Jan Bernauer, Research Scientist, MIT - Analysis coordinator

Axel Schmidt, Graduate Student, MIT - Rad. generator, tracking

Brian Henderson, Graduate Student, MIT - 12° luminosity monitor

Rebecca Russell, Graduate Student, MIT - ToF, Rad. generator, tracking

Colton O’Connor, Graduate Student, MIT - SYMB luminosity monitor

Lauren Ice, Graduate Student, ASU - ToF, tracking

Dmitry Khaneft, Graduate Student, Mainz - SYMB luminosity monitor
Initial look at $\sigma^{e^+p}/\sigma^{e^-p}$ ratio

Pushed to get result from $\approx 1000$ runs ($\approx 20\%$ of data) in time for PRC

First look at ratio 10 days ago
- initial impression positive with some concerns

Presented to the OLYMPUS collaboration 7 days ago
- positively received

Since then
- collaboration expressed concerns about the review process
- further studies at MIT on systematics showed some problems

Not ready for a public release of a preliminary result.
Initial Look at Ratio

Initial look at $\sigma^{e^+p}/\sigma^{e^-p}$ ratio - small $Q^2$ bins

D.K. Hasell - M.I.T.
PRC Closed Session
May 11, 2015
Initial look at $\sigma^{e^+p}/\sigma^{e^-p}$ ratio - structure in data and MC
Initial look at $\sigma^{e^+p}/\sigma^{e^-p}$ ratio - large $Q^2$ bins

![Graph showing the ratio $\sigma^{e^+p}/\sigma^{e^-p}$ vs. $Q^2$ with statistical and systematic uncertainty bands.](image)
Initial look at $\sigma^{e^+p}/\sigma^{e^-p}$ ratio - large $\epsilon$ bins
Initial look at $\sigma^{e^+p}/\sigma^{e^-p}$ ratio - large $\theta_l$ bins
\( \sigma_{e^+p} / \sigma_{e^-p} \) ratio - average, left / right, up / down

Investigate systematics

- All
- Left
- Right
- Up
- Down

\[ \begin{align*}
\sigma_{e^+p} / \sigma_{e^-p} & \approx 0.85 \\
& \approx 0.9 \\
& \approx 0.95 \\
& \approx 1 \\
& \approx 1.05 \\
& \approx 1.1 \\
& \approx 1.15
\end{align*} \]
Stability of yield with time

Investigate time dependence
Investigate time dependence

Stability of yield with time - left / right

High-\(\epsilon\) elastics / S.C. luminosity [a.u.]

Run Number

Left Electrons
Right Electrons
Left Positrons
Right Positrons
Investigate time dependence

Stability for different $\epsilon$ bins

Elastic Rate Stability

Elastic Yield / S.C. Luminosity [a.u.]

Run Number

Electrons

Positrons

Brian S. Henderson (MIT) Progress on OLYMPUS May 11, 2015 23 / 26
Systematics

OLYMPUS has abundant statistics

- $\sim 5 \times 10^9$ events
- $\sim 5 \times 10^8$ $ep$ elastics scattering events
- can study and correct systematic effects over the entire kinematic range

Some conservative estimates of the effect of systematic uncertainties

**Table:** Systematics as a percentage for bins of $\theta_l$.

<table>
<thead>
<tr>
<th></th>
<th>$25^\circ$</th>
<th>$35^\circ$</th>
<th>$45^\circ$</th>
<th>$55^\circ$</th>
<th>$65^\circ$</th>
<th>$75^\circ$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luminosity</td>
<td>0.2 %</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>$E_{beam}$</td>
<td>0.5 MeV</td>
<td>0.08</td>
<td>0.08</td>
<td>0.08</td>
<td>0.07</td>
<td>0.08</td>
</tr>
<tr>
<td>$\Theta_L$</td>
<td>0.05°</td>
<td>0.60</td>
<td>0.46</td>
<td>0.35</td>
<td>0.30</td>
<td>0.25</td>
</tr>
<tr>
<td>Momentum</td>
<td>1.0 %</td>
<td>0.41</td>
<td>0.46</td>
<td>0.37</td>
<td>0.53</td>
<td>0.46</td>
</tr>
<tr>
<td>Total</td>
<td>0.76</td>
<td>0.69</td>
<td>0.55</td>
<td>0.64</td>
<td>0.57</td>
<td>0.43</td>
</tr>
</tbody>
</table>
Systematics - Luminosity

Left+Right MWPC Luminosity

![Graph showing Left+Right MWPC Average]

- Red line: $\nu = 1.024, \sigma = 0.022$
- Blue line: $\nu = 1.015, \sigma = 0.024$

Counts per 0.0078 in the Ratio

MWPC-Only Left/Right
Systematics - Lepton Scattering Angle

$\theta$ Reconstruction Improvement

October, 2014
Current tracker
Momentum Reconstruction Improvement

- Black line: October, 2014
- Red line: Current tracker

Counts [arb. units.]

