Manual for the multiwire proportional counter

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Contents

Chapter 1

Intro

The MWPC (Fig. 3.1) has 4 independently counting channels. Currently we are using just one channel (channel 1). The layout is shown schematically in Fig. 3.2. Currently we have two versions which differ in anode wire diameter. The serial number can be checked at the side of the brass plate on the inboard side; properties associated with each serial number are given in Table 3.1.

Chapter 2

Hardware Setup and Wiring

2.1 Setting Up the Gas Manifold

The 2 plasic hoses with Swagelock connectors are connected as labeled to the vacuum pump and the gas cylinder respectively. The 2 stainless steel bellows with 4-VCR fittings attach to the detecor. You have to use 2 Nickel plated VCR gaskets. Attach the Capacitance manometer and the Pirani gauge controller. The Pirani gauge is only useful to check for leaks at very low pressure (less than 1 Torr). Working pressure is read at the analog capicitance manometer, whose reading is independent of gas composition.

2.2 Detector and Readout Components

A schematic diagram of the setup is shown in Fig. 3.3. The power cord plugs into the connector of a NIM Crate. The test output of the electronics is connected to the output of the pulser (BNL Model IO-391). From the high voltage supply (Bertan Model 1755X) the negative polarity (outputs at back of device) is hooked up directly to the counter. The positive polarity has to go through the current monitor, which is a shielded sheet metal box with a DVM inside. Connect a DVM to the 'HV monitor' (1 kV produces a reading of 1 V). From output 1 of the electronics we go by a oscilloscope (use T-piece) to the input of the high bandwith amplifier (LeCroy model ???). From the AC output of the amplifier we go to the input of the 4-channel discriminator (LeCroy Model 621BL). The discriminator output may be used for the frequency counter and as inputs for the LeCroy multi channel scaler Model 3521A (for scans) and the quad scaler Model 2550B (for spectrum scans). Note that the discriminator has coupled outputs, which are symbolized by a white line connecting them. Use the 3 independent outputs, otherwise you run into trouble, because each separate output requires a 50 Ω termination.

Chapter 3

Starting Up the Detector

3.1 Gas Supply

Before changing gas pressure be sure that the high voltage is turned down, since the detector gain varies strongly with gas pressure. Too high a gain causes a discharge, which shuts down the HV power supply (see section "high voltage").

The gas manifold has a coarse valve and a needle valve for the gas in and the gas out side. The coarse valve is closed during operation and is only used for start up or shutdown.

Make sure that all valves are closed. Turn on the rotary pump. Open the coarse valve on the gas out side. The pressure should go down to about 1×10^{-1} Torr (digital Pirani gauge) within 15 Minutes. Otherwise there could be a serious leak in the system and you have to check the connections and the counter (Are the SiN membranes OK? Is the wax seal OK?). Double check by closing the coarse valve on the pump side and watching the pressure in the system rise. It should take about 10 minutes to go up to 1 Torr (digital Pirani gauge).

Check that the valves of the regulator which is attached to the gas bottle are closed. Now open the coarse valve on the gas in side to evacuate the line all the way to the gas cylinder. Wait till the pressure drops well below 1 Torr. For flushing out contaminants, close the coarse valve on the gas in side and open the valves of the gas bottle. Adjust the regulator to about 10 PSI overpressure. Close the valves on the regulator and bottle again. Open the coarse valve on the gas in side slowly and pump out the gas which is in the line (don't let the pressure in the system rise above 100 Torr; *MONITOR IT!*). Wait til the pressure drops well below 1 Torr which means that you again evacuated all the way to the regulator. Close both coarse valves.

Coarse valves are closed now. Reopen the valves on the gas bottle regulator (leave at 10 PSI overpressure). Set the needle valve on the gas in side to 2.0 on the micrometer scale. Adjust the needle valve on the gas out side to get to the desired pressure (e.g. 0.12 is appropriate for about 200 Torr). To accelerate the filling with or evacuation of gas one may carefully tweak the coarse valves.

Fine adjustment of the pressure is done by changing the position of the needle valve on the gas out side. Small changes may have big effects.

