

# Bhim B. Bam

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## Education

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### **2024: Master of Science ,Specialization in Particle Physics**

The University of Alabama (UA), Tuscaloosa

### **2018 – Present: Doctoral Student in Experimental High Energy Physics**

The University of Alabama (UA), Tuscaloosa

Supervisor: *Dr. Sergei Gleyzer*

Research: Beyond Standard Model Search for rare decays of the Higgs boson in the merged  $\tau$  channel with end-to-end deep Machine Learning techniques [Ph.D Dissertation work still on progress....]

### **2014: Masters of Science in Physics, Specialization in plasma Physics**

Tribhuvan University (TU), Nepal

Supervisor: *Dr. Raju Khanal*

Research: Extension of Kinetic Trajectory simulation (KTS) model to Collisional plasma sheath [Completed Dissertation for M.Sc.]

### **2009: Bachelors of Science in Physics (minor: Chemistry and Math)**

Tribhuvan University (TU), Nepal

## Work Experience

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### **2018 – Present: Graduate Research/Teaching Assistant at The University of Alabama (UA) Tuscaloosa**

I joined the University of Alabama in the fall of 2018 as a Ph.D. student specializing in high-energy experimental research. During my time here, I have served as both a Teaching Assistant and a Research Assistant. As a Teaching Assistant, my primary responsibilities included teaching lab sessions, grading assignments, and assisting students with their coursework. As a Research Assistant under the Department of Energy (DOE) CMS grant, I have been actively involved in developing End-to-End deep Machine Learning tool for analysis and search beyond standard model (BSM) particles . I also have contributed to the High Granularity Calorimeter (HGCAL) project, which is part of the high luminosity upgrade of the CMS experiment. In addition to my Ph.D. studies, I also earned a second Master's degree in Physics from the University of Alabama.

### **2017 – Present: Assistant Professor at Tribhuvan University (TU) Nepal**

In 2017, I joined Tri-Chandra Multiple Campus, Tribhuvan University as a Assistant Professor. In this role, I taught applied mathematics and quantum mechanics to undergraduate students and coordinated lab and research activities.

### **2015 – 2016: Assistant Lecturer of Physics at Siddhnath Science Campus, Tribhuvan University Nepal**

I worked as an Assistant Lecturer at Siddhnath Science Campus, Tribhuvan University, where I gained valuable academic experience. My role involved guiding undergraduate and graduate students in lab assignments and teaching theory classes in Plasma Physics, Digital Electronics, and Mathematical Physics.

### **2014 – 2016: Secondary level math and science Teacher at Holy Family Higher Secondary School Nepal**

After completing my master's degree, I worked as a secondary math and science teacher at this school. My

teaching responsibilities encompassed teaching Math/Science at both basic and advanced levels, along with teaching business mathematics to school-level students.

#### **2010 – 2011: Computer assistant at IT Park Nepal**

During my undergraduate studies, I received training in fundamental computer hardware, software, and electrical work at this institution. Following this training, after graduation, I started working part-time as a Computer assistant there. In this role, I assisted new students in the lab and addressed any hardware or software issues that arose during training classes.

## **Research Experiences**

#### **Characterization of Hexaboard for High Granularity Calorimeter (HGCAL) at CMS lab University of Alabama (UA) (2024-Present):**

After gaining experience in the High Granularity Calorimeter (HGCAL) upgrade at Fermilab, I am now participated in setting up a lab at University of Alabama to evaluate Hexaboards, which are the building blocks of the High Granularity Calorimeter (HGCAL). My specific focus will be on visual inspection as well as electrical testing for these boards at room temperature and very low temperatures  $-40^{\circ}\text{F}$ . In the future, we anticipate receiving more than 10,000 of such boards for testing, so we are planning to train other graduate and undergraduate students for testing purposes and to employ a Machine Learning (ML) based model for testing.

#### **Characterization of Application Specific Integrated Circuit (ASIC) for CMS High Granularity Calorimeter (HGCAL) (ECON) at Fermi National Laboratory (2022-2024):**

I got Guest and Visitor award by Fermi National Laboratory for working in CMS upgrade project with Fermilab scientists and became member of HGCAL project. I spend approximately two year in Fermi national laboratory for HGCAL upgrade project. In the context of the forthcoming HL-LHC upgrade of the CMS detector, I engaged in the testing of the endcap concentrator ASICs (ECON-T, ECON-D) that are integral to the High Granularity Calorimeter (HG-CAL) readout system. My specific focus lies in executing quality control assessments for the chips. This involves a range of tests, including phase scans, evaluations of input-output delays, verification of phase loop stability, and read-write tests. Additionally, I contributed to the preparation of testing scripts and the development of the database essential for the final robotic testing phase of approximately 100K such chips.

