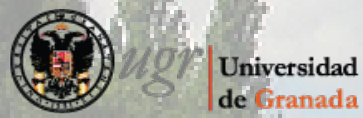
Mid Term Report

Davide Melini, ESR21

University of Granada & IFIC Valencia

Bruxelles, 17th April 2015



Introduction

Academic background

- High school: Liceo Scientifico Marconi, Chiavari, Italy (2004-2009)
- Bachelor Degree: Universita di Genova, Italy (autumn 2009- summer 2012)
- Master Degree: Universita di Genova, Italy (autumn 2012- summer 2014)
- Master thesis: NIKHEF, Amsterdam, Holland (autumn 2013- spring 2014)
- PhD at Universidad de Granada and IFIC Valencia. (autumn 2014 - now)
  Supervisors: Roberto Pittau, Juan Fuster Verdu.

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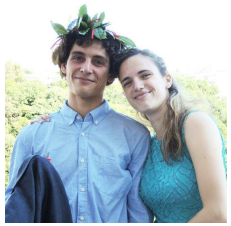
Non-academic background:

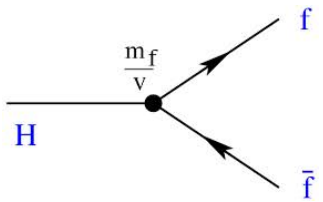
- Born 20th Ferbruary 1990
- I love sports
- I love music
- I love my girlfriend (too)



higgstools

Research

Research project focused on investigating Top-Higgs coupling



Research

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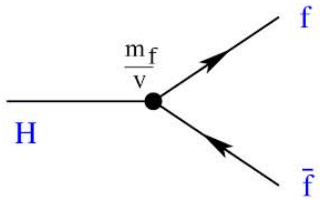
- Strongest interaction of the Higgs is with Top-quark
- If there is a deviation from what is predicted by the Standard Model (SM) at high energies, it could be visible in the Top-Higgs interaction.
- Parametrize deviations using: $\mathcal{L}_{\text{gen}} = -y_t \text{tH}(a + b\gamma^5)\bar{\text{t}}$ in the SM $a = 1, b = 0$ and $y_t \propto m_t$
  Comput.Phys.Commun. 185 (2014) 323-329
- $\mathcal{L}_{\text{gen}}$ is model independent and takes into account corrections due to dimension 6 operators.
  Nucl.Phys. B821 (2009) 215-227



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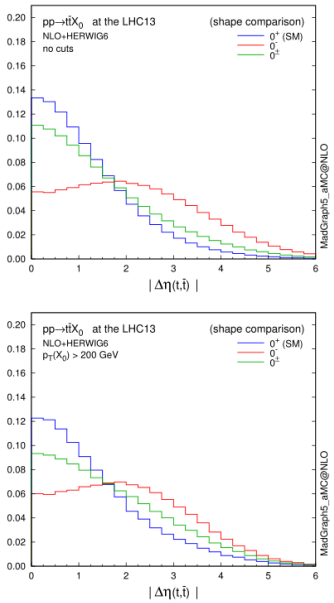


ttH is the leading process in which a *direct* measurement of y_t is possible.

Differential distributions are most sensitive to new (BSM) physics effects.

arXiv:1407.5089

Research in the context of HiggsTools

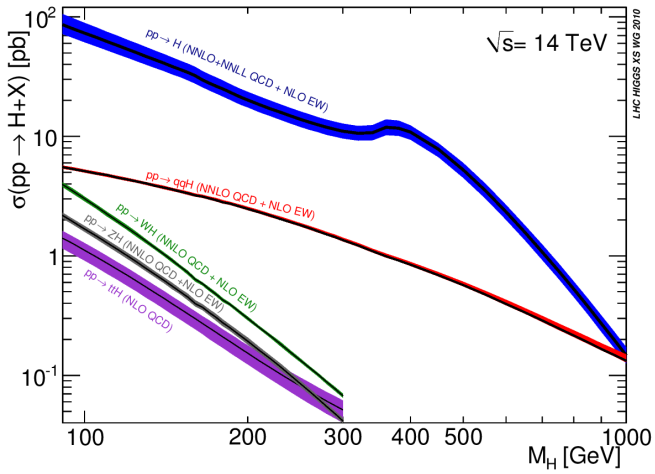
WP1: Interpretation of Data:

- Task 1.1: Extraction of model-independent results from data
  - M1.1.3 Extending the mass range and coupling range in different Higgs boson search channels $\rightarrow$ ttH channel
- Task 1.2: Measurement of Higgs properties
  - M1.2.1 Extraction of constraints on Higgs couplings from fits to all available data $\rightarrow$ use real data from ATLAS
  - M1.2.2 Extraction of information on Higgs spin and CP properties $\rightarrow$ CP behaviour inside $\mathcal{L}_{\text{gen}}$
- Task 1.3: Interpretation of experimental results in different models
  - M1.3.1 Constraints on physics beyond the SM, distinction between different models $\rightarrow$ measurement of y_t constrains BSM models

Technical problems

Main challanges:

- Low cross section.
- Not enough luminosity expected in 2017.
- ATLAS experimenters duties.



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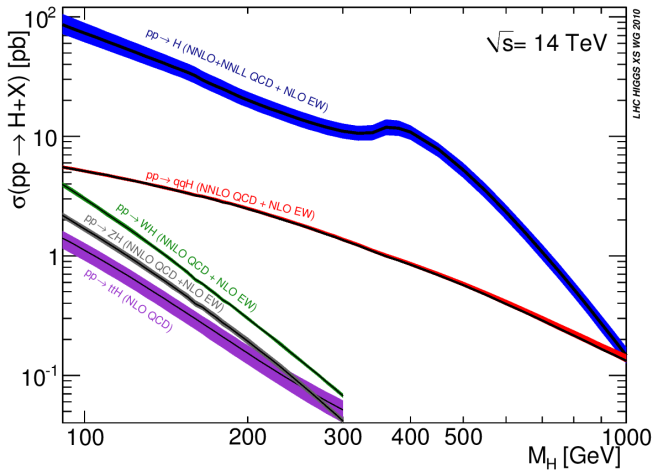
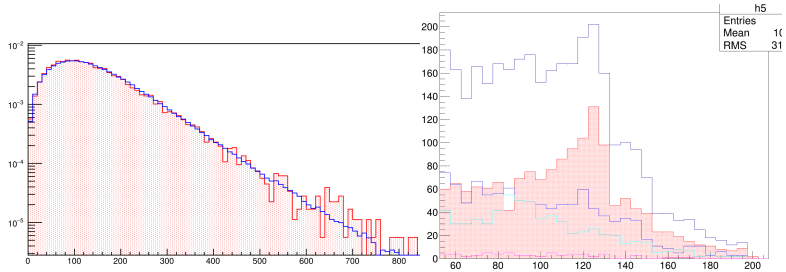


Some simulations (reproducing arXiv:0910.5472and arXiv:1104.5613) :



Transverse momentum distribution for top in ttH production and events expected after "fat jet" analysis (arXiv:0910.5472)

when	# signal
1 fb^{-1}	0,48
end of 2016 $\int \mathcal{L}$	$\approx$ 20
end of 2017 $\int \mathcal{L}$	$\approx$ 40

Too few events to have statistical significance!

