5/30/01
@JHF-SK Nu WS

ν_μ ®ν_μ disappearance analysis

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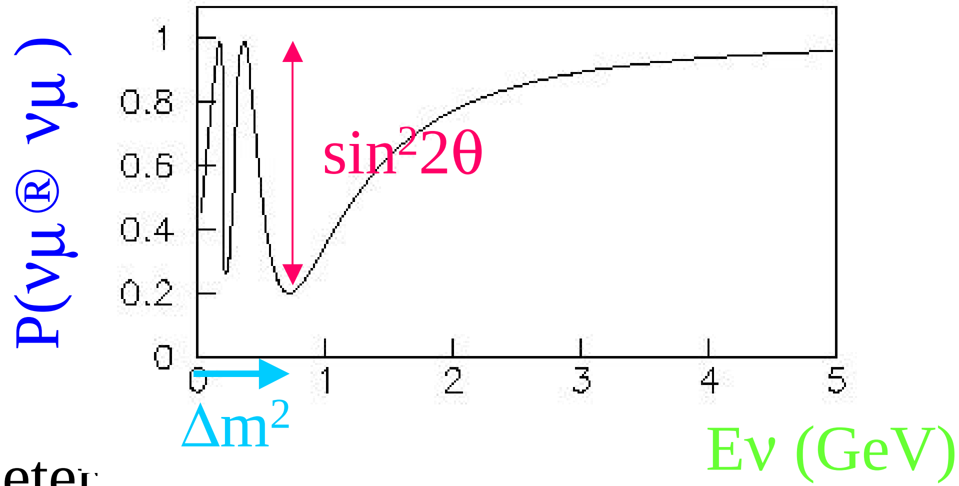
1. Introduction

$P(n_m \circledR n_m) = 1 - \cos^4\theta_{13} \sin^2 2\theta_{23} \sin^2(1.27\ \Delta m_{23}^2\ L/E)$

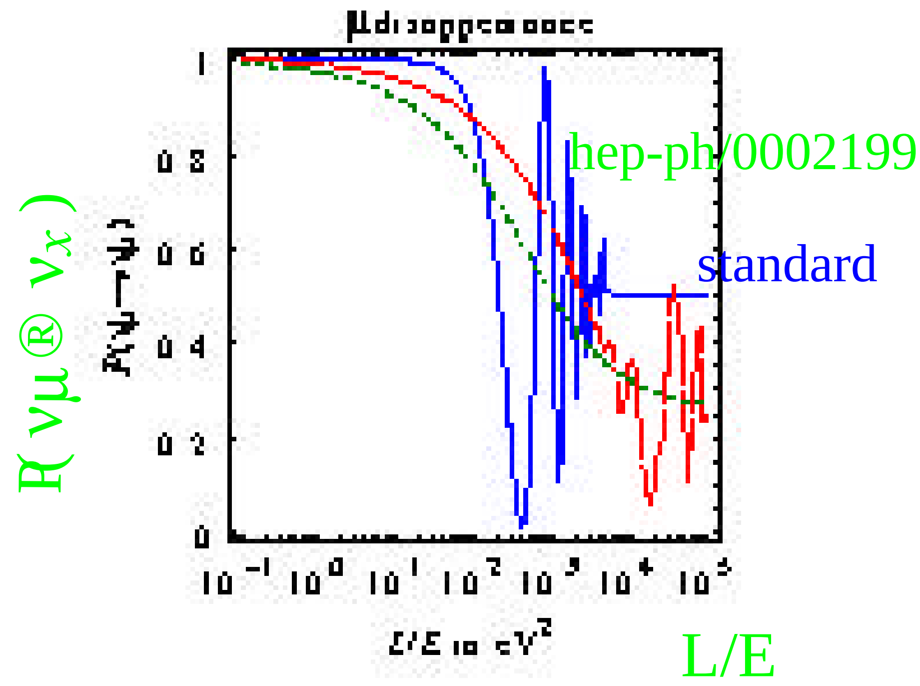
~1



- Dm_{23}^2
  - Mass is a basic parameter.
  - If $m_3 >> m_2$, the measurement is the mass itself which indicates a scale at high energy. <= GUT
- q_{23}
  - $q_{23} = \pi/4$ or NOT (several predictions from GUT)
    - $\sin^2 2\theta = 0.93$ (Yanagida and Fukugita)
      $= 0.81\text{-}0.96$ (J. Pati, hep-ph/0005095)

