Proposal for NESSiE at FNAL-BNB

Prospects for the measurement of ν_μ disappearance at the FNAL-Booster

The NESSiE Collaboration

FNAL-P-1057 and arXiv:1404.2521

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we are open to new collaborators and/or be part of a larger project for SBL at FNAL!

Key-points of the proposal

1. ν_μ disappearance is crucial to clarify the sterile neutrino issue

2. A stand-alone ν_μ measurement (with q-discrimination capabilities)
   Fully compatible with an upstream LAr
   A small active scintillator target might be foreseen at Near-site

3. identical near and far detectors

4. Study of an optimal configuration for the Near and Far sites
   Systematics studies

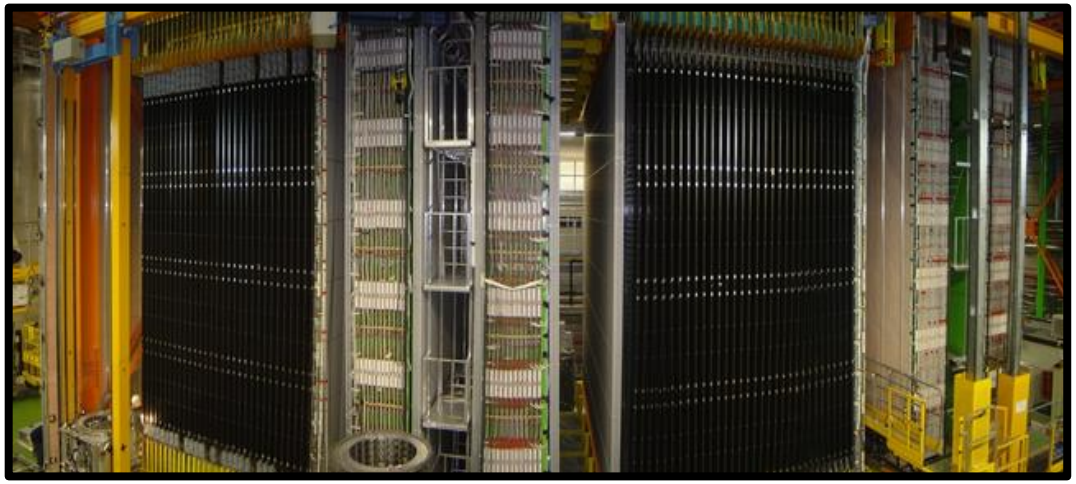
5. Robustness of the program
   Refurbishing/upgrade.
   No R&D (re-use of well proven detectors, straightforward extension)

