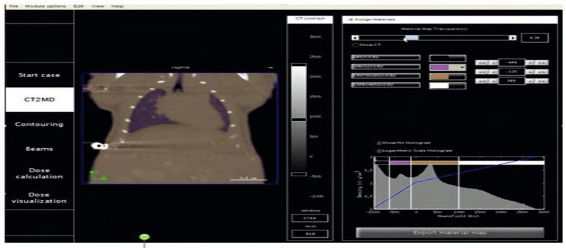


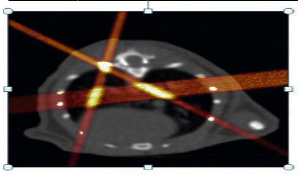

Fig 1. Screenshot from SmART-Plan (top) where the tissue segmentation procedure is shown, whereby several categories of mouse tissues are being assigned to the correct regions. The left panel shows a Monte Carlo dose calculation for 3 kV photon beams of mm dimensions.

Fig 1 shows a screenshot of Smart-Plan of the module where CT images of animal specimens are inspected for their electron density, and where a range of tissues is assigned to the very small voxels. The bottom panel shows a Monte Carlo dose distribution in a mouse thorax from 3 stationary photon beams in the range of 1-5 mm field size. The results are presented as dose-to-medium, meaning the photon transport was done in the proper media and doses are expressed in the media as well (an alternative is to express doses in water). The calculation times for a typical treatment plan are about 5 minutes. The dose verification in the heterogeneous phantom revealed good agreement between measured and calculated dose distributions.

**Conclusions:** A novel radiotherapy treatment planning system for small animals was developed and validated. The system may play an important role in pre-clinical translational studies.

## OC-0065

## Small field dosimetry in flattening filter free (FFF) beams: comparison of diode, film and scintillation dosimeters

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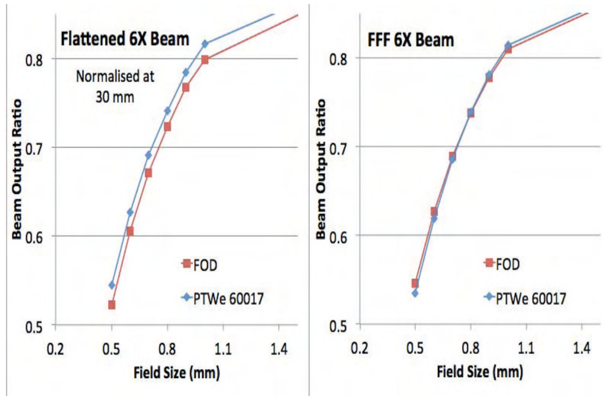
**Purpose/Objective:** Flattening filter free (FFF) beams can can improve the delivery of radiotherapy treatments by reducing treatment times. The delivery of stereotactic treatments , in particular, can greatly benefit from FFF beams as the combination of high dose per fraction combined with patient immobilization can result in long periods of patient discomfort. However, the small treatment fields used in stereotactic treatments and the changes in beam spectrum and scattering conditions that occur with a FFF beam provides challenging conditions for accurate dosimetry. This study aims to assess the performance of a range of dosimeters in an FFF beam with particular attention focused on small field dosimetry. The dosimeters used were: an ionisation chamber; diodes; an air core fibre optic dosimeter (FOD) and EBT2 film.

**Materials and Methods:** The beam output ratios (OR) for fields as small as 0.5 cm, were measured at depths of 5 cm and 10 cm in water with all detectors. Measurements were performed on the Elekta Synergy and the Varian Trubeam at a nominal 6 MV. The response of various detectors at small fields was compared between flattened and FFF beams, as well as to measurements on the Varian Novalis which uses a smaller stereotactic flattening filter.

**Results:** For all linacs, the FOD agreed with the EBT2 film within measurement uncertainty for all field sizes, in both flattened and FFF beams. In the flattened beam, diode detectors showed an overresponse at small fields, as predicted in the literature (Ralston 2012, McKerracher 1999). For the smallest field, the OR measured with a PTWe diode was 4.4% higher than that measured with the FOD. For the same irradiation in an FFF beam, however, the expected overresponse was not observed. The PTWe diode instead showed an underresponse of 2.0% relative to the FOD.




**Conclusions:** These results support the conclusion of Scott (2012), derived from Monte Carlo simulation, that density correction factors for specific beam conditions may not be applicable to other beam conditions. Diode correction factors derived on-axis for flattened beams at a particular depth may not be applicable off-axis, for FFF conditions or at other depths.

## OC-0066

## Detector comparison for small field output factor measurements with flattening filter free photon beams

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**Purpose/Objective:** Flattening filter free(FFF) photon beams offer various advantages compared to flattened (FF) beams,e.g. a higher dose rate, reduced head scatter and leakage radiation. Forms of applications of FFF-beams are the treatment of tumors with small volumes in a hypofractionated stereotactic setup and the treatment of concave shaped tumors using IMRT or VMAT. For both, an accurate determination of output factors is mandatory. Therefore, influence of filtering on the measurement of output factors was investigated in this study.

**Materials and Methods:** Several different ionization chambers and solid state detectors were investigated for small field dosimetry. An Elekta Precise Linac (Elekta, Crawley, UK) which is able to produce 6MV and10MV FF and FFF photon beams was used in this study. The fields were shaped by a BrainLab M3 μMLC (BrainLAB AG, Heimstetten, Germany). The detectors were mounted in a Blue Phantom (IBA dosimetry, Germany) at SSD 95 in 5cm depth. For this study 10 different square fields between 10x10cm² and 0.6x0.6cm² were investigated. All detectors were pre- irradiated with 1000MU. For each field 5 x 100MU were delivered. A Bragg Peak chamber (PTW, Germany) with its entrance window positioned at the water surface was used to verify the Linac output. The measured output factors were corrected for volume averaging effects which were determined in collaboration with the IAEA. Within this collaboration, output factors measured with the CC01 were compared to alanine measurements which agreed within 1% for all investigated field sizes. Hence, the measured output factors were normalized to those of the CC01.

Tab. 1. Summary of detectors used for output factor measurements.

| Detector Type | |
|---|---|
| **PTW** | PinPoint 31014 |
| **PTW** | PinPoint 31016 |
| **PTW** | Diamond 60003 |
| **PTW** | MicroLion 31018 |
| **IBA** | CC13 |
| **IBA** | IC10 |
| **IBA** | CC04 |
| **IBA** | CC01 |
| **IBA** | PFD |
| **IBA** | SFD |
| **IBA** | EFD |