



# Measurement of t-channel single top-quark production with the ATLAS detector

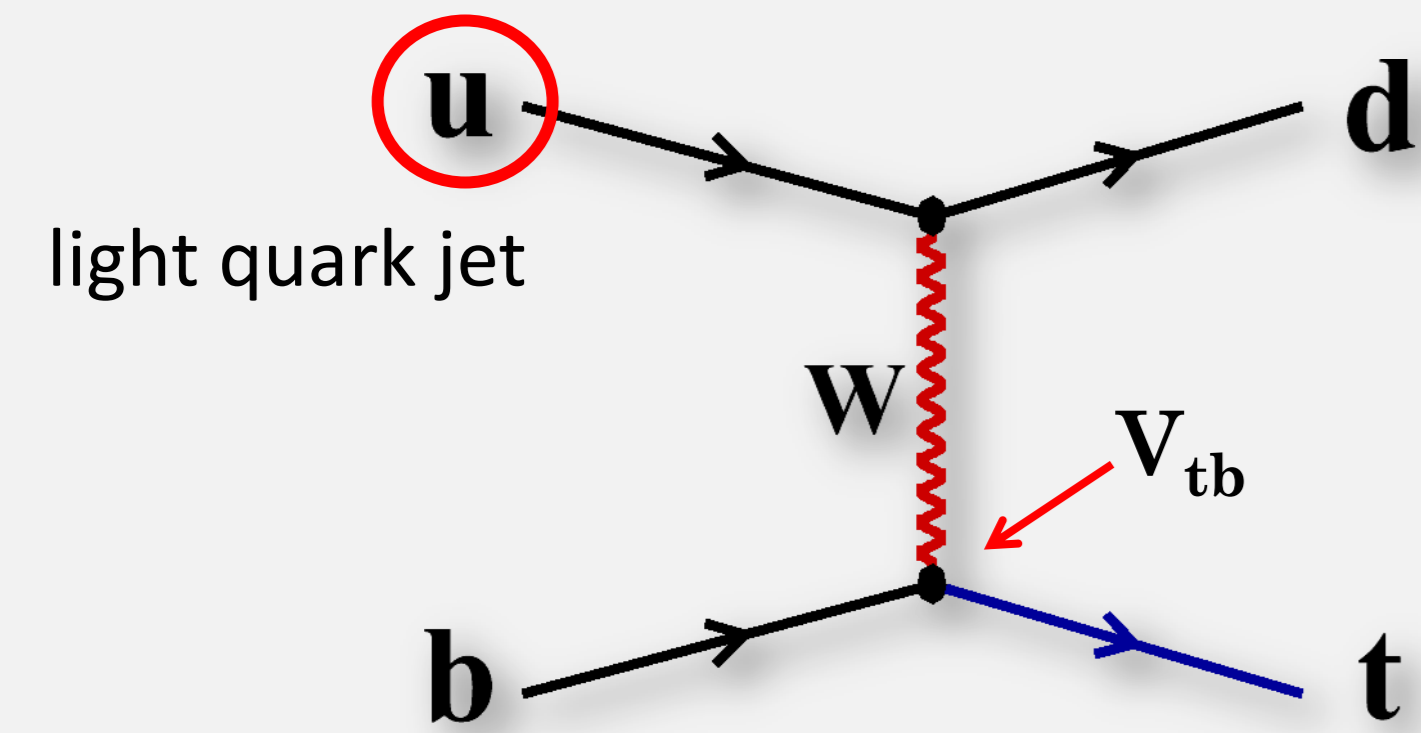
ATLAS note with 4.7 fb<sup>-1</sup>: ATLAS-CONF-2012-056

Poster by Kathrin Becker, University of Wuppertal, for the Physics at LHC 2012 conference in Vancouver



