**Contribution aux exercices de prospective 2020-2030**

***Contribution to the 2020-2030 prospective reflection***

**Sciences Nucléaires et Vivant**

*Nuclear Science and Health*

**Description détaillée de la contribution**

*Detailed description of contribution*

**Title**: Cross sections measurements for space radiation protection

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**Description de la contribution**:

The growing interest for exploratory space missions on Mars drives the necessity of the accurate characterization of the space radiation environment. Indeed, the main hindrance to long-duration interplanetary missions is the important exposure of astronauts to galactic cosmic rays (GCR). These GCR are quite different from the radiations we are usually exposed on Earth: most of the space radiation energy is peaked around 1 GeV/n, and these GCR include ions from protons to uranium (1), while X and γ-rays compose the main contribution of cosmic rays reaching Earth. It was calculated that a 3-years mission to Mars would lead to a dose exposure of astronauts’ whole body up to 1 Sv, which would considerably increase the radiation induced mortality up to 10% (2).Therefore, the precise estimation of the space radiation fields is of key importance. This radiation fields characterization is currently mainly achieved with computational models and Monte Carlo simulations. Although important improvements have already been done in these models, a significant lack of cross sections data of high-energy and charge particles (HZE) on tissue equivalent targets still exists (3). In a 2013 report, ICRP (International Commission on Radiological Protection) stated that cross sections data for light fragments and neutrons have to be completed in order to improve the simulation codes (4), to allow a better estimation of the dose received by astronauts for different mission scenarios.

The main goal of this prospective project is first to develop a dedicated experimental setup, based on IN2P3 expertise in nuclear and particle physics, allowing the measurements of total and double differential cross sections of HZE nuclear reactions on targets of interest (graphite, PMMA, Al2O3, …). The setup we think of will consist in a dual charged-neutral particle detector. A scheme of the setup is presented on Figure 1.



**Figure 1.** Scheme of the setup

On a second phase of this prospective project, we aim at implementing the measured data in the Geant4 Monte Carlo code. Indeed, the production of secondary particles in this type of code is usually handled by theoretical models, such as the binary cascade model for hadronic interactions. However, it was previously demonstrated that these models can present important discrepancies with experimental data, especially in the energy range of GCR (5–8). Therefore, the development of hadronic models based on experimental data is necessary before using these Monte Carlo codes for space radioprotection problematics (dose computation, radiation shielding development, …).

In addition to the important local expertise in instrumentation, the project will benefit from the existing contacts with the Biophysics department of GSI, with which we actively collaborate. Indeed, some of the experiments will be carried out in collaboration with the Space Radiation Physics group. Moreover, contacts were already established with John Norbury, who is the lead research physicist of Langley’s space radiation group (NASA). As a prospective project, the ambition is also to gather researchers and engineers from different existing teams on this new topic at IN2P3.

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