Measurement of Top-Yukawa coupling at ILC

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TILC09 2009.04.19

Two pillars of Standard Model

$\mathcal{L}_{BSM}$

$\mathcal{L}_{Gauge} + \mathcal{L}_{Higgs} + \mathcal{L}_{Yukawa}$

Is it possible to study at 500GeV?

Gauge Principle

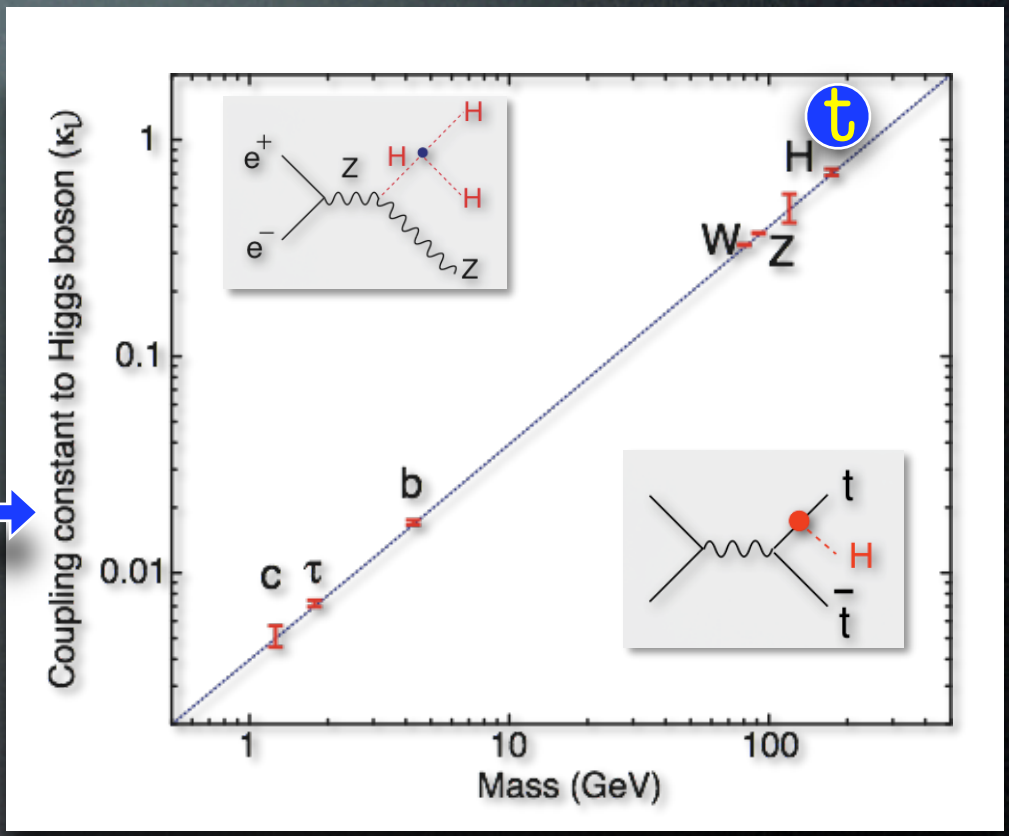
Established by precision EW Studies

Symmetry Breaking & Mass Generation

Untested!

