

# Tau ID efficiency measurement

S3Be workshop

January the 24<sup>th</sup>, 2014

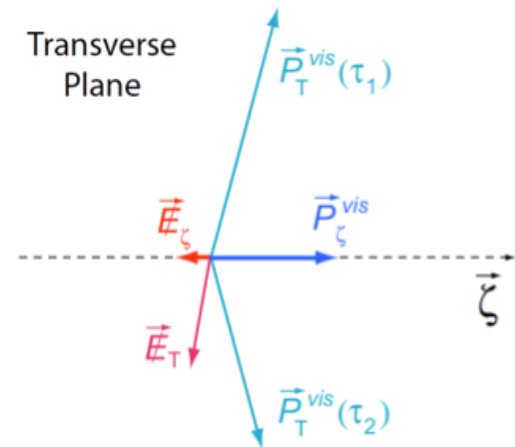
Cécile Caillol

# Objectives

- Measurement of tau ID efficiency data/MC scale factor:
  - Is it equal to 1.0?
  - What is its uncertainty?
  - Does the scale factor depend on tau  $p_T$ ?
  - Does the efficiency depend on the event topology (Drell Yan,  $t\bar{t}$ )?

# Method – $Z \rightarrow \tau_h \tau_\mu$ events

- Selection in brief:
  - 1 isolated muon
  - 1 OS loose tau
  - $MT(\mu, MET) < 40$  GeV
  - $P_\xi = P_\xi^{\text{mis}} - 0.85P_\xi^{\text{vis}} > -15$  GeV
- Divide events whether the tau passes/fails ID (decay mode finding + isolation)
- Fit simultaneously both regions with:
  - Parameter of interest (POI) : tau ID efficiency scale factor
  - Nuisance parameters: luminosity, cross-sections, tau fake rate, MET uncertainties, ...
- Tau ID parameter is anti-correlated between “Pass” and “Fail” regions!



# Background estimation

- **Signal:** From MC DYJets,  $Z \rightarrow \tau_h \tau_\mu$  where the real tau and the real muon have been selected.
- **DY others:** All the other DY events, mainly  $Z \rightarrow \mu\mu$ ,  $Z \rightarrow \tau_\mu \tau_\mu$  and  $Z \rightarrow \tau_h \tau_\mu$  where the wrong leptons have been selected; from MC.
- **ttbar:** from MC.
- **W+jets:** Shape from MC, normalization from high  $M_T$  ( $M_T > 70$  GeV) sideband.
- **QCD:** shape and normalization from SS region.

# Uncertainties

	Signal	DY others	W+jets	QCD	TTbar
Luminosity	2.6%	2.6%	-	-	2.6%
DY xs	3.0%	3.0%	-	-	-
ttbar xs	-	-	-	-	15%
W+jets norm	-	-	3%	-	-
Mu ID/iso	2.0%	2.0%	-	-	2.0%
QCD norm (shape)	-	-	-	yes	-
QCD OS/SS extrap.	-	-	-	5%	-
Tau scale (shape)	3.0%	3.0%	3.0%	3.0%	3.0%
Tau FR (shape)	-	30.0%	-	-	30.0%
bin-by-bin (threshold=0.05)	yes	yes	yes	yes	yes
Tracking (shape)	3.8%	3.8%	3.8%	-	3.8%
Hadronization (shape)	-	10.0%	10.0%	-	10.0%

