

Report on ttH Analysis

S. Uozumi (Kobe)

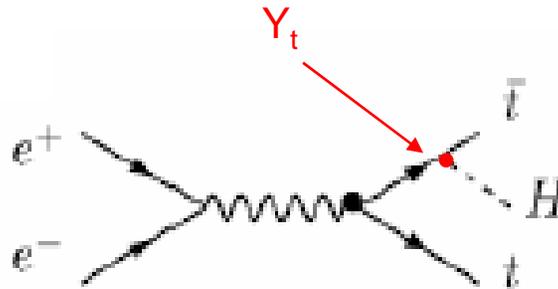
R. Yonamine (GUAS)

K. Fujii (KEK)

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Introduction

- Top Yukawa coupling is a fundamental parameter in the SM.
- Recent study shows that LHC seems to be very difficult to measure Y_t .
- ILC is the only place to measure it (SLHC also?)
- NLO + Threshold effect of $t\bar{t}$ system + e^+ polarization will significantly enhance the $\sigma(e^+e^- \rightarrow t\bar{t}H)$.
 - Born $\sigma=0.074\text{fb}$ (including ISR and bremsstrahlung effects)^{hep-ph/0512246}
 - $M_h=120\text{GeV}$, $M_t^{1S}=180\text{GeV}$, $E_{\text{cm}}=500\text{GeV}$ and $(P_{e^-}, P_{e^+})=(-0.9, 0.0)$
 - NLO $\sigma=0.18\text{fb}$
- Estimate sensitivity of Y_t at the ILC first stage ($E_{\text{cm}}\sim 500\text{GeV}$)
 - With Higgs mass of $120 \sim 200 \text{ GeV}$, region not well explored.



Event features

- Assume $m_H = 120 \sim 200$ GeV
 - $E_{\text{thre}} = 2 * m_t + m_H = 470 \sim 550$ GeV
- $\sigma(E_{\text{thre}} + \alpha) = O(0.1)$ fb → $O(100)$ events with 1000/fb
 - ~ 1 fb with $m_H = 120$ GeV at $\sqrt{s} = 550$ GeV
- Decay
 - $ttH \rightarrow bWbW$ (bb, WW or ZZ) → 8 or 10 fermions
 - High jet multiplicity
- Backgrounds
 - $ttg \rightarrow ttbb$ will be the dominant source for $H \rightarrow bb$ channel
 - SM backgrounds like $ttZZ, ttWW$ exists for heavier higgs.

Status

- Need to maintain signal generator with tt-system threshold enhancement -> done
- For BG study , event generation is done by MadGraph.
- Now trying quick detector simulation, reconstruction and cutting on kinematical quantities for BG rejection.

Event Display

- Very dense 8 jets event.
- Challenging for reconstruction.

