Status of NEWS-G3 Experiment and Muon Veto System

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NEWS-G

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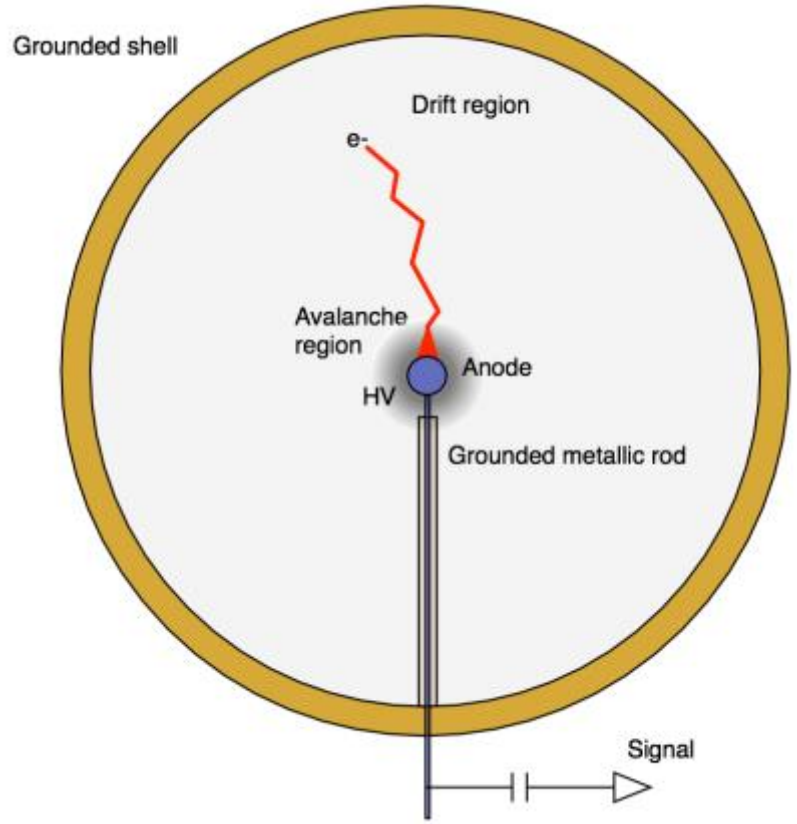
NEWS-G

- Spherical proportional counter (SPC) detector
- Located in SNOLAB in Sudbury, ON
- 2km of earth above provides shielding from muons
- Performs a direct dark matter search
- 140cm sphere filled with light noble gases
- Goal is to detect low mass Weakly Interacting Massive Particles (WIMPs)

NEWS-G

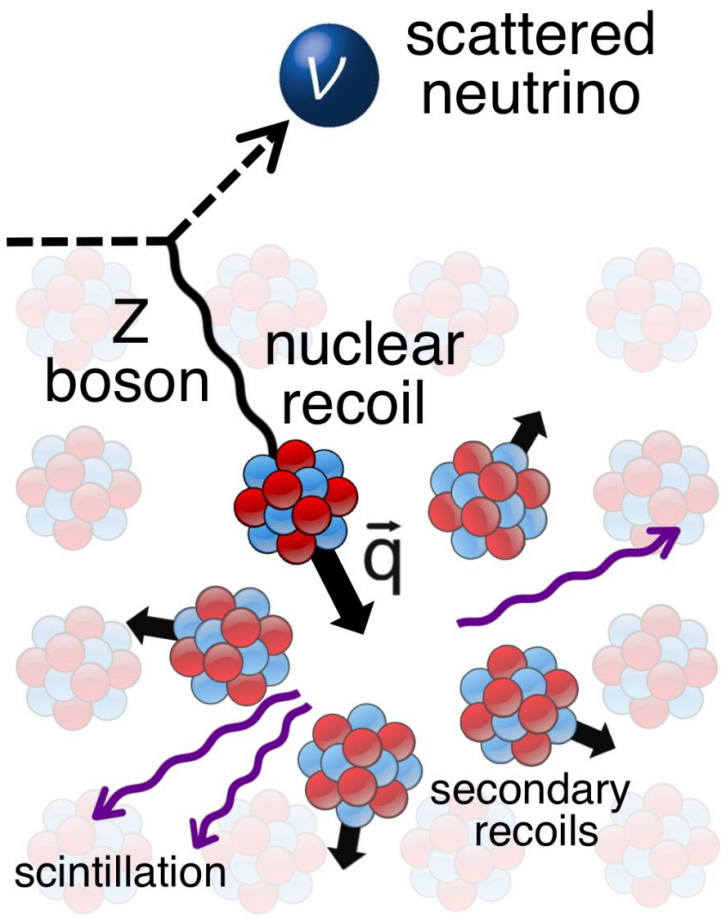
- Direct detection method is looking for nuclear recoils of the target nucleus caused by the WIMP
- The scattered nucleus causes the gas to ionize
- The free electrons then drift to the central anode for detection



