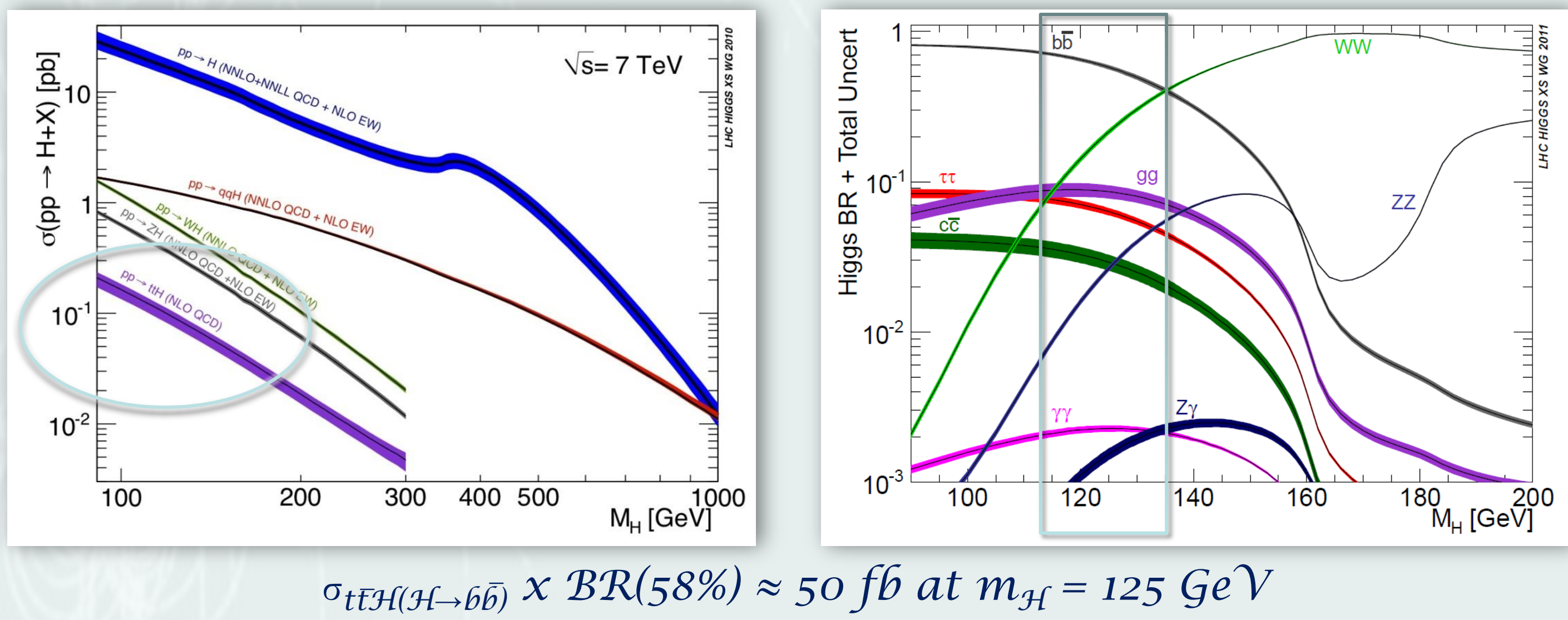


Search for the Standard Model Higgs boson produced in association with top quarks and decaying to $b\bar{b}$ in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector at the LHC

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1. Motivation

- Convincing evidence of SM Higgs-like boson [1,2]
 - production mode: associated top-Higgs production
 - Access to top-Higgs and H-b Yukawa couplings
- Channel studied: $t\bar{t}H \rightarrow l^\pm \nu q \bar{q} b\bar{b} (H \rightarrow b\bar{b})$, with $l=e,\mu$

