



# GATE

## Optical Imaging Simulation

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hGATE meeting Strasbourg

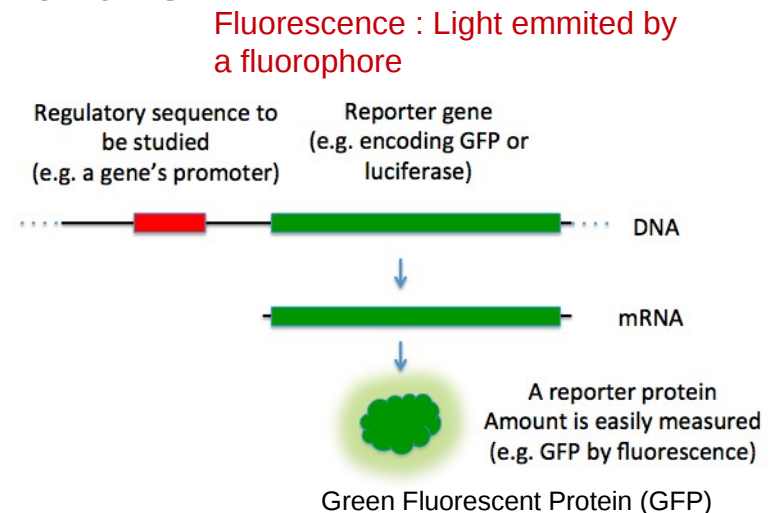
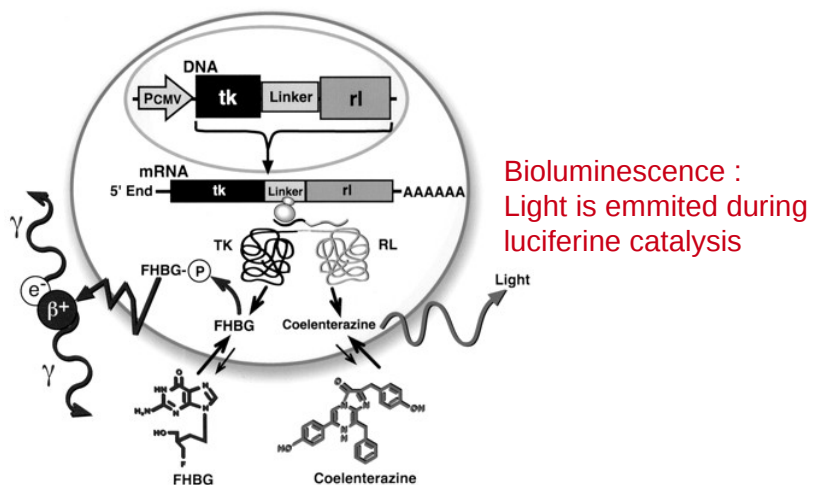
16 Decembre 2011

# Optical Imaging : Fluorescence /Bioluminescence

- Great interest in 3D Images of the light distribution emitted from the surface of the small animal :
  - **Non-invasive** real time study of biological processes
  - **Non radioactive tracers** are used
  - **Low cost** technique (charged coupled device (CCD) camera) w.r.t conventional ones
- But the tissue optical properties have a **strong dependence on depth**

