Analysis of DAEδALUS with Hyper-Kamiokande and Shaper Calibration for MicroBooNE

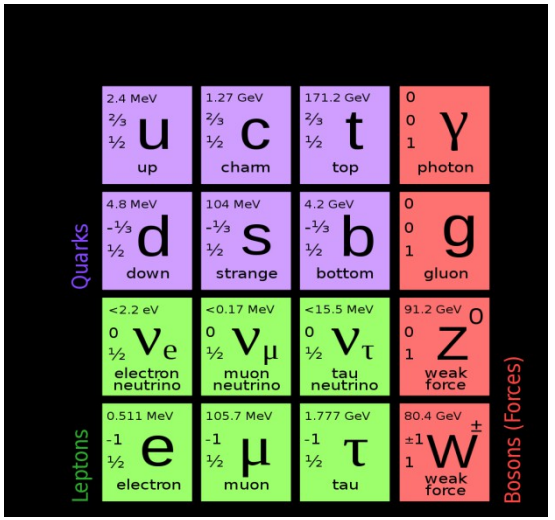
Daniel Garisto

Overview

- What are neutrinos?
- Why do we look for neutrinos?
- MicroBooNE
  - Electronics
- DAEδALUS
  - Simulations

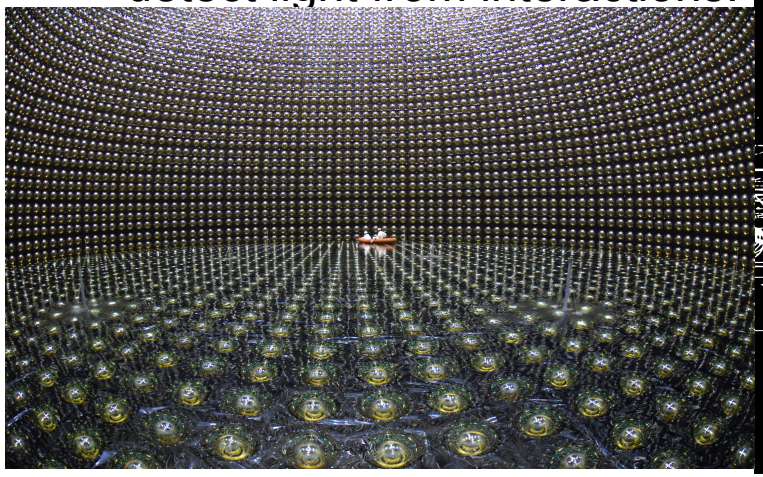
What are Neutrinos?

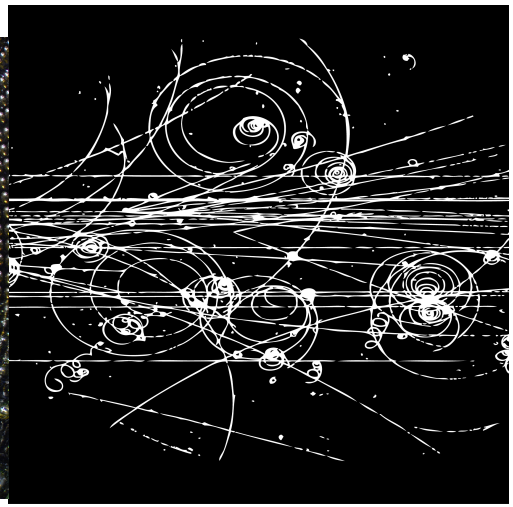
- Postulated in 1930 by Wolfgang Pauli to explain missing energy, momentum, and spin in beta decay.
- $n^0 \rightarrow p^+ + e^- + \nu_e$
- Solar neutrino problem leads to neutrino oscillations (changes between flavor states of neutrinos).
- If there are oscillations, neutrinos must move through time, and thus have mass.

