Downhole MCA for High-Resolution Spectral Gamma Logging for Characterization of Radiological Contaminants – 16321

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ABSTRACT

A downhole data system for spectral gamma ray detectors has been developed and deployed in boreholes at the US DOE Hanford Site in southeastern Washington State. This system consists of a digital multichannel analyzer, power supply, and high-voltage power supply located in the borehole probe. Communication up the cable to a computer at the surface is digital, meaning that issues related to analog pulse transmission over the logging cable are eliminated. This system can support either scintillator or solid-state detectors.

INTRODUCTION

High-resolution spectral gamma logging allows gamma-emitting radionuclides to be identified and assayed from characteristic gamma emissions associated with decay. Historically, these systems have depended on analog pulse transmission from a detector and preamplifier in the logging borehole probe up to an amplifier and multichannel analyzer (MCA) located at the surface in the logging truck. As a result, the logging cable has been a limiting factor, with pulse distortion and data throughput being major problems. A specialized cable with coaxial conductors has been required, and maximum length has been limited to 600 feet. Even so, line transmission has been a problem, particularly as the characteristic impedance of the cable can change over time, both from normal wear and tear, and from radiation effects on the insulation.

DESCRIPTION

This recently developed downhole MCA (DHMCA) system can operate with conventional 7-conductor logging cable over lengths of at least 1000 ft. Power and digital communication are provided to the detector and DHMCA through the logging cable. A conventional laptop computer at the surface collects and stores data, and controls the logging process. Software specifically written for hoist control, integration of the depth measurement and spectral data acquisition operates in the laptop in Windows 7 or 8. Gamma energy spectra are accumulated downhole and transmitted to the surface via digital protocol. They can be analyzed using commercial spectral data analysis packages.

Currently, an HPGe detector equipped with the DHMCA has been constructed in a 3.375-inch OD cylindrical housing to function in pushed or drilled boreholes as small as 3.75-inch ID. The DHMCA has also been constructed in a 1.5-inch OD housing that can accommodate other detectors such as LaBr(Ce), BGO, NaI(Tl) or CZT. This system can be used in casings as small as 1.75 inch ID.

In geophysical logging, the cable serves to position the borehole probe in the borehole, supply power and to transmit data. The DHMCA effectively eliminates most of the data transmission issues related to the cable by moving everything critical to data collection into the borehole probe. A cable is still required, if for no other reason than to move the borehole probe up and down the borehole.

Figure 1 is a block diagram depicting the DHMCA system and components. RS485 communications protocol is utilized to transmit data up the logging cable. Cable lengths of at least 1000 ft are possible, with a data rate of 115.8 kbps. The system has an inherent immunity to electromagnetic interference. Note that for logging with an LN-cooled detector below groundwater level, a vent line may still be required, because the liquid nitrogen in the dewar flask must be at atmospheric pressure to maintain detector temperature

The DHMCA photo shown in figure 2 is a 3.375-inch OD cylindrical housing on top of the borehole probe assembly. The DHMCA and low voltage circuit boards included in the DHCMA section are custom fabricated.

The detector assembly shown in figure 2 contains a HPGe detector (60% relative efficiency) with a transistor reset preamp and a custom fabricated high voltage power supply. Figure 3 shows the surface control, acquisition laptop, and hoist control box.

