Cosmics in the ν_e Appearance Search

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This talk includes work done by Christoph, Andrzej, and others.

What is the effect of Cosmic Backgrounds on MicroBooNE's ability to resolve an excess?

- Goal: combine the best simulation of cosmic events I can get with the beam Monte Carlo estimates to study the cosmic background in a ν_e appearance search

- Examine the effect of a proposed, basic cut to mitigate the amount of cosmic backgrounds in the sample.

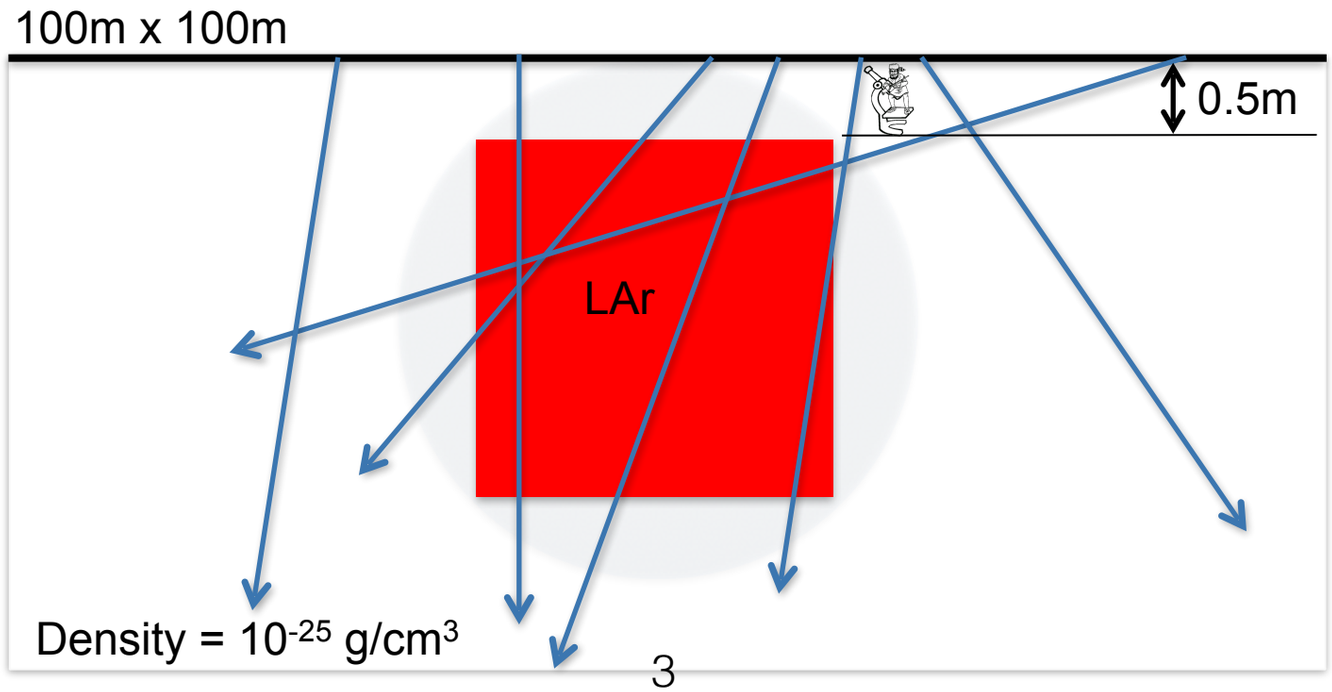
- Looking to get improved cosmic simulations from the Overburden Task force and incorporate them - the osc group can help that task force.

