Enhancing ATLAS OpenData educational resource with the first ROOTbooks

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TECHNISCHE UNIVERSITÄT DRESDEN

NETZWERK TEILCHENWELT

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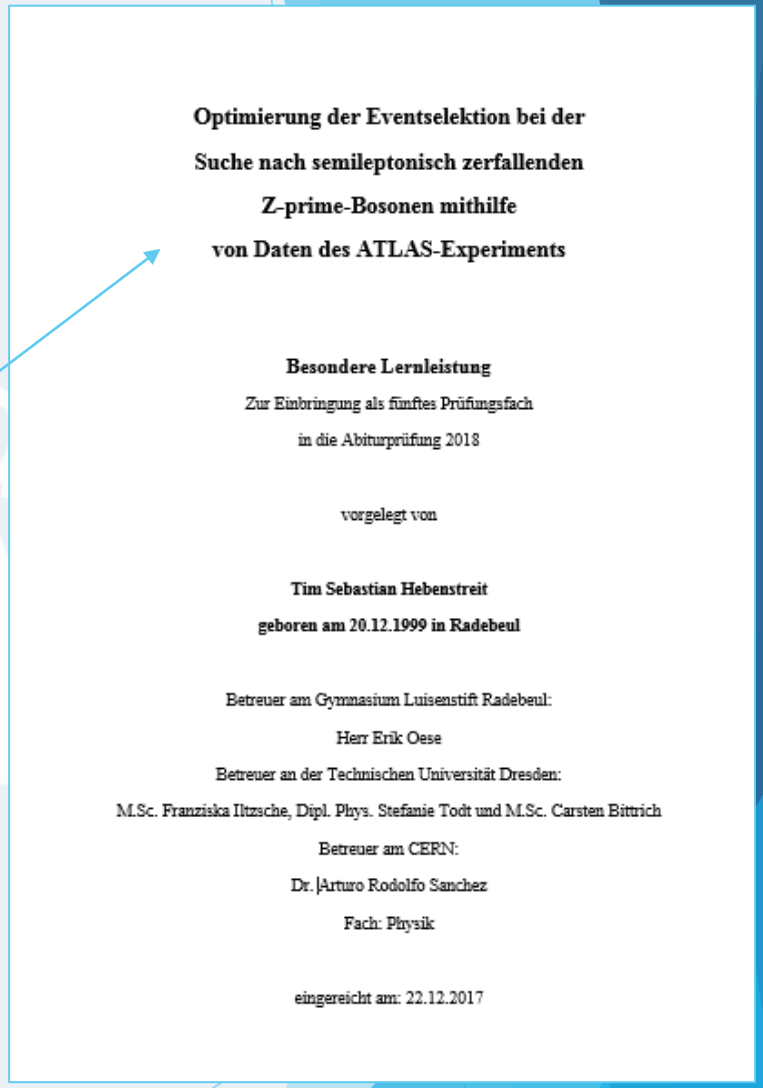
Background information

- High school student → work together with TU Dresden
- Currently writing a high school project (feb. 2017 – may 2018)
- Topic: „Optimization of the event selection in the search after semileptonic decaying Z prime bosons with data from the ATLAS experiment“
- April 2017: one week at TU Dresden for writing this analysis
- October 2017: CERN project weeks



Optimierung der Eventselektion bei der Suche nach semileptonisch zerfallenden Z-prime-Bosonen mithilfe von Daten des ATLAS-Experiments