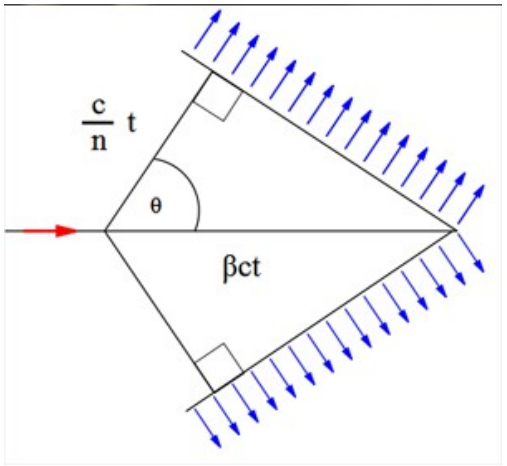


How do we detect neutrinos?

- Neutrinos only interact through the weak nuclear force(W+, W-, Z bosons).
  - Neutral Current(Z): neutrino imparts energy and momentum.
  - Charged Current(W+,W-): neutrino is transformed into its partner lepton.
- Detectors either use metal calorimeters, or are filled with liquid and PMTs to detect light from interactions.





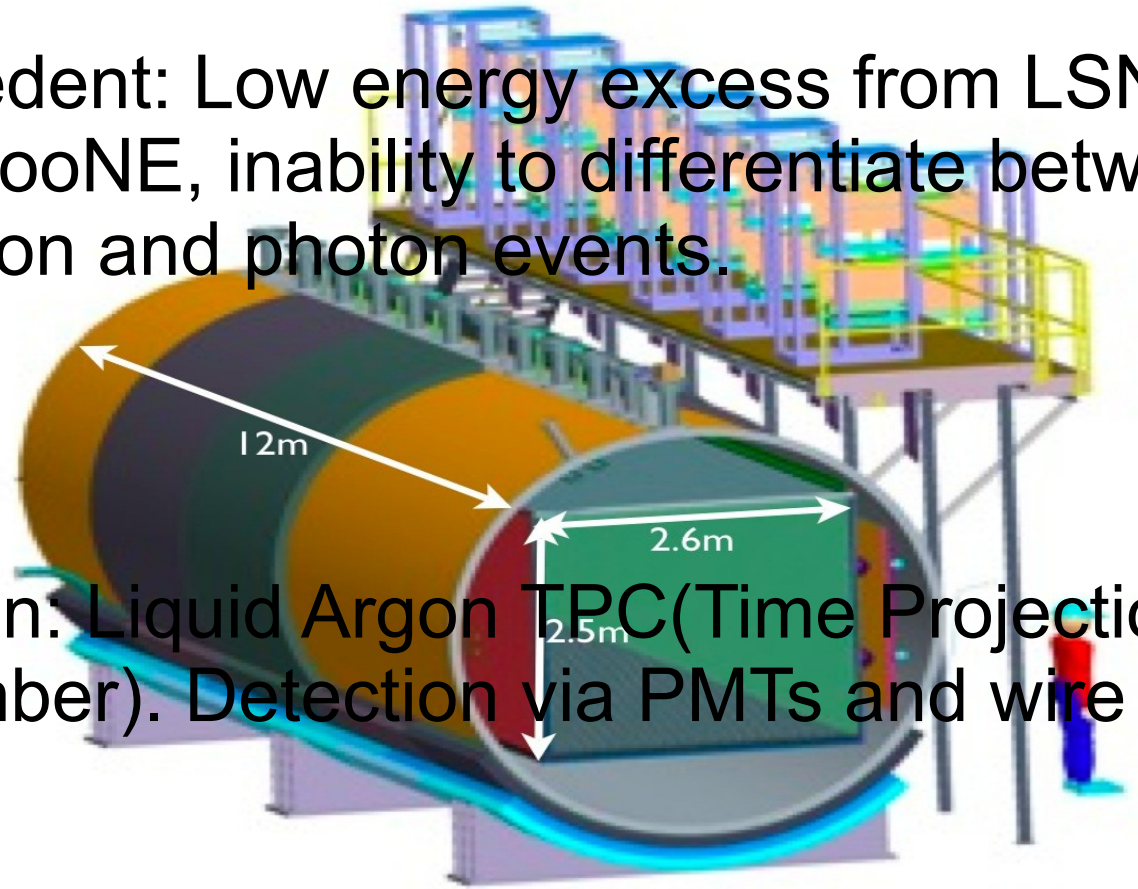


Why do we care?

