null
In contrast, the high energy and luminosity available at the LHC facilitate a study of single diffractive Higgs production, where also the striking $H \to \gamma \gamma$ decay should be observed. Also a few DPE Higgs events may be observed. The quality of a diffractive event changes, however, at LHC energies. Besides the production of a hard subsystem and one or two leading protons, the energy is still enough for populating forward detector rapidity regions with particles. As seen in Fig. 3, the multiplicity of particles is considerably higher at the LHC, compared to the Tevatron. The requirement of a "clean" diffractive Higgs event with a large rapidity gap in an observable region cannot be achieved without paying the price of a lower cross section. Requiring gaps instead of leading protons gives a substantial reduction in the cross section, as seen in Table I. Note that the high luminosity mode of LHC cannot be used, since the resulting pile-up of events would destroy the rapidity gaps.

The Monte Carlo model does not include any specific mechanism for the exclusive reaction $pp \to ppH$ and our simulations did not produce any such events.

For comparison we have also investigated single diffractive Higgs production in the pomeran model. This is based on the Regge framework with the exchange of a Pomeron with vacuum quantum numbers [18], given by an effective pomeron flux [1]. In case of a hard scattering process, which resolves an underlying parton level process, a parton structure of the Pomeron may be considered [1] and the data on diffractive deep inelastic scattering from HERA can be well described by fitting parton density functions in the Pomeron [19]. Applying exactly the same model for $p\bar{p}$ gives, however, diffractive hard scattering cross sections that are up to two orders of magnitude larger than what is observed at the Tevatron. Although this can be cured by appropriately modified pomeron flux functions, it may indicate a deeper non-universality problem of the pomeron model [6].

To get numerical estimates we use the pomeron model implemented in the PomPyt Monte Carlo [20]. The parton densities in the Pomeron are from a fit (parameterization $f_{1}(x)$ [21]) to the diffractive structure function measured at HERA. The pomeron flux [22] has been renormalized [23] so as to reproduce the observed relative rates of diffractive hard scattering processes both at HERA and the Tevatron.

The pomeron model is constructed to give a leading proton with a spectrum essentially as $1/(1-x_F)$. It is developed for situations where $x_F \to 1$ dominates and usually taken to be trustworthy only for $x_F > 0.9$. As shown in Fig. 4, however, this distribution is strongly distorted in this case due to the kinematical condition imposed by the Higgs mass. At the Tevatron energy, the cross section is dominated by smaller $x_F$. This makes the results of the model sensitive to a phase space region where the pomeron model cannot be safely applied. In particular, the diffractive Higgs cross section will depend on whether the usual requirement $x_F > 0.9$ is applied or not. The resulting cross section also depends strongly on what conditions for diffraction are applied. The requirement at the Tevatron experiments of no particles in the rapidity region $2.4 < |\eta| < 5.9$ imposes a very strong reduction. If the gap can be in a more forward rapidity region, based on extended detector coverage, a much

<table>
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<th>TABLE I: Cross sections at the Tevatron and LHC for Higgs in single diffractive (SD) and DPE events, using leading proton or rapidity gap definitions, as well as relative rates (SD/All and DPE/SD) and number (#) of events, obtained from the soft color exchange models SCI and GAL.</th>
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<tbody>
<tr>
<td>$m_H = 115$ GeV</td>
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<tr>
<td>$\sqrt{s} = 1.96$ TeV</td>
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<tr>
<td>$L = 20$ fb$^{-1}$</td>
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<td>$\sigma(b)$ Higgs-total</td>
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<td># H + leading-p</td>
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<tr>
<td># H + leading-p</td>
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<td>R [%] leading-p</td>
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<td># H + leading-p</td>
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<tr>
<td>$x_F &gt; 0.0$</td>
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FIG. 3: Multiplicity (for LHC divided by 2.5) in the region $2.4 < |\eta| < 5.9$ in the hemisphere of a leading proton with the indicated minimum $x_F$, for Higgs events from the SCI and the pomeran models.

FIG. 4: Multiplicity (for LHC divided by 2.5) in the region $2.4 < |\eta| < 5.9$ in the hemisphere of a leading proton with the indicated minimum $x_F$, for Higgs events from the SCI and the pomeran models.

x F  > 0.9

x F  > 0.5

x F  > 0.0

x F  > 0.0

x F  > 0.5

x F  > 0.9

x F  > 0.5

x F  > 0.9
larger rate of diffractive Higgs is obtained as illustrated in Fig. 4. Similar, but not as strong effects are also present at LHC energies.

In view of this, predictions for the diffractive Higgs cross section will be somewhat uncertain in the pomeron model. To give some numbers, nevertheless, we use criterion (1) with a leading proton with $x_F > 0.9$, but no specific gap requirement. This gives a cross section of 2.8 fb for single diffractive Higgs production at the Tevatron and 410 fb at the LHC. This includes reduction factors of 5.2 and 9.2, respectively, from the pomeron flux renormalization [23] making HERA and Tevatron data compatible but leaving an extrapolation uncertainty for the LHC energy.

In contrast to the pomeron model, the SCI and GAL models are constructed to describe different final states through a general mechanism for soft color exchanges giving a smooth transition between diffractive and nondiffractive events. This implies a better stability with respect to variations of the conditions used to define diffractive events. Moreover, the energy dependence of SCI and GAL has proven successful. Data on various diffractive hard scattering processes at HERA and Tevatron are well reproduced. The soft color exchange models should, therefore, give more reliable predictions.

In conclusion, we have investigated the prospects for discovering the Higgs boson in diffractive events having a lower hadronic background activity that should simplify the reconstruction of the Higgs from its decay products.

We find that the rate of diffractive Higgs events at the Tevatron will be too low to be useful. Therefore, the Higgs must here be searched for in normal events with their larger hadronic activity. At LHC diffractive events are not as clean as expected, since the large available energy produces an increased hadronic activity. Still, LHC should facilitate studies of Higgs in single diffraction and the observation of some DPE events with a Higgs boson.