AbstractID: 7406 Title: MVCT may reduce proton range errors in treatment plans for patients with metal implants

Purpose:
Treatment planning calculations for proton therapy require accurate knowledge of radiological pathlength, or range, to the distal edge of the target volume. Traditionally, the range is calculated using kilovoltage (kV) computed tomography (CT) images. Metal implants such as hip prostheses can cause severe streak artifacts that lead to large uncertainties in proton range. The purposes of this study were to quantify streak-related range errors and to determine if they could be avoided by using artifact-free megavoltage (MV) CT images in treatment planning.

Method and Materials:
Proton treatment plans were constructed for a simple heterogeneous phantom and for a prostate-cancer patient with a metal hip prosthesis using corrected and uncorrected kVCT images, uncorrected MVCT images, and a combination of registered MVCT and kVCT images (the hybrid approach). By examining the differences in the apparent required ranges calculated by the treatment planning system, the range errors associated with the streak artifacts were estimated.

Results:
In the phantom, the implant-related range uncertainty was estimated at <3 mm for both the corrected kVCT-based plan and the uncorrected MVCT-based plan. In the patient plan based on uncorrected kVCT images, streak-induced range errors of 5 to 12 mm were observed. Manually correcting the streaks reduced the range errors by about half. The hybrid planning approach yielded the best overall result because the kVCT images provided good delineation of soft tissues and the streak-free MVCT images provided smaller range uncertainties; subjective artifact corrections were not needed.

Conclusion:
The hybrid kVCT/MVCT planning approach allowed for good delineation of anatomic structures and resulted in smaller range errors relative to the kVCT-based planning approach. This was accomplished using existing radiotherapy systems and therefore may provide a practical method to manage range errors in patients with prostheses who will receive proton therapy.