DR. RIJEESH KELOTH

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EDUCATION

Fermilab, USA *January 2015 – April 2019*
Visiting Ph.D Student (Indian Institutions and Fermilab Consortium)
Thesis Topic: A search for Anomalous Muon Neutrino Disappearance and
Tau Neutrino Appearance using NOvA Near Detector

Cochin University of Science and Technology, INDIA *November 2012 – December 2019*
Ph. D in Experimental Neutrino Physics

Mahatma Gandhi University, Kerala, INDIA *June 2006 – March 2008*
M.Sc. in Physics

Calicut University, Kerala, INDIA *June 2005 – March 2006*
B.Ed. in Physical Sciences

Kannur University, Kerala, INDIA *June 2002 – March 2005*
B.Sc. in Physics

AWARDS

- Best Ph.D. thesis award 2019 – Dept. of Physics, Cochin University of Science and Technology.

- Second place poster award – 11th International Neutrino Summer School 2017 (INSS), Fermilab (17th August 2017).

- Qualified National Eligibility Test (NET) for Lectureship conducted by University Grants Commission and Council for Scientific and Industrial Research(UGC-CSIR), INDIA (December 2010).

LEADERSHIP AND OUTREACH

- Data Operations and Data Quality group convener of the SoLid neutrino experiment (2020 December – continuing).

- Data Manager of the SoLid neutrino experiment (2021 November – continuing).

- Day to day support to one PhD student for oscillation analysis in SoLid experiment (2020 November – 2021 November).

- Co–guided one master's student in NovA collaboration (2019 June – 2020 June).

- Day to day support to two PhD students at IIT Hyderabad for a year (2019 June – 2020 June).

- 3rd year B.Sc. physics students group-project mentor of 4 students at Malabar Christian College, Calicut (2011 – 2012).

- Speaker represented Indian Institutions and Fermilab collaboration at the NOvA, MINOS, and MINERVA detectors surface building of Fermilab during the visit of the Secretary Rick Perry (Department of Energy, USA).

- Invited speaker in the national workshop titled *Theory Thoughts* conducted by Dept. of Physics, St. Paul's College, Kalamassery, Kerala, India on National Science Day (Feb 28, 2018) on the topic *Neutrino Oscillations.*

- NuMI underground tour guide at Fermilab for the visit of the Secretary Arun Srivastava (AEC and Head Institutional Collaboration and Programs Division, India) on July 28, 2016.

- NuMI underground tour guide at Fermilab for the visit of Dr. Ranjit Kumar (The Dept. of Atomic Energy, India) on Nov 17, 2016.

- Author of two books about 'Light' and 'Basic electronics' for high school students in local language (Malayalam) published by Haritham Publications, Calicut. India.

- Writer in LUCA, the popular online science magazine published by Kerala Sastra Sahitya Parishad.

- Neutrino Social Organizing Committee (NSOC) member at Fermilab (4th April 2017 - January 2020).

- Science club organizing committee member at Malabar Christian College, Calicut (2011– 2012).

- Member in Kerala Sastra Sahitya Parishad (People's Science Movement of Kerala, India) 2003 – 2005.

RESEARCH EXPERIENCE

Post-doctoral Research Associate in SoLid Neutrino Experiment   *Oct 2020 – present*
(IIHE / HEP@Vrije Universiteit Brussel, Belgium)

Currently I am working in the SoLid neutrino experiment located at BR2 Nuclear Research Reactor run by SCK·CEN, the Belgian National Nuclear Research Laboratory in Mol, Belgium. The primary goals of the experiment are to precisely measure the electron antineutrino energy spectrum and flux and to search for very short distance neutrino oscillations as a probe of eV-scale sterile neutrinos.

I am the co–ordinator of data operations and data quality (Ops/DQ) group in the experiment from April 2021. Also I am responsible for managing data transfers from experimental site to remote servers of the experiment starting from November 2021.

I have a significant contribution in the on-going sterile neutrino oscillation search in the experiment by performing the analyses related to the variable stabilities and simulation tuning. I have performed the BiPo background studies on entire Phase–I reactor–off data of two years (2018 – 2020) to tune simulation. I have introduced a Gradient Boosted Decision Tree (BDTG) based signal selection for one of the oscillation analyses.

Additionally, I have performed the Electromagnetic Scintillation (ES) signal calibration of the detector for the Phase–II run period of November 2020 and April 2021. Right now, I am involved in the comparison of Na-22 and Muon calibration methods used in the experiment.

I have a significant contribution in the ongoing heavy neutral lepton (HNL) analysis in the experiment, which include development of the machine learning based tools for the HNL signal selection. I have developed a Boosted Decision Tree based signal-background discriminant first time for this analysis in the experiment. Also I am participating in the detector operations by taking online control room shifts.

Post-doctoral Research Associate in NOvA Neutrino Experiment   *June 2019 – June 2020*
(Indian Institute of Technology, Hyderabad, India)

The NOvA experiment at Fermilab consists of two finely segmented, liquid scintillator detectors, a near and a far detector, operating 14.6 mrad off-axis from the Neutrinos at Main Injector (NuMI) muon-neutrino beam. The Near Detector is located on the Fermilab campus, 1 km from the NuMI target, while the Far Detector is located at Ash River, MN, 810 km from the NuMI target. I was working as a post doctoral fellow in NOvA from 10th June 2019 to 9th June 2020.

