influence of dose resolution (re-sampling of the simulated dose distribution to the detector resolution) on gamma result. Clinical relevance of such MLC errors should be also investigated.

**EP-1600**

VMAT lung SBRT: 3D evaluation in pretreatment patient QA and in vivo dose verification

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**Purpose or Objective:** SBRT requires patient specific-QA with high spatial resolution, stability and dynamic range. EPID dosimetry has been proved to be efficient to give accurate results for both conventional and special treatments. In this work, a commercial QA software is used for a lung SBRT clinical case to obtain 3D dosimetry from fluences measured by EPID gantry angle-resolved data acquisition. The purpose is to obtain information on actual delivered dose to the tumor volume and surrounding critical structures in terms of clinical dosimetric parameters which are meaningful for both physicians and physicists.

**Material and Methods:** VMAT SBRT lung treatment is planned by Varian Eclipse planning system using ACUROS algorithm. Treatment is delivered using a Varian 2100CD linear accelerator’s 6 MV x-ray beam. Fluences are acquired on a Varian aSi1000 EPID. Dosimetry Check (Math Resolutions LLC) is a commercial QA software performing 3D treatment plan verification: the necessary measurements for the exit image kernel for SBRT includes EPID images of various field sizes (minimum field size: 1x1 cmxcm). Fluence maps acquired on the EPID during pre-treatment QA and patient treatment are separately applied to the patient’s CT. Agreement between planned and delivered dose distributions for patient-specific SBRT quality assurance is assessed for a lung case utilizing the gamma index method ad dose volume histogram (DVH)-base metrics. The stereotactic approach requires a tight margin: the distance to agreement criterion is set to 1mm. The dose difference is set to 3% if a homogeneous phantom is used and 5% for calculations on a heterogeneous CT set.

**Results:** Results include 3D gamma evaluation and dose volume histogram (DVH). Volumetric, planar, and point dose comparison between measured and computed dose distributions agreed favorably indicating the validity of technique used for VMAT SBRT QA. Gamma pass rate in axial, coronal and sagittal plane through the isocenter is respectively 93.4%, 86.3% and 95.1% for pretreatment QA; 92.8%, 82.6% and 76% for in vivo QA. 3D values are 89.4% and 90%. Significant clinical structure values from DVH are shown in Table 1.

**Conclusion:** An efficient procedure of verifying VMAT lung SBRT plans with high accuracy has been obtained. Results from a clinical case are presented in terms of doses to the anatomical structures and in terms of gamma evaluation. Dosimetry Check system employs a pencil beam algorithm in order to calculate dose from fluence measurements taken with the EPID. It can be assumed that some dose differences will arise from the pencil beam algorithm used in Dosimetry Check and the more sophisticated algorithms used in TPS. Differences may depend on the level of heterogeneity of the anatomical site. Further research is needed to assess these differences.

**EP-1601**

Dosimetric consequences of using two common energy matching techniques in Monte Carlo

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**Purpose or Objective:** The aim of this abstract was to report the observed differences between measured and Monte Carlo (MC) calculated dose distributions when using common incident electron energy matching techniques.

**Material and Methods:** PDDs and profiles on a 6MV Elekta Precise linac were acquired in a PTW MP3 watertank with a semiflex chamber (0.125cm3) at 90cm SSD. A MC model of the linac was created in BEAMnrc. Phase Space files were scored at 90cm from the target at a plane perpendicular to the direction of the beam. The phase space files were used as an input into DOSXYZnrc to calculate dose in a water phantom (60x60x30cm2, 90cm SSD, voxel size=0.3x0.3x0.3cm3). The incident electron beam was set to have a Gaussian distribution with a FWHM in the GT and AB directions of 1.92 and 2.42 mm respectively. The energy spectrum of the incident electron beam had a FWHM of 0.5MeV and an energy window of ±0.6MeV. The mean energy of the incident electron beam was determined in two ways: Method 1:

The mean energy of the electron beam was varied until the calculated CAX PDD matched the measured for a 10x10cm2 photon field (between 5-25 cm). 40x40cm2 dose profiles (90cm SSD, 10cm deep) were subsequently calculated and compared to measurement. Method 2:

The mean energy of the electron beam was varied until the calculated 40x40cm2 dose profiles matched the measured profiles to within 0.5% (within 80% field width). A 10x10cm2 CAX PDD (90cm SSD) was subsequently calculated and compared to measurement.

**Results:**

**Results - 1:**

The agreement between calculated and measured 10x10cm2 CAX PDD was best (between 5-25cm) for an incident electron beam mean energy of 6.65MeV. The resultant 40x40cm2 profiles at 90cm SSD, 10cm deep, revealed a reduction in the dose homs of 4% in comparison to the measured profile (Figure 1).

**Results - 2:**

The agreement between calculated and measured 40x40cm2 profiles at 90cm SSD, 10cm deep was best for an incident electron beam with a mean energy of 6.2MeV. The resultant CAX 10x10cm2 PDD revealed an agreement to within 1% (between 5-25cm) of the measured PDD.

![Comparison of 40x40cm2 profiles for the mean electron energy determined using both methods](image-url)
Conclusion: The MC model of the linac revealed that CAX 10x10cm2 PDDs are not very sensitive to changes in the mean energy of the incident electron beam. However 40x40cm2 profiles reveal a high sensitivity to changes in the mean energy of the incident electron beam. The use of 10x10cm2 CAX PDDs to match the mean energy of the incident electron beam can result in undesired differences between measured and calculated 40x40cm2 profiles. However using 40x40cm2 profiles to match the mean energy of the incident electron beam can provide an overall better match to measurement of both PDDs and profiles.

