Ideas for FLARE Test Setup DAQ Electronics

FLARE Thursday Meeting Presented by D. Edmunds 1-DEC-2005

The purpose of this presentation is to describe three possible ways that DAQ Electronics could be provided for the FLARE test setups at Fermilab. I'm certain that there are other good ways that the DAQ Electronics could be implemented for these tests.

The three ideas presented here are: Pure ICARUS-CAEN, Half ICARUS-CAEN Half Our Own, All Our Own.

Any of the above schemes depend on someone setting up scintillator counters and NIM logic to make a trigger for muons going through the LArTPC. I assume that the choice of DAQ Electronics should be driven by minimizing the risk of a FLARE test setup failing because of a problem with this electronics.

- Pure ICARUS-CAEN
  - The ICARUS-CAEN system is a complete system and includes things like the wire plane Bias Voltage distribution and a test pulse system.
  - The digital part of this is a lot more complicated than just a "circular buffer". The digital part includes generation of triggers and sparcification of the readout data. I don't know how much of that can be turned off for simple tests.
  - The analog part is about as good as you can do with preamps located both outside of the cryostat and in a separate rack (i.e. not in a box bolted to the cryostat right at the cryostat's signal port).
  - The preamps by themselves are low noise, i.e. two parallel low noise junction FETs in each channel. A concern is setting things up correctly so that one does not squander the low noise characteristic of the raw preamps by addeding too much capacitance running the signals over to the preamp rack or by not being able to maintain the preamp rack at the same ground as the cryostat.
  - If the managers want to pursue this solution then I think it is important to obtain a complete ICARUS-CAEN system right away.
    - Verify that we can actually get all of this material.
    - It is complicated and there is a lot to learn about it so we would need to start soon.
    - We know that this system needs to be connected to a computer for readout and that will take some time to setup so we need to start work soon.
  - Can we make this a complete turn-key system, i.e. get a good energetic person to come over with the equipment for "N" months ?

- Half ICARUS-CAEN Half Our Own
  - This setup would use ICARUS-CAEN Analog with Our Own Digital
  - \- The output from the ICARUS-CAEN analog card is defined and runs all of the time. Thus one could plug the digital output from ICARUS-CAEN analog card into our own circular buffer computer readout card.
  - We could make this very simple: the analog card writes into the circular buffer until either an external trigger signal tells it to stop or for testing the computer tells it to stop. In either case the computer would then readout the data from the circular buffer and then allow the analog card to begin writing again.
  - We have equipment at MSU that would allow us to quickly setup a demo of this and investigate what the problems may be. If the managers are interesting in this we would probably want to try it soon to verify that there are not some hidden problems.
  - With this extensive modification of the "pure ICARUS-CAEN system" it might make sense to try to mount their analog cards in a box right on the cryostat.
  - What I called "ICARUS-CAEN analog card" in the above points is actually a set of I think 4 different types of cards and a special backplane plus the required power supplies and such. The 4 cards are:
    - CAEN V791 preamp, ADC, serial data output, test pulse
    - CAEN A764 Bias Voltage distribution, calibration signal distribution
    - CAEN V793 Slow Control for the above modules, signal distribution
    - "High Voltage Filter Card" wire Bias Voltage filter
    - See: www.pd.infn.it/ bagdat/group/data33.htm for descriptions.
  - There is a lot to learn about the above cards and a computer connection is probably required to these ICARUS-CAEN cards to operate the slow control to enable the V791 to run and set the test pulses on/off,...

- All Our Stuff
  - If the managers want to pursue a local solution for a system that could handle up to a few hundred signals then we could think about something like the following:
  - Use D-Zero preamps or some other preamps that already exist. There are a number of varieties of D-Zero preamps and we would have to look at them in detail to determine which is best for this application.
  - Design and make a circuit board to hold the preamps and to take care of: preamp power supply distribution, wire plane Bias Voltage distribution, and test pulse distribution. I assume that the number of preamps per card would be 16 or 32.
  - Mount the above in a box right on the cryostat. If possible have a separate signal port on the cryostat just for wire signal feed-through and mount the box right over it. Power the box from its own set of linear supplies that run from an isolation transformer. For a channel count of a few hundred these items are of modest size and are easy to implement.

- Run the analog output from the preamp box over to a 6U VME crate with D-Zero ADF-2 cards in it. Each ADF-2 card provides 32 channels of 10 bit ADC followed by an FPGA that can be configured to implement a circular buffer.
  * A total of 20 spare ADF-2 cards exist. 80 are used in the running system at D-Zero. Zero failures to date.
  * Firmware basically exists to run the ADF-2 as just a circular buffer. That is a small part of what runs in its firmware during its normal operation. There is enough memory in the FPGAs on the ADF-2 to provide 2048 words for each of the 32 channels. With an ADC sample once every 400 nsec the 2048 words provides a 800 usec history for each wire. This is all setup in FPGA firmware so if one needs a long buffer for a test you can put all of the memory on one ADC or whatever combination you want.
  * The ADF-2 card is part of the new Run 2B L1 Cal Trig system at D-Zero. It is not part of the main Cal DAQ Electronics.
  * The ADC on the ADF-2 can be operated at any fraction of the 53.104 MHz TeV RF frequency.
  * The analog input to the ADF-2 is differential and has a fully differential opamp in front of the ADC to set the analog input range and frequency response range.
  * The ADF-2 cards run in a normal VME-64 crate and provide distribution of a set of isochronous control signals once every 132 nsec, e.g. there is a way to distribute a stop writing into the circular buffer signal.
  * Readout time per word is about 1 usec.
- If a scheme like this is of potential interest then I would like to make a very short time-scale for a demonstration of it. Show something in a month, i.e. prove that you can reach the required noise level on a couple of channels. If noise is OK then do all of the above in 6 months. The point being, if this is not going to work then find that out early while there is still time to do something else.