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Top Quark Anomalous Coupling Study Using the SiD

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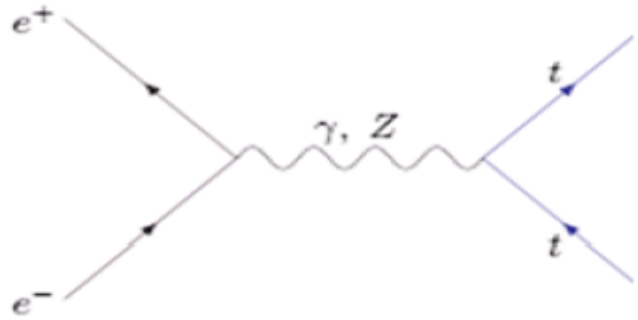
Motivation

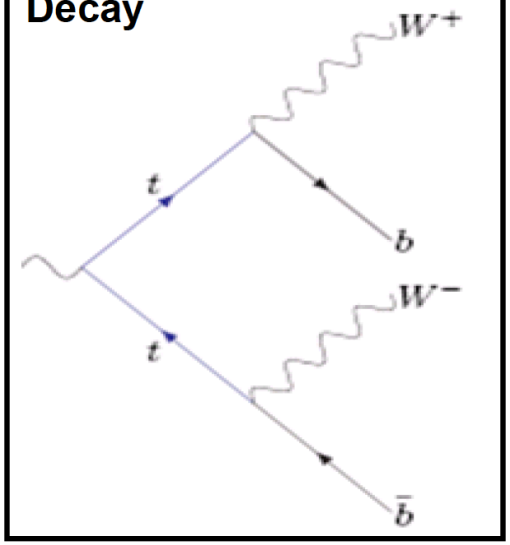
- Effort is based on previous LOI study
- New physics predicts deviations from the SM of the left and right top couplings to the Z.
- As such, studying the forward-backward asymmetry for each polarization provides access to each coupling

Event Topology

ILC - main production channel



Decay



Channels :

- $t\bar{t} \rightarrow b\bar{b}l\nu q\bar{q}$ *(11%)*
- $t\bar{t} \rightarrow b\bar{b}l\nu$ *+ 2 jets* *(44%)*
- $t\bar{t} \rightarrow b\bar{b}$ *+ 4 jets* *(45%)*

Br(t→Wb)~99.8%

No missing energy allowing for kinematic constraints used b-jet calibration and top quark mass measurement

MC Samples Used

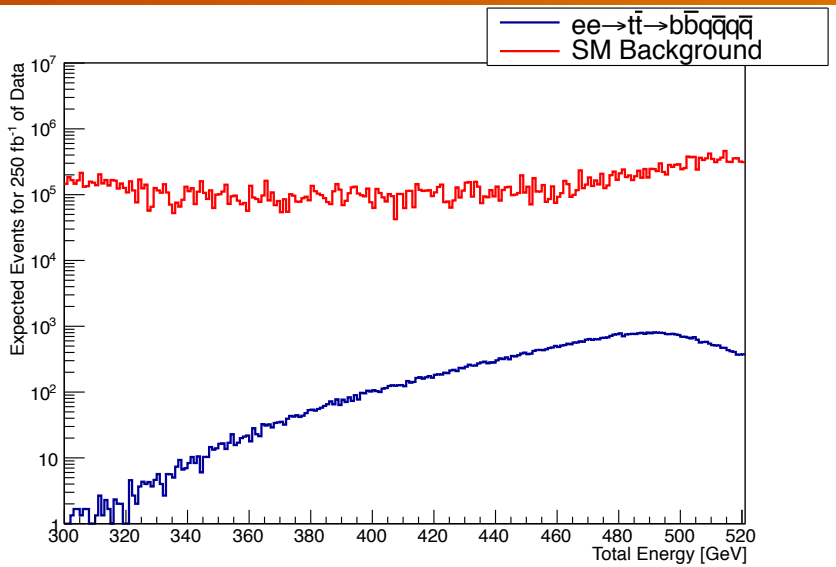
- Analysis was performed with E_{cm} set to 500GeV
- 6f_ttbar_mt174p0 (m80p30 and p80m30)
- all_SM_background (m80p30 and p80m30)
- Corresponds to sample numbers: 1974-1977

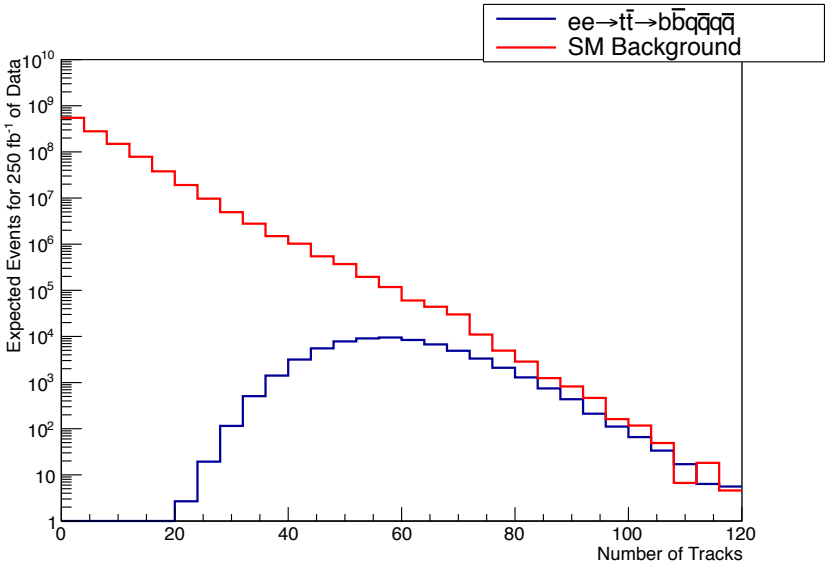
Few Words on MC Cross-Sections

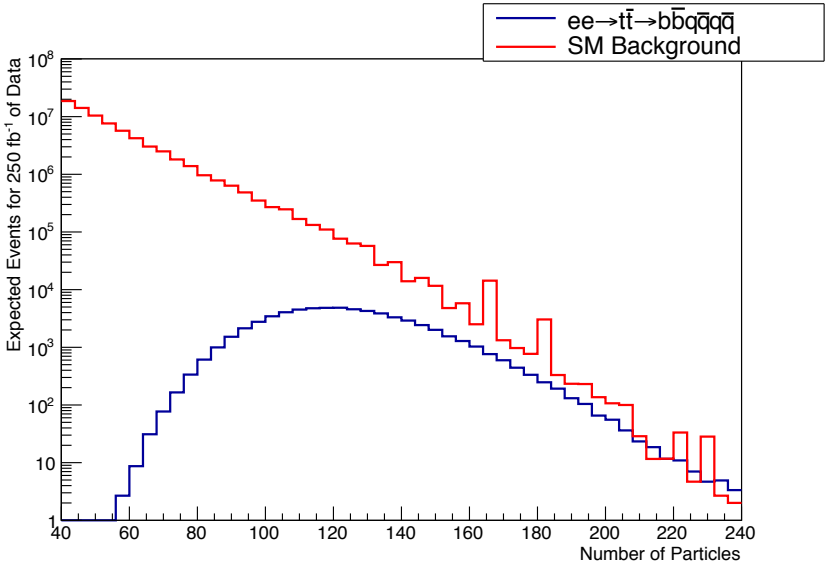
- MC signal events generated for 1000fb^{-1} (m80p30), for 938761 which yields a cross-section of 938 fb
- There is approximately ~15% of events that are duplicated which yields a cross-section of ~800 fb
- There is also approximately ~30% events that are not ttbar, therefore cross-section is ~660 fb
- Therefore, base on these number the tt->bbqqq cross-section should be ~250 fb
- This number appears to low
- Working with the Roman Poeschl to understand the cross-section provided by Whizard and provide consistent value for SiD/ILD

Pre-Selection

- Sum of the jet energy > 400 GeV
- Track multiplicity > 30
- Jet particle constituents > 5
- Sum of the jet particle constituents > 80
- Jet Pt between 10-200 GeV
- Number of jet constituents>5
- Requires 6 jets





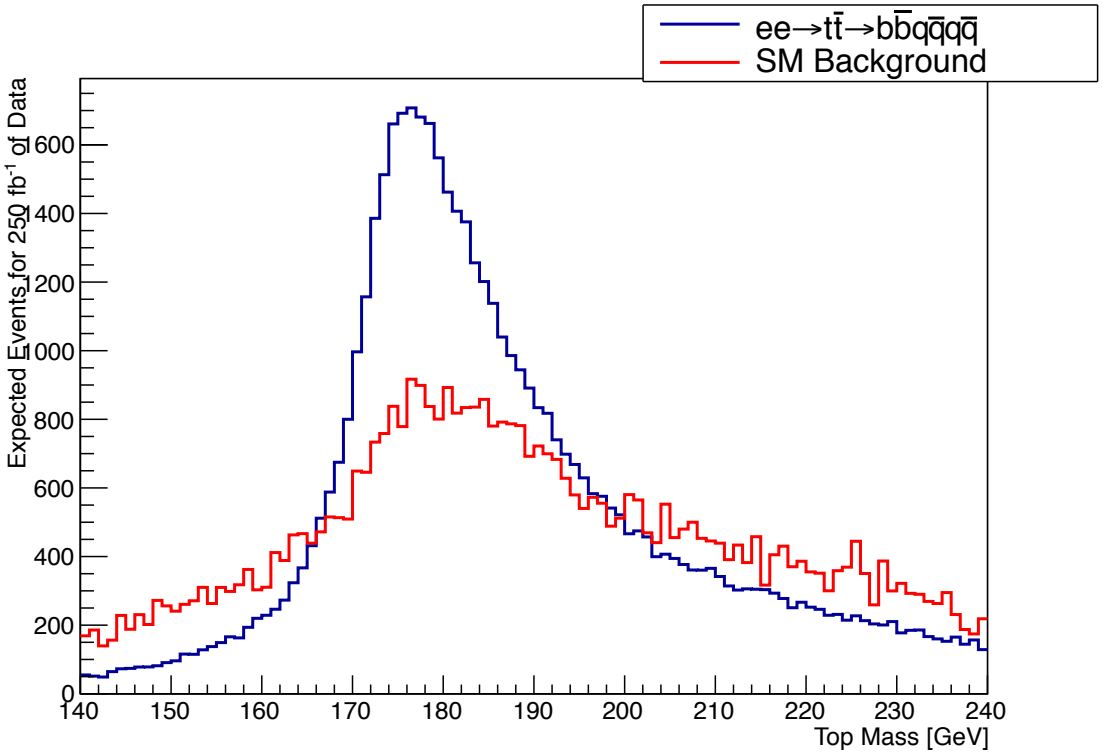


Additional Selection Requirements

- The two jets with the highest b-tagging value are assume to originate from the top decay
- The jet with the highest b-tag value must have a b-tag value greater than 0.9
- The jet with the second highest b-tag value must have a b-tag value greater than 0.4
- The remaining 4 jets are assume to originate from the hadronic W decay
- W-boson candidates must have a mass between 50-110 GeV
- The top quark candidates must have a mass between 145-195 GeV

Reconstructed Objects

- The top candidates where reconstructed using a Kinematic Fitter using constraints in table below
- By identifying the b-jets we reduced the combinations from 6 to 4



$M(t_1)$	=	$M(t_2)$
$M(W_1)$	=	80.4 GeV
$M(W_2)$	=	80.4 GeV
$M(b_1)$	=	5.8 GeV
$M(b_2)$	=	5.8 GeV
E_{tot}	=	E_{cm}
px;py;pz	=	0

Cross-section* For tt->bbqqqq

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Process	Raw MC	Initial	Final	Eff.	X-sec [fb]
Mt174p0 (-80%/+30%) (signal)	821535	65448	15616	0.239	261.79±2.67
Mt174p0 (+80%/-30%) (signal)	410354	31048	7554	0.243	124.19±1.79
Sum	1231889	96496	23170	0.240	192.99±1.61

- Analysis for 250fb^{-1} per polarization
- Uncertainty on the cross-section is 1.02%, 1.44%, and 0.83%
- Errors are based on the statistical uncertainty of the expected number of events

*Values are based on input from Whizard

$A_{FB}(t)$

- For the A_{FB} measurement we must assign each top candidate a charge.
- The top candidate charge is determined by calculating the momentum weighted sum of the charges from the tracks in the associated b-quark.
- Since we have two top candidates, we require that their charges be opposite.
- The $A_{FB}(t)$ is calculated:

$$A_{fb} = \frac{\sigma(\theta < 90^o) - \sigma(\theta > 90^o)}{\sigma(\theta < 90^o) + \sigma(\theta > 90^o)}$$

- The number of top candidates in each region is calculated: $N_{sig}=(N_{tot}-N_{bkg})*\varepsilon_p$
- The purity, ε_p, is determine by matching the reconstructed top candidate with the truth particle and verifying that the charge is consistent.

$A_{FB}(t)$ Results

- Using the MC truth to determine the expected A_{FB} (t):
  - A_{FB}(+80%/-30%): 0.431
  - A_{FB}(-80%/+30%): 0.367
  - A_{FB}(mixed): 0.380

- Reconstruction numbers after cuts:
  - A_{FB}(+80%/-30%): 0.441
  - A_{FB}(-80%/+30%): 0.371

To-do

- Working with ILD members to finalize ttbar cross-section and the A_{FB}
- Once this is done we will update our numbers

- Plan to work on other physics channels that are not covered in the DBD (Invisible Higgs, etc.)