[1] TAU RECONSTRUCTION & IDENTIFICATION IN THE ATLAS EXPERIMENT

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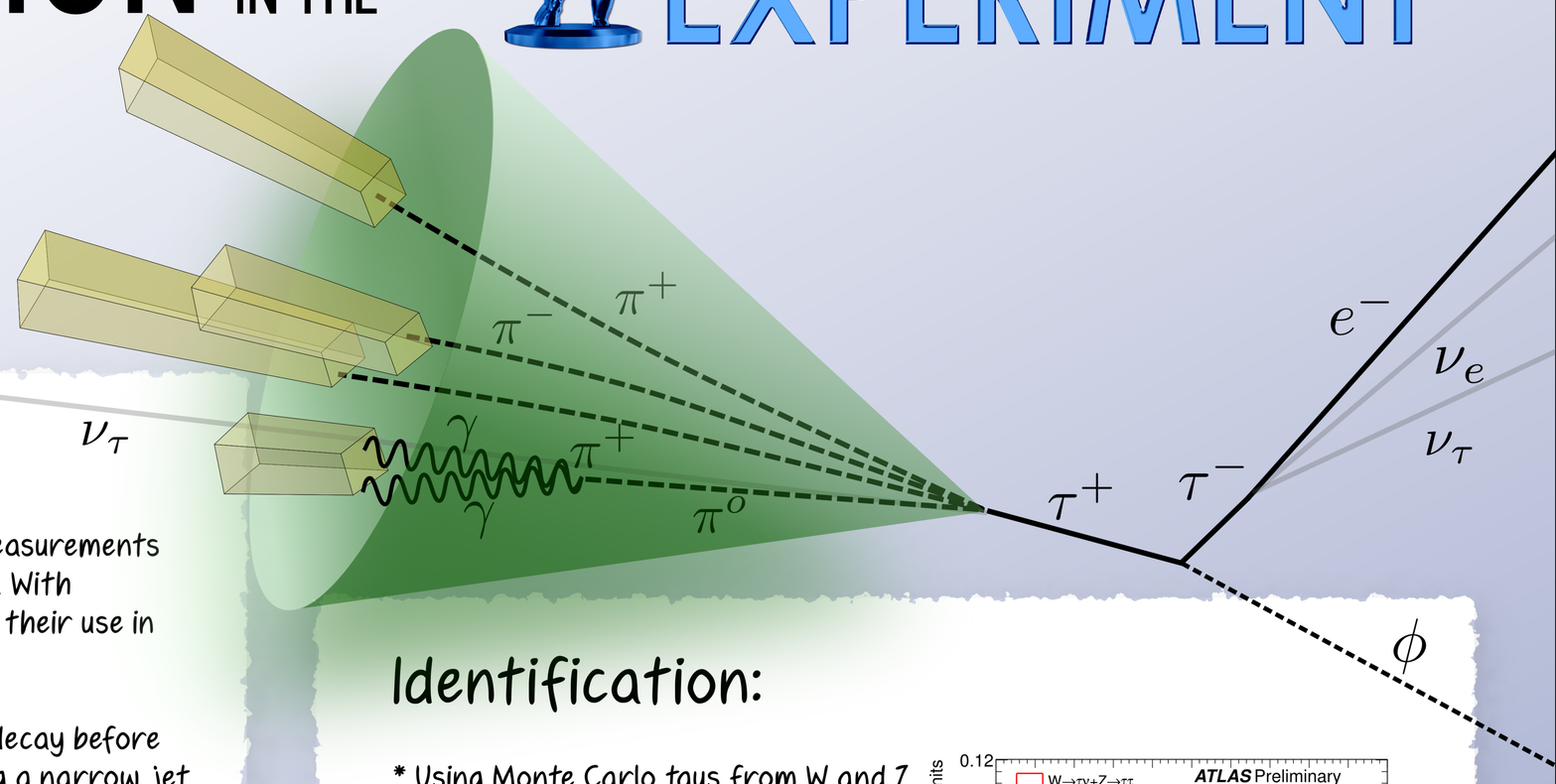
on behalf of the ATLAS Collaboration

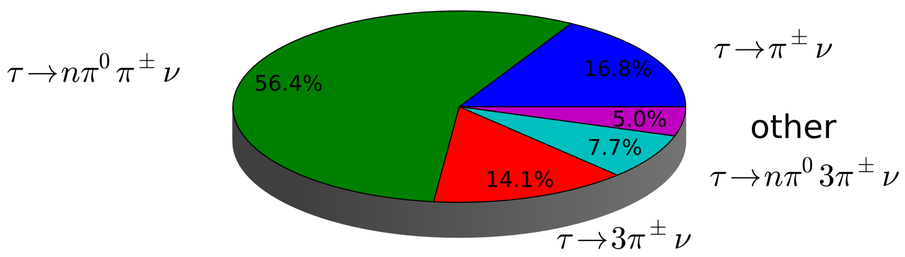


Introduction:

* Hadronically decaying tau leptons play an important role in measurements of the Standard Model as well as in the search for new physics. With hadronically decaying taus having been observed in ATLAS [2, 3], their use in physics analyses is expected to grow.

