Dead time Analysis

Dead time

Method 1

hccoda@hcvme01:~/hms/hcvme01/hcvme01.c

```
tiSetTriggerHoldoff(1,10,0);   /* 1 trigger in 10*16 nsec */
tiSetTriggerHoldoff(4,7,1);    /* 4 trigger in 7*3840 nsec (26.99 usec) */
```

Rule 1

Rule 4

- 1D histogram for time interval between adjacent events
- The minimum of the time interval is T_{dead}
- N events, total time T
- DT = $\frac{N \times T_{dead}}{T}$ ***Percentage of the time***

Method 2

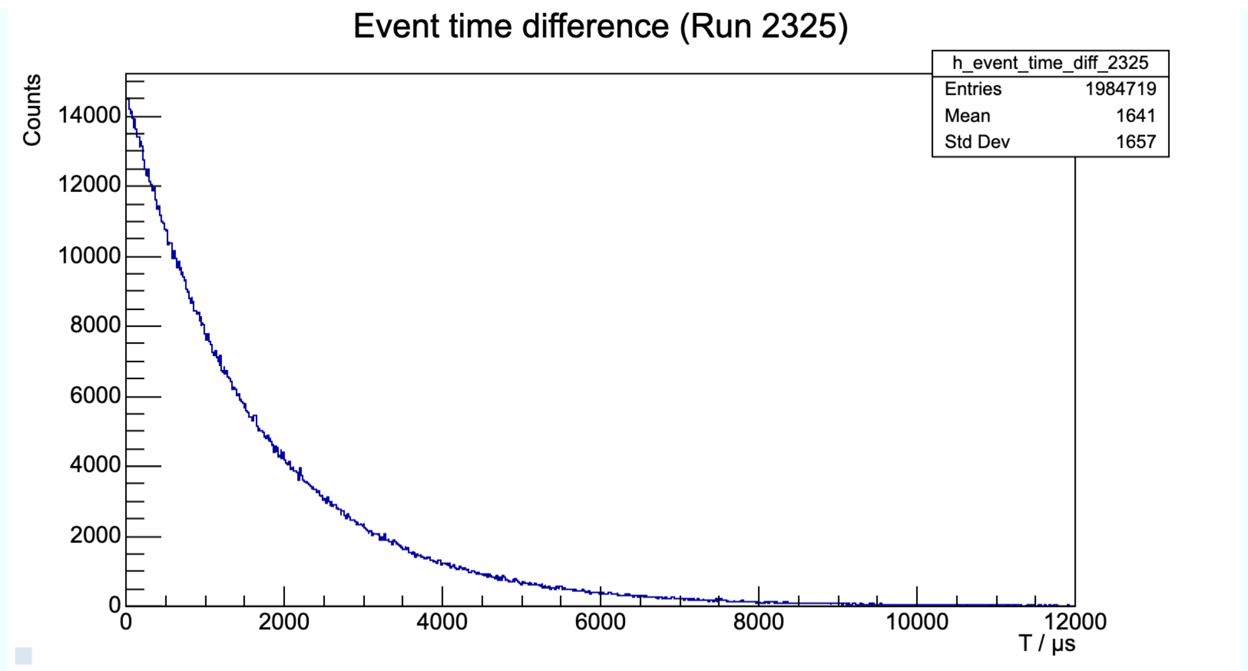
hccoda@hcvme01:~/hms/hcvme01/hcvme01.c

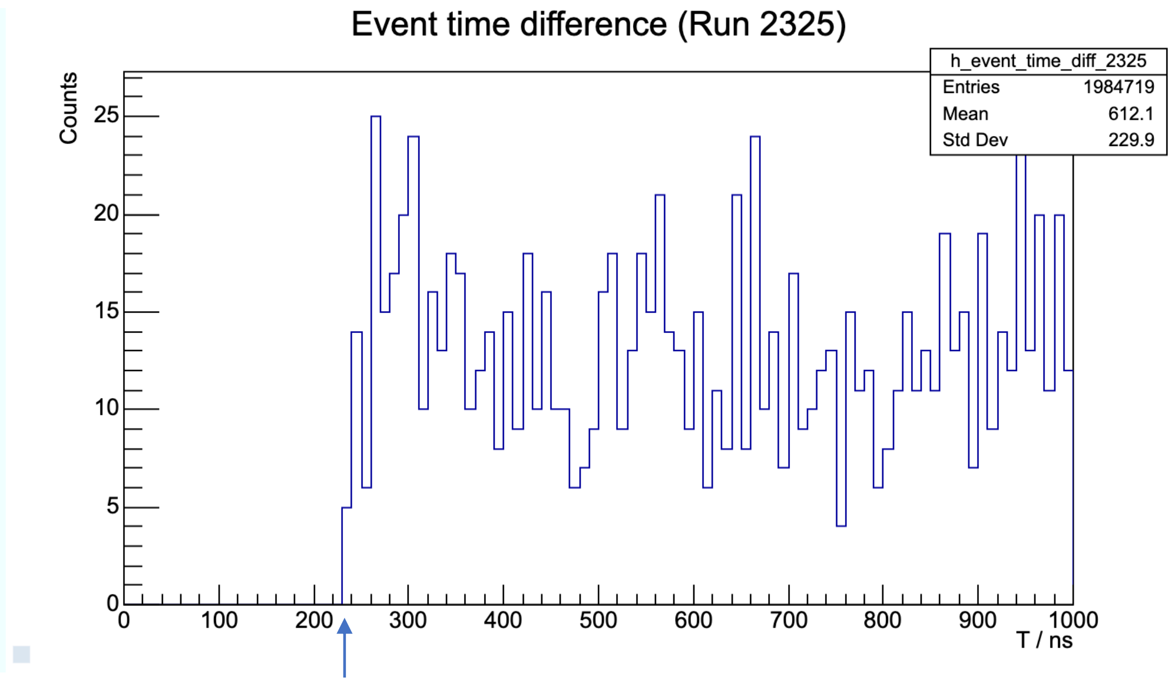
```
unsigned int V1190_TW_OFF = 3970;//changed from 3400(2023/08/23)
unsigned int V1190_TW_WID = 3600;//changed from 3200(2023/08/23)
```

- We can have multiple TDC hits for a single event
