Characterization of the NPS and COMPCAL Readout

Fernando J. Barbosa, Alex Somov, Chris Stanislav, Nick Sandoval

Jefferson Lab

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Following previous tests [1][2], two additional tests were performed on the NPS and COMCAL readout: full DAQ use with an fADC250 to determine the dynamic range setting and general behavior of a system similar to what is expected in an actual experiment; full characterization of the PMT and HV divider with preamp without the crystal and excited by a laser.

1. Tests with an fADC250

The setup consisted of an LED pulser, the R4125 PMT and HV divider with preamp and 55 feet of RG-58 type coaxial cable, as previously used [1]. The full DAQ with an fADC250 in Hall D was employed.

LED characteristics:

Wavelength	465 nm
Pulse width (FWHM)	20 ns, externally adjustable from pulse generator
Repetition rate	Up to 240 MHz, adjustable from pulse generator

Test Setup: Crystal, R4125 PMT, HV divider with preamp

Cable Length: 55 ft (~17 m)

Readout: Hall D DAQ with fADC250

The fADC250 input range was set to 500 mV for the full 12-bit dynamic range. Fig. 1 shows a representative average of pulses obtained with the fADC250. In this example, the pulse amplitude is about 2100 ADC counts or about half the dynamic range (0 to 4095) of the fADC250 setting, which corresponds to about 250 mV.

The setup was tested at various LED intensities and repetition rates. The LED intensity was set by the pulse amplitude from the external pulser, which also provided the trigger signal. Fig. 2 shows the results acquired with the fADC250 for three distinct LED intensities with varying rates (left) and normalized at 1 KHz rate (right).

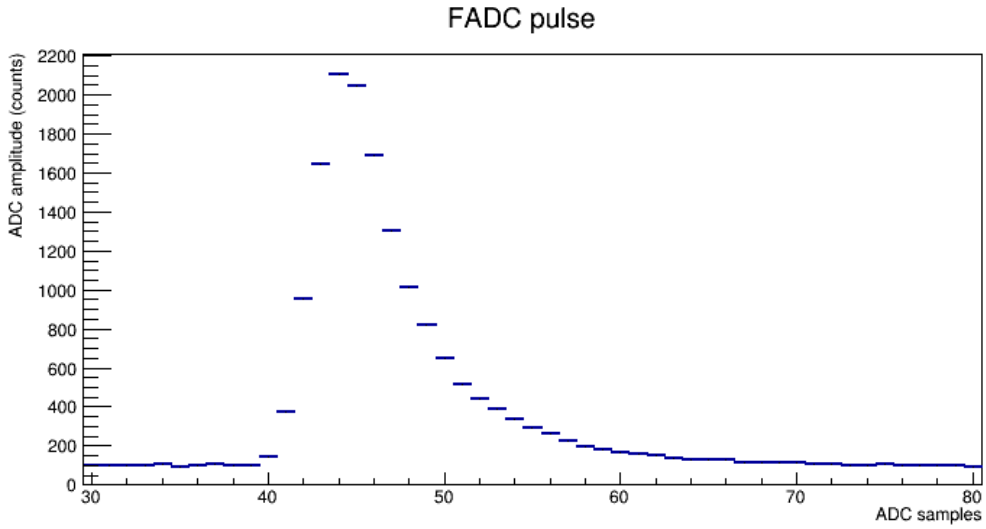

Fig. 1 – Pulses obtained from an fADC250 (~250 mV peak amplitude)

