Prospects of measuring the CKM matrix element $|V_{ts}|$ at the LHC

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Motivation

Summary of Tevatron results:

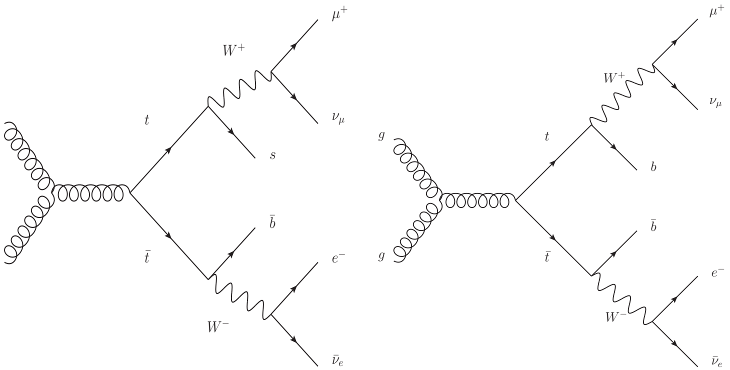
- top mass at $\sim 1\%$
- top pair cross section at $\sim 10\%$
- single top cross section observed ===> $|V_{tb}| > 0.79$ at 95% CL

$$V_{\rm CKM} \equiv \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} .$$

In the Wolfenstein Parametrisation, this matrix is expressed as

$$V_{\rm CKM} \simeq \begin{pmatrix} 1 - \frac{1}{2}\lambda^2 & \lambda & A\lambda^3(\rho - i\eta) \\ -\lambda(1 + iA^2\lambda^4\eta) & 1 - \frac{1}{2}\lambda^2 & A\lambda^2 \\ A\lambda^3(1 - \rho - i\eta) & -A\lambda^2(1 + i\lambda^2\eta) & 1 \end{pmatrix} ,$$

where A, λ, ρ and η are the Wolfenstein parameters.
In the SM $|V_{ts}| = 0.041 \pm 0.001$

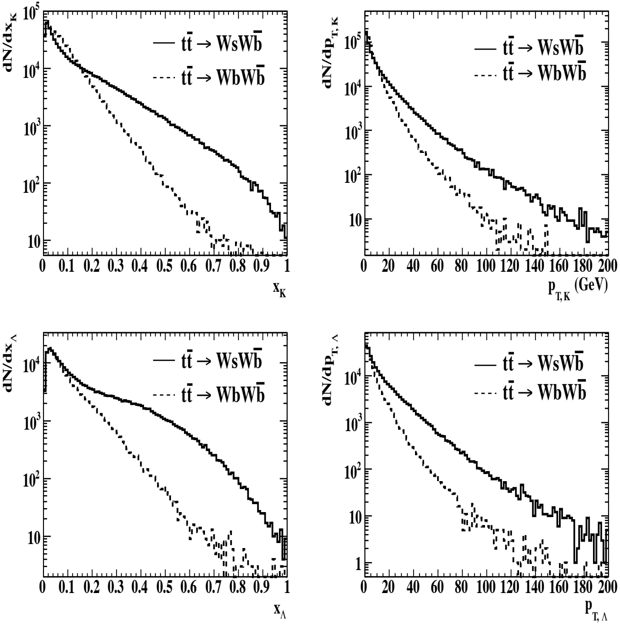


To distinguish between **s**− (signal) and **b**−jets (background) look at

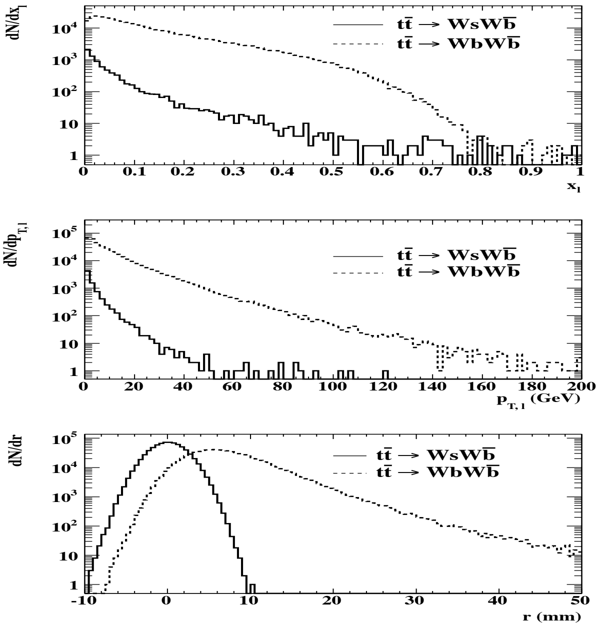
- K_s^0 and Λ production, leading (soft) in **s**− (resp. **b**−) jets
- soft leptons present (absent) in **b**− (resp. **s**−) fragmentation
- secondary vertices associated to **b**−jets

To this end we have generated 1M events with PYTHIA 6.4 with $|V_{ts}| = |V_{tb}| = 0.5$.

