# WG2 Summary

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Questions from NuFact 2010

1) The puzzle of CC QE cross-sections and M_A

- "Recent" and "older" experiments disagree
- HE and LE experiments disagree
- "Bubble chamber" and other experiments disagree
- (some) experiments and theory disagree
- Or do they? → Significant progress

2) Precision cross-section measurements

- How well can present beams & expts do?
- What could be done with a mini-ν factory (μ-SR)?

3) Near detector technology: can <my favorite technology> be used in a ND for a superbeam/NF/β-beam?
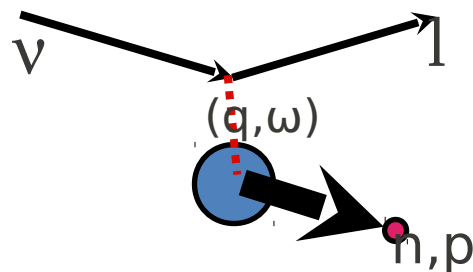
From the Round Table

- Jim Strait asks:
  "If you didn't have a neutrino factory , how precise a measurement of parameters can be done with superbeams before reaching their limitations? What "external" measurements, e.g. particle production, neutrino cross-sections, etc., can be done to improve the current systematic error limits on superbeam experiments and what are the ultimately limiting systematic errors?