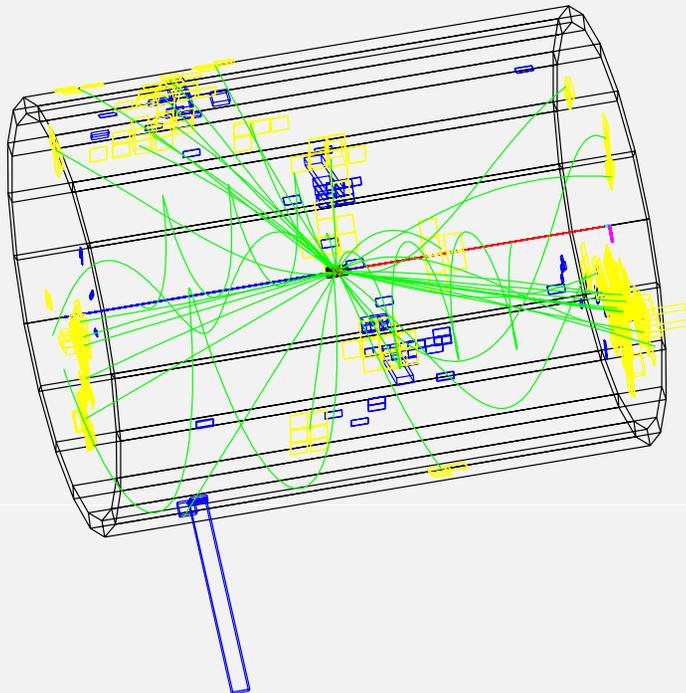
$E_{cm}=500\text{GeV}$

$M_H=120\text{GeV}$

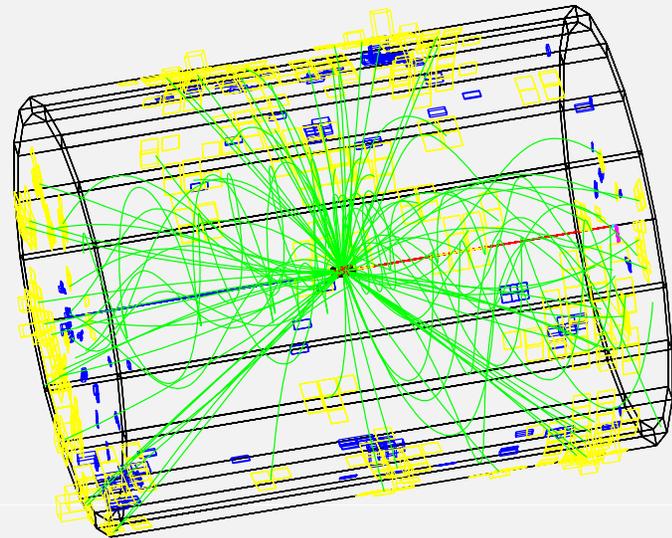
$ttH \rightarrow (bW)(bW)(bb) \rightarrow (bud)(bev)(bb)$