EP-1602
Redefinition of the Electron beam treatment parameters for IORT applications
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Purpose or Objective: The large number of conventional electron accelerators on the market (we estimate it around 5000) far exceeds the small, but growing number of mobile IORT linacs suitable for unsheilded operating rooms. In this paper we discuss the technical aspects of the treatment beams produced by such small mobile IORT linacs. Beam parameter characterization for such machines need to be redefined in order to better reflect mobile IORT applications and provide basis for future technological development in the industry.

Material and Methods: Using currently accepted industry standards, we compared the following electron treatment parameters of conventional and IORT linacs. Treatment field size and shape, Penetration depth, Surface dose, Beam Penumbra and Flatness.

Treatment on angular surface
Beam Penumbra and Flatness
Surface on the angular surface
Penetration depth
Surface dose
Bevel
Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conventional</th>
<th>Mobile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment field size and shape</td>
<td>Steady - 10x10 cm is used and is controlled by the collimator and the position of the applicator.</td>
<td>Size of the field is less than 10 cm, often 4-6 cm on diameter. Usually collimated, but some oblong applications are available</td>
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<tr>
<td>Treatment on angular surface</td>
<td>Soft edges placed on the patient surface can compensate for inhomogeneous distributions of dose within the field</td>
<td>All IORT applicators have a beam of 4 cm wide penumbra might lead to as much as 30% of the treatment volume being either underexposed, or “not properly accounted for”</td>
</tr>
<tr>
<td>Penetration depth</td>
<td>Quantized with about 1 cm step (0.5 cm equivalent)</td>
<td>Quantized with about 1 cm step (3 cm equivalent)</td>
</tr>
<tr>
<td>Surface dose</td>
<td>There are always a tendency to reduce surface dose to spare the skin</td>
<td>Surface dose should be as close to 100% as possible to provide optimal treatment</td>
</tr>
<tr>
<td>Flatness</td>
<td>Bevel generally quite flat</td>
<td>Bevel generally less flat, Steamed flatness definitions are often non-applicable</td>
</tr>
<tr>
<td>Penumbras of the beam</td>
<td>Treated to a 5 cm distance. Due to the high gradient inside the treatment area, penumbras of the beam only affect exposure of the healthy tissue outside for treatment field.</td>
<td>Treated in contact with the tissue. Medium applicator provides almost 100% reduction of the tissue inside the applicator, and penumbras now affect cold spots inside the applicator</td>
</tr>
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</table>

Table 1. Comparison of the critical beam characteristics for conventional linacs and mobile IORT linacs.

Results: The following key beam parameters are either not controlled at all for IORT, or controlled in a way that is not very clear and effective. Flatness of the beam: Not well defined. For the applicators 6 cm and below current flatness definition produces no sensible beam characterization. Penumbra: Not well defined. For beam sizes under 6 cm, the 1 cm wide penumbra might lead to as much as 30% of the treatment volume being either underexposed, or “not properly accounted for” PDD drop off and Surface dose: Not controlled. PDD curve can change significantly as a function of field size and energy spectrum. An ideal monoenergetic beam has parameters which are not desirable in most IORT treatments. Effective treatment volume: Not defined or controlled. Very critical parameter. Ratio of the treatment volume with delivered dose above treatment threshold (e.g. 90%) to the nominal treatment volume can be as low as 30% if cold spots are not properly accounted for. Beveled applicator characteristics. Not defined or controlled. Procedures for testing of beveled applicators are very vague, not defined, and what definitions do exist are not very useful.

Conclusion: In order to properly redefine critical IORT beam parameters we present newly defined parameters such as controlled Flatness, PDD drop off, Surface dose and Effective treatment volume. When defined and controlled, these parameters will allow engineering teams to optimize the parameters of the treatment devices and provide the superior beam characteristics to improve treatment results. We also propose unified beveled and oblong applicator measurement protocol to summarize the knowledge currently present in the field.

EP-1603
Improved performance of the Varian TrueBeam Portal Dosimetry system for large fields
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Purpose or Objective: The performance of the Portal Dosimetry (PD) used for pre-treatment verification is affected by the beam profile correction used in the MV imager dosimetry calibration. This study evaluates a method to improve the performance of the TrueBeam PD system.

Material and Methods: A 40x40 cm2 diagonal profile measured at dmax is used as part of the imager calibration for the Portal Dosimetry software (PDIP). An over-response of the measured dose to predicted dose as the distance increases away from the central axis has been reported. Previous publications relating to the IDU20 panel have shown that manually modifying each point of the diagonal profile or applying software corrections can improve this off-axis effect. This method can be time consuming. A solution for the IDU20 panel with the Clinac model is available as part of the Varian Pre-Configured PDIP Package that utilizes an improved beam profile correction but is not currently available for the TrueBeam. The diagonal profile at d5 cm is almost identical with the profile at dmax up to about 10 cm and deviates downward as the distance increases. Using this profile for the calibration process could improve the off-axis areas of mismatch. The response of measured doses with predicted PDIP doses were evaluated in Varian TrueBeams equipped with either the IDU20 or the new DMI MV imaging panel. The PDIP algorithm was configured for use at 100 cm SSD following the manufacturer’s guidelines. Plans were created to compare the predicted with measured dose obtained by calibrating the imager at dmax and at d5 cm for 6X and 10X. Open fields and complex fluence patterns were compared to those predicted by the PDIP to evaluate the