

Simulation in part of a detector to cope with high pileup

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Outline

- Goals and Problems
- Solution: module that selects SimHits by location and type
- Some examples for Muons and Taus
- Summary and plans

Goals

- Goal: be able to emulate and to study muon and tau L1 trigger performance in SLHC conditions:
 - ▶ Up to 400 pileup events per BX

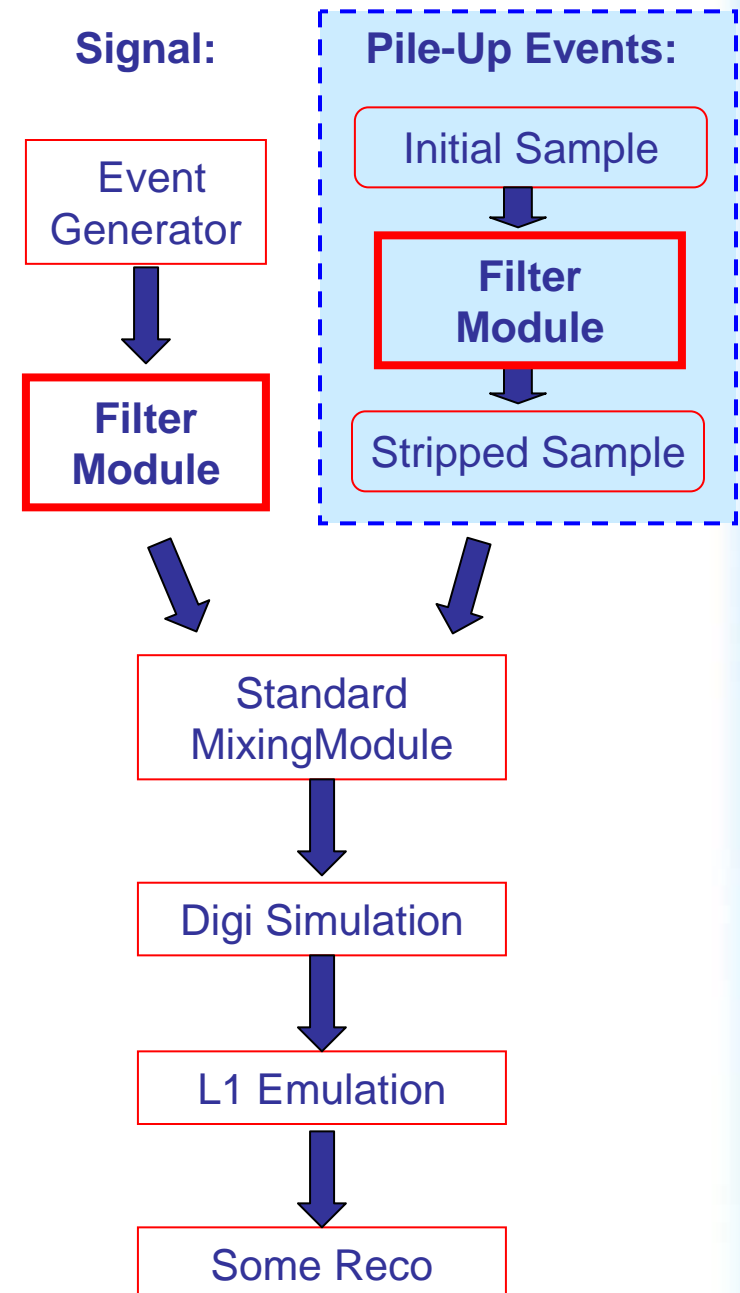
- Usual simulation sequence:
 - A. Generate minbias sample, simulating g4SimHits
 - B. Generate signal, simulate g4SimHits
 - C. Combine **B** and **$A \times N_{pileup}$** using MixingModule
 - D. Full-scale digitization of SimHits
 - E. L1 trigger emulation
 - F. Any necessary/possible reconstruction (e.x.: calorimetry)

Problems with High N_{pileup}

- Straightforward approach results in crash after using up huge amount of memory during digitization
 - ▶ Ex: can do only ~5 evt. for $N_{pileup}=100$
not a single evt. for $N_{pileup}=200$
 - ▶ Failure usually happens during digitization of tracker SimHits
 - ▶ Problem scales with N_{pileup}
 - ▶ Resulting event size is huge!!!

