fake rate measurements using 2017 & 2018 re-reco

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HEEP + DiMuon Meeting

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2017 Dataset files

/SingleMuon/Run2017B-17Nov2017-v1/MINIAOD
/SingleMuon/Run2017C-17Nov2017-v1/MINIAOD
/SingleMuon/Run2017D-17Nov2017-v1/MINIAOD
/SingleMuon/Run2017E-17Nov2017-v1/MINIAOD
/SingleMuon/Run2017F-17Nov2017-v1/MINIAOD

- **Using the Muon Physics JSON file**
  Cert_294927-306462_13TeV_PromptReco_Collisions17_JSON_MuonPhys.txt

- **With recorded lumi: 41.9/fb (approved certified lumi)**

- **Triggers used for the main analysis:**

  HLT_Mu50_V*

2018 Dataset files

/SingleMuon/Run2018A-17Sep2018-v2/MINIAOD
/SingleMuon/Run2018B-17Sep2018-v1/MINIAOD
/SingleMuon/Run2018C-17Sep2018-v1/MINIAOD
/SingleMuon/Run2018D-22Jan2019-v2/MINIAOD

- **Using the Muon Physics JSON file**

Cert_314472-325175_13TeV_17SeptEarlyReReco2018ABC_PromptEraD_Collisions18_JSON_MuonPhys.txt

- **With recorded lumi: 61.3/fb**

- **Triggers used for the main analysis:**

HLT_Mu50_V*

Other MC samples “CMSSW94X”

All MCs are done with RunII Fall17 MiniAOD-94X

/WjetsToLNu_TuneCP5_13TeV-madgraphMLM-pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM

/TTTo2L2Nu_TuneCP5_13TeV-powheg-pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v2/MINIAODSIM

/WW_TuneCP5_13TeV-pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM

/WZ_TuneCP5_13TeV-pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM

/ZZ_TuneCP5_13TeV-pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM

/ST_tW_top_5f_NoFullyHadronicDecays_TuneCP5_13TeV-powheg-pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM

/ST_tW_antitop_5f_NoFullyHadronicDecays_TuneCP5_13TeV-powheg-pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM

/DYJetsToLL_M-50_TuneCP5_13TeV-madgraphMLM-pythia8/RunIIFall17MiniAOD-RECOSIMstep_94X_mc2017_realistic_v10_ext1-v1/MINIAODSIM

QCD MC samples “CMSSW94X”

/QCD_Pt_15to30_TuneCP5_13TeV_pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM
/QCD_Pt_30to50_TuneCP5_13TeV_pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM
/QCD_Pt_50to80_TuneCP5_13TeV_pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM
/QCD_Pt_80to120_TuneCP5_13TeV_pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM
/QCD_Pt_120to170_TuneCP5_13TeV_pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM
/QCD_Pt_170to300_TuneCP5_13TeV_pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM
/QCD_Pt_300to470_TuneCP5_13TeV_pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM
/QCD_Pt_470to600_TuneCP5_13TeV_pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM
/QCD_Pt_600to800_TuneCP5_13TeV_pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM
/QCD_Pt_800to1000_TuneCP5_13TeV_pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v2/MINIAODSIM
/QCD_Pt_1000to1400_TuneCP5_13TeV_pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM
/QCD_Pt_1400to1800_TuneCP5_13TeV_pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM
/QCD_Pt_1800to2400_TuneCP5_13TeV_pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM
/QCD_Pt_2400to3200_TuneCP5_13TeV_pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM
/QCD_Pt_3200toInf_TuneCP5_13TeV_pythia8/RunIIFall17MiniAOD-94X_mc2017_realistic_v10-v1/MINIAODSIM

Fake Rate definition

$$FR = \frac{\text{Nb. Of muon objects pass the high pt muon selection \& hlt trigger}}{\text{Nb. Of muon objects pass the FR pre-selection}}$$

→ **Definition of FR**

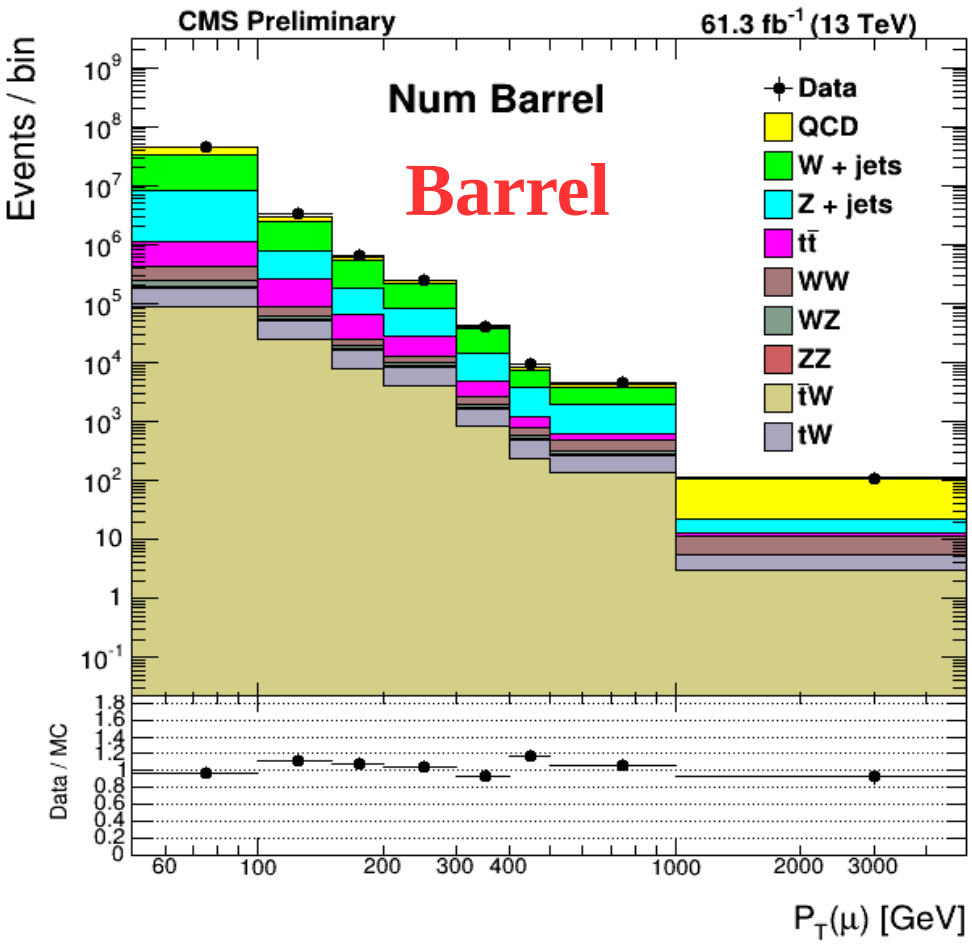
variable	cut value
is GlobalMu and is TrackerMu	true
$\lvert d_z \rvert$	< 1.0
$\lvert d_{xy} \rvert$	< 0.2
Nb. of Tracker Layers with Measurement	> 5
Nb. of Valid Pixel Hits	> 0

