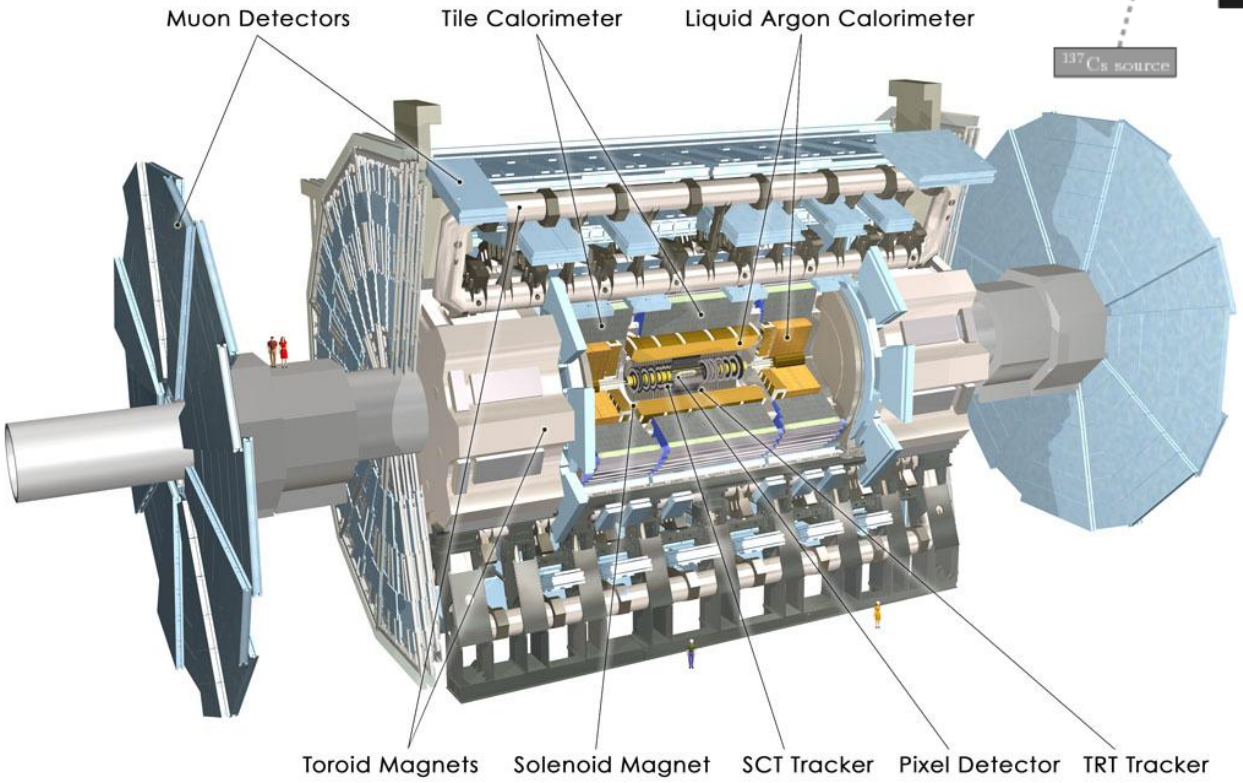
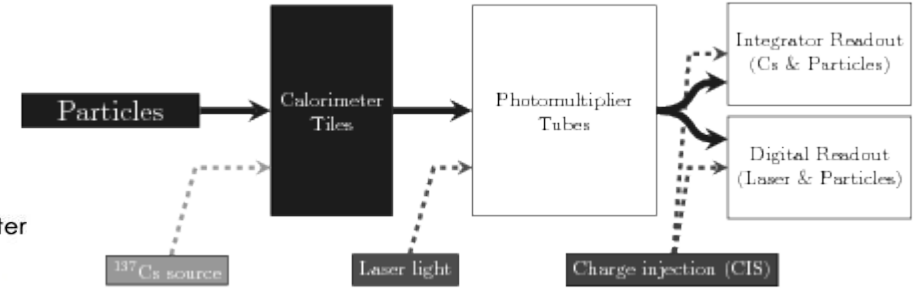
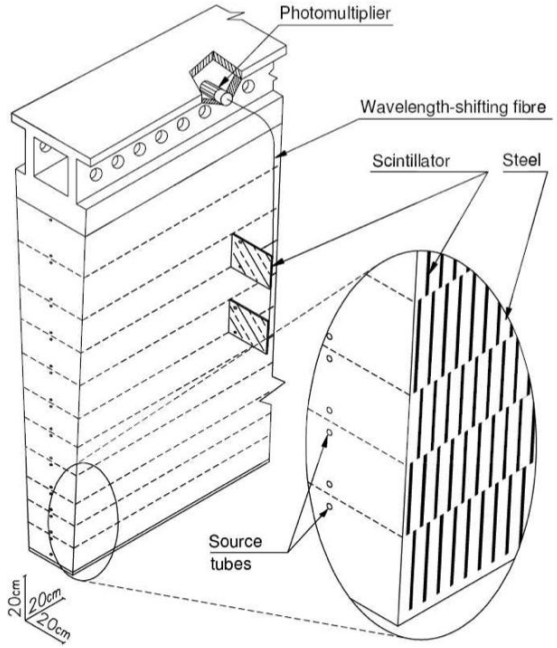
TileCal PMT Response to Laser Pulses Sent in Empty Bunches During Physics Runs

