Status of DRICH analysis

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Analysis details

Two sets of simulations using **hepmc** files as input.

- HEPMC files (4662) located at:
  - https://github.com/deepaksamuel/hepmc-drich-eic/blob/main/README.md
- Each file (with fine kinematic bins) contains 2000 events but the simulation, due to time constraints, was done with the first 1000 events.
  - **PIDs:** [2212, 321 or 211]
  - **Momentum (74 bins):** [0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10.0, 10.5, 11.0, 11.5, 12.0, 12.5, 13.0, 13.5, 14.0, 14.5, 15.0, 15.5, 16.0, 16.5, 17.0, 17.5, 18.0, 18.5, 19.0, 19.5, 20.0, 20.5, 21.0, 21.5, 22.0, 22.5, 23.0, 23.5, 24.0, 24.5, 25.0, 25.5, 26.0, 26.5, 27.0, 27.5, 28.0, 28.5, 29.0, 29.5, 30.0, 30.5, 31.0, 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 55.0, 60.0]
  - **Pseudorapidity:** [1.5-3.5] in 0.1 steps
    - Example 1.5 ⇒ bin of 1.499 to 1.501
  - Bin details in
    - https://docs.google.com/spreadsheets/d/1qNh3giwhRENJi25z45lgeh5d7QwIw5Uy3lepISHCv9Y/edit?gid=2032570815#gid=2032570815

Two sets of simulations

- 1019 ⇒ n=1.019

```
<!-- dRICH aerogel, for density=0.11 g/cm3 -->
<matrix name="RINDEX__Aerogel_DRICH" coldim="2" values="
  1.23984*eV  1.01826
  1.28348*eV  1.01828
  1.33030*eV  1.01829
  1.38067*eV  1.01831
  1.43500*eV  1.01833
  1.49379*eV  1.01835
  1.55759*eV  1.01838
  1.62709*eV  1.01840
  1.70308*eV  1.01844
  1.78652*eV  1.01847
  1.87855*eV  1.01852
  1.96673*eV  1.01856
  2.05490*eV  1.01861
  2.14308*eV  1.01866
  2.23126*eV  1.01871
  2.31943*eV  1.01876
  2.40761*eV  1.01881
  2.49579*eV  1.01887
  2.58396*eV  1.01893
```

- 1026 ⇒ n=1.026

```
<matrix name="RINDEX__Aerogel_DRICH" coldim="2" values="
    1.2398*eV       1.02498
    1.30505*eV      1.025
