

# Acceptance Studies of the Combined 2KM Detectors

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tools used:

- 2KM vectors

</net/sukfs1/k2k/hayato/jfs/vects/h2o.neut4.4.jparc.nd1.00?.dat.nfsi.nt>  
for now: select only CC  $\nu_\mu$ , study outgoing  $\mu$  only

- GEANT4 + simple simulation

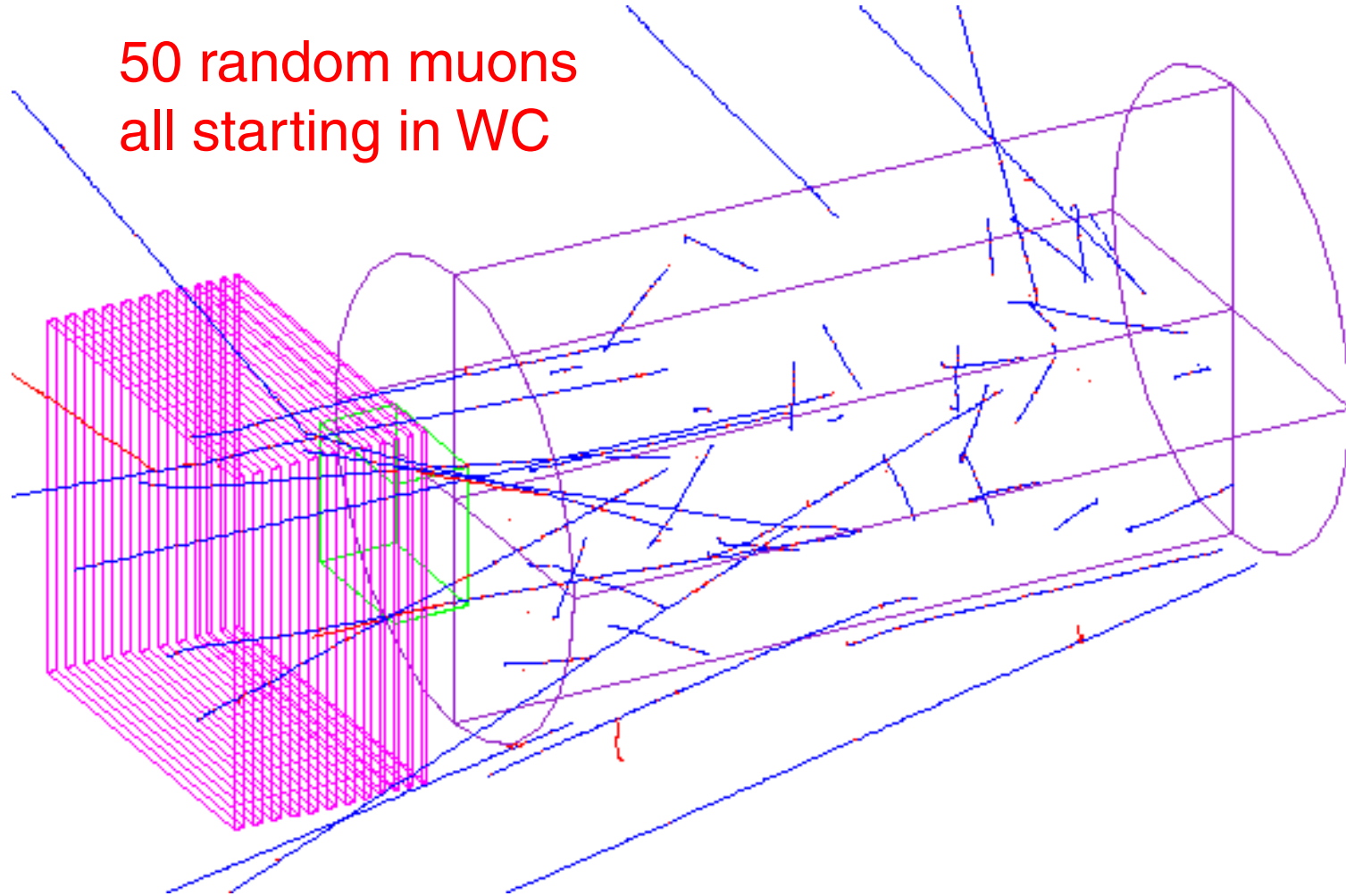
GEANT4 is a complete object oriented C++ rewrite of GEANT3  
GEANT3 may not be supported by the time of J-PARCnu

main question addressed today:

- Should 2KM detector order be FGD-WC-MRD or WC-FGD-MRD ?

