Data Analysis Jamboree: HCAL

Edmund A. Berry

Tuesday, September 16, 2014

Section 1

Introduction

Introduction

- Last few months have been very useful for HCAL
- In addition to MWGR participation, several projects involving local running

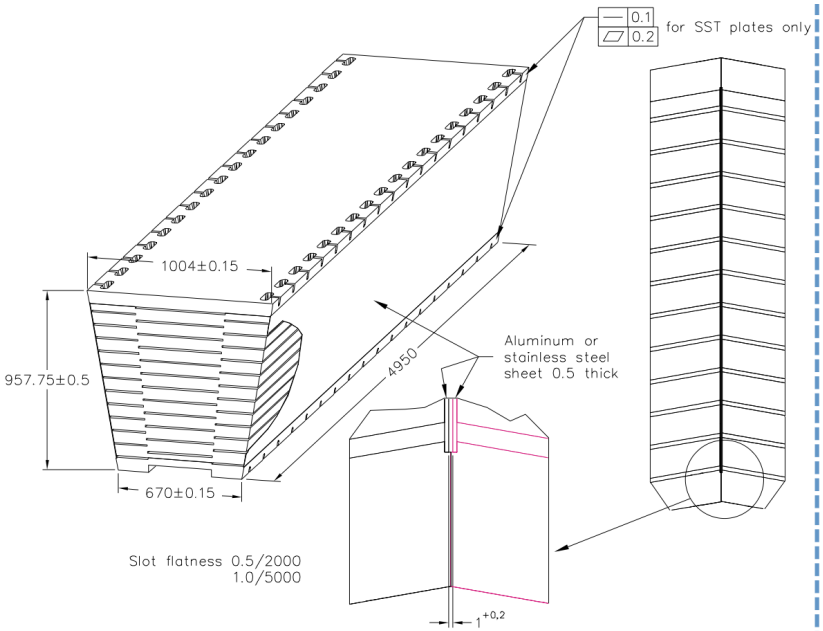
I will focus on three major efforts:

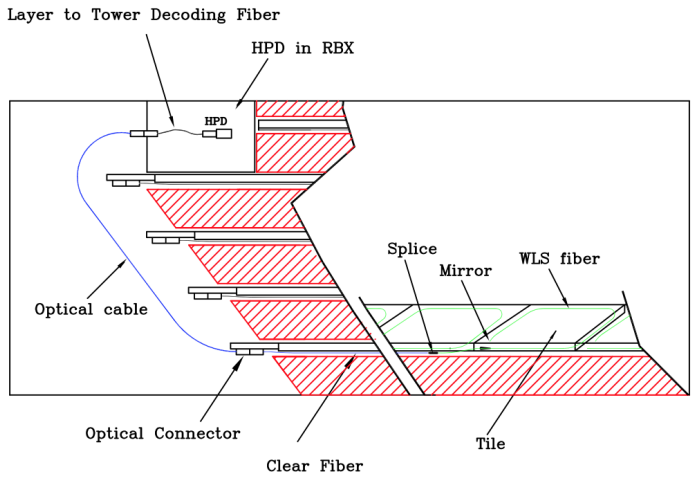
1. HB sourcing
2. HF commissioning
3. Laser commissioning

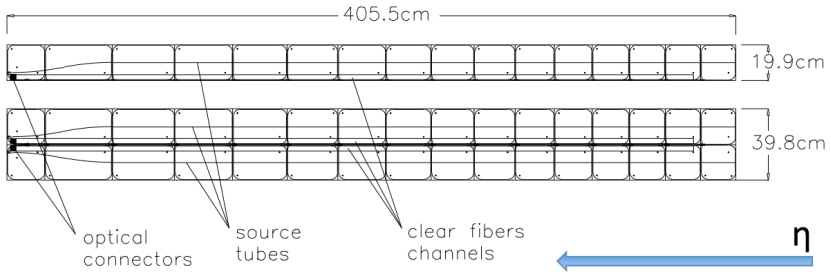
Section 2

HB sourcing

What is sourcing?







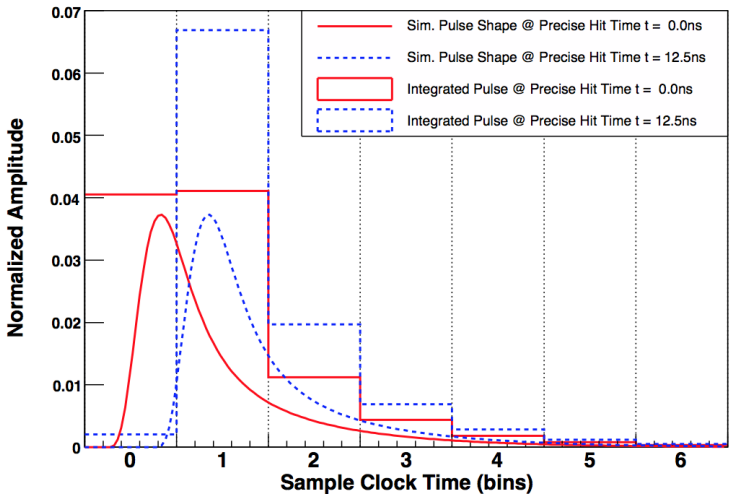
One layer of a typical HB wedge.
Source tubes go along eta.

