Status of electronic deadtime measurement in E00102/E01020, part 1

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1 Introduction

The data presented in this document are drawn from the Q1 section of the E01020 dataset. The same deadtime measurement system was used for E00102 and E01020, so any problems in the measurement should be common to the two datasets.

2 Output of deadtime measurement system

The details of how the deadtime measurement system and software work will be presented in a subsequent report. Here we will simply show the output of the standard system. A code "dtchk" was provided to analyze the raw data and extract both the total livetime and computer livetime for each run. The electronic livetime is extracted from these two:

$$TLT = ELT \times CLT \tag{1}$$

where ELT is the electronic livetime, CLT is the computer livetime, and TLT is the total livetime. A ROOT script was written to fit the total livetime as a function of single-arm trigger rates by minimization of:

$$\chi^2 = \sum_{i=1}^{N} \left(\frac{TLT_i - (1 - CDT_i) * (1 - d_1 * R1_i) * (1 - d_3 * R3_i)}{\sigma_i} \right)^2 \tag{2}$$

where the index i denotes the i^{th} run in the data set, $R1_i$ is the T1 trigger rate for the i^{th} run, $R3_i$ is the T3 trigger rate for the i^{th} run, CDT_i is the computer deadtime for the i^{th} run, TLT_i is the total livetime for the i^{th} run and σ_i is the statisitical error on TLT_i reported by dtchk. The parameters d_1 and d_3 are determined by the fitting software. After removing bad runs from the data sample, the fitter returns:

$$d_1 = 5.95947 \times 10^{-7} \pm 2.15554 \times 10^{-8} s \tag{3}$$

$$d_3 = 7.26335e \times 10^{-7} \pm 1.4794 \times 10^{-8} s \tag{4}$$

The output of dtchk, and the fit results, are shown in Fig 1.

If we divide out the computer livetime, which is determined precisely, we get the electronic livetime for the run:

$$ELT_i = \frac{TLT_i}{CLT_i} \tag{5}$$

The electronic livetime is plotted as a function of T5 rate in Fig 3. Notice that electronic livetimes as low as 85% are seen.

