Accelerator Commissioning for IMRT: Small MU Segments and Small Fields

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Introduction Within the last two years the Northern Centre for Cancer Treatment (NCCT) has introduced into clinical use three Siemens Primus accelerators with photon beam qualities of 6 and 15 MV and equipped with double-focused multi-leaf collimators (MLC). Siemens Primus accelerators are designed to deliver intensity modulated fields using a multiple static field (step-and-shoot) technique. Currently at NCCT simple forward IMRT planning and delivery is carried out for patients treated for disease in the head and neck. Work is underway for the implementation of complex IMRT (inverse) planning and delivery. Inverse plans generated by the optimisation software of a planning system generally consist of beam portals with highly irregular shapes and comprising of multiple small monitor unit and/or small size beam segments. Those segments to be delivered from the same gantry angle can be grouped in IM-groups and delivered in an auto-sequenced mode (IM-mode). In between each segment delivery, the linac does not switch off but is brought to a desynchronised (paused) state and intended to produce a beam instantaneously on demand.

For standard radiotherapy treatments, commissioning beam data are acquired once the machine has reached a stable state (after the delivery of at least 50 monitor units) and at collimator settings generally not smaller than 3cm×3cm [1], [2]. Start-up characteristics during the first few MU are not normally examined [3], [4]. For complex IMRT treatments, reliable and stable start-up characteristics cannot safely be assumed and simple extrapolation of standard data to small fields is unacceptable.

Dose monitor linearity, inter-segment variation, and beam profile uniformity (flatness and symmetry) for small MU beam segments for the Siemens Primus accelerators at NCCT were investigated in this work. The dosimetric accuracy of calculated output factors (using the Helax-TMS treatment planning system) in water for small symmetric and asymmetric (offset) fields was also verified for the 6MV and 15MV beams.

Methods Dose monitor linearity and inter-segment response at small monitor units were examined using a 0.6cc ionisation chamber connected to PTW-UNIDOS electrometer in solid water material (WT1) at the machine isocentre and at a depth of 10cm. The collimator setting was 20cm × 20cm and ionisation readings were recorded for monitor units ranging from 1MU to 10MU in steps of 1MU, and for every 10MU thereafter up to 100MU. The average of a maximum of five readings per MU setting was calculated and normalised to the number of monitor units applied to obtain the detector response per MU for each setting. The results were further normalised to the value at 100MU.

The inter-segment response was investigated for a collimator setting of 10cm × 10cm and for beam segments of 1, 2, 3 MU. The percentage deviations of 20 sequential readings at each one of these MU settings from the mean reading were examined.

Beam uniformity investigations for beams with small MU were carried out using a Schuster-BMS96 linear detector array, which comprises of 88 diodes embedded at a depth of 1cm in a PMMA block. The array board rotates from 0^{o} to 90^{o} enabling profile measurements at both orientations (in-plane and cross-plane). Beam profiles for a collimator setting of 40cm × 40cm were acquired for all beams at both orientations. These were compared with definitive profiles acquired with the same detector under the same irradiation geometry under stable linac conditions (following the delivery of at least 100MU).

Relative output factors were measured using both a 0.125cc ionisation chamber and a diamond detector connected to the PTW-UNIDOS electrometer. All measurements were carried out in a water tank at a depth of 10cm in the plane of the isocentre for a range of radiation fields defined by collimator settings ranging from 1cm × 1cm up to 5cm × 5cmin steps of 1cm and for 10cm × 10cm fields. The fields were positioned on-axis and at off-axis positions (2, 4, 8 cm). The mean ionisation reading at each position was normalised to that of a 10cm × 10cm symmetric field. Prior to each output factor measurement in-plane and cross-plane profiles for each field were acquired with the diamond detector in order to determine the actual radiation field size. These field sizes were used in the treatment planning system (TPS) to calculate output factors that were compared with measurements.

Results For the 6MV beams the deviations of relative ionisation per MU for the range of MU examined from the ionisation reading at 100MU were well within ±2%. Initially for the 15MV beam and for beam segments with monitor units less than 5, deviations were greater than ±2%. In particular for a 1MU segment deviations are about 28%, for a 2MU segment it is of the order of 5% and for segments of 3 and 4MU the deviations were close to 3%. The non-linearity observed at 1, 2, or even 3MU were not of primary concern as it is unlikely that patient treatment plans will be authorised with such small MU segments. However the discrepancies at 4MU were not considered acceptable. Further investigations demonstrated how the dose monitor linearity for small monitor units could be readily improved for this beam by adjusting the value of a dose calibration parameter in the Siemens Primus software (D1_C0).

