As discussed by the previous speakers, standard practice helps assure that clinical target volumes (CTVs) receive adequate geometric coverage in the living patient by adding margins around them to form planning target volumes (PTVs). However, while this process can demonstrate that the CTV will indeed receive a high dose, the original single static dose calculation does not include uncertainties from daily setup or organ motion, and thus it may not represent the actual dose distribution received by the patient over the course of treatment. This is of growing concern in attempts to further reduce tissue volumes irradiated to high dose, and to model the responses of both tumors and normal tissues to radiation. Here we will demonstrate that data similar to those presented for defining PTVs can also be used to help construct realistic average expected dose distributions.

The general methods used to form composite dose distributions include direct simulations (Monte Carlo) and convolution type calculations, both using modeled data for the distributions of expected setup and patient motion errors as above. For direct simulation, these distributions are randomly sampled for each patient fraction to simulate setup orientation and organ position and the dose distribution is recalculated to produce one realization of the course of treatment. This process is repeated, and the results are averaged to determine an average expected dose distribution. In the convolution methods, an original dose distribution is convolved with functions representing the distribution of expected tissue locations to predict the average realizable dose distribution. Resulting dose distributions from both methods generally show a blurring or spreading out of dose in the original high dose gradient regions in the directions of the setup and motion uncertainties. These more realistic dose distributions can be compared to the original planned dose calculation, or used to place confidence limits on the dose distributions or on representations of those distributions such as DVHs.

It is also now possible to contemplate using the more realistic dose calculational approach above in an iterative reverse fashion to help design block or MLC margins, or IMRT fluence patterns directly for the CTV. Treatment planners could use these more realistic calculations to help decide among and select plans that most nearly meet their multiple objectives of conformal CTV coverage and normal tissue dose tolerance.

This objective of this presentation are to:

1) review methods that may be used to compute average dose distributions that include uncertainties due to patient setup uncertainties and organ motion.
2) discuss some implications of these more realistic calculations of average expected dose distributions along with confidence limits on the range of expected outcomes.