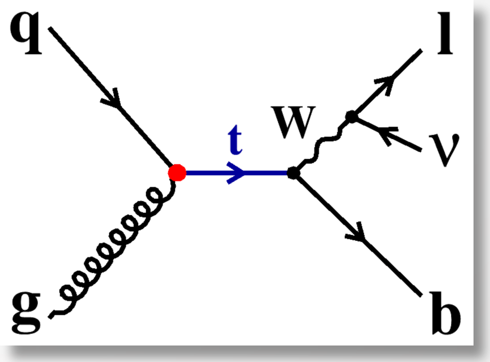

Search for FCNC in strong interactions with the ATLAS detector

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Supervised by Wolfgang Wagner and Dominic Hirschbühl

Physics at the Terascale 2021

Flavor in the Standard Model

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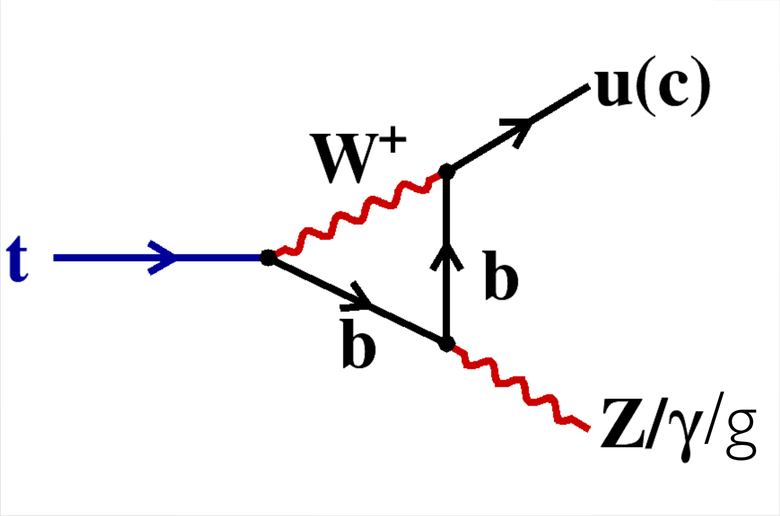
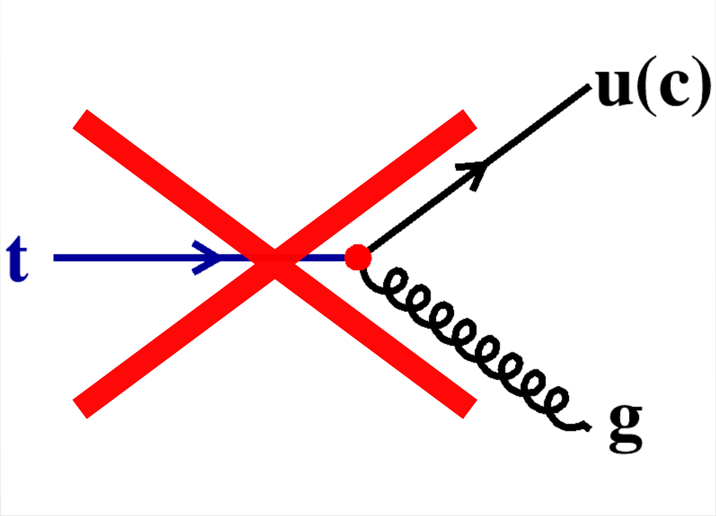
- In SM flavor is
  - conserved by the strong and electromagnetic force
  - changed by (charged) $W^{\pm}$ bosons
- Neutral flavor changing only possible in loops





