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GAMMA FLUX IN ^{14}C LABORATORIES

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ABSTRACT. An informal collaborative group of radiocarbon dating laboratories, the Low-Level Club, has been established to measure the gamma radiation flux and to test the efficiency of the anticoincidence counting system in laboratories with a NaI detector unit. The detector will record gamma radiation from cosmogenic nuclides, muons and secondary γ radiation formed in the passive shield by charged cosmic-ray particles. We present here the first phase of this work.

Introduction

A small group of scientists from laboratories that use gas proportional counters met at the 13th International ^{14}C Conference in Dubrovnik, 1988, and organized the Low-Level Club, agreeing to collaborate on a project of comparing γ-radiation flux in their laboratories, both inside and outside the counter shield. A 5 cm × 5 cm NaI crystal will be used in this study, as, in most cases, it will fit into the space normally occupied by the sample counter. Stenberg and Olsson (1968) showed that these measurements can also: 1) monitor efficiency of the anticoincidence counter system and 2) show partial elimination of the background contribution of secondary γ radiation formed by muons and protons in the shield (Theodórsson 1992).

Wallac Oy in Finland contributed the low-level NaI detector unit, manufactured by Bicron Inc. Although only preliminary results can be presented at this time, we consider it useful to report on the potential of the technique, and to encourage other laboratories to participate in the project.

Experience has shown that it is time-consuming to send the detector unit alone to participating laboratories. Thus, we intend to assemble a compact unit with a high voltage supply, amplifier and a multichannel pulse-height analyzer, in addition to the detector itself. The system will be sent to participating laboratories.

The crystal unit will record the region of natural γ activity (<3 MeV), as well as energies up to 25 MeV, in order to measure the muon peak and secondary radiation formed in the shield by cosmic-ray muons and protons.

Measurements

The detector unit was first used at the University of Bern to record γ activity below 3 MeV under 15 different conditions inside various low-level shields. Figure 1 shows the spectrum inside one of the shields where peaks of the U and Th series are seen, together with the 1.46 MeV line from ^{40}K. Figure 2 shows the net count rate of the most prominent peaks under the 15 different counting conditions. The γ spectrum in most of the shields is similar, and is dominated by inherent γ contamination in the NaI detector unit itself, mainly in the glass of the photomultiplier tube. An important part of the project is to see how these differences are reflected in the background of the counters in the shield being measured.

The main purpose of the study at the Science Institute, University of Iceland, was to evaluate the pulse-height spectrum of secondary radiation above 3 MeV. Figures 3A and B show measurement results, both without a shield and with a 10-cm-thick lead shield. Run time was three days, in each

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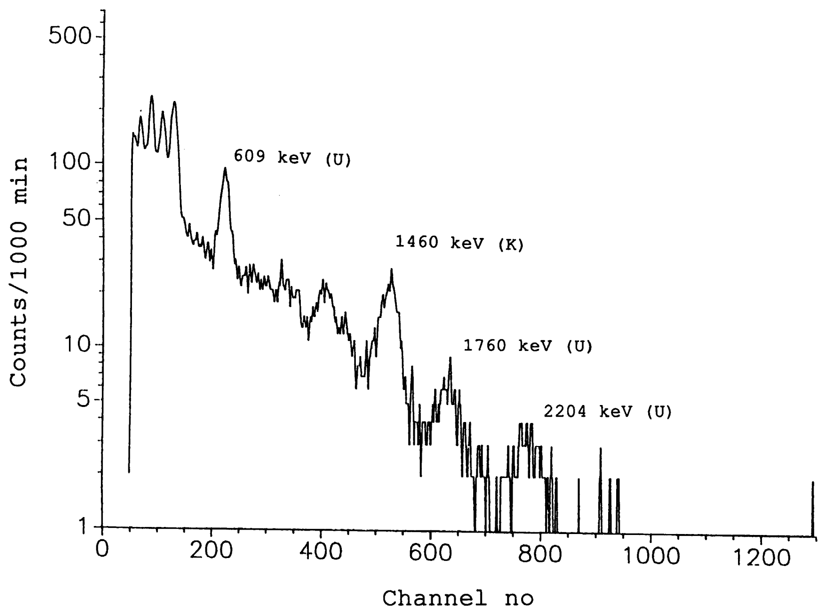

Fig. 1. Spectrum of the 2" × 2" NaI crystal in a lead shield in an underground laboratory in Bern

