

# Ankur Agrawal

## Curriculum Vitae

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### Interests

Experimental High Energy Physics, Solid State Physics, Spintronics and Superconductors

### Education

2011-2016 **B.Tech and M.Tech in Engineering Physics with Specialization in Nanoscience**,  
*Indian Institute of Technology Bombay*,  
Cumulative Performance Index : 8.11/10 after 9 semesters.

### Teaching Experience

- Ongoing **Digital Electronics Lab (EP 230)**,  
*Tutoring 42 students for senior lab in FPGA programming; designing lab assignments, solving experimental and theory doubts, and evaluating papers.*
- Fall 2015 **Analog Electronics Lab (EP 223)**,  
*Tutoring 42 students for senior lab; designing lab assignments, solving experimental and theory doubts, and evaluating papers.*

### Master's Thesis

- Ongoing **Silicon Detector Fabrication**,  
*Department of Physics, IIT Bombay.*  
Guided by: *Prof. Raghava Varma*

I have completed a research literature survey spanning physics, various technological methods and geometries of silicon detector fabrication. I designed and optimized the pad geometry using simulation tool SILVACO, to obtain the desired device characteristics. Also, learnt a layout editor software **CleWin 5** to design a multi-layer photomask for lithography patterning. Currently, optimizing the dopants profile to maximize the sensitive region by varying anneal time and performing **SIMS** analysis; learnt **Clean Room** fabrication methods to build a prototype of silicon pad and a strip detector. We intent to enrich the oxygen content of standard silicon by diffusion of oxygen from a thick oxide layer to increase the radiation hardness. The device will be integrated with the read-out board (FPGA) to carry out the characterization at IIT Bombay and the particle beam testing at **CERN**. This prototype will be a part of the Forward Calorimeter (FoCAL) detector, upgrade in **ALICE** experiment.

### Internships and Research Experience

- Summer 2015 **Study of Radiation Damage in Silicon Detectors**,  
*Research Internship, Utrecht University.*  
Guided by: *Prof. Thomas Peitzmann & Prof. Marco van Leeuwen*
- This involved learning new simulation frameworks, **Geant4 & Fluka** to simulate the particle transport in a material and collide proton-proton at centre of mass energy of 13 TeV using Pythia generator. I learnt the ALICE (AliROOT) framework and integrated FoCAL detector geometry with the existing ALICE detector to score relevant quantities like incident kinetic energy of particles and the energy deposited (dose). I built a computational framework using Non-Ionizing Energy Loss (NIEL) hypothesis and **ROOT** to estimate 1 MeV Neutron Equivalent fluence and the dose by different particles. The results from my study (both, Geant4 and Fluka) predicts the FoCAL detector to be safe from radiation damage for the LHC Run2.

Spring 2015 **MPCVD Diamond Detector.**

Guided by: *Prof. Raghava Varma*

Diamond is looked upon as the future material for detectors, replacing silicon due to its radiation hardness and fast response. It involved comprehensive literature survey of Diamond like band-gap, Charge Collection Efficiency (CCE) from the research conducted by RD 42 Collaboration at CERN. We implemented the Diamond detector geometry and defined Diamond as a material to perform the simulations using SILVACO. Based on the results, we are using a Microwave Plasma Chemical Vapor Deposition (MPCVD) apparatus and currently, optimizing process parameters like temperature, pressure and microwave modes for making 300  $\mu\text{m}$  thick diamond films of high purity.

Fall 2013 **Cell Proliferation in a Tissue,**

*Supervised Learning Project, IIT Bombay.*

Guided by: *Prof. Anirban Sain*

Studied the coupled dynamical equations for cell density, velocity and polarity in order to understand the spreading pattern of a tissue. I understood and applied the concepts from Continuum elasticity theory and fluid mechanics to simplify the set of equations governing the spreading pattern and tried to simulate it using **MATLAB** to obtain the stable-point solutions.

