

# Shyam Kumar

# Curriculum Vitae

**Contact:** Hostel 13A, 605, IIT Bombay,

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**Born:** 06-03-1990

**Nationality:** Indian

**Sex:** Male

## Education

**PhD in Physics**, Indian Institute of Technology, Bombay 2017

**Supervisor:** Prof. Raghava Varma, IIT Bombay

**Thesis Title:** Growth, Characterisation and Simulation for using diamond as a detector material in HEP Experiments and Measurement of D meson azimuthal correlations with charged particles in p-Pb collisions at  $\sqrt{s_{NN}} = 5.02$  TeV with ALICE

**Masters in Physics** 2012

IIT Bombay, Mumbai

**B.Ed. (Education)** 2010

DayalBagh Educational Institute, Agra,  
Deemed University

**B.Sc. (Maths)** 2008

DayalBagh Educational Institute, Agra,  
Deemed University

## Research Experience

Summary of the last 6 years of research activity from my masters onwards:

### 1. Hardware

- Microwave Plasma Chemical Vapour Deposition (MPCVD) system for growth of diamond films 2012-2017

We work on application of synthetic diamond as a radiation-hard semiconductor for particle physics experiments. I have set up a MPCVD system for the growth of diamond films. I have optimized the system through design and fabrication. The system allows long term stability of the plasma (tried up to 8 days) which enables us to grow high quality films with large thickness (300  $\mu\text{m}$  to 1 mm).

- Growth of **Single crystal and Polycrystalline diamond film** by MPCVD process in Laboratory 2012-2017

I have grown the diamond film by homoepitaxy on HPHT (100) diamond substrate and also on CVD diamond substrate. Later the grown film is removed by laser cutting in a company and polished on diamond coated wheel. I have also grown the film by heteroepitaxy on Si (100) substrate, which requires pretreatment before growth. The film is grown up to 300  $\mu\text{m}$  thickness on silicon substrate.

- Characterisation of diamond film by using current voltage (I-V), capacitance voltage

(C-V) characteristics and **Transient Current Technique (TCT) measurement** 2016-2017

I have done the characterization of diamond films (grown, commercial and also electronic grade) by X-ray diffraction, Raman spectroscopy, Atomic force microscopy, Scanning electron microscope image, Time of Flight-SIMS (Secondary Ion Mass Spectroscopy), I-V characteristic, C-V characteristic and TCT measurements.

## 2. Software and Physics

- **Microwave Plasma simulation** and design of resonant cavity for the growth of diamond film 2014-2017

For understanding the Microwave plasma, I have performed the simulation in COMSOL and in Computer Simulation Technology (CST). I have simulated the E-field and H-field and S-parameter for the design. This plays an important role in the stability of plasma. I have designed both TE and TM both type of resonant cavities for microwave of frequency 2.45 GHZ. I have also tried to do it for 915 MHZ where will get large size of plasma but due to lack of time, I have skipped that.

- Comparison of **Radiation damage for Si,Ge, GaN and Diamond** using simulation package SRIM and FLUKA 2014-2017

For understanding of radiation damage, I have simulated the Ionizing radiation dose and also the number of Frankel pairs in Fluka for Si,Ge, GaN and diamond. It was found that diamond is more radiation hard than others. I have performed the simulation by using USRBIN card and for cross checking the things, I have also matched the results with EVENTBIN card. In Fluka, I also have simulated energy loss for comparing the signal created by MIP, which is used to calculate charge collection efficiencies and also for estimation of signal to noise ratio.

- Experience in ROOT geometry writing and visualization of detector geometries and creating animations 2012-2016

I have experience to write the geometries used in HEP experiments. I can also visualize the detector geometries for any experiment by using GeoManager class and EventManager class.

- Six months service task done in ALICE on Coding convention checker using Static Analysis Suite package based on Clang and LLVM compiler coding 2015-2016

After joining the ALICE, I have performed the service task in ALICE on Coding convention checker using Static Analysis Suite package based on Clang and LLVM. It takes the functions of compiler and use them to check the conventions you want to follow for coding.

- Inclusion of **Photon Multiplicity Detector (Indian detector) in ALICE Event Display**, by creating a simplified geometry and also made the animation 2016

I have also included the PMD in event display as a service work. This requires understanding of the flow of data in ALICE for Event display. I have understood the flow, then created a simplified geometry (committed in ALIROOT) and then included it in ALICE event display and also made the animation for the Indian group to show

during the meetings or conferences.

