

DIRECT MEASUREMENT OF THE TOP YUKAWA COUPLING

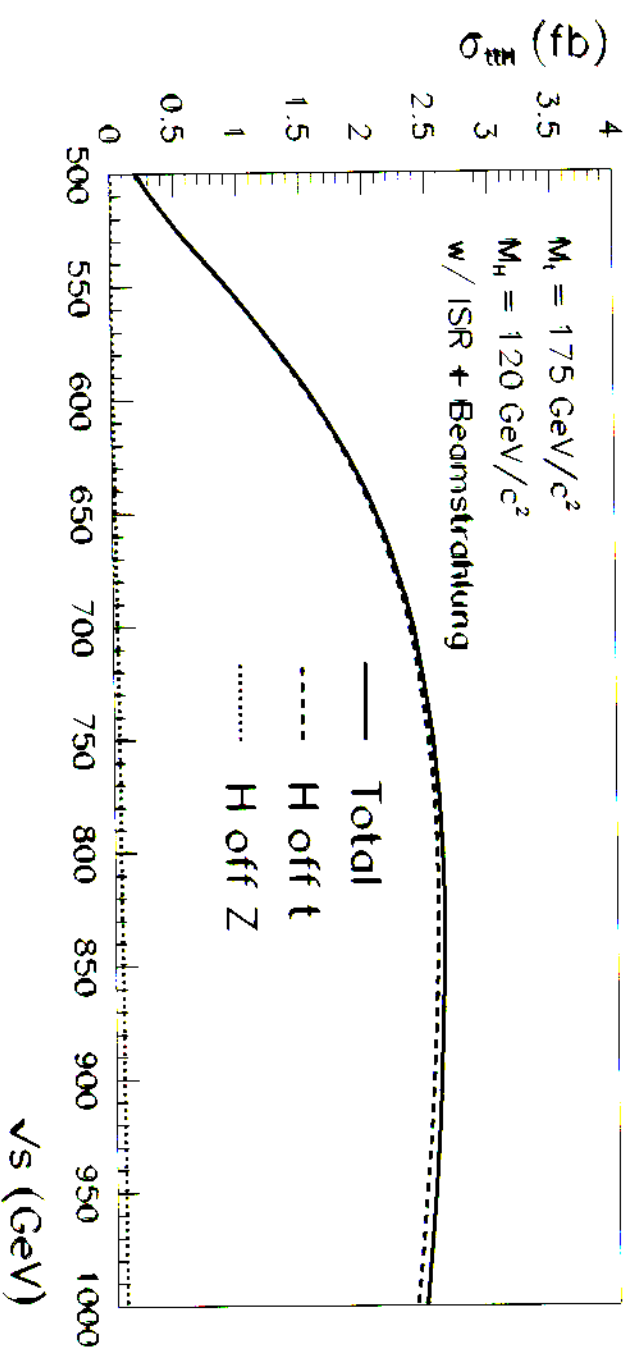
2 INDEP. ANALYSIS:

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($ttH \rightarrow \gamma q$)

* A. JUSTE, G. MERINO
($ttH \rightarrow \gamma q$; $t\bar{t}H \rightarrow b\bar{q}l\gamma$)

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Theoretical Scenario



- Higgs-strahlung diagrams dominate

$$\Rightarrow \sigma_{t\bar{t}H} \propto g_{t\bar{t}H}^2$$

BOTH ANALYSIS...

* ASS. CONDITIONS:

- $M_H = 120 \text{ GeV}$
- $\sqrt{s} = 800 \text{ GeV}$
- $\int \mathcal{L} dt = 1000 \text{ fb}^{-1}$

* ISR/BS INCLUDED

* EV. RECONSTRUCTION:

- DETECTOR (CDR) \rightarrow Simdet v.3.1
- VDET: CCD (R.beampipe = 1cm)

Background processes

	$\sigma(fb)$	Generator	N_{GEN}
$t\bar{t}Z$	4.57	$t\bar{t}Z$ Madgraph	100K
$t\bar{t}$	303.2	PYTHIA	1M
$qq(5f)$	1558.7	PYTHIA	1M
W/W	4401.1	PYTHIA	3.8M
ZZ	308.9	PYTHIA	300K

$t\bar{t}H \rightarrow 6q\nu$ Channel

- Look for a lepton candidate:

\Rightarrow That with max $E_l \cdot (1 - \cos\theta_{lT})$

- Force the rest to 6 jets
- Preselection cuts:

$$500 < M_{vis} < 750 \text{ GeV}$$

$$30 < N_{ch \text{ tot}} < 100$$

$$60 < N_{eflw \text{ tot}} < 190$$

$$N_{eflw/jet \text{ min}} > 2$$

$$N_{jets} (J_{ADE} y_{cut}=0.001) > 5$$

$$\text{Thrust} > 0.85$$

$$\text{Spher} > 0.2$$

$$h_{10} > 0.5 ; h_{20} > 0.7$$

$$h_{30} > 0.45 ; h_{40} > 0.5$$

$$P_{m_l} > 20 \text{ GeV} ; P_{m_h} > 120 \text{ GeV}$$

$$\sum_{i=1}^4 \text{Pbtag} (i) < 1.0$$

$t\bar{t}H \rightarrow 6q\nu$ Channel

- **Preselected events:**

$$\epsilon = 0.54 \cdot \text{BR}(WW \rightarrow l\nu qq) ; \rho = 0.0335$$

$$\left(\frac{\Delta g_{t\bar{t}H}}{g_{t\bar{t}H}} \right)_{\text{STAT}} \approx \left(\Delta g_{t\bar{t}H}^2 \right)_{\text{STAT}} = \frac{1}{S\sqrt{\epsilon\rho L}} \sim 11\%$$

...this is assuming a perfect knowledge of σ_{bckg} , but...

Considering:

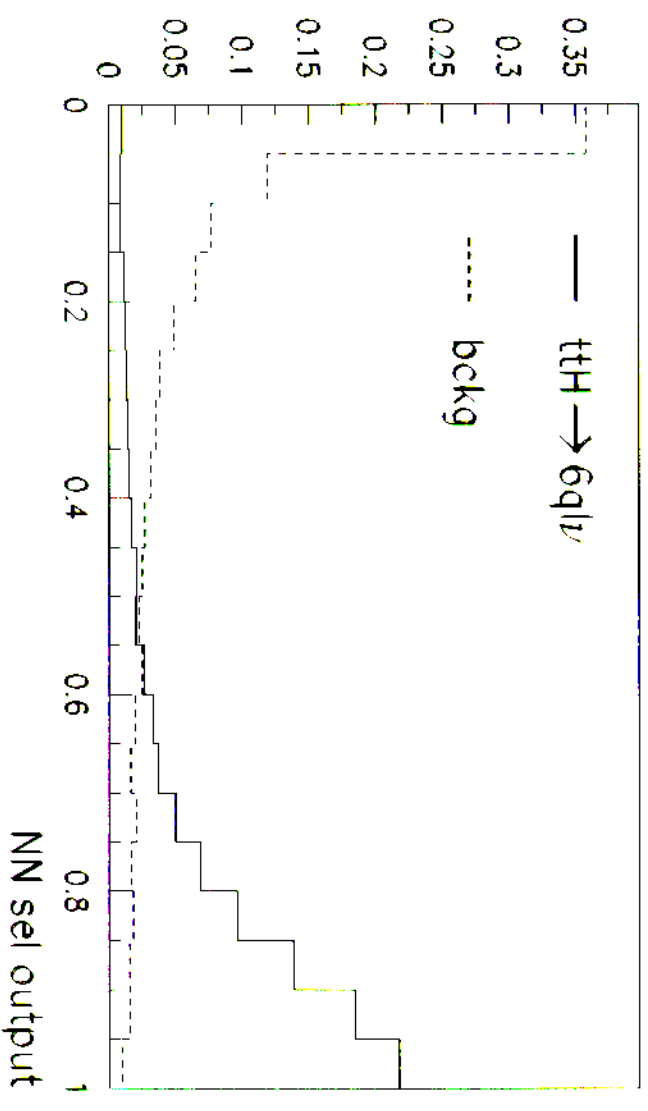
$$\left(\frac{\Delta\sigma_{\text{BCKG}}}{\sigma_{\text{BCKG}}} \right)_{\text{SYST}} \approx 5\%$$

$$\Rightarrow \left(\frac{\Delta g_{t\bar{t}H}}{g_{t\bar{t}H}} \right)_{\text{SYST}} \approx \left(\sigma_{t\bar{t}H} \left| \frac{d\sigma_{t\bar{t}H}}{dg_{t\bar{t}H}^2} \right|^{-1} \right) \frac{(1-\rho)}{\rho} \left(\frac{\Delta\sigma_{\text{BCKG}}}{\sigma_{\text{BCKG}}} \right) \sim 74\% !!$$

$t\bar{t}H \rightarrow 6q\nu$ Channel / Selection NN

- After training...

