# *Framework of AARM Simulation Package*

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on behalf of simulation group

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# The Goal of AARM Simulation Package

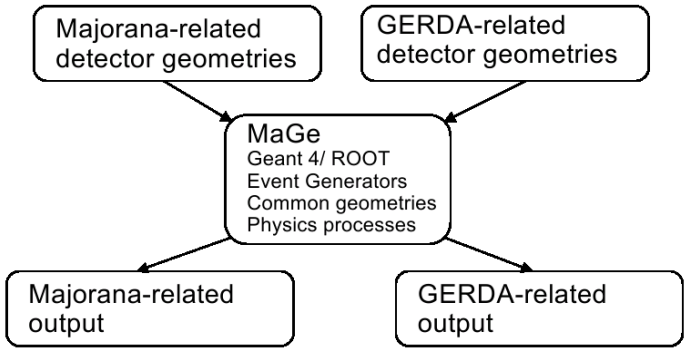
Nov. 2010 AARM collaboration meeting decided to develop an integrated simulation package based on the following motivations:

- Provide the collaboration with a simulation package to support its design, operation and data analysis.
- Incorporate all characterized Homestake background data which will be shared with modular geometries.
  - Homestake external muon, gamma, neutron, radon background and rock composition have been measured at various level of depth.
  - According database is under construction.
  - Various geometry modules will be developed.
- Dedicated physics focusing on low energy region.
  - Rich and selectable physical models and processes.
  - Evaluated physics process and database for interested elements.
- Retrievable output results.
  - Detailed historic and event information.
  - For verification purpose, retrieve tracking information for any interested event, step by step.

# Existing Packages

(DUSEL-related)

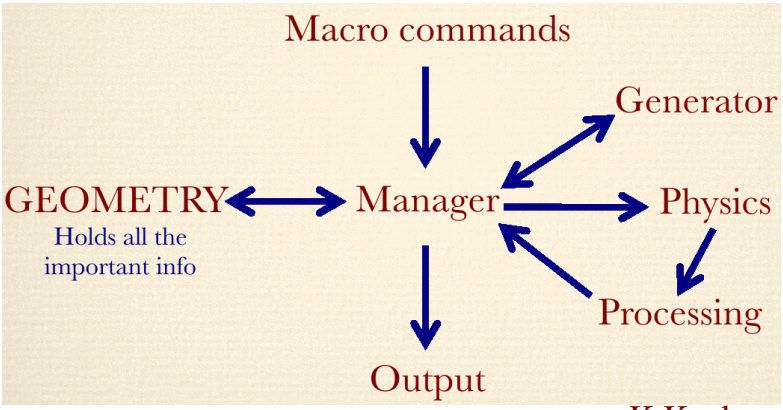
- MaGe – G4 base, integrated simulation package for GERDA and Majorana.
  - rich physical processes included
  - dedicated event generators: radioactive sources, point sources, signal sources...
  - support different geometries(include user defined) and output schemes.
  - well maintained, documented




R Henning

Rich and Robust !!!

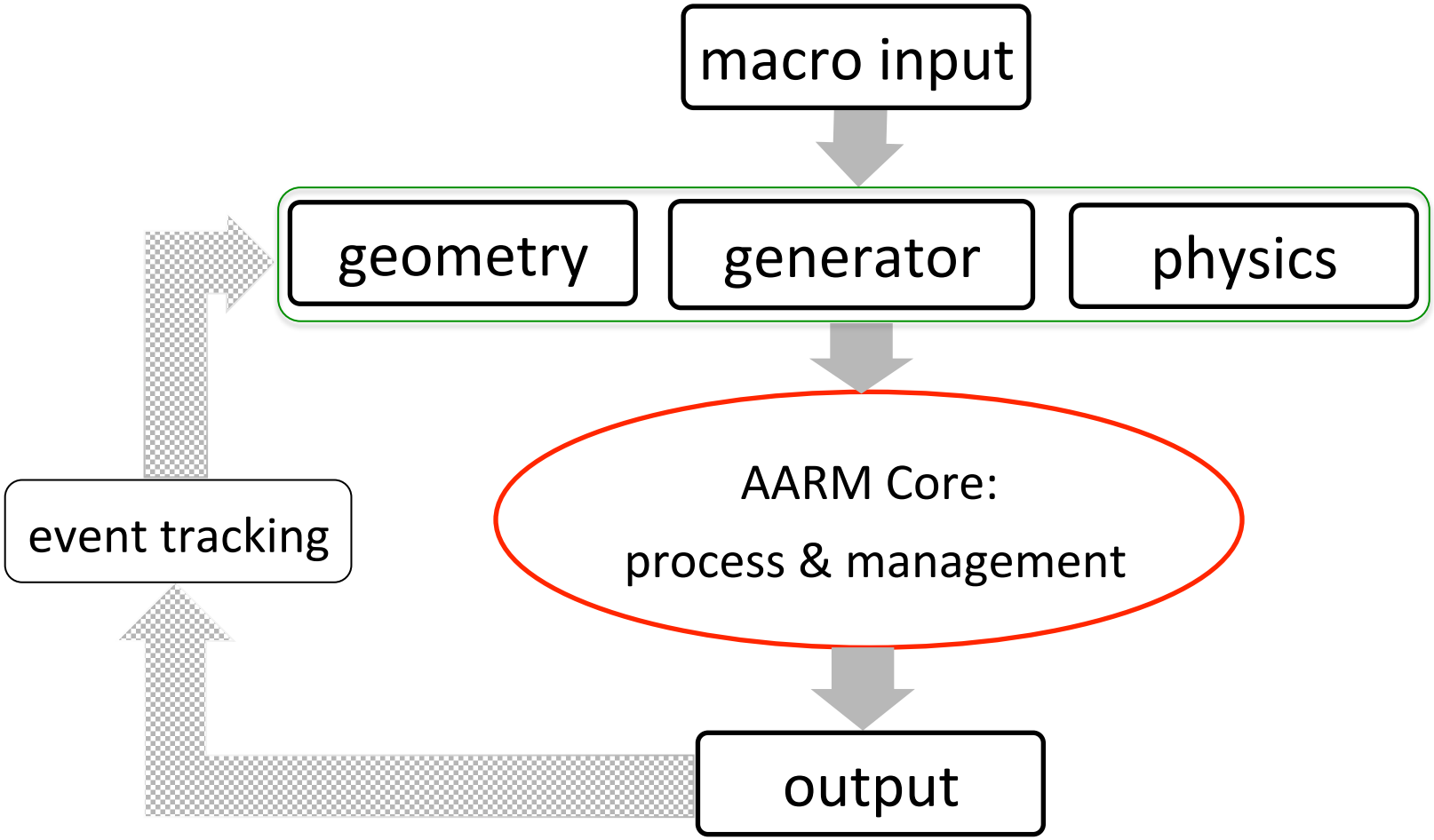
- LUXSim – simulation package for LUX.
  - simple but rich physics list
  - component-centric approach, easily scalable to different geometries
  - multiple sources and activities
  - optimized management with sub-system
  - automatic documentation in the data file




