Ground Plane Pulser

1. Introduction

The TPC uses a pulser system to calibrate the FEE electronics, check for bad channels, and correct for slight variations in the start time for each channel (t0).

The system consists of a Wavetek model 395 Arbitrary Waveform Generator, a rate limiter, fanout/amplifier modules in a VME crate and a patch panel. The system is in Rack 2A5. Fig. 1 shows the VME crate holding the fanout modules, with the patch panel below. The pulser is on a shelf directly below the patch panel. The rate limiter is located inside Rack 2A5 and has its own power (AC to DC converter).

The system, under DAQ control, sends a known constant pulse to the ground plane of each TPC sector. This pulse is detected on the pads through capacitive coupling and is read out by DAQ.

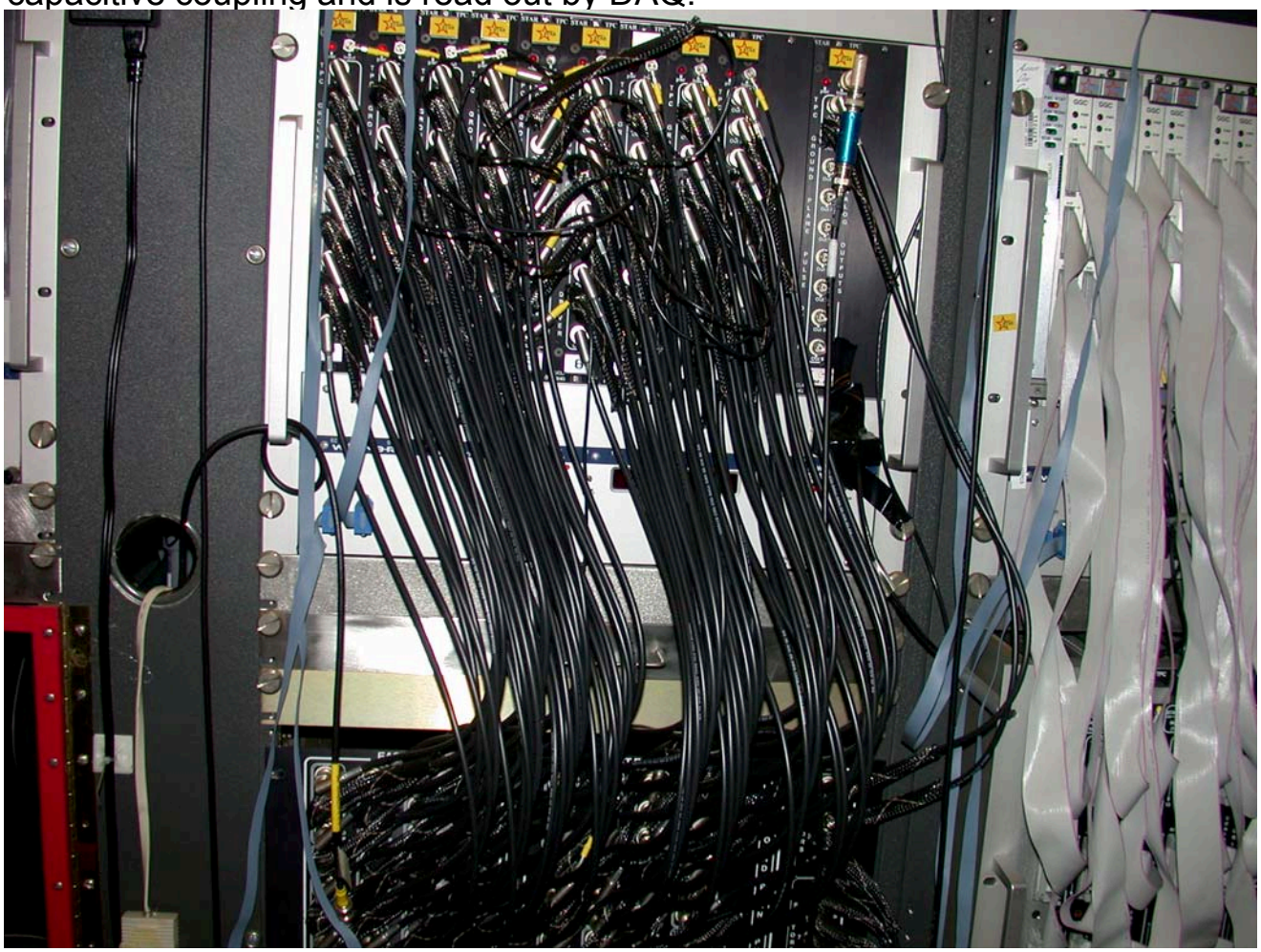
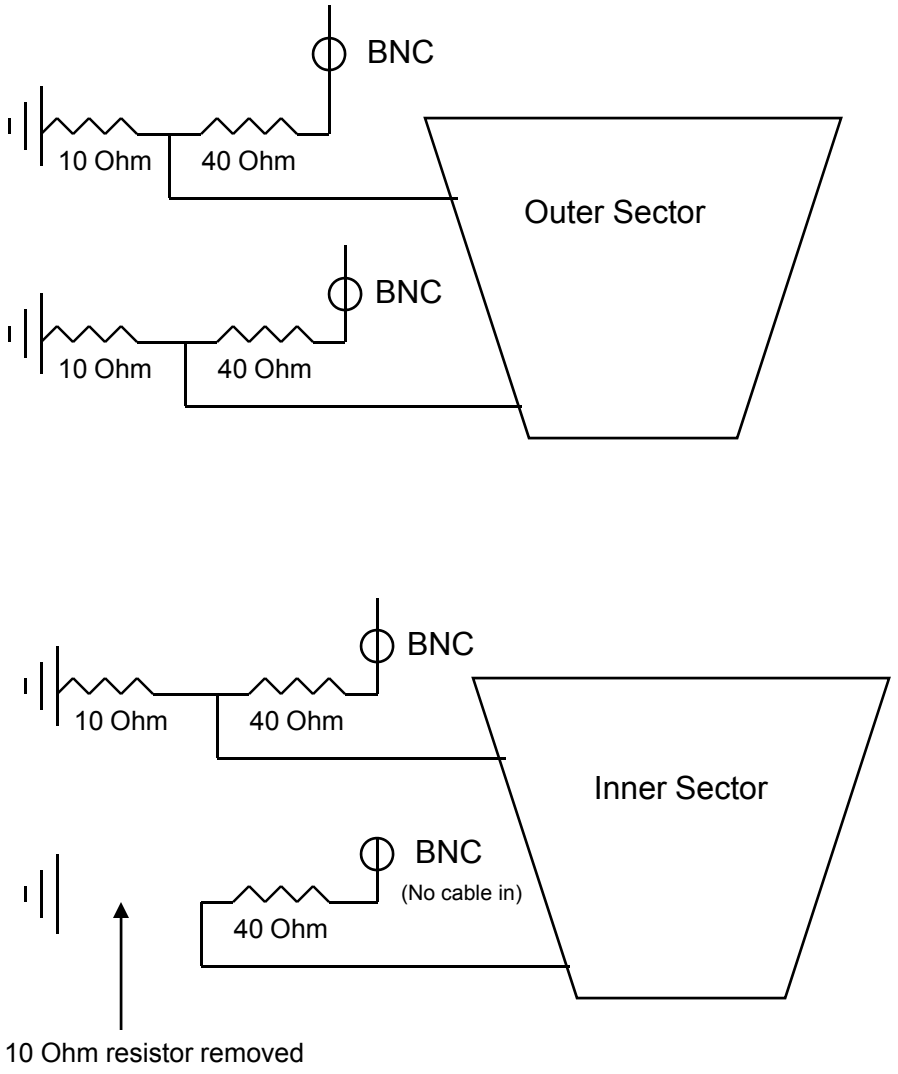


Figure 1

2. Schematic

The pulse from the Wavetek (main out) first goes to a rate limiter module located inside Rack 2A5. This module limits the output frequency to be less than ~800 Hz. A higher frequency would cause the fanout modules to overload. The pulse is then input to one of the amp/fanout units. Each of the 9 outputs from this module is used as an input to the other nine fanout units. (8 for the TPC and 1 for the FTPC). For an outer sector two outputs are used to drive the ground plane, while only one is used for each inner sector. Thus one amp/fanout unit (9 outputs) drives three supersectors. The output cables from the fanouts go to a feedthrough patch panel located below the VME crate. The cables (~ 100 ft RG58 BNC) from the patch panel go to the sectors and are terminated internally with 50 ohms each. The BNC connectors are located on the side of each sector.

The sector terminations look like: (See STAR TPC TESTS LOGBOOK II, pg 58)



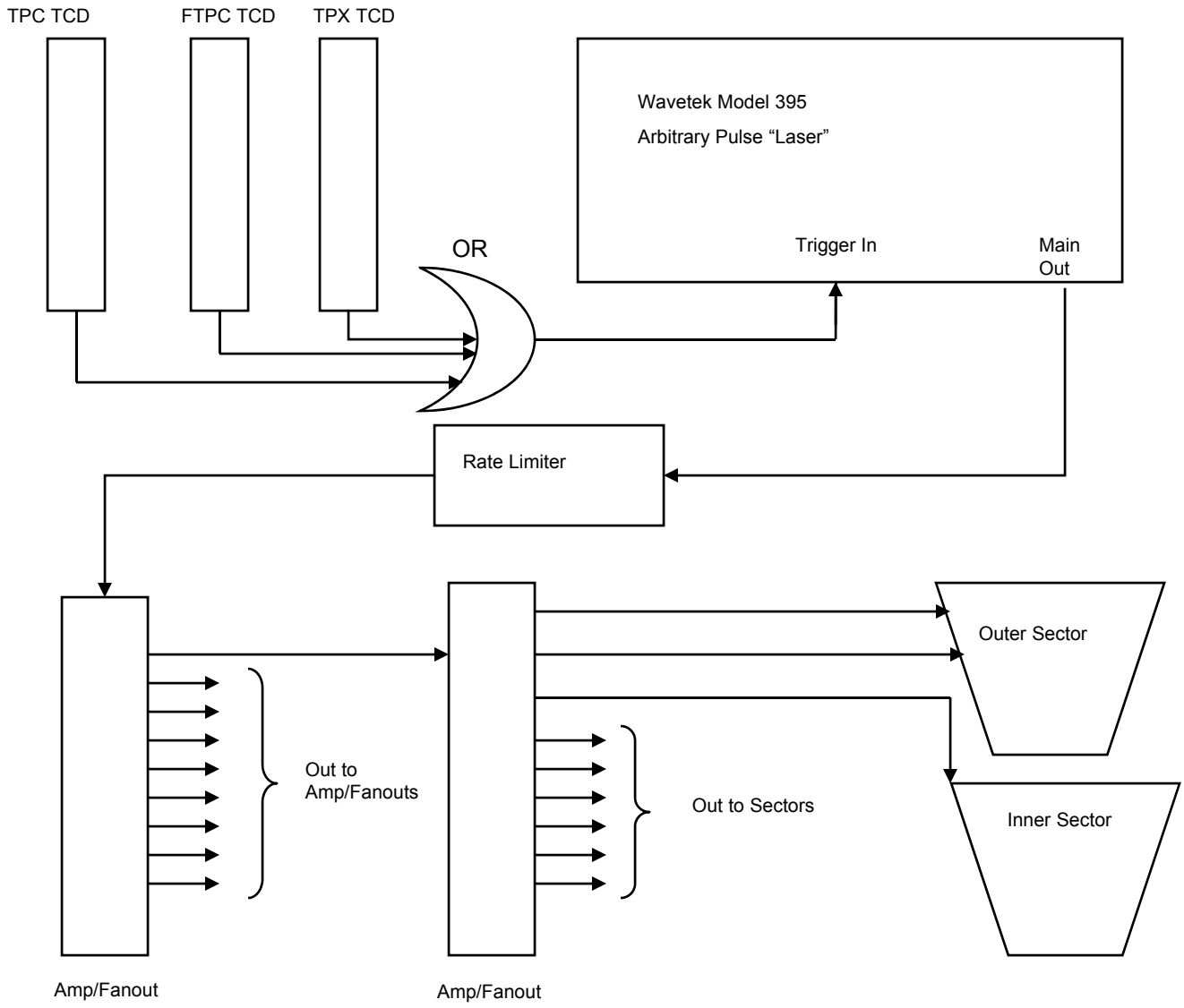


Figure 2

The trigger for the pulser comes from the TPC TCD located in rack row 1A2. This signal is OR'ed with the same output from the TPX (DAQ 1000) and FTPC TCDs. This allows any one of the three systems to make an independent pulser run. The trigger pulse is TTL and comes from the TCD output labeled "pul out". The TCD is controlled by DAQ and run control for making pulser runs.
See Figure 2 for a schematic

3. WAVETEK Settings:

Currently (1/15/2007) we are using an arbitrary waveform labeled “LASER” which has been downloaded to the Wavetek and is stored in memory. This pulse was downloaded in 1999 by Fabrice Retiere and it is a convolution of a TPC signal. It is essentially a square wave with a slightly rounded corner on the rising edge. (See picture in BCS Logbook 1, pages 87-88). Unfortunately we are no longer able to download pulses to the Wavetek – the original method used a Labview program and PC which no longer exist. We also had plans to develop a download ability using a VME processor, but this was never completed. The downloaded pulse has stayed in memory for 7 years. Theoretically the pulse could be restored by entering the datafile by hand, but I have never done this. If this is unsuccessful a standard square wave pulse would probably be sufficient. The data file for the pulse “LASER” is as follows: (see also BCS Logbook 1, page 84.)

1-169	0
170	417
171	1151
172	1501
173	1686
174	1775
175	1818
176	1855
177	1887
178	1914
179	1936
180	1955
181	1969
182	1981
183	1991
184	1997
185	2001
186	2002
187-269	2002
270 – 380	0

Each data point is the relative amplitude for a 100 nanosec time bin. Thus the whole waveform is 38 microsec long, with a rising edge at 17 microsec and a width of 10 microsec.

If the stored pulse is ever lost the Wavetek manual has examples of how to re-enter and store this data file.

After a power outage on the platform it is necessary to make an access and restore some settings for the Wavetek that aren't saved. The settings are input using the front panel pushbuttons and knob, and the built-in LCD screen. Specifically:

1. Push the Waveform Select button "Arbitrary"

2. Push the button which selects the pulse labeled "Laser"

3. Push the Amplitude button then use the knob to change the amplitude to 200 mVp. The two buttons to the left and right of the knob can be used to select the digit that you are changing. Thus, if the amplitude is 1.3 Vp, select the ones digit using the arrow buttons, then use the knob to dial in 0. Then select the tenths digit and dial in 2 for 200 mVp.

4. Select the "Offset" button and make sure the offset is 0.00. If not, set it.

5. Push the "Trig In" button and push the "Source" button until "External" is displayed. Once the trigger is set to External the green LED next to the trigger input BNC should light. Push the "Slope" button until "Positive" is displayed. Then push the "Trigger Level" button and use the knob to set the level to 1.0 V.

6. Push the "Mode" button and select "Trig'd, Cnt" to be 0000001

7. Push the "Arbitrary" button again and make sure the pulse "Laser" is still selected. Then push the "Frequency" button. On the Frequency menu, select "Sample" and set the sample frequency to 10.0 Mhz (Alternatively, set the sample period to 100 ns.) Then select "Waveform" and set the Frequency to 26.32 kHz (or period = 38 microsec.)

8. Push the "Arbitrary" button again.

9. Check the green LED next to the "Main Out" BNC. If the LED is not on, push the "Main Out" button above the connector.

The Wavetek should now be ready for pulser runs.

4. Fanout/Amplifier Modules

The Fanout/Amplifier modules have one input and 9 outputs. The gain for all modules have been adjusted to be equal, since the output pulse is used to calibrate the FEE gain for all sectors. The outputs for all modules were initially checked by me in 1999. (See pages 24-25 of BCS Logbook 1.) For a 200 mV pulse out of the Wavetek the output from each fanout is ~3.68 V. The sigma for all outputs was ~ .037 (1%). I usually check these outputs once each year as part of the startup procedure.

Each module also has a red LED on the front panel to indicate that the power is on. If the LED is not on it usually means that the internal fuses are blown. The fuses are accessible by removing the side panels of the module. One spare module and spare fuses are in the TPC cabinet.

Note also that, for historical reasons, the VME crate that holds the fanouts is interlocked by the TPC interlock system – the interlock is the same as the one for the gated grid. The interlock signal is on a DB15 cable that plugs into the front of the VME crate.

NOTE: During STAR data taking the pulser fanouts are left on continuously, even during physics runs. This means that any excessive noise on the outputs of the fanouts couples directly into the FEE amplifiers. We have had 2 instances where this was seen in the past:

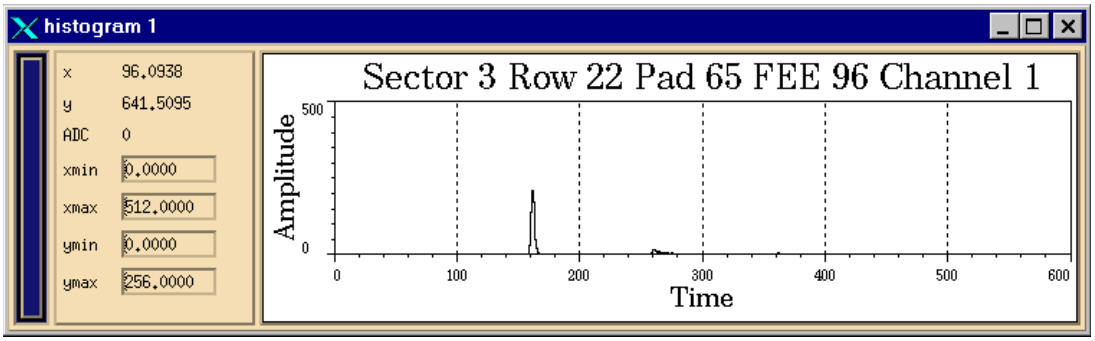
1. The fanout for the FTPC was not screwed into the crate and the output was noisy – this was seen in the FTPC pad monitor. Securing the module fixed the problem.

2. The rms baseline noise for three TPC supersectors went up by a factor of ~ 2. This was noticed during FEE testing in 2006. The effect was found by looking at pedestal runs using the TPC pad monitor, which can measure pedestal means and rms. The problem was eventually traced to a bad input cable to the module.

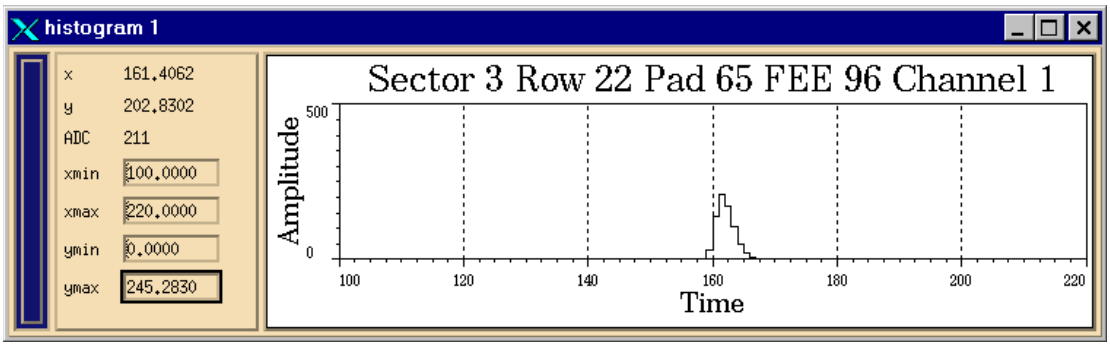
5. Pulser Runs

Pulser runs are used to calibrate the gain of each channel of the TPC, correct for jitter in the start time (t0) and to identify dead channels. Pulser runs are initiated using DAQ. Typically a pulser run is 500 events, and is run using the local STAR clock. This means that a pulser run should be immediately preceded by a pedestal run also using the local clock.

The pulse should look like the following pad monitor picture:



The pulse is essentially the response of the FEE to the rising edge of the Wavetek pulse. The small pulse ~ 10 microsec later (time bin 260) is the overshoot caused by the trailing edge of the Wavetek pulse. Expanding the time scale shows the pulse shape:



6. Known Problems

1. The pulse height for sector 8 inner is smaller than that of the other sectors. Speculation is that, during construction, the 10 ohm resistors was not removed from the unused input. Therefore that sector has less than the normal termination and the pulse seen on the pads is smaller. This anomaly is corrected offline in software.

7. Pulser Troubleshooting

Possible reasons for not seeing the pulser in the data:

1. The Wavetek is not being triggered – make sure DAQ is configured for a TPC pulser run. If an access is possible, look for trigger pulses (TTL) out of the TCD in conjunction with a DAQ run.

2. The fanout VME crate is off or inhibited – check that the VME crate in Rack 2A5 (Canbus #55) is on and the voltages are correct. If the crate can't be turned on remotely, using the slow controls GUI, it may be inhibited by the TPC interlock system. The pulser crate uses the same inhibit signal as the gated grid crate. (The crate inhibit signal is on a DB15 cable that plugs into the front of the crate.) Make sure this cable is plugged in and the the gated grid permissive is on. (Check the state of the TPC interlocks using the slow controls GUI or look at the light panel in the gas mixing room.)

3. The rate limiter may be dead or unplugged. Check if the pulse from the Wavetek comes out of the rate limiter. (We currently have no spare for the rate limiter – the system could be run without it if the rate is kept below < 800 Hz. Typically, DAQ takes pulser events at a 10 Hz rate.)

4. The Wavetek is not set-up properly. Check the settings listed in Section 3. Make sure the trigger and main out green LEDs are lit.

5. If some sectors have a pulse, but others don't, look for bad fanout modules. If the front panel red LED is not lit the module probably has blown fuses. One spare module and fuses are in the TPC spares cabinet.

8. Spares and Repairs

There is no spare for the Wavetek. We would use another pulser with a square wave pulse out if the Wavetek is sent out for repair. There is one spare fanout module, but no spare rate limiter. Vahe Ghazikhanian from UCLA made the fanouts and rate limiter and he can repair these modules.

9. References

1. Wavetek manual

2. BCS TPC manual Volume I

3. STAR TPC tests logbook Vol II