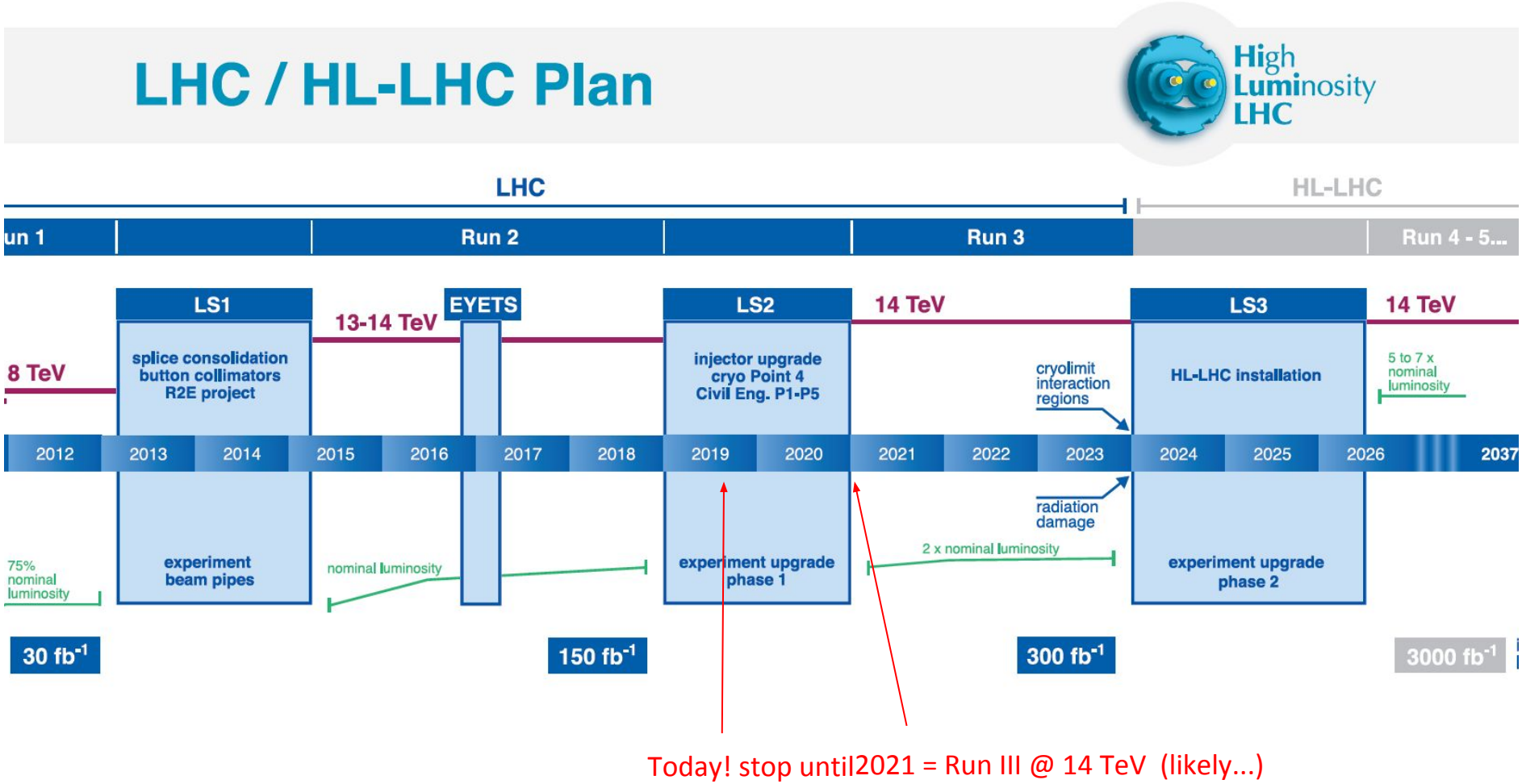
UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II

CMSNA Physics news, staus and plans

Analysis meeting 26/7/2019

Alberto Orso Maria Iorio

LHC plans



Today! stop until2021 = Run III @ 14 TeV (likely...)

Publication plans

Dataset:

- **All new analyses** now will have to be full-Run II
- Few exceptions for ongoing systematics dominated SMP and TOP analyses

Timelines:

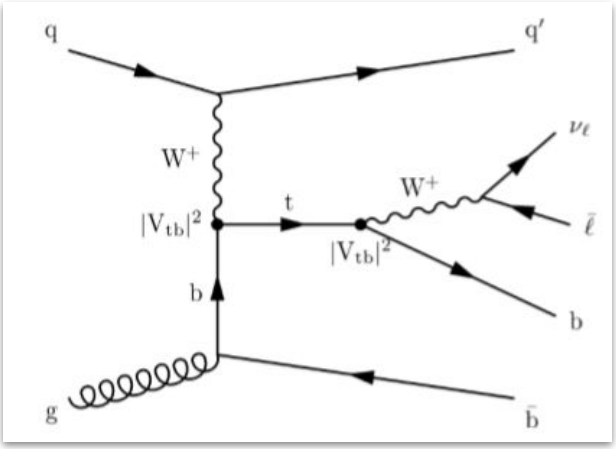
- **2020-early 2021** is the ideal timeline for Run-II papers.
- Early statistics with 2014 will be smaller → better try new stuff than reloading Run-II analyses!

Goal: complete our **line set of analyses by 2021**

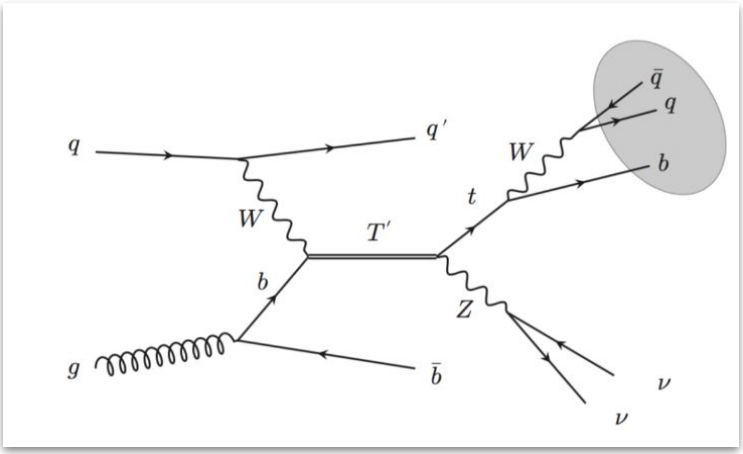
Prepare the ground with **new techniques and "analysis independent" ideas** for Run-III

CMS NA : Overview of the physics analyses

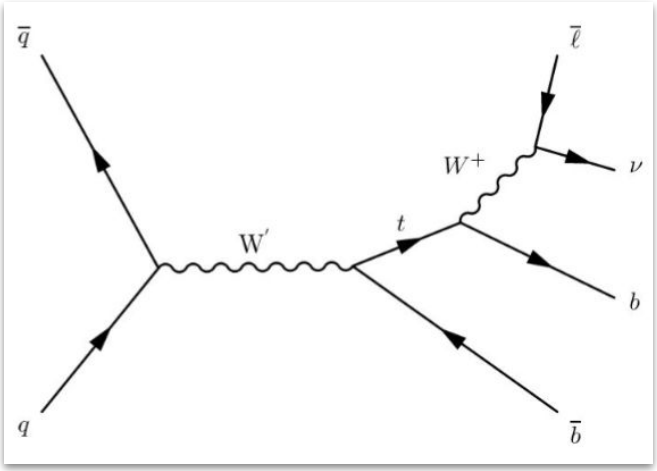
Standard model measurements: single top Vtb/d/s



