

Paolo Giacomelli  
CMS-GEM Italia meeting  
Wednesday, January 22nd, 2014



# Strategy

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- Choose benchmark signals with muons ranging from few GeV to a few TeV
  - $H \rightarrow ZZ \rightarrow 4\mu$
  - $H \rightarrow \mu\mu$
  - $H \rightarrow \tau\tau \rightarrow \mu + \tau_{\text{had}}$
  - $Z \rightarrow \mu\mu$
  - $Z' \rightarrow \mu\mu$
  - and more...

For the TDR focus only on channels that can provide a solid justification for the GEMs



# Tools

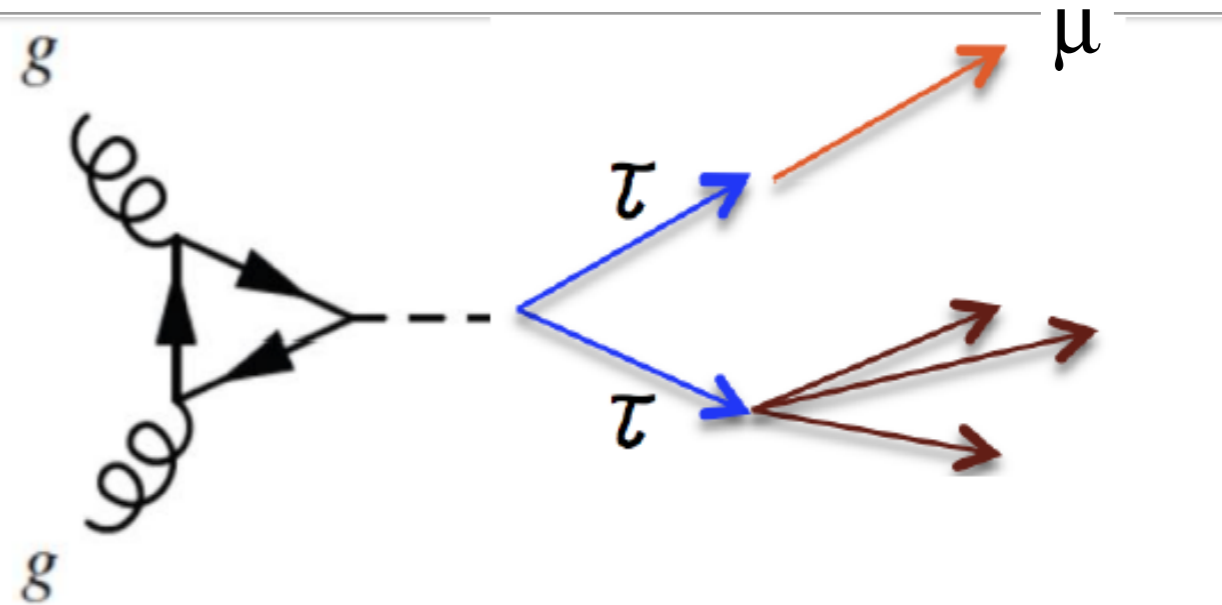
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- We finally start to have MC samples with GEMs (GE1/1) reconstructed
  - <https://twiki.cern.ch/twiki/bin/view/MPGD/SamplesforGEMsCMSPhysics>
    - Used CMSSW\_620\_SLHC5
- We would like to redo many of the studies that we performed at gen. level with the full AODSIM output including the GE1/1



# $H \rightarrow \tau\tau \rightarrow \mu + \tau_{had}$

- Signal:  $\mu + \tau_{had}$
- **Muons coming from tau decay have a quite soft pt spectrum**  $\rightarrow$  Need to keep high The trigger and reconstruction efficiency for soft muons.



Dataset	EVENTS	PU
<a href="#">aabdelal_Pythia6_Tauola_GluGluH_tautau_14TeV_GEN_SIMv5_RECO_CMSSW_6_2_0_SLHC5/</a>	200K	0
<a href="#">/GluGluToHToTauTau_M-125_13TeV-powheg-pythia6/Fall13dr_tsg_PU20bx25_POSTLS162_V2-v1/AODSIM</a>	500K	20

## What's new:

- GEM included in muon track reconstruction, both in standalone and global muon!
- 0 pile up scenario

## Strategy

Two different kind of studies

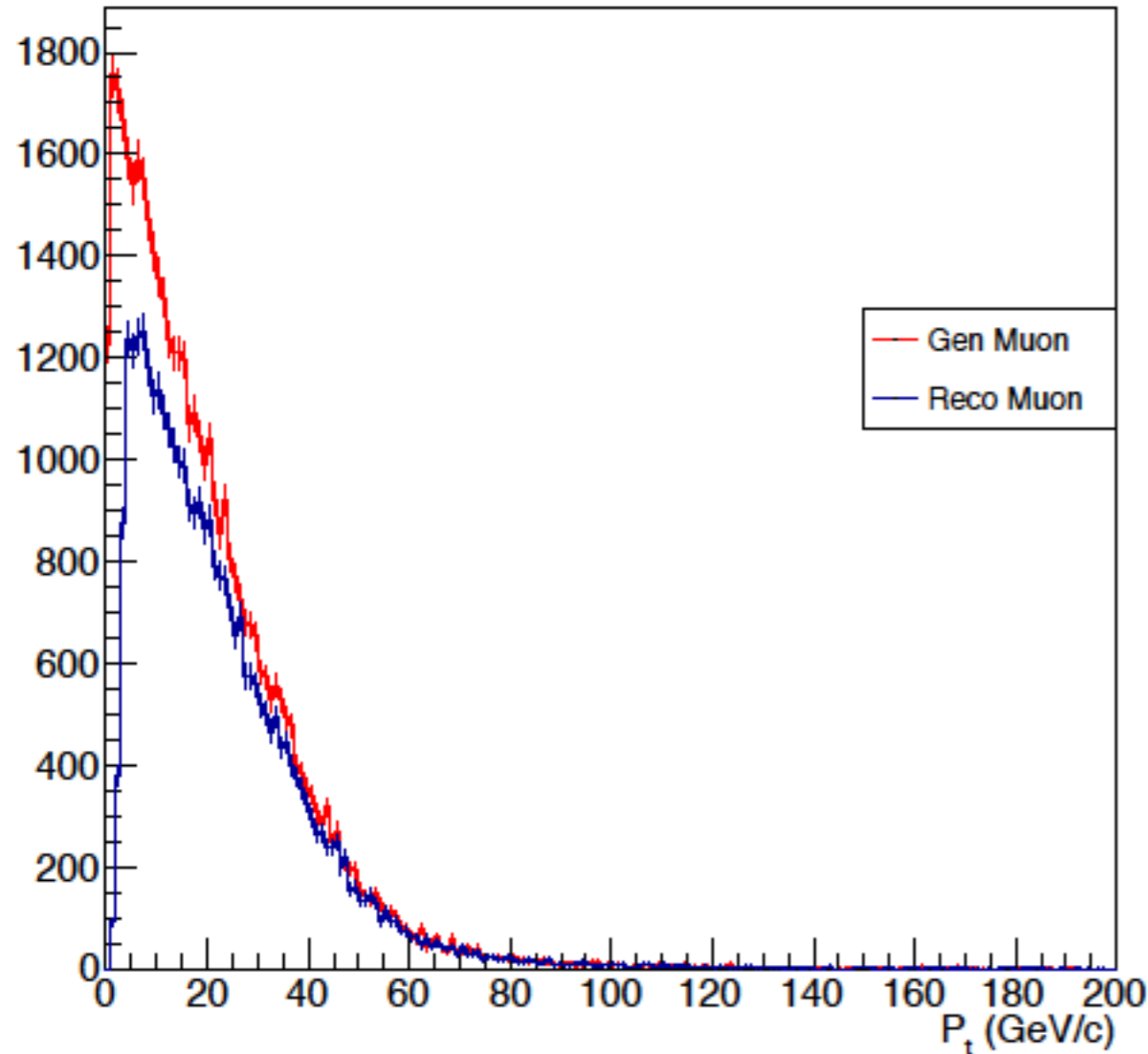
- Baseline analysis following 8 TeV prescription described in HIG-13-004
- Generator-level studies



