Tau Polarisation Measurement in Z Decays Using the ATLAS Detector

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Introduction

The tau polarisation from Z decays given by: $P_\tau = \frac{N_R - N_L}{N_R + N_L}$

and has been measured at LEP to be

$$P_\tau = -0.137 \pm 0.019$$

Motivation for Measurement

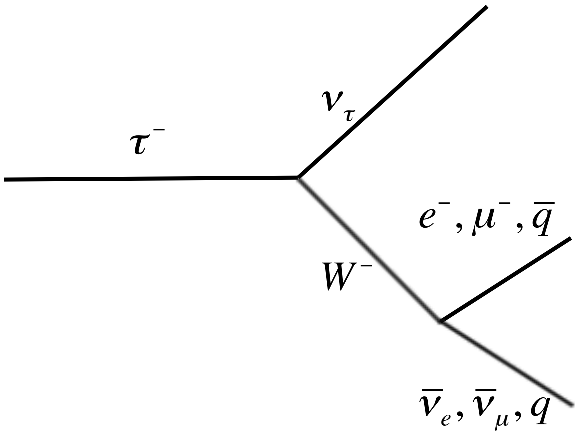
Test if such a measurement is possible at a hadron collider.

In case of new particles decaying to taus one will be able to measure their coupling asymmetry to left and right handed particles.

Tau Decay Modes

Leptonic decays:

Branching fraction: ~35 %



Hadronic decays:

Branching fraction: ~65%

1-prong: $\tau^- \to h^- n\pi^0 \nu_\tau$

3-prong: $\tau^- \to h^- h^+ h^- n\pi^0 \nu_\tau$

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Tau Decay Modes as Polarisation Analysers

The Leptonic Decay Channels:

Not very sensitive to polarisation of the tau due to two neutrinos.

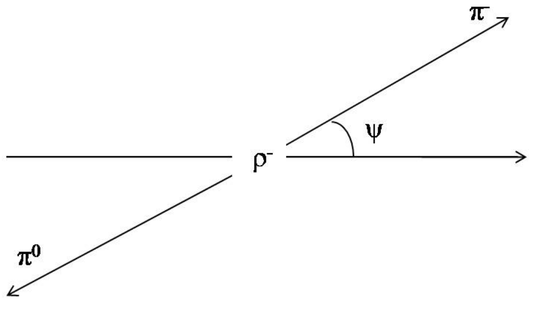
The Hadronic Decay Channels:

- The pion channel:
  - Sensitive to the polarisation of the tau.
  - Requires knowledge of the energy of the tau -> low efficiency

- The rho channel:
  - Sensitive to the polarisation of the tau.
  - Large branching fraction (~25 %).
  - Requires only knowledge of the energy of the decay products of the rho meson.

The Rho Decay as Polarisation Analyser

The angle between the rho and the π^-, ψ, is sensitive to the polarisation of the tau.

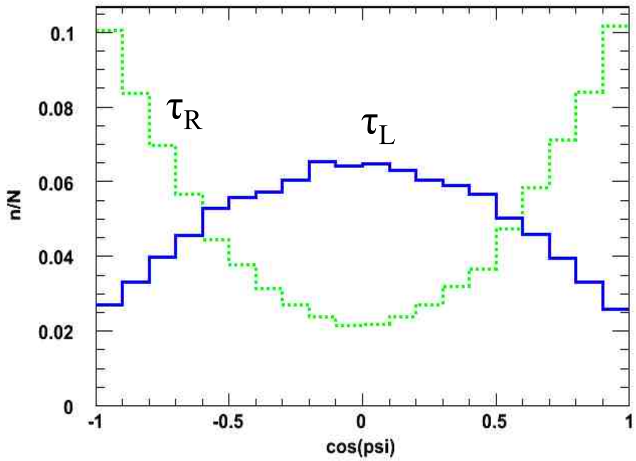


$$\cos(\psi) = \frac{m_\rho}{\sqrt{m_\rho^2 - 4m_\pi^2}} \cdot \frac{E_\pi - E_{\pi^0}}{\left|\vec{p}_\pi + \vec{p}_{\pi^0}\right| \cdot c}$$

At the experiment the charged energy fraction is used instead.

$$\Upsilon = \frac{E_{h^-} - E_{\pi^0}}{E_{h^-} + E_{\pi^0}}$$

Experimentally we study Υ inclusively for all one prong hadronic decays.



$Z \to \tau\tau$ Analysis

The semileptonic (one leptonic and on hadronic decaying tau) is used. In this talk the focus is on the muon selection.

Object selection:

Muon:

- p_T > 17 GeV
- $|\eta|$ < 2.4
- Cuts on hits in tracking detectors

Hadronic tau:

- p_T > 25 GeV
- $|\eta|$ < 2.4 excluding 1.37 < $|\eta|$ < 1.52
- One track

Overlap removal between muon and tau.

$Z \to \tau\tau$ Analysis

Dilepton veto:

- Only one muon and no electrons.

Opposite sign charge:

- The tau and the muon must have opposite sign charges.

W suppression cuts:

- Cuts on the angle between the muon/tau and the missing E_T.
- Cut on transverse mass.

