Contribution ID: **230** Type: **not specified**

How nuclear physics can be used against cancer and space radiation

Wednesday, 5 September 2018 13:00 (30 minutes)

Charged particles are one of the elements that link innovations in cancer treatment with challenges related to space exploration.
The growing popularity of radiotherapy with protons and Carbon ions as well as the interest in finding additional candidate ions (as Helium or Oxygen) calls for nuclear and dosimetry measurements to develop and validate the delivery techniques.
The roadmap of space exploration foresees longer and further travels also outside the Earth orbit as well as the establishment of permanent outposts on other celestial bodies like Mars. It is now generally acknowledged that exposure to space radiation represents the main health risk for exploration-class missions.
Many challenges in radiotherapy with ions and in space radioprotection are related to the investigation of the same nuclear processes and require similar approaches to be tackled. To advance in both these fields experimental data have to be combined with predictions from theoretical and Monte Carlo codes to characterize the interactions of the primary particles with different media and, as a final step, to assess their biological effect and associated health risk.
One of the most important reactions is nuclear fragmentation.
In radiotherapy, it causes a loss of primary ions along their path towards the target volume and becomes especially relevant for the treatment of deep-seated tumors. Independently of the radiation type, the dose profile calculated with a Treatment Planning System (TPS) relies on the fragmentation cross sections for estimating the number of ions reaching the treatment site.
In space, fragmentation occurs when external radiation transverse the spacecraft walls and contents, including the astronauts' bodies, and plays a key role both in assessing the effectiveness of shielding materials and in predicting the radiation risks inside a habitat.
Different experimental approaches for characterizing nuclear reactions of interest in both fields (and in particular fragmentation) will be presented. Examples on the applications of the experimental data to tackle challenges in radiotherapy and space radioprotection will be also discussed.

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Session Classification: Nuclear Physics Applications