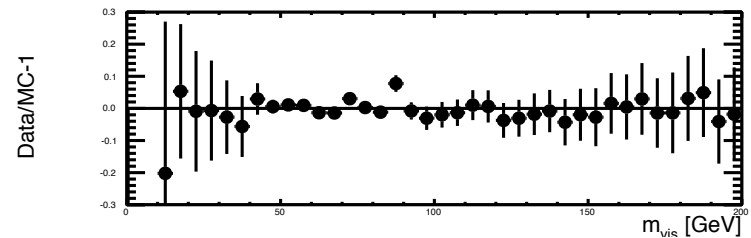
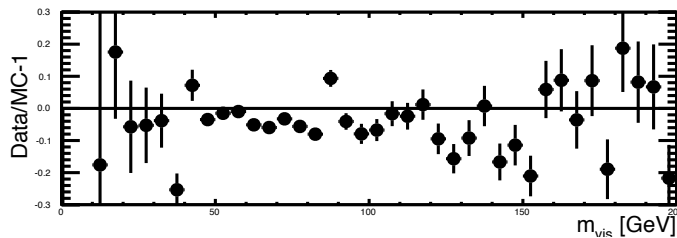
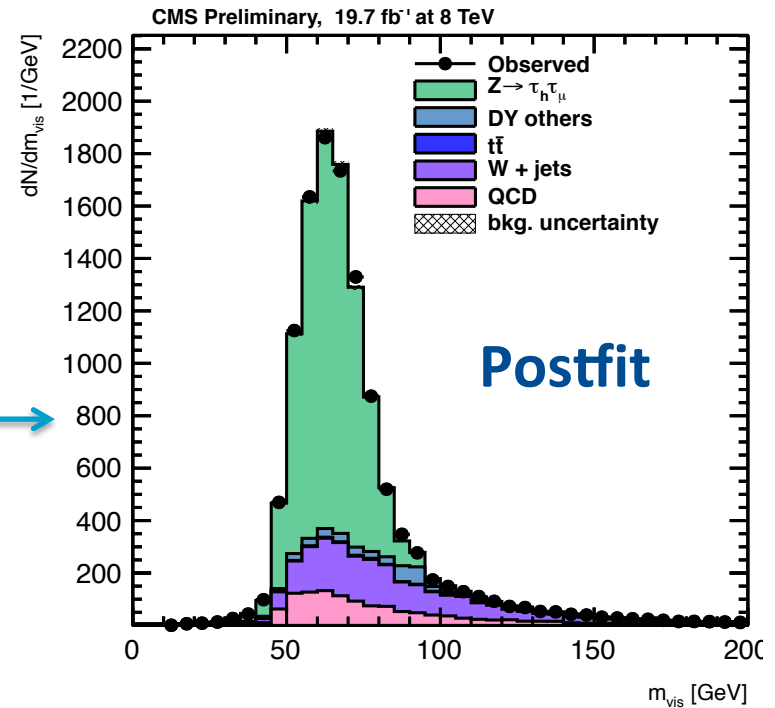
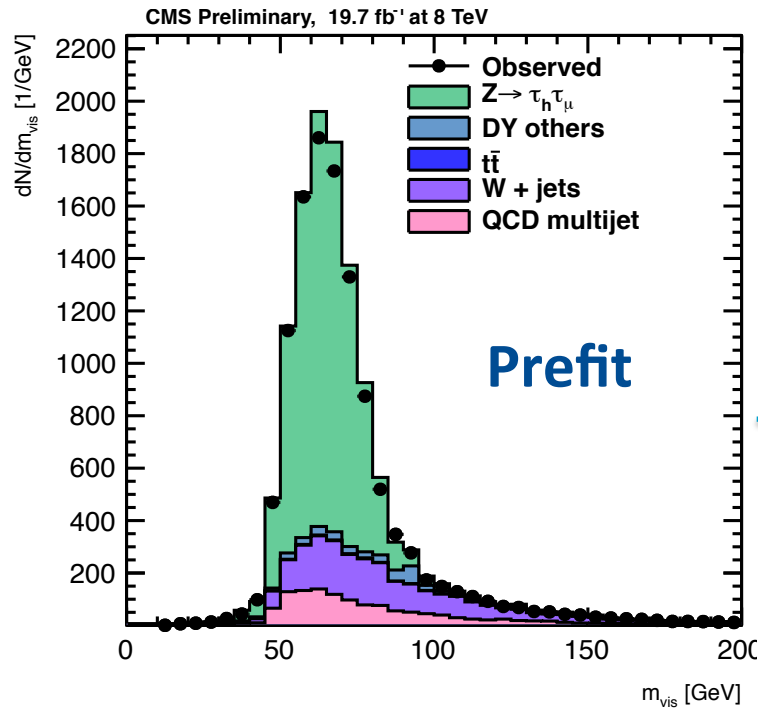
Fully correlated

