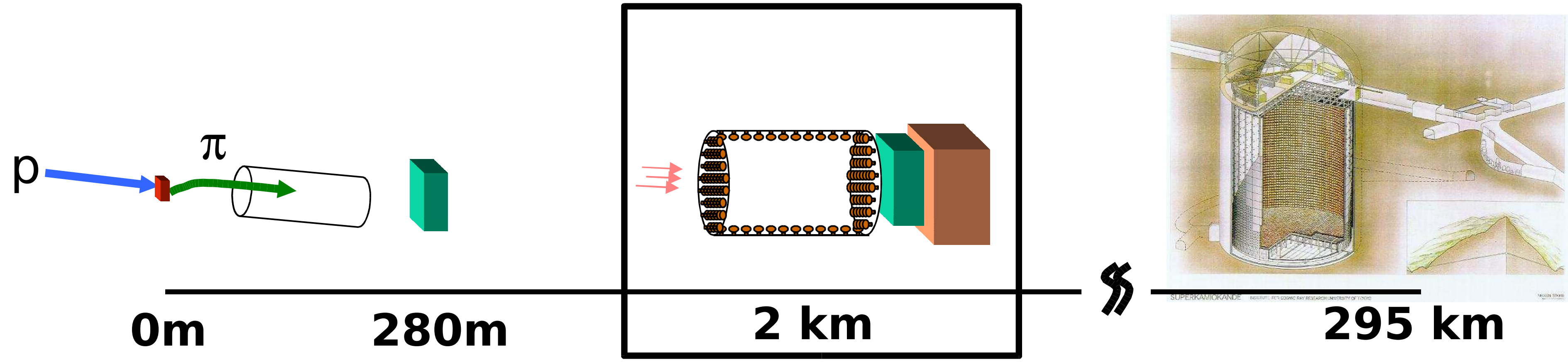
T2K 2km Detector



- The addition of a 2km detector to T2K will:
  - Measure energy spectrum with almost the same ν beam as seen at SK.
  - Measure interactions on water with the same technique and algorithms as in Super-K.
  - Measure the neutral current pion and intrinsic electron neutrino background for ν_e appearance search.

Reduce systematic uncertainties

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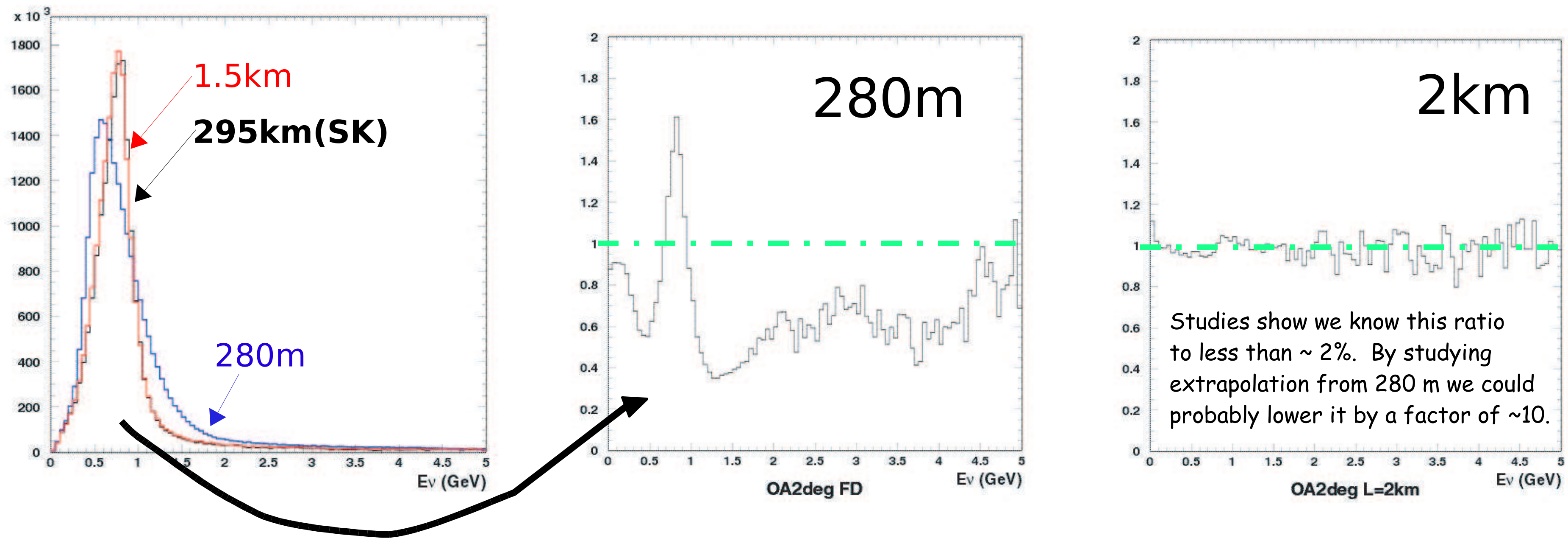
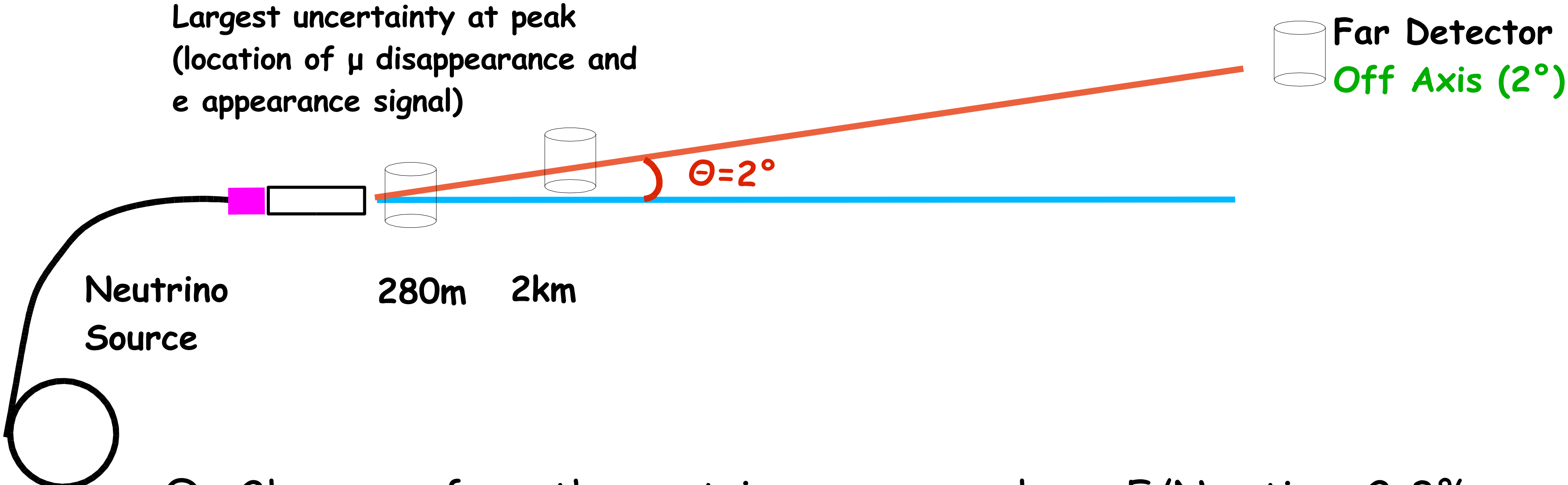
SAGENAP 04/04

