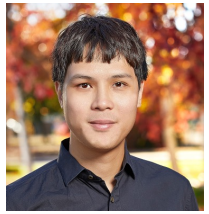
Heavy-Ion Physics @ LLNL

Theory

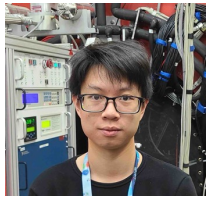


Experiment

Staff

Postdoc

Data Scientist



Luis and JiaJun (RENEW students)

Heavy Flavor & Cold Nuclear Matter

- Ramona Vogt, Vincent Cheung (PD)

- Highlights:
  - Quarkonium polarization in Pb+Pb collisions in the improved color evaporation model (with Cheung)
  - Co-PI of 'Heavy Flavor Probes of QCD Matter' Topical Collaboration

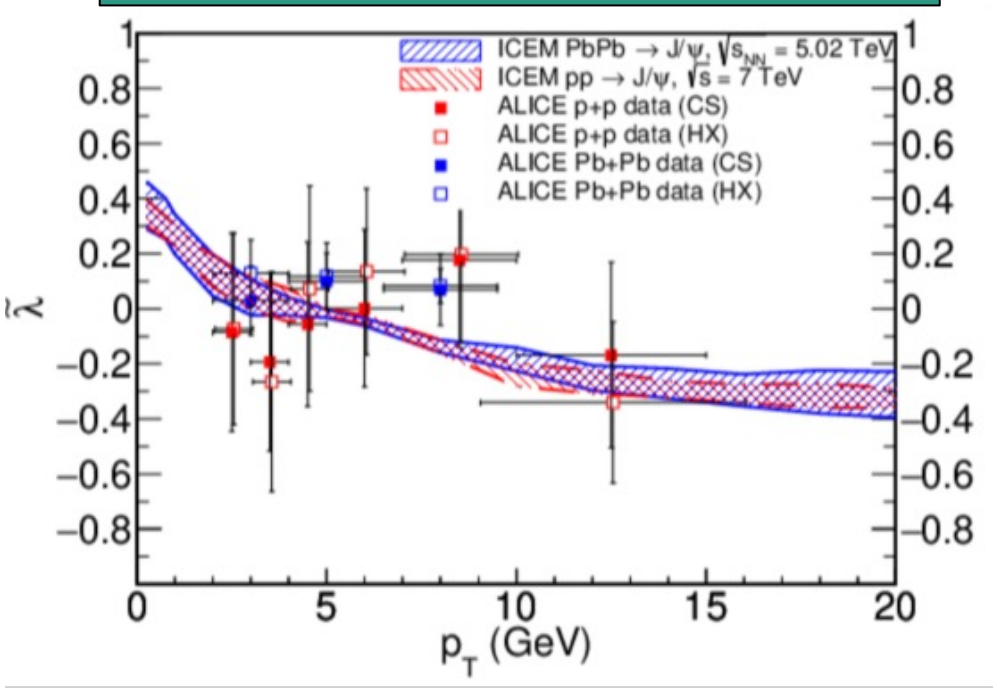
- Publications/Talks:
  - 1 Publication (PRC); 3 invited talks

Service:

- Editorial board for Phys. Rev. Research; Associate Editor for PRC; reviewer for multiple journals
- DNP Secretary-Treasurer; APS Fellowship Committee
- DNP Program Committee for April 2023; INT program organizer (10/22); IAC of Hard Probes 2023 (3/23); GHP biennial meeting committee (4/23); QWG organizer (9/22);
- Hot & Cold QCD Organizing Committee; NSAC LRP Writing Committee, Nuclear Data Sub-Committee

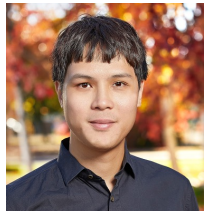
- Upcoming in FY23+:
  - ICEM charmonium production in e+p collisions at the EIC; calculations of feed down contributions

