Live time and dead time in RUN4

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Duration of a run

$$T_{\text{run}}^{\text{acquired}} = \left(510\,\text{ms} \times N_{\text{pics}}^{\text{acquired}} + t_{\text{wf}} \times N_{\text{wfs}}^{\text{acquired}} + 510\,\text{ms} \times N_{\text{pics}}^{\text{empty}} \right)$$

Known run by run

Known run by run

Known run by run

Time to readout a single waveform, "unknown"

Number of empty pics, "unknown"

$$510\,\text{ms} = 300\,\text{ms} + \mathcal{O}(180)\,\text{ms} + 30\,\text{ms}$$

exposure of each row

time to open the whole sensor

fixed time we dedicate to the readout of the pictures

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Duration of a run

$$T_{\text{run}}^{\text{acquired}} = \left(510 \text{ ms} \times N_{\text{pics}}^{\text{acquired}} + t_{\text{wf}} \times N_{\text{wfs}}^{\text{acquired}} + 510 \text{ ms} \times N_{\text{pics}}^{\text{empty}} \right)$$

Known run by run

Known run by run

Known run by run

Time to readout a single waveform, "unknown"

Number of empty pics, "unknown"

N.B. if the trigger rate is much higher than 1/510 ms ($\sim$ 2 Hz) then we can safely assume that $N_{\text{pics}}^{\text{empty}} \simeq 0$

Estimation of t_{wf} from the calibration runs

Using 30 calibration run with iron (not strongly collimated, measured TR ~ 80 Hz)

```
∨ runs = [45414, 45415, 45416, 45417, 45418, 45254, 45254, 45256, 45257, 45258, 45636, 45637, 45638, 45639,
          45640, 46069, 46070, 46071, 46072, 46073, 46227, 46228, 46229, 46230, 46231, 46384, 46385, 46386,
          46387, 46388]
```

$$T_{\text{run}}^{\text{acquired}} = \left(510 \text{ ms} \times N_{\text{pics}}^{\text{acquired}} + t_{\text{wf}} \times N_{\text{wfs}}^{\text{acquired}} + \cancel{510 \text{ ms} \times N_{\text{pics}}^{\text{empty}}} \right)$$

$$< t_{\text{wf}} > = < \frac{T_{\text{run}}^{\text{acquired}} - 510 \text{ ms} \times N_{\text{pics}}^{\text{acquired}}}{N_{\text{wfs}}^{\text{acquired}}} >$$

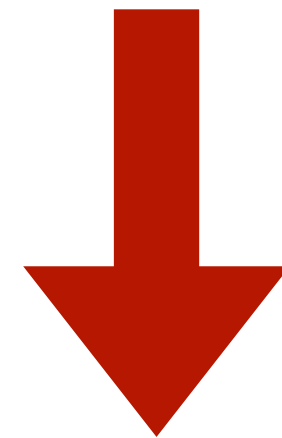# **Estimation of t_{wf} from the calibration runs**

