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PhD Thesis Abstract

Edge instabilities across the L-H transition and in H-mode

Nuclear fusion is a promising solution to the world energy problems, but it faces difficult challenges that must be surpassed before its application to commercial power plants. One of the main obstacles to achieving net fusion power in a magnetically confined plasma is the anomalous energy loss which occurs due to turbulence driven by instabilities. This situation is improved when sufficient heating causes the plasma to transition to H-mode, a state of higher confinement when compared to the previous one (L-mode). The H-mode is known to exhibit an region of reduced transport at the edge called the pedestal, but the physics of the L-H transition is not fully understood yet. Besides this, H-mode operation is accompanied by edge localized modes (ELMs) which limit fusion performance and pose risks to plasma facing components. ELMs and the structure of the pedestal are caused and affected by several instabilities, but a full picture of the processes in play remains to be developed, limiting fusion performance and preventing reliable extrapolations to future devices.

The main goal of this project is to improve the physics understanding of the L-H transition and the H-mode pedestal by experimentally investigating edge instabilities in different scenarios. Hopefully this will contribute to a better understanding of turbulent transport and the ELM cycle, which are key issues for the success of fusion energy. The work will be conducted in the ASDEX Upgrade (AUG) and Joint European Torus (JET) tokamaks using mainly reflectometry diagnostics. These will allow the investigation of poloidal asymmetries in edge turbulence and quasi-coherent modes, as well as a detailed characterization of instabilities across different regimes and plasma parameters.