Uncorrelated

Anti-correlated

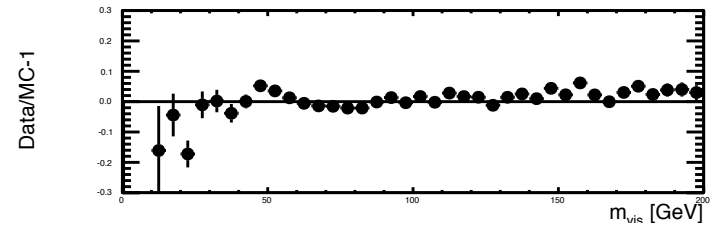
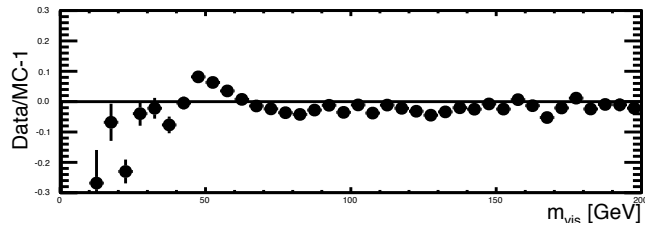
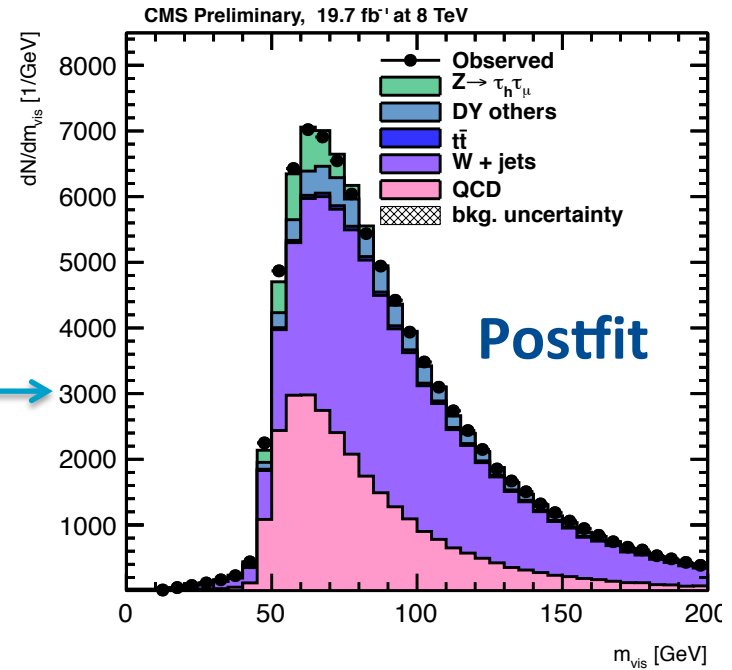
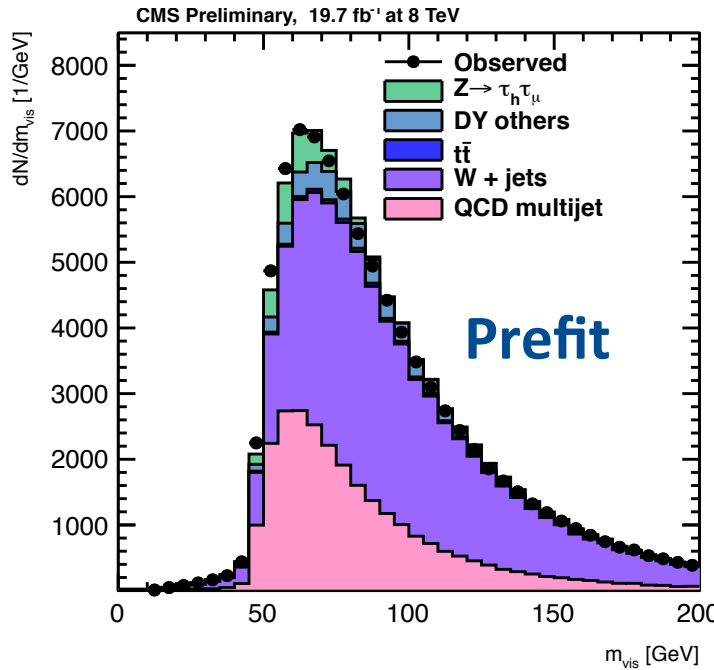
between pass and fail

