Study of RPV stop signals in paired dijet signatures

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ATLAS collaboration

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Introduction

- The extension of the Standard Model where R-parity is violated was considered.
- We examined the stop squark production and decay into four jets process.
- We investigated the possibility of identifying four jets in final state at the trigger level.

R-parity

- In the most popular version of Minimal Supersymmetric Standard Model (MSSM), a symmetry called R-parity is assumed to be an exact symmetry.
- R-parity conservation has also the implication that the lightest superpartner (LSP) is stable and can be identified as the dark matter of the universe.

In the MSSM the R-parity P_R is defined by:

$$P_R = (-1)^R = (-1)^{3B-L+2S} \equiv (-1)^{3(B-L)+2S}$$

where B is baryon number, L is lepton number and S is the spin of the particle.

ATLAS experiment

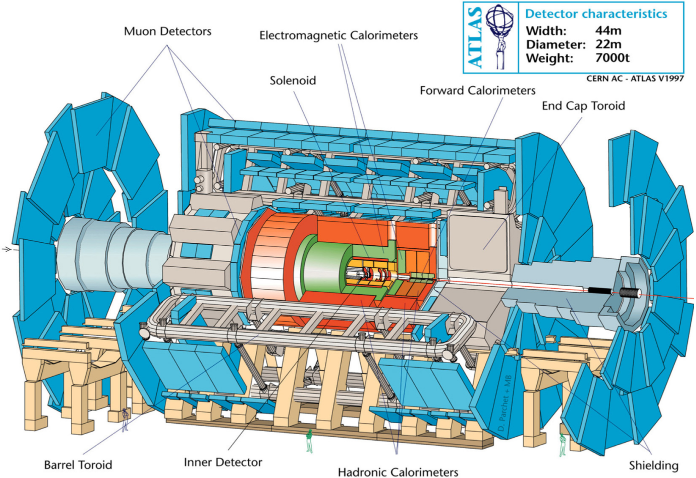

Figure: ATLAS detector.

Trigger-object Level Analysis

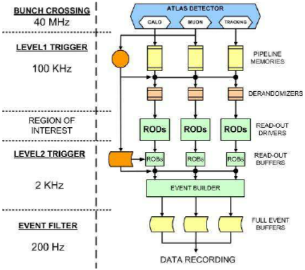

Figure: ATLAS three level trigger architecture.

The large fraction of events with a jet $p_{\mathrm{T}} < 400$ GeV are discarded. This limitation can be avoided by recording only a summary of the jet information needed for performing a resonance search in the dijet mass m_{jj} spectrum.

Tools used for analysis

- Lxplus - Public Login User Service;
- The Grid - Worldwide LHC Computing Grid;
- xAODAnaHelpers - analysis framework;
- ROOT - analysis framework;

Production process

The analyzed process was stop pair production in a proton-proton collision with 4-jet final state. The feynman diagram for this process is shown in 3.

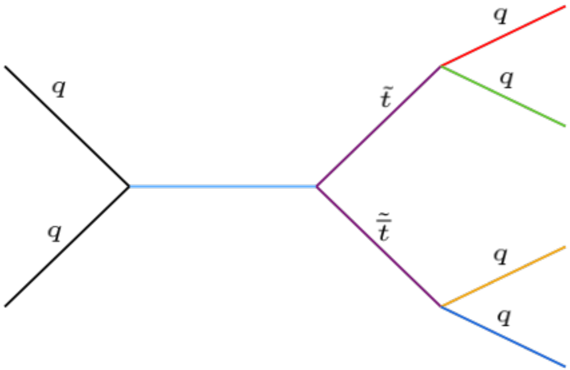

Figure: Feynman diagram of stop production with the 4-jet final state.

Event generation

Events were generated with Pythia 8.1 and underwent a simulation with Geant4. There were generated four samples for each stop mass. The samples contained:

- 8 975 460 events for 80 GeV stop mass;
- 3 914 633 events for 150 GeV stop mass;
- 6 556 512 events for 200 GeV stop mass;

Number of jets

The number of jets that were in the generated samples and passed the $p_{\mathrm{T}} > 20$ GeV cut are plotted for each stop mass accordingly. It is noticeable, that the stop of the lowest mass of 80 GeV on average produces less jets.

