Likelihood analysis for e/π^0 separation

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Outline

- Motivation
- Maxim's Results
- Likelihood variables
- Likelihood results and comparison with Maxim's results
- Future plan

Introduction

Motivation: For the T2K to Korea (T2KK) project, we need a good e/π^0 separation over a large energy range.

→ Created a new likelihood for e/π^0 separation

But this new likelihood is also useful in the T2K energy range $0.35 < E < 0.85$ GeV

Maxim's Results

Assuming the following precuts:

- FCFV, Evis > 100 MeV
- Single ring
- E-like
- No decay electron

At Super-K, 22.5Kt, 5 years, $\Delta m^2_{23} = 2.5$ e-3 eV^2

	$\nu\mu$ CC mis-ID	NC	Beam νe	Signal (chooz)
$0.35<E\nu<0.85$ (Gev)	1.37(0.07%)	50.8 (6.3%)	20.7 (11.3%)	127.2 (58.3%)
1. $\cos\theta_{\nu lepton}<0.9$	1.025 (0.05%)	35.8 (4.5%)	17.5 (9.6%)	111.4 (51.1%)
2. Polfit $M\gamma\gamma$ < 100 MeV/c²	0.47 (0.02%)	11.8 (1.5%)	13.9 (7.6%)	94.1 (43.2%)
3. ΔlogLikelihood < 80	0.35(0.017%)	9.8 (1.2%)	13.5 (7.4%)	91.9 (42.2%)

I did not use cuts 1. 2. 3. but I use those variables and add new variables into a likelihood.

Input variables for the likelihood

NB: Polfit2 is used in this study

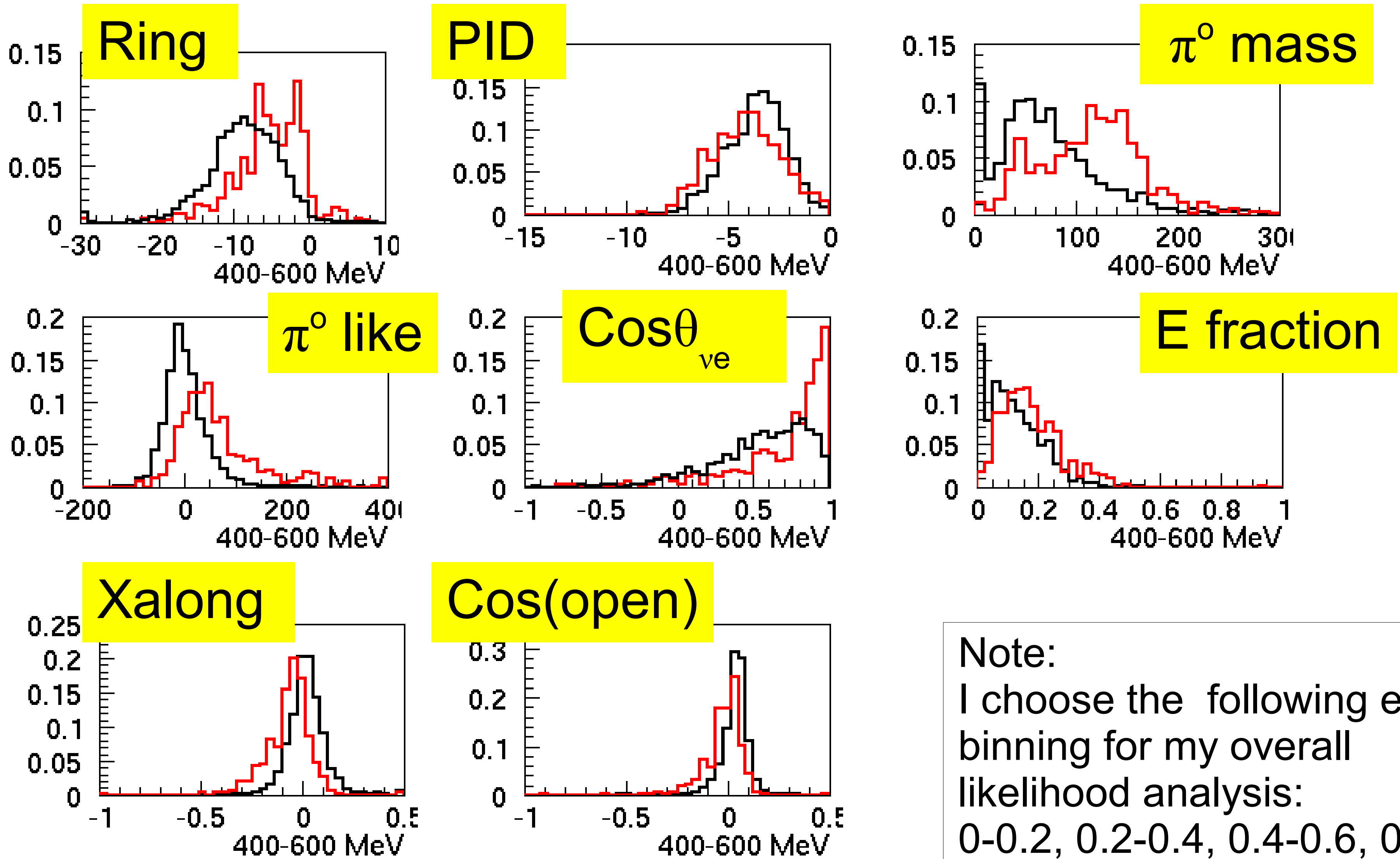
Ring parameter	*dlfct*
PID parameter	*(sqrt(-probms(2,1))-(sqrt(-probms(3,1))))*
π^o mass 2.	*pi0mass(1)*
π^o likelihood 3.	*(pi0like(1)-pi0like(2))*
$\cos\theta_{\nu e}$ 1.	(dir(i,1)*dirnu(i,1))
Energy fraction	*pi0_e(2,1)/(pi0_e(1,1)+pi0_e(2,1))*