- Non standard ν oscillation scenario

Large Extra Dimension



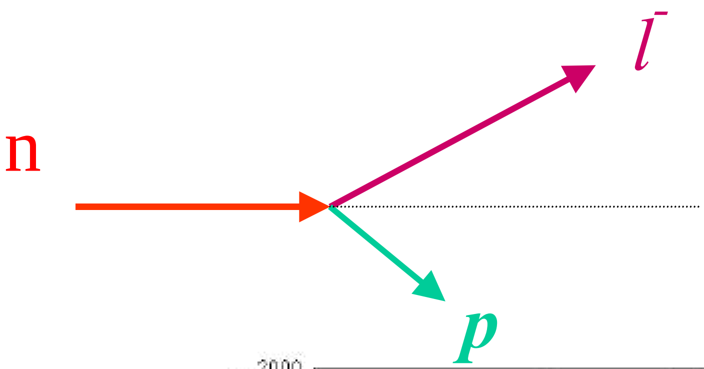
<u>It is important to measure the oscillation patter.</u>

- **Principle of the experiment**
  - Beam energy is tuned to be at the oscillation maximum.
    - High sensitivity — Δm^2= 1.6~4x10^{-3}eV^2
    - Less background — $\boldsymbol{E}_n$ = 0.4~1.0 GeV
  - ~1 GeV ν beam energy is ideal for **Quasi-elastic** interaction.
    - ~60% for WBB, 75~80% for NBB and OAB

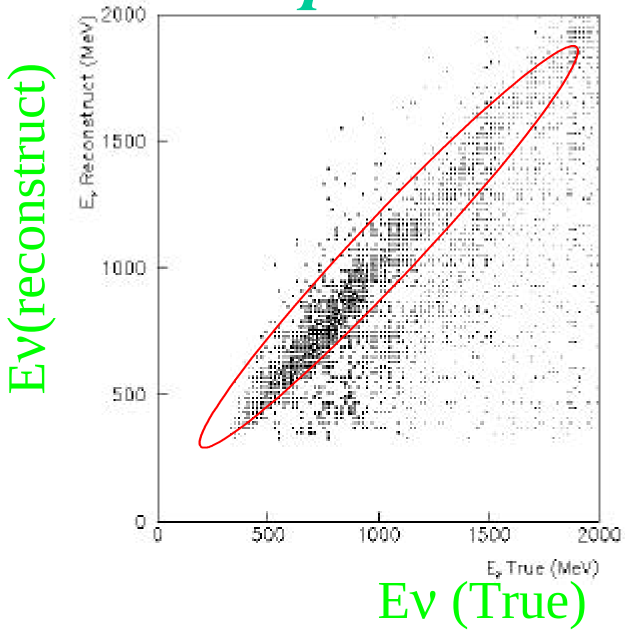
ν energy reconstruction with an assumption of **quasi-elastic scattering**

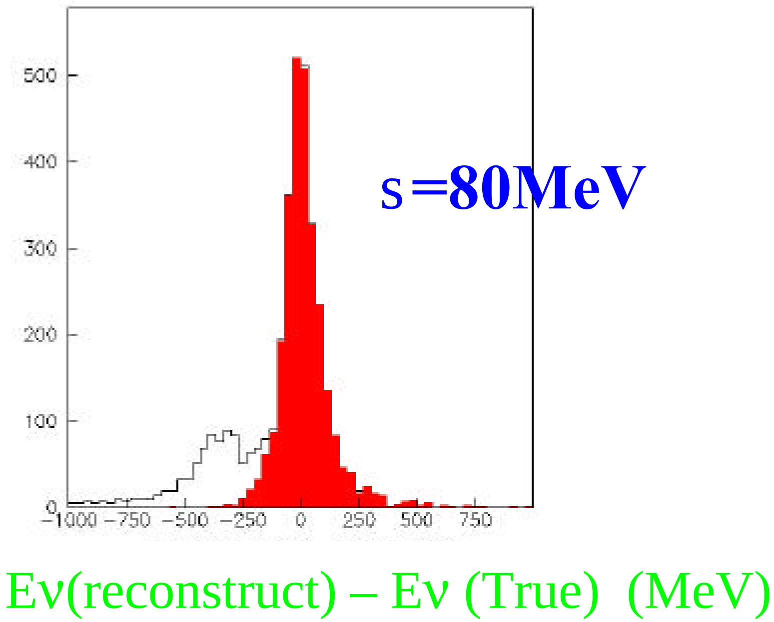
$$\nu_l + n \rightarrow l + p$$

(E_l, p_l)



