Methods for L1 trigger efficiency measurement using Cosmic Muon data (CRAFT08)

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Outlines:

- Sample
- Track Selection
- Methods
- Performance of different methods
- Conclusions

Sample

MC :

/CosmicMC_BON_10GeV_AllCMS/Winter09_COSMMC_22X_V6_TrackingPointing_ToscaMap090322_v1/GEN-SIM-RAW-RECO

CRAFT08 data:

/Cosmics/Commissioning08_CRAFT_ALL_V12_229_Tosca090322_ReReco_FromTrackerPointing_v1/RAW-RECO

→ Tracker pointing tracks

→ MC and data are skimmed for tracker pointing muons : R = 90 cm and z = 130 cm

→ Re-processed with new B-field

Runs Number	
Run Number	number of events
66676	143182
66722	347929
66740	185505
66746	198530
66748	287440
66783	267735
67818	420791

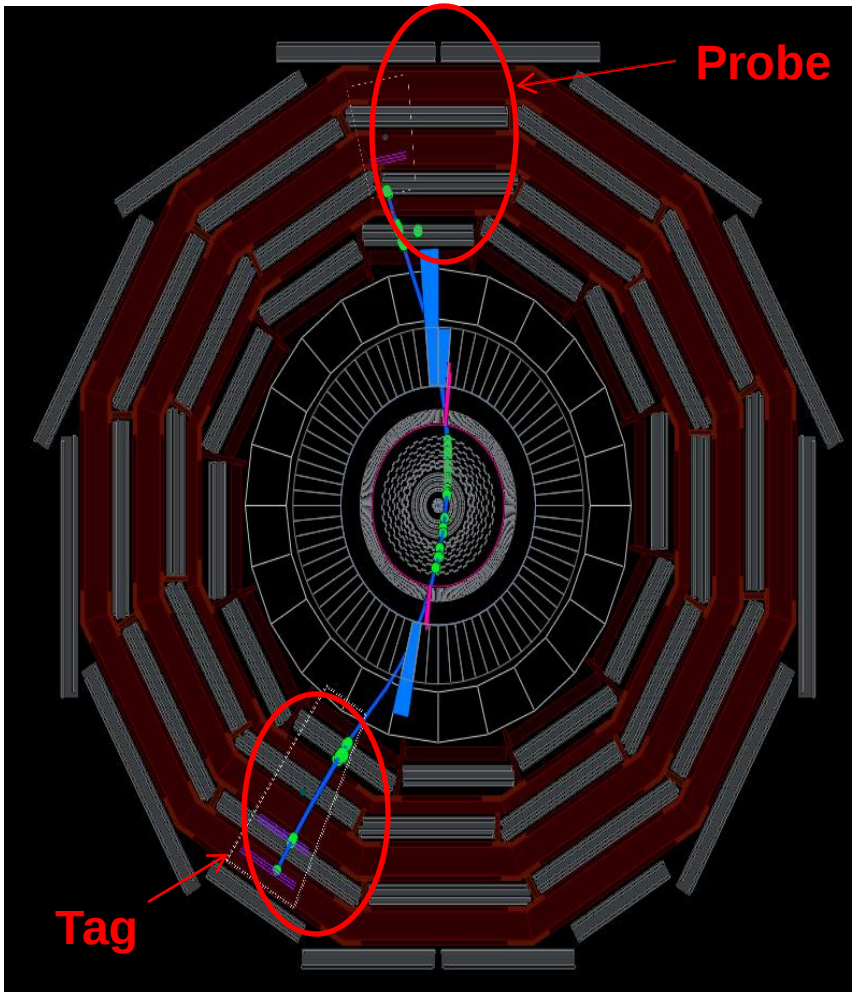
Table 1: List of good runs used.

Track Selection

- Standalone Track Collection “cosmicMuons1Leg”.
- Taking only downward tracks ($p_y < 0$).
- Momentum of tracks > 5 GeV
- $hits_{DT} + hits_{RPC} > 20$

Run → Cut ↓	data	Monte-Carlo
downward tracks	91.56 ± 0.02	96.53 ± 0.02
Momentum > 5 GeV	79.62 ± 0.03	92.85 ± 0.03
$Hits_{DT} + Hits_{RPC} > 20$	88.59 ± 0.03	86.82 ± 0.03

Tag&Probe



- Tracks propagated (taking outermost point) along/opposite the momentum upto 2nd muon (R = 500 cm) MB station (bottom) using Stepping Helix propagator.

→ Direction of propagation is decided by checking Outermost position WRT 2nd MB station.

If r (outermost Position) > R : Opposite to Momentum

If r (outermost Position) < R : Along the Momentum

- L1 trigger DT|| RPC object checked in the vicinity of tag.

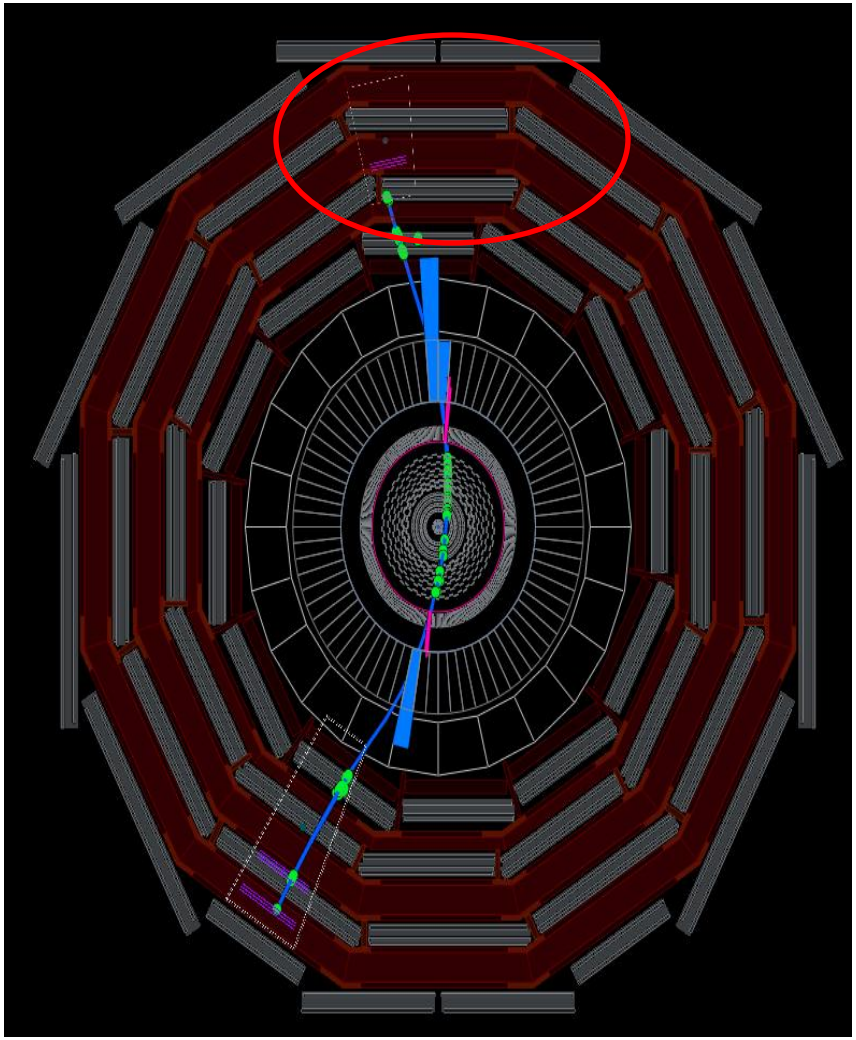
If trigger found, propagate the track (taking innermost point) in top half upto in 2nd muon station. Look for trigger !