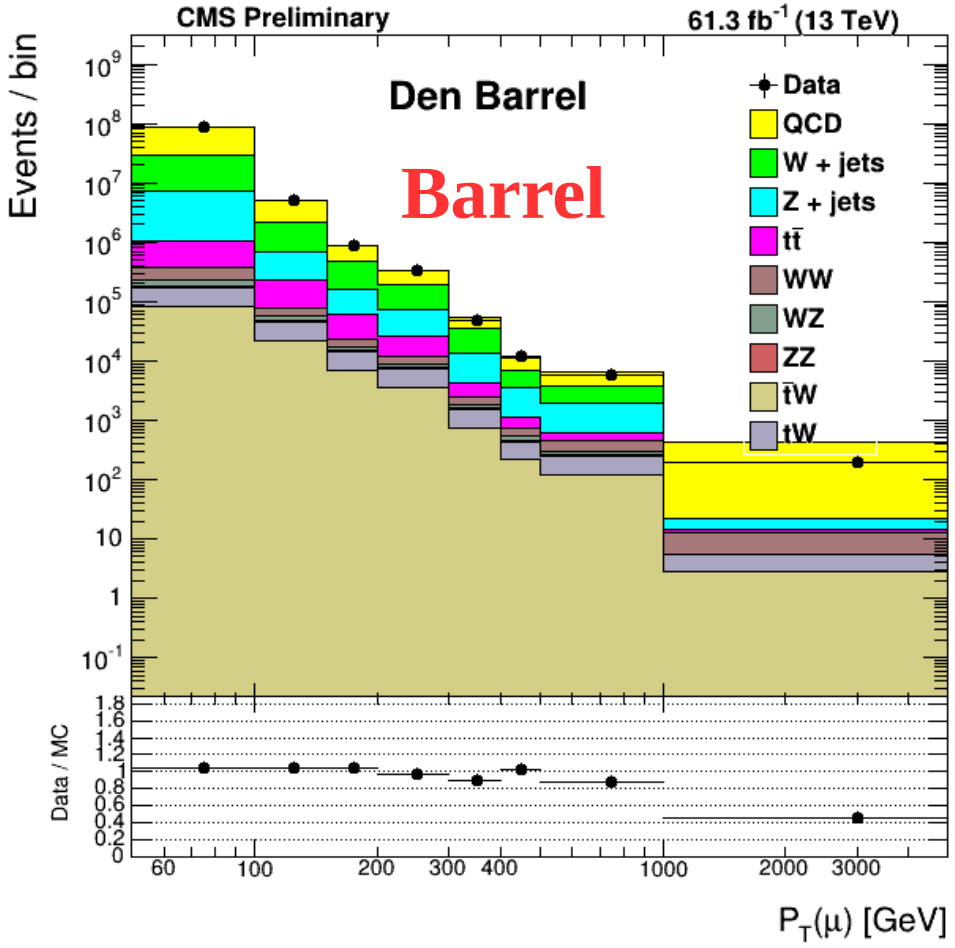
→ **FR pre-selection**

Table 5: The selection requirements to define the control region for the fake rate calculation.

Same method which has been used for
2015, 2016 , 2017 AN

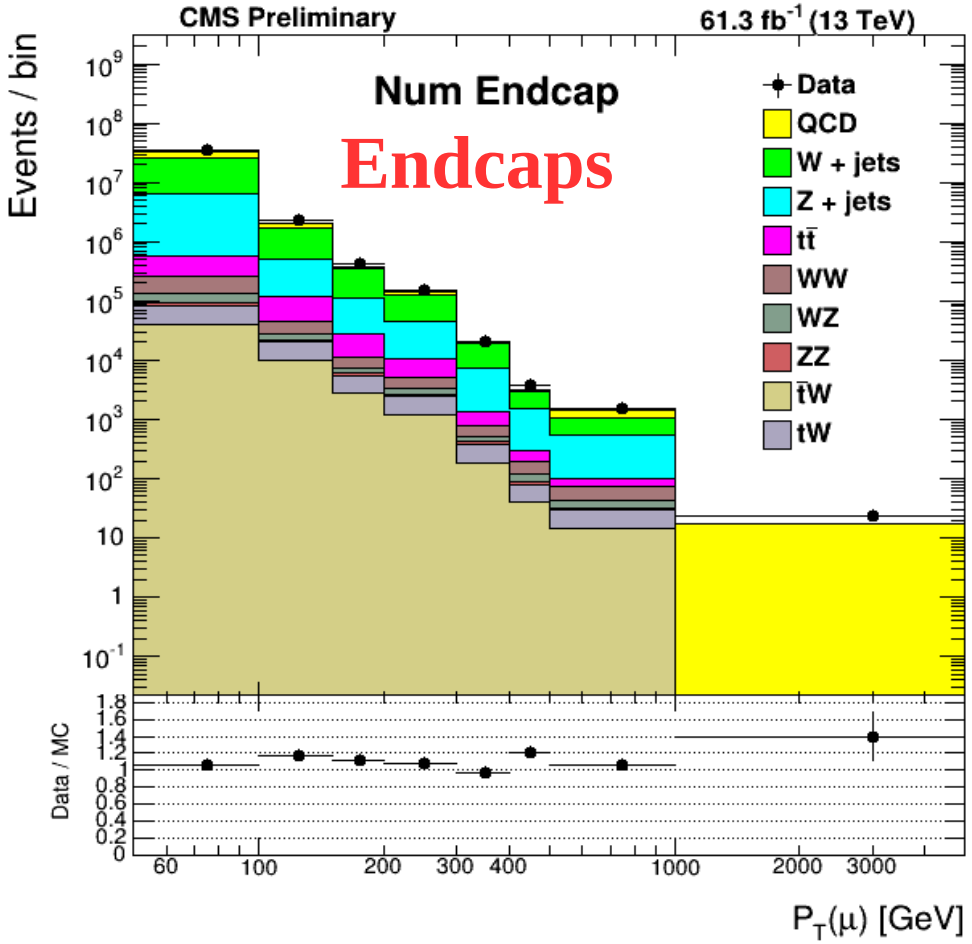
Num & Den distributions (Barrel)

