ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE
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SUPERVISOR'S REPORT ON PH.D. THESIS

Author: Ing. Martin Kákona

Title: Research on cosmic rays on board aircraft using a newly developed PIN diode detector

Let me first introduce the student. Martin Kákona changed his field in 2015. The results of his past research in the field of random character generators and cryptography are subject to state secrecy and are therefore not published. Nevertheless, he was able to capitalize on the experience of leading the development team also in the academic environment, cement the team, and help to get and solve national and international projects. Martin is a team worker but, as well, he evaluated his Ph.D. thesis individually. He communicated well also with me as his supervisor. He is a capable developer and electronics engineer focusing on open-source, i.e. all his inventions are publicly available, and this approach is visible in his scientific work and Ph.D. thesis.

The selected topic of the Ph.D. thesis is actual although the issue of cosmic radiation exposure of aircraft was being solved already at the beginning of air transport. In the Czech Republic, the systematic interest in the issue of exposure of aircraft crews to cosmic radiation was initiated by the adoption of Directive 96/29 / Euratom in 1996 and its implementation in national legislation in 1998. This Directive mandated the obligation to make estimates of personal doses of aircraft crews if such doses could exceed 1 mSv per year. The methods were evaluated using calculation codes and have been implemented in the routine dosimetry of aircraft crew in the Czech Republic by our group at the Nuclear Physics Institute, Department of Radiation Dosimetry. Effective doses of aircraft are regularly monitored since 1998. However, it is known that the calculated doses need to be validated by measurements because the calculated doses may be subject to major uncertainties. The main reason is that cosmic radiation forms a mixed radiation field composed of many particles of a wide range of energies. This problem recently led to the preparation of the ISO norm 20785-4:2019 Dosimetry for exposures to cosmic radiation in civilian aircraft — Part 4: Validation of codes. It shows the topicality of the issue. From this point of view, Martin Kákona's work has the potential to contribute to more accurate measurements of personal doses, as it involves the development of a dosimeter for measurements on board aircraft. In addition, it has the potential to show the relationship between personal doses on board aircraft and cosmic radiation data measured by neutron monitors in the context of actual questions of space weather studies.

Our group performs long-term measurements with Liulin PIN diode detector onboard one aircraft since 2001. Martin is author of the CR10 - a publicly available database of radiation measurements with Liulin and its comparison with neutron monitor on ground - at the top of Lomnicky štít. The relevant paper was published by Martin. However, the main problem was the absence of aircraft data at times of local extremes of neutron flux measured on the ground. It was therefore clear that measurements

on board aircraft had to be intensified. For this purpose and in order to understand the measurement with a dosimeter Liulin, Martin embarked on the development of its own silicon detector. It was based on the involvement of Ing. Pavel Krist, Ph.D. from the Institute of Nuclear Physics AS CR, v.v.i., Department of Accelerators, his co-supervisor. This is how the CANDY detector was created. The most interesting result achieved with the CANDY detector is the characterization of the type of ionizing radiation using a single PIN diode. This work resulted in the application of the invention and the Czech patent. CANDY was base for development of the AIRDOS detector dedicated to long-term measurements on board aircraft with comparable results to Liulin. Martin has not only develop the detector but also has calibrated it (for evaluation of absorbed dose in silicon and ambient dose equivalent) and personally performed many inter-comparison experiments. In addition, Martin has proposed an improved method for the detection of neutrons - highly represented in the mixed radiation field onboard aircraft.

Summing up, I am convinced that the author of the presented Ph.D. thesis demonstrated his ability to conduct individual research work and bring valuable results. All three main goals defined for this work were fulfilled. For this reason, I recommend that he will be delivered the scientific title Ph.D.

In Prague, May 11th, 2020

Ing. Ondřej Ploc, Ph.D.
Nuclear Physics Institute of the CAS
Department of Radiation Dosimetry
Na Truhlářce 39/64, 180 00 Praha 8
Czech Republic