Parallel Session 2B
Basic & Extended Examples

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22nd Geant4 Collaboration Meeting,
26 September 2017, Wollongong

Agenda

New DICOM HEAD reader	*Susanna Guatelli*	New Examples
Building 6, room 210	14:00 - 14:10	
New dna examples: icsd, mfd, slowing, spower	*Sebastien Laurent Incerti*	
Building 6, room 210	14:10 - 14:35	
New biasing/GB05,GB06 examples	*Marc Verderi*	
Building 6, room 210	14:35 - 14:40	
New exoticphysics/dmparticle example	*Vladimir Grichine et al.*	
Building 6, room 210	14:40 - 14:45	
New radiaoactivedecay/Activation example	*Michel Maire*	
Building 6, room 210	14:45 - 14:50	
Status of Work Plan 2017 Items	*Ivana Hrivnacova*	Work Plan
Building 6, room 210	14:50 - 15:20	

New development in the DICOM Interface

Presented by S. Guatelli

- The DICOM interface is an extended example of Geant4
- 128 slices and matrix size of 1024×1024 pixels
- Unique for its anatomical details and high spatial resolution (0.18 x 0.18 mm^2 pixel size).
  - Slice thickness: 1.25 mm
  - Homogeneous brain, Spinal disks, ear canals, sinus cavities, deciduous and descending teeth with enamel and dentin.
- To be released in Geant4 10.4 within the DICOM interface
- Flag **DICOM_HEAD =1**

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Giacometti, V., Guatelli, S., Bazalova-Carter, M., Rosenfeld, A.B., Schulte, R.W. (2017) Physica Medica, 33, pp. 182-188

HN715,CIRS

Geant4 model

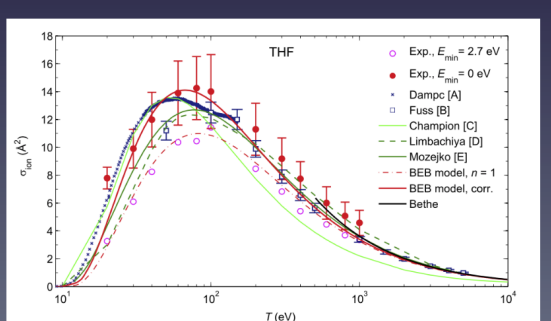
EM low energy / Geant4-DNA extended examples

Presented by I. Hrivnacova on behalf of S. Incerti

New bio-materials discrete XS

- New cross sections available for biomaterials in Geant4-DNA: part of the effort to extend Geant4-DNA models to other materials than liquid water
- Cross sections for biological materials are proposed since Geant4 10.4 Beta, they are applicable to DNA constituents
  - tetrahydrofuran (THF), trimethylphosphate (TMP), pyrimidine (PY) and purine (PU)
  - serving as models for the deoxyribose and phosphate groups in the DNA backbone as well as for DNA bases
- For the following incident particles
  - electrons (12 eV-1keV, elastic + excitation + ionisation) : from measurements @ PTB, Germany
  - protons (70 keV-10 MeV, ionisation) from the HKS approach

Eg. total electron ionisation cross sections in THF



More details in Rad. Phys. Chem. 130 (2017) 459–479

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1) icsd

EM low energy / Geant4-DNA extended examples

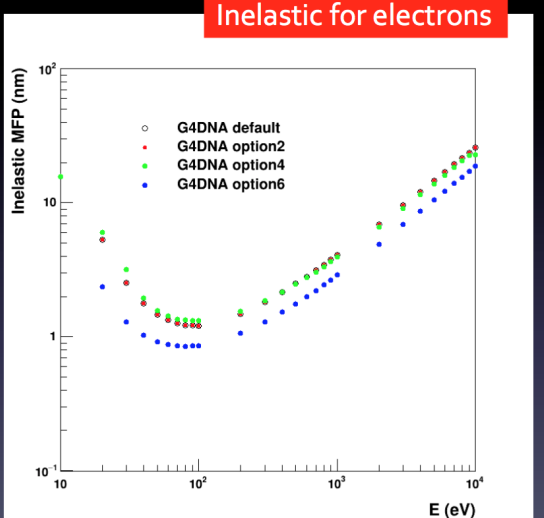
Presented by I. Hrivnacova on behalf of S. Incerti

