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Building a Detector to measure Low Energy Events

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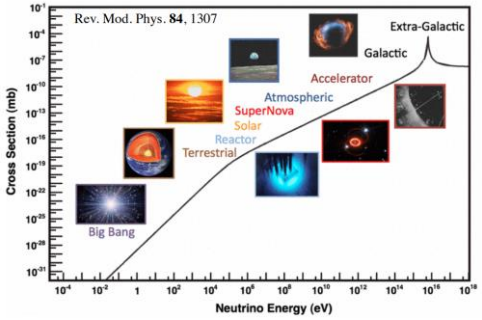
Introduction

- Neutrinos are the most abundant massive particle of the universe.
- Neutrino was first hypothized to explain the continuous spectrum of nuclear beta decay.
- Some sources of neutrinos are solar neutrinos, supernovas, cosmic neutrinos, atmospherics neutrinos and big bang.
- Neutrinos from different sources have energies of different order.
- Neutrinos are leptons with three flavors, namely, electron neutrino, muon neutrino and tau neutrino.
- Each neutrinos have their respective antineutrinos namely, electron antineutrino, muon antineutrino and tau antineutrino.



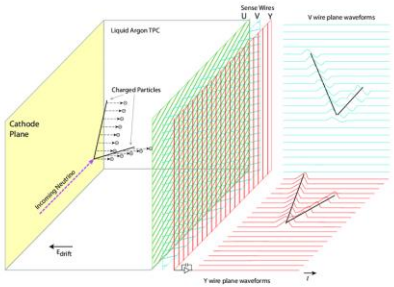
Liquid Argon Time Projection Chamber (LArTPC)

Favorable properties of liquid argon -

- It is 40 % more dense than water.
- It is abundant. (1% of the atmosphere)
- It is inert.
- It ionizes 55,000 electrons/cm
- It produces abundant scintillation light.
- The transparent property of liquid argon is also a big advantage.

Process-

- Neutrinos interact with the argon atom to produces ionization charge and scintillation light.
- The ionization charge and the scintillation light is collected using precision wires and Photo Multiplier Tubes.
- Ionization signal provides the energy and trajectory information and scintillation light provides the timing information.
- This information can create a 3D picture of the particles' trajectory.



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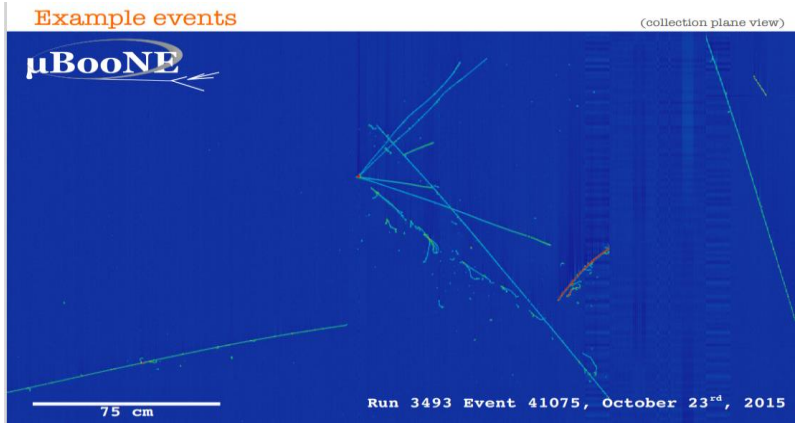
Low Energy detection in TinyTPC

- In a LArTPC the ionization and scintillation signals are anti-correlated.
- The efficiency of LArTPC of collecting the scintillation light is very low.
- The photosensitive dopants convert the scintillation light into ionization charge.
- Converting scintillation light to ionization charge allows LArTPCs to leverage their near perfect charge readout to collect information about the light.
- Then radioactive sources will be introduced to study the low energy performance of the TinyTPC.
- The difference between with and without using photosensitive dopants can be observed.



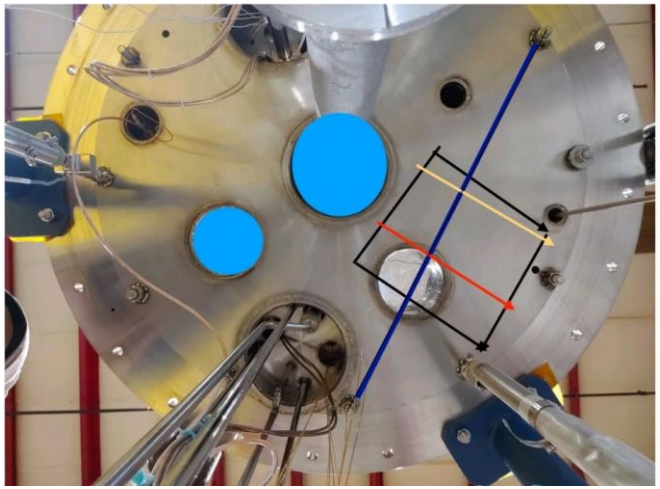
Process to build the detector

The components of building the TinyTPC are -

- G10 frames/ field cage frames
- Cathode board
- PTFE screws
- Pixel readout plane

Process-

- All the components of the TinyTPC are attached and the soldering of the cathode boards are done.
- The TinyTPC should be put inside the cryostat under the blanche lid using threaded rods and bars.
- The cryostat should be filled with liquid argon.



LArPix reception test

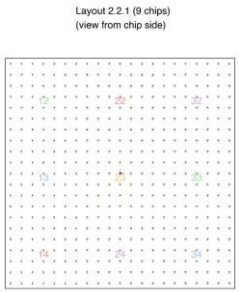
LArPix is a chip which has a low noise and very low power ionization signal detection and readout. The geometry map of the pixel readout is gotten using the LArPix scripts.

The electronic components required for the LArPix reception test are-

- LArPix
- PACMAN
- Flange

Process-

- PACMAN transmits data between the LArPix and computer via a ribbon cable.
- PACMAN will be supplied with 24 DC and 1 Amp DC Power Supply.
- PACMAN should be controlled using an Ethernet cable, which should be connected to the MacBook Pro.



Conclusion and Future Work –

- The biggest advantage of this work is that new physics could be explored if the low energy event information is more accurate.
- Some phenomenon like neutrinoless double beta decay could be explored from this work.
- The event information can be gotten with more accuracy by this research which will expand the scope of analysis.
- This could be used in the big neutrino experiments like DUNE in the future.

Acknowledgements

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