Ram Krishna Sharma

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Research Interests

- Higgs physics, Vector Boson Scattering (VBS), High Level Trigger (HLT) Development.

Employment History

2020 – onwards — **Post Doctoral Fellow**; Institute of High Energy Physics, Beijing, China.

Education

2012 – 2019 — **Ph.D., University of Delhi, India**; Experimental High Energy Physics.
Thesis title: *Search For Anomalous Gauge Coupling through Vector Boson Scattering and Development of the GEM Detectors at the CMS Experiment*

2009 – 2012 — **M.Sc. Physics, University of Delhi, India**
Topic for Dissertation: *Dynamics of charged particle in the presence of a magnetic monopole having an electric dipole moment.*
Mentor: Professor Patrick Das Gupta

2006 – 2009 — **B.Sc. (Honours) Physics, University of Delhi, India**
Project-1: To Fabricate thin silicon diaphragm by anisotropic etching at Electronic and Material Devices Laboratory (EDML) 2008-2009
Mentor: Professor Vinay Gupta
Project-2: Effect of annealing temperature on Sol-Gel derived ZnO thin films at EDML 2007 – 2008
Mentor: Professor Vinay Gupta

Skills

Languages	Strong reading, writing and speaking competencies for English, and Hindi.
Computing	C/C++, PHP, Python, Shell Script, LaTeX, Git, GitLab/GitHub CI/CD.
Libraries	ROOT, RooFit, UpROOT, TensorFlow, Keras, Pandas, sklearn, NumPy, Matplotlib
MC Event Generator	Madgraph, Pythia, VBFNLO, MCFM
Interpersonal Skills	project management, leadership, effective communication, knowledge sharing, mentoring

Roles as CMS Collaboration Member

Oct 2020 – onwards	Co-convener of the “EGamma HLT" group of CMS experiment at CERN, Geneva
Sep 2015 – Nov 2016	Liaison of “GEM Phase2 R&D" and “Detector Performance Group" of CMS experiment at CERN, Geneva
July 2015 – Nov 2016	Co-convener of “GEM Detector Response Modelling" group of CMS experiment at CERN, Geneva

Research Experience

Ongoing Projects

H→4L
- Higgs To 4 lepton differential and fiducial cross-section measurement. We are doing an extensive studies using many 1D and 2D differential observable, that will be measured and unfolded. Furthermore, we are working on the theoretical interpretations of this measurements. Which includes the interpretations in the kappa-like framework and SMEFT framework. Using which we will try to put constraints on the effective Hbb and Hcc couplings from b-quark and c-quark contributions to the Hgg loop (k_b, k_c) as well as constraint on the Higgs boson trilinear self-coupling (k_λ) performed for the first time with 137 fb^{-1}. **CMS HIG-21-009**.

Di-Higgs
- **Non-Resonant di-Higgs production**: Main analyzer of the fully hadronic channel ($HH \rightarrow WW\gamma\gamma$) and exploring the machine learning tools to enhance the signal sensitivity. Currently, the analysis is pre-approved (which is the first step towards getting the analysis public) by the CMS Higgs PAG. **CMS CADI: HIG-21-014**.
- **Resonant di-Higgs production**: Started working on this in the fully hadronic channel ($X \rightarrow HH \rightarrow WW\gamma\gamma$). Here, the Radion mass is probed from 250 GeV to 3 TeV, where the kinematics changes from resolved to semi-resolved to boosted topology, depending on the mass of Radion. We are looking for all three cases, i.e., resolved, semi-resolved and merged. (**Target publication by early 2023)**

Higss Mass Measurement
- **Higgs mass measurement using** $H \rightarrow \gamma\gamma$: Recently, join the effort with the $H\gamma\gamma$ group of IHEP for the Higgs mass measurement using the $\gamma\gamma$ channel. (**Target publication by Moriond 2023)**

CPPF
- Concentration Pre-Processing Fan-out (CPPF) is a μTCA based card which is deployed at CMS L1 for RPC overlap and endcap region. This provides pre-processing algorithm for the track finding. Here, I am maintaining the framework which analyzes the data from hardware and emulator, which make sure if everything is working fine in the L1 Data Quality Monitoring.

HLT
- Working on the electron and photon HLT development studies for the upcoming LHC Run-3 and Phase-II upgrade of CMS detector. Being the EGamma HLT convener, also responsible to review various HLT-related studies ongoing within the group.

Completed Projects

VBS
- VBS studies using the opposite charge WW in semi-leptonic channel ($pp \rightarrow W^+W^-jj \rightarrow l\nu jjjj$). Performing the production cross section measurement for the first time for this process in CMS. Submitted to PLB for publication. **CMS CADI: SMP-20-013**.

aQGC Measurement
- Worked on the measurement of the anomalous quartic gauge coupling (aQGC) with opposite sign WW ($pp \rightarrow W^+W^-jj \rightarrow l^\pm\nu jjjj$) using 2016 pp-data collected by CMS at 13 TeV. This was the first analysis from CMS using the semi-leptonic WW channel. This channel gave the **world's best limit** on the quartic vector boson interactions in the framework of dimension-eight effective field theory operators in 2019. The results were also interpreted for the resonant singly and doubly charged Higgs using the Georgie-Machacek (GM) model. This analysis was published in PLB in 2019.

Research Experience (continued)

GEM Detectors

- Contributed to the laboratory setup for assembly and characterization of GEM detectors and lead their characterization studies at University of Delhi. Actively participated in the beam test studies of GEM detector at CERN and online data quality monitoring throughout the beam test. Main analyzer of the offline test beam data analysis and worked on the software-based alignment of the GEM detectors. I refined the alignment algorithm and this improved the efficiency of the GEM detectors. We have two publications based on my studies.

Awards and Achievements

2019
- Selected for **Young Scientist Forum (YSF)** talk at **La Thuile 2019** - Les Rencontres de Physique de la Vallée d'Aoste, La Thuile, Aosta Valley, Italy, 10^{th}-16^{th} March 2019.

2018
- Instructor at the "**CMS Data Analysis School 2018**" held in Fermilab, 8 January - 13 January 2018 for two short exercises "*Tracking & Vertexing*" and "*PileUp/MET*", and a long exercise on "*Contact Interaction*".

2017
- Selected in "**Summer 2017 Guests & Visitors program to the LPC, Fermilab, USA**" for carrying out the VBS analysis.

2016
- Instructor for "**Collider Physics Simulation, Event Generation**" in SERC School for Experimental High Energy Physics, a national school held once in two year, University of Delhi, 19 April - 09 May 2016.

2015
- Awarded "**2015 Fundamental Physics Special Recognition Award**" from the CMS Fundamental Physics Scholar Committee, CERN, Switzerland in December 2015.

2014
- Awarded **Senior Research Fellowship (SRF)** from University Grant Commission (UGC), Government of India, for pursuing Ph.D. at the Department of Physics and Astrophysics, University of Delhi, August 2014 - August 2017.

2012
- Awarded **Junior Research Fellowship (JRF)** from University Grant Commission (UGC), Government of India, for pursuing Ph.D. at the Department of Physics and Astrophysics, University of Delhi, August 2012 - August 2014.
- Selected through **National Eligibility Test**, a criteria for Assistant Professorship in Physical sciences conducted by the University Grant Commission (UGC-CSIR), Government of India, June 2012.

Conference Talks

2021
- Presented a talk in "**CLHCP-2021: China LHC Physics Workshop**" on "Evidence for vector boson scattering in semileptonic $l\nu qq$ final states in proton-proton collisions at $\sqrt{s}$ = 13 TeV with CMS", 25^{th}-28^{th} November 2021.
- Presented a plenary invited talk in "**LISHEP 2021: Workshop on High Energy Physics**" on "Standard Model and Electroweak Results from CMS", 6^{th}-8^{th} July 2021.

2019
- Presented a talk in **Young Scientist Forum (YSF)** on "Search for Anomalous Electroweak Production of WW/WZ/ZZ Boson Pairs in Association with two Jets in p-p Collision at 13 TeV", **La Thuile 2019 - Les Rencontres de Physique de la Vallée d'Aoste**, La Thuile, Aosta Valley, Italy, 10^{th}-16^{th} March 2019.

Conference Talks (continued)

2018 Talk presented at the **XXIII DAE High Energy Physics Symposium** on "Search for Anomalous Electroweak production of WW/WZ/ZZ Boson Pairs in Association with two jets in p-p Collision at 13 TeV", IIT Madras, Chennai (India), December 10-14, 2018.

2016 Talk presented at the **XXII DAE High Energy Physics Symposium** on "Test Beam Study of Gas Electron Multiplier (GEM) Detectors for the Upgrade of CMS Endcap Muon System", University of Delhi, India, December 12-16, 2016.

2015 Poster presented at the **2015 IEEE Nuclear Science Symposium and Medical Imaging Conference (NSS/MIC)**, "Charged particle detection performance of Gas Electron Multiplier (GEM) detectors for the upgrade of CMS endcap muon system at the CERN LHC", Town and Country Hotel, San Diego, California, USA, 31 October - 7 November 2015.

