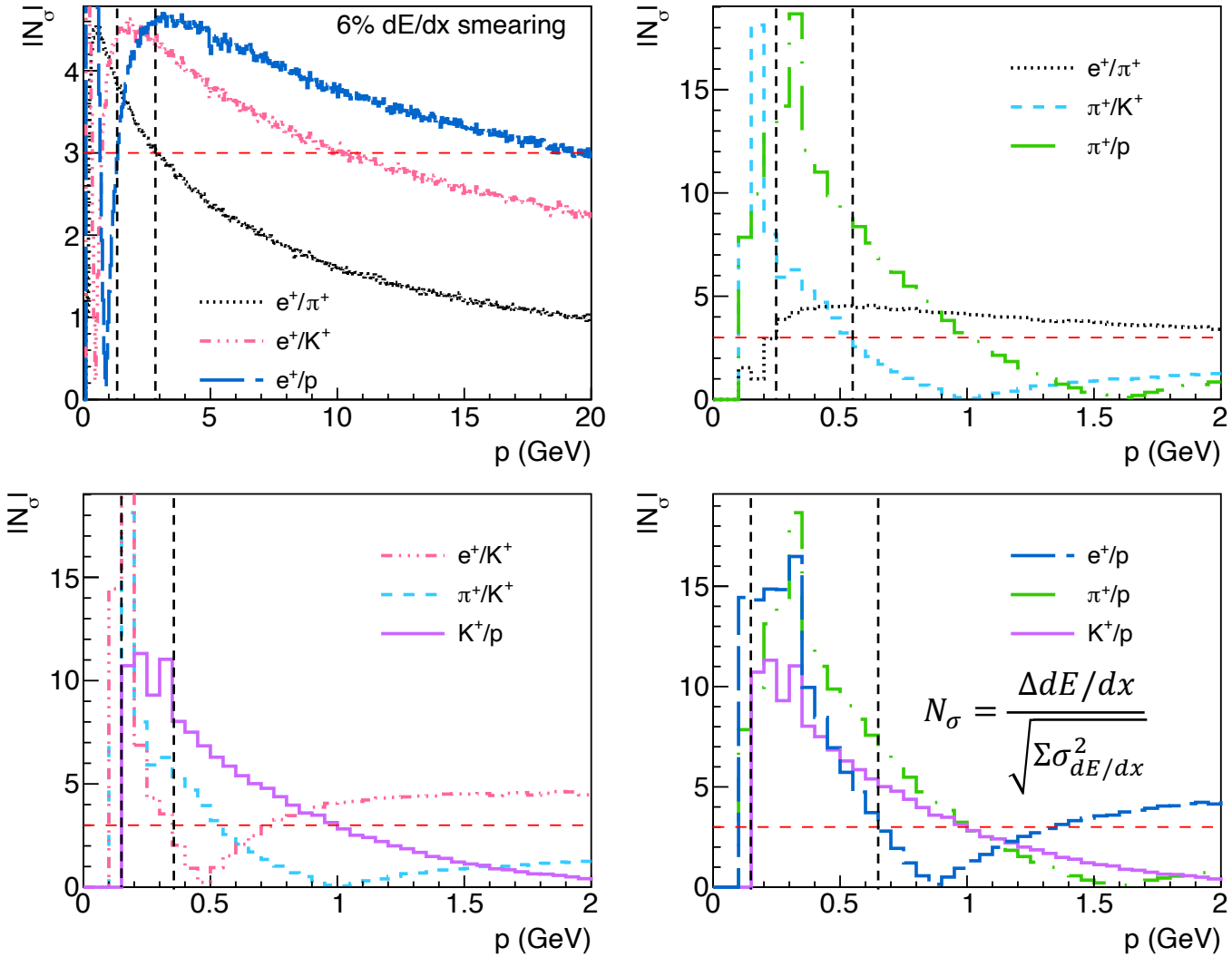
PID Separation Power using dE/dx

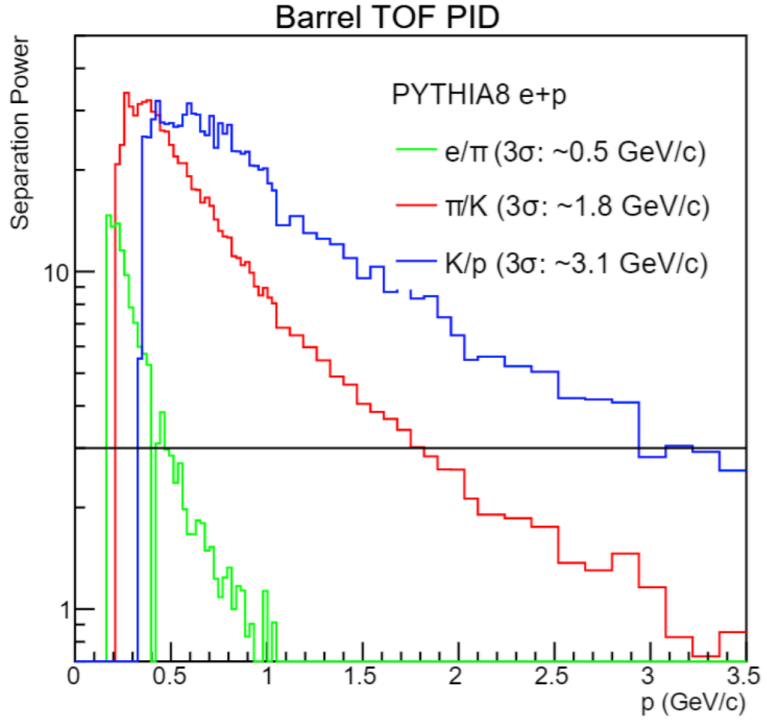
- Single track events, $|\eta| < 1$
- 6% dE/dx smearing (STAR: 8%, ALICE (6-9%))
- No hit/clustering efficiency
- Did not apply TPC digitization





e ID $\geq 3\sigma$	1.3 < p < 2.9 GeV
π ID $\geq 3\sigma$	0.25 < p < 0.55 GeV
K ID $\geq 3\sigma$	0.15 < p < 0.4 GeV
p ID $\geq 3\sigma$	0.15 < p < 0.7 GeV

