HCAL ALCA TRIGGERS

Anton Anastassov
(Northwestern University)

On behalf of the HCAL DPG Group

HCAL Calibrations

- Goals:
  - Equalize the response of HCAL in phi for each iEta ring (towers with iEta=const)
  - Equalize response across iEta in HB and part of HE at a fixed energy
  - Establish a smooth response across sub-detector boundaries

- HCAL calibrations will be performed
  - At start-up
  - When HCAL conditions change
  - Periodically for adjustments and/or monitoring: every 1-2 months, exact frequency will be determined as we gain experience

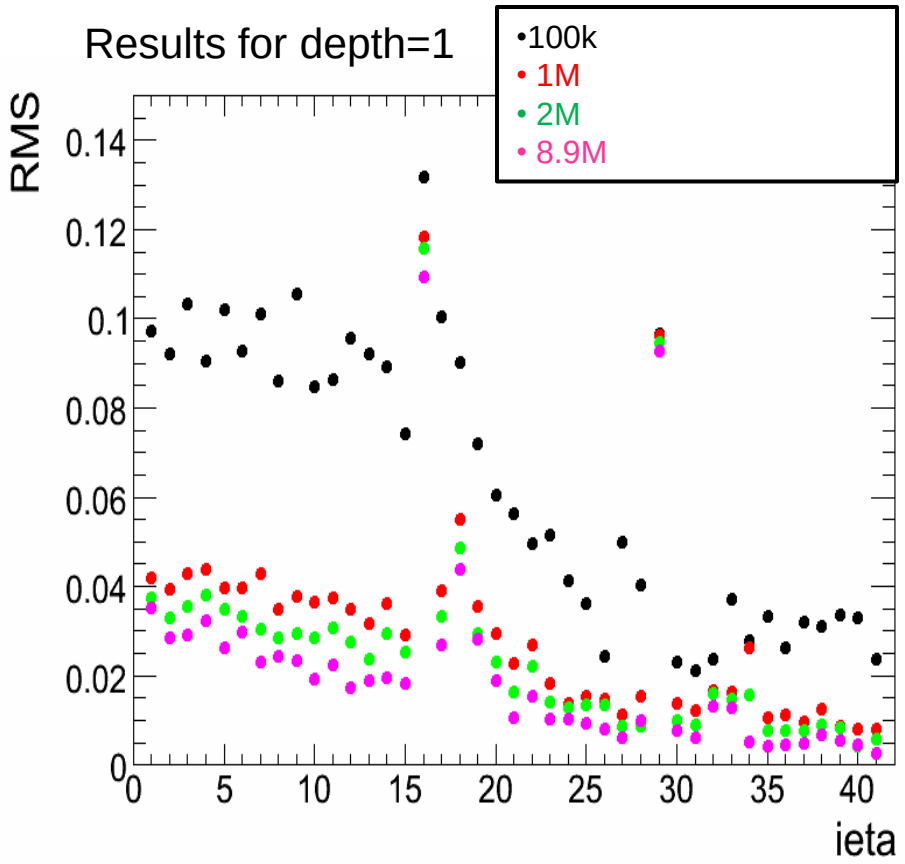
Samples for early HCAL calibration

- MinBias events and Noise samples
  - Need a dedicated trigger (AlCa_HcalPhiSym)
    - Used in special runs with no zero suppression (NZS) in HCAL
    - Discussed in this presentation
- Isolated tracks
  - Need a dedicated trigger (HLT_IsoTrack)
    - Data collected during physics runs (HCAL is zero-suppressed)
    - Discussed in this presentation
- DiJet samples
  - Selected with the single jet triggers, see Grigory Safronov's talk at the Jet & MET Trigger Review on Dec 11, 2008
- Muon samples for HO calibration
  - Selected with the single muon triggers, see David Futyan's talk at the Muon Trigger Review on Dec 15, 2008

Phi-calibration with MinBias events

- Assumes phi-symmetric energy deposition
- Relies on information in HCAL only
- Corrections can be obtained for HB/HE/HF
- Small average energy per cell, comparable with noise
  - Deploy a techniques that uses noise subtraction via variances: https://twiki.cern.ch/twiki/bin/view/CMS/AzymSym
  - Data must be collected with no zero suppression (NZS) in HCAL
- "Noise" is obtained from the same sample: 0-3 time slices:
  - AlCaRaw contains HCAL FED's