Far/Near ν Flux Ratio vs. Detector Distance

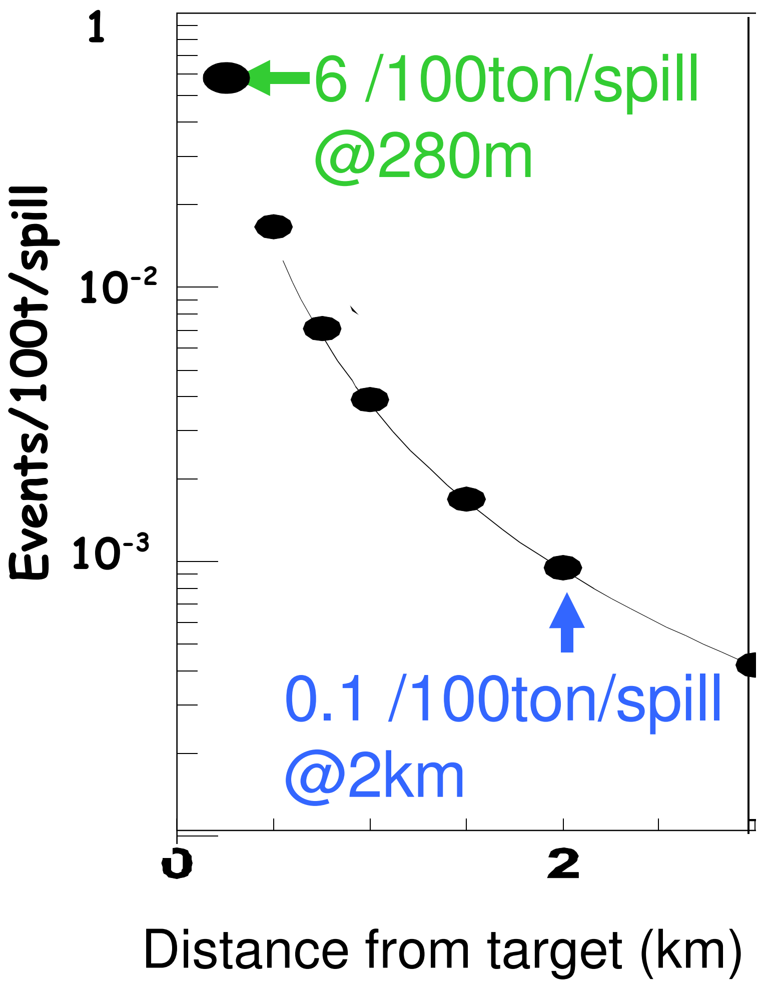


Largest uncertainty at peak (location of μ disappearance and e appearance signal)

