

HCAL Sourcing Status and Plans

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November 15, 2013

Introduction

Why sourcing?

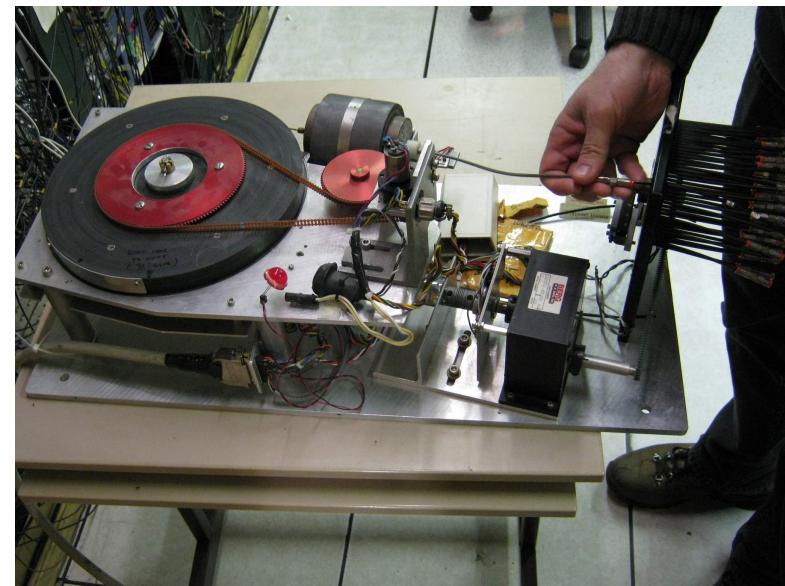
- HF: Photomultiplier tubes (PMTs) are being replaced, so sourcing old and new PMTs can give us first calibrations. Can also check mapping of towers to readout channels.
- HE: Study radiation damage, comparing with 2006 data, vs. eta and layer. From laser monitoring this is worse than expected. Laser only probes 2 layers (1, 7) while sourcing could probe all. More details in Jordan's talk later.
- HB: Expect nonzero radiation damage in first layers. Sourcing can establish a baseline measurement which can be monitored later on. Laser only probes layer 9, middle of absorber.

Introduction - 2

A cobalt-60 source of a few mC activity is driven inside stainless steel source tubes in HB, HE, HF

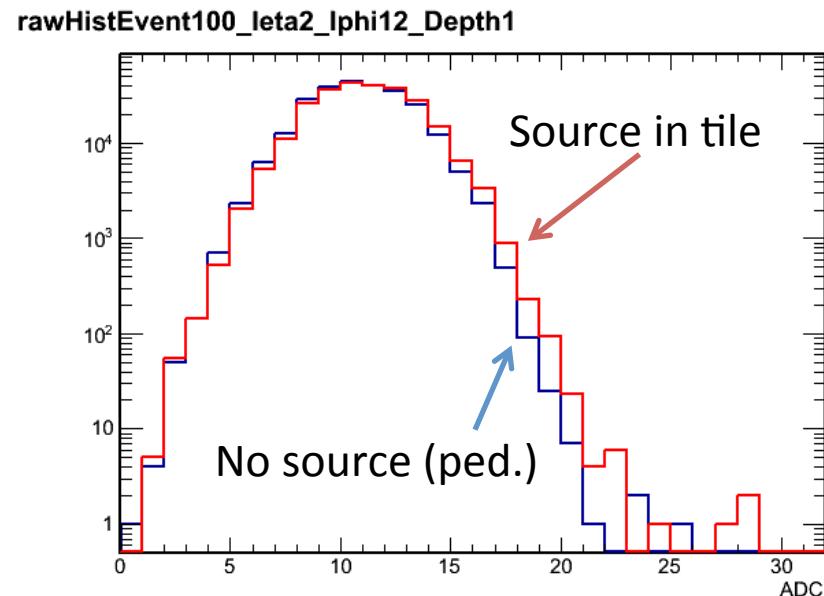
- Tubes run through scintillating tiles (HB,HE) or along quartz fibers (HF)
- The source is fixed in the tip of a chemically plated stainless steel wire

The source driver moves the source into and out of the tubes, selects individual tubes, and monitors source position and other parameters

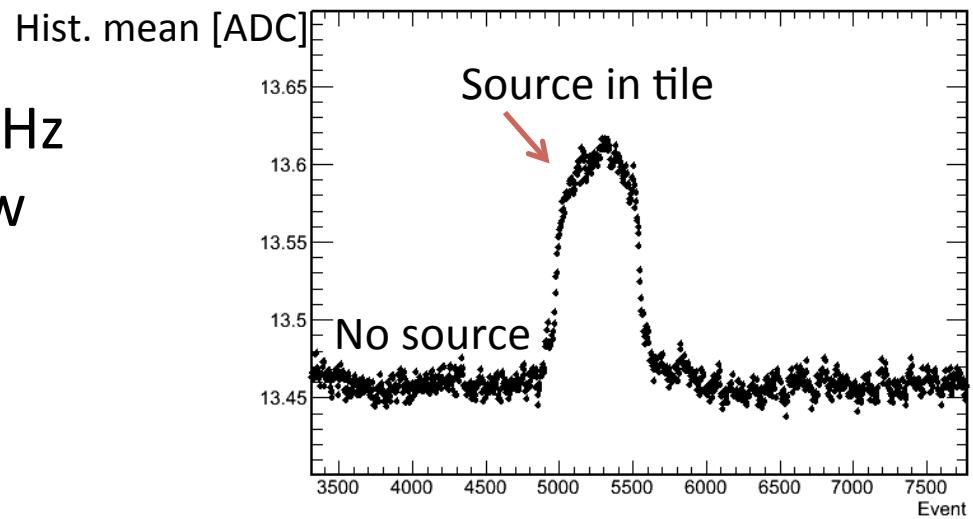


Source Signal (HB/HE)

- The source signal is very small (fraction of an ADC count) so a special “histogram” readout firmware is used in the HTR
- In HB/HE, the source signal can be seen as a shift of the pedestal mean value



- Histograms are filled at 40 MHz → read out histograms at few hundred Hz



Sourcing in LS1

The entire sourcing system was successfully tested at the H2 test-beam area in July (HB wedge)



H2, Prévessin

Then 2 quadrants (near side) of HF- were sourced from October 21-28

- Histogram readout at just under 100 Hz
- Source was moved at about 1 cm/s in the absorber

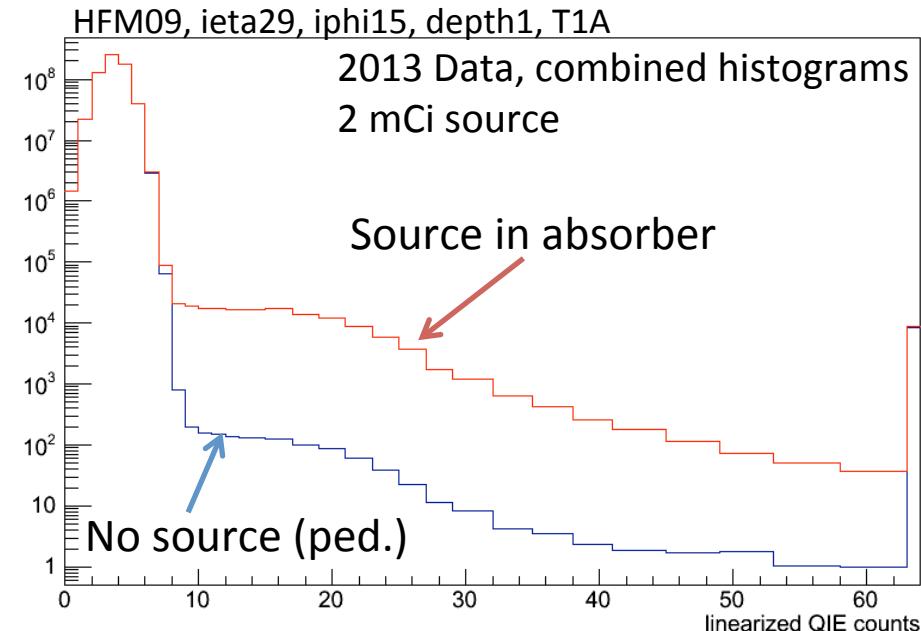


HF, UXC

HF- Sourcing Results

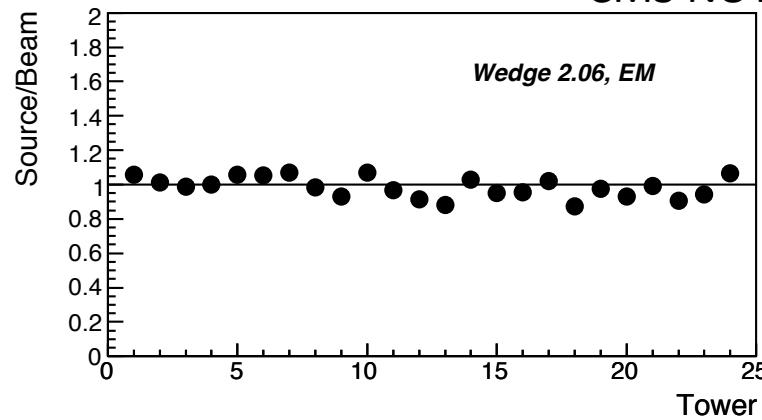
HF signal is usually absent, so hard to see vs. event or source position.

