AbstractID: 9024 Title: MR-guided radiotherapy: magnetic field dose effects

Purpose:
In cooperation with Elekta Oncology and Philips Medical Systems, we have designed a 6 MV radiotherapy system with 1.5 Tesla (T) MRI guidance during the actual treatment. In this system, the patient will be irradiated in the presence of a 1.5T magnetic field, which will influence the radiotherapy dose distribution.

Method and Materials:
The influence of the magnetic field on the dose distribution has been determined using GEANT4 Monte Carlo simulations on geometric water phantoms. The simulations have been validated by comparison to dose measurements in the presence of a magnetic field. Additionally, IMRT treatment plans have been calculated for three patient anatomies (prostate, larynx and oropharynx). Fluence optimization was performed on the basis of pre-calculated beamlet kernels, resulting in the optimal dose distribution with and without a magnetic field.

Results:
Results show that when irradiating in the presence of a 1.5T magnetic field, the build-up distance is reduced, the penumbra dose profile becomes asymmetric and the electron return effect (ERE) causes striking dose increase at all tissue-air boundaries due to electrons returning into the patient. The build-up distance and the ERE strongly depend on the surface orientation. Also, the ERE characteristics strongly depend on the magnetic field strength. The validation study shows that the GEANT4 simulations with magnetic field are in agreement to measurements within 3%. IMRT optimized dose distributions with and without a 1.5T magnetic field show that, in spite of all magnetic field dose effects, the same target coverage and sparing of organs at risk can be achieved with and without a 1.5T magnetic field.

Conclusion:
Irradiating in the presence of a magnetic field results in distinct magnetic field dose effects. However, using IMRT and multiple beam directions, a 1.5T magnetic field does not compromise the ability to achieve desired dose distributions.