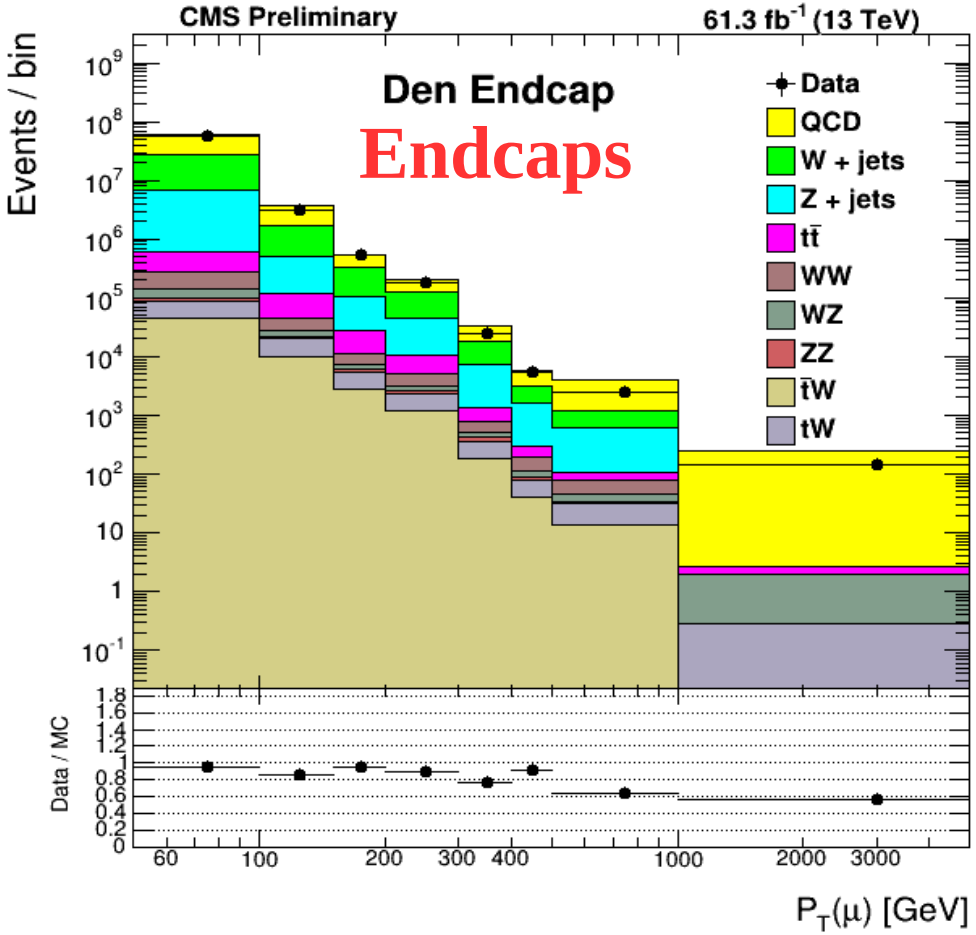




- Variable bin width is used
- Good agreement is seen between Data and MCs within 20% (systematic error).

Num & Den distributions (Endcaps)