    1.37756*eV      1.02499
    1.39303*eV      1.025
    1.40886*eV      1.025
    1.42506*eV      1.02501
    1.44163*eV      1.02502
    1.45859*eV      1.02503
    1.47595*eV      1.02504
    1.49373*eV      1.02505
    1.51195*eV      1.02505
    1.53062*eV      1.02506
    1.54975*eV      1.02507
    1.56937*eV      1.02508
    1.58949*eV      1.02509
    1.61013*eV      1.0251
    1.63132*eV      1.02511
    1.65307*eV      1.02512
    1.67541*eV      1.02513
    1.69836*eV      1.02515
```

epic/compact/optical_materials.xml

Two sets of simulations

- 1019 ⇒ n=1.019

```
irt_cfg.radiators.insert({"Aerogel", RadiatorConfig{}});
irt_cfg.radiators.at("Aerogel").referenceRIndex = 1.0190;
irt_cfg.radiators.at("Aerogel").attenuation     = 48; // [mm]
irt_cfg.radiators.at("Aerogel").smearingMode    = "gaussian";
irt_cfg.radiators.at("Aerogel").smearing        = 2e-3; // [radians]
```

- 1026 ⇒ n=1.026

```
irt_cfg.radiators.insert({"Aerogel", RadiatorConfig{}});
irt_cfg.radiators.at("Aerogel").referenceRIndex = 1.026;//1.0190;
irt_cfg.radiators.at("Aerogel").attenuation     = 48; // [mm]
irt_cfg.radiators.at("Aerogel").smearingMode    = "gaussian";
irt_cfg.radiators.at("Aerogel").smearing        = 2e-3; // [radians]
```

EICrecon/src/detectors/DRICH/DRICH.cc

Duration

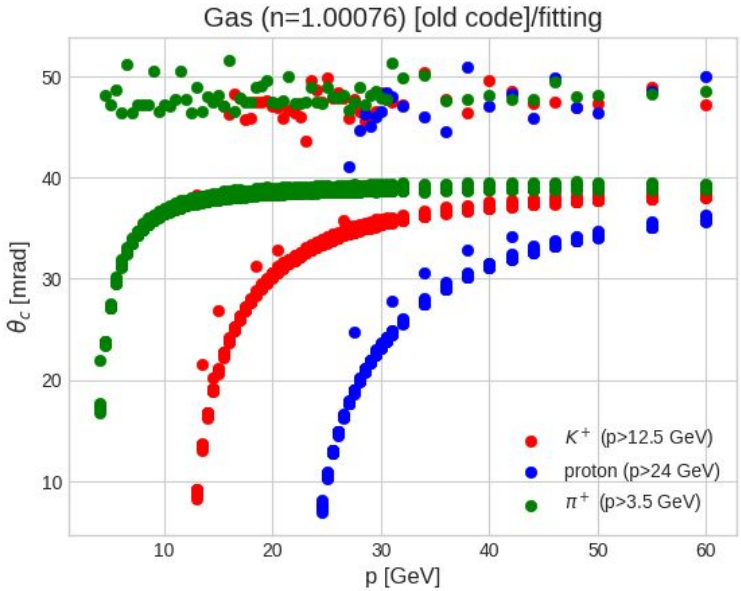
- It took about 5 days to complete both simulations for 1019 and 1026 each using 25 cores of the GPU@CUK
- Few files of simulations, reconstruction were retained without deleting:
  - ```
    eta_retain = [0,11,21] #[1.5,2.5,3.5]
    mom_retain = [1,5,10,15,20,25,30,40,50,60]
    ```
- It was noticed later that eta_bin 21 is not there since there are only 20 bins!
    ```

Procedure for analysis

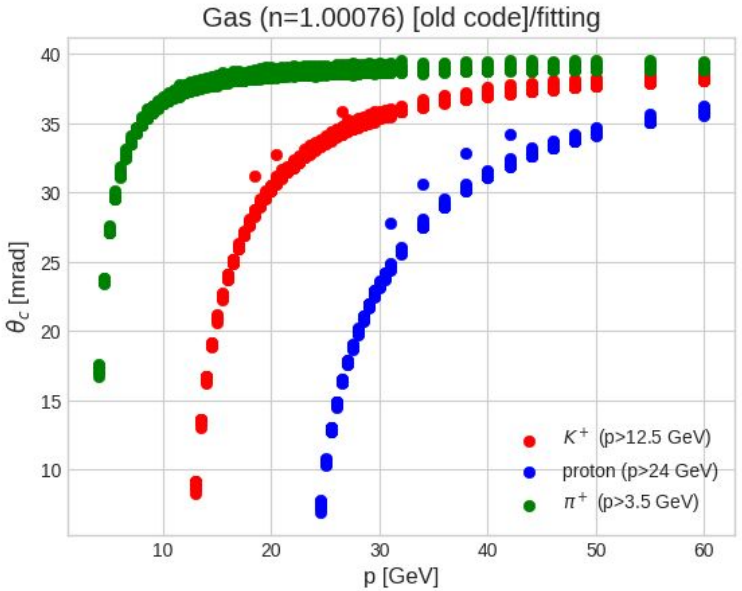