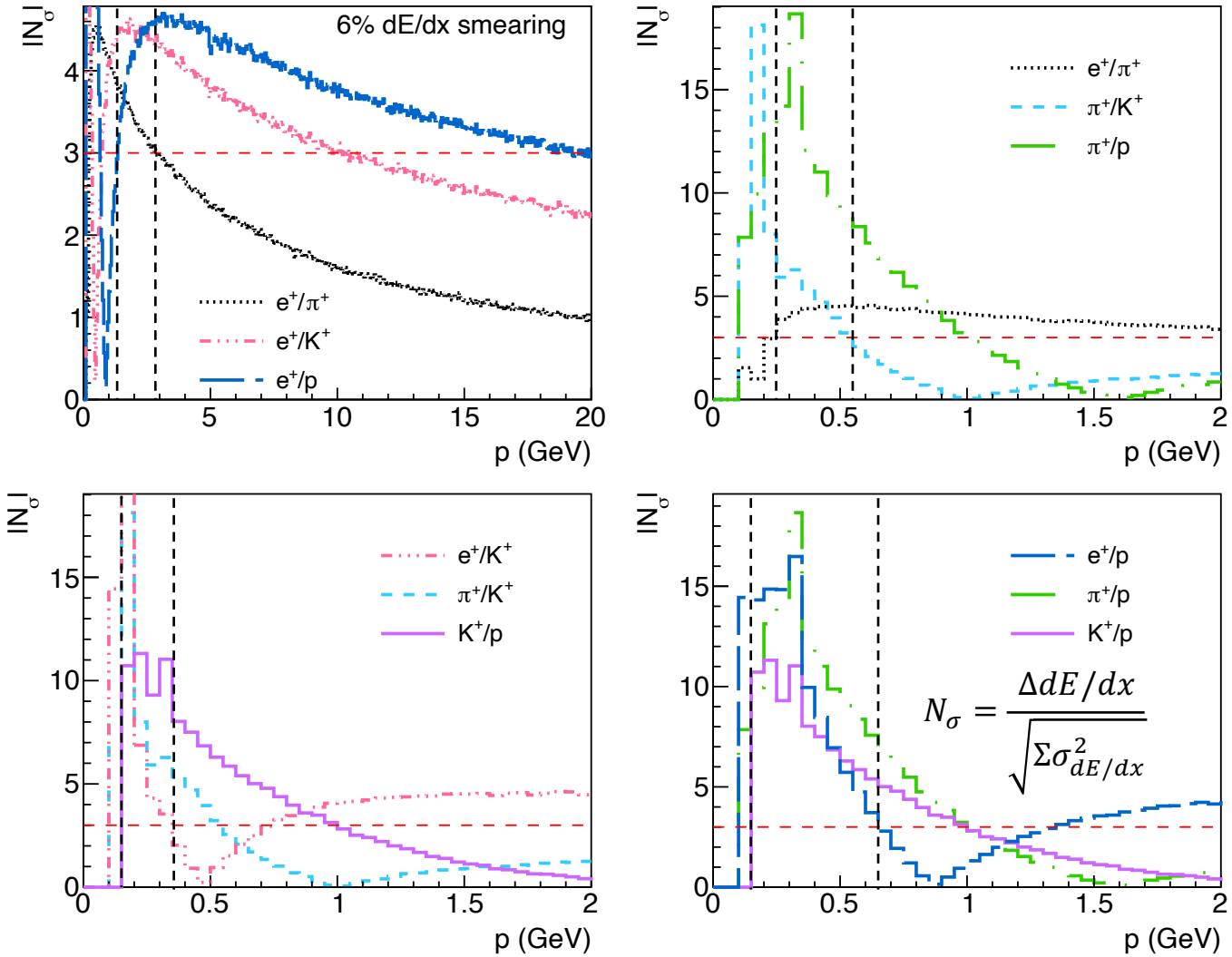
PID Separation Power using dE/dx



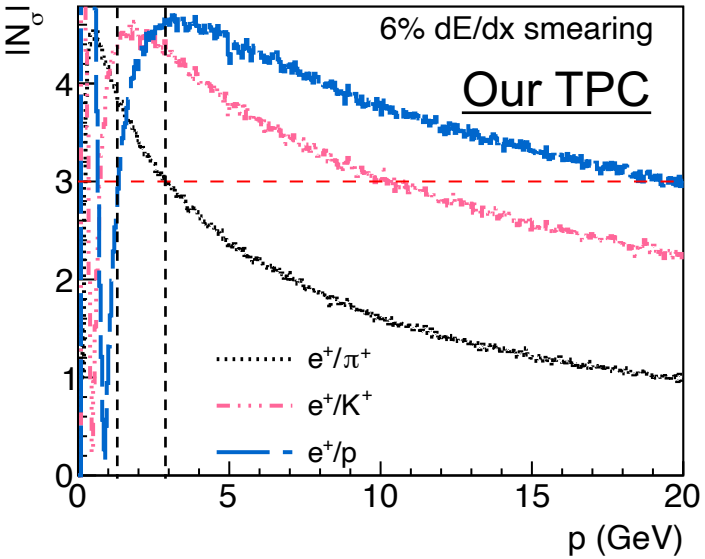
https://indico.bnl.gov/event/17621/contributions/71751/subcontributions/2172/attachments/45491/76755/EPIC_TOF_SIM_COLLAB.pdf

