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Constraining EFT operators in the Top sector using ATLAS data

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EFT for new physics

- Many searches for new particles from BSM theories
- Unfortunately we have not found a new particle
- Constraining EFT operators another way to look for new physics - complementary way to search for new physics

EFT for new physics

- EFT (Effective field theory) is an low energy approximative theory that do not introduce new degrees of freedom below the cut-off energy scale Λ
- It is a way to introduce new physics that does not require new particles at energies we are probing in experiments today

EFT for new physics

- EFT Lagrangian can be written (ignoring the dimension 5 operators that only involve leptons and Higgs fields)

$$\mathcal{L} = \mathcal{L}_{SM} + \sum_i \frac{c_i}{\Lambda^2}\mathcal{O}_i + \ldots$$

- The operators of interest in the top sector:

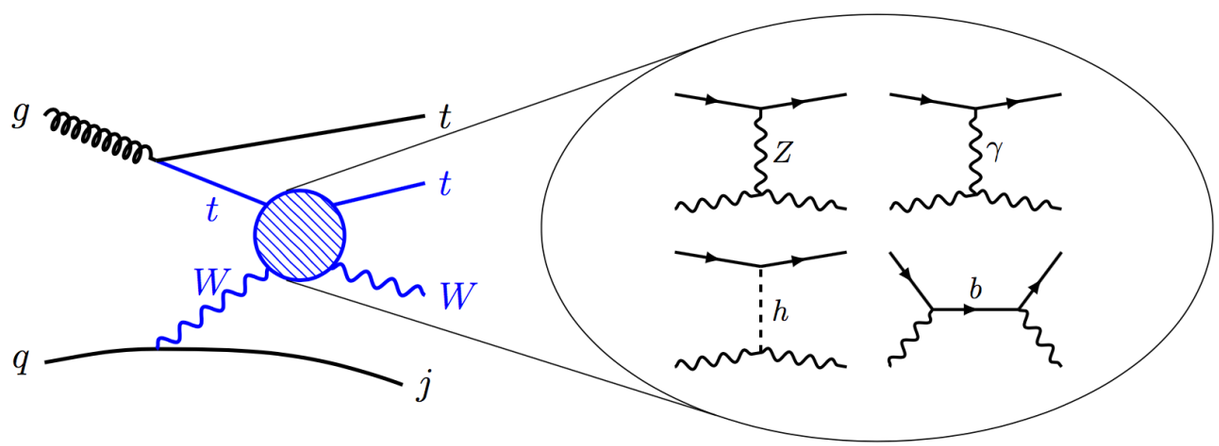
$$\begin{aligned}\Delta\mathcal{L}_t = & \frac{i\bar{c}_L^{(1)}}{v^2} H^\dagger \overleftrightarrow{D_\mu} H \bar{q}_L \gamma^\mu q_L + \frac{i\bar{c}_L^{(3)}}{v^2} H^\dagger \sigma^a \overleftrightarrow{D_\mu} H \bar{q}_L \gamma^\mu \sigma^a q_L \\ & + \frac{i\bar{c}_R}{v^2} H^\dagger \overleftrightarrow{D_\mu} H \bar{t}_R \gamma^\mu t_R + \frac{i\bar{c}_R^b}{v^2} H^\dagger \overleftrightarrow{D_\mu} H \bar{b}_R \gamma^\mu b_R + \left(\frac{i\bar{c}_R^{tb}}{v^2} \tilde{H}^\dagger \overleftrightarrow{D_\mu} H \bar{t}_R \gamma^\mu b_R + \text{h.c.} \right) \\ & + \frac{\bar{c}_u y_t}{v^2} H^\dagger H \bar{q}_L \tilde{H} t_R + \text{h.c.} \ ,\end{aligned}$$

where $\widetilde{H} = i\sigma_2 H$

[1] arXiv:1205.4231v1

Coupling between top and Z

- Not all dimension 6 operators are involved in all the physical processes
- In our analysis we are only interested in the ones that affect the top-Z couplings
- A promising way to constrain these operators is to study the scattering process of $Wt \to Wt$



[1] arXiv:1205.4231v1

Why Wt scattering?