- Only the first hit was recorded as an event
- Poisson distribution: $P(N(t) = k) = \frac{e^{-\lambda t}(\lambda t)^k}{k!}$
- Exponential distribution: $P(T > t) = P(N(t) = 0) = e^{-\lambda t}$
- 1D histogram for time interval between adjacent hits
- Fit the histogram to get the λ
- Mathematical expectation: $E\big(N(t)\big) = \lambda t$
- DT = $1 - \frac{1}{\lambda t+1} = \frac{\lambda t}{\lambda t+1}$ ***Percentage of the event counts***

Dead time Analysis

Method 1





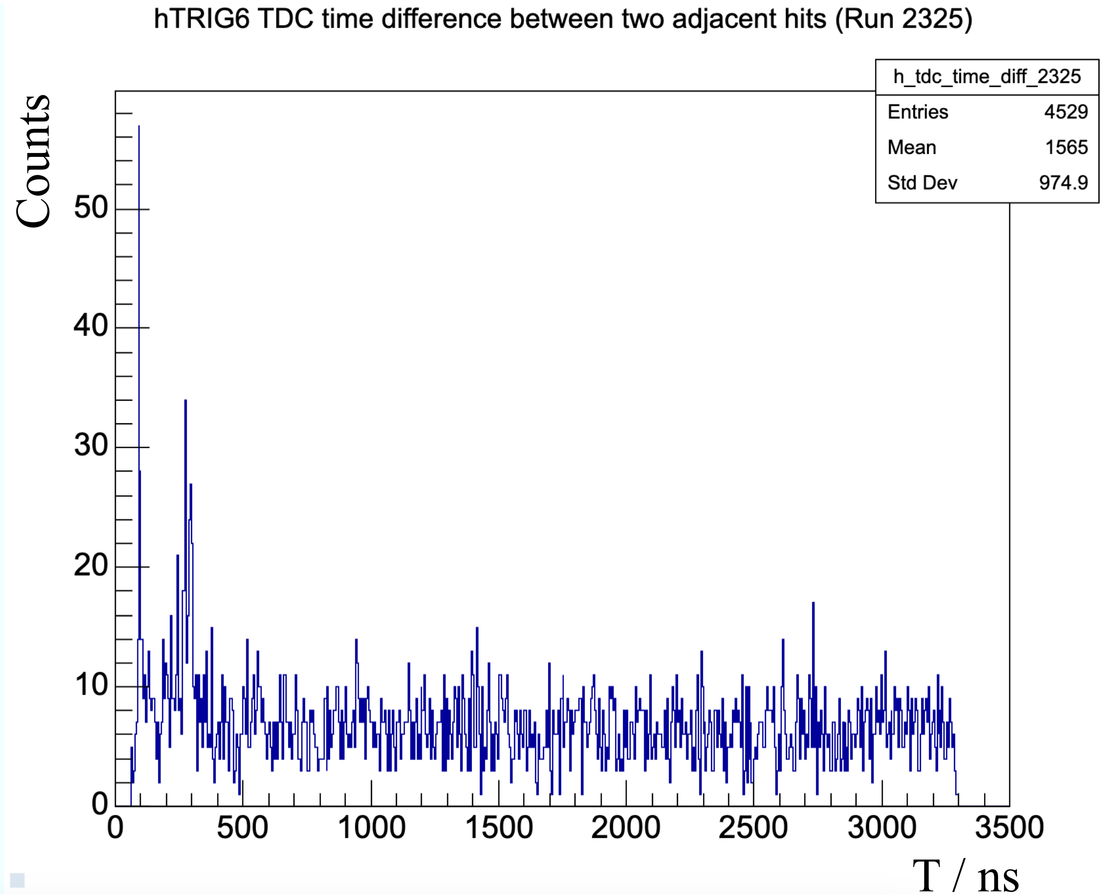
$T_{dead} = 230\,ns$

```
Total events: 2128022
Without EDTM events: 1984720
Total time: 3581.55 second
Dead time per event: 230 ns
Total dead time =  1984720 * 230 / 1e9 = 0.456486 second
Live time (percentage): 99.9873 %
```