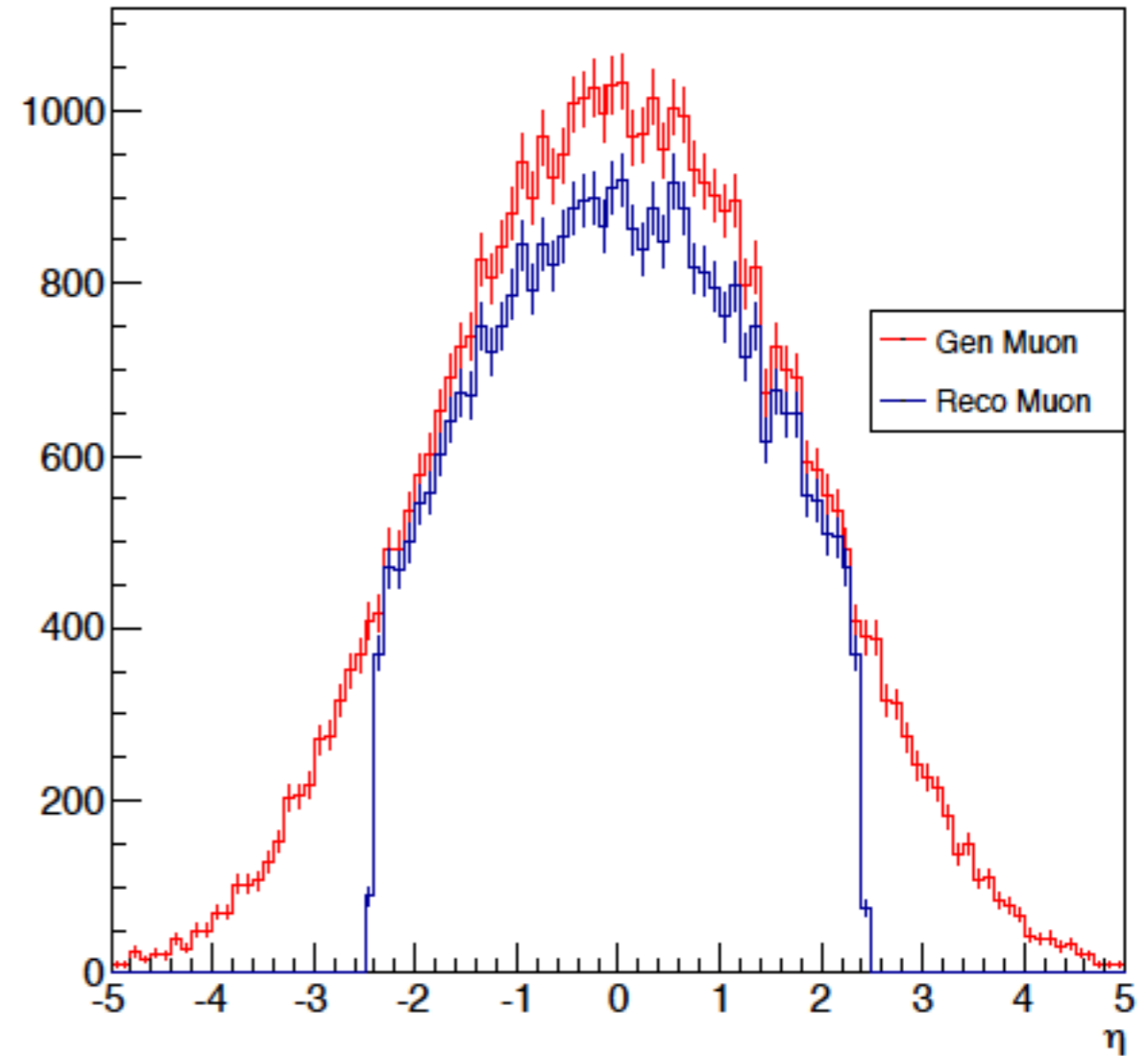
$$H \rightarrow \tau\tau \rightarrow \mu + \tau_{\text{had}}$$