Solution: Preselection of SimHits

- Focusing on some specific system (ex: muons or taus)
 - ➔ Don't need all types of SimHits
- Create **special filter module**
 - ▶ selects desirable types of sim hits, tracks & vertices
 - ▶ selects in some eta-phi sector of detector
- The **modified simulation sequence** now starts with:
 - A. generate minbias, simulate g4SimHits
 - ◆ **run it through filter module**
 - B. generate signal, simulate g4SimHits
 - ◆ run it through filter module (might use different settings)
 - C. ...



Some Things to Note

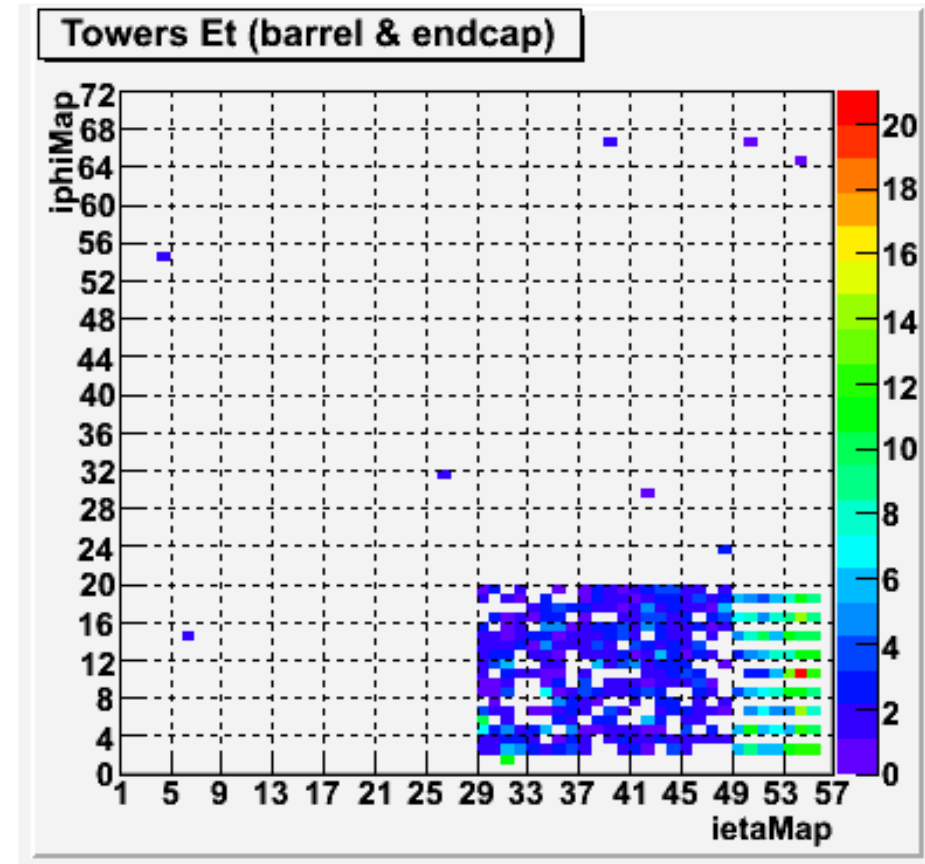
- So far all our studies are in **CMSSW 1_6_12**
(some of it is in 1_8_0)
- Since **CMSSW 2_x**:
new CrossingFrame design and updated **MixingModule**
allow mixing of only specific types of SimHits
- However, our module allows more refined type selection
plus selection in eta-phi
- We keep it outside of MixingModule and CrossingFrame
to allow easy customization

Performance

- With all types of SimHits kept we can successfully run 20 events simulation for muons and taus
 - ▶ in 1/4 of detector for $N_{\text{pileup}} = 200$
 - ▶ in 1/8 of detector for $N_{\text{pileup}} = 400$ (5 min/evt)
- Mixing only muon SimHits and dropping all the rest:
 - ▶ 50 evt. in 1/2 of detector $N_{\text{pileup}} = 400$
 - ▶ can even do full detector if we really need to

Example: $Z \rightarrow \text{TauTau}$ Event

- Energy towers snapshot
- Pileup is simulated in 1/8 of detector
- Singal: full detector
- Tau triggering becomes very challenging
(see Alexei's talk)

