Gourab Saha

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Interests

High Energy Physics, Data Analysis, Statistics, Machine Learning, Software Development, Detectors

Education / Qualification

Institut Pluridisciplinaire Hubert Curien (IPHC, CNRS) **PostDoc (ANR-TAO)**
Strasbourg, France *2023 –*
Topic : Search for CP Violation in $H \to \tau\tau$ decays, Tau Full Momentum Regression using Machine Learning, Tau Offline Validation, Level-3 Tau-CQM (Calibration and Quality Monitoring by validating tau reconstruction with latest CMS data and simulation, by validating the performance of tau for each new CMS software release, and by providing all possible corrections for physics analyses those involve taus)
Advisors : Prof. Anne-Catherine Le Bihan, Prof. Saskia Falke

Saha Institute of Nuclear Physics (SINP, HBNI) **Ph.D**
Kolkata, India *2017 – 2023*
Topic : Search for HH in $bbWW$ decay with CMS full run 2 data, test beam data analysis to study the performance of the outer tracker 2S modules of the upcoming CMS tracking system for HL-LHC, Monitoring and Validation of the digitized form of the RAW detector signal for Phase-II tracker as a part of DQM (Data Quality Monitoring), Phenomenological Analyses
Thesis : Search for HH Production in the $b\bar{b}W^+W^-$ decay channel in p-p collisions using CMS data at $\sqrt{s} = 13$ TeV at the LHC
Supervisor : Prof. Suchandra Dutta

Saha Institute of Nuclear Physics (SINP, HBNI) **Post M.Sc**
Kolkata, India *2016 – 2017*
Topic : Particle Physics, Detector Physics, C++, Python, ROOT
Project : μ and τ identification with Monte Carlo simulation and 2016 CMS data
Supervisor : Prof. Suchandra Dutta
Score : 76.5%

Indian Institute of Technology (IIT) **M.Sc**
Delhi, India *2013 – 2015*
Topic : Classical Mechanics, Relativistic and Non-Relativistic Quantum Mechanics, Electrodynamics, Condensed matter physics, Optics, Electronics
Thesis : Study of Surface Plasmon Resonance of metallic nano-particles
Supervisor : Prof. Pankaj Srivastava
Score : 71.5%

A.B.N.Seal College, University of North Bengal (NBU) **B.Sc**
Cooch behar, India *2009 – 2012*
Topic : Physics major with Mathematics and Chemistry
Score : *73.8%*

Research Experience

IPHC **Analysis**

Search for CP Violation in $H \to \tau\tau$ decay *2023 –*

- Restructuring and developing the analysis for Run 3 using Columnflow
- Regression of full Tau momenta using Machine Learning (LBN, GNN, Transformer based architecture)
- Strategic improvements especially using Polarimetric Vector method to reconstruct the most optimal discriminator "Acoplanarity Angle", i.e. the angle between the decay plains of the the taus in the rest frame of Higgs over Run2, and granular categorization of the final state signature

IPHC **Software**

Offline Data Quality Monitoring and Validation with real and fake taus *2023-2024*

- A new module in the in the central and official DQM and validation sequence of the main CMS software (CMSSW) to acquire, produce, process and even analyze the recorded data by the CMS.
- New GUI layouts are developed and already deployed to study the performace of tau for each new CMSSW release

SINP [7] **Analysis**

Search for HH Production in the $b\bar{b}W^+W^-$ decay channel *2020-2022*

- Primarily involved in the Non-Resonant Analysis
- LBN for classification, jet-parton assignment with BDT for W-jet tagging
- Cross-checked yields among different frameworks

SINP **Analysis**

Searching for the evidence of $H^{\pm\pm}$ and $H^{\pm}$ with full Run-2 data $\sqrt{s} = 13$ TeV *2018-2020*

- Motivated by the high energy scale stability of Higgs potential with type-II seesaw mechanism [6]
- Developed the analysis workflow
- Generation of signal Monte-Carlo samples from Gridpack to NanoAOD
- Full scale generator level study and Data/MC comparison with 2016 CMS Data

SINP [1] **Beam Test**

Performance of the 2S Modules of the CMS Phase-2 Tracker in Test Beam Environments *2018-2021*

- Data Analysis to study the TB2S mini and full-sized modules tested in the beam tests at FNAL and DESY, respectively
- Key Points: Studied Cluster and Stub efficiency in threshold and angular scan