Why sourcing?

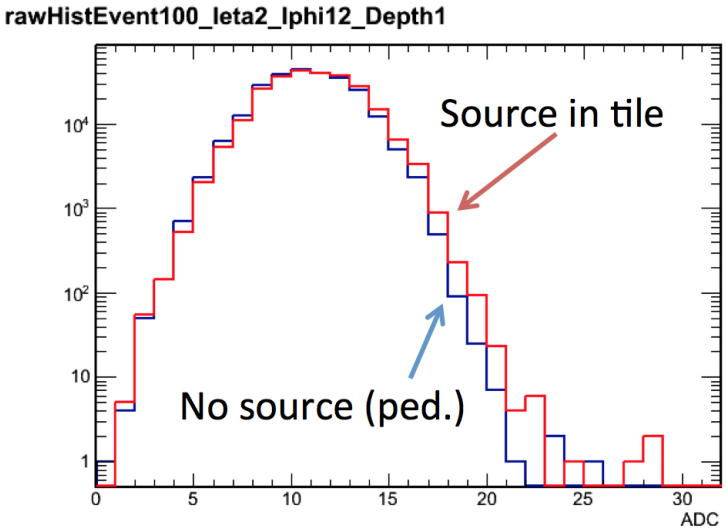
- HF: PMTs are being replaced, so sourcing old and new PMT readouts can give us first calibrations
  - Sourcing done
  - Analysis ongoing
- HB/HE: Study radiation damage, comparing with sourcing before Run 1
  - Laser in HB only probes 1 layer (9)
  - Laser in HE only probes 2 layers (1, 7)
  - Sourcing can probe all layers and look for layer-dependent radiation damage
- Focus of this discussion is HB sourcing
- Sourcing contact: S. Cooper
- Analysis contact: A. Gribushin

Sourcing analysis

Normal HF output (same principle for HB)



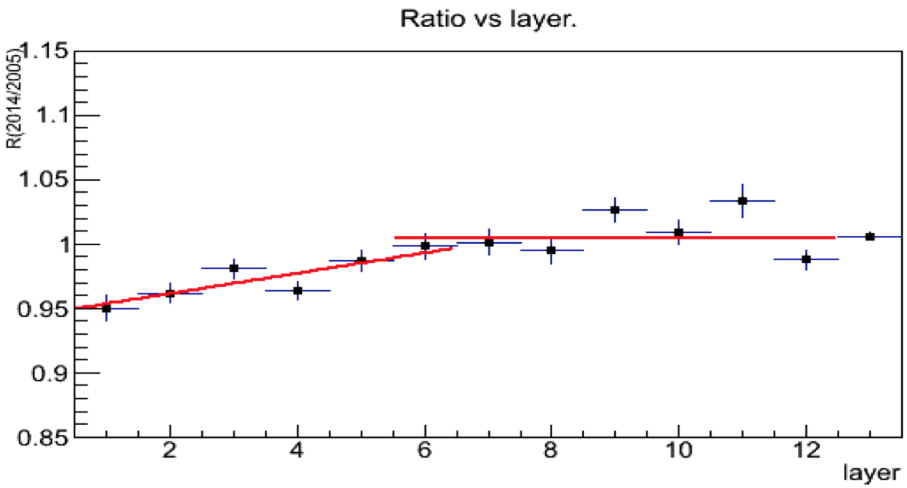
Histogram output for sourcing (from HCAL HTR FW)



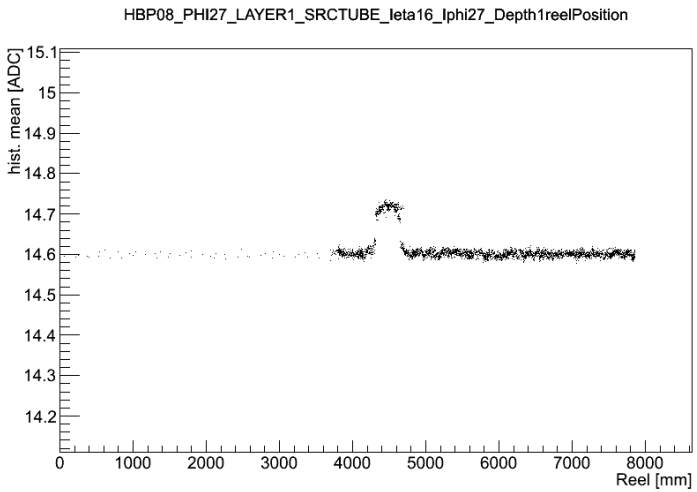
- Normally, DIGIs are read out at 40 MHz
- Source signal is small, so fill histograms at 40 MHz & read histograms at O(100) Hz