Invariant J/y polarization in p+p and Pb+Pb



HEFTY QQ COLLABORATION QQ

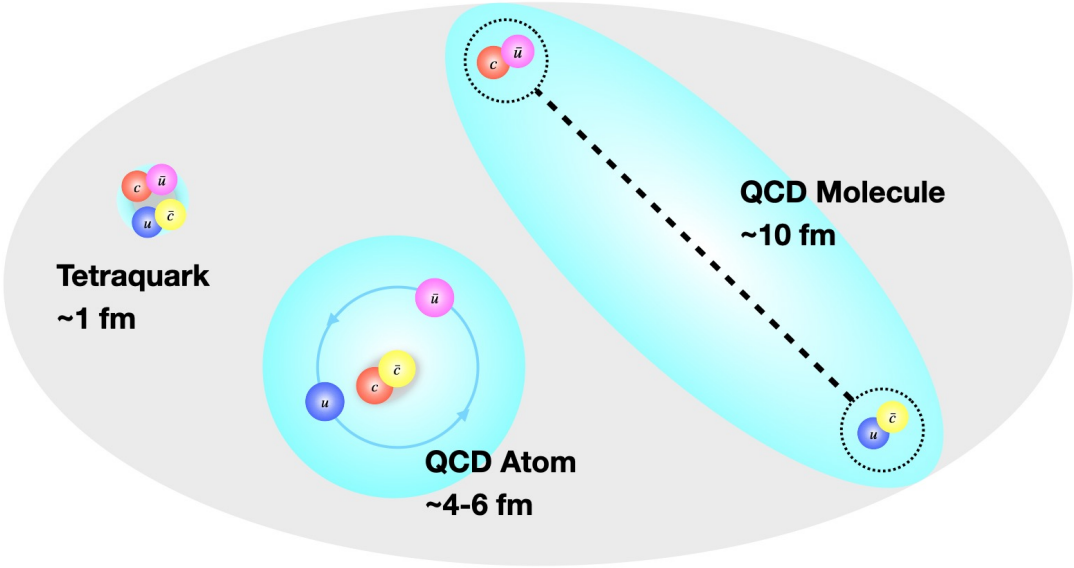
Do Tetraquarks exist? Understanding the nature of the mysterious X(3872) (Postdoc-led LDRD)




- V. Cheung (PI), Q. Hu (co-PI), A. Angreami, R. Vogt

- Objectives:
  - Determine whether the X(3872) is a compact tetraquark or some larger object

- Approach:
  - Use ATLAS measured data to quantify the size of QCD states in heavy-ion collisions
  - Comover interaction model to interpret ATLAS data, describe how QCD states behave in QGP medium
  - Intrinsic Charm model to predict momentum and spatial distributions inside the detector
  - Improved color evaporation model to describe the orientation (polarization) of QCD states



ATLAS: Jets & Substructure

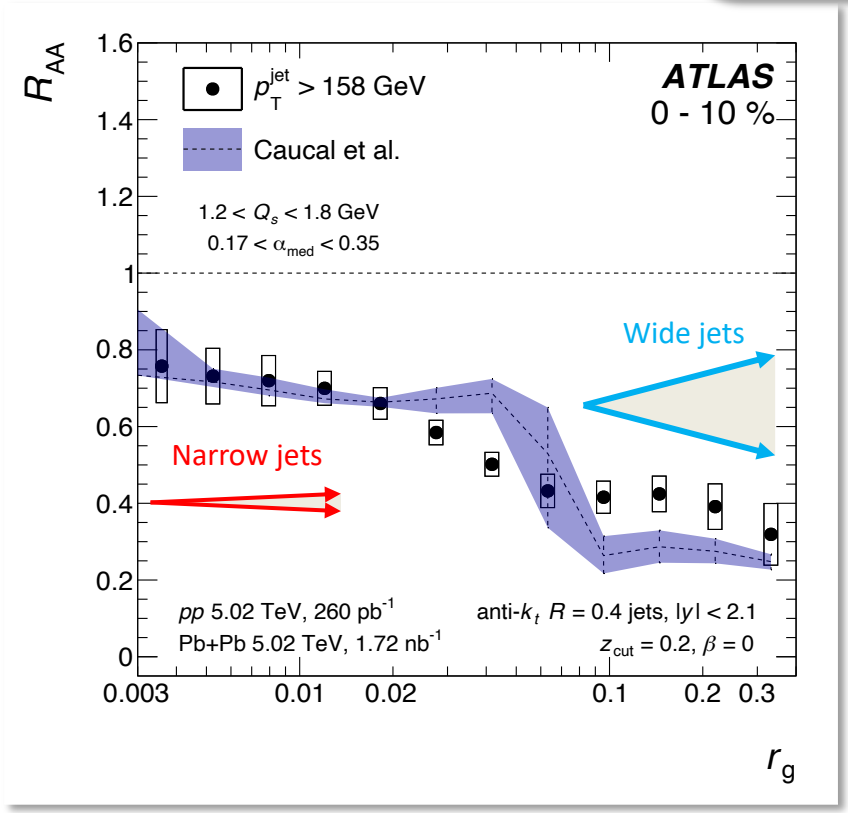
Soon published with JETSCAPE Comparisons (arXiv.org/2211.11470)