Cosmic Sample

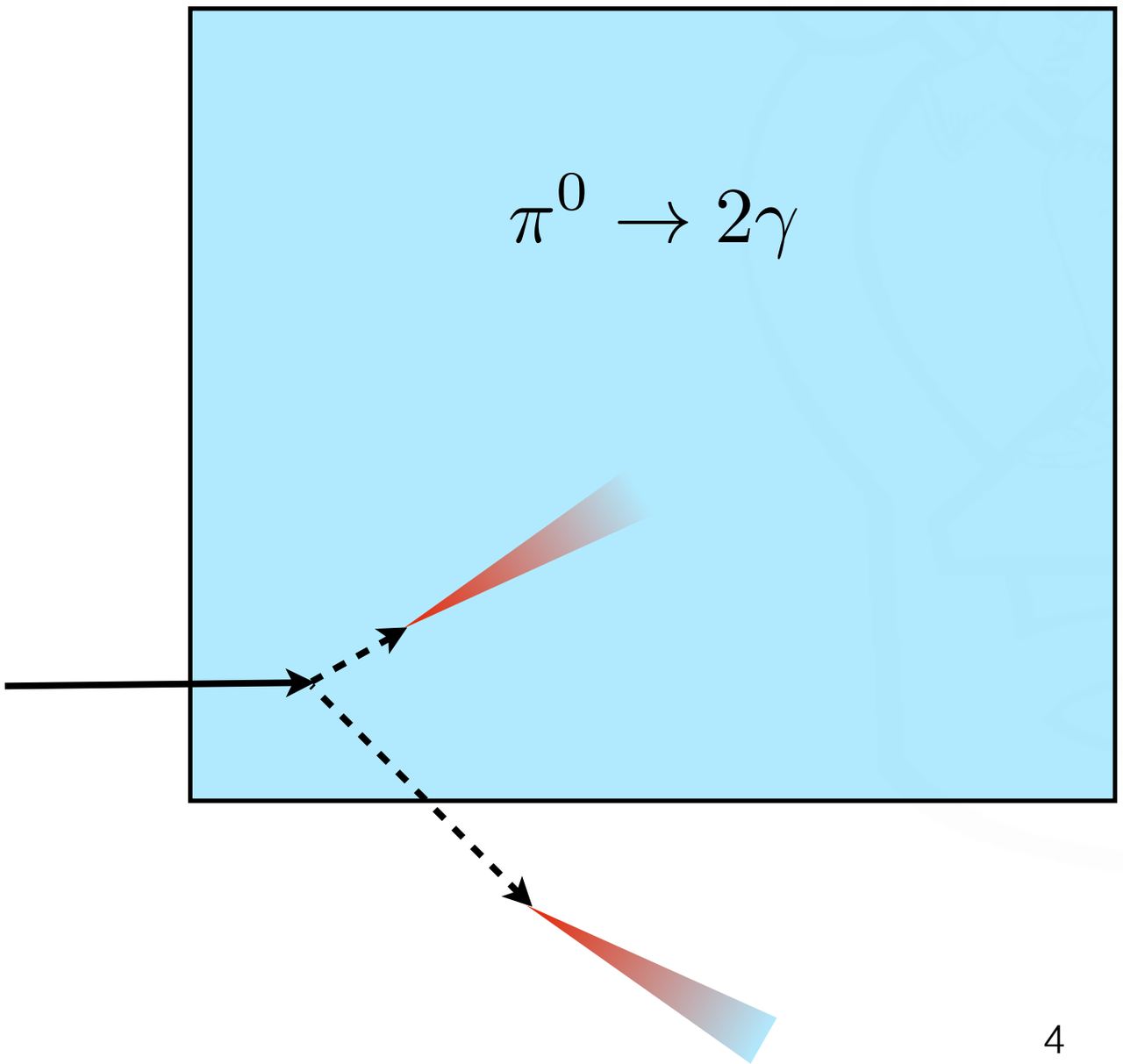
- Generated by Christoph using primary gammas from CRY and no other particles. Geometry is only the active volume of uBooNE.