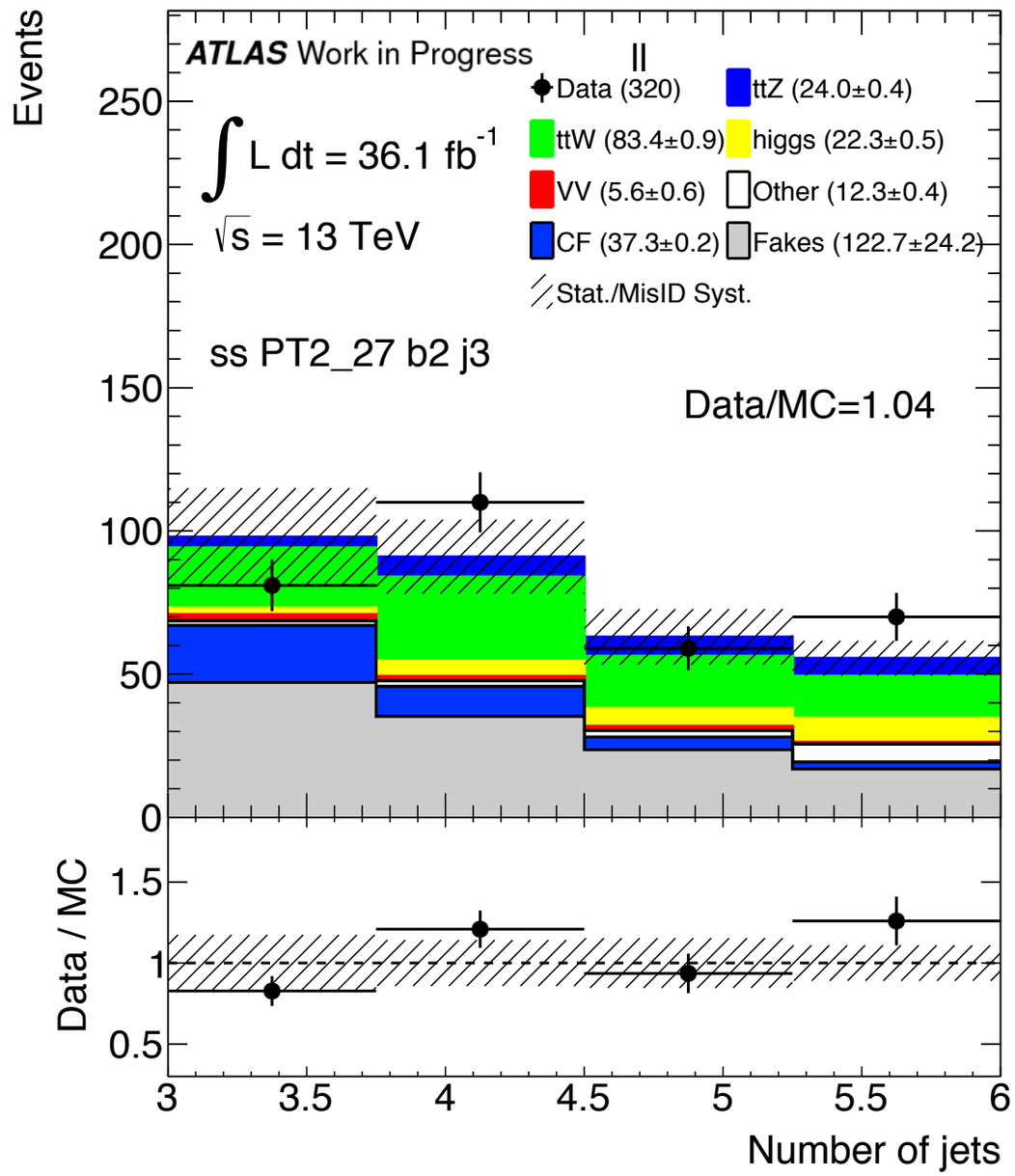
There are a few advantages of using Wt scattering to constrain EFT operators between the top quark and Z boson[1]:

1. The ttWj process have a same sign lepton final state which is a rare state in SM
2. The amplitude of Wt scattering increases with the square of energy, Λ^2, while ttZ increases with Λ if the top-Z couplings differ from the SM.
   Ztt coupling is of interest since this can be affected by new physics as opposed to the Zbb coupling. Zbb coupling has been measured at LEP (with high accuracy) to the SM value.