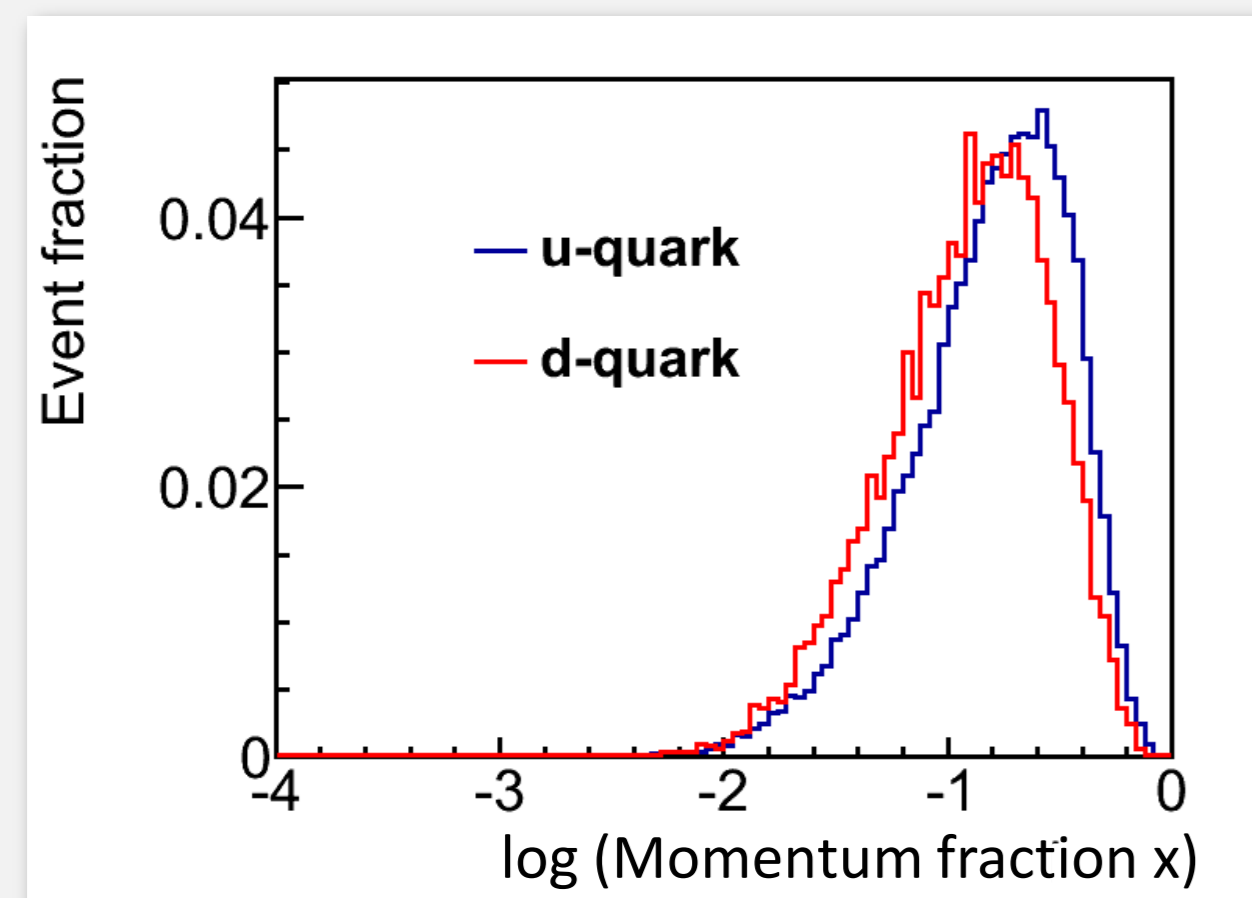
## Motivation

Electroweak production of top quark in the t-channel via a W-t-b vertex via W boson exchange



## Test of Standard Model predictions

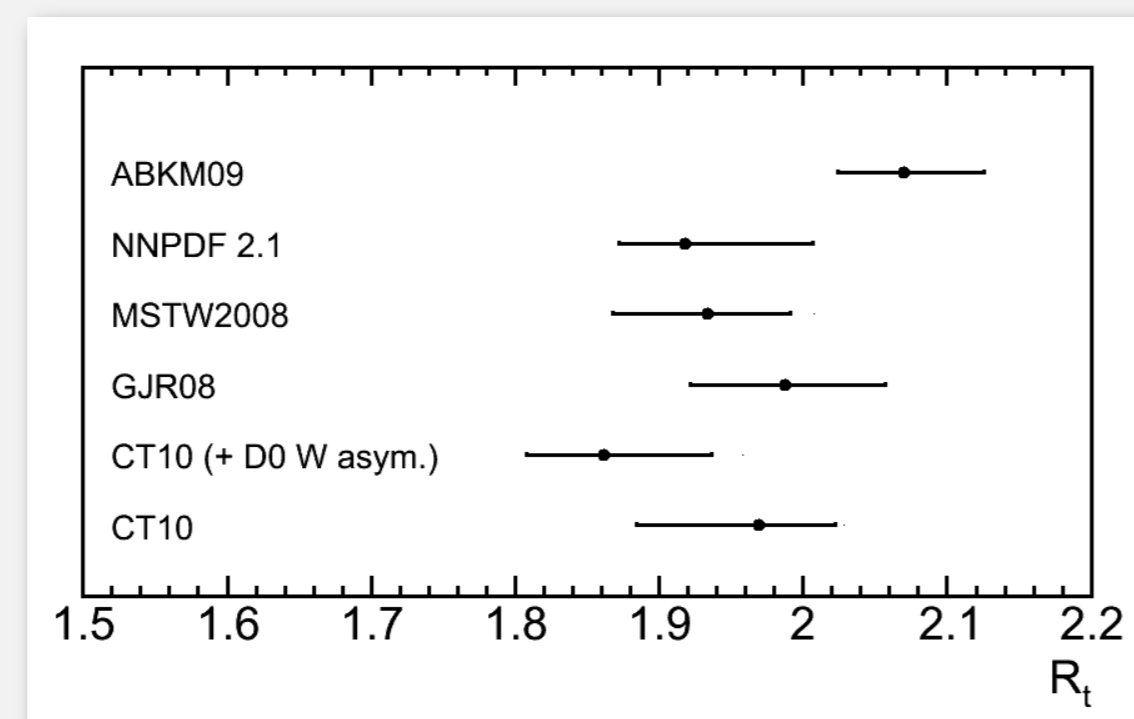
- Direct probe of W-t-b vertex
- Cross-section  $\sigma(t + \bar{t}) \propto |V_{tb}|^2$ 
  - test unitarity of the CKM matrix
  - Hints for existence of a 4<sup>th</sup> generation?
- **Measurements:  $\sigma(t)$  and  $\sigma(\bar{t})$**