Summer Zuber, July 20, 2017
University of California, Santa Cruz
Tutors: Dr Fabrizio Scuri, Dr Henric Wilkens

Quick Reminder...







PMT Response Evolution Behavior: Expectations

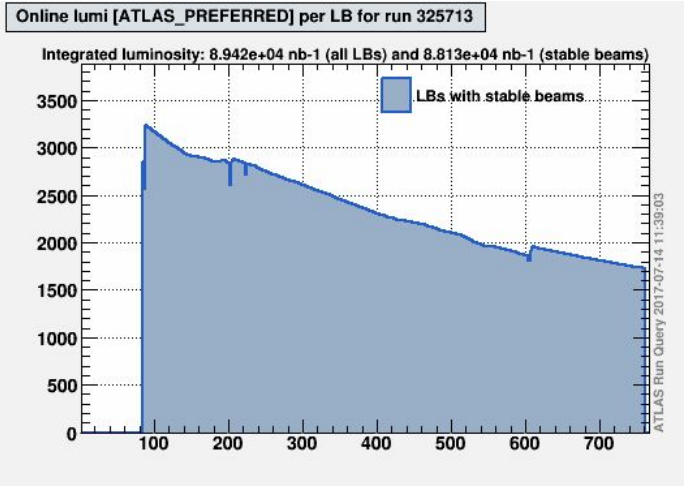
In 2015-2016 there was a clear jump observed in the time profile of the PMT response when stable beams are declared

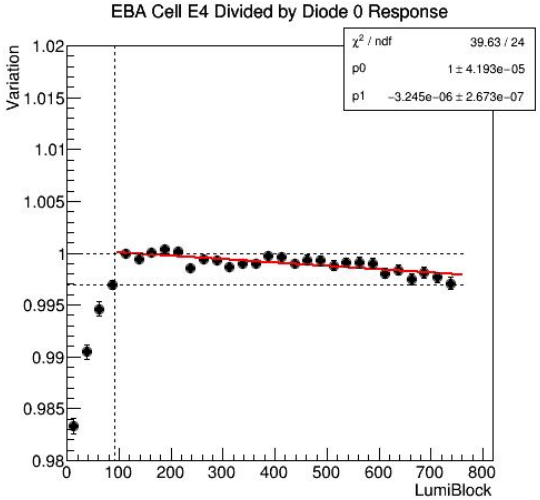
The size of the jump was clearly correlated with the peak luminosity of the run

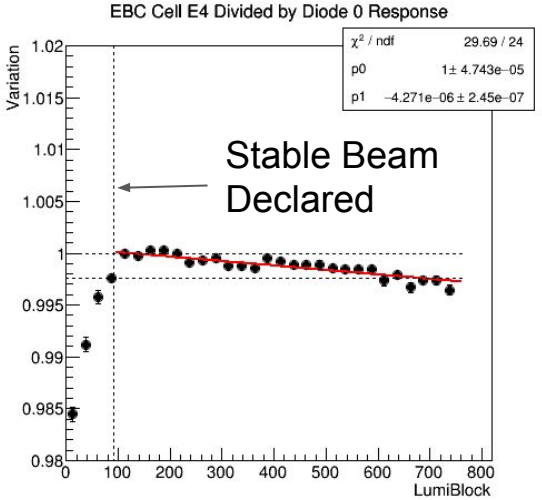
This preliminary study looks at the behavior of the time profile of the PMT response in the 2017 collision data so far