- No gammas produced in the TPC itself

- **See MicroBooNE docdb [3438]**



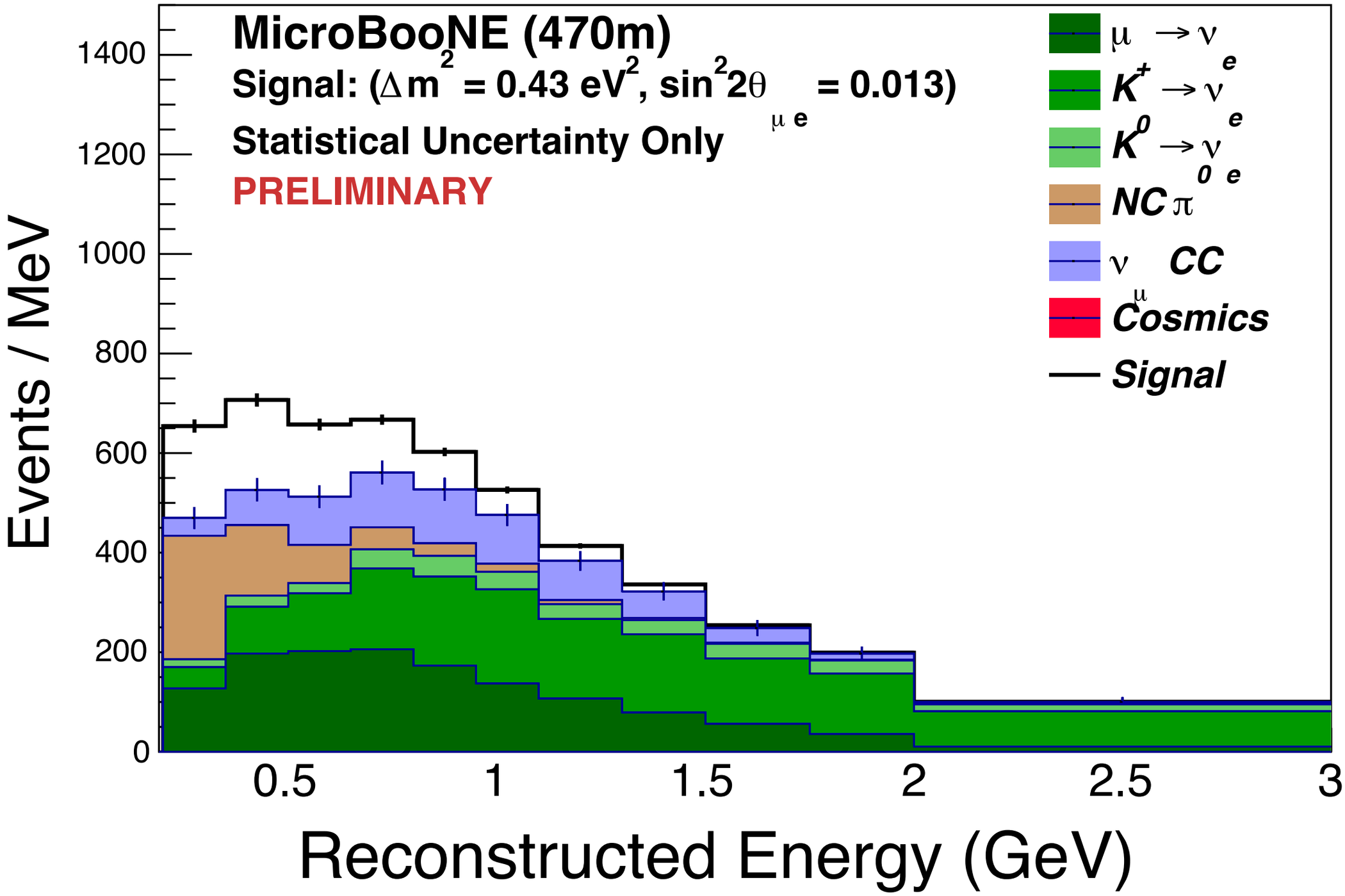
ν_e Backgrounds



