Conclusions: Results of this study suggest that a matching between our two gantries seems feasible, thus potentially allowing for a significant time saving in both TPS commissioning and clinical operations. We will test additional clinical indications to see whether the results of this study apply to all relevant treatment scenarios.

PO-0823
Evaluation of the accuracy of Cyberknife tumor tracking using gafchromic EBT3 films
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Purpose/Objective: The purpose of this study was to evaluate the accuracy of the Cyberknife tumor tracking system with gafchromic EBT3 films and triple-channel film dosimetry.

Materials and Methods: The CT scan of the Easy Cube Phantom (Sun Nuclear, FL) was acquired with the clinical parameters used for Cyberknife patients. The Easy Cube Phantom was mounted on the ET Gating Phantom (Brainlab, GE), which can move along the superior-inferior axis of the patient to simulate the respiratory motion of a lung tumor. A gafchromic EBT3 film was positioned between two slabs of the Easy Cube while a PinPoint ionization chamber was placed in an appropriate insert. 8 fiducial markers were inserted into the Easy Cube for the treatment set-up and for the tracking.

The synchrony tracking method was used for the template QA plan: the patient’s plan was recalculated on the Easy Cube phantom and centred in the sensitive volume of the ionization chamber. The dose distributions were calculated with Ray-Tracing algorithm.

The EBT3 films were calibrated with a 6 MV linear accelerator (Triology, Varian), from 0 to 15 Gy.

A total of 8 patients were evaluated statically (no motion of the ET Gating Phantom) and in different dynamic conditions (e.g. motion amplitude from 10 to 25 mm), for a total of 40 cases.

The films were scanned using an Epson 10000XL scanner (transmission mode, 48-bit colour, 96 dpi resolution) and the planar dose distributions were built with the multichannel film analysis performed by the FilmQA Pro software (Ashland, NJ).

Calculated and measured planar dose distributions were compared with the gamma analysis method, both in static and in dynamic irradiation conditions. The local gamma passing rates (%GP) were evaluated using three difference acceptance criteria: 3% 3mm threshold (TH) = 10%, 2% 2mm TH = 20% and 2% 1mm TH = 50%.

PinPoint absolute dose measurements were also compared with the TPS doses, calculated in the sensitive volume of the chamber.

Results: The percentage of treatments passing the gamma analysis (95% of dose points that comply the acceptance criteria) was 100% for all the three criteria. The %GP ± SD were 99.8 ± 0.2 for the 3% 3mm criteria, 95.8 ± 2.0 for the 2% 2mm and 97.2 ± 1.2 for the 2% 1mm criteria. No significant differences were found between the static and the dynamic cases. The percentage differences between calculated and measured PinPoint dose range from -1.0 to 7.5 with a mean value of 4.0 ± 2.8.

Conclusions: Preliminary results obtained with EBT3 gafchromic films and the triple-channel analysis show an excellent agreement between calculated and measured dose distributions in all the cases. First of all, we can definitely assert that this is an efficient method for pretreatment patient-specific QA. Furthermore, no significant differences were found between the static cases and the different motion conditions, confirming the validity of this method to evaluate the accuracy of Cyberknife tumor tracking system.

PO-0824
Influence of the biological target volume modeling on ionization cluster-size distributions using Geant4-DNA
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Purpose/Objective: The aim of this study was to evaluate the influence of the geometrical detail of description of the biological target volume on the topology of ionization clusters induced by protons and alpha particles of different energies using Geant4-DNA. A simplified geometry would have the advantage of speeding up calculations but may lead to inaccurate results compared to a detailed DNA model.

