COMPANY	SuperGrid Institute
FIELD OF ACTIVITY& PRODUCTS	R&D company focused on advanced electricity transmission technologies, particularly high-voltage direct current (HVDC) and medium-voltage direct current (MVDC) systems. Its mission is to support the energy transition by enabling large-scale integration of renewable energy and developing the future "supergrid" electricity networks.
JOB REQUEST	Thesis (PhD) - Combined Experimental and Digital Twin Approach for Assessing the Degradation of Si-IGBT and SiC-MOSFET Modules in Railway Traction Converters W/M
LOCATION	Villeurbanne (France)
MISSION	The R&D team at SuperGrid Institute, in collaboration with Alstom and with the support from Politecnico di Torino (Italy), is offering an exciting research work part of the POWERDIAG project, funded by the French National Research Agency (ANR). The development of advanced conditions and health monitoring functions for power electronics converters used in railway traction relies on validated and robust lifetime models for each degradation mechanism, robust algorithms for the prediction of Remaining Useful Life (RUL) and trained Digital Twins. The validation of these approaches is challenging because they must be implemented in the early design phase while their benefits are expected in the long term (a railway converter is designed for 30 years typically) with no possibility to run test without acceleration factors. As a consequence, dedicated methodologies and test benches must be developed in order to generate the necessary datasets to support the validation activities. Supergrid Institute has developed a multi-stress test bench combining accelerated load cycling stress with hard switching under high voltage, high current conditions to be as close as possible to the real application conditions. Phenomena at different time scale are reproduced on this test bench (from semi-conductor switching (#10 µs) to reproduction of a railway use profile in the minute range). This test bench is extensively instrumented (Vce, Vce sat, I load, I switch, Vge, Tcase, Tjunction, ...). A new test bench with higher current and voltage capabilities will be designed during the project to perform Power Cycling Test (PCT) and also Short-circuit stress, for Si IGBT but also SiC MOSFET. In this context, the PhD candidate will be responsible to diagnose the state of health and prognose the remaining lifetime of SiC Mosfet and Si IGBT in the context of Railway Traction Converters by combining experimental data with a digital twin. A specific focus will be made on a multi-stress test plan to maximize the learnings in the context of railway power modules. Also, a digital twin of the power module will be developed and used both to optimize the test plan and to simulate long term degradation. This thesis aims to provide answers to the following key questions: 1. In the context of railway traction applications, what are the specific electrical, thermal, and mechanical stresses experienced by power modules, and what degradation mechanisms are expected to lead to their failure? 2. How to design an appropriate accelerated multi-stress test plan that considers the relevant combinations and magnitudes of stressors, while incorporating the statistical variability of the influencing factors? 3. How to choose, measure and extract the relevant data-set from the accelerated ageing tests to train the Digital Twin (data volume vs precision) ? 4. How can the test plan be optimized for a given technology, considering the industrial need to minimize the number, duration, and cost of tests while maintaining their relevance?

	5. How can a digital twin of the power module be designed, parameterised, and validated so that it can interpolate and extrapolate test conditions, and simulate long-term degradation caused by a typical railway mission profile?
DURATION	3 years
REQUIRED SKILLS	• Electrical engineering and power electronics, in particular : - Signal processing, metrology, sensors and instrumentation - Physics of ageing mechanisms • Aptitude for experimental work - Operation of test benches - Development of measurement methods (digital and analogue electronics) • Knowledge in system modeling, component reliability, and statistical processing of experimental data • Fluency in French and English
REQUIRED EDUCATION	Degree in Electrical Engineering, specialising in Power Electronics. Knowledge of semiconductor physics would be appreciated.
REQUIRED EXPERIENCE	
REQUIRED TRAVEL	Possible mobility to Politecnico di Torino (Italy) 1 month/year
Wage/Salary	38 k€ (1st year) -39 k€ (2nd year) -40 k€ (3rd year)
Others	
CONTACT	https://www.supergrid-institute.com/fr/ Hiring section