Electrons in Dense Environments

Christopher Lawrence Davou
Supervisor: Associate Prof. Deepak Kar

School of Physics and Institute for Collider Particle Physics
University of the Witwatersrand

lawrence.davou.christopher@cern.ch

Presented at the 2020 HEPP Workshop

January 29, 2020

Overview

- Introduction
- Challenges with the boosted regime
- samples and quantities used in electron identification
- Brief description
- Plots of ID variables for electron close to jet and isolated electron
- Electron in jet variables in ΔR 0.4 with profile
- Table showing ID variables, χ^2, difference and remark
- Summary

Introduction

- Electron and jet reconstruction
- The boosted regime

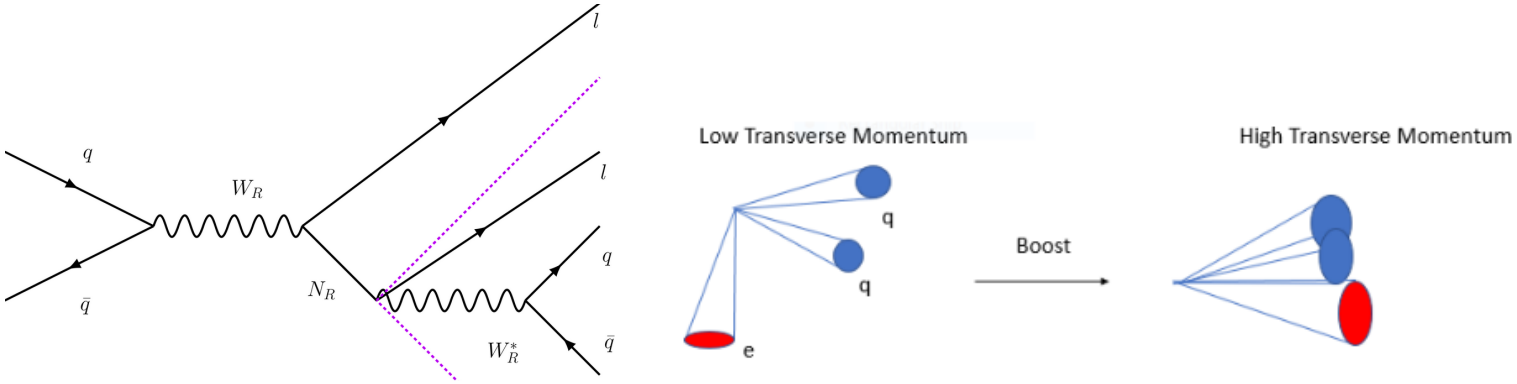


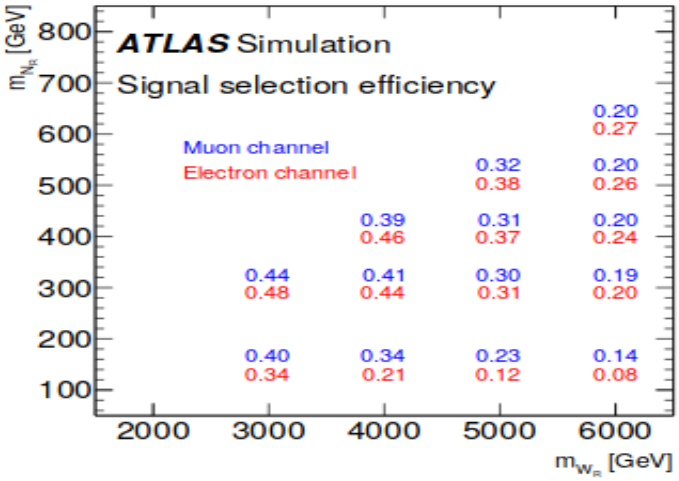
Figure: Our model

Cases where this is common

- Top-antitop pair production
- Semi-leptonic decay
- Boosted heavy neutrino analysis

