

# Status Report for Light Dark Matter Search at DUNE ND

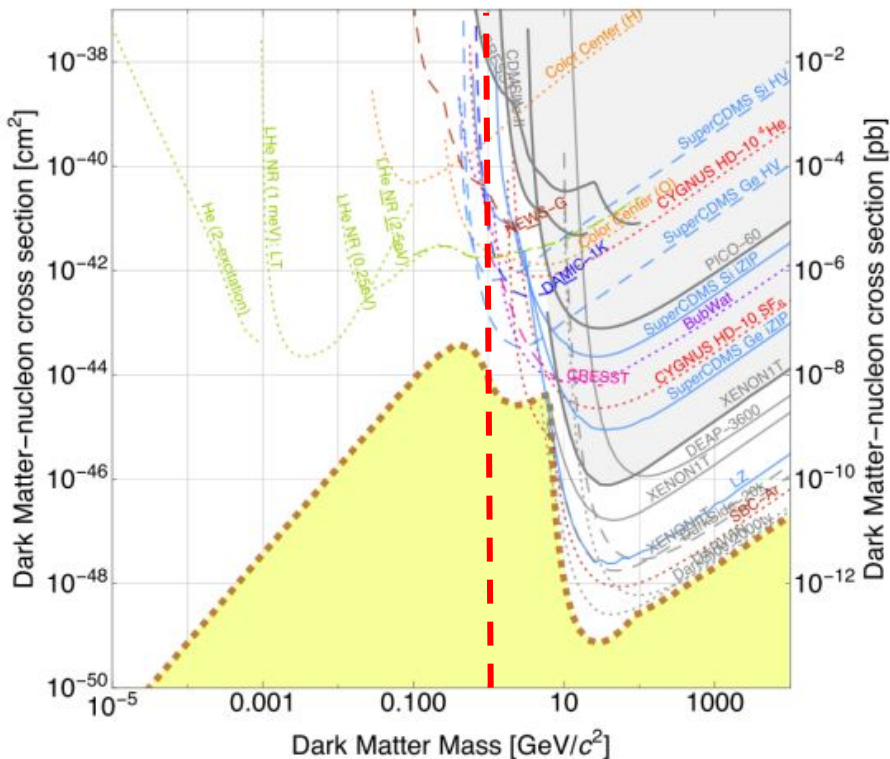
Beam BSM WG meeting  
10/15/2024

Wooyoung Jang  
University of Texas at Arlington



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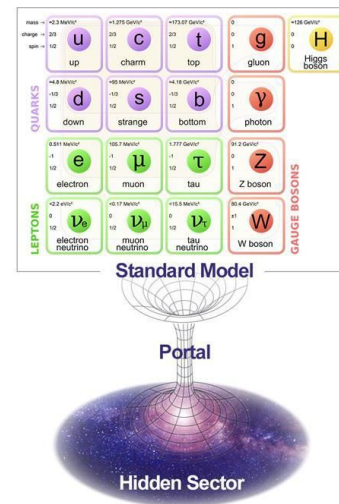
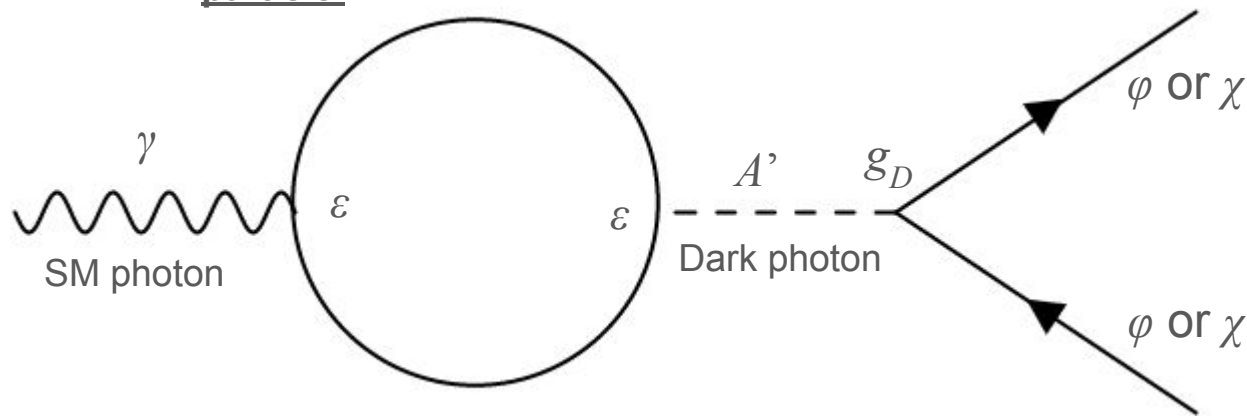
# Physics Motivation of sub-GeV Dark Sector Search at DUNE



