Updates of sensitivity study

10/6/2005

2km meeting

1. Current status
2. Sensitive curve
3. Conclusions and Future Plans

Naho Tanimoto

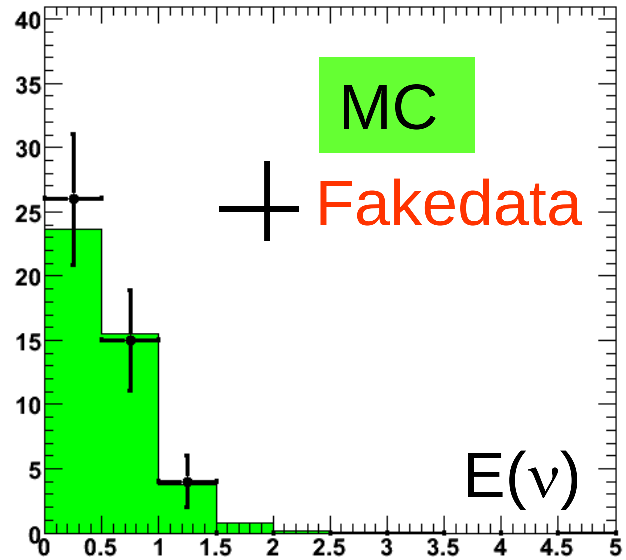
Maximilien Fechner

Chris Walter

Current Status

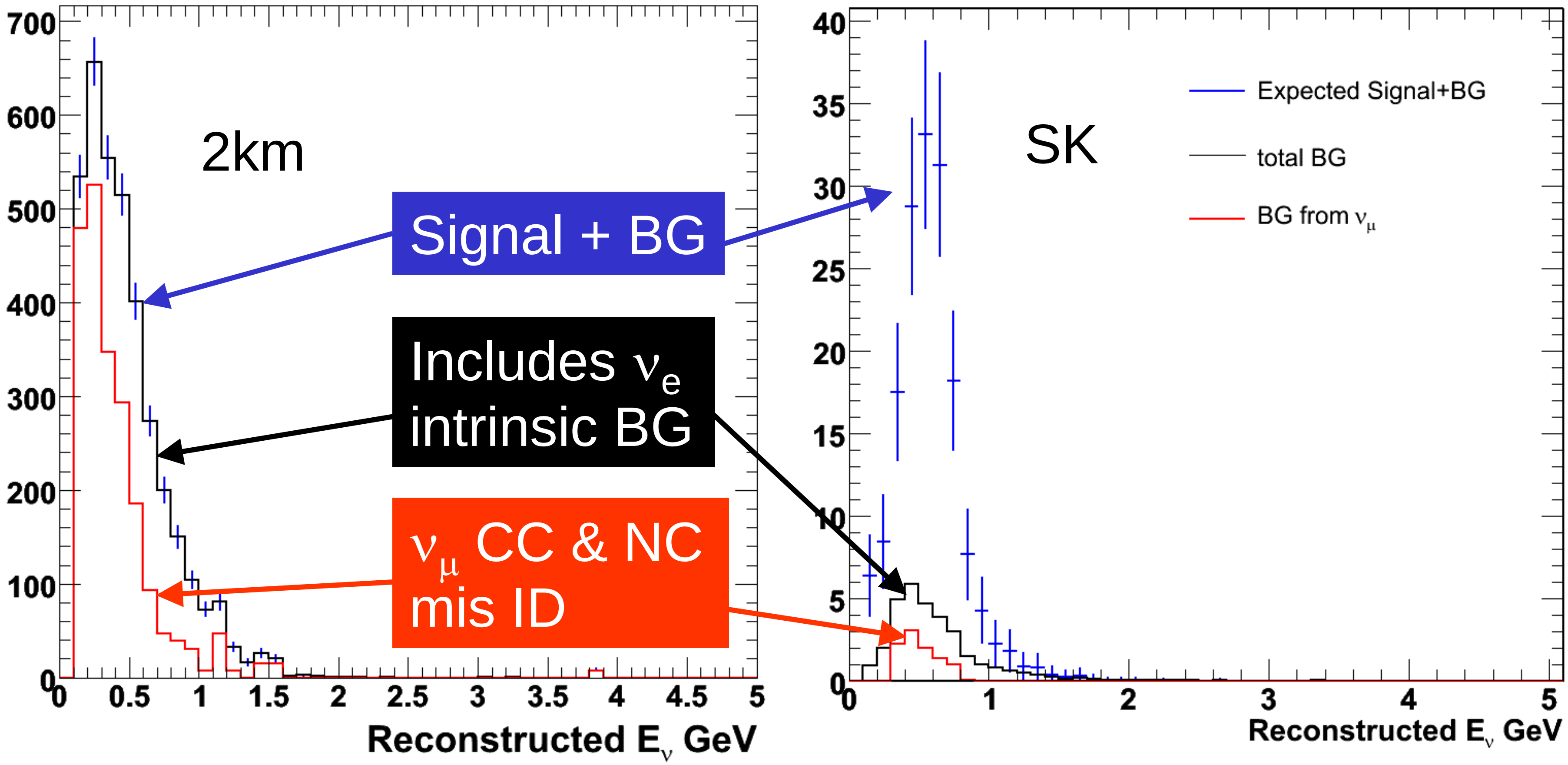
Goal : Do full ν_e sensitivity analysis using both the 2km and SK MC with realistic systematic errors