- For both gas and aerogel, the θ_c and $\Delta\theta_c$ histograms were analysed
- The mean and RMS/sigma of the histograms were obtained from two methods:
  - Statistical
  - **Gaussian Fitting**
- For gas, the histogram range was restricted to 50 for the θ_c histograms
- Separation power:
  - **theta:** Mean from gaussian fit to θ_c
  - **sigma**: Sigma from gaussian fit to θ_c

$$N_\sigma = 2 \times \frac{\theta_c^\pi - \theta_c^k}{\sigma_c^\pi + \sigma_c^k}$$

eta: 3.1 shows a deviation from the usual trend **(for gas)**



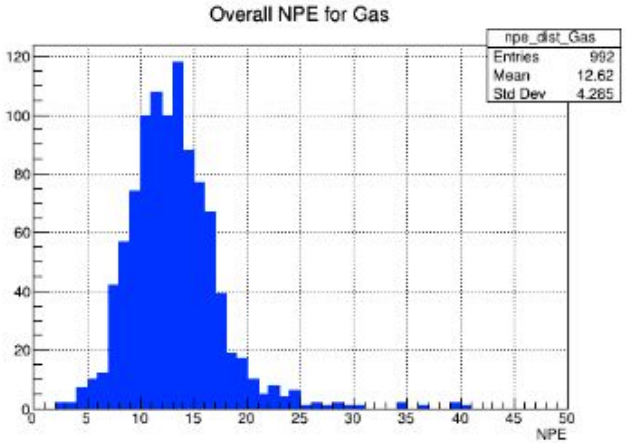
Before removal of eta=3.1

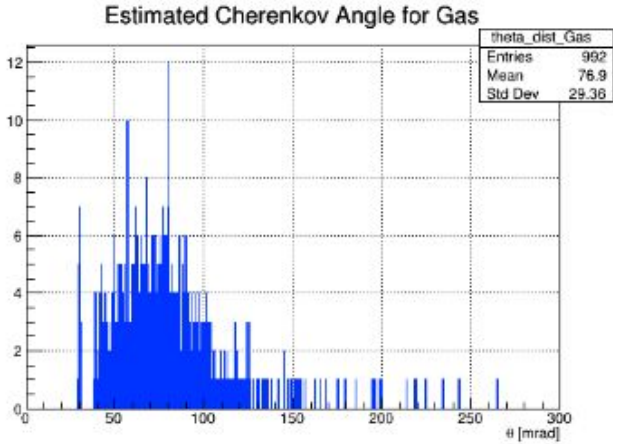


After removal of eta=3.1

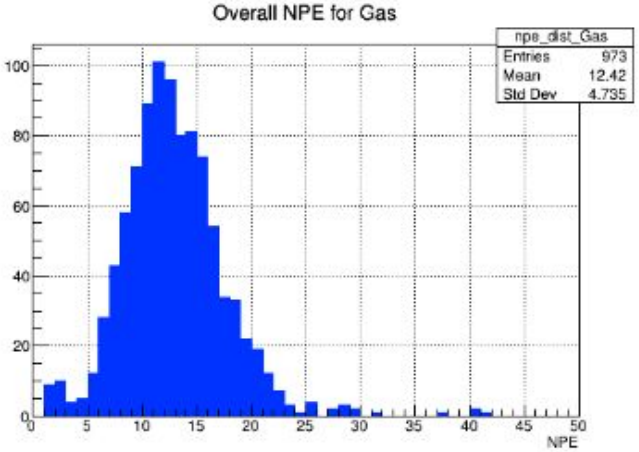
The same was observed in revised code with new aerogel parameters: the abnormal trend was observed for 3.1 and 3.2

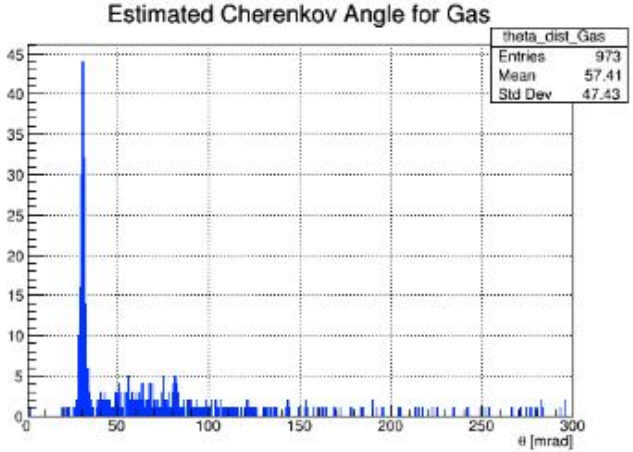