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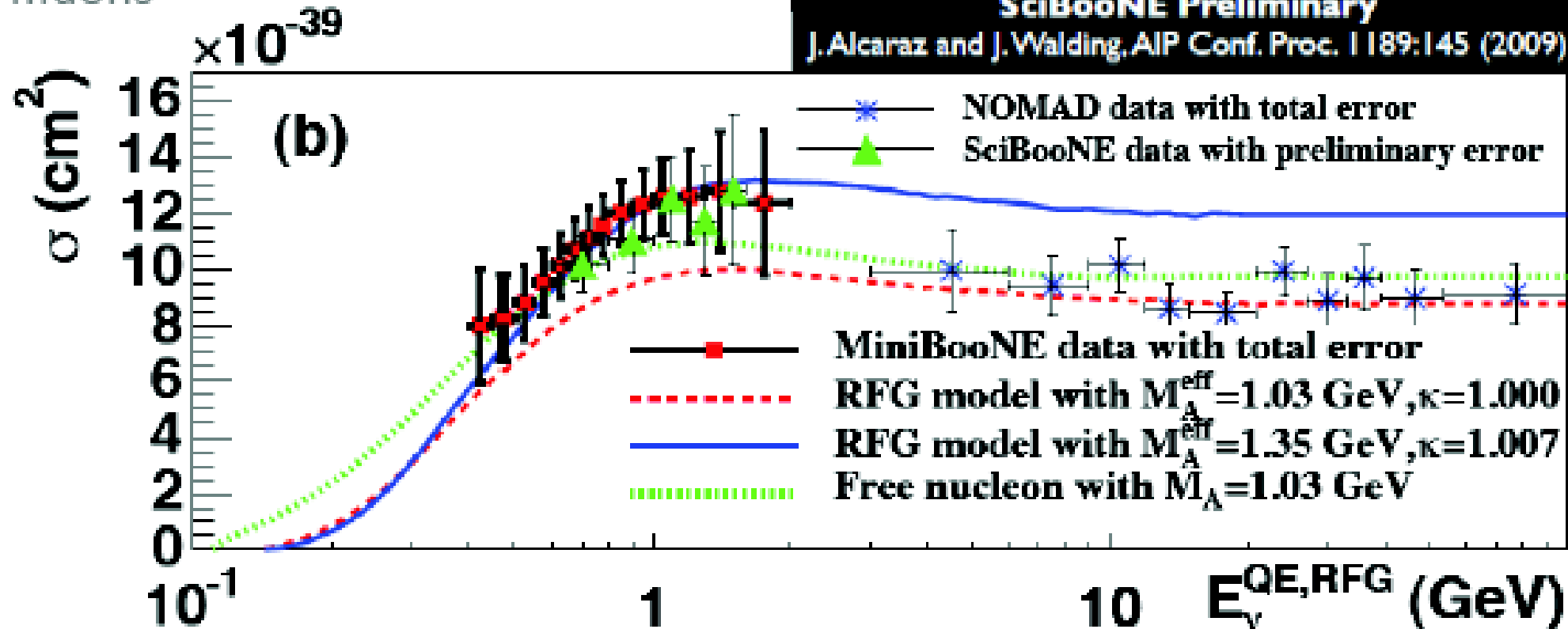
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Quasi-elastics
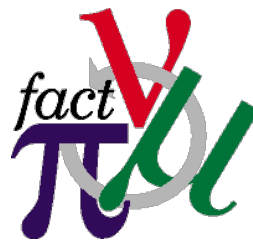
