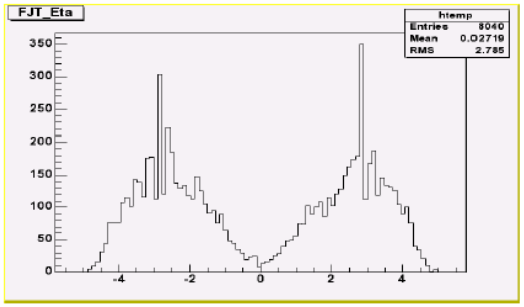
HCAL HF

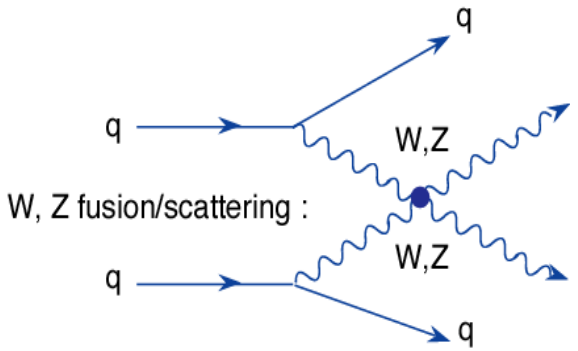
Summary

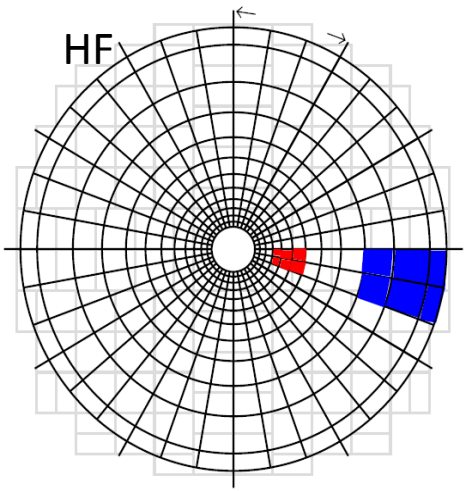
FNAL October Upgrade Workshop

HF Basics

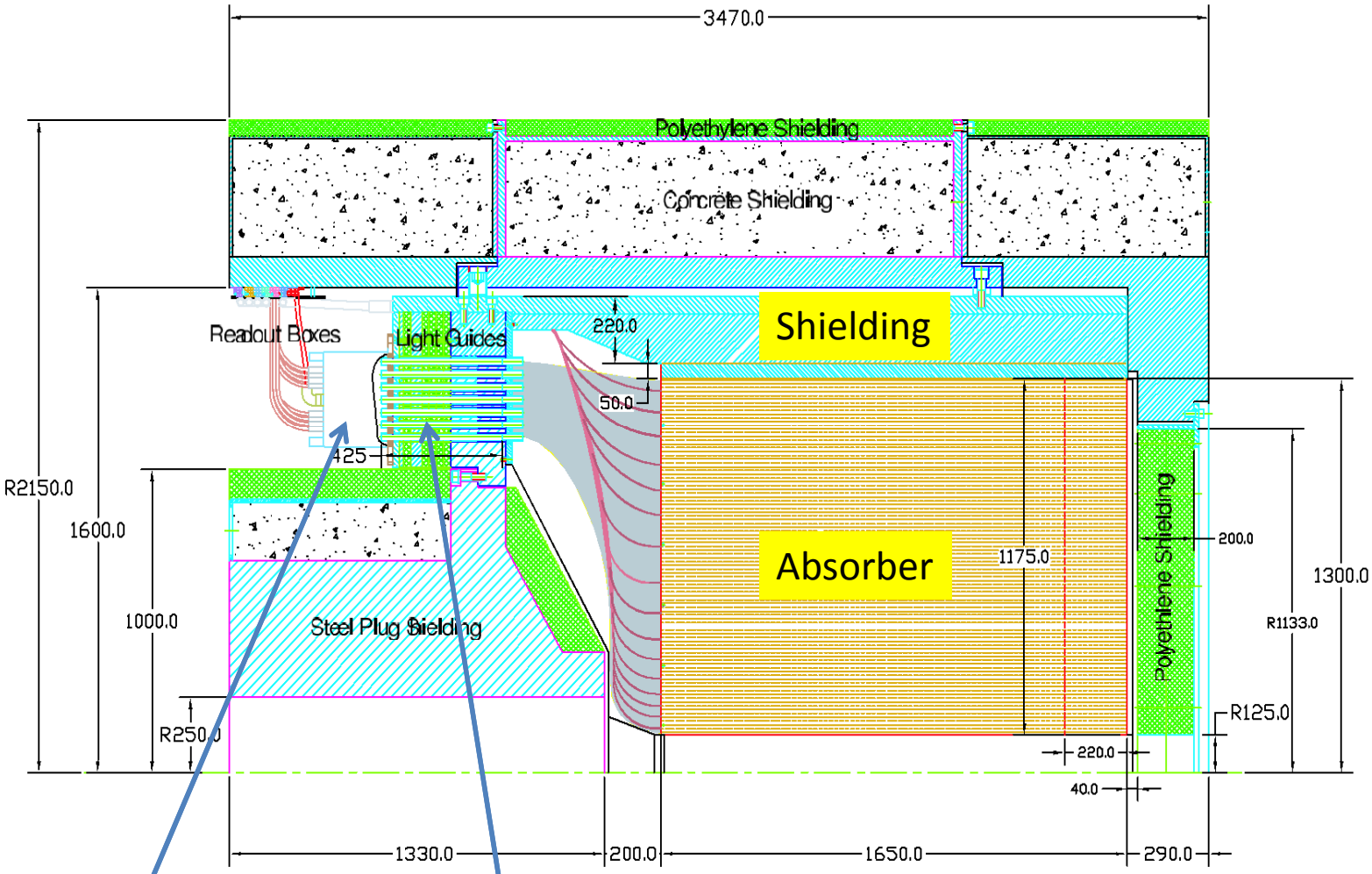


- HF covers ~3 < η < 5
  - WBF forward partons peak at η ~ 3!
- Steel absorber and rad hard quartz fibers
  - Cerenkov light collected via phototubes, uniform HCAL re
- 36φ and 12η = 432 towers per side
  - Δφ=10° and Δη=0.166
- Each tower has a long and a short fiber running along z
  - Short is in the back ~ "ET_{HAD}"
  - Long is front to back ~ "ET_{EM+HAD}"
  - Makes 2x432=864 towers per side
- Level 1 Trigger and HF
  - TPGs are built inside HTRs for HF and transmitted to RCT, pass through to GT
    - Combines 2φ x 3η = 6 towers = 1 trigger primitive (TPG)
    - Δφ=20° and Δη=0.5



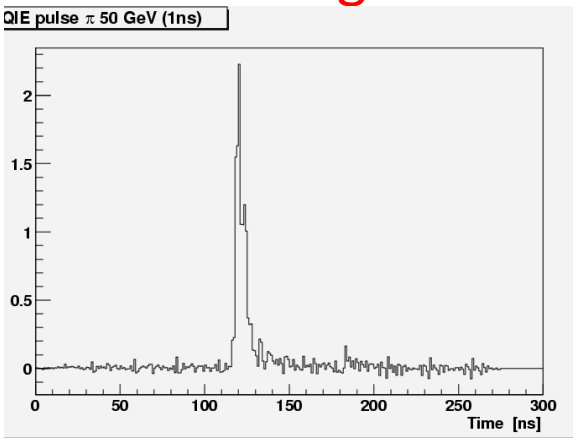


My HF


3470.0
Polyethylene Shielding
Concrete Shielding
Shielding
Readout Boxes
Light Guides
220.0
50.0
425
R2150.0
1600.0
1000.0
R250.0
Absorber
1175.0
Steel Plug Shielding
Polyethylene Shielding
200.0
1300.0
R1133.0
R125.0
220.0
40.0
1330.0
200.0
1650.0
290.0
IP
PMT/Readout
Light Guides

In a Nutshell

- HF will withstand Phase 1 with no trouble
  - The device is inherently radhard
- However, there will be significant pileup
  - Note on current HF:
    - Quartz fibers produce a pulse that is quite fast with $\Delta t<25ns$
    - But there is no capability in current HF to measure time of arrival
  - At higher luminosities we will be measuring rare processes, and need to have handles on non-bx-related backgrounds
  - Therefore we are considering whether we can add a timing capability to HF by piggybacking on the HB/HE FE electronics effort.
    - Would make for a better device to do physics!