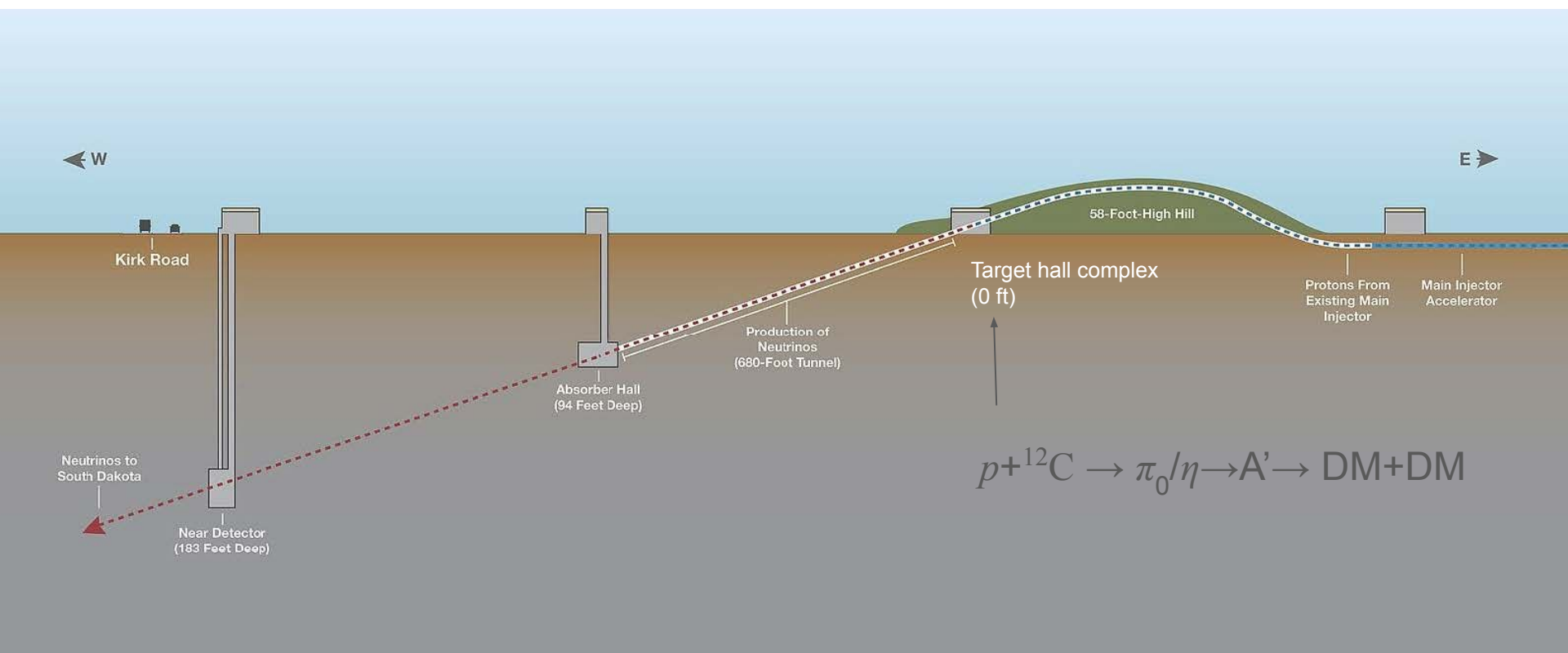
- Exclusion plot of WIMP direct searches shows an inaccessible region in terms of mass below sub-GeV region.
- Experimentally, this limit originated from detection threshold limit of DM-nucleon scattering in LXe detectors.
- Theoretically, the WIMP scenario imposes a limit of around 2 GeV by resulting in an absurd relic abundance of dark matter when the mass of dark matter goes below 2 GeV.

# Light Dark Matter Scenario

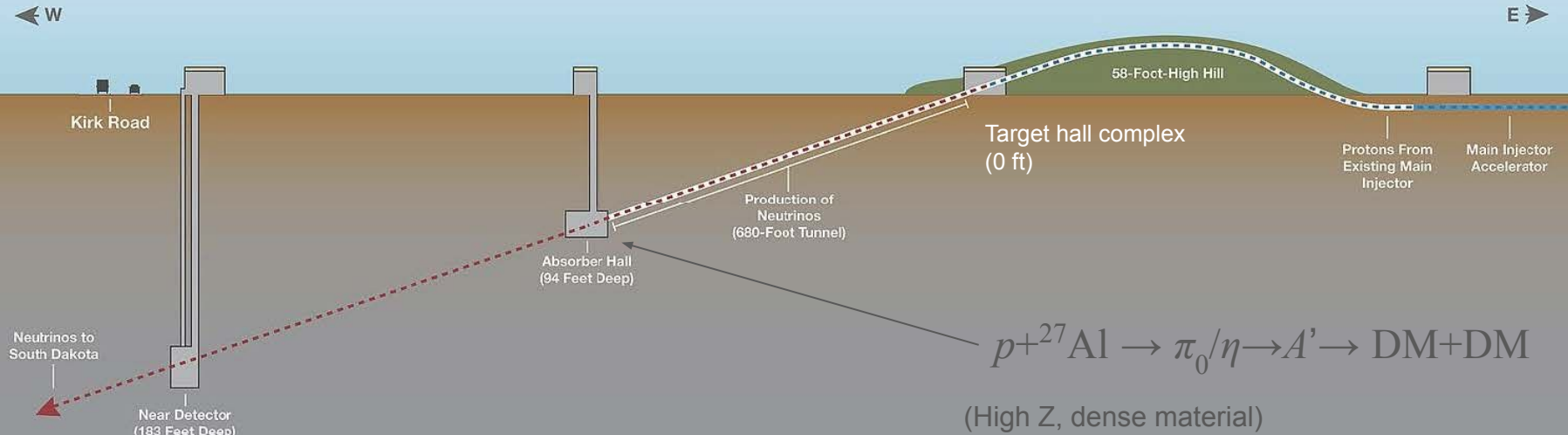
- How do we go beyond the WIMP paradigm?
  - Introduce a new U(1) gauge symmetry and corresponding gauge boson called ‘dark photon’.
  - We call the new interaction between Standard Model (SM) photon and dark photon as ‘portal interaction’.
  - We can detect this DM by observing recoiled particles in ND by invisible particle.



