06 / April / 2022

PID in dRICHes

(HERMES reminiscence, EIC attempts)

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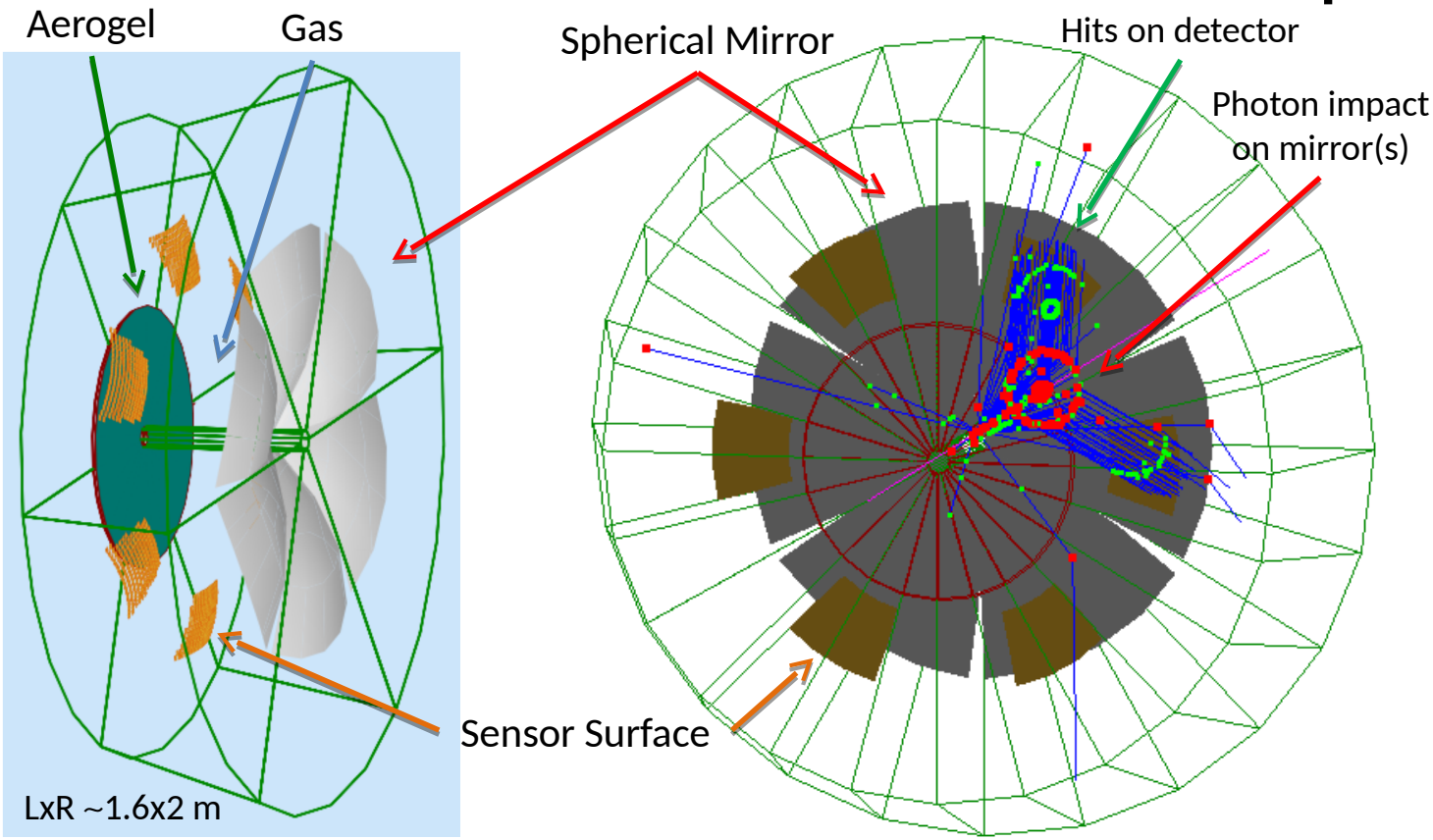
dRICH in JLEIC h-endcap



