Report from SLAC

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G4NAMU meeting @ AAPM Houston
27 July 2008
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- Makoto Asai's PENELOPE interface
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EM Changes Document

- Changes in Geant4 Electromagnetics from Release 4.6.1 to 4.9.1

- Attempt to summarize for my own understanding the changes that have occurred in Geant4 electromagnetics since the publication of the significant paper by E. Poon et. al that used release 4.6.1. The focus is on changes that would be of relevance to medical physics applications.

- Note: may have overlooked some of the changes relevant to proton/ion since the initial focus of this document was just on electron/xray therapy. A separate document of this kind would be helpful for proton/ion.
  - Jarlskog/Paganetti Paper gives us some of this
Progress in Neutrons and Ions

- Work for Space, Medical and Shielding communities has focused on improving processes for neutrons and ions
- C12 290MeV/n on Carbon Secondary neutron spectra

Tatsumi Koi, SLAC
Progress in Neutrons and Ions

- Ne20 400MeV/n on Carbon Secondary neutron spectra

+ Data
+ G4BinaryCascade
+ G4QMD

Tatsumi Koi, SLAC
New PENELOPE Interface

• Need for better physics in Geant4 for very low energy
  – The “Standard Electromagnetic” package of Geant4 provides accurate results for all particles down to about 1 keV
  – The “Low Energy Extensions” package of Geant4 provides results for some (but not all) particles down to about 250 eV

• Work in this area is ongoing, driven by both the space and medical communities

• From the SLAC Geant4 team, Makoto Asai has developed a new interface that couples the latest Geant4 to PENELOPE-2006 (well established MC for electrons, positrons, gammas down to 50 eV)
  – User configures everything as usual for Geant4 Standard Electromagnetics
  – When particle energy falls below 500 keV, Geant4 calls out to PENELOPE to continue physics down to 50 eV

• Such innovation is facilitated by Geant4’s very flexible architecture
Geant4 PENELOPE Examples

Standard EM down to 500 keV
Penelope from there to 50 eV

Red : electrons with
    Standard EM

Pink : electrons with
    Penelope

Blue : positrons with
    Standard EM

Light Blue : positrons with
    Penelope

Yellow : gammas with
    Penelope
Geant4 PENELOPE Examples

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Ease of Use Example: Scoring

- **HEP**: every detector is a novel design
  - user designs own “hit” classes to record relevant data or pass that data on to the rest of a special-purpose analysis system
- **Med Phys**: may just want to score dose or flux in standard ways
  - so now provide simple, command-based scoring
  - flexible design accommodated this major change easily
Geant4 Timeline

- Dec ’94 - Project start
- Apr ’97 - First alpha release
- Jul ’98 - First beta release
- Dec ’98 - First Geant4 public release - version 1.0
- We currently provide one to three public releases every year.
  - Bimonthly beta releases are available to the registered beta-testers.
- 11 May ’07 - Geant4 Version 8.3
- 29 June ’07 - Geant4 Version 9.0
  - 28 Aug ’07 - Geant4 Version 9.0.patch01
- 14 Dec ’07 - Geant4 Version 9.1
  - 5 Feb 08 - Geant4 Version 9.1.patch01
  - 9 May ’08 - Geant4 Version 9.1.patch02
- 4 July ‘08 - Geant4 Version 9.2-beta-01

Current version

27 July 2008
Geant4: Report from SLAC - Joseph Perl (SLAC/SCCS)
Three Main Kinds of Releases

- **Patch**
  - No new features, only fixes

- **Minor Release**
  - Fixes and new features
    but we promise not to break existing user code.

- **Major Release**
  - fixes and new features
    AND you may have to update your user code
  - We do not make a major release unless we have very compelling design reasons (that make it worth the effort of updating your code)
New in Release 9.1 for Medical Physics

- December 07
  - Minor Release, so will not break your user code

- EM Changes Summarized in previously mentioned document

- New voxel option, “Regular Navigation” (see later talk)

- Alpha release of QMD (quantum molecular dynamics) model for nucleus-nucleus interactions

- Beta release of Command-based scoring
  - Leverages a very large amount of work on “Parallel Worlds”
Parallel Worlds: New example N07

- Mass geometry
  - sandwich of rectangular absorbers and scintillators
- Parallel scoring geometry
  - Cylindrical layers
Releases since 9.1

• We are in a period of consolidation. Not trying to get a lot of new features out at this time, but a lot of tuning, cleaning up, extending implementation of the many recent additions.

• Also, the CERN and SLAC teams are pretty heavily focused on the needs of the LHC experiments

• Two patches:
  – Release 9.1 Patch 1, Feb 08
  – Release 9.1 Patch 2, May 08
Beta Release

- Geant4 release 9.2 Beta 1
  - We don’t feel we have enough major new features to merit distracting our users with a new release, but we also didn’t want to go a whole year without forcing ourselves to create a solid “checkpoint”, and have a decent pool of users try it, so we’ve produced a beta release.
    - Probably not something you need

- We also have a “reference” release every two months.
  - These do not receive the level of testing that we do for public or beta releases, so we don’t expose them to the public
  - Only members of the Geant4 collaboration have access to them
    - they can share them with you if you need them
    - ask me if you need one (but you probably don’t)
History of Geant4: Funding

To understand where Geant4 IS and CAN GO in Medical Physics, you must first understand some history

• Geant4 has been primarily funded by HEP

• SPACE funding now online
  – ESA, JAXA,
    and beginnings from NASA

• Medical funding only just starting
  – primarily in Japan and Italy

• Funding in HEP has recently become very tight
  – getting harder for HEP to do “volunteer work” in other areas

• Success stories from Geant4 Space Apps and from EGS are encouraging
SLAC Geant4 Group

- Looking to increase engagement with interested groups outside of our original high energy and nuclear physics community

- Makoto Asai:
  - Expert in Geant4 kernel, tracking, geometry
  - Coordinator of Geant4 run, event and detector working groups
  - Geant4 collaboration deputy spokesperson

- Tatsumi Koi:
  - Expert in Geant4 hadronic interactions, neutrons and ions
  - Significant experience in spacecraft radiation effects

- Joseph Perl:
  - Coordinator of Geant4 visualization working group
  - Coordinator of Geant4 North American Medical Users Organization

- Dennis Wright:
  - Coordinator of Geant4 hadronics working group
Central Support for G4 Medical Physics

• Take care of the basic shared issues
  – Such as we’ve been trying to do for you from SLAC

• So that the individual medical physics user can focus on their own unique research