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 unshielded 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

Surface dose
- There are attempts to reduce surface dose to spare the skin
- Surface dose should be as close to 100% as possible to provide optimal treatment

Flatness
- Beam is generally quite flat
- Beam is generally less flat, especially for small applicators
- Beam must be uniform in all directions

Penumbra of the beams
- Treatment is 5 cm distance.
- Due very good flatness inside the treatment area, penumbra only effects exposure of the healthy tissue outside for treatment field

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 nominal treatment volume being either underexposed, or “not properly accounted for”.

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 PDIP algorithm of 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 SDD 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
effect of the diagonal profile calibration in the dose measurements.

Results: Measurements of open fields showed an over-response (>3%) between measured and predicted doses at distances beyond 5 cm from CAX for IDU20 and beyond 10 cm from CAX for DMI calibrated with dmax profiles. Profile analysis for a 30x30 cm² field IDU20 panel calibrated using the d5 diagonal profile showed an improved match (<3%) up to X=12 and Y=8 cm for 6X and up to X=13 and Y=9 cm for 10X. The improvement for the DMI panel was up to 15 cm and 14 cm for 6X and 10X, respectively, in both X and Y (Fig. 1).

The backscatter from the IDU20 panel is not corrected with this method and resulted in an increased discrepancy in the Y direction. For the DMI panel, which has reduced backscatter, the calibration with the d5 profile yielded an excellent match between predicted to measured dose. Furthermore, for the DMI panel, the open fields gamma analysis improved by up to 5.3% for 6X and 15.2% for 10X. The test fluence patterns resulted in an improvement of up to 7.5% for 6X and 6.6% for 10X (Table 1).

Conclusion: The calibration of the imager panel using a diagonal profile at depth of d5 cm instead of the recommended depth of dmax resulted in an improved match between measured and predicted images for larger fields without affecting the results for smaller fields.

EP-1604
Evaluation of safety by skin dosimetry in Intraoperative Radiotherapy for breast cancer patients
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Purpose or Objective: We investigated the safety of IntraBeam™ system, X-ray unit for intraoperative RadioTheray (IORT) by measuring surface dose using Optically Stimulated Luminescent Dosimeter(OSLD).

Material and Methods: 30 patients were selected, who were in breast cancer patients and had an operation of breast conserving surgery (BCS). At the inner surface of tumor bed, 20 Gy were described, and 5 Gy at 1cm depth from the inner surface. Along the the size of tumor bed which could be decided after resection of tumor, the size of applicator were determined. Usual treatment time were from 18 to 40 minitutes. For the measurement of surface doses, OSLD were placed at superior (U1,2), inferior(D1,2), lateral(L1,2) and medial(M1,2) directions from the center of applicator. Each direction, two OSLD were placed at 0.5 cm and 1.5 cm from the center. Mean, maximum, and minimum doses were analyzed to be compared.

Results: Mean values were U1 2.23±0.80 Gy, U2 1.54±0.53 Gy, D1 1.73±0.63 Gy, D2 1.25±0.45 Gy, L1 1.95±0.82 Gy, L2 1.38±0.42 Gy, M1 2.03±0.70 Gy, and M2 1.51±0.58 Gy. Maximum values were 4.34 Gy at U1, and Minimum values were 0.45 Gy at M2. 13.3 % of patient (4pts out of 30) were reported that surface dose were over 4 Gy.

Conclusion: The fact that skin dose of all patients were less than 5 Gy based on OSLD measurement showed the safety of IntraBeam™ system. In the relatively small breast volume, the tendency that surface dose was increased had been shown, which was analyzed by the data of patients who irradiated over 4 Gy at skin surface. Therefore, for appropriate indication for IORT, it is suggested that breast volume as well as the size and position of tumor should be carefully considered.

EP-1605
Dose from kV cone beam CT to lens, breast and gonads for children using different standard protocols
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Purpose or Objective: With daily image guided kV cone-beam computed tomography (kVCBCT), dose to organs near the target can exceed 1 Gy during a treatment with 30 fractions. Treatment with proton radiation reduces the dose outside the tumor, and reducing the dose from kVCBCT gets even more relevant. Reducing the dose from kVCBCTs can be done by shrinking the area that receive kVCBCT or lower the dose used for the uptake of kVCBCT. Prior study showed that the mAs used for kVCBCT can be greatly reduced without reducing the image quality (B. Loutfi-Krauss, 2015). This study have measured and compared the dose to organs at risk in children using different kVCBCT protocols.

Material and Methods: The dose from kVCBCTs in the Varian TrueBeam™ system, X-ray unit for intraoperative RadioTheray (IORT) by measuring surface dose using Optically Stimulated Luminescent Dosimeter(OSLD).

Conclusions: The calibration of the imager panel using a diagonal profile at depth of d5 cm instead of the recommended depth of dmax resulted in an improved match between measured and predicted images for larger fields without affecting the results for smaller fields.