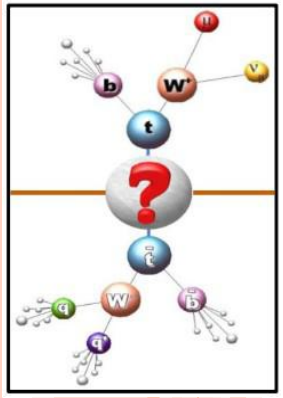

Search for ttbar resonances in the lepton plus jets channel at 7TeV: Plan for 8 TeV

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ILCP General Meeting

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Outline

- Motivation
- Analysis overview
- Results
- Plan for 8Tev

MOTIVATION

- **The "usual" introduction:**

  Top physics is one of the most interesting subjects at the LHC

  Detector calibration

  precision measurements, and

  search for new physics (Top quark strongly couples to dynamics of electroweak symmetry breaking)

New physics in the top sector may happen in production, decay, association

Many models predict resonances in production, for which a spectacular signature would be a peak in mtt → Focus in this analysis

Different spin states and different widths are possible.

→ Higgses
→ Axigluons
→ Technicolor Z'
→ KK excitations

Benchmark Models considre in the analysis:

→leptophobic **Z'**

→ Randall-Sundrum

→KK gluons **gKK**

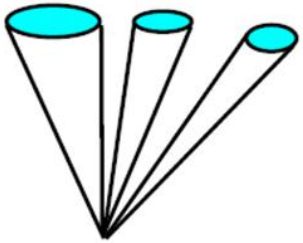
→(RS1) gravitons **G***

Analysis Overview

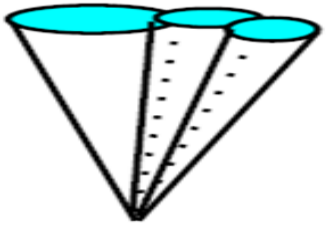
Goal: investigation of m_{tt} as possible signature of presence of new physics in top-pair production

Top production is studied in different kinematic regions and reconstruction is adapted not to loose sensitivity in any portion of phase space

Analysis Strategy:



Low, medium Energy tops: Resolved regime



High Energy tops Boosted regime

combine ttbar reconstruction topologies

If no evidence found Combination of resolved and boosted in limit setting

ANALYSIS OVERVIEW- TTBAR RECONSTRUCTION MASS

Boosted regime:

Sum of leptonic W, AKT4 Jet, AKT10 Jet
→AKT4 jet (lep.jet): ΔR(l,jet)<1.5, pT>25 GeV
→ AKT10 jet (had. Jet)
ΔR(lep jet, AKT10)>1.5, pT>350GeV
mass>100 GeV,
∫d12>40 GeV
Δφ(l, AKT10)>2.3
→leptonic top → *Wlep+ AKT4 jet (closest to lepton)*
→ hadronic top → AKT10 jet (closest to leptonic jet)

For both regimes:

W(lν) = lepton(e,μ) + MET

Neutrino pz component is determined by applying the Wboson mass as a constraint.
→If more than one solution, take smallest |pz|.
→ If no solution, rotate MET until there is one.

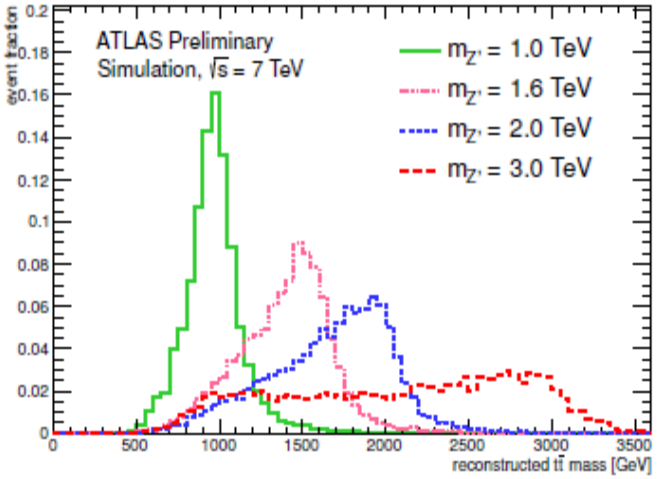
Resolved regime:

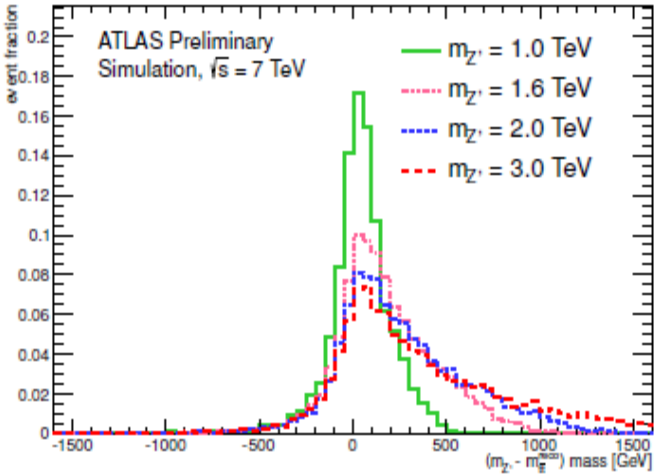
χ^2 method: select combination of jets for which χ2 is minimal.

$$\chi^2 = \left[\frac{m_{jj} - m_W}{\sigma_W}\right]^2 + \left[\frac{m_{jjb} - m_{jj} - m_{th-W}}{\sigma_{th-W}}\right]^2 + \left[\frac{m_{jlv} - m_{tl}}{\sigma_{tl}}\right]^2 + \left[\frac{(p_{T,jjb} - p_{T,jlv}) - (p_{T,th} - p_{T,tl})}{\sigma_{diffpT}}\right]^2$$

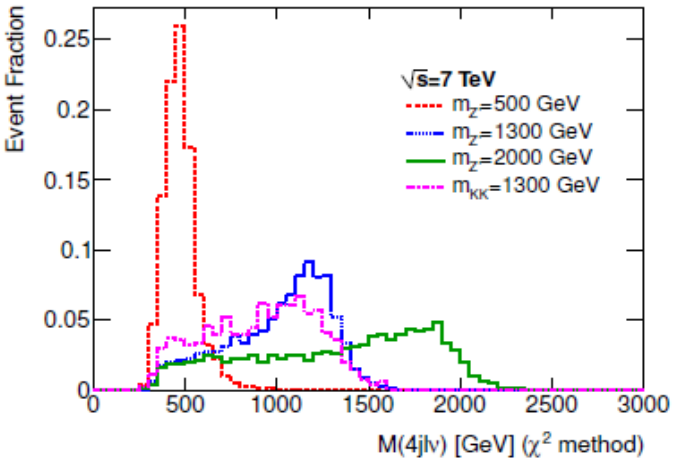
Results at 7 TeV

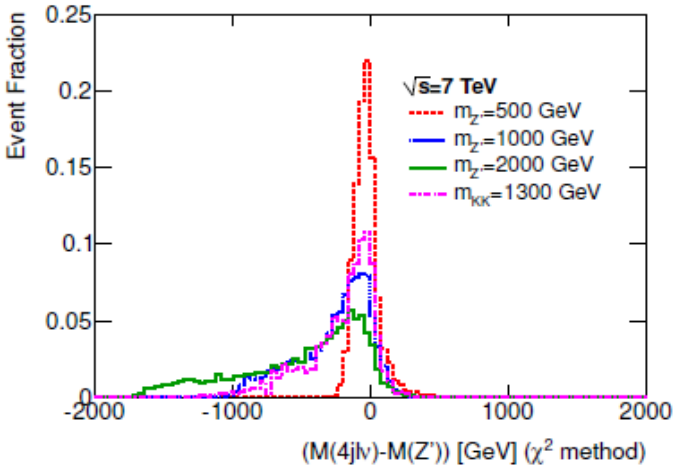
Boosted regime





Resolved regime:





Backgrounds Estimation

Background estimated using MC:

- SM ttbar
- Single top
- Z+jets
- Diboson

W+jets: estimated using MC but using data-driven methods to determine the total normalisation and flavour-fraction.

For boosted, normalisation factors were derived in a control region without b-tagging, mass and d12 cuts.

QCD: estimated from data using Matrix Method as nominal and Jet Electron as cross-check.

Fake-rate/efficiency estimated for resolved and boosted separately.

