Description of the proposed experiments

Beam monitoring

Desired beam:

C-12, 62 MeV/amu, 10^8 s^{-1}
Protons, 80 MeV, 10^{10} s^{-1}

One goal of this part of the program is to verify the feasibility of evaluating the beam profile by placing a thin metal foil in the beam and by measuring the secondaries that reach a Medipix silicon detector, placed close to the beam.

Contrary to Medipix (which would not survive high beam intensities), the GEM detector can be placed directly in the beam. In particular, the triple GEM detector system has an extended dynamic range (up to 10^8 particles cm^{-2} s^{-1}) and is radiation hard (2 C/cm^2). In order to fully characterize the beam two GEM detectors will be used. The first detector will be specifically designed and constructed with a 128-pad readout for a total active area of 24x24 mm^2. This detector will be directly placed in the beam with the aim to measure its profile. The second detector, namely a TPC ionization chamber, was already tested in CNAO (Pavia, Italy) in June 2011 and will be used to measure the beam intensity and time profile.

Another objective of this project is to test a detector where the Medipix chip is coupled to the GEM detector (GEM-PIX, a Gas detector with highly pixelated readout). The Medipix chip is much more radiation resistant than the associated silicon sensor. In the GEM-PIX configuration, the silicon sensor of Medipix is either replaced by one or more GEM foils in gas, or it is coupled to a microchannel plate under vacuum. The feasibility of a 28x28 mm^2 GEM-PIX beam monitor will be assessed.

Passive measurements

Desired beam:

C-12, 62 MeV/amu, 10^3 s^{-1} and 2 pA

Stacks of CR39 will be placed in beam to measure the position of the Bragg peak. The track analysis system permits to evaluate the LET distribution and to obtain the adsorbed dose. Track detectors with wide area (tens of square cm) will be arranged to cover both the in-beam and the off-beam region. This permits to obtain a map of the dose delivered to healthy tissues. The results will be compared with the data obtained by other detectors in the frame of this experiment. Also thin track detectors will be used, in order to improve the spatial resolution along the beam axis.

Microdosimetry

Desired beam:

C-12, 62 MeV/amu, 1 pnA

The quality of hadron-therapy beams can be assessed through microdosimetry. The microdosimetric spectra give the absorbed dose distribution against lineal energy (a quantity which can be related to LET). These spectra will be measured in-phantom across the Bragg peak in order to assess the variation of the absorbed dose against LET. The spectra acquired with the silicon telescope microdosimeter will be compared with the ones measured with other microdosimeters, i.e. the SOI microdosimeter developed by UOW (see below) and possibly some of the detectors used for the measurements under point C. The absorbed dose values integrated over the microdosimetric spectra will be compared with the data measured with the other dosimeters employed in the framework of the present experiment. Measurements will be performed both in-beam and off-beam, the latter to assess the contribution of secondary particles to the dose in healthy tissues.

SOI microdosimeters will be used for measurements of dose equivalent out of field laterally and downstream of the SOBP. New microdosimeters with 3D sensitive volumes will be used in parallel with previous generation of planar SVs. RBE will be obtained in-beam and out of the field for different locations of the microdosimeters.

A first test will be performed with the newly developed GEM-PIX, in order to assess its potential use as microdosimeter.

Secondary dose distributions in and around phantom to patient

Desired beam:

C-12, 62 MeV/amu, 10^{8} s^{-1}

Protons, 80 MeV, 10^{10} s^{-1}

The distribution of secondary radiation around a small tissue equivalent phantom approximately equal in volume to an eyeball will be measured using Timepix and the newly developed GEM-PIX. These detectors can actively distinguish different components of the radiation field exiting the phantom by measuring the energy deposited in the detector and the shapes of the tracks. Neutrons can be measured through the use of converter foils. Measurements with carbon and proton beams will allow the direct comparison of the two detector technologies.