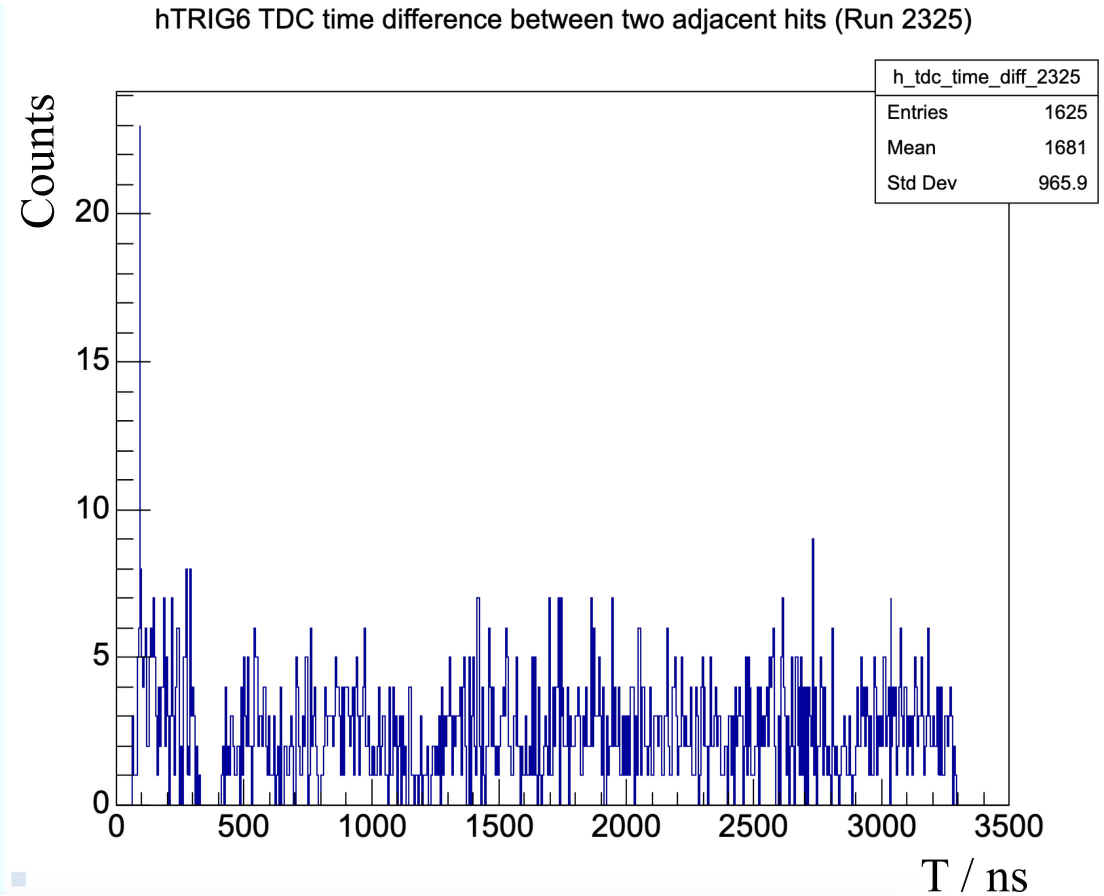
$$\mathrm{LT} = 1 - \frac{N \times T_{dead}}{T} = \frac{1984720 \times 230\,ns}{3581.55\,s} = 99.9873\%$$