Event yield

Resolved selection			
Type	e+jets	μ+jets	Sum
$t\bar{t}$	19,607 ± 2,098	24,506 ± 2,622	44,113 ± 4,720
Single top	1,430 ± 110	1,813 ± 140	3,243 ± 250
QCD e+jets	2,490 ± 1,245	– ± –	2,490 ± 1,245
QCD μ+jets	– ± –	1,005 ± 201	1,005 ± 201
W+jets	2,322 ± 464	4,008 ± 802	6,330 ± 1,266
Z+jets	462 ± 222	386 ± 185	848 ± 407
Dibosons	55 ± 26	70 ± 33	124 ± 60
Total	26,366 ± 2,496	31,786 ± 2,759	58,153 ± 5,255
Data	26, 853	34, 720	61, 573
Boosted selection			
Type	e+jets	μ+jets	Sum
$t\bar{t}$	326 ± 35	613 ± 66	939 ± 101
Single top	18 ± 1	32 ± 2	50 ± 4
QCD e	12 ± 6	0 ± 0	12 ± 6
QCD mu	0.00 ± 0.00	19.75 ± 3.95	19.75 ± 3.95
W+jets	32 ± 6	51 ± 10	83 ± 17
Z+jets	4.3 ± 2.1	3.5 ± 1.7	7.8 ± 3.7
Di-bosons	0.48 ± 0.23	0.41 ± 0.20	0.88 ± 0.42
Total	393 ± 36	720 ± 67	1113 ± 103
Data	367	712	1079

Extraction of limits

Since no data excess over the expected SM background is observed, an upper limits, using a Bayesian approach, has been considered on the production cross-section for the analysis benchmark models.

Most significant experimental + theory sources are included:

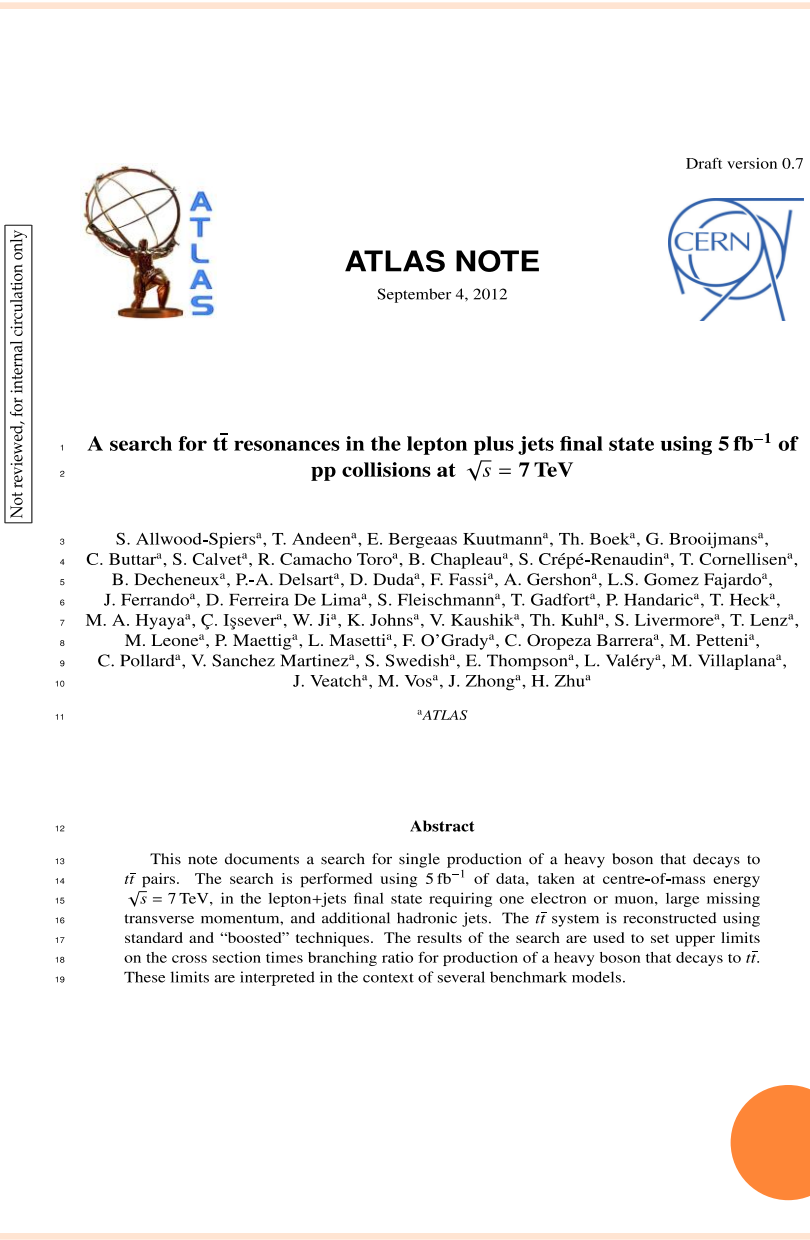
- Scale variation
- JER/ JES
- Boosted JES
- W+jets shape, W+jets HF composition
- ISR/FSR and PDF for ttbar
- Parton shower
- b-tagging efficiency and mis-tag rates
- ttbar and QCD normalisation

Latest observed limits:
draft CONF note/paper on approval stage.
Scheduled soon.