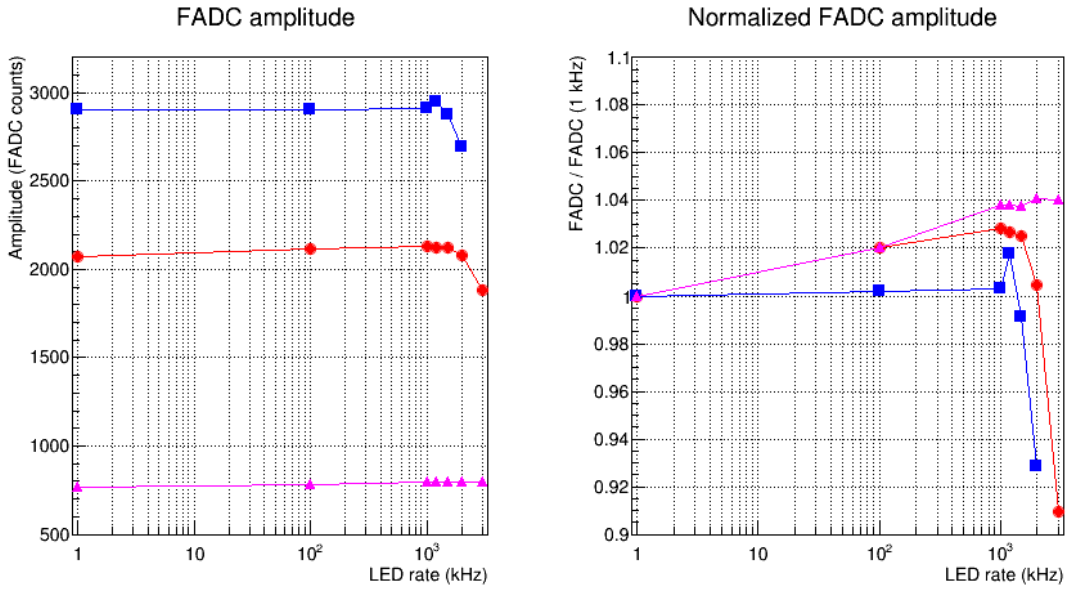

Fig. 2 – Results from distinct intensities (left) and normalized (right)

The LED intensities were chosen experimentally to exercise a large portion of the fADC250 dynamic range and were about 90 mV, 250 mV and 350 mV in amplitude. The normalized results show that linearity is better than 4% at 1 MHz. Note, however, that non-linearity is more pronounced at lower intensities and this is likely due to the LED being driven near or below its breakdown voltage.

2. Characterization with a Laser

Proper characterization of the readout required separation and removal of the crystal from the PMT. The readout only includes the PMT and the HV divider with preamp. The test setup is shown in fig. 3.

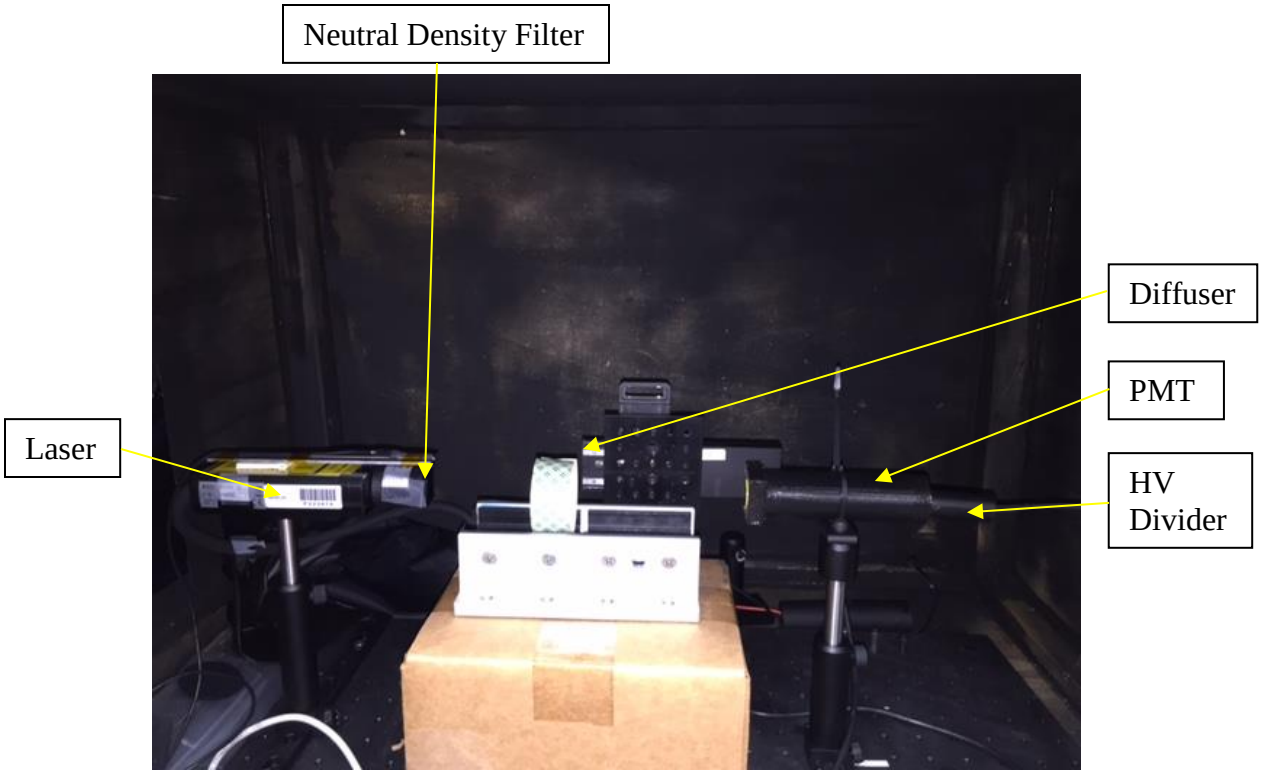

Fig. 3 – The NPS/COMCAL readout test setup

Laser head characteristics:

Wavelength	405 nm
Pulse width (FWHM)	70 ps
Repetition rate	Up to 100 MHz, externally adjustable
Intensity	Externally adjustable
Class	3B

Test Setup: R4125 PMT, divider with preamp

Cable Length: 55 ft (~17 m)

Readout: Oscilloscope (1 GHz, 5 MSPS)

The neutral density filter was installed to attenuate the intensity of the laser in order to allow for tests with amplitudes similar to what is expected with the fADC250, i.e. 500 mV range. Fig. 4 shows an average of pulses from this setup with an amplitude of 427 mV, a rise time of 2.1 ns and a width of 6.2 ns (FWHM) at a rate of 1 kHz. Because of the fast laser pulse characteristics, the impulse response of the readout is slightly shaped but agrees with the specification of a rise time of 2.5 ns for this PMT.

Tests were performed at various laser intensities to exercise the anticipated dynamic range of 500 mV and at various repetition rates. Fig. 5 shows the response of the readout for distinct amplitudes ranging from 100 mV to 400 mV and for rates ranging from 1 KHz to 5 MHz.

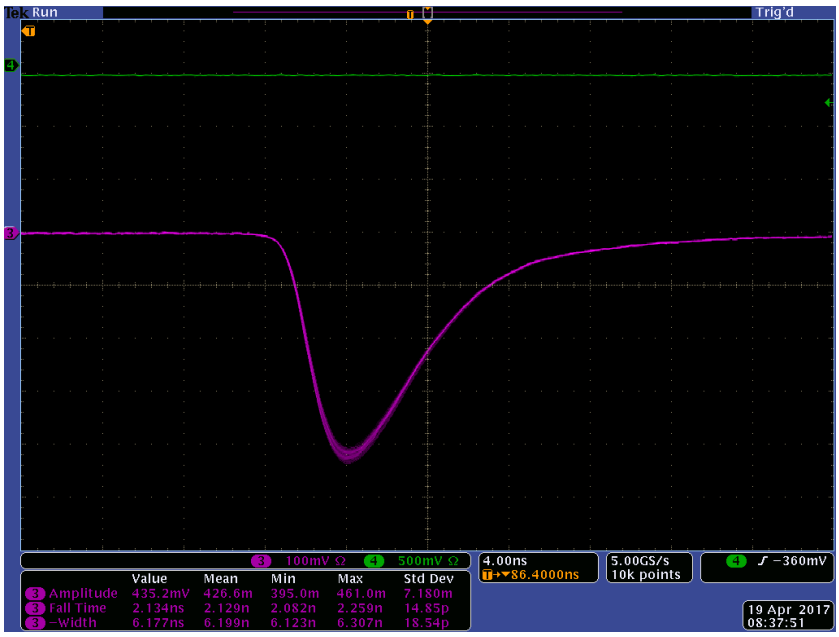

