



PhD in SCIENZE E TECNOLOGIE ENERGETICHE E NUCLEARI / ENERGY AND NUCLEAR SCIENCE AND TECHNOLOGY - 38th cycle

PNRR_352 Research Field: MULTIPHYSICS ANALYSIS OF SYSTEMS AND COMPONENTS IN NUCLEAR FUSION DEVICES

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

Context of the research activity	
<p>Motivation and objectives of the research in this field</p>	<p>Energy is today at the forefront of the World as well as of the European and Italian concerns, because of the emerging, new trilemma: global warming, strategic and geo-politic dependence, economic impact. The ecologic transition is one of the key pillars of the EU policies as well as of the Italian recovery plan (PNRR).</p> <p>Nuclear energy represents today almost 50% of the carbon-free electricity in EU and around 10% of total electricity consumption in Italy. According also to IPCC reports, the CO2 equivalent emissions per kWh produced for nuclear are equivalent to wind power and lower than photovoltaic.</p> <p>In such a framework, fusion energy is the most promising solution of CO2-free, reliable and programmable energy supply in the long run (2050).</p> <p>Moreover, fusion does not present concerns in terms of safety and environmental impacts beyond greenhouse gases.</p> <p>The Italian industrial supply chain in the fusion energy sector, where Ansaldo Nucleare is a leading company, is active and highly competitive, representing the second Country (after France) in the world ranking about number and total amount of contracts won for the construction of ITER fusion reactor plant in Cadarache (FRA).</p> <p>Moreover, Italy is building a new, world-class facility (DTT - Divertor Tokamak Test) to support fusion energy</p>



	<p>development.</p> <p>For the above-mentioned reasons, the motivation and objective of the research can be fully considered in line with the topics targeted by DM n.352 (09/04/2022), Art.s 1.7 ("<i>missions</i>") and 6.4a ("<i>companies' innovation needs</i>"). PNRR: Mission#2C2 and Mission#4C2.</p> <p>More in detail, the R&D activity proposed is part of the Italian effort in the field, focusing on the design of components of the fusion reactor, subject to complex load conditions, deriving from the superimposition of electromagnetic, fluid dynamic, thermal and mechanical phenomena.</p> <p>Specific objectives of the investigation will be:</p> <ul style="list-style-type: none"> - to become familiar with the main systems and components used in nuclear fusion experiments (with particular reference to tokamak: vacuum vessel, superconducting magnets, thermal shield, cryostat, plasma facing components, etc.); - to analyze the relevant physical phenomena at an electromagnetic, thermo-mechanical and fluid-dynamic level under normal operating conditions and during the main dimensioning transients (plasma disruption, short circuit in the magnets, etc.); - to calculate the distribution of currents, electromagnetic forces, temperature and the state of mechanical stress deriving from the main components of the tokamak; ζ to carry out the main structural integrity checks on the components, in accordance with the reference codes; - to evaluate the main problems in the design and construction of components and propose possible solutions and possible improvements. <p>The PhD student will spend at least 6 months at Ansaldo Nucleare.</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>A holistic approach will be adopted, to address electromagnetic, fluid dynamic, thermal mechanic and system features. Safety features will be addressed as well.</p> <p>The methods and techniques to be used will be mainly of numerical-modelling type with a multi-physics approach. Among the state-of-the-art simulation codes: ANSYS suite, OpenFoam, MODELICA, Matlab-Simulink.ASME</p>



	and RCC-M codes for structural design will be adopted.
Educational objectives	<p>The PhD candidate will develop an interdisciplinary approach: devoted to address not only the key features of the fusion reactor system (from vacuum vessel to cryostat), but also the integration with the other plant systems, as well as the dynamic behavior (normal operation, abnormal operation and accident conditions). Control systems and strategies will be analysed and innovative solutions developed.</p> <p>The educational path of the PhD candidate on the main features of fusion reactor components and systems, their behavior and interaction, will be developed together with Ansaldo Nucleare.</p> <p>Team working and problem solving capabilities will be key educational objectives as well.</p>
Job opportunities	<p>The emerging candidate's profile will be highly attractive both in the research environment, where cross-disciplinary skills are more and more appreciated, and in the expanding field of fusion energy system design, analysis, manufacturing and management.</p> <p>Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research: ITER Organization (FRA), Università di Milano-Bicocca (ITA), NIER Engineering (ITA), Fusion4Energy (EU).</p>
Composition of the research group	<p>1 Full Professors 2 Associated Professors 2 Assistant Professors 10 PhD Students</p>
Name of the research directors	prof. Antonio Cammi

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

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Ansaldo Nucleare, Corso F.M. Perrone, 25, 16152 Genova
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	(azienda, centro di ricerca o università europee o extra-europee, da concordare con Ansaldo Nucleare; ad es. presso ITER-FRA)
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. The amount is about Euro 5700.

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. Accommodation in Politecnico's Residences (<http://www.residenze.polimi.it>) is available for PhD candidates; special rates will be applied to selected out-of-town candidates (detailed info in the call for application).

Research period abroad: Our candidates are strongly encouraged (6 months minimum is mandatory) to spend a research period abroad, joining high-level, research groups in the specific PhD research topic, selected in agreement with the Supervisor. An increase in the scholarship will be applied for periods up to 6 months (approx. 700 euro/month- net amount).