L1 Muon and Global Trigger Emulator

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CMS online selection meeting
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Status of the muon trigger emulator

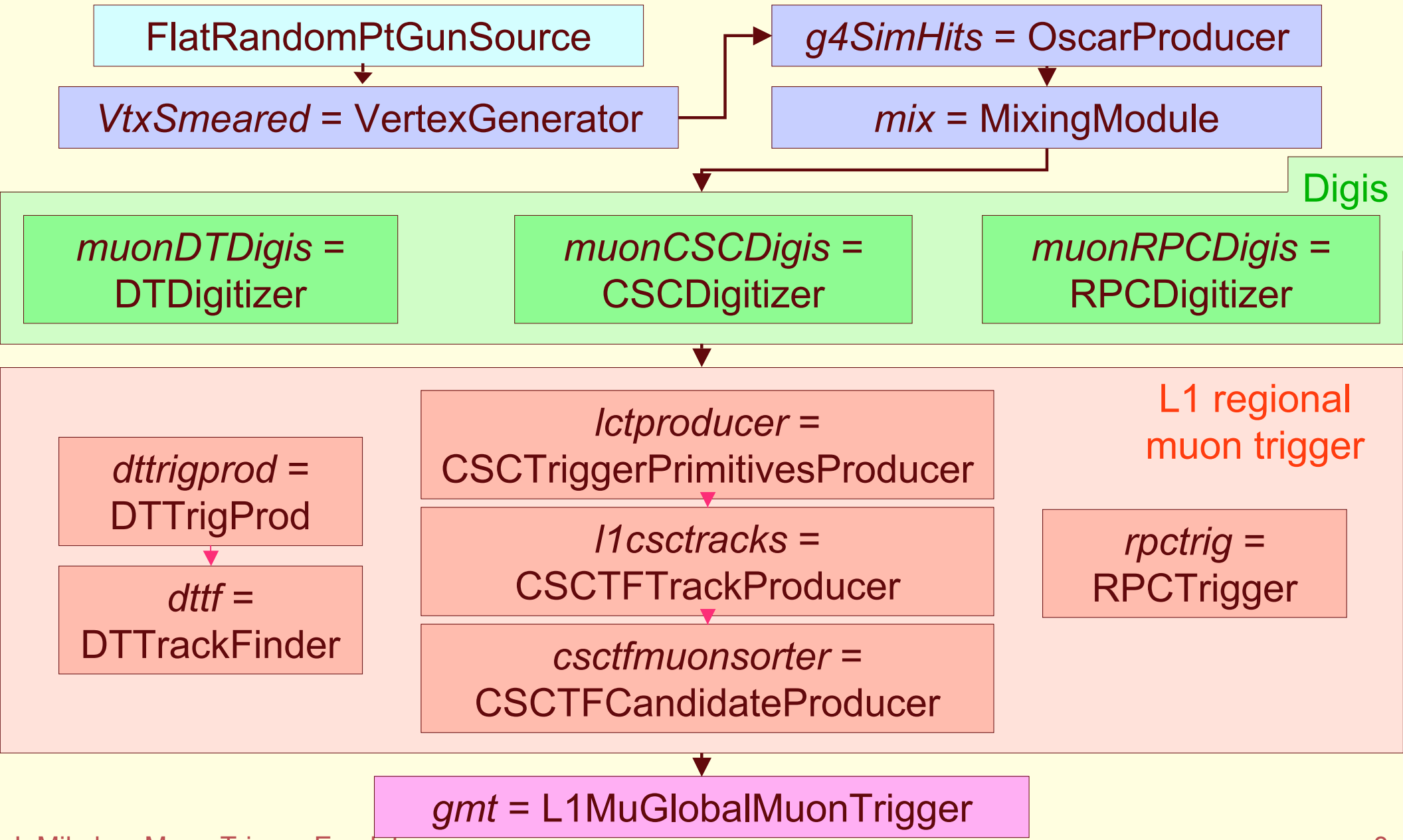
- **All components:**
  - **DT TPG**
  - **DTTF**
  - **CSC TPG**
  - **CSCTF**
  - **RPC Trigger**
  - **GMT**

  are functional and most of them provide a .cfi file (DT TPG only partially and DTTF not yet)
- **The complete L1 muon emulator can be run from digi's by including:**