eta_bin: 16

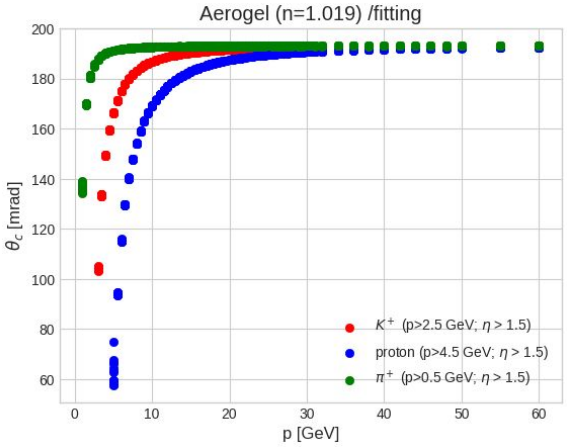


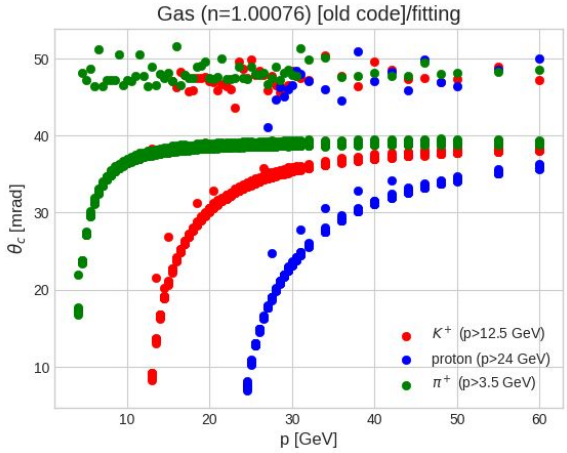


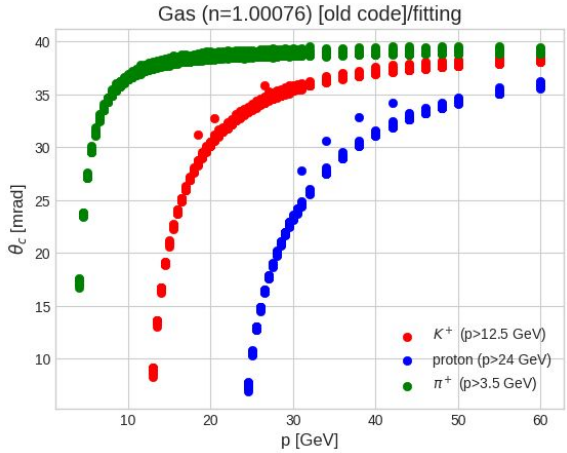
eta_bin: 17
[1019]

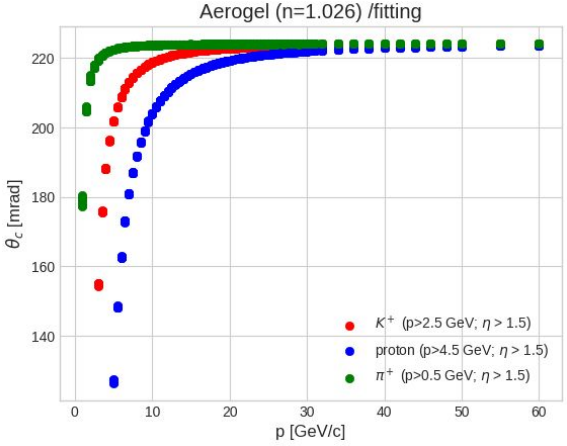


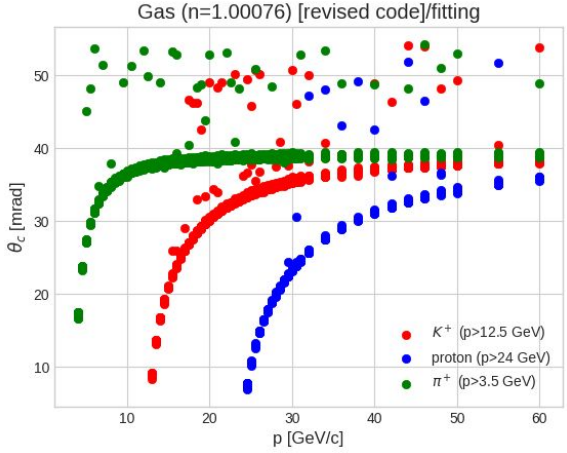


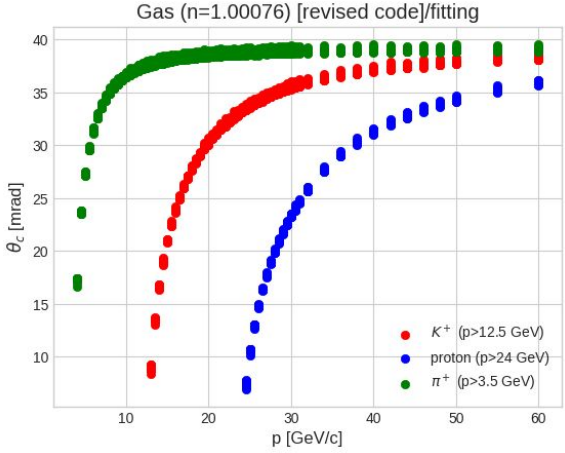

Aerogel (n=1.019) /fitting
θ_c [mrad]
p [GeV]
K^+ (p>2.5 GeV; η > 1.5)
proton (p>4.5 GeV; η > 1.5)
π^+ (p>0.5 GeV; η > 1.5)

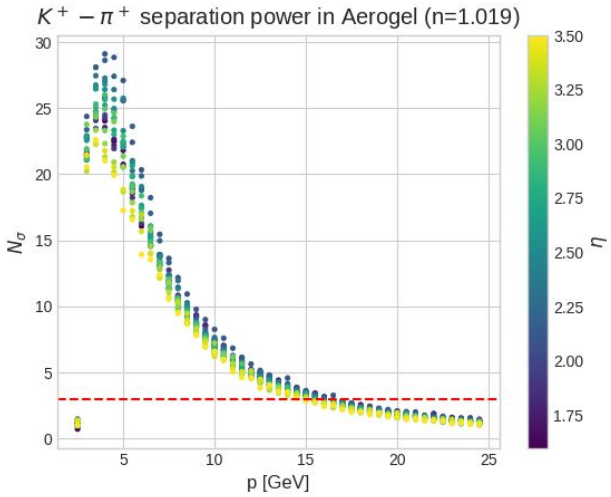

Gas (n=1.00076) [old code]/fitting
θ_c [mrad]
p [GeV]
K^+ (p>12.5 GeV)
proton (p>24 GeV)
π^+ (p>3.5 GeV)

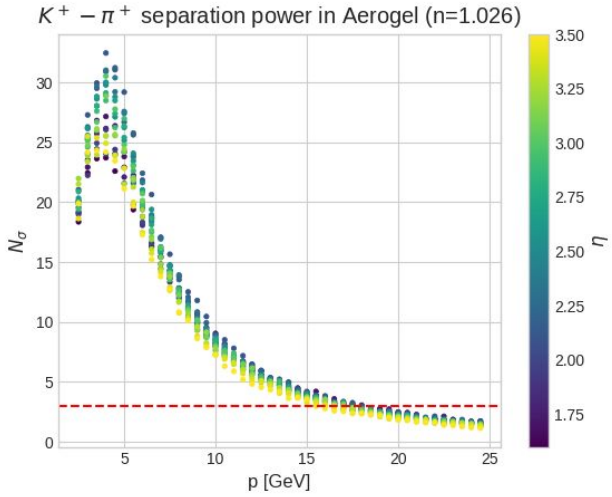

Gas (n=1.00076) [old code]/fitting
θ_c [mrad]
p [GeV]
K^+ (p>12.5 GeV)
proton (p>24 GeV)
π^+ (p>3.5 GeV)

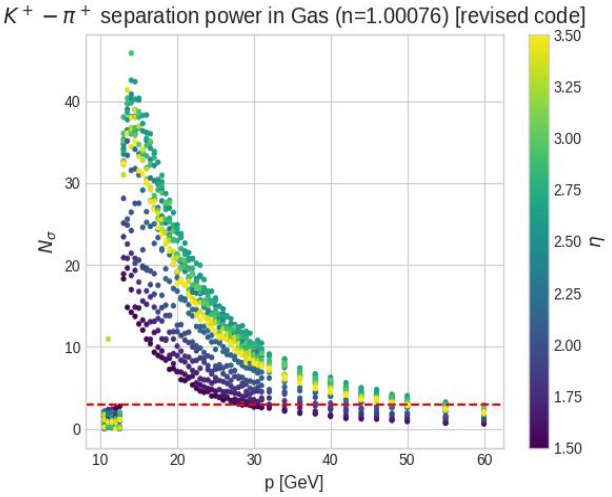

Aerogel (n=1.026) /fitting
θ_c [mrad]
p [GeV/c]
K^+ (p>2.5 GeV; η > 1.5)
proton (p>4.5 GeV; η > 1.5)
π^+ (p>0.5 GeV; η > 1.5)


