Project For Levon Vogelsang

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The project is to develop a test stand to perform XY scanning of the MAPMT using the VA_BTeV readout electronics. This is extremely useful since this XY scan can be used to produce a response versus (X,Y) of the MAPMT, and hence determine the active area as well as the overlap region between neighboring cells.

A block diagram of the setup is shown in the figure below in Figure 1.

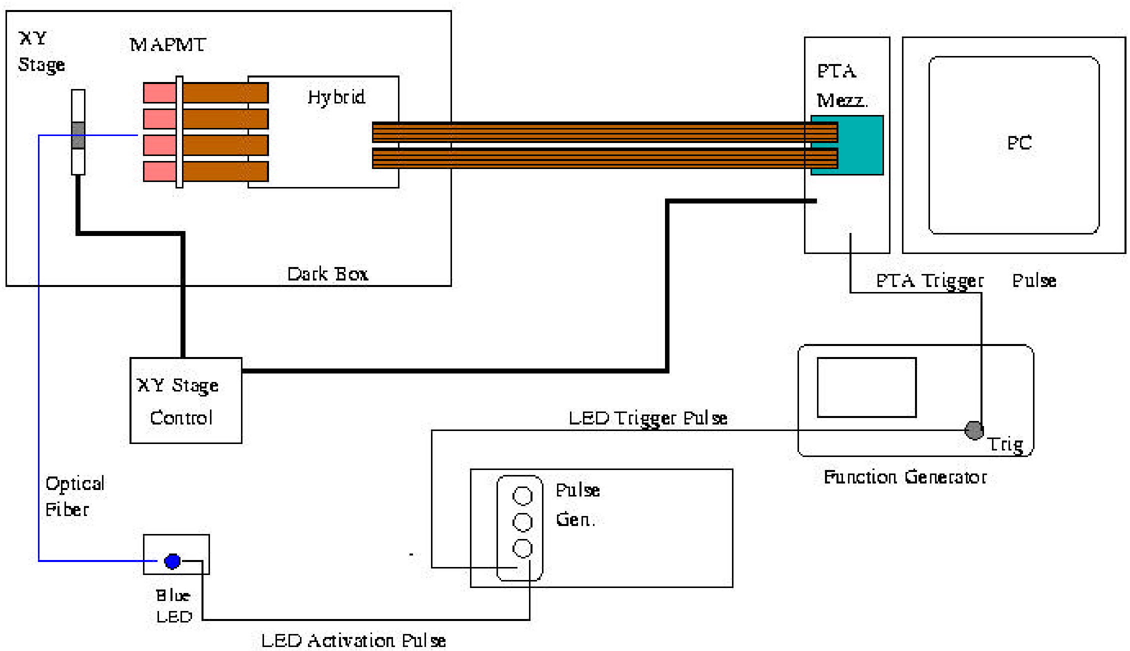

Figure 1: Block diagram of test setup for scanning MAPMTs using VA_BTeV readout.

The PC communicates with both the PTA/Mezzanine card via the PCI bus as well as with the XY motion controller. At this time, separate programs exist to communicate with these devices. One program controls the PTA/Mezzanine card in order to initialize FPGAs in the PTA and Hybrid, as well as control data acquisition from the hybrid. A separate program enables motion control of the XY stage.

In Fig. 1, the function generator produces square pulses, typically run at 4 kHz. These pulses are split, with one used to trigger the PTA (to readout the data in the hybrid) and a second (LED Trigger Pulse) goes to a pulse generator in a NIM crate. The LED trigger pulse causes the pulse generator to produce an output pulse whose width, delay and amplitude can be varied using knobs on the front panel. The output pulse activates a blue LED whose light is passed along an optical fiber into the dark box. The light from the fiber needs to be collimated as to produce a small spot on the face of the MAMPT. The amplitude of the LED activation pulse can be varied using the amplitude control know in order to obtain a reasonable number of photons. It is recommended that we aim to have 1 photon on average, typically in a 100 ns wide LED activation pulse.