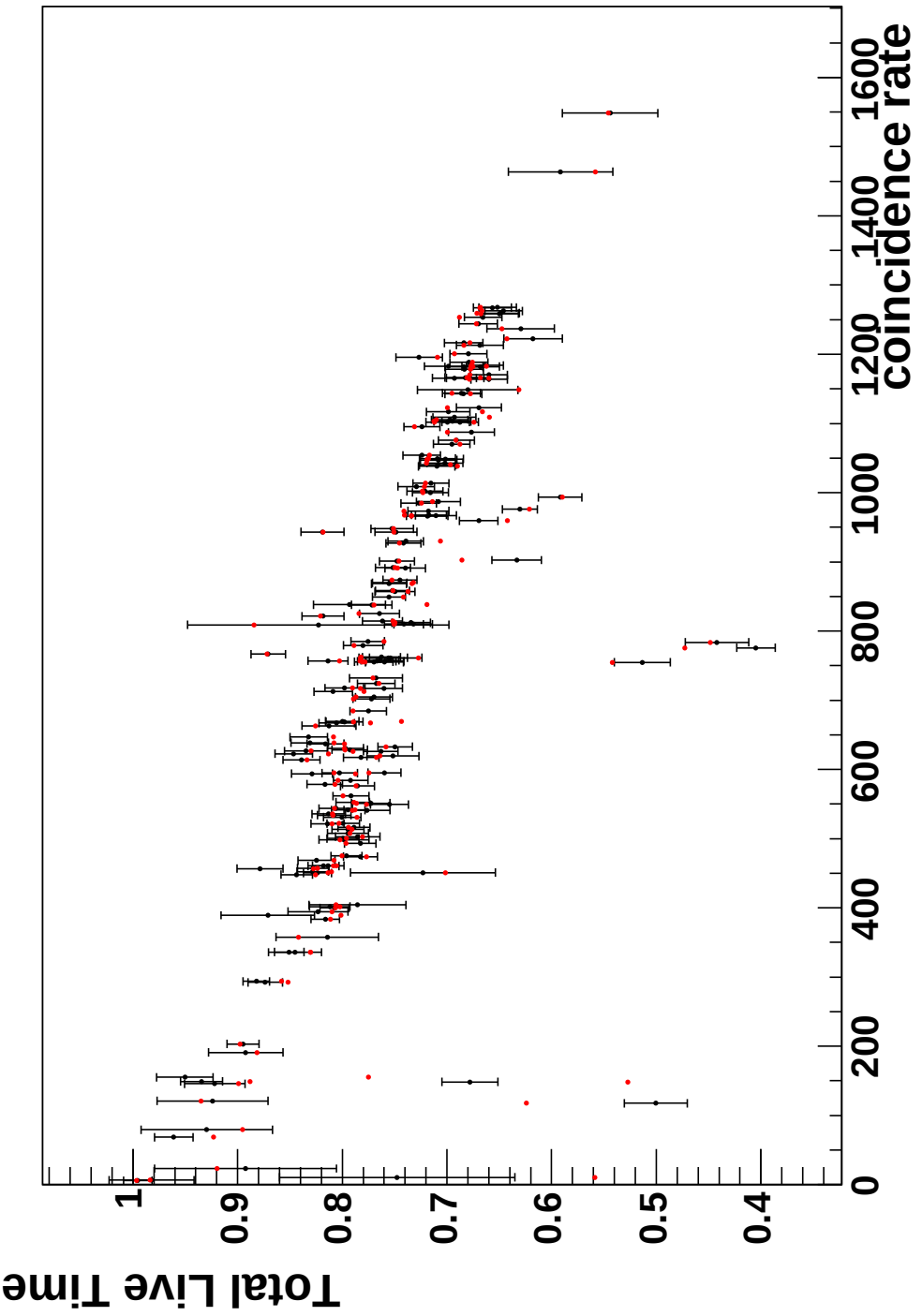

Figure 1: The black points show the total livetime and statistical error as determined by dtchk. The red points show the value determined from the fit parameters d_1 and d_3 and the T1 and T3 trigger rates for the run. The horizontal axis show the T5 trigger rate for the run.