Dead time Analysis

Method 2



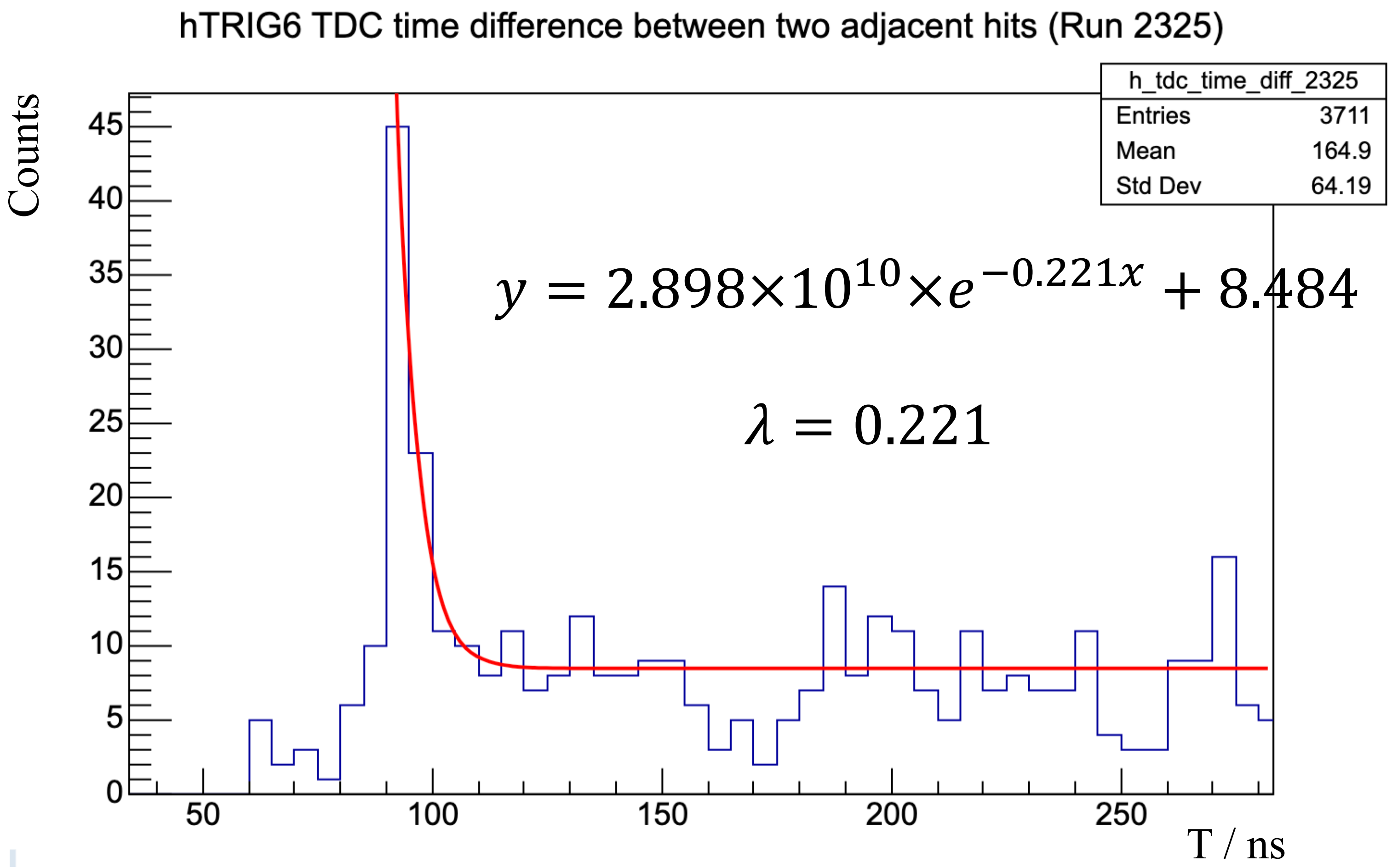
All events



No nclust=0 events

Dead time Analysis

Method 2



$$y = 2.898\times10^{10}\times e^{-0.221x} + 8.484$$