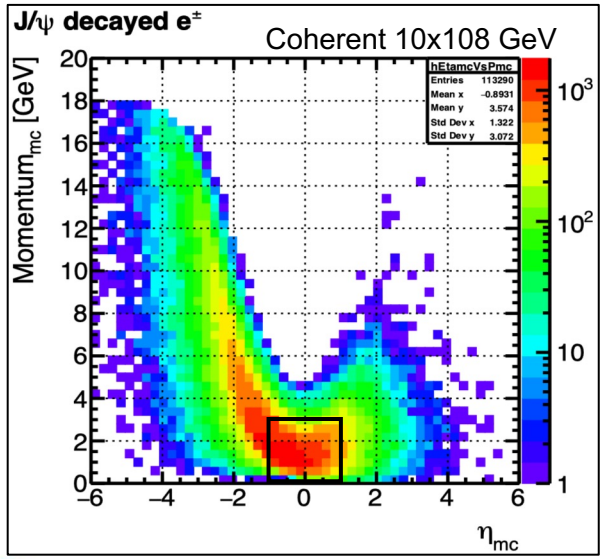
TPC could provide e/π separation in a wider momentum range compared to the ePIC ToF

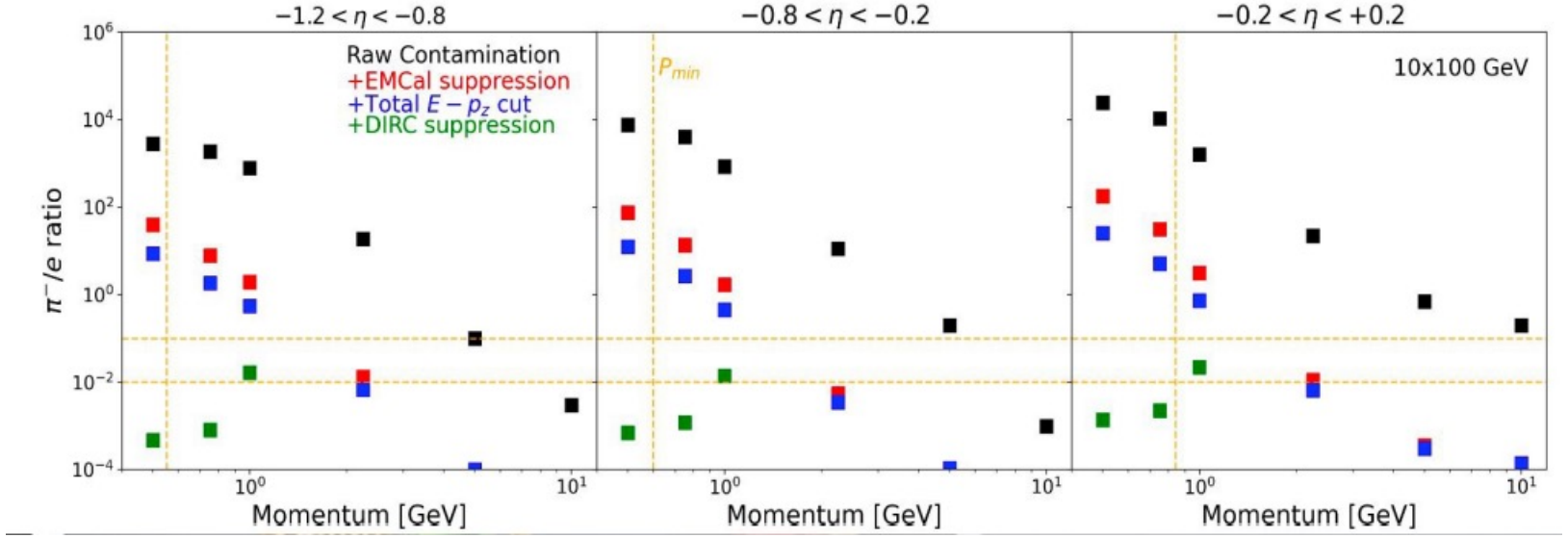
Our TPC



PID Separation Power using dE/dx





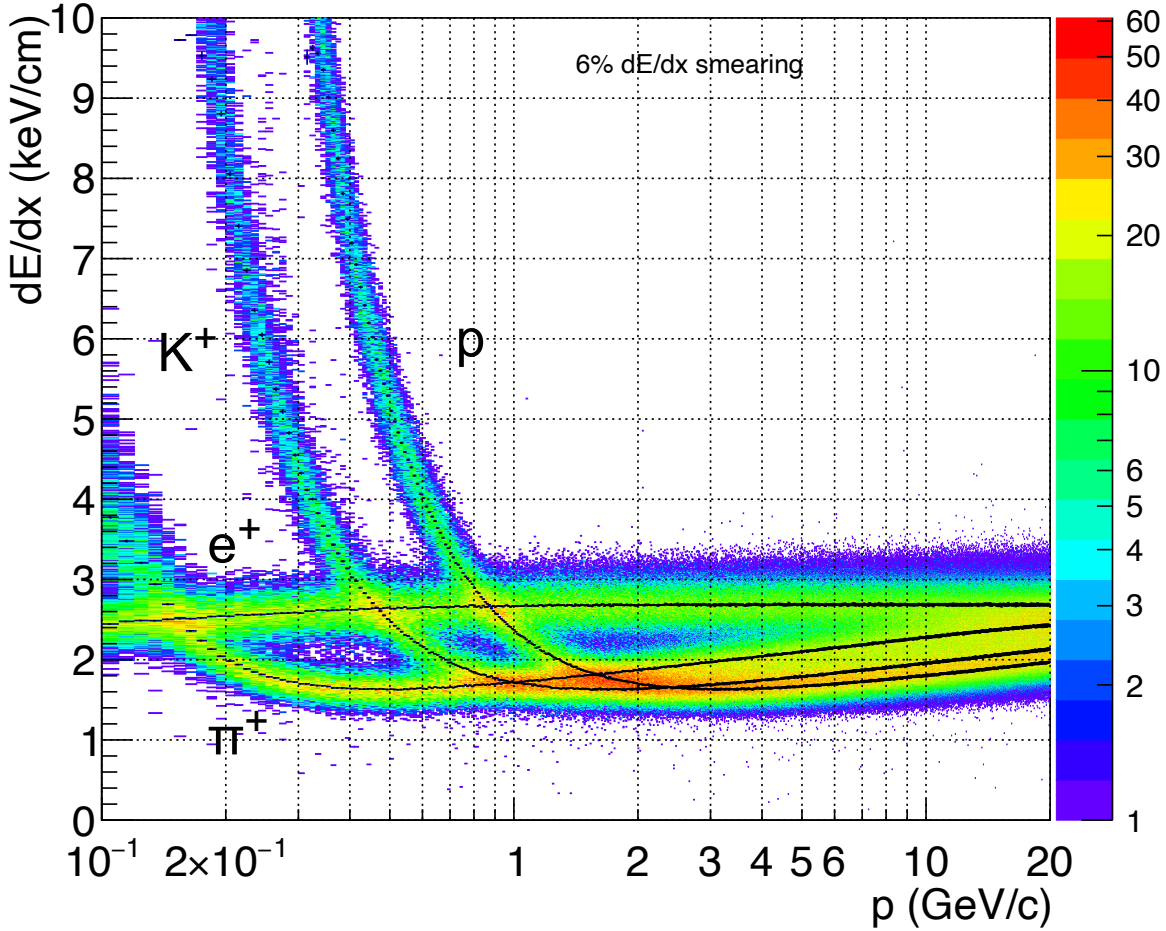


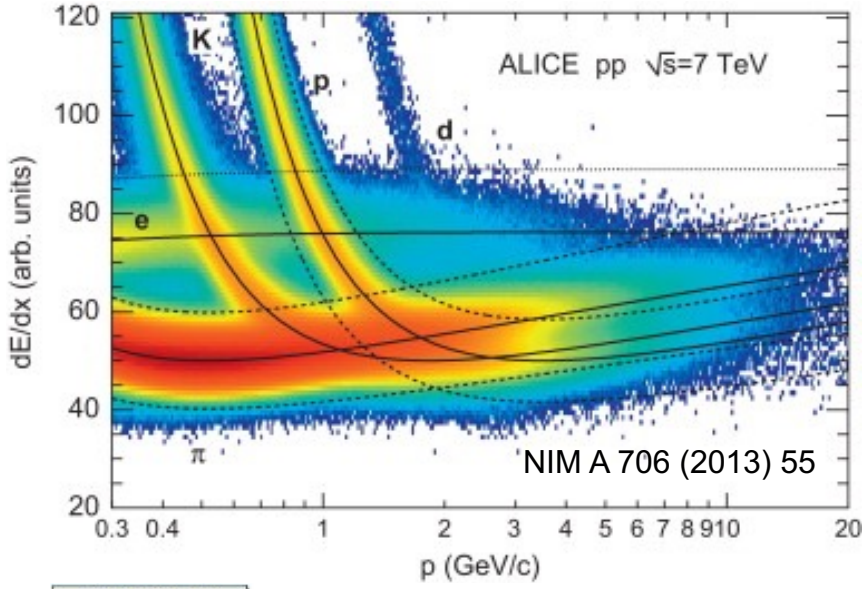
https://indico.cern.ch/event/1339557/contributions/5898474/attachments/2860045/5003664/ePIC_EMCal_CALOR24.pdf

- TPC could provide e/π separation in a wider momentum range than the hpDIRC (<1.2 GeV) [NIM A 1062 (2024) 169168]
- However, the hpDIRC and barrel Ecal can achieve 99% e- purity already together

