Geant4 Simulation

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Geant4 (Geometry and tracking)

- CERN collaboration initially focused on high energy physics (Geant3).
- C++, OO, ~1 million lines of code.
- Composition and rejection Monte Carlo methods.
- Transportation approach.

Building the simulation

- Select physics models and data to be used.

- Design the geometry and composition of the detectors/target.

- Set the particle type and energy.

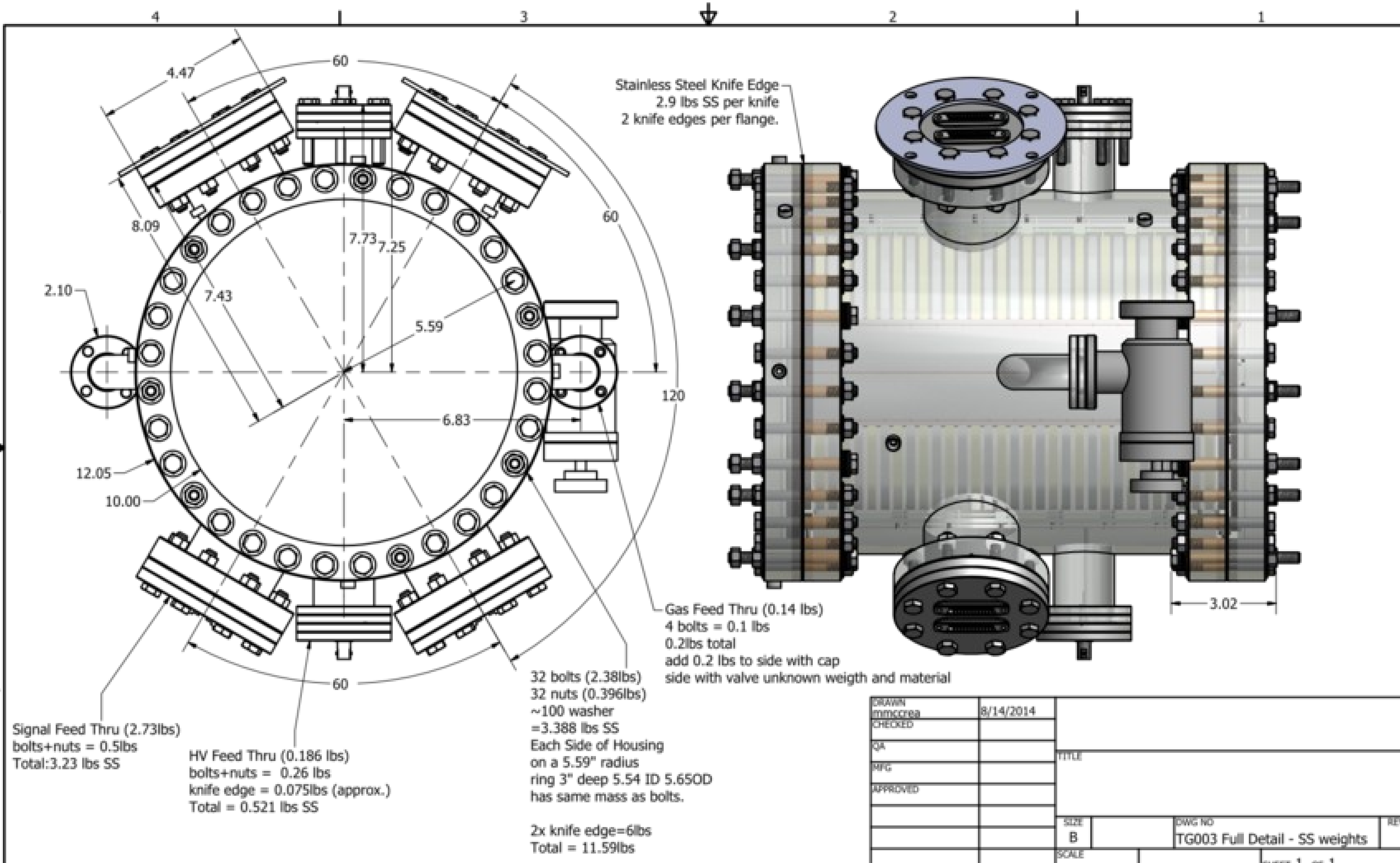
Physics Lists

- Select ideal physics lists for transport of low energy neutrons.
  - EM physics.
  - Decays.
  - Hadron physics.
  - Electron physics.

