ND @ 2km for HK

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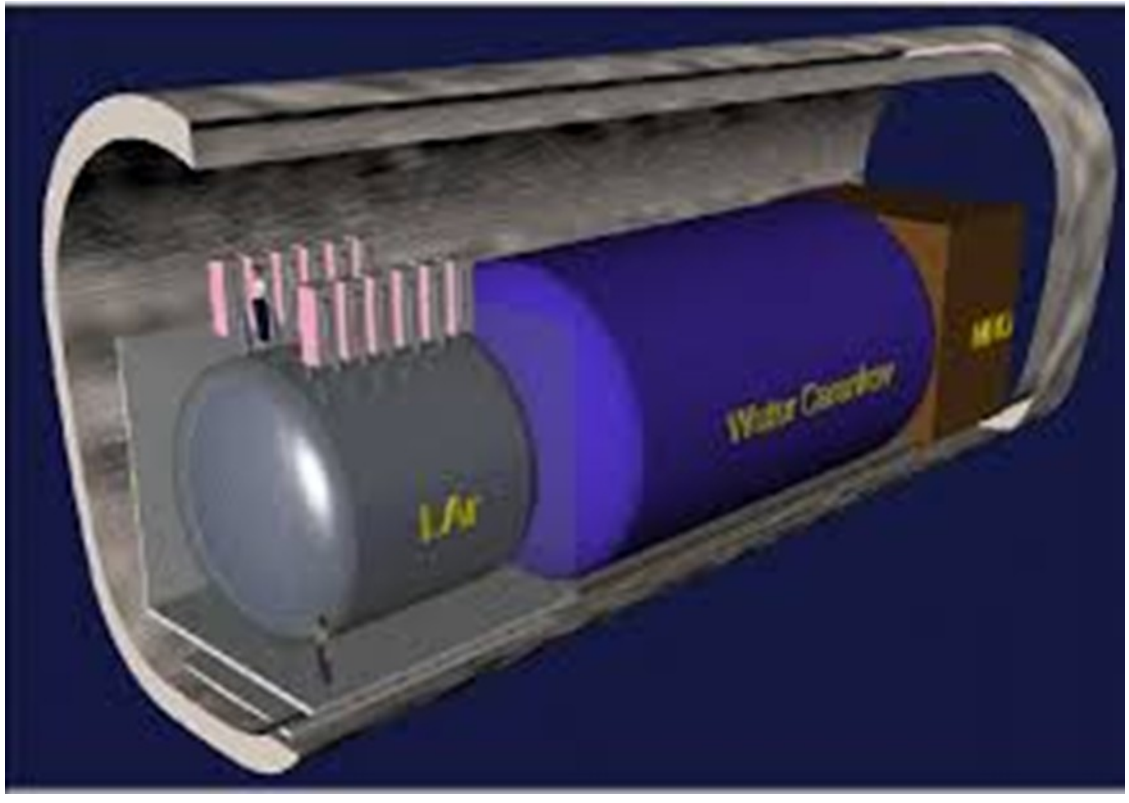
ND HK working group meeting
July 11th, 2013

Aims

- What we aim to do is to investigate the potential of a possible 2km ND
  - This means looking at the error reduction at the far detector
- The starting point is the 2007 2KM Design Report
- At the moment we started to investigate the potential of having a WC 2KM detector, then expand to a precise detector for xsection/ν_e measurements and/or a muon catcher
- Unlikely using a LAr detector due to a different nucleus than Oxygen



- In today's presentation we will concentrate on an outline of the planned study

Planning

- Implement method to investigate error reduction due to the 2km detector (see next slides)
- Focus on a WC "standard" detector (starting w/ a 1kton) - later on more configurations will be studied
- Ingredients:
  - 2km/SK beam fluxes (Mark: thanks!)
  - Reconstructed events at 2km and HK
  - Selection: use a "standard" SK selection
  - Error implementation in near-to-far extrapolation: use similar error propagation method as in T2K
- Timeline:
  - ~Now: develop method
  - July/August: aim for small production at 2km (SKDsim)
  - July/August: quantify improvement/optimize size basic detector
  - September-December: finalize study

