The 22nd International Conference on
Strangeness in Quark Matter
22-27 March, 2026, Los Angeles, CA

Contribution ID: **196** Type: **Oral Presentation**

Deterministic AI Surrogate Modeling for Fast Hydrodynamic Evolution of the Quark Gluon Plasma

Wednesday, 25 March 2026 09:25 (20 minutes)

Accurate modeling of the space–time evolution of the quark–gluon plasma (QGP) through relativistic hydrodynamics is essential for connecting initial-state fluctuations to final-state observables and for understanding interactions between hard probes and the evolving QGP in heavy-ion collisions. However, full hydrodynamic simulations are computationally intensive, posing major challenges for large-scale parameter scans and event-by-event analyses. A typical 2+1D simulation requires about an hour per event on CPU, while a 3+1D evolution for central Pb+Pb collisions can take up to ten hours per event, making comprehensive studies prohibitively expensive. We introduce a deterministic AI–based surrogate model that emulates the full QGP hydrodynamic evolution with unprecedented speed. Trained on viscous hydrodynamic solutions from MUSIC, the model achieves orders-of-magnitude faster inference while maintaining high fidelity to the underlying dynamics. This dramatic reduction in computational cost transforms the feasibility of QGP evolution studies, enabling fast and accurate access to full time-dependent information and paving the way for precision, high-statistics analyses.

Authors: Dr GO, Yeonju (Brookhaven National Laboratory); Dr CHAMIZO LLATAS, Maria (Brookhaven National Laboratory); Dr SCHENKE, Bjoern (Brookhaven National Laboratory); Dr HUANG, Jin (Brookhaven National Laboratory); Dr YIHUI, Ren (Brookhaven National Laboratory); Dr LEE, Seungjun (Brookhaven National Laboratory); Dr TORBUNOV, Dmitrii (Brookhaven National Laboratory)

Presenter: Dr GO, Yeonju (Brookhaven National Laboratory)

Session Classification: Parallel VIII: Open Questions and Future