# Top2015 - 8th International Workshop on Top Quark Physics

Sunday 13 September 2015 - Friday 18 September 2015

Continental Hotel, Ischia

# Book of Abstracts

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## t$\gamma$, tH and tZ Production Through FCNCs.

**Author:** Artur Amorim[1]

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We study the t$\gamma$, tH and tZ production through Flavour Changin Neutral Currents (FCNCs) anomalous couplings, in particular how the distributions of physical observables depend on the anomalous couplings. We find that the angular distributions of the decay products depend on the quirality of the anomalous coupling and that the kinematic distributions of the top quark, photon, Higgs boson and Z boson change according to the nature of the anomalous coupling. We also study the expected sensitivity of the LHC experiments to the tZ production via FCNC at the run-2.

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## Towards NLO QCD radiative corrections for the associated production of heavy quarks and vector bosons

**Author:** Felix Anger[1]

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The production of vector bosons in association with heavy quarks constitutes an irrecducible background to many processes relevant for the ongoing physics programm at the LHC, for both SM measurements and BSM searches. In order to provide NLO QCD radiative corrections to these processes, we employ the framework of generalized unitarity, where loop amplitudes are constructed by combining tree amplitudes. The latter are generated by the use of a Berends-Giele off-shell recursion. With this set of methods, we aim to extend existing predictions for the associated production of heavy quarks and vector bosons to higher mulitplicities. Here we report recent progress with this process class.

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## Associated production of single top plus Higgs and W at NLO-QCD accuracy

**Authors:** Benedikt Maier[1]; Federico Demartin[2]

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Like single top plus W production, associated production of a top quark together with a Higgs and a W boson (tHW) at the LHC is well defined only at LO in QCD and in the 5-flavour scheme. NLO-QCD corrections to the tHW process feature an overlap with the associated production of a top quark pair and a Higgs boson (ttH).

I present results from various techniques that can be employed to separate the ttH contribution from the other NLO corrections to tHW (diagram removal, diagram subtraction) and discuss under which conditions this separation can provide sensible predictions, both for the total cross section and for differential distributions.

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## Measurement of top quark polarization with the D0 detector

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## Measurement of the ttbb cross section and the ratio σ(ttbb)/σ(ttjj) in the lepton+jets final state at √s=8 TeV with the CMS experiment

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The associated production of a top-quark pair with at least two additional jets is studied in the single lepton+jets final state for an integrated luminosity of 19.6/fb at 8 TeV. The jets from the top-quark decay are identified using a constrained kinematic fit and multivariate classifiers in different categories split by the jet multiplicity. The contributions of ttjj and ttbb with at least two additional jets of any flavor or b jets to the inclusive top-quark pair production are extracted with a simultaneous template fit of b-tag discriminants. The measured cross sections σ(ttbb) = 271.0 ± 103.0(stat) ± 32.2(syst) ± 7.0(lumi) fb, σ(ttjj) = 23.1 ± 2.3(stat) ± 2.9(syst) ± 0.6(lumi) pb and the cross section ratio σ(ttbb) /σ(ttjj) = 0.0117 ± 0.0040(stat) ± 0.0003(syst) correspond to the phase space of the additional jets to the top-quark pair defined at generator-level as: pt > 40 GeV/c, |η| <2.5, ΔR > 0.5. The flavor of the generated jets is defined by the flavor of the leading quark in the jet. The obtained results are in good agreement with NLO calculations and the CMS measurement in the dilepton channel when an appropriate jet definition is used.

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## Measurement of associated top-quark-pair and b-jet production at CMS

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Presented is the measurement of sigma(ttbar bbbar) and sigma(ttbar jj), as well as their ratio, using pp collisions at centre-of-mass energy of 8 TeV recorded with the CMS detector at the LHC. The data used in the measurement corresponds to the integrated luminosity of 19.6 inverse femtobarn. The measurement is performed in the dileptonic final state of the ttbar system for two thresholds of additional jet tranverse momentum: 20 GeV and 40 GeV. The measured ratio for pT > 40 GeV is higher but compatible with a theoretical NLO prediction within 1.6 standard deviations.