$ttH \rightarrow (bW)(bW)(bb) \rightarrow (bcs)(bcs)(bb)$

6 jet

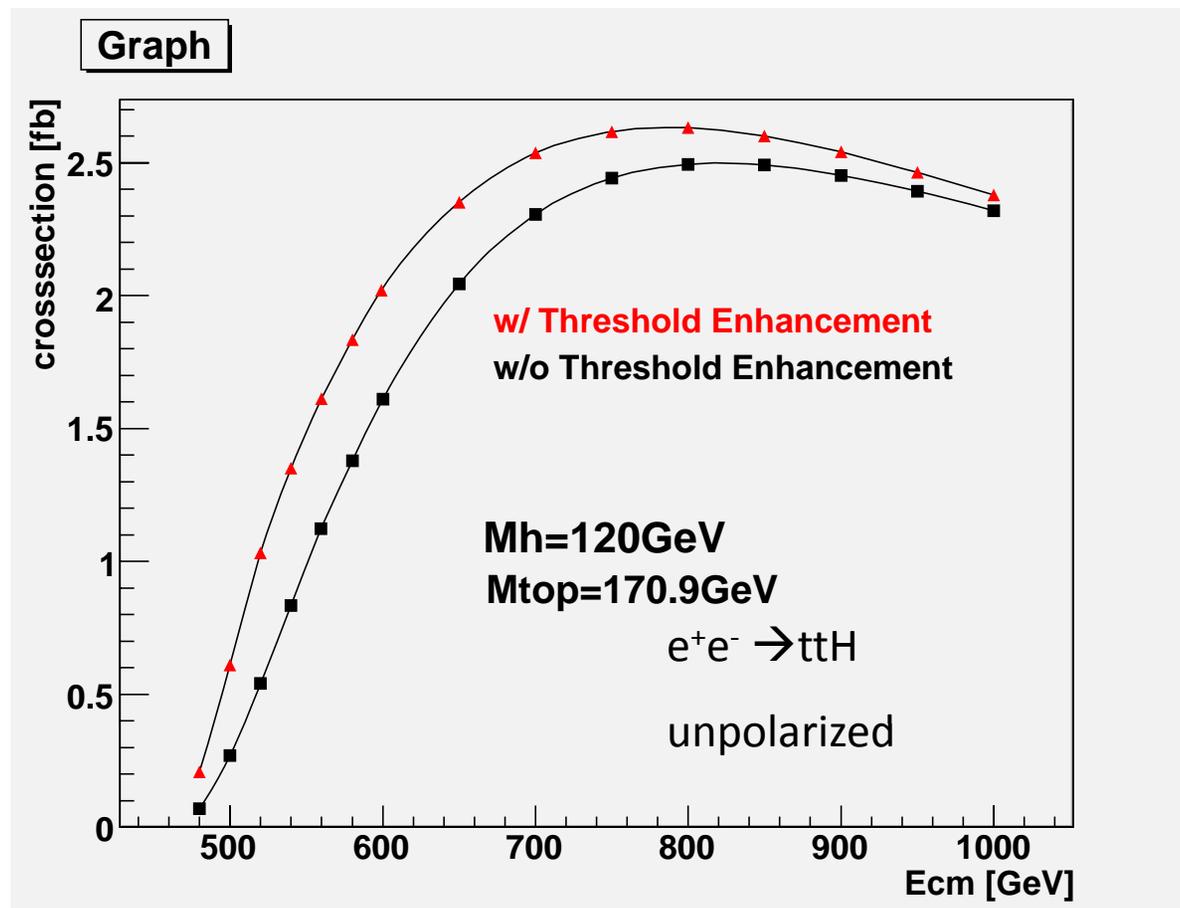


8 jet



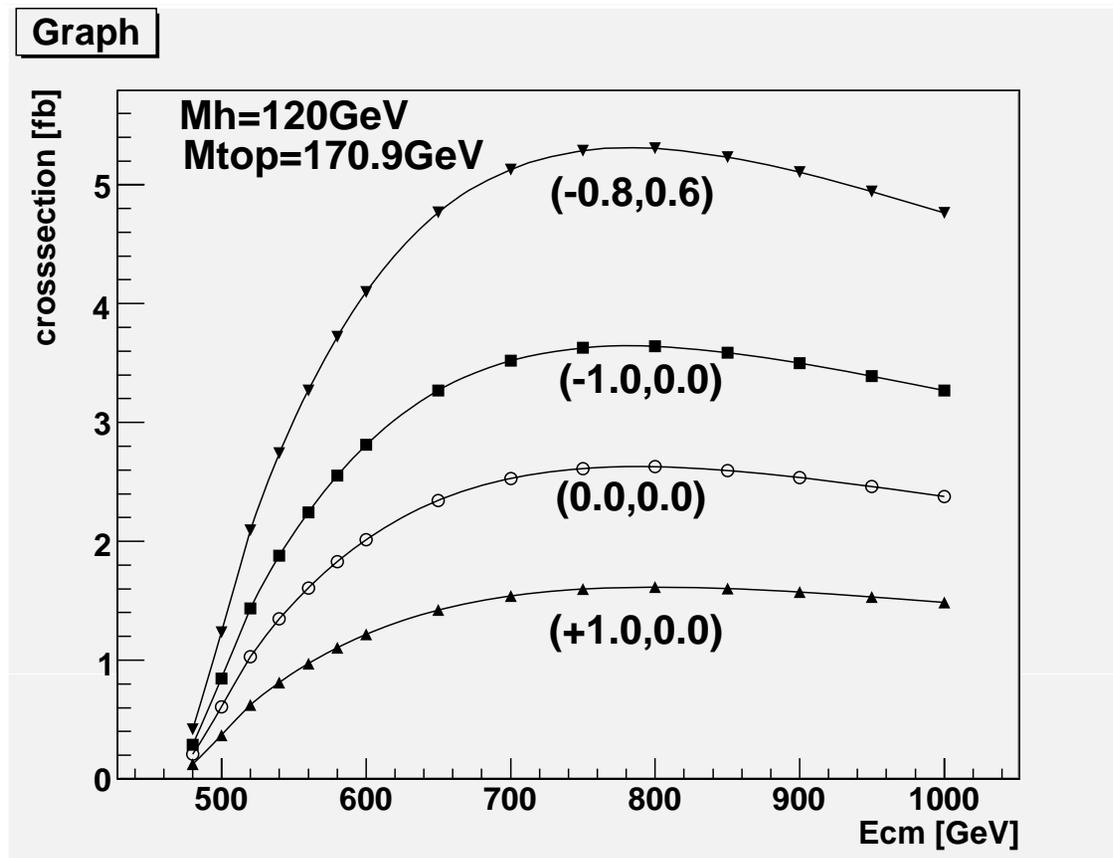
Signal Generator

- Signal generator which includes $t\bar{t}$ mass threshold enhancement has been made .
- The generator is maintained on framework of GLD simulation software.



