

Suvadeep Bose

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EDUCATION

- **Tata Institute of Fundamental Research, Mumbai, India**
Ph.D. Physics, September 2010
Thesis Topic: *QCD studies with the CMS detector at the LHC*
- **University of Cambridge, Cambridge, UK**
M.S. in Natural Sciences (Physics), July 2003
- **Jadavpur University, Kolkata, India**
B.Sc.(Honours) in Physics, July 2001

ACADEMIC POSITIONS

- **University of Nebraska Lincoln, NE / Fermi National Accelerator Laboratory, IL**
Postdoctoral Research Associate, September 2009 – Present
- **Fermi National Accelerator Laboratory, Batavia, IL**
CMS Visitor, June 2007 – August 2009

AWARDS/ GRANTS

2010	University Research Organization (URA) Fellowship, USA
2004-05	<i>Kanwal Rekhi</i> Scholarship for career development, TIFR, India
2003-09	Ph.D. Research Scholarship offered by TIFR, Mumbai, India
2002	St Edmund's College (UK) Commonwealth and Overseas Student award
2001	Commonwealth Scholarship to study MA in Cambridge, UK
2001	Scholarship of Indian Academy of Sciences, Bangalore, India
1996	National Scholarship for ranking 2 nd in the Secondary Board Examination, India

TEACHING EXPERIENCE

- Instructor and Developer**, Jet Tutorial, CMS Data Analysis School (CMSDAS)
- LHC Physics Center, Fermilab, USA, January, 2011
- Instructor and Developer**, Jet Tutorial, CMS Data Analysis School (CMSDAS)
- INFN Pisa, Pisa, Italy, January, 2011

OUTREACH ACTIVITIES

- Mentored high school students through **Adopt-a-Physicist** program, October 2012

- Arrange seminars at Fermilab with the LPC Topic of the Week Seminar Committee, 2012-present

LEADERSHIP EXPERIENCE

LHC Physics Center, Fermilab, Batavia, IL

- Supervise graduate and undergraduate students on Physics Research Projects
- Served as Simulation contact for Quantum Chromo Dynamics in CMS
- Served as a Contact person of the Jet trigger group in CMS

SELECTED PUBLICATIONS (as lead investigator / major critical contribution)

- Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC, CMS Collaboration, *Physics Letters B*, **716**, Issue 1, (2012), 30-61.
- Search for New Physics with Jets in CMS, to be published by *American Institute of Physics*.
- Dijet physics with CMS detector at the Large Hadron Collider, *Pramana - Journal of Physics* **79**, Issue 4, 839-843 (2012).
- Search for quark compositeness in dijet angular distributions from pp collisions at $\sqrt{s}=7$ TeV, CMS Collaboration, *Journal of High Energy Physics* **05** (2012), 055.
- Measurement of Dijet Angular Distributions and Search for Quark Compositeness in pp Collisions at $\sqrt{s} = 7$ TeV, *Physical Review Letters* **106**, 201804 (2011).
- Response of CMS Hadron Calorimeter to Electron Beams, S. Bose, *Pramana - Journal of Physics* **69**, No.6, (2007).
- A Note on the neutrino mass implication of the K2K experiment, S. Bose and A. Raychaudhuri, *Journal of Physics G: Nuclear and Particle Physics*, **29** (2003), 1069-1074.
- Two time correlation for a noise driven double-well oscillator in the Suzuki regime, S. Bose and S. Samui, *Physica A: Journal of Statistical Physics*, **310** (2002), 85-90.

Listed as an author for 242 peer-reviewed journal articles whose scientific results were obtained in collaboration with others. My **citation index** is 47. Complete list is available via the *Inspire* website: [http://inspirehep.net/search?p=author%3AS.Bose.1+exactauthor%3A" Bose,+Suvadeep"](http://inspirehep.net/search?p=author%3AS.Bose.1+exactauthor%3A)

Additionally I wrote several notes internal to the collaboration that are instrumental towards understanding of the detector and commissioning of physics objects in CMS.

