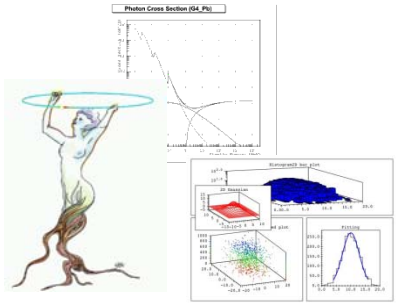
Python Interface, Geant4 Education, and Geant4 on Web

Koichi Murakami

(KEK/CRC)

Geant4 Python Interface



matplotlib

Analysis tools

GUI tools

tcl/tk

wxPython

- interactivity
- flexible application configuration

Geant4Py

python™ Python Interface

•scripting environment
•Python software bus

plug-in modules

Python binding

Geant 4 C++ class library

geometry

primaries

physics process

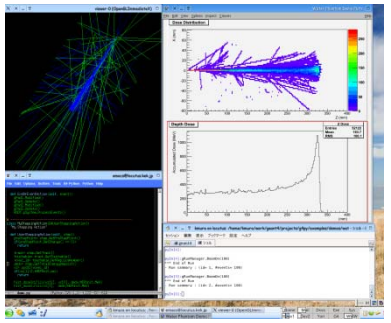
analysis

User codes

CherryPy web-ware

eGee Enabling Grids for E-sciencE Grid-ware

Service tools



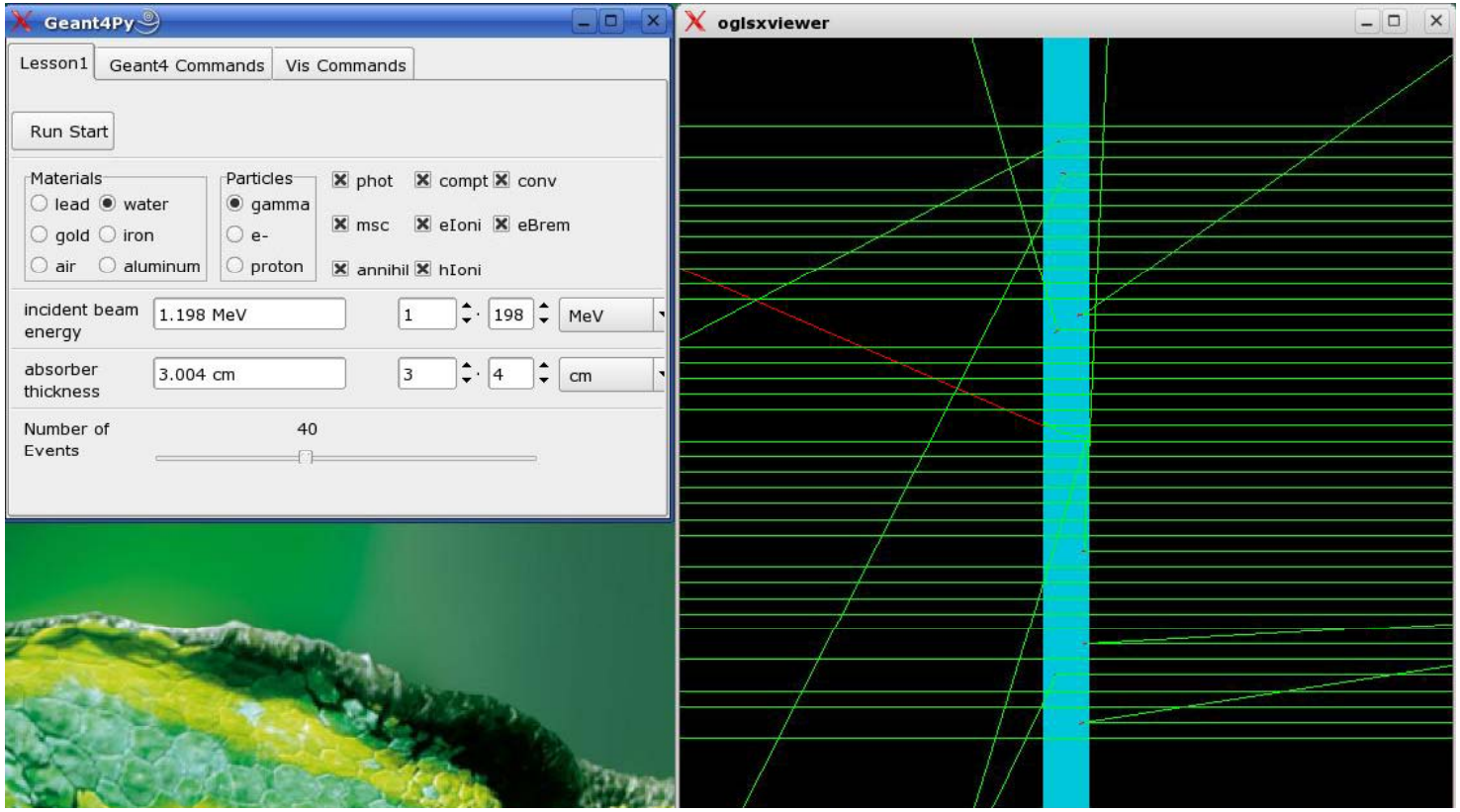
User applications

Python Interface, Geant4 Education and on Web

- Geant4 Python Interface
  - ✓ flexibility to configure user applications
  - ✓ scripting environment
- Geant4 Education
  - ✓ Hajime kicked off the project.
  - ✓ several workshops, to collect user requirements.
  - ✓ some prototype examples
  - ✓ how to merge and distribute?
- Geant4 on Web
  - ✓ Web 2.0 (rich client on Web) is a new possibility of Geant4 interface.

