Status report on L1Calo energy calibration

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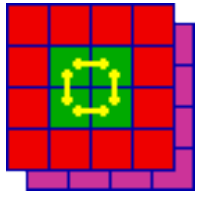

Level 1 Calorimeter Trigger Joint Meeting, Cambridge, 23-25 March 2011

Outline

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Calibration procedure

Aim: calibrate each TT such that 4 ADC count = 1 GeV "raw" calorimeter transverse energy

(LUT calibration important, not subject of this talk)

Currently default ADC calibration procedure:

- **Input**: pulser runs (taken by LAr/TILE shifters)
- **Automatic processing in place**: calibration algorithms, data merging (TILE + LAr), D3PD production, etc.
  (see also talks by Peter J. W. Faulkner and Juraj Bracinik)
- **Output**: stored permanently on CASTOR
- **Implementation**: validated calibration sent to Damien Prieur (sqlite file)

Physics data analysis → calibration good, but not perfect

In December 2010, for the first time, ADC gains computed from physics data were loaded into L1Calo (details later in this talk)

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Previous calibration changes

For more details, see dedicated twiki:
https://twiki.cern.ch/twiki/bin/view/Atlas/L1CaloCommissioningChanges

- **Periods A-C**: Inital calibration from Jan/Feb 2010
- **Period D**: Update of FCAL TT $\rightarrow$ cell mapping
- **Period E**: FCAL fix
- **Period G**: Presampler HV change

- **Period J1 (HI)**: New LUT scheme and LUT slopes
  (Stephen Hillier, Alan Watson, William Buttinger, etc.)
- **Period J2 (HI)**: Final 2010 calibration (gains from physics data)

Still problems in FCAL: Rx to offline mapping possibly wrong
(John Morris is working on that)

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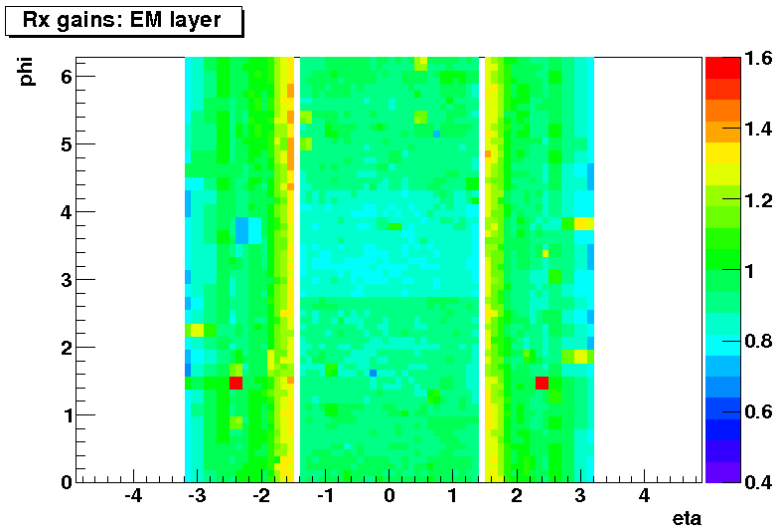
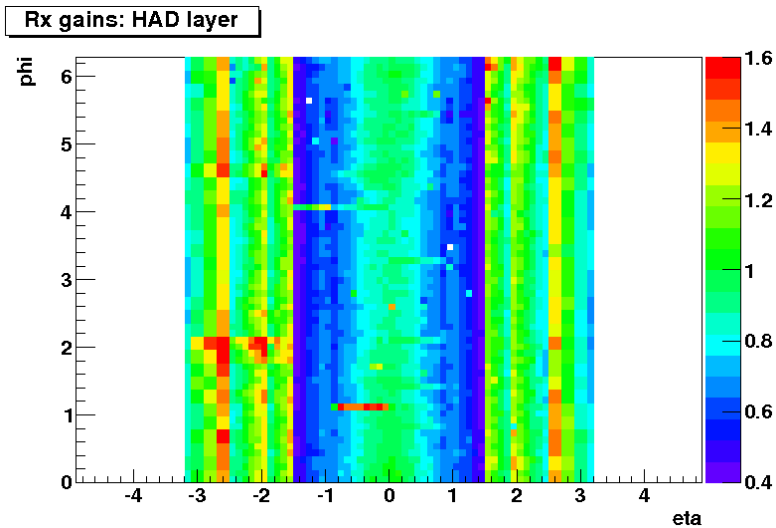
L1Calo ADC gains during periods G-I

Source of Rx gain data: dbTree in John Morris' D3PDs

Here, EM overlap region and FCAL are excluded





Some features:

- Strong η dependence in EMEC
- Structure in ϕ correlates with cable lengths
- Some irregular substructures in ϕ in HAD layer

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Input data, definitions, binning, cuts

Input data: Periods G, H, I (Egamma stream, L1Calo D3PDs p272)

Event selection: Standard Egamma GRL

Definition: ADC energy (GeV) := (maxADC − pedestal) × 0.25 GeV

General cuts

- Saturation cut: maxADC <= 1000
- Timing cut: maxADC in the middle of the signal
- LUT cut: LUT $\neq 0$
- Quality cut (HEC only): quality < 5000

Cuts for L1Calo-Calo deviation analysis

- Dead and BadCalo channels discarded
- Overlap region $1.4 < |\eta| < 1.5$ in EM layer discarded
- Energy cut: 2×ADC + 3×Calo > 6 GeV

Binning in Calo energy (GeV)

4, 7, 10, 14, 18, 22, 26, 30, 40, 50, 60

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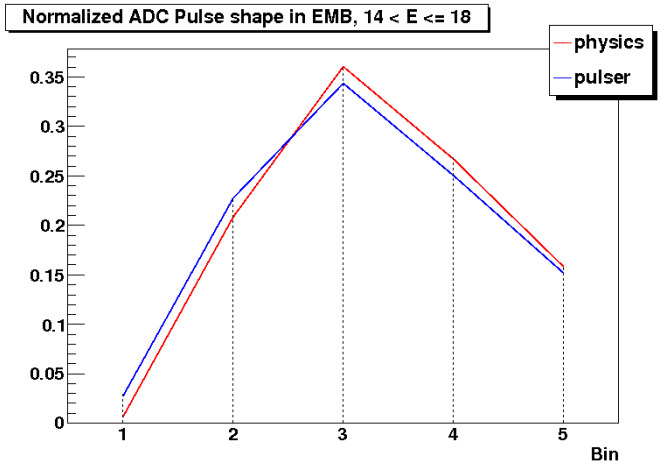
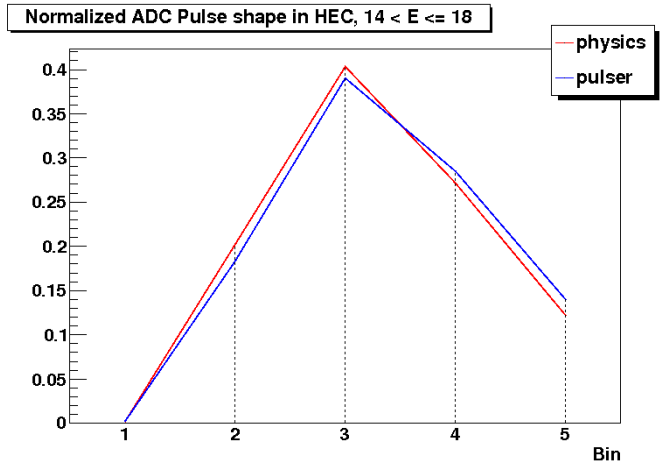
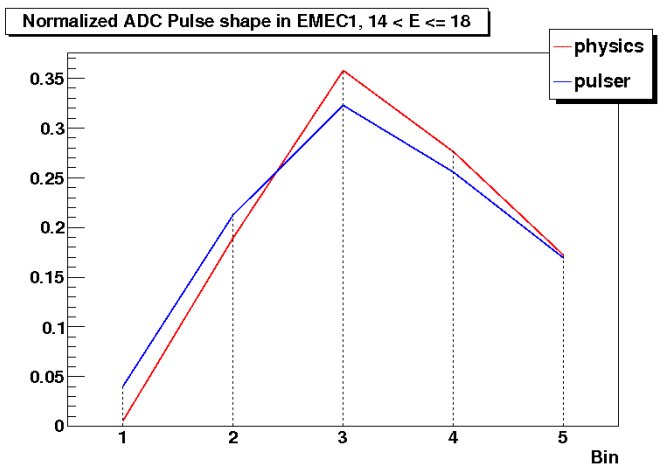
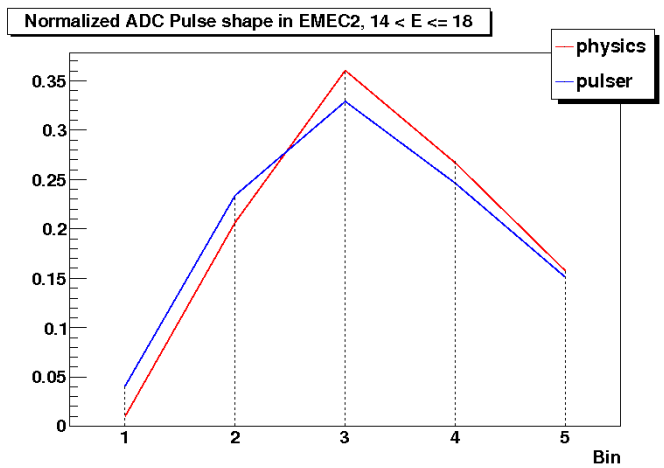
Pulse shape comparison: physics vs pulser (run 177383)