## Constraining PDFs with single top

- The charge of the top is connected to the incoming light flavor quark
- Measurements:**
  - Measure cross section ratio top-quark/top-antiquark production  $R_t = \sigma(t)/\sigma(\bar{t})$
  - Measure cross section ratio vs.  $p_T/\eta$  of light quark (planned)

Theory predictions at  $\sqrt{s} = 7$  TeV ( $m_t = 172.5$  GeV):  
 $\sigma(t + \bar{t}) = 64.6^{+2.7}_{-2.0}$  pb,  $\sigma(t) = 41.9^{+1.8}_{-0.8}$  pb,  $\sigma(\bar{t}) = 22.7^{+0.9}_{-1.0}$  pb,  $R_t = 1.85$   
at NLO + NNLL resummation by N. Kidonakis: Phys. Rev. D 83 (2011) 091503

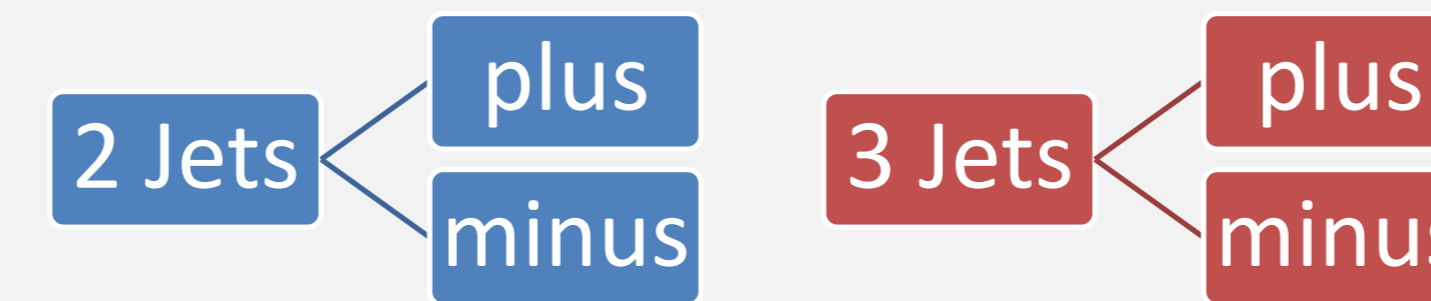


## PDF predictions for cross-section ratio $R_t$

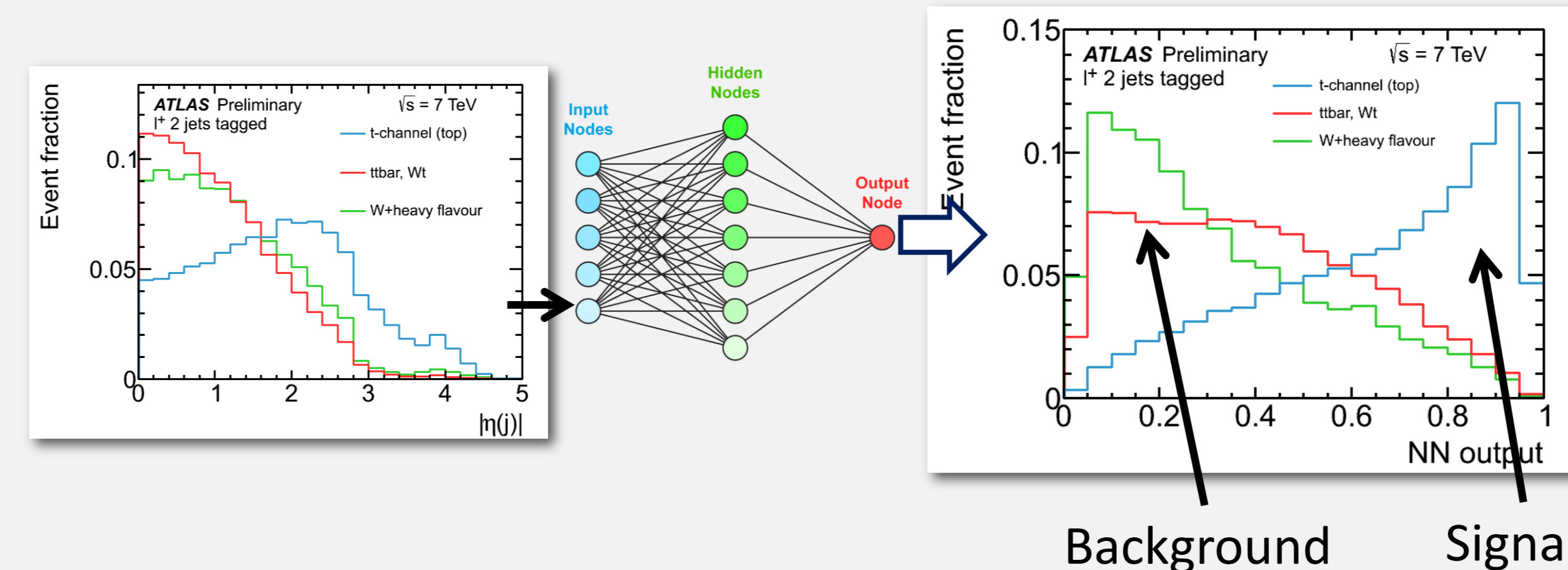
- PDF predictions for  $R_t$  quite different  $R_t \in [1.86, 2.07]$
- Uncertainty on plot includes statistical, scale and PDF uncertainties
- Momentum fractions for incoming u- and d-quarks in t-channel single top events:  $0.02 < x < 0.5$