Currently analyzing the data with more sophisticated techniques as was done previously.

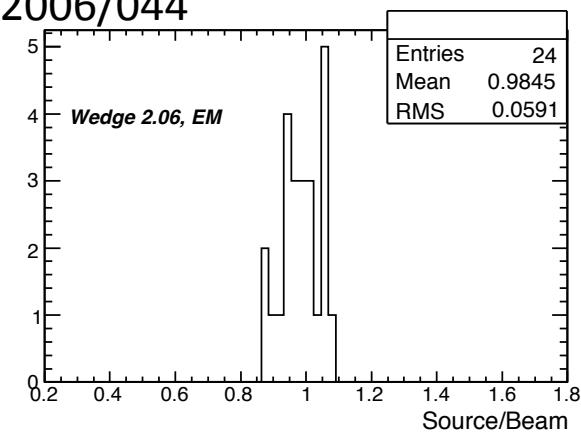


Past results showed good correlation between beam-derived and sourcing derived calibration constants.

Expect same from 2013 data.



CMS NOTE 2006/044



5 mCi source

HF Plans

Next step is to source both HFs when the new photodetectors are installed

- Must be done when HF's are still in garages
 - Finish sourcing both by early August 2014
- HF+ ready by end of February
 - Sourcing planned for April
- HF- ready by early June
 - Sourcing planned for July

HE- Sourcing Plans

Dry run without source in December, real sourcing in January 2014

- CMS radiation protection approves this plan
- Discussions with CMS TC ongoing
- CERN radiation protection is reviewing our safety documents

How much data-taking time is needed?

- Based on HF campaign, it takes a little less than 8 minutes per tube
- We propose sourcing 6 megatiles (3 phi sectors) of HE-, long tubes only → 53 tubes total, or under 3 hours per sector
- Could be done in 3 evenings during the weekend (Fri-Sat-Sun)
 - Source can be mechanically locked in the driver when not being used
 - Cavern access will be blocked when sourcing is in progress

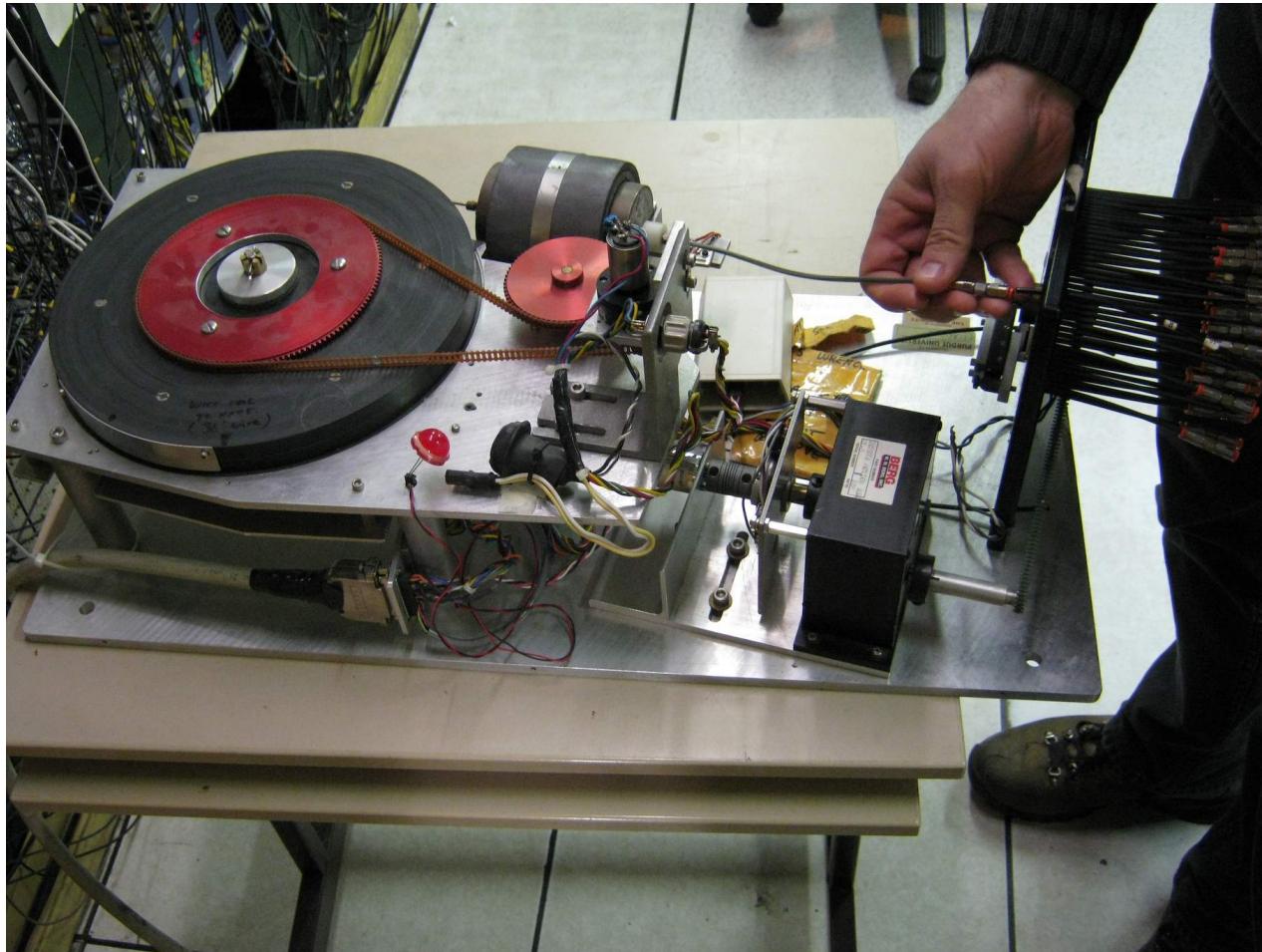
We are having a new driver built by January, in time to be used for this campaign

Outlook

- HCAL sourcing is well-motivated, both for relative calibration and studying radiation damage
- Source signal is small but can be reliably extracted from the data
- Sourcing exercise in H2 and HF- sourcing in UXC have been conducted successfully
- Plans are to source HE in January 2014, and each HF when it is ready: March (HF+) and June (HF-)
- Organization is in place and steps are being taken to meet this schedule