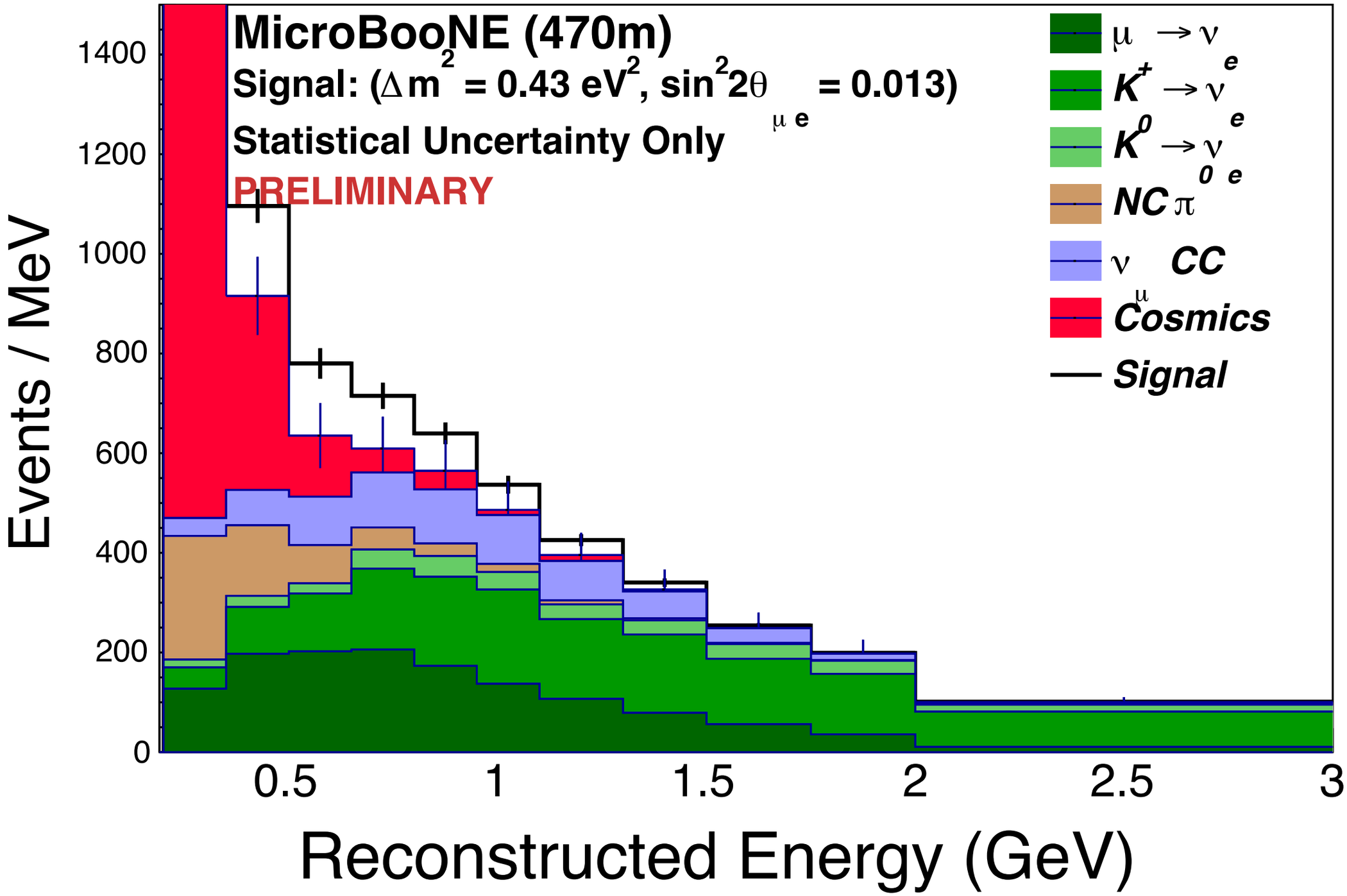
- Intrinsic Electron Neutrinos @ 80%
- ν_μ CC MisID @ 0.1%
- Single Photons from π^0 @ 6% (2 photons rejected)

