Search for Supersymmetry in strongly produced events with hadronically decaying τ-leptons at the ATLAS experiment

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ATLAS EXPERIMENT

FSP 101 ATLAS

bcgs
Bonn-Cologne Graduate School of Physics and Astronomy

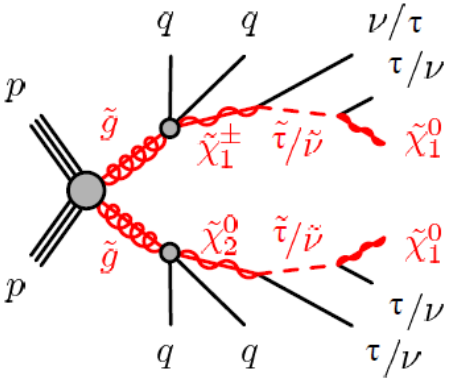
universitätbonn

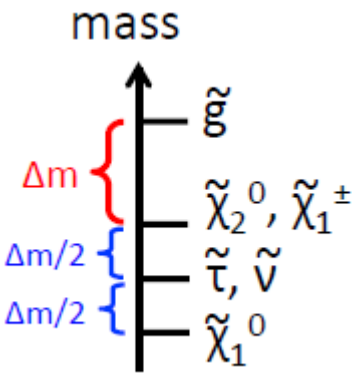
The general idea

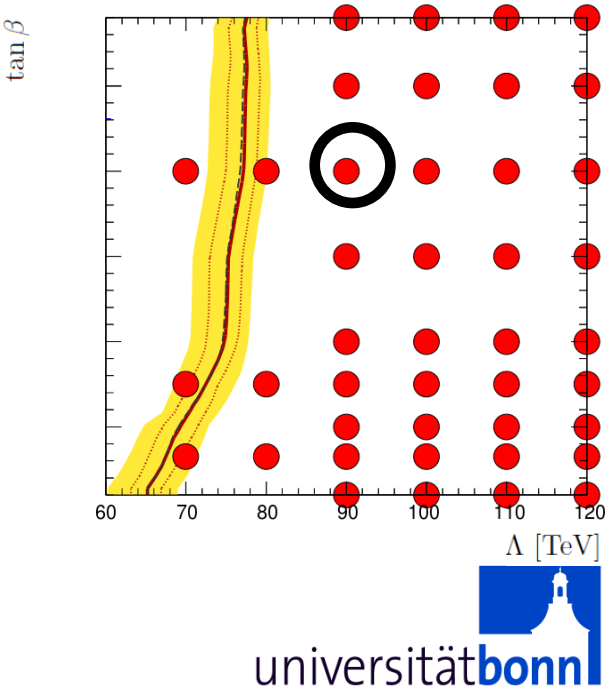
- Run-1: focus on GMSB
  - Analysis strategy
    - Design SR/CR/VR
    - Determine bkg normalisation in CRs → migrate to SRs, check in VRs
    - „Cut-and-Count“-experiment
- Run-2: focus on Simplified Models (SMS)
  - No discovery → look for a more general signal (SiMos)
  - Higher energy → higher mass scales accessible (GMSB→ ewk.)
  - Analysis strategy
    - Design SR/CR/VR
    - Perform multi-bin shape fits in CRs and SRs in parallel (HistFitter)
- This talk: DiTau analysis, selected benchmarks

The signals: GMSB, SMS

- GMSB/SMS benchmark study for 2670 pb^{-1}
- Re-optimisation of SRs, re-design of CRs for GMSB
- Design and optimisation of SRs and CRs for the SMS
- SR regions scaled to 3500 pb^{-1}
- Benchmark points
  - GMSB: Lambda = 90 TeV, TanBeta = 40
  - SMS: m(g) = 1305 GeV, m(chi) = 705 GeV