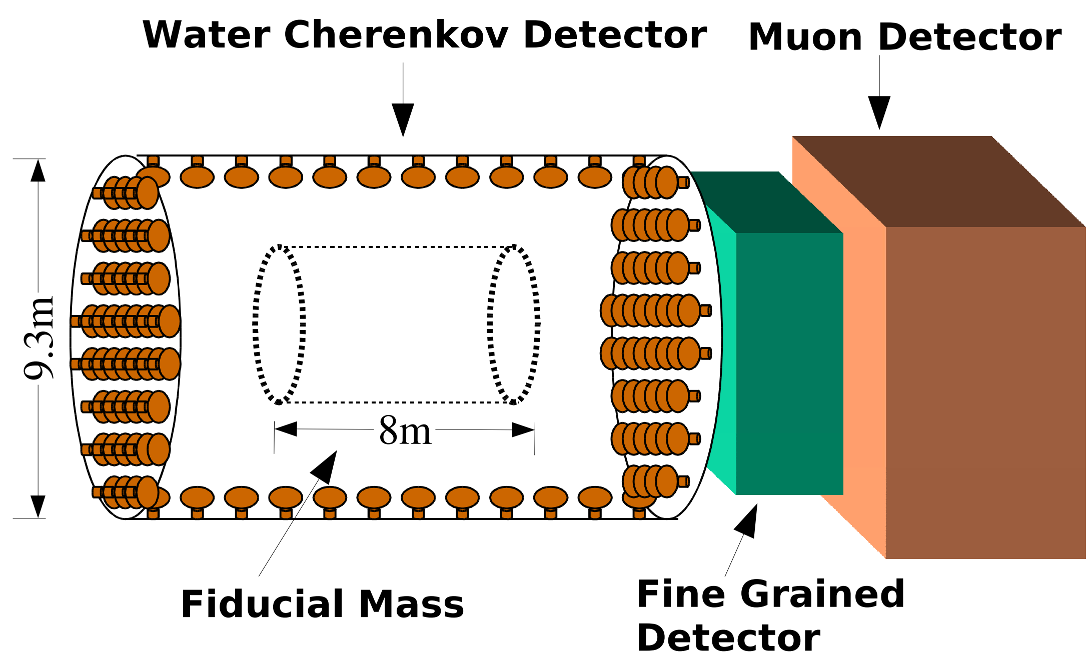


@ ~2km away from the neutrino source we know F/N ratio ~ 2-3%

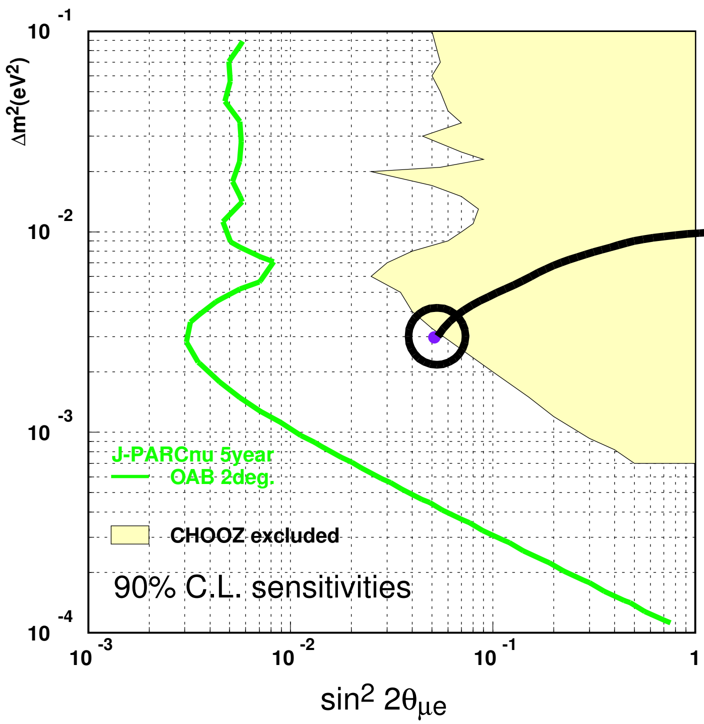
Measuring the ν interactions in water



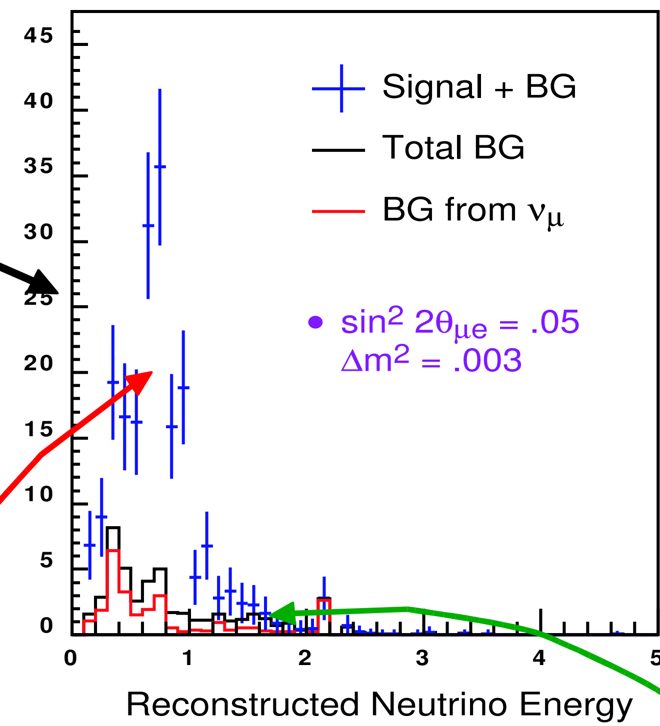
- Need to measure ν interactions on H_2O.
  - Large water Cherenkov detectors work best with single interactions
  - At location where F/N ratio is flat the event rate is ~1/spill for a mass of ~ 1kton
  - Natural extension of SK group's work.



