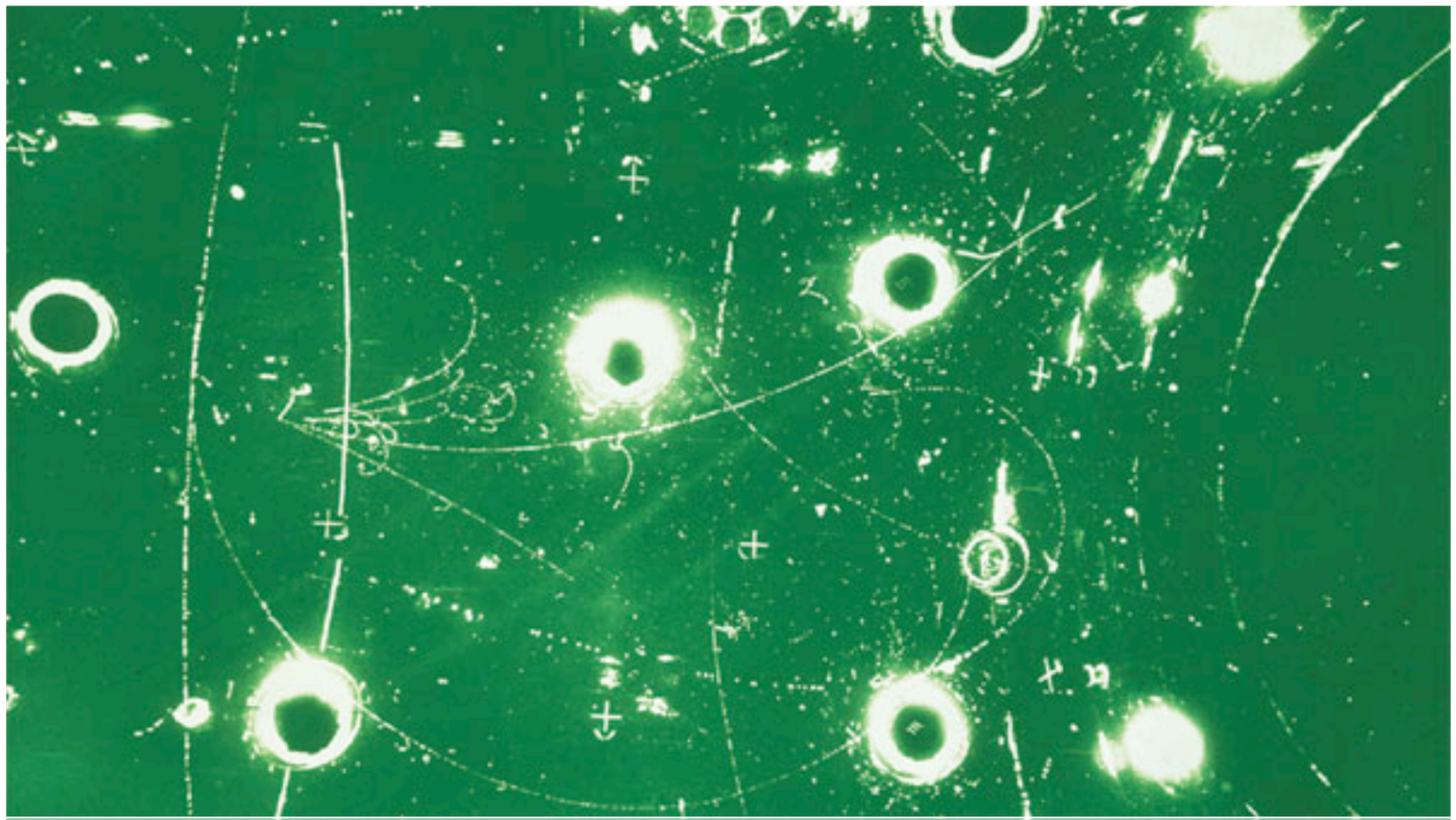

Lecture 5.
Other Processes

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"Others" Outline

- NC elastic
- CC1pi0
- A-dependence

K2K (SciBar, 1kt +MRD), MiniBooNE, SciBooNE

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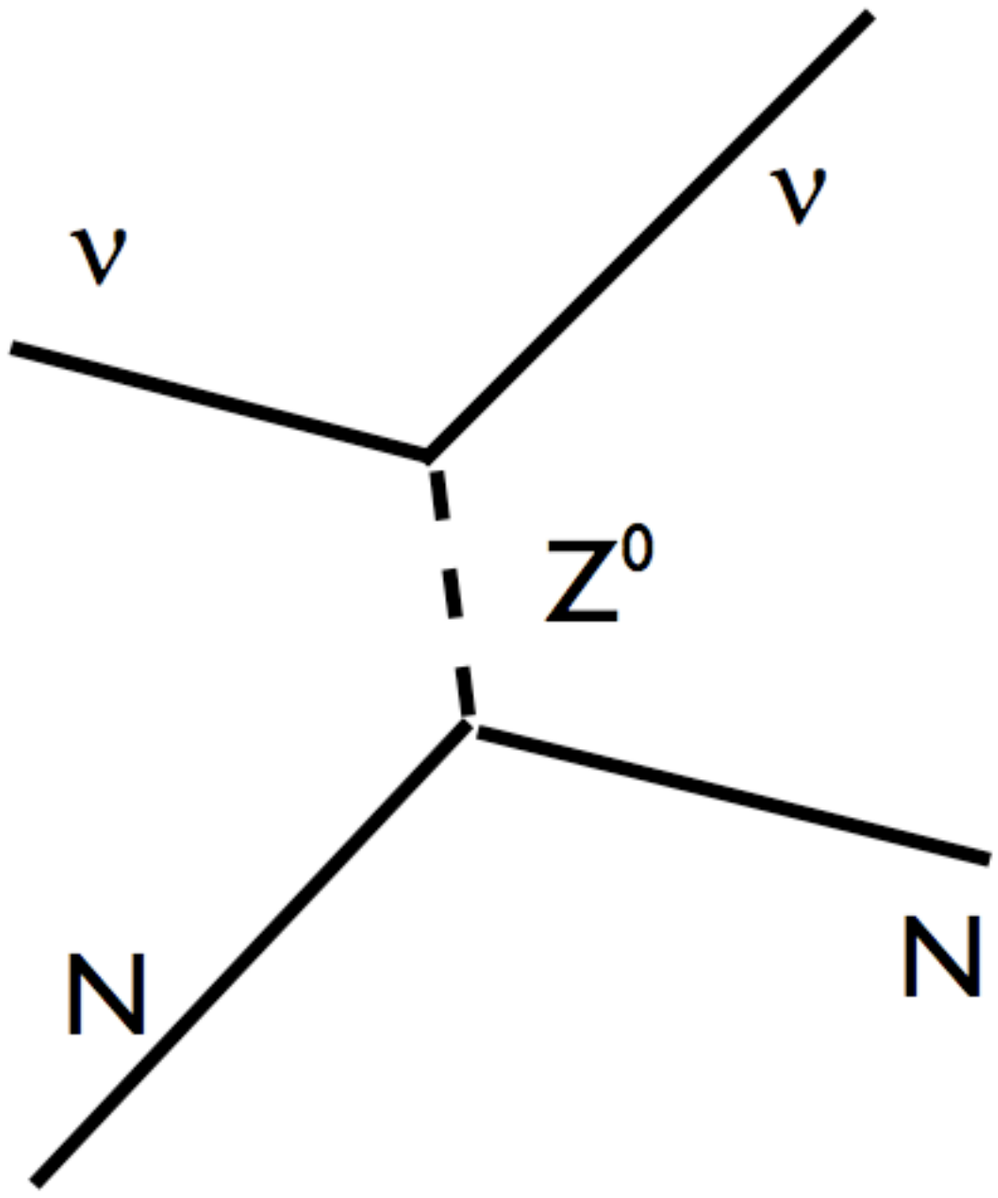
NC Elastic Intro



- Neutral current elastic scattering
- Protons & Neutrons
- Only recoil nucleon observed in detector

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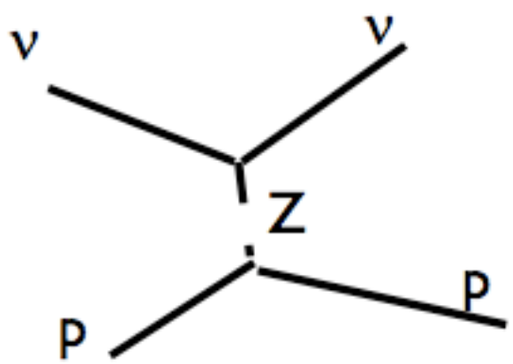
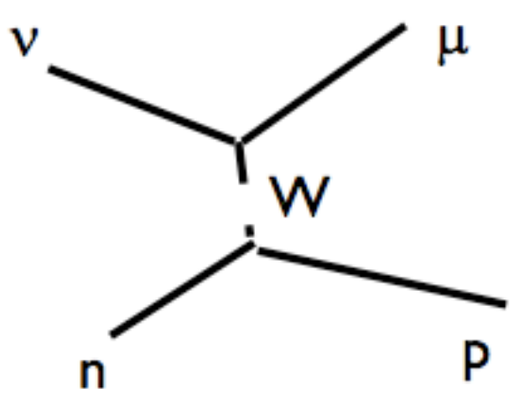
Nucleon axial structure

D.C. Cox, NuInt07

An experiment like MiniBooNE would measure the ratio of NC elastic and CCQE interactions:



neutral current elastic (NCE)



charged current quasi-elastic (CCQE)

$$\frac{d\sigma}{dQ^2} \propto (\pm G_A(Q^2) + G_A^s(Q^2))^2$$

NCE depends on Δs

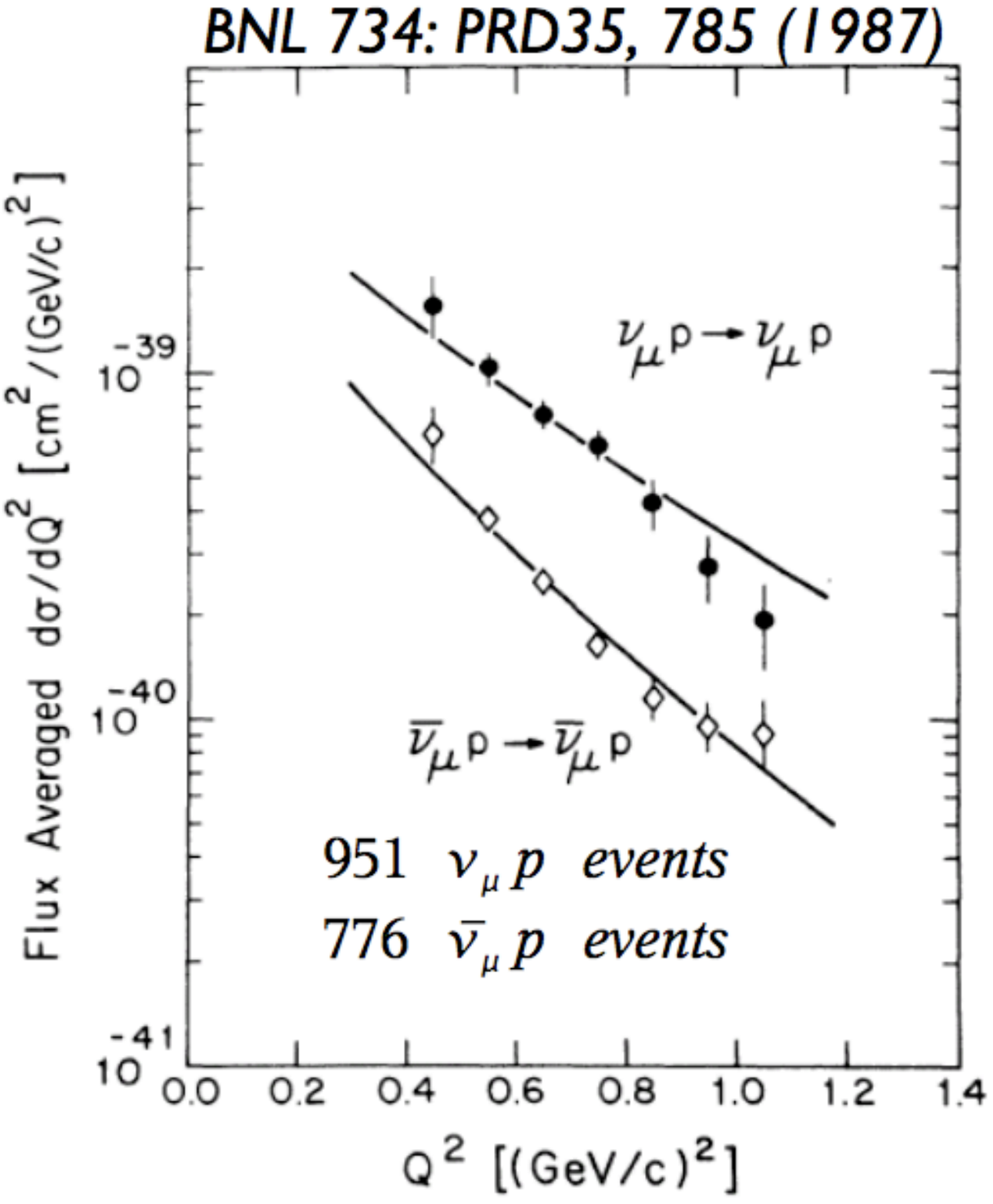
CCQE doesn't depend on Δs

A ratio reduces uncertainties from

- knowing absolute flux and other n systematics
- nuclear models and other form factors

Requires ability to distinguish protons from neutrons, currently not possible in MiniBooNE

Past Measurement



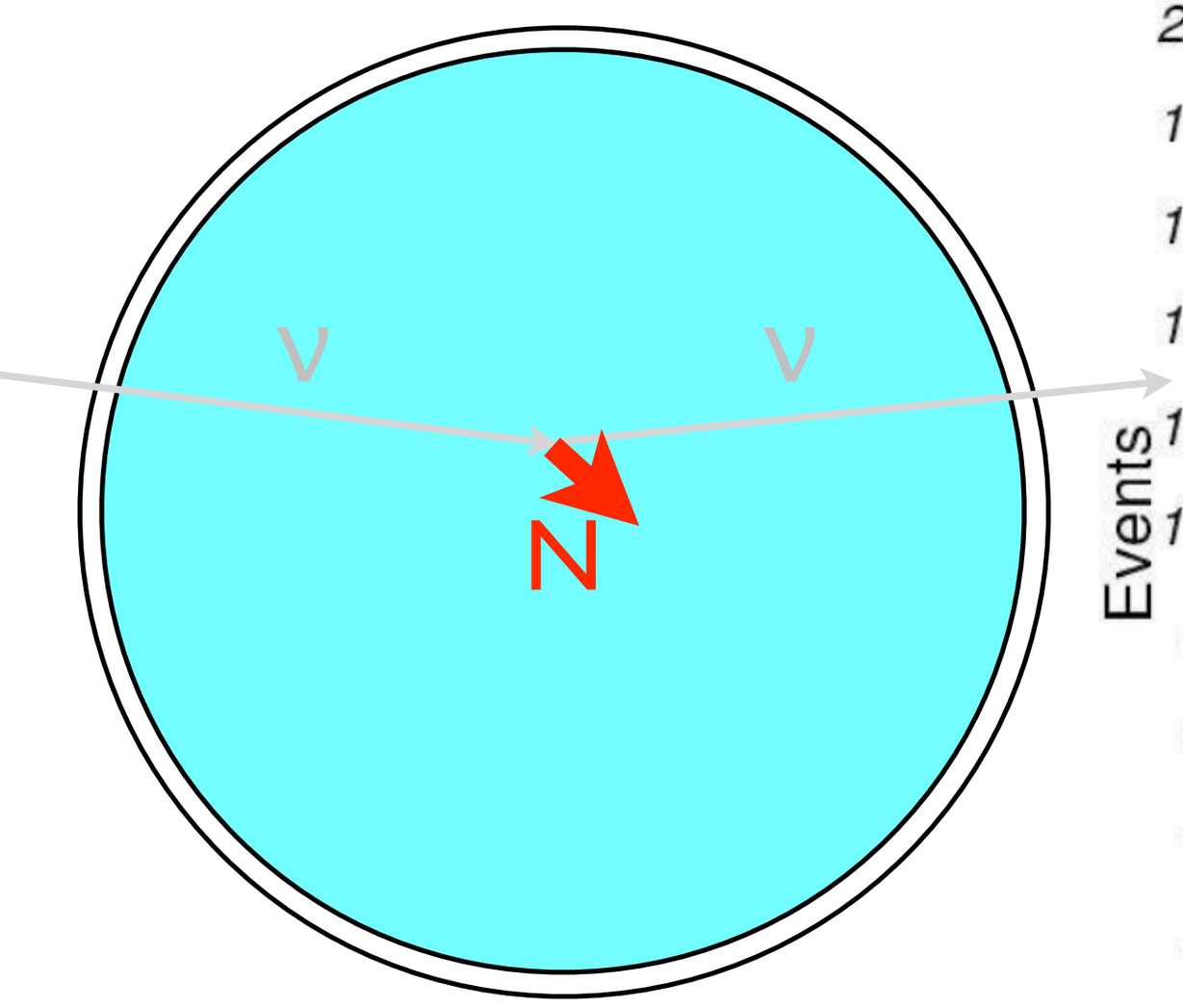
$$G_A(Q^2) = \frac{g_A(0)}{(1+Q^2/M_A^2)^2}$$

BNL best fit MA = 1.06 ± 0.05 GeV/c²
world (1987) MA = 1.032 ± 0.036 GeV/c²

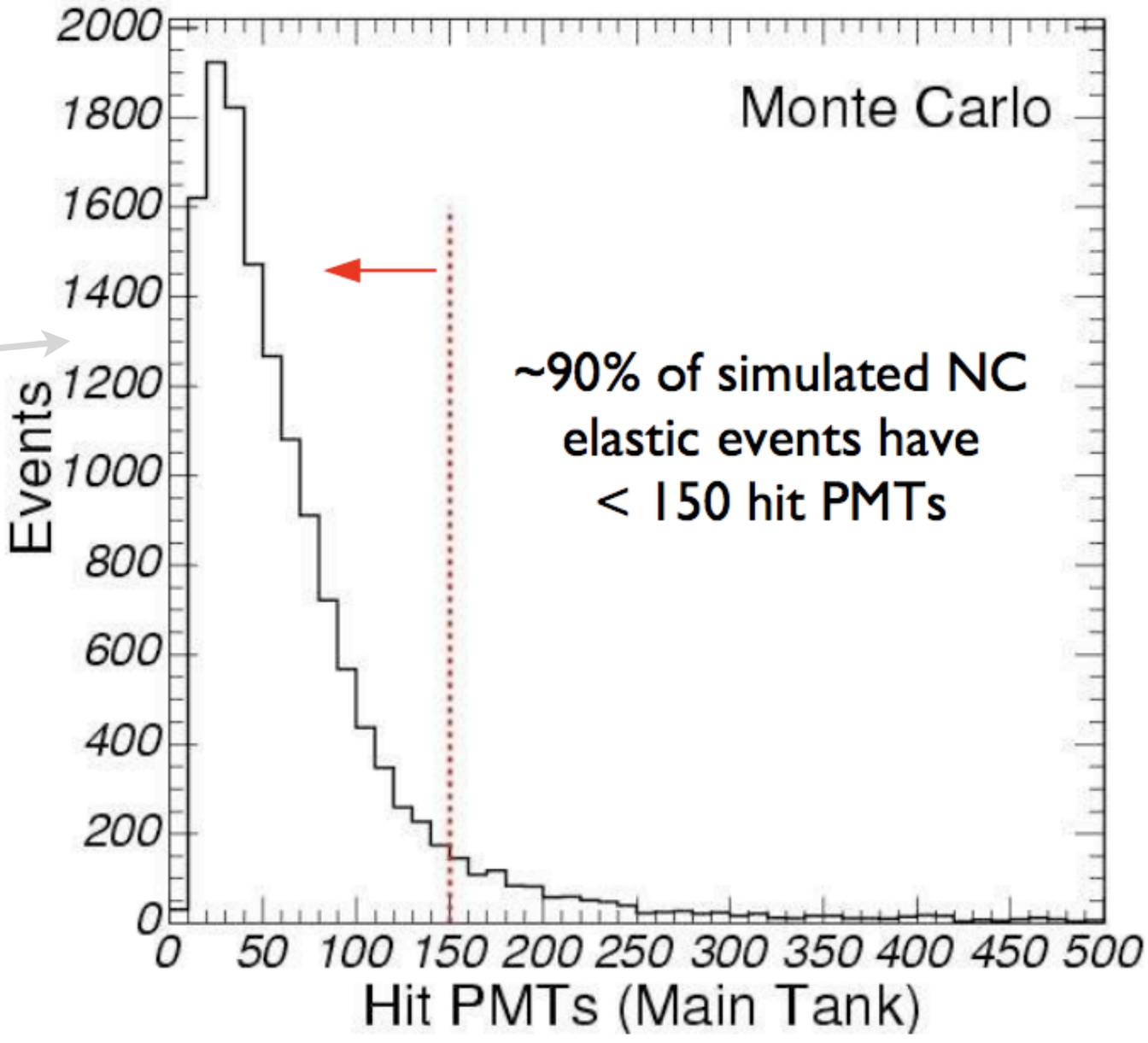
Bubble chamber experiment allowed accurate NC proton selection

MiniBooNE NC Elastic

Event Selection



C. Cox



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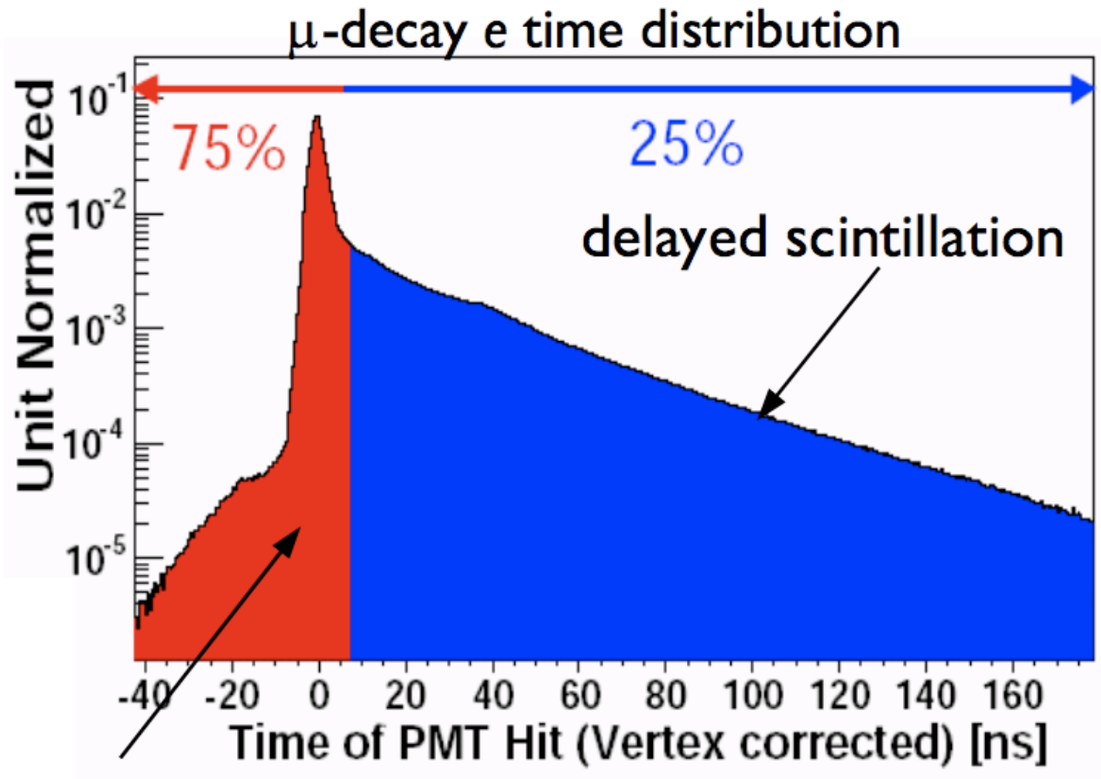
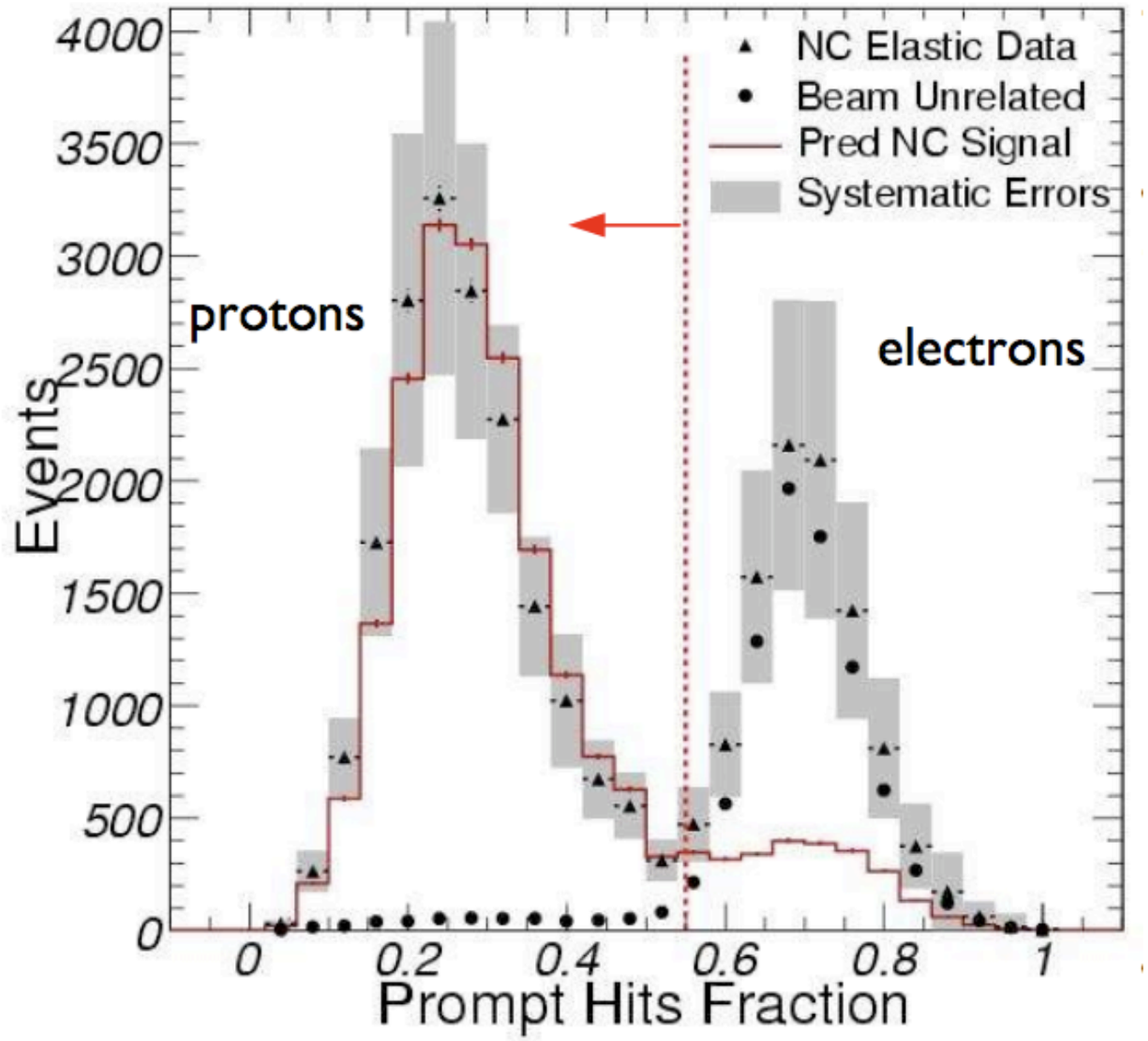
Particle ID



prompt Cherenkov

C. Cox



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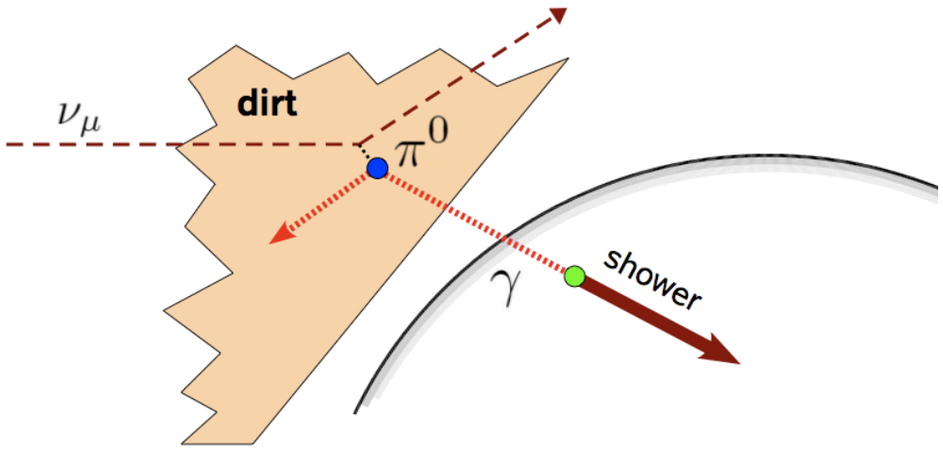
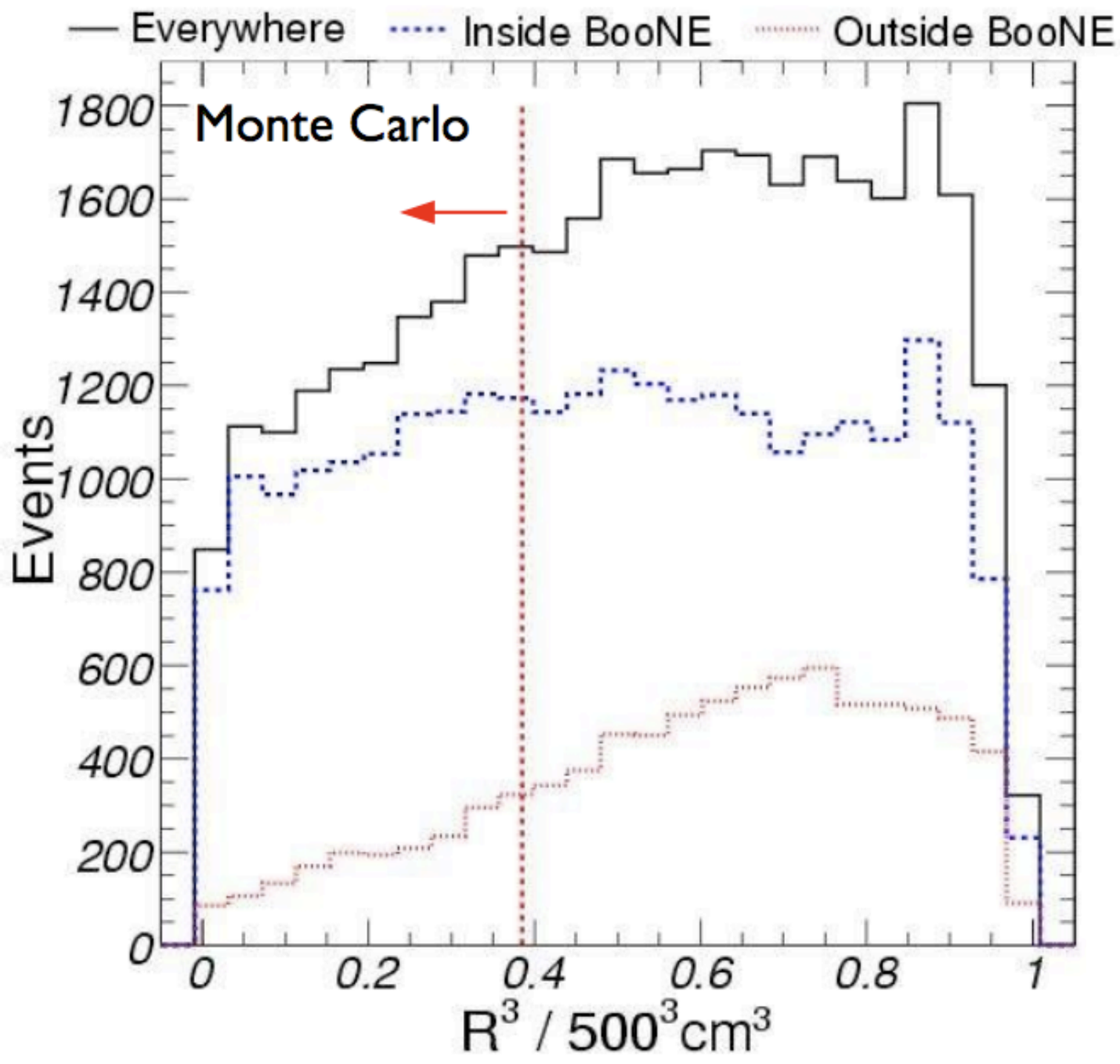
“Dirt” Backgrounds

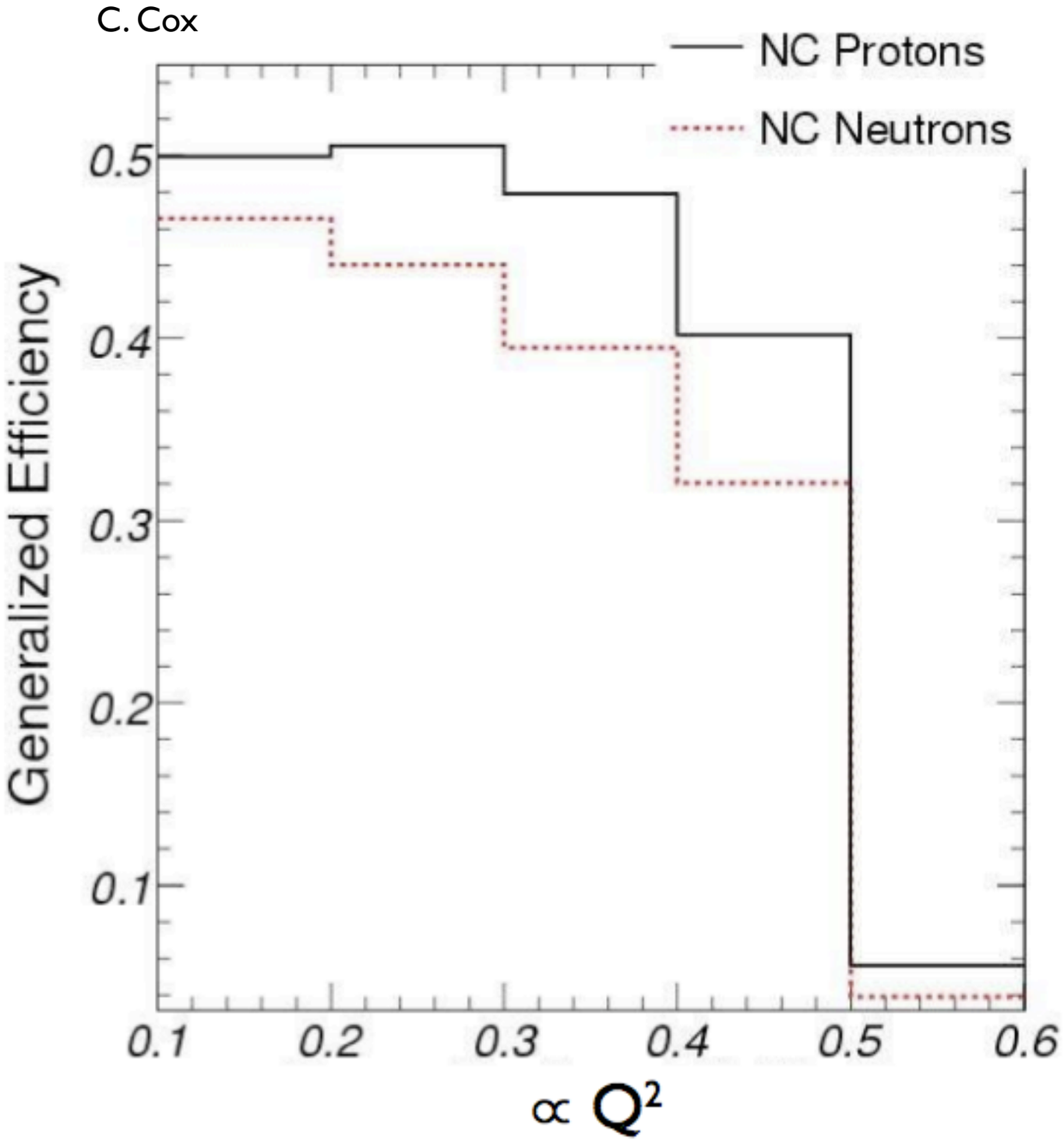


C. Cox



Efficiency

C. Cox



$$\sigma = \frac{(NC\ events - bkgd)/\epsilon_{NC}}{(\int \Phi_{\nu} * N_{POT} * N_{nucl})}$$

MiniBooNE predicts 5:4 ratio
NC p : NC n cross sections.

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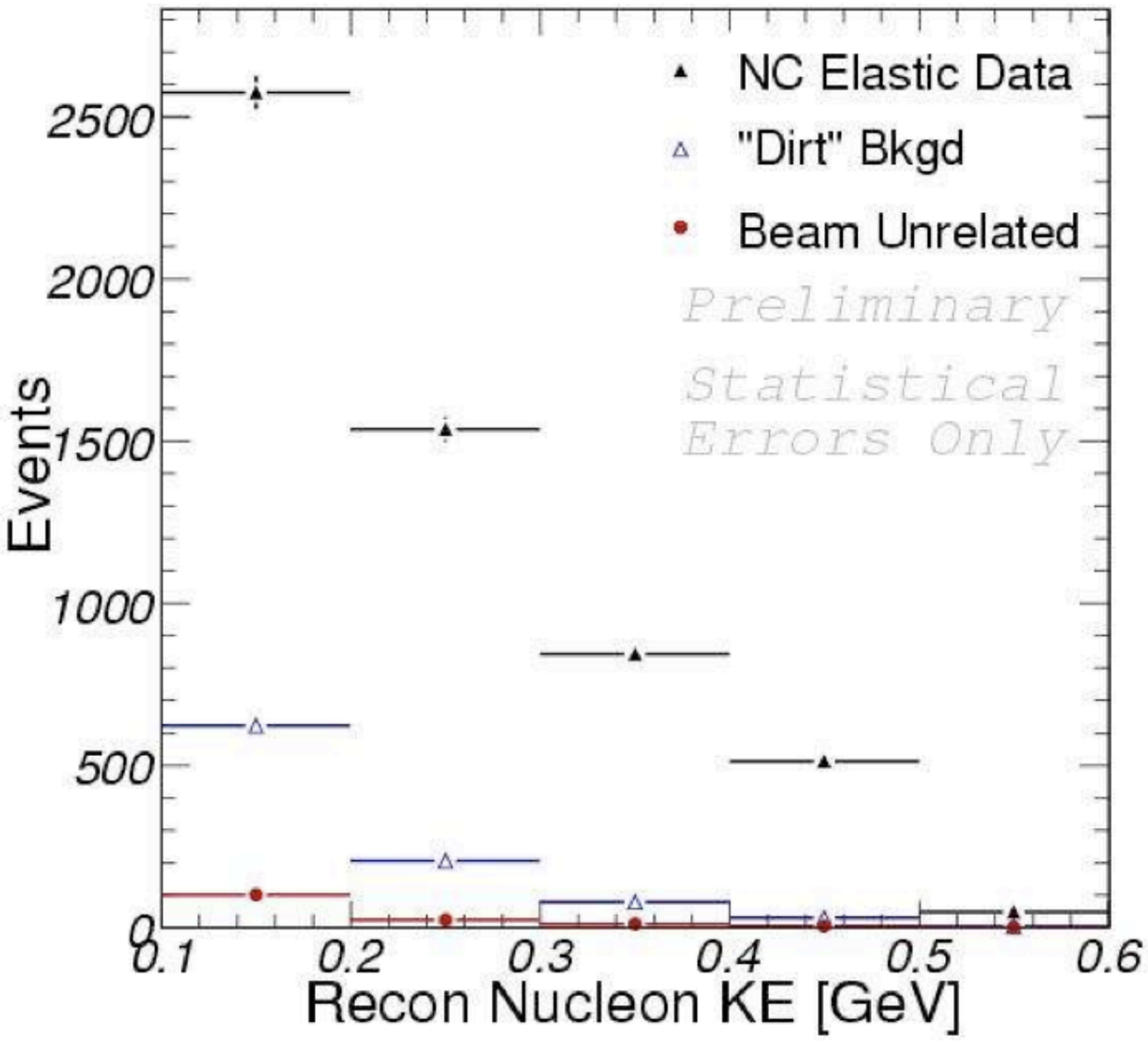
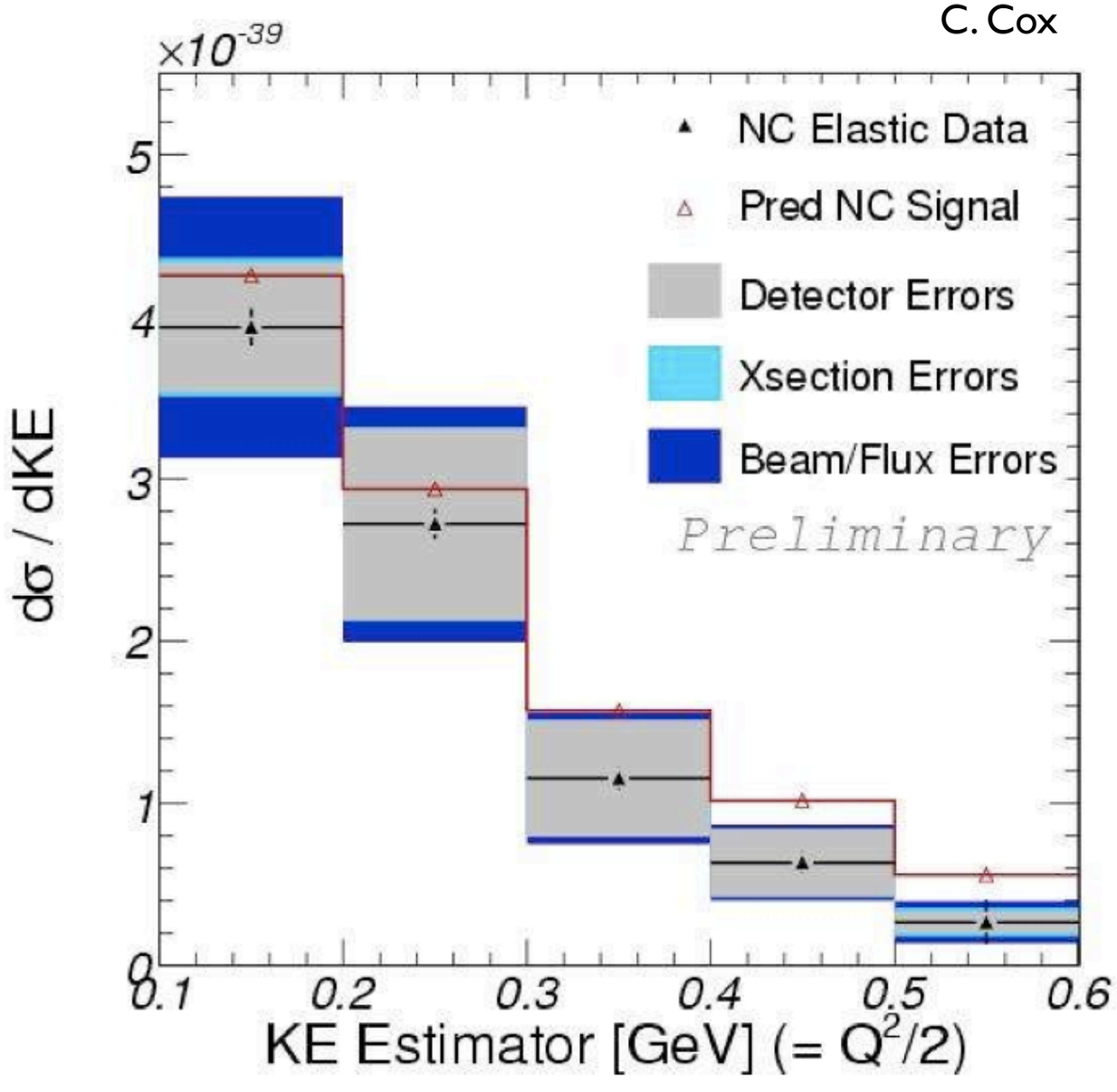
Yield and Cross Section

C. Cox





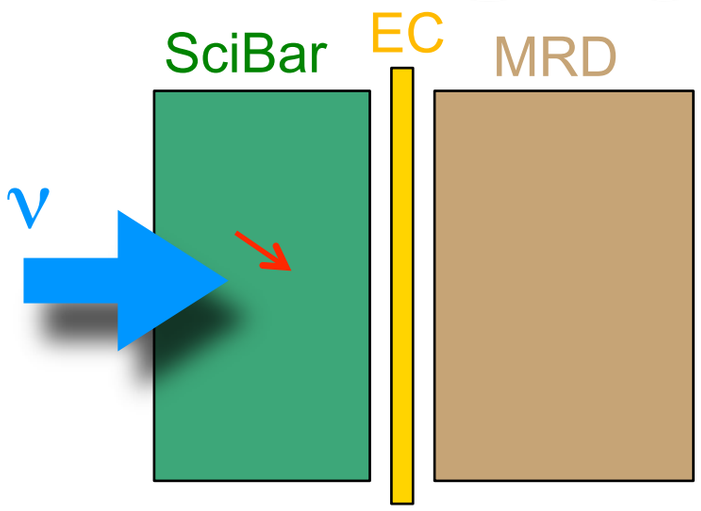
After efficiency correction and unsmearing

Future

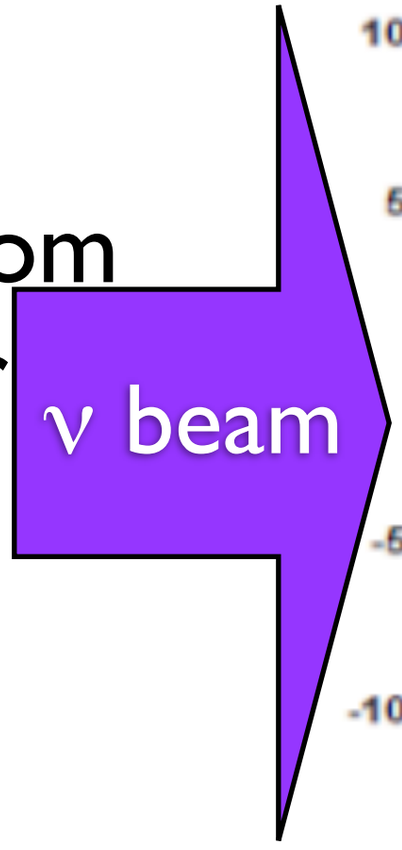
- New analysis with improved event fitter and higher statistics
- Released in 2009

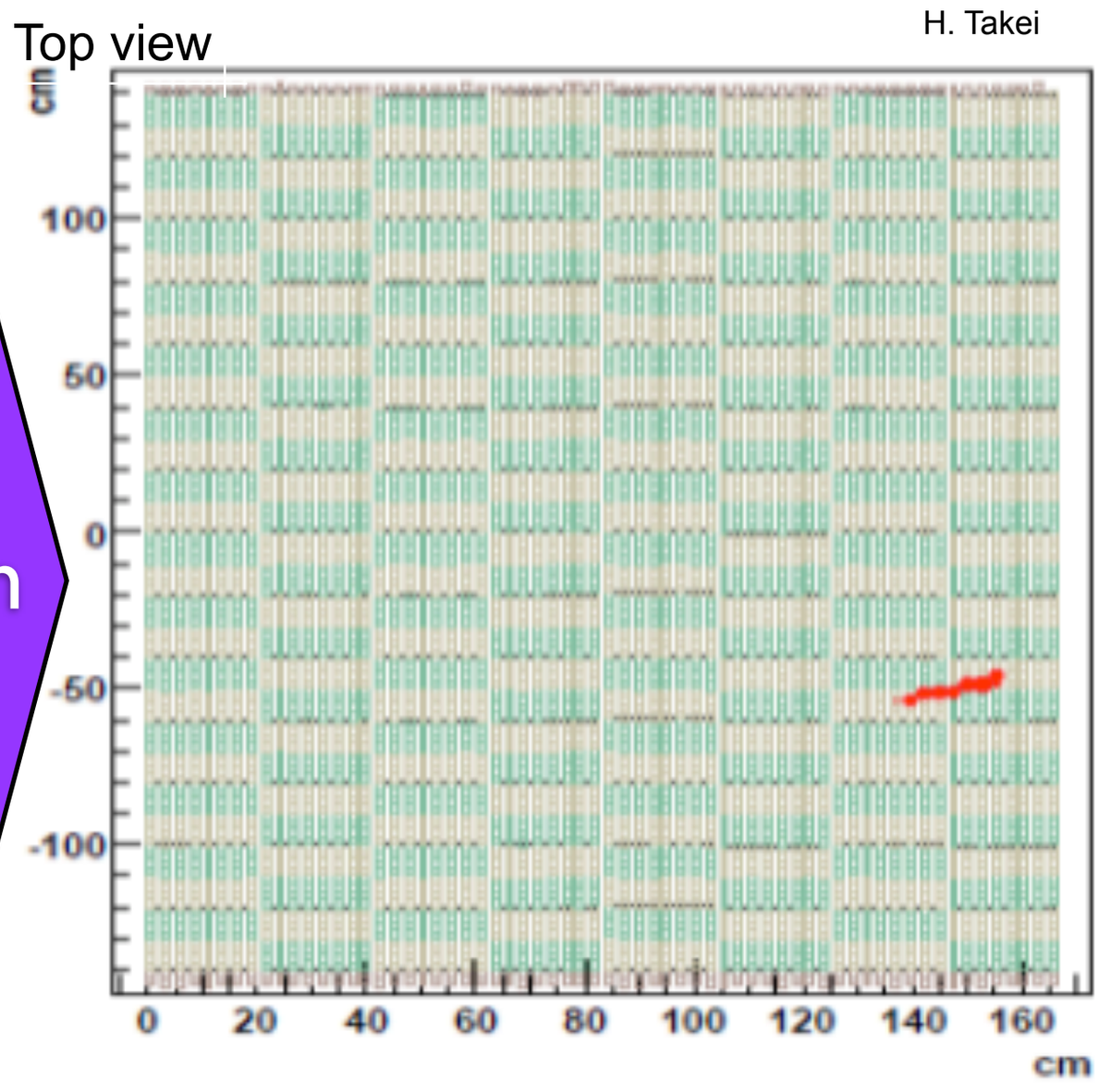
SciBooNE NC Elastic

NC elastic scattering



- No interference from photon propagator
- Simple signature: recoiling nucleon
- Tuning PID cuts





Results in 2009

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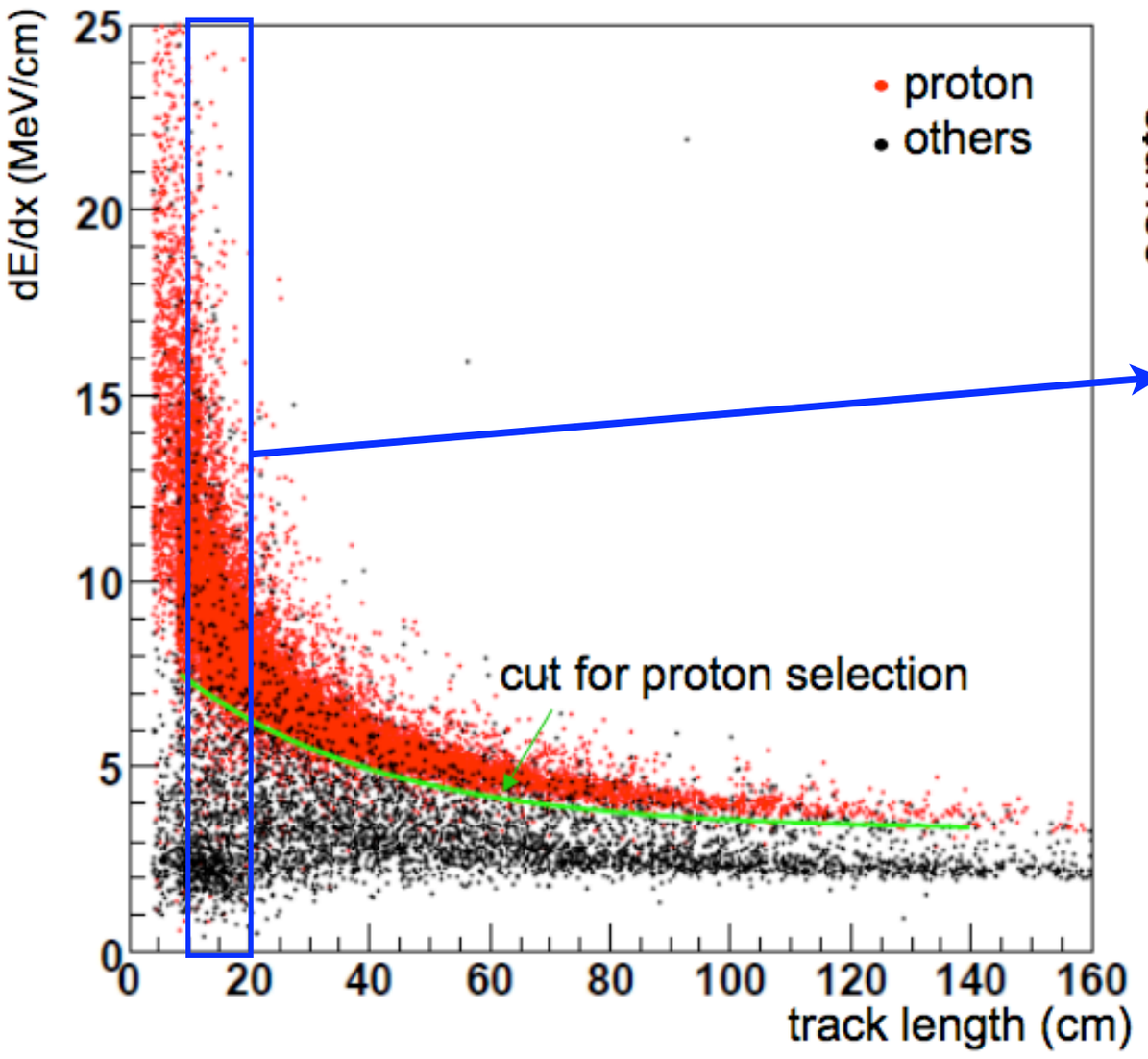
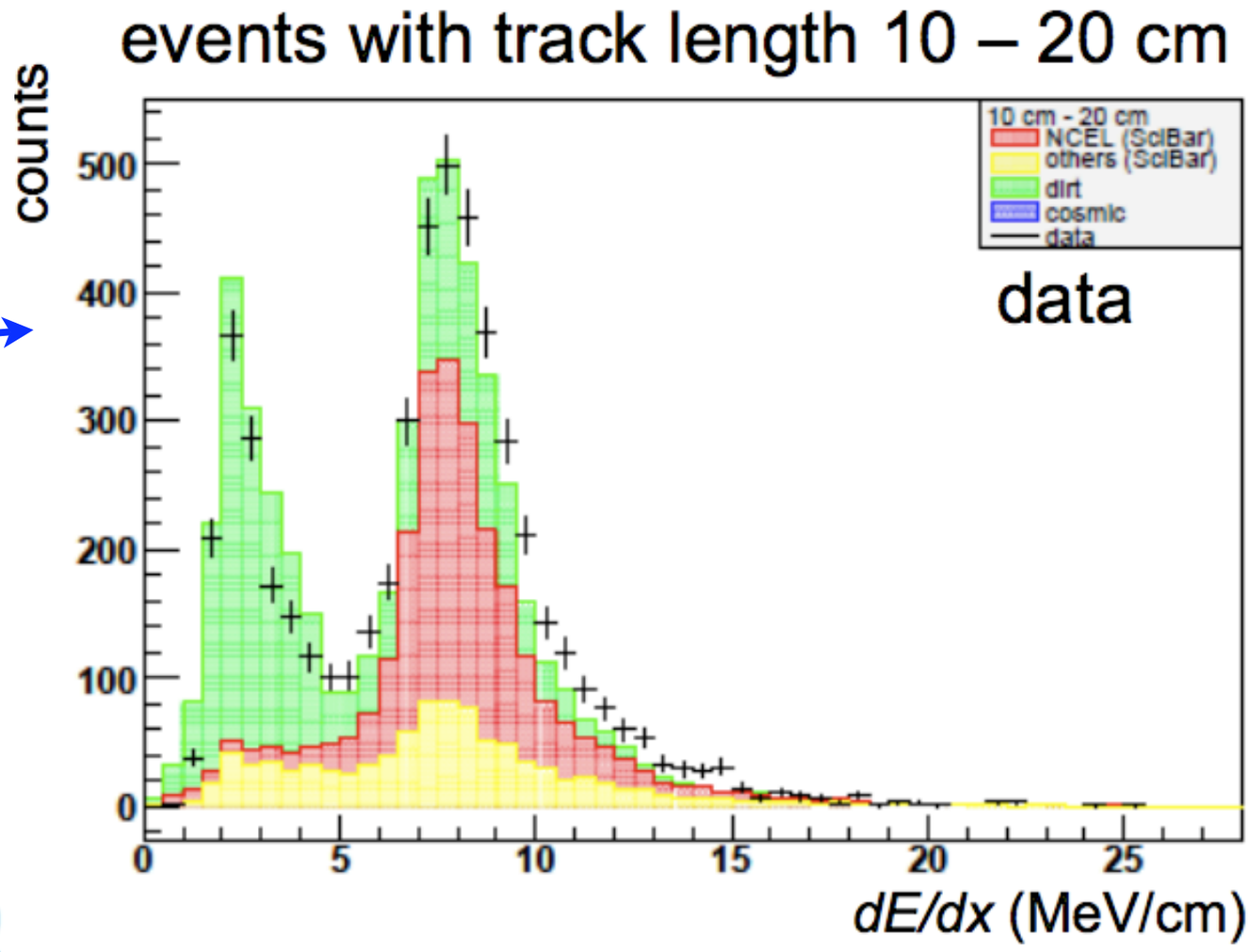
Particle ID

H. Takei





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Event Selection

event selection	data	MC (signal)	MC (B. G.)*	purity*(%)
total *	1877675	34962	161296	21.7
veto	123501	27962	96341	22.5
1 track	18325	5200	16415	24.7
decayed particle rejection	13917	5017	7739	39.3
dE/dx cut	8441	4340	3335	56.5

*total numbers of neutrino beam trigger

*MC (B.G.) includes all non-NC elastic interactions in SciBar and dirt backgrounds.

*purity:
(NC) / (MC signal+B.G.)

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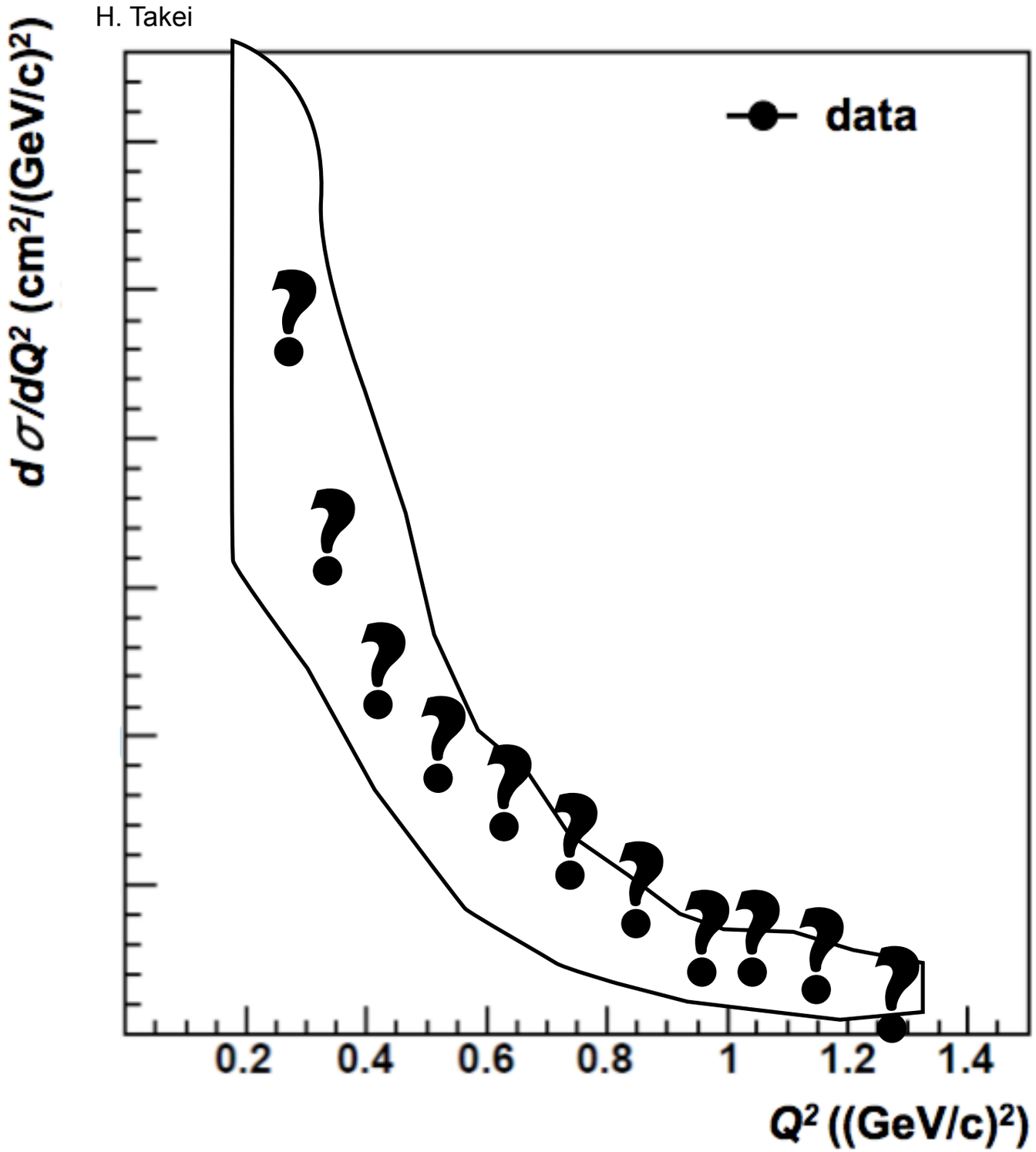
SciBooNE NCE Progress



- Initial cross section analysis completed
- Now performing final studies and systematics estimates
- Should be released in 2009

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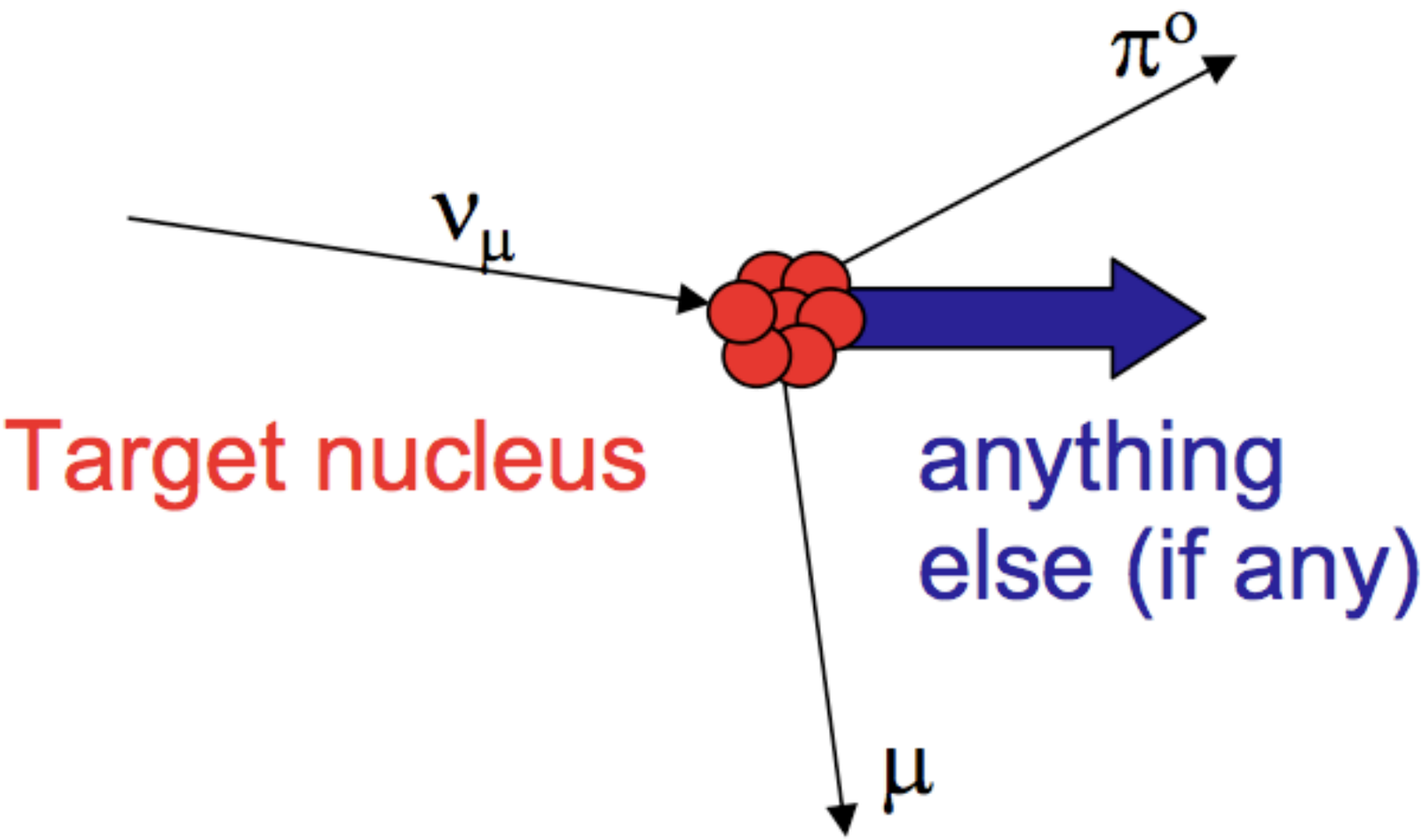
CCπ^0 Intro



K2K CCpi0

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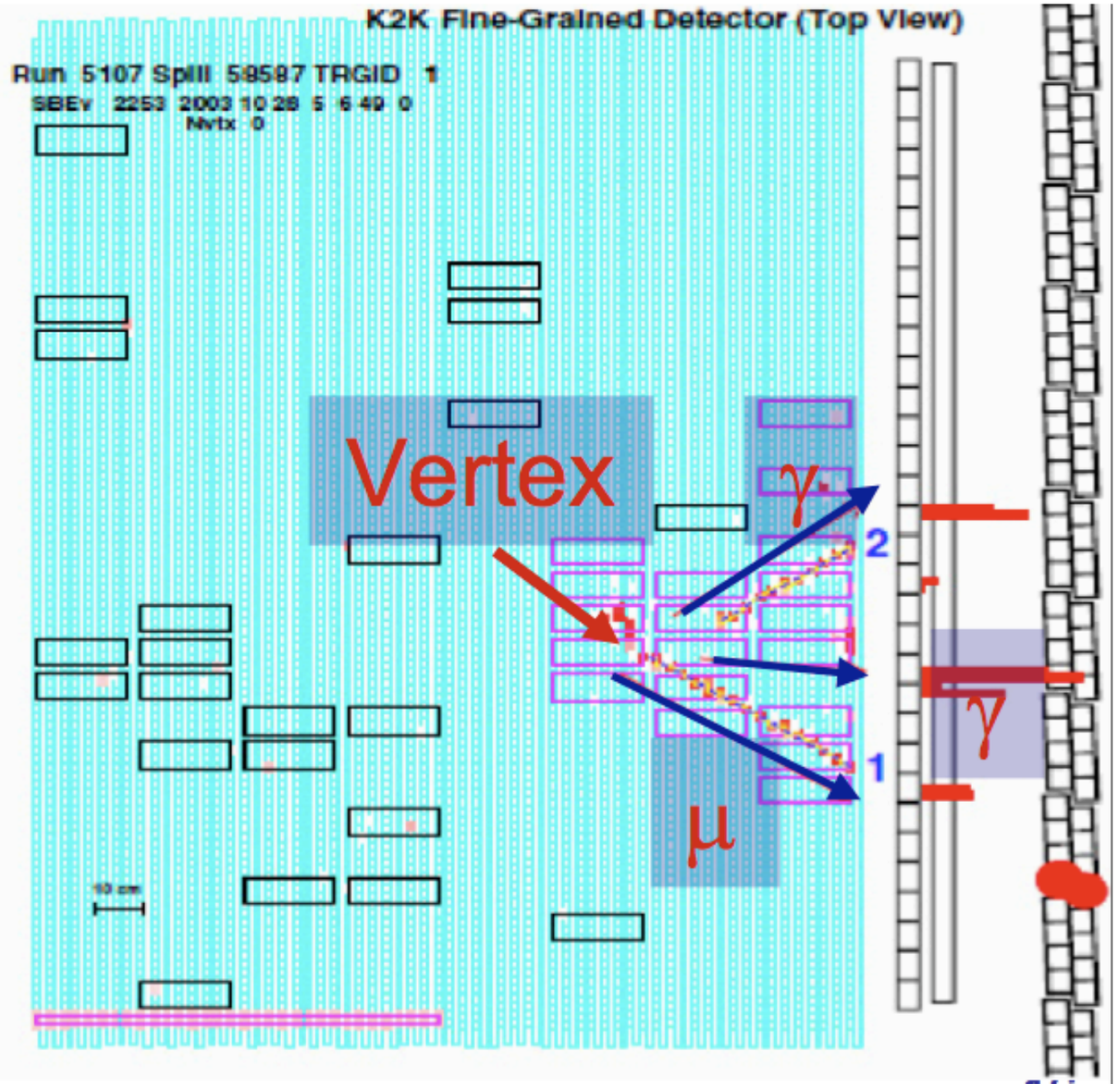
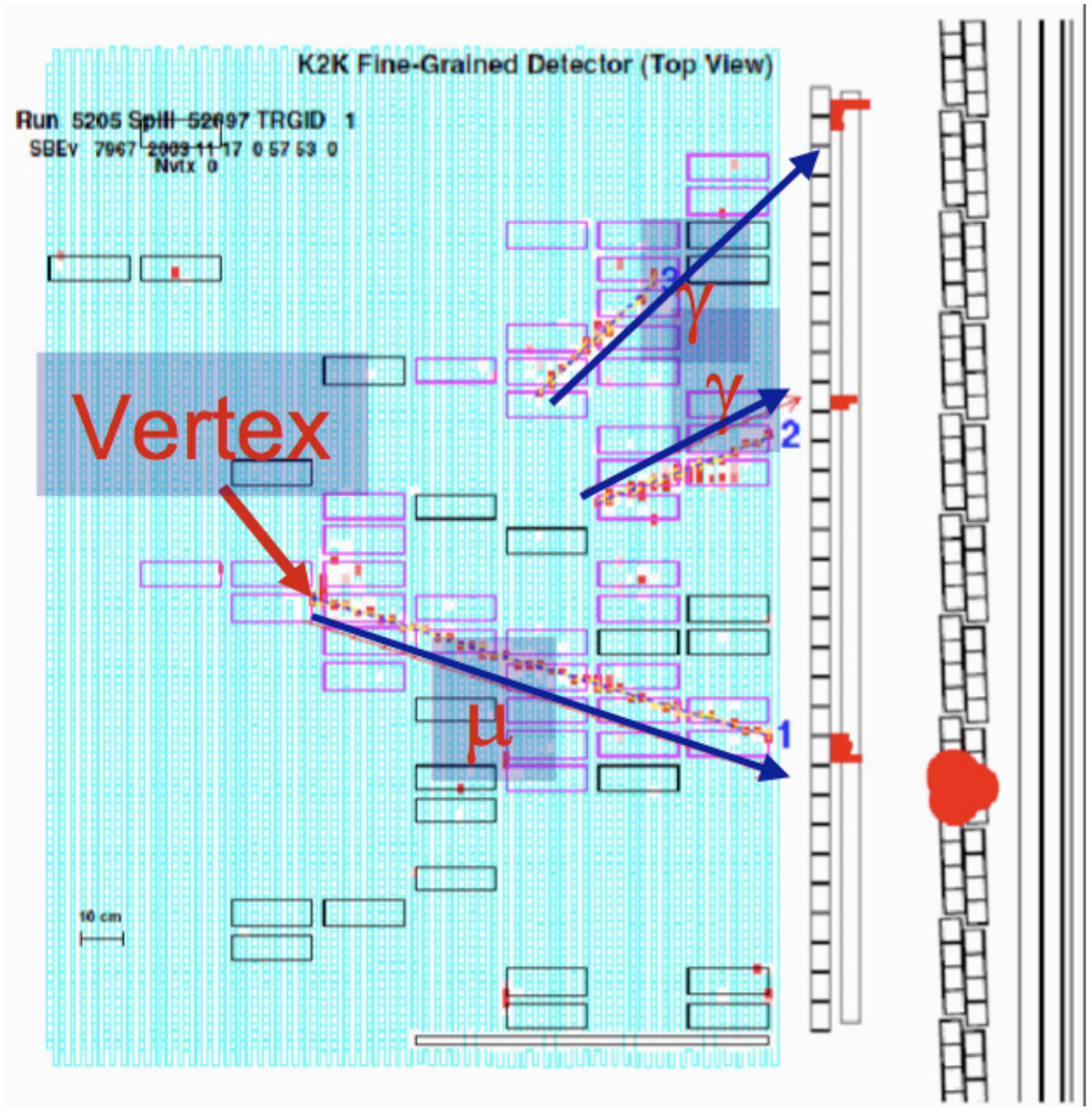
Signal Event Displays





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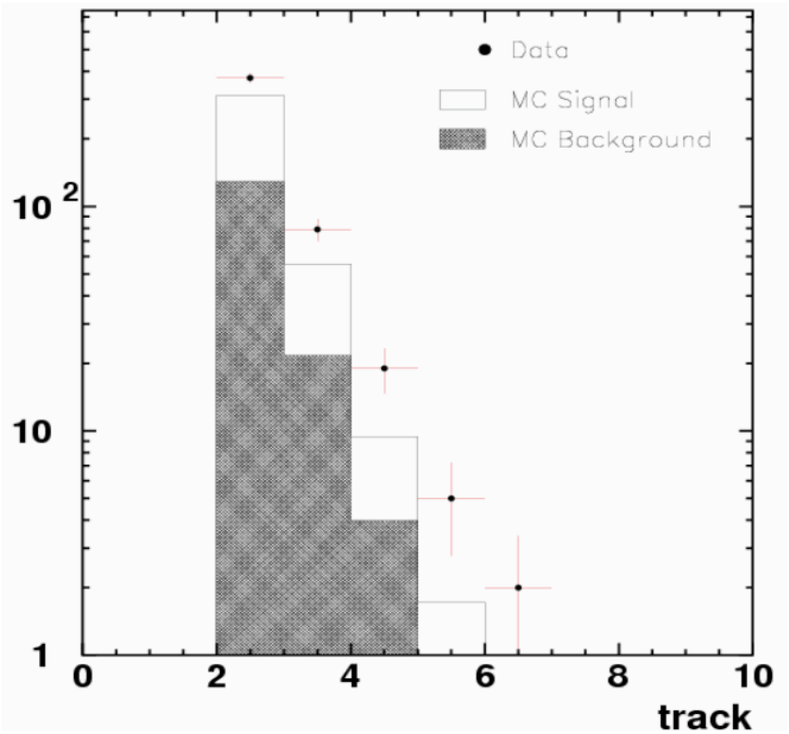
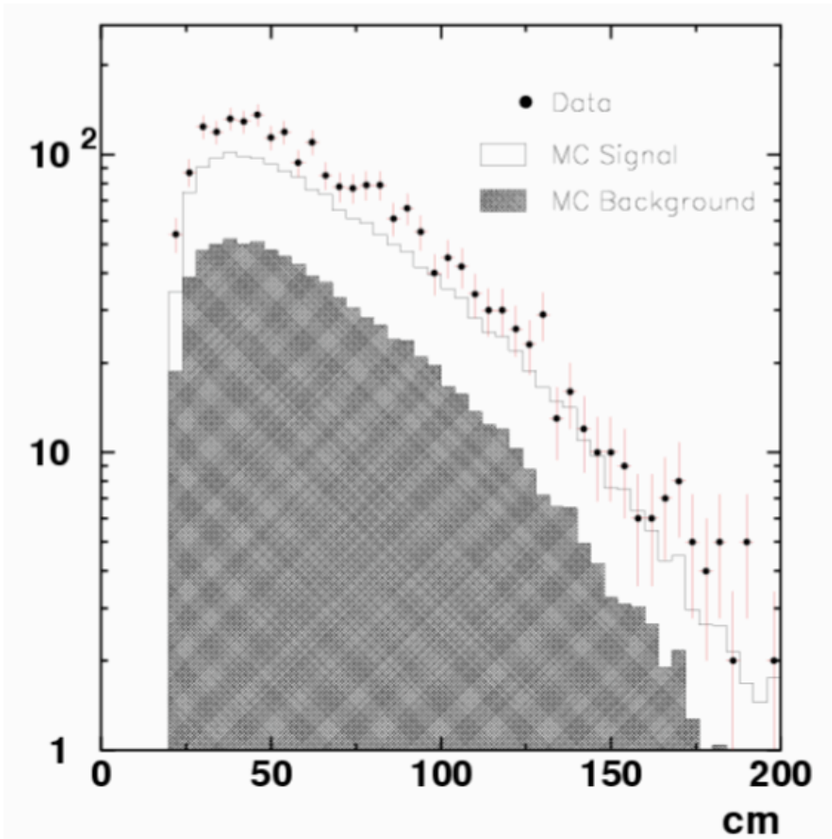
Event Selection

C Mariani

- Fiducial & timing cuts
- MRD matching for the muon
- At least 2 photons
- Disconnected tracks
- Fit with normalization parameters to estimate BG





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Event Stats & Purity

Sample	Sample number	Data	MC norm
2 γ in SB	1	353	279.6
1 γ in SB +1 γ in EC	2	96	77.8
2 γ in EC	3	30	22.6

True π^o signal (59%)	
Composition:	**Source:**
• Prompt π^o: 82%; • π^o from reinteractions: 11%; • η decay: 7%;	• Single pion from resonances: 45%; • Multi pion from resonances: 49%; • DIS: 6%;

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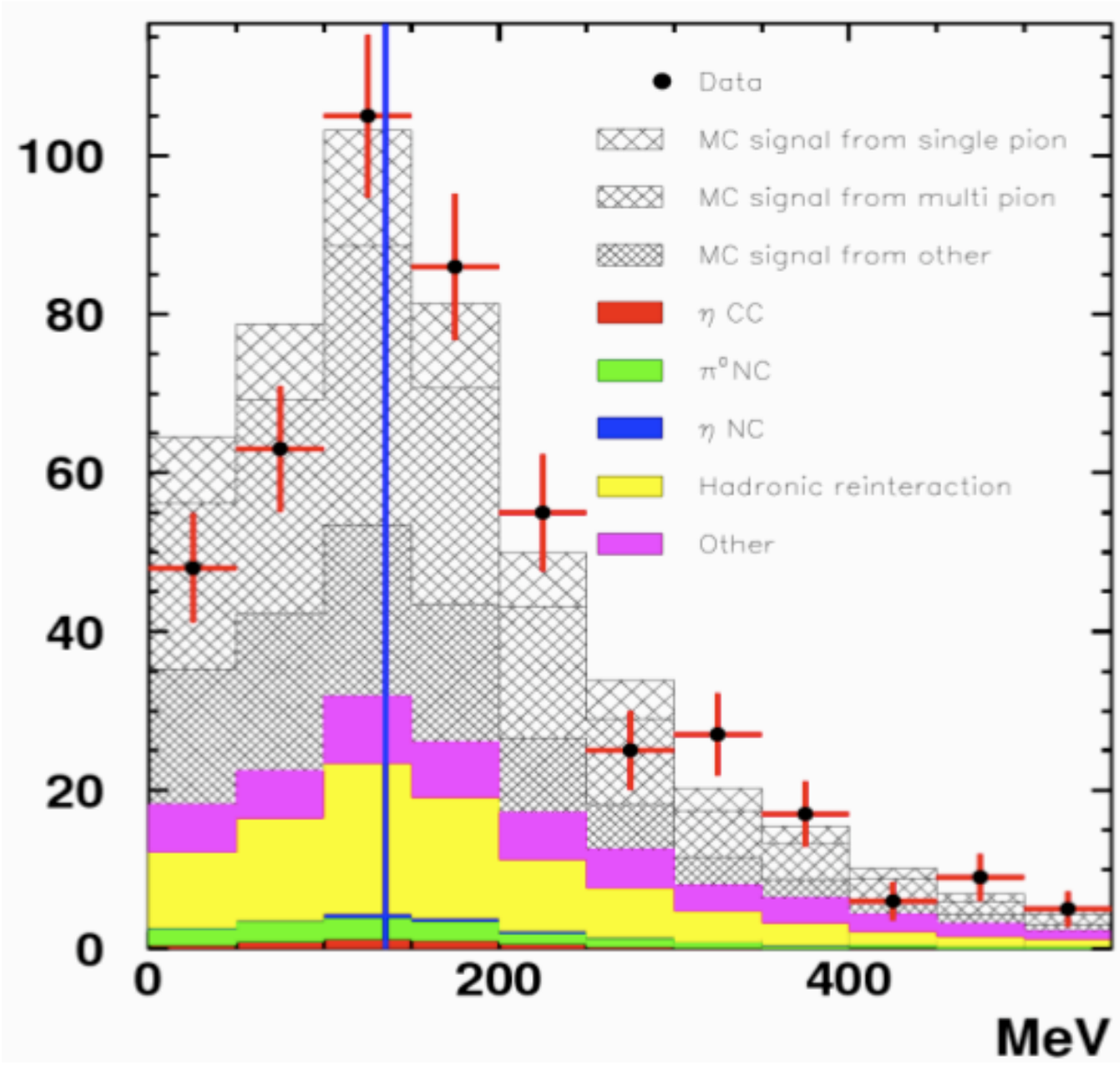
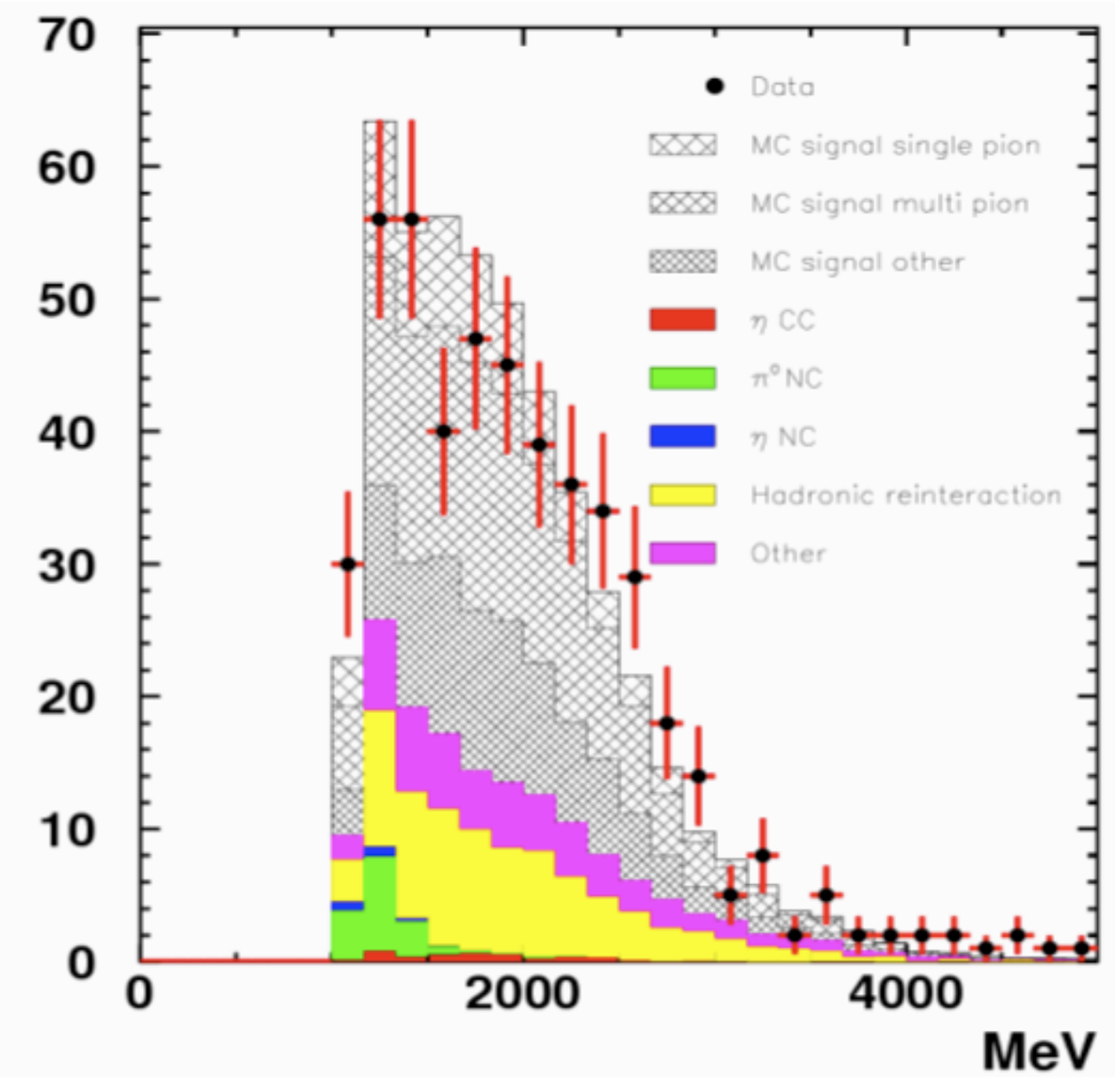
After Fitting

C Mariani





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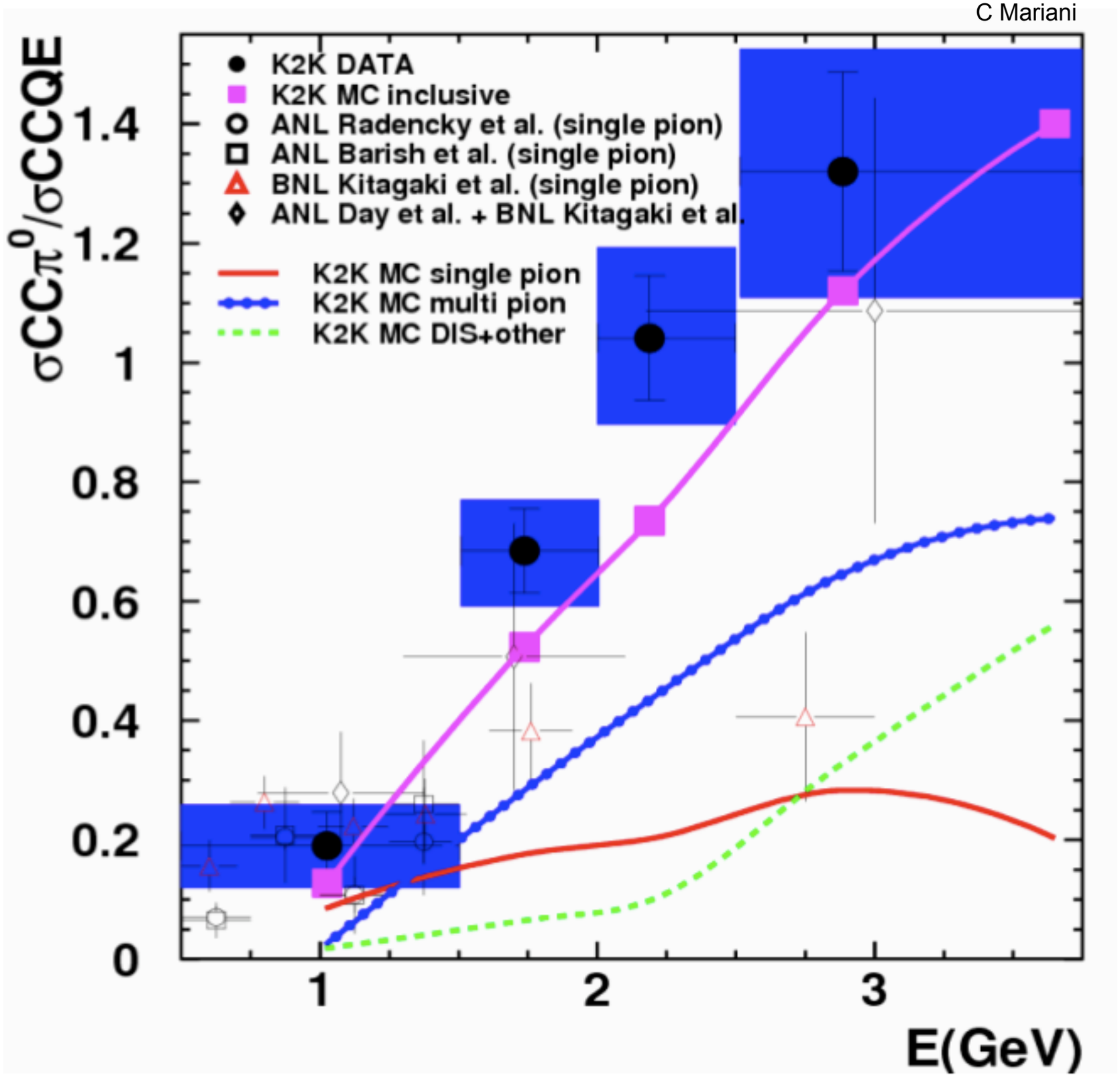
Cross Section Ratio

C Mariani



SciBooNE CCπ0

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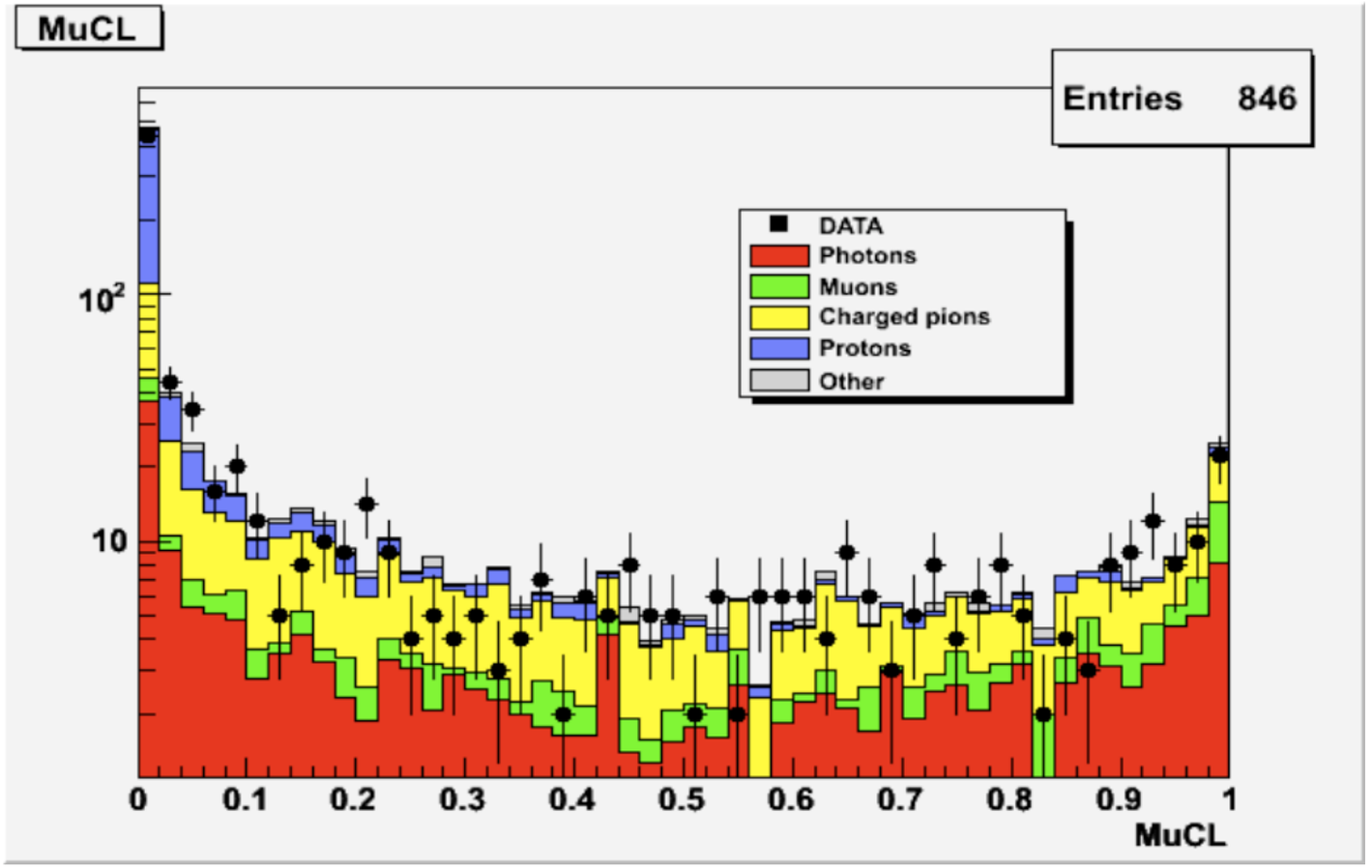
Event Selection

- SciBar-MRD matched track
- At least 2 additional tracks
- Track Disconnection
- Particle ID

- Next steps:
  - Extended tracks, to collect untracked hits into photon showers



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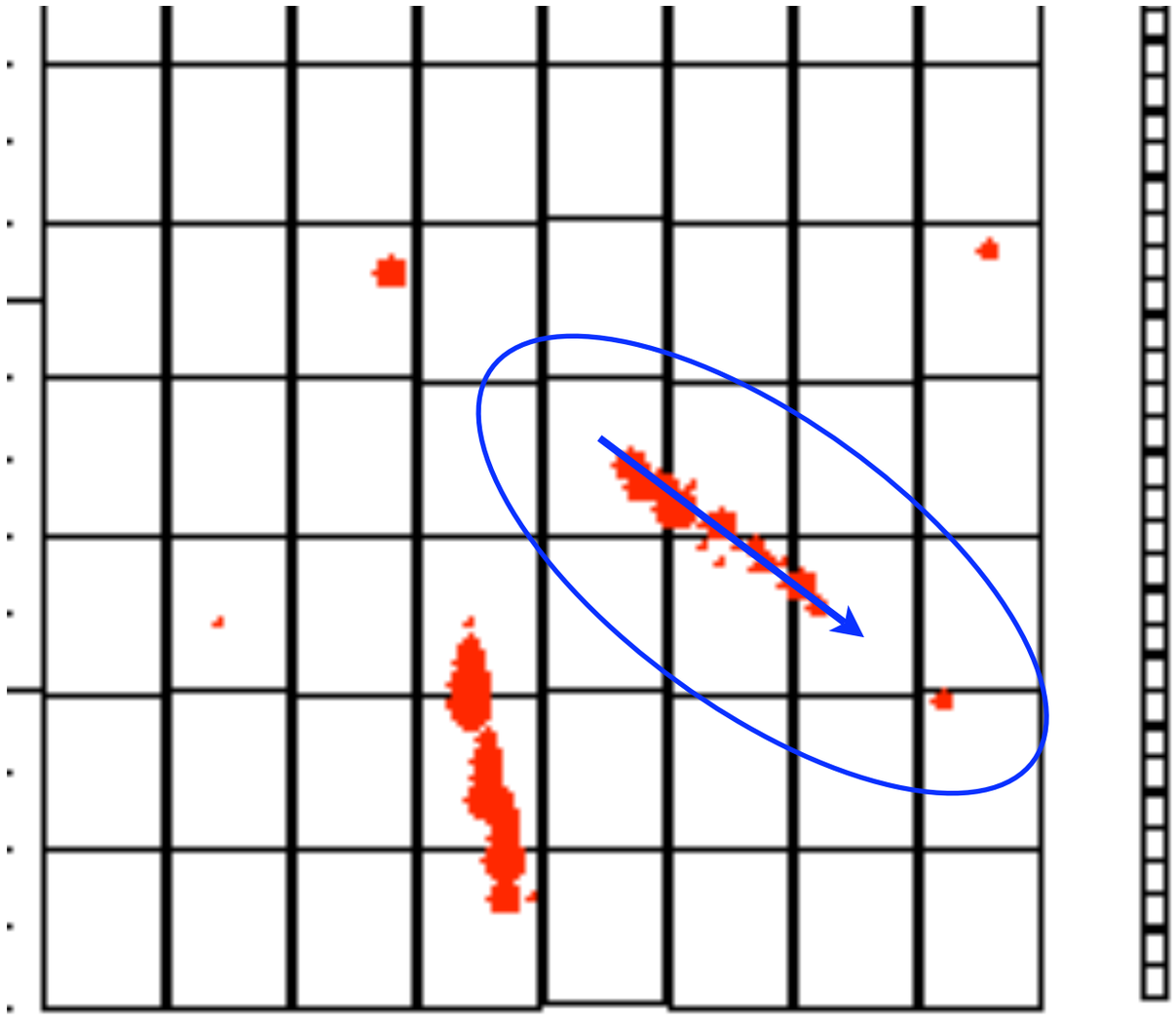
Extended Tracks



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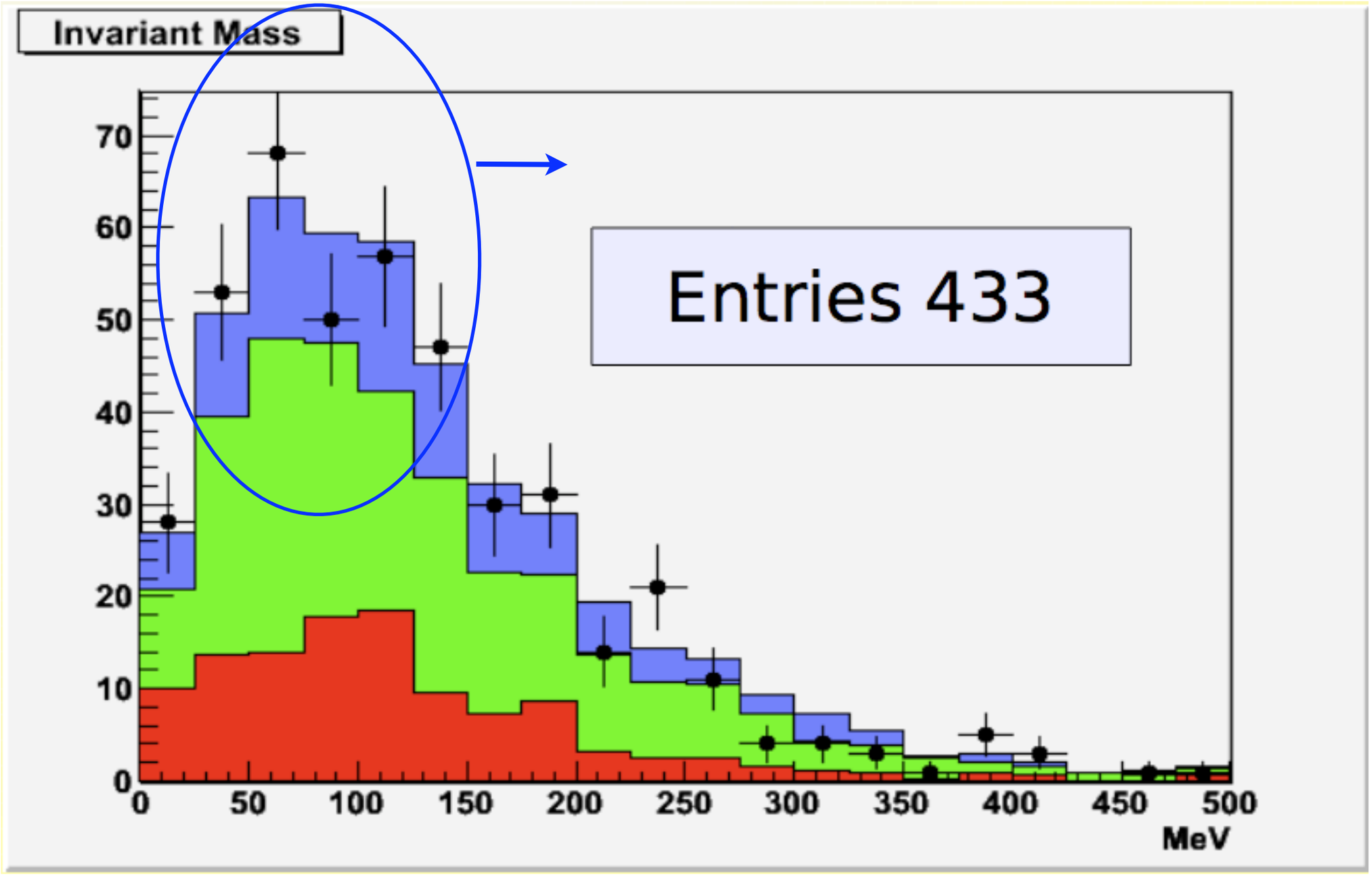
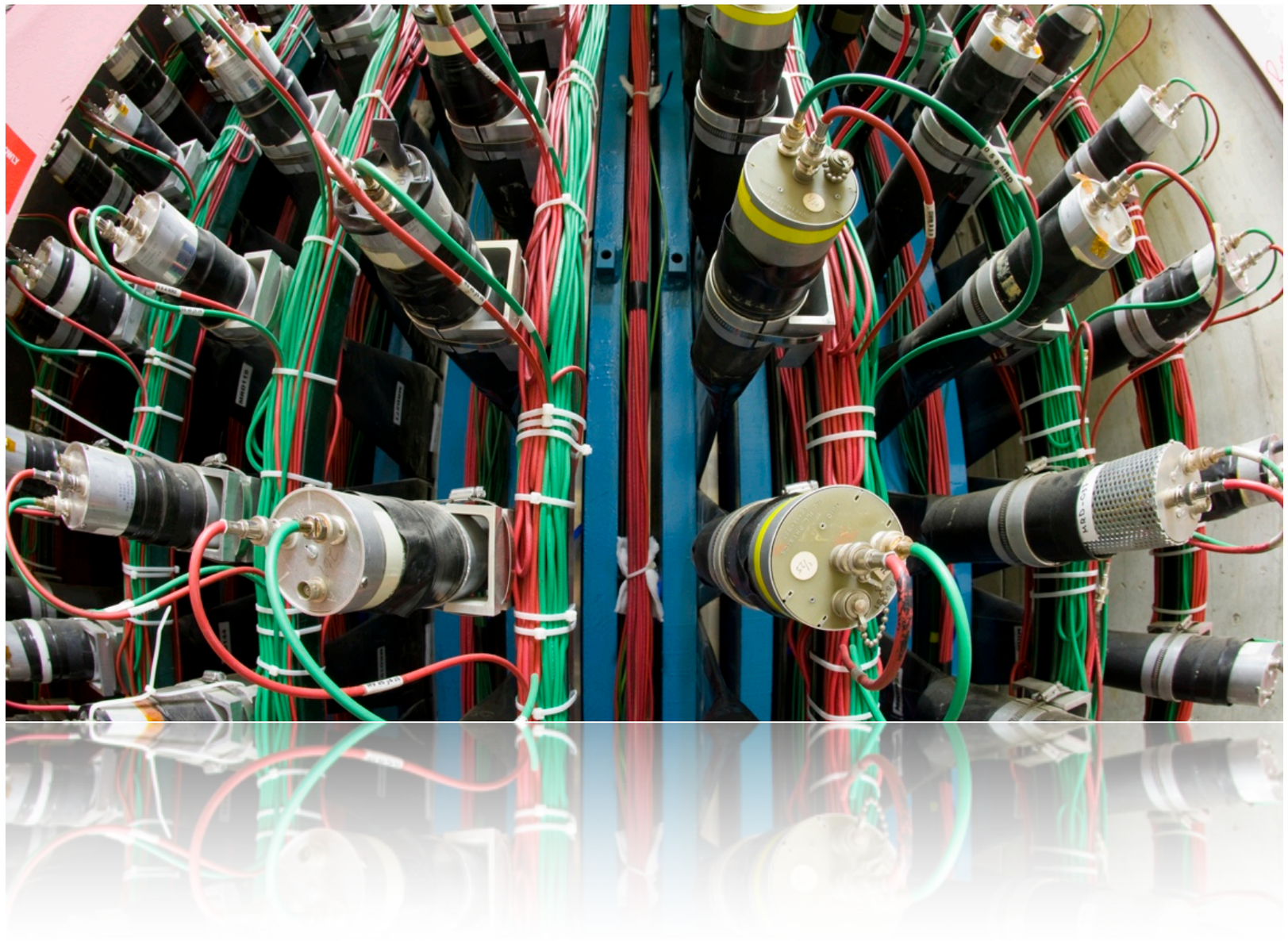
Pi0 Mass Reconstruction





A Dependence

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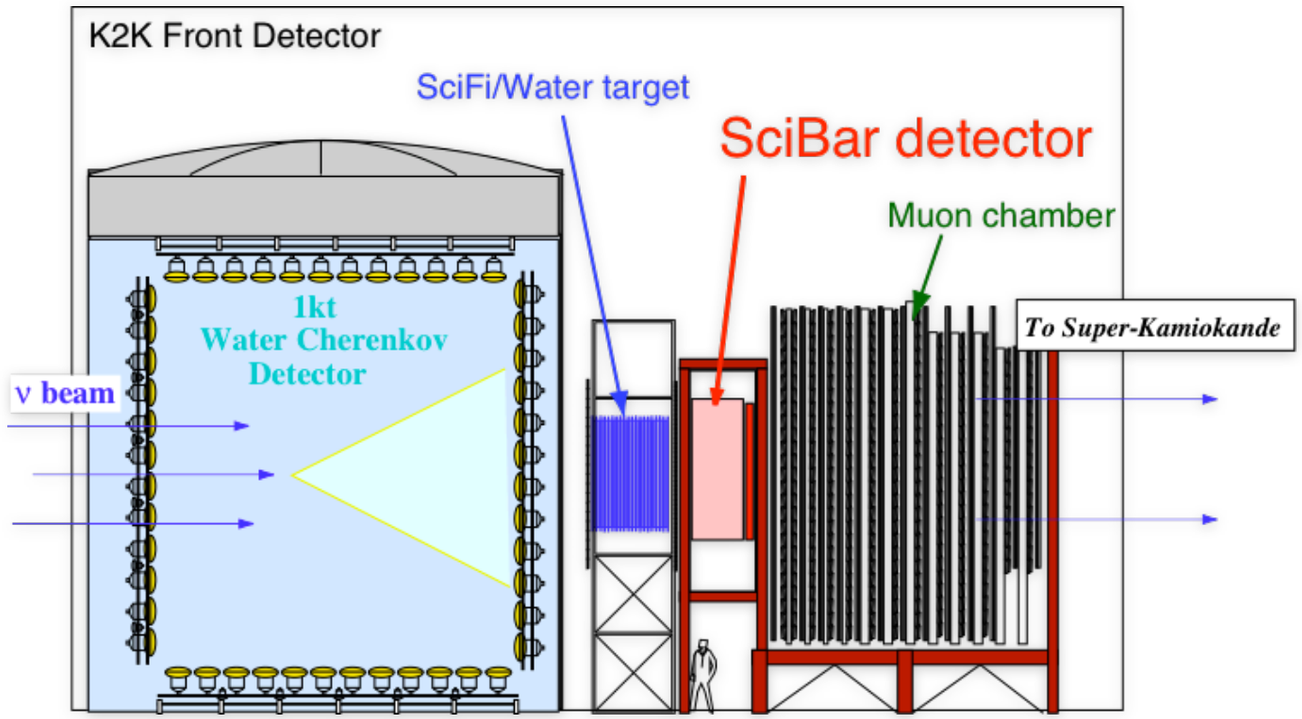
K2K A-Dependence



Oxygen *Iron*

- Cross section comparison between water (1kT) and iron MRD
- $(Data/MC)_{MRD}/(Data/MC)_{1kT}=1.04\pm0.003^{+0.08}_{-0.11}$

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Systematics

TABLE VIII: Systematic errors of the event-rate double ratio $(\text{data/MC})_{\text{MRD}}/(\text{data/MC})_{\text{1KT}}$

Source	Error +(%)	-(%)
Fiducial volume	+1.6	-5.7
Selection efficiency	+1.2	-5.7
Tracking efficiency	+1.0	-1.0
Beam direction	+1.9	-0.0
MRD detector oriented total	+2.9	-8.1
1KT detector oriented total	+4.1	-4.1
Neutrino spectrum	+0.9	-0.9
NC/CC ratio	+4.0	-3.7
Non-QE/QE ratio	+5.3	-3.7
Spectrum and neutrino int.	+6.7	-5.3
Grand total	+8.4	-10.5

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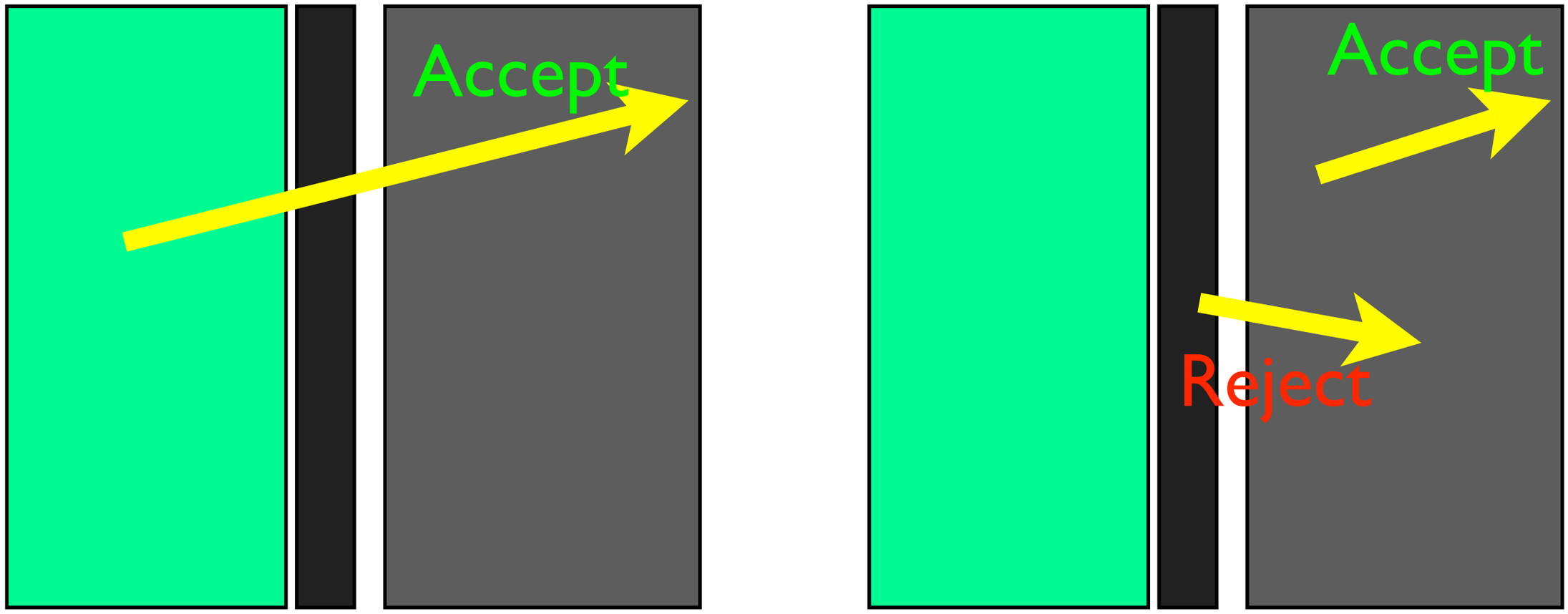
SciBooNE A Dependence

Carbon

Iron



Simple CC rate comparison in SciBar and MRD
Same neutrino beam!

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One more thing...