Studies of the tau pair system in ATLAS

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Bergen, 9 oct 2009 - Review of analysis currently in progress

Introduction - studying tau pairs in the Standard Model and beyond

A tau lepton pair is a common decay mode of the Z^0 boson. Furthermore, tau pairs are very important decay modes in certain Higgs boson and SUper SYmmetric scenarios – even considering difficulties associated in reconstructing properties such as boson mass the tau pair system remains an important tool both for Standard Model physics and beyond. We want to perform a general analysis of the tay pair system including

- Acquire expertise on the tau reconstruction code, tauRec, by taking an active part in developing the code (figure 1)
- Exploiting symmetry of τ and μ to understand SM backgrounds (figure 2)
- Optimizing the tau candidate selection using tools developed by the ATLAS tau working group, starting by analyzing Z^0 signal (figure 3)
- Create a tool set to study correlations between energies and variables in the final states of the two taus (figure 4)
- Studying invariant mass distributions from the reconstructed tau pair system, and try to make use of missing energy calculations to correct for energy lost by neutrino production in the tau decay (figure 5)

In summary, we hope that a careful analysis of the tau-tau system will enable us to contribute to the understanding of the production of Z^0 bosons in early data, as well as to optimization of the sensitivity to new physics in this final state.

NOTE: Plots are private snapshots of *work in progress*, and reflect in no way *final results*!

Thomas Burgess - Tau EDM

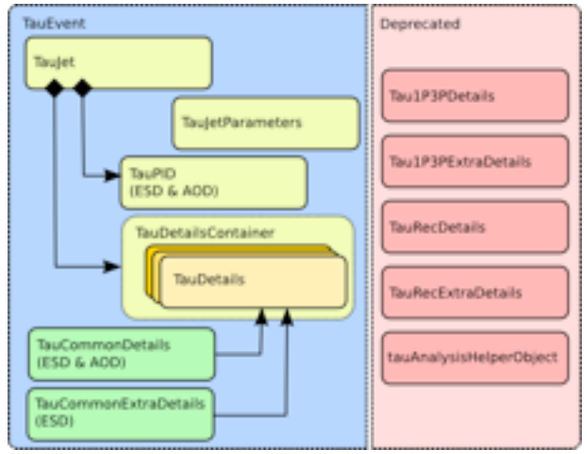

Figure (1) The tau Event Data Model - tauEvent - is the software responsible for storing and accessing observables of reconstructed tau jet candidates created by tauRec. The EDM is evolving with the reconstruction software as well as ATHENA's framework for persistent storage.

Arshak Tonoyan - τ ↔ μ switching

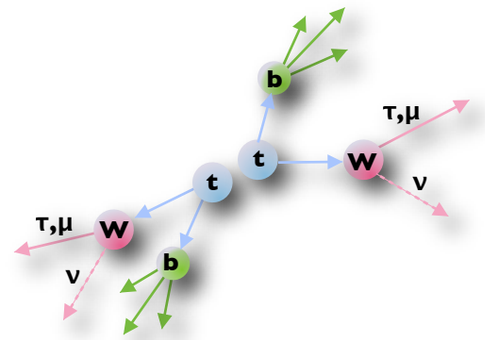

Figure (2) As high energy Standard Model processes are symmetric in leptons, an observed anomalous tau production can indicate physics beyond SM. Furthermore, results from SM muon measurements can beused to model SM tau processes which are hard to measure. Here methods for swapping taus and muons in simulations and prospects of using this to model backgrounds in our ongoing SUSY search are investigated

Ørjan Svandal - Tau Selection With Safe Variables

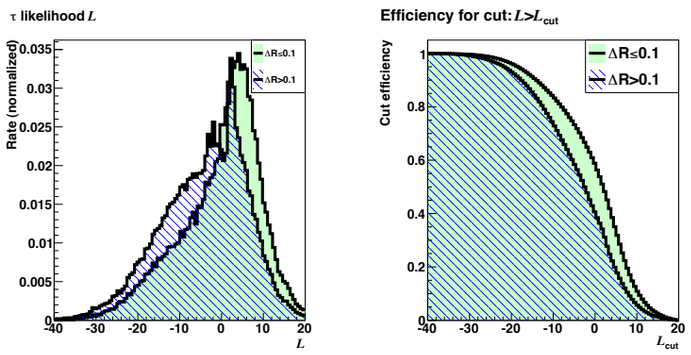

Figure (3) Tau identification with a likelihood variable, comparing well reconstructed τ-jets to all τ-like jets in $Z^0 \to \tau^+\tau^-$ simulations. In the left plot the distributions of tau likelihood variables are compared for the samples. The right plot shows the selection efficiency as a function of the cut on the variable. Many additional variables can be used, and the idea is to combine these in an optimal way in the selection of $\tau^+\tau^-$ pairs.

Peter Rosendahl - Tau Helicity Correlation Studies

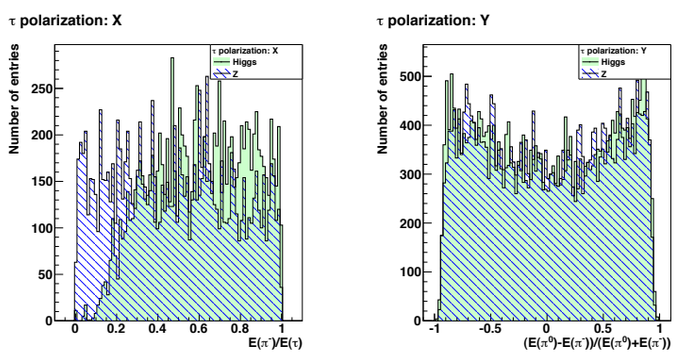

Figure (4) Monte Carlo truth study of tau polarization in simulated $Z^0 \to \tau^+\tau^-$ and Vector-Boson-Fusion Higgs$\to\tau^+\tau^-$ events. In the left figure the energy ratio between the pion and the tau is shown in the cases where the tau decays directly into a pion and a neutrino. In the right figure the energy ratio between the neutral and the positive pion is shown in the cases where the tau decays like $\tau^- \to \rho^- \nu \to \pi^- \pi^0 \nu$ is shown.

Alette Aasvold - Tau-pair Invariant Mass Studies

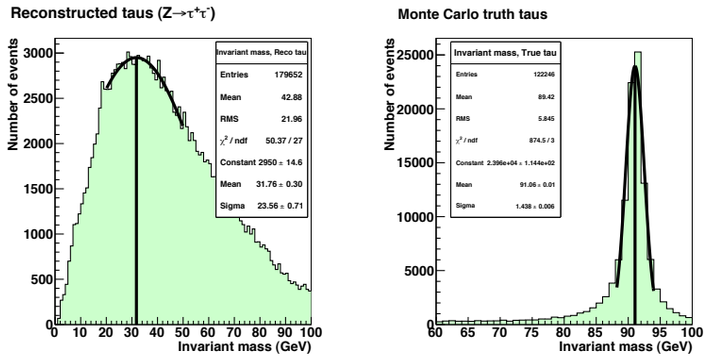

Figure (5) Invariant mass of τ-pair in $Z^0 \to \tau^+\tau^-$ simulations. The invariant mass of the reconstructed (left) and generated (right) τ-pairs. The reconstructed mass underestimates the Z^0 mass because energy is carried away by neutrinos produced in the τ-decay. A correction to the mass is possible using the missing energy and the "co-linear approximation" that the neutrinos from the decaying taus are parallel to the taus. We are studying the validity of this approximation in the low energy region which will be important in ATLAS early data.