# GEANT4 Simple Model

50 random muons  
all starting in WC



(WC)

- Water Cherenkov: 17m long x 9.7 m diameter  
FV is 13m long x 5.7m diameter, for FCFV use first 10m only

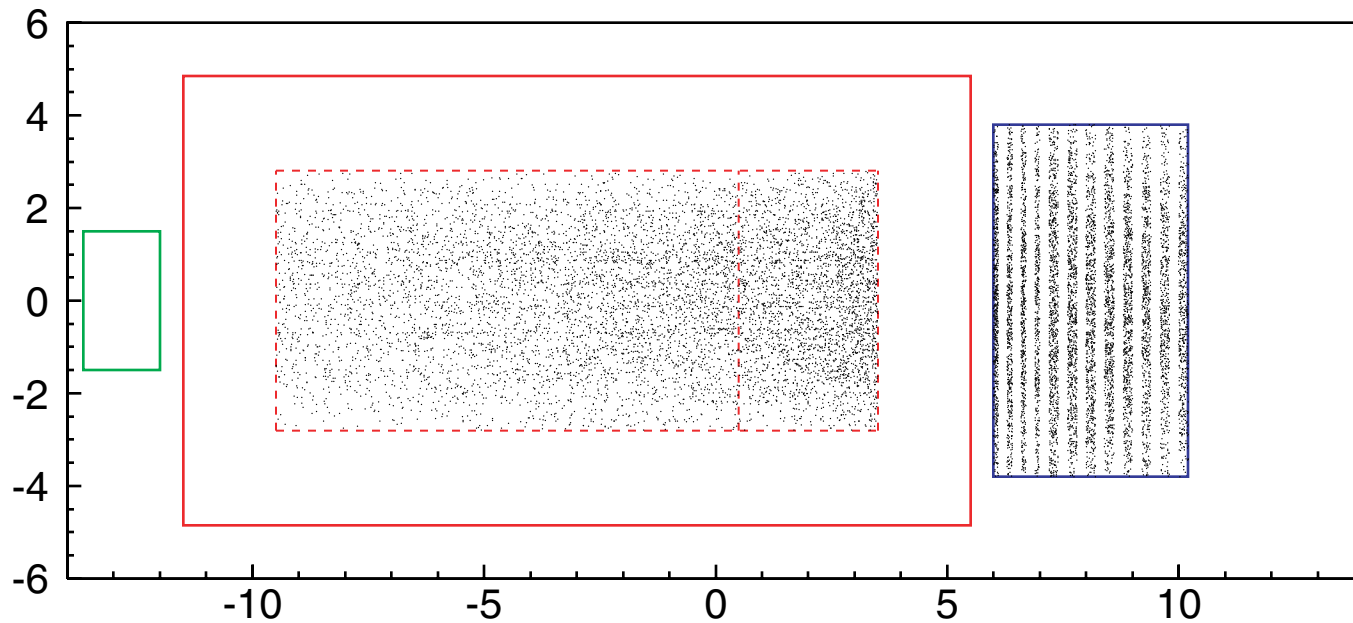
(FGD)

- Fine Grained Detector: 3m x 3m x 1.66m (same as K2K SciBar)

(MRD)

- Muon Range Detector: 7.6m x 7.6m x 12 layers (same as K2K MRD)