- Radiators: Aerogel (4 cm, $n_{(400nm)}$~1.02) + 3 mm acrylic filter, Gas (1.6 m, n_{C2F6}~1.0008)
- 6 Identical Open Sectors (Petals):
  - Large Focusing Mirror with R ~2.9 m
  - Optical sensor elements: ~4500 cm^2/sector, 3 mm pixel size, UV sensitive, out of charged particles acceptance

Advantages:
- Full momentum, continuous coverage
- Relatively simple geometry/optics
- Expected to be Cost Effective (respect to 2 x detectors solution)

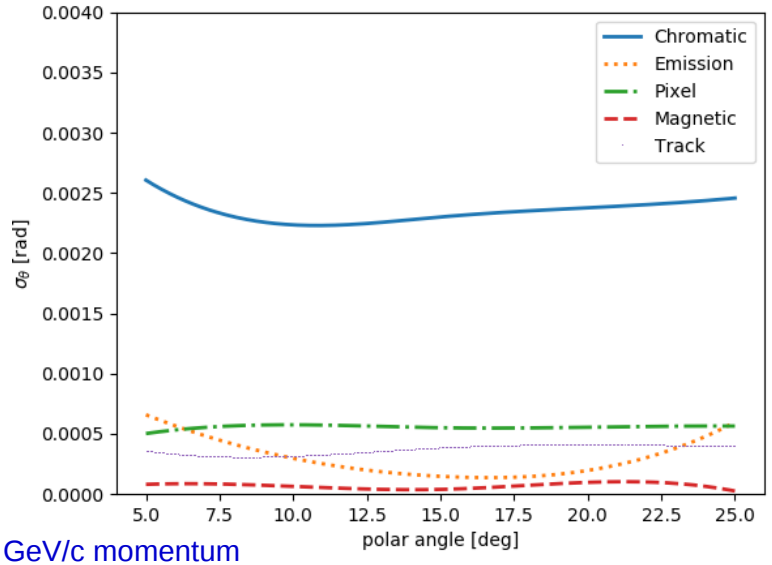
dRICH: Angular resolution

All the main contributions to the Cherenkov angle resolution have been evaluated by MC

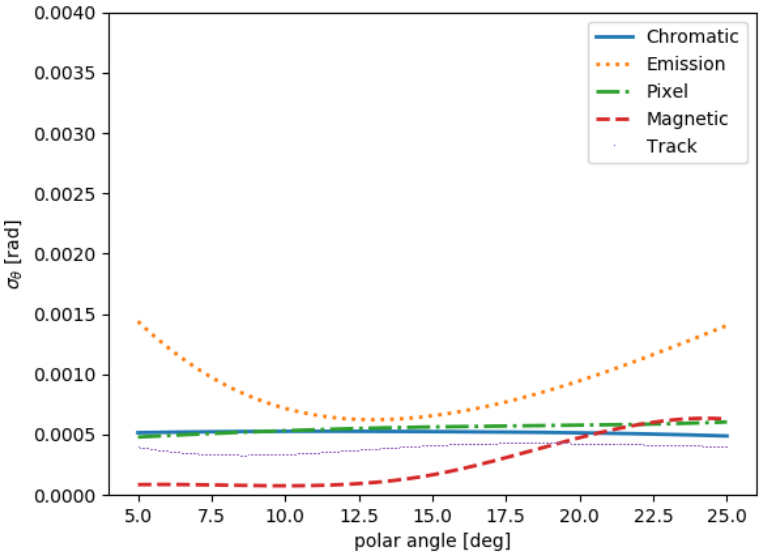
Largest effects from

- Aerogel chromatics (variation of refractive index with wavelength)
- Gas emission (unknown emission position of the photons and focusing optics)