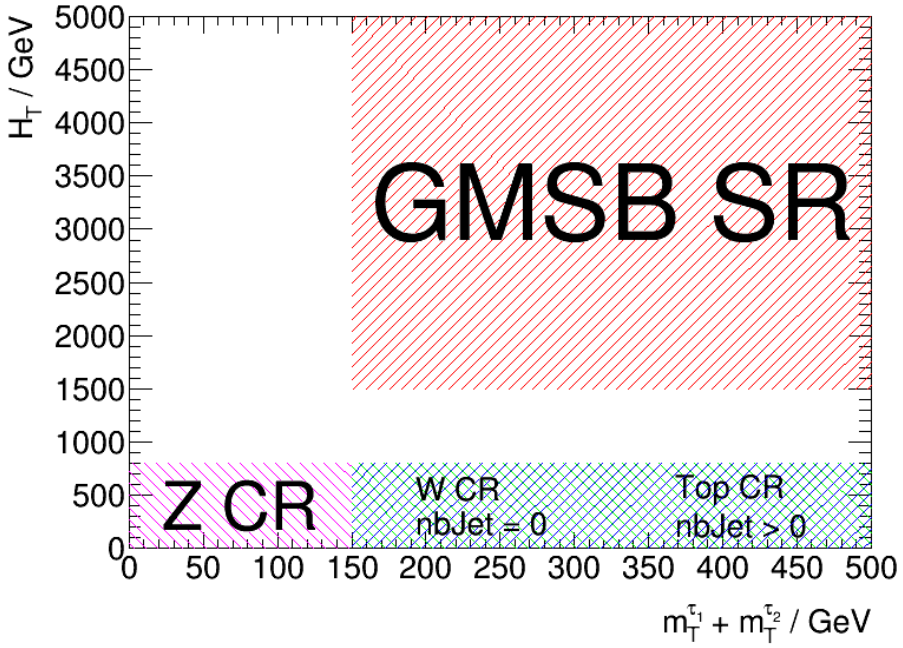


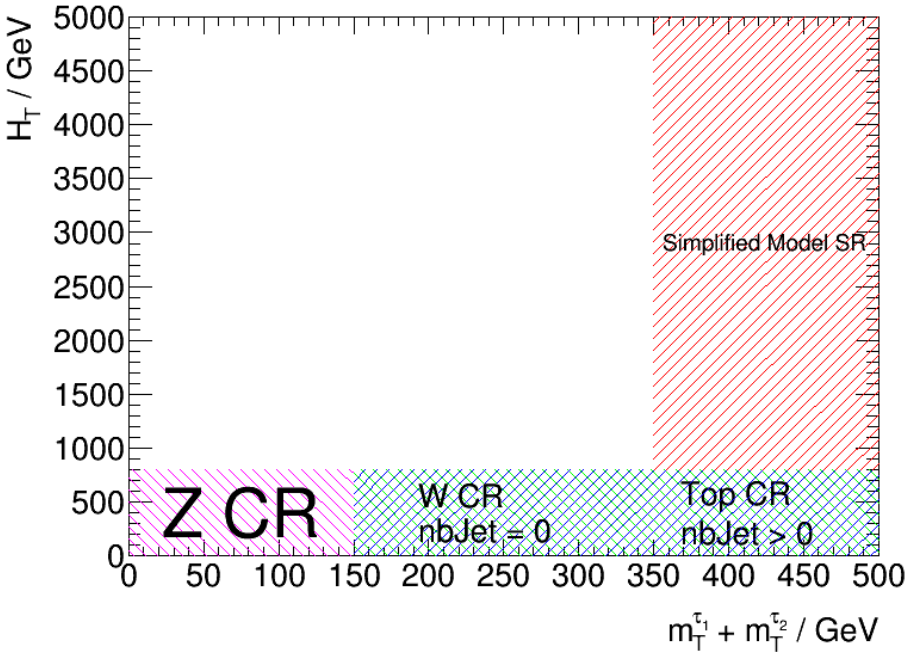


Used background & signal samples

- MC simulated signals:
  - GMSB: Herwig++
  - SiMo: MadGraph+Pythia8
- MC simulated backgrounds:
  - Top: Sherpa (also: Powheg+Pythia8)
  - W+Jets: Sherpa (also: MadGraph+Pythia8)
  - Z+Jets: Sherpa (also: MadGraph+Pythia8)
  - DiBoson: Sherpa
- Semi-data driven background estimate: QCD-Multijet
  - „Jet-Smearing“ procedure (used in Run-1)
  - Not yet available