# FGD - WC - MRD

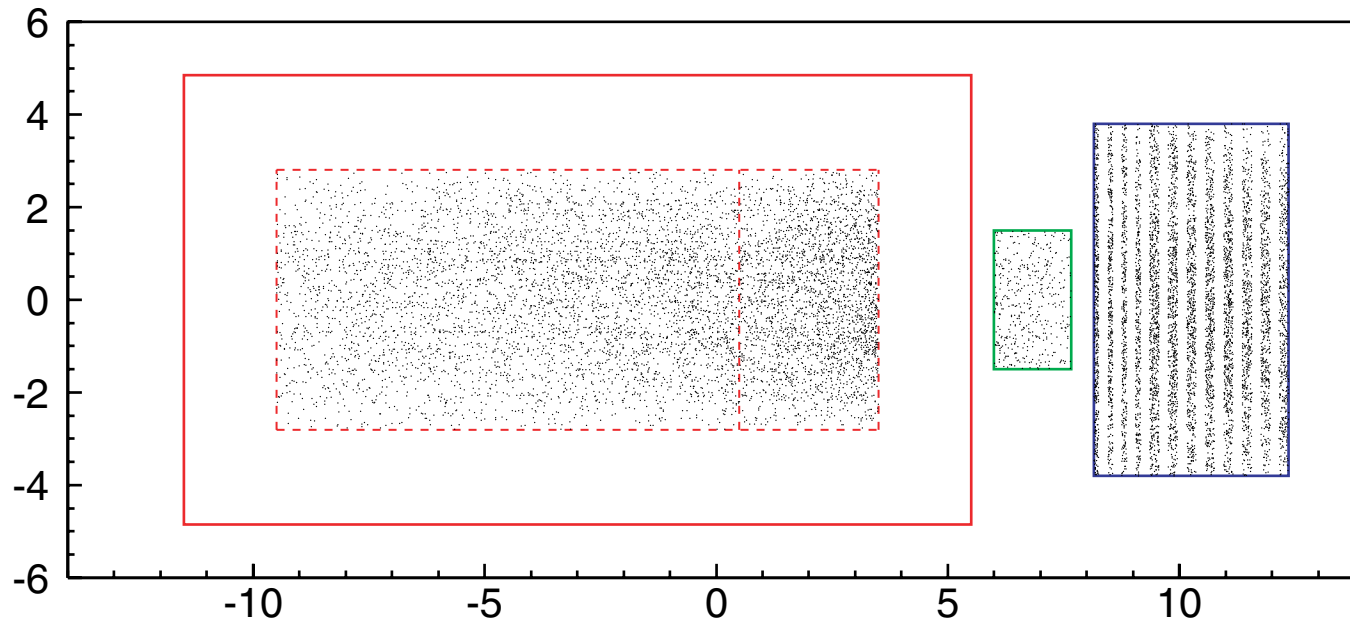


side view  
distances in meters  
0.5 meter gaps

starting points and stopping points plotted

- + Best acceptance for  $\nu$  interaction in WC to stop in MRD (high energy tail of neutrino spectrum)
- FGD and MRD do not work together

