θ_{13} analysis

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$$N = \frac{F \times M \times \epsilon \times T \times \sigma}{4\pi R^2}$$

F = flux of neutrinos
M = detector mass (number of protons)
ε = efficiency of detecting IBD events
T = detector live time
σ = IBD cross section
R = distance between reactor and detector

Assume 1 reactor, 1 near detector and 1 far detector

$$\frac{N_{Far}}{N_{Near}} = \frac{((P_{Osc\,Far} \times F) \times M \times \epsilon \times T \times \sigma)/(4\pi R_{Far}^2)}{((P_{Osc\,Near} \times F) \times M \times \epsilon \times T \times \sigma)/(4\pi R_{Near}^2)}$$

$$\frac{N_{Far}}{N_{Near}} = \frac{P_{Osc\,Far}}{P_{Osc\,Near}} \times \frac{R_{Near}^2}{R_{Far}^2}$$

$$\frac{P_{Osc\,Far}}{P_{Osc\,Near}} = f(\sin^2(2\theta_{13}))$$

Complications:

Not that simple – multiple detector, multiple neutrino sources

Number of protons: biggest relative detector systematic (0.3%)

Measure R accurately

Efficiency: energy calibration to make cut in energy to select Gd captures

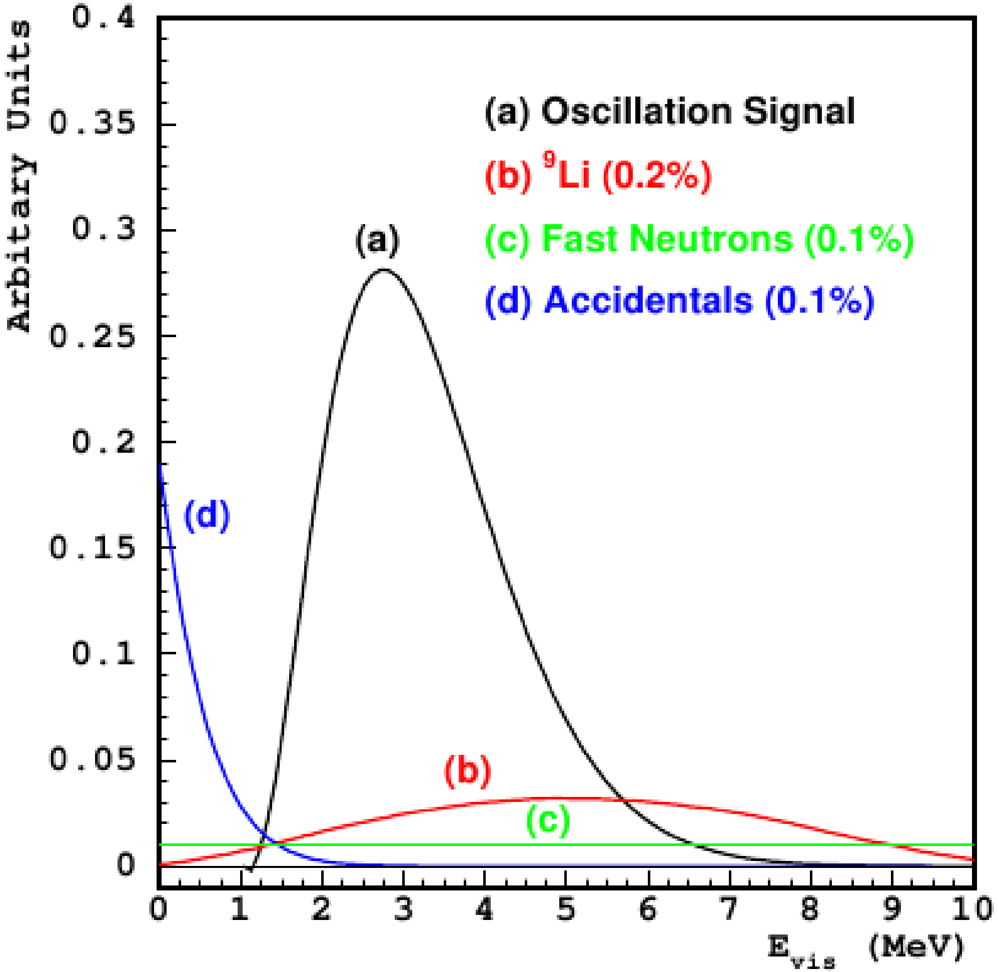
Complications (cont'd)

Correlated Backgrounds:

1) Accidentals – accidental correlation between two random readouts

2) fast neutrons – neutron from muon interacting in the rock, hits proton (prompt), slows down and captures (delayed)

3) Li9/He8 – muon interacting in the detector creates these isotopes, decay causes a prompt/delayed signal correlation (beta, neutron)



Arbitary Units
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
(a) Oscillation Signal
(b) ^{9}Li (0.2%)
(c) Fast Neutrons (0.1%)
(d) Accidentals (0.1%)
(a)
(b)
(c)
(d)
0 1 2 3 4 5 6 7 8 9 10
E_{vis} (MeV)

What do we measure?

IBD rate in each detector
(also energy spectrum)
Mass (w/ uncertainty)
Baseline(s)
Backgrounds
Selection efficiency (w/ uncertainty)
Live time
Flux (because it doesn't exactly cancel)