Influence of metallic implants on dose distributions during ion radiotherapy

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In cancer treatment, the application of proton and heavier ion beams present a promising way to improve clinical outcome. The number of ion beam therapy centers has a steep increasing tendency.

In clinical applications, approximately every second patient has implants of materials characterized by a high atomic number and density. These implants can lead to artefacts in CT scans and at least 10% of them are large enough to militate against the benefits of modern radiotherapy using charged particles by increasing the uncertainties in the determination of the particles' range. Since the effect of CT artefacts can have severe implications – for example joint implants in both hips can lead to the rejection of patients from proton and ion radiotherapy – this issue is in the focus of current research. To improve ion beam therapy treatment planning, the application of dual energy and or mega voltage computed tomography techniques have been studied for high Z materials.

In addition to artefacts on CT scans, metallic implants might cause dose perturbations and an increase production of unwanted secondary particles. It is not always possible to avoid irradiation implants close to organs at risk. Several studies have been performed on the effects of metallic implants on particle range and dose perturbations. Hitherto, there is no information about the influence on radiation quality (i.e. the linear energy and particle spectra) in close proximity of metallic implants. Since the biological efficiency (the "biological dose") and thus the clinical outcome of ion therapy is determined by this quality, reliable experimental data are of significant importance for the assessment of the risk factor posed by metal implants and the improvement of treatment in case of patients with implants.

The goal of the project is to study the influence of metal implants on dose distribution, beam quality, and additional production of secondary particles in proton and carbon ion beams used for radiotherapy of tumour. Solid track etched detectors (TED) will be used for experimental measurements, which will be accompanied by theoretical simulations using Fluka code. The results of the study shall confirm or exclude the possibility to introduce metallic implants into treatment planning system and allow such patients to be treated by proton and or carbon therapy.