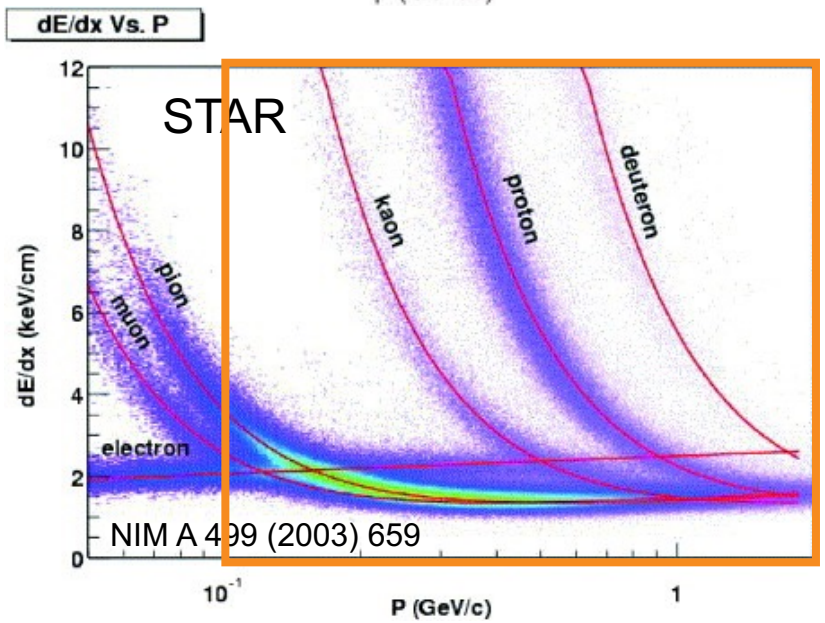
dE/dx: Compare to Other Experiments

Our TPC



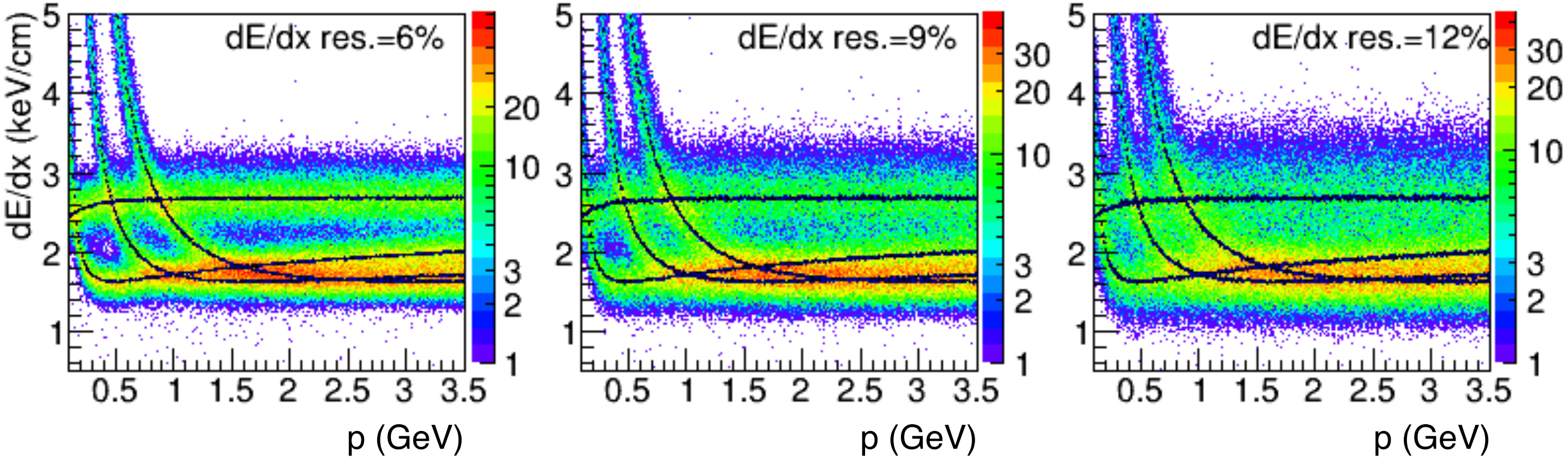


NIM A 706 (2013) 55

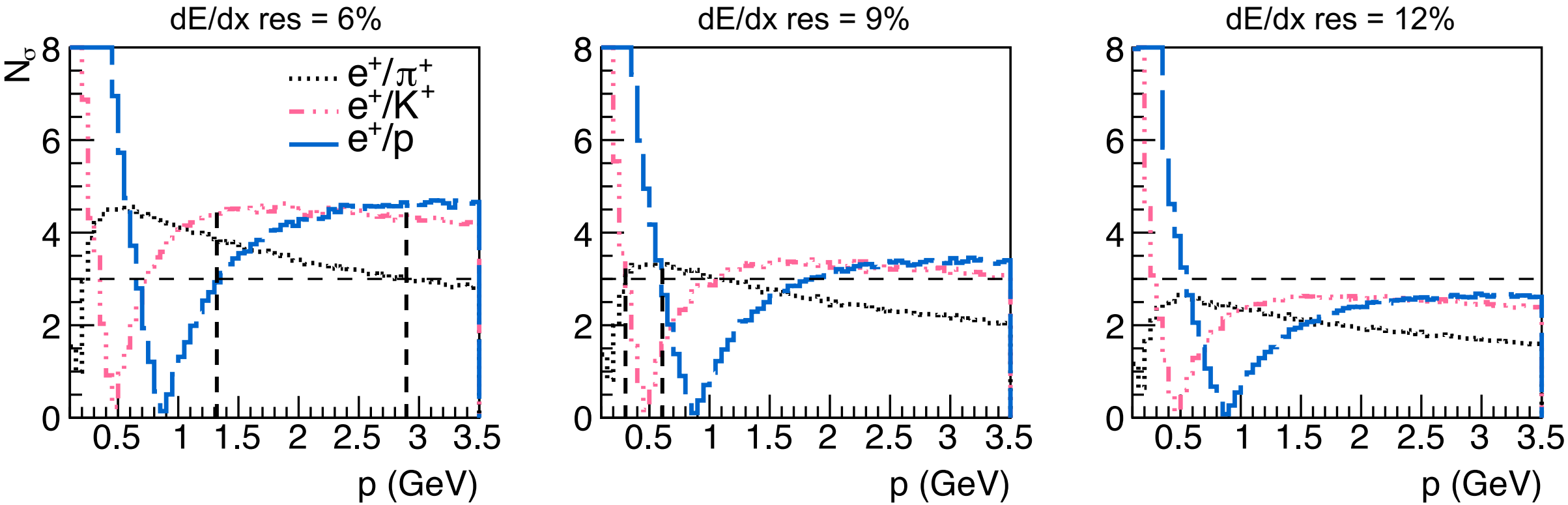


NIM A 499 (2003) 659

Compare dE/dx w/ Diff. Resolutions

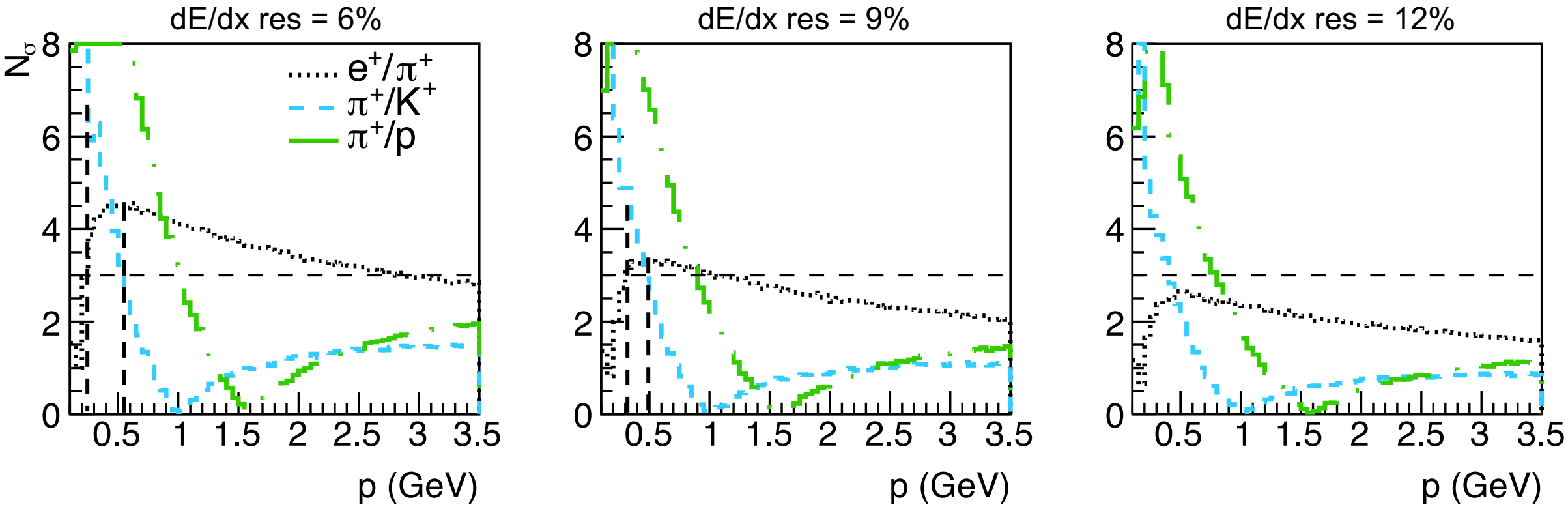


Separation Power w/ Diff. Resolutions : e ID

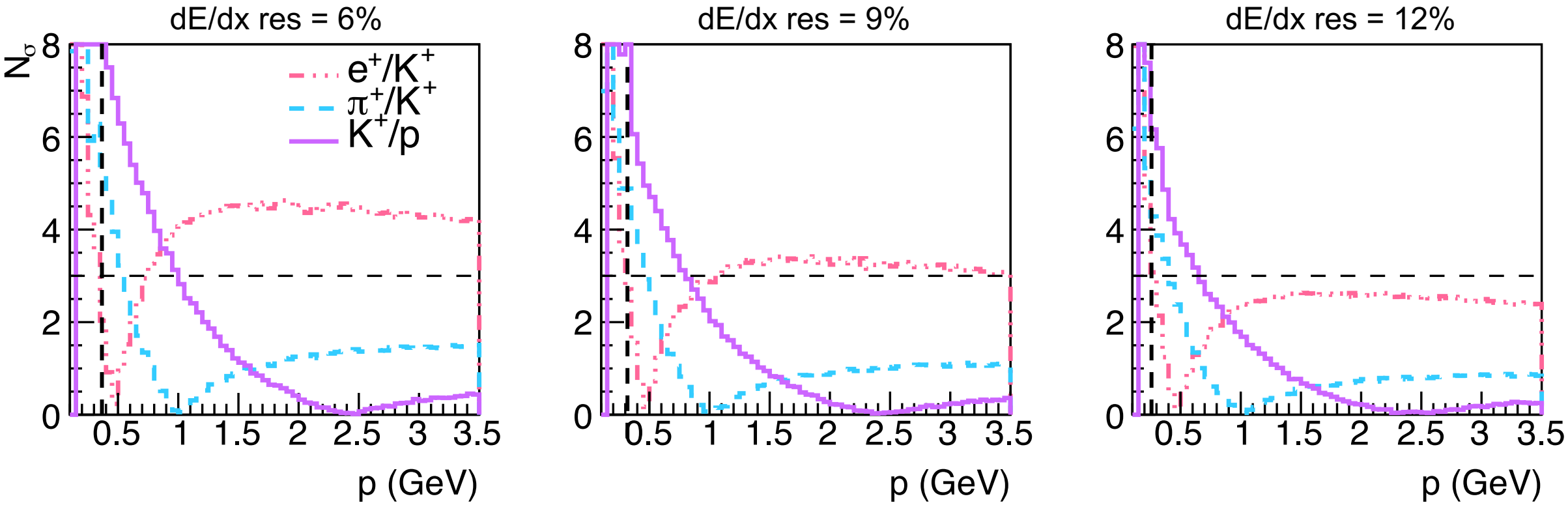


e/h separation from TPC is compromised with 12% dE/dx smearing