Example of Virtual Lab

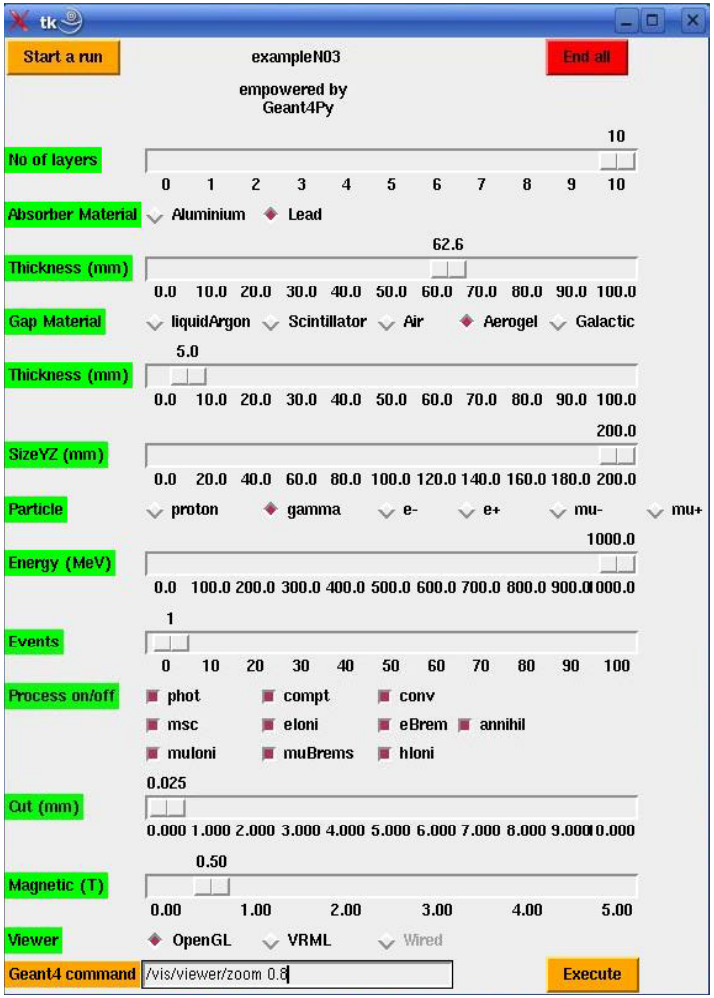
Measurement of mass attenuation coefficient

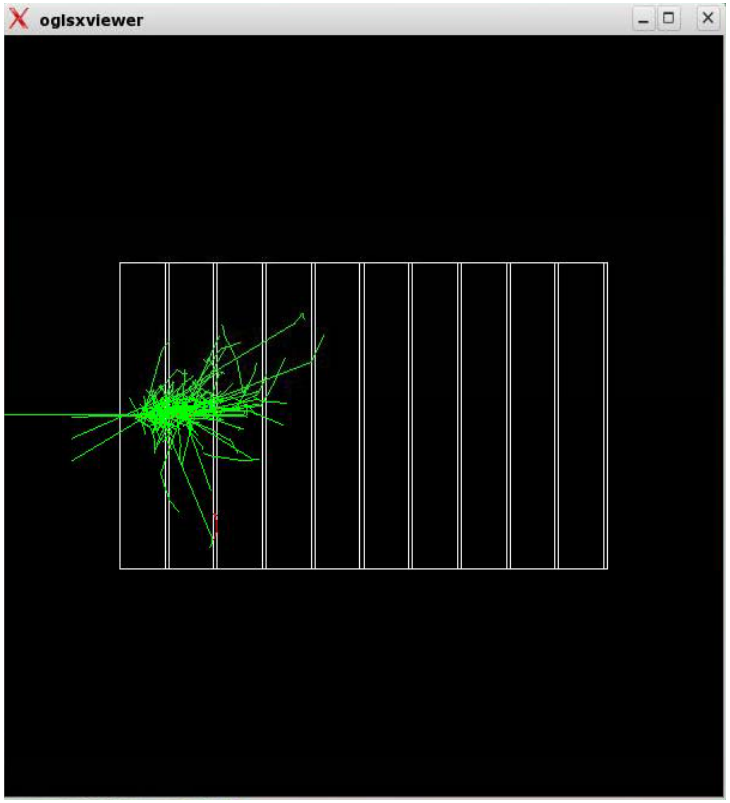


- 1.198 MeV gammas entering 3.004 cm of water
- 40 events are displayed to “measure” the probability of the through gammas
- All EM interactions are activated