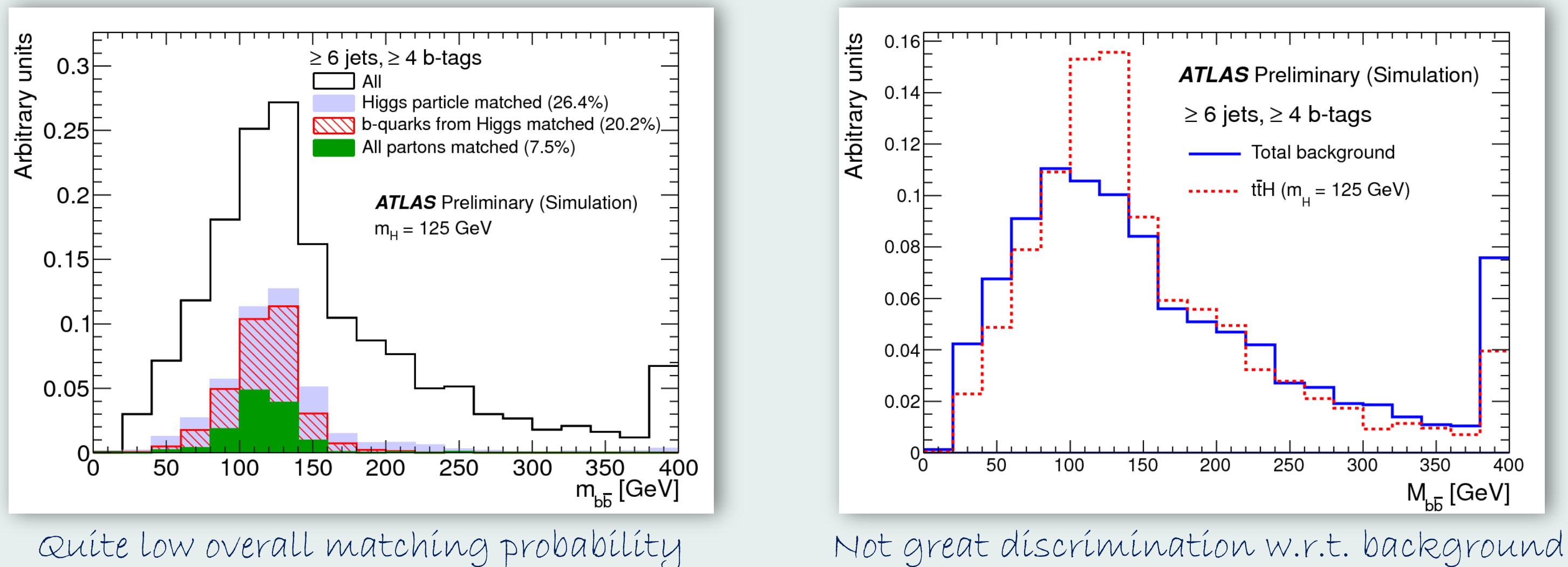


3. Kinematic fitting

- Principle of kinematic fitting
 - Transfer Functions (W) : parametrize detector resolution
 - Use Breit-Wigner (BW) constraints on m_W and m_{top}
 - Reconstruct top pair: 2 additional jets assigned to Higgs
- Kinematic Likelihood function [3]:

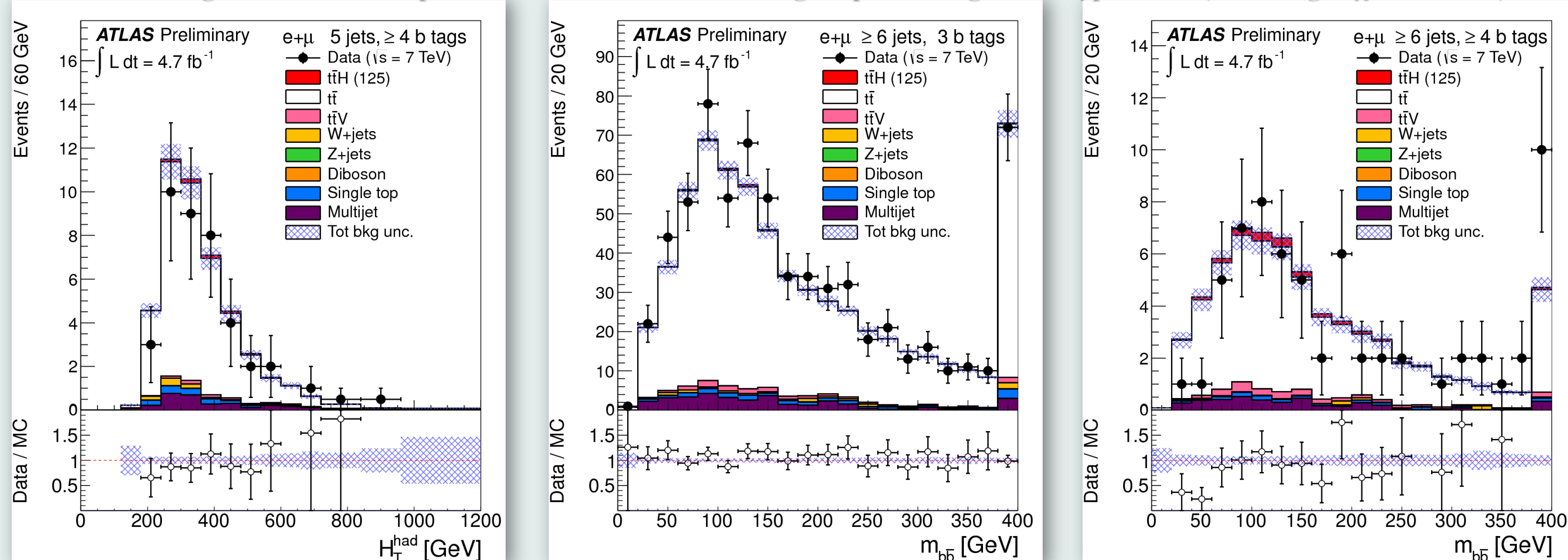
$$L_{kin} = \prod_{j=1}^6 W(\tilde{E}_j | E_j) \cdot \left(\frac{W(\tilde{E}_e E_e)}{W(\tilde{p}_{T,\mu} p_{T,\mu})} \right) \cdot W(\tilde{E}_x^{miss} | p_x^\nu) \cdot W(\tilde{E}_y^{miss} | p_y^\nu) \cdot BW(m_{q_1 q_2} | m_W, \Gamma_W) \cdot BW(m_{l\nu} | m_W, \Gamma_W) \cdot BW(m_{q_1 q_2 b_{had}} | m_{top}, \Gamma_{top}) \cdot BW(m_{l\nu b_{lep}} | m_{top}, \Gamma_{top})$$

- Reconstructed Higgs boson mass ($m_{b\bar{b}}$):

