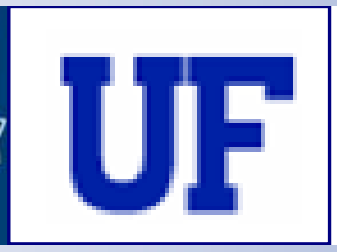
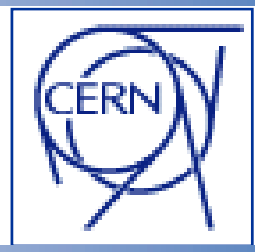


Track Selection Performance of the CMS Cathode Strip Chamber Track Finder and Level 1 Trigger

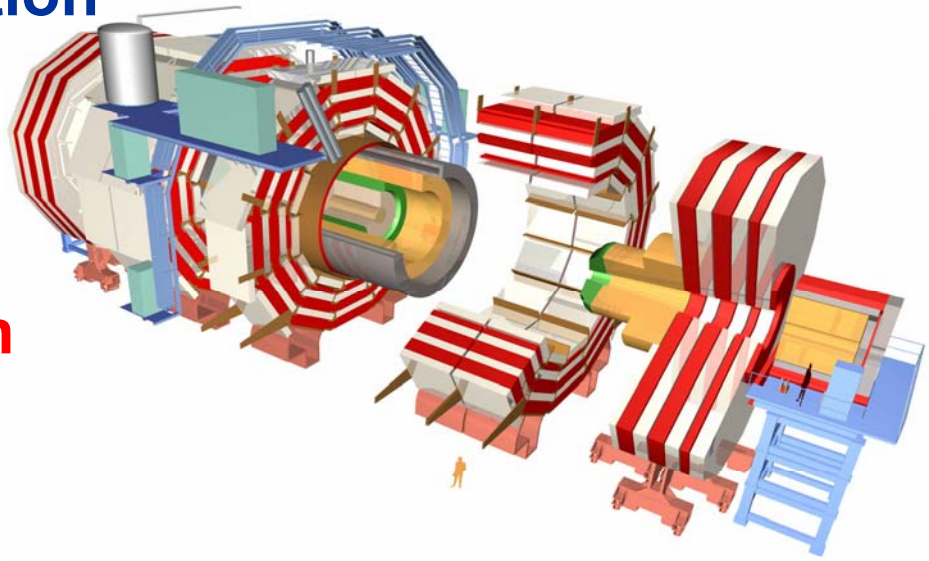
Kristin Beck

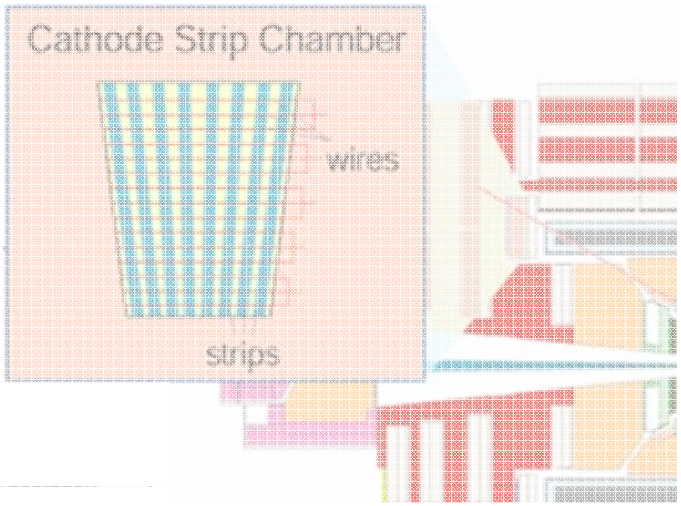
Advisors: Dan Holmes, Darin Acosta

14 August, 2008

Cathode Strip Chambers

- One of three muon detection systems in CMS = Compact Muon Solenoid
- Located in the endcaps
- Responsible for muons in $0.9 \leq n \leq 2.5$





- CSCs consist of wires and strips arranged in a grid pattern
- Muons produce LCTs = Local Charged Tracks
- Track Finder uses multiple LCTs to reconstruct a muon's path

