

Dirt Neutrons in MicroBooNE

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with

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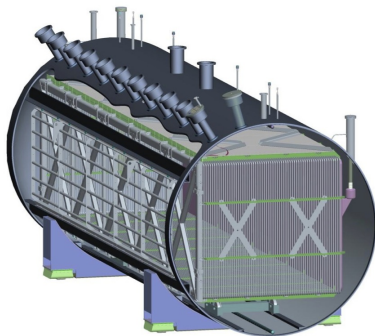


New Perspectives

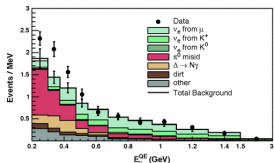
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MicroBooNE

- ▶ MicroBooNE is a liquid Argon time projection chamber (LArTPC) designed to detect neutrino interactions
- ▶ The liquid argon serves as a target for a neutrino beam
- ▶ Charged particles ionize the argon
- ▶ Ionization electrons follow electric field to anode
- ▶ Three wire anode planes on the TPC record the signals



MicroBooNE

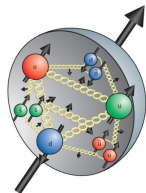


▶ MicroBooNE physics goals

- ▶ Investigate neutrino **oscillations** at low energies
→ Look at MiniBooNE low-E excess
- ▶ Measure neutrino **cross sections** at low energies

▶ NMSU-MicroBooNE physics goals

- ▶ Want to understand proton structure
- ▶ Measure low Q^2 neutral current interactions
- ▶ At low Q^2 , NC-elastic cross section dominated by axial form factor
- ▶ Can measure strange quark contribution to proton spin, Δs
 - ▶ Δs has been a puzzle for over 30 years

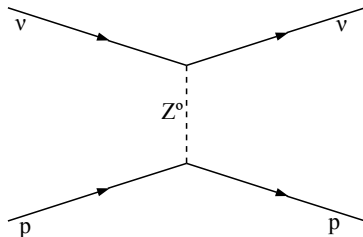


Neutral Current Neutrino Interactions

Neutral current (NC)

neutrino interaction:

- Exchange of Z^0 boson

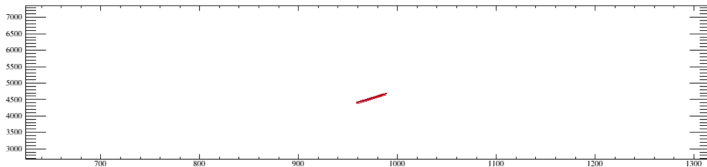
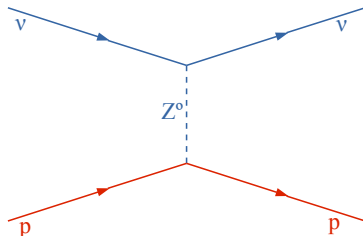


Neutral Current Neutrino Interactions

Neutral current (NC)

neutrino interaction:

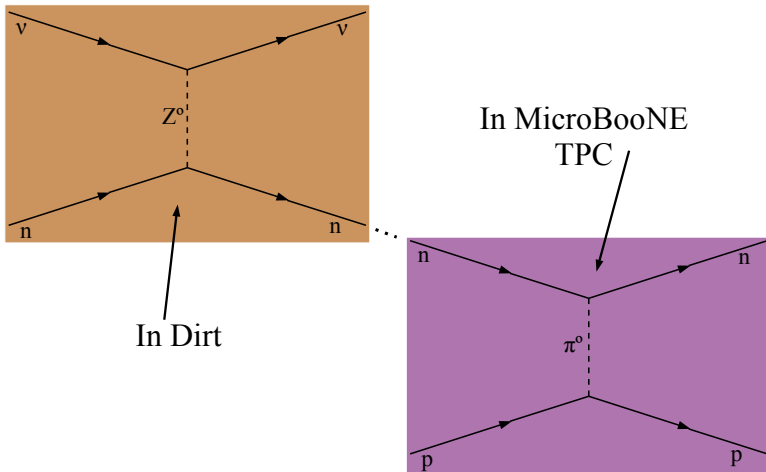
- Exchange of Z^0 boson



Simulated example proton event in MicroBooNE

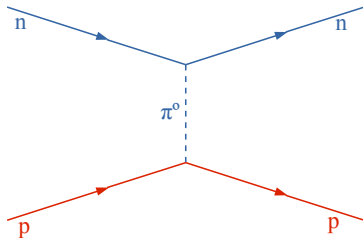
Dirt Neutrons

- ▶ Dirt neutrons are produced in dirt and interact inside MicroBooNE
 - ▶ Worst background to NC-elastic events