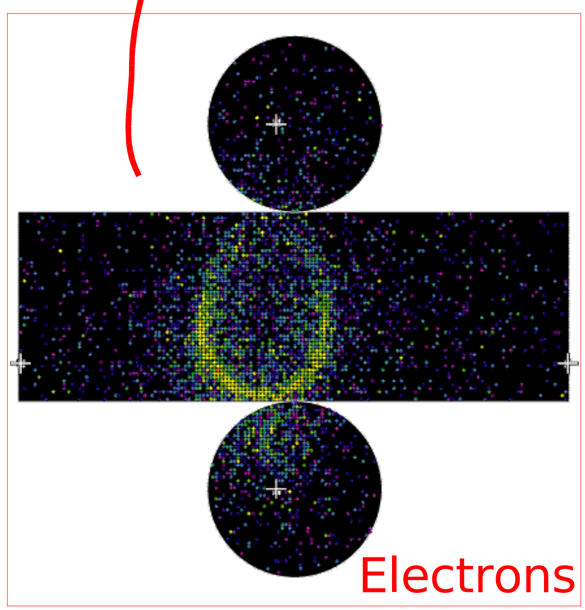
Total Mass ~ 1000 tons

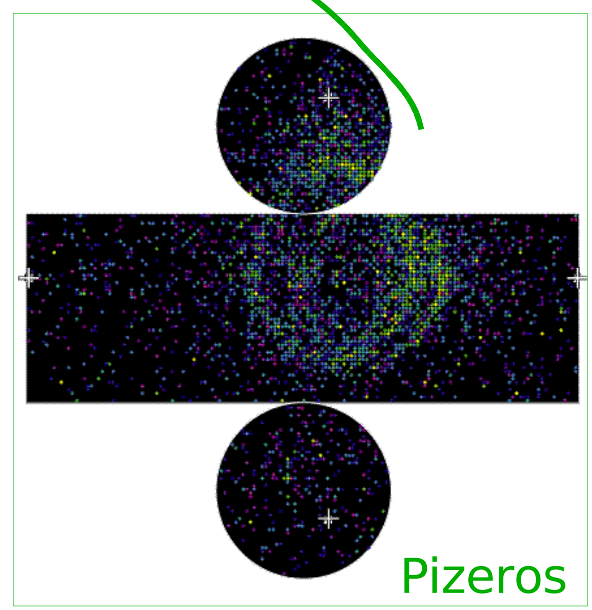


Expected Signal



Electron Appearance Search



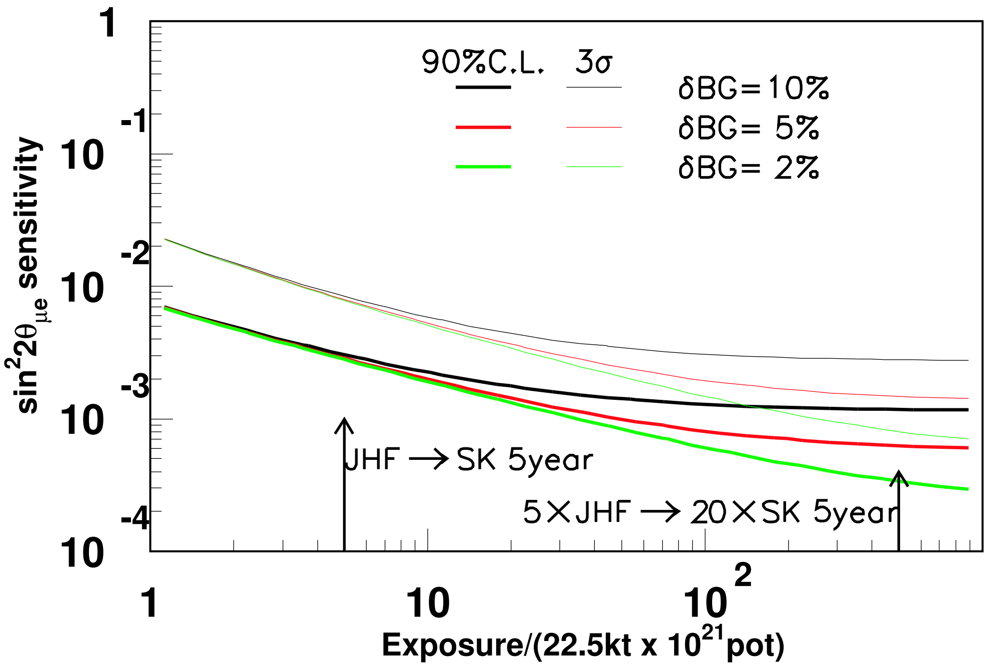


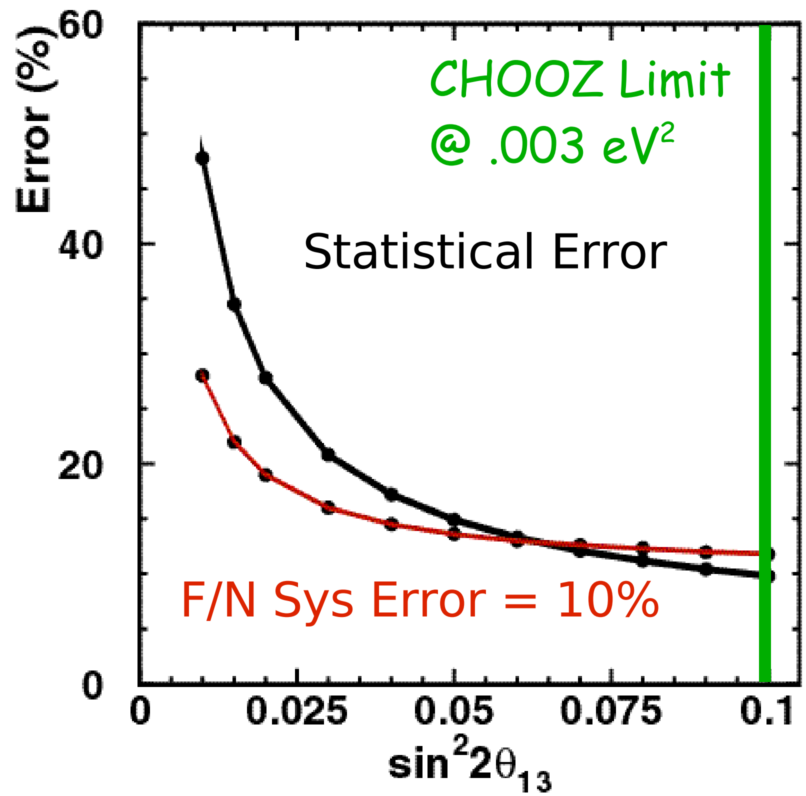
Signal: ~40% efficient