CAVEAT: Most collision runs so far have been used in machine studies in which the beam parameters are changed, even after stable beams are declared

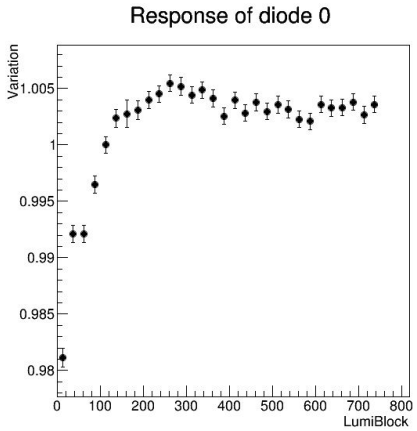
Run 325713: An example of expected time profile

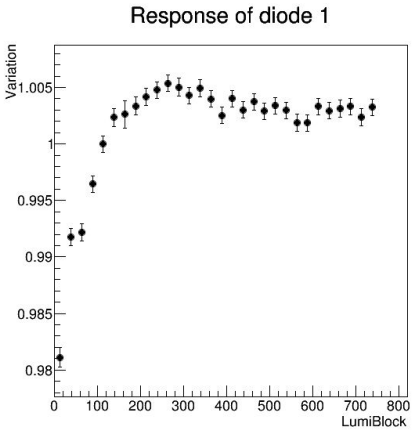


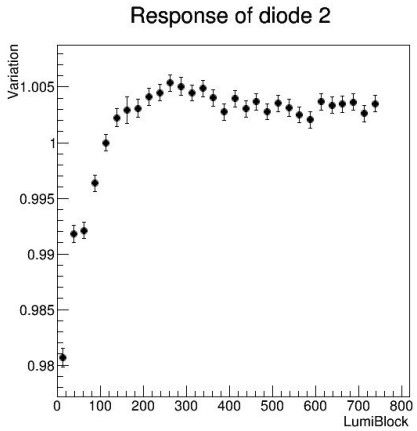




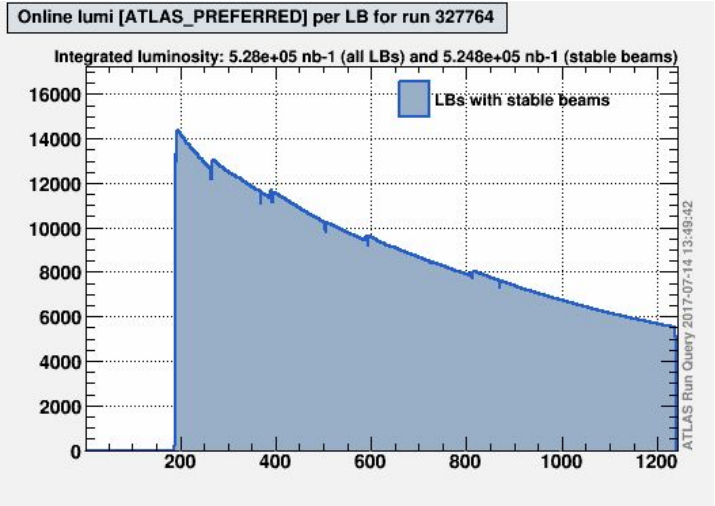
Laser Intensity Monitors:

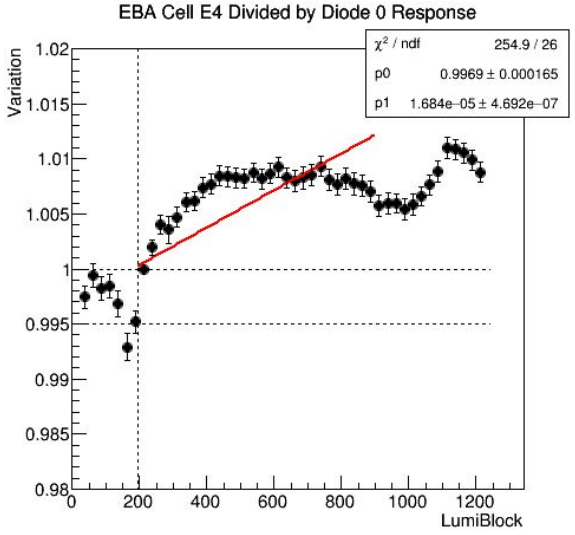


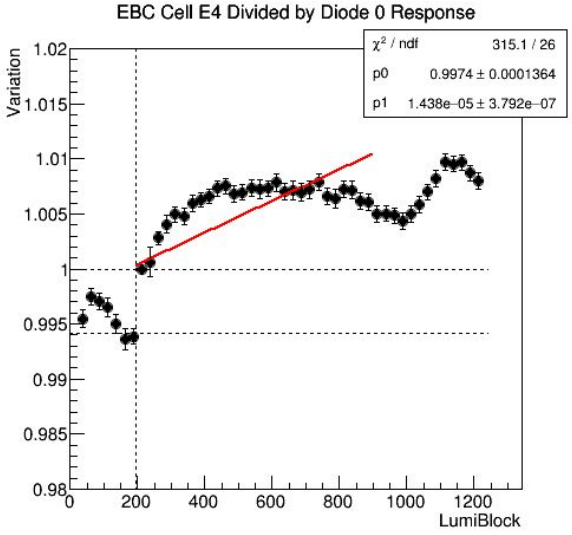


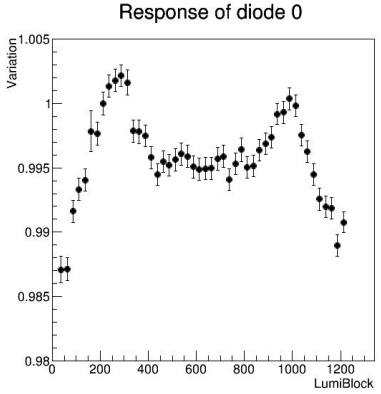


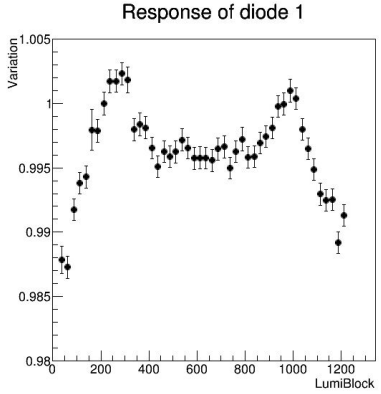
Run 327764: An example of anomalous time profile

