Simulation of Top Quarks in a Photon Photon Collider

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LCWS99
Sitges

Tohru Takahashi, Katsumasa Ikematsu

Hiroshima University

Motivation

- Rich Physics in top quark production
  - H,A interference,,,

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- How many top can be detected against W pair backgrounds
- Realistic Luminosity distribution
- Detector effect
- Feasibility of top quark reconstruction

How Realistic

- Calculate Luminosity w/ machine parameters
  - PLC as an option of JLC-I
    - same emittance, beam energy etc
      - Eb = 250 GeV
  - Laser
      - λ = 1052 nm, 1J/pluse
  - Polarization for the Electron and the Laser

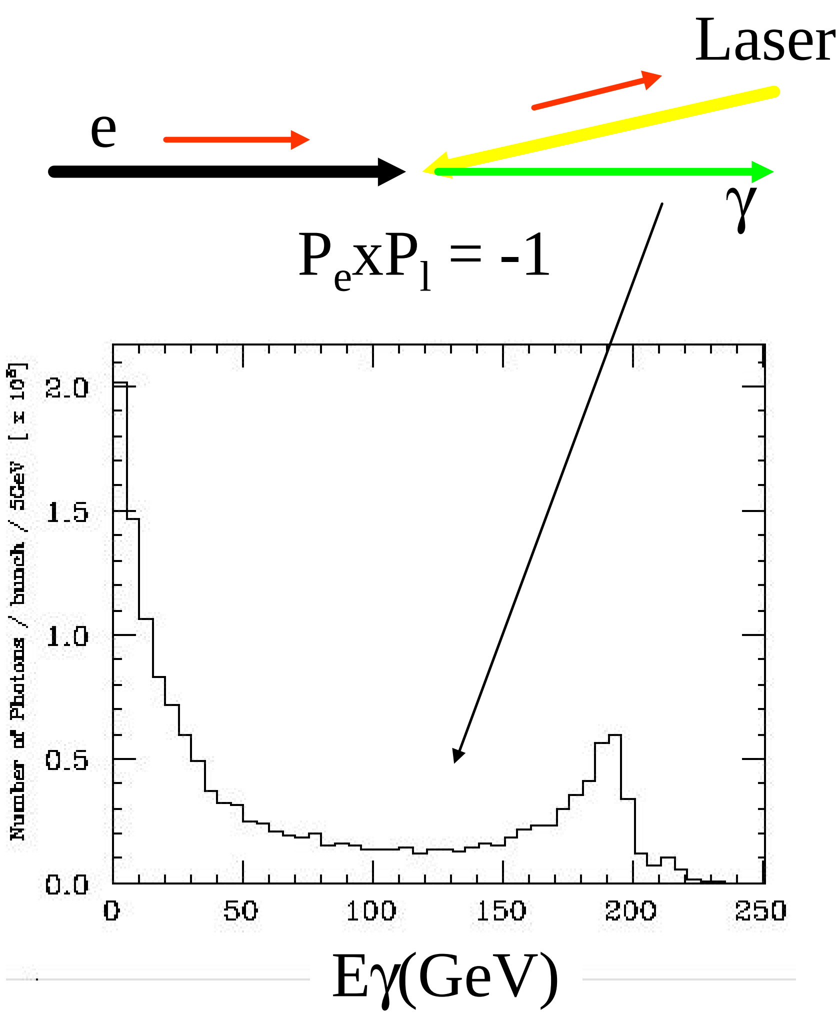
→ •Tools: CAIN

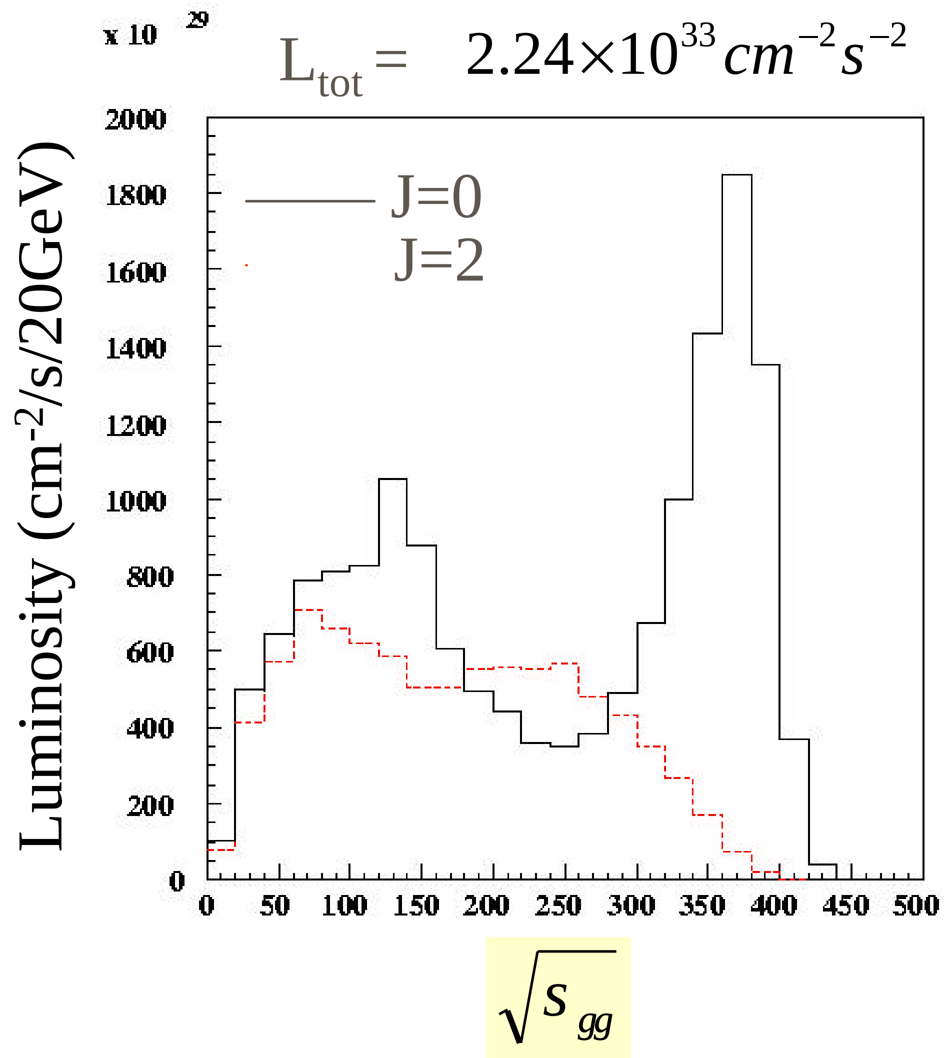
Parameters

e- beam parameters				**Laser parameters**			