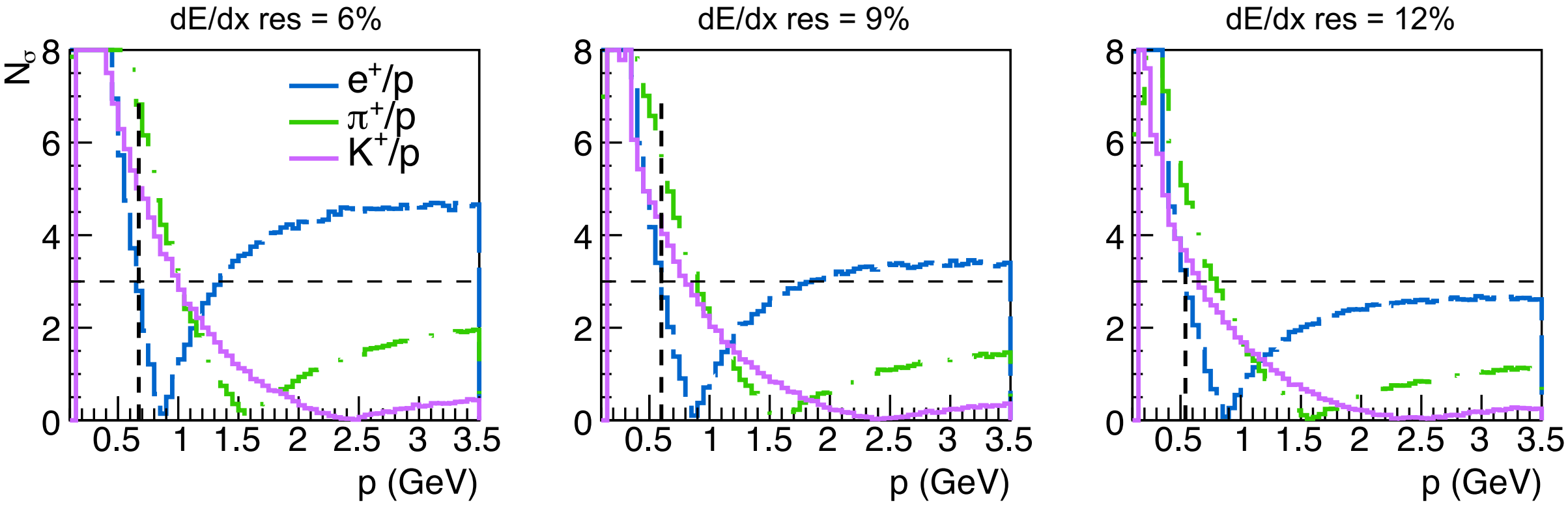
Separation Power w/ Diff. Resolutions : π ID



Separation Power w/ Diff. Resolutions : K ID



Separation Power w/ Diff. Resolutions : p ID



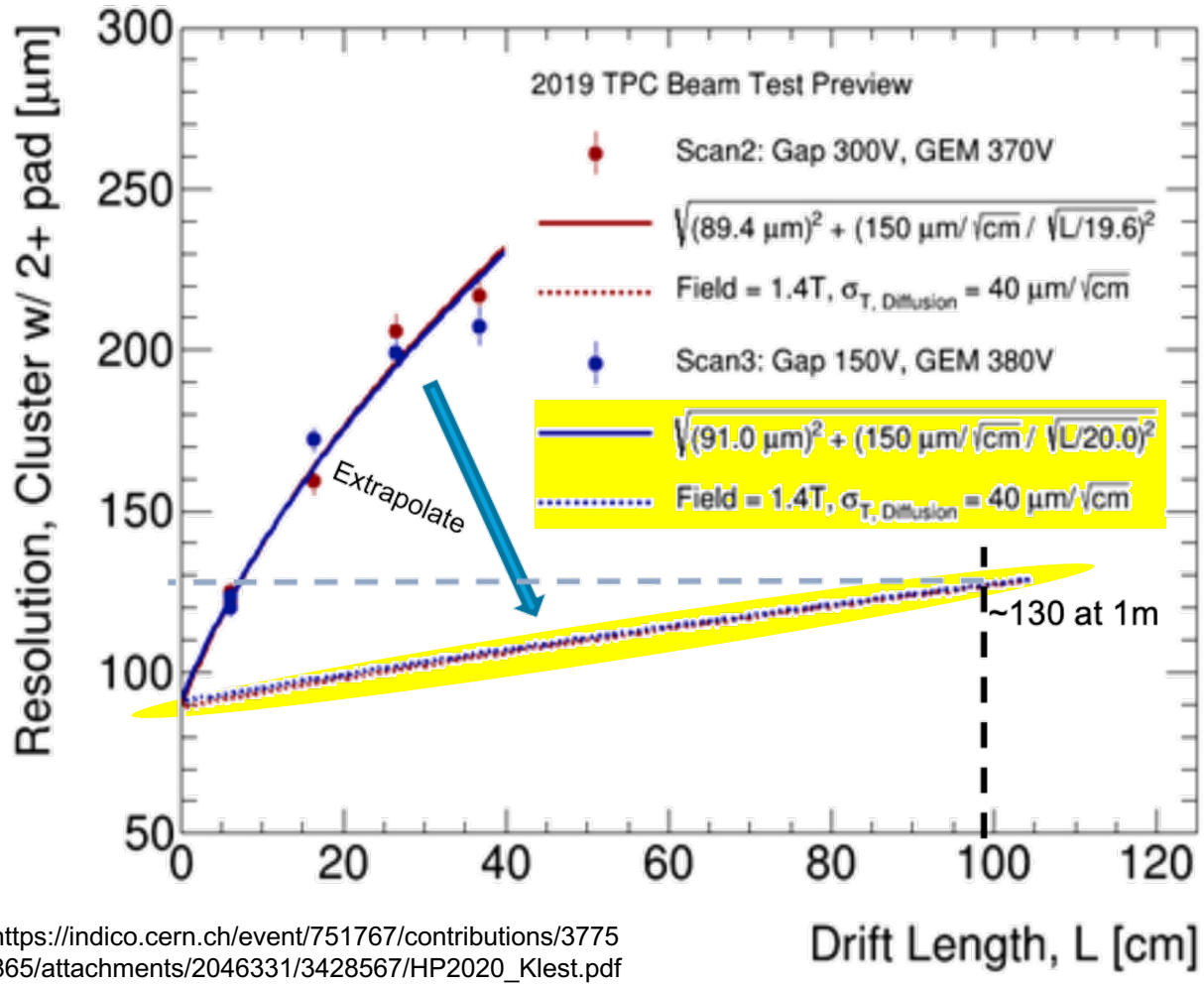
Summary

Single track, $|\eta| < 1$

	dE/dx res. 6%	dE/dx res. 9%	dE/dx res. 12%
e ID $\geq 3\sigma$	1.3 < p < 2.9 GeV/c	0.3 < p < 0.6 GeV/c	/
π ID $\geq 3\sigma$	0.25 < p < 0.55 GeV/c	0.3 < p < 0.5 GeV/c	/
K ID $\geq 3\sigma$	0.15 < p < 0.4 GeV/c	0.15 < p < 0.3 GeV/c	0.15 < p < 0.3 GeV/c
p ID $\geq 3\sigma$	0.15 < p < 0.7 GeV/c	0.15 < p < 0.6 GeV/c	0.15 < p < 0.55 GeV/c

sPHENIX TPC Beam Test Results

Space charge uncertainty is negligible in the beam test



https://indico.cern.ch/event/751767/contributions/3775865/attachments/2046331/3428567/HP2020_Klest.pdf

$$\sigma_{tot}^2 = \sigma_{intrinsic}^2 + \frac{\sigma_{diffusion}^2}{N_{eff}} \cdot L + \sigma_{space\ charge}^2$$