Consistency in the beam profile for small monitor unit segments was demonstrated for both energies and at both cardinal collimator axes. Beam profiles from small MU beams (1, 2 etc) are almost identical in shape to those measured for 100MU.

For a 6MV beam the maximum deviation from the mean of 20 consecutive ionisation readings of 1MU was ±3.5%, at 2MU it was about ±1.5% and at 3MU this was reduced to ±1%. However for the 15MV beam the corresponding results for 1MU irradiation were ±10%, for 2MU of the order of ±5% and for 3MU within ±2%, but as before this was before adjustment of the D1_C0.

Dosimetric verification of calculated output factors was carried out for both dose calculation algorithms available on the Helax-TMS treatment planning system. These are a pencil beam (TMS-PB) and a collapsed cone (TMS-CC) model. For the 6MV beam and with the exception of the smallest collimator setting (1cm × 1cm) calculated output factors for fields on axis deviated from those measured with the diamond detector by an average of +2.4% for the TMS-PB algorithm and by and average of +0.7% for the TMS-CC. The differences for fields off axis were similar and in all cases the TMS-CC model generated output factor values closer to those measured with a worst case deviation measurement for the TMS-CC model of -1.2% for fields offset by 8cm from the collimator rotation axis. For the 15MV beam a similar pattern was observed, with the TMS-CC model in better agreement with measurement whereas the TMS-PB model was found to overestimate output factors up to 5%.

Conclusions Siemens Primus accelerators are ideally suited for step and shoot IMRT as their characteristics in beam uniformity, energy and dose linearity are virtually independent of MU segment size. Inter-segment MU deliveries for 6MV and 15MV beams are within ±2% for beam segments equal or greater than 3MU. This performance is achieved for even smaller number of MU for the 6MV beams. Output factor verification has shown that for all energies and examined fields, the collapsed cone algorithm is more accurate than the pencil beam model. Calculated output factors for a collimator setting of 1cm × 1cm did not however agree with measurements (errors of the order of 10%). This could partly be due to uncertainties associated with the measurements (detector positioning at the centre of a very small field) and partly to limitations associated with the dose calculation. Because of these uncertainties use of 1cm × 1cm beam segments is not recommended.

References

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An Elegant Extension to the ESTRO Dosimetry System

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Introduction The introduction of ESTRO's recommended dosimetry system [1] is a welcome step towards standardisation in the context of independent MU checking. However, a number of aspects of ESTRO's system make it less attractive than it might be. The difference between the way isocentric and fixed/extended SSD are treated with respect to field size means that although there is some consistency in the terminology used, the equivalence in the general approach is not clear. Data is referenced in terms of 'field size' rather than the less ambiguous collimator setting. Because the symmetry is then lost between the different treatment conditions, implementation, whether by hand or by software, is specific to each. For software implementation, this increases the potential for coding errors.

A minor modification to the ESTRO system improves this situation and leads to an elegant, simpler, safer, self consistent dosimetry system. Data for all treatment conditions (isoc, Fixed/extend SSD) would be measured and referenced to collimator setting rather than 'field size'. This necessitates the production of isocentric and SSD specific phantom scatter and dose/MU data. However, provided the number of SSD options are limited, this involves a relatively small workload premium at commissioning. In ESTRO's published implementation, corrections for SSD are made at MU calculation time. In this modified implementation, corrections are made once (at commissioning time), spot checked against measurements and tabulated separately for each system. The ESTRO presentation presents many options including referencing data measured at the fixed treatment distance or isocentrically but none include the simplification of always referencing to collimator setting.

For unwedged beams, for example, and using the equivalence between ratio of volume scatter ratio and S_p for clarity:Fixed SSD (all SSDs):

$$D(c,d) = U \times \dot{D}_{10,ssd} \times S_{p,ssd}(EqColl) \times S_c(c) \times RDD_{ssd}(d, EqColl)$$

Isocentric:

$$D(c,d) = U \times \dot{D}_{10,iso} \times S_{p,iso}(EqColl) \times S_c(c) \times T(d, EqColl)$$

this could be generalised to:
All systems:

$$D(c,d) = U \times \dot{D}_{10,syst} \times S_{p,syst}(EqColl) \times S_c(c) \times DR(d, EqColl)$$

where *syst0 (iso, ssd, ext ssd)* and *DR* is a depth ratio = TPR if isocentric and RDD is fixed ssd.
An additional benefit of this approach is the simplification of teaching when there is such clear symmetry between the calculation system for each treatment distance.

