GAMMA SCANNING WITH A LITHIUM-DRIFTED GERMANIUM ANTICOINCIDENCE SPECTROMETER*

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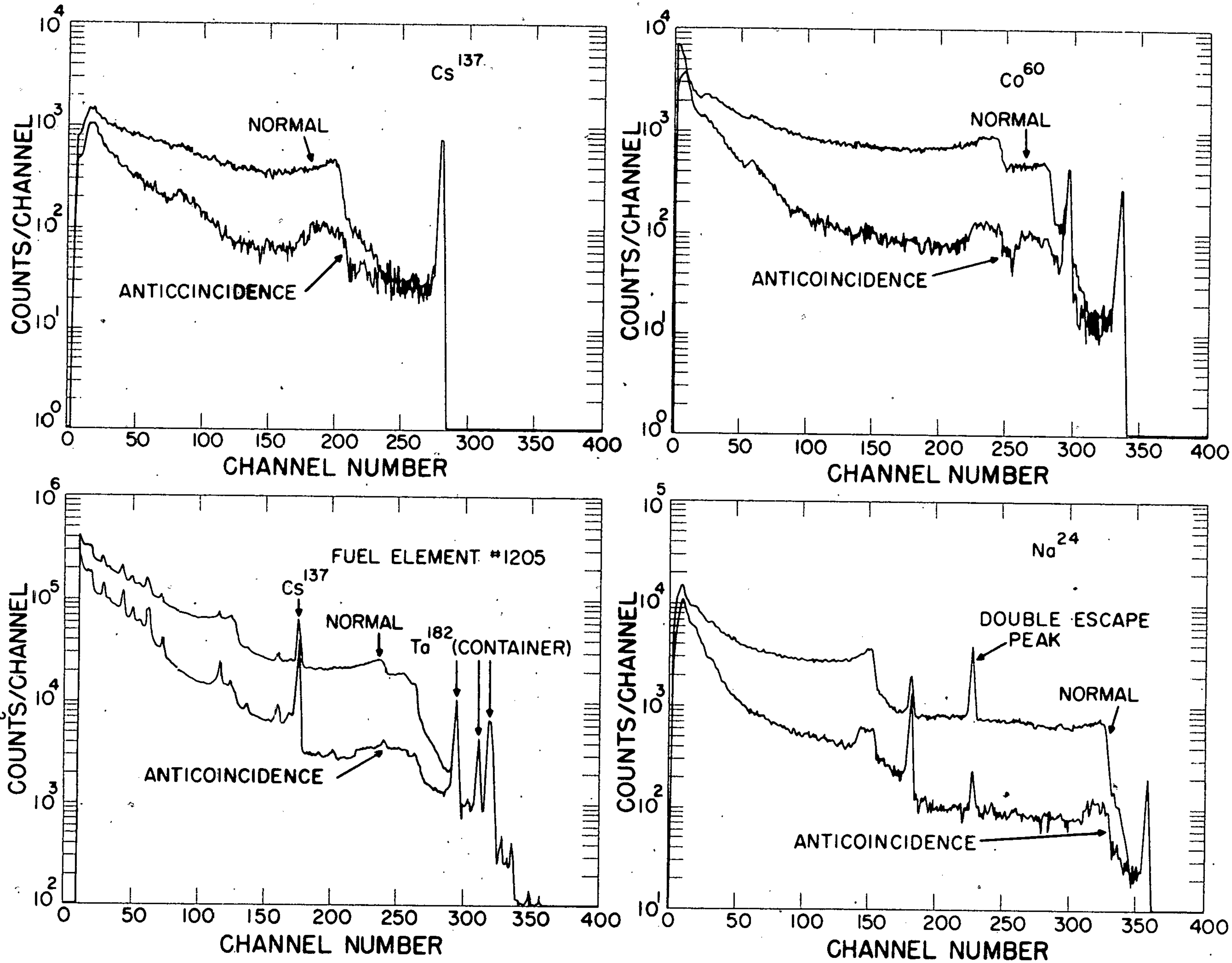
Despite the presence of a large number of gamma rays in gross fission products, the rather poor energy resolution of NaI detectors has limited the application of gamma scanning to the more prominent fission products. The advent of lithium-drifted germanium semiconductors makes it possible to perform more comprehensive analyses on these complex spectra. The high energy resolution of these detectors makes them attractive, despite their low efficiency.

Figure 1 shows some typical spectra taken with the small (3 mm x 2 cm^2) lithium-drifted germanium detector system previously described.[1] The pronounced improvement in the signal-to-noise ratio by anticoincidence can easily be seen in the spectrum of the fuel element #1205. No significant loss in the full-energy peaks is observed.

Plutonium fuel elements, which had been irradiated while molten, were positioned with a precision scanner in front of a collimated anticoincidence spectrometer, permitting spectra to be taken at various positions along the element. Figure 2 shows a series of spectra taken in the gas phase (i.e., portion of an element above solidified fuel). This figure shows that, even with the high resolution of the semiconductor, it is still necessary to do spectral unfolding of overlapping peaks. This can be seen by observing the 0.364 Mev peak from I^{131} at position 1.60" and the changes that occur in the other spectra. The interference peak at 0.350 Mev has been tentatively identified as Ta^{183} from double neutron capture of Ta^{181} in the fuel-container capsule. At position 1.95", near the fuel surface, Cs^{136} and La^{140} lines can be seen, along with the Ta^{182} activation of the container.

