

Letter to the Editor

A FAST TIMING LIGHT PULSER FOR SCINTILLATION DETECTORS

J.S. KAPUSTINSKY, R.M. DeVRIES, N.J. DiGIACOMO, W.E. SONDEHEIM and J.W. SUNIER

Los Alamos National Laboratory, Los Alamos, NM 87545, USA

H. COOMBES

University of Alberta at TRIUMF, Vancouver, British Columbia, Canada V6T 2A3

Received 20 August 1985

We report on the development of a compact, inexpensive and fast light pulser system designed to set up the timing of scintillators in a medium energy physics spectrometer.

The importance of light pulsers in the setup, timing and calibration of scintillators in physics experiments is emphasized by the number of designs that have been reported. Some of those that incorporate light emitting diodes (LED) as the light source accomplish fast time response with hand picked avalanche transistors that provide high voltage driver pulses [1]. Other require multistage transistor circuits [2]. Often these systems are difficult or expensive to reproduce. The circuit we describe is simple, compact and inexpensive and as such is well suited to a broad range of applications.

The light source we use is a 2.2 mm diameter green LED [3] with a peak emission wavelength of 565 nm *. The driver electronics and LED are mounted on a printed circuit board that is approximately 1.5 cm × 1.25 cm (see fig. 1). The circuit is comprised of eight components, four of which are off-the-shelf miniature chip devices.

The circuit diagram of the driver board is shown in fig. 2. An external trigger is sent to the driver board on a coaxial cable. The trigger is a negative 1.5 V pulse with a minimum width of 150 ns that rides on a variable negative dc bias level, 0–24 V. The dc component of the trigger charges a 100 pF capacitor. The complementary pair transistors are switched on by the trailing edge of the differentiated input pulse. The subsequent circuit path to ground provides a low impedance path for the capacitor to dump its charge through the LED. The 10–90% rise time of the light pulses we observe typically show no significant contribution to the 2.5 ns rise time of our photomultipliers (see fig. 3). This is as good a response as any previously reported for a pulse green

LED. In addition, the low power driver pulses do not adversely affect the lifetime of the diode. Thus far, we have had no LED failures in our system. The 100 nH inductor in the circuit develops charge in opposition to the discharging capacitor. This action reduces the decay constant τ of the light pulse, which follows the time

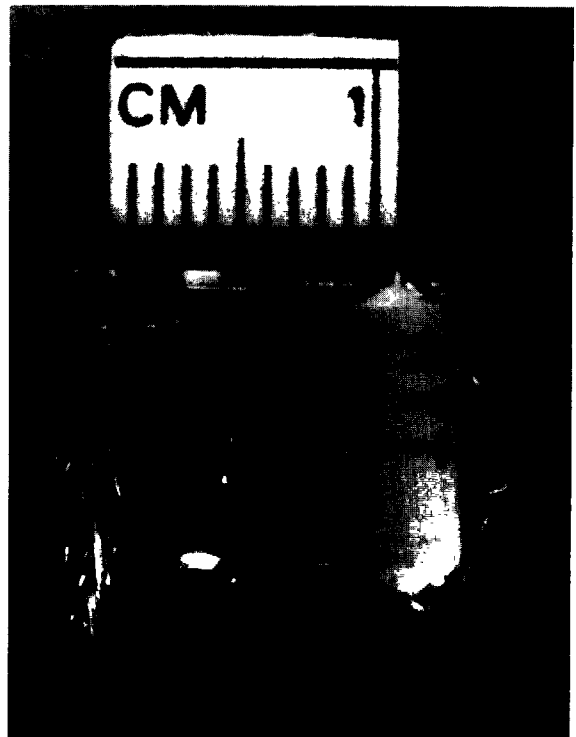


Fig. 1. Photograph of the LED and driver board.

* Design work incorporating a red LED, without the circuit inductor, was performed at TRIUMF.

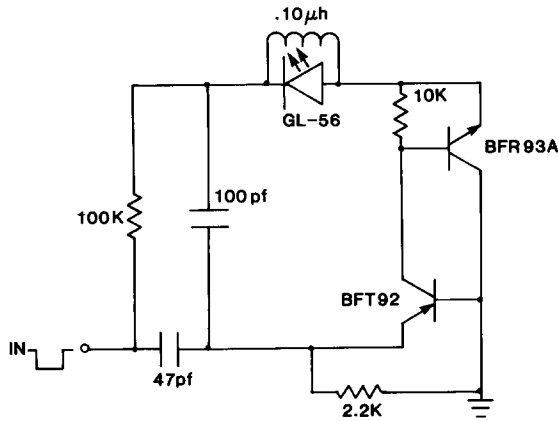


Fig. 2. Schematic drawing of the driver board circuitry.

dependence $e^{-t/\tau}$. With no inductor in the circuit we measured the decay constant to be about 100 ns. A 100 nH inductor shortens this to approximately 12.5 ns.