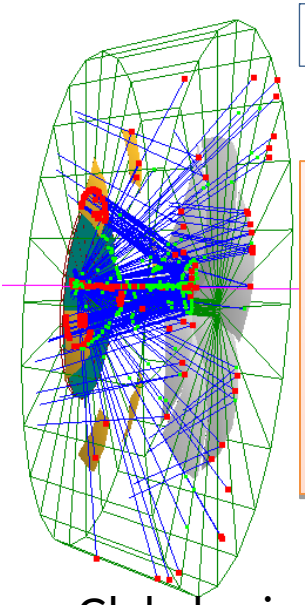
HERMES	Aerogel (mr)	C4F10 (mr)
emission	1.8	2.2
pixel	5.6	5.2
chromatic	2.5	
tile	3.0	
nvar	1.1	
pressure		1.0
Total-MC	9.2	9.5



30 GeV/c momentum



IRT Event Based Reconstruction



Nt : tracks (+ background «dummy track»)

Nh : photon hits (photoelectrons)

Nr : radiators (aerogel and gas)

Np : potential particle types (e,pi,K,p)

~40% of PYTHIA events have multiple tracks in dRICH
~50% of them overlapping rings;
Simple track based IRT → π/K contamination>10%

Global naive «brute force» approach: explore all possible combinations of

Track ∈ Particle type hypothesis: $\mathbf{Np^{Nt}}$

Photon hits ∈ (Track ⊗ Radiator + Background) : $\mathbf{(Nt*Nr+1)^{Nh}}$

Each combination has an associated Likelihood; take the maximum

Our approach:

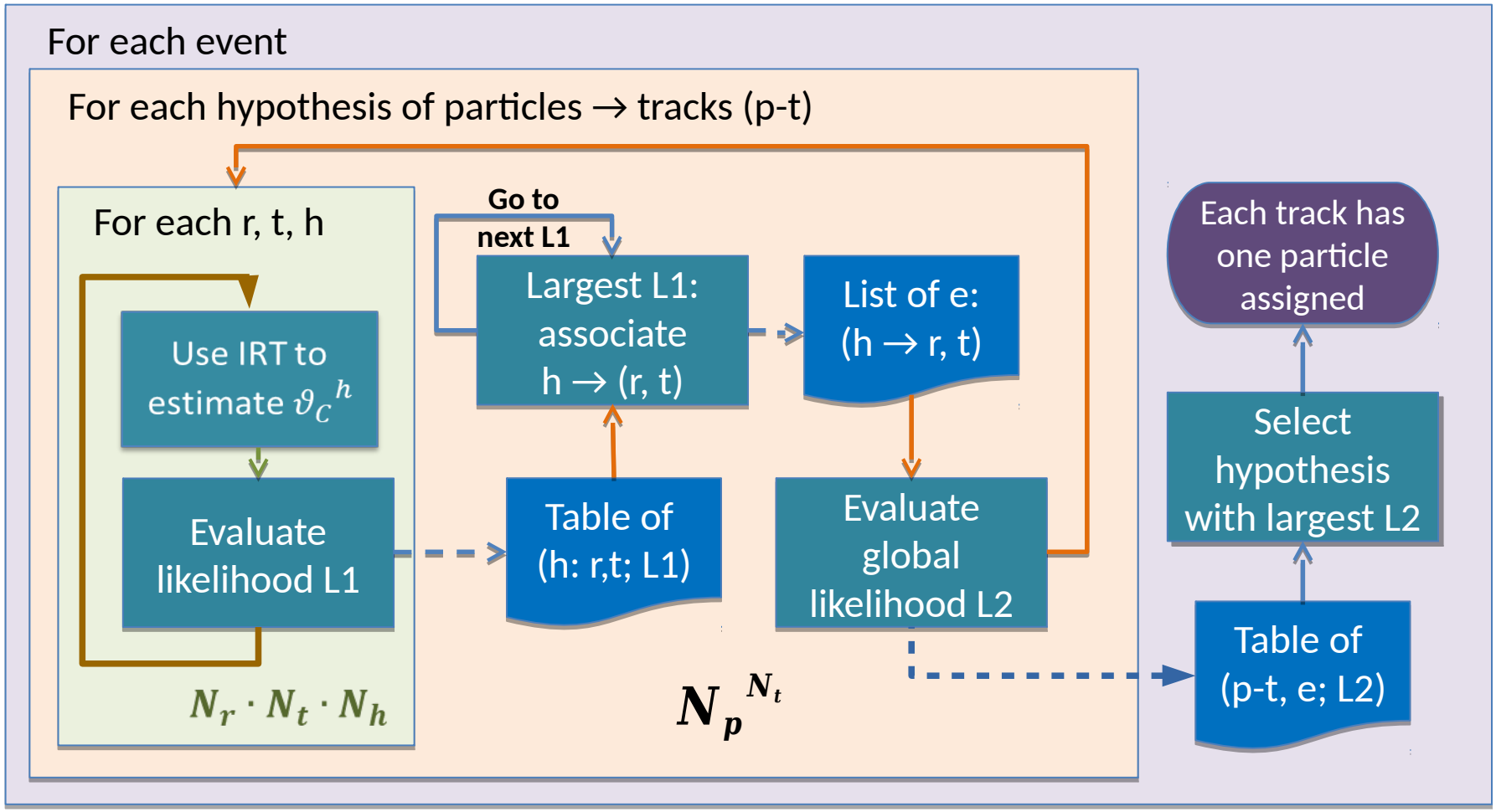
- Determine (by IRT) the potential emission angles corresponding to each photon hit
- Split the problem in two steps (for each event):
  1) Sequential hits association to tracks/radiators using a first likelihood L1 (combinations drop to **(Nt*Nr+1)*Nh**)
  2) Once all hits are associated, estimate a global Likelihood (L2) for each (track ∈ particle) combination; choose the combination with max L2