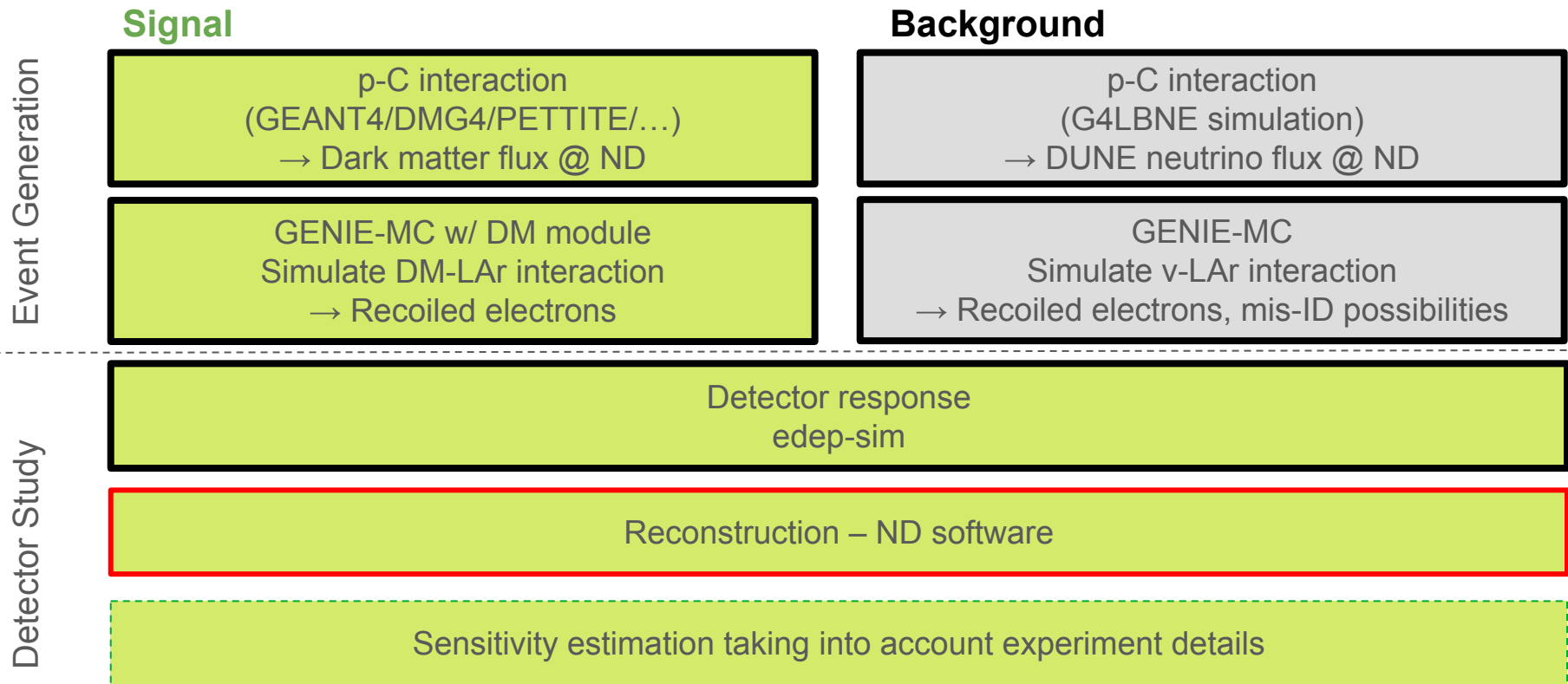
# Light Dark Matter Production / Detection Scenario (Target Mode)