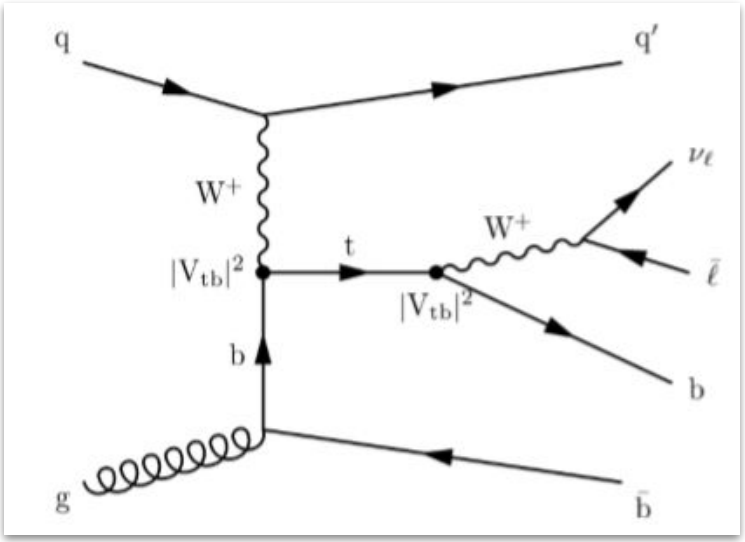
Vector like quarks: single T searches

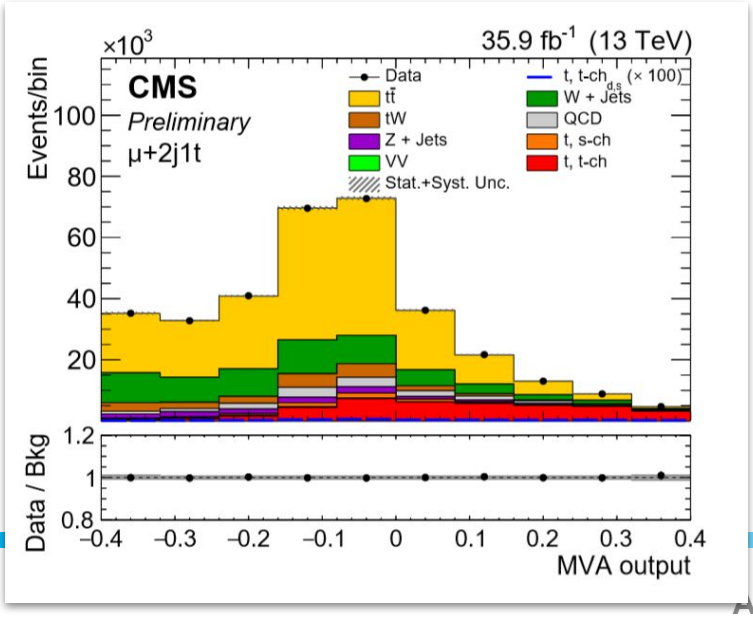


Heavy resonances: W' search



Single top quark *t*-channel





Measurement of Vtb/d/s with 2016 data:

- Currently reviewed by the ARC

- Solved most of the issues of physics.
→ PDF uncertainty now reduced,the result on |Vtb| is **more precise than the Run-I combination**

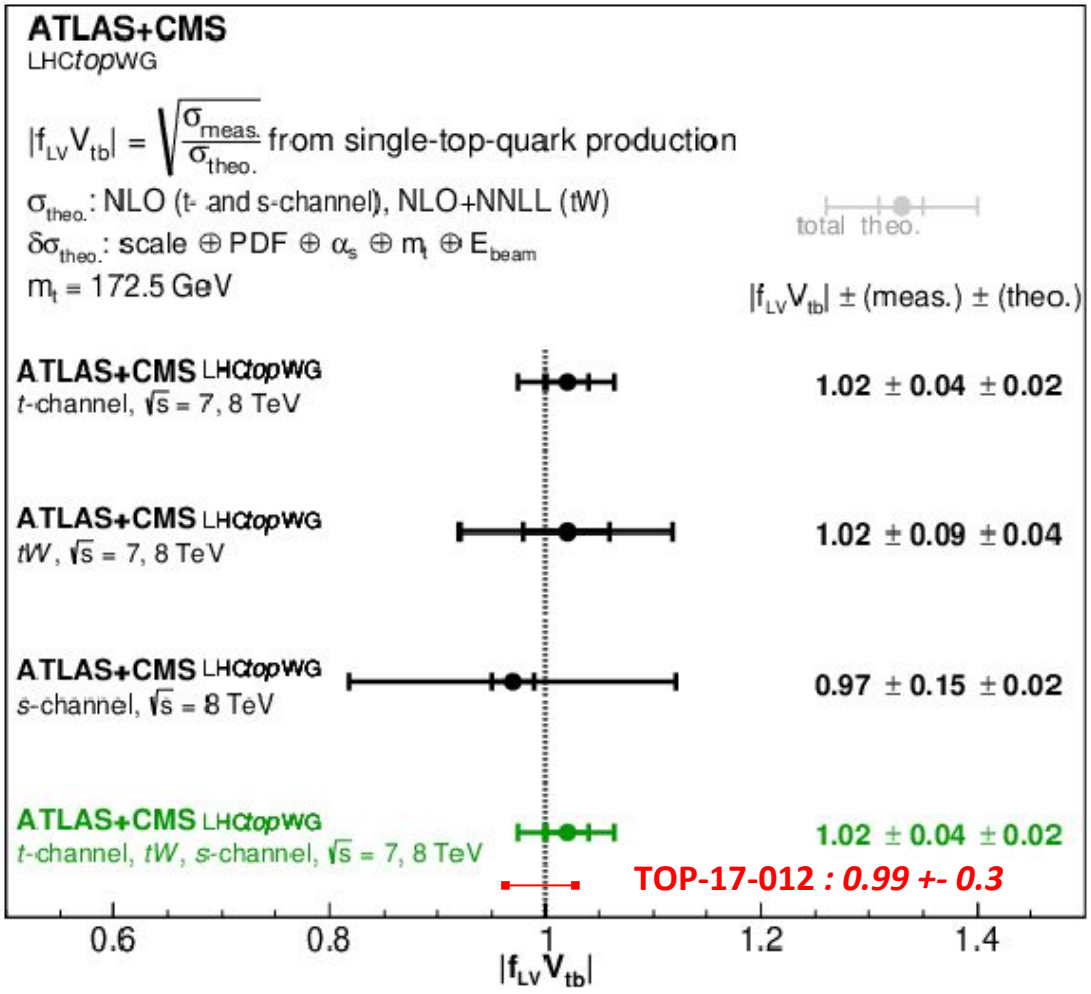
- Only issue remaining for publication: **constrained fit**
→ Requires some model building in combine
→ being cross-checked right now

CADI line: ***TOP-17-012***

Target: ***TOP 19!***

Agostino de Iorio, Lukas Layer, Luca Lista, O.I.

Single top quark *t*-channel



@Current stage: best **direct Vtb** measurement atm thanks to different assumptions wrt standard measurement

Main assumption: top decays only through W+quarks (e.g. SM case), or **other decays are very small in BR**.

Limits on Vtd/ts:

→ At the moment, some assumptions on |Vtd|/|Vts|

→ Low discriminating power wrt production.

