

A NEW ULTRA SMALL BATTERY OPERATED
PORTABLE MULTI-CHANNEL ANALYZER

M. A. Wolf and C. J. Umbarger

Health Research Division
Los Alamos Scientific Laboratory
MS-401
Los Alamos, New Mexico 87545Summary

A newly designed portable multi-channel analyzer (MCA) has been developed at Los Alamos that has much improved physical and performance characteristics over previous designs. Namely, the instrument is very compact (25 cm wide x 14 cm deep x 21 cm high) and has a mass of 4.2 Kg (9.2 lb). The device has 1024 channels and is microprocessor controlled. The instrument has most of the standard features of present laboratory-based pulse height analyzers, including CRT display, region of interest integration, etc. Battery life of the MCA is nearly eight hours, with full charging over night. An accessory case carries a small audio cassette recorder for data storage. The case also contains two different NaI (Tl) detectors. Another case contains a 10% efficient hyperpure germanium (HpGe) detector for very high energy resolution gamma ray spectroscopy. That detector (commercially available) is portable and can carry enough liquid nitrogen for 10 hours of field use. All necessary electronics to acquire data from the various detectors are located on the detectors themselves. No additional power supplies, NIM equipment, etc., are necessary for field operation.

I. Introduction

As part of the continuing radiation monitoring instrumentation development program of the Health Research Division at the Los Alamos Scientific Laboratory (LASL), we have developed a truly portable, full capability, multi-channel analyzer (MCA). The portable MCA is the latest development in a series¹⁻⁶ of recent portable instrumentation designed at LASL. The MCA, along with an accessory package containing two small NaI(Tl) detectors and an audio cassette recorder for data storage, provide a complete data acquisition capability in the field in a configuration that is convenient, as well as powerful. A portable hyperpure germanium (HpGe) detector is included in a separate accessory package. The goal of the MCA development program was to provide a portable MCA that was sophisticated, yet simple to operate by non gamma-ray spectroscopists. In addition we have designed the signal input requirements to be general in nature, making the MCA applicable to many types of radiation detectors as well as other voltage-producing devices (3 v. input).

In application and features, but not electronic design, this MCA is similar to that developed several years ago by McGibbon.⁷ That design was not microprocessor-based and the unit, which included the NaI detector and camera (but no other data-recording device) weighed approximately 37 lb.

II. MCA: General Description

The portable MCA is shown in Fig. 1. Also shown in the figure is the first accessory case that normally contains two small NaI detectors (one 3 mm thick, one 37 mm thick detector) and the audio cassette recorder (not shown). The accessory kit as shown weighs approximately 6 lb. The MCA (left side Fig. 1) weighs 9.2 lb (4.2 Kg). Also shown in Fig. 1 is a portable HpGe detector for high resolution gamma ray spectroscopy. For field use, all necessary equipment are contained in the MCA and accessory cases. For field operation of the HpGe, the high voltage supply, preamp, and amp were all located on the detector. An additional battery supply was added to the HpGe carrying case to allow sufficient total battery lifetime (approaching eight hours continuous use) using the HpGe. Figure 2 shows the MCA with its outer case removed to exhibit the mechanical details of the unit.

III. MCA: General Electronic Design

The instrument is microprocessor-controlled (Motorola 6802) and has 1024 channels of memory (20 bits each). Extension to 4096 channels is straightforward but to date has not been attempted. The ADC is of the Wilkinson design and uses a 20 MHz clock. As shown in Figure 2, the MCA is keyboard-controlled and has many of the features of commercial laboratory based instruments, including CRT display. A single cursor marks the locations of selected channels, and a LED display gives each channel number (location) and data contents. Multiple regions of interest and integrals (via intensified regions of display) are also provided for on-site data analysis. Memory regions of full, halves, and quarters are provided.

Data storage is via an ordinary audio cassette recorder. Data transfer rate is 300 baud with 10 bits per character, with 8 characters per channel. The entire 1024 memory then takes approximately 4.6 min. to transfer and record, with six spectra storage capability per 30-minute cassette tape. The data is formatted on the tape using standard receive modem tones. This can then be entered into any computer using an ordinary modem.