# Light Dark Matter Production / Detection Scenario (Dump Mode)

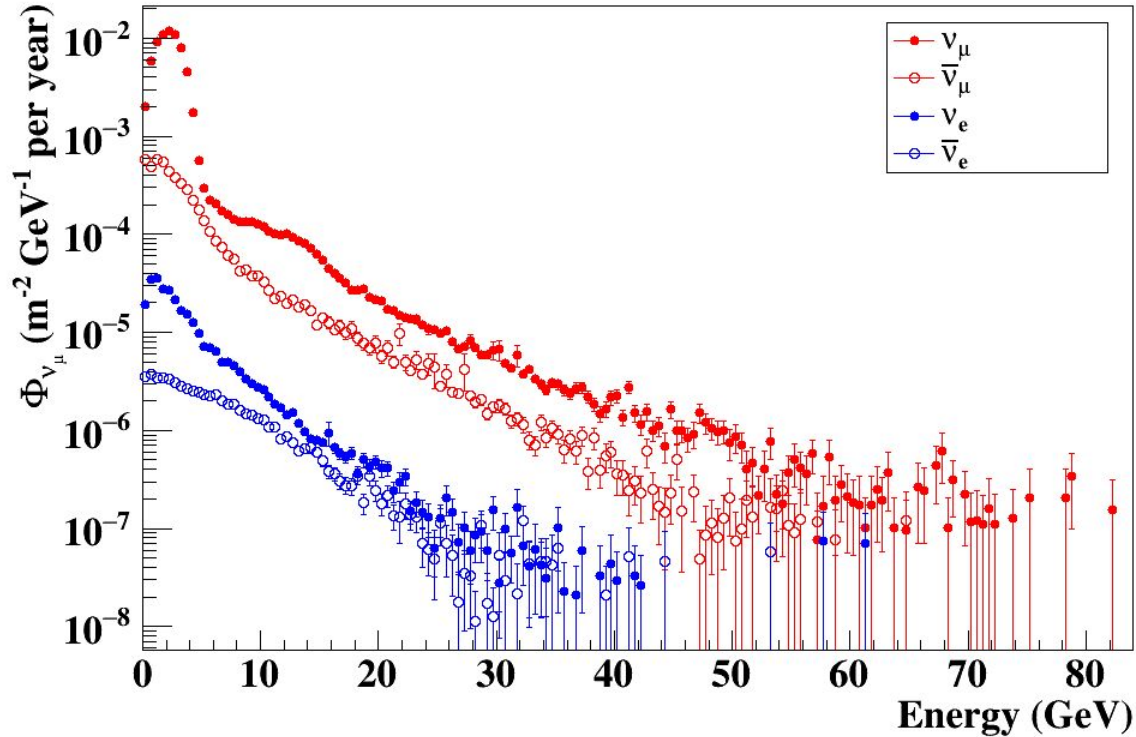


# Simulation Work-flow



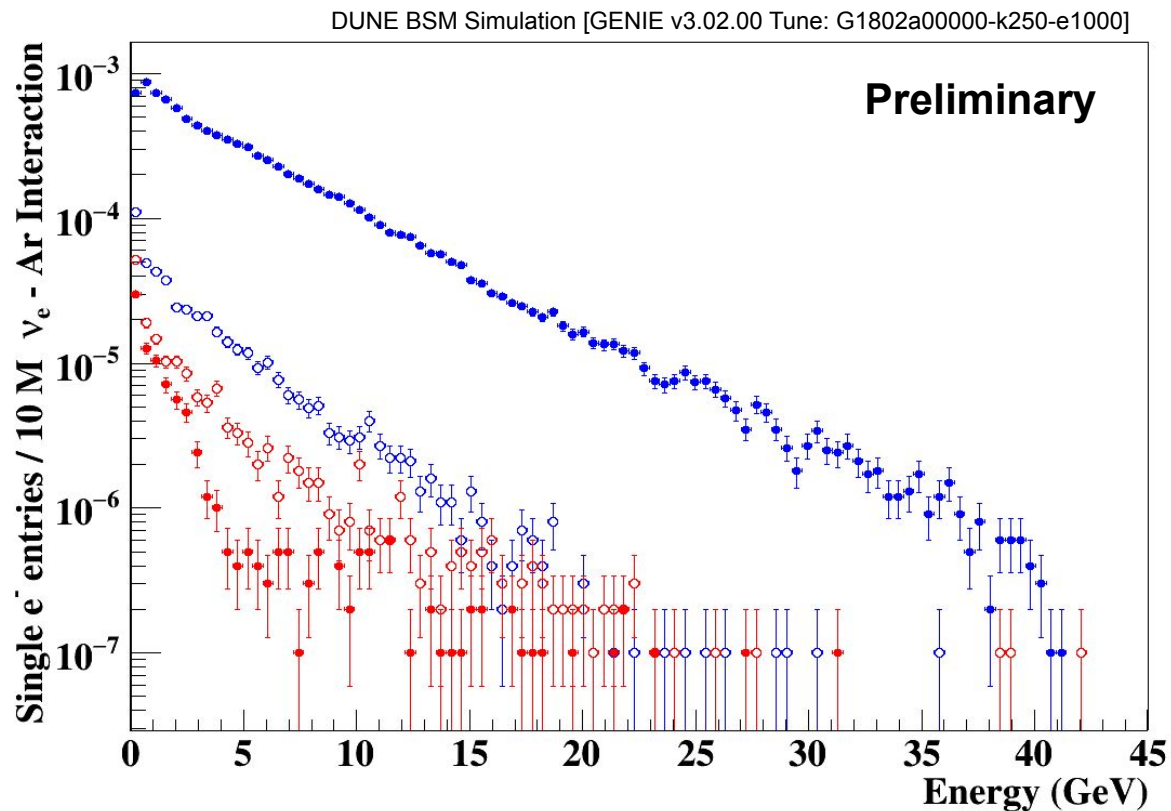
# Background Simulation (GENIE-MC) – Input Flux

g4lbne\_ntuple/pnfs/dune/persistent/users/ljf26/fluxfiles/g4lbne/v3r5p6/QGSP\_BERT/OptEngNov2017\_150cmTargetCone\_NoMod2/neutrino/flux