Besondere Lernleistung

Zur Einbringung als fünftes Prüfungsfach

in die Abiturprüfung 2018

vorgelegt von

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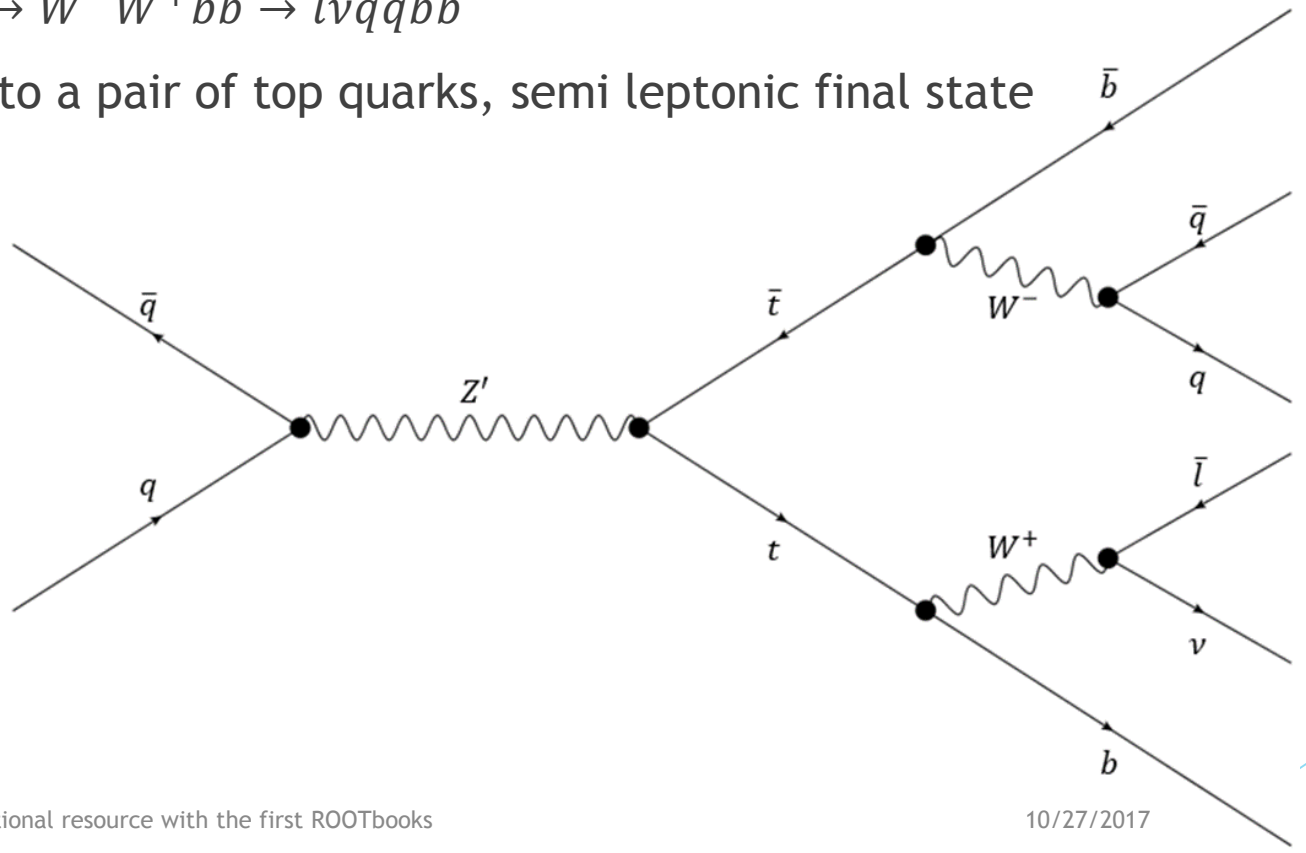
Fach: Physik