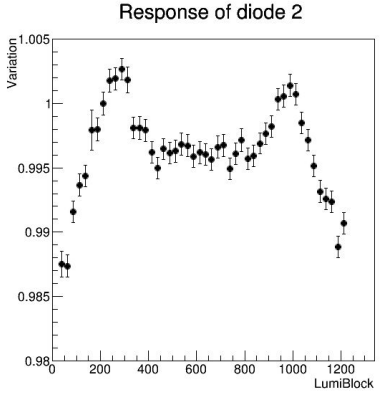




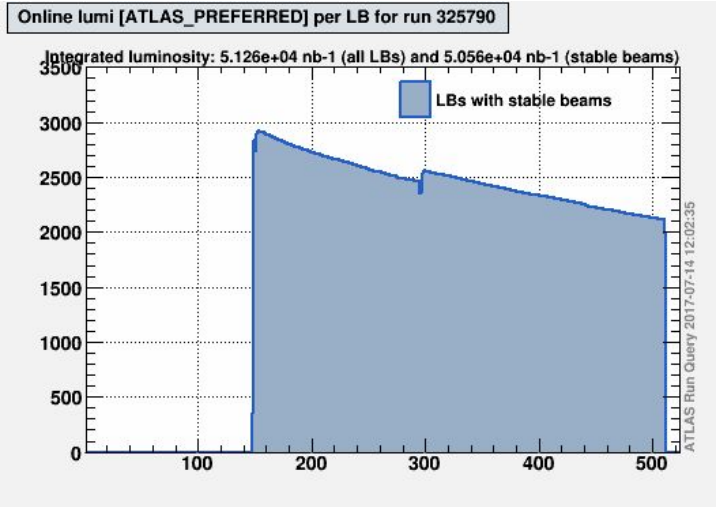


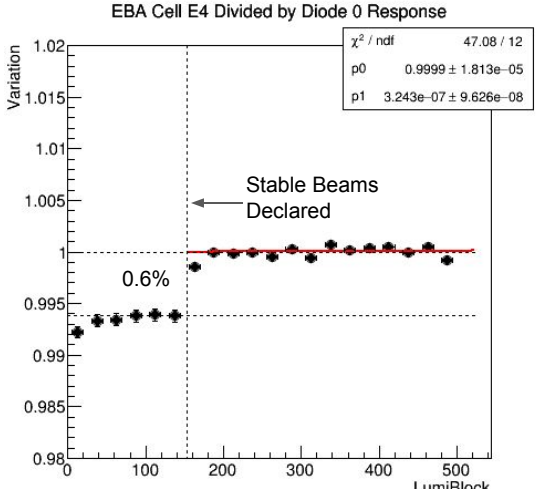


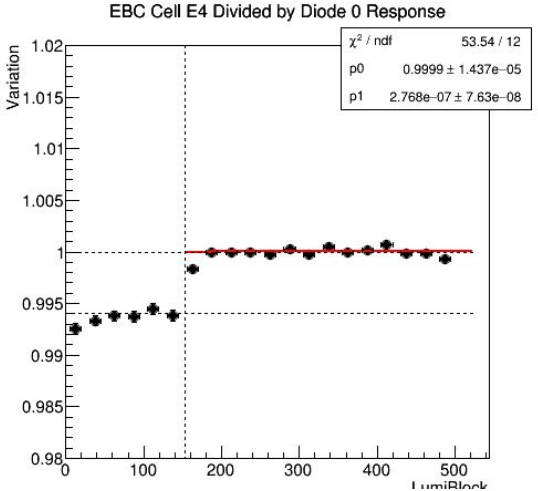




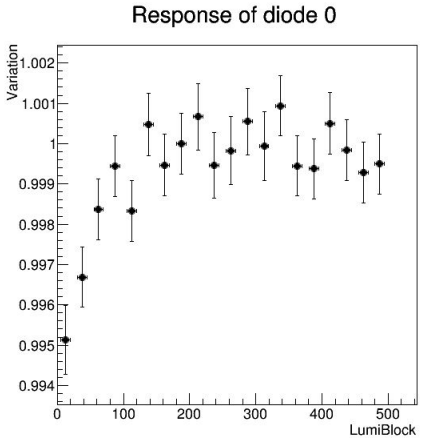
Run 325790: An example of clear jump at stable beam declaration