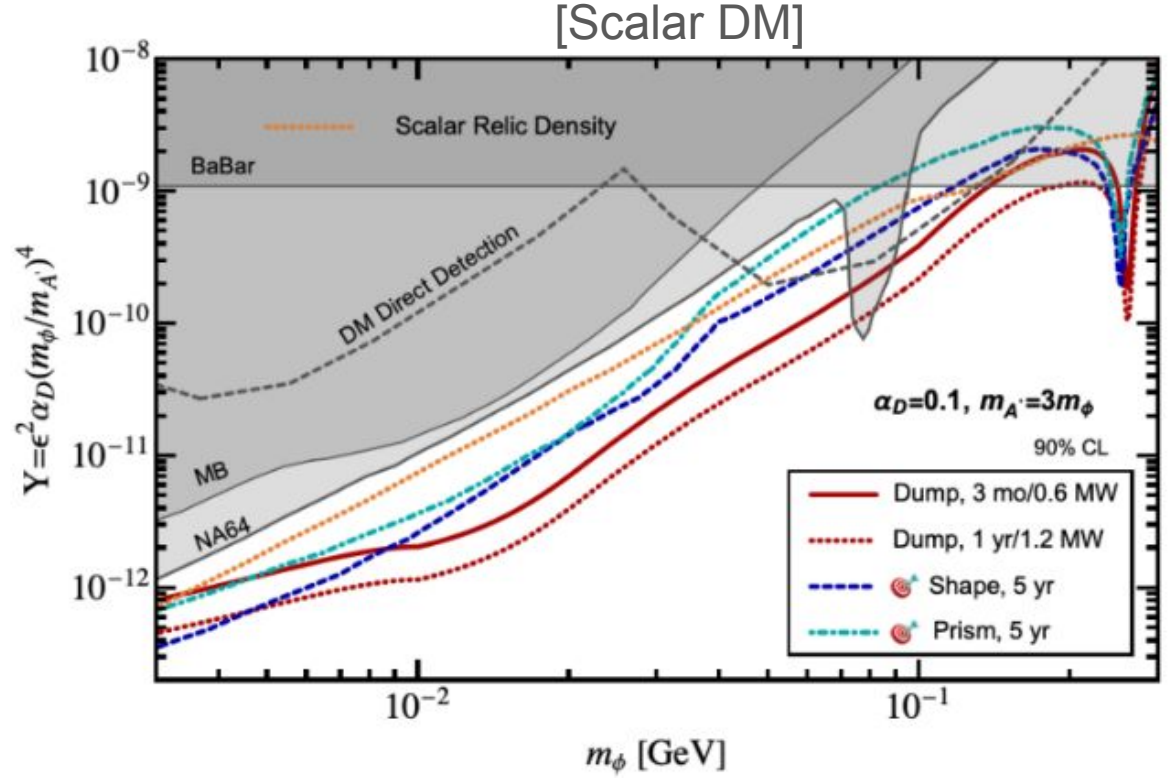
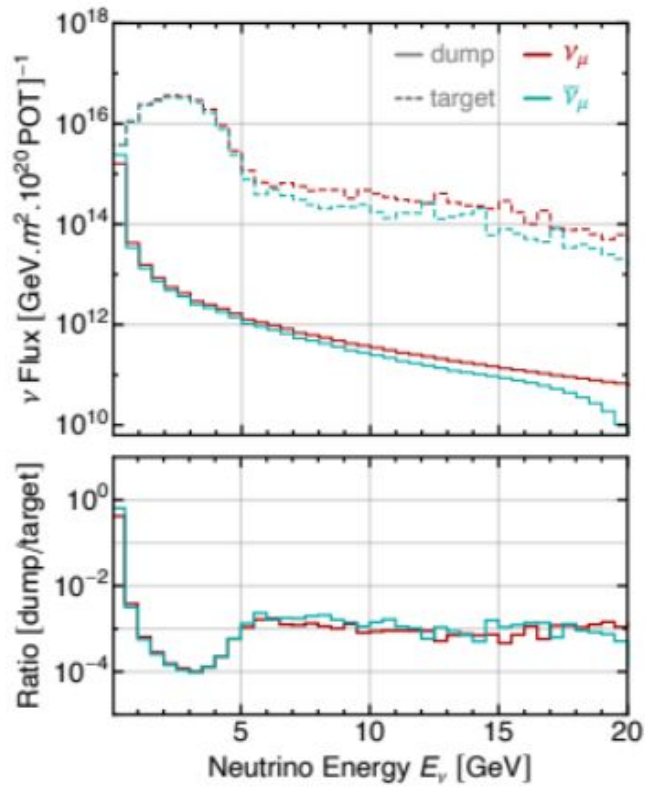
GENIE v3.02.00 Tune: G1802a00000-k250-e1000