eingereicht am: 22.12.2017

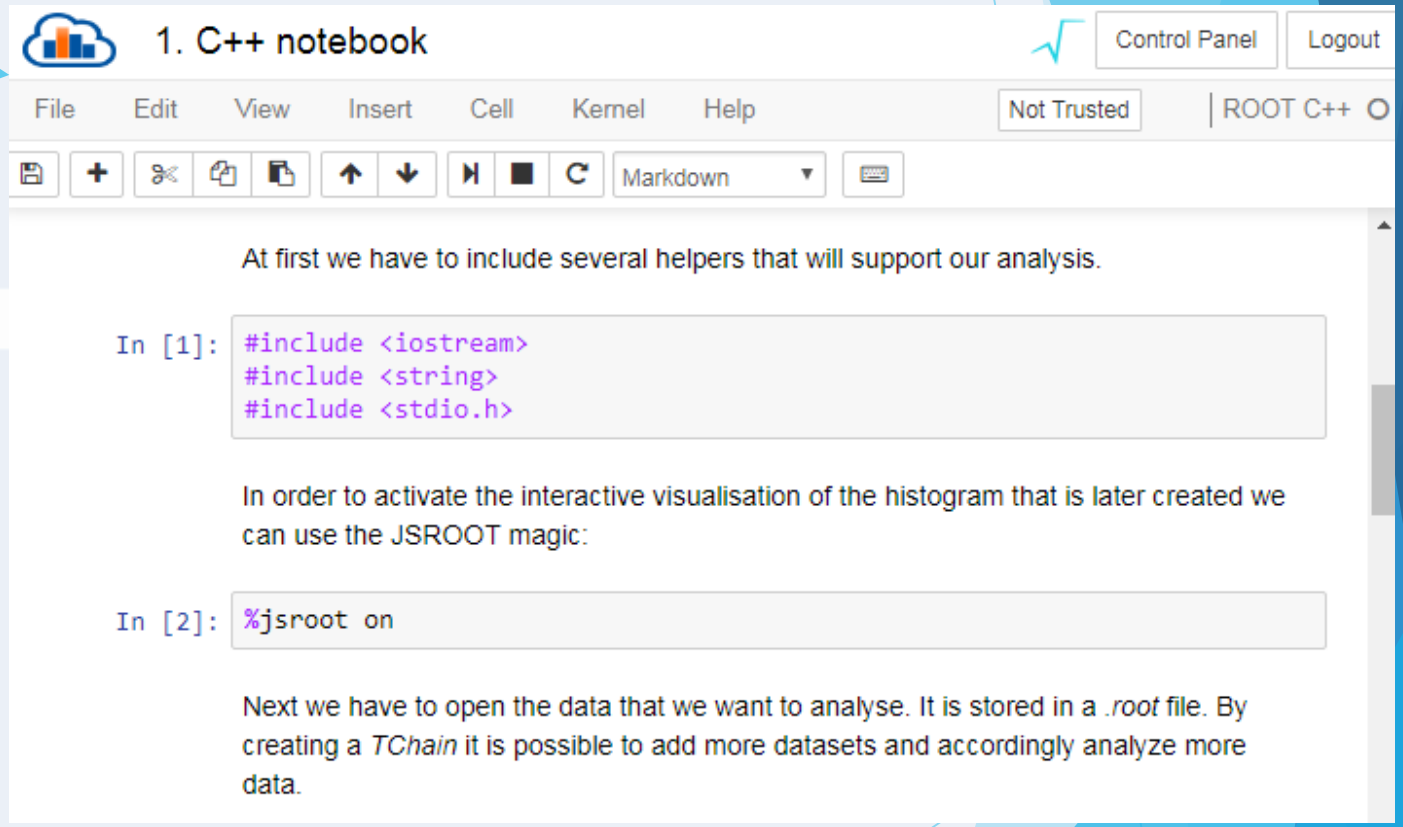
The analyzed decay

- $pp \rightarrow Z' \rightarrow \bar{t}t \rightarrow W^-W^+\bar{b}b \rightarrow \bar{l}\nu\bar{q}q\bar{b}b$
- Z' decaying into a pair of top quarks, semi leptonic final state



My task for the CERN project weeks

- Creation of ROOTbooks of different degrees of difficulty
- Goal: explain beginners the main analysis techniques of HEP
- After creation: run notebook with SWAN



