AI and finding signatures of phase transition

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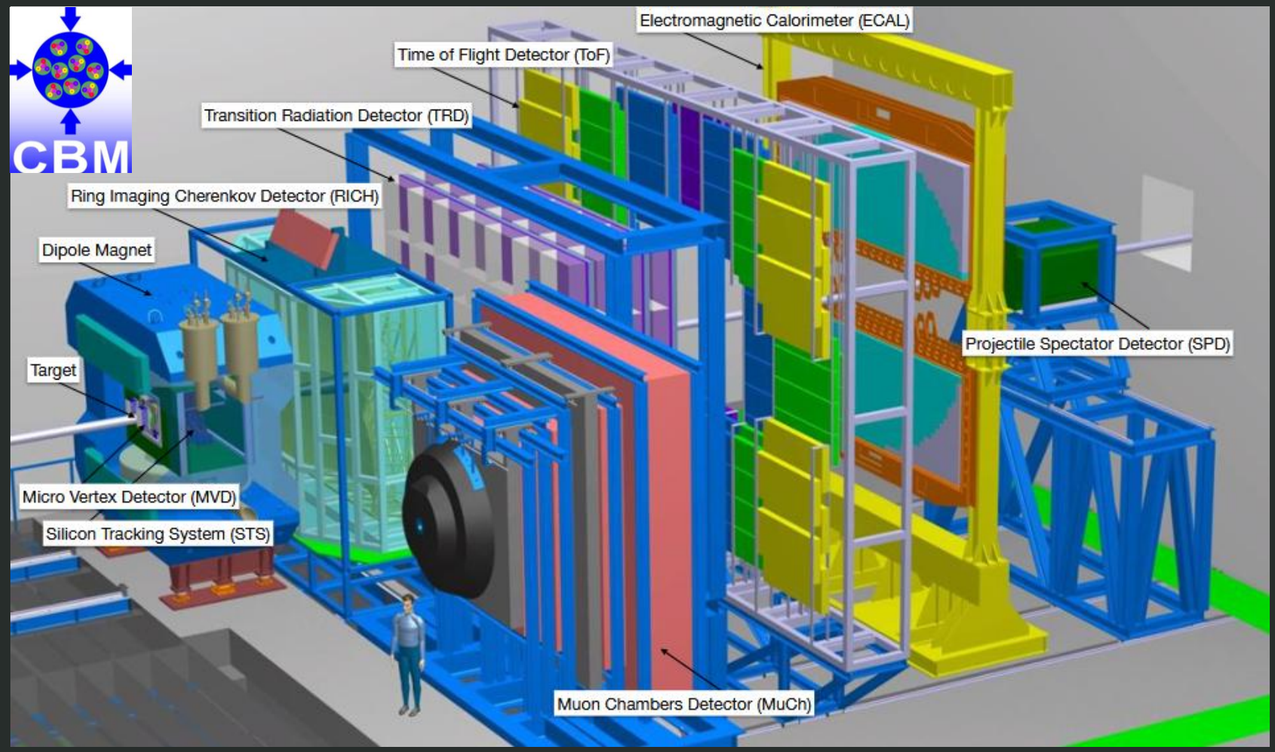
Poster #6

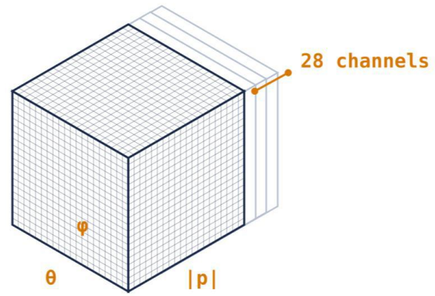


Interaction rate > 10^7 Hz
100 GB/s throughput ceiling
Only a small fraction of collisions can be stored - Selection must happen online