Expected Phi-resolution from MinBias



- Resolution depends on both statistics and average signal/noise
- The presented resolutions are obtained after excluding pathological cells
  - These (if present) will be treated separately
- Meeting resolution goals in HB require large samples : ~10M events

Proposed trigger: AlCa_HcalPhiSym

The trigger will be used only in dedicated HCAL NZS runs

- L1 seeding: L1_SingleEG2 OR L1_DoubleEG1
- No reconstruction or selection in HLT
  - Extract and store only HCAL FEDs (without unpacking)
    - Adds ~0.33ms to HLT processing
  - Event size ~260 KB (full size + NZS HCAL ~400 KB)

- If allocated 100 MB/s bandwidth:
  - Time to collect 10M events (assuming 100% efficiency)
    - 7 hours for $1x10^{31}$, $8x10^{29}$ menus from Dec 4th prescales, $1x10^{31}$ menu with Nov 24th prescale
    - not an option with $8x10^{29}$ menu and Nov 24th prescale (23 days!)
- In case we share the bandwidth required time will increase

- The trigger has been tested in CRAFT (collected ~160 M events)

AlCa_HcalPhiSym

- The data will be taken once at startup,
  - If detector conditions change we will need to take data again
- Control of rate/bandwidth will be managed through HLT prescale

Current development/support for the triggers:

Grigory Safronov – ITEP (Russia)

Expect to add one more person

Isolated Tracks Trigger for HCAL Calibration

Main use of isolated tracks in HCAL calibration:

- Obtain eta-dependent correction and set reproducible energy scale in HB and part of HE
  - For early calibration (~1 week of data) with small samples we will do the calibration using 15-25 GeV tracks
  - For larger samples use 40-60 GeV tracks

- Need to collect high-statistics sample of isolated tracks while avoiding bias from L1 selection
- Currently implemented as AlCaRaw path; AlCa_IsoTrack has been included in the default HLT menu since 2_0_X
- Propose new trigger version: HLT_IsoTrack

HLT_IsoTrack Trigger

- Implement as a regular HLT trigger due to:
  - Small data size reduction in AlCaRaw: 164 kB → 85 kB
  - Relatively low HLT rate ~10 Hz
- Need data availability on CAF within 1-2 days

- Improved HLT selection relative to the previous version
  - Use information from silicon strip tracker to reduce sensitivity to pixel misalignment
    - Reduce rate; increase purity of the samples for startup (ideal) conditions by a factor of 8 (2)
    - Lower track momentum threshold to collect sufficient number of tracks for phi-calibration cross-check
    - Reduce bias
- The new HLT code exists; easy AlCa_ → HLT_ migration (modify configuration file)

HLT_IsoTrack trigger at $1x10^{31}$ $cm^{-2}s^{-1}$

Here and below we use the prescales from the Dec 4 menu.
Sample: MinBias with STARTUP_V5 conditions.

L1 seeding	Prescale	Rate (Hz)
L1_SingleJet30	50	165.79
L1_SingleJet50	5	134.24
L1_SingleJet70	1	128.71
L1_SingleJet100	1	20.72
L1_SingleTauJet30	100	18.16
L1_SingleTauJet40	10	64.15
L1_SingleTauJet60	1	111.81
L1_SingleTauJet80	1	23.64
Total ("OR" of triggers)		~517