Example of Virtual Lab

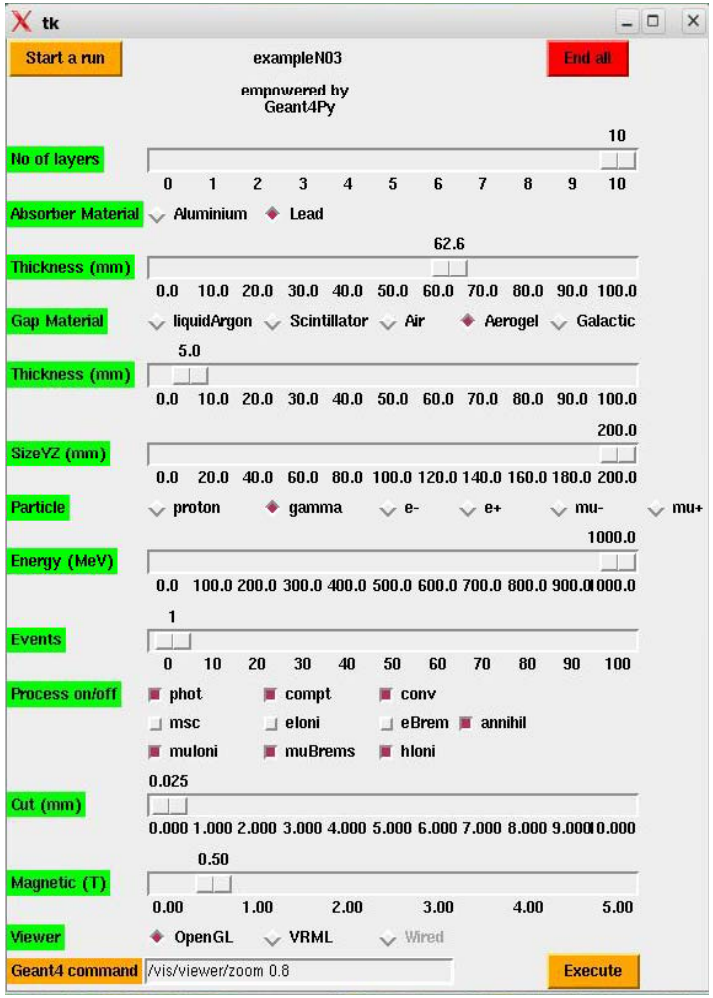
EM cascade in sandwich calorimeter

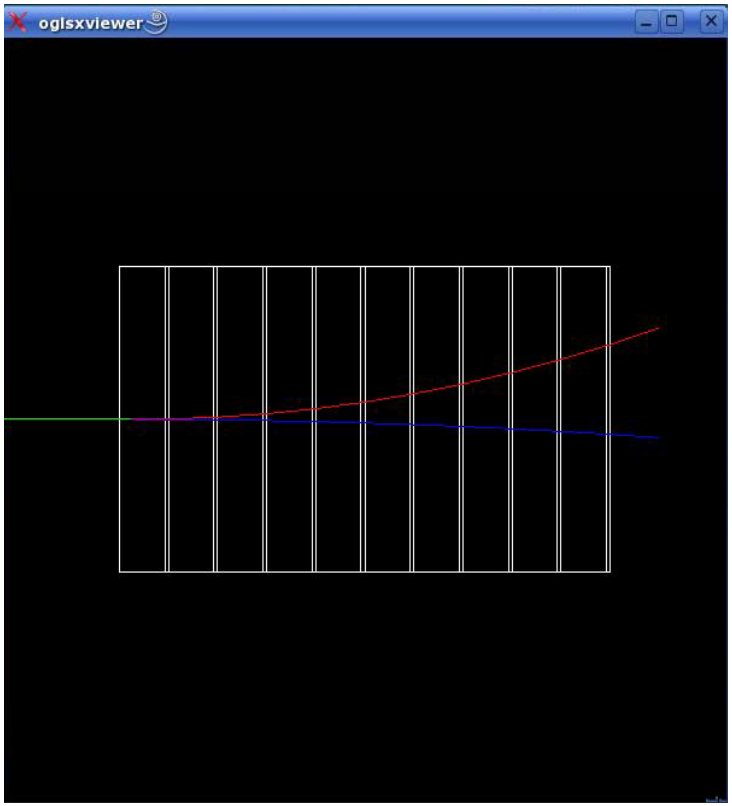




Example of Virtual Lab

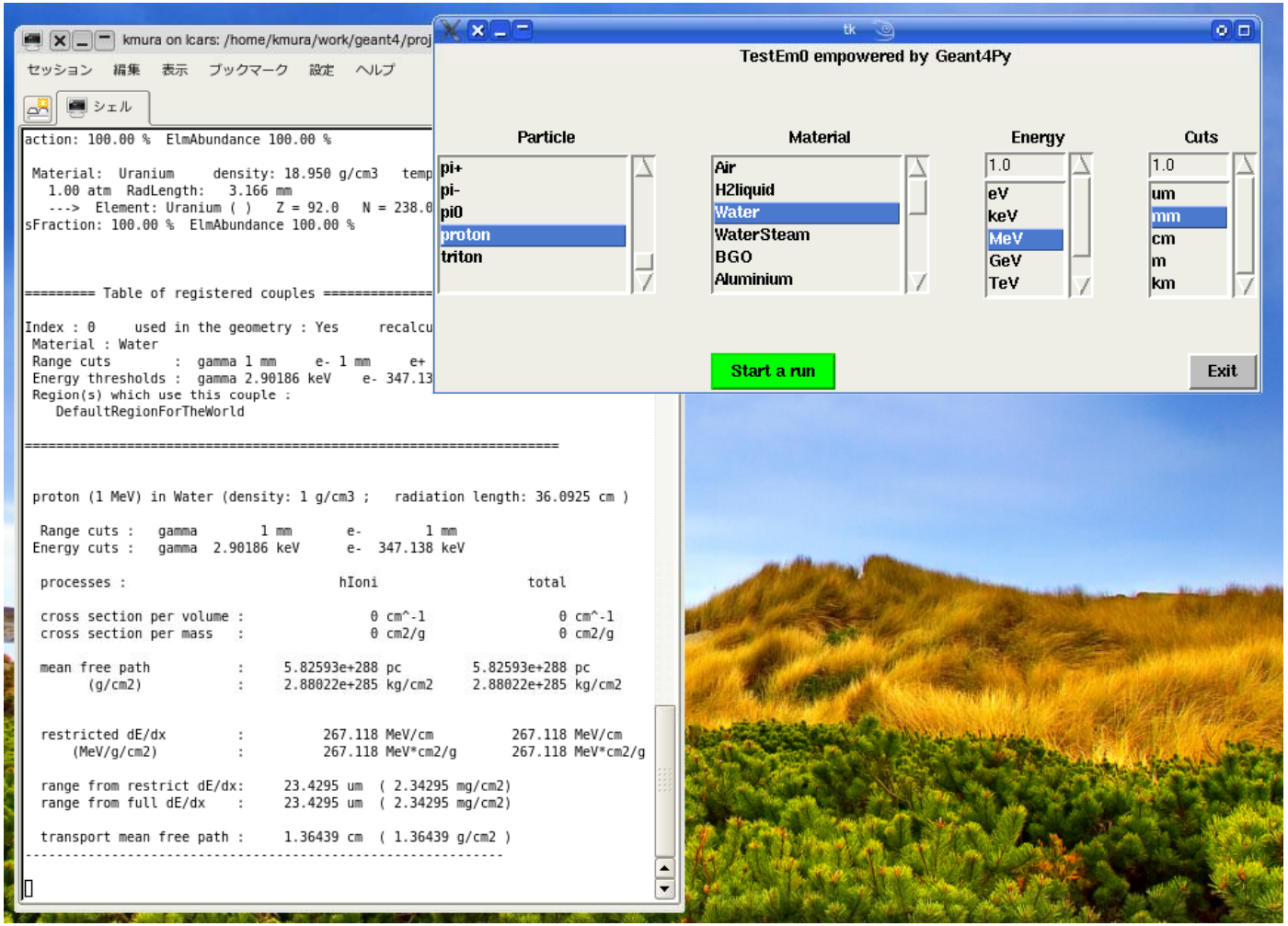
Sandwich calorimeter (process switch on/off)