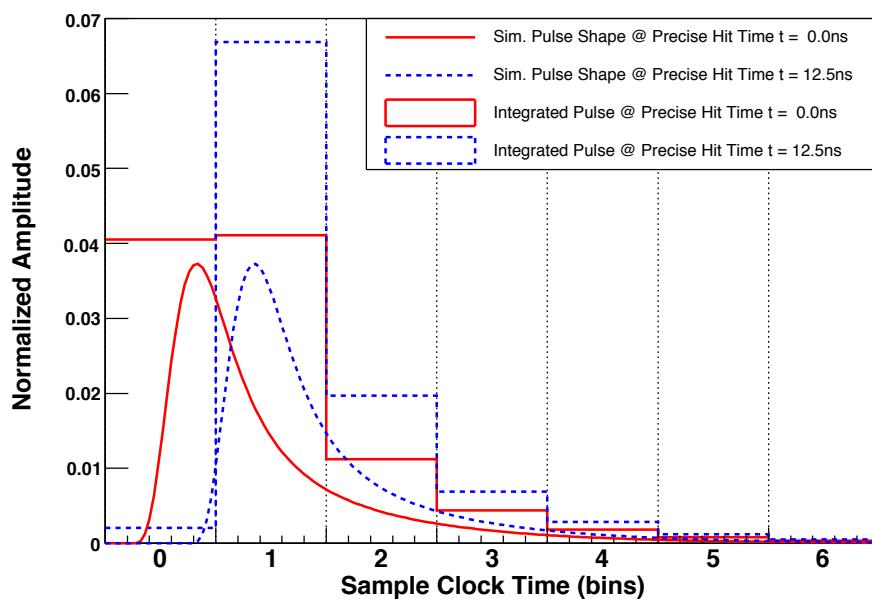
Backup

Source Driver



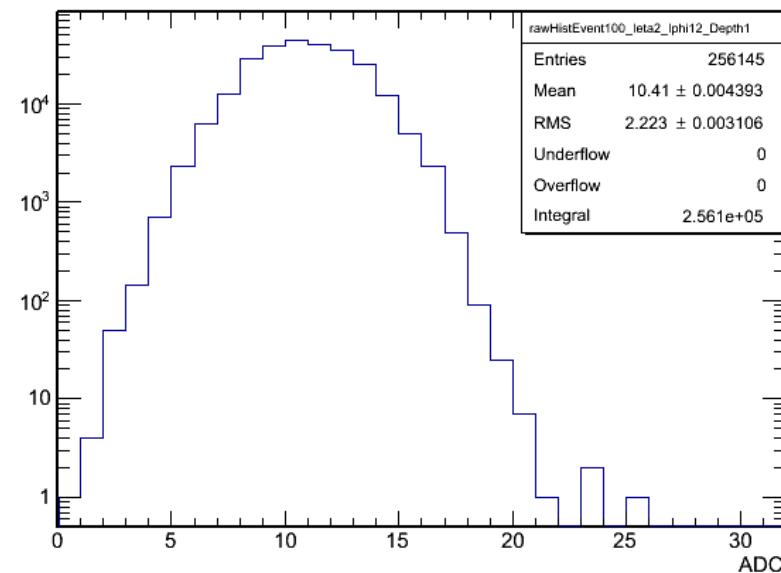
Machine that drives the source in and out of the tubes. Can be connected to a few hundred tubes, using an indexer system to select an individual tube. Typical wire speed: 10 cm/s.

Histogram Mode vs. Regular Readout



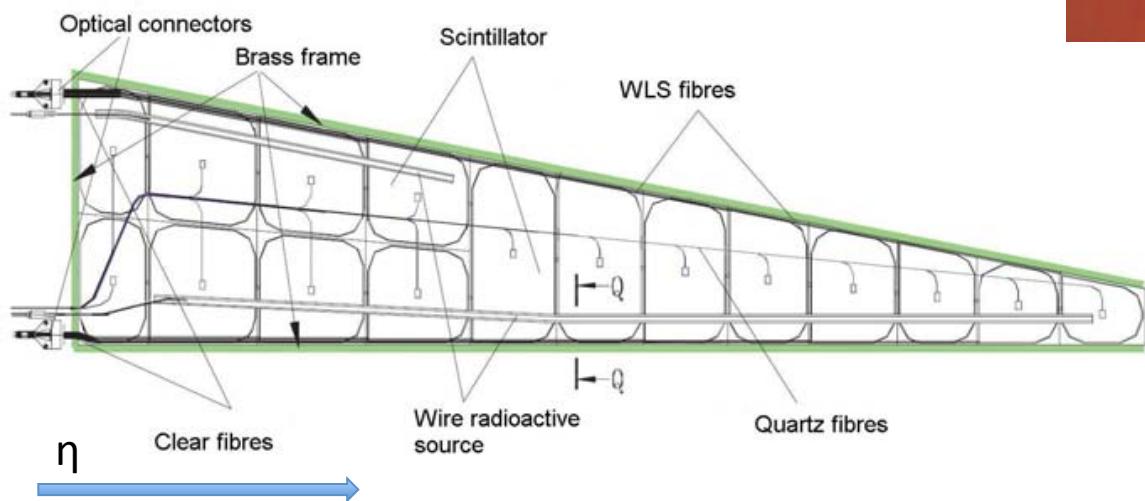
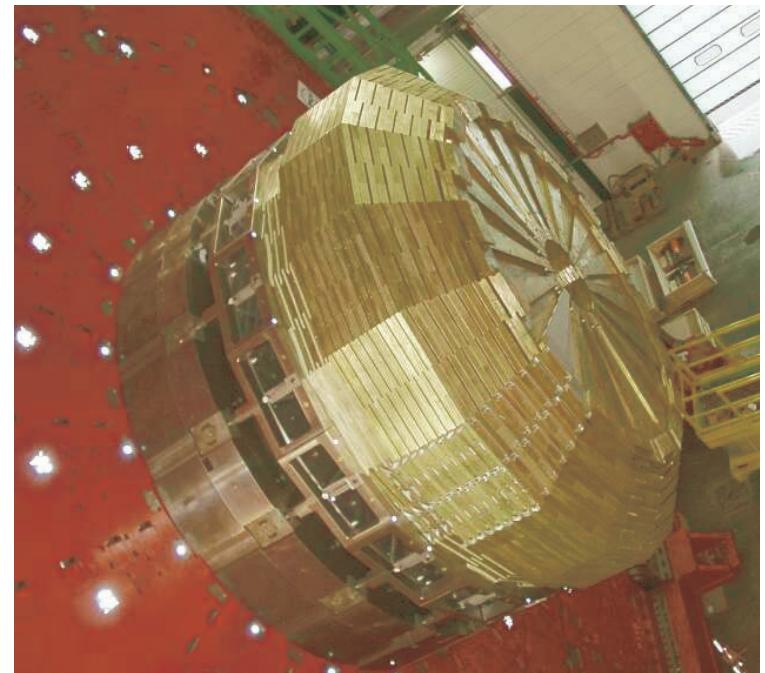
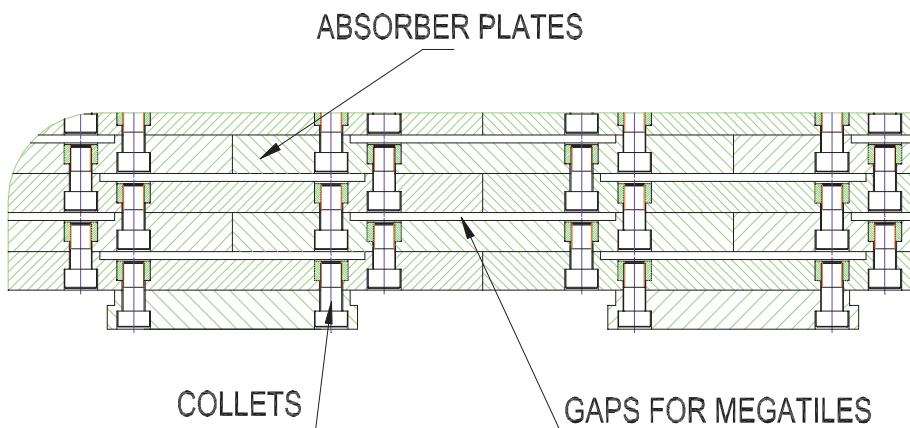
Normally, in the read out, there are 10 time samples, each containing the ADC value of the integrated analog pulse over that time slice. Seven time slices shown here, with their analog pulse shapes (1 time slice = 1 BX).

