Preliminary study for ttbar resonance search in dilepton channel and performance of muon reconstruction close to jets in ATLAS

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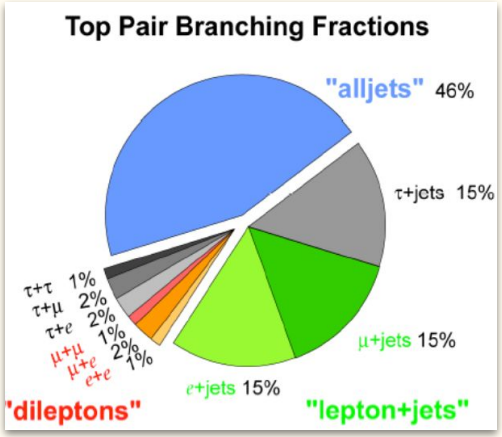
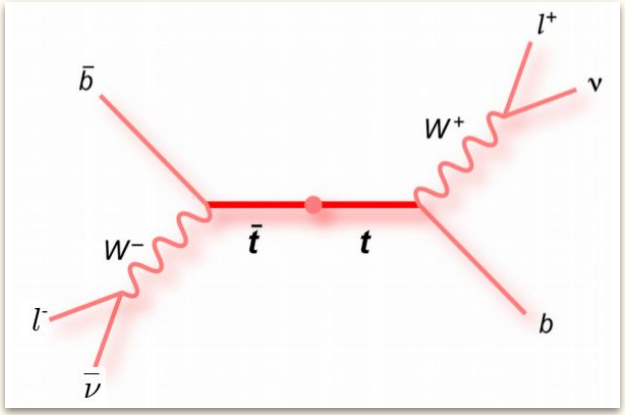
Overview

- Introduction to ttbar resonance;
- Preliminary studies about the analysis;
- Introduction to reconstruction efficiency for muons close to jets;
- Reco efficiency using J/Ψ events;
- Summary.

Introduction to ttbar resonance

My PhD analysis consist of the study of the ttbar resonance in dilepton channel. Including the tau leptonic decay, is only the ~7% of the total Branching Ratio (BR). Though the BR is small (low statistic), the channel is very clean (low background).





The resonance study is useful to search Beyond Standard Model (BSM) phenomena.

- Dilepton channel is more sensitive to variations of spin correlation;
- Various signal of new physics change the spin correlation near the resonance.

Idea: combine invariant mass mtt or a transverse mass proxy (to be studied) and the spin correlation (e.g. $|\Delta\varphi|$).

Preliminary studies: event selection

Electron selection:

- Pt $>$ 25 GeV;
- $|\eta| < 2.5$ exluding $1.37 < |\eta| < 1.52$.

Muon selection:

- Pt $>$ 25 GeV;
- $|\eta| < 2.5$.

Jet selection:

- Pt $>$ 25 GeV;
- $|\eta| < 2.5$;
- anti-kt R $= 0.4$.

For all : MET > 60 GeV

For these selection:

- Signal: ttbar
- Background: Diboson, Z+Jet and single top

Preliminary studies: Data and MC

We use data 2015+2016 (36.5 fb-1) → + 2017 (~80 fb-1)

