CENTRO NAZIONALE
PROTEZIONE DALLE RADIAZIONI
E FISICA COMPUTAZIONALE

SAPIENZA
UNIVERSITÀ DI ROMA

INFN
Istituto Nazionale di Fisica Nucleare

MC INFN

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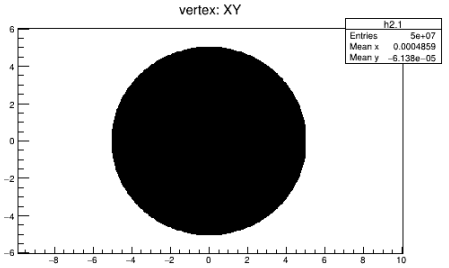
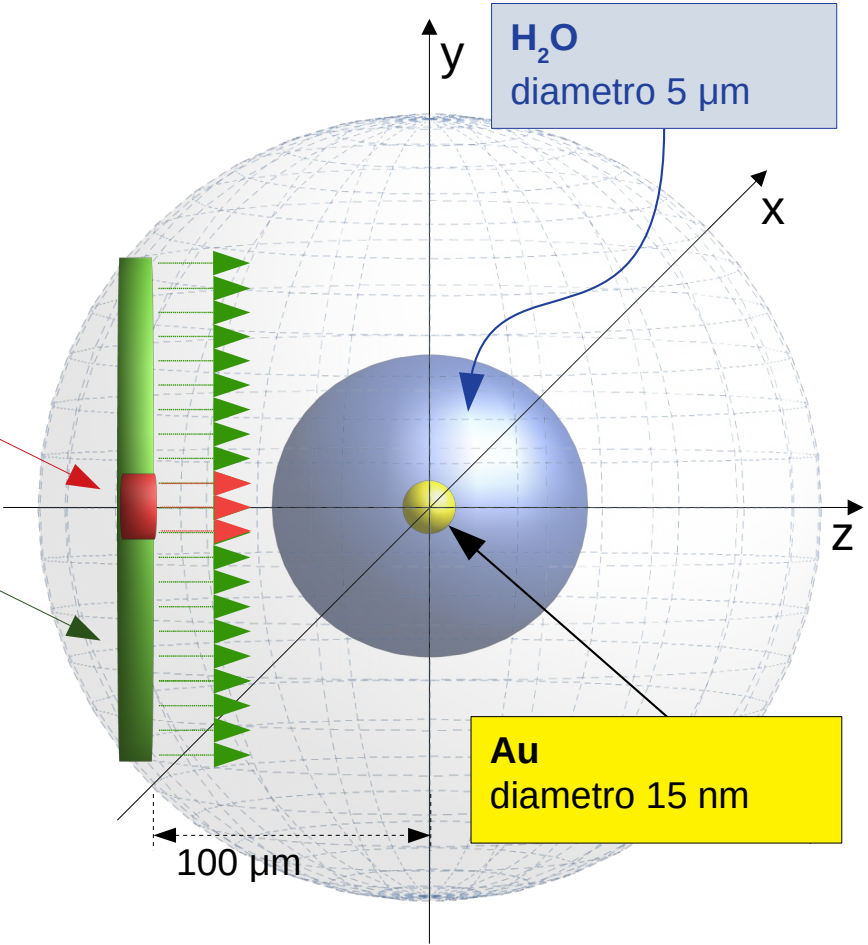
Gold Nano Particle



Fascio fotoni
paralleli
monocromatici
E = 81 keV
sezione circolare

diametro 25 nm

diametro 10 μm



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Original paper

Intercomparison of dose enhancement ratio and secondary electron spectra for gold nanoparticles irradiated by X-rays calculated using multiple Monte Carlo simulation codes