Sourcing analysis

Ratio of 2005 vs. 2014 sourcing from first 2014 HB sourcing



Example sourcing signal from latest 2014 HB sourcing



- First HB sourcing campaign suggests layer-dependent radiation damage of approximately 5%
- Latest HB sourcing campaign adds 4 more HB wedges: analysis ongoing

Section 3

HF commissioning

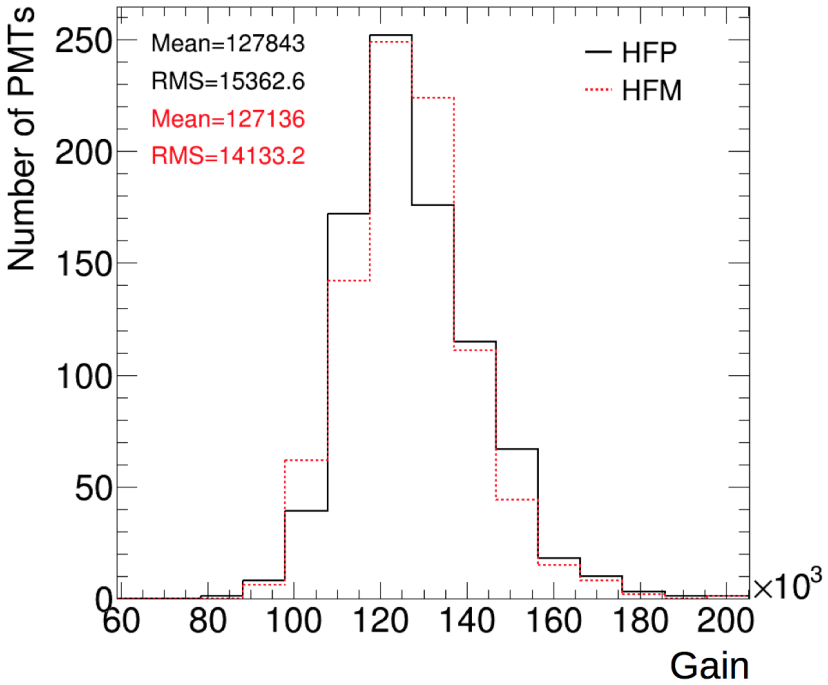
What improvements have been made to HF?

- Why change?
  - Punch-through
  - Cerenkov light in PMT glass
- What has changed already?
  - New PMTs: thick glass & single anode $\rightarrow$ thin glass & multi-anode
  - New readout cables capable of 2-channel readout
- What is still coming?
  - Upgrade of HF backend uTCA readout (review today)
- Analysis contact: K. Bierwagen

What improvements have been made to HF?

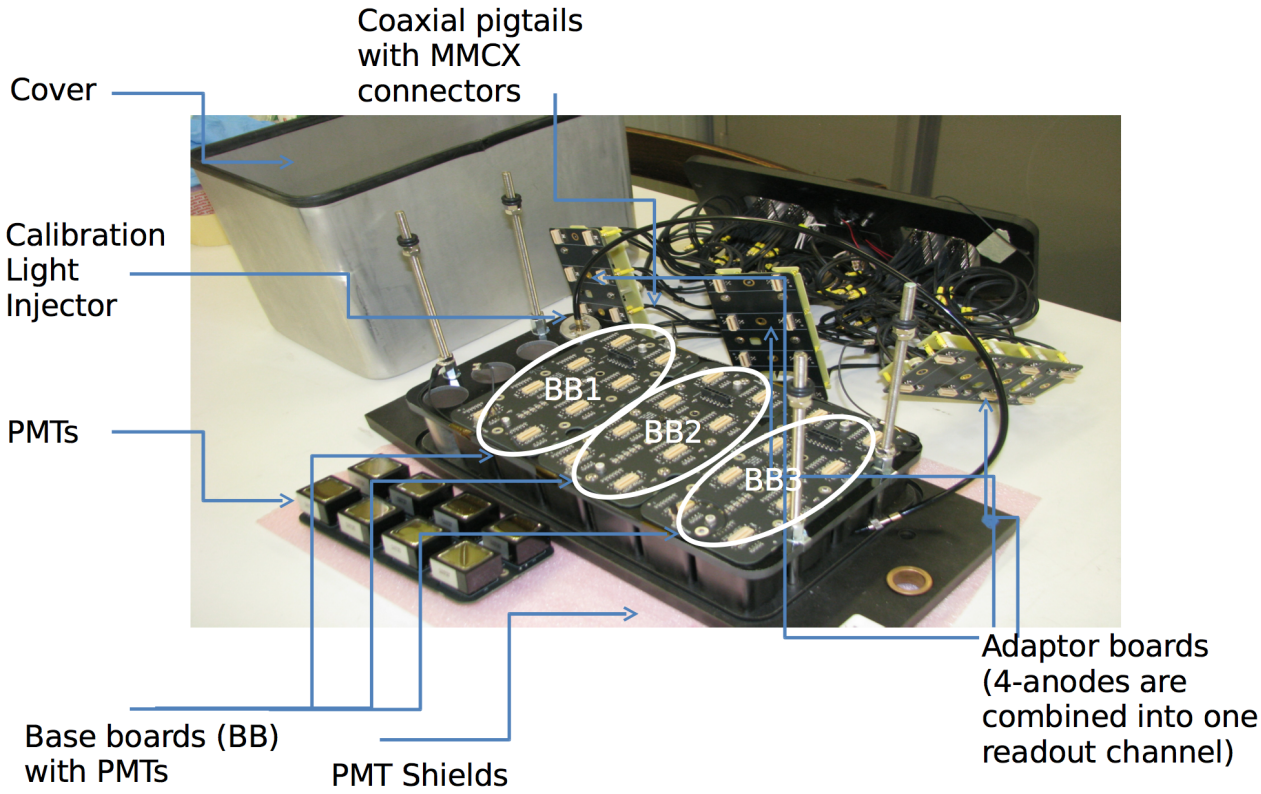
Item	Status	Completed by
PMT qualification	DONE	01/05/2013
Robox components test	DONE	01/05/2013
Robox refurbishment & test	DONE	20/12/2013
Robox sign off	DONE	31/03/2013
Cables delivery/test • Long Cables • Pigtails • Adaptor cables	 DONE DONE DONE	01/03/2014
On detector installation • Robox • Cabling	 DONE DONE	 08/04/2014 13/06/2014
Infrastructure • Cable trays • LV system reorganization • HV system	 DONE DONE DONE	 17/04/2014 13/06/2014
• HFP installed/readout • HFM installed/readout	DONE DONE	01/03/2014 13/06/2014

