August 26, 2008
LG, XS, MS, HW

Mimostar3 Testing Follow-up Report

We report on additional testing of the Mimostar3 sensors from the new fabrication run from wafer # B61510W01PB6. Our additional testing is related to the phone conference between IPHC and LBNL held on August 19, 2008. Additional results have been obtained in the following categories indicated below. This report is intended primarily as an update to the current status of ongoing testing and is intended to be part of a dialog for sharing testing results and ideas.

Cluster Analysis

MS performed the sensor cluster analysis with the calibration runs shown in the original report (http://rnc.lbl.gov/hft/hardware/docs/Mimostar3_test_results_LBNL_2008_08_18.pdf).
The results of the cluster analysis are, generally consistent with what was first observed. To begin with, there appear to be multiple calibration peaks on the gain=5 setting. This was suspected but not clearly observed in the original CDS histograms.
Data collected for 4 chips were analyzed with the typical cluster analysis with the cuts of 5 and 2 on S/N for the central pixel and for the 9-pixel cluster, respectively. We have observed significant differences between distribution obtained with the internal chip gain of 3 and 5. The calibration peak is clearly visible for gain 3 but not for gain 5 in majority of the measurement.
Distributions of signals in the central pixel, 4-pixel cluster, 9-pixle cluster, and 25 pixel cluster are shown in Figure 1 for the gain of 3 (chip2).
Most likely, due to high noise, the peak of signal collected form the epitaxial layer is not visible. Probably this peak is hidden by the noise distribution. Cluster signal distributions are also affected and don't show separate cluster peaks.

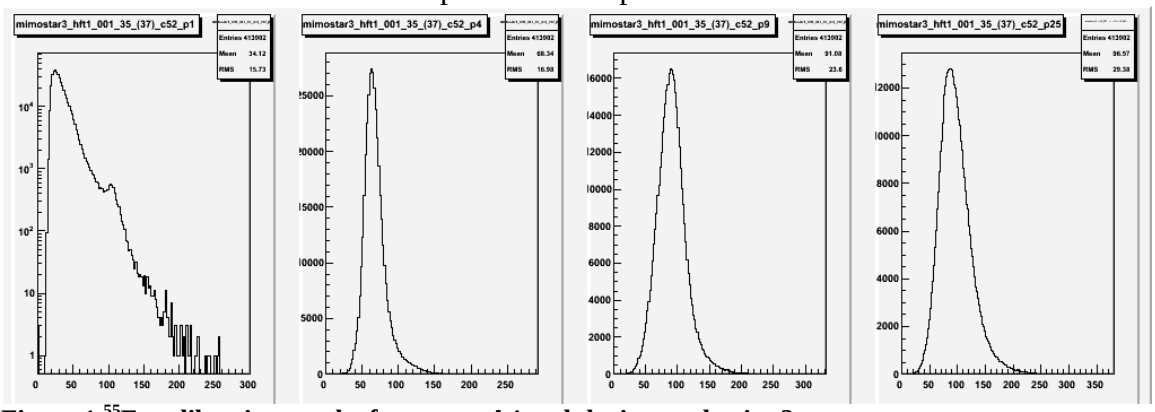

Figure 1 ^{55}Fe calibration results for sensor A4 and the internal gain=3.

A typical cluster signal distribution for gain=5 is shown in Figure 2 for chip2. Each row shows distributions for one sensor sub-array (=one output). These distributions are typical and similar plots have been obtained for other chips. The complete set of pictures is available at http://rnc.lbl.gov/~maszelezniak/ with run descriptions available at http://pdsfweb01.nersc.gov/~sunxm/MSresult/runlog.txt.

