

# Tag and Probe Real Data Jpsi Peak

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# Tag and Probe

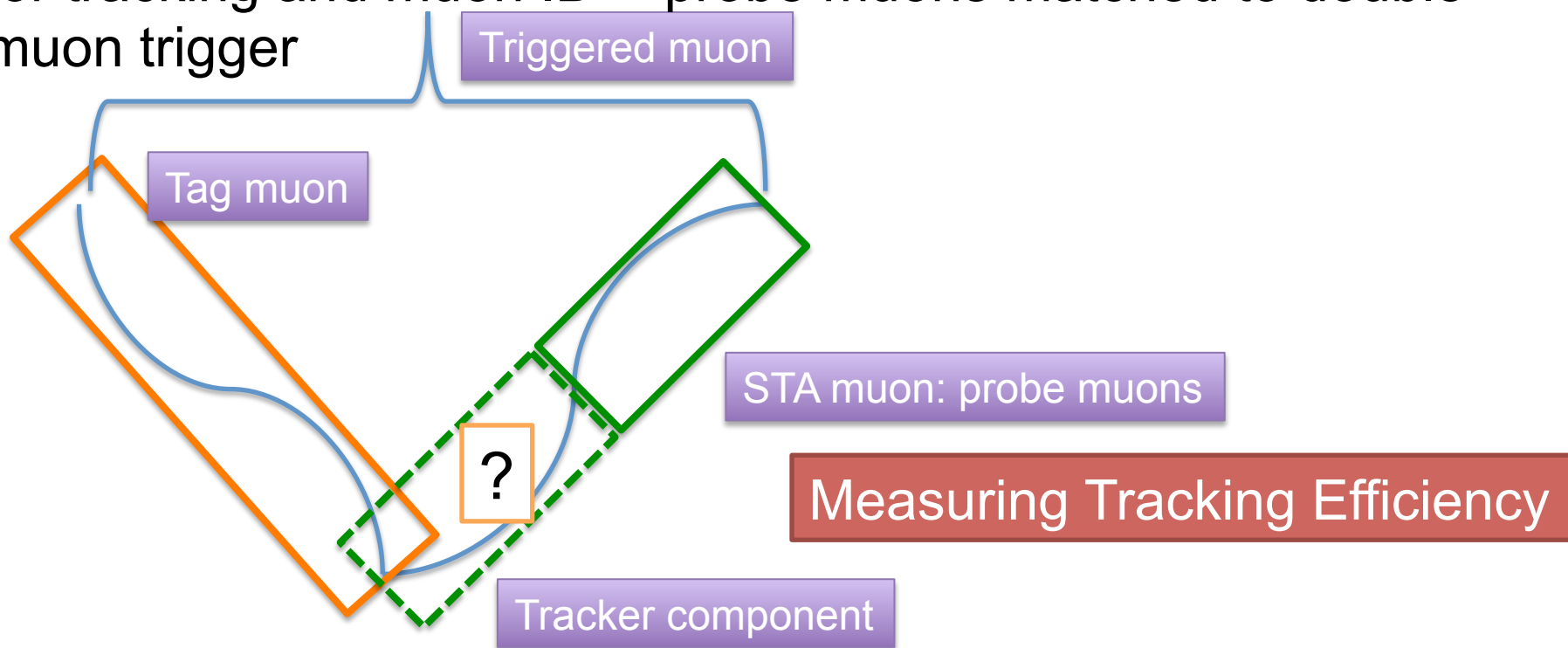
- New vs Old Tag and Probe
- Triggering Efficiency
- Muon ID Efficiency
- Tracking Efficiency



# TnP Old vs New Comparison

Old Style: Tag muons matched to single muon trigger and probe doesn't match to any trigger.

New Style: Tag muons matched to -- single muon trigger for trigger efficiency only -- and -- matched to double muon trigger for tracking and muon ID -- probe muons matched to double muon trigger



# Dataset

- **Data:** Results are ongoing
- **MC:** Still waiting for new TnP pairs
- **Jpsi Mass Region and Pt:**
  - For Trigger and Muon ID efficiency: 2.6 - 3.5 GeV/c<sup>2</sup> and Jpsi pt > 6.5 GeV/c
  - For Tracking efficiency: - 3 - 5 GeV/c<sup>2</sup> and Jpsi pt > 6.5 GeV/c
- **Good Quality:**
  - Inner Track Chi2/ndof < 4.
  - Global Track Chi2/ndof < 10.
  - Valid Tracker Hits > 10.
  - Valid Muon Hits > 0.
  - TrackerMuonArbitrated.
  - **In Acceptance:** '( (abs(eta)<1.0 && pt>=3.4) || (1.0<=abs(eta)<1.5 && pt>=5.8-2.4\*abs(eta)) || (1.5<=abs(eta)<2.4 && pt>=3.3667-7.0/9.0\*abs(eta)) )'
- **Not Implemented:** abs(Dz)<0.15 cm and abs(Dxy)<0.03 cm
  - Dz and Dxy are not useful, because they are measured from CMS (0,0,0) position, as opposed to the primary vertex.



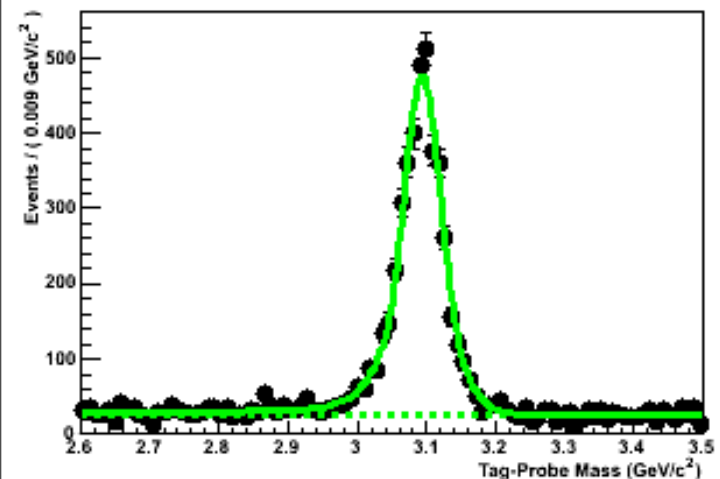
# Trigger Efficiency

- **tag:**
  - a global muon with good quality and matched to (HLT\_HIL1SingleMu0\_NHitQ?).
- **probe:**
  - global muon that fulfills all quality cuts in the acceptance.
- **passing probe:**
  - probe that can be matched to (HLT\_HIL1DoubleMu0\_HighQ\_v2||HLT\_HIL2DoubleMu3).

