ttH multilepton backgrounds in ATLAS

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ATLAS EXPERIMENT
http://atlas.ch

Overview

- Multilepton channels primarily sensitive to ttH, H $\longrightarrow$ WW or H $\longrightarrow$ ττ
- Channels under consideration (ℓ = e/μ):
  - 2 same sign ℓ, 0 τ_h
  - 3 ℓ
  - 4 ℓ
  - 1 ℓ, 2 τ_h
  - 2 same sign ℓ, 1 τ_h

  } mainly H $\longrightarrow$ WW

  } target H $\longrightarrow$ ττ

- Main backgrounds: tt+fake (either ℓ or τ), ttW and ttZ
  - will discuss the irreducible backgrounds ttW and ttZ
  - also briefly tZ, VV+HF

Final States

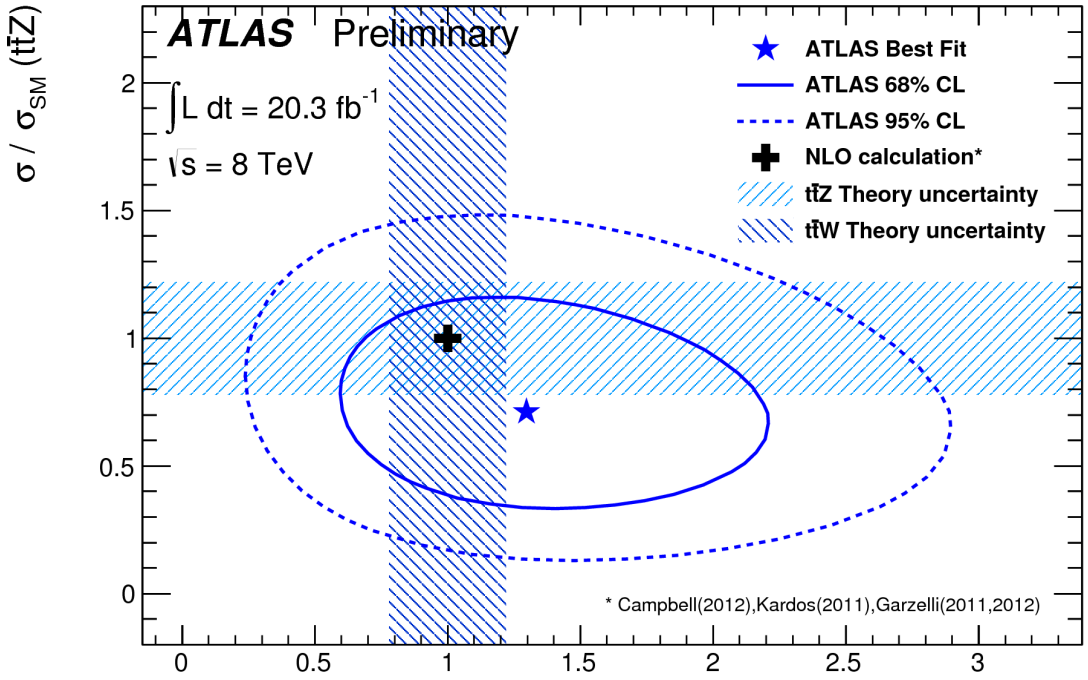
- Interested in relevant # of leptons, multiple jets, and b-jets

Channel	2lοτ (WW)	3l (WW)	4l (WW)	2l1τ (ττ)	1l2τ
Exp # jets	6j [2b]	4j [2b]	2j [2b]	4j [2b]	4j [2b]

- ttZ/γ* contributes to some of these signatures at leading order (e.g. 3ℓ, 4ℓ)
  - off-shell contributions are key
- ttW contributes when extra jets are added
  - multileg generation used
- Also tZ/γ* …
  - we tend to only require **one** b-tag which allows this to contaminate our signal regions
- And VV+HF

ttV

- Insufficient data for now to measure ttW and ttZ/γ* with precision comparable to theory uncertainties
- In particular, for ttW, in situ constraints will not be competitive any time soon



ATLAS-CONF-2014-038

Run 1 Generator Choice

- We use MadGraph 5 LO (from before aMC@NLO merger) for both ttZ/γ* and ttW
  - Pythia 6 for showering and top/W decays
- ttW generated with up to two extra partons, ttZ generated with up to one
- in both cases generate t t~ X, so top spin information is lost in decays
  - presumably also for W in t t~ W?
  - potentially important since we want to take advantage of spin correlation in $H \rightarrow WW$
- Shape systematics (α_s scale in ISR, renormalization/factorization scale, PDF) negligible compared to overall cross section

NLO use

- Have so far used aMC@NLO to compute inclusive cross sections + error bands
  - able to reproduce cross sections and errors of Campbell & Ellis (arxiv:1204.4424) and Garzelli et al. (arxiv:1208.2665)
- Exploring use for event generation for Run 2
  - would certainly want matching between NLO ttV and ttVj
  - even then we have LO formal accuracy for ttWjj
- Spin correlations may be as important to keep

