On behalf of the Single Top Analysis Group

F. Canelli, C. Ciobanu, S. Budd, T. Junk, Y. Kemp, Th. Müller, S. Richter, B. Stelzer, W. Wagner, Jeannine Wagner, T. Walter

CDF Collaboration Meeting
Barcelona, 6/1/2005

- B-Tagging with NN
- Plug electrons with NN
- Check of Production Model
Motivation for Improvements

Single top publication:

- \textit{b-tag using SecVtx}: $\approx 50\%$ of non-top BG from $W + c/uds$
  $\Rightarrow$ Increase purity with improved \textit{b}-tagging

- \textbf{Central $e$}: $|\eta(e)| < 1.1 \approx 70\%$
  $\Rightarrow$ Increase acceptance including plug electrons

- \textit{Signal modeling}:
  $\Rightarrow$ Comparison between NLO and standard MC

Single top signature:
- $W + \text{Jets}$
- 1 high $p_T$ lepton, high missing $E_T$
- $\geq 1$ \textit{b}-jet
### B-Tagging With a Neural Net

**Svenja Richter, Wolfgang Wagner**

#### Non-top BG Fraction (After SecVtx-Tag)

<table>
<thead>
<tr>
<th>Non-top BG</th>
<th>Fraction [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Wb\bar{b}$</td>
<td>33</td>
</tr>
<tr>
<td>$Wc\bar{c}, Wc$</td>
<td>24</td>
</tr>
<tr>
<td>$Wuds$</td>
<td>26</td>
</tr>
<tr>
<td>Non-W</td>
<td>14</td>
</tr>
<tr>
<td>Di-boson</td>
<td>3</td>
</tr>
</tbody>
</table>

- 50% of non-top BG from charm or light quarks

**New B-Tagging exploits:**
- Large lifetime (also used by SecVtx)
- High mass of $b$-hadrons
- High decay probability into leptons
- High track multiplicity

Combination of 23 quantities (relevance $> 4.5\sigma$) in a NN (NeuroBayes)

Correlations between quantities are exploited
Example of Used Quantities

Different shapes for $b$-signal and BG

(Version 5.3.3)

Data are described by the MC

(incl. $e$ sample used)
Use sample composition according to BG estimation

Optimization on $S/\sqrt{BG}$

$\Rightarrow$ cut on NN output of $> -0.2$

<table>
<thead>
<tr>
<th>NN output</th>
<th>cut efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$&gt; -0.2$</td>
<td></td>
</tr>
<tr>
<td>single top</td>
<td>90    signal</td>
</tr>
<tr>
<td>$tt, Wb\bar{b}$</td>
<td>88   b-like BG</td>
</tr>
<tr>
<td>$Wc/uds$</td>
<td>40    non-b BG</td>
</tr>
<tr>
<td>$\sum BG$</td>
<td>67</td>
</tr>
</tbody>
</table>

$\Rightarrow$ Expected purity increase for single top $\approx 35\%$

Good Separation
Scale Factor for Neural Net Efficiencies

- Select $b\bar{b}$ sample: (incl. 8 GeV $e$ sample)
  - 1 high $p_T$ $e$ near jet (SecVtx-Tag)
  - Use jet (SecVtx-Tag) opposite in $\phi$ for NN

⇒ Scale factor: $1 \pm 0.05$
Plug Electrons Using a Neural Net

Yves Kemp, Wolfgang Wagner

- Use same quantities as in cut based selection
- Combine quantities in NN
- Exploit correlations between quantities

- e-Signal: Z events
- BG: 2 jet events
- 1 very well measured central e/jet; e cand. in Plug

Good separation

(Version 4.11 used)

Sig., BG normalised to equal area

$\varepsilon_{\text{NN}}^{\text{Sig.}}, \varepsilon_{\text{NN}}^{\text{BG}}$ can be optimized, eg. $S/\sqrt{BG}$
Performance of NN for $W+\text{Jets}$ Events

- Determine signal fraction from fit to MET for different NN outputs

**W+2jets** (used for single top)

![Graph showing MET vs. number of signal and background events]

- $\sim 6\%$ more signal
- Same BG
- Same signal
- 20\% less BG

**Optimisation e.g. on $S/\sqrt{BG}$ possible**
Check of Single Top Production Model

**Jan Lück, Wolfgang Wagner**

**Single top:** \( t \to bW \)

- **s-channel** (no problem)
- **t-channel**

**Pythia:**

- \( 2 \to 3 \) process not simulated (t-channel)
- \( \Rightarrow \) Modeling of 2nd \( b \) wrong

**MadEvent:**

- \( p_T^{2ndb} \leq 10 \text{ GeV: } 2 \to 2 \)
- \( p_T^{2ndb} > 10 \text{ GeV: } 2 \to 3 \)
  (current 5.3.3 official samples)

**Comparison with NLO calculation?**

CDF Collaboration Meeting: June 2005

J. Wagner, Universität Karlsruhe
Matched MadEvent versus NLO (ZTOP)

- Good Qualitative agreement between MadEvent and NLO
  ⇒ Matching works

- Will use comparison to derive syst. error on model uncertainty
  (so far obtained from dev. between TopRex and MadEvent)
Summary and Outlook

Working on several improvements for single top analysis:

- **NN for $b$-tagging (based on SecVtx-Tag):**
  - Estimated purity increase for single top $\approx 35\%$
  - Scale factor for NN output cut efficiency: $1 \pm 0.05$
  - **Outlook:** Development of a NN without SecVtx-Tag req. (e.g. useful for events with $\geq 2$ b-jets)

- **Acceptance increase using Plug $e$ ($|\eta(e)| > 1.1 \approx 30\%$):**
  - NN: 20% less QCD BG for same signal ($W+2$jets)

- **Check of single top production model:**
  - Good agreement between matched MadEvent and NLO
  - **Outlook:** Use deviations between MadEvent and NLO to derive syst. error on model uncertainty