#### **University of Alabama End-to-End Machine Learning Group (UA ML) (2021-Present):**

Being a part of this group has provide me valuable opportunity to comprehend the complexities of implementing an end-to-end (E2E) machine learning approach in the field of high-energy particle research. With this group I actively involved in crafting the necessary tools for End-to-End deep machine learning applications in CMS analysis, which offers a cutting-edge perspective. Through various small-scale projects and assignments, I've worked on tasks involving particle classification using deep neural networks and distinguishing between background and signal processes using deep Machine learning methodologies . Presently, my focus lies in the analysis of rare higgs decay,  $H \rightarrow AA \rightarrow 4\tau$  boosted, where the standard model (SM) Higgs decays into two non-standard particles A(pseudoscalar), each of which subsequently decays into boosted SM  $\tau$  particles. Given the analytical challenges of the boosted region, I am employing an E2E deep learning approach to enhance the accuracy and efficiency of my analysis. Currently I am taring deep learning E2E resnet based [Convolutional Neural Network (CNN)] Model for mass-regression of pseudoscalar(A) and classification of signal and background for my analysis. I am also planing to developpe Graph Neural Network (GNN) based Models and vision transformer for this analysis.

#### **University of Alabama CMS Diphoton Group (2018-2020):**

I joined UA CMS Diphoton group in 2018 and become an associate member of the European Organization for Nuclear Research (CERN). During time with this group, I got the opportunity to fully engage myself in the CMS data framework environments and explore the CMS detector. My primary focus within the group was to study of photon efficiency based on a cut-based photon ID. A significant part of my contribution was dedicated to visualizing efficiency through the application of high transverse momentum ( $p_T$ ) photon IDs across various pileup scenarios. This experience provided me with insights into data analysis within the CMS domain and allowed me to contribute to the enhancement of photon identification techniques.

#### **Plasma Sheath Study at Tribhuvan University Nepal (2011-2014):**

For my Master's Dissertation titled "Extension of Kinetic Trajectory simulation (KTS) model to Collisional plasma sheath", I conducted research using MATLAB to simulate plasma dynamics through a Kinetic model. The aim was to investigate the influence of collisional degrees within plasma sheaths. These sheaths form minute layers between plasma and interfacing materials. While traditionally considered collision-free, actual sheaths involve non-negligible collision probabilities. My research delved into diverse density profiles, scrutinizing their modifications under varying collision levels. This study shed light on the impact of such collisions on plasma behavior.

## Mentorship and facilitator

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**Facilitator for CMSDAS2024 School at Fermilab Illinois:** Participate as a facilitator

**Mentor for Google Summer Code 2024 [Machine Learning for science (ML4SCI)]:** Project: Masked Auto-Encoders for Efficient E2E Particle Reconstruction & Compression for CMS Experiment

**Mentor for Google Summer Code 2023 [Machine Learning for science (ML4SCI)]:** Project: Graph Neural Networks for End-to-End Particle Identification with the CMS Experiment

Project: Exploring the underlying symmetries in particle physics with equivariant neural networks

**Mentor for Google Summer Code 2022 [Machine Learning for science (ML4SCI)]:** Project: Graph Neural Networks for End-to-End Particle Identification with the CMS Experiment

## Skills

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**Programming Language:** Python, C/C++, ROOT

**Technical Softwares/toolkit:** Pytorch, Scikit-learn, Keras, TensorFlow, MATLAB, LATEX.

**Language:** English, Nepali (native), Hindi

## Memberships and Awards

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**Member of Compact Muon Solenoid (CMS) Collaboration:** 2019 - Present

**Member of Nepal Physical society (NPS):** Lifetime member award (2017)

**Member of High Granularity calorimeter (CMS HGCal) Collaboration :** 2022 - Present

## Professional Profile links

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**Google profile:** [https://scholar.google.com/citations?view\\_op=list\\_works&hl=en&hl=en&user=IeH9YR0AAAAJ&pagesize=80](https://scholar.google.com/citations?view_op=list_works&hl=en&hl=en&user=IeH9YR0AAAAJ&pagesize=80)

**Linkedin:** <https://www.linkedin.com/in/bhim-bam-94a480296/>

**GitHub Repository:** <https://github.com/bhbam>

## Contributed Poster

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**Title:** Progress on testing of the ECON-T-P1 Trigger Data Concentrator ASIC for the CMS HGCal  
CMS Upgrade Days Feb 2023, CERN Geneva (Switzerland)

## Selected Publications

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Davide Braga and others (including B. Bam). First test results of the HGCal concentrator ASICs: ECON-T and ECON-D. *JINST*, 19(03):C03050, 2024.