SELECTED PRESENTATIONS

Talk at the Eleventh Conference on the Intersections of Particle and Nuclear Physics:
New Physics Searches with Dijets and Multijets in CMS, St Petersburg, FL, USA, June 2012

Talk at the USLHC Users Organization meeting:

Search for quark compositeness with dijet angular distributions, Argonne National Laboratory, Chicago, IL, USA, November, 2011

Poster presented at the XXV International Symposium On Lepton Photon Interactions At High Energies:

Dijet Physics with CMS detector at the LHC, Mumbai, India, August 2011

Invited Plenary Talk at ASPEN 2011 Winter Conference on New Data From the Energy Frontier:

Hard QCD in CMS, Aspen, Colorado, USA, February 2011

Invited Plenary Talk at Boston Jet Physics Workshop:

Jet Shapes in CMS, Cambridge, MA, USA, January 2011

Talk at American Physical Society April meeting on Particle and Nuclear Physics:

QCD Multijet Studies in CMS at 10 TeV, Denver, CO, USA, May 2009

Talk at the JTerm data analysis school at the LHC Physics Center:

QCD Multijet Studies in CMS at 10 TeV, Fermilab, IL, USA, January 2009

Poster presented at the Fermi Users Meeting 2008:

Understanding CMS Endcap Calorimeter, Fermilab, IL, USA, June 2008

SEMINARS / COLLOQUIA

- HEP seminar, Northwestern University, Evanston, IL, USA, April 2012
- Seminar at Indian Institute for Science Education and Research, Mohali, India, September 2011
- HENPP seminar at Saha Institute for Nuclear Physics, Kolkata, India, September 2011
- Seminar at Indian Association for Cultivation of Science, Kolkata, India, September 2011
- Seminar at the All USCMS meeting, Fermilab, IL, USA, April 2011

MENTORING

- Mentored several graduate students at LPC, Fermilab and University of Nebraska Lincoln towards completion of projects / Ph.D. (2009-present)

REVIEWING PAPERS

I have so far reviewed 7 papers in the capacity of a reviewer within my collaboration. Two of them have been published, one is accepted and two are submitted to international journals after being approved by the collaboration. Two are still being finalized within collaboration to be sent to journals. The details of the papers I reviewed are listed below.

- Search for Pair Production of Second-Generation Scalar Leptoquarks in pp Collisions at $\sqrt{s}=7$ TeV, *Physical Review Letters*, **106**, 201803 (2011)
- Search for heavy Majorana neutrinos in $\mu\mu$ +jets and ee +jets events in pp collisions at 7 TeV, *Physics Letters B*, **717**, Issues 1-3 (2012) 109-128
- Search for new physics in events with opposite-sign leptons, jets, and missing transverse energy in pp collisions at $\sqrt{s}=7$ TeV, Accepted by *Physics Letters B* (2012), arXiv:1206.3949

- Evidence for associated production of a single top quark and W boson in pp collisions at 7 TeV, Submitted to *Physical Review Letters* (2012), arXiv:1209.3489
- Azimuthal correlations and event shapes in Z + jets production in pp collisions at $\sqrt{s}=7$ TeV, Submitted to *Physics Letters B* (2012)
- Search for Jet Extinction in inclusive jet p_T spectrum at 7 TeV, CMSPAS EXO-11-068
- Search for Dijet Resonances, CMS PAS EXO-12-059

IN THE NEWS

- **UNL TODAY:** December 22, 2010:
<http://newsroom.unl.edu/unltoday/2010/12/22>
- **SCARLET:** The news source for faculty and staff at the University of Nebraska Lincoln December 17, 2010: <http://scarlet.unl.edu/?p=9750>
- **FERMILAB TODAY:** March 16, 2012:
http://www.fnal.gov/pub/today/archive/archive_2012/today12-03-16.html

PROFESSIONAL REFERENCES

References on request

RESEARCH EXPERIENCE

My research interests broadly lie in the field of experimental particle physics. The main areas of interest include the phenomenon of electro-weak symmetry breaking, the origin of the matter anti-matter asymmetry in the Universe, and the search for new physics beyond the established Standard Model of particle physics.

