

# E02-013 Analysis Update

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September 23, 2009

- ▶ Analysis
  - ▶ Pass 2  $\rightarrow$  4 analysis
  - ▶ Compared to Jon
  - ▶ Added in inelastic correction (still need error analysis)
- ▶ Kin 3 pass 2 Moved to tape
- ▶ Monte Carlo
  - ▶ Error analysis
  - ▶ Proton contamination analysis

# Problems Found

My analysis:

- ▶ Missing mass calculation was wrong (was good in prelim analysis)
- ▶ Did not have vertex in neutron arm calculation (basic correction was added in for time of flight)

Jon's analysis:

- ▶ 20% of runs has time of flight peaks split to  $\pm 1$  ns
- ▶ Missing a few cuts

# Changes

|             | Pass 2     |            | Pass 4     |
|-------------|------------|------------|------------|
|             | Prelim     | Redux      | Present    |
| Presh.      | $\geq 400$ | $\geq 500$ | $\geq 500$ |
| $y_{NA}$    | +0.2 m     | +0.2 m     | Correct    |
| Path Len.   | No $v_z$   | No $v_z$   | Correct    |
| Optics      | Old        | New        | New        |
| Blind Cond. | 1 hit      | 1 hit      | 2 hits     |
| RF          | No RF      | No RF      | RF         |
| Trip        | No Cut     | No Cut     | Cut        |

# Raw Asymmetries

|                | Pass 2  |         | Pass 4  |
|----------------|---------|---------|---------|
|                | Prelim  | Redux   | Present |
| Kin 3 <i>N</i> | 15325   | 15578   | 16865   |
| <i>A</i>       | -0.0255 | -0.0221 | -0.0398 |
| Kin 2 <i>N</i> | 39144   | 36413   | 37349   |
| <i>A</i>       | -0.0384 | -0.0366 | -0.0489 |
| Kin 4 <i>N</i> | 156061  |         | 146931  |
| <i>A</i>       | -0.0578 |         | -0.0548 |

- Pass 2 analyses agree fairly well

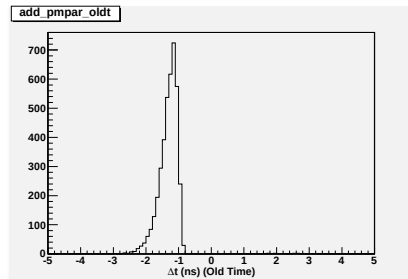
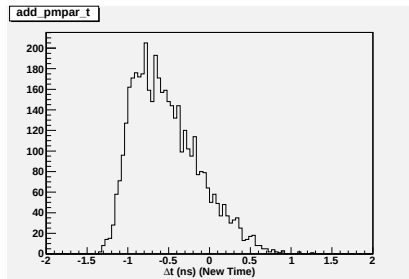
## Kin 2, Pass 2 $\rightarrow$ 4 comparison

|                             | $N_+$ | $N_-$ | $A$                |
|-----------------------------|-------|-------|--------------------|
| Old Neut QE                 | 18910 | 17555 | $-0.037 \pm 0.005$ |
| New Neut QE                 | 19523 | 17733 | $-0.048 \pm 0.005$ |
| Agree Neut QE               | 11060 | 9957  | $-0.052 \pm 0.007$ |
| More Old Neut QE            | 6500  | 6353  | $-0.011 \pm 0.009$ |
| $W$                         | 168   | 169   | $+0.003 \pm 0.054$ |
| $p_{\text{miss},\perp}$     | 811   | 812   | $+0.001 \pm 0.025$ |
| $p_{\text{miss},\parallel}$ | 1701  | 1601  | $-0.030 \pm 0.017$ |
| $M_{\text{miss}}$           | 1219  | 1168  | $-0.021 \pm 0.020$ |
| $y_{\text{NA}}$             | 2380  | 2382  | $0.000 \pm 0.014$  |
| $x_{\text{NA}}$             | 2     | 4     | $+0.333 \pm 0.385$ |
| $\sqrt{-1}$ calc            | 5     | 5     | $0.000 \pm 0.316$  |
| Was Blind                   | 0     | 0     | $0.000 \pm 0.000$  |
| Was Charged                 | 0     | 0     | $0.000 \pm 0.000$  |
| No match                    | 214   | 212   | $-0.005 \pm 0.048$ |
| No event to compare         | 1350  | 1245  | $-0.040 \pm 0.020$ |

