Physics from HERA-B

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Outline

• Data samples
• Physics topics
• Pentaquark searches
• ψ(2S) production
• A –dependence
• bb cross section
• Summary
Data samples

Minimum Bias data

\(200\ M\ \text{events on C,Ti,W}\)

\(1000\ \text{ev/s} > 1\text{TB/day}\)

Dilepton triggered data

\(150\ M\ \text{dilepton trigger events}\)

\(300\ 000\ J/\psi (>1000\ \text{per hour})\)

\(15\ 000\ \chi_c\)

\(5\ 000\ \psi(2S)\)

Hard photon trigger

\(35\ M\)
Topics under study

• Upper limit on \( \text{BR}(D^0 \rightarrow \mu^+\mu^-) \) (Phys.Lett.B596:173-183,2004)
• Pentaquark searches \((pK_s, \Xi\pi)\) (hep-ex/0408048) accepted by Phys. Rev. Lett.
• Inclusive \(b\bar{b}\) cross section
• Upsilon cross section
• Production of \(\phi\) and \(K^*\) mesons
• \(\psi(2S)\) production
• \(D^+/D^0\) production ratio
• \(J/\psi\) cross section in MB
Topics cont’d

- Hard photon production
- $\Lambda^0$ polarization
- $\chi_c$ production
- A dependence charmonium production
- $J/\psi$ differential distributions
- $V^0$ and hyperon production
- Jet production
\( \Theta^+, \Xi^- \) Searches


\[ B \cdot d\sigma/dy \mid_{y=0} = 4-16 \mu b/N \]

@ 1521-1555 MeV/c^2

\( \Theta^+ / \Lambda(1520) < 3 - 12 \% \)

\[ B \cdot d\sigma/dy \mid_{y=0} = 2.5 \mu b/N \atop \text{@ 1862 MeV/c}^2 \]

\( \Xi^- / \Xi^- < 3/B \% \)

\( \Xi^- / \Xi(1530)^0 < 4/B \% \)
**ψ(2S) / J/ψ Production Ratio**

\[
\frac{BR(\psi(2S) \to l^+l^-) \cdot \sigma_{\psi(2S)}}{BR(J/\psi \to l^+l^-) \cdot \sigma_{J/\psi}} = \frac{N_{\psi(2S)}}{N_{J/\psi}} \cdot \frac{\varepsilon_{J/\psi}}{\varepsilon_{\psi(2S)}}
\]

**Preliminary results for**

\[
\frac{Br' \cdot \sigma(\psi')}{Br \cdot \sigma(J/\psi)} \quad [\%]
\]

<table>
<thead>
<tr>
<th>Target</th>
<th>electron</th>
<th>muon</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1.6 ± 0.2</td>
<td>1.65 ± 0.1</td>
</tr>
<tr>
<td>W</td>
<td>1.8 ± 0.4</td>
<td>1.54 ± 0.2</td>
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HERA-B (not fitted)
$\psi(2S)$ differential distributions

For $x_F < 0$, the differential distributions in $p_T^2$ and $x_F$ are shown. The data points are from HERA-B and preliminary results for carbon are also displayed.

- $d\sigma/dx_F$ for $e^+e^-$ and $\mu^+\mu^-$ events.
- $d\sigma/dp_T^2$ for $e^+e^-$ and $\mu^+\mu^-$ events.

The fit results include:
- $\chi^2$/ndf = 6.8/9 for $e^+e^-$, $\chi^2$/ndf = 2.83/6 for $\mu^+\mu^-$, $\chi^2$/ndf = 2.83/6 for $\mu^+\mu^-$.
- Probabilities: 0.658 for $e^+e^-$, 0.829 for $\mu^+\mu^-$.
- Parameters: $A = 3.11e+05 \pm 2.37e+04$, $c = 5.02 \pm 0.697$ for $e^+e^-$.
- Parameters: $A = 6.02e+04 \pm 4.73e+03$, $p_0 = 2.96 \pm 0.0947$ for $\mu^+\mu^-$. 
J/ψ A dependence

\[ \sigma_{pA} = \sigma_{pN} \cdot A^\alpha; \quad \sigma = N/(\varepsilon \cdot L) \]

\[ \alpha = \frac{1}{\ln(\frac{A_W}{A_C})} \cdot \ln \left( \frac{N_W}{N_C} \frac{L_C}{L_W} \frac{\varepsilon_C}{\varepsilon_W} \right) \]

- only 1 target config (C-W)
- \( \sim 15\% \) of \( \mu^+\mu^- \) sample
- similar results for e\(^+\)e\(^-\)
- Hera-B normalization
- Statistical errors only

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**bb production**

\[ b(\bar{b}) \rightarrow B \rightarrow J/\psi + X \]

**J/ψ → μ⁺μ⁻; e⁺e⁻**

**Measurement relative to direct J/ψ production to minimize trigger/reconstruction uncertainties**

\[ \sigma_{\bar{b}b} = \sigma_{J/\psi} \cdot \frac{n_B}{n_{J/\psi}} \cdot \frac{1}{\epsilon_R \cdot \epsilon_{B}^{\Delta \gamma} \cdot Br(\bar{b}b \rightarrow J/\psi + X)} \]

**B Selection:**
- Lepton impact to the wire
- Distance of J/ψ to wire

**B selection eff. from MC 30-45%**
**bb production**

Full statistics

$\frac{\sigma(b\bar{b})}{\sigma(J/\psi)} = 0.027 \pm 0.004 \pm 0.005$

20% sys. error under investigation

main contribution:

$\text{Br}(b\bar{b} \to J/\psi X) = 2.32 \pm 0.20\%$

**E771/E789:** scaled to 41.6 GeV

$\sigma(J/\psi) = 357 \pm 2 \pm 36 \text{ nb/nucleon}$

preliminary

$\sigma(b\bar{b}) = 9.8 \pm 1.4 \pm 2.0 \text{ nb/nucleon}$

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Summary

• Good data quality
• Several QCD related results expected
• Preliminary results on most topics presented at conferences (>40)
• 2 papers finished
  (BR(D^0 \rightarrow \mu^+\mu^-) (UL), pentaquark (UL))
• Publication on advanced analyses in preparation
  (b\bar{b}, Y, D^+/D^0, \phi/K^*, J/\psi, \psi(2S),...)
• Other topics could lead to publication, manpower permitting
• Analysis will continue until end 2005