# WC - FGD - MRD



+ FGD and MRD do work together:  
can measure  $\pi$ ,  $p$  that exit FGD

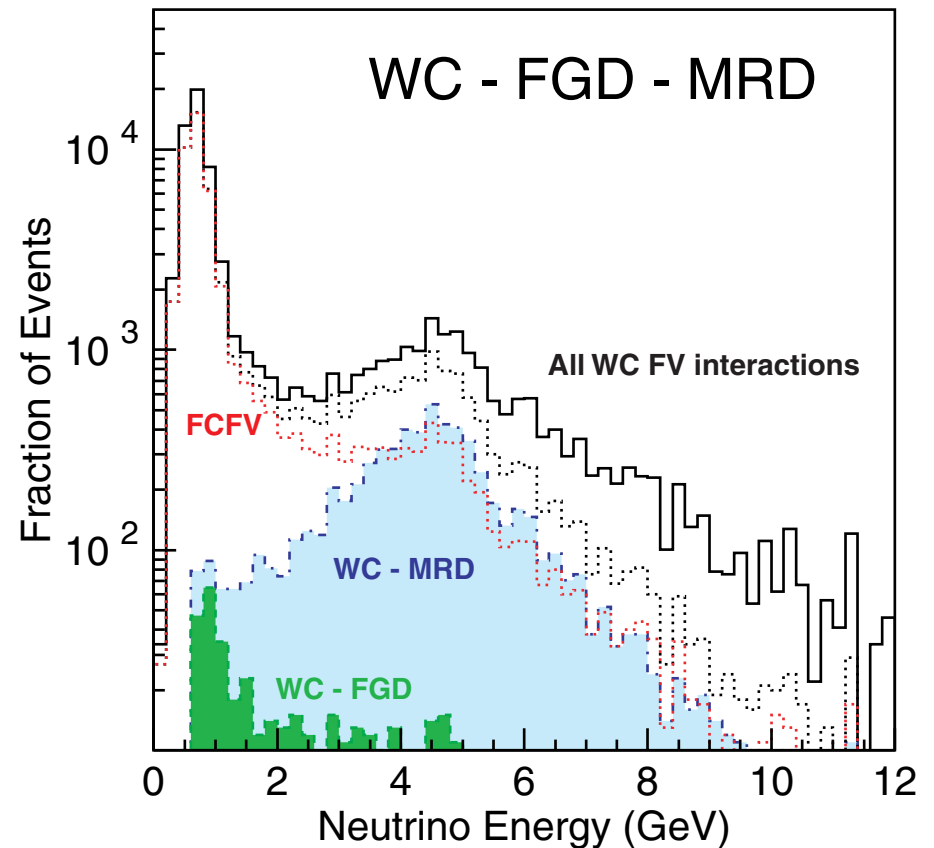
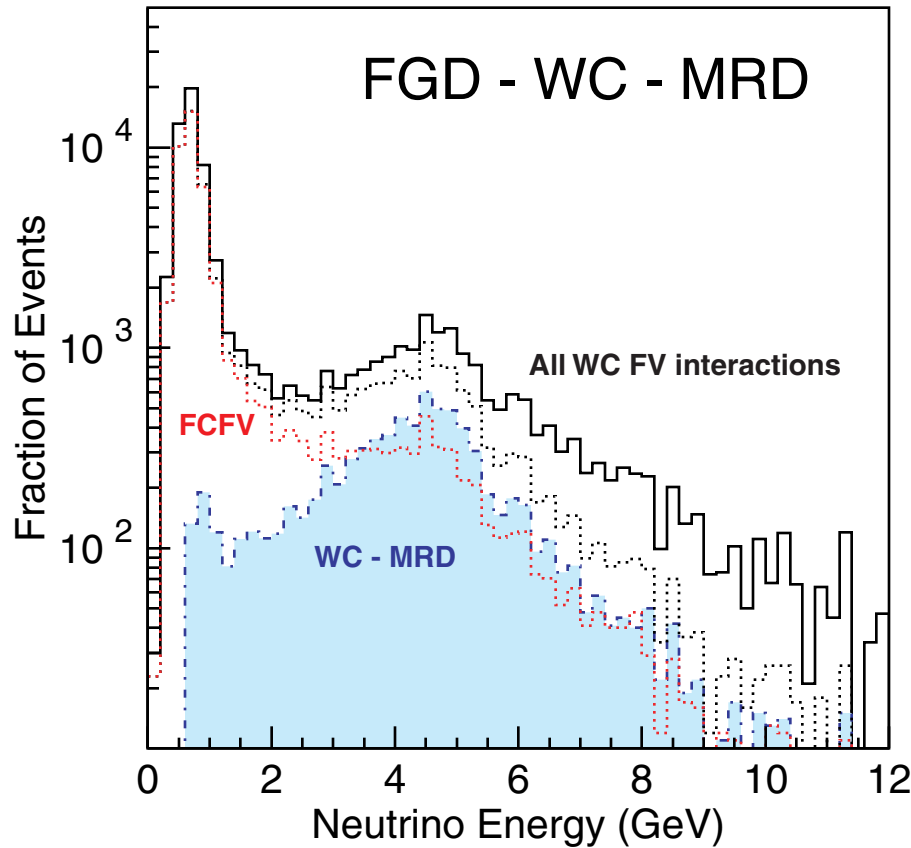
- Smaller acceptance for  $\nu$  interaction in WC to stop in MRD  
(high energy tail of neutrino spectrum)

? Other options become possible:

- magnetic toroid for particle-id/momentum  
(further from WC pmts)