# “Pass” fit - $Z \rightarrow \tau_h \tau_\mu$ events



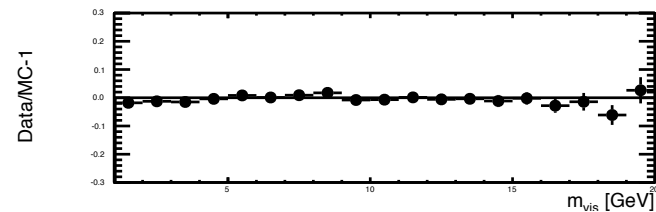
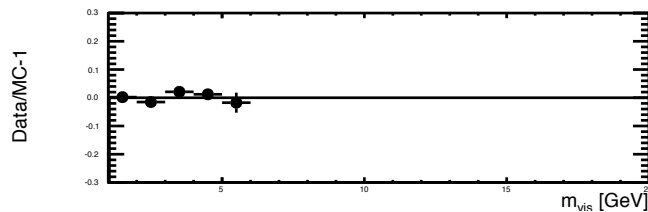
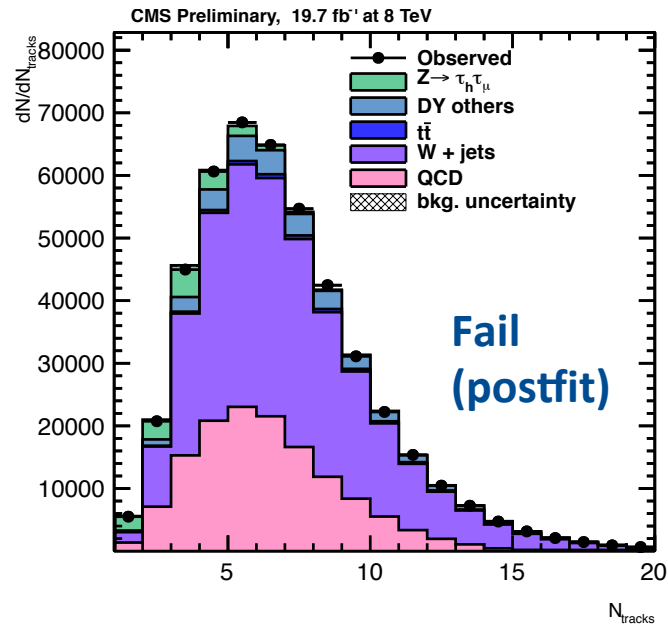
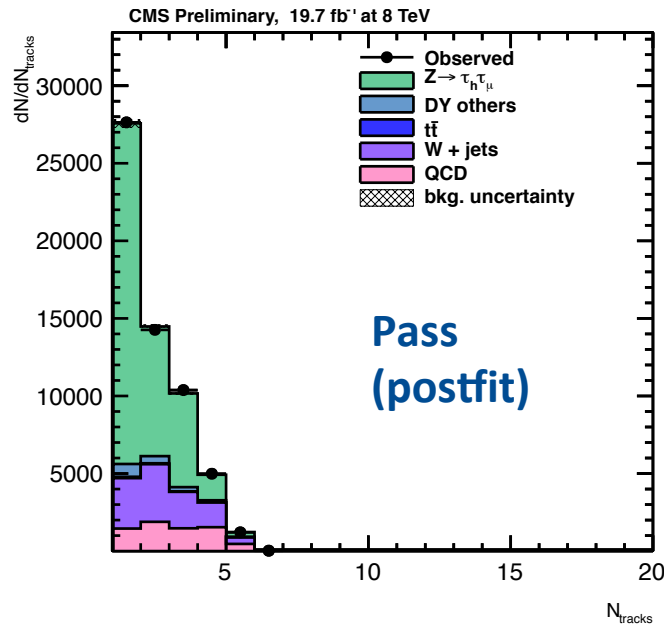
- Observable:  $m_{visible}(\mu, \tau)$

# “Fail” fit - $Z \rightarrow \tau_h \tau_\mu$ events



- Scale factor:  $0.950 \pm 0.046$  (“Pass” and “Fail” fitted simultaneously)

