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# Analysis of Voltage Effect on Microdischarges

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## 1. Introduction

The objective for this exercise was to analyze the beamtest runs to see if evidence of microdischarges could be seen as the bias voltage was increased. Runs 81 through 85 were selected; these runs were 170.5 mV threshold, zero degree positron runs, that were operated at different bias voltages, from 150V to 60V, respectively. Only noisy strips that had strip occupancies grater than 0.1% were analyzed.

In run 81 (150V) we looked at the number of hits in each strip in each layer to determine strips that had a large amount of hits above the baseline (occupancy greater than 0.1%). After determining the noisy strips, using this method, we looked at the same strips and layers in the remaining four runs. From this data, we could obtain the amount of noise above the baseline in the noisy strips and divide this value by the total number of hits in that layer. This normalized value was then analyzed at the five different voltages to see if any trends appeared. The noise is expected to increase as the square root of voltage, since

$$leakage\ current \propto Width\ Depth \text{ and } Width \propto \sqrt{Voltage}$$

If in addition to this growth an exponential or very sharp increase is seen, then this is evidence of microdischarges. (Note: we cannot quantify how much current is actually in a given strip)

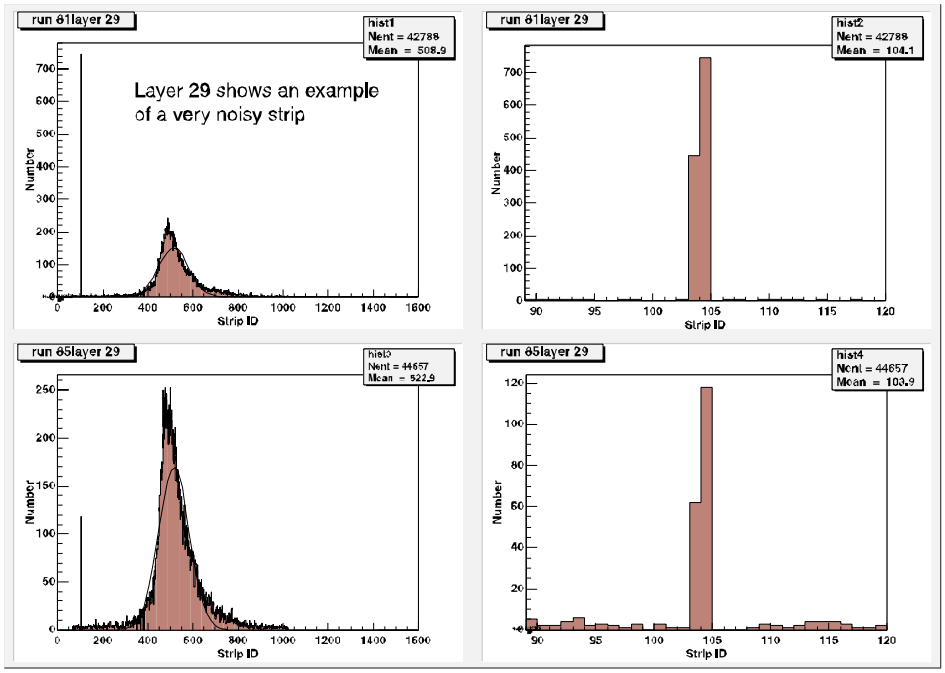
## 2. Noisy Strips vs. Voltage

Throughout this report the following table will be useful to translate between run number and bias voltage.

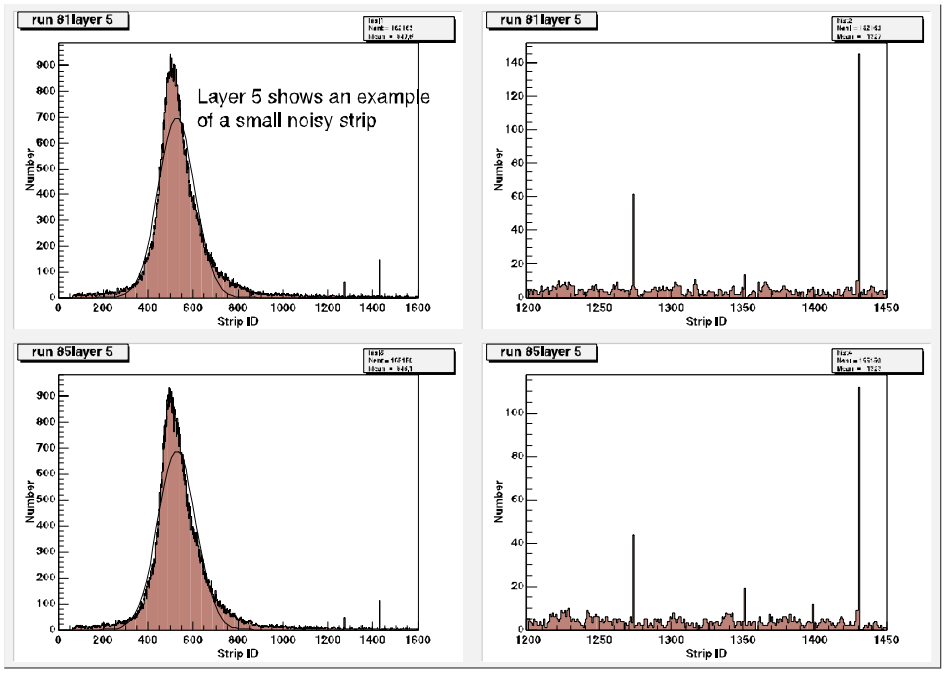
| Run Number | Bias Voltage |
|---|---|
| 81 | 150 |
| 82 | 120 |
| 83 | 100 |
| 84 | 80 |
| 85 | 60 |