- Solar neutrinos can tell us about the inside of the sun.
- They can warn us about supernovae.
- Our understanding of how the universe works on the most basic level.
- CP violation (in leptons) would indicate why we're made of matter, and not antimatter.

MicroBooNE

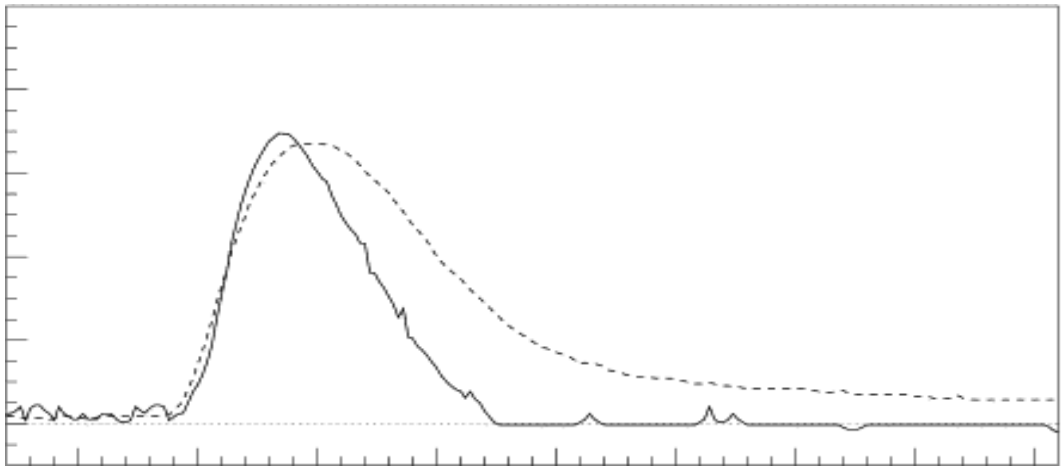
- Precedent: Low energy excess from LSND and MiniBooNE, inability to differentiate between electron and photon events.



- Design: Liquid Argon TPC(Time Projection Chamber). Detection via PMTs and wire planes.

