Top Production Close to Threshold

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☆ Plan of Talk

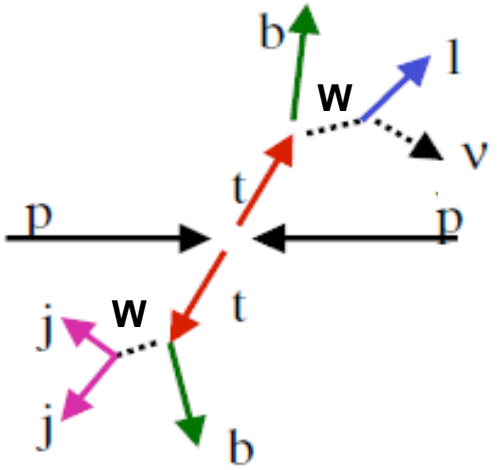
Motivation

- Ref: Top event reconstuction @ Tevatron

Top Production Close to Threshold

- How to compute
- Result

Motivation



Huge top quark sample

Good template for physics case study and understanding detectors.

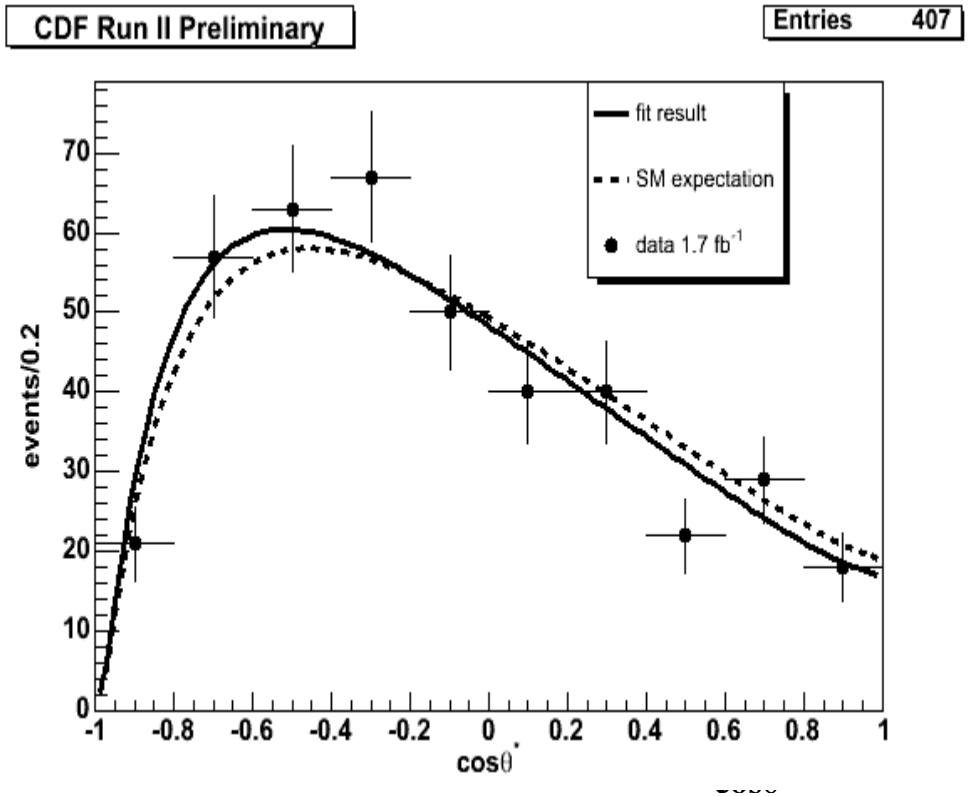
10 fb^{-1}, after cuts

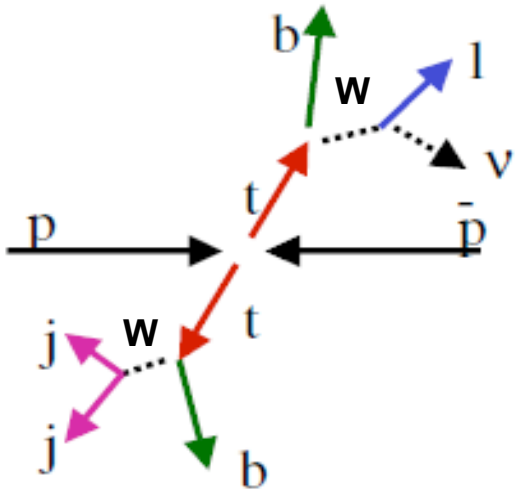
- $\ell + 4$ jets
  (with at least 1b-tag) 8×10^5 $t\bar{t}$
- dilepton mode
  (without b-tag) 8×10^4 $t\bar{t}$
  (with at least 1b-tag) 6×10^4 $t\bar{t}$