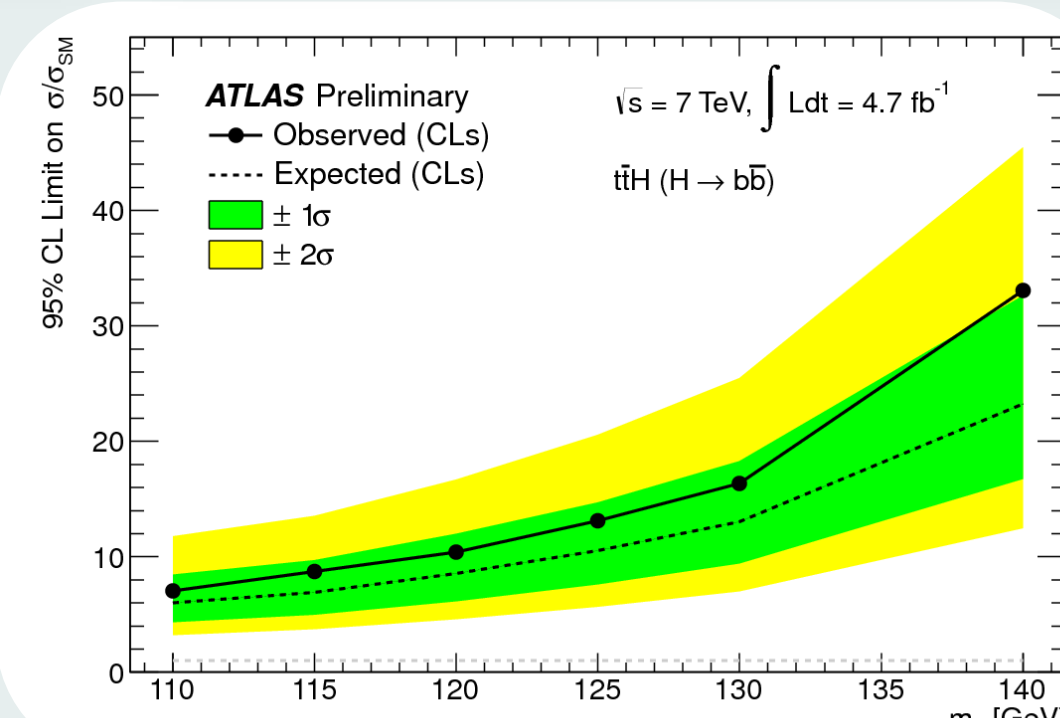


5. Results

After fitting of the nuisance parameters to data under the signal-plus-background hypothesis (assuming $m_H = 125$ GeV)

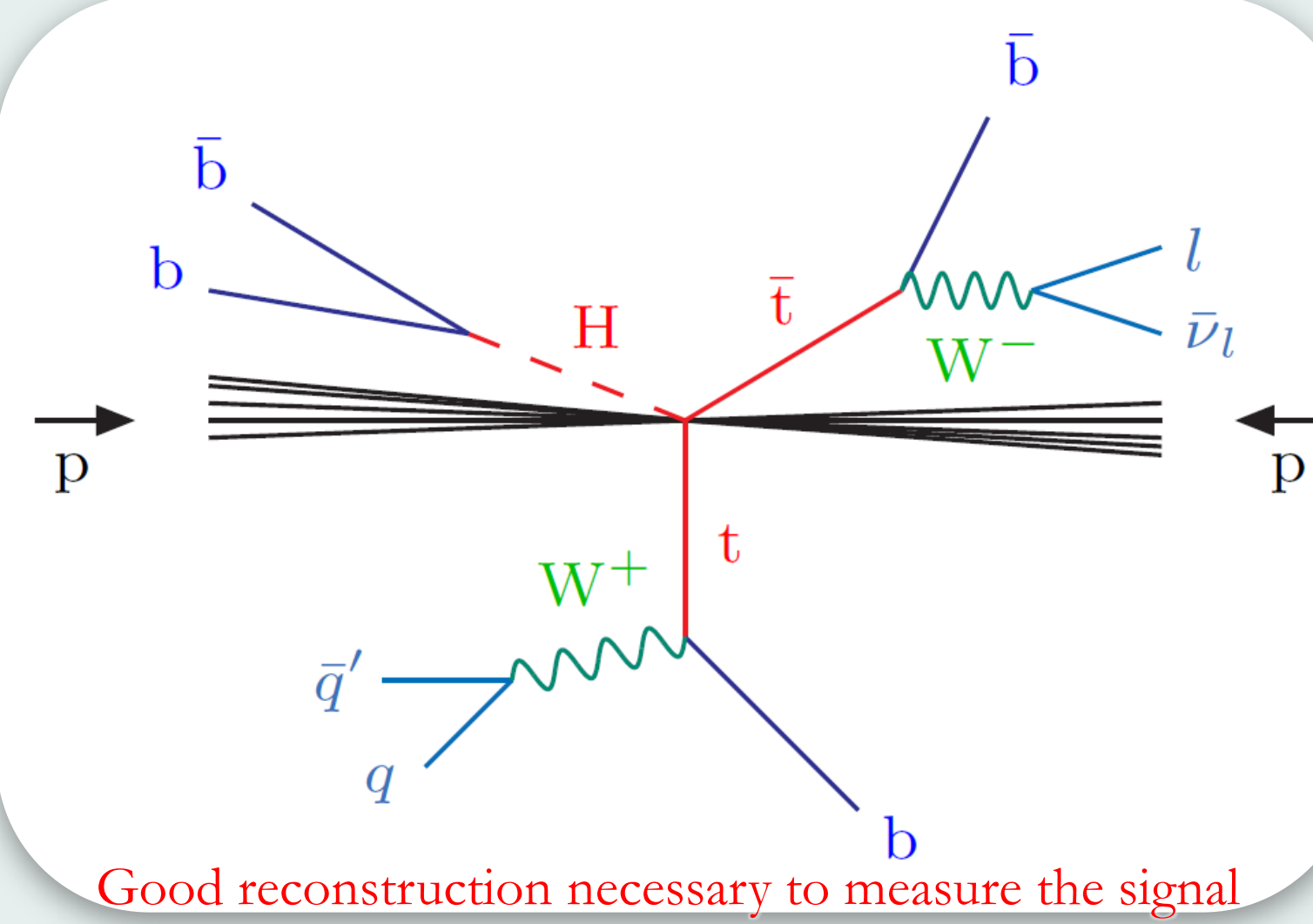


- No excess of events observed [4]
 - Observed (expected) 95% CL upper limit of 13.1(10.5) times SM cross-section for m_H of 125 GeV