The ATLAS OpenData Portal

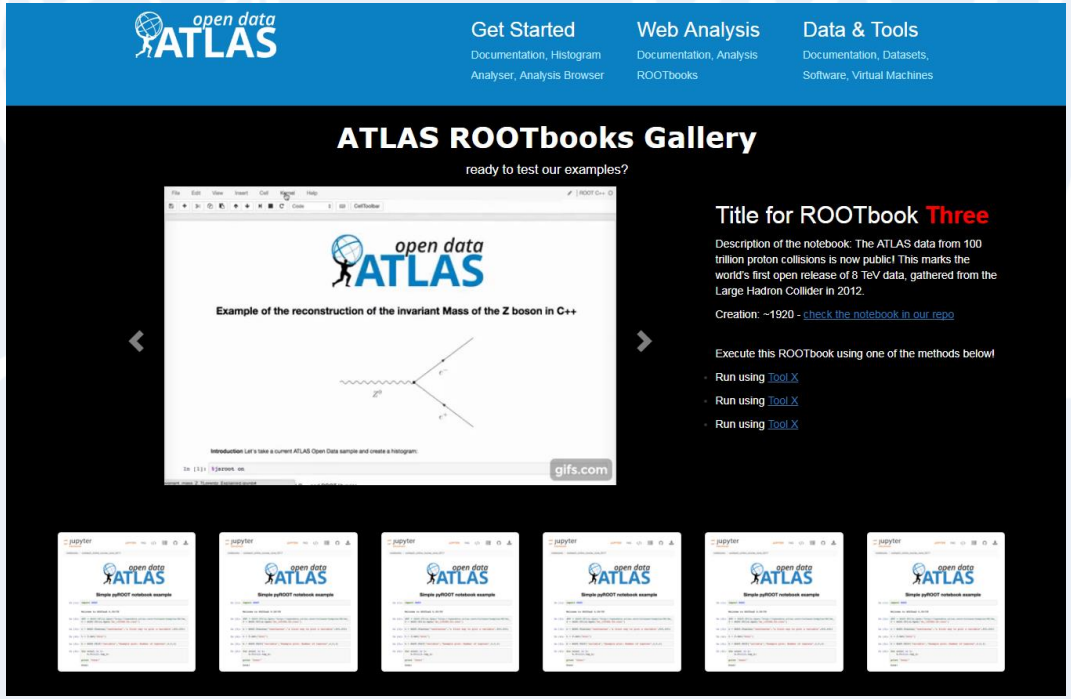
- access to a range of data produced at CERN (especially ATLAS) → software and documentation to understand and analyze the data being shared
- for students and general public to learn sth. about the research at CERN

What is a ROOTbook?

- Jupyter notebook: document containing computer code and text elements
- https://jupyter.readthedocs.io/en/latest/
- ROOTbook: jupyter notebook with inlcuded ROOT library for python/C++ to analyze data, especially if it comes as ROOT files

Integration into the ATLAS OpenData Portal

- Let‘s look at the ROOTbooks:
  http://nbviewer.jupyter.org/github/timhebe/ROOTbooks/tree/master/



Pros and cons of ROOTbooks

Pros

- Useful for education and training
- Easy to document code (via Markdown)
- Clear structure and clear pointers on what to execute
- Implementation in websites is easy (e.g. via GitHub)

Cons

- Lack of performance if large amount of data
- No good options to visualize large amount of plots
- Loops only executable in one box