 $\mu$ 

Reco Muon is matched in DR=0.03 with the gen level muon



Muon Pt



Muon Eta

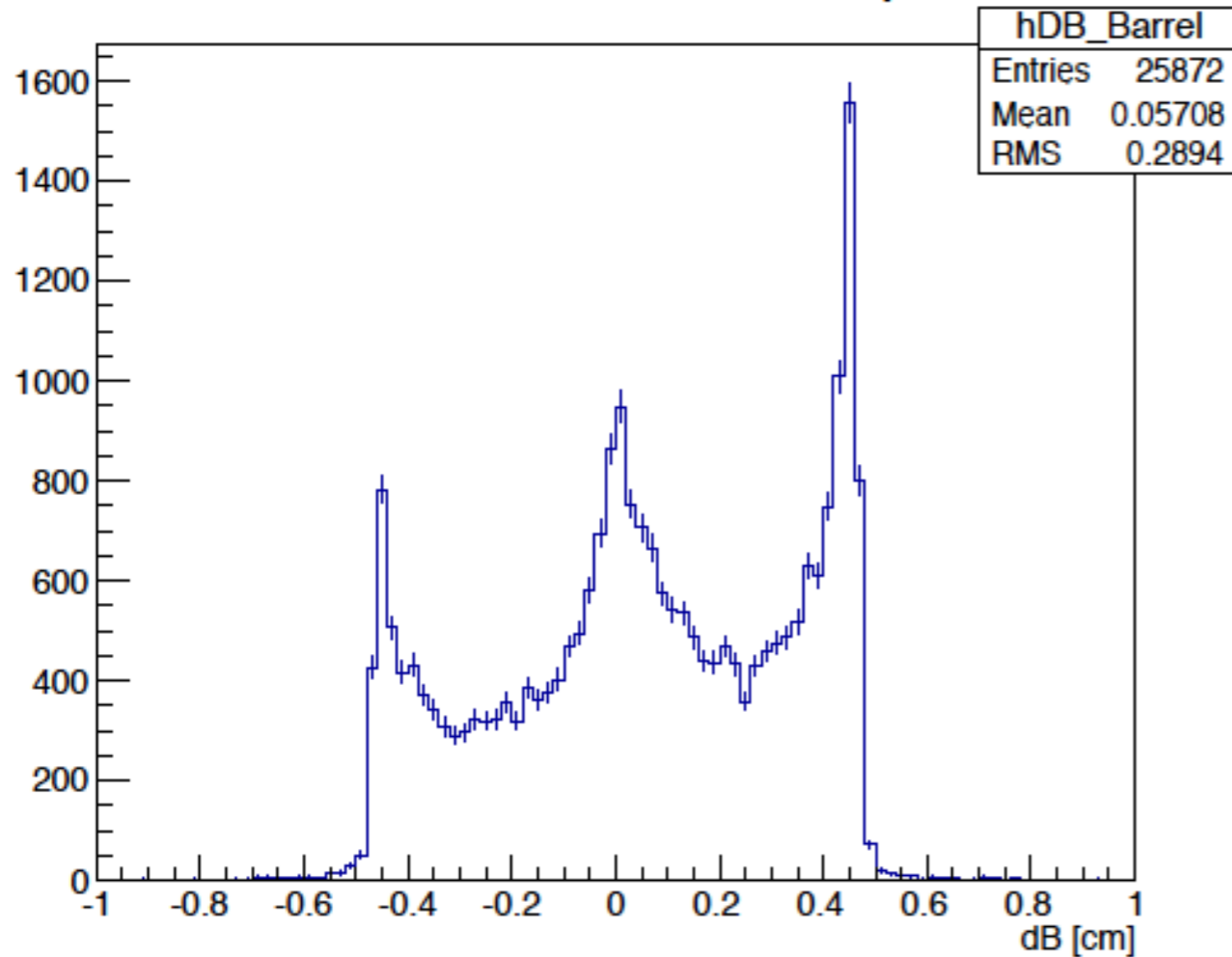


$$H \rightarrow \tau\tau \rightarrow \mu + \tau_{had}$$

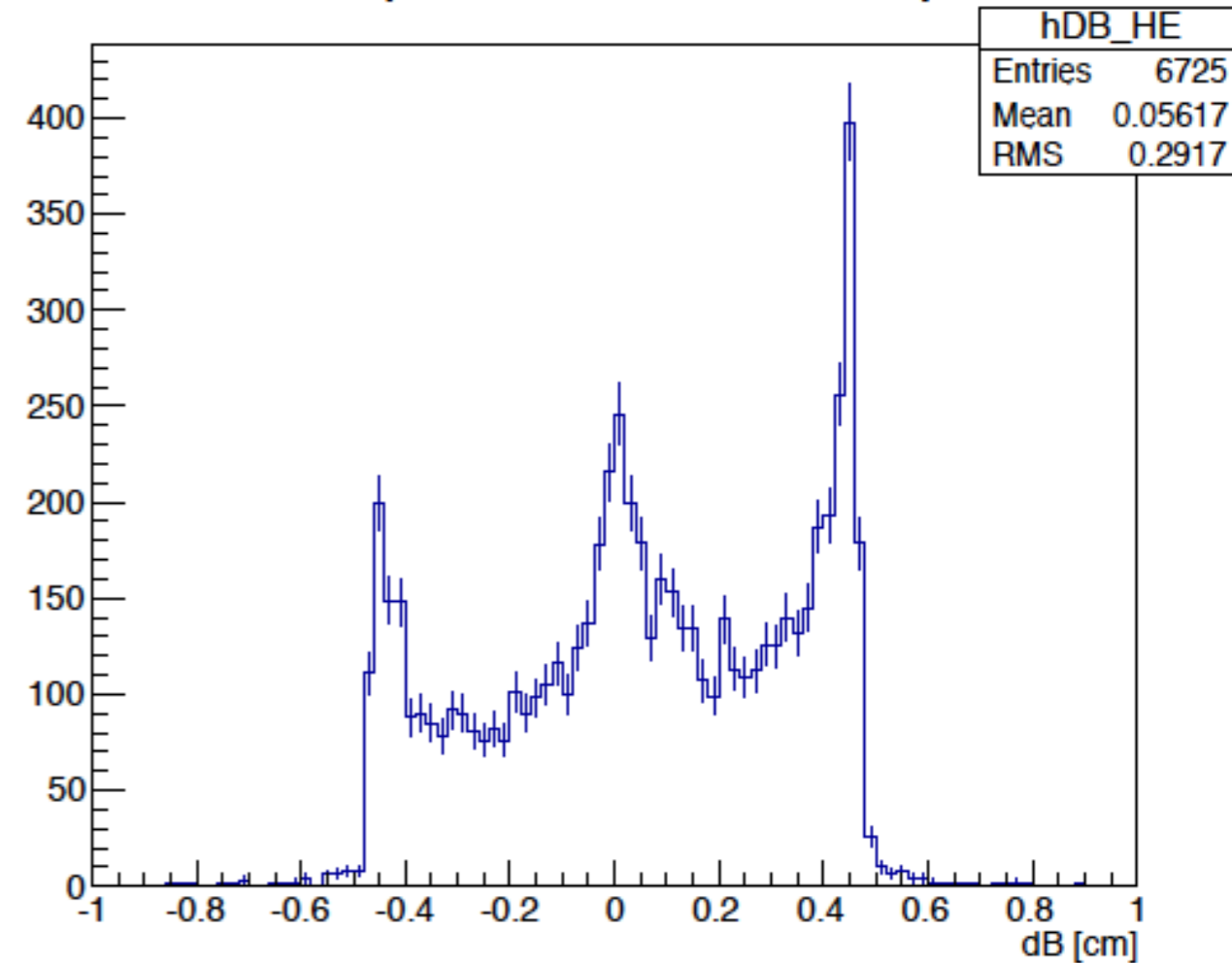
 $\mu$ 

Reco Muon is matched in DR=0.03 with the gen level muon

Muon Impact Parameter in  $|\eta| < 1.6$



Muon Impact Parameter in  $1.6 < |\eta| < 2.2$

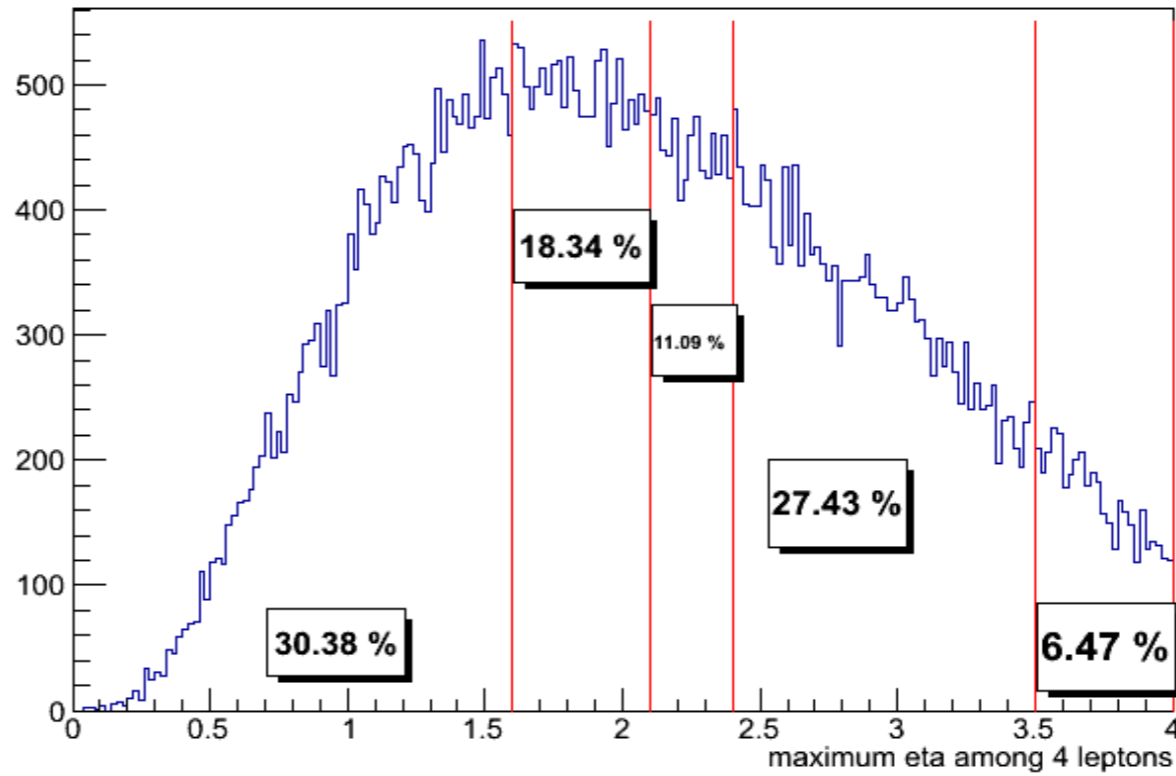


→ Under investigation!



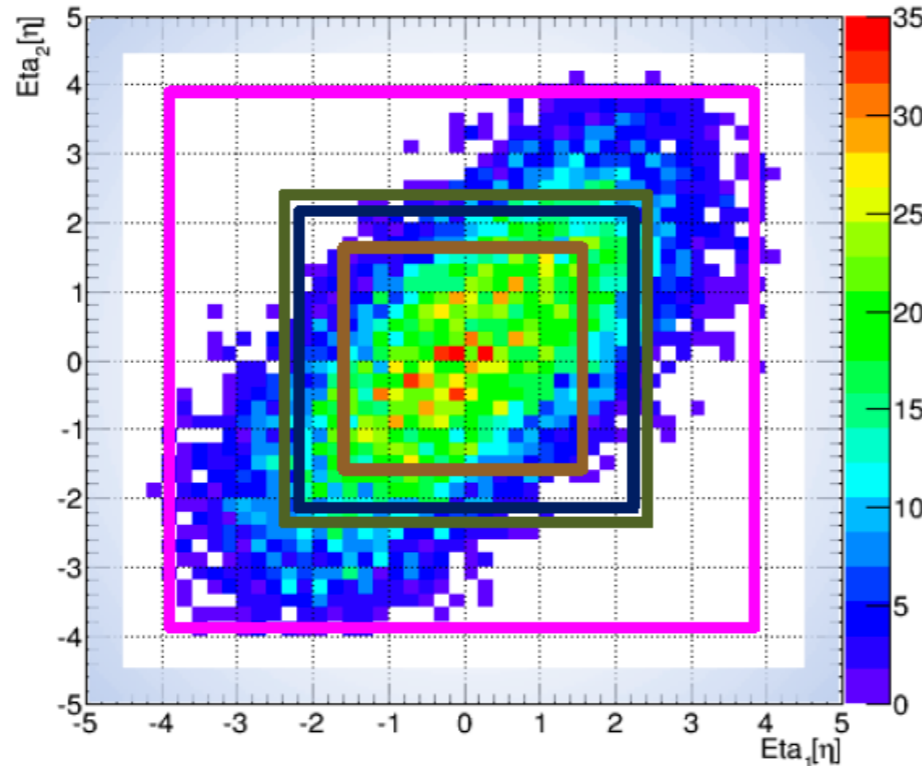
# Physics channels considered

$H \rightarrow 4\mu$



VBF\_Pair\_Muon\_Eta

$H \rightarrow \mu\mu$



Eta Range	Pt1 : Pt2				
	No cuts	15 : 15	25 : 15	35 : 15	45 : 15
1.6	46.88% 44.29%	46.21% 44.01%	46.21% 44.01%	46.18% 43.77%	45.62% 42.46%
2.1 (GE1/1)	65.53% 62.45%	63.84% 61.64%	63.84% 61.50%	63.60% 60.40%	62.42% 57.52%
2.4 (GE2/1)	74.34% 72.10%	72.19% 70.82%	72.16% 70.56%	71.83% 69.03%	70.34% 65.14%
3.9	97.20% 96.71%	92.39% 92.56%	92.24% 91.65%	91.42% 88.32%	88.90% 81.87%

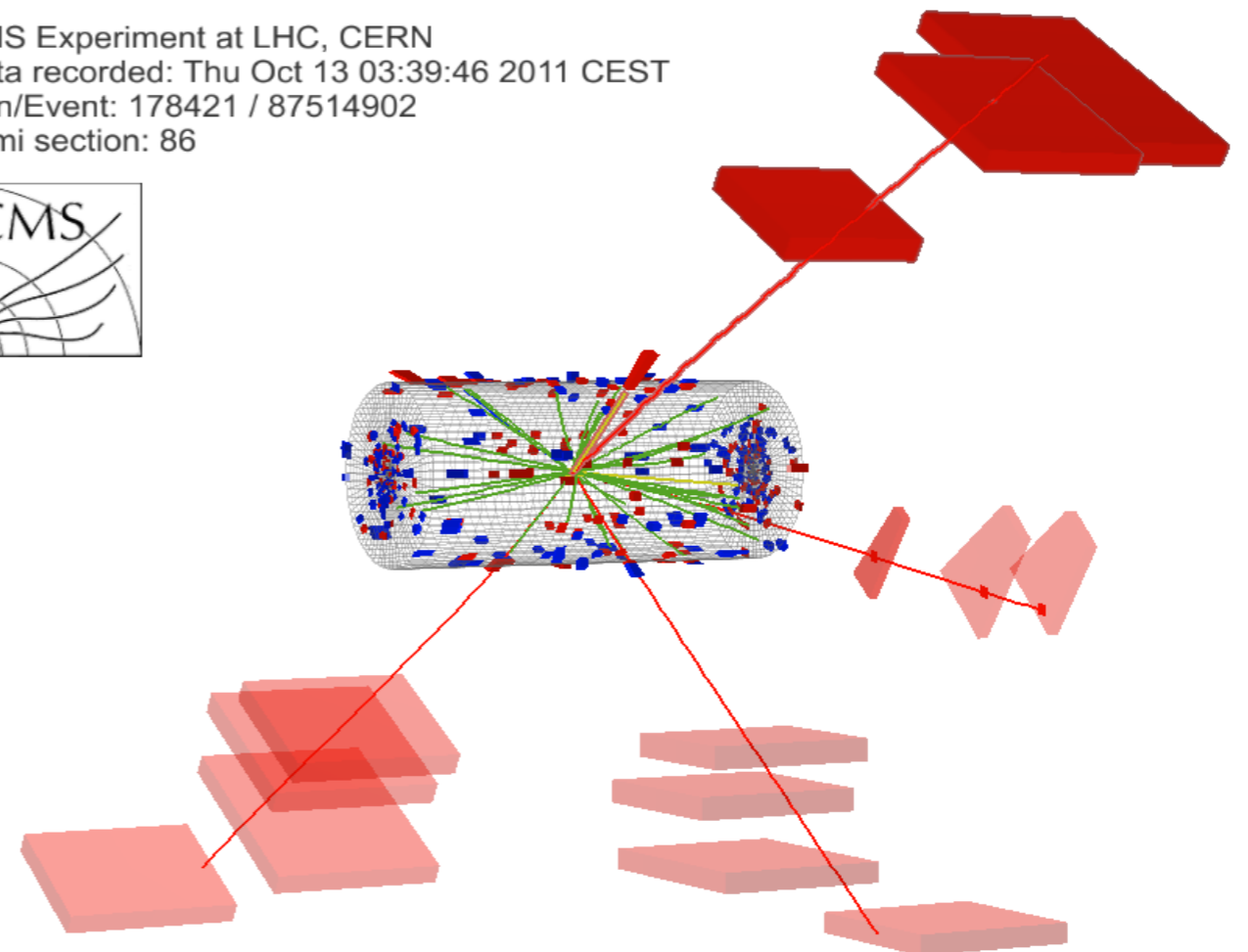
# $H \rightarrow 4\mu$ channel at 14 TeV