Solutions

Low cross section: boosted objects

- *Boosted* analysis enhance signal over background ratio.
- When a particle with high transverse momentum decays, it is convenient to describe decay products together in a single object (*large jet*) and then study its internal structure.

arXiv:0910.5472

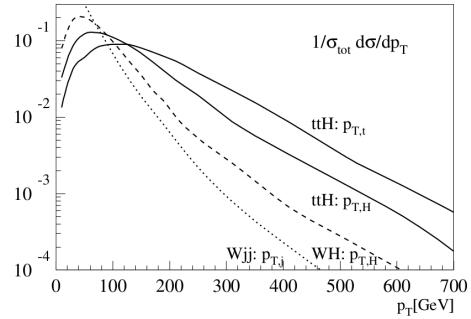
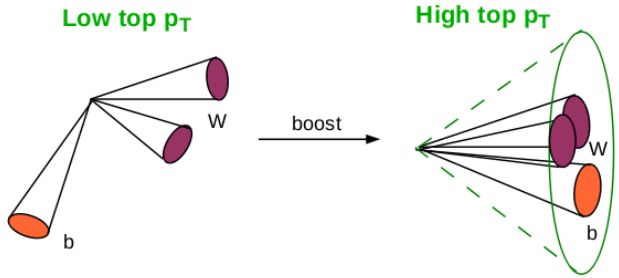


FIG. 1: Normalized top and Higgs transverse momentum spectra in $t\bar{t}H$ production (solid). We also show $p_{T,H}$ in W^-H production (dashed) and the p_T of the harder jet in W^-jj production with $p_{T,j} > 20$ GeV (dotted).



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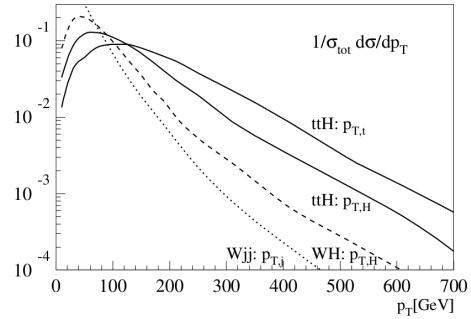

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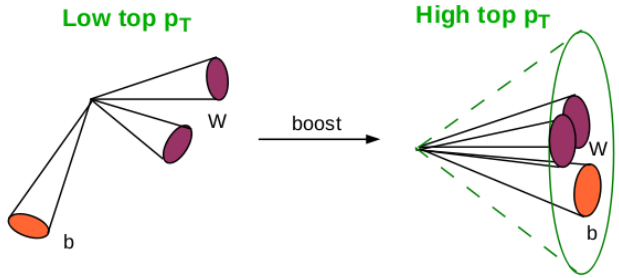

Qualification work in ATLAS on jet mass calibration for boosted objects.

WP3: Tools→ Task 3.1: Improved analysis tools →M3.1.1 Tools for boosted objects & fat jets

Solutions

Work on real data: top pole mass

Opportunity to work on real data

$\downarrow$

Do a measurement strictly related to the yukawa coupling in ttH.

$\downarrow$

Top pole mass (in SM: $y_t \propto m_t^{\text{pole}}$)

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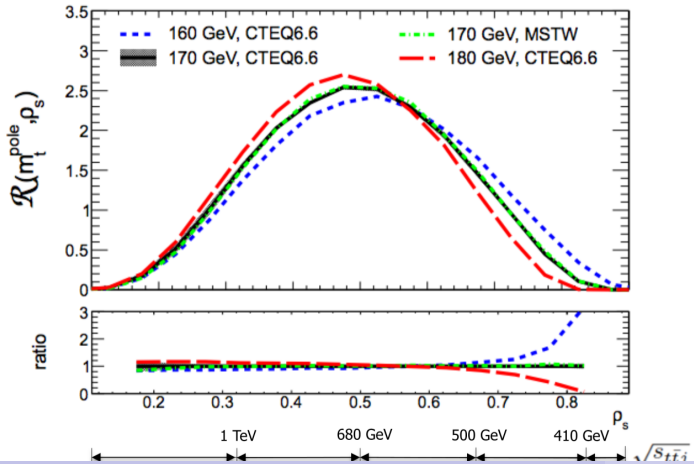
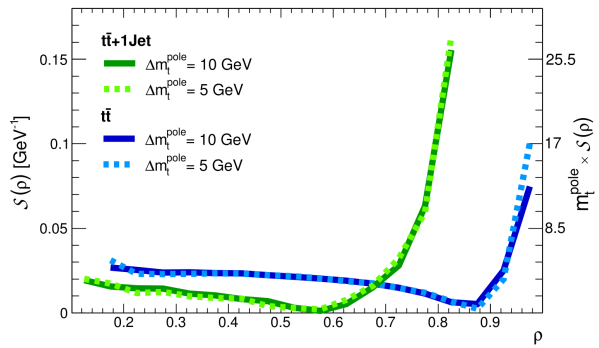
Top pole mass (in SM: $y_t \propto m_t^{\text{pole}}$)

