

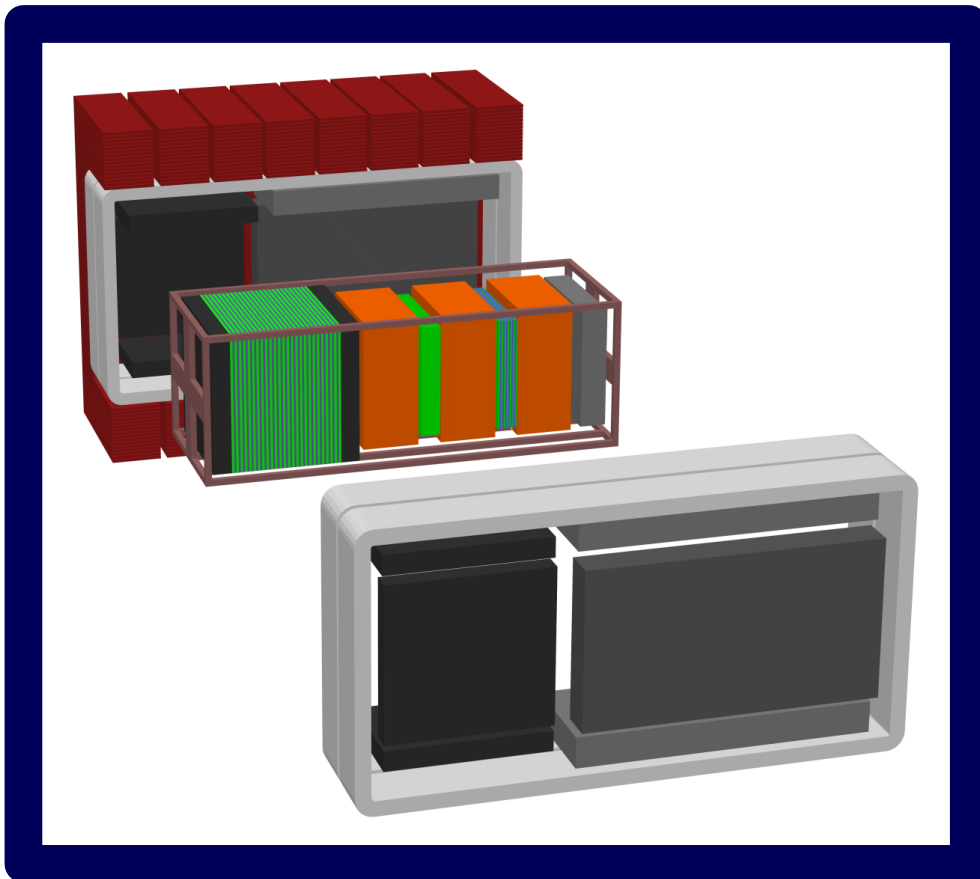
Neutrino Cross-Section Measurements at T2K

Daniel Scully

IoP HEPP & APP

03.04.2012

T2K



$$\nu_{\mu} \rightarrow \nu_e$$
$$\nu_{\mu} \rightarrow \nu_{\mu}$$

Beam: J-PARC

Near Detector: ND280

Far Detector: Super-K

Why ν Cross-Sections?

T2K Oscillation Analyses

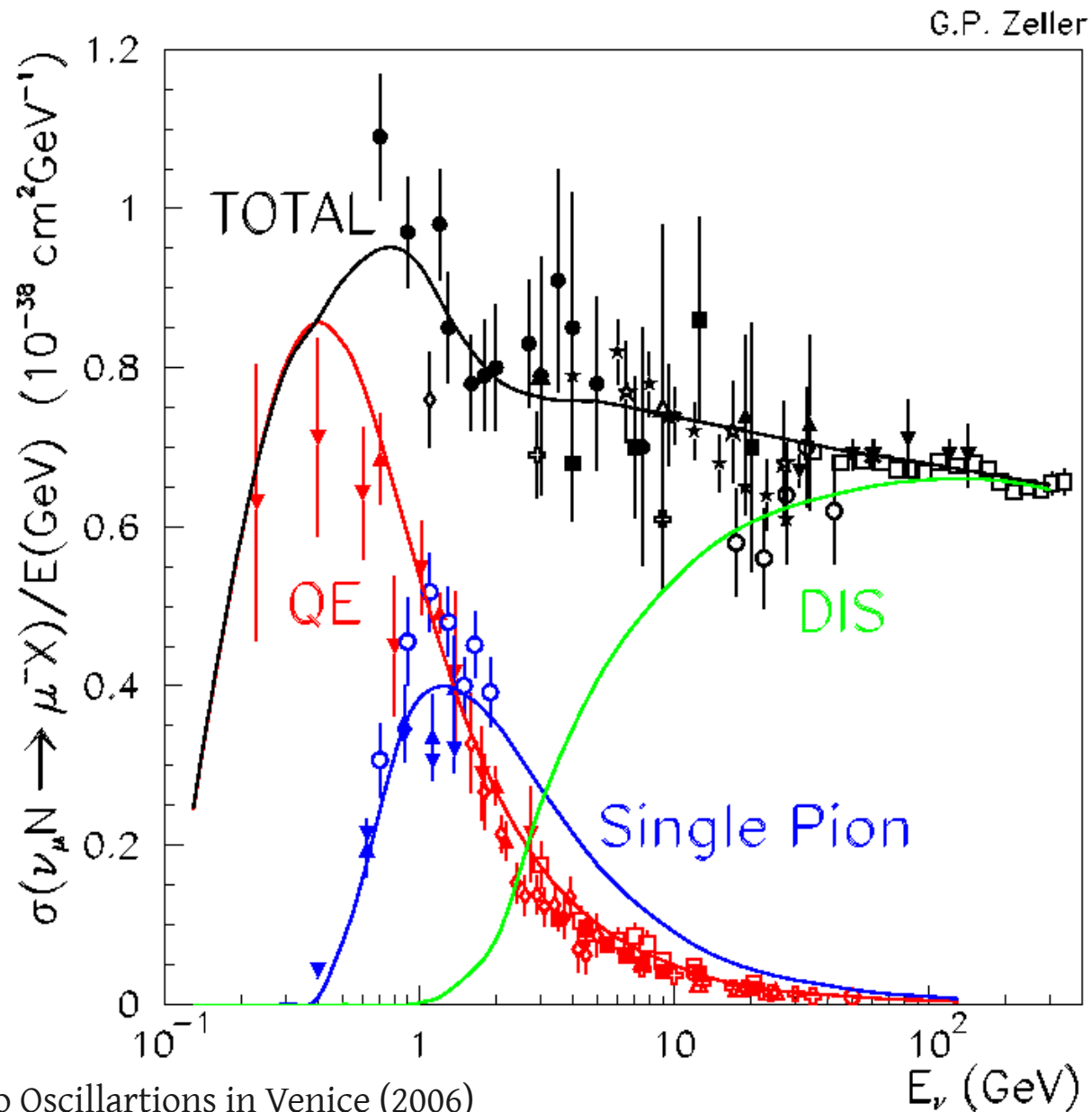
- Understand Signal
- Understand Background (e.g. NC π^0)

