dRICH simulation for pre-TDR

Chandradoy Chatterjee on behalf of dRICH simulation team

Few words on the simulation chain

dRICH simulation: simulation that involves the study of detector performance, characterization, geometry and other optimization using the entire ePIC simulation framework!

- We are using the full ePIC simulation framework for all the TDR plots.
- Several groups can run and perform the simulation studies independently.
- We are currently using the existing reconstruction software (IRT-v1).
- Alexander has restarted his effort to integrate IRTv-2 to EICrecon. As a first step we will test all the dRICH plots are reproducible with the updated reconstruction software. Before, the final version of the pre-TDR, we expect IRTv-2 functioning for d+pf RICH.
- Benchmarking can be independent of the eic software shell.

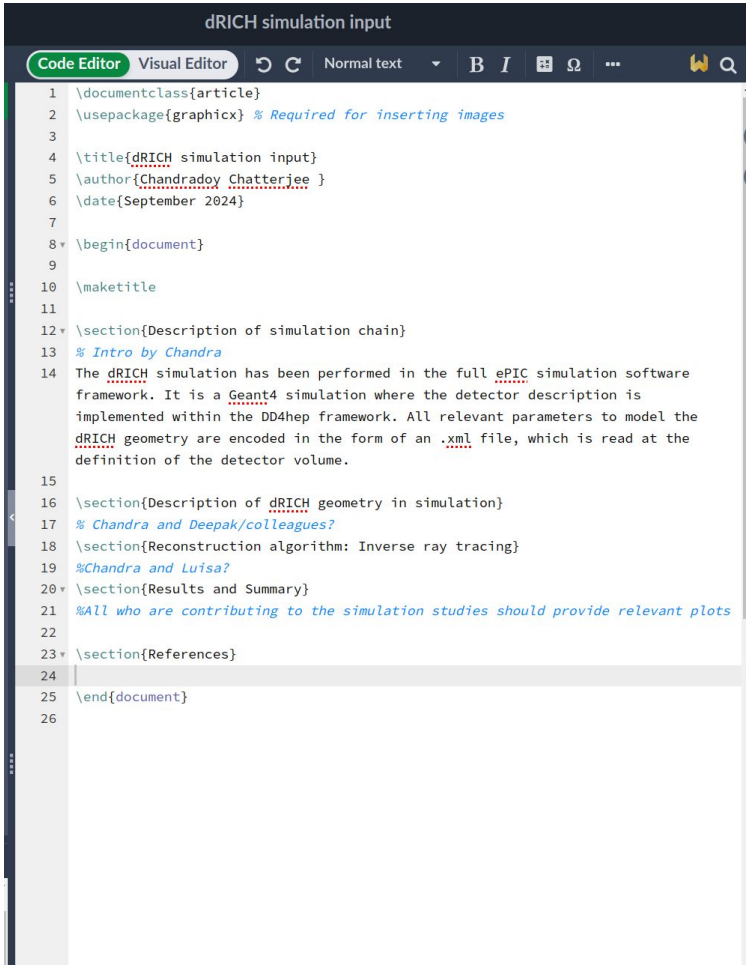
Team and tasks involved

- Deepak, Meenu, Raman and students:
  a) Generation of the look-up tables with fine bins in momentum and eta bins.
  b) PID performance of dRICH (n-sigma separation) in kinematic bins.
- Tapasi, Rohit, Luisa:
  a) To study the effect of the safety factor and consistency of the number of photons.
  b) PID performance of dRICH with C4F10.
- Luisa, Chandra:
  a) Effect of different contributing factors to the single photon resolution (with Marco).
  b) Ensuring the functionality of IRT v-2 (with Alexander)
  c) Splitting the dRICH and implementation of realistic noise studies (potential interest from other colleagues).
- …

Computing resources

- GPU facility @CUK
- INFN Trieste computing farm.
- BNL computing facility.

Documentations



I am preparing the write-up as the input for the dRICH simulation studies.