Challenges with the boosted Regime

- Generally poor signal efficiency



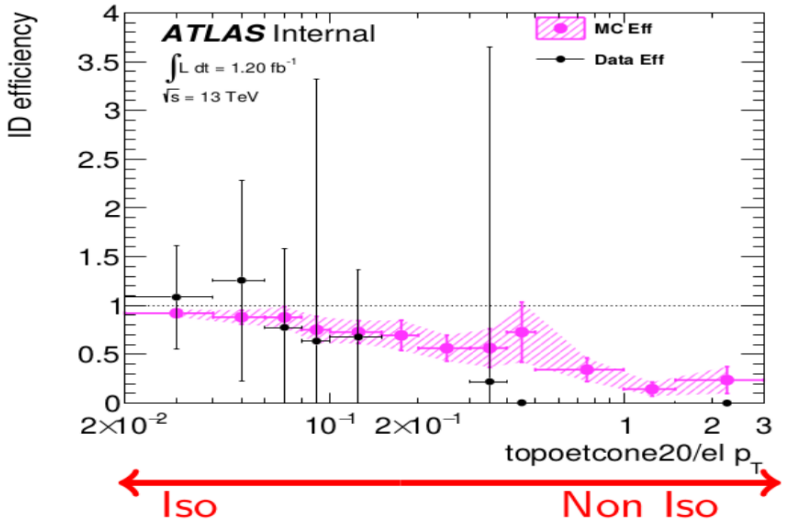


Figure: Signal efficiency for muons and electrons

This is from current heavy boosted neutrino analysis
https://cds.cern.ch/record/2266957

Challenges with the boosted Regime cont.