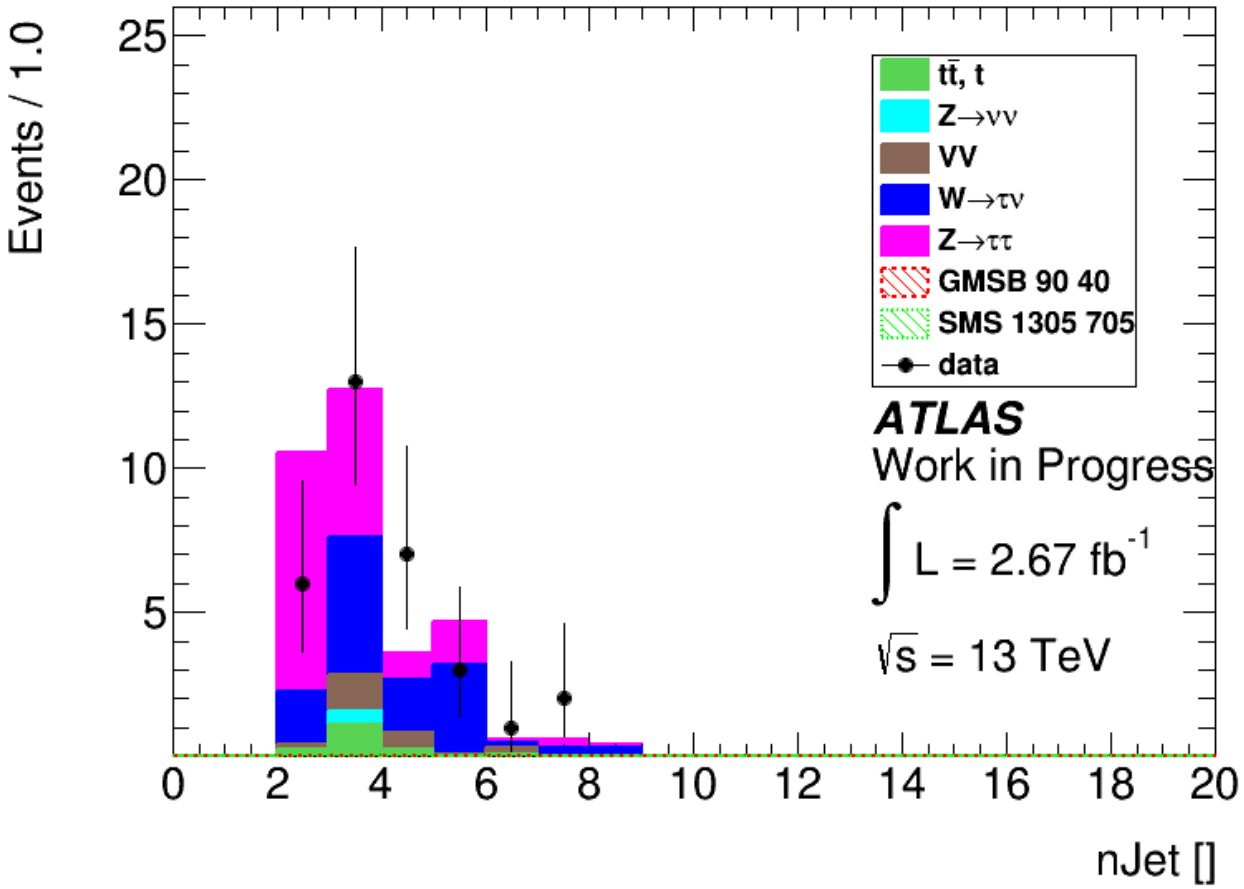
Phasespace overview





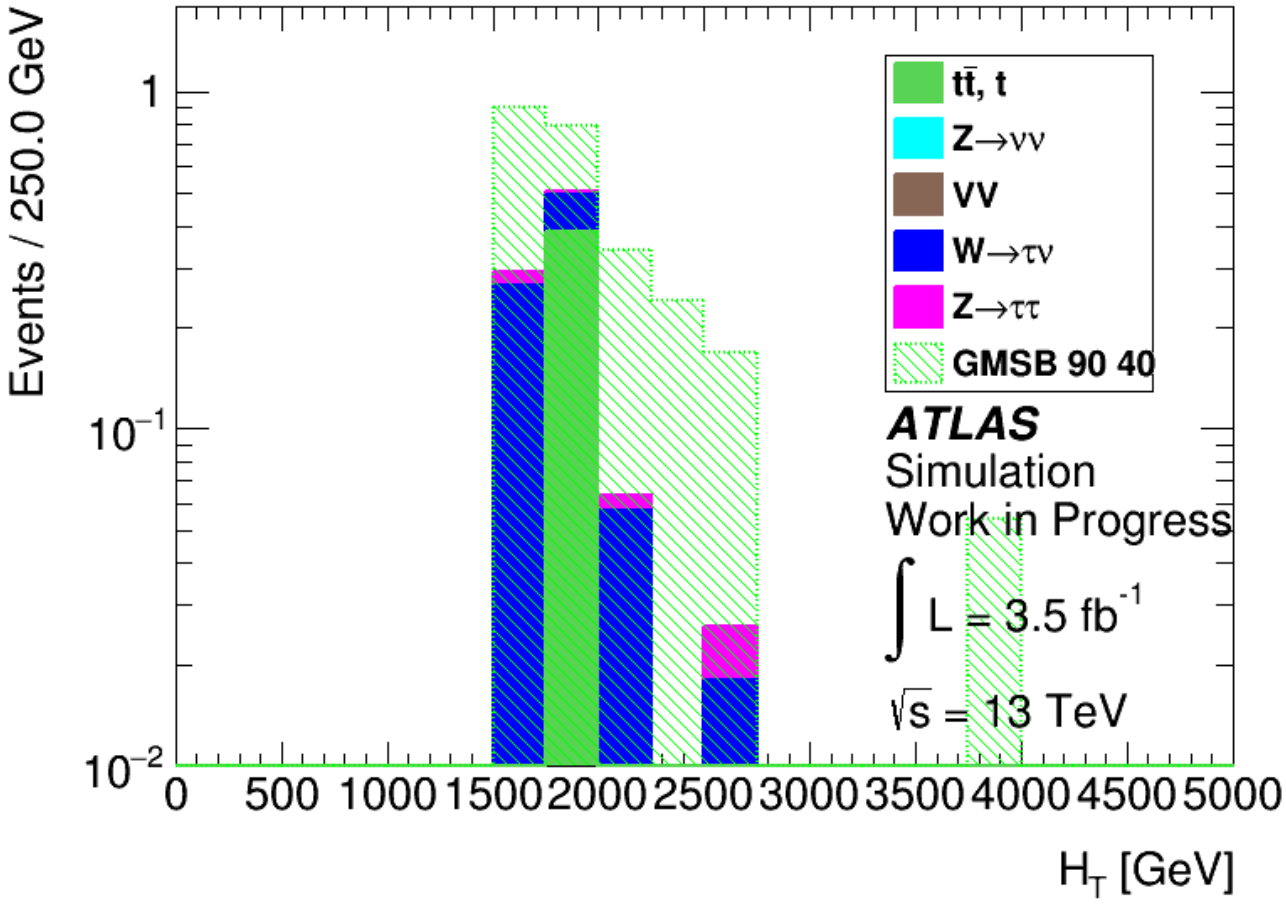
- Pre-selection:
  - nTau > 1, light lepton veto
- Baseline selection
  - MET-Trigger (70 GeV online, 200 GeV offline), Jet_1/2_delPhi > 0.3