September, 2009 – Present:

As a postdoctoral research associate stationed at Fermilab LHC Physics Centre (LPC) I work on the Compact Muon Solenoid (CMS) detector at the Large Hadron Collider (LHC) experiment at CERN which provides a crucial new capability to study the elementary constituents of matter and the fundamental forces that control their behavior at the most basic level.

I highlight below the major research contributions that I have made/involved in so far.

- Search for Standard Model Higgs boson produced in association with a W or Z boson and decaying to bottom quarks:

I search for the Higgs boson produced in association with a Z or W boson where the Higgs boson decays to a b-bbar pair. At the LHC the main Higgs production mechanism is the direct production via gluon fusion, however $H \rightarrow b\bar{b}$ decay was rendered nearly impossible due to overwhelming background. However recent studies of $H \rightarrow b\bar{b}$ in associated production with a vector boson has shown the background to be reduced quite significantly resulting in an enhanced analysis sensitivity. I am one of the lead analyzers for the study of $Z(\tau\mu)H(b\bar{b})$ decay

mode where the τ lepton decays fully hadronically. The results on these studies with the full data recorded by CMS experiment are expected for publication by summer of this year.

- Jet substructure techniques in Higgs search:

With the discovery of a Higgs like particle with mass 125 GeV the Higgs searches in CMS even in poor search channels which suffer from large backgrounds have become exciting and techniques that can improve sensitivity are becoming popular. At high transverse momenta, employing state-of-the-art jet reconstruction and decomposition techniques known as jet substructures, show potential to transform these channels as promising search channels for the standard model Higgs boson. I have been looking into $Z(\nu\nu)H(bb)$ channel implementing the jet substructure techniques and the analysis is heading for completion by the summer conferences.

- Dijet Angular Distributions and Search for Quark Compositeness in pp Collisions (*PRL* **106**, 201804 (2011), *JHEP* **05** (2012), 055):

At large momentum transfers, dijet production has the largest cross section of all processes at a hadron collider and therefore directly probes the highest energy regime. It can be used to test the standard model of particle physics at previously unexplored small distance scales and to search for signals predicted by new physics models. The angular distribution of dijets with respect to the hadron beam direction is directly sensitive to the dynamics of the underlying reaction. I studied the dijet angular distributions measured over a wide range of dijet invariant masses in proton proton collisions at a center of mass energy of 7TeV, at the LHC. The data are found to be in good agreement with the predictions of theory and there is no evidence of a new physics such as quark compositeness model. We also set a lower limit on the contact interaction scale for left-handed quarks at the 95% confidence level. At the time of publication, this limit was the most stringent limit in the world.

In addition, I have contributed to the **Detector Performance Measurements** for CMS.

- Track and Vertex reconstruction using only pixels (CMS PAS TRK-12-001):

The precise and efficient determination of charged particle momenta and primary vertex position are crucial for many physics measurements of CMS. These impact the ability to reconstruct leptons, charged hadrons, jets, and photon conversions and provide an important tool to separate the interesting hard interactions from the huge background. The Pixel detector of CMS provides high resolution, three-dimensional space points allowing for precise pattern recognition. With three pixel hits per charged particle, using only the pixel data tracks can be reconstructed and primary vertices can be found. Such pixel-only track reconstruction is useful for track seeding, primary vertex finding and in a variety of High Level Trigger (HLT) algorithms. I am one of the key contributors in understanding the tracking and vertexing performance of the CMS pixel detector. The paper is pre-approved for publication.