# Recoiled Electron Spectrum



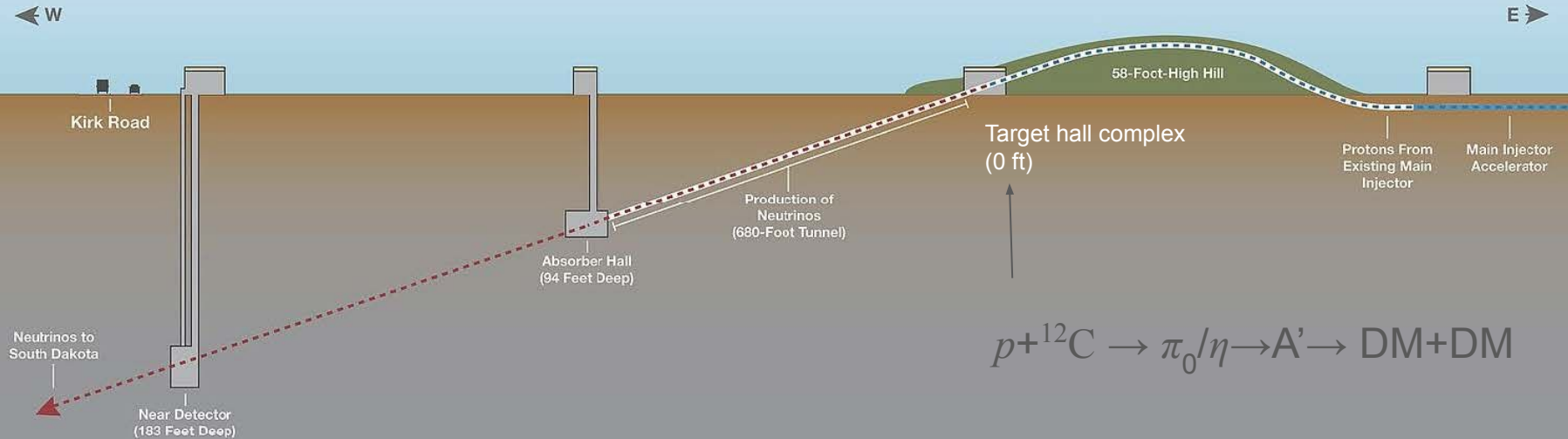


# Expected Sensitivities from Pheno. Studies

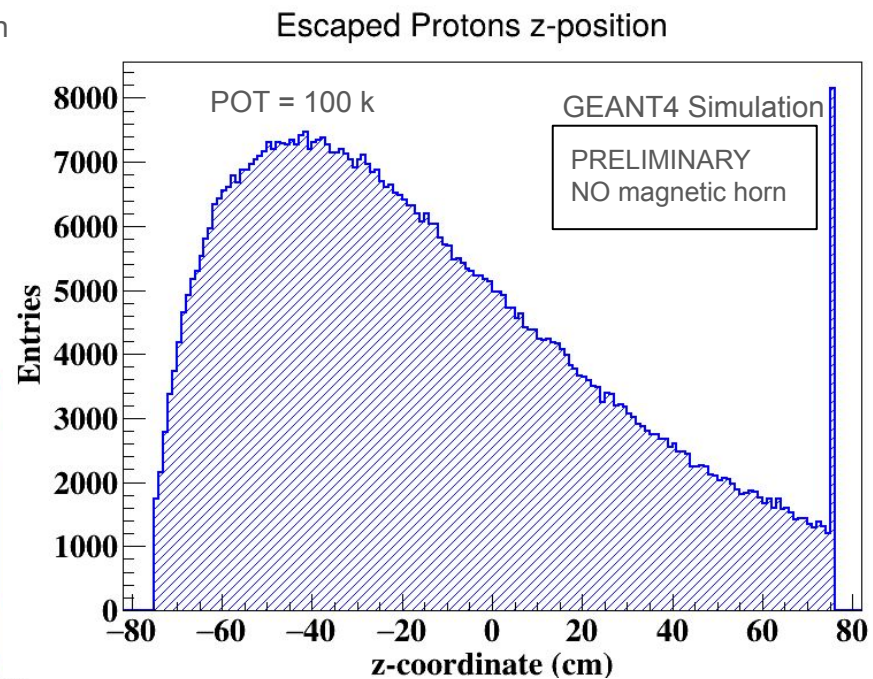
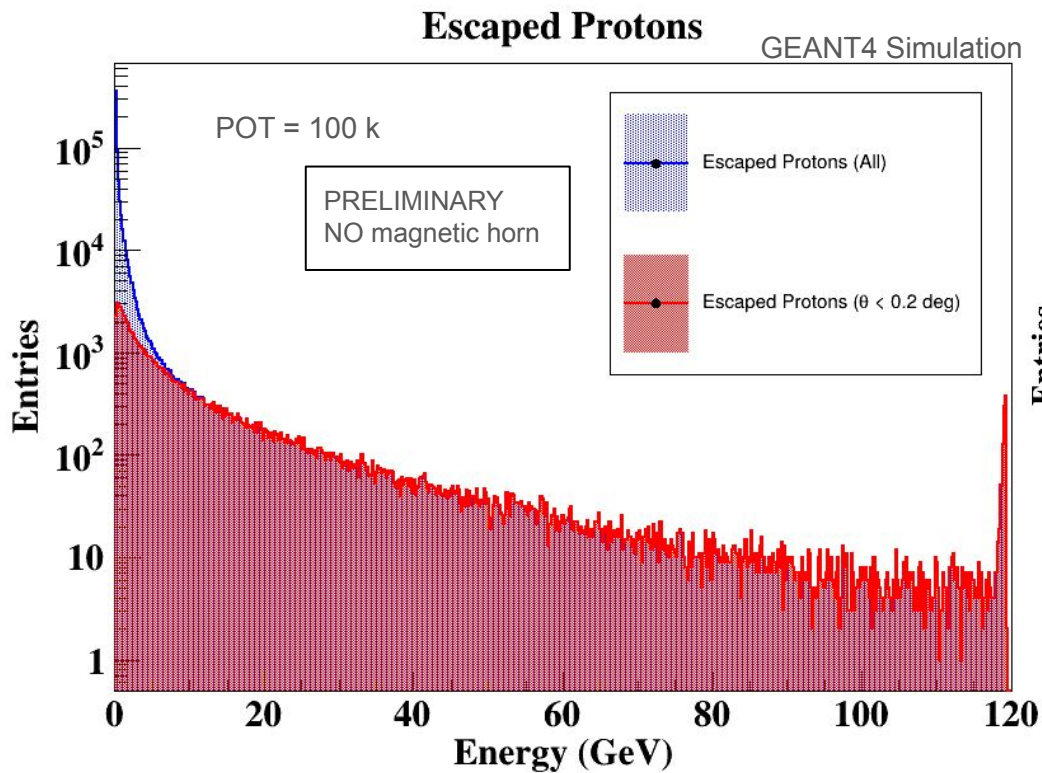


