

Purpose: Provide the proton therapy community a comprehensive free software tool to improve usability of Monte Carlo simulation for patient safety, research, QA and clinical applications.

Methods: TOPAS incorporates the already-proven Geant4 simulation toolkit into a comprehensive architecture for treatment delivery system simulations and patient calculations. Treatment Head Geometry, Patient Handling, Imaging and Scoring become both flexible and easy to use. Users import DICOM, perform automatic HU conversion, use pre-defined components (range modifier wheels, propellers, steering magnets, jaws, etc.), adjust components or add new components. TOPAS handles time-dependence such as component motion and beam current modulation. Beam input can come from parameterized sources or IAEA-compliant phase space. Output includes 3D dose, phase space, high quality graphics and more. TOPAS puts all this functionality under a comprehensive Parameters Control System that simplifies research and clinical workflow. Settings validated during research can be reliably locked in to translate the setup to repeatable QA or clinical applications.

Results: Using the examples of the MGH gantry treatment delivery system, the MGH radiosurgery delivery system and the UC Davis eye treatment delivery system, we demonstrate the versatility of TOPAS. The Parameters System contains all setup information in a well-defined way to build these beamlines or others. Ability of the user to make common simulation mistakes is minimized through comprehensive and sophisticated architecture. Many checks are performed automatically, such as insisting all numbers have appropriate units. Patient calculations match those previously obtained with conventionally-built Geant4 simulations.

Conclusions: TOPAS has enhanced usability of Monte Carlo simulation while reducing possibilities for user error. TOPAS has begun to replace in-house Monte Carlo research codes at MGH and UCSF. A second phase of TOPAS has recently begun to speed up simulation, through code profiling and variance reduction techniques. TOPAS will be free to all interested Beta testers by Fall 2012.

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