TestEm0 with Tcl/TK

- Jean created a new example based on TestEm0.



Experiences at Michel's course

- Visualization is a key element for observation of physical phenomena by students.
  - ✓ Trajectories and geometries
- Simple geometry like a water box are useful to "measure" physical quantities like the mass attenuation coefficient, etc…
- Simple measurement like Rutherford don't need advanced analysis tools. Intuitive "measurement" is effective.
- Analysis tools will be necessary to study quantitative features

- How to manage contents and distribute as coursewares?

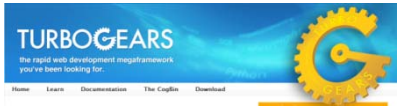
Web application is one of the best solution.

Possibilities of Geant4 on Web

- Course-ware on Web
  - ✓ Geant4 Education
    - Not to teach Geant4 but use Geant4 to teach Physics
    - for HEP experiment, radiological physics and dosimetry,…
    - hyper document with textbook and hands-on work
- G4 examples on Web with user manual
  - ✓ hyper experience with G4 for instant users
- Exposure inside G4
  - ✓ particle, material, cross section, etc.
  - ✓ framework of presenting physics validation results
- Geant4 simulation server
  - ✓ medical applications
  - ✓ radiation background study
- And more?

Inside Geant4 on Web

- Run Geant4 as web service
  - ✓ independent of client enviroment
  - ✓ Python web application framework
    - TurboGears / Pylons
    - MVC (Model/View/Control) model