# Target and Image

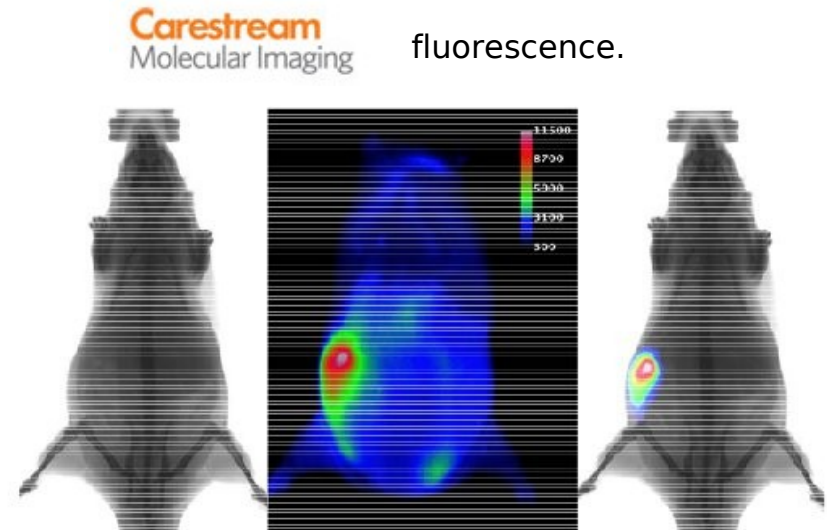
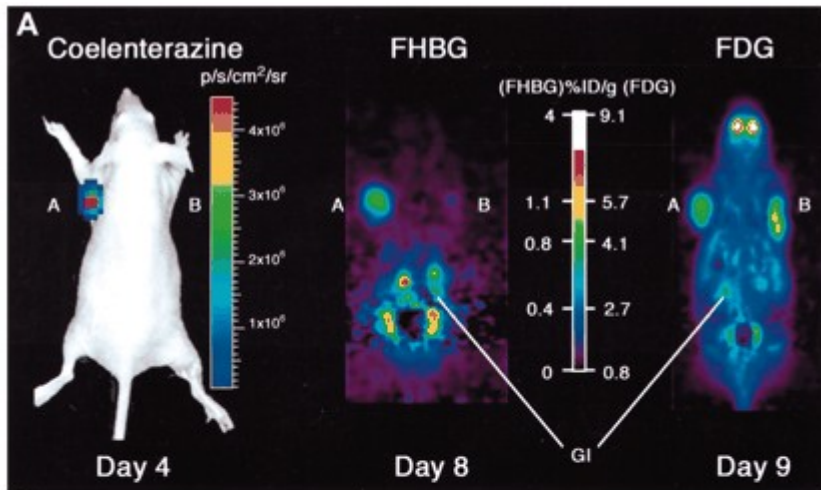
- Identify biomarkers specific to a pathology
- Protein + (PET reporter gene) + bioluminescence/fluorescence optical reporter gene
- Label the reporter gene by bioluminescent/fluorescent molecule: complex chemical nature



# Target and Image

- Near IR region of light (650-900 nm) is an optical window for bioluminescence/fluorescence imaging

An ultra-sensitive CCD camera : bioluminescence.



# GATE Optical Photons

- Run GATE with Optical Photons Enabled
- Generate and Track Optical Photons in Gate V6 :
  - OpticalAbsorption
  - OpticalRayleigh
  - OpticalBoundary

```
*****
* G4Track Information:  Particle = opticalphoton,  Track ID = 1,  Parent ID = 0
*****
```

Step#	X(mm)	Y(mm)	Z(mm)	KinE(MeV)	dE(MeV)	StepLeng	TrackLeng	NextVolume	ProcName
0	0	0	0	3e-06	0	0	0	WaterBox_phys	initStep
1	1.88	3.61	-0.916	3e-06	0	4.17	4.17	WaterBox_phys	OpticalRayleigh
2	1.27	5	0.164	3e-06	0	1.86	6.03	pixel_phys	Transportation
3	1.27	5	0.164	3e-06	0	0	6.03	WaterBox_phys	Transportation
4	0.944	4.26	0.739	3e-06	0	0.992	7.03	WaterBox_phys	OpticalRayleigh
5	0.962	4.2	0.496	3e-06	0	0.251	7.28	WaterBox_phys	OpticalRayleigh
6	0.96	3.7	0.6	3e-06	0	0.511	7.79	WaterBox_phys	OpticalAbsorption