Beam energy	E_e	GeV	250	Wave lengtl	λ_L	μm	1.053
Particles/bunch	N		0.63×10^{10}	Pulse energ	E_L	J	1
Repetition rate	f_{rep}	Hz	150	Pulse lengtl	σ_z^L	μm	230
bunches/pulse	n_b		85	Rayleigh ler	$Z_R=4\pi\sigma_0^{L2}/\lambda_L$		120
Bunch length	σ_z	μm	90	r.m.s spot s	σ_0^L	μm	3.17
Bunch size at CP	σ_z^C/σ_y^C	nm	584/56.1	Peask powe	P_d	10^{18}W/cm^2	0.823
Bunch size at IP	σ_x^*/σ_y^*	nm	58.1/8.86	x parameter	$4\omega_L E_e/m_e^2$		4.51
Beta function at IP	β_x^*/β_y^*	mm	0.5/0.8	max. η para	η^2		0.334
Disruption parameter	D_x/D_y		1.68/11.0	Max. photo	$xE_e/(1+\eta^2+x)$	GeV	193
Disruption angle	θ_0	m rad	1.08				
Norm.emittance	$\varepsilon_{xn}/\varepsilon_{yn}$	nm rad	3300/48				
Geom. emittance	$\varepsilon_x/\varepsilon_y$	10^{-12}m rad	6.75/0.0981				
CP-IP distance	d	mm	5				
ρ parameter	$d/(\gamma\sigma_y^*)$		1.15				
Geom. Luminosity	L_{geom}^{ee}	cm^{-2}s^{-1}	7.83×10^{33}				

