

New Scoring Functionalities

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Sept.23.2021



NATIONAL
ACCELERATOR
LABORATORY

- Command-based real-world scorer
 - User may assign a scorer to a logical volume defined in the mass world.
- Command-based probe scorer
 - User may locate scoring “probes” at arbitrary locations. A “probe” is a virtual cube, to which any Geant4 primitive scorers could be assigned. Probes are placed in a dedicated parallel world so that they may overlap to the volumes defined in the mass geometry.
- 1-D histogram directly filled by a primitive scorer
 - Scorer directly fills step-by-step value to a histogram such as energy spectrum.
- Other minor updates
- Some UI commands convenient for macro

- With a UI command, user can define a scorer to a logical volume in the mass world.
- Once a real-world scorer is defined, user can associate arbitrary number of primitive scorers and filters like the conventional scoring mesh.
 - All physical volumes have the same primitive scorers but score individually.
 - Logical volume name is used as the scorer (mesh) name.

```
/score/create/realWorldLogVol Gap 1  
/score/quantity/energyDeposit eDep MeV  
/score/quantity/trackLength sLen mm  
/score/filter/charged cFilter  
/score/create/realWorldLogVol Abso 1  
/score/quantity/energyDeposit eDep MeV  
/score/quantity/trackLength sLen mm  
/score/filter/charged cFilter  
/score/close
```

**Logical volume name
(= scorer name)**

**Use copy number of the
mother (i.e. one level up)
volume ("Layer") as the
index**

exampleB4a

World
Calorimeter : placement
Layer : replica
Gap : placement
Abso : placement

*You no-longer need
UserSteppingAction
or UserEventAction*

- Do not use this `/score/create/realWorldLogVol` command to a mother logical volume.
 - For example of this exampleB4, “Layer” is fully filled with “Gap” and “Abso” daughter volumes. You won’t see any energy deposition on “Layer” volume.

```
/score/create/realWorldLogVol Gap 1  
/score/quantity/energyDeposit eDep MeV  
/score/quantity/trackLength sLen mm  
/score/filter/charged cFilter  
/score/create/realWorldLogVol Abso 1  
/score/quantity/energyDeposit eDep MeV  
/score/quantity/trackLength sLen mm  
/score/filter/charged cFilter  
/score/close
```

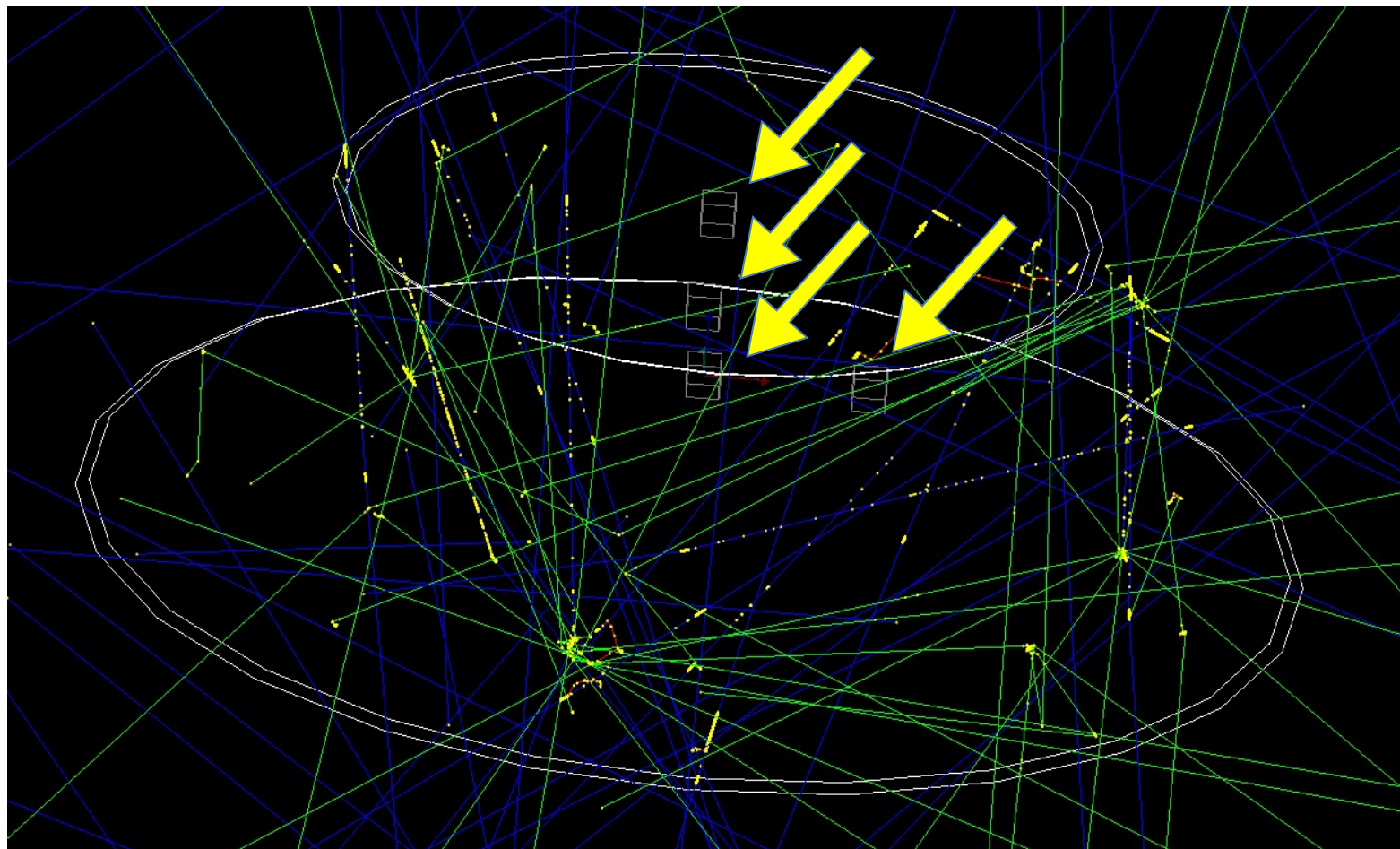
If this is not set, given “Gap” and “Abso” are placed with copy number 0, energy deposition and track length are accumulated for all layers.