BG: 10 evts/5 yrs beam ν_e

BG: 11 events/5 years

If possible we should <u>measure</u> BG in beam before oscillations.

Expected Sensitivity of Electron Appearance Search

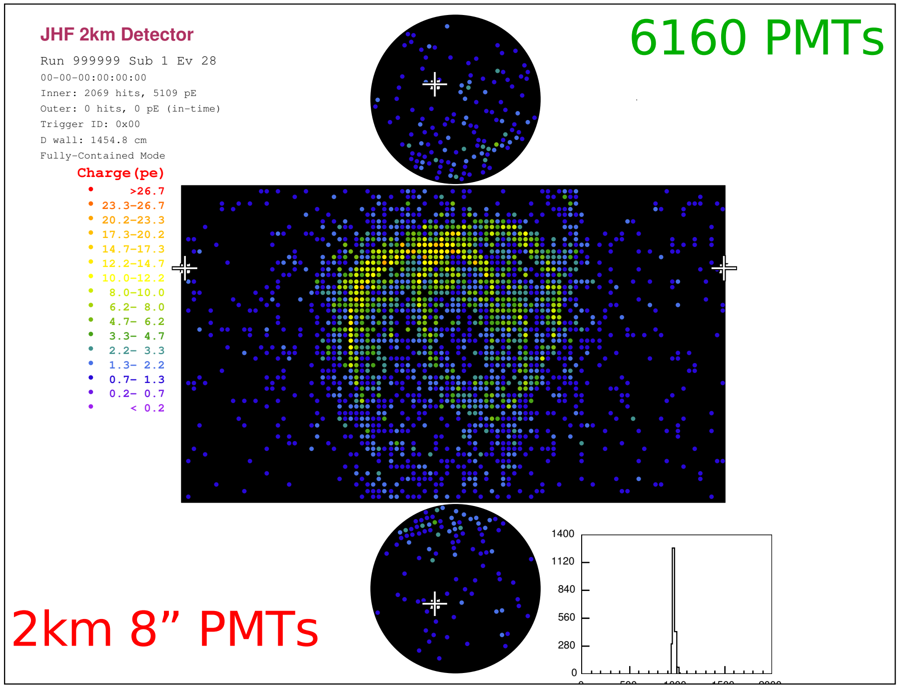




For JPARC-I the TOTAL BG error should be ~< 10%.