Relativistic Quantum Field Theory

Relation between mass and coupling constant with Higgs



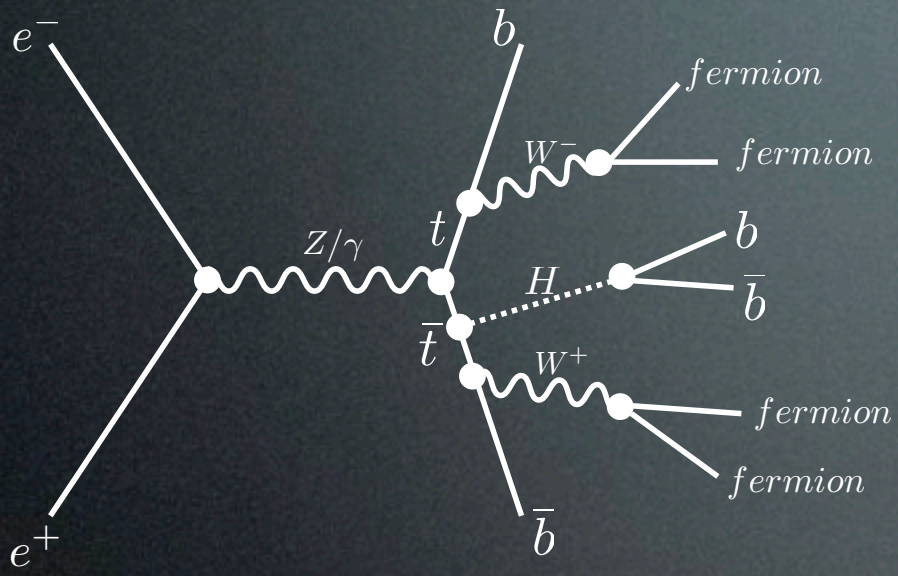
What we want to do is to measure Top-Yukawa coupling.
Because ...

- Direct measurement of Top-Yukawa coupling is important to understand mass generation in SM.
- Top-Yukawa coupling is expected to be the strongest.

Top-Yukawa coupling g_{tth}^2 is proportional to Xsection σ_{tth} .

⟶ Measurement for Top-Yukawa coupling is a kind of counting experiment.

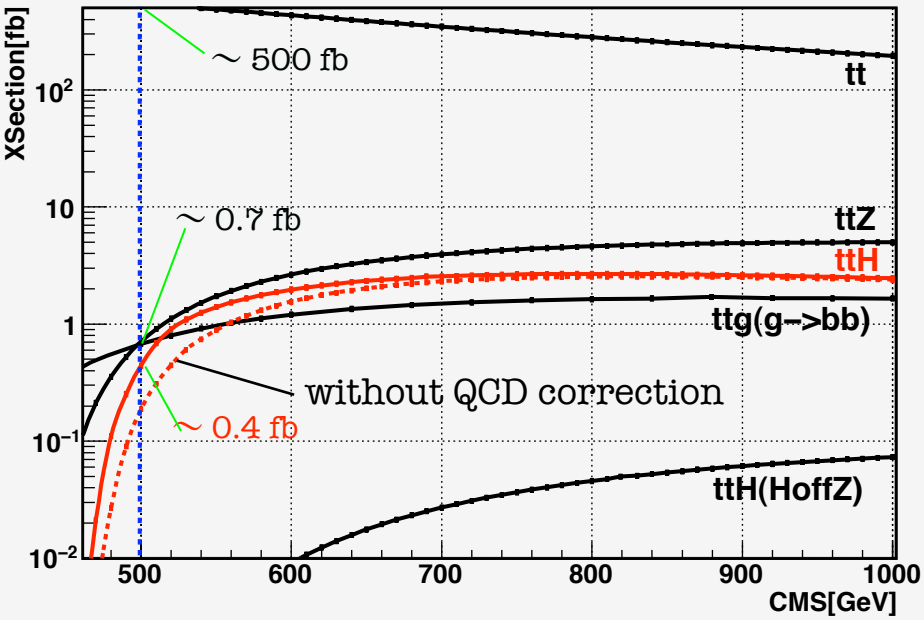
TTH diagram(in the case of H → bb)