Z-CR



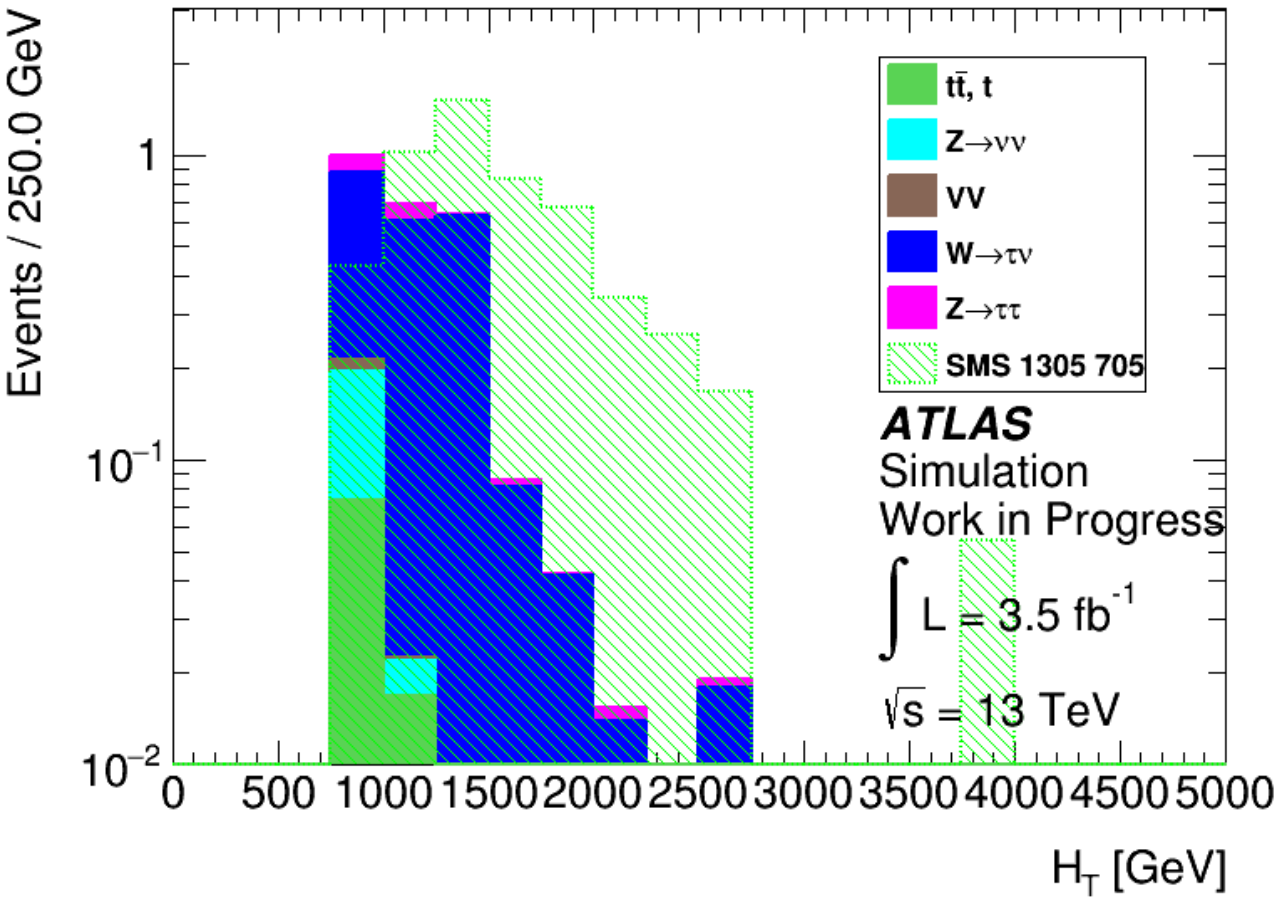
- SumMT($tau_{1,2}$) < 150 GeV, HT < 800 GeV, b-veto

