Search for heavy neutral resonances in the fully hadronic di-tau channel at the ATLAS detector

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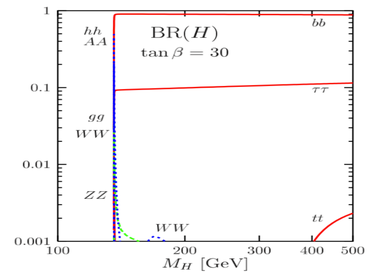
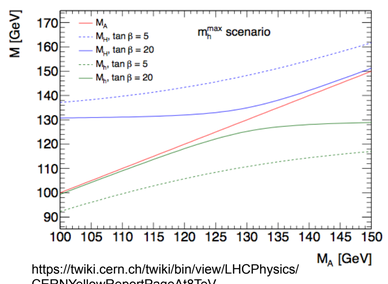
Motivation

Most of Beyond the Standard Model (BSM) theories predict heavy neutral bosons decaying into two tau leptons. In some supersymmetric extensions of the SM two heavy neutral Higgs bosons with enhanced couplings to tau leptons are predicted. Other theories, such as the Sequential Standard Model (SSM) introduce new gauge groups. This may yield to additional heavy neutral boson, e.g. the Z' boson.



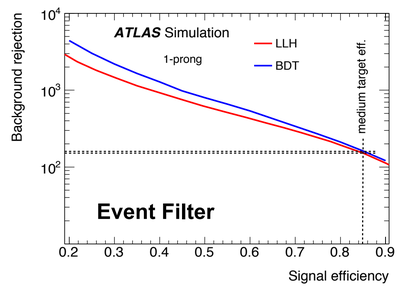
arXiv: hep-ph/0412238

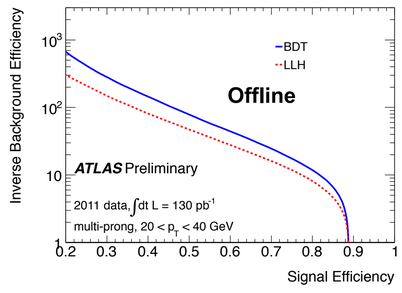


https://twiki.cern.ch/twiki/bin/view/LHCPhysics/CERNYellowReportPageAt8TeV

Triggering on and identifying hadronic tau decays

- Crucial for all tau based analyses
- Development of new Event-filter (EF) trigger algorithm based on multi-variate techniques
- Application of multi-variate techniques: Log-Likelihood, Boosted Decision Trees (BDT)
- Separation based on:
  - Low track multiplicity
  - Collimated track and energy deposits in calorimeter





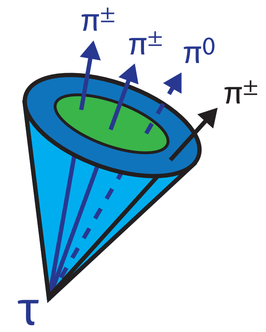


Figure: Performance of tau identification at Event Filter level (left) and at offline level (right).

ττ event selection

Preselection

- Event cleaning
- No preselected electrons or muons
- At least 2 hadronic tau decays with
  - p_T > 50 GeV, $|\eta|$ < 2.5
  - 1 or 3 tracks, |q| = 1
  - Loose BDT criteria
- $\Delta\phi(\tau,\tau)$ > 2.7
- Opposite sign

Single-tau triggered (STT)

- EF_tau125_medium triggered event
- Trigger match leading tau
- Leading tau p_T > 150 GeV

Di-tau triggered (DTT)

- Fail STT
- EF_2tau38T_medium1
- Trigger match of both taus

Background estimation

QCD multi-jet estimation

- Single-tau-triggered category
  - Next-to-leading tau unbiased w.r.t. tau identification
  - Apply tau fake factor measured in QCD di-jet data

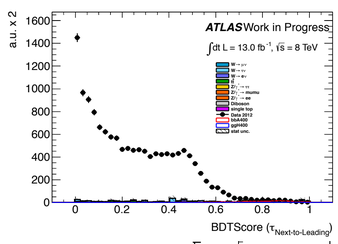


Figure: BDT Score distribution of the next-to-leading tau candidate before tau identification criteria is applied.

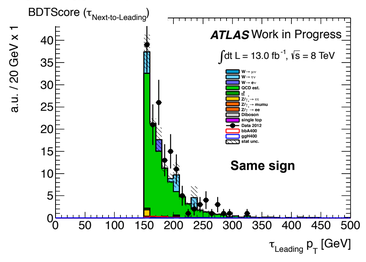


Figure: Transverse momentum of the leading tau after final selection in the single-tau-triggered category.

- Di-tau-triggered category
  - 2-dimensional side-band method based on charge product and identification requirement

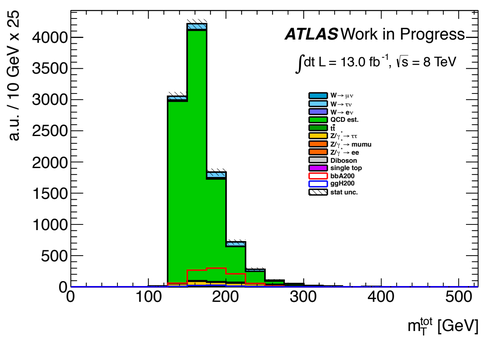


Figure: Total transverse mass distribution after final selection in the di-tau-triggered category.

Electroweak backgrounds

- Shape modeling by Monte-Carlo simulation
- Normalisation by weight corresponding to fake rate measured in W -> μν + jets

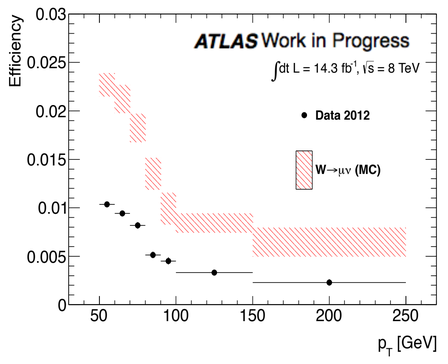
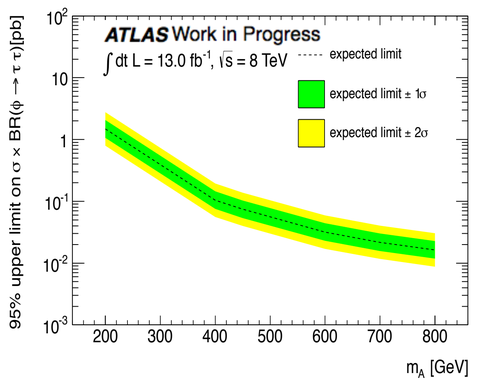
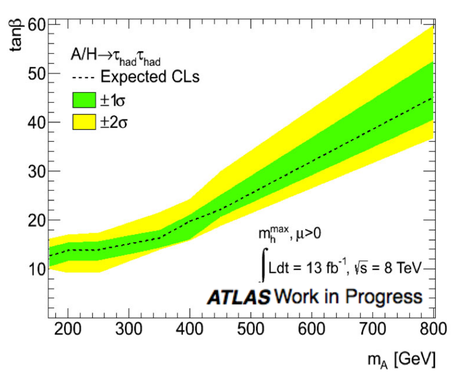


Figure: Tau identification fake rate for BDT loose criteria as a function of tau p_T.

Recent Results

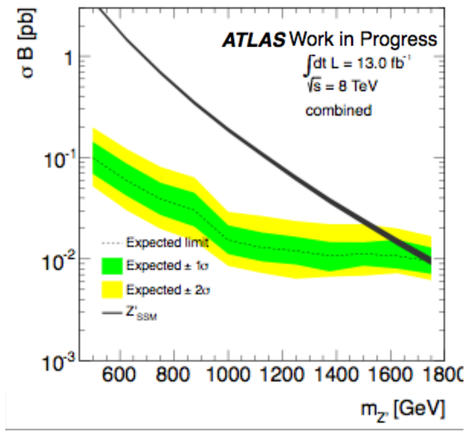
Expected 95% CLs exclusion limit on MSSM H/A ➔ $\tau_{had}\tau_{had}$





- Systematic uncertainties under evaluation
- Improved expected sensitivity by increased data set and optimised analysis strategy

Expected 95% CLs exclusion limit on Z'➔ $\tau_{had}\tau_{had}$



- Expect sensitivity of signal exclusion up to $m_{Z'}$ of 1.8 TeV

Outlook:

- Analysis will be updated to full 2012 data set
- Combination of 2011 and 2012 data
- Evaluation of systematic uncertainties
- Interpretation of high mass limits within different theory models, e.g. E_6 GUT, V-A and V+A coupling structure

Selected Publications

[1] "*Performance of the Reconstruction and Identification of Hadronic tau Decays in ATLAS with 2011 Data*", ATLAS Collaboration, ATLAS-CONF-2012-142

[2] "*Search for the Standard Model Higgs boson in H->tau+tau- decays in proton-proton collisions with the ATLAS detector*", ATLAS Collaboration, ATLAS-CONF-2012-160

[3] "*Search for the neutral Higgs bosons of the Minimal Supersymmetric Standard Model in pp collisions at √s=7 TeV with the ATLAS detector*", , ATLAS Collaboration, arXiv:1211.6956, submitted to JHEP

[4] "*Performance of the ATLAS tau trigger in 2011*", ATLAS Collaboration, ATLAS-COM-CONF-2012-054

[5] "*Triggering On Hadronic Tau Decays: A challenge met by ATLAS*", M. Morgenstern, arXiv:1201.5492

[6] "*Search for Neutral MSSM Higgs Bosons in A/h/H→τ+τ−→eμ+4ν Final State with 0 Jets in Proton-Proton Collisions at s√=7 TeV with the ATLAS Detector*", F. Friedrich, C. Gumpert, M. Kobel, W. Mader, M. Morgenstern, A. Straessner, ATL-COM-PHYS-2012-2011

Selected Talks

- "*Physics with tau leptons at ATLAS*", Phenomenology 2012 Symposium, May 2012, Pittsburgh
- "Data driven background estimation in tau physics analysis", ATLAS-D physics meeting, Wuppertal, September 2012
- "*Estimation of Theory Systematics in MSSM Neutral Higgs Searches*", Terascale 6th annual meeting, December 2012

Profit from the GK

- Soft skill courses at the HU graduate school
- Financial support for conferences and international workshops
- Contact to theoretical and experimental colleagues within the GK

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DRESDEN concept

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