G4 10.4 December 2017

MeanFreePath

- a test to evaluate the accuracy of the code compared to other track structure (discrete) codes of the literature:
  - calculation of Mean Free Path in liq. water (using Gean4-DNA)
  - regular request by users
- the user can simulate MFP activating discrete processes of his/her choice
  - inelastic
  - full
  - with or without Geant4-DNA sub-excitation processes

Inelastic for electrons



See extended/medical/dna/mfp example

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1) icsd

2) mfp

EM low energy / Geant4-DNA extended examples

Presented by I. Hrivnacova on behalf of S. Incerti

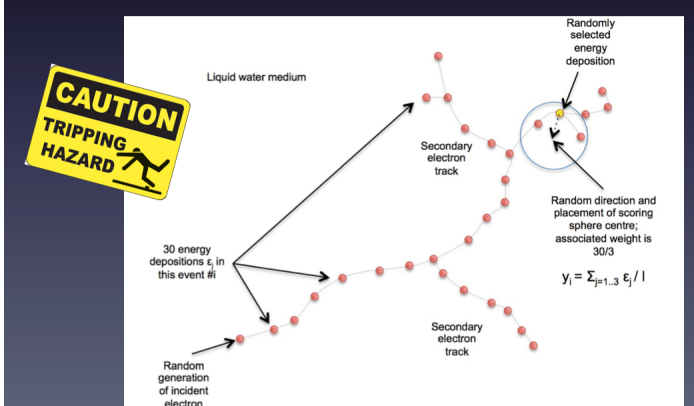
G4 10.4 December 2017

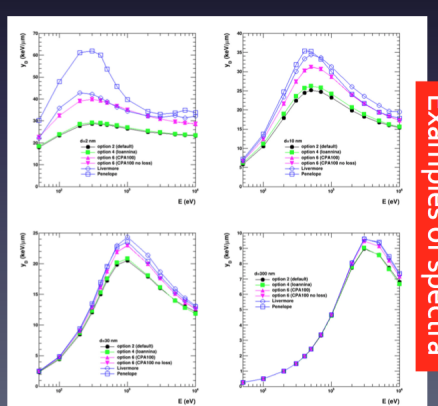
J. Appl. Phys. 122 (2017) 024303 (link)

microyz

- For the first time, we provide an extended example capable of simulating microdosimetry spectra: lineal energy (y), specific energy (z), frequency-mean lineal energy, dose-mean lineal energy, frequency-mean specific energy, dose-mean specific energy
- energy scored in spheres of selected radius
- particular care for weighting of energy scoring… (many users ignore weighting)

$\bar{y}_F$ $\bar{y}_D$ $\bar{z}_F$ $\bar{z}_D$





Examples of spectra

See extended/medical/dna/microyz example

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1) icsd
2) mfp
3) microyz

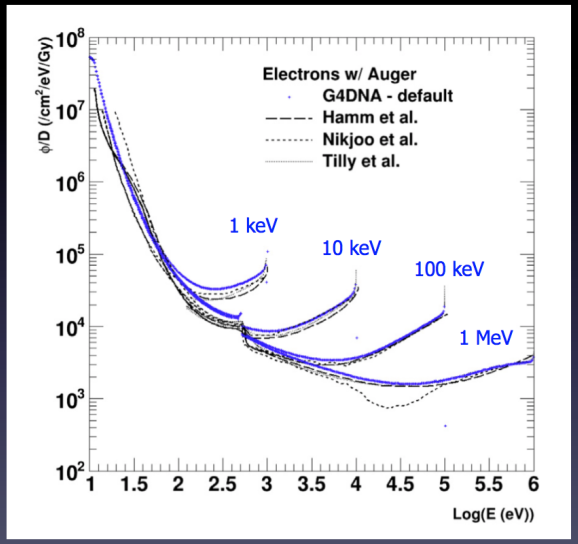
EM low energy / Geant4-DNA extended examples

Presented by I. Hrivnacova on behalf of S. Incerti

G4 10.4 BETA
30 June 2017

slowing down spectra

- a reliable test to evaluate the performance of track structure codes
- represent the fluence distribution (differential in energy) of both the primary and all subsequent generations of secondary electrons generated through the full slowing-down process in liquid water
- ⌀(E)dE is the total distance travelled by electrons while their energy is in the interval E, E+dE (Vassiliev, 2012)
- method: we record for each simulation step the kinetic energy of each electron undergoing a Geant4-DNA inelastic process in a log-binned histogram, setting for each record a statistical weight equal to the size of the step.
- small influence of sub-excitation processes at low energy; Auger electron production from Oxygen should be considered.
- includes UI tracking cut selection