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## Inclusive and differential measurements of the $t\bar{t}$ charge asymmetry at 8 TeV with the CMS experiment

**Author:** Thorsten Chwalek[1]

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The ttbar charge asymmetry is measured in proton-proton collisions at a centre-of-mass energy of 8 TeV. The data, collected with the CMS experiment at the LHC, correspond to an integrated luminosity of 19.7/fb. Selected events contain an electron or a muon and four or more jets, where at least one jet is identified as originating from b-quark hadronization. The ttbar charge asymmetry is measured inclusively and differentially as a function of rapidity, transverse momentum, and invariant mass of the ttbar system. For the first time at the LHC, the measurements are also performed in a reduced fiducial phase space of top quark pair production.

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## Using the Standard Model Effective Field Theory to Search for BSM Physics in the Top Sector

**Author:** Liam Moore[1]

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This poster will summarize some results from the Standard Model Effective Field Theory (EFT), in particular, how dimension-six operators can modify top quark observables and affect the fundamental parameters of the SM. Results will be shown from a recent global fit of the Wilson Coefficients affecting top-pair and single-top production to current collider data using novel fast-fitting methods. Finally, there will be some information on progress towards a more detailed analysis, including efforts to incorporate NLO QCD corrections to the higher dimensional operators.

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# Measurement of the differential top quark pair production cross section in pp collisions at 8 TeV

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Normalized differential top quark pair production cross sections are measured in $p\bar{p}$ collisions at a centre-of-mass energy of 8 TeV at the LHC using the CMS detector. The dataset used for these measurements corresponds to an integrated luminosity of 19.7 fb$^{-1}$. The measurements are performed in the lepton+jets (e+jets and $\mu$+jets) and in the dilepton (ee, $\mu\mu$, and e$\mu$) decay channels. The $t\bar{t}$ production cross section is measured as a function of kinematic properties of the charged leptons, the jets associated to $b$ quarks, the top quarks, and the $t\bar{t}$ system. The data are compared with several predictions from perturbative QCD calculations up to approximate next-to-next-to-leading-order precision. No significant deviations are observed relative to the standard model predictions.

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# Measurement of the top-quark mass

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The mass of the top quark is measured using a sample of ttbar candidate events collected by CMS in pp collisions at √s=8 TeV at the LHC, corresponding to an integrated luminosity of up to 19.7/fb. This poster presents the results in the lepton+jets, all-jets, and dilepton channels, and their combination.

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# ttW and ttZ production cross sections in leptonic final states in 8 TeV pp collisions at ATLAS

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A measurement of the production cross section of a pair of top quarks in association with a W or Z boson is presented, using $20.3\,\text{fb}^{-1}$ of $pp$ collision data collected by the ATLAS detector at $\sqrt{s} = 8\,\text{TeV}$. The measurement combines four separate analyses which consider final states with two opposite sign, two same sign, three and four leptons. A simultaneous fit to data of the $t\bar{t}W$ and $t\bar{t}Z$ signals measures their cross sections to be $\sigma_{ttZ} = 176^{+58}_{-52}$ fb and $\sigma_{ttW} = 369^{+100}_{-91}$ fb, consistent with next-to-leading order theoretical calculations. Tested against the background-only hypothesis, these correspond to an observed (expected) significance of $4.2\sigma$ ($4.5\sigma$) for $t\bar{t}Z$ and $5.0\sigma$ ($3.2\sigma$) for $t\bar{t}W$.

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# Search for single top-quark production via flavour-changing neutral currents at 8 TeV with the ATLAS detector

