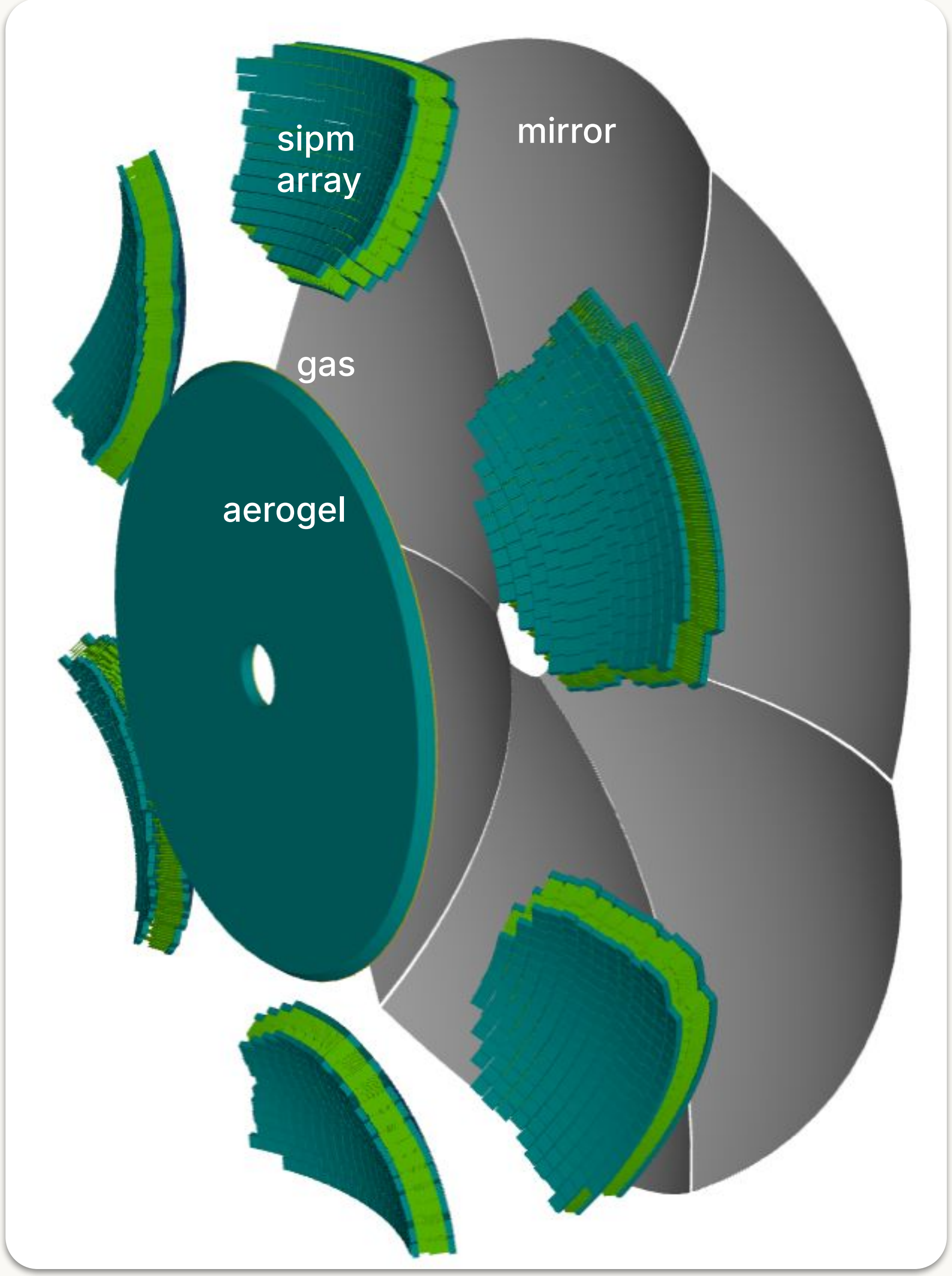
CNN and Vision Transformers for DRICH- PID