- Take the  $H \rightarrow 4\mu$  channel at 14 TeV, at  $1.6 < |\eta| < 2.4$ 
  - used **post-LS1** beam conditions and geometry
  - how much do we lose for  $X\%$  of non-working CSC, randomly distributed?
  - how much can we gain by adding GEM disks?
  - what if CSC degrade, losing in local efficiency?
- Efficiency for a benchmark L1 Trigger: **DoubleMu\_17\_8**
- Trigger **emulated at generation level**

CMS Experiment at LHC, CERN  
Data recorded: Thu Oct 13 03:39:46 2011 CEST  
Run/Event: 178421 / 87514902  
Lumi section: 86



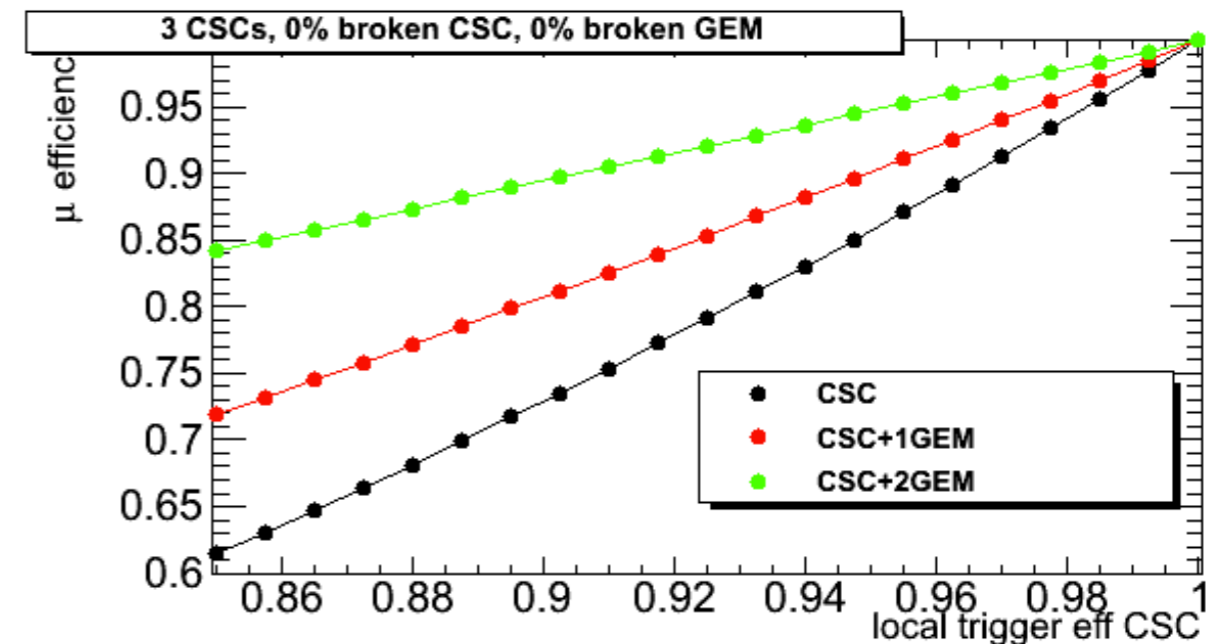
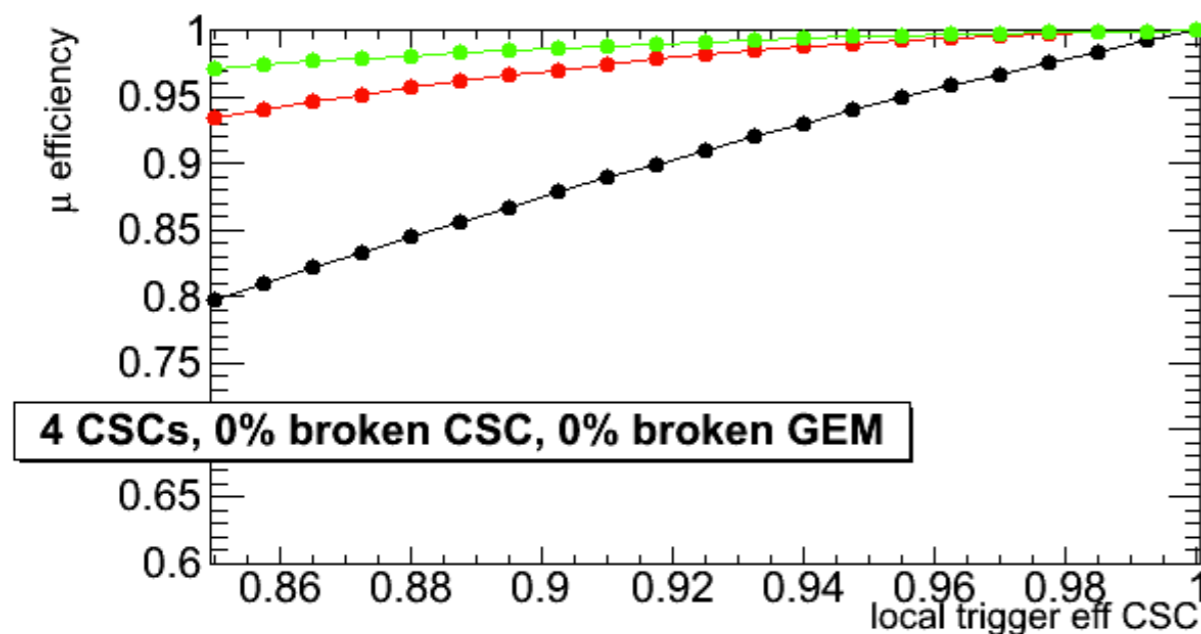
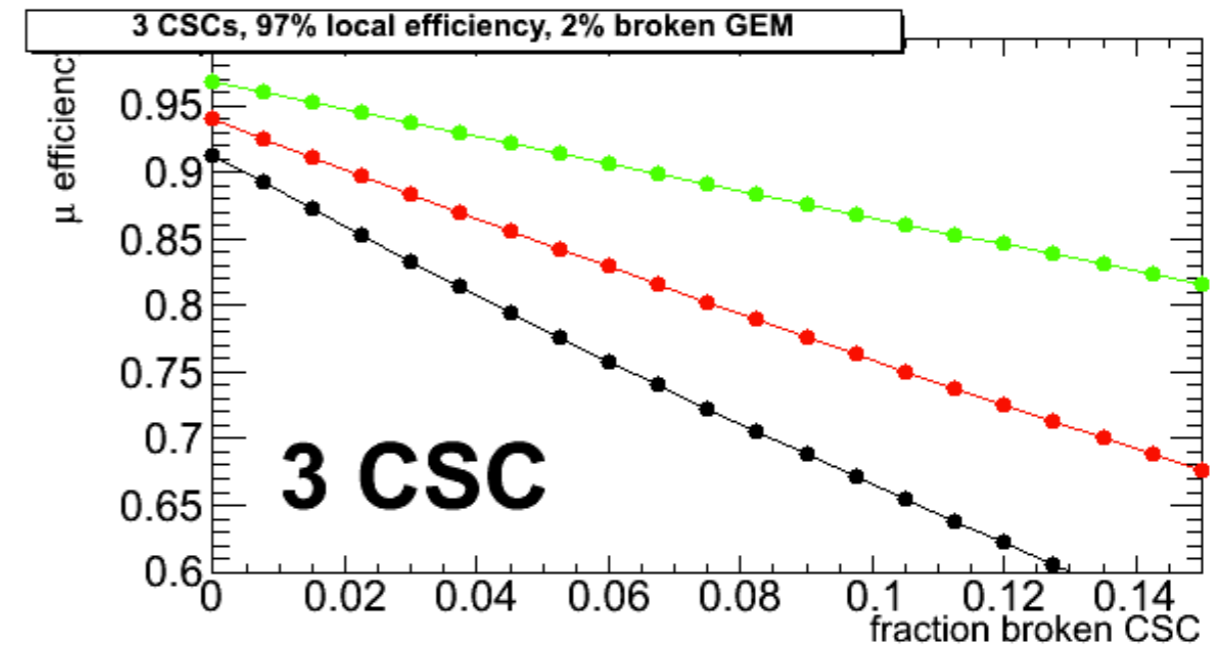
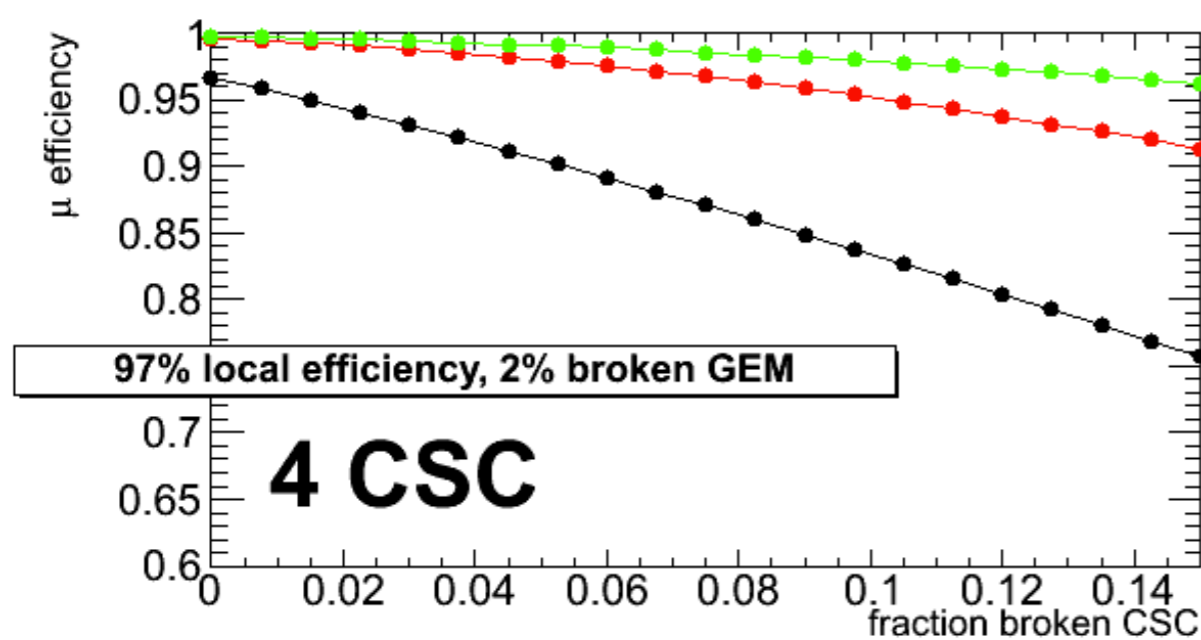
The MC sample used is  $H \rightarrow 4$  at 14 TeV,  
standard detector geometry:  
GluGluToHToZZTo4L M-125 14TeV-powheg-pythia6  
Summer12-Upgrade StdGeom2.root