Nucl. Instrum. Meth. B 397 (2017) 45 (link)

See extended/medical/dna/slowing example

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1) icsd
2) mfp
3) microyz
4) slowing

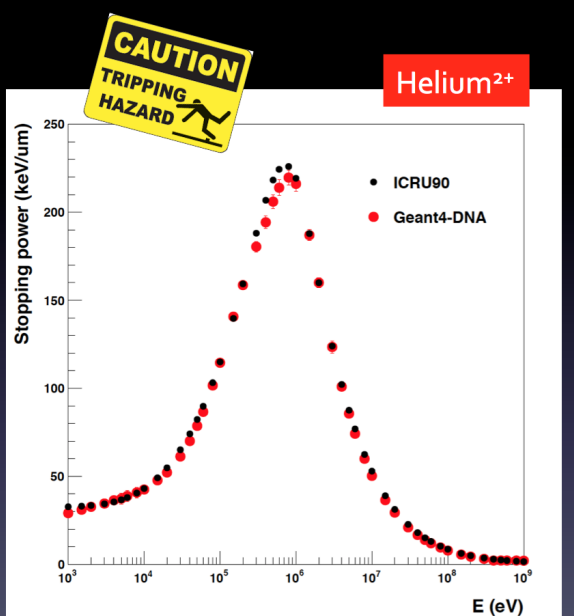
EM low energy / Geant4-DNA extended examples

Presented by I. Hrivnacova on behalf of S. Incerti

G4 10.4 BETA 30 June 2017

stopping power

- a reliable test to evaluate the accuracy of the code
- Geant4-DNA does not use SP tables: then how can we calculate SP ?
- users usually try to simulate SP by dividing energy loss over step length but forget to select stationnary regime
  - (alternative analytical calculation is always possible from differential ionisation cross sections and excitation cross sections)
- we provide specific stationary Geant4-DNA physics constructors for liquid water which activate stationary regime in all inelastic models



Nucl. Instrum. Meth. B 397 (2017) 45 (link)

See extended/medical/dna/spower example

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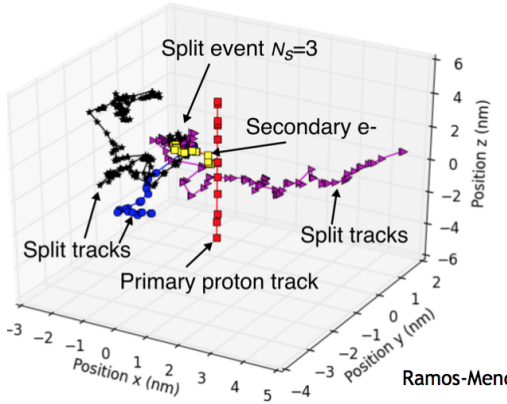
1) icsd
2) mfp
3) microyz
4) slowing
5) spower

New extended example medical/dna/splitting

Presented by J. Perl
on behalf of J. Ramos-Mendez

Background

- To overcome the biasing, an identification number (flag) is assigned to each split particle, which is inherited by all progeny and used to separate the new tracks.
- In *splitting* example, uniform particle split is performed at ionizations events of secondary e-.



Ramos-Mendez, et. al., PMB 62(15), 2017

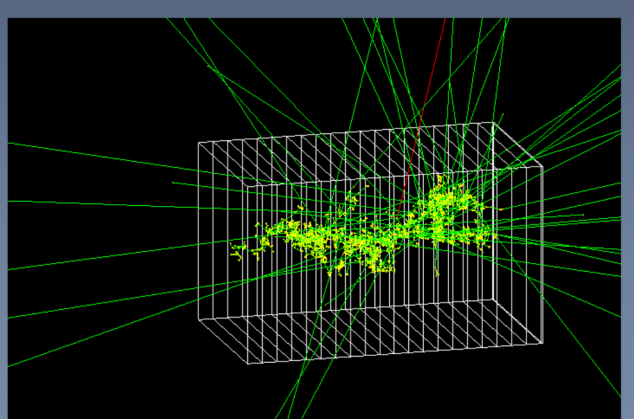
A secondary e- (yellow) of a 0.5-MeV primary proton moving vertically upwards (red) was split into N_s = 3 split electrons with flag equal to 3 - blue, 4 - black, 5 - magenta). The statistical weight of the new electrons is set to w=1/3

