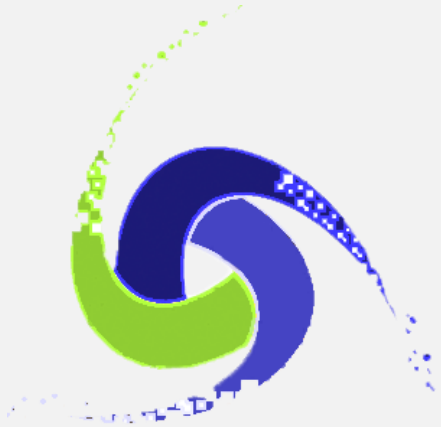


Development Of Testing Suite For Event Biasing

Kyungseop Yoon

EP-SFT

CERN Summer Student Session

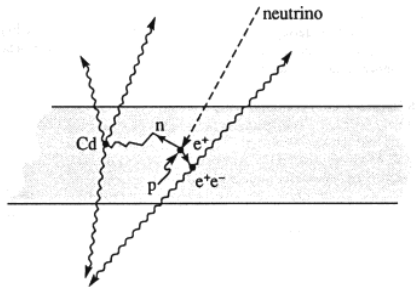
06 August, 2019

About Myself

Kyungseop Yoon (Kevin)

- **Citizenship: South Korea**
- **Education:**
  - **University of California, Irvine**
  - **Physics, Bachelor of Science**
- **CERN Summer Studentship:**
  - **EP-SFT**
  - **Next step: apply to PhD programs in the U.S.**
  - **Literally cherishing every part & moment of it :)**

~~... except the lack of A/C in some rooms and buildings~~

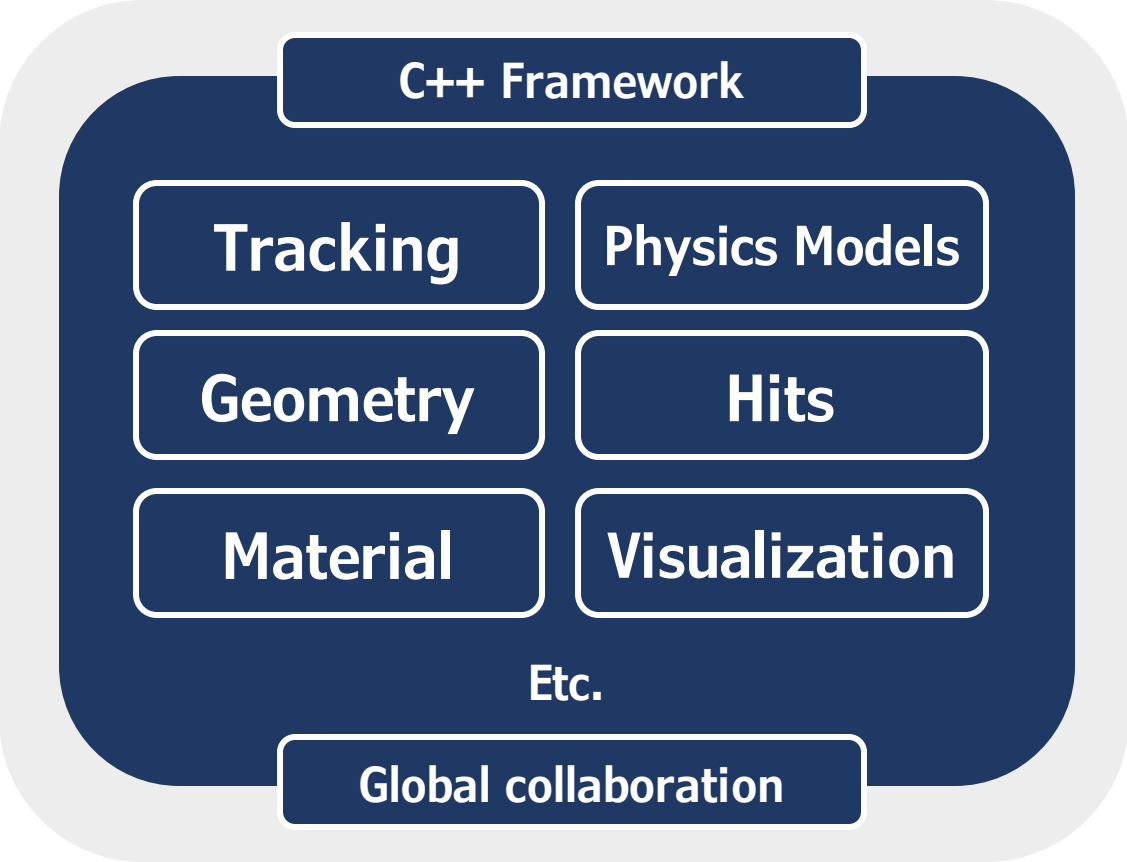


[1995 Nobel Prize]

https://geant4.web.cern.ch/

What is GEANT4?

