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Doctoral Research

10/2019 – 7/2024

- **PhD, Experimental Particle Physics**
  Department of Physics and Astronomy
  University of Sheffield, UK

  Title: Calibration of the DUNE FD Using Cosmic-ray Muon Events

  — Generation and simulation of cosmic-ray muon events for the DUNE FD
  — Characterisation and analysis of cosmic-ray muon events
  — Analysis of π^0 reconstruction in the DUNE FD
  — Energy calibration of the DUNE FD using stopping muons, pions, and protons
  — R&D of LArTPC, pixel-based TPC charge readout

Research Position and Employment History

02/2020 – 01/2023

- **Graduate Teaching Assistant (GTA)**
  Department of Physics and Astronomy, University of Sheffield, UK.
  — Taught tutorial classes and marked homework for undergraduate students
  — Taught experimental lab and marked lab reports for undergraduate students
  — Assessed student presentations
  — Supervised groups of students for their research projects
  — Support and assist academic staff in the delivery of teaching and student assessment
  Subjects: Nuclear Physics, Quantum Mechanics, Atomic Physics, Classical Mechanics, Solid Physics, Thermal & Statistical Physics.

02/2021 – 01/2023

- **One-to-one Teaching**
  Department of Physics and Astronomy, University of Sheffield, UK.
  — Taught BSc and MSc courses
  Subjects: Mathematical Physics, Nuclear Physics, Quantum Mechanics, Particle Physics & Advanced Quantum Mechanics.

2022

- **Facilitator of the Research Ethics and Integrity Module**
  Department of Physics and Astronomy, University of Sheffield, UK.
  — Facilitated the Research Ethics and Integrity course, a compulsory module for PhD students at UK universities.
  — Led and engaged diverse groups of students from various departments and backgrounds.
  — Promoted an inclusive learning environment that encouraged equitable participation and respect for diverse perspectives.
  — Guided students in developing a strong understanding of ethical research practices.

02/2018 – 09/2019

- **Research Project Fellow**
  Department of Physics & Astrophysics, University of Delhi, India
  The project entitled "R & D of Gas Electron Multiplier Detector (GEM) for Scientific and Medical Applications".
  — Supervised three engineering students for their master dissertation

Research Position and Employment History (continued)

10/2017 – 01/2018
- **Research Project Fellow**
  Department of Physics & Astrophysics, University of Delhi, India
  The project entitled "R & D Activity of Resistive Plate Chamber (RPC) Detectors".

02/2015 – 07/2015
- **Research Assistant**
  Department of Physics & Astrophysics, University of Delhi, India
  The project entitled "Study of New Particles With Large Hadron Collider and Heavy Ion Physics Using LHC at CERN– CMS Experiment".

08/2014 – 10/2014
- **Research Assistant**
  Department of Physics & Astrophysics, University of Delhi, India
  The project entitled "R &D Activity for Indian Neutrino Observatory (INO)-Iron Calorimeter (ICAL) Resistive Plate Chamber Detectors (RPC)"

08/2013 – 04/2014
- **Research Assistant**
  Department of Physics & Astrophysics, University of Delhi, India
  The project entitled "R &D Activity for Indian Neutrino Observatory (INO)-Iron Calorimeter (ICAL) Resistive Plate Chamber Detectors (RPC)"

05/2013 – 07/2013
- **Research Project Fellow**
  Department of Physics & Astrophysics, University of Delhi, India
  The project entitled "Development of Proton Computed Tomography (PCT) for Cancer Therapy".

Education

2011 – 2014
- **M.Sc. Physics**.
  Hindu College, University of Delhi, Delhi, India
  Specialisation Subjects: Particle Physics, String Theory, General Theory of Relativity, Astronomy and Astrophysics.

