User Requirements

Medical Physics

22nd Geant4 Collaboration Meeting, 25th-29th September, 2017

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Geometry

Originator: A. McNamara, MGH

- **Develop a string volume**
  - to model DNA
  - e.g. defined by coordinates and radii at each coordinate
- **Applications: study of radiation effects at nanoscale**
- **Status: open**

Radiation fields – UR37

- **Originator: Laurent Desorgher**
- Definition of irradiation profile w.r.t. time for radiation therapy
  - User defined irradiation profile
- This is for shielding study for beam line.
- Should in principle be covered by the biasing capabilities of the radioactive decay module, but has to be verified” (Marc Verderi).
- **Status: open**

Physics: new physics models (1)

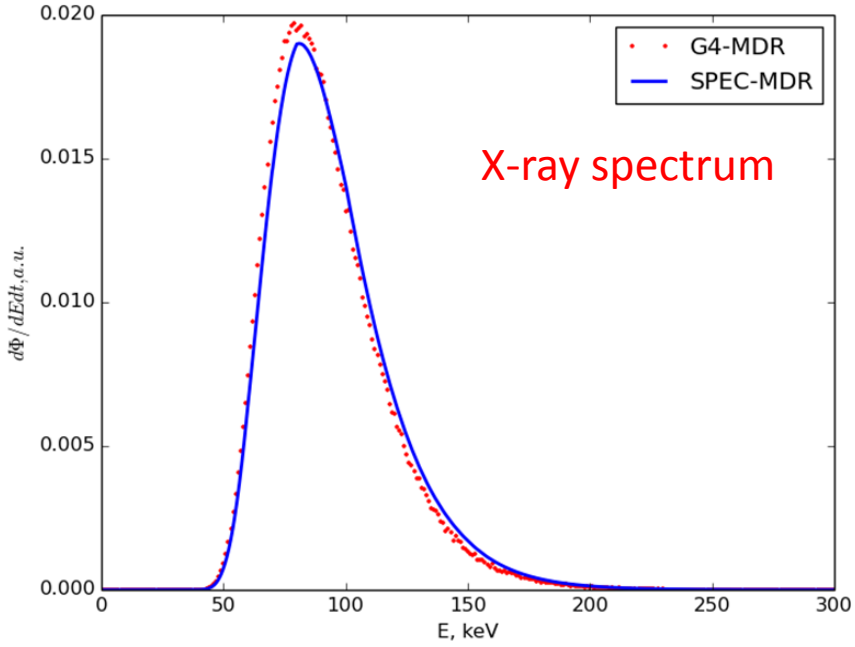
- **From papers, conferences, etc.**
- **Develop ad-hoc track structure physics models for nanomaterials**
  - Graphite, gold, platinum, gadolinium, iodine, iron and iron oxide
  - Similar to Geant4-DNA
- **Applications: nanomedicine**
- **Status**: **in progress**
  - Models for silicon available
  - Models for gold under development (S. Incerti, D. Sakata and I. Kyriakou, et al)
  - Upgrade of Geant4 low-energy EM models for liquid water using new experimental data and theoretical developments (I. Kyriakou and D. Emfietzoglou, Univeristy of Ioannina)

Physics: new physics models for Microbeam Radiation Therapy (2)

- **Originator: Elke Braeuer-Krisch, ESRF, France**
- **Modeling of x-ray optics**
  - E.g. Model surface effects
- Relevant for the Synchrotron Radiation community
- **Status: Open**

Physics validation: Microbeam Radiation Therapy

- **Originator: Susanna Guatelli, UOW**
- Validate the polarised physics models
- Relevant for the Synchrotron Radiation community
- **Status: in progress (see talk by M. Cameron)**



Physics validation
X-ray radiotherapy

Not from one originator only: from papers, conferences, etc.