* Having a mean lifetime of 2.9×10^{-13} seconds ($c\tau$ = 87 μm) taus decay before leaving the beam pipe. 65% of taus decay into hadrons producing a narrow jet in the ATLAS detector. The hadronic decay modes are labeled by the number of charged decay products (prongs):

Hadronic Decay Modes



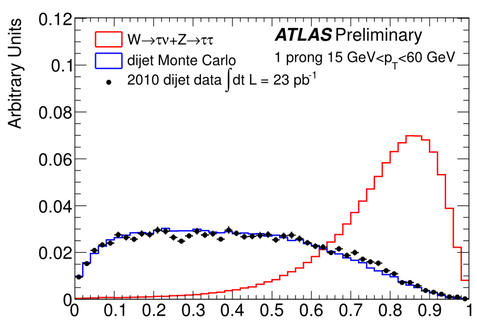
Reconstruction & Energy Calibration:

* Tau candidates are seeded by calorimeter jets of cell clusters created by the anti-k$_t$ algorithm within the η-range of the ATLAS tracking system. Tracks within $\Delta R < 0.4$ of the jet axis are associated with the tau candidate if they pass certain quality criteria. A candidate is defined as a single or multi-prong tau by the number of tracks contained within a core region of $\Delta R < 0.2$ around the jet axis.

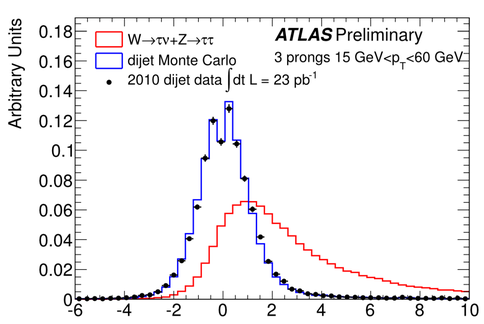
* A dedicated tau energy calibration has been derived by determining response functions defined by ratios of the EM scale energy to the true generated energy of hadronic tau decays in Monte Carlo simulations. Response functions are constructed separately for single and multi-prong candidates as well as in separate $|\eta|$ regions of the ATLAS detector.

* The tau reconstruction algorithm provides little rejection against the vast QCD multijet background. Discriminating variables are first defined by the reconstruction algorithm and are then used by a separate set of identification algorithms. Some of the primary features which distinguish taus from the QCD background include width (top left), mass (bottom left), a displaced secondary vertex (top right), and a leading track (bottom right):