  `L1Trigger/GlobalMuonTrigger/data/l1muon.cff`

  in your .cfg file

Scheme of the CMSSW path from source to GMT

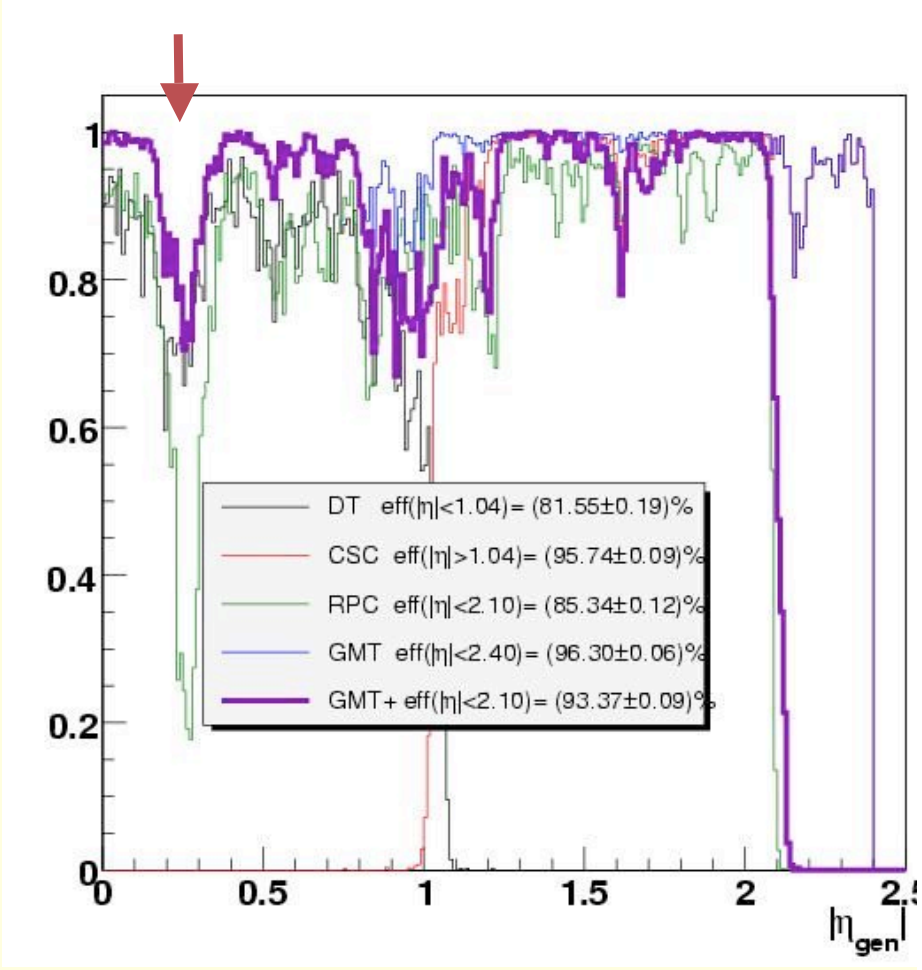


Performance of the L1 muon emulator

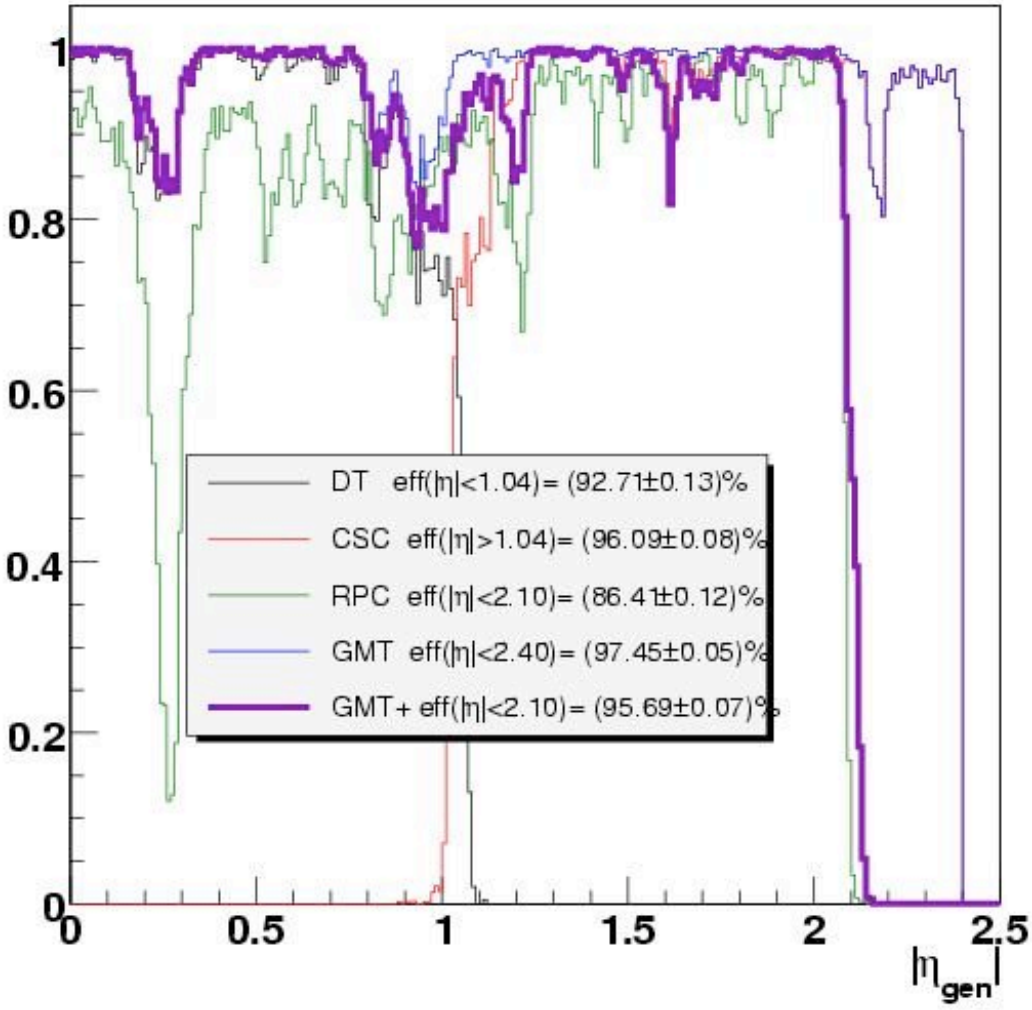
- **Latest performance check with 120pre4 (see further)**
- **No fixes needed anymore:**
  - **Phi coordinate offsets in RPC and DT fixed**
  - **CSC bunch crossing number shift fixed**
  - **DTTrigger synchronization delay wrt. to DT digis is now adjustable (see e.g. l1muon.cff)**
- **Comparing 100k single muon samples, generated with p_T=2-100GeV between:**
  - **cmssw120pre4 - new**
  - **cmssw091(additional fixes were needed - see Aug 30 talk)**
  - **orca8130**

Efficiency vs. pseudorapidity

CMSSW 0.9.1+



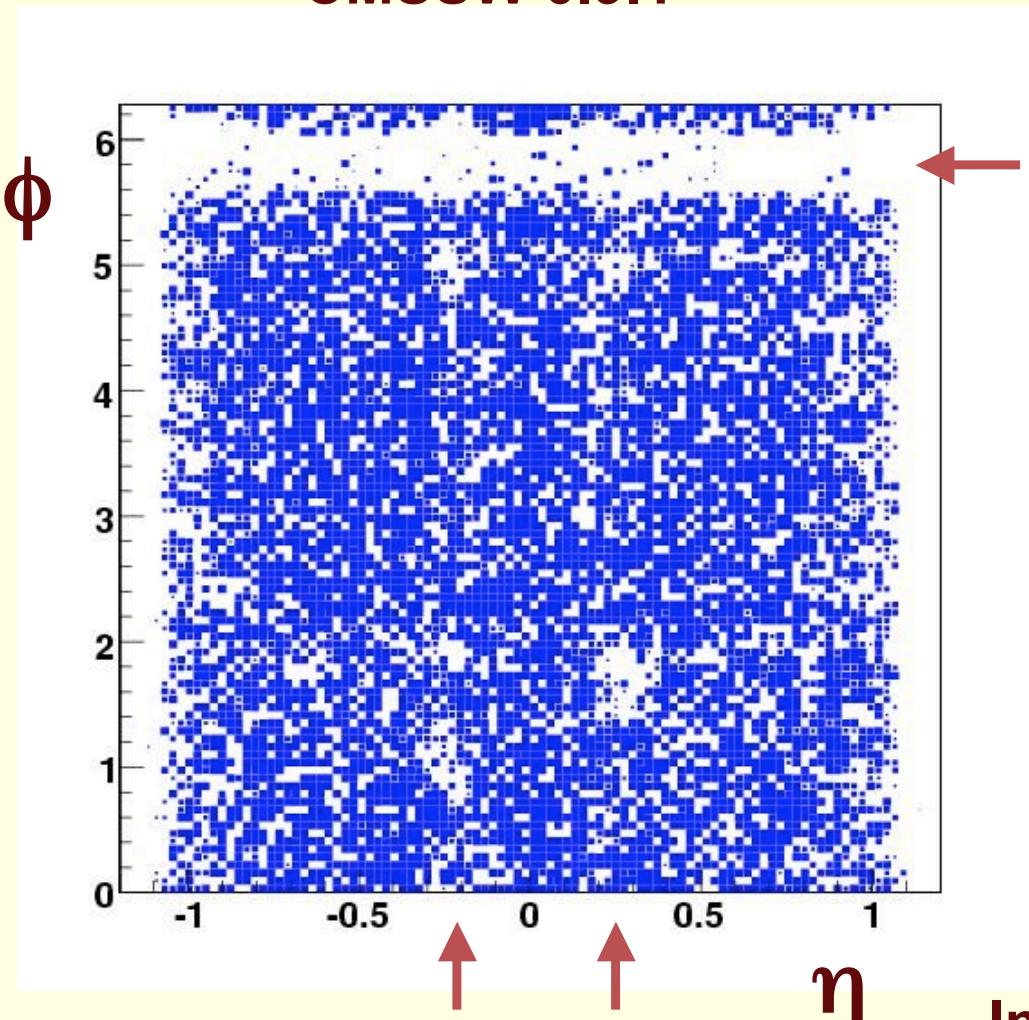
CMSSW 1.2.0.pre4



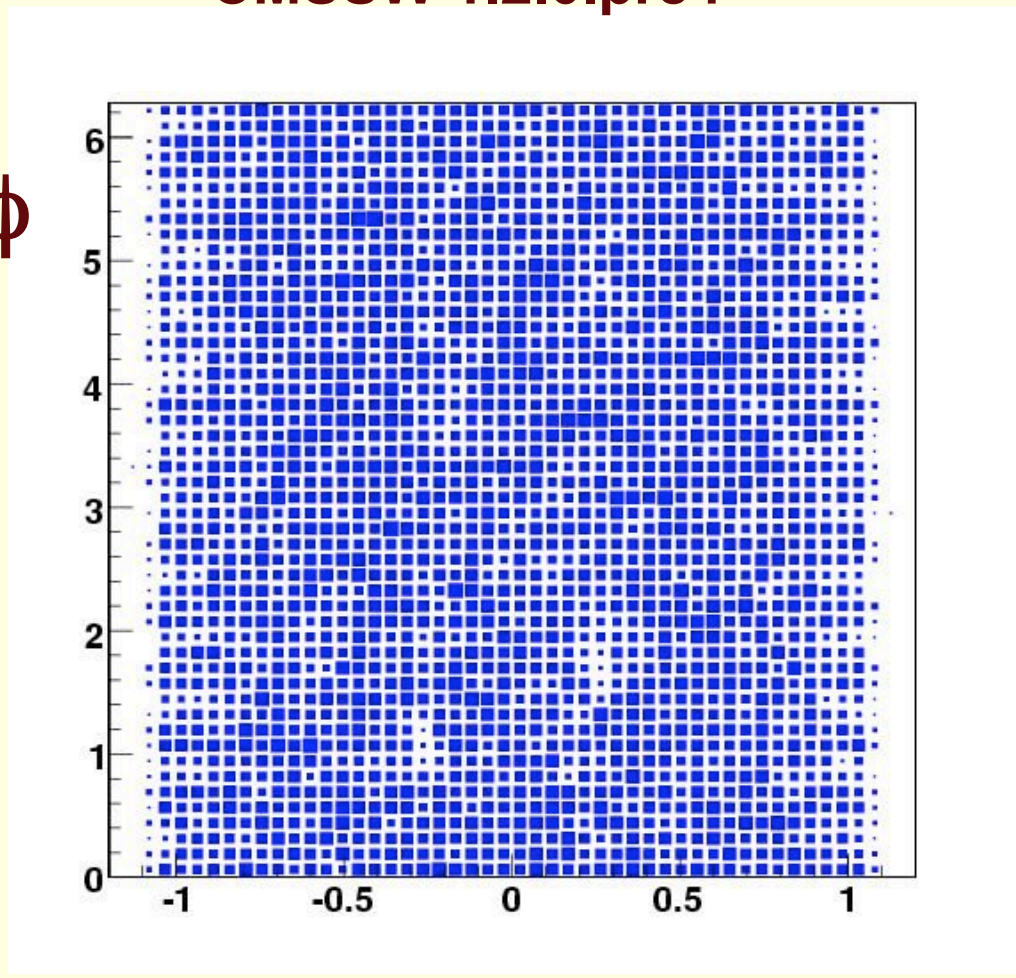
Strong improvement in the DT trigger efficiency

DTTF eff. vs eta and phi

CMSSW 0.9.1+



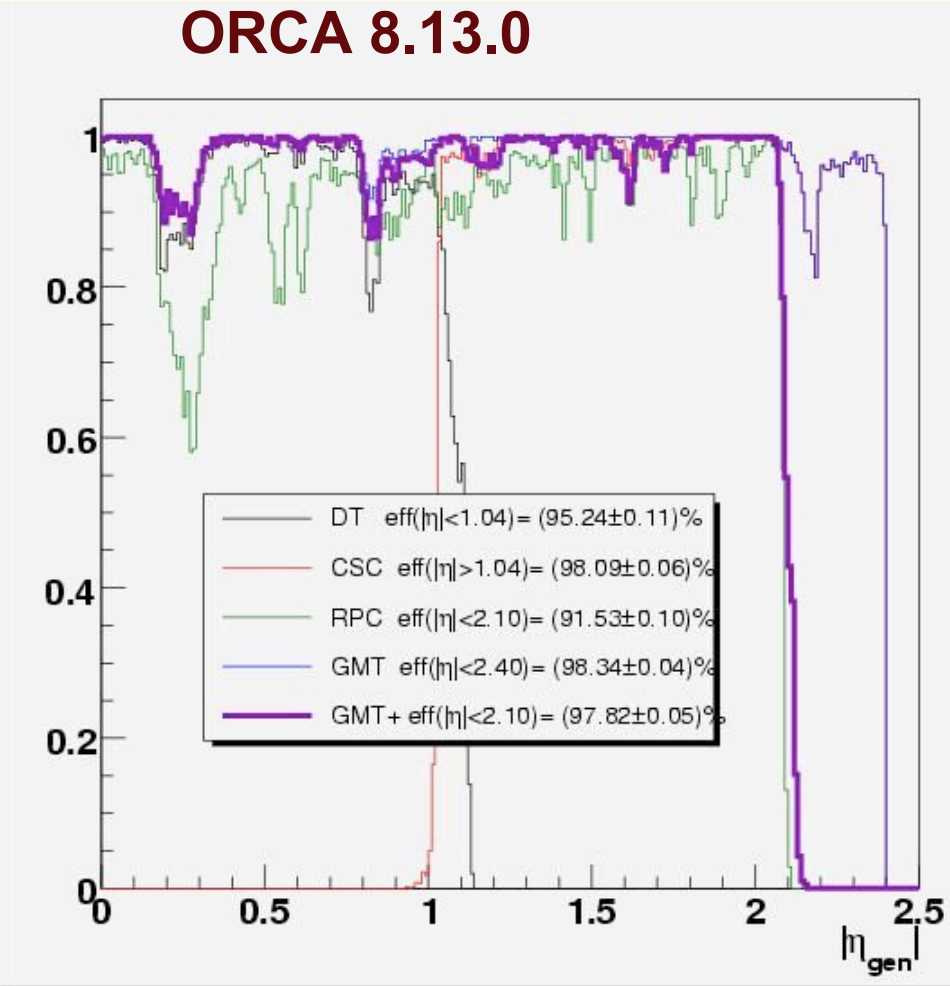
CMSSW 1.2.0.pre4



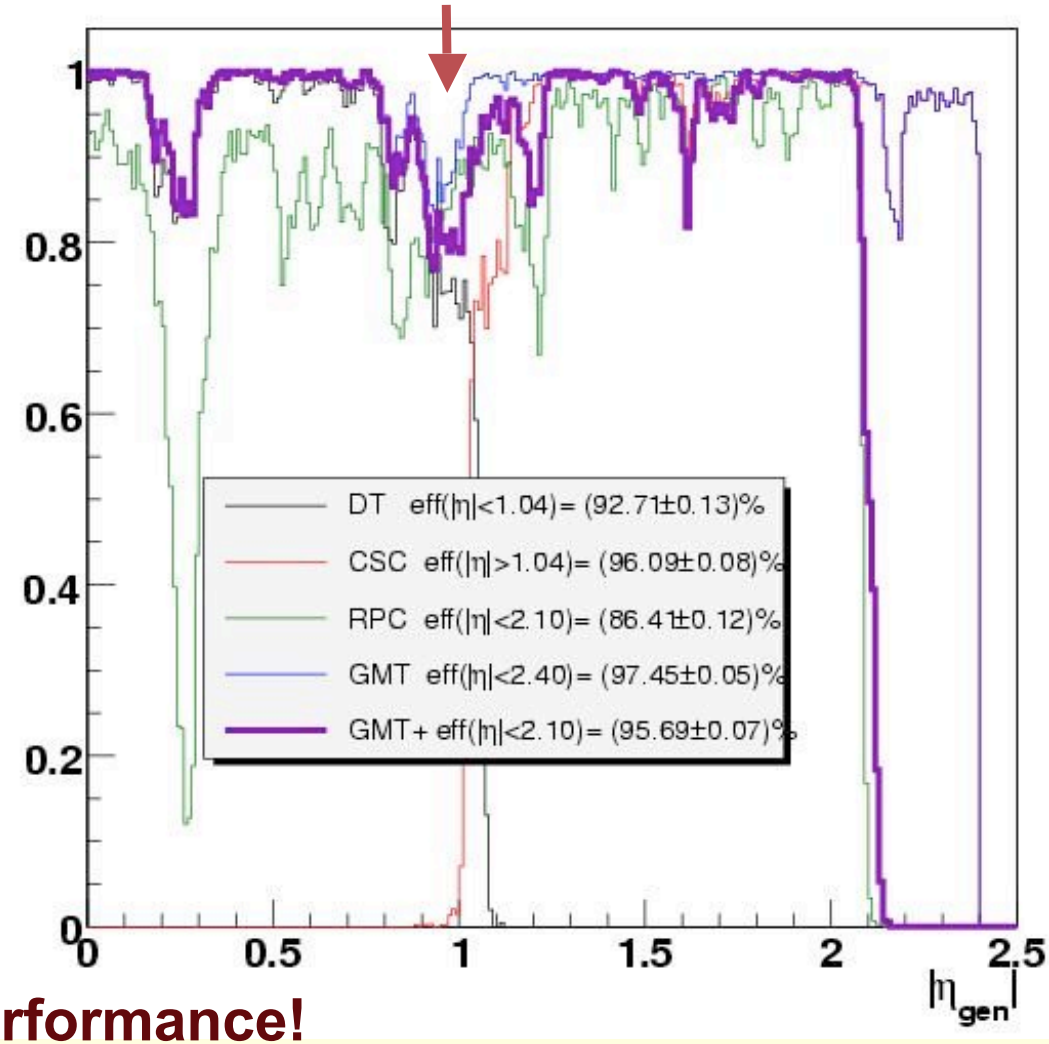
Improvement due to correct sector numbering

Efficiency vs. pseudorapidity - comp to ORCA

ORCA 8.13.0



CMSSW 1.2.0.pre4



Getting very close to the ORCA performance!

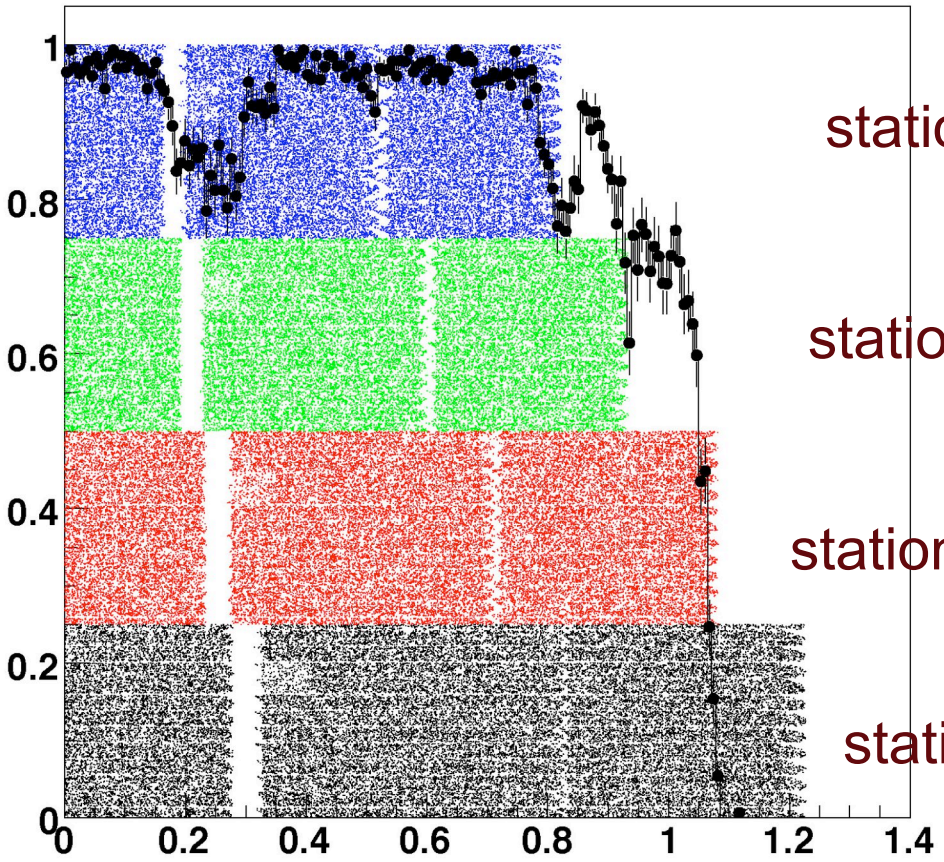
CSC-DT exchange and RPC barrel eff. - last dominant differences

DTTF and CSCTF eff. and hit maps

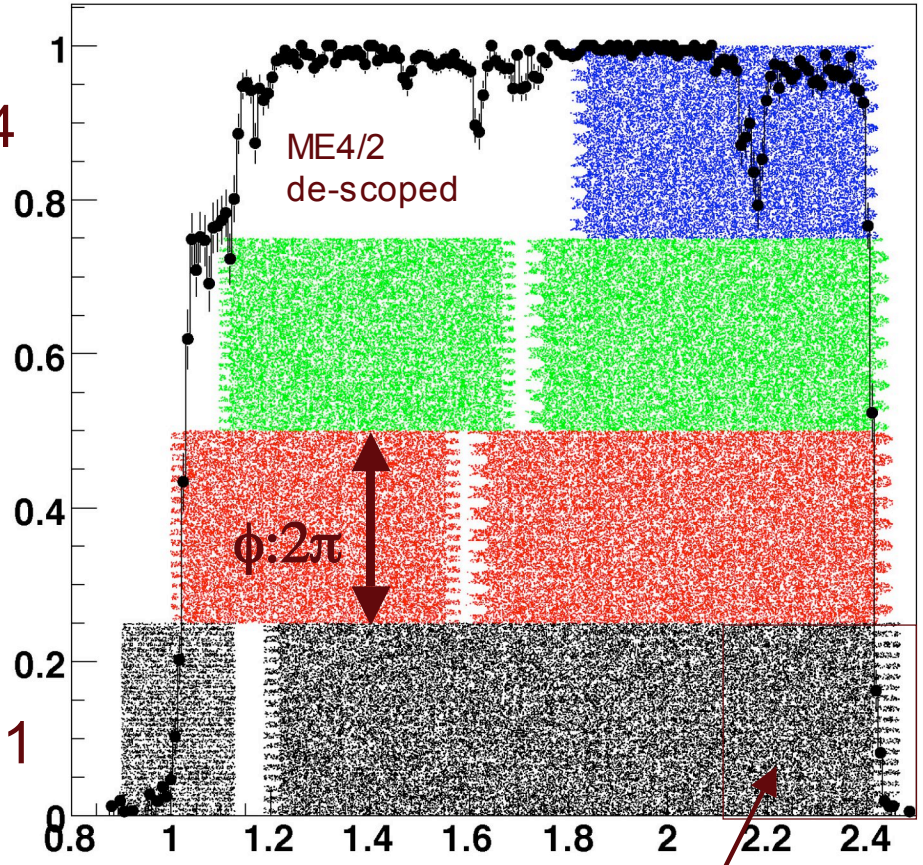
Histogram: efficiency vs eta

Scatter plot: hit maps ϕ vs η

DTTF



CSCTF

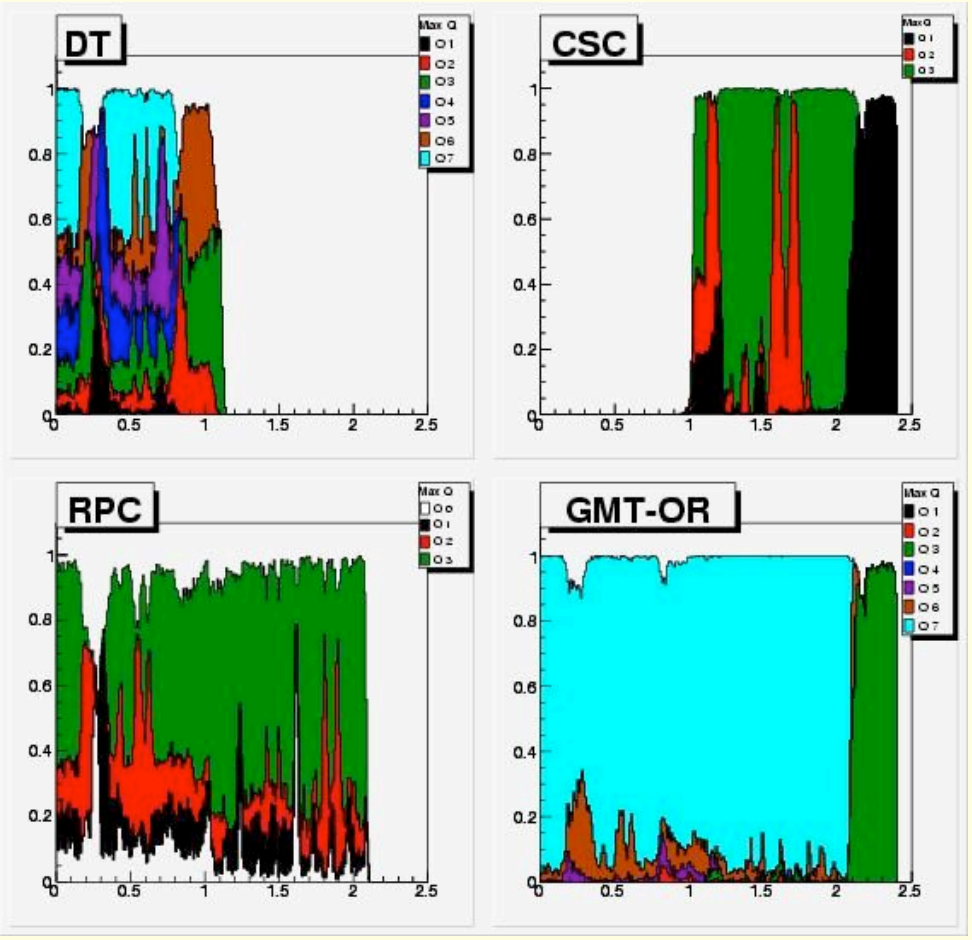


Inefficiencies - mainly acceptance

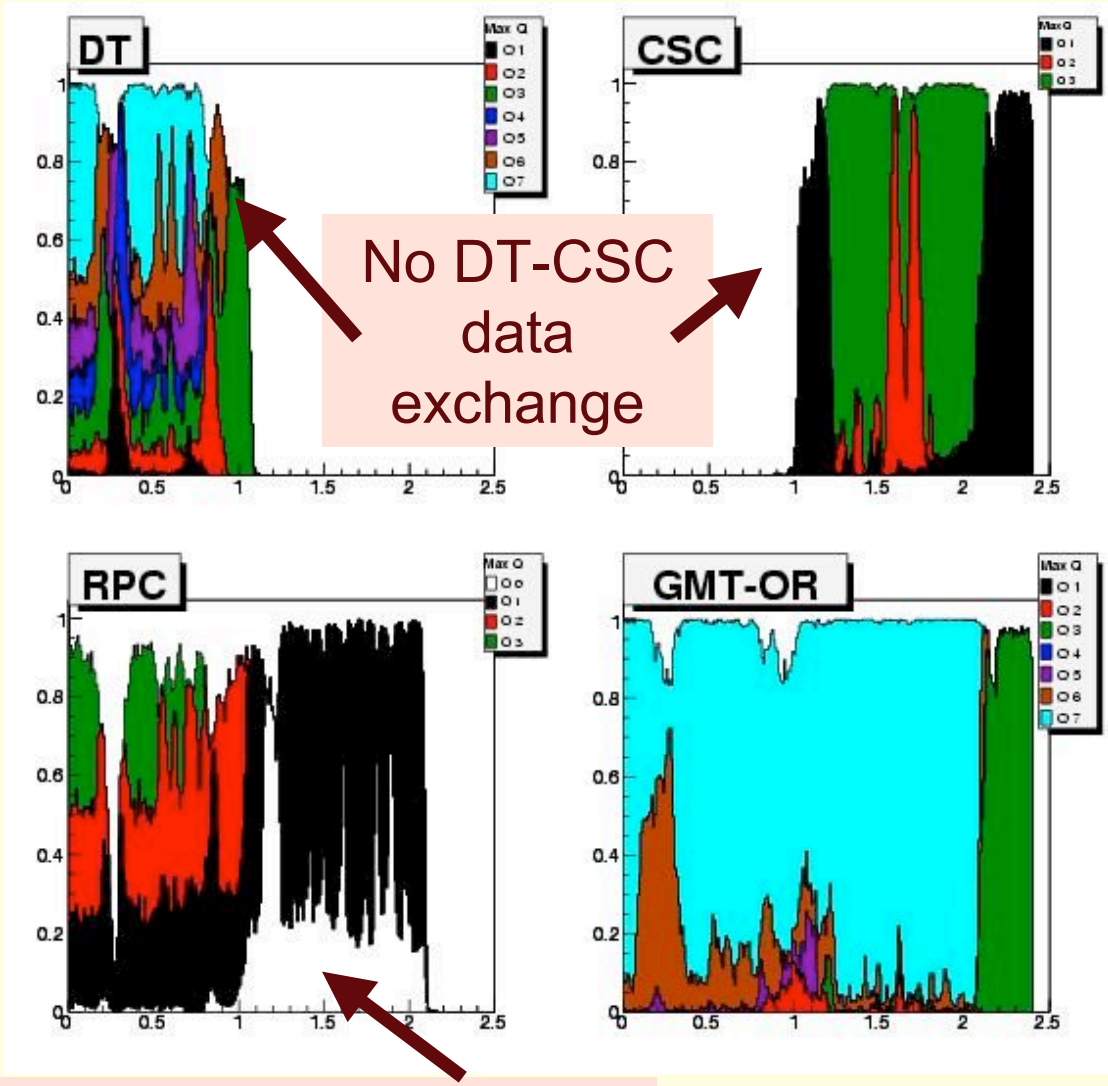
ME1/1 not used in the trigger

Quality bits vs. pseudorapidity

ORCA 8.13.0



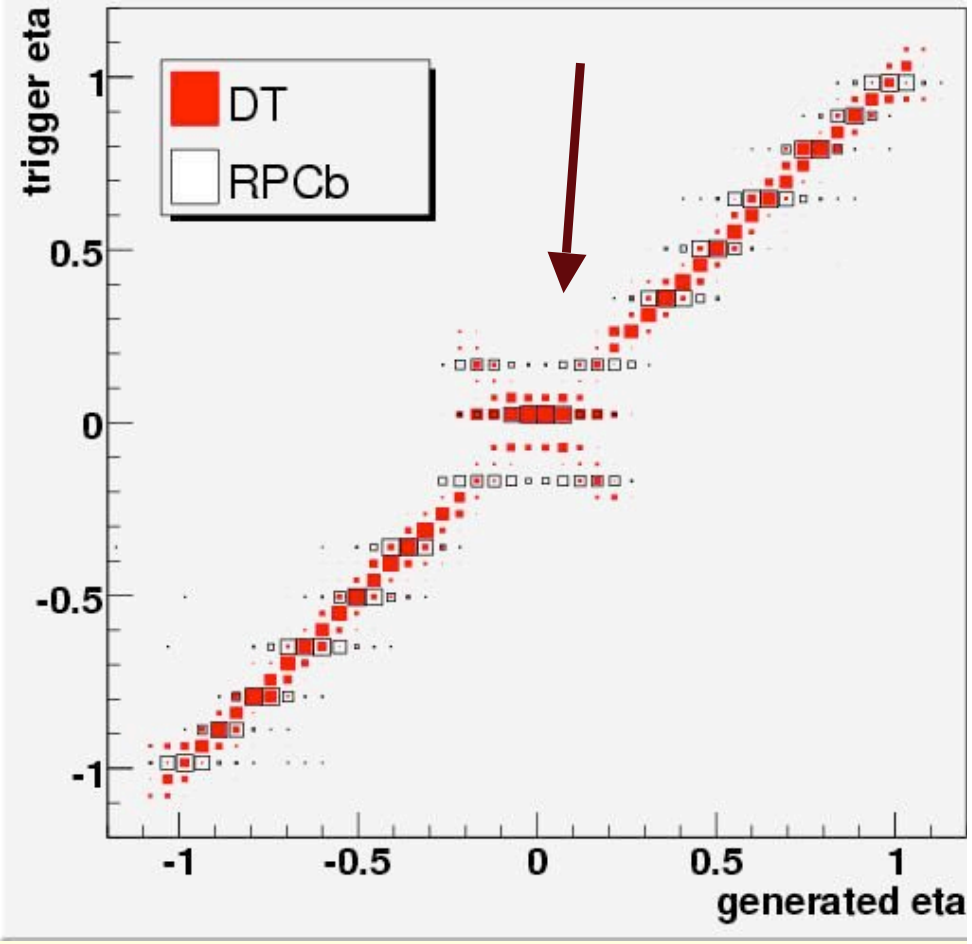
CMSSW 1.2.0.pre4



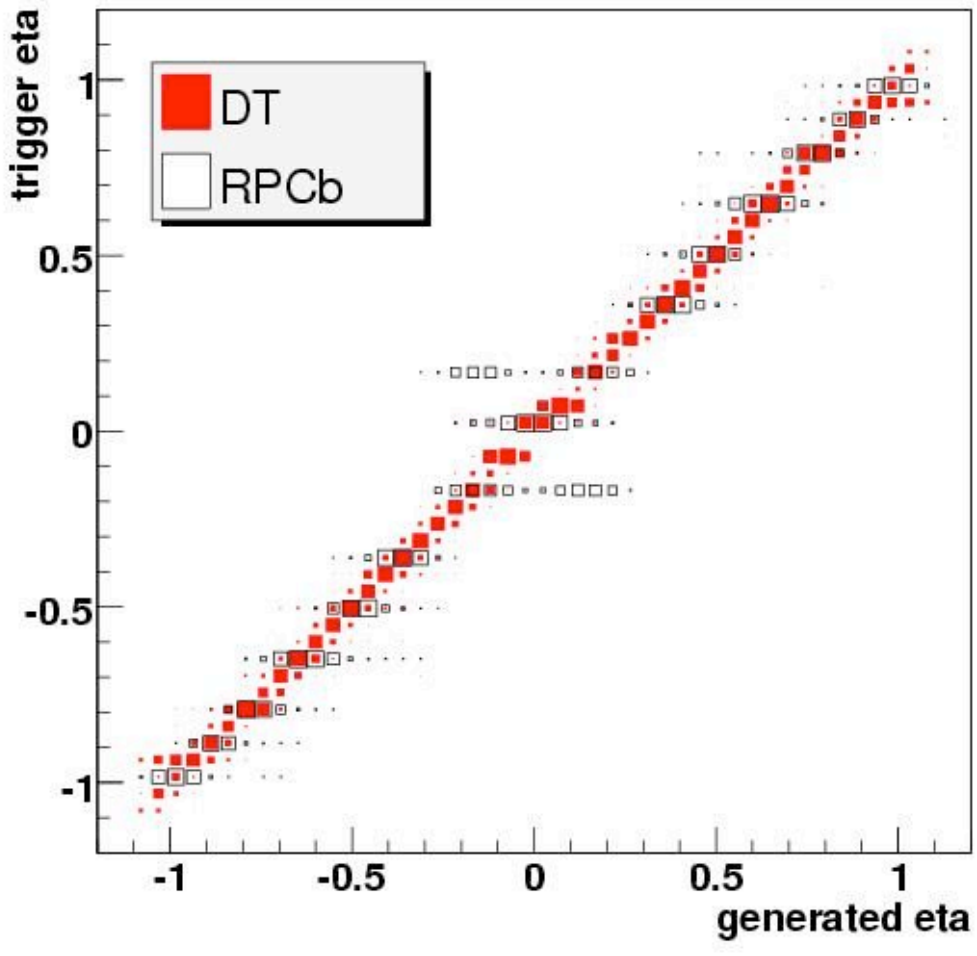
Problem at the central eta

- wrong measured eta sign in central wheel - DT ok now, RPC not