NEVER EXCEED ATMOSPHERIC PRESSURE IN THE DETECTOR. The window will pop off.

3.2 High Voltage

This has to be done after adjusting the pressure of the counter gas, since the pressure highly effects the gain of the detector.

Figure 3.1: Multiwire proportional counter

Parameter	Serial 01	Serial 02
Pressure	270 Torr	270 Torr
cathode HV	-150 V	-150 V
anode HV	-950 V	-1040 V
Anode wire diameter	15 μm	50 μm

Table 3.1: Approximate settings for different chambers

On the Bertan high voltage supply first reset the potentiometer dials to zero. Turn the inner switches down to "reset" and put the outer switches up into the "on" position. Now move the inner switches up into the "trip hold" position. The "trip hold position" causes the power supply to SHUT DOWN IF A CRITICAL CURRENT IS EXCEEDED. THIS IS IMPORTANT TO KEEP THE COUNTER ALIVE! Both red LEDs should be lit now. The dials below the analog current meter should be set to 10 μA (critical current), which is the middle position . Attach a digital voltmeter (DVM) to the voltage monitor port of the power supply. A reading of 1 V on the DVM corresponds to an applied voltage of 1 kV. You are now in a position to commission the counter and set the high voltage. Please refer to "Comissioning the Counter"