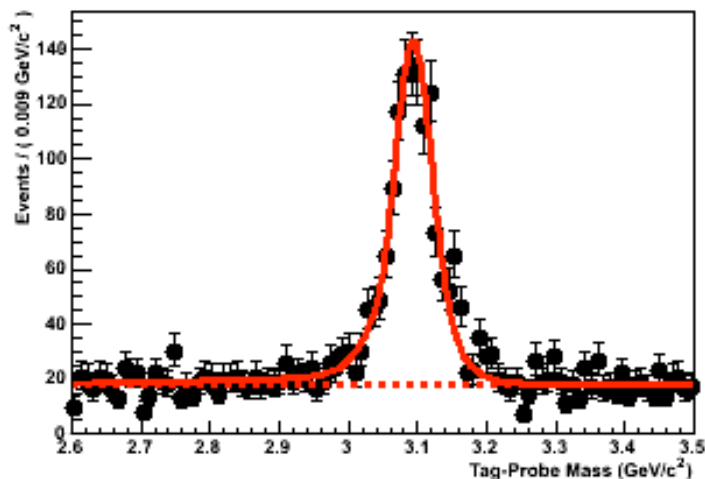


# Trigger Efficiency – Centrality Integrated mass fits

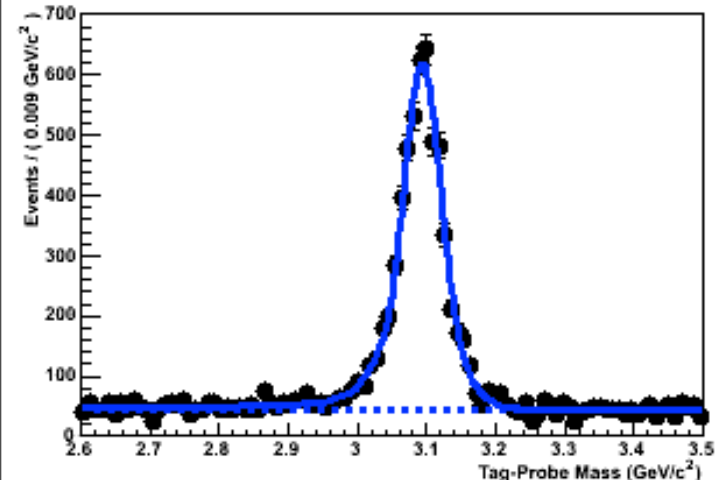
Passing Probes



Failing Probes



All Probes

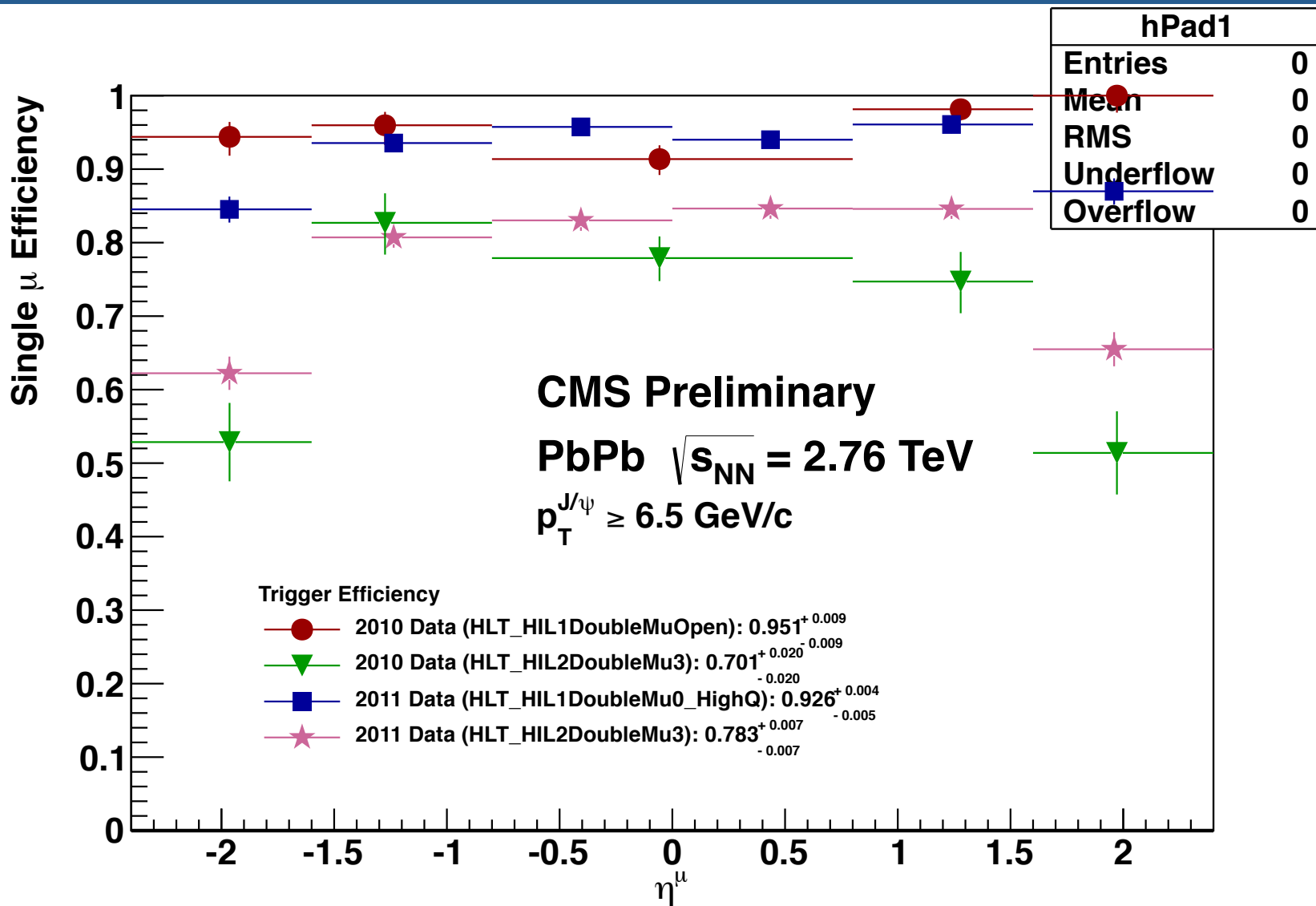


$\alpha = 1.7 \pm 0.1$   
 $\text{efficiency} = 0.783 \pm 0.007$   
 $f = 0.63 \pm 0.08$   
 $lp = 0.02 \pm 0.09$   
 $\text{mean1} = 3.0932 \pm 0.0006$   
 $n = 1.0 \pm 0.2$   
 $\text{numBackgroundFail} = 1839 \pm 54$   
 $\text{numBackgroundPass} = 2587 \pm 98$   
 $\text{numSignalAll} = 5290 \pm 129$   
 $\text{sigma1} = 0.025 \pm 0.001$   
 $\text{sigma2} = 0.045 \pm 0.004$

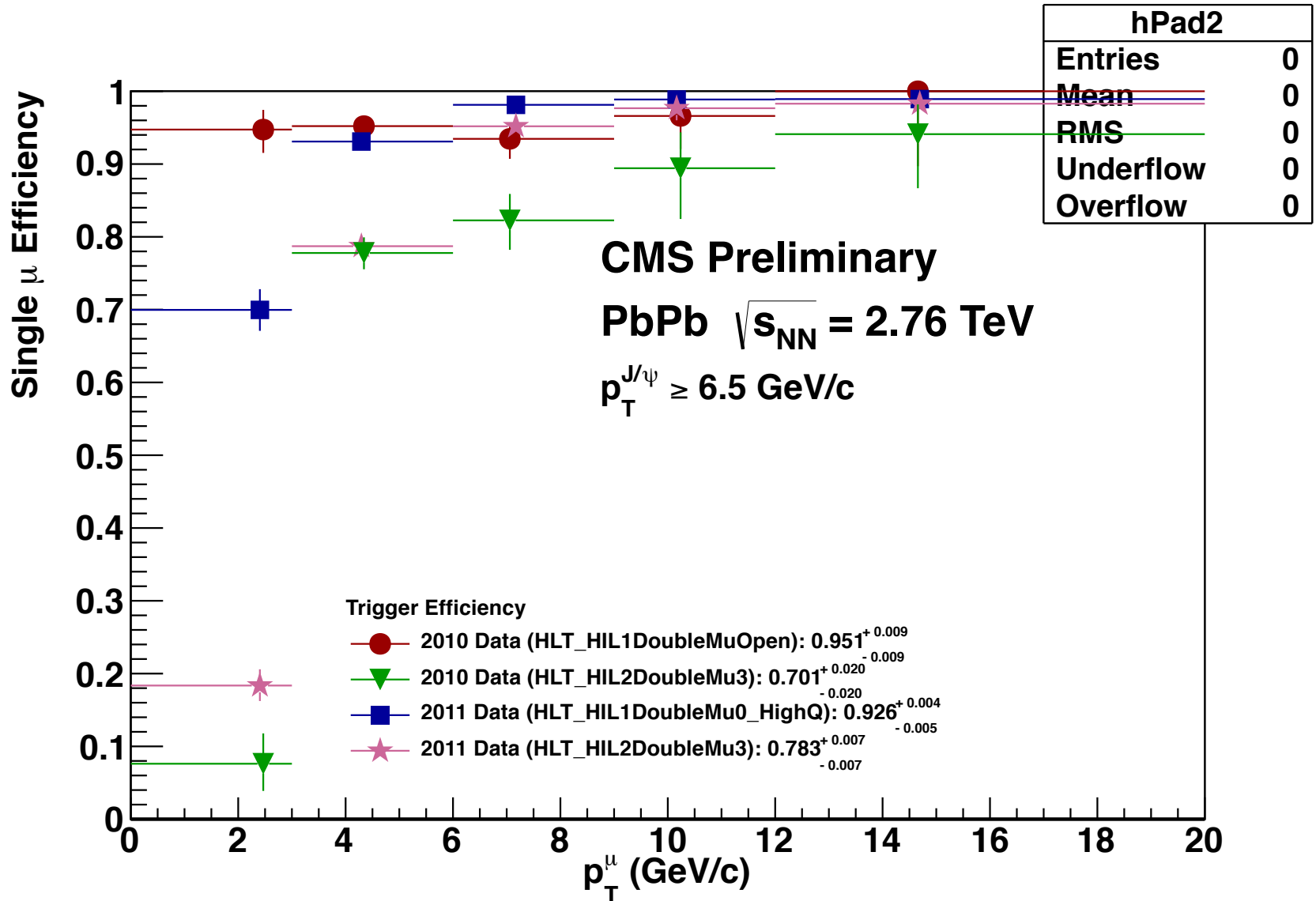
CB(mean1[3.1,3.0,3.2],  
 sigma1[0.03,0.01,0.04],alpha[1.7,1.0,10.0],n[2.3,1.0,4.0])  
 Gaussian mean1,sigma2[0.060,0.040,0.150])