→ Direction of propagation is decided by checking innermost position WRT 2nd MB station.

If r (innermost Position) > R : Along the Momentum

If r (innermost Position) < R : Opposite to Momentum

DTvsRPC

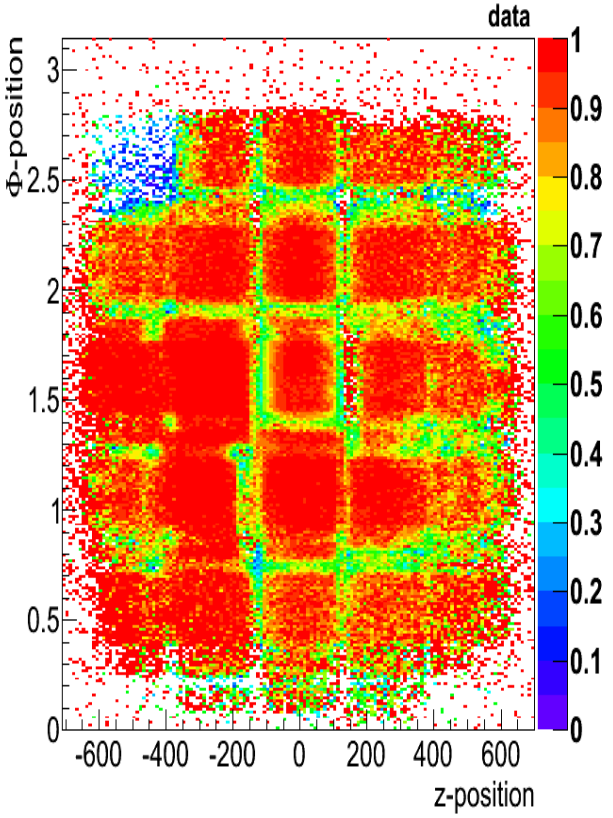


- This method is based on the redundancy of Muon system if one trigger is fire in some region, second trigger must be fired.

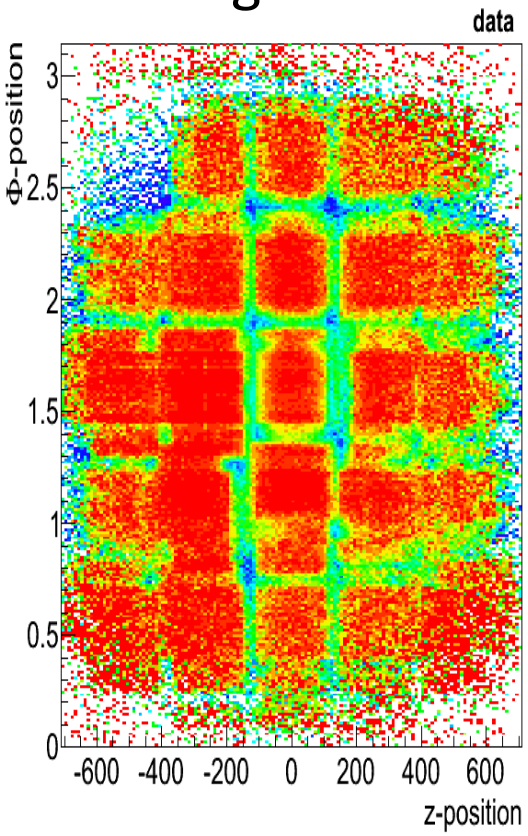
- Propagate track in any direction (top half in present case) look for the RPC (DT) trigger in the vicinity of the track. If RPC (DT) trigger search for DT (RPC) trigger in same region.