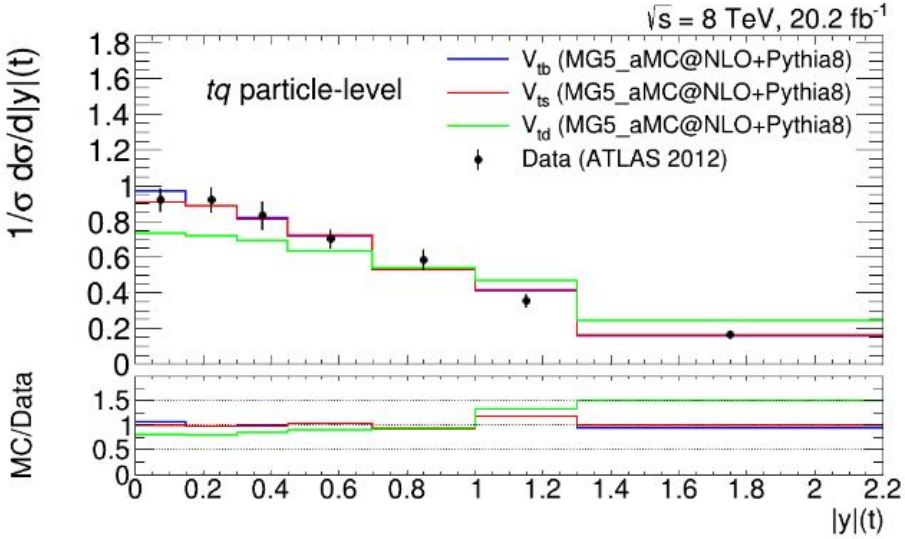
Limits on $|Vtd|^2 + |Vts|^2 < 0.2$

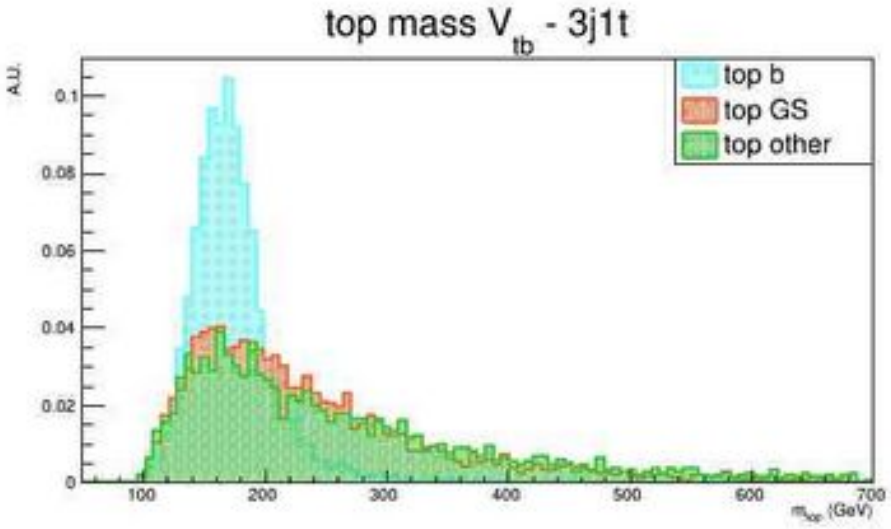
t-channel: future developments

Physics improvement goal: try and increase the power to measure of Vtd in production. See also this paper:

Systematics improvement: aim at reducing the syst. On modelling: ancillary measurements?

Statistics: adding full Run-II when ultra-legacy arrives





How?

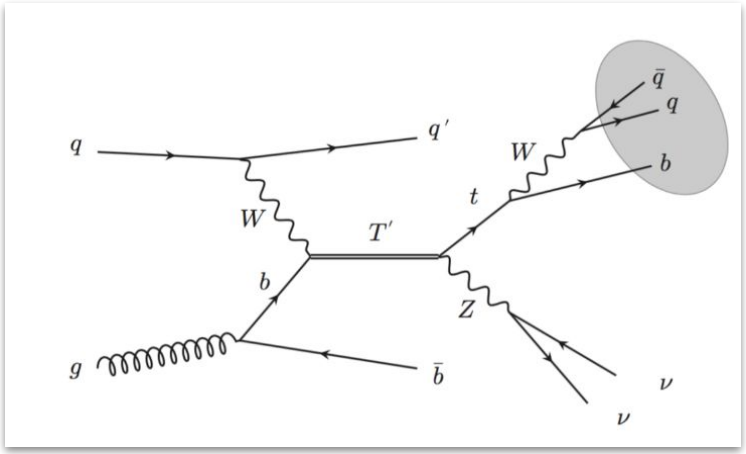
1) Leptonic top reconstruction:
Establish as strong as possible single-leptonic **top ID criterion (ML based)**.

2) Use in conjunction with S/B multi-classification: 3 signals + 2 main backgrounds.

3) New physics objects:
- PUPPI for pileup rejection
- DeepJet for b-tagging

Valeria D'Amante.

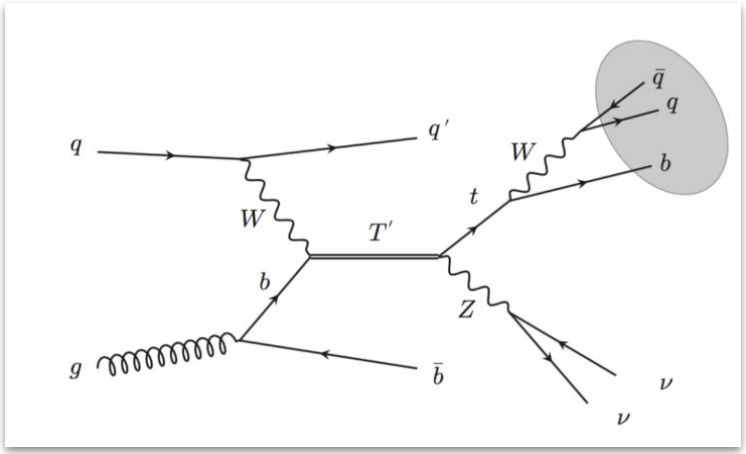
T' search:



- Hadronic top:
→ "standard" top tagging
→ relies on b-subjet

- Invisible Z (νν)
→ Transverse T' mass reconstr.

F. Fabozzi, Lukas Layer, O.I.



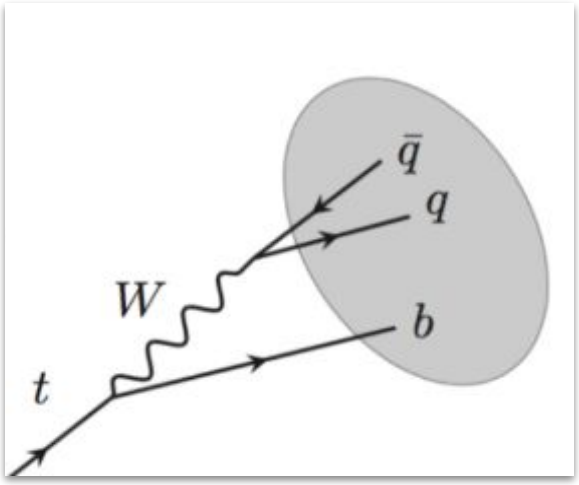
- Leptonic top:
→ lepton, b, neutrino
→ standard top quark reconstr.

- Hardonic Z or H (bb/qq)

Lorenzo Vigilante, Francesco Carnevali, O. I.