NEWS-G3

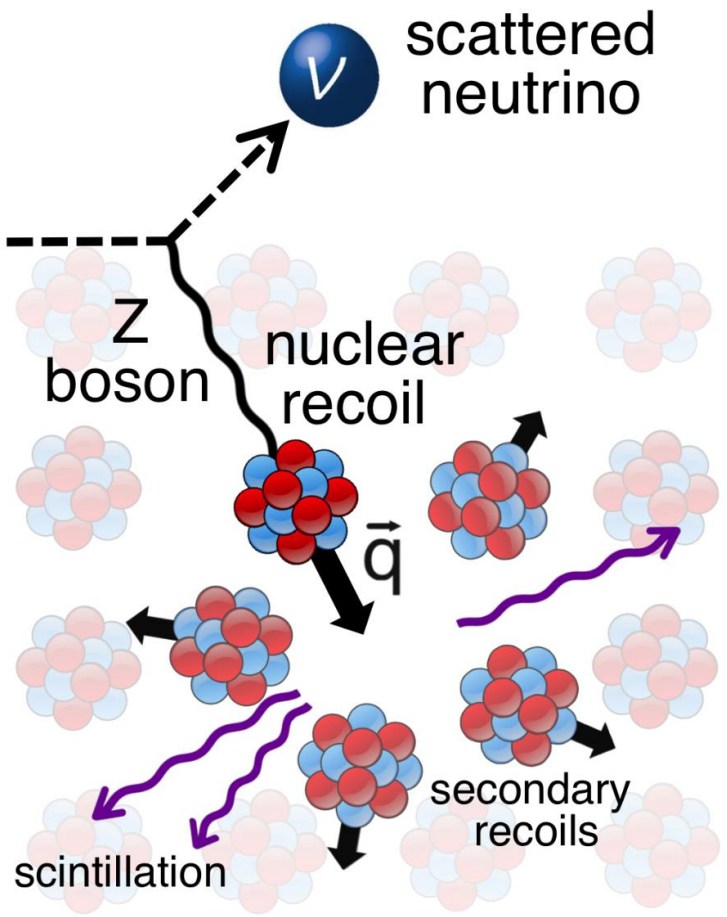
NEWS-G3 Potential

- Goal of NEWS-G3 detector is to be placed next to nuclear reactor to observe coherent elastic neutrino-nucleus scattering (CEνNS)
- Nuclear reactor produces enormous flux of neutrinos
- Can lead to new discoveries of neutrino properties
  - Sterile neutrinos
  - Neutrino magnetic moment
  - Non-standard interactions
- Can be applied to non-intrusive reactor monitoring



