DEVELOPMENT OF A COMPACT DETECTION SYSTEM FOR NEUTRON MEASUREMENTS IN HADRONTHERAPY

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The treatment of cancer by ion beam, or hadrontherapy, has demonstrated significant advantages in recent years compared to photon radiotherapy. Among these advantages, the most significant are improved conformation of the dose delivered to the tumor volume, and improved efficiency of the particles against radioresistant cells (hypoxic tumor). However, during hadrontherapy treatments, primary ions undergo nuclear fragmentations that lead to the production of charged and neutral secondary particles. These particles, which have very variable biological effects compared to the primary beam, will result in a dose deposition both in the tumor and in the surrounding healthy tissues (out-of-field dose). For example, secondary particles, and especially neutrons, are indicated as a potential source of secondary malignancies in cancer therapy, especially important for pediatric patients. Therefore, it is crucial to accurately estimate spatial and energetic distribution of these secondary particles, as well as the corresponding physical and biological doses, in order to optimize hadrontherapy treatments.

Therefore, the precise estimation of the neutrons radiation field in hadrontherapy treatments is of key importance. Software currently used for treatment planning is unable to precisely reproduce experimental data, which can generate an inaccurate prediction of the received dose. Therefore, experimental campaigns are needed to measure secondary neutrons fields, and benchmark simulation codes used by treatment planning system.

Neutron energy measurement is a complex task, as it usually involves systems that are not easily transportable and require time consuming unfolding procedure (e.g. Bonner sphere spectrometry). Since several years, the DeSIS team of IPHC is developing different portable systems for neutron detection: a Recoil Proton Telescope (RPT), made of pixelated CMOS sensors, capable of reconstructing neutron energies, and a neutron counter (AlphaRAD sensors) able to evaluate the number of thermal and fast neutrons emitted in a given environment. All these systems have low consumption, and can be easily placed in a treatment room of a hadrontherapy center.

In this context, the DeSIS team wants to recruit a PhD student that will work on the upgrade and characterization of the experimental systems developed by the team to measure the secondary neutral particles produced by nuclear interactions of ions used in therapy. The main work of the PhD student will focus on performing physics experiments for secondary neutron measurements, and analyzing the obtained data. The experiments will be carried out in hadrontherapy centers with ^{4}He, ^{12}C, and ^{16}O ions, such as CNAO (Pavia, Italy) or CAL (Nice, France), or also in neutron facilities such as AMANDE (Cadarache, France) or NFS (GANIL, France). The PhD student will also compare its experimental results to Monte Carlo simulations (with Geant4, FLUKA, PHITS...). The PhD student recruited will benefit from the existing collaborations between the DeSIS group and several international teams, such as the Space Radiation Group from the Biophysics department of GSI (Darmstadt), or the CNAO hadrontherapy center, with which a collaborative agreement was recently signed.