Single T' to t(had)Z(vv): Look at 2018 data

F. Fabozzi, O.I.



- Merged top quarks:
→ PUPPI AK8 Jet
→ 105 < SD mass < 220 GeV
→ Loose tau32 < 0.80
→ DeepCSV L subjet
2017 WP and SF, see JMAR page

OR

- Merged W jets (+ 1 b):
→ PUPPI AK8 Jet
→ 65 < SD mass < 105 GeV
→ Tight tau32 DDT < 0.43
2017 WP and SF, see JMAR page

AK4 jets definitions:

- Tight ID, defined here:
- DeepCSV jets: see here:

MET:

- MET: T1 corrected PF MET, see next slides

AN-2017/069

Target: ***END OF YEAR 19!***

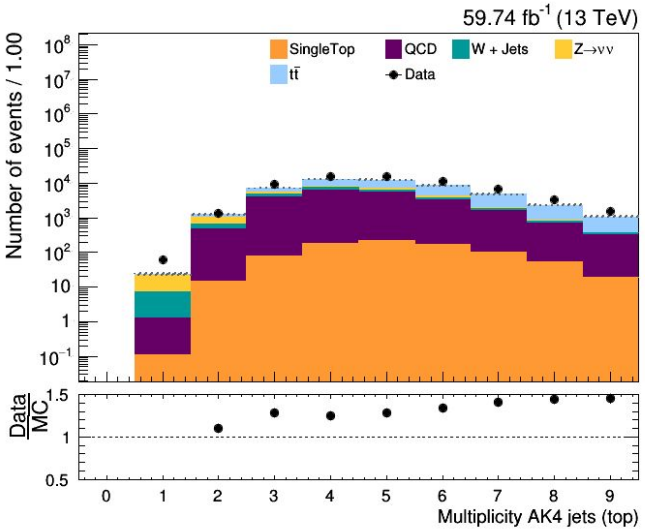
Plots at preselection level

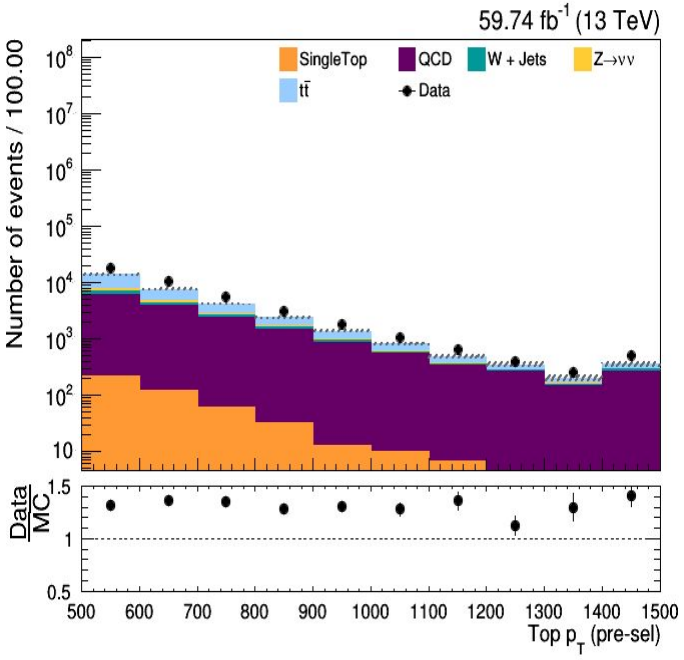
Preselection:

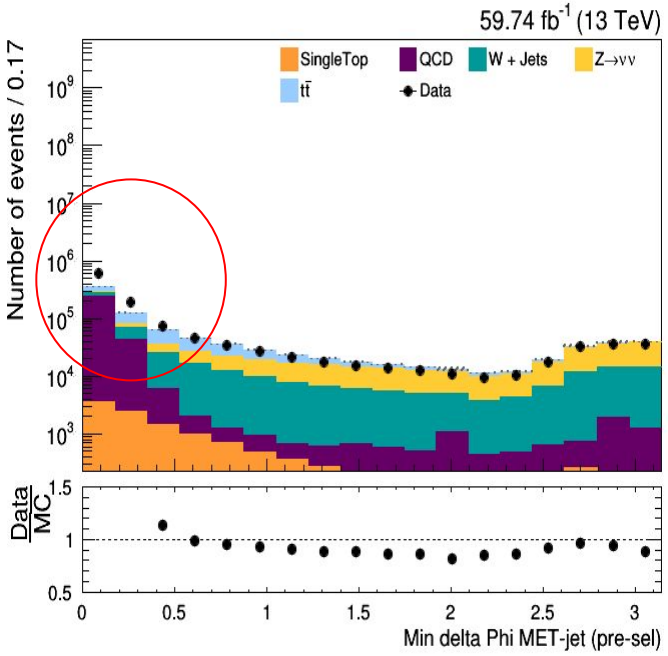
- MET > 200 GeV
- 1 AK8 Jet , Pt > 200 GeV.
- 0 loose muons or veto electrons.

Some difference concentrated in the **QCD-like** regions.**Why?**

- *Reason: abundance of QCD because of MET - phi issue*







MET phi at preselection level

MET at preselection:

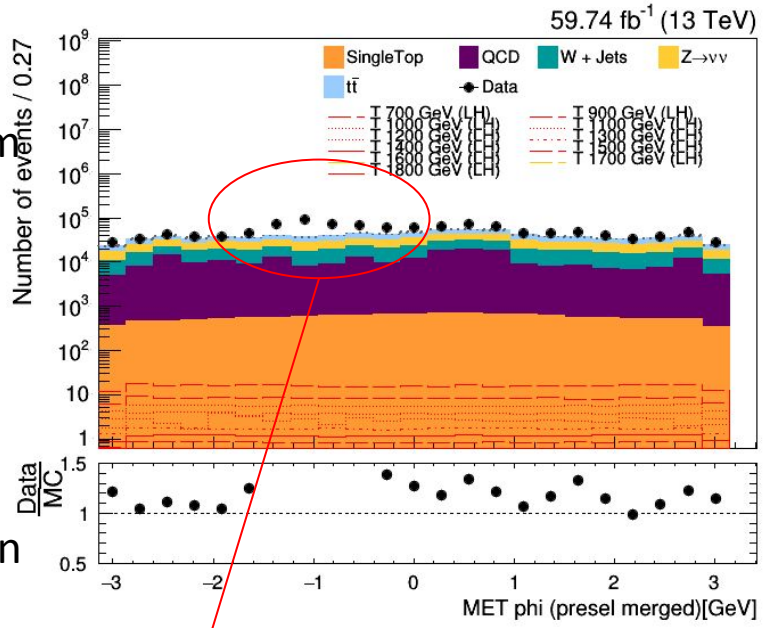
- Suffering from the **failure of a HEM module** from Run 319007 onwards

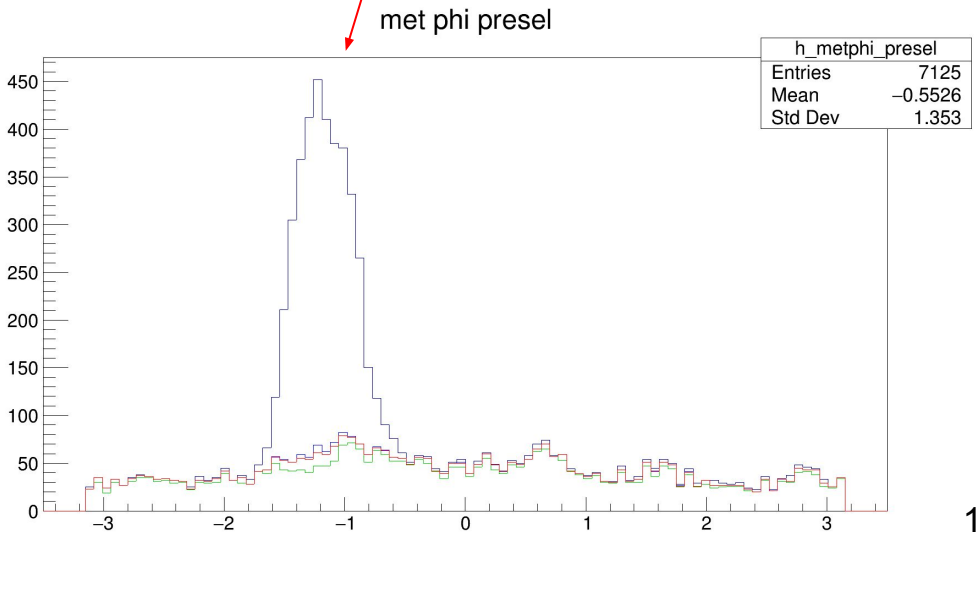
→ There is a hole in the detector!

