Single-lepton final state: the case of t-channel pair-top-quark production

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Outline

- My motivation
- Knowing the project
- What was done by ATLAS collaboration?
- Our contribution

My motivation

Passion

For theoretical and computational elementary particle research (specially quarks), going deeper into its implications in phenomena already known, such as the mass and charge in fundamental particles and beyond the SM.

Collaborate with Atlas experiment

It is one of the most important detectors in particle physics capable of discovering new particles and new phenomena expected from extensions of the Standard Model such as supersymmetry or dark energy/matter.

Help others

Encourage scientific dissemination by making ATLAS data science a few more comprehensible and accessible for students or even teachers and lecturers interested in fundamental research.

Knowing the project

International Science Week
Challenges of Science in the 21st Century

7-8/Oct/2019 - Data Science Workshop lectured by Dr. Arturo Sánchez at Universidad industrial de Santander (UIS), Santander Colombia.

[2]

What was done by ATLAS collaboration?

ATLAS PUB Note

PUB-OTRC-2020-01

22nd January 2020

Review of the 13 TeV ATLAS Open Data release

The ATLAS Collaboration

The ATLAS Collaboration is releasing a new set of proton–proton collision data to the public for educational purposes. The data has been collected by the ATLAS detector at the Large Hadron Collider at a centre-of-mass energy $\sqrt{s}$ = 13 TeV during the year 2016 and corresponds to an integrated luminosity of 10 fb^{-1}. This dataset is accompanied by simulated events describing both several Standard Model processes, as well as hypothetical Beyond Standard Model signal production. Associated computing tools are provided to make the analysis of the dataset easily accessible. This document summarises the properties of the 13 TeV ATLAS Open Data set and the available analysis tools. Several examples intended as a starting point for further analysis work by users are shown. The general aim of the dataset and tools released is to provide user-friendly and straightforward interactive interfaces to replicate the procedures used by high-energy-physics researchers and enable users to experience the analysis of particle-physics data in educational environments.

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What was done by ATLAS collaboration?: Specific example

ATLAS Open Data C++ framework for 13 TeV analyses

artfisica input path to public repo — d148200 on 27 Jan — History

..		
HWWAnalysis	input path to public repo	9 months ago
HZZAnalysis	input path to public repo	9 months ago
HyyAnalysis	input path to public repo	9 months ago
SUSYAnalysis	input path to public repo	9 months ago
SingleTopAnalysis	input path to public repo	9 months ago
TTbarAnalysis	input path to public repo	9 months ago
WBosonAnalysis	input path to public repo	9 months ago
WZDiBosonAnalysis	input path to public repo	9 months ago
ZBosonAnalysis	input path to public repo	9 months ago
ZPrimeBoostedAnalysis	input path to public repo	9 months ago
ZTauTauAnalysis	input path to public repo	9 months ago
ZZDiBosonAnalysis	input path to public repo	9 months ago
clean.sh	general cleaning	9 months ago

GitHub [2]

master — atlas-outreach-cpp-framework-13tev / Analysis / TTbarAnalysis / — Go to file — Add file

This branch is 16 commits behind atlas-outreach-data-tools:master. — Pull request — Compare

artfisica input path to public repo — d148200 on 27 Jan — History

..		
TTbarAnalysis.C	general cleaning	9 months ago
TTbarAnalysis.h	general cleaning	9 months ago
TTbarAnalysisHistograms.h	general cleaning	9 months ago
main_TTbarAnalysis.C	input path to public repo	9 months ago
run.sh	general cleaning	9 months ago

ROOT Data Analysis Framework

SWAN

What was done by ATLAS collaboration? Specific example: Important remark

General selection criteria

Electron (e)	Muon (μ)	Photon (γ)
InDet & EMCAL rec. loose identification loose isolation $p_T > 7$ GeV $\|\eta\| < 2.47$	InDet & MS rec. loose identification loose isolation $p_T > 7$ GeV $\|\eta\| < 2.5$	InDet & EMCAL rec. tight identification loose isolation $E_T > 25$ GeV $\|\eta\| < 2.37$

Hadronically decaying τ-leptons (τ_h)	Small-R jets	Large-R jets
InDet & EMCAL rec. medium identification $p_T > 20$ GeV $\|\eta\| < 2.5$ 1 or 3 associated tracks	EMCAL & HCAL rec. anti-k_t, R = 0.4 $p_T > 20$ GeV $\|\eta\| < 2.5$ b-tagging (MV2c10)	EMCAL & HCAL rec. anti-k_t, R = 1.0 $p_T > 250$ GeV $\|\eta\| < 2.0$ trimming: $R_{sub} = 0.2$, $f_{cut} = 0.05$

Figure a)

[1]

Specific criteria for Top quark pair production

- Single-electron or single-muon satisfied
- Exactly one lepton (electron/muon) with $P_T > 30$ Gev
- Missing transverse momentum E_T^{Miss} larger than 30 Gev
- Transverse mass of the W-boson M_T^W larger than 30 Gev
- At least four jets with $P_T > 30$ Gev, where at least two are b-tagged