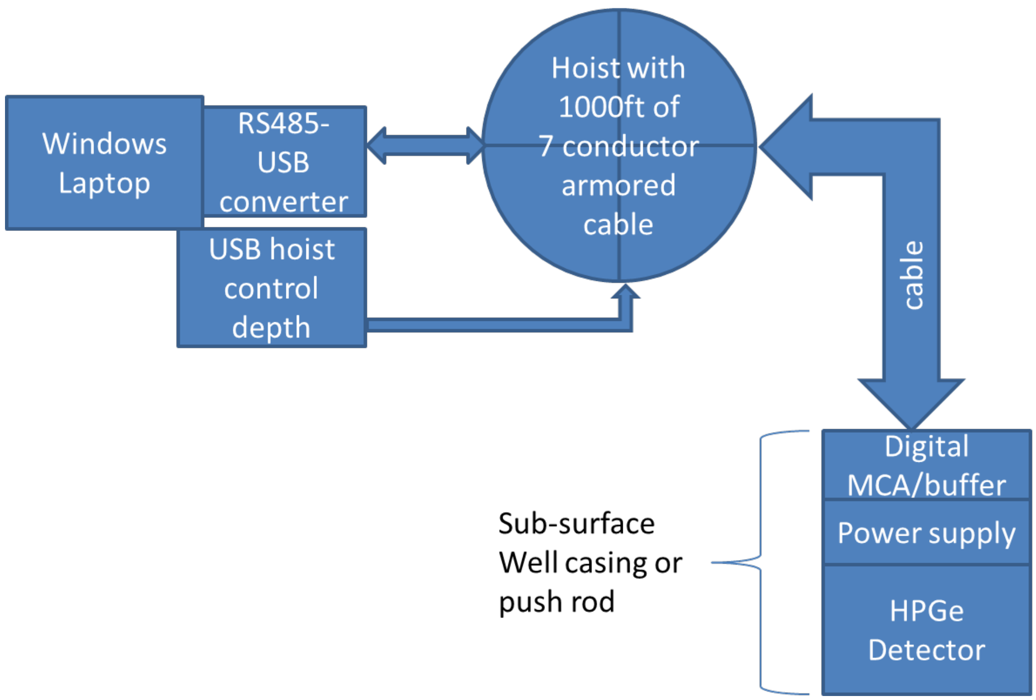

Figure 1. This diagram depicts the system configuration.

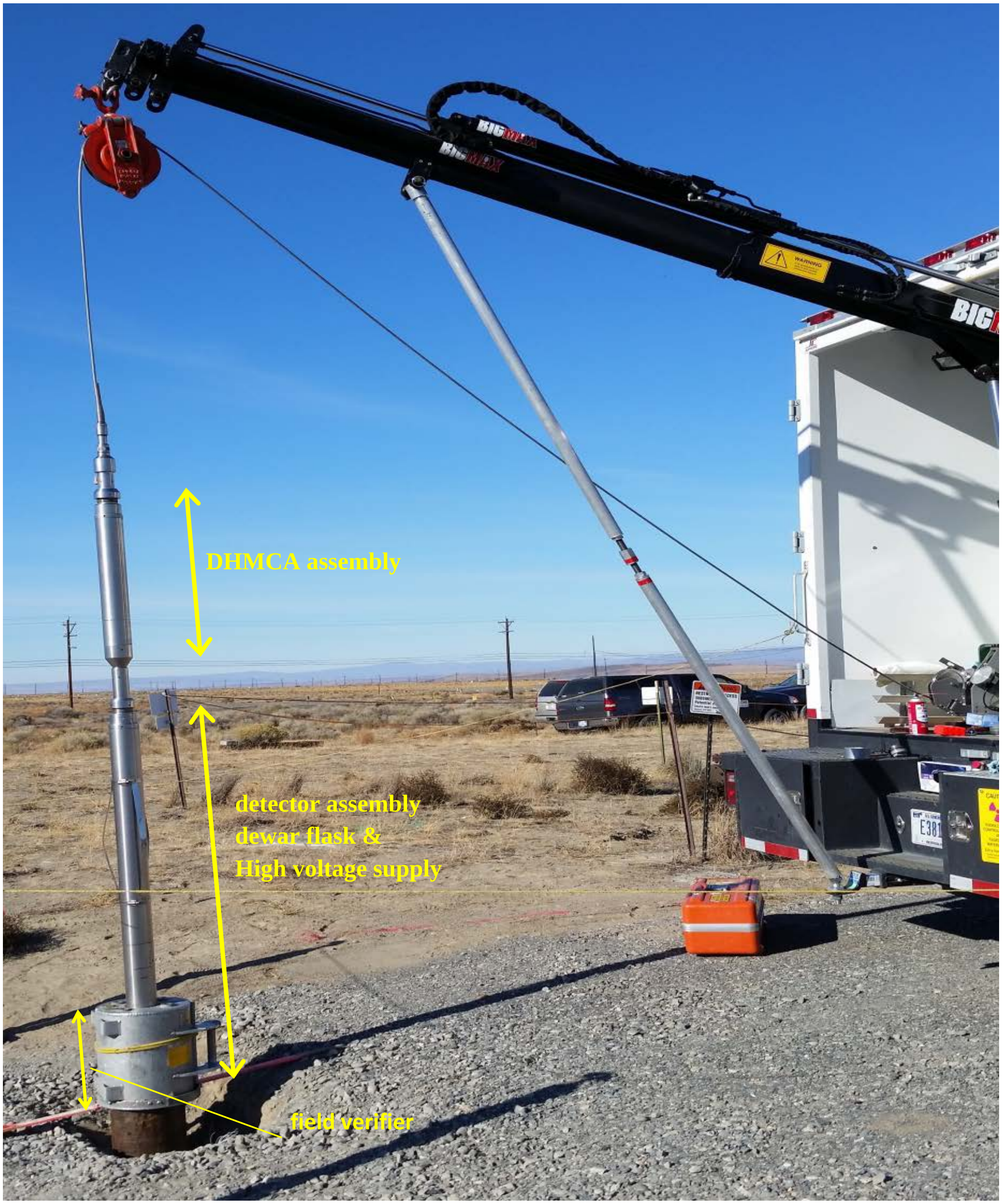

Figure 2. This image shows the 3.375-inch OD DHMCA attached to an SGLS borehole probe collecting a verification measurment in a KUTh verifier.

