

# An Interface Framework between Treatment Planning System and Monte Carlo Simulation for Proton Therapy

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## Abstract

**Objective:** In order to facilitate the Monte Carlo (MC) simulations, which is known as the most accurate but computational intensive tasks, into the daily dose verifications in the comparison with commercial Treatment Planning System (TPS), a streamlined interface between TPS and Monte Carlo simulations for exchanging a plan's information needs to be implemented. However there still exist many hurdles to apply the MC methods into a routine clinical environment using a commercial TPS. Thus the main objective of our study was to analyze those issues and construct an interface framework that makes the dose verification process between MC simulations and TPS effectively.

**Methods and Materials:** TOPAS (Tool for Particle Simulation) and in-house GEANT4 application were deployed as the Monte Carlo simulation engines and RayStation was chosen for the proton TPS at Samsung Medical Center. The interface developed based on the Python, a general purpose programming language, provides generation of input files for our Monte Carlo engines based on a plan information (e.g., DICOM-RT) from TPS, a MC job submission to our cluster system, and analyzing outputs from MC results in TPS. Furthermore the file transfer between TPS and the cluster system, such as uploading patient CT images and downloading MC results, was designed to be handled by the interface so that we could directly compare the MC dose distribution with TPS calculation results with all functions in TPS.

**Results:** The developed interface works well for the wobbling mode including ridge filter, MLC, compensator and block and the pencil beam line scanning mode using Sumitomo proton machine. With this framework, we could effectively execute Monte Carlo simulations from the TPS side and analyze the Monte Carlo dose distribution and dose volume histogram than ever before.

**Conclusion:** We have described a TPS-Monte Carlo simulation interface framework to effectively evaluate the accuracy of dose calculation algorithm and to be used for further research topics in Samsung Medical Center. As most importantly the interface runs in a user-friendly GUI as part of TPS, so any users even who are not MC experts can perform dose verifications. Although the current developed framework has been mainly focused on our proton facility using RayStation and Sumitomo proton machine, it could be easily extended to other TPSs and proton machines in the future since our framework was based on the standard DICOM RT-ION protocol.

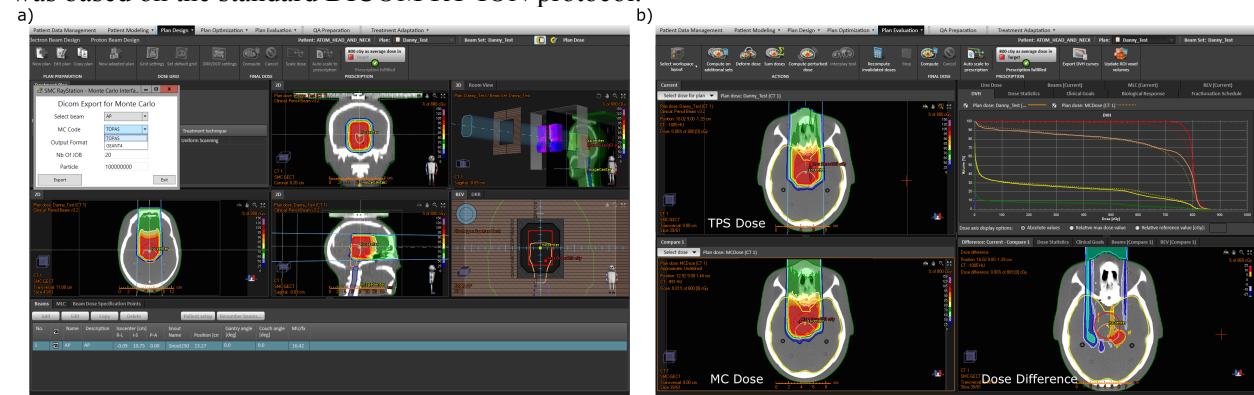


Figure 1.

- The developed interface for exporting Monte Carlo input file for the TOPAS and GEANT4
- Dose difference between planning system dose and Monte Carlo dose with dose volume histogram