The MCA is powered by a single 6-volt Gel Cell with 2.6 amp-hour rating. With no displays turned on, the MCA draws 250 ma. With the displays on, the current drawn is 750 ma. The memory is CMOS, but not the microprocessor. We are told that CMOS micros are going to be available very soon. This would drop the current approximately 100 ma. A blanking feature is included that shuts off the CRT display after two minutes and the LED display after ten seconds. With all displays off, the MCA battery lifetime is nearly eight hours. A battery charger is included in the first accessory package and recharges the MCA over night.

While performance trials are only now beginning, stability, differential nonlinearity, etc., appear to be satisfactory for high energy resolution applications.

IV. Use and Application

Anyone working in the area of nuclear radiation spectroscopy recognizes the benefits of being able to acquire and analyze pulse height data in the field. Areas of application include health physics, environmental monitoring, radioactive waste management, mineral prospecting, and nuclear safeguards. Typical types of data that can be acquired with the portable MCA is represented in Fig. 3. Fig. 3 shows a low energy photon spectrum acquired with a thin planar HpGe detector and an ^{241}Am source. The various photon lines of interest are labeled. While this particular detector was not of the portable variety, the spectrum is representative of that obtainable with hand-held detector/dewar configurations. Our plans at this point are to have the MCA manufactured commercially.

References

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Fig. 1. The portable MCA is located on the left; the portable HpGe detector is in back behind the standing NaI detector; the accessory case for the NaI detectors and the audio cassette recorder is in front on the right.