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This poster presents a search for single top-quark production via flavour-changing neutral current processes
from gluon plus up- or charm-quark initial states in proton–proton collisions at the LHC.
Data collected with the ATLAS detector at a centre-of-mass energy of
8 TeV and corresponding to an integrated luminosity of 20.3 fb-1 are used.
Candidate events for a top quark decaying into a lepton, a neutrino and a jet are selected and classified
into signal- and background-like candidates using a neural network.
No signal is observed and an upper limit on the production cross-section multiplied by the $t \to Wb$ branching fraction is set. The observed 95% CL limit is $\sigma_{qg \to t} \times BR(t \to Wb) < 3.4$ pb
The observed limit can be interpreted as upper limits on the coupling constants of the flavour-changing neutral current
interactions divided by the scale of new physics
$\kappa_{ugt}/\Lambda < 5.8\ 10^{-3}\text{TeV}^{-1}$ and
$\kappa_{cgt}/\Lambda < 13\ 10^{-3}\text{TeV}^{-1}$
and on the branching fractions
$BR(t \to ug) < 4.0\ 10^{-5}$ and
$BR(t \to cg) < 17\ 10^{-5}$.

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# Measurement of the charge asymmetry in top quark pair production in 8 TeV pp collision data collected by the ATLAS experiment

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The charge asymmetry in top quark pair production, AC, measured using 20.3 fb$^{-1}$ of data recorded with the ATLAS detector at a center-of-mass energy $\sqrt{s} = 8$ TeV is presented.
Events where one top quark decays semi-leptonically ($e$+jets or $\mu$+jets) are considered.
The ttbar system is fully reconstructed using a likelihood fit.
A Bayesian unfolding procedure is performed to determine AC at the parton level. An inclusive result is presented along with differential measurements with respect to the velocity of the ttbar system, $\beta_{z,ttbar}$, the transverse momentum of the ttbar system, $p_{T,ttbar}$, and the invariant mass of the \ttbar{} system, $m_{ttbar}$.
All measurements are consistent with Standard Model predictions.

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## Measurement of colour flow with the jet pull angle in ttbar events using the ATLAS detector

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The distribution and orientation of energy inside jets is predicted to be an experimental handle on colour connections between the hard–scatter quarks and gluons initiating the jets. This poster presents a measurement of the distribution of one such variable, the jet pull angle. The pull angle is measured for jets produced in ttbar events with one W boson decaying leptonically and the other decaying to jets using 20.3 inverse fb of data recorded with the ATLAS detector at a centre-of-mass energy of 8 TeV at the LHC. The jet pull angle distribution is corrected for detector resolution and acceptance effects and is compared to various models.

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## Measurement of ttbar production with a veto on additional central jet activity in pp collisions at $\sqrt{s}$=8 TeV using the ATLAS detector

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This poster presents a measurement of the amount of QCD radiation in top quark pair-production ($t\bar{t}$) events, using dilepton $t\bar{t}$ events that have an opposite-sign $e\mu$ pair and two $b$-tagged jets in the final state. The measurement includes the complete 2012 ATLAS data sample of 20.3 fb$^{-1}$ integrated luminosity of $pp$ collision data at $\sqrt{s} = 8$ TeV. The fraction of signal events that does not contain additional jet activity in a central rapidity region is measured as a function of (a) the minimum transverse momentum of any additional jet in the event, and (b) the minimum scalar transverse momentum sum of all additional jets in the event, and the results shown for four central rapidity regions and four regions of the invariant mass of the $e\mu bb$ system. Compensation for detector effects is applied to the measurement and the results compared at the particle level to prediction from simulation by several next-to-leading order (NLO) and multi-leg leading order (LO) Monte Carlo generators.

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## Measurement of $t\bar{t}$ differential cross-section for highly boosted top quarks produced at ATLAS in proton proton collisions at $\sqrt{s}$ = 8 TeV

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The measurement of the differential cross-section for top quark pair production as function of top transverse momentum will be presented.
The used dataset has been collected in 2012 in proton-proton collisions at a center of mass energy of 8 TeV.

The measurement is performed for $t\bar{t}$ events in the semileptonic channel decay where the hadronically decaying top quark has a
transverse momentum above 300 GeV.
The hadronic top quark decay is reconstructed as a single large radius jet
and identified using the jet substructure properties.
This technique allows to increase the detection efficiency extending the cross-section measurement to high $p_T$
region never reached before.

The main background sources are evaluated both with data driven methods (for W+jets and fake leptons contributions) and using Monte Carlo simulations (Z+jets, diboson, $t\bar{t}$ dilepton channel, single top).