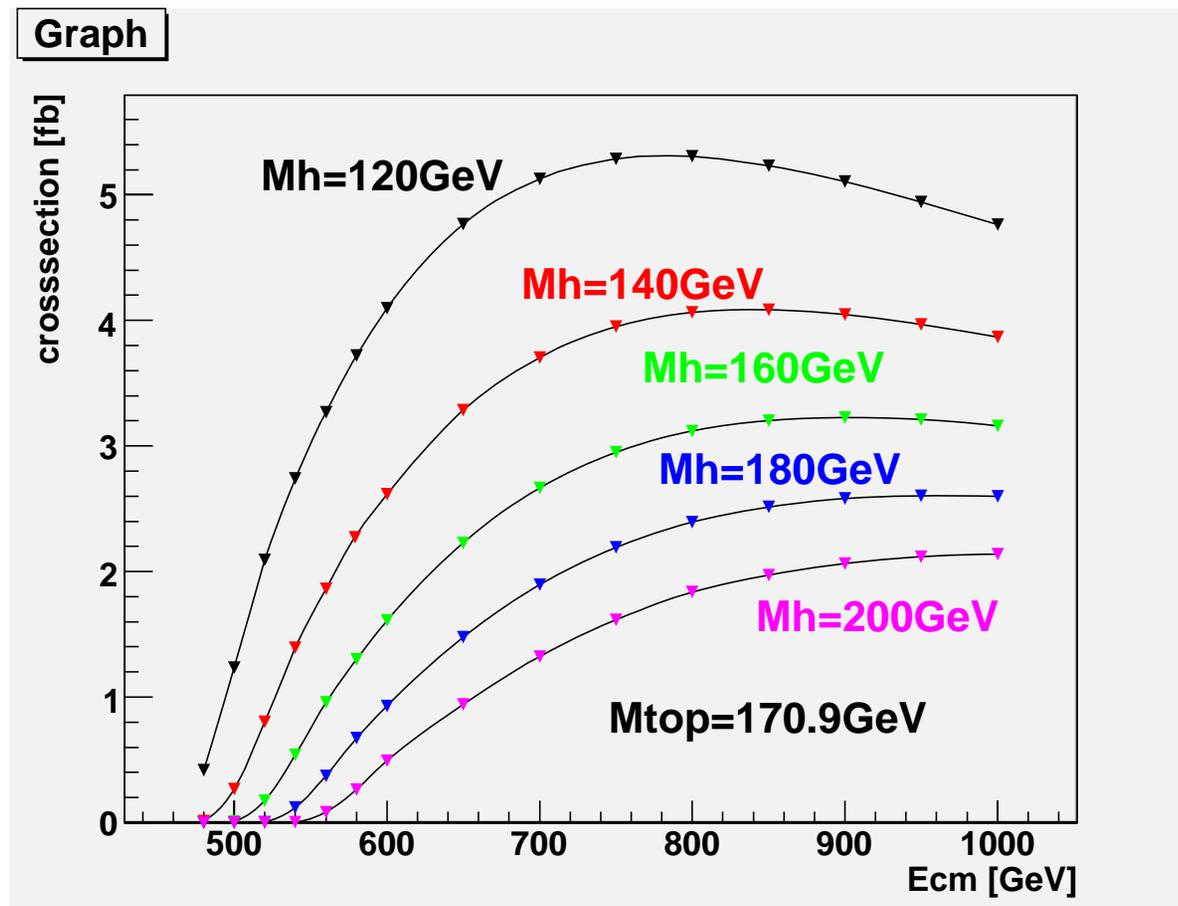
Beam Polarization for ttH

- Cross-section is calculated as a function of E_{cm} for $P=(-1.0, 0.0)$, $P=(1.0, 0.0)$ and $P=(-0.8, 0.6)$ with $M_h = 120$ GeV and $M_t = 170.9$ GeV.