Summer 2011 **Traveling Salesman Problem,**

*Web and Coding Club, IIT Bombay.*

Guided by: *Anil Shanbhag*

We applied a **genetic algorithm** to optimize the route that a traveling salesman should take, covering a given number of cities by traveling least distance. We mimicked **randomization, crossover, mutation and natural selection** to find near optimal solutions. The coding was done in Python.

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## International Competition

2012-2014 **Home Automation System,**

*Team Shunya, Solar Decathlon Europe 2014, France,*

Solar powered building design competition patronized by US Dept. of Energy; selected among top 20 teams from 16 countries; multidisciplinary team consisting of 36 students.

Faculty Advisor: *Prof. Rangan Banerjee*

We did an extensive market survey of the commercially available automation systems based on their customisability, affordability and energy efficiency. Recruited a team of 3 students to build an indigenous system which was affordable, energy efficient and modular. We developed our own **Load Shedding Algorithm** to intelligently shift the heavy load to non-peak hours minimizing the electricity bill and wisely storing the solar energy produced during the day. Our algorithm helps in reducing the electricity consumption by **~24%**. Later, we partnered with **Ingersoll Rand** to develop and test automation system for commercial launch; developed a **web page** to remotely control home appliances.

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## Honours and Awards

- Awarded **Undergraduate Research Award (URA 01)** for exemplary research work in Radiation Damage 2015
- Awarded **Honourable Mention** for Sustainability, Solar Decathlon Europe'14, France 2014
- **Ranked 1** among the Dual Degree students of the Engineering Physics department at IIT Bombay for two consecutive years 2013 & 2014
- Awarded the **Institute Academic Prize** for academic excellence 2013 & 2014
- Secured **All India Rank 1493**, in IIT-JEE, taken by approximately 800,000 students 2011

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## Invited Talks and Presentations

Fall 2013 **Control Systems.**

(Talk) Home Automation System in a Solar Powered House, 4<sup>th</sup> *International Conference on Computing Communication and Networking Technologies (ICCCNT), Tiruchengode (India)*

Spring 2014 **Green Building.**

(Poster Presentation) Affordable Net Zero Energy Solar Powered House, *Techfest, IIT Bombay*

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## Seminars & Course Projects

### Fall 2013 **Quadrotor.**

Faculty Advisor: *Prof. Pradeep Sarin*

As a team of 7 students, we developed an Inertial Measurement Unit (IMU) algorithm to obtain fused data from an accelerometer, gyroscope & magnetometer for a Quadrotor. I was involved in simulating the gyro-magnetic sensors with the PID feedback loop to fine tune the roll, pitch and yaw motions of the quadrotor; project was implemented on an Arduino micro-controller.

### Fall 2014 **Accelerator Driven Sub-critical Reactors.**

Guided by: *Prof. Pradeep Sarin*

I completed a research literature survey in this field, including the technological development over the period. I summarized the work done by Prof. Carlo Rubia et al in the ADSR and its application in the thorium based nuclear power plants using the proton beam technology from PSI, Switzerland. It is a potential candidate to solve the energy crisis in India, given the huge reserves of thorium.

### Spring 2015 **Chemical Aspects of Semiconductor Nano-crystals.**

Guided by: *Prof. Senthil Kumar*

We presented latest chemical synthesis techniques employed to fabricate nano-crystals in the R&D field which are chemically pure, homogeneous and defects free with high degree of crystallinity. Techniques like Controlled precipitation in confined spaces, Molecular precursors route and Cluster building-up approach were discussed.

### Fall 2012 **Duffing Oscillator.**

Guided by: *Prof. Punit Parmananda*

We delivered a talk on non-linear duffing oscillator and discussed its mathematical form to find the solutions analytically. We simulated the non-linear differential equations and plotted phase-space diagrams using **MATLAB** to show the SDIC (Sensitive Dependence on Initial Conditions) behavior.

