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Development of microdosimetric detectors for radiobiology in hadron therapy facilities

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The ability to measure the radiation effects on healthy and tumorous tissue at the microscale is essential and still presents a huge challenge. There are some instruments that can make such measurements, but most of these are bigger than the size of a cell, and the measured dose is integrated over a small volume. These instruments are unable to produce microscopic descriptions about how the energy is being distributed on the cells by knock-on electrons and other secondary particles. The development of materials able to describe the particles'interactions at the microscale, namely the interactions of hadrons used in cancer treatment, is the scope of this thesis. Based on micrometric Scintillating Plastic Optical Fibers (SPOF) it is proposed the development of micrometric active dosimeters. Using electrospinning technology, the production of micrometric SPOF two orders of magnitude smaller than those commercially available is now possible. With this dosimeter, the real-time detection of the energy distribution at the cell level can be a reality. We foresee the fabrication procedure's optimization, particularly to achieve the best mechanical properties required to have orderly aligned structures, able to be layered, and produce volumes with tenths of μm (cross-section), able to be read by standard photodetectors. Corundum crystals (Al2O3) have been used to produce passive dosimeters that achieve a more detailed description of the particle's energy deposition. This is a consequence of using specific dopants in the crystals. We aim to use the flux method and carbon and magnesium doping to produce FNTD (fluorescent neutral tracking detectors) dosimeters. The optimization of their characteristics for low mass particles and neutrons could be attained by changing the doping elements. The use of GEANT4/TOPAS simulation will be an essential tool to track the experimental developments and produce the adequate translation of the experimental data into physical quantities.

Primary author: RODRIGUES, Cristiana (LIP)

Presenter: RODRIGUES, Cristiana (LIP)

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