- $\sigma = 1.2$ fb for $P=(-0.8, 0.6)$ and $E_{\text{cm}}=500$ GeV

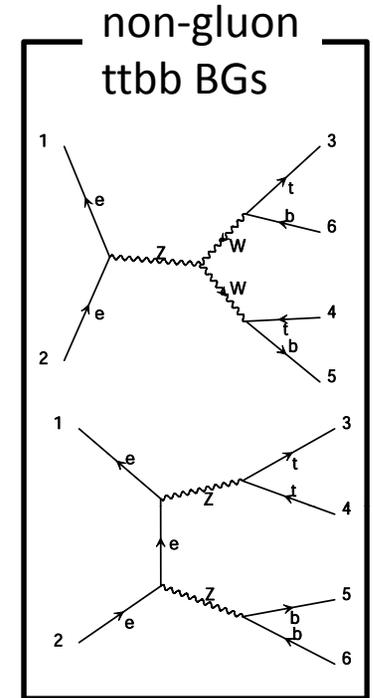
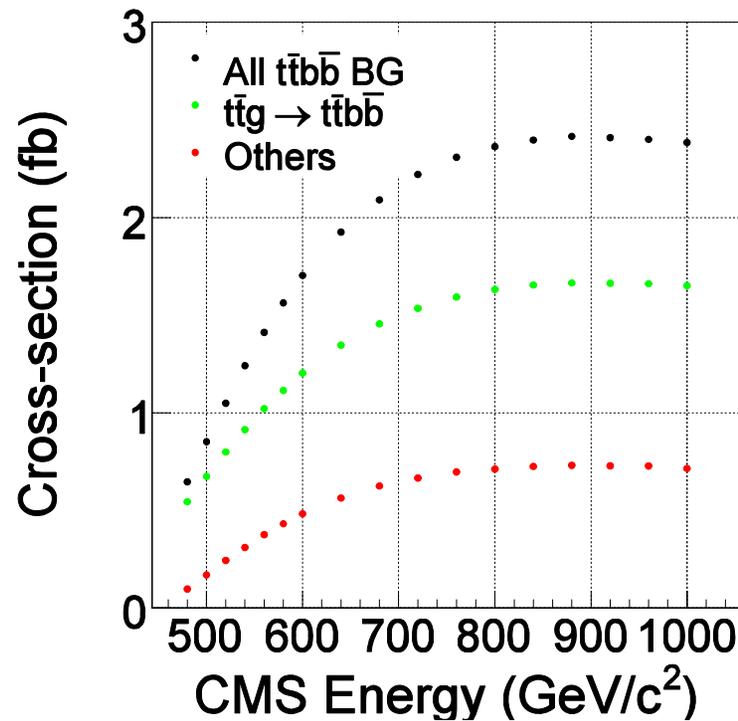
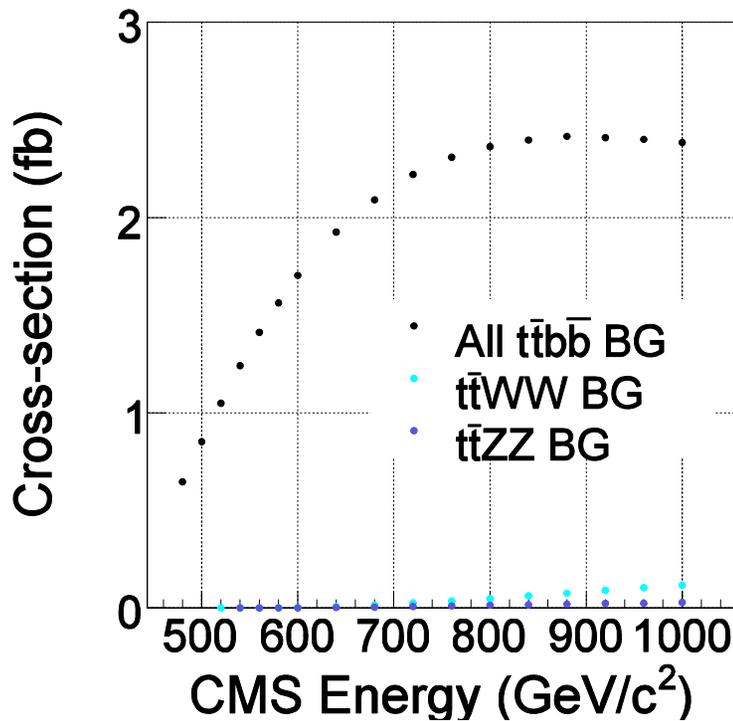