  Dissertation thesis topic: Study of Resistive Plate Chamber (RPC) Detector for INO-ICAL
  — Fabrication and characterisation of RPCs
  — Efficiency measurement of RPCs

2006 – 2010
- **B.Sc. Physical Sciences**
  Zakir Husain Delhi College, University of Delhi, Delhi, India
  Courses taken: Classical Mechanics, Quantum Mechanics, Nuclear Physics, Mathematical Physics, Thermal Physics, Solid State Physics, Electronics and others.

Research Publications

[1] **P. Kumar**, "Energy reconstruction and calibration techniques of the DUNE LArTPC", arXiv:2501.00802v1 (2025).

[2] **P. Kumar**, "Calibration of the DUNE far detector using cosmic-ray muon events", PhD thesis, University of Sheffield (2024), `https://etheses.whiterose.ac.uk/35330/`.

[3] A. C. Ezeribe, **P. Kumar** *et al*., "A liquid argon test stand for pixel based TPC charge readout studies: design, engineering and calibration", Prepared for submission to JINST.

[4] M. Naimuddin, **P. Kumar** *et al*., "Characterization of 3 mm glass electrodes and development of RPC detectors for INO-ICAL experiment", Nuclear Instruments and Methods in Physics Research A **774**, 74 (2015).

[5] A. Kumar, **P. Kumar** *et al*., "Study of RPC bakelite electrode and detector performance for INO-ICAL", Journal of Instrumentation **9**, C10042 (2014).

[6] M. Naimuddin, **P. Kumar** *et al*., "Characterisation of glass electrode and RPC detector for INO-ICAL experiments", Journal of Instrumentation **9**, C10039 (2014).

[7] M. Hasbuddin, **P. Kumar** *et al*., "RPC electrode characterization and performance studies with different gas compositions", Springer Proc. Phys. **174**, 293 (2016).

[8] A. Gaur, **P. Kumar** *et al*., "Characterization of different electrode materials and resistive plate chamber detector performance studies", Proceedings of the DAE Symposium on Nuclear Physics, Banaras Hindu University (B.H.U), Varanasi, India **59**, 960 (2014).

Collaboration Papers

[9] A. Abed, **P. Kumar** *et al.* (DUNE Collaboration), "Doping liquid argon with xenon in ProtoDUNE Single-Phase: effects on scintillation light", arXiv:2402.01568v2 (2024).

[10] A. Abed, **P. Kumar** *et al.* (DUNE Collaboration), "Reconstruction of interactions in the ProtoDUNE-SP detector with Pandora", Eur. Phys. J. C **83**, 618 (2023).

[11] A. Abed, **P. Kumar** *et al.* (DUNE Collaboration), "Highly-parallelized simulation of a pixelated LArTPC on a GPU", Journal of Instrumentation **18**, P04034 (2023).

[12] A. Abed, **P. Kumar** *et al.* (DUNE Collaboration), "Identification and reconstruction of low-energy electrons in the ProtoDUNE-SP detector", Phys. Rev. D **107**, 092012 (2023).

[13] A. Abed, **P. Kumar** *et al.* (DUNE Collaboration), "Separation of track- and shower-like energy deposits in ProtoDUNE-SP using a convolutional neural network", Eur. Phys. J. C **82**, 903 (2022).

[14] A. Abed, **P. Kumar** *et al.* (DUNE Collaboration), "Design, construction and operation of the ProtoDUNE-SP Liquid Argon TPC", Journal of Instrumentation **17**, P01005 (2022).

[15] A. Abed, **P. Kumar** *et al.* (DUNE Collaboration), "Scintillation light detection in the 6-m drift-length ProtoDUNE Dual Phase liquid argon TPC", Eur. Phys. J. C **82**, 618 (2022).

[16] D. Caratelli, **P. Kumar** *et al*., "Low-energy physics in neutrino LArTPCs", arXiv:2203.00740 (2022).

[17] A. Abed, **P. Kumar** *et al.* (DUNE Collaboration), "Deep Underground Neutrino Experiment (DUNE) near detector conceptual design report", Instruments **5**, 31 (2021).