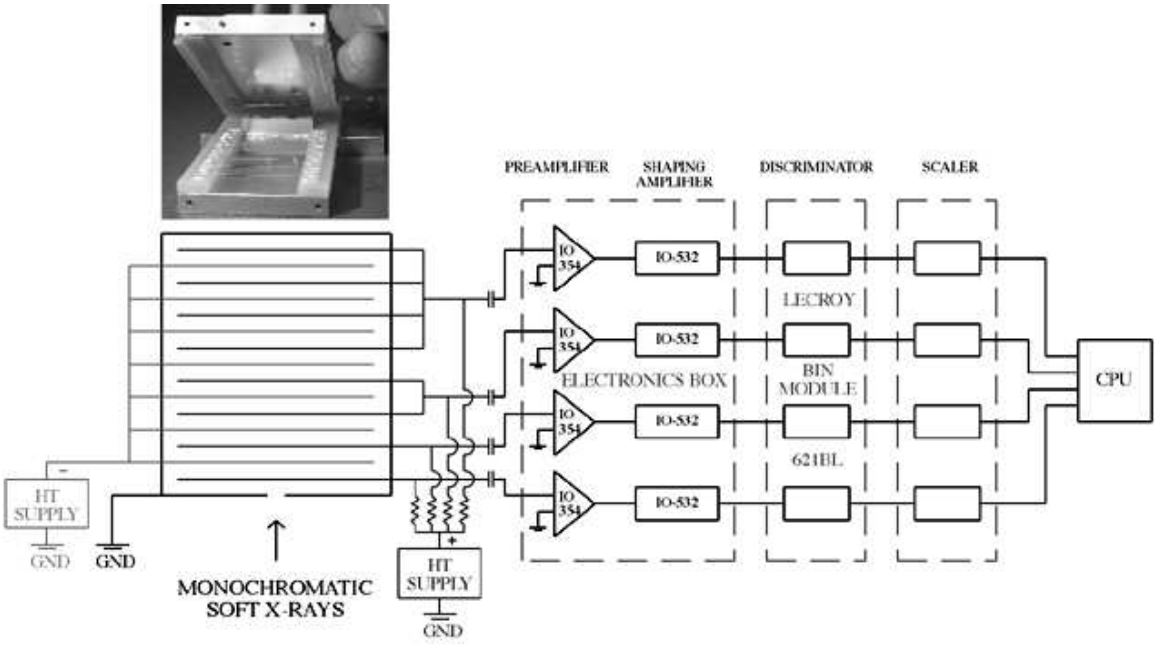

Figure 3.2: Layout of detector and electronics

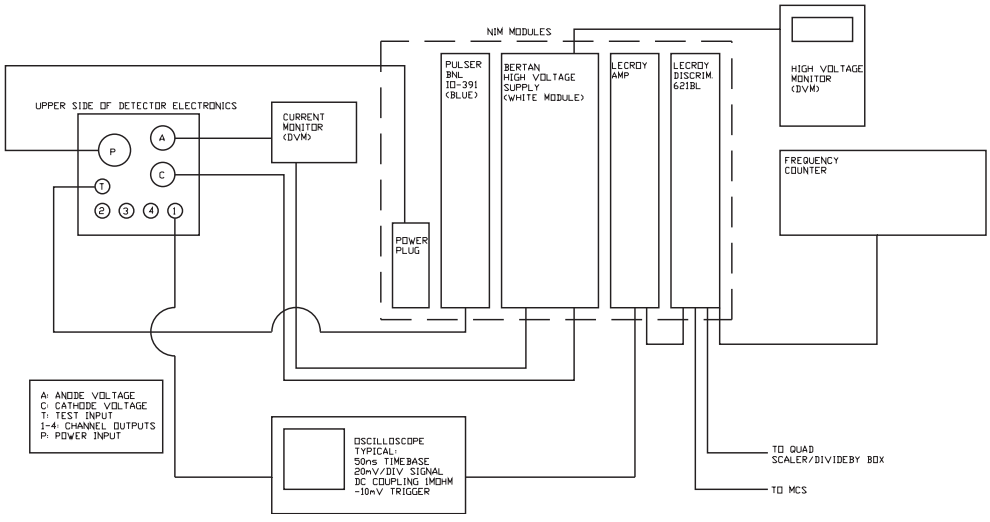

Figure 3.3: Wiring diagram

Chapter 4

Commissioning the Counter

4.1 Electronics

High voltage is turned down for commissioning the electronics.

The output of the detector electronics is monitored by a oscilloscope (1 MΩ input resistance) inbetween detector and discriminator. Typical settings for the oscilloscope are 20 ns time base and 200 mV/Div with DC coupling for this test. You will want to trigger on the falling edge of the signal. The electronic noise signal can be seen with a trigger threshold set to -5 mV. It should not exceed -15 mV.

For testing the electronics a pulser signal (square pulse) is given onto a test capacitance located on the shaping amplifier card located in the electronics box of the counter. Turn the pulser on by putting the switch "low/high" to the high position. This pulse charges up a test capacitance of 0.35 pF to simulate a real event. A typical signal observed on an oscilloscope is shown in Fig. 4.1.

This shows that the electronics work properly. If you already connected the frequency meter, you also should see the corresponding frequency of the pulser there. Turn the pulser off by moving the "high/low" switch to the middle (off) position.

4.2 Optimization of the Detector Gain

You need to be sure to get x-rays into the detector to do this. If you are not sure, go to a previously established setting of gas pressure and high voltage (see Table 3.1). After this, search for signal (counts on the frequency meter).

On the oscilloscope, which monitors the detector output, you see the x-ray signals. Go to a photon energy of 295 eV. Adjust the positive high voltage to move the avarage x-ray signal to 30 mV. With appropriate settings you should see an output on the oscilloscope which should look like Fig. 4.2. The little peak corresponds to the electronic noise (taken out by the discriminator); the large amplitude peak to x-ray signals.

Now check that the gain is not too high. Move the trigger threshold of the oscilloscope down. You should have just a few signals lower than -100 mV in pulse height. Remember that, if the gain is too high, you encourage discharges to happen.