A photon incident on the MAPMT has a ~25% chance of producing a photo-electron via the photoelectric effect. This photo-electron produces a cascade of electrons in the 12-dynode stage MAPMT, leading to an output pulse of about 1 million electrons. A cartoon of this process is indicated in Fig.2.

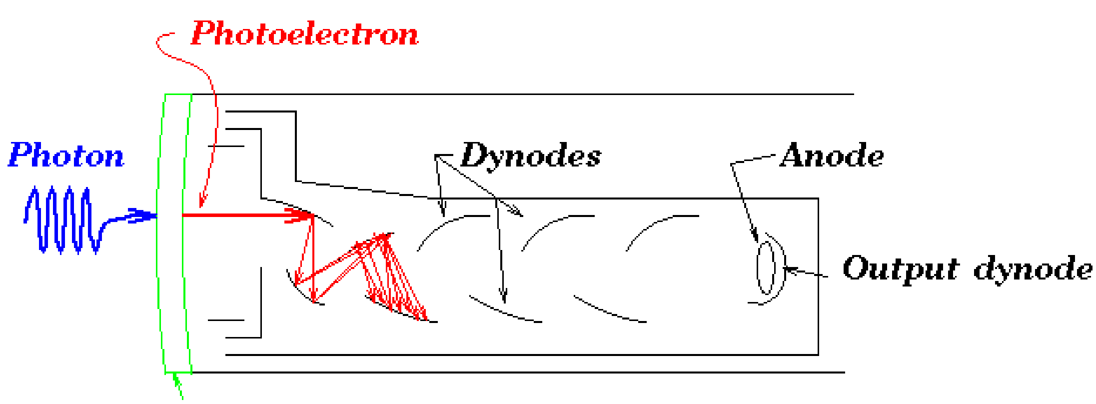

Figure 2: Cartoon showing the electron cascade produced. The output on the anode is typically a charge of 1 million electrons.

This signal is passed along a 30 AWG flat cable to the MAPMT hybrid. An electrical block diagram of the VA chip is shown in Figure 3. The hysbrid contains two VA chips, each one comprised of 64 identical amplifier-shaperdiscriminator (ASD) circuits. The single channel block-diagram of the VA chip has This diagram The charge is injected into a charge-sensitive preamp and shaped to have a rise time of about 75 ns and a fall time of about 200 ns. The performance of these op amps are controllable (to some extent) by the voltages Vfp and Vfs. These are settable via the DAQ.