Cathode Strip Chambers

- One of three muon detection systems in CMS = Compact Muon Solenoid
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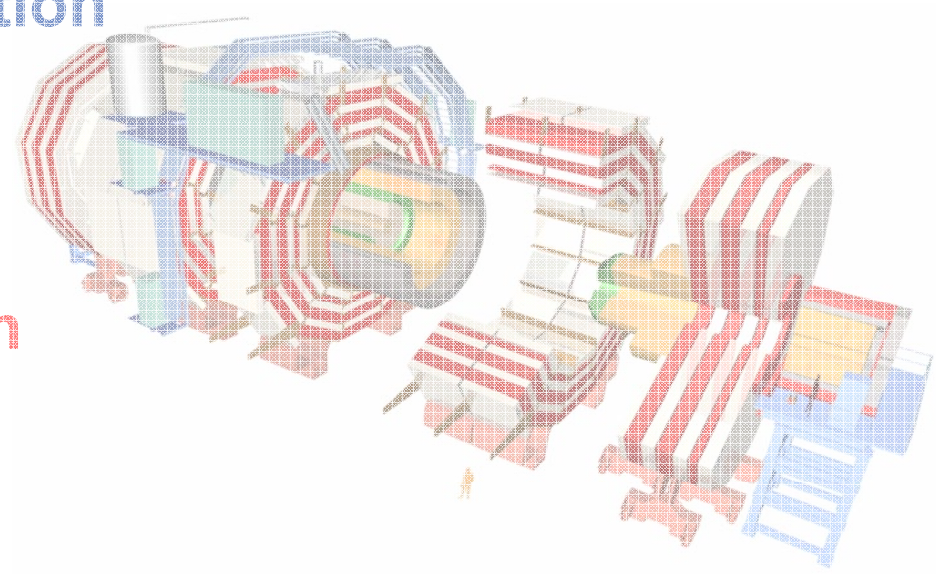
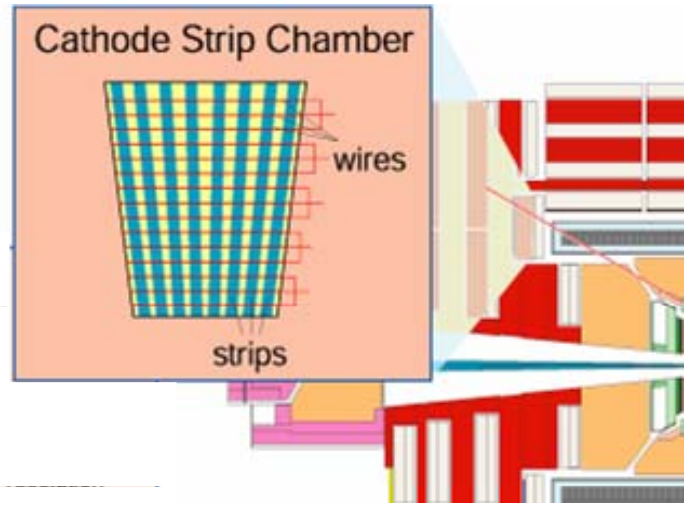
  Responsible for muons in $0.9 \leq \eta \leq 2.5$





- CSCs consist of wires and strips arranged in a grid pattern
- Muons produce LCTs = Local Charged Tracks
- Track Finder uses multiple LCTs to reconstruct a muon's path

Level 1 Trigger

the problem

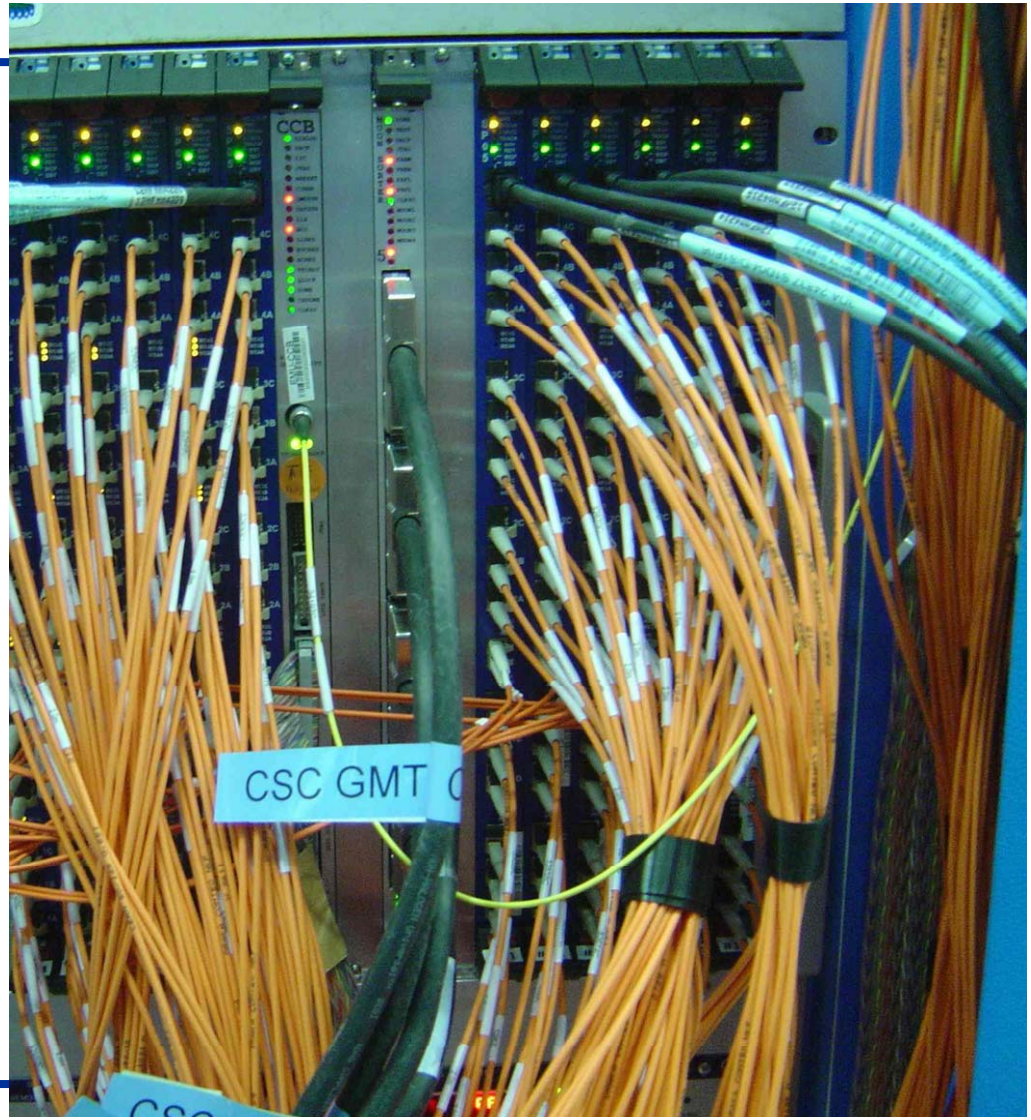
- At full luminocity, expect 40MHz from CMS detector
- Can only store ~200Hz