Flavor-changing neutral currents

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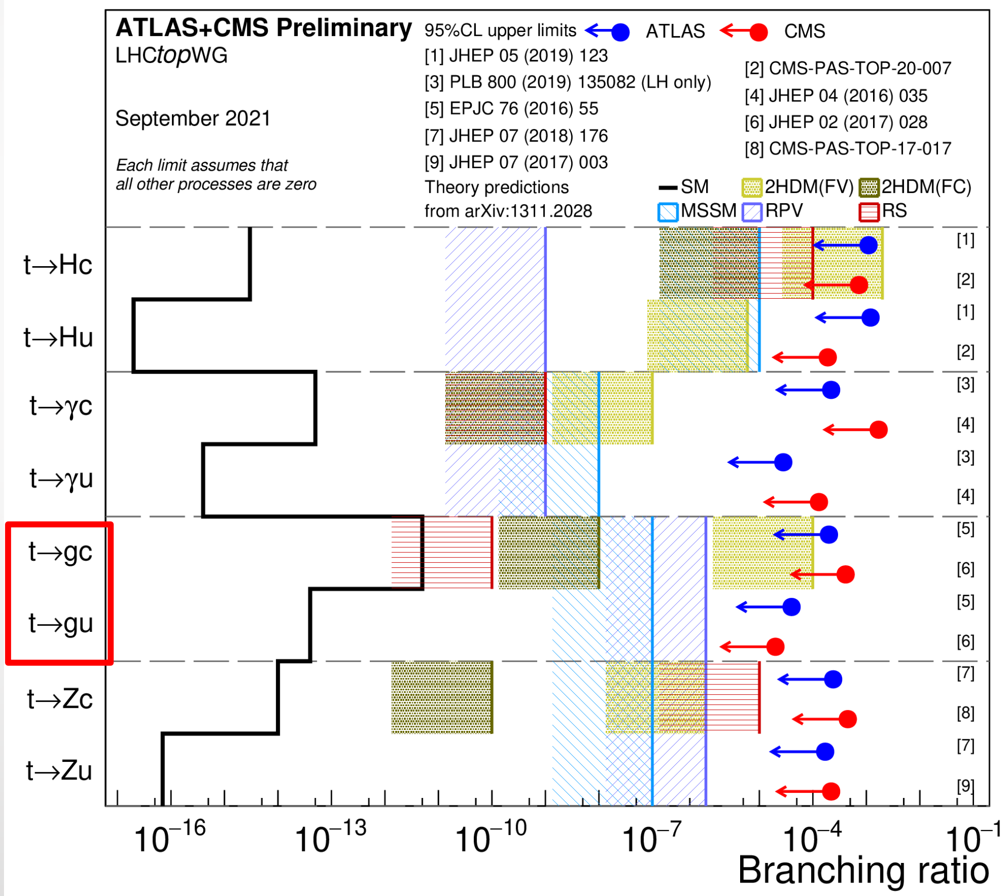
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PUBNOTES/ATL-PHYS-PUB-2021-037/



- In SM very small branching ratios
- Suppressed by GIM mechanism
- Some models of new physics predict many orders of magnitude higher branching ratios
- Experimental limits close to some BSM predictions

Signal region

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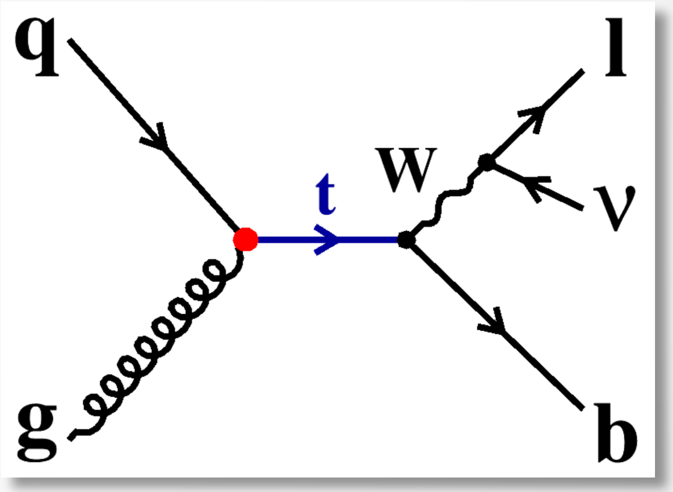
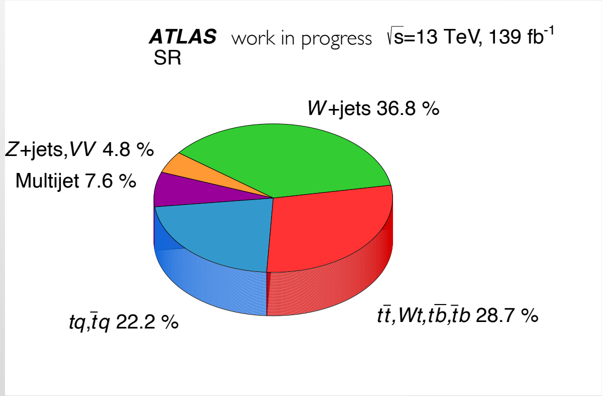
- 1 charged lepton , veto of 2nd loose lepton
- Cuts on E_T^{miss} and $m_T(W)$ to reduce multijet background
- 1 b-tagged jet with 30% efficiency
  - strongly reduce the amount of mis-tagged c-jets
  - c-jet rejection rate is 1500 instead of 32 when using 60% efficiency (WIP)