Luminosity

- Assume 100% Polarization





Double differential luminosity

$\gamma\gamma$ system is not at rest

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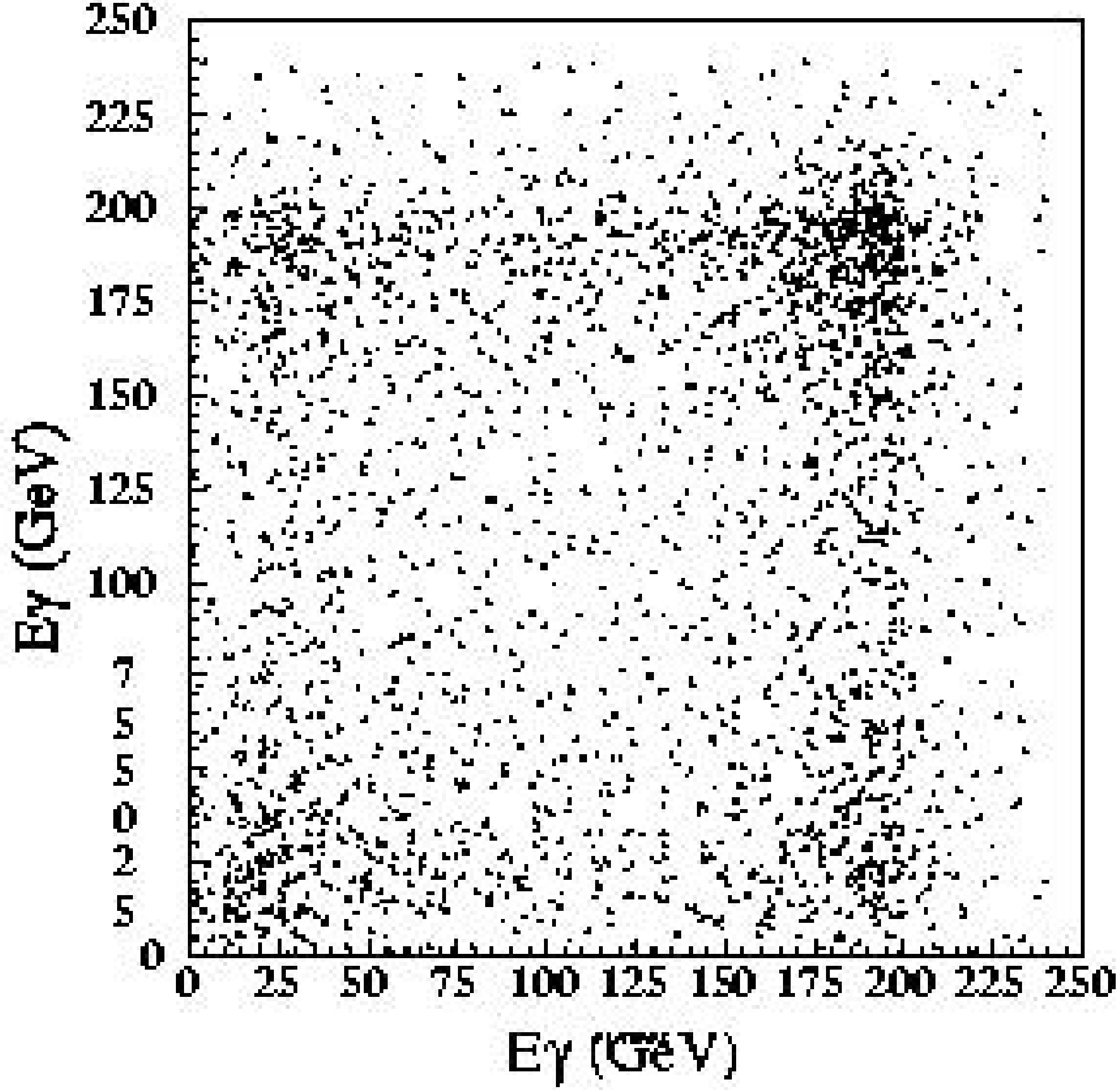
Affect detection efficiency