- All processes are based on theoretical models and evaluated data (ENDF/B-VI, SAID, EEDL).

Geometries and Materials

- Internal DB of materials built from NIST database of elements and isotope compositions.
- Geometries defined manually or by GDML.



DRAWN mmccrea	8/14/2014	
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QA		TITLE
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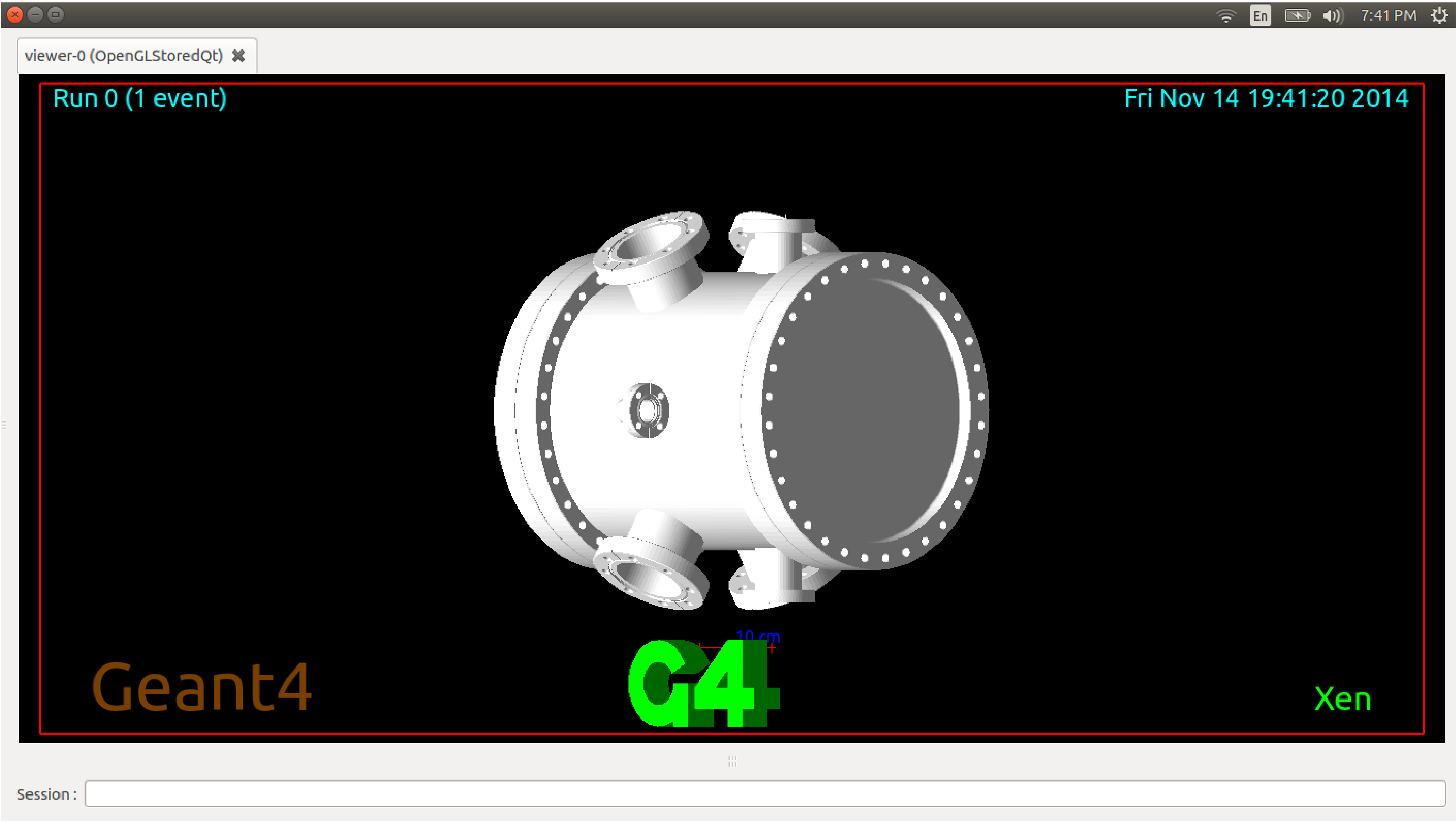
SIZE	DWG NO	REV
B	TG003 Full Detail - SS weights	

SCALE		SHEET 1 OF 1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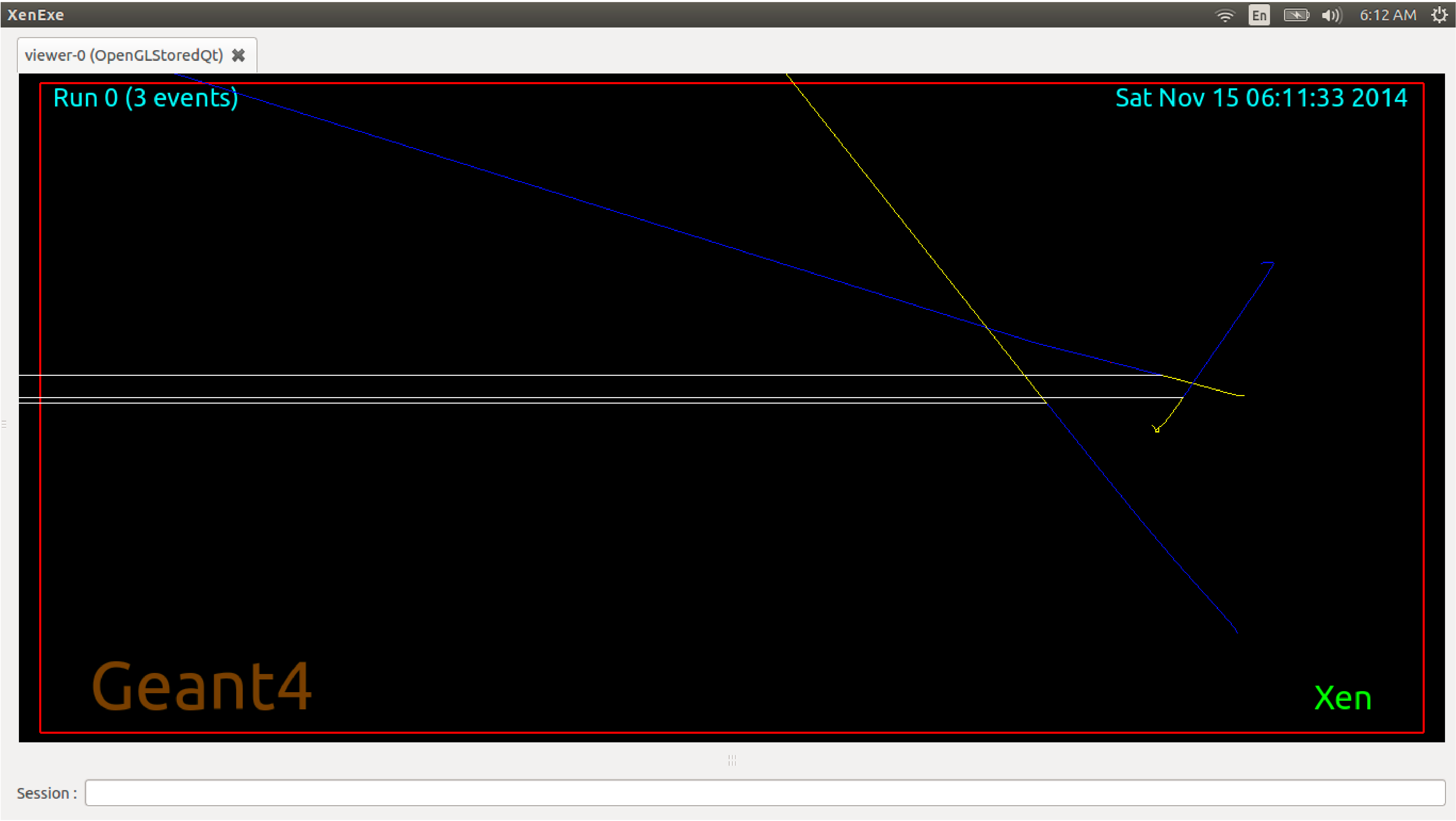
En
viewer-0 (OpenGLStoredQt)
Run 0 (1 event)
Fri Nov 14 19:41:20 2014
10 cm
Geant4
G4
Xen
Session :

Geant4 Structure

- Run
  - Event #1
    - Track #1
      - Step #1
      - Step #2
  - Event #2
    - Track #1

Steps defined by the physics process, geometric boundaries, cut offs.


XenExe
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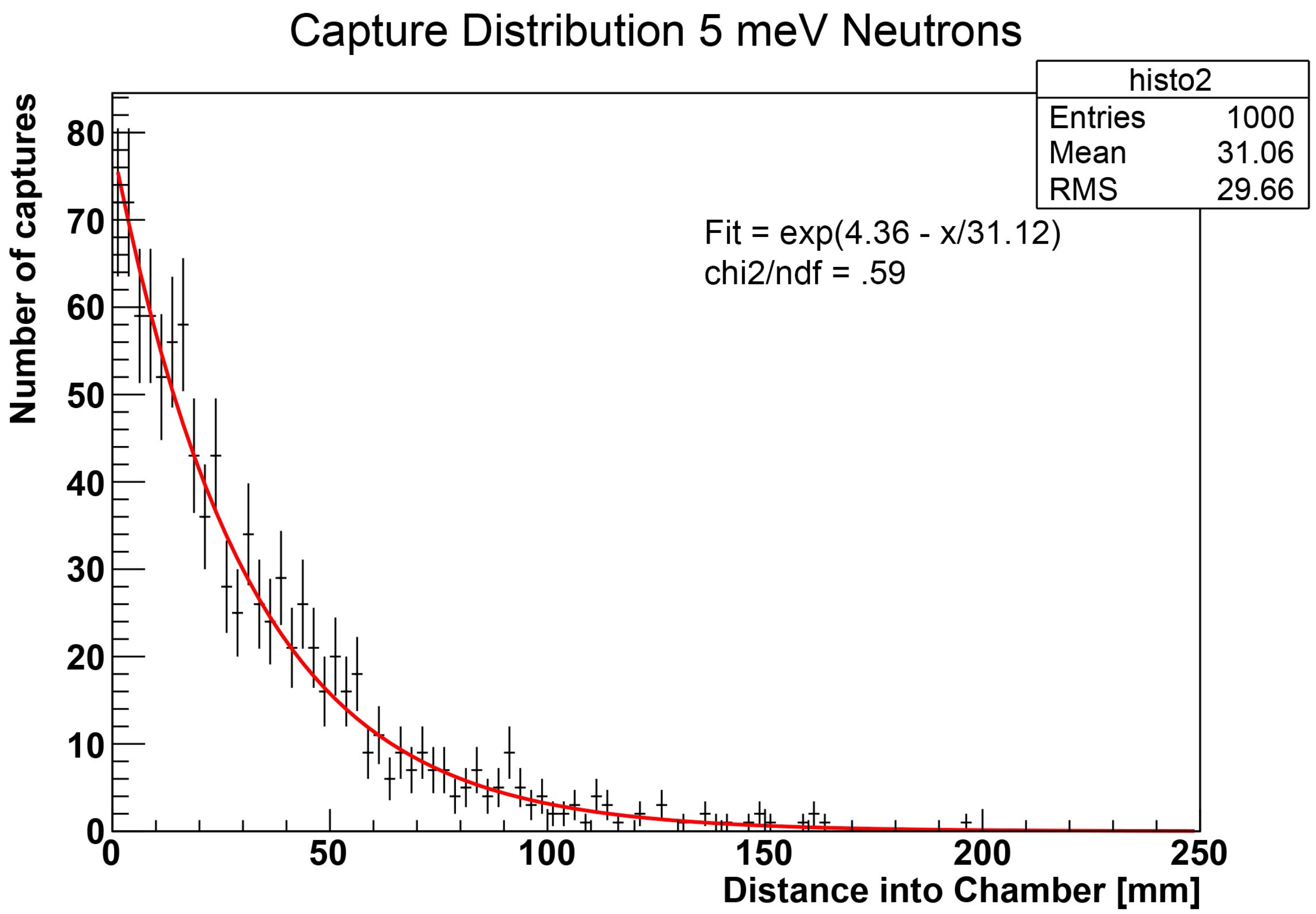