- MC samples : SK [ν_e, ν_μ] and 2km [ν_e, ν_μ]
- Applied ν_e appearance cuts + $0.35 < E(\nu) < 0.85$ GeV (See next slide)
- For the sensitivity study, generated `fake data' at both of SK and 2km based on non-oscillated $E(\nu)$
  - Generate Poisson random number in each energy bin → Fakedata
  - Centered value of random number is based on rescaled MC with fluctuation given by proper statistics



E(ν) with all ν_e appearance cuts

- ν_e analysis cuts applied
- Fully reconstructed ν_e energy at SK and 2km for 5 yr with $\sin^2 2\theta_{13}=0.1$ and $\Delta m^2=0.0025$

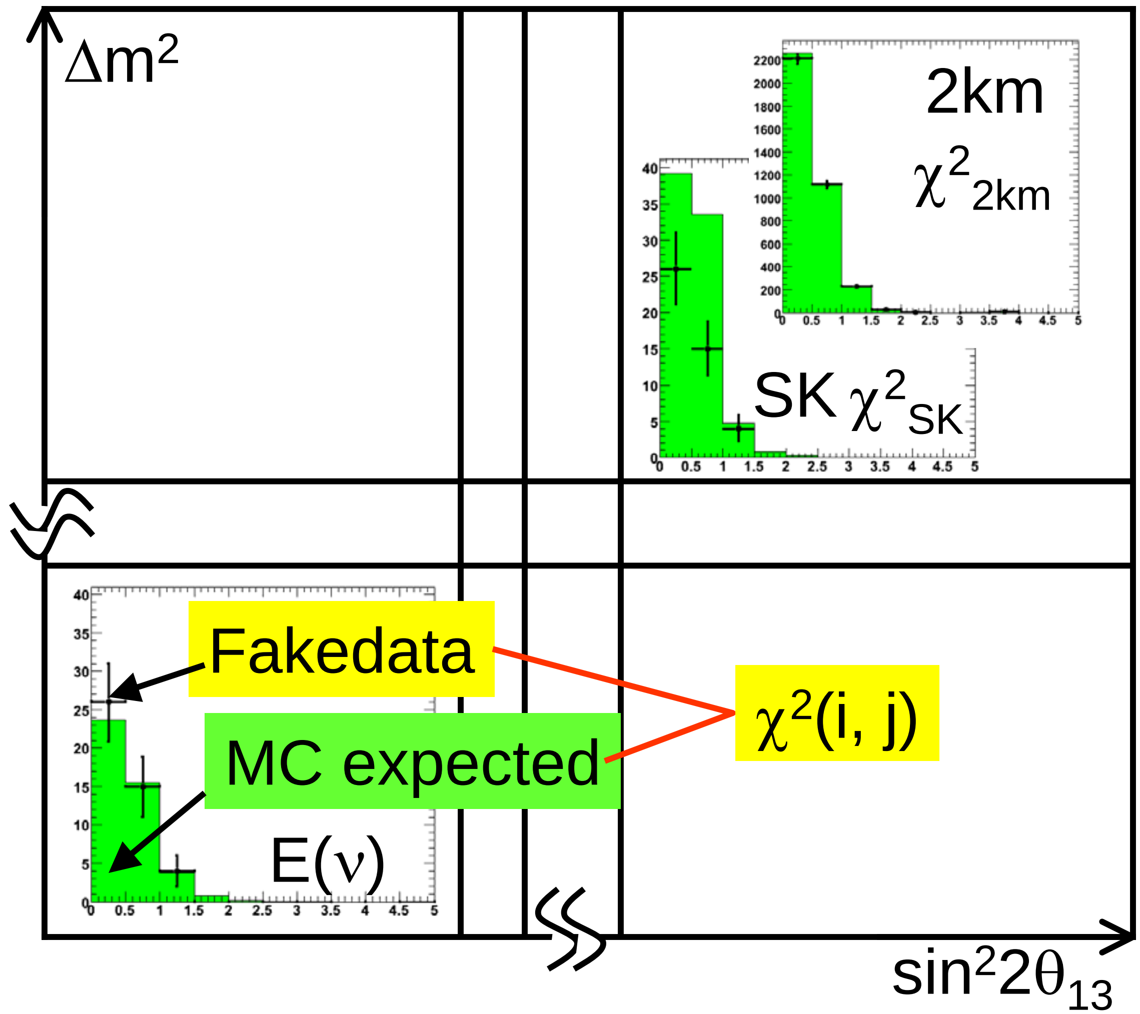


Now we apply cuts correctly

Map of χ^2

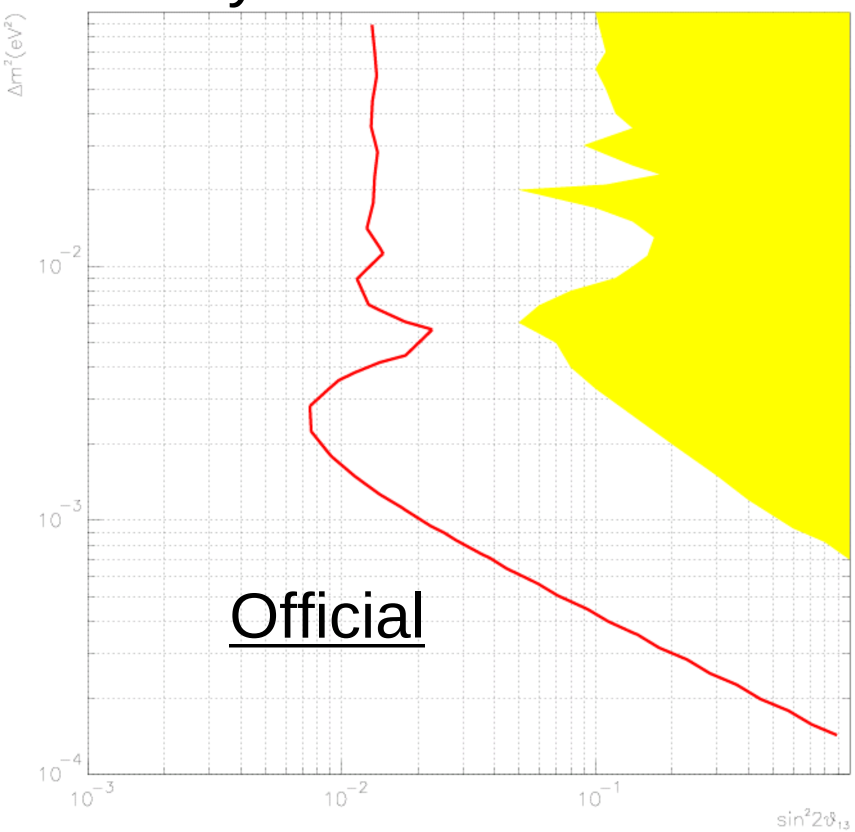
- Made map of $E(\nu)$ histograms at both of SK and 2km in $\sin^2 2\theta_{13}$ and Δm^2 space
- Calculate χ^2 between Fakedata and MC, $\chi^2 = \chi^2_{SK} + \chi^2_{2km}$
- Calculate