- **Validate e.m. physics models in**
  - Non electronic equilibrium / at the interface between different media / high spatial resolution
  - Dictated by small field X-ray radiotherapy treatments (e.g. tumors in lungs)
  - Originator: S. Guatelli, CMRP, UOW.
- **Validation of bremsstrahlung process for targets used in radiotherapy (such as tungsten), energy range: 6-15 MeV.**
  - Progress: validation up to 2.8 MeV. Lack of exp data above that energy
  - Originator: B. Caccia, Istituto Superiore di Sanita', Rome, Italy
- **Status: open**

Validation - carbon ion therapy

- **Originator: S. Guatelli**
- Validate e.m. and hadronic physics models
  - Protons, α, carbon and oxygen ions (E < 400 MeV/nucl)
  - E.g. Bragg Peaks, fragmentation, radioactive decays (in-vivo verification of Bragg Peak position)
- **Status:** in progress (e.g. see talks by D. Bolst and A. Chacon)

Validation- radiobiology

- **Originator: Eva Bezak, University of South Australia, Australia**

- Validate the Geant4-DNA chemistry w.r.t. experimental measurements

- **Status:** In progress (by S. Incerti)

Validation for microdosimetry

- **Originator: Ioanna Kyriakou, University of Ioannina**

- Validate the microdosimetric performance of low-energy EM physics models for liquid water

- **Status:** in progress (I. Kyriakou)

Validation for radiation protection-UR36

- **Originator: Laurent Desorgher**
- Computation of activation in bunker therapy by protons, neutrons, and gammas
- Correct production of activated nuclei by nuclear spallation needed
- **Status: open**

Validation – BNCT and Fast Neutron Therapy

- **Originator: S. Guatelli**
- Validate neutron physics and activation
- Validation against experimental measurements
- **Status: open**

ICRU90

- Report 90: Key Data for Ionizing-Radiation Dosimetry: Measurement Standards and Applications
- Stopping Powers of electrons (and positrons), protons, α particles and carbon ions for three key materials: graphite, air, and liquid water
- Benchmark of Geant4 against this Report
- Status: New.
- Note: some comparisons by S. Incerti

Calculation of the ambient dose equivalent (UR-34)

- **Originator: Laurent Desorger**
- Tallying of the ambient dose equivalent H*(10) (value + error or tally)
- **Status: in progress (M. Aso)**

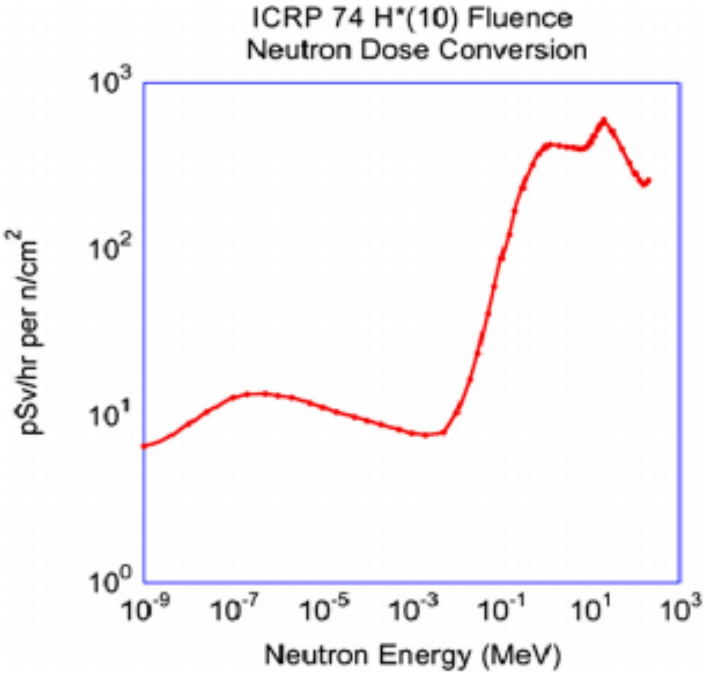


Fig. 4. Fluence-to-ambient dose equivalent conversion coefficients $h^*(10,E)$ [Sv·cm^2] taken from [19].

Cadini et al, Physica Medica 32 (2016) 1862–1871

UR-35

- **Originator: Laurent Desorgher**
- Be able to calculate the Dose H*(10) resulting from radioactive decay at different time windows
- Important to assess the dose from decay of activated materials or radioactive source at different time windows
- **Status: in progress (M. Aso)**