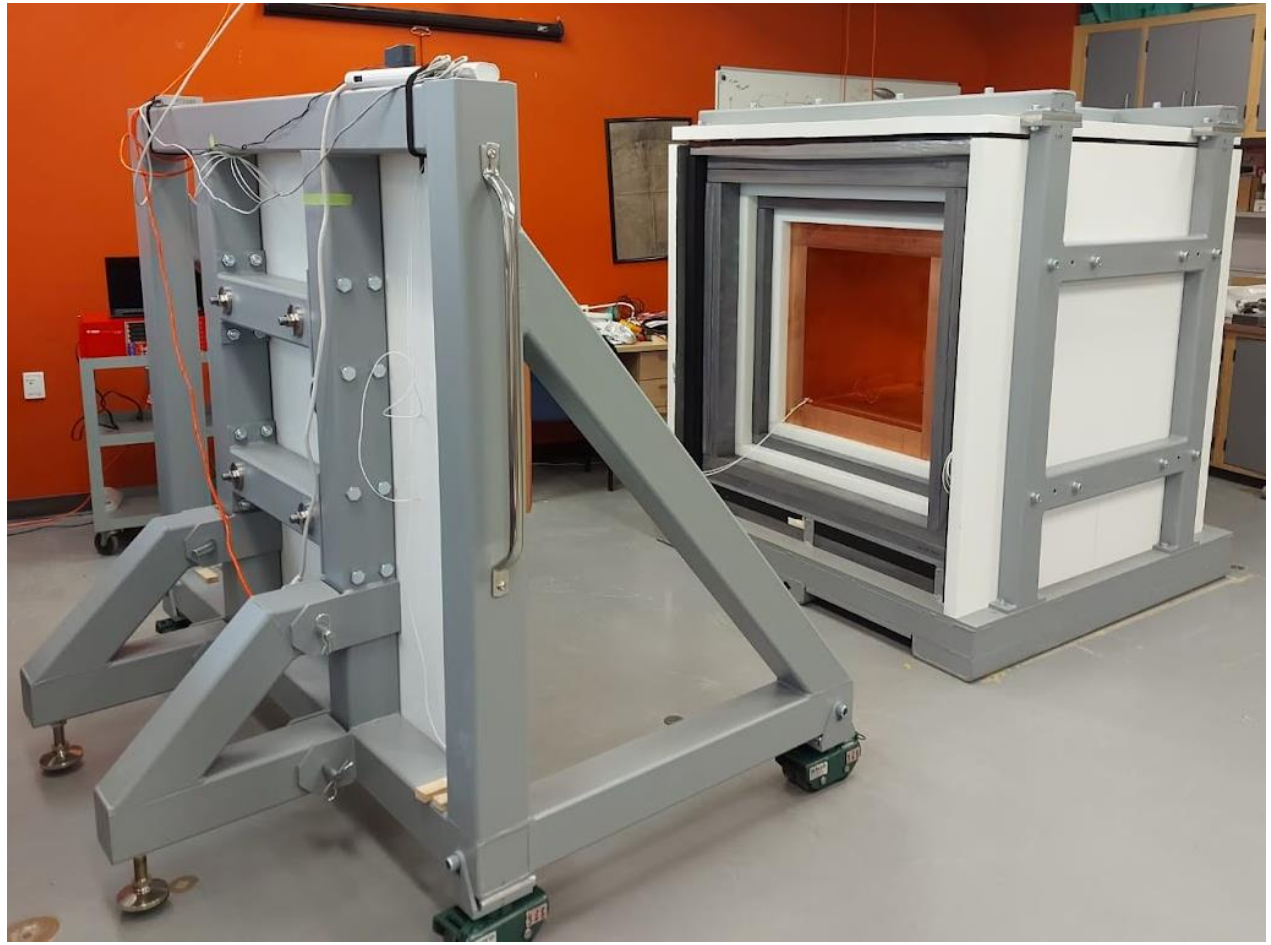
CEνNS

- Neutrino interacts with a target nucleus causing it to recoil
- Nucleus recoils as a whole; coherent up to E_ν~50 MeV
- Recoiling nucleus is low energy (~keV) from a single interaction
- A recoiling nucleus has diminished ability to generate measurable scintillation or ionization in common detectors



