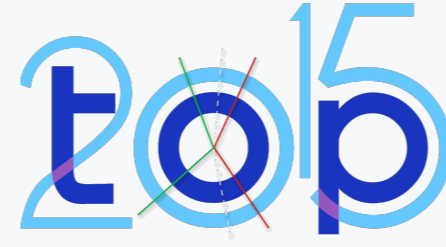


Measurement of associated top-quark-pair and b-jet production at CMS

PLB 746 (2015) 132 | CMS-TOP-13-010

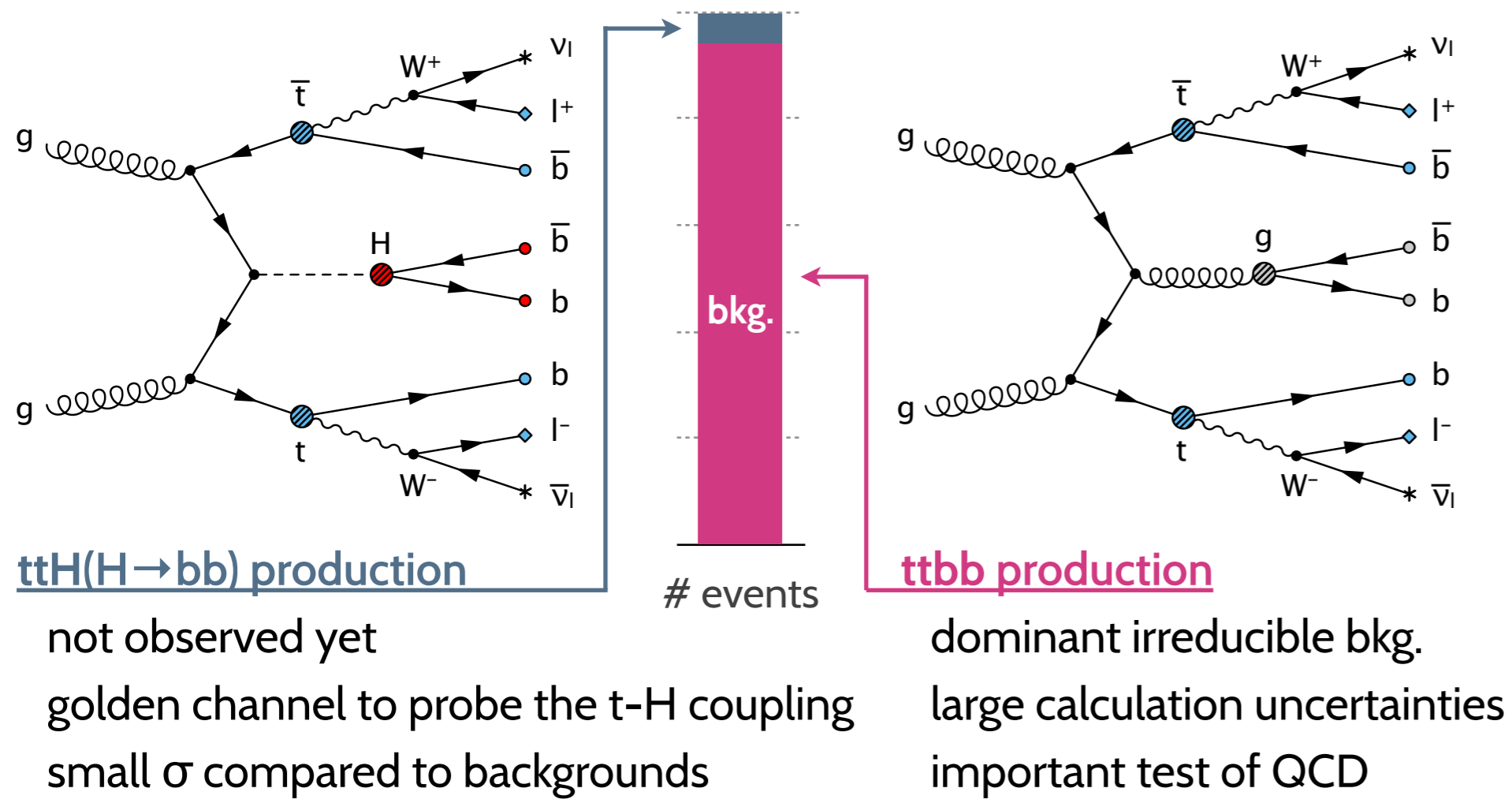


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on behalf of the CMS Collaboration