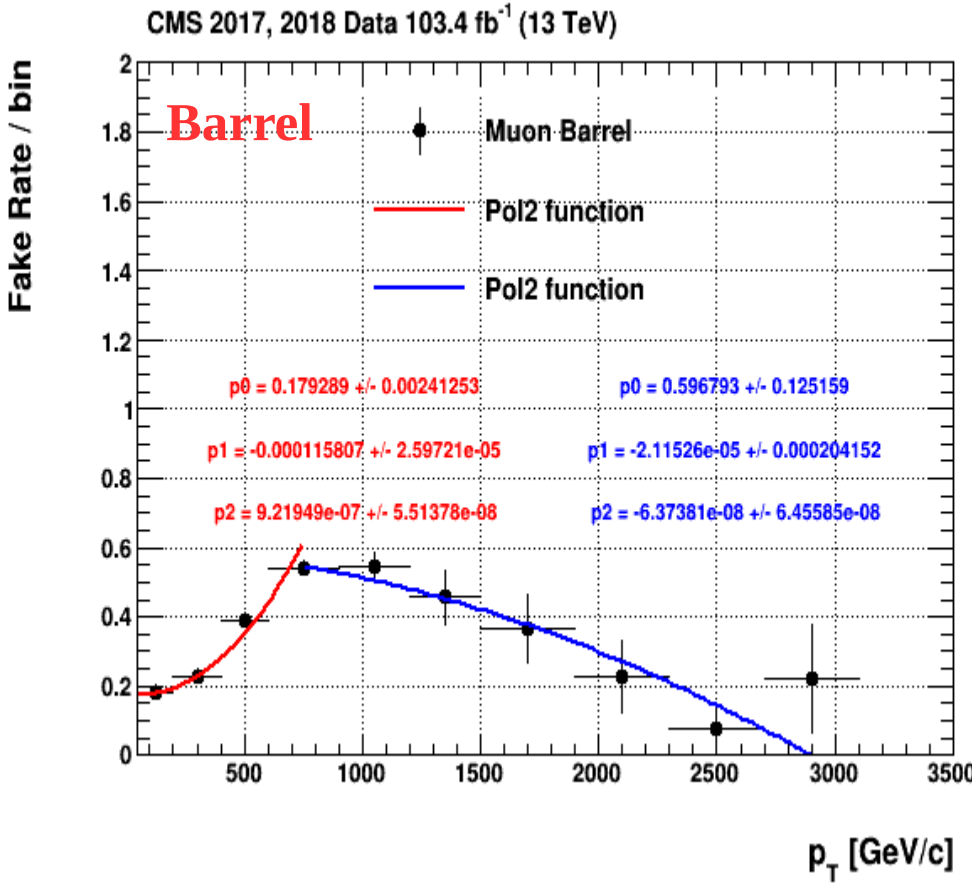


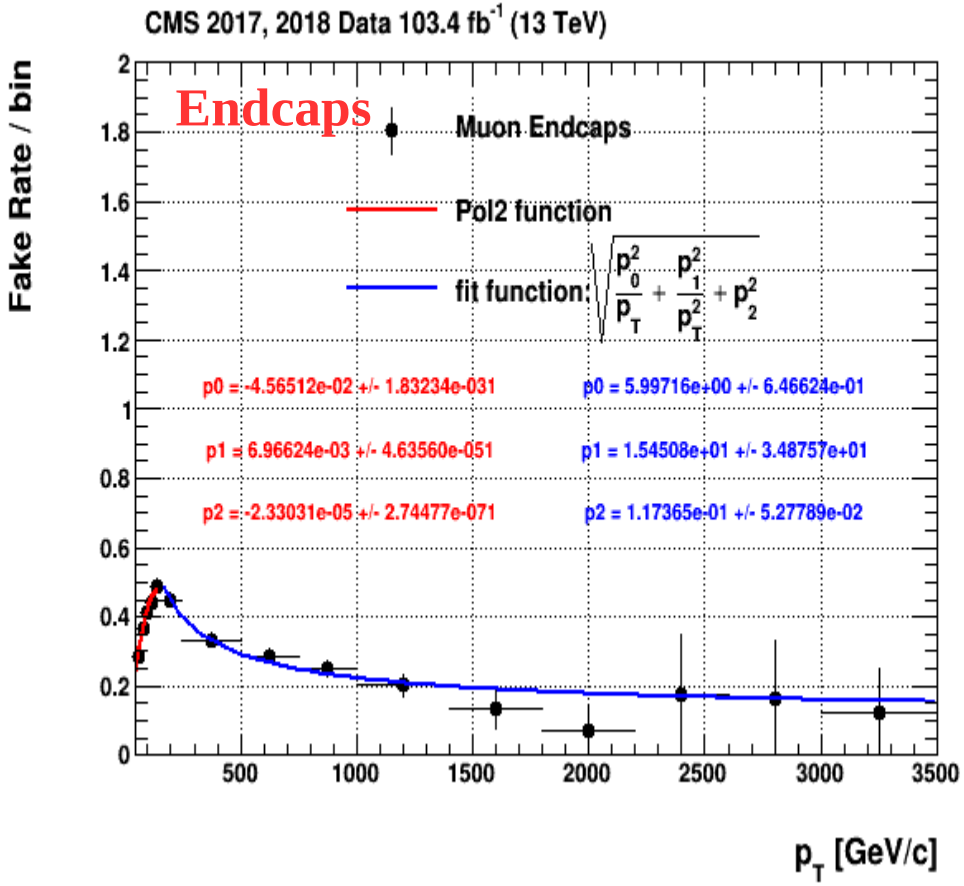


- Variable bin width is used
- Good agreement is seen between Data and MCs within 20% (systematic error).

FR parametrization vs P_T (Muon Barrel & Endcaps)

2017 and 2018 combined fake rate estimate





Jets estimate using FR a'la HEEP (see HEEP AN p.30)

- The fake rate is measured with respect to muon candidates passing both the fake rate pre-selection (**see b.s.16**) and either the HLT_Mu50_V*

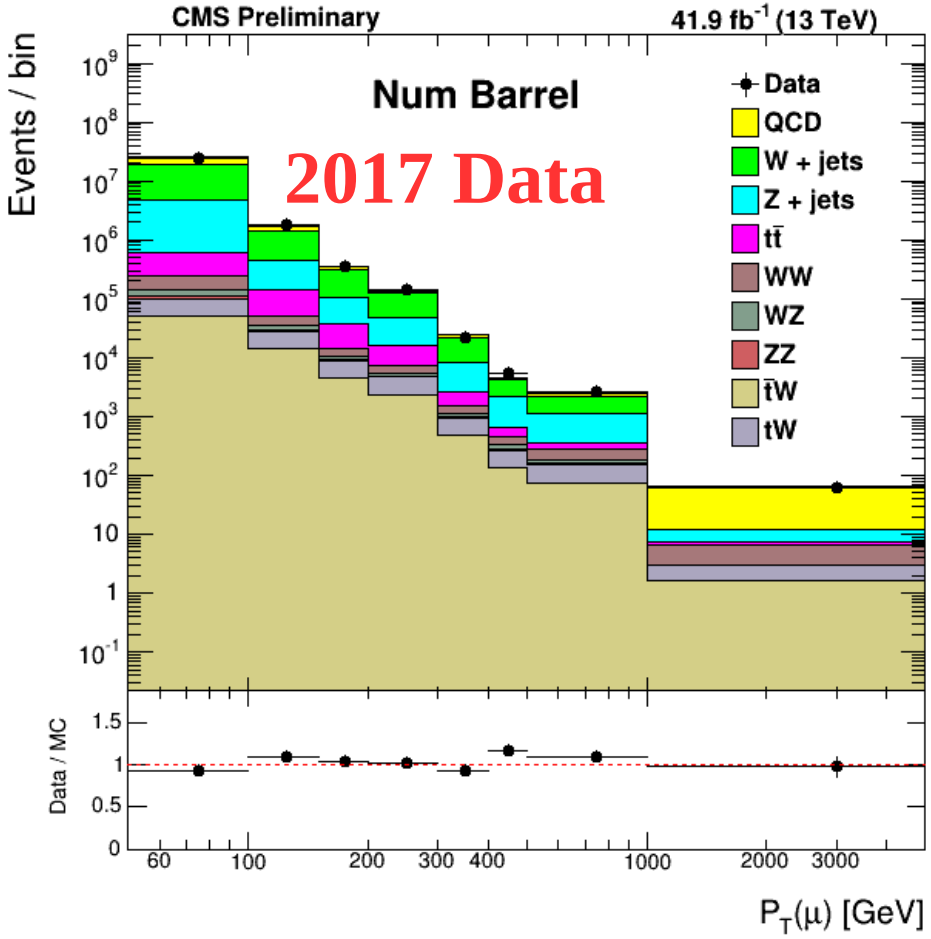
- The fake rate is therefore the number of misidentified jets in this sample which then go on to pass the High pt muon selection (**see b.s.19**).

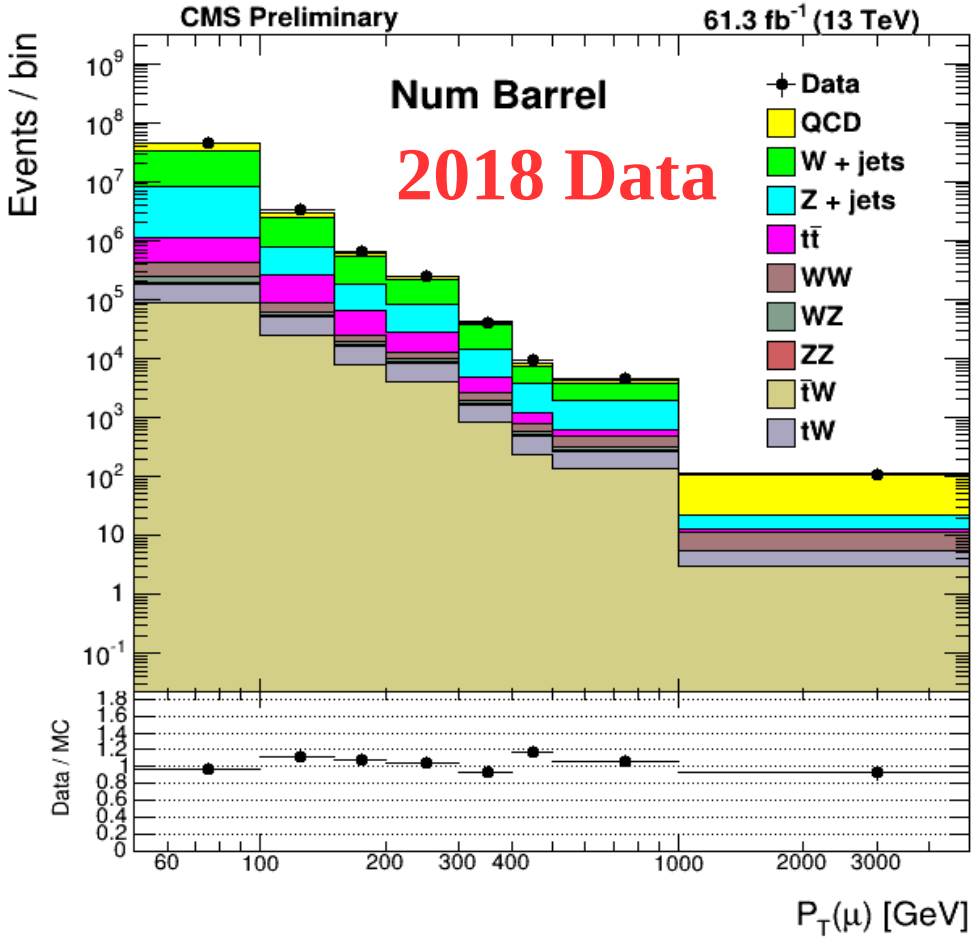
- **2FR estimate:**
  - The di-jet component can be estimated by selecting muon pairs where both muons pass the FR pre-selection but fail the high pt muon selection, selected using the primary analysis trigger.
  - These events are weighted by FR1/(1 − FR 1) × FR2 / (1 − FR2)