DT Efficiency

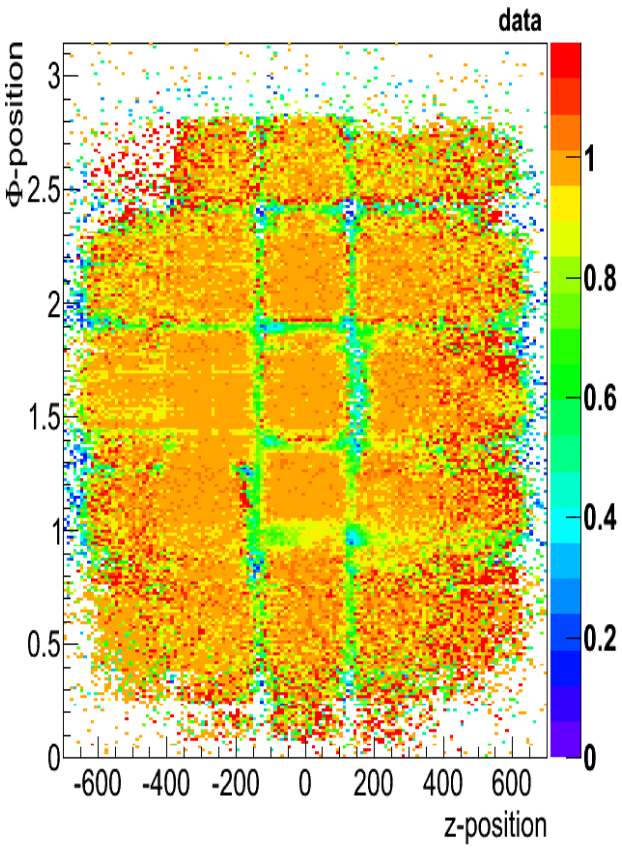
DTvsRPC



Tag&Probe



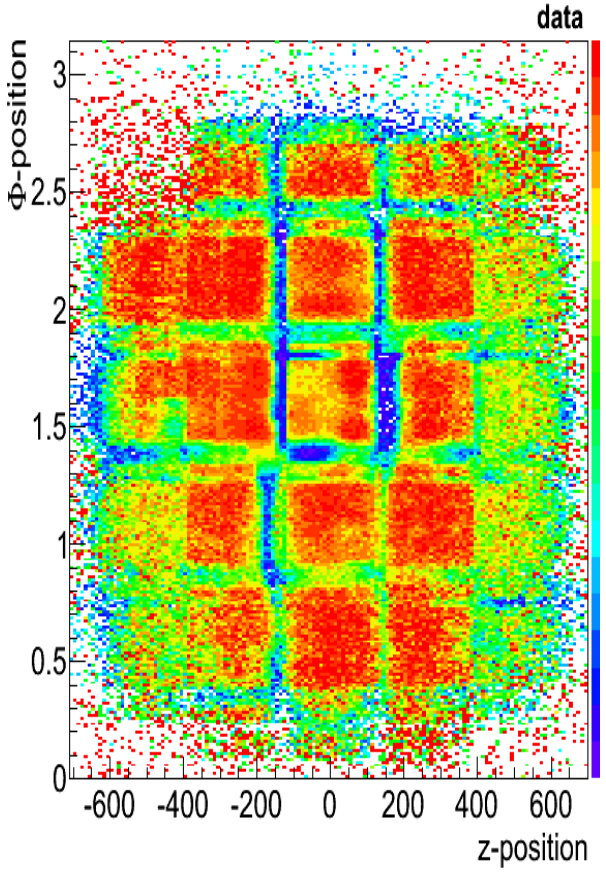
Tag&Probe/DTvsRPC



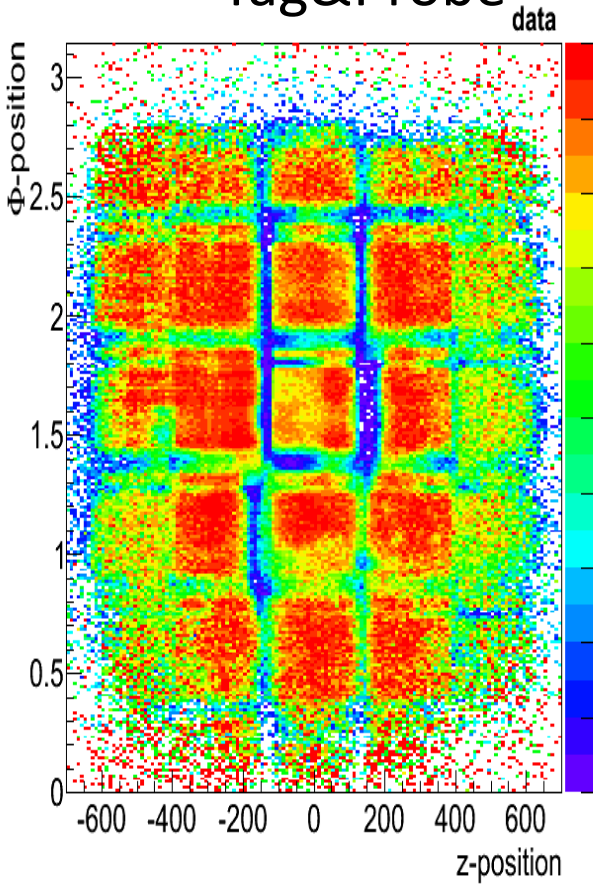
- Most of the inefficiency is because geometrical acceptance (like cracks, chimneys).
- Effect of cracks between YB+-2 and YB+-1 is not visible because of selecting only tracker pointing muons