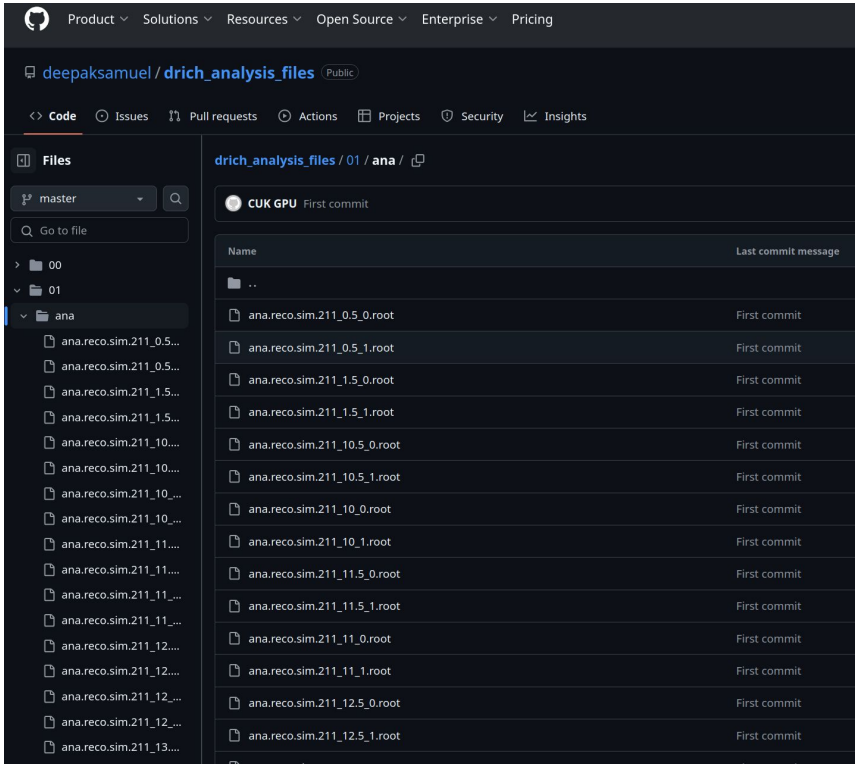
The description would contain more quantitative information about dRICH geometries and parameters. Some might go to the supplementary materials.

Also a part dedicated to the reconstruction software (in synergy to pfRICH) and implementation of IRT into the EICRecon.

The results and summaries (pTDR and supplemental plots)

https://wiki.bnl.gov/athena/images/6/64/SupplementaryMaterialRICH.20211205.pdf

Data availability

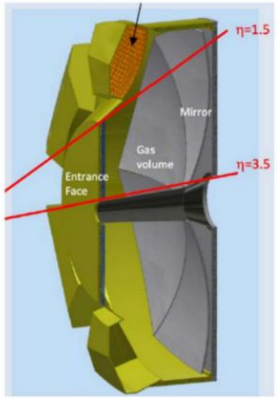


Great initiative by Deepak and colleagues to put all the analysis data available.

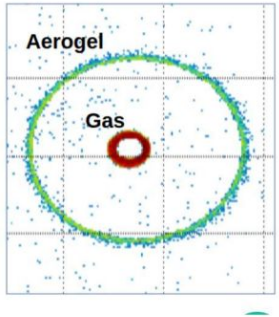
All the simulation input (hepmc files) and proper naming convention has been adopted.

This satisfies the requirements of Markus on the data availability.

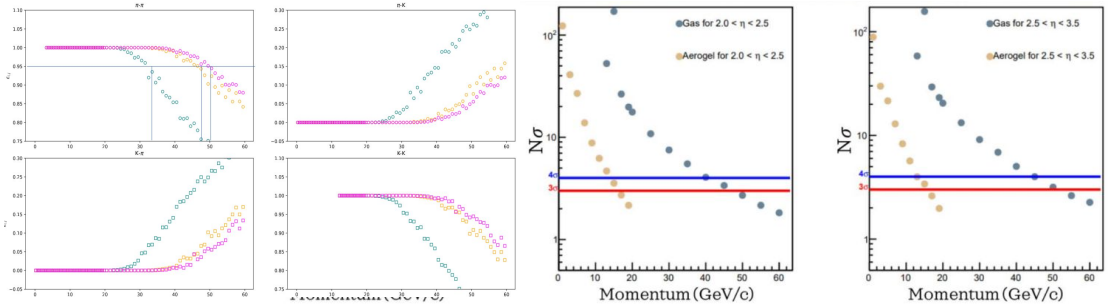
Plots that have been identified so far from simulation input