K Kazkaz

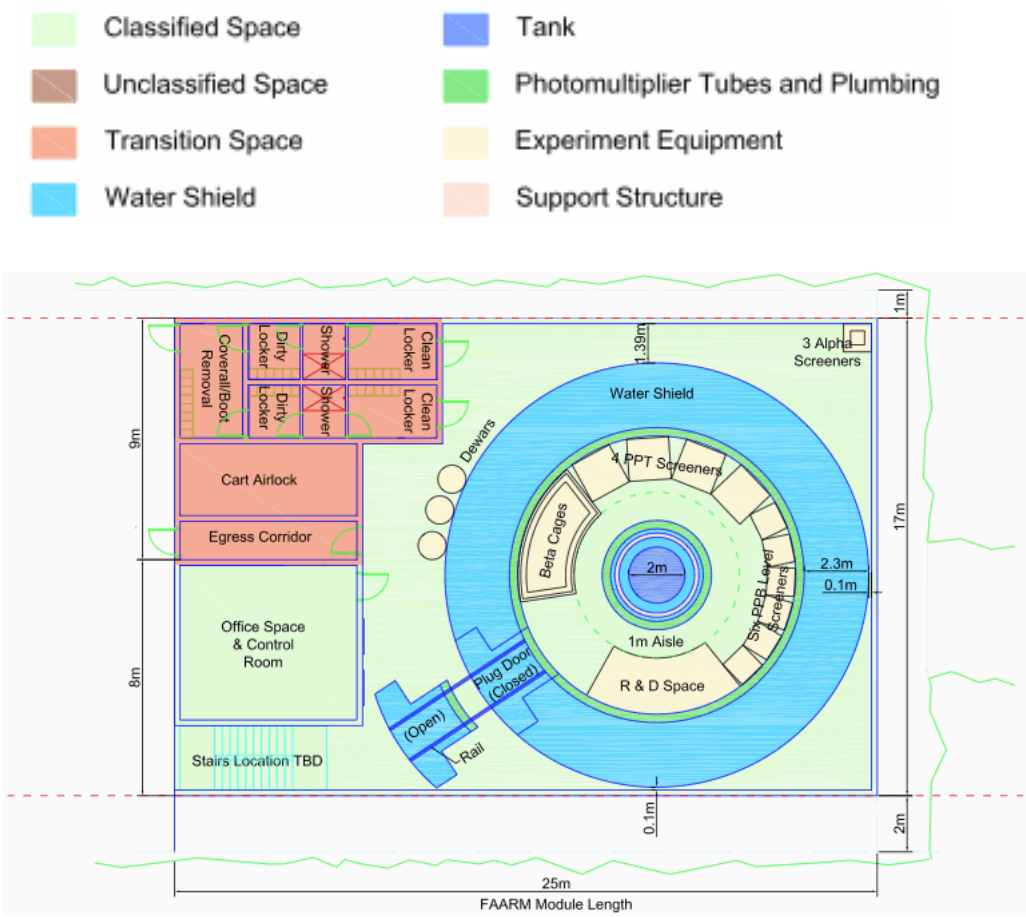
Simple and Dynamic !!!

