

# ABHISHEK

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📍 KNOXVILLE, USA

## EDUCATION

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### PhD Candidate In Physics CGPA 0.0/0.0

Aug 2025 - Present

University of Tennessee, Knoxville, TN, USA

### Integrated M.Sc Physics CGPA 8.36/10

August 2019 - July 2024

National Institute of Science Education and Research (NISER), Bhubaneswar, India

## RESEARCH PROJECTS

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### Classification of hadrons in Granular Hadron Calorimeters Using Deep Sets. [Aug, 2024 - Aug 2025]

INFN-Padova, Italy

Dr. Tommaso Dorigo

- Investigating whether higher granularity in hadron calorimeters improves particle discrimination (proton/pion/kaon).
- Simulated a  $100 \times 100 \times 100$  Lead Tungstate calorimeter geometry using GEANT4.
- Recorded per-cell features including energy deposition, momentum, and interaction counts.
- Training a deep sets base learning model on the extracted features to evaluate classification performance.

### Investigation of $\rho^0(770)$ Meson Production [Aug, 2024 - Dec, 2024]

Central University of Tamil Nadu, India

Dr. Nirbhay Kumar Behera

- Studying short-lived resonances to probe the properties of the quark-gluon plasma (QGP).
- Focus on  $\rho^0(770)$  production in pp collisions at  $\sqrt{s} = 13.6$  TeV.
- Reconstruct  $\rho^0 \rightarrow \pi^+\pi^-$  by calculating the invariant mass in sphericity bins.
- Subtract like-sign pairs to remove combinatorial background.
- Generate collision events and final states using Pythia.

### Developing Imaging Algorithms and RPCs for Muography Studies [Aug, 2023 - Jun, 2024] [Master Thesis]

NISER, India

Prof. Bedangadas Mohanty & Dr. Raveendrababu Karnam

- Developed track reconstruction algorithms and detector design for Muon Scattering Tomography (MST).
- Transitioned from a fully simulated MST study (completed in Summer 2023) to constructing a physical muon telescope (“Muoscope”).
- Designed the detector system using Resistive Plate Chambers (RPCs), dividing the project into simulation and experimental phases.
- Implemented POCA (Point of Closest Approach) and BCA (Binned Clustering Algorithm) methods for 3D tomographic image reconstruction in simulation.
- Built and characterized three  $16 \times 16$  cm<sup>2</sup> glass RPC detectors for the prototype Muoscope.
- Established data readout using NIM modules for detector performance evaluation.

## Cosmic Muons Scattering Simulation Using GEANT4 [May, 2023 - Jul, 2023] [Report]

Université Catholique de Louvain, Belgium

Dr. Andrea Giammanco

- Simulated cosmic muon scattering using Geant4 and analyzed data in ROOT.
- Designed a four-layer muoscope for material identification via scattering signatures.
- Applied the Point of Closest Approach (PoCA) algorithm for 3D material imaging.
- Integrated Garfield++ to improve detector response accuracy in simulation.

## Forward-Backward Sphericity Correlation in pp Collisions at $\sqrt{s} = 13 \text{ TeV}$ [May, 2022 - Jul, 2022] [Report]

Indian Institute of Technology Bombay, India

Dr. Sadhana Dash

- Used sphericity to classify pp collision events into jetty (hard QCD) and isotropic (soft QCD) categories.
- Investigated soft-QCD dominated events for possible heavy-ion-like signatures in small systems.
- Simulated minimum-bias pp collisions using Pythia.
- Observed a forward-backward correlations in the bins of sphericity, indicating non-trivial event shape dynamics.

### ACADEMIC PROJECTS AND TALKS

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## Advanced Physics Lab-I: Metamaterial hyperlens demonstration of propagation without diffraction [Report]

- Developed hyperlens allowing diffraction-free microwaves using cost-effective ribbon cable arrays.
- Successfully demonstrated diffraction-free propagation with this metamaterial.

## Advanced Physics Lab-II: Construction of a straw tube proportional gas flow counter [Report]

- Proportional Counter: Utilizes gas multiplication for ionizing radiation detection in pulse mode.
- Experiment Achievements: Constructed a Single-wire Proportional Counter for Iron-55 X-ray detection and a Straw Tube Proportional Counter without a window using OHP Sheet and aluminum tape.

