# AbstractID: 9097 Title: Study of the use of protons and carbon ions for patient imaging

**Purpose** An evaluation of protons and carbon-ions for generating radiographic images is performed. The contrast, signal-to-noise ratio, energy and spatial spread of protons and carbon ions passing through various tissues defined in ICRU were evaluated for different incident energies.

**Method and Materials** The Monte Carlo package GEANT4 was used to simulate the transport of protons/carbon-ions through different ICRU soft tissues such as: $H_2O$, lung, adipose tissue, soft-tissue, muscle, cartilage and cortical bone. Proton energies were 150-300 MeV and carbon ion energies were 360-500 AMeV. In order to study how the energy and the spatial spread of the beam varies for different thicknesses of ICRU tissues. The incident proton and carbon ions were pencil beam like with spot size of 1 micron-meter and with direction of motion perpendicular to the surface of the phantom. The spatial spread of exit particles is obtained from the standard deviation of the position of the exit particles relative to the center of the incident beam.

**Results** The spatial-spread of 200-300MeV protons and 360-500 AMeV carbon-ions passing through 20cm of soft-tissue, representing a typical body thickness, was respectively 2mm and 0.05mm. Carbon-ions allow significantly better spatial resolution than proton beams. The mean exit energy for protons and carbon-ions was respectively 87-223MeV and 113-320 AMeV. The energy spread of the protons and carbon-ions was respectively 5.1-8.0MeV and 1.28-0.91 AMeV. The contrast of 10mm of bone-to-soft tissue is 7.20%-2.1% and 59%-53% respectively for protons and carbon-ions.

**Conclusions** The spatial-resolution attainable with protons and carbon-ions passing through 20cm is respectively 2mm and 0.050mm. The significantly heavier carbon ions suffer less multiple Coulomb scatter within the patient than the protons and therefore can allow sharper images. Contrast of bone-to-tissue is higher in carbon-ions than in protons. The high contrast makes this tool attractive for online treatment-position-verification.