rawHistEvent100_Ieta2_Iphi12_Depth1



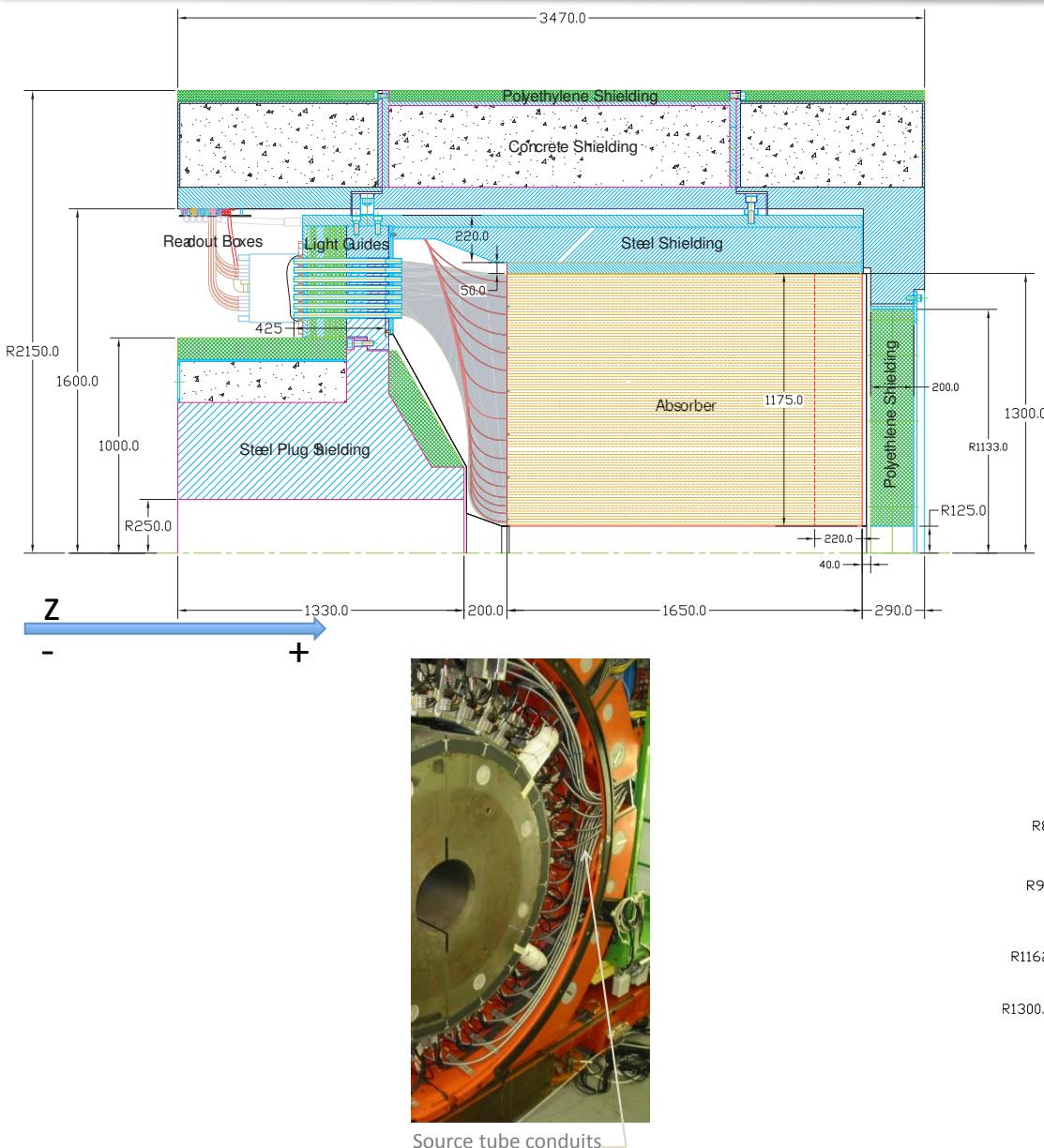
In histogram mode, the integrated pulse value is kept and stored in a histogram. When the histogram is full, it is available for read out. Readout speed is thus significantly less than 40 MHz.

HE Wedge Layout



One layer of a typical HE wedge.
Source tubes go along eta.

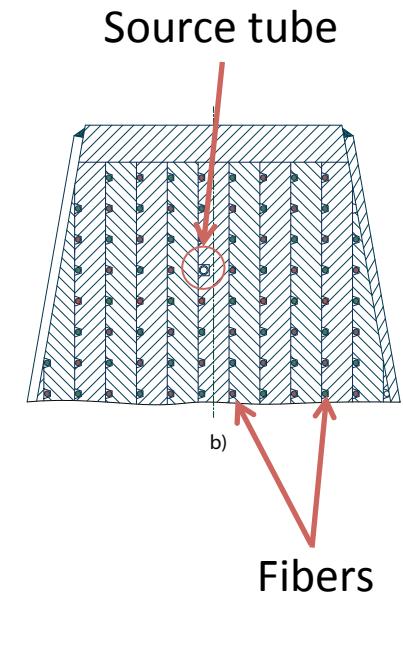
HF Layout



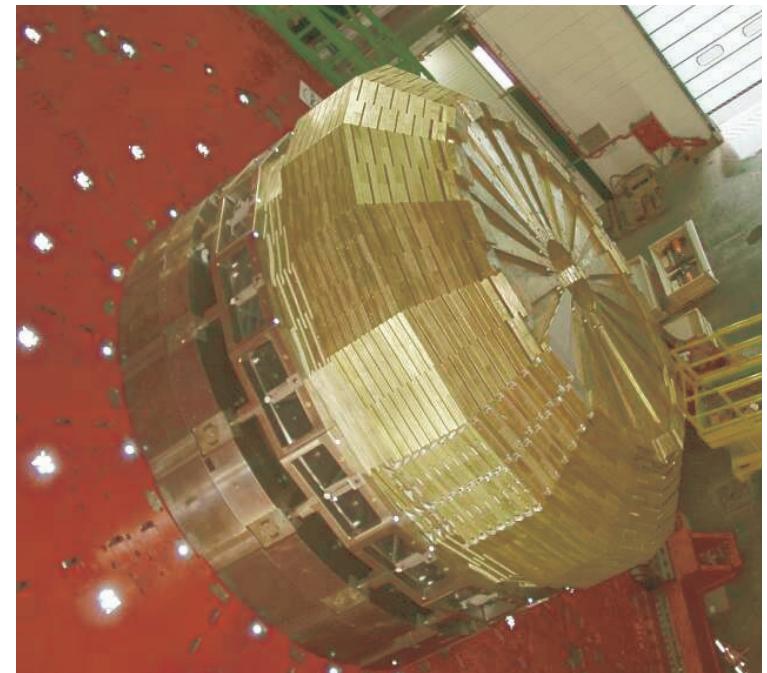
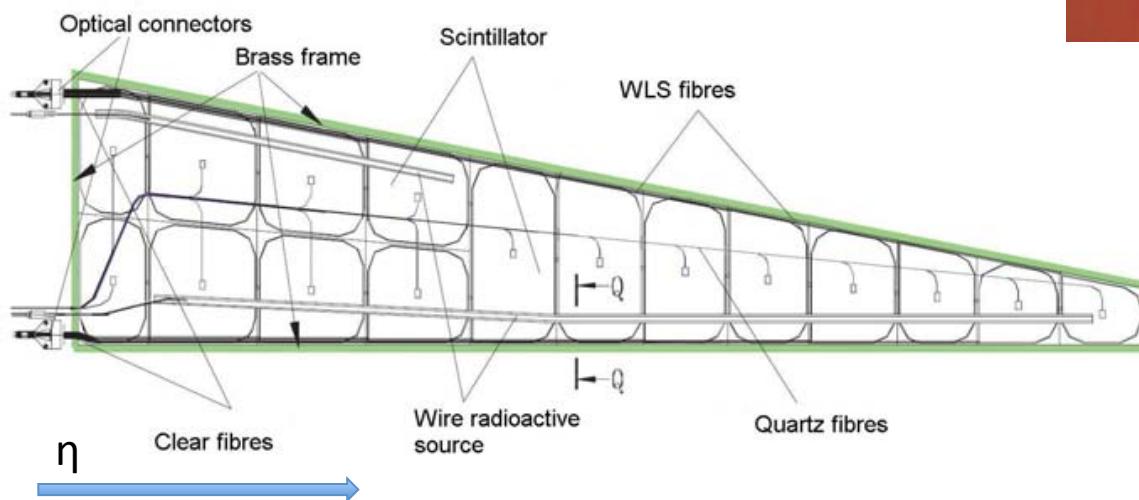
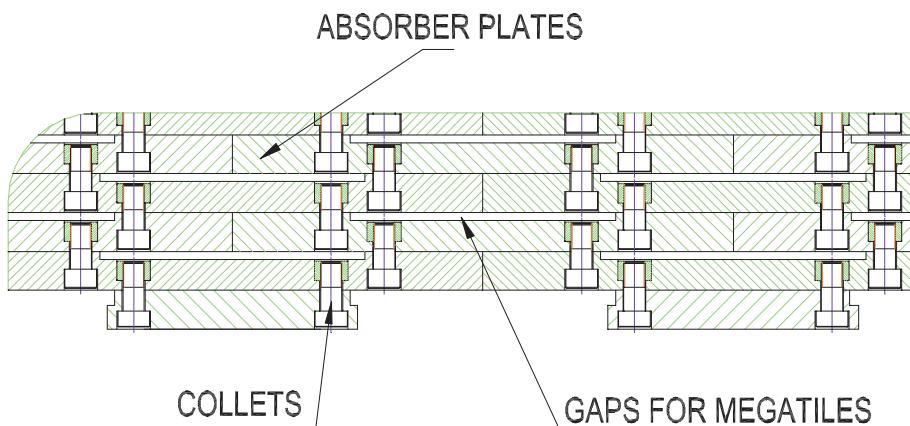
Source tubes go along z-axis (parallel to fibers).
1-2 per eta/phi tower.