Docdb 2963

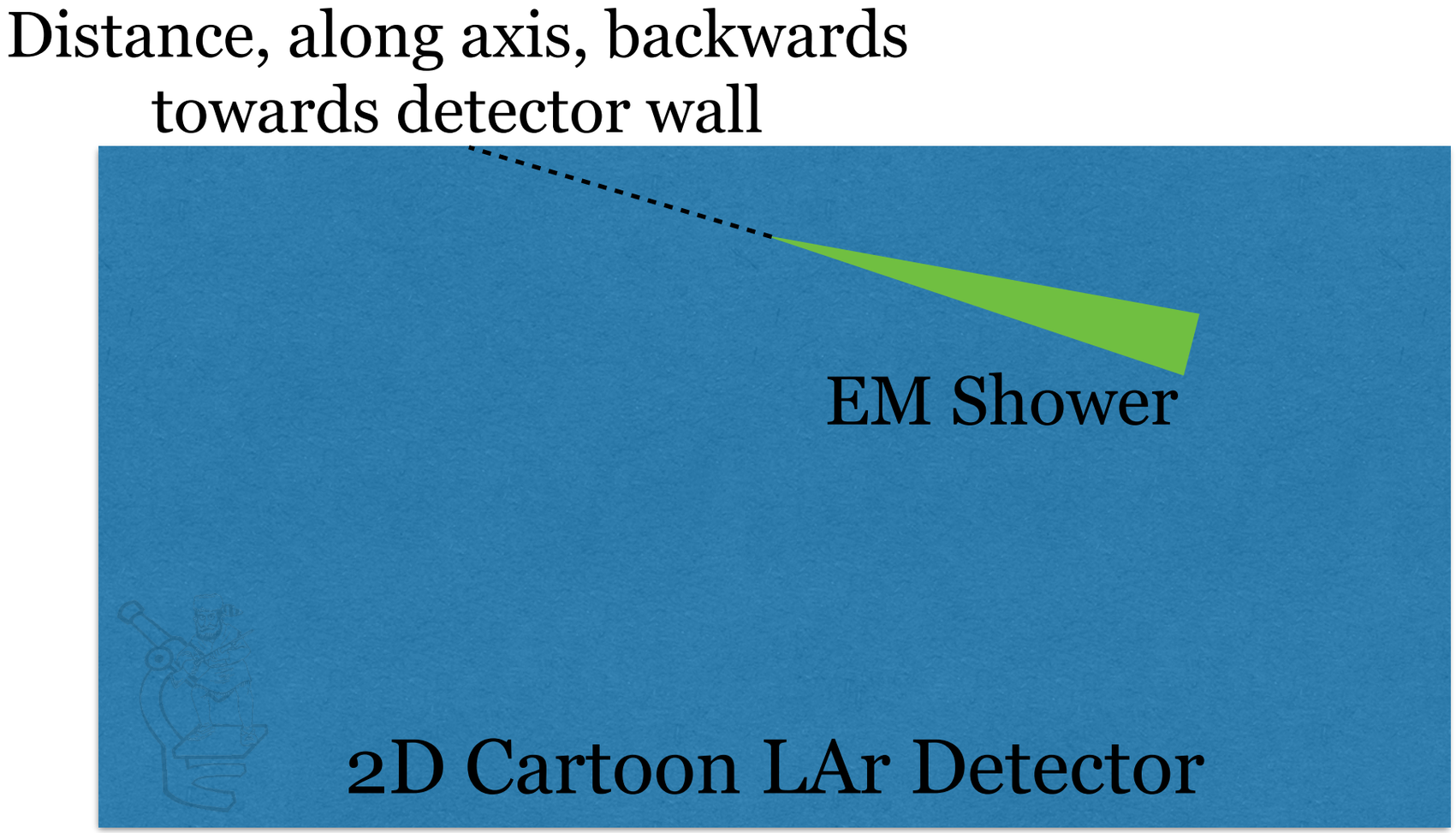
Nominal Distribution



Including all Cosmics

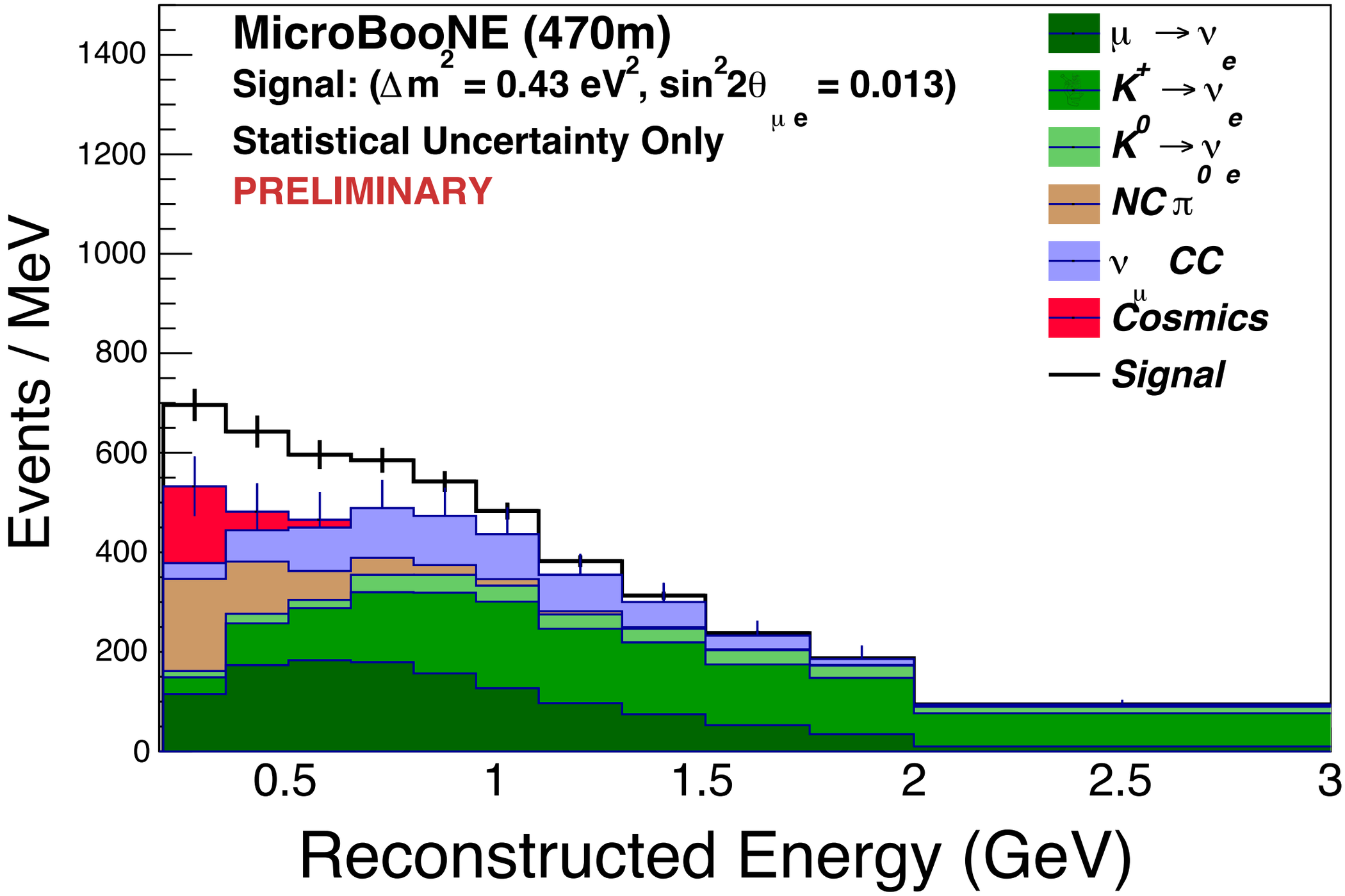


Proposed Cut:
“Backwards distance to Wall”