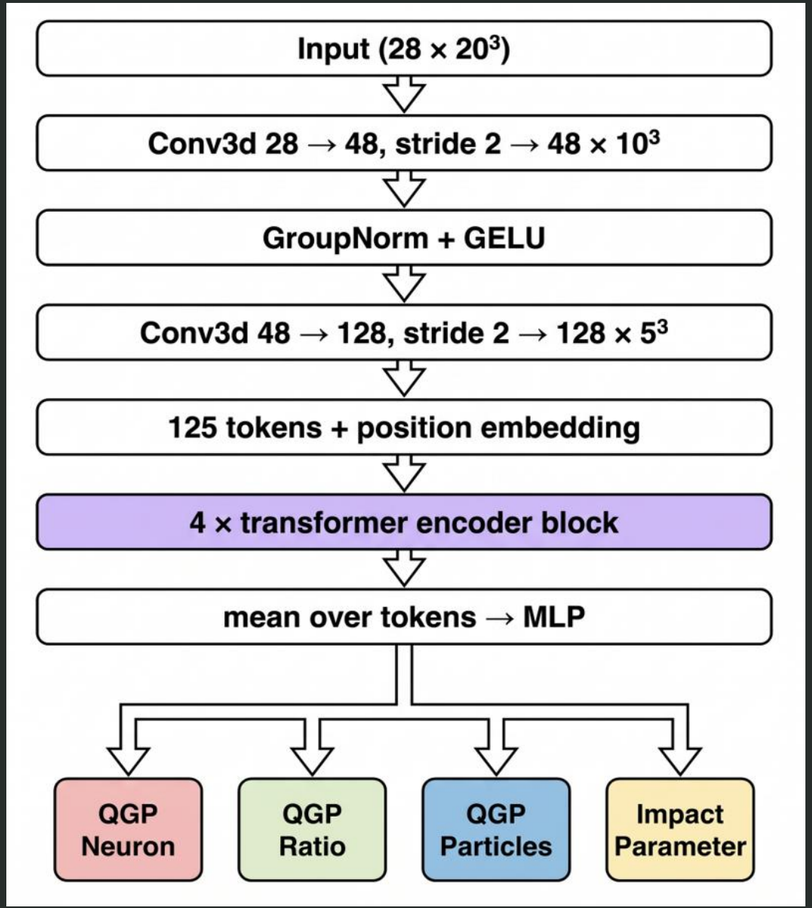
The goal: Establish whether an ANN trigger can select QGP-sensitive events from reconstructed final states – and whether its decision survives changing the event generator and passing through a real detector chain.

