AbstractID: 11807 Title: MR image susceptibility distortions: quantification of impact on the radiation treatment planning of cancer sites

Purpose
To investigate the impact of magnetic resonance (MR) image susceptibility-induced distortions on radiation treatment planning (RTP) of cancer sites.

Methods
We used a method relying on a) patient CT datasets are segmented into susceptibility relevant structures (soft-tissue, bone, air), b) susceptibility masks are generated by assigning bulk values to volumes from a) and magnetic field numerical simulations are performed using finite difference methods, c) magnetic field distributions are converted into corresponding distortion fields applied to subsequently warp CT images, and d) CT-based RT plans are generated and compared to corresponding CT+susceptibility plans, i.e. warped CT images. We used CT images instead of MR images to isolate the susceptibility effects. It is difficult to perform this analysis on MR images due to interference given by residual scanner-related distortions (especially for large pelvic volumes), chemical shift artifacts, and CT-MR image fusion errors.

Results
The susceptibility distortions were determined for several cancer sites, i.e. brain, prostate, abdomen, and lung, for magnetic fields of 0.2T, 1.5T and 3.0T. The maximum distortion decreases with the increase of read gradient strength and the decrease of main magnetic field. The magnitude of susceptibility artifacts also depends on the anatomical structures' shape and their orientation with respect to the applied field. Evaluating RT plans, it was found that 0.2T susceptibility distortions do not alter the plan accuracy due to a reduced distortion levels (within image resolution). At higher fields and/or low gradient strengths the accuracy of the plans decreased significantly. Tumor target dose coverage was insufficient and critical structures were exposed to higher dose levels.

Conclusions
The susceptibility distortions characteristic to several cancer sites were determined using numerical simulations and quantified for the RTP process. Depending on the scanning sequence, images may need correction to achieve spatial accuracy and ultimately ensure the efficiency of the RTP process.