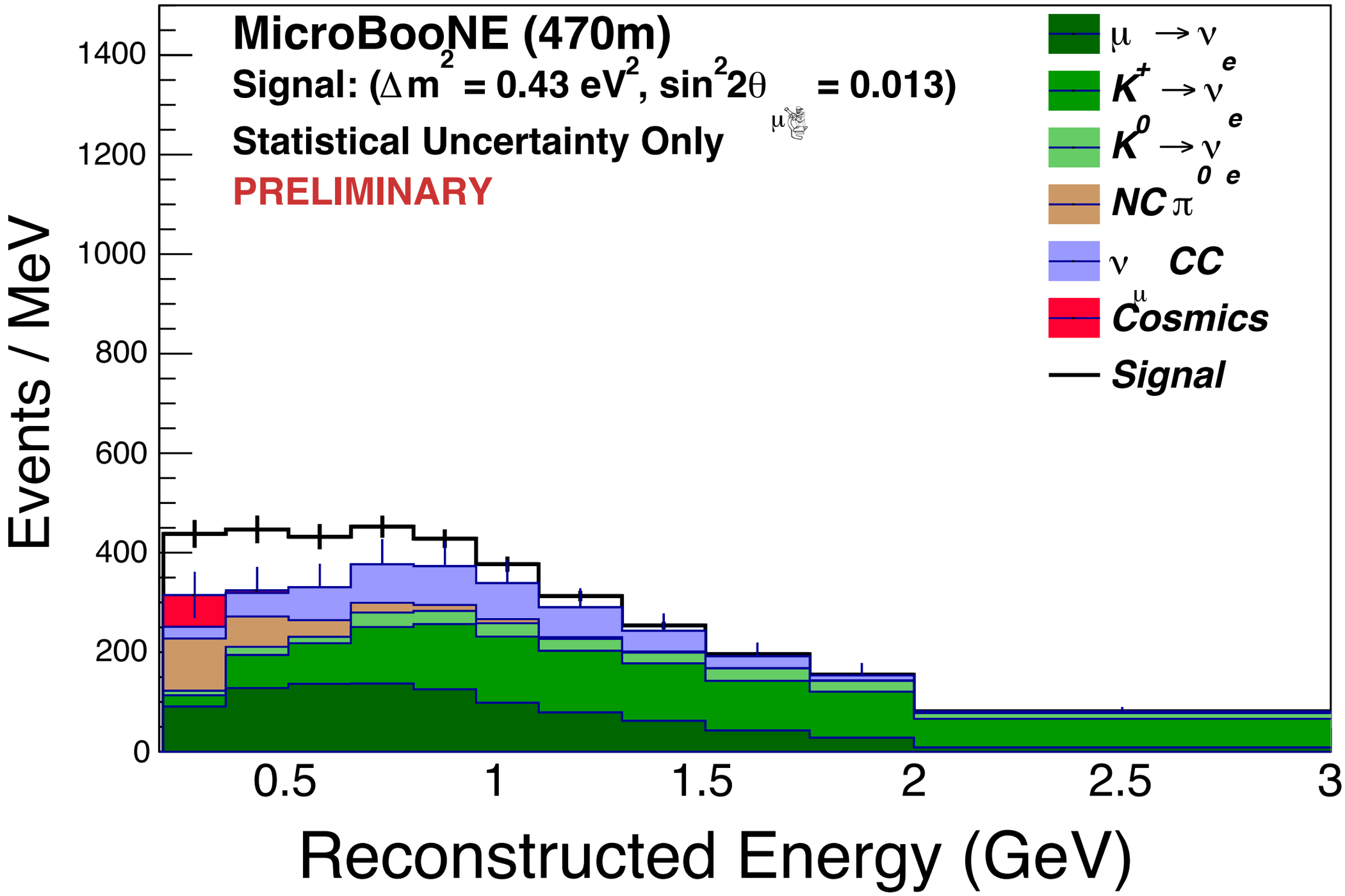


Assumption: Comptons from cosmic photons will occur closer to detector walls. Cut on the distance from the wall **along the axis of the shower.**

50cm Cut


MicroBooNE (470m)
Signal: (Δm^2 = 0.43 eV^2, $\sin^2 2\theta_{\mu e}$ = 0.013)
Statistical Uncertainty Only
PRELIMINARY
$\mu \rightarrow \nu_e$
$K^+ \rightarrow \nu_e$
$K^0 \rightarrow \nu_e$
NC π^0
ν_μ CC
Cosmics
Signal
Events / MeV
0
200
400
600
800
1000
1200
1400
0.5
1
1.5
2
2.5
3
Reconstructed Energy (GeV)

100cm Cut


MicroBooNE (470m)
Signal: (Δm^2 = 0.43 eV^2, $\sin^2 2\theta_{\mu\mu}$ = 0.013)
Statistical Uncertainty Only
PRELIMINARY
$\mu \rightarrow \nu_e$
$K^+ \rightarrow \nu_e$
$K^0 \rightarrow \nu_e$
NC π^0
ν_μ CC
Cosmics
Signal
Events / MeV
Reconstructed Energy (GeV)
0
200
400
600
800
1000
1200
1400
0.5
1
1.5
2
2.5
3

Event rates for entire 200 MeV to 3GeV Region by Category

	No Cut	50 Cut	100 Cut	% Reduction @ 50cm	% Reduction @ 100cm
ν_e Intrinsic (total)	607	555	448	**9%**	**26%**
ν_e Intrinsic (μ decay)	227	206	162	**9%**	**29%**
ν_e Intrinsic (K^+ decay)	315	289	236	**8%**	**25%**
ν_e Intrinsic (K^0 decay)	65	60	50	**8%**	**23%**
$\nu_\mu + e \rightarrow \nu_\mu + e$	6	6	5	**8%**	**14%**
π^0 Mis ID	87	66	38	**25%**	**57%**
ν_μ Mis ID	118	108	86	**8%**	**27%**
Cosmics	352	31	10	**91%**	**97%**
Signal (3+1 Model)	116	105	81	**10%**	**30%**
Signal / Sqrt(Bg.)	**3.40**	**3.80**	**3.34**		

