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# PhD PROPOSAL 2017



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**Title :** Study of tokamak plasma disruptions and runaway electrons in a metallic environment

**Topic description:**
Disruptions are abrupt terminations of tokamak plasma discharges. They arise from large scale magnetohydrodynamic instabilities leading to the loss of the plasma thermal and magnetic energy on a timescale of a few milliseconds. Controlling disruptions and learning how to mitigate them is essential for a reliable operation of future machines including ITER. Therefore a good understanding of the physics processes involved in the phenomenon is needed. In particular, one of the consequences of disruptions is the generation of multi-MeV electron beams due to the presence of large parallel electric fields. The dynamics of runaway electrons during the disruption are influenced by the presence of a cold background plasma behind the beam, which is also suspected to prevent the penetration of material coming from disruption mitigation systems such as massive gas injection. This cold dense plasma was observed on various tokamaks but its features and the physics processes involved in its interaction with the runaway electron beam remain largely unknown. The background plasma characteristics as well as the disruption dynamics were also found to depend on the tokamak configuration and wall material (Beryllium/tungsten or carbon). In this respect, the WEST tokamak scheduled to start operations at the end of 2016 is an ideal tool for such a study.
The goal of the thesis is therefore to study disruptions and runaway electrons in a metallic tokamak environment. It will aim in particular at identifying the physics processes involved in the creation of the runaway background plasma and to determine which models are most adequate to describe its interaction with the runaway electron beam.
The first step will be to perform a characterization of the background plasma using past experiments on Tore Supra or other tokamaks in Europe (JET, Asdex-Upgrade, TCV) as well as disruptions obtained on WEST. The power balance of the background plasma (ohmic heating, collisions from runaways vs. radiation processes, etc.) and its particle balance (outgassing from the wall, massive gas injection) will be investigated. Dependences of those physics features to parameters such as the machine size, configuration (limiter or divertor) or wall material will also be established. A comparison between Tore Supra data and WEST data is particularly well suited for this study. The opportunity will be given to participate to experiments carried out on other tokamaks in Europe (JET, TCV, Asdex-Upgrade).
Once the characteristics of the beam and the background plasma are determined, they will be used to identify which type of physics is involved: infer from experimental kinetic profiles which kind of transport physics is adapted to describe the plasma, estimate from magnetic topology the importance of MHD effects, determine from current profiles and plasma shape the influence of the equilibrium stability. Interpretative models will be built to account for the effects observed in the experiments. Exploring plasma models outside the ones used in typical fusion plasmas (i.e. cold plasmas), should they prove adequate, will be encouraged.
A comparison of these models will then be made with results obtained from dedicated modelling tools, such as 3D MHD codes like JOREK for MHD phenomena or more first principles transport codes such as the IMAGINE code.