GMSB SR



- SumMT($tau_{1,2}$) > 150 GeV, HT > 1500 GeV

Simplified Model SR

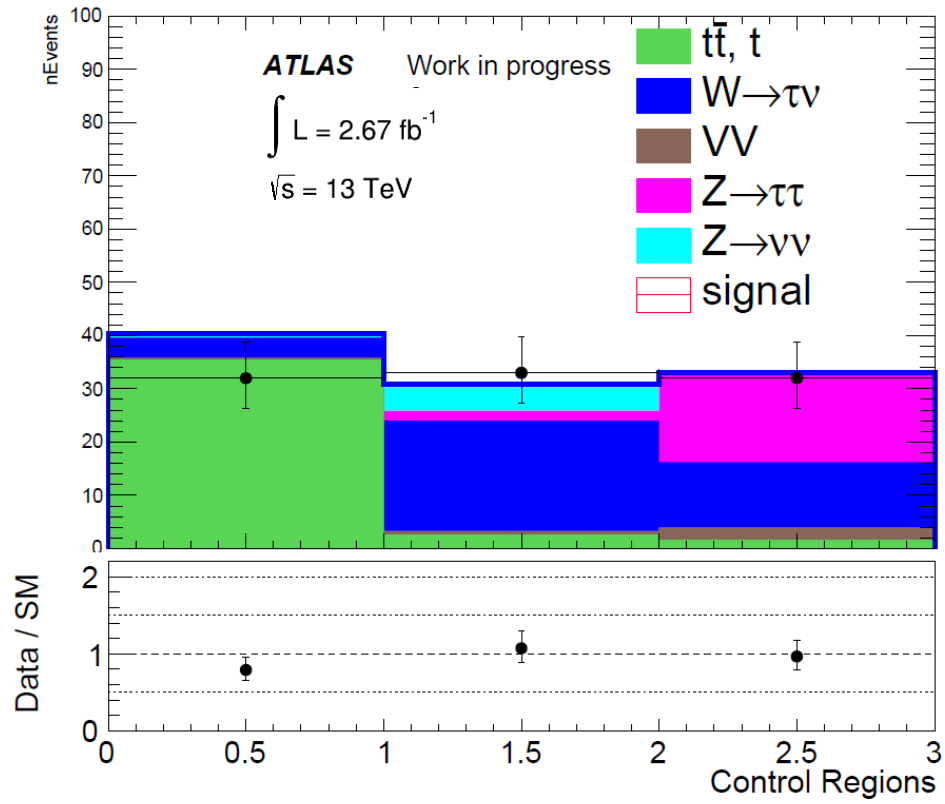


- SumMT($tau_{1,2}$) > 350 GeV, HT > 800 GeV, nJet > 2

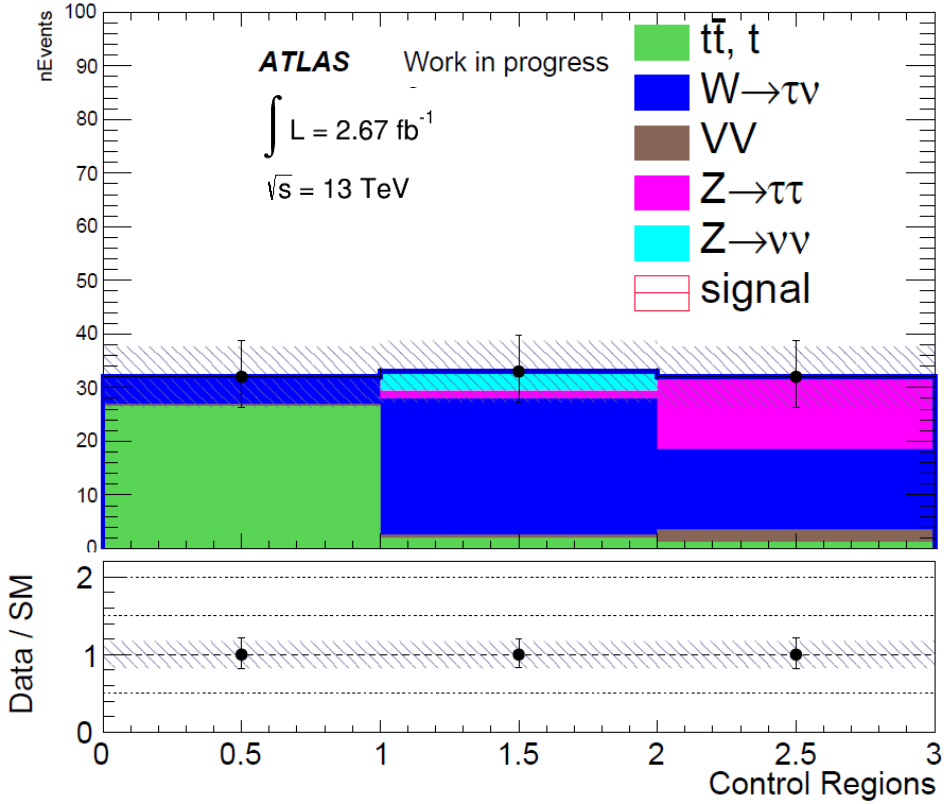
HistFitter – Putting everything together