\( \Delta p/p \ [%] \)

-80 -60 -40 -20 0 20 40 60 80
Systematics

\[ \sigma_{e+p}/\sigma_{e-p} \]

\[ \epsilon \]

\[ 0 \pm 0.04 + r \]

\[ 0.02 + r \]

\[ 0 \pm 0.02 + r \]

\[ 0.04 + r \]

\[ 0 \pm 0.04 + r \]
## Systematics

<table>
<thead>
<tr>
<th>System/Source</th>
<th>Current Estimate</th>
<th>Expected</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SYMB</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current Systematic</td>
<td>5–8%</td>
<td></td>
<td>Asymmetry under investigation</td>
</tr>
<tr>
<td>Statistical</td>
<td>0.05%/run</td>
<td>Run ≈ 20 min., about 3k good runs</td>
<td></td>
</tr>
<tr>
<td>Cuts</td>
<td>&lt; 0.05%</td>
<td>Early studies of cut systematics promising</td>
<td></td>
</tr>
<tr>
<td>Geometry/Survey</td>
<td>&lt; 0.5%</td>
<td>Studied already in MC</td>
<td></td>
</tr>
<tr>
<td>Background/digitization</td>
<td>&lt; 0.2%</td>
<td>Subject to resolution of current issues</td>
<td></td>
</tr>
<tr>
<td>Efficiency/Resolution</td>
<td>&lt; 0.01%</td>
<td>Studied already in MC</td>
<td></td>
</tr>
<tr>
<td>Magnetic Field</td>
<td>&lt; 0.01%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MWPC Telescopes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statistical</td>
<td>1.0%/run</td>
<td>1.0%/run</td>
<td>Run ≈ 20 min., about 3k good runs</td>
</tr>
<tr>
<td>Geometry/Acceptance</td>
<td>0.4%</td>
<td>0.1%</td>
<td>Improvements continuing on geometry</td>
</tr>
<tr>
<td>Cuts</td>
<td>0.2%</td>
<td>0.1%</td>
<td></td>
</tr>
<tr>
<td>Magnetic Field</td>
<td>&lt; 0.2%</td>
<td>&lt; 0.2%</td>
<td></td>
</tr>
<tr>
<td>Monte Carlo</td>
<td>&lt; 1.0%</td>
<td>&lt; 0.2%</td>
<td>Includes a variety of effects</td>
</tr>
<tr>
<td><strong>GEM Telescopes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current Systematic</td>
<td>∼10%</td>
<td></td>
<td>Severe time varying efficiency, not expected to improve</td>
</tr>
<tr>
<td><strong>Main Volume Tracking/Trigger</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Efficiency Inhomogeneity</td>
<td>1.0%</td>
<td>0.2%</td>
<td>May be able to model to even better</td>
</tr>
<tr>
<td>Geometry/acceptance</td>
<td>5–6%</td>
<td>&lt; 0.05%</td>
<td>Improvements continuing on geometry</td>
</tr>
<tr>
<td>Reconstruction</td>
<td>1–2%</td>
<td>&lt; 0.2%</td>
<td>Improvements continuing on tracking</td>
</tr>
<tr>
<td>Beam Energy</td>
<td>&lt; 0.06%</td>
<td>&lt; 0.06%</td>
<td>Worst case (200 keV offset)</td>
</tr>
<tr>
<td>Beam Position</td>
<td>0.2%</td>
<td>&lt; 0.1%</td>
<td>Additional information from reconstruction</td>
</tr>
<tr>
<td>Radiative Corrections</td>
<td>0.1%</td>
<td>0.1%</td>
<td>Multiple generator weights, models, etc.</td>
</tr>
<tr>
<td>Background</td>
<td>0.5%</td>
<td>&lt; 0.5%</td>
<td>Worst case, applicable to high $\theta$ only, much better in forward bins</td>
</tr>
</tbody>
</table>