Production Cross Section

- covolution with the luminosity distribution

$$\hat{s}_{t\bar{t}} \equiv \frac{1}{L_{tot}} \sum_{Jz=0,2} \int \frac{dL^{J}_{gg}}{d\sqrt{s_{gg}}} s_{t\bar{t}}(\sqrt{s_{gg}})\, d\sqrt{s_{gg}}$$

$$\approx 0.17\ pb$$

$$N_{\exp} / year^{*} = \hat{s}\,(\approx 0.17\, pb) \times L / year (= 22.4\, fb^{-1})$$

$$\approx 4000$$

*year = 10^{7}s

Background

W pair Production

$$\hat{s}_{ww} \equiv \frac{1}{L_{tot}} \sum_J \int \frac{dL^J_{gg}}{d\sqrt{s_{gg}}} s^J_{ww}(\sqrt{s_{gg}})\, d\sqrt{s_{gg}}$$

$$\approx 45\,pb$$

1200k/year,,,,,,, 300times larger than tt production

mimic top pair topology

Good for luminosity measurement, anomalous coupling

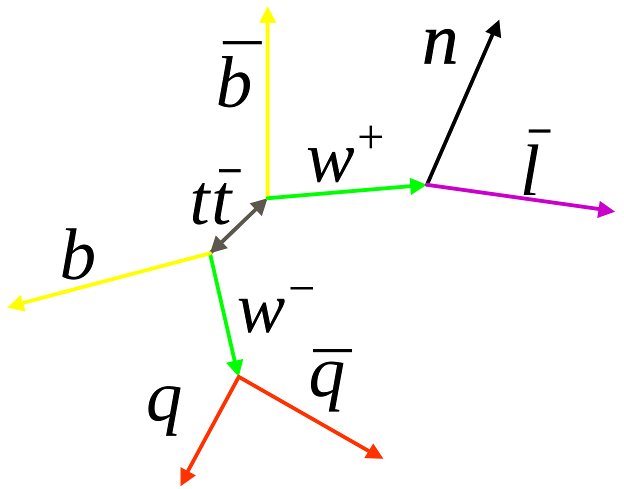
see KEK-Report 97-17, LCWS95 proceedings

Selection w/ JLC-I detector

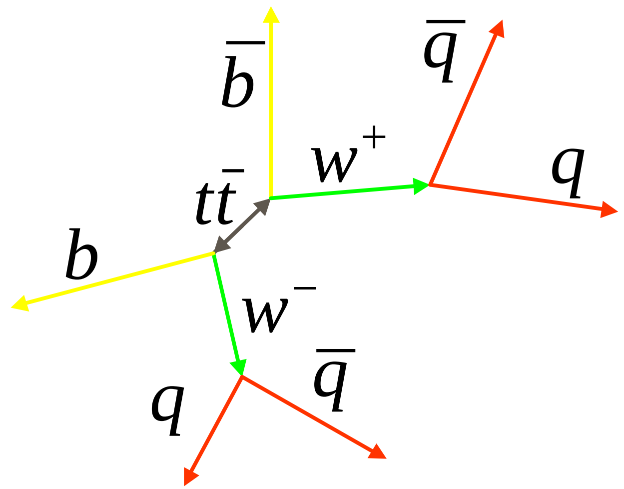
- Lepton + 4 jets
  - clean signature --> charge assignment