Note on MC Production

- Francesca in contact with s/w group produce events on the Grid
- Look at:

http://www-sk.icrr.u-tokyo.ac.jp/indico/getFile.py/access?sessionId=3&resId=0&materialId=0&confId=1409

- Just finalizing DNS, needed to get the HK VO for the Grid
- Files will be retrieved using the iRODS data management system (no need to have the Grid certificate)

- As ND group we can make a request of MC to be produced, e.g. 2km detector – unless early studies are negative.

Strategy to use 2km ND spectrum

- Extend the "T2K near detector fitting method" to a 2km ND.
- Use the factorization method to include the 2km detector too:

$$L(b, x, o|M^{ND280}, M^{2km}, M^{SK}) = L(b, x|M^{ND280}) * L(|b, x, o|M^{2km}) * L(|b, x, o|M^{HK})$$

M^X= data of detector X, b,x,o = beam, xsection, osc. params

- The probability distribution at 2km should be combined with the one from ND280.
- The SK oscillation probability should be combined with the probability at ND280 and 2km.
- In total the contributions to the HK fit from the near detectors will be the xsections/beam parameters and the predicted background.

Contribution from the 2km to HK

The rate prediction at HK can be written explicitly in terms of flux predictions, cross section predictions and detector efficiencies:

$$N_{HK} = N_{2km} \frac{\sum \sigma_j \epsilon_j \phi_i}{\sum \sigma_j \epsilon_j \varphi_j}$$

When looking at the systematics errors, due to the flux, xsection and efficiency, the errors are reduced due cancellation in the ratio.

- Next:
  - estimate what background components @ 2km can be measured
  - estimate possible errors and correlation and check error improvement at the FD

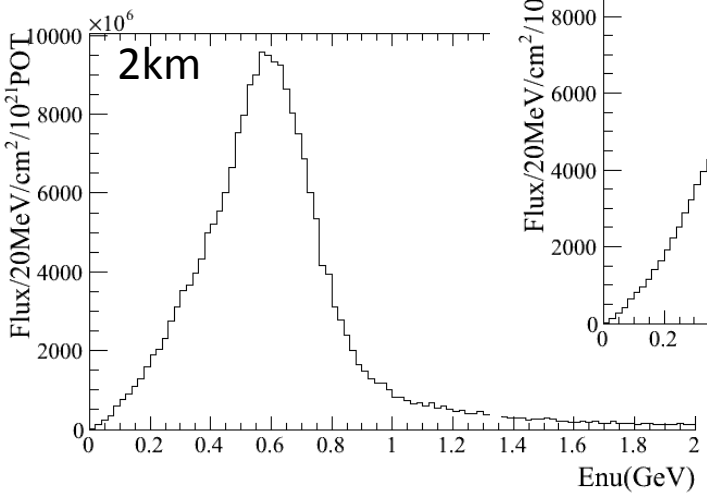
Neutrino Energy Bin and Flavour Selection

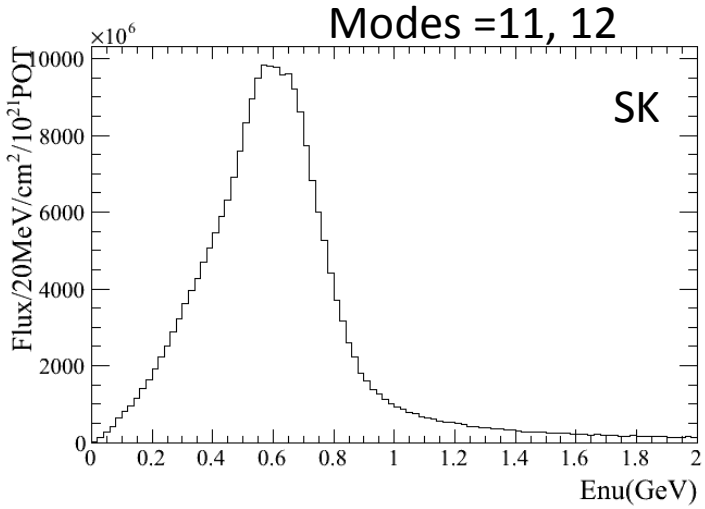
Binning of neutrino energy as in beam group release

