06 / April / 2022

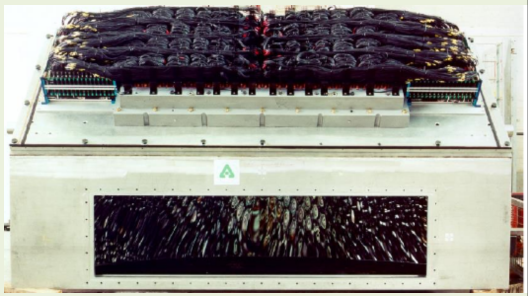
PID in dRICHes

(HERMES reminiscence, EIC attempts)

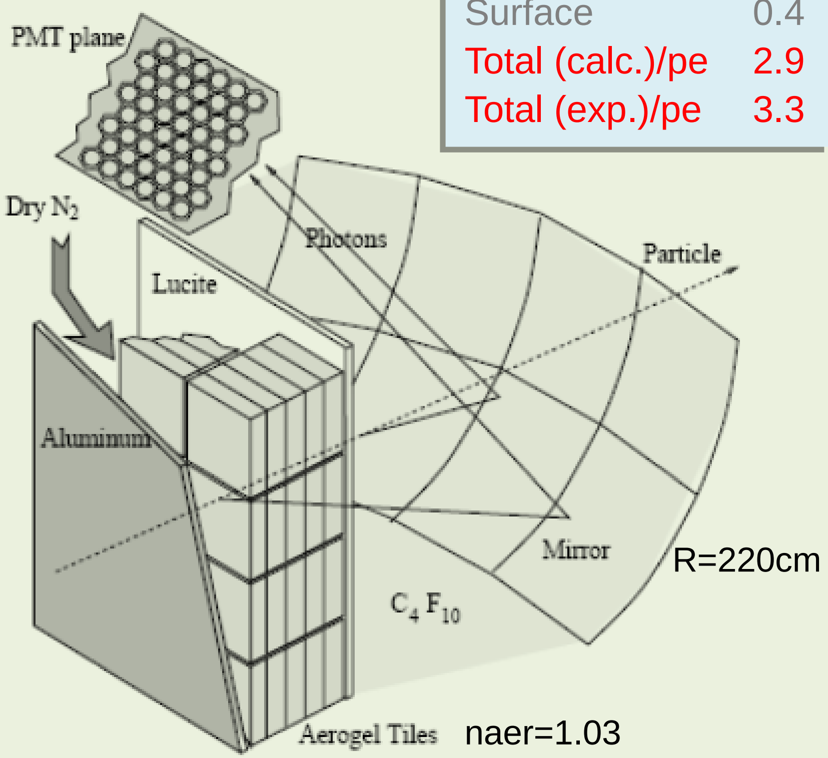
E. Cisbani

HERMES RICH - IRT

Npe aerogel (meas.) ~10



Angular resolution (aerogel ring)	
Pixel	**2.3**
Chromatic	**1.3**
Point emiss.	0.7
Mirror	0.6
n spatial disp.	0.5
Forw. scatt.	0.4
Surface	0.4
Total (calc.)/pe	2.9
Total (exp.)/pe	3.3



Main reconstruction method based on
Indirect (Inverse) Ray Tracing:
computationally efficient, *single hit processing*

Knowns:
- detector geometry (and angular resolution σ_ϑ)
- hit position
- track information (trajectory and momentum)

Assumed:
- radiator (hypothesis)
- emission vertex along trajectory

Reconstruct (numerical solution):
→ emission angle for each hit
Choose radiator hypothesis (usually simple) and evaluate average emission angle

Select particle type based on
- product of aerogel and gas gaussian likelihoods on expected and average emission angles (assumed single photon resolution)

$$L(\langle\vartheta\rangle) = exp\left[-\frac{(\vartheta_{theo} - \langle\vartheta\rangle)^2}{2\sigma_\vartheta^2/N}\right]$$

HERMES RICH - DRT

Direct Ray Tracing / global reconstruction, computational demanding

Knowns:

- detector geometry and physics/optics properties (detector response)
- tracks information (trajectory and momentum, including tracks of known particles)
- pixels with signal: C(i)

For each hypothesis: track-particle time (h)=(t,p), compute by ray-tracing/MC:

- Geometrical probability of each pixel to be hit
- Average #PE on each pixel (from Cherenkov radiation and background sources): $N_{PE}^{(h)}(i)$