RPC Efficiency

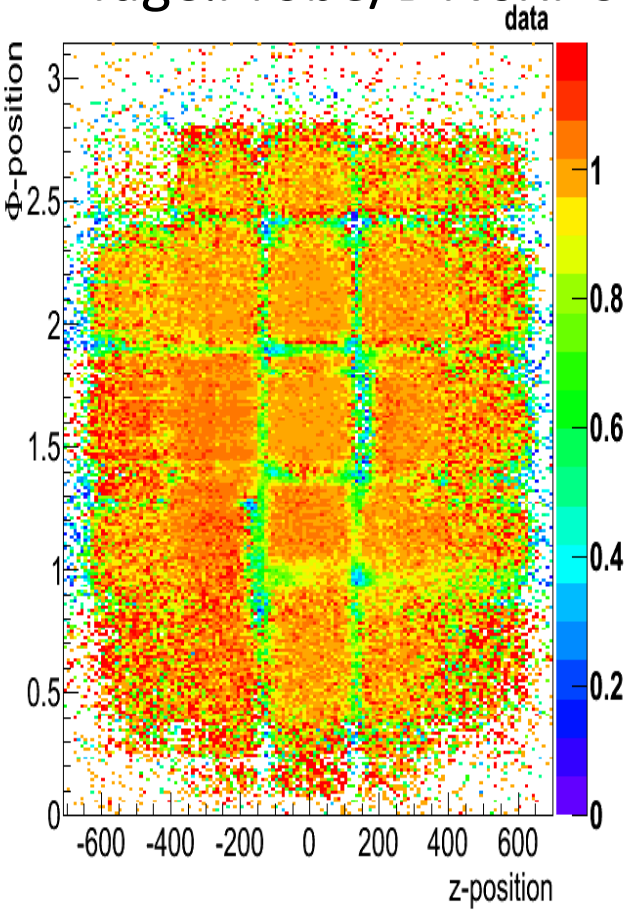
DTvsRPC



Tag&Probe



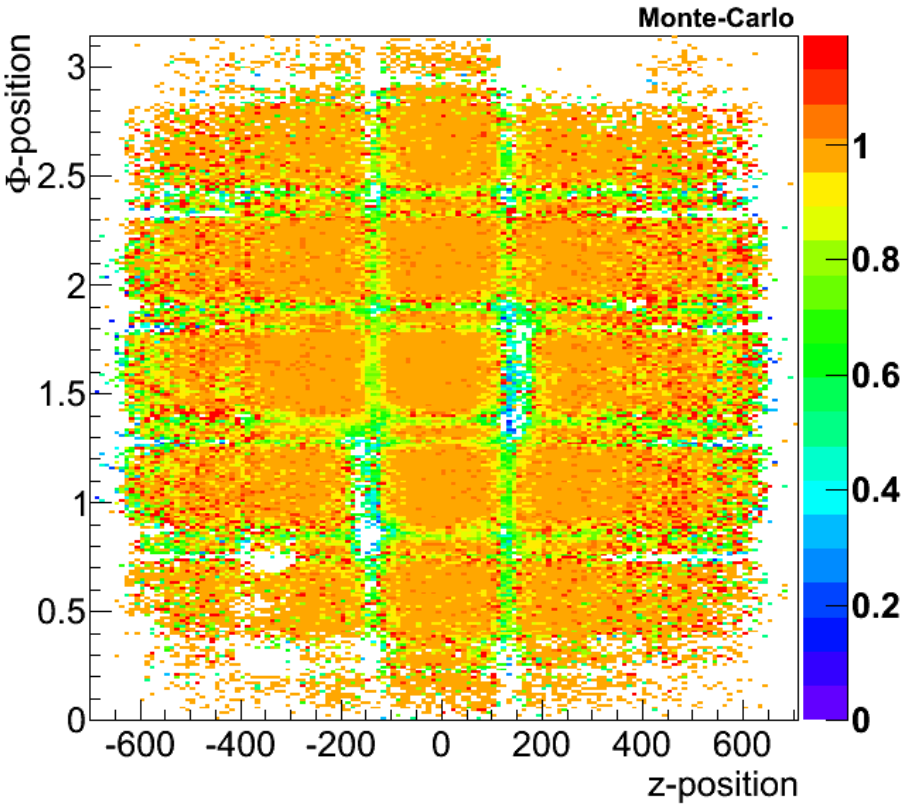
Tag&Probe/DTvsRPC



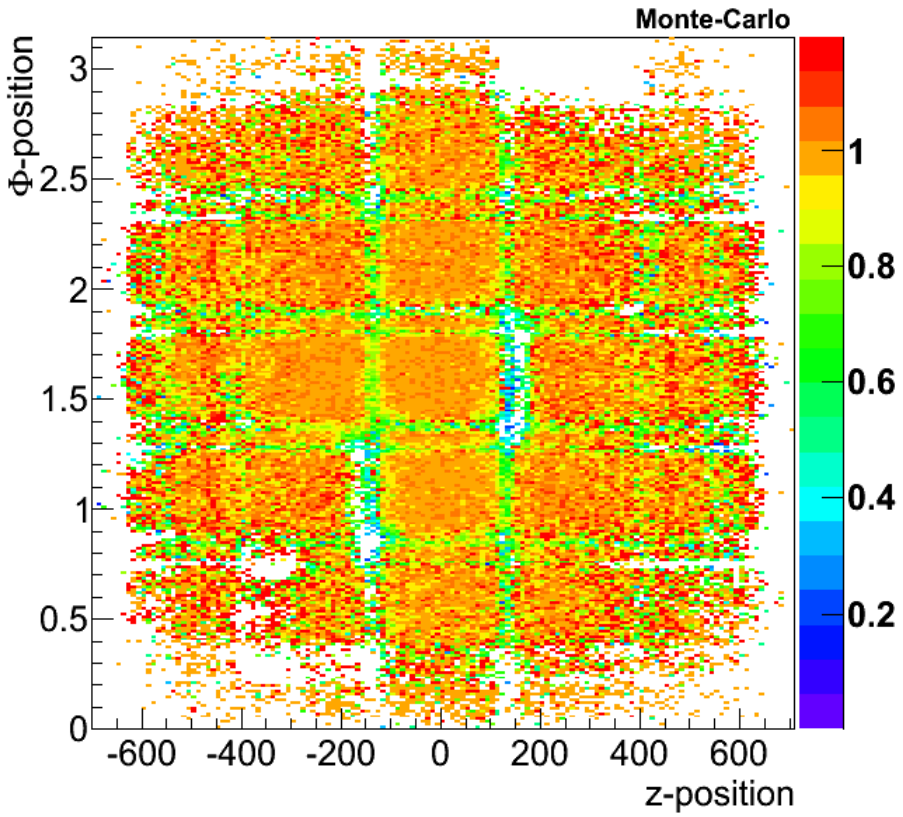
- DTvsRPC method is not good in the region where DT and RPC triggers have correlated inefficiency