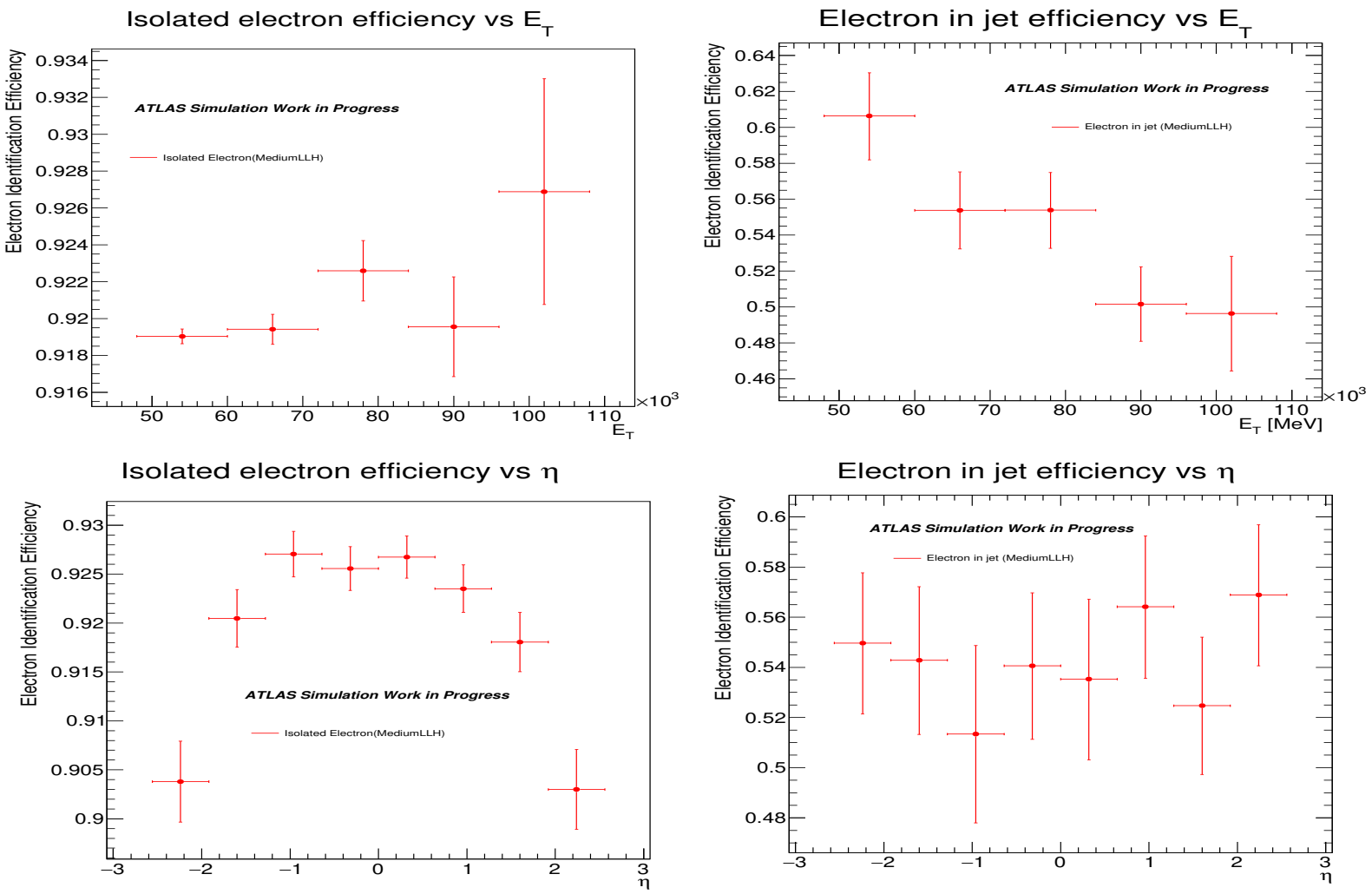


Figure: Top left and right: Isolated and electron in jet ID efficiency in E_T. Bottom left and right: Isolated and electron close to jet ID efficiency in η

Challenges with the boosted Regime cont.