Adopted solution:

→ removing events with activity in the HEM region

-3.05 < h < 1.35 ; 1.4 < phi < -0.8





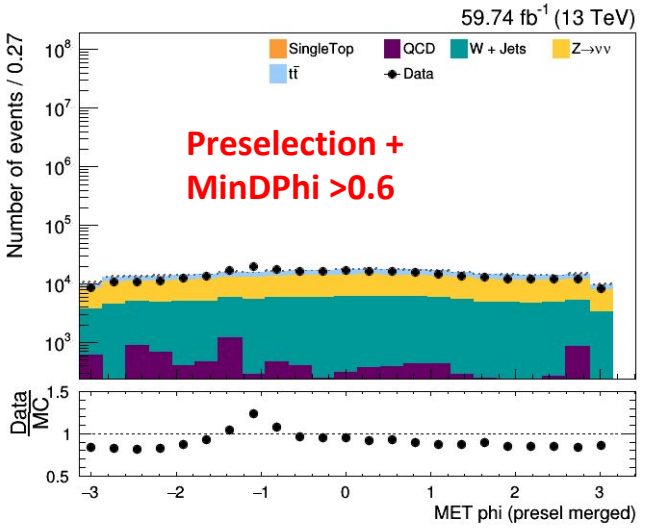
MET Phi after different cuts downstream:

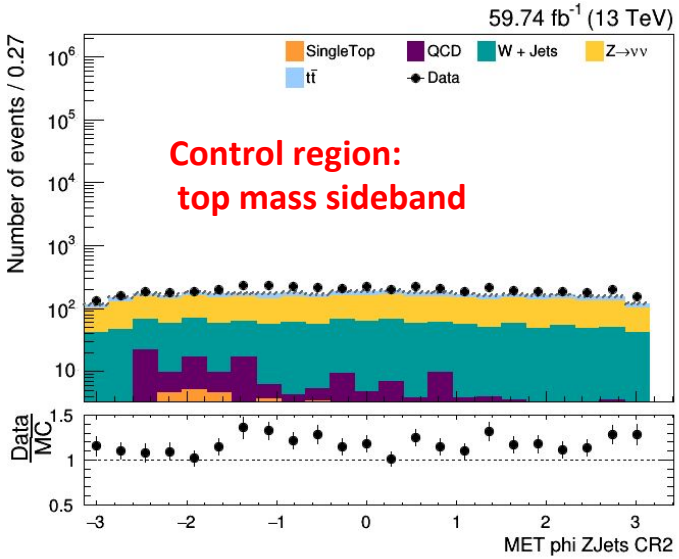
Suffering from some MET XY modulation issues

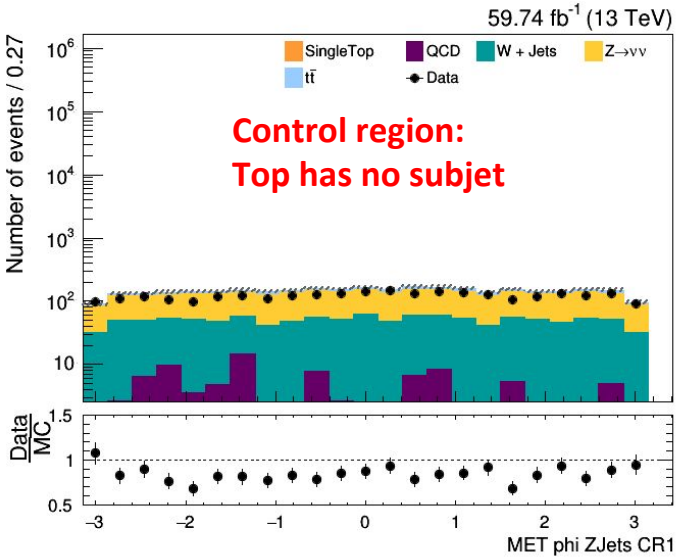
→ cutting in dphi helps reducing the modulation.

After dphi: modulation removed, still some peak

ZJets CR: top mass sideband (left) some structure, Much better in 0 b-subjet sideband (right)

