for the MRIdian plans. The mean results and the standard deviations are summarized in the table.

<table>
<thead>
<tr>
<th>Standard Deviation</th>
<th>MRIdian</th>
<th>RapidArc</th>
<th>IMRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>V55 PTV (%)</td>
<td>6.4</td>
<td>5.6</td>
<td>6.9</td>
</tr>
<tr>
<td>V155 PTV (%)</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>V55 PTV (%)</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>V155 PTV (%)</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Mean Dose Bladder (Gy)</td>
<td>3.3</td>
<td>4.5</td>
<td>4.9</td>
</tr>
<tr>
<td>Homogeneity Index PTV</td>
<td>0.2</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Homogeneity Index PTV</td>
<td>0.2</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Mean Dose Bladder (Gy)</td>
<td>3.3</td>
<td>4.5</td>
<td>4.9</td>
</tr>
<tr>
<td>Homogeneity Index PTV</td>
<td>0.2</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Homogeneity Index PTV</td>
<td>0.2</td>
<td>0.4</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Conclusion: A comparable PTV dose coverage between the 3 plans was found for rectal cancer, with a HI advantage for the PTV1 for the MRIdian plan. Differences were described for OARs, especially for low dose areas (V5 Body). MRIdian allowed to reach dosimetric goals comparable to RapidArc and IMRT gold standards. The evaluation of a possible reduction in PTV margin and a proper target coverage by MRI based gating will be analyzed when the system will become operative at Gemelli ART.

OC-0081
Robust photon versus robust proton therapy planning with a library of plans for cervical cancer
K. Crama1, A. Van de Schoot1, J. Visser1, A. Bel1
1 Academic Medical Center, Radiotherapy, Amsterdam, The Netherlands

Purpose or Objective: The cervix-uterus shows large day-to-day variation in position and size, mainly depending on bladder and rectum filling. Image-guided adaptive radiotherapy with a library of plans (LOP) is a strategy to mitigate these large variations, resulting in less dose to organs at risk (OAR) compared to the use of a single plan with a population-based PTV margin. A further reduction of OAR dose can be achieved using proton therapy. However, it is challenging to achieve a target coverage that is robust for range and position uncertainties. The aim of this study is to compare target coverage of robustly optimized photon and proton therapy plans using a LOP adaptive strategy for cervical cancer.

Material and Methods: Five cervical cancer patients treated with photon therapy were retrospectively included. For each patient a full and empty bladder planning CT and weekly repeat CTs were acquired. Depending on the magnitude of cervix-uterus motion, one to three ITV sub ranges were generated by interpolation of the CTV delineations on full and empty bladder CT. Target and OARs were delineated on all repeat CTs. Robustly optimized photon (VMAT) library plans and proton (IMPT) library plans were generated with a prescribed dose of 46 Gy in 23 fractions to the ITV. For robust optimization, a position uncertainty of 0.8 cm was applied; for protons 3% range uncertainty was included as well. The plans were required to have sufficient target coverage (V95%≥99%) for both the nominal scenario and twelve scenarios with different range and position errors. Both for photons and protons the actual delivered dose was simulated. Repeat CTs were registered to the full bladder planning CT using bony anatomy, the best fitting library plan was selected and the dose was recalculated. The DVH for the whole treatment was estimated by adding and scaling DVHs. The target coverage was evaluated for the total CTV as well as the CTVs of the corpus uteri, cervix, vagina and elective lymph nodes.

Results: For the total CTV, on average, the V95% for the whole treatment was 99.9% (range 97.3%-99.8%) for photons and 96.3% (93.5%-98.1%) for protons. The V95% of the corpus uteri was 95.7% (86.3%-99.9%) and 88.7% (68.4%-99.9%) for photons and protons, respectively. Figure 1 shows a repeat CT with insufficient target coverage both for photons and protons. The elective lymph nodes received sufficient dose with photons, on average, V95% was 99.1% (98.1%-99.8%). With protons this volume decreased to 96.2% (94.9%-98.5%). For the cervix and vagina no differences between the use of photons and protons were observed.

Figure 1. Example of a recalculated dose distribution in a sagittal view. The CTV of the corpus uteri is the yellow structure, the CTV the orange structure. The top view is in the plane of the prostatic urethra. The green line represents the 95% isodose.

Conclusion: The robustly optimized proton therapy plans did not result in an adequate target coverage for all patients for the realistic robustness parameters used. For some cases the used LOP strategy is not sufficient to cope with the large movements of the cervix-uterus for both modalities. The impact of underdosing is larger using protons than using photons.

OC-0082
Validation of MR based dose calculation of prostate cancer treatments
R.L. Christiansen1, H.R. Jensen1, D. Georg2, C. Brink1,3
1 Odense University Hospital, Laboratory of Radiation Physics, Odense, Denmark
2 Medical University Vienna, Department of Radiation Oncology, Vienna, Austria
3 University of Southern Denmark, Institute of Clinical Research, Odense, Denmark

Purpose or Objective: Dose calculation is currently based on the density map provided by CT. However, for delineation of the prostate gland and organs at risk T2-weighted MR imaging is the gold standard. Dose calculation based on MR information would remove the need for a CT scan and avoid the uncertainty related to registration of the images. Pseudo-CT generation from MR scans has recently become available. This study investigates the validity of dose calculation based on pseudo CT created with commercial software (MR for Calculating ATtenuation – MRCAT) compared to standard CT based dose calculation.

Material and Methods: Seven high risk prostate cancer patients were MR and CT scanned. The clinical, curatively intended treatment (78 Gy in 39 Fx) using single arc VMAT was based on the conventional CT. From the MR scan pseudo-CT were created using MRCAT (Philips, Helsinki, Finland). To eliminate dose comparison uncertainties related to patient positioning differences between CT and MR rigid CT-MR
registration was performed. The VMAT plan was transferred to the pseudo-CT and dose calculation was performed using Pinnacle (V9.10). Pass rate of the Gamma index was used to evaluate the similarity of the dose distributions. The dose acceptance criterion was evaluated as a percentage of the prescribed dose applying 2%/2 mm and 1%/1 mm criteria.

Results: MRCAT was generated for six of the seven patients. One patients’ pelvic anatomy was not correctly recognized by the software model, which prohibited MRCAT reconstruction. Pass rates for both acceptance criteria are summarized in table 1. For 2%/2 mm, pass rates are high, above 97.6% for all analyzed structures. Even for the 1%/1 mm criterion, pass rates are generally above 97%. In patient 3, lower pass rates in PTV78, seminal vesicles and rectum are observed. For this patient the gamma values above one are located mainly in and around an air cavity in the rectum (see figure 1). MRCAT does not assign air density to air cavities inside the patient, leading to the observed dose differences. However, in the pelvic region it might be at least as good an approximation to treat air cavities as water due to the mobility of the rectal air during the treatment course. As seen in figure 1, gamma values above one are also present close to the surface of the patient, which is caused by differences in definition of the outer contour of the patient.

Conclusion: Overall the pseudo-CT based dose calculations are very similar to the CT based calculation for prostate cancer patients. The MRCAT software classifies internal air cavities as water density leading to dose differences compared directly to CT. In terms of the dose precision observed in this study the MRCAT is able to substitute the standard CT simulation, but a larger cohort of patients is needed to validate this finding. This will also reveal whether bone recognition capability is sufficiently versatile for standard clinical use.