CMSSW 0.9.1+

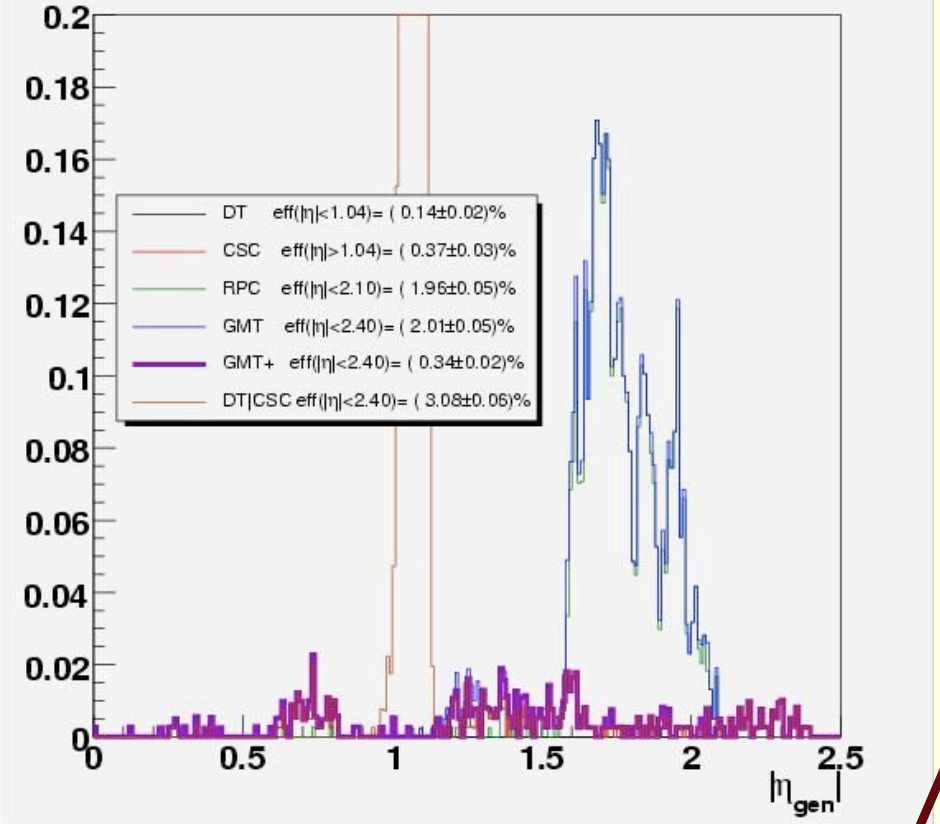


CMSSW 1.2.0.pre4

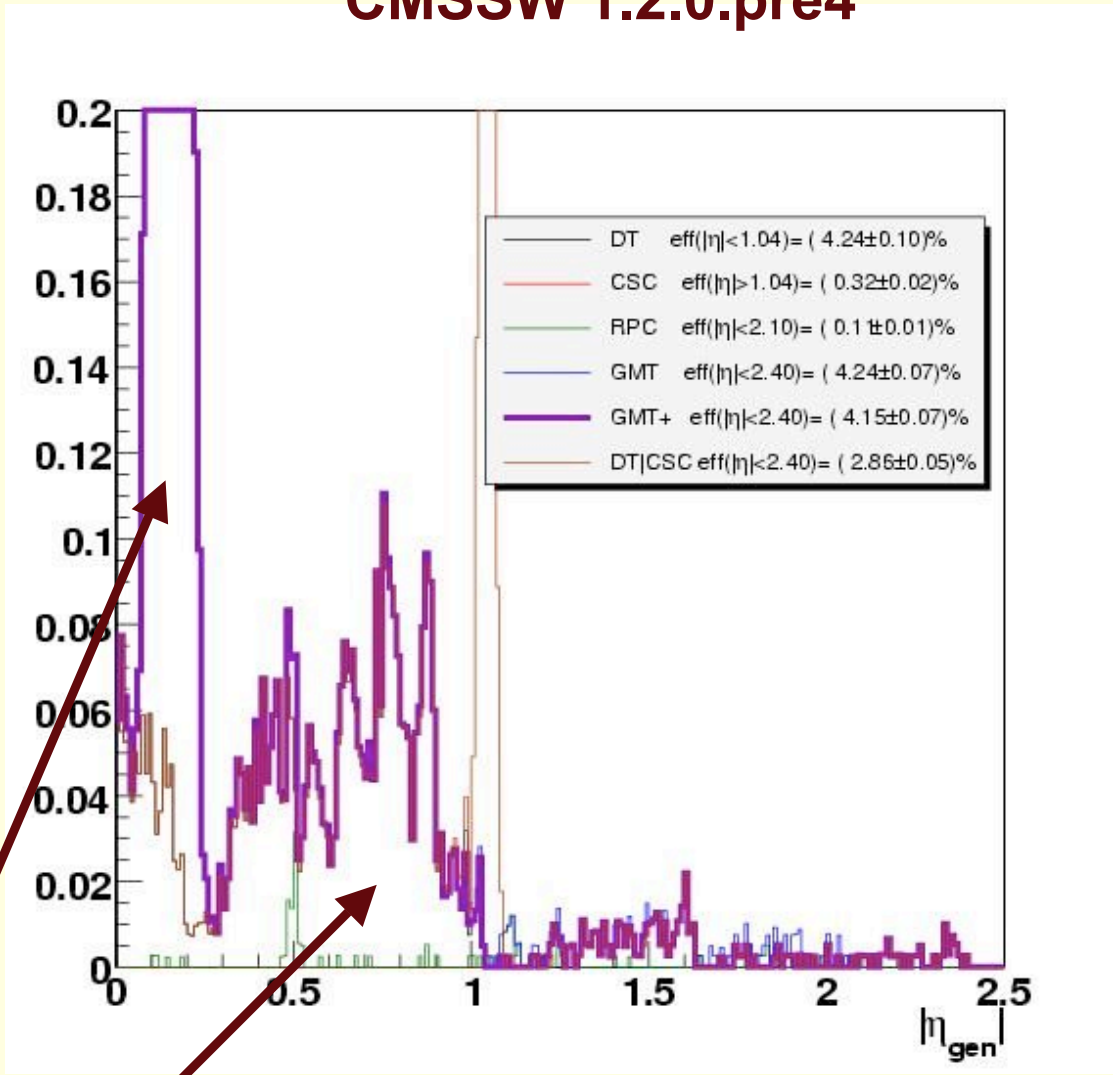


Ghost probability

ORCA 8.13.0



CMSSW 1.2.0.pre4



- Ghosts due to wrong RPCb eta
- Still high DTTF ghost rate (as in 091)