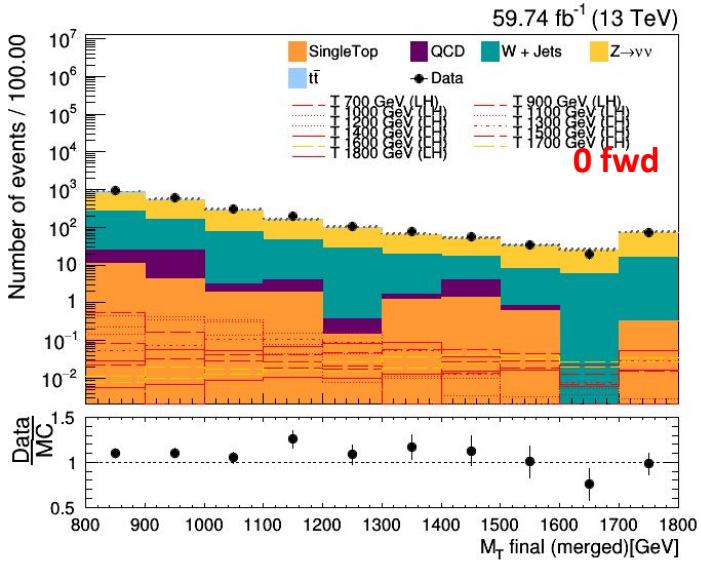


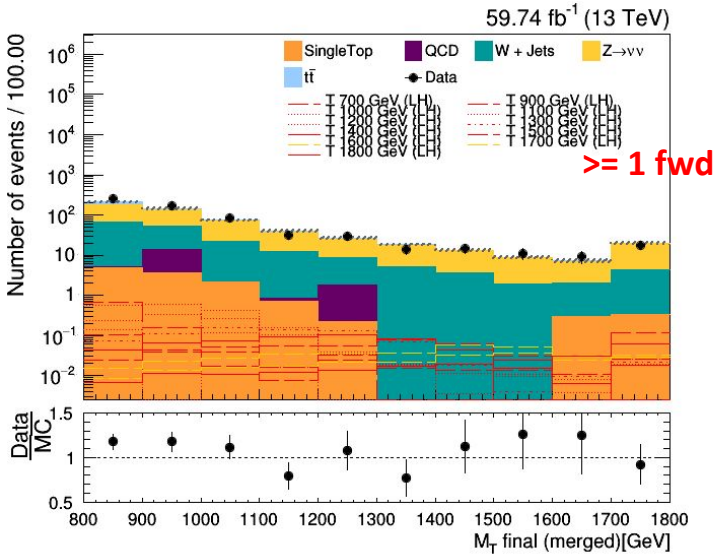




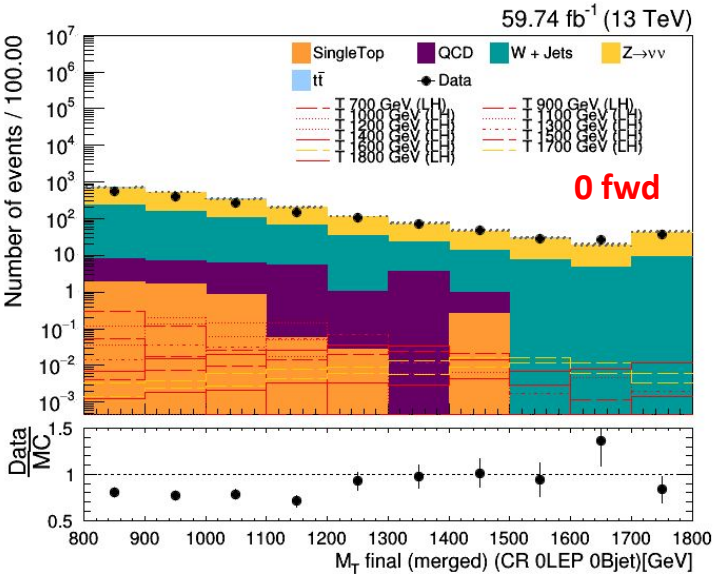
MT in Z+jets control regions, 2018

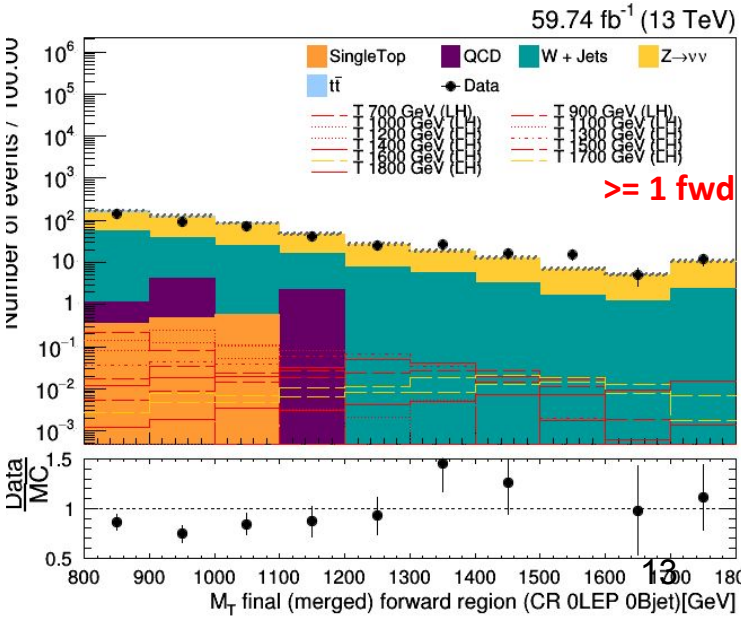
Top mass sideband:



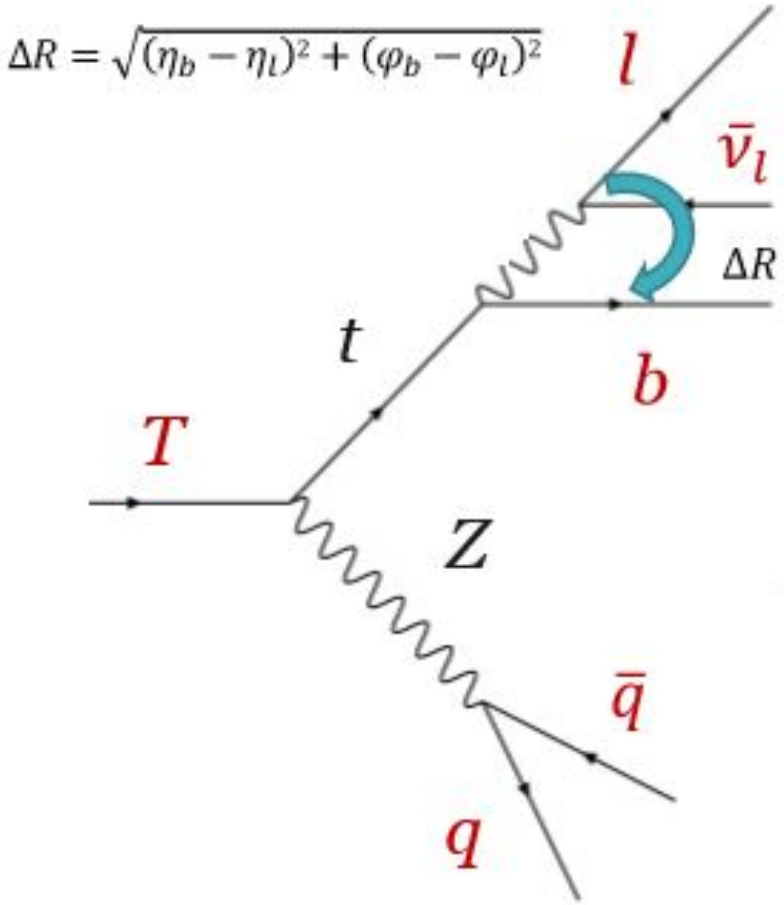


0 b-top subjets





Single T' to t(lep)Z(had):



- Leptonic top quarks

→ b-jet, lepton and neutrino close by

→ Reconstruction: resolved only cases considered!

→ Improvement possible at high mass

- Merged Z jets:

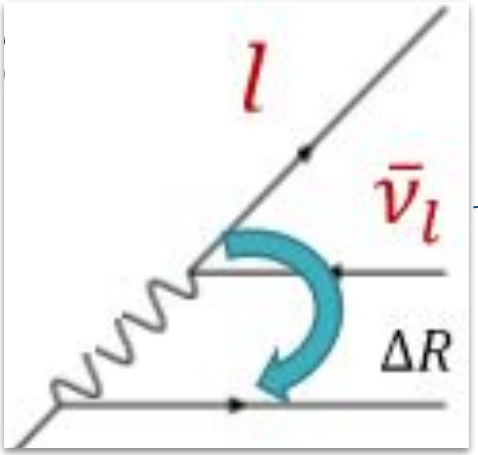
→ PUPPI AK8 Jet

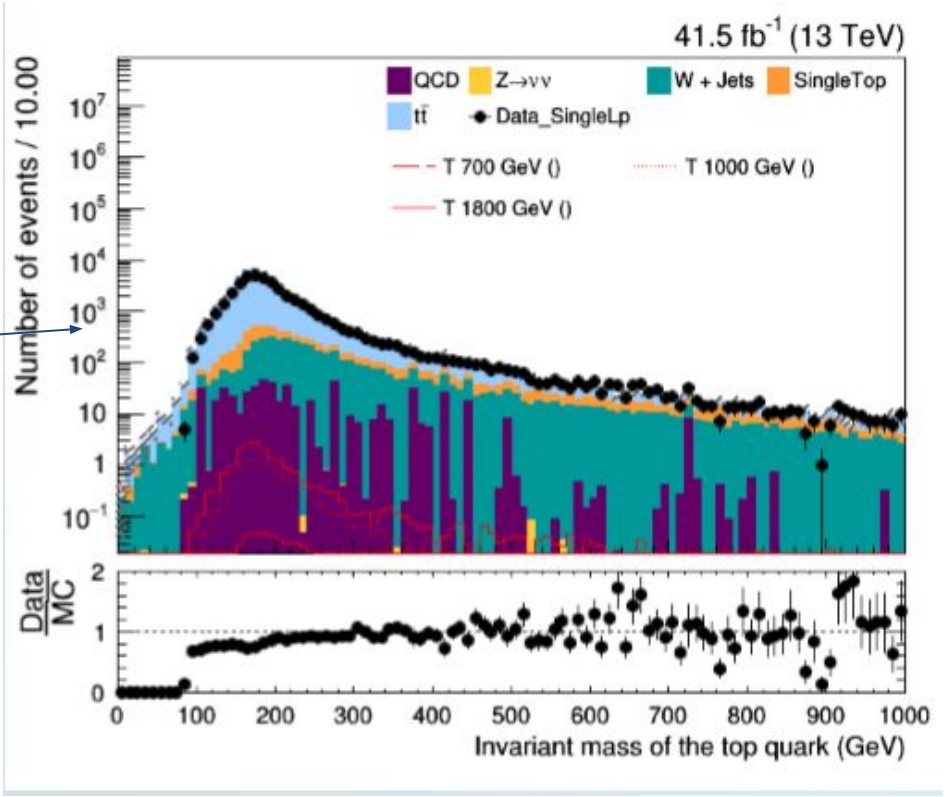
→ 65 < SD mass < 105 GeV

→ tau21 DDT < 0.45 (tight) / 0.6 (loose)