## Neural network analysis

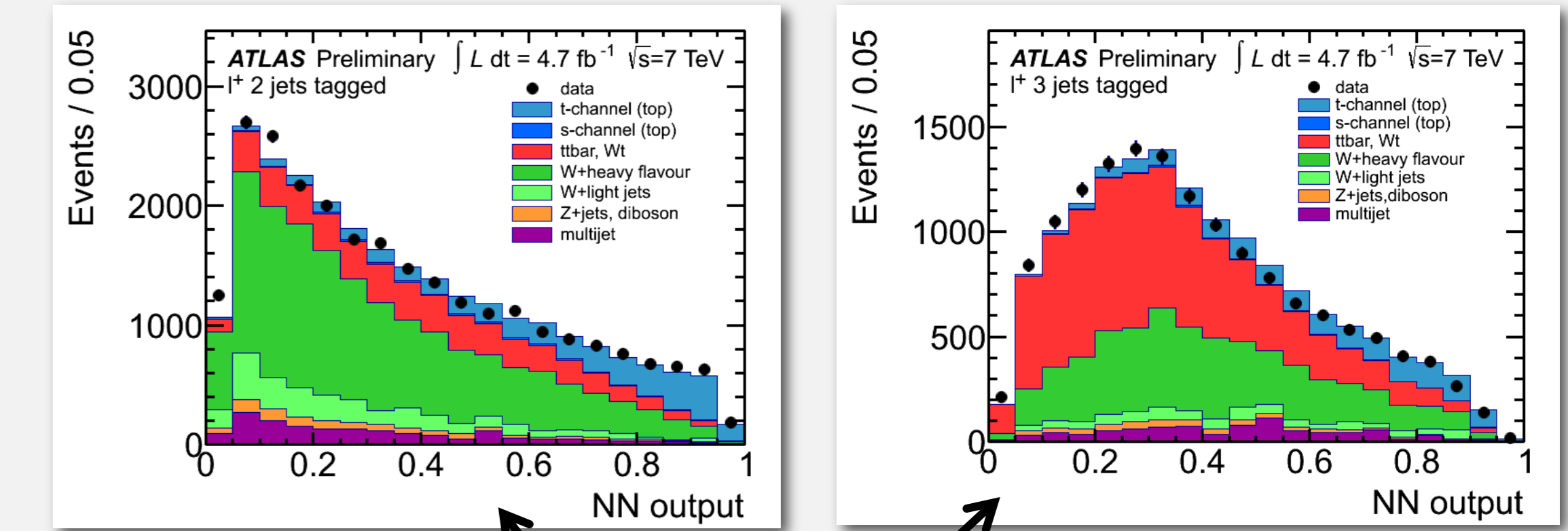
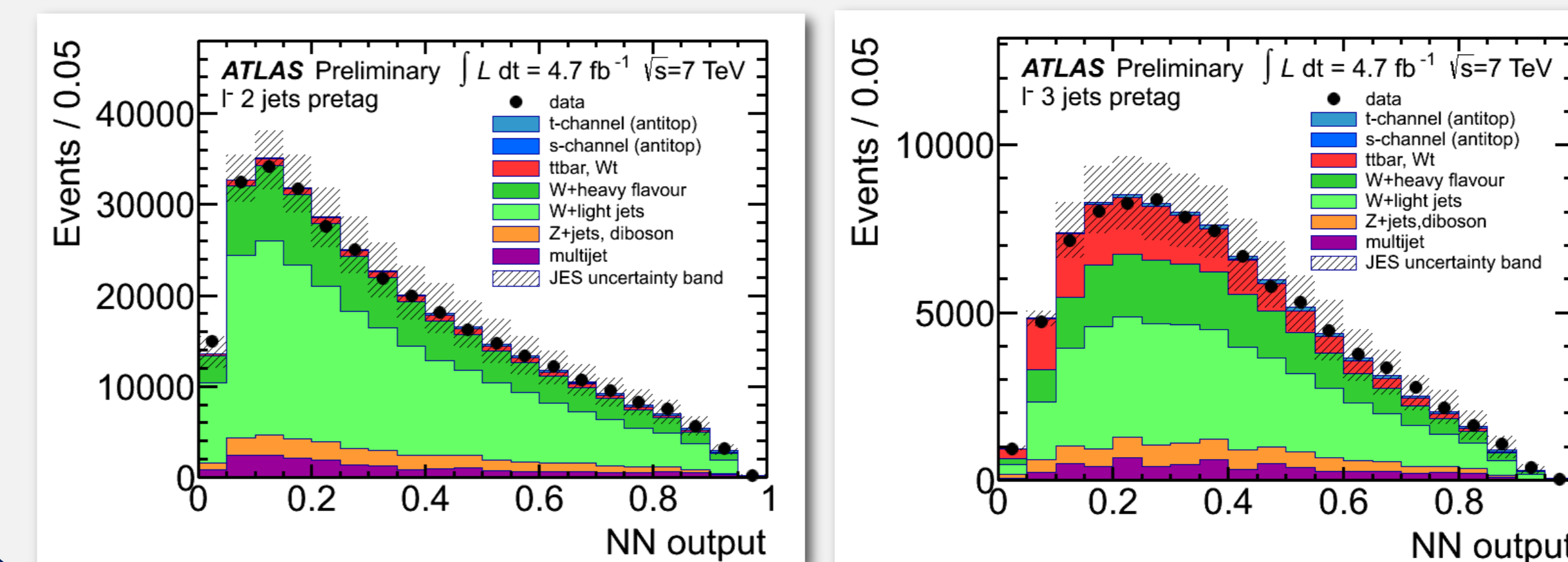
- Measurement in 4 channels:



- Train a neural network each of the 4 channels to extract the signal



- Check the NN discriminant in the background dominant pretag sample

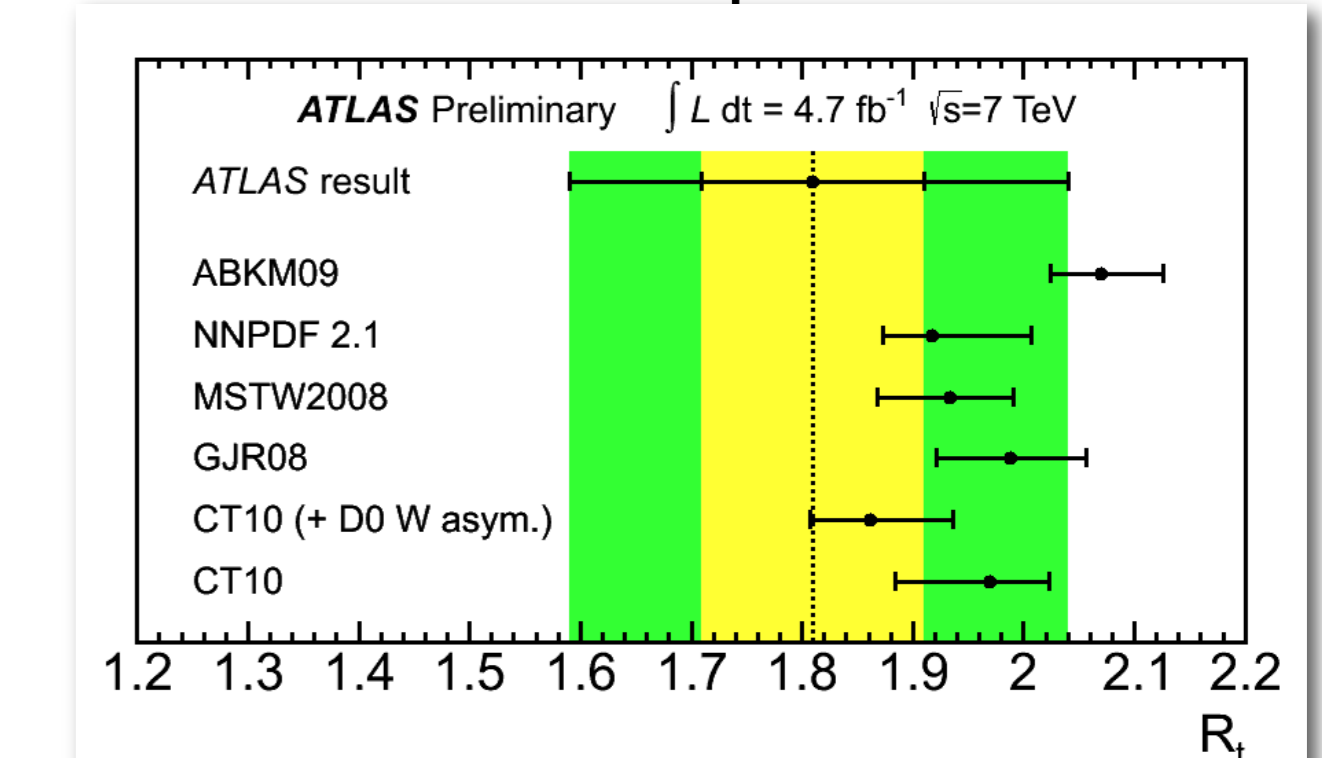


## Extract the result with binned likelihood fit

- Fit backgrounds, t-channel top quark and antiquark in all channels simultaneously in the full NN output to extract their cross-sections and  $R_t$