Mass dependence

- Mass dependence of cross section is also calculated with $P=(-0.8, 0.6)$.
- Need $E_{cm} > 550$ GeV for $M_h > 170$ GeV.



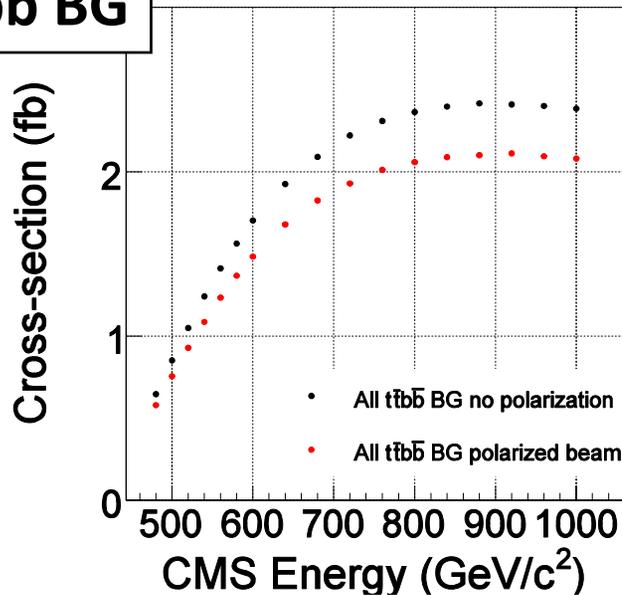
Background Cross-section



- Generated by Madgraph with different CMS energies.
- No selection is applied yet.
- At this level $t\bar{t}b\bar{b}$ BG has comparable x-section with the signal.
- In the $t\bar{t}b\bar{b}$ BG, $t\bar{t}g \rightarrow t\bar{t}b\bar{b}$ is x2 larger than other $t\bar{t}b\bar{b}$ BG.

