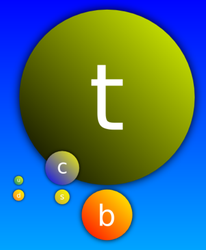
TOP-ANTITOP PAIR PRODUCTION IN ATLAS
TRIESTE-UDINE GROUP

Our group works on data analysis inside the ATLAS experiment at the LHC proton-proton collider at CERN.

The top quark (or simply t):



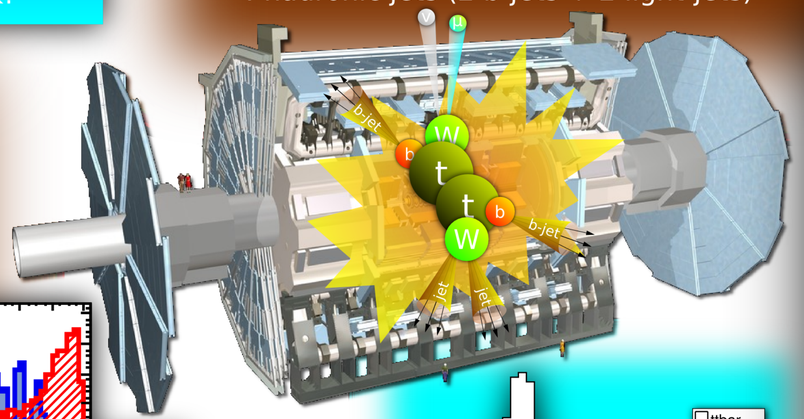
The top quark, discovered in 1995 at the Tevatron $p\bar{p}$ collider in the US, with his mass of 172.5 GeV, is the heaviest elementary particle ever know! In the figure, the ratio between the six quark masses can be visualized as the ratio between the volume of the corresponding spheres.

Due to his huge mass, the top quark decays before hadronising: there isn't enough time to form any bound state with other quarks and gluons. So the top is the only one observable free quark!

The semi-leptonic $t\bar{t}$ channel:

The top decays almost always in a Wb pair, but, depending on the W boson decay, a $t\bar{t}$ pair can give rise to final states with different topologies. The most convenient to study decay channel is the so called semi-leptonic channel, with a final state including:

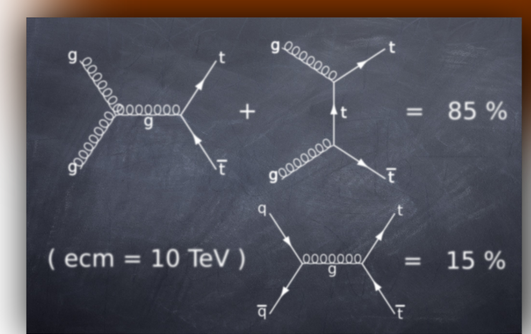
1 electron or muon (very useful to trigger the event)
1 neutrino (visible only as missing energy in the detector)
4 hadronic jets (2 b-jets + 2 light-jets)

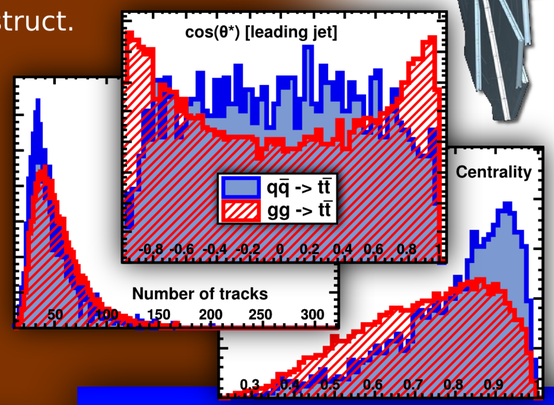


Top pair production at the LHC:

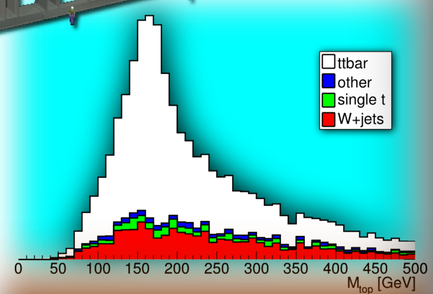
The top quark can be produced, in high energy pp collisions, as single top (through weak interaction) or as top-antitop pairs (trough strong interaction). The pair production is expected to be more abundant and easier to reconstruct.

There are two main sub-processes contributing to the strong tt production: the gluon-gluon fusion and the quark-antiquark annihilation. Their relative contribution to the total cross section depends on the center of mass of the pp collisions.





Some kinematical distribution of $t\bar{t}$ events: the angular distribution of the leading jet, the total number of hadronic tracks, and the centrality of the jets in the event. These variables seem to have a different shape depending on which sub-process originates the $t\bar{t}$ pair. The strategy to extract the relative contributions of the two main sub-processes starts from these distributions.



3-jet invariant mass distribution for signal and background events passing the semi-leptonic $t\bar{t}$ event selection. The mass peak around the top mass value indicates the good reconstruction of the hadronically decaying top.

Actual topics of our group:

Waiting for the LHC startup and the arrival of the first data, our group is focusing on the optimization of the analysis strategy for the determination of the $t\bar{t}$ cross section, in the semi-leptonic decay channel. Indeed, this will be one of the first measurements in ATLAS.

Initially, the energy of pp collisions will be below the nominal 14 TeV (around 10 TeV or slightly lower), and therefore we will need to adjust to lower energies some details of the analysis.

Meanwhile, some other studies are being carried out. These include a study for the determination of the fraction of tt events produced through the two main sub-processes (gg fusion and $q\bar{q}$ annihilation), and different strategies to determine the abundance of background events (mainly the production of W + jets and jets from QCD) directly from data.

Why it is important to measure the $t\bar{t}$ cross section?

1) to test the standard model predictions
2) $t\bar{t}$ is a background for Higgs and SUSY
3) the $t\bar{t}$ reconstruction and isolation will involve most part of the ATLAS detector; so, to be sure the detector is working properly, and so to be able to claim new physics discovery, we must see the top first!

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