# Trigger Efficiency - Eta



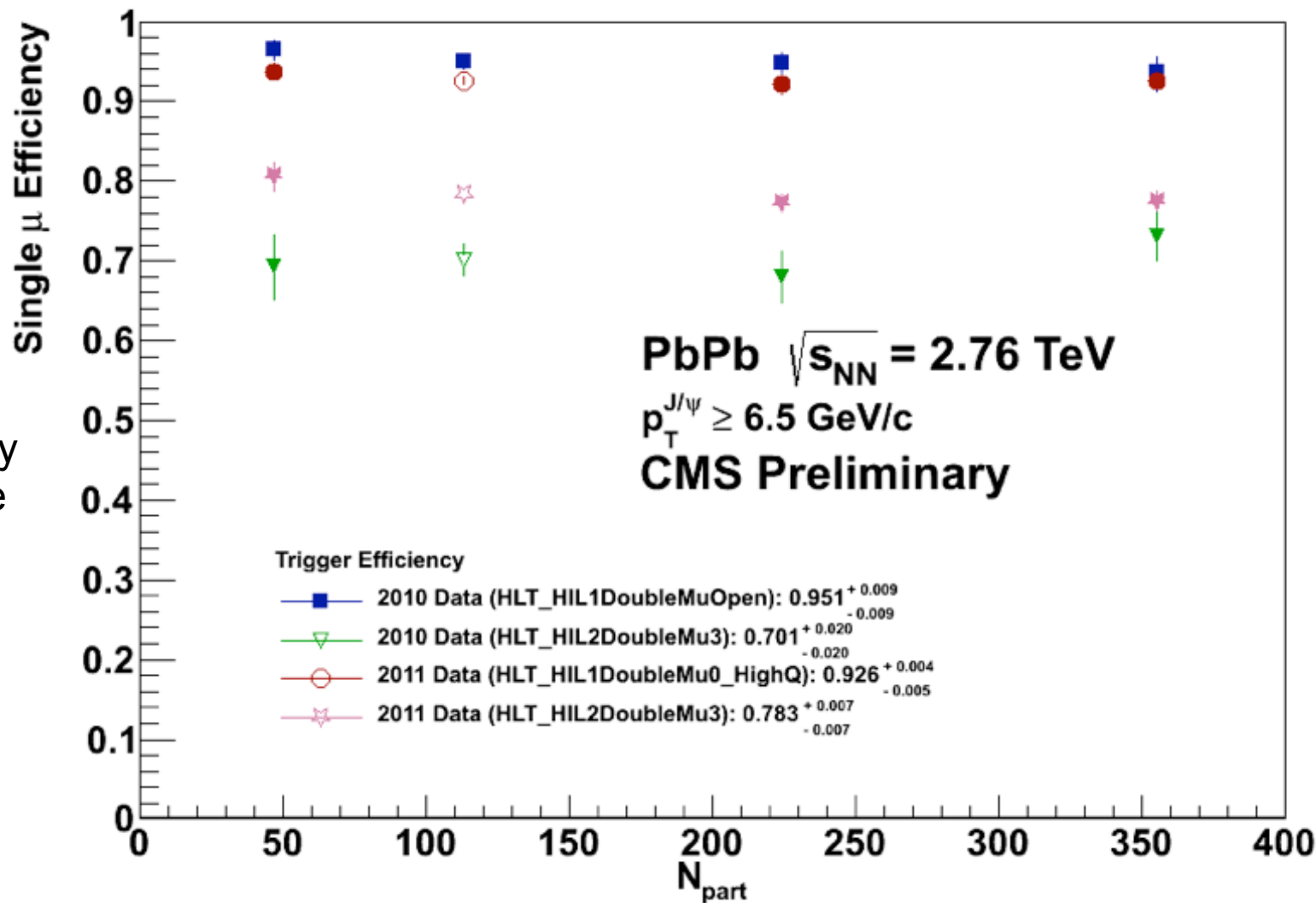
# Trigger Efficiency - Pt





# Trigger Efficiency - Npart

No Centrality dependence



# Inner Track Reconstruction Efficiency

- **tag:**
  - a global muon with good quality and matched to HLT\_HIL1DoubleMu0\_HighQ
- **probe:**
  - STA muon with at least one valid hit in the muon station, matched to HLT\_HIL1DoubleMu0\_HighQ\_v2
- **passing probe:**
  - probe that fulfills isGlobalMuon() with good quality.



# Reconstruction Efficiency– Centrality Integrated mass fits

Due to the presence of two signals in the invariant mass region of (3 - 5 GeV/c<sup>2</sup>) we have agreed on using two gaussians but only with two floating parameters instead of four

Gaussian of mean1, sigma1

Gaussian of mean2, sigma2

$\sigma_2 = \sigma_1[0.15, 0.05, 0.25] * \text{rat}[1.1902]$

$\text{mean}_2 = \text{mean}_1[3.1, 3.0, 3.2] + \text{deltaMean}[0.58917]$

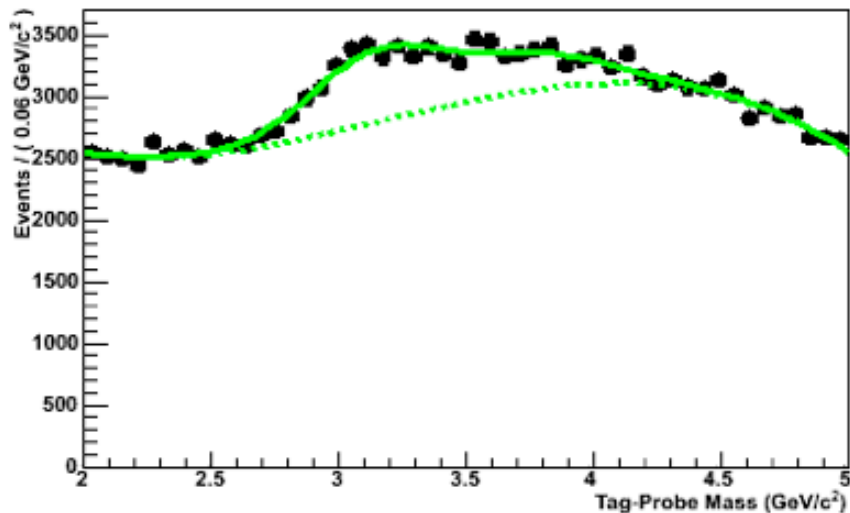
Only sigma1 and mean1 are allowed to float.

