CDF Note 10584

Combination of the Forward-Backward Asymmetry in the Top Pair Production from L+J and DIL Channels using 5 fb^{-1}

Thomas Schwarz[1], Yen-Chu Chen[2], Yuji Takeuchi[3], Dan Amidei[4], Myron Campbell[4], Andrew Eppig[4], Dave Mietlicki[4], Glenn L Strycker[4], Monica Tecchio[4], Alexei Varganov[4], Tom Wright[4], Robin Erbacher[1], Joey Huston[5], Jaroslav Antos[6], Chang-Seong Moon[7], Youngdo Oh[8], Hyunsoo Kim[9]

[1] *University of California, Davis, USA;*
[2] *Institute of Physics, Academia Sinica, Taiwan;*
[3] *University of Tsukuba, Japan;*
[4] *University of Michigan, USA;*
[5] *Michigan State University, USA;*
[6] *Slovak Academy of Science, Slovakia;*
[7] *Seoul National University, Korea;*
[8] *Kyungpook National University, Korea;*
[9] *Chonbuk National University, Korea*

(Dated: July 7, 2011)

The forward-backward asymmetry in the $t\bar{t}$ production has been studied in both lepton plus jet and di-lepton channels, which yield results of $0.158 \pm 0.072_{stat} \pm 0.017_{sys}$ and $0.42 \pm 0.15_{stat} \pm 0.05_{sys}$ respectively. Combining these two results we obtain $0.20 \pm 0.07_{stat} \pm 0.02_{sys}$. This note describes the procedure of the combination.

I. INTRODUCTION

The forward-backward symmetry of the top pair production has been measured at CDF using both lepton plus jet (L+J) and di-lepton (DIL) samples. The results are $0.158 \pm 0.072_{stat} \pm 0.017_{sys}$ [1] and $0.42 \pm 0.15_{stat} \pm 0.05_{sys}$ [2] respectively. Where the L+J samples require one and only one high transverse momentum lepton plus multiple jets; the DIL samples require two and only two high transverse momentum leptons plus two or more jets. These two samples are mutually exclusive to each other.

The combination of the results from L+J and DIL samples is done via estimating the effective forward and backward events from both results; adding them individually and then computing the final asymmetry from the combined effective forward and backward number of events. Only statistical uncertainty is considered in estimating the effective forward and backward number of events.

Systematical uncertainties are considered for each given category via fluctuating the nominal value by one sigma up or down. The deviation from the final asymmetry if taken as the systematic uncertainty of that category.

II. SUMMARY OF L+J AND DIL RESULTS

A summary of the results from both L+J and DIL samples are given in Table I. Where the first raw shows the individual asymmetry, A_{fb}, result from L+J and DIL. The rest are the systematic uncertainties considered. The background of L+J affects only the L+J result but not the DIL result. Likewise the background of DIL affects only the DIL result but not the L+J result. The "JES" is the effect of the jet energy scale on both L+J and DIL results. The "PDF" is the uncertainty due to the Parton Distribution Function. The "Signal model" combines all other systematic uncertainties that are related to the signal modeling.

TABLE I: The forward-backward asymmetry of the $t\bar{t}$ pair production measured in both L+J and DIL samples

	L+J	DIL
A_{fb}	$0.158 \pm 0.072_{stat} \pm 0.017_{sys}$	$0.42 \pm 0.15_{stat} \pm 0.05_{sys}$
Background L+J	0.171	0
Background DIL	0	0.043
JES	0.007	0.008
PDF	0.005	0.004
Signal model	0.0065	0.029

III. COMBINATION

The asymmetry, A_{fb}, is computed as

$$A_{fb} = \frac{F-B}{F+B},$$

where F and B are the number of forward and backward events. Knowing A_{fb} and its statistical uncertainty one can estimate the effective F and B,

$$F = (1 + A_{fb})\frac{(1-A_{fb}^2)}{(2(dA_{fb})^2)},$$

$$B = (1 - A_{fb})\frac{(1-A_{fb}^2)}{(2(dA_{fb})^2)}.$$

The effective F and B are shown in Table II. These are combined to form the total F and B. From the combined F and B we obtain the total asymmetry of $0.201 \pm 0.065_{stat}$, where the uncertainty is statistical only.

For each category of the systematical uncertainties the A_{fb} of both L+J and DIL are fluctuated up and down based on their corresponding uncertainties. New F and B numbers for both L+J and DIL are calculated and combined

TABLE II: The effective forward and backward number of events from both L+J and DIL A_{fb} measurements.

	F	B
LJ	108.9	79.2
DIL	26.0	10.6
Combined	134.9	89.8

for the calculation of fluctuated A_{fb}. The average of deviation from the nominal value is quoted as the systematic uncertainty for the given category. Table III shows the uncertainties of the categories considered. The combined systematic uncertainty is 0.018.

TABLE III: The uncertainties of the combined result

	sys.
background LJ	0.011
background DIL	0.0054
JES	0.0070
PDF	0.0047
Signal model	0.0092

IV. CONCLUSION

Combing the A_{fb} results from both L+J and DIL samples we obtain

$$A_{fb} = 0.20 \pm 0.07_{stat} \pm 0.02_{sys}.$$

This is 2.9 σ deviation from no asymmetry.

[1] T. Schwarz et al., CDF note 10224 (2010).
[2] Y. Takeuchi et al., CDF note 10398 (2011).