"Software toolkit for the
simulation of the passage of particles through matter"



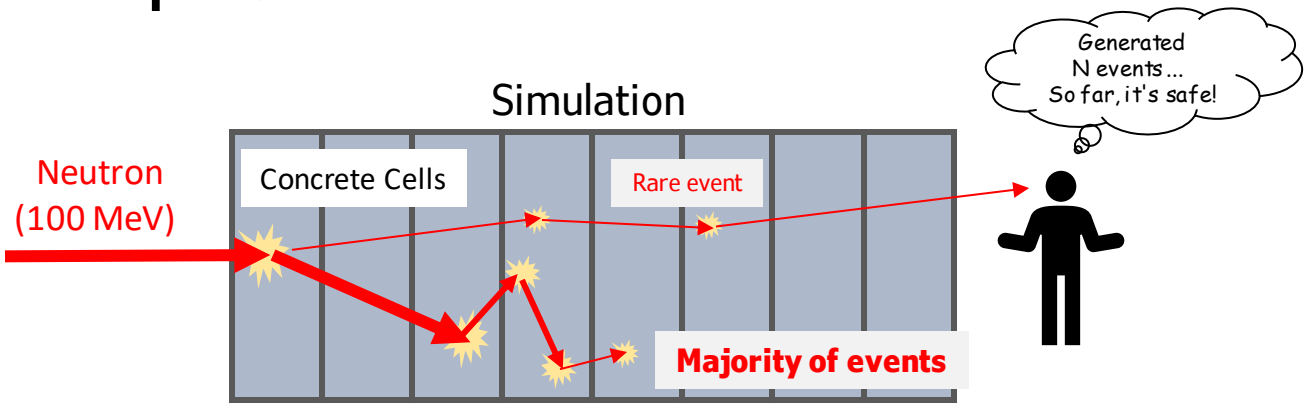
Application

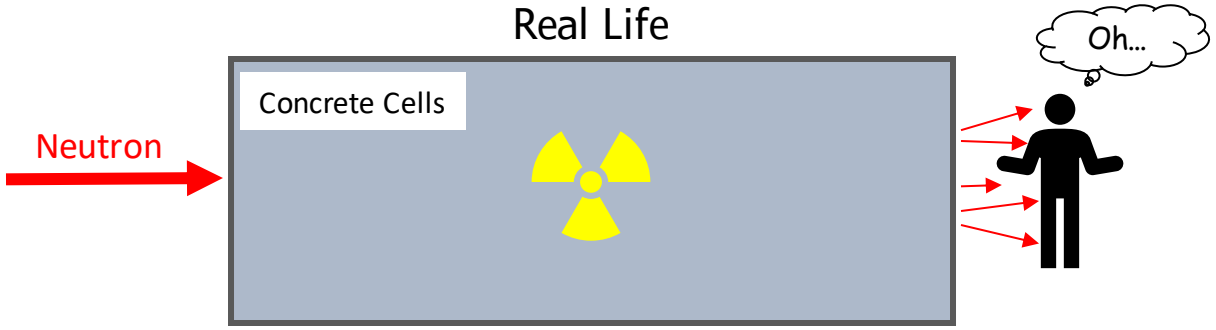
- HEP Experiments
  Why do we need simulations?
- Medical Physics
- Radiation Protection
- Astrophysics
- Space Engineering

Event Biasing

Algorithms to simulate rare events accurately and efficiently

Example simulation of a "rare event"

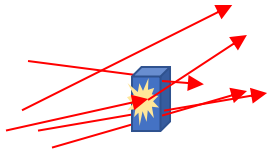




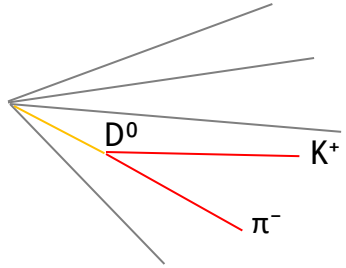
Other Examples

- D^0 -> K + π (@ LHCb)
- Forced interactions in thin detectors
- Neutrino interactions

- Cosmic rays in astrophysics
- Low energy neutrons
  CPU-draining (@ CMS)