New method to measure top quark *pole* mass (arXiv:1303.6415).

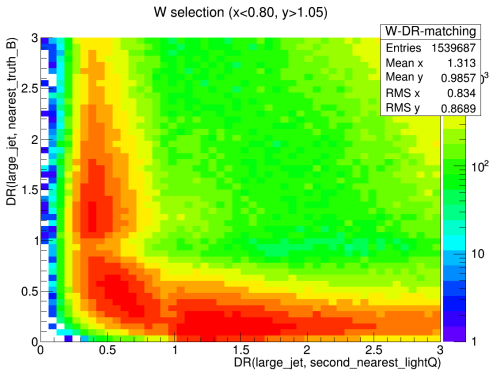
$$\mathcal{R}^{\text{parton}}\left(m_t^{\text{pole}}, \rho_s\right) = \frac{1}{\sigma_{t\bar{t}+1-\text{jet}}} \frac{\mathrm{d}\sigma_{t\bar{t}+1-\text{jet}}}{\mathrm{d}\rho_s}$$

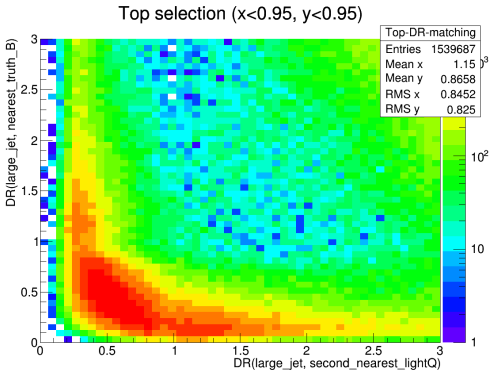


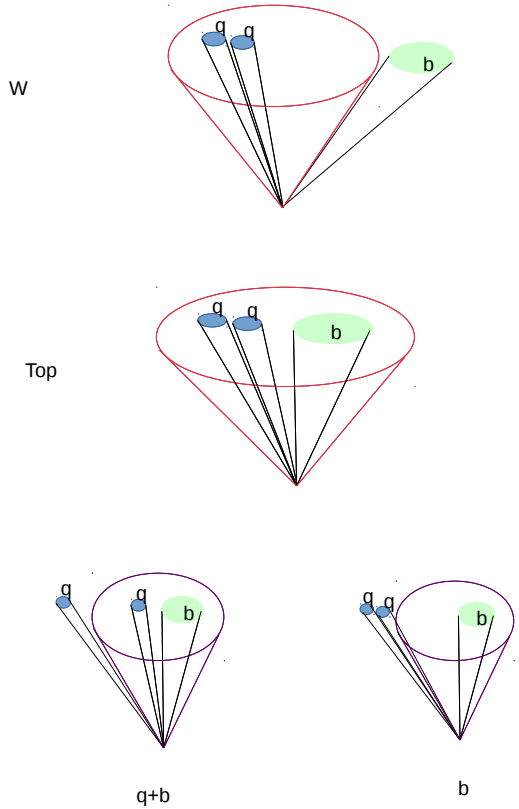


Results: research
Boosted objects

Large jets can be matched to different topologies, by looking to distance of light and bottom quarks from the jet axis.