Strange particle production

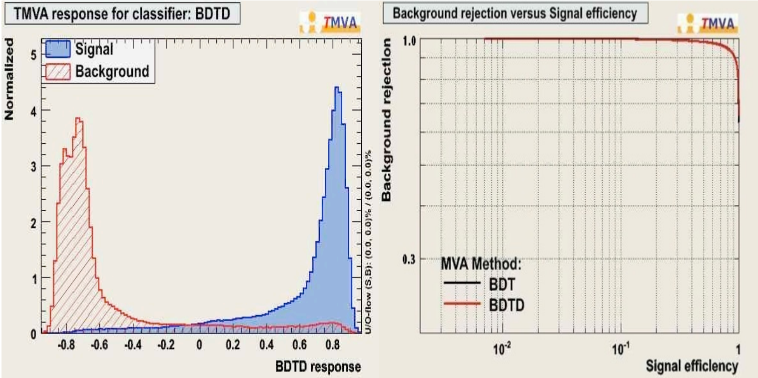


Soft leptons and secondary vertex distributions

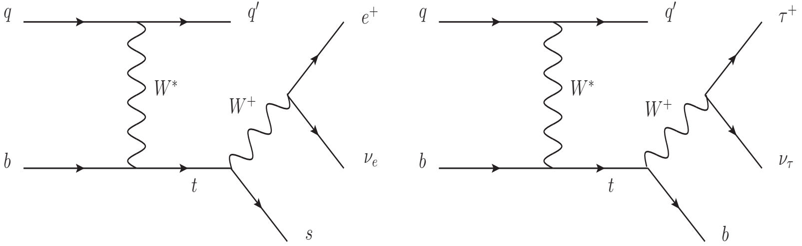


Efficiency vs background rejection in the $t\bar{t}$ case

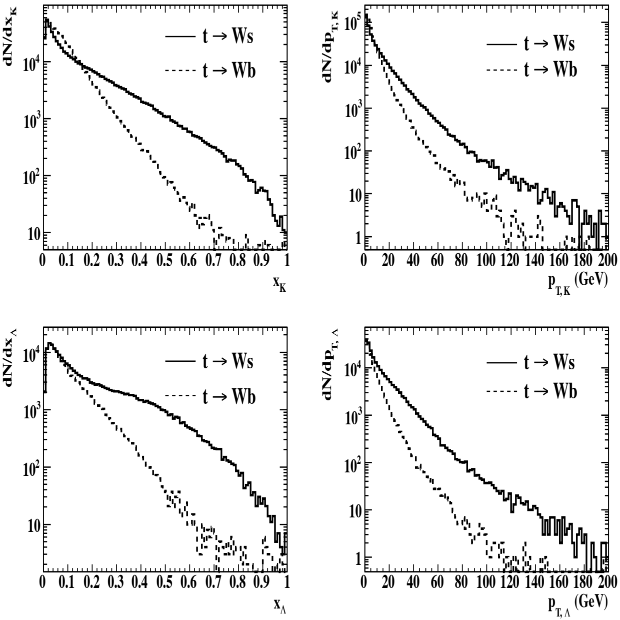
We have trained a BDT algorithm in the TMVA framework with the distributions shown above. The BDT response as well as the ROC curves (Signal efficiency versus background rejection) are shown below.



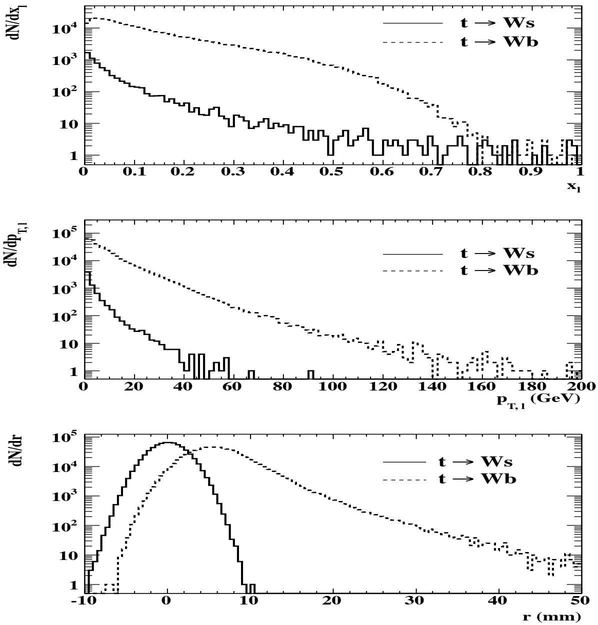
Single top production has also being studied.



Strange particle production in single top



Soft leptons and secondary vertex distributions in single top



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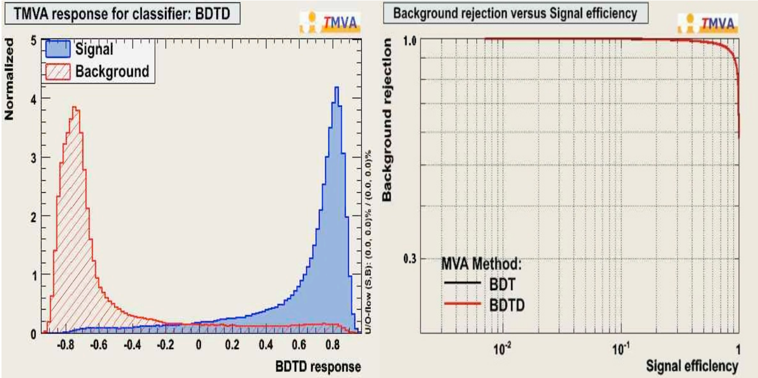

TMVA results in 5% efficiency for s-tagging with 10^3 b-jet rejection.
Oversimplified exercise for an integrated luminosity of 10 fb^{-1} at $\sqrt{s} = 14\ TeV$ taking $\sigma(t\bar{t}) \sim 1nb$:

- Number of signal events: $0.05 \times 2 \times 1.7 \times 10^{-3} \times 10^6 = 170$ events
- Number of back events: $10^{-3} \times 10^6 = 1000$ events

Expected significance $S = \frac{170}{\sqrt{1000}} \sim 6\sigma$.
Similar excercise for single top gives $S = \frac{100}{\sqrt{1000}} \sim 3\sigma$.
At 7 TeV scale down by factor of two for the same luminosity.

Outlook

Need to do a more realistic analysis with ATLAS full simulation events.
Aim:

- Short and medium term: set limits
- Longer term: do a measurement