Expert opinion

Study of Equilibrium Magnetic Configuration in Tokamak Type Devices written by Mgr. Josef Havlíček

Oponent: Prof. RNDr. Pavel Kubeš, CSc.

This doctoral thesis describes the magnetic fields of the COMPASS tokamak and work done during its reinstallation in the Czech Republic. There are two main topics in the thesis, the description of the COMPASS magnetic field systems, and utilization of the MHD equilibrium reconstruction convenient for the realization of the COMPASS physical programme.

The first chapter mentions the goals of the work and overview of the main topics of the tokamak problems. The second chapter describes the tokamak COMPASS and gives the list of its comprehensive diagnostics. The third chapter descripts the system of the COMPASS magnetic field. It presents the calculation of the distribution of the magnetic field, and the self- and mutual inductance and continues by the description of the five circuits of poloidal field: circuit for plasma current drive and ohmic heating, equilibrium circuit for generating of the vertical magnetic field, circuit for plasma shaping and creation of divertor plasma configuration, circuit for horizontal and vertical magnetic field and circuit for fast feedback control of vertical plasma. This chapter continues by description and discussion of the stray magnetic fields, and the filters designed for the coils of the poloidal field. It mentioned the power supplies, their principles, simulations, preliminary measurement and the status of the current. Finally, this chapter contains description of the mutual influence between individual power supplies, the description of their control and heir possible improvements. The fourth chapter focuses on the numerical reconstruction of the MHD equilibrium on the base of the Grad-Shafranov equation. The reconstruction of this topology is performed using the numerical code EFIT. Especially, for the COMPASS tokamak, the version called EFIT++ was adapted. It is shown the example of the reconstructed equilibrium used for tokamak operation. Finally, the examined global power balance in non-stationary phases and the numerical determination of induced voltage are described, and the detailed analysis for L-mode, several examples of different combination of L-H-mode transition, X-point creation and ELMs frequency are discussed. Chapter 5 summarizes the presented results. Attached articles published in journals and proceedings provide information about the fast amplifiers and power supply built for control of vertical plasma position, algorithm for real time plasma position and improvements in both. All these items are more detail described in the sections of this thesis.

The work is lucidly written with illustrated graphics and understandable language and it shows the authors scientific capability.

Actuality of the work:
The distribution and self-control of the magnetic field, its computation and reconstruction are the principle task for operation of the COMPASS tokamak. The presented ideas enabled to better understand to the measured signals and to improve the control of the plasma in different regimes. The work gives important information to members of the COMPASS team.

Methods of elaboration:
The author's main contribution leads in summarizing of the different technical and physical aspects of comprehensive tokamak operation important for practical realization of experiments. The author demonstrated his ability to be the useful member of the team.

Fulfilling of the goals:
The basic goals of this thesis, physical and engineering description of the COMPASS magnetic field systems, and utilization of the MHD equilibrium reconstruction for COMPASS operation, were fulfilled.

Results and contribution:
Mgr. Josef Havlíček describes and summarized problems of the distribution of the currents and accompanied magnetic fields in the tokamak facility, namely their reconstruction, and role of the signals of the set of detectors in the process of the control and stabilizing of the plasma column.

I have a question to the author: The crucial problem in the tokamak COMPASS is found the physical interpretation for transition of H-L mode and generation of ELMs. These phenomena should be connected with reconnection of magnetic line and redistribution of currents. Can you present the characteristics of the H-mode and its surface parameters?

Conclusions
The author demonstrates knowledge in the field of the description and control of the magnetic field in tokamak device and ability of the creative scientific work of the international importance. He presents erudition in calculations, simulations and experimental works. This thesis fulfills the requirement for the final work of the doctoral studying. Consequently, I recommend, after the successful defend, to award Mgr. Josef Havlíček the title doctor.