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A Field-Deployable Gamma-Ray Spectrometer Utilizing High Pressure Xenon

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Summary: American Nuclear Society 1997 Annual Meeting

A Field-Deployable Gamma-Ray Spectrometer Utilizing High-Pressure Xenon*, *Graham C. Smith, George J. Mahler, Bo Yu, Walter R. Kane, and James R. Lemley (BNL)*

INTRODUCTION

Most nuclear materials in the nuclear energy, safeguards, arms control, and nonproliferation regimes emit gamma rays with a unique signature. Currently, two categories of spectrometers are available to evaluate these materials:

1. Semiconductors, with excellent energy resolution, which operate at cryogenic temperatures.
2. Scintillation detectors, which function at ambient temperature, but with poor energy resolution.

A detector which functions for extended periods in a range of environments, with an energy resolution superior to that of a scintillation spectrometer, would have evident utility. Recently, in the research community, such a device has evolved, an ionization chamber utilizing xenon gas at very high pressure (60 atm)[1,2]. Its energy resolution, typically, is 20 keV for the 661 keV gamma ray of ^{137}Cs. With high xenon density and its high atomic number (Z=54), and superior energy resolution, its sensitivity is comparable to that of a scintillator.

DESCRIPTION

Two spectrometers utilizing xenon at high pressure have been fabricated at Brookhaven National Laboratory (BNL). The first is a prototype, intended for evaluation to provide an understanding of its operating characteristics and to optimize its performance. The second is field-deployable,

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The drift velocity can be increased by small admixtures of helium or hydrogen (5-fold increase for 1% H or He)[1]. This minimizes electron losses and permits higher counting rates. If one atmosphere of ^{3}He is added, the spectrometer will have a substantial detection efficiency for thermal neutrons, functioning simultaneously as a gamma-ray spectrometer and thermal neutron detector.

CONCLUSIONS

The xenon-filled ionization chamber possesses a number of advantages:

- A wide operating envelope. It can tolerate a wide range of pressures, temperatures, accelerations, etc., functioning in difficult environments.
- Operation at ambient temperature.
- Energy resolution intermediate between semiconductors and scintillators.
- Toleration of fast neutrons without degradation of performance.
- With the addition of ^{3}He, simultaneous operation as a gamma-ray spectrometer and slow neutron detector.
- Minimal power requirements.

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1. V. V. DMITRENKO et al., " Compressed Gaseous Xenon Gamma-Ray Detector with High Energy Resolution," SPIE Vol 1734, Gamma-Ray Detectors (1992).
2. C. LEVIN, J. GERMANI, and J. Markey, "Charge Collection and Energy Resolution Studies in Compressed Xenon Gas Near its Critical Point," Nuclear Instruments and Methods in Physics Research A332, 206 (1993).

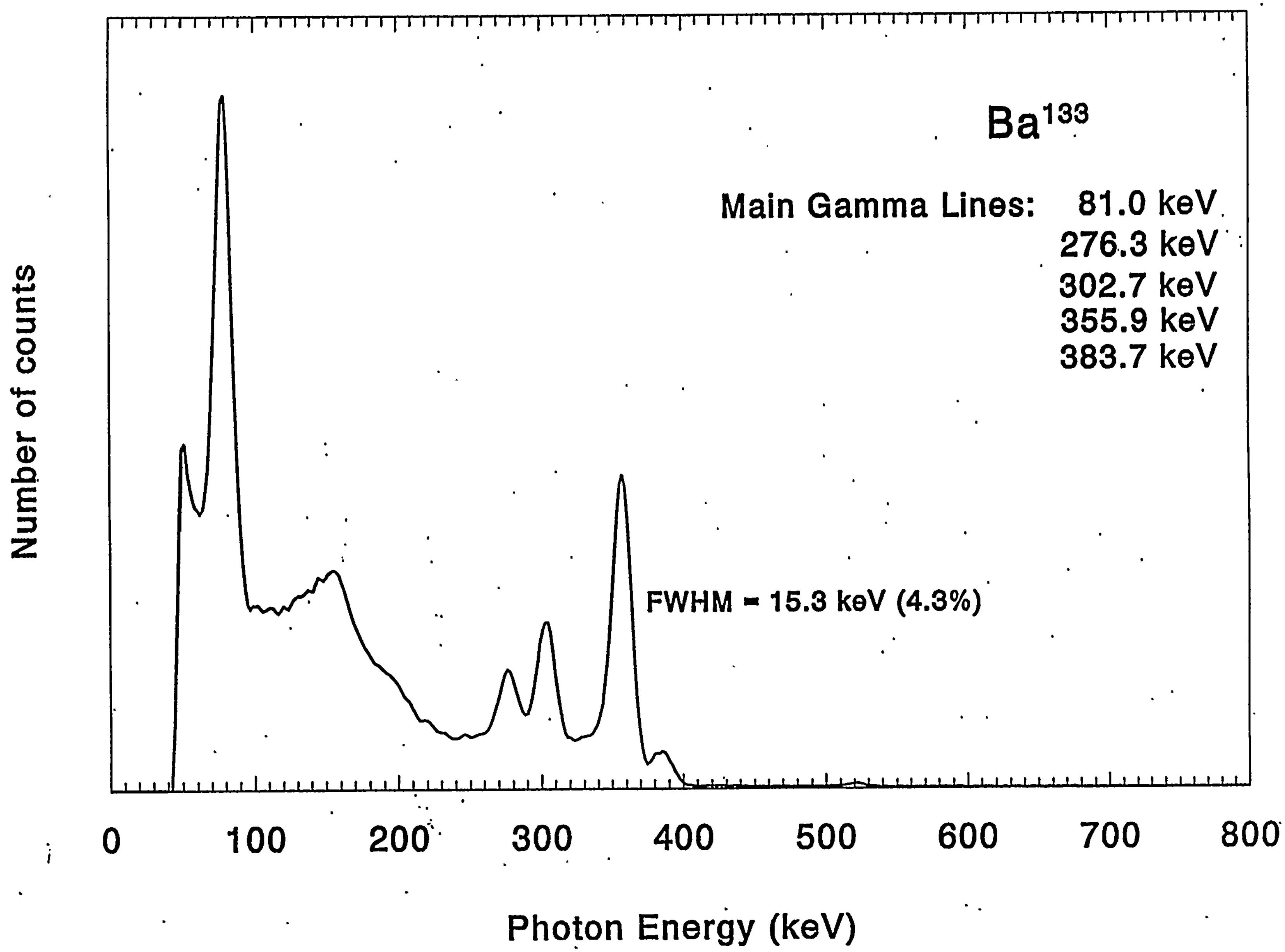

Fig. 2. Spectrum of ^{133}Ba Gamma Rays.