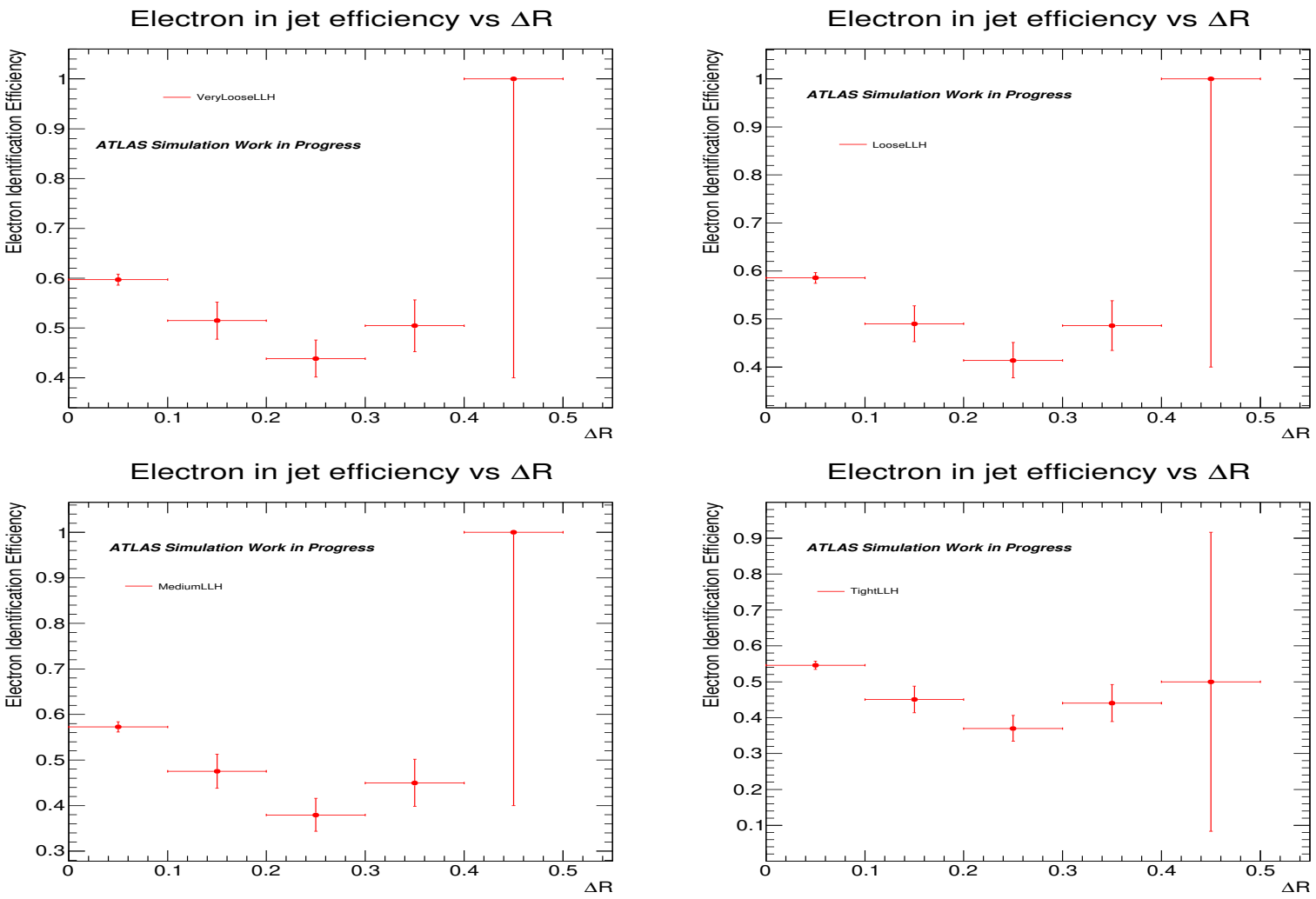


Figure: Efficiency for electron in jet for different likelihoods

Samples and Quantities used in electron identification

Signal and standard Sample

- This is a 3TeV w_R decaying into a boosted neutrino and a lepton with the boosted neutrino decaying into $q\bar{q}l$.
- This is a $Z \rightarrow ee$ sample

Quantities used in electron identification

- Hadronic leakage (R_{had})
- Second layer of Electromagnetic (EM) calorimeter (R_η, $w_{\eta 2}$, R_ϕ)
- Third layer of EM calorimeter (f_3).
- First layer of EM calorimeter (f_1, E_{ratio}, w_{tots1}).
- Track condition (d_0, $|d_0/\sigma(d_0)|$, $\Delta p/p$, n_{Blayer}, n_{pixel}, n_{Si}).
- Track-cluster matching ($\Delta\eta 1$, $\Delta\phi_{rescaled2}$, E/P).
- Transition radiation tracker (eprobabilityHT).

Brief discription

- R_η, R_ϕ, $w_{\eta 2}$ and w_{tots1} are the energy widths variables that distinguish narrow electron showers from diffuse hadronic showers.
- f_1, f_3, R_{had} and E_{ratio} are the energy ratio variables.
- $\Delta\eta 1$, $\Delta\phi_{rescaled2}$ and E/p are the track-cluster match variables.
- d_0 , $|d_0/\sigma(d_0)|$, Δp/p, n_{Blayer}, n_{pixel}, n_{Si} are the track conditions.
- eProbabilityHT is the likelihood probability base on information from the transition radiation tracker.