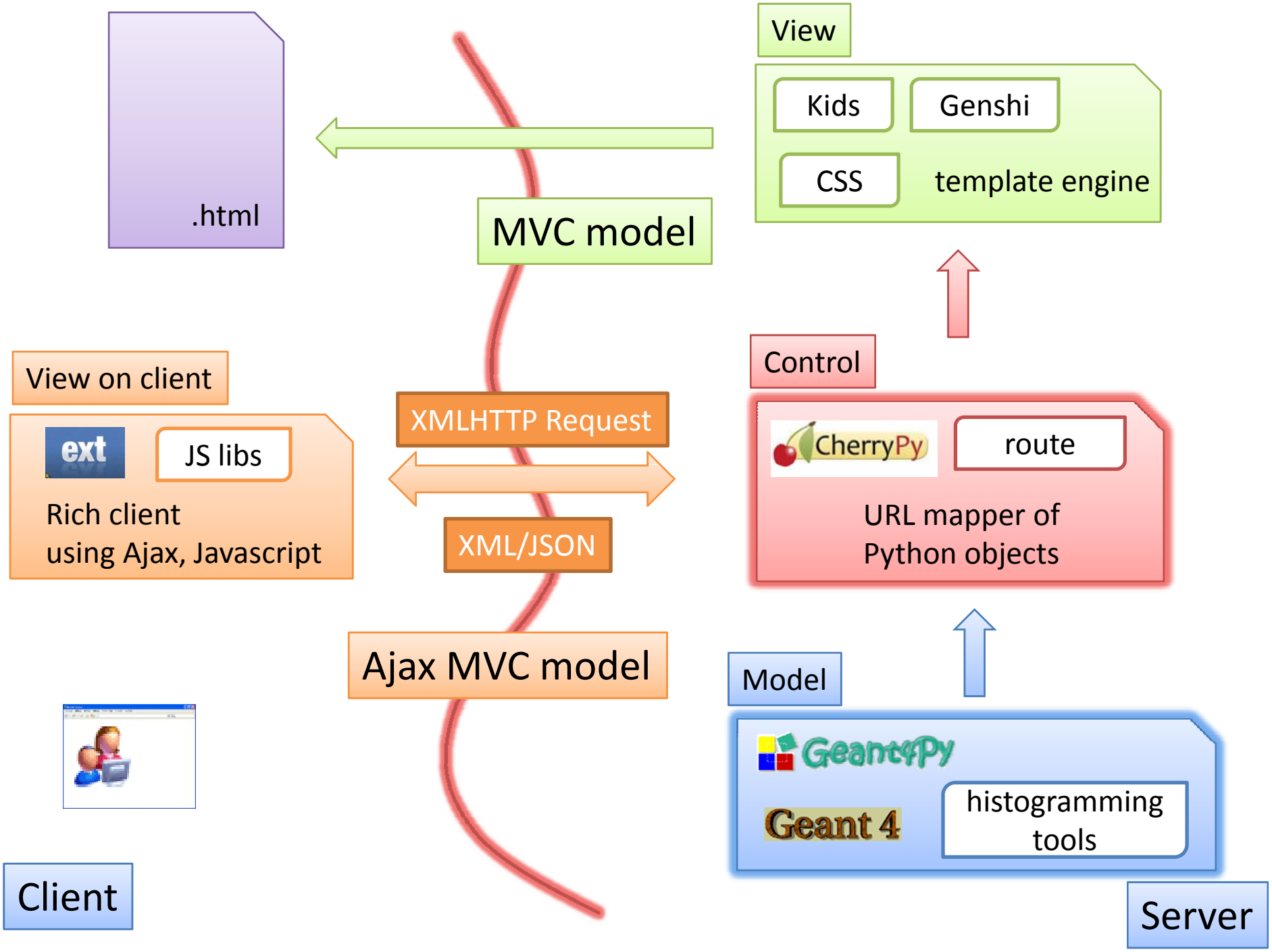


- MVC model

  - ✓ Model: Geant4 / Python-interface / document management
  - ✓ View: HTML template (Kids/Genshi/Mako) / XHTML+CSS
  - ✓ Control: URL mapping of Python functions
    - CherryPy, route

- Rich client
  - ✓ Ajax (Javascript) powered
    - Ext

- Multi-users access and scalability
  - ✓ Deployment of web servers


.html
MVC model
View
Kids
Genshi
CSS
template engine
View on client
ext
JS libs
Rich client
using Ajax, Javascript
XMLHTTP Request
XML/JSON
Control
CherryPy
route
URL mapper of
Python objects
Ajax MVC model
Model
GeantPy
Geant 4
histogramming
tools
Client
Server

Geant4 Virtual Laboratory

Educational Courseware on Elementary Particle Physics

Exercise 1: Annihilation of a positron

Author: M. Maire (LAPP Annecy)

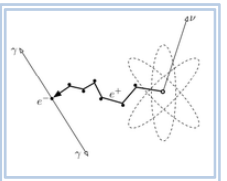
Description | Geometry /... | Physics List | Primary Pa... | Detector | Experiment | Questions / ...

Electron-positron annihilation into two photons

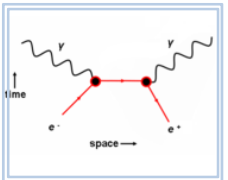
Electron-positron annihilation occurs when an electron and a positron (the electron's anti-particle) collide. The result of the collision is the conversion of the electron and positron and the creation of gamma ray photons or, less often, other particles.

In the most common case, two photons are created, each with energy equal to the rest energy of the electron or positron (511 keV). Since the system had zero linear momentum before the annihilation, the gamma rays are emitted in opposite directions.

This process is the physical phenomenon relied on as the basis of PET imaging. Also used as a method of measuring the Fermi surface and Band structure in metals.



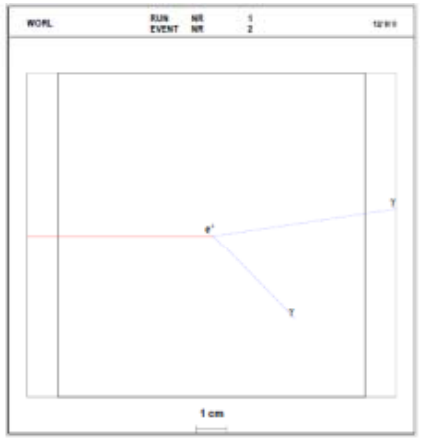
Naturally occurring electron-positron annihilation as a result of beta plus decay

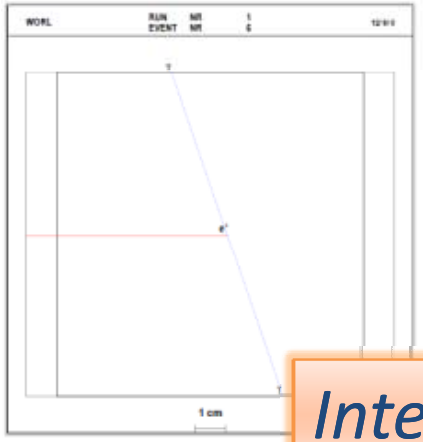


Feynman Diagram of Electron-Positron Annihilation

Micro-view of the interaction

This is the annihilation of a positron in fly (left), or at rest (right), within a given material.





Interface Design

Console

Exercise 1: Annihilation of a positron

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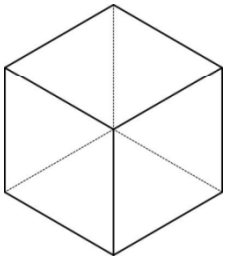
Description | Geometry /... | Physics List | Primary Pa... | Detector | Experiment | Questions / ...

Geometry and Material

There a simple cube in the "Virtual Laboratory". Set a cube size and choose a material inside the cube.



