FÍSICA MÉDICA
RED TEMÁTICA EN FÍSICA MÉDICA
CONACYT

contacto@fisicamedica.mx
+52 (55) 5622-5059
Circuito de la Investigación Científica,
Ciudad Universitaria,
Ciudad de México 04510, México.

Red Temática de Investigación en Física Médica (CONACyT)

Programa

Monte Carlo simulations in radiation therapy: Geant4

Dr. Lucas Burigo and Dr. José Ramos-Méndez

Outline

1 Overview (15 min)

2 Introduction to radiation therapy: x-ray and electrons (1.5 hours)

- Interaction properties of electrons and x-rays
- Physical quantities in radiation physics
- Dose from therapeutic electrons and x-rays

3 Basics of Monte Carlo simulation (1.5 h)

- A brief history of Monte Carlo
- Random number generation
- Sampling techniques
- Statistical error estimation

4 G4-Lab-1: Setup of software and simple simulations (4.0 h)

- Software requirements
- Building setup

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1 Introduction to radiation therapy: protons and carbon ions (1.5 h)

- Introduction
- Stopping power of charged particles: the Bragg curve
- Multiple scattering of charged particles
- Nuclear interactions: elastic and inelastic interactions
- Dose from therapeutic protons and carbon ion beams

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2 Introduction to Geant4 (2 sessions of 1.5 h)

- Introduction to Geant4: architecture and argot
- Definition of materials
- Geometry
- Modular physics list
- Primary generation
- Scoring methods

3 G4-Lab-2: The command line and parallelism (4.0 h)

- Building simple applications
- The command line parameters
- Splitting jobs: random seeds
- Multithreading overview

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1 G4-Lab-3: Patient dose calculation (2.0 h)

- Parameterized and replicated volumes
- Advanced scoring techniques

2 G4-Lab-4: Generic LINAC setup (2.0 h)

- X-Ray from lead target
- Electron scattering from thin foils
- Generic geometry devices
- Phase space scoring

3 G4-Lab-5: Variance reduction (1.0 h)

- Uniform bremsstrahlung splitting
- Russian roulette

4 G4-Lab-6: Scintillator detectors (2.0 h)

- Optical materials
- Optical physics parameters
- Optical surfaces as sensitive detector

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1 Monte Carlo simulations for proton and ion beams (1.5 h)

- Clinical use of proton beams
- Clinical use of carbon beams

2 G4-Lab-7: Beam modeling (1.5 h)

- Pencil beam setup
- Phase space setup

3 Biological modeling in particle therapy (0.5 h)

- About the biological implications of heavy charged particles

4 Monte Carlo track structure simulations with Geant4-DNA (0.5 h)

- A nanodosimetric view point of radiation damage

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1 Individual consulting (On demand)

- 30-60 minute slots available to be booked by individual attendees (faculty with students and post-docs) to help with their particular projects or for individual discussion

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References

1. P.N. McDermott and C.G. Orton, “The Physics and Technology of Radiation Therapy,” 2010, Medical Physics Publishing, Madison, WI.

2. F.H. Attix, “Introduction to Radiological Physics and Dosimetry,” Wiley-VCH

3. Eric J. Hall, Amato J. Giaccia, “Radiobiology for the radiologist,” 7th ed, Philadelphia : Wolters Kluwer Health/Lippincott Williams & Wilkins, c2012

4. "Monte Carlo Techniques in Radiation Therapy" edited by Saco and Verhaegen

5. A. Bielajew. “Fundamentals of the Monte Carlo method for neutral and charged particle transport” http://www- personal.umich.edu/~bielajew/MCBook/book.pdf

6. H. P. Langtangen “A primer of scientific programming with Python” http://hplgit.github.io/primer.html/doc/pub/half/book.pdf

7. Geant4 Collaboration. “User’s guide: For application developers.” https://geant4.web.cern.ch/geant4/support/userdocuments.shtml