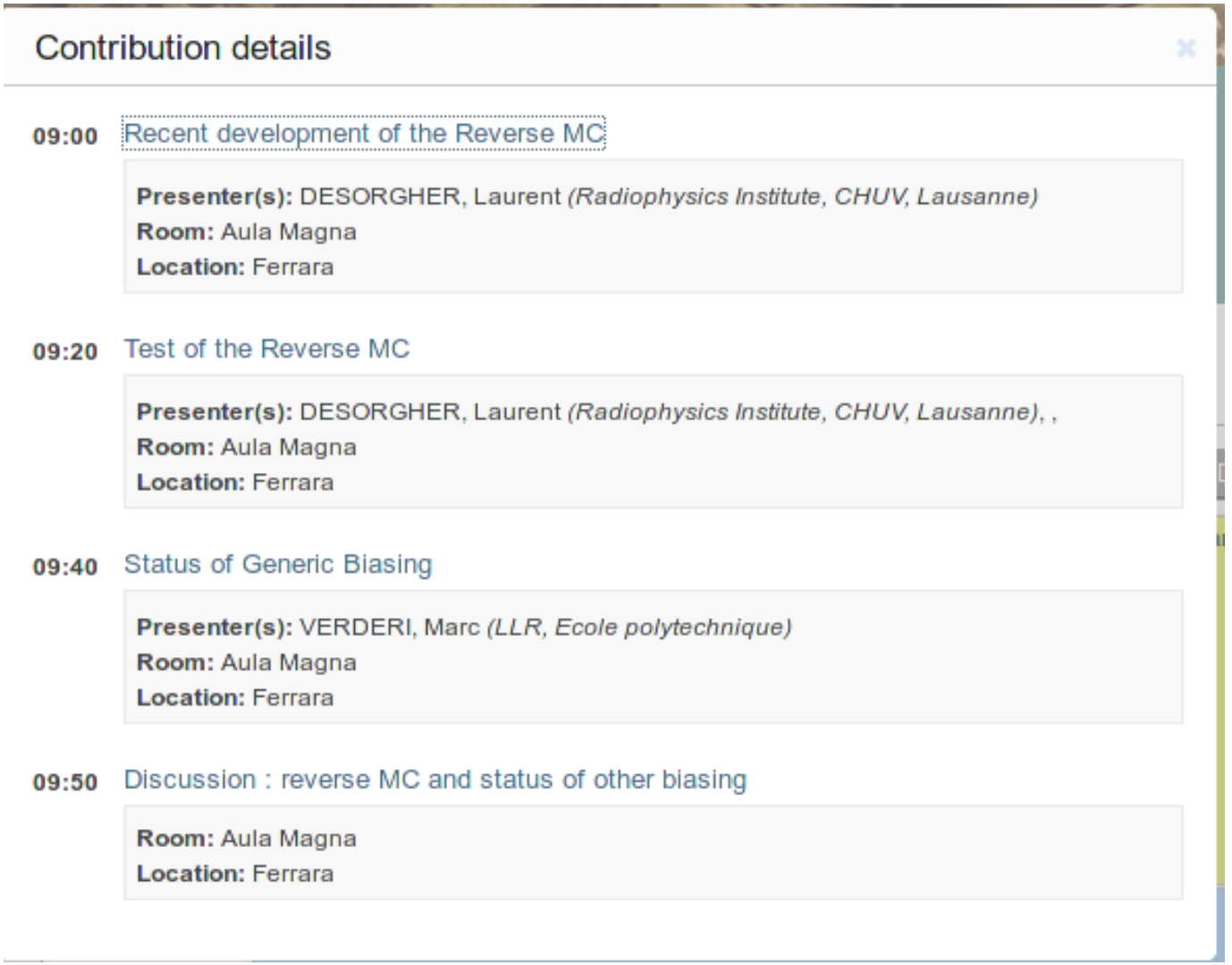
Parallel 5B - ReverseMC and Biasing



Contribution details

09:00 Recent development of the Reverse MC

Presenter(s): DESORGHER, Laurent *(Radiophysics Institute, CHUV, Lausanne)*
Room: Aula Magna
Location: Ferrara

09:20 Test of the Reverse MC

Presenter(s): DESORGHER, Laurent *(Radiophysics Institute, CHUV, Lausanne), ,*
Room: Aula Magna
Location: Ferrara

