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$p\bar{p}$ cross sections for the Tevatron energy scan

Nathan Goldschmidt

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Abstract

The Tevatron energy scan will present unique operational challenges for the CDF detector as a whole and the CLC luminosity detector in particular. The primary concern for CLC operations is the energy dependence of the $p\bar{p}$ cross section. In this note, values for the hadronic $p\bar{p}$ cross section at the center–of–mass energies to be visited during the scan are tabulated.

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The CLC [1] measures μ, the average number of interactions per bunch crossing in $p\bar{p}$ collisions at the Tevatron. The relationship between μ and the total rate of $p\bar{p}$ collisions is,

$$\mathcal{L} = \frac{\mu \cdot f_{\mathrm{BC}}}{\sigma_{\mathrm{tot.}}}, \tag{1}$$

where rate of bunch crossings, f_{BC}, is 48 kHz and $\sigma_{\mathrm{tot.}}$ is the total $p\bar{p}$ cross section. At $\sqrt{s} = 1.96$ TeV the total $p\bar{p}$ cross section is 81.90 ± 2.30 mb [2,3]. The CLC is insensitive to elastic scattering—the inelastic $p\bar{p}$ cross section used in the luminosity calculation for collisions at $\sqrt{s} = 1.96$ TeV is $\sigma_{\mathrm{inel.}} = 61.9 \pm 1.4$ mb [3].

The Tevatron energy scan will collide protons and antiprotons at center–of–mass energies of 300, 630, and 900 GeV. The total, elastic and inelastic cross sections at these energies are determined according to data provided by the Particle Data Group [6, 7]. At each center–of–mass energy to be visited during the scan, the cross section is estimated by performing a linear interpolation between the adjacent data points. These cross sections are given in Table 1. Reference is given to the original publications for data used in the interpolation.

It is worth noting that the acceptance for events to be measured by the CLC will differ for varying center–of–mass energies. To estimate the acceptance, a study including full simulation of the detector elements is required. Unfortunately, such a study has not been preformed at these energies. The acceptance can be estimated *a posteriori* by examining zero–bias data and applying the method described in CDF note 6054 [5].

References

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[3] J. Konigsberg *et al.* "A first look at the CLC luminosity measurements," CDF internal note CDF/ANAL/CDF/CDFR/6052 (2002).