Example: event with 2 tracks and 15 hits

Brute Force: up to **~488 billion** combinations
Our approach: **1200** combinations

Based Global Reconstruction

Particle Type (p), Radiator (r), Track (t), Hit (h)



L1: Function of distance between estimated and expected ϑ_C normalized to σ_ϑ

L2: Sum of distance between average and expected angles, weighted by Poisson

Choice of L1

$$L_1(p,t,r;h) \equiv G(\theta_h^{t,r}|\theta^{c,r},\sigma_{\theta^{c,r}}) \cdot P_S(N_a^{c,r}+1;N^{c,r})$$

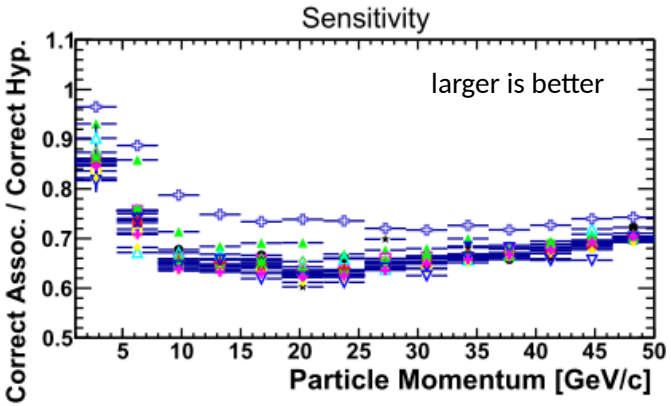
Degree of correlation of estimated and expected angle

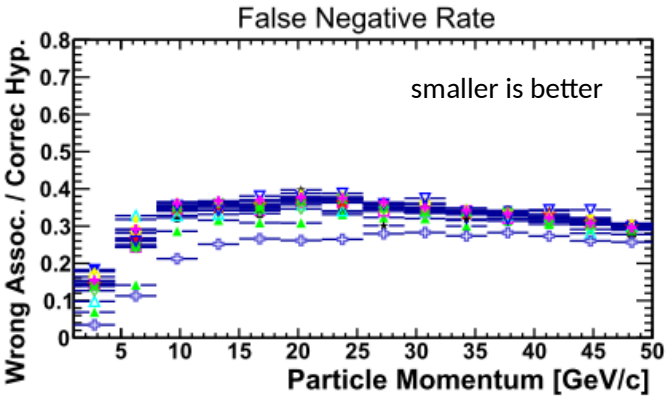
Probability to assign a new photon to the track/rad/part by random choice