# Kin 2, Pass 2 $\rightarrow$ 4 comparison

|                             | $N_+$ | $N_-$ | $A$                |
|-----------------------------|-------|-------|--------------------|
| Old Neut QE                 | 18910 | 17555 | $-0.037 \pm 0.005$ |
| New Neut QE                 | 19523 | 17733 | $-0.048 \pm 0.005$ |
| Agree Neut QE               | 11060 | 9957  | $-0.052 \pm 0.007$ |
| More New Neut QE            | 8254  | 7539  | $-0.045 \pm 0.008$ |
| $W$                         | 179   | 178   | $-0.003 \pm 0.053$ |
| $p_{\text{miss},\perp}$     | 648   | 649   | $+0.001 \pm 0.028$ |
| $p_{\text{miss},\parallel}$ | 4061  | 3603  | $-0.060 \pm 0.011$ |
| $M_{\text{miss}}$           | 1262  | 1164  | $-0.040 \pm 0.020$ |
| $y_{\text{NA}}$             | 1241  | 1156  | $-0.035 \pm 0.020$ |
| $x_{\text{NA}}$             | 0     | 0     | $0.000 \pm 0.000$  |
| $\sqrt{-1}$ calc            | 2     | 3     | $+0.200 \pm 0.438$ |
| Was Blind                   | 727   | 652   | $-0.054 \pm 0.027$ |
| Was Charged                 | 94    | 82    | $-0.068 \pm 0.075$ |
| No match                    | 40    | 52    | $+0.130 \pm 0.103$ |
| No event to compare         | 209   | 237   | $+0.063 \pm 0.047$ |

# Kin 2 Differences





# Kin 3, Pass 2 $\rightarrow$ 4 comparison

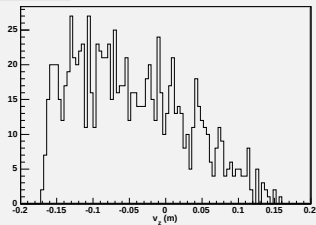
|                             | $N_+$ | $N_-$ | A                  |
|-----------------------------|-------|-------|--------------------|
| Old Neut QE                 | 7982  | 7630  | $-0.023 \pm 0.008$ |
| New Neut QE                 | 8766  | 8089  | $-0.040 \pm 0.008$ |
| Agree Neut QE               | 3559  | 3318  | $-0.035 \pm 0.012$ |
| More Old Neut QE            | 3762  | 3679  | $-0.011 \pm 0.012$ |
| $W$                         | 163   | 161   | $-0.006 \pm 0.056$ |
| $p_{\text{miss},\perp}$     | 522   | 566   | $+0.040 \pm 0.030$ |
| $p_{\text{miss},\parallel}$ | 1073  | 1045  | $-0.013 \pm 0.022$ |
| $M_{\text{miss}}$           | 823   | 727   | $-0.062 \pm 0.025$ |
| $y_{\text{NA}}$             | 1100  | 1101  | $0.000 \pm 0.021$  |
| $x_{\text{NA}}$             | 0     | 1     | $+1.000 \pm 0.000$ |
| $\sqrt{-1}$ calc            | 2     | 2     | $0.000 \pm 0.500$  |
| Was Blind                   | 0     | 0     | $0.000 \pm 0.000$  |
| Was Charged                 | 0     | 0     | $0.000 \pm 0.000$  |
| No match                    | 79    | 76    | $-0.019 \pm 0.080$ |
| No event to compare         | 661   | 633   | $-0.022 \pm 0.028$ |