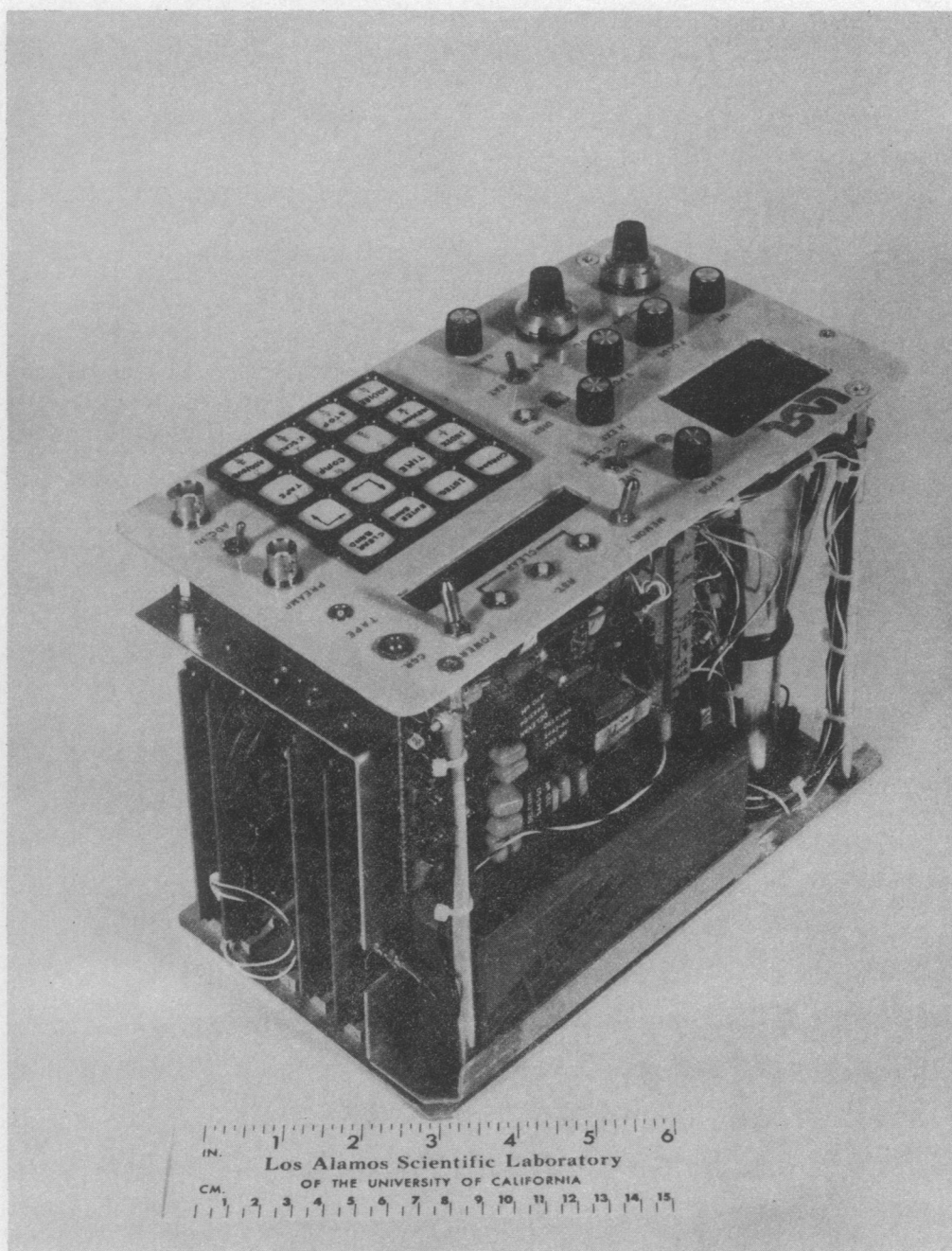


Fig. 2. The MCA with its outer case removed to show the electronics and Gel Cell battery.

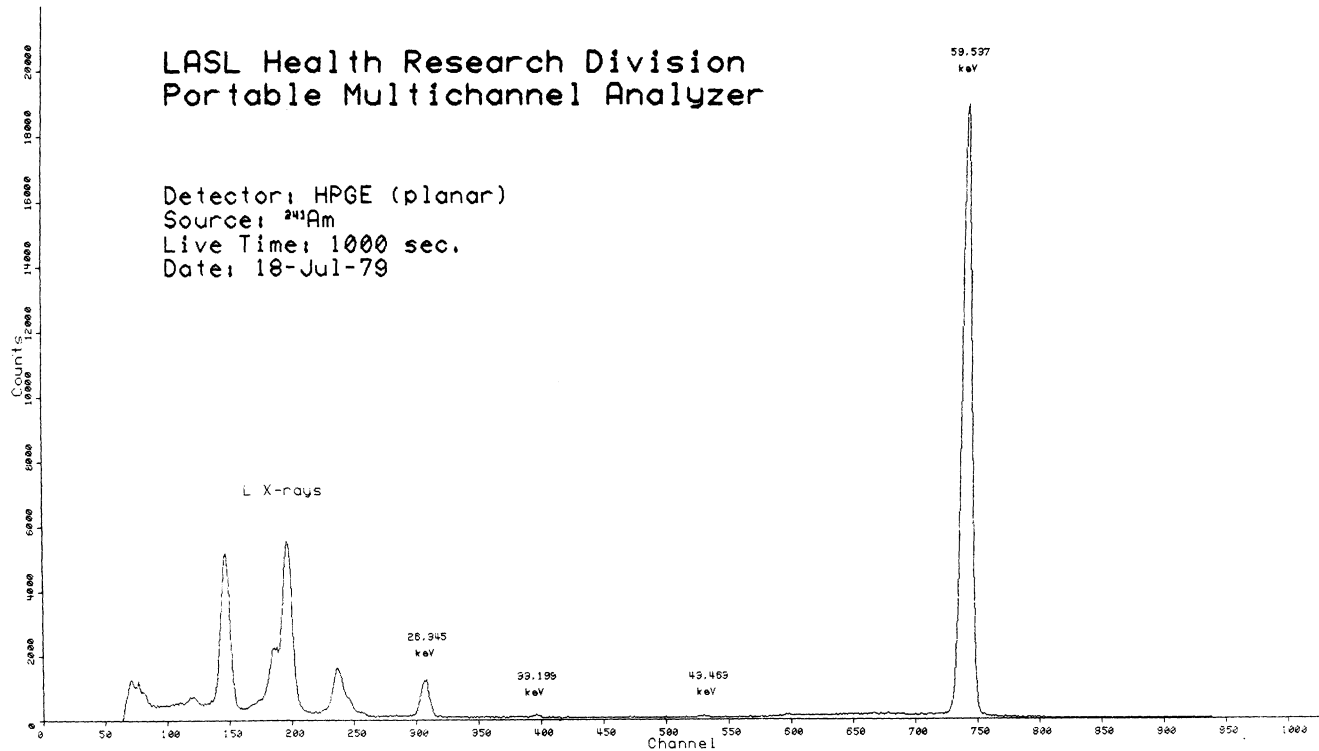


Fig. 3. A typical pulse height spectrum acquired in the MCA, recorded onto the cassette recorder, and then transferred into a standard mini-computer for analysis and plotting. The detector was a thin planar HPGe detector. The radioactive source was ^{241}Am .