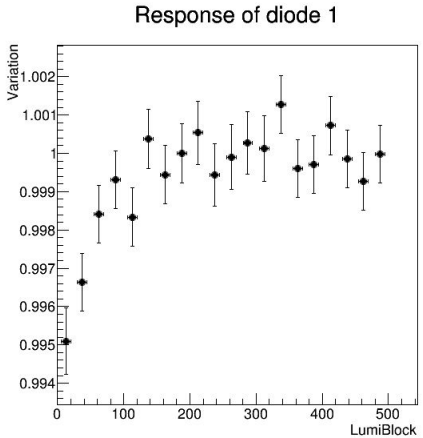


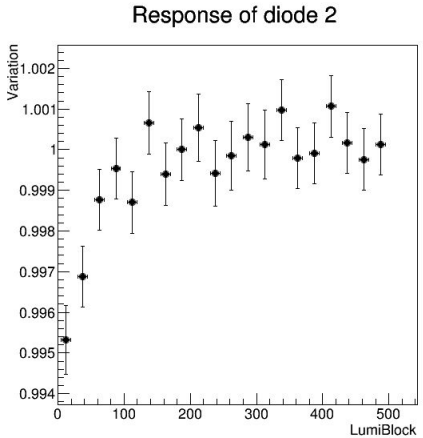




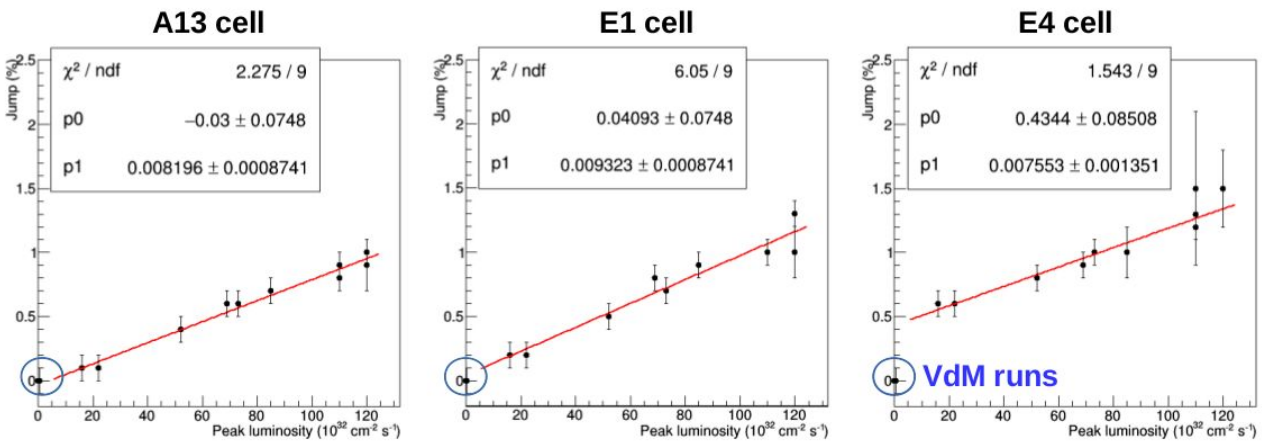
Laser Intensity Monitors:



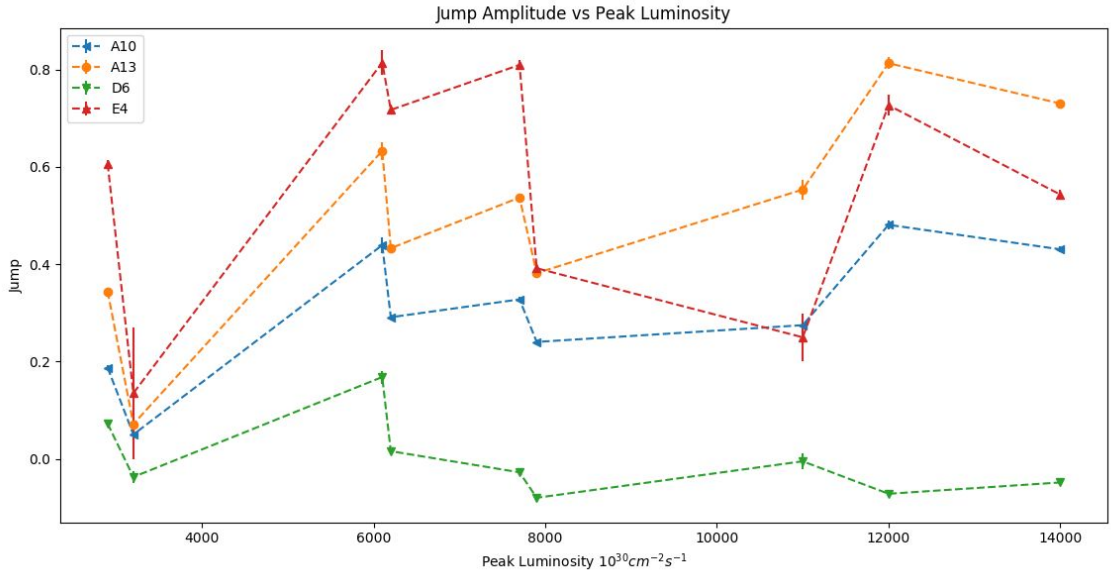




2015-2016 Analysis of Jump Amplitude:



2017 Analysis of Jump Amplitude:



Conclusions and Further Study

So far no correlation between jump amplitude and peak luminosity observed

Analysis of the jump amplitude should be repeated using collision runs with stable beam conditions

There is a correlation between the cell exposure and the jump size

PMT Response Evolution between Calibration Runs:

Comparing Average PMT Response of Last Calibration Run to PMT Response Right After Stable Beam in Physics Run

Construct observables: $\Delta = \frac{2(PHY - \overline{CAL})}{PHY + \overline{CAL}}$ $\Delta_0 = \frac{2(PHY_0 - \overline{CAL_0})}{PHY_0 + \overline{CAL_0}}$

And study Correlation with parameters such as time elapsed between calibration and physics