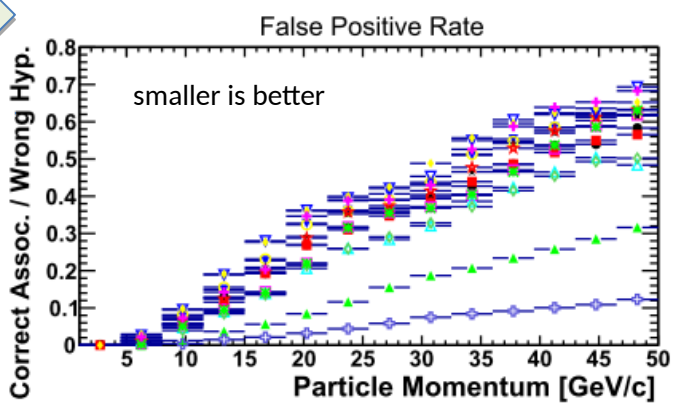
- Gaussian distribution with max=1
- Normalized gaussian (integral = 1)
- ERF function
- =1 (no contribution)
- Combine correlation and anti-correlation

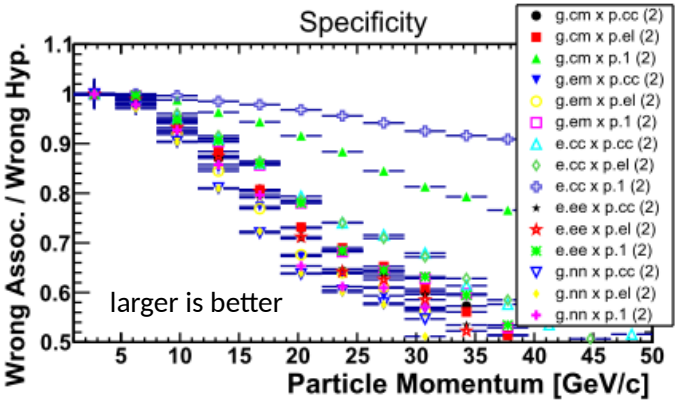
- Cumulated Poisson: prob. assign one or more photon to a given track/rad...)
- Partitioning: enumerate all combinations on "n" photons into "m" partitions (track/rad..);
- =1 (no contribution)