Summary of Phase 1 for HF

- If it makes sense to add timing…

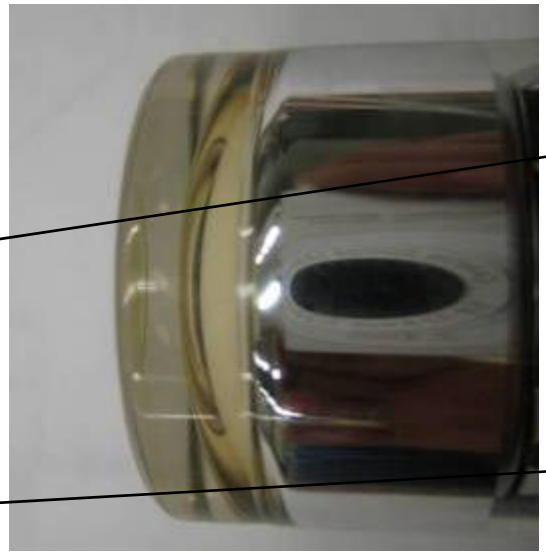
…and if the HB/HE FE effort yields electronics,

we can apply this to HF

  - We will be therefore have to understand the time profile of what we see in HF

“PMT Window Events”

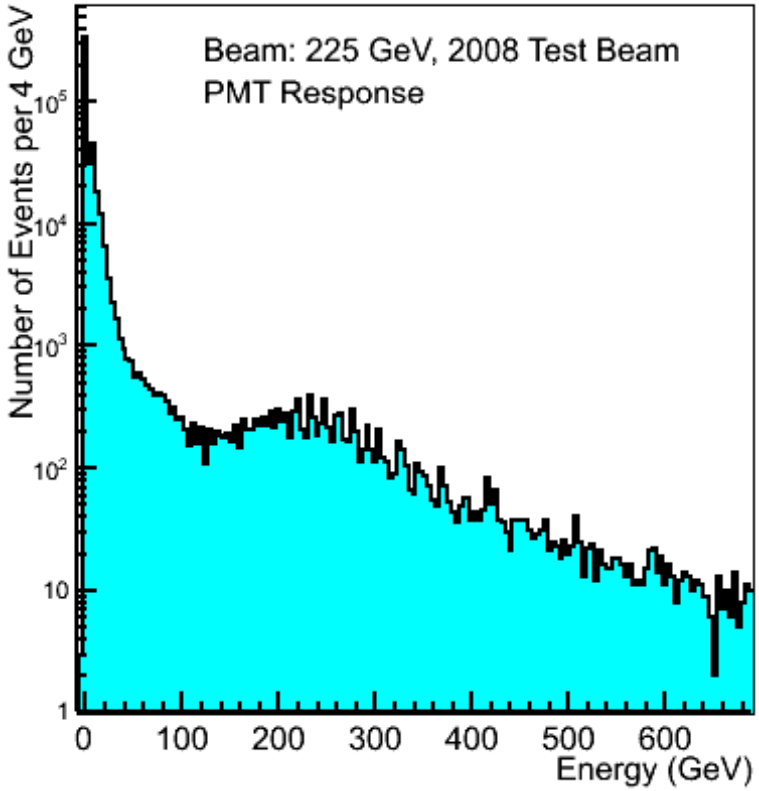
- Cerenkov light from charged particles radiating in the PMT window (aka “PMT window events”) has a lot of attention



Window Events

- There are 2 components
  - "Peak" at ~30 γ's, ~150 GeV in energy, rate ~10^{-2-3}
    - Going through the glass at normal incidence
  - Long tail going up to TeV energies, another factor ~10 drop in rate
    - Going through thick part? Multiple particles? Charge exchange? TBD
- Events in the peak <10 GeV ET outer rings
  - But will make MET suffer
- Events in the tail ~100GeV or more
  - Risk that these will trigger
- We might be able to handle some of this in the HTRs where we make the TPG TBD…