Geometry

Cube Size

X: unit...

Y: unit...

Z: unit...

Material

Standard Material (NIST) select a material ...

Name	Density (g/cm3)	Z	Potential (eV)	#comp	State
G4_CSI	4.5	-	12.1	2	-

Composite

Density: unit...

Add Element mol

Element	Ratio
Na	1.0
I	1.0

Interface Design

Console

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Description | Geometry /... | **Physics List** | Primary Pa... | Detector | Experiment | Questions / ...

Physics List

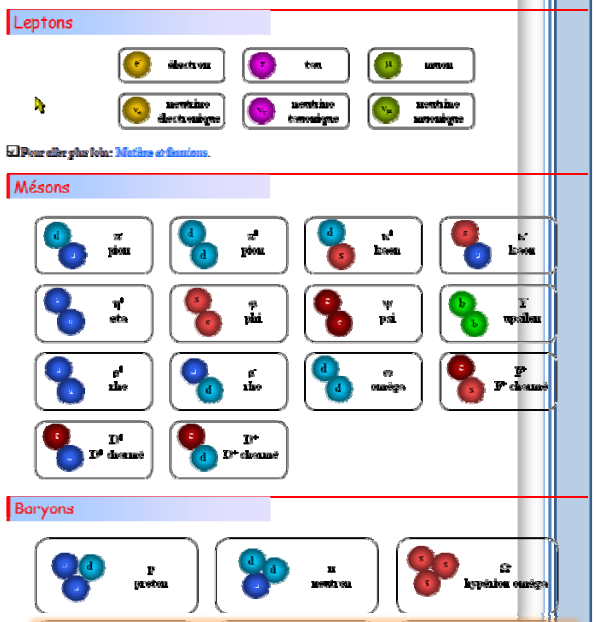
Detail

Switch each physics process active/inactive.

List of defined particles

List of defined particles

- ☐ **photon interaction**
  - ☐ photoelectric effect ☐ Compton scattering ☐ gamma conversion
- ☑ **electron/positron interaction**
  - ☑ ionization ☑ bremsstrahlung ☐ multiple scattering ☑ positron annihilation
  - Detail Parameters
    - ☐ energy straggling
- ☐ **muon interaction**
  - ☐ ionization ☐ bremsstrahlung ☐ multiple scattering ☐ pair creation
  - ☐ energy straggling
- ☐ **hadron interaction**
  - ☐ ionization ☐ elastic scattering ☐ inelastic scattering
  - ☐ energy straggling



Interface Design

Console

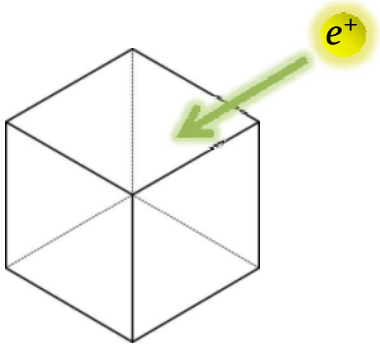
Exercise 1: Annihilation of a positron

Author: M. Maire (LAPP Annecy)

Description | Geometry /... | Physics List | **Primary Pa...** | Detector | Experiment | Questions / ...

Primary Particle

Set parameters (particle species, kinetic energy, direction, etc.) of primary particle.



Particle Gun Setting

Particle: positron (e+)

Kinetic Energy: MeV

Direction:

X: 0.0 **Y:** 0.0 **Z:** 1.0

Interface Design

Console

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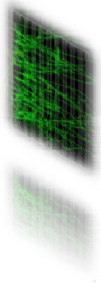
Author: M. Maire (LAPP Annecy)

Description | Geometry /... | Physics List | Primary Pa... | Detector | **Experiment** | Questions / ...

Let's Experiment

Are you ready for an experiment? Let's beam On!

Check your setting



Run Condition

# of events: 1

Tracking Verbosity: 0

Visualization Output

- [x] HEPREP
- [x] VRML
- [x] DAWN

Run Control

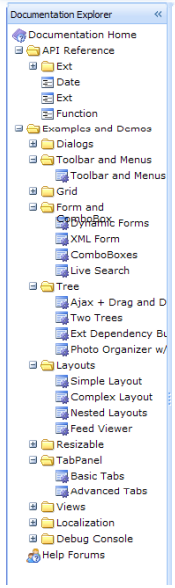
Current Status: Idle

Start | Abort

Output

Log | Vis. | Analysis | My Docs.

Download



Console

```
*************************************************************
 Geant4 version Name: geant4-08-02-patch-01    (23-February-2007)
                      Copyright : Geant4 Collaboration
                      Reference : NIM A 506 (2003), 250-303
                            WWW : http://cern.ch/geant4
*************************************************************

Visualization Manager instantiating...
Visualization Manager initialising...
Registering graphics systems...
```

Interface Design

Exercise 1: Annihilation of a positron

Author: M. Maire (LAPP Annecy)

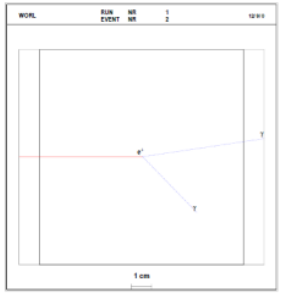
Description | Geometry /... | Physics List | Primary Pa... | Detector | Experiment | **Questions / ...**

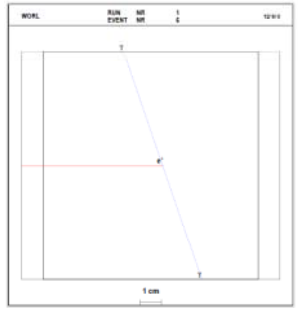
Questions and Report

Question:

Let's get similar pictures, playing with

- Choose a material.
- Set a thickness of the absorber.
- Set an energy of the primary positron.





