Chapter 6

Testing and Results

The MPFD technology has already been proven to work through the development of the detectors presented in the thesis [1]. This chapter presents additional data to not only support the claims of long life and operability, but also tests the MPFD^3-T 3D System's electronics and its capability to follow reactor operations.

6.1 Detector Lifetime

Since the MPFD^3-Ts were installed in the reactor core on December 18, 2008, the reactor has generated a logged 264,316 kWh as of February 23, 2012. According to the Kansas State University TRIGA Mark-II Nuclear Reactor training manual, the fast neutron flux (>10 keV) is 1.2×10^{13} n cm^{-2} s^{-1} in the central thimble and 3.5×10^{12} n cm^{-2} s^{-1} in the outer "F" ring of the reactor at 250 kW. Likewise, the respective slow neutron flux (<0.21 keV) is 1.0×10^{13} n cm^{-2} s^{-1} and 4.3×10^{12} n cm^{-2} s^{-1} while the gamma-ray radiation dose rate is 2.5×10^{4} rad/s and 1.5×10^{4} rad/s [13]. This means that the MPFD^3-Ts have experienced neutron fluences between 1.3×10^{19} to 4.6×10^{19} fast n cm^{-2} and 1.6×10^{19} to 3.8×10^{19} slow n cm^{-2} with a gamma-ray dose between 5.7×10^{10} to 9.5×10^{10} rad.

6.2 Detector Pulses

The auxiliary ports provided by the daughter boards and accessible on the back panel (Section §4.3.2), provides a buffered access to the preamplifier output of each detector (Section §4.1.1). These ports allow connection of external nuclear instrumentation modules (NIM) and multi-channel analyzers (MCA). Figure 6.1 shows an oscilloscope screen capture from one of the detectors. The buffered output of the detector is connected to channel 1

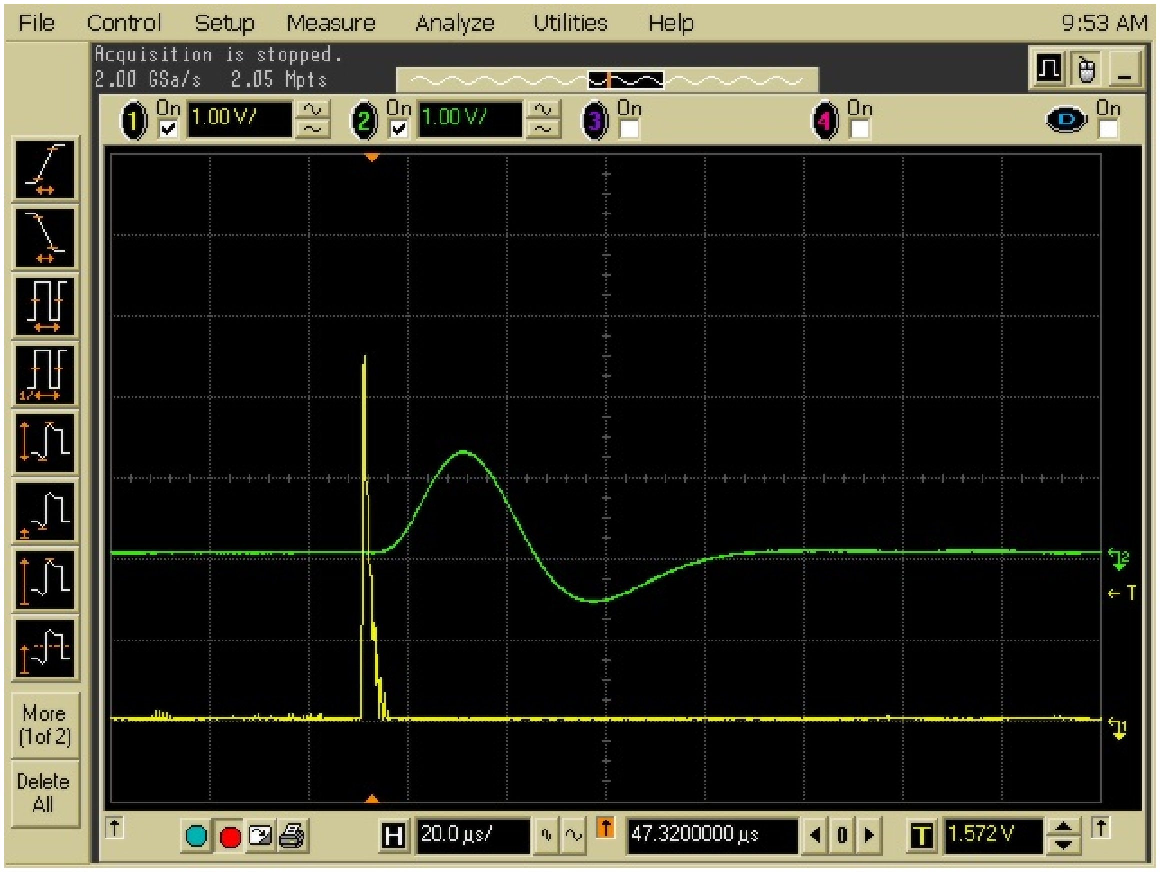

Figure 6.1: Oscilloscope screen capture of a pulse signal from one of the MPFD detectors.

(yellow trace) of the oscilloscope and to the input of a Canberra 2022 amplifier. The coarse gain was set to 10 while the fine gain was set to 0.3, providing a total gain of 3. A shaping time of 12 µs and a positive input polarity was used. The unipolar output of the amplifier was connected to channel 2 (green trace) of the oscilloscope along with the input of an ORTEC Trump MCA. The pole-zero adjustment of the amplifier could not be adjusted in order to remove the undershoot seen after the pulse on channel 2 of the oscilloscope screen shot. The pulse should rise above the baseline (0 V) and return to the baseline without going back below if the pole-zero adjustment is set correctly to compensate the preamplifier. Unfortunately, the range of this particular 2022 amplifier's pole-zero could not match the requirements of the preamplifier.

The second oscilloscope screen capture shown in Figure 6.2 is of a pulse which has