Neutrino Community

- Interaction theorists
- Event Generators
- Other experiments
- Future experiments

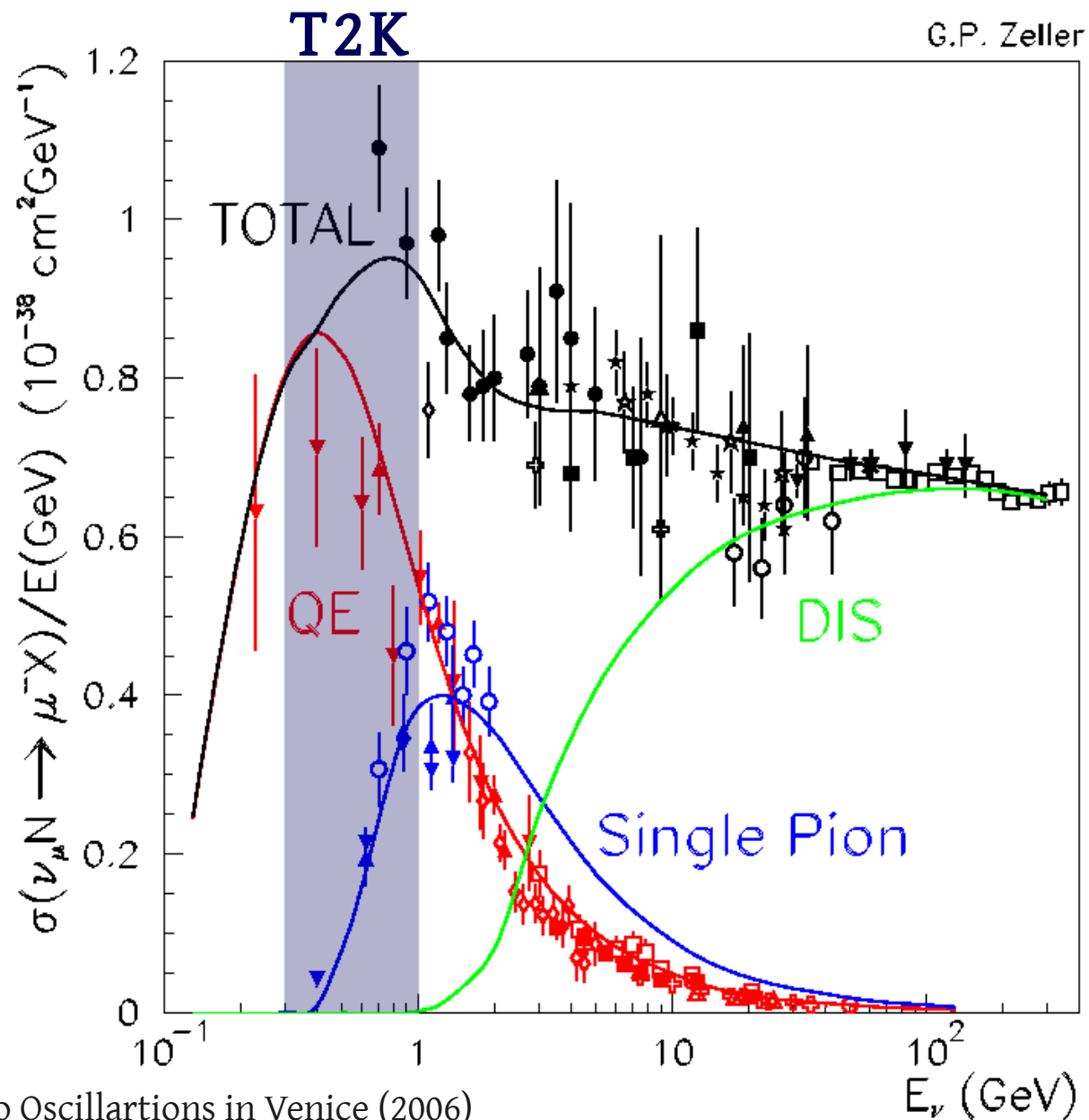
Physics

ν Cross-Sections