exampleB4a

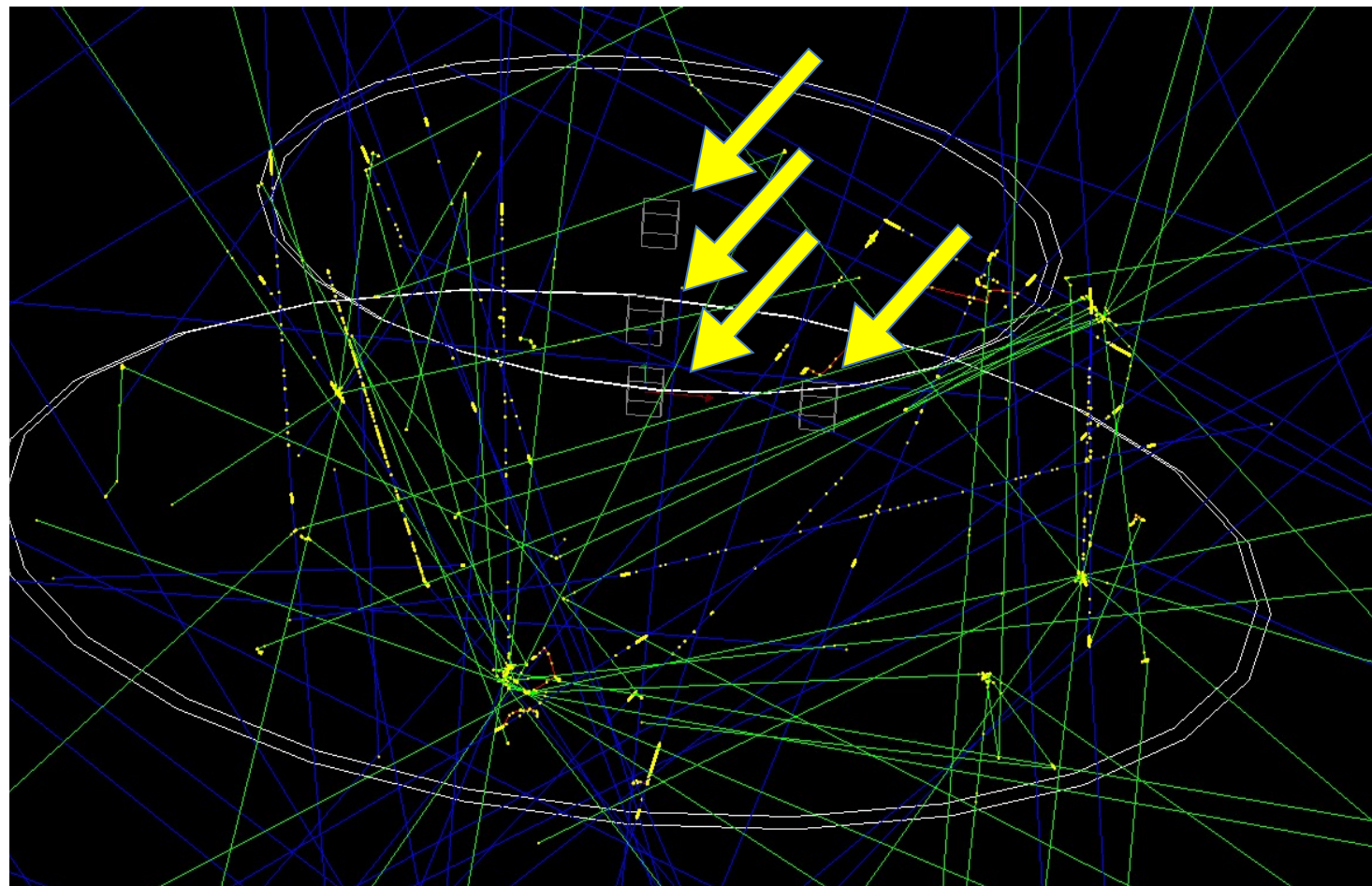


World
Calorimeter : placement
Layer : replica
Gap : placement
Abso : placement

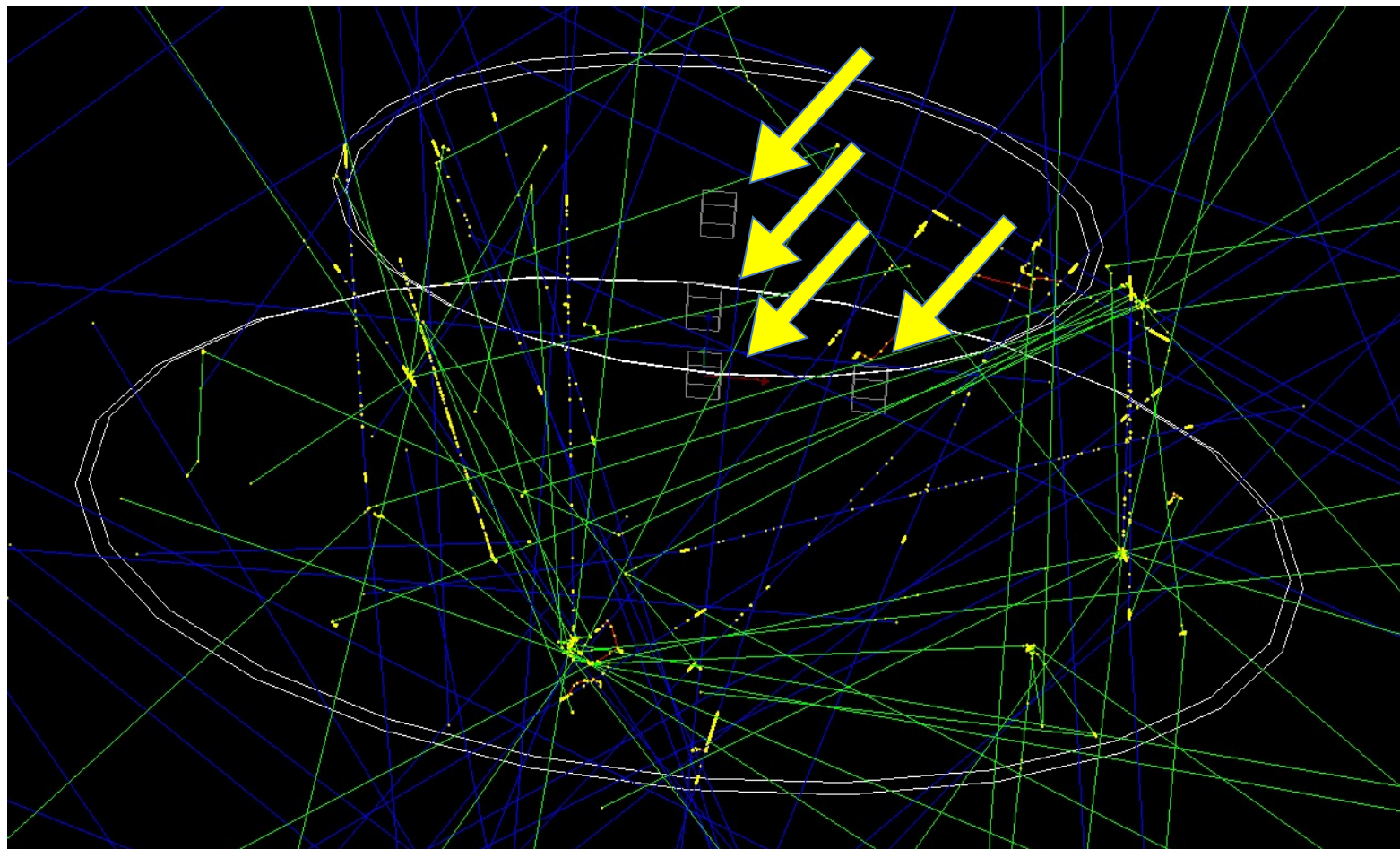
- User may locate scoring “probes” at arbitrary locations. A “probe” is a virtual cube, to which any Geant4 primitive scorers could be assigned.
- Given these probes are located in an artificial “parallel world”, probes may overlap to the volumes defined in the mass geometry, as long as probes themselves are not overlapping to each other or protruding from the world volume.
- Once a probe is defined, user can associate arbitrary number of primitive scorers and filters like the conventional scoring mesh.
 - All probes have the same scorers but score individually.