Heavy Ions WG

Conveners: M. Rybar, **A. Angerami**

Subgroup	Conveners
Global	J. Jia, A. Milov
Electroweak	Z. Citron, A. Lebedev
Jets	S. Tapia, **D. Hangal**
UPC	S. Mohapatra, P. Steinberg
Trigger	**Q. Hu**, J. Kremmer

- ***Goal:***
  - —Quantitative insight into jet quenching using jet substructure observables
- ***Approach:***
  - — Correlate jet energy loss with new observables sensitive to QGP length scales
  - — Improve particle reconstruction with ML treating calorimeter clusters as high dimensional images
  - — Data Scientist (Piyush Karande) fully integrated into project
  - — Enable new capabilities to exploit ML techniques in other contexts



Heavy Ion Plans

Aaron Angerami, RS, Dhanush Hangal + 1-2 new postdoc positions to be posted in 2023

ATLAS:

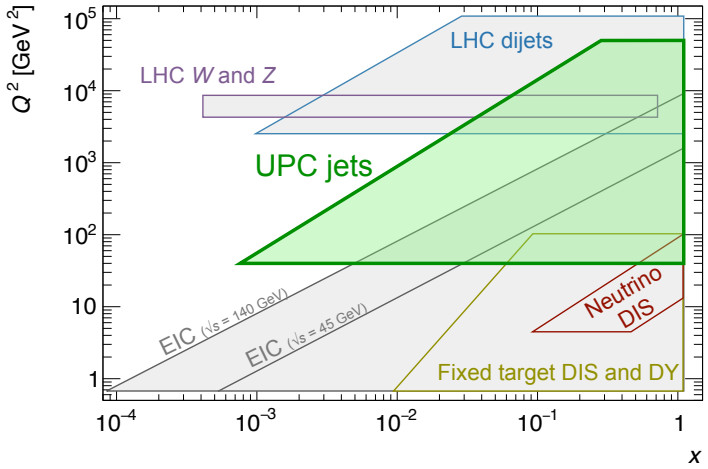
- Participation in LHC run 3 (2023-24)
- Improving reconstruction with ML
- Constrain nuclear PDFs with UPC dijets
- Heavy flavor jet quenching and substructure
- Complete definitive jets in HI exp. methods paper

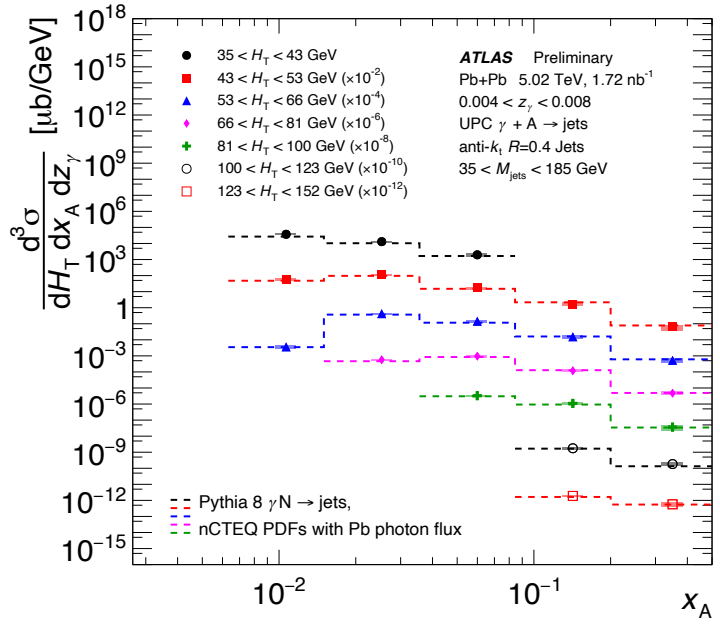
sPHENIX:

- Apply ML methods to TPC-Distortion Corrections
- Upsilon production, jet suppression and substructure

EIC (includes FOA funding):

- Build on AI-driven detector design proposal:
  - ML-informed optimized detector configuration
  - Exploring new ML applications with UC-EIC partners