Difference in digital signal shape:

- → Difference in analog signal shape
- → Difference in physics and pulser calibration

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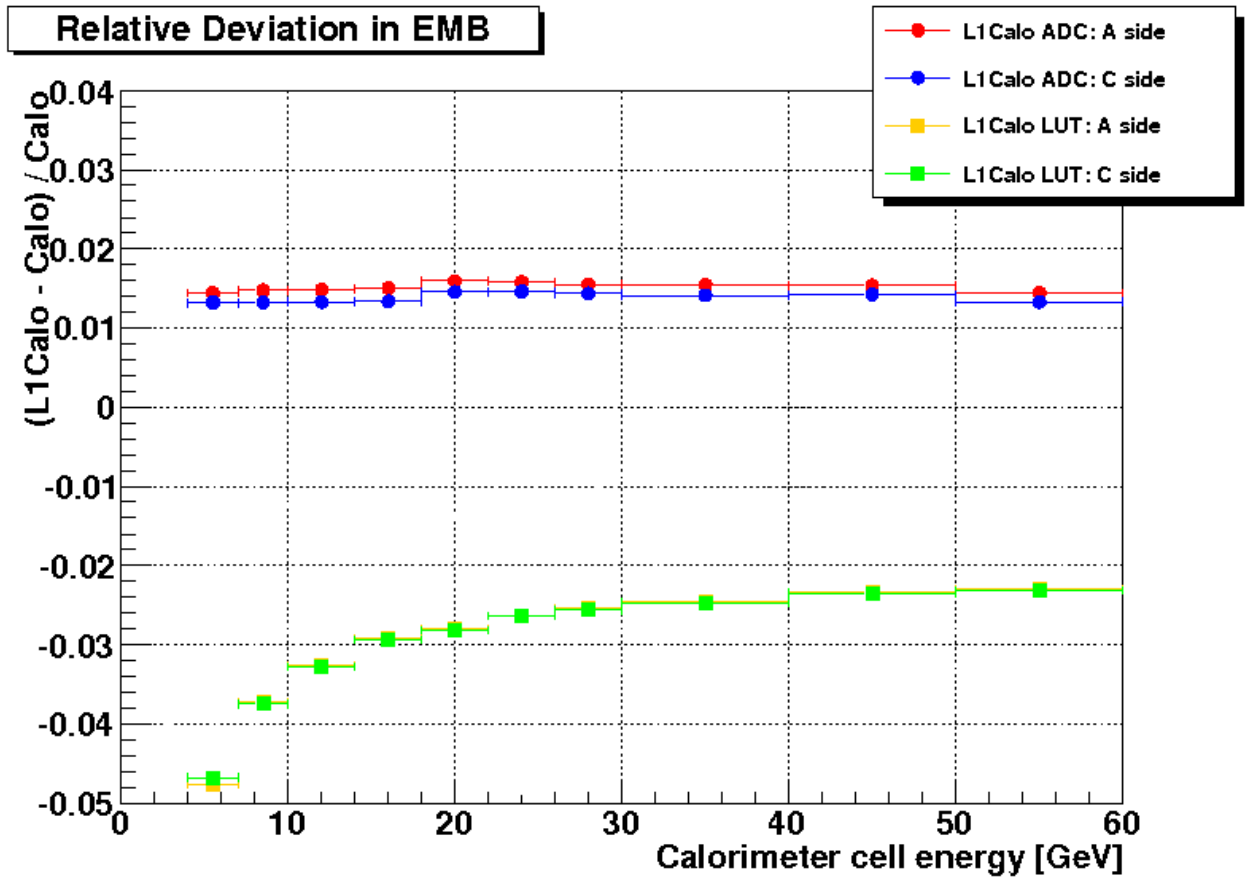
Energy dependence



Features:

- ADC calibration stable in E_t, deviation from offline $< 2\%$
- LUT problems: LUT "droop", ADC-LUT offset

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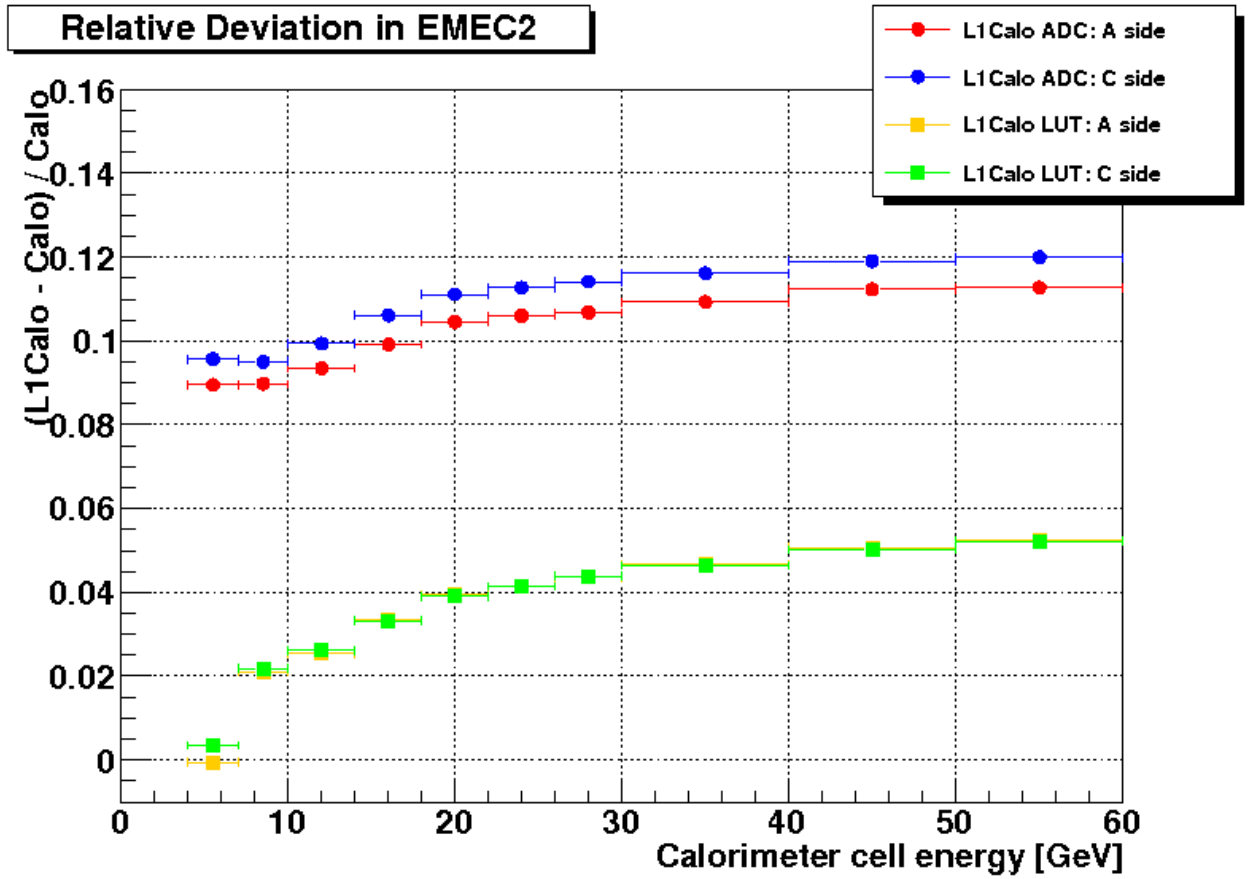
"EMEC 2" - the presampler region, $1.5 < |\eta| < 1.8$