$$< t_{\mathrm{wf}} > = < \frac{T_{\mathrm{run}}^{\mathrm{acquired}} - 510 \text{ ms} \times N_{\mathrm{pics}}^{\mathrm{acquired}}}{N_{\mathrm{wfs}}^{\mathrm{acquired}}} >$$
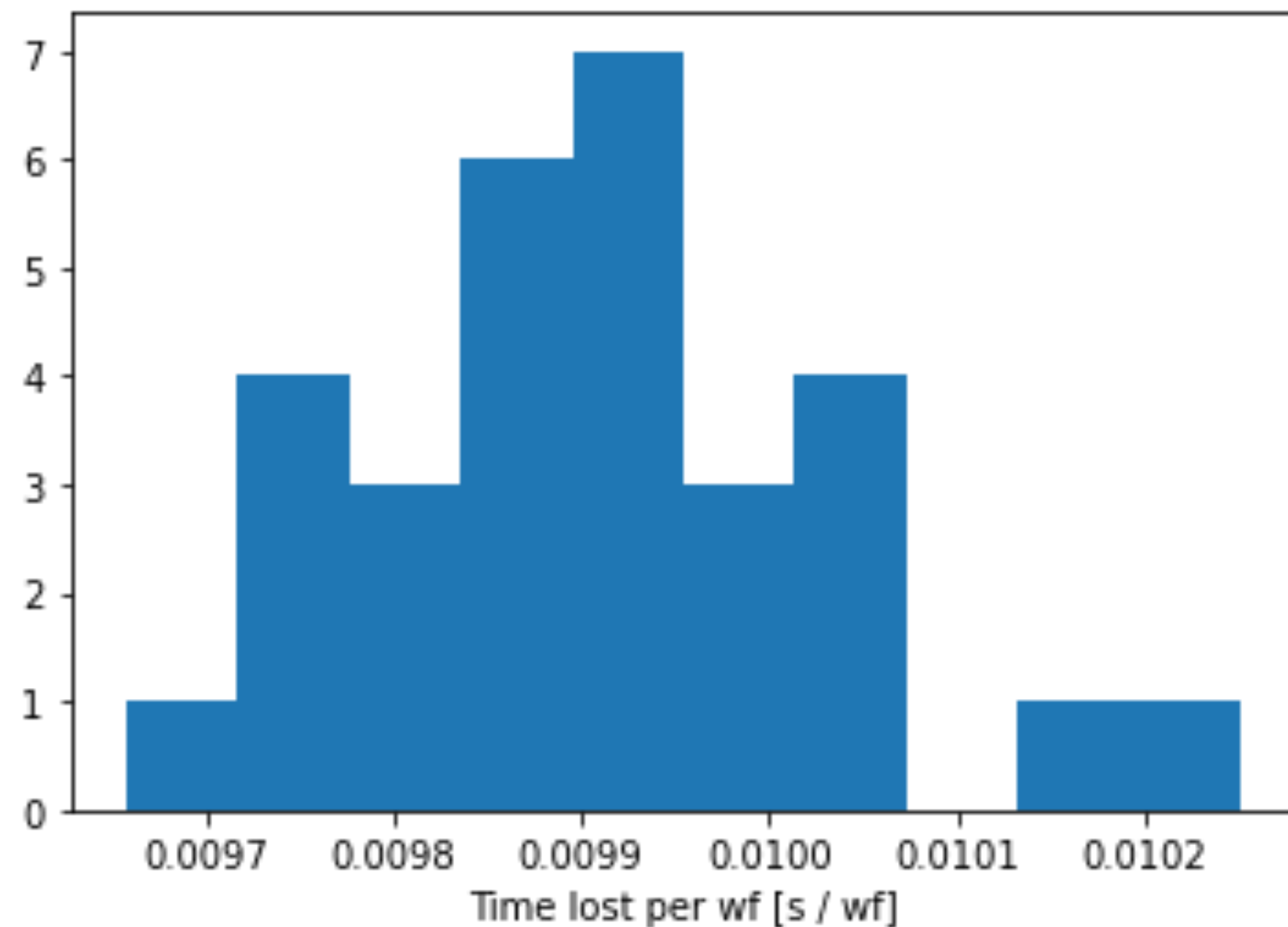
$$< t_{\mathrm{wf}} > = \left(9.906 \pm 0.022\right) \text{ ms}$$

Duration of a run

$$T_{\text{run}}^{\text{acquired}} = \left(510 \text{ ms} \times N_{\text{pics}}^{\text{acquired}} + t_{\text{wf}} \times N_{\text{wfs}}^{\text{acquired}} + 510 \text{ ms} \times N_{\text{pics}}^{\text{empty}} \right)$$

$$T_{\text{run}}^{\text{acquired}} \simeq \left(510 \text{ ms} \times N_{\text{pics}}^{\text{acquired}} + <t_{\text{wf}}> \times N_{\text{wfs}}^{\text{acquired}} + 510 \text{ ms} \times N_{\text{pics}}^{\text{empty}} \right)$$

Known run by run

Known run by run

Known run by run

Time to readout a single
waveform, **measured**

Number of empty pics,
"unknown"