- In addition, the user may optionally set a material to the probe. Once a material is set to the probe, it overwrites the material(s) defined in the mass geometry when a track enters the probe cube.
 - Because of this overwriting, physics quantities that depend on material or density, e.g. energy deposition or dose, would be measured accordingly to the specified material.
 - Please note that this overwriting material obviously affects to the simulation results, so the size and number of probes should be reasonably small to avoid significant side effects.



```
/score/create/probe Probes 5. cm  
/score/probe/material G4_WATER  
/score/probe/locate 0. 0. 0. cm  
/score/probe/locate 25. 0. 0. cm  
/score/probe/locate 0. 25. 0. cm  
/score/probe/locate 0. 0. 25. cm  
/score/quantity/energyDeposit eDep MeV  
/score/quantity/doseDeposit dose mGy  
/score/quantity/volumeFlux volFlx  
/score/quantity/volumeFlux protonFlux  
/score/filter/particle protonFilter proton  
/score/close
```



Note: To visualize the probes defined in a parallel world, the following command is required.
`/vis/drawVolume world`**s**

1-D histogram directly filled by a primitive scorer

- Through a newly introduced interface class (G4TScoreHistFiller) a primitive scorer can directly fill a 1-D histogram defined by G4Analysis.
 - Track-by-track or step-by-step filling allows command-based histogram such as energy spectrum.
- G4TScoreHistFiller template class must be instantiated in the user's code with his/her choice of analysis data format.

```
#ifndef MyAnalysis_h
#define MyAnalysis_h 1
//#include "g4root.hh"
#include "g4csv.hh"
//#include "g4xml.hh"
#endif
```

```
#include "MyAnalysis.hh"
#include "G4TScoreHistFiller.hh"

auto histFiller =
    new G4TScoreHistFiller<G4AnalysisManager>;
```