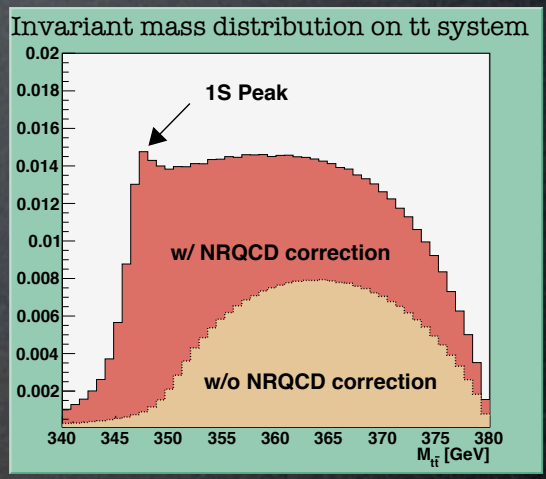
In the case of H → bb

1-lepton + 6-jet	~45%
8-jet	~44%
2-lepton + 4-jet	~11%

Xsection for each process



Effect of QCD threshold enhancement



E_{CM} = 500[GeV]
M_H = 120[GeV]
M_{top} = 175[GeV]

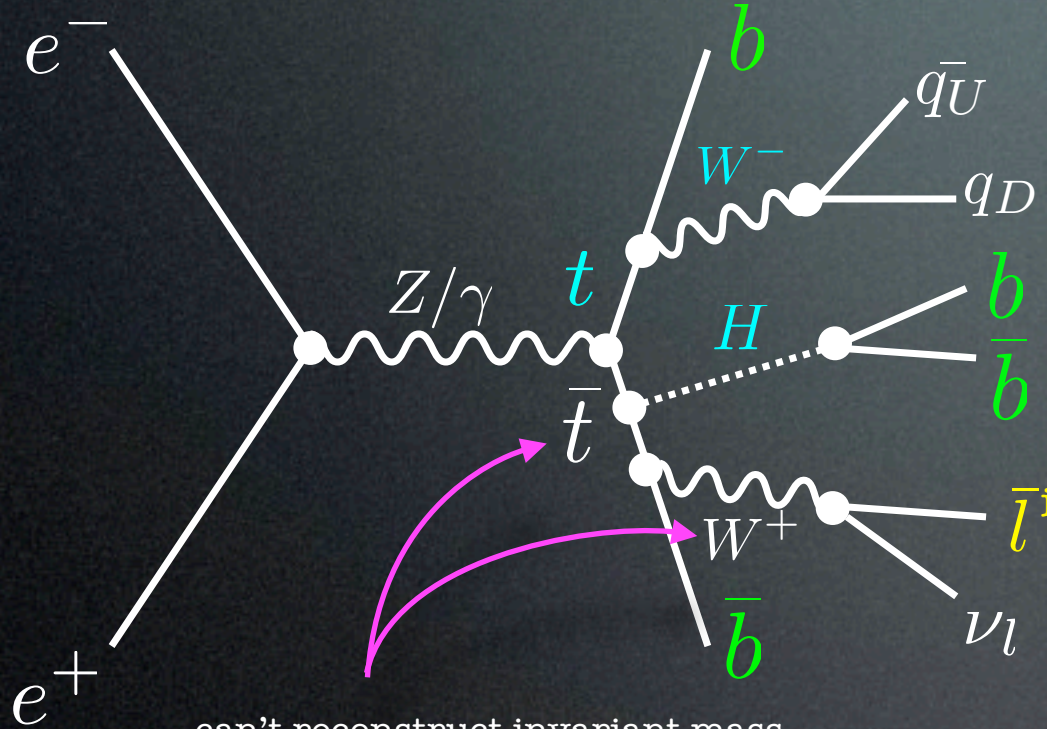
Our TTH event generator includes this QCD enhancement

No electron polarization at this moment ⟶ Possibility to improve S/N

How to suppress BG?