Plots of ID variables for electron close to jet and isolated electron

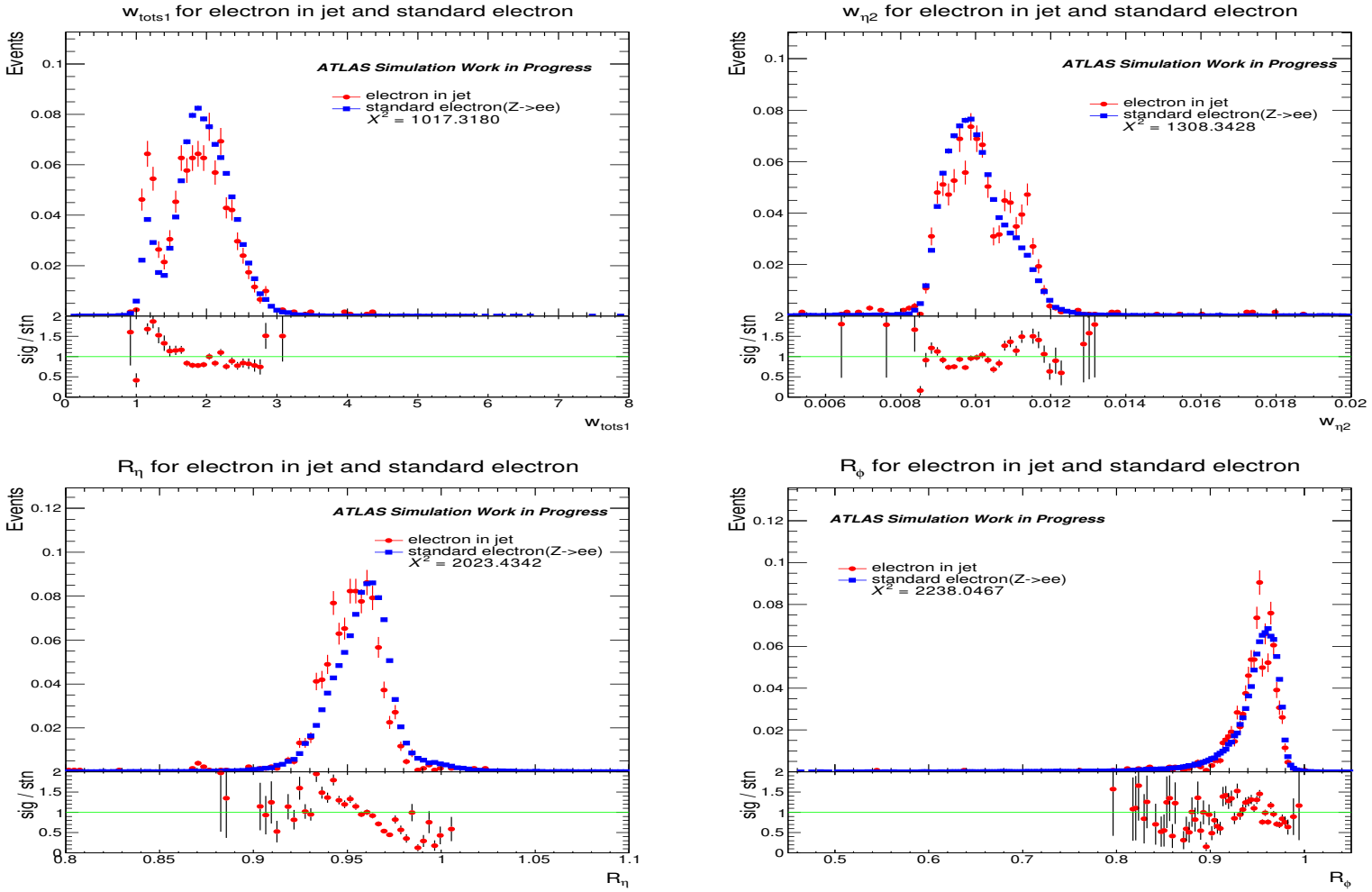


Figure: Width variables

Plots of ID variables for electron close to jet and isolated electron cont.

