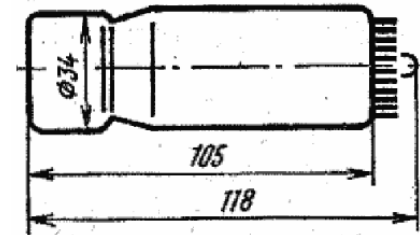# *SBS ECAL PMT Testing @ JMU Status Report*

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James Madison University

- ## *Lots of FEU-84 PMTs to test*
- ## *Reject defective tubes*
- ## *Measure:*
  - ### *Pedestal, Gain vs HV, Rel. Q.E.*

  - ### *After pulsing*
  - ### *Baking…*
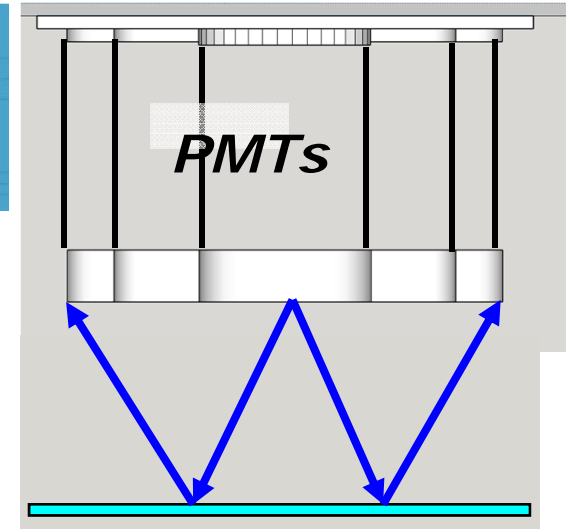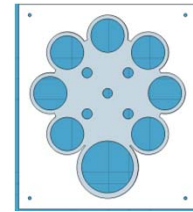
FEU-84 Specifications
Translation from Russian

Photocathode diameter	25 mm
Number of stages	12

FEU-84, FEU-84-1

Wavelengths of maximum sensitivity	420-480 nm
Cathode lumininous sensivity (300-350 V)	> 80 microA/lm
Anode luminous sensitivity (1700 V)	100 microA/lm
Cathode radiant sensitivity (694 nm)	>3 mA/W
Dark current	< 200 nA
Life expentancy	> 1500 h
Anode sensitivity after 1500 h	> 80 A/lm
Dark current after 1500 h	< 250 nA

FEU-84-3

Wavelengths of maximum sensitivity	420-550 nm
Dark current	< 50 nA
Signal to noise ratio ?	22

Maximum Ratings

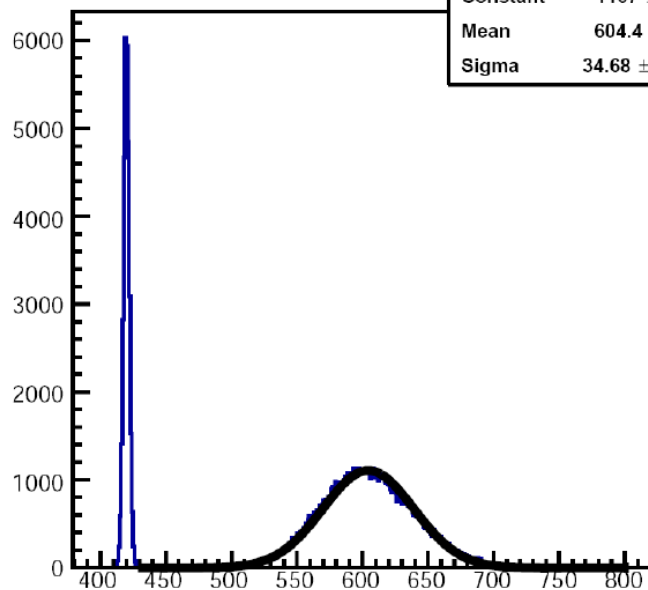|	
Max Voltage	1900 V
Max anode current	5 micro A

Testing Facility
(recap from last time)

⊕ *Gain vs HV (for several HV)*

⊕ *Relative Q.E.*
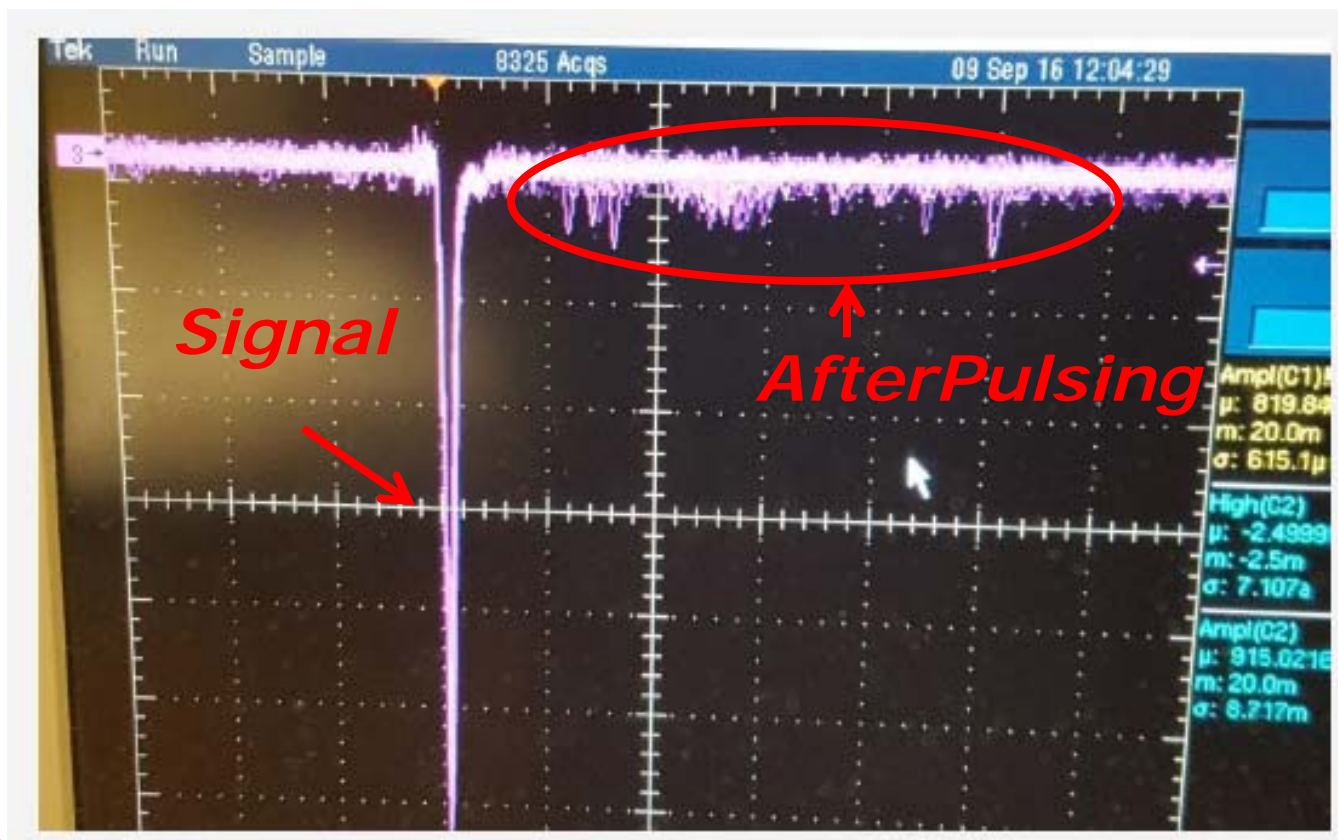
⊕ *ped. & signal in the same run*

⊕ *Automated*

PMTs

Gabriel *Meeting*
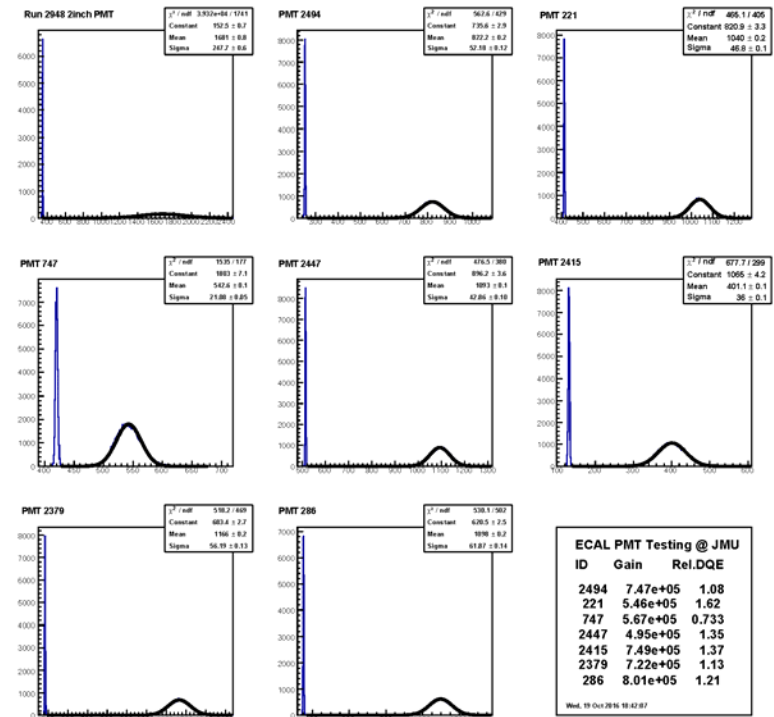
Afterpulsing

- As the tubes are not new there might be accumulation of foreign substances (gases) inside the tube
- If instead of electrons one accelerates an ion between the window and the first dinode one gets a delayed pulse
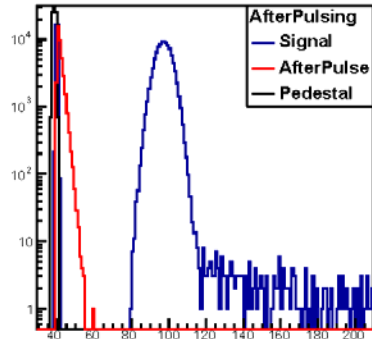- Thus AfterPulsing

Afterpulsing (II)

- *To quantify this phenomenon we produced a larger, delayed gate and acquired data with this as well (@1500V)*
- *Note: delay in the picture below is OK, width is NOT!*
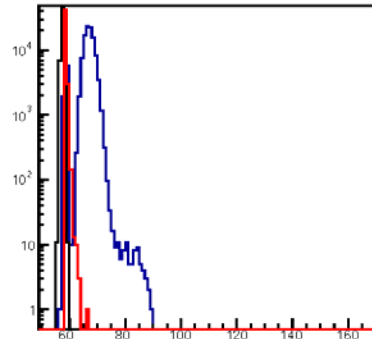- *Signal Gate (72 ns), A.P. gate (1 us) so 14x...*
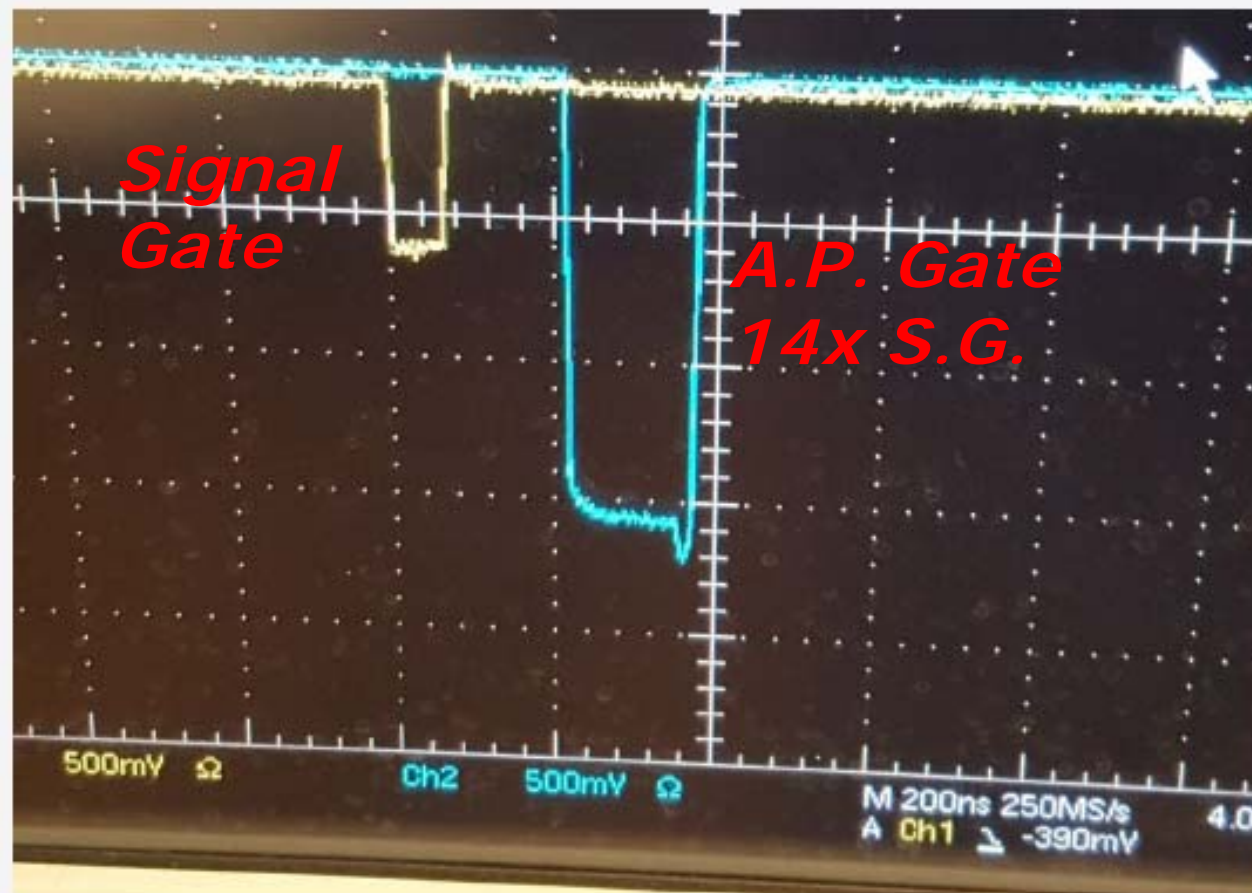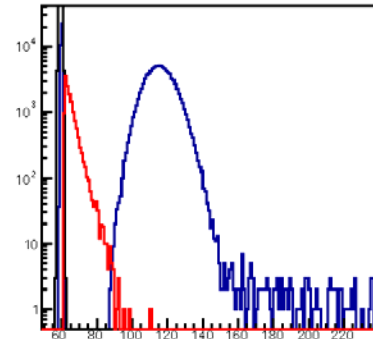
Afterpulsing (III)
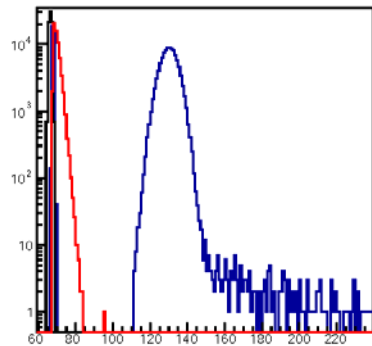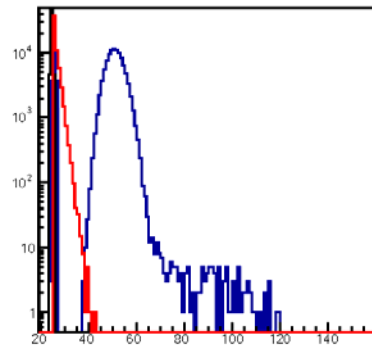
PMT 2663

AfterPulsing
— Signal
— AfterPulse
— Pedestal

PMT 2484

PMT 1654

PMT 1916

PMT 2604

PMT 2628
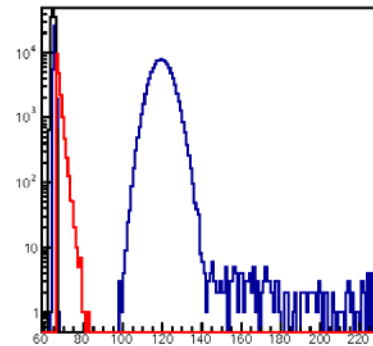
PMT 1188
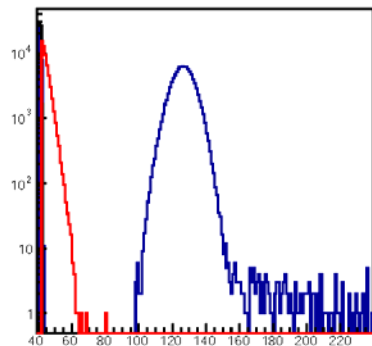
ECAL AfterPulse Testing
ID Count-Prob Charge-Prob.

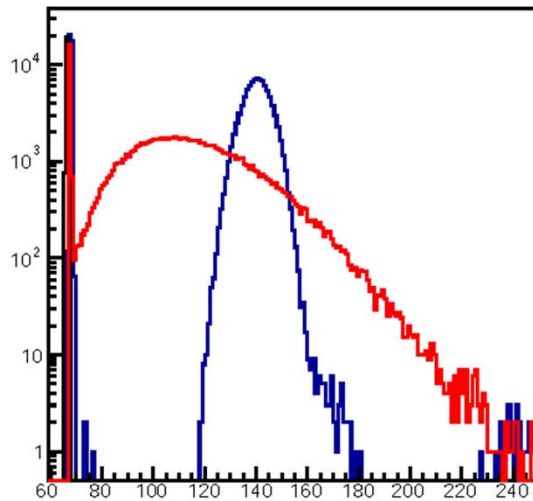| ID	Count-Prob	Charge-Prob.
2663	0.3613	0.0139
2484	0.0307	0.0038
1654	0.1404	0.0120
1916	0.5875	0.0234
2604	0.2211	0.0178
2628	0.1810	0.0065
1188	0.5520	0.0211

Wed, 19 Oct 2016 18:13:39

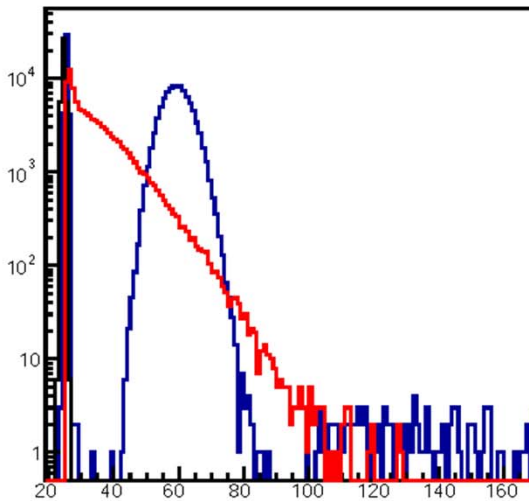⊕ *Note: Distributions were not scaled w/ the relative size of their gates!*
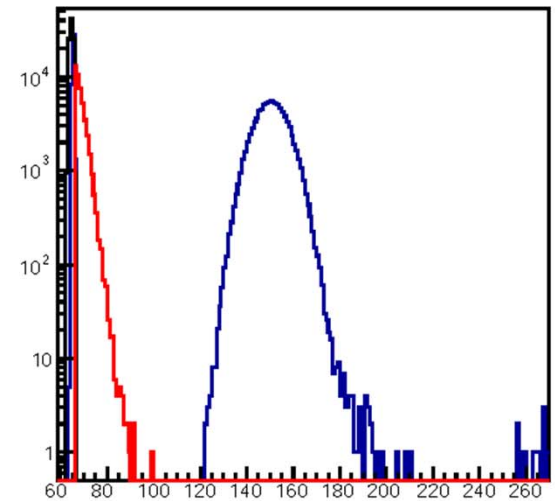
Afterpulsing (IV)

- Some tubes show really-really high afterpulse rates, as shown here
- If not for afterpulsing 2447 and 2379 above would be identical...
- We will test all tubes for afterpulsing!

Baking

- ✛ **As ECAL will function in a heated environment the question of the temperature influence on tube parameters was raised.**

- ✛ **To address this question we baked a subset of tubes for one hour @ 100 Celsius. Used a convection oven, calibrated with a thermocouple probe to ensure heating uniformity.**

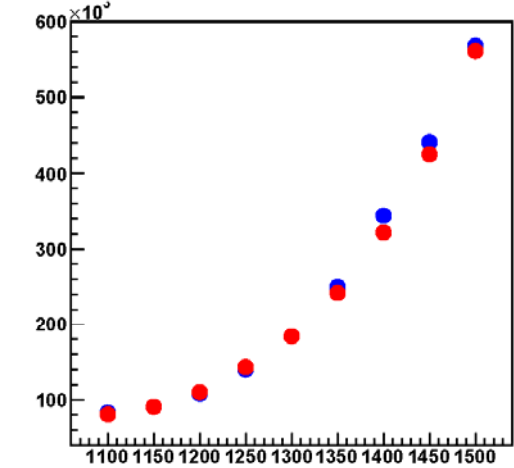- ✛ **After cooling the tubes were subjected to the same batch of tests as before.**

Baking (II)

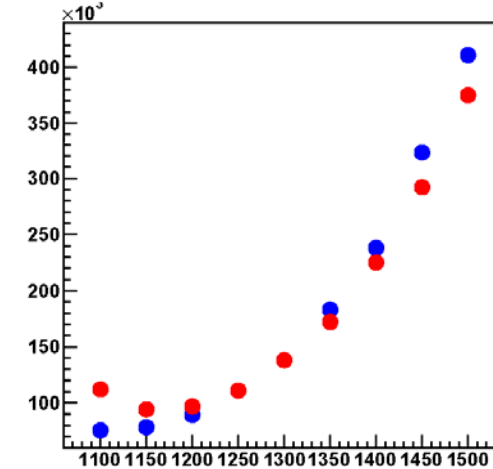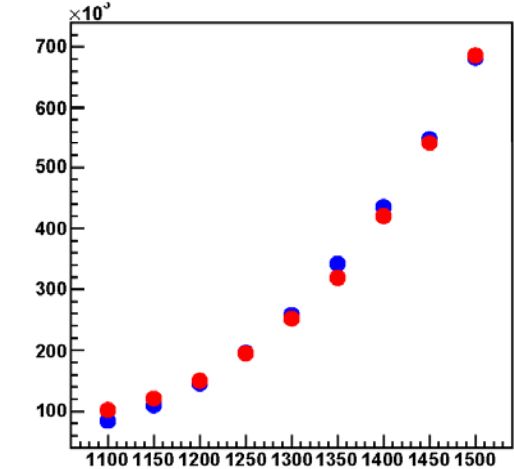⊕ *Sampling of four tubes Gain vs HV before and after baking*

Gabriel Niculescu, SBS Weekly Meeting
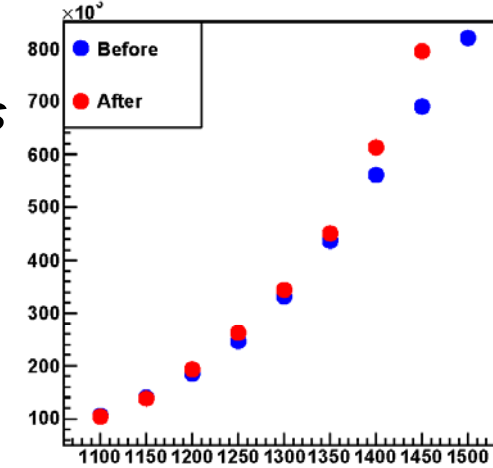
Baking (III)

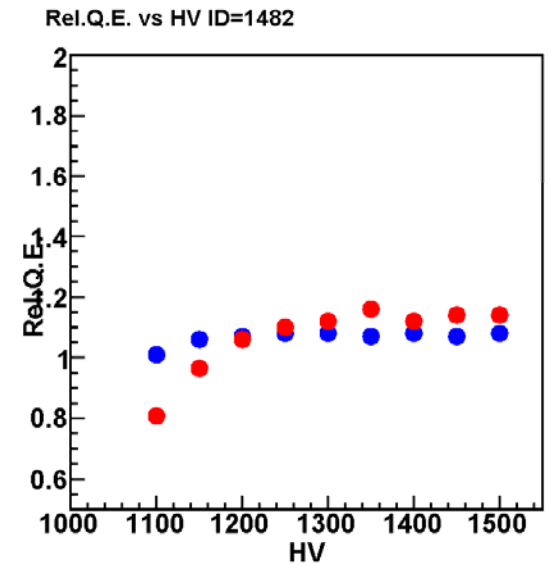Rel.Q.E. vs HV ID=1482
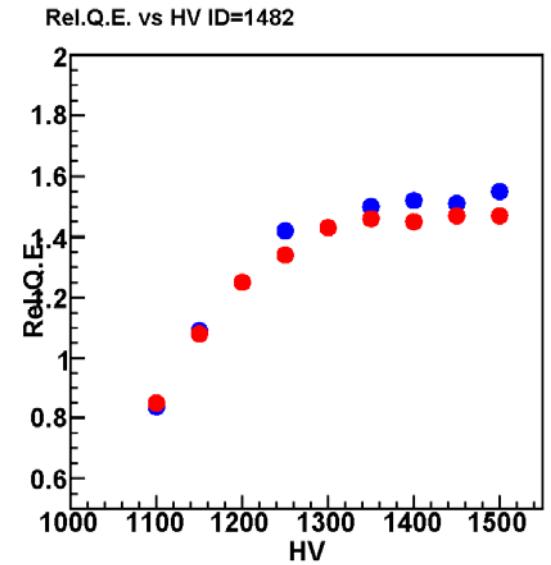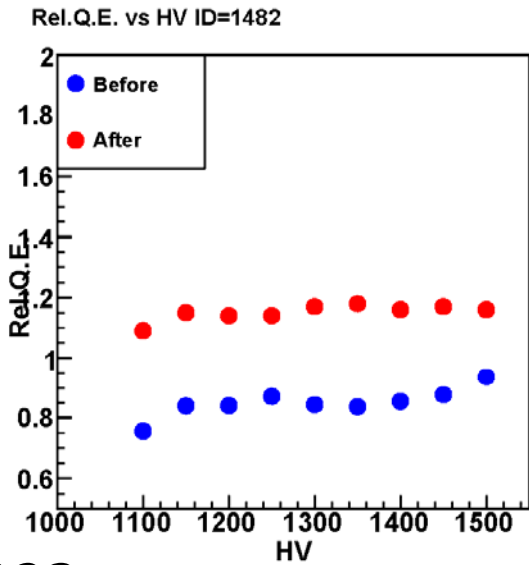
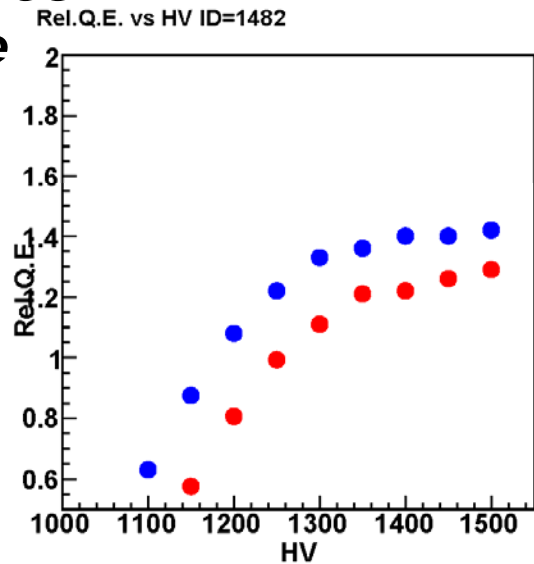**Sampling of four tubes
Rel. QE vs HV before
and after baking**

Baking (IV)

Baking Test, PMT 2639

AfterPulsing before and after baking

Legend:
- Signal (93389)
- A.P. Before (11542)
- A.P. Baked (43170)
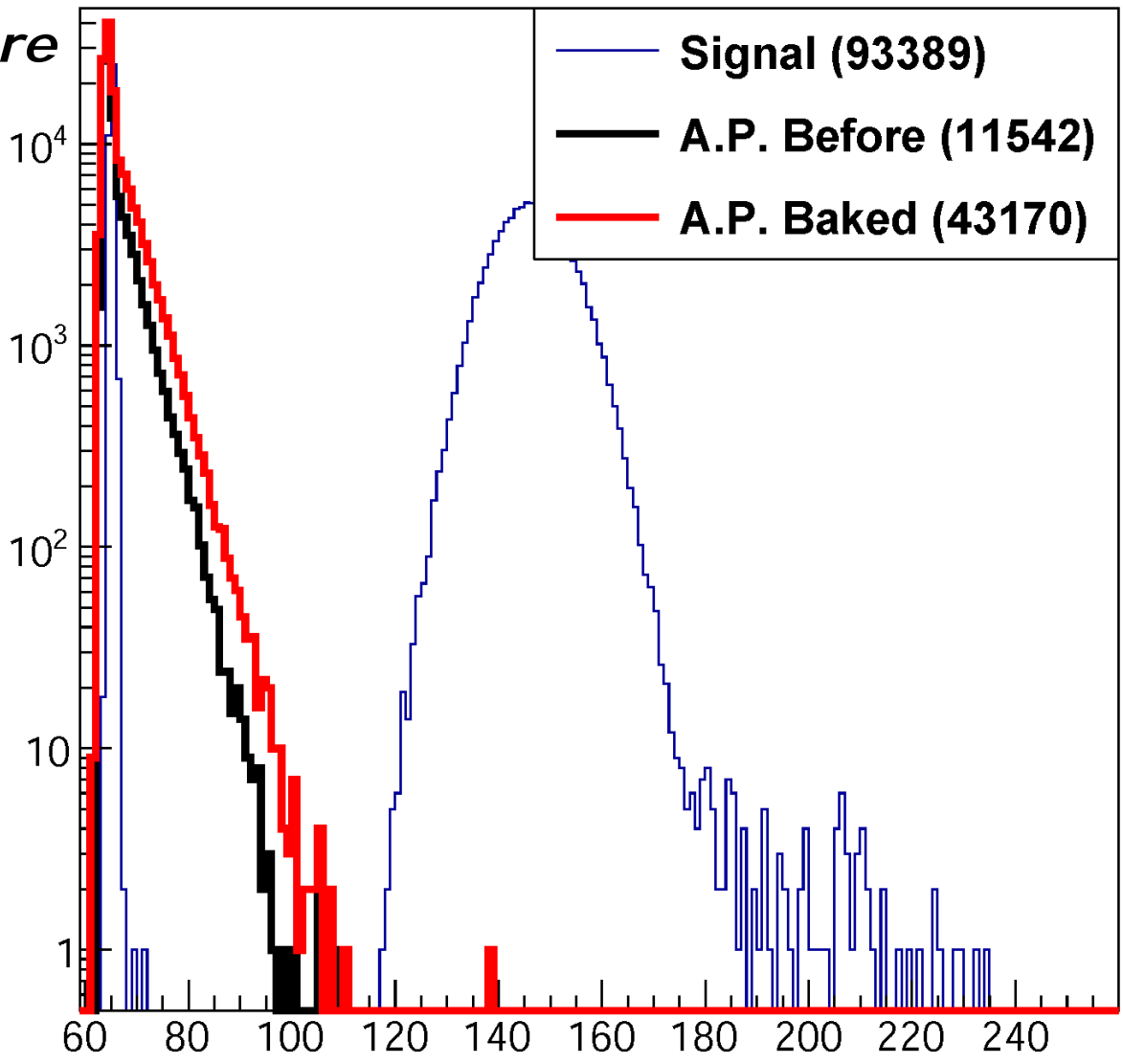
Baking (IV)

…more of the same…

Baking Test, PMT 1307

Legend:
- Signal (97651)
- A.P. Before (72917)
- A.P. Baked (77906)
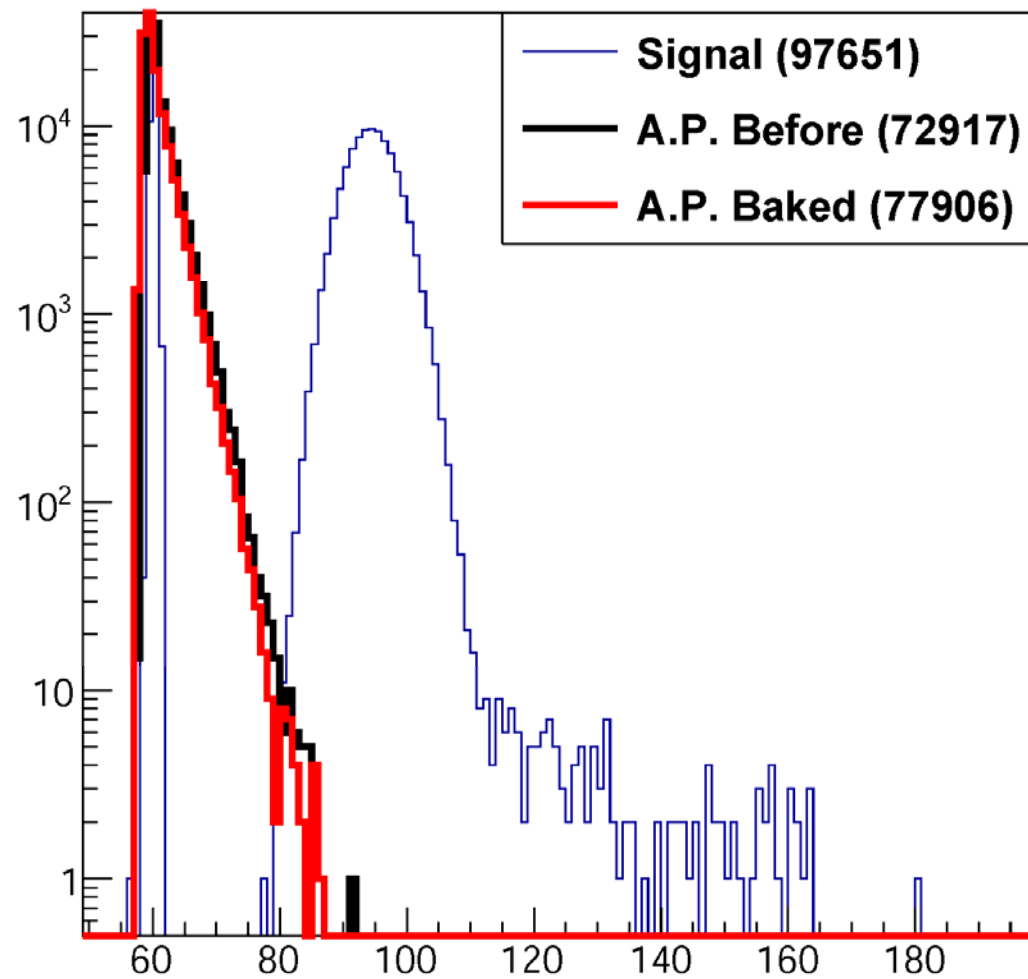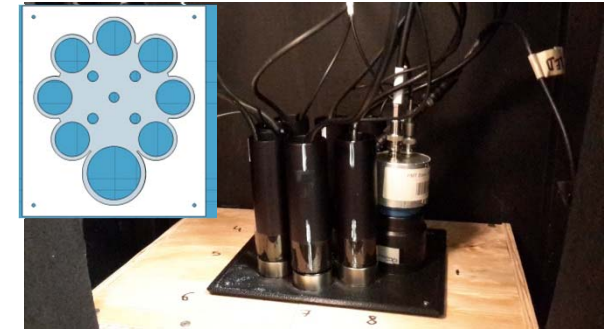
Summary

- *Expanded the batch of tests to AfterPulsing and (subset of tubes) baking.*

- *Baking seems to have minimal effect on the tubes*

- *AfterPulsing can be large for some tubes, especially when looking only at the # of counts.*

- *Closing in on ~200 tubes tested – hope to get into steady-state production.*

- *Results: .txt files, root trees, histograms*

ECAL PMTs Tested

Counts

10^2

0   0.2   0.4   0.6   0.8   1   1.2   1.4   1.6   1.8   2
Baked?