NEWS-G3

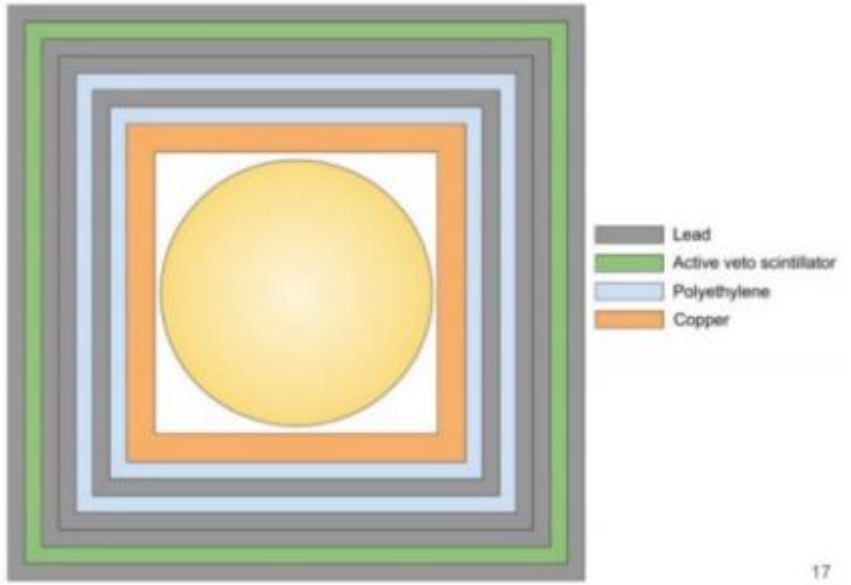
- Construction complete in summer 2022
- In laboratory at Stirling Hall at Queen’s University
- Eight layers of shielding materials



NEWS-G3: Shielding

Shielding Layers (outer to inner)

1. Lead
2. Muon Veto Scintillator Panels
3. Lead
4. Lead
5. PE Plastic
6. Lead
7. PE Plastic
8. Copper

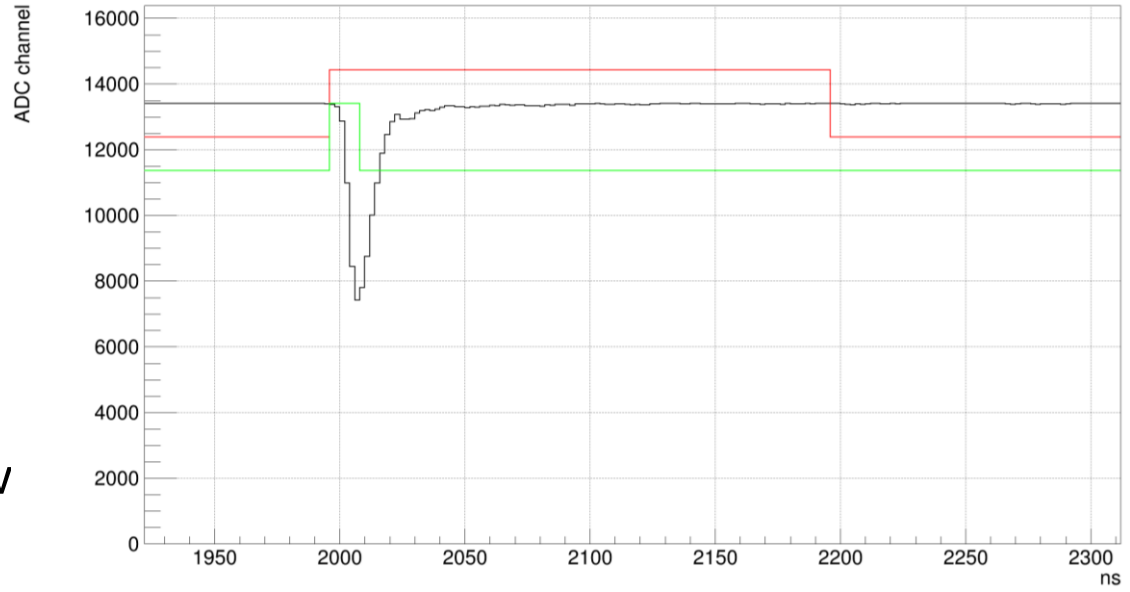


NEWS-G3: Shielding

- Lead and copper
  - Eliminate gamma
- Plastic
  - Eliminates beta and neutrons
- Muon veto scintillator panels
  - Cannot eliminate muons from the background as they are high energy particles
  - Detect when they interact with the detector

