

top yukawa study

T. Tanabe, R. Yonamine

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current status

- TBW background sample event generation complete
- re-analysis including TBW background finished
- paper writing now **at final draft stage**
- final plots have been prepared

Measuring the top Yukawa coupling at the ILC at $\sqrt{s} = 500$ GeV

Ryo Yonamine,¹ Katsumasa Ikematsu,² Tomohiko Tanabe,³
Keisuke Fujii,⁴ Yuichiro Kiyoi,⁴ Yukinari Sumino,⁵ and Hiroshi Yokoya^{6,7}

¹*Department of Particle and Nuclear Physics, The Graduate University for Advanced Studies (Sokendai), Tsukuba 305-0801, Japan*

²*Fachbereich 7 - Physik, Universität Siegen, D-57068 Siegen, Germany*

³*International Center for Elementary Particle Physics, The University of Tokyo, Tokyo 113-0033, Japan*

⁴*High Energy Accelerator Research Organization (KEK), Tsukuba 305-0801, Japan*

⁵*Department of Physics, Tohoku University, Sendai 980-8578, Japan*

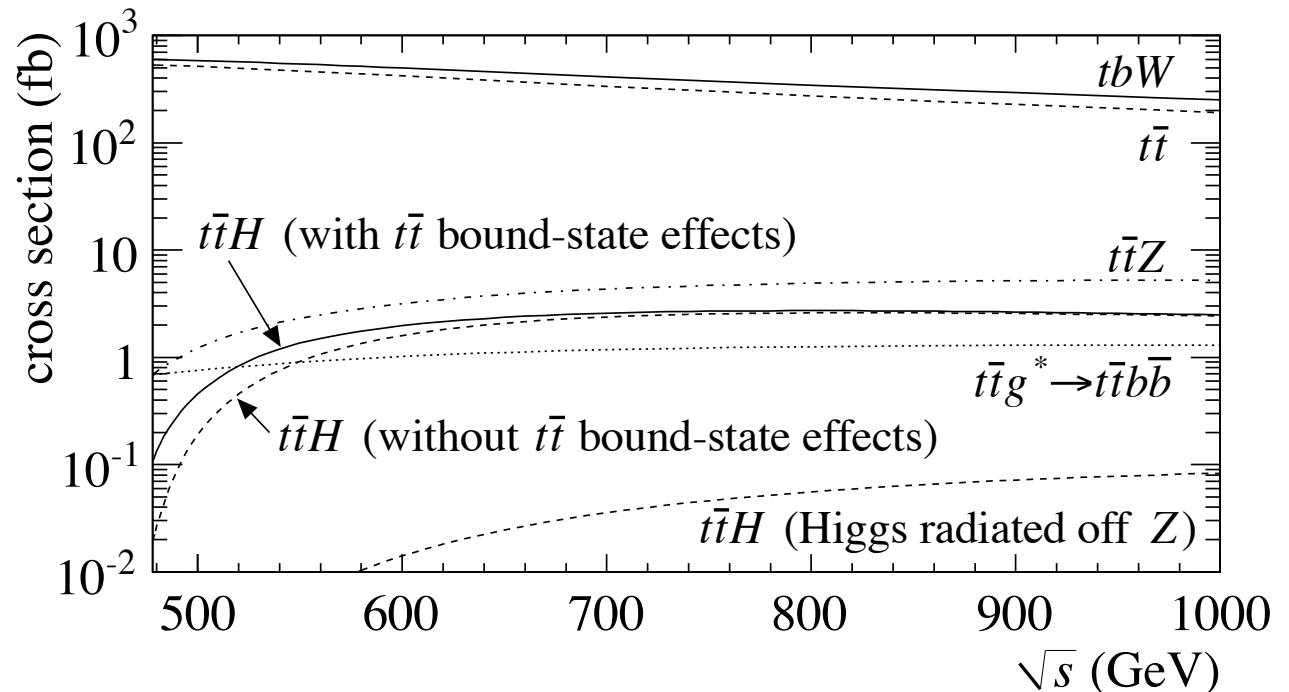
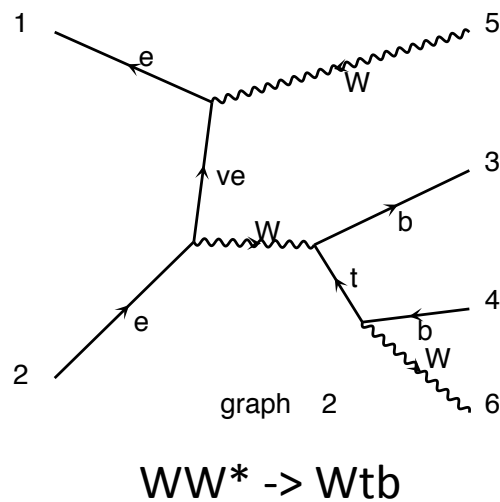
⁶*Theory Unit, Physics Department, CERN, CH-1211 Geneva, Switzerland*

⁷*Department of Physics, National Taiwan University, Taipei 10617, Taiwan*

We report on the feasibility of the direct measurement of the top Yukawa coupling g_t at the International Linear Collider (ILC) during its first phase of operation with a center-of-mass energy of 500 GeV. The signal and background models incorporate the non-relativistic QCD corrections which enhance the production cross section near the $t\bar{t}$ threshold. The $e^+e^- \rightarrow t\bar{t}H$ signal is reconstructed in the 6-jet + lepton and the 8-jet modes. The results from the two channels are combined. The background processes considered are $e^+e^- \rightarrow t\bar{t}W^-/\bar{t}bW^+$ (which includes $e^+e^- \rightarrow t\bar{t}$), $e^+e^- \rightarrow t\bar{t}Z$, and $e^+e^- \rightarrow t\bar{t}g^* \rightarrow t\bar{t}b\bar{b}$. We use a realistic fast Monte-Carlo detector simulation. Signal events are selected using event shape variables, through jet clustering, and by identifying heavy flavor jets. Assuming a Higgs mass of 120 GeV, polarized electron and positron beams with $(P_{e^-}, P_{e^+}) = (-0.8, +0.3)$, and an integrated luminosity of 1 ab^{-1} , we estimate that the $e^+e^- \rightarrow t\bar{t}H$ events can be seen with a statistical significance of 5.7σ , corresponding to the relative measurement accuracy of the top Yukawa coupling to be $|\Delta g_t/g_t| = 9\%$.

TBW process

- the TBW process **contains the t-tbar resonance**
 - other examples of TBW include $WW^* \rightarrow Wtb$
- TBW xsec is roughly 1.1 times t-tbar
- the **non-resonant contribution is equally important** in our analysis since the background contribution of this process is due to **mis-reconstruction** (jet clustering & b-tagging)



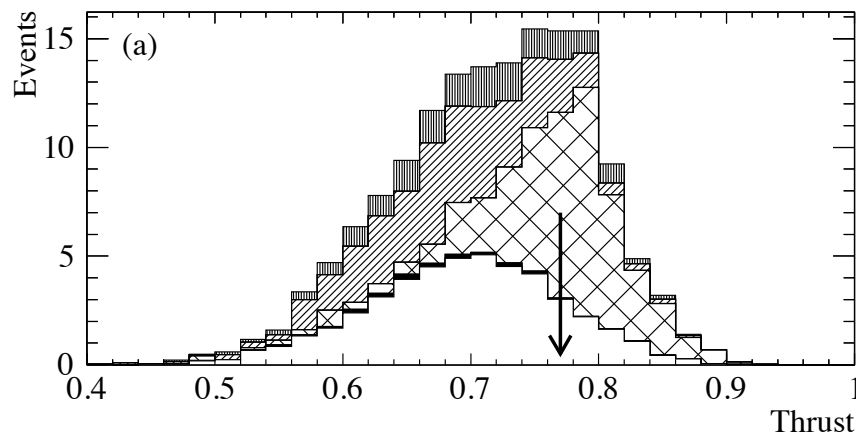
TBW sample

- TBW sample size has been increased from 5 million (per beam polarization) to 10 million
- this ensures **enough MC statistics**, with L_{equiv} over 6 ab^{-1}
 - (we assume $L=1 \text{ ab}^{-1}$ in our analysis)

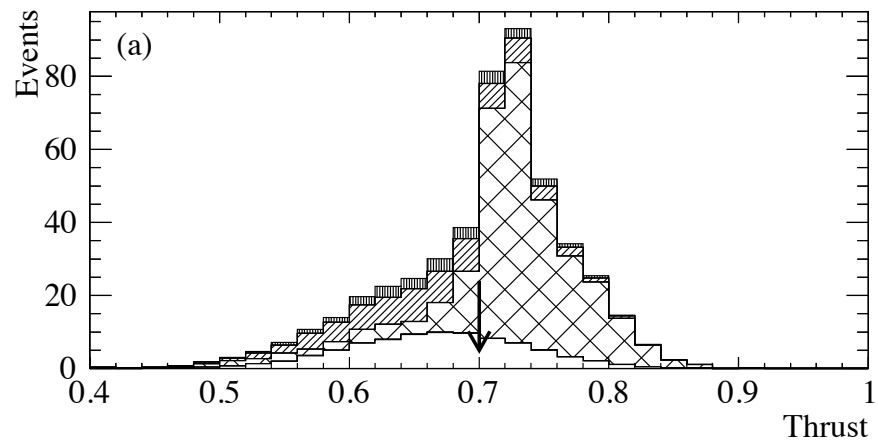
Process	σ (fb)	N	\mathcal{L} (ab^{-1})
$e_L^- e_R^+ \rightarrow t\bar{t}H$	1.07	5.00×10^4	47.8
$e_L^- e_R^+ \rightarrow t\bar{t}Z$	4.04	5.00×10^4	12.4
$e_L^- e_R^+ \rightarrow t\bar{t}g^*$	1.93	5.00×10^4	25.9
$e_L^- e_R^+ \rightarrow tbW$	1633.	1.00×10^7	6.1
$e_R^- e_L^+ \rightarrow t\bar{t}H$	0.45	5.00×10^4	92.6
$e_R^- e_L^+ \rightarrow t\bar{t}Z$	1.32	5.00×10^4	37.8
$e_R^- e_L^+ \rightarrow t\bar{t}g^*$	0.86	5.00×10^4	58.2
$e_R^- e_L^+ \rightarrow tbW$	700.	1.00×10^7	14.3

cut re-optimization

- the analysis cuts have been re-optimized.
- we find a tighter thrust cut to be more effective
 - it was found that the thrust cut in the old analysis (with TT sample) was not optimized
 - thrust cut 0.85 -> 0.77 (6-jet + lepton)
 - thrust cut 0.80 -> 0.70 (8-jet)
- minor adjustments to other cuts (yclus & mass cuts)



6-jet + lepton mode



8-jet mode

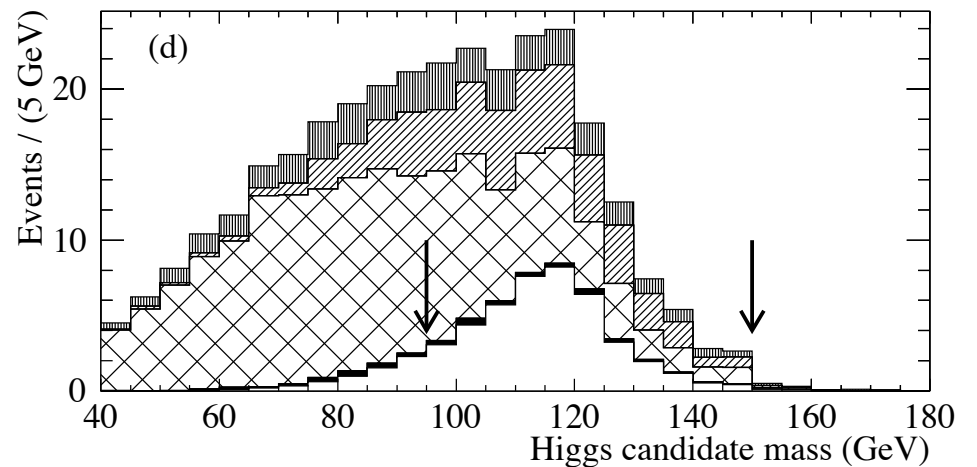
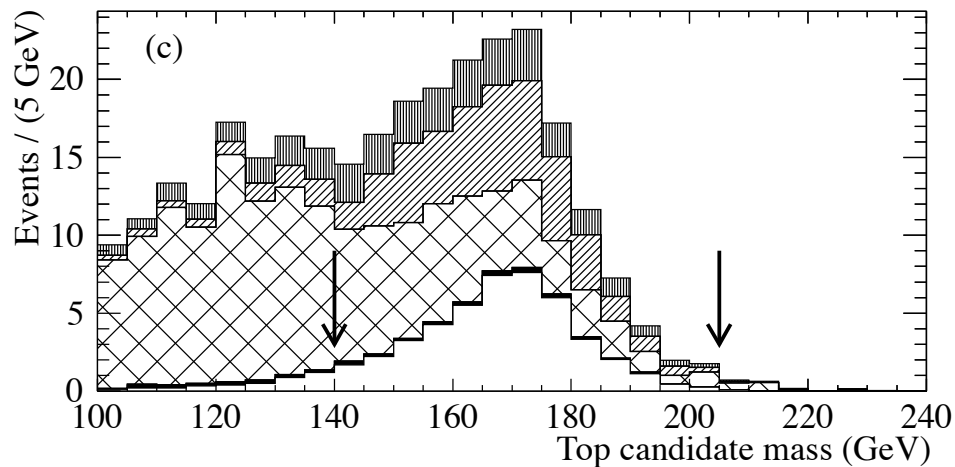
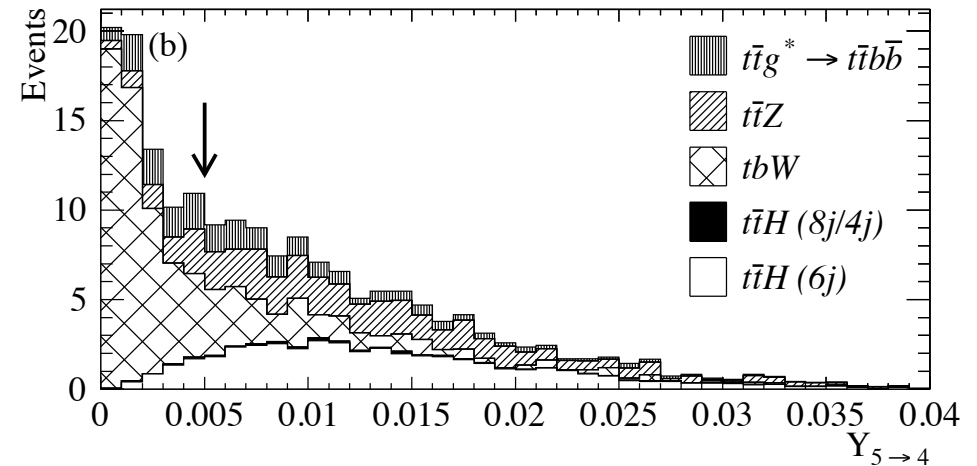
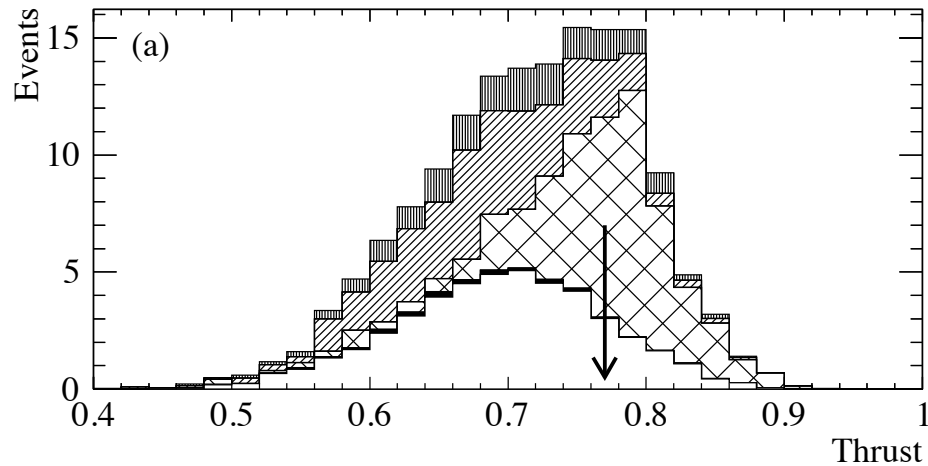
yield estimates

- the thrust cut now reduces the TBW sample more
- TTZ** is now the largest background contribution

	$t\bar{t}H(6j)$	$t\bar{t}H(8j)$	$t\bar{t}H(4j)$	tbW	$t\bar{t}Z$	$t\bar{t}g^*(b\bar{b})$
no cuts	282.3	289.5	68.3	980738.5	2406.9	1159.6
single isolated lepton	179.6	20.7	28.3	340069.0	790.6	397.7
6-jet + lepton (-0.8,+0.3)						
thrust < 0.77	145.7	18.5	19.2	144999.0	616.7	266.0
$Y_{5\rightarrow 4} > 0.005$	125.5	16.6	9.2	12297.7	416.2	113.7
b -tagging	49.0	1.3	2.9	172.9	53.3	37.8
mass cuts	39.5	1.2	0.4	23.0	33.9	13.2

	$t\bar{t}H(8j)$	$t\bar{t}H(6j)$	$t\bar{t}H(4j)$	tbW	$t\bar{t}Z$	$t\bar{t}g^*(b\bar{b})$
no cuts	289.5	282.3	68.3	980738.5	2406.9	1159.6
reject isolated leptons	266.3	85.6	6.6	589716.0	1351.4	701.2
8-jet (-0.8,+0.3)						
thrust < 0.7	167.7	44.0	2.7	107227.0	818.0	311.5
$Y_{8\rightarrow 7} > 0.0007$	130.1	17.4	0.4	6693.7	424.0	97.2
b -tagging	76.6	9.3	0.2	312.9	93.2	57.9
mass cuts	56.7	0.5	0.0	47.5	55.2	18.6