$$E_\nu = \frac{m_N E_\mu - m_\mu^2/2}{m_N - E_\mu + p_\mu \cos\theta_\mu}$$





2. Analysis and Result

Selection Criteria

- 22.5kton fiducial volume (2m away from the wall)
- Fully Contained Single Ring μ events.
- Pμ > 300 MeV/c (We have to check this again).
- #decay electrons < 2

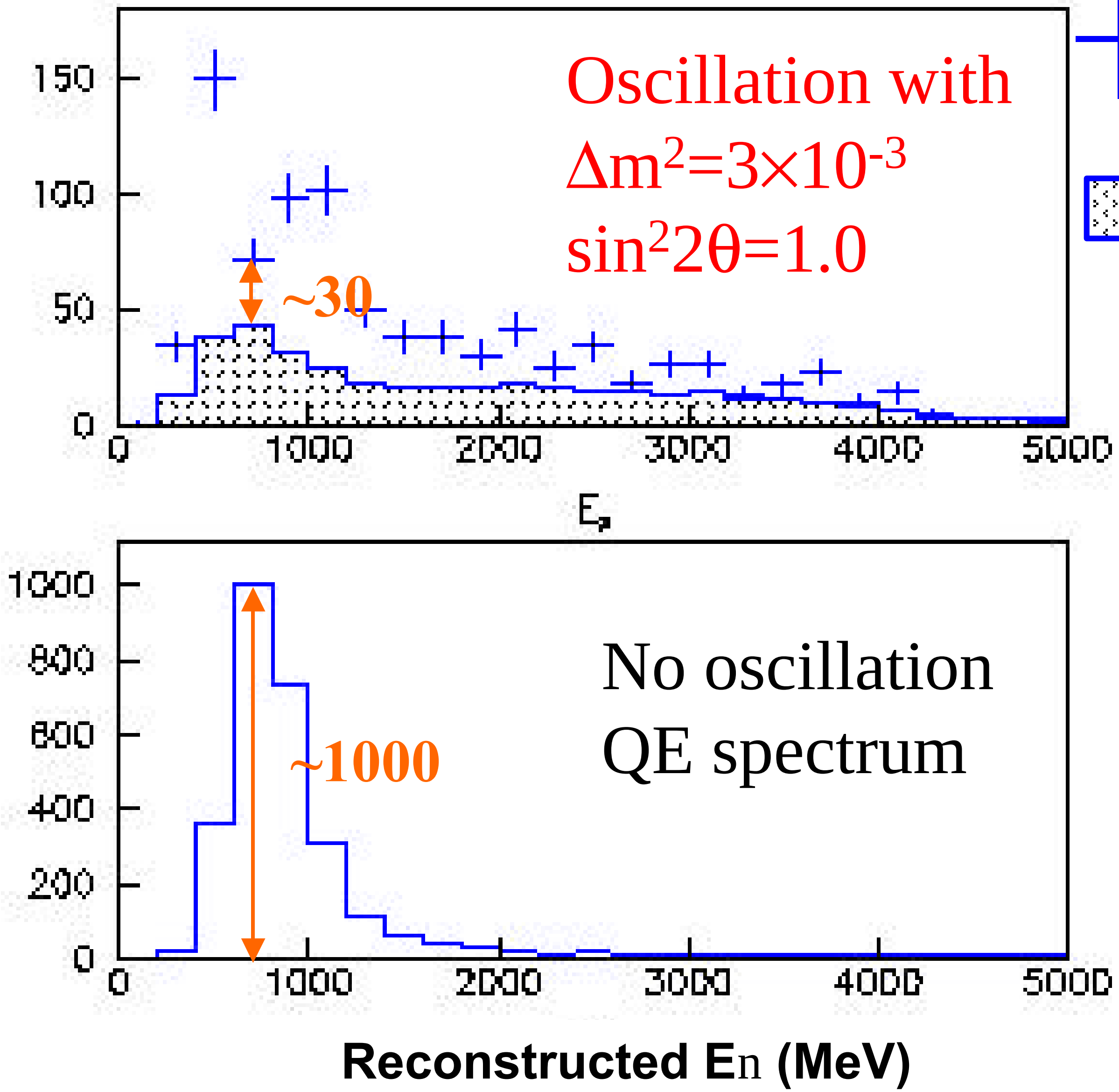
With oscillation,

#events = 3700®860 / 5years for OAB2 (Δm^2=3.5×10^{-3}eV^2)