(Table 1)

As the leaky strips were being tabulated, they were broken down into three categories: *Large leaky* (fig.1), where the noise above the baseline is higher than the actual highest signal from where the beam went through the detector; *Medium Leaky* (fig.2); and *Small leak* (fig.2), where the noise is less than 100 above the baseline. All categories have occupancy at 150V greater than 0.1% (fig.4)




(fig.1) This shows a *Large Leaky* Strip. The top two graphs are from the 150V run, the bottom two, from 60V run. The leftmost plots show all strips to show the picture of the beam, the rightmost plots are zoomed in on the leaky strips 103-104.

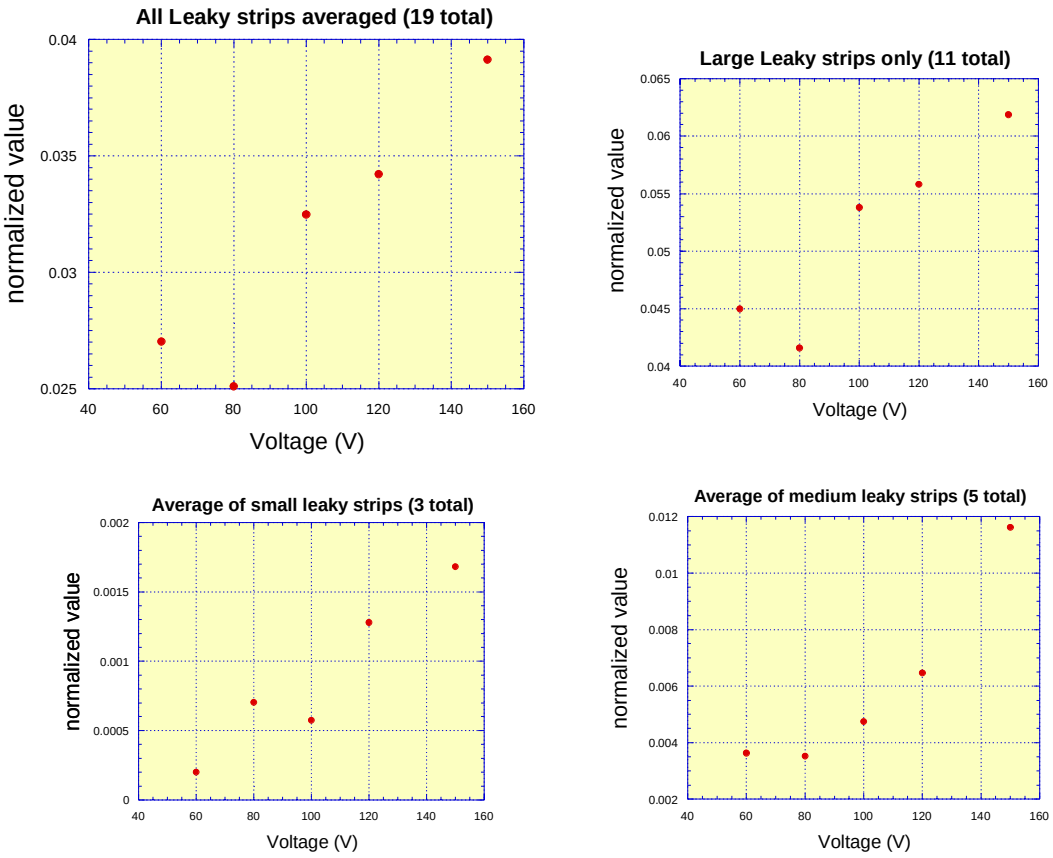



(fig.2) This shows a *Medium Leaky* strip (1430) and a *Small Leaky* Strip (1273). The layout of the four plots is the same as in (fig.1)

For each of the leaky strips that were analyzed, 19 total, the *normalized noise* was calculated.

$$normalized\ noise = \frac{noise - baseline}{num\ hits\ in\ layer\ for\ all\ events}$$

The average of this value for each category of strip (*Large*, *Medium*, *Small*) was plotted as a function of voltage (fig.3). And the average of this value for all strips regardless of category was also plotted (fig.3).




