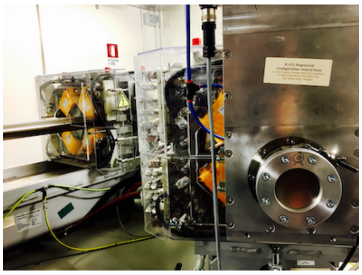

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Advanced solar particle event simulation at medical accelerators (CELESTIAL)

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Intense solar particle events (SPE) pose a significant risk to unsheltered astronauts and mission critical electronic systems. Over the duration of a typical SPE the whole-body dose in an unshielded scenario can reach more than 500 mGy and acute radiation effects like nausea and vomiting can occur. It is important to note that SPEs show large variations in dose depending on the specific energy distribution and fluences of a given SPE and the composition of the vehicle or habitat. In the EVA case, an astronaut is only offered minimal radiation protection by his/her space suit while during normal mission routine the astronauts are offered reasonable protection by their vehicle. Additionally, the high amount of radiation during an intense event can limit the lifetime of spacecrafts or satellite electronics and transient effects, like Single Event Upsets, can lead to irreversible system disruption.
To estimate the effects of SPEs on astronauts or electronics typically a serious of serialized monoenergetic proton beams provided by a high-energy particle accelerator are used. Due to the serialized approach effects created by the complex interplay of e.g. different proton energies impinging on the e.g. biological sample within a short time period cannot be assessed. To mitigate the limitations of the current SPE simulation approach, a 3d-printed modulator was designed to instantaneously emulate the full energy and LET distribution of protons of a given SPE. The designed modulator consists of two parts, a porous material (e.g. LN300) to broaden the energy distribution of the primary protons and a complex, 3d-printed steel modulator. In short, particles impinging on the complex modulator pass through different thicknesses of the modulation structure. Depending on the traversed thickness, energy loss and multiple scattering are modulated differently. This results in a spatial homogeneous radiation field after all particles traversed a sufficiently large air gap (around 30 to 60 cm).
Within this context, an experimental campaign to benchmark and optimize this SPE simulation concept will be presented and submitted in the near future to the TiFPA PAC. The general design philosophy, Monte Carlo simulations on the expected performance as well as the proposed benchmarking experiments will be presented.

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