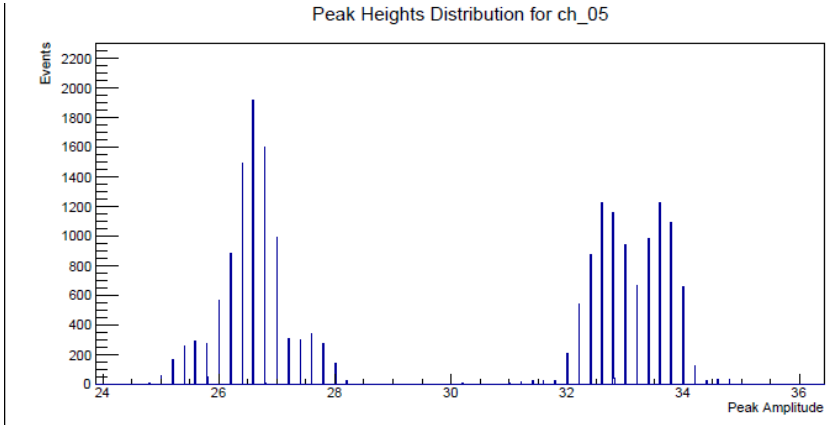
Shaper role

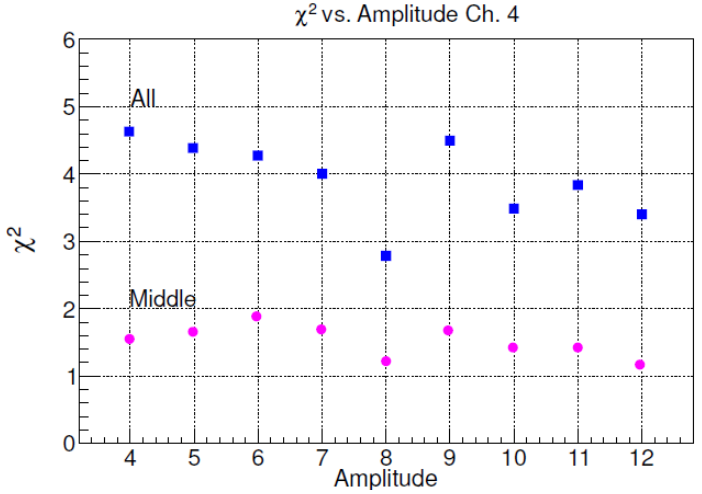
- Shaper receives analog pulses of electricity from the PMTs and integrates over the pulse width.
  - This smoothes the signal and removes noise, for better analysis.
- Our goal: Calibrate the software functions we use to interpret the shaper, so the readout is as accurate and precise as possible.



How to calibrate

- Send a simulated PMT pulse to the shaper, receive data. (10000 events on 9 amplitudes in 16 channels). Data is put into binary files, and then converted to .root files.
- We use ROOT to examine peak height and sum charge to estimate their energy. Then we plot the mean sum charge and mean peak height against the input amplitude to check linearitv.

