Volume Visualization Tools
for Geant4 Simulation

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Background and Purpose

- Geant4 toolkit has been utilized for many medical physics applications.
    - Existing visualization tool of Geant4
        - Surface rendering
        - There is no visualization tool for volume rendering

- Developed visualization tool
    - It has a capabilities of
        - volume rendering
        - fusion of modality image and calculated dose distribution.

Standard Geant4 Visualization
---- surface rendering

- **Proton irradiation events in Geant4**
  - visualized by the OpenGL driver
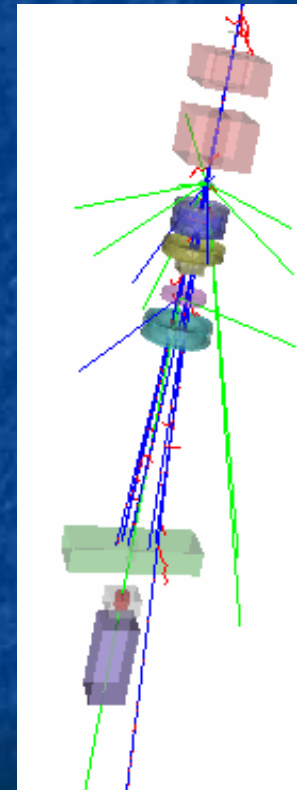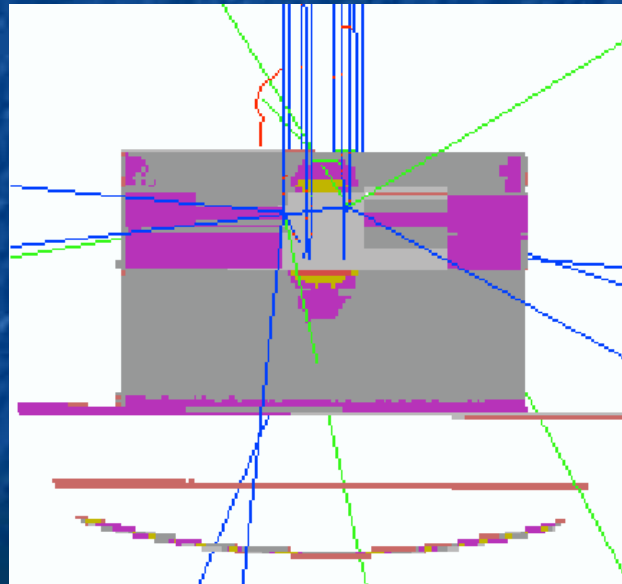
Visualization Tool for volume rendering

- **gMocren**
  - High-quality volume rendering of Geant4 medical simulation
  - Simultaneous visualization of a complex modality image and a calculated dose distribution
  - Enough Fast Interactive visualization

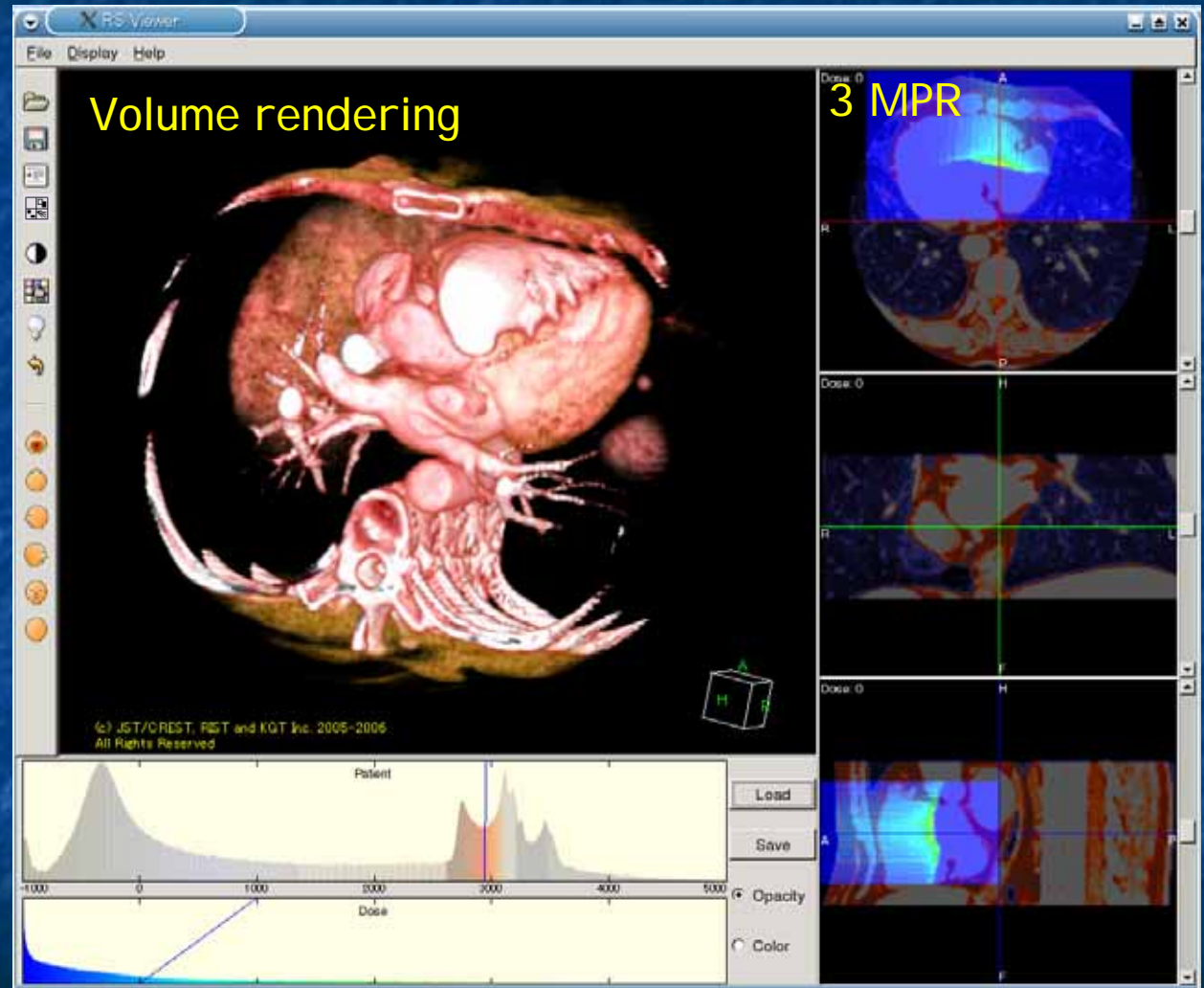- It is useful for debugging and extract intuitive information.

Appearance

Tool buttons
- Open file
- Save as image
- Data information
- Data Selection
- MPR contrast
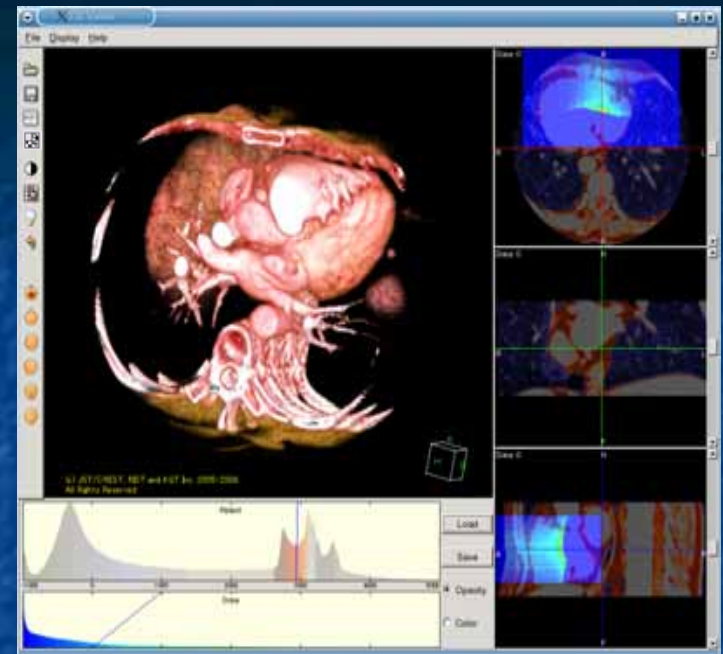- 3D Resolution
- 3D Light
- 3D Reset

View directions

image setting

Volume rendering

3 MPR

Appearance

- **Three panes**
  - **Volume rendering, MPR and image setting panes**
    - **Volume rendering**
      - A ray-casting method with an early termination technique
    - **MPR (Multi-Planner Reformat)**
      - Three directions
    - **Image setting**
      - Transfer functions and color maps of the volume rendering

gMocren Data File (GDD file)

- Described data are stored

  - modality image

  - dose distribution

  - Region of Interests (RoI)

  - trajectories

```
DICOM Data
    │
    ▼
  Geant4
    │
    ▼
  GDD File
    │
    ▼
  gMocren
```

- We provide a class library for the file I/O and a Geant4 sample program with our DICOM interface.

  - These are included in the Geant4 package
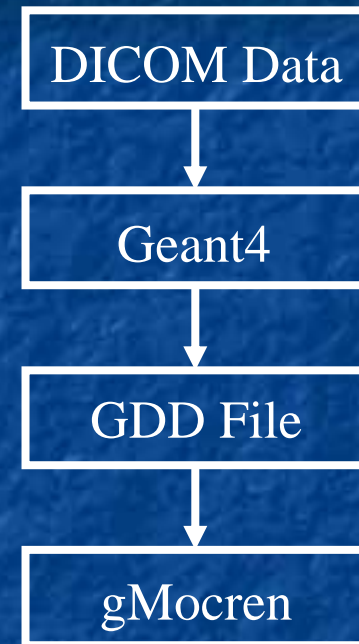
System Requirement

- OS
  - MS Windows 2k/XP or Linux with a GTK library
- CPU
  - Intel Pentium4 processor or faster
- Main memory
  - more than 512 MB
- HDD
  - 100 MB of available space

- No special hardware is required. However, it is the enough fast interactive visualization.
  - By using mouse, rotate, zoom in, zoom out, etc
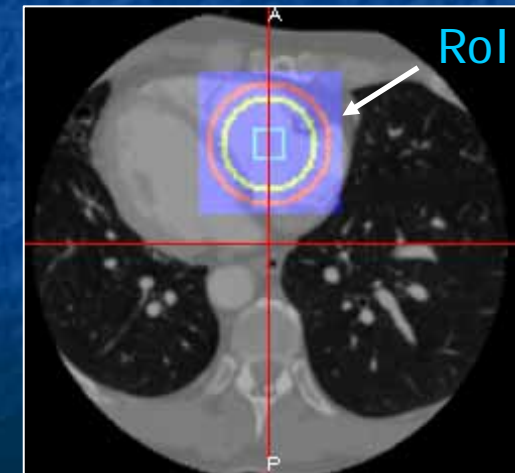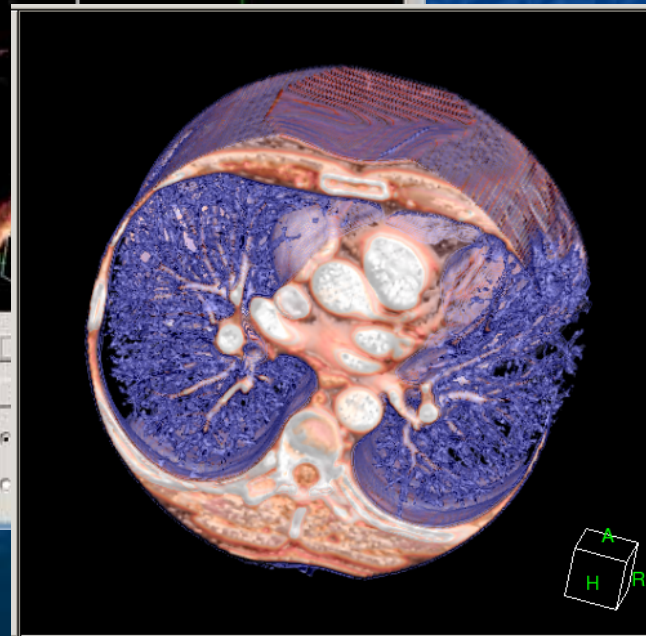 - Use of assembler in rendering engine

Sample Images (1)

A breast region data
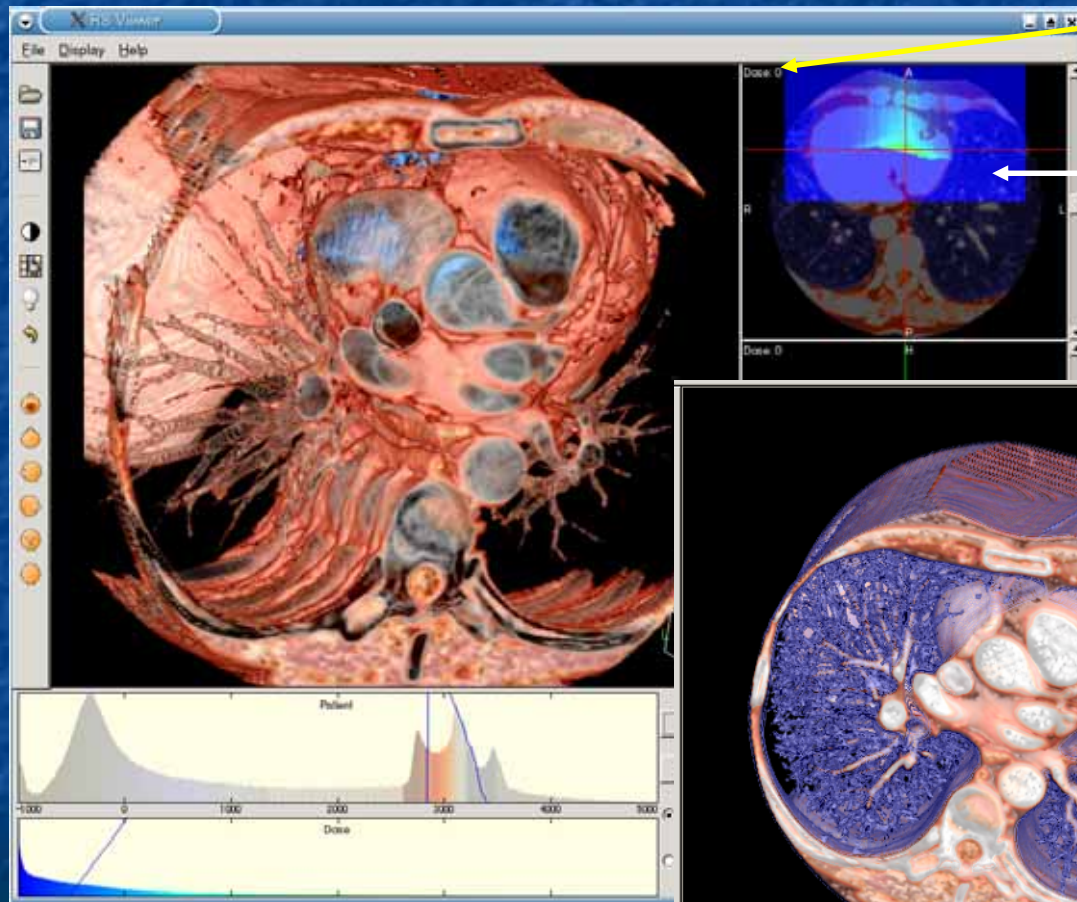
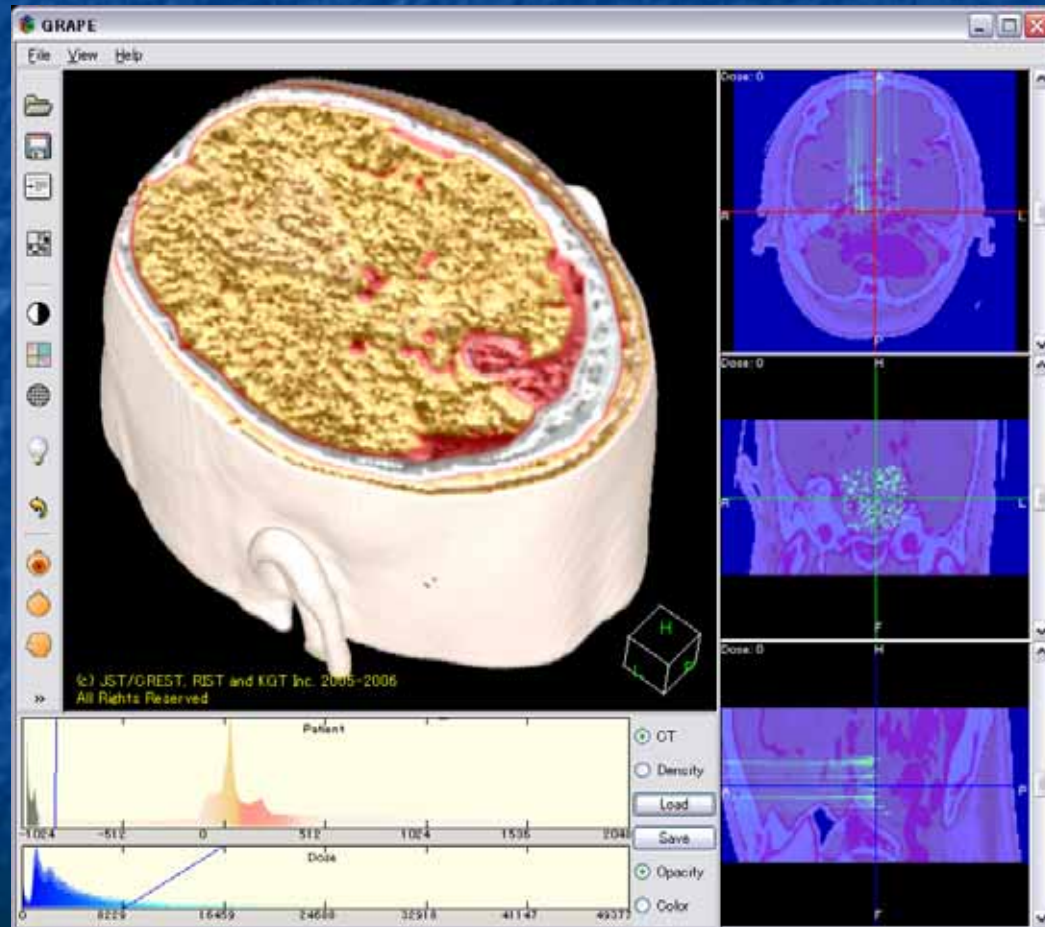By pointing with the mouse, the dose value in the dose map region is displayed.

Dose map region

High-quality VR

RoI

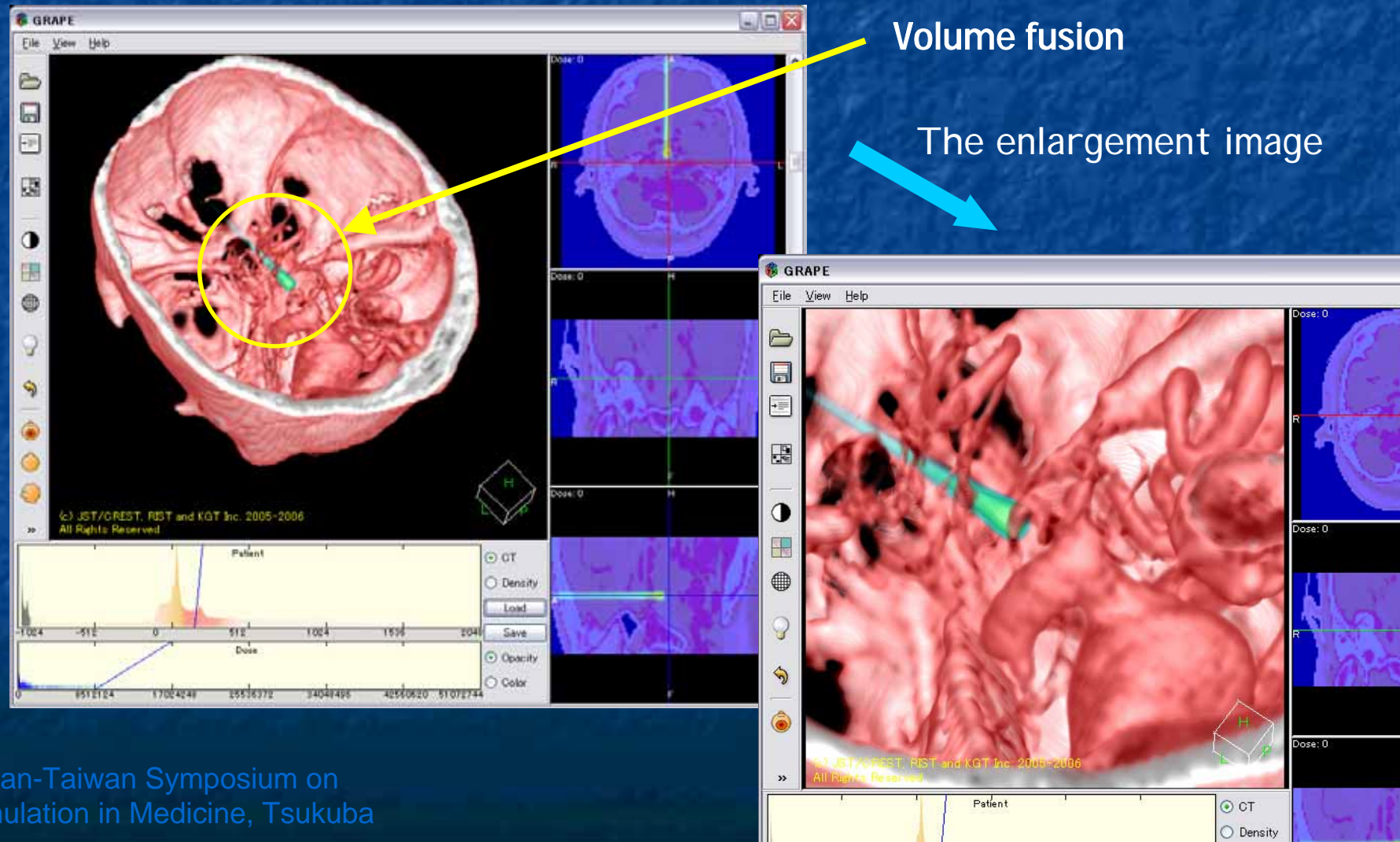# Sample Images (2)

A head region data

Sample Images (3)

A head region data with a different image setting

Volume fusion

The enlargement image

Hardware acceleration in progress

- We are developing a visualization tool with options of hardware acceleration:
  Hardware-dependent but fast

  - Volume Pro

    - The hardware is expensive, however it is capable of a high speed rendering of large data.   (~30 fps max.)

  - GPU-based ray-casting

    - Relatively cheap and reasonable performance (2-3 fps in a laptop)
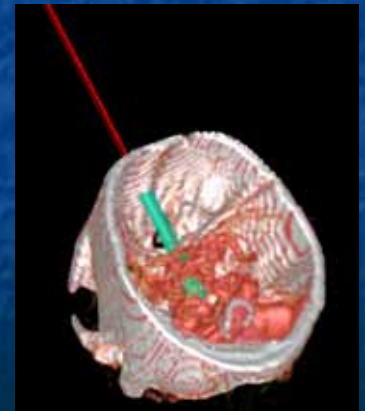
Software Distribution

- freely available with a registration at the web site:

  http://geant4.kek.jp/gMocren/
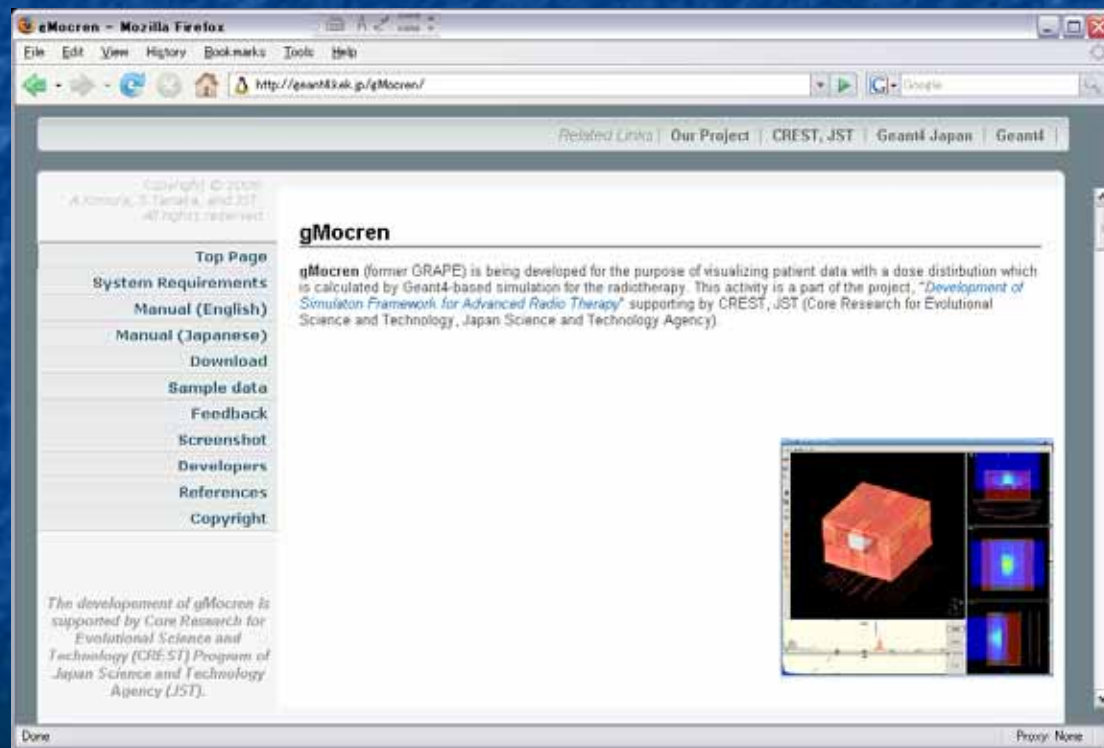
Conclusions

- We have developed a visualization tool, gMocren, for Geant4-based medical physics applications.
  - gMocren realizes high-quality volume rendering of Geant4 simulation.

  - By using gMocren, the calculated dose distribution can be visualized with the modality image.

  - It enables us to easily get debugging and intuitive information from a Geant4 simulation.

  - gMocren does not depend on any special hardware

    - Options of much fast hardware acceleration is also under development

Acknowledgment

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Thank you for your attention !