Report:

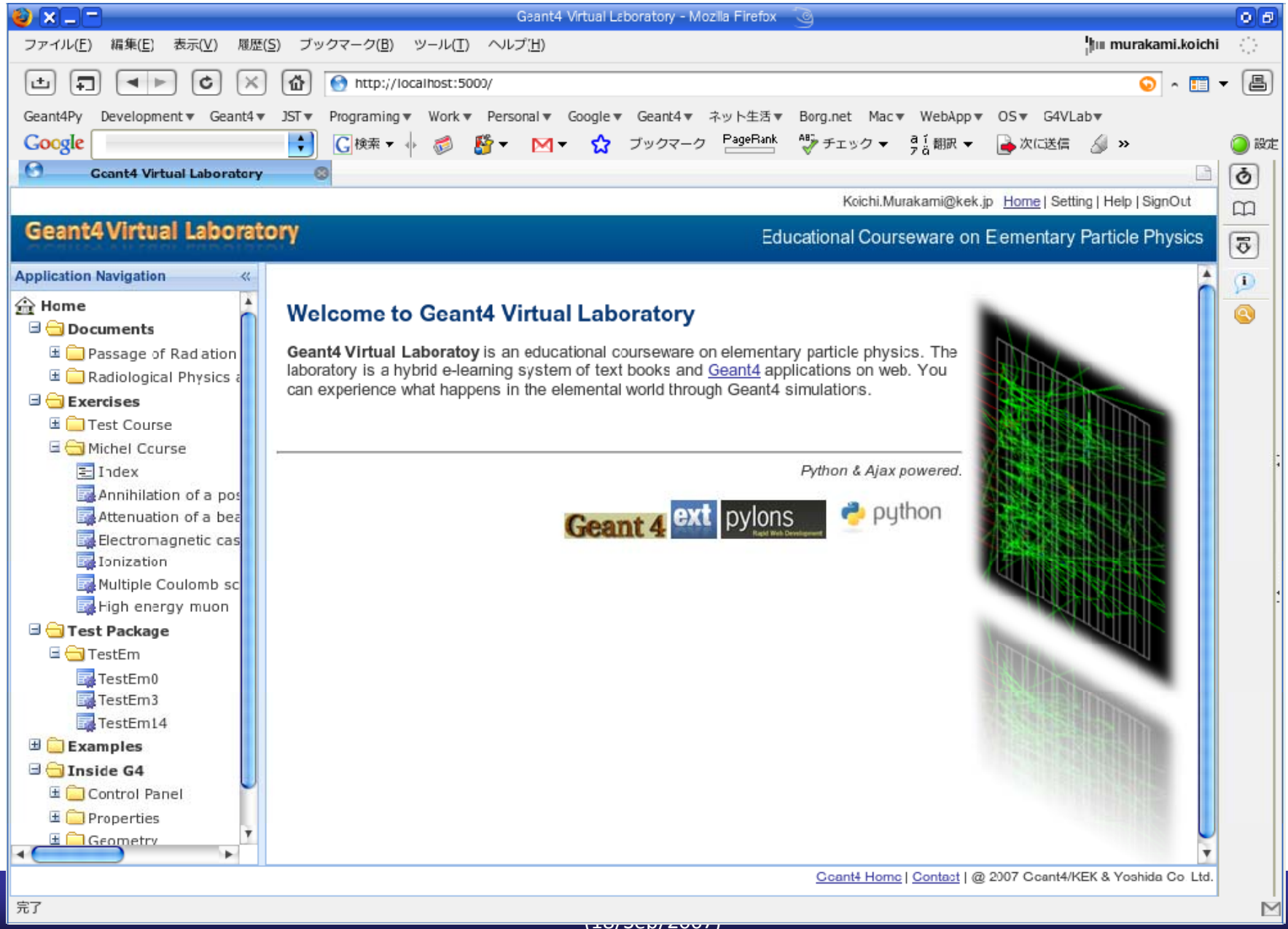
Tahoma

Open | Save

Interface Design

Console

Snapshots from prototype



Geant4 Virtual Laboratory - Mozilla Firefox

ファイル(F) 編集(E) 表示(V) 履歴(S) ブックマーク(B) ツール(T) ヘルプ(H) murakami.koichi

http://localhost:5000/

Geant4Py Development Geant4 JST Programing Work Personal Google Geant4 ネット生活 Borg.net Mac WebApp OS G4VLab

Google 検索 ブックマーク PageRank チェック 翻訳 次に送信 設定

Geant4 Virtual Laboratory

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Geant4 Virtual Laboratory

Educational Courseware on Elementary Particle Physics

Application Navigation

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  - Radiological Physics
- Exercises
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  - Michel Course
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    - Electromagnetic cas
    - Ionization
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    - High energy muon
- Test Package
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    - TestEm0
    - TestEm3
    - TestEm14
- Examples
- Inside G4
  - Control Panel
  - Properties
  - Geometry

Exercise 1: Annihilation of a positron

Description | Geometry/Ma | PhysicsList | Primaries | Detector | Experiment | Output | Report

Electron-positron annihilation into photons

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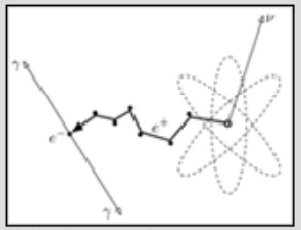
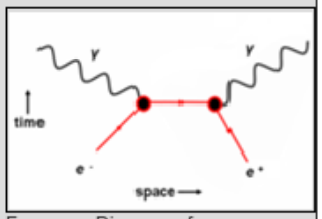


