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PENSSART, a new Monte Carlo system for quality control in radiotherapy

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Abstract: A new Monte Carlo system called PENSSART for PENELOPE Simulation for the Safety in Radiotherapy has been developed for quality control of the treatment plans. PENSSART is based on the 2006 release of PENELOPE that we have adapted to allow for the transport of particles in voxelized geometries. The new platform is built upon three main modules that help the user in the definition of the different control procedure steps. The purpose of this study was twofold. In a first part we have validated the beam implementation and the patient/phantom description in PENSSART. In a second part we have compared dose distributions obtained experimentally, with PENSSART and also with an algorithm usually used in clinical practice for treatment planning. The results demonstrate the usefulness of the developed system.

KEYWORDS: Monte Carlo simulation, PENELOPE, radiotherapy, TPS, quality control

I. Introduction

Radiotherapy modalities are now more and more complex and accurate dose calculations are essential for treatment planning. However, in presence of small field sizes and light densities, commercial treatment planning systems (TPS) often fail to predict accurate dose distribution. In this aim, we have developed a new Monte Carlo system called PENSSART for PENELOPE Simulation for the Safety in Radiotherapy.

II. Method

1. Description of the PENSSART system

The PENSSART system uses the 2006 release of the PENELOPE code (1) adapted to allow for the transport of particles in voxelized geometries.

2. Evaluation of the functionalities

PENSSART is in itself a TPS that uses PENELOPE to perform dose calculations in voxelized geometries. As PENELOPE has already been widely benchmarked against other codes (2), a special attention was paid to the benchmark of the major functionalities introduced in the PENSSART platform, i.e. the patient anatomy description and the beam settings implementation.

3. Comparison with measurements and evaluation of a TPS algorithm

Physical anthropomorphic phantoms have been used to compare measured and simulated radiation doses in the cases of breast and lung treatments. Measurements were performed with OSL dosimeters while the PENSSART system was used to determine dose distributions. Comparisons with the TPS dose distributions were also performed to determine the limits of the TPS algorithm used for the dose planning.

III. Results

Evaluation of the PENSSART functionalities will be presented as well as results of dose calculation for clinical configurations.

V. Conclusion

The results showed that the system did not introduce any bias in the dose calculation due to an error in beam settings or in geometry model. Moreover the system also allows determining the limits of a TPS algorithm in the cases of breast and lung treatments.

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