SINP **Software**

Data quality monitoring and Validation with Digi for phase-2 tracker upgrade *2019-2020*

- Developed two CMSSW modules and plugged them in the central DQM and validation sequence

SINP, IPHC [3, 4] **Phenomenology**

Searching exotic Higgs boson at the LHC *2020-2022*

- Search for exotic scalars motivated by an S3 symmetric flavor model
- Madgraph and Delphes based analysis from simulated processes using Machine Learning

SINP [5] **Phenomenology**

Muon $g-2$ and W mass in a framework of colored scalars *2021-2022*

- Motivated by type-X 2HDM with color octet iso-doublet respecting the CDF W-mass and muon $g-2$ observations
- Parametric Deep Neural Network for classification in $bb\tau\tau$ final states

Schools / Conferences

Orsay, Paris — **Conference**
Higgs Hunting — *2024*

CERN [Remote] — **School**
4^{th} Tracker Upgrade DAQ School, Built a DAQ system from scratch for tracker phase-2 upgrade — *2021*

Tsukuba, Japan [Remote] — **Conference**
Vertex, Poster : Performance of full-sized TB2S modules in DESY Test Beam Setup — *2020*

Pisa, Italy — **School**
CMS Data Analysis School [Best final presentation] — *2019*

IIT Madras, India 2018 — **Conference**
XXIII DAE-BRNS, Talk : Performance of mini TB2S modules in FNAL Test Beam Setup — *2018*

Leadership / Teaching / Detector Shift

IPHC — **Leadership**
TauCQM Level 3 Convener-ship — *September 2024 -*

IPHC — **Teaching**
Supervision of one M1 student on quark gluon discriminator using Graph Neural Network — *2024 [Mar - May]*

IPHC — **Shift**
CMS technical (DCS) Shifter at Point 5 of the CMS experiment — *2023 - 2024 [10 shifts]*

SINP — **Leadership**
Tracker Offline DQM Shift Leader — *2022 [2 weeks]*

SINP — **Shift**
Tracker Offline DQM Shifter — *2018 - 2022 [11-12 weeks]*

SINP — **Teaching**
Twenty hours course on PyROOT and Tag & Probe method to Masters Summer Students — *2021*

SINP — **Teaching**
Tutor of Python Course for Post-M.Sc — *2019*

Computing Skills

Language
C/C++, Python, Shell, HTML, TeX — *Experienced*

Analysis Software
ROOT, CMSSW, Bamboo, Law, Columnflow, Combine tool — *Experienced*

Simulation Software
MadGraph, Pythia, Delphes — *Experienced*

ML Software
Pytorch, PyTorch Geometric, Tensorflow, Keras — *Experienced*

Package
Numpy, Awkward Array, Pandas — *Experienced*

Reference

[1] Adam, W., et al. Test beam performance of a CBC3-based mini-module for the Phase-2 CMS Outer Tracker before and after neutron irradiation. *JINST 18*, 04 (2023), P04001.

[2] Adam, W., et al. Beam Test Performance Studies of CMS Phase-2 Outer Tracker Module Prototypes.

[3] Bhattacharyya, G., Chakraborty, I., Ghosh, D. K., Jha, T., and Saha, G. Searching for exotic Higgs bosons from top quark decays at the HL-LHC. *arXiv 2212.09061* (12 2022).

[4] Bhattacharyya, G., Dwivedi, S., Ghosh, D. K., Saha, G., and Sarkar, S. Searching for exotic Higgs bosons at the LHC. *Phys. Rev. D 106*, 5 (2022), 055032.

[5] Chakrabarty, N., Chakraborty, I., Ghosh, D. K., and Saha, G. Muon $g-2$ and W-mass in a framework of colored scalars: an LHC perspective. *arXiv 2212.14458* (12 2022).

[6] Ghosh, D. K., Ghosh, N., Saha, I., and Shaw, A. Revisiting the high-scale validity of the type II seesaw model with novel LHC signature. *Phys. Rev. D 97*, 11 (2018), 115022.

[7] Hayrapetyan, A., et al. Search for Higgs boson pair production in the bbWW decay mode in proton-proton collisions at $\sqrt{s} = 13$ TeV.

[8] Saha, G. Performance of 2S Modules of the CMS Phase-2 Tracker in a Test Beam Environment. *JPS Conf. Proc. 34* (2021), 010022.