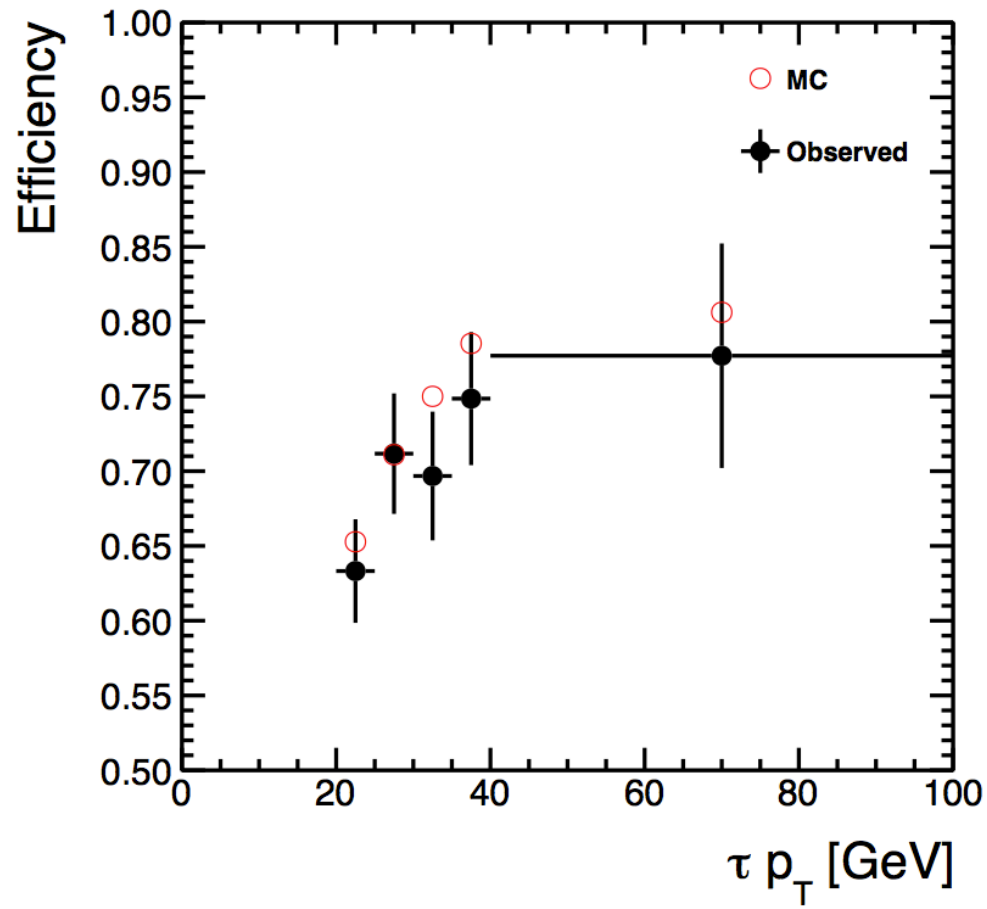
# Fit – $Z \rightarrow \tau_h \tau_\mu$ events



- $N_{tracks}$ : number of charged tracks in tau isolation and signal cones  
 → Variable independent of tau pT!
- Data/MC scale factor (HPS loose 3 Hits): 0.96 +/- 0.04  
 → Compatible with measurement using  $m_{vis}$  as observable