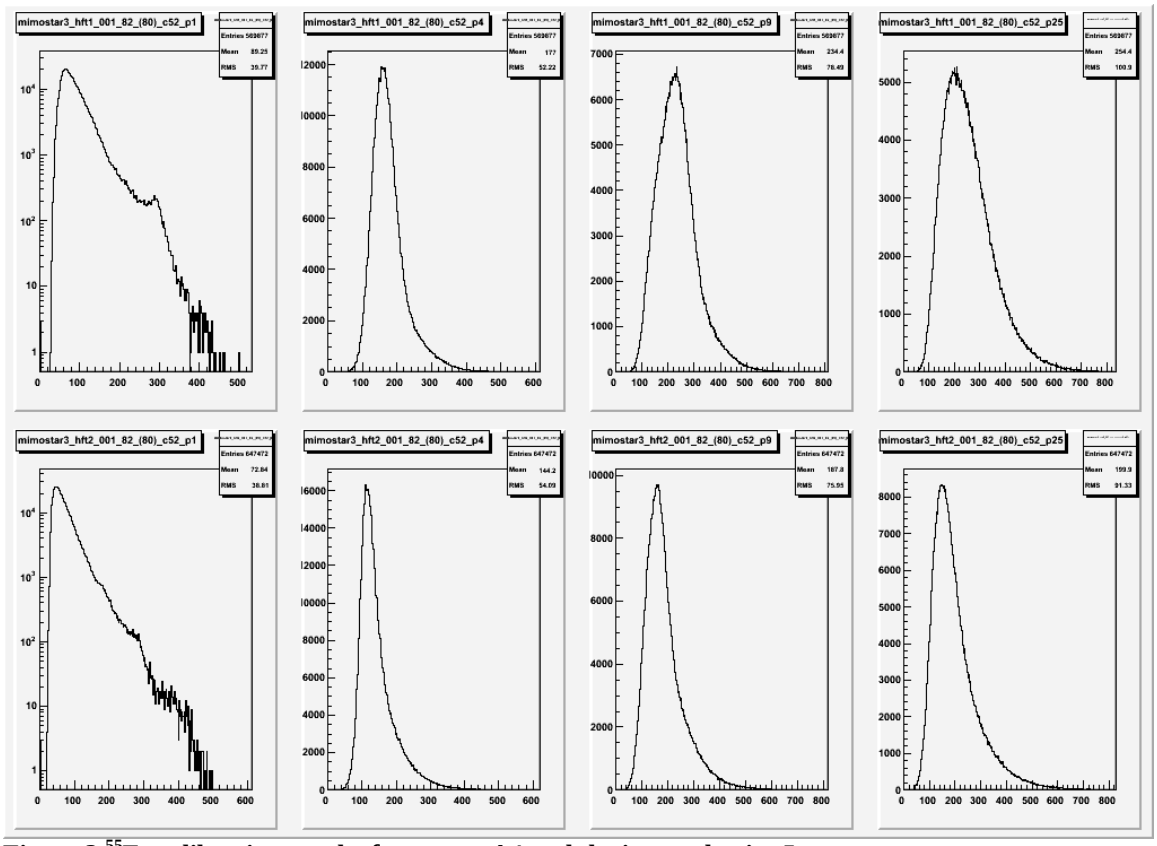

Figure 2 ^{55}Fe calibration results for sensor A4 and the internal gain=5.

Given that there are 5 sub-arrays per each sensor output, we looked at calibration peak distributions for each sub-array independently. A typical set of distributions is shown in Figure 3. The presented set of plots represents the overall distribution in the upper-left corner and 5 contributing distributions. Overall, we can see that, generally, distributions from individual sub-arrays don't show a clear calibration peak.