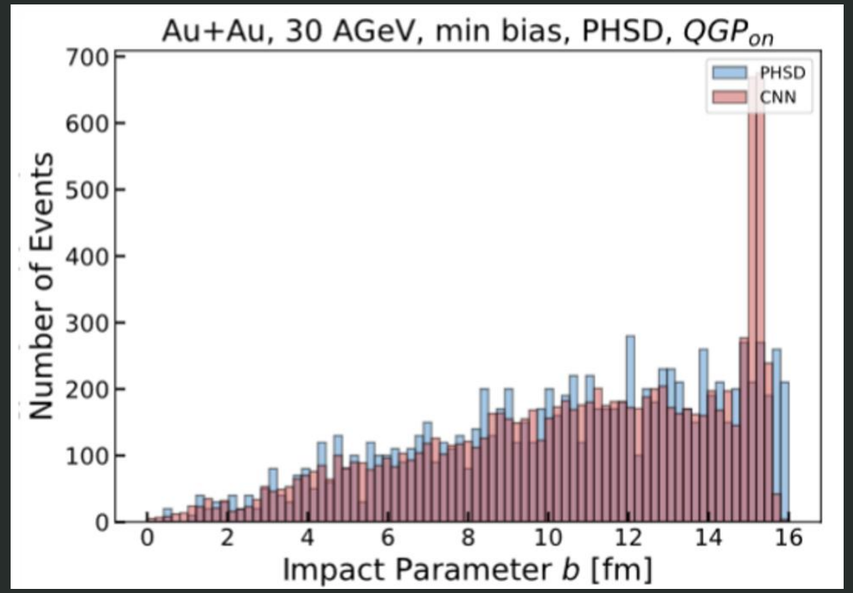
Multi-output hybrid NN

28 x 20 x 20 x 20 input tensor

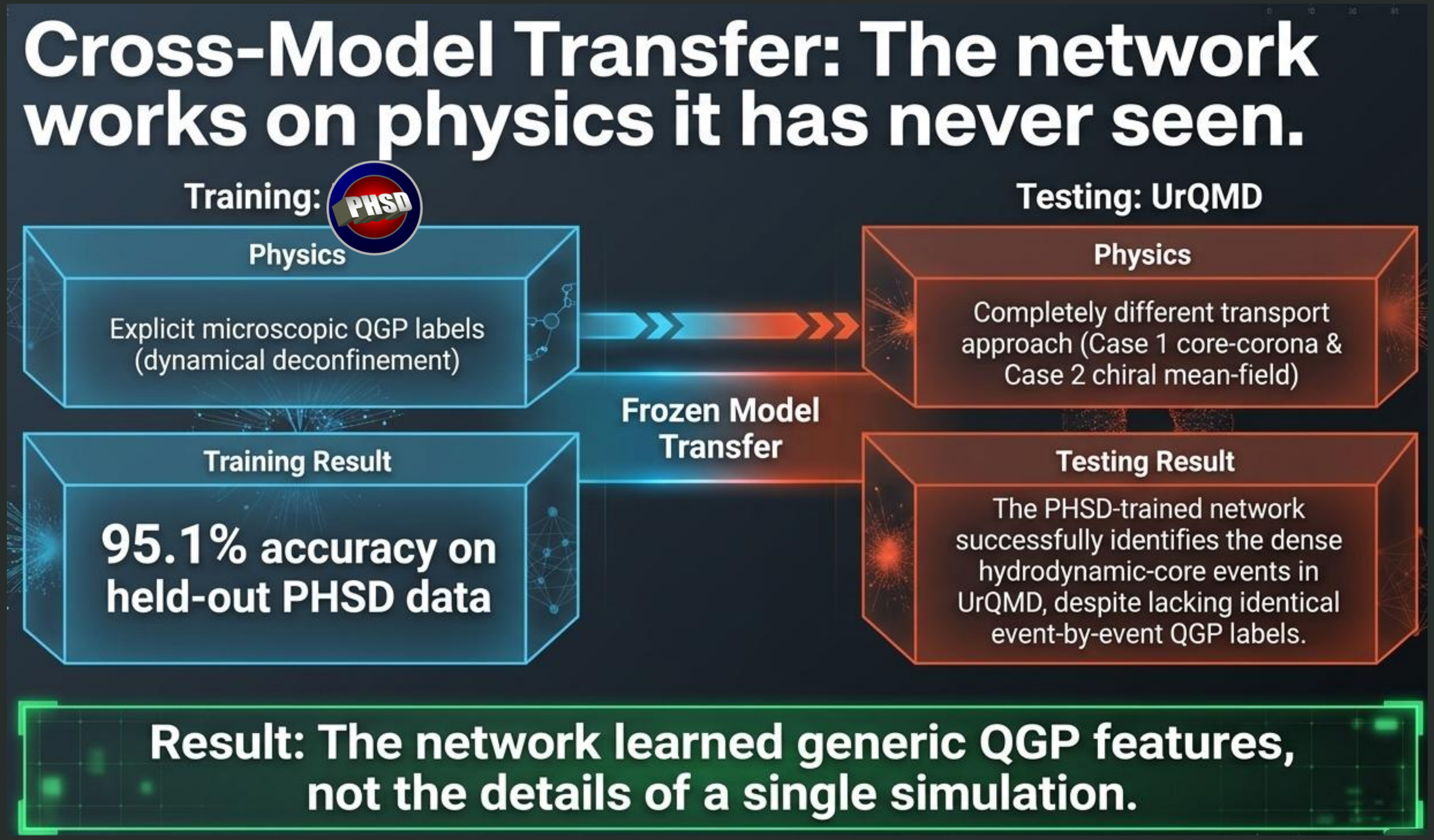


28	particle species	channels; seen ≥ once per 1000 events
20	|p| momentum	log-binned, dense at low momentum
20	θ polar angle	equal bins
20	φ azimuthal angle	equal bins





Cross-Model Transfer: The network works on physics it has never seen.



Result: The network learned generic QGP features, not the details of a single simulation.