Academic Achievement, Award & Honour

12/2018 • **National Eligibility Test (NET)**
The NET in Physics is a nationwide examination conducted by CSIR-UGC in India for individuals seeking to work as assistant professor in Indian universities and colleges.

05/2023 • **Fellow of the Higher Education Academy (FHEA)**
FHEA in the UK is a prestigious recognition for educators who demonstrate excellence in teaching and learning. The FHEA status is conferred upon the candidate in recognition of their attainment against the UK Professional Standards Framework for teaching and learning support in higher education.

Research Interests

- Simulation and analysis for high energy physics experiments
- Neutrino physics, dark matter searches
- Muon physics
- Detector hardware and instrumentation
- Liquid Argon Time Projection Chamber (LArTPC), Resistive Plate Chamber (RPC), Gas Electron Multiplier (GEM), and scintillator detector

Research Activities

10/2019 – 02/2024
- **Simulation, reconstruction and analyses for the DUNE**
  — Generation and simulation of cosmic-ray muon events using MUSUN generator for the DUNE FD
  — Familiar with the GEANT4
  — Write codes for analysis modules for DUNE
  — Run LArSoft software
  — Run Pandora software
  — Used HTCondor for job submission
  — Energy calibration of the DUNE FD
  — R&D of Liquid Argon Time Projection Chamber (LArTPC)
  — Data processing using NIM and VME DAQ

02/2018 – 09/2019
- **Gas Electron Multiplier (GEM), detector**
  — Production and assembly of GE1/1 GEM detector for CMS CERN upgrade
  — Various Quality Control (QCs) test
  — Efficiency measurement of GEM detector using cosmic muons
  — Charge and timing measurement of GEM detector
  — Fabrication of plastic scintillator detectors of various sizes
  — Data processing using NIM and VME DAQ

05/2013 – 01/2018
- **Resistive Plate Chamber (RPC) and plastic scintillator**
  — Characterization of the electrodes; glass and bakelite
  — Fabrication of RPCs using glass and bakelite electrodes
  — Calibration of the gas mixing unit
  — Fabrication and testing of plastic scintillator
  — Efficiency studies of fabricated RPCs using cosmic muons
  — Data processing using NIM and VME DAQ
  — Data acquisition (DAQ) system programming
  — Study of the timing of resistive plate chambers

Conference and Collaboration Talks

16 – 22 Sep. 2024
- **Energy reconstruction and calibration techniques of the DUNE LArTPC**
  NuFact 2024 - The 25th International Workshop on Neutrinos from Accelerators, Argonne National Laboratory, Illinois, United States.

22 – 26 Jan. 2024
- **Calibration of DUNE FD using stopping particles (muons, pions, and protons)**
  DUNE Collaboration Meeting, CERN, Switzerland.

25 – 30 Sept. 2023
- **Absolute energy calibration using stopping cosmic muons**
  DUNE Collaboration Meeting, Santa Marta, Colombia.

22 – 26 May 2023
- **An update on π^0 and stopping cosmic-ray muon calibration**
  DUNE Collaboration Meeting, Fermilab, USA.

12 – 16 Sept. 2022
- **π^0 and stopping cosmic-ray muon calibration**
  DUNE Collaboration Meeting, University of Manchester, UK.

03 – 06 April 2022
- **Calibration of DUNE far detector using cosmic-ray muons**
  IOP HEPP & APP Annual Conference 2022
  Rutherford Appleton Laboratory STFC, UK.

Poster Presentations

05/2021 • **Deep Underground Neutrino Experiment**
Science Graduate School Showcase
University of Sheffield, UK.