Consider each mode separately

In the case of 1-lepton + 6 - jet mode



can't reconstruct invariant mass because of a missing energetic neutrino.

	signatures
W_{jj}	mass, anti-b-tag
b	b-tag
t	mass
H	mass, (b-tag)
$W_{l\nu}$	isolated lepton

b-tag

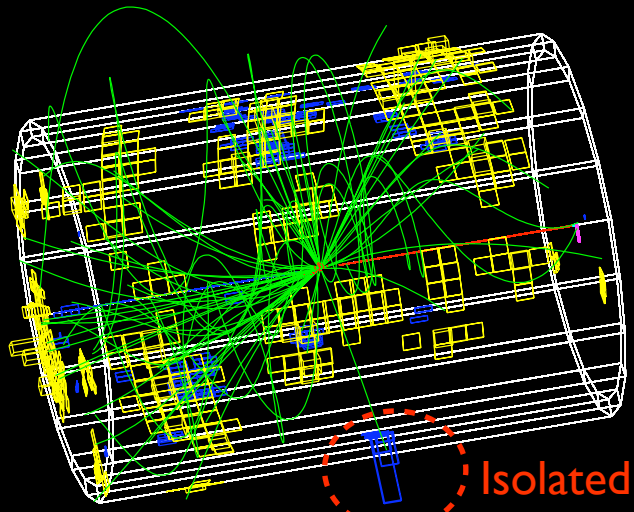
Jet Clustering

are essential!

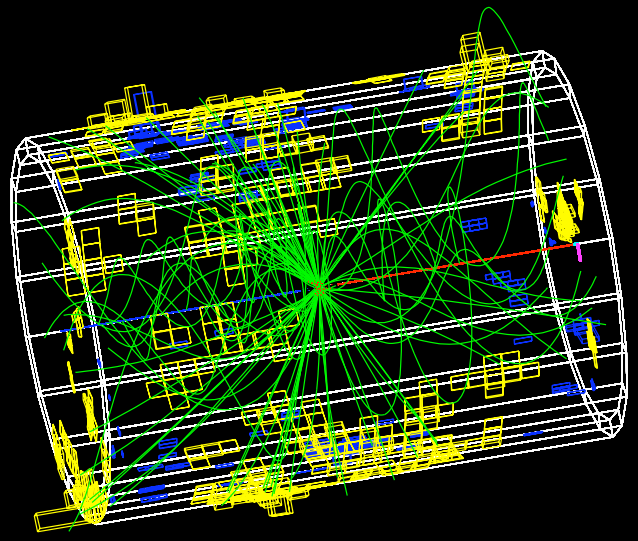
Why TTZ,TTg,TT can be B.G. ?

	TTZ, TTg	TT
reason	similar signature	mis-clustering
key for BG rejection	Z mass , g mass	b-tag, jet clustering

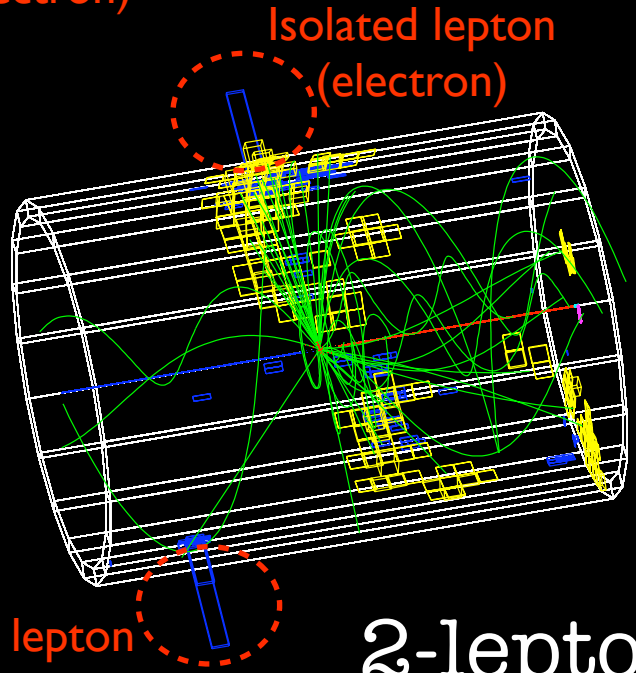
Event Display with Quick Simulator



1-lepton+6-Jet



8-Jet



2-lepton+4-Jet

Charged particle tracks

Signals on H-Cal.