Reference

[1] Monitor Unit Calculation for High energy photon beams, ESTRO Booklet No 3, 1997

Evaluation of Elekta iViewGT™ Flat Panel Detector in Portal Imaging

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Introduction The Elekta iViewGT™ has been introduced for real time portal imaging. This is an amorphous silicon detector with Kodak Lannex Fast™ phosphor with copper to remove electrons. The pixel size is 400µm. It is necessary to quantify the image quality parameters for QA and acceptance testing.

Method The detector was tested on 6 and 10 MV. The high contrast spatial resolution was measured using a Huttner 18D. The threshold contrast detail curves were measured using a range of test objects. The Noise Power Spectrum was measured with and without 25cm of tissue equivalent scattering material and hence the peak Detective Quantum Efficiency was estimated. Preliminary measurements of Modulation Transfer Function were made using an edge technique with 15.5cm thick steel bar.

Results The high contrast spatial resolution was measured to be 1.3 $\mathrm{lp \cdot mm^{-1}}$ on the detector and 0.9 lp.mm-1 at the isocentre. The Las Vegas test object, currently used for threshold contrast in portal imaging, has too high a contrast; the most suitable commercially test object available is the CDRAD (University of Nijmegen). The DQE was estimated to be 1.7% for both 6 and 10MV, the DQE with scatter appeared slightly higher due to the additional flux. The preliminary MTF 5% value is at 1.25$\mathrm{cycles \cdot mm^{-1}}$.

Conclusions The Huttner and MTF compare well with the theoretical limit of 1.25 $\mathrm{lp \cdot mm^{-1}}$. Normally the resolution measured at the isocentre would be higher due to magnification, however this has been degraded due to the focal size. The CDRAD is a good indicator of the threshold contrast, however a new test object may need to be designed. To allow comparison and acceptance testing the test object should be on the detector. The use of flat panel technology has been shown give good image quality in portal imaging.

Characterisation of Open and Wedged Photon Fields Produced by a Linear Accelerator with Multi-leaf Collimators Using MCNP

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The energy and fluence of the photons produced by the linear accelerator is spatially variant across the treatment field; when the physical wedge is employed the variation becomes asymmetric. Accurate non-Monte Carlo computation of radiation dose deposition therefore requires comprehensive information about the beam incident on the patient. Non-Monte Carlo based treatment planning dose calculation algorithms make simplifying assumptions about the photon field characteristics which affect the accuracy of their results [1]. Although Monte Carlo calculations are still considered to be too slow for routine treatment planning of photon beams, they are used to generate the necessary spectral input for faster alternative algorithms such as the convolution/superposition methods of dose calculation [2], [3]. The equivalent information may be difficult if not impossible to obtain by measurement.

This study has used the Monte Carlo N-Particle radiation transport code MCNP (version c) on a personal computer to simulate the MLC shaped open and wedged, and symmetric and asymmetric 6 MV photon fields.

The symmetric field depth dose distributions and dose profiles at constant depths for various field sizes have been simulated and compared to measured data; agreement has been found to be better than 1%. Energy spectrum and fluence variation across the open and wedged, and symmetric and asymmetric photon fields have been simulated. The accuracy of the model for generation of comprehensive asymmetric to symmetric field off-axis ratio data for asymmetric field calculations as well as leaf response functions for MLC shaped fields has been demonstrated.

Results of the study have also been used to evaluate the significance of the assumptions made in non-Monte Carlo based treatment planning dose calculation algorithms such as the convolution/superposition method.

References

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Chapter 12. Radiotherapy Physics

How should we measure and use collimator scatter factors?

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Introduction The wider implementation of geometrically conformed radiotherapy (G-CFRT) recommended by the Royal College of Radiologists [1] continues apace. Clinical governance dictates that prior to treatment, an independent check of the treatment monitor units provided by the planning system is made [2]. Most centres choose to do this using an in-house based 'system'. Sophisticated in-house dosimetry systems are required to make meaningful comparisons when complex conformed treatment field shapes are employed. An important aspect of many modern radiotherapy dosimetry systems is the separation of the 'field size' factor into its two main sources: scatter within the patient (S_p) and 'extra-focal' scatter (S_c). If these scatter contributions are not treated separately, then one scatter factor can be in error by 5% or more in circumstances when the area of each scatter source is different.