Naturally occurring electron-positron annihilation as a result of beta plus decay

Micro-view of the interaction

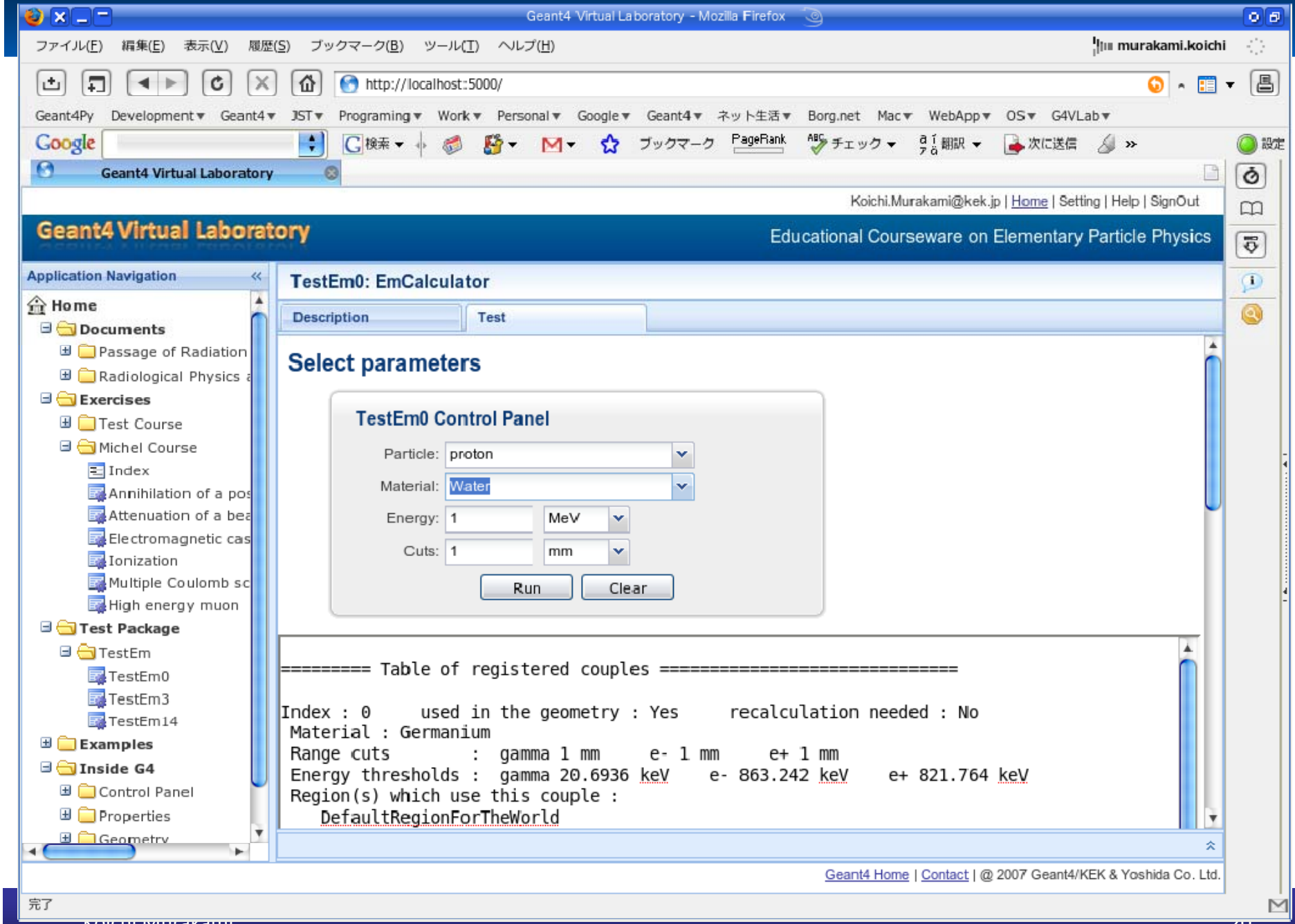
This is the annihilation of a positron in flight (left), and at rest (right), within a given material.



Feynman Diagram of

Geant4 Home | Contact | @ 2007 Geant4/KEK & Yoshida Co. Ltd.

http://localhost:5000/michel/annihilation/index.html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http://localhost:5000/
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Educational Courseware on Elementary Particle Physics
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Geometry
TestEm0: EmCalculator
Description
Test
Select parameters
TestEm0 Control Panel
Particle: proton
Material: Water
Energy: 1 MeV
Cuts: 1 mm
Run
Clear
========== Table of registered couples ==========
Index : 0 used in the geometry : Yes recalculation needed : No
Material : Germanium
Range cuts : gamma 1 mm e- 1 mm e+ 1 mm
Energy thresholds : gamma 20.6936 keV e- 863.242 keV e+ 821.764 keV
Region(s) which use this couple :
DefaultRegionForTheWorld
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Wish Items

- Off-line visualization
  - ✓ VRML file and HepRep file are currently available.
- We want a drawing engine to directly generate jpeg/png/gif files.
  - ✓ DAWN
    - Tcl/Tk GUI frontend (currently)
    - command-line interface (wish)
      - can convert PS to jpeg by “convert” command.
  - ✓ OpenGL
    - offline interface, directly generate a jpeg file without drawing (wish)
    - possible?