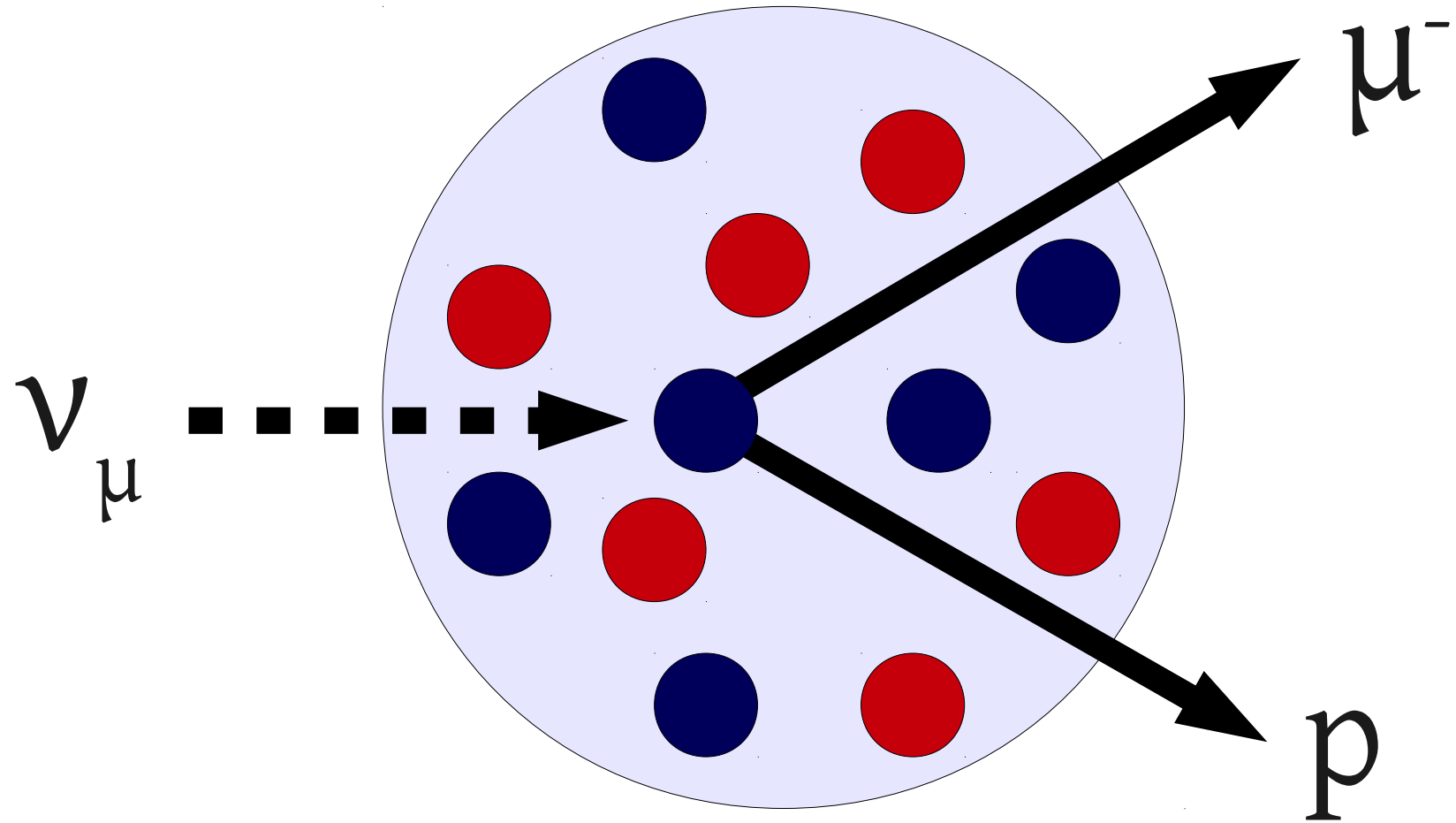
G.P. Zeller
Proceedings of Neutrino Oscillations in Venice (2006)

ν Cross-Sections



G.P. Zeller
Proceedings of Neutrino Oscillations in Venice (2006)

