Top Quark at a Linear Collider

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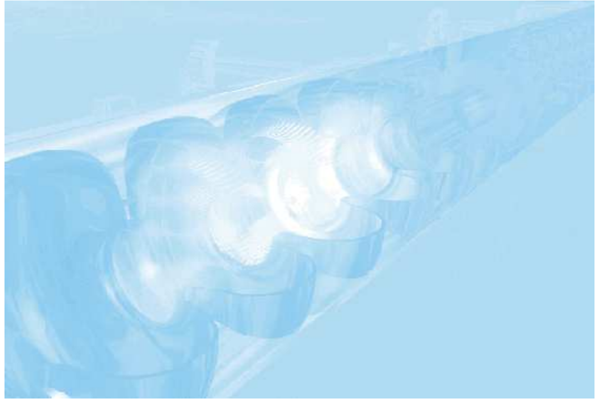

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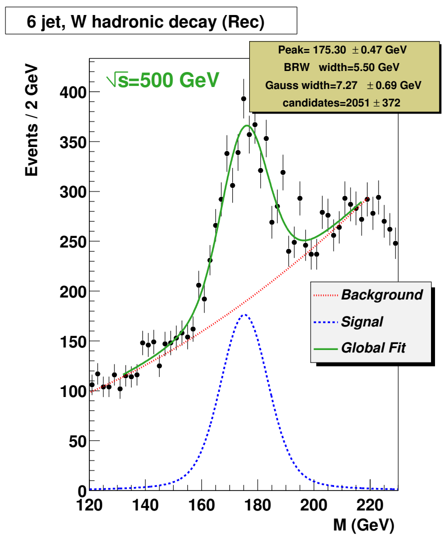
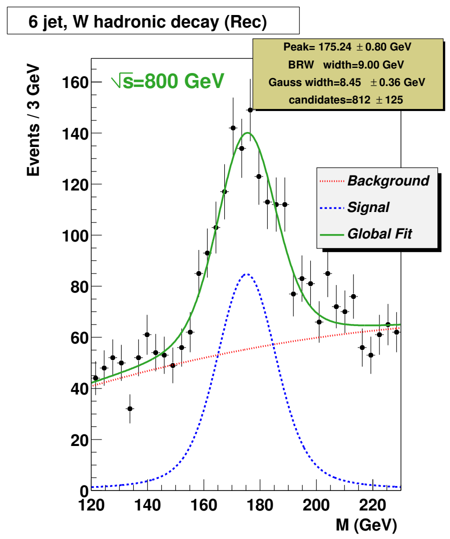
Introduction



Recall 6-jet analysis results



PYTHIA, $\sqrt{s} = 500$ GeV	δm_t (GeV)	BRW width (GeV)	Gaussian width (GeV)
Generator	0.030	9.5 ± 0.4	-
Reconstructed	0.105	9.5 (fixed)	5.0 ± 0.2

PYTHIA, $\sqrt{s} = 800$ GeV	δm_t (GeV)	BRW width (GeV)	Gaussian width (GeV)
Generator	0.04	7.7 ± 0.4	-
Reconstructed	0.230	7.7 (fixed)	9.5 ± 0.4

Study $e^+e^- \to t\bar{t} \to 4\ jets\ +\ e^\pm\ /\ \mu^\pm\ +\ \nu_e\ /\ \nu_\mu$ at 500 and at 800 GeV.

This analysis does not use:

- kinematic refitting
- b-tagging

Use as much as possible fully simulated events in the analysis:

- all signal events are fully simulated and fully reconstructed
- background is generator level with detector smearing applied

Selection criteria

1. **Find and skip** *(from further jet finding)* **a lepton with momentum more than 20 GeV.**
   Very efficient to suppress background.

2. **Force the event into 4 jet topology.** *(Durham jet finder algorithm, with* $Y_4 > 2 \times 10^{-4}$*,*
   Y_4 *is the value of YCUT for which the event flips from 5 to 4 jet configuration.)*

3. **Form 3-jet clusters from the 4 jets.** *(Four possible contributions).*

4. **Select 3–jet cluster if the invariant mass of any 2 jets is within** $|M_{jj} - M_W| <$ **15 GeV.**

Monte–Carlo samples

PYTHIA 6.2

e^+e^- events at $E_{CM} = 500\ GeV\ (800\ GeV)$

- **270k PYTHIA inclusive** $e^+e^- \to (\gamma, Z) \to$ everything **events (without top quarks) after E-Flow smearing.**
- **9.6k** $e^+e^- \to t\bar{t} \to$ everything events **with full detector simulation and reconstruction using BRAHMS 306.**

Input values: Top mass = 175 GeV, width = 1.39 GeV.

Statistics corresponds to $\sim$ 20 days of accelerator running.

- ISR and first level QCD corrections are included as well as Bose-Einstein correlations.
- Parameters of E-Flow smearing for continuum events:

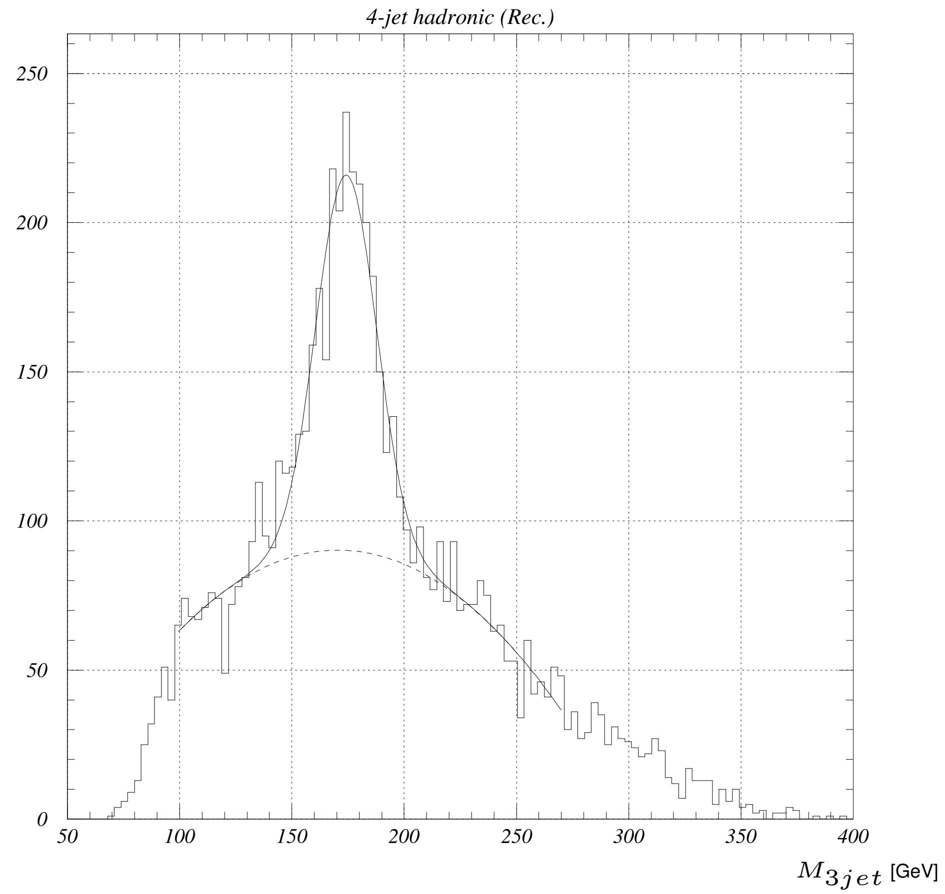
$$\sigma_{ch.hadr.} \approx 10^{-4} E^2_{ch.hadr.} \ ; \ \sigma_\gamma \approx 0.12\sqrt{E_\gamma} \ ; \ \sigma_{neut.hadr.} \approx 0.4\sqrt{E_{neut.hadr.}}$$

Cuts:

$E_{lepton} >$ 20 GeV, $\Delta_{Y_4} > 2 \cdot 10^{-4}$, $|M_{jj} - M_W| < 15$ GeV.