EMEC 2 Features:

- ADC miscalibration of 10—12%: LAr and presampler problem (e-mail discussions in autumn 2010)
- Also ADC "droop" (yet to be understood)

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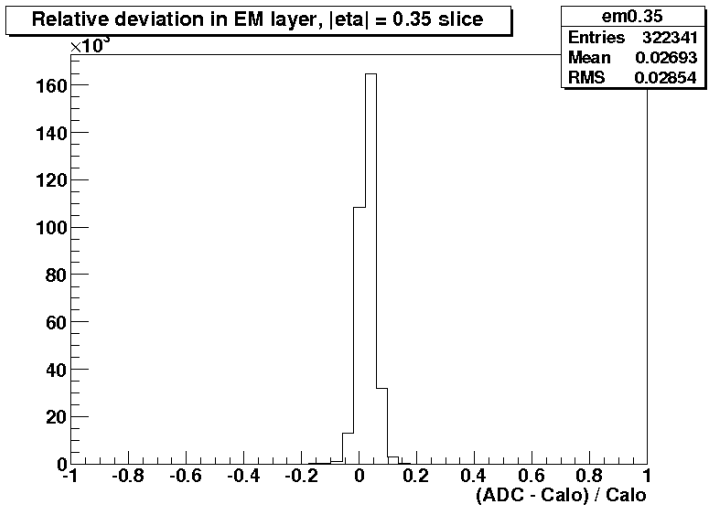
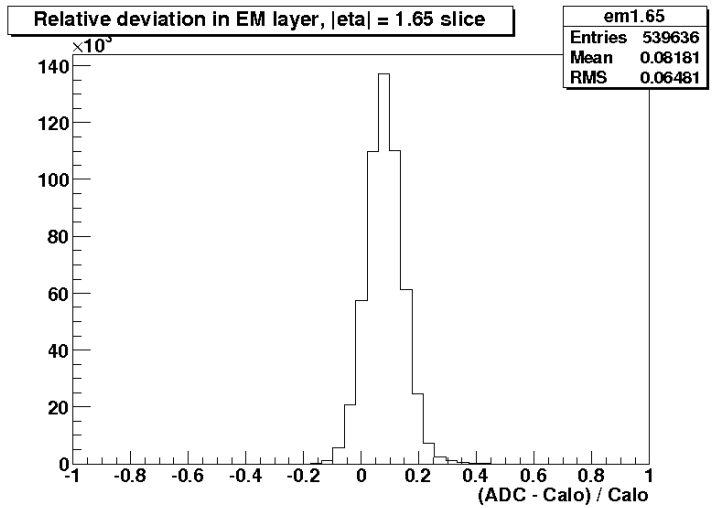
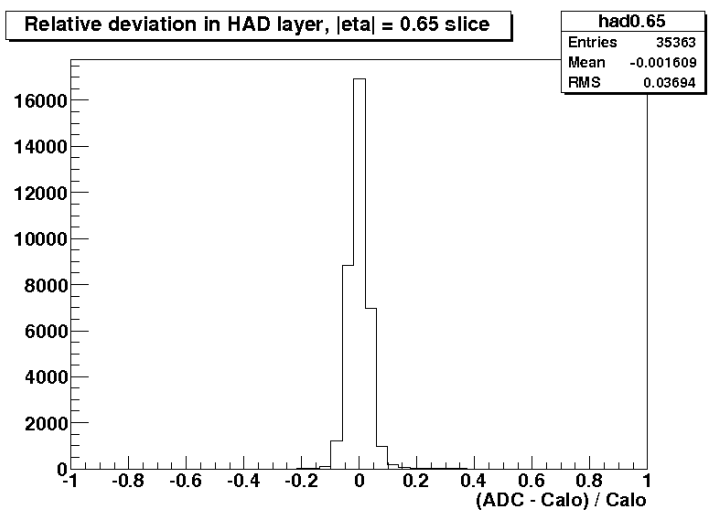
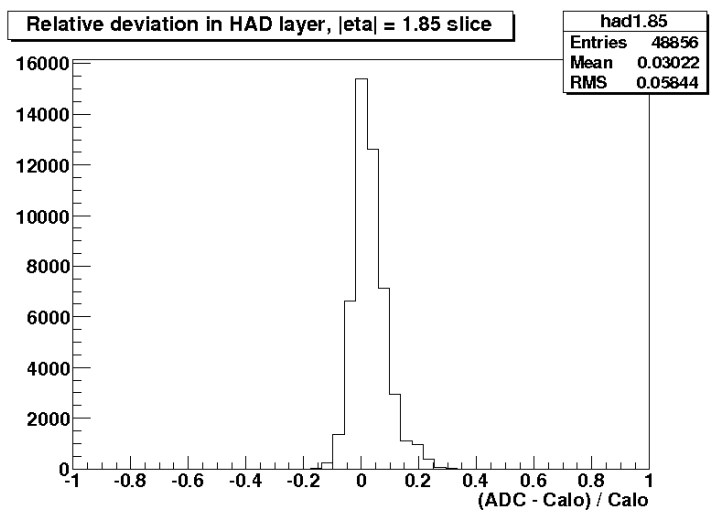
Measured gains (ADC / Calo)

Examples of ADCvsCalo relative deviation histograms in $|\eta|$ slices:









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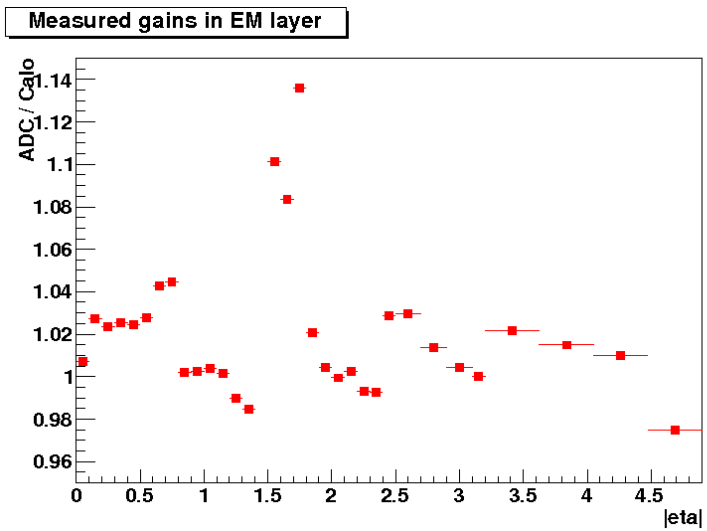
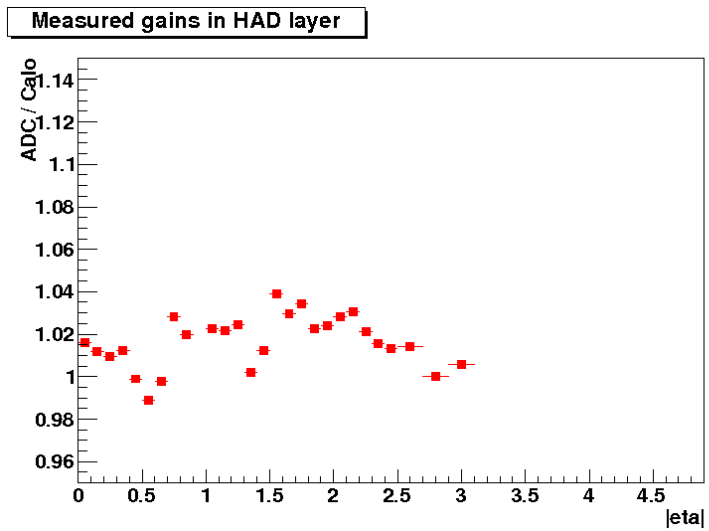
Measured gains (ADC / Calo)