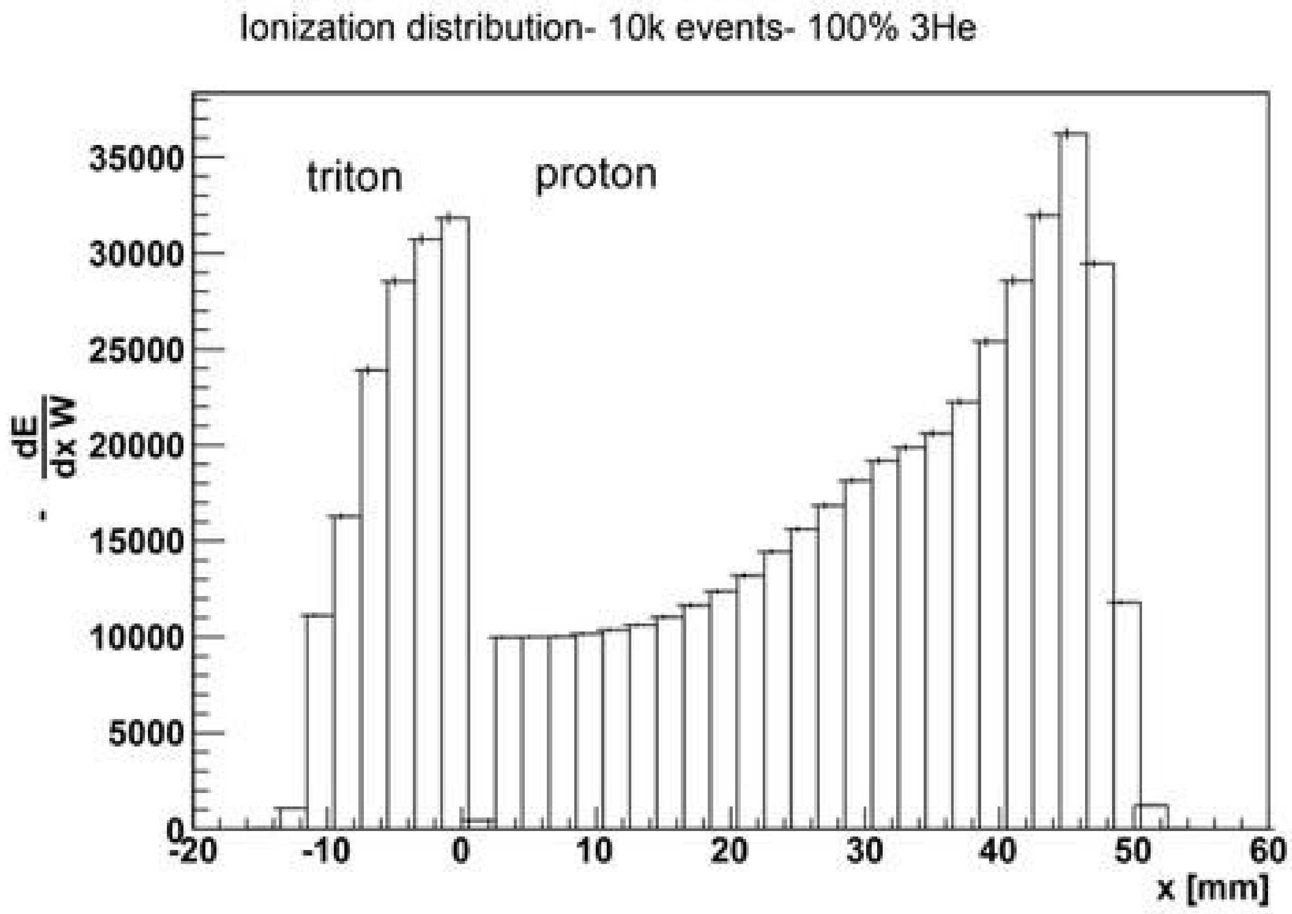
Geant4
Xen
Session :

