Study of L-H transition and small ELM scenarios on MAST-U spherical tokamak

Student project description

TDK, BSc, MSc level

By Daniel Dunai

HUN-REN Centre for Energy Research

Date: 27. January 2024

EUROFusion collaboration

Status: Opened

Comments: paid internship position, participation in physics experiments near Oxford, possible project work in University of York

Keywords: plasma physics, data analysis, turbulence, tokamak, L-H transition, MAST-U

Project description

The field of magnetically confined fusion physics changes rapidly in these years. From the laboratory size experiments we move towards reactor size machines. In the UK UKAEA has launched the STEP project, which could be the first fusion reactor, which generates net electricity. Although fusion research globally focuses increasingly on technology development, the plasma physics is still key to the design of the new devices. A key question towards the fusion reactors is to understand and experimentally study the particle and heat transport in fusion plasmas.

The H-mode is a good confinement mode of the fusion plasmas, where a transport barrier is formed in the edge of the plasma. The H-mode is characterized by suppressed edge plasma turbulence, but disruptive edge-localized mode (ELM) instability occurs in this operation mode. In the experiments often a dithering H-mode phase is observed, when the H-mode transition and back-transition is observed with relative high frequency. In the emerging pedestal the evolving instability can be measured and characterized with Beam Emission Spectroscopy diagnostic. One of the most important ongoing EUROFusion program is to develop small ELM and ELM free scenarios, where the advantages the H-mode could be kept, without the harm of large ELMs.

Address: 29-33. Konkoly-Thege Miklós rd., Budapest, H-1121 **Mailing address**: P.O.B.: 49, Budapest, H-1525. **E-mail:** dunai.daniel@ek.hun-ren.hu **Phone.**: +36 1 392 2222 **Webpage**: www.ek-cer.hu

A two-dimensional turbulence imaging Beam Emission Spectroscopy (BES) diagnostic has been installed on MAST in collaboration of Fusion Plasma Physics Laboratory of the Centre for Energy Research and CCFE. The BES diagnostic is operated by University of York and CER and are jointly responsible for the data evaluation. This gives a unique opportunity to participate in the physics program of the leading spherical tokamak experiment.

To characterize edge plasma turbulence via the analysis of the experimental data is the primary aim of this project. The H-mode transition can be observed as significantly decreased density fluctuations in the edge and evolving density pedestal. As the transport from the confined region is decreased divertor H_alpha diagnostic signal drop is observed. In the analysis the transition times are to be identified first, and the edge turbulence patterns are to be characterized via correlation functions in various phases. The radial and poloidal correlation lengths are calculated as well as changes in the poloidal velocity.

A python program package was developed in CER for fluctuation analysis. A part of the work is to learn the numerical methods and implement codes utilizing the existing functions. In case of interest the candidate can participate in the operation of the diagnostic either as remote participant or in longer term in person at CCFE.

Understanding of fusion physics is necessary but can be obtained during the project. In the case of appropriate performance and interest paid internship position is available at CER. A collaboration is being formed with University of York, which would allow the candidate to work in close collaboration with colleagues in UK and possibly implement partly their project in York.

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Prerequisite skills

python programming, English language skills,

Application

Applications are open until the position is filled.
Please contact Dániel Dunai via email at ***dunai.daniel@ek.hun-ren.hu***

Address: 29-33. Konkoly-Thege Miklós rd., Budapest, H-1121 **Mailing address**: P.O.B.: 49, Budapest, H-1525. **Phone.**: +36 1 392 2222
E-mail: dunai.daniel@ek.hun-ren.hu **Webpage**: www.ek-cer.hu