Aritra Bal

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Education

Karlsruhe Institute of Technology — *Germany*

PhD Student | Supervisors: Prof. Dr. Markus Klute and Dr. Benedikt Maier — *August 2022- ongoing*

Indian Institute of Technology Kharagpur | GPA 9.07/10.00 — *India*

BSc (Honors) + MSc, Physics — *2017-2022*

Experience

2022	**Summer Student**, CMS Group, DESY, Supervisor: Dr. Achim Geiser	*Hamburg, DE*
2021	**Summer Student**, CERN	*Geneva, CH*
2020-21	**Student Researcher**, VECC, Department of Atomic Energy	*Kolkata, IN*

Current Research

Unsupervised Anomaly Detection with the CMS Detector at the LHC — *KIT*

2023 - ONGOING

- Part of the CMS Anomaly Search Effort (CASE) to search for Physics Beyond the Standard Model.
- Used Variational Autoencoders to learn representations of QCD like jets and use the loss as an anomaly metric after decorrelating from the variable of interest using a novel technique based on Deep Quantile Regression.
- Physics publication submitted to Reports on Progress in Physics (ROPP), and Machine Learning publication in pipeline, with CMS Public Note already available.

Particle Physics data encoding for Machine Learning on Quantum Computers — *KIT and Imperial College, London*

2024 - ONGOING

- Developed novel data encoding technique for representing particle physics jet data onto a qubit, for usage in anomaly detection and classification tasks
- Developed and demonstrated competitive performance of quantum machine learning models, for both classification and anomaly detection, using this novel encoding. Methods were shown to be comparable to state of the art benchmarks, including the first ever application to real data using a CMS Open Data release, thereby proving that the robustness of our approach in real-world scenarios
- Supervised two Master theses at Imperial College London as part of this project
- Manuscript submitted to Physical Review Letters (PRL) in March 2025

Knowledge Distillation for Pileup Mitigation — *KIT*

2023

- Supervised a bachelor thesis at KIT, which demonstrated the viability of knowledge transfer from a more complex transformer-based neural network to a simpler student network, for the purpose of mitigating pileup in collider physics data at the LHC.
- Results published in Machine Learning Science and Technology (MLST)

Skills

Programming and Frameworks, • Python • C • C++ • Linux • ROOT

Libraries, • Tensorflow • Keras • PyTorch •PennyLane, Qiskit, •JAX •MPI •OpenMP

Tools, • Docker • Singularity • Bash • HPC: Slurm, HTCondor

Recent Talks

2024	**Model-agnostic search for dijet resonances with anomalous jet substructure**,	*ML4Jets, Paris*
2023	**Anomaly Detection with CASE at CMS**,	*CERN ML Town Hall, Geneva*
2023	**Unsupervised Searches at the CMS Experiment**,	*EXO Workshop, Rome*