

DOCTORATE AT THE CHARLES UNIVERSITY IN PRAGUE (Faculty of Mathematics and Physics, Department of Surface and Plasma Sciences)

Mrs. Ekaterina Matveeva

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

Report by Prof. G. Van Oost, Ghent University (Belgium)

This is a well written, extensive and very well documented study of plasma disruptions in the tokamak COMPASS. Quenching of the plasma current in a tokamak plasma leads to a sudden loss of the thermal plasma energy which flows towards the inner wall of the plasma vessel within a very short time. The high plasma energy involved can start the melting of surfaces, which can limit the total lifetime of the components of the first wall of the reactor. In addition, the rapid drop in plasma current induces currents in the plasma vessel which cause high forces acting on the vessel. Therefore, the study of characteristics of disruptions as well as their avoidance and mitigation is very important for the sustainability of future tokamak fusion power plants. The COMPASS tokamak was very well suited for this study.

The doctoral thesis is subdivided in 3 chapters. After an introduction, Chapter 1 describes plasma confinement in tokamaks and gives an overview of the tokamak COMPASS, while Chapter 2 gives an overview of disruption causes, phases and consequences, as well as of the main sources of electromagnetic loads. The subsequent Chapter 3 gives an overview of the relevant available diagnostics on COMPASS, in particular the magnetic diagnostics, and presents the main results of the present doctoral research work. Finally, the results are summarized and conclusions

This elaborate work (partly in collaboration with ITER IO) is based on a sound methodology and scientific approach and contains all the important information, while referring to the candidate's own publications, as well as to other published work, for a more thorough description of each specific item. The English could be improved.

Questions for the candidate

1. Do disruptions in ITER have to be considered as a particular safety risk for staff or public?
2. Section 2.1.: "Sudden release of large thermal energy poses a high risk of damage for PFCs. This is a particular concern for larger machines as the stored energy scales as R^5 ". Do spherical tokamaks have an advantage in this respect?
3. How will be the diagnostics capability to study disruptions (including the impact of runaway electrons) in COMPASS-U in comparison with COMPASS ?
4. Since the occurrence of disruptions is inconsistent with continuous power generation in a fusion power plant, it is being investigated intensively worldwide how the plasma can be controlled so that the occurrence of disruptions is minimized, and disruptions are mitigated. Will this also be investigated in COMPASS-U ?

Suggestions for orthographic and style corrections

Abstract, paragraph 2, line 4: 5 toroidal positions ; line 9: sideway forces

Contents: "Summary and conclusions" instead of "Conclusion"

Page 4, paragraph 4: main phases of disruption; par. 2 from bottom: A comparison ...is presented.

P. 9: , par. After (1.13): The inverse of...

p.10, par.1: generated with complex...

p.17, par.1: Addressing the problem; par. 2:, line 2: followed by edge cooling

p.23, par. 3, line 6: as it requires a large number of sensors...
p.30, par.3: Magnetic diagnostics are...
p.42, par.2:cross talk
p.79:., par.3: Section 2.1; par.5: Their major advantage is the capability to...
p.80, par.2: This parameter plays a role

Very often no article is used; some examples:

Abstract, line 4: The allowable number, paragraph 2, line 12: This brings a new perspective for the estimation...in the poloidal cross section...allowing the measurement of...contributed to the confirmation...

Page 3, par. 1: fuel to a minimum during operation; par.2: to overcome the energy crisis; , par.5: contribute to the understanding..., line3 from bottom: Analysis of a special...

Final appraisal:

Overall, the scientific quality and level of the experimental and data analysis work is very good, which is also supported by the fact that several topics covered in the work are the subject of published/accepted peer-reviewed articles.

The candidate showed, in her work, the capability of making use of all instruments and techniques at her disposal, and to look for adequate ones when not available, in order to reach her goal. With these appreciable efforts Ekaterina Matveeva paved the way for those who will continue in this line of research. The candidate has made substantial original contributions, advancing the forefront of research. The candidate has convincingly demonstrated that she is qualified to carry out self-contained research of high quality in the relevant field.

Prof. Em. Dr. Dr.h.c. ir. Guido Van Oost
Department of Applied Physics
Ghent University (Belgium)

28 November 2022