

# The “Path Forward”

- rather than invite a single summary speaker, we have elected to try a new format
- “summary” session will be devoted entirely to discussion  
(so have a chance to recap, openly discuss some of the results/presentations we have seen at this workshop ... what does this all mean? where we go from here?)
  - focus on 4 topics:
    - QE scattering
    - coherent  $\pi$  production
    - final state interactions
    - Monte Carlo convergence

# Format

- first, conveners will briefly introduce each topic (Sam, Jan)
  - set the stage
- then, several invited speakers will give short presentations
  - have been asked offer their own commentary & concluding remarks
  - balance of theorists and experimentalists
  - to be fair, each speaker confined to a few slides ( $\lesssim$  8 minutes each)
- open the floor for discussion
- hope is that we can collectively summarize the workshop and at the same time, define our goals for the next NuInt

# Topic #1: QE Scattering

- To recap ... have seen a number of new results on  $M_A$  (data spanning several different energy ranges and targets)

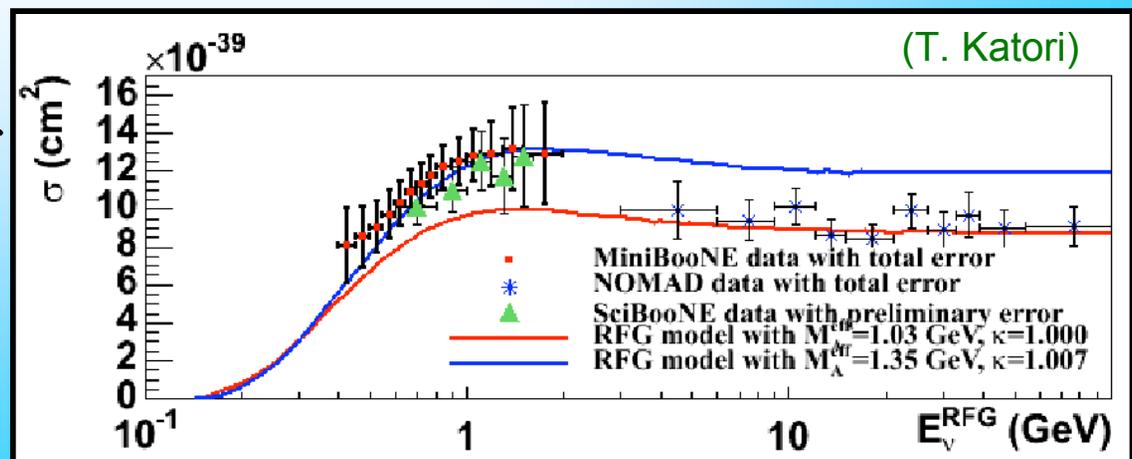
- MiniBooNE ( $^{12}\text{C}$ ):  $M_A = 1.35 \pm 0.17 \text{ GeV}$
- MINOS (Fe):  $M_A = 1.26^{+0.14}_{-0.16} \text{ GeV}$
- NOMAD ( $^{12}\text{C}$ ):  $M_A = 1.07 \pm 0.05 \text{ GeV}$
- past world avg ( $\text{D}_2$ ):  $M_A = 1.02 \pm 0.03 \text{ GeV}$

} **shape fits to**  
 $Q^2$  distribution  
of QE data

granted, results agree within  $\sim 1\sigma$ , but what assume for  $M_A$  has a direct impact on normalization of QE cross section & predicted QE rates

- have also seen new absolute  $\sigma$  measurements

- plus first reporting of QE double differential  $\sigma$ 's



# Topic #1: QE Scattering

- Given what we have just seen, do we really have a **better understanding** of QE scattering on nuclei?
- Do we understand the **normalization of the QE cross section**?
- Do we understand the **difference in  $M_A$  values** from various experiments?
- Can **theoretical calculations** explain what we are seeing in experimental data in both shape & normalization? Saw examples using RPA ([Alvarez-Ruso](#)) & SFs ([Meloni](#)). Next steps?
- Is the axial form factor **dipole**?
- Do we need to **start thinking beyond  $M_A$** ? Is  $M_A$  measuring nuclear effects or axial form factor? Is there a more reliable way to make comparisons?
- What about **handling of low  $Q^2$  region**, are there better alternatives to the  $\kappa$  parameter?

# QE Scattering Speakers

to help address some of these questions, have invited several speakers to offer their opinions:

- Luis Alvarez-Ruso (Universidad de Murcia)
- Omar Benhar (INFN)
- Rex Tayloe (Indiana University)

+ open discussion

**focus:** what might this all mean?  
and what are the next steps?

# Topic #2: Coherent $\pi$ Production

- To recap ...
- A lot of new theoretical work on coherent  $\pi$  production. There are noticeable differences between various predictions (some understood, some not)
- Also, differences between recent experimental measurements of NC and CC coherent pion production at low E:
  - **K2K**: no evidence for CC coherent  $\pi^+$  ( $Q^2$  distribution)  
*Hasegawa et al.*, PRL 95, 252301 (2005)
  - **MiniBooNE**: evidence for NC coherent  $\pi^0$  in  $\nu$  and  $\bar{\nu}$  ( $\theta_\pi$  distribution)  
*Aguilar-Arevalo et al.*, PL B664, 41 (2008)
  - **SciBooNE**: no evidence for CC coherent  $\pi^+$  ( $Q^2$  distribution)  
*Hiraide et al.*, PRD 78, 112004 (2008)  
new: but some hint in  $p_\mu > 0.7$  and  $\bar{\nu}$  samples

# Topic #2: Coherent $\pi$ Production

- Is there a way to **reconcile the exp'l results theoretically**? Need to upgrade our predictions or find a way to report such that less model dep?
- Are there **alternative measurements** or approaches we should be pursuing to help shed further light on this?
- There has been a **host of new model calculations** for coherent  $\pi$  production in the past year. What are the differences/commonalities between various calculations? Is there a preferred approach (and in certain energy regions)? Could use some guidance on making choices.
- How well do we understand the physics of **diffractive neutrino scattering** in the context of the coherent  $\pi$  production process?

# Coherent $\pi$ Production Speakers

to help address some of these questions, have invited several speakers to offer their opinions:

- Juan Nieves (IFIC, CSIC-UV)
- Manny Paschos (Technical University Dortmund)
- Jorge Morfin (Fermilab)
- Morgan Wascko (Imperial College, London)

+ open discussion

**focus:** what this might all mean?  
and what are the next steps?