$$\lambda = 0.221$$

$$t = T_{dead} = 230\,ns$$

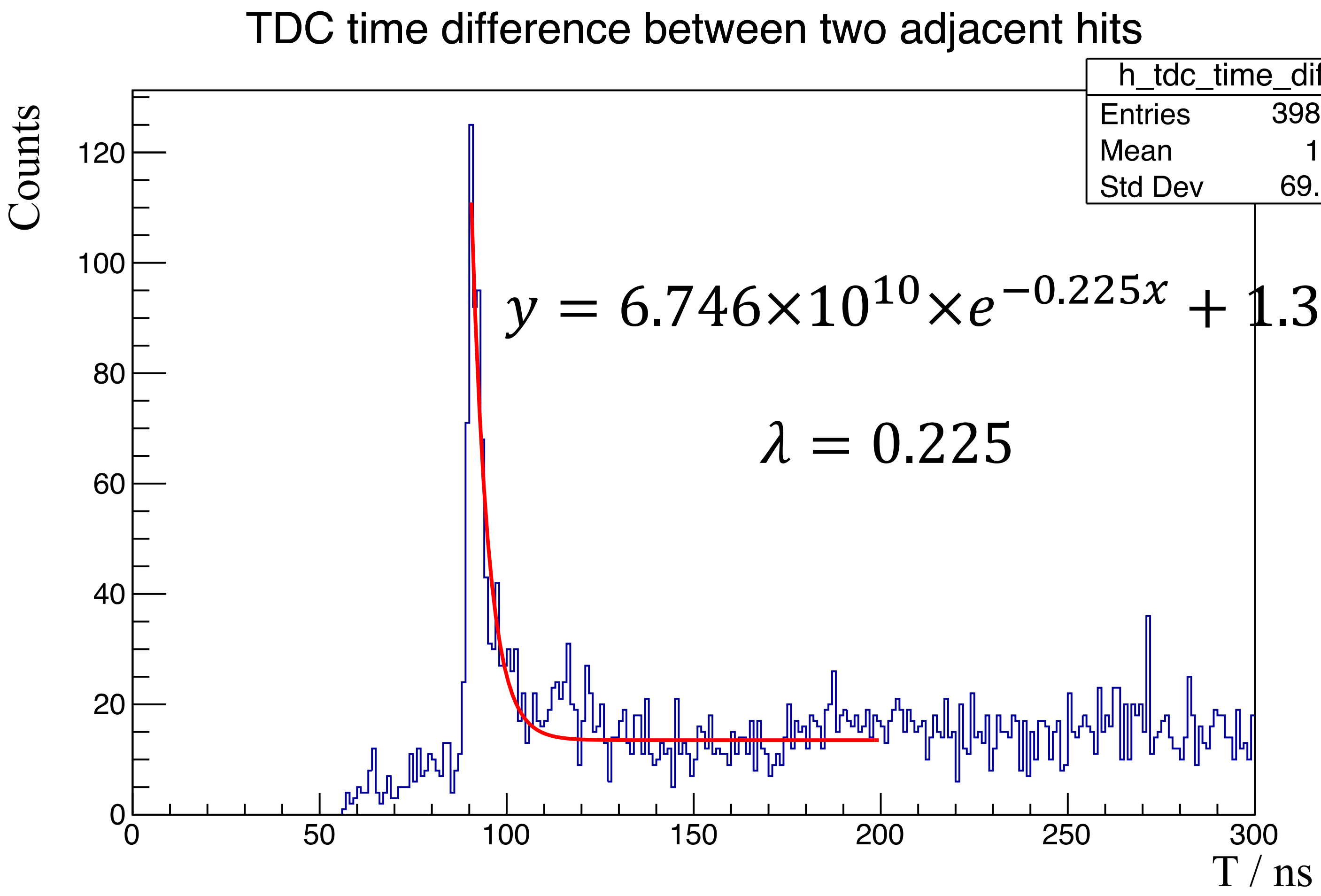
$$\mathrm{DT} = 1 - \frac{1}{\lambda t+1} = \frac{\lambda t}{\lambda t+1} = 98.1\%$$