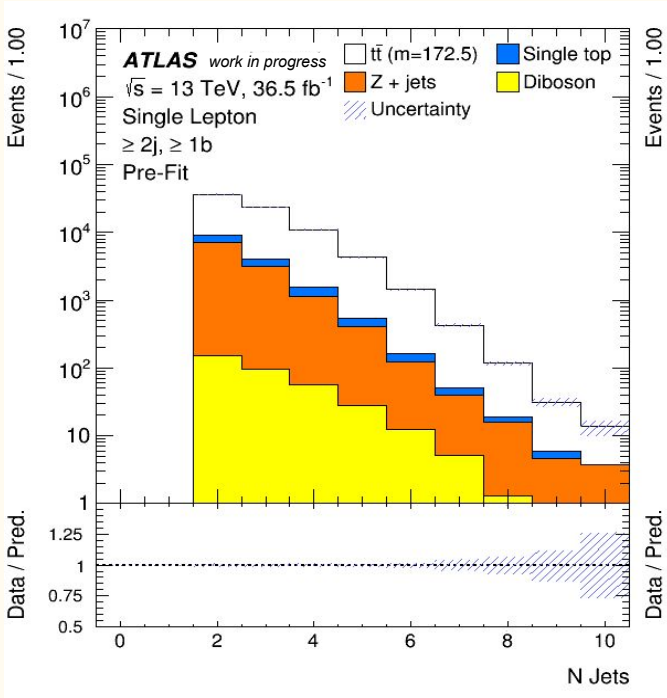
Simulations:

- **ttbar** production is simulated using POWHEG +PYTHIA8;
- **Diboson** and **Z+jets** productions are simulated using SHERPA NLO;
- **Single top** production is simulated using POWHEG +PYTHIA6.

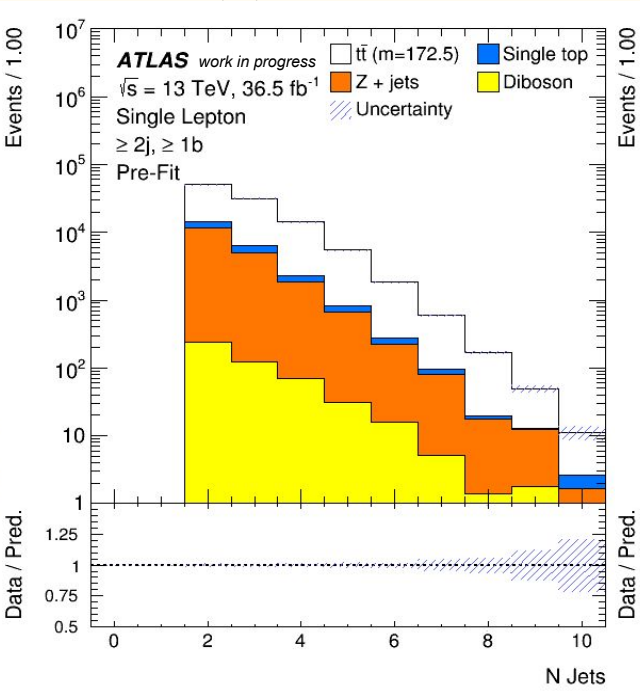
Preliminary studies: studies on kinematics I

Distribution of the number of jets in different samples.