Near the CHOOZ limit in order to not be limited by systematic error the error on the F/N ratio should be ~< 5%

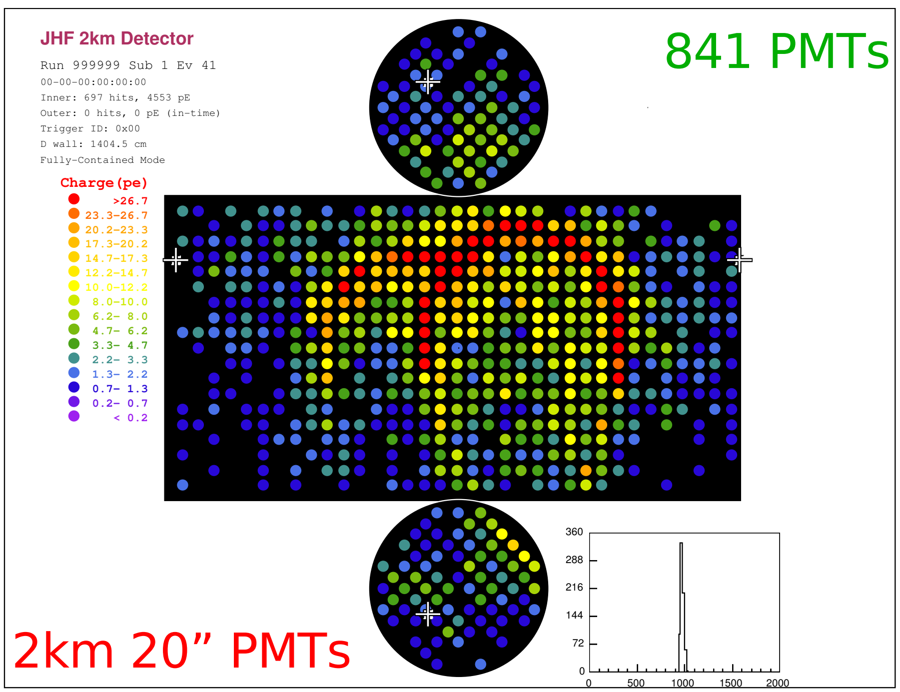
To maximize potential we should try to control the F/N ratio to <~ 5%

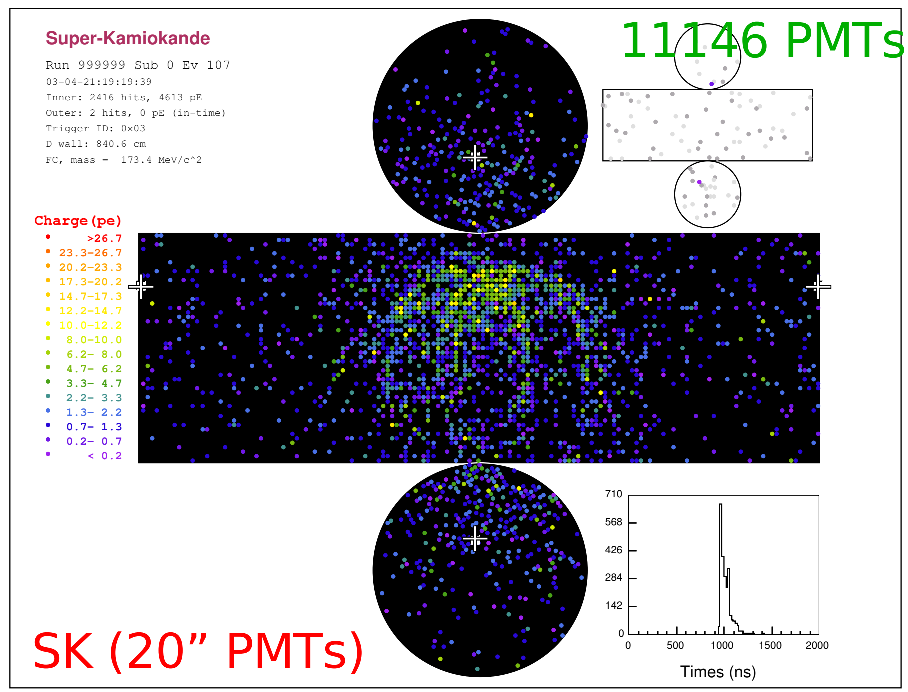


Full Geant4 simulation of 2km detector is being used to optimize the design.