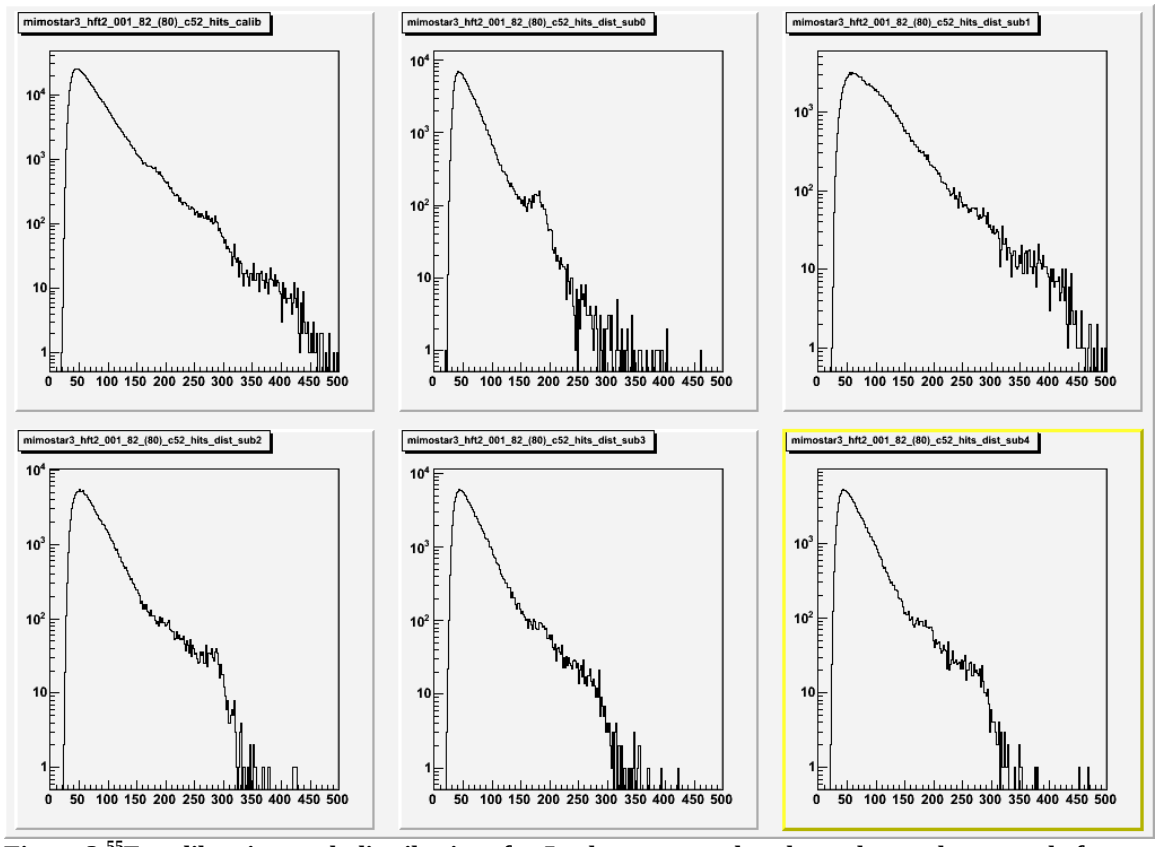

Figure 3 ^{55}Fe calibration peak distributions for 5 sub-arrays analyzed together and separately for sensor A4 and the internal gain=5.

Cuts Analysis

XS performed a cuts analysis of the calibration data. In this analysis, the idea was to select only pixels that absorbed all of the photon energy from the source without any additional influence from conversions that resulted in partial charge sharing between pixels. In order to accomplish this he placed cuts such that none of the eight "crown" pixels around any pixel can have a CDS value that exceeds 6 ADC counts for gain=3 and 10 ADC counts for gain=5. The complete histogram data in the form of ROOT files and .gif plots for all measured sensors for the presented analyses as well as a text file of the run numbers can be found at http://pdsfweb01.nersc.gov/~sunxm/MSresult/. Also important to note is that raw ADC signal distributions (that can be seen in XS files) do not indicate any signal truncation even for gain=5. Typical results are shown below;

