POSTUMA-1: Design of a neutron beam for BNCT treatment of deep-seated tumours and evaluation of its therapeutic potential and suitability

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The availability of neutron sources from proton accelerators is boosting the publication of Beam Shaping Assemblies (BSA) design to shape suitable beams for patient treatment. Until few years ago, the only guidelines were the in-air, free-beam parameters described in the IAEA TecDoc released in 2001. More refined analysis, testing the beams in anthropomorphic phantoms and in treatment planning of real clinical case have been proposed in the last years. More recently, radiobiological figures of merit, able to condensate in one parameter the effect of the three-dimensional dose distributions obtained in the treatment, have demonstrated to be a powerful analysis tool.

Starting from the neutron source obtained by the 5 MeV, 30 mA proton accelerator coupled to a beryllium target designed and manufactured by INFN, we designed an epithermal neutron beam. The aim was to project a clinical facility to be installed at the National Centre of Oncological Hadrontherapy (CNAO), Italy. Starting from several designed BSA, we applied different criteria to select the most adequate for a clinical scenario. In particular, we studied the therapeutic potential and the suitability. The *therapeutic potential* is evaluated by analysing the classical in-air free-beam characteristics and calculating a radiobiological figure of merit related to the therapy outcome. The *suitability* takes into account the safety of the beam, by evaluation of the peripheral dose absorbed by out-of-beam organs. This procedure allowed selecting the clinically most performing beam which also complies with the Italian radio-protection limits. This beam was then compared, through a treatment planning simulation, to a real clinical case who received BNCT in the past.

This work demonstrates that the physical characteristics of the beam are not sufficient to select a clinical BNCT beam: wider considerations are necessary to take proper decisions on the safest and most effective beam for patients.