Combine hypothesis of each track and evaluate overal probability (e.g. assume Poisson) to be/not to be hit by each pixel (I):

$$P^{(h)}(i) = 1 - exp\left(-N_{PE}^{(h)}(i)\right) = 1 - \bar{P}^{(h)}(i)$$

Select hypothesis that maximize likelihood:

$$L(h) = \prod_i \left[P^{(h)}(i)C(i) + \bar{P}^{(h)}(i)(1 - C(i))\right]$$

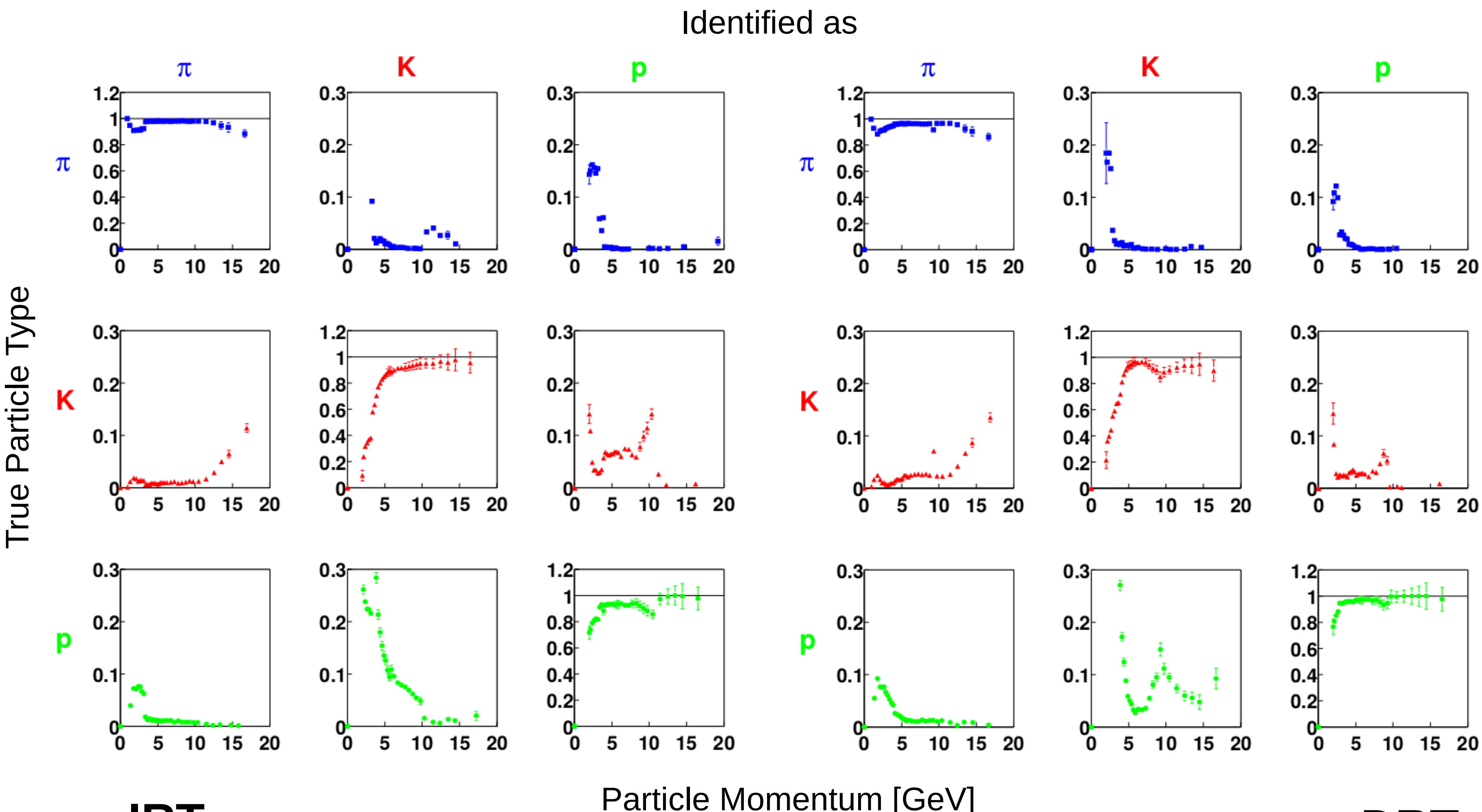
A confidence level of reconstruction can be estimated by:

L(1) and L(2) the largest likelihoods with L(1)>L(2)

$$G \doteq \frac{\log L(1) - \log L(2)}{\sigma(\log L)}$$

HERMES RICH PID Performance

Kentaro Suetsugu – Master's Thesis – Feb 2001



IRT

works reasonably well
in low occupancy and “simple” optics

DRT

performances strongly depend
on the reliability of the detector
model and corresponding simulation