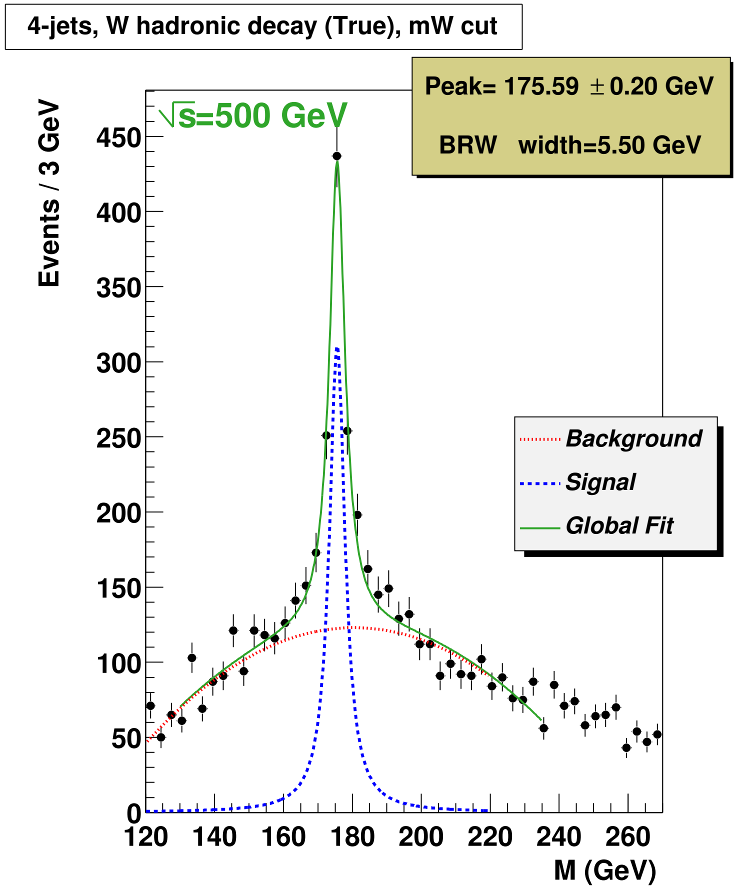
Background shape

Full detector simulation of $t\bar{t} \longrightarrow$ everything events.

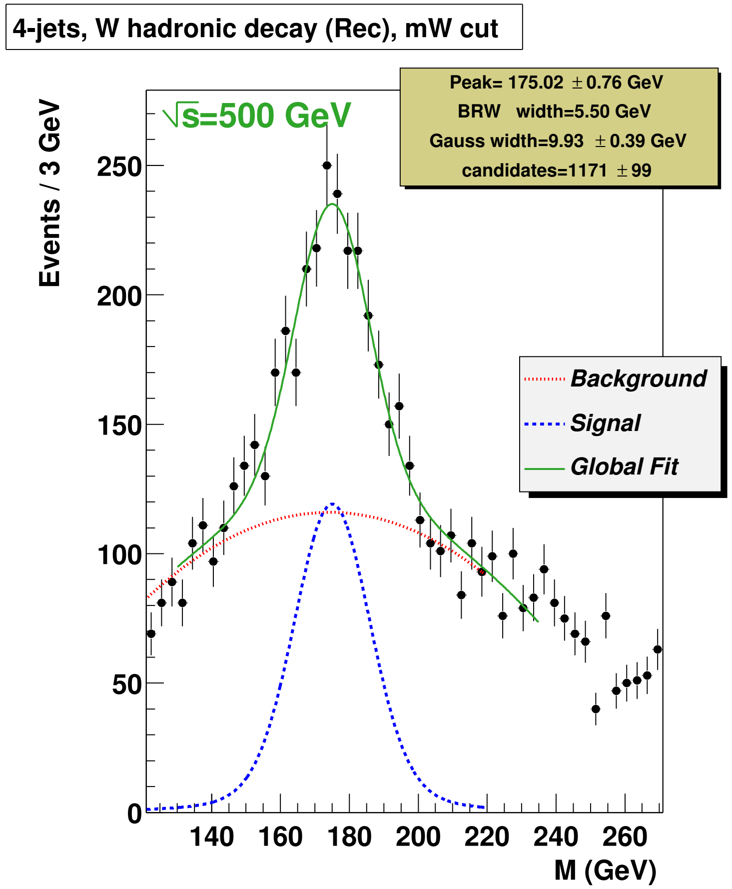


Shape for combinatoric background was chosen as second–order polynomial in range 120 – 230 GeV.