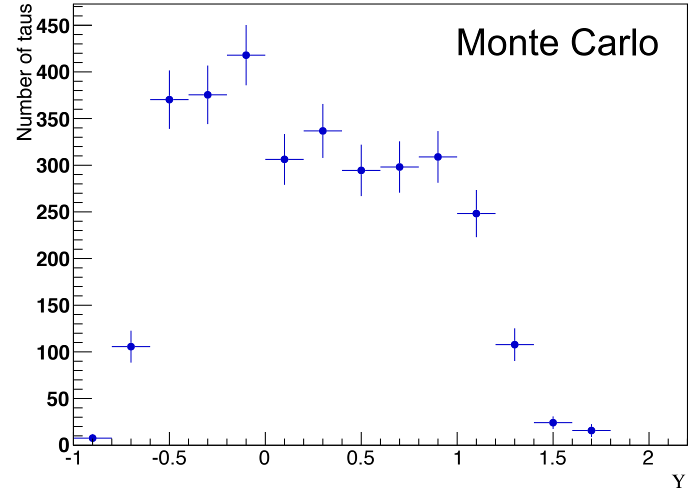
Visible mass:

- 35 GeV < m_{vis} < 75 GeV

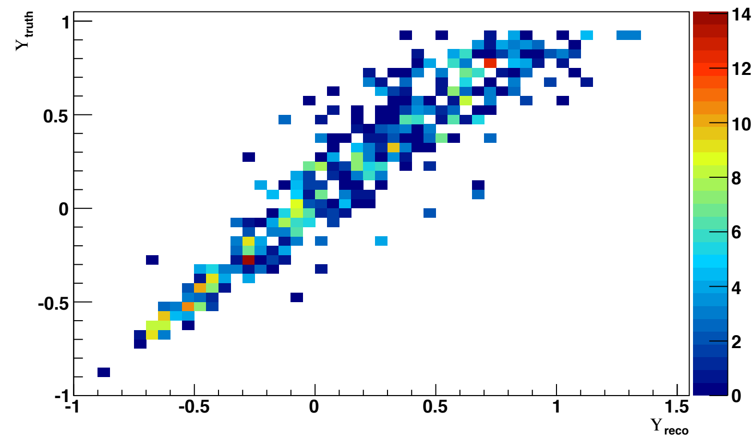
Charged energy fraction, MC

Monte Carlo: Pythia+tauola

Reconstructed charged energy fraction after full Z->tautau selection.



Correlation between true and reconstructed charged energy fraction after full Z->tautau selection.



It is seen that Υ_{truth} and Υ_{rec} are highly correlated.

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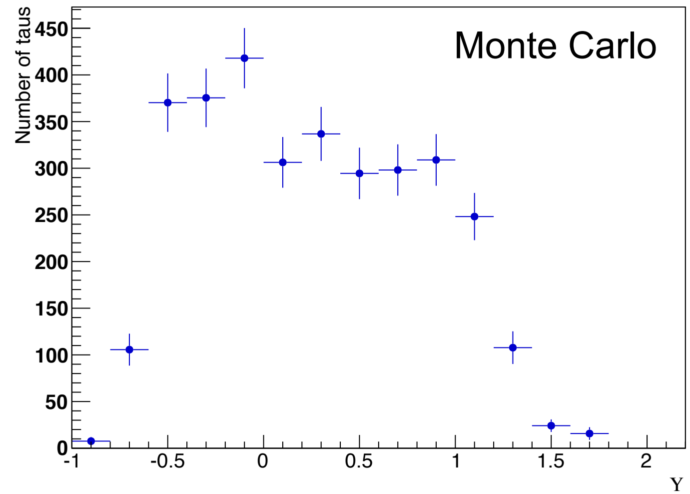
Preliminary Results

Monte Carlo: Pythia+tauola

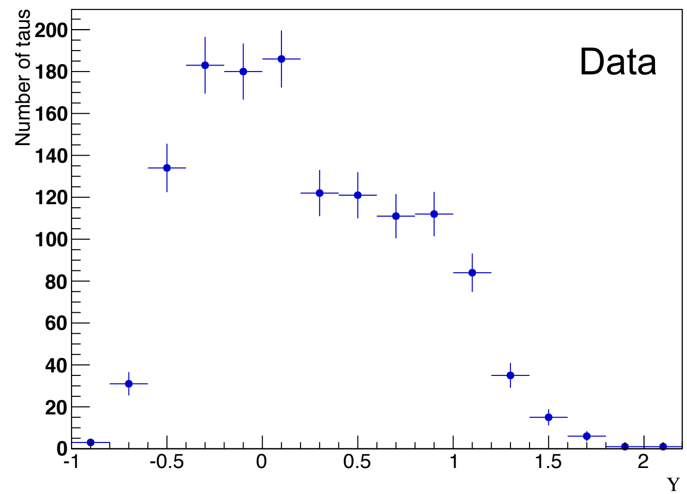
Reconstructed charged energy fraction after full Z->tautau selection.

(Only signal – no background)



Data: 1.55 fb^{-1}, first half of 2011

Charged energy fraction from data after full Z->tautau selection.



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Conclusion and Outlook

Reconstructed charged energy fraction is seen to correspond well with the truth.

Data has the same shape as the signal monte carlo.

Next steps is to include electron channel, investigate background (electroweak and QCD), fit with likelihood and systematic uncertainties.

In case of a double hadronic decay of taus the spin of the original particle can be found from correlations of the charged energy fraction.

Thank you for your attention!