(Try to match performance of SK and 2km - one example: PMT Size)

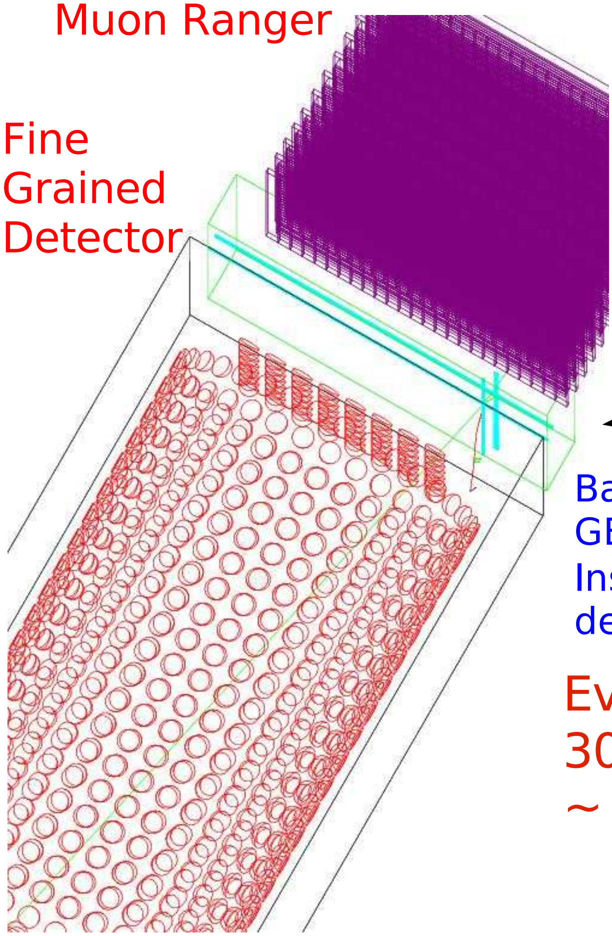
[Validating MC with SK and K2K MC/Data]

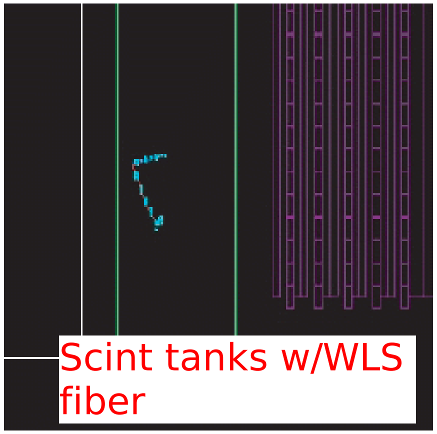




Other 2km detector elements

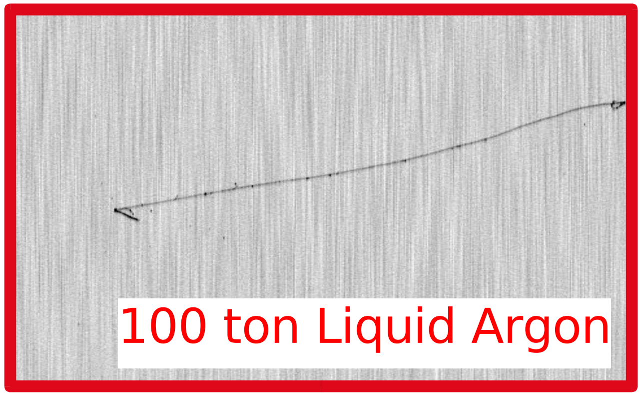
Good opportunity for new groups to get involved.

