IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Development of wide bandgap semiconductors as Novel Proton Monitors for the COMET experiment at J-PARC**	
Project Number	**IMURA0840**	
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Research Clusters:

Highlight which of the Academy's CLUSTERS this project will address? *(Please nominate JUST **one.** For more information, see www.iitbmonash.org)*	
1	*Material Science/Engineering (including Nano, Metallurgy)*
2	*Energy, Green Chem, Chemistry, Catalysis, Reaction Eng*
3	*Math, CFD, Modelling, Manufacturing*
4	*CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control*
5	*Earth Sciences and Civil Engineering (Geo, Water, Climate)*
6	*Bio, Stem Cells, Bio Chem, Pharma, Food*
7	***Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng***
8	*HSS, Design, Management*

Research Themes:

Highlight which of the Academy's Theme(s) this project will address? *(Feel free to nominate more than one. For more information, see www.iitbmonash.org)*	
1	***Advanced computational engineering, simulation and manufacture***
2	*Infrastructure Engineering*
3	*Clean Energy*
4	*Water*
5	***Nanotechnology***
6	*Biotechnology and Stem Cell Research*
7	*Humanities and social sciences*
8	Design

The research problem

Develop a radiation hard semiconductor device for use in ionizing radiation detection in particle physics, with possible spinoffs in other areas like space-borne instrumentation, medical device physics etc.
Most silicon based semiconductor detectors used so far in the above applications suffer from performance degradation in terms of decreased signal response and/or worsening timing etc as they are exposed to higher levels of radiation.

The COMET experiment aims to measure Charged Lepton Flavour Violation (CLFV) in the direct decay of a muon into an electron in the field of an atomic nucleus. This decay is highly suppressed in the Standard Model of Particle Physics (SM) and its observation would be an indication of new physics beyond the SM. COMET aims to improve the limits on this reaction by a factor of 100 in its first phase of operation. In order to perform this measurement, COMET needs to produc a very large number of muons, which is accomplished using an intense proton beam which is steered into a graphite target producing pions which subsequently decay into muons. Monitoring the proton beam will be a critical part of ensuring the success of the COMET experiment.

Project aims

This thesis will be focused on investigating the properties of some novel wide bandgap materials as an alternative to silicon with the aim of (1) faster baseline response than silicon and (2) much higher tolerance to large doses of radiation. Associated readout electronics for such devices would typically be different than the ones traditionally used for silicon. Hence development of such readout electronics would also fall within the scope of the thesis including developing and testing Proton beam monitor hardware prototypes, software for readout and data acquisition from beam monitors, and software for simulation of beam monitors. There will also be an opportunity to commission the beam monitor system at J-PARC

Expected outcomes

A wide bandgap semiconductor that can be used for monitoring intense proton beams in a high radiation accelerator environment and act as a successful proton beam monitor system to be deployed in COMET. There would also be an opportunity to participate in the COMET physics program.

How will the project address the Goals of the above Themes?

Development of new semiconductor technology using the joint intellectual and infrastructural synergy between IIT Bombay and Monash University

Capabilities and Degrees Required

Masters degree in Physics or M.Tech. in Electrical Engineering.
Hands-on experience with RF electronics instrumentation is a necessary pre-requisite for this position.
A Master's degree in Physics in India would not usually cover adequate level of particle detector physics applications, hence and student with MTech in EE with a desire to apply their knowledge to particle physics applications is preferred.

Potential Collaborators

Prof. Apurba Laha, Department of Electrical Engineering, IIT Bombay
Monash Center for Nanofabriaction.

Select up to **(4)** keywords from the Academy's approved keyword list **(available at http://www.iitbmonash.org/becoming-a-research-supervisor/)** relating to this project to make it easier for the students to apply.

Semiconductor technology, Nanofabrication, RF instrumentation, Particle physics