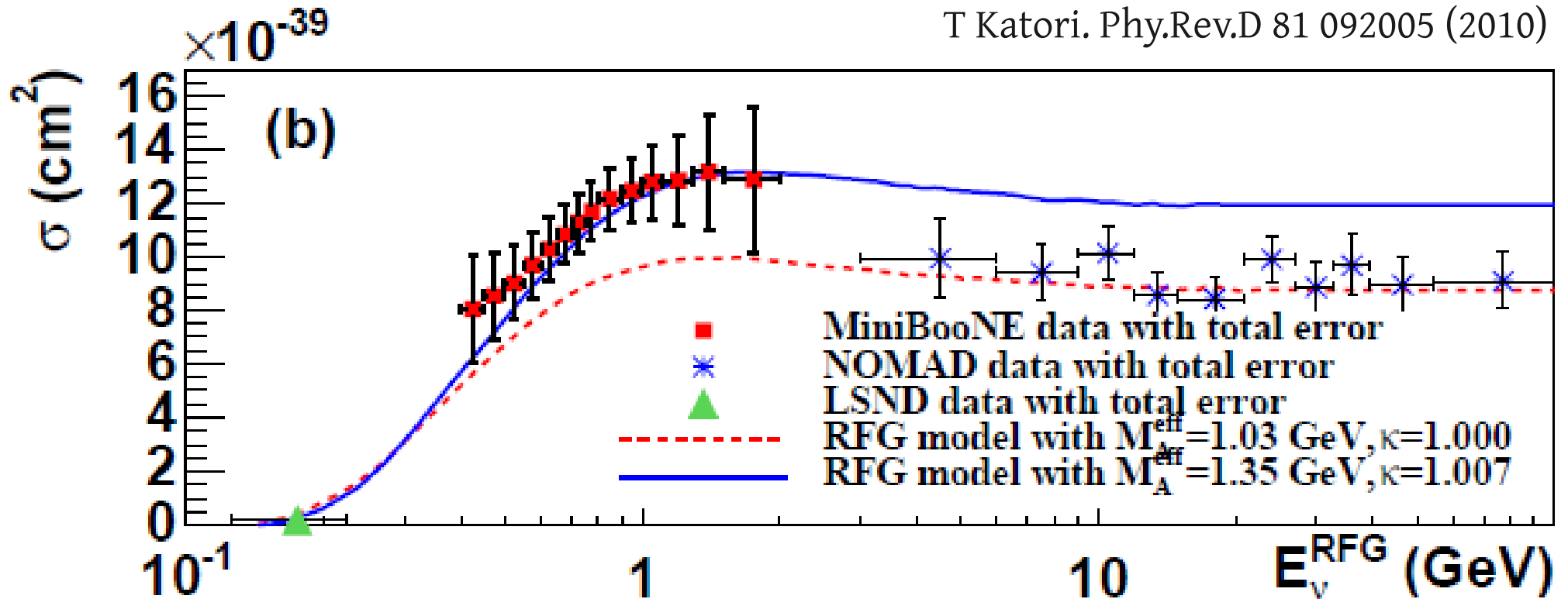
Quasi-Elastic



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

Quasi-Elastic

T Katori. Phys.Rev.D 81 092005 (2010)



Non-Dipole form factor?