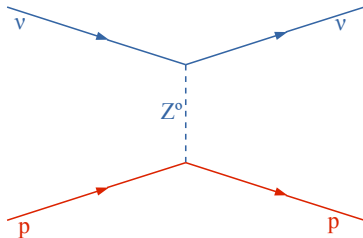
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- ▶ Dirt neutrons are produced in dirt and interact inside MicroBooNE
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- ▶ These neutrons won't ionize the argon



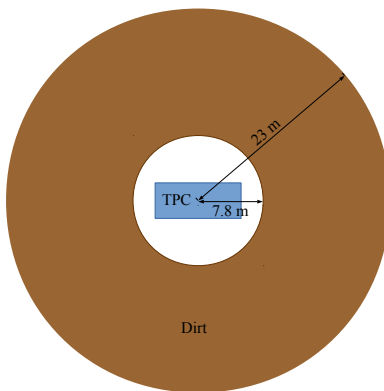
Dirt Neutrons

- ▶ Dirt neutrons are produced in dirt and interact inside MicroBooNE
 - ▶ Worst background to NC-elastic events
- ▶ These neutrons won't ionize the argon
- ▶ Signal looks like NC-elastic protons

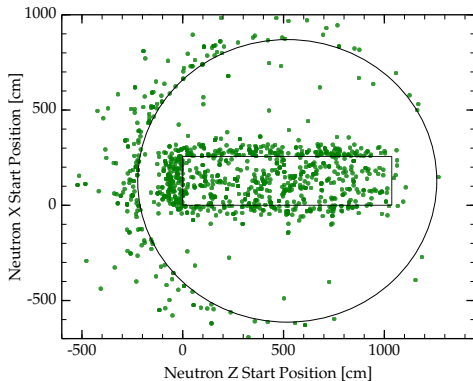


Dirt Neutrons

- ▶ Very large Monte Carlo Sample generated
 - ▶ Genie to generate neutrino events
 - ▶ Geant4 to simulate geometry and propagate tracks
- ▶ $\sim 5,000,000$ events generated
 - 5.09×10^{19} POT \sim **10% of total MicroBooNE POT**



Dirt Neutrons

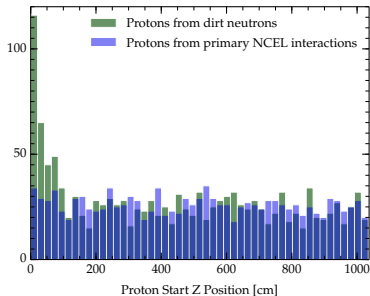
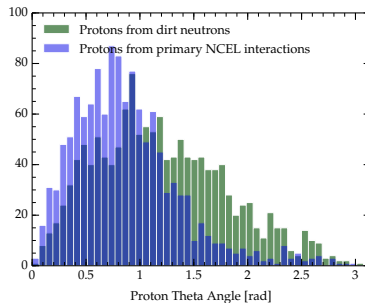
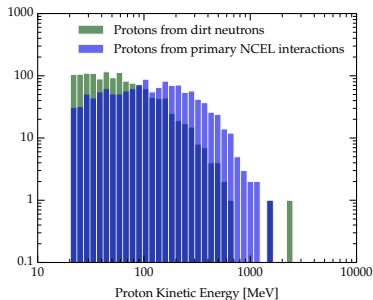


Plot shows origin of neutrons that scatter protons in the TPC

From Monte Carlo:

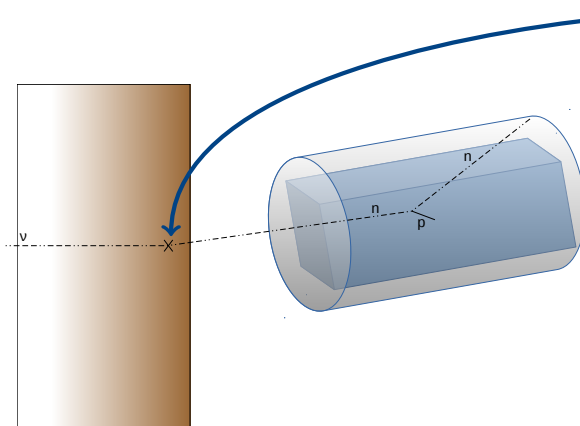
- ▶ 1277 protons from NC-elastic interactions
- ▶ 1371 protons from dirt neutrons
- ▶ Without any cuts
— roughly one-to-one

