2.3 Improving HRS DAQ Deadtime

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2.3.1 Deadtime Overview

In a simple 1-trigger, non-prescaled system the DAQ deadtime is approximately

$$DT \approx D_r + D_c\,, \tag{1}$$

where D_r is the readout deadtime, and D_c is the conversion (frontend) deadtime [1]. Using Poisson probability theory, the two deadtime components can be broken down into two infinite sums:

$$D_c = \sum_{n=1}^{\infty} \frac{\mu_c^n e^{-\mu_c}}{n!}\,, \tag{2}$$

$$D_r = \sum_{n=1}^{\infty} \frac{\mu_r^{b+n} e^{-\mu_r}}{(b+n)!}\,, \tag{3}$$

where $\mu_c = R\tau_c$, $\mu_r = R(\tau_r - \tau_c)$, R is the rate, τ_c is the conversion time, τ_r is the readout time and b is the buffer factor [1]. The conversion time is fixed and module dependent. The readout time depends on the number of modules being read out and whether the readout is done via block reads or single module reads. When running the DAQ at low to moderate rate in buffered mode, b = 8, the buffer factor reduces the the readout contribution to the overall deadtime. The deadtime is then dominated by the conversion time. As the rate increases the probability of a full buffer also increases and the readout time begins to dominate the deadtime.

2.3.2 Improving Deadtime

Experiments typically aim for a maximum of 20% dead time. In the past, this translated into a maximum non-prescaled acceptable DAQ rate of ~ 4 kHz. To increase the rate, a third Fastbus crate was added to the Left HRS. By distributing the module population throughout the three crates, the readout time of each was decreased, resulting in an improvement in the rate from 4 kHz to 6 kHz while maintaining comparable deadtime.

2.3.3 Deadtime Testing

The updated DAQ system was tested during commissioning for experiment E08-027. During the test the DAQ consisted of a Happex crate, three Fastbus crates and a Trigger Supervisor crate for scalers. The results in Table 3 highlight the 6 kHz improvement. Also using Eq. 2 and Eq. 3, we were able to model the deadtime. The model, plotted in Figure 13, compares favorably with the experimental data. As a comparison, the performance of two Fastbus crates is also presented for the Right HRS; the results are shown in Table 4 .

References

[1] R. Michaels, private communication.

Table 3: LHRS Deadtime. Included are the conversion and readout times used in the model in Figure 13. Note: The Happex and TS Scaler crates cannot be buffered; they operate on their own branch of the TS. The busy time listed for these components is the total busy time, and we have labeled it as the "readout" time.

Trigger Rate (kHz)	Deadtime (%)	Crate	τ_c (μs)	τ_r(μs)
14.2	49	TS/Happex		36
7.3	29	Fastbus	12	90
6.5	24			
5.3	20			
4.2	15			
3.2	12			

Table 4: RHRS Deadtime with two Fastbus crates, Happex crate and TS scaler crate.

Trigger Rate (kHz)	Deadtime (%)	Crate	τ_c (μs)	τ_r(μs)
19.5	60	TS/Happex		44
7.4	31	Fastbus	12	100
5.7	25			
4.4	20			

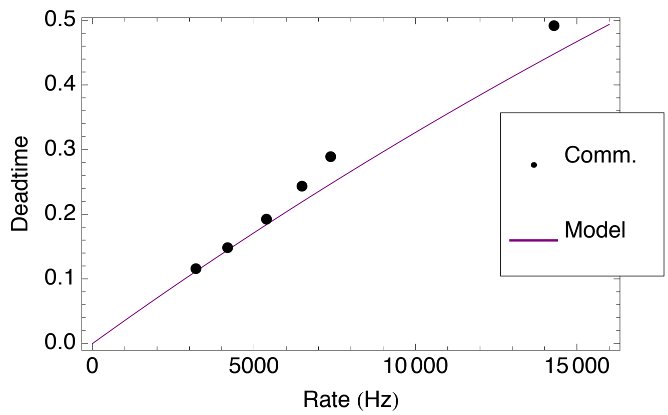

Figure 13: LHRS Deadtime with model prediction. The total deadtime is then a sum of the TS/Happex crate and slowest Fastbus crate.