PHENIX Technical Note

PHENIX Data Acquisition Performance Measurements

John S. Haggerty
Physics Department
Brookhaven National Laboratory

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Abstract

The data acquisition rate of individual granules in PHENIX have been measured.

A systematic program of measuring speeds from PHENIX granules was undertaken to check the data integrity and to measure the speed at which data can be transmitted to the Sub-Event Buffer.

1 Method

The speed of taking data from individual DCMGROUP's was measured by running a granule in standalone using the dcm and gtm commands. (A DCMGROUP is a group of DCM's with one Partition Module; a group of DCMGROUP's constitutes a granule.) Granules were first run with standalone run control to verify that they were functional.

1.1 GTM Configuration

The GTM file was modified so that it had the maximum possible rate of Forced Accepts, which was accomplished by adding a sequence of one Forced Accept every five clock ticks (a total of 24 Forced Accepts every 120 tick turn). The GTM files were called "GTM.granule.FA.FAST." Generally, the tests described here were done with single event buffering in the FEM's, which restricts the rate of Level 1 Accepts to a frequency f of

$$f = \frac{9200 \text{ kHz}}{(t_{Convert} + n_{ENDAT} t_{ENDAT})} \tag{1}$$

with the Master Timing Module internal clock, where $t_{Convert}$ is the FEM Conversion Time in clock ticks, n_{ENDAT} is the number of ENDAT's, and t_{ENDAT} is the length of the ENDAT time in clock ticks. (Note there is often confusion about setting the number of ENDAT's, since the register in the GTM is $n_{ENDAT} - 1$.) For the "standard" defaults of 40 μs, this gives a readout deadtime of 120 μs which corresponds to a rate of about 8.3 KHz. This was checked by removing the DCM BUSY's from the GTM to verify that the GTM behaved as expected.

1.2 DCM Configuration

The DCM was set up normally, except the pcf file was processed with the flag "-DPAR_JSEB" so that data would be sent through the Partition Module to the JSEB.

1.3 SEB Configuration

Test programs run in a dedicated SEB were used to read the data through the JSEB interface. These programs have been described elsewhere [1]. The programs readdata and jsebdaq were used to read data from a DCMGROUP. The number of events per JSEB bank was set to 100, and bank full was determined by polling in a tight loop. Data were checked for integrity with badjseb and dcmchecksum.

1.4 Timing

Many of the early measurements of speed were made by stopping triggers by turning on the VME Busy in the GTM and measuring the number of triggers taken during an interval measured with a stopwatch. Later measurements were taken with a script (gtmtime.pl) which cleared the VME busy, slept for a fixed period, and set the VME busy again, with the sleep time measured by the high resolution timer function of gettimeofday.

2 Performance with PHENIX DCM Groups

2.1 GL1

The GL1 differs from other granules in that data are not transmitted to the DCM by a glink fiber, and the readout is not controlled by the GTM's FEM Convert Time and ENDAT time. The maximum rate of Level 1 Accept's is restricted by the "dead-for-four" rule which limits the instantaneous rate of triggers to $\frac{1}{5}$ of the beam crossing rate and the "Governor Busy," which limits the total rate to 25 kHz.

With a Forced Accept rate of 20 kHz and GL1 and GL1p data only, the measured rate of reading GL1 data with readdata and jsebdaq was 6.5 kHz. When the readout of the BB, ZDC/NTC, and MUID.S H and V Local Level

1 (LL1) boards was include in the readout, the maximum rate of reading GL1 and LL1 boards was found to be 3.5 kHz.

2.2 BB

The rate of Level 1 Accepts was 8.3 kHz, consistent with the FEM Convert Time of 370 and ENDAT time of 370 ticks. The NTC FEM had a glink lock problem during these tests, so only the BB FEM's were read out, so a single DCM channel was in use. The JSEB read 573 words per event (including all headers).

The speed with both readdata and jsebdaq was about 5.2 kHz. About a million events were logged by jsebdaq and checked with badjseb and dcmchecksum before hitting the two gigabyte file size limit. No errors were reported.

The BB is actually multiplexed one, so one could reach a higher rate of Level 1 accepts by setting the number of ENDAT's to 0 in the gtm menu. With this configuration, Level 1 accepts were sent at a rate of 12.2 kHz. However, the rate of data taking by the test programs remained about 5 kHz.

Setting the number of events per JSEB bank to 1 resulted in a measured rate of 3 kHz.

2.3 MUID.S

The rate of Level 1 Accepts was 8.3 kHz, consistent with the FEM Convert Time of 370 and ENDAT time of 370 ticks. The JSEB read 204 words per event (including all headers).

The speed measured by readdata and jsebdaq was basically the same as the rate of Level 1 accepts (8.2 kHz), consistent with the absence of any busy except the Count-N busy visible to casual inspection. About 2.5 million events were logged and checked with dcmchecksum and badjseb.

Setting the number of events per JSEB bank to 1 resulted in a measured rate of 2.8 kHz.

2.4 PC.W

The PC FEM was set up with Miljko Bobrek's latest FPGA code, which can run with multievent buffering in the FEM enabled. Level 1 triggers occurred with a 5 event burst every 140 μs, or 5×7.1 kHz. With no zero suppression, the JSEB read 6918 words (including all frame and packet headers, and padding bank); with zero suppression on, but not tuned in any way, there were about 1940 words/event.

The data could be logged with jsebdaq at about 1.4 kHz non-zero suppressed, and 4.6 kHz zero suppressed. However, the zero suppressed data could be read by readdata at about 6.7 kHz, suggesting a limitation of the local disk used to log the data.

2.5 EMC.W.B

The Run 3 EMCAL FPGA code was used in the EMC.W.B granule, which resulted in a maximum rate of Level 1 Accepts of 5.1 kHz. Zero suppression was on, although not tuned, and the event length was approximately 1000 words.

Data could be logged by jsebdaq at a maximum of about 4.9 kHz, although readdata was slightly faster, at 5.1 kHz.

2.6 Conclusion

The systems tested indicate that it should be possible to push data into the SEB's at 5-6 kHz, although it is important to measure the performance of granules one by one to make sure that there is no bottleneck in any one of them. The granules that have been tested have shown a very low data error rate in the DCM checksum and the padding bank with JSEB version 0x13 firmware.

The data rate that can actually be sustained with all the granules is hard to predict. Although all the granules are buffered quite deeply both in the JSEB and the SEB memory, it is still possible that there are limitations beyond what has been measured here. There are many things to study to understand the ultimate rate limitations, from the GTM firmware and the behavior of the FEM's with conversions stacked up with readout, through the DCM and Partition Module capability to transmit data and perform zero suppression, to the operation of the JSEB in burst mode, the network performance of the SEB, and possible contention between network and JSEB operations.

References

[1] J. Fried and J. Haggerty, PHENIX Technical Note.