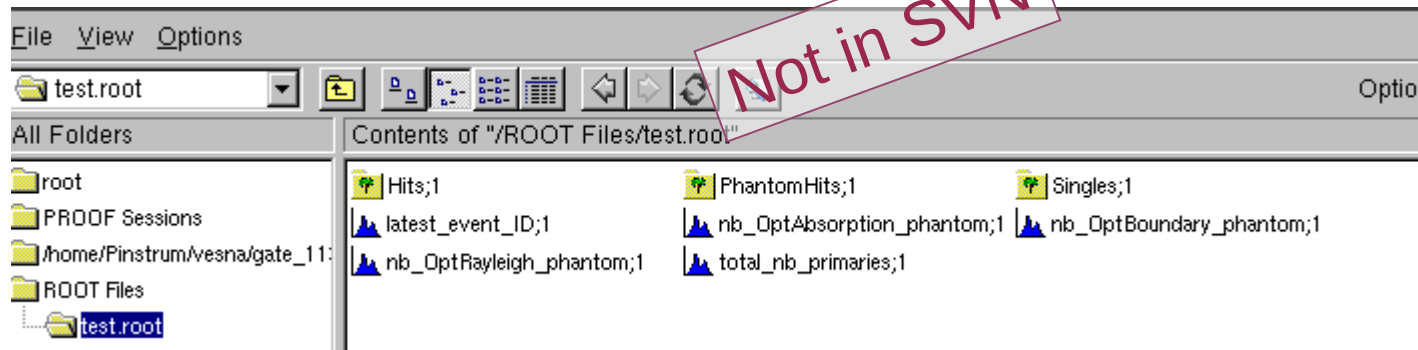
```
>>PostStepDoIt (process by process):  Process Name = OpticalBoundary
```

```
++G4Step Information
Address of G4Track      : 0x24e91d0
Step Length (mm)       : 6.005861215768914
Energy Deposit (MeV)    : 0
```

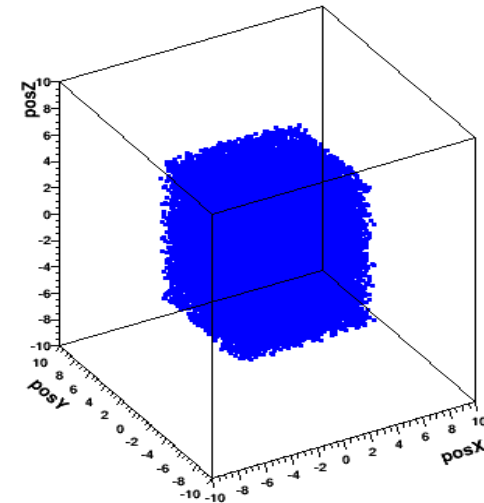
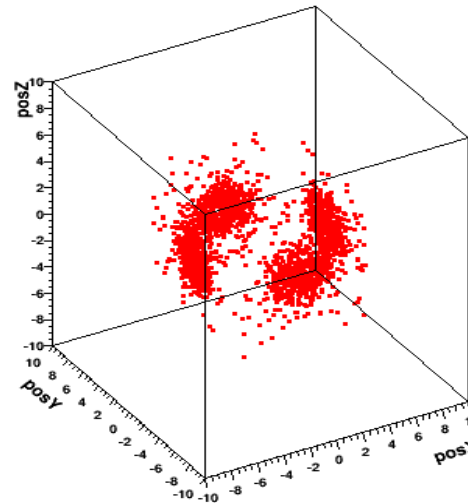
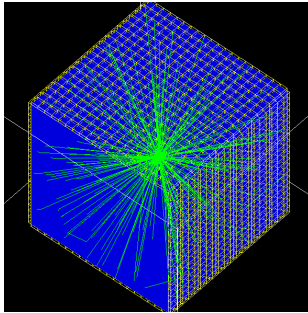
StepPoint Information		PreStep	PostStep
Position - x (mm)	:	0	-1.956279178873416
Position - y (mm)	:	0	5
Position - z (mm)	:	0	2.691345521738821
Global Time (ns)	:	399308095.1615438	399308095.1615459

# New in ROOT output

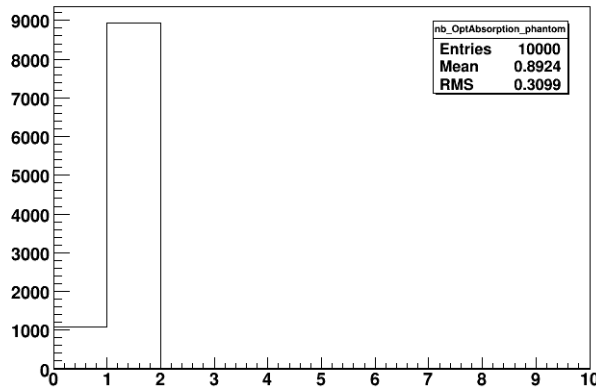
- PhantomHits tree : Hit Global Position
- New Histograms :
  - Number of Absorbed Optical Photons in the Phantom
  - Number of Rayleigh Scattered Optical Photons in the Phantom
  - Number of Refracted/Reflected Optical Photons in the Phantom



