

I. IDENTIFICATION DATA

Title:	Development and validation of new features for the G4SEE radiation effect simulation toolkit
Author's name:	Bc. Eva Fialová
Type of assignment:	Master Thesis
Faculty:	Faculty of Nuclear Sciences and Physical Engineering (FNSPE)
Department:	Department of Dosimetry and Application of Ionizing Radiation
Supervisor:	MSc. Dávid Lucsányi
Supervisor's affiliation:	CERN, Systems Department, Sources, Targets and Interactions Group

II. ASSESSMENT OF CRITERIA

Work assignment and topic motivation	demanding
<i>Assess how demanding the assigned topic is. Brief introductory word on motivation for choosing the topic.</i>	
<p>The development, application and experimental validation of a Monte Carlo simulation tool (like G4SEE) in the context of Single Event Effects in microelectronics is a very interdisciplinary and complex topic, requiring large variety of skills (programming in C++ and Python, software development, data analysis, MC simulations, experiments), as well as knowledge of a wide range of fields (particle-matter interactions, nuclear physics, electronics, Monte Carlo methods, etc.). Because of these, the topic is quite demanding for a master student. Motivations behind the topic were to give insights to every aspect of this complex and interdisciplinary topic, as well as the contribution to the G4SEE simulation toolkit with new features, also applying or validating these features with new use cases, while benefiting from and contributing to applied research projects of international collaborators.</p>	

Fulfilling the assignment	fulfilled
<i>Consider whether the work submitted meets the assignment topic. Comment, if necessary, on items of the assignment not fully answered, or mention whether the scope of the assignment has been broadened. If student failed to fully treat the assigned topic, try to assess the importance, impact and/or the reasons for failings.</i>	
<p>The submitted work meets the assignment topic. Eva learned about all the fields and acquired skills mentioned above, she implemented useful simulation features and applied them for various use cases, successfully contributing to the G4SEE toolkit. All important sub-topics have been treated and documented. One task however, the experimental test campaign to validate one implemented feature (LET scoring) could not be performed unfortunately, due to external facility and logistics issues (as explained also in the thesis). Therefore thesis lacks some experimental results, but this has no negative impact on the submitted work, since most of the essential preparation work has been done already by Eva, supporting the postponed proton test campaign. Other experimental test data were used for validation of energy deposition per interaction feature and detector simulation study.</p>	

Student's effort and independent approach to the topic solution	average
<i>Assess whether student displayed constant effort while investigating the problem, whether they regularly consulted the issues and whether they attended consultations well prepared. Assess student's creativity and independence.</i>	

I confirm that motivation and effort of Eva was constant, she has been progressing with her tasks continuously. We had consultations regularly, she was prepared for meetings, and she reported both on her results and technical difficulties, as well as about mistakes and bugs which she has fixed. When she was stuck, she asked for help. In the beginning, she needed more support, but over time she became more proactive and independent. After the initial attempts, she successfully solved the programming and data analysis issues she faced.

Professional standard

average

Give your opinion on the professional standard of the work, application of course knowledge, references, and data from student's practice.

She has gained lot of relevant professional experience, skills and knowledge during this work, which she has all applied as well, resulted in the good, professional quality of her work. She described how and why she has performed a simulation, implemented a code, but in some cases not provided enough details. Explanations and discussions on the simulation results and comparisons are often missing from the simulation studies, mainly in case of SiC MOSFET and proton LET simulations.

Level of formality and of the language used

excellent

Assess the use of scientific formalism, the typography and language of the work.

Formality and language of the work is good. Typography is excellent, she has used LaTeX well for the thesis. The thesis looks very nice, it is well formatted and structured, and contains every relevant part a MSc thesis should contain.

Choice of references, citation correctness

average

Give your opinion on student's effort in utilizing references in their investigation. Characterize the choice of references and say whether all relevant sources were utilized. Verify whether all resource facts were properly distinguished from student's own findings and results, whether there was no breach of citation ethics, and whether all reference citations are complete and agree with the citation usage and standards.

She got familiar with, used and referenced the professional literature, including the state-of-the-art methods, tools and simulation works. Relevant sources have been used and cited in an ethical way, referenced facts and work can be clearly distinguished from the results and work of Eva. She has clearly stated and acknowledged the experimental and simulation work done by colleagues and collaborators. Formatting and consistency of citations could have been improved, URL links are often missing.

Further comments and assessment

Give your opinion on the quality of the main results obtained in the work, e.g. on the level of quality of theoretical results, or the applicability of the engineering and programming outputs of the solutions obtained, on publication activity,

experimental skills, etc.

Level of quality of all the outcome and results of thesis work is good. The implemented new simulation capabilities for G4SEE will be merged into its open-source repository and released to the public, which then will be available and useful for the whole user community of the G4SEE toolkit. Thanks to the improved energy deposition per interaction scoring earlier limitations will be overcome significantly increasing statistics of rare inelastic events in SEE simulations. Documentation, tutorial and example input files will be practical for users. The new LET scoring will enable new type of simulation studies for which the community has lacked accurate and simple MC simulation tools so far. Both carbon (diamond), and silicon carbide devices have been simulated applying the newly implemented features, contributing to the better understanding of energy deposition distribution in such devices. Valuable comparisons between experimental and simulation results were made, further validating applicability and accuracy of G4SEE. Essential preparation work for experimental proton irradiation test campaign has been done (including many preliminary G4SEE simulations, camera data acquisition script implementation and testing). Some of her simulation results are planned to be published in a peer-reviewed journal paper in the near future.

III. OVERALL ASSESSMENT AND SUGGESTED GRADE

Summarize all aspects of the work most influential for the overall assessment. If adequate, write questions to be answered by student during the defence of their work before the board.

In summary, the work assignment was demanding, since the interdisciplinary and complex topic required various skills and knowledge of many different fields to learn. The submitted work meets the assignment topic, all important sub-topics have been treated and documented. Eva was constantly motivated and progressing with tasks continuously. Thesis has excellent typography, it is well formatted and structured. Relevant sources and references were used and cited in an ethical way, the work done by other people has been acknowledged, however formatting and consistency of citations could have been improved. Major issue is that some parts of the thesis lack explanation or discussion on the simulation results, as well as comparison between different results. Overall, the master thesis work has good quality and merit. She has gained lot of relevant professional experience, new skills and knowledge, which she has all applied during this thesis work. Eva successfully contributed to the G4SEE toolkit with significant and useful new features and simulation results, from which the whole G4SEE user community and her collaborators will benefit directly.

Suggested grade:

Date:

Signature:

