

Status of (G)UI and Geant4 Application for Education

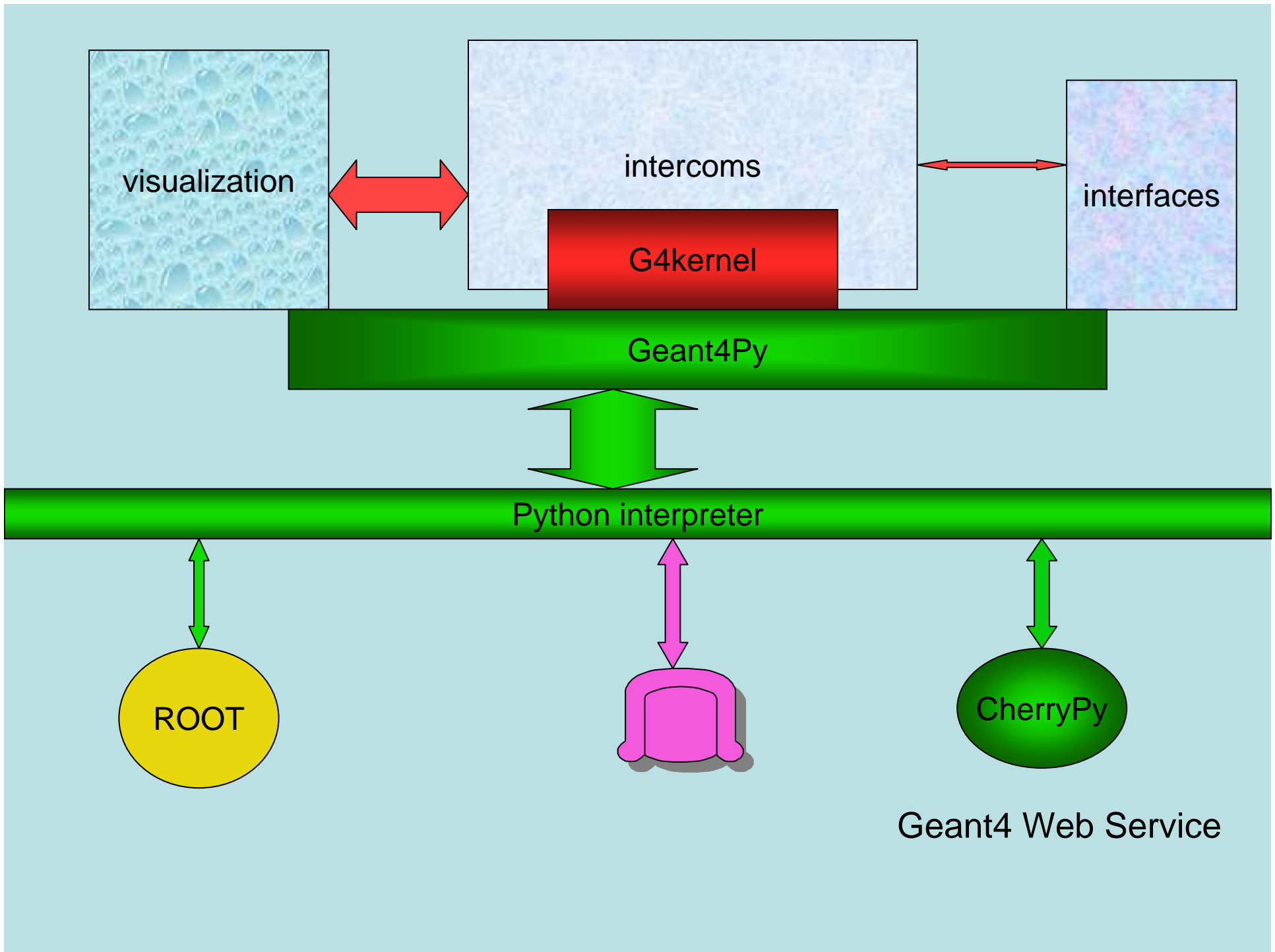
Geant4 Workshop
10 November 2005, Bordeaux

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Naruto University of Education

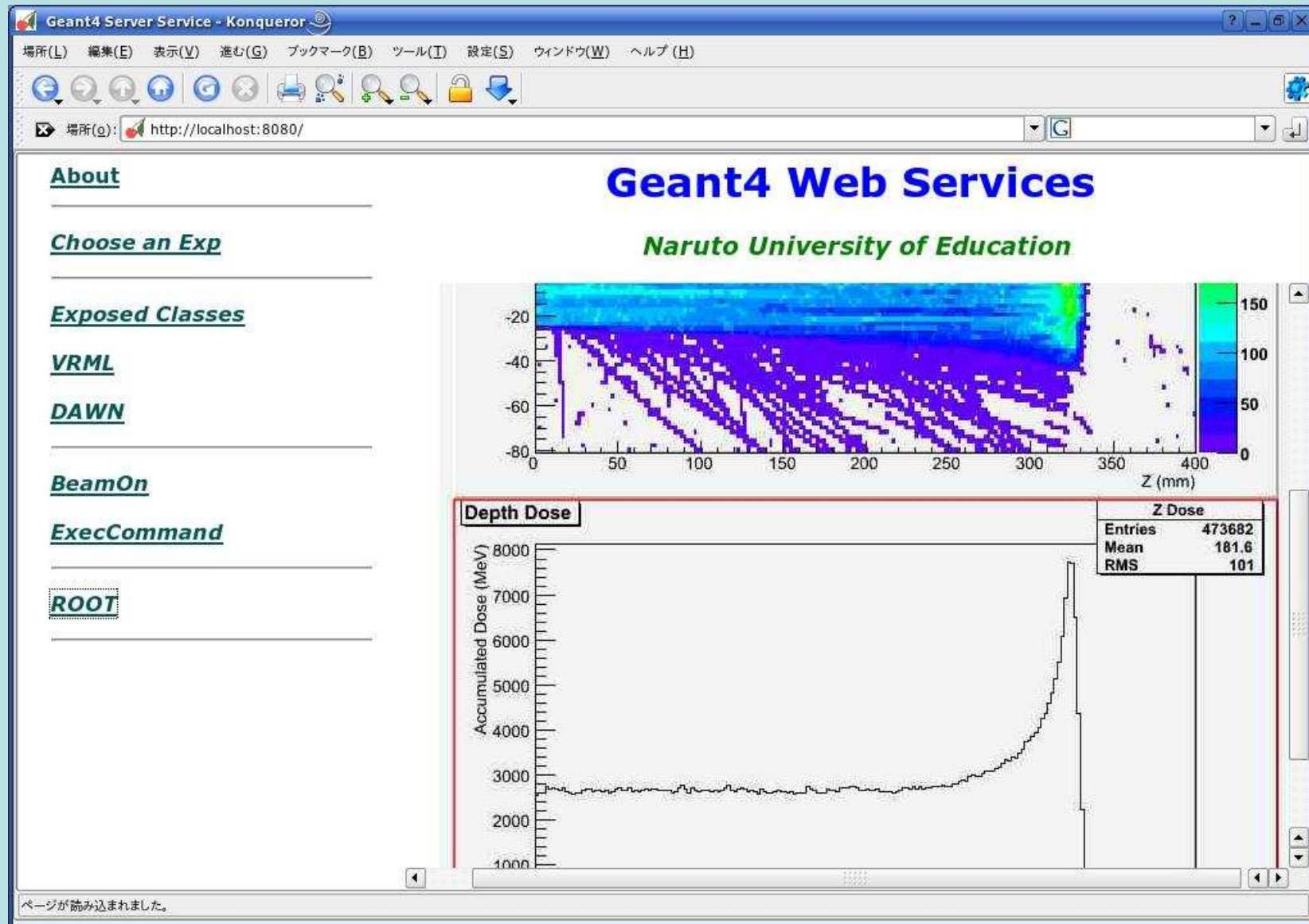
1. Migration to <sstream>
2. Geant4Py; Pythonization
3. Consequences of Pythonization;
Geant4CherryPy, a Geant4 Web
Service
4. Report of the “Geant4 for Education
Workshop” at Naruto UE

Gabriele is working

- Dear Koichi, Hajime,
- the tags you submitted for the migration to <sstream>: global-V07-01-02 intercoms-V07-01-02 interfaces-V07-01-00 are currently under testing and everything seems to be OK and work fine.
- There are however still some remnants of this migration which requires to be fixed. In order to complete the migration, I'm verifying now that the gcc compiler does not issue 'backward-compatibility warnings' in compilation for strstream.
- To verify so, you should pick up the tag "global-V07-01-04", where I have removed in G4Types.hh the deprecation statement for gcc, i.e., the following lines: `#if (__GNUC__>=3) && (__GNUC_MINOR__>=0)`
`#undef __DEPRECATED #endif` and try compiling. By doing so, you'll observe the following warnings ...
- ----- Nov. 09 -----



Geant4CherryPy Web Services



Possible applications

- Execution over the Internet including visualization and analysis
 - Education; e-learning
 - Medical; access thru the firewall
 - Etc
- DAWN file generation service
 - Please import my geometry and create .prim file which I will get later when ready
- Batch run monitoring
- Integration in a GRID environment

Education as an Application Domain of Geant4

- List of a bunch of “emerging” application was shown by Katsuya
- Education has its own requirements and may be a domain new to Geant4
- Michel created course materials for education and felt a lack of interactivity
- Time is now when we have the Pthonization implementation by Koichi.

Geant4Py: Contexts in Educational Application

- We should take care of **two** user layers;
 - Contents Creators (*teachers*)
 - End Users (*students*)
- For Contents Creators
 - Python interface can work as component bus.
 - Modularizing, combining, and using components
 - Material / Geometry (predefined geometry / easy geometry setup)
 - Physics list (EM, Hadrons, Ion)
 - Detector response (Calorimeter / Tracker)
 - Analysis packages (ROOT, HBOOK, AIDA, ...)
 - Visualization
 - GUI (Qt, Tk, ...) / Web applications (mod-python, CherryPy)
- For End Users
 - Scripting with Python is **NOT** essential!
 - Of course, they can play with scripting.
 - They are not necessarily required to learn Python language.
 - GUI / Web applications should be presented.
 - They can be built on the Python interface.

Geant4 for Education Workshop

September 12 – 16 , Naruto University of Education, sponsored by KEK program
Materials are available at <http://erpc1.naruto-u.ac.jp/~geant4/>

After ten years of Geant4, Geant4 is now in the second ages of its life cycles.
Objective : Not to teach Geant4 but to use it to teach

Participants = Developers and course material creators

Name	affiliation	category	fields/backgrounds
• Michel Maire	LAPP, Annecy	Geant4 developer	HEP
• Dennis Wright	SLAC, Stanford	Geant4 developer	HEP
• Koichi Maruyama	Kitasato Univ.	Geant4 user	medical sciences
• Tomoyuki Hasegawa	Kitasato Univ.	Geant4 user	radiological technology
• Katsuya Amako	KEK	Geant4 developer	HEP
• Takashi Sasaki	KEK	Geant4 developer	HEP
• Koichi Murakami	KEK	Geant4 developer	HEP
• Go Iwai	JST/KEK	Geant4 user	HEP
• Satoshi Kameoka	JST/KEK	Geant4 user	Nuclear Physics
• Hajime Yoshida	Naruto UE	Geant4 developer	HEP
• Yoshihiro Kawanishi	Naruto UE	Geant4 UI	Technology Education

Michel's course materials for HEP/NP

- Michel worked as a course material creator
 - Not for Geant4 but to introduce physical concept to students
- Based mainly on the geometry and physics list of the examples/novice/N03 and extended/electromagnetic/testEms
 - Compton ~10 slides
 - Gamma conversion ~ 25 slides
 - Ionization ~40 slides
 - Em shower ~13 slides etc.
 - All explained with visualization
- Courseware including
 - ~38 exercises
 - Histogramming
 - Visualizable answers in the form of macro files
- Much more interactivities are necessary
 - Create a volume with a newly defined material and put it at a desired position etc.

The Use Case and Requirements: for medical education

- 1) Radiation Physics in Medical Education
- 2) **Simulation Tools for Radiation Physics related Lectures and Laboratories**

1) By Koichi MARUAYAMA

2) By Tomoyuki Hasegawa

Allied Health Sciences &

Graduate School of Medical Science

Kitasato University

Geant4 Mini Workshop for Education @ Naruto UE, Sept. 12,

05

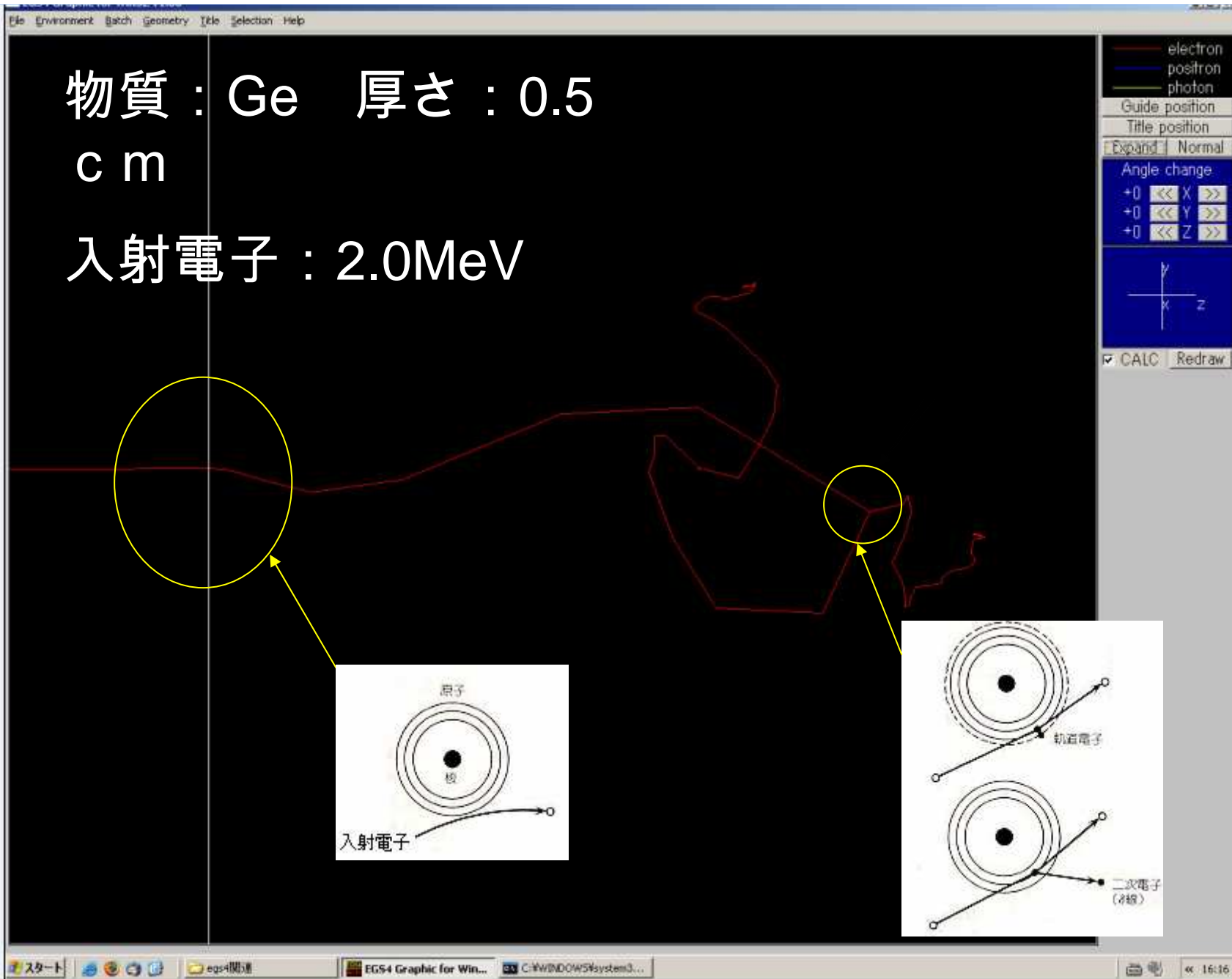
A Special Laboratory Scene with Simulation Tools

- Including under-graduate, graduate students, medical physicists, and radiological technologists



物質 : Ge 厚さ : 0.5
cm

入射電子 : 2.0MeV



Self-Study and e-Learning Scenes with Simulation Tools



Experiences at Kitasato

- Visualization is the key element
 - Trajectories and geometries
- Simple geometry like an Aluminium plate is enough to “measure” the mass attenuation coefficient etc.
- Simple “measurements” a la Rutherford don’t need analysis tools. Intuitive “measurement” is pedagogically effective.
- Analysis tools will be necessary to learn dosimetry etc.

Radiation Equipments to be Simulated

- Radiation Detectors
 - Ionization chamber
 - Proportional chamber
 - GM counters
 - Scintillation detectors
 - etc.



Radiological Equipments to be Simulated

- X-ray Equipments
 - X-ray tube, filaments, rotating anodes, filters
 - image intensifiers, X-ray detectors, grids
 - tube-voltage, contrast, energy spectra, etc.
- X-ray CT scanners
 - rotating X-ray tube and detectors
 - tube-voltage, beam hardening, etc.
- Etc.



Various Phantoms to be Simulated



Summary(1)

Simulation tools are useful for lectures, laboratories, and self-study (e-learning):

- For lectures (handled by teachers)
 - Easy to understand demonstration
 - Some quantitative calculation, etc.
- For laboratories (handled by students and teachers)
 - More quantitative calculation is important, etc.
- For self-study and e-learning (handled by anyone)
 - Better to be a PC program, Easy to handle, Speed, etc.

Could be useful for clinical staffs and researchers as well as students, as a part of the post-graduation education.

Summary(2)

Possible subjects and themes:

- **Radiation Therapy, Radiological Technology**
 - Interaction of radiation with a body, phantoms and various radiological equipments
 - Energy deposits distribution, Production of secondary particles
 - etc.
- **Radiation Physics, Medical Physics**
 - Basic interaction of radiation in various materials, including production of secondary particles
 - etc. Simulation in slow motion will be helpful.
- **Radiation Measurement and Detection, Radiological Equipment**
 - Interaction of radiation in objects and detectors
 - Data processing
 - Imaging
 - etc.
- And so on

Discussions by participants

- Concrete and realistic “standard” geometries must be provided whose geometrical data must be available publicly.
- Some generic geometries which can be customized by teachers will be useful to create their own courseware
- We need interactivities for courseware creators to customize for their own

Geometry subgroup report

selected detector components for education

List of components for medical education

- Standard ionization chambers
 - Track visualization in and around
 - Build up cap
 - Total number of created ions
- Curie well chamber
- Gamma camera
 - Number of photons
 - Energy spectrum
- PET
- GM counter
 - Track visualization