The phantom scatter can be calculated from S_c and total scatter factor (S_{cp}). S_c can be measured using a 'miniphantom' or high-Z build-up cap. Aspects of the design and use of these phantoms can significantly affect the S_c field size variation and a variety of miniphantoms/build-up caps have been proposed in the literature. Use of an inappropriately designed miniphantom could lead to treatment calculation errors of up to, or greater than, 10%, particularly for small field sizes. Despite this, the importance of these critical aspects of miniphantom design is somewhat neglected in the published recommendations [3,4].

Methods A number of different phantoms/caps have been designed and constructed. These were used to measure S_c at different SSDs on a number of treatment units with different head designs and over a range of energies.

Results The measured data are presented and discussed and the dangers of using inappropriate miniphantoms are demonstrated. In addition, use of published S_p data in the light of these data is discussed.

References

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[3] Monitor Unit Calculation for High energy photon beams, ESTRO Booklet No 3, 1997

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6 Day Linac Commissioning – Fact or Fiction?

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Starting in June 2000 three new Siemens Primus linear accelerators have been installed in the Northern Centre for Cancer Treatment (NCCT) at Newcastle General Hospital. The first Primus was a high-energy dual photon beam accelerator whilst the following two were medium-energy single photon beam machines. This paper describes the specification of the match of beam characteristics (energy, beam profile, wedge profile and relative output) for the 6 MV photon beam common to all three accelerators. The match achieved between the first two accelerators was such, that it was possible to significantly reduce the commissioning process for the second accelerator. Details of the match are given along with a review of the subset of commissioning measurements made prior to its introduction into clinical use.

With the installation of the third machine a consistent ability to achieve beam matching to a high standard was demonstrated. As a consequence of this match, the commissioning process was further reduced and was completed in a matter of days.

In conclusion it must be stated that the linear accelerator is a very expensive technical resource that has traditionally spent close to 5% of its design lifetime undergoing an individual characterisation process. If beam matching to the level demonstrated here is consistently achievable, then the need for this individual characterisation is removed and the clinical availability of a linear accelerator over its working lifetime can be significantly enhanced.

Experiences of a proactive Radiotherapy IRMER inspection.

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Introduction A proactive IRMER inspection of the Clinical Oncology Department, Raigmore Hospital, Inverness, was carried out during last November on behalf of the Scottish Executive, Department of Health. The aim of the inspection was to assess compliance with the Ionising Radiation (Medical Exposure) Regulations 2000. This paper will describe the IRMER 'experience' and will try to address some of the important elements of implementing IRMER in a department that operates an ISO 9000 Quality Management System. Some key elements, which will be covered, include the requirements for full documentation of duty holder's responsibilities, the importance of the treatment prescription sheet in the demonstration of compliance with IRMER, patient ID and pregnancy questions, dose recording procedures, and other aspects of the standard operating procedures.

Reference

[1] The Ionising Radiation (Medical Exposure) Regulations 2000 (IRMER), Health and Safety 2000 No. 1059

Investigation of the Properties of the "Magic" Gel Dosimeter: Initial Results

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Introduction Recently a new polymer gel dosimeter has been reported in the literature [1]. This gel, with the acronym "MAGIC" can be manufactured more easily than previous formulations. The purpose of this paper is to report the initial results of investigations of the properties of the gel. These include the linearity of the dose response, and stability with time, polymer diffusion and the effects of phantom wall materials.

Method The "MAGIC" gel was manufactured using the formulation proposed in the literature [1] with no additional precautions to exclude oxygen. Glass vials were filled with the gel and irradiated using 6 MV photons giving absorbed doses up to 50 Gy. The resulting relaxation rates of the polymerised gels were measured 2h after irradiation using a 1.0 T MRI scanner. Several measurements were then made up to 50 days after the initial irradiation. A single 40 x 40 photon field was used to irradiate another gel and measurements made of the width of the polymerised area over 1 month. The effects of phantom wall materials such as Barex, PVC and Perspex were also compared with glass.

Results The gel was found to linear from 0 to 50Gy and that the polymerisation was stable 1 month after irradiation. There appeared to be no diffusion of polymer over a month and unlike previous polymer gels the wall material of the phantom did not effect polymerisation.

Reference

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A Risk Assessment of Radiotherapy Treatment Rooms

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Introduction Risk Assessment forms an integral part of illustrating compliance with the Health and Safety at Work Act 1974. The aim of this project was to identify and assess the risks associated with Radiotherapy treatment rooms and to take action where necessary to improve the overall safety for patients and staff alike.