# Kin 3, Pass 2 $\rightarrow$ 4 comparison

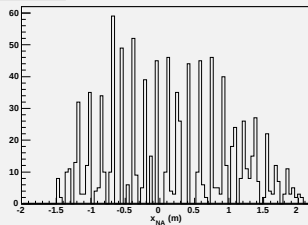
|                             | $N_+$ | $N_-$ | A                  |
|-----------------------------|-------|-------|--------------------|
| Old Neut QE                 | 7982  | 7630  | $-0.023 \pm 0.008$ |
| New Neut QE                 | 8766  | 8089  | $-0.040 \pm 0.008$ |
| Agree Neut QE               | 3559  | 3318  | $-0.035 \pm 0.012$ |
| More New Neut QE            | 4726  | 4349  | $-0.042 \pm 0.010$ |
| $W$                         | 195   | 187   | $-0.021 \pm 0.051$ |
| $p_{\text{miss},\perp}$     | 592   | 540   | $-0.046 \pm 0.030$ |
| $p_{\text{miss},\parallel}$ | 1675  | 1605  | $-0.021 \pm 0.017$ |
| $M_{\text{miss}}$           | 1233  | 1139  | $-0.040 \pm 0.021$ |
| $y_{\text{NA}}$             | 323   | 273   | $-0.084 \pm 0.041$ |
| $x_{\text{NA}}$             | 0     | 2     | $+1.000 \pm 0.000$ |
| $\sqrt{-1}$ calc            | 1     | 4     | $+0.600 \pm 0.358$ |
| Was Blind                   | 573   | 463   | $-0.106 \pm 0.031$ |
| Was Charged                 | 88    | 97    | $+0.049 \pm 0.073$ |
| No match                    | 46    | 39    | $-0.082 \pm 0.108$ |
| No event to compare         | 481   | 422   | $-0.065 \pm 0.033$ |

# Kin 3 Differences

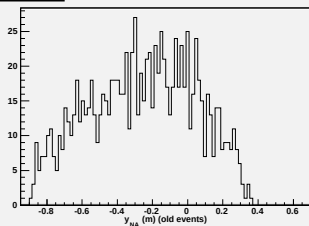
out\_blind\_vz



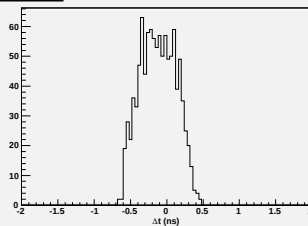
out\_blind\_x



out\_blind\_y

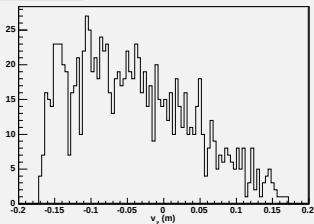


out\_blind\_t

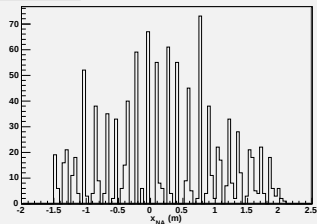


# Kin 3 Differences

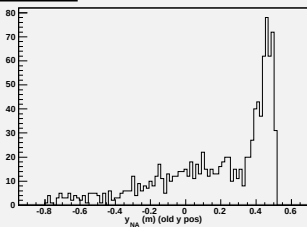
out\_pmpersp\_vz



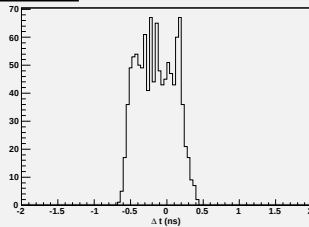
out\_pmpersp\_x



out\_pmpersp\_y

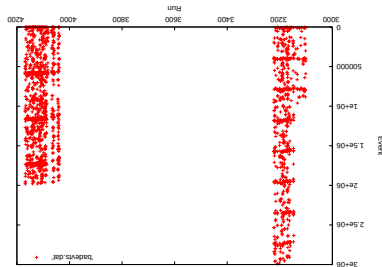
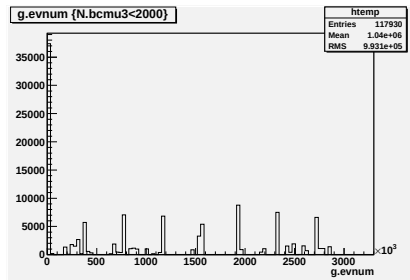


out\_pmpersp\_t



# Weird Issues

- ▶ Of 12909931, 7 helicities changed sign kin 3 pass2 to pass4
- ▶ Scalers seem to have some strange periodic behavior