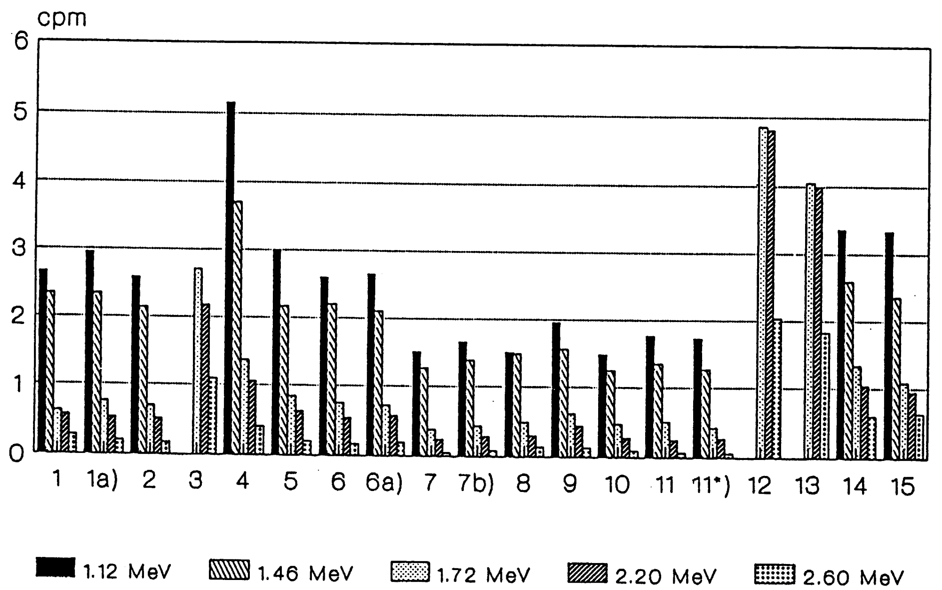

Fig. 2. Net count rate of γ-peaks above 1 MeV taken under various conditions at the University of Bern. Runs 1–11 were taken in the underground laboratory inside various shields.

case. The broad muon peak is at *ca.* 24 MeV; below that, we see the spectrum of the secondary γ rays.

In the future, we plan to measure the γ spectrum with the NaI unit inside the shield of a gas proportional counter, replace the sample counter, and record both the total and the anticoincidence spectrum. Characteristics of the 24-MeV peak in the anticoincidence pulse-height spectrum will show how effective the guard counter system is in eliminating the muons passing through the sample counter (Stenberg & Olsson 1968). Further, attenuation of the secondary γ radiation below the muon peak in the anticoincidence spectrum compared to the total spectrum will show the effectiveness of the inner shield and the anticoincidence system in reducing the background component of secondary radiation (Theodórsson 1992).

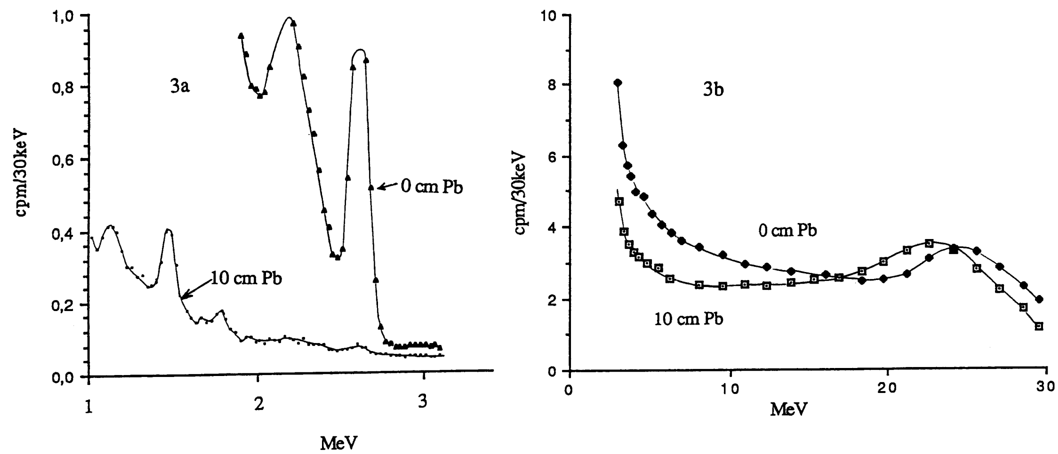

Fig. 3. Spectrum of the 2" × 2" NaI crystal at the Science Institute of the University of Iceland

Conclusion

It is our hope that after these measurements have been made in a number of low-level laboratories, the data will give us a better understanding of the residual background count rate of low-level gas proportional counters, and indicate how it can be reduced.

References

Theodórsson, P. 1992 Quantifying background components of low-level gas proportional counters. *Radiocarbon*, this issue.

Stenberg, A. and Olsson, I. U. 1968 A low level gamma-counting apparatus. *Nuclear Instruments and Methods* 61(2): 125–133.