Backup

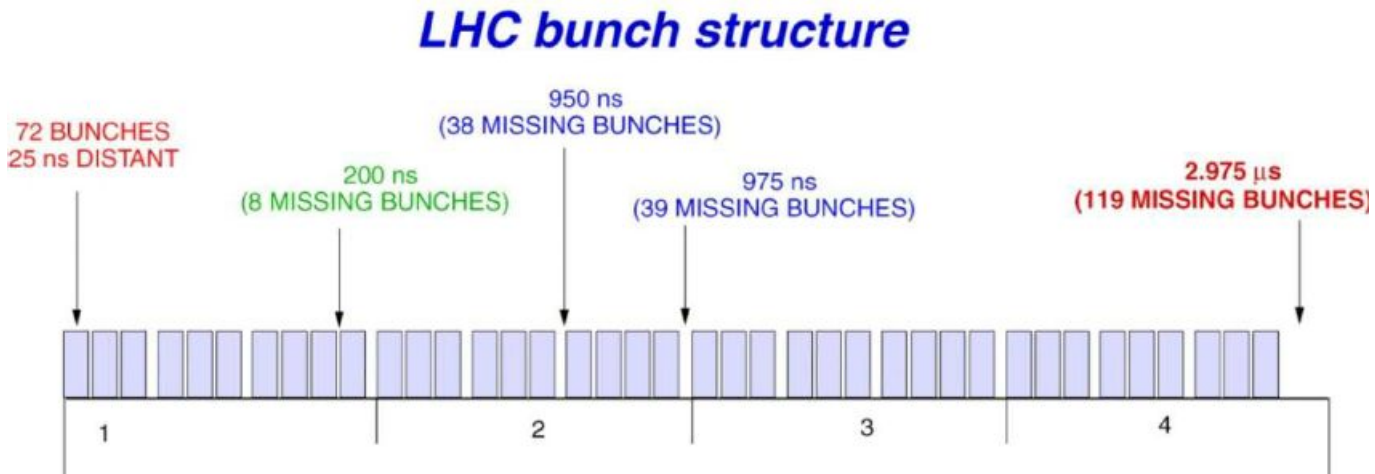
Laser Pulses in LHC Empty Bunches

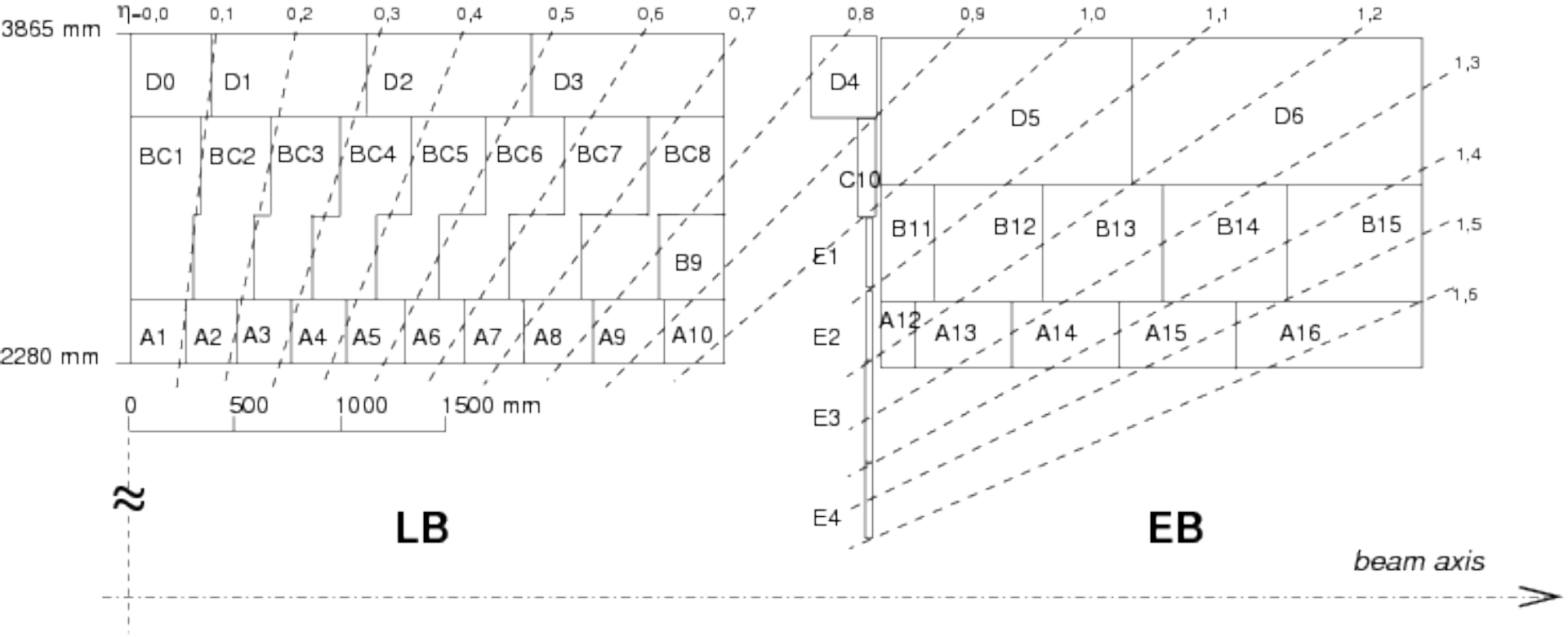
In the LHC there are two beams circling in opposite directions