Overview 4–jets, hadronic decay W

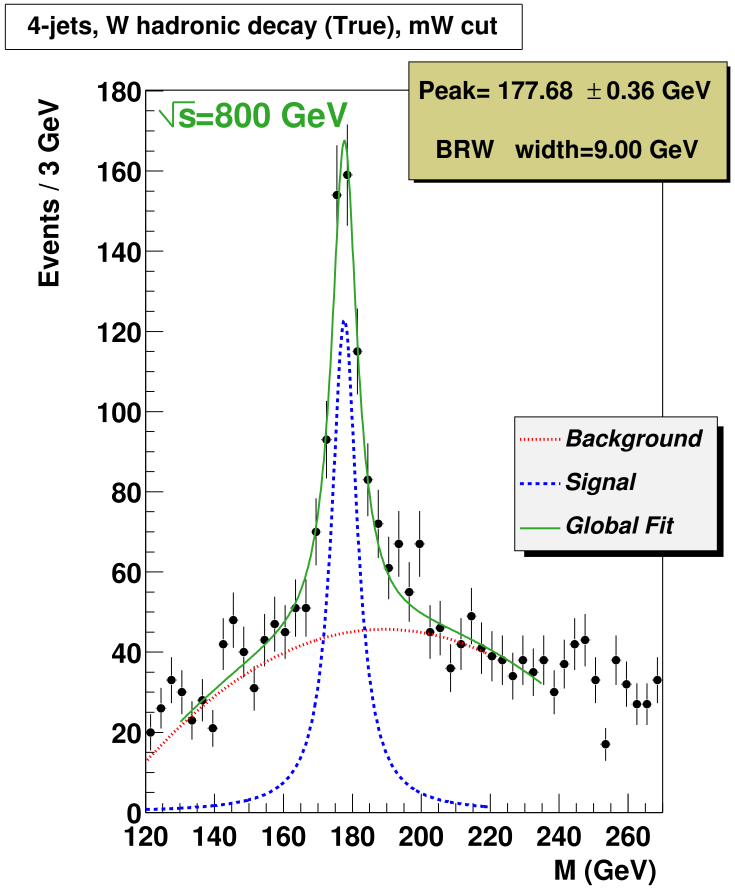


True events

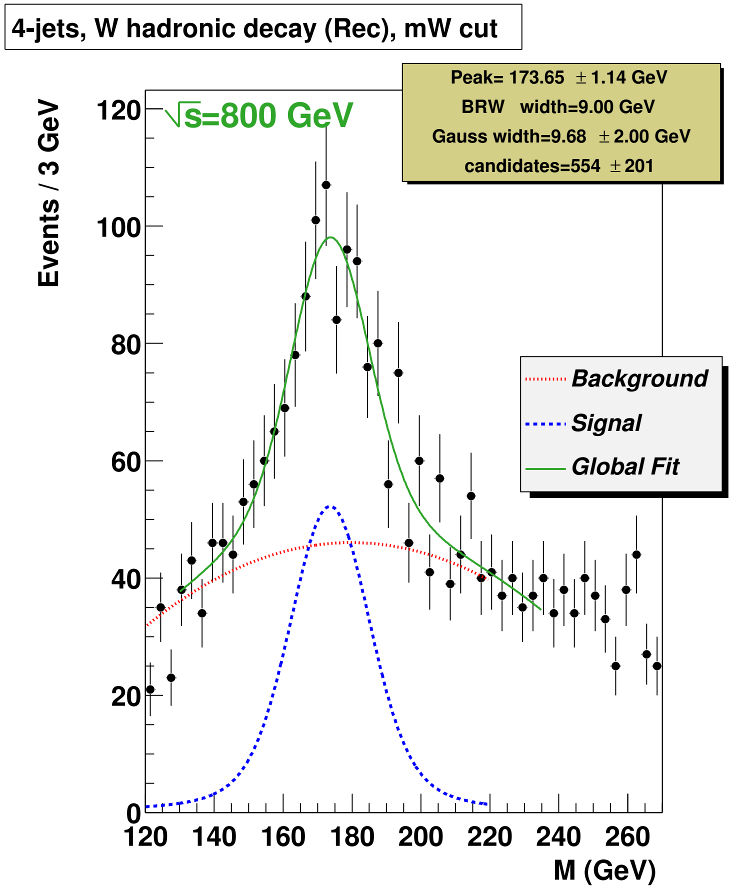


$t\bar{t}$ events only

Overview 4–jets, hadronic decay W