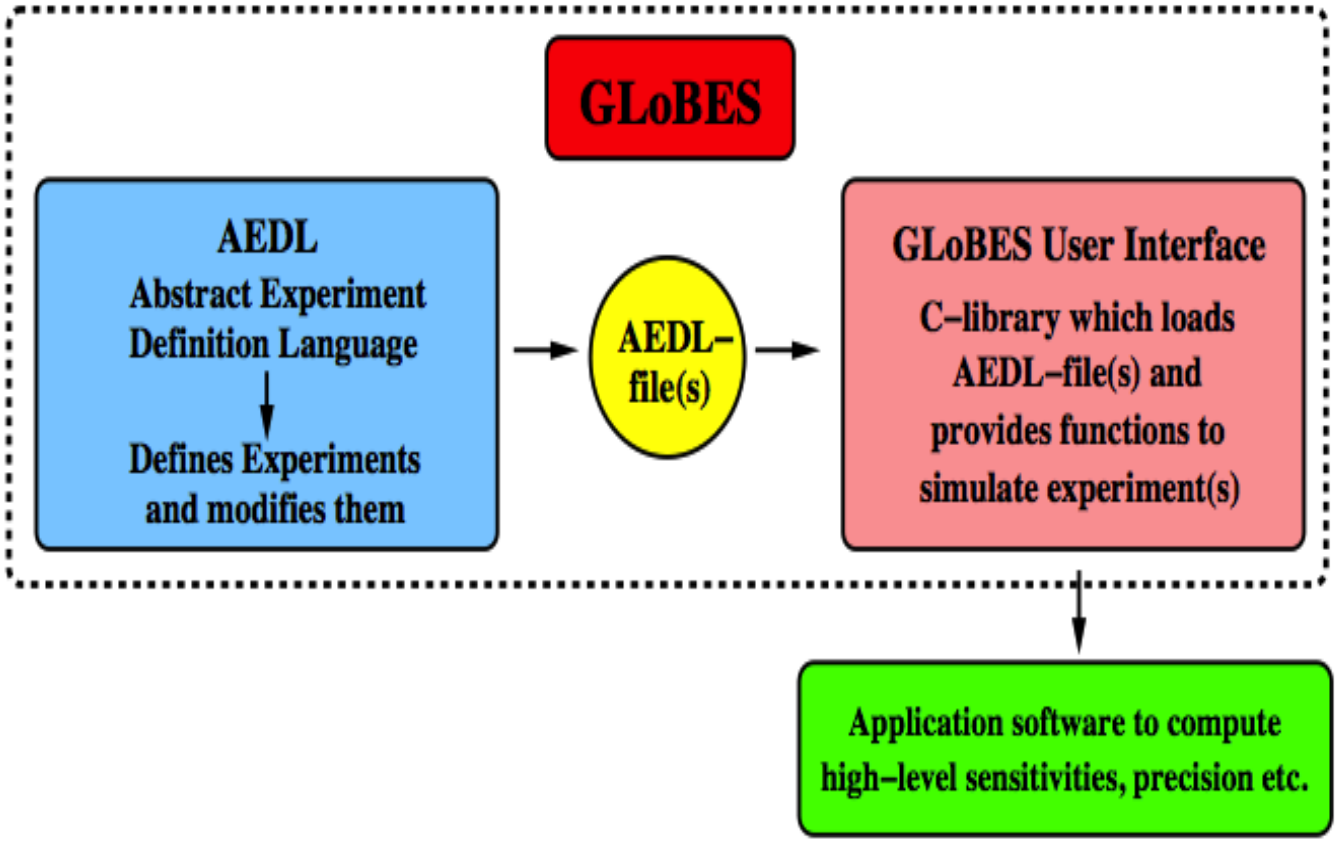




DAEδALUS

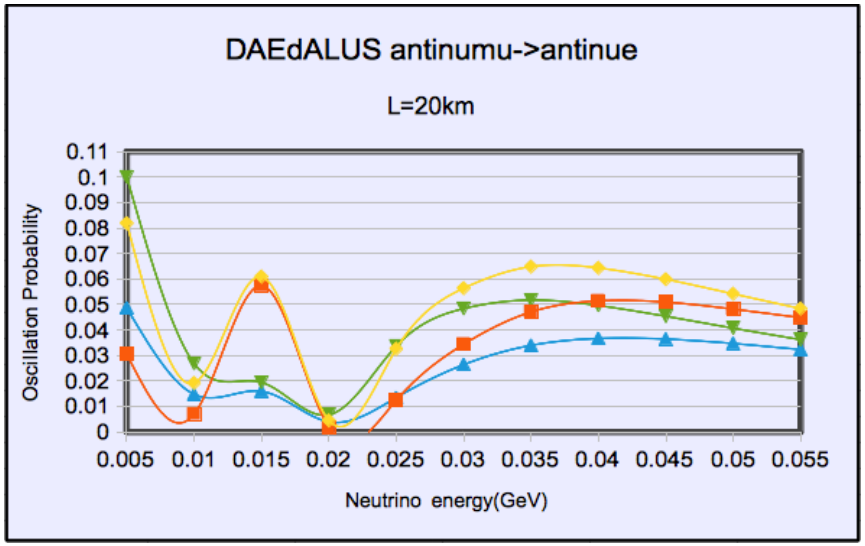
- Decay at rest Experiment for δ_{cp} studies at the Laboratory for Underground Science.
- Use new cyclotron technology to create high intensity of neutrinos to interact with detectors to investigate δ_{cp}.
  - Muon antineutrinos to electron antineutrinos; value of δ_{cp} indicated by difference in oscillation events between distances.
- Proposed experiment needs verification and support for monetary backing.

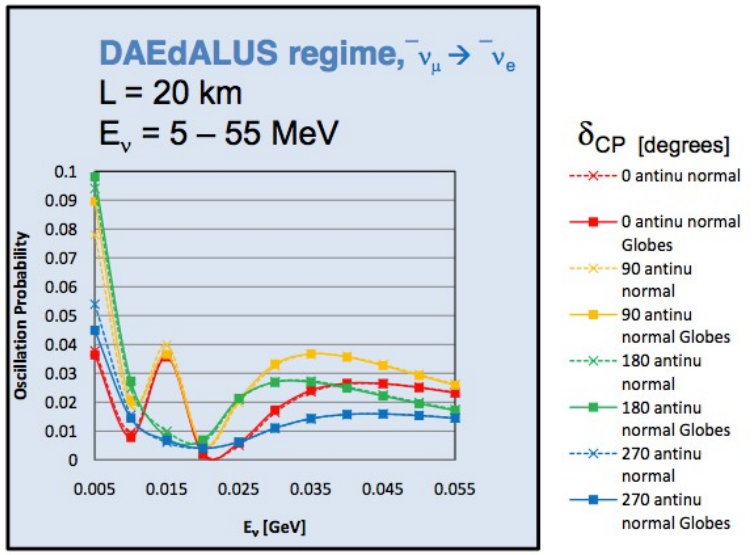
GLoBES


GLoBES
AEDL
Abstract Experiment Definition Language
Defines Experiments and modifies them
AEDL-file(s)
GLoBES User Interface
C-library which loads AEDL-file(s) and provides functions to simulate experiment(s)
Application software to compute high-level sensitivities, precision etc.