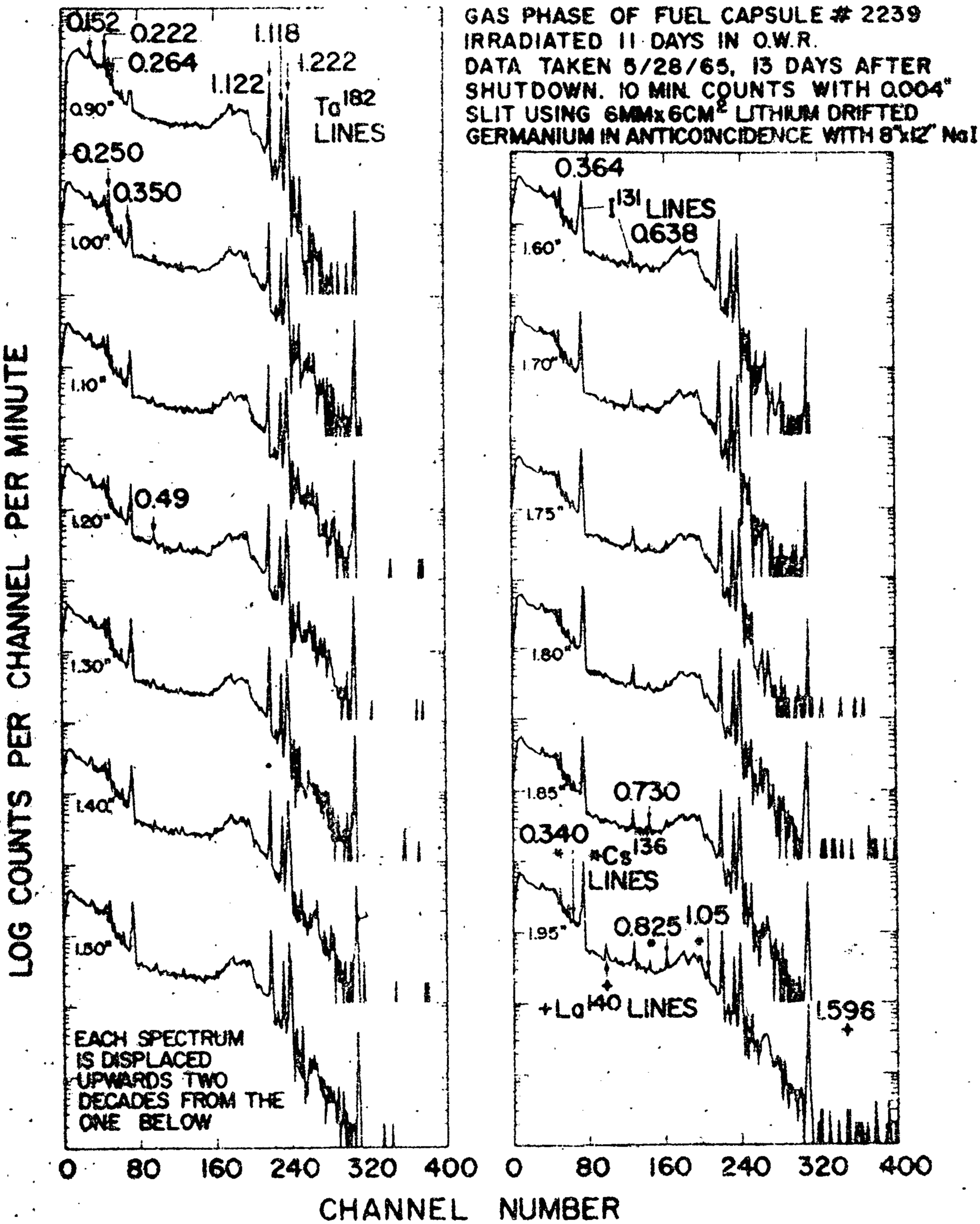
*Work done under the auspices of the U. S. Atomic Energy Commission

DISCLAIMER



Some Typical Spectra Taken with a Small (3 mm x 2 cm^2) Lithium-Drifted Germanium Detector System

Fig. 1



GAS PHASE OF FUEL CAPSULE # 2239
IRRADIATED 11 DAYS IN O.W.R.
DATA TAKEN 5/28/65, 13 DAYS AFTER SHUTDOWN. 10 MIN. COUNTS WITH 0.004" SLIT USING 6MM x 6CM² LITHIUM DRIFTED GERMANIUM IN ANTICOINCIDENCE WITH 8"x12" NaI
LOG COUNTS PER CHANNEL PER MINUTE
CHANNEL NUMBER
0.152
0.222
0.264
1.118
1.122
1.222
Ta182 LINES
0.250
0.350
0.49
0.90"
1.00"
1.10"
1.20"
1.30"
1.40"
1.50"
EACH SPECTRUM IS DISPLACED UPWARDS TWO DECADES FROM THE ONE BELOW
0.364
I131 LINES
0.638
1.60"
1.70"
1.75"
1.80"
1.85"
1.95"
0.730
0.340
*Cs136 LINES
0.825
1.05
+La140 LINES
1.596
0
80
160
240
320
400

Figure 2 shows that I^{131} is localized in a region above the fuel, and the relative distribution can easily be seen. The high resolution of the anticoincidence lithium-drifted detector is required to obtain the detail and accuracy shown. In general, continuous scans are taken with NaI and single channel analyzers to determine regions of change, but the detailed analysis is done with semiconductors.

REFERENCE: D. M. Holm and W. M. Sanders, "A Semiconductor Anticoincidence Detector System", Radiochemical Methods of Analysis, Vol. II, I.A.E.A., Vienna, 1965