AbstractID: 14461 Title: Small Field Dosimetry

Small and non-standard field dosimetry in MV photon beams

Use of small photon fields have been an established practice in stereotactic radiotherapy for many years and have more recently been used for extra-cranial stereotactic treatments and IMRT. Linear accelerators with thin leaf collimators implicitly encourage the use of small field sizes with else standard equipments. Large discrepancies in dosimetric measurements amongst institutions have been reported, as well as incidents, primarily as a result of the use of inappropriate detectors and/or less adequate modelling in the commissioning of small field treatments.

Small field conditions occur as a result of source occlusion, lack of charged particle equilibrium or dose gradients larger than the detector resolution. Accurate measurement of dosimetric quantities in such fields strongly depends on the size of the detector with respect to the field dimensions and beam energy. An ionisation chamber, which is large in this sense, may perturb the particle fluence in the irradiated medium such that the conversion from ionisation to dose based on cavity theory using the currently available perturbation factors is not accurate.

Within the geometrical limits of a small field, the dose distribution in water exhibits a significant gradient at any point. Over that, lateral electronic equilibrium gets lost and the contribution from scattered photons vanishes. It is necessary to use a detector with small sensitive volume and to determine the field size dependence of the stopping power and absorption coefficient ratios thoroughly. Silicon diodes provide high spatial resolution and a high dose signal. However they over-respond at regions with increased contribution of low energy photons to the total dose, which has consequences for relative dosimetry.

Accurate treatment planning of small fields requires that both the radiation field is well modelled, and that the fluence modelling of the incident field is correct. Modern treatment planning systems utilize multi-source configurations to deal with partial source blocking effects. The size of the direct beam source, and methods for its estimation, are the far most important factors for beam fluence modelling, but related issues with partial transmission through collimator leaf ends and alignment of supplementary blocks are important. For dose calculations, methods that can consider deviations from charge particle equilibrium due to both small field sizes and non-unit density media become critical.

The purpose of this teaching session is to review the challenges and current status in measuring and modelling dose for small photon fields for general applications in radiotherapy.

Learning objectives:

1. The physics and challenges in small field dosimetry
2. Choice of detectors and corrections.
3. Modelling for treatment planning.