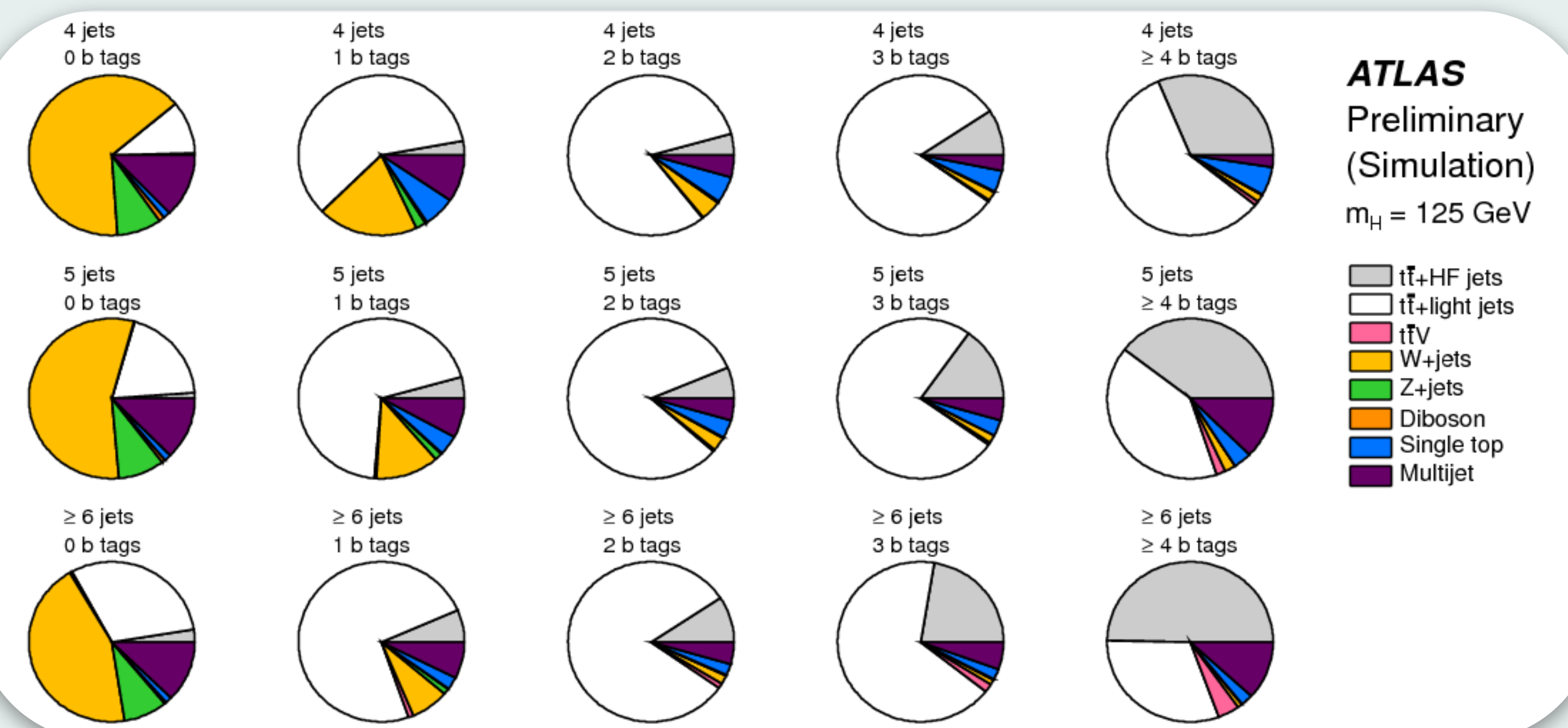


2. Signal and Backgrounds

Example of a production and decay diagram in lepton+jets final states:



- Signatures
 - High p_T isolated lepton
 - $E_{T,miss}$
 - ≥ 6 jets (≥ 4 b-jets)
- Backgrounds
 - irreducible: $t\bar{t} + b\bar{b}$ ($\sim 30x$)
 - irreducible: $t\bar{t}V(W/Z)$ ($\sim 1x$)
 - reducible: $t\bar{t} + \text{light jets}$ ($450x$)
 - other: $W + \text{jets}$, Multijet



- Categorization in 13 independent topologies
 - 4 validation (VR), 5 background (BR) and 4 signal regions (SR)

	0 b-tags	1 b-tags	2 b-tags	3 b-tags	≥ 4 b-tags
4 jets	BR, H_T^{had}	BR, H_T^{had}		BR, H_T^{had}	
5 jets	VR, H_T^{had}	VR, H_T^{had}	BR, H_T^{had}	SR, H_T^{had}	SR, H_T^{had}
≥ 6 jets	VR, H_T^{had}	VR, H_T^{had}	BR, H_T^{had}	SR, $m_{b\bar{b}}$	SR, $m_{b\bar{b}}$

H_T^{had} = scalar sum of jet transverse momenta

4. Systematic uncertainties

- $N \equiv$ normalization
- $SN \equiv$ shape and normalization

Profiling in action:
 ≥ 6 jets ≥ 4 tags

	Systematic uncertainty	Status	Components	Pre-fit		Post-fit		
				$t\bar{t}$	$t\bar{t}$	$t\bar{t}$	$t\bar{t}$	
Object-oriented	Luminosity	N	1	+1.8/-1.8	+1.4/-1.4	+1.8/-1.8	+1.4/-1.4	
	Lepton ID+reco+trigger	N	1	+1.3/-1.3	+1.1/-1.1	+1.3/-1.3	+1.1/-1.1	
	Jet vertex fraction efficiency	N	1	+2.5/-1.9	+1.9/-1.4	+2.5/-1.9	+1.9/-1.4	
	Jet energy scale	SN	16	+13.5/-15.2	+7.1/-8.0	+13.5/-15.2	+7.1/-8.0	
	Jet energy resolution	N	1	+0.7/-0.7	+0.6/-0.6	+0.7/-0.7	+0.6/-0.6	
	b-tagging efficiency	SN	9	+22.9/-25.2	+9.9/-10.5	+22.9/-25.2	+9.9/-10.5	
	c-tagging efficiency	SN	5	+16.5/-17.3	+11.8/-12.3	+16.5/-17.3	+11.8/-12.3	
	Light jet-tagging efficiency	SN	1	+11.4/-12.1	+8.8/-9.3	+11.4/-12.1	+8.8/-9.3	
					+9.9/-10.7	+3.0/-3.2	+9.9/-10.7	+3.0/-3.2
	Physics Bkg cross-sections modelling	$t\bar{t}$ cross section	N	1	-	-	-	-
$t\bar{t}V$ cross section		N	1	-	-	-	-	
Single top cross section		N	1	-	-	-	-	
Dibosons cross section		N	1	-	-	-	-	
W+jets normalisation		N	3	-	-	-	-	
Multijet normalisation		N	7	-	-	-	-	
W+heavy-flavour fractions		SN	4	+15.8/-20.2	+6.3/-8.8	+15.8/-20.2	+6.3/-8.8	
$t\bar{t}$ modelling	SN	3	+25.9/-25.9	+11.1/-11.1	+25.9/-25.9	+11.1/-11.1		
$t\bar{t}$ +heavy-flavour fractions	SN	1	-	-	-	-		
$t\bar{t}H$ modelling	N	1	+46.3/-50.1	+13.8/-16.0	+46.3/-50.1	+13.8/-16.0		

Significant reduction in overall background uncertainty

6. Prospects for the future

- Analysis being updated to full $\sqrt{s} = 8$ TeV dataset
- Usage of MVA techniques and $t\bar{t}H$ NLO MCs

References