## Results

- $\sigma_t(t) = 53.2^{+10.8}_{-10.8}$  pb
- $\sigma_t(\bar{t}) = 29.5^{+7.4}_{-7.5}$  pb
- $R_t = 1.81^{+0.23}_{-0.22}$  (+12.8% -12.4%)
- disfavors ABKM09 prediction



## Event Selection

Lepton + 2/3 jets + E<sub>t</sub><sup>miss</sup>

Lepton:

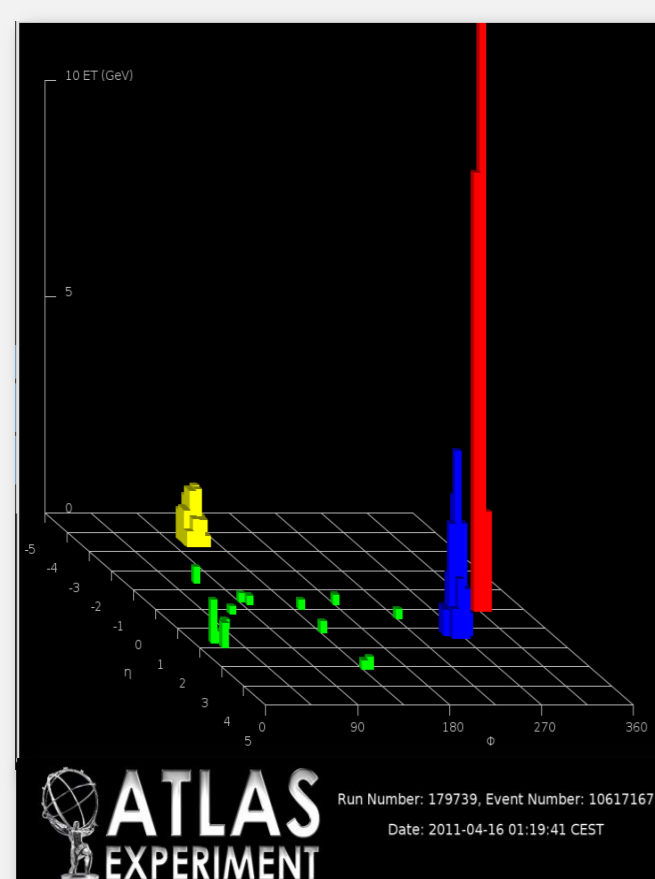
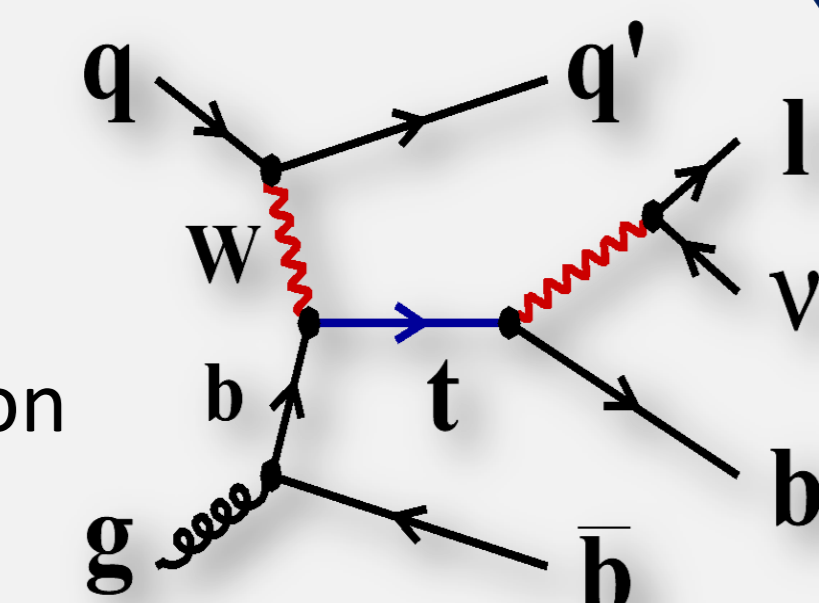
- One isolated electron or muon
- $p_T > 25$  GeV,  $|\eta| < 2.5$

