5 The DØ experiment at the Tevatron $p\bar{p}$ collider: Search for rare decays of B_s-mesons and a new silicon detector layer

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The full DØ collaboration consists of 80 institutes from 18 countries: Argentina (1), Brazil (3), China (1), Czech Republic (3), Colombia (1), Ecuador (1), France (7), Germany (6), India (3), Ireland (1), Korea (1), Mexico (1), Netherlands (3), Russia (5), Sweden (4), United Kingdom (3), United States of America (35) and Vietnam (1)

(DØ Collaboration)

Until LHC at CERN starts its operation in 2007 the Tevatron at the Fermi National Accelerator Laboratory, Batavia, USA, is the world's highest energy accelerator with an available center of mass energy of 2 TeV. The so-called Run II of the $p\bar{p}$ collider has started in 2001 and addresses some of the most important questions in particle physics. The most recent physics results involve direct searches for as yet unknown particles and forces, including both those predicted or expected (like the Higgs boson and supersymmetry) and those that would come as a surprise. Other important aspects of this programme are precise measurements of the top quark properties and new accurate determinations of the mass of the W boson and the couplings of the electroweak bosons. Moreover, numerous measurements of various B meson decay modes have already allowed the investigation of B meson properties that are not accessible at other colliders as well as searches for CP-violating effects. A recent overview of the latest B physics results from DØ is presented in [1].

Because of the tantalizing physics prospects a high integrated luminosity run will bring, a second phase of Tevatron running, that will cover the years 2006 until 2009, is presently being prepared. The innermost layer of silicon detectors situated close to the beampipe will be replaced [2] since it will suffer from the harsh radiation environment and might lose efficiency.

After the DØ detector became fully operational for Run II and about 300 pb^{-1} of $p\bar{p}$ collision data have been taken until now, we started with our physics analysis programme of rare B_s decay searches. The study of the B_s meson is unique to hadron colliders since the particle can not be produced at the $\Upsilon(4S)$ resonance at which e^+e^- B-Factories like BaBar and Belle are running. So far we have focused on the flavor-changing neutral current decay $B_s \to \mu^+\mu^-$, which is forbidden at tree level. This decay channel is a very clean and attractive probe for physics beyond the Standard Model (SM) since it has a very small SM branching ratio of $3.5 \cdot 10^{-9}$ and many supersymmetric extensions of the SM could enhance it significantly [3]. Especially at high $\tan\beta$ any model with an extended Higgs sector leads to rates which may already now be observable at the Tevatron.

So far, we have analyzed about 180 pb^{-1} of DØ data and optimized the event selection in the invariant mass regions next to the signal region (the "box") which has been left to avoid any bias (see Figure 5.1). We expect 7.3 ± 1.3 background events in the box which corresponds to an upper limit of $1 \cdot 10^{-6}$ at 95% confidence level assuming no signal [4], almost a factor three lower than the Run I limit of CDF [5].

Our plan is to open the signal box for the ICHEP conference in August 2004. By then we will have doubled the statistics which will start to constrain the parameter space of certain supersymmetric models at high $\tan\beta$.

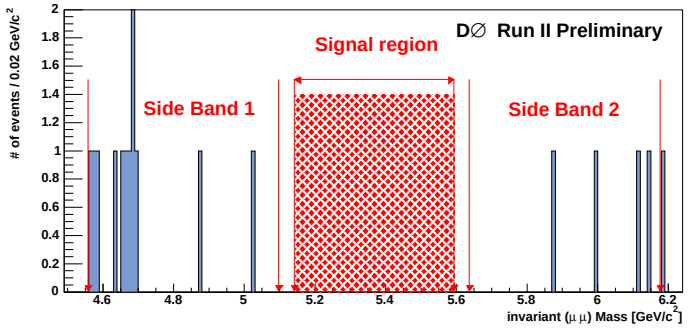

Figure 5.1: $\mu^+\mu^-$ *invariant mass distribution around the region of interest. The latter has not yet been looked at.*

We are also involved in the construction of the new DØ silicon detector layer which will be put in operation in 2005. We have worked on the specifications, the design and the quality assurance procedures for the silicon sensors which have been ordered by now [6]. In addition we have designed a long low-mass cable with a very fine pitch to route the analog signals from the innermost silicon detector layer to the readout electronics. Together with the Swiss company Dyconex [7] several cable prototypes were developed and characterized. The production of those cables has just started.

[1] *Recent Results from B Physics at DØ* , talk presented by F. Lehner at the XII International Workshop on Deep Inelastic Scattering, DIS 2004, Strbske Pleso, Slovakia, April 14-18, 2004.

[2] The DØ Run IIb silicon detector collaboration: *DØ Run IIb silicon detector upgrade, Technical Design Report*, http://d0server1.fnal.gov/projects/run2b/Silicon/www/smt2b/Layer00/l0html.

[3] A. Dedes, H. Dreiner and U. Nierste, Phys. Rev. Lett. **87**, 251804, 2001.

[4] R. Bernhard and F. Lehner: *Sensitivity analysis of the rare decay $B_s \to \mu^+\mu^-$ with the DØ detector*, DØ note 4377.

[5] F. Abe *et al.* [CDF Collaboration], Phys. Rev. D **57**, 3811 (1998).

[6] A. Bean *et al., Silicon Sensor Quality Assurance for the* DØ *RunIIb Silicon Detector: Procedures and Equipment*, DØ note 4120, see also `http://www.physik.unizh.ch/~lehnerf/dzero/run2b.html`.

[7] Dyconex advanced circuit technologies, Zurich, Switzerland.