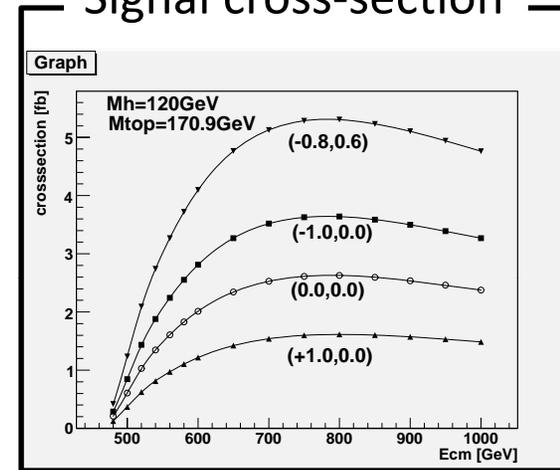
Effect of beam polarization to BG

ttbb BG

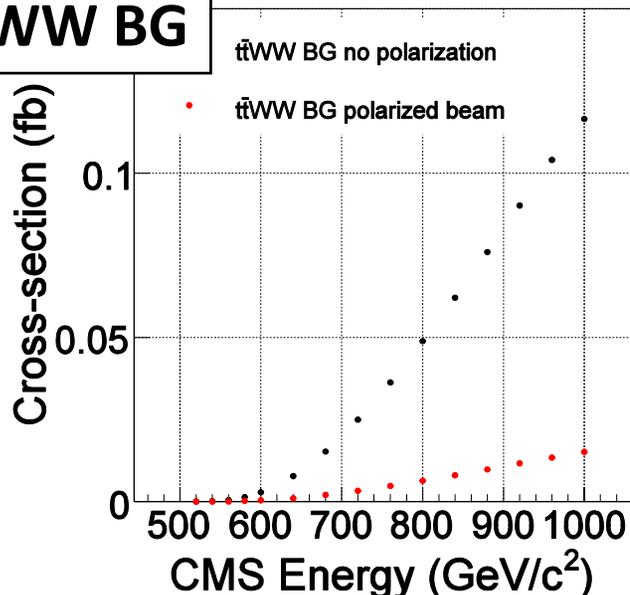


- cases of $P=(0,0)$, $(-0.8,0.6)$ are examined.
- Slight improvement can be seen with the $t\bar{t}b\bar{b}$ BG.

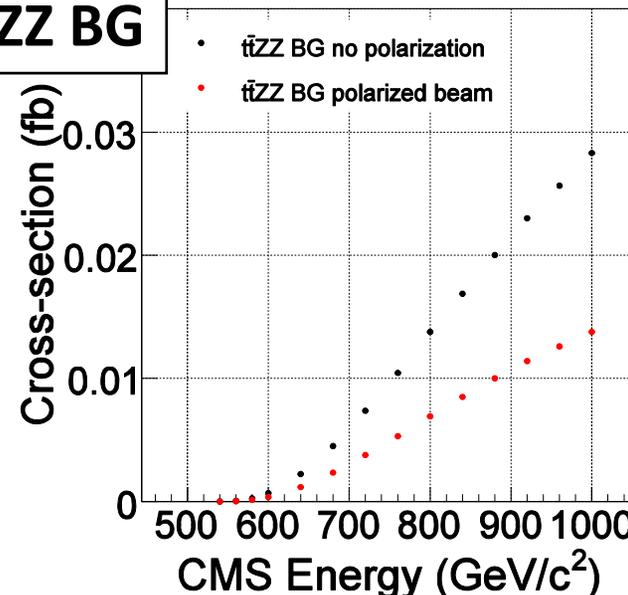
Signal cross-section



ttWW BG



ttZZ BG



Summary

- $e^+e^- \rightarrow ttH$ ($H \rightarrow bb$) Generator has been prepared.
- Electron and positron polarizations are very useful to enhance signal cross section.
 - $\sigma = 1.2$ fb for $E_{cm} = 500$ GeV, $P = (-0.8, 0.6)$ and $M_h = 120$ GeV
- Cross sections of BG modes are calculated.
- Dominant BGs are ttg , ttZ , tt and WW .

Plans

- Generate full sets of signal and backgrounds.
- Pass the generator information to quick simulator.
- Try event reconstruction and calculate sensitivity.