

## 7 Particle Physics at DESY/HERA (HERA-B)

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(HERA-B collaboration)

The difficulties encountered by the HERA machine crew in recommissioning the accelerators have prevented the HERA-B collaboration from taking new data, too. The detector is ready and the planned improvements on the microstrip gas chamber system for the inner tracker (see last years annual report [1]) have been carried out. The experiences gained with this system during design, prototyping, testing and one year of exposure to the beam in 2000 have now been documented and submitted for publication [2].

From a short exploratory run in 2000 it was possible to determine the  $b\bar{b}$  production cross section for 920 GeV protons, albeit with rather limited accuracy [3]. Since the first level trigger of HERA-B was not fully operative the proton interaction rate was limited to 5 MHz. The analysis was based on the chain  $pA \rightarrow b\bar{b} X$ ;  $b\bar{b} \rightarrow J/\Psi Y \rightarrow (e^+e^-/\mu^+\mu^-) Y$ , with b-hadron decays into  $J/\Psi$  distinguished from prompt  $J/\Psi$  background using the *lifetime tag*, i.e. employing a vertex cut. The prompt  $\mu^+\mu^-$  mass spectrum is shown in Fig.7.1. With a

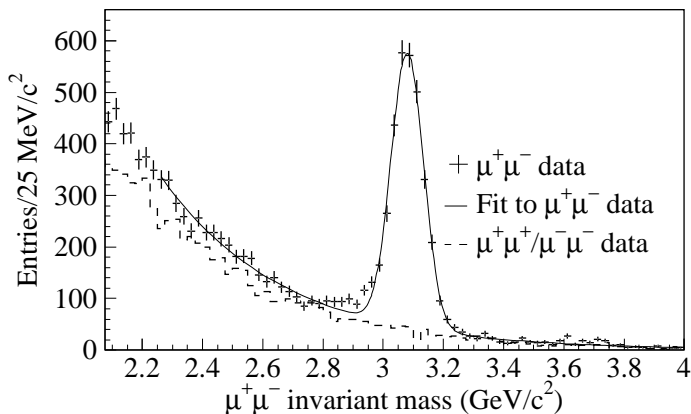


Figure 7.1: The  $\mu^+\mu^-$  invariant mass spectrum, after the  $J/\Psi$  selection cuts, observed in a one week exploratory run in 2000.

decay length resolution of  $\sigma(\Delta z) = 715 \pm 24 \mu\text{m}$  and a mean decay length of the triggered  $b$ -hadrons of about 8 mm, a few events (see Table 7.1) survive a vertex cut of  $> 5$  mm downstream from the wire, on which the interaction occurred. The background from the tails of the vertex distributions can be estimated by looking at the upstream sample, or from a Monte Carlo simulation of the charm contribution. When normalized to the inclusive  $J/\Psi$  production cross section measured elsewhere [4], and using the calculated acceptance the cross section listed in Table 7.1 and plotted in Fig.7.2 results. The latest QCD calculations [5, 6] predict cross sections at 920 GeV of  $\sigma(b\bar{b}) = 25_{-13}^{+20}$  and  $30 \pm 13$  nb/nucleon, respectively, in favorable agreement with the measured value  $\sigma(b\bar{b}) = 32_{-12}^{+14}$  (stat.)  $\pm 7$  (syst.) nb/nucleon. This analysis indicates, that the upcoming 2002/3 data taking may also lead to significant tests of potentially refined QCD predictions in the  $b\bar{b}$  sector similar to what has been discussed in connection with the H1  $ep$  data elsewhere in this annual report.

Table 7.1: Parameters entering the calculation of the  $(b\bar{b})$  cross section.  $\Delta\sigma$  refers to the restricted kinematic range  $-0.25 < x_F < 0.15$ .

		$\mu^+\mu^-$ ch.	$e^+e^-$ ch.
Target	77% C(A=12) + 23% Ti(A=48)		
Beam energy	920 GeV		
pp c.o.m. energy	41.6 GeV		
$\sigma(J/\Psi) \times A^\alpha/A$ , $\alpha$ [4]	$314 \pm 31$ nb/nucleon, 0.955(5)		
Prompt $J/\Psi$		$2880 \pm 60$	$5710 \pm 380$
Detached $J/\Psi$		$1.9^{+2.2}_{-1.5}$	$8.6^{+3.9}_{-3.2}$
Acceptance $\epsilon_R \cdot \epsilon_B^{\Delta z}$		$0.41 \pm 0.01$	$0.44 \pm 0.02$
Branching ratio ( $b\bar{b} \rightarrow J/\Psi X$ )	$0.0232 \pm 0.0020$		
$\Delta\sigma(b\bar{b})$ (nb/nucleon)		$16^{+18}_{-12}$	$38^{+18}_{-15}$
Combined $\Delta\sigma(b\bar{b})$	$30^{+13}_{-11} \pm 6$ (syst.) nb/nucleon		
Combined $\sigma(b\bar{b})$	$32^{+14}_{-12} \pm 7$ (syst.) nb/nucleon		

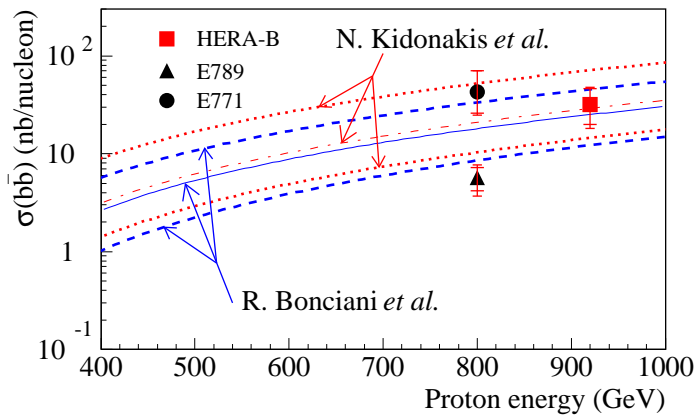


Figure 7.2: Comparison of the HERA-B (2000)  $b\bar{b}$  production cross section with other experiments [4] and theoretical predictions of Bonciani et al. [5] and Kidonakis et al. [6]

## References

- [1] Physik-Institut, Universität Zürich, Annual Report 2001/2, available at <http://www.physik.unizh.ch/jb/2001>.
- [2] *Studies of aging and HV break down problems during development and operation of MSGC and GEM detectors for the inner tracking system of HERA-B*, Y. Bataguria et al., hep-ex/0204022, Nucl. Instr. Meth. **A**, in print.
- [3] *Measurement of the  $b\bar{b}$  production cross section in 920 GeV fixed-target proton-nucleus collisions*, I. Abt et al, to be submitted to Eur. Phys. J.C.
- [4] M.H. Schub et al., Phys. Rev. **D52** (1995), 1307; T. Alexopoulos et al., Phys. Rev. **D55** (1997), 3927.
- [5] R. Bonciani et al., Nucl. Phys. **B529** (1998), 424.
- [6] N. Kidonakis et al., Phys. Rev. **D64** (2001), 11401.