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Measurement of the boosted $t\bar{t}$ differential cross section in lepton + jets channel in pp collisions with the ATLAS experiment

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Summary. — The top quark is the heaviest particle in Standard Model. When it is produced with a large Lorentz boost, its decay products tend to overlap, making the standard reconstruction techniques inefficient; large R jet substructure analysis techniques allow to increase the detection efficiency for these events. Differential cross section measurements of boosted $t\bar{t}$ from pp collisions with $\sqrt{s} = 8\,\text{TeV}$ will be shown, using a sample of $\sim 20\,\text{fb}^{-1}$, recorded by ATLAS during 2012.

1. – Introduction

The top quark is the heaviest particle in the Standard Model. It decays before the hadronization process, giving the unique possibility to study a bare quark. In addition, the measurement of its production cross section allows to test the perturbative QCD calculations and to search for possible resonances Beyond the Standard Model (BSM) with the mass in the TeV region. Many BSM theories involve large couplings to top quarks. In this case, the top quarks can be produced with high Lorentz boost and their decay products tend to overlap, so it is necessary to use strategies which are different from the standard ones which reconstruct individually the separate objects. An analysis on boosted top differential cross section has been developed [1] using a sample of $\sim 20\,\text{fb}^{-1}$, recorded by the ATLAS experiment [2] of LHC during 2012.

2. – Description of the analysis

At LHC, top quark are produced mainly by gluon-gluon fusion (93%). Almost every top quark decays into Wb, and the measurement has been done in the lepton + jets decay channel of the $t\bar{t}$ pair, with one W decaying hadronically and the other leptonically: $t\bar{t} \to Wb + Wb \to (l\nu)b + (jj)b$. Because of the overlapping of the decay products due to the large Lorentz boost, the boosted top is reconstructed in a large radius jet (where $\Delta R = \sqrt{\Delta\eta^2 + \Delta\phi^2} = 1$), whose internal structure is then analyzed. In order to discriminate the signal from the QCD background, these large jets have to satisfy several selection criteria on mass and energy, and one algorithm is applied to reduce the pile-up contamination. The events are selected in this way: there has to be only one isolated

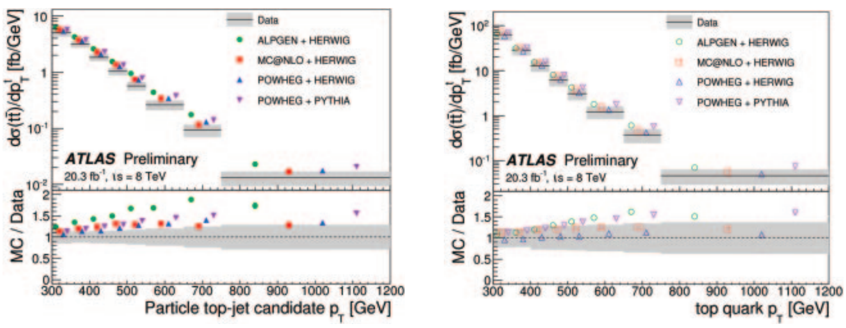

Fig. 1. – Unfolded differential cross section for the p_T spectrum at *particle* and *parton level* and comparison with the Monte Carlo models [1].

electron or muon; the events should have a sizable missing transverse energy; there has to be at least one jet (*anti-kt* with a cone of $\Delta R = 0.4$) within a $\Delta R < 1.5$ from the lepton, and at least one large R jet ($\Delta R = 1$) spatially separated from the lepton; at least one jet must be tagged as coming from a b (the *b-jet* could be the one linked to the leptonic top, one inside the larger jet, or both).

The results are corrected through an unfolding procedure both at at *particle level* and *parton level*. The *particle level* uses stable and semi-stable particles ($\tau > 0.3 \cdot 10^{-10}$ seconds) from simulation and is defined in a fiducial region as close as possible to the event selection. At *particle level* jets contain muons and neutrinos, and there is no isolation or overlapping between objects, since they don't overlap by definition. The *parton level* uses the partonic top quark before the decay, after the radiation process.

Unfolding is composed by three operations. First, the distribution is corrected by acceptance, which is the fraction of events that pass the *particle level* selection among the events that pass the event selection. Second, there is a correction by the migration from generated events to reconstructed events, through a regularized matrix inversion procedure. Third, the distributions are corrected by the efficiency, which is the fraction of events that pass the event selection among those passing the *particle level* selection.

The main systematic uncertainties which affect the results are the ones regarding the p_T scales of the large R jets at *particle level* and the signal modelization at *parton level*. The signal modelization uncertainty leads to different measurement after the unfolding, depending on the different Monte Carlo simulations used.

3. – Conclusions

The preliminary differential cross section results are shown in fig. 1. There is a general tendency of the Monte Carlo predictions to overestimate the data, especially at high p_T. Among the tested Monte Carlo simulations, the ones which are closer to the data distributions have been obtained with MC@NLO+HERWIG and POWHEG+HERWIG.

REFERENCES

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