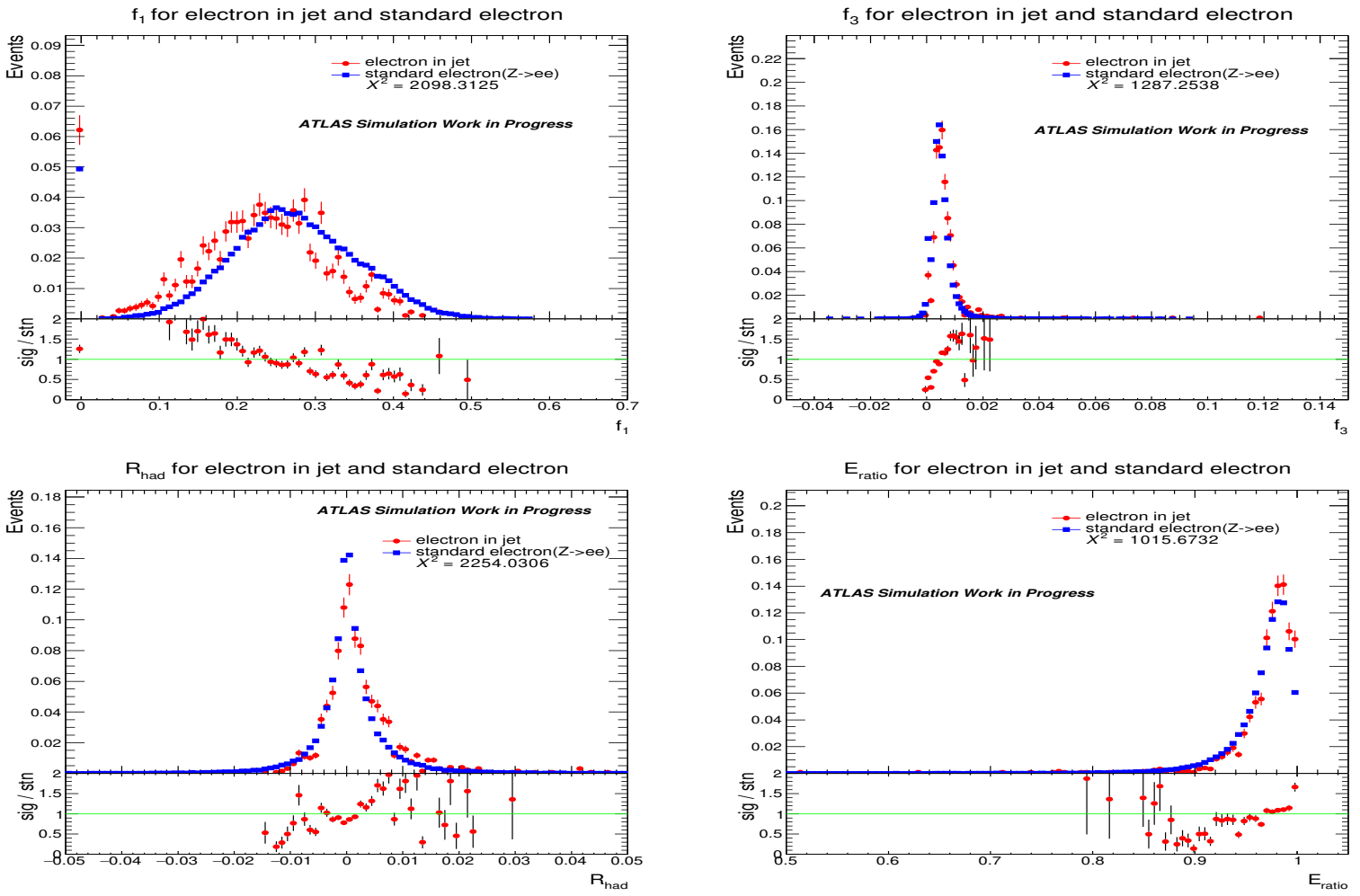
