The observations presented in the *Science* report titled "Energetic Radiation Produced During Rocket-Triggered Lightning," by Dwyer *et al*. were made at the International Center for Lightning Research and Testing (ICLRT) at Camp Blanding, Florida, by an instrument recently constructed at the Florida Institute of Technology. The instrument consists of two detectors: an "active" detector containing a 12.71 cm diameter by 7.62 cm long cylinder of NaI(Tl) crystal scintillator, attached to a 5-inch photomultiplier tube (PMT), and a "control" detector that is identical in every way to the active detector except that it contains no scintillator. Each detector was manufactured by Saint-Gobain (M-style detector) and was wrapped in a μ-metal shield and sealed inside an aluminum, light-tight housing. An Ortec Model 296 photomultiplier tube base, a self-contained high-voltage supply and preamplifier, was mounted to each PMT. Both detectors were sealed inside a heavy aluminum box, used to keep out water, light and RF noise. All sides of the box had a minimum thickness of 1.0 cm, except for a 0.32 cm thick aluminum window that covered the top parts of the detectors, allowing low-energy (>20 keV) x-rays to enter. The box was welded together, and the lid sealed with both a Viton O-ring to prevent water and light leaks and a metal RF gasket. Extensive tests were performed using a bright strobe light with a 3 μsec pulse width to insure that light leaks were not producing false signals.

Because the instrument operates in the close vicinity of lightning, no conducting power or data cables entered or exited the box. The detectors and electronics were all internally powered by a 12 V battery. The output of the preamplifiers for the two detectors were connected directly to two fiber optic transmitters, located inside the box.

Fiber optic feedthroughs were used to exit the box, and a pair of standard multimode fiber-optic cables, 100 m long, made the connection to the receivers, located next to the data acquisition computer in a shielded trailer. The transmission format was straight analog, utilizing modified Terahertz Technology video transmitter and receiver pairs with 10 MHz bandwidth.

The output of the two fiber-optic receivers went directly into a National Instruments PCI 5102 data acquisition (DAQ) card, the output of which was subsequently stored on the hard drive of a PC. The DAQ card independently measured the signals on the two channels (from the two receivers) once per μsec, with 8-bit resolution over a ±1 V range. Acquisition was initiated by an external digital trigger, derived from the current measured at the rocket launcher, due to the lightning return stroke. Once a trigger was received, the data acquisition system stored 0.1-seconds (100,000 records) of pre-trigger data and 0.9 seconds (900,000 records) of post-trigger data simultaneously for both channels. Both channels were treated identically, with no distinctions made between the active and control detectors. Once the data were transferred to the hard drive of the computer, an additional 1 second (10^6 record) measurement was taken approximately 10-seconds later, giving a measurement of the background.

During triggered lightning experiments, all electronics, including the receivers, DAQ card, and PC were powered by a generator, located next to the trailer underneath an electromagnetic shield covering the immediate area. The power supply was filtered by a UPS, and a Tenma DC power supply provided 12 V to the receivers. Consequently, gain fluctuations in the amplifiers due to variations in the power inputs were minimal. Indeed, the University of Florida lightning research group has been making lightning observations for many years using exactly the same facilities with no problems due to variability on the power supply.

For 5 of the triggered lightning flashes measured during the summer of 2002, the instrument was located 25 m from an 11 m tall tower, from which the rockets used to trigger the lightning were launched. For the remaining two triggered lightning flashes the instrument was placed 50 m from a mobile launch platform mounted on the back of a truck. For all measurements the detectors were mounted vertically so that the effective area of the scintillator was 127 cm^2 when viewed from above. The facility at Camp Blanding was instrumented to measure optical emission, electric and magnetic fields and currents from triggered lightning *(s1)*, and the "classical" triggering technique *(s2)*, using a small rocket that spools out a thin copper wire connected to the ground, was used for all the launches reported. During thunderstorm conditions, the rockets were launched when the measured electric field on the ground exceeds a value of about -5 kV/m. Typically, when the wire reaches a length of a few hundred meters, the electrostatic field enhancement at the rocket tip becomes large enough to instigate an upward positive leader. The leader then propagates to the thundercloud and initiates a continuous current, lasting typically a few hundred milliseconds. Several negatively charged downward leaders and the resultant upward return strokes usually follow a short period without current.

In Fig. 1 in the report, the gamma ray was produced by a 5 μcurie Cs-137 radioactive source, temporarily placed on top of the instrument, outside the box, and the 1-second data record was initiated by an internal software trigger and not by lightning. The pulse shape is characterized by a fast (< 1 μsec) rise-time, followed by a slow, exponential decay due to the 45 μsec RC-time of the preamplifier circuit. Because the preamplifiers are AC coupled to the fiber optic transmitters, an undershoot occurs with a much longer (1260 μsec) RC-time, which slowly returns the signal to the baseline. The pulse shape is governed completely by the behavior of the preamplifier/transmitter circuit and is essentially independent of the energy of the particle measured. Furthermore, the response of the detector to large signals, such as in Fig. 3 in the report, is understood, since atmospheric cosmic-ray particles (mostly muons) with a rate of 3.8 counts/sec also generate similar, although slightly smaller (factor of ~2) signals.

References

s1. V. A. Rakov *et al*., *J. Geophys. Res.* **103**, 14,117 (1998).

s2. P. Lalande *et al*., *J. Geophys. Res.* **103**, 14,109 (1998).