CMS Collaboration (including B. Bam). Performance of the CMS high-level trigger during LHC Run 2. *JINST*, 19(11):P11021, 2024.

CMS Collaboration (including B. Bam). Measurement of the  $B_s^0 \rightarrow J/\psi K_S^0$  effective lifetime from proton-proton

collisions at  $\sqrt{s} = 13$  TeV. *JHEP*, 10:247, 2024.

CMS Collaboration (including B. Bam). Observation of double  $J/\psi$  meson production in pPb collisions at  $\sqrt{s_{NN}}=8.16$  TeV. *Phys. Rev. D*, 110(9):092002, 2024.

CMS Collaboration (including B. Bam). Measurement of the polarizations of prompt and non-prompt Image 1 and  $\psi(2S)$  mesons produced in pp collisions at  $\sqrt{s}=13$  TeV. *Phys. Lett. B*, 858:139044, 2024.

M. Aamir and others (including B. Bam). Using graph neural networks to reconstruct charged pion showers in the CMS High Granularity Calorimeter. *JINST*, 19(11):P11025, 2024.

CMS Collaboration (including B. Bam). Search for a resonance decaying to a W boson and a photon in proton-proton collisions at  $\sqrt{s} = 13$  TeV using leptonic W boson decays. *JHEP*, 09:186, 2024.

CMS Collaboration (including B. Bam). Observation of quantum entanglement in top quark pair production in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *Rept. Prog. Phys.*, 87(11):117801, 2024.

CMS Collaboration (including B. Bam). Observation of  $\gamma\gamma \rightarrow \tau\tau$  in proton-proton collisions and limits on the anomalous electromagnetic moments of the  $\tau$  lepton. *Rept. Prog. Phys.*, 87(10):107801, 2024.

CMS Collaboration (including B. Bam). Searches for violation of Lorentz invariance in top quark pair production using dilepton events in 13 TeV proton-proton collisions. *Phys. Lett. B*, 857:138979, 2024.

CMS Collaboration (including B. Bam). Search for new physics in high-mass diphoton events from proton-proton collisions at  $\sqrt{s} = 13$  TeV. *JHEP*, 08:215, 2024.

CMS Collaboration (including B. Bam). Search for production of a single vectorlike quark decaying to tH or tZ in the all-hadronic final state in pp collisions at  $\sqrt{s}=13$  TeV. *Phys. Rev. D*, 110(7):072012, 2024.

CMS Collaboration (including B. Bam). Search for the Z Boson Decay to  $\tau\tau\mu\mu$  in Proton-Proton Collisions at  $\sqrt{s}=13$  TeV. *Phys. Rev. Lett.*, 133(16):161805, 2024.

CMS Collaboration (including B. Bam). Performance of CMS muon reconstruction from proton-proton to heavy ion collisions. *JINST*, 19(09):P09012, 2024.

CMS Collaboration (including B. Bam). Measurement of multijet azimuthal correlations and determination of the strong coupling in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *Eur. Phys. J. C*, 84(8):842, 2024.

CMS Collaboration (including B. Bam). The CMS Statistical Analysis and Combination Tool: Combine. *Comput. Softw. Big Sci.*, 8(1):19, 2024.

CMS Collaboration (including B. Bam). Searches for Pair-Produced Multijet Resonances Using Data Scouting in Proton-Proton Collisions at  $\sqrt{s}=13$  TeV. *Phys. Rev. Lett.*, 133(20):201803, 2024.

CMS Collaboration (including B. Bam). Search for  $ZZ$  and  $ZH$  production in the  $b\bar{b}b\bar{b}$  final state using proton-proton collisions at  $\sqrt{s} = 13$  TeV. *Eur. Phys. J. C*, 84(7):712, 2024.

CMS Collaboration (including B. Bam). Measurement of the production cross section of a Higgs boson with large transverse momentum in its decays to a pair of  $\tau$  leptons in proton-proton collisions at  $\sqrt{s}=13$  TeV. *Phys. Lett. B*, 857:138964, 2024.