## Term Paper: Ads/CFT correspondence and lower bound of $\eta/s$ [Report]

We used the Ads/CFT correspondence to calculate the correlation function of the stress-energy tensor in the gravity regime and to compute the shear viscosity  $\eta$  of a strongly coupled Yang-Mills plasma and use the known entropy density  $s(T)$  to calculate  $\eta/s$ . We review the KSS bound on  $\eta/s$  and describe possibilities for the lower bound to be violated.

## Term Paper: Introduction to Artificial Neural Networks [Report]

This paper presents the study and implementation of an Artificial Neural Network (ANN) from scratch using Python. First, it was implemented using the code provided by J. Sargent & John Stachurski, and then some new methods were tested to improve the overall efficiency and usage of the ANN.

## Term Paper: Introduction to Matrix Product States [Report]

This report provides a concise overview of Matrix Product States (MPS) and Tensor Networks in quantum physics. It discusses Singular Value Decomposition (SVD) in the context of MPS. The report concludes by solving the 1D Ising model and computing magnetization and correlation length.

### RELEVANT ELECTIVE COURSES

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1. Quantum Field Theory, 2. Particle Physics, 3. Introduction to Phase Transition And Critical Phenomena, 4. Relativistic Nucleus-Nucleus Collision And Quark-Gluon Plasma, 5. Introduction To Quantum Optics, 6. Computational Physics, 7. Quantum information & Quantum computation, 8. Experimental Techniques

## SCHOOLS

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- ESCAPE summer school on data science for Astronomy, Astroparticle and Particle Physics (June 2021). [\[Certificate\]](#)
- Statistical Methods and Machine Learning in High Energy Physics at ICTS Bengaluru.

## SCIENTIFIC CONTRIBUTIONS

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- First Author, "A modular muon telescope for tomography and radiography applications," Nuclear Inst. and Methods in Physics Research, A., <https://doi.org/10.1016/j.nima.2025.170399> [\[Publication\]](#)
- Co-Author, "Hadron Identification Prospects With Granular Calorimeters," at 4th MODE Workshop - Valencia (Spain). This work received the award for Best Poster at the conference, MDPI Particles. [\[Publication\]](#)
- Co-Author, "Neuromorphic Readout for Homogeneous Hadron Calorimeters," MDPI Particles. [\[Publication\]](#)
- Co-Author, "End-to-End Detector Optimization with Diffusion models: A Case Study in Sampling Calorimeters" MDPI Particles. [\[Publication\]](#)
- "Particle Identification in Highly Granular Calorimeters With Deep Sets" at Fifth MODE workshop - Crete (Greece). [\[Poster\]](#) [\[Slides\]](#)

## SKILLS

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|---------------------------------|--|
| • <b>Data Analysis</b>          | ROOT <sup>‡</sup> , Python <sup>‡</sup> , C++ <sup>‡</sup> .   |
| • <b>Python Libraries</b>       | Pandas <sup>‡</sup> , NumPy <sup>‡</sup> , Uproot <sup>*</sup> , Awkward <sup>*</sup> , Numba <sup>°</sup> , SciPy <sup>*</sup> .  |
| • <b>Monte Carlo Simulation</b> | GEANT4 <sup>‡</sup> , Pythia <sup>*</sup> , Garfieldpp <sup>*</sup> .  |
| • <b>Machine Learning</b>       | JAX <sup>*</sup> , PyTorch <sup>‡</sup> ; Algorithms: Decision Trees <sup>‡</sup> , Graph Neural Networks <sup>*</sup> , DeepSets <sup>*</sup> .                                     |
| • <b>Additional Tools</b>       | JupyterLab <sup>‡</sup> , Git <sup>*</sup> , SSH <sup>*</sup> , VNC <sup>*</sup> , Multi-threading <sup>*</sup> , Linux <sup>‡</sup> , ECoMuG <sup>‡</sup> , $\LaTeX$ <sup>‡</sup> . |
| • <b>Communication</b>          | Hindi (Native), English (Fluent).  |
| • <b>Hardware</b>               | ASIC <sup>°</sup> , FPGA <sup>°</sup> , NIM and CAEN modules <sup>‡</sup> .  |

<sup>‡</sup> Expert <sup>‡</sup> Proficient <sup>\*</sup> Competent <sup>°</sup> Novice

## AWARDS/ACHIEVEMENT

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- **DISHA** fellowship by the Department of Atomic Energy (DAE) in India. This fellowship is granted to only a few students selected from DAE-aided institutions. [\[Certificate\]](#)