Dead time Analysis

Data from runs: 2325, 2354, 2375, 2376, 2396, 2398

Kinc_x50_4, LH2, 35uA

Method 2



$$y = 6.746\times10^{10}\times e^{-0.225x} + 1.351$$

$$\lambda = 0.225$$

$$t = T_{dead} = 230\ ns$$

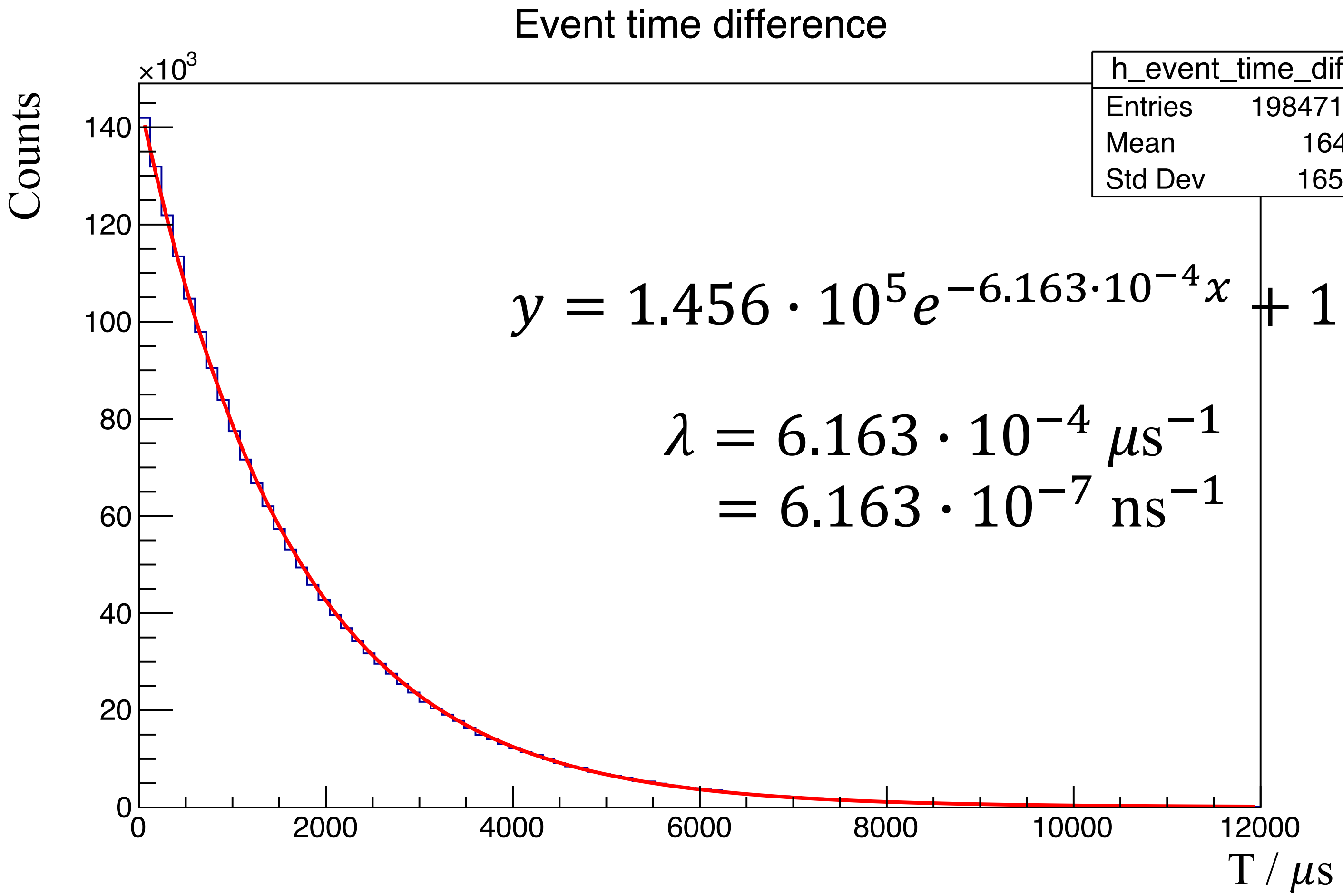
$$\mathrm{DT} = 1 - \frac{1}{\lambda t+1} = \frac{\lambda t}{\lambda t+1} = 98.1\%$$

Dead time Analysis

Data from run: 2325

Kinc_x50_4, LH2, 35uA

Method 2



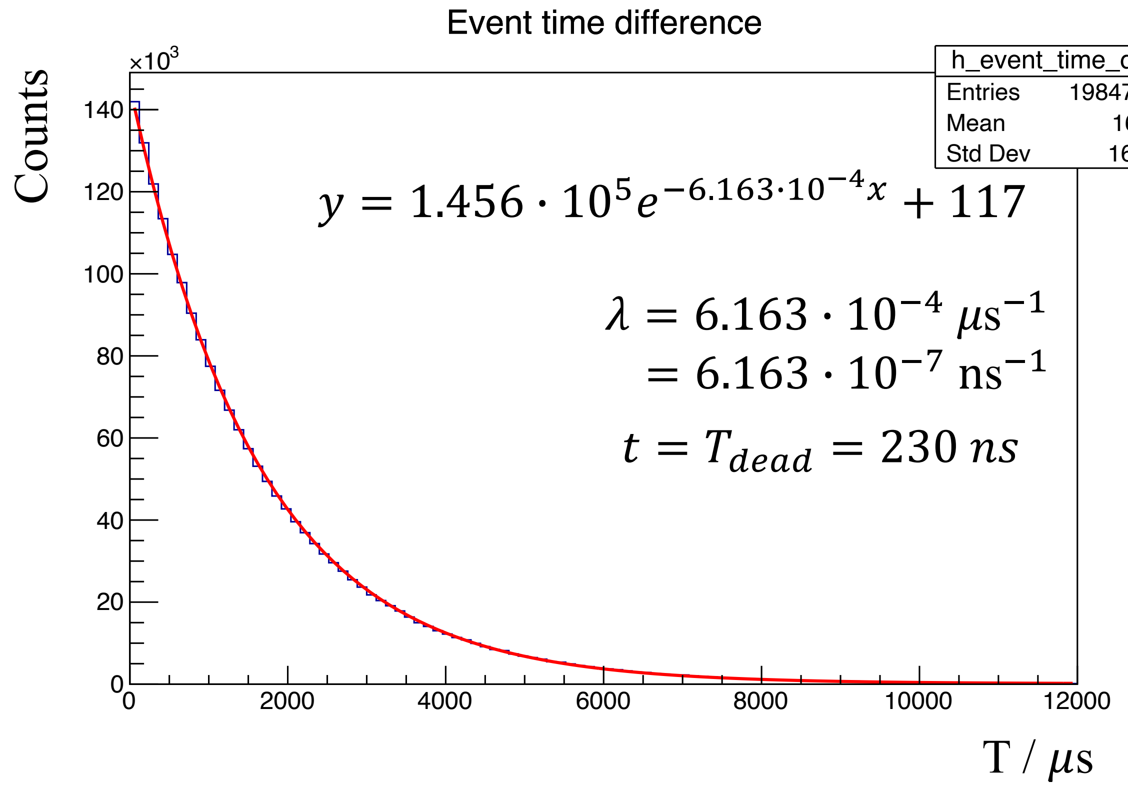
$$y = 1.456 \cdot 10^5 e^{-6.163 \cdot 10^{-4} x} + 117$$

