
SUMAN DEB

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Post Doctoral Researcher in Experimental Particle Physics in HADES at the GSI
Laboratoire de Physique des 2 infinis Irène Joliot-Curie, Orsay, France

Education

SL. No.	Class	Board	Subject	Remark(s)
1	Post Doctoral Researcher	IJCLab, CNRS	Experimental Particle Physics (HADES collaboration)	01/12/2022 to Present
2	Visiting Researcher	IIT Indore	Experimental Particle Physics (ALICE collaboration)	29/08/2022 to 30-11-2022
3	PhD	IIT Indore	Experimental Particle Physics (ALICE collaboration)	Awarded on 19-10-2022
4	M.Sc.	Tezpur University	High Energy Physics (specialization)	1 st class
5	B.Sc.	NEHU	Physics (Major), Electronics, Mathematics	University Topper

Work Experience

(A). Experiment Particle Physics

Supervisor : *Prof. Raghunath Sahoo, IIT Indore, India*

- Data analysis in ALICE experiment with PWG-LF group on “Event shape and multiplicity dependence of $K^*(892)^\pm$ meson production in proton+proton collisions at $\sqrt{s} = 13$ TeV ”. ([Link to Analysis note](#))
- Worked on improving the modelling of the underlying event simulations in the Sherpa Event generator with Göttingen group under MCnetITN short-term studentship (**Marie Skłodowska-Curie Early Stage Researcher position**). (<https://www.montecarlonet.org/deb>)

- Quality Control post processing integration for EMCAL and rivet analysis as a part of Service task in ALICE at the LHC, CERN

(B). Phenomenological work:

1. "Glauber model for a small system using the anisotropic and inhomogeneous density profile of a proton." - **Suman Deb**, Golam Sarwar, Dhananjaya Thakur, Pavish S., Raghunath Sahoo, and Jan-e Alam, *Phys. Rev. D* **101**, 014004 (2020), (SCI-indexed, Impact factor: 5.296)
2. "Multiplicity Dependence of J/Ψ Production and QCD Dynamics in p+p Collisions at $\sqrt{s} = 13$ TeV."- **Suman Deb**, Dhananjaya Thakur, Sudipan De, and Raghunath Sahoo, *Eur. Phys. J A* **56**, 134 (2020), (SCI-indexed, Impact factor: 3.131)
3. "J/Ψ Production Dynamics: Event shape, Multiplicity and Rapidity dependence Proton + Proton Collisions at LHC energies using PYTHIA8." - Anisa Khatun, Dhananjaya Thakur, **Suman Deb**, and Raghunath Sahoo, *Journal of Physics G: Nuclear and Particle Physics* **47**, 055110 (2020), (SCI-indexed, Impact factor: 3.519)
4. "Deciphering QCD dynamics in small collision systems using event shape and final state multiplicity at the Large Hadron Collider." - **Suman Deb**, Sushanta Tripathy, Golam Sarwar, Raghunath Sahoo, and Jan-e Alam, *Eur. Phys. J. A* **56**, 252 (2020), (SCI-indexed, Impact factor: 3.131)
5. "Bose-Einstein Condensation of pions in Proton-Proton collisions at the Large Hadron Collider using non-extensive Tsallis statistics."- **Suman Deb**, Dushmanta Sahu, Raghunath Sahoo, and Anil Kumar Pradhan, *Eur. Phys. J. A* **57**, 158 (2021), (SCI-indexed, Impact factor: 3.131)
6. "Estimation of Impact Parameter and Transverse Sphericity in heavy-ion collisions at the LHC energies using Machine Learning."- Neelkamal Mallick, Sushanta Tripathy, Aditya Nath Mishra, **Suman Deb**, and Raghunath Sahoo, *Phys. Rev. D* **103**, 094031 (2021), (SCI-indexed, Impact factor: 5.296)
7. "Study of QCD dynamics using small systems."- **Suman Deb**, Golam Sarwar, Raghunath Sahoo, and Jan-e Alam, *Eur. Phys. J. A* **57**, 195 (2021), (SCI-indexed, Impact factor: 3.131)
8. "Investigating Heavy-flavor vs. Light-flavor Puzzle with Event Topology and Multiplicity in Proton + Proton Collisions at $\sqrt{s} = 13$ TeV using PYTHIA8."- **Suman Deb**, Raghunath Sahoo, Dhananjaya Thakur, Sushanta Tripathy, and Arvind Khuntia, *Journal of Physics G: Nuclear and Particle Physics* **48**, 095104 (2021), (SCI-indexed, Impact factor: 3.519)

9. "Charmonium suppression in ultra-relativistic Proton-Proton collisions at LHC energies: A hint for QGP in small systems."- Captain R. Singh, **Suman Deb**, Raghunath Sahoo, and Jan-e Alam, *Eur. Phys. J. C* **82**, 542 (2022), (SCI-indexed, Impact factor: 5.172)
10. "Hadron gas in the presence of a magnetic field using non-extensive statistics: A transition from diamagnetic to paramagnetic system."- Girija Sankar Pradhan, Dushmanta Sahu, **Suman Deb**, and Raghunath Sahoo, *arxiv: 2106.14297*.