Further literature

- http://opendata.atlas.cern/
- http://jupyter.org/

Little discussion

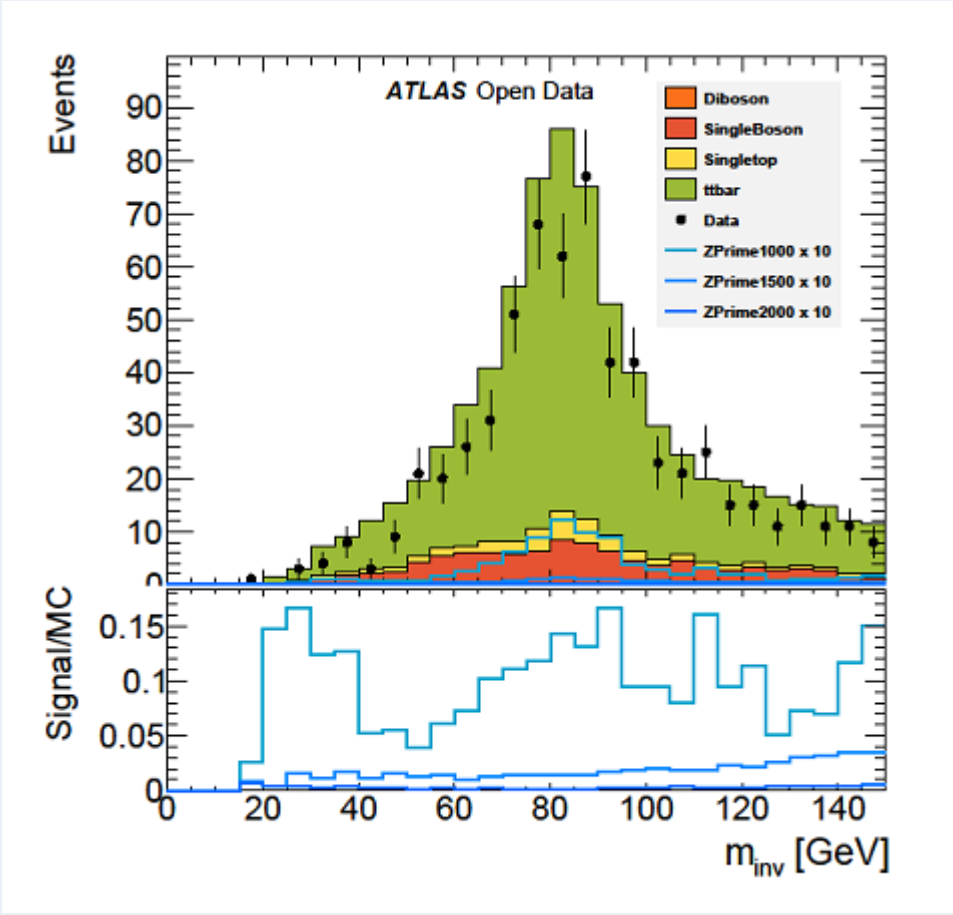
- What do you think about the notebooks?
- What should be improved?