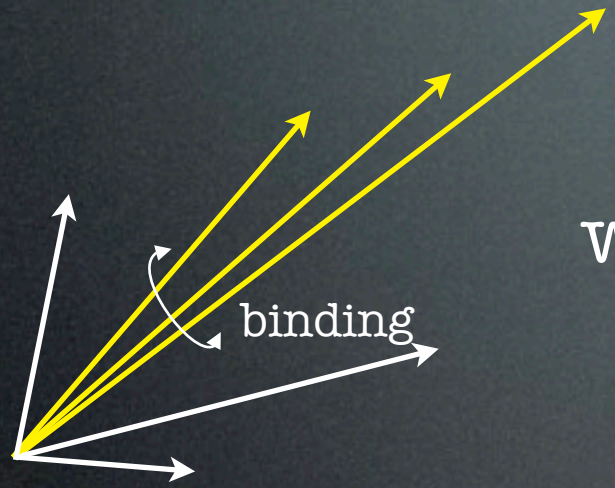
Signals on E-Cal.

Jet Clustering

using Forced n-jet clustering

Forced n-jet clustering

1. Putting together tracks around a seed track until y reaches a certain value (Ycut).

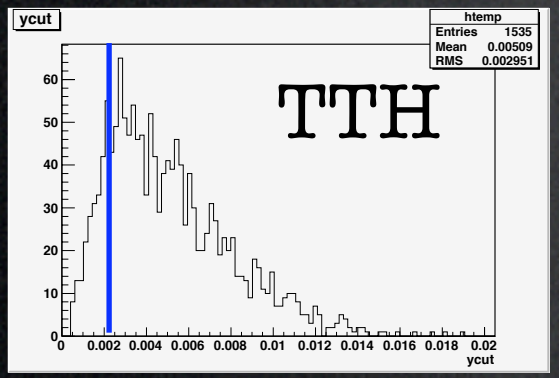


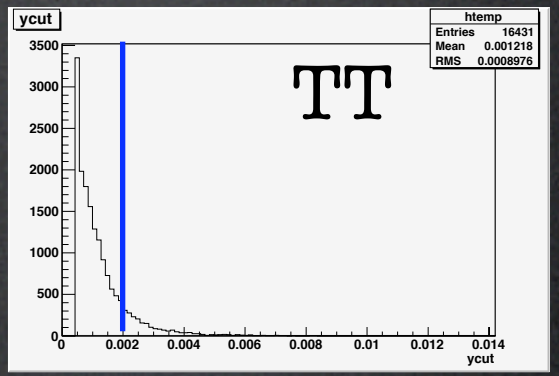
while ...

$$Y_{cut} > y := \frac{M_{Jet}^2}{E_{visible}^2}$$

2. Forced n-jet clustering always makes n jets by adjusting Y_{CUT} automatically for every event.

If we apply Forced 6-Jet Clustering for 4-Jet event, Ycut will be small.