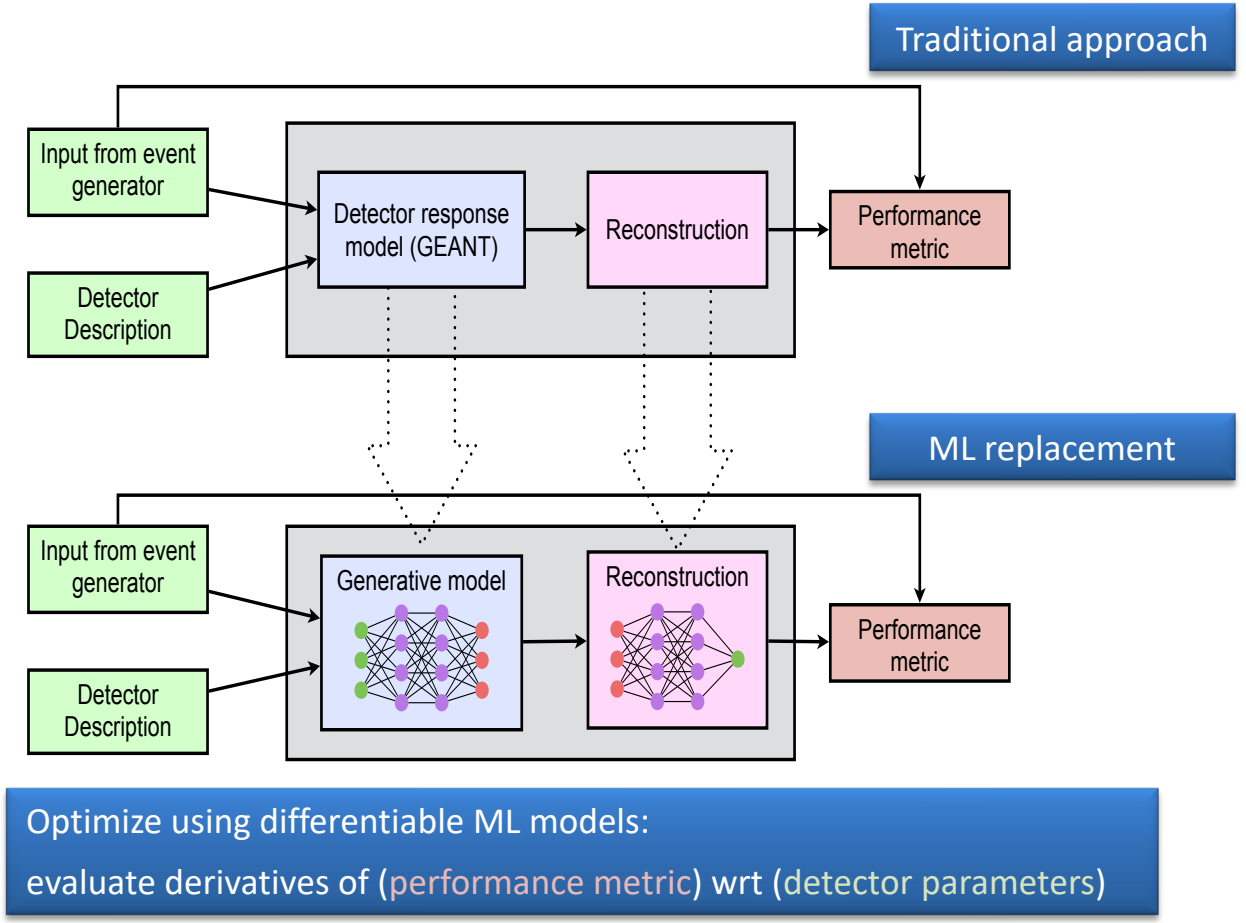


LLNL Heavy-Ion UPC ML techniques

AI-Driven Detector Design for the EIC

Collaborative NP-FOA with B. Nachman (co-PI, LBL) and M. Arratia (lead PI, UC Riverside)
Supporting postdoc Fernando Torales-Acosta (former UCB student and LLNL NSSC intern)

- ***Goal:***
  - New detector design optimized enabled by deep neural networks
- ***Approach:***
  - Use EIC detector simulations to train and surrogate model (differentiable)
  - Use surrogate to optimize detector parameters, e.g. segmentation, number of layers, …
  - Fast calorimeter simulation for optimal detector configuration
  - Specific demonstration for ATHENA EM barrel calorimeter
  - Builds directly on ML expertise acquired from LDRD, including collaboration with data scientist



Planned Optimizations would not be possible w/o ML Surrogate Models

Primary LLNL EIC Focus = NP RENEW

Initially funded 2022 as NP Traineeships to Broaden and Diversify Nuclear Physics
Cal-Bridge-2-EIC in collaboration with UCR (Miguel=Lead), UCLA (Zhongbo), LBNL (Ernst), & CPP

- ***Goal:***
  - Long overdue program to reach wider, more diverse community and convince them to join the Nuclear Science Research Communicate, emphasis on undergraduates at MSI's
- ***Approach:***
  - Initial 2-year focus on EIC and integrate CalBridge Program https://www.cpp.edu/calbridge/
  - Next round, refine focus to UC-EIC and local Cal-State campuses (more discussion earlier/later)
  - LLNL focus on teaching EIC physics and ML tools through https://lc.llnl.gov/jupyterhub, maintained by Livermore Computing (https://computing.llnl.gov)