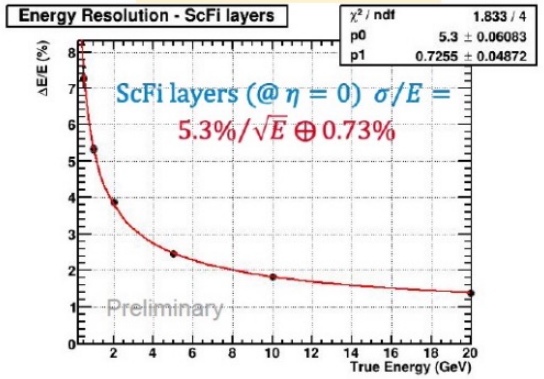
- $\boldsymbol{\sigma_{intrinsic}} = \mathbf{91\ um}$
  ($\sigma_{intrinsic} = 70$ um in doi:10.1088/1742-6596/1498/1/012024)
- $\boldsymbol{\sigma_{diffusion}} = \mathbf{40\ um/\sqrt{cm}}$ (at B = 1.4 T)
- $\boldsymbol{\sigma_{space\ charge}} = \mathbf{50\ um}$
  doi:10.1088/1742-6596/1498/1/012024
- $\boldsymbol{N_{eff}} = \mathbf{20}$ effective number of electrons
  ($N_{eff} = 20.5$ in doi:10.1088/1742-6596/1498/1/012024)

$$\sigma_{tot} = \sqrt{91^2 + \frac{40^2}{20}(1\ \mathrm{m}) + 50^2} \approx 100\ \mathrm{um}$$

https://indico.cern.ch/event/1339557/contributions/5898474/attachments/2860045/5003664/ePIC_EMCal_CALOR24.pdf

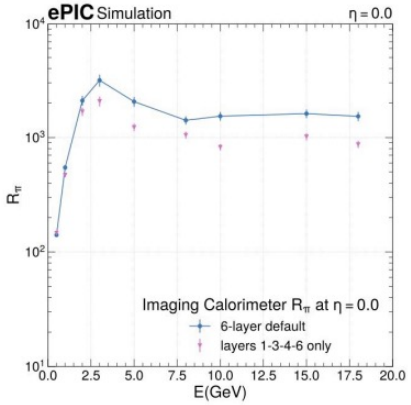
Barrel: Performance at EIC

Energy Resolution

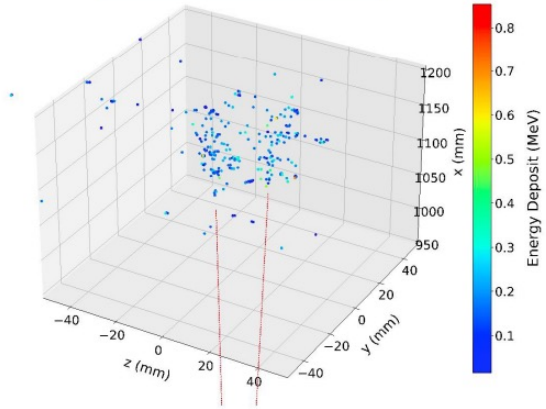


Test Beam: $\sigma/E \sim 5.2\%/\sqrt{E} \oplus 2\%$

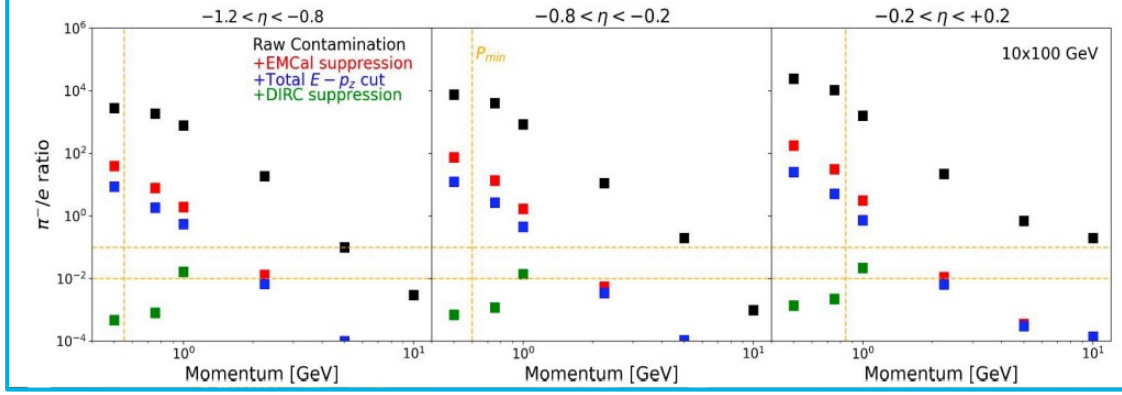
π- rejection



15 GeV $\pi 0 \rightarrow \gamma\gamma$



DIS electron purity



- Very good energy resolution
- Strong $\pi\pm$ rejection for eID
- DIS electron purity of ~99% or better achieved
- $\pi 0/\gamma$ far beyond the required 10 GeV

Fully satisfies the EIC Detector Requirements