These results were obtained from analysis of just several runs of period G, JetTauEtMiss stream





Only good channels with smooth and noiseless energy correlation contribute to their respective $|\eta|$ slices

Missing bins: No good channels (quality of channels determined visually)

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Calibration changes in Period J (heavy ions)

In December, it was decided to apply calibration corrections from physics data not channel-by-channel, but in $|\eta|$-slices

New gains were calculated from the data shown on slide 13

Also, in December, the new LUT scheme was implemented and new LUT slopes were loaded (see talk by William Buttinger)

The new calibration could be checked with HI data

Input: Run 169884 (HI)

No GRL selection

Cuts: Same cuts as pp except for **low energy cut**: ADC + 2×Calo > 2 GeV

Binning in Calo energy (GeV):

3, 5, 7, 9, 12, 15, 20, 30

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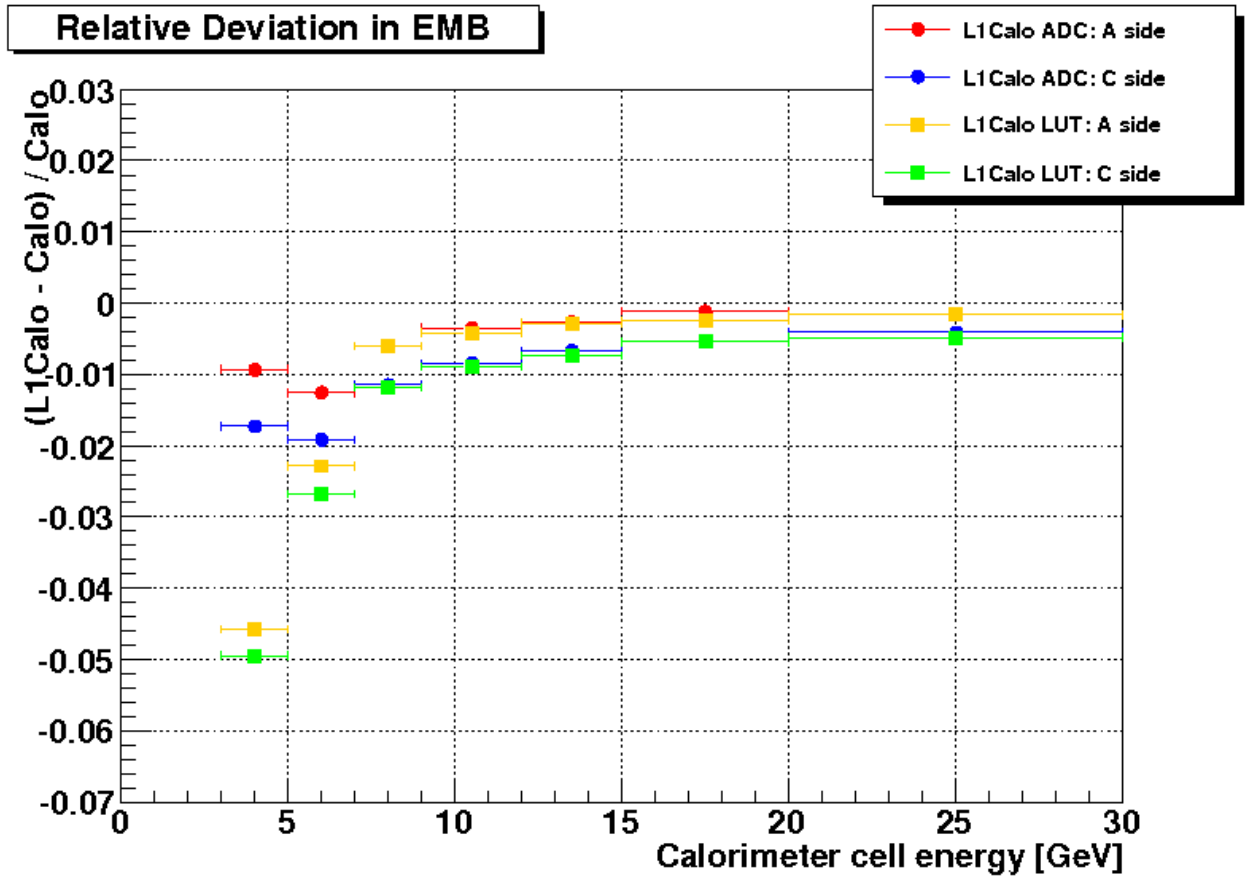
L1Calo/Calo deviation in EMB (HI)



Features:

- ADC calibration better: deviation $< 1\%$ for $E_t \gtrsim 10$ GeV
- ADC—LUT offset reduced to almost 0
- Still some residual LUT "droop"

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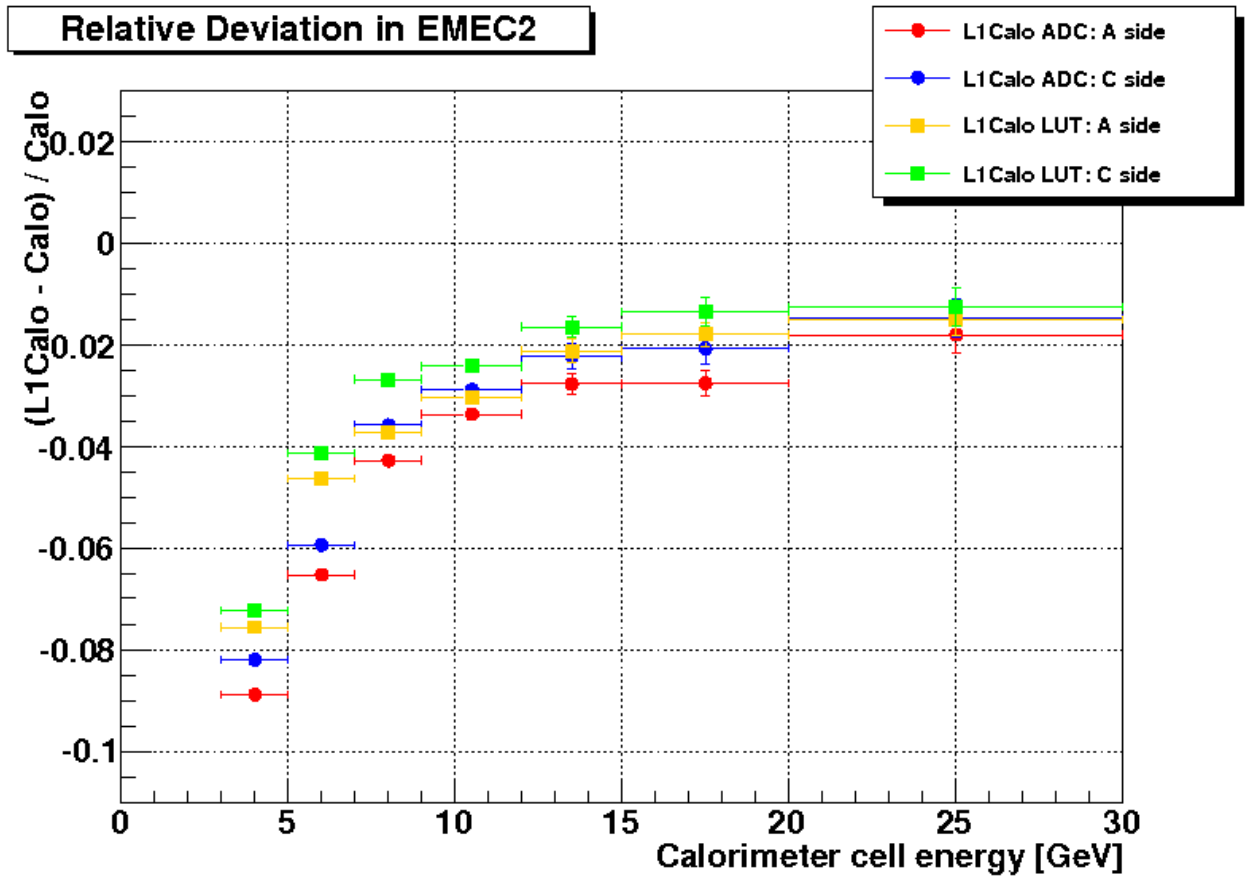
EMEC 2 (PS region, $1.5 < |\eta| < 1.8$) (HI)