RADIUS	ETA
R125.0	5.205
R169.0	4.903
R201.0	4.730
R240.0	4.552
R286.0	4.377
R340.0	4.204
R406.0	4.027
R483.0	3.853
R576.0	3.677
R686.0	3.503
R818.00	3.327
R975.0	3.152
R1162.0	2.976
R1300.0	2.866

a)

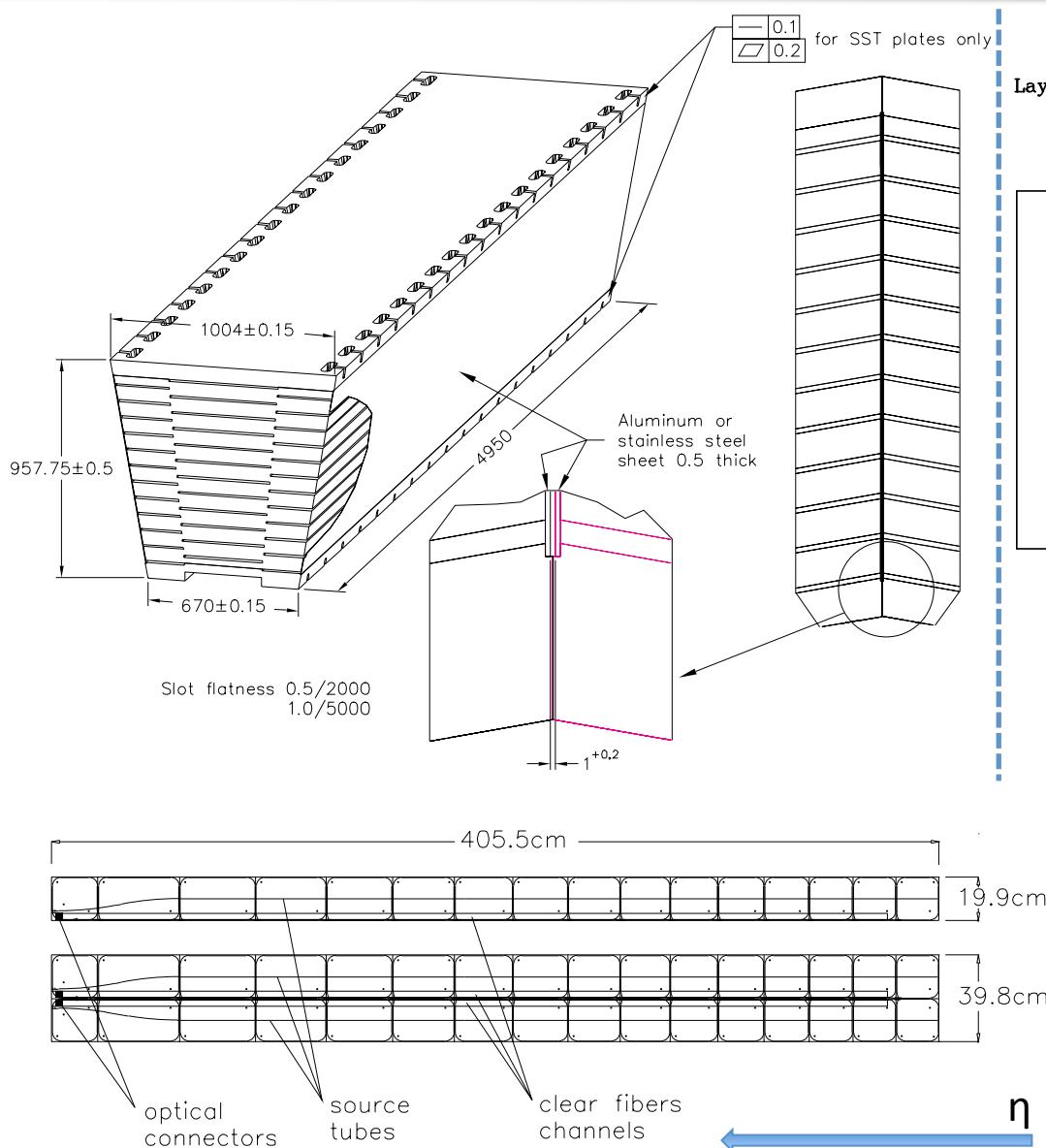


HE Wedge Layout

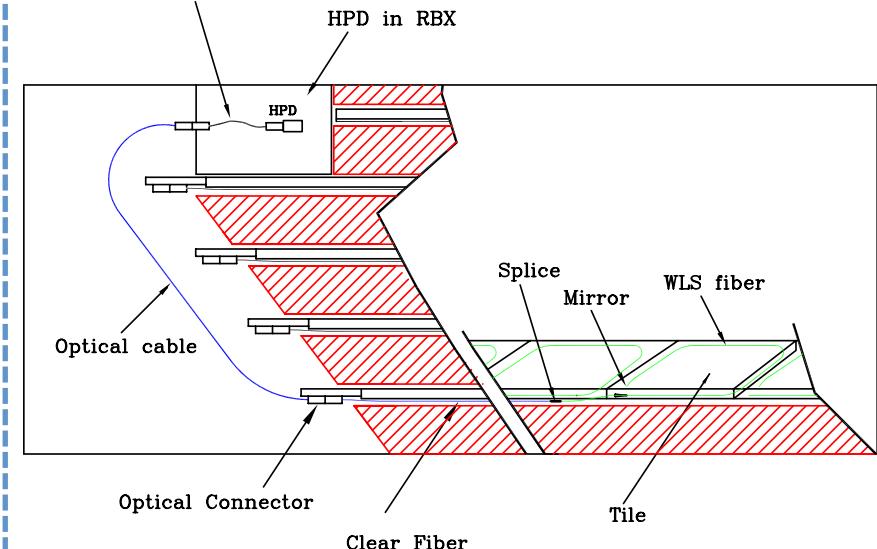


One layer of a typical HE wedge.
Source tubes go along eta.

HB Wedge Layout

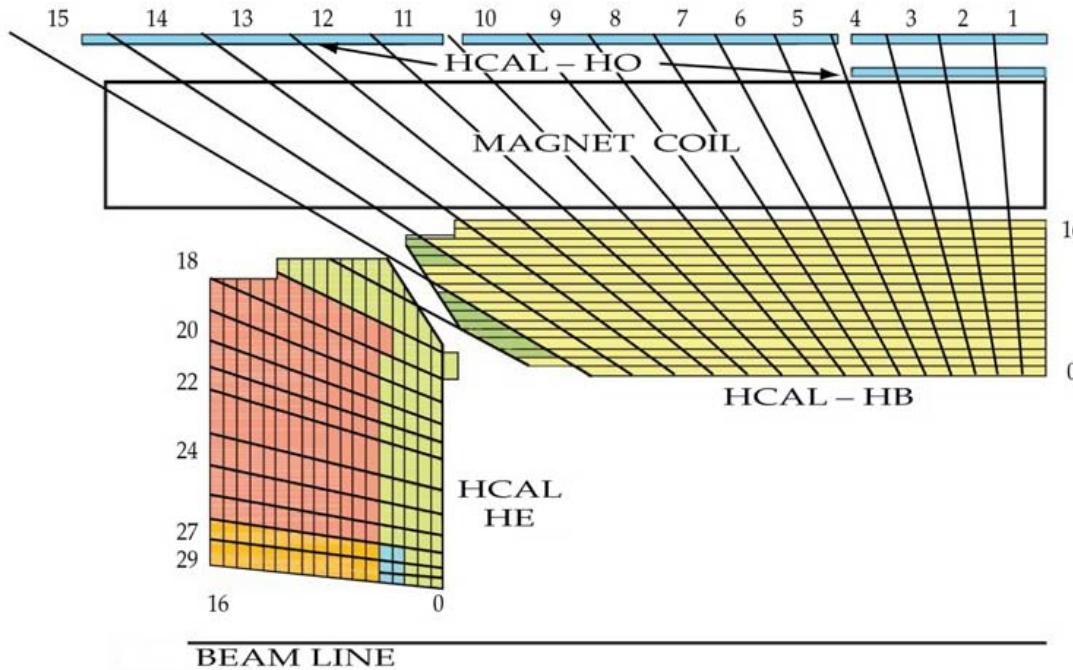


Layer to Tower Decoding Fiber



One layer of a typical HB wedge.
Source tubes go along eta.

