**PhD in Fusion Science and Engineering**
**Università di Padova e Napoli "Federico II"**

**Call for admission to the PhD courses 2021/22 (XXXVII cycle)**

**Research topic funded by DTT scarl**

| | |
|---|---|
| **PROJECT TITLE** | Development of new solutions for high voltage power supplies of Neutral Beam Injectors for nuclear fusion experiments |
| **FUNDED BY** | DTT scarl |
| **CONTACT PERSON** | Elena Gaio<br>elena.gaio@istp.cnr.it |
| **SHORT DESCRIPTION** | In nuclear fusion experiments, Neutral Beam Injectors (NBI) are often adopted to inject power and momentum into the plasma. High voltage power supplies are necessary to feed the acceleration grids of the NBIs with voltages up to several hundreds of kV dc and direct currents up to tens of Amperes. In ITER and in the full-scale NBI prototype under construction in Padova, Italy, the high voltage is provided by 5 step-up oil transformers, fed at the input by 3-phase Neutral Point Clamped inverters, and connected at the output to diode bridges insulated with SF6, all connected in series to reach a full voltage up to 1 MV.<br><br>This custom-made solution could be further improved in terms of controllability of output voltage, size of dc output filters, volume of SF6, efficiency etc.<br><br>Alternative technologies are being investigated for the NBI Acceleration Grid Power Supply (AGPS) of next generation of fusion machines, in particular for DTT, the Italian reactor under construction in Frascati, and DEMO, the European demonstration power plant, presently under conceptual design.<br><br>In particular, the Modular Multilevel Converter topology is considered; it is derived from the HVDC applications, but it possible adoption for NBI AGPS require a dedicated R&D. Several aspects needs to be explored, among them:<br><br>• the capability to sustain repetitive short-circuits at the output due to breakdowns (BD) among the acceleration grids and restart in few ms, minimizing the energy transferred to the arc;<br><br>• the current rating of the power modules, much lower than in the usual HVDC applications, which shall be exploited in order to reduce the overall dimensions and cost of the conversion system;<br><br>• the regulation range of the output voltage, about 10 ÷ 100%;<br><br>• the fast dynamics required, the need of on-off modulation and the integration with the central control system.<br><br>A PhD on the application of innovative topologies for this specific application is proposed, including conceptual design studies, analyses of normal, breakdown and fault conditions, also with the use of models, optimization of the control system, layout studies and definition of the interfaces with the rest of the plant. Small-scale prototypes could be also developed, to test the solutions identified. |