## Kin 2, Jon → Seamus comparison

|                             | $N_+$ | $N_-$ | $A$                |
|-----------------------------|-------|-------|--------------------|
| Jon Neut QE                 | 16771 | 15295 | $-0.046 \pm 0.006$ |
| My Neut QE                  | 18016 | 16156 | $-0.054 \pm 0.005$ |
| Agree Neut QE               | 11850 | 10694 | $-0.051 \pm 0.007$ |
| More Jon Neut QE            | 3726  | 3379  | $-0.049 \pm 0.012$ |
| $W$                         | 561   | 523   | $-0.035 \pm 0.030$ |
| $p_{\text{miss},\perp}$     | 300   | 294   | $-0.010 \pm 0.041$ |
| $p_{\text{miss},\parallel}$ | 264   | 244   | $-0.039 \pm 0.044$ |
| $M_{\text{miss}}$           | 550   | 509   | $-0.039 \pm 0.031$ |
| $y_{\text{NA}}$             | 329   | 294   | $-0.056 \pm 0.040$ |
| $x_{\text{NA}}$             | 5     | 1     | $-0.667 \pm 0.304$ |
| $\sqrt{-1}$ calc            | 60    | 53    | $-0.062 \pm 0.094$ |
| Charge ID                   | 859   | 721   | $-0.087 \pm 0.025$ |
| No match                    | 561   | 523   | $-0.035 \pm 0.030$ |
| No event to compare         | 1195  | 1222  | $+0.011 \pm 0.020$ |

# Kin 3, Pass 2 $\rightarrow$ 4 comparison

|                             | $N_+$ | $N_-$ | $A$                |
|-----------------------------|-------|-------|--------------------|
| Jon Neut QE                 | 16771 | 15295 | $-0.046 \pm 0.006$ |
| My Neut QE                  | 18016 | 16156 | $-0.054 \pm 0.005$ |
| Agree Neut QE               | 11850 | 10694 | $-0.051 \pm 0.007$ |
| More My Neut QE             | 5194  | 4611  | $-0.059 \pm 0.010$ |
| $W$                         | 645   | 580   | $-0.053 \pm 0.029$ |
| $p_{\text{miss},\perp}$     | 350   | 323   | $-0.040 \pm 0.039$ |
| $p_{\text{miss},\parallel}$ | 1443  | 1261  | $-0.067 \pm 0.019$ |
| $M_{\text{miss}}$           | 320   | 306   | $-0.022 \pm 0.040$ |
| $y_{\text{NA}}$             | 18    | 14    | $-0.125 \pm 0.175$ |
| $x_{\text{NA}}$             | 182   | 140   | $-0.130 \pm 0.055$ |
| $\sqrt{-1}$ calc            | 0     | 0     | $+0.000 \pm 0.000$ |
| Charge ID                   | 88    | 97    | $+0.049 \pm 0.073$ |
| No match                    | 738   | 646   | $-0.066 \pm 0.027$ |
| No event to compare         | 972   | 851   | $-0.066 \pm 0.023$ |

- ▶ Results for three kinematics follow
- ▶ Preliminary results are shown with FSI



## Kin 4 Results

P\_nulc 0.484974 +/- 0.021678  
P\_n 0.860000 +/- 0.020000  
P\_beam 0.835000 +/- 0.011000  
D\_back 0.96700 +/- 0.01900  
D\_inel 1.00000 +/- 0.00000  
D\_N2 0.94500 +/- 0.00200  
D\_p 0.75700 +/- 0.01500  
K 0.95000 +/- 0.00000  
A\_back -0.00010 +/- 0.00048  
A\_inel 0.00000 +/- 0.00000  
A\_p -0.00060 +/- 0.00010

## Kin 4 Results

N\_QE 146931

A\_raw -0.05475

dA\_raw 0.00260

d/A\_raw -0.04755

A\_phys -0.23846

d\_sys 0.013648

d\_sys/A -0.057232

d\_stat 0.011477

d\_stat/A -0.048128

T[0] -0.065

T[1] 0.973

Q<sup>2</sup> 1.72 GeV<sup>2</sup>

Lambda -0.190

dLambda 0.022

## Kin 4 Results

Lambda -0.190 +/- 0.022

GMn -0.165568 +/- 0.002874

GEn 0.031395 +/- 0.002305 +/- 0.002795

## Kin 2 Results

P\_nulc 0.451962 +/- 0.020203  
P\_n 0.860000 +/- 0.020000  
P\_beam 0.835000 +/- 0.011000  
D\_back 0.99300 +/- 0.00400  
D\_inel 1.00000 +/- 0.00000  
D\_N2 0.94300 +/- 0.00300  
D\_p 0.77700 +/- 0.03940  
K 0.95000 +/- 0.05000  
A\_back 0.00000 +/- 0.00044  
A\_inel 0.00000 +/- 0.00000  
A\_p -0.00041 +/- 0.00009