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Estimation of the empty pics

$$T_{\text{run}}^{\text{acquired}} \simeq \left(510 \text{ ms} \times N_{\text{pics}}^{\text{acquired}} + <t_{\text{wf}}> \times N_{\text{wfs}}^{\text{acquired}} + 510 \text{ ms} \times N_{\text{pics}}^{\text{empty}} \right)$$

$$N_{\text{pics}}^{\text{empty}} \simeq \frac{T_{\text{run}}^{\text{acquired}} - 510 \text{ ms} \times N_{\text{pics}}^{\text{acquired}} - <t_{\text{wf}}> \times N_{\text{wfs}}^{\text{acquired}}}{510 \text{ ms}}$$
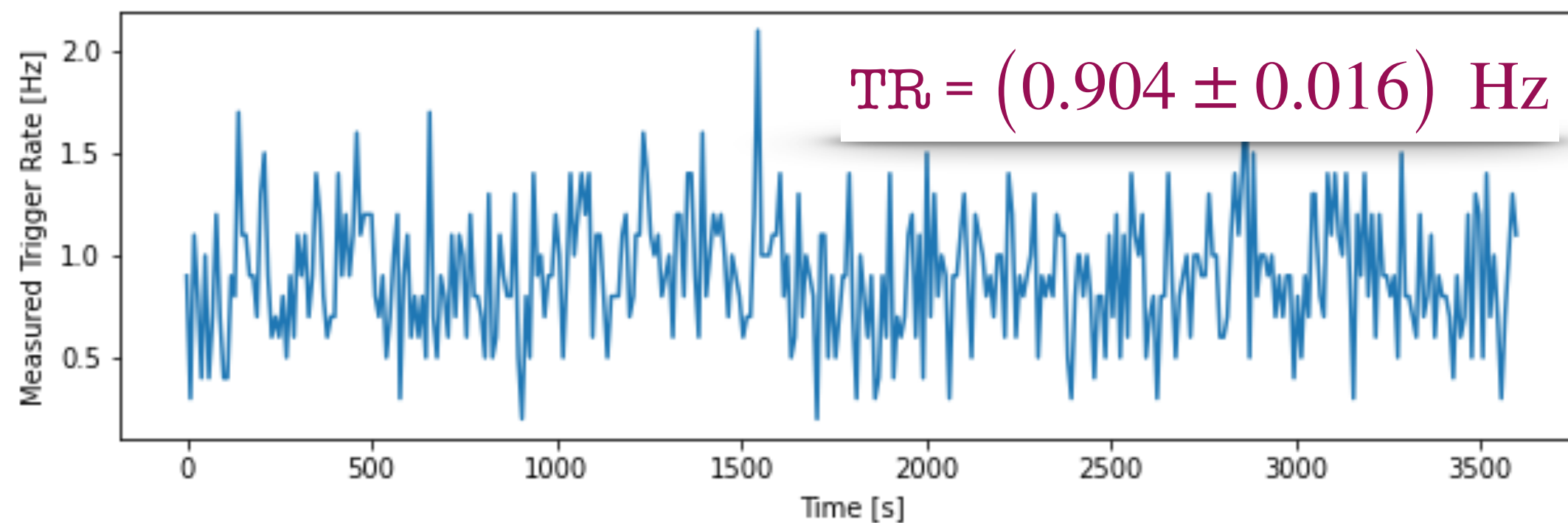
Example and crosschecks

```
run 48057: =============
Total duration: 602.0 s
Total pics collected: 400
Total wfs collected: 492
Total time lost for the acquired pics: 204.0 s
Total time lost for the acquired wfs:  6.2 s
Estimated number of lost pics: 771
```

Trigger Rate (TR) as measured by the Trigger module

$\text{TR} = (0.904 \pm 0.016)\ \text{Hz}$

- Assuming a $\sim 10\%$ inefficiency in the PMT acquisition (from simulation of the DAQ logic):

$$N_{\text{wfs}}^{\text{acq., exp}} = T_{\text{run}}^{\text{acq.}} \times \text{TR} \times 90\,\%$$

$$= 490 \pm 9$$

$$N_{\text{wfs}}^{\text{acq.}} = 492 \pm 22$$

Example and crosschecks: camera

```
run 48057: ==============
Total duration: 602.0 s
Total pics collected: 400
Total wfs collected: 492
Total time lost for the acquired pics: 204.0 s
Total time lost for the acquired wfs:  6.2 s
Estimated number of lost pics: 771
```

$$T_{\text{pics}}^{\text{tot}} = T_{\text{run}}^{\text{acq.}} - <t_{\text{wf}}> \times N_{\text{wfs}}^{\text{acq.}} \sim 598 \text{ s}$$

$$N_{\text{tracks}}^{\text{exp}} \gtrsim T_{\text{pics}}^{\text{tot}} \times \text{TR} \times \text{FV} \times \frac{300 \text{ ms}}{510 \text{ ms}} \sim 260$$

Trigger Rate (TR) as measured by the Trigger module

$$\text{TR} = (0.904 \pm 0.016) \text{ Hz}$$
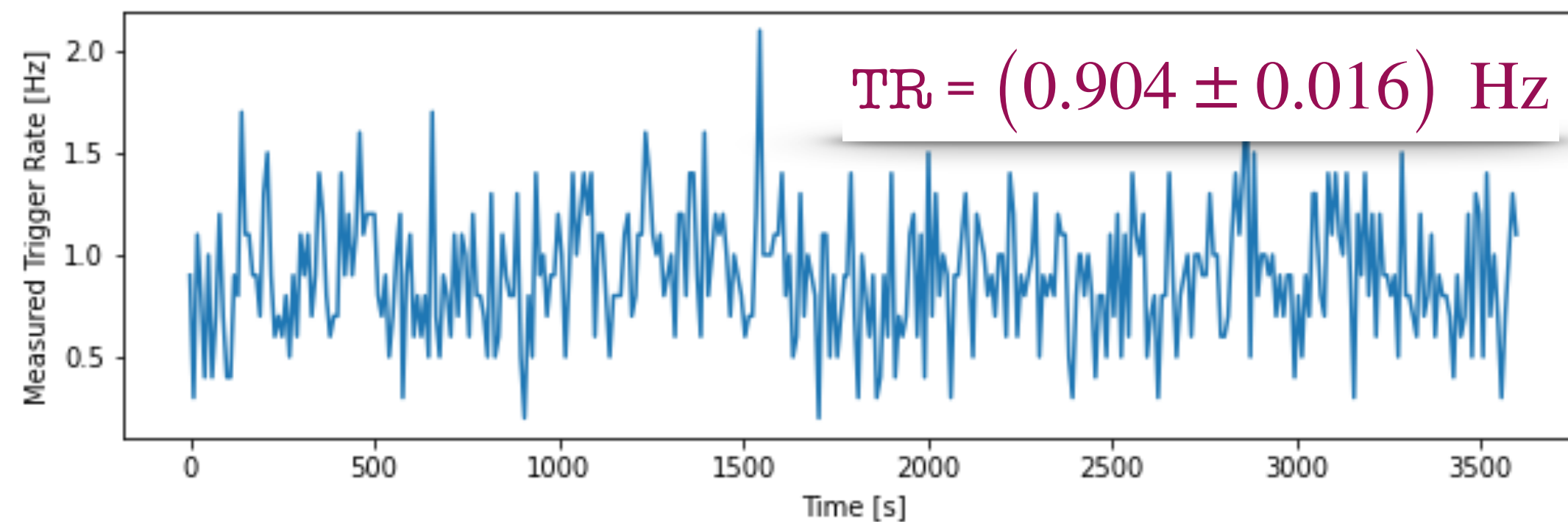
- Applying the usual quality cuts:
  - ◉ sc_rms > 6
  - ◉ sc_tgausssigma > 0.5 / 0.152

$$N_{\text{tracks}}^{\text{acq.,cut}} = 287$$

Dead time for spotlike tracks due to the partial exposure of the sensor