Estimation of the multijet background

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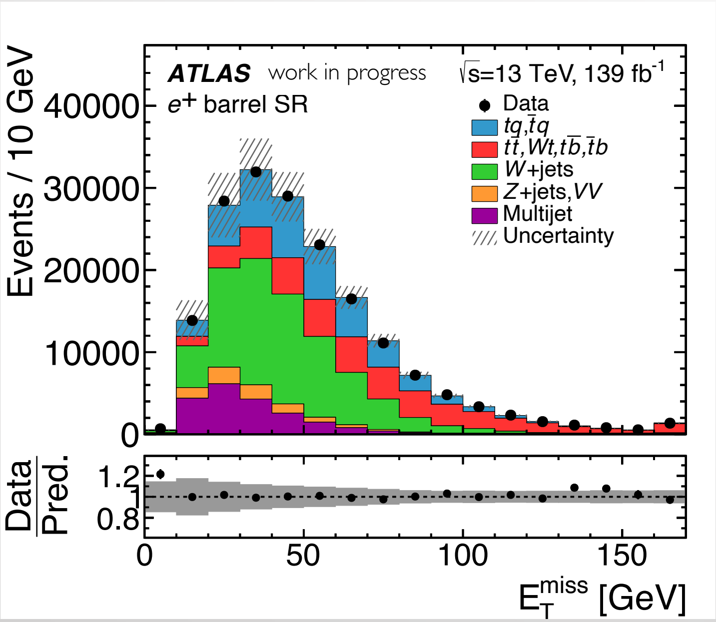
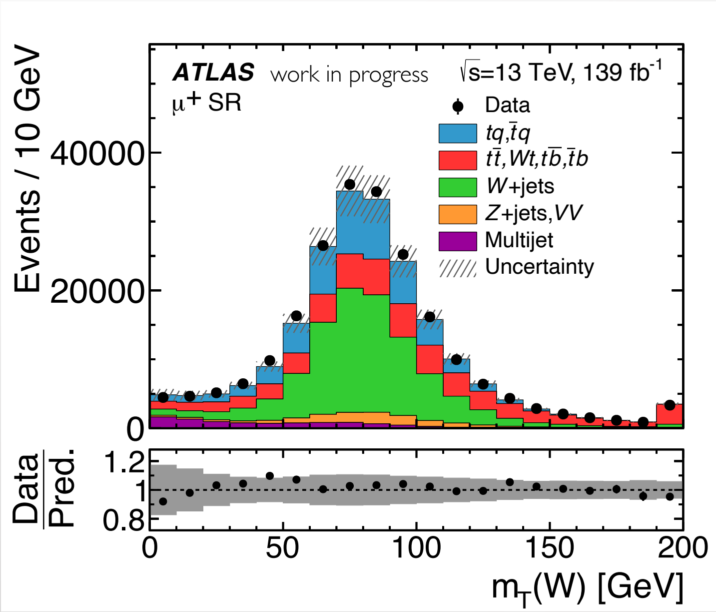
- The shape is modeled with the jet-electron model (diet MC with labelling jets electrons) and the anti-muon model (collision data with inverting some identification cuts)
- The rate of mis-identifying jets as charged leptons is not well described in simulation
- The rate is determined in a data-driven way
- The ETmiss (electrons) and mtw (muons) distributions are fitted for estimating the rate of the multimeter background