Bin Width (GeV)	0.1	0.2	0.5	1.0	2.0
Range of Values (GeV)	1 – 2.4	2.4 – 4.0	4.0 – 5.0	5.0 – 8.0	8.0 – 10.0

Neutrino flavour selected using mode cuts

- ν_μ: 10<mode<20
- anti-ν_μ: 20<mode<30
- ν_e: 30<mode<40
- anti-ν_e: 40<mode<50



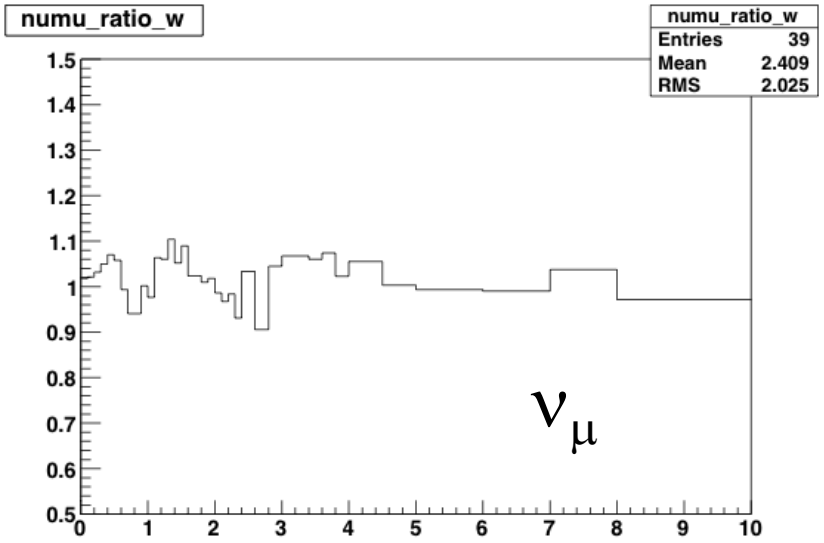


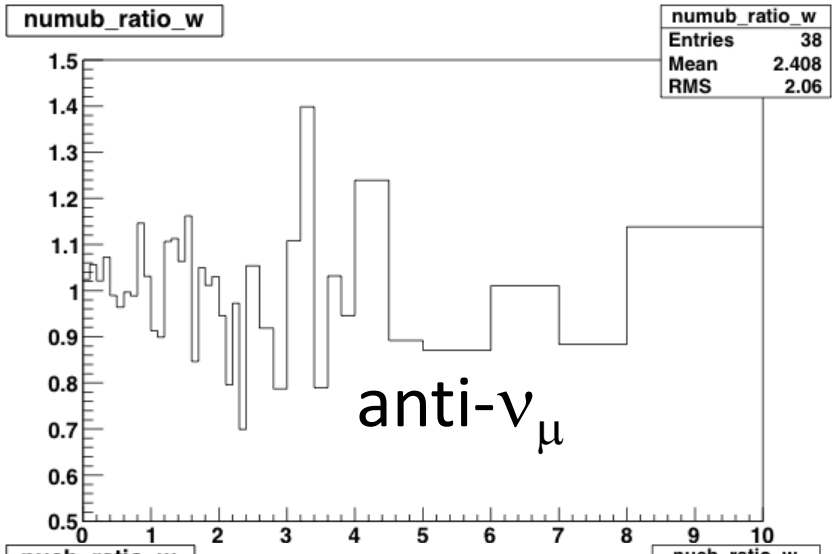
as defined in
http://www.t2k.org/beam/NuFlux/FluxRelease/11arelease/ntpdef

