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Master Thesis Review

Bc. Lukáš Marek has prepared a master thesis entitled "Directional and spectrometric mapping of secondary radiation induced during hadron radiotherapy with miniaturized particle trackers". The work is focused on the application of miniaturised, pixelated semiconductor detectors for measurements of mixed radiation fields induced by radiotherapeutic ion beams. The particular purpose of the work is to apply a telescope system, consisting of two Timepix semiconductor detectors for range monitoring in radiotherapy with carbon pencil beams.

The thesis consists of four parts. In the first chapter the Author presents a theoretical description of semiconductor PN junction constituting the basis of semiconductor detector operation, Timepix detector family and physics of charged particle interactions with matter. The second chapter is dedicated to processing methods of the data obtained with Timepix detectors, including the clusterization of the signal and coincidence of measured particles for a telescope configuration, as well as identification of particles in mixed radiation fields. In the third chapter, the application of the methods developed in this thesis for tracking and identification of secondary particles produced during irradiation with therapeutic ion beams is presented. The Author focuses mostly on the uncertainties of the particle tracking and particle identification, as well as their possible sources. The analysis is performed using the data acquired at Heidelberg Ion-Beam Therapy Center irradiating heterogeneous phantom with carbon ion beam and based on Monte Carlo simulation results. The thesis is summarized with a conclusion chapter.

The thesis is well organised and consistent. It includes the theoretical introduction, description of developed methods, example application with uncertainty analysis and discussion of the results. It contains 43 bibliographic positions. The typography of the thesis as well as plots and drawings are prepared satisfactory. Incorrect references to figures, creating "??" marks in the text can be noticed in three positions. Small font size used in some of the plots and the fact that the figures are often even a few pages away from the place where the Author refers to, is inconvenient for a reader. Also an inconsistency with the nomenclature for Timepix detectors can be misleading, when the Author is using the same term, Timepix, for the Timepix family detectors or technology and for the first version of Timepix. I evaluated english grammar and style as sufficient for a master thesis.

Generally, the Author is presenting a novel approach to particle identification based on the comparison of the measured cluster parameters to the parameters database. It is shown in the thesis that the classification of protons and electrons can be performed with reasonable accuracy. The proposed approach allows for further enhancement and adjustment for specific applications. The thesis is substantially correct and contributes new methods for analysis of the experimental data obtained with Timepix detectors. Taking into account the editorial and language issues, balanced by the amount and quality of work presented in the thesis, as well as the importance of the results, I assess the thesis on B (very good) grade.