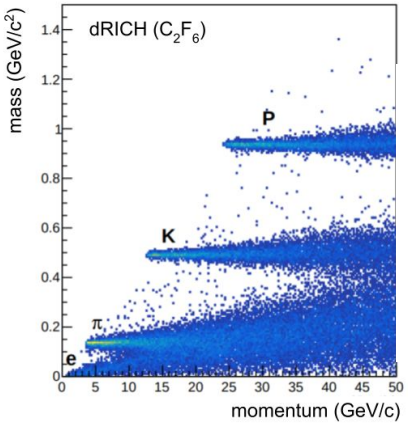
An event display

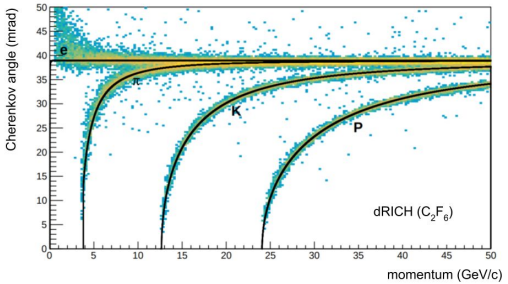


Consolidated N-sigma separation

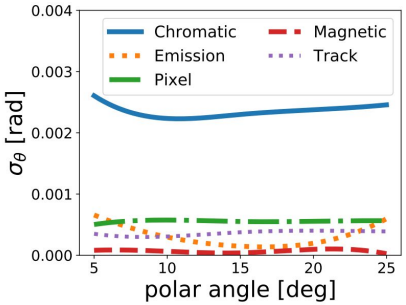


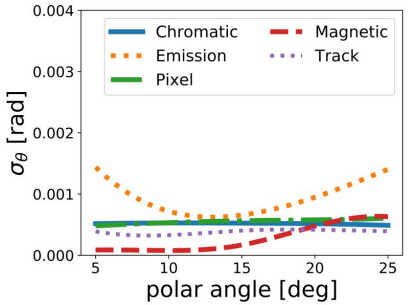
Cherenkov curves/mass plots (gas+aero)





Single photon resolution contribution





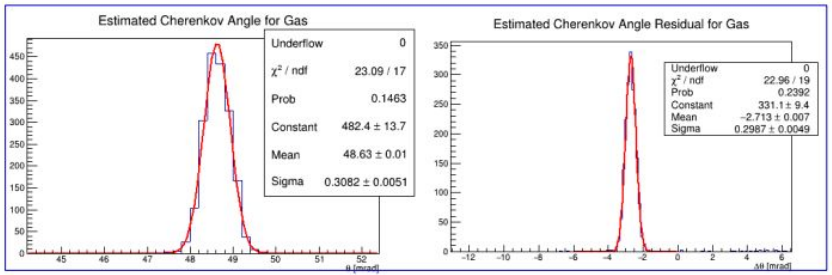
Some other plots (supplement) to support technological choices -1

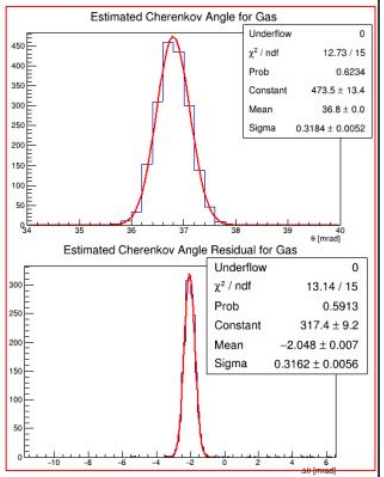
Comparison of C_4F_{10} and C_2F_6 in ePIC simulations

INFN Istituto Nazionale di Fisica Nucleare

50 GeV/c π and K shot at η = 2.5 (Chandra Chatterjee)

Gas	Npe(π/K)	Th_π	Th_K	Sig_π	Sig_K	N_Sig
C_2F_6	16.03/14.94	36.8	35.67	0.32	0.33	3.5
C_4F_{10}	24.8/23.8	48.63	47.8	0.29	0.30	2.8