We badly need a standard candle!
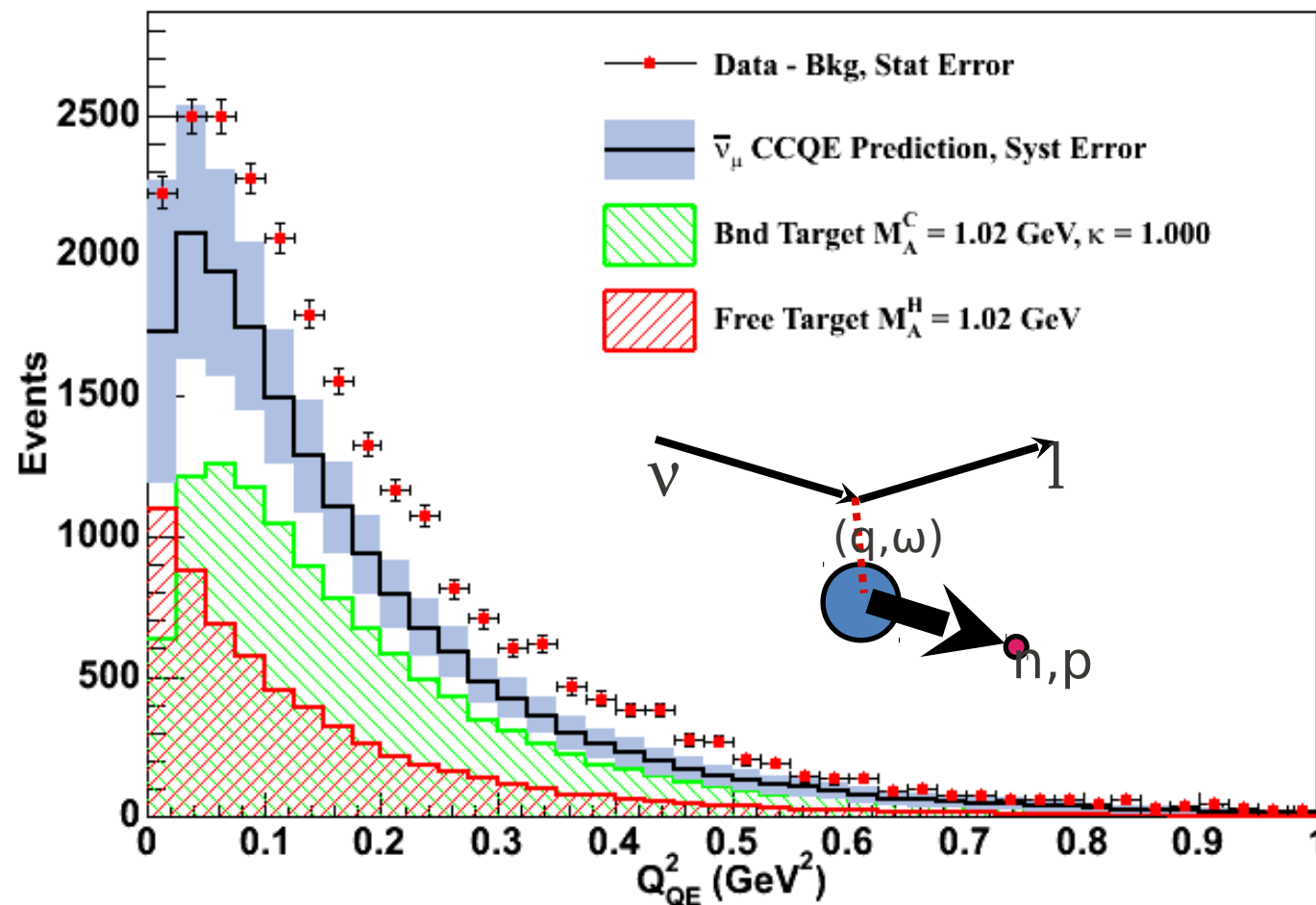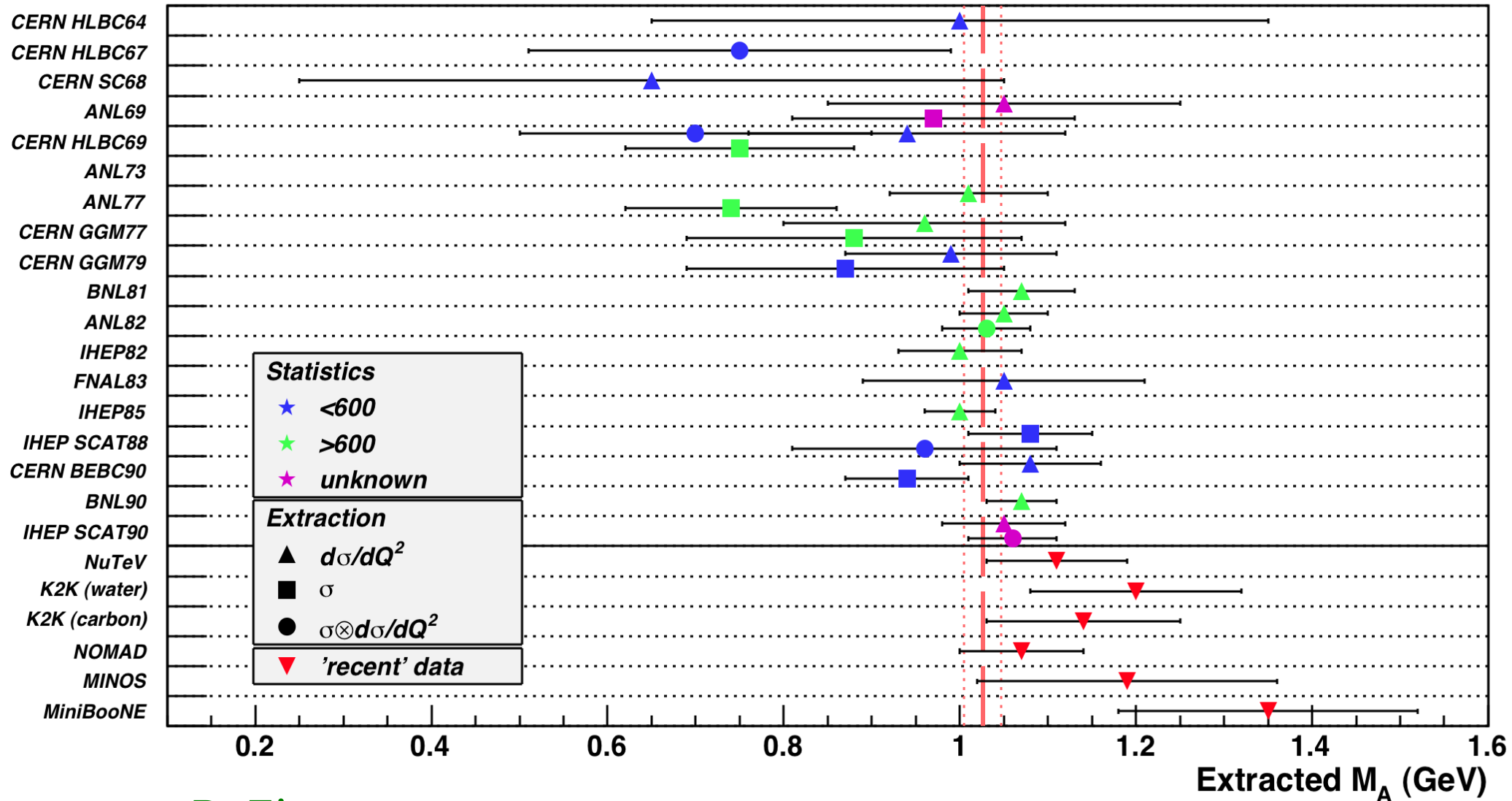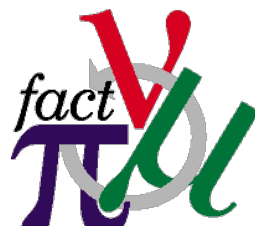
Quasi-elastics

