OECD/NEA Data Bank
Training Course / Workshop on

Electron-Photon Transport Modeling with PENELOPE-2022

Physics, Code Structure and Operation

3-7 July, 2023

Universitat de Barcelona
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Scope and Objectives

This course is addressed to researchers in Radiation Physics and its applications. The main objective is to provide the participants with a detailed description of the new 2022 version of PENELOPE, with an ample perspective on Monte Carlo methods for simulation of electron/photon transport. The course will consist of theoretical lectures and hands-on sessions. Basic aspects of Monte Carlo sampling methods and scoring, physical interaction models, constructive quadric geometry, and transport schemes for charged particles will be introduced in the theoretical lectures. Benchmark comparisons with experiments will also be presented to illustrate the capabilities and reliability of the code.

Hands-on sessions will be based on the generic main program PENMAIN, which operates with a variety of radiation sources (including radioactive sources) in material structures described by the quadric geometry tool PENGEOM. The exercises will be performed with the Windows graphical user interface PenGUIn that largely simplifies the operation of the code. Participants are expected to run their own Windows laptops. Practical sessions will deal with
●1) the installation of required programs and tools (GUIs),
●2) the use of PENMAIN for the set of examples provided in the distribution package,
●3) the design of simulations of other experimental arrangements (geometry, radiation source, simulation parameters).

As in previous editions, the duration of the course is four and a half days. To allow closer practical tuition, the number of participants is limited to a maximum of 15.

SYLLABUS (T, theory; P, practical):

T1. Monte Carlo simulation. Basic concepts

T1.1. Random sampling methods
T1.2. Monte Carlo integration. Statistical uncertainties
T1.3. Simulation of radiation transport. Scoring
T1.4. Concepts in variance reduction

T2. Physics of photon interactions

T2.1. Rayleigh scattering
T2.2. Photoelectric effect

T2.3. Compton scattering
T2.4. Pair production
T2.5. Scattering of polarised photons

T3. Physics of electron/positron interactions

T3.1. Elastic scattering
T3.2. Inelastic scattering
T3.3. Bremsstrahlung emission
T3.4. Positron annihilation

T4. Electron/positron transport mechanics

T4.1. Multiple elastic scattering
T4.2. Energy-loss straggling
T4.3. Condensed and mixed simulation schemes
T4.4. The random hinge method
T4.5. Simulation parameters: accuracy vs. simulation speed
T4.6. Transport in electromagnetic fields

T5. Geometry

T5.1. Quadric surfaces
T5.2. Constructive quadric geometry
T5.3. The PENGEOM geometry package
T5.4. Geometry editor/viewer/debugger PenGeomJar

P1. The PENELOPE code system

P1.1. Structure of the simulation package
P1.2. Software installation
P1.3. Generation of material data files (MATERIAL)
P1.4. Visualization of macroscopic parameters (TABLES)
P1.5. Visualization of electron-photon showers (SHOWER)

P3. Practical simulations with PENMAIN

P3.1. Structure of the input file: source definition, simulation parameters
P3.2. Scoring: impact detectors, angular detectors, energy-deposition detectors
P3.3. The graphical-user interface (PenGUIn)
P3.5. Examples in the distribution package
P3.6. Designing the simulation of your application

Teachers of the Training Course / Tutorial

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