Antenna characterization for simulated electromagnetic propagation in soil with GEANT4

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Abstract

The Geant4 Monte Carlo radiation transport toolkit provides the infrastru-cture required for the development of simulation where any kind of radiation is passing trough matter. A Cross Well Radar is a technique where a set of transmitting antennas placed underground generate radio-waves that are detected by others antennas, this allows the measurement of electromagnetic properties of soil. The implementation of a simulated cross-well radar using GEANT4 requires that we characterize the antenna as a beam of photons equivalent in energy so the antenna radiation is expressed in terms of the library. With this a detail simulation of the energy dissipation in the soil can be put in place and we will pass to the next level of the simulation implementation, the simulated soil.

Objective

The objective of this work is to develop a methodology to simulate the propagation of electromagnetic wave on soil using the Geant4 library. The idea is to construct an accurate simulation for the detection of underground contaminants based on medical devices techniques.

What is Geant4?

Geant4 is a Monte Carlo radiation transport toolkit that provides the infrastructure required for the development of simulation where any kind of radiation is passing trough matter. This library has been used extensively in High Energy Physics, Space radiation and instrumentation shielding studies, and in Medical Physics to do simulation of PET and SPECT scanners.

What is GATE?

GATE is an advanced opensource software developed by the international OpenGATE collaboration and dedicated to numerical simulations in medical imaging and radiotherapy. It currently supports simulations of Emission Tomography (Positron Emission Tomography - PET and Single Photon Emission Computed Tomography - SPECT), Computed Tomography (CT) and Radiotherapy experiments.

Research to Reality

The Geant4 technology is currently been use to simulate medical devices such as Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT). It plays a key role in the design of new medical imaging devices and in the development and assessment of image reconstruction algorithms and correction techniques. If successfully used to simulate the cross-well radar it could be also use to develop instrumentation and algorithms to find soil contaminants.

IGERT Intelligent Diagnostics

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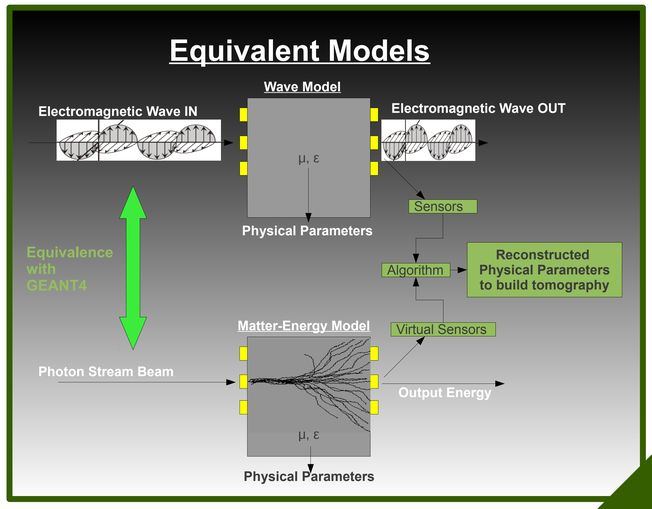
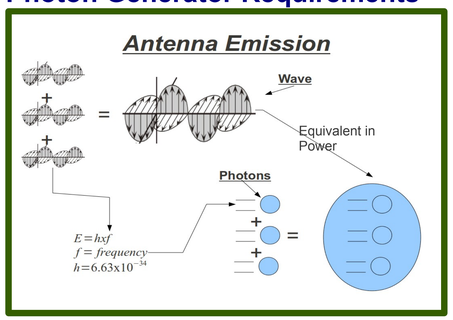
Simulation Concept



Characterization of the Antenna emission

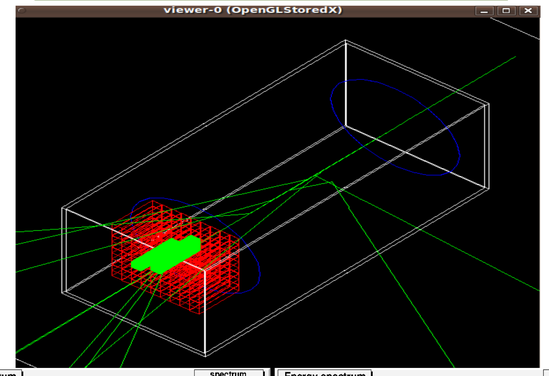
Photon Generator Requirements

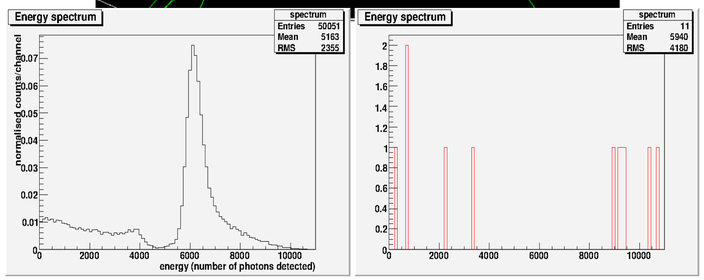


We build a computer cluster

GEANT4 + GATE

Testing Simulation





Conclusion

We have been able to setup the a computer cluster to run the computer intensive simulation and also the basic software package have been put in place. Some preliminary test have been run and now we are calibrating the particle beam. In the near future, once the calibration of the beam and the sensors are done we will make the simulation to run in parallel and later we will add soil to the simulation to see how the signal behave.

Reference

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