Background is a second order polynomial

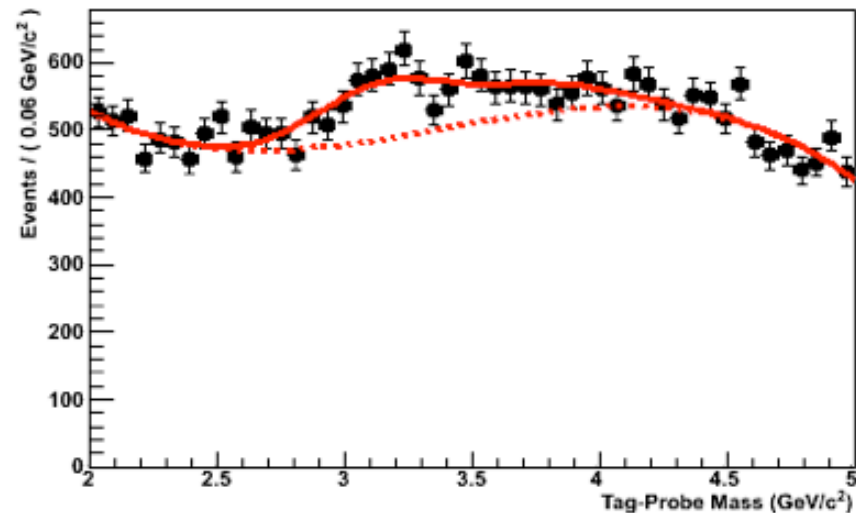


# Reconstruction Efficiency MinBias mass fits

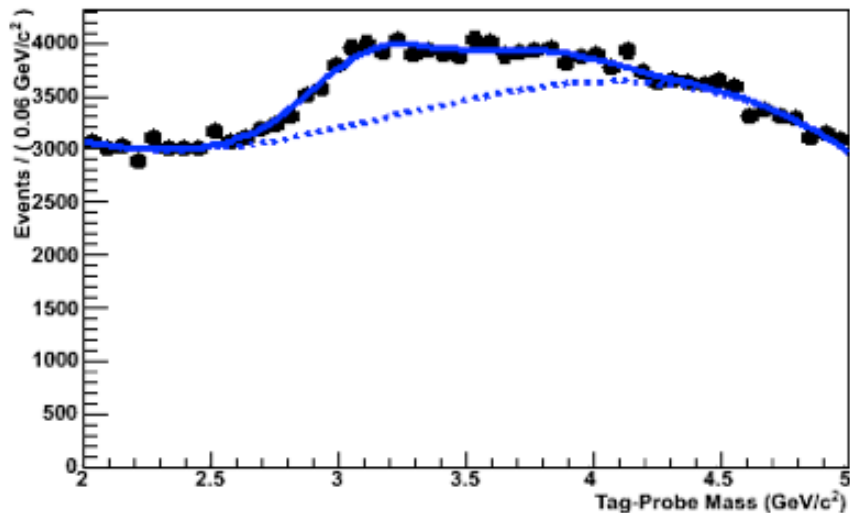
Passing Probes



Failing Probes

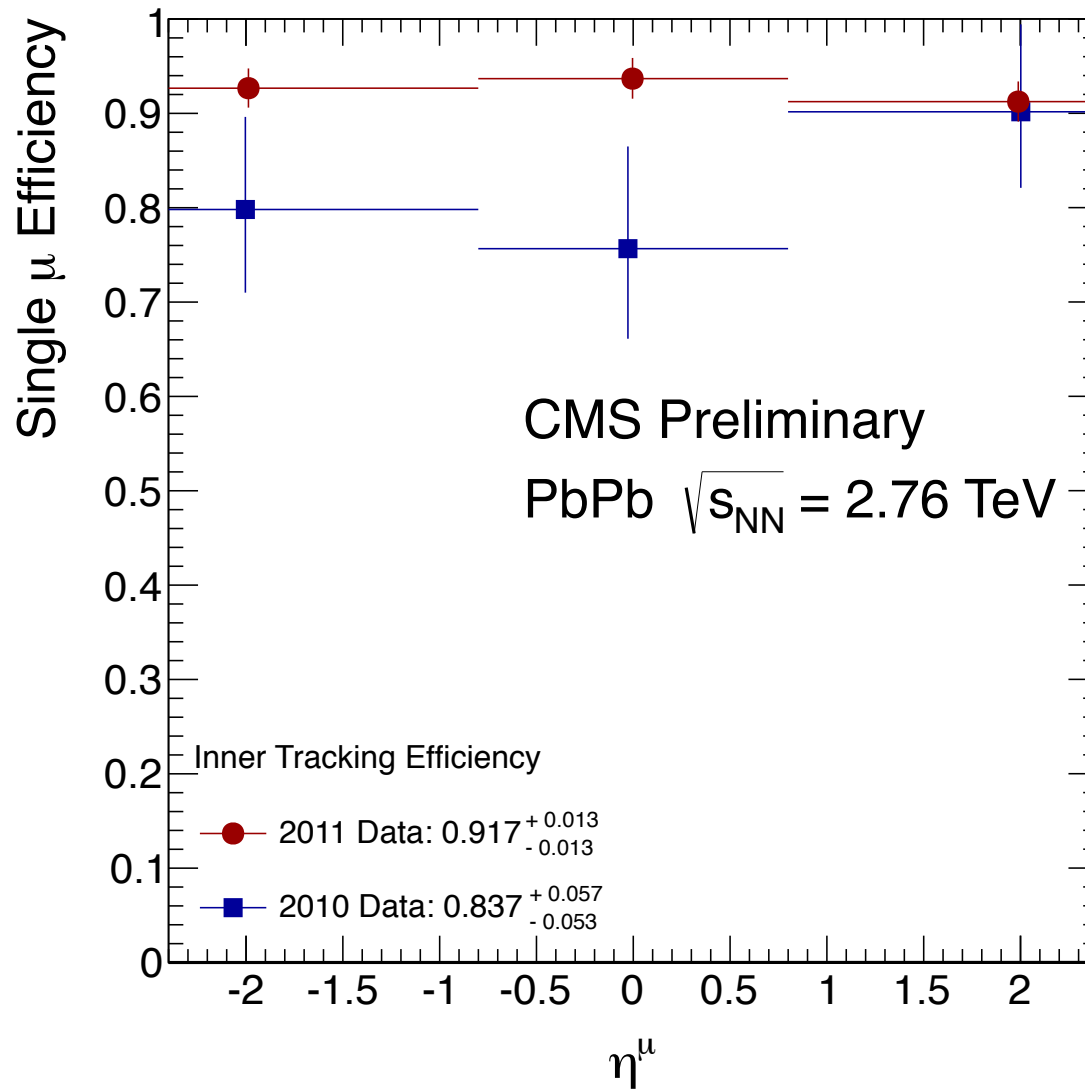


All Probes

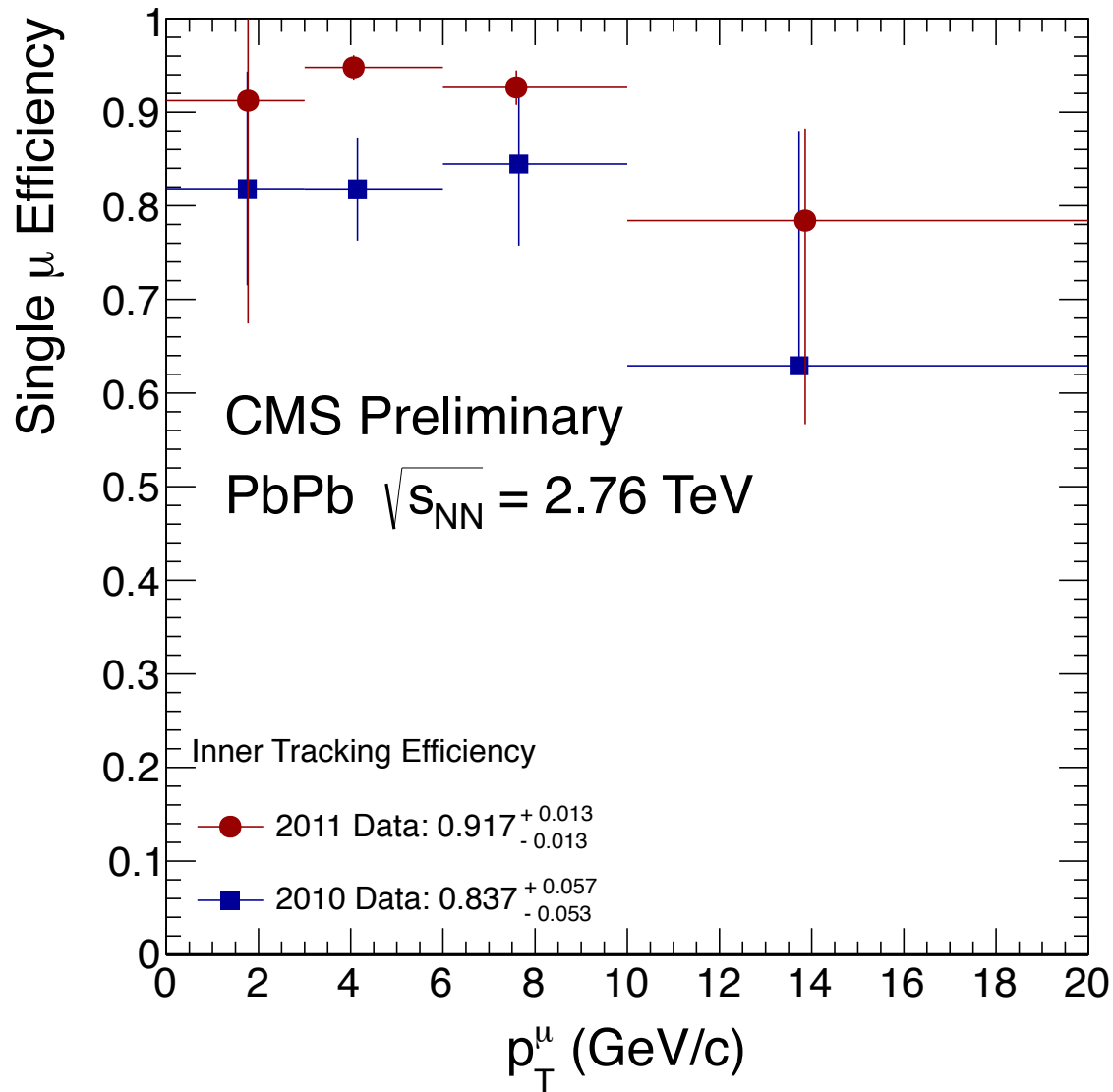


$c_{Fail} = -0.026 \pm 0.01$   
 $c_{Fail2} = -0.034 \pm 0.03$   
 $c_{Fail3} = -0.076 \pm 0.01$   
 $c_{Pass} = 0.059 \pm 0.006$   
 $c_{Pass2} = -0.074 \pm 0.02$   
 $c_{Pass3} = -0.0578 \pm 0.008$   
 $efficiency = 0.87 \pm 0.02$   
 $f = 0.62 \pm 0.03$   
 $mean1 = 3.14 \pm 0.02$   
 $numBackgroundFail = 24955 \pm 536$   
 $numBackgroundPass = 141019 \pm 2304$   
 $numSignalAll = 10636 \pm 2717$   
 $sigma1 = 0.2 \pm 0.2$

