Sensitivity to HWW anomalous couplings at ATLAS

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Motivation

- Higgs boson discovered in 2012, needs to be scrutinized
  → can be a window for BSM physics
- CP-odd Higgs couplings not predicted in the SM
  → **modify shapes of distributions**
- **CP-odd couplings entail CP violation, required to explain observed baryonic asymmetry**

Theoretical framework: extended HWW vertex

Effective Field Theory techniques

- **model-independent** approach to parametrize deviations to the SM
  → add higher dimensional operators to $\mathcal{L}_{SM}$
  * combinations of SM operators
  → valid for energy scales **below the lowest new physics scale**, Λ

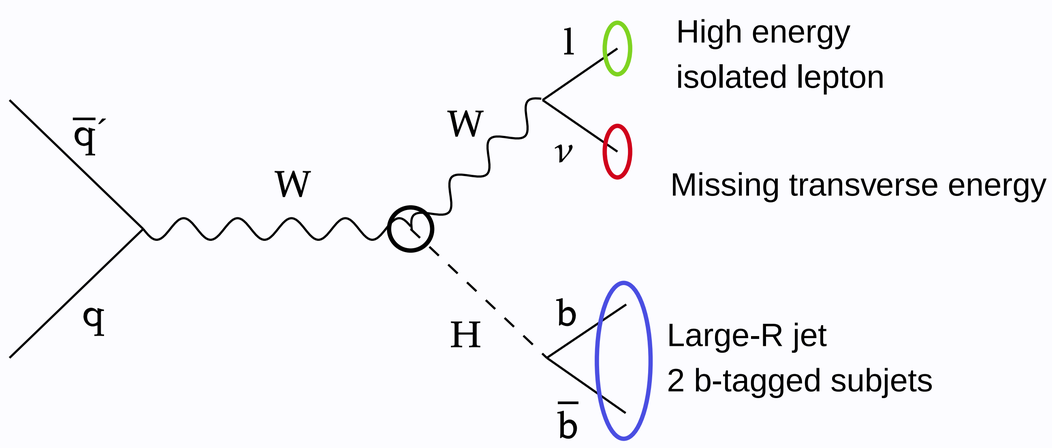
$$i\Gamma^{\mu\nu}_{HWW}(k_1,k_2) = i(g_2 m_W)\left[\eta^{\mu\nu}\left(1+a_W-\frac{b_{W1}}{m_W^2}(k_1\cdot k_2)+\frac{b_{W2}}{m_W^2}(k_1^2+k_2^2)\right)\right.$$
$$\left.+\frac{b_{W1}}{m_W^2}\,k_1^\nu k_2^\mu-\frac{b_{W2}}{m_W^2}\,(k_1^\mu k_1^\nu+k_2^\mu k_2^\nu)+\frac{c_W}{m_W^2}\epsilon^{\mu\nu\rho\sigma}k_{1_\rho}k_{2_\sigma}\right]$$

- k_1, k_2: gauge boson momenta
- a_W: additional CP-even SM contribution ($a_w = 0 \Leftrightarrow SM$)
- b_{W1}, b_{W2}: **CP-even** BSM couplings
- c_W: **CP-odd** BSM coupling

Boosted WH production

BSM couplings push p_T distributions to higher values

- **increased sensitivity at higher energies**



Angular observables

Higher dimensional operators **modify spin correlations**

- differences in angular observables, such as

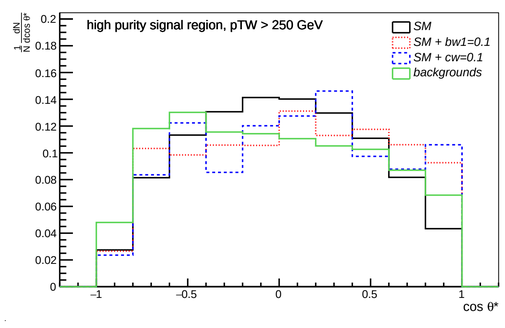
$$\cos\theta^* = \frac{\mathbf{p}^{(W)}_{l_1}\cdot\mathbf{p}_W}{|\mathbf{p}^{(W)}_{l_1}||\mathbf{p}_W|} \qquad \cos\delta^+ = \frac{\mathbf{p}^{(W)}_{l_1}\cdot(\mathbf{p}_H\times\mathbf{p}_W)}{|\mathbf{p}^{(W)}_{l_1}||\mathbf{p}_H\times\mathbf{p}_W|}$$

