Thorough dosimetric evaluation of optimization techniques with an anthropomorphic head phantom

T. Tessonnier, A. Rozes, P. Dutheil, A Batalla, A. Vela
Centre François Baclesse, Radiation Oncology, Caen, France

Introduction

The **Normandy Proton Therapy Center** began treating patients in July 2018, most of which were treated for brain tumors or superior head and neck with **SFO-IMPT** robust optimization technique. While most TPS validations are performed in homogenous media such as water or water-equivalent slabs (RW3), only few validations are performed using **anthropomorphic phantoms** prior to treatment. The extension to other localizations such head and neck, pelvis or utilization of new optimization techniques, such as MFO-IMPT, require thorough validation comparing **Monte Carlo** (MC) dose prediction of the TPS against **measurements**. Investigations using the **CIRS Anthropomorphic Head phantom** were performed. Several regions can be differentiated, such as homogeneous brain region after passing through skull, brain/bone interface, tissue/air interface, a neck region and a neck region with titanium inserts. This work is focused on the results between MC TPS calculation (RayStation, RaySearch Lab.) in a brain **homogenous region** or a **highly heterogeneous** region and **MatriXXOne** (IBA Dosimetry) measurements.

Methods

Several plans are generated and calculated with the TPS MC dose engine:

- **Homogeneous** region (figure 1-left):
  - **Robust optimized SFO-IMPT** (3%/3mm) with **1 beam** (0° or 40°)
  - **Robust optimized SFO-IMPT** (3%/3mm) with **2 beams** (0° & 40°) with different **Air Gaps** (5 , 15, 30cm)
  - **Robust optimized MFO-IMPT** (3%/3mm) with **2 beams** (0° & 40°) with different **Air Gaps** (5 , 15, 30cm)
- **Heterogeneous** region (figure 1-right):
  - **Robust optimized SFO-IMPT** (3%/3mm) with **2 beams** (0° & 40°)
  - **Robust optimized MFO-IMPT** (3%/3mm) with **2 beams** (0° & 40°)

Transverse 2D dose distributions are extracted at different depth (figure1)

Measurements are performed for each beam using the phantom associated to RW3 slabs and the **MatriXXONE** then compared to the 2D dose distributions using a **3%/1mm γ-index local** criteria (figure 2).