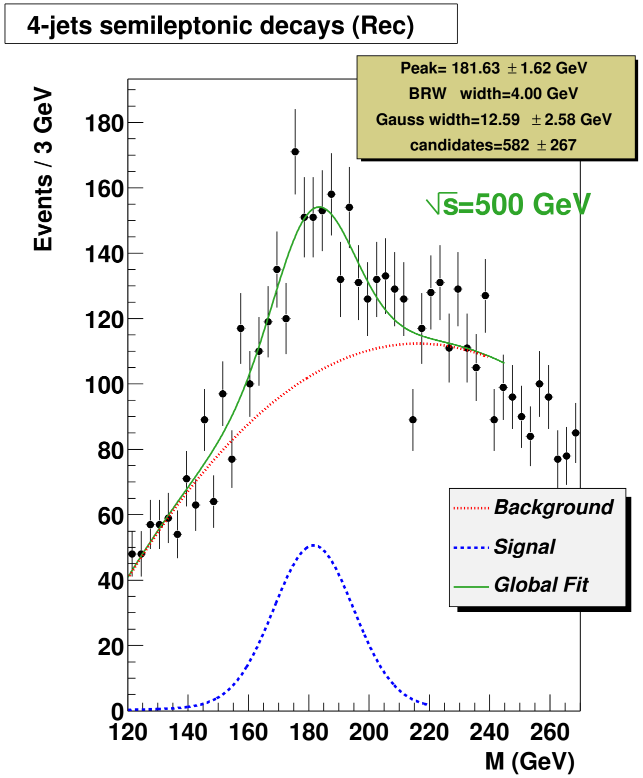
True events



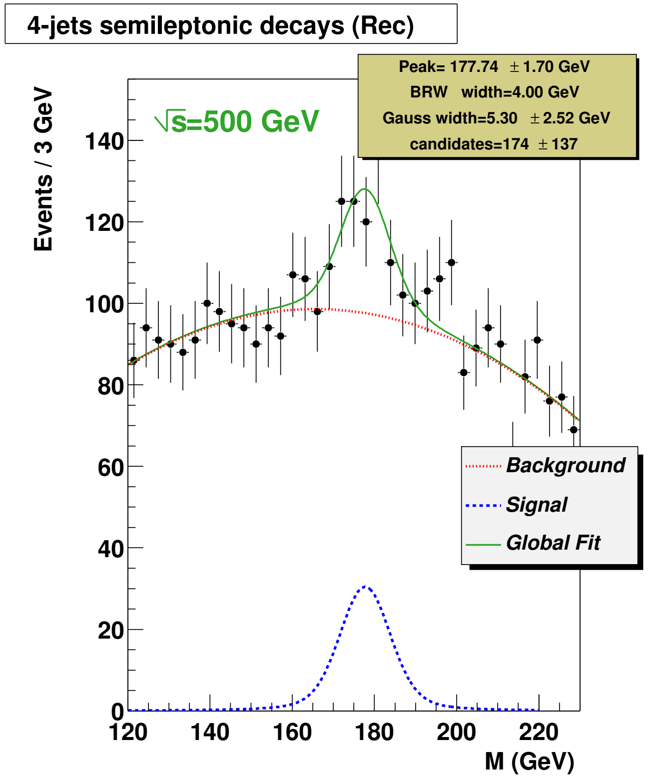
$t\bar{t}$ events only

Attempt to reconstruct neutrino momentum

using missing momentum and energy.