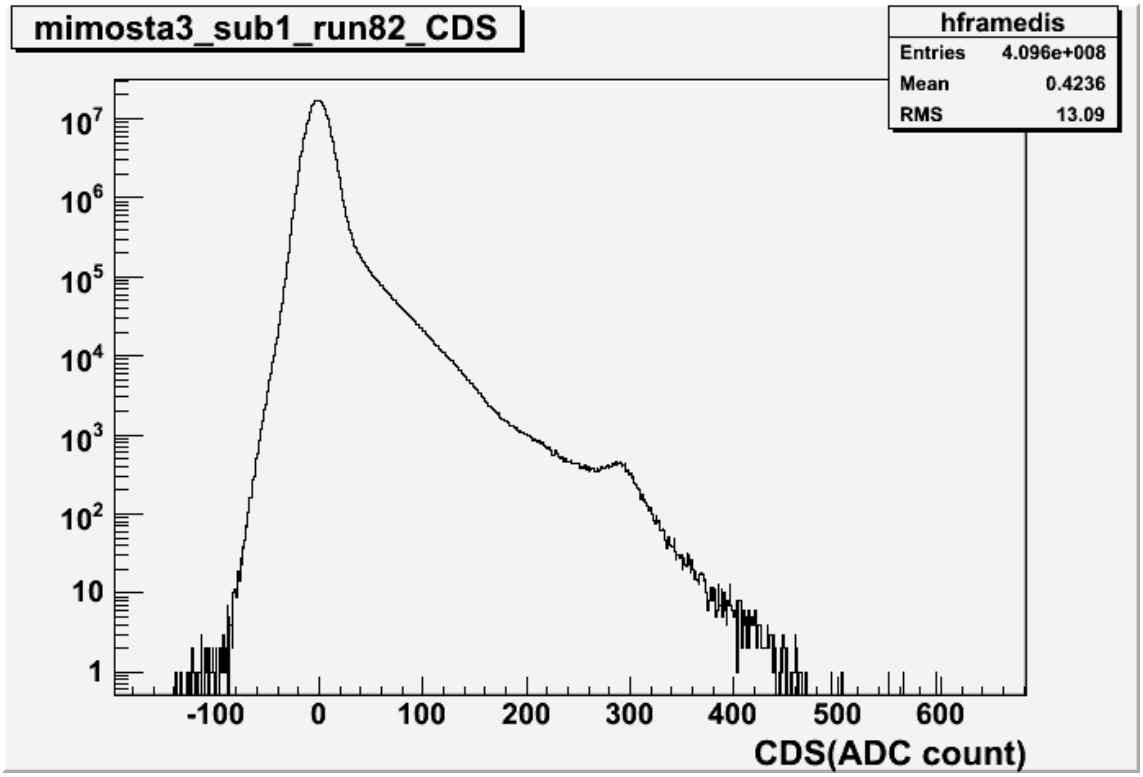

Figure 4 Sensor A2 raw CDS spectrum on gain=5 setting

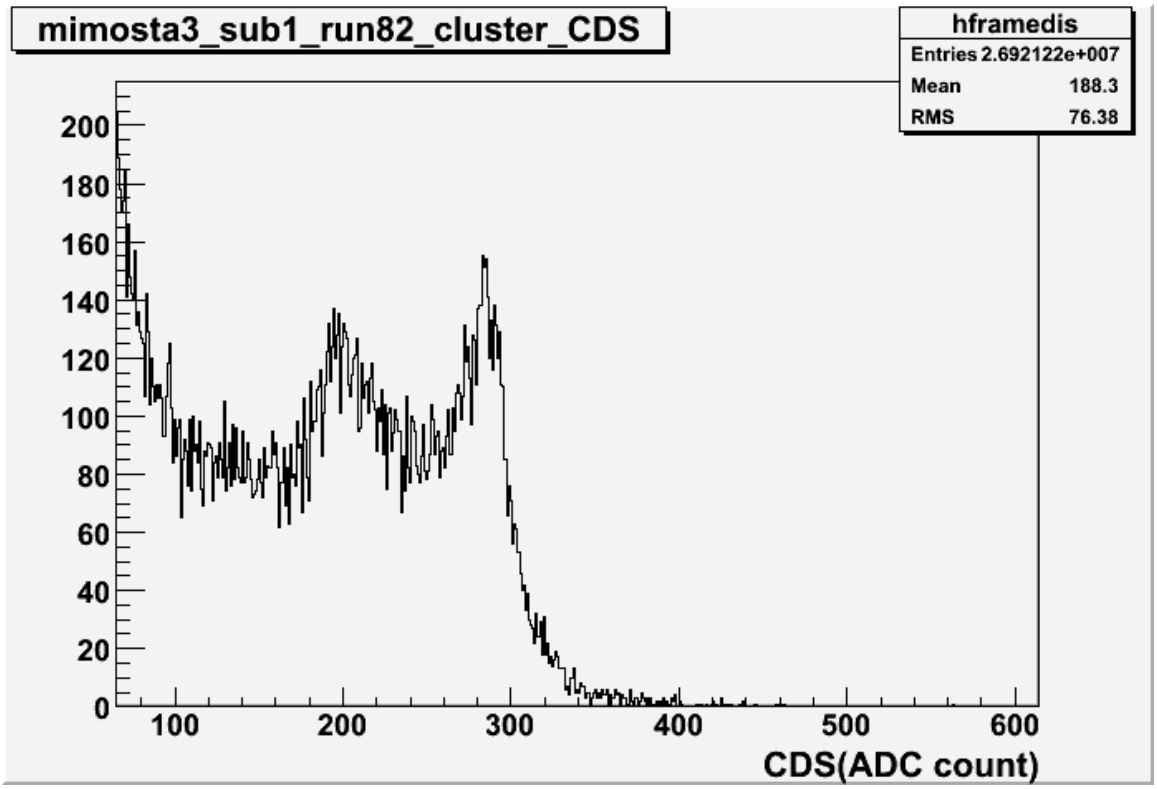

Figure 5 Sensor A2 raw CDS spectrum on gain=5 setting with XS cuts analysis (zoomed)

Though the exact bias of these cuts is not known, they clearly qualitatively show more than one CDS calibration peak.