09:40 Status of Generic Biasing

Presenter(s): VERDERI, Marc *(LLR, Ecole polytechnique)*
Room: Aula Magna
Location: Ferrara

09:50 Discussion : reverse MC and status of other biasing

Room: Aula Magna
Location: Ferrara

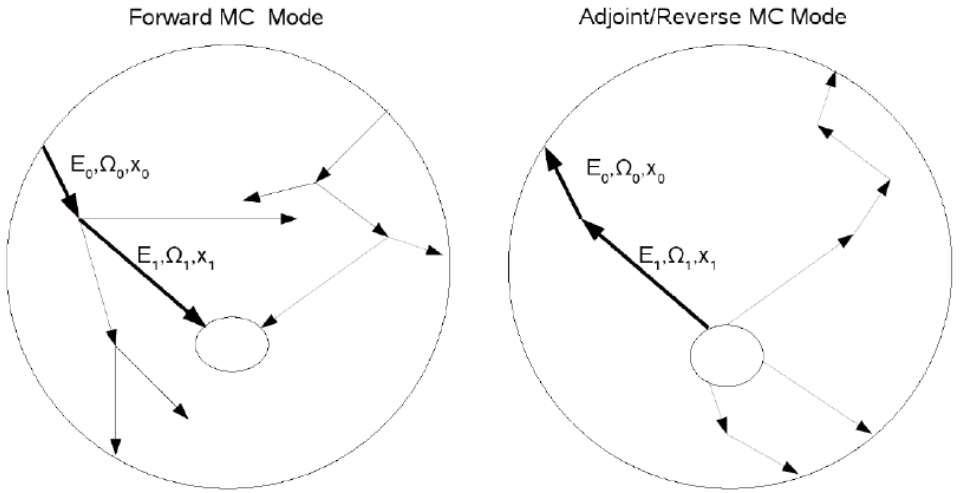
Session in the echo chamber – so the discussion was limited...

Alex Howard and Marc Vederi

Recent Developments of the Reverse MC (1)

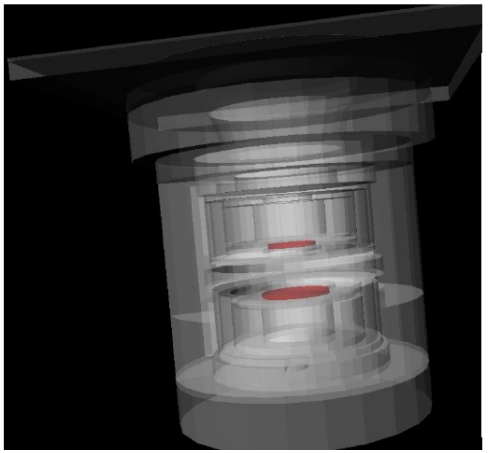
- Development work recently restarted
- Promising results
- Testing with simple shields shows that some further investigation is required

Reverse MC method

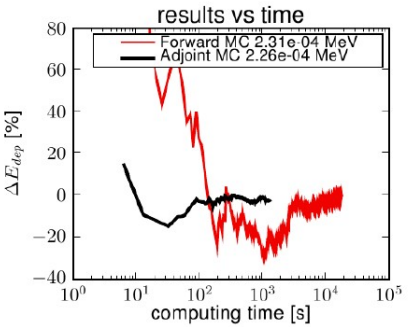


Reverse MC
- Start from the tiny sensitive volume
- Reverse tracking with occurence of reverse processes till external sources
- In Geant4 Reverse Compton, Photoe-electric, bremsstrahlung, ionisation e-,protons

Reverse MC example with SREM detector of ESA



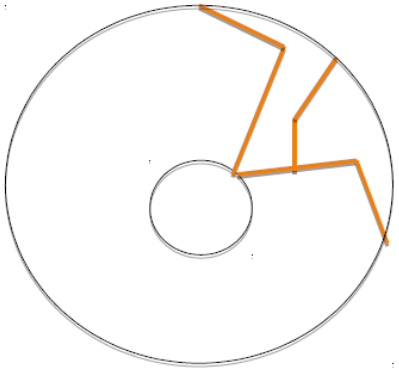
- Primary spectrum exp(-E/1MeV)



Recent Developments of the Reverse MC (2)