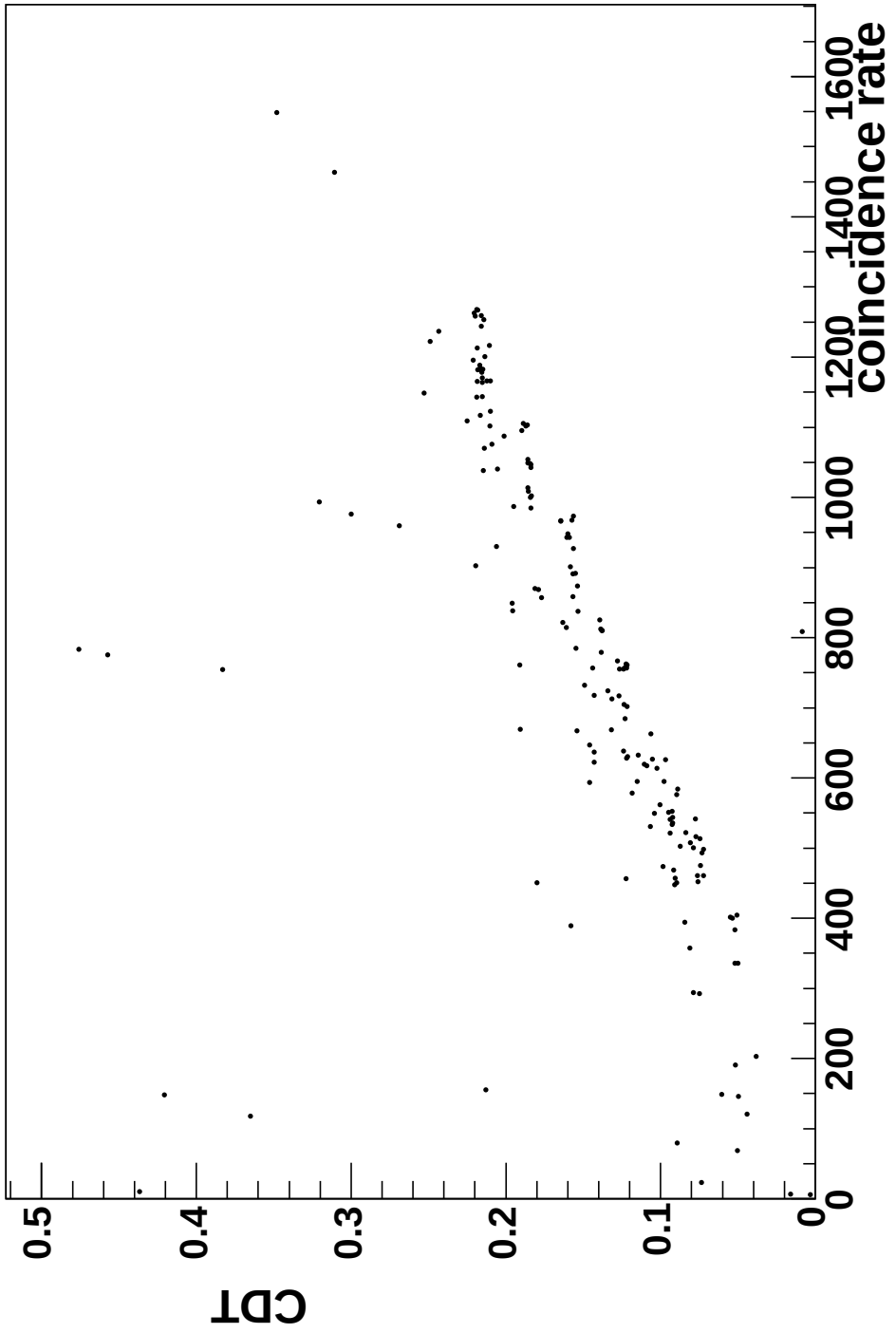

Figure 2: The computer deadtime for each run, plotted against the T5 rate.

