



Project Proposal for Ph.D.

Project Details (The research problem must clearly indicate the need for an interdisciplinary approach)	
Project Title	Design, Development, and Thermo-Electrical Characterization of Superconducting Persistent-Current Switches for Whole-Body MRI Magnet Systems
Project Summary (Minimum 500 and maximum 2000 characters)	The development of an indigenous whole-body Magnetic Resonance Imaging (MRI) scanner requires several critical technologies associated with the superconducting MRI magnet system. The superconducting persistent-current switch (PCS) is a crucial component for achieving persistent-mode operation, ensuring high temporal stability of the magnetic field during clinical imaging. Many technologies associated with commercial MRI magnets remain proprietary and are controlled by international manufacturers. Indigenous development of superconducting switches will address this technological gap and strengthen India's self-reliance in MRI technology. The primary coils of MRI magnets generally use NbTi superconductors embedded in a high-conductivity copper matrix, whereas superconducting switches employ NbTi filaments embedded in a high-resistivity CuNi matrix. Although this configuration facilitates switching between superconducting and normal states, its limited thermal stability presents significant challenges in design and operation. The switch must operate reliably during magnet charging and discharging and enable the transition to persistent mode with minimal current decay. Its thermal, electrical and switching characteristics are therefore critical to magnet performance and field stability. This project aims to design, simulate, develop and characterize indigenous superconducting switches for whole-body MRI magnets employing liquid-helium bath-cooled and conduction-cooled configurations. The key objectives are: (i) electromagnetic and thermal simulation, design optimization and performance prediction; (ii) development of superconducting switches for different MRI magnet configurations; (iii) Design and development of a dedicated 4 K test facility; and (iv) experimental characterization of thermal, electrical and switching responses under representative operating conditions. The project requires interdisciplinary collaboration between the Physics Department at IIT Delhi, with expertise in superconductivity, and the Cryogenics and Applied Superconductivity Laboratory at IUAC, New Delhi, with expertise in cryogenic engineering and superconducting magnet systems. By integrating superconductivity physics, electrical engineering and cryogenics, this collaboration will establish indigenous capability in a critical MRI magnet technology, reduce dependence on imported components and support the development and commercialization of whole-body MRI systems in India.

Ph.D. Supervisors+ (Supervisor 1 and Supervisor 2 cannot be from the same department of IITD)				
Role	Name of Faculty	Date of Superannuation ^{\$} (DD/MM/YYYY)	Academic Unit in IITD/Institute/University	Email ID (Official) & Contact Number
Supervisor 1*	Dr. Sujit Manna	30/10/2048	IIT Delhi, Physics	smanna@physics.iitd.ac.in

Supervisor 2	Prof. Satyabrata Patnaik	02/05/2034	School of Physical Science,JNU	spatnaik@mail.jnu.ac.in
Supervisor 3	Dr. Soumen Kar Scientist-G,	31/07/2033	Inter- University Accelerator Centre (IUAC Delhi)	soumen@iuac.res.in

*Supervisor 1 must be from IIT, Delhi.
 +All cells in this table are mandatory fields that need to be filled by faculty for consideration of proposal.
 \$The date of superannuation of supervisors should be at least three years from the date of registration of selected candidates.

Project requirements (Student qualifications, experience required, etc)
 *The candidate will be shortlisted based on common shortlisting criteria decided by ScRC (SIRe)

- Essential Qualification:**
 M.Sc in Physics or MS (Physics Research) from a recognized university or equivalent with first class degree.
- Desired Qualification:**
 Candidate with valid GATE score/ NET score / Inspire Fellowship/ working experience in the field of cryogenics, low temperature physics and applied superconductivity/ having experience on FEA based simulation software like ANSYS, CAD software or Multiphysics software like COMSOLE

 Good technical writing skills.
 Ability to work both independently and collaboratively.

Source of fellowship/funding and project number
 (CSIR/UGC/DBT/ICMR/ICAR/NEET-PG/DST-INSPIRE/IRD/FITT Project details, if any)

Ministry of Electronics and Information Technology (MeitY) Project: No.1(1)/2026-Me&HI; start dated 12/03/2026 (for five years)

Role of Faculty Members involved:	
Supervisor-1	Provide necessary guidance in engineering of the using superconductor thinfilms, design superconducting components for the project
Supervisor-2	Prof. Patnaik will complement his expertise towards topological superconductor crystals and magneto-transport characterization of the switches
Supervisor-3	Provide necessary guidance in design and development of 4K test rigs Provide guidance in testing of superconducting persistent switches using 4k test rigs and IUAC

- Note :-**
- Approval from the respective DRC/CRC/ScRC of your Department/Centre/School will be required for using the "Full-time Institute Assistantship (Category-wise) (FIA)" for selecting the students in SIRe.
 - Declaration:-** Faculty members, please ensure that you have at least 3 years of service left before superannuation along with adequate sitting space & lab facilities for the SIRe student.
 - PI/s are also encouraged to submit joint proposals with AIIMS, NII, JNU and institutes with which IITD has an existing MoU. If the Co-PI (Supervisor 2) is from outside IITD, kindly share his/her detailed CV.
 - If a research scholar is to be considered for selection under the project fellowship, then the project should have a minimum of two-year duration remaining.
 - A candidate applying with a valid JRF/INSPIRE/any national level fellowship should have at least two-year validity from the date of joining the Ph.D. program.
 - The third supervisor’s name (if required) can be added only after the formation of Student Research Committee (SRC) subject to a strong recommendation of SRC and subsequent approval from the competent authority.
 - If institute fellowship is being sought then the DRC approval of the parent departments of both supervisors is required at the time of selection.