DOCTORATE AT THE CHARLES UNIVERSITY IN PRAGUE

Applicant: **Mrs. Ekaterina Matveeva**

Title**: Studies of plasma disruptions in the COMPASS tokamak**

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The thesis is devoted to one of the most important topics of magnetic fusion, namely disruptions in tokamaks. Disruptions are an inherent property of tokamak plasmas, which may not be completely eliminated. The consequences of disruptions are especially dangerous for large machines like JET and even more so for ITER and DEMO. Disruptions can cause large Electro-Magnetic (EM) loads on the tokamak components and huge thermal loads on the Plasma Facing Components (PFCs). Moreover, high-energy powerful Runaway Electron beams may arise during disruptions and cause serious damage to the machine. Thus, the topic of the thesis is relevant and of great interest to the scientific community.

The thesis contains three large chapters, as well as Introduction and Conclusion sections. Chapter 1 describes the general concept of nuclear fusion, magnetic fusion tokamak approach and the main features and parameters of COMPASS tokamak. Chapter 2 describes the origin of the disruption and the nature of the EM loads on the vessel of the tokamak. Finally, Chapter 3 deals with a disruption study on the COMPASS tokamak.

The COMPASS disruption database contains a large number of disruption events, approximately 7000, which provides an extensive data set for disruption analysis. The main part of the disruption manifests itself as a hot Vertical Displacement Event (VDE) ~ 76%, and the rest of the disruption (~ 24%) manifests itself as a major disruption.

Subsection 3.1 provides a thorough and complete description of COMPASS magnetic diagnostics together with the sophisticated post-processing procedures that are critical to disruption studies. In subsection 3.2 the author provides Current Quench (CQ) data in accordance with the requirements of the International Tokamak Physics Activity (ITPA) disruption database. The currents (toroidal, poloidal and halo) in the vacuum vessel, which are responsible for the EM loads, are outlined in subsection 3.3. Subsection 3.4 is devoted to toroidally asymmetrical disruptions. The majority (~87%) of the detected disruptions at COMPASS are asymmetrical disruptions. The COMPASS data are largely consistent with the JET data, confirming the general nature of the asymmetrical distribution. Moreover, the thesis contains unique halo current data on COMPASS asymmetrical disruptions, which appear to be

below ITPA limit of the toroidal peaking factor. The author of the thesis performs the experimental validation of the Asymmetric Toroidal Eddy Currents model (ATEC) proposed for the estimation of the sideways forces on ITER. One of the important findings of the study is that the gaps between the PFCs can be short-circuited during disruptions creating a parallel vessel current circuit. These currents, in addition to EM load, can create additional thermal load on the edges of the PFCs.

The Conclusion section summarizes the presented results.

Question:

Figure 1 shows the relationship between the asymmetries of the plasma currents and the halo currents measured in two opposite cross-sections of the tokamak. Can it be concluded that the upper bound of the data represents the relationship between the I_p asymmetries and the halo currents?

Comment:

Page 62. TPF calculation refers to formula 2.13, while the calculation was carried out according to formula 2.12.

Final assessment:

In general, the work was done at a high scientific level. The main results have been presented at conferences and published in peer-reviewed papers due to this dissemination, the results of the author are well-known to the scientific community. In the course of working on her Ph.D. thesis, the author has shown a deep interest in scientific research. Mrs. E. Matveeva has demonstrated a good ability to work as part of an international team. She has also demonstrated the ability to overcome challenges that have arisen to achieve her goals.

I believe this thesis meets the requirement for doctoral graduate work and therefore from my point of view, Mrs. Ekaterina Matveeva deserves to be awarded the title of doctor.

I would also like to wish Ekaterina continued success in her scientific career.

Dr Sergei N. Gerasimov

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