Thank you for your attention ☺

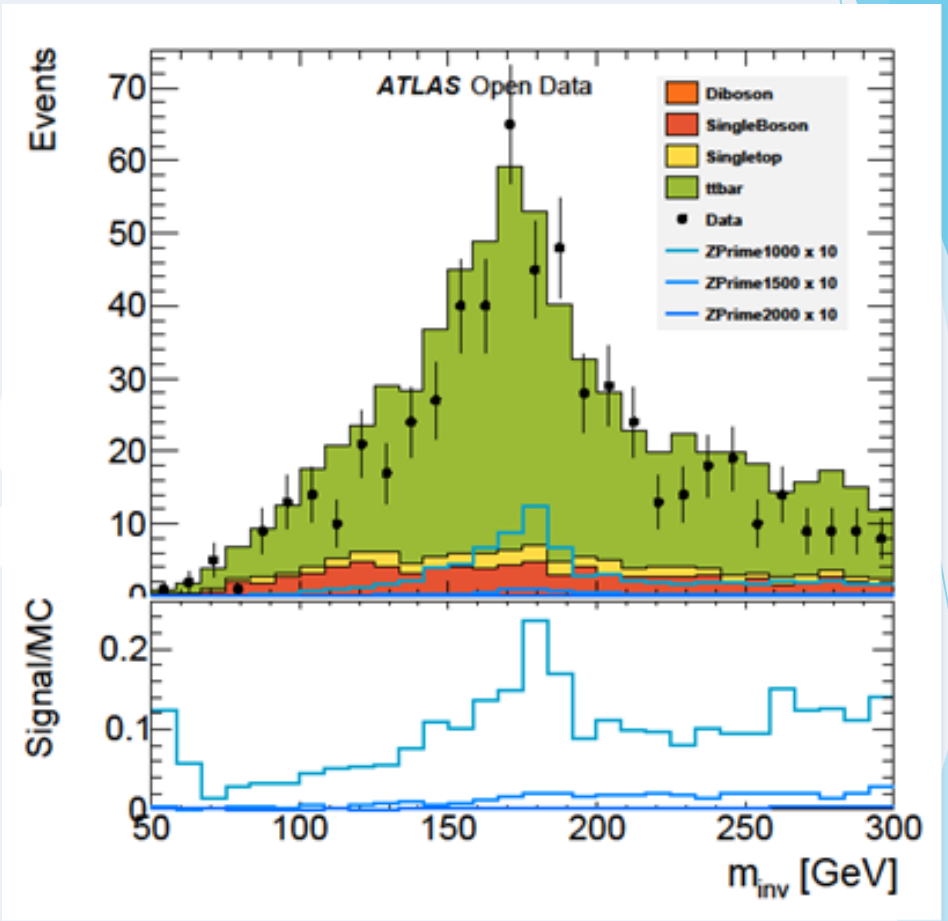
Backup

Conclusion of the results for a mass hypothesis of the Z prime Boson of $1000GeV$

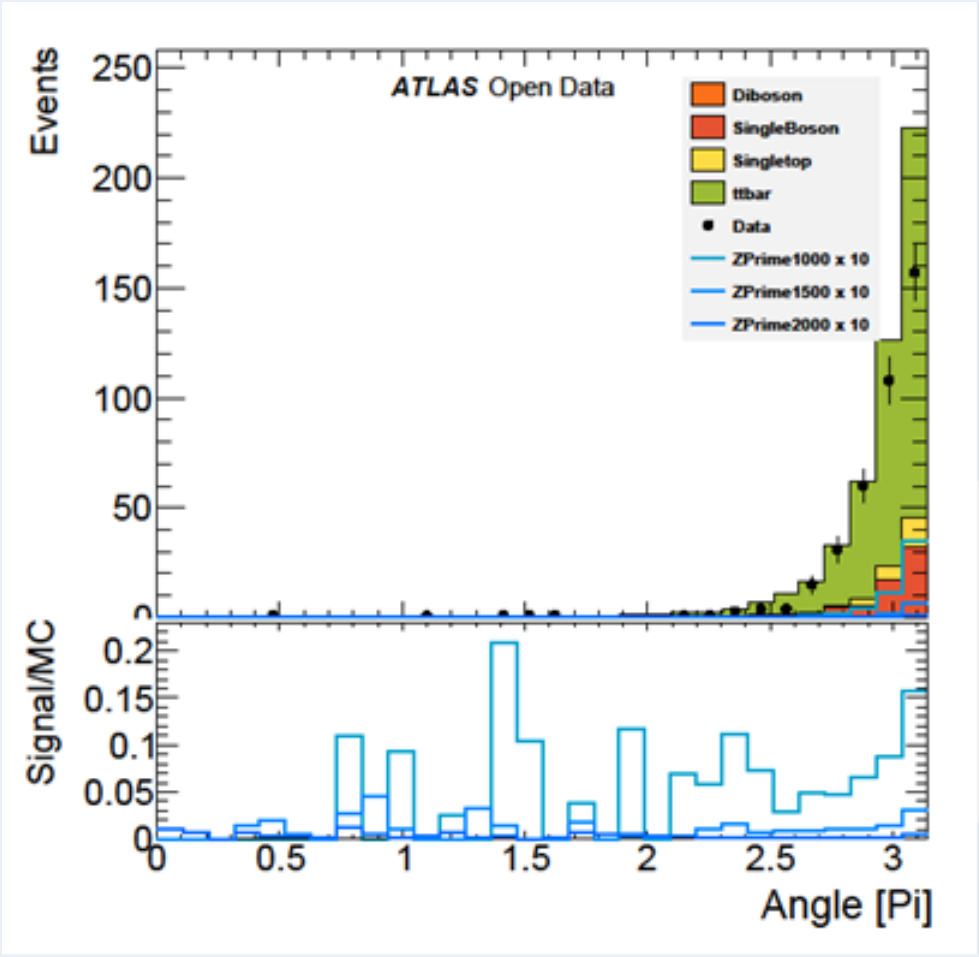
- $n_{leptons} = 1$
- $MET > 150GeV$
- $n_{jets} \geq 4$
- $1 \leq n_{b-jets} \leq 2$
- $m^{T}_{W-Boson} \geq 30GeV$
- $m^{T}_{W-Boson} + MET \geq 60GeV$