Status of Biasing Examples

Presented by M. Verderi

Parallel Worlds

- Ability of using parallel worlds in generic biasing introduced in 10.3
- Example `extended/biasing/GB06`: illustrate the usage of this
  - With the classical shield problem
  - Using a geometry-based importance splitting
- Geometry:
  - Mass geometry : a single block of concrete
  - Parallel world : define the slices
    - Importance of slices being a function of their copy number



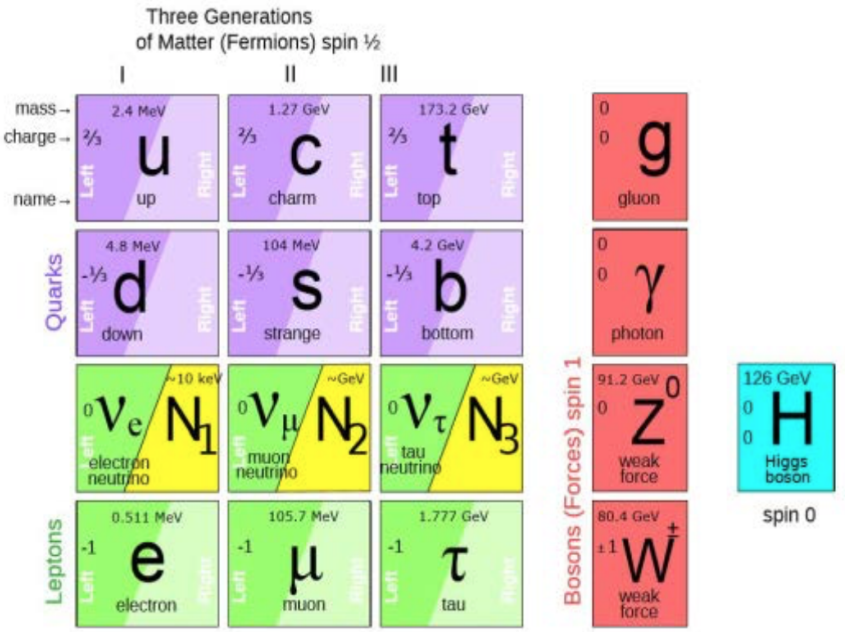
Incident neutron in concrete block with biasing activated.
Slices on this figure are in the parallel geometry

- New examples GB05, GB06
- Planned examples & ongoing activity

New extended example dmparticle

Presented by V. Ivantchenko

Dark matter particles



The minimal set of left hand fermions includes N_1, N_2, N_3 light objects having very weak coupling with standard fermions and bosons

Interactions of left hands fermions are very similar to electromagnetic and weak interactions of standard fermions and bosons but with different coupling constant

New Example Activation

Presented by I. Hrivnacova on behalf of M. Maire

Example : Activation

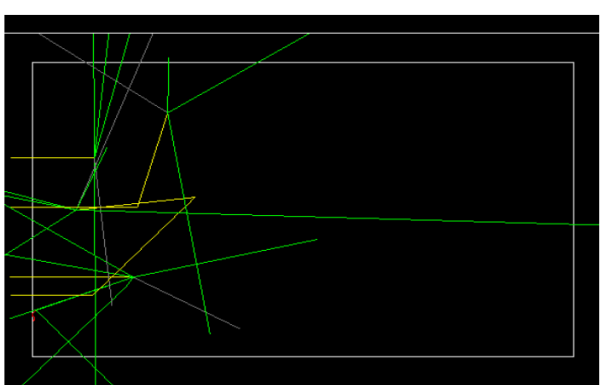
Michel Maire (Lapp – G4AI)

beam + target → A + … ---> B ---> C --->

- Evolution of populations : $N_a(t)$, $N_b(t)$, $N_c(t)$ … as a function of time
- Activities of emerging particles

purpose

Provide an example as simple and generic as possible, to illustrate this family of applications



- To be renamed in “activation
- Check if an activation example does not already exist

Work Plan 2017

- Status of planned developments
- Code review concentrated on UI commands and macros
- Coding guidelines