Capture Distribution



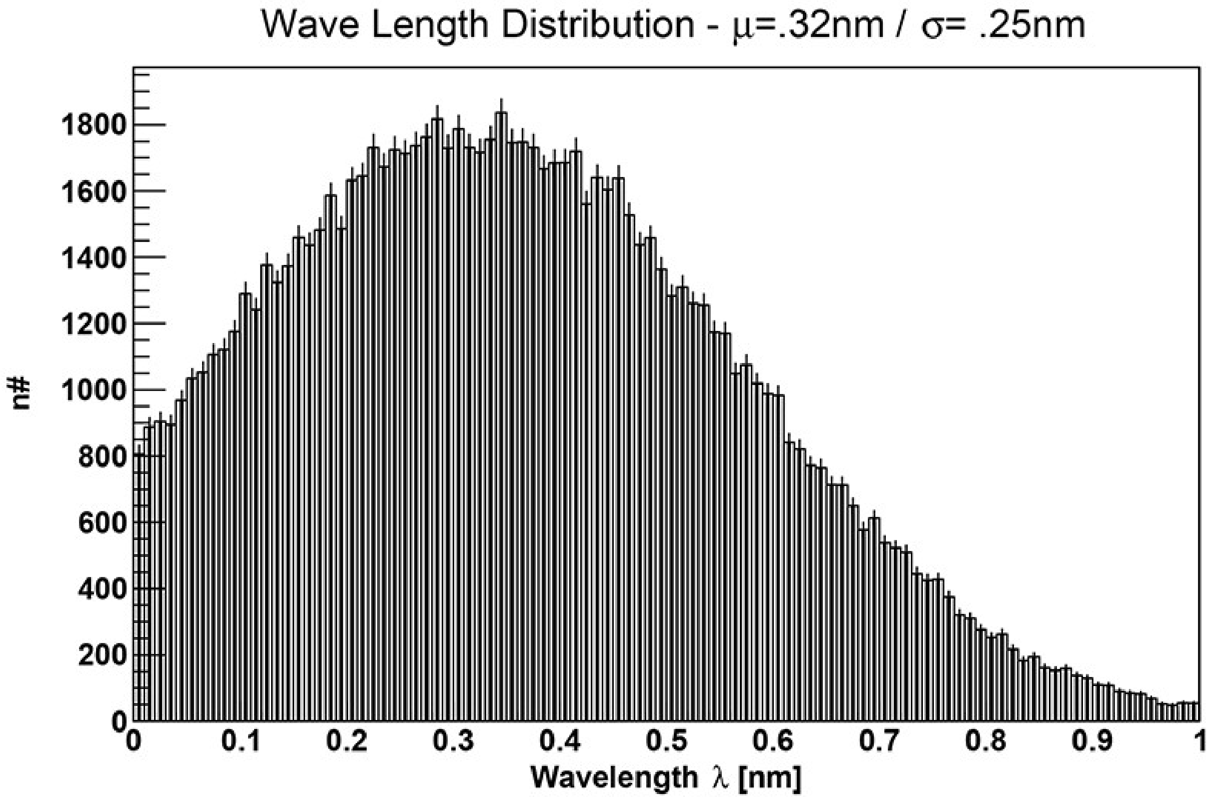
10% Nitrogen, 90% 3He

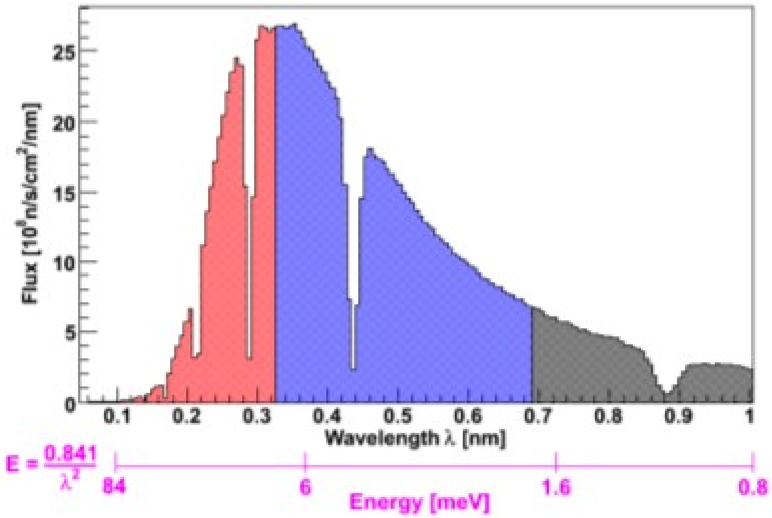
Ionization distribution

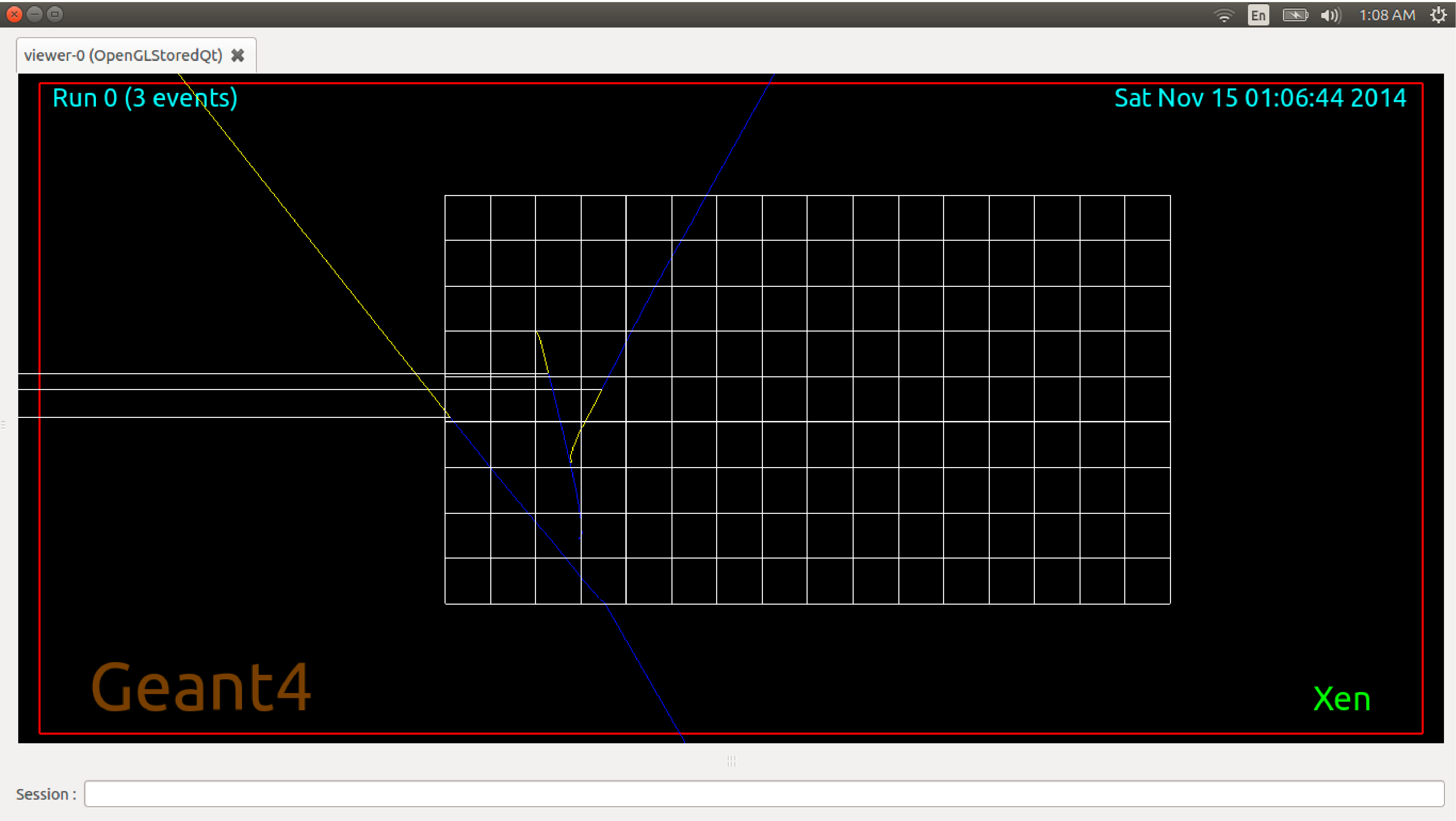


Pair production as a function of range.

Wavelength distribution



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Geant4
Xen
Session :

Geometric Factor

Define the total energy deposited $E_T \equiv E_T(\theta, z)$

and the energy deposited per event k,

$f_k \equiv f_k(\theta, z, E_n)$