Nuclear modelling?
Different analysis samples?

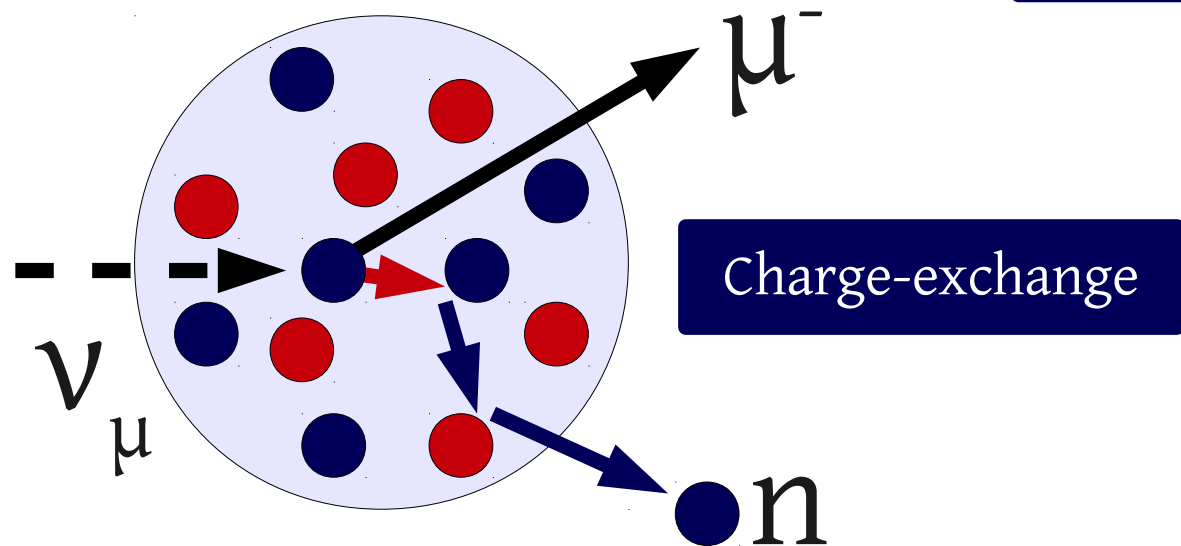
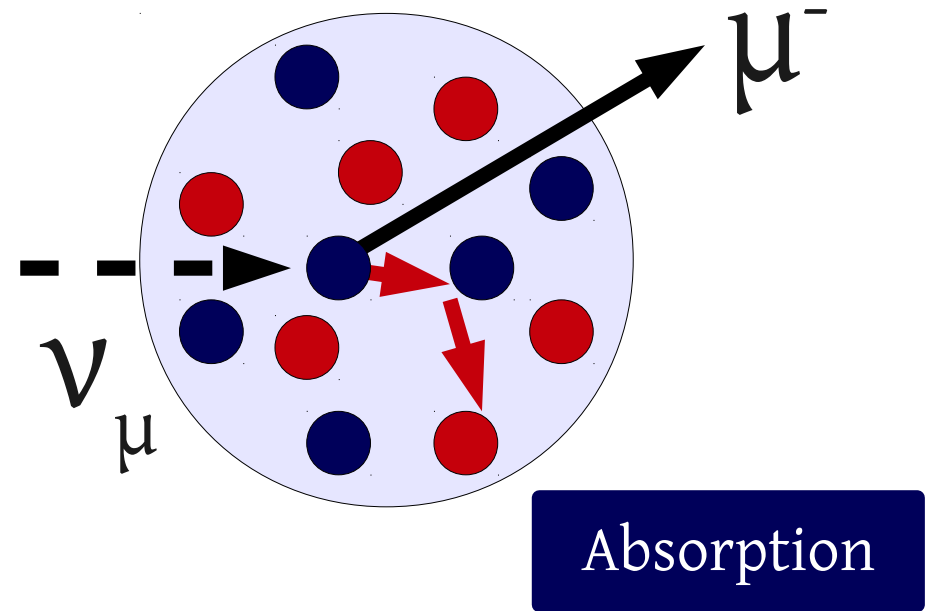
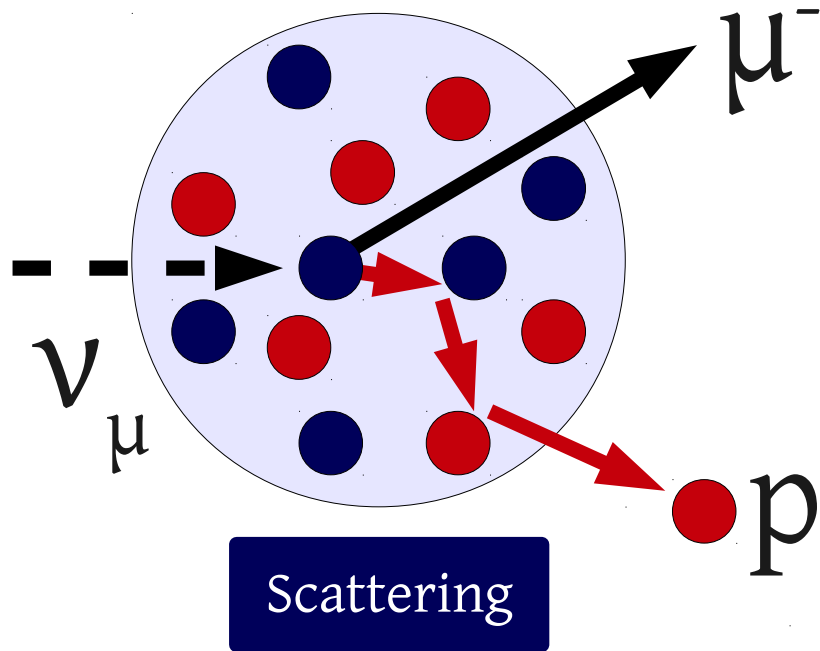
Low E_ν Kinematics

$$E_\nu = 600 \text{ MeV}$$

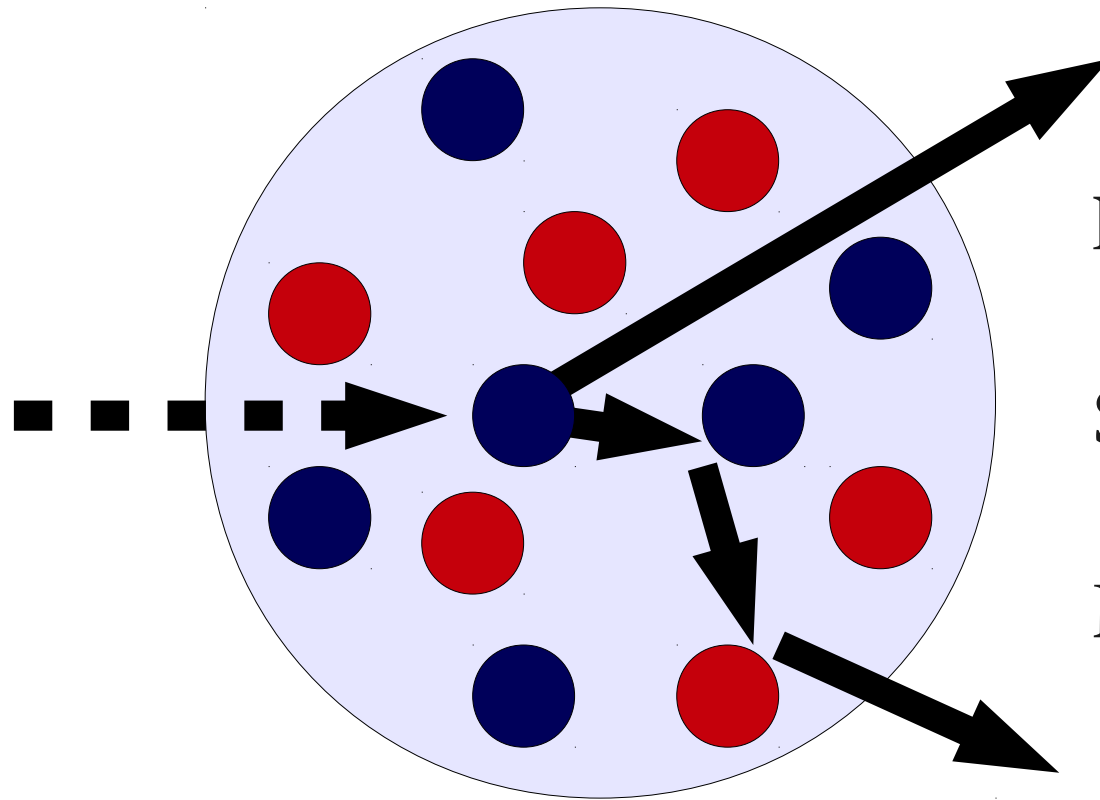
$$m_\mu = 106 \text{ MeV}$$

$$k_F = 221 \text{ MeV (carbon)}$$

Final State Interactions



Nuclear Modelling



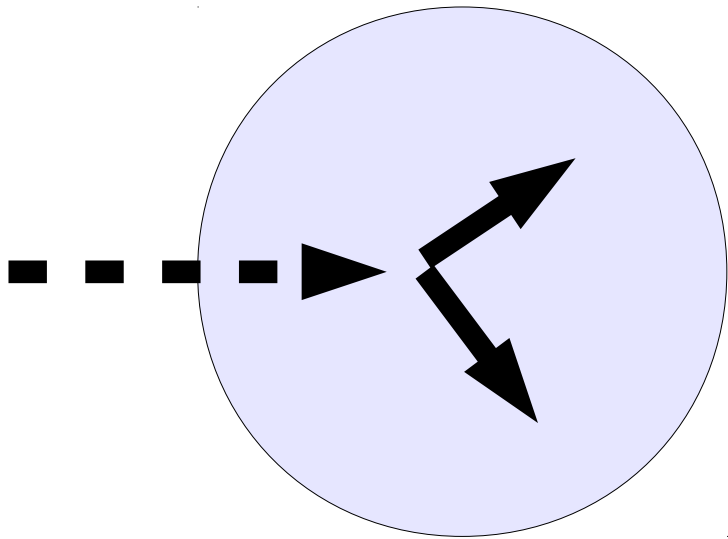
Nuclear Models

Short-Range Correlations

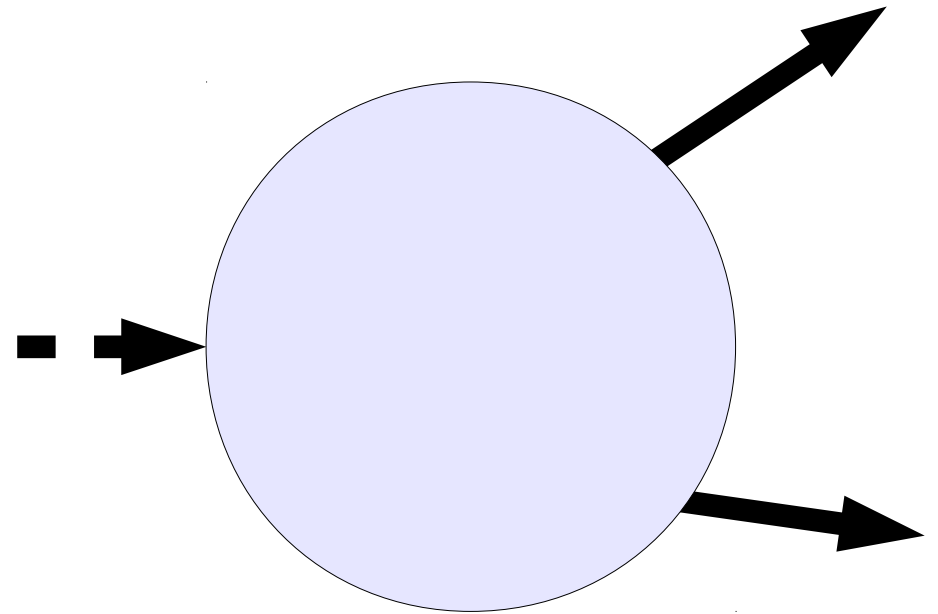
Multi-Nucleon Interactions

Measuring What?

Theory



Experiment

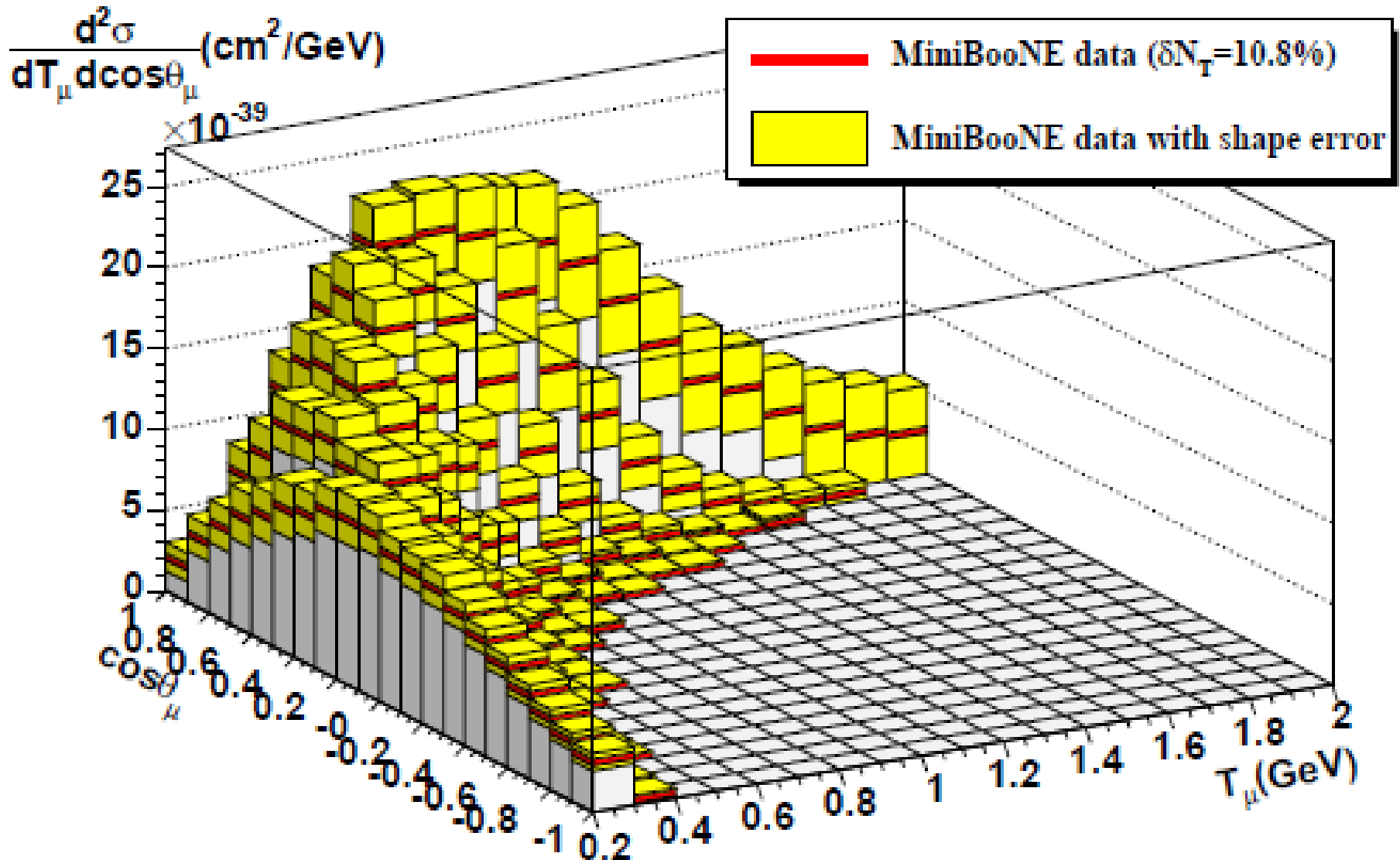


Measure final state cross-sections
Not interaction cross-sections

Can't reconstruct interaction-level quantities

Statistics

T Katori. Phys.Rev.D 81 092005 (2010)



Cross-Sections at T2K

Cross-Sections at T2K

Summer 2012

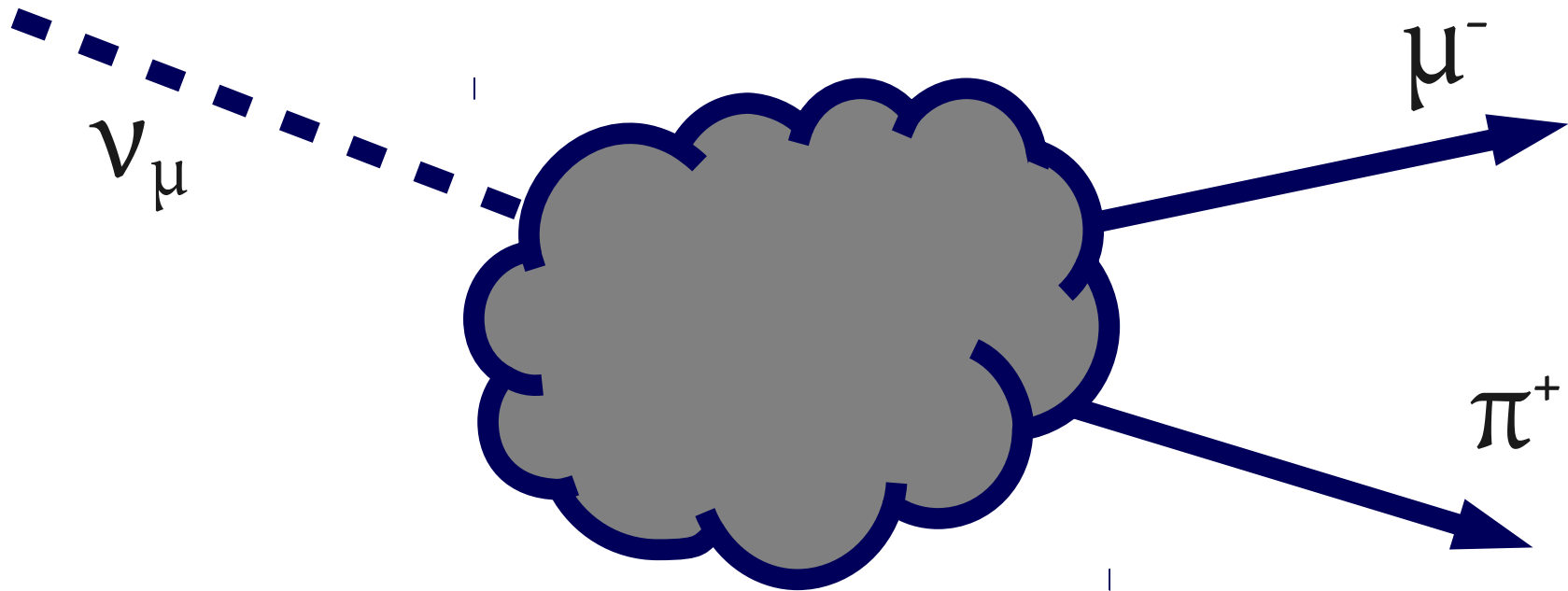
CC Inclusive Cross-Section

$$\frac{d\sigma}{dp_{\mu} d\cos\theta_{\mu}}$$

CC Quasi-Elastic

CC Coherent π^+

(My Analysis)

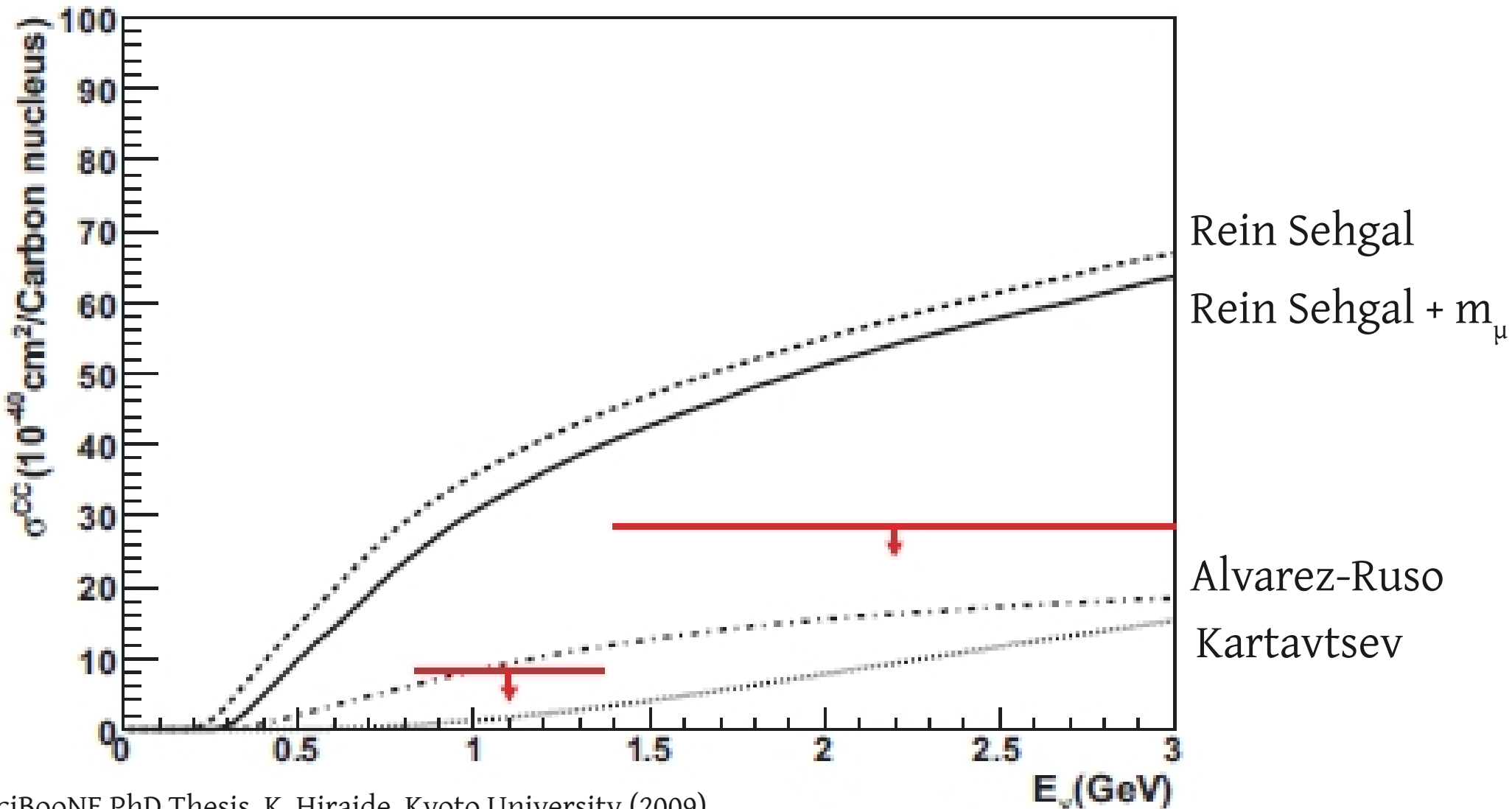


Final nucleus in same state as initial nucleus

Pion and muon momentum distributions peaked in forward direction

Struck nucleon does not / hardly recoils

CC Coherent π^+ (My Analysis)



SciBooNE PhD Thesis, K. Hiraide, Kyoto University (2009)

CC Coherent π^+ (My Analysis)

“Forward going
Charged Current
Single Pion Production
with low vertex activity”
cross-section

Cross-Sections at T2K

ν_{μ} : CC Single π
CC Multi π
Etc.

ν_e : Inclusive

$\bar{\nu}_{\mu}$: CC Inclusive
CC Quasi-Elastic
 $\bar{\nu}_{\mu} / \nu_{\mu}$ ratios

Targets: Carbon, Oxygen, Lead

Summary

Low E_ν Cross-Sections

Poorly understood, but crucial to experiments

Need new Models

Need new Measurements

T2K ideally placed to contribute:

Papers starting Summer 2012!

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