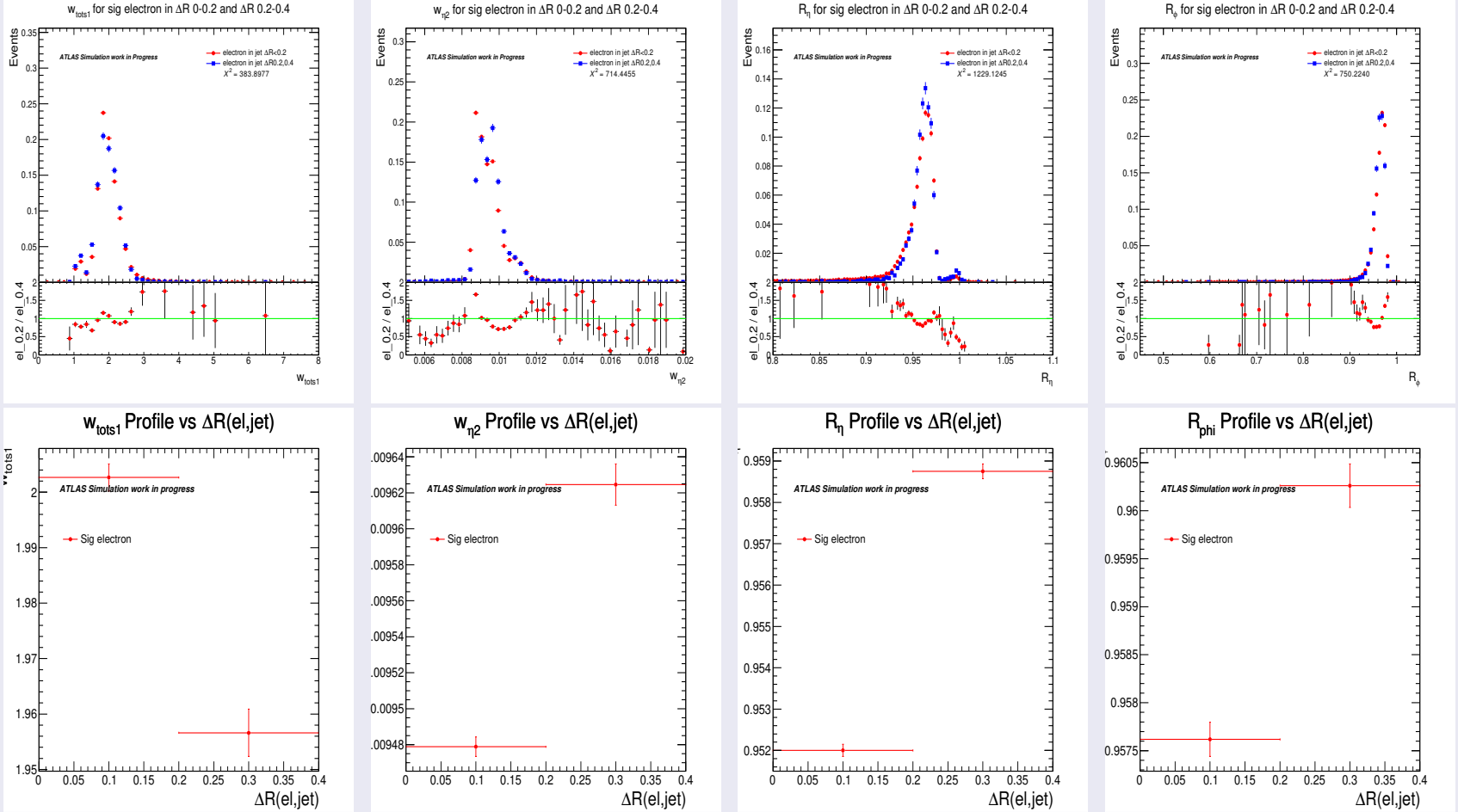