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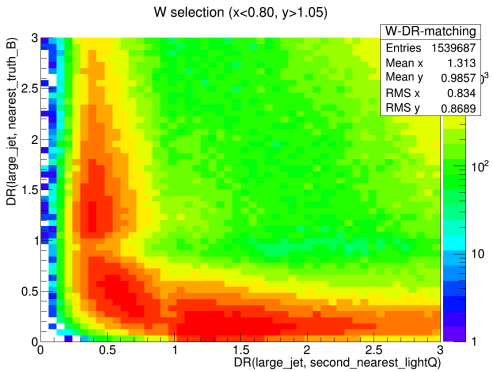
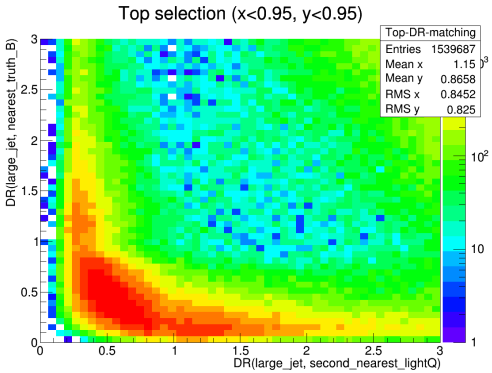
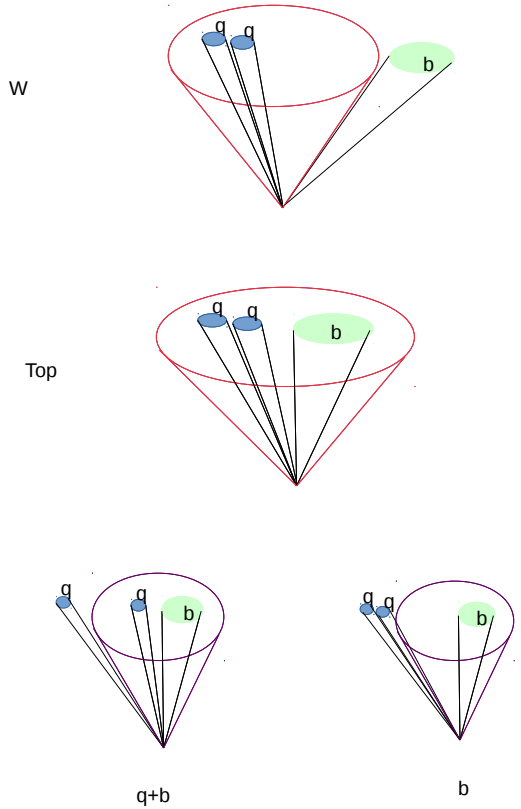
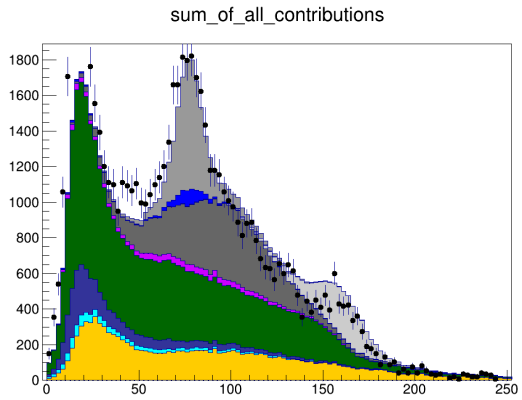