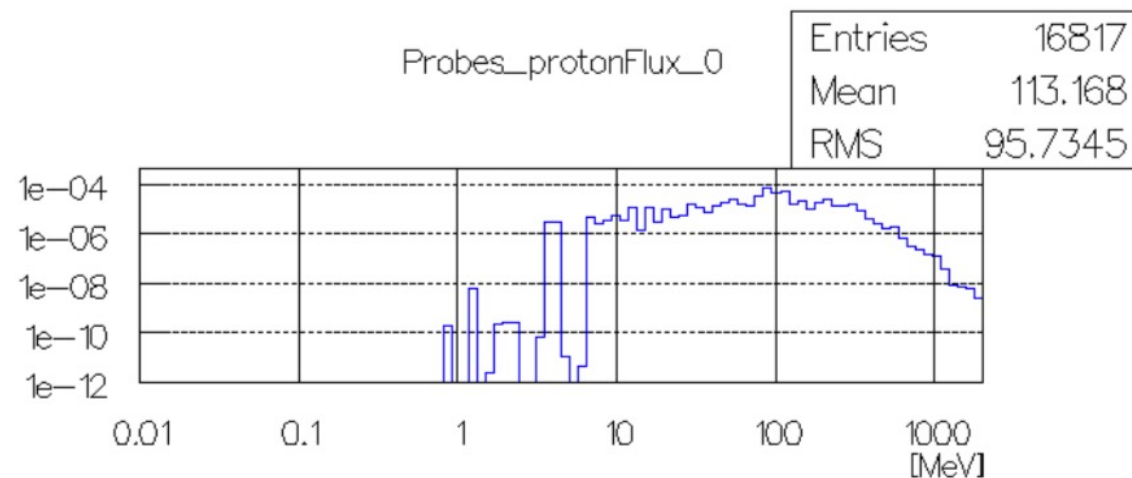
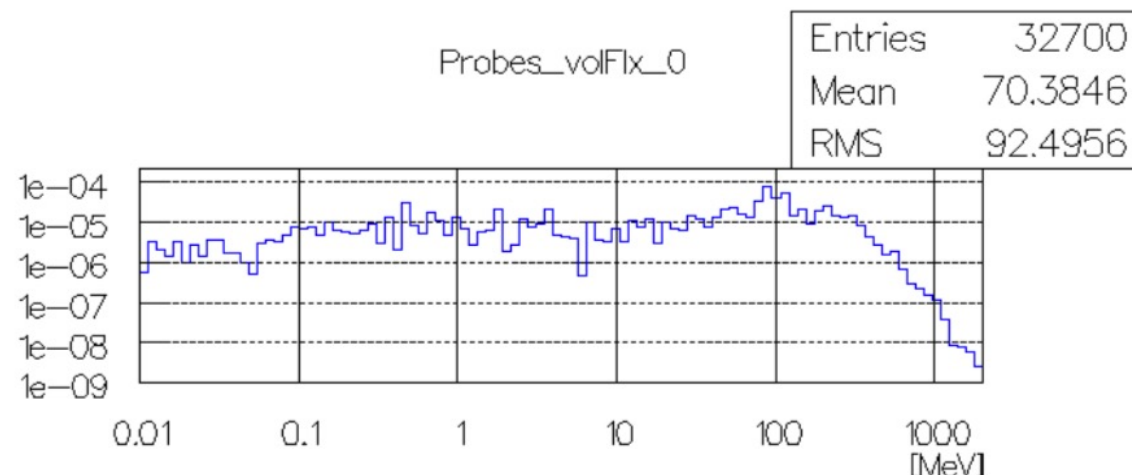
- Primitive scorer must be defined in advance to setting a histogram.
- Histogram must be defined through /analysis/h1/create command in advance to setting it to a primitive scorer.
- This functionality is available only for primitive scorers defined in real-world scorer or probe scorer.
 - Not available for box or cylindrical mesh scorer due to memory consumption concern.

1-D histogram directly filled by a primitive scorer

```
/score/create/probe Probes 5. cm
/score/probe/locate 0. 0. 0. cm
/score/quantity/volumeFlux volFlux
/score/quantity/volumeFlux protonFlux
/score/filter/particle protonFilter proton
/score/close
/analysis/h1/create volFlux Probes_volFlux
                                100 0.01 2000. MeV ! log
/score/fill1D 1 Probes volFlux
/analysis/h1/create protonFlux Probes_protonFlux
                                100 0.01 2000. MeV ! log
/score/fill1D 2 Probes protonFlux
```

N.B. If probe is placed more than once, *fill1D* command should be defined for each *copyNo*.

```
/score/fill1D 1 Probes volFlux 0
```



- G4GenericMessenger :
 - Adding G4ThreeVector type without unit to DeclareProperty().
 - Removing unnecessary duplications of G4UIdirectory objects.
- G4Ulmanager : adding access methods to individual UI command and G4Ulcommand : adding command-type identifier.
 - Allows easy update of command's properties on the fly, e.g. default value, parameter range

- Some UI commands are extremely useful for simplifying macro file (and even some example coding).
- `/control/doifBatch`, `/control/doifInteractive`
 - For example,
`/control/doifInteractive /control/execute vis.mac`
- `/control/getVal`, `/control/getEnv`, `/control/doif`
 - For example,
`/control/getVal vLevel /tracking/verbose`
`/control/doif {vLevel} > 0 /control/execute myMacro.mac`
`/control/getEnv G4FORCENUMBEROFTHREADS`
`/control/doif {G4FORCENUMBEROFTHREADS} > 1 /control/execute myMTMacro.mac`
- `/control/macroPath`
 - For example,
`/control/macroPath /usr/local/lib:~/geant4/install/lib`
- `/control/shell`
- `/control/loop`, `/control/foreach`