Method Six main types of hazard were identified:

1. Radiation levels– TLDs were used to assess the radiation doses in specific areas in addition to routine personal monitoring.
2. Manual Handling – four main areas with manual handling concerns were highlighted: engineering, patient handling, physics QC and using beam modifiers. Our assessments were compared with previous expert reports.
3. Infection control – swabs were taken from patient equipment and transferred to agar plates, incubated for two weeks, and the number of bacterial colonies counted.
4. Electrical Safety – an audit of evidence of systematic electrical safety testing of all equipment was carried out.
5. Lasers - the level of risk associated with the positioning lasers was investigated.
6. General safety – a visual inspection was performed and a report summarising the risks was produced.

Results

1. No significant doses were found compared to background levels.
2. The assessment highlighted the need for tighter control over movement of QC equipment.
3. The assessment stresses the importance of thorough cleaning immediately prior to any TBI treatment.
4. Electrical safety tests were due on some medical and non-medical equipment.
5. Lasers – the report showed that the blink reflex is sufficient protection, however warning labels were not prominently placed.
6. No major safety problems were identified.

Conclusion There are many different hazards associated with a Radiotherapy treatment room, however means can be taken to ensure the levels of risk resulting from these are kept to an acceptable minimum.

Increase in skin dose due to the use of a carbon fibre couch panel for palliative radiotherapy treatment

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Introduction Two types of couch tops for parallel opposed fields are used at Maidstone Hospital. One is lightweight and rigid consisting of thin carbon fibre sheets bonded to a foam core. The other type is a tennis racket design which is heavier and has a tendency to sag.

Purpose To determine if the carbon fibre panel causes a higher dose to be delivered to the skin in contact with the couch than the 'tennis' racket.

Method For a 20cm separation the depth dose curve was measured from the entry surface down to the depth of maximum dose and from 19cm deep to the exit surface. This enabled the build-up and backscatter components of skin dose to be determined. Measurements were made in 6 and 15MV photon fields at constant SSD with a thin window chamber in a solid water phantom under appropriate increments of material. The chamber readings were corrected for side scatter of electrons from the chamber wall [1]. Measurements were performed with both types of panel and with no panel.

Results: The dose to the radiosensitive layer of the skin was calculated from the measured depth dose curves. At 6MV the skin dose (expressed as a percentage of the Mid-plane Dose) increases from 48% using the tennis racket to 79% with the carbon fibre panel. At 15MV the skin dose increases from 42% to 64%.

Conclusion The carbon fibre panel significantly increases the absorbed dose to the basal layer of the skin.

Reference

[1] David E Mellenberg, Jr . Determination of build-up region over-response corrections for a Markus-type chamber Med. Phys, 1990; 17:1041-1044

An Implementation of Electronic Data Transfer from the CMS Treatment Planning System to the Varian VARIS System.

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At our Cancer Centre we have implemented the automatic upload of data from our CMS treatment planning system to the treatment management system that is attached to our cluster of Varian Linacs. This is advantageous because the treatments we are performing are becoming more complicated and optimised for the individual patient. We could argue that we are moving away from 'class solutions' and so it is even more important to eliminate potential errors such as the application of the wrong wedge, field shape etc. The electronic transfer of data round the department (between SIM/MRI/CT/planning system/Linac) will certainly facilitate the elimination of potential transcription errors in our part of the patients' treatment management.

The industry is working towards standardisation of such data flow operations and the recent releases by many manufacturers with compliance to the newer DICOM 3.0 data objects such as RT PLAN should make this process simpler. We have implemented this data transfer, using what is commonly referred to as DICOM-RT, this process uses an intermediate application from Varian called RTPExchange 6.1c that inserts the required treatment data in the VARIS database patient record. We find this data transfer is essentially very efficient and has eliminated a great deal of data transcription.

We will present an overview of the mechanics of the data exchange process and briefly explore the 'DICOMRT' process in order to provide an understanding of its nature and to justify our commissioning approach. We will give details of the testing we have undertaken on our system and an overview of the commissioning process QA we designed.

An Independent Monitor Unit Calculator for Delivery of Radiotherapy by Multi-Leaf Collimator

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Introduction The Multi-Leaf Collimator is a (relatively) new and powerful tool for delivering Conformal Radiotherapy. However, the Quality Assurance of the complex field shapes that can be produced is notoriously difficult. This paper describes a software tool that assists in such QA.

Methods Using a leaf sequencing file produced by a commercial planning system, the monitor units delivered to each profile are summed giving an overall intensity map (assuming no scatter). Superimposed upon this are factors for small fields and edge proximity. Using these tools, points within the map can be selected for verification by film dosimetry.