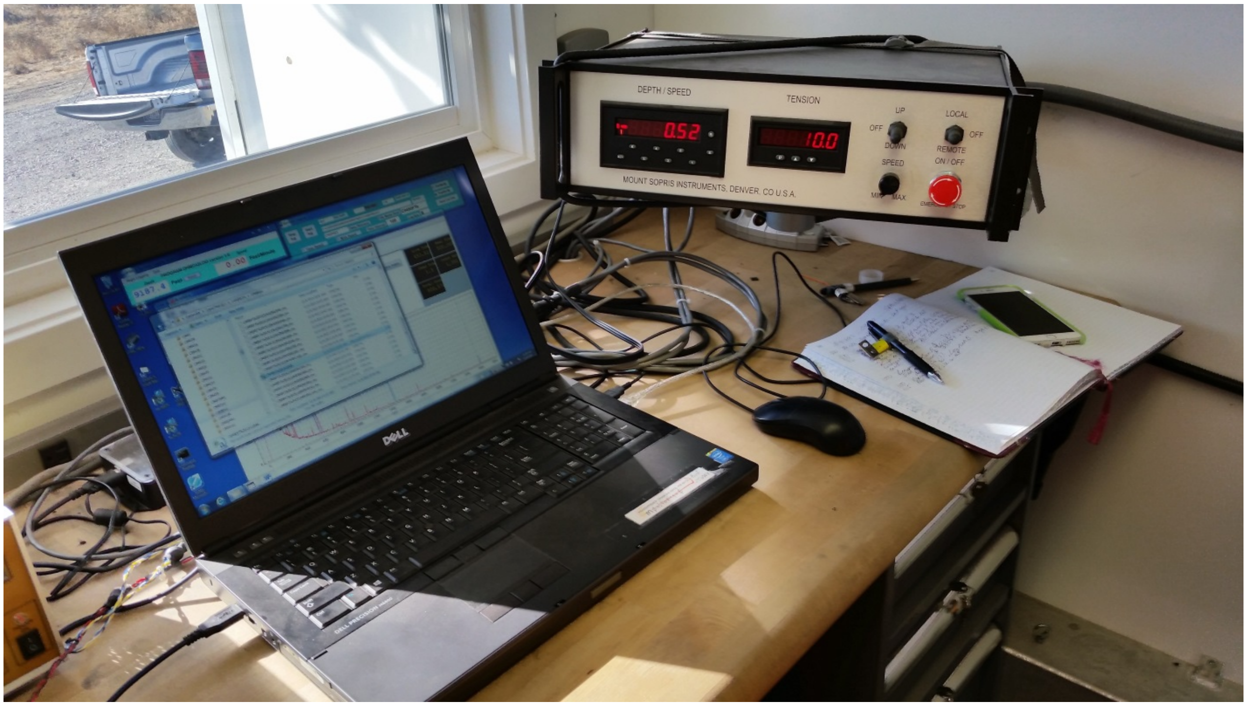

Figure 3. Logging computer (used for logging and dataacquisition) and hoist control inside the logging cab.

CONCULUSIONS

This DHMCA system can be utilized at any site for characterization of radiological waste sites where boreholes or push rods are deployed. In the original system, the detector pulse was transmitted as an analog signal from the logging borehole probe to the amplifier / MCA in the logging truck. This made the logging cable a critical component of the data collection system. With the DHMCA, the MCA is located much closer to the detector and the gamma energy spectrum is accumulated downhole. This eliminates the cable as a critical component, improves throughput, and alleviates spectral distortion. It also allows greater cable length and a simpler logging cable.

This DHMCA configuration raises the possibility of using a logging system for remote measurement other than in boreholes. By hanging the sheave wheel from a crane, and using both the crane and logging winch to position the borehole probe, it would be possible to perform remote measurements without personnel access to the measurement area, thus reducing potential hazards to personnel. In other applications, it is entirely likely that the cable could be eliminated entirely by use of wireless technology.