HB/HE Layer Segmentation



HCAL Source Coordinator: main piece of DAQ software

- Handles communication with source driver
- Decides in which order to source specified tubes
- Inserts source position information into data stream
- Guides the run through stages:
 1. Decide on tube to source
 2. Pedestal taking
 3. Moving source into and out of the tube
 4. Source next tube or quit

Web Interface - 2

HCAL Source Calibration Coordinator - Mozilla Firefox <@cmshcal02.cern.ch>

File Edit View History Bookmarks Tools Help

CMS HCAL Supervisor Control | HCAL Source Calibration Coo... | +

cmshcal02.cern.ch:35001/urn:xdaq-application:lid=120/Poke

Source Coordinator Configuration

Testing mode set (not communicating with driver)

Select region of tubes to list:

Min Ieta Max Ieta
Min Iphi Max Iphi
Min Layer Max Layer

Available Tubes:

Tubes to source:

Configure Reset

Available Subregions:

The screenshot shows a web-based configuration tool for HCAL tubes. At the top, a red oval highlights a group of input fields for selecting a region of tubes: Min Ieta (-41), Max Ieta (41), Min Iphi (1), Max Iphi (72), Min Layer (-1), and Max Layer (17). Below these are two large text areas: 'Available Tubes' and 'Tubes to source', each with scroll bars and navigation buttons (<<, >>). At the bottom, there's a section for 'Available Subregions' with a 'Select Subregion' button. A red arrow points from the explanatory text on the right to the 'Available Tubes' and 'Tubes to source' sections.

User selects eta/phi/
layer ranges for tubes:
max/min read from
configuration snippet—
depends on run
configuration

Web Interface - 5

HCAL Source Calibration Coordinator - Mozilla Firefox <@cmshcal02.cern.ch>

File Edit View History Bookmarks Tools Help

CMS HCAL Supervisor Control... HCAL Source Calibration Coo... x

cmshcal02.cern.ch:35001/urn:xdaq-application:id=120/Poke

Source Coordinator Configuration

Testing mode set (not communicating with driver)

Select region of tubes to list:

Min Ieta Max Ieta
Min Iphi Max Iphi
Min Layer Max Layer

GetTubesInSelectedRegion

Available Tubes:

- HFM01_ETA29_PHI55_T1A_SRCTUBE
- HFM01_ETA29_PHI55_T1B_SRCTUBE
- HFM01_ETA29_PHI57_T14A_SRCTUBE
- HFM01_ETA29_PHI57_T14B_SRCTUBE
- HFM01_ETA30_PHI55_T2A_SRCTUBE
- HFM01_ETA30_PHI55_T2B_SRCTUBE
- HFM01_ETA30_PHI57_T15A_SRCTUBE
- HFM01_ETA30_PHI57_T15B_SRCTUBE
- HFM01_ETA31_PHI55_T3A_SRCTUBE
- HFM01_ETA31_PHI55_T3B_SRCTUBE
- HFM01_ETA31_PHI57_T15A_SRCTUBE
- HFM01_ETA31_PHI57_T15B_SRCTUBE
- HFM01_ETA31_PHI57_T3A_SRCTUBE
- HFM01_ETA31_PHI57_T3B_SRCTUBE
- HFM01_ETA31_PHI57_T16A_SRCTUBE
- HFM01_ETA31_PHI57_T16B_SRCTUBE
- HFM01_ETA32_PHI57_T4_SRCTUBE
- HFM01_ETA32_PHI57_T17_SRCTUBE
- HFM01_ETA33_PHI55_T5_SRCTUBE
- HFM01_ETA33_PHI57_T18_SRCTUBE
- HFM01_ETA34_PHI55_T6_SRCTUBE
- HFM01_ETA34_PHI57_T19_SRCTUBE
- HFM01_ETA35_PHI55_T7_SRCTUBE
- HFM01_ETA35_PHI57_T20_SRCTUBE

Tubes to source:

<< >>

Configure Reset

Available Subregions:

- Subregion 0 (tubes 1 to 40)
- Subregion 1 (tubes 41 to 80)
- Subregion 2 (tubes 81 to 120)
- Subregion 3 (tubes 121 to 160)
- Subregion 4 (tubes 161 to 200)

Select Subregion

HCAL Source Calibration Coordinator - Mozilla Firefox <@cmshcal02.cern.ch>

File Edit View History Bookmarks Tools Help

CMS HCAL Supervisor Control... HCAL Source Calibration Coo... x

cmshcal02.cern.ch:35001/urn:xdaq-application:id=120/Poke

Source Coordinator Configuration

Testing mode set (not communicating with driver)

Select region of tubes to list:

Min Ieta Max Ieta
Min Iphi Max Iphi
Min Layer Max Layer

GetTubesInSelectedRegion

Available Tubes:

- HFM01_ETA29_PHI55_T1B_SRCTUBE
- HFM01_ETA29_PHI57_T14B_SRCTUBE
- HFM01_ETA30_PHI55_T2B_SRCTUBE
- HFM01_ETA30_PHI57_T15A_SRCTUBE
- HFM01_ETA31_PHI55_T3A_SRCTUBE
- HFM01_ETA31_PHI55_T3B_SRCTUBE
- HFM01_ETA31_PHI57_T16B_SRCTUBE
- HFM01_ETA32_PHI55_T4_SRCTUBE
- HFM01_ETA32_PHI57_T17_SRCTUBE
- HFM01_ETA33_PHI55_T5_SRCTUBE
- HFM01_ETA33_PHI57_T18_SRCTUBE
- HFM01_ETA34_PHI55_T6_SRCTUBE
- HFM01_ETA34_PHI57_T19_SRCTUBE
- HFM01_ETA35_PHI55_T7_SRCTUBE
- HFM01_ETA35_PHI57_T20_SRCTUBE
- HFM01_ETA36_PHI55_T8_SRCTUBE
- HFM01_ETA36_PHI57_T21_SRCTUBE
- HFM01_ETA37_PHI55_T9_SRCTUBE
- HFM01_ETA37_PHI57_T22_SRCTUBE
- HFM01_ETA38_PHI55_T10_SRCTUBE
- HFM01_ETA38_PHI57_T23_SRCTUBE
- HFM01_ETA39_PHI55_T11_SRCTUBE

Tubes to source:

<< >>

Configure Reset

Available Subregions:

- Subregion 0 (tubes 1 to 40)
- Subregion 1 (tubes 41 to 80)
- Subregion 2 (tubes 81 to 120)
- Subregion 3 (tubes 121 to 160)
- Subregion 4 (tubes 161 to 200)

Select Subregion

Selecting tubes by hand and moving into right-hand list.
Can also use subregions.