B. Louis
MiniBoone

$d\sigma/dQ^2$ depends on EM form factors + axial form factor only measured in ν scattering

Expect $M_A \approx 1.0 \pm 0.05 \rightarrow$ determines norm & shape

Quasi-elastics
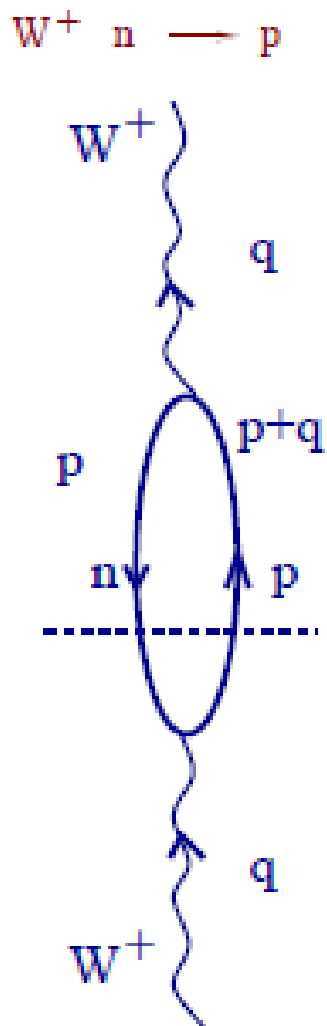

B. Ziemer
Minerva
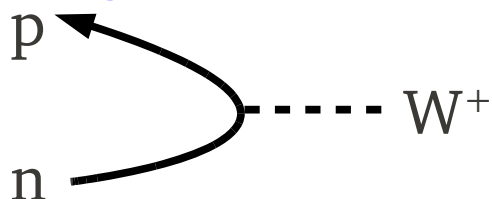
Quasi-elastics

Theorists:

Experiments may be confusing two similar processes
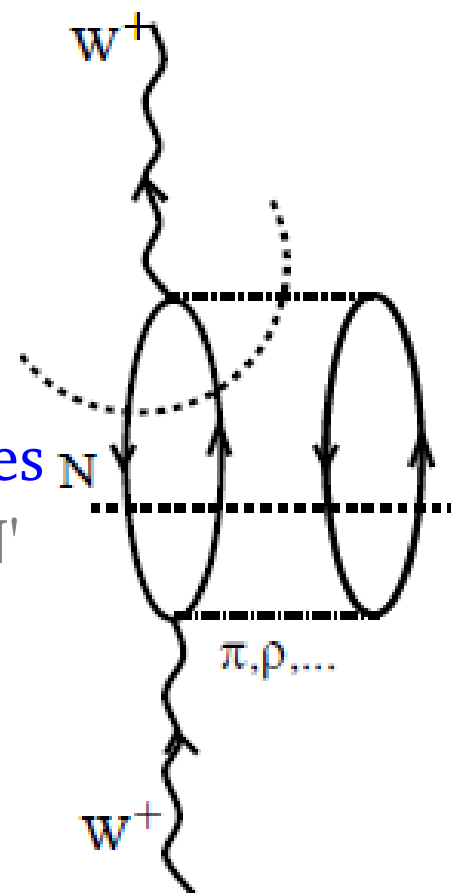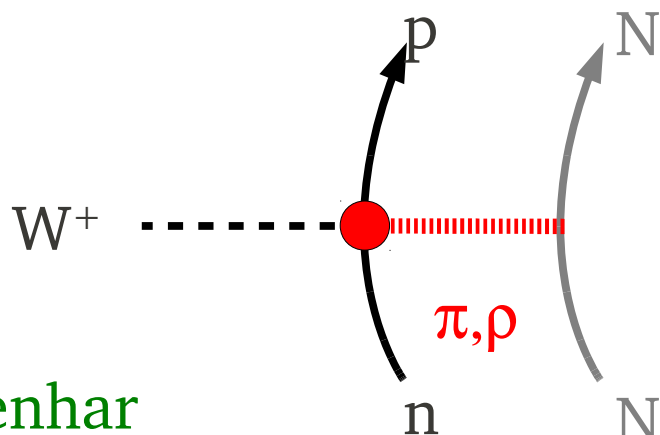
Quasi-elastic
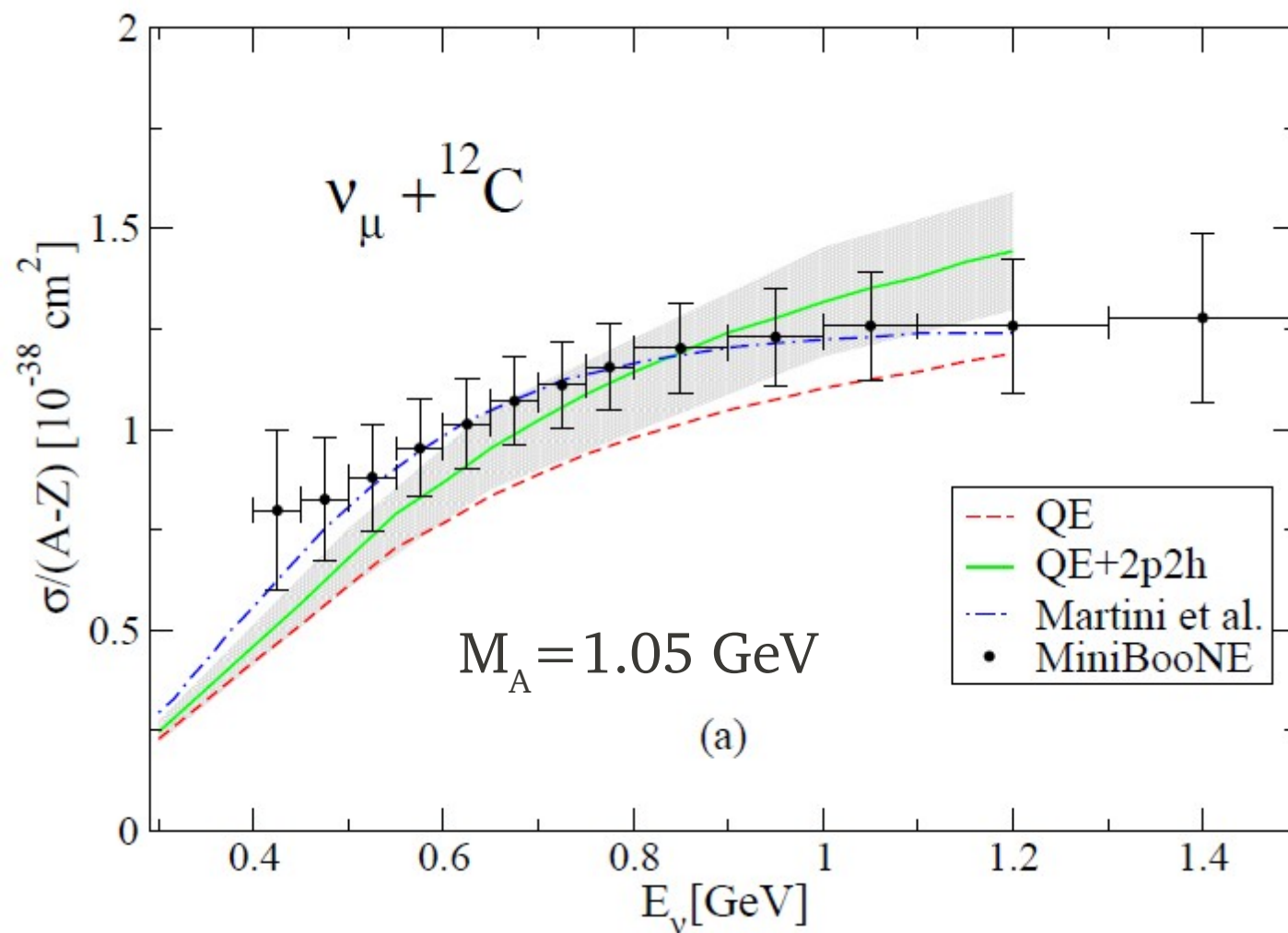
Meson Exchange Currents
2 particles – 2 holes