(C). Conference Proceedings:

1. "Insight into J/Ψ production with hard-QCD and RAA like factor in high multiplicity $p + p$ collisions at $\sqrt{s} = 13$ TeV" -**Suman Deb**, Dhananjaya Thakur, Sudipan De, and Raghunath Sahoo, *DAE Symp.Nucl.Phys.* **63**, 918 (2018)
2. "Understanding Medium formation in Small system using heat capacity at the Large Hadron Collider Energies" - **Suman Deb**, Golam Sarwar, Raghunath Sahoo, and Jan-e Alam, *DAE Symp.Nucl.Phys.* **64**, 714 (2020)
3. "Modeling Initial condition for Proton-Proton Collisions at the LHC energies" - **Suman Deb**, Golam Sarwar, Dhananjaya Thakur, Pavish S., Raghunath Sahoo, and Jan-e Alam, *DAE Symp.Nucl.Phys.* **64**, 786 (2020)
4. "Energy and rapidity dependence of J/Ψ production as a function of charged-particle multiplicity in different event shapes"- Anisa Khatun, Dhananjaya Thakur, **Suman Deb**, and Raghunath Sahoo, *DAE Symp.Nucl.Phys.* **64**, 768 (2020)
5. "Extension of Glauber-like model for Proton-Proton collisions using anisotropic and inhomogeneous density profile", **Suman Deb**, Golam Sarwar, Dhananjaya Thakur, Pavish S., Raghunath Sahoo, and Jan-e Alam, *LHCP2021 9th National Annual conference on Large Hadron Collider Physics* (<https://doi.org/10.22323/1.397.0225>)
6. "Implementation of machine learning techniques to predict impact parameter and transverse sphericity in heavy-ion collisions at the LHC", Aditya Nath Mishra, Neelkamal Mallick, Sushanta Tripathy, **Suman Deb** and Raghunath Sahoo, *PoS LHCP2021*, 265 (2021)
7. "Multiplicity Dependence of Charmonia Suppression in pp Collisions at the LHC Energies", Captain R. Singh, **Suman Deb**, Raghunath Sahoo, and

Jan-e Alam, *DAE Symp.Nucl.Phys. 65, (2022) 670-671*

1. "Estimation of impact parameter and transverse sphericity in heavy-ion collisions at the LHC using machine learning techniques", Neelkamal Mallick, Sushanta Tripathy, Aditya Nath Mishra, **Suman Deb** and Raghunath Sahoo, *DAE Symp.Nucl.Phys. 65, (2022) 642-643*

(D). Poster Presentations:

1. "Multiplicity dependence study and role of MPIs on J/Ψ production in p + p collisions at $\sqrt{s} = 13$ TeV using PYTHIA8" - **Suman Deb**, Dhananjaya Thakur, Sudipan De, and Raghunath Sahoo, *3rd Heavy Flavour meet 2019 at IIT Indore (Best Poster award)*
2. "Elucidating the implications of deep inelastic scattering in proton-proton collisions with Glauber-like model" -**Suman Deb**, Golam Sarwar, Dhananjaya Thakur, Pavish S., Raghunath Sahoo, and Jan-e Alam, *DAE-BRNS HIGH ENERGY PHYSICS SYMPOSIUM 2020 at NISER*
3. "Investigating the markers of thermalisation in a small system using event topology and final state multiplicity at the LHC energies" - **Suman Deb**, Raghunath Sahoo, Golam Sarwar, Sushanta Tripathy, Jan-e Alam, *DAE-BRNS HIGH ENERGY PHYSICS SYMPOSIUM 2020 at NISER*
4. "Event shape and multiplicity dependence of $K^*(892)^\pm$ meson at midrapidity in pp collisions at $\sqrt{s} = 13$ TeV with ALICE at the LHC" - **Suman Deb (on behalf of ALICE Collaboration)**, *29th International Conference on UltraRelativistic Nucleus-Nucleus Collisions (Quark Matter), April 4-10, 2022, at Kraków, Poland*
5. "Event topology and multiplicity dependence of charmed hadron production in Proton+Proton collisions at $\sqrt{s} = 13$ with ALICE at the LHC" - **Suman Deb**, *29th International Conference on UltraRelativistic Nucleus-Nucleus Collisions (Quark Matter), April 4-10, 2022, at Kraków, Poland*
6. "Event shape and multiplicity dependence of $K^*(892)^\pm$ production at mid-rapidity in pp collisions at $\sqrt{s} = 13$ TeV using pQCD inspired model" - **Suman Deb**, *10th Annual Large Hadron Collider Physics (LHCP2022) conference, May 16-20, 2022, at Taipei, Taiwan*
7. "Topological dependence of $K^*(892)^\pm$ meson at midrapidity in pp collisions ALICE at the LHC" - **Suman Deb (on behalf of ALICE Collaboration)**, *20th International conference on strangeness in Quark Matter, May 13-17, 2022, at Busan, Republic of Korea*