- Studies of Pileup Effects on Missing transverse energy (MET) reconstruction (CMS AN-2011/297, CMS AN-2012/073):

In the course of taking more data the CMS detector has measured a much increased pileup contribution, due to the high instantaneous luminosity of LHC from the year 2010 to 2012. These high pileup interactions degrade the MET measurement in CMS. I developed tools to reduce the

effect of pile up on MET, using the timing information of the electromagnetic calorimeter, thereby improving MET resolution. This tool will benefit the collaboration at large.

- Remote Operations (Data Quality Monitoring shifts):

I take the Data Quality Monitoring (DQM) shifts for CMS from the Remote Operation Center at Fermilab.

August 2004 - August 2009:

As a graduate student at Tata Institute of Fundamental Research and as CMS visitor to Fermilab LPC I worked in the CMS experiment at the LHC focusing on test beam activities of Hadron Calorimeter and Quantum Chromo Dynamics (QCD) with CMS simulations.

- Multijets study in CMS (CMS AN-2009/073):

I have been involved in the study of topological variables in inclusive three and four jet events to test the validity of the QCD theory and to tune the event generators used in CMS to describe data. These variables provide crucial tools to study the amount of gluon radiation and the details of hadronization process and give the sensitivity to measure the strong coupling constant.

- Analysis of test beam data in CMS (CMS NOTE-2008/020, CMS NOTE-2008/025):

Before the start of the LHC we were doing tests on various parts of the detector to understand their performance. This experience helped us tuning our Monte-Carlo simulation to describe the data as precisely as possible. In the summer of 2007, a slice of the CMS calorimeter was tested at CERN test beam facility with different beams with known momenta ranging from 1GeV/c to 300GeV/c. I worked with that data to calibrate parts of the calorimeter system and studied the response and resolution of the hadron calorimeter. I worked on the physics validation with Geant4 simulation in order to better tune the Monte Carlo with physics data.

I took part in on site test beam operation shifts at CERN's test beam facility during the calorimeter test beam shifts in 2006 and 2007.

2000 - 2004:

Before joining the Ph.D. program I did two short projects (as an M.Sc. student in Cambridge, UK, and as a B.Sc. student in Kolkata, India) that resulted in publication. I describe in brief the main outcomes of these two works.

- Neutrino mass implication of the K2K experiment (Journal of Physics G: Nuclear and Particle Physics **29**, 1069-1074 (2003)):

The first results presented by the K2K experiment on the observation of muon neutrinos showed depletion consistent with the neutrino oscillations with a mass splitting in the range favored by the Super Kamiokande atmospheric neutrino measurements. I examined the extent by which the range of mass splitting obtained from the K2K measurements can vary due to various uncertainties.

- Two time correlation for a noise driven double-well oscillator in the Suzuki regime

(Physica A: Journal of Statistical Physics 310, 85-90 (2002)):

We found that, for a clearly out-of equilibrium situation characterized by the Suzuki regime in a double-well oscillator, either the spherical limit or the leading order summation of all diagrams provide a significantly better description of the two time correlation than the mode-coupling approximation.

Technical accomplishments (Hardware experience):

2009-2010:

- Tests of radiation-hard sensors for the SLHC:

At the Super LHC (LHC upgrade scenario), after 2500 pb⁻¹ of data, the expected maximum fluence for the pixel region (<20 cm) will be 2.5 x 10¹⁶ cm⁻². To cope with this unprecedented radiation environment, there have been quite a few collaborations being formed at CERN to find possible solutions for vertex and tracking detectors at the SLHC. A variety of solutions have been pursued. These include diamond sensors, 3D sensors, MCZ planar silicon detectors made from MCZ wafers, epitaxial, p-type silicon wafers and thin silicon detectors. In the Fermilab Meson Test Beam Facility (MTest), the performance of various sensors that are radiation hard and viable candidates for use in the innermost vertex detector for the SLHC environment, are studied. I participated in the Pixel Test Beam activities at Fermilab.