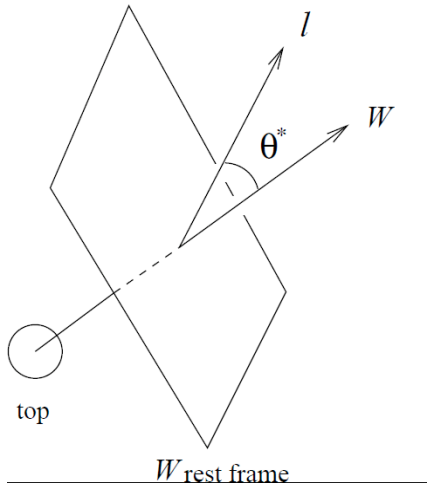
Reference: Top event reconstruction @ Tevatron

Kinematical reconstruction using likelihood fitting

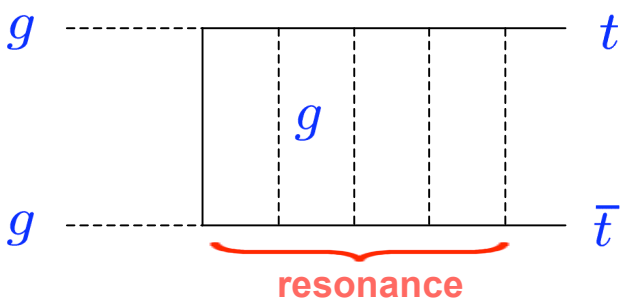
lepton+4jet mode, 1 or 2b tag

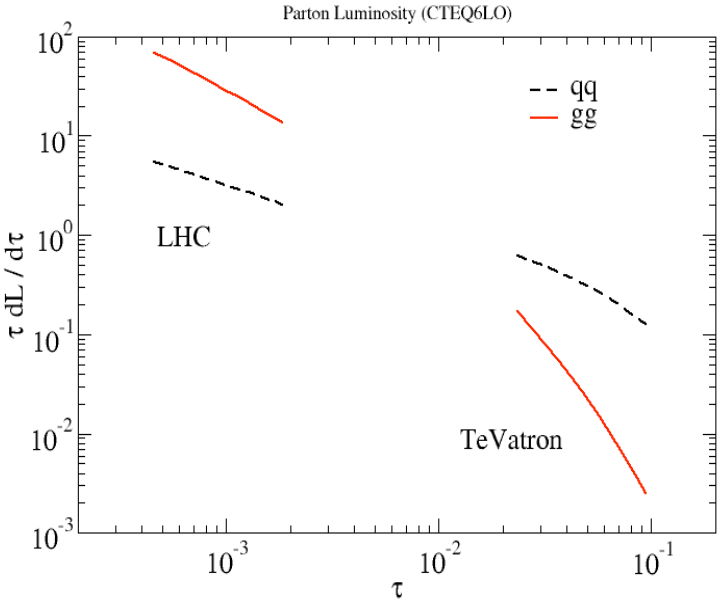






$t\bar{t}$ Production Close to Threshold





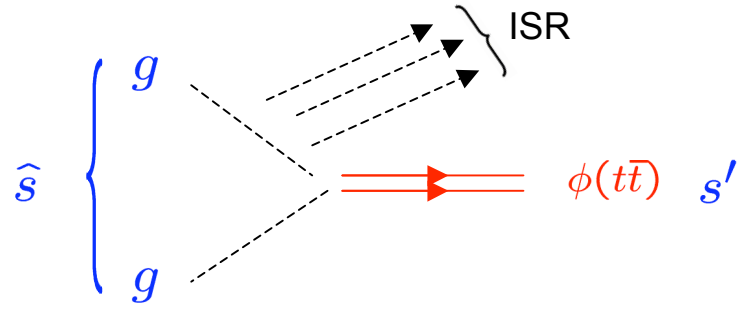
Dominant resonance contribution

$J = 0, \quad CP = -$; color singlet

$(L = 0, \ S = 0)$

Effective operator $\epsilon^{\mu\nu\rho\sigma} G_{\mu\nu} G_{\rho\sigma} \, \phi(t\bar{t})$

How to compute top production cross section



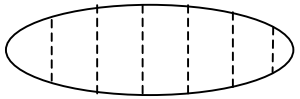
ISR and boundstate effects factorize:

$$\hat{\sigma}(\hat{s})_{\mathrm{ISR}+\phi(t\bar{t})} = \int ds'\,\sigma(s')_{gg\to\phi(t\bar{t})} \times \Big[\delta(1-\frac{s'}{\hat{s}}) + \int \frac{d^3\vec{k}}{(2\pi)^3 2k^0} C_A\, 4\pi\alpha_s \frac{2k_1\cdot k_2}{(k_1\cdot k)(k_2\cdot k)} \delta(1-\frac{s'}{\hat{s}}-\frac{2k^0}{\sqrt{\hat{s}}}) + \cdots\Big] \times \underbrace{\big(1+C_{\mathrm{hard}}\,\alpha_s\big)}_{\text{Hard vertex corr.}}$$

