A VOLUMETRIC COMPARISON OF THE ICRU 50 PLANNING TARGET VOLUME (PTV) APPROACH VERSUS A MOBILE CLINICAL TARGET VOLUME (CTV) APPROACH TO TREATMENT PLANNING, Y. Lu, E. Fontenla, and G.T.Y. Chen, University of Chicago.

A simple model of spherical target and spherical or cylindrical normal organ is employed to study the differences between the ICRU 50 recommended PTV approach and an approach which explicitly considers a mobile CTV and mobile normal organs, in the presence of interfractional positioning uncertainty. The positioning uncertainty is assumed to follow a Gaussian probability distribution with a pre-determined standard deviation. For a single field conforming to the target with a margin, the percentage volumes associated with given probabilities of being in the field aperture are calculated for the static PTV and for the mobile CTV. The results yield the dependence of the target coverage on the margin size and the target dimensions, and show qualitative differences in the target coverage between the two approaches. The volumes of the normal organ associated with given probabilities of being in the field aperture are calculated as a function of the aperture margin size and the width of the Gaussian distribution. It shows that the effective volume of being constantly inside the field is usually smaller for a mobile normal organ than for a static one considered in ICRU 50. Implications of the results on tumor control probability (TCP) and normal tissue complication probability (NTCP) are discussed.

PROSPECT OF USING 25-50 MEV ELECTRONS IN RADIOTHERAPY, H. Huizenga and E. Woudstra, Institute of Radiotherapy, University of Nijmegen and Daniel den Hoed Cancer Center/Academic Hospital Rotterdam, Netherlands.

The availability of high energy electron beams (25-50 MeV) in radiation oncology, in addition to high energy photon beams, offers a wide variety of attractive possibilities for high precision, high dose, conformal radiotherapy. Although advocated since the 1960's, it's only possible nowadays thanks to the availability of the Racetrac Microtron and accurate 3D-dose planning algorithms like the phase space evolution model, in addition to CT and MRI. Preliminary investigations have shown that

a) Opposed electron field irradiation, unequally weighted and of unequal energy might be an attractive alternative in the thorax region in order to deliver the highest dose at the tumor site and to spare the spinal cord.

b) Penumbra sharpening of electron beams might be obtained by edge enhancement with narrow photon beams.

c) For various abdominal and thoracic indications, replacing photon beams by high energy electron beams, yield a better sparing of the spinal cord and/or simplifies the irradiation technique.

d) Intensity and energy modulated orthogonal beams might be an alternative to a wedged pair photon beam irradiation in the head and neck and other regions with more sparing of critical tissues.

A MOBILE CLINICAL TARGET VOLUME (CTV) APPROACH TO TREATMENT PLANNING was carried out for ten patients using three techniques for which considerable clinical experience is available: (i) Four-field box (4FB), (ii) Six-field (6F), and (iii) Four-field non-axial (4FNA). The target volume was the prostate and seminal vesicles with a 2 cm margin, planned to receive 50 Gy. The boost target volume was the prostate alone with the same margin, planned to receive an additional 20 Gy. Bladder and rectal Dose-Volume Histograms (DVH) were generated for each patient and technique. DVH differences between pairs of techniques for each patient as well as the average over ten patients were examined. Bladder and rectal doses were found to be highly dependent on individual anatomy. Although the fractional volumes receiving more than 80% dose (35 Gy) differed on average by less than 10%, the 4FB technique delivered 50% or more of the prescribed dose (35 Gy) to 13% more of the bladder and 19% more of the rectum than 6F or 4FNA. At and below 50% dose 6F irradiated 24±5% more bladder and (11±6)% more rectum than 4FNA. The results of comparisons for dose escalation will also be reported.

OPTIMIZATION OF RELATIVE BEAM WEIGHTS AND WEDGE ANGLES IN TREATMENT PLANNING: L. Xing, E. Pelizzari, G.T.Y. Chen, F.T. Kuchnir, University of Chicago, Chicago, IL 60637. Optimization in treatment planning is to select a set of beam parameters to best achieve a desired dose. A complete optimization of all relevant parameters is very difficult. Previous work has been focused on optimizing beam weights for a given set of beam directions and wedges. Wedges are usually chosen by exhaustively evaluating all possible standard wedge combinations for a treatment, and is very expensive in terms of computer time. Furthermore, for accelerators with universal wedge, where the effective wedge angle can be changed continuously, an exhaustive search becomes completely impractical. In this work we describe an efficient algorithm for optimizing relative beam weights and wedge angles. This approach is based on the fact that a wedged field can be regarded as a superposition of an open field and a nominal wedged field. This reduces the problem of evaluating a large number of independent plans into optimizing a linear system of J2 variables, where J is the total number of gantry angles. The optimization is done by using an iterative algorithm similar to the iterative-least-square technique in image reconstruction. The calculation is similar in principle to inverse treatment planning, but modulation of beam intensity is suppressed. Relative importance of structures based on clinical considerations is incorporated in the algorithm. In addition, the technique has been generalized to optimize the fields of custom wedges. Implementing this technique provides a powerful automated treatment planning system. Applications of this algorithm to several clinical examples will be discussed.

PARAMETRIZATION OF THE INDEPENDENT VARIABLES IN TREATMENT PLANNING OPTIMIZATION: D. H. Hristov and B. G. Fallone, Medical Physics Unit and Dept. of Physics, McGill University, Montreal, Canada.

Parametrization of the independent variables is introduced that allows algorithms such as the conjugate gradients method (CGM) to be used for the minimization of an objective function in the course of three-dimensional treatment planning with intensity modulated beams. The method is an attractive alternative to the constrained steepest descent method (SDM) that has been drawing considerable attention for it provides good balance between speed, computer resources and versatility in the choice of the objective function. The main advantage of the latter is the fact that the physically relevant constraints on the independent variables can be simply imposed at