We designed the light pulser system to set up the timing of the data acquisition electronics associated with detector modules in the CALLIOPE spectrometer [4]. Each module consists of a ΔE counter, a Cherenkov detector, and an x, y position sensitive wire chamber. The ΔE counters are PILOT B scintillator and the Cherenkov detectors are a laminated construction [5] of PILOT 425 and UVT lucite. The rise and fall times we obtain from the LED are a good approximation to the time characteristics of the scintillation light, and the attenuation to the 565 nm wavelength light pulse is acceptable. The scintillators are slabs of $65 \times 15 \times 1.25$ cm. The Cherenkov detectors are $65 \times 15 \times 2.5$ cm. Each detector has a phototube at either end to view the light. We place the LED in a shallow hand drilled hole at the center of the top $2.5b \times 65$ cm surface of the detector. The signals from each pair of phototubes, and a simultaneously triggered wire chamber pulse, are then used to calibrate the system timing. The light pulse amplitude is adjusted by varying the dc bias level of the trigger pulse.

The light pulsers also enable us to monitor the long term integrity of the optical couplings in the detector assemblies. As gain drift reference monitors their use is limited to relatively large gain shifts since there is no light output stabilization in the circuit, and the LED is subject to both long and short term drift due to aging and temperature fluctuation.

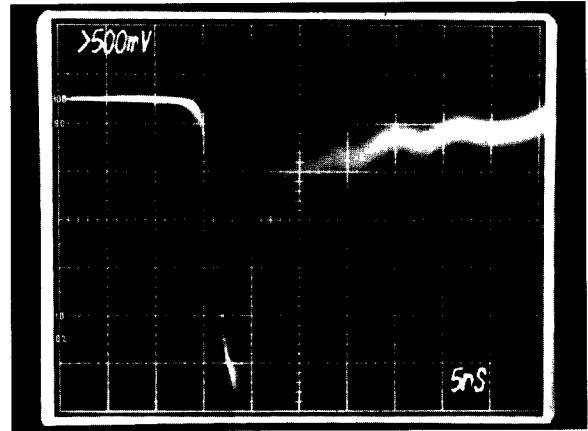


Fig. 3. Light pulse viewed with an EMI-9813 photomultiplier tube.

In other applications, the pulsers were used to study the light output temperature dependence of bismuth germanate crystals [6]. Here we split the light signal between two fiber optic strands, one strand illuminating a BGO crystal and the other going to a PIN photodiode in order to monitor gain shifts in the light output of the LED. In another instance, the pulsers were used to investigate the light output and attenuation characteristics of SCG1C [7] scintillation glass. In both cases the LED circuit inductor was removed to more closely simulate the longer decay time pulses of those scintillator materials.

References

- [1] D.R. Green, Nucl. Instr. and Meth. 151 (1978) 307.
- [2] W.L. Reiter and G. Stengl, Nucl. Instr. and Meth. 173 (1980) 307.
- [3] Litronix GL-56 Green Light Emitting Diode, Siemens Comps. Inc., Cupertino, California, USA.
- [4] J.W. Sunier, K.D. Bol, M.R. Clover, R.M. DeVries, N.J. DiGiacomo, J.S. Kapustinsky, P.L. McGauchey and W.E. Sondheim, Nucl. Instr. and Meth. A241 (1985) 139.
- [5] W.E. Sondheim, R.M. DeVries, M.R. Clover, N.J. DiGiacomo, J.S. Kapustinsky and J.W. Sunier, Nucl. Instr. and Meth. 219 (1984) 97.
- [6] P.E. Koehler, S.A. Wender and J.S. Kapustinsky, paper presented at the 6th Symp. on X- and Gamma-Ray Sources and Applications (1985) Ann Arbor, Michigan, to be published in Nucl. Instr. and Meth. A (1986).
- [7] Manufactured by Ohara Optical Glass Mfg., Inc., Japan.