Interpretable ANN: Rediscovering Strangeness Enhancement

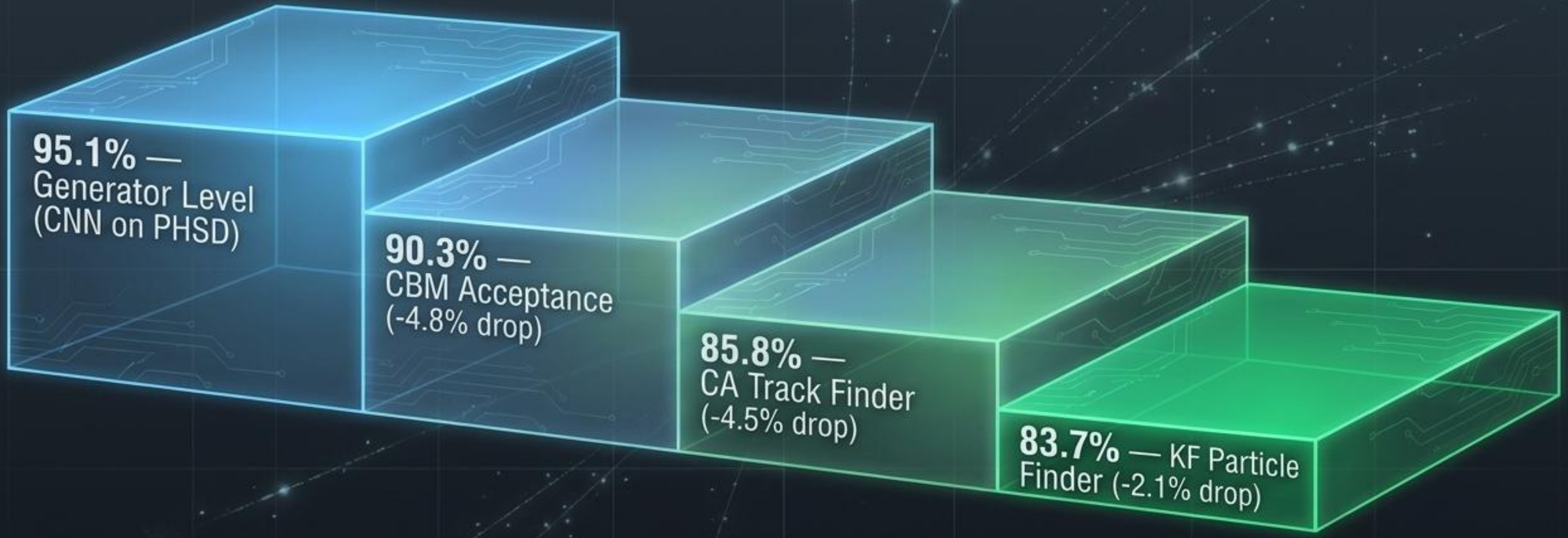
The Insight

SHAP (Shapley Additive Explanations) analysis reveals that the network's decision is heavily driven by the presence of strange particles (K, Λ, Ξ, Ω) and antibaryons.

The Validation

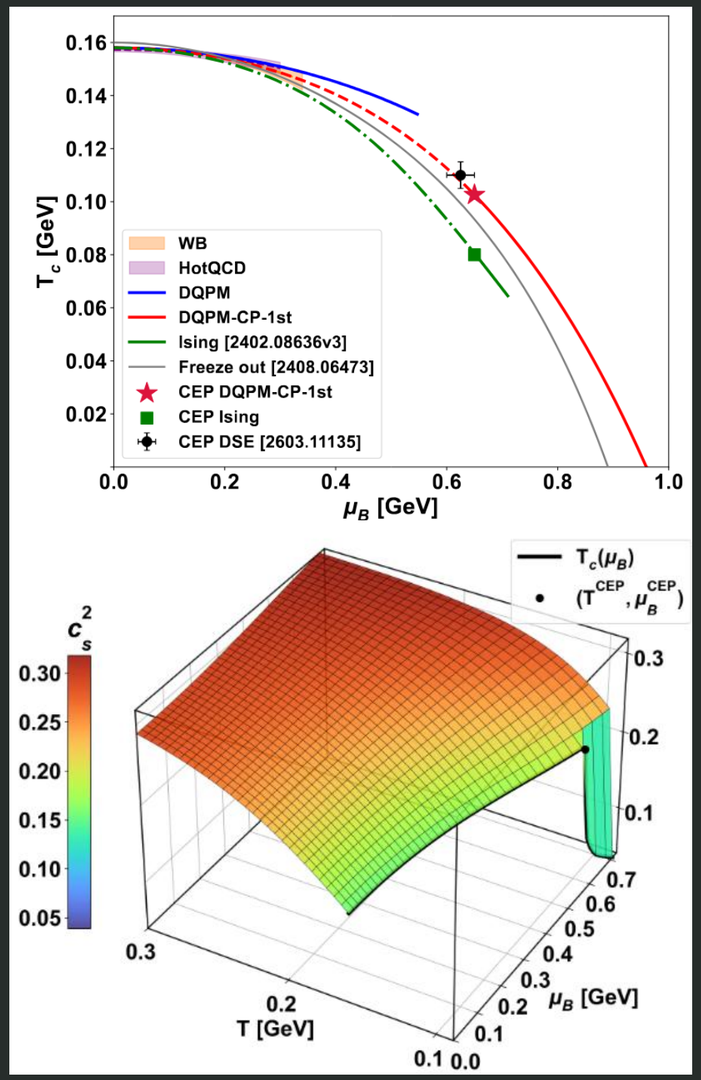
No strangeness observables or physics-informed loss functions were ever imposed during training. The CNN learned the correct features associated with QGP production entirely on its own.

