

# PMT Testing - Ringing in Shaper

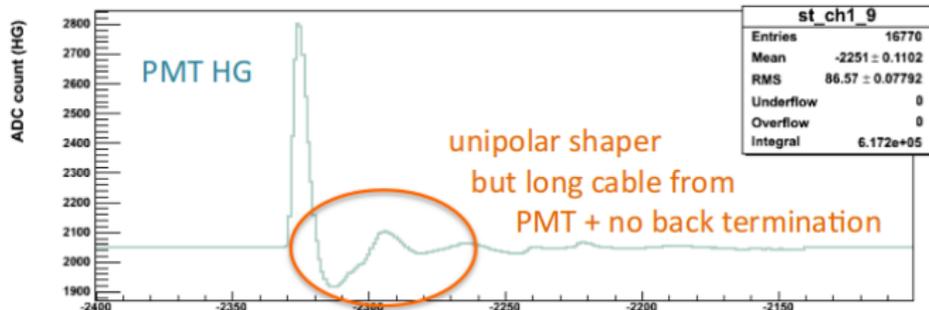
David Caratelli, Victor Genty, Georgia Karagiorgi

Nevis Labs - Columbia University

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# Motivation

- ▶ Some background info: DocDC 2600 (Georgia)
- ▶ In short: Bo sees ringing in the PMT output from the shaper.
- ▶ Possible cause: the signal reflection that occurs with a long cable causes ringing in the shaper output. We tested this hypothesis.



## The Idea:

- ▶ As the signal travels along the cables in the circuit, imperfections and connections between cables cause a portion of the signal to reflect back.
- ▶ If we assume the signal bounces back and forth at the end of a cable, we should expect secondary voltage peaks at time-scales comparable to the signal's travel time in the wire.
- ▶ How will the shaper respond to this? If the signal reflections happen quickly (short wire) and within the original pulse coming from the PMT, the final output signal will be "clean". For a long cable, the shaper output will show ringing

## What Are We Looking For?



The capacitor + resistance ( $50\ \Omega$  for both lengths) forms an RC circuit. This sets the timescale for voltage variations:

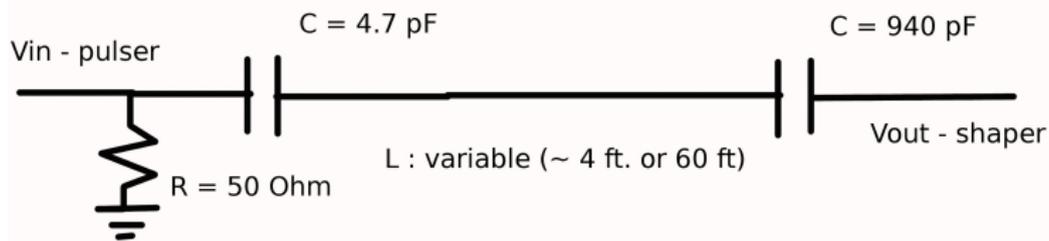
$$\tau_{\text{circuit}} = RC = 50\ \Omega \times 940\ \text{pF} = 47\ \text{ns} \quad (1)$$

This time needs to be compared with the time-scale for ringing in the circuit, i.e. how long does it take the signal to bounce back and forth in the wire?

$$v_{\text{signal}} = 1\ \text{foot}/1.5\ \text{ns} \rightarrow \tau_{\text{short}} = 6\ \text{ns} \quad \tau_{\text{long}} = 90\ \text{ns} \quad (2)$$

No ringing for  $\tau_{\text{circuit}} \gg \tau_{\text{wire}}$

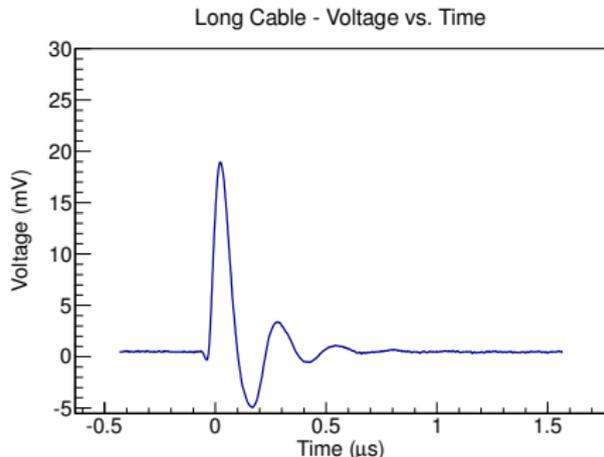
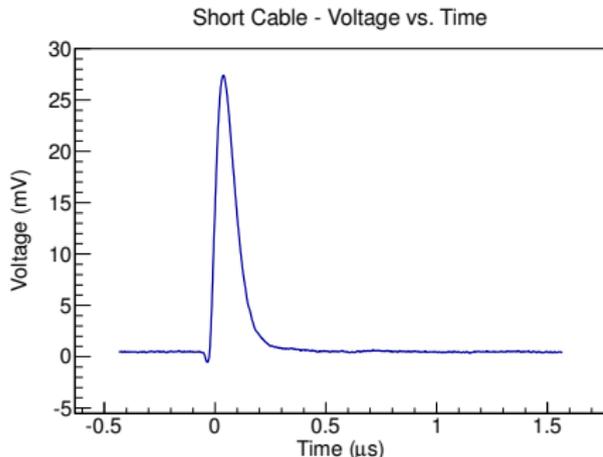
# Our Setup



# Circuit Output Signal, Without Shaper



# Results



Looking at the output signal from the shaper. This agrees with the idea that the long cable is responsible for the ringing.

Reflections get integrated by shaper and cause wiggles if they do not happen within the pulse (long cable).

**Two solutions:** Increase capacitance or shorten cables.

If more evidence needed could look at how the effect changes for various cable lengths.