Then the expectation value of the total energy is $\langle E_T \rangle = \langle \sum_k f_k \rangle$

And the observed yield with helicity h

$$Y^h = \langle E_T (1 + h\alpha_{ph} cos\theta) \rangle$$

Geometric Factor

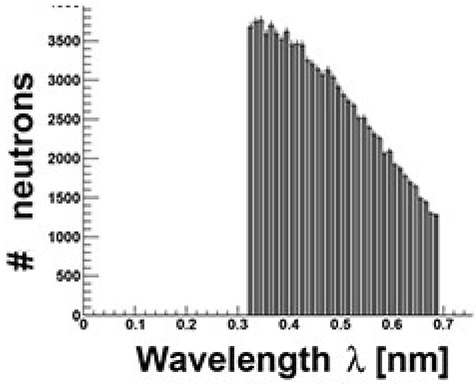
Then using the relation $$\frac{Y^+ - Y^-}{Y^+ + Y^-} = \alpha_{ph} \langle \frac{E_T \cos\theta}{E_T} \rangle$$

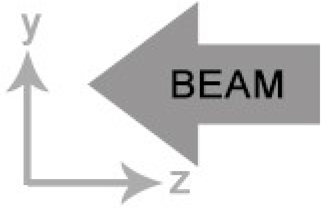
we find an expression for the physics asymmetry.

