Referee Report on the Ph.D. Thesis of Soma Olasz

The thesis submitted by the Candidate addresses an important and timely topic within fusion plasma physics, specifically the dynamics of runaway electrons in tokamak disruptions. The work significantly contributes to our understanding by employing comprehensive numerical modeling and presenting relevant physical insights.

The subject of the thesis is highly significant. Runaway electrons represent a critical challenge for tokamak operation, especially in next-generation devices like ITER and DEMO. Accurate modeling and deeper understanding of their dynamics during disruptions are essential for developing reliable mitigation strategies.

The structure of the thesis is clear and logical, consisting of five main chapters: Introduction, Runaway electron physics, Modeling infrastructure, Modeling results, and Summary and Outlook. The theoretical foundations provided in Chapter 2 are detailed and rigorous, particularly regarding the derivation and interpretation of collision operators, demonstrating the Candidate's profound understanding of plasma kinetic theory.

The methodology, as described in Chapter 3, is robust, utilizing advanced computational tools (NORSE, DREAM, ETS, and SOFT). However, there are notable issues regarding the clarity and quality of illustrations within this chapter. In particular, figures 3.1 and 3.2 suffer from insufficient resolution and readability, detracting from their explanatory power. It is recommended that these figures be revised or redrawn to clearly convey their intended message.

Moreover, Chapter 3 would significantly benefit from an expanded and detailed description of the physics behind the *Runaway Fluid* and *Runaway Indicator* codes. These tools are introduced briefly, but a deeper theoretical background and clearer explanations would substantially strengthen the chapter's completeness and facilitate a deeper understanding of their role in the integrated modeling workflow.

In Chapter 4, the Candidate presents thorough modeling results, including studies on Dreicer generation, integrated kinetic modeling, and simulations of runaway electron radiation in JT-60SA. These results are valuable contributions to runaway electron research, and the Candidate commendably compares simulation results with experimental data and other simulation codes, enhancing their credibility. Still, explicit identification and discussion of limitations and uncertainties in these modeling approaches could provide a more comprehensive perspective.

Additionally, in Chapter 6, *Thesis Statements*, explicit references to the Candidate's own publications supporting each claim are notably absent. Including such references is crucial for clearly establishing the novelty and authenticity of the stated results and is thus strongly recommended.

Questions for Scientific Debate:

1. Can the Candidate elaborate on the specific uncertainties and sensitivities of the kinetic modeling methods, especially concerning different collision operator treatments?

2. How significantly would the presence of partially ionized high-Z impurities alter the presented simulation results, especially in disruption scenarios?

3. What are the primary numerical or physical limitations constraining further improvements in the integrated modeling approach?

4. How could the Candidate's modeling of runaway electron radiation in JT-60SA be directly employed to enhance experimental diagnostics or inform practical operational strategies?

5. Considering the findings, what practical mitigation strategies does the Candidate foresee for effectively preventing or limiting runaway electron generation in large-scale tokamaks?

Obligatory Statements:

- I accept the results claimed in the associated thesis booklet as new scientific results achieved by the Candidate, noting only minor clarifications as outlined above.

- I recommend the thesis of Soma Olasz for public defense.

In summary, the thesis by the Candidate represents a strong scientific contribution, clearly meeting the doctoral standards. With minor revisions and clarifications as outlined, the thesis will be an even stronger basis for future research and practical applications in fusion reactor technology.

Budapest, 22. April, 2025

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