Jets:

- Two or three jets, one of them tagged, one forward
- $p_T > 25$  GeV, if  $2.75 < |\eta| < 3.75$ :  $p_T > 50$  GeV,  $|\eta| < 4.5$
- Anti-k<sub>T</sub> algorithm R=0.4

Missing transverse energy:

- $E_t^{\text{miss}} > 30$  GeV
- QCD multijet veto:
- $M_T(W) > 30$  GeV



## Backgrounds

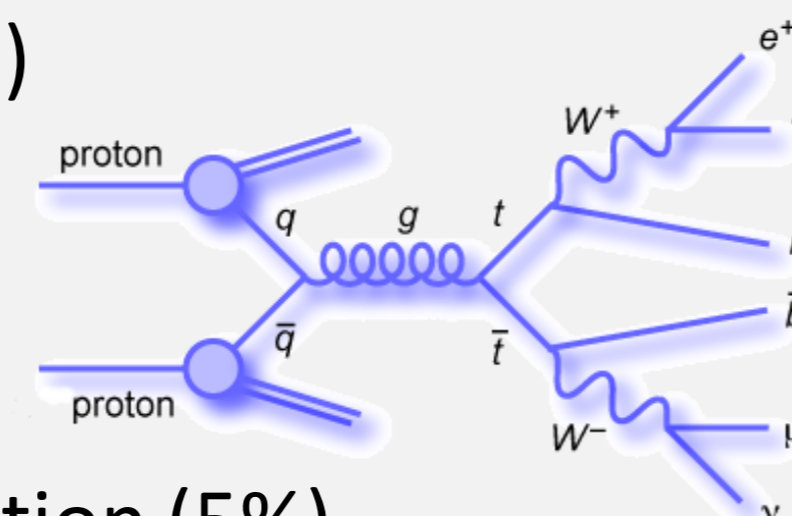
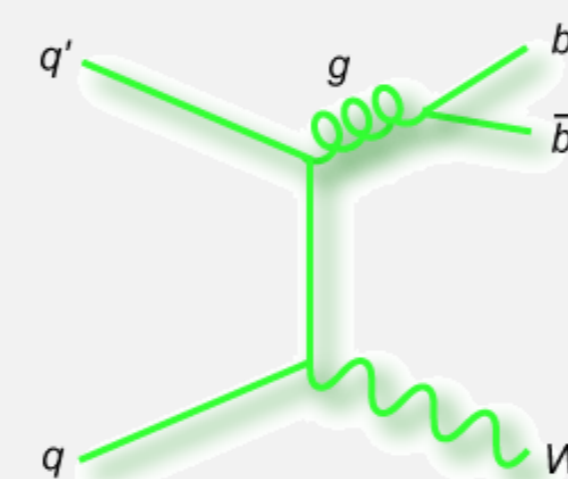
Main background: W+jets (50%)