TOP2015 (8th International Workshop on Top Quark Physics)
14-18th September, Ischia, Italy

1. Measurement motivation



2. Cross-section definition: dileptonic final state

VISIBLE phase space: particle level jets

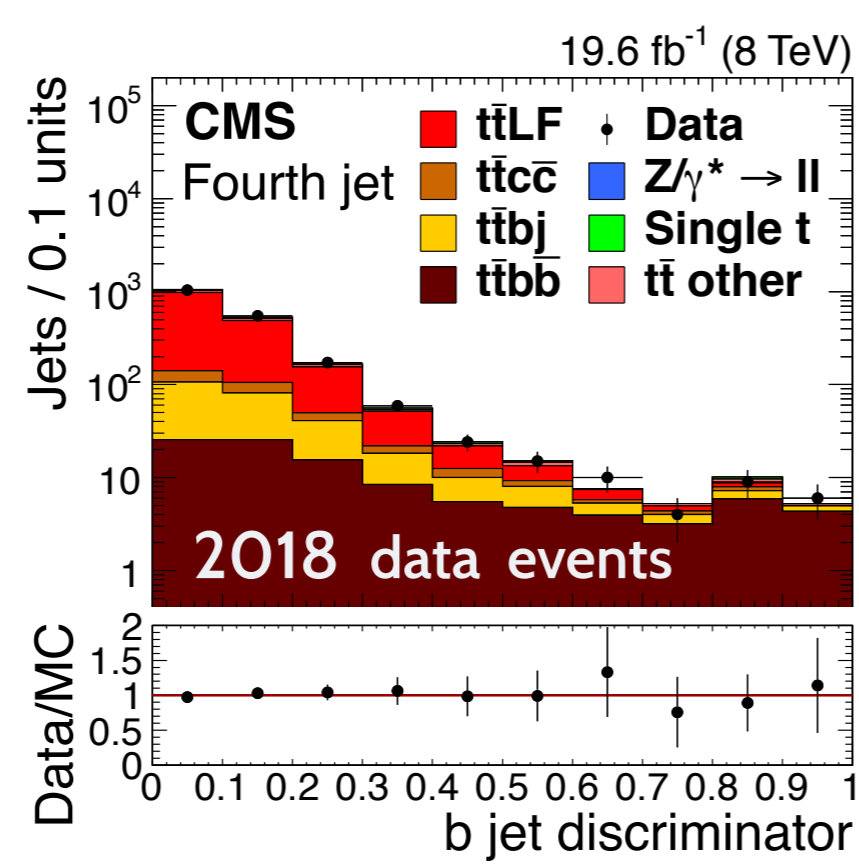
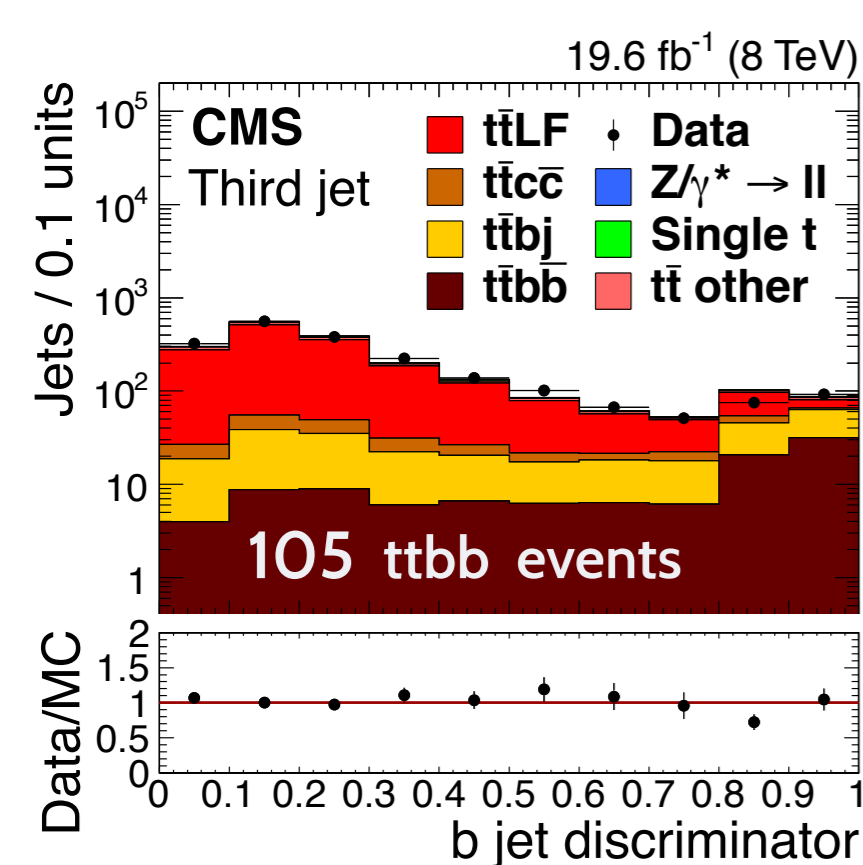
<ul style="list-style-type: none"> 2 charged leptons: $p_T > 20$ GeV/c $\eta < 2.4$ $t \rightarrow W \rightarrow e/\mu$ OR $t \rightarrow W \rightarrow \tau \rightarrow e/\mu$ ≥ 4 jets: $p_T > 20$ GeV/c $\eta < 2.5$ stable particles except $\nu \rightarrow$ anti-k_T clustering: $R=0.5$ $\Delta R(l, j) > 0.5$ ≥ 2 b jets: $p_T > 20$ GeV/c $\eta < 2.5$ containing decay products of a B hadron ≥ 4 b jets: $p_T > 20$ GeV/c $\eta < 2.5$ containing decay products of a B hadron 	ttjj
<ul style="list-style-type: none"> ≥ 2 jets: $p_T > 20$ (40) GeV/c $\eta < 2.5$ partons: g, u, d, s, c, b \rightarrow anti-k_T clustering: $R=0.5$ ≥ 2 b jets: $p_T > 20$ (40) GeV/c $\eta < 2.5$ closest to b quarks not from $t \rightarrow b$: $\Delta R(b\text{-quark}, b\text{-jet}) < 0.5$ 	ttbb