- **1FR estimate:**
  - The jet background is estimated by selecting muon pairs passing the primary analysis trigger with one muon passing the high pt muon selection and one muon passing the FR pre-selection but failing the high pt muon selection.
  - The events are then weighted by FR/(1 − FR)
  - There is a residual contamination of the Z/γ^{*}---> $\mu+ \mu-$ events which is corrected for by directly subtracting off the MC estimate.
  - The 1FR estimate includes the background from **W +jets, γ+jets and di-jets** but due to combinatorial effects, the 1FR estimate overestimates the di-jet contribution by a factor 2.
  - 2FR is then subtracted off the 1FR estimate to estimate the total jet background without any double counting.

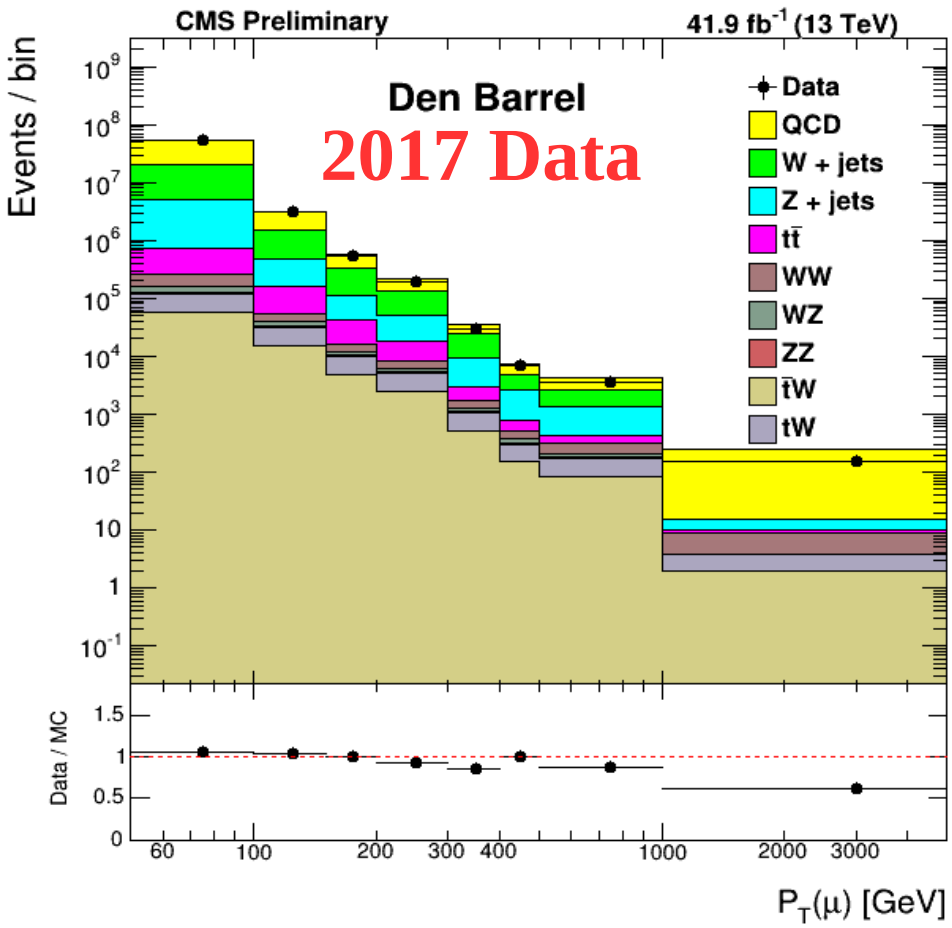
Backup

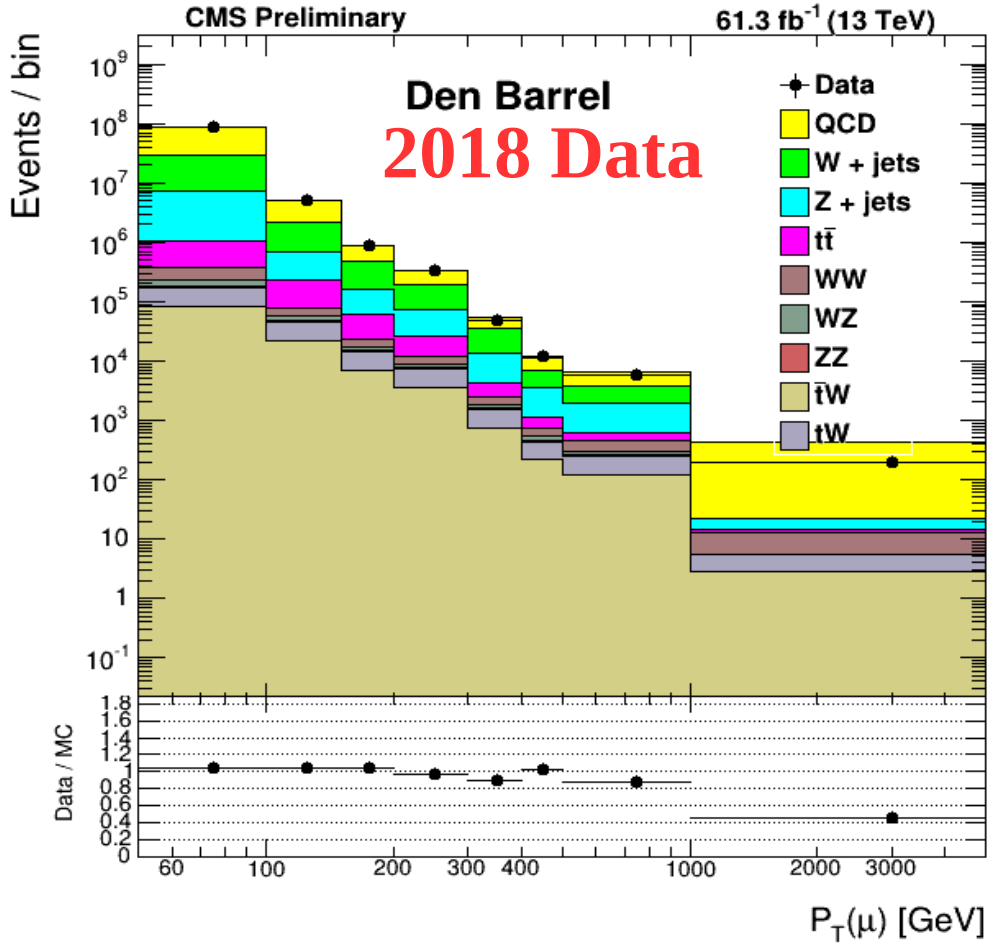
Num dist in the Barrel with 2017 & 2018 Data