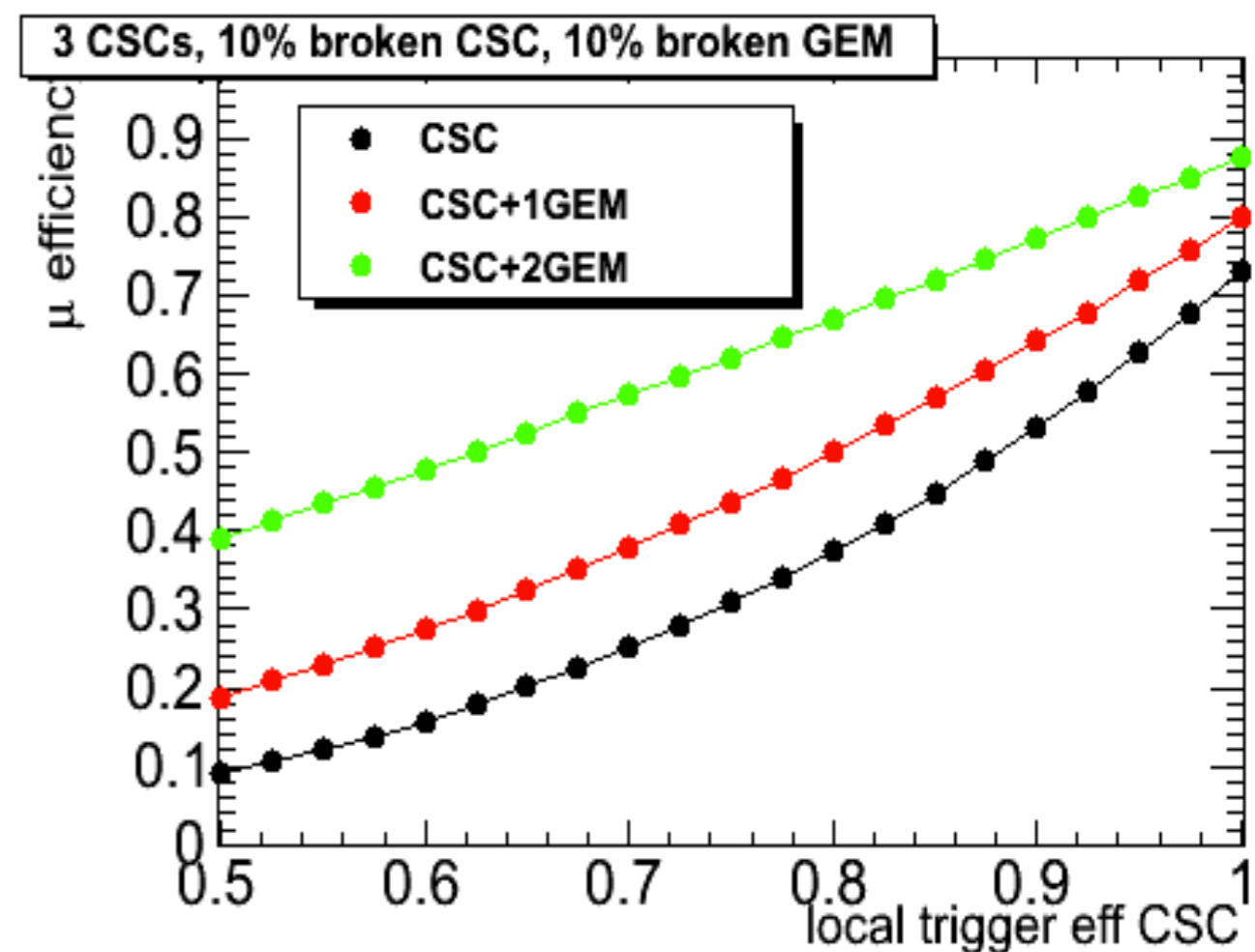
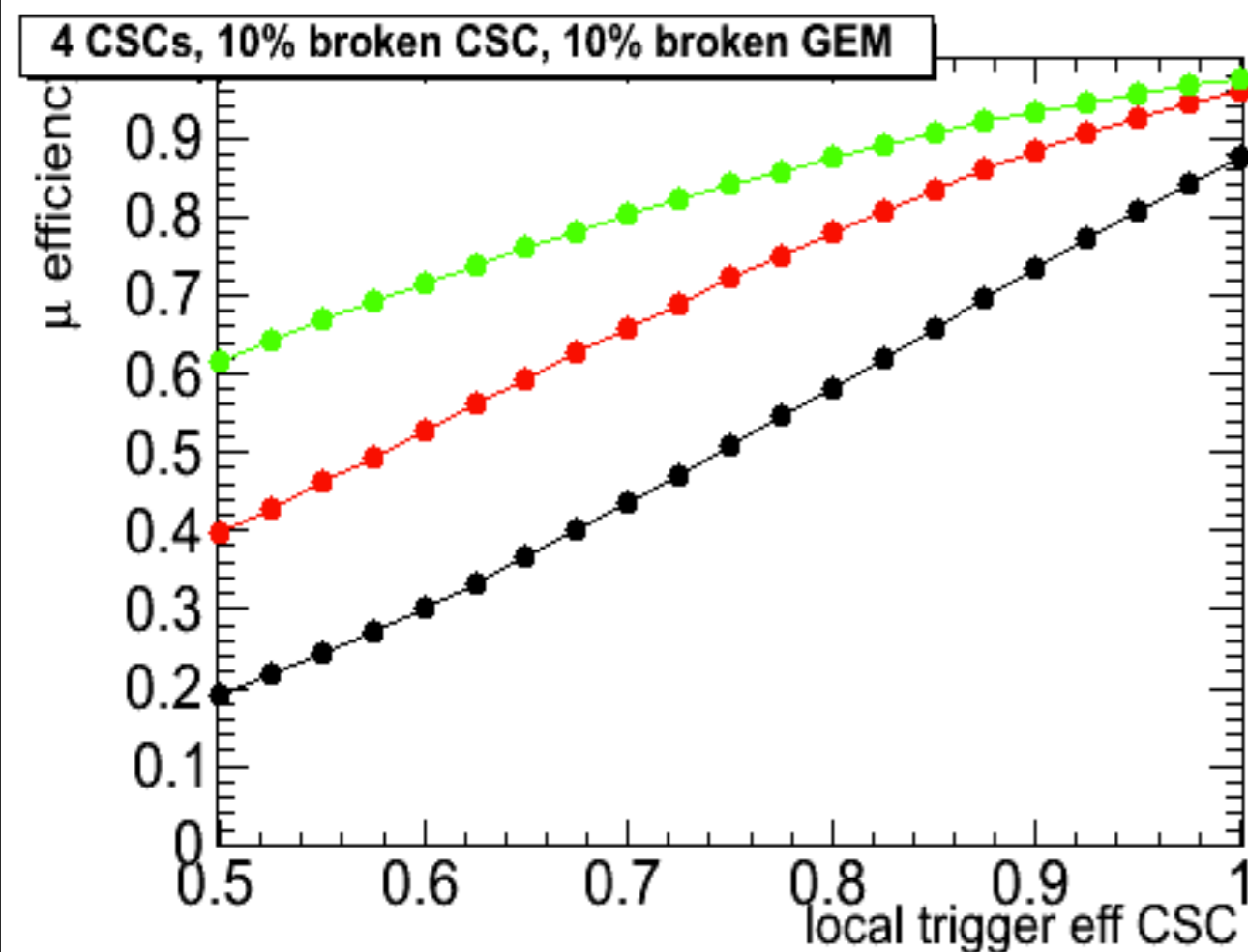
# Individual $\mu$ efficiency

- To trigger an **individual** muon (**one of the two of DoubleMu\_17\_8**) in the forward region acceptance depends on what happens in the four crossed chambers