b-tag

n-sig method

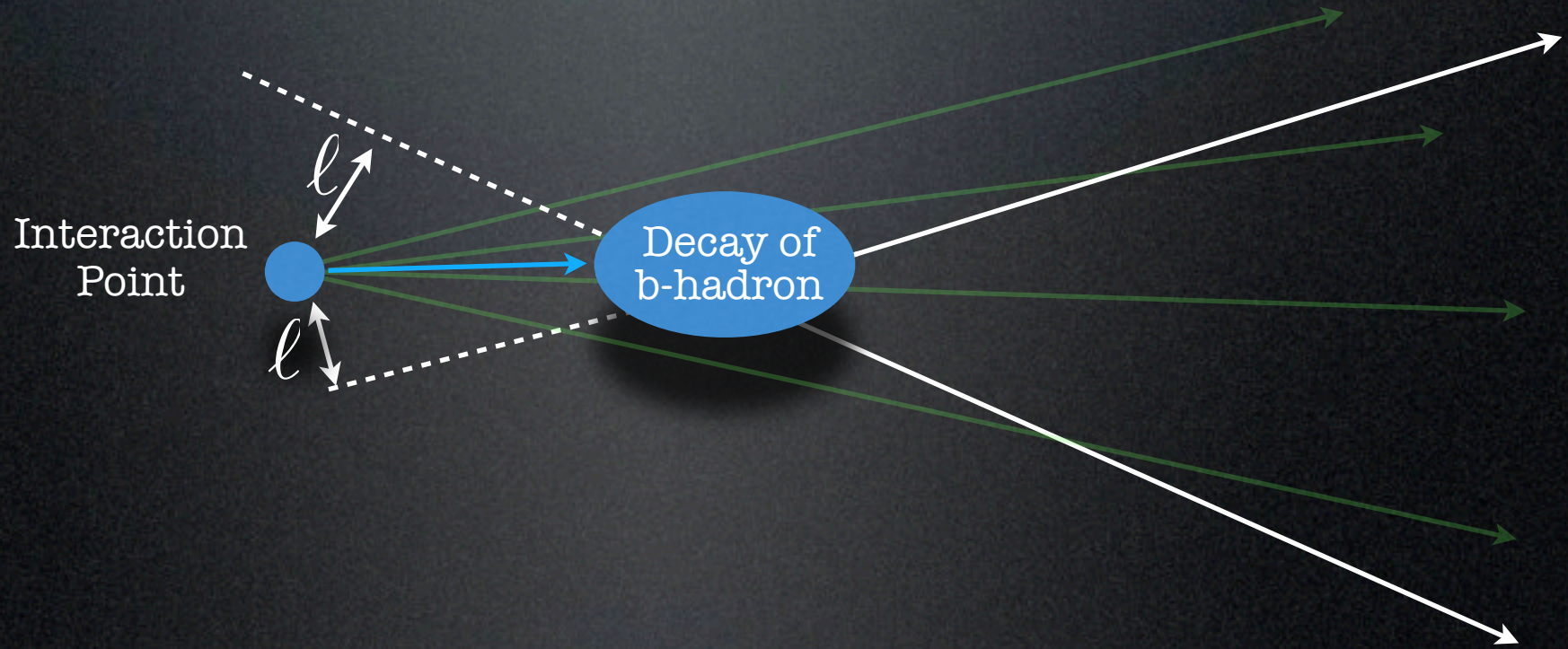
n-sig method

Given the distance between a tracks and IP, ℓ

and the measurement error, σ_ℓ

define the track as "off vertex track" if $\frac{\ell}{\sigma_\ell}$ is over a certain value

define the jet as b-jet if the number of "off vertex tracks" in a Jet is over a certain value.



