Purpose: A factor that greatly limits the use of Monte Carlo methods for patient specific dose calculations in research is the substantial amount of effort required to define the Monte Carlo geometry of the actual treatment and patient setup. The purpose of this study was to develop and validate computational infrastructure to automatically convert radiation field parameters and computed tomography (CT) data from Digital Imaging and Communications (DICOM)format to Monte Carlo input format, and automate a Monte Carlo based dose calculation system for external beam photon radiation therapy.

Methods: Computational infrastructure was developed using DCMTK, the DICOM tool kit. The dose calculation system (ADCS) was automated using a shell script. For validation of the ADCS, in-field doses calculated by the ADCS were compared with those calculated by the treatment planning software using an eight-field, 6 MV, step-and-shoot intensity modulated radiation therapy plan. Doses were calculated in a water phantom, and an anthropomorphic phantom based on CT data.

Results: For each field, more than 95% of the dose voxels passed 3% and 3-mm criteria of gamma-index analysis of 3-D dose distributions in the water phantom. The central axis depth dose curve agreed with in 15% (1stardard deviation) to the TPS calculations in the anthropomorphic phantom for a single representative field of the RT plan.

Conclusions:The ADCS can accurately extract patient-specific radiation treatment parameters and automatically incorporate them into the Monte Carlo format and create final dose distributions compatible with commercial treatment planning systems. This automated calculation infrastructure reduces the time required to define the Monte Carlo geometry and potential for human error. This system is capable of automating and calculating doses for conventional radiation therapy and 18MV. It is also capable of calculating out-of-field doses (region of interest in patient anatomy can be selected prior to running ADCS).