



UNIVERSITÀ
degli STUDI
di CATANIA

DIPARTIMENTO DI FISICA E ASTRONOMIA

DOTTORATO DI RICERCA IN FISICA

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**The Monte Carlo method in nuclear and applied physics
basics of GEANT4/GEANTV toolkit**

2 CFU

Teaching staff

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Program of the course:

Basic ideas and concepts on the Monte Carlo method; evaluation of random processes; evaluation of definite integrals; Elementary probability theory; Random number generation Monte Carlo sampling techniques: probability, sampling, means and variances, variance reduction techniques, biasing. Examples of sampling techniques. Transport in media, interaction models. Condensed and continuous approach: the electron step problem.

Introduction to Geant4. Basic prerequisites.

Fundamentals of a Geant4 application: generation of primary particles, definition of the geometry, definition of physics processes and models. Definition of a sensitive region and simulation of a detector. Output of simulation data. Coins on the new GeantV developments.

Practical sessions: Installation of Geant4; Practical exercises on: beam generation, simulation of a geometry, implementation of physics processes and models.

Realization of a simple simulation for a medical physics application: reconstruction of the Bragg peak;

Realization of a simple simulation for a nuclear physics application: simulation of a Germanium detector for gamma spectroscopy.

Bibliography:

- “A Monte Carlo primer, a practical approach to radiation transport”, S. A. Dupree and S. K. Fraley, 2002.

- "Geant4-A simulation toolkit", S Agostinelli et al. Nuclear Instrument and Methods A (506)3 250-303, 2003;
- "Geant4 developments and applications", J.Allison et al., IEEE Transaction on Nuclear Science (53) 270-278, 2006;
- "Recent developments in Geant4", J Allison et al. Nuclear Instruments and methods A (835) 185-225, 2016;
- "User's guide for Application developers", The Geant4 Collaboration;
<http://geant4.web.cern.ch/geant4/UserDocumentation/UsersGuides/ForApplicationDeveloper/html/index.html>