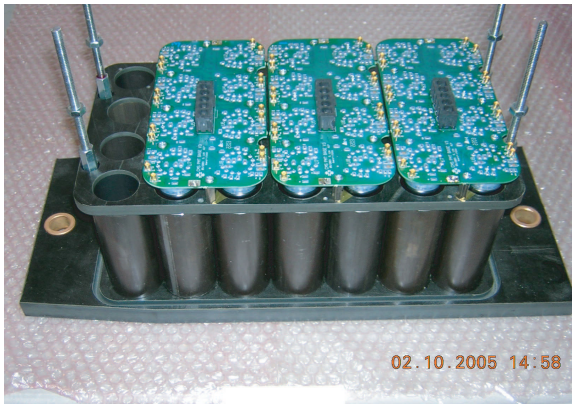
But we would do well to not have this exposure, and we need handles

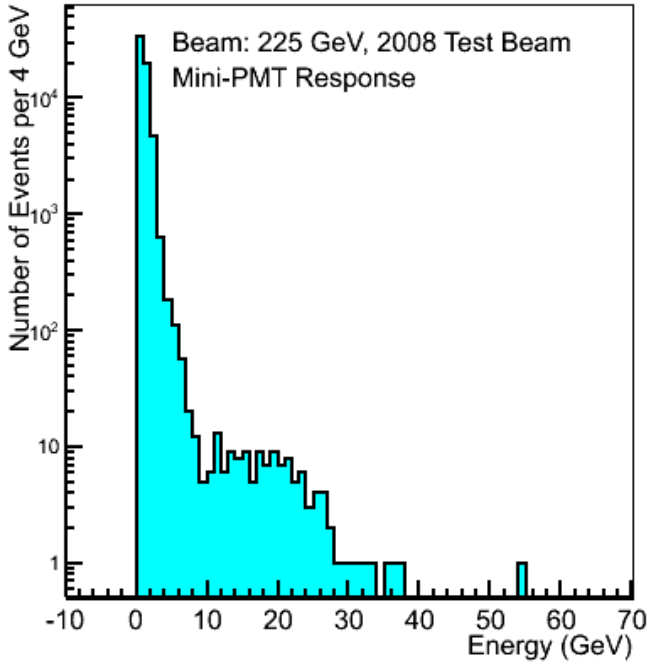


Plan of Attack

- Consider new PMTs "MiniPMT"
  - Thinner window, metal sides
    - This means fewer photons from PMT window photons
  - Higher QE (almost x2)
    - Less GeV/photon calibration
- This solution is under study
- We will propose to put some of these new tubes in place in near future to compare to current tubes
  - Working on this now…

Type No.	Photocathode	Quantum Efficiency (%)	Typical Gain
R9880U-110	Super Bialkali	40	4.0×10^6
R7600U-200	Ultra Bialkali	43	1.0×10^6
R7600U-200-M4	Ultra Bialkali	43	1.3×10^6
R7525	Bialkali	25	5.0×10^5





PMT Window and Phase 1

- One of the possible new PMTs with multi-anode readout
  - This would allow increased lateral segmentation
  - Making use of this segmentation will allow additional firmware/software handles for this particular problem
- Necessitates sending x4 more data to USC55
  - Fits in nicely with increased transmission capability for HB/HE given SiPM/longitudinal segmentation
- Summary:
  - Timing considerations, and additional transverse segmentation, might mean upgrading HF front-end with new HB/HE front-end electronics
    - With the new 4-anode instead of single-anode PMTs

Phase 2?

- HF likely radiation levels:
  - 1Grad/year at the absorber for inner rings
  - 100kRad/year at the electronics
- Lots of discussion and thinking and proposing on what to do, e.g.
  - Replace quartz fibers?
  - Replace entire HF?
  - Run with a more limited pseudo-rapidity?
- Radiation measurements in next few years will be very important
  - And verification with computer codes

Luminosity	Ring 1-5	Ring 6-9	Ring 10-13
LHC (at 10^{34})	1 Mrad/year	10 Mrad/year	100 Mrad/year
Phase I (1.5 *10^{34})	1.5 Mrad/year	15 Mrad/year	150 Mrad/year
Phase II (3 *10^{34})	3 Mrad/year	30 Mrad/year	300 Mrad/year
SLHC (10^{35})	10 Mrad/year	100 Mrad/year	1 Grad/year