Top production: $e^+e^- \to t\bar{t} \to$6 jets

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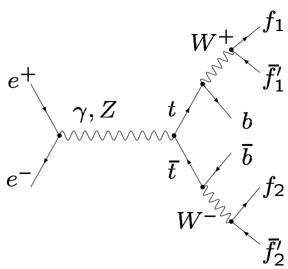
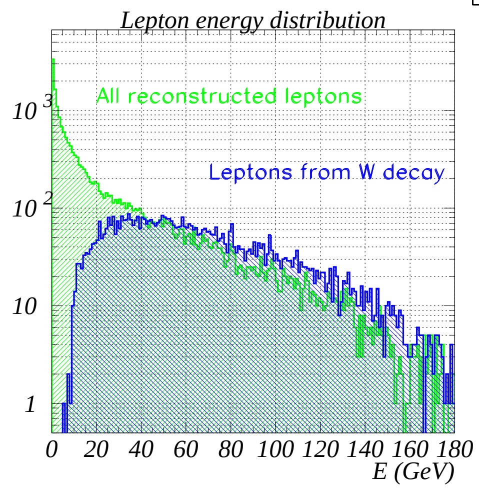
- $e^+e^- \to t\bar{t}$
- **Mass of top quark**
- **KtJet package (C++) @ MARLIN**
- **Summary and outlook**

$e^+e^- \rightarrow t\bar{t} \rightarrow 6jets$

$e^+e^- \longrightarrow t\bar{t} \longrightarrow b\bar{b}\,W^+W^-$ in PYTHIA



Type	b-jet	W-jet/lepton	W-jet/lepton	N jets	N ν	Prob.
1	2b	2q	2q	6	0	45.60 %
2	2b	2q	τ	5	1	14.625 %
3	2b	2q	e	4	1	14.625 %
4	2b	2q	μ	4	1	14.625 %
5	multi lepton events					10.56 %



Semileptonic decay of W–boson is rejected if one or more lepton with $E_{lept.} \geq 20$ GeV exists.

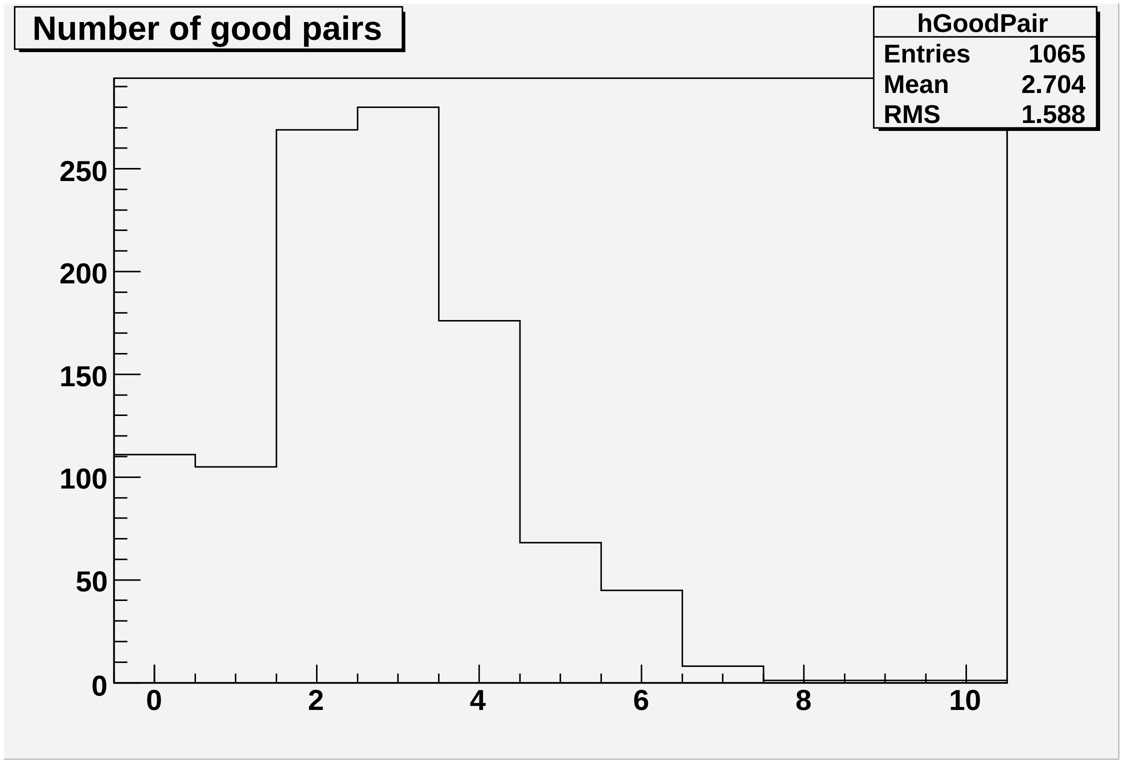
$e^+e^- \rightarrow t\bar{t} \rightarrow$6 jets @ 500 GeV