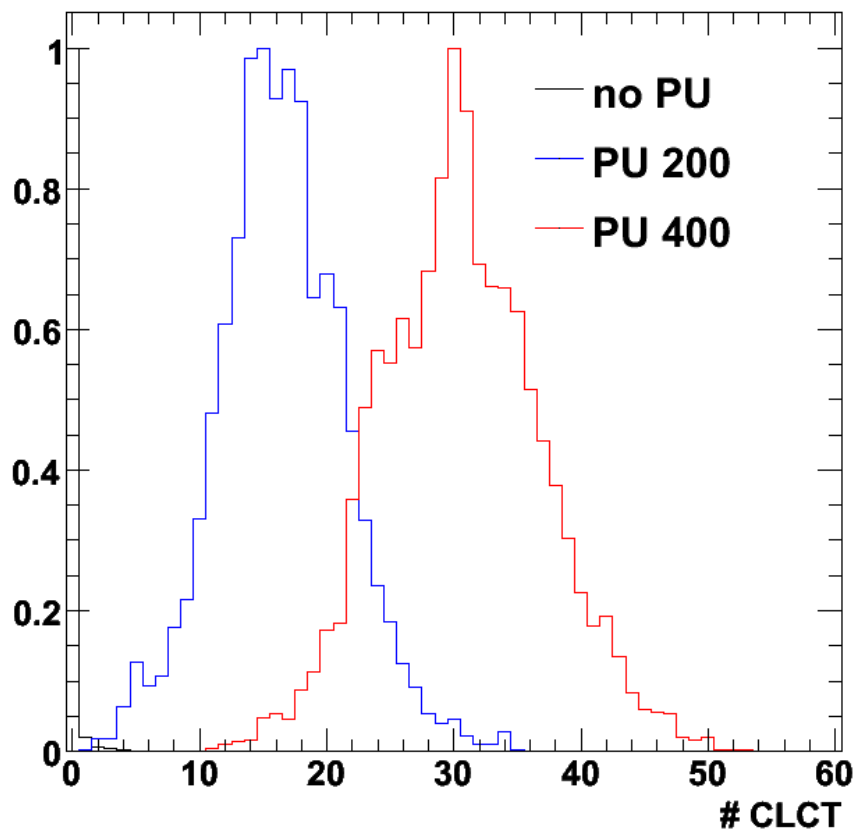


Example: CSC Muons (no signal)

- Rates: minbias, no signal
- For no-pileup sample look at underlying event of Z->mm

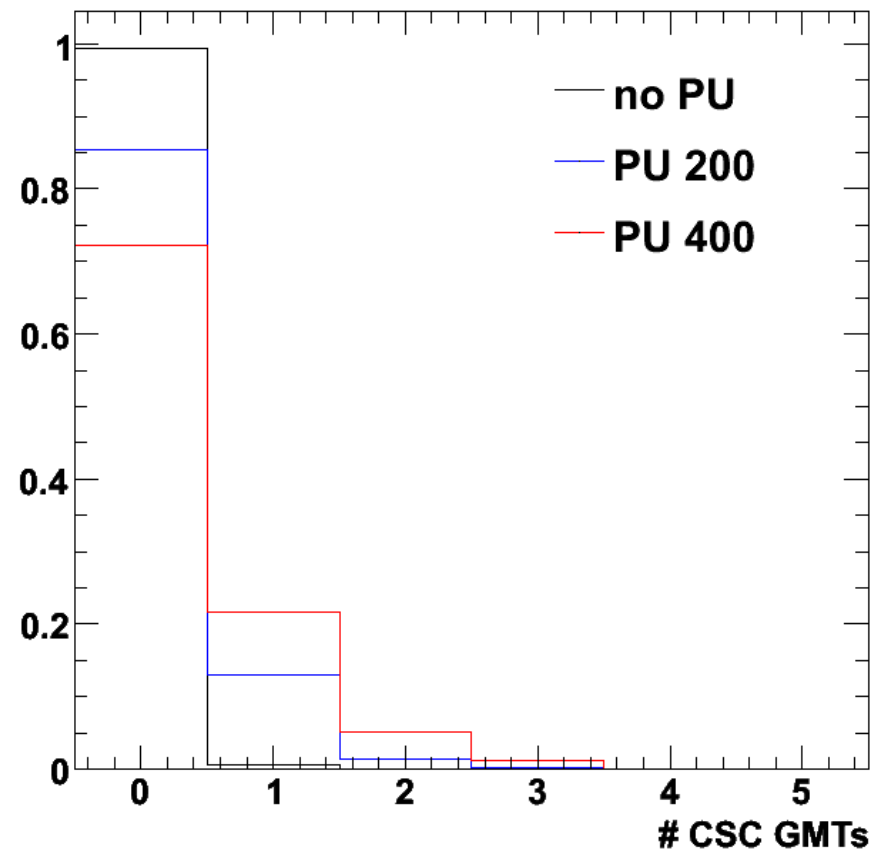
CLCT occupancy shapes
over $\frac{1}{2}$ of detector