Event Rates in Low Energy Region

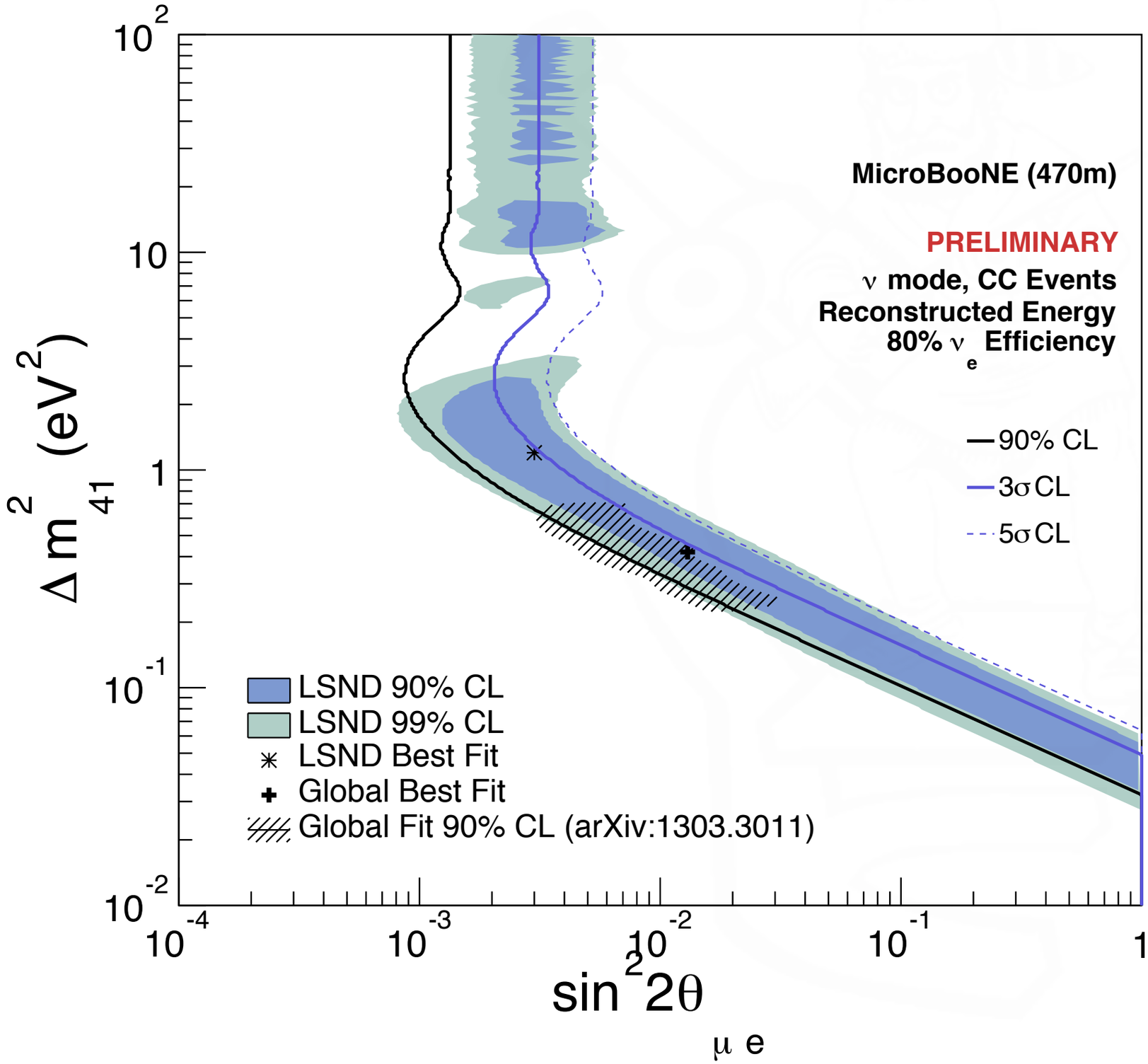
Range (MeV)	No Cut			50cm Cut			100cm Cut			% Red. @ 50cm	% Red. @ 100cm
	200-350	350-500	200-500	200-350	350-500	200-500	200-350	350-500	200-500		
ν_e Intrinsic (total)	28	47	**75**	24	41	**66**	18	32	**50**	**12%**	**33%**
ν_e Intrinsic (μ decay)	19	30	**49**	17	26	**43**	14	19	**33**	**11%**	**33%**
ν_e Intrinsic (K^+ decay)	6	14	**21**	5	13	**18**	3	10	**13**	**14%**	**35%**
ν_e Intrinsic (K^0 decay)	2	3	**6**	2	3	**5**	1	2	**4**	**16%**	**33%**
$\nu_\mu + e \rightarrow$  $+ e$	2	1	**3**	1	1	**2**	1	1	**2**	**13%**	**23%**
π^0 Mis ID	37	21	**58**	28	16	**43**	16	9	**25**	**26%**	**57%**
ν_μ Mis ID	5	11	**16**	5	9	**14**	4	7	**11**	**11%**	**34%**
Cosmics	257	58	**315**	23	6	**29**	10	1	**10**	**91%**	**97%**
Signal (3+1 Model)	26	26	**52**	23	23	**46**	17	17	**35**	**11%**	**33%**
Signal / Sqrt(Bg.)	1.44	2.20	**2.41**	2.59	2.69	**3.72**	2.49	2.46	**3.50**		

Comments

- The neutral pions are reduced by more than beam intrinsic because the beam intrinsic events are evenly distributed throughout the active volume and the neutral pion misIDs are more likely to occur near the edge of the volume.

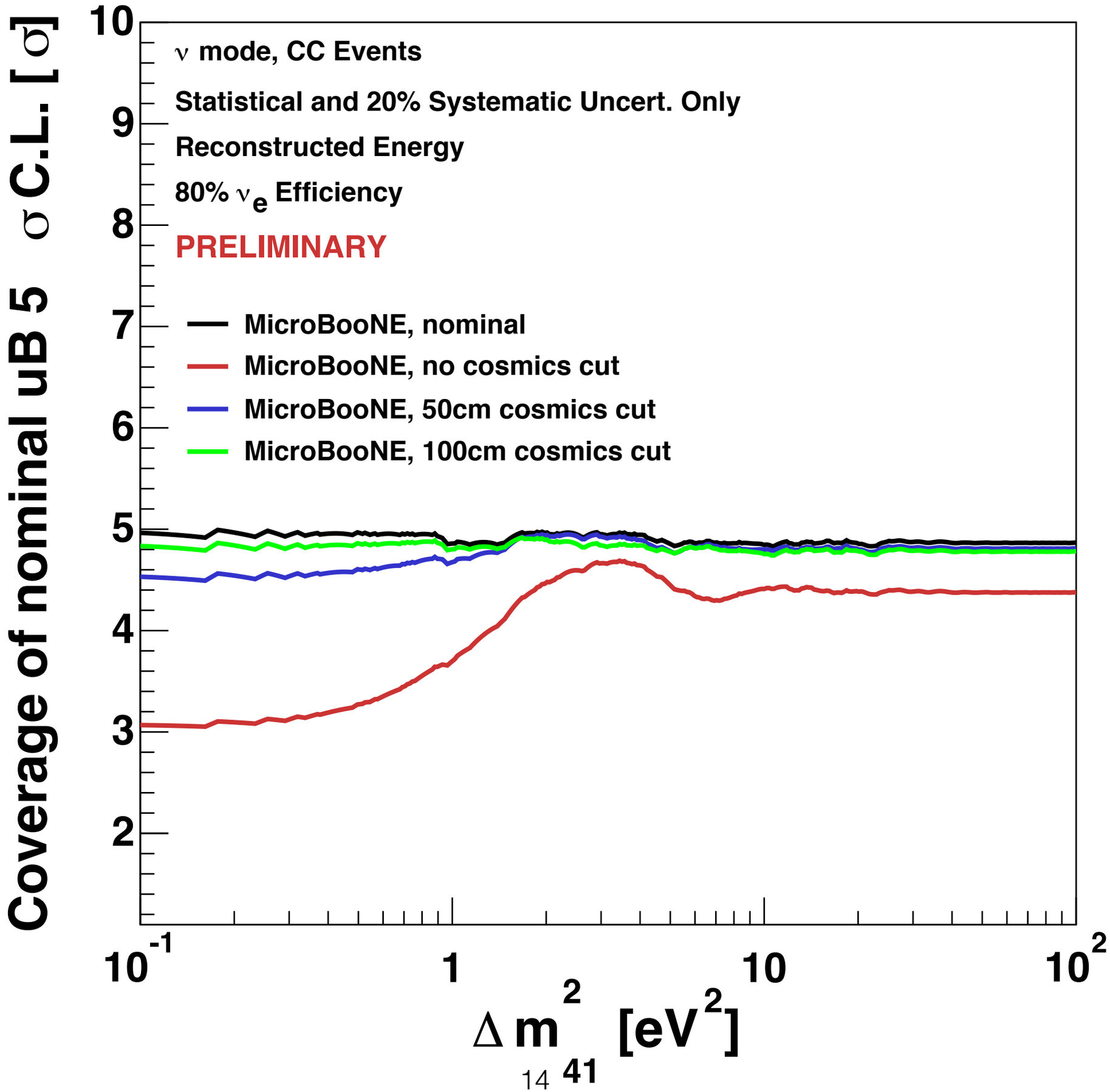
- This cut is very effective on these cosmics but does reduce intrinsic events. It could be optimized to maximize sensitivity to an excess by balancing misIDs with statistics.

“Nominal Sensitivity”



To make comparisons between the different scenarios, it’s useful to compute the sensitivity under the same assumptions for each scenario and compare the χ^2 at the same range of $(\Delta m^2, \sin^2 2\theta)$.

Choose to use the 5σ contour in the nominal case as the reference set of points in $(\Delta m^2, \sin^2 2\theta)$.


Coverage of nominal uB 5 σ C.L. [σ]
10
9
8
7
6
5
4
3
2
ν mode, CC Events
Statistical and 20% Systematic Uncert. Only
Reconstructed Energy
80% ν_e Efficiency
PRELIMINARY
MicroBooNE, nominal
MicroBooNE, no cosmics cut
MicroBooNE, 50cm cosmics cut
MicroBooNE, 100cm cosmics cut
10^-1
1
10
10^2
Δm^2_41 [eV^2]