L1=(1-ERF) provides best predictions

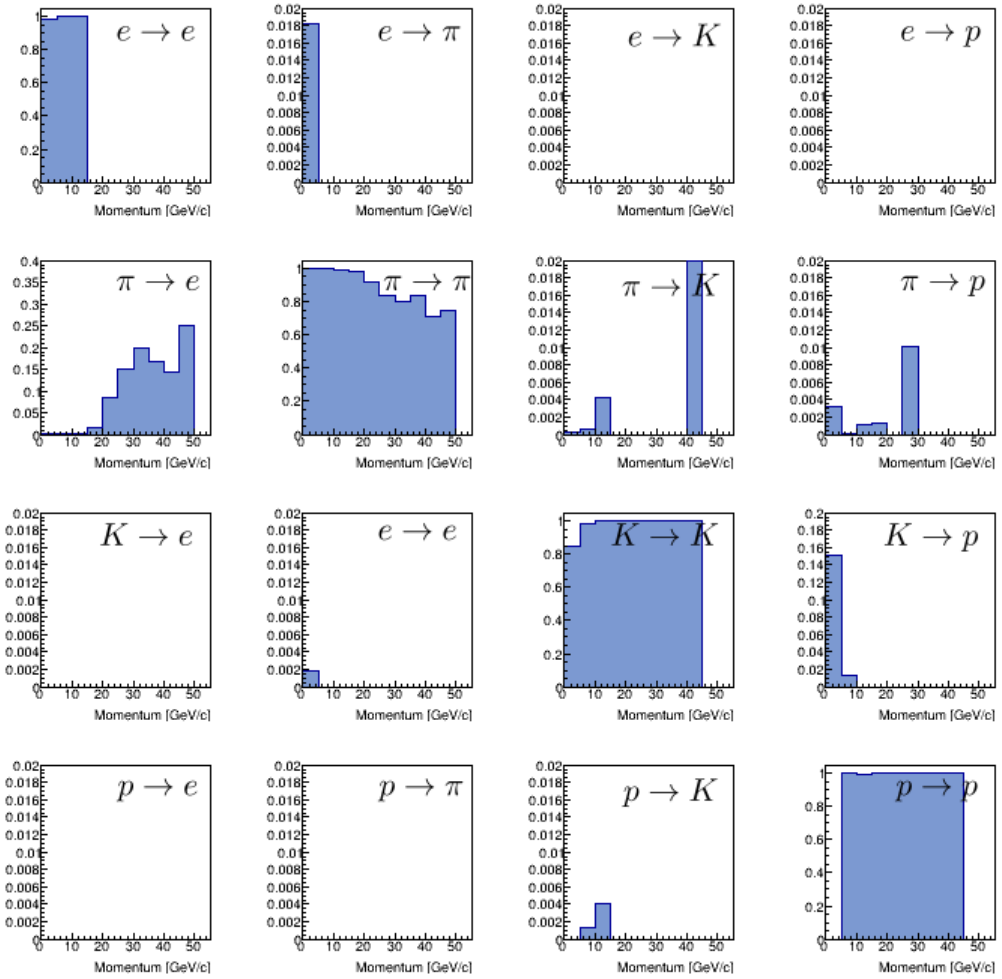


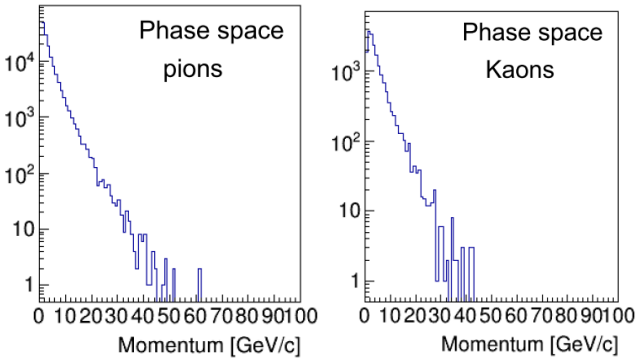


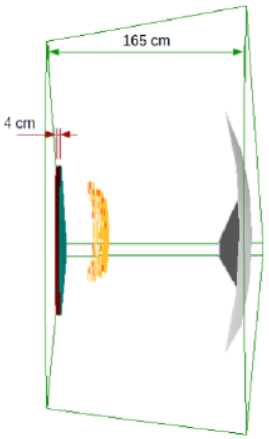


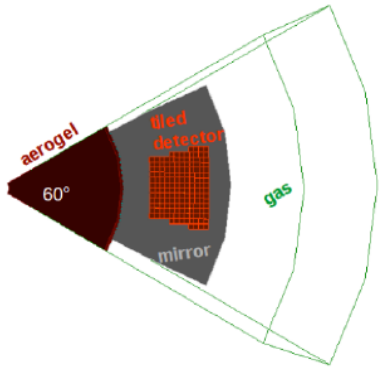


dRICH performance for a key process (PYTHIA DIS simulation)









one of the six dRICH sectors

	Momentum Threshold (GeV/c)	
Particle	Aerogel (1.02)	C2F6 (1.0008)
e	0.003	0.013
pi	0.694	3.49
K	2.46	12.3
p	4.67	23.5