# Flow Chart of the Framework



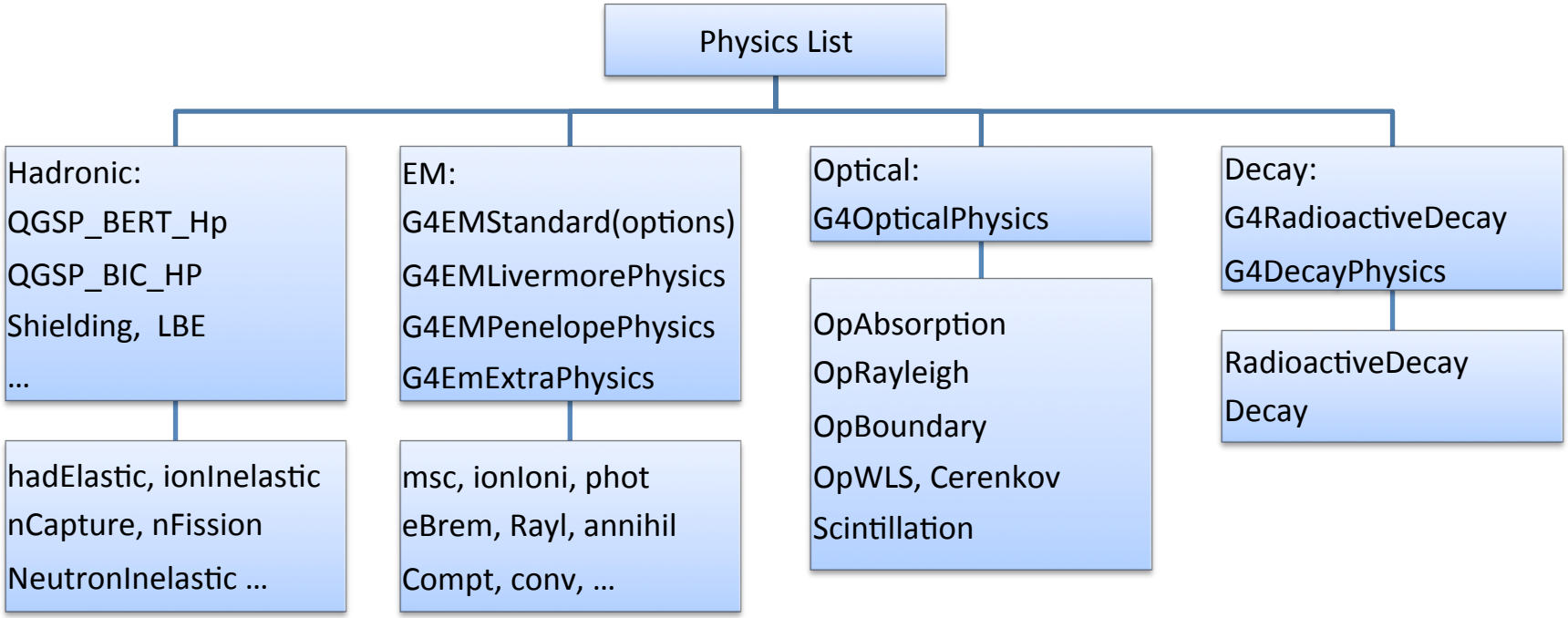
# Basic Structure/Function - Geometry

- A 200m$^3$ experiment hall is defined as the world volume which is scalable using macro commands.
- Shared geometries, such as cavern rocks, concrete, water tank, muon veto, can be switched on/off using input commands.
- Individual modules will be selected and loaded as specified daughter geometries before the beamOn.
- Using “UpdateGeometry()” method to refresh modified geometries.
- Detailed materials and their optical attributions will be developed.



