

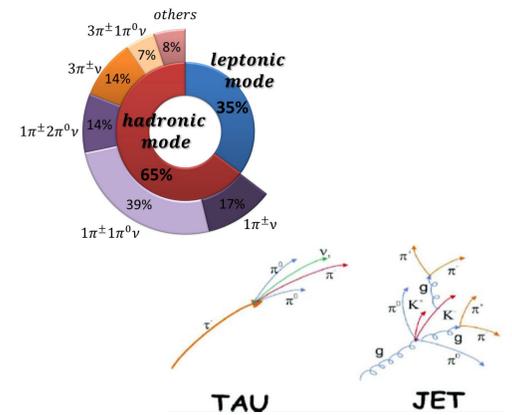
Introduction

The minimal supersymmetric standard model (MSSM) predicts three neutral Higgs bosons ($h/H/A$) and two charged ones (H^\pm). The analyses presented on this poster is focusing on neutral Higgs bosons and is performed in the di-tau channel, where one of the taus decays leptonically and the other hadronically. Data collected with the ATLAS detector in 2013 will be used, corresponding to roughly 21.7 fb^{-1} .

Tau Leptons

Tau leptons are important signatures for Standard Model processes and searches for new physics. With a mass of $1.777 \text{ GeV}/c^2$ the tau is the heaviest lepton. Due to its short lifetime of 2.9×10^{-13} seconds ($c\tau = 87 \mu\text{m}$) the tau lepton decays inside the beam pipe.

In ATLAS, tau reconstruction and identification concentrates on the hadronic decay mode of a tau lepton. Hadronic tau decays are classified according to the number of charged decay particles (prongs). These decays can be differentiated from QCD jets by their characteristics, such as low track multiplicity and collimated energy deposits.

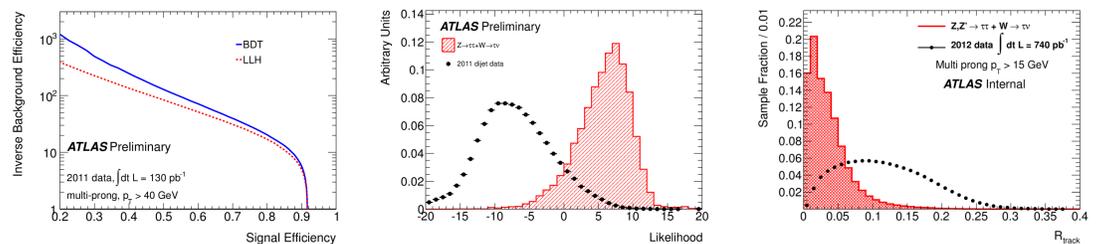


Tau Reconstruction

Calorimeter jets with a transverse energy larger than 10 GeV and within the detector acceptance are used as a seed for tau candidates reconstruction. Tracks within a cone of $\Delta R = \sqrt{(\Delta\phi)^2 + (\Delta\eta)^2} < 0.4$ around the jet axis passing certain quality criteria are associated to the tau candidate and used to calculate the discriminating variables. The number of tracks within $\Delta R < 0.2$ are used to classify the tau candidate into single- or multi-prong categories. The tau energy is calculated using all clusters within a core of $\Delta R < 0.2$ around the 4-vector sum of clusters associated with the jet seed. Calibration factors are derived from response functions using Monte Carlo simulations.

Since the reconstruction provides only little discrimination power between QCD jets and tau a dedicated identification step is needed.

Two multi-variate methods – one using a projective likelihood (LLH) and the other a boosted decision tree (BDT) approach – are trained separately for single and multi-prong tau candidates.