The observed yield, after the background subtraction,
is corrected for efficiency and resolution effects to obtain the result both in a fiducial region close to the event selection and also extrapolated to the full partonic phase-space.
The final differential cross section has been compared with several theoretical predictions that generally slightly exceed the measured distribution.

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## Top Tagging at ATLAS

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Studies of the boosted sector in top-quark physics have known a fast-growing development with the arrival of high-energy data at LHC. Different techniques to identify high-pT top quarks based on substructure analyses of large radius jets have been developped for Run-1 and Run-2 data. New results are presented on the optimization and performance comparisons, for the different techniques (HEPTopTagger, Shower Deconstruction and substructure variables cut-based taggers), using pp collision data and MC simulations at sqrt(s)=8 TeV. In addition, prospects for Run-2 analyses, using MC simulations at sqrt(s)=13 TeV with 2015 data-taking conditions, are also presented.

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## Studies of top quark pair modelling using ATLAS measurements

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The data collected during the Run 1 at the LHC have given a large boost to measurements involving top quarks and triggered tremendous activities on the experimental and theoretical side.
The precision of most of these measurements are limited by the systematic uncertainties related to the modelling of the ttbar signal process, to the event modelling and the description of the hard scattering environment.
Choices to be made in the signal simulation are the proton distribution functions, the Monte Carlo generator and the hadronisation model. On the event modelling side, important ingredients are related to the description of the underlying event, via Monte Carlo tunes, and the settings adopted for the modelling of colour reconnection, extra QCD radiation and the description of additional interactions accompanying the hard scatter (pile-up).

A huge experimental effort is underway with the aim of reducing the signal modelling uncertainties in close collaboration with the theory community. Recently new Monte Carlo generators based on NLO matrix elements for the hard scattering process matched with parton showers have become available. In addition, a new frontier has been reached with the advent of Monte Carlo generators based on merged NLO matrix elements with up to 4 partons hard scattering process and matched to parton showers.
This kind of studies not only for ttbar process but also the production of top quark pairs in association with bosons, photons, Z and Higgs, which become now accessible at the LHC, are also of extremely interest. The predictions of various Monte Carlo generators are compared to data from Run 1 and presented in this work.

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## First cross section measurements of $t\bar{t}$ pairs at $\sqrt{s}$ = 13 TeV in the same—flavour dilepton events

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First results of the inclusive cross-section measurement of $t\bar{t}$ events in the same-flavour dilepton decay mode are presented using data collected by the ATLAS experiment in Summer 2015 at a centre of mass energy of 13 TeV.

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## Unravelling the non-standard top and Higgs couplings in associated top-Higgs production at the High-luminosity LHC

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## search for single top quark production in the $s$-channel by the CMS at 8 TeV

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Results of the search for single top-quark production in the s-channel in p-p collisions at a center-of-mass energy of 8TeV by the CMS experiment at the LHC will be presented. Leptonic decays mode of top quarks with an electron or muon in the final state are considered . In order to separate the expected signal from background processes, a multivariate discriminant is defined using Boosted Decision Trees. This analysis leads to an upper limit on the cross section of 11.5 Pb, corresponding to 2.1 times the standard model cross section, at 95% Confidence Level (TOP-13-009)

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## First measurement of the differential cross section for ttbar production in the dilepton final state at a center-of-mass energy of 13 TeV

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Differential cross sections of top-quark pair production are measured in dilepton decay channel with proton-proton collisions at a center-of-mass energy of 13 TeV. The measurement is performed with a RunII data using CMS detector at the Large Hadron Collider. In this analysis, we measure the differential cross sections with respect to kinematic variables of leptons, bjets, and top-quarks.

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## Constraining QCD multijet background in single top t-channel production at 13 TeV

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Precision measurement of the cross section for single top production in t channel is an important test of the Standard Model (SM). The purity of the collected data in single top events is limited by the understanding of the shape and yield of background contributions. Besides electroweak and ttbar processes, QCD multijet events are a non-negligible background for this measurement, with large intrinsic modeling uncertainties. We report on how we control this contamination in the context of the measurement of t-channel single top cross section at 13 TeV.