Simulation effort at UC Davis

UC Davis has most of the simulation tools needed to provide a realistic detector response for ANNIIE

- R. Svoboda has the muon range geometry (Will adapt to WCSim)

- Experience adapting WCSim to low-energy studies. Created a simplified data format for more efficient analysis. Knowledge of rootcint

Low energy analysis tools

WATCHMAN (see tomorrow talk) requires analysis of neutron capture at low energy, also have extensive low-energy generator for various physics process (U/Th, fast neutrons, reactor anti-neutrino,...)

Currently using Michael Smy’s low energy fitter BONSAI for WATCHMAN studies.

In the process of integrating BONSAI to Hyper-Kamiokande.
Fast-neutron (from cosmic muons)

Can adapt for a simple “dirt” neutron model

WATCHMAN Geometry

Particle interactions created by 388 MeV neutron

\[ \pi^\pm \text{can be produced by fast neutrons on nuclei} \]


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Fast neutron detected multiplicity

\[ \text{mult}_\text{FVR} \]

Entries 323
Mean 1.61
RMS 2.184

Fiducial Volume Requirement

Entries \( R_{\text{prompt}} \cdot R_{\text{delayed}} < 100 \mu s \)

Entries \( R_{\text{prompt}} \cdot R_{\text{delayed}} < 2 \text{ m [Cand.(PC)]} \)
Data Format (Work in progress)

Created a simple macro to extract the relevant info from wcsim files and output a ntuple format in the context of HK and WATCHMAN

In the process of adding pre-digitize information for PMT/LAPPD, this is the photon information at the point where it interacts with the glass surface

Less of a learning curve to start doing some analysis; file size is also generally smaller

Current WCSim root tree structure

```
EVENT:0
wcsimrootevent = (WCSimRootEvent*)0x1049bd510
fUniqueID = 0
fBits = 50331648
fEventList = (TObjArray*)1049be9c0
```

“Ntuple” format root tree structure

```
EVENT:0
event = 0
N_subevents = 0
subevent = 0
SubEvtTime = 108.779
LAPPD_N_HIT = 876
LAPPD_T = 0, 0, 0, 0, 0,
LAPPD_Photon_Wavelength = 0, 0, 0, 0, 0,
LAPPD_PreDigi_X = 0, 0, 0, 0, 0,
LAPPD_PreDigi_Y = 0, 0, 0, 0, 0,
LAPPD_PreDigi_Z = 0, 0, 0, 0, 0,
LAPPD_PreDigi_dirX = 0, 0, 0, 0, 0,
LAPPD_PreDigi_dirY = 0, 0, 0, 0, 0,
LAPPD_PreDigi_dirZ = 0, 0, 0, 0, 0,
LAPPD_PreDigi_polX = 0, 0, 0, 0, 0,
LAPPD_PreDigi_polY = 0, 0, 0, 0, 0,
LAPPD_PreDigi_polZ = 0, 0, 0, 0, 0,
LAPPD_LOC = 0, 0, 0, 0, 0,
N_PMT = 876
PMT_T = 980.232, 979.295, 993.658, 967.927, 1026.66, 1003.82,
PMT_Q = 1.86753, 1.02419, 1.434, 1.0435, 0.176814, 1.96162,
PMT_ID = 61326, 59889, 86835, 48699, 87844, 26000,
PMT_X = 2281.11, 2243.97, 1819.56, 1969.97, 2206.02, 668.044,
PMT_Y = -896.912, -986.152, 466.967, 1459.17, 724.604, 2358.31,
PMT_Z = 1837, 1739.46, 2451.05, 1056.68, 2451.05, -536.47,
PMT_LOC = 1, 1, 0, 1, 0, 1,
photoelectrons = 1162.15
OD_PMTs = 0
MC_E = 100.511
MC_X = 1
MC_Y = 0
MC_Z = 0
MC_DIRX = 1
MC_DIRY = 0
MC_DIRZ = 0
```
Neutron capture analysis

Brainstorming:

Low-energy water studies are ongoing

Impact of LAPPD timing resolution on reconstruction needs to be evaluated

My SNO thesis used a Multiple Ring Fitter, can this be applied to distinguish the multiple gammas for Gd capture (Challenging)

$\beta_{14}$ or other technique may also be used