1st Year PhD Report

Using $Z \to \tau\tau$ events to calculate Tau ID scale factors using high p_T Tau leptons

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Declaration

I hereby declare, that I am the sole author and composer of my thesis and that no other sources or learning aids, other than those listed, have been used. Furthermore, I declare that I have acknowledged the work of others by providing detailed references of said work.

I hereby also declare, that my Thesis has not been prepared for another examination or assignment, either wholly or excerpts thereof.

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Place, Date   Signature

Abstract

foo bar

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1 Introduction

2 Tau physics overview

This chapter is a review of the Tau lepton properties. They include the nature of this particle, its interactions with other Standard Model (SM) particles, its main decay modes and the physics implications of the so called Lepton Universality (LU), one of the SM predictions.

2.1 The Tau Lepton

The Tau is a spin $\frac{1}{2}$, electrically charged particle that belongs to the same family of particles as the electron, the muon and the neutrinos, they are all called leptons. Leptons are elementary particles that interact only via the weak and electromagnetic interactions, for the latter case only if they have electric charge.

2.2 Lepton Universality

3 Analysis

Explain the math and notation.

3.1 The LHC and the ATLAS experiment

3.2 Tau Identification on the ATLAS detector

3.3 Monte Carlo Samples

3.4 The Collinear Approximation

3.5 Event Selection

a $\longrightarrow$ b

Figure 1: Use tikz to draw nice graphs!

Algorithm 1 Stochastic Gradient Descent: Neural Network

Create a mini batch of m samples $\mathbf{x}_0 \dots \mathbf{x}_{m-1}$
foreach sample $\mathbf{x}$ **do**
$\quad$ $\mathbf{a}^{\mathbf{x},0} \leftarrow \mathbf{x}$ $\qquad\qquad\qquad\qquad\qquad$ $\triangleright$ Set input activation
$\quad$ **foreach** Layer $l \in \{1 \dots L-1\}$ **do** $\qquad$ $\triangleright$ Forward pass
$\quad\quad$ $\mathbf{z}^{\mathbf{x},l} \leftarrow \mathbf{W}^l \mathbf{a}^{\mathbf{x},l-1} + \mathbf{b}^l$
$\quad\quad$ $\mathbf{a}^{\mathbf{x},l} \leftarrow \varphi(\mathbf{z}^{\mathbf{x},l})$
$\quad$ **end for**
$\quad$ $\boldsymbol{\delta}^{\mathbf{x},L} \leftarrow \nabla_{\mathbf{a}} C_{\mathbf{x}} \odot \varphi'(\mathbf{z}^{\mathbf{x},L})$ $\qquad$ $\triangleright$ Compute error
$\quad$ **foreach** Layer $l \in L-1, L-2 \dots 2$ **do** $\quad$ $\triangleright$ Backpropagate error
$\quad\quad$ $\boldsymbol{\delta}^{\mathbf{x},l} \leftarrow ((\mathbf{W}^{l+1})^T \boldsymbol{\delta}^{\mathbf{x},l+1}) \odot \varphi'(\mathbf{z}^{\mathbf{x},l})$
$\quad$ **end for**
end for
foreach $l \in L, L-1 \dots 2$ **do** $\qquad$ $\triangleright$ $\qquad$ $\triangleright$ Gradient descent
$\quad$ $\mathbf{W}^l \leftarrow \mathbf{W}^l - \frac{\eta}{m} \sum_{\mathbf{x}} \boldsymbol{\delta}^{\mathbf{x},l} (\mathbf{a}^{\mathbf{x},l-1})^T$
$\quad$ $\mathbf{b}^l \leftarrow \mathbf{b}^l - \frac{\eta}{m} \sum_{\mathbf{x}} \boldsymbol{\delta}^{\mathbf{x},l}$
end for

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4 Results

The approach usually starts with the problem definition and continues with what you have done. Try to give an intuition first and describe everything with words and then be more formal like 'Let g be ...'.

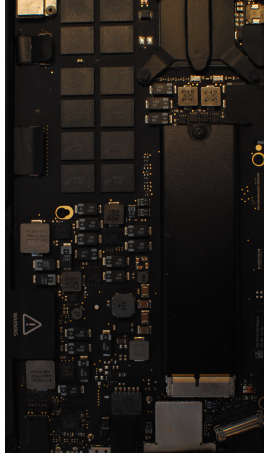## 4.1 $\mu\tau$ Final state

4.2 $e\tau$ Final state

Start with a very short motivation why this is important. Then, as stated above, describe the problem with words before getting formal.

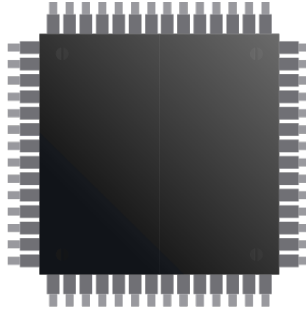## 4.3 Monte Carlo and data discrepancies

5 Conclusions and prospects

Type	Accuracy
A	82.47 ± 3.21
B	78.47 ± 2.43
C	84.30 ± 2.35
D	86.81 ± 3.01

Table 1: Table caption. foo bar...

(a) Some cool graphic

(b) Some cool related graphic

Figure 2: Caption that appears under the fig Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

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