Materials and Methods: Two geometrical descriptions of the biological target volume at the level of a single chromatin fiber containing 18·10^3 base pairs (bp) have been considered for the Monte Carlo calculations. The detailed geometry (GeomHist) included a realistic molecular description of the DNA double helix (2.3 nm diameter) wrapped around cylindrical histones. Based on the assumption that relevant
biological damages occur within short segments of DNA, the simplified geometry (GeomCyl) was modeled as 10 bp-long homogeneous cylinders (2.3 nm diameter and 3.4 nm height) randomly placed within the chromatin fiber volume. Ionization clusters were revealed by the DBSCAN algorithm according to a proximity criteria among energy transfer points separated by less than 3.4 nm (i.e. 10 bp). Cluster size probability distributions, deposited energy, and spatial extension of clusters were compared for the two geometries. Results: The total number of clusters was comparable (differences, Δ, <5%) for both protons and alpha particles with LET>50 keV/μm. For lower LET values a larger number of clusters was found in the GeomCyl geometry (Δ up to 20%). The mean ionization cluster size increased linearly with LET, and was found to be systematically larger in the GeomCyl geometry (Δ of 6-7%) regardless of radiation quality. Similarly, the mean energy deposited per cluster was higher (up to 20%) in GeomCyl. The spatial extent of energy transfer points within clusters was systematically larger for GeomHist; the modeling of the DNA in GeomCyl as segments of constant length prevented the gathering of additional ionizations afforded by the DBSCAN algorithm, thus leading to clusters with a higher density of ionizations compared to GeomHist. Conclusions: The two geometrical descriptions of the scoring volume led to significantly different ionization cluster-size distributions for both protons and alpha particles. The use of the simplified geometry led to more complex clusters compared to the detailed geometry. The modeling and arrangement of the DNA molecule significantly influences the frequency distributions, energy deposited and spatial extent of ionization clusters, from which strand breaks and higher-order biological endpoints are estimated.

PO-0825
Monte Carlo model for IOERT dose distribution studies
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Purpose/Objective: Intra-Operative Electron Radiation Therapy (IOERT) is a radiotherapeutic technique that uses high energy electron beams during surgical interventions to directly irradiate tumoral tissues, while minimizing the dose in adjacent sensitive tissues. The use of electrons is preferred due to their short range and low penetration. In abdominal or pelvic IOERT, shielding is sometimes used to partially block the radiation field. This work is the basis for the study of the influence on dose distributions of various factors that frequently occur in pelvic IOERT. Here, the effects of shielding, as well as the impact of irradiating non-flat surfaces will be addressed.

Materials and Methods: Treatment planning for IOERT procedures is based on measurements performed in reference conditions, on the depth of tissue to be treated. However the dose distribution is altered by shielding, and by the geometry of the irradiated area. To evaluate these effects, the Monte Carlo simulation codes BEAMnrc and EGS++ were used to model a Varian Clinac 2100 CD linear accelerator, its hard docking system, and the IOERT applicators. Our model is validated with respect to measurement of dose distributions in a homogeneous water phantom (reference conditions). Percentage depth dose (PDD) curves and transversal dose profiles, at different depths, were measured for three different IOERT applicator diameters (6, 7 and 8cm), three energies (6, 9 and 12MeV) and four bevel angles (0, 15, 30 and 45°).

After validation, phantom measurements were performed in a situation with a lead shield placed in the beam field. This configuration was simulated and the results compared. Also, a situation where the IOERT beam irradiates a water equivalent volume with non-flat surface was modeled.

Results: All possible configurations of IOERT applicator diameter, energy and bevel angle were simulated and the results analyzed using the gamma index. Some results are shown in figure 1. The simulation results show a good agreement with experimental measurements, with 98.3% of analyzed points within gamma < 1, using a 2% difference dose and 2mm distance to agreement (DTA) as validation criteria. Comparisons between simulation and measurement for partial lead shielding situation were performed. Finally, the simulated dose distributions for IOERT beam irradiating both curved and flat surfaces were studied (a comparison in shown in fig 1c).

PO-0826
Novel epitaxial silicon array for small field dosimetry
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Conclusions: A IOERT Monte Carlo model was implemented and validated by comparing the numerical data with measurements acquired at different beam energies, applicator diameters and bevel angles. The validation was quantified by gamma index analysis. The potential of this tool is exemplified by the study of dose distribution distortions when the IOERT beam irradiates a curved surface, and when shielding elements are introduced in the beam field. Further studies are in progress.