Current status and future prospects

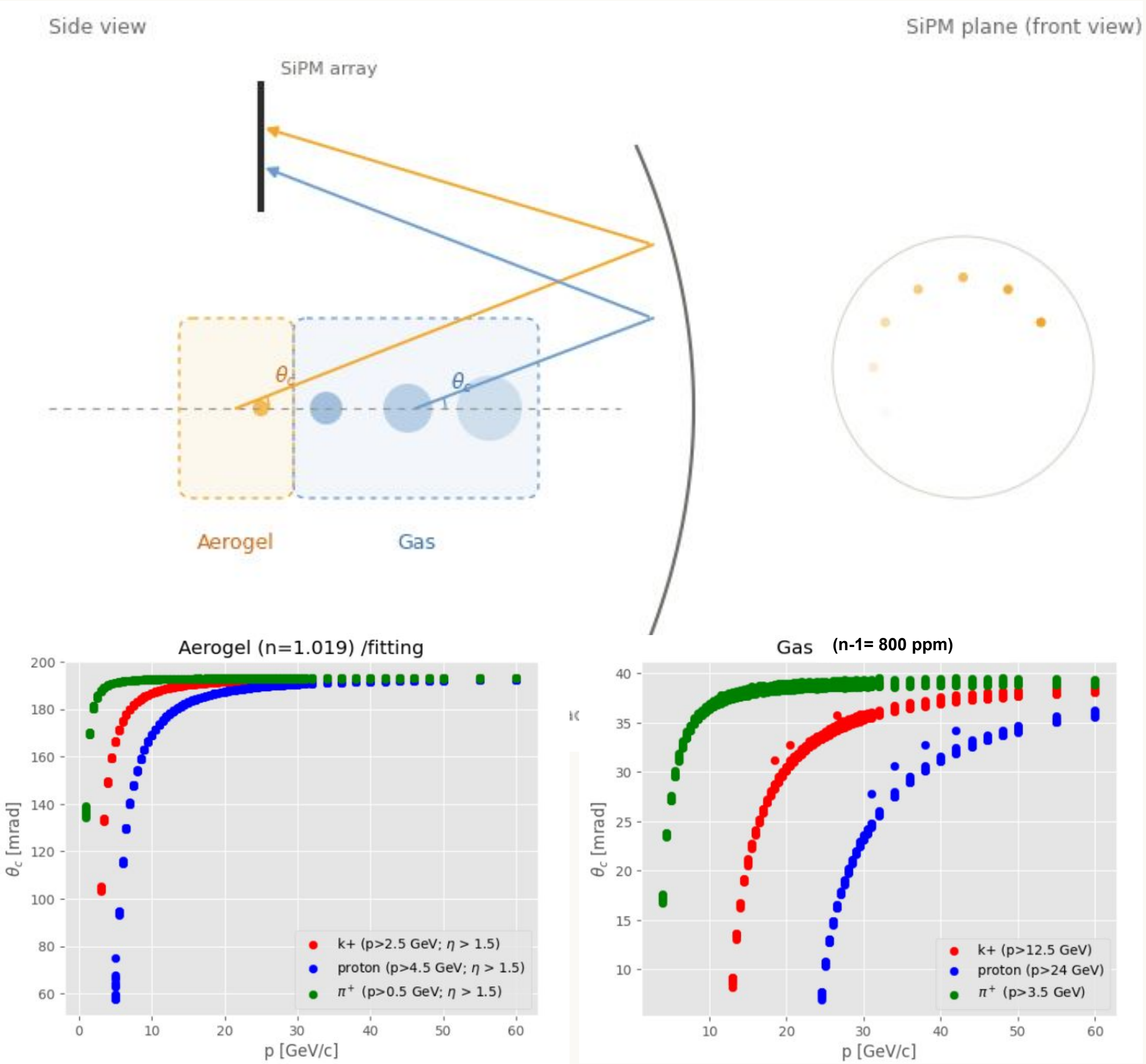
Deepak Samuel · 16 July 2026 · AI Town Hall Meeting

The DRICH detector

- Particle identification in the hadronic end-cap
- 3-σ separation of particles in a broad momentum range from a few GeV/c up to 50 GeV/c
- Cherenkov light produced by two different mediums to cover the full momentum range



Existing algorithm: Inverse Ray Tracing (IRT) for DRICH PID



Constructs using ray tracing,

- θ_c for aerogel rings and gas rings (if present) for every hit.