Vdiode analysis

We tested sensor from wafer position A2 varying the diode voltage in 50 mV steps from 3.0 V to 3.7 V in gain=3 mode and from 3.2 V to 3.5 V in gain=5 mode. The JTAG settings were as described before in the previous report. The raw ADC value (averaged over 100 frames) at one voltage setting was subtracted from the raw ADC value of the next voltage setting (50 mV higher) for every pixel. The plot for the Vdiode 3.35 V–3.30 V (our operating point) for all pixels in sub-array 0 at the gain=5 setting is shown below.

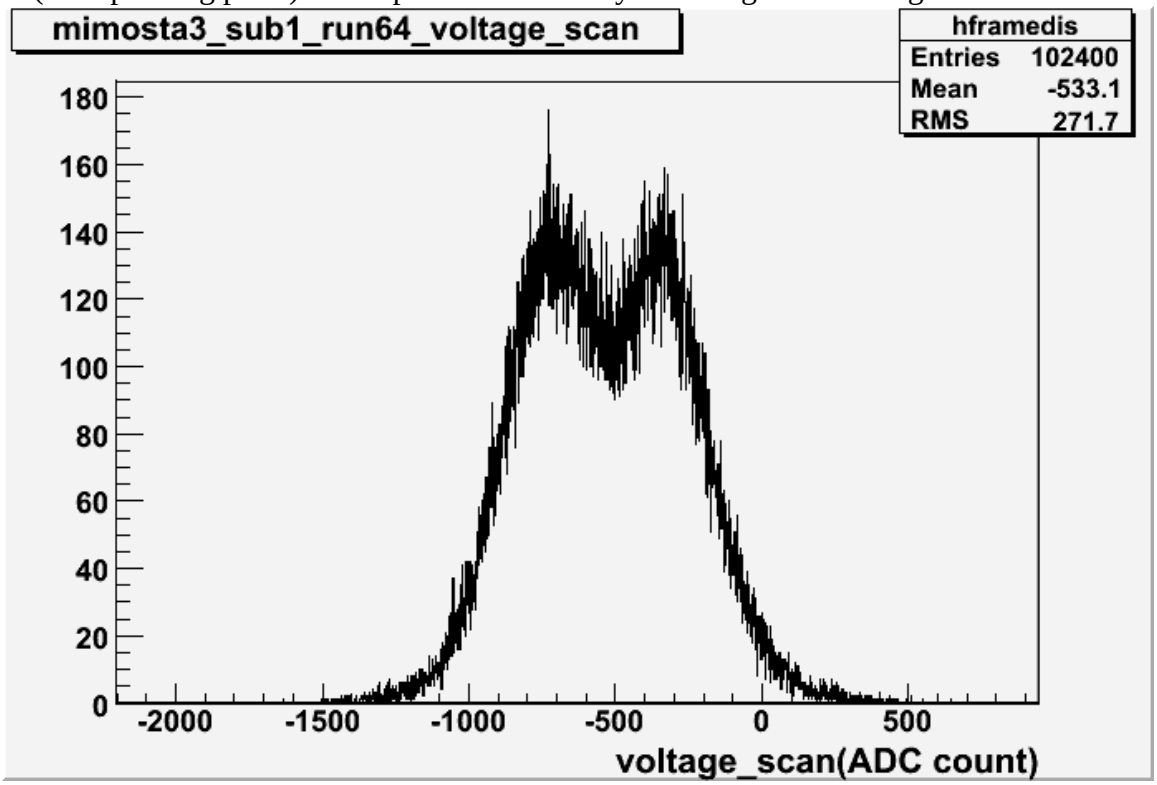

Figure 6 Vdiode 3.35 V – 3.30 V (our operating point) for all pixels in the sub-array

Note the bimodal structure in the ADC subtraction spectrum.

We decomposed this into the smaller sub-arrays based on each of the 5 gain=3/5 amplifiers in sensor sub-array 0. These histograms are shown below.

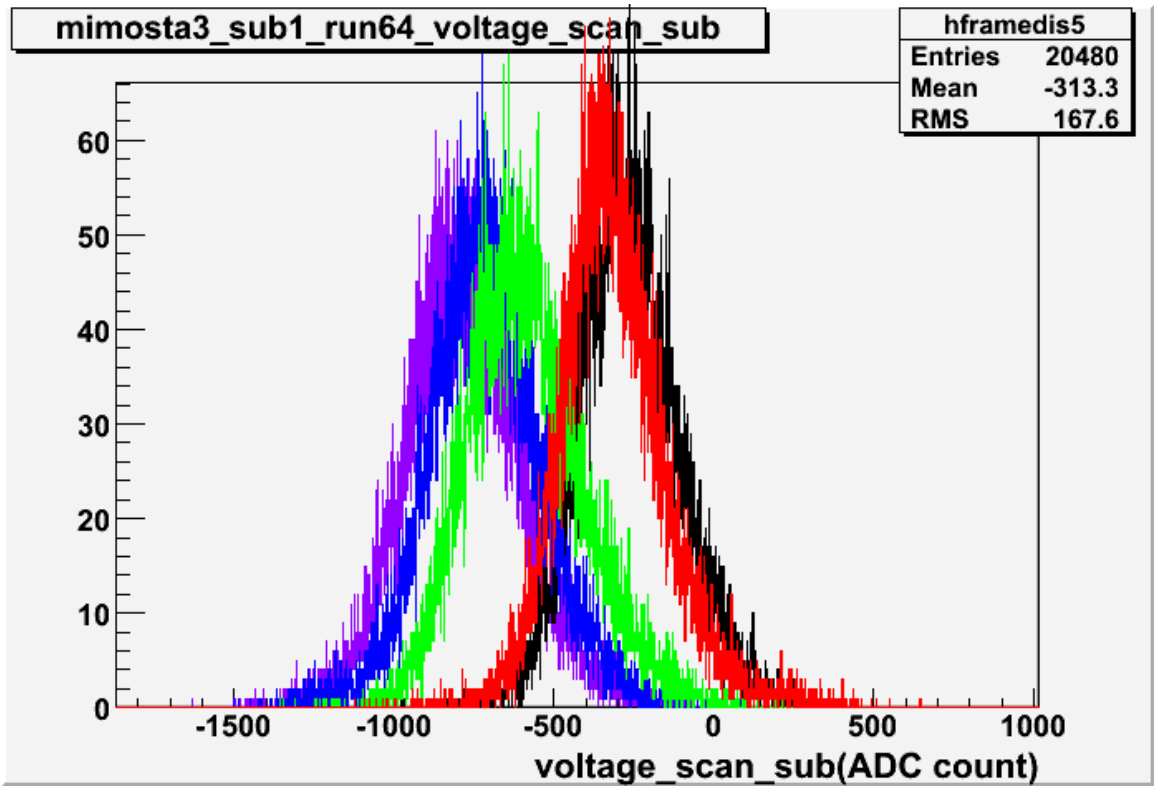

Figure 7 Histograms of smaller sub-arrays based on each of the 5 gain=3/5 amplifiers in sensor sub-array 0 at the gain=5 setting

Note that the means for these histograms are -783.8, -266.2, -715, -587.5, -313.3. The sum of these distributions would seem to account for the somewhat bimodal shape of the histogram in the all pixel sub-frame 0 subtraction plot. The histogram data for the other subtractions can be found in the link given above. The file names are as indicated in the plot titles and in the text run log. The ADC subtractions vary quite widely for the gain=3/5 amplifiers under the gain=5 setting. The gain=3 setting is relatively stable. A typical plot is shown below for the same subtraction (3.35 V–3.30 V) and sub-array 0.

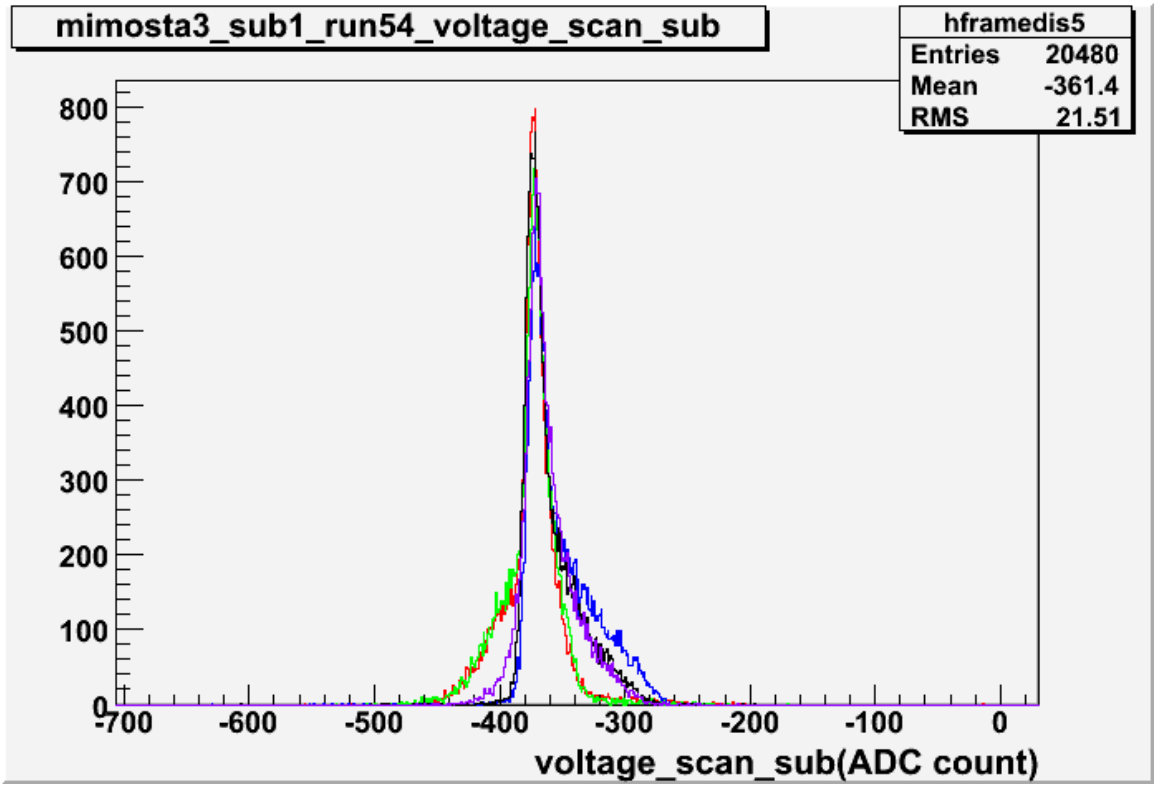

Figure 8 Histograms of smaller sub-arrays based on each of the 5 gain=3/5 amplifiers in sensor sub-array 0 at the gain=3 setting

The initial ^{55}Fe source calibration CDS histogram distribution is shown in figure4 and the data run through the XS cuts analysis is shown in figure 5, we clearly see multiple peaks at the gain=5 setting.
We also tested the relative gain of the system by looking at the marker pixels on the scope and varying the VTEST0/1 voltages. We examined two marker pixels and measured appropriate voltage level changes as a function of VTEST0/1 voltage for both pixels in both gain settings.

Observations / Conclusions

We have done additional testing to complement what was presented during the August 19, 2008 phone conference. We made the following observations / conclusions;

- As shown in the cluster and cuts analyses, the ^{55}Fe calibration peak for Mimostar3 in the gain=5 mode appears to have multiple components.
- These components appear to correspond to different gains in each internal sub-array read out through each of the multiplexed gain 3/5 amplifiers.
- The gain=3 setting does not appear to have this structure corresponding to the gain=3/5 amplifier sub-arrays.

Future testing plans

We plan to do further investigation in the following areas;

- The Mimostar2 sensor will be tested according to the analyses presented above.
- We will look at the distributions of the calibration peaks broken down into the gain amplifier cub-arrays.
- We will measure the Mimostar3 sensor at a lower operating temperature.
- We will calibrate and plot histograms for the old MS3 with dead pixels.

Any comments, suggestions, or observations are most welcome.