Geometry subgroup report - HEP and NP

- Tracking
 - Vertex chamber
 - Drift chamber
 - TPC
 - MWPC
- Calorimetry
 - Sampling energy and position
 - Crystals
- PID
 - Cerenkov
 - ToF
 - dE/dX
- Absorbers

Site-module package for pre-defined applications

- We will also provide site-module package as pre-defined components.
 - Material
 - sets of pre-defined materials
 - NIST materials via G4NistManager
 - Geometry
 - “exN03” geometry as pre-defined geometry
 - “EZgeometry”
 - provides functionalities for easy geometry setup (applicable to target experiments)
 - Physics List
 - pre-defined physics lists
 - easy access to cross sections, stopping powers, ... via *G4EmCalculator*
 - Primary Generator Action
 - particle gun
 - Sensitive Detector
 - calorimeter type
 - tracker type
- They can be used just by importing modules.
- They can be combined and connected to higher application layers (Analysis / GUI components).

Interactivity subgroup

- EZgeometry
 - NISTmanager has been wrapped and Go demonstrated how to exchange a material
 - Implement N02 equivalent using EZgeometry
 - Voxelization and replica are available now
 - CVS repository of g4py and site-modules are available. Users' forum is provided.
 - <http://www-geant4.kek.jp/projects/Geant4Py>
- Analysis : Excel format is a preferable one?

Navigating Geant4 Hadronics

- Model/Process catalog <= waited by many
 - work in progress
 - will allow a user to find out:
 - which processes may be assigned to which particles
 - which models may be assigned to which processes
 - which cross sections may be assigned to which processes
 - which physics lists use which processes
 - exercise for student:
 - find the appropriate model for anti-proton inelastic scattering at 300 GeV
 - how many processes (hadronic + electromagnetic) are available for elastic proton scattering

How to Build a Physics List (1)

- Space radiation environment toy example
 - understand the physics to be studied: particles, energies
 - cosmic rays: 85% protons, 14% alpha, + C, N, O; most effects in 100 MeV to 20 GeV range
 - Van Allen belts: electrons up to 10 MeV, protons ~10 – 100 MeV
 - solar particles: protons up to a few GeV
 - diffuse gamma background: 0.1 – 200 MeV
 - decide which electromagnetic processes to use
 - refer to novice example N03
 - use e-, e+, gamma processes listed there
 - use N03 processes for p and alpha

How to Build a Physics List (2)

- Space radiation environment toy example
 - decide which hadronic processes, models, cross sections to use
 - G4PhotoNuclearProcess with G4GammaNuclearReaction model
 - G4HadronElasticProcess with G4LElastic model for p, alpha
 - G4ProtonInelasticProcess with G4LEProtonInelastic model
 - G4AlphaInelasticProcess with G4LEAlphaInelastic model
 - default cross sections
 - are unstable particles needed?
 - if so, need G4Decay

Exercises

- Thin target experiment
 - simple box target, mono-energetic beam
 - histogram outgoing angle, energy, multiplicity
 - change energy, models, cross sections -> observe results
- Model tester
 - build a stand-alone application which invokes one hadronic model at a time
 - histogram final state information
- Test beam experiment
 - hadronic calorimeter
 - look at collected energy resolution
 - look at e/pi

Physics subgroup

Physics lists for medical

- A common physics list must be provided -> done!.
- Medical max < 1 GeV
- Start with N03
 - Switching on/off any processes
 - Hadronic processes
 - P elastic, inelastic
 - N elastic, inelastic
 - π
 - Ion
 - Radioactive decays, generic decays
 - Choice of models
 - LEP, Bertine, Binary cascade
 - Process can be turned on one by one. Range cut and step size must be easily modifiable
 - Only the hadronic processes can be visualized – Michel's magic

Physics list for HEP/NP

- We must provide a pre-built list each of whose processes can be turned on/off one by one
- Fixed models are to be used
- Can control the number of secondaries