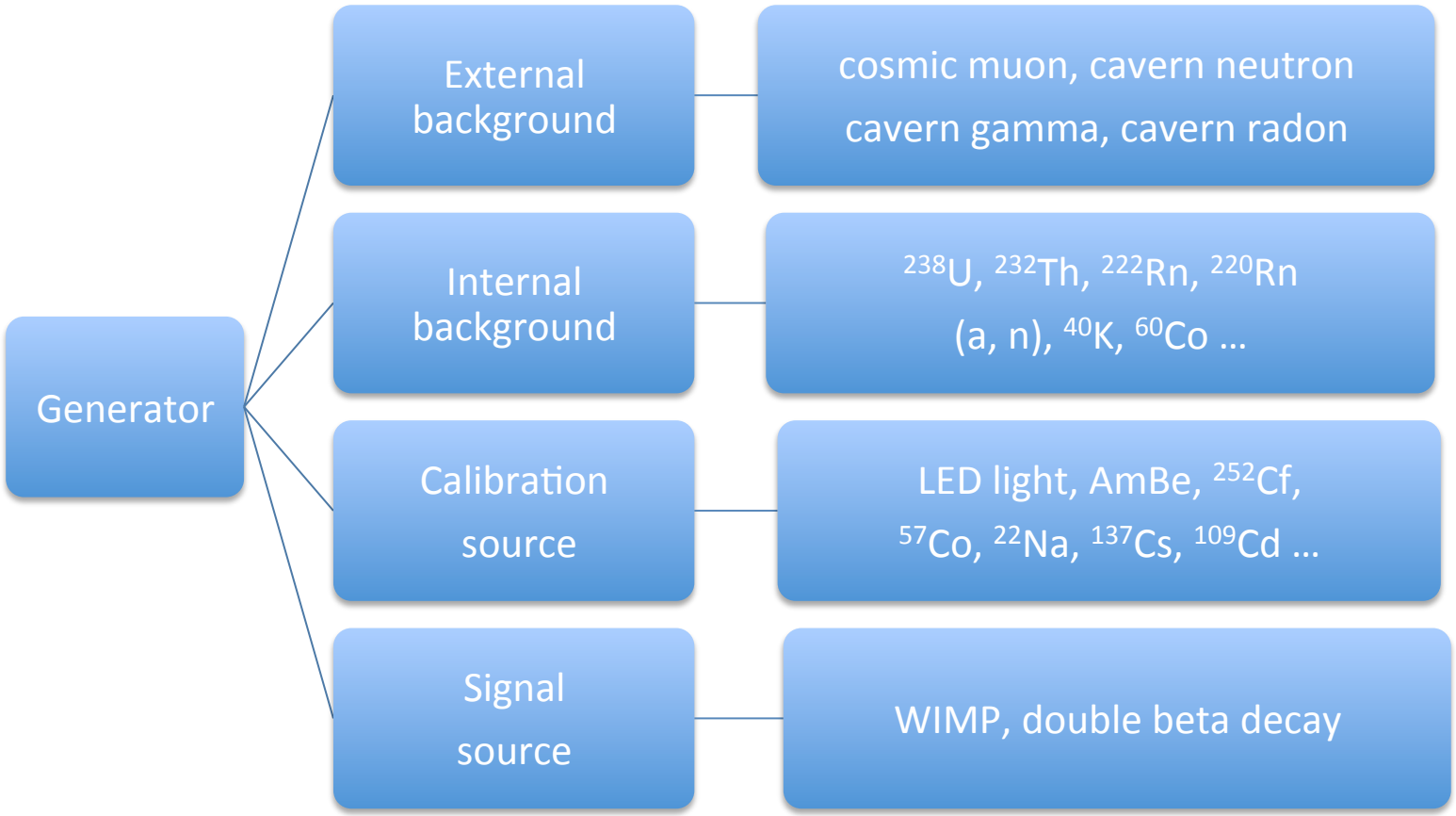
# Basic Structure/Function - Physics

- Using G4VModularPhysicsList to include hadronic, EM, decay, optical physics.
- Physics modules can be selected using macro commands. “UpdatePhysics()” method must be use to refresh the change.
- Every physical process/cut can be activate/inactivate or reset during the run.



# Basic Structure/Function - Generator

- Includes various background, calibration and signal sources which can be specify in macro commands.
- Multiple sources can be generated at a point or uniformly inside/on-surface of any specified geometry cell.



# Basic Structure/Function - AARMCore

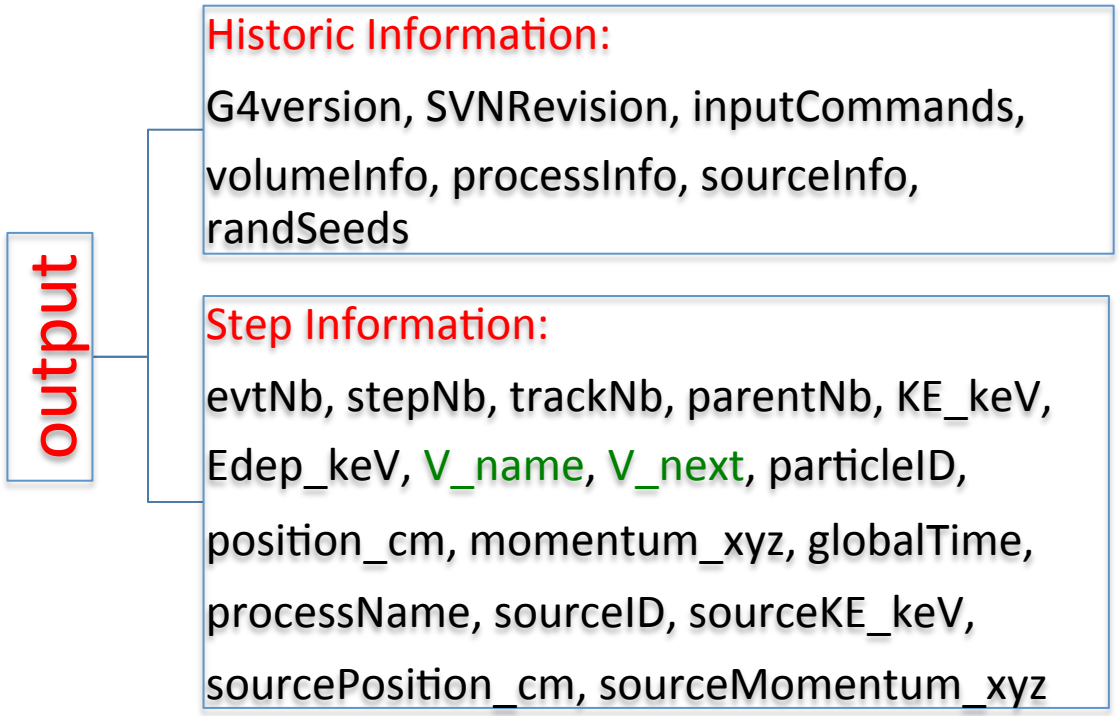
- Before the “BeamOn”, it collect and calculate geometry, physics and source parameters, allocate position information for event generator.
- As an information exchanging harbor, it access each necessary class and manages data processing/transporting.
- Save all history information, mediate results event by event to output class.

```
//Accumulate all used physical volumes
    void AddPhysicalVolume(G4VPhysicalVolume* vol)
    void CalculateVolumeParameter();
    std::vector<volumeInfo> GetVolumeParameter()
    G4ThreeVector GetUniformPositionSolid(G4String volName);
    G4ThreeVector GetUniformPositionSurface(G4String volName);
//Physics processes lookup table
    G4String * processNameArray;
//Record Primary particle information
    std::vector<primaryInfo> GetPrimaryParticle();
//Record stepping information
    void RecordStep( stepInfo stepping);
    std::vector<stepInfo> GetStepInfo();
    void DumpEventInfo();
//Set and get random seed
     G4int GetRandomSeed() {return randomSeed;};
//Mediate output recording
    void OutputRecord(G4int);
```