Forced interactions

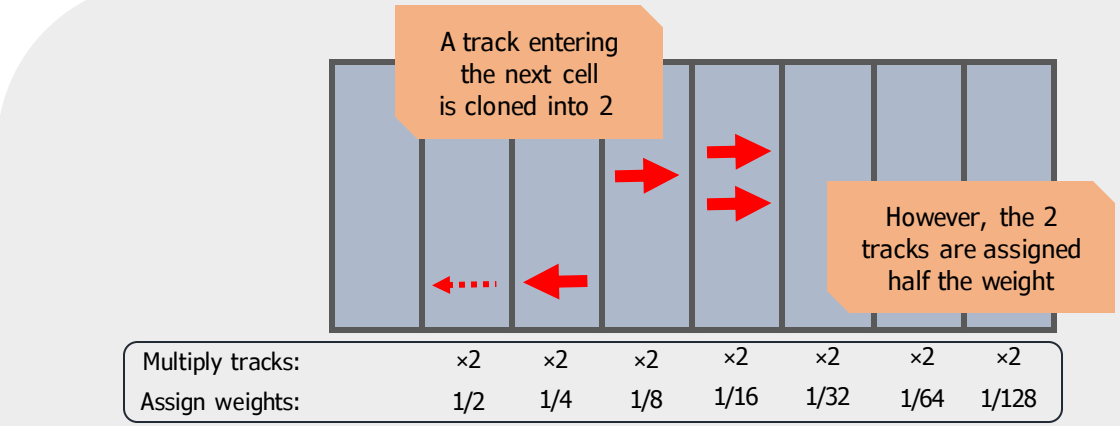


D^0 -> K + π

Without event biasing, you need to simulate LOTS of events to get a good result.

Event Biasing: Cloning/Killing

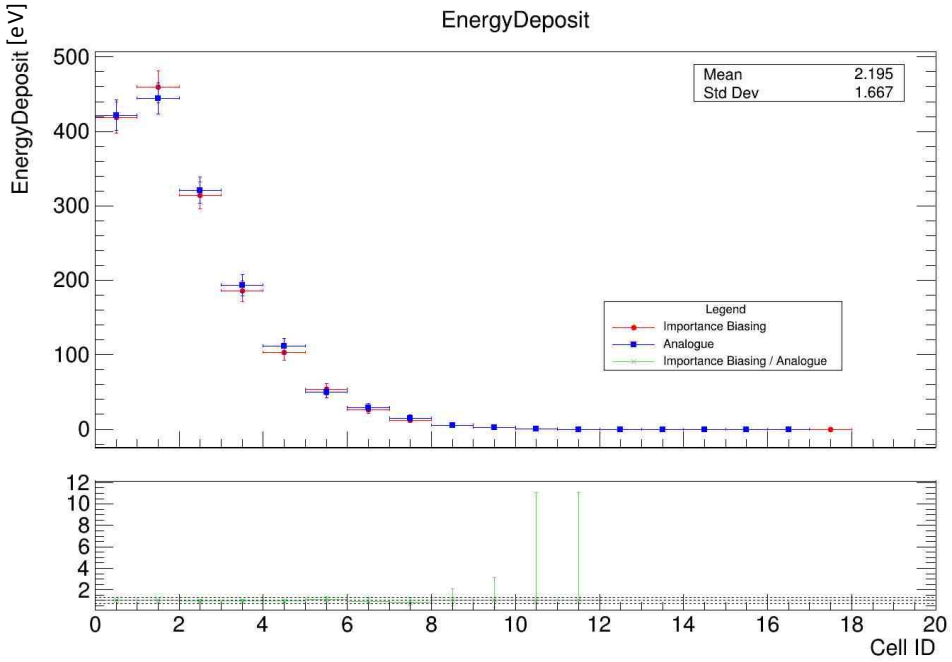
A simple example of a biasing technique



The probability of interaction increases,
but the total outcome is preserved.

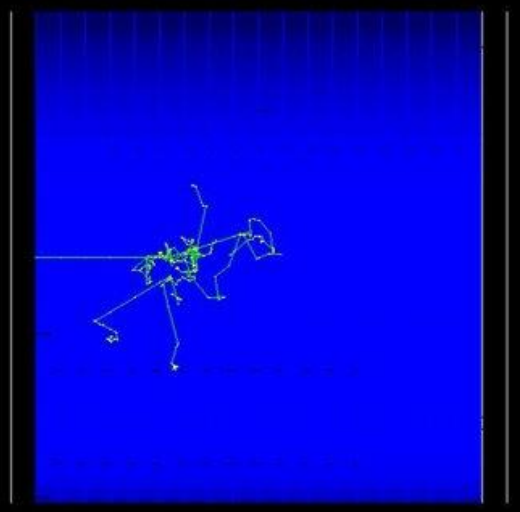
Generate less events to get the same results!