The protons of each beam are grouped into bunches separated by 25 ns

There are intervals of 25 ns with no protons i.e. “empty bunches”

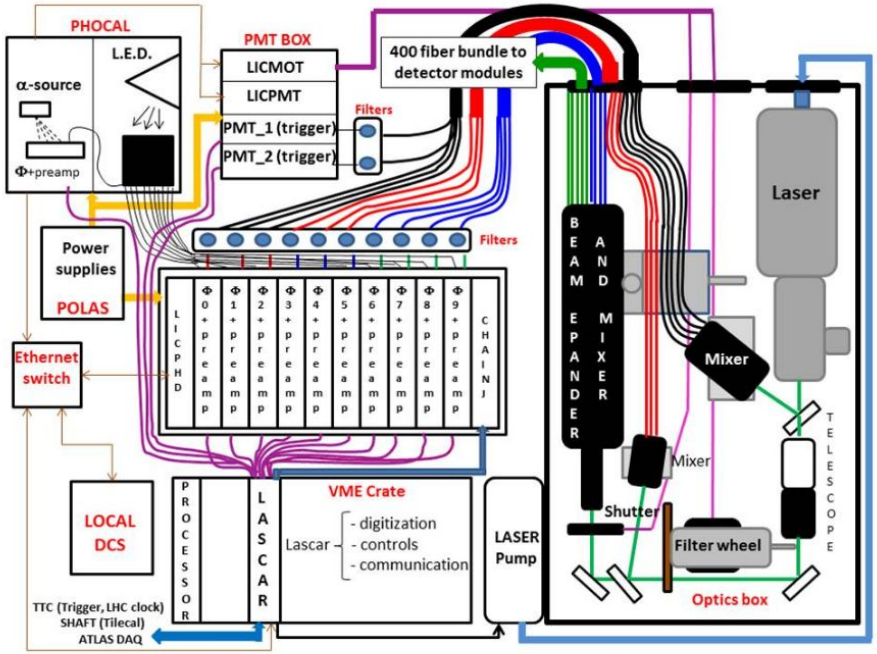
At the time in which empty bunches intersect at an interaction point laser pulses are sent to all TileCal channels




η
0,0
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1,0
1,1
1,2
1,3
1,4
1,5
1,5
3865 mm
2280 mm
D0
D1
D2
D3
D4
D5
D6
BC1
BC2
BC3
BC4
BC5
BC6
BC7
BC8
B9
C10
B11
B12
B13
B14
B15
E1
E2
E3
E4
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A12
A13
A14
A15
A16
0
500
1000
1500 mm
LB
EB
beam axis

Laser Calibration

The full LaserII system:



Laser is used to send laser pulses to all 10,000 PMTs via optical fibers

The response of each PMTs can be normalised to the response of a monitor diode just downstream of the laser

Skills to Gain this Summer:

Knowledge of operation of a hadronic calorimeter

Knowledge of calibration systems for sub-detectors

Knowledge in C++ programming for developing analysis algorithms

Knowledge of using the ROOT software package

Physics Runs

Exclude all bad PMTs

Total response of each event divided by response of diode 0 (for each individual pmt)

Average over all events in 25 LumiBlock period (for each individual pmt)

Normalize to first bin of stable beam

Take Mean over all modules for a given cell over a given 25 LumiBlock period

Plot response versus LumiBlock → evolution of the response

Normal Calibration Runs

Divide into 10 bins of equal number of events ~ 10 second bins

Special Calibration Runs

Bins of ~ 5 LumiBlock by assuming ~ 180 events per LumiBlock