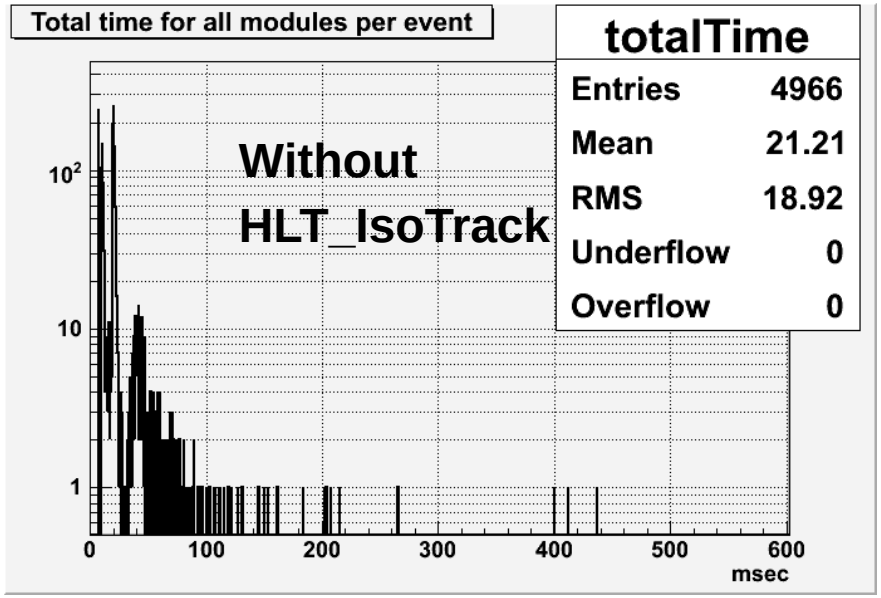
HLT selection:

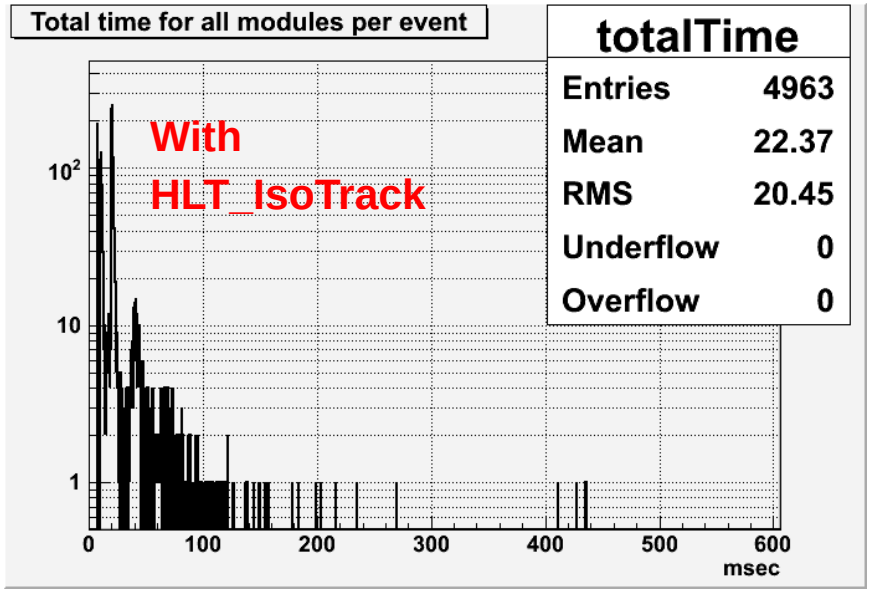
- Exclude region with $R(\eta,\varphi) < 1.2$ to triggered L1 jet to avoid bias
- Require a pixel track with $p_T > 3.5$ GeV, $|\eta| < 2.0$, $d_{XY} < 0.05$
- Veto if additional track with $p_T > 0.9$ GeV is found in cone of $R(\eta,\varphi) < 0.3$ (0.5) in HB(HE)
- On demand tracking seeded by pixel track in cone 0.05; require single track with p>10 GeV

- HLT output rate: 8.7±0.5Hz
- Overlap with other triggers: ~13%

→ Events can not be "harvested" from other samples

HLT timing (using $1x10^{31}$ menu)