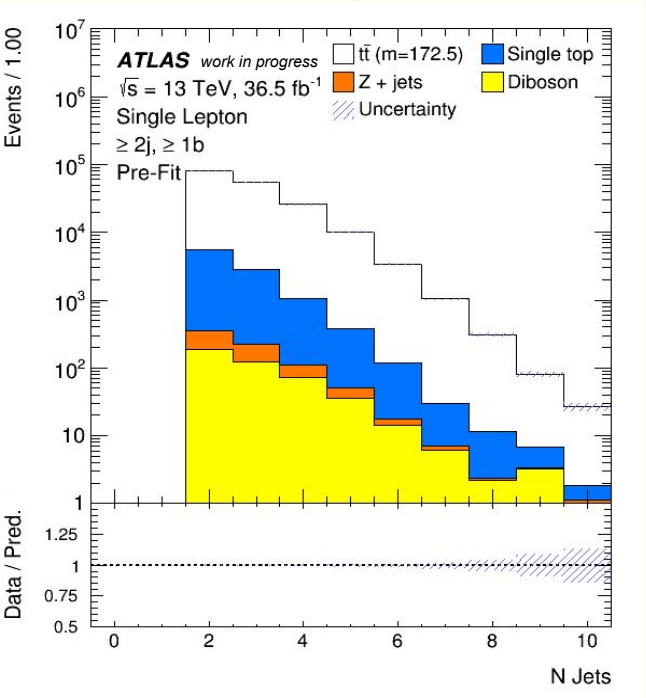
el-el



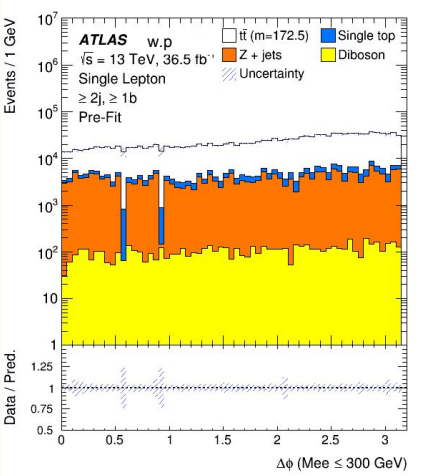
μ-μ

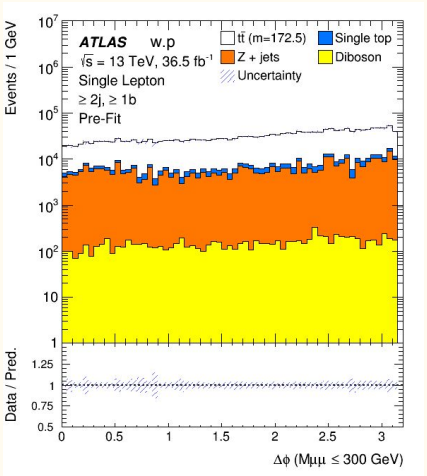


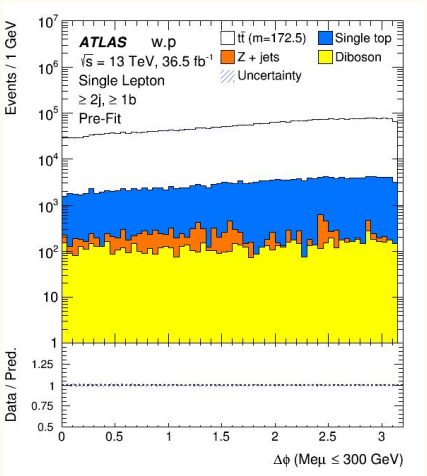
el-μ

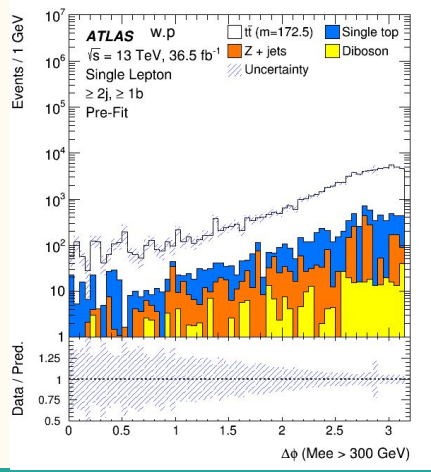


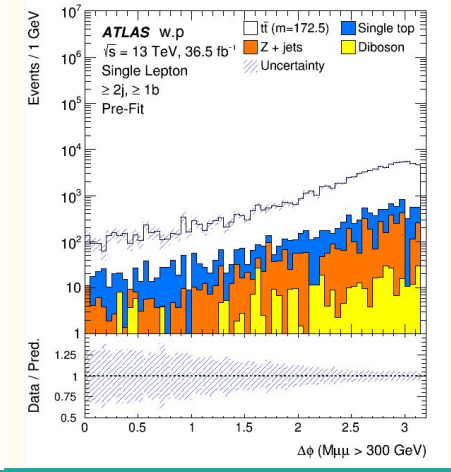
Preliminary studies: studies on kinematics III