Target mode & PRISM study from [PRD 100, 095010](#)  
 Dump mode study from [PRD 107, 055043](#)

# Light Dark Matter Production / Detection Scenario (Target Mode)

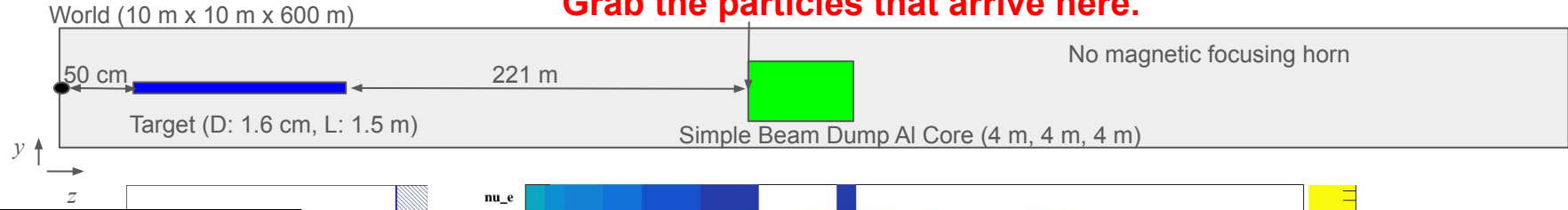


# Escaped Protons (PRELIMINARY)

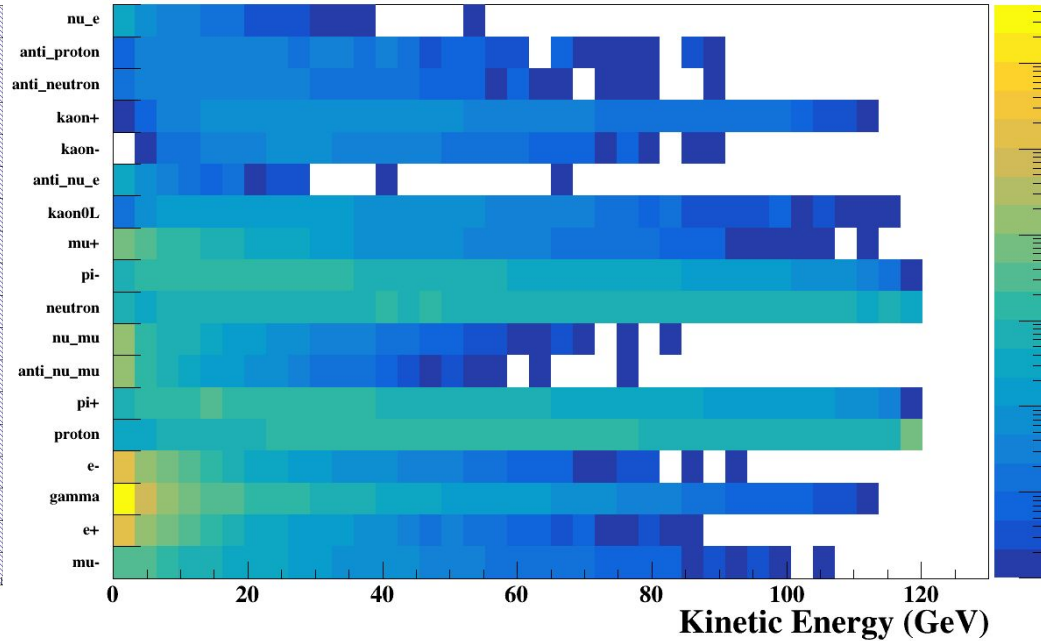
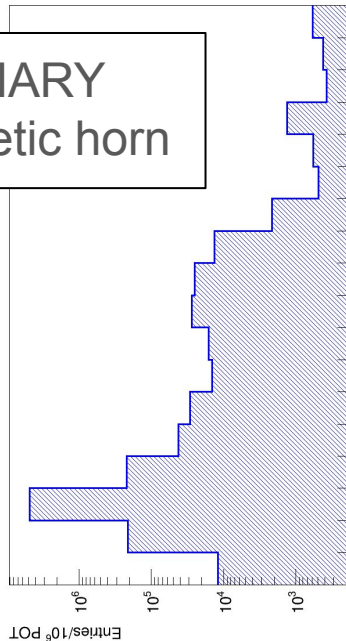