Single T' to t(lep)Z(had):

Lorenzo Vigilante



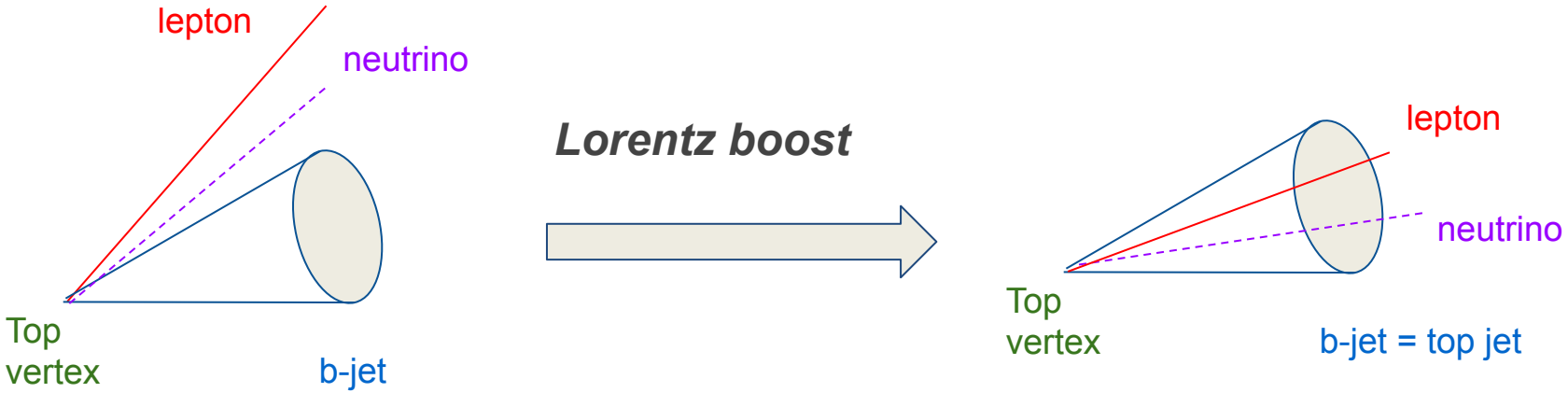


- Best top selected according to chi2 on top mass

→ Limitation: b-jet and lepton are produced close by: low acceptance at high mass!

Single T' to t(lep)Z(had): future improvements

Francesco Carnevali



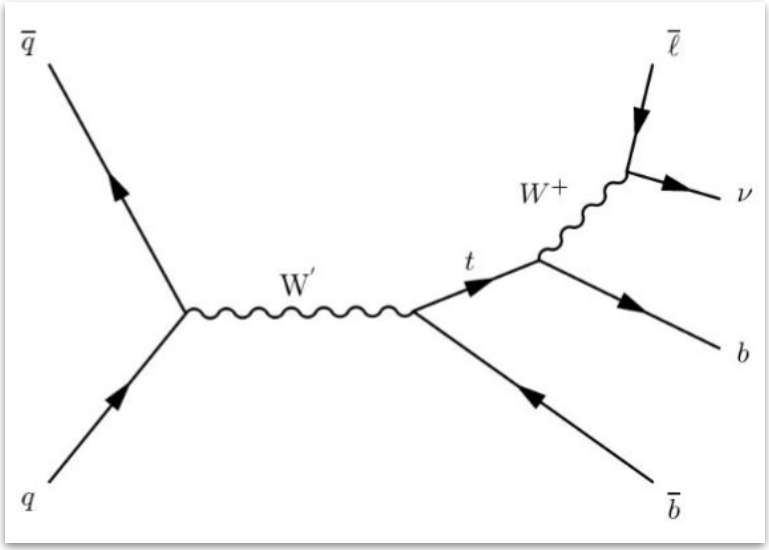
→ High momentum : lower efficiency of leptons due to overlap with b-jets!

→ Improvement by considering leptons INSIDE jets

→ Clustering of top-b jets

W' search

Agostino de Iorio, Andrea Piccinelli, O.I.



→ High momentum : lower efficiency of leptons due to overlap with b-jets, same as T'

→ Lower b-tagging efficiency: recover with non b-tagged events.