$$\Delta\chi^2(i,j)=\chi^2(i,j)-\chi^2(min)$$



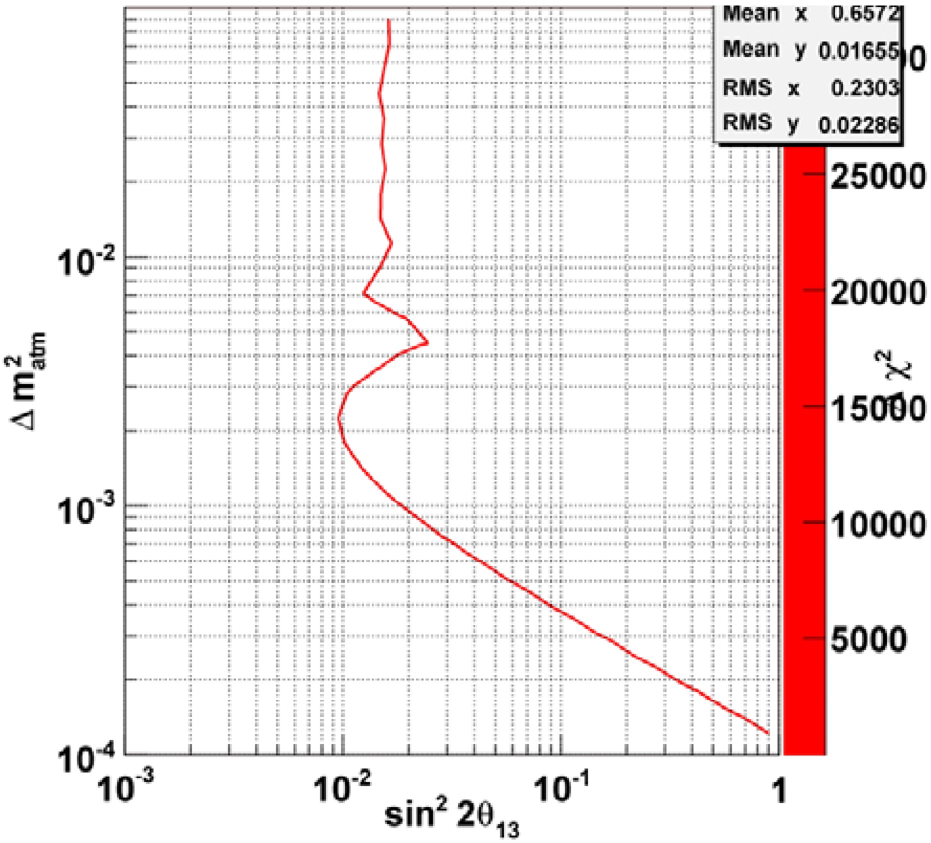
Sensitivity curve at 90% C.L.

With 10% systematic uncertainty
SK only



Based only on # of events

No systematic uncertainty
SK + 2km



Based on of χ^2 energy distribution at SK and 2km

List of Systematic errors

SK atmospheric ν group's pull fit method

$$\chi^2 = \sum_{n=1} \frac{\left(N^n_{obs} - N^n_{exp}(1 + \sum_{k=1}^{K} f^n_k \cdot \varepsilon^k) \right)^2}{\sigma_n^2} + \sum_{k=1}^{K} \left(\frac{\varepsilon^k}{\sigma_k} \right)^2$$

N^n_{obs} : observed, N^n_{exp} : expected, ε^k : systematics

SK:

~~Neutrino flux~~
- ~~flux absolute normalization~~
- ~~flavor ratios(Eν<1.33GeV,Eν>1.33GeV)~~
- ~~anti-neutrino/neutrino ratio(νe,νμ)~~
- ~~Up/down ratio~~
- ~~Horizontal/vertical ratio(3D calc., K/π)~~
- ~~Neutrino flight length~~
- ~~Energy spectrum~~
- ~~Sample-by-sample normalization (FC multi-GeV, PC+up stop μ)~~

Neutrino interaction
- M_A in quasi-elastic and single-pi
- Quasi elastic scattering (model dependence)
- Quasi elastic scattering (cross section)
- single-pion production (cross section)
- multi-pion production (model dependence)
- multi-pion production (cross section)
- coherent pion production (cross section)
- NC/CC ratio
- Nuclear effect in ^{16}O
- Charged current ν_τ interactioin

(C) Event selection
- a. FC reduction
- b. PC reduction
- c. Up-μ detection efficiency
- d. FC/PC relative normalization
- e. Hadron simulation
- f. Non-ν BG (e-like, μ-like)
- g. Through-going/stopping μ separation

(D) Event reconstruction(6)
- a. 1-ring/multi-ring separation
- b. Particle ID (single-ring, multi-ring)
- c. Energy calibration for FC
- d. Energy cut for upward stopping μ
- e. Up-down asymmetry of energy calibration

Total number of errors: 36

Treated as independent error term in χ2 calculation

Saji's talk at Noon2004

+ T2K related :
- 2km detector
- ….

Conclusions and Future plan

Conclusion

- Made ROOT based analysis framework
- Fake data generator is implemented
- Made sensitivity curve without systematic uncertainty

Plan

- Started to incorporate systematic uncertainties using SK Atmospheric ν group's pull fit method
- Systematic uncertainties (two ways)
  - Calculate correlations between systematic errors and solve equations analytically
  - Use MINUIT to minimize χ^2 for systematic errors
- Generate a lot of fakedata histograms → Average of χ^2
- Flat beam intensity profile in time → Use time dependent intensity
- Add more histograms to constrain systematic errors (i.e. π^0 BG, intrinsic ν_e BG)