What was done by ATLAS collaboration?: Specific example
Some primarily results

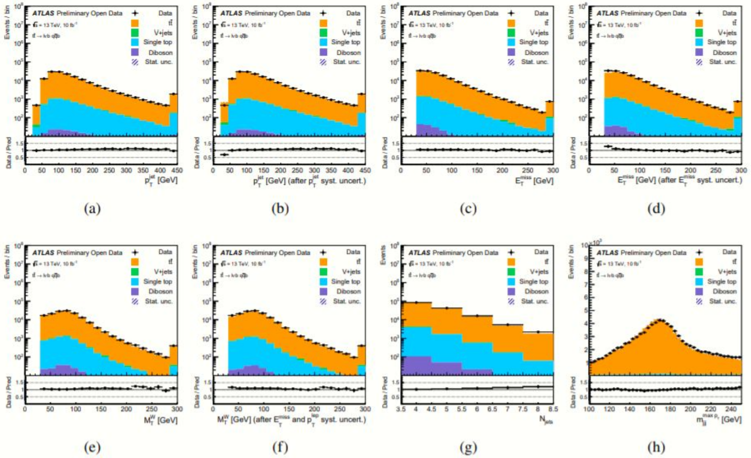

Figure 3: Comparison between data and MC prediction for several distributions in the $t\bar{t} \rightarrow W^+W^-b\bar{b} \rightarrow \ell\nu q\bar{q}'b\bar{b}$ selection. Distributions of the leading selected jet transverse momentum (a) before and (b) after a jet energy scale systematic uncertainty variation, missing transverse momentum (c) before and (d) after E_T^{miss} scale and resolution systematic uncertainty variation, transverse mass of the W-boson (e) before and (f) after the E_T^{miss} and lepton scale and resolution systematic uncertainty variatios, (g) number of selected jets and (h) invariant mass of the three-jets combination with the highest vector p_T sum are shown. The points represent experimental data. The filled histograms show the prediction from different MC simulations. The contributions are stacked. The statistical uncertainty is represented by the error bars on the data points and the hashed area on the MC prediction. The last bin in all figures contains the overflow. The lower panels in each figure show the ratio of the data points to the stacked histogram.

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What was done by ATLAS collaboration?: Specific example
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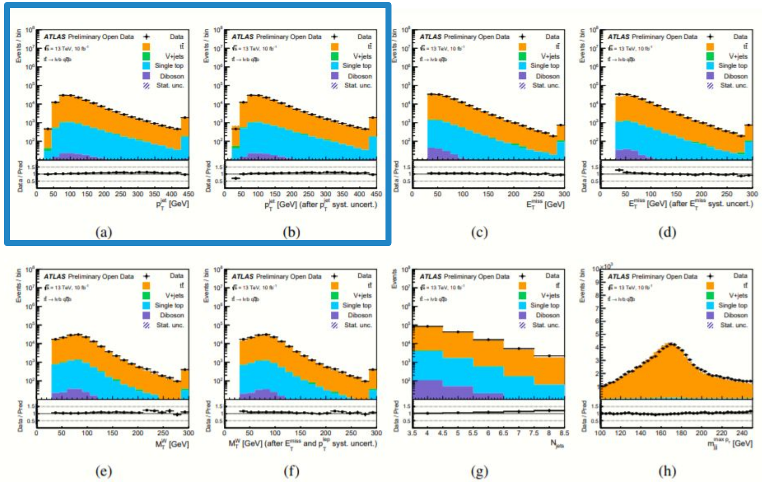
Leading selected jet transverse moment



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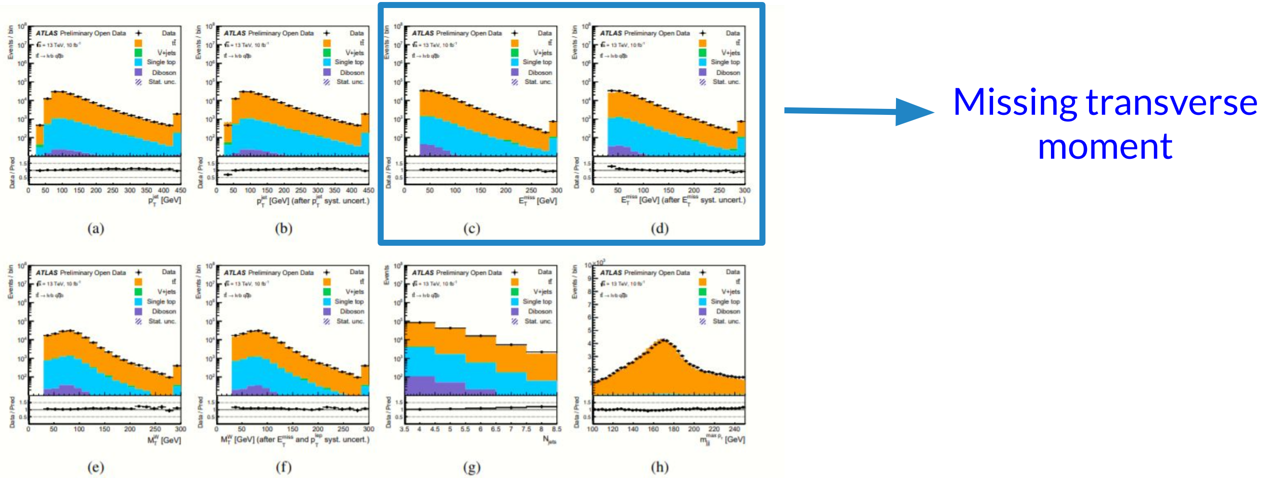