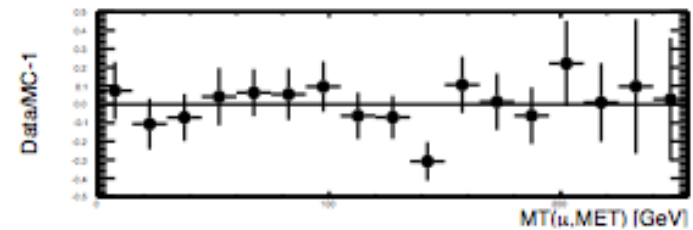
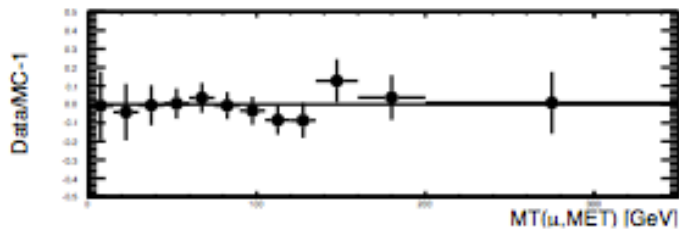
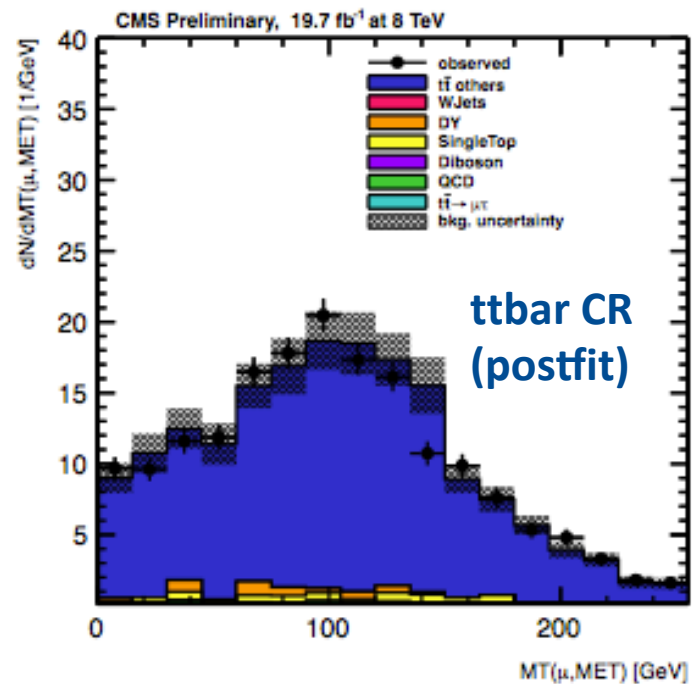
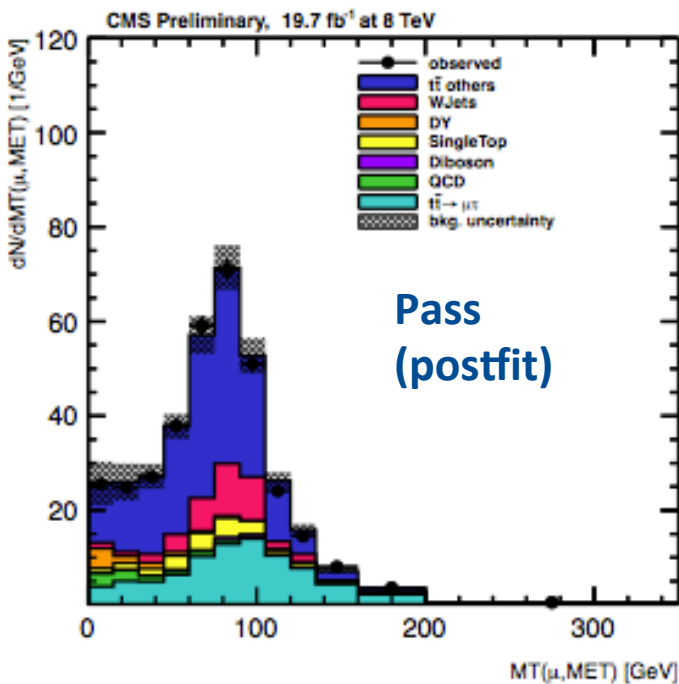
# First measurement in tau pT bins



# Method – $t\bar{t} \rightarrow \mu\tau_h$ events

- Selection overview:
  - IsoMu24 trigger
  - 1 isolated muon
  - 1 OS loose tau
  - 2 or 3 jets with  $p_T > 30$  GeV
  - At least 1 b-jet
  - MET > 40 GeV
- “Fail” region idle because of too small signal fraction → Use a  $t\bar{t}b\bar{b}$  control region instead to control nuisance parameters
- Selection in  $t\bar{t}b\bar{b}$  control region similar as signal region but:
  - 2 isolated OS muons
  - 1 loose tau failing ID

