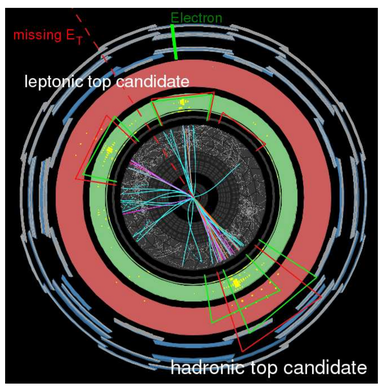
Search for new physics in the invariant mass of boosted top pairs at ATLAS

Motivation

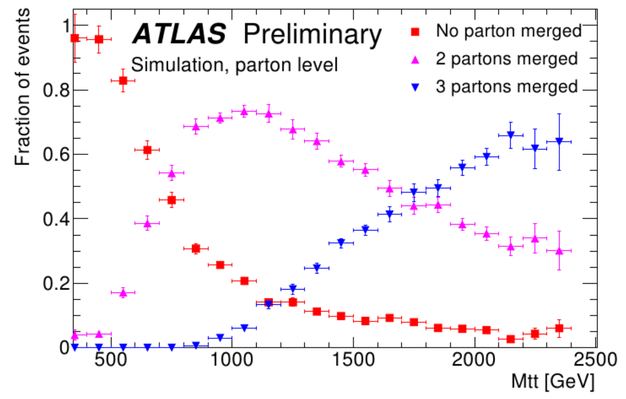
Several models beyond the Standard Model postulate heavy particles decaying predominantly into top pairs and become apparent in the invariant mass spectrum of the top-antitop system. For particle masses above 1 TeV top pairs become highly boosted and their jets in purely hadronic top decays merge and cannot be resolved experimentally. New methods to identify and reconstruct boosted top pair events are required which make use of substructure observables such as jet shapes and masses to identify the individual hadronic decay products. These will be applied on data taken with the ATLAS detector during 2012.

Boosted top pairs



Left Event display of a top pair candidate ($m_{t\bar{t}} = 2.5$ TeV) where the jets from the hadronic top decay overlap [1].

Right The probability that the jet cones of two (partially merged) or all three (fully merged) partons of the hadronic top decay overlap rises with the invariant mass of top-antitop system [5].



Analysis

Event selection

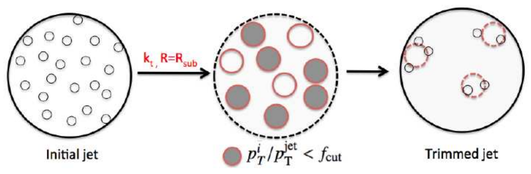
- missing transverse energy
- exactly one isolated lepton using a relative isolation:

$$\sum_{\Delta R(\mathrm{trk,lep})<k_T/p_{T,\mathrm{lep}}} p_{T,\mathrm{trk}} < \mathrm{const} \times p_{T,\mathrm{lep}}$$

.

- one narrow b-jet ($\Delta R = 0.4$)
- for the resolved (partially merged) case: at least four (three) narrow jets (including one jet with $m_j > 60$ GeV)
- for the fully merged case: at least one additional fat jet ($\Delta R = 1.0$) with $m_j > 100$ GeV, high p_T and cuts on jet substructure and event topology

Jet grooming Remove low energetic jet contamination from pile-up, multiple interactions and initial state radiation with trimming algorithm: recluster jet clusters with k_t-algorithm and small cone size and remove subjets which contribute little to the jet p_T [7].