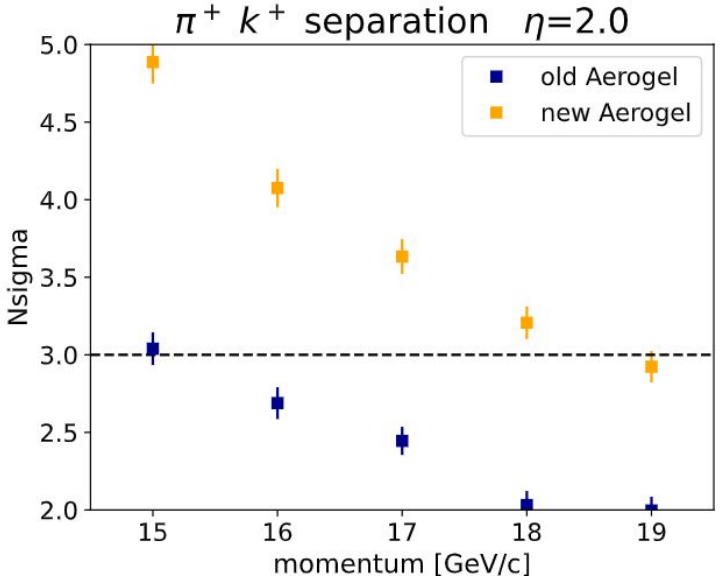


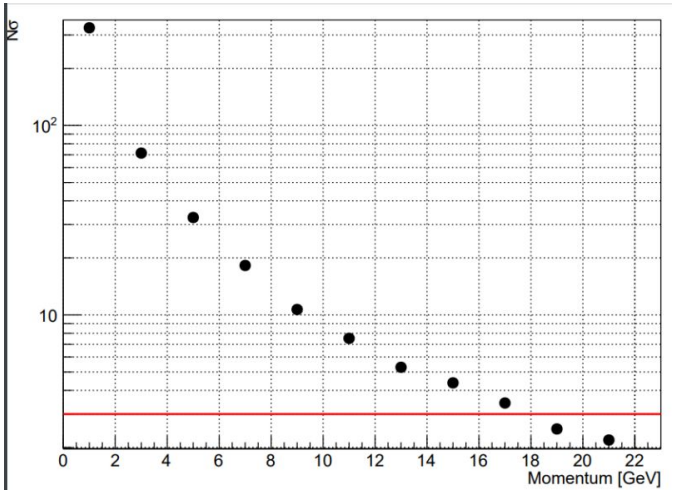
- C_4F_{10} does not qualify the 3.5 σ test.
- Offset of 2 mrad in theta residual is present consistently in both gases.
- The number of photons compatible to COMPASS for C_4F_{10} (for PMTs we have <Npe> ~60 at saturation)

A plot that demonstrates the performance of different gas radiators and the selection of optimized one for PID requirements

In terms of Nsigma separation? And some Accessory plots

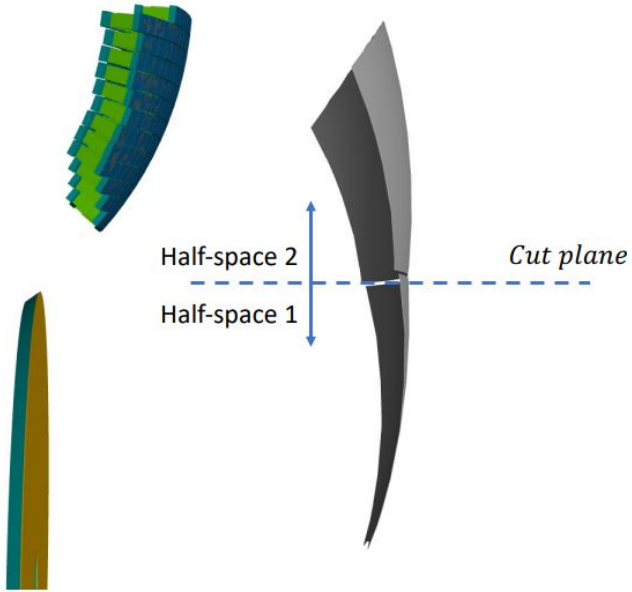
Some other plots (supplement) to support technological choices -2