Chi_Xalong

Chi_cos(open)

} See later

Distributions



Background

Signal

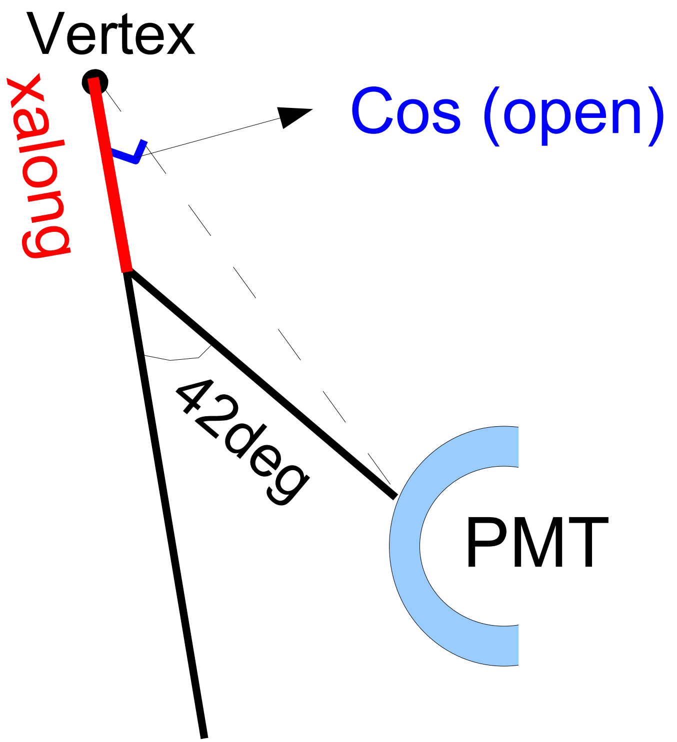
400-600 MeV

Note:
I choose the following energy binning for my overall likelihood analysis:
0-0.2, 0.2-0.4, 0.4-0.6, 0.6-0.9
0.9-1.5, 1.5-
But the efficiency was calculated for
0.35< E < 0.85 GeV

Xalong and Cos(open)

