CC/NUMBER 50
DECEMBER 15, 1980

This Week's Citation Classic

Green R E & Bell R E. Notes on a fast time-to-amplitude converter. *Nucl. Instrum. Meth.* **3**:127-32, 1958. [Radiation Lab., Dept. Physics, McGill University, Montreal, Canada]

This paper described an electronic circuit for converting the time intervals between initial and final pulses from two nuclear detectors into amplitudes for measurement. Typical intervals were 10-10 to 10-9 seconds, of interest for nuclear lifetimes and positron lifetime in condensed materials. [The *SCI*® indicates that this paper has been cited over 95 times since 1961.]

R. E. Bell
Department of Physics
McGill University
Montreal H3A 2T8
Canada

November 10, 1980

"During the 1950s and 1960s, great efforts were made to improve electronic instrumentation for recording coincident nuclear events or the intervals between nuclear events. The main object was to improve the time resolution, a second object was to record the whole distribution of intervals be tween many pairs of events in a single measurement. The arrival of fast scintillation detectors in the late 1940s made possible a greatly improved time resolution. Later the wide availability of multichannel pulse amplitude analyzers made it possible to record a whole 'time spectrum' at once, via a time-to-amplitude converter (TAC).

"This paper is one step in the development of TAC circuits. In 1952 Graham, Petch, and I published[1] a paper on the design and use of fast coincidence circuits using the early scintillation detectors. That paper depended on the 'fast-slow' coincidence technique first described briefly by Bell and Petch2 in 1949. The expression fast-slow' was not used in either of these papers, but came later from Oak Ridge; I wish we had thought of it ourselves. (We called it 'post-coincidence pulse height selection.) It refers to measuring the short time intervals between pairs of pulses that are unselected as to amplitude, and then selecting on a relatively slow scale only those results that were caused by pulses of the correct amplitudes. The fast intervals may be 10^{-9} seconds, whereas the slow selection may require a few times 10^{-6} seconds. The effect is the same as if the amplitude selection itself were performed very fast, which is generally not possible.

"It is hard to realize now, 30 years later, that this rather obvious fast-slow idea was then a distinct advance. The device described in this paper was developed by Ralph Green and myself, mainly for measuring the annihilation lifetimes of positrons in condensed materials. We were able to show that, for example, positrons in water behave quite differently when oxidants (e.g. $NaNO_3$) are added to the water than when paramagnetic salts (e.g. $FeCl_3$) are added. Work was also done on various solids. These results opened up a field of positron (or positronium) solid-state and chemistry studies.

"A further paper by Belli in 1965 on coincidence techniques brought the resolving time down from several times 10^{-9} sec. in 1952 to about 0.8 times 10^{-9} sec. in 1958 (the present paper) to about 0.2 x 10^{-9} sec. in 1965. We would now call this 0.2 ns. or 200 ps. The resolving times haven't changed much since.

"Why were such papers cited a lot? Because in earlier times anyone who wanted to do these measurements had little choice but to consult the literature and build his own apparatus. Nowadays one buys plug-in high-speed discriminators off the shelf, I haven't checked, but I'll guess that these citations have pretty well ceased."

1. **Bell R E, Graham R L & Petch H E.** Design and use of a coincidence circuit of short resolving time. *Can. J. Phys.* **30**:35-52, 1952.
2. **Bell RES Petch H E.** Upper limit for the lifetime of the 411-keV excited state of Hg^{198}. *Phys. Rev.* **76**:1409-10, 1949.
3. **Bell R E.** Coincidence techniques and the measurement of short mean lives. (Siegbahn K, ed.) *Alpha-, beta-, and gamma-ray spectroscopy.* Amsterdam: North-Holland, 1965. p. 905-29.