EUTEMPE-RX Module 03:
Monte Carlo simulation of x-ray imaging and dosimetry

Aim and main outcomes

Monte Carlo simulation of radiation transport has numerous applications in medical radiation physics, largely due to its detailed modeling of radiation interactions and to its suitability for dealing with complex geometries. This course aims at providing medical physics experts with the theoretical and, especially, practical abilities required to efficiently use the general-purpose Monte Carlo code PENELOPE/penEasy to simulate x-ray imaging problems and their dosimetry. The coupling between ionizing radiation and light, or electron-hole pairs, in conventional x-ray digital detectors will also be addressed in the context of the MANTIS code.

The main learning outcomes will be:

- Assess Monte Carlo algorithms for practical problems in x-ray imaging.
- Construct simplified models of x-ray transport problems to efficiently simulate them with PENELOPE/penEasy and MANTIS.
- Apply Monte Carlo simulation for the estimation of the absorbed dose to the patient.
- Manage a simulation project from beginning (conceptual modeling) to end (analysis of results).

Online and face-to-face phases

The module will use a combination of online content and face-to-face (f2f) sessions. The central components of the module, including guided practical exercises, will be presented during the f2f part, which will be covered over a period of one week.

The online phase will be split in two parts, one previous to the f2f phase and another after it. The pre-f2f phase, available online at the platform provided by EUTEMPE, will be based on preparatory reading material and on the installation of and familiarization with auxiliary software used during the f2f part. The post-f2f phase will be based on forums to discuss advanced exercises and further issues on the use of the simulation codes.

For more information

Josep Sempau (module leader), email: josep.sempau@upc.es
Visit the EUTEMPE-RX website at http://www.eutempe-rx.eu.

Face-to-face course

Contents

- Monte Carlo (MC) simulation of radiation transport
  The MC method. Radiation transport. Variance-reduction techniques.
- X-ray and electron physics
  Interaction models. Condensed simulation of charged particles. General-purpose codes.
- The PENELOPE/penEasy system
  Structure, installation and operation. Material and geometry data files.
- The physics of imaging detectors
  Detector models. Imaging metrics. Indirect & direct detectors.
- Packages for imaging detectors
  The MANTIS family. ARTEMIS and other codes.
- Exercises
  Computation of absorbed dose distributions. Spectrometry. X-ray tubes & image formation. Dose distribution in voxelized geometries. Point spread functions & pulse height spectra in indirect detectors.
- Applications in diagnostic and interventional radiology

Lecturers

- Josep Sempau, Technical University of Catalonia
- José M. Fernández-Varea, University of Barcelona
- Aldo Badano, U.S. Food and Drug Administration
- Hilde Bosmans, Katholieke Universiteit Leuven

Dates (2017) & location

Pre-online phase: May 22 - June 18 (4 weeks)
Face-to-face: June 19 - June 23 (1 week)
Post-online phase: June 26 - July 21 (4 weeks)

School of Industrial Engineering of Barcelona (http://www.etseib.upc.edu),
Technical University of Catalonia (UPC)
Diagonal 647, 08028 Barcelona, Spain
https://maps.google.com/maps?q=41.384835,2.115628

Registration fee

The registration fee is 760 EUR. It includes (free) copies of the simulation software and a social dinner. A reduced fee at 380 EUR is available for selected countries—see the EUTEMPE-RX website for details.

Accomodation

The University Residence Halls (RESA) are a convenient and relatively affordable solution. Please visit http://www.resa.es/en for details.