Work done by Danka

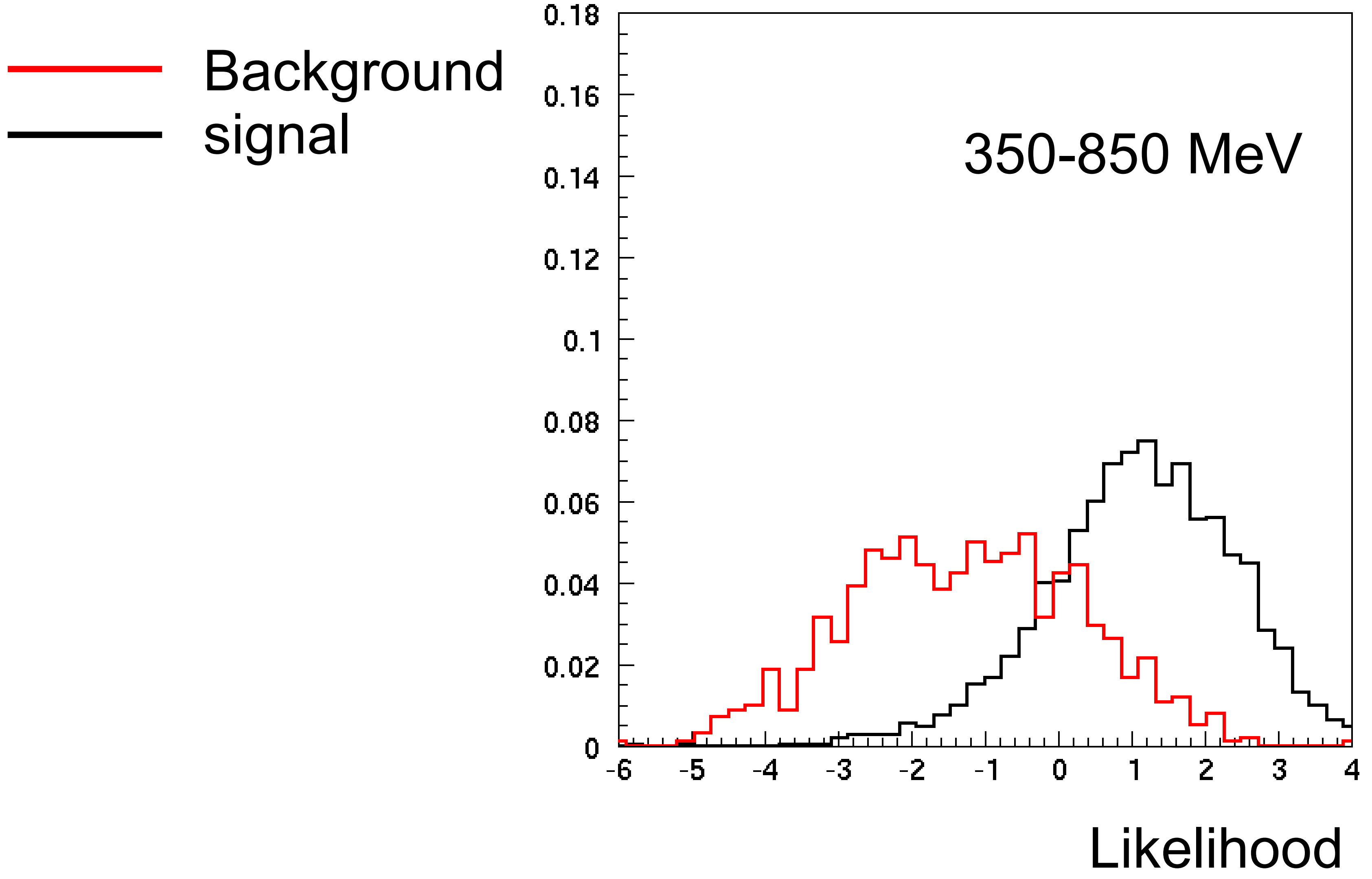
Xalong: Distance between vertex and emitting point of Cherenkov light.



Cos(open): Angle between vertex-pmt vector & direction of neutrino

- I compute those values for each hit pmt, plot distributions.
- Using part of the MC I create templates of those distributions.
- For each event, I assign a χ^2 value comparing the event against the templates.
- The χ^2 value is added to the likelihood.

Final Likelihood results:



Likelihood results

Maxim:

	νμ CC mis-ID	NC	Beam νe	Signal (chooz)
0.35<Eν<0.85 (Gev)	1.37(0.07%)	50.8 (6.3%)	20.7 (11.3%)	127.2 (58.3%)
$\cos\theta_{\nu lepton}$<0.9	1.025 (0.05%)	35.8 (4.5%)	17.5 (9.6%)	111.4 (51.1%)
Polfit Mγγ < 100 MeV/c²	0.47 (0.02%)	11.8 (1.5%)	13.9 (7.6%)	94.1 (43.2%)
ΔlogLikelihood < 80	0.35(0.017%)	9.8 (1.2%)	13.5 (7.4%)	91.9 (42.2%)

New:

	νμ CC mis-ID		NC		Beam νe		Signal (chooz)	
0.35<E<0.85	1.5	47.0%	53.1	6.5%	18.9	12.1%	125.9	58.7%
Likelihood	0.5	0.023%	10.9	1.3%	15.4	9.9%	102.6	47.8%

Signal efficiency is better: 42.2% → 47.8%

Background rejection (NC) equivalent: 1.2% → 1.3%

Future plan

There is room for improvement:

- one more variable: total pe / evis is useful around 800 MeV → will be added by Sunday.

- Study which variable is useful more carefully.

- Compare with atmospheric data
  → Check how well the variables are reproduced by MC.

- Use different variables for different energy range might give better results.

- Upgrade to SK-II software:
  new ring counting (includes ringer)

Bakcups..

How to use those variables:

Using 20yr of MC:

Create template of Xalong and Cos(open) distributions.

On 100yr MC:

For each event compute χ^2 (signal) and χ^2 (bckg) using the templates.

$$\chi^2_{sig} = \sum_{bin} [\frac{(event(bin) - template_{sig}(bin))^2}{(event(bin))}]$$

Define new variables: var = χ^2 (bckg) - χ^2 (signal)

Create new bank containing those variables (EPI0SEP)

Create new zbs and hbk files containing this new bank

Add those 2 variables in the likelihood.