# Neutrino Energy Spectrum

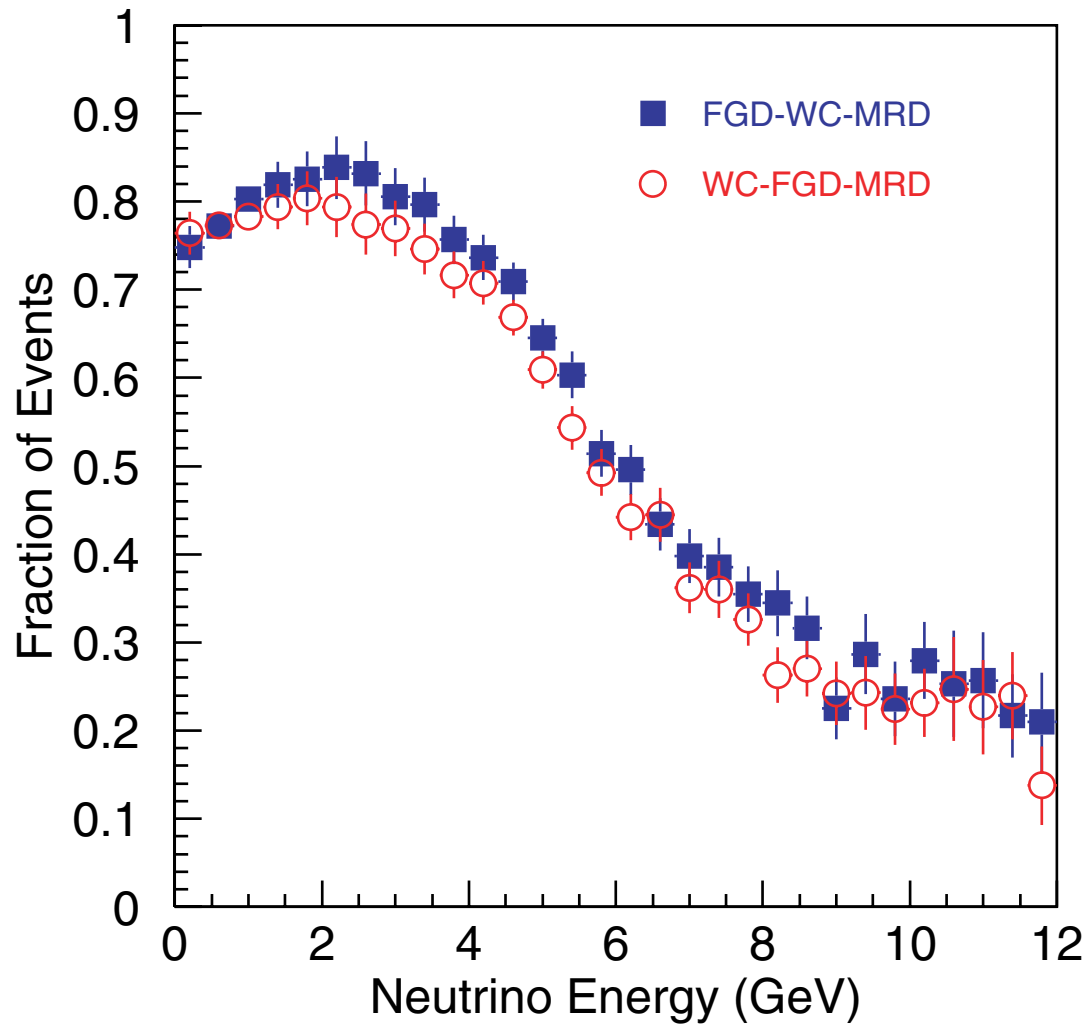
~72K events CC  $\nu_\mu$  in FV of WC



FCFV in WC	62%	62%
FC $\rightarrow$ MRD	11.2%	9.8%
FC $\rightarrow$ FGD	0%	0.6%

14% more events for FGD-WC-MRD versus WC-FGD-MRD

# Fraction of Events in MRD

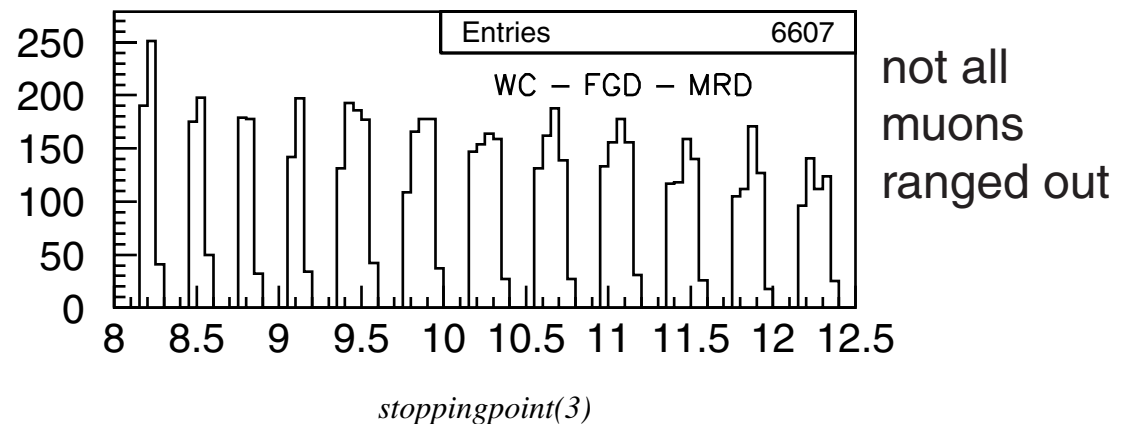
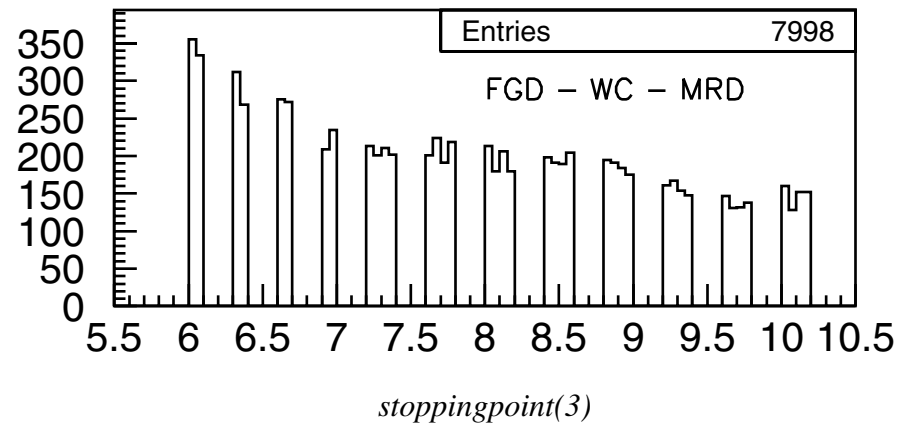
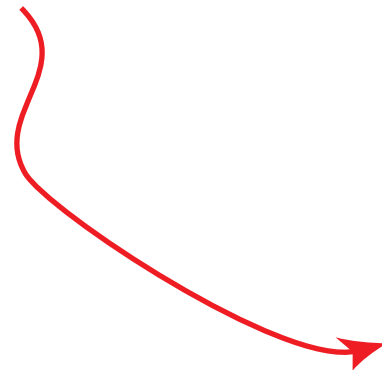


difference in measurement of high energy tail  
seems small

# Other Studies (to do)

Doable with simple simulation of absorbers (no PMTs, no bars, etc.)

- Calculate expected event rates for POT goal
- Fully simulate interactions:  $\pi^+$ , p from FGD  $\rightarrow$  MRD ... see if useful
- Simulate  $\pi^0$  in FGD ... how many? consider EM shower tail catcher
- Consider magnetic toroid (MINOS is 8m diameter, 2.5 cm thick,  $\sim 1.5$  T)
- What is best dimension for FGD? Wider and less deep if we use MRD?
- Should MRD be thicker than K2K device?



# Summary

- Simple model of 2KM combined detector studied with GEANT4
- 14% more  $\nu_\mu$  CC events if FGD-WC-MRD  
slightly improved measurement of high energy tail
- Physics opportunity with WC-FGD-MRD order (like K2K) needs study,  
but it seems more natural
- Other detector options (B-field, EM tail catcher, etc) should be studied (soon!).
- Detector sub-groups should consider adopting GEANT4 framework,  
since it will have the best support in the LHC era.

(eg. workshop for students at FNAL October 27-29)