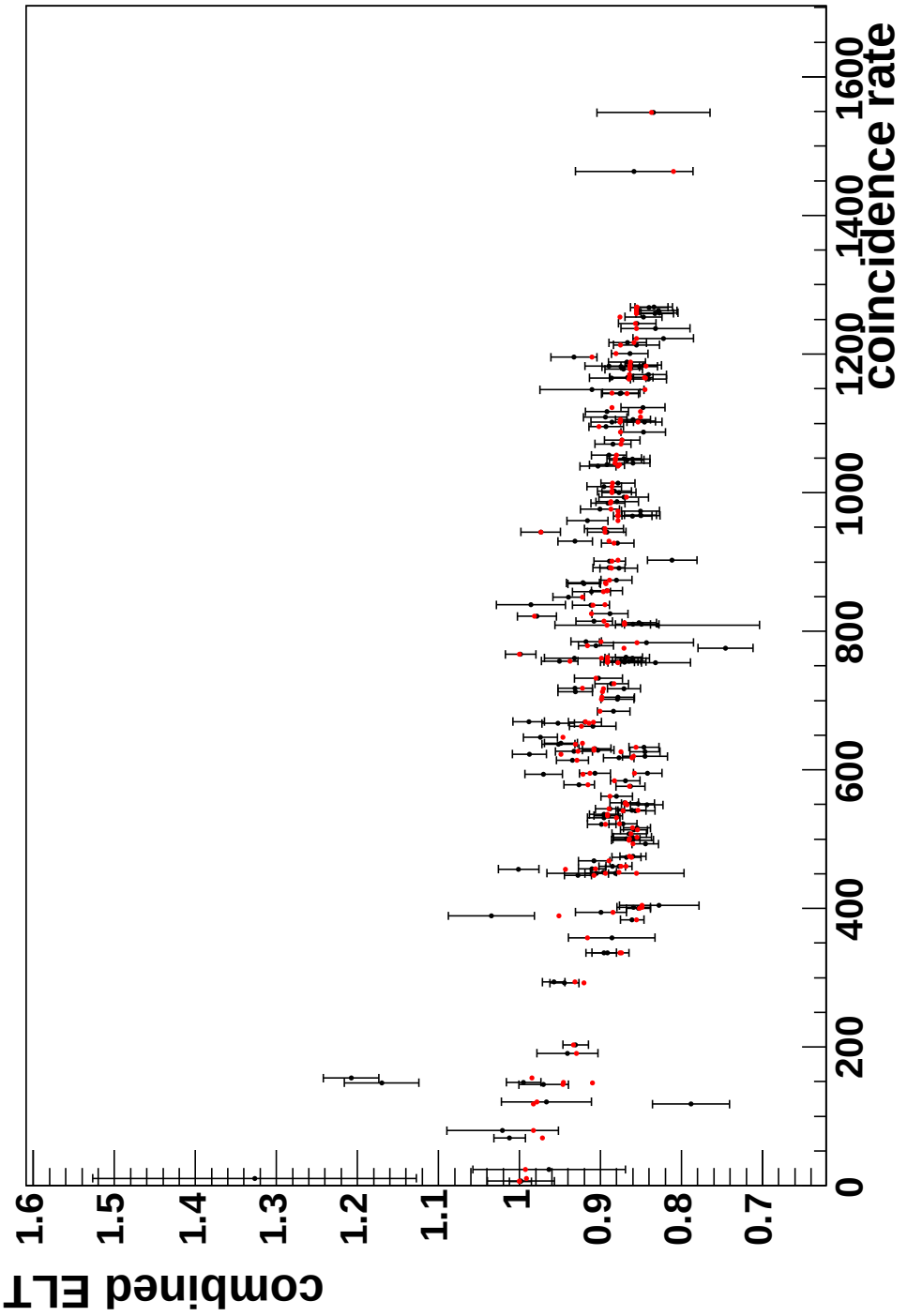

Figure 3: Electronic livetime for each run, plotted against the T5 trigger rate. The black points show the extracted values, and the red line shows $ELT_i = (1 - d_1 R1_i)(1 - d_3 R3_i)$.

We can try to look at the electronic deadtime due to each spectrometer arm separately. We take:

$$1 - EDT1_i = 1 - \frac{TLT_i}{(1 - CDT_i)(1 - d_3 R3_i)} \tag{6}$$

and

$$1 - EDT3_i = 1 - \frac{TLT_i}{(1 - CDT_i)(1 - d_1 R1_i)} \tag{7}$$

The single-arm deadtimes are shown as a function of the single arm rates in Fig 4,5.

The deadtimes seen in any of the figures are much larger than is expected. The size of the fit parameters suggest that somewhere in the electronics there is a component with a gate width on the order of 500-720 nanoseconds. However, no one has been able to identify what component that might be, as all dicriminators, etc, were supposed to be set to have output widths of 100 ns (see document at www.jlab.org/r̃om/edt_annrpt_2001.ps).