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Physics List

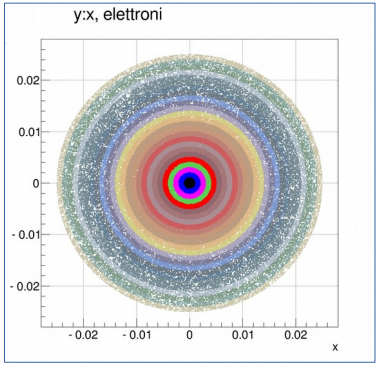
```
//
// This example is provided by the Geant4-DNA collaboration
// Any report or published results obtained using the Geant4-DNA software
// shall cite the following Geant4-DNA collaboration publication:
// Med. Phys. 37 (2010) 4692-4708
// The Geant4-DNA web site is available at http://geant4-dna.org
//
// $ID$
/// \file PhysicsList.cc
/// \brief Implementation of the PhysicsList class

#include "PhysicsList.hh"
#include "G4SystemOfUnits.hh"
#include "G4EmParameters.hh"

#include "G4EmDNAPhysics.hh"
#include "G4EmDNAPhysics_option1.hh"
#include "G4EmDNAPhysics_option2.hh"
#include "G4EmDNAPhysics_option3.hh"
#include "G4EmDNAPhysics_option4.hh"
#include "G4EmDNAPhysics_option5.hh"
#include "G4EmDNAPhysics_option6.hh"
#include "G4EmDNAPhysics_option7.hh"

#include "G4EmStandardPhysics_option4.hh"
#include "G4DecayPhysics.hh"

#include "G4EmDNAPhysicsActivator.hh"

//....oooOOOOOooo.....oooOOOOOooo.....oooOOOOOooo.....oooOOOOOooo.....

PhysicsList::PhysicsList(): G4VModularPhysicsList()
{
  SetDefaultCutValue(1.0*nanometer);

  SetVerboseLevel(1);

   // FIRST METHOD TO ACTIVATE Geant4-DNA Physics,
  //  using a Geant4-DNA Physics constructor only
  //
  //  RegisterPhysics(new G4EmDNAPhysics());
  // or
  //  RegisterPhysics(new G4EmDNAPhysics_opt
  // or
  //  RegisterPhysics(new G4EmDNAPhysics_opt
  // or
  //  RegisterPhysics(new G4EmDNAPhysics_opt
  // or
  //  RegisterPhysics(new G4EmDNAPhysics_opt
  // or
  //  RegisterPhysics(new G4EmDNAPhysics_opt
  // or
  //  RegisterPhysics(new G4EmDNAPhysics_opt
  // or
  //  RegisterPhysics(new G4EmDNAPhysics_opt

  // or SECOND METHOD TO ACTIVATE Geant4-DNA
  // (this includes combination with Geant4

  RegisterPhysics(new G4EmStandardPhysics_op

  RegisterPhysics(new G4DecayPhysics());

  RegisterPhysics(new G4EmDNAPhysicsActivato


  G4ProductionCutsTable::GetProductionCutsTa
      SetEnergyRange(10*eV, 1*GeV);
  G4EmParameters* param = G4EmParameters::In
  param->SetMinEnergy(10*eV);
  param->SetMaxEnergy(1*GeV);
}

//....oooOOOOOooo.....oooOOOOOooo.....

PhysicsList::~PhysicsList()
{}

//....oooOOOOOooo.....oooOOOOOooo.....

void PhysicsList::SetCuts()
{
  SetCutValue(0.1*um, "gamma");
  SetCutValue(1.*um, "e-");
//  SetCutValue(1.*m, "e+");
  G4ProductionCutsTable::GetProductionCutsTa
//  DumpCutValuesTable();
}
```

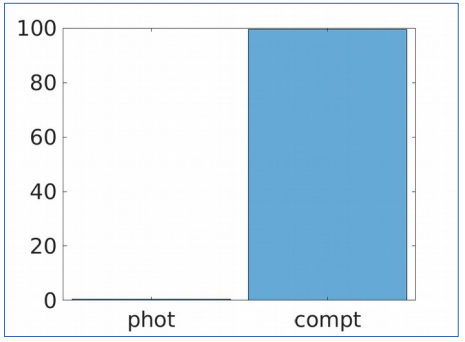
```
  // or SECOND METHOD TO ACTIVATE Geant4-DNA Physics
  // (this includes combination with Geant4 EM Physics)

  RegisterPhysics(new G4EmStandardPhysics_option4());

  RegisterPhysics(new G4DecayPhysics());

  RegisterPhysics(new G4EmDNAPhysicsActivator());


  G4ProductionCutsTable::GetProductionCutsTable()->
      SetEnergyRange(10*eV, 1*GeV);
  G4EmParameters* param = G4EmParameters::Instance();
  param->SetMinEnergy(10*eV);
  param->SetMaxEnergy(1*GeV);
}

//....oooOOOOOooo.....oooOOOOOooo.....oooOOOOOooo.....oooOOOOOooo.....

PhysicsList::~PhysicsList()
{}

//....oooOOOOOooo.....oooOOOOOooo.....oooOOOOOooo.....oooOOOOOooo.....

void PhysicsList::SetCuts()
{
  SetCutValue(0.1*um, "gamma");
  SetCutValue(1.*um, "e-");
//  SetCutValue(1.*m, "e+");
  G4ProductionCutsTable::GetProductionCutsTable()->SetEnergyRange(1.*eV,100*GeV);
//  DumpCutValuesTable();
}
```