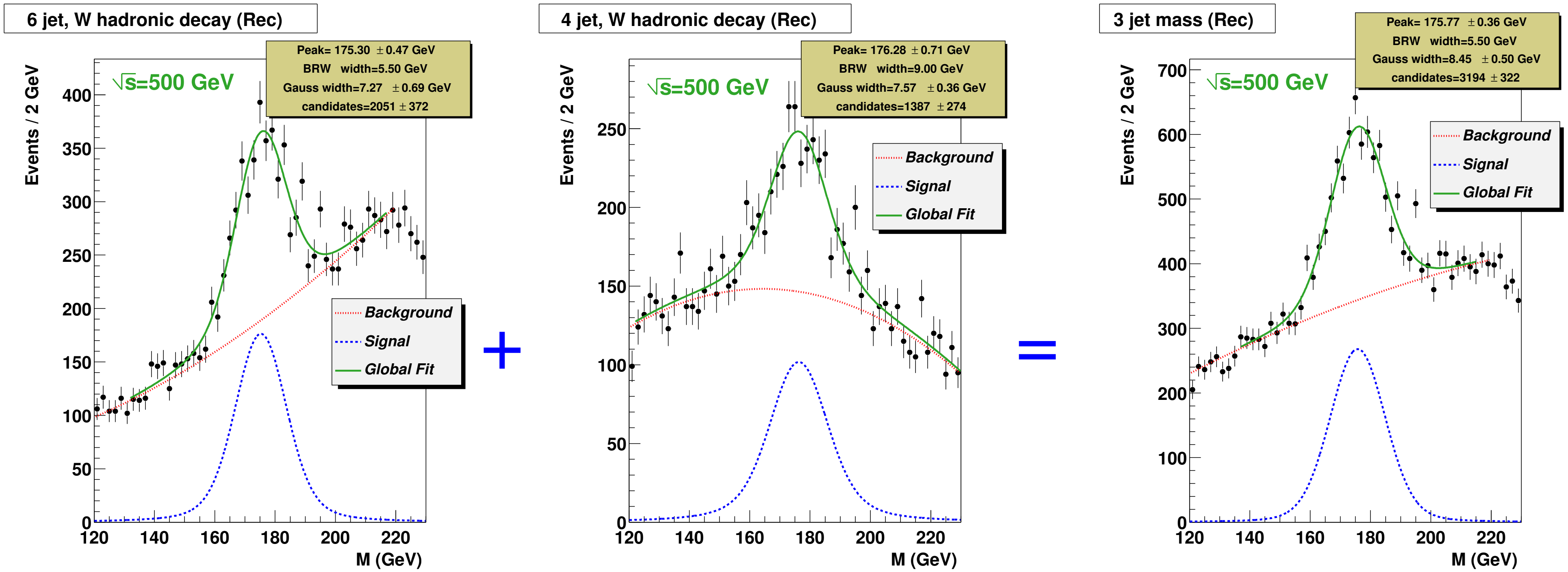
$t\bar{t}$ events only



$t\bar{t}$ events plus continuum background

Too big mass width due to the whole detector errors are included, as well as any additional neutrinos in event.