Cut Statistics

Preliminary

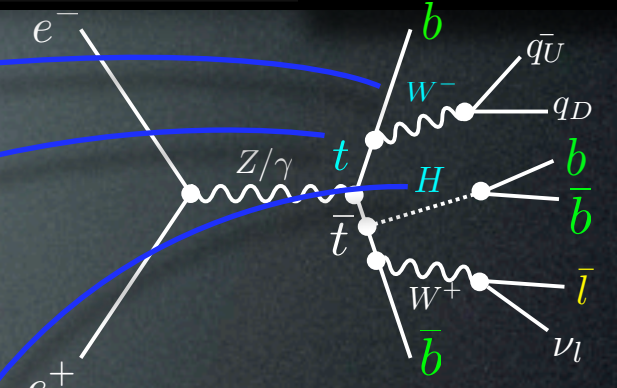
1-lepton + 6-jet mode

$1000fb^{-1}$

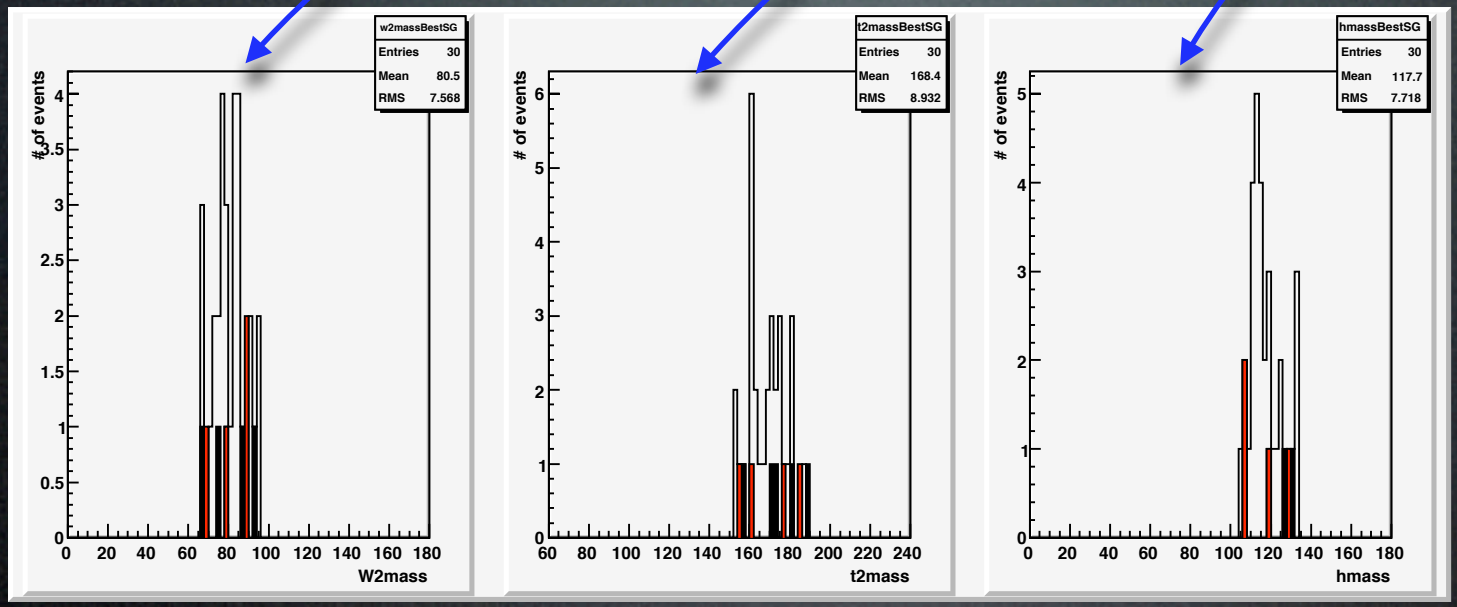
	TTH	TTZ	TT
No Cut (1L+ 6-Jet)	440 (200)	710	5×10^5
# of isolated lepton = 1	154	232	173386
	Forced 6-Jet clustering		
Ycut > 0.002	135	173	21577
4 b-tag + Mass Cut (W, t, H)	25	6	4

Need more statistics

Mass distribution after BG rejection



Invariant mass distribution



TTH
TTZ
TT

In the case of 1000 fb^{-1}

	TTH	TTZ	TT
events	25	6	4

Preliminary

Significance : $\dfrac{25}{\sqrt{(25+6+4)}} \sim 4$

Summary

We made a simulation study in order to evaluate the feasibility of measuring Top-Yukawa coupling at 500GeV.

The QCD correction increases the signal X-section roughly by a factor of two due to the threshold enhancement for the t-tbar sub-system.

We haven't yet considered the ttg BG , which might be the main back ground. If it is controllable, we can measure Top-Yukawa coupling at even E_{CM}= 500GeV.

Present problem & Next Step

increase B.G. statistics
ttg(g->bb) B.G. (Strategy: invariant mass of gluon)
Beam polarization of electron & positron
8-Jet mode
H-> WW*(15%)
Better jet clustering method & better b-tag are wanted for better S/N
Move on to full simulation for more precise estimation