= 1070®180 / 5years for NBB-1.5 (Δm^2=3.5×10^{-3}eV^2)

= 2900®310 / 5yaers for NBB-3 (Δm^2=5×10^{-3}eV^2)

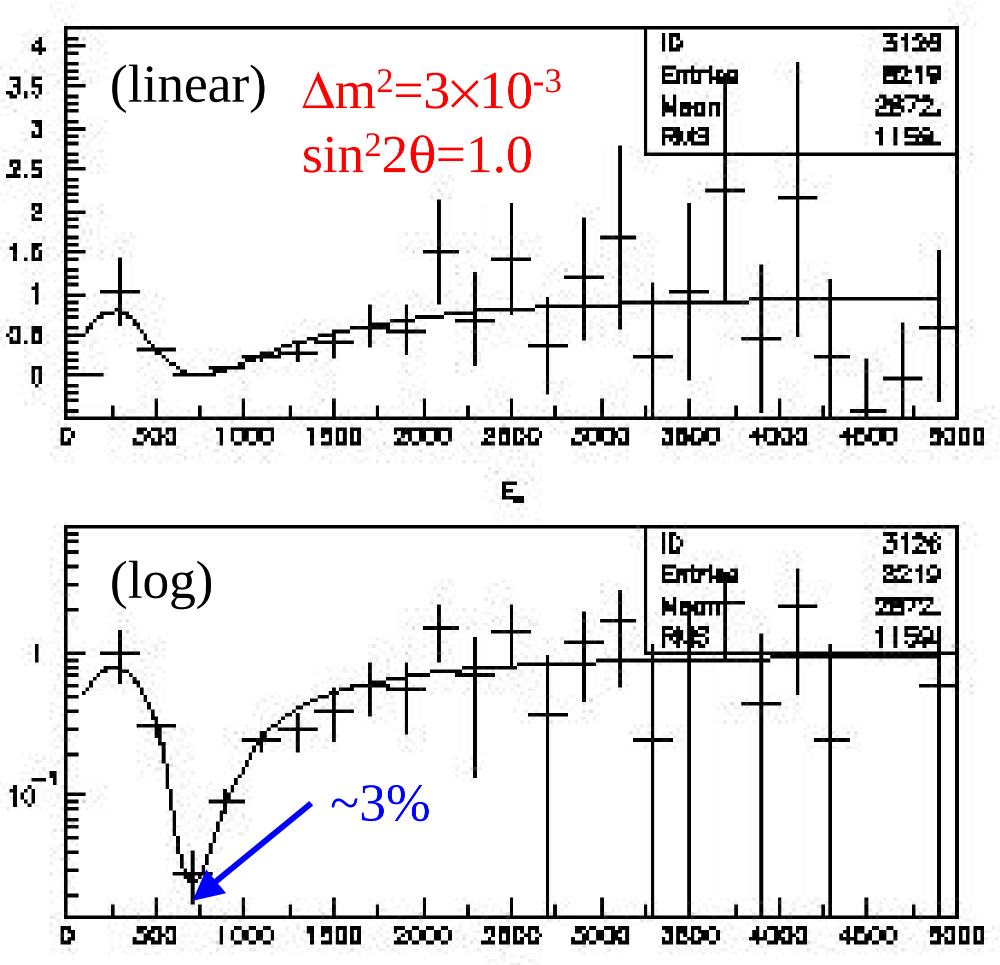
For OAB2 (5 years)



+ Observed spectrum

Non-QE contribution by MC estimation w/ iterations by Δm^2 fit result.