Sum up of all channels (4 jet + 6 jet) at 500 GeV

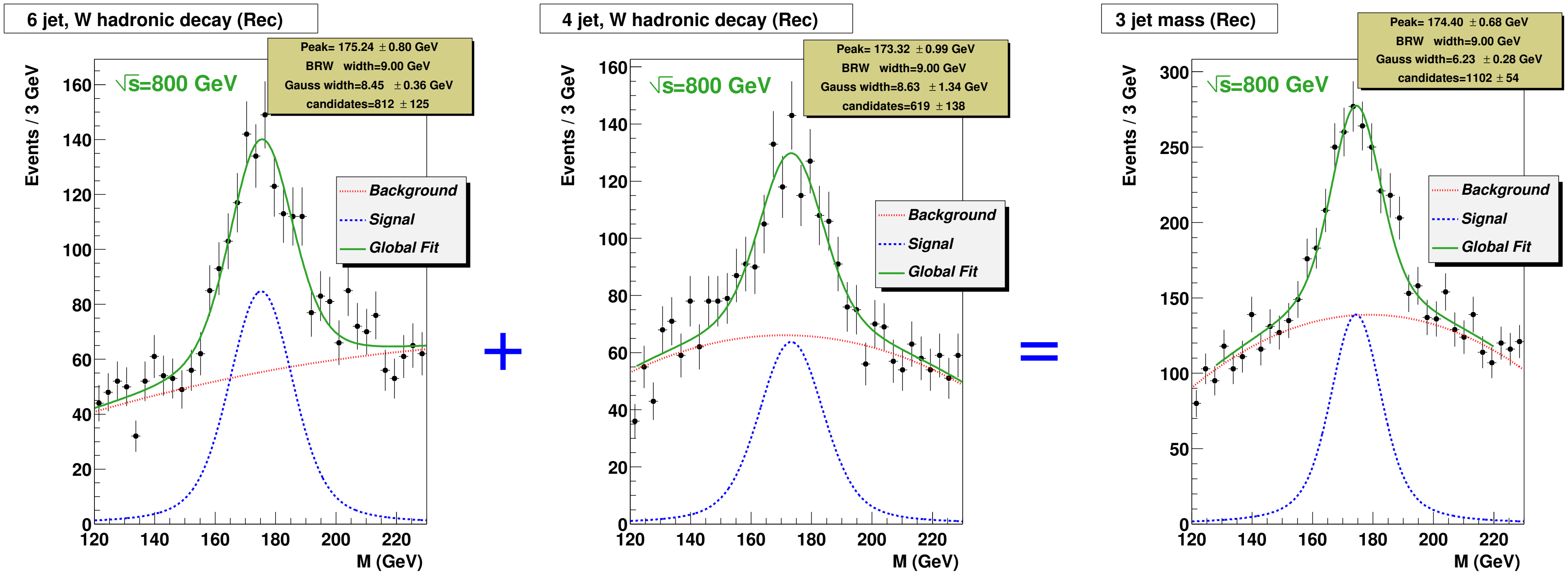


Efficiency $\approx$ 36 % Signal/Background $\approx$ 0.24 (in window 175 ± 35 GeV)

PYTHIA, $\sqrt{s} = 500$ GeV	δm_t (GeV)	BRW width (GeV)	Gaussian width (GeV)
Generator	0.030	5.5 ± 0.4	-
Reconstructed	80 MeV	5.5 (fixed)	8.45 ± 0.5

The statistical uncertainties on the top-mass measurement assuming an integrated luminosity of 300 fb^{-1} for e^+e^- annihilation events at $\sqrt{s} = 500$ GeV.

Sum up of all channels (4 jet + 6 jet) at 800 GeV



Efficiency ≈ 12 % Signal/Background ≈ 0.39 (in window 175 ± 35 GeV)

PYTHIA, $\sqrt{s} = 800$ GeV	δm_t (GeV)	BRW width (GeV)	Gaussian width (GeV)
Generator	0.04	9.0 ± 0.4	-
Reconstructed	200 MeV	9.0 (fixed)	6.23 ± 0.28

The statistical uncertainties on the top-mass measurement assuming an integrated luminosity of 300 fb^{-1} for e^+e^- annihilation events at $\sqrt{s} = 800$ GeV.

Conclusion

A simple approach to reconstruct the top quark at a linear collider has been proposed for center–of–mass energies far above the top–production threshold.

- Effectively suppresses the QCD multi-jet background
- Does not require a b–tagging for all channels, and W mass knowledge for 6 jet channels
- Has a good efficiency ($\simeq$ 36 % at 500 GeV) for QCD studies of top reconstruction, ($\simeq$ 12 % at 800 GeV)
- Statistical error $\sim$ 300–400 MeV for 20 days of data taking (at 800 GeV uncertainties about twice as large)

Future plan

Develop the model independent search of top quark branching ratios.

$\Rightarrow$ **needs a jet flavour tagging algorithm** $\tau,\ b, c, \ldots$

as well as a relativistic model of vertex detector

and full simulation