Features:

- ADC "droop" still there
- Around 1—2% undercalibrated now ($E_t \gtrsim 20$ GeV)

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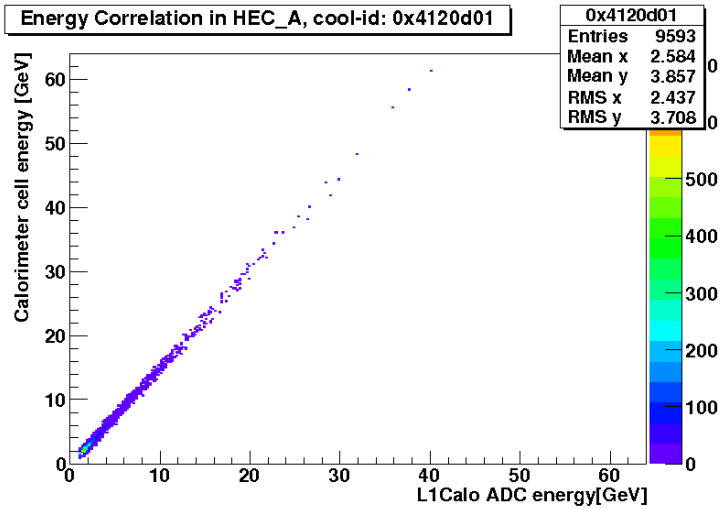
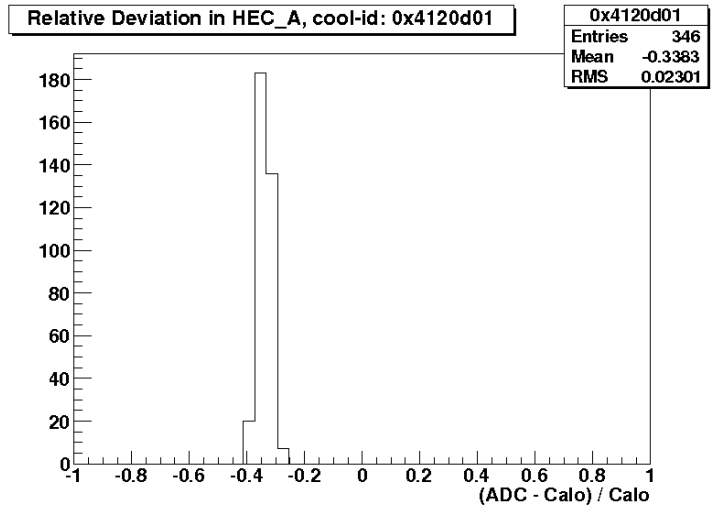
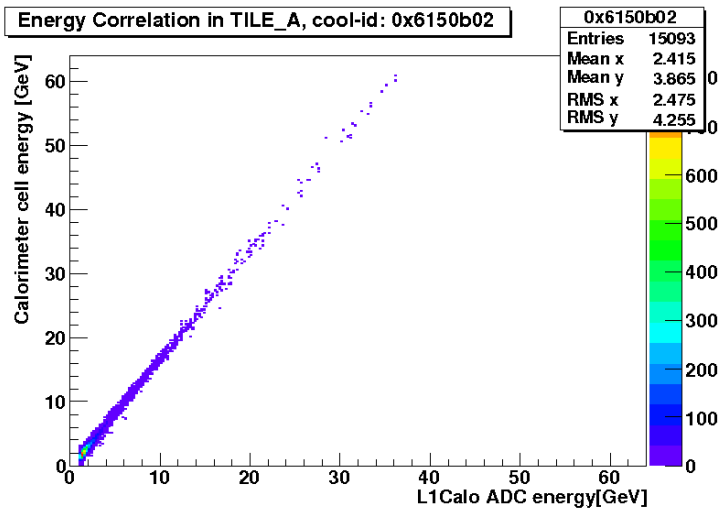
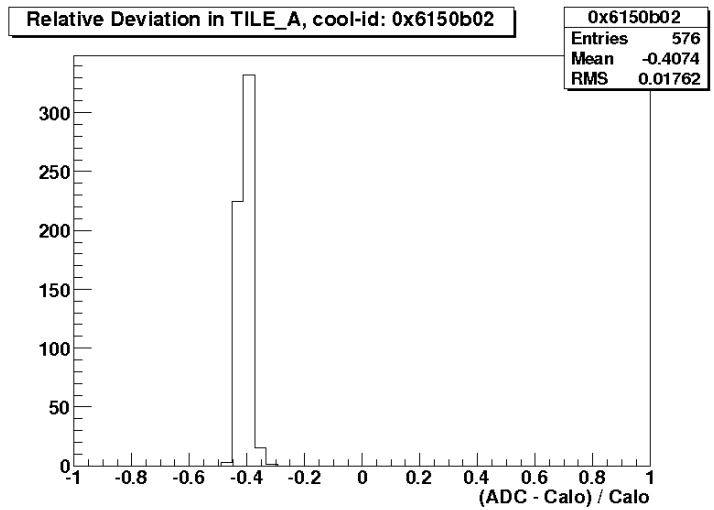
Two miscalibrated channels in HEC









Correlation seems to be OK, calibration awful

Same in recent pulser runs (see next slide)