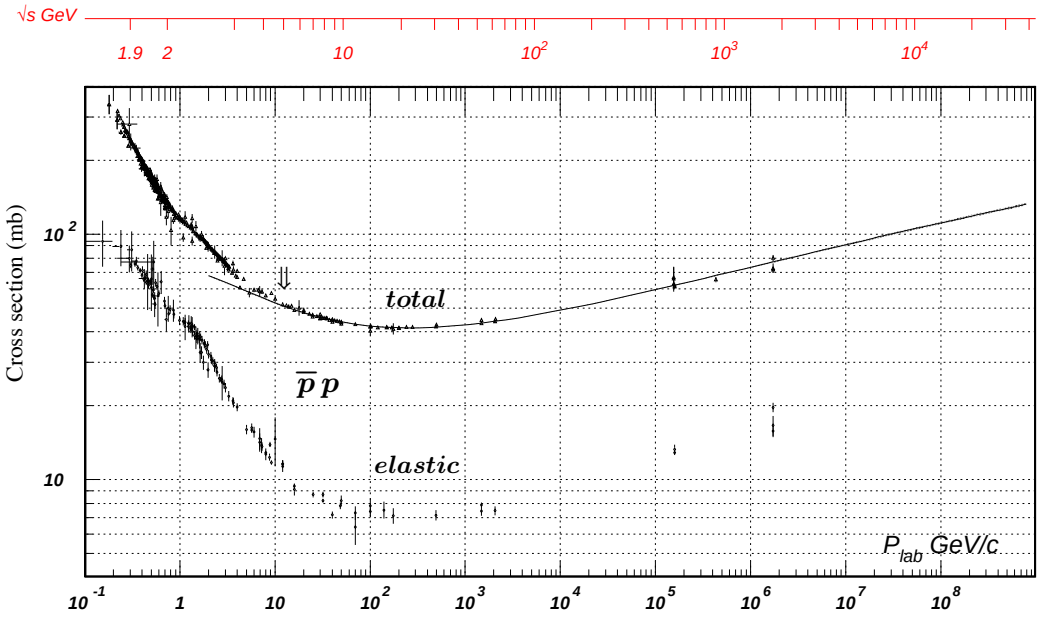

Figure 1: Total and elastic cross sections for and $p\bar{p}$ collisions as a function of laboratory beam momentum and total center–of–mass energy. Corresponding computer-readable data files may be found at http://pdg.lbl.gov/2011/hadronic-xsections/. (Courtesy of the COMPAS group, IHEP, Protvino, August 2005) [6,7].

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$\sqrt{s}$	300 GeV	630 GeV	900 GeV
$\sigma_{\text{tot.}}$(mb)	$51.6 \pm 1.4 \pm 0.9$	$62.5 \pm 3.5 \pm 1.1$	$65.3 \pm 0.7 \pm 2.3$
$\sigma_{\text{el.}}$(mb)	$9.0 \pm 11.4 \pm 0.0$	$13.4 \pm 1.5 \pm 0.0$	$13.7 \pm 1.4 \pm 0.0$
$\sigma_{\text{inel.}}$(mb)	$42.6 \pm 11.5 \pm 0.9$	$49.2 \pm 3.8 \pm 1.1$	$51.6 \pm 1.6 \pm 2.3$

Table 1: Total, inelastic and elastic cross sections for $p\bar{p}$ scattering at $\sqrt{s} = 300$, 630, and 900 GeV, according to [6, 7]. The first error is statistical, the second systematic.

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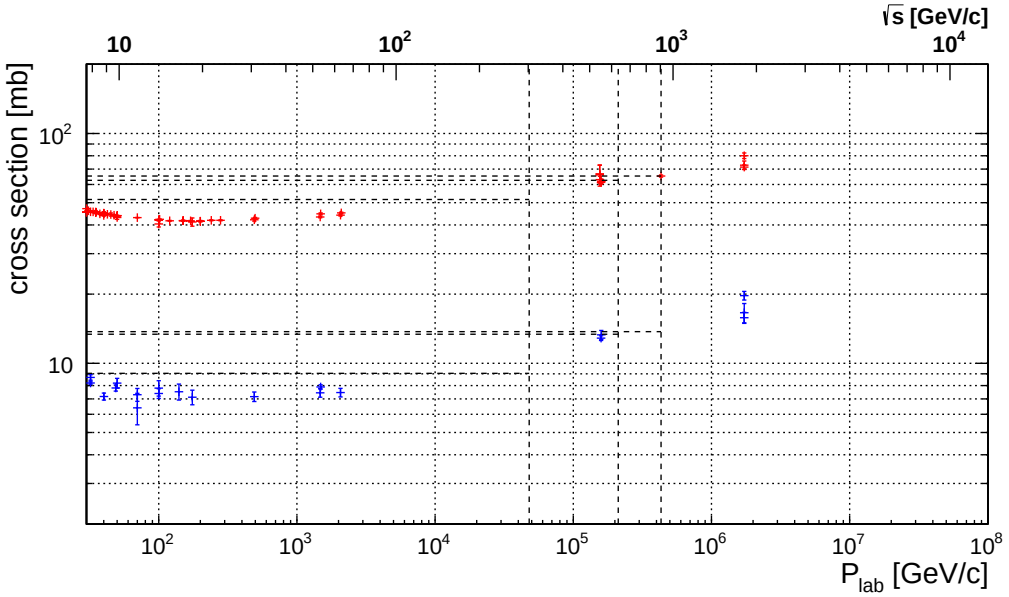

Figure 2: Total and elastic cross sections for and $p\bar{p}$ collisions as a function of laboratory beam momentum and total center–of–mass energy. The red points indicate the total cross section, the blue points the elastic cross section. The center–of–mass energies to be visited during the Tevatron energy scan ($\sqrt{s}$ = 300, 630, 900 GeV) are indicated by dashed lines. [6, 7].