Technical Summary

- Scientific Coding in C
- Object oriented programming in C++
- Hands on experience with CERN based Root5 and Root6
- Bash scripting
- Familiar with ALICE framework and Aliroot (based on C++)
- Event generator like PYTHIA, AMPT, VINCIA and SHERPA
- Machine Learning tool like Scikit learn, TMVA
- Web and network: GIT
- <https://github.com/sdeb0101>(Github account)

Description of PhD research:

The proton-proton (pp) collisions have been studied for a long time at the LHC, which have given fascinating results. However, these exciting results still need further investigation. Event shape observables like transverse sphericity are sensitive to the hard and soft processes and represent a valuable tool to isolate the jetty (Hard QCD processes) and isotropic (Soft QCD processes) events in pp collisions and allow more differential study of particle production. Recent results on high multiplicity pp collisions show a decreasing trend of particle ratios of $K^*(892)^0$ to kaon as a function of charged particle multiplicity. Such a similar trend has been observed in heavy-ion collisions, where the system size is larger compared to the system produced in pp collisions. The decreasing trend of particle ratios is attributed to the re-scattering of decay daughters in the hadronic medium. This question of whether the observed resonance suppression is due to a partonic phase is still open.

Furthermore, the observation of resonance suppression in high multiplicity pp and p–A event has added an additional challenge to the re-scattering hypothesis. Even in the high multiplicity events where the configuration space is small are not expected to have the same amount of re-scattering than larger A–A events. Hence, the sphericity class helps disentangle the hard and soft events and looks into the resonance ratios in different sphericity classes to understand such behavior.

My analysis focusses on the study of the production of $K^{*\pm}$ (892) meson by following observables:

- p_T spectra in high-multiplicity and sphericity classes
- Affect of different quantiles of sphericity classes on $K^{*\pm}$ (892) meson production
- Mean p_T in high multiplicity and sphericity classes
- dN/dy in multiplicity and sphericity classes
- Particle ratios as a function of multiplicity, sphericity classes and energy
- Comparisons of results with Monte-Carlo models

In addition, I have also worked on phenomenological aspect of understanding the system formation at the high-multiplicity proton-proton collisions using various tools ranges from the application of Tsallis statistics, monte- carlo simulations (PYTHIA8, SHERPA), machine learning etc. This quest has earned me ten publications in reputed journals (<https://inspirehep.net/authors/1757389>).


Significant highlights of my works like “***Glauber model for a small system using the anisotropic and inhomogeneous density profile of a proton***” (<https://doi.org/10.1103/PhysRevD.101.014004>), which explores the possibility of Glauber-like model (model which was previously used for the heavy-ion system) calculation in pp system, thereby calculating geometric quantities like number of binary collisions, number of participating partons, etc. This calculation helps define nuclear-modification-like quantities in the pp system for the first time. My other work, “***Bose-Einstein condensation of pions in proton-proton collisions at the Large Hadron Collider using non-extensive Tsallis statistics***” (<https://doi.org/10.1140/epja/s10050-021-00464-1>), explores the possibility of formation of Bose-Einstein condensation of lightest meson, pions in the low p_T region of pp collisions and defines a threshold multiplicity to observe such condensation in experiments. My other work, “***Study of QCD dynamics using small systems***” (<https://doi.org/10.1140/epja/s10050-021-00496-7>), explore the

possibility of the formation of the thermalized system in high-multiplicity pp collisions by comparing different thermodynamical quantities obtained using experimental data (ALICE) and confronting the results with PYTHIA8, which is devoid of thermalization. And “*Investigating Heavy-flavor vs. Light-flavor Puzzle with Event Topology and Multiplicity in Proton+Proton Collisions at $\sqrt{s} = 13$ TeV using PYTHIA8*” (<https://doi.org/10.1088/1361-6471/abf88a>), discusses the use of an event shape tool called transverse sphericity, which helps to disentangle events sample into jets (Hard QCD) and isotropic (Soft QCD) in the production of heavy-flavored particles like J/Ψ , Λ_c^+ and D^0 particles.

Other responsibilities

- (1). **ALICE Juniors Ambassador (India)** from 01-03-2020 to 11-02-2021, where represented the issues/problems faced by Phds/Post Docs working in ALICE collaboration within India at the ALICE committee (CERN).
- (2) **ALICE Junior Representative (India)** from 03-03-2019 to 05-02-2021, where worked in close collaboration with the Head of ALICE-India Collaboration to safeguard the interest of the students working in the ALICE collaboration within Indian institutes.
- (3). Worked as one of the **webpage developers and local organizer** of the 3rd ALICE-India School on Quark-Gluon Plasma – 2020 (https://iiti.ac.in/people/~raghunath/ALICE-India_School_2020/index.html).
- (4). Experience working as Teaching Assistant to B.Tech classes for electrodynamics and Physics laboratory, IIT Indore.
- (5). Reviewer of Journal of Physics G: Nuclear and Particle Physics, IOP-UK Publishing and MDI (Switzerland).

Date: 14-12-2022
Place: Orsay, France



(Suman Deb)