# Basic Structure/Function – I/O

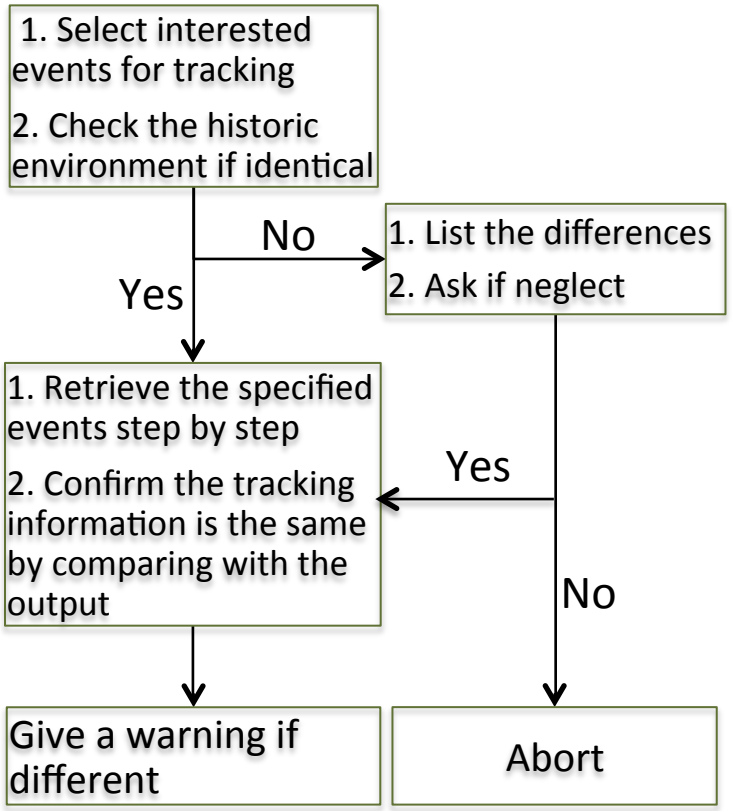
- Various example macro inputs will be developed to demonstrate different simulation purpose.
- Collect all the historic information to make the result repeatable.
- Use verbose level to control the output recording size.
- Multiple output schemes will be developed to support different needs