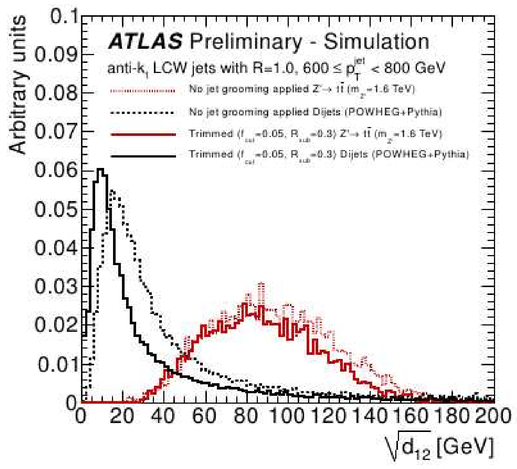


Jet substructure

Using the substructure of fat jets, for instance the k_t-splitting scale, i.e. the k_t-distance of the final step in the k_t jet clustering algorithm,

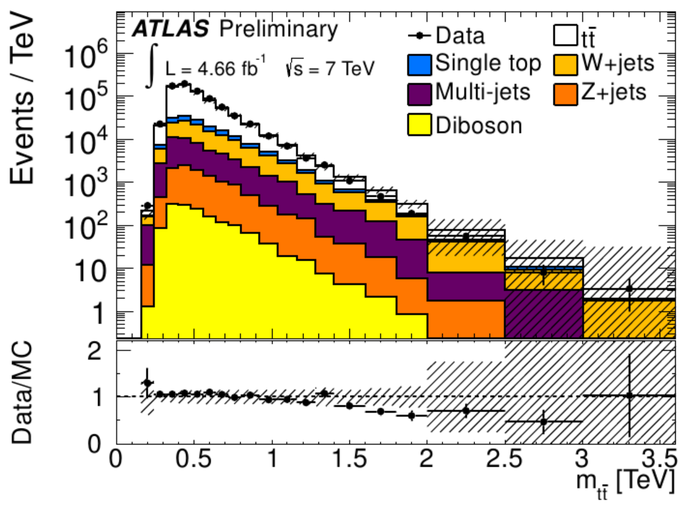
$$\sqrt{d_{12}} = \min(p_{T1}, p_{T2}) \times \Delta R_{12},$$

helps to distinguish between merged jets from pure two-body heavy particle decays ($\sqrt{d_{12}} \approx m_{\mathrm{jet}}/2$) and asymmetric light quark or gluon jets, respectively [7].



Reconstruction of the $t\bar{t}$ invariant mass spectrum

The plot includes all spectra from the e and μ channels and from the boosted and resolved selection. The shaded areas indicate the total systematic uncertainties. For the resolved reconstruction the jets are assigned by a χ^2 based algorithm with t- and W-mass constraints [8].



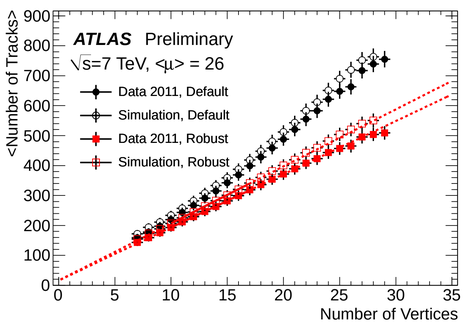
Selected Publications and References

[1] JHEP **1209** (2012) 041.
[2] ATLAS-CONF-2012-042.
[3] ATL-PHYS-PROC-2012-111.
[4] ATL-PHYS-SLIDE-2012-126.

[5] ATL-PUB-PHYS-2010-008.
[6] EPJ C72 (2012) 2083.
[7] ATLAS-CONF-2012-065.
[8] ATLAS-CONF-2012-136.

Track Reconstruction at high luminosities

With an average number of up to 40 pile-up interactions per bunch crossing in 2012 data taking the ATLAS Inner Detector already reached its design specifications. This makes high demands on the track reconstruction with respect to fake tracks, CPU time and disk space. Robust cuts have been developed which eliminate additional fake distribution in simulation and data [2].



Selected Talks

- Herbstschule für Hochenergiephysik Maria Laach, Bautzen, 09/2011 (talk).
- DPG Frühjahrstagung, Göttingen, 03/2012 (talk).
- LHCC, CERN, 03/2012 (poster).
- CHEP, New York, 05/2012 (poster).
- ESHEP, Anjou, 06/2012 (poster).

Profit from the GK

- Possibility to attend block courses
- Additional financial support for international conferences
- Contact to other students

Contact Details and further Information

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