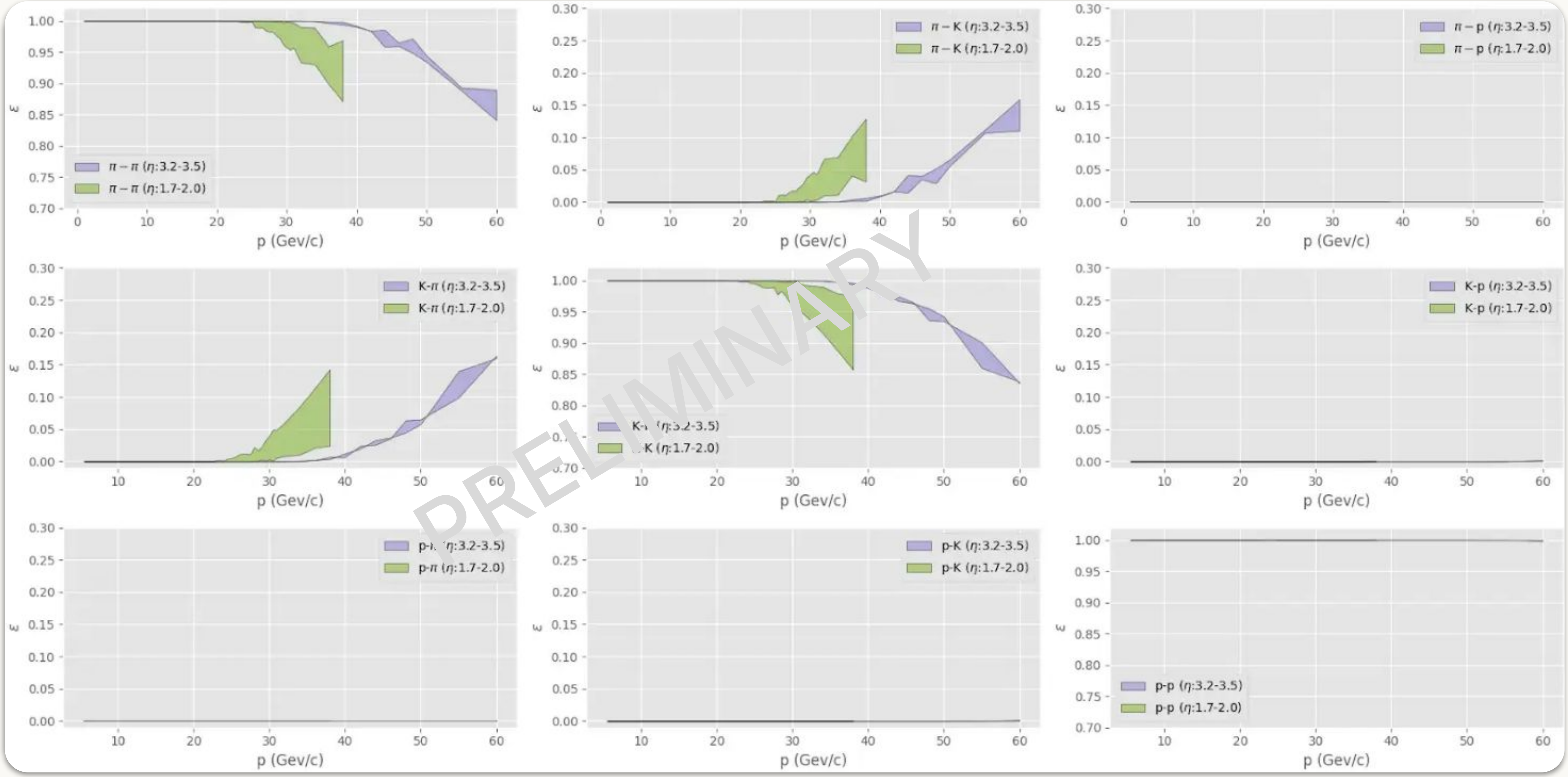
Use θ_c and σ_θ to estimate the PID

- on a track by track basis
- Event level chi-square (IRT-2)

Well tested and benchmarked

- for single particle analysis
- with and without dark current effect
- Efficient handle to calibrate the detector optics, geometry and other components.