CMS's solution

- Select data to store before saving
- Two stages : Level 1 & HLT = High Level Trigger
- L1 is custom electronics that reduce data rate to 100kHz
- HLT consists of commercial processors

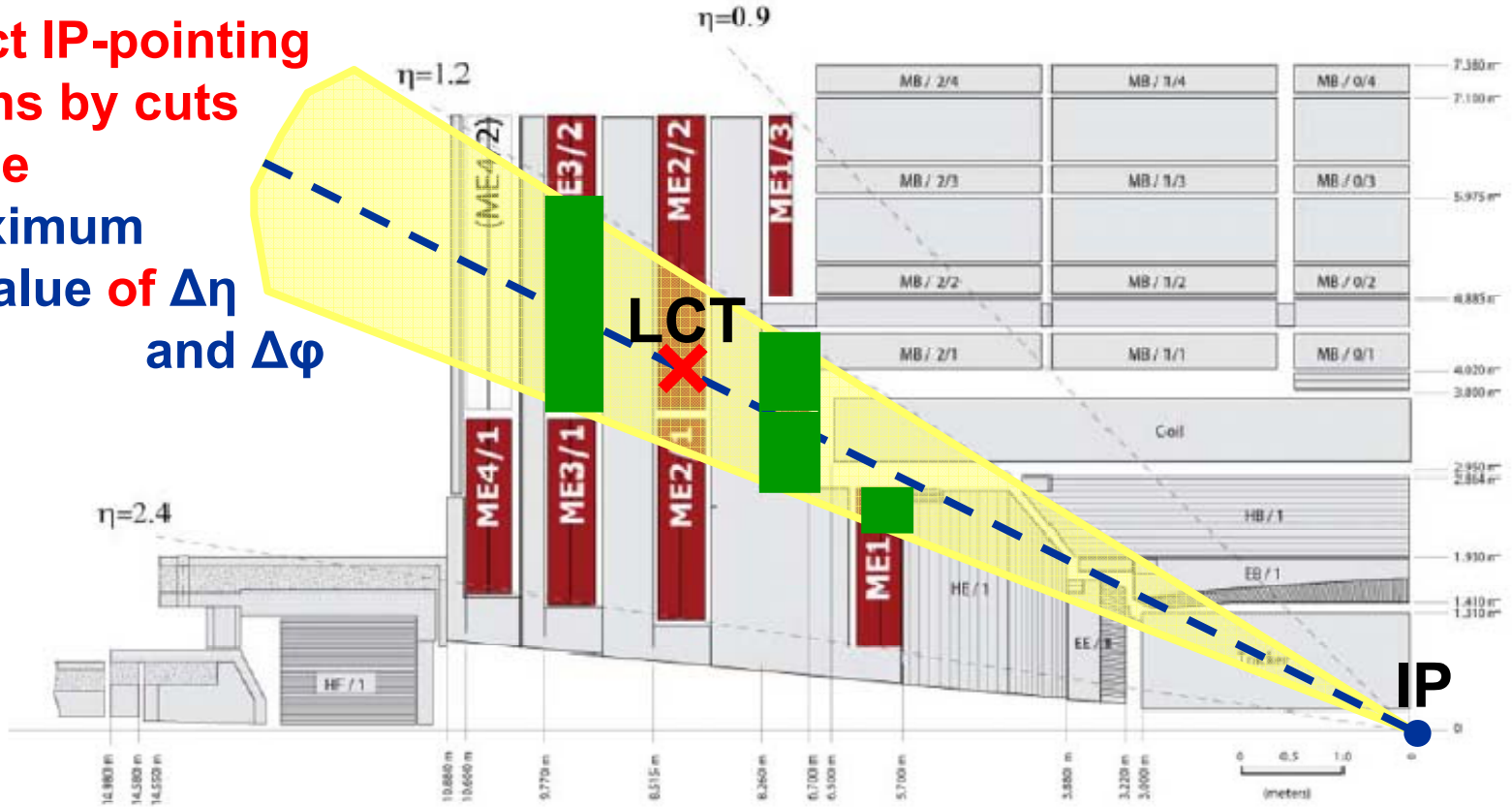
CSC Track Finder/Level 1 Trigger

- CSC L1 Trigger selects up to 4 muons per bunch crossing (25ns) to pass on to GMT = Global Muon Trigger