(fig.3) The normalized value of noise as a function of voltage. The dominant contribution to the shape of the overall average comes from the large leaky strips, since 11 of the 19 are in this category. We don't understand why there is a dip at 80V; however, we are not looking for quantified effects, only trends in the distribution.

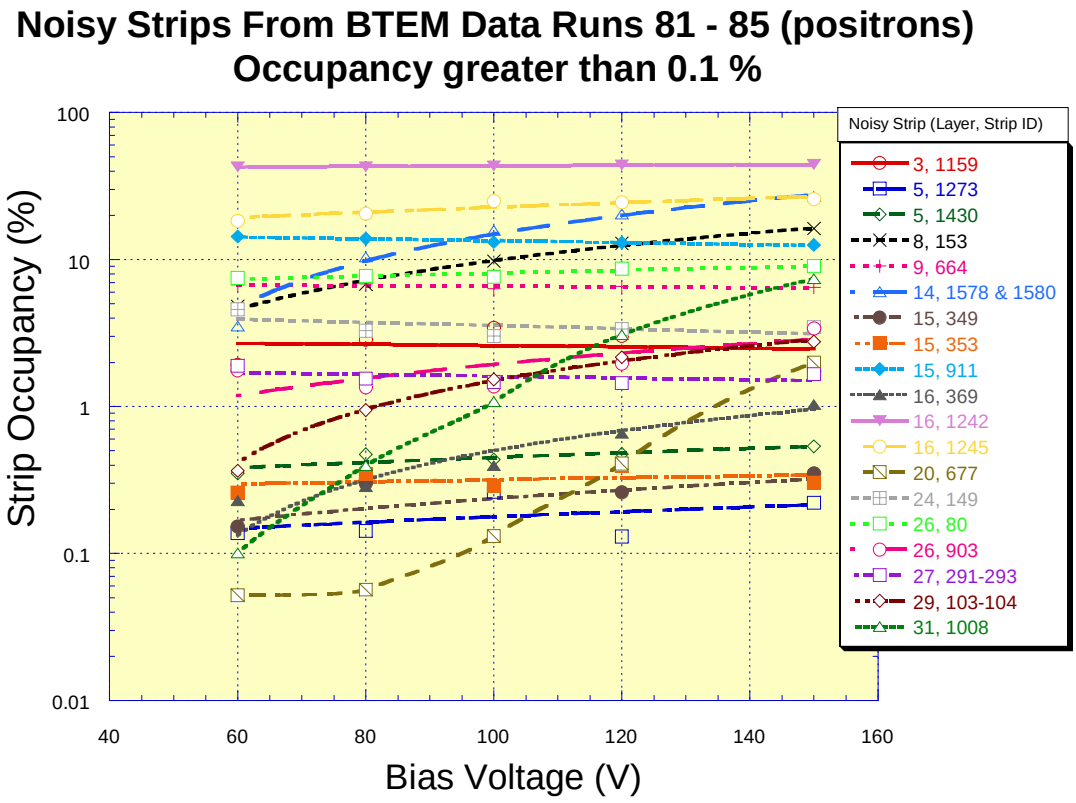
From these plots we can see the noise above baseline grows almost linearly with time, but there is no evidence of a large jump or an exponential increase. No new noisy strips appeared as the bias voltage was increased.

## 3. Occupancy

The occupancy of the noisy strips as a function of Bias voltage was also analyzed (fig.4).

$$strip\ occupancy = \frac{number\ of\ \ hits\ in\ the\ strip}{total\ \ number\ events\ in\ run}$$

We did this for each of the nineteen leaky strips that were used throughout this analysis. This results in looking at all noisy strips in the detector that have occupancy at 150V of greater than 0.1%. The noisiest strip (layer 16 strip 1242) has occupancy of 45% at 150V (fig.4).




(fig.4) Showing the occupancy of each strip analyzed as a function of bias voltage.

## 4. Conclusion

The noise in the leaky strips increases with voltage, but there is no evidence of a large jump at the bias voltages used in the beamtest. There is no exponential run-away or increase in the number of leaky channels either; there is no evidence of microdishcarge effects. Also, the largest occupancy value seen is 45%, with 14 of the 19 strips falling below 10% occupancy at 150V, for a nominal threshold of 170.5 mV. Therefore strips should be masked in the final GLAST instrument