



# PhD in INGEGNERIA ELETTRICA / ELECTRICAL ENGINEERING - 39th cycle

**PNRR 117 Research Field: CONTROLLED INTERRUPTION OF DC ARC IN AIR FOR HIGH CURRENTS**

Monthly net income of PhDscholarship (max 36 months)
<b>€ 1400.0</b>
In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
<b>Motivation and objectives of the research in this field</b>	<p>Design DC power distribution require components able to manage and cope with interruption of high DC currents. The needs to operate and protect DC circuits in nominal and fault conditions represent a common challenge in many areas and applications including power transmission and distribution, renewable energy systems, nuclear fusion and high-energy physics facilities, and others. Reliability and sustainability of the energy transition are among the motivations and goals to deeply investigate the “control of DC current interruption”:</p> <ol style="list-style-type: none"> <li>1. Grid Modernization: The modernization of power grids towards efficient and flexible grid architectures involves the combined integration of AC and DC circuits to improve efficiency and reliability in the energy distribution. DC current interruption research supports the development of smarter, efficient, and more sustainable grid architectures.</li> <li>2. AC/DC Power System Analysis: Understanding the transient behavior during interruption is crucial for designing reliable protection systems.</li> <li>3. Renewable Energy Integration: as renewable energy sources like solar and wind are DC power sources, efficient and reliable DC current interruption becomes important to integrate these sources into the grid.</li> <li>4. Support superconducting facilities and new energy source development: laboratories for nuclear fusion and high-energy physics require the development of new devices capable of interrupting high-intensity direct currents both for auxiliary circuits as well as EMAG</li> </ol>



	<p>plasma confinement and particle accelerations.</p> <p>5. Reliability and Safety Enhancement: Interruption of DC currents is crucial for safety and protection against electrical faults, short circuits, and overloads. Ability in monitor and diagnostic DC apparatus behavior is a crucial knowledge to design and release reliable grid components.</p> <p>The goals of the research are in line with the following objectives outlined in the current Italian National Recovery and Resilience Plan (PNRR):</p> <ul style="list-style-type: none"> <li>- Mission 1 (Digitalization, Innovation, Competitiveness, Culture, and Tourism), objective M1C2 (Digitalization, Innovation, and Competitiveness in the Production System).</li> </ul> <p>The research directly aligns with the PNRR's focus on innovation and competitiveness in the production sector. The development of innovative solutions for managing DC outages will contribute to the improvement of industrial processes, fostering economic growth and global competitiveness.</p> <ul style="list-style-type: none"> <li>- Mission 2 (Green Revolution and Ecological Transition), objective M2C2 (Renewable Energy, Hydrogen, Network, and Sustainable Mobility).</li> </ul> <p>Exploring ways to manage DC outages will actively support Italy's transition to renewable energy sources and sustainable mobility. The results could have a direct impact on the integration of renewable energy systems and the development of resilient energy grids, in line with the PNRR's green revolution objectives.</p>
<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<p>Multiphysics modelling (physical, electrical, magnetic, mechanical...) of DC electrical arc in air are part of the methods and techniques that will be used during the research.</p> <p>Theoretical models definition, parameters calculation/estimation from literature and/or experimental laboratory measurements on scaled down demonstrators as well as study and analysis of DC air breaker interaction with electrical power circuit are parts of the candidate activities.</p> <p>The cooperation with ABB will allow to strength the</p>



	research with information on MV DC apparatus/prototypes and extend the initial models and findings to higher voltage ratings.
<b>Educational objectives</b>	To prepare researchers with high scientific qualifications and research capabilities in the area of DC arc interruption diagnostics and control: this includes specific skills in physical phenomenon modeling, simulations, critical analysis and validation of results.
<b>Job opportunities</b>	The main job opportunities generally come from DC switch manufacturers, such as the industry partner ABB, a multinational company with several subsidiaries. In addition, there are promising options within companies and research centers engaged in applications where substantial DC interruption is a technological challenge (e.g., distribution system operators such as Enel-distribuzione, EDF Distributie, RWE, E.ON, Iberdrola Distribución Eléctrica, etc., and research laboratories with superconductor facilities such as CERN and ITER).
<b>Composition of the research group</b>	2 Full Professors 7 Associated Professors 0 Assistant Professors 5 PhD Students
<b>Name of the research directors</b>	Prof. Gabriele D'Antona

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<b>Additional support - Financial aid per PhD student per year (gross amount)</b>	
<b>Housing - Foreign Students</b>	--
<b>Housing - Out-of-town residents (more than 80Km out of Milano)</b>	--

<b>Scholarship Increase for a period abroad</b>	
<b>Amount monthly</b>	700.0 €
<b>By number of months</b>	6



National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	ABB S.p.A.
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	Universidad Politécnica de Madrid Departamento de Ingeniería Eléctrica, Electrónica, Automática y Física Aplicada
By number of months abroad	6

**Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information**

**Educational activities:**

Financial aid per PhD student is available for purchase of study books and material, funding for participation in courses, summer schools, workshops and conferences, instrumentations and computer, etc. This amount is equal to 10% of the annual gross amount, for 3 years.

**Teaching assistantship:**

Availability of funding in recognition of supporting teaching activities by the PhD student. There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

**Computer availability:** individual use.

**Desk availability:** individual use.