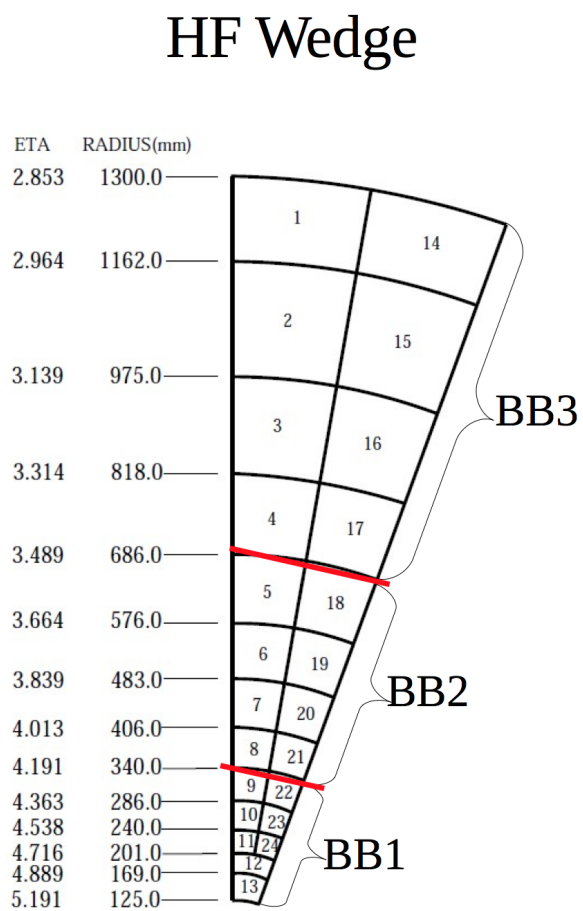
HF analysis: LED gain measurement



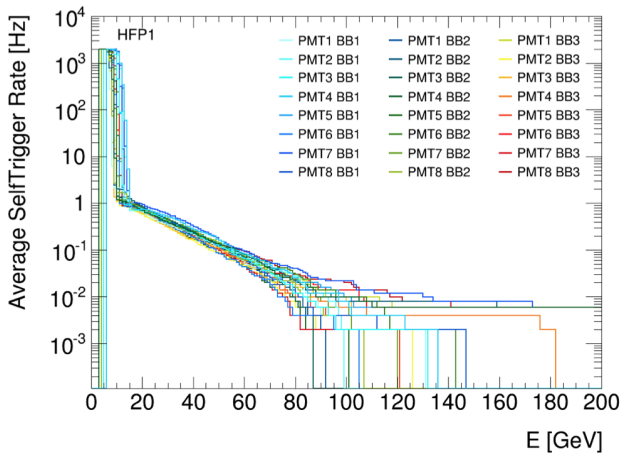
- Mean gain: ~127k
- Gain RMS: ~12%
- Saturation: ~8 TeV