Web Interface - Status

HCAL Source Calibration Coordinator - Mozilla Firefox

File Edit View History Bookmarks Tools Help

X CMS HCAL Supervis... X HCAL Source Calibr... X HCAL Source Calibr... +

cmshcal02.cern.ch:35001/urn:xdaq-application:lid=120/Peek Google

Source Coordinator Status

Testing mode set (not communicating with driver)

Current tube
name: HFM02_ETA30_PHI61_T15B_SRCTUBE
subDetector: HF
ieta:-30 to -30
iphi:61 to 62

40 Remaining Tubes to Source:

HFM01_ETA29_PHI55_T1A_SRCT
HFM01_ETA29_PHI55_T1B_SRCT
HFM01_ETA30_PHI55_T2A_SRCT
HFM01_ETA30_PHI55_T2B_SRCT
HFM01_ETA31_PHI55_T3A_SRCT
HFM01_ETA31_PHI55_T3B_SRCT
HFM01_ETA32_PHI55_T4_SRCTU
HFM01_ETA33_PHI55_T5_SRCTU
HFM01_ETA34_PHI55_T6_SRCTU
HFM01_ETA35_PHI55_T7_SRCTU

Driver Info

Driver index position : 0
Driver reel position : 0
Driver last command reported :
Driver status : 0
Driver last command status is accepted
Driver status reported : 0
Message counter : 0

Coordinator Info

My last command sent :
Current status : Configured
Task state is : IDLE
Highest event read out : 0

STOP Driver Immediately! Autorefresh page (1 sec)
Pause triggers

Information updated after configuration and throughout run

Information on coordinator commands and state

Information on driver commands and communication, state; wire position (index/reel)

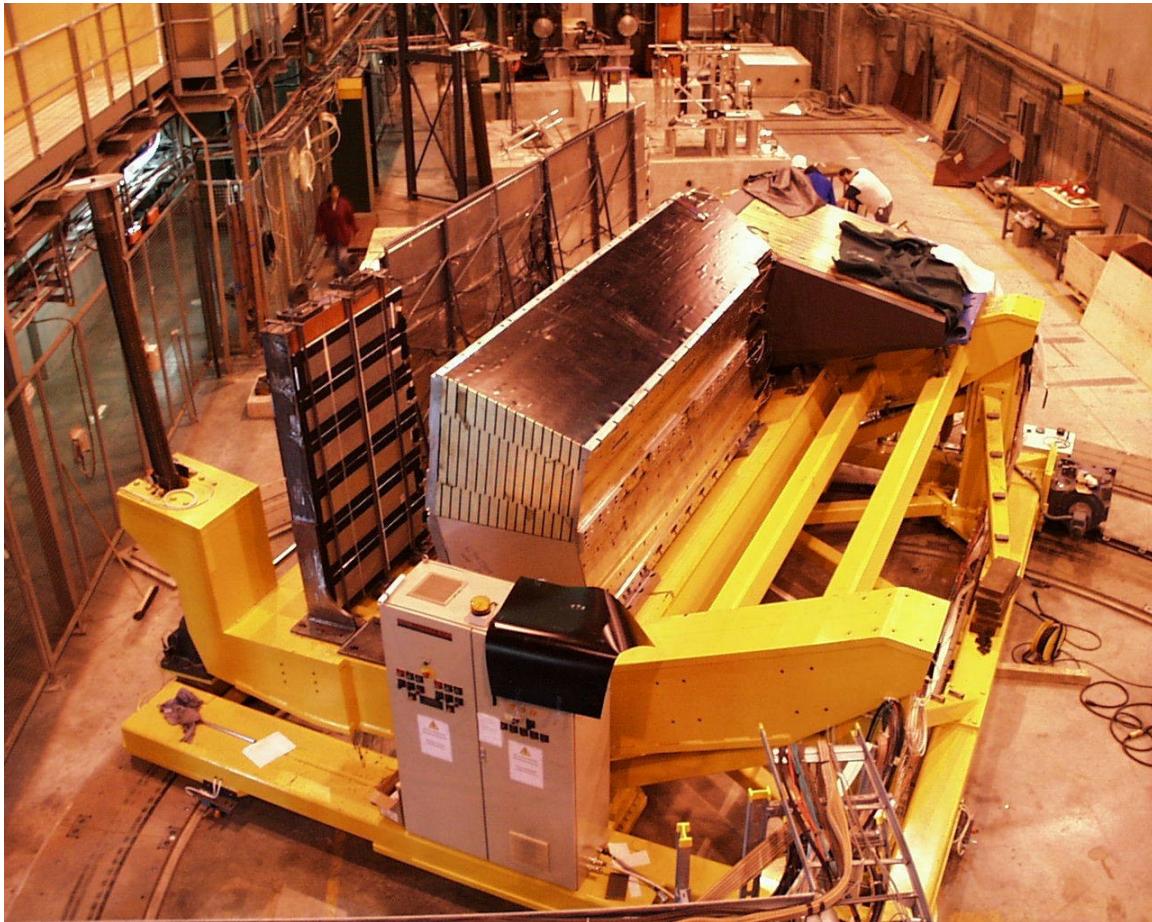
H2 Sourcing Overview

- Tests of source driver and readout with the DAQ were performed on July 22-23 at H2 (Prevessin site)
- Green light was obtained from CERN Radiation Protection to install the source and proceed
- Last time we performed these kinds of tests was in 2007!
 - As expected, there were some changes to the procedure that made it more complex
 - Valuable experience for HF sourcing campaign that will take place soon

H2 Sourcing Details

- Only one phi sector of HB+01 was connected and sourced
- Layers 0 and 16 were not sourced due to lack of brass absorber for shielding
- Only HPD's were used in the readout
- The exercise was short, but all objectives were achieved quickly

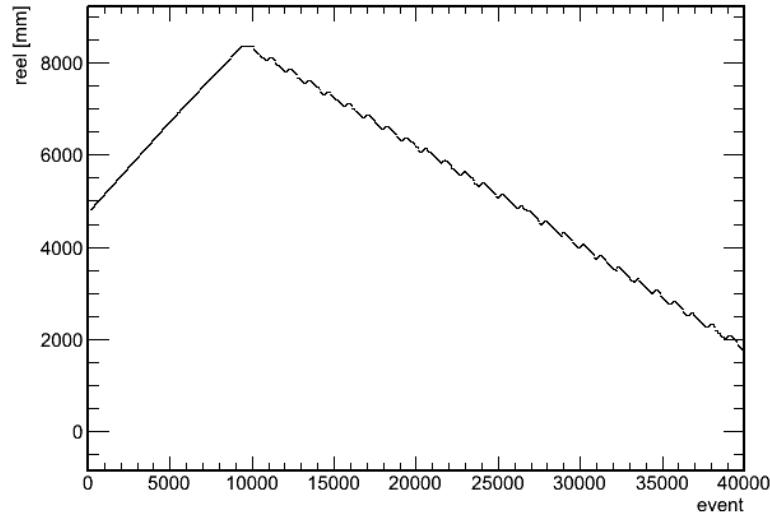
H2 HCAL Testbeam Setup



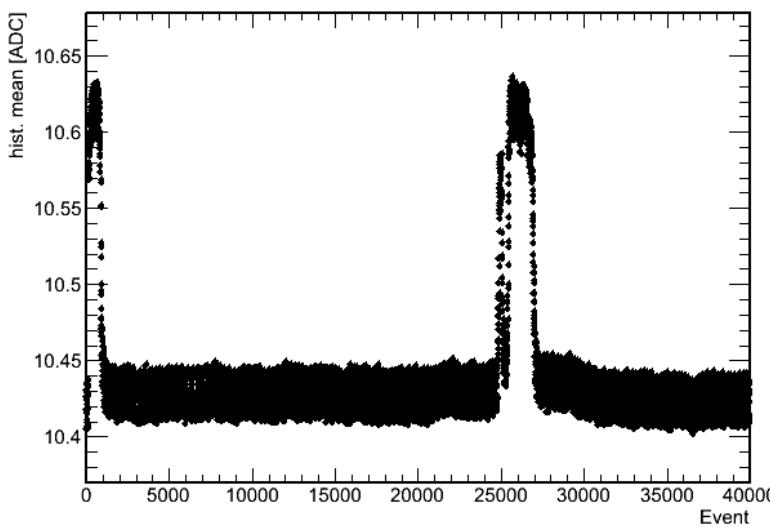
Several HCAL prototypes are installed in a permanent setup in the H2 area (in Prevessin bat. 887) which sits in the SPS beamline.

There are 2 wedges of HB covering 40° in phi and 1 HE sector also covering 40° in phi (only inner 20° instrumented in HE). These can be seen in the photo to the left, where the HB/HE wedges are mounted on a moving table.

Run 6700: Reel and Hist. Avg. vs. Evt.



ieta2_Iphi12_Depth1



Layer 1 tube only.