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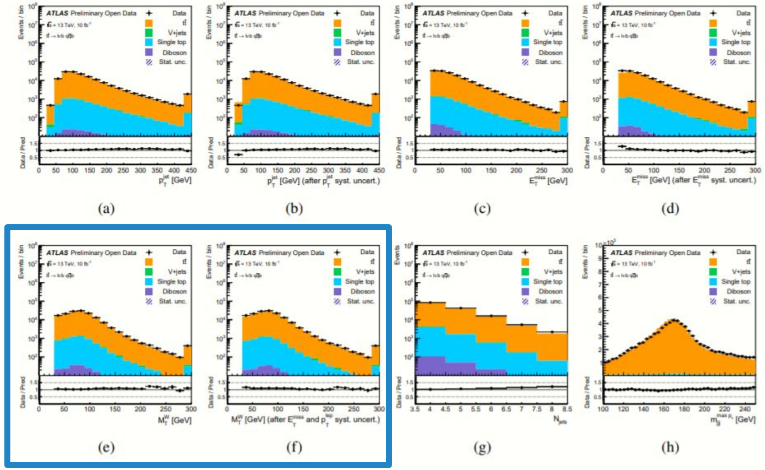
W-boson
Transverse mass



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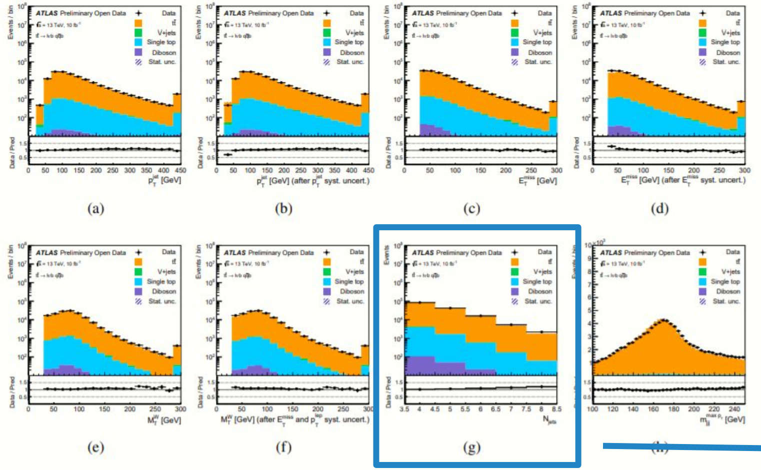

Jets selected

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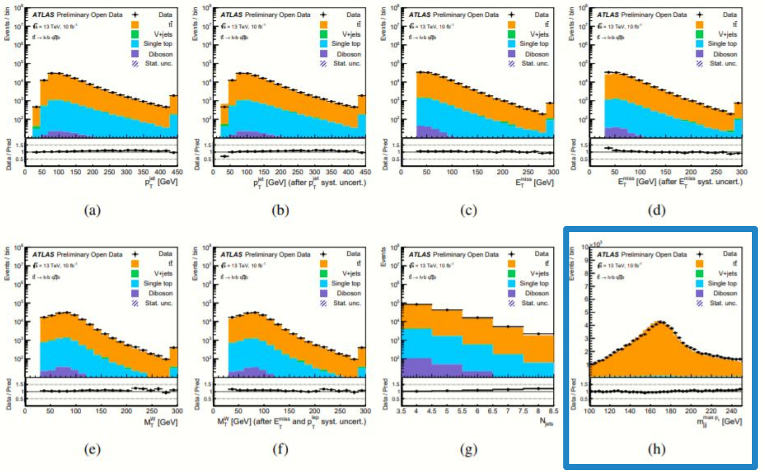

Invariant mass of the three-jets combination

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Our contribution in 3 steps

Reproduce

By compiling the code in order to obtain the same histograms as shown in the review.

Analyse

The results understanding the phenomena in every histogram result.

Optimize

The computational code and results to make it faster with theoretical step by step description.

References

- [1] Atlas Collaboration. (2020). Review of the 13 TeV ATLAS Open Data release. ATL-OREACH-PUB-2020-001.
- [2] Angélica Blanco Ríos - Radio Nacional Bucaramanga, 21 Junio, 2017. Telescopio hecho en Santander estudiará los volcanes de Colombia. Recuperado de: https://www.radionacional.co/noticia/actualidad/telescopio-hecho-santander-estudiara-los-volcanes-de-colombia
- [3] Atlas Collaboration. (2020). ATLAS Open Data C++ framework for 13 TeV analyses. Recuperado de: https://github.com/angie-sanchez/atlas-outreach-cpp-framework-13tev/blob/master/Analysis/TTbarAnalysis/main_TTbarAnalysis.C

Thank you!