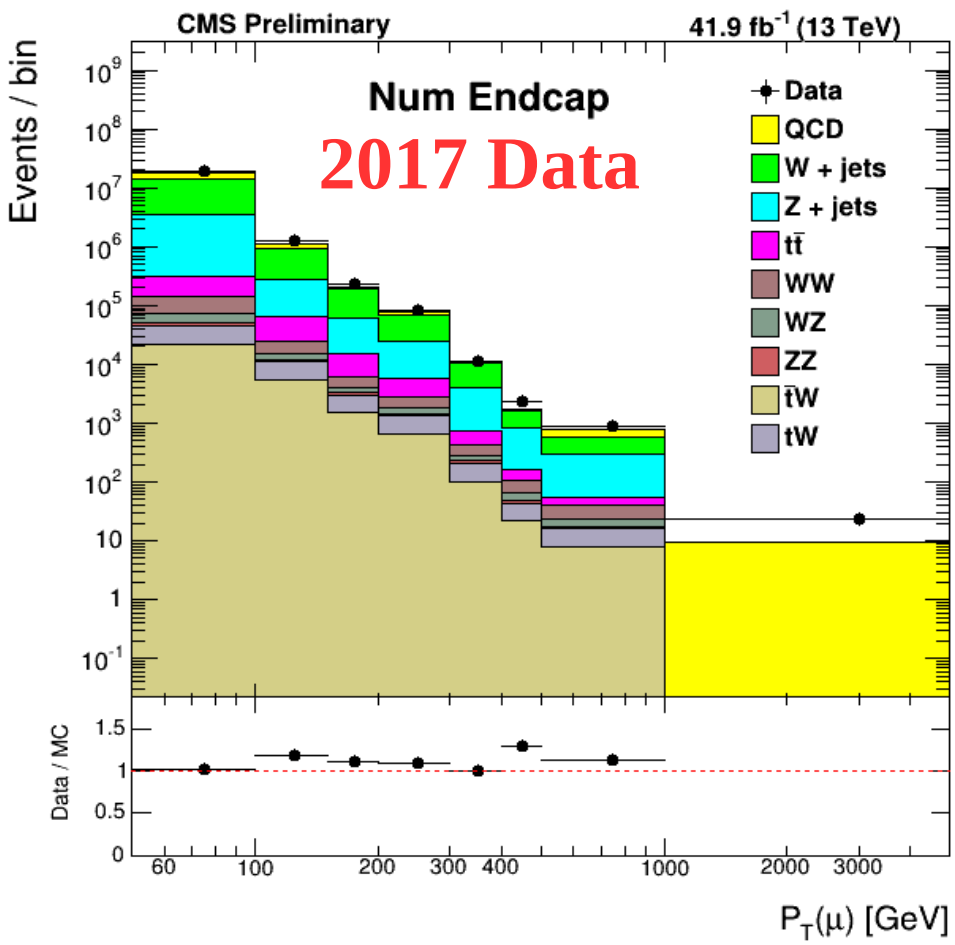


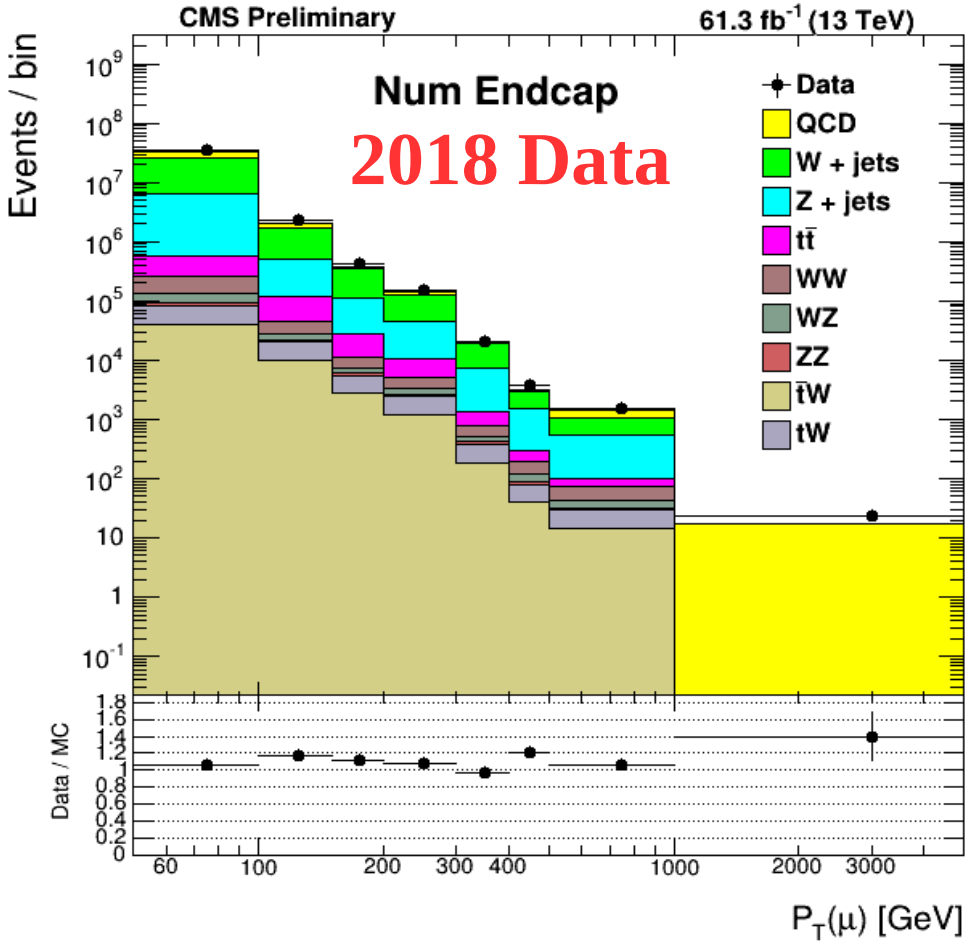
Den dist in the Barrel with 2017 & 2018 Data