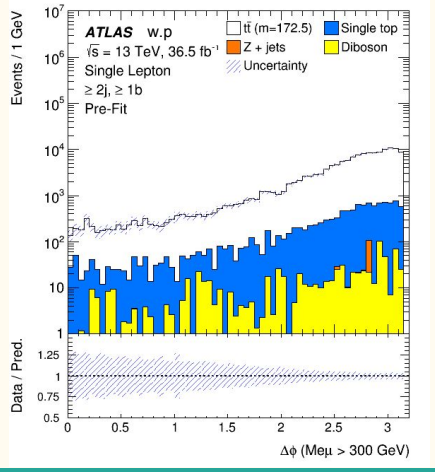












Resp. el-el, μ-μ and el-μ

$\Delta\varphi$ (mll $<$ 300 GeV)

(mll is the invariant mass of the two charge leptons in the dilepton final states)

$\Delta\varphi$ (mll $>$ 300 GeV)

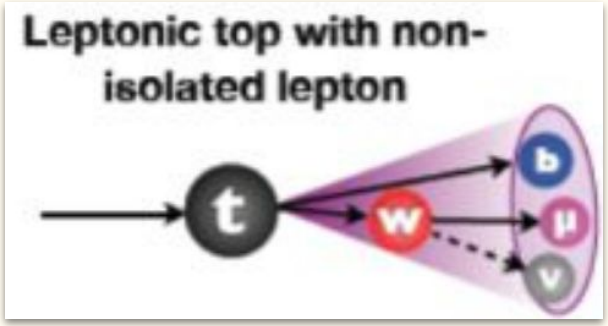
Next steps

- Include neutrinos and b-jets in the channel to measure the invariant mass of ttbar events;
- Evaluate sensitivity to BSM signals with MC and simplified analysis;
- Choose the good variable (or combination);
- Only when full analysis model (including all systematic uncertainties) in place, compare simulations and data to see if there is any change in the spin correlation → BSM?

Introduction to reconstruction efficiency

Other work that I did involved the study of the reconstruction efficiency for muons close to jets. Muons are very useful for a lot of measurements and analysis.

Muons close to jets are used in some analysis that use muon information inside jets, for example this study will be useful for the ttbar resonance analysis, because for high ttbar invariant mass the leptons will be close to the b-jets (jets with bottom quark).



The reconstruction efficiencies are made using the Tag&Probe method with J/Ψ samples. The method is based on the selection of an almost pure muon sample from $J/\Psi \rightarrow \mu\mu$ events, requiring one leg of the decay (tag) to be identified as a muon that fires the trigger and the second leg (probe) to be reconstructed by a system independent of the one being studied.

This study is performed with the Muon Combined Performance (MCP) group.

Muons close to jets: Selections

Tag selection:

- Pt $>$ 4 GeV;
- $|\eta| < 2.5$;
- matched with the trigger.

Probe selection:

- Pt $>$ 4 GeV;
- $|\eta| < 2.5$;
- $2.7 <$ m(tag-probe) < 3.5 GeV;
- ΔR(jet, probe) < 0.4 .

The regions of three variables under study for muon close to jets:

pt : ptvarcone30/pt > 0.06

Et : topoetcone20/pt > 0.06

ΔR(jet, probe) : $0 < \Delta R < 0.2$ and $0.2 < \Delta R < 0.4$

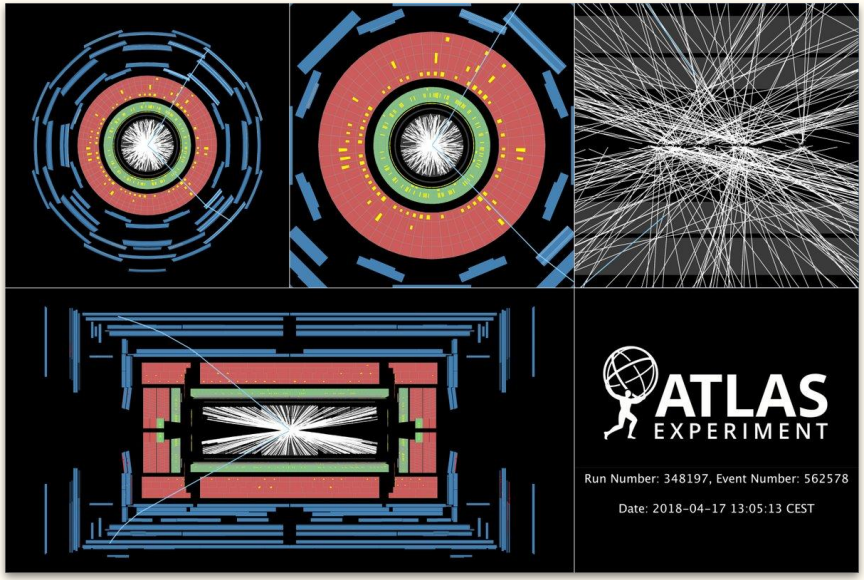
Where $\Delta R = \sqrt{\Delta\eta^2 + \Delta\varphi^2}$; ptvarcone30 is the pt of the tracks near the muons in a cone of $\Delta R = 0.3$ and topoetcone20 is the transverse energy of the tracks near the muon in a cone of $\Delta R = 0.2$.

Muons close to jets: Selections II

Total recostuction efficiency for muons with Medium quality:

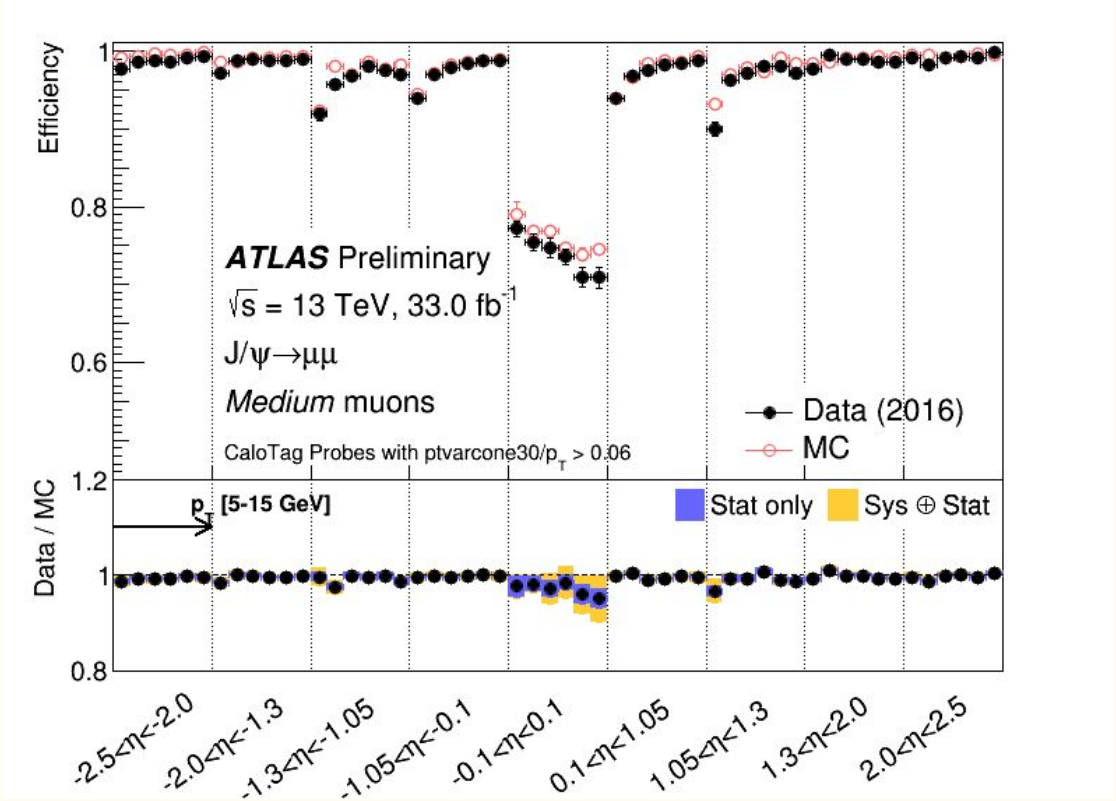
ε(Medium) = ε(Medium|CP) * ε(ID|MS) Labeled as “CaloTag probes”

Where “Medium” is a kind of muon selection that minimises the systematic uncertainties associated with muon reconstruction and calibration; CP (Calo Probes) are the Inner Detector (ID) tracks tagged as muons by the calorimeter deposit; MS are the probe muons in the Muon Spectrometers.



Muons close to jets I

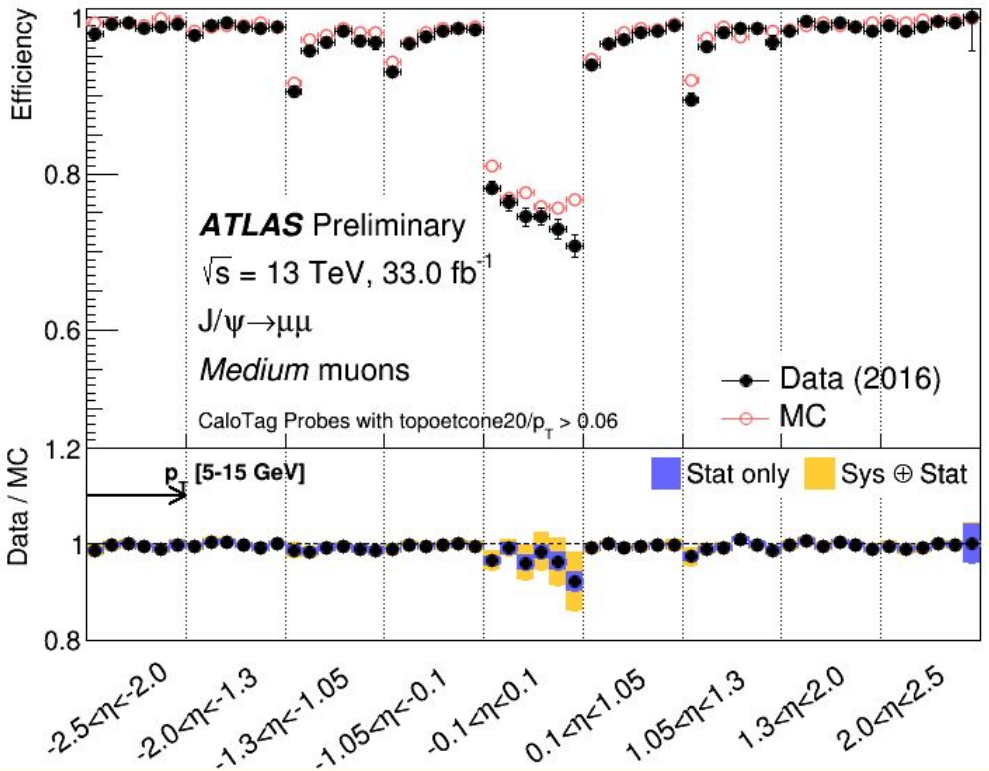
Reco efficiencies in region ptvarcone30/pt(probe) > 0.06



This studies have been compared to isolated muons and this comparison is consistent with the total P(χ^2) (within the statistical errors).