- After non-QE BG subtraction, take the ratio between observed spectrum and the expected QE spectrum.
- Fit the ratio by $1-\sin^2 2\theta \cdot \sin^2(1.27\Delta m^2 L/E)$



Reconstructed En (MeV)

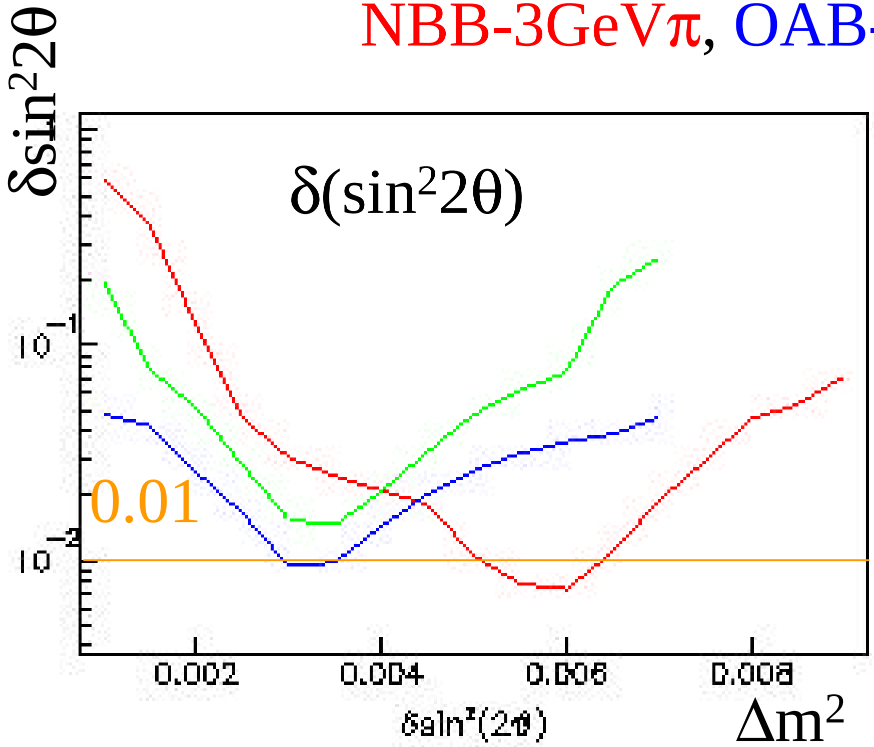
FIT result:

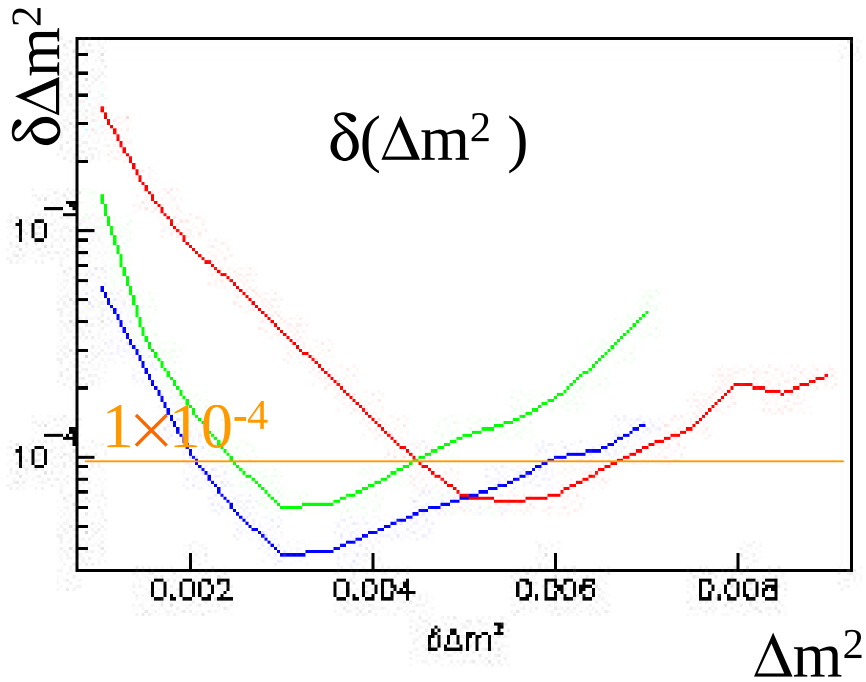
$\Delta m^2=(2.96\pm0.04)\times10^{-3}$

$\sin^2 2\theta=1.00\pm0.01$

Sensitivity for several beam configurations.