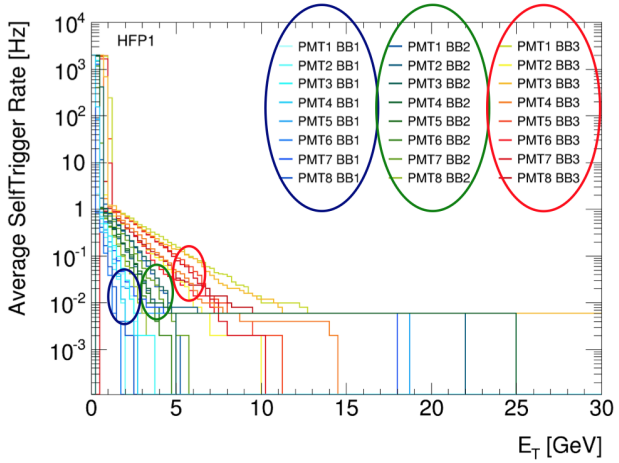
PMT base board (BB) groupings



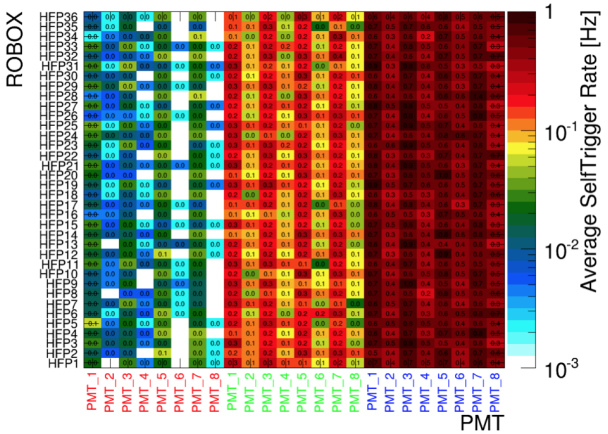


HF analysis: self trigger rate

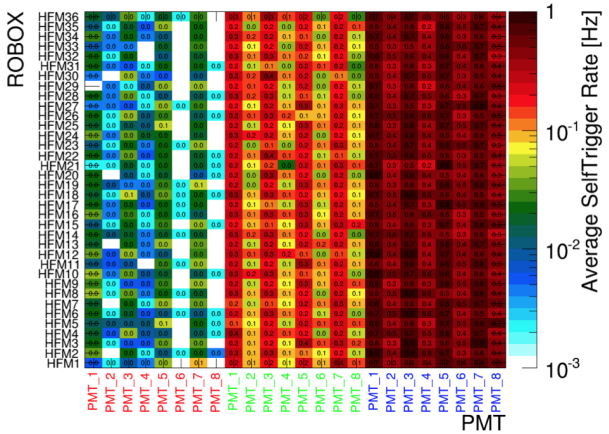




HFP



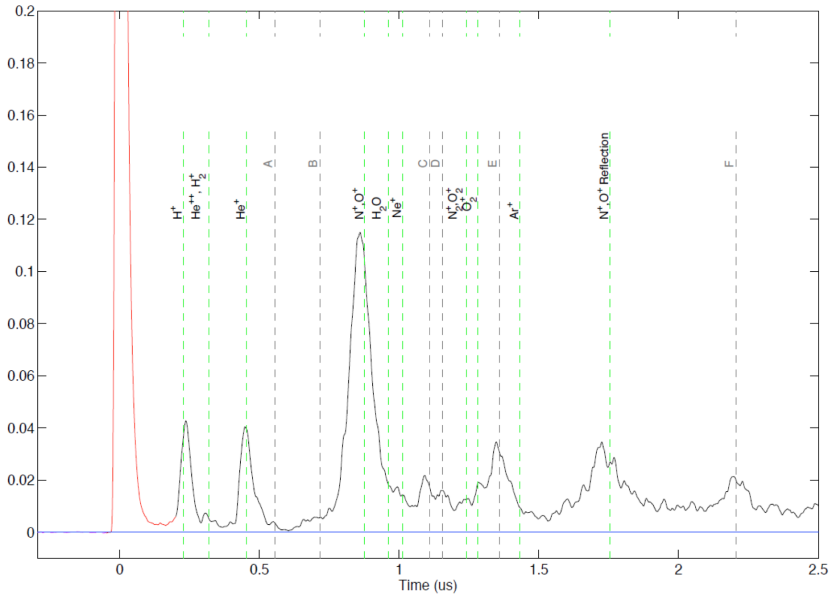
HFM



HF analysis: after pulse rate

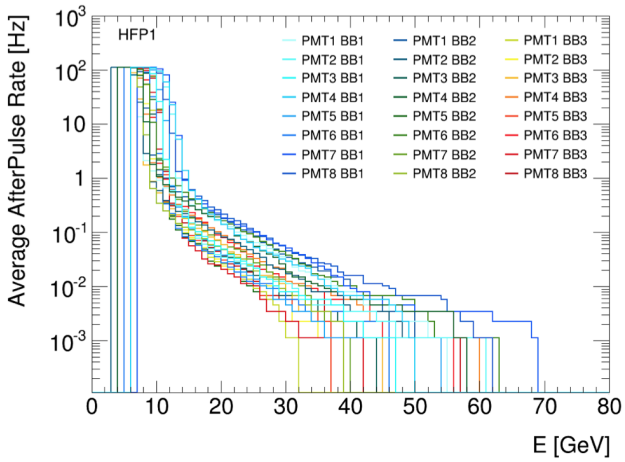
- After pulses (APs) are spurious pulses which appear in the tail of real pulses
  - Elastic scat. e's → APs with short delays
  - Positive ions → APs with long delays