FULL phase space: stable t quarks, parton-level jets

<ul style="list-style-type: none"> ≥ 2 jets: $p_T > 20$ (40) GeV/c $\eta < 2.5$ partons: g, u, d, s, c, b \rightarrow anti-k_T clustering: $R=0.5$ ≥ 2 b jets: $p_T > 20$ (40) GeV/c $\eta < 2.5$ closest to b quarks not from $t \rightarrow b$: $\Delta R(b\text{-quark}, b\text{-jet}) < 0.5$ 	ttjj
<ul style="list-style-type: none"> ≥ 2 b jets: $p_T > 20$ (40) GeV/c $\eta < 2.5$ closest to b quarks not from $t \rightarrow b$: $\Delta R(b\text{-quark}, b\text{-jet}) < 0.5$ 	ttbb

3. Event selection [ee/μμ channels only]

- dilepton trigger: $ee, e\mu, \mu\mu$ | $p_{T,1} > 17$ GeV/c | $p_{T,2} > 8$ GeV/c
- ≥ 1 isolated l^+l^- pair: lepton $p_T > 20$ GeV/c, $|\eta| < 2.4$
- $m_{ll} > 12$ GeV/c | $m_{ll} \notin m_Z \pm 15$ GeV/c²
- $E_T > 30$ GeV/c² | $E_T = -|\sum \vec{p}_T| \leftarrow$ all reconstructed particles
- ≥ 4 jets: $p_T > 30$ GeV/c, $|\eta| < 2.5$ | anti- k_T : $R=0.5$
- ≥ 2 b-tagged jets: $P_{mistag} = 0.1\%$ | $\epsilon_b \approx 45\%$



7. Summary

- Cross section of ttbb production and $\sigma_{ttbb}/\sigma_{ttjj}$ ratio measured by CMS.
- Analysed pp collisions recorded at $\sqrt{s}=8$ TeV during 2012, corresponding to the integrated luminosity of 19.6 fb⁻¹ (extending CMS-PAS-TOP-12-024)

