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Constraints on Higgs boson production with large transverse momentum using $H \to b\bar{b}$ decays in the ATLAS detector

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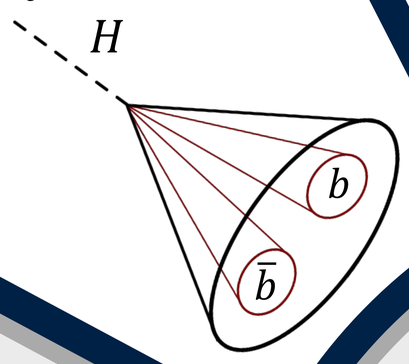
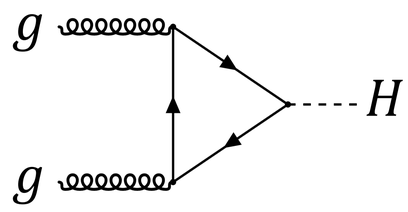
Introduction

- Probe **Higgs** boson production at **high** p_T - constrain cross-section
- High-p_T topology contains energetic **recoil jet**(s)
- Higgs decay products clustered inside large-radius **calorimeter jet**



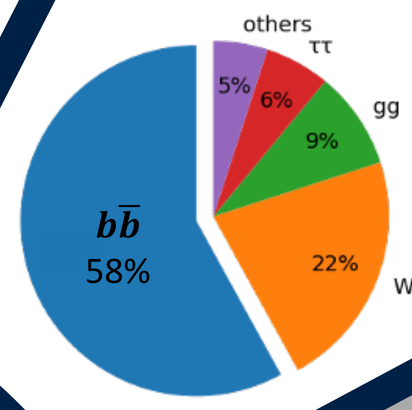
Motivations

- Probe **unexplored** region $p_T^H > 1$ **TeV**
- **New physics** in **ggF** loop? Potential cross-section enhancement at high p_T
- **New resonances** at EW mass scale?



The $b\bar{b}$ Final State

- Issue: **low statistics** at high p_T
- Use $b\bar{b}$ final state - highest BR
- Drawback: large **QCD** multijet background

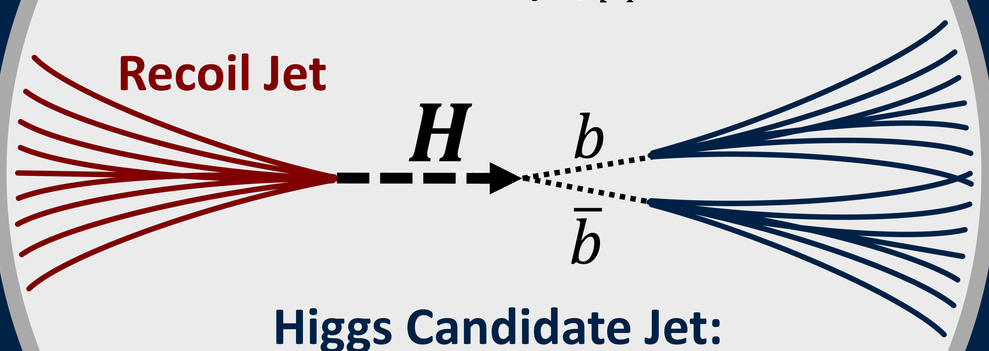


Recoil Jet

- No requirement on nature of **recoil jet**(s)
- Analysis inclusive in Higgs production mode: **ggF**, **VBF**, **VH**, **ttH**
- ggF dominant contribution (55% inclusively)
- Access to potential cross-section enhancements

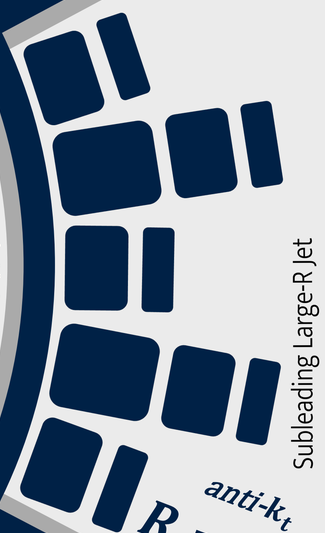
Event Selection

- Large-R jet trigger, $p_T > 450$ GeV, $m > 60$ GeV
- At least 1 additional jet, $p_T > 200$ GeV



