SUPERVISOR'S ASSESSMENT OF FINAL WORK

I. IDENTIFICATION DATA

Title:	**Tungsten transport studies via multi-diagnostic approach**
Author´s name:	**Jiri Malinak**
Type of assignment:	Master Thesis
Faculty:	Faculty of Nuclear Sciences and Physical Engineering (FNSPE)
Department:	Department of Physics (DP)
Supervisor:	Fabien Jaulmes
Supervisor´s affiliation:	IPP of the CAS

II. ASSESSMENT OF CRITERIA

Work assignment and topic motivation — **demanding**

The distribution and transport of tungsten (W) inside the confined tokamak plasma is of importance in order to predict fusion reactor conditions: even a small relative concentration of order ~0.0001 can cause dramatic cooling of the thermonuclear plasma. The complexity of the measurements of the tungsten concentration comes from the large number of possible ionization stages across the plasma radial profiles. This correlates with a large range of photon energies.
Several integrated transport models have been developed based on neoclassical theory. Whilst these models can account for the L-mode transport with reasonable accuracy, it is still under investigation if there is a good theory that can account for the measured W density and transport in H-mode plasmas.
The project aimed at comparing the measured transport with the neoclassical transport model in H-mode plasmas during specific Laser Blow-Off (LBO) experiments in ASDEX Upgrade using several diagnostics. Specifically, the assignment was to extract the measured W profiles from the relevant experimental data, spanning the experiments #41146, #37639, #37614, #36496, #36486, #36476.

Fulfilling the assignment — **fulfilled**

We can consider the assignment overall fulfilled. The student has developed a clear methodology that relies on the Bolometers, ADAS PEC40 and tomographic reconstruction. He can extract data in a relatively efficient and fast way. Due to the limited time available during the project, the student did not make a broad statistical study of the measured profiles over a very large range of time points, plasma backgrounds, heating combinations, etc… This could be a future development of the project.

Student´s effort and independent approach to the topic solution — **excellent**

The seriousness and high scientific-level of the student's approach during the project are undeniable. He really pushed for an in-depth study of the assumptions hidden behind the radiation models and the description of the measured emissivity. The theoretical background and state-of-the-art bibliography was established very thoroughly. Furthermore, this was consolidated by the development of a high-quality python library of personal tools, which allowed him to navigate and reconfigure quickly the reconstructed spectra and emissivity in order to assess the pros and cons of each model. The student chose to meet on a weekly / bi-weekly basis and had each time some new material to discuss and/or very relevant questions.
Both the theoretical investigations and the programming skills demonstrated during the project are excellent. Regarding the ability to decide on the lines of research and having a critical eye on his own results, the student needed some support, but overall the supervision remained in the background while the student was able to progress independently.

Professional standard	**excellent**
During the project, the student demonstrated a professional attitude and his ability to communicate with specialists from outside IPP of the CAS. He showed initiative in attending the meetings offered at IPP of the CAS (eg. on the use of ADAS data). The student had the required knowledge regarding the operation of the tokamak and spectroscopic measurements. He was able to grasp new concepts regarding transport theory and modelling.	

Level of formality and of the language used	**excellent**
The student has excellent communication skills, both written and oral. During the project, he communicated on the results efficiently using python notebooks and did a 2/3 project summary presentation. The report is of the expected quality for a Master's thesis. Within the written documents, the final results of various shots and LBOs lack a bit in organization, but this is mostly because of the overall ambitious scope of the project.	

Choice of references, citation correctness	**excellent**
The level of the bibliography is very good and in depth, especially in the beginning of the manuscript. The material reused in this work is mostly from T. Puetterich's work and is clearly identified and distinguished from the student's own work. The formulas which are not completely explicated have the proper reference mentioned next to them. However, the final comparison with the FACIT transport model could have used comparisons with similar recently published material.	

Further comments and assessment
The work of the student is of overall very good quality: the results, whilst incomplete in their scope, can be in the future applied to larger range of ASDEX Upgrade discharges. The computational model developed is rather solid and can be implemented as a separate module. It can be used both with online access to the database of ASDEX Upgrade and offline downloaded files. The python module will be considered for implementation in a close coupling with a transport solver such as Aurora. When more systematic data processing is performed on a larger range of LBOs discharges, we believe that the overall output of this Master thesis can be published in a scientific journal. However, the theoretical investigations of the transport model in the report are too simplified and can be further expanded and refined. Once again this is mostly due to the limited time of the study and rather ambitious scope of the project than a lack of work from the student.

III. OVERALL ASSESSMENT AND SUGGESTED GRADE

The student has answered all of the research questions of the topic using a clear methodology that relies on the Bolometers, ADAS PEC40 and tomographic reconstruction. An interactive and well written python library has been implemented which allows the interpretation of measured data in an efficient way.
The "multi-diagnostic" approach still needs to be refined regarding the combined use of several diagnostic. It was difficult during the course of the project to get all the proper information regarding the uncertainties of each measurement, making any choice of a specific diagnostic a bit arbitrary. Obtaining the relevant calibration data would have required a visit to IPP Garching in some cases (XVR or spectrscopy): this was unfortunately not doable

in practice. We regret though that the BLB+SXR combination is not further investigated in this work.
Regarding the interpretation of the results, the conclusions of the comparison with FACIT neoclassical transport model are a bit limited. A scan regarding the possible parametrization of the computational transport solver is missing. The consideration regarding the Low Field Side poloidal asymmetry of the W distribution and the effect of toroidal rotation in the model are not discussed.
To summarize, the work done during the course of the project is very solid and lays the foundation for future development. The student's attitude during the project was very professional and he paid great attention to all details. We believe that, after further developments, and using extended datasets, Jiri will have the opportunity to publish his results in a scientific journal.

Suggested grade: **B - very good.**

Date: 27.5.2024

Signature: