# Report on OD PMT Gain-Setting

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**Gain Setting Method**

We selected the high voltage by adjusting the HV such that the peak of the single photoelectron (spe) trace on an analog scope was set to a particular pulse height. The new tube spe characteristic is very good, with a clear peak and clean valley allowing unambiguous level setting by eye. The peak level can be determined reliably to within about $\pm 2$ mV.

We installed an LED in the dark box, but it was rarely necessary; the spe trace was almost always clearly visible from dark noise alone.

We initially set all of the tubes for a pulse height of 30 mV, and then later decided that the appropriate level was 25 mV (which is close to the mean for new OD tubes currently in the tank: see Figure 1.) For each tube, we also measured spe pulse height vs HV over a range from about 15 mV to 40 mV. We were therefore able to find the appropriate voltage for a pulse height of 25 mV, which is the final recommended voltage. We found that the HV settings for a given pulse height are stable and reproducible to within 10 V or so.

We chose this scope method for simplicity and speed.[1] To confirm the method's reliability, we did a survey of the scope-measured spe pulse height levels of the new tubes of crate 2 in hut 2, and compared them to the counts-per-pe values determined from the data using the in-situ "dark noise" method[2, 3]. Figure 2 shows the result: the correlation is very good. Furthermore, the scope-measured spe value is stable; Figure 2 compares spe pulse heights measured in July with dark noise gains from April.

HV vs spe pulse height for a few sample tubes is shown in Figure 3. A linear relation in fact works extremely well, and a linear fit was used to determine voltage required for 25 mV.

**Procedure**

We used the spare LeCroy HV supply, an old paddle card, a connector made by Jeff, and a paddle card scope interface with lemo connectors[1]. In all cases, the HV specified is the one entered on the supply (note that there is a voltage drop across the paddle card). Some tubes had MHV connectors on their cables. For these, we used Bill's pickoff box.

The tube was turned on in the dark box, and the HV set for a pulse height of 30 mV using the scope (with trigger level set such that the pulse just barely triggers the scope trace). We then let the tube sit under voltage for 5 minutes (most tubes are stable even from first turn-on, but we found

[1] We also tried a LeCroy QVT, gated by the LED-firing pulse with appropriate delay. We succeeded in getting spe spectra, but were unable to get rid of noise distorting the pedestal and affecting the peak evaluation. In addition the QVT method was quite slow.

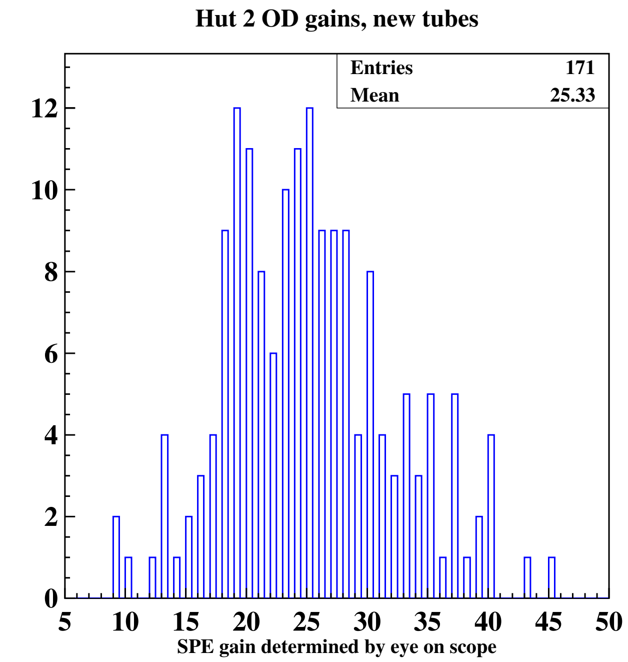


Figure 1: Distribution of spe pulse heights for new tubes in hut 2, crate 2, measured July 21, 2005.

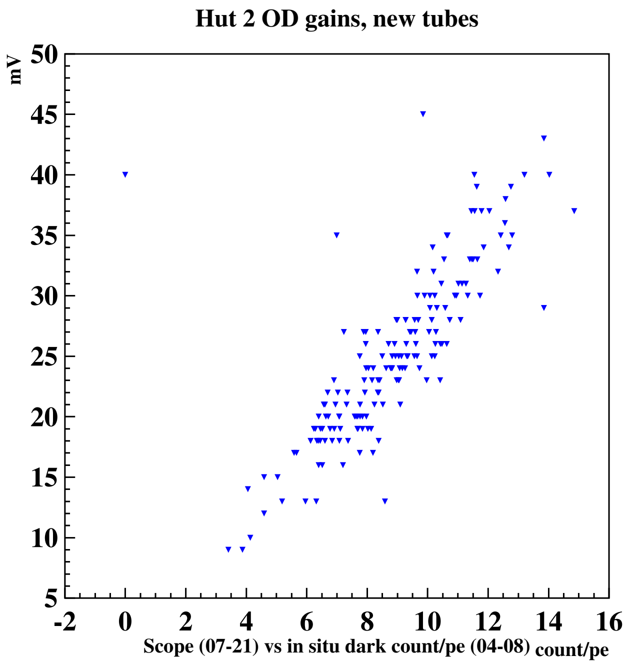


Figure 2: Correlation between spe pulse heights for new tubes in hut 2, crate 2, versus "dark noise" counts per pe from run 25003 (April 8, 2005).

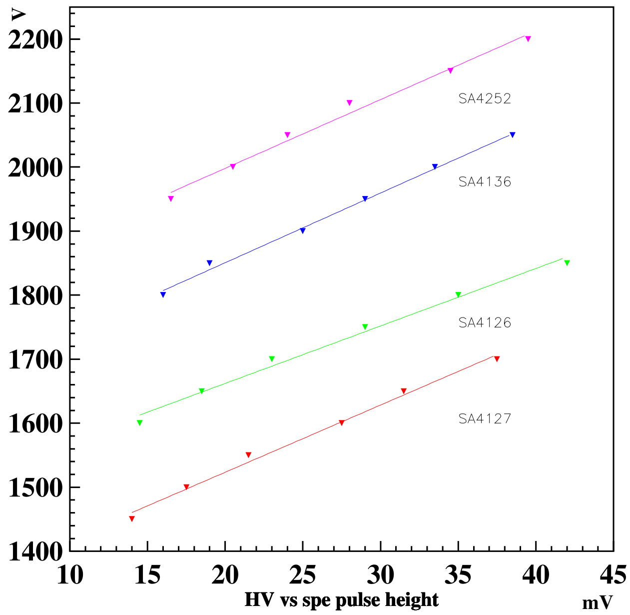


Figure 3: HV versus spe pulse height for a few sample tubes.

some whose spe pulse heights settle down by a few to 5 mV over the course of several minutes after turn-on; hence the short wait requirement).

We then recorded the spe pulse height for two or three 50 V increments above and below the 30 mV level.

Finally, we packed up the tube, protecting the cable end from water using the same bags they were originally packed in, and duct tape.

**OD Tube Database**

- The full database, including transcribed notes, can be found at `http://phy.duke.edu/~schol/superk/gains/tubedb.txt`.
- The full database in format ready to import into a spreadsheet can be found at `http://phy.duke.edu/~schol/superk/gains/forimport.csv`.
- The full database in OpenOffice .sxc spreadsheet format can be found at `http://phy.duke.edu/~schol/superk/gains/tubedb.sxc`.
- The full database in xls spreadsheet format can be found at `http://phy.duke.edu/~schol/superk/gains/tubedb.xls`.

Note: tubes referred to as "old" in the notes are actually new tubes, but from the first reconstruction era. We found only two IMB tubes, and did not set their voltages. Two tubes, both from the first reconstruction era, had no signal at all.

A list of tubes and their recommended voltages for 25 mV, ordered by tube number, can be found at `http://phy.duke.edu/~schol/superk/gains/toset.dat`.

Figure 4: Are we having fun yet?

**<u>Status</u>**

The tube boxes are labeled and stacked in voltage order in the area behind hut 2. The voltage to set is the one **written on the white tape**.

Some boxes are not labeled with white tape. These contain either dead tubes (two of these in all), IMB tubes (two of these in all), or new tubes that seem good but with short cables (removed during first reconstruction era?) The appropriate voltages for these, if needed, may be found on the gain sheets or in the database. Many of these no-white-label boxes have two tubes per box and are not really properly packed (we repacked some in available empty boxes but did not have enough); workers should take care handling these.

# References


[1] http://www-sk.icrr.u-tokyo.ac.jp/~berns/SUPERK/MISC/paddle.html

[2] TK Focht, MIT senior thesis, 2004

[3] Collaboration meeting talk, November 2003