**Purpose or Objective:** Treatment planning systems for IORT (intraoperative radiation therapy) are able to predict the absorbed dose in the patient only when their algorithm precisely considered the dosimetric characteristics of electrons like energy fluence, angular distribution, etc. Hence, the main objective of the present work was to study the contribution of direct (electron component without interaction with the collimator) and scattered electrons to the energy fluence distribution, fluence and mean energy of total electrons.

**Material and Methods:** Different electron energies of 3, 5 (low energies), 7 and 9 MeV (high energies) at cylindrical field size of 40, 50 and 100 mm of a dedicated mobile IOERT linac NOVAC7 (SIT, Vicenza/Italy) were investigated. For analysis, the phase-space file generated by Monte Carlo code BEAMnrc including the LATCH variable, for specific energy and applicator, was used by the BEAMDP Monte Carlo user code. The LATCH variable is a 32-bit variable to track the history of particles. On the other hand, BEAMDP was used to obtain energy spectra, fluence and mean energy of the direct and scattered electrons at the phantom surface for different applicator diameters.

**Results:** It was in general observed that the energy fluence distribution of electrons did not change significantly with decreased applicator diameter. Furthermore, it was shown that the contribution of the direct and the scattered electrons on the total fluence changed depending on the applied energy moving from central axis toward the applicator wall. With respect to the fluence of direct electrons the contribution of the scattered component was much lower on the beam axis but increased significantly near the field edge. This is mainly due to the huge increase of interaction events occurred inside the therapeutic beam between electrons and applicator wall. It was also found that, the mean energy of scattered electrons increased intensely decreasing the applicator diameter up to about 28%. Due to the increased number of scattered electrons (higher fluence) and the larger energies of scattered component in the energy spectrum, the mean energy value of scattered electrons increased.

**Conclusion:** Significant results regarding the behavior of different electron components were found. It was shown that the fluence and mean energy of different electron components increase at larger energies and smaller applicators especially in the vicinity of the applicator wall. This could be useful to interpret dosimetric difficulties encountered working with such IOERT linacs. Furthermore, it is expected that the results discussed here support for accurate patient dose calculation in an IOERT treatment planning system. Moreover, these results can be employed to chamber simulation regarding the determination of perturbation correction factor.

**EP-1572**

**Effective target spot size and grid size for acuros algorithm on penumbra and delivered dose**

**Purpose or Objective:** Purpose of the study is to analyze how penumbra and the delivered dose vary with the effective target spot size and grid size.

**Material and Methods:** Acuros beam model was configured for Varian TrueBeam 6 MV. ‘Beam Data’ section of ‘Beam Configuration’ of Eclipse 11 treatment planning system (TPS) was used at configuration of Acuros with different spot sizes (0, 1, 2 mm). Beam Analysis section was utilized to evaluate profiles of 4 fields (2x2, 3x3, 10x10 and 15x15 cm) at 5 depths (1.5, 5, 10, 20, 30 cm) with 4 grid sizes (1.0, 1.5, 2.0, 2.5 mm). To perform analysis, penumbra of 80 profiles were calculated and compared with the measured profiles. A virtual water phantom and the same fields were prepared at TPS to calculate output factors at two different setups. The first has a Source Surface Distance (SSD) of 100 cm and depth is 1.5 cm. The second one’s the depth is 5 cm while SSD is 95 cm. Profiles were measured at SSD of 100 cm with Edge detector while output factors measured with PTW pinpoint detector. Average of 4 fields of each spot size and grid size in units of percent was used to analyze the overall performance of the variables.

**Results:** All of the errors at each output are less than 1 %. Minimum average error in the first case was found to be 0.29 % when the grid size of 1 mm and the spot size of 2 mm were used. Furthermore, maximum average error was 0.51 % when the grid size of 2.5 mm and the spot size of 2 mm were used. In the second case, maximum average error was 0.31 % when the grid size of 2.5 mm and the spot size of 0 mm. Minimum average error was calculated to be 0.05 % when the spot size of 2 mm and the grid size of 2.5 mm were used. Noting that the profiles of 15x15 field cannot be calculated at 1 mm grid size due to the TPS hardware requirements. Error in penumbra reaches as high as 6.6 mm. Maximum average penumbra error is nearly 2 mm. Change of average errors of the profiles and the maximum errors of each grid with the target spot size is given in table.

**Conclusion:** It is understood from the results that the output factors and the profiles can be analyzed separately as the variation of the outputs with the grid size and the spot size is negligible. Moreover, it is observed that penumbra of fields at different depths varies with the spot size and the grid size. Therefore, medical physicists have to take into account during the commissioning of the algorithm. The method defined in this study is quite precise, sensitive, easy and effective to analyze the spot size and the grid size.

**EP-1573**

**Validation of a dedicated Intra-operative radiotherapy TPS: an innovative tool for image-guided IORT**

**Purpose or Objective:** The Image Guided Intra-operative Radiotherapy (IGIORT) is a new methodology based on the planning optimization using intra-operative target images acquired after surgery. The dedicated Treatment Planning System (TPS) CSRAD+ has been developed in order to plan intra-operative radiotherapy treatments for patients with malignant diseases as clinically appropriate, using a dedicated mobile accelerator and an imaging device. The CSRAD+ performs IORT dose distribution calculation relying on pre-treatment and intra-operative DICOM, RT images. The aim of this work is to validate the dosimetric output and the performances of CSRAD+ before its introduction in clinical practice.