Results

Supporting documentation for the analysis can be found here:
ATLAS-COM-PHYS-2012-797
https://cdsweb.cern.ch/record/1455225

ATLAS-COM-CONF-2012-174
https://cdsweb.cern.ch/record/1476727



Draft version 0.7

Not reviewed, for internal circulation only

ATLAS NOTE

September 4, 2012

A search for $t\bar{t}$ resonances in the lepton plus jets final state using 5 fb^{-1} of pp collisions at $\sqrt{s} = 7$ TeV

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Abstract

This note documents a search for single production of a heavy boson that decays to $t\bar{t}$ pairs. The search is performed using 5 fb^{-1} of data, taken at centre-of-mass energy $\sqrt{s} = 7$ TeV, in the lepton+jets final state requiring one electron or muon, large missing transverse momentum, and additional hadronic jets. The $t\bar{t}$ system is reconstructed using standard and "boosted" techniques. The results of the search are used to set upper limits on the cross section times branching ratio for production of a heavy boson that decays to $t\bar{t}$. These limits are interpreted in the context of several benchmark models.

Summary

- Search for ttbar resonaces with 5fb-1 of proton-proton data at 7 TeV.
  - No significant deviation from SM background is observed.
  - Upper limits on the production cross-section for different benchmark models. Z' masses below 1.66 TeV and gKK masses below 1.94 TeV are excluded with 95% C.L.

Plan for short and medium term

Potential at 8 TeV: Reproduce the limit curves at 8 TeV with the expected collected luminosity

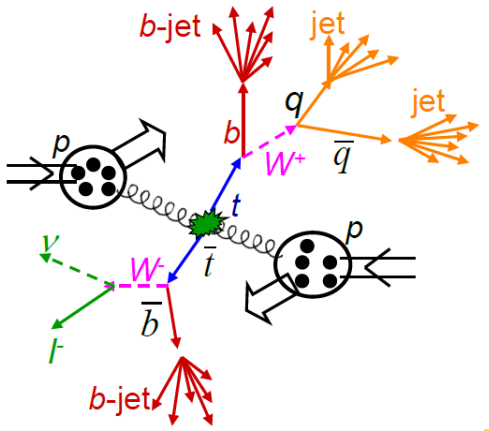
Analysis framework: We have developped a dedicated package for Boosted regime→TopD3DP Boosted
update the package to Boosted D3PD 8 TeV and new conditions

Jet substructure: Study and try another algorithms to understand deeper the constitute of the fat jet.
improves the systematics, optimize the cut variables

BACKUP

EVENT SELECTION

Considered modes: **e+jets, μ+jets**



	e+jets	mu+jets
C0	total number of events	total number of events
C1	Pile-up+lumi re-weighting+GRL	Pile-up+lumi re-weighting+GRL
C2	Pass trigger + LAr error	Pass trigger + LAr error
C3	1 good vertex	1 good vertex
C4	>=1 lepton, pt > 25	>=1 lepton, pt > 25
C5.1	=1 lepton	=1 lepton
C5.2	Veto other leptons(e:with pt>25, mu: pt>20)	Veto other leptons(e:with pt>25, mu: pt>20)
C8.1	Jet cleaning	Jet cleaning
C9	MET > 30	MET > 20
C10	Mwt > 30	Mwt+MET > 60
C11	>= 1 akt4 jet pt > 25 && DR(lep,akt4 jet) < 1.5	>= 1 akt4 jet pt > 25 && DR(lep,akt4 jet) < 1.5
C11.1	LepJet = akt4 jet with min DR(lep,akt4 jet)	LepJet = akt4 jet with min DR(lep,akt4 jet)
C12	>=1 akt10 jet (pT > 350 && m > 100 && DPhi(lep,akt10 jet) > 2.3 && SPLIT12 > 40 && DR(LepJet,akt10 jet) > 1.5)	>=1 akt10 jet (pT > 350 && m > 100 && DPhi(lep,akt10 jet) > 2.3 && SPLIT12 > 40 && DR(LepJet,akt10 jet) > 1.5)
C13	>= 1 akt4 jet with MV1 > 0.601713 (no matching necessary)	>= 1 akt4 jet with MV1 > 0.601713 (no matching necessary)