final plots: 6-jet + lepton (-0.8,+0.3), 1 ab⁻¹

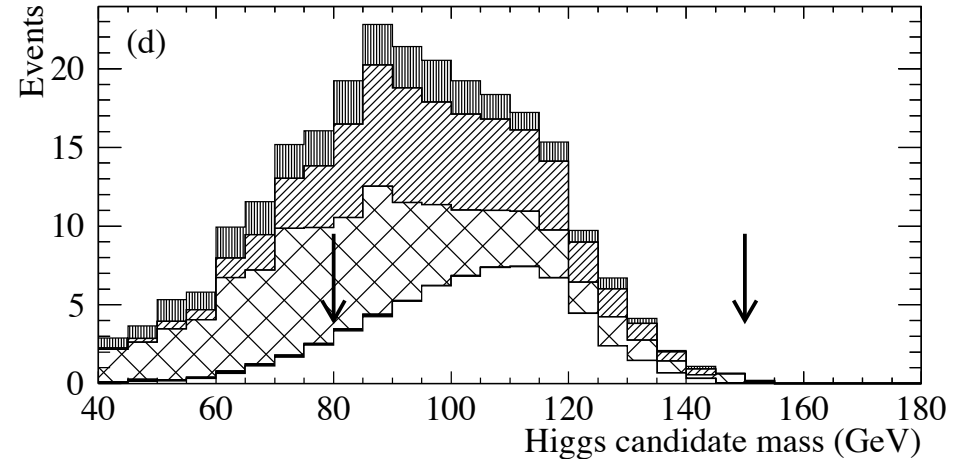
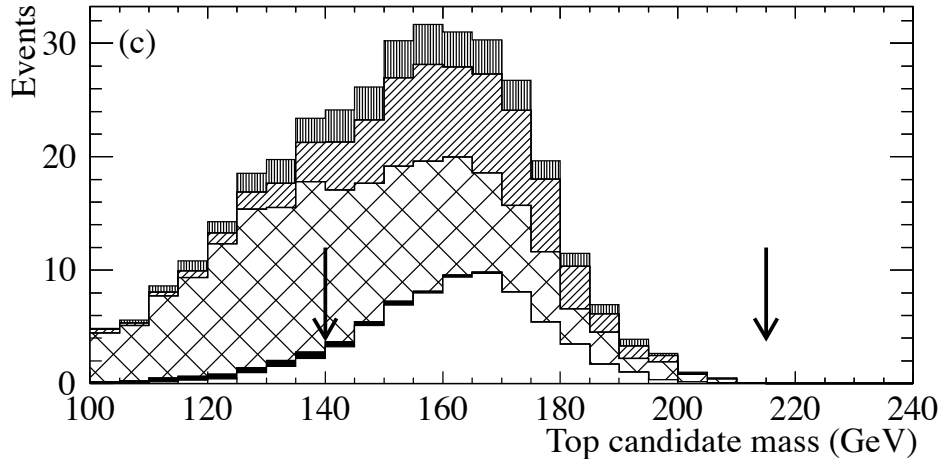
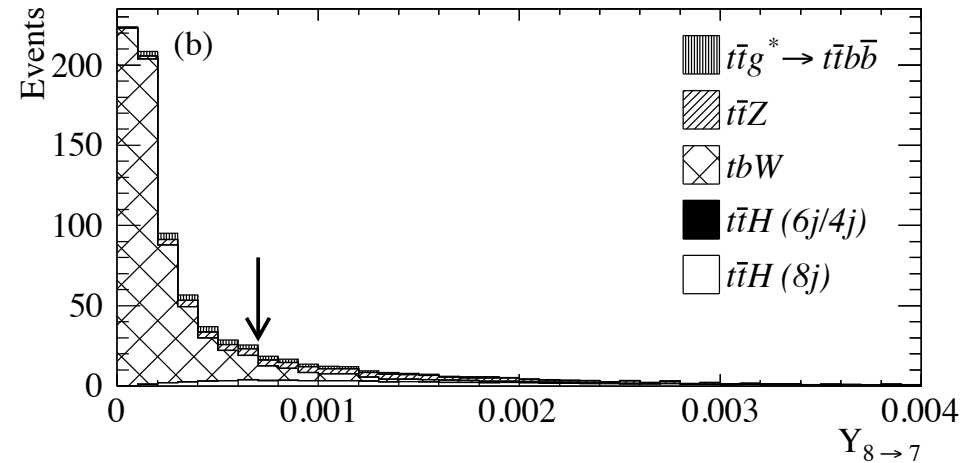
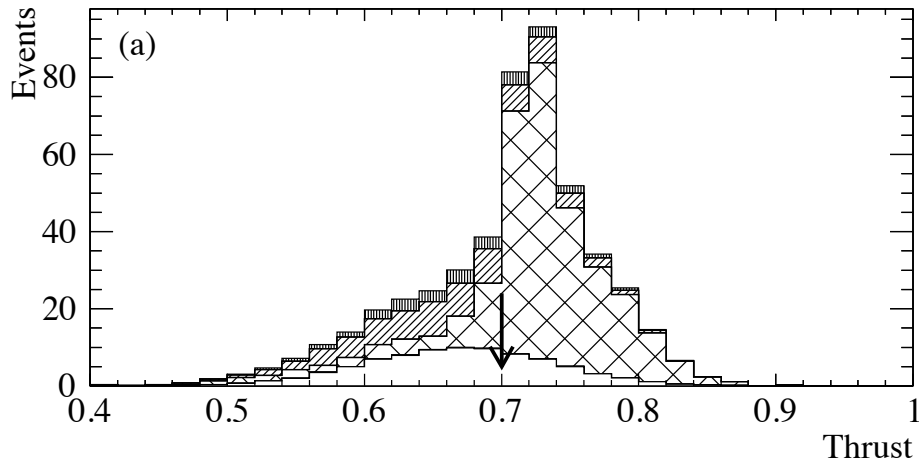


6-jet + lepton mode:

significance 3.7, $|\Delta g_t/g_t| = 14\%$ (-0.8,+0.3)

significance 2.9, $|\Delta g_t/g_t| = 17\%$ (0.0,0.0)

final plots: 8-jet (-0.8,+0.3), 1 ab-1



8-jet mode:

significance 4.2, $|\Delta g_t/g_t| = 12\%$ (-0.8,+0.3)

significance 3.3, $|\Delta g_t/g_t| = 15\%$ (0.0,0.0)

6-jet + lepton & 8-jet combined:

significance 5.7, $|\Delta g_t/g_t| = 9\%$ (-0.8,+0.3)

significance 4.4, $|\Delta g_t/g_t| = 11\%$ (0.0,0.0)

conclusions

- TTH study now at final stage
 - paper final draft has been prepared
- pending review of the co-authors (theorists), we will upload the paper to arXiv next week
 - proceed to journal submission