Status of Biasing Development

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Stanford Linear Accelerator Center

Geant 4

Biasing and Scoring Mini-Workshop

http://geant4.slac.stanford.edu/EBMS/

Geant 4

Geant4 Event Biasing and Scoring Mini-Workshop
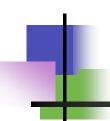
Stanford Linear Accelerator Center
Menlo Park, California, U.S.A.
March 19 - 23, 2007

The Geant4 Event Biasing and Scoring Mini-Workshop addresses the emergent needs of event biasing and scoring options.
It targets to:
- Understand the users needs of event biasing and scoring options,
- Sort out the options currently available in Geant4,
- Understand the potential design iteration required in Geant4, and
- Discuss and plan the work for the coming releases for design, implementation, documentation and examples.

This mini-workshop is closed to the members of Geant4 Collaboration.

workshop local organizer   01/10/2007 19:58:48

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Workshop Participants

- JAp - John Apostolakis (VRVS)
- PA - Pedro Arce (VRVS)
- MA - Makoto Asai
- TA - Tsukasa Aso
- GC - Gabriele Cosmo
- AH - Alex Howard
- VI - Vladimir Ivancenko (VRVS)
- TK - Tatsumi Koi
- HK - Hisaya Kurashige
- FL - Fan Lei (VRVS)
- JP - Joseph Perl
- JT - Jane Tinslay
- MV - Marc Verderi (VRVS)

- Work plan developed with short, medium and long term goals
  - http://geant4.slac.stanford.edu/EBMS/material/Summary_EBminiworksh op.ppt

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Status of Geometrical Biasing

Slides from Alex Howard, CERN

New Biasing Scheme (default since v9.0)

- Parallel geometry now must inherit from G4VUserParallelWorld

- Parallel and mass sampler classes now combined into one G4GeometrySampler class:

    e.g.: mgs(detector->GetWorldVolume(),"neutron");
  An additional set method defines whether or not the sampler is in a parallel geometry: mgs.SetParallel(false);

- When a parallel world is created, parallel navigation must be activated. An application with physics list that uses the AddTransportation method will automatically use G4CoupledTransportation which is picked up by the creation of the parallel world copy.

- All scoring can be implemented *only* through the Primitive Scorer classes.

- Users utilising the older scoring classes will need to migrate to using Primitive Scorers. The same functionality is provided apart from G4ScoreTable. Scorers are now attached to logical volumes (in place of geometry cells). This requires explicit copy numbers to be utilised for the same logical volume and the GeometryCell methods should be accessed through the physical volume & replica number method.

- A demonstration of the new biasing and scoring is available in examples/extended/biasing/B01 and B02.

Developments since mini-workshop (1)

- New module for process-based biasing

- Migrated classes from processes/scoring and transportation modules

- Removed classes from old biasing scheme

- These are now replaced by either G4CoupledTransportation (parallel navigation) or in processes/biasing module

- The scoring is implemented with the new scoring framework (in digits_hits and processes/scoring modules).

- The following classes were removed: G4ParallelNavigator, G4ParallelStepper, G4ParallelWorld, G4VParallelStepper, G4VPGeoDriver, G4VScorer, G4ImportanceSplitExaminer, G4VImportanceSplitExaminer, G4VWeightWindowExaminer, G4WeightWindowExaminer.

Developments since mini-workshop (2)

- Examples B01 and B02 migrated to new scheme
    - And found to reproduce the old system
- B03 removed (python/obsolete)
- TIARA still needs updating / re-writing / migrating / maintaining
- Benchmarking vs. data with Figure of Merits still need developing for biasing
- Documentation updated

Coupled Transportation

- Most of the effort with respect to biasing development has been spent on CoupledTransportation

- CoupledTransportation allows parallel navigation which is required for Geometrical Biasing

- We attempted to introduce this as the default transportation for Geant4 in release v9.0, but due to performance issues it was not possible

- Further profiling and debugging is continuing so that it can be introduced in v9.1

- For biasing in parallel geometries this is now the only possibility for transportation

Status of Physics Based Biasing

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Physics Based Biasing in Geant4

- Existing physics biasing fragmented
  - Eg, hadronic leading particle biasing embedded in G4HadronicProcess
  - Limits code reusability
  - Limits transparency
- Would like to:
  - Be able to implement everything/most of the techniques available in other Monte Carlo codes, including specialisations implemented in each code
    - EGS family, Fluka, MCNP family, Penelope
  - Enable user to experiment with their home grown biasing technique
  - In Geant4, be nice to either have access to built in techniques or examples of:
    - Implicit capture
    - General cross section biasing
    - Interaction forcing
    - Path length biasing
    - Advanced bremsstrahlung splitting
    - Electromagnetic leading particle biasing, general multiplicity reduction biasing techniques

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Physics Biasing Framework

- Aim to provide flexibility through common physics biasing framework
  - Make life a little easier for the users

- Two levels to biasing
  - Processing (G4SteppingManager) level :
    - Manippulating physics & processing lists, taking into account when a physics list/process is active (triggered)
      - Independent of process type
        - Although whatever process grouping constraints currently imposed must still be applied
  - Process level:
    - Actual biasing code
    - Executed in GPIL/DoIt methods
    - Avoid "do it all" interface classes to simplify biasing while allowing access to underlying processes when need to do more complex biasing
      - More complex biasing working on process type level is limited as to what interfaces the actual process provides

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- Physics list manipulation
  - Create a brand new physics list for a given particle
    - Either new default list
    - Or new list to be picked up in certain circumstances (trigger), eg, region, volume, primary track etc
- Process list manipulation
  - Want to do multidimensional process list manipulation
    - Add/remove process
    - Override one or more DoIt/GPIL methods multiple times
    - Combine multiple DoIt/GPIL methods
    - Mask out specified processes
  - Clear documentation explaining issues/features with particular processes
- When to trigger biasing
  - Specify circumstance/set of circumstances in which biasing is to be applied
    - Eg, volume in world, energy, creator process…
  - Separate out triggering decision from biasing code
    - Code reusablility, flexibility

Prototype Physics Biasing Framework

- Prototype code in CVS under geant4/source/processes/biasing/test/physics_biasing/
    - Tag: jst17092007

- It's development code
    - Lots of debugging print
    - Subset of desired features implemented
    - Most likely buggy
    - Just an example of how things could be done
    - Let me know if you need a hand getting it running

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A01 Example Biasing Demonstrations

- Under:
  - processes/biasing/test/physics_biasing/gpr_examples/A01

- Example implementations showing:
  - Electromagnetic and hadronic leading particle biasing
  - Bremsstrahlung splitting with Russian Roulette
  - How to create new physics lists used only in the calorimeter

- Future development
  - Try to implement more complex techniques - eg, forced interaction, cross section biasing & see where the holes are

- More details in biasing parallel session

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