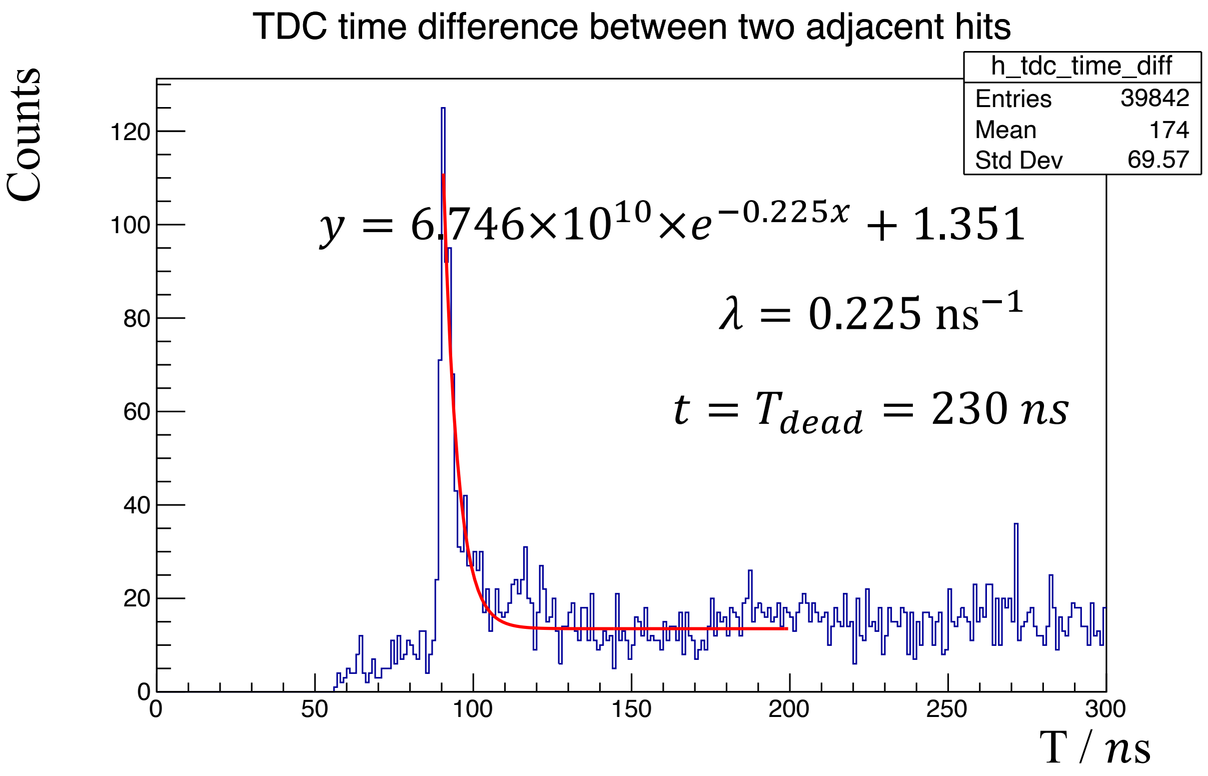
$$\lambda = 6.163 \cdot 10^{-4}\ \mu\text{s}^{-1}$$
$$= 6.163 \cdot 10^{-7}\ \text{ns}^{-1}$$

$$t = T_{dead} = 230\ ns$$

$$\text{LT} = \frac{1}{\lambda t + 1} = 99.9858\%$$

Brief Summary





Method 1: *Percentage of the time*

$$LT = 1 - \frac{N \times T_{dead}}{T} = \frac{1984720 \times 230\ ns}{3581.55\ s} = 99.9873\%$$