ISR Dawson

where boundstate effects are included in

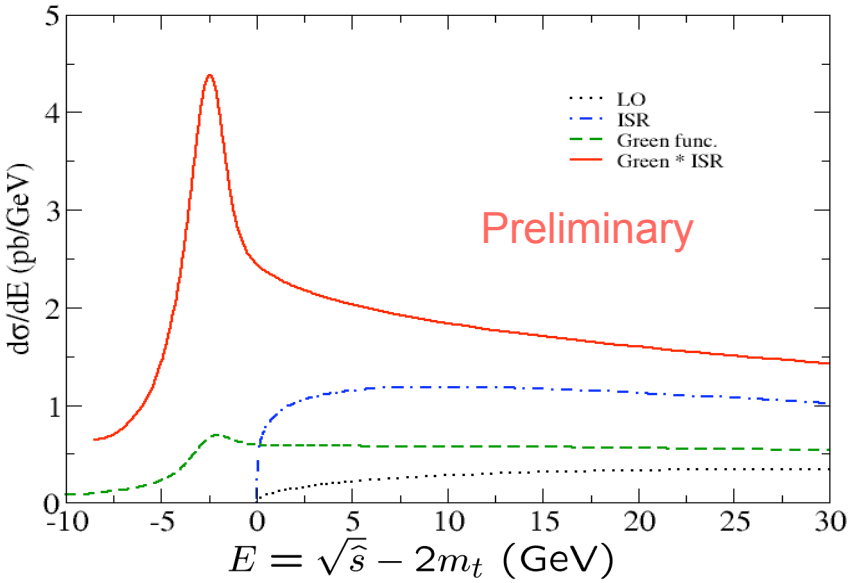
$$\sigma(s')_{gg\to\phi(t\bar{t})} \propto \mathrm{Im}\, G(0; E'+i\Gamma_t) \quad ; \quad E' = \sqrt{s'} - 2m_t$$

Green fn  resums $c_0 + c_1\big(\frac{\alpha_s}{\beta'}\big) + c_2\big(\frac{\alpha_s}{\beta'}\big)^2 \cdots$ Fadin, Khoze

Then convolute with gluon PDF

Result

LHC, gg, color-singlet, spin-0 Yokoya



$$\sigma(s)_{pp\to t\bar{t}}\big|_{\text{singlet,spin0}} = \int dE\, \frac{d\sigma}{dE}$$

$$\frac{d\sigma}{dE} = \underline{\frac{dL}{dE}}\, \hat{\sigma}(\hat{s})_{\text{ISR}+\phi(t\bar{t})} \quad ; \quad \hat{s} = \tau\, s,\ E = \sqrt{\hat{s}} - 2m_t$$

Gluon luminosity fn

Rem: Top momentum distr. is also strongly distorted by boundstate effects at E<0.

Y.S., Fujii, Hagiwara, Murayama, Ng

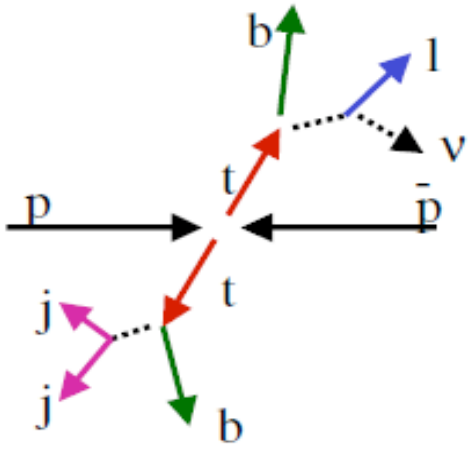
Kühn, Jeżabek, Teubner

Reference: Top event reconstruction @ Tevatron

Kinematical reconstruction using likelihood fitting Tsuno,Tanaka,Nakano,Y.S.

5 free params:

Energy of jets (4), boost vector (1)



Likelihood function :

$$L = \underbrace{\prod_{i=1}^{4} P^{i}_{E_T}(E_T^{obs.}, E_T^{i})}_{\text{jet } E_T \text{ response function}} \cdot \underbrace{P_{\Gamma_{W+}} \cdot P_{\Gamma_{W-}} \cdot P_{\Gamma t} \cdot P_{\Gamma \bar{t}}}_{\text{W and top mass constrain with Breit Wigner mass}} \cdot \underbrace{P_{PDF}}_{\text{constrain by PDF } (x_{1(2)}=(E_{CM} \pm Pz_{CM})/2E_{beam})}$$