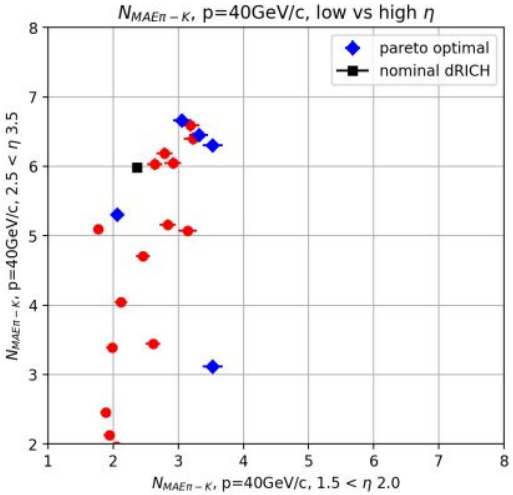


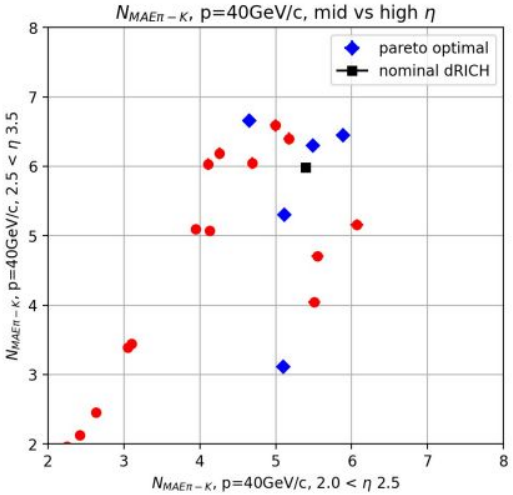


To consolidate the performance limit of different aerogels and to justify the choice of the aerogel parameters for the design.

Some other plots (supplement) to support technological choices -3

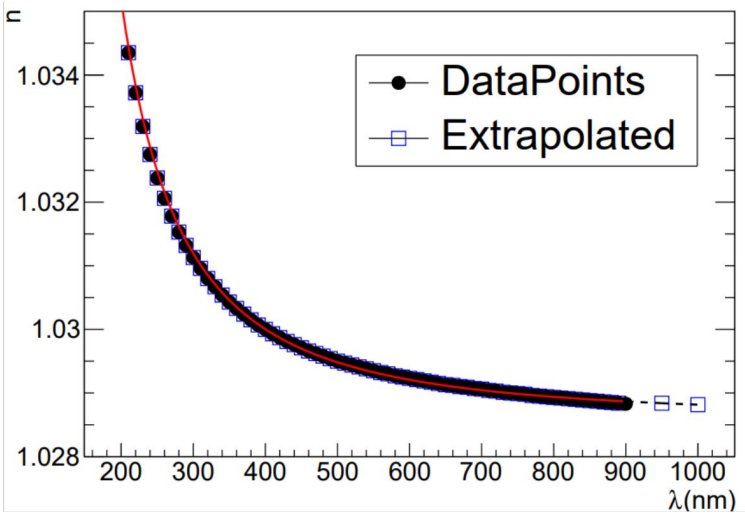


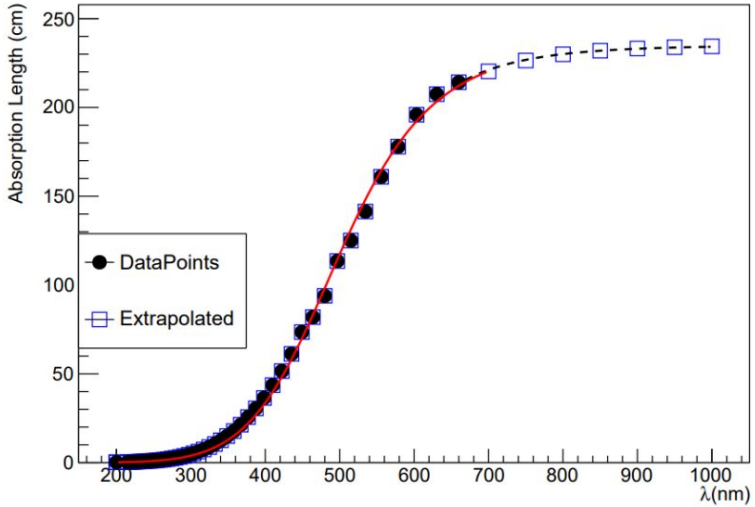




The IRT v-2 is capable of handling multiple photon paths, in case we have a fully working IRT v-2, we can supplement the studies related to the possibility of different mirror parameters to cover different pseudorapidity ranges.

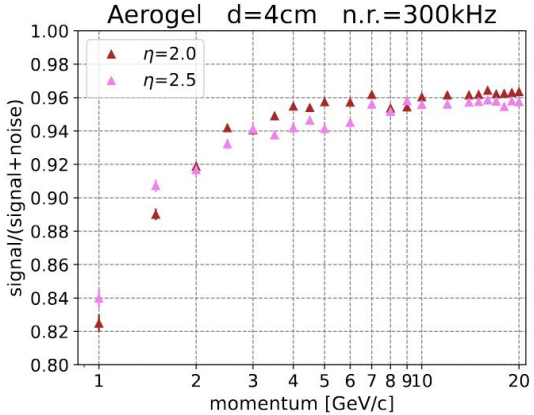
Some other plots (supplement) to support technological choices -4

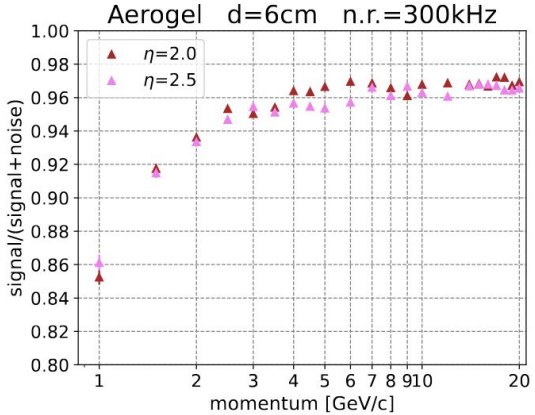


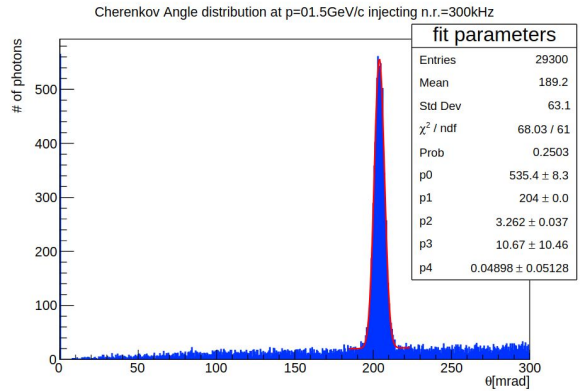


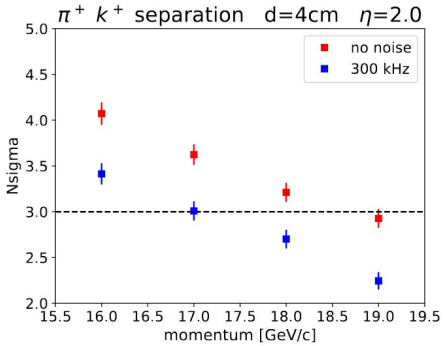
Plots like these can also be used in supplemental materials to demonstrate the parameters that are used in the simulation studies.

Some other plots (supplement) to support technological choices -5









Tiziano's preliminary studies indicated that the SiPM dark counts is not limiting the PID performance (1 ns window and 300 kHz noise rate).

Without fully tested IRT V2 we will not be able to include noise for a full detector performance study.

But, at supplementary level this plot can demonstrate the fact, importance of noise has been considered and initial studies have been made.

Summary

- **We have the full machinery ready with more than one team involved (x-checks are easy and obvious).**
- Apart from the main plots, there are plenty of supplement plots that can enter into the dRICH simulation description.
- In the next two months we will have intense activities to generate all the final plots.
- Keep an eye on our dRICH simulation meetings page: https://indico.bnl.gov/category/422/