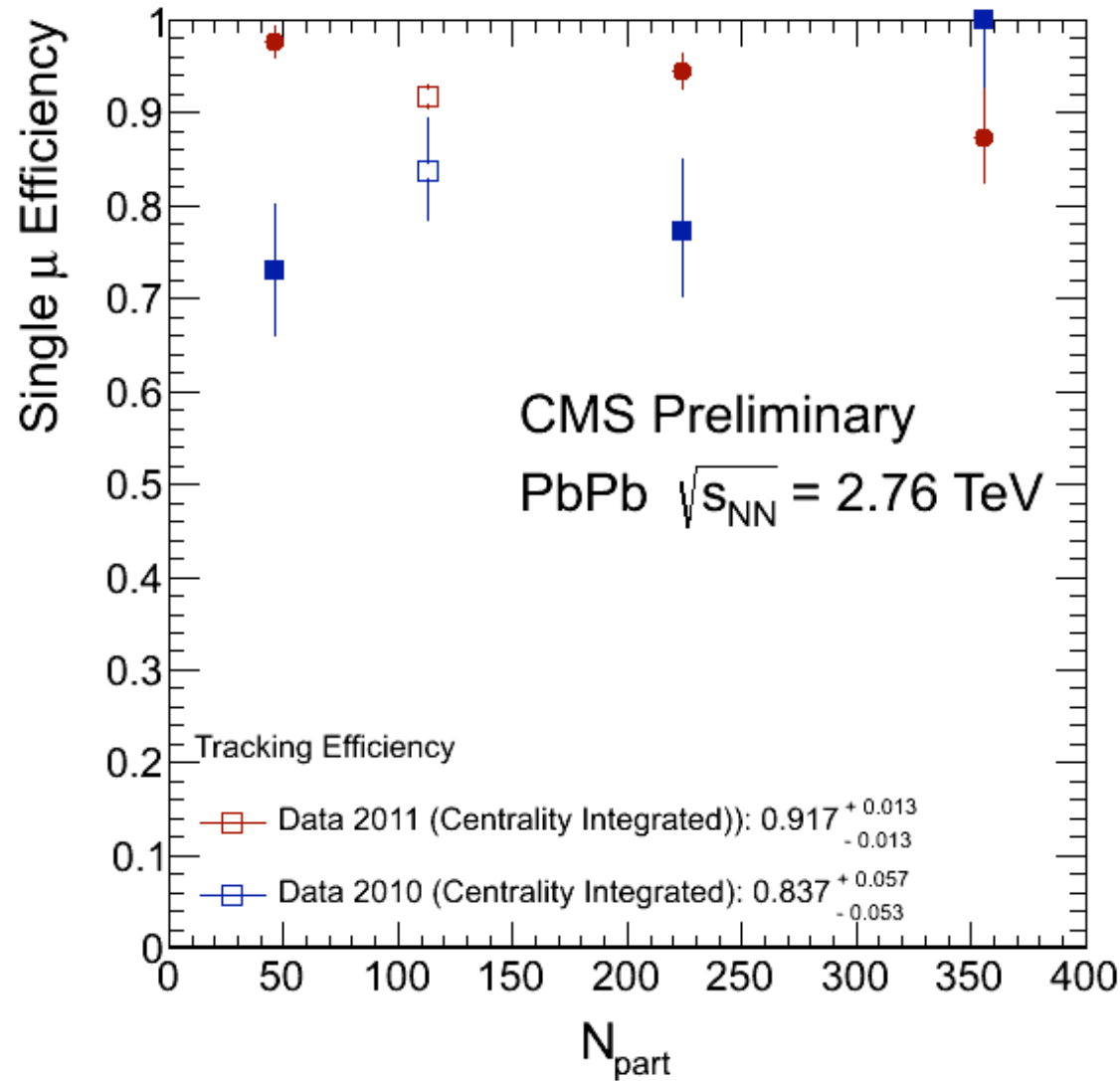
# Reconstruction Efficiency - Eta



# Reconstruction Efficiency - Pt



# Reconstruction Efficiency - Npart



# Muon ID Efficiency

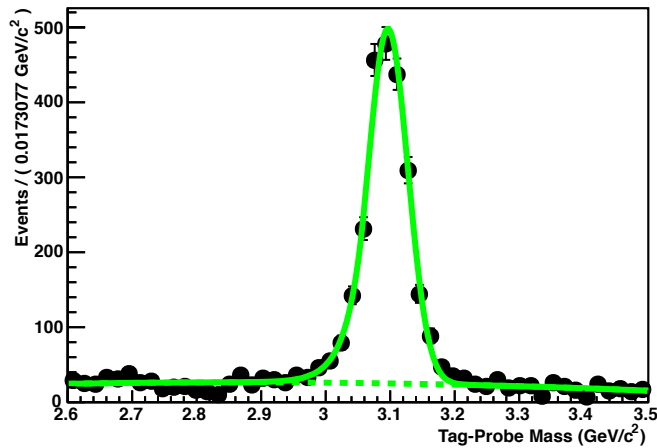
- **tag:**
  - a global muon with good quality and matched to HLT\_HIL1DoubleMu0\_HighQ\_v2
- **probe:**
  - tracker muon in acceptance, passing track cuts and matched to HLT\_HIL1DoubleMu0\_HighQ\_v2
- **passing probe:**
  - probe that can be matched to a global muon in the acceptance and fulfills all quality cuts.