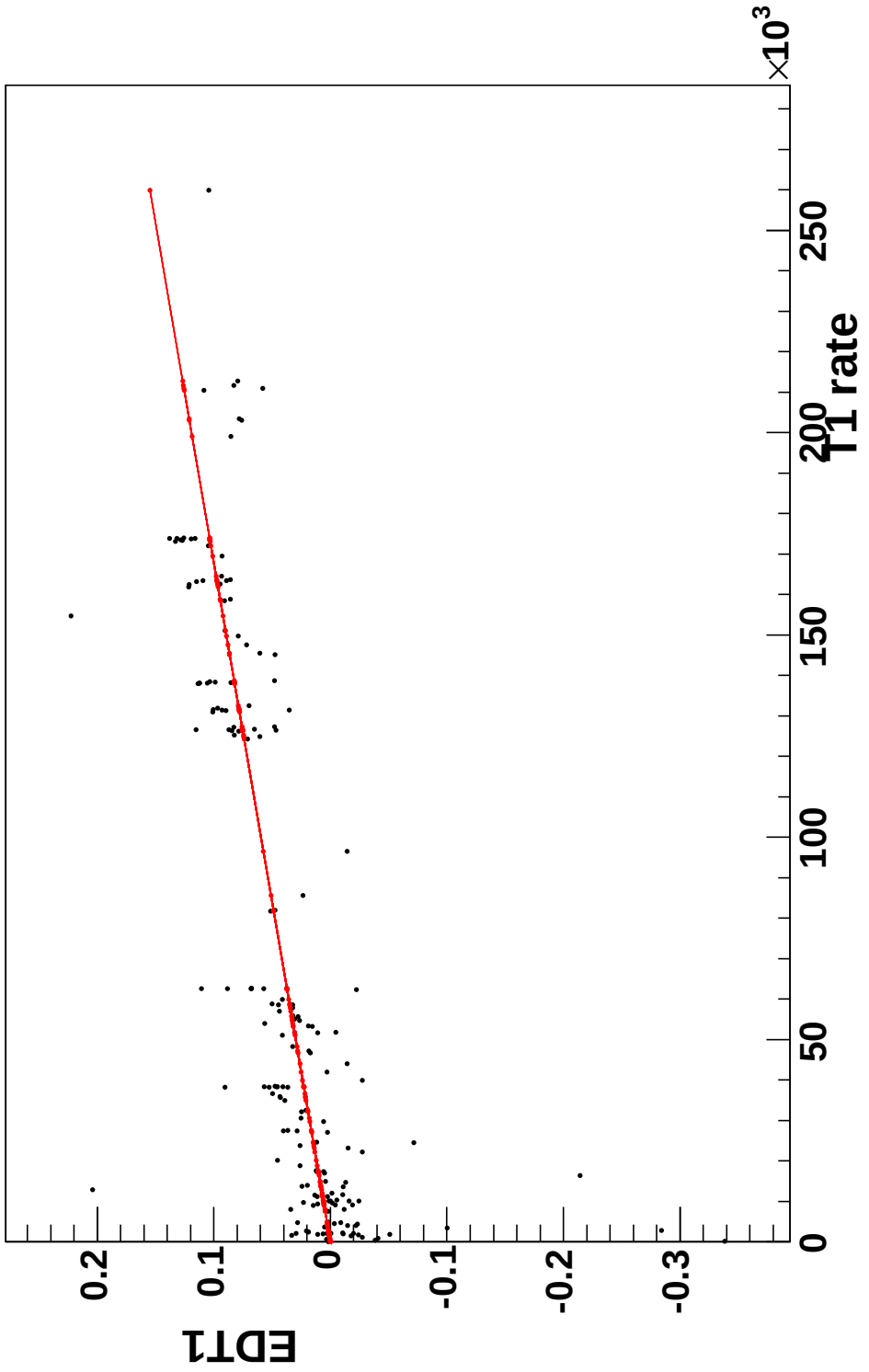

Figure 4: Extracted single-arm deadtime for the right arm, plotted against the T1 trigger rate. The black points show the extracted values, and the red line shows $EDT1_i = d_1 R1_i$.