- **Work on top reconstruction @ Linear Collider**
  - **hep-ex/0301014: S. V. Chekanov and V. L. Morgunov**
  - **hep-ex/9910065: Masako Iwasaki**
  - **. . . . .**
- **Inprovement @ this work**
  - **We follow method in hep-ex/0301014**
  - **For LDC00Sc model**
  - **PFA: PandoraPFO, there are a few bugs in the creation of PFOs from this version of PandoraPFA.**
  - **C++ k_t jet finder: KtJet package in Marlin**
  - **Jet pairing and Kinematic fitting (underway)**
- **Vassilly Morgunov: PYTHIA 6.3 Monte Carlo samples @ ILC Data Samples**
  - **Top mass 178 GeV and with 1.484 GeV**
  - **MSTP(61) = 0: Main ISR switcher is OFF**

$e^+e^- \rightarrow t\bar{t} \rightarrow$6 jets

- **We follow the method in paper hep-ex/0301014**
- **Event selection: reject events with a significant fraction of neutrinos**
  - **hadron level: stable particle in the generator, remove neutrinos and particle in beam pipe ($TMath :: Abs(\cos(\theta)) < 0.995$)**
  - **detector level: particle flow objects**
  - $|E_{vis}/\sqrt{s} - 1.0| < 0.07$
  - $\frac{|\sum \vec{p}_{//i}|}{\sum |\vec{p}_i|} < 0.04$
  - $\frac{|\sum \vec{p}_{Ti}|}{\sum |\vec{p}_i|} < 0.04$
  - **jets number $\geq$ 6 @ $y_{cut} = 0.0002$ (Durham jet finder) then force events to have 6 jets for top reconstruction**
- **Six jets $\Longrightarrow$ $C_6^3/2 = 20/2 = 10$ pairs (pair: two 3-jet groups) per event**
  - $|M_{jjj}^A - M_{jjj}^B| < 40.0$ **GeV** $|\vec{p}_{jjj}^A + \vec{p}_{jjj}^B| < 20$ **GeV**