Validation regions

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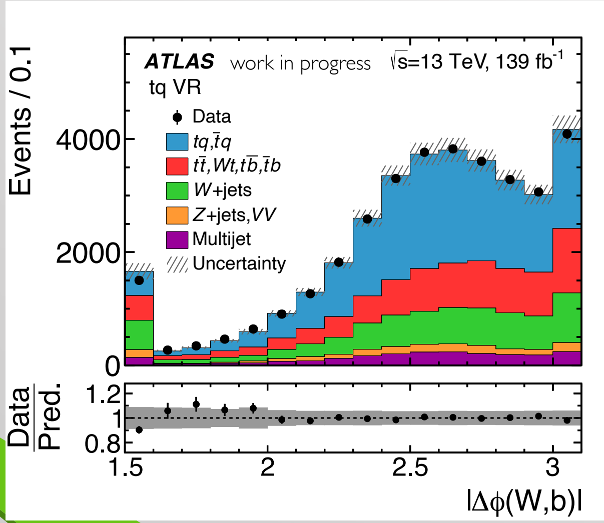
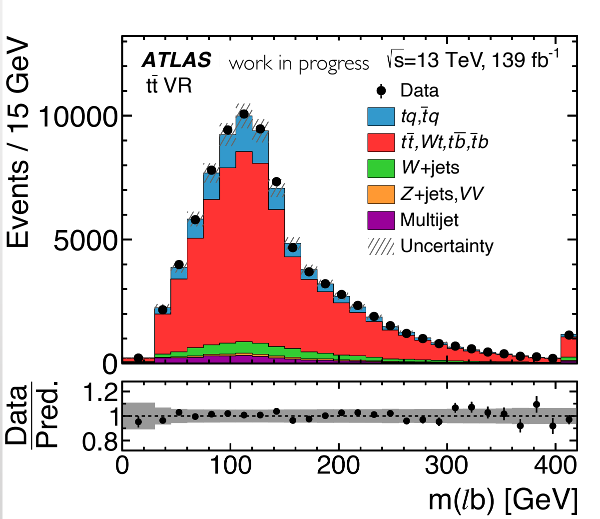
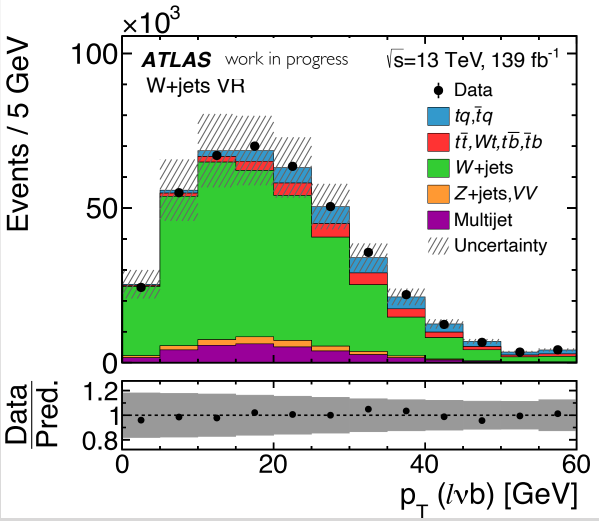
- The modeling of basic variables and reconstructed objects is validated
- Regions defined by variations in jet multiplicities
- Used for the 3 main backgrounds