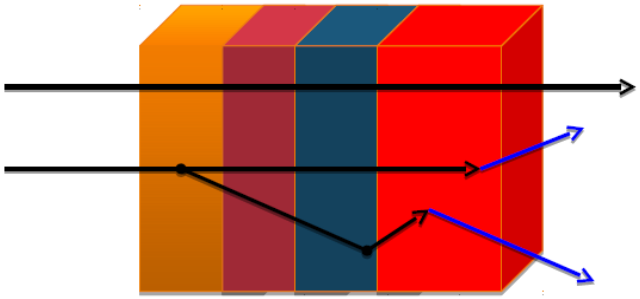
- New combined biasing techniques
  - Gamma splitting → factor of 5 speed up
  - Forced interaction → ongoing

Implementation of reverse tracking splitting



- Several tracks can reach the external source during the same event
- The user has now the possibility to split creation of adjoint primary /adjoint/SetNbOfPrimaryAdjGammasPerEvent /adjoint/SetNbOfPrimaryAdjElectronsPerEvent
- Open the possibility to implement other biasing method for reverse tracking

Ongoing Implementation of forced interaction in gamma reverse physics



- Most of the time the reverse/forward gamma will no interact with the geometry
- Force interactions along the track of the reverse gamma to go back to a primary electron on the othe side of the shielding
- Give more weights for interaction in external layers
- Only valid for gamma induced by primary elecetrons

Testing of Reverse MC (1)

- New small scale ESA project to test ReverseMC
- First results positive with shielding, but some issues identified
  → further investigation required

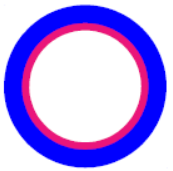
Spherical Shielding Tests

Version of GRAS/Geant4 tested

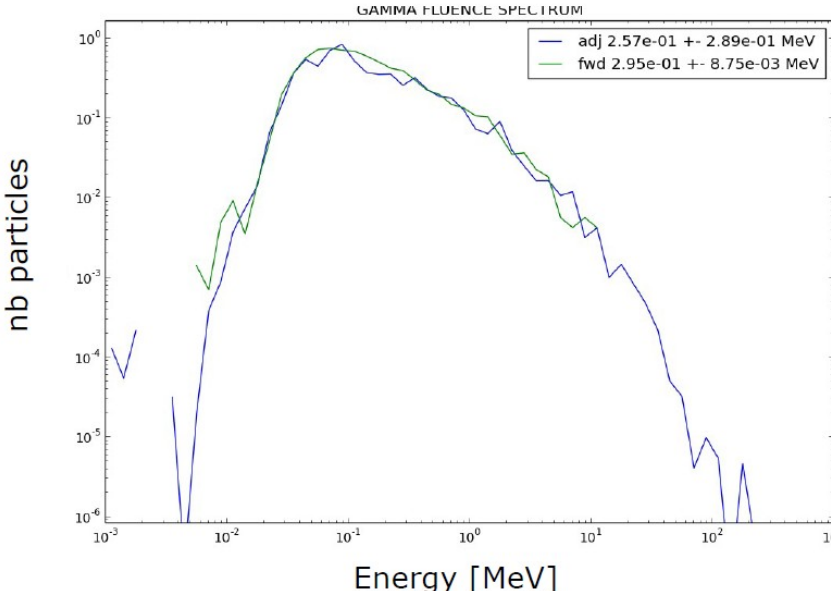
- GRAS:Trunk HEAD
- G4: geant4-10-02-ref-07

Running the spherical shell tests with both FMC and RMC:

- JUICE e- spectrum
- 0.1 – 50 mm Al and Ta spherical shell of 10 cm inner radius
- Evaluated quantities:
  - in 10 micro thick Si placed immediately inside the shell
  - Electron and gamma spectra after the shell
  - Convergence of the calculated Dose, in the case of RMC



