# Estimated Visualization of Dose Calculation with GEANT4 in Medical Linac

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## Introduction

Geant4 is a toolkit used to simulate the passage of particles through matter. Recently, it has been used in many medical physics applications. In radiotherapy, positron emission tomography, and magnetic resonance tomography, Geant4 has been applied to accurately simulate the propagation of particles and the interaction of particles, not only with medical devices, but also with patient's phantoms.[1,2] Many researchers try to use patient's image data to calculate the dose. The use of DICOM images files to simulate is desired. We construct detector with parameterized volume for Geant4 simulations, which can be applied to simulations using DICOM data as the input.

We try to apply this code to the patient's DICOM images to simulate the propagation and interaction of the particles. So we can calculate the absorbed dose of the patient. In this study, the used visualization tool is called gMocren.[1-2] The purpose of the present paper is to verify a volume visualization tool that simultaneously displays both the complex patient data and the simulated dose distribution with real patient's DICOM data.

## Materials and Methods

DICOM (Digital Imaging and COmmunication in Medicine) interface handler which provided from GEANT4 doesn't work correctly, so we had been modified independently PHILIPS CTSim-DICOM data had been tested. Intermediate file creation modules are plugged in for converting original CT data into a suitable one for making the geometry.

We use machine specific calibration curve to convert CT-Hounsfield number to physical density. An assignment of material densities to materials are done from the information in the file Data.dat. GEANT4(v9.3_p02)_gMocren shows a screen, which consists primarily of the following panes, a volume rendering pane, a multiplanar reformat pane, and two histogram panes. The volume-rendering pane displays 3D images and MPR plane displays the projections of the 3D image onto the xy, yz, and zx planes.

We calculate the absorbed dose of patient with real patient's image files and display this dose with gMocren code. We planned same patient with RTP system which is used in radiation therapy planning (XiO).

## Results and Discussion

We calculate the absorbed dose of each voxel point in every slices for real patient's image files and compared with measured dose and RTP's planned dose. We displayed calculated dose to the computed tomography and reviewed with gMocren tools are shown in Fig.1. and Fig.2. And compared with RTP's plan data in field size 10x10 $cm^2$ are shown in Fig.3.

gMocren is very useful tool for displaying the GEANT4 simulation result, but difficult to find every voxel real dose value, so we developed to create the each slice's dose matrix and stored with table for further use.

The simulated dose distribution can also be displayed as a contour plot. With a gMocren utility we can extract dose data. But we can't create nice contour plot on the DICOM image like planned data with RTP system. And it is very difficult to compare with RTP's plan data.

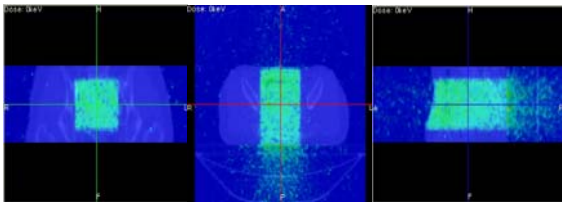

Fig. 1. 2D section images of *xz-xy-yz*-planewiththe MPR. The simulated dose is displayed by means of a distribution map.

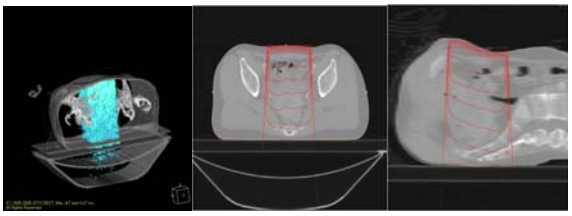

Fig. 2. 3D images of the pelvic obtained using the dose method in gMocren.

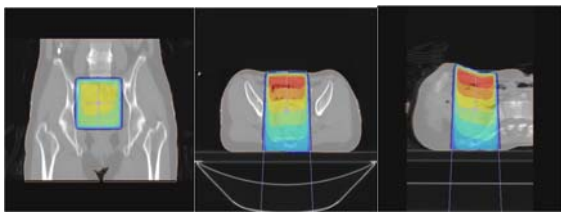

Fig. 3. Planning data in field size 10x10 $cm^2$ to compare with calculations.

Table 1. Calculated dose distribution table of the center slice. The first columns are voxel's copy numbers and second are doses in that voxels

| | A | B | C | D | E | F | G | H | I | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 442368 | 4.44E-21 | 442369 | 6.87E-22 | 442370 | 2.71E-21 | 442371 | | 442372 | | 442373 | 5.88E-22 |
| 2 | 442496 | 8.19E-21 | 442497 | 4.96E-21 | 442498 | 2.46E-21 | 442499 | 7.23E-22 | 442500 | 3.56E-21 | 442501 | 1.59E-21 |
| 3 | 442624 | 2.20E-21 | 442625 | 1.99E-21 | 442626 | 3.32E-21 | 442627 | 8.64E-21 | 442628 | 1.38E-21 | 442629 | 1.24E-21 |
| 4 | 442752 | 3.05E-21 | 442753 | | 442754 | 1.44E-21 | 442755 | 6.28E-21 | 442756 | 4.55E-21 | 442757 | 6.66E-21 |
| 5 | 442880 | 6.11E-21 | 442881 | 2.48E-21 | 442882 | 9.35E-21 | 442883 | 5.41E-21 | 442884 | 8.72E-21 | 442885 | 2.36E-21 |

## Conclusions

We applied a volume visualization tool for GEANT4 simulation. We developed to create the each voxel's dose tables of the every slices and review the distribution with DICOM file, gMocren is very convenience tool but provide only qualitative analysis. We need more enhanced functions to display contour like RTP and utility program to create dose table in every points.

Acknowledgements
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## References

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