In this period I was working on the topics related to Muon Removal – tau (MR-tau) studies for finding the selection efficiencies of tau neutrinos in the NOvA near detector. Additionally, I was giving day–to–day support to two PhD students at IIT Hyderabad who were newly joined in the ongoing Indian Institutions and Fermilab Collaboration (IIFC) project. Also I have a significant contribution in sensitivity studies conducted on neutrino non-standard interactions from the disappearance of muon (anti) neutrinos at the NOvA experiment. I was co–guiding Luiz Ricardo Prais from Universidade Federal de Gois, Brazil for his master's thesis on this topic.

Visiting Graduate Student in NOvA Experiment   *January 2015 – August 2018*
(Fermilab, USA)

I joined as a junior research fellow at the Cochin University of Science and Technology in November 2012. After that I moved onsite at Fermilab in January 2015 as a graduate student in the NOvA experiment representing Indian Institutions and Fermilab Consortium (IIFC). The NOvA experiment is primarily designed to measure electron-neutrino appearance at the Far Detector using the Near Detector to control systematic uncertainties; however, the Near Detector with L/E in the range 0.1–1 is well suited to search for anomalous short-baseline oscillations. In my first 6 months at Fermilab, I have conducted a feasibility study of measuring short-baseline oscillations using $\nu_\mu \to \nu_e$ channel with the NOvA Near Detector (ND). As a part of that, I have performed studies to estimate the potential of building additional detectors at different off–axis angles for the sensitivity to light sterile neutrinos.

My PhD thesis was on short-baseline neutrino oscillation search using tau neutrinos in NOvA ND. As a part of that I have expanded new tools to enhance the oscillation framework for short-baseline τ appearance in ND. Most important part of the study was developing particle identifiers for hadronic mode ν_τ CC interactions using Machine Learning algorithm.Using a Boosted Decision Tree (BDT) algorithm, I have developed the particle discriminants for signal selection of this analysis. I had to produce special tau-overlay files for an improved simulation of the neutrino interactions in the NOvA near detector. Optimization of event selection for $\nu_\mu \to \nu_\tau$ and $\nu_\mu \to \nu_\mu$ channels were challenging in this analysis considering the complexities of the tau neutrino interactions and systematic uncertainties. Additionally, I have been performing comprehensive systematics studies for this first NOvA analysis using τ's. Finally, I led the sideband studies for the validation of these new particle identifiers using the real ND data and performed a complete sensitivity study for the joint $\nu_\mu - \nu_\tau$ analysis in NOvA.

This work has been presented in major international conferences like Neutrino 2016 (London, 2016 - poster), International Neutrino Summer School (Fermilab, 2017 - received 2–nd place poster award), Neutrino 2018 (Germany, 2018 - poster), April Meeting of American Physical Society (Washington DC, January 2016 - talk) and Meeting of Division of Particles and Fields of American Physical Society (Fermilab, April 2017 - poster).

Computing and File Production

The major responsibilities of a Data co–ordinator in the SoLid experiment are the management of data transfers from BR2 server at Mol to T2B cluster at IIHE Brussels and ensure the two additional backup of data in remote storage devices of IN2P3 at France and Imperial at UK.

I was an expert in monte-carlo production in NOvA. I have made significant contributions to the production of data files corresponding to 8×10^{20} POT needed for the various analyses in NOvA including 2016 and 2017 ν_e appearance, ν_μ disappearance and 2017 Neutral Current disappearance analyses.

Hardware

In addition to this research work I have also had the opportunity to participate in hardware projects in the NOvA experiment. I have a significant contribution in the quality analysis of the avalanche photodiodes (APDs) used for the replacement of malfunctioning APDs in NOvA. I was a trained expert in the replacement of malfunctioning electronics on the detector.

TEACHING EXPERIENCE

Malabar Christian College(MCC), Calicut, INDIA   *October 2009 - March 2012*

· Teaching(B.Sc. level)- Electronics, mechanics, electrodynamics and quantum physics (24 hrs./week)

Cochin University of Science and Technology, INDIA   *November 2013 - March 2014*

· My PhD supervisor gave me a great opportunity to teach Mathematical Physics for 1st semester M.Sc. students (15 hours)

TECHNICAL SKILLS

Computer Languages	C++, bash scripting, python
Software	File production, Neutrino oscillation framework
Data analysis	Neutrino Oscillation Analysis
Hardware	Avalanche Photo Diode (APD) quality analysis
	Electronic circuit board installation and replacement

CONFERENCE TALKS AND POSTERS

Neutrino Searches @ SoLid Experiment (talk).
IIHE/HEP@VUB Colloquium, IIHE Brussels, November 2021.

NOvA's Short-baseline Muon-neutrino Disappearance and Tau-neutrino Appearance Search (talk).
DAE-BRNS Symposium, IIT Madras, December 2018.