Research Publications

Journal Articles

1. Sirunyan, A. M. et al. (2021). Measurements of production cross sections of the Higgs boson in the four-lepton final state in proton-proton collisions at $\sqrt{s} = 13$ TeV. doi:10.1140/epjc/s10052-021-09200-x. arXiv: 2103.04956 [hep-ex]
2. Collaboration, C. (2021). WV VBS in the semileptonic channel using full run 2 data. arXiv: --- [**Under review; Target journal PLB**]
3. Abbas, M. et al. (2020). Performance of prototype GE1 / 1 chambers for the CMS muon spectrometer upgrade. *Nucl. Instrum. Meth. A*, *972*, 164104. doi:10.1016/j.nima.2020.164104. arXiv: 1903.02186 [physics.ins-det]
4. Sirunyan, A. M. et al. (2019). Search for anomalous electroweak production of vector boson pairs in association with two jets in proton-proton collisions at 13 TeV. *Phys. Lett. B*, *798*, 134985. doi:10.1016/j.physletb.2019.134985. arXiv: 1905.07445 [hep-ex]
5. Shah, A., Ahmed, A., Gola, M., **Sharma**, **R. K.**, Malhotra, S., Kumar, A., … Srinivasan, K. (2018). Development, characterization and qualification of first GEM foils produced in India **(Corresponding author)**. *Nucl. Instrum. Meth. A*, *892*, 10–17. doi:10.1016/j.nima.2018.02.078. arXiv: 1803.03260 [physics.ins-det]

Conference Proceedings

1. **Sharma**, **R. K.**, Naimuddin, M., Dorney, B., Merlin, J. A., Sharma, A., Gruchala, M. M., … Mehta, A. (2018). Test Beam Study of Gas Electron Multiplier (GEM) Detectors for the Upgrade of CMS Endcap Muon System. In M. Naimuddin (Ed.), (Vol. 203, pp. 179–183). doi:10.1007/978-3-319-73171-1_40
2. Abbaneo, D. (2016). Charged particle detection performance of Gas Electron Multiplier (GEM) detectors for the upgrade of CMS endcap muon system at the CERN LHC. In *2015 IEEE Nuclear Science Symposium and Medical Imaging Conference* (p. 7581797). doi:10.1109/NSSMIC.2015.7581797

CMS Internal Analysis Notes

1. Chen, M., Li, P., Mandrik, P., Marzocchi, B., Orimoto, T., **Sharma**, **R. K.**, … Wang, J. (2020). *Search for Di-Higgs Production in the $WW\gamma\gamma$ Channel with the Full Run 2 Dataset*. (**In progress**): AnalysisNote-2020/165

2. Chen, M., Milenovic, P., Sperka, D., **Sharma**, **R. K.**, Guo, Q., & Javaid, T. (2020). *Measurements of Higgs differential cross section and interpretations in $H \to 4l$ $(l = e, \mu)$ channel*. (**In progress**): AnalysisNote-2020/233

3. Ahmad, M., Amapane, N., Bonanomi, M., Cappati, A., Charlot, C., Chen, M., … Zhang, C. (2019). *Measurements of properties of the Higgs boson in the four-lepton final state at $\sqrt{s}$ = 13 TeV with full Run II data*. CMS: AnalysisNote-2019/139

4. Govoni, P., Massironi, A., Valsecchi, D., Mapelli, D., Apyan, A., Green, D., … Naimuddin, M. (2019). *Search for the EW production of a VW pair plus two jets in the semi-leptonic $l\nu jj$ channel with full Run-II data*. CMS: AnalysisNote-2019/239

5. Apyan, A., Beretva, A., Berryhill, J., Govoni, P., Green, D., Naimuddin, M., … Valsecchi, D. (2017). *Search for anomalous electroweak production of WW/WZ/ZZ boson pairs in association with two jets in proton-proton collision at 13 TeV*. CMS: AnalysisNote-2017/236

6. Bhatnagar, V., Dorney, B., Gruchala, M. M., Kumari, P., Mehta, A., Naimuddin, M., … Singh, J. (2016). *Test beam studies of Gas Electron Multiplier (GEM) detectors for the upgrade of CMS endcap muon system*. CMS: DetectorNote-2016/017

7. Shah, A., Sharma, A., Kumar, A., Dorney, B., Lentdecker, G. D., Merlin, J., … de Oliveira, R. (2016). *Performance of prototype GE1/1 chambers for the CMS muon spectrometer upgrade*. CMS: DetectorNote-2016/016

8. Ahuja, S., Candelise, V., Chen, C.-W., Cocoros, A., Ferencek, D., Giannini, L., … Yu, S.-S. E. (2015). *Search for heavy resonances decaying to a pair of Higgs bosons in four b quark final state in proton-proton collisions at $\sqrt{s}$ = 13 TeV*. CMS: AnalysisNote-2015/2876

References

Available on Request