AbstractID: 8403 Title: Evaluation of radiobiological effects of carbon ion beams: mixed particle fields and fragmentation

Purpose: The purpose of this report is to investigate the effects on the Relative Biological Effectiveness (RBE) due to nuclear fragmentation during irradiation with therapeutic carbon ion beams, by using biological model calculations. **Method and Materials:** In order to disentangle the biological effects of the mixed particle fields, we evaluated the RBE originated by primary carbon ions and by fragments together and separately. The radiobiological efficiency of charged particles is mainly characterized by their high local ionization density which can be directly correlated to the local density of DNA damage. We developed a code based on the Local Effect Model (LEM) for the calculation of the cell survival after irradiation with carbon ions. As input we use particle distributions sampled at different depths in a water volume, for different energies of the primary ions (between 150 and 400 MeV/u), generated by Monte Carlo simulations using the package GEANT4. The computational effort was performed using the distributed INFN (Istituto Nazionale di Fisica Nucleare) Grid computing resources. **Results:** For carbon ions, high RBE values were found in the high-LET region (Bragg peak), as well as in the low-dose region, the distal region after the Bragg peak, where the contribution to the RBE is mainly due to fragments. We show that the global biological effect can be well reconstructed by a weighted combination of the alpha and beta parameters of the Linear-Quadratic Model (LQM) evaluated separately for primary ions and fragments. The analysis provided also an estimate of the RBE sensitivity to the uncertainties present in the experimental data of fragment yield. **Conclusion:** Our work estimated the impact of the fragments in hadrontherapy using carbon ion beams. Due to the high RBE values found, the resulting biological dose can be important in regions outside the irradiated target, in presence of organs at risk.