Muons close to jets II

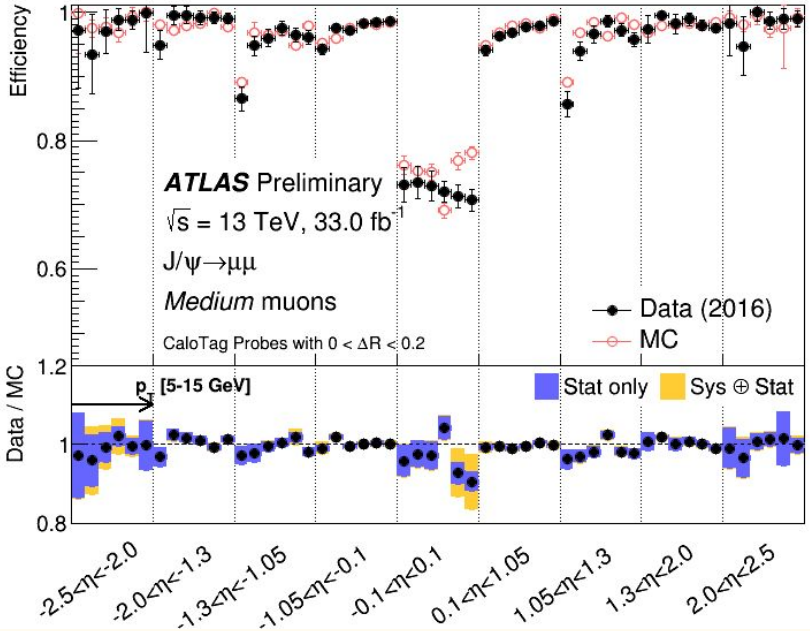
Reco efficiencies in region topoetcone20/pt(probe) > 0.06

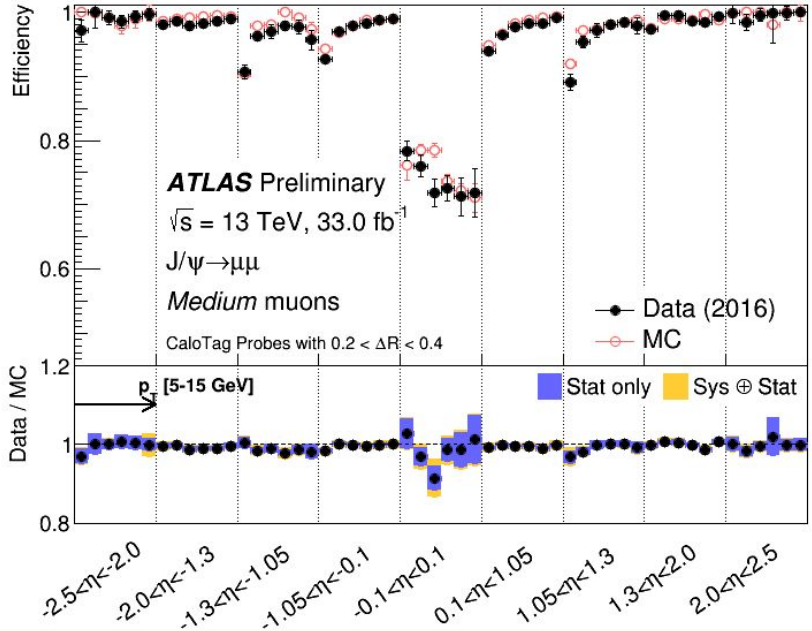


This studies have been compared to isolated muons and this comparison is consistent with the total P(χ^2) (within the statistical errors).

Muons close to jets III

Reco efficiencies in region $0 < \Delta R < 0.2$ (left) and $0.2 < \Delta R < 0.4$ (right)





In region $0 < \Delta R < 0.2$ the shapes have big stat error. This is due to the fact that the MC doesn't have enough probes in this "high" non-isolated region.

This studies have been compared to isolated muons and this comparison is consistent with the total P(χ^2) (within the statistical errors).

Summary

- In some weeks will start the analysis of ttbar resonance in dilepton channel to search new phenomena BSM;

- First reconstruction efficiency for muons close to jets ever made in Muon Combined Performance group (ATLAS-CERN).