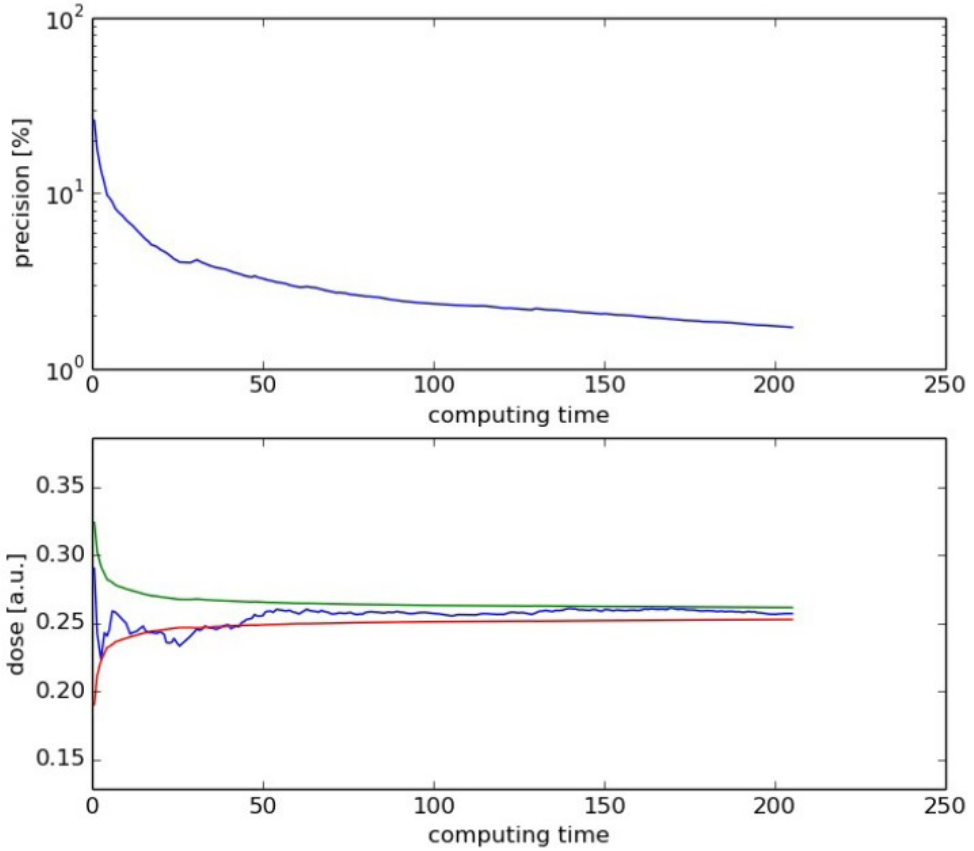
5 mm Al Shielding



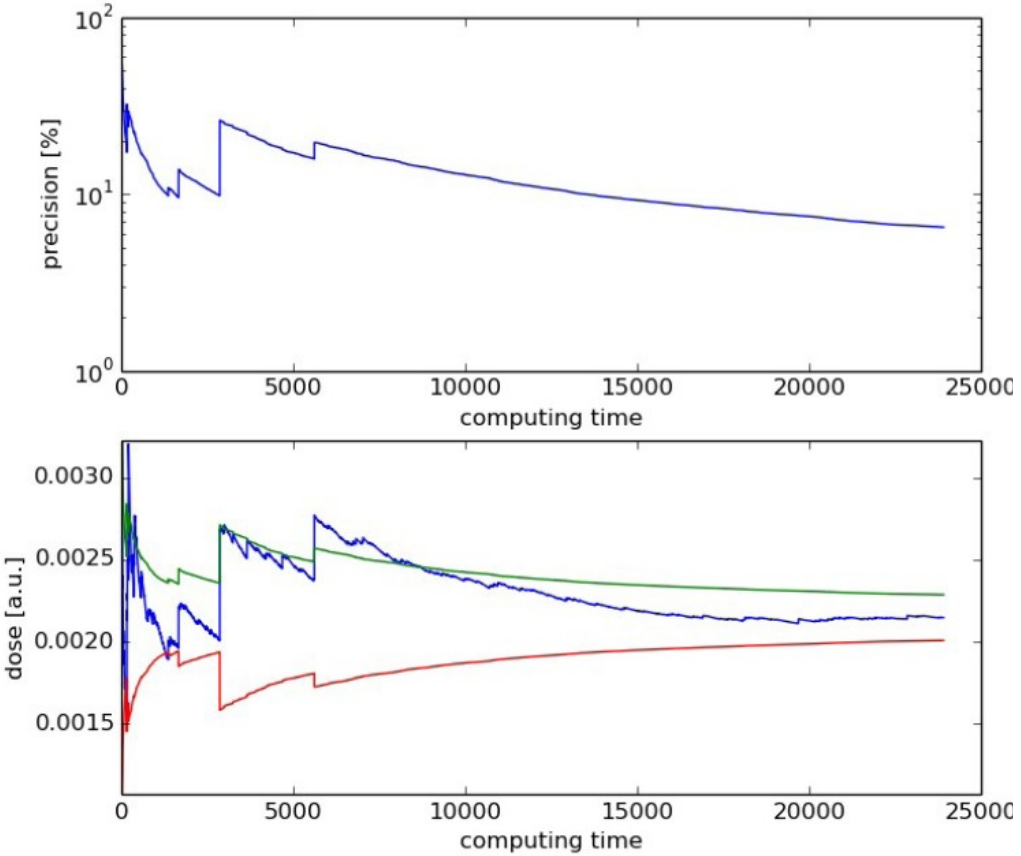
Testing of Reverse MC (2)