NEWS-G3: Scintillator Panels

- Twelve total panels enclosing the detector
- Plastic scintillating material each coupled with a photomultiplier tube (PMT)
- Muon deposits energy in the material which produces light through scintillation
- PMT then detects the light produced
- When muon is detected a dead-time window is opened

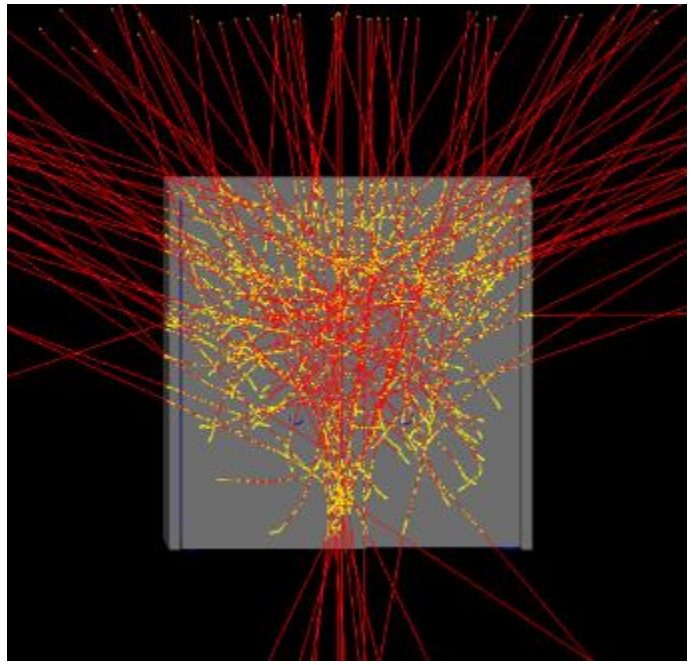


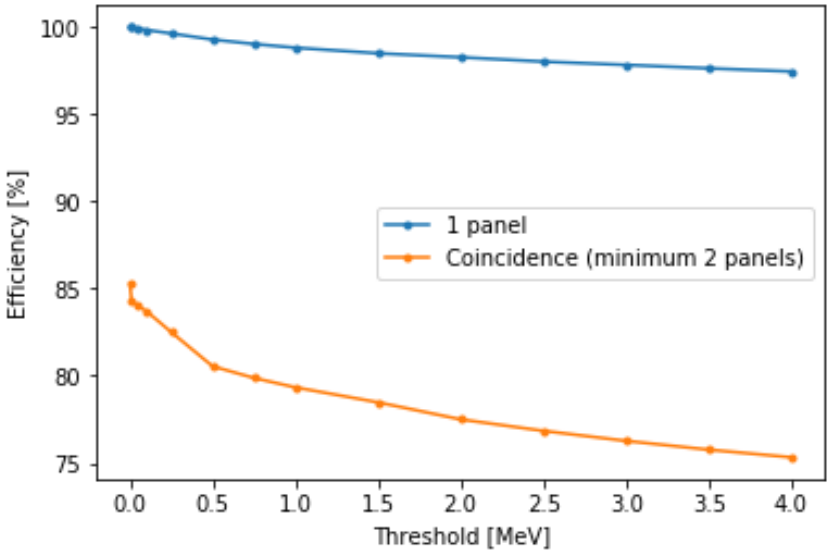
Background Noise

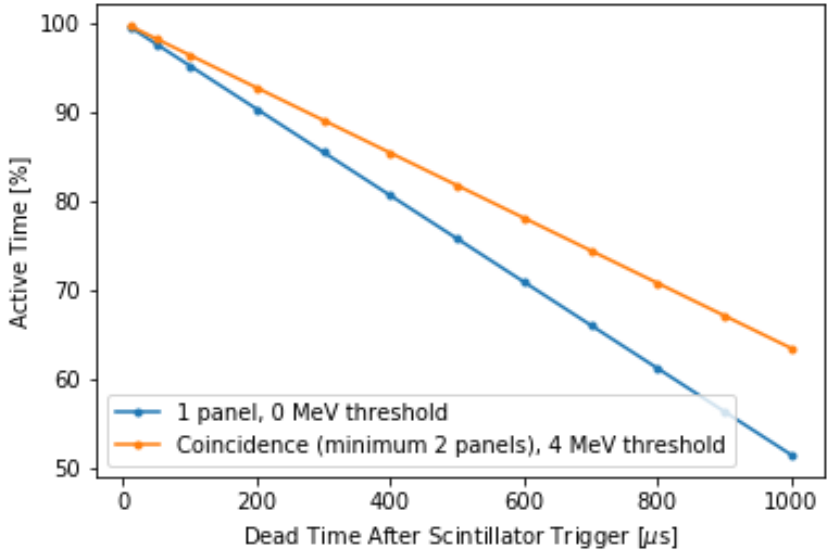
- Muon-induced secondary particles produced inside the shielding
- Spallation: fast neutrons and gammas from lead
- De-excitation: nuclei will produce gammas when returning to ground state