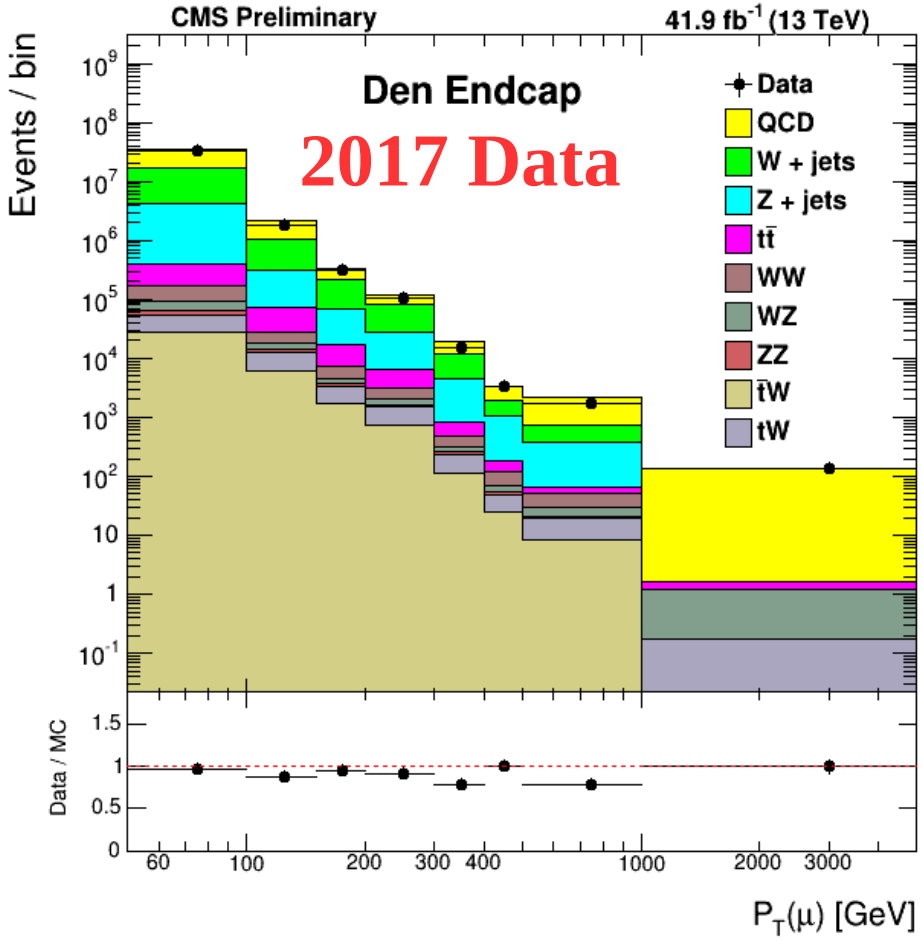


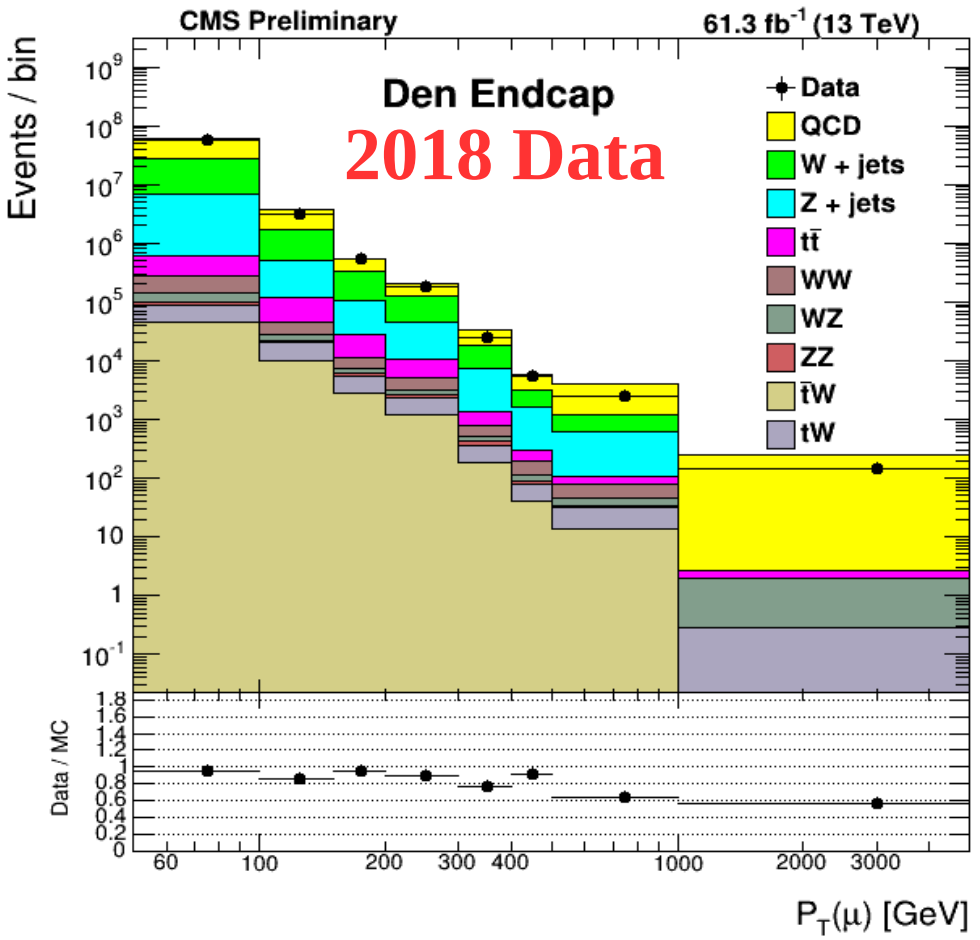
Num dist in the Endcaps with 2017 & 2018 Data