Performance with MC

Ratio of DT Efficiency

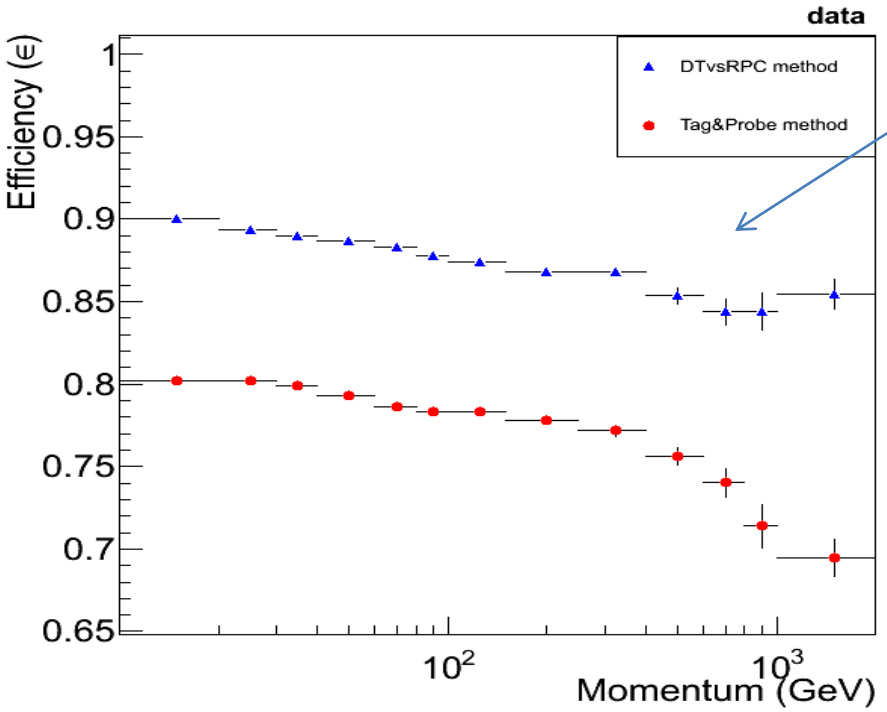


Ratio of RPC Efficiency



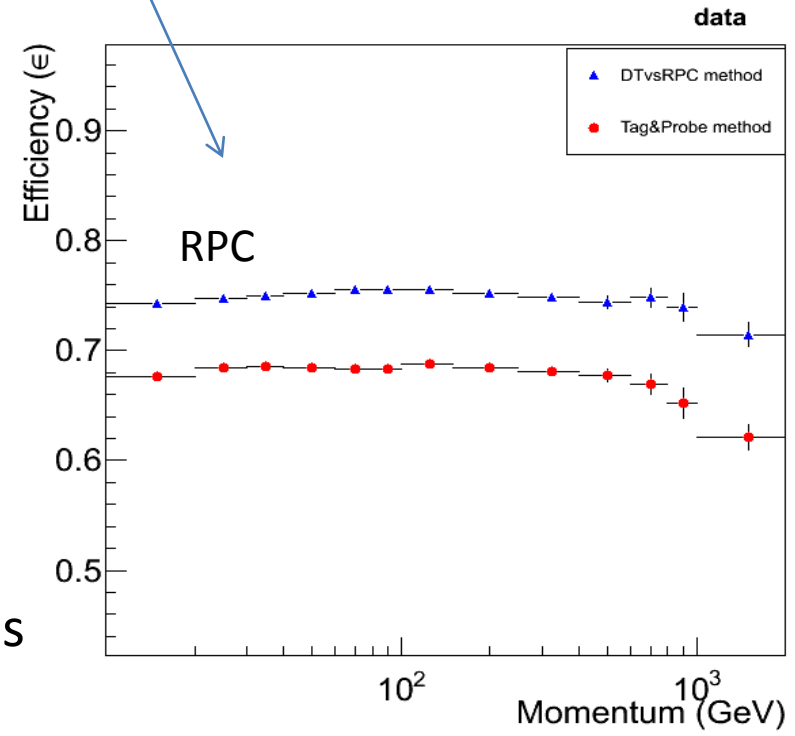
→DTvsRPC and Tag&Probe methods are in good in agreement even for MC

DT & RPC efficiency as function of track momentum



DT Efficiency

RPC Efficiency



→Two method differ by 8-10%, mainly due to crack regions (as seen in previous slides)

→ This difference disappear with removal these regions (next slides)

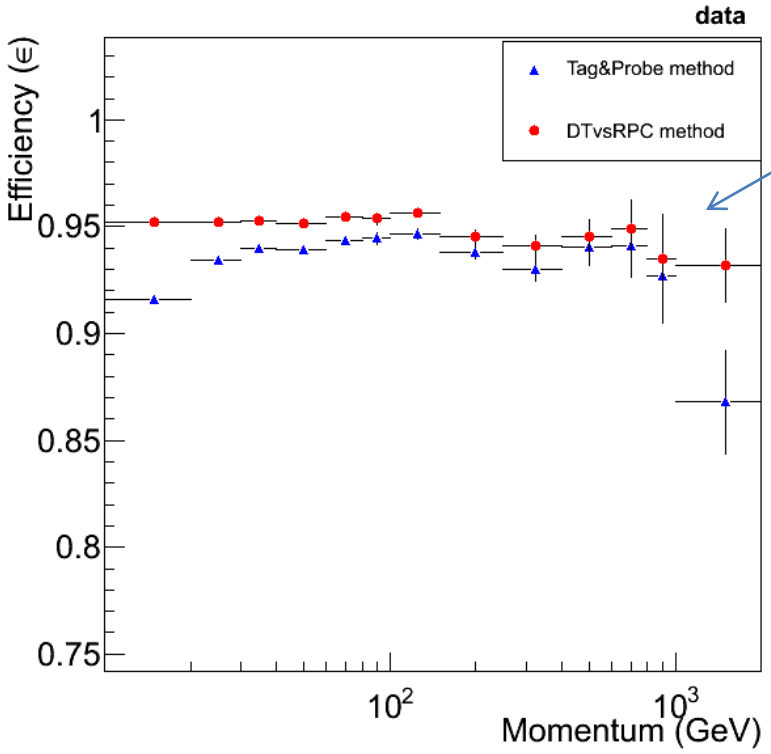
Acceptance cut:

Aims to select only center of the sector (top 3) in center of the wheels

- $|\text{z-position}| < 100$ cm or ($|\text{z-position}| < 300$ cm and $|\text{z-position}| > 200$ cm) or ($|\text{z-position}| < 550$ cm and $|\text{z-position}| > 450$ cm).
- ($\Phi > 0.96$ rad. and $\Phi < 1.13$ rad.) or ($\Phi > 1.48$ rad. and $\Phi < 1.66$ rad.) or ($\Phi > 2.01$ rad. and $\Phi < 2.18$ rad.)

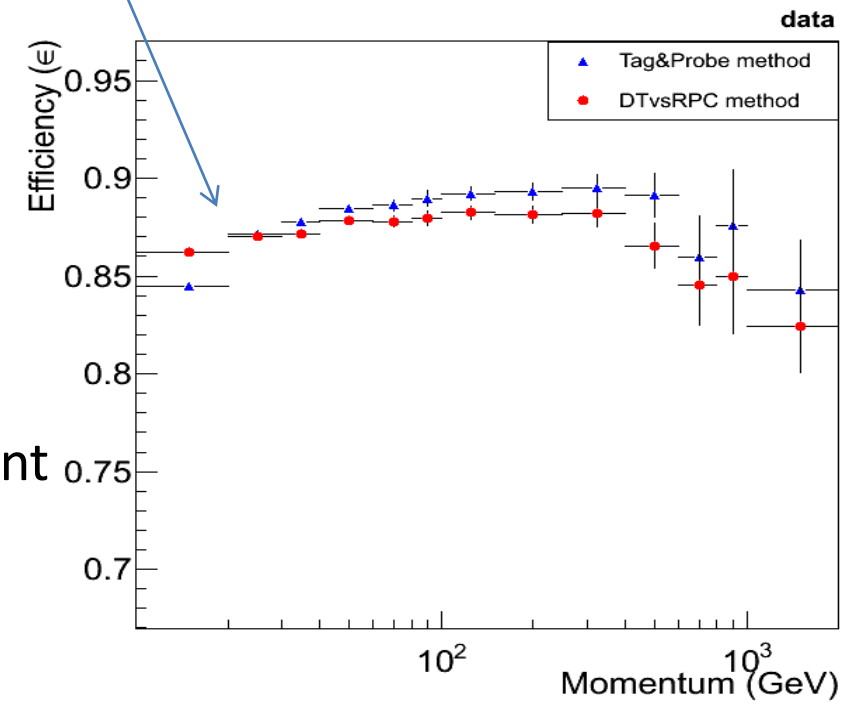
Z and ϕ are the positions of the tracks at 2nd muon station in top half

