The KLOE calorimeter at KLOE-LNF is a high-sampling, lead/scintillating-fiber calorimeter primarily designed to detect photons with very high efficiency. During a KLOE study of kaon interactions in the apparatus walls, hints of a high efficiency for low energy neutrons (100 MeV) were observed and confirmed by the experiment simulation. A more systematic study, involving exposing the prototype on a dedicated neutron test beam at TSL, Uppsala and detailed simulations with Geant4 and Fluka concluded on a possible explanation for the increased efficiency, mainly due to increased neutron inelastic scattering on lead and the high sampling structure. In this paper we repeat the simulation using the Virtual Monte Carlo interface as a front-end to Geant3 and Geant4 and compare with existing simulation results and test beam data.

**Abstract**

The KLOE calorimeter at KLOE-LNF is a high-sampling, lead/scintillating-fiber calorimeter primarily designed to detect photons with very high efficiency. During a KLOE study of kaon interactions in the apparatus walls, hints of a high efficiency for low energy neutrons (100 MeV) were observed and confirmed by the experiment simulation. A more systematic study, involving exposing the prototype on a dedicated neutron test beam at TSL, Uppsala and detailed simulations with Geant4 and Fluka concluded on a possible explanation for the increased efficiency, mainly due to increased neutron inelastic scattering on lead and the high sampling structure. In this paper we repeat the simulation using the Virtual Monte Carlo interface as a front-end to Geant3 and Geant4 and compare with existing simulation results and test beam data.

**The KLOE(n) calorimeter**

- **Active material:** Polyethylene, $\rho = 1.050 \text{ g/cm}^3$, $\lambda = 1.6$
- **High sampling structure:** 200 layers of 0.5 mm grooved lead foils (95% Pb and 5% Bi)
- **Fluka-Virtual Monte Carlo (VMC) interface** for validating simulation output against existing KLOE calibration data
- **Vega Energy Reserve** for maintaining the KLOE calorimeter's high efficiency for photons. If a high neutron detection efficiency were observed, this could be the first of a new kind of neutron detector

**Neutron detection is important for the KLOE-2 program @ LNF:**
- **AMADEUS:** study of deeply bound kaonic nuclei
- **DIANE:** measurement of nuclear time-like reaction n.m. form factors

**Very high efficiency above 4 times larger than what expected if only the amount of scintillator is taken into account (\*1% for 8 cm of scintillating fibers)**

**The Virtual Monte Carlo**

- **User Code**
  - **VMC Concept (The ALICE-PMC collaboration):**
    - **Input:** VMC Simulation and detector description
    - **Output:** Simulation results
  - **VMC Design (The ALICE-PMC collaboration):**
    - **Input:** Detector design and simulation
    - **Output:** Simulation results

**Application of VMC for the KLOE(n) calorimeter**

- **Specific advantages in using VMC:**
  - **GEANT3 and GEANT4 interfaced tests by ALICE collaboration.**
  - **In fact, the VMC API was based on GEANT3 API (now obsolete) and ROOT Geometric Modeller is based on GEANT4.**
  - **The KLOE calorimeter is also based on ALICE-FLUKA code.**
  - **Grid-based ROOT VMC code.**
  - **User writes geometry in the ROOT Geometric Modeller.**
  - **Can be saved as root file, **
  - **Geometry defined in this file, visualized within ROOT.**

**Strategy for using VMC:**

- **Built a VMC application, following one of the existing examples from geant4_vmc (they are backend-independent, can be used by Geant4 and Fluka):**
- **Essentially a list of C++ files that build into an executable linking with dynamic libraries (VMC, MC, ROOT) and some configuration scripts.**
  - **An SVN repository was setup for code versioning.**
  - **Use GEANT4 development under GNS/Linux (SIL/STGS).**
- **Defined the geometry in ROOT Geometric Modeller, using as input the G3 simulation code and documentation.**
  - **The geometry is essentially C++ code, one or more dynamically loadable C++ macros.**
  - **How to check the feasibility of a good neutron-source simulation within this framework.**
  - **For the moment a simple “momentum-space box”**
  - **The framework also use the VMC application code.**
  - **The physics processes and materials are loadable C++ macros, no need for rebuilding the application.**
  - **Define the metrics, i.e histograms and other useful output.**
  - **This partly in the VMC application and partly in C++ macros that contain the actual analysis.**
  - **Run TIGER (VMC for Geant4) simulation and validate against existing results. Repeat with TIGER3 and TIGRA.**

**References**