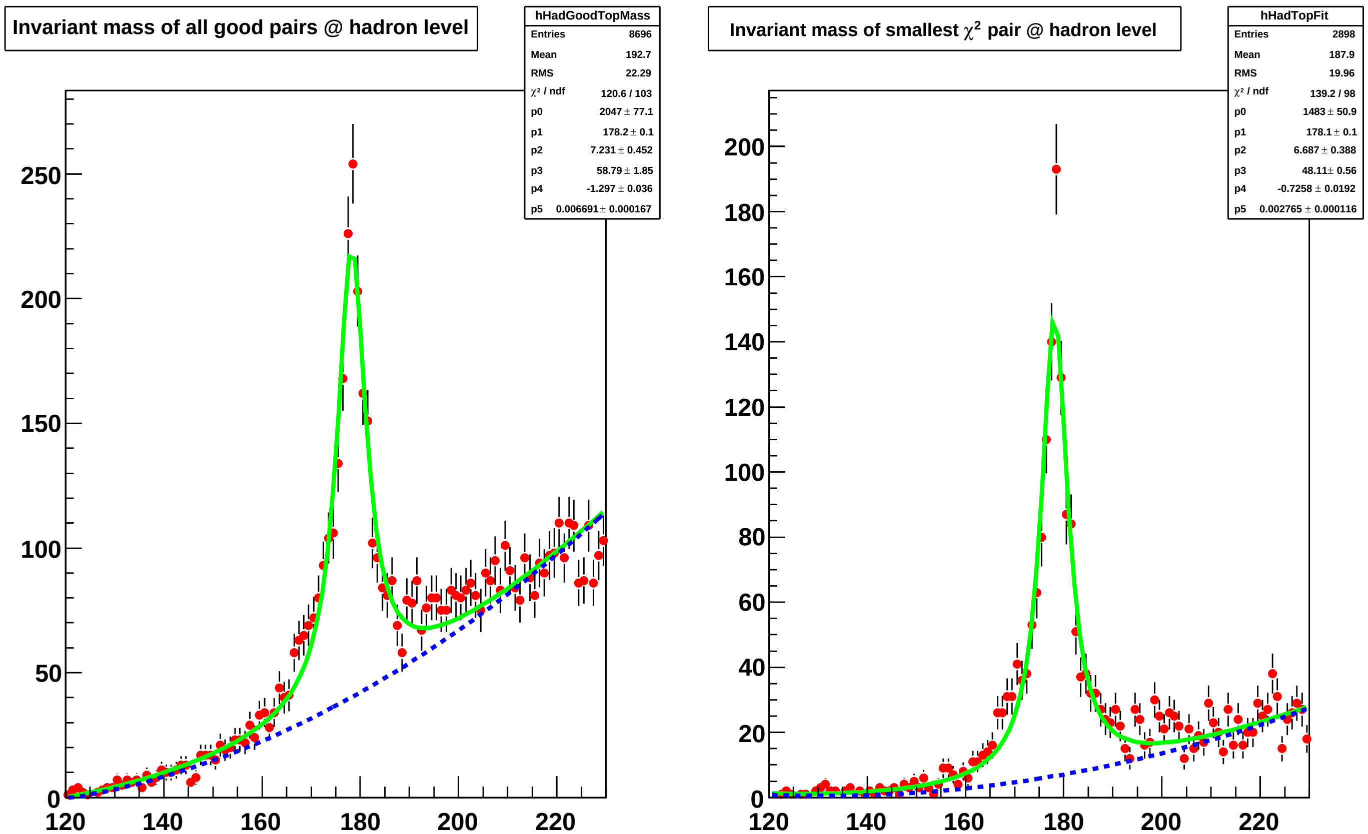
Jet pairing



- **We define $\chi^2 = (M^A_{jjj} - M_t)^2 + (M^B_{jjj} - M_t)^2$ (simple), and find the minimal χ^2 for each pair.**