Nieves, Martini, Benhar

π, ρ

May be invisible to expts

Quasi-elastics

MEC/2p2h

cause the cross-section to increase at low energy

Nieves, Martini, Benhar

Lessons Learned

not only from the QEL saga
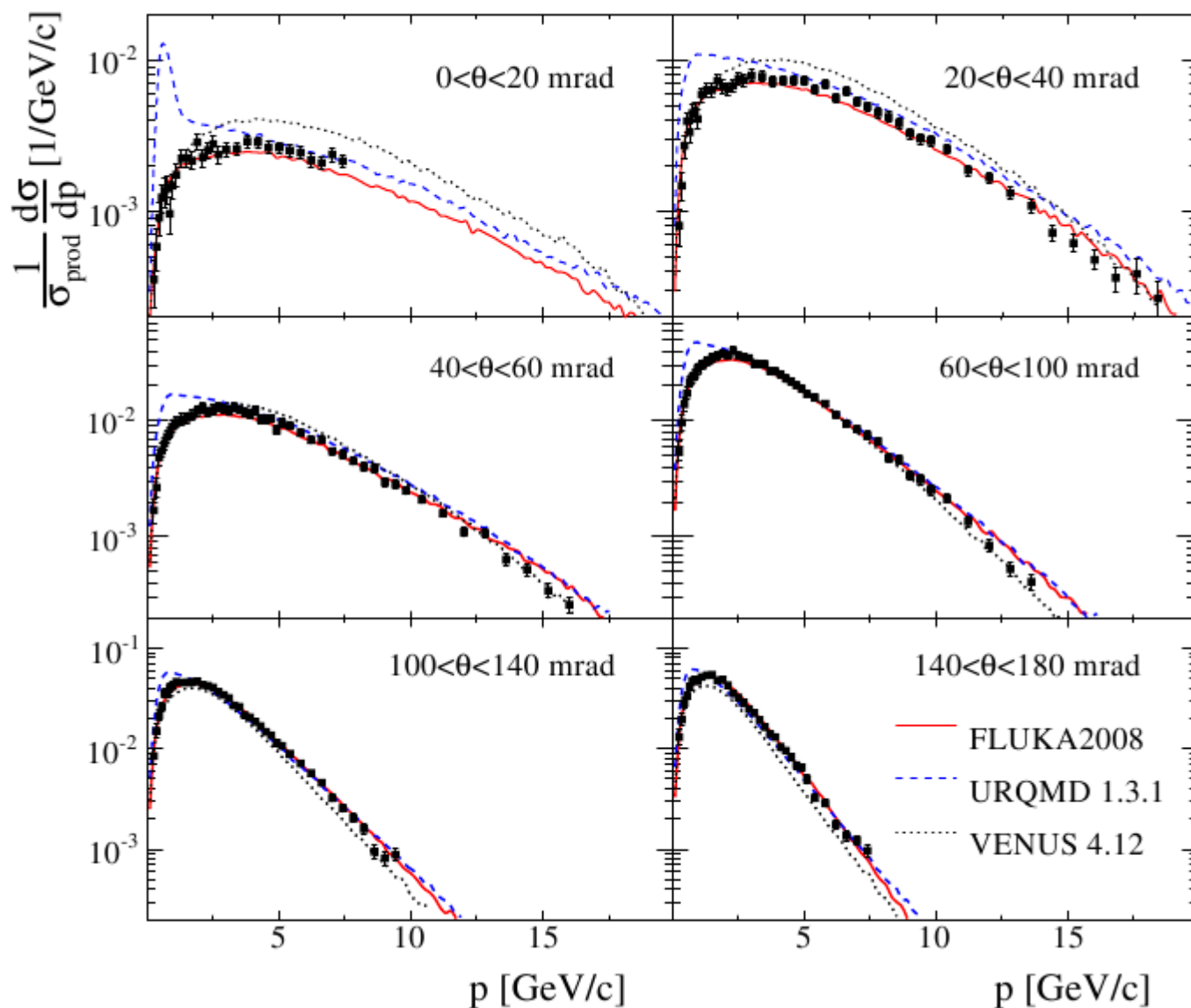
- Apparently simple processes are not so simple