4. Cross-section measurement: template fit

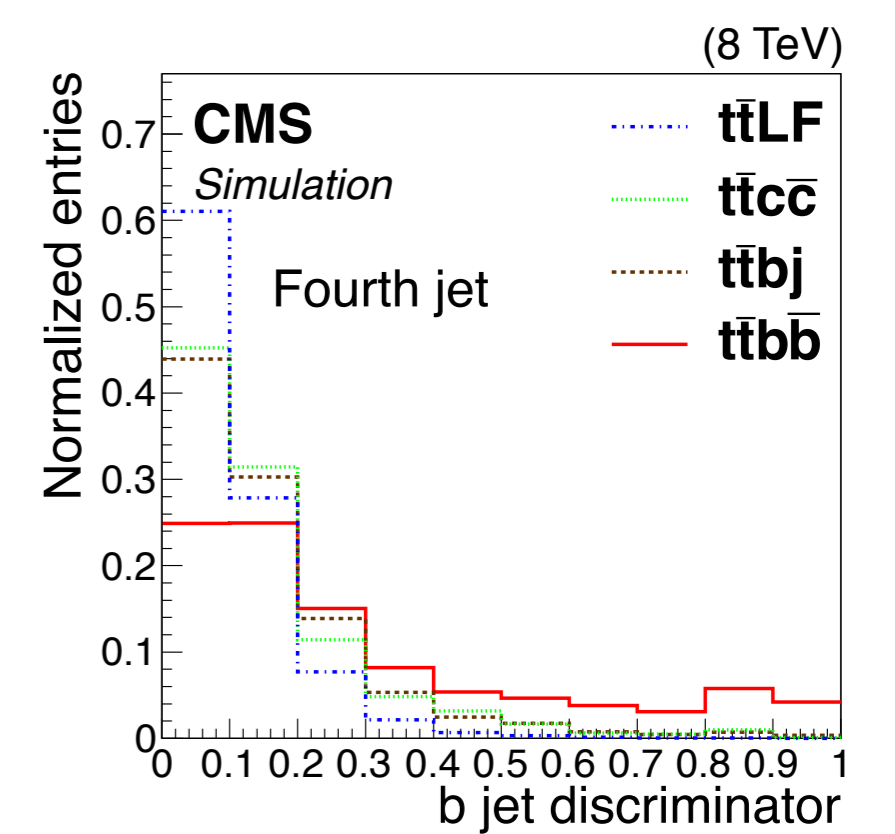
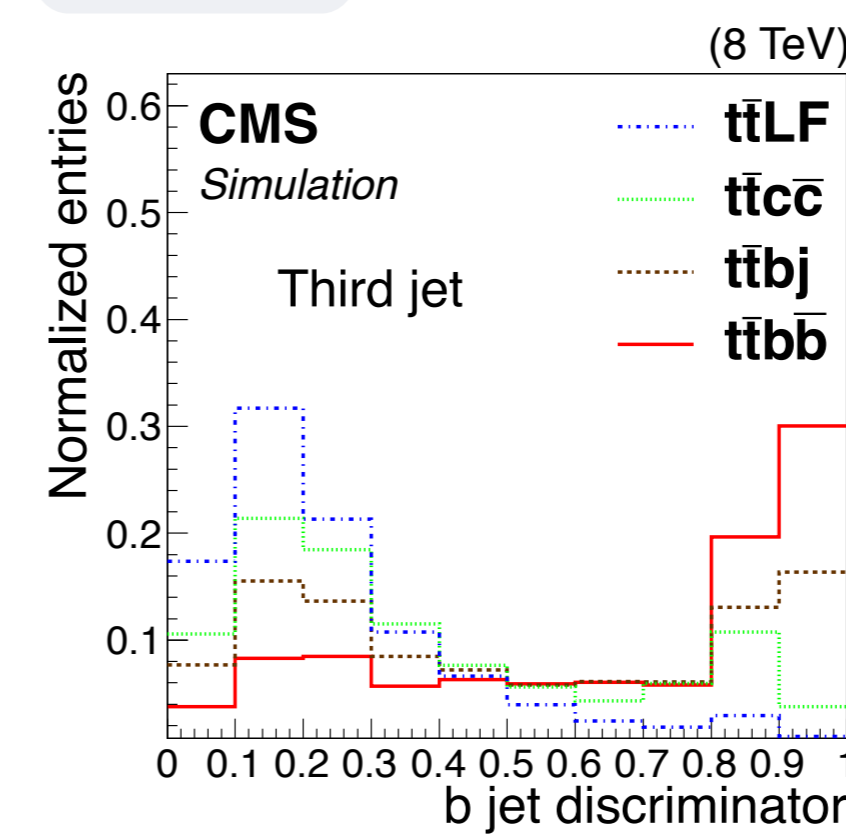
Jets ordered by b-tag discriminant: \downarrow CSV