Summary muon emulator

- **Significant improvement of the DTTrigger and DTTF performance: fixed the mismatch between sector numbering and the sign of the eta measurement in the central wheel (Carlo Battilana, Jorge Troconiz)**
- **CSC timing is now (pre4) corrected (Tim Cox, Slava Valuev)**
- **Remaining items to be looked at:**
  - **DT-CSC data exchange** (important!)
  - **RPC barrel - efficiency and eta sign**
  - **pT resolution (CSC)**
  - **charge measurement (CSC,RPC)** (a detail to be fixed)
- **All subsystem are working on making the code match more closely the hardware** (does not mean necessarily a better performance)
- **New work on CSCTF** (pT res., DT-CSC exchange) **is starting (Mingshui Chen, Dayong Wang)**
- **CSC TPG has used MTCC data to update the emulator and the emulator was used to improve firmware (Slava Valuev)**

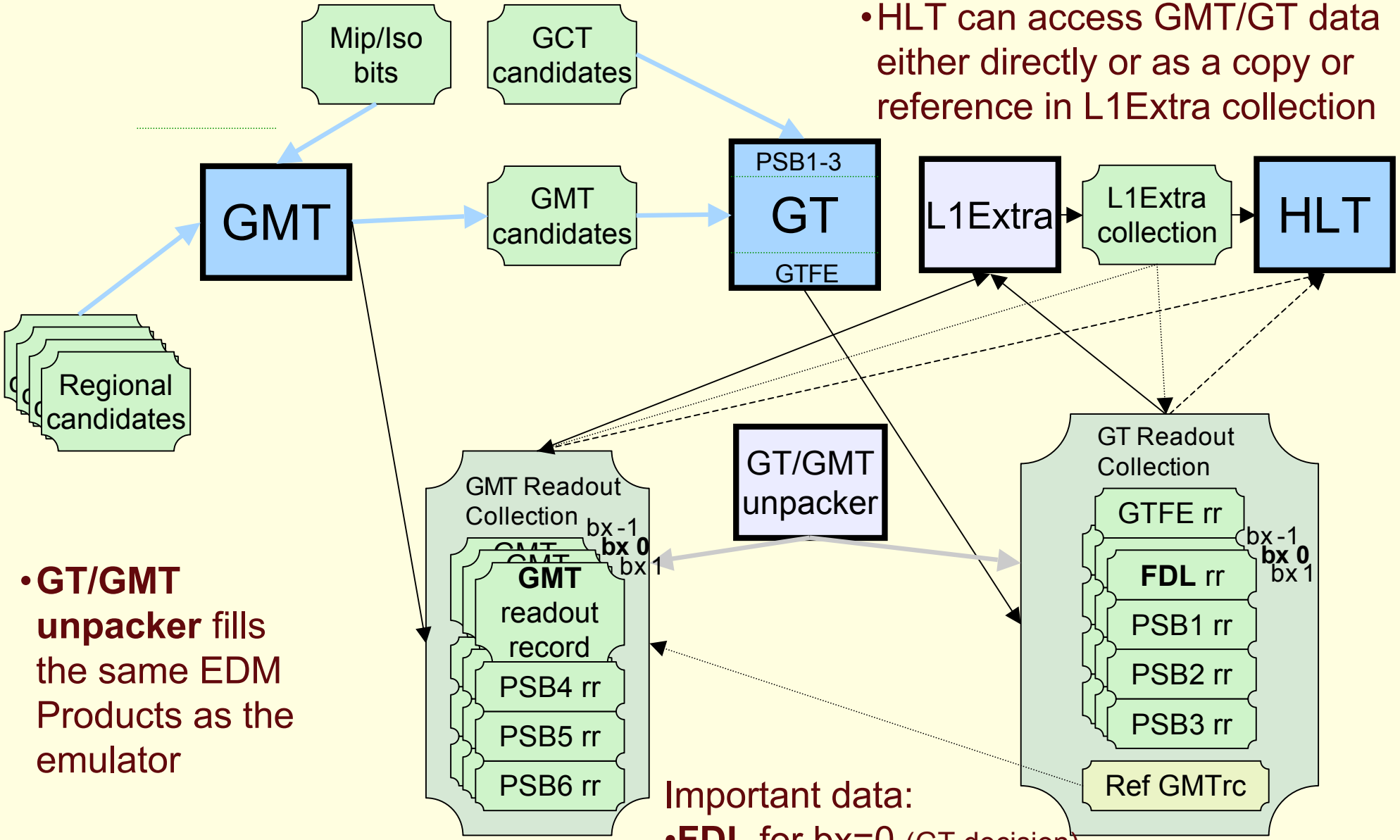
Further steps

- Need to add GMT interface to GCT (MIP/ISO bits)
- Agreed with Werner that the regional and GMT muon candidate classes will contain also physical values (pt, phi, eta) - instead of having them only for GMT candidates in L1Extra as originally intended (this will suit better the HLT use - discussions with Juan and Nicola)
- Work on unpackers and DQM started
- Configuration database is being setup and filled (from the online side) - need to work on Event Setup modules to access the database from the emulator and replace hardwired and .cfg configurations with db information

Global Trigger: Status

- **Status for prerelease CMSSW_1_2_0_pre5**
  - Decision part re-organized according to hardware readout record
    - reproduce bit-by-bit the hardware, but has simple methods for user to retrieve the global decision and the decision word (unchanged interface)
    - DataFormats/GlobalTrigger: common for emulator and unpacker
      - classes for FDL, GTFE, TCS, readout records sent to Event Manager (class L1GlobalTriggerEvmReadoutRecord) and DAQ (L1GlobalTriggerReadoutRecord)
      - methods to get/set these classes added
  - Muon part re-organized (see diagram in GT talk, HLT workshop, Oct 31)
    - persistent reference to collection produced by GMT emulator edm::RefProd<L1MuGMTReadoutCollection>
      - give direct access to GMT, CSC, DT, RPC muons (L1MuGMTExtendedCand class), in addition to methods in L1GlobalTriggerReadoutRecord
    - input tag introduced (emulator or unpacker)
  - Bunch cross treatment included
    - reproduce hardware readout record: correct treatment for all GT classes, GMT
    - temporary workaround for GCT

GMT - GT emulator data flow



- HLT can access GMT/GT data either directly or as a copy or reference in L1Extra collection

- **GT/GMT unpacker** fills the same EDM Products as the emulator

Important data:
- **FDL** for bx=0 (GT decision)
- **GMT** for bx=0 (muon candidates)

L1Extra interface change

- **Quote from Werner:**

  Since 120pre5 there will be a new interface for **l1extra::L1MuonParticle** which provides a direct access to the hardware objects. For the moment it holds a copy of the hardware object instead of edm::Ref.

- **see also:**

  https://hypernews.cern.ch/HyperNews/CMS/get/online-selection/170.html

Global Trigger: Status (*cont.*)

- Status for prerelease CMSSW_1_2_0_pre5
  - Printing functions:
    - use ostream reference – user can decide the log level it prints
    - -> interface change for all printing function
  - cfi file:
    - module name changed to L1GtEmul (*is there a CMS convention?*)
    - input tags for GCT, GT; other hardware parameters added
  - cff file included, using GMT and GCT cff files
  - Analyzer:
    - extended to show more available methods

Global Trigger: Plan

- Short term plan for Global Trigger (in order of priorities)
  - implement trigger particle map (associate algorithms and conditions with the trigger objects involved) - CMSSW_1_3_0_preX
  - change to PSB classes in the GT DAQ readout record, instead of calorimeter objects
  - run integrated chain GCT – GMT – GT
  - validate (pending correct output from GCT, trigger scales)