Gas (n=1.00076) [revised code]/fitting
θ_c [mrad]
p [GeV/c]
K^+ (p>12.5 GeV)
proton (p>24 GeV)
π^+ (p>3.5 GeV)

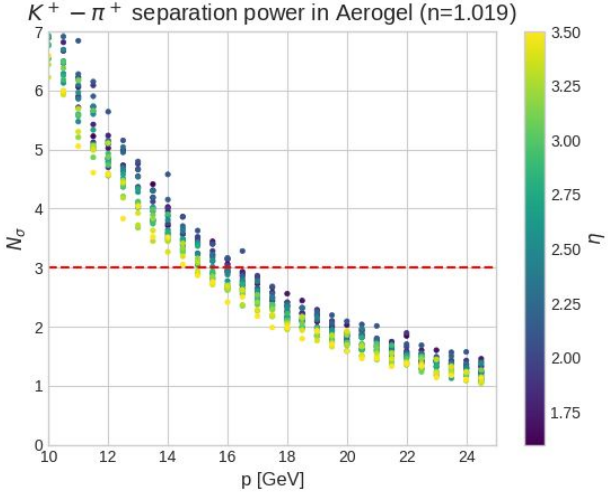

Gas (n=1.00076) [revised code]/fitting
θ_c [mrad]
p [GeV/c]
K^+ (p>12.5 GeV)
proton (p>24 GeV)
π^+ (p>3.5 GeV)

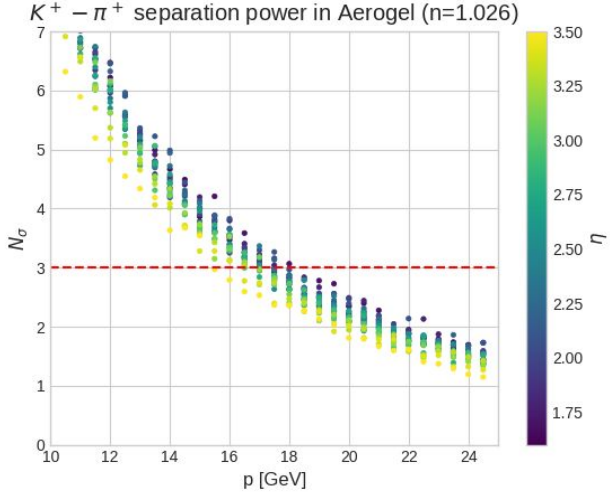


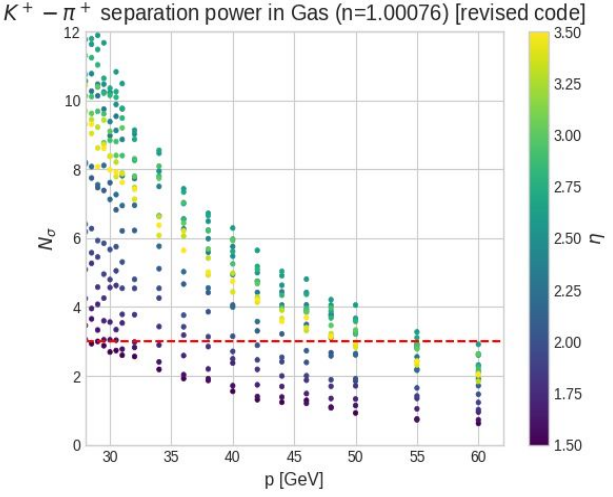


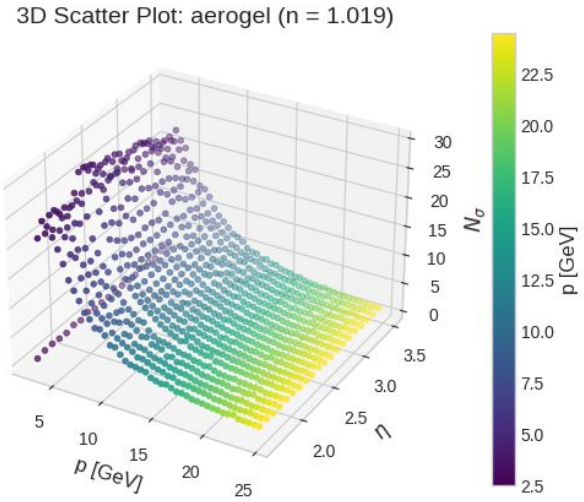


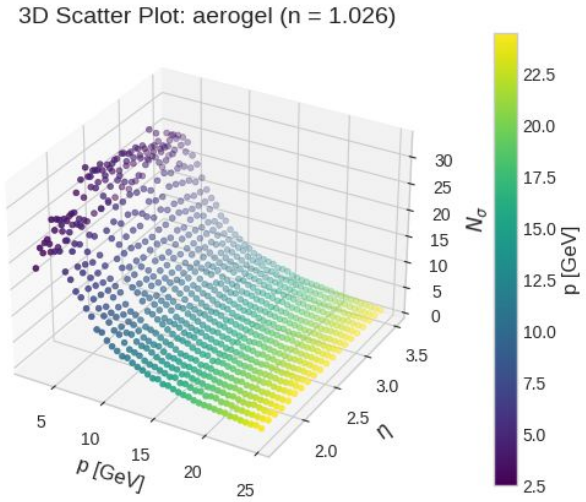
NB: bins 16 and 17 removed in gas analysis

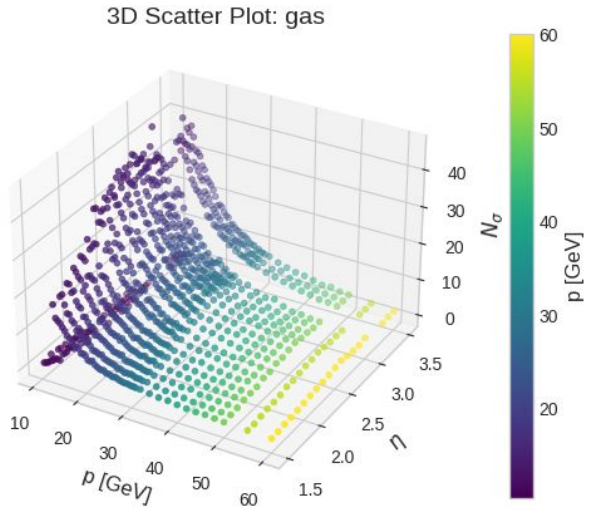




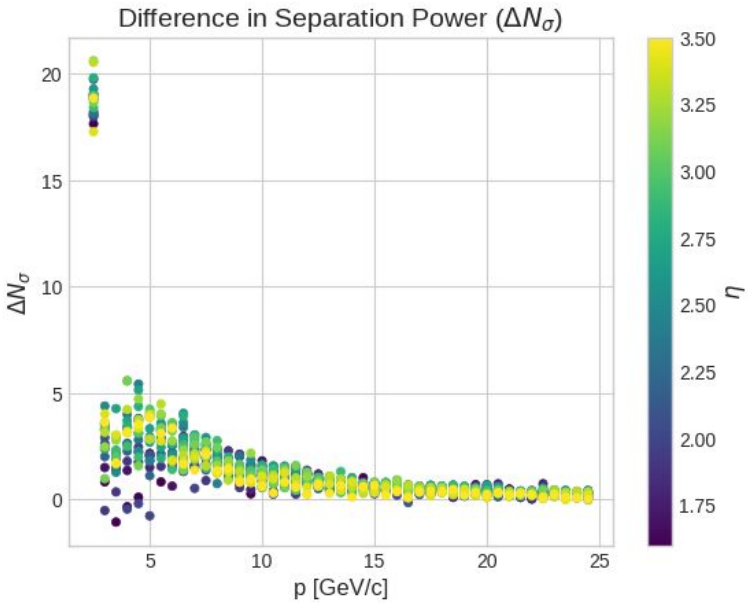


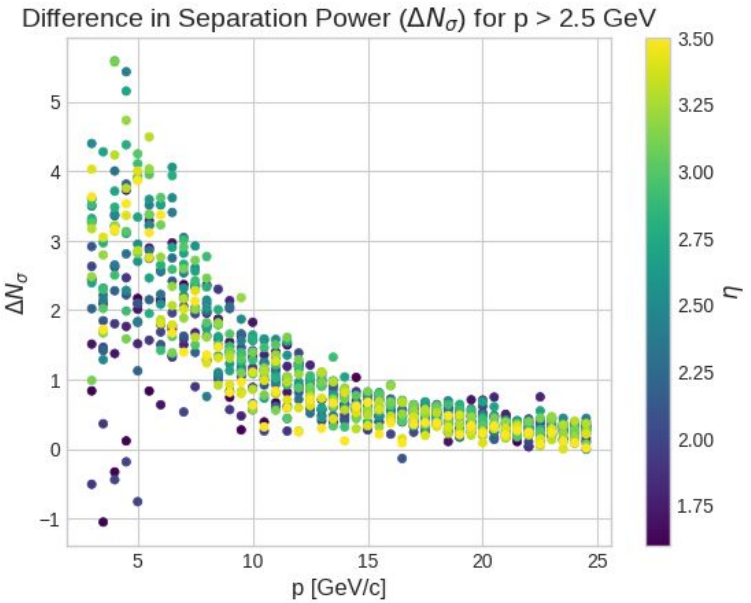

3D Scatter Plot: aerogel (n = 1.019)
p [GeV]
η
N_σ
p [GeV]


3D Scatter Plot: aerogel (n = 1.026)
p [GeV]
η
N_σ
p [GeV]


3D Scatter Plot: gas
p [GeV]
η
N_σ
p [GeV]

Difference between separation powers 1.026-1.019





A closer look…

- Improvement in the separation power with new aerogel parameters

Links

Link	Comments
https://github.com/deepaksamuel/hepmc-drich-eic/blob/main/README.md	HEPMC files used to generate the data
https://github.com/deepaksamuel/drich-analysis-aero-1019	Analysis files for n=1.019
https://github.com/deepaksamuel/drich-plots-aero-1019	Plots for n=1.019
https://github.com/deepaksamuel/drich-analysis-aero-1026	Analysis files for n=1.026
https://github.com/deepaksamuel/drich-plots-aero-1026	Plots for n=1.026
https://colab.research.google.com/drive/1Y2yWznPo-eY8UurjVE2qkkDCq4KmJYFo#scrollTo=f0XMo8DcuF_B	Code to analyse the data on Colab
https://docs.google.com/spreadsheets/d/1hLUnqW_EfVnwAKXdeo4D96ngOLVud8m5zq37vmTGJkk/edit?usp=drive_link	Results of analysis 1019 in a spreadsheet
https://docs.google.com/spreadsheets/d/1kDdnKv707daWRUOX_PI1f1VUf8bKPJo3PDVwJ6OU5Os/edit?usp=drive_link	Results of analysis 1026 in a spreadsheet