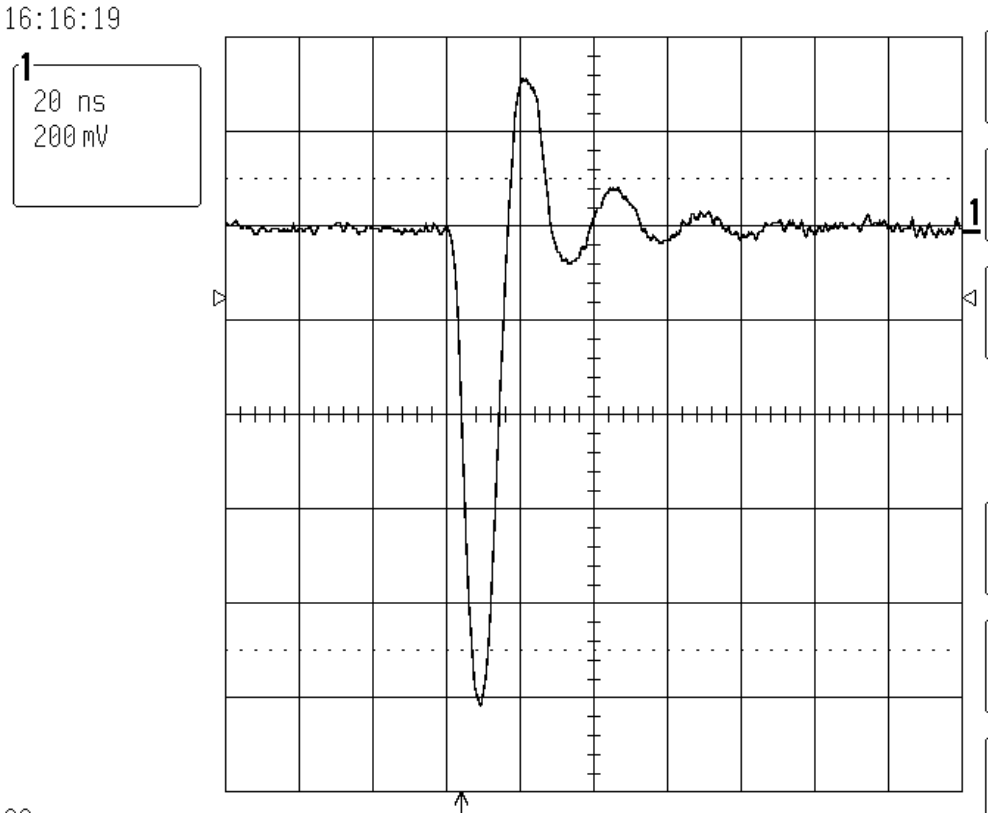

Figure 4.1: signal with pulser on

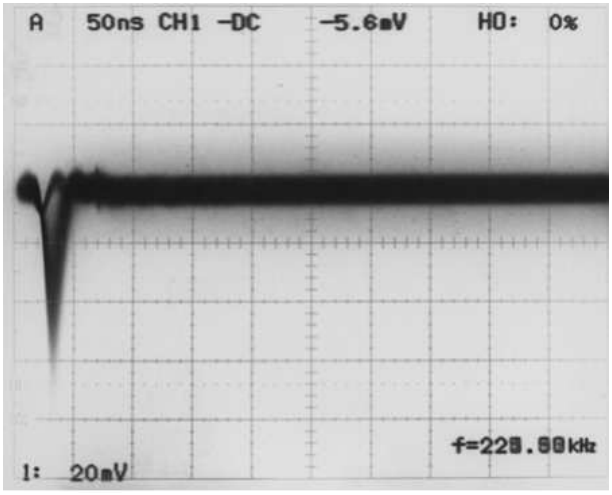

Figure 4.2: 295 eV X-Ray signal

Chapter 5

Troubleshooting the Detector

5.1 No Counts

Check the signal on the oscilloscope.

If you see a signal which compares to Fig. 4.2 with x-rays incident check the cables connecting the oscilloscope with the remaining NIM modules and electronics. Check output of Lecroy amplifier and Discriminator with the oscilloscope.

If you have no signal on the oscilloscope check the electronics as described in the subsection "Electronics" in the section "Commissioning the Counter". Check that the high voltage supply is working (both LEDs on) and that you are running at the appropriate energy. Check the alignment of the counter. Check that the power is connected to the counter.

If the electronics are fine and you have a stable high voltage check the current which is drawn by looking at the DVM in the shielded sheet metal box. If it reads less than 0.003 (corresponding to 3 nA) it's most likely that the detector is working fine. You probabley have misaligned the detector or your optics. Check.

If everything goes wrong you can check the situation out with the old counter.

5.2 What The Heck - Counts and No Incident Photons

You probably ran into a discharge situation, which indicates that the high voltage setting is inapproriate for the counting gas pressure. Turn down the positive high voltage a bit and follow the gain optimisation procedure described in the subsection "Optimisation of the Detector Gain" of the section "Commissioning the counter.