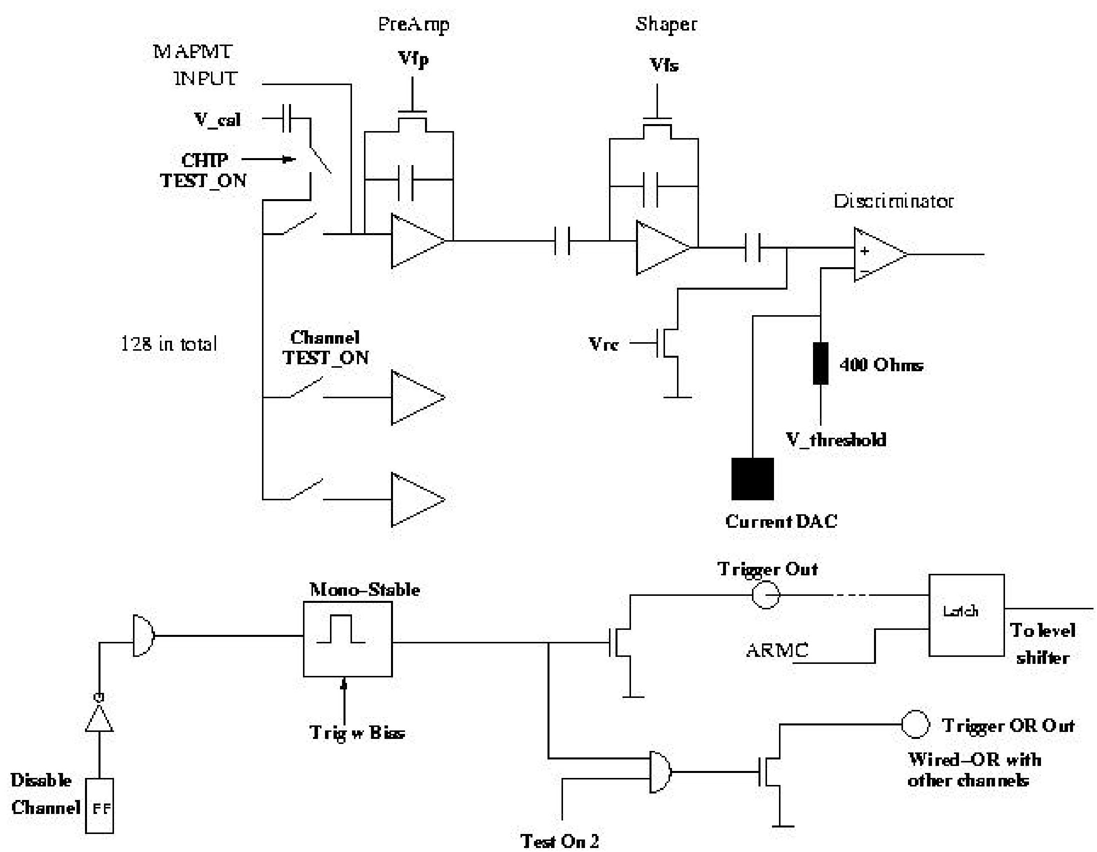

Figure 3: Block diagram of the FE hybrid for the MAPMT..

The shaped pulse is then passed to a discriminator whose threshold is settable using the Vth DAC. Typically we run with thresholds around –20 to -40 mV, corresponding to DAC values of 117 – 105. Note here that DAC=128 corresponds to about 0 mV and DAC=200 corresponds to around –200 mV. If the input pulse is above the predefined threshold, an output pulse is produced whose width depends on the time-over-threshold. This pulse is then set to a fixed width using a monostable.

There is the option in the DAQ to enable/disable any of the 128 channels as shown in the figure. The mask can be modified within the DAQ codeand is indicated by the “Disable Channel” flip flop in Fig. 3. After the monostable, the pulse reaches the latch shown on the bottom right. Also going to the latch is the so-called ARMC pulse. This pulse is produced by the FPGA on the hybrid and its cause can be traced back to the TRIGGER pulse which was sent to the PTA/Mezzanine card. Since this puls, and the pulse which generates the LED pulse are times to the output pulse of the function generator, the signal from the MAPMT channel should arrive nearly in time with the ARMC pulse. A cartoon of the timing is shown in Figure 4 below.

