# High Voltage Diagnostics and Trouble Shooting in MicroBooNE

(The MicroBooNE Collaboration)

(Dated: March 23, 2017)

## Abstract

At the end of January, MicroBooNE ramped down it's drift HV system after a series of unusual and worrying behavior on HV monitoring plots. This document presents a summary of the tests performed, diagnostics developed, and a chronological ordering of events. We also include some "lessons learned" that may be useful to future LArTPCs.

# I. INTRODUCTION

# II. DESCRIPTION OF MICROBOONE HV SYSTEM

## A. HV Supply

## B. HV Feedthrough

## C. Cathode and Resistor Chain

## D. Anode and Wire Bias

## E. Pickoff Point

## III. SYMPTOMS

As the high voltage issues developed, several symptoms were identified which provided metrics to judge the stability or instability of the system. Several were monitoring variables of the HV system itself, such as the current readback from the Glassman power supply and the voltage of the pickoff point. Others were detected through the readout of the detector, including persistent high frequency (900kHz) noise on some detector channels, and "burst" events, described below.

### A. Pickoff Point Instability

The first symptom to be detected during MicroBooNE's high voltage incident was large, sustained deviations on the pickoff point (see Section II E). Nominally, this point sits at a value of approximately $\frac{5M\Omega}{17.1G\Omega} = 0.029$ % of the applied voltage by the power supply. As seen in Figure 2, the pickoff point values deviated significantly from the nominal values. In this figure, the band of nominal values is selected as the minimum and maximum of a two week stable period.

### B. HV Power Supply Current RMS

As seen in Figure 2 is the calculated current from the back of the high voltage power supply. The power supply outputs and analog voltage from which we derive a current using the following formula:

The current shown in the figure demonstrates clear increases in noisiness when the pickoff point deviations occur, indicating that whatever the cause of the problems is, it affects both the HV power supply and the pickoff point simultaneously.

Because of the way the monitoring data is archived, we lack precise enough data

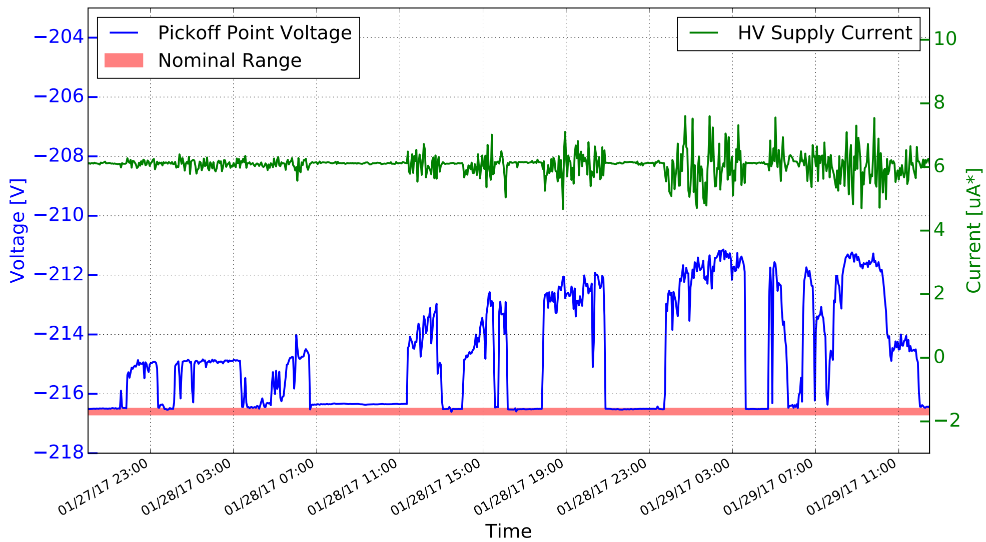


Figure 1. Pickoff point deviations over the weekend of Jan 27th. Though the absolute calibration is not correct on the current from the HV power supply, there is clearly a correlation between the pickoff point deviations and noise on the HV power supply.

to calculate an RMS of the calculated current from the back of the power supply, and can make only qualitative comparisons to historical data. We have since implemented archiving of not just the values output by the power supply, but also the noise on those value measurements.

### C. TPC Asic LV Current Draw

### D. "Burst" Events

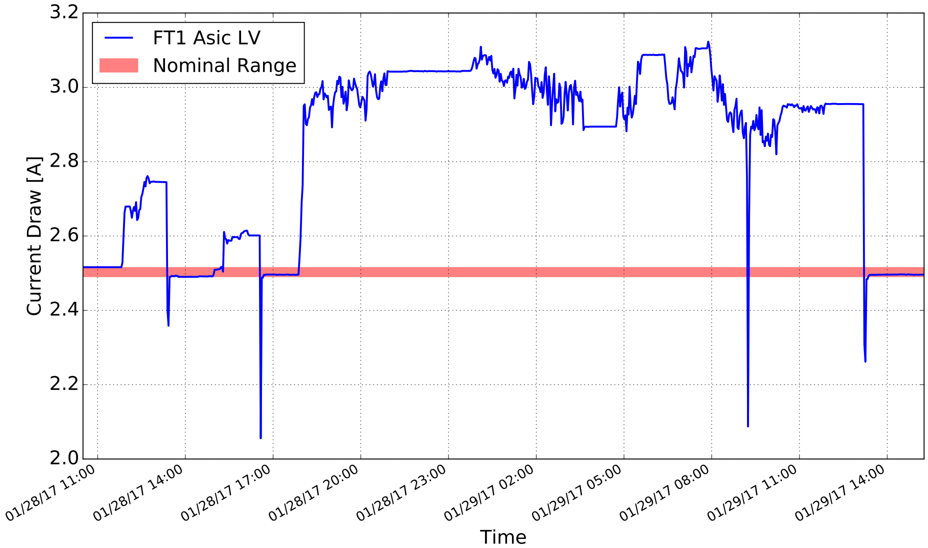


Figure 2. Pickoff point deviations over the weekend of Jan 27th. Though the absolute calibration is not correct on the current from the HV power supply, there is clearly a correlation between the pickoff point deviations and noise on the HV power supply.

# IV. DIAGNOSTICS

## A. (Warm) HV Supply Tests

### *1. Glassman HV Supply replacement*

### *2. HV Cable inspection*

### *3. AC Power Distribution Inspection*

### *4. "In air" Test of HV Supply*

## B. V vs. I Tests on cathode

## C. Pickoff Point Measurements

### *1. Current-source mode measurements*

### *2. Measurement of field cage resistance*

### *3. Voltage-source mode measurements*

### *4. Measurement of pickoff point resistance*

### *5. Measurement of field cage resistance*

### *6. Measurement of burst rate at pickoff point bias*

## D. "Burst" Analysis

## E. Cathode Pulse Tests

## V. RESOLUTION

## VI. LESSONS LEARNED

## VII. CONCLUSION

Chronological Timeline