Comparison after removal of cracks



DT efficiency

RPC efficiency

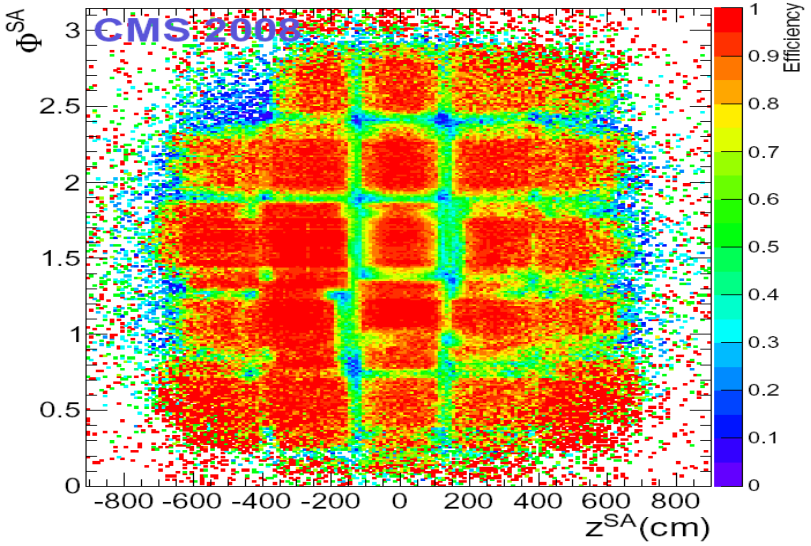


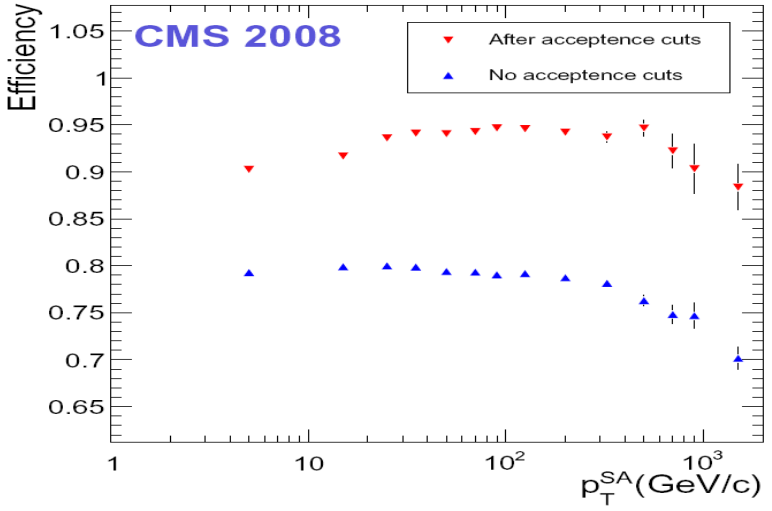
→Two methods are in good agreement in central regions
(still there is difference of 2-3%)

Results in CRAFT paper for L1 DPG

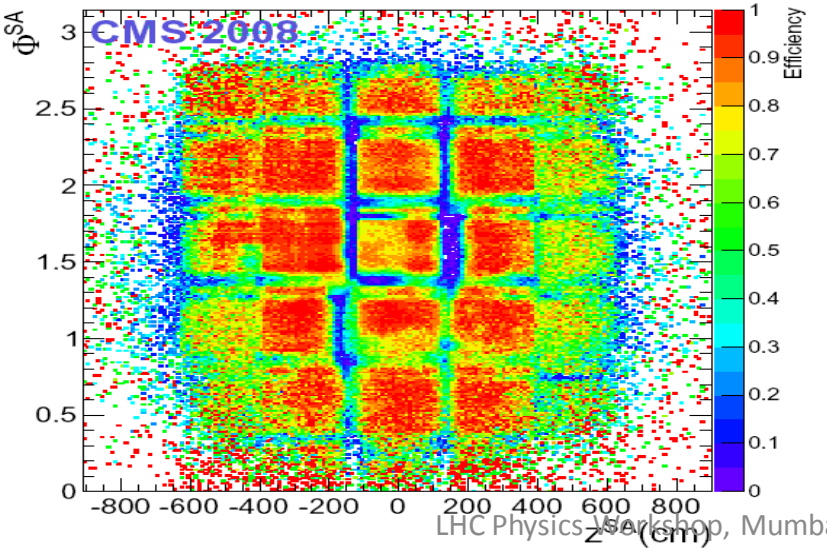
→ DT & RPC efficiency, z/ Φ map and function track pT ,using Tag&Probe method (which more unbiased compare to DTvsRPC)