### Fall 2014 **Nanosphere Lithography (NSL).**

Guided by: *Prof. Parinda Vasa*

We studied the physical properties of Gold nanoparticles of different sizes and fabricated a mono-layer of Polystyrene (PS) beads and characterized the roughness parameter of the substrate using the **Atomic Force Microscopy** (AFM). The fabricated PS layers were used as a mask to prepare Gold nanoparticle layers using NSL technique.

### Fall 2014 **Photoluminescence (PL) Spectroscopy.**

Guided by: *Prof. Parinda Vasa*

We prepared CdSe Quantum Dots of different size using the stock solutions available and performed PL spectroscopy using **He-Cd laser** to characterize the physical and optical properties of QDs. Later, we calculated the band - gap of semiconductor QDs and its relation with particle size; shift in absorption and emission spectra was also analyzed and were consistent with known results.

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## Relevant Courses

### Mathematics.

- Data Analysis and Interpretation, Numerical Analysis, Multi-variable Calculus, Linear Algebra, Ordinary & Partial Differential Equations, Complex Analysis

### Physics.

- Applied Solid State Physics, Advanced Magnetic Materials, Superconductivity, Physics of Quantum Devices, Semiconductor Physics, Nuclear and Particle Physics, Non-linear Dynamics, Advanced Simulation Techniques, Statistical Physics, Methods in Analytical Techniques, Quantum Mechanics 1 & 2, Photonics, Continuum Mechanics, Classical Mechanics, Photonics, Electricity and Magnetism 1 & 2, Modern Physics. Nanotechnology courses

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## Positions of Responsibility

### 2012-2014 **Deliverable Head, Team Shunya.**

- Planned and coordinated with **10 sub-teams** to produce deliverables for organizers and **25** sponsors against a budget of **USD 0.5 Million**; also responsible for collating and designing template of Project Manual.

2012-2014 **Social Media Manager, Team Shunya.**

- Established **Social Media Campaign** via creating Facebook page, twitter account to create awareness among the common people about sustainability and alternate sources of energy.
- Initiated and conducted 12 “**audit workshops**” targeting 1500 school children to teach sustainability and energy efficiency concepts.

2012 **Coordinator, Mood Indigo.**

- Initiated and executed first **Spell Bee competition** at Mood Indigo, the annual cultural festival of IIT Bombay; more than 500 students participated and two **Guinness World Records** were set.

## Technical Skills

### Languages.

- C, C++, Python

### Software.

- MATLAB, ROOT, CleWin, Mathematica,  $\text{\LaTeX}$ , Origin, GEANT, FLUKA, Adobe InDesign & Photoshop, SketchUp, MS Office

### Hardware.

- Arduino, ZigBee, BeagleBoard

### Others.

- Undergone **Clean Room** training for nanofabrication, learnt handling of photolithography (DSA), ellipsometry, laser writer, annealing and chemical etching
- Undergone certified training for machine-tools used in construction

## Extracurricular Activities

- First Runners up, Freshers English Debate Championship, IIT Bombay
- Winner, Freshizza Literary Arts Award and participate in on-campus literary club events
- Enthusiastic about learning new languages; learning German (organized by DAAD) and completed basic Chinese (organized by Beijing University) certified course
- Enjoy cooking and aspire to own a restaurant; play squash, bike and swim in my free time

## References

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| ◦ Raghava Varma<br>Professor/ Principal Investigator<br>IIT Bombay<br>varma@phy.iitb.ac.in | ◦ Thomas Peitzmann<br>Professor/ Principal Investigator<br>Utrecht Univerity<br>T.Peitzmann@uu.nl |
| ◦ Marco van Leeuwen<br>Professor<br>Utrecht Univeristy<br>M.vanLeeuwen1@uu.nl              | ◦ Anirban Sain<br>Professor<br>IIT Bombay<br>asain@phy.iitb.ac.in                                 |
| ◦ Avinash Mahajan<br>Professor<br>IIT Bombay<br>mahajan@phy.iitb.ac.in                     |   |