# b-tags \ # jets	1	2
1 loose	W+jets	
1	SR	t-channel
2		$t\bar{t}$

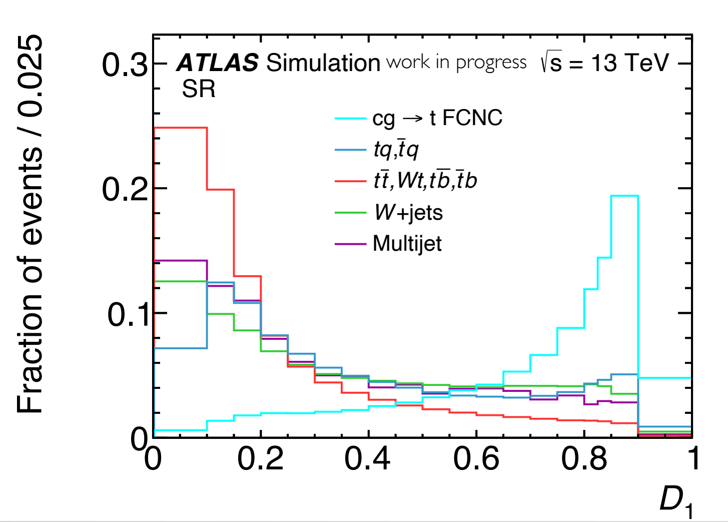


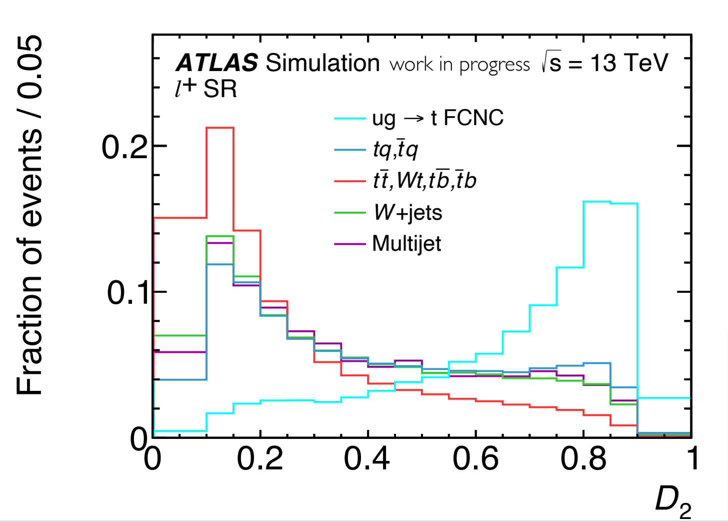




Separating signal and background events

- Train artificial neural networks to obtain discriminants separating signal and background
- One network trained with the $c + g \rightarrow t$ process as signal $\rightarrow D_1$, discriminant used for the cgt analysis and $\bar{u} + g \rightarrow \bar{t}$ signal (negative channel) of the ugt analysis (sea quarks in the initial state)
- The second network is trained with $u + g \rightarrow t$ events $\rightarrow D_2$ discriminant (positive channel)