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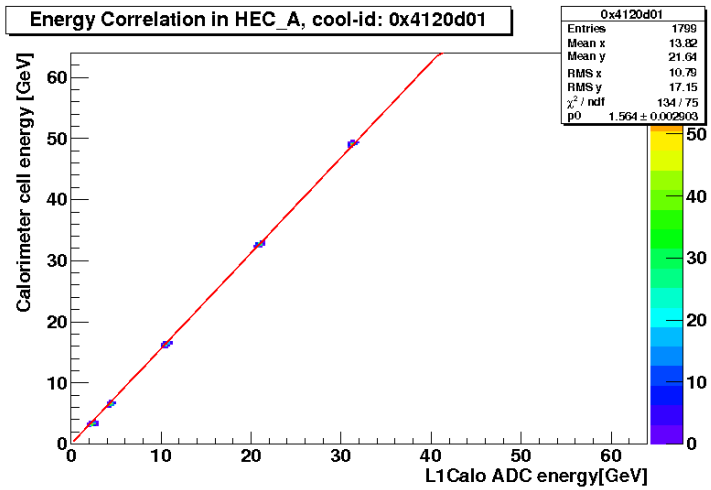
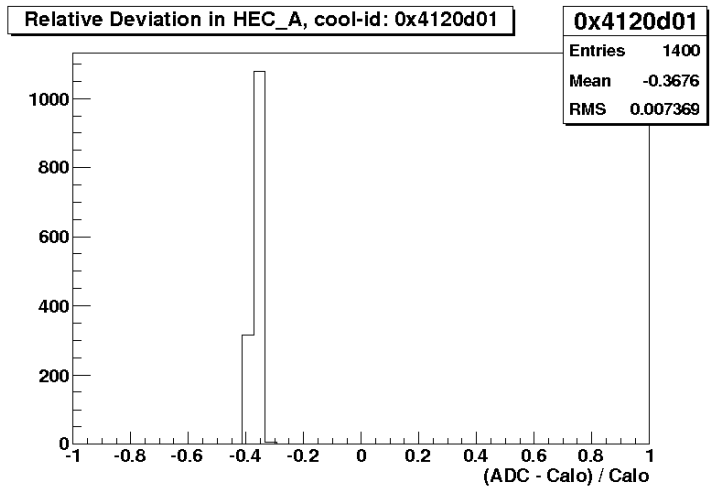
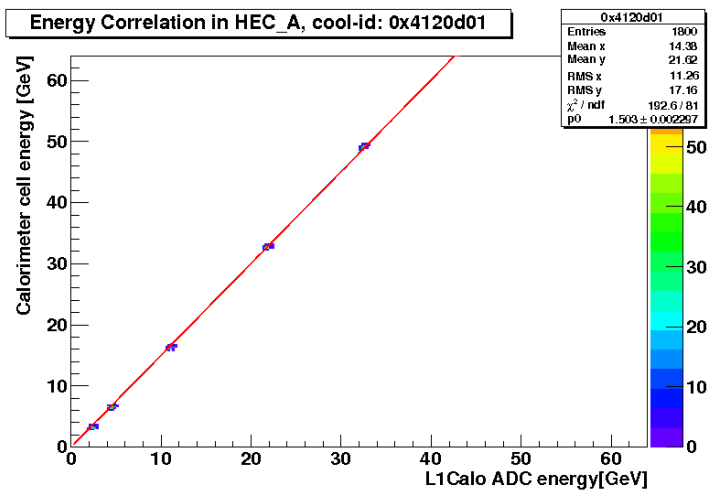
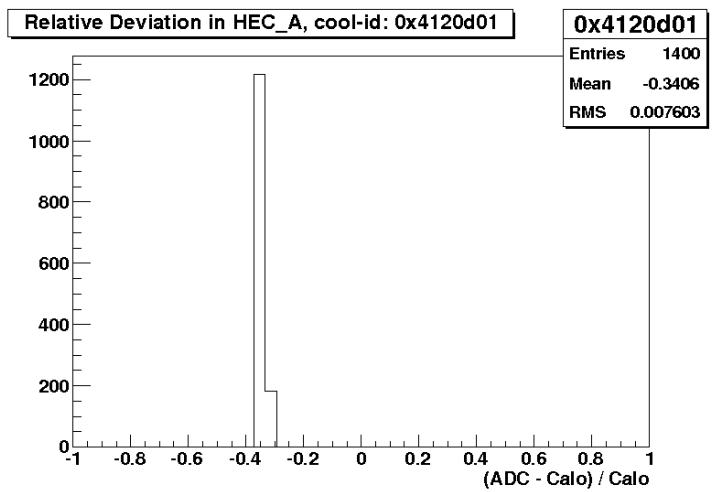
Two miscalibrated channels in HEC (pulser data)





Pulser run 177382 (gain 1)





Pulser run 177383 (default gain)

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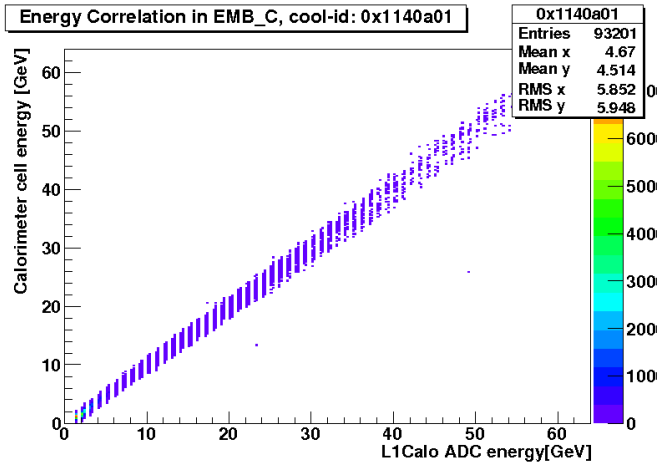
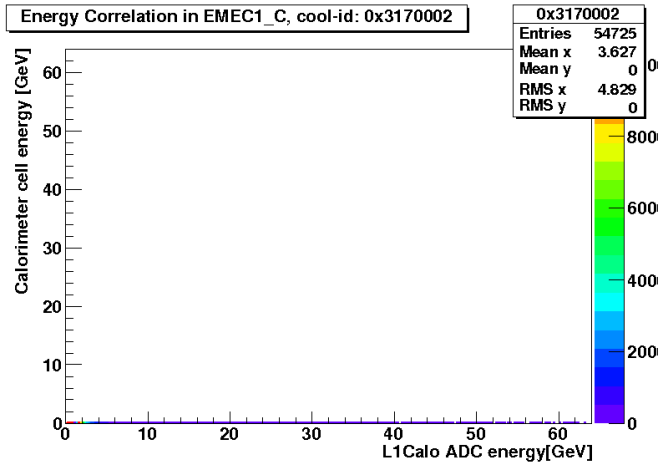
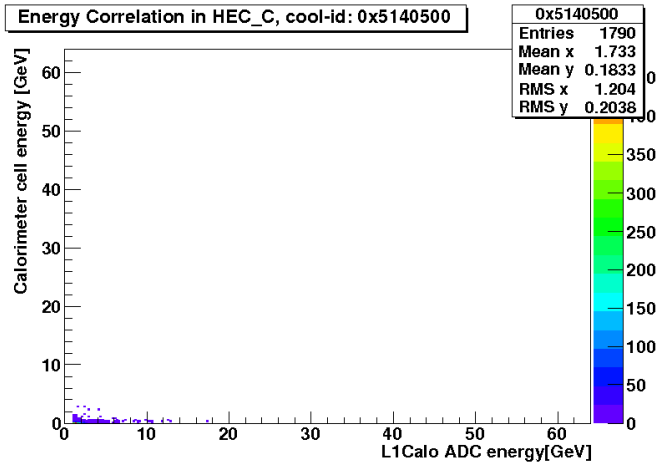
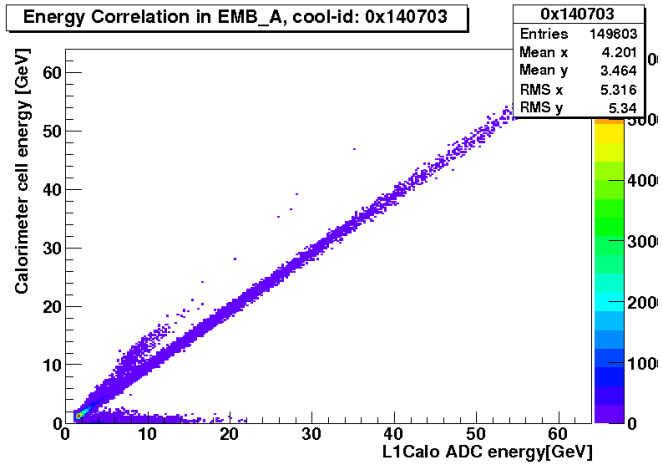
Some problematic channels









Top left: Second ADC bit seems to be broken (also in pulser, see slide 26)
Top right, bottom left: Broken channels not marked as dead
Bottom right: Strange noise tails of noise

