



# **Results:** Boosted top quark pair production at multi-TeV CLIC (1.4/3 TeV)

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# Extraction of observables



- Updated equation with a more “natural and modern theoretical language”
- At tree level the three terms can be related to the cross sections for producing top-quark pairs with different helicity combinations for the two top quarks in the final state

$$\frac{d\sigma}{d\cos\theta} = \sigma_1(1 + \cos\theta)^2 + \sigma_2(1 - \cos\theta)^2 + \sigma_3(1 - \cos^2\theta)$$

## **Old parametrisation**

$$\frac{d\sigma}{d\cos\theta} = \frac{3}{8}(1 + \cos^2\theta)\sigma_U + \frac{3}{4}\sin^2\theta\sigma_L + (\sigma_U + \sigma_L)A_{\text{FB}}\cos\theta$$

# Extraction of observables



- Updated equation with a more “natural and modern theoretical language”
- At tree level the three terms can be related to the cross sections for producing top-quark pairs with different helicity combinations for the two top quarks in the final state

## Derivation

$$\sigma_{\text{F}} = \int_0^1 \frac{d\sigma}{d(\cos\theta)} d(\cos\theta) = \frac{1}{3}(7\sigma_1 + \sigma_2 + 2\sigma_3),$$

$$\sigma_{\text{B}} = \int_{-1}^0 \frac{d\sigma}{d(\cos\theta)} d(\cos\theta) = \frac{1}{3}(\sigma_1 + 7\sigma_2 + 2\sigma_3).$$

## Observables

$$\sigma_{\text{t}\bar{\text{t}}} = \sigma_{\text{F}} + \sigma_{\text{B}} = (4/3)(2\sigma_1 + 2\sigma_2 + \sigma_3).$$

$$A_{\text{FB}} = \frac{\sigma_{\text{F}} - \sigma_{\text{B}}}{\sigma_{\text{F}} + \sigma_{\text{B}}} = \frac{1}{\sigma_{\text{t}\bar{\text{t}}}} 2(\sigma_1 - \sigma_2).$$

# Asymmetry extraction at 1.4 TeV



- Cross section and asymmetry extracted from fit (scaled to MC Truth level), statistical uncertainty from background taken into account through  $\sqrt{S+B}$
- Cross section uncertainty in parenthesis assumes uncorrelated errors

$P(e^-) = -80\%$

$\sqrt{s'}$ [GeV] 750 fb <sup>-1</sup>	$A_{FB}$ True <sup>***</sup>	$A_{FB}$ Reco	$\sigma^*$ True [fb]	$\sigma^*$ Reco [fb]
>1200 <sup>**</sup>	0.563	0.561 ± 0.018 (0.018)	18.41	18.45 ± 0.43 (1.08)
>1200	0.563	0.561 ± 0.018 (0.033)	18.41	18.45 ± 0.43 (0.97)
900-1200	0.551	0.550 ± 0.023 (0.043)	11.04	11.06 ± 0.33 (0.74)
400-900	0.452	0.451 ± 0.031 (0.054)	16.56	16.57 ± 0.62 (1.45)

\*same values presented as last meeting (Alasdair adapted code to the same procedure as used here)

\*\*fit performed with old parametrisation ( $A_{FB}$  from 1 parameter, cross section from 2). New parametrisation has  $A_{FB}$  from 2 parameter, cross section from 3)

\*\*\*extracted from count (will be updated)

# Asymmetry extraction at 1.4 TeV



- Cross section and asymmetry extracted from fit (scaled to MC Truth level), statistical uncertainty from background taken into account through  $\sqrt{S+B}$
- Cross section uncertainty in parenthesis assumes uncorrelated errors

**$P(e^-) = +80\%$**

$\sqrt{s'}$ [GeV] 750 fb <sup>-1</sup>	$A_{FB}$ True <sup>***</sup>	$A_{FB}$ Reco	$\sigma^*$ True [fb]	$\sigma^*$ Reco [fb]
>1200 <sup>**</sup>	0.620	0.619 ± 0.019 (0.019)	9.83	9.86 ± 0.26 (0.64)
>1200	0.620	0.619 ± 0.019 (0.038)	9.83	<b>9.86 ± 0.26 (0.57)</b>
900-1200	0.607	0.608 ± 0.027 (0.058)	5.86	5.91 ± 0.22 (0.51)
400-900	0.523	0.513 ± 0.046 (0.078)	8.63	8.69 ± 0.45 (1.05)

\*same values presented as last meeting (Alasdair adapted code to the same procedure as used here)

\*\*fit performed with old parametrisation ( $A_{FB}$  from 1 parameter, cross section from 2). New parametrisation has  $A_{FB}$  from 2 parameter, cross section from 3)

\*\*\*extracted from count (will be updated)

# Asymmetry extraction at 3 TeV



- Asymmetry extracted from fit (scaled to MC Truth level), statistical uncertainty from background taken into account through  $\sqrt{S+B}$
- Cross section uncertainty extracted from  $\sqrt{S+B}/S$  (fit results in parenthesis)
- Results at 3 TeV still with preliminary MVA cut

$P(e^-) = -80\%$	$\sqrt{s'} \text{ [GeV]} \ 1500 \text{ fb}^{-1}$	$A_{\text{FB}} \text{ True}^{***}$	$A_{\text{FB}} \text{ Reco}$	$\sigma^* \text{ True [fb]}$	$\sigma^* \text{ Reco [fb]}$
	>2600	0.592	$0.586 \pm 0.09 \ (0.176)$	3.48	$3.72 \pm 0.53 \ (1.15)$
$P(e^-) = +80\%$	$\sqrt{s'} \text{ [GeV]} \ 1500 \text{ fb}^{-1}$	$A_{\text{FB}} \text{ True}^{***}$	$A_{\text{FB}} \text{ Reco}$	$\sigma^* \text{ True [fb]}$	$\sigma^* \text{ Reco [fb]}$
	>2600	pending	pending	pending	pending