Variable	Discriminant Power (%)
Mwis	7.2
Njet(JADE)	9.0
$\Sigma P_{btag}(1-4)$	21.4
Log(Probbevt)	14.4
Thrust	8.5
Aplanarity	7.8
EI	11.8
Mass νl	10.8
$\cos\theta_{lJ}$	9.1



$t\bar{t}H \rightarrow 6q\nu$ Channel

- $g_{t\bar{t}H}$ measurement:

Method	$\Delta g_{t\bar{t}H}/g_{t\bar{t}H}$ (STAT) [%]	$\Delta g_{t\bar{t}H}/g_{t\bar{t}H}$ (SYST) [%]	$\Delta g_{t\bar{t}H}/g_{t\bar{t}H}$ (TOT) [%]	ϵ_s [%]
After preselect	11.5	63.1	64.1	54.08
Fit to N_{No}	4.4	9.1	10.1	54.08
Optimum N_{No} cut	5.5	5.2	7.6	21.7
Optimum N_{No} cut + Fit to N_{no}	5.1	3.8	6.3	21.7

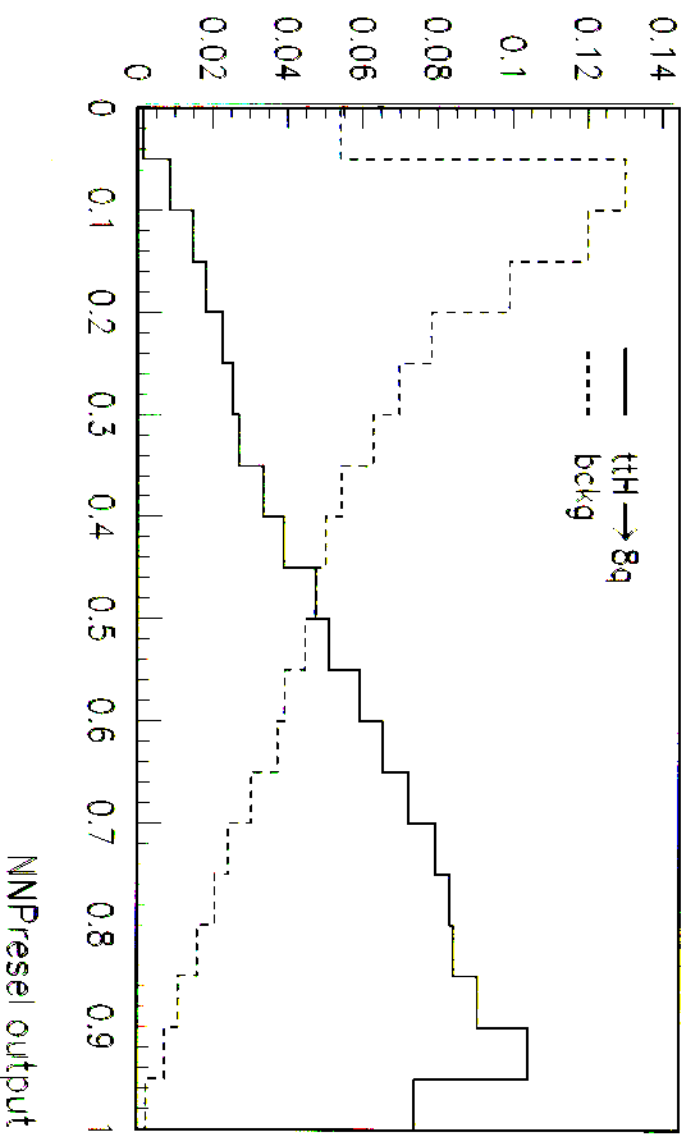
$t\bar{t}H \rightarrow 8q$ Channel

- Force the event to 8 jets (JADE)
- Preselection cuts:
 - $M_{vis} > 0.7\sqrt{s}$
 - $N_{eflow\ tot} > 120$
 - $N_{eflow}/jet\ m_{min} > 1$
 - $N_{jets\ (JADE)} > 6$
 - $m_{min\ di-jet\ inv\ mass} > 20\ GeV$

$t\bar{t}H \rightarrow 8q$ Channel / Preselection NN

- After training...

Variable	Discriminant Power (%)
Mis	15.3
N _{effw} tot	87
Min(N _{effw} /jet)	14.4
N _{jets} (JADE)	12.3
Min(M _{ij})	14.0
Log(Pr _{bbbar})	23.8
Pr _{tag4} Pr _{tag1}	11.5



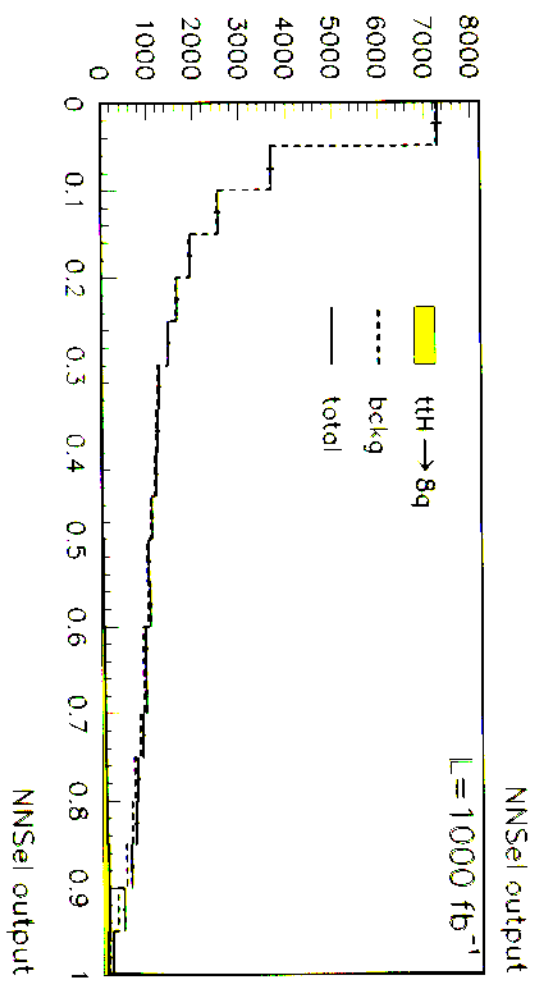
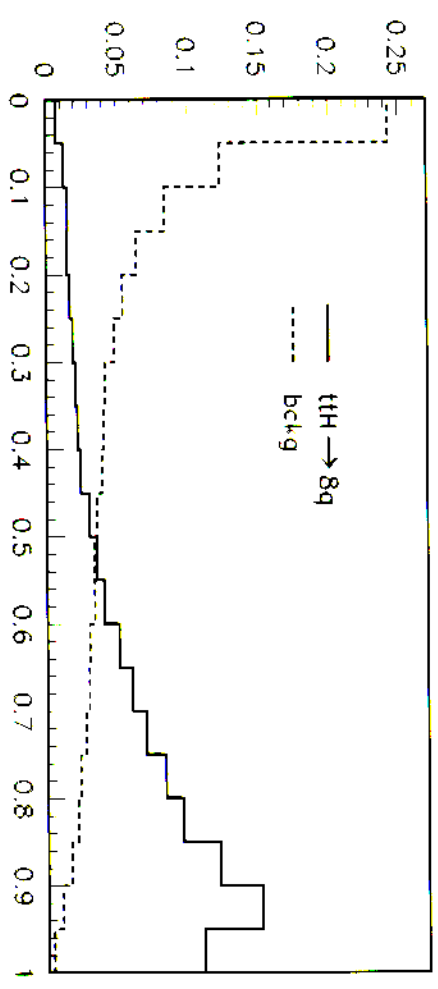
$t\bar{t}H \rightarrow 8q$ Channel / Selection NN

- After training...

Variable	Discriminant Power (%)
N jets	6.9
(L_{CLUS} dcut=6.5GeV) Σ P b tag ord	6.5
E jet max-E jet min	7.6
E vis	5.9
Thrust	13.3
Oblateness	5.4
P m h	7.3
P m l	8.2
Aplanarity	11.5
M H reco	11.7
NN O (pre sel)	15.7

Output

$t\bar{t}H \rightarrow 8q$ Channel / Selection NN



$t\bar{t}H \rightarrow 8q$ Channel

- $g_{t\bar{t}H}$ measurement:

Method	$\Delta g_{t\bar{t}H}/g_{t\bar{t}H}$ (STAT) [%]	$\Delta g_{t\bar{t}H}/g_{t\bar{t}H}$ (SYST) [%]	$\Delta g_{t\bar{t}H}/g_{t\bar{t}H}$ (TOT) [%]	ϵ_S [%]
After presel	9.8	83.5	83.5	76.7
Fit to N_{H0}	4.2	13.7	14.3	76.7
Optimum N_{H0} cut	7.3	3.0	7.9	8.5
Optimum N_{H0} cut + Fit to N_{H0}	7.2	2.9	7.8	8.5

A) Event generation

• $e^+e^- \rightarrow t\bar{t}b\bar{b}$

CompHEP

⇒ signal: $e^+e^- \rightarrow t\bar{t}H$
↳ $b\bar{b}$

irr. bkg: $e^+e^- \rightarrow t\bar{t}Z$
↳ $b\bar{b}$

$e^+e^- \rightarrow t\bar{t}g$
↳ $b\bar{b}$

$e^+e^- \rightarrow b\bar{b}g$
↳ $t\bar{t}$

In total 53 diagrams

- 2 of them involve $g(t\bar{t}H)$
- 1 diagram: Higgs radiation off Z
(strongly suppressed)

S. Moretti (hep-ph/9902214):

2 → 8 body: $e^+e^- \rightarrow b\bar{b}b\bar{b}l^{\pm}\nu_l q\bar{q}$ ($t\bar{t}H!$)

⇒ practically all of irr. bkg
 $e^+e^- \rightarrow t\bar{t}Z$
→ $t\bar{t}g$

c) Event analysis

$$\sqrt{s} = 800 \text{ GeV}; M_H = 120 \text{ GeV}$$

• General event selection criteria

- total visible energy : $> 360 \text{ GeV}$

- total transv. energy : $> 120 \text{ GeV}$

- # of charged particles : > 24

- # of jets : ≥ 8

for each jet :

• $E(\text{jet}) \geq 10 \text{ GeV}$

• $|\cos(\text{jet})| < 0.95$

• $\Delta(j_i, j_k) > 10^\circ$

• # of particles / jet ≥ 3

- # of b-jets : ≥ 3

Def. b-jet : # of tracks with
large impact parameter
($r_\phi; r_z$) ≥ 3

(large impact parameter:
 $DCA/\sigma \geq 3$)

and at least 1 out of the ≥ 3 -b jets

..... ≥ 4

..... ≥ 4

• criteria against background

- find the two non-b-jet pairings best compatible with W's
- if there are remaining 'light' jets, define them as b-jets
- find the two (b, W) pairings ↳ qq̄ best compatible with top → bW → b(qq̄)
- calculate for the remaining b-jets M(bb) with the constraints
$$72.5 < M(q\bar{q}) < 88.5 \text{ GeV}$$
$$160 < M(bW) < 185 \text{ GeV}$$
- energy-momentum conservation to improve the jet-energies

Reducible Backgrounds

- 1) $e^+e^- \rightarrow t\bar{t}(g)$ 350.000 events
- 2) $e^+e^- \rightarrow WW$ 5 Mill. events
- 3) $e^+e^- \rightarrow WWZ$
 $\rightarrow ZZZ$ } \rightarrow 6-jet events 20.000 thousand events

Reactions (1) and (3) are included !

Results

Estimating

of signal events S
of background events B } $M(B\bar{B})$:
100 - 130 GeV

$$\Rightarrow \frac{\sqrt{S+B}}{S} \approx 17\% \quad \text{for } \Delta\sigma(t\bar{t}H)$$

- semileptonic channel
- selection criteria robust, simple - not optimized
and if detailed detector behaviour known
 \rightarrow improvements

CONCLUSIONS:

- 2 IND. ANALYSIS LEADING TO LOW ATITBLE RESULTS FOR S/B SEPARATION
- B-TAGGING VARIABLES \rightarrow HIGH DISCR. POWER
- SCKG NORMALISATION UNCERTAINTY:
 - TAILS OF DISTRIBUTION ($\frac{\Delta O_B}{O_B} = ?$)
 - EXP. ANALYSIS CAN STILL BE REFINED IN ORDER TO HAVE $\delta \uparrow$ ($\epsilon \downarrow$)

WORK FOR SITGES:

- REPEAT ANALYSIS FOR OTHER VDETS AVAILABLE IN SIMULOT \rightarrow IMPACT ON $\frac{\Delta S_{\text{eff}}}{S_{\text{eff}}}$
- ESTIMATE THE $\frac{\Delta O_B}{O_B}$ BY GENERATING BCKGS WITH HERWIG