IRT PID performance (preliminary)



AI-based PID for the DRICH

Objectives

Quantify performance of ML-models with respect to efficiency, speed and robustness

Motivations

Performance of DRICH under noisy conditions and possibility multi-particle identification

Can timing information improve the performance of PID. If yes, to what extent?

Models considered

CNN and the more recent Vision Transformers

Vision Transformer (ViT) attains excellent results compared to state-of-the-art convolutional networks while requiring substantially fewer computational resources to train

Dosovitskiy, Alexey, et al. "An image is worth 16x16 words: Transformers for image recognition at scale." arXiv preprint arXiv:2010.11929 (2020).

Status

Team

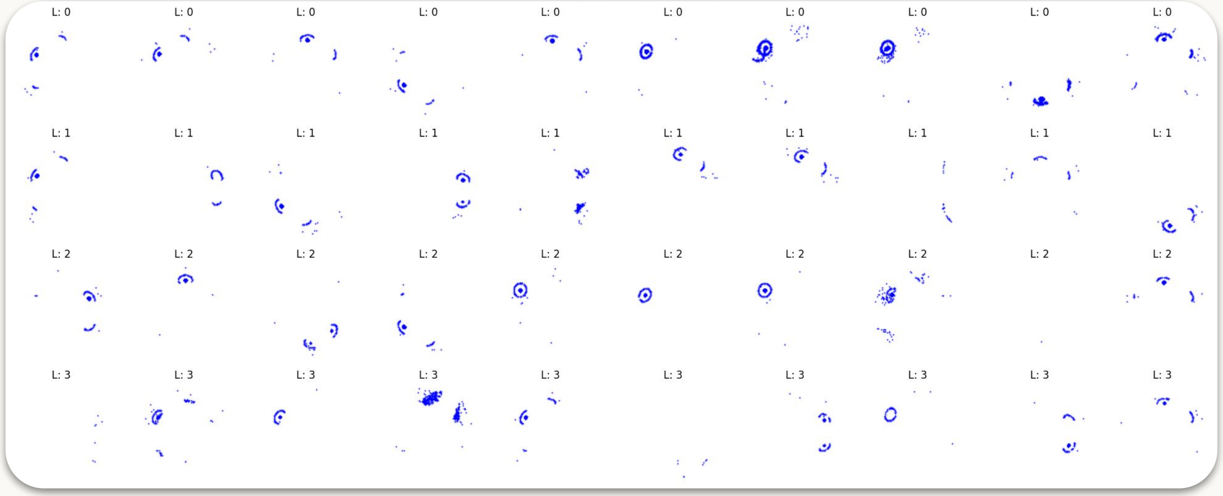
Chandra, Raman (INFN, Trieste), Tanya Tanvi (CU Haryana), and myself

Datasets

10K events each for e, π, p and K for training, 2K for testing

https://github.com/deepaksamuel/drich-ml-analysis/

Simulation hits, scaled to 100 × 100 pixels



Phase 2

Increase sample size for training ViT

Status

Progress made so far

Tanya has started training with a basic CNN but more fine-tuning is required to achieve IRT-level efficiency