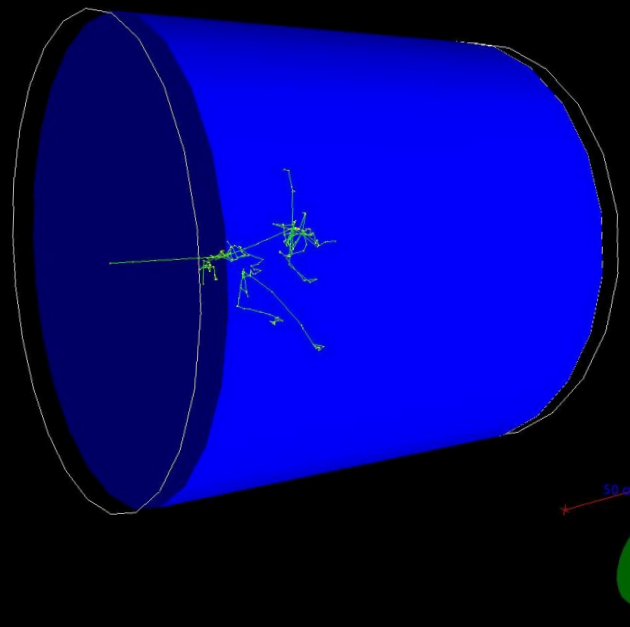
(Probability of interaction) ∝ (# of tracks)
tally = (# of tracks) × (weight)



**For large number of events,
the results of biasing and non-biasing simulations
should be almost identical to each another.**

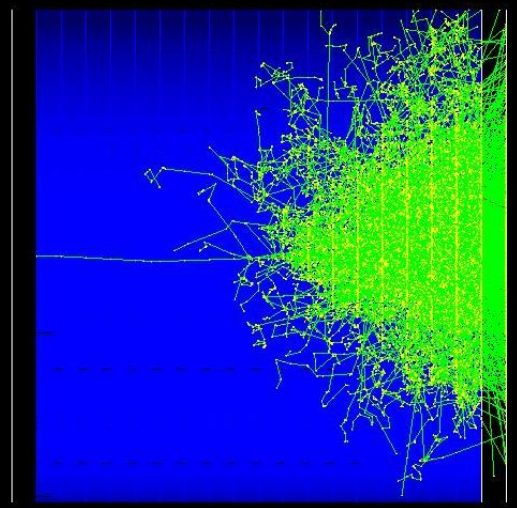
No Biasing (1 event)

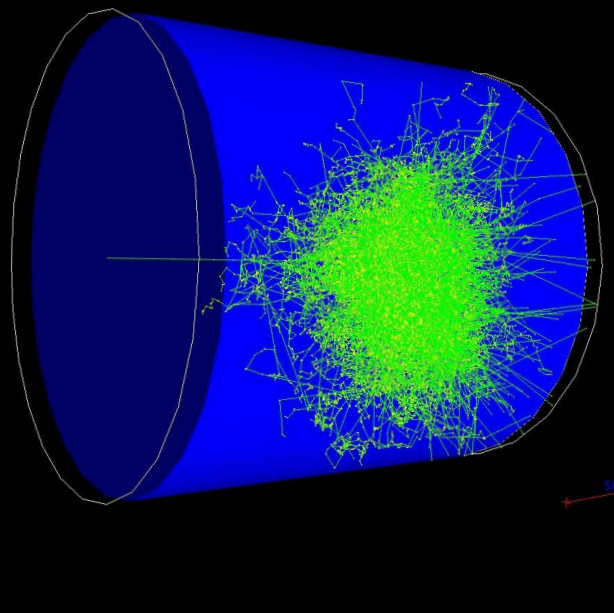




Neutron, 100 MeV
Concrete Cylinder
(18 cells)

Biasing (1 event)