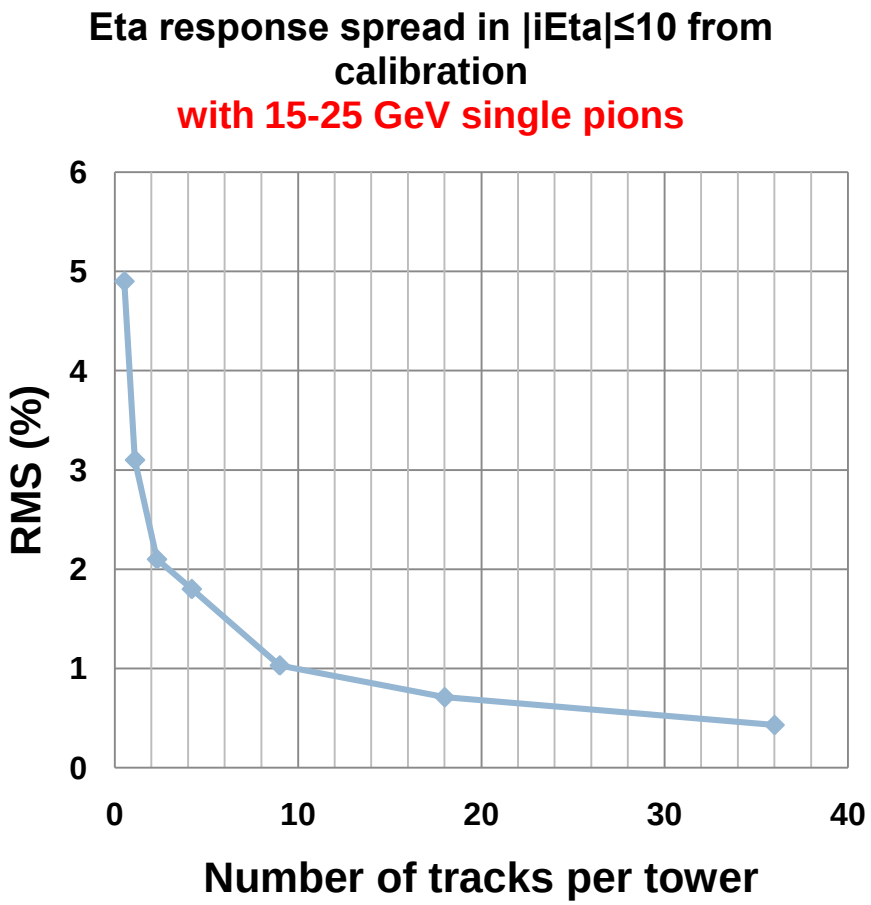




HLT_IsoTrack **adds ~1.2 ms** to the average time of HLT processing (for our new HLT version)

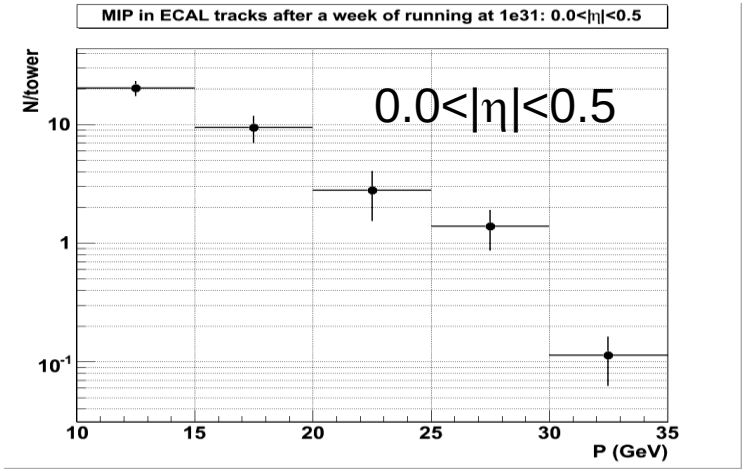
Calculation done using the Dec. 4 prescales.

