



HF NEW PMT R&D PLANS AND SCHEDULE



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- HF PMT Upgrade R&D Group:
- **Iowa, Fairfield, Fermilab, Maryland, Trieste**
- Extended Group for HCAL Upgrades:
- **Boston, Minnesota, Princeton, Virginia**

HF UPGRADE STATUS

The HF is integral to the use of calorimetry to identify tagging jets, missing Et and luminosity. HF is stand-alone. There is no Tracker or Ecal in front, no muon system behind, and only 2 quite non-independent segmentations. Furthermore, the DAQ system does not even remotely make use of most of the raw performance characteristics or most of the information published by the PMT - fake events are obvious on an oscillograph. Reducing the fake events is therefore crucial.

A primary source of fake events is expected to be due to interactions in the PMT windows. We have studied two candidate PMTs to reduce the rate of such interactions – a thin window single-channel PMT and a thin window four-channel tube. Both tubes were extensively studied in the 2009 test beam program, and both will reduce the fake interaction rate significantly. Multi-channel readout of the four-channel tube provides additional powerful handles for background rejection but full implementation will require the Phase 1 upgraded electronics. Since the light is completely mixed from the incoming fiber bundles, all four channels see the same signal from the calorimeter, but different signals from the windows. With the four channels ganged into one, we expect the four-channel tube to perform very similarly to the single channel. Ganging into two or more outputs allows window interactions to be easily identified.

HF UPGRADE STATUS

Our preliminary analysis shows that:

- **The raw background signal through the window is at least 2-5 times lower (up to 10 times in the tail) than that of the existing PMT--> this is consistent with the glass thickness profiles of the PMT's**
- **The quad anode configuration allows vetoing events through the window by at least x10 rejection. Three anodes similar, 1 anode high**
- **The signal size of the ultra-bialkali candidate is at least 2.0 x the signal of the existing PMT.**

CMS DN 2009/011, CMS DN 2009/012, CMS NOTE 2009/XXX (draft)

HF UPGRADE STATUS

To gain further experience we propose in FY2010 to develop a prototype package for the four-channel tube. This will allow system studies, and put the project in a position where we could perform in-situ testing at P5 should this be deemed necessary, and proceed rapidly to fabrication if the background rates are found to be unacceptable. This prototype package would contain eight PMTs, which forms one unit of the power distribution system.

The decision path in 2010 would then consist of:

- 1. Develop, build and operate the 8-channel unit with both single and double-channel readout capability in FY2010**
- 2. Measure the fake rates under collision conditions at P5 with the present PMTs, and determine the severity of effects on physics**
- 3. Decide whether to request CMS to allow deploying the prototype 8-channel unit at P5. This would allow a detailed comparison with existing tubes in the real environment. Note that the change over will take only 1-2 days.**
- 4. Decide whether to replace existing PMTs with single channel or four-channel PMTs. The replacement would be in FY2011**

HF UPGRADE STATUS

- **We will prepare an 8 tube set for plugging into an RBX (R7600U-200-M4). We have recently ordered the PMTs and bases due to long delivery schedule.**
- **Ianos Schmidt has started to work on the design of RBX.**

In order to develop additional benefits possible with the four-channel PMT as part of the HCAL Phase I upgrade (comparing signals in two channels, and improved timing) we would like to do the following R&D in 2010.

- (a) The design of hardware/software to implement a rejection/correction algorithm of the HF towers using 2 or more photodetector channels per lightguide, to go in before the trigger inputs (i.e. in a 10-15 ns latency).**
- (b) At least 8 channels of waveform digitization implemented with commercial 2 GHz, 400 MHz BW 10+ bit modules during first beam- this could utilize a new PMT box with the last dynode signals used to drive the WFD w/o any changes in the present DAQ stream on the anodes.**

HF UPGRADE STATUS

We have requested funding from M&O (fix) and Phase I (upgrade) through HCAL Manager. This is consistent with the CMS UMB approval of this project in May 2009.

The UMB recommends approval of proposal 09.02. As part of this approval, the UMB provides the following guidance for the research program of these two proposals.

The Phase 1 Research of Proposal 09.02 for upgrade of the HF PMTs should receive the highest priority due to the potential contingency that the HCAL M&O program may need to leverage results from this R&D. This priority extends to the necessary readout and infrastructure, including the retrofit of the HF readout box, to mount and operate these PMTs in the present HF environment and to beam and radiation tests sufficient to ensure reliable operation in the LHC design environment.

Status and Timeline for HF PMT Replacement

- Proposed HF Upgrade schedule for PMT replacement:

	<u>Date</u>	
Tests at FNAL MTest	April 2009	✓
Tests at H2 CERN	July 2009	✓
Order Components (PMTs, bases, etc.)	Oct. 2009	✓
Modify/Build a PMT Box	Dec. 2009	✓
Replace PMT Box in a HF Wedge	Jan. 2010	
Take data with 1/3 PMT Box	Spring 2010	
Order PMTs (2 months lead time)	May 2010	
Test the PMTs in Iowa, Fairfield, Maryland	Until 2011	
Deliver PMTs and RBX to CERN	March 2011	

Pending analysis of collision data and CMS approval

Status and Timeline for HF PMT Simulations

Finalizing shower parameterization	Nov. 2009
Correcting the energy scale for PMT events	Nov. 2009
Comparing HF PMT simulation with TB04	Nov. 2009
Generating physics samples	Dec. 2009
Detailed analysis with physics samples	June 2010
Detailed study for trigger effects	Dec. 2009
Making official code release	Jan. 2010
Studies with collisions data	Jan. 2010 - June 2010