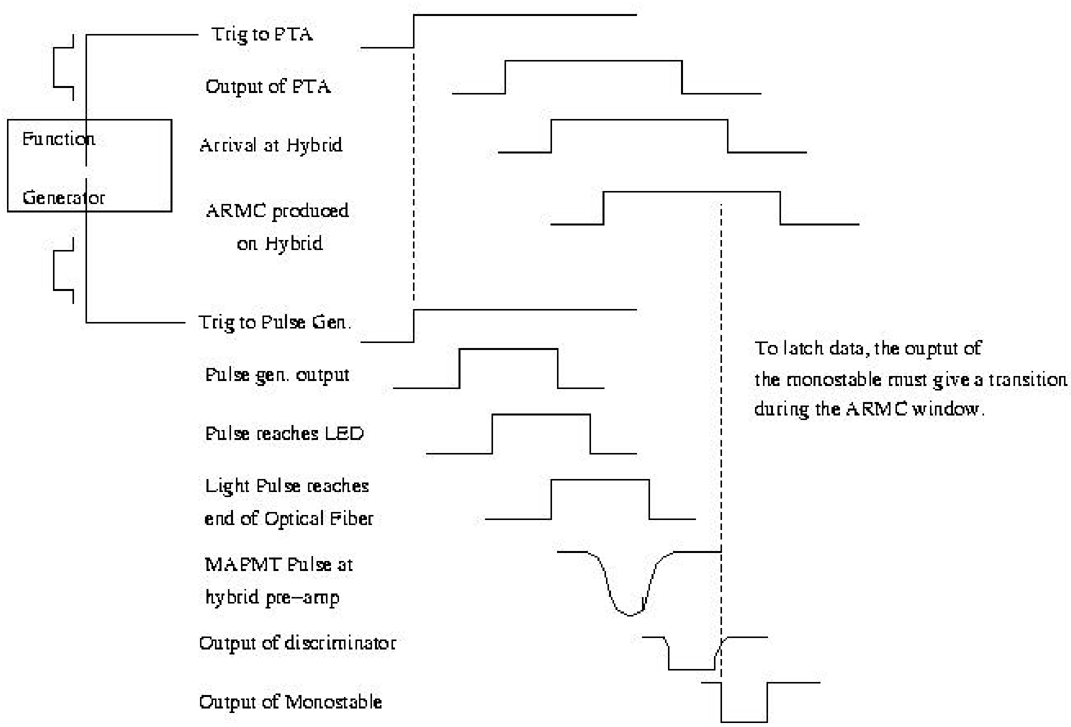

Figure 4:Cartoon showing the relative timing between the TRIG pulse which produces ARMC and the arrival of the digital signal output resulting from a photon incident on the MAPMT.

It is important that the output of the monostable make its transition while ARMC is high in order to latch the data. The ARMC window is adjustable via the DAQ and is typically set to a larger than necessary value of about 500 ns. For the BTeV experiment, it will be more like 100 ns. The lateched data is read by the PTA and stored in a local memory. It is eventually read and decoded by the Labview DAQ software and displayed on the screen.

Notice that in Figure 3 that there is an alternate way to send charge into the front end amplifier, through the CAL input. Here, we inject a known pulse into a 1 pF capacitor, which injects a charge, q=CV into the front end. To enable the CAL circuitry, one must turn on the “Chip TEST_ON”, a single channel’s TEST_ON and connect the calibration signal into the lemo connector on the side of the hybrid. For 1 pF, this corresponds a 1 mV amplitude corresponds to 6250e-. The minimum pulse height is 20 mV, which corresponds to 125,000 e-.

When running the DAQ, one can control the number of TRIGs over which to collect data. For example, we typically use 1000 triggers. This means we send 1000 TRIG pulses and sum up the number of times each channel has a hit within the ARMC window. If no signal is put on a channel, there should be 0/1000. When light or a calibration signal is used on a channel the channel will record some number of hits, which by definition must be less than or equal to 1000.

The outline of this project is to scan the LED across the MAPMTs. At each location, we record a user-definable number of triggers (say 10000) and write them to a file. Note that the buffer in the PTA can only hold about 2000 triggers (I believe) so one may have to do 10 acquisitions, each being 1000 triggers. To the file we should write:

A) Pertinent information which are set for the entire “run”
   a. HV setting, Threshold, MAPMT ID, step size, etc

B) The (X,Y) positions, and 128 numbers, corresponding to the number of hits in each of the 128 channels. This file is updated as we scan. The program should allow the user to define initial X,Y locations, step size and number of steps.

Once this file is written, we can do offline analysis and reconstruct profile distributions of the response of the MAPMT versus position. An XY profile which was produced using the CAMAC-based system is shown in

Figure 5. An example of how the output file could be structured is shown in Fig. 6.

The ability of the VA_BTeV electronics to run at much lower threshold than the CAMAC-based system makes this an important test for the MAPMT active area. It also sets the stage for the production and quality assurance testing of the full set of photodetectors (10,000 in total) which we will have to test.