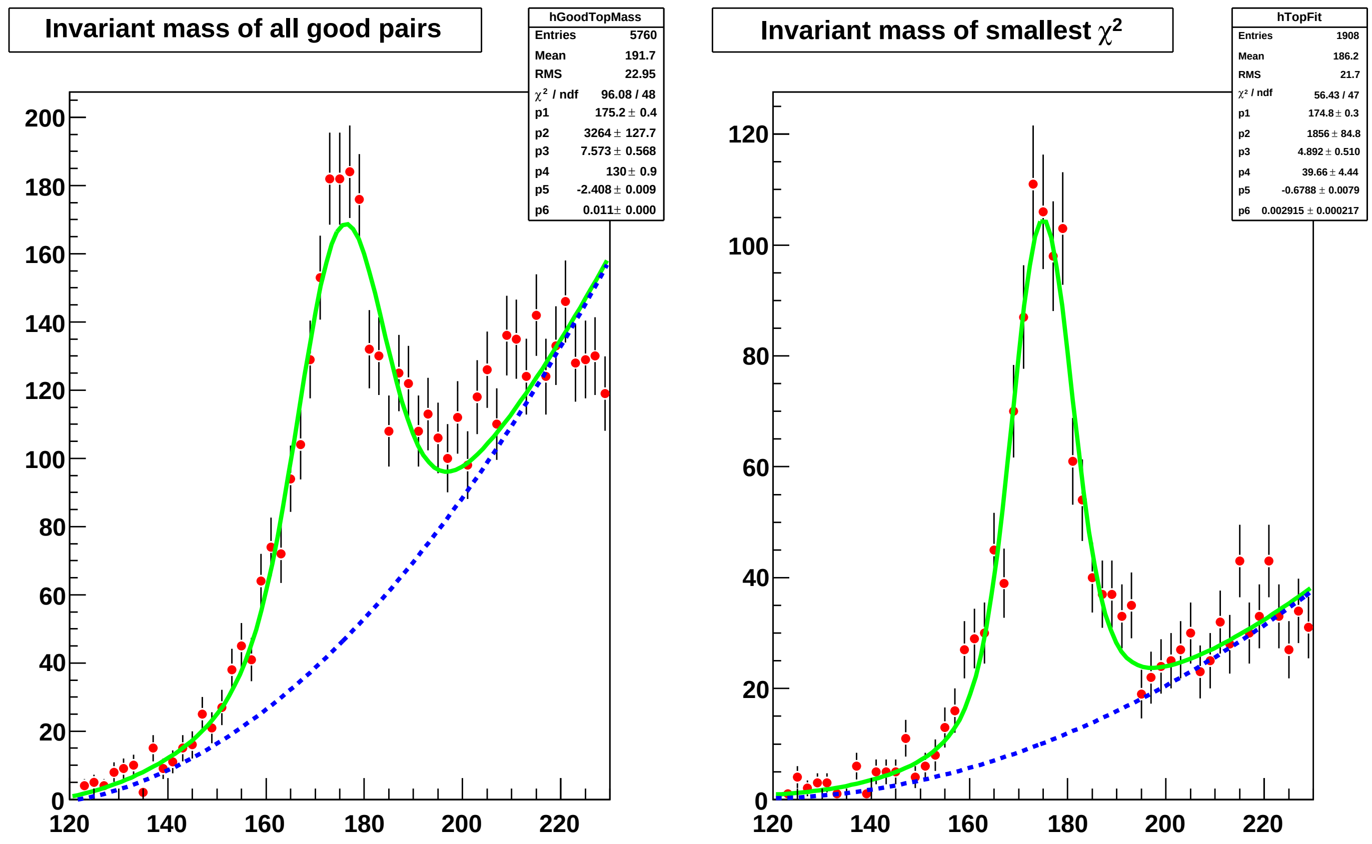
- **We choose smallest χ^2 for all good pairs in one event**

$e^+e^- \to t\bar{t}$ @ hadron level



- **Breit-Wigner fitting: mean ~ 178 GeV and width $\sim 7.2/6.7$ GeV, we fix the width of Breit-Wigner in top mass reconstruction at detector level**

$e^+e^- \to t\bar{t}$ @ detector level



- **Breit-Wigner $\oplus$ Gaussian convolution function fitting: mean $\sim$ 175 GeV, detector simulation has $\sim 7.6/4.9$ GeV Gaussian spread of top mass resolution**

Kt jet finder: KtJet package in C++

- **Jet finder @ MARLIN**
  - **Satoru jet package from OPAL in FORTRAN**
  - **Durham jet finder**
    - $d_{kl}^2 = 2\min(E_k^2, E_l^2)(1 - cos\theta_{kl})$
    - **E-scheme:** $E_{kl} = E_k + E_l \quad \vec{p}_{kl} = \vec{p}_k + \vec{p}_l$
- **KtJet package in C++: Comp. Phys. Comm. 153 (2003) 85-96**
  - **When are two objects combined into one object ?**
    - **Jet resolution variables**
  - **How are two objects combined into one object ?**
    - **Recombination schemes**
  - **Adding new schemes: possible**
- **Run KtJet package into Marlin ?**