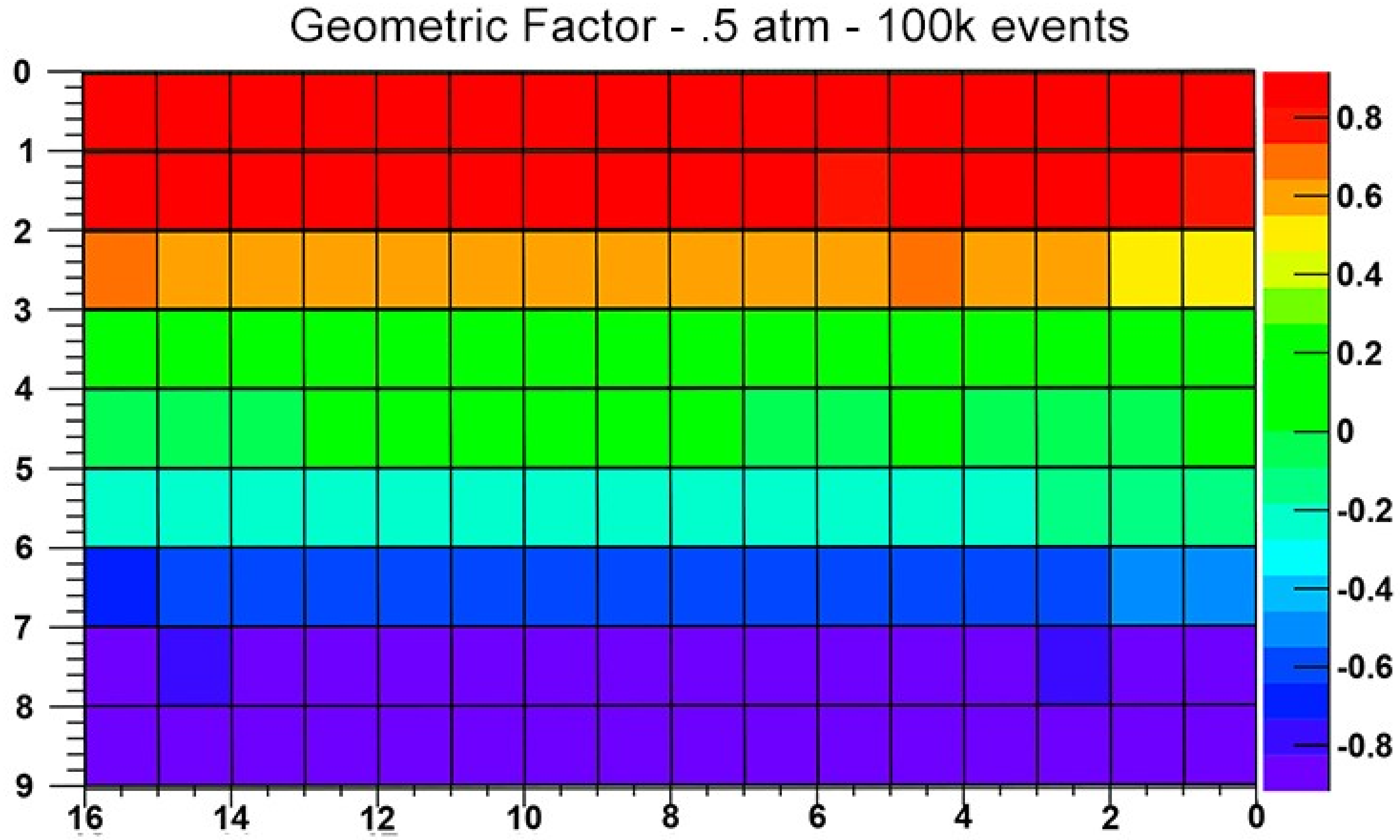
And defining the Geometric Factor for the cell ij as

$$G^{ij} = \langle \frac{E_T^{ij} \cos\theta}{E_T^{ij}} \rangle = \frac{\sum_k f_k^{ij} \cos\theta}{\sum_k f_k^{ij}}$$

Geometric Factor







Next tasks

- Divide the events in time bins.
- Calculate background contribution to the signal.
- Calculate uncertainty.
- Update the beam profile.
- Interface to Garfield for simulation of charge collection.

Asymmetry

Finally, the experimental asymmetry in the cell ij is given by

$$A_{\exp}^{ij} = \alpha_{ph}^{ij} G^{ij}$$