- Thermalization of neutrons: when the plastic layer captures neutrons, gamma particles are produced

Background Simulation

– Muon simulation in GEANT4 to understand background

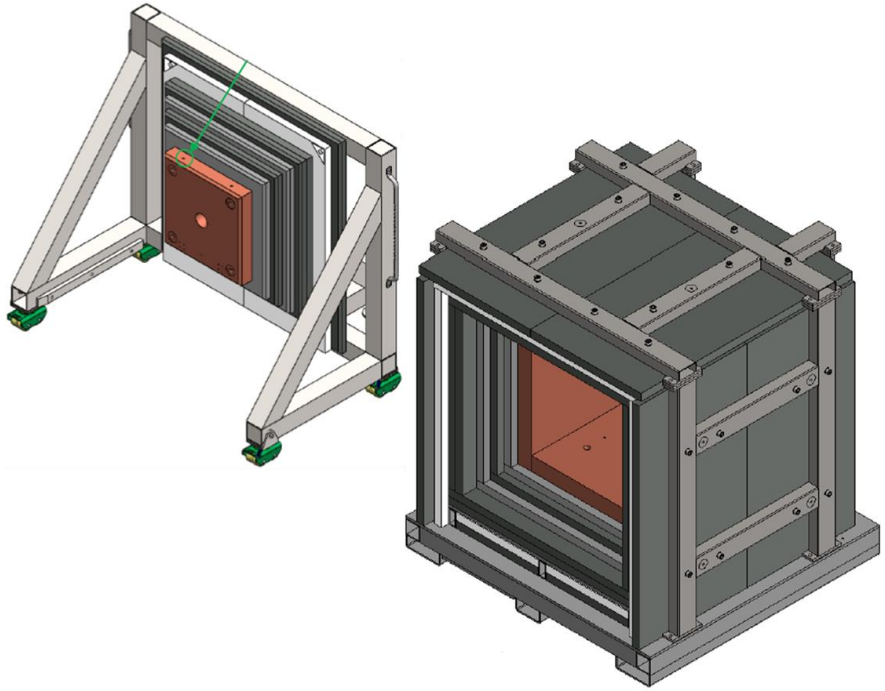






Background Simulation

- Simulation is being further developed to ensure muon-induced secondary particle background is fully understood
- Simulation will validate successful background suppression of shielding



Future Work

- Preliminary data is being taken using a 30cm stainless steel sphere
- 60cm Cu SPC is being procured
- Experimentally validate background suppression of shielding through data taking

Thank you.
Questions?