→ Effort on modelization needed

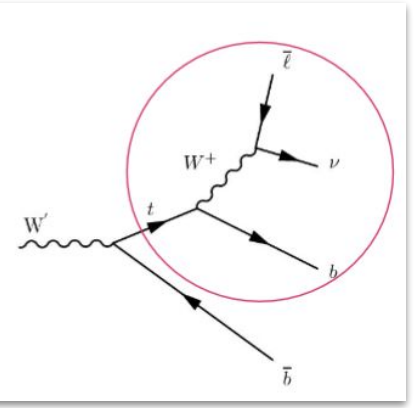
W' search: best top quark - b jet combo

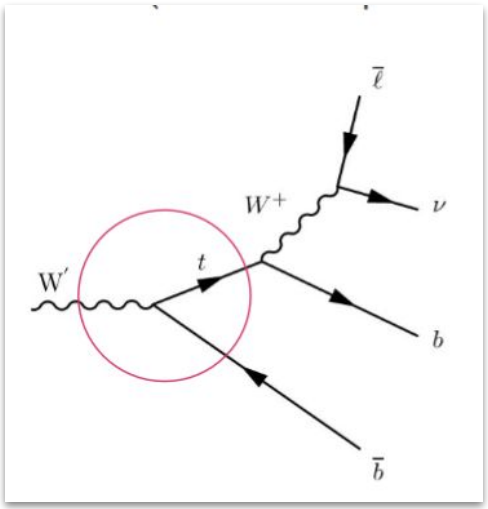
Andrea Piccinelli

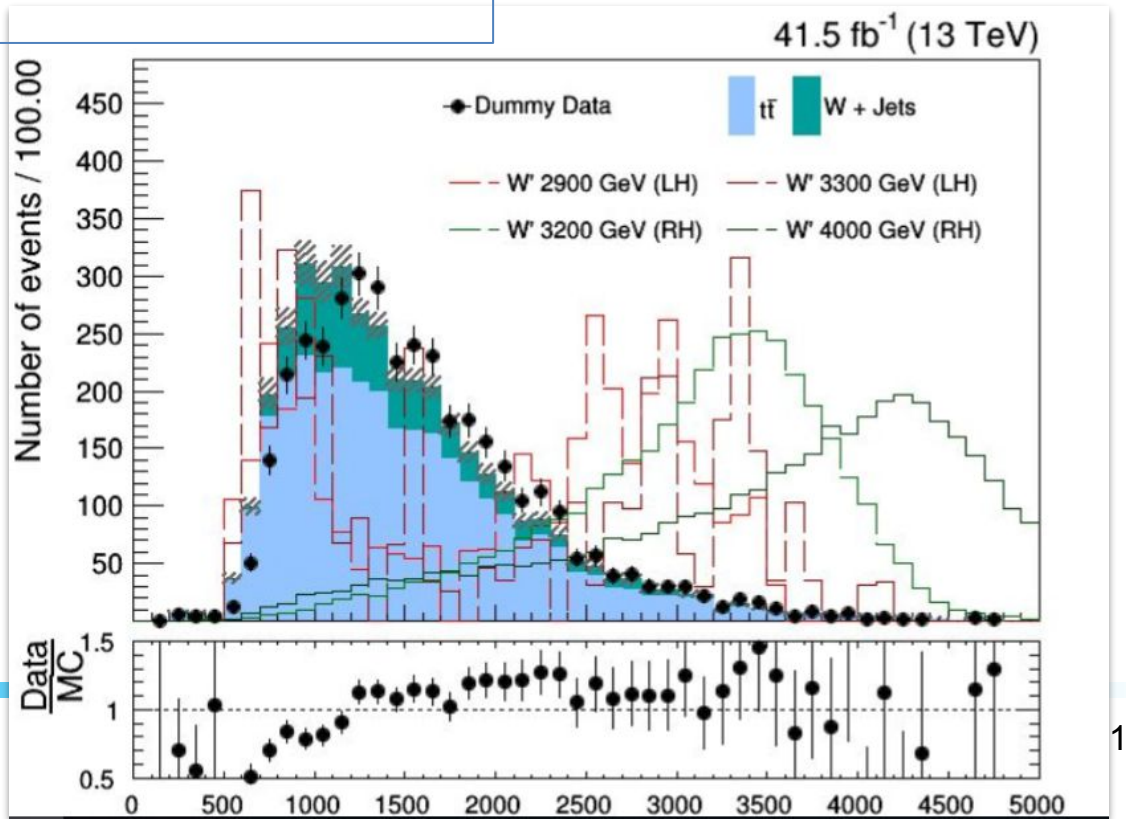
Best top : the one with min DR from the MET

Best b for W: the one with highest PT

W mass: reconstructed from the 4 momenta of top-b jet



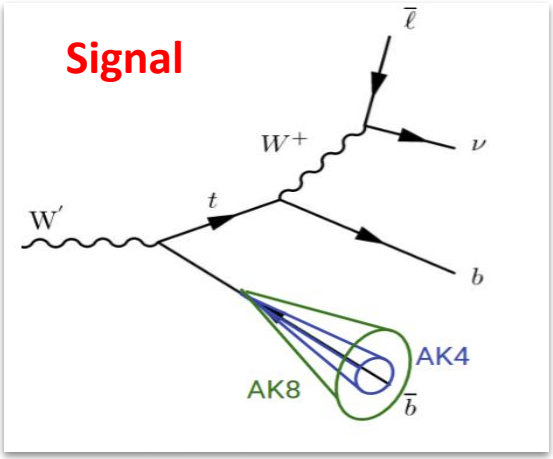


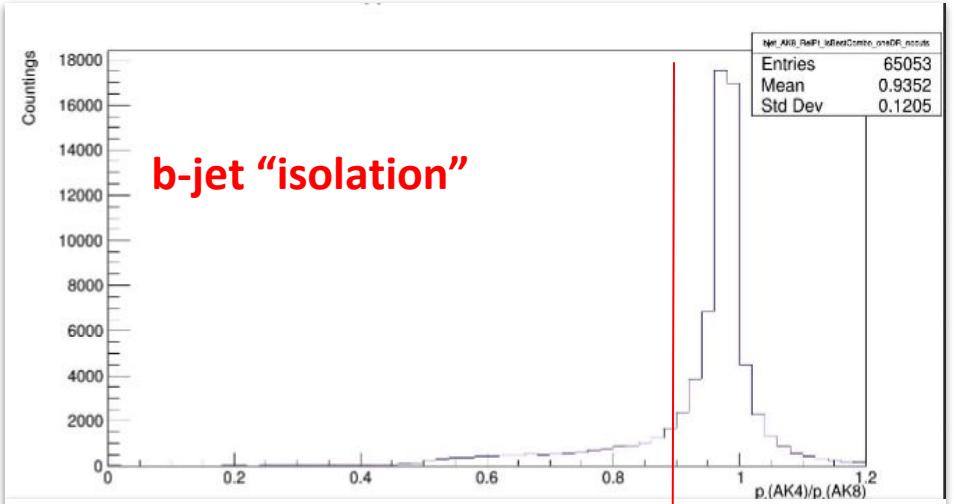


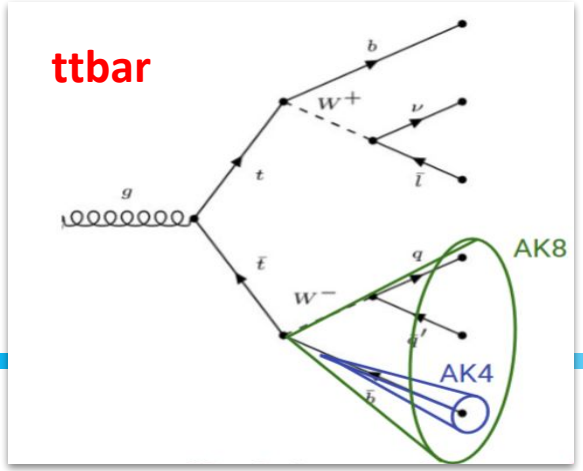
W' search: optimisation and top veto

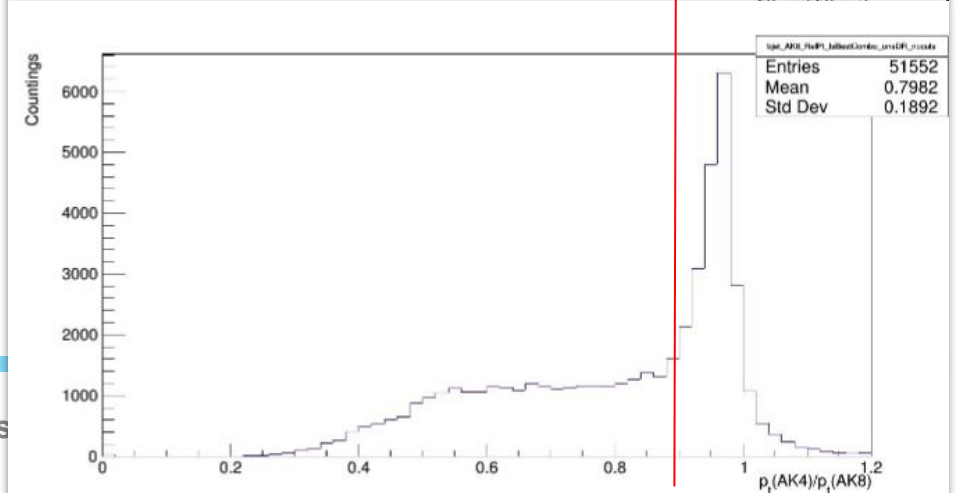
Andrea Piccinelli

Searching top quarks around the second b-jet: large radius AK8 jet around the small radius AK4 b-jet









W': modeling and relations with theorists

Agostino De Iorio

New simulation with wide width samples!

- possible "stealth" signature due to disappearance of mass peak

- New MC being developed by Agostino

Theorists in Naples will help in categorizing models with W' → tb final states

- Team of Prof. Rino Miele, Stefano Morisi, Damiano Fiorillo and new master student, Roberta Calabrese

Conclusions

Several synergies across analyses

- Leptonic top tagging and selection at low / high mass

- Multi-dimensional fits with constraints useful for complex modelling

- First round of measurements finishing this year.

→ Second generation of papers can profit of Machine Learning discriminants for significant improvements!