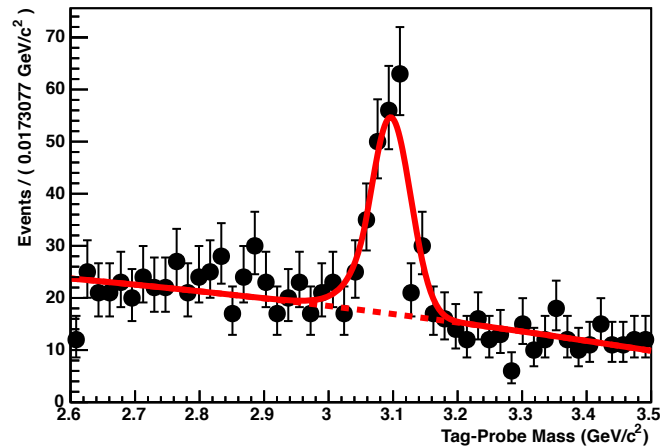


# Muon ID Efficiency - MinBias mass fits

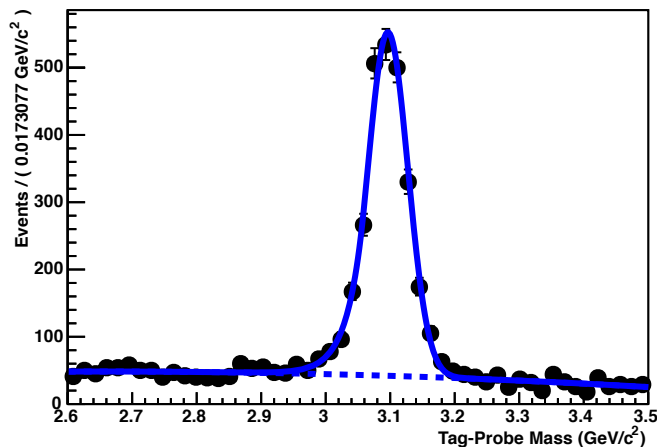
Passing Probes



Failing Probes



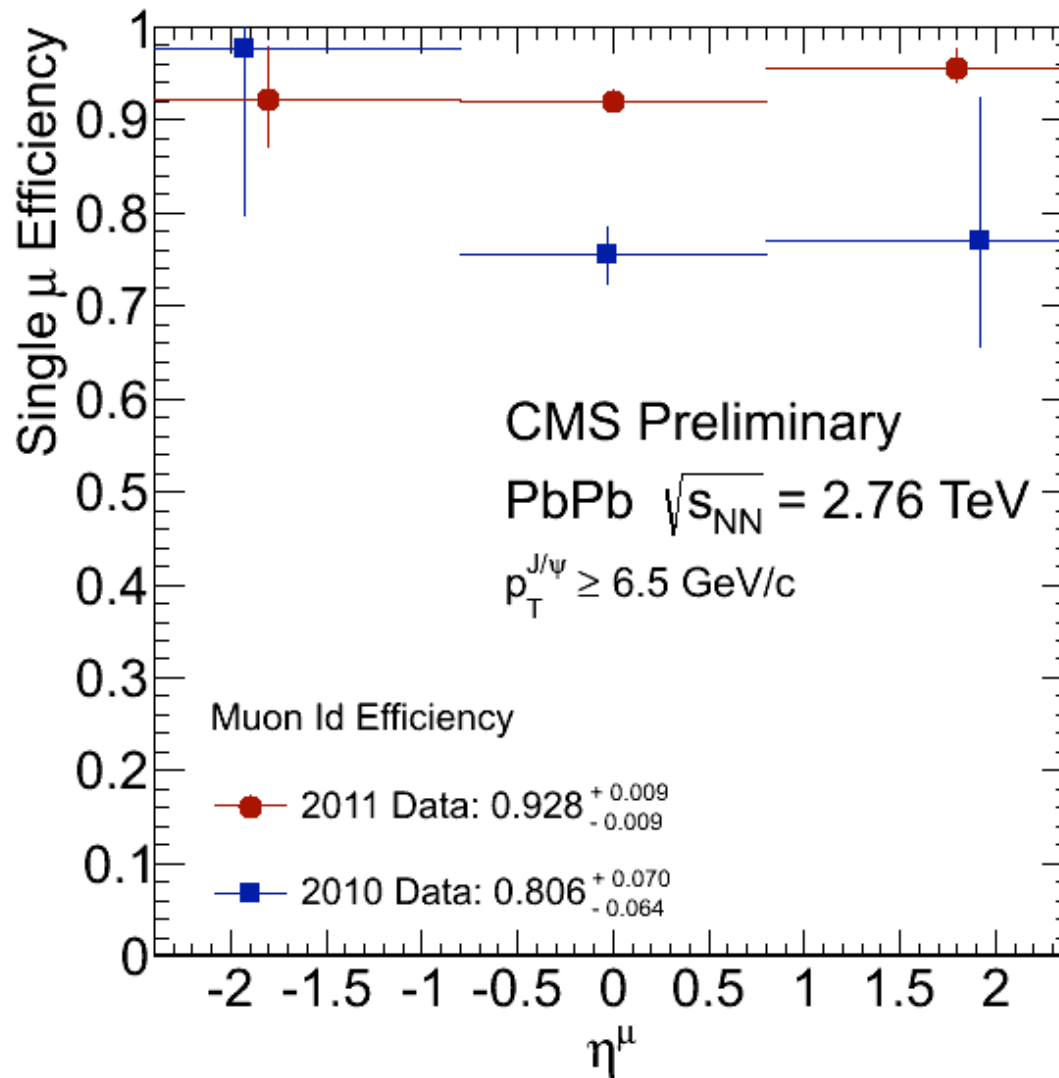
All Probes



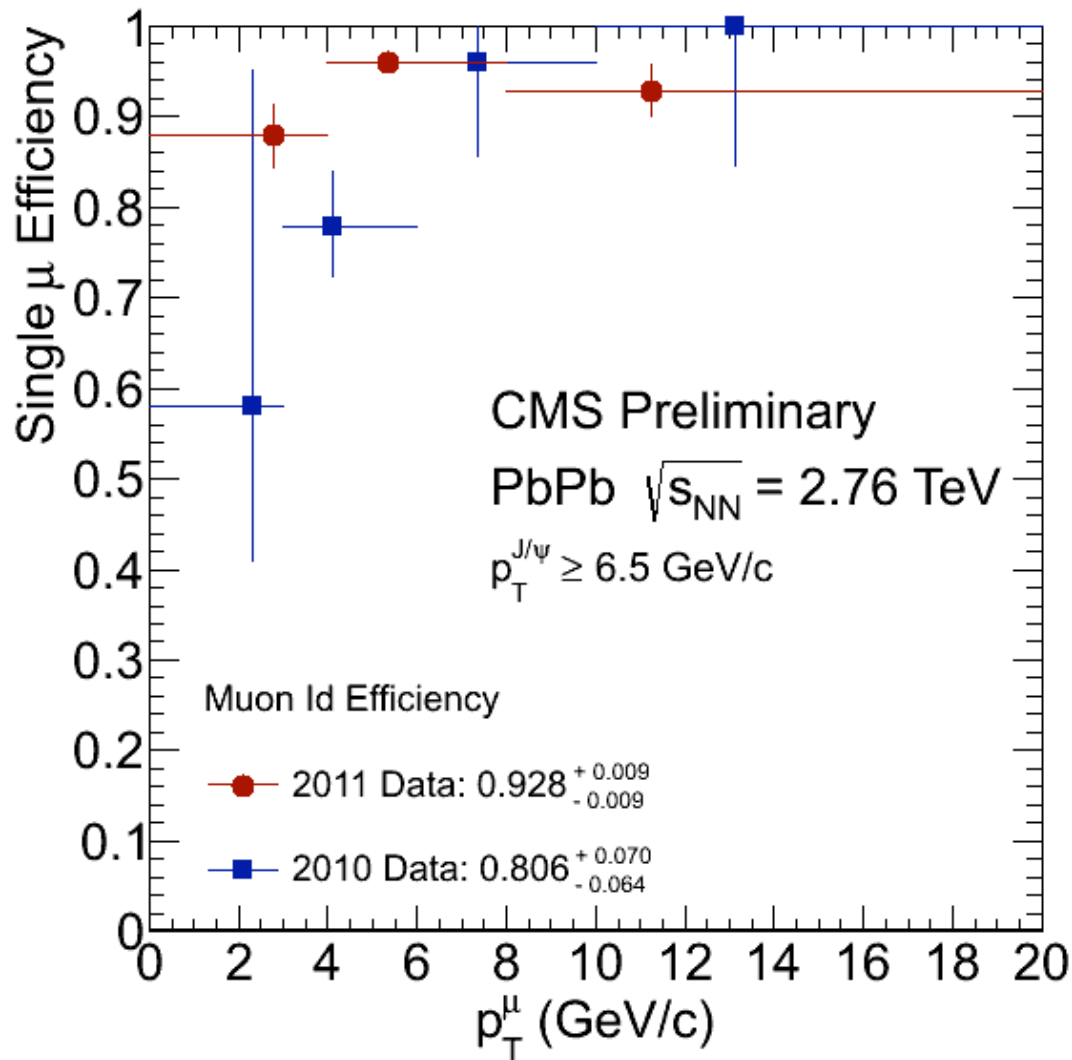
$\alpha = 1.2 \pm 0.1$   
 $c_{Fail} = -0.402 \pm 0.05$   
 $c_{Fail2} = -0.026 \pm 0.06$   
 $c_{Pass} = -0.201 \pm 0.05$   
 $c_{Pass2} = -0.124 \pm 0.06$   
 $efficiency = 0.926 \pm 0.008$   
 $mean = 3.0965 \pm 0.0009$   
 $n = 99 \pm 65$   
 $numBackgroundFail = 905 \pm 33$   
 $numBackgroundPass = 1232 \pm 45$   
 $numSignalAll = 2402 \pm 59$   
 $sigma = 0.0310 \pm 0.0009$

Crystal Ball for signal  
 $mean(3.1, 3.0, 3.2)$ ,  $sigma(0.02, 0.02, 0.1)$ ,  
 $\alpha(1.0, 0.2, 3.0)$ ,  $n(4, 0.5, 100.)$   
 Exponential background

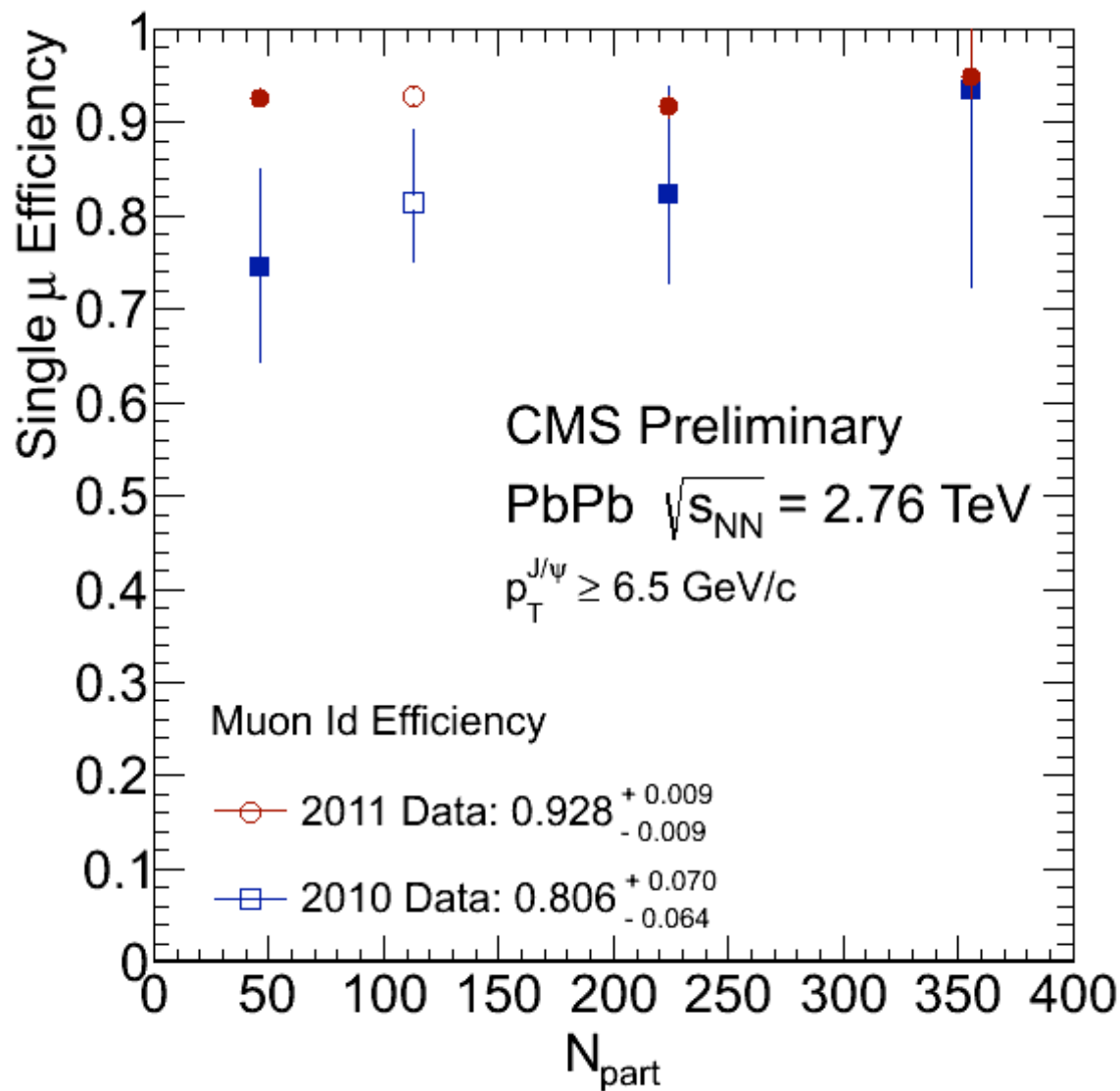
# Muon ID Efficiency - eta



# Muon ID Efficiency - pt



# Muon ID Efficiency - Npart



# To do

- Add Montecarlo comparison
- Understand better the background making several pt cuts on the probe muons.