KtJet package: Jet resolution variables

Taken from KtJet Package: Comp. Phys. Comm. 153 (2003) 85-96

- **Angular scheme:**

$$d_{kB} = 2E_k^2(1 - cos\theta_{kB}), \qquad d_{kl} = 2\min(E_k^2, E_l^2)(1 - cos\theta_{kl}).$$

- **ΔR scheme:**

$$d_{kB} = p_{tk}^2, \quad d_{kl} = \min(p_{tk}^2, p_{tl}^2)R_{kl}^2, \quad R_{kl}^2 = (\eta_k - \eta_l)^2 + (\phi_k - \phi_l)^2.$$

- **QCD emission scheme:**

$$d_{kB} = p_{tk}^2, \quad d_{kl} = \min(p_{tk}^2, p_{tl}^2)R_{kl}^2$$

$$R_{kl}^2 = 2[cosh(\eta_k - \eta_l) - cos(\phi_k - \phi_l)].$$

KtJet package: Recombination schemes

Taken from KtJet Package: Comp. Phys. Comm. 153 (2003) 85-96

- E **scheme** **Simple 4-vector addition:** $p_{kl} = p_k + p_l$
- p_t **scheme** $p_{t(kl)} = p_{tk} + p_{tl}, \quad \eta_{kl} = \frac{p_{tk}\eta_k + p_{tl}\eta_l}{p_{t(kl)}}, \quad \phi_{kl} = \frac{p_{tk}\phi_k + p_{tl}\phi_l}{p_{t(kl)}}.$

  This definition constrains only the 3 spatial components of the object's 4-vector. The energy is made equal to to the magnitude of its 3-momentum.
- p_t^2 **scheme** $p_{t(kl)} = p_{tk} + p_{tl}, \quad \eta_{kl} = \frac{p_{tk}^2\eta_k + p_{tl}^2\eta_l}{p_{tk}^2 + p_{tl}^2}, \quad \phi_{kl} = \frac{p_{tk}^2\phi_k + p_{tl}^2\phi_l}{p_{tk}^2 + p_{tl}^2}.$
- E_t **scheme** $E_{t(kl)} = E_{tk} + E_{tl}, \quad \eta_{kl} = \frac{E_{tk}^2\eta_k + E_{tl}^2\eta_l}{E_{tk}^2 + E_{tl}^2}, \quad \phi_{kl} = \frac{E_{tk}^2\phi_k + E_{tl}^2\phi_l}{E_{tk}^2 + E_{tl}^2}.$

KtJet package: $t\bar{t}$ events @ hadron level

- **KtJet package in Angular scheme and E scheme and Durham jet finder Because both jet finder have same defintions, these two jet finder should have SAME results, and the results confirm this points**

- **For ttbar events at hadron level, KtJet package in E scheme has smallest fitted Breit-Wigner width, and the fitted Breit-Wigner mean value is consistent with true value. For the Et scheme, Et^2 scheme, Pt scheme and Pt^2 scheme, the fitted Breit-Wigner mean value has a shift.**

- **For Angular scheme, QCD scheme and ΔR scheme, the fitted Breit-Wigner parameters are consistent.**

Summary and Outlook

- We follow the method in hep-ex/0301014 to study top mass reconstruction based on LDC00Sc model and pandora energy flow.
- We could run KtJet package (C++ k_t jet finder) in Marlin
- KtJet finder in Angular scheme and E scheme is best one for top mass reconstruction in $t\bar{t} \to 6$ jets events within KtJet package.
- ToDoList
  - kinematic fitting (underway)
  - jet pairing: χ^2 definition
  - different detector model
  - try b-tagging or $|M_{jj} - M_W| < \Delta_W$
  - try improved version of Pandore PFA

Results @ hep-ex/0301014

- **PYTHIA 6.2 Monte Carlo generator**
  - **Top mass 175 GeV and with 1.39 GeV**
  - **ISR switcher is ON**