The software produces three maps: a simple sum, a corrected sum (using small field factors) and a leaf-edge proximity map. In addition, three overlays are possible: the centres of the geometric fields [1] (in the form of a cross scaled to indicate total area), a map across a leaf pair and a total dose at a point.

Results Although a simplistic model, the software gives a good correlation with the measured and predicted (by the planning system) map, thus aiding in the verification of the plan.

Conclusion The 3 types of map produced (together with the three types of overlay) give a rich set of visual data to assist in verifying the plan.

Reference

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Characterization of Asymmetric Photon Fields Produced by a Linear Accelerator with Multi-leaf Collimators Using MCNP

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Linear accelerator produced photon beams have position variant energy spectra and fluence across the treatment field. Characterisation of the radiation field may be further complicated in the presence of additional beam shaping tools such as the physical wedge. Most of the data collected and used by planning systems are for symmetrically collimated radiation beams [1], [2]. When using asymmetric fields it is necessary to confirm the validity of the dosimetric calculations performed by the treatment planning system, usually with respect to the original isocentre. One method of calculation is to use Off-axis Asymmetric to Symmetric field Ratios (OASR) in conjunction with the symmetric field data [3]. Measurement of the required OASR's can be time consuming and the results may be susceptible to positional and dosimetric inaccuracies.

The Monte Carlo N-Particles radiation transport code MCNP has been used in this study to characterise the asymmetric photon fields. Spatial variations of photon energy spectra and fluence across the treatment fields have been simulated. The OASR's for 6 MV photons have also been acquired. Variation of the OASR's with field size, field position and in-phantom depth has been evaluated and results have been found to agree well with measured data.

Results have been used to evaluate the consequences of some of the simplifying approximations made in non-Monte Carlo treatment planning system dose calculation algorithms such as the convolution/superposition method. Results are also used in independent dose check calculations.

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Characterisation of the MLC Performance for 6 MV Photon Fields Produced by a Linac Using Monte Carlo Simulation

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The photon energy spectrum and fluence are spatially variant across the linear accelerator produced treatment fields. As the clinical implementation of Conformal and Intensity Modulated Radiotherapy [1] becomes more widespread, quantitative characterisation of the Multi-leaf Collimator (MLC) performance is required by many radiotherapy planning system dose calculation algorithms as well as for development of accurate independent dose check calculations [2].

This study has used the Monte Carlo N-Particle radiation transport code MCNP (version c) on a personal computer to simulate MLC shaped 6 MV photon fields. The depth dose distributions and dose profiles at constant depths for various regular symmetric fields have been simulated and found to be in good agreement with measured data.

The influence of the individual and grouped MLC leaves on the spatially variant energy spectrum and fluence has been evaluated. In-phantom variation of "leaf response" across and along individual and grouped leaves have been obtained using MCNP and have been shown to agree well with measured data. Results of the application of a superposition method for dose computations under the MLC using the "leaf response function" will also be presented.

References

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Electron Profile QA Analysis: Quicker and Better?

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The introduction of multi-modality, multi-energy linear accelerators has necessitated an increase in quality assurance measurements. Due to clinical pressures the amount of time available to perform such measurements is limited. Many departments now use linear diode arrays (such as the Schuster BMS-96) for routine QA to obtain profiles from which to assess the flatness and symmetry of treatment beams. The need for a sensitive yet rapid method of analysing the large quantity of data obtained is discussed.

The information obtained with the Schuster diode array can be used visually to compare the profile with a reference profile taken at commissioning. IPEM report 81 recommends that the flatness and symmetry of an electron beam are quantified using indices. The disadvantage with the method suggested by report 81 is that information about the shape of the beam is lost. This effect is significant if the treatment planning system uses the shape of the profile when calculating treatments. Visually comparing profiles is a more rapid form of assessment, taking the shape of the profile into account, but it does not provide a method of quantifying any trend in the flatness of the beam.

The available protocols for calculating electron flatness and symmetry indices using the Schuster BMS software were compared with the recommendations of report 81. The use of indices in detecting significant changes in the shape of the beam profile was investigated and compared with the accuracy of visual assessments to note erratic behaviour and out of limits conditions.

It was concluded that the protocols available on the Schuster were not appropriate for calculating the flatness and symmetry indices. An Excel spreadsheet was therefore developed for this purpose. It was decided that in addition to the use of indices, the profiles obtained should be visually assessed to account for any erratic behaviour of the beam.