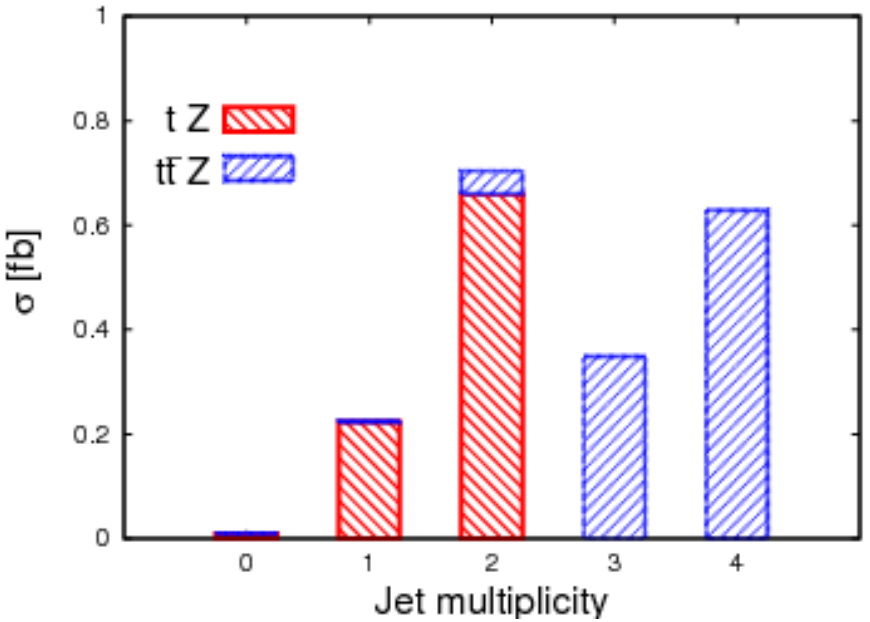
Asymmetric γ*

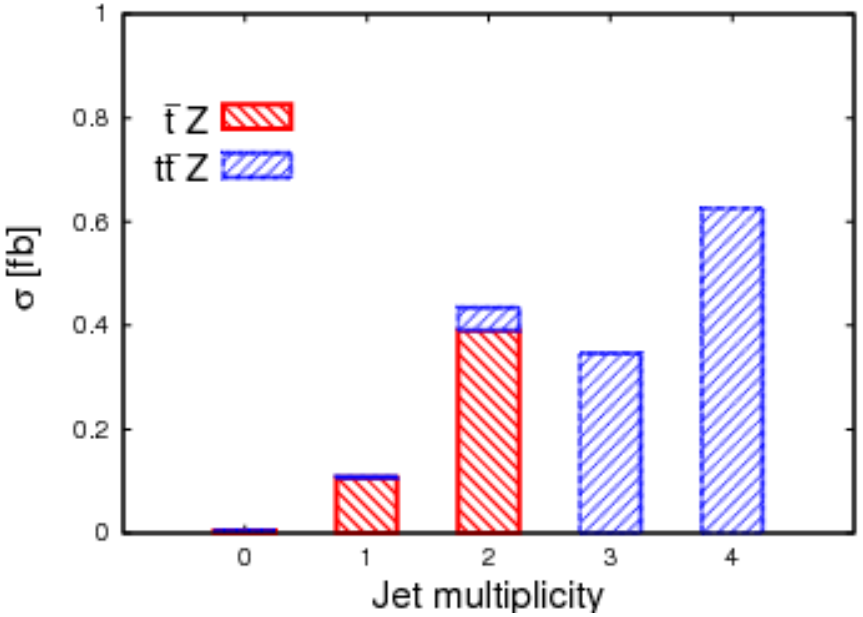
- ggF H → WW analysis has a background of Wγ*, γ* → ℓℓ where only one lepton has high p_T
- Successful simulation requires going down to very low values of m(γ*) - to threshold if possible
  - for Run 1 ggF analysis, Wγ* done with Sherpa
  - stability hard to achieve for ttγ*
- ttγ* potentially contaminates 2l and 3l channels through this mechanism. Recommendations for handling this welcome…
  - in particular do we have to worry about t → ℓνbℓ'ℓ' ?

tZ/γ*

- at LO can separate this process from ttZ/ttH in 3l decays by jet multiplicity
- at NLO, or with multileg generation, this separation breaks
- do we have reliable control on tWZ?

Campbell, Ellis, Röntsch, 1302.3856





WZ+HF

- VV+jets (esp. WZ) can contribute to signal regions:
  - mistags of light jets (can control from untagged events)
  - WZ+charm (sensitive to strange PDF; controllable from W+charm?)
  - VV+bb: how best to control? How similar to V+bb?
- Generated with Sherpa (including HF explicitly) and Powheg+Pythia 6 (not)
  - predictions are very compatible
- Control by using njet spectrum when 1 b is found
  - huge errors…

Summary and Needs

- Primary irreducible backgrounds to ttH multilepton search are ttZ/γ*, ttWjj, tZ, VV+HF
- All of these are difficult to constrain with data directly so we rely heavily on theory uncertainties
  - are we doing this right?
- Should we be going to NLO?
- What analogous processes should we use to test generators?