12 – 15 April 2021 • **Calibration of DUNE FD using cosmic-ray muons**
Institute of Physics (IOP), Joint APP, HEPP and NP Conference
University of Edinburgh, Edinburgh, UK

15 – 26 March 2021 • **DUNE FD calibration using cosmic-ray muons**
STFC Summer HEP School
Lancaster University, Lancaster, UK

Scientific Training & School

08/2021 • **Open Science Grid (OSG) Virtual School 2021: Learn to harness large-scale computing for research**
University of Wisconsin-Madison
Center for High Throughput Computing, USA.

June – July 2021 • **The DUNE Neutrino Interaction School (online)**

15 – 26 March 2021 • **STFC Summer HEP School**
Lancaster University, Lancaster, UK.

10 – 21 Aug. 2020 • **48th SLAC Summer Institute (SSI 2020) (online)**
SLAC National Accelerator Laboratory
Stanford University, USA.

13 – 24 July 2020 • **Warwick Week PhD Graduate Training (online)**
University of Warwick, Warwick, UK.

Aug. – Sep. 2011 • **Introduction to Mathematica**
University of Delhi, India

Workshops

01 – 03 Nov. 2021 • **6th UK LArTPC Software Analysis Workshop**
University of Edinburgh, Edinburgh, UK.

06/2020 • **DUNE Physics Week (online)**
Fermilab, USA.

07/2020 • **Theoretical Innovation for Future Experiments Regarding Baryon Number Violation**

28 – 30 Oct. 2019 • **4th LArTPC Software Analysis Workshop**
University of Manchester, UK.

2014 • **Contemporary trends in high-energy physics and experimentation**
Panjab University, Chandigarh, India

2013 • **Matlab and Simulink academic tour**
Cluster Innovation Centre, University of Delhi, India

Lecturing Workshops

02/2023 • **Learning and Teaching Scholarship Network (LTSN) Ethics Workshop**
The University of Sheffield, Sheffield, UK

Lecturing Workshops (continued)

09/2020
- **Foundation Pathway Explorer Workshop**
  The University of Sheffield, Sheffield, UK
- **STA Introduction to Teaching as a GTA**
  The University of Sheffield, Sheffield, UK.

05/2020
- **Foundation Pathway Orientation Workshop**
  The University of Sheffield, Sheffield, UK.
- **Sheffield Teaching Assistant Lecturing Workshop**
  The University of Sheffield, Sheffield, UK

Conferences

16 – 22 Sep. 2024
- **NuFact 2024 - The 25th International Workshop on Neutrinos from Accelerator**
  Argonne National Laboratory, Illinois, United States

July – Aug. 2023
- **Young Experimentalists & Theorists Institute (YETI) 2023: Almost Everything About Flavour**
  Durham University, Durham, UK.

13 – 17 March 2023
- **CERN Neutrino Platform Pheno Week 2023 (online)**
  CERN, Switzerland.

June 2023
- **New Perspective 2023 (online)**
  Fermilab, USA.

03 – 06 April 2022
- **IOP HEPP & APP Annual Conference 2022**
  Rutherford Appleton Laboratory STFC, UK.

12 – 15 April 2021
- **Joint APP, HEPP and NP Conference (online)**
  Institute of Physics (IOP), University of Edinburgh, Edinburgh, UK.

July – Aug. 2020
- **ICHEP 2020 (online)**
  Prague, Czech Republic.

June – July 2020
- **Neutrino 2020 Conference (online)**
  Fermilab, USA.

Computer Skills

Operating systems	• UNIX (Linux, Mac) and Windows
Computer languages	• C++, Shell scripting, Python
Software for data analysis	• ROOT, HTCondor
Software for simulation	• LArSoft, GEANT4, MUSUN cosmic-ray muon generator
Computer text mark-up languages	• LaTeX

Services and Administration

2007 – 2008
- **Sports Secretary of Zakir Husain Delhi College Hostel**
  Zakir Husain College, University of Delhi, India.
- **Captain of College Hostel Cricket Team**
  Zakir Husain College, University of Delhi, India.