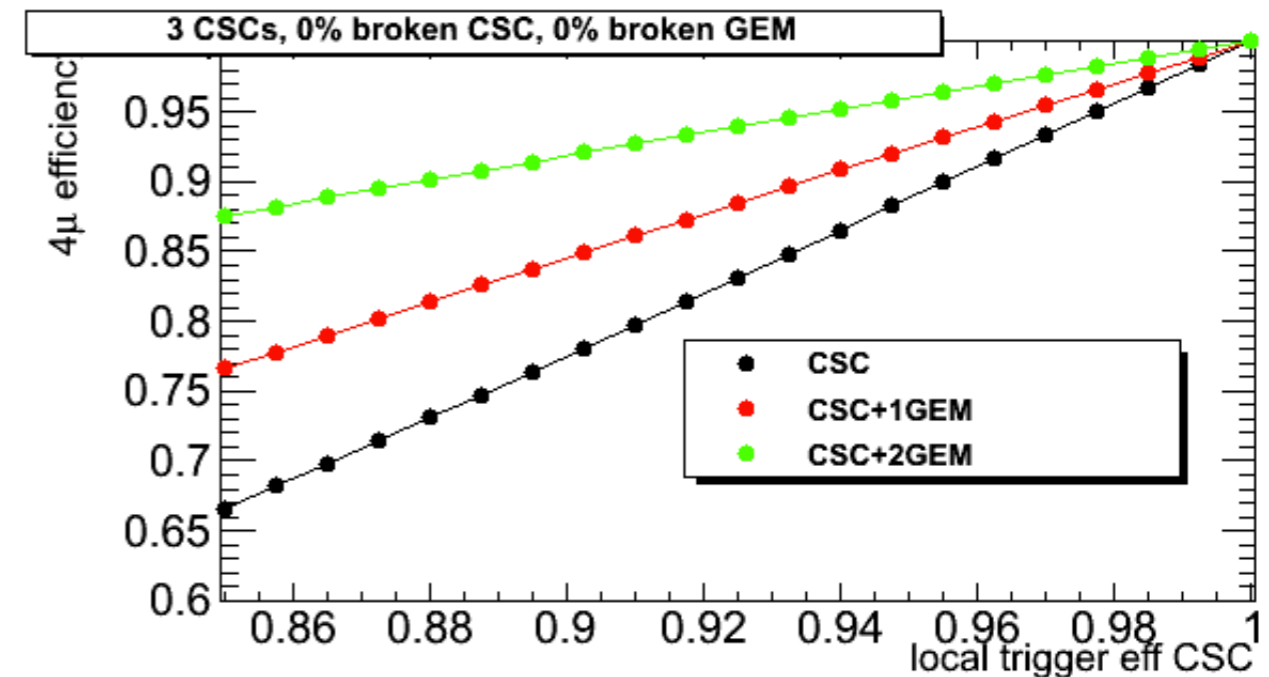
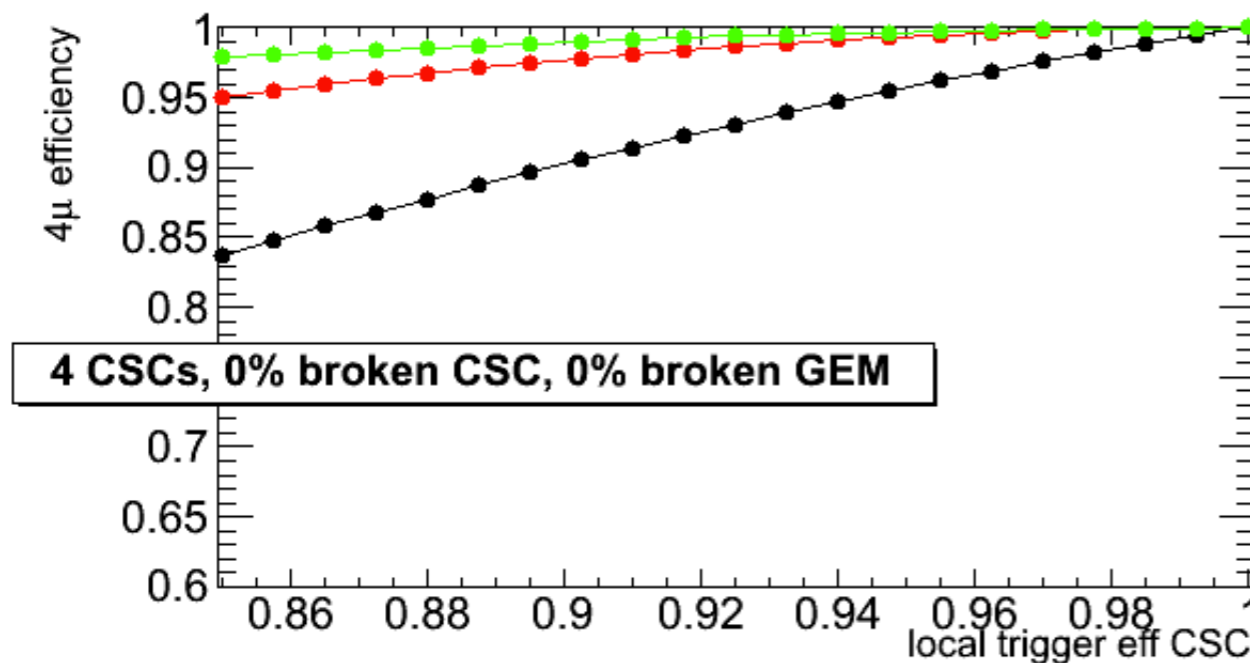
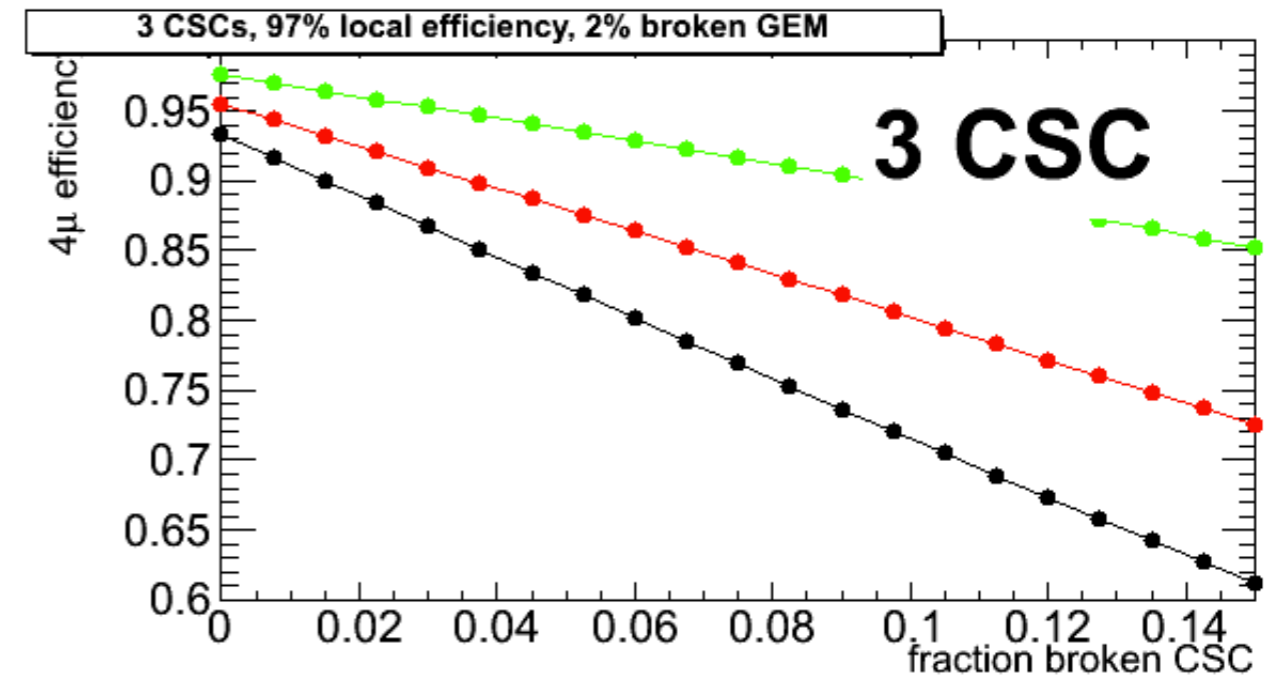
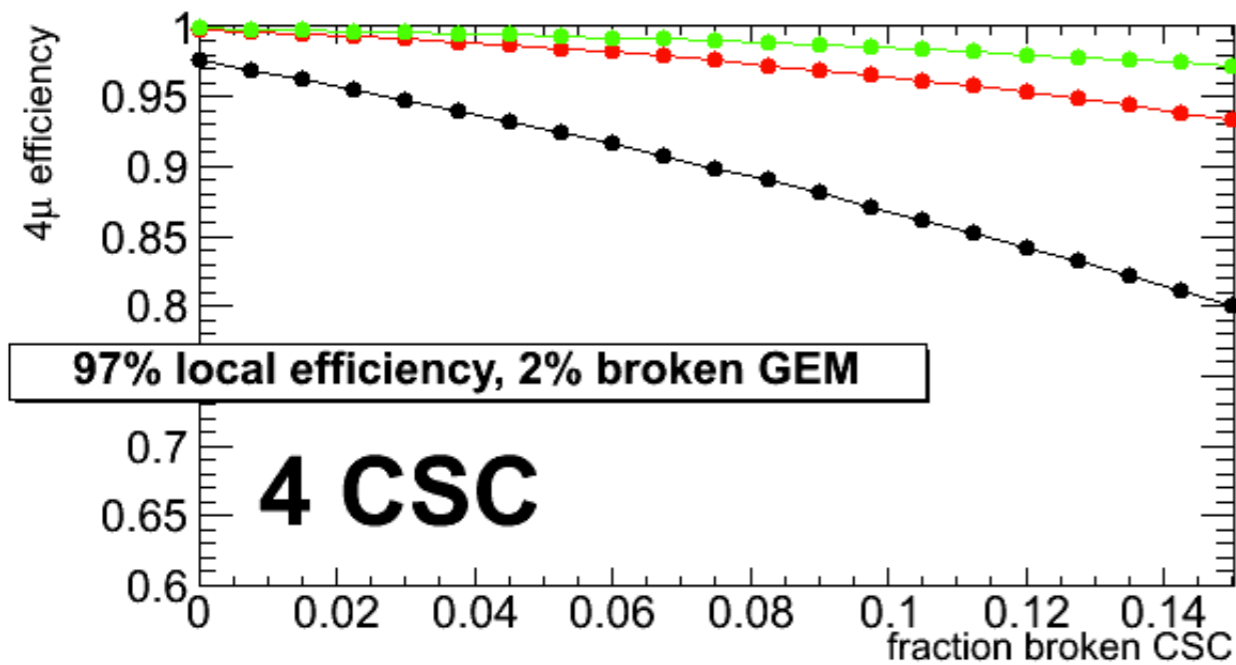
# Individual $\mu$ efficiency