**Material and Methods:** The home-made CSRAD+ allows to calculate the dose distributions of a IORT dedicated mobile linac for each energy, applicator diameter and bevel angle in water using a cartesian grid with a 2 mm resolution, using Monte Carlo data stored in a database as look-up tables. Two dose calculation algorithms have been implemented both with and without inhomogeneity corrections. The DICOM images of the representative phantom test cases were acquired using a dedicated CT Scan. The calibration curves were loaded in both the CSRAD+ and in the EGSphant module.
Comparison between Monte Carlo (a), Gaf Chromic films (b) and TPS (c) dose distributions: 10 MeV electron beam in an homogeneous phantom at four different depths

Conclusion: The developed tool allows independent validation of algorithms implemented within CSRAD+ and MC for absolute dose calculations. The method can test patient-like geometries and more complicated setups.

Purpose or Objective: Linac or pre-treatment quality control applications are now commonly based on electronic portal imaging device (EPID) acquisitions due to the high spatial resolution and the ease of use of this detector. Several commercial solutions are available depending on the application. Indeed, commercial algorithms assume the EPID grey level is related to the absorbed dose delivered by the treatment beam. This hypothesis leads to the introduction of correction factors depending on geometric and beam conditions. Consequently, those algorithms are dedicated to a specific application. The goal of our work was then to develop an algorithm able to convert an EPID image into an absorbed dose to water matrix from a single model by energy beam. The study compared our algorithm EpiDream to EpiDose (Sun Nuclear), a commercial solution for EPID dosimetry.

Material and Methods: Two 6MV beams produced by two Clinac (Varian) equipped with AS1000 EPID were included in this study. EpiDream model was based on a set of homogeneous calibration acquisitions to establish a relation between the grey level and the absorbed dose to water for each acquisition frame at a reference depth and a specific arm-backscatter correction. The algorithm yielded to dose to water matrices for all type of fields used in routine (homogeneous fluence, IMRT and VMAT) at 5cm depth in water. EpiDose models were generated for IMRT and VMAT pre-treatment quality controls, applying first the RT Plan to the acquired image to compute the EPID based dose matrix. EpiDream and EpiDose models were compared for 14 VMAT and 19 IMRT (Eclipse V10) pre-treatment quality controls using gamma pass rates (3%, 3mm). Moreover, the robustness of both algorithms was evaluated first, using gamma pass rates (2%, 2mm) for homogeneous fluence beams and second, using a fake RT Plan to convert EPID images into absorbed dose.

Results: The test cases were reproduced experimentally and the reference measurements were performed with the LIAC mobile IORT accelerator. The proposed test cases have shown a good agreement between measured and calculated dose distributions (at the surface, at the build-up depth and in clinically relevant points corresponding to the isodoses of 90% and 80%) in all the experimental setups containing both horizontal and lateral inhomogeneities, as reported in the figure for the homogenous phantom test case.

Results: For the modulated plans, the g-comparison led to a very good agreement between both EPID based dose matrices. The success rate was respectively 98.5±2.4% and 98.0±1.7% for VMAT and IMRT fields. Using the same models, the homogeneous beams comparison showed large discrepancies, with a low gamma pass rate (86.6±2.1%). However, EpiDream presented a good agreement with Eclipse RT Dose matrices (97.1±1.2%). So, unlike EpiDose, EpiDream can be used for many controls with a single model. In addition, as EpiDose converted the image into dose using some data extracted from the RT Plan, a fake RTPlan led to a large error in the dose matrix. EpiDream algorithm, only based on the acquired image provided correct dose matrix. Discrepancies between both models were high with a gamma pass rate equal to 89.7±5.7%.

Conclusion: The EpiDream solution allows us to perform the quality control tests for machine and patient in a single application. The independence of the model with the irradiation conditions, except beam energy, ensures computing more consistent absorbed dose matrices compared to other algorithms.

EP-1575
The effect of dental implants on dose distributions calculated by AXB in head and neck IMRT cases
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Purpose or Objective: Acuros XB (AXB) has been implemented and available commercially for clinical use for several years. Different authors have reviewed the algorithm and demonstrated that AXB shows superior performance in dose estimation accuracy. In some cases, patients may be implanted with high density materials, AXB solves the deterministic solution of linear Boltzmann transport equation, in which the Hounsfield unit and the type of material must be input in order to calculate the dose distribution. However, there are only a few studies to evaluate the effect of high density material on dose distribution by AXB, and clinical data is still lacking. Moreover, most of the clinicians may not know the material of the dental implants. The universal assignment of material for permanent high density dental implants may contribute an uncertainty to the dose calculation. Thereupon the current study aims to investigate the impact of dental implants on dose distributions calculated by AXB in Head and Neck (HN) IMRT cases and hence provide clinical suggestion to unknown dental material assumption for planning.

Material and Methods: Three materials were evaluated, namely: titanium alloy, zirconia and stainless steel. 50 patients with dental implants and treated with H&N IMRT were evenly divided into two groups according to the location of implants. AXB was used to recalculate the dose distribution, originally computed using Analytic Anisotropic Algorithm (AAA). The dosimetric data among material models were compared statistically. In addition, the dose distribution calculated by AXB were verified with measurements of parallel plate ionization chamber, radioluminescent films and Gamma analysis.

Results: There were no sig. differences (P>0.05) among material models in the Planning Target Volume (PTV)