Installation of OPERA Spectrometers

September 2003

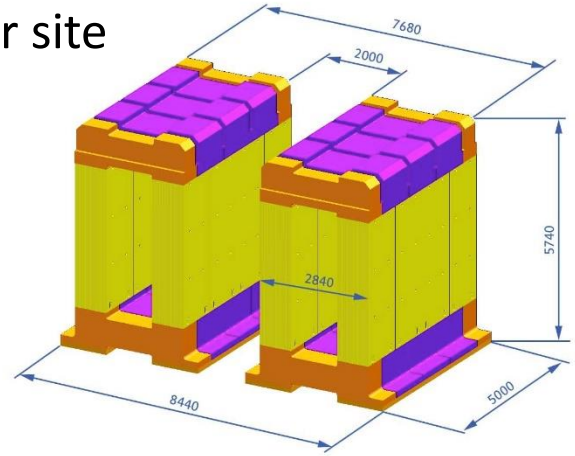
2004

2005

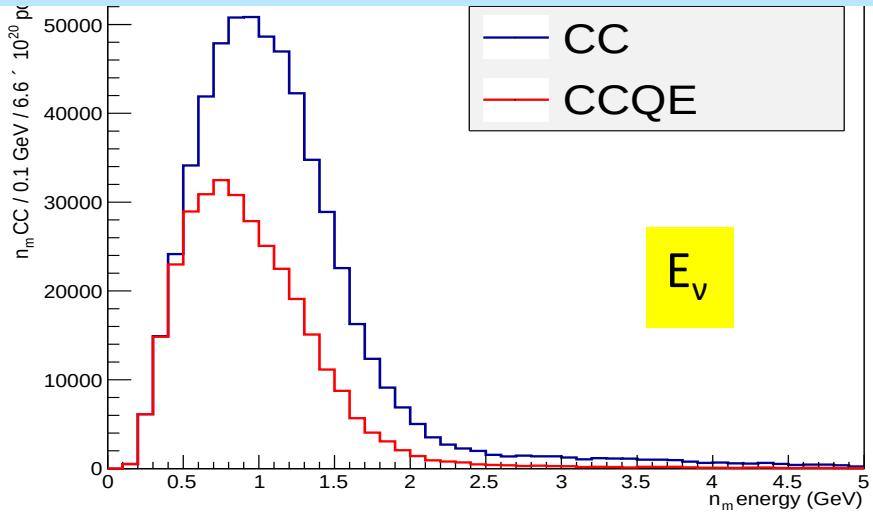


Detector Setup

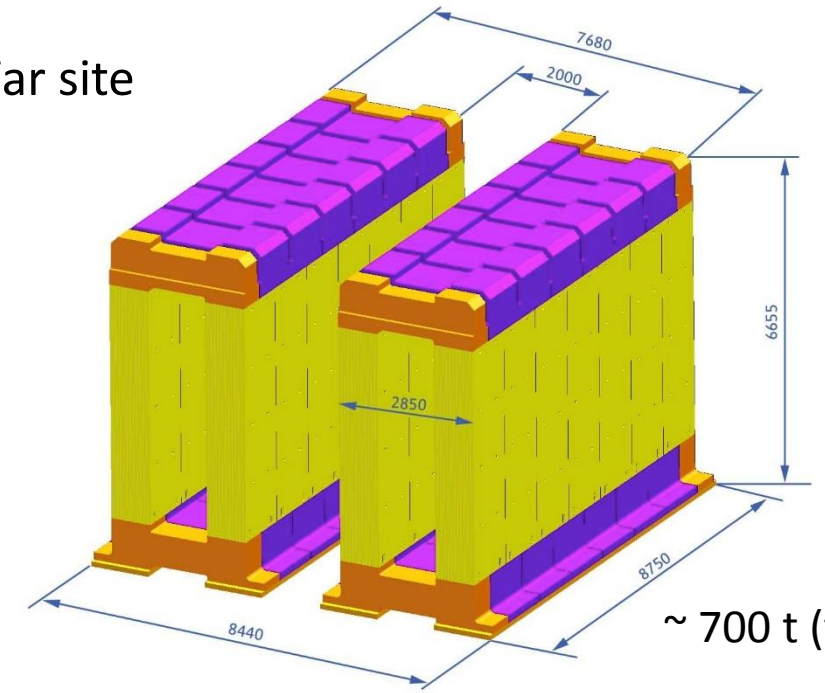
Near site



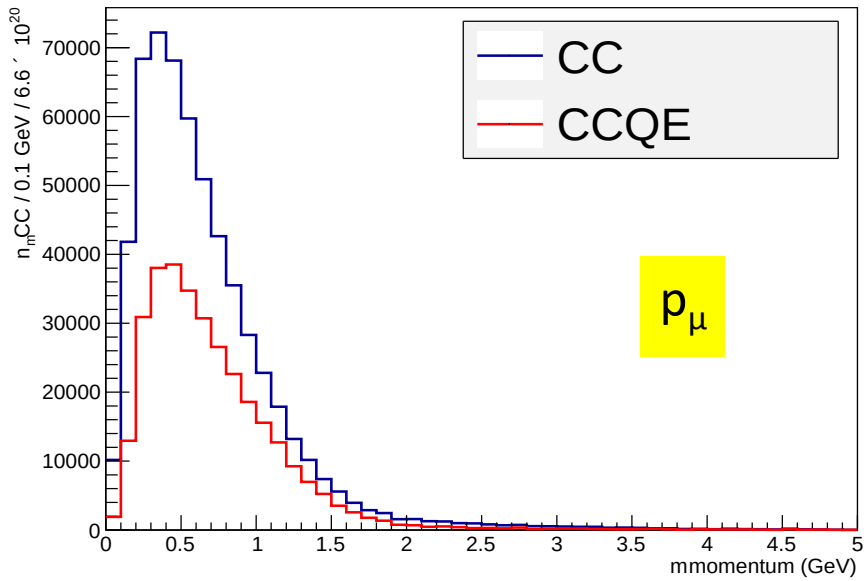
~ 300 t (fid.)



Far site



~ 700 t (fid.)



ABSOLUTE n. of interactions in Far fiducial volume, 3 years data taking

Detailed study of the BNB neutrino beam

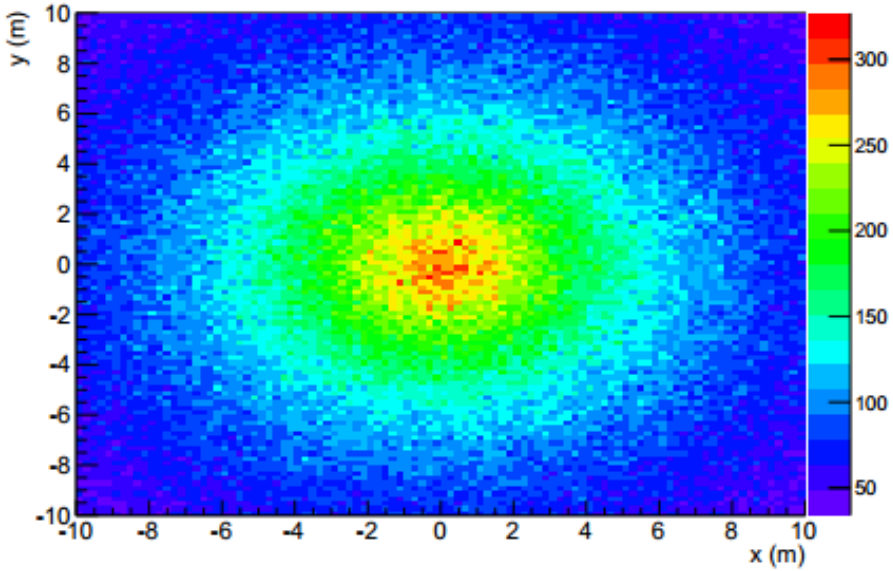
based on previous knowledge from MiniBooNE, SciBooNE
and Hadro-production data by HARP and E910.

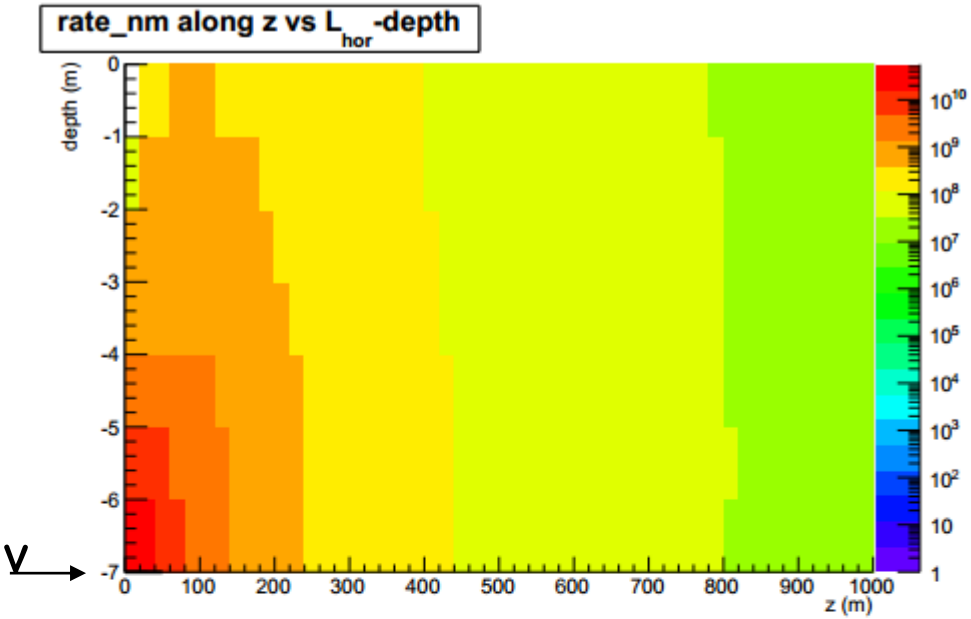
- Full simulation of the beam-line with GEANT4
- Hadro-production using FLUKA-GEANT4 or a data-constrained Sanford-Wang parametrization
- detailed systematic error source analysis
  (use of Sanford-Wang parametrization)