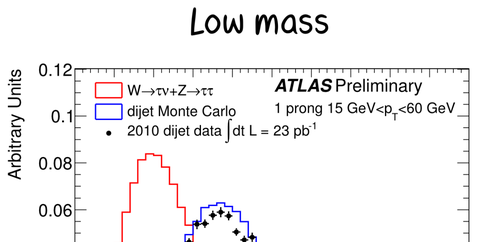
Narrow jet width



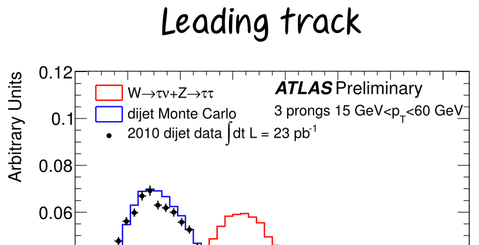
Displaced secondary vertex



Low mass



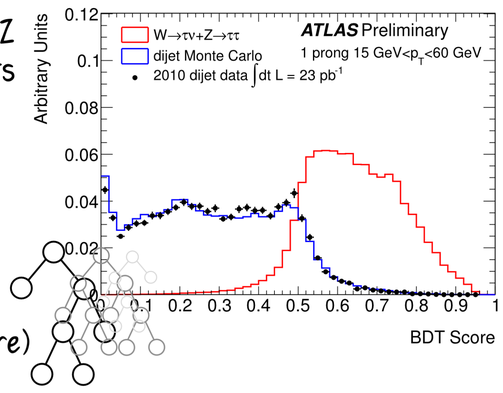
Leading track



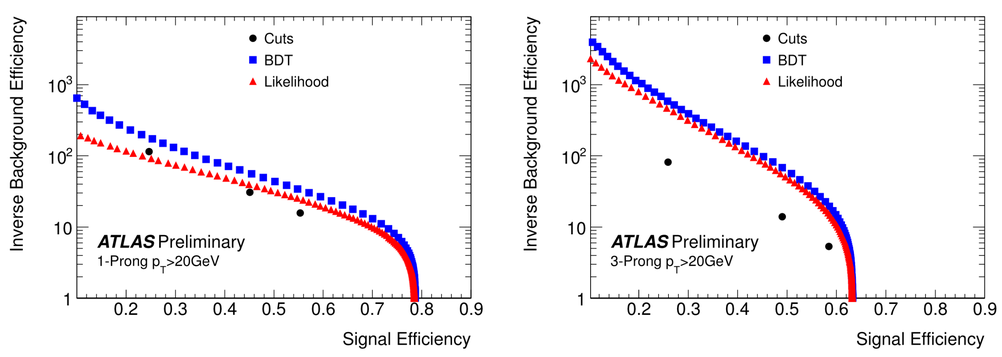
Identification:

* Using Monte Carlo taus from W and Z as signal and, for the first time, dijets from real ATLAS data as background, three identification techniques have been optimized:

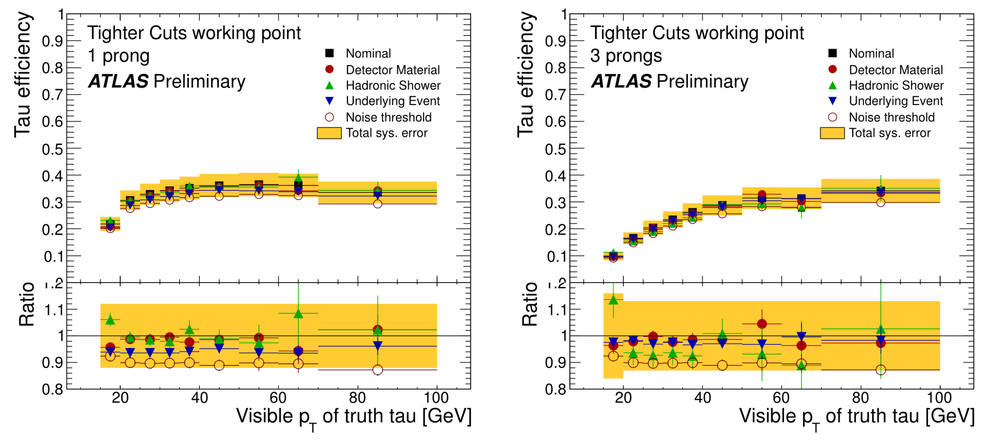
  - cut-based approach
  - projective likelihood
  - boosted decision trees (shown here)



* Each technique uses information from multiple identification variables to produce a discriminant more powerful than any single variable. The 1-prong and 3-prong performance, expressed as inverse background efficiency versus signal efficiency, is shown below for all three techniques.



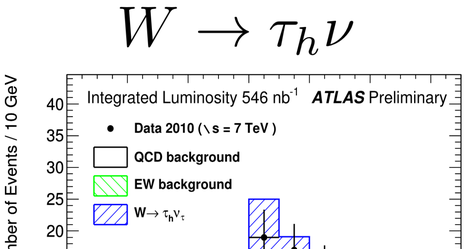
* First estimates of the systematic error on the signal efficiency have been determined by considering variations in the detector geometry, underlying event model, Monte Carlo tuning, shower model, and different noise thresholds on the calorimeter cells for cluster reconstruction. The systematic error versus p_T of the tau candidate is shown below:



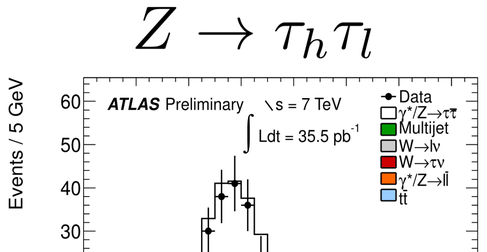
Observation:

* Hadronic tau decays have been observed from both W and Z decays [2,3]:

$W \to \tau_h \nu$



$Z \to \tau_h \tau_l$



References:

[1] The ATLAS Collaboration, *Reconstruction, Energy Calibration, and Identification of Hadronically Decaying Tau Leptons in the ATLAS Experiment*, ATLAS-CONF-2011-077, May, 2011.
[2] The ATLAS Collaboration, *Observation of W->tau nu Decays with the ATLAS Experiment*, ATLAS-CONF-2010-097, Nov, 2010.
[3] The ATLAS Collaboration, *Observation of Z->tau$_h$tau$_l$ Decays with the ATLAS Experiment*, ATLAS-CONF-2011-010, Feb, 2011.

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