- Simultanious fits in …
  - … 3 CRs
  - … 1 SR at a time
- Signal-free CRs
- DiBoson not fitted
- Z→tautau and Z→nunu scaled together
- Here: one-bin fits, no systematic uncertainties considered
- Also possible: multi-bin shape fits, consideration of systematic uncertainties

HistFitter – CR plots



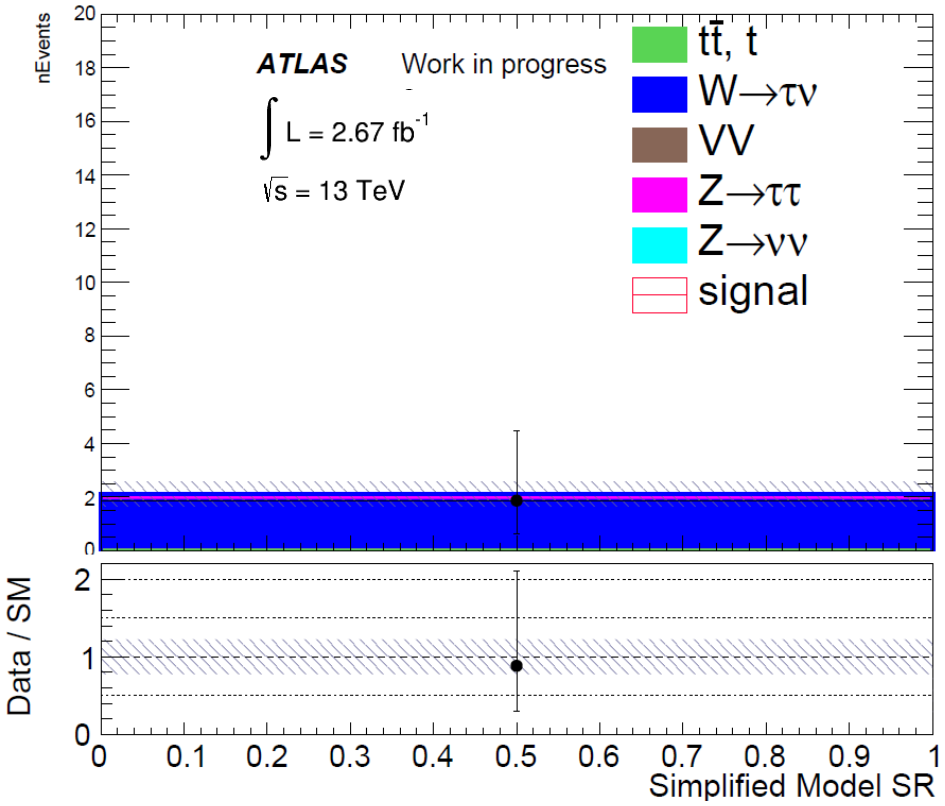
pre-fit



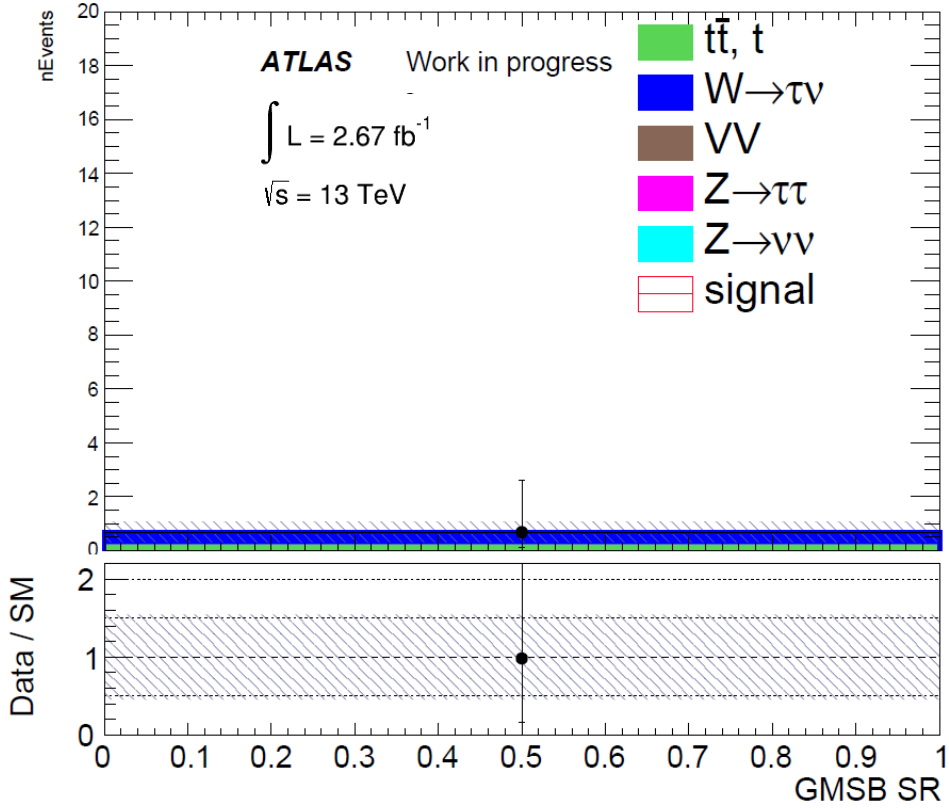
post-fit

- CR1 ←→ Top CR, CR2 ←→W CR, CR3←→Z-CR

HistFitter – SR plots



SMS



GMSB

- „Blinded data“: data = bkg. before fit

Obtained scale factors & correlations

Phasespace region	Fitted SF	SF error	Global Correlation
$t\bar{t}$, t	0.75	0.17	0.27
$W \to \tau\nu$	1.20	0.36	0.78
$Z \to \tau\tau$, $Z \to \tau\nu$	0.81	0.49	0.77

ATLAS Work in progress