Separating signal and background events

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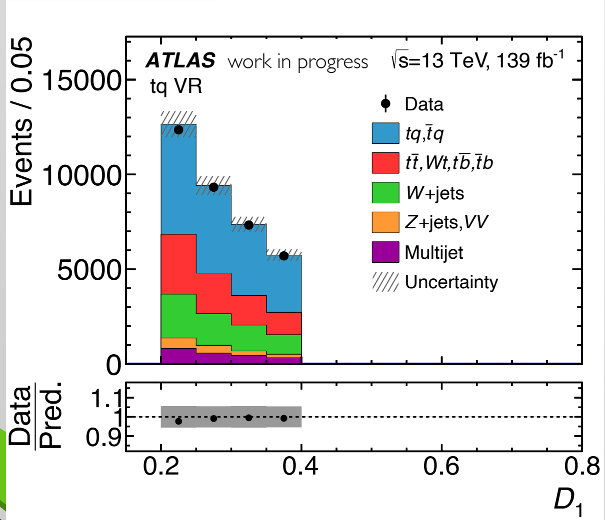
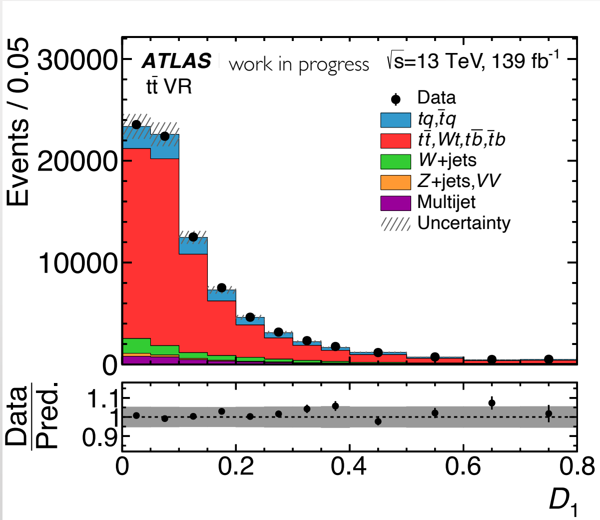
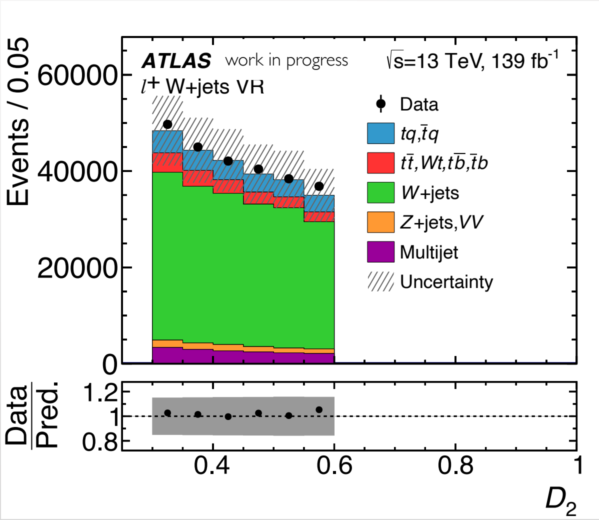
- The modeling of the output variables of the neural networks are validated in the validation regions
- The definition of the validation regions of tq and W+jets include a cut on the output distribution
  - Increase purity of main background
  - Reduce signal contamination