Analysis

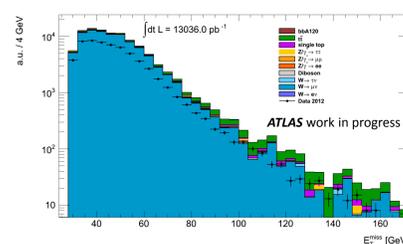
Preselection:

- Combination of single-lepton and lepton-tau trigger
- Data quality criteria and event learing
- Exactly 1 well identified and isolated electron or muon
- Exactly 1 well identified hadronic tau
- $|\Delta\phi(\text{lepton}, MET)| + |\Delta\phi(\text{tau}, MET)| < 3.3$

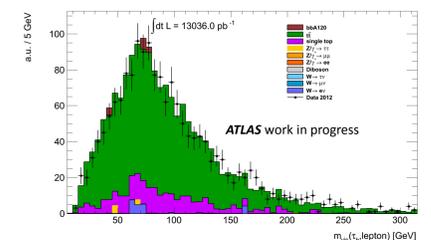
Divide Analyses in different categories:

- Low-mass and b-tag category
 - transverse mass less than 60 GeV
 - a b-jet with $p_T < 60 \text{ GeV}$
- Low-mass and b-veto category
 - transverse mass less than 60 GeV
 - no identified b-jet
- High-mass category
 - $|\Delta\phi(\text{lepton}, \text{tau})| > 2.4$
 - $\Delta p_T(\text{tau}, \text{lepton}) > 45 \text{ GeV}$

Background estimation:

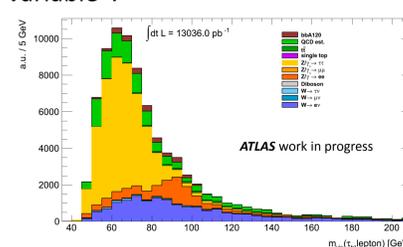


- Missing E_T distribution for the low-mass b-veto category in the W-background control region. The W production rate will be adjusted to the rate observed in data.



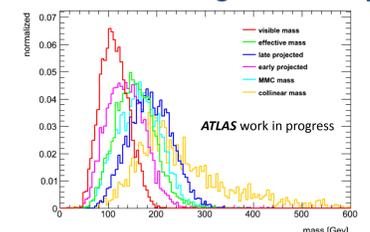
- Visible mass distribution for the low-mass b-veto category shown in the $t\bar{t}$ control region. The top pair production rate is adjusted to the rate observed in this control region.

“Final Variable”:



- Visible mass distribution for the high-mass category shown for the signal region (without data).

Mass reconstruction algorithm comparison



- reconstructed mass of a $pp \rightarrow bb + A$ Monte Carlo sample with $m_A = 120 \text{ GeV}$ for different algorithms.

Publications

- Identification of the Hadronic Decays of Tau Leptons in 2012 Data, W. Davey et. al., ATL-COM-PHYS-2012-1821
- Performance of the Reconstruction and Identification of Hadronic tau Decays in ATLAS with 2011 Data, ATLAS Collaboration, ATLAS-CONF-2012-142
- Search for the Standard Model Higgs boson in $H \rightarrow \text{tau} + \text{tau}^-$ decays in proton-proton collisions with the ATLAS detector, ATLAS Collaboration, ATLAS-CONF-2012-160

- Search for the neutral Higgs bosons of the Minimal Supersymmetric Standard Model in pp collisions at $\sqrt{s} = 7 \text{ TeV}$ with the ATLAS detector, ATLAS Collaboration, arXiv:1211.6956, submitted to JHEP
- Tau Lepton Reconstruction and Identification at ATLAS, F. Friedrich, arXiv:1201.5466

Selected Talks and Posters

- Tau Reconstruction and Identification at ATLAS, Poster, HCP 2011, Paris, November 2011
- Physics with Tau Lepton Final States in ATLAS, HEP 2012, Valparaiso (Chile), January 2012
- Physics with Tau Leptons at ATLAS, Poster, Terascale 6-th annual meeting, Hamburg, December 2012

Profit from the GK

- Block Course: comprehensive lectures of a specific topic from particle physics
- financial support for conferences (especially outside Europe)
- possibility of joining soft skill courses at the HU (for me as a PhD student at TUD)

Contact Details and further Information

PhD Student: Felix Friedrich (TUD), felix.friedrich@tu-dresden.de

PhD Advisors: Jun.-Prof. Arno Straessner (TUD), Prof. Heiko Lacker (HU)