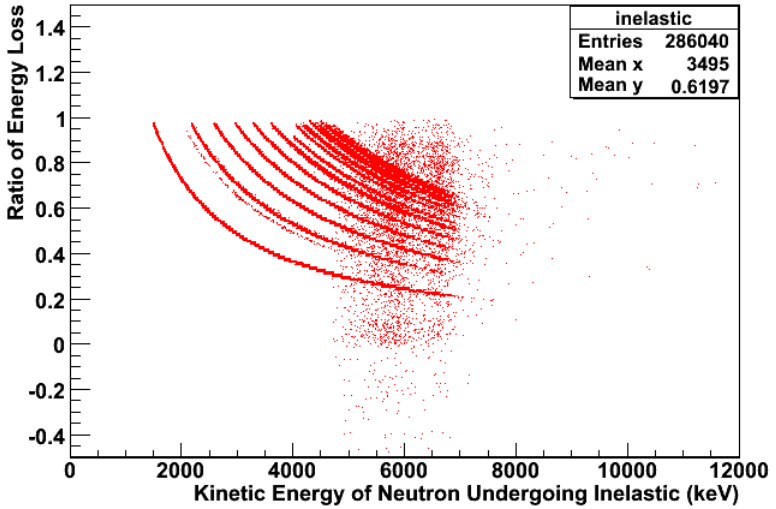
```
/control/verbose 0
/run/verbose 0
/event/verbose 0
/tracking/verbose 0
### Select physics models
#/AARM/phys/select   QGSP_BERT_HP
### useOpticalPhy is set to be false as default
#/AARM/phys/useOpticalPhys true
### This method must be included
/run/initialize
### Select geometry module
/AARM/det/select SimpleGeometry
### geometry must update once being changed
/AARM/det/update

### Set random seed for current run
/AARM/setRandomSeed 900854369
### Generate event inside/surface in specified
### geometry cell
#/AARM/source/select Rn222 Room solid
/AARM/source/select Rn222 Room surface
#/process/inactivate msc
/AARM/beamOn 1
```

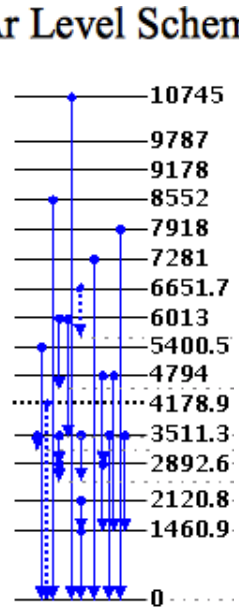


# Basic Structure/Function – Event tracking

- Retrieve interested events according to the historic information provided in output.
- Tracking the events step by step to identify the issues in the processing.




```
**********************************************************************************************
*
* G4Track Information:   Particle = neutron,   Track ID = 1,   Parent ID = 0
**********************************************************************************************
*

Step#     X      Y      Z      KineE   dEStep  StepLeng  TrakLeng   Volume     Process
   1  -13.4 cm  -11.2 cm  -5.01 cm   4.98 MeV    0 eV     0 fm   18.2 cm     Absorber   initStep
   2  -47.9 cm  -35.8 cm  -2.67 mm     0 eV      0 eV   42.7 cm   60.8 cm     Absorber  NeutronInelastic
   :----- List of 2ndaries - #SpawnInStep=  2(Rest= 0,Along= 0,Post= 2), #SpawnTotal=  2 ----------
   :  -47.9 cm  -35.8 cm  -2.67 mm   9.36 MeV   neutron
   :  -47.9 cm  -35.8 cm  -2.67 mm    631 keV Ar40[0.0]
   :---------------------------------------------------------- EndOf2ndaries Info ----------
```

# Package Status

- Package takes Geant4.9.4 as its working base.
- The basic structures are finished and initialized to SVN repository(http://svn.csci.usd.edu/AARM).
- The framework are divided to several sub-systems for job taking(more manpower needed):
  - Management & physics – Chao(USD)
  - Input/Output – Oleg(USD)
  - SVN administration – Doug(USD)
  - Geometry & materials – Anthony(UMN)
  - Generator - ?
  - Tracking & visualization - ?

# Future Plans

- From now on → the end of this year
  - The primary simulation package will be formed and released for using.
  - Focus then will shift to low energy physics issues.
- 2012 → 2015
  - Physics and database checking will be performed element by element.
  - Validation, bug report/fix.