Proposal for Calibration and Threshold DACs for the GTFE Chip

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1 Introduction

This note discusses the values for the calibration and threshold DAC for the GTFE chip. The DAC's have seven bits but one of the seven bits is used to switch between a high gain and low gain. Compared to the old versions of the GTFE chips only the step size of the DAC's is changed.

The gain between the amplifier input and comparator input is shown in the following figure.

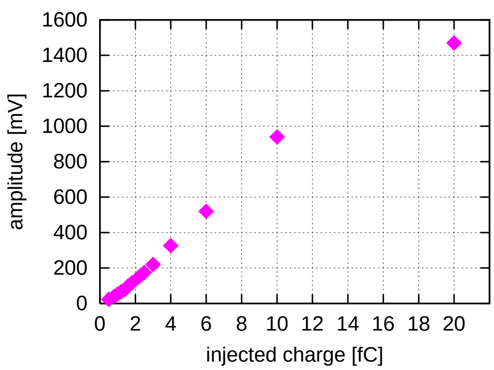

Figure 1: Comparator input signal versus injected charge.

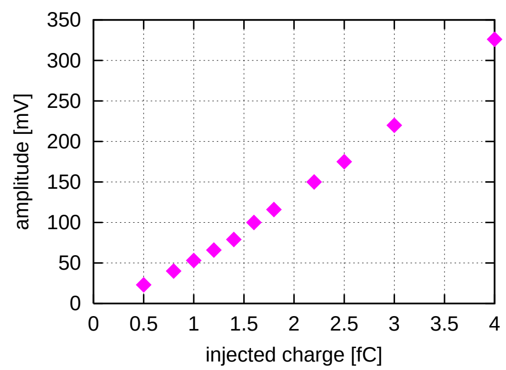

Figure 2: Comparator input signal versus injected charge (zoomed in).

The small signal gain at 1 fC is 75 mV/fC at 5 fC (one mip) the small gain increases to about 100 mV/fC. The noise is assumed to be 1300 electrons, which might be better then the real value.

The issues for the calibration and threshold DACs are:

1. Threshold for tracker operation. Threshold will be between 1fC - 2fC.
2. Setting large thresholds to test the system for mip signals. The threshold has to be larger than the average mip signal.
3. Performing threshold scans for mip signals.
4. Calibration of the ToT for 1-2 mips large signals.
5. Measure the saturation of the ToT.
6. Perform charge injection scans for the nominal thresholds (1-2 fC).

The suggested values are shown in Table 1.

Table 1: Suggested DAC values.

	low gain step size	high gain step size
threshold DAC	4.5 mV	12.5 mV
max thresh. DAC Value	288 mV	800 mV
calibration DAC	1.37 mV	16.0 mV
max calib. DAC Value	87.7 mV	1024 mV
max calib. DAC Value	4.03 fC	47.1 fC

2 Threshold DAC

The low gain threshold DAC is used for normal operation of the tracker. The threshold will be between 1fC and 2fC corresponding to 60 - 140 mV. With a step size of 4.5 mV the maximum value of the low gain is about 290 mV.

The high gain is used to measure the noise and efficiency of a one mip signal. A mip signal (5 fC) will be about 400 mV at the comparator input. In order to measure the noise the step size should be smaller then the noise. For a noise of 1300 electrons and a gain of 120 mV/fC at 5 fC the noise is about 20 mV. If the maximum setting for the DAC is about 800 mV (a mip is about 400 mV), the step size is 12.5 mV which is 0.6 of the noise. This still allows to take threshold curves to measure noise and response.

3 Calibration DAC

3.1 Low Range

The low range calibration DAC is used to measure noise and response for a threshold setting of 1 - 2 fC. I assume 1200 electrons noise which corresponds to 0.19 fC. The following table shows the range of the calibration DAC assuming a step size of 1/2 and 1/3 0f the noise. The charge injection capacitor is 46 fF.

Table 2: Low gain calibration DAC.

	1/2 noise	1/3 noise
Δ Q [fC]	0.09	0.063
Δ DAC [mV]	1.96	1.37
Max Charge [fC]	5.76	4.03

3.2 High Range

The high gain is used to test the ToT performance. It should exceed 2 mips. Two mips correspond to 10.4 fC. The difference between one and two mips is 5.2 fC. We chose the step size so that 5.2 fC correspond to 7 steps (7 is random). Therefore the DAC step size is 0.74 fC and the full range is 47 fC. The full range is about four times larger then a two mip signal. A factor of four should account for landau fluctuations and and increased energy loss due to angular tracks. The step size is 16 mV (assuming 46 fF).