Future work

Increase data samples and start training with ViT

Make comparison of IRT / CNN / ViT

Prepare performance benchmark with various noise rates and QEs

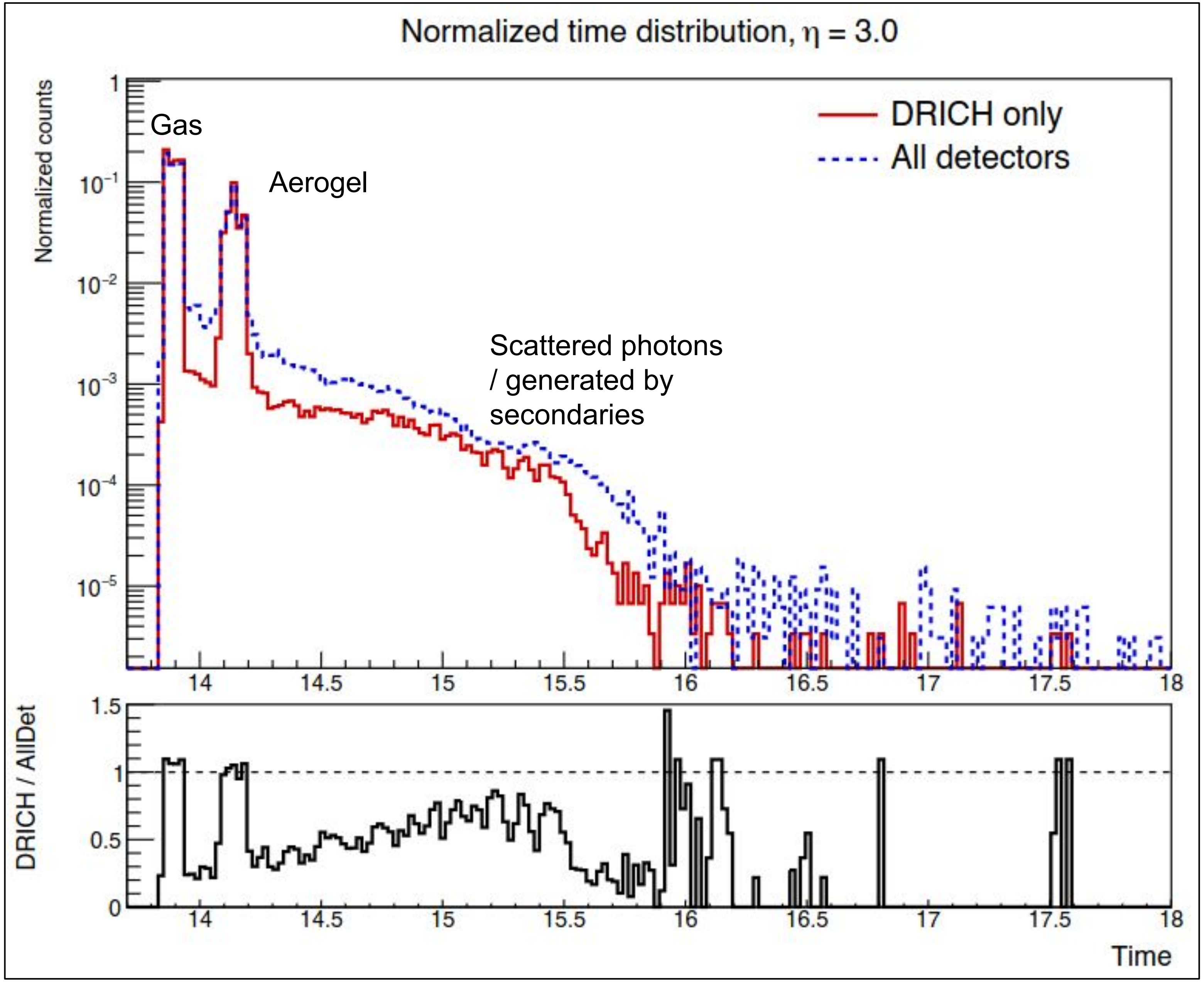
Study performance of CNN/ViT for multi-ring scenarios

First results expected

December 2026

Backup

particle	mass [GeV/c²]	aerogel threshold (n = 1.026)	gas threshold (n = 1.0008)
electron	0.000511	0.0022 GeV/c (2.2 MeV/c)	0.013 GeV/c (13 MeV/c)
pion	0.13957	0.61 GeV/c	3.49 GeV/c
kaon	0.49368	2.15 GeV/c	12.34 GeV/c
proton	0.93827	4.09 GeV/c	23.45 GeV/c



Normalized time distribution, η = 3.0
Normalized counts
Gas
Aerogel
DRICH only
All detectors
Scattered photons
/ generated by
secondaries
DRICH / AllDet
Time

dRICH event topologies — full detector extent (simulation)