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MAGNETO-RADIOTHERAPY: EFFECT OF MAGNETIC FIELD ON DOSE DISTRIBUTION & RBE

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INTRODUCTION: Magneto-radiotherapy is the application of magnetic fields during radiotherapy procedures. It aims to improve the quality of cancer treatment by altering the dose deposition of charged particles in the tissue volume being targeted. Our research has focused on applying the concept of magneto-radiotherapy to conventional linac treatment and MRT (Microbeam Radiation Therapy) oncology modalities.

METHODS: We have used a combination of Monte Carlo (MC) simulations and physical measurements to investigate the effect of a magnetic field on the dose distribution by secondary electrons from primary photon beams. Two magnetic field orientations were used to investigate this effect: longitudinal magnetic fields (where the direction of field is parallel to the beam axis), and transverse magnetic fields (where direction of field is along a plane perpendicular to beam axis). MC (PENELOPE) simulations have been done to ensure modified PENELOPE code can accurately reproduce: measured data for a 6-MV linac beam (i.e. dose-profiles and depth-dose curves) in the absence of a magnetic field; and published magneto-RT results in the presence of a magnetic field. Measurements for magneto-MRT, investigating the effect of a static 1T magnetic field on the *Peak to Valley Dose Ratios* (PVDRs) of the MRT microbeam-array with depth, are scheduled for early October 2005 at ESRF (European Synchrotron Research Facility). A comparison of these measurements with results from a MC study of PVDRs with depth will be conducted.

RESULTS: A strong *longitudinal* magnetic field reduces lateral scattering of secondary electrons causing a narrowing of the beam penumbra in the plane perpendicular to beam axis. A strong *transverse* magnetic field forces the charged particles into helical trajectories about the field direction, producing a confined beam penumbra with depth. The therapeutic advantage of using either magnetic field orientation is that both confine the dose-deposition of secondary electrons to produce regions of dose-enhancement and dose-reduction that can be aligned with tumour and healthy tissue regions, respectively. Below is a comparison of the dose-perturbation we obtained with MC simulation of a transverse magnetic field applied to a 6-MV linac beam (fig.1), to that obtained by Li, *et al.1* with a 15-MV beam (fig. 2).

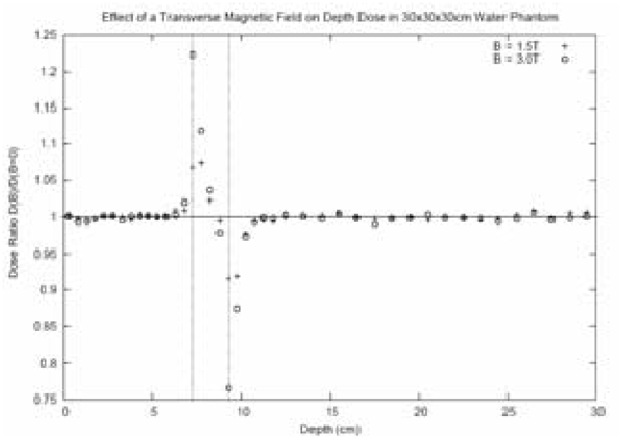

Figure 1. *Dose-perturbation with transverse B-field of 6-MV beam.*

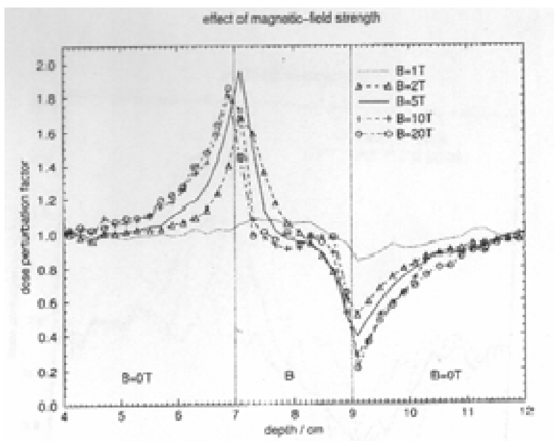

Figure 2. *Dose-perturbation with transverse B-field of 15-MV beam*

DISCUSSION & CONCLUSIONS: Incorporating magnetic fields into current oncology modalities promises a number of therapeutic benefits, the most obvious being a dose enhancement in the tumour tissue and dose-reduction in adjacent healthy tissue. Magneto-RT has the potential to alleviate problems in cancer treatment such as the treatment of tumours close to critical structures. Radiobiological effects have never been investigated for magneto RT. We will carry out MC simulations to obtain the low-energy secondary electron spectra of photon radiation beams to examine the radiobiological effects, in particular, RBE (Relative Biological Effectiveness) of magneto-RT applications.

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REFERENCES:

[1]Li, X.A., Reiffel, L., Chu, J.C.H. and Naqvi, S., *Med. Phys.*, 28**:**127-33, 2001.