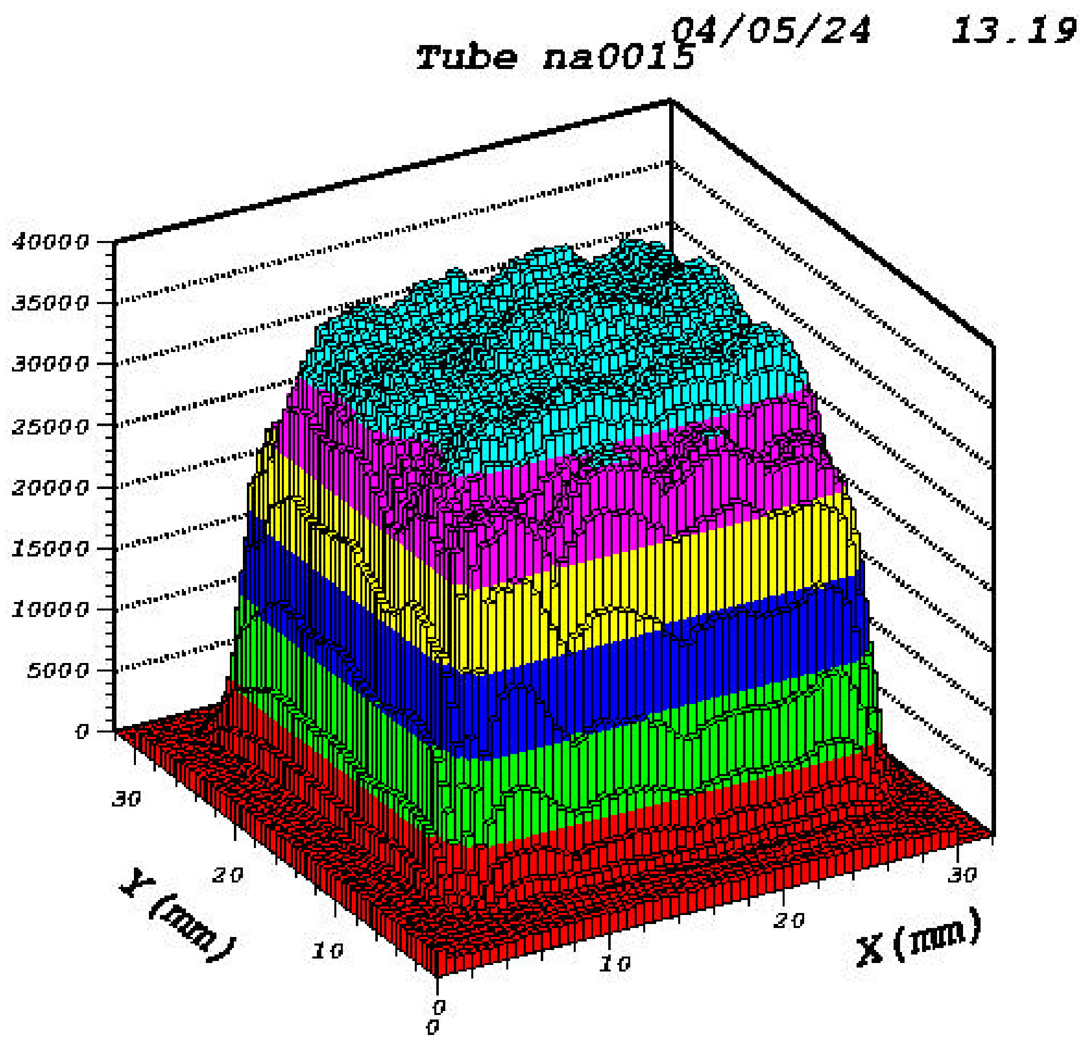

Figure 5:Response of an MAPMT as a function of X,Y position using the CAMAC-based system.

NA0049	700	117	0.1	0.1			
X	Y	1	2	3	4	5	6
1.000	1.000	200	225	0	0	0	0
1.000	1.100	360	80	0	0	0	0
1.000	1.200	450	40	0	0	0	0
1.000	1.300	500	0	0	0	0	0
1.000	1.400	450	40	0	0	0	0
1.000	1.500	375	70	0	0	0	0
1.000	1.600	250	260	0	0	0	0
1.000	1.700	100	250	0	0	0	0

Figure 6: Illustrative example of how the output file could look. The top line gives the Tube ID, HV setting, DAC threshold, and X and Y step size. The data then follows with X,Y positions and counts on each of the channels. Only the first 6 channels are shown, but in the data file it would extend to 128.