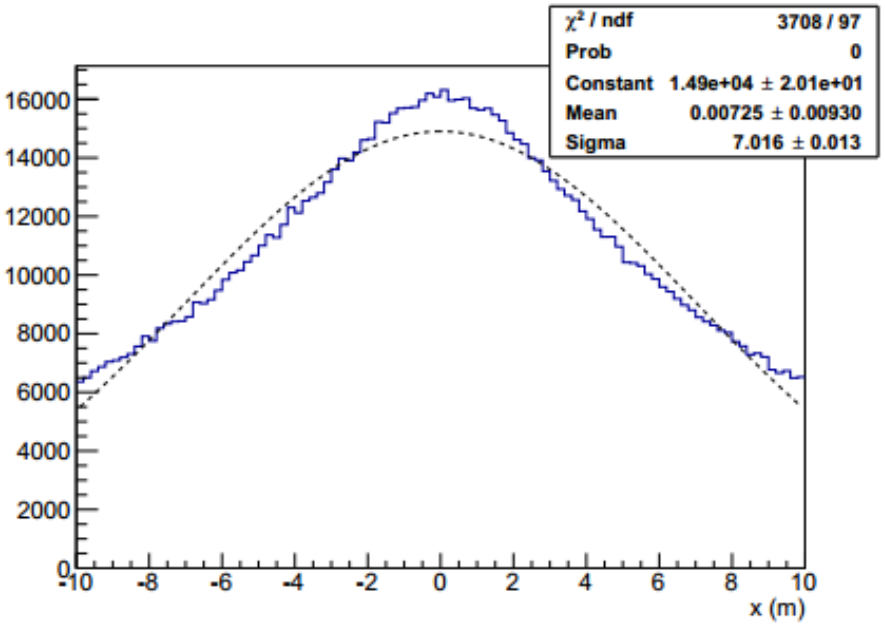
Several configurations analyzed, on/off-axis including MicroBooNE site
and different detector sizes

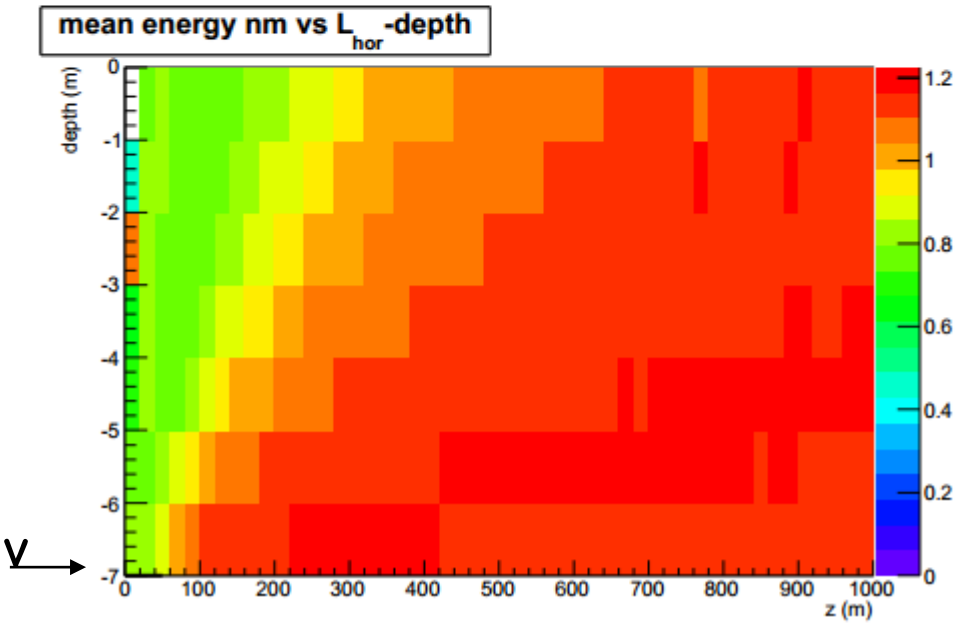
Beam simulation

Beam profile at 110 m from the target





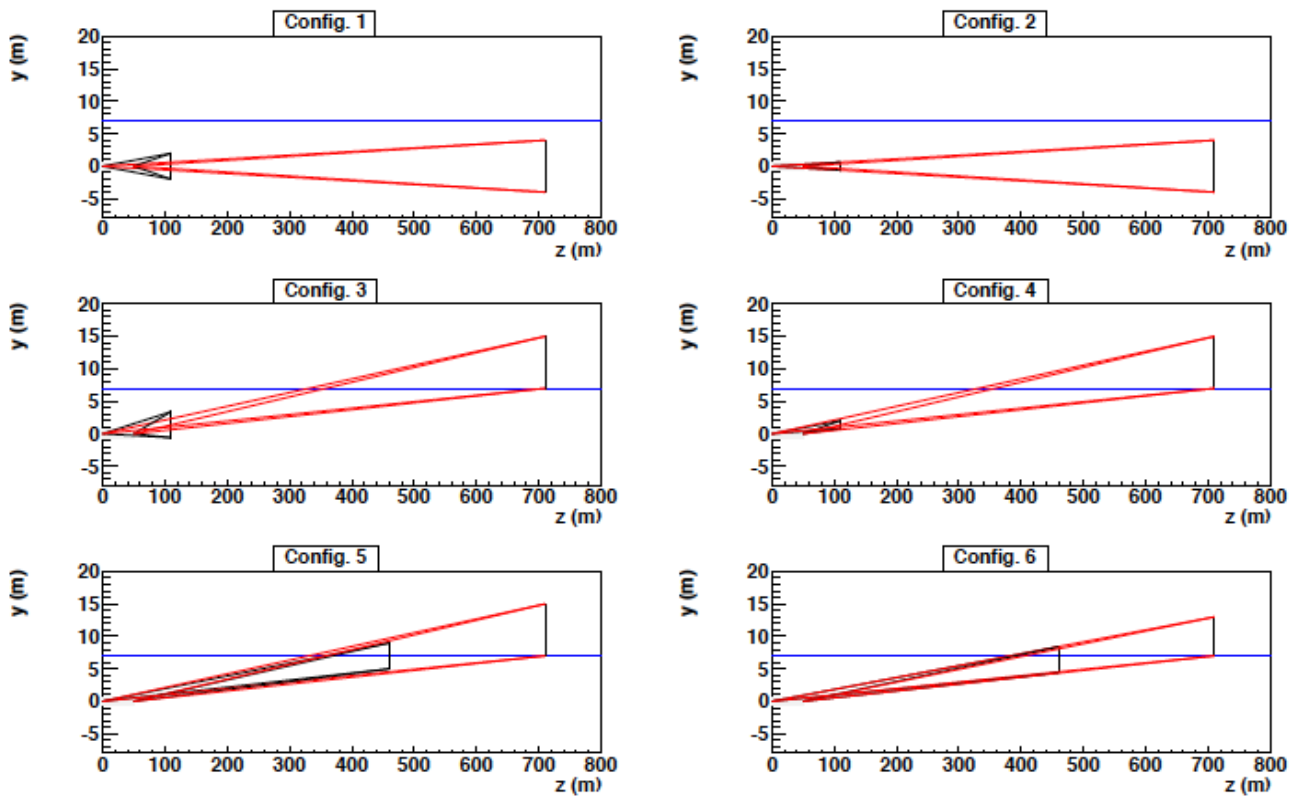




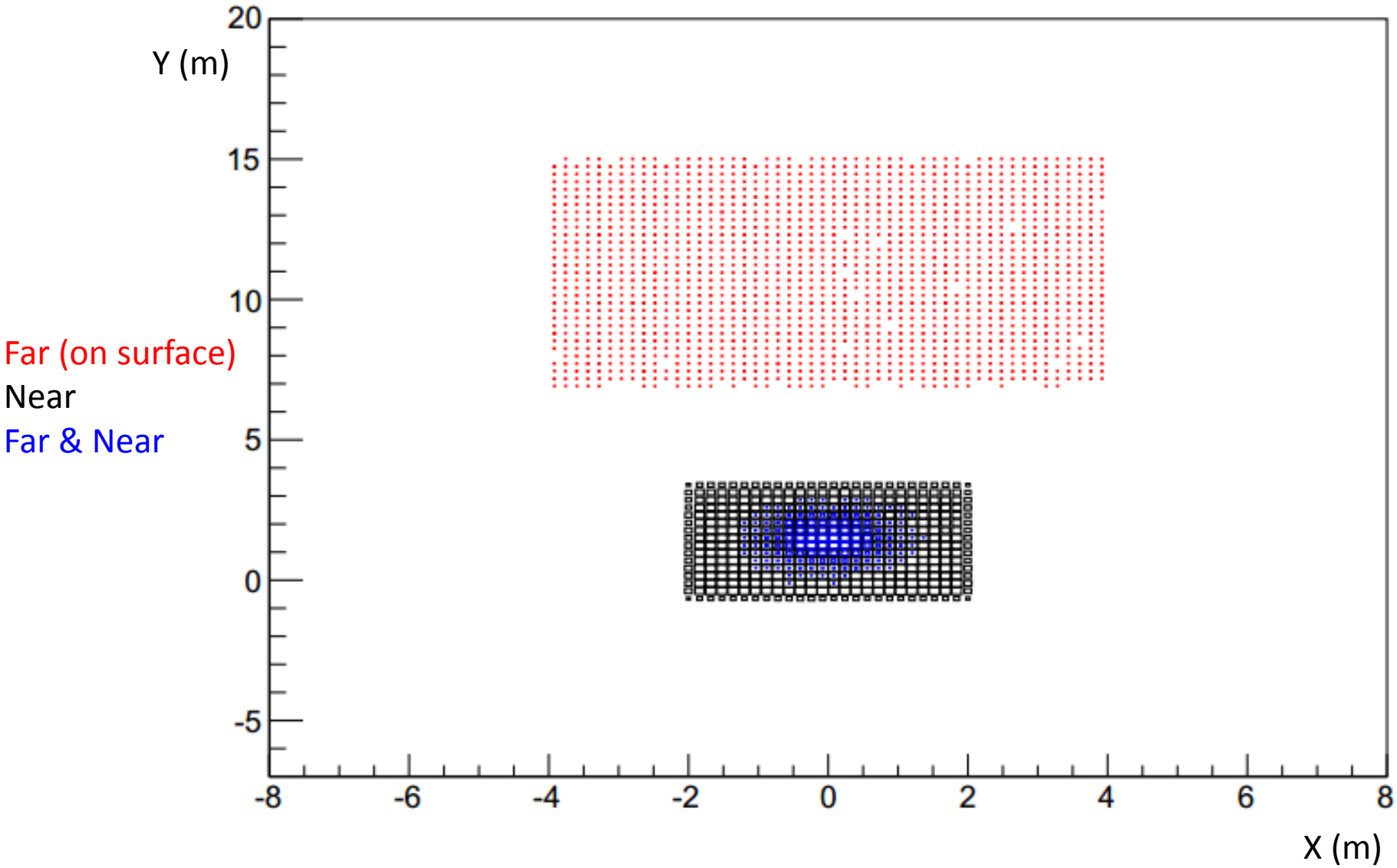
Considered configurations

configuration	L_N (m)	L_F (m)	y_N (m)	y_F (m)	s_N (m)	s_F (m)
1	110	710	0	0	4	8
2	110	710	0	0	1.25	8
3	110	710	1.4	11	4	8
4	110	710	1.4	11	1.25	8
5	460	710	7	11	4	8
6	460	710	6.5	10	4	6

Table 2: *Near-Far detectors configurations. $L_{N(F)}$ is the distance of the Near (Far) detector from the target. $y_{N(F)}$ is the vertical coordinate of the center of the Near (Far) detector with respect to the beam axis which lies at about -7 m from the ground surface. $s_{N(F)}$ is the dimension of the Near (Far) detector.*



Transverse distributions of neutrino impact points



Evolution of the Far/Near ratio as a function of the considered geometries

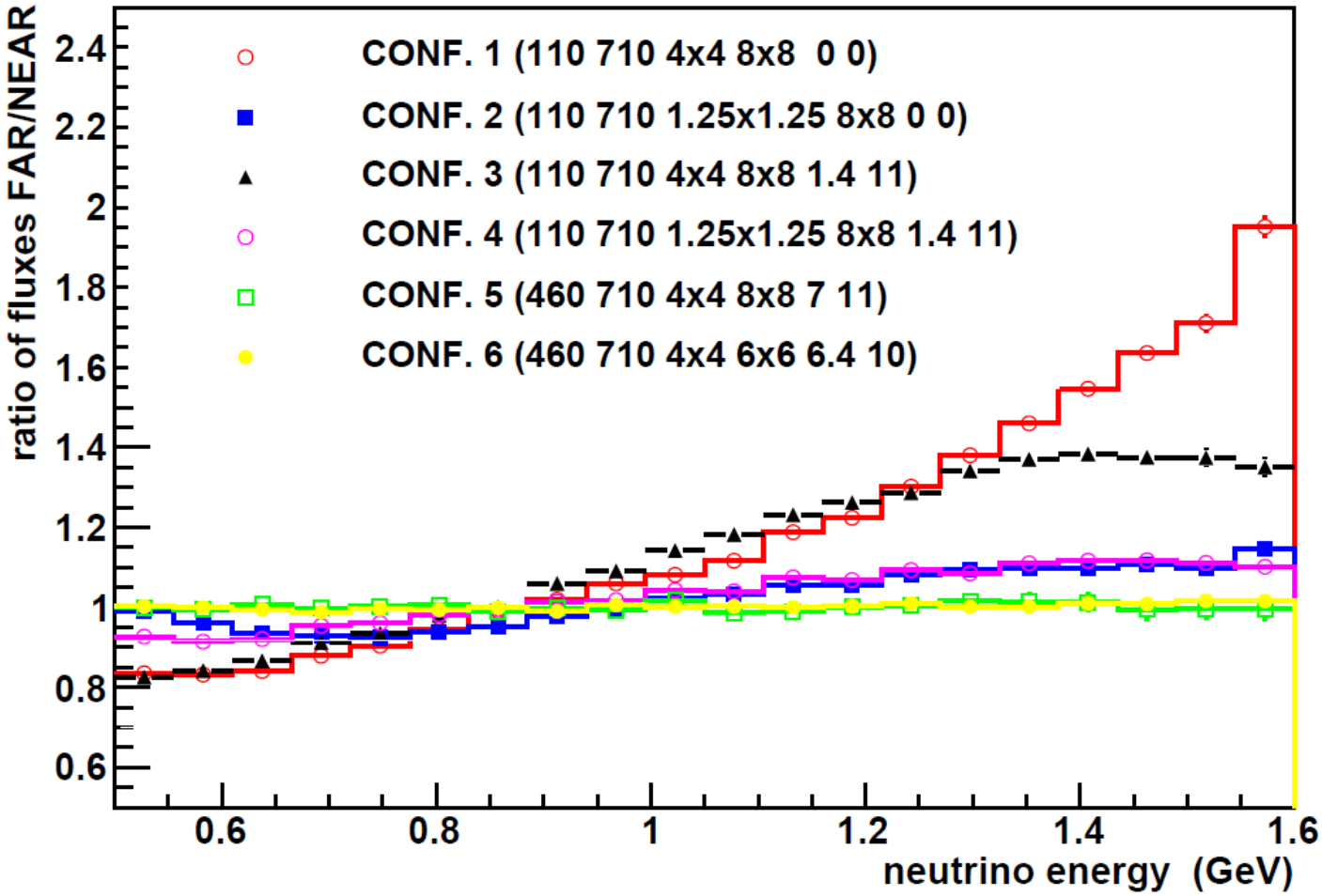


Figure 11: *Far–to–Near ratios for the six considered configurations using the Sanford–Wang parametrization.*

Far/Near ratio for different configurations and simulations

Error belt on the F/N ratio obtained sampling the parameters of the S.W. parametrization taking correlations of parameters into account (HARP-E910 published fits/covariance matrices).

A systematic of order 1% looks achievable for a setup at 110-710m with a proper choice of the fiducial volume (Config. 4).

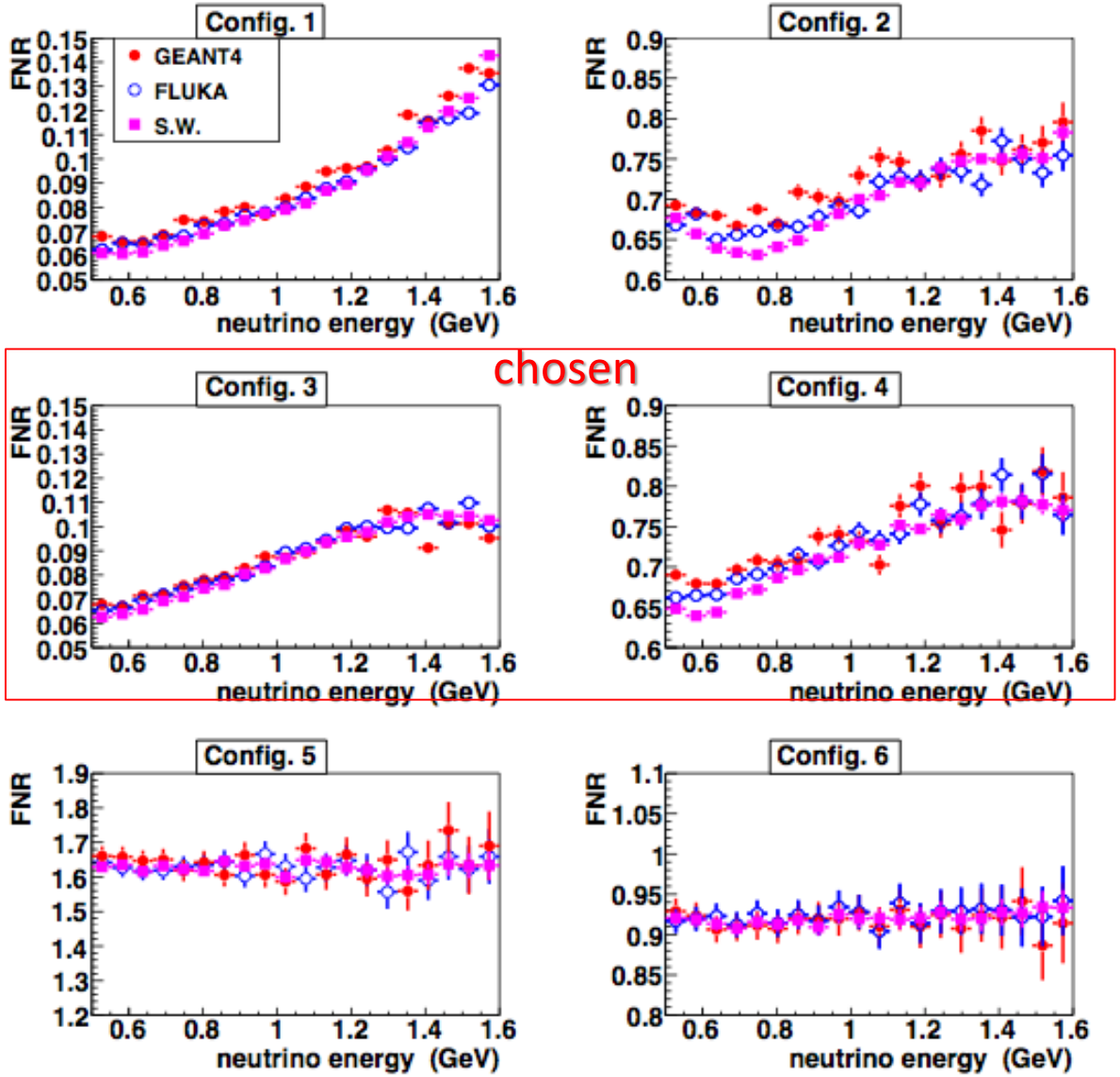
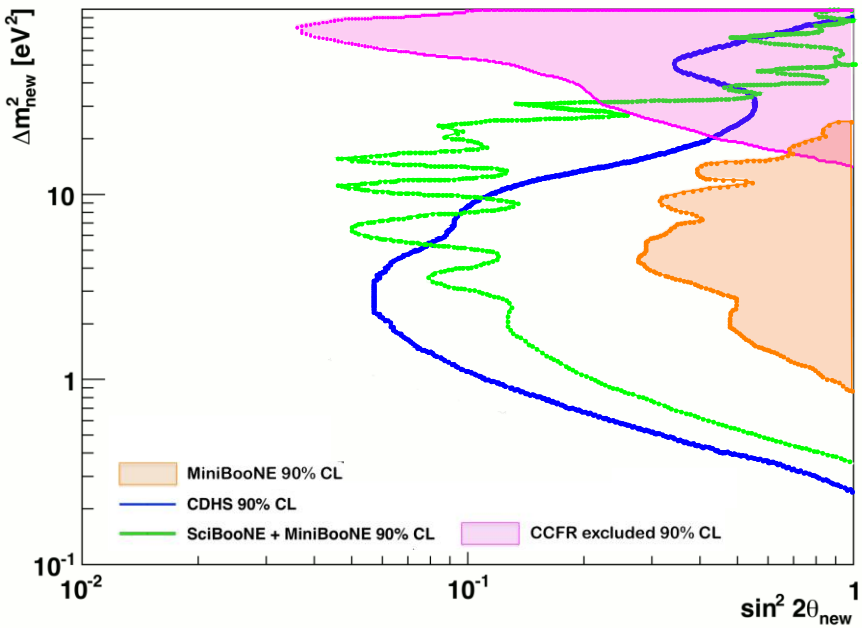


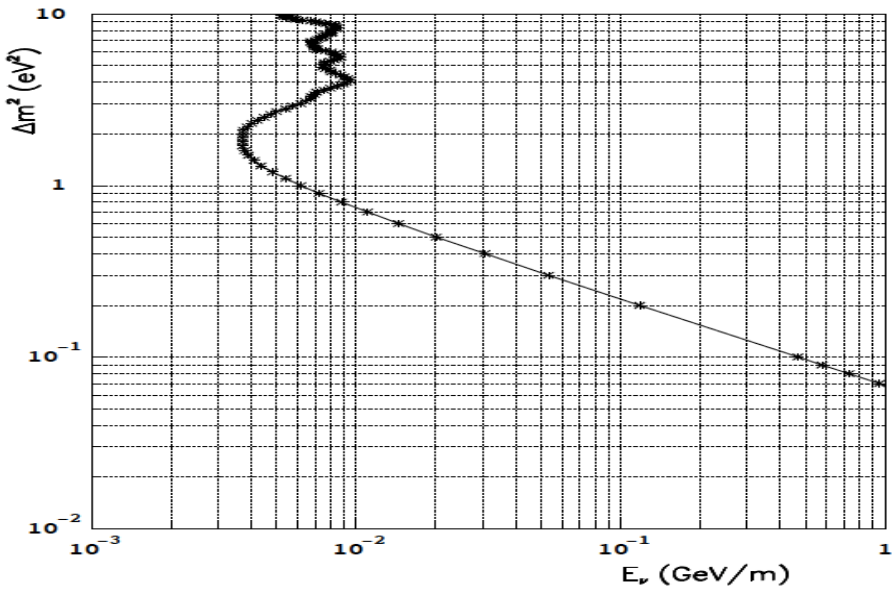
Figure 10: *Far-to-Near ratios for the six considered configurations. Comparison of FLUKA and GEANT4 for hadroproduction.*

Sensitivity

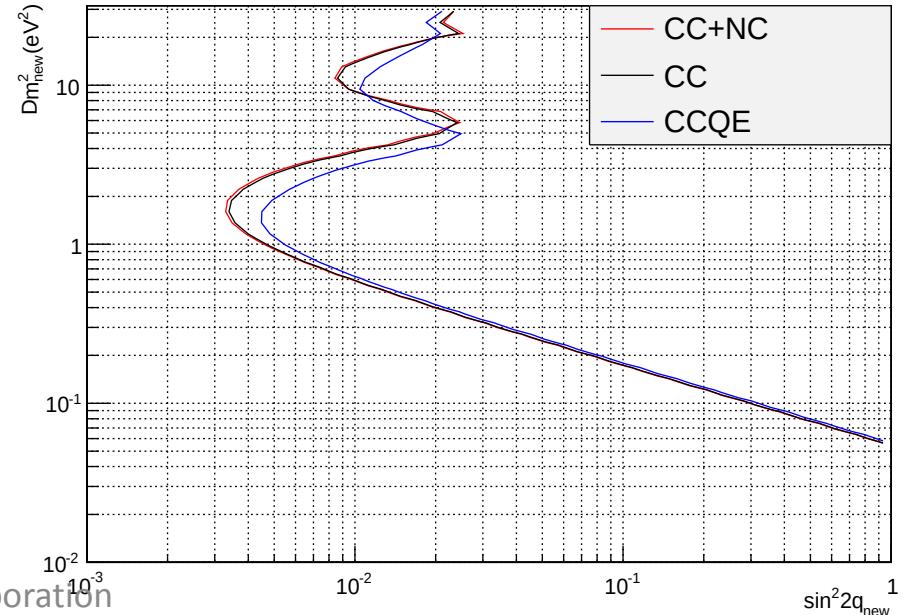
Present situation



NESSiE (6.6e20 pot, ν mode)



Sensitivity [95% C.L.][RANGE][Î $_{shape}$ = 1%]



Fit observables:
* range of the longest track.
* number of crossed planes

Smearing matrices from
a detailed simulation into GLoBES.

Three independent analyses,
with different approaches.

Schedule and Costs

A bit aggressive, but reliable schedule based on successful OPERA experience

Year(portion)	Action
1^{rst} half 2015	Define tenders/contracts
2nd half 2015	Site preparation
	Setting up Detectors Test-stands
1^{rst} half 2016	Mechanical Structure construction
	Start Magnet installation
	Start detectors installation
2nd half 2016	End installation
1^{rst} half 2017	Commissioning and Starting Run
2nd half 2019	End Data Taking

Both Near and Far

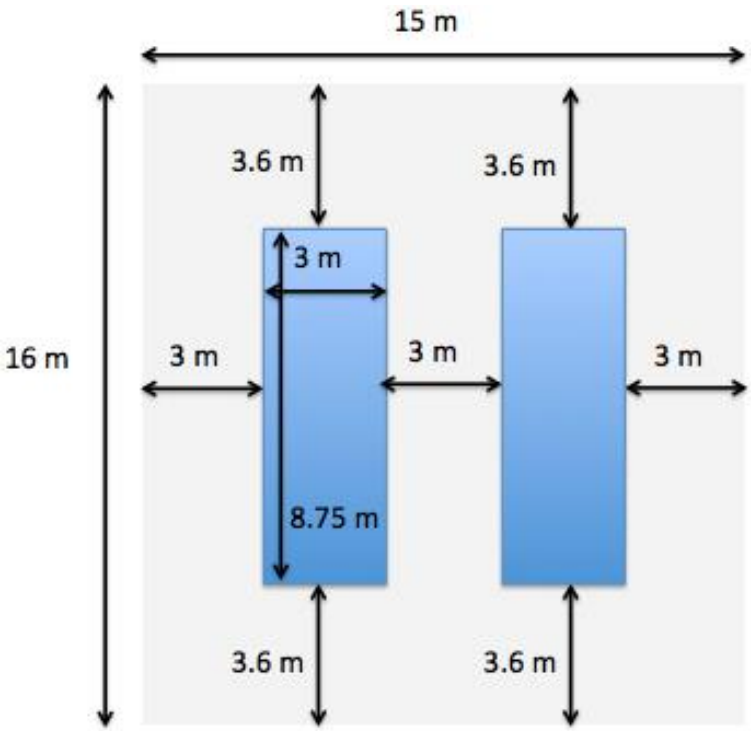
Item	Cost (in M €)	
Far		
Magnet		2.5 (in–kind)
RPC detectors		0.8 (in–kind)
Strips		0.3 (in–kind)
New Electronics	0.2	
Data Acquisition	0.1	
Near		
Magnet		2.0 (in-kind)
Top/bottom yokes	1.0	
Coils, Power Supplies	0.2	
RPC detectors		0.6 (in–kind)
New detectors	0.2	
Strips		0.2 (in–kind)
New Electronics	0.1	
Data Acquisition	0.1	
Transportation	0.6	
Total	2.5 + 6.4 (in–kind)	

(new Electronics, new DAQ, 2 x coil number)

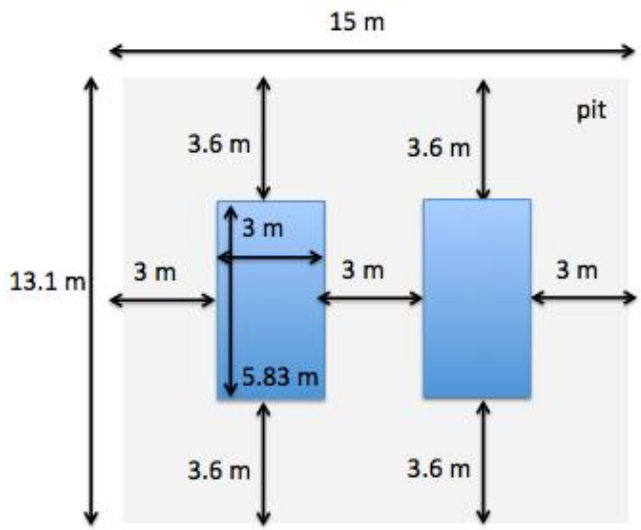
Space requirements

These clearances allow an “easy” installation

FAR site, on SURFACE



NEAR site, in the pit



Some room for further geometry optimization

Thank you !

NESSiE at FNAL

Iron slabs thinner than those available by OPERA NOT worth

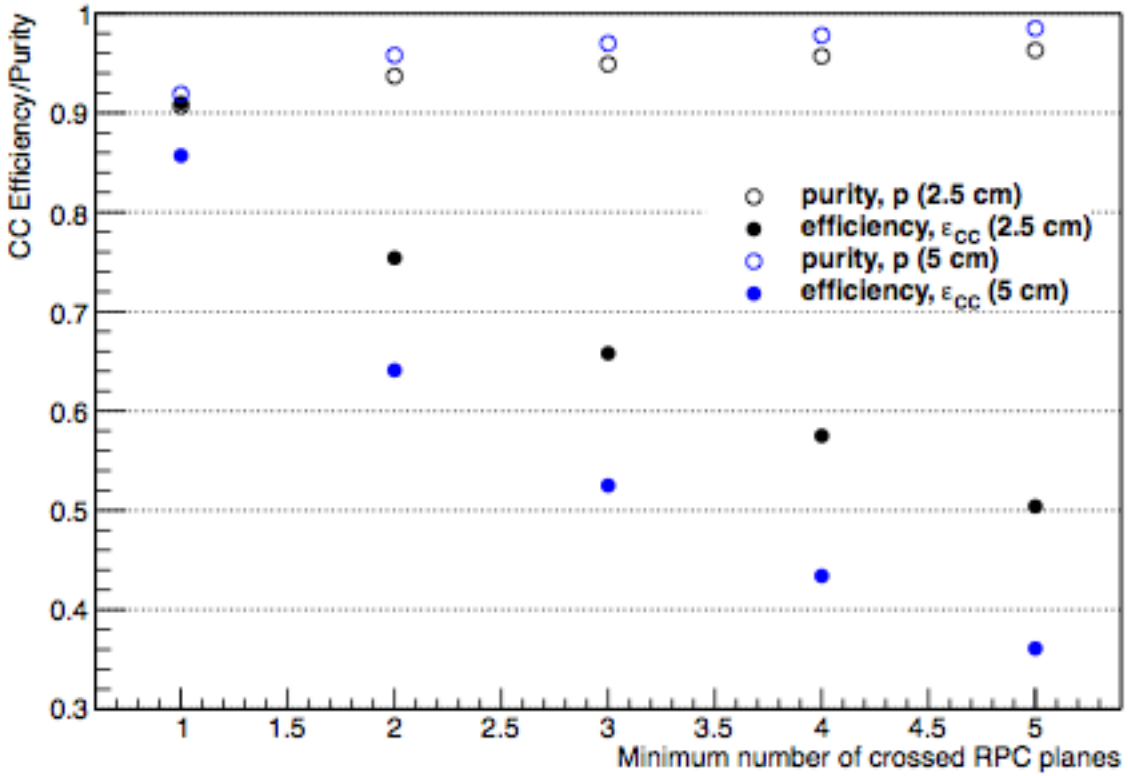


Figure 18: *CC efficiency (ε_{CC}, points) and purity (p, open circles) as a function of the minimum number of RPC planes for the two spectrometer geometries, 5 cm slabs (in blue) and 2.5 cm slabs (in black). For a given level of purity p the efficiencies for the two geometries are similar, therefore no advantage in statistics is taken requiring the same NC contamination suppression.*

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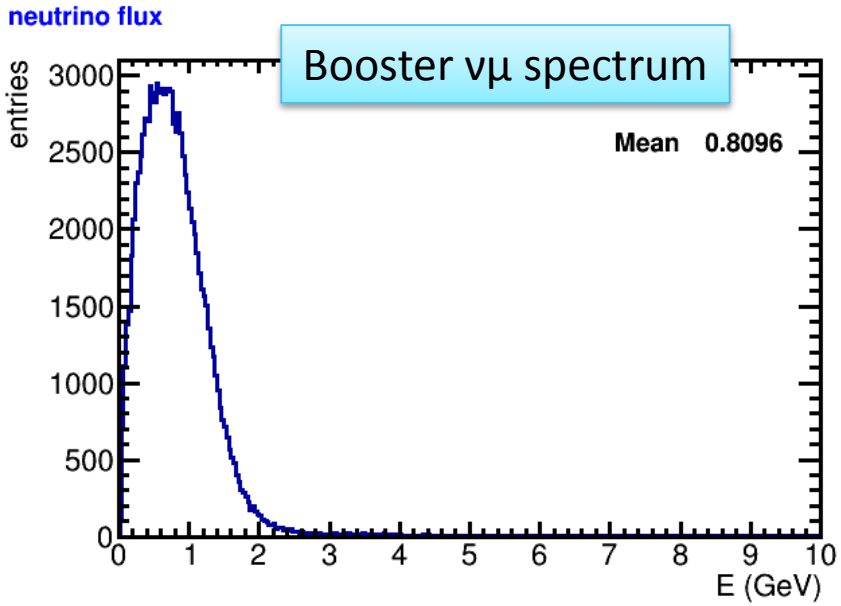
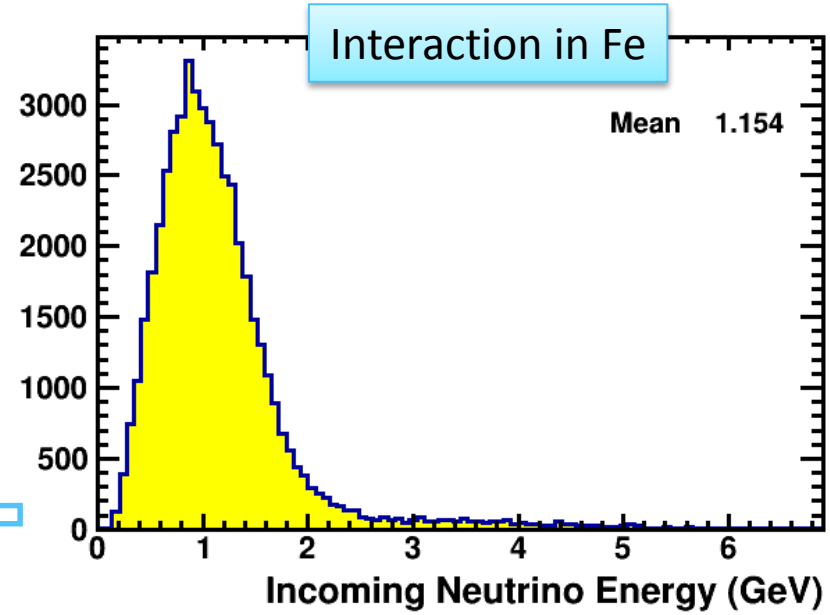
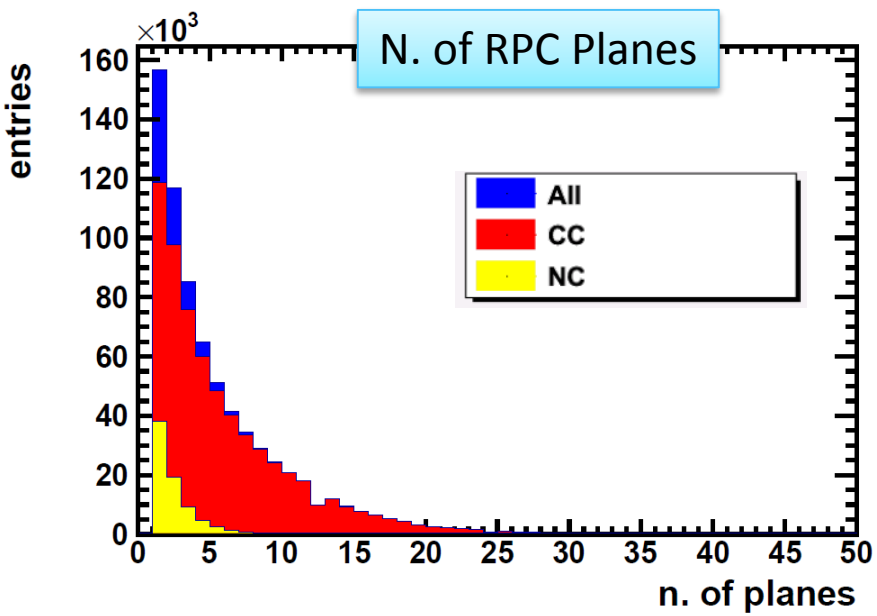
N. Planes and Range

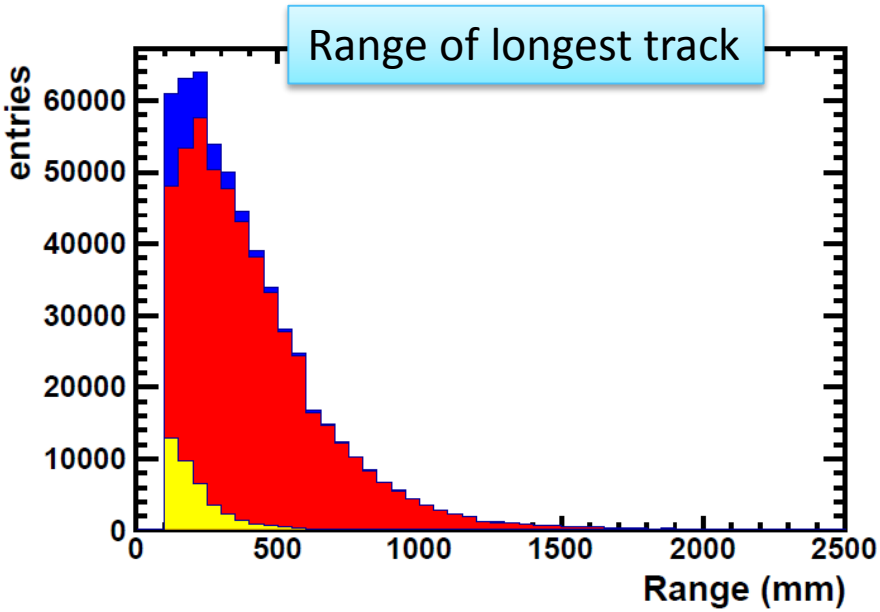


GENIE



Fluka
Geant





Efficiencies and Smearing Matrices for GLoBES analysis