## Kin 2 Results

N\_QE 37349

A\_raw -0.04892

dA\_raw 0.00515

d/A\_raw -0.10533

A\_phys -0.23611

d\_sys 0.021300

d\_sys/A -0.090211

d\_stat 0.024035

d\_stat/A -0.101795

T[0] -0.013

T[1] 0.822

Q<sup>2</sup> 2.49 GeV<sup>2</sup>

Lambda -0.292

dLambda 0.048

## Kin 2 Results

Lambda  $-0.292 \pm 0.048$

GMn  $-0.096075 \pm 0.002162$

GEn  $0.028067 \pm 0.003476 \pm 0.003144$

## Kin 3 Results

P\_nulc 0.477482 +/- 0.021343  
P\_n 0.860000 +/- 0.020000  
P\_beam 0.835000 +/- 0.011000  
D\_back 0.99200 +/- 0.00400  
D\_inel 1.00000 +/- 0.00000  
D\_N2 0.94000 +/- 0.00800  
D\_p 0.84100 +/- 0.06500  
K 0.95000 +/- 0.00000  
A\_back -0.00003 +/- 0.00070  
A\_inel 0.00000 +/- 0.00000  
A\_p -0.00035 +/- 0.00008

## Kin 3 Results

N\_QE 16865

A\_raw -0.03979

dA\_raw 0.00757

d/A\_raw -0.19016

A\_phys -0.21267

d\_sys 0.020093

d\_sys/A -0.094481

d\_stat 0.038004

d\_stat/A -0.178701

T[0] 0.041

T[1] 0.700

Q<sup>2</sup> 3.47 GeV<sup>2</sup>

Lambda -0.388

dLambda 0.076



# Kin 3 Results

Lambda  $-0.388 \pm 0.076$

GMn  $-0.054994 \pm 0.001059$

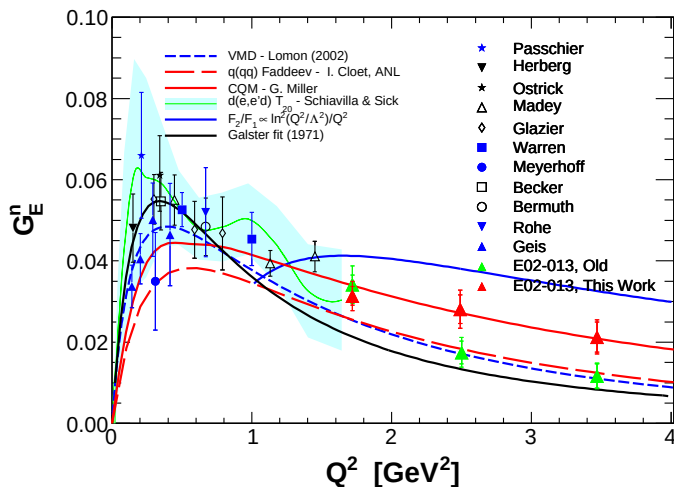
GEn  $0.021317 \pm 0.003697 \pm 0.001998$

# Inelastic Contributions

$$A = \frac{A_{\text{phys}} - A_{\text{inelas}}}{D_{\text{inelas}}}$$

|            | $D_{\text{inelas}}$ | $A_{\text{inelas}}$ |
|------------|---------------------|---------------------|
| Kin 4      | 0.9839              | -0.0038             |
| Kin 2      | 0.9834              | -0.0030             |
| Kin 3      | 0.9726              | -0.0050             |
| Kin 3 wide | 0.905               | -0.0143             |

# Results



# To Do

- ▶ Error analysis on MC
- ▶ Proton contamination and error from MC
- ▶ Work in polarization
- ▶ Will be gone Sat - Mon