NBB-3GeVπ, OAB-2degree, NBB-1.5GeVπ



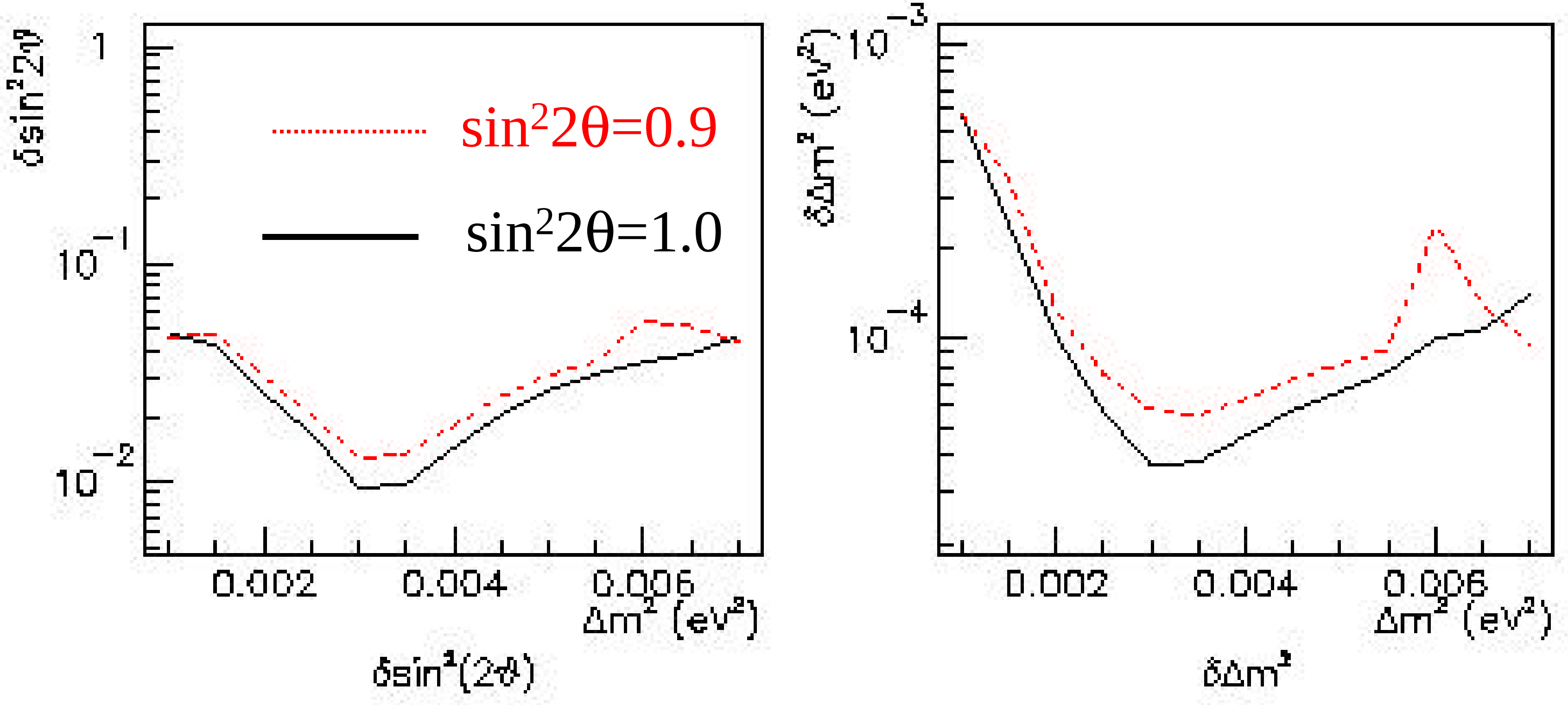


$\delta(\sin^2 2\theta) \sim 0.01$ in 5 years

$\delta(\Delta m^2) \sim < 1\times 10^{-4}$ in 5 years

Sensitivity in the case of $\sin^2 2\theta \neq 1.0$.

OAB2 (5years)



Sensitivity is worse by a factor of ~1.3 (stat. only)

3. Systematic Uncertainty (in the case of $\sin^2 2\theta=1.0$)

1.Non-QE background subtraction. (±20%).