- To trigger a **individual** muon (**one of the two of DoubleMu\_17\_8**) in the forward region acceptance depends on what happens in the four crossed chambers
- With 10% of randomly distributed non-working chambers
- Efficiency as a function of local trigger efficiency



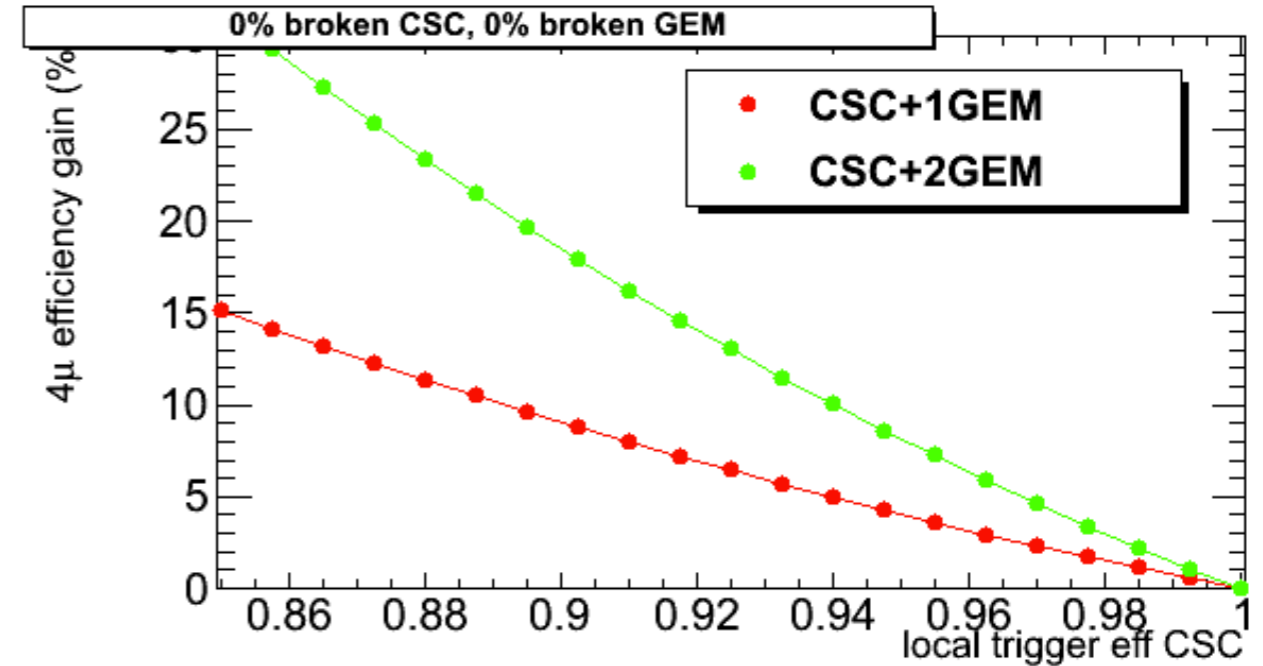
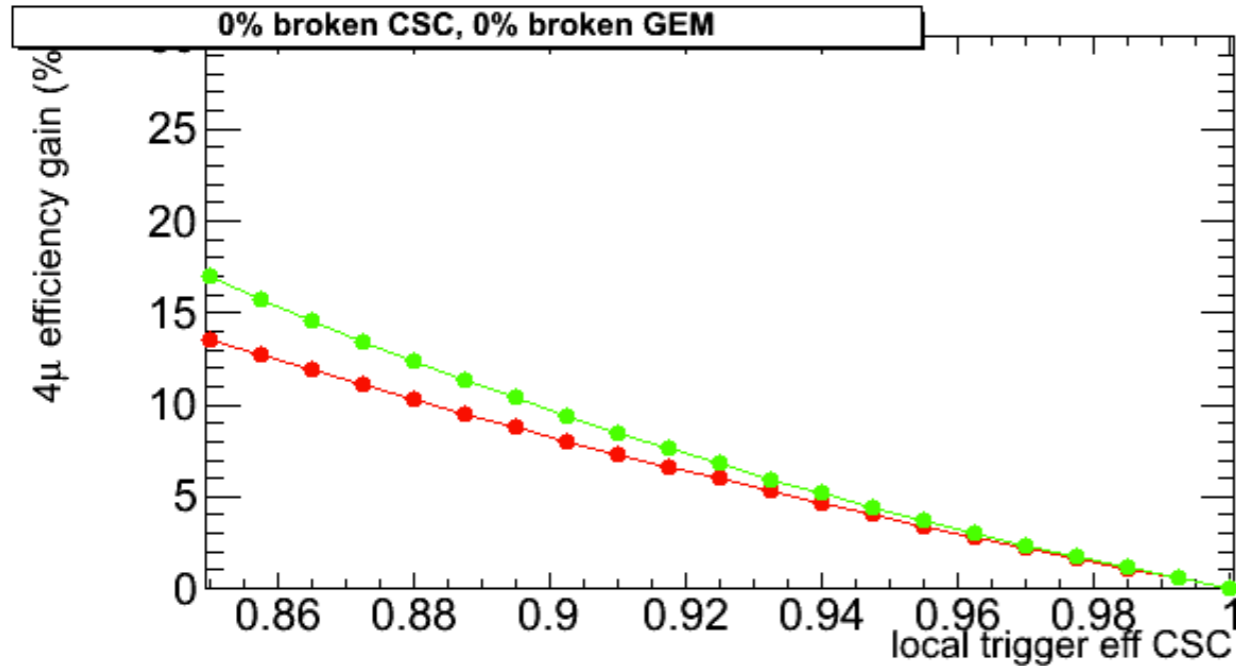
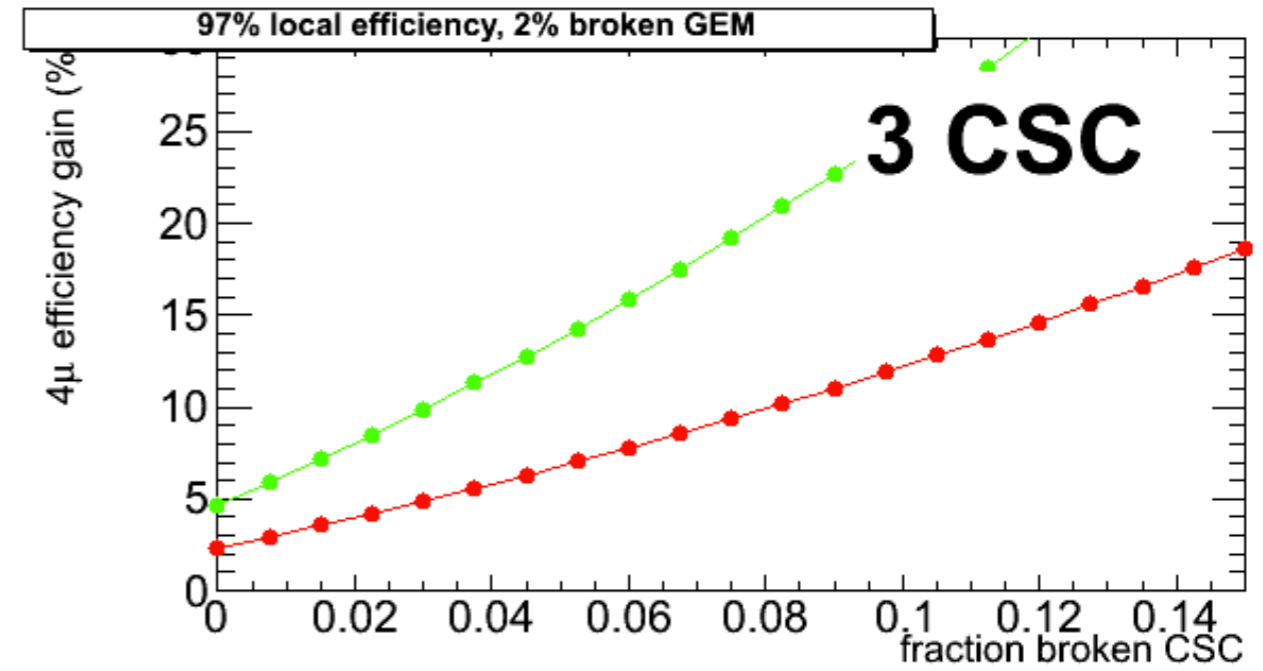
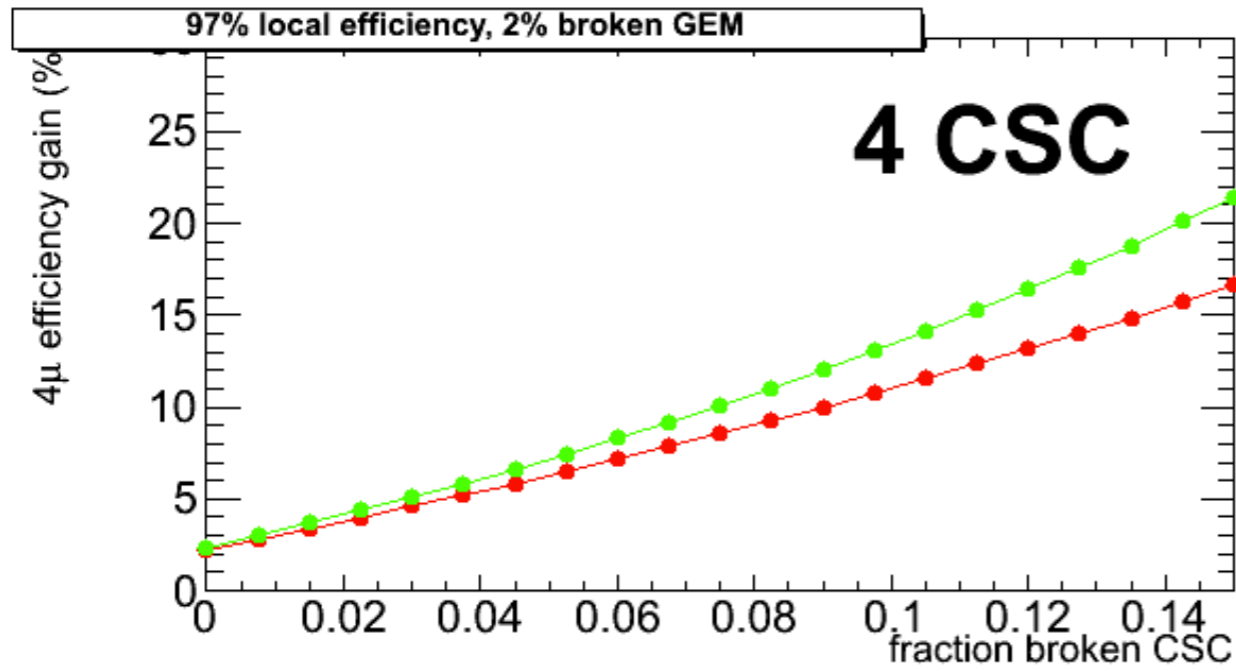
# $H \rightarrow 4\mu$ efficiency at $1.6 < |\eta| < 2.4$

