Contribution ID: **161** Type: **poster preferred**

Dose Delivery performances with clinical carbon beams

Thursday, 18 October 2012 16:28 (1 minute)

Purpose: Centro Nazionale di Adroterapia Oncologica (CNAO) is treating patients since September 2011, with a 3D active beam delivery system, which irradiates the tumor using a large number of beam spots. The first treatments were performed with protons while the commissioning phase is ongoing with carbon ion beam. In vitro and in vivo experiments with carbon have been performed and the clinical treatments are expected to start within the next months. A detailed analysis on Dose Delivery performances with carbon and proton beams will be shown: the results in terms of difference between required spots (number of particles and positions of each spot) and delivered ones will be presented.

Methods: the CNAO facility is based on a synchrotron designed to accelerate and deliver proton or carbon ion beams optimized for clinical treatments. The delivery technique is the "quasi-discrete" active scanning where dedicated magnets are used to drive a pencil beam through the target and the beam is normally not switched off during the transition between adjacent spots. The DD is composed by five ionization chambers to check the spot position and the number of particles delivered during the treatment in order to achieve a dose distribution matching the prescription. The safety of the treatment relies on an interlock system able to interrupt immediately the beam in case of failure in the delivery process. Different sets of calibration for protons and carbon ions are used to correct detector sensitivity and to manage in accurate way the beam scanning.

Results: the single spot position and fluence accuracies measured with protons will be compared with those obtained in the carbon deliveries. The operational characteristics of the scanning system for different beam energies and particles are measured and compared. The safety and reliability of the system will be presented analyzing the interlocks and failures occurred. The stability of the calibration curves will be shown.

Conclusions: the Dose Delivery operational results measured at CNAO during the initial clinical experience with proton indicate a good accuracy, reliability and stability of the system. The commissioning phase of carbon beam will allow verifying if the same performances with clinical carbon beams can be achieved.

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Session Classification: Poster Session 3

Track Classification: Charged Particles in Medicine and Space Research