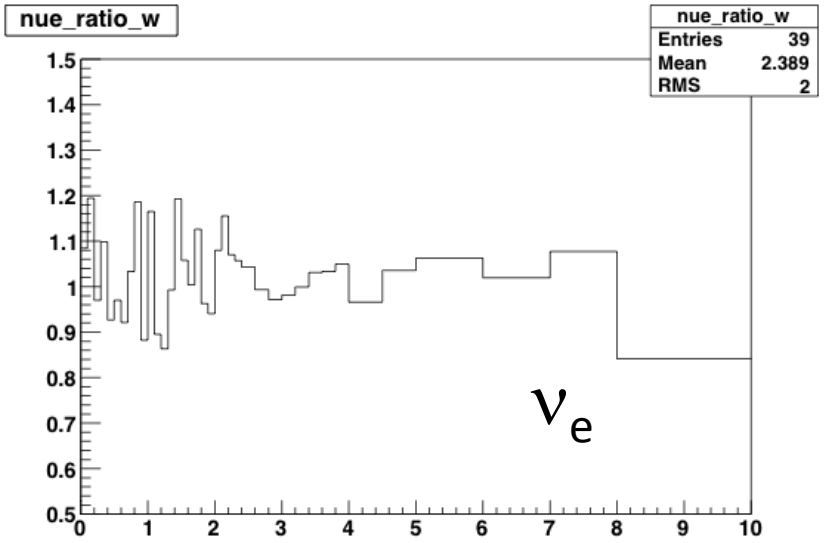
Ratio Histograms

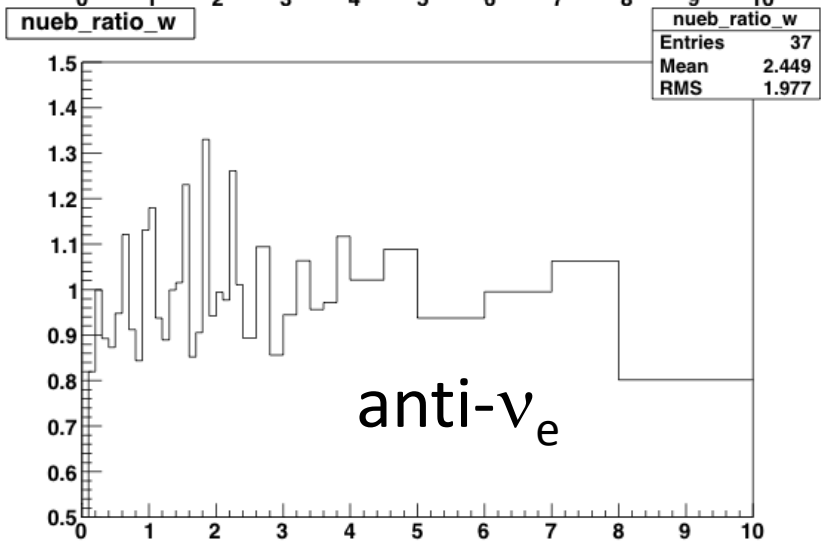
Ben

F/N ratio









E_ν (GeV)

Conclusions

- Establishing method to assess the 2km ND
- Will use SK and possibly small 2km ND production to make first studies

Normalizations for Fluxes

SK:

- POT – number of files 1/985
- Binning – divided through by relative bin width / 0.1 GeV
- Distance – L^2_{SK}/L^2_{2km} 21756.25

2km:

- POT – number of files 1/985
- Binning – divided through by relative bin width / 0.1 GeV
- Conversion to cm^2 9.988 $x10^{-07}$ (log files)
- Enforced angular selection (ynu>(-871-500) && ynu<(-871+500))