- Restricting to events where there is **potential trigger but NO central trigger**
- Obtained propagating the individual muon efficiency to  $H \rightarrow 4\mu$  events





# $H \rightarrow 4\mu$ efficiency gain



# Impact of trigger threshold

F.Cavallo  
(Bologna)

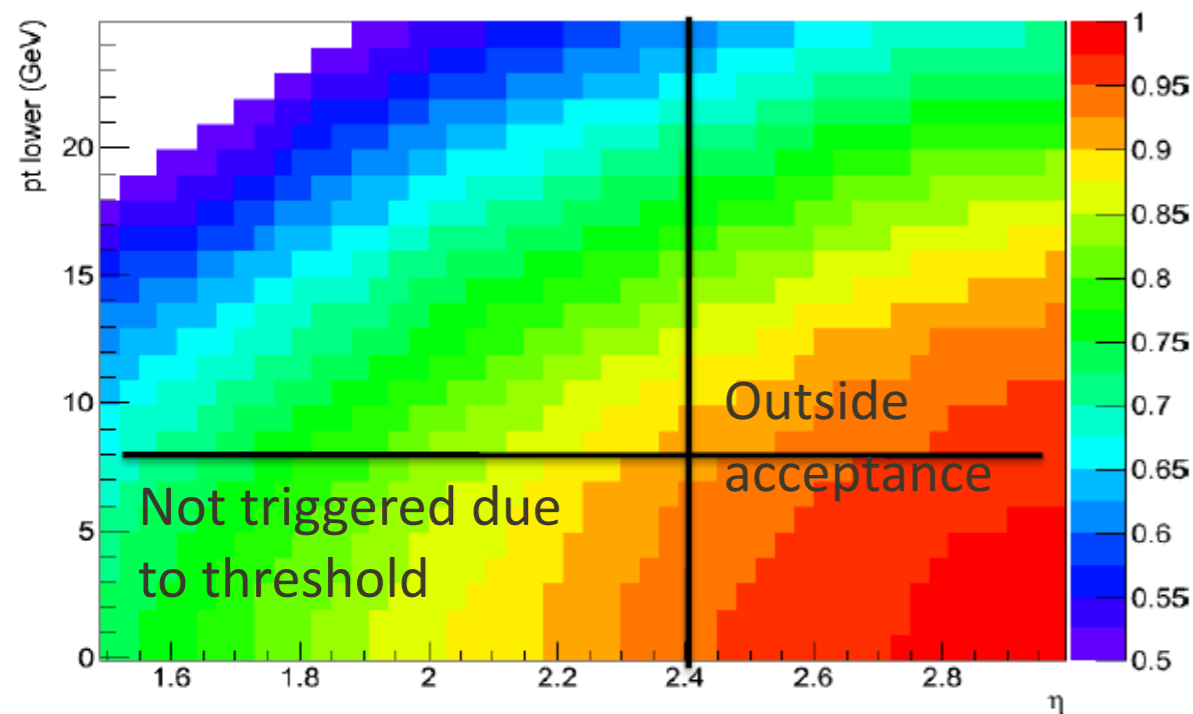
$$H \rightarrow ZZ \rightarrow 4\mu$$

<https://indico.cern.ch/getFile.py/access?contribId=1&resId=0&materialId=slides&confId=224991>

- Signature: 4 muons of relatively low  $p_T \rightarrow$  trigger thresholds matter
- Study based on 14 TeV samples

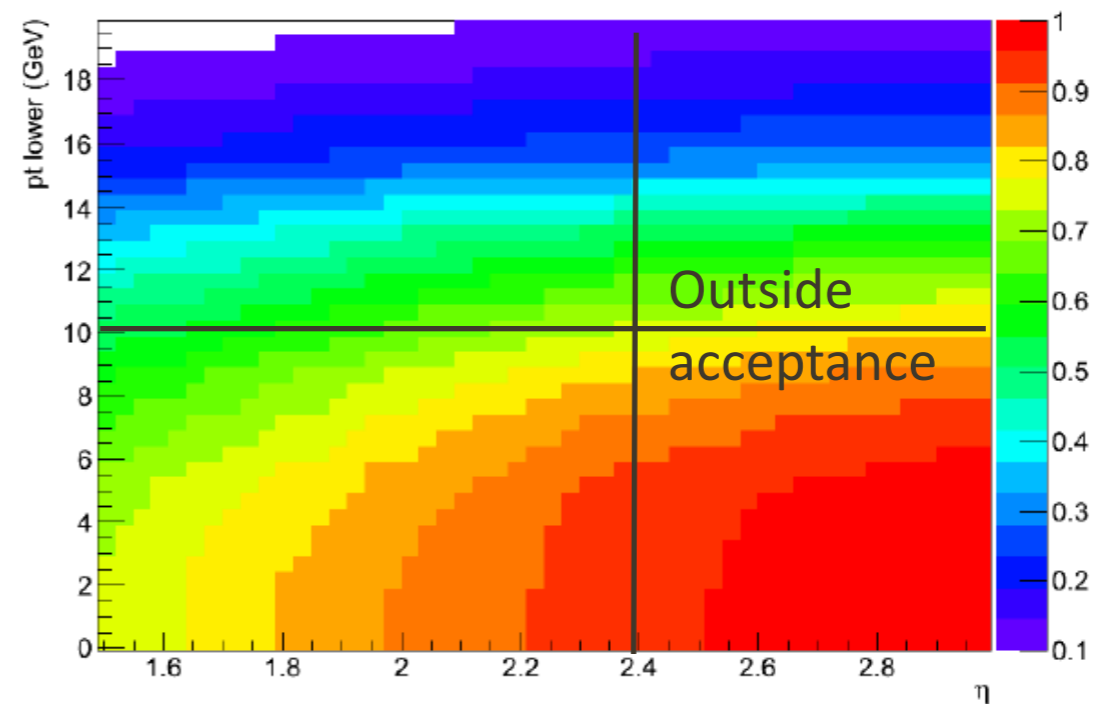
NOW  $p_T > 8$  GeV/17 GeV

triggered 4mu events, at generation



post-LS1 described in L1 upgrade TDR

triggered 4mu events, at generation



Would be highly beneficial to

- Lower trigger threshold
- Increase acceptance beyond 2.4



# Conclusioni

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- Ancora molto lavoro da fare!
- Cominciamo ad avere gli strumenti per lavorare in dettaglio
- Selezioniamo solo alcuni canali di fisica di benchmark
- Timeline per il TDR e' molto "challenging" ma possiamo farcela

# Backup

# $H \rightarrow 4\mu$ - L1 trigger

- Considered trigger: **DoubleMu\_17\_8**
  - emulated at generation level: i.e. trigger if there are at least two muons in geometrical acceptance with  $p_T$  over threshold
  - muons can be both in C (= Central trigger)  $|\eta| < 1.6$ , both in Forward  $|\eta| > 1.6$ , or one and one
- The fraction of events with trigger is 90%

DoubleMu_17_8 Trigger	Fraction of $H \rightarrow 4l$ triggers
not CENTRAL trigger (!C)	21.6%
!C trig , one Central muon	15.2%
!C trig, no Central muons	6.4%

- For ~22% of events that should give trigger, the **forward region** ( $1.6 < |\eta| < 2.4$ ) plays an essential role
- Let's see what happens to **this 22%**