[1] arXiv:1205.4231v1

ttWj analysis

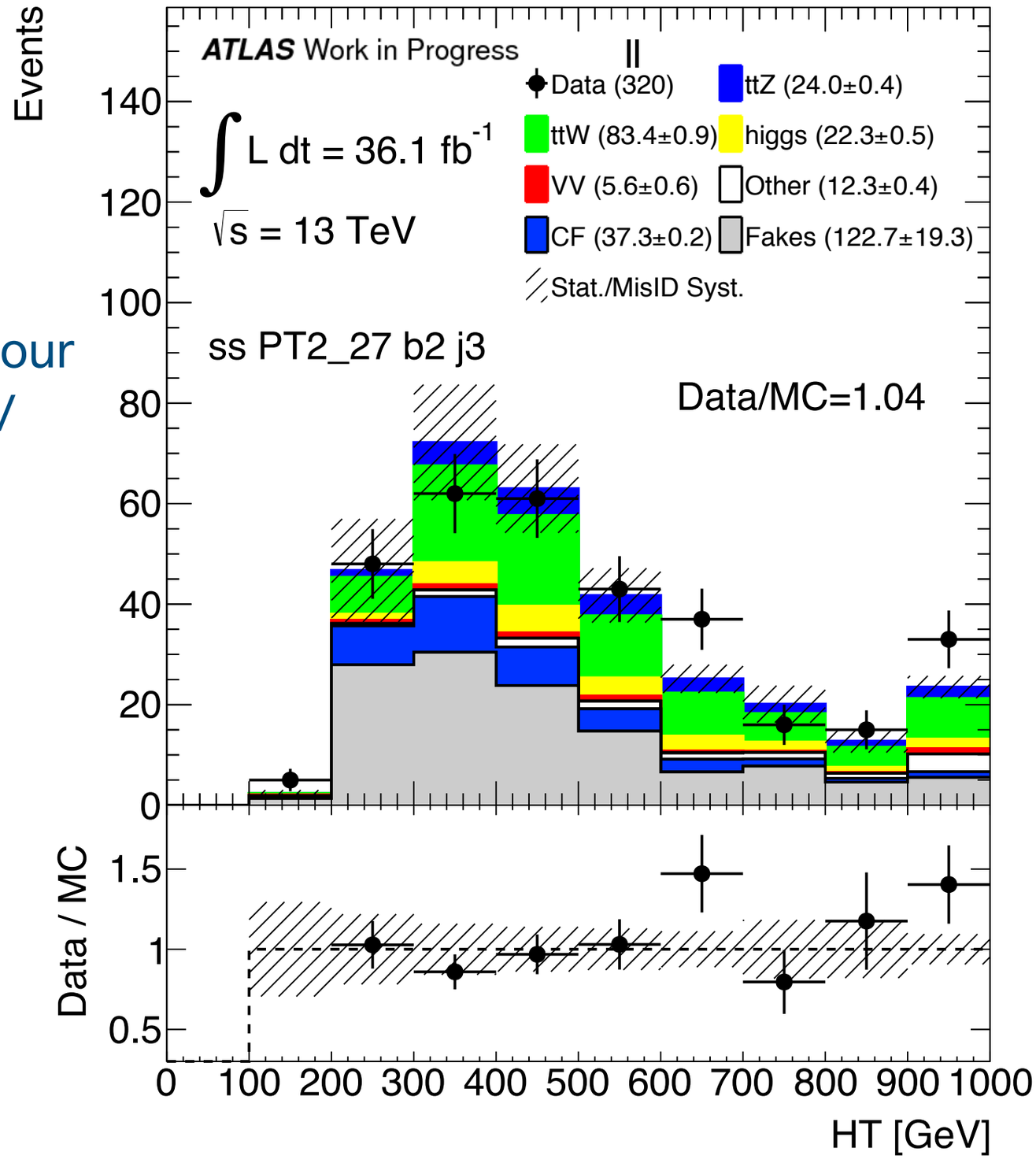
- The analysis is in the starting phase
- One of the most important task is to estimate the fake lepton background from heavy flavour jets - the main background for the analysis



This plot uses unblinded data from 2015 and 2016
https://cds.cern.ch/record/2639674

ttWj analysis

The mean energy in our process ~500 GeV



ttWj analysis current tasks

- We are in the progress of assessing different methods for the estimation the EFT operators.
- Two metods: Neural networks or a more traditional Likelihood
- We are also currently working on the fake lepton background estimation and the charge flip background estimation

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Thank you!