- Reasonable background scalings
  - Improvement expected with better statistics and proper PRW

Summary & outlook

- Analysis design almost complete
  - SR design complete
  - Design of signal-free CRs complete
  - VRs left to implement
    - Free space in SumMT-HT-plane
    - Substitution of particles, e.g. tau → muon
  - Add QCD-Multijet background
- Extend fit to multi-bin shape fit
- Include systematic uncertainties
- Combined analysis aims for Moriond publication
  - Include OneTau-analysis (University of Bergen)
  - Include compressed SMS spectrum (LMU Munich)
  - 3500 pb-1 expected lumi

Backup

SR optimisation

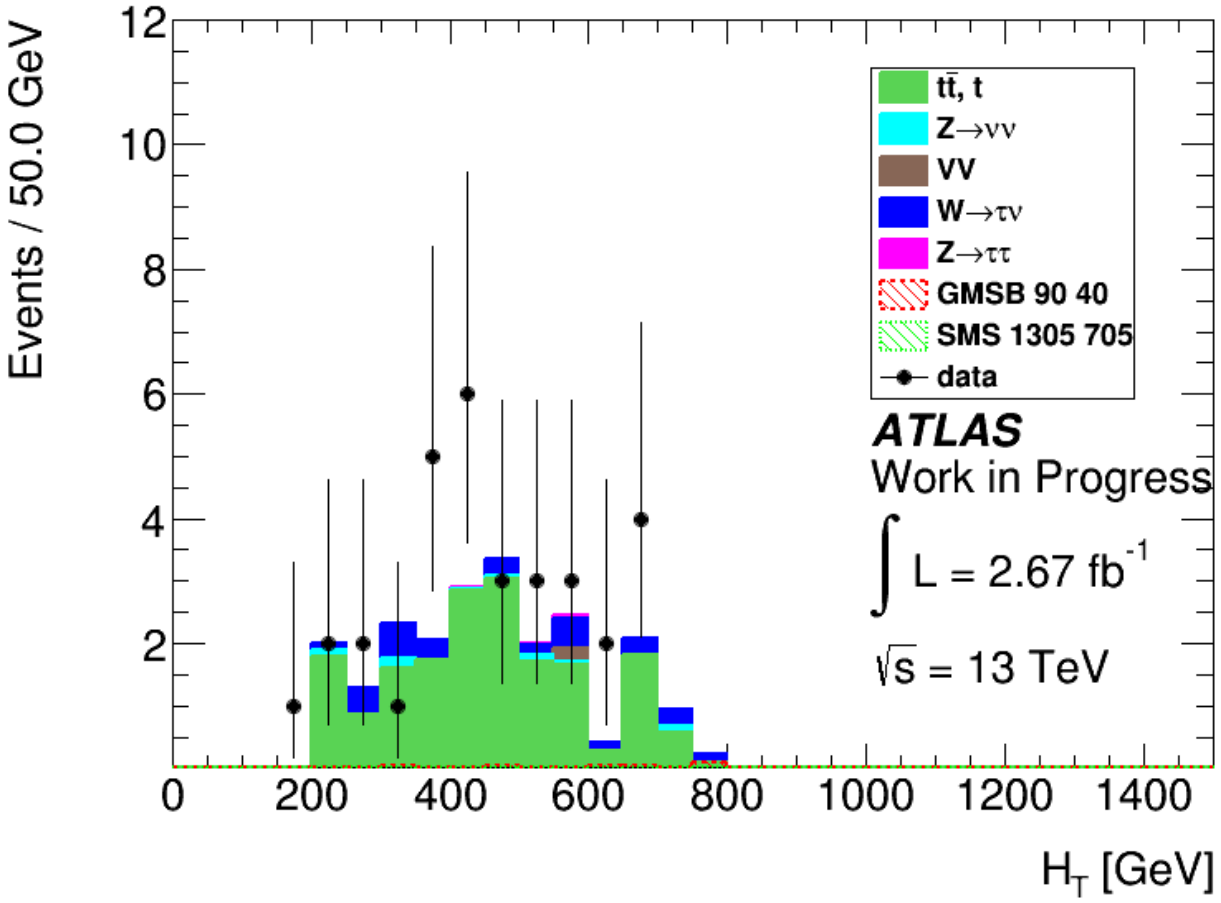
- SR optimisation via modified Asimov significance for discovery (by Glen Cowan)