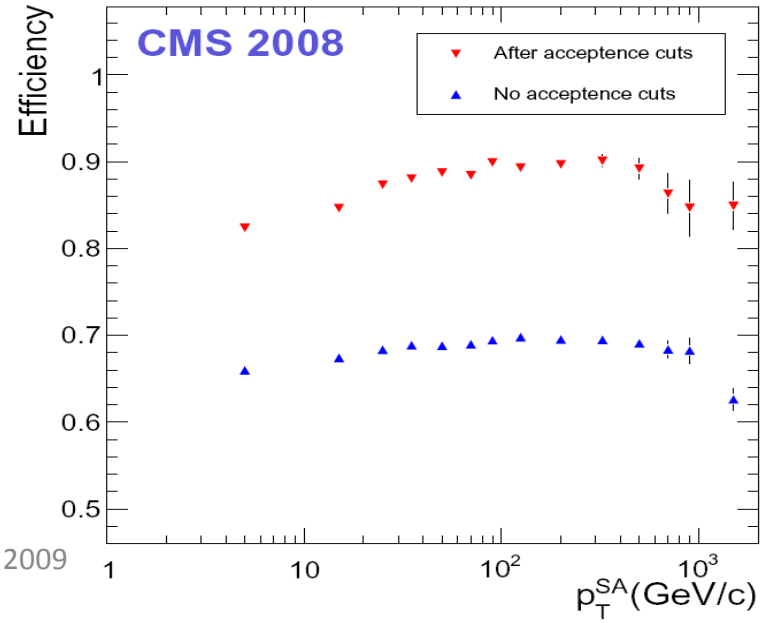
DT Efficiency





RPC Efficiency





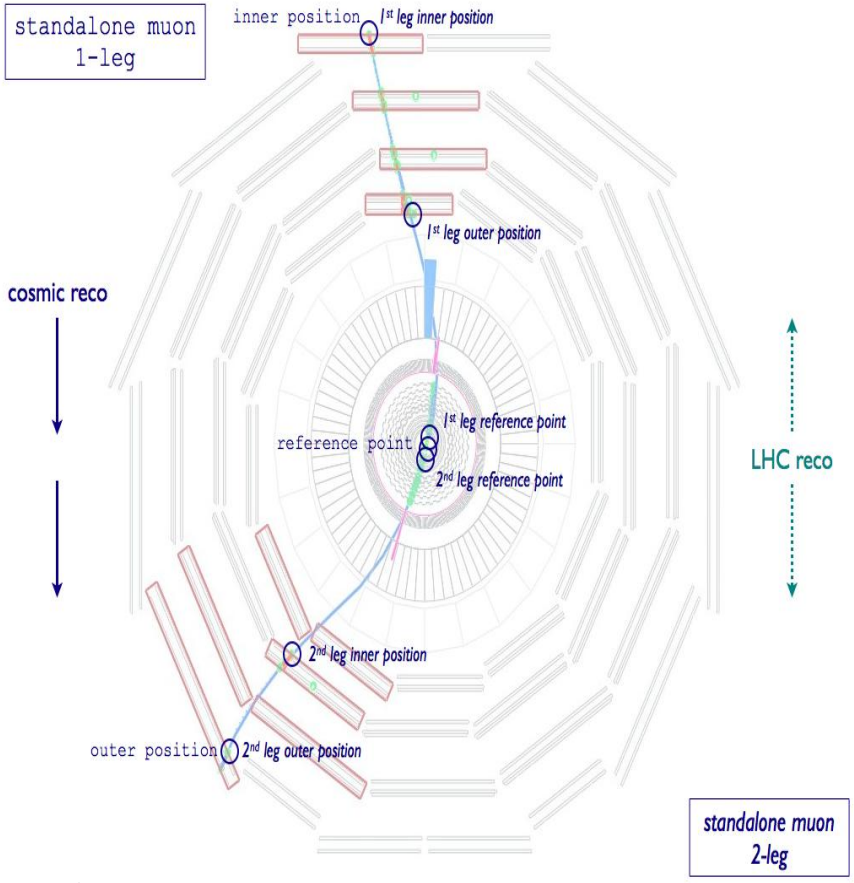
Conclusions/To-Do

- DT Efficiency: 92-96% (using DTvsRPC and TP method) at high pT. At low pT 70-90% (TP method) an 90-92% (DTvsRPC method).
- DT efficiency inside the sector agrees with expected intrinsic DT trigger primitive efficiency (92-98%)
- RPC Efficiency: 85-90% (using DTvsRPC method and TP method).
- DTvsRPC and TP method give good agreement (difference 2-3%).
- Both methods give similar performance for MC as well qualitatively.

✓ Re-checking performance of two methods with CRAFT09 data

✓ Estimation of RPC and CSC trigger efficiency in endcap

Access of Informations



Muon Collection:

```
edm::Handle<reco::TrackCollection> muonHandle;
iEvent.getByLabel(cosmicMuon1Leg,muonHandle);
```

RPC barrel Trigger:

```
edm::Handle<std::vector<L1MuRegionalCand> > rpcBarrel;
iEvent.getByLabel ("gtDigis","RPCb",rpcBarrel);
```

DT Trigger:

```
edm::Handle<std::vector<L1MuRegionalCand> > DT;
iEvent.getByLabel ("gtDigis","DT",DT);
```

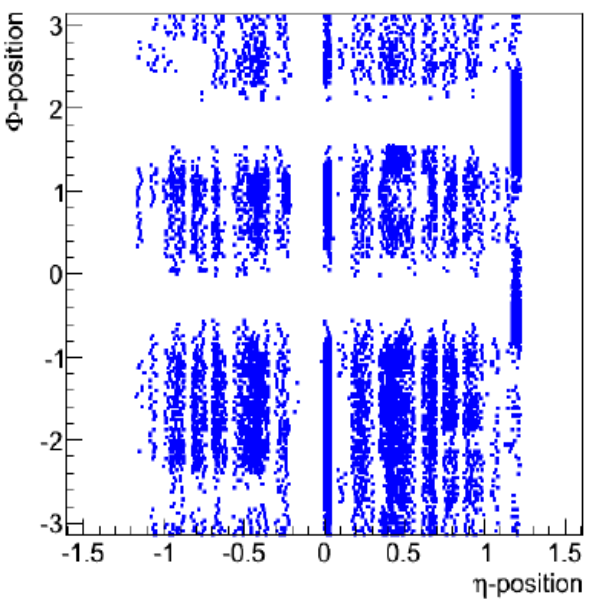
Propagation of tracks :

```
SteppingHelixPropagator *thePropA  = new
SteppingHelixPropagator(&*bField,oppositeToMomentum/Along);
```

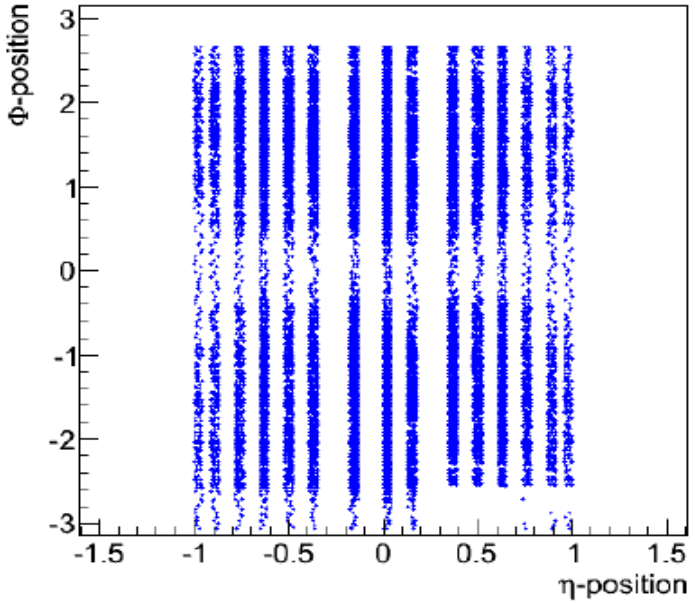
→ Track is propagated upto 2nd Muon Station (Trigger information (eta/phi) evaluated here). On the surface of cylinder with radius R = 500 cm

Trigger Matching

Only $\Delta\phi$ matching because η is not well configured for DT trigger primitive