fotoni	fotoelettrico	LivermorePhElectric	0 eV – 1 GeV
	Compton	LowEPComptonModel	0 eV – 20 MeV
		Klein-Nishina	20 MeV – 1 GeV
	produz coppie e+e-	PenConversion	0 eV – 20 MeV
		Bethe-Heitler	20 MeV – 1 GeV
elettroni	scattering Rayleigh	LivermoreRayleigh	0 eV – 1 GeV
	ionizzazione	LowEnergyIoni	0 eV – 100 keV
		MollerBhabha	100 keV – 1 GeV
	bremsstrahlung	eBremSB	0 eV – 1 GeV
	scattering multiplo	GoudsmitSaunderson	0 eV – 100 MeV
		WentzelVIUni	100 MeV – 1 GeV
	CoulombScat	eCoulombScattering	100 MeV – 1 GeV
	produz coppie e+e-	ePairProd	0 eV – 1 GeV

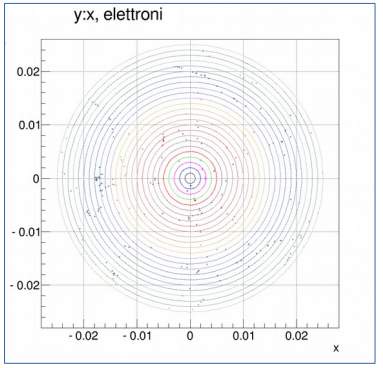
Compton vs fotoelettrico

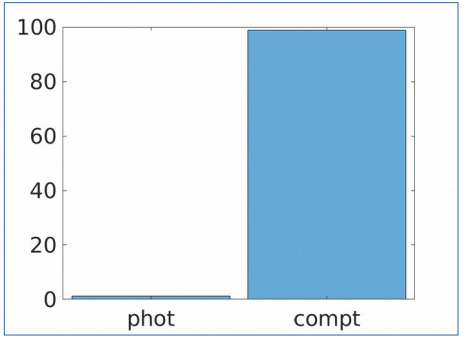
senza oro, sorgente 25 nm, 5 x 10^9 y



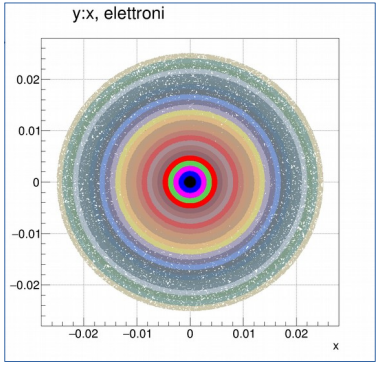


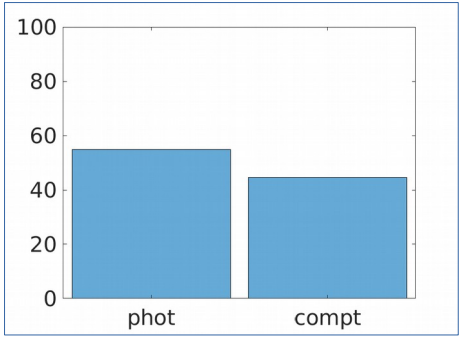
senza oro, sorgente 10 μm, 5 x 10^9 y



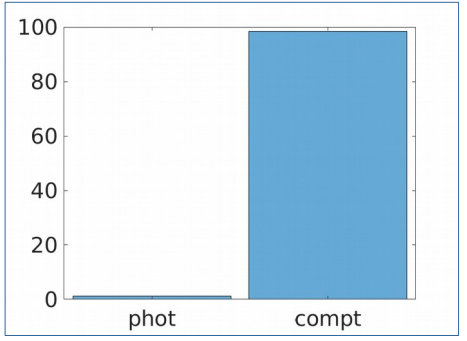


con oro, sorgente 25 nm, 5 x 10^9 y





con oro, sorgente 10 μm, 5 x 10^9 y



Da fare/in corso d'opera

- Definire meglio il campo di radiazione tenendo costante la densità di fotoni
- Affinare il conteggio degli elettroni prodotti per processo e studiarne la distribuzione spaziale in gusci radiali
- Studiare l'andamento del dose enhancement ratio con la distanza
- Migliorare la PhysicsList in relazione alle energie e ai materiali in gioco

- Gestire la geometria da macro file