# Example : water box phantom and pixel detector

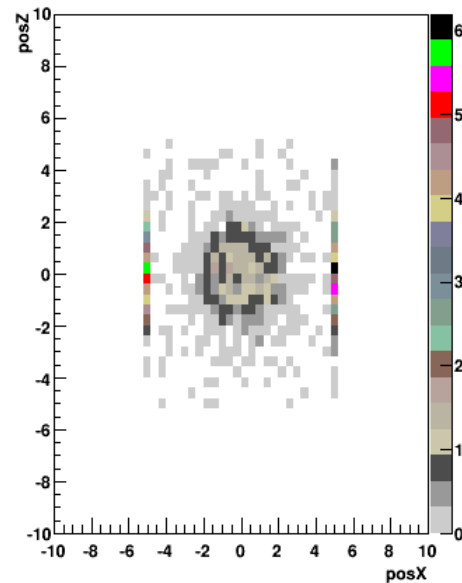


nb\_OptAbsorption\_phantom(#)



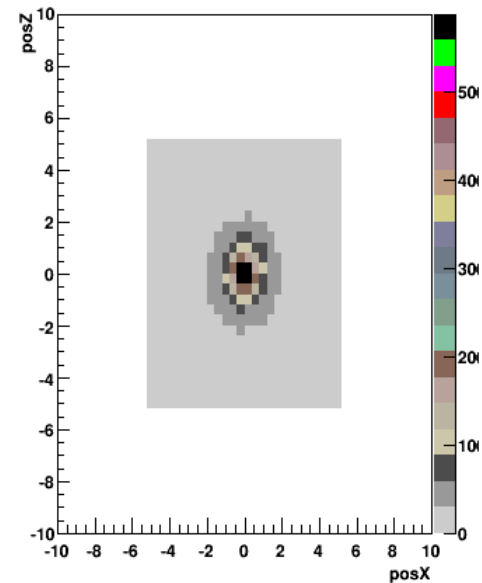
Crystal Hits

Entries 1950

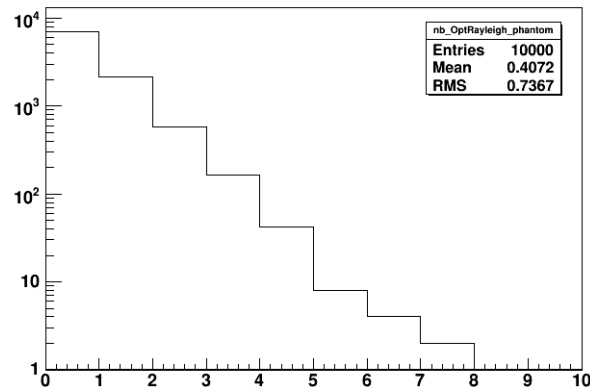


Phantom Hits

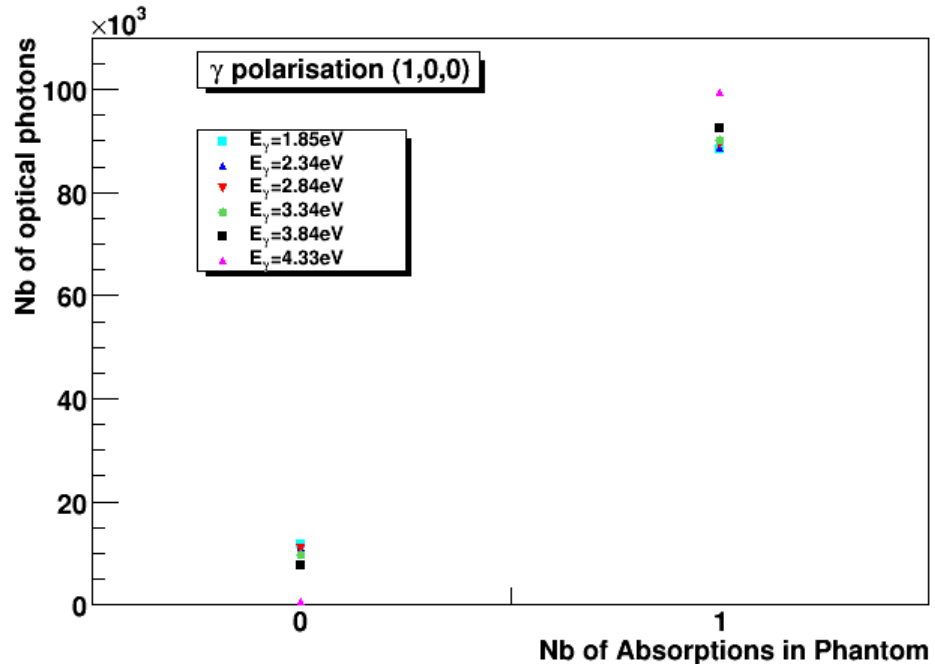
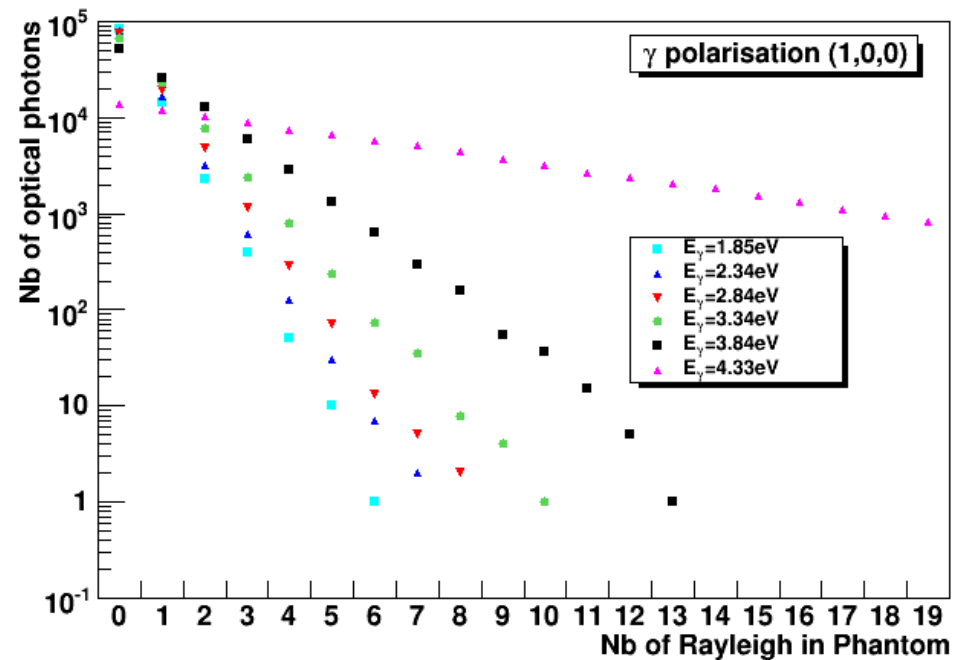
Entries 139161



nb\_OptRayleigh\_phantom(#)



# Number of Rayleigh or Absorptions in the phantom medium as function of the Optical Photon Energy (photon polarization along X)





# Plan

- Validate GATE optical photon (optical photon generated from a source) results :
  - Setup a common benchmark with Frederic Pain
  - Materials with known/measured optical properties
  - Validation (which plots/tables?) **[January-February 2012]**
  
- Production of Optical Photons : G4Scintillation
  - Generate optical photons from Scintillation
  - Validation of Gate Scintillation Process **[??]**
  
- Production of Optical Photons: G4AtomicDeexcitation (G4FluoTransition) :
  - Need to write the code in Gate **[January 2012]**
  - Validation of Gate Atomic Deexcitation Process **[??]**
  
- Surface properties for Optical Boundary Processes :
  - Manpower in January/February with a Post-doc at IMNC
  - Characterization/Measurements of optical properties of tissues **[February-?? 2012]**
  - Validation of Gate Optical Boundary Processes **[??]**
  
- GPU transportation « starting » in February 2012 [CEA tutorial on GPU programming methods end of January 2012]

BACKUP

# Number of Rayleigh as function of the Optical Photon Energy (photon polarization along Y or Z)