Combined template fit for the 3rd and 4th jet discriminant: 2 parameters

$$f(k, R) = N_{bkg}^{data-driven} + k \cdot N_{bkg}^{MC} + k \cdot N_{ttjj} \cdot [R \cdot N_{ttbb}^{norm} + R' \cdot N_{ttbj}^{norm} + (1 - R - R') \cdot N_{ttLF+ttcc}^{norm}]$$

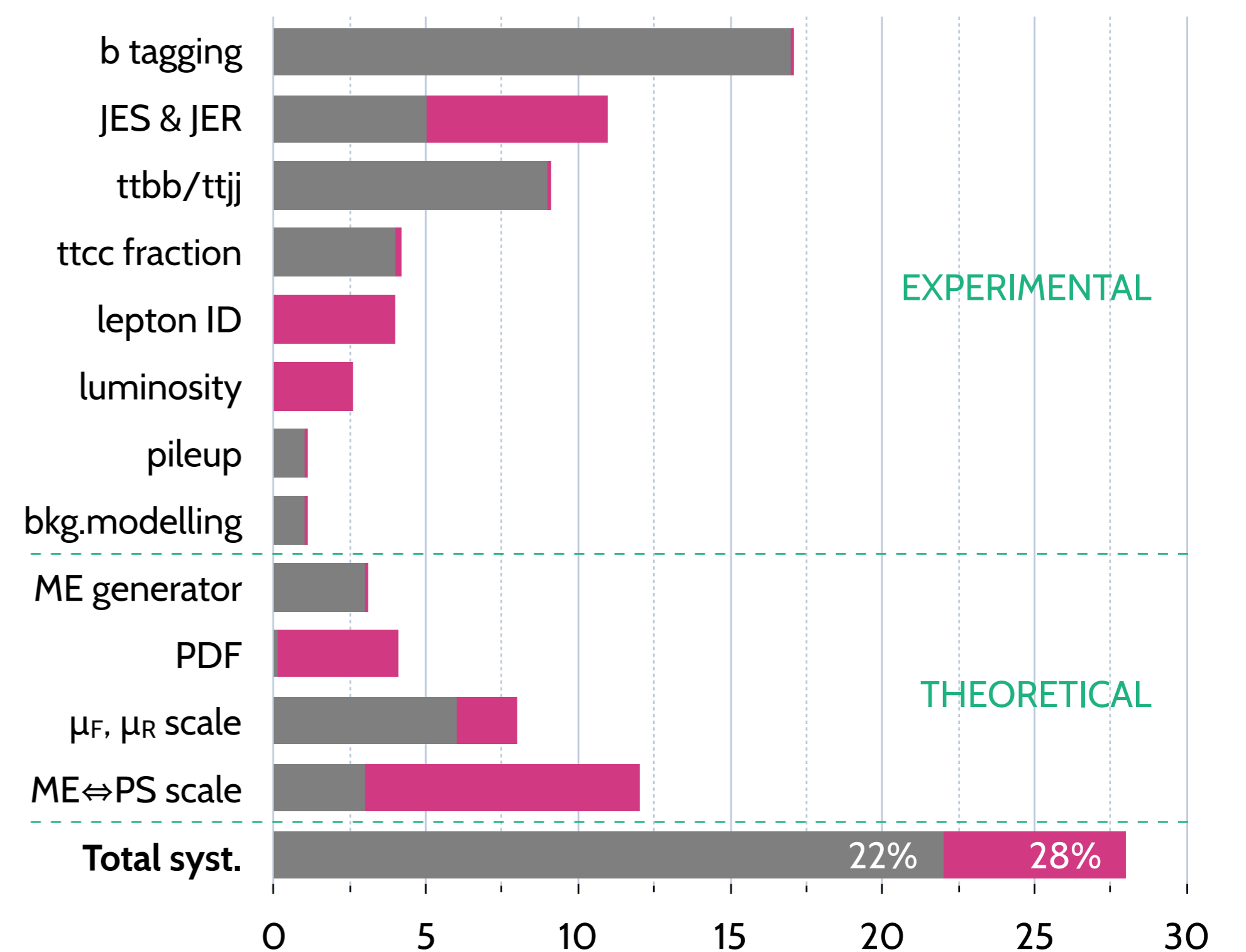
$$k = ttbj/ttjj \quad + \text{acceptance correction:} \quad R = ttbb/ttjj$$

$$\frac{\sigma_{ttbb}}{\sigma_{ttjj}} = R \cdot \frac{\epsilon_{ttbb}}{\epsilon_{ttjj}} = R \cdot \frac{18.7\%}{7.2\%}$$