Binned maximum likelihood fit

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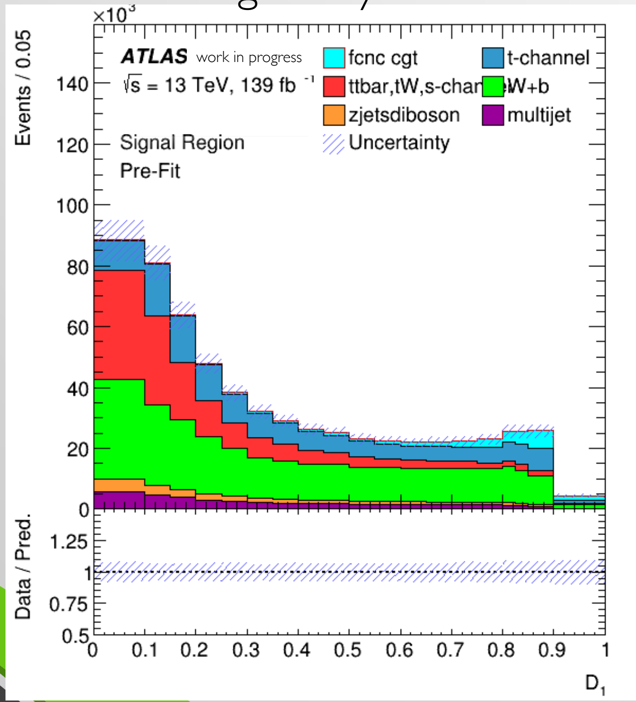
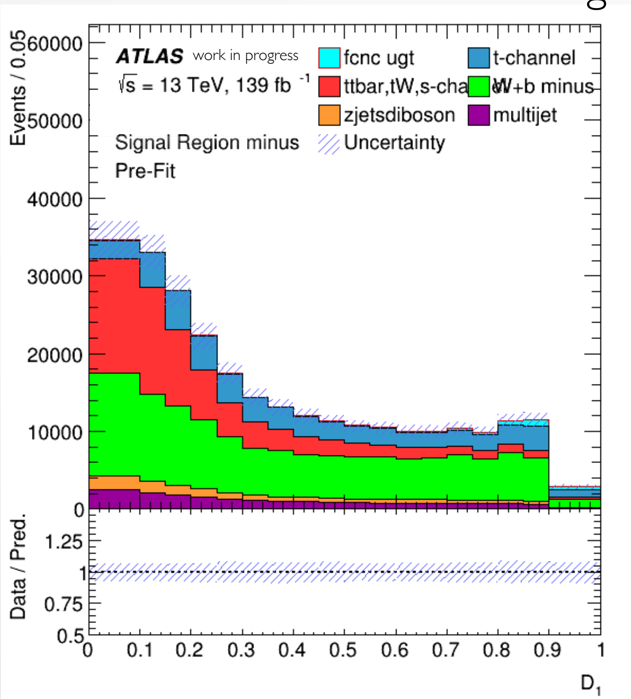
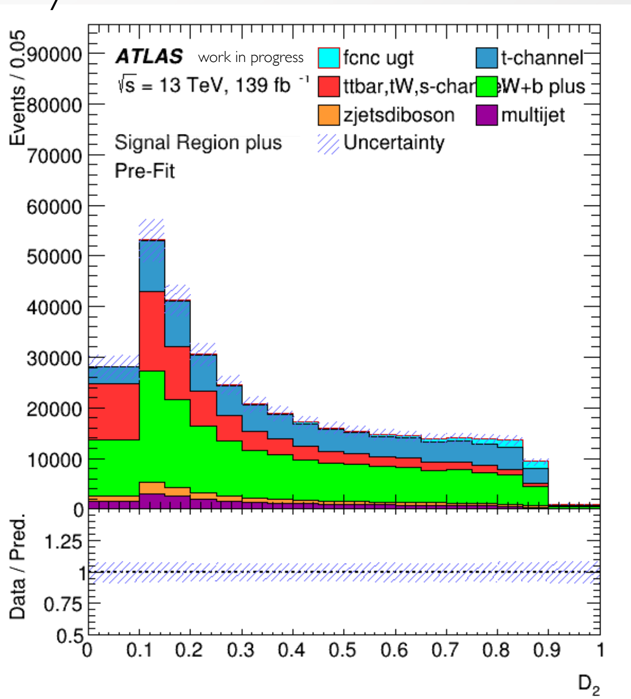
- Perform a binned maximum likelihood fit in the neural network output discriminant
- Use D_1 for cgt analysis and D_1 in the negative, D_2 in the positive channel for the ugt analysis
- Fit to Asimov data to extract expected upper limits for cross sections

cgt analysis



ugt analysis





Signals normalised to current upper limit

Expected exclusion limits

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- Limits are set for the branching ratios
  - $t \rightarrow u + g$ and $t \rightarrow c + g$
- Both limits expected to improve the previous ones set by ATLAS by a factor of ≈ 2
- Both limits are limited by systematic uncertainties
- Also setting Limits on EFT couplings - strongest Limits on these couplings expected

Scenario	Description	$\mathcal{B}_{95}^{\text{exp}}(t \rightarrow u + g)$	$\mathcal{B}_{95}^{\text{exp}}(t \rightarrow c + g)$
(1)	Data statistical only	1.1×10^{-5}	2.4×10^{-5}
(2)	Experimental uncertainties only	3.1×10^{-5}	12×10^{-5}
(3)	All uncertainties except MC statistical	3.9×10^{-5}	18×10^{-5}
(4)	All uncertainties	4.9×10^{-5}	20×10^{-5}

Expected limits on EFT couplings (WIP):

$$\frac{C_{uG}^{ut}}{\Lambda} < 0.057\,\text{TeV}^{-1} \quad \text{and} \quad \frac{C_{uG}^{ct}}{\Lambda} < 0.14\,\text{TeV}^{-1} \quad \text{at the 95 \% C.L.}$$

Outlook

- Presented strategy to search for FCNC in strong interactions
- Final state with few objects, large background
- Use dedicated neural networks to separate signals and background
- Increase in energy increases backgrounds stronger
- Larger statistics, but limited by systematics
- Expected to improve current upper limits for considered couplings