CMS Collaboration (including B. Bam). Observation of the  $J/\psi \rightarrow \mu^+\mu^-\mu^+\mu^-$  decay in proton-proton collisions at  $\sqrt{s}=13$  TeV. *Phys. Rev. D*, 109(11):L111101, 2024.

CMS Collaboration (including B. Bam). Search for the decay of the Higgs boson to a pair of light pseudoscalar bosons in the final state with four bottom quarks in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *JHEP*, 06:097, 2024.

CMS Collaboration (including B. Bam). Search for Soft Unclustered Energy Patterns in Proton-Proton Collisions at 13 TeV. *Phys. Rev. Lett.*, 133(19):191902, 2024.

CMS Collaboration (including B. Bam). Search for long-lived heavy neutrinos in the decays of B mesons produced in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *JHEP*, 06:183, 2024.

CMS Collaboration (including B. Bam). Search for dark QCD with emerging jets in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *JHEP*, 07:142, 2024.

CMS Collaboration (including B. Bam). Constraints on anomalous Higgs boson couplings from its production and decay using the WW channel in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *Eur. Phys. J. C*, 84(8):779, 2024.

CMS Collaboration (including B. Bam). Search for heavy neutral leptons in final states with electrons, muons, and hadronically decaying tau leptons in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *JHEP*, 06:123, 2024.

CMS Collaboration (including B. Bam). Observation of the  $\Xi_b^- \rightarrow \psi(2S) \Xi^-$  decay and studies of the  $\Xi_b(5945)0$  baryon in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *Phys. Rev. D*, 110(1):012002, 2024.

CMS Collaboration (including B. Bam). Search for long-lived particles using displaced vertices and missing transverse momentum in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *Phys. Rev. D*, 109(11):112005, 2024.

CMS Collaboration (including B. Bam). Portable Acceleration of CMS Computing Workflows with Coprocessors as a Service. *Comput. Softw. Big Sci.*, 8(1):17, 2024.

CMS Collaboration (including B. Bam). Search for long-lived particles decaying to final states with a pair of muons in proton-proton collisions at  $\sqrt{s} = 13.6$  TeV. *JHEP*, 05:047, 2024.

CMS Collaboration (including B. Bam). Measurement of Energy Correlators inside Jets and Determination of the Strong Coupling  $\alpha_S(m_Z)$ . *Phys. Rev. Lett.*, 133(7):071903, 2024.

CMS Collaboration (including B. Bam). Search for bottom-type vectorlike quark pair production in dileptonic and fully hadronic final states in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *Phys. Rev. D*, 110(5):052004, 2024.

CMS Collaboration (including B. Bam). Combination of Measurements of the Top Quark Mass from Data Collected by the ATLAS and CMS Experiments at  $\sqrt{s} = 7$  and 8 TeV. *Phys. Rev. Lett.*, 132(26):261902, 2024.

CMS Collaboration (including B. Bam). Search for pair production of scalar and vector leptoquarks decaying to muons and bottom quarks in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *Phys. Rev. D*, 109(11):112003, 2024.

CMS Collaboration (including B. Bam). Nonresonant central exclusive production of charged-hadron pairs in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *Phys. Rev. D*, 109(11):112013, 2024.

CMS Collaboration (including B. Bam). Test of lepton flavor universality in  $B^\pm \rightarrow K^\pm \mu^+ \mu^-$  and  $B^\pm \rightarrow K^\pm e^+ e^-$  decays in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *Rept. Prog. Phys.*, 87(7):077802, 2024.

CMS Collaboration (including B. Bam). Extracting the speed of sound in quark-gluon plasma with ultrarelativistic lead-lead collisions at the LHC. *Rept. Prog. Phys.*, 87(7):077801, 2024.

CMS Collaboration (including B. Bam). Observation of Enhanced Long-Range Elliptic Anisotropies Inside High-Multiplicity Jets in pp Collisions at  $\sqrt{s} = 13$  TeV. *Phys. Rev. Lett.*, 133(14):142301, 2024.

CMS Collaboration (including B. Bam). Search for Long-Lived Heavy Neutral Leptons with Lepton Flavour Conserving or Violating Decays to a Jet and a Charged Lepton. *JHEP*, 03:105, 2024.

CMS Collaboration (including B. Bam). Search for the lepton flavor violating  $\tau \rightarrow 3\mu$  decay in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *Phys. Lett. B*, 853:138633, 2024.

CMS Collaboration (including B. Bam). Search for new Higgs bosons via same-sign top quark pair production in association with a jet in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *Phys. Lett. B*, 850:138478, 2024.