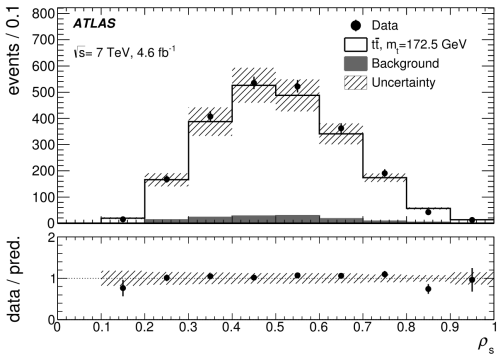


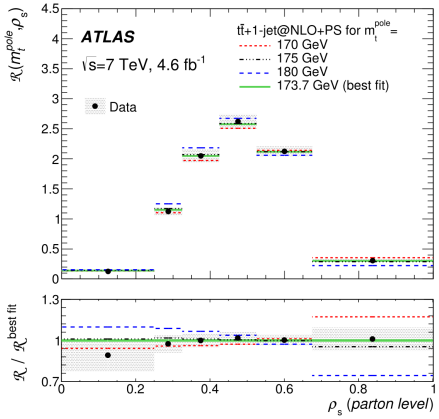


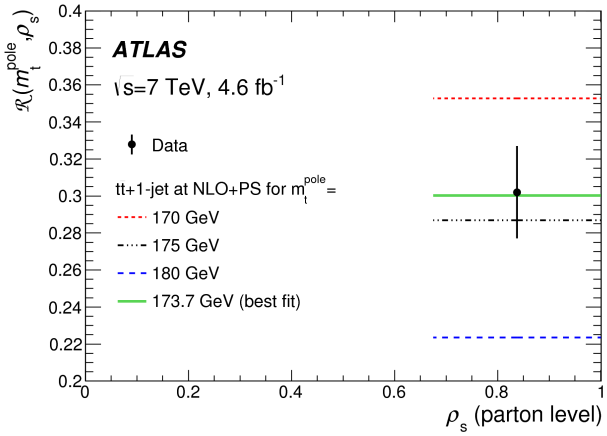


Results: research
Top pole mass (7TeV)

Can't show 8TeV results so far. These are the results of 7TeV analysis (arXiv:1507.01769).



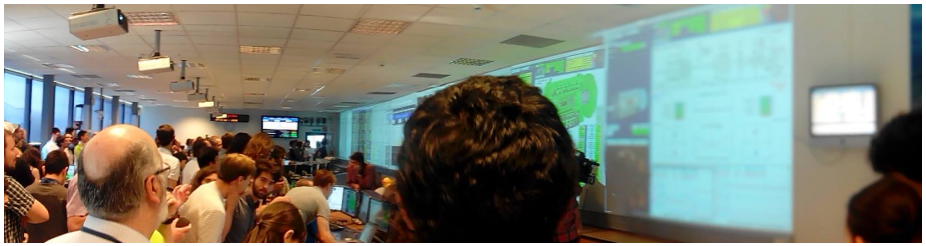




$$m_t^{\text{pole}} = 173.7 \pm 1.5(\text{stat}) \pm 1.4(\text{syst})^{+1.0}_{-0.5}(\text{theory})\ \text{GeV}$$

Trainings and conferences

ATLAS shifts in the Muons detector



Benasque high energy physics school (TAE 2015)

16:05 - 16:25 Run 2 in-situ JMS/R *20'*
Speaker: Davide Melini (Instituto de Fisica Corpuscular (ES))
JMR_MC15.pdf

16:25 - 16:45 Run 1 insitu JMS/R Update *20'*
Speaker: Jason Robert Veatch (University of Arizona (US))
jms_jmr_veatch_2...

16:45 - 17:05 JMS/R Discussion *20'*
Speaker: Ben Nachman (SLAC National Accelerator Laboratory (US))
Nachman_JetMas...

ATLAS JSS meetings

Outlook: research

Next steps:

- Obtain final result of pole mass top measurement at 8TeV.
  with the Valencia ATLAS group (P.Fernandez, J. Fuster, M.Vos)
- Precise simulations of the ttH signal with available tools
  in Granada (with R.Pittau)

Doing an analysis and receiving tainings in ATLAS will help in understanding the ttH signal at the LHC.
New tools (*boosted objects*) learned will be important when simulating the ttH process (future task of PhD).

Outlook: future carrer

Continue the academic career would be nice.

Apply boosted objects techniques to enhance the ttH and look for deviation to the SM in differential distribution will be interesting.

Private sector secondements could help in case of a b-plan.