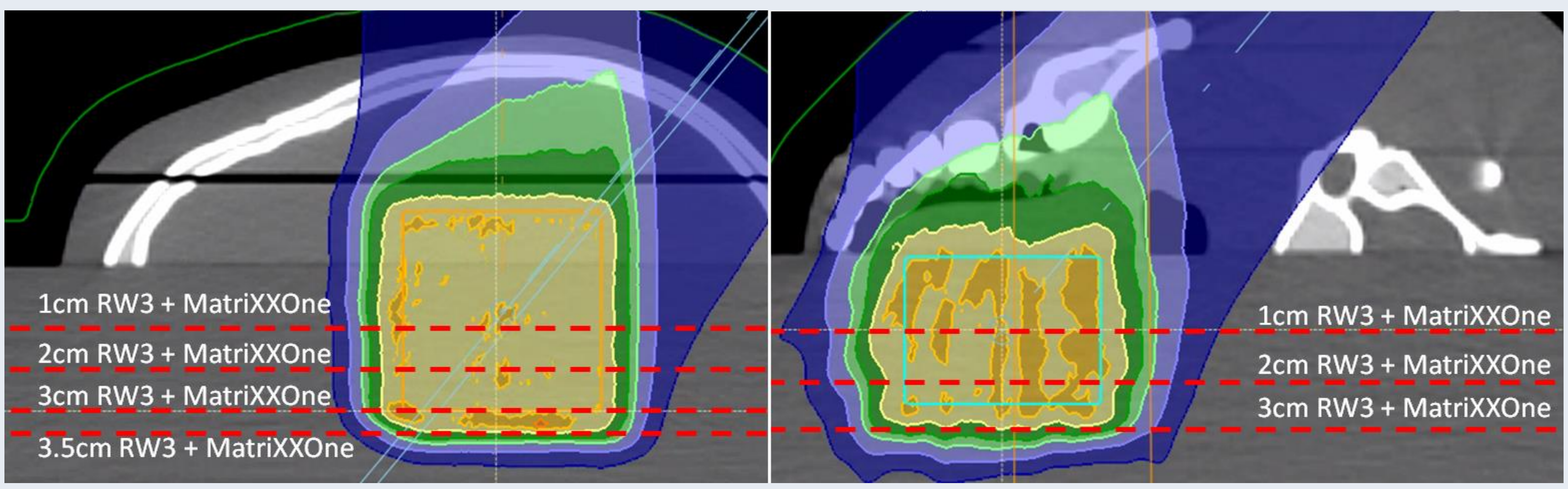

Figure 1: Left: Brain homogeneous region and its corresponding target. Right: Heterogeneous region and its corresponding target. Lines represent the extracted dose planes from the TPS.

Results

- For the homogeneous region, all measurements were having *a γ-index > 95%* (except for 1 measurement in the distal gradient), regardless of the optimization technique or the Air Gap.

- For the heterogeneous region, all measurements in the high dose regions were having *a γ-index > 95%*. Measurements in the distal fall-off show *a γ-index > 95%* for a 3%/3mm criteria.

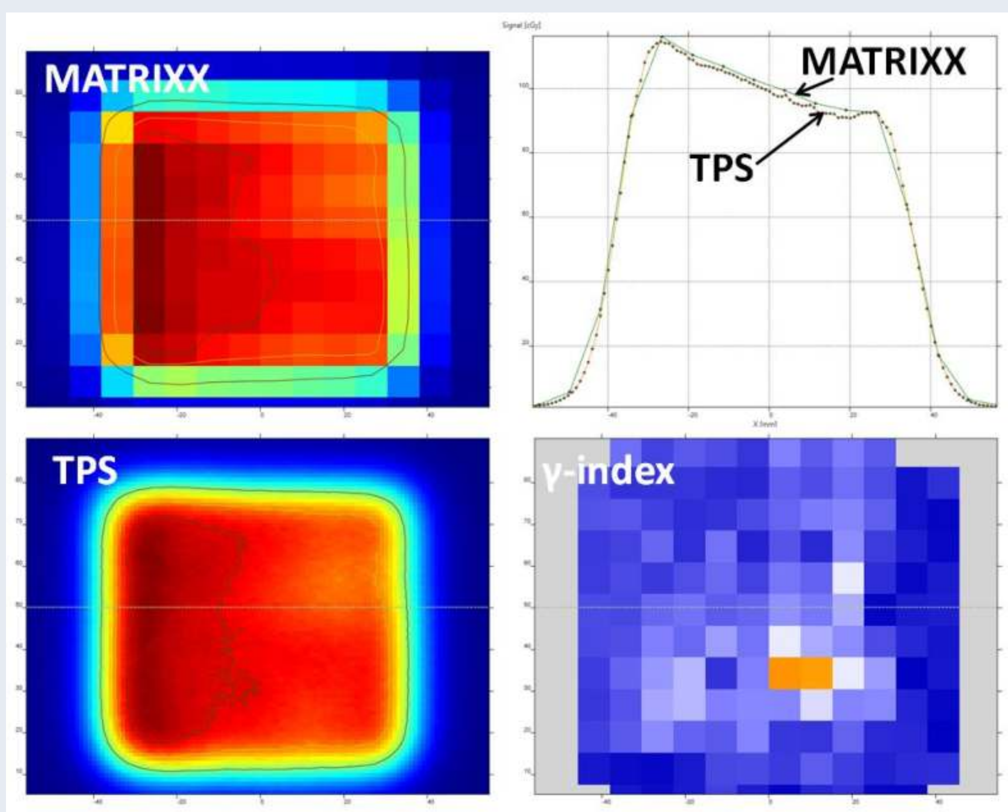

Figure 2: Example of a comparison between TPS and MatriXXOne dose plane for a SFO-IMPT plan. Dose profile and γ-index map are shown.

Conclusion

Good agreements were found between MC dose predictions and measurements. These results shows also the limits of the MatriXXOne when gradients start to be stronger such as in the distal fall-off, for these regions **other detectors** such as the Lynx could me more appropriate

For further information: *t.tessonnier@baclesse.unicancer.fr*
PTCOG 2019, Manchester