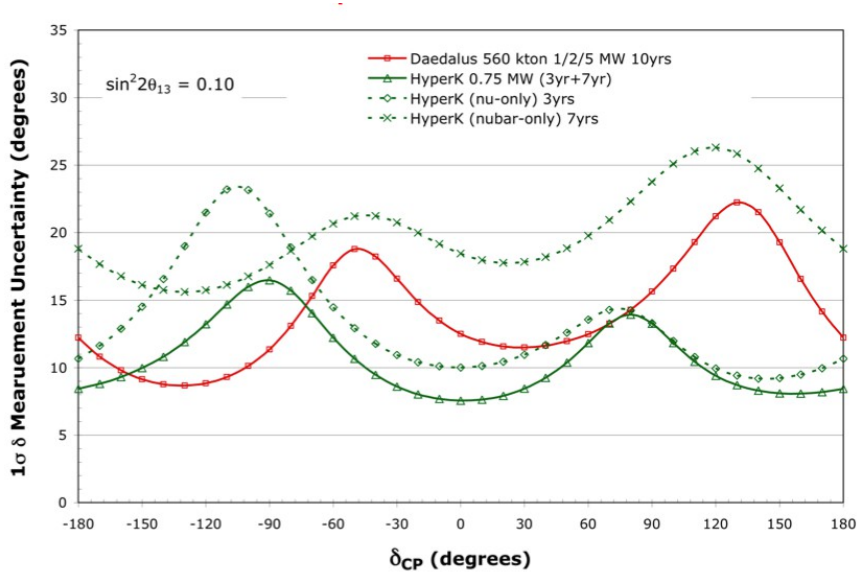
Simulations

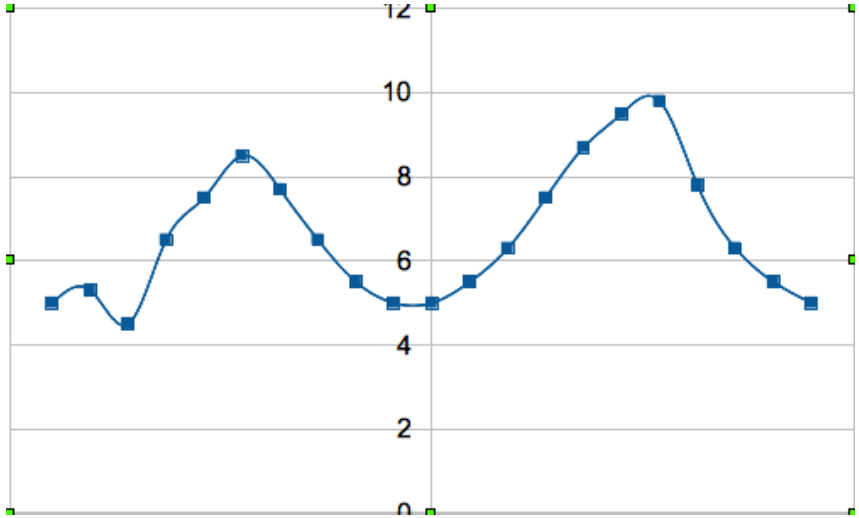
- The first order of business is making sure that GLoBES has accurate experiment files.
- I'm checking my results against Professor Shaevitz's Fortran results.





Simulations pt.2





The red line is DAEδALUS, which my results are beginning to match the pattern of. It's quite rough, but promising.

The Future!

- Additional GLoBES simulations:
- Investigation of inverse mass hierarchy
- Potential sterile neutrinos incorporated into analysis
- Many, many years down the road: Maybe they'll build DAEδALUS!

Acknowledgements

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