2.Relative flux between FD and SK. (± 10%)

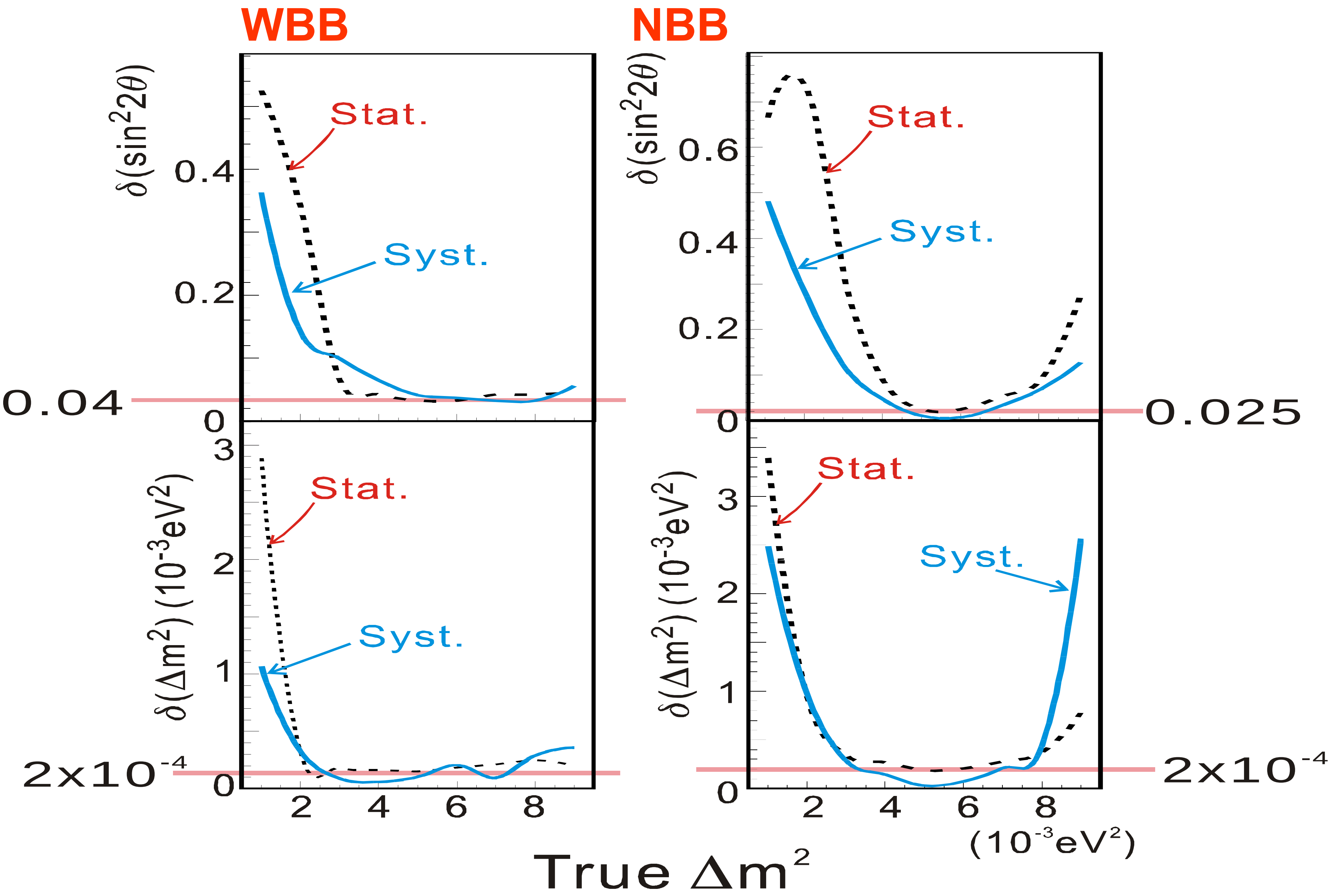
3.Non-linearity in energy measurement. (± 3%)

4.$\Phi_{SK}=(1\pm0.04)\ \Phi(E)_{FD}$, 10% flux increase at 2.5 GeV/c

5. Effect by high energy tail is under study now.

Though WBB is systematic dominant, but NBB is not at the oscillation maximum.

1 year sensitivity



3. Summary and Conclusion

Oscillation pattern will be clearly seen.

Sensitivity (goal) could be:

$\delta \sin^2 2\theta_{23} < 0.01$

$\delta \Delta m_{23}^2 < 1\times10^{-4}\text{eV}^2$

at ($\sin^2 2\theta=1.0$, $\Delta m^2=3.2\times10^{-3}\text{eV}^2$)

Further Study:

- More systematic errors (from far to near ratio?)