Fig. 4 – The NPS/COMCAL readout response from a fast laser pulse

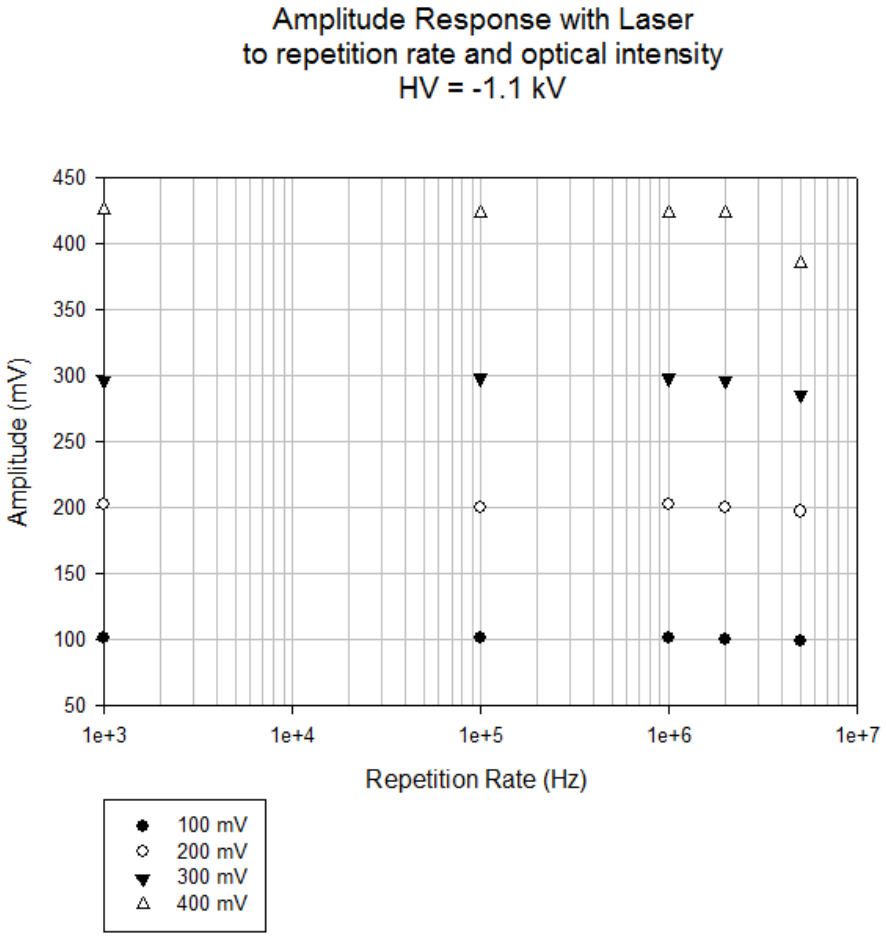

Fig. 5 – The NPS/COMCAL readout amplitude response

Fig. 6 shows the normalized responses indicating that the linearity of the readout is better than 2% for rates of up to 2 MHz and for amplitudes within the fADC250 range setting of 500 mV.

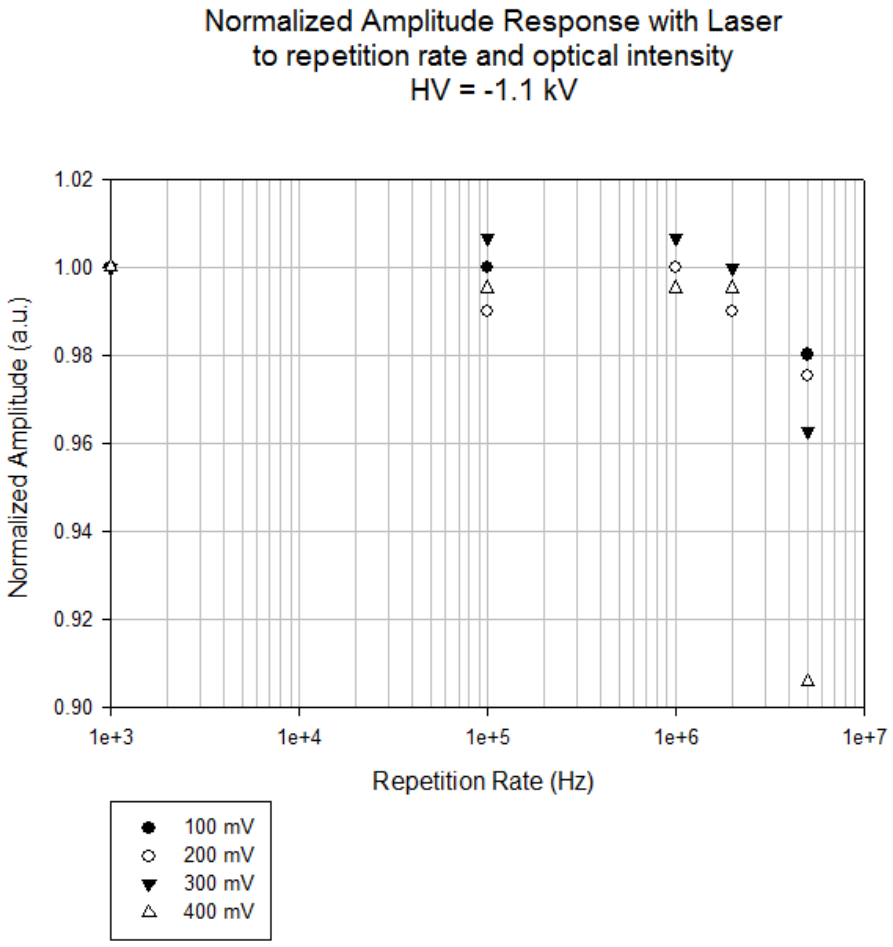

Fig. 6 – Normalized amplitude responses to various optical intensities

3. Summary

In concurrence with previous tests, good operation from this readout with linearity better than 2% and for rates of up to 2 MHz can be expected. Further optimization may be possible by adjusting the PMT HV in finer increments, therefore, balancing rates, linearity and dynamic range requirements. Operation with the fADC250 and associated DAQ was also demonstrated and in agreement with previous tests performed with a scope.

[1] F.J. Barbosa, **Tests of the NPS and COMCAL Readout**
[2] F.J. Barbosa, **The NPS and COMCAL Readout – Response to Short and Long Cables**