# Particles Entering into the Dump

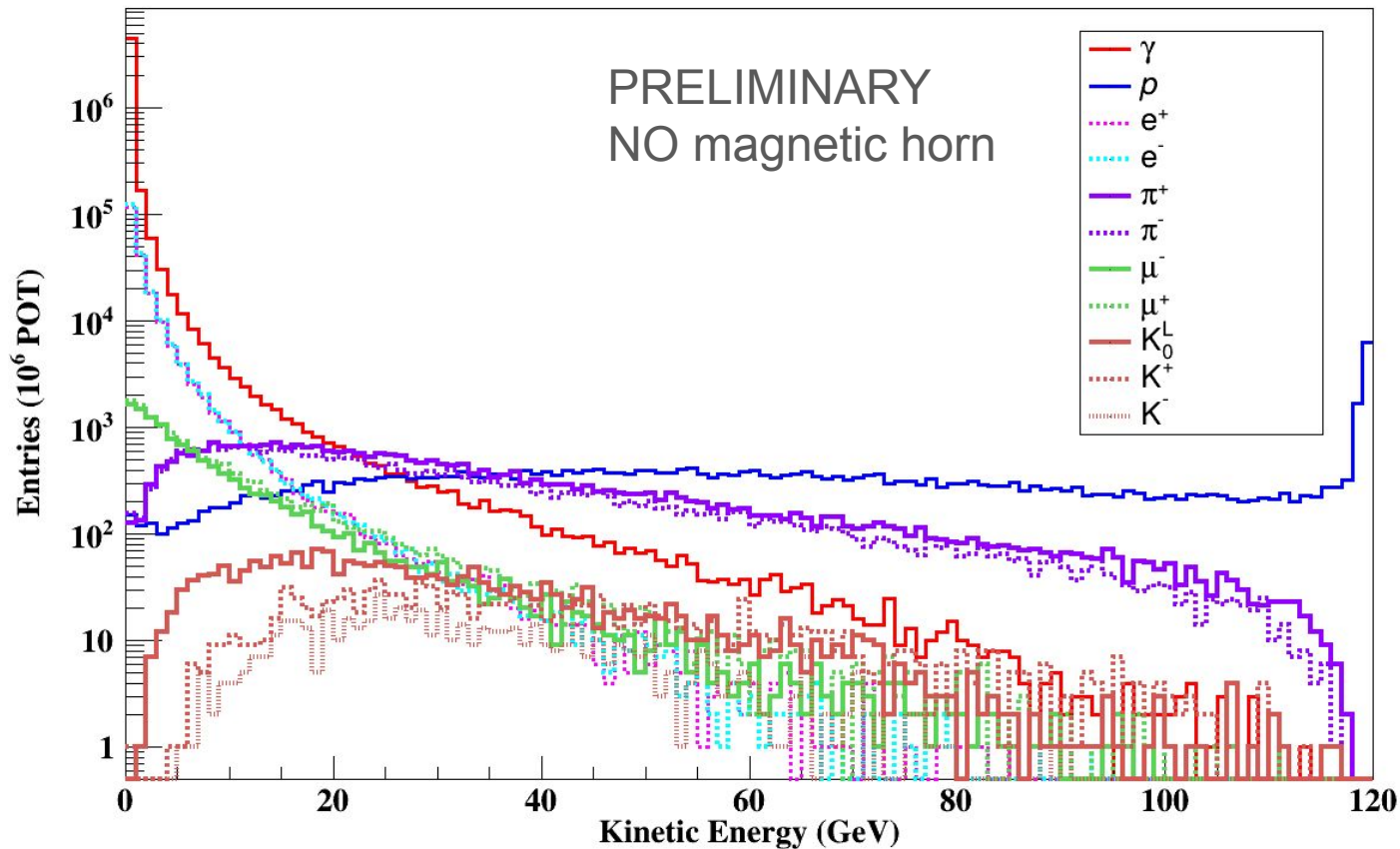
**Grab the particles that arrive here.**



PRELIMINARY  
NO magnetic horn



# Particles Entering into the Dump



# Future Plan

- 1) Detailed target and dump simulation (with magnetic horn implementation)
- 2) GENIE-MC with ND geometry
- 3) Revisit signal study with PETITE
- 4) **Reconstruction study using ND software**
- 5) Limit (or sensitivity) calculation

Questions and Comments?