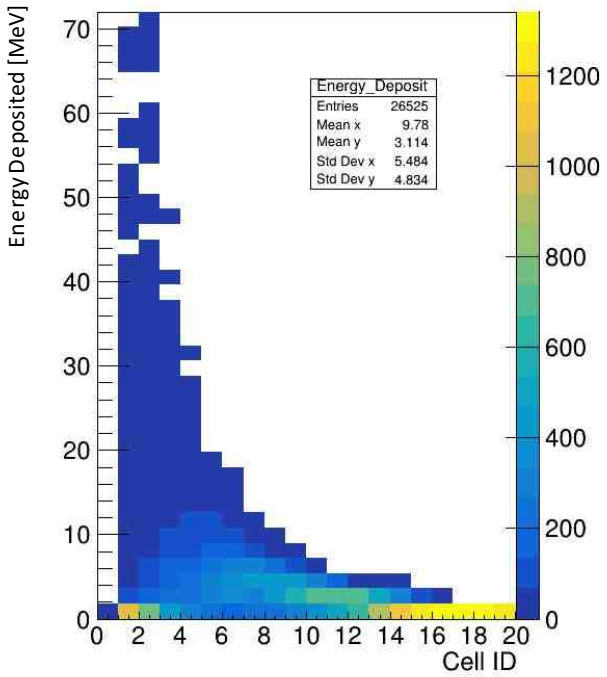




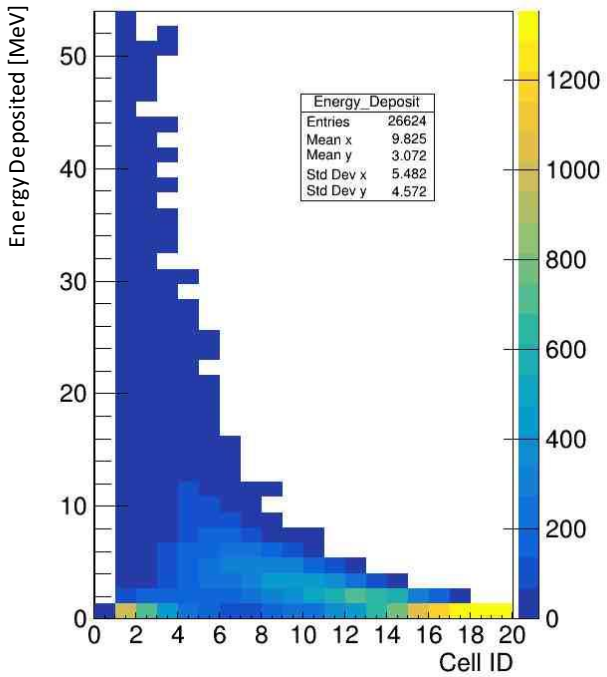
Assigned weights: 1 ½ ¼ … … ½^17

Area of Need: Visual Comparison Tool

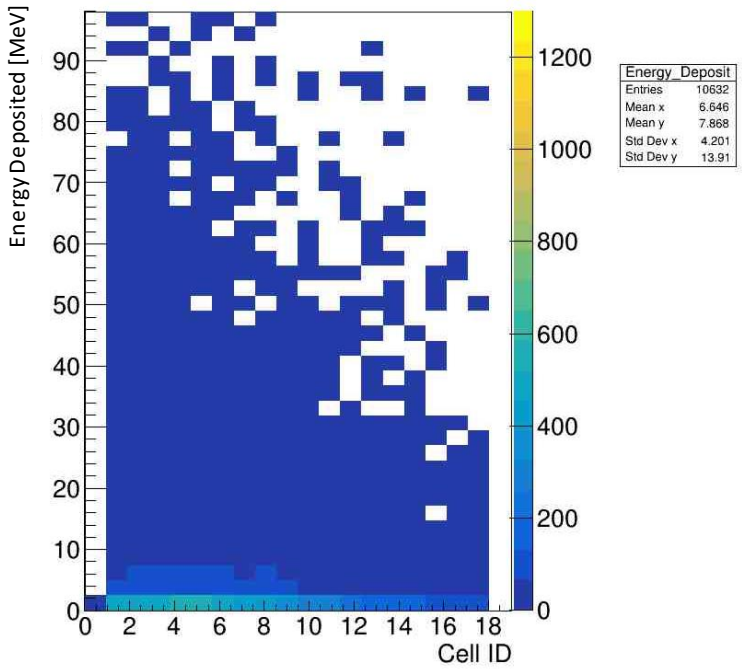
Example: Energy deposited per cell
(1500 events / method)



Importance Biasing



Weighted Window



Analog

Area of Need: Visual Comparison Tool

Event Biasing ToolKit used for development, debugging, validation, and users.

Extended Functionality

Plan for next 3 weeks :)

EVENT BIASING TOOLKIT

- Distance between 2 interactions of same type
- Population of particles in the detector
- Number of created secondaries
- Weight change
- Histograms in weighted vs. unweighted versions

Conclusion

- Event biasing techniques are used to achieve better effienciency in simulating rare events.
- In Geant4, event biasing options exist but need validation & comparison tools.
- In my remaining weeks, I will develop a generic toolkit for developers and users.