- Extrapolations by track mode
- Input parameters include η, φ, Δη and Δφ
- Output to GMT is the quality and P_T of track candidates
- Highly configurable, FPGA-based trigger



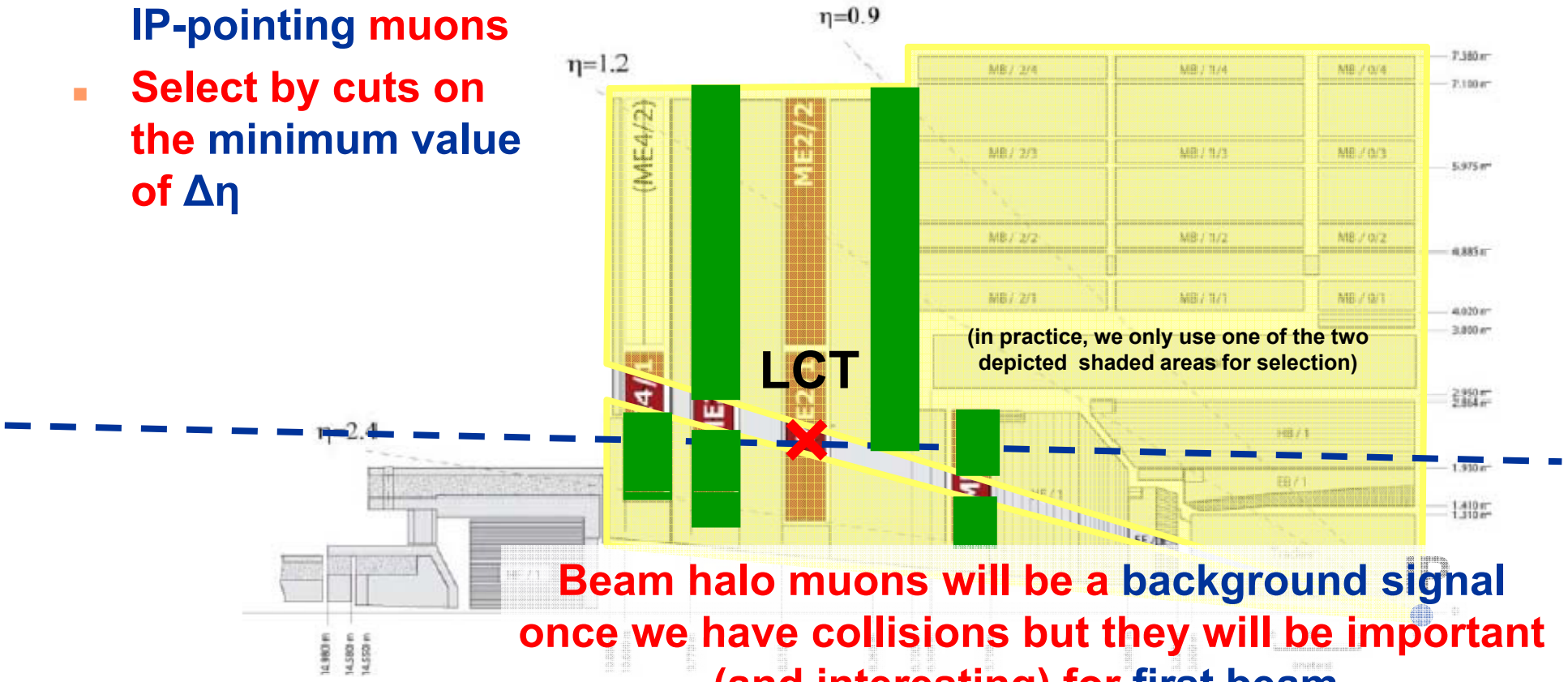
Identifying Tracks

- Muons coming from new physics originate near the IP = Interaction Point
- Expect ~ constant η, φ
- Select IP-pointing muons by cuts on the maximum value of Δη and Δφ



Identifying Tracks

- Beam Halo Muons are produced beam+pipe and beam+gas interactions
- Expect non IP-pointing muons
- Select by cuts on the minimum value of Δη

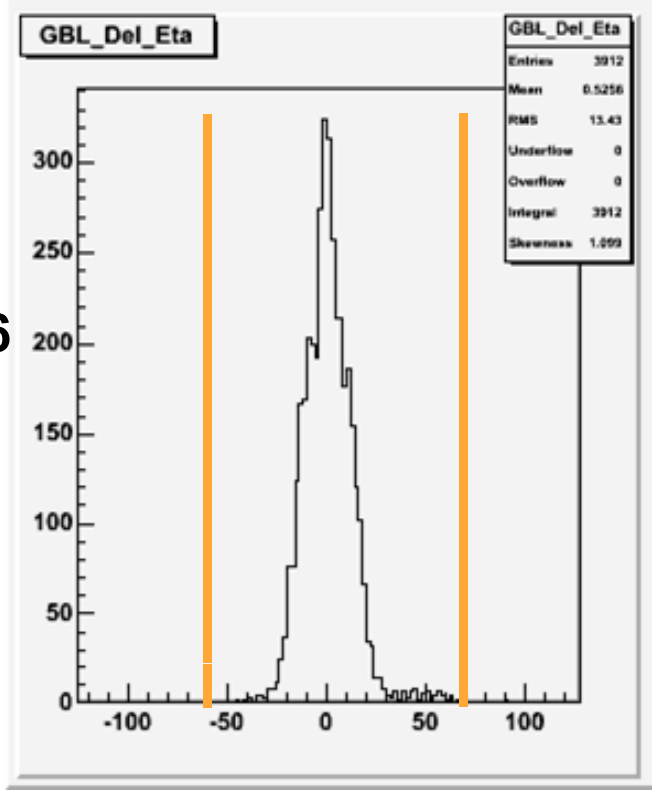


Beam halo muons will be a background signal once we have collisions but they will be important (and interesting) for first beam.

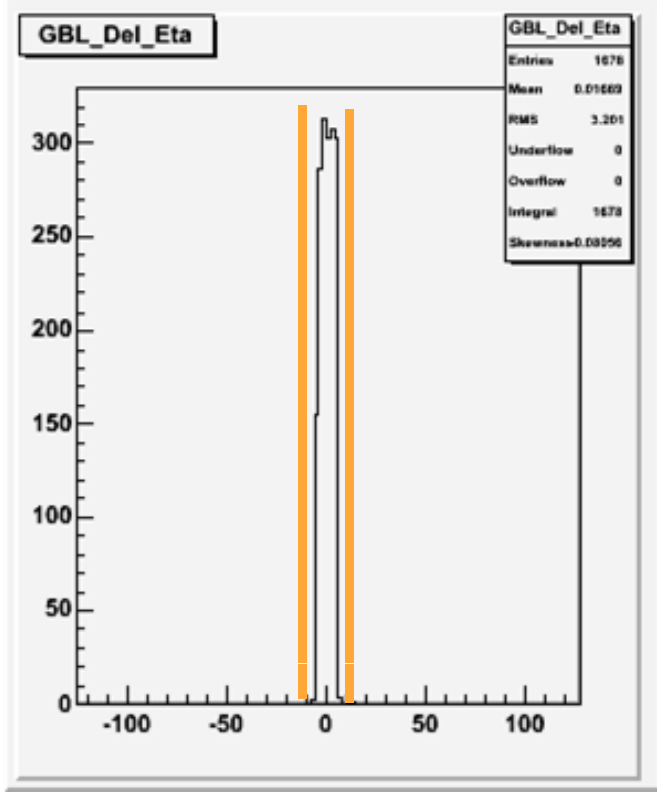
Track Selection Performance: Δη

- **Δη Cut Confirmation (…maybe)**
  - **Two runs from CRUZET2, one with no restriction on Δη and one with Δη set to 0x5 (Δη < 0.25, or θ < 5°)**

Max: 97
Min: -96



46788



46794

Max: 13
Min: -8

  - **What about the tracks with |Δη|>0x5? (<1% of all tracks)**

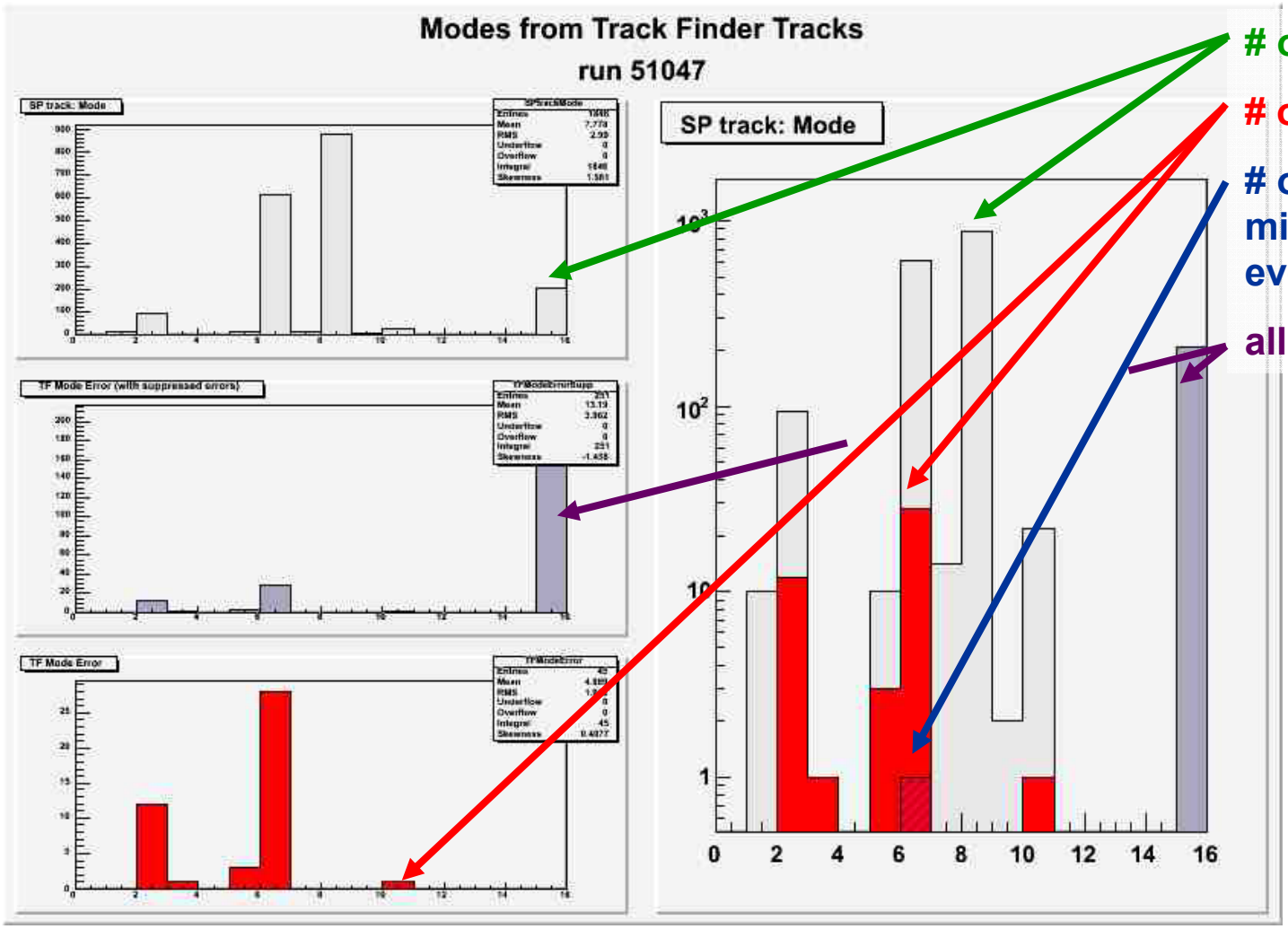
Tracking down that last 1%

Are the track mode assignments self consistent?

- Complications
  - Recent firmware update not reflected in software
  - Undocumented special cases for track mode assignment
  - Unrecorded “out of time” LCTs

… yes (mostly)

Mode Analysis Output (graphical)



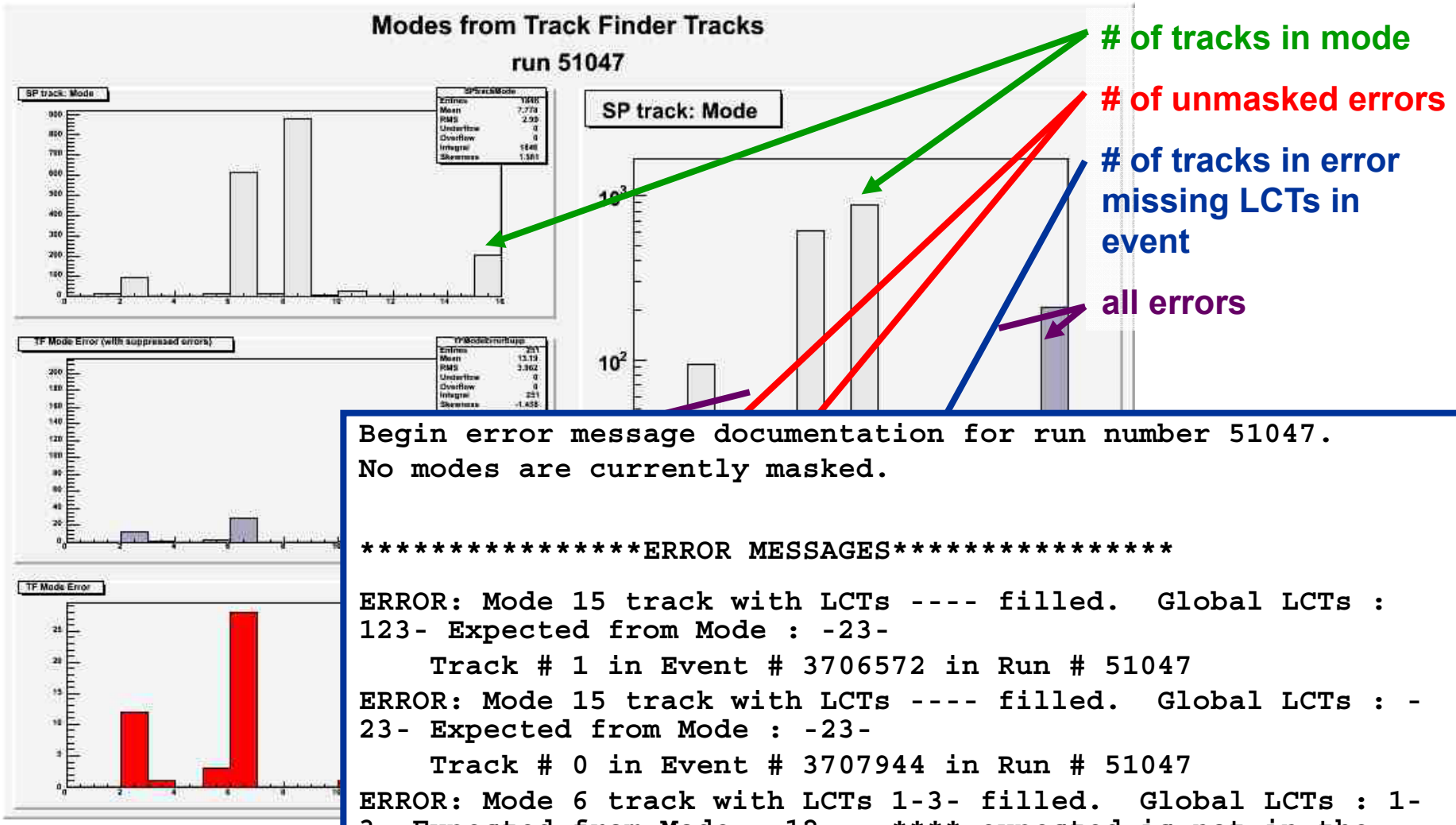
# of tracks in mode

# of unmasked errors

# of tracks in error missing LCTs in event

all errors

Mode Analysis Output (graphical)




```
Begin error message documentation for run number 51047.
No modes are currently masked.

****************ERROR MESSAGES****************

ERROR: Mode 15 track with LCTs ---- filled.  Global LCTs :
123- Expected from Mode : -23-
    Track # 1 in Event # 3706572 in Run # 51047
ERROR: Mode 15 track with LCTs ---- filled.  Global LCTs : -
23- Expected from Mode : -23-
    Track # 0 in Event # 3707944 in Run # 51047
ERROR: Mode 6 track with LCTs 1-3- filled.  Global LCTs : 1-
3- Expected from Mode : 12--  **** expected is not in the
track ****
    Track # 0 in Event # 3742778 in Run # 51047
```

Tracking down that last 1%

Are the track mode assignments self consistent?

- Complications
  - Recent firmware update not reflected in software
  - Undocumented special cases for track mode assignment
  - Unrecorded "out of time" LCTs

… yes (mostly)

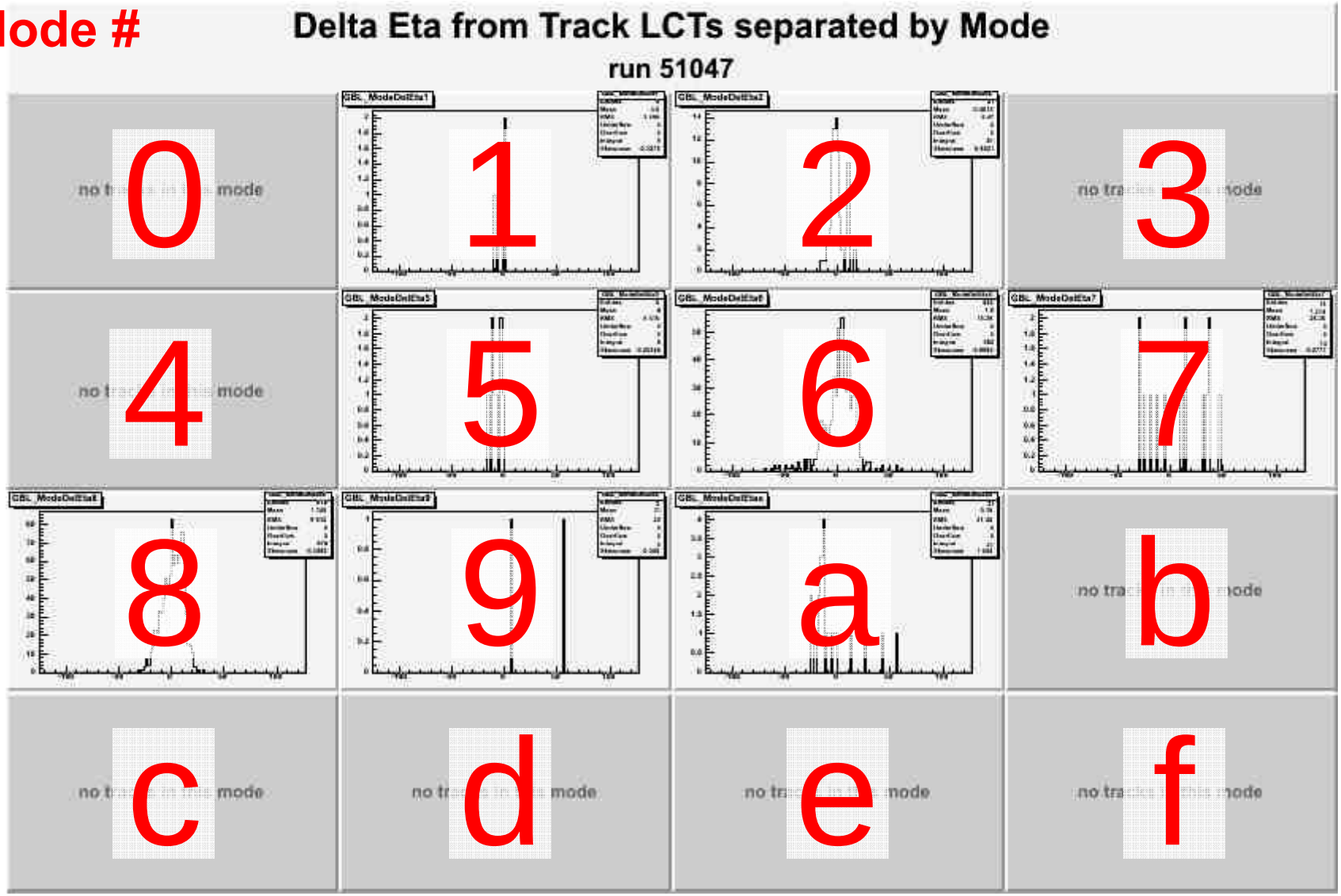
- **Are we looking at Δη between the wrong LCTs?**

- **In run 46794, tracks with |Δη|>0x5 are in mode 6 and mode 8**
- **These modes only contain 2 LCTs**

… no

Δη Output (graphical)

Mode #



Conclusions

- **Basic Δη cut works (to first order)**
- **Further study needed**
  - **What are the outstanding issues in the Δη cut?**
  - **Is the current error level manageable?**
  - **How is track finder performance with mode-specific cuts?**
  - **What about cuts on other parameters?**
- **Deliverables**
  - **Analysis package that computes Δη and Δφ and checks LCT agreement with assigned track mode**

Documentation: http://cern.ch/csctf/studies/studies.html

Technical Presentation: http://indico.cern.ch/conferenceDisplay.py?confId=39150

Questions?

Thanks to…

Darin Acosta, Dan Holmes, Dayong Wang, Khristian Kotov, Joe Gartner

Homer Neil, Myron Campbell, Jean Krisch, Jeremy Herr

NSF, University of Michigan, CERN