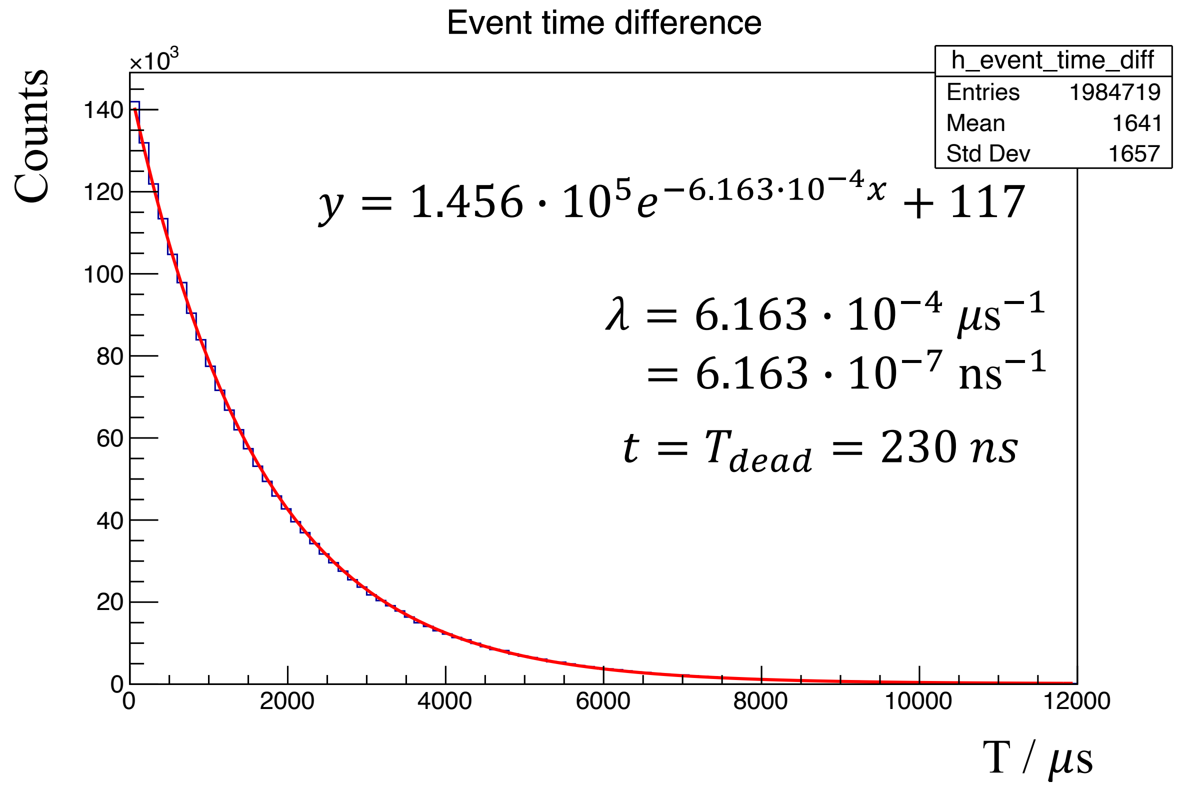
Method 2: *Percentage of the event counts*

$$LT = \frac{1}{\lambda t + 1} = 99.9858\%$$

Method 2: *Percentage of the event counts*

$$LT = \frac{1}{\lambda t + 1} = 1.8957\%$$

Dead time Analysis



Method 1: ***Percentage of the time***

$$\mathrm{LT} = 1 - \frac{N \times T_{dead}}{T} = \frac{1984720 \times 230\ ns}{3581.55\ s} = 99.9873\%$$

Method 2: ***Percentage of the event counts***

$$\mathrm{LT} = \frac{1}{\lambda t + 1} = 99.9858\%$$

For the following plot:

- Kinc_x50_4 (RunNo: 2325-2498)
- All the good coin_sparse runs:
  - ✓ Charge > 1 mC
  - ✓ Fitting error for λ is smaller than 1 μs^{-1}
- Use method 2 to calculate the live time for each run
- Errors are too small so that the error bar is not visible

Dead time Analysis

Kinc_x50_4, good coin_sparse runs