- Thicker shielding shows some “high weight” jumps
- Some other systematic differences – more work needed

5 mm Al shielding



50 mm Al, JUICE Spectrum



New Developments in Generic Biasing (1)

- Not much progress since last collaboration workshop
- But...

Reminder About Existing Functionalities

- Design of generic biasing relies on:
  - two main abstract classes:
    - G4VBiasingOperation:
      - Biasing of physics processes
        - Change of process interaction law
        - Change of final state generation
      - Splitting/killing
    - G4VBiasingOperator:
      - Which takes decisions on what biasing operation to apply
      - At the beginning of the step, and at the post step
  - One concrete class : G4BiasingProcessInterface
    - Makes the connection between the biasing and the tracking
    - Gets instructions from the biasing operator about operations to apply
- Concrete implementations:
  - Biasing operation to change a process cross-section
  - Forced collision scheme à la MCNP
  - Both functionalities validated with neutral particles
- Set of examples example/extended/biasing/GBXX
  - GB01 : change of XS
  - GB02 : force collision
  - GB03 : geom. importance based biasin
  - GB04 : bremsstralhung splitting

First released in 10.0 then consolidation in 10.1 and 10.2. In particular in 10.2 : use of track auxiliary information (forced collision scheme) & easy access to phys. process XS to operator.

Status as of Today

- Not much happened this year
- Several items are planned
  - Not all will be delivered this year

  ⇒Take opportunity to discuss needs/priorities
- Prioritized list for now (not all for this year !):
  - Statistical tests / statistical test suite
  - Refactor existing generic biasing bremsstrahlung splitting example to source
  - Implicit capture
  - Biasing of charged particles
  - Allow use of parallel worlds
  - Use of occurrence biasing to allow continuous density chang inside a same volume
  - DXTRAN-like biasing
  - Material/isotope biasing
  - Woodcock tracking

New Developments in Generic Biasing (2)

- Statistical testing of biasing is important
- Need to verify if different biasing schemes are always correct
- Other extensions are cross-category – no global cross-section

Statistical Test Suite

- This is the priority
  - as needed to validate any biasing developments
- Goal : perform a statistical validation of the biased simulation against the analog one
  - Hence, need to run heavy analog statistics
    - Clusters ? Grid ?
- Simple in principle:
  - Record "same" histograms and some observables
  - With quantities entered with proper weights
  - And make statistical tests
- In practice:
  - Might be a same test that is run with:
    - A light statistics mode, for testing purposes
    - A heavy statistics mode, for statistical validation
      - and a script/macro to perform the comparisons
  - Can/must be done with already existing options

Dependencies on Other Physics Packages

- Dependencies between biasing and other physics packages must be introduced
  - Because of absence of generic interfaces for XS and differential XS
  - XS : interaction law biasing
    - G4VProcess provides the interaction length in a generic way
    - But getting the cross-section at the end of the step to apply the "integral approach" will likely involve explicit dependencies on physics packages
  - Differential XS : final state biasing:
    - Splitting/killing of primary/secondaries could be made using G4VProcess interface only
    - But any change of final state distribution will likely require dependencics on physics packages to access related laws
- Could consider:
  - Biasing depending on other physics packages
    - And all concrete biasing classes reside under biasing

      ** Or (exclusive) **
  - Physics packages depend on biasing
    - To access the biasing interfaces
    - Having the concrete biasing classes residing in physics packages
- Must be discussed.