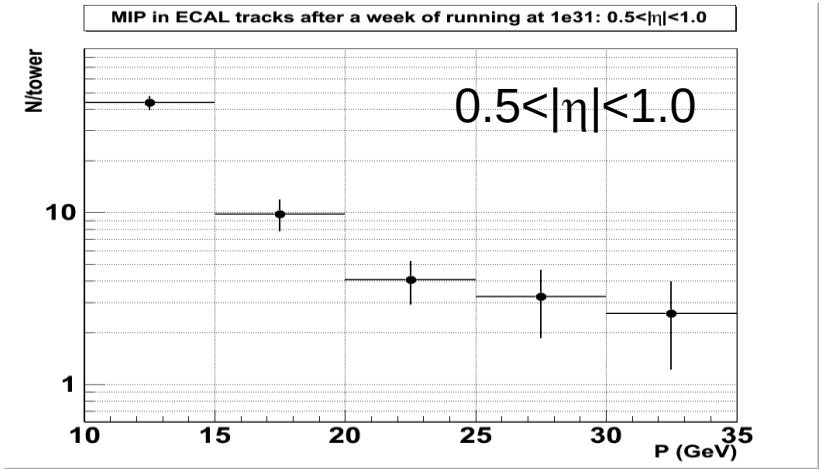
Resolution of intercalibration in eta

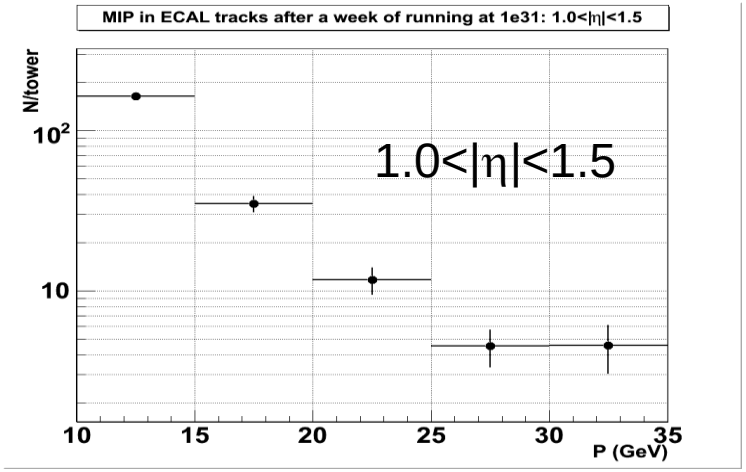


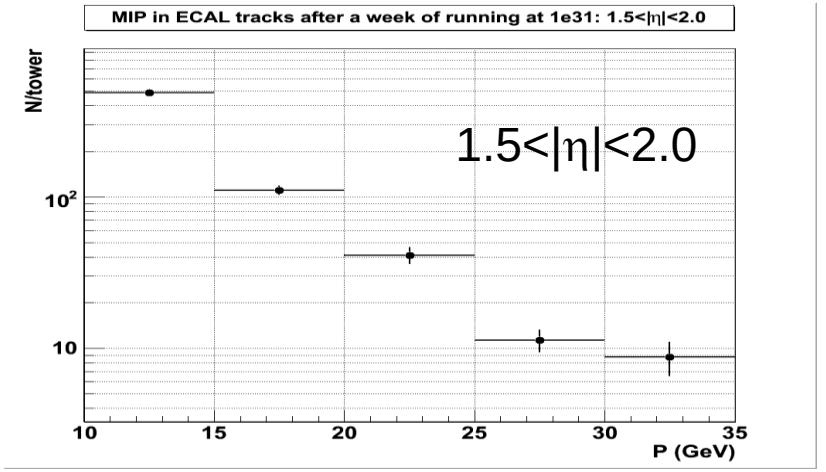
- Characterizes flatness of detector response in eta of the calibration
- The resolutions are taken as the spread of mean responses in different iEta after calibration
- Bias (shift from resp=1.0) changes from ~2% to 0.4% in the considered sample sizes
- Represents an ideal limiting case characterizing the procedure and sample choice
  - busy event environment leads to deterioration of resolution

Tracks/twr at $1x10^{31}$ $cm^{-2}s^{-1}$









30% data-taking inefficiency, 1 week running ~4.2 pb

Isolated track statistics from $1x10^{31}$ menu

Number of tracks per tower collected within 1 week, assuming 30% inefficiency (corresponds to integrated luminosity of ~4.2 pb^{-1} for $L_{inst}=1x10^{31}$)

Region in $\|\eta\|$	Number of tracks/tower	
	15 <p<25 GeV	40<p<60 GeV
0.0-0.5	12	1.3
0.5-1.0	14	1.4
1.0-1.5	34	4.9
1.5-2.0	140	15.5

- Sufficient to get eta-dependent calibrations with 15<p<25 GeV sample
- Calibration with 40<p<60 GeV tracks can be performed with ~3x larger sample (~15 pb^{-1} collected with the $1x10^{31}$ menu)

Use of Isolated tracks for phi-corrections cross-check and monitoring

- Isolated tracks can be used to cross-check and supplement phi-corrections obtained from MinBias events
- Provide a reference at a different energy scale
- Especially valuable in HB (most “difficult” region for MinBias phi calibration)

$10 < p < 25$ GeV, $|iEta| < 10$

Num trks/twr	Resolution (%)
55	7.8
110	5.5
225	2.8

Resolutions of ~3% are achievable with 25-30 pb^{-1} of data

(Based on estimated trigger rates for the $1x10^{31}$ menu)

HLT_IsoTrack Trigger

- Provide calibrations at startup, periodic updates
  - Increased samples will provide refined calibration, improved resolutions
- Trigger rate at high luminosity running will be controlled through increase of track momentum thresholds
- Monitoring packages are under development, will be finalized before CMSSW_3_1_X (see Stephanie Beauceron's presentation at DQM-HLT workshop on Feb 2, 2009)
  - Monitor track eta, phi, momentum distributions, HLT↔offline matching, purity, etc.