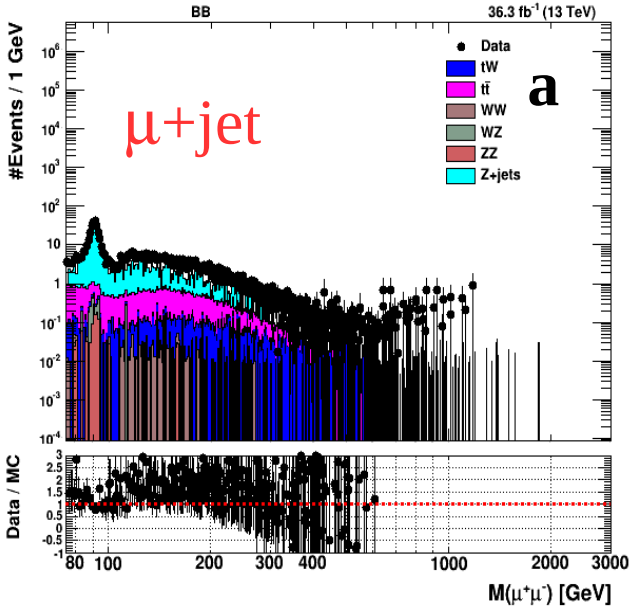


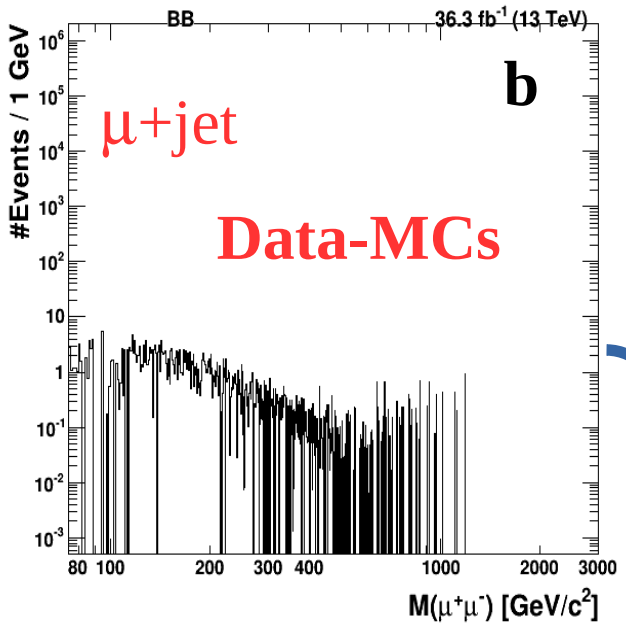
Den dist in the Endcaps with 2017 & 2018 Data

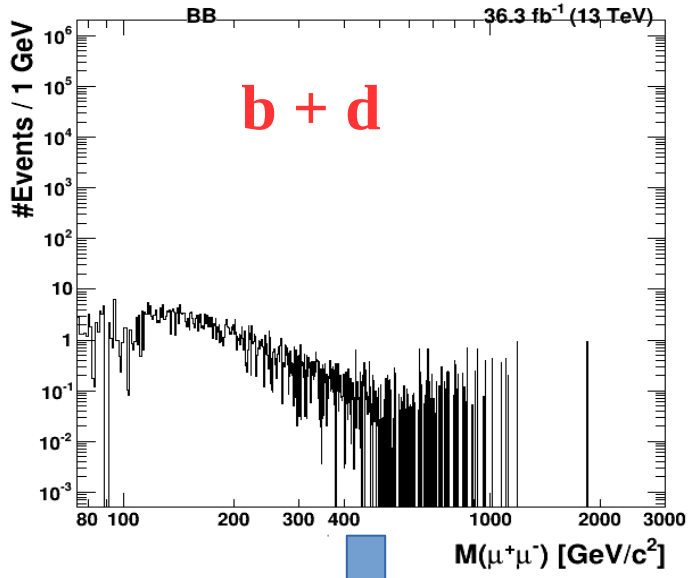


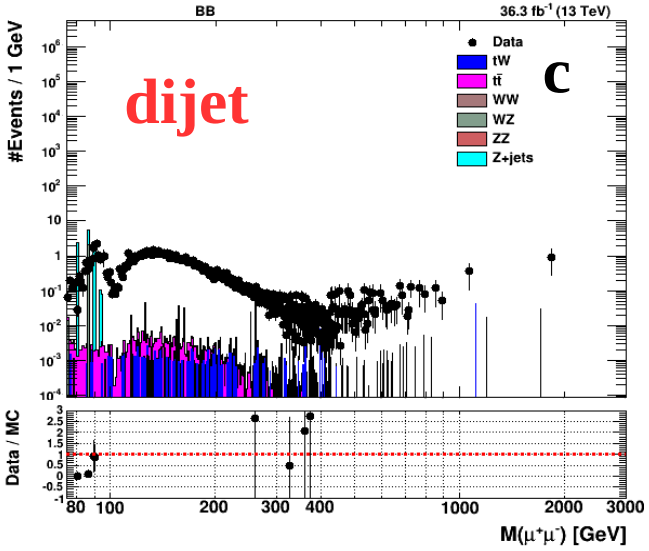


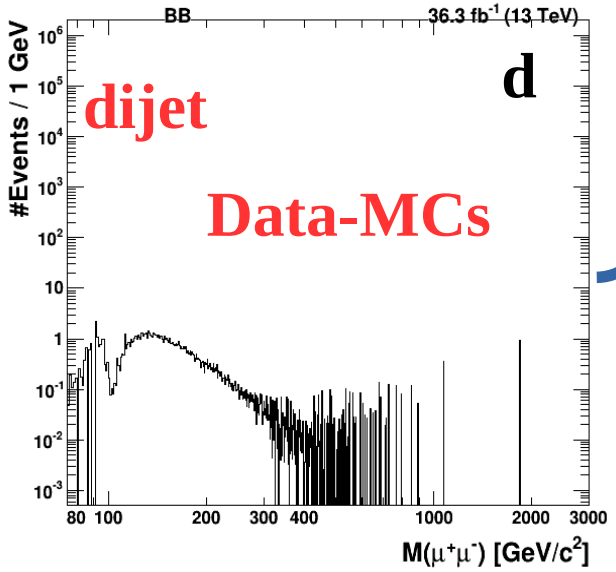
Jets estimate using FR a'la HEEP (see HEEP AN p.30)

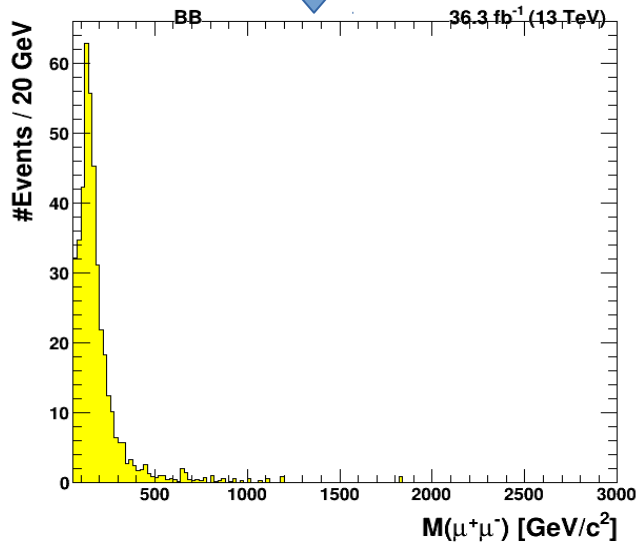












High pt muon ID 2017

[1] Muon must be reco as global muon
[2] pt(TuneP) > 35.0 GeV
[3] δpt(TuneP)/pt(TuneP) < 0.3
[4] |dxy| < 0.2
[5] Nb. of Valid Muon Hits [from Global Track] > 0
[6] Nb. of Valid Pixel Hits [from Global Track] > 0
[7] Nb. of Tracker Layers With Meas. [from Global Track] > 5
[8] Relative track iso. < 0.10
[9] Nb. of Matched Stations > 1

New Proposed Cut*:

```
if (firstMuon->numberOfMatchedStations()>1 || (firstMuon->numberOfMatchedStations()==1
    && !(firstMuon->stationMask()==1 || firstMuon->stationMask()==16))  || ((firstMuon-
>numberOfMatchedStations()==1 && (firstMuon->stationMask()==1 || firstMuon->stationMask()==16)) &&
firstMuon->numberOfMatchedRPCLayers()>2) )
```