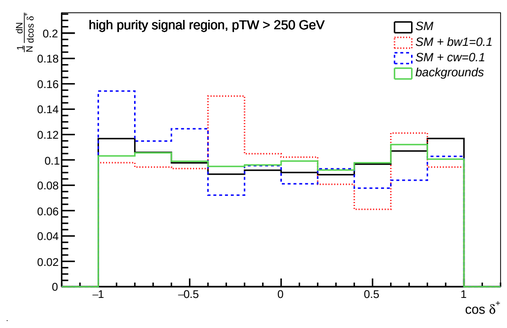
- $\mathbf{p}^{(W)}_{l_1}$ = 3-momentum of charged lepton in W rest frame

Analysis

Reconstrution-level comparison

- detector simulation, event reconstruction and full event selection applied
- comparing **shape-only** (unit area)



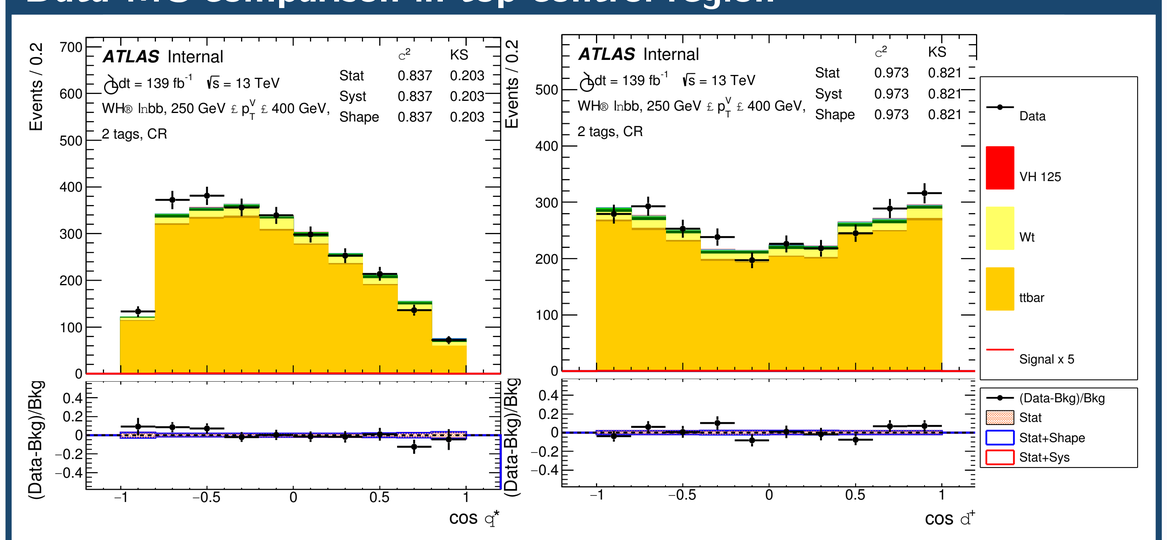


- SM signal and backgrounds skewed to lower values w.r.t BSM signals
- symmetric for SM signal and backgrounds
- **asymmetric for SM+CP-odd coupling**

Contributions to ATLAS analysis

- boosted Higgs tagging strategy studies
- event selection optimization

Data-MC comparison in top control region



$\cos\theta^*$(left) and $\cos\delta^+$(right) in the $t\bar{t}$ control region for 250 GeV $< p_{T_W} <$ 400 GeV

- **well modelled for backgrounds**

Conclusions

Angular observables such as $\cos\theta^*$ and $\cos\delta^+$ are sensitive to the CP-odd coupling and should be implemented in future work

Next steps:

- implement in next iteration of ATLAS analysis
- study methods to extract value of CP-odd coupling
  → calculation of asymmetry
  → multivariable method

Acknowledgements

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