DT



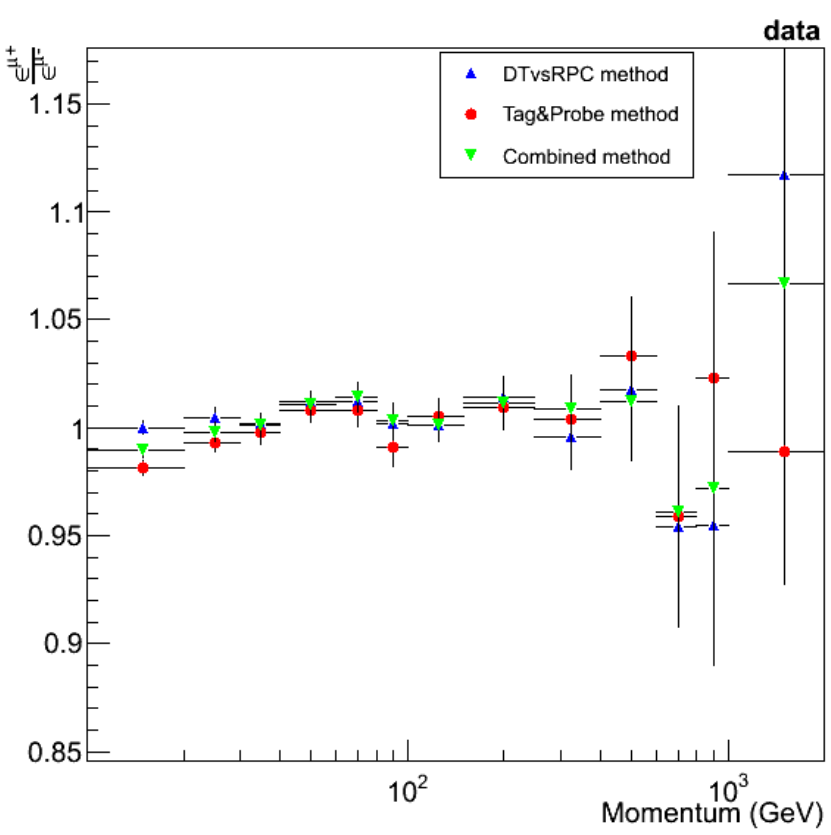
RPC

L1 efficiency	DT matching at Top	DT matching at Bottom	RPC matching at Top	RPC matching at Bottom
Tag&Probe method				
DT efficiency	0.872 rad. (50^o)	0.872 rad. (50^o)	-	0.513 rad. (30 ^{o})
RPC efficiency	-	0.872 rad. (50^o)	0.872 rad. (50^o)	0.513 rad. (30 ^{o})
DTvsRPC method				
DT efficiency	0.872 rad. (50^o)	-	0.513 rad. (30 ^{o})	-
RPC efficiency	0.872 rad. (50^o)	-	0.872 rad. (50^o)	-

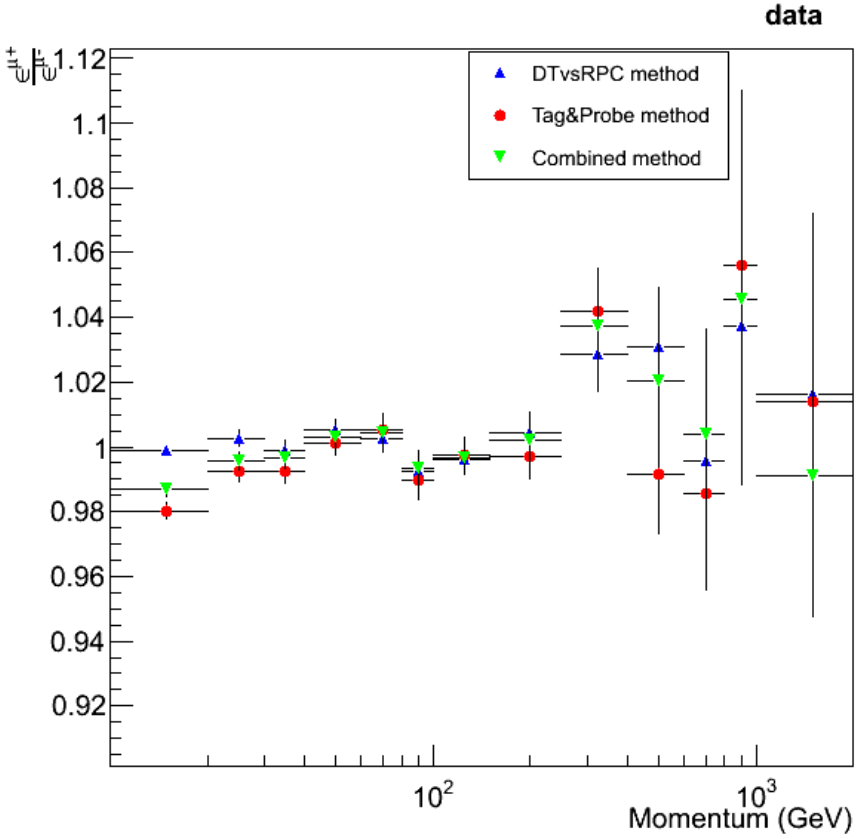
→ Wide $\Delta\phi$ used for matching because of mis -configuration of some channels in the trigger primitive assignment

Charge dependence

Ratio of RPC Efficiency for +ve and –ve muons



Ratio of DT Efficiency for +ve and –ve muons



→ **There seems to be no biases because of charge of tracks**

Integrated Trigger efficiency

Method	Trigger	Charge	data	Monte-Carlo
DTvsRPC method	DT Eff.	μ^+	95.29 ± 0.06	97.44 ± 0.07
		μ^-	95.15 ± 0.07	97.49 ± 0.08
	RPC Eff.	μ^+	87.04 ± 0.10	72.24 ± 0.17
		μ^-	86.62 ± 0.11	72.44 ± 0.19
Tag&Probe method	DT Eff.	μ^+	92.56 ± 0.08	96.97 ± 0.07
		μ^-	93.12 ± 0.09	97.00 ± 0.08
	RPC Eff.	μ^+	86.24 ± 0.11	71.99 ± 0.18
		μ^-	86.58 ± 0.12	72.07 ± 0.20
Combined method	DT Eff.	μ^+	92.94 ± 0.07	96.90 ± 0.07
		μ^-	93.19 ± 0.08	96.90 ± 0.07
	RPC Eff.	μ^+	85.07 ± 0.10	71.82 ± 0.16
		μ^-	84.98 ± 0.11	71.98 ± 0.19

Table 4: DT/RPC trigger efficiency estimated using different method.

→ RPC efficiency is low in case of MC because RPC trigger pattern is not properly set.