5. Systematic uncertainties: σ_{ttbb} VS $\sigma_{ttbb}/\sigma_{ttjj}$

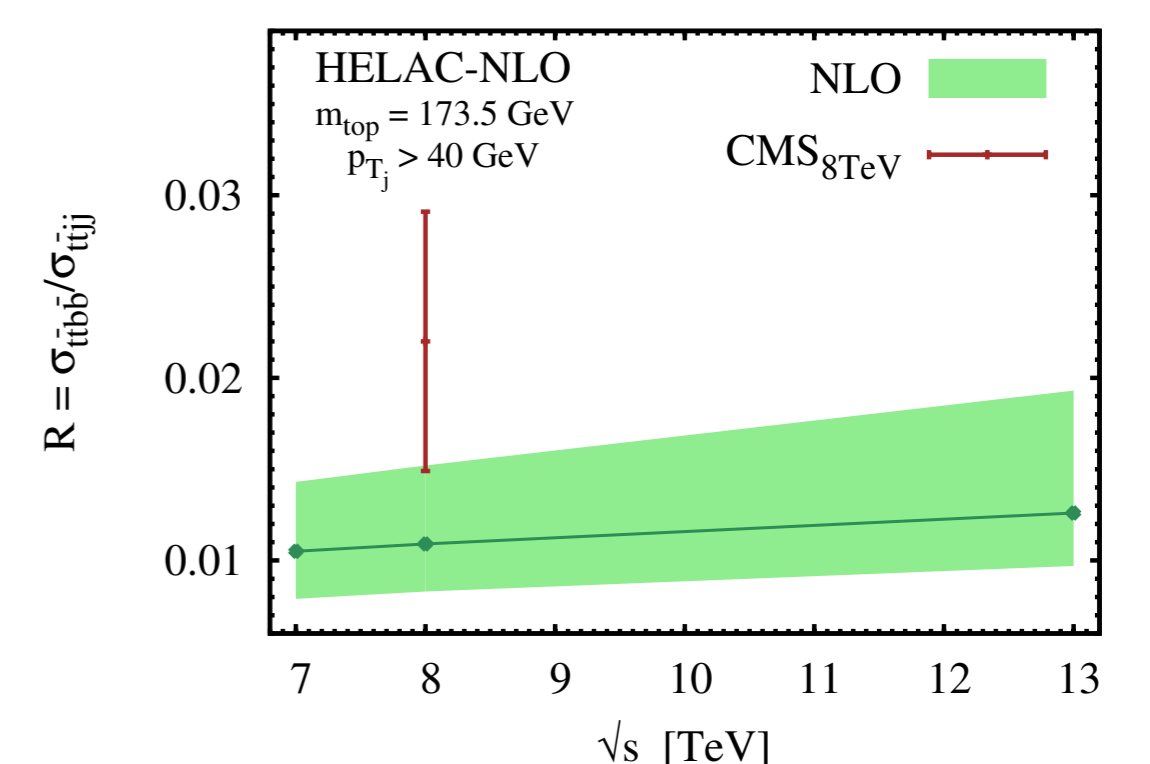
Partial cancellation of uncertainties in the ratio: $\sigma_{ttbb}/\sigma_{ttjj}$



6. Results

	Additional jets	σ_{ttbb} [fb]	$\sigma_{ttbb}/\sigma_{ttjj} \times 10^{-2}$
Visible PS	$p_T > 20$ GeV/c	29±3±8	2.2±0.3±0.5
Full PS	$p_T > 40$ GeV/c	360±80±100	2.2±0.4±0.5
(NLO) Full PS	$p_T > 40$ GeV/c	230±50	1.1±0.3

- $\sigma_{ttbb}/\sigma_{ttjj}$ ratio consistent between full and visible phase space
- Measured σ_{ttbb} and $\sigma_{ttbb}/\sigma_{ttjj}$ higher than HELAC-NLO prediction
- Compatible with NLO within 1.6 standard deviations



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- Measurement compatible with NLO theory predictions within uncertainties.
- Differential σ_{ttbb} measurement as a function of b-jet kinematic properties in preparation: a stronger test of QCD, sideband region for a ttH(H→bb) search.