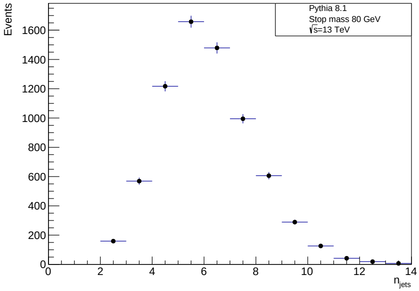

Figure: Number of jets distribution for the generated sample for the stop mass of 80 GeV.

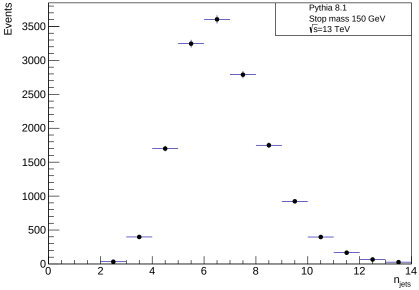

Figure: Number of jets distribution for the generated sample for the stop mass of 150 GeV.

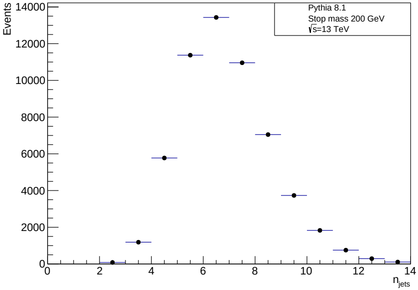

Figure: Number of jets distribution for the generated sample for the stop mass of 200 GeV.

Transverse momentum distribution

The jets can be hard to distinguish by their p_{T} which is quite similar for the two jets with lowest p_{T}. However, the difference between p_{T} of the these two jets is larger at the higher stop masses.

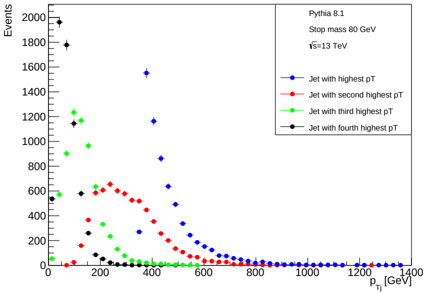

Figure: Transverse momentum distribution of each of the four jets for the generated sample (stop mass of 80 GeV).

Efficiency after selection

The cuts were chosen in order to select the events that would be recorded by triggers, that did not come from the QCD background and that could be a candidates for the stop production process.

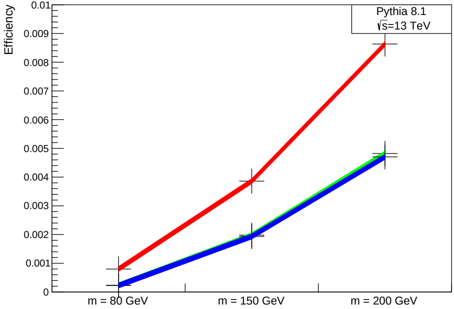

Figure: Efficiency of the event selection at each selection stage for each stop mass: red - first stage, green - second stage and blue - third stage.

Conclusions and Outlook

This analysis showed that:

- The identification of four jets in the final state for the selected process could increase with higher stop masses.
- The efficiency of the jet selection depends on the stop mass significantly.
- However, in all the selection stages only less than 1% of events are identified as having at least four jets in the final state so different jet analysis strategy might be more efficient.

Conclusions and Outlook

- TLA analysis with applied requirements for jets has a comparable efficiency to ATLAS-CONF-2016-084 fig. 3b efficiency times acceptance (0.1-0.7 %) so the TLA could be used for analyzing large amounts of p-p data.
- Further studies are needed to assess the feasibility of such a strategy, as low p_{T} jets are difficult to reconstruct and calibrate at the trigger level.