- **Measurement of D<sup>+</sup>-hadron azimuthal correlations in p-Pb collisions at  $\sqrt{s_{NN}}=5.02$  TeV with ALICE** 2015-2017

The extension of two particle correlation studies to heavy-flavour would shed light on interaction of heavy quarks with the QGP medium. I started working in ALICE framework since January 2015. Initially, as a practice, I started working on D<sup>+</sup>-hadron azimuthal correlations in pp collision  $\sqrt{s_{NN}}=7$  TeV with ALICE. Later on, I worked on D<sup>+</sup>-hadron correlations in p-Pb collision at  $\sqrt{s_{NN}}=5.02$  TeV with ALICE. The results of my studies were recently approved by the Collaboration as ALICE Preliminaries. Currently, I have also performed centrality dependence study for D<sup>+</sup>-hadron correlations for which the results are approved by the Collaboration as ALICE Preliminaries and publication is foreseen in the coming months.

- **Simulation, Digitization, Material Budget and Event display of START detector in PANDA Experiment** based on double sided strips diamond sensors 2012-2014

I have started my research with PANDA experiment, which is under construction at GSI, in Darmstadt, Germany. I have worked on the implementation of a start detector based on double-sided strip sensors of diamond for the Forward time of Flight, which is supposed to give the start time with ps time resolution and will help in improvement of Particle Identification by time of flight method. In addition, it will also help in the reconstruction of charged particles. I have included this detector in PANDAROOT framework and performed dedicated simulations to obtain the Monte Carlo points and then implemented the digitization in which we get charge collected and hit position reconstruction etc. I have checked the material budget and also checked the radiation damage of the detector in the simulation. All the classes and macros are committed in the development branch of PANDAROOT.

## Research Visits

- Two Month CERN visit for taking shifts in data taking in ALICE experiment and Analysis work 2017
- Two Month CERN visit for the completion of Service task on Coding Convention Checker for ALICE O2 project 2016
- 42 Days CERN visit for doing service task, Photon Multiplicity Detector shifts in ALICE Control Room and Analysis work 2015
- Three months Visit to Forschungszentrum, Germany for Simulation Of START Detector Based On Diamond in PANDA Experiment 2013

## — Software Experience

**Languages:** FORTRAN, MATLAB, BASH SCRIPT, Python, C/C++, Weightfield2

**Data Analysis:** ROOT, PANDAROOT, ECLIPSE, ALIROOT, GEANT and FLUKA

**Others:** Linux, Windows, Highscore Plus, SRIM, Origin Pro, COMSOL, **Computer Simulation Technology (CST)** [mostly used for Accelerator Designing]

## — Schools, Workshops and Conferences

- Selected for **Young scientist with support granted by the Organising Committee** as the full waive of registration fee in Quark Matter-18, held in Venezia, Italy May 2018
- Selected in **2017 CERN-Fermilab HCP Summer School**, CERN with **funding support** Aug-Sep 2017
- Working as **Junior representative** of ALICE India Collaboration Group" March 2017
- Selected for **Young researcher grants** in Advanced Detectors for Nuclear, High Energy and Astroparticle Physics, Kolkata, India Feb 2017
- 27th RD50 Workshop on **Radiation hard semiconductor devices** for very high luminosity colliders, CERN, Switzerland Dec 2015
- SERC School on Nuclear Matter under Extreme conditions, VECC, Kolkata, India Jan 2013
- Selected in Summer Students Visiting Programme (**SSVP-2011**) in Institute of Physics, Bhubaneswar, India May-June 2011
- Selected in Mathematics Training and Talent Search (**MTTS-2007**) Programme held in Panjab University Chandigarh, India May-June 2007

## — Teaching

- Supervised and evaluated Undergraduate and Masters level nuclear physics and instrumentation lab course for 3 semester at IIT Bombay 2014-2016
- Supervised summer students on growth of Diamond film and characterisation 2015
- Supervised and evaluated undergraduate and masters level Condensed matter physics lab for two semester at IIT Bombay 2014
- Supervised and evaluated Undergraduate first year lab for a semester at IIT Bombay 2013
- Supervised and evaluated Preparatory lab course for a semester at IIT Bombay 2012
- Supervised and evaluated Electronics lab Analog and Digital for two semester at IIT Bombay 2012

