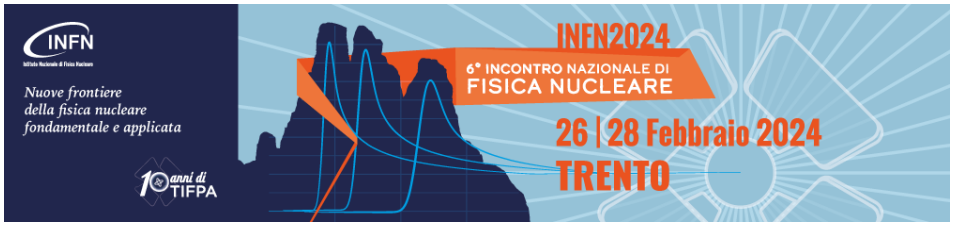

Contribution ID: **100** Type: **flash talk**

A model for particle beams response at Ultra-High Dose Rate including LET and oxygenation interplay effects

Tuesday, February 27, 2024 5:20 PM (5 minutes)

FLASH radiotherapy is a novel technique based on Ultra-High Dose Rate (UHDR) irradiation (i.e., an overall dose rate > 40 Gy/s for a single dose > 10 Gy), which allows obtaining fewer side effects on healthy tissue and unchanged tumor effectiveness with respect to conventional delivery. In recent years, much experimental evidence [Schüler et al. Med. Phys. (2022)] confirmed this FLASH effect; however, the underlying mechanism remains largely unexplained.

Since the involvement of multiple scales of radiation damage has been suggested [Weber et al. Med. Phys. (2022)], in particular, the crucial role of the chemical environment has been underlined, and the development of multi-stage tools capable of investigating this radiobiological effect is crucial. Therefore, in this context, we developed the MultiScale Generalized Stochastic Microdosimetric Model (MS-GSM2) [Battestini et al. Front. Phys. (2023)], that is able to capture several possible effects on DNA damage at the UHDR regime. In particular, we extend the GSM2 [Cordoni et al. Phys. Rev. E (2021), Cordoni e .al. Rad. Res. (2022)], a probabilistic radiobiological model, coupling the slow time evolution of DNA damages in a cell nucleus to the fast chemical reaction kinetics [Labarbe et al. Radiother. Oncol. (2020)], with the possibility of describing different levels of spatiotemporal stochasticity, in physics, in chemistry and biology (Figure 1).

We study the combined effects of several chemical species and the formation and time evolution of DNA damage, for different dose delivery time structures, oxygenation conditions, and radiation qualities, including high Linear Energy Transfer (LET) beams. We assume that UHDR modifies the chemical environment, which implies a reduction in the indirect DNA damage yield only at UHDR. Further, this effect is more pronounced at high doses (Figure 2), reproducing experimental evidence (Figure 3), such as the larger sparing of healthy cells occurring at the FLASH regime observed, for example, with Carbon ions [Tinganelli et al. Int. J. Radiat. Oncol. Biol. Phys.(2021)].

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