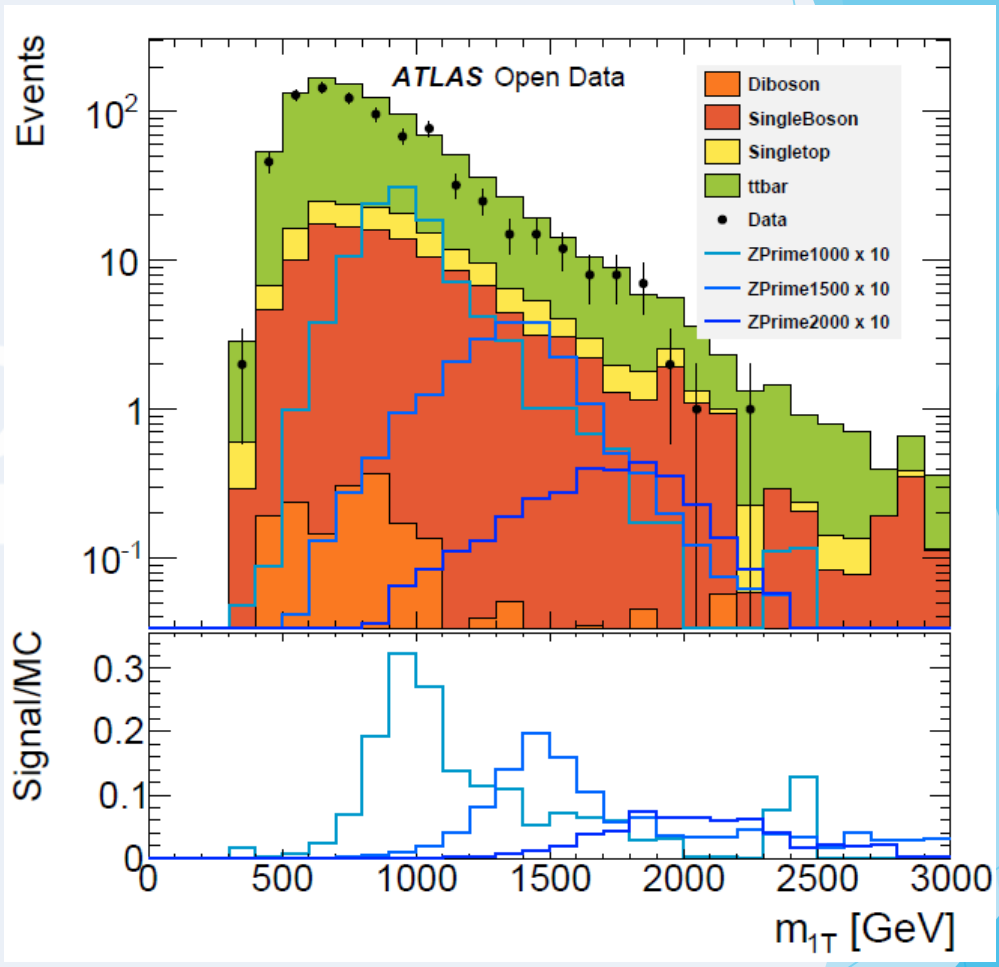
- Mass of the hadronic decaying W boson



- Mass of the hadronic decaying top quark



- Angle between the decaying top quarks



- The late-projected invariant mass m_{1T} of the Z prime boson