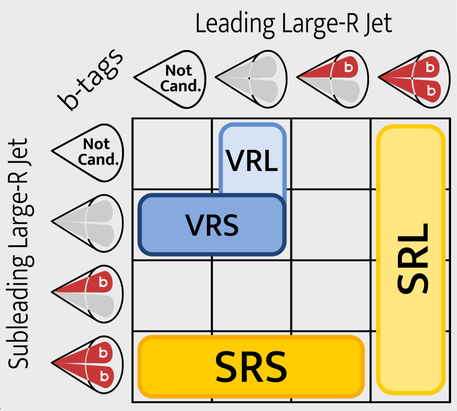
Higgs Candidate Jet:

- $p_T > 250$ GeV, $m > 60$ GeV, $|\eta| < 2$
- Boosted: $2m/p_T < 1$
- 2 variable radius track jets



Event Classification

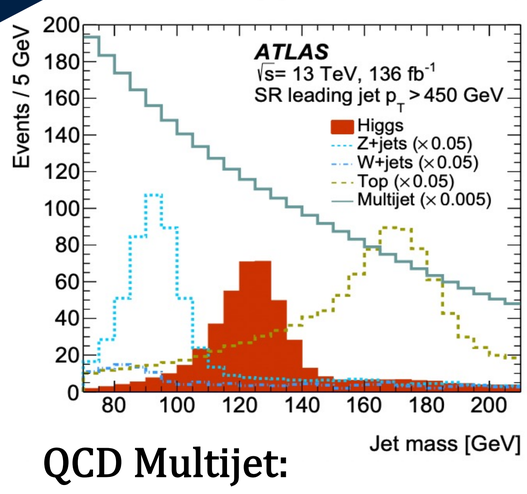
Signal (**SR**) and validation (**VR**) regions based on ***b*-tagging** of **Higgs candidate**

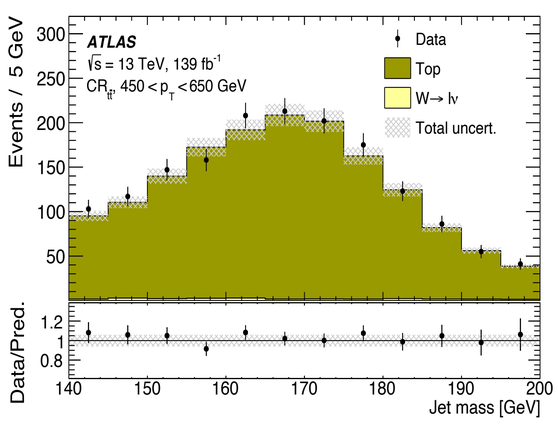


Regions split further into p_T bins for differential measurement

Signal and Background Modelling

Higgs, $t\bar{t}$ and V+jets modelled with MC





QCD Multijet:

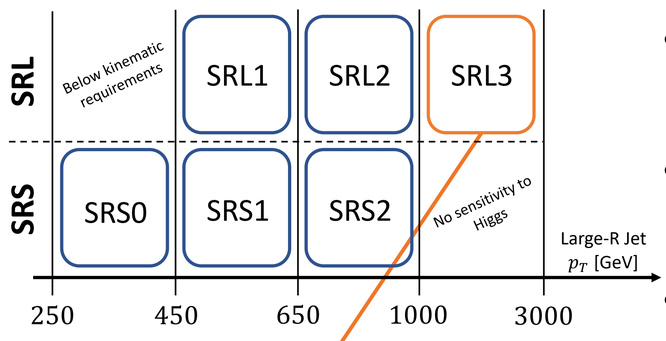
- Largest background
- Modelled with polynomial
  - Optimised on kinematically corrected and statistically equivalent VR datasets

$t\bar{t}$:

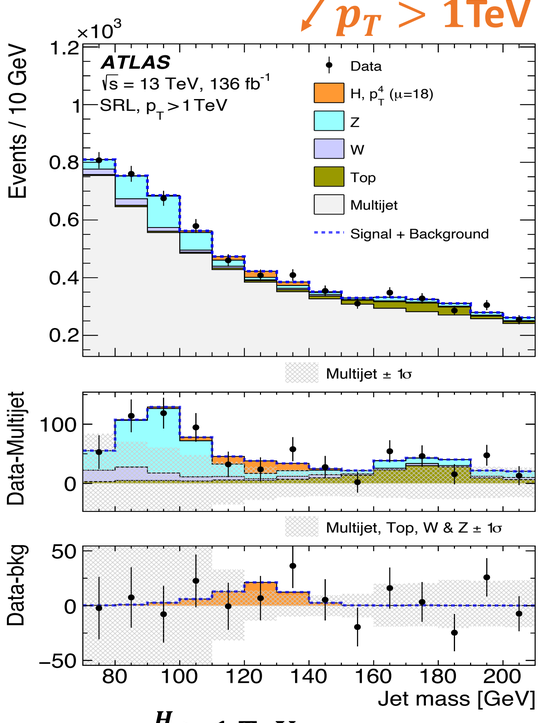
- Constrained with control region ($CR_{t\bar{t}}$) data
  - Targets semi-leptonic $t\bar{t}$ decays

Differential Result

Split SRL, SRS and $CR_{t\bar{t}}$ into candidate jet p_T regions

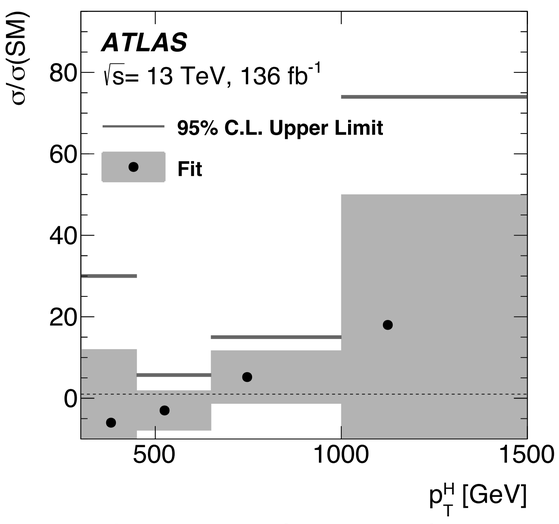


$p_T > 1$ TeV



$$\mu_H^{p_T^H > 1\,\mathrm{TeV}} = 18 \pm 32$$

- In each region, Higgs split in truth p_T^H templates
- Simultaneous fit to all regions
- Higgs signal strengths correlated among regions

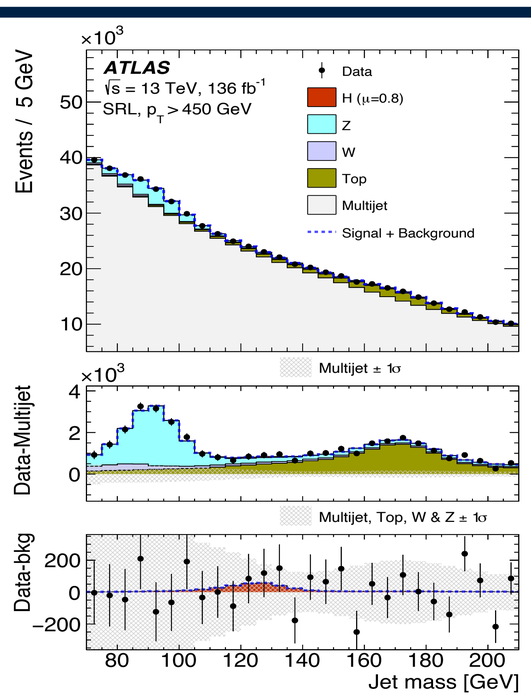


- Cross-section consistent with SM predictions
- Results are statistically limited

Inclusive Result

- Maximum likelihood fit to candidate jet mass
- Simultaneous fit to SRL, SRS and $CR_{t\bar{t}}$
- Higgs signal strength (μ_H) consistent with SM

Result	μ_H
Expected	1.0 ± 3.2
Observed	0.8 ± 3.2



Future Prospects

- Use more advanced neural-network based *b*-tagger
- Purify signal selection using jet substructure
- New physics interpretation

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