Inclusive Higgs Production
Via Double Pomeron Exchange

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Work done in collaboration with M.Boonekamp (Saclay, CERN), R.Peschanski (Saclay)
Contents

• Formalism

• Comparison with dijet production in diffractive events (CDF, run I data), dijets mass fraction distribution

• Fast simulation of D0/CDF detectors and roman pots

• Predictions for Higgs diffractive cross section

• Outlook and conclusion
Formalism: Inclusive cross sections

\[ p \rightarrow x_1, v_1 \]

\[ H, \overline{QQ}, gg \]

\[ p \rightarrow x_2, v_2 \]
• Idea: convolute exclusive cross section
  \((\text{partons} \rightarrow \text{Higgs and partons} \rightarrow \text{dijets})\)
  with the probability of finding these partons
  in the pomeron

• Higgs inclusive cross section:

\[
\frac{d\sigma^{incl}_{H}}{d\sigma^{excl}_{H}(s \rightarrow x_1^g x_2^g s)} = \frac{dx_1^g}{x_1^g} \frac{dx_2^g}{x_2^g}
\]

• Same idea for dijet cross section
**Formalism: Exclusive cross sections**

- Starting point: double pomeron exchange: Bialas-Landshoff for Higgs cross section, and Bialas-Szeremeta-Janik for dijet production: \( p\bar{p} \rightarrow p\bar{p}H \) and \( p\bar{p} \rightarrow p\bar{p}q\bar{q} \)

- Higgs:

\[
\sigma_H \sim \left( \frac{s}{M^2_H} \right)^{2\epsilon} \frac{1}{x_1} \frac{1}{x_2} \delta \left( (1-x_1)(1-x_2) - \frac{M^2}{s} \right) (1-x_1)^{\alpha'} v_1^2 (1-x_2)^{\alpha'} v_2^2 \exp \left( -2\lambda (v_1^2 + v_2^2) \right)
\]

where:
- \( \alpha(t) = 1.08 + 0.25t \) \((\alpha' = 0.25)\)
- \( x_i \) is the momentum fraction of the proton
- \( v_i \) their transverse momentum
- \( k_i \) the outgoing jet momentum
- \( \lambda \sim 4 \text{ GeV}^2 \), the slope of the pomeron-proton coupling
Gluon density in the pomeron

Detector simulation and acceptance

- Fast simulation (shw) of the CDF and D0 central detector

- For dijet CDF measurements: $\bar{p}$ tagged, $0.035 \leq \xi_P \leq 0.095$, $|t| < 1 \text{ GeV}^2$, $0.01 \leq \xi_P \leq 0.03$ total cross section: $\sigma \sim 14.4 nb$, CDF: 43.6 nb, we scale our cross section to the CDF measured one.

- Resolution and acceptance for Higgs predictions:
  - $\xi$ resolution: 0.2 %
  - $t$ resolution: $0.1 \sqrt{t}$
  - $\xi$ acceptance: 100% if $\xi > 0.04$, 0% if $\xi < 0.01$, linear between 0 and 100% if $0.01 < \xi < 0.04$
  - $t$ acceptance: $|t| \leq 0.5 \text{ GeV}^2$
CDF dijet mass fraction

- **Yellow:** $xG +$ diquarks with radiation (fully simulated)

- **Dashed line:** $xG +$ diquarks without radiation (fully simulated)

- **Dotted line:** $xG +$ diquarks without radiation (generator level)

- **Conclusion:** Radiation needed..., good description of CDF data
CDF dijet mass fraction

Entries 3141
Higgs and $b\bar{b}$ distributions

![Graphs showing distributions of $e(1)$ and QQ smeared mass, as well as $(etjet1+etjet2)/2$.](image)
Energy and angle distributions for Higgs

- **Entries:** 40286
- **Entries:** 39271
- **Entries:** 40286
- **Entries:** 39271
- **Entries:** 17398
**H mass reconstruction (missing mass method)**

- **Missing mass method**: perfect method to reconstruct Higgs mass: \( M_H = \sqrt{\xi_p \xi_{\bar{p}} S} \)

modified to take into account loss of energy in detectors and radiation

\[
M_H = \sqrt{\xi_p \xi_{\bar{p}} S \cdot \frac{E_{\text{jet1}} + E_{\text{jet2}} + E_p + E_{\bar{p}}}{2E_{\text{beam}}}}
\]

- Mass method with much worse resolution with radiation
H mass reconstruction (missing mass method)
### Number of Higgs events for $1 fb^{-1}$ after shw

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<th>$M_{Higgs}$</th>
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<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
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<td>0.0</td>
<td>0.0</td>
<td>2.9</td>
</tr>
</tbody>
</table>

- **(1):** generator level
- **(2):** detected in roman pots ($b\bar{b}$ channel)
- **(3):** + at least two jets of 30 GeV $p_T$
- **(4):** $\tau$ channel
- **(5):** $W^+W^-$ channel

- $H \rightarrow \tau^+\tau^-$ and $H \rightarrow W^+W^-$ at high mass with almost no background
Conclusion

• **New generator** ready to get diffractive events in double pomeron exchange

• Results compared to CDF data in run I: **dijet mass fraction** in good agreement if one allows radiation (inclusive jet and Higgs production)

• **Higgs cross section promising** (about 2-5 events per $fb^{-1}$ at Tevatron run II) for a mass between 100 and 140 GeV, very nice and clean process

• Price to pay the high cross sections: **missing mass method** not working so nicely

• **Other promising channels** to be studied with this relatively high cross sections: $\tau$ and $W^+W^-$ Higgs decays, which are almost background free
Outlook

- **Full simulation:** needed to get a precise prediction

- **Comparison with other models:** Our model is based on a non perturbative calculation by Bialas-Landshoff, which works to describe the dijet mass fraction. However, other models lead to much lower cross sections. Needs to be understood and studied in more detail.

- **LHC:** Clearly an important topic for LHC as well, with higher cross sections, pot installation studies in CMS in progress