- $$Z_{\mathrm{A}} = \left[2 \left((s+b) \ln \left[\frac{(s+b)(b+\sigma_b^2)}{b^2 + (s+b)\sigma_b^2} \right] - \frac{b^2}{\sigma_b^2} \ln \left[1 + \frac{\sigma_b^2 s}{b(b+\sigma_b^2)} \right] \right) \right]^{1/2}$$

Alternative trigger strategy

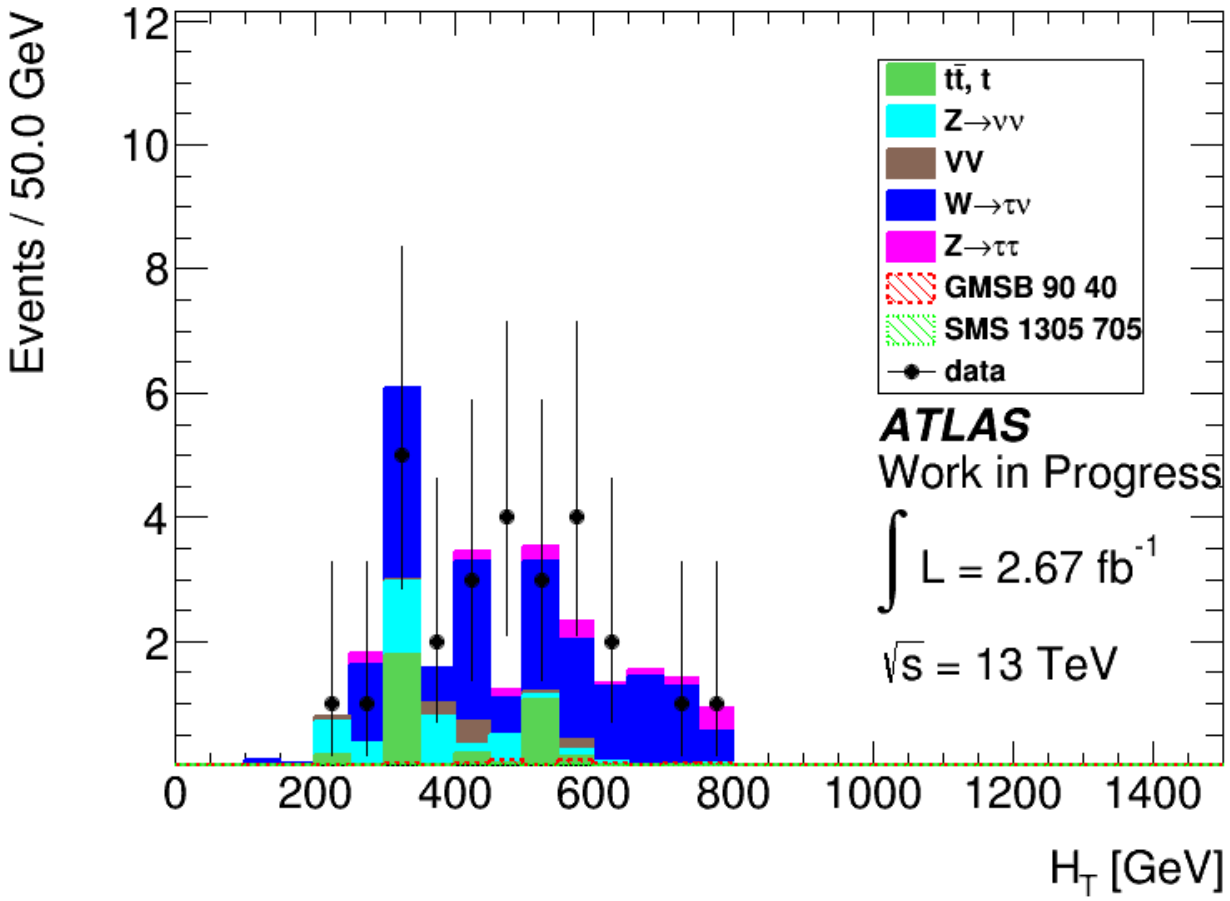
- DiTau tirgger
  - Online pT requirements 35 GeV/25 GeV
  - Offline pT requirements 45 GeV/35 GeV
  - Offline MET requirement 100 GeV
- Logical OR between DiTau and MET triggers
  - Offline MET requirement for DiTau trigger:
    100 GeV < MET < 180 GeV

Top-CR



- SumMT($tau_{1,2}$) > 150 GeV, HT < 800 GeV, nbJet > 0

W-CR



- SumMT($tau_{1,2}$) > 150 GeV, HT < 800 GeV, b-veto