Number of CLCTs in one of endcaps



CSC GMT Mu occupancy
over $\frac{1}{2}$ of detector

Number of CSC GMTs in one of endcaps



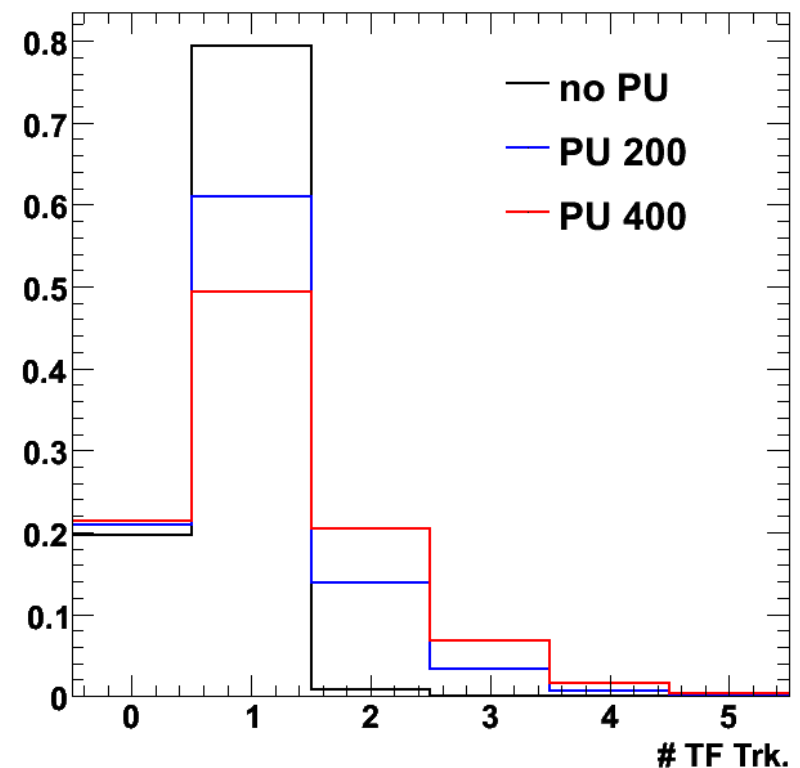
With current setup rates would become very high @ SLHC

Example: CSC Muons (per muon)

- $Z \rightarrow \text{MuMu}$ in $\frac{1}{2}$ of detector
- Can match different trigger primitives to a particular muon SimTrack
- Need it to control efficiency and quality of trigger primitives
- *More on L1 CSC efficiencies etc. in my talk at Muon WG on Thursday morning*

Example:
number of TF tracks
with stubs matched to
muon SimTrack

Number of TF tracks matched to SimTrack



Summary

- SLHC conditions are challenging for full simulation
- Acceptable solution is to limit studies to a part of detector and/or to fully simulate only select objects of interest
- Simple filter module allows to do it with high degree of customization
- Constrained detector region allows studies of efficiencies and rates for local triggers, and reasonable estimates for global triggers
- So far worked well for muon and tau trigger studies

... and Plans

- Collaborate with interested parties in getting various SLHC software tools together for further improvements
- Moving on to CMSSW 2x & 3x
- Adding noise from calorimeter into SLHC simulations
- Adding ability to overlap real MB events to better simulate events where MC can be not safe
- Moving towards producing necessary customized samples (including various tracking scenarios etc) and making them publicly available so that other people can use it in algorithm development along with necessary instructions