Contribution ID: **117** Type: **Oral**

In-vivo patient treatment verification with in-beam PET at the National Center for Oncological Hadron-therapy: inter-fractional data analysis using the gamma evaluation method

Wednesday 29 June 2022 11:40 (20 minutes)

Background and purpose: In-beam Positron Emission Tomography (PET) is one of the modalities that can be used for in-vivo non-invasive treatment monitoring in proton therapy. The INSIDE system, installed at the National Center of Oncological Hadron therapy (CNAO), has acquired in-beam PET data during several patient proton therapy treatments. Despite the fact that PET treatment monitoring has been applied in several treatment centers, there is still no straightforward method to translate the acquired images into easy to interpret information for clinical personnel. The purpose of this work is to apply the gamma evaluation method, mostly used to compare dose distributions, to in-beam PET images to identify regions where morphological changes occur in patients.

Methods: For our study we first simulated a series of PET data of a patient, that gradually changed during the treatment course, using the FLUKA Monte Carlo code. We studied how the PET signal changed and performed the 3d-gamma evaluation method to compare the PET images with a reference image without changes. Then we applied the 3d-gamma evaluation method to real PET data, acquired with the INSIDE system during the treatment of eight patients. The results of the gamma analysis were compared to the CT scan.

Results and conclusions: For the simulated patient, we found that it was clearly possible to locate the anatomical changes with the gamma evaluation method (Figure 1). Regarding the real data, despite the image artefacts typically present in in-beam PET images and the limited statistics, we found that it was possible to identify variations in patients.

In this presentation we show the most recent results of the gamma analysis applied to in-beam PET data analysis of simulated data, and a selection of new results obtained for **real patient in-beam PET imaging data** will be presented.

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Session Classification: Applications