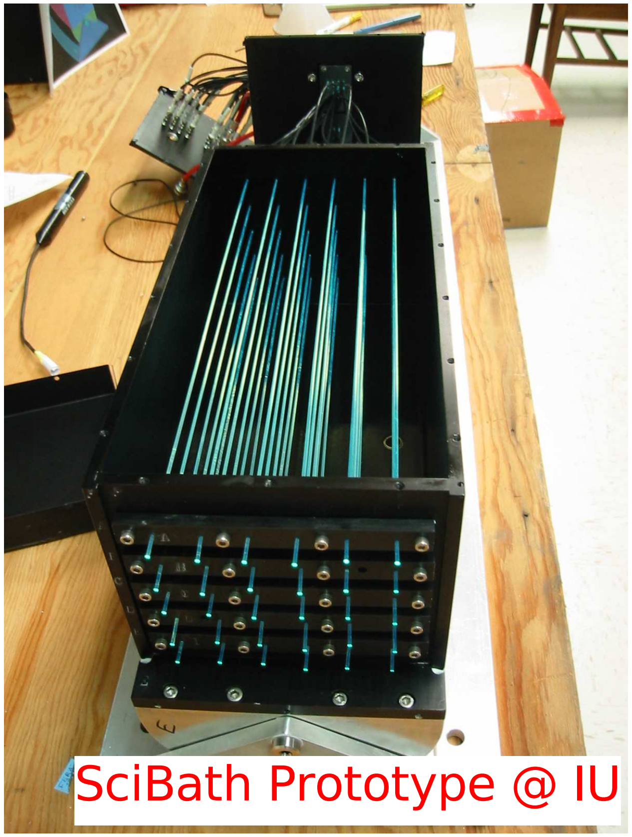




Baseline design in GEANT 4 now. Inspired by NovA design

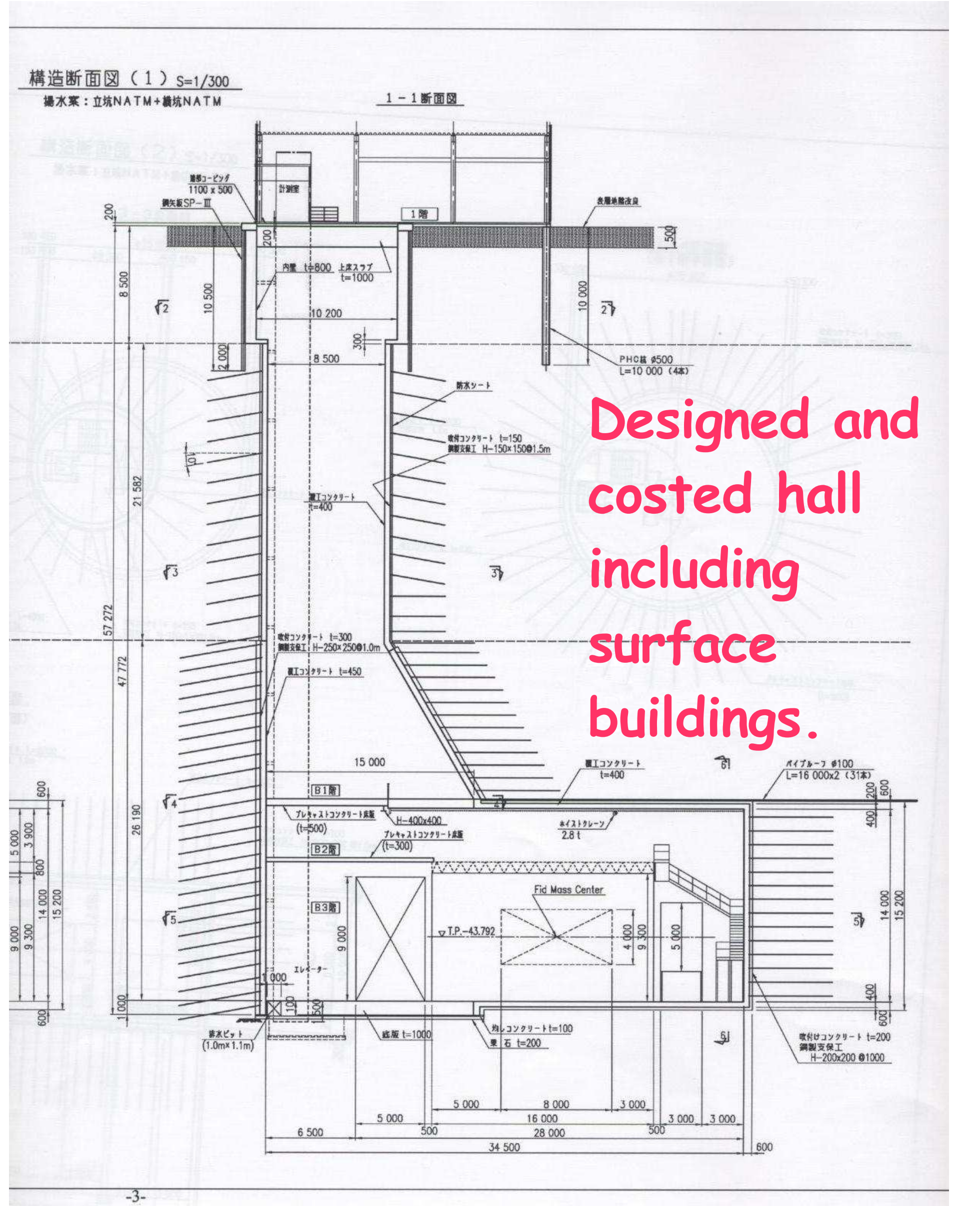
Event Rates in 100 tons:
300,000/(yr=10^{21} pot):
~ 100 x SK rate





- Use to measure neutrino flux with QE events
- Use to measure exclusive nonQE cross sections

Site has been identified @ 1.84 km



Members of 2km working group and interested parties.

SUPER-K

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LSU: S. Dazeley, B. Metcalf, R. McNeil, B. Svoboda

SUNY SB: C. McGrew

UCI: D. Casper, B. Kropp, S. Mine, M. Smy, H. Sobel

U. Wash: J. Wilkes

Warsaw: D. Kielczewska

T2K

Alabama: J. Busenitz, I. Stancu

INR: A. Butkevitch, M. Khabibullin

INFN Napoli: V. Palladino, M. Mezzetto

U. Penn: G. Beier

Saclay: C. Cavata, J. Bouchez, M. Fechner

Expressed Interest

IU/Fermilab: R. Tayloe, B. Fleming
Finesse SciBath

Napoli/Zurich: A. Rubbia, A. Ereditato
Liquid Argon

Conclusions

- Adding a detector at 2km will reduce the systematic errors for the experiment and allow us to measure backgrounds and cross-sections in the same beam and with the same target as Super-K.
- Monte Carlo studies are now underway to optimize the design of the 2km detector
- At present the 2km detector is not in the base budget of the T2K experiment. We hope to assemble an international team to build and operate this upgrade to T2K.