Current development/support for the triggers:

Grigory Safronov – ITEP (Russia)

New addition: Seema Sharma – Fermilab (USA)

Summary

- Request the inclusion of two dedicated triggers for HCAL calibrations:
  - AlCa_HcalPhiSym for use in special NZS HCAL runs
  - HLT_IsoTrack for use in physics runs, need data on CAF within 1-2 days
- These triggers are essential for HCAL calibration with physics events
  - No other sources can provide the required data samples
- The expected initial performance of these triggers is adequate for performing the planned calibration tasks

backup

IsoTrack trigger at $8x10^{29}$ $cm^{-2}s^{-1}$

- L1 seeds: jets and taus (~680 Hz)
- HLT Rate: 12 Hz
- Overlap with other triggers: ~12%

Used in estimates, however, these should be uncorrected energies.

L1 seeding	Rate (Hz)
L1_SingleJet30	662.65
L1_SingleJet50	53.58
L1_SingleJet70	10.30
L1_SingleJet100	1.66
L1_SingleTauJet30	145.69
L1_SingleTauJet40	51.66
L1_SingleTauJet60	8.95
L1_SingleTauJet80	1.89
Total ("OR" of triggers)	~680

Estimates are not very reliable due to use of corrected jets… just as a guideline:

Number of isolated tracks obtained within 1 week (with 30% inefficiency) should be comparable to the $1x10^{31}$ menu. For $L=8x10^{29}$ this corresponds to 0.34 pb^{-1}

- L1 rate is comparable
- some difference in central region due to different fraction of low/high p_T jets

Impact of menu choices on MinBias data collection time

Menu	version: Nov 24		version: Dec 4	
	$8x10^{29}$	$1x10^{31}$	$8x10^{29}$	$1x10^{31}$
L1 rate (Hz)	5	640	1021	1280
Output rate (MB/s)	1.8	162	259	324
Prescale needed	N	Y	Y	Y
Time* (for 100 MB/s)	23 days	7h	7h	7h

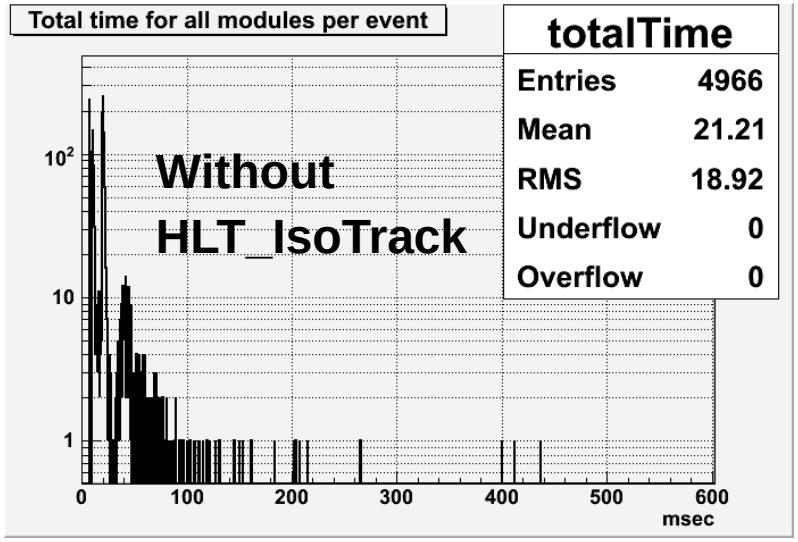
* Assumes 100% efficiency

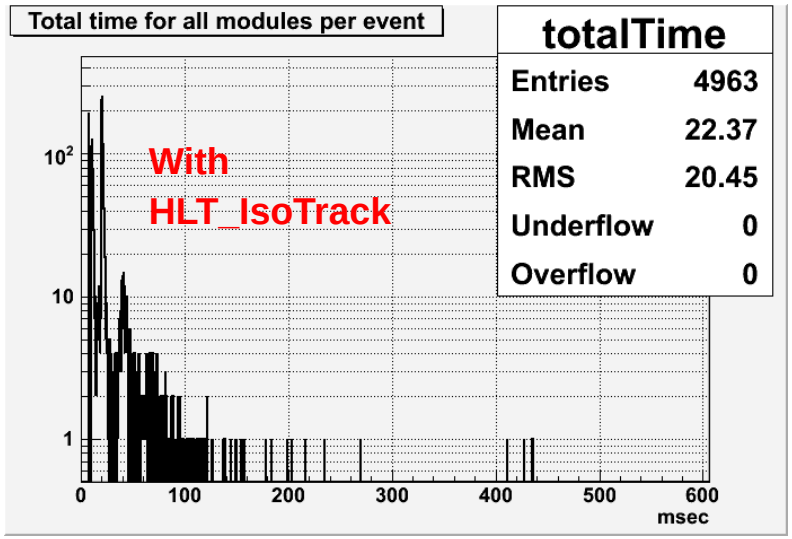
Comparison of HLT logic: current and proposed

	Current	Proposed
L2 reco	do pixel reco	do pixel reco
L2 selection		dXY to vertex < 0.05; pixel track pT > 3.5 GeV; isolation pT** < 0.9 GeV; pixel track $\|\eta\|$< 2.0
L3 reco		do on demand tracking seeded by L2 candidates: seeding cone 0.05
L3 selection	dR to L1 tau jet < 0.5; pixel track pT > 20Gev; isolation pT** < 2GeV	require single track with p>10 GeV in unpacked cone

In both configurations region with R(η,φ)<1.2 to triggered L1 jet is excluded from the search of isolated pixel tracks

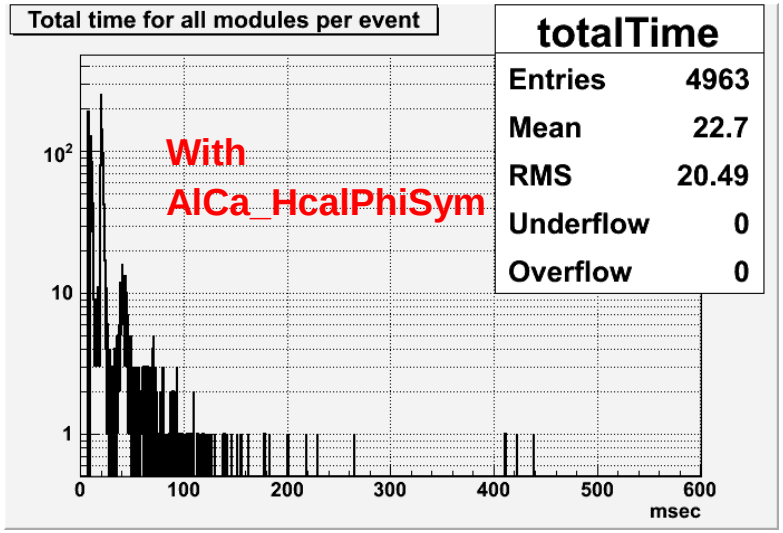
HLT timing (using 1x10^{31} menu)