For Triggering Efficiency

```
– process.probeMuons = cms.EDFilter("PATMuonSelector",  
–   src = cms.InputTag("patMuonsWithTrigger"),  
–   cut = cms.string(QUALITY_CUTS + ' && pt>4 && ' + IN_ACCEPTANCE)  
–   )
```

For MuonID Efficiency

```
– process.probeMuonsTrk = cms.EDFilter("PATMuonSelector",  
–   src = cms.InputTag("patMuonsWithTrigger"),  
–   cut = cms.string("pt > 4 && isTrackerMuon && " + IN_ACCEPTANCE + "  
&& " + TRACK_CUTS + " && !  
triggerObjectMatchesByPath('HLT_HIL1DoubleMu0_HighQ_v2').empty()")  
–   )
```

For Tracking Efficiency

```
– process.probeMuonsSta = cms.EDFilter("PATMuonSelector",  
–   src = cms.InputTag("patMuonsWithTriggerSta"),  
–   cut = cms.string("pt > 4 && outerTrack.isNonnull && !  
triggerObjectMatchesByPath('HLT_HIL1DoubleMu0_HighQ_v2').empty()")
```



# Conclusions

- Please make comments.



# BACK UP



# Trigger Efficiency

## In onia2MuMuPAT\_cff.py

- **IN\_ACCEPTANCE** = '(abs(eta)<2.4 && pt>=10)'
- **TRACK\_CUTS** = "track.numberValidHits > 10 && track.normalizedChi2 <4"
- **GLB\_CUTS** = "isGlobalMuon && isTrackerMuon && globalTrack.normalizedChi2 < 10 && muonID('TrackerMuonArbitrated') && globalTrack.hitPattern.numberValidMuonHits > 0"
- **QUALITY\_CUTS** = GLB\_CUTS + ' && ' + TRACK\_CUTS
- **process.tagMuonsSglTrg** = cms.EDFilter("PATMuonSelector", src = cms.InputTag("patMuonsWithTrigger"), cut = cms.string(QUALITY\_CUTS + ' && ' + IN\_ACCEPTANCE + " && (! triggerObjectMatchesByPath('HLT\_HIL2Mu3\_NHitQ\_v\*').empty() || ! triggerObjectMatchesByPath('HLT\_HIL2Mu7\_v\*').empty() || ! triggerObjectMatchesByPath('HLT\_HIL2Mu15\_v\*').empty())"))
- **process.probeMuons** = cms.EDFilter("PATMuonSelector", src = cms.InputTag("patMuonsWithTrigger"), cut = cms.string(QUALITY\_CUTS + ' && ' + IN\_ACCEPTANCE))

## In temp\_Trg.py

- **process.tpPairsTrigNew** = cms.EDProducer("CandViewShallowCloneCombiner", cut = cms.string('60.0 < mass < 120.0 && abs(y) < 2.0'), decay = cms.string('tagMuonsSglTrg@+ probeMuons@-'))
- **flags** = cms.PSet( HLT1 = cms.string("!" triggerObjectMatchesByFilter('hltHIDoubleMuLevel1PathL1HighQFiltered').empty())||!" triggerObjectMatchesByFilter('hltHIL2DoubleMu3L2Filtered').empty())||!" triggerObjectMatchesByFilter('hltHIDimuonL3FilteredOpen').empty())||!" triggerObjectMatchesByFilter('hltHIDimuonL3FilteredMg2OSnoCowboy').empty()"),),





# Inner Track Reconstruction Efficiency

## In onia2MuMuPAT\_cff.py

- **IN\_ACCEPTANCE** = '(abs(eta)<2.4 && pt>=10)'
- **TRACK\_CUTS** = "track.numberOfWorkingHits > 10 && track.normalizedChi2 < 4"
- **GLB\_CUTS** = "isGlobalMuon && isTrackerMuon && globalTrack.normalizedChi2 < 10 && muonID('TrackerMuonArbitrated') && globalTrack.hitPattern.numberOfWorkingMuonHits > 0"
- **QUALITY\_CUTS** = **GLB\_CUTS** + ' && ' + **TRACK\_CUTS**
- **process.tpPairsSta** = cms.EDProducer("CandViewShallowCloneCombiner", cut = cms.string('40.0 < mass < 140.0'), decay = cms.string('tagMuonsDbITrg@+ probeMuonsSta@-'))
- **process.tagMuonsDbITrg** = cms.EDFilter("PATMuonSelector", src = cms.InputTag("patMuonsWithTrigger"), cut = cms.string(**QUALITY\_CUTS** + ' && ' + **IN\_ACCEPTANCE** + " && ! triggerObjectMatchesByPath('HLT\_HIL1DoubleMu0\_HighQ\_v\*').empty()"))
- **process.probeMuonsSta** = cms.EDFilter("PATMuonSelector", src = cms.InputTag("patMuonsWithTriggerSta"), cut = cms.string("outerTrack.isNonnull && ! triggerObjectMatchesByPath('HLT\_HIL1DoubleMu0\_HighQ\_v\*').empty()"))

## In temp\_Trk.py

- **TRACK\_CUTS** = "track.numberOfWorkingHits > 10 && track.normalizedChi2 < 4 && track.hitPattern.pixelLayersWithMeasurement > 0"
- **GLB\_CUTS** = "isGlobalMuon && isTrackerMuon && globalTrack.normalizedChi2 < 10 && muonID('TrackerMuonArbitrated') && globalTrack.hitPattern.numberOfWorkingMuonHits > 0 "#move id cut to tracking efficiency
- **QUALITY\_CUTS** = **GLB\_CUTS** + ' && ' + **TRACK\_CUTS**
- **flags** = cms.Pset( isGlb = cms.string(**QUALITY\_CUTS**),),



# Muon ID Efficiency

## In onia2MuMuPAT\_cff.py

- **IN\_ACCEPTANCE** = '(abs(eta)<2.4 && pt>=10)'
- **TRACK\_CUTS** = "track.numberValidHits > 10 && track.normalizedChi2 < 4"
- **GLB\_CUTS** = "isGlobalMuon && isTrackerMuon && globalTrack.normalizedChi2 < 10 && muonID('TrackerMuonArbitrated') && globalTrack.hitPattern.numberValidMuonHits > 0"
- **QUALITY\_CUTS** = **GLB\_CUTS** + ' && ' + **TRACK\_CUTS**
- **process.tagMuonsDbITrg** = cms.EDFilter("PATMuonSelector", src = cms.InputTag("patMuonsWithTrigger"), cut = cms.string(**QUALITY\_CUTS** + ' && ' + **IN\_ACCEPTANCE** + " && ! triggerObjectMatchesByPath('HLT\_HIL1DoubleMu0\_HighQ\_v\*').empty()"))
- **process.probeMuonsTrk** = cms.EDFilter("PATMuonSelector", src = cms.InputTag("patMuonsWithTrigger"), cut = cms.string("isTrackerMuon && " + **IN\_ACCEPTANCE** + " && " + **TRACK\_CUTS** + " && ! triggerObjectMatchesByPath('HLT\_HIL1DoubleMu0\_HighQ\_v\*').empty()"))

## In temp\_Muld.py

- **process.tpPairsNew** = cms.EDProducer("CandViewShallowCloneCombiner", cut = cms.string('60.0 < mass < 120.0 && abs(y) < 2.0'), decay = cms.string('tagMuonsDbITrg@+ probeMuonsTrk@-'))
- **TRACK\_CUTS** = "track.numberValidHits > 10 && track.normalizedChi2 < 4 && track.hitPattern.pixelLayersWithMeasurement > 0"
- **GLB\_CUTS** = "isGlobalMuon && isTrackerMuon && globalTrack.normalizedChi2 < 10 && muonID('TrackerMuonArbitrated') && globalTrack.hitPattern.numberValidMuonHits > 0 "#move id cut to tracking efficiency
- **IN\_ACCEPTANCE** = '( abs(eta)<2.4 && pt>=10 )'
- **QUALITY\_CUTS** = **GLB\_CUTS** + ' && ' + **TRACK\_CUTS**
- **flags** = cms.PSet(PassingGlb = cms.string(**QUALITY\_CUTS**),),)