Dirt Neutrons



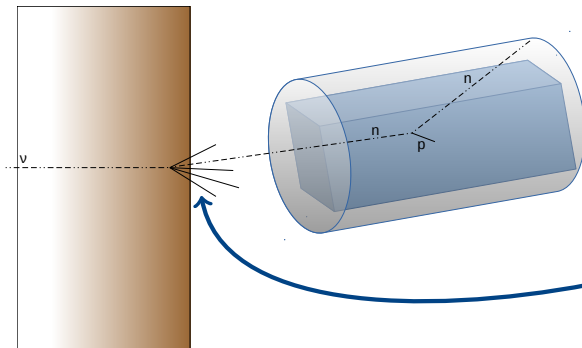
- ▶ Ratio of signal to background varies by energy, angle and position of proton
- ▶ A clean sample of dirt neutron data would allow us to study these distributions

Dirt Tagger Wall



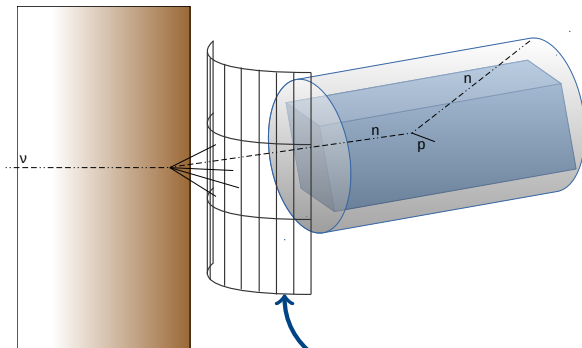
- ▶ Dirt neutron produced upstream in the dirt
- ▶ Other charged particles may be produced in interaction
- ▶ Scintillator detector just upstream of μ BooNE could detect these
 - ▶ Potential upgrade currently under study

Dirt Tagger Wall



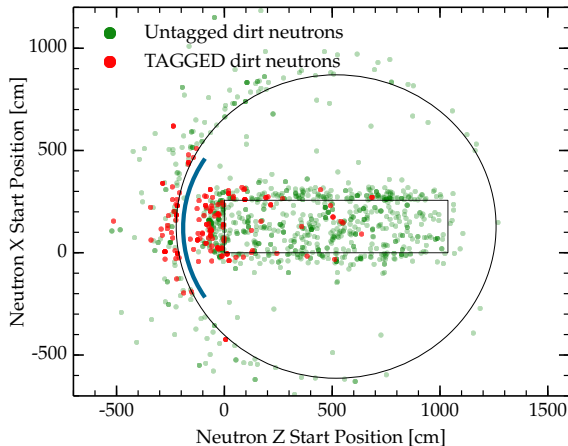
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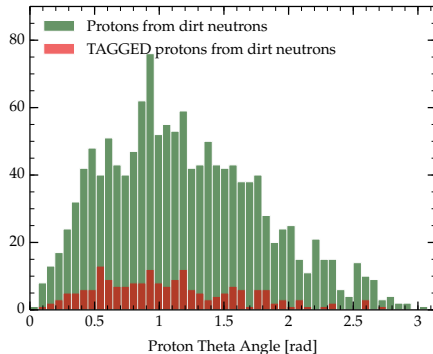
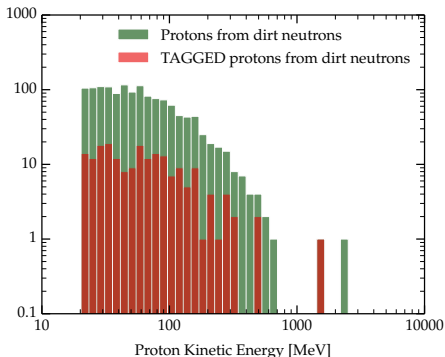


► 14% of dirt neutron events tagged

► Less than 1% of NC-elastic events tagged

► Tagged sample is 95% dirt events

Dirt Tagger Wall



- Dirt tagger gives a representative subset of dirt neutron events for certain variables

Conclusion

- ▶ Dirt neutrons are a very large background to NCE proton scattering
 - ▶ These are not easily separable
 - ▶ We need to be confident in the dirt neutron distributions
 - ▶ A dirt event tagger could provide us with a clean sample
- ▶ Next Steps:
 - ▶ Study which variables can be represented by the dirt tagger subset
 - ▶ Determine how much impact this will have on NC-elastic analysis

Thank you!