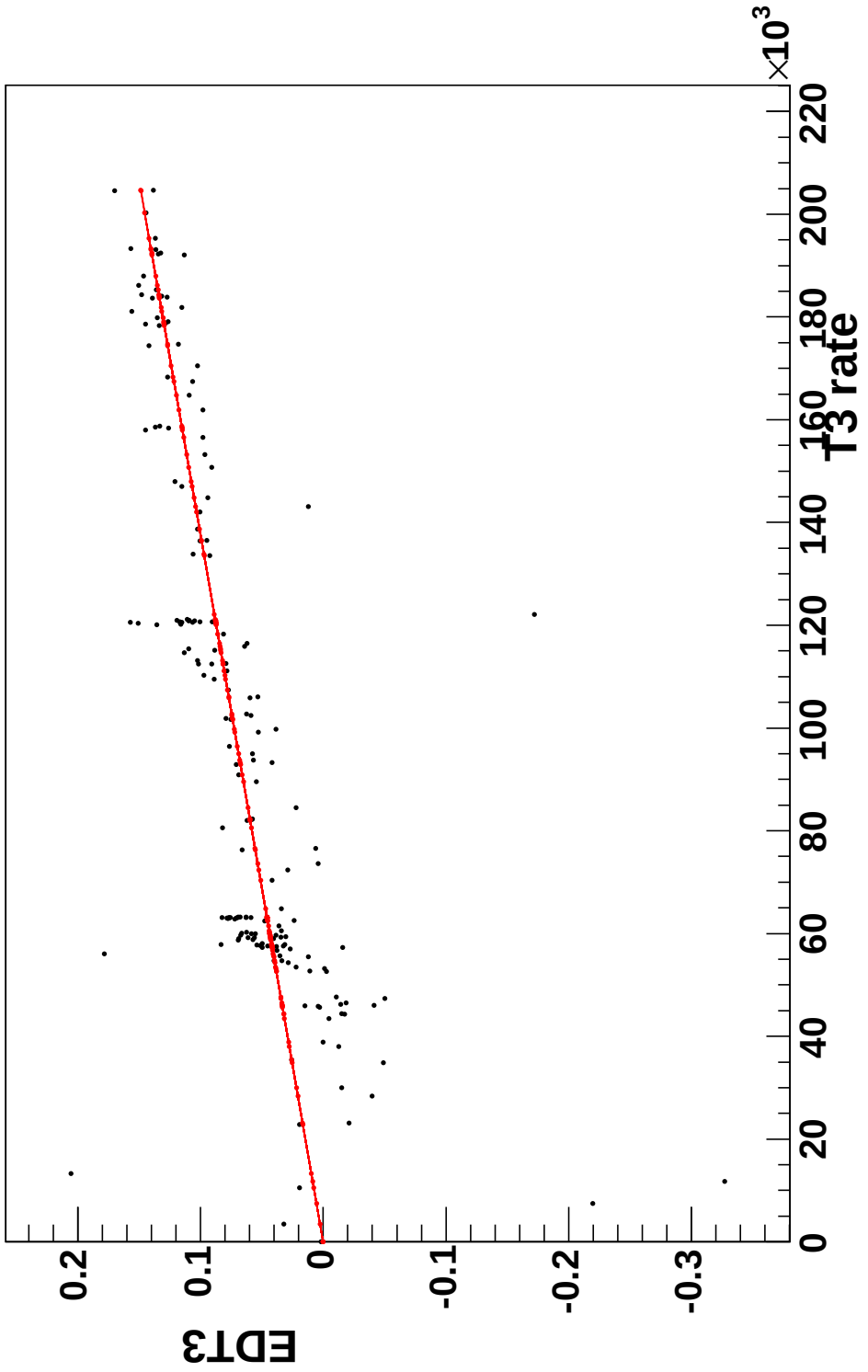

Figure 5: Extracted single-arm deadtime for the left arm, plotted against the T3 trigger rate. The black points show the extracted values, and the red line shows $EDT3_i = d_3R3_i$.