- Look for APs within 0.25 us and 0.5 us by studying 20 TS
  - Inject light in 1st 10 TS
  - Look for effect in 2nd 10 TS

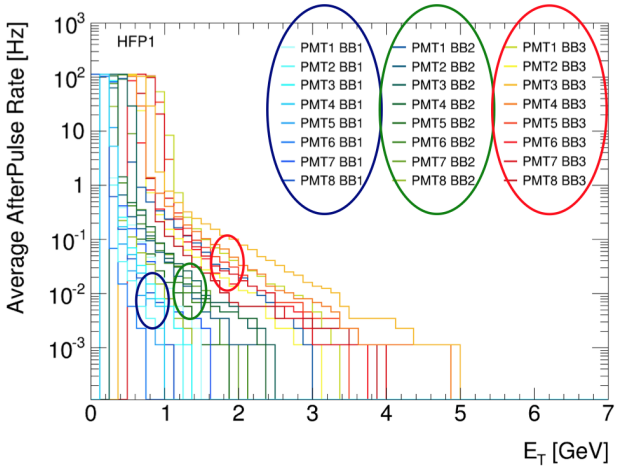
Theoretical picture

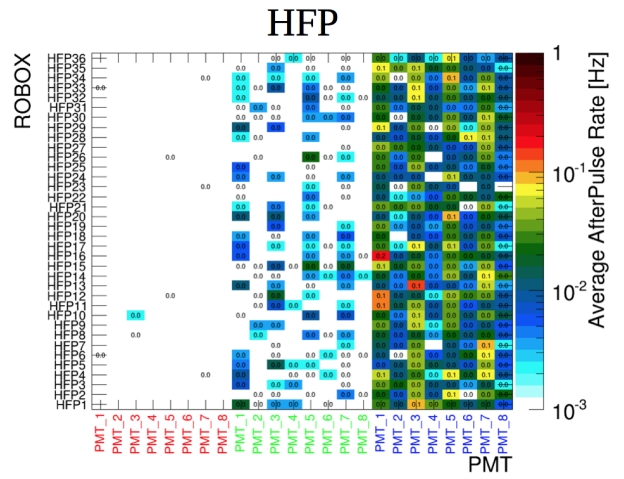


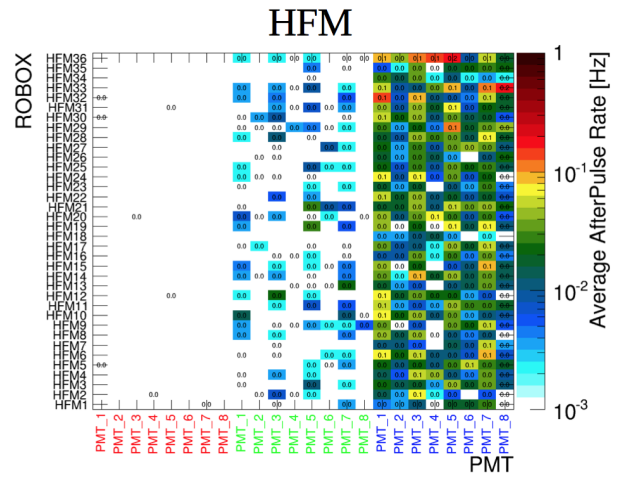
C. Faham

HF analysis: after pulse rate









HF analysis: rate numeric results

- Self trigger rate (thr. ET = 2 GeV):
  - ~8 Hz for BB1
  - ~90 Hz for BB2
  - ~320 Hz for BB3
- After pulse rate (thr. ET = 2 GeV)
  - ~0.02 Hz for BB1
  - ~1 Hz for BB2
  - ~14 Hz for BB3