NOvA's Short-Baseline Tau Neutrino Appearance Search (talk).
New Perspectives, Fermilab, 2018.

NOvA Short-Baseline Tau Neutrino Appearance Search (talk).
New perspectives, Fermilab, 2017.

NOvA Short-Baseline Tau Neutrino Appearance Search (poster).
Meeting of Division of Particles and Fields of American Physical Society, Fermilab 2017.

NOvA Short-Baseline Tau Neutrino Appearance Search (poster).
International Neutrino Summer School, Fermilab, 2017.

NOvA Short-Baseline Tau Neutrino Appearance Search (poster).
Young Investigators Meeting, Chicago, 2017.

Searches for Sterile Neutrinos with NOvA (joint poster).
International Conference on HEP, Chicago, 2016.

NOvA Short-Baseline Tau Neutrino Appearance Search (talk).
April Meeting of American Physical Society, Washington DC, January 2016.

NOvA Short-Baseline Tau Neutrino Appearance Search (joint poster).
Neutrino '16, London, 2016.

LIST OF PUBLICATIONS

M.A. Acero,..., R. Keloth et al., (NOvA Collaboration), *An Improved Measurement of Neutrino Oscillation Parameters by the NOvA Experiment*, to be Published.

M.A. Acero,..., R. Keloth et al., (NOvA Collaboration), *Search for active-sterile antineutrino mixing using neutral-current interactions with the NOvA experiment*, Phys. Rev. Lett. 127, 201801 (2021)

M.A. Acero,..., R. Keloth et al., (NOvA Collaboration), *Extended search for supernova like neutrinos in NOvA coincident with LIGO/Virgo detections*, Published in Phys. Rev. D 104, 063024 (2021)

M.A. Acero,..., R. Keloth et al., (NOvA Collaboration), *Seasonal variation of multiple-muon cosmic ray air showers observed in the NOvA detector on the surface*, Published in Phys. Rev. D 104, 012014 (2021)

M.A. Acero,..., R. Keloth et al., (NOvA Collaboration), *Search for Slow Magnetic Monopoles with the NOvA Detector on the Surface*, Published in Phys. Rev. D 103, 012007 (2021)

M.A. Acero,..., R. Keloth et al., (NOvA Collaboration), *Adjusting Neutrino Interaction Models and Evaluating Uncertainties using NOvA Near Detector Data*, Published in The European Physical Journal C volume 80, Article number: 1119 (2020)

M.A. Acero,..., R. Keloth et al., (NOvA Collaboration), *Search for Multi-Messenger Signals in NOvA Coincident with LIGO/Virgo Detections*, Published in Phys. Rev. D 101, 112006 (2020)

M.A. Acero,..., R. Keloth et al., (NOvA Collaboration), *Supernova neutrino detection in NOvA*, Published in Journal of Cosmology and Astroparticle Physics, Volume 2020, October 2020 JCAP10(2020)014

M.A. Acero,..., R. Keloth et al., (NOvA Collaboration), *First measurements of neutrino oscillation parameters using neutrinos and antineutrinos by NOvA*, Published in Phys. Rev. Lett. 123, 151803 (2019).

M.A. Acero,..., R. Keloth et al., (NOvA Collaboration), *Observation of seasonal variation of atmospheric multiple-muon events in the NOvA Near Detector*, Published in Phys. Rev. D 99, 122004.

M.A. Acero,..., R. Keloth et al., (NOvA Collaboration), *Measurement of Neutrino-Induced Neutral-Current Coherent ?0 Production in the NOvA Near Detector*, Published in Phys. Rev. D 102, 012004 (2020)

M. A. Acero,..., R. Keloth et al., (NOvA Collaboration), *New constraints on oscillation parameters fromν_e appearance and ν_μ disappearance in the NOvA experiment* , Published in Phys. Rev. D 98, 032012 (2018).

P. Adamson,..., R. Keloth et al., (NOvA Collaboration), *Search for active-sterile neutrino mixing using neutral- current interactions in NOvA* , Published in Phys. Rev. D 96, 072006.

P. Adamson,..., R. Keloth et al., (NOvA Collaboration), *Constraints on Oscillation Parameters from ν_e Appearance and ν_μ Disappearance in NOvA* , Published in Phys.Rev.Lett. 118 (2017) no.23, 231801.

P. Adamson,..., R. Keloth et al., (NOvA Collaboration), *Measurement of the neutrino mixing angle θ_{23} in NOvA* , Published in Phys.Rev.Lett. 118 (2017) no.15, 151802.

G.S. Davies et al., *Searches for Sterile Neutrinos with NOvA*, Published in Proceedings of Science: International Conference on HEP, 972 (2016).

Rijeesh Keloth et al., *NOvA Short-Baseline Tau Neutrino Appearance Search*, Published in Conference proceedings, DPF 2017, Fermilab.

A. Aurisano and R. Keloth, *NOvA Short-Baseline Tau Neutrino Appearance Search*, Published in J. Phys.: Conf. Ser. 888 012143(2017).