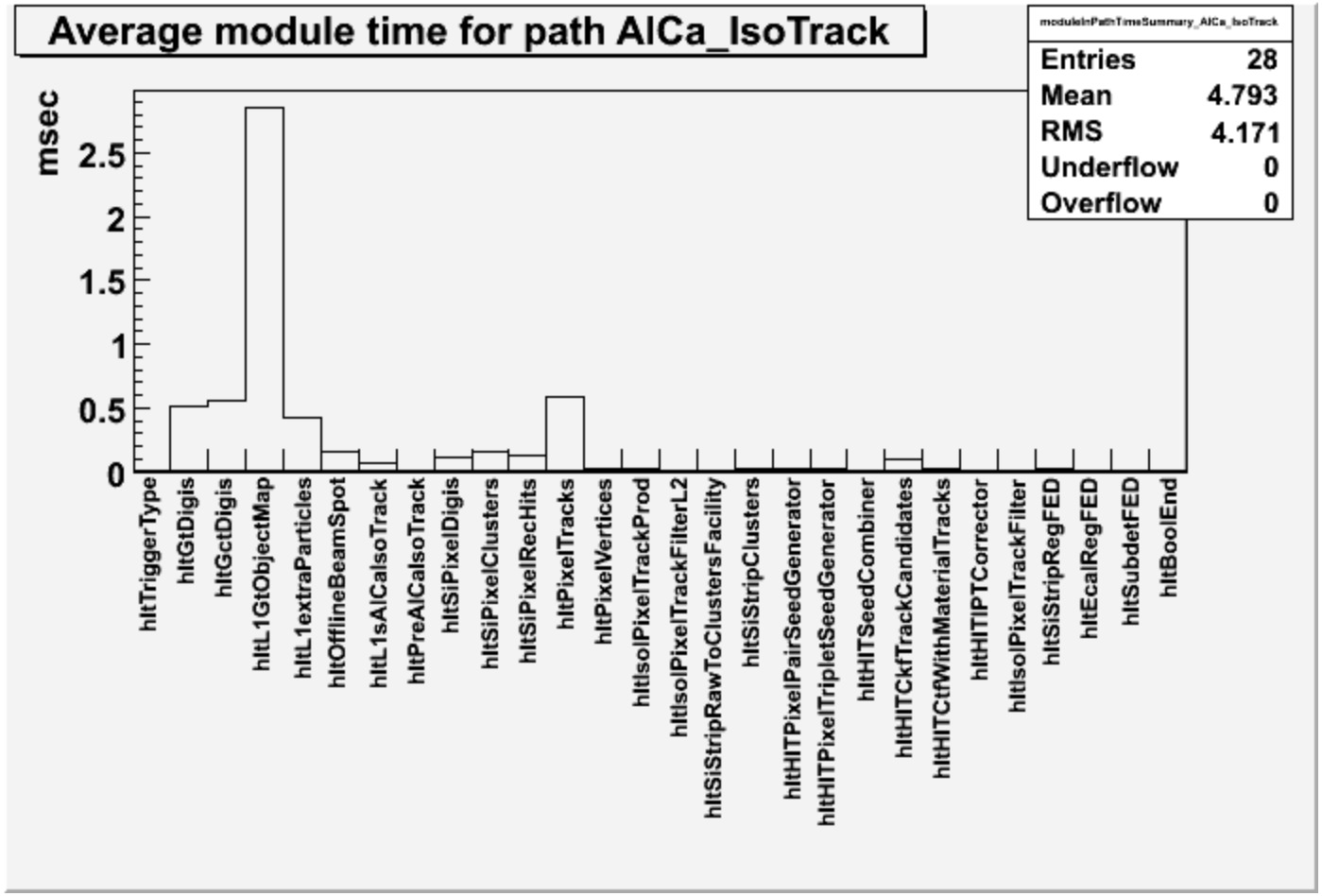




HLT_IsoTrack **adds ~1.2 ms** to the average time of HLT processing

AlCa_HcalPhiSym **adds ~0.33 ms**
Total average time (including HLTBeginSequence) when run standalone: **~5.8ms**




Average module time for path AlCa_IsoTrack
moduleInPathTimeSummary_AlCa_IsoTrack
Entries 28
Mean 4.793
RMS 4.171
Underflow 0
Overflow 0
msec
2.5
2
1.5
1
0.5
0
hltTriggerType
hltGtDigis
hltGctDigis
hltL1GtObjectMap
hltL1extraParticles
hltOfflineBeamSpot
hltL1sAlCaIsoTrack
hltPreAlCaIsoTrack
hltSiPixelDigis
hltSiPixelClusters
hltSiPixelRecHits
hltPixelTracks
hltPixelVertices
hltIsolPixelTrackProd
hltIsolPixelTrackFilterL2
hltSiStripRawToClustersFacility
hltSiStripClusters
hltHITPixelPairSeedGenerator
hltHITPixelTripletSeedGenerator
hltHITSeedCombiner
hltHITCkfTrackCandidates
hltHITCtfWithMaterialTracks
hltHITIPTCorrector
hltIsolPixelTrackFilter
hltSiStripRegFED
hltEcalRegFED
hltSubdetFED
hltBoolEnd