- Teaching General Physics laboratory course for a semester at **IIT Goa** 2018

## Poster and Presentations

- Poster "Measurement of D meson azimuthal correlations with charged particles in p-Pb collisions at  $\sqrt{s_{NN}} = 5.02$  TeV with ALICE", **presented in Quark Matter** held in Venezia, Italy (May 2018)
- Talk "Diamond as the future material for High Energy Physics Experiments", "NSPDI-2017", TIFR, Mumbai, India (October 2017)
- Talk "Comparison of Silicon, Germanium and Diamond sensors for Using it in HEP Detector Applications", "Advanced Detectors for Nuclear, High Energy and Astroparticle Physics", Kolkata, India (Feb 2017)
- Poster "Comparison of Si, Ge and Diamond Sensors as Trackers in Collider Experiments, DAE-HEP, organised at Delhi University, India (2016)
- Poster "Comparative Study of Radiation damage in Si, Ge and Diamond used as Detector", Proceeding of DAE Symp. on Nucl. Phys. 61 (2016), organized in SINP, Kolkata, India (2016)
- Talk "Diamond as the future material for Detector Applications in HEP", SYMPHY organized in IIT Bombay, Mumbai, India (2015)
- Poster "Material budget study for Lambda disks with Silicon and Diamond sensors in PANDA Experiment", in DAE-HEP organized in IIT Guwahati, India (2014)
- Talk "Growth of Diamond film by MPCVD Process for Detector Applications", in DAE-HEP organized in IIT Guwahati, India (2014)
- Poster "Development of ultrafast radiation hard diamond detectors for particle physics applications", Proceedings of the DAE Symp. on Nucl. Phys. 59 (2014)
- Poster Fabrication and Characterization of Diamond Radiation Detector as an Alternative to Silicon Detectors, Proceedings of the DAE Symp. on Nucl. Phys. 58 (2013), organized in BARC, Mumbai, India (2013)
- Poster Growth of Diamond by MPCVD Process, Proceedings of the DAE Symp. on Nucl. Phys. 58 (2013), organized in BARC, Mumbai, India (2013)
- Talk "Semiconductor Detectors", 2nd DST-SERC School organized at VECC Kolkata, India (2013)

## Publications

1. Shyam Kumar and Raghava Varma, Comparison of Silicon, Germanium and Diamond Sensors as Trackers in Collider Experiments, XXII DAE High Energy Physics

- Symposium. accepted as Proceedings in Springer International Publishing AG (2018)
2. Bilal Ahmad Reshi, Shyam Kumar, Moses J. Kartha, and Raghava Varma, Surface smoothening effects on growth of diamond films, American Institute of Physics Conference Proceedings 1942, 060027 (2018)
  3. Shyam Kumar et al., Comparison of Si, Ge, and Diamond Sensors for Using It in HEP Experiments, Advanced Detectors for Nuclear, High Energy and Astroparticle Physics. Springer Proceedings in Physics, vol 201. Springer, Singapore (2018)
  4. Shyam Kumar\*, Comparative Study of Radiation damage in Si, Ge and Diamond used as Detector, Proceeding of DAE Symp. on Nucl. Phys. 61, 1076, India (2016)
  5. M.Jadhav\*, S. Kumar, K. Das Gupta, and R. Varma, Development of ultrafast radiation hard diamond detectors for particle physics applications, Proceedings of the DAE Symp. on Nucl. Phys. 59, 842, India (2014)
  6. Manoj Jadhav\* and Shyam Kumar, K. Das Gupta, D. S. Misra, P. Sarin, R. Varma, Fabrication and Characterization of Diamond Radiation Detector as an Alternative to Silicon Detectors, Proceedings of the DAE Symp. on Nucl. Phys. 58, 872, India (2013)
  7. Shyam Kumar et al., Growth of Diamond by MPCVD Process, Proceedings of the DAE Symp. on Nucl. Phys. 58, 920, India (2013)
  8. "Measurement of azimuthal correlations of D mesons with charged particles in pp collisions at  $\sqrt{s} = 7$  TeV and p-Pb collisions at  $\sqrt{s_{NN}} = 5.02$  TeV", Eur.Phys.J. C77 (2017) no.4, 245 (2017)
  9. "D-meson production in p-Pb collisions at  $\sqrt{s_{NN}} = 5.02$  TeV and in pp collisions at  $\sqrt{s} = 7$  TeV", Phys.Rev. C94 no.5, 054908 (2016)
  10. "D-meson production versus multiplicity in p-Pb collisions at  $\sqrt{s_{NN}} = 5.02$  TeV", JHEP 1608 (2016)

## References

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5. Barbara Trzeciak, Nikhef National institute for subatomic physics (NL)(ALICE)  
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