Data begins to be taken when source is at entrance into detector, the wire is sent out, then retracted, and data-taking stops when source is in garage (not shown).

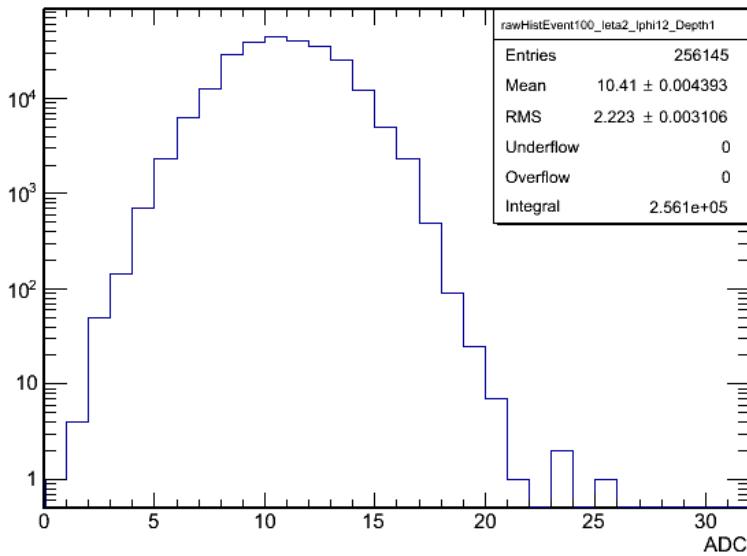
First (and last) tile to see the signal is known as ieta2.

Tiles should be illuminated from high to low eta. Cables were inspected and found to be reversed in this layer: sourcing already proven its worth!

Source signal ~ 0.2 ADC

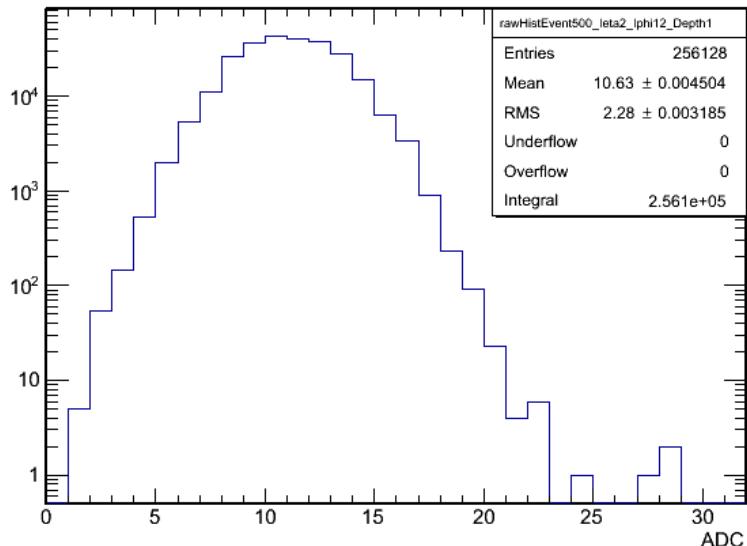
Run 6700: Histograms

rawHistEvent100_Ieta2_Iphi12_Depth1



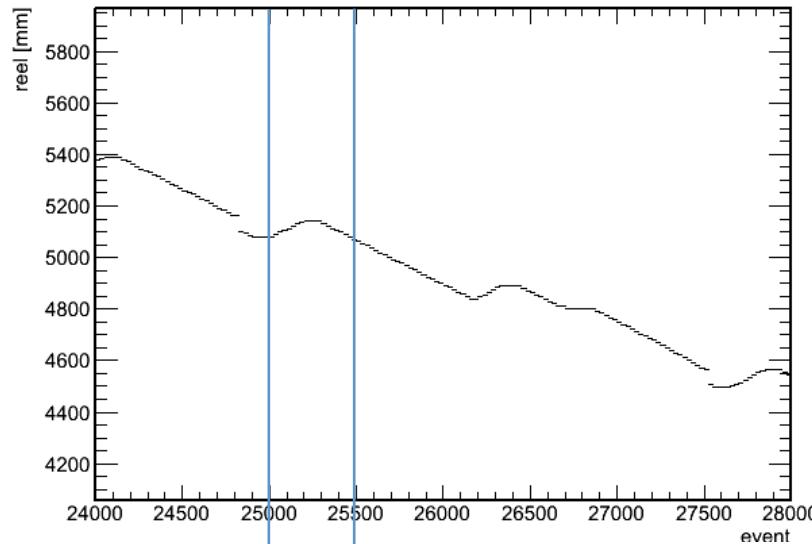
Pedestal only; mean 10.41, RMS 2.22 ADC

rawHistEvent500_Ieta2_Iphi12_Depth1

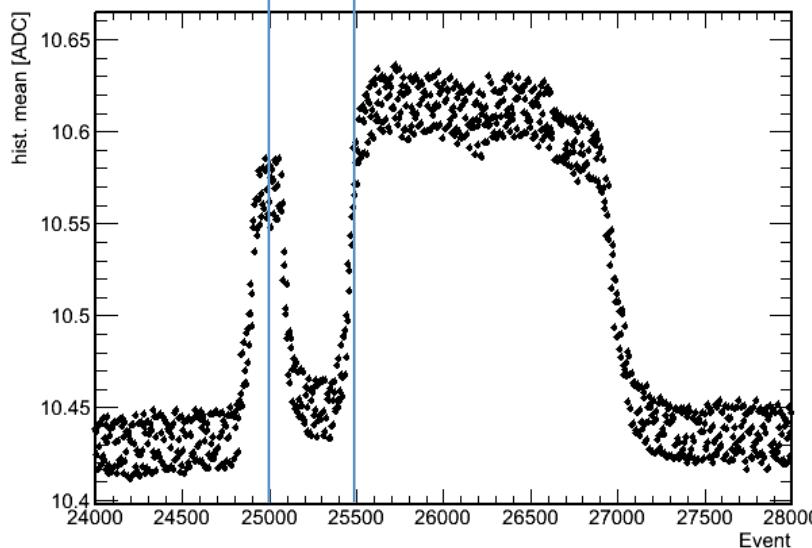


Source inside; mean 10.63, RMS 2.28 ADC

Run 6700: Spooling



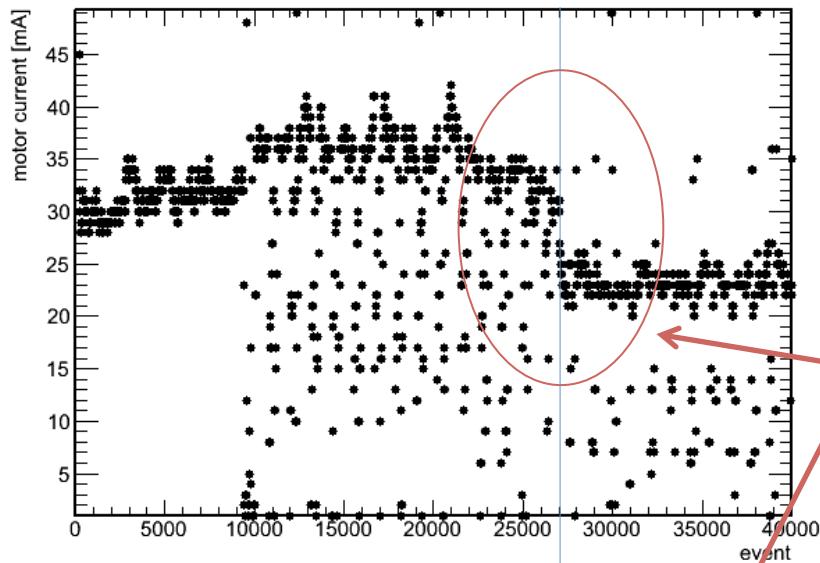
Ieta2_Iphi12_Depth1



When retracting, every so often, the motor driving the reel will reverse itself to make sure the wire is laying nicely on the spool. This is called “spooling.”

In this case, the spooling begins when the source is just inside this tile, causing the source to move outside the tile and leading to a loss of signal. Then the retraction restarts, the source reenters the tile, and the signal reappears.

Run 6700: Motor Current



Can see a drop in current from ~ 30 to 23 mA
as source exits the megatile.
About a 30% drop.
Also seen in current vs. reel plot:

