



$t/\bar{t} + X$ CMS for HL/HE LHC

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Plan

- Interest
 - Precision x-sec measurements of $TT+W$, tZq .
and differential $TT+Z$, $TT(2l)+\text{Gamma}$
 - BSM & EFT interpretations – electroweak top couplings
- Status
 - ttZ/W 13 TeV incl. xsec + EFT submitted <https://arxiv.org/abs/1711.02547>
 - $tt + \gamma$ at 8 TeV, no result yet on 13 TeV
- HL/HE specific:
the forward jet category in tZq can profit from upgrade
 - Otherwise, projections are probably sufficient
- EFT/BSM Interpretation:
 - plan to project sensitivity of differential $TT+Z$ measurements

TTZ Interpretation

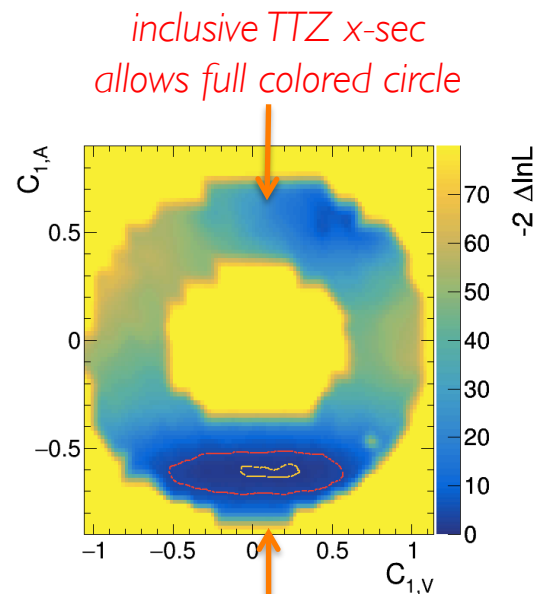
- Anomalous couplings modify differential x-sec

$$\mathcal{L}_{SM+BSM} = e\bar{u}(p_t) \left(\gamma^\mu (\underline{C_{1,V}} + \gamma^5 C_{1,A}) + \frac{i\sigma^{\mu\nu} q_\nu}{m_Z} (\underline{C_{2,V}^Z} + i\gamma^5 C_{2,A}^Z) \right) v(p_{\bar{t}}) Z_\mu$$

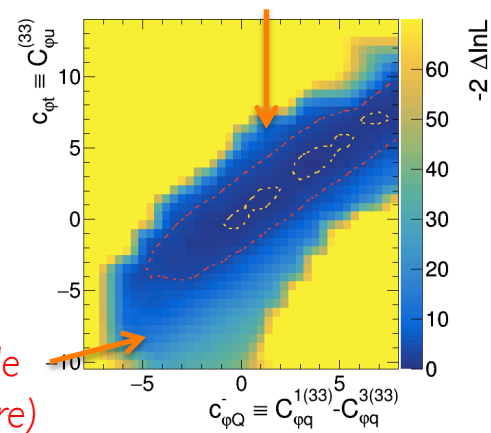
- Alternatively, parameterize in EFT context.
Recent paper emerged from TopLHCWG
[1] <https://arxiv.org/pdf/1802.07237.pdf>

- Adopt a minimal strategy to exploit $p_T(Z)$ in TTZ for BSM search.
Based on gen-level reweighting of a strategy similar to <http://inspirehep.net/record/1467646>

- Example plots to the right are scaled to $3/ab$.
Anomalous ttZ couplings (top)
and EFT [1] (bottom).



inclusive TTZ x-sec allows full colored circle
differential TTZ x-sec pins down anomalous couplings (contours)

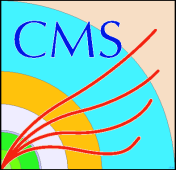


inclusive TTZ x-sec allows full colored circle (show only a wedge here)



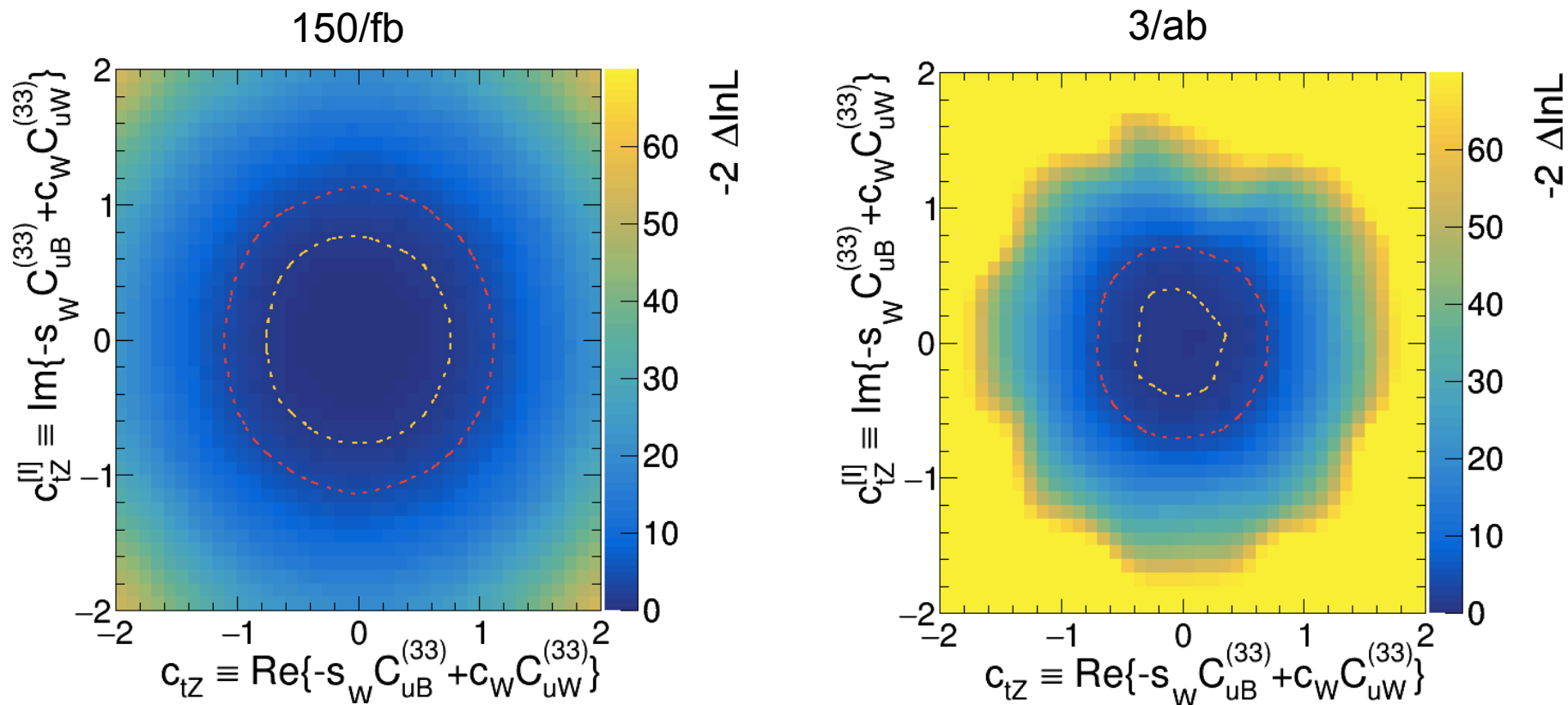
Plan

- Plan to have more 1D & 2D maps of Wilson coefficient limits and anomalous couplings and comparing scenarios
- Timeline
 - for TTZ differential, $TT+W$, $TT(2l)+G$ plan to project sensitivity to $3/\text{ab}$ (2-3 months)
 - use Delphes samples if helpful (tZq ?) and to estimate systematics
 - similar timescale for ttZ differential projection
 - BSM & EFT projection is ready, consider using Delphes samples for a better estimate on uncertainties
- Background samples: TT , DY , $TT+H$, WZ , $ttWZ$
- Manpower: 3 Ph.D, 2 Postdocs



Backup

top EWK dipole moments



- TT+Z differential mock-up scaled to 150/fb and 3/ab
- EFT based on <https://arxiv.org/pdf/1802.07237.pdf>
- The two WC c_{tZ}/c_{tZ}^{II} induce top EWK dipole moments