6 jets

large branching ratio



branching fraction ~ 29%



branching fraction ~ 46%

→ b tagging is crucial

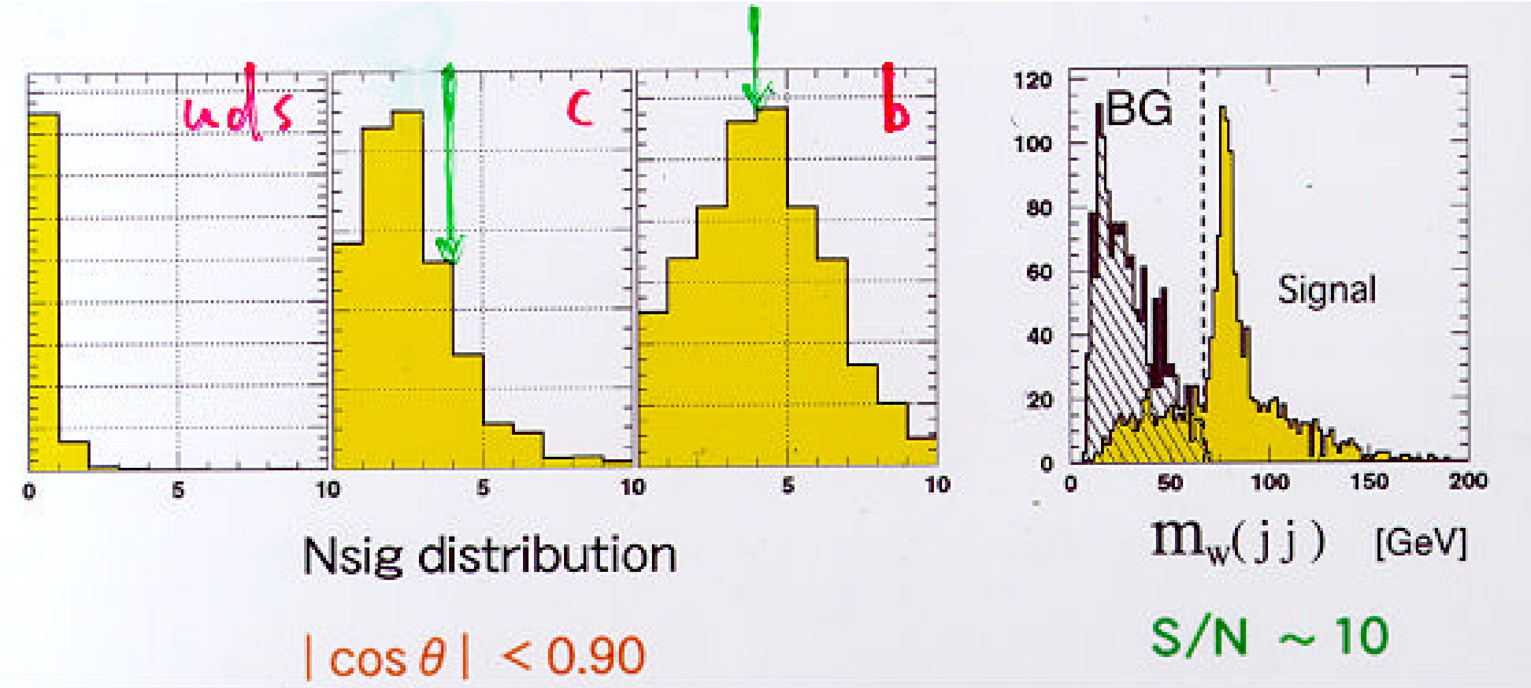
b tagging

impact parameter resolution

$$s_b = 4.4 + 5.5/(p\sin q)^{2/3}$$

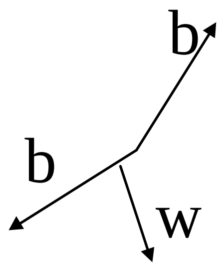
apply impact parameter method

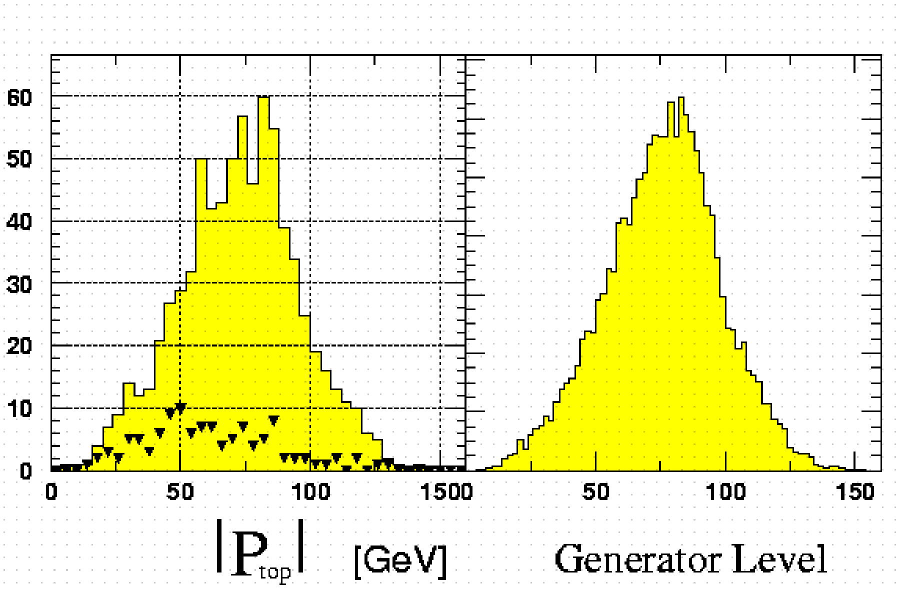
Nsig (# of track of $b/\sigma_b > 3$) →

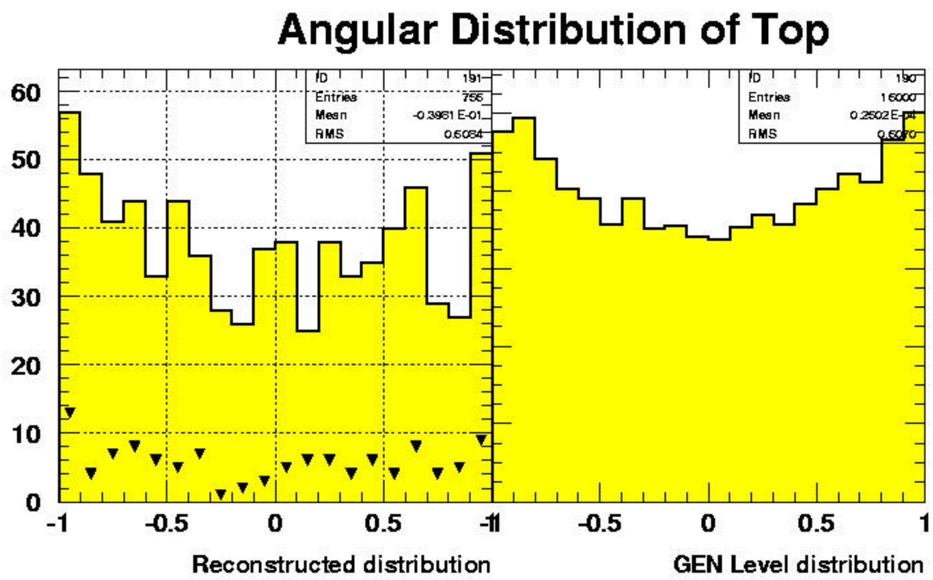


Results

- selection efficiency
  - 9% (360/year) for lepton + 4jets
  - 15.6% (620/year) for 6jets
  - total 28.8% (980/year)
- Toward precise measurement







Summary

- 980 event/year with $\gamma\gamma$ collider of JLC option against huge ww background
  - 360 for lepton + 4 jets
  - 620 for 6jets
- $\gamma\gamma$ system is not at rest but looks ok for event selection
- precise measurement, needs more study but some hints