Unfolding the $M_X$ Spectrum in $B \rightarrow X_u \ell \nu$

- Measure $M_X$ on the recoil of fully reconstructed hadronic $B$ decays
- Resolution about 300 MeV
- 244 signal events in full $M_X$ range ($80 \text{ fb}^{-1}$)
- First attempt to unfold spectrum for experimental efficiencies and resolution
- Spectrum and moments sensitive to $m_b$ and nonperturbative parameters

ICHEP04
[hep-ex/0408068]

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Future Perspective – $M_X^2$ Moments

★ OPE predictions now with $M_X$ and $E_\ell$ cuts (P. Gambino, G. Ossola, work in progress)

<table>
<thead>
<tr>
<th></th>
<th>$220 \text{ fb}^{-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma(M_1)$ in %</td>
<td>19 → 11</td>
</tr>
<tr>
<td>$\sigma(M'_2)$ in %</td>
<td>53 → 18</td>
</tr>
<tr>
<td>$\sigma(M'_3)$ in %</td>
<td>136 → 57</td>
</tr>
</tbody>
</table>

★ Scale statistical uncertainties ($80 \rightarrow 220$) $\text{fb}^{-1}$

★ No $M_X^2$ cut $\rightarrow M_X^2 < 5.6 \text{ GeV}^2$

★ $M_X^2$ cut removes experimentally most poorly known region

**Experimental uncertainties**

<table>
<thead>
<tr>
<th></th>
<th>$220 \text{ fb}^{-1}$</th>
<th>No $M_X^2$ cut</th>
<th>$M_X^2 &lt; 5.6 \text{ GeV}^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m_b/\text{GeV}$</td>
<td>±0.18</td>
<td>±0.06</td>
<td></td>
</tr>
<tr>
<td>$\mu_\pi^2/\text{GeV}^2$</td>
<td>±0.6</td>
<td>±0.1</td>
<td></td>
</tr>
<tr>
<td>$\rho_D/\text{GeV}^3$</td>
<td>±0.5</td>
<td>±0.1</td>
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</tbody>
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★ Central values $m_b, \mu_\pi^2$ from $BABAR$ HQE fits in $B \rightarrow X_c\ell\nu$
How Do We Use This Best?

★ Anticipated accuracy interesting for constraining $m_b$
  ★ Expect results by summer 2005
  ★ Expect 450 fb$^{-1}$ by summer 2006

★ How are the moments best used in testing underlying OPE assumptions - also in combination with $B \rightarrow X_c \ell \nu$?
  ★ If test successful - how are they best combined with corresponding information from $B \rightarrow X_c \ell \nu$?

★ How do we make best use of unfolded $M_X^{(2)}$ spectrum for better understanding and improved accuracy for extraction of $|V_{ub}|$?

★ Would it be useful to extract moments separately for $B^+$ and $B^0$?