



Top electroweak couplings study using di-leptonic state at $\sqrt{s} = 500$ GeV, ILC with the Matrix Element Method

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Cut table (LCWS2017)

250 fb⁻¹ (-0.8,+0.3) Left	initial	$\mu^+ \mu^-$	b-tag1>0.8 or b-tag2>0.8	$q_{\min} < 3$ & $P_{z,\gamma} < 50$ GeV
Signal $bb\mu\mu\nu\nu$ (True)			1921 (80.9%)	945 (90.7%)
Signal $bb\mu\mu\nu\nu$ (Miss)	2961 (e = 92.0 %)	2725 (19.1%)	453 80.2%	97 (9.3%)
$bbll\nu\nu$ (except $bb\mu\mu\nu\nu$)	23609	387	335	71
$bblvqq$	104114	40	31	3
$qqll$ (ZZ)	91478	13800	2519	21
ll (weight = 4)	212274 (→ 849096)	74961 (→ 299844)	90 (→ 360)	0
$l\nu l\nu$ (WW) (weight = 4)	377058 (→ 1508232)	1884 (→ 7536)	3 (→ 12)	0
$lll\nu l\nu$ (llWW)	3021	947	19	0

Binned likelihood analysis (LCWS2017)

Estimate the number of events in each bin of the ω distribution described as function of δF , $N_b(\delta F)$, from the full MC simulation.

Fit $N_b(\delta F)$ to the "data" using the following $\chi^2(\delta F)$.

$$\chi^2(\delta F) = \sum_{b=1}^{N_{\text{bin}}} \frac{(n_b^{\text{Data}} - N_b(\delta F))^2}{n_b^{\text{Data}}}$$

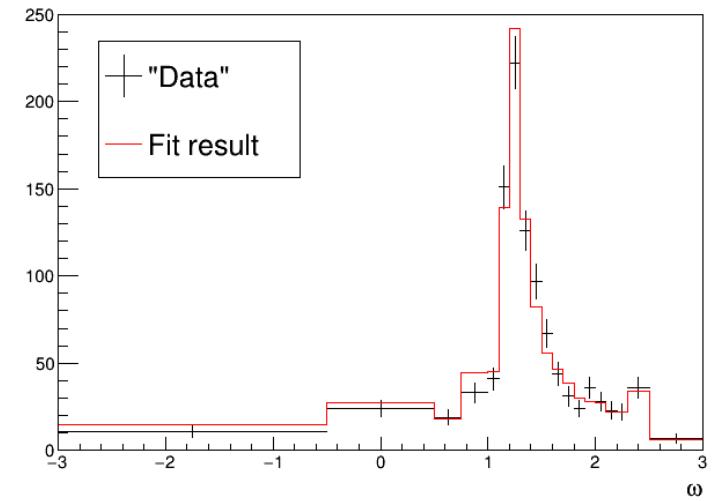
where n_b^{Data} is the number of events in bin b of the "data".

This method is by construction unbiased if the full MC simulation describes the "data" and one can use $\chi^2(\delta F)$ to assess the goodness of fit.

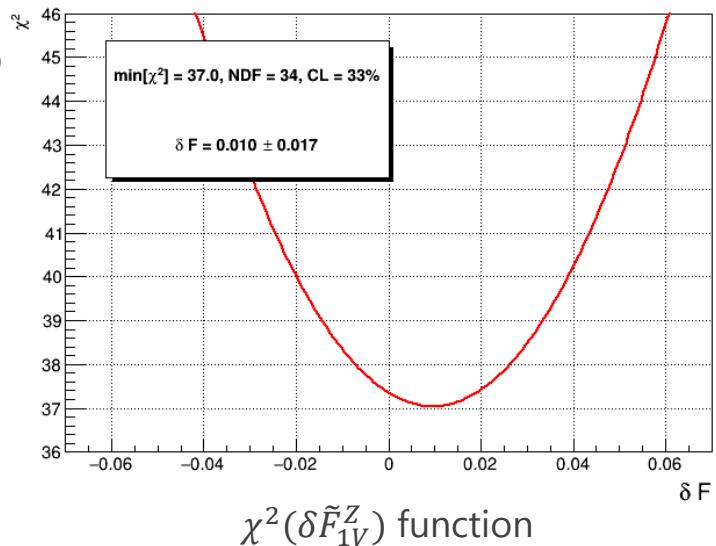
Example : Result of 1 parameter fit

$$\delta \tilde{F}_{1V}^Z = 0.010 \pm 0.017 \text{ (CL = 33%)}$$

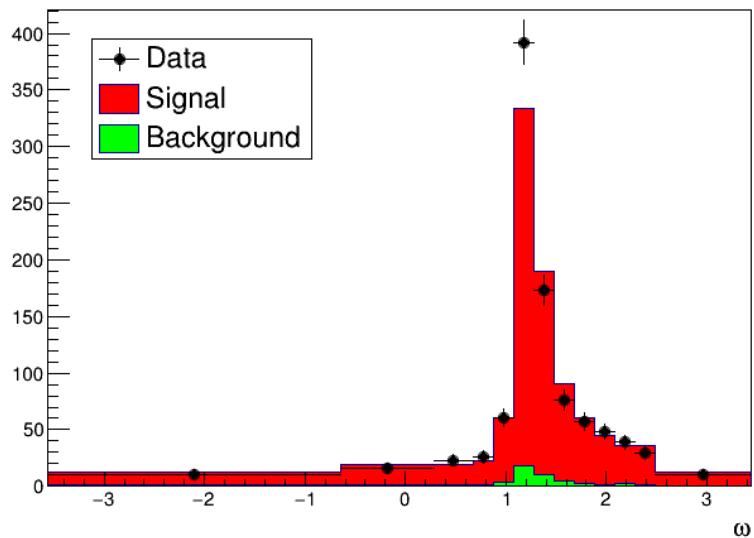
For the multi-parameter fit, more statistics of the full MC simulation is required.



ω distribution for δF_{1V}^Z of Left polarization events



Binned likelihood analysis



We modified the cut criteria, but the efficiency and purity are almost same.

Consider the background events, but only $b\bar{b}llvv$, which are dominant and are also depend on δF .

$$\chi^2(\delta F) = \sum_{b=1}^{N_{\text{bin}}} \frac{\left(n_b^{\text{Data}} - N_b^{\text{sig}}(\delta F) - N_b^{\text{bkg,tt}}(\delta F) \right)^2}{n_b^{\text{Data}}}$$

Result of 1 parameter fit

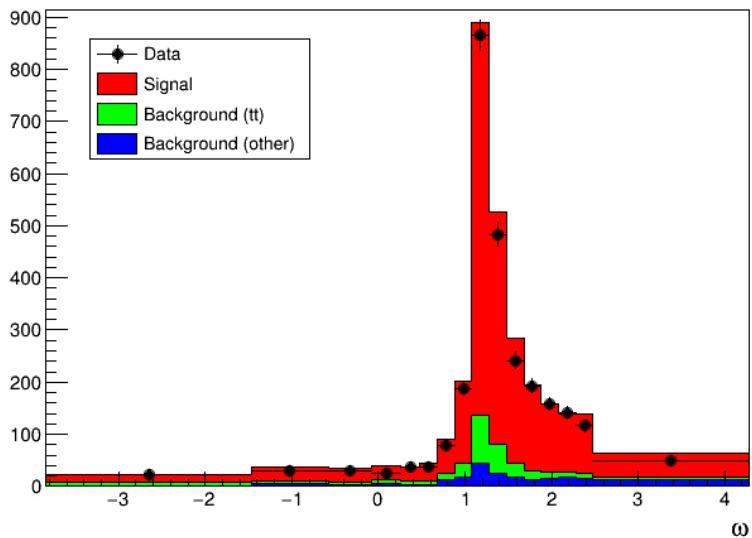
$$\delta \tilde{F}_{1V}^Z = -0.016 \pm 0.018 \text{ (CL = 9.1%)}$$

Binned likelihood analysis

However we don't need such tight cuts for the binned likelihood.

250 fb⁻¹ (-0.8,+0.3) Left	initial	$\mu^+ \mu^-$	b-tag1>0.8 or b-tag2>0.8	$q_{\min} < 10$
Signal $bb\mu\mu\nu\nu$ (True)			2059 (82.7%)	1856 (84.1%)
Signal $bb\mu\mu\nu\nu$ (Miss)	2837	2618 (e = 92.3 %)	430 (17.3%)	350 (15.9%)
$yyll\nu\nu$ (except $bb\mu\mu\nu\nu$)	23733	500	371	285
$yylvqq$	104114	40	35	8
$qqll$ (ZZ)	91478	13827	2943	180
ll (weight = 4)	212274 (\rightarrow 849096)	75147 (\rightarrow 300577)	152 (\rightarrow 608)	1
$lvlv$ (WW) (weight = 4)	28835 (\rightarrow 115340)	1776 (\rightarrow 7104)	6 (\rightarrow 24)	0

Binned likelihood analysis



Consider the all background events.

$$\chi^2(\delta F)$$

$$= \sum_{b=1}^{N_{\text{bin}}} \frac{(n_b^{\text{Data}} - N_b^{\text{sig}}(\delta F) - N_b^{\text{bkg,tt}}(\delta F) - N_b^{\text{bkg}})^2}{n_b^{\text{Data}}}$$

Result of 1 parameter fit

$$\delta \tilde{F}_{1V}^Z = -0.002 \pm 0.012 \text{ (CL = 20%)}$$

- Although there are large background, the result is consistent with the SM
- Thanks to looser cut, the statistical precision is improved.

Backup

Cut table

250 fb⁻¹ (-0.8,+0.3) Left	initial	$\mu^+ \mu^-$	b-tag1>0.8 or b-tag2>0.8	$q_{\min} < 10$
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