- W + charm / bottom jets (40%)
- W + light jets (10%)
- Heavy flavor estimation from data
- Simultaneous fit with signal extraction

Fractions given for all analysis channels combined

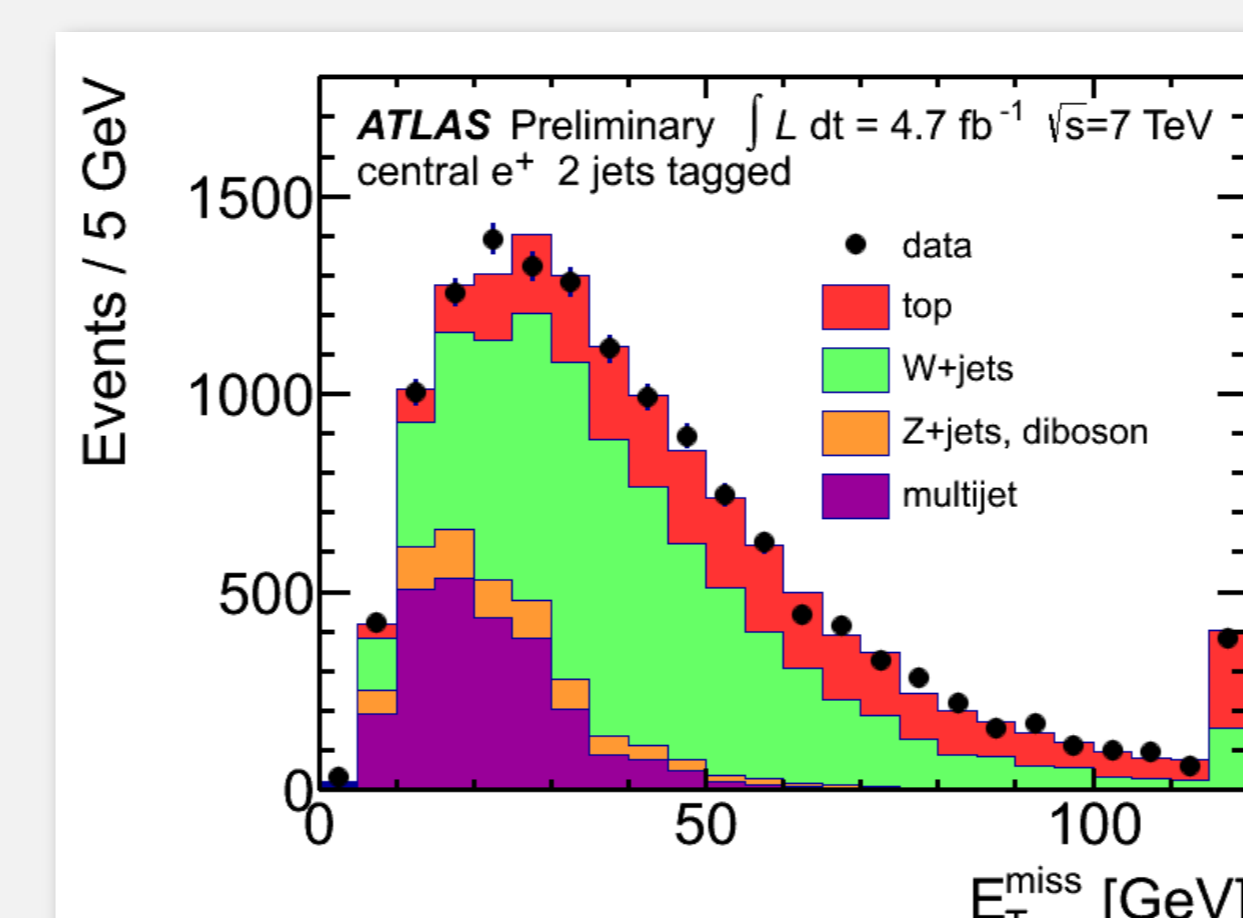
Other backgrounds

- Top pair production (30%)
- Z+jets (2%)
- Diboson (1%)
- Wt and s-channel production (5%)
- Estimation with simulation and theoretical cross-sections



QCD Multijet Background (8%)

- Fake leptons in QCD multijet events
- Estimation with data-driven Jet-Electron Model
- Take jet with high em. Fraction as lepton
- Fit the shape of the selected data sample in the full E<sub>T</sub><sup>miss</sup> distribution



## Systematic uncertainties

- Evaluate systematic uncertainties with pseudo experiments (frequentist approach)
- Rate and shape variations
- experimental effects and uncertainties on theoretical predictions
- Largest uncertainties for the measurements:
  - jet energy scale
  - b-tagging efficiency
  - signal Monte-Carlo generator
  - background normalization

