

## Implementation of Sparse Readout with USB CAMAC Crate Controller

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### Introduction

In the field of high energy Nuclear physics based experiments, Data Acquisition programs are used to interface various pulse processing electronics with the user. Considering the requirements of data acquisition systems for Accelerator based experiments USB based Fast CAMAC Crate Controller with the Data Acquisition software called FREEDOM installed for pulse processing. The signals from the detectors are normally processed by various pulse processing systems and then digitized using ADC and TDC and QDC etc. In order to synchronize the events, the digitization modules are located in an addressable instrumentation system such as CAMAC and VME which can be read out into a computer. At IUAC, CAMAC based Data acquisition systems are widely used. The software called FREEDOM has changed substantially, to make it compatible with the commercially available USB port based CMC100 crate controller. This DAQ software is tested and installed in various beam line for the user experiments. This Data Acquisition system reduces the Hardware compared to the existing ISA bus based indigenously developed CAMAC Crate Controller at IUAC.

### USB based CAMAC Crate controller

The CMC100 contains host interface of USB2.0 and inbuilt host to carry out CAMAC instructions. Incoming commands and data from either source are assembled into 32 bit words and sent to the command interpreter via a FIFO buffer. The CMC100 can read data from CAMAC modules at up to 30 Mbytes/sec. The 24 bit data words are expanded to 32 bits (adding a byte containing X, Q, Lam and crate #) and sent to the FIFO buffer. The rate into the USB

interface is 40 Mbytes/sec. The USB host must pull the data from controller. The USB 2.0 interface transmits data to and from the host in 512 byte blocks. It has a List Processor (LP) which can include a command list of upto 512 words. The execution of the LP program can be triggered by LAM, NIM pulse or external command.

### USB FIFO Buffer read out

The readout method is by polling. The USB buffers are normally available to be read by the host, this is done only by obtaining the FIFO status periodically, from the extra USB endpoint. The flush (or commit to USB) command will cause partially full buffer to be committed to the USB and available for transmission to the host.

### Q – Stop readout Mode

The CMC100 includes the Q-stop readout Algorithm in its LP. In this Mode, while reading e.g. 32 channels from Philips ADC, if channels are not within a specified interval of values which are skipped during readout. Sparse readout using FREEDOM Software is saving enormous amount of readout time.

**Following Table shows, Two Philips 7164 ADC's i.e. 32 channels assigned and input is fed to 13 ADC channels.**

Trigger Rate	Accepted Trigger Rate	Q-stop	Normal	Q-stop
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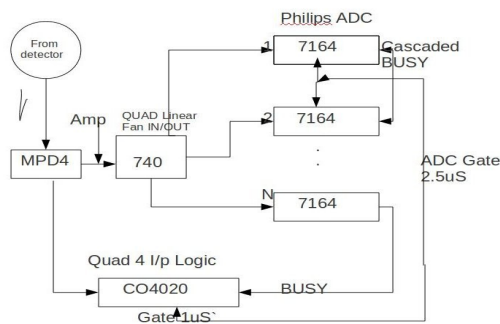
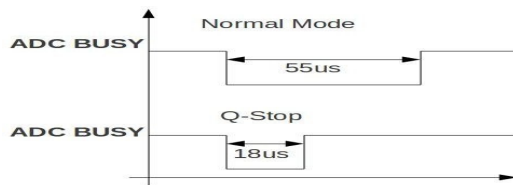
<b>7.7K</b>	<b>5.3K</b>	-	<b>31%</b>	<b>15%</b>
<b>42.K</b>	<b>12.2K</b>	<b>21K</b>	<b>71%</b>	<b>50%</b>

### FREEDOM Software for CMC100

The important aspect of the experiment depends upon how much of the processed data can be visualized on line while the acquisition is in progress. At IUAC FREEDOM software has SERVER and CLIENT programs to collect the events data. A driver for USB readout of the CMC100 is provided by Cheese cote Mountain manufacturer. This driver, we compiled under various Operating systems like Scientific Linux, Cent OS etc. Software written to acquire the data from both mixing of the normal (sequential) mode and zero-suppressed (Q-Stop) modes. Separate functions for decoding are provided, since these are specific for different module types and Q- stop Mode.

### Q-stop mode Observation

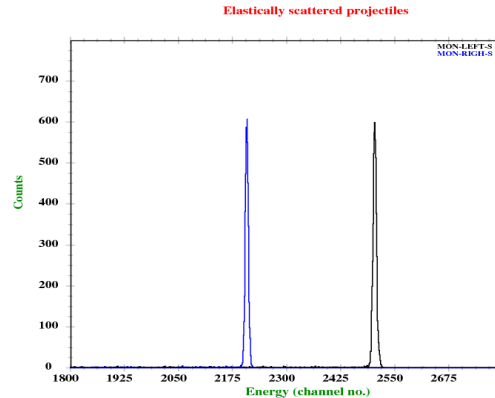
Using this Data Acquisition Software, Philips ADC and TDC's large Number of channels are fed, with input from detectors and the BUSY output total time is calculated as 55µs for 32 channels in Normal read out Mode and 18µs for 32 channels in Sparse Read out mode.



**Fig. 1** Sparse Readout Electronics setup CAMAC Scaler and Histogram Modules

We have included the separate files for CAMAC Scaler (HYTEC 350A) for dead time

monitoring and Histogram Module in the Server part of the FREEDOM Software and using status window, we can monitor single readouts which are possible without interrupting the main List Mode of data flow.



**Fig. 2** Spectra for <sup>19</sup>F 108 MeV Energy

### Acknowledgment

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### Conclusion

With this USB based Fast CAMAC Crate Controller, we find its useful with Reduced Hardware and it less cable between the PC and CAMAC Crate. We installed the New Data Acquisition system in LINAC beam line and Data Room for a long period and for the X- Ray measurements also. The software can acquire data in Normal mode and in Sparse read out mode. Sparse read out mode is tested successfully with 300 channels assigned in user NAF list.

### References

- [1]Cheesecote Mountain CAMAC, USA, <http://www.cmcamac.com> .
- [2] Radiation Detection and measurement G.K.KNOLL