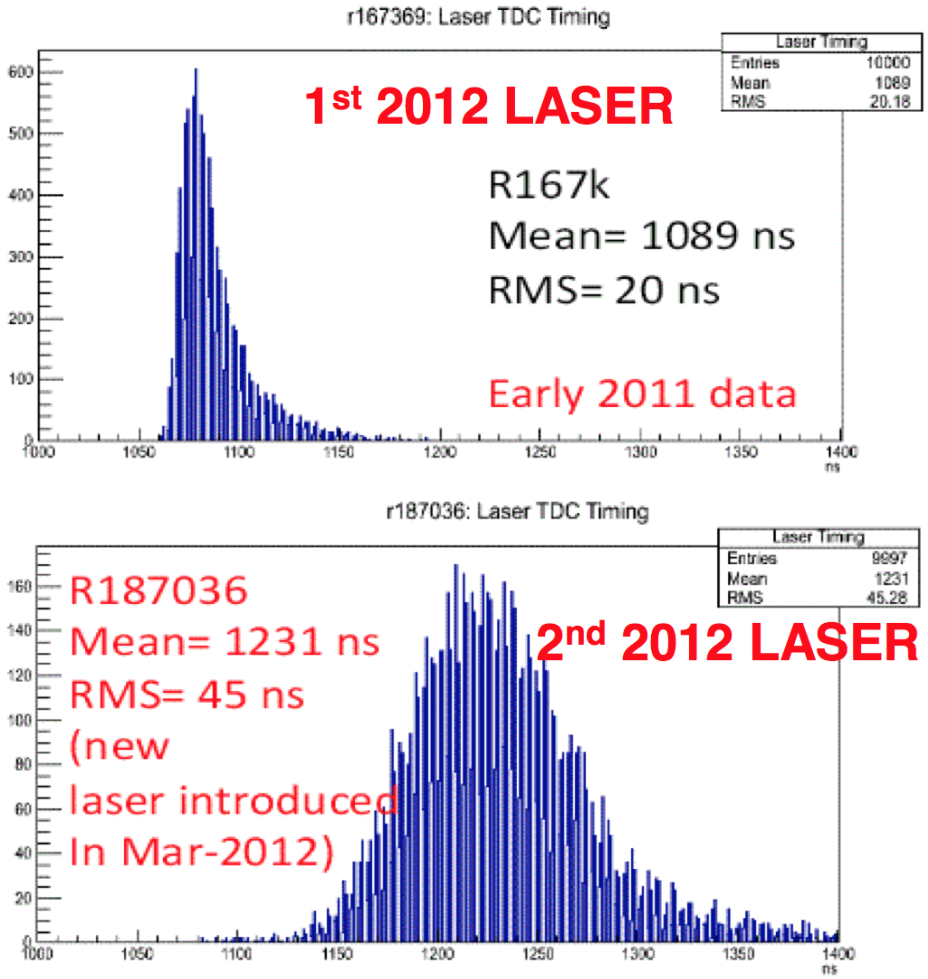
Section 4

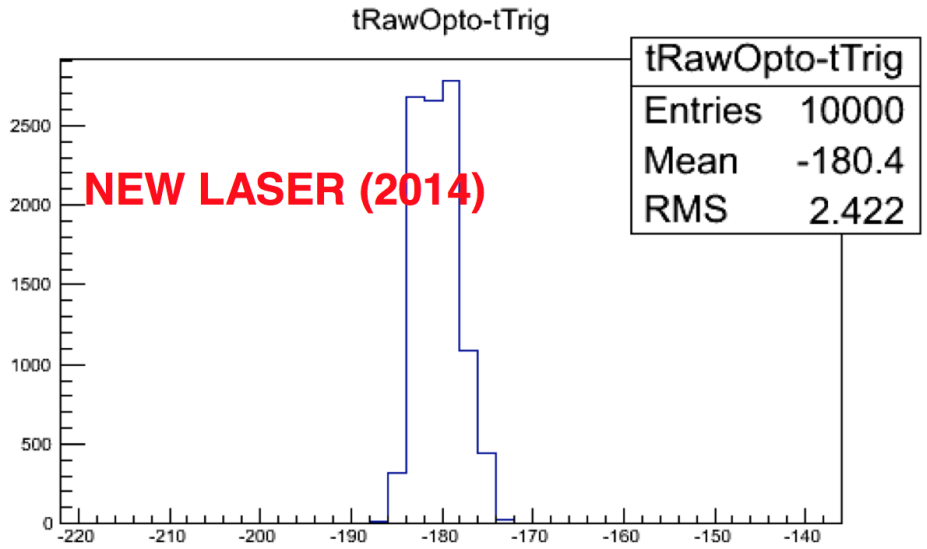
Laser commissioning

Introduction to laser commissioning

- HCAL laser can track radiation damage (RADDAM) in the HBHE and HF (critical in R1)
- Laser light to megatiles excites scintillator of a particular HCAL layer
- Laser pulse is timed to simulate actual time calorimeter signals arrive from particles produced by pp collisions at the center of CMS
- New laser installed for 2014 to improve timing resolution
- Analysis contact: D. Vishnevskiy