Figure: Energy ratio variables

Electron in jet ID variables in ΔR 0.4 with profile

Top: ID variables. Bottom: Profile plots



Electron in jet ID variables in ΔR 0.4 with profile cont.

Top: ID variables. Bottom: Profile plots

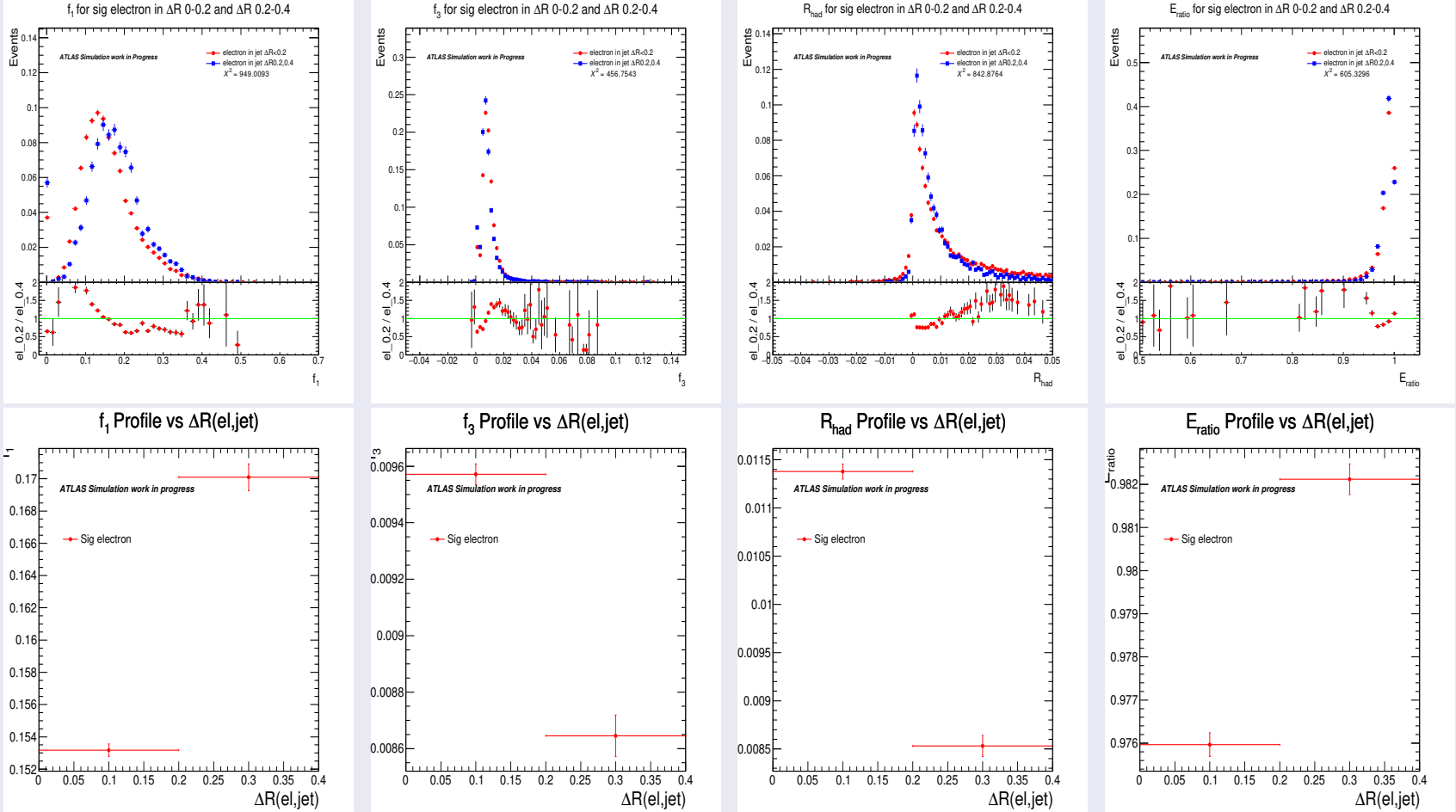


Table: 1 showing ID variables, their χ^2, their difference and those chosen.

ID variables	χ^2	|X(ΔR< 0.2) - X(ΔR[0.2,0.4])|	New ID?
R_{had}	842.8764	0.00285	No
R_η	1229.1245	0.00675	No
$\Delta\eta 1$	303.6312	0.00002	Yes
$w_{\eta 2}$	714.4455	0.00015	No
f_1	949.0093	0.01692	No
R_ϕ	750.2240	0.00264	No
f_3	456.7543	0.00093	Yes
$\Delta p/p$	148.3094	0.00101	Yes
$\Delta\phi_{rescaled2}$	387.9096	0.00007	Yes
$d_0/\sigma(d_0)$	105.4380	0.05418	Yes
d_0	105.2062	0.00055	Yes
E/p	281.6260	0.06753	Yes
w_{tots1}	383.8977	0.04604	Yes
E_{ratio}	605.3296	0.00615	No

Summary

- We have seen from the studies how the effect of nearby hadronic activity affects the standard ID variables used in electron reconstruction.
- We have also seen the effect of the standard electron ID on the efficiency of electron in jet.
- We will use our chosen ID variables that are specific for electrons in jets to build an ID.
- We will test the performance of this new ID against nearby hadronic activity and also test its signal efficiency/background rejection.
- At the moment we are tuning this electron in jet ID.

Acknowledgement: This work is based on the research supported by the National Research Foundation of South Africa (NRF) in conjunction with The World Academy of Science (TWAS) Grant number 1106886 and Ref No: SFH170530235137, without which this study might not have been possible.