# Results – $t\bar{t} \rightarrow \mu\tau_h$ events



# Results – $t\bar{t} \rightarrow \mu\tau_h$ events

Discriminator	MC efficiency	Scale factor
Combined isolation 8-hit Loose <sup>1</sup>	59.1%	$1.001 \pm 0.098$
Combined isolation 8-hit Medium <sup>1</sup>	47.5%	$0.964 \pm 0.107$
Combined isolation 8-hit Tight <sup>1</sup>	43.8%	$0.977 \pm 0.114$
Combined isolation 3-hit Loose <sup>1</sup>	58.4%	$0.976 \pm 0.097$
Combined isolation 3-hit Medium <sup>1</sup>	46.4%	$0.970 \pm 0.102$
Combined isolation 3-hit Tight <sup>1</sup>	42.8%	$0.994 \pm 0.112$
MVA isolation Loose <sup>1</sup>	65.2%	$1.138 \pm 0.100$
MVA isolation Medium <sup>1</sup>	55.6%	$1.053 \pm 0.101$
MVA isolation Tight <sup>1</sup>	46.8%	$1.004 \pm 0.105$
MVA2 isolation Loose <sup>1</sup>	65.9%	$1.089 \pm 0.098$
MVA2 isolation Medium <sup>1</sup>	60.2%	$1.064 \pm 0.105$
MVA2 isolation Tight <sup>1</sup>	52.2%	$1.060 \pm 0.108$

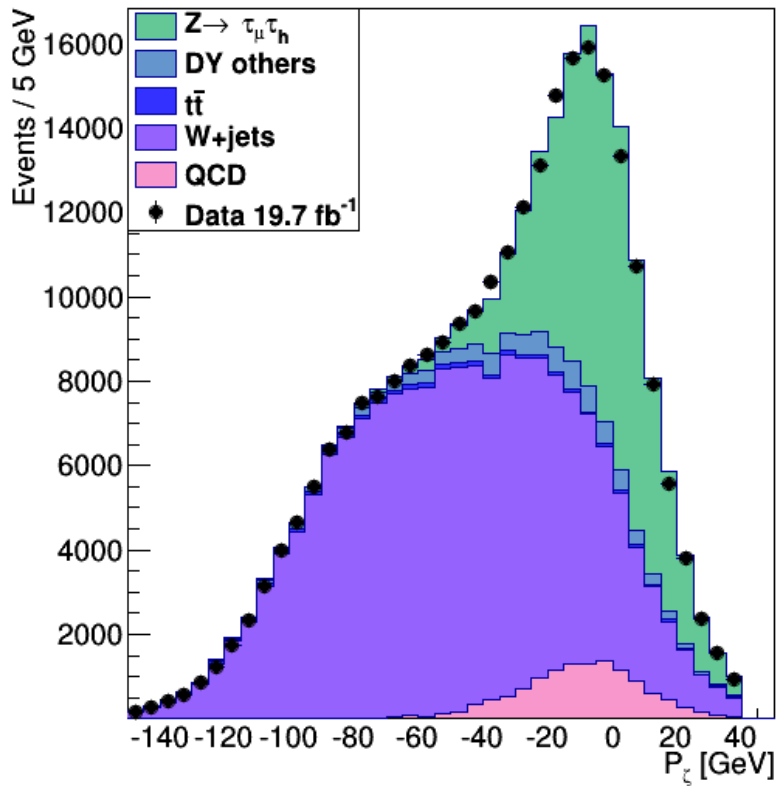
# Summary

- Tau ID efficiency measured in data in DY and  $t\bar{t}$  events
- Scale factors more or less compatible with 1.0 (slight trend to be lower)
- Efficiency smaller in  $t\bar{t}$  events than in Drell-Yan events due to higher hadronic activity
- Complementary to  $Z \rightarrow \mu\mu / Z \rightarrow \tau\tau$  ratio method, but possibility to measure efficiency in bins of tau  $p_T$
- Scale factors independent of tau  $p_T$
- Next step is to measure scale factors for new tau ID discriminators
- Results to be published in a tau performance paper (summer 2014).

# BACK-UP

# Control distribution (P zeta)

## Pass



## Fail