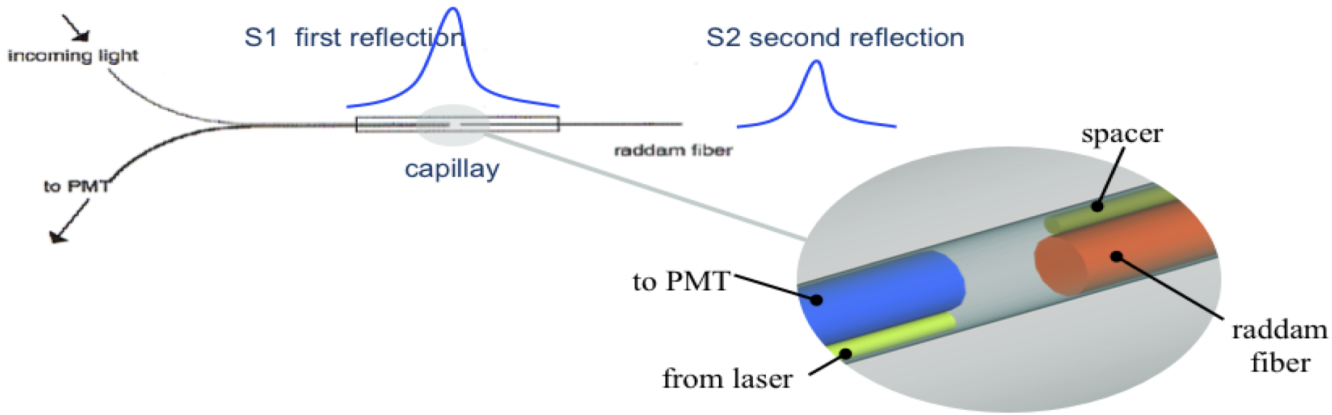
Timing improvement of new laser (HF shown)





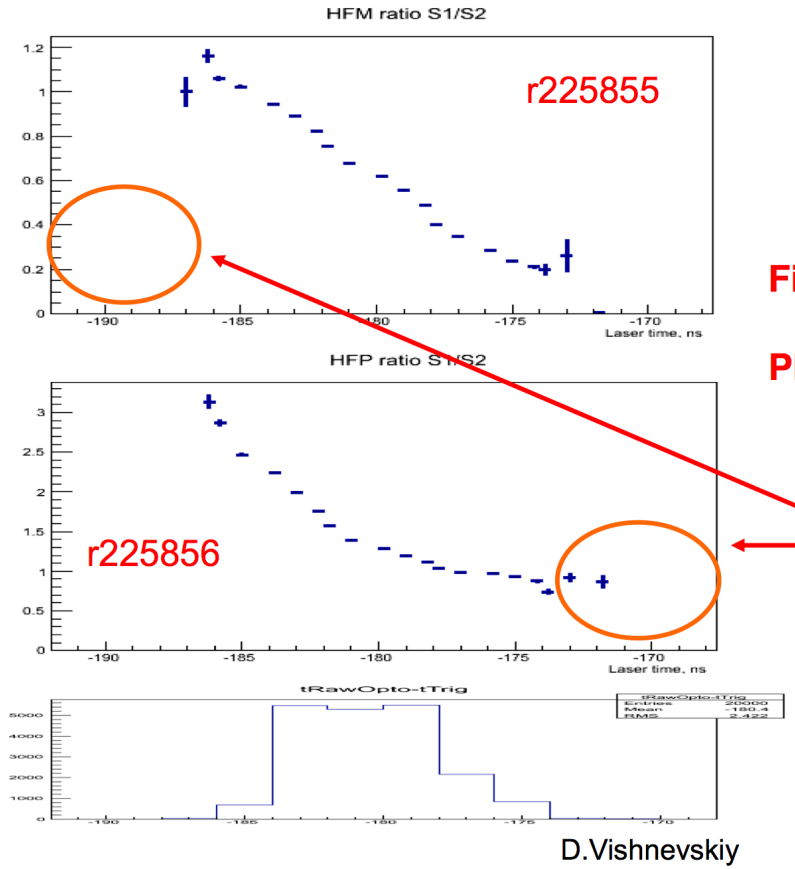
- Old laser: unstable timing and jitter
- New laser: ~2.4 ns jitter
- Stability is being monitored

Radiation damage monitoring



- Principle of RADDAM monitoring is to measure S1/S2
- S1/S2 varies as a function of phase (laser - TTC)
- Need to find a region of phase where S1/S2 is stable

Phase scan needed



- Lack of plateau region shows laser is not timed in
- Phase scan needed

Section 5

Conclusion

Partial to-do list

1. Complete sourcing analysis
   - start-up calibration of HF
   - better understanding of radiation damage in HBHE
2. Complete commissioning of Laser
3. Continue taking/analyzing reg. local commissioning runs

Conclusion

- HCAL has been very busy over the last few months
- These slides discuss three important campaigns (among others):
  - Analysis of HB sourcing data has already yielded interesting results. More analysis is coming.
  - HF installation and commissioning is finalized, and basic detector parameters have been established. These include two PMT effects, which contribute extra energy to the event
  - A new laser with significantly improved timing resolution is being commissioned