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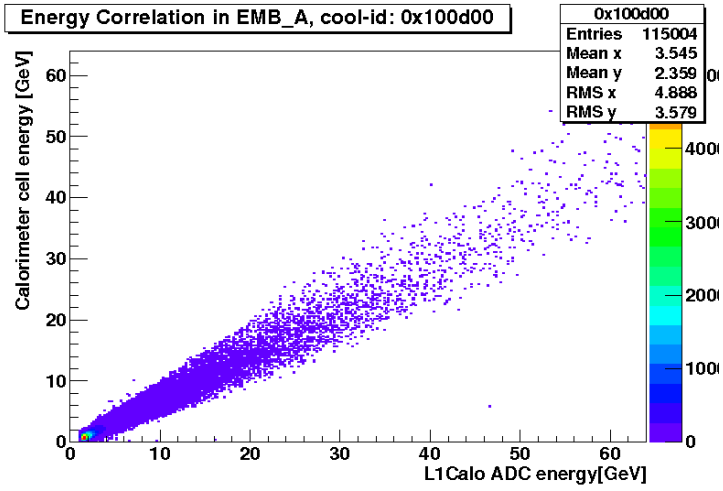
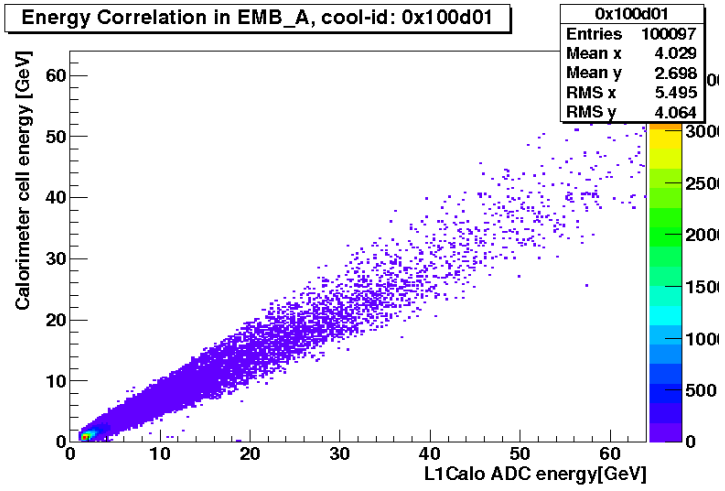
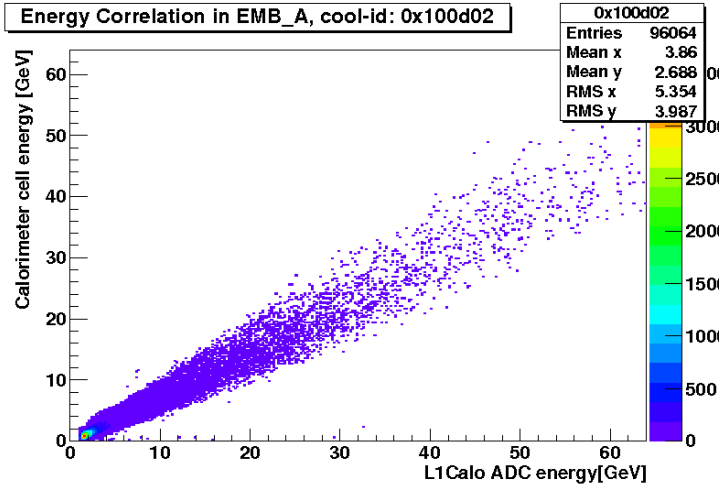
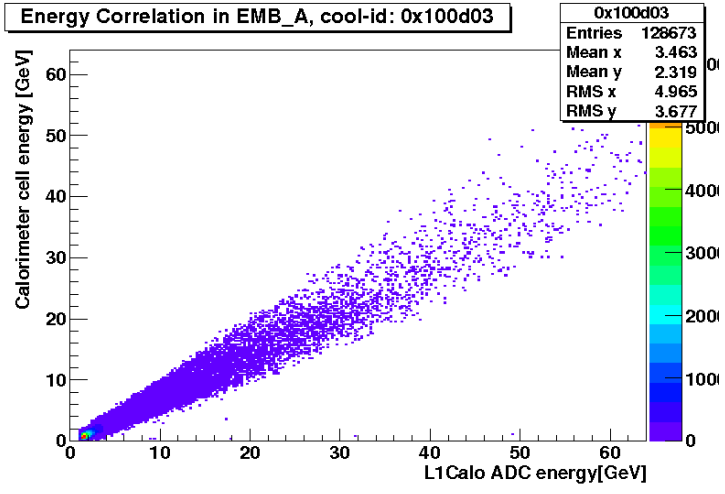
Example of offline problems









In EM layer, very often four "broken" channels on same MCM
Correlation with OTX maps, i.e. offline and not L1Calo problem

(see also backup slides 27 and 28)

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Conclusions & Outlook

Conclusions:

- **For the first time, L1Calo ADC calibration constants were determined from physics data**, however not yet channel-by-channel
- **EMEC 2 (PS region, $1.5 < |\eta| < 1.8$) calibration was improved**, still some effects not understood
- **Channel-by-channel analysis done, some channels with anomalous features found**

Outlook:

- **Deviations between pulser and physics data calibration need to be studied further** (e.g. in pulse shape studies[1])
- **A classification for bad channels (cuts on certain features) has to be established for automatic channel-by-channel analysis**
- **Long-term plan: calibrate L1Calo channel-by-channel with physics data** (whether as pure physics calibration or as correction to pulser calibration)

[1] Pulse shape studies have been done by William Buttinger to calculate new FIR coefficients and dropbits for LUT (see his talk)

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Backup slides

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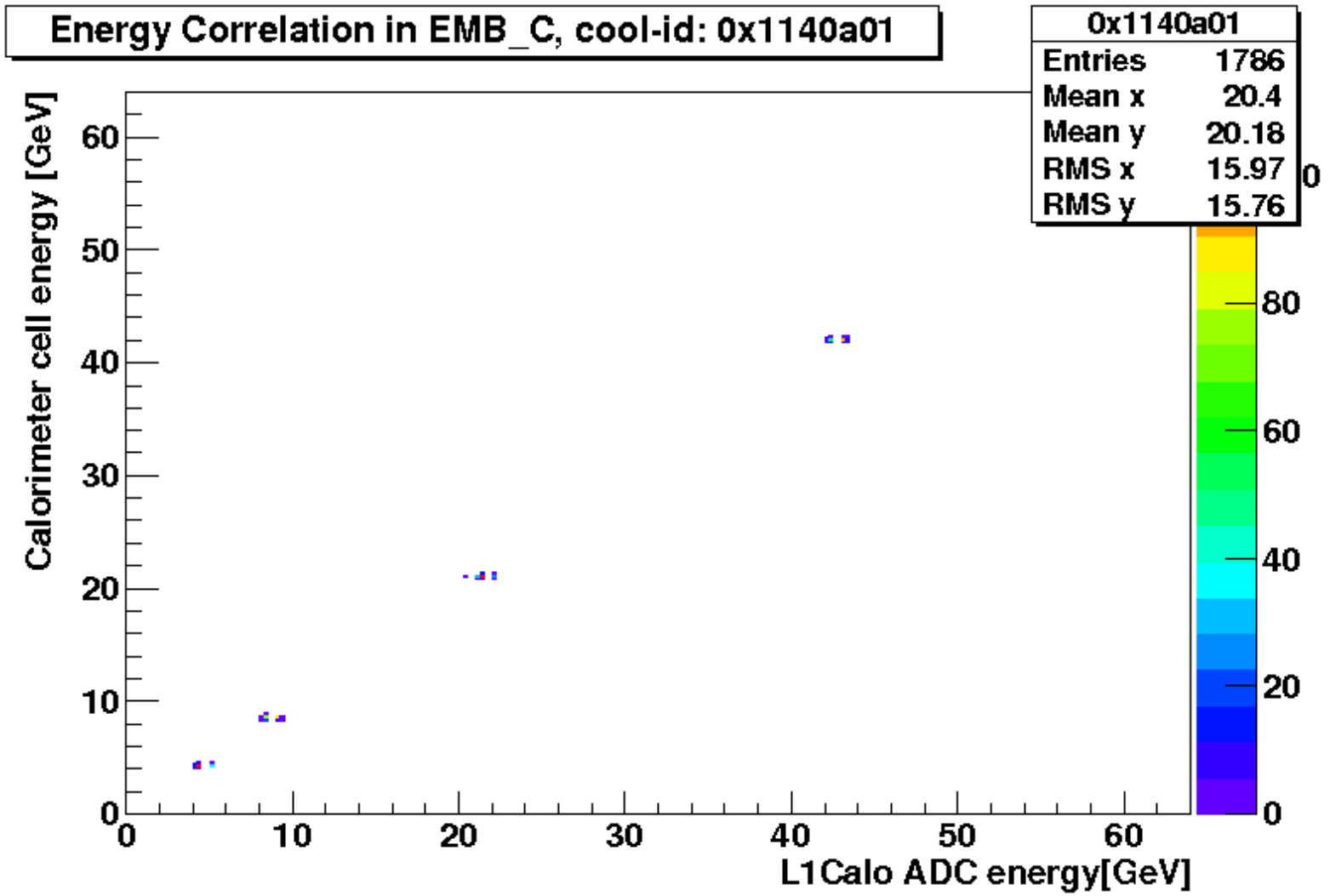
Channel 0x1140a01 with broken bit