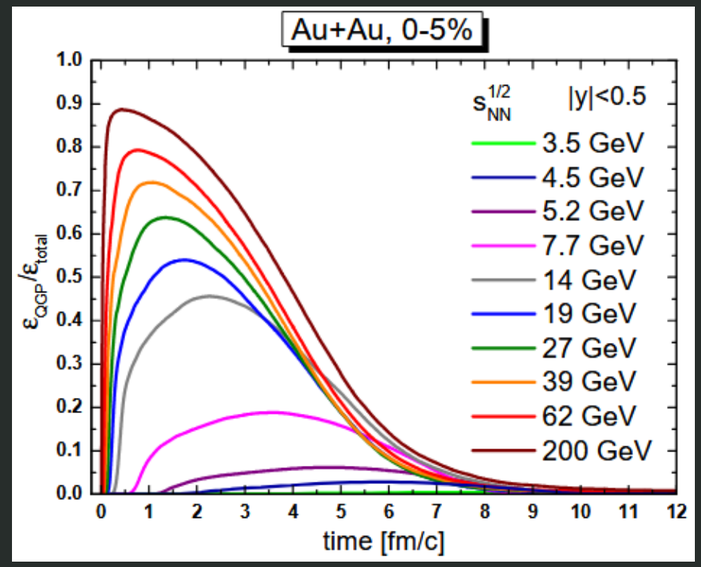
From Ideal Simulations to the Beam



Takeaway: Accuracy drops gracefully. The model is highly robust against incomplete detector information, tracking uncertainties, and partial topology loss.

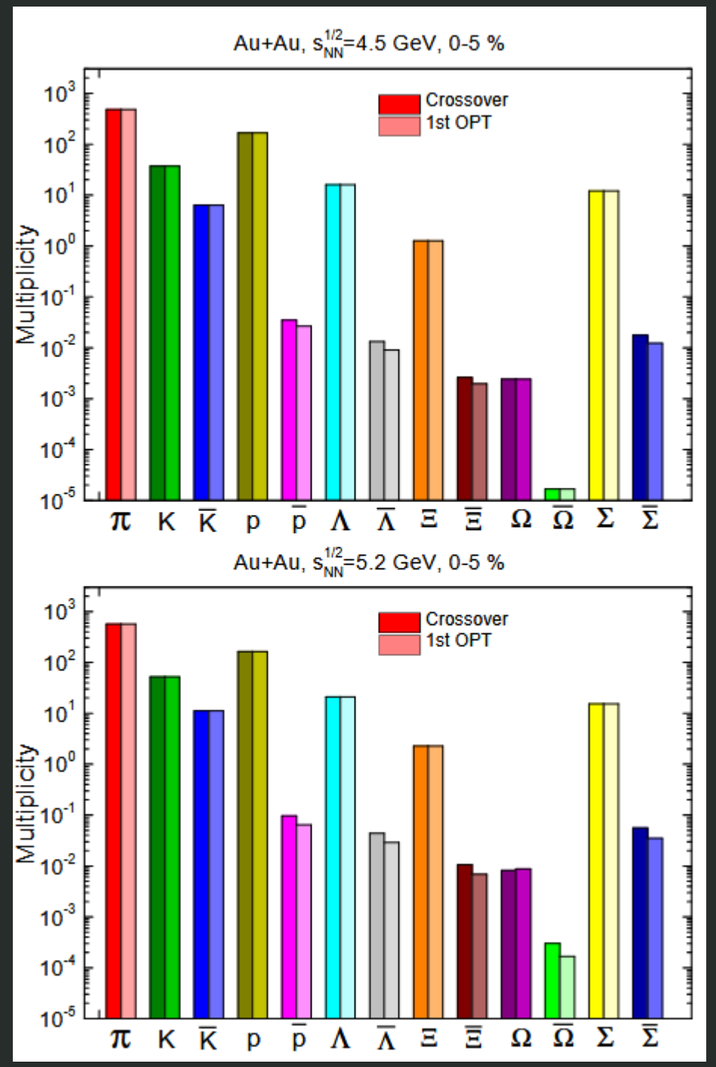
Signatures of phase transition





! QGP fraction is small at low $\sqrt{s_{NN}}$

- **Selective Antibaryon Suppression**
- **Softened Transverse Momentum** (p_T)



A faster, accurate QGP trigger ready for the CBM Experiment

‘Speed’

0.14 ms

per event.

Runs seamlessly (~7,300 events/sec) on a single laptop GPU

‘The Core Proofs’

- **Model Independent**
  (Transfers from PHSD to UrQMD)
- **Physically Interpretable**
  (Driven by strangeness/antibaryons)
- **Detector Robust**
  (Survives full CBM reconstruction chain)

‘Call to Action’

Scan for the full poster and physics references.