Commissioning and Quality Assurance of scanned beams produced by a synchrotron for particle therapy – *M. Ciocca, CNAO*

Scanned particle beams using intensity-controlled raster scanning technique and spill-to-spill active energy variation by the synchrotron have recently become available at our facility. Between March and August 2011, a fixed horizontal proton beam line was first commissioned, while the commissioning of carbon ion beams has been completed in summer of 2012. Fluka Monte Carlo (MC) code was extensively used to generate first the library of beam energies and foci, then part of the input physical database for the TPS (Siemens Syngo RT Planning, vers. VB10). For each of the available beam energies, laterally-integrated depth dose distributions in water were acquired using the PTW Peakfinder system. EBT3 radiochromic films and PinPoint ion chambers were used to measure spot sizes in air at different distances from the vacuum window, as well as dose transversal profiles in water at different depths. Beam monitors were calibrated using a Farmer-type ionization chamber (modified IAEA TRS-398 formalism) at the depth of 2 cm in water, exposed to homogeneous fields at 9 beam energies. QA tests included checks of field homogeneity, spot position accuracy, long-term constancy of beam energy and monitors, plan recovery from treatment interruptions, pt-specific pre-treatment plan verification. HU look-up tables for the CT scanner and each scan protocol were determined.

Close agreement between measured and MC calculated depth-dose curves was found (Ipot for water set to 77 eV, mean offset equal to 0.13+/-0.05 mm). For protons, spot sizes in air, at the isocenter plane, varied from about 7 to 22 mm (FWHM) for 226.9 and 62.3 MeV/u, respectively. Beam monitor calibration factor, in terms of number of particles per count, was measured at 9 different energies and interpolated to create a calibration curve. Dose daily changes observed in a period of more than 6 months were smaller than 1%. Using a scan step respectively equal to 3 and 2 mm for protons and carbon ions, field dose homogeneity in the transversal plane within 5% was found, as well as spot position accuracy within 1 mm. Range shifters and ripple filters were also configured in the TPS.