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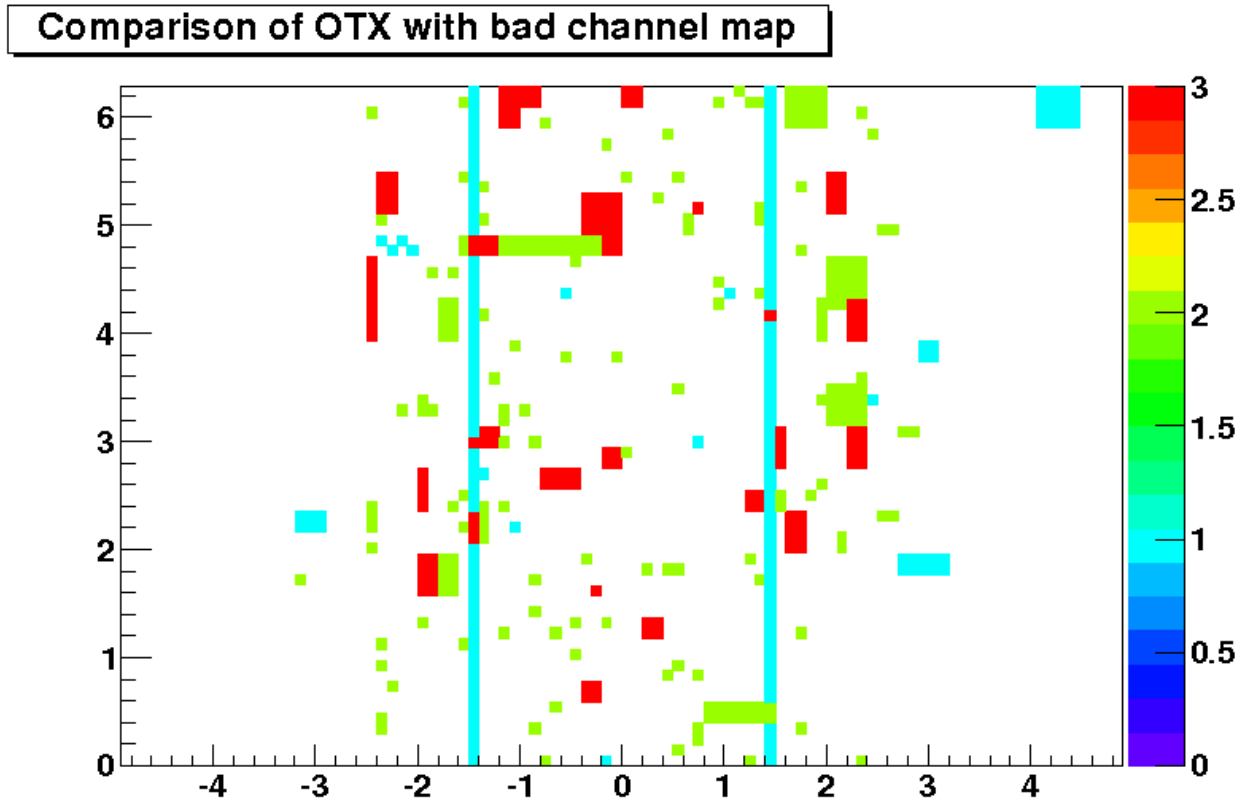
Pulser run 177383

Comparison of EM bad channel map to OTX maps



Colour code

- **1 (cyan)**: marked as bad (visual investigation)
- **2 (light green)**: at least one of 4 layers (PS, layers 1—3) in OTX maps are broken (OTX map: run 167521)
- **3 (red)**: both visually bad and bad OTX

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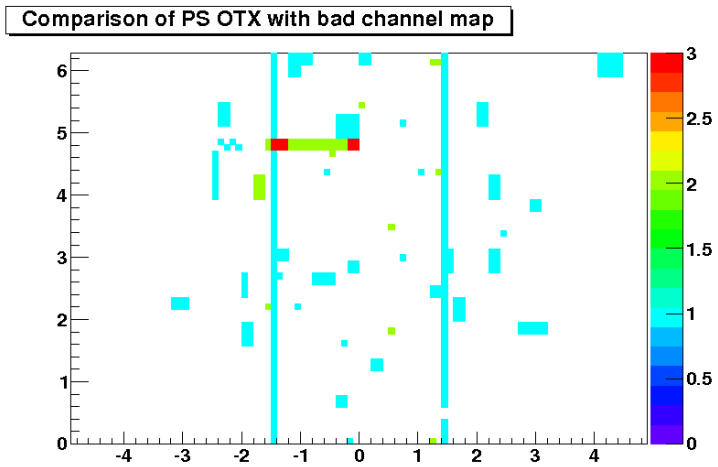
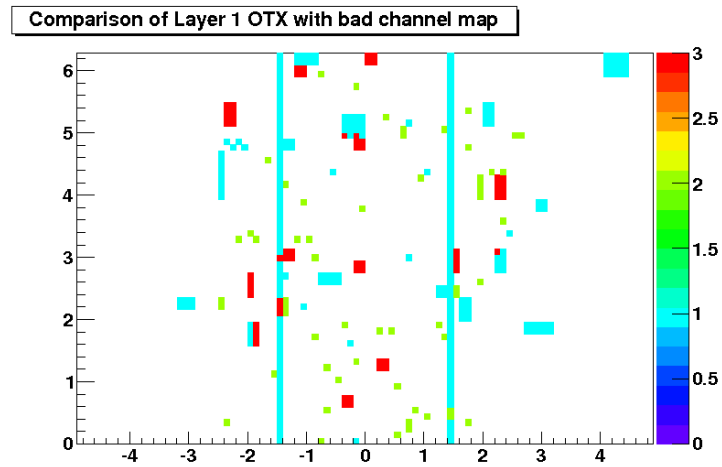
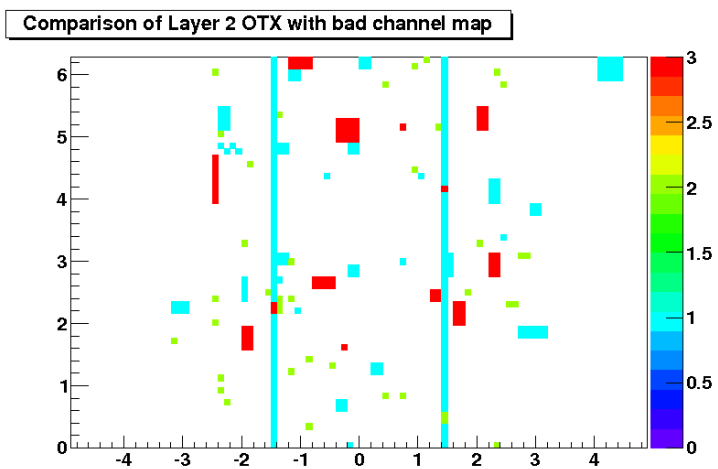
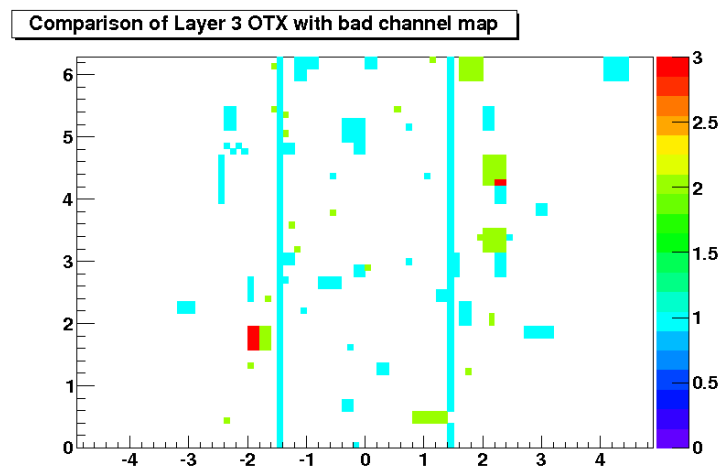
Comparison of EM bad channel map to OTX maps









Same colour code as on slide 27, but now for each layer separately

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