- We need to be careful when defining what we mean by "quasi-elastic", "coherent pion", etc.

- Experiments should try to make model independent statements

  - M_A fit bad $\leftrightarrow$ $d^2\sigma/dpd\theta$ good

  - Avoid integrating over flux

  - Also, great care to state kinematic limits and acceptance correct
    Ex: $d\sigma/dt\, dE_\nu$ for 1π events with $p_\pi > 0.3$GeV/c,
    $p_\mu > 0.5$ GeV/c and $\theta_\mu < 35^o$ and extra energy < 50 MeV

- Theorists: please contribute models to MC codes! Make them work over a broad energy range and for many A, even if a little "dirty"

 - experiments are used to dirty and we like it.

Precision Cross-sections

- Future experiments: Minerva, ND280 and LAr all have low hadron thresholds, good resolution

  - Minerva: Perdue, Ziemer, Devan

  - T2K: Brooke-Roberge, Ikeda, McCauley

  - LAr: Palamara

- They need to make enough measurements to inform theory and allow MC to predict less capable experiments

  - Ankowski, Hayato, Nakamura, Sobczyk

- Also, explore QCD/PDFs

  - Lalakulich, Morfin, Yang

- Problem is the neutrino flux

Precision Cross-sections

NA61/SHINE/T2K
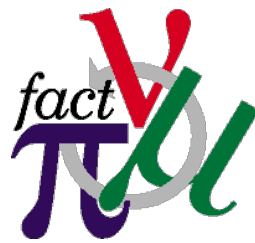
Posiadala
Di Luise
Abgrall
Galymov

Cerutti (Fluka)
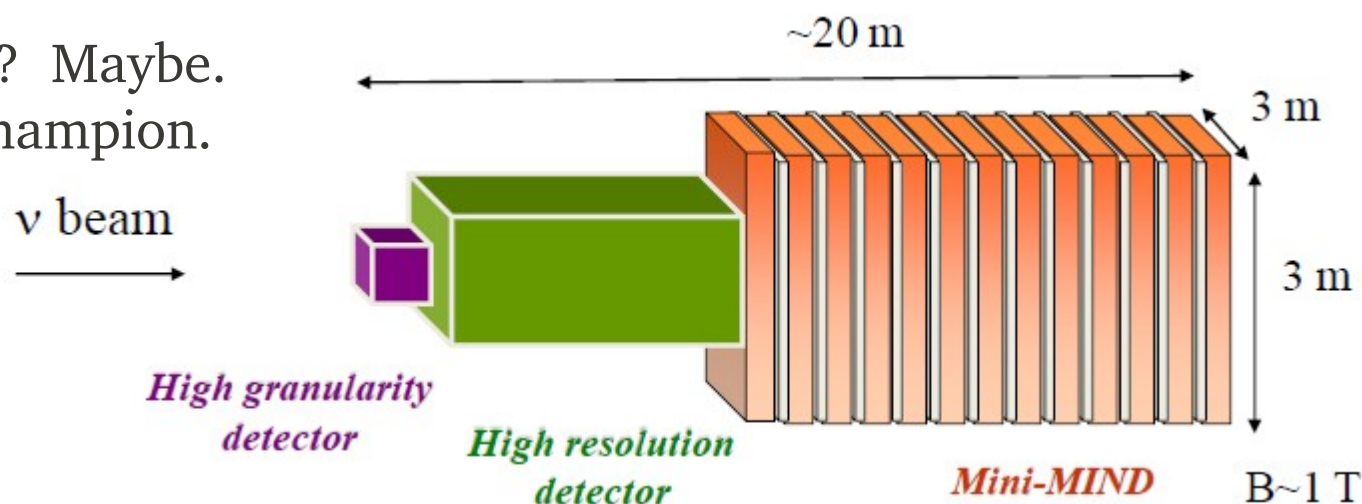
# Precision Cross-sections
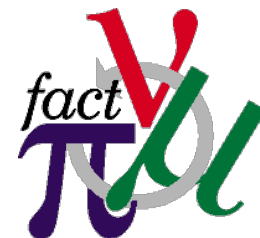
- MINERvA will begin by tuning to NA49 pC @158 GeV/c

  - Additional handles from μ-monitors and beam flexibility

  - But a long target measurement may be needed. LBNE would probably find this useful.

- Only accounting for flux uncertainty, you may be able to do 5-10% absolute. Ratios better.

- A μ-SR could be used to push errors down further.

NuFact ND Technology
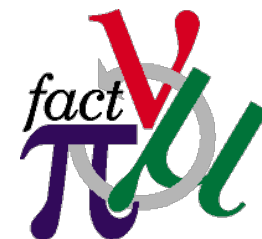
- Major requirement is to measure the ν_μ flux to a precision of ~1%

- The suggestion is to measure $\nu e \rightarrow \nu e$ and $\nu_\mu e \rightarrow \mu \nu_e$

- These interactions are very forward so the detector has to be able to resolve small scattering angle

- Currently considering SciFi and/or straw chambers followed by plastic scintillator.

- Could LAr work? Maybe. Would need a champion.

~20 m

3 m

3 m

ν beam

High granularity detector

High resolution detector

Mini-MIND

B~1 T

Questions for NuFact12

1) What program of measurements is needed to reduce the uncertainty in ν_τ CC cross-section?

2) two nucleon mechanisms (NN) / meson exchange currents (MEC)
   - How do we get treatment of NN/MEC in MC codes used by T2K/Minerva/etc?
   - How do we distinguish, experimentally, between NN/MEC and FSI? Can ND280/Minerva/LAr see these events?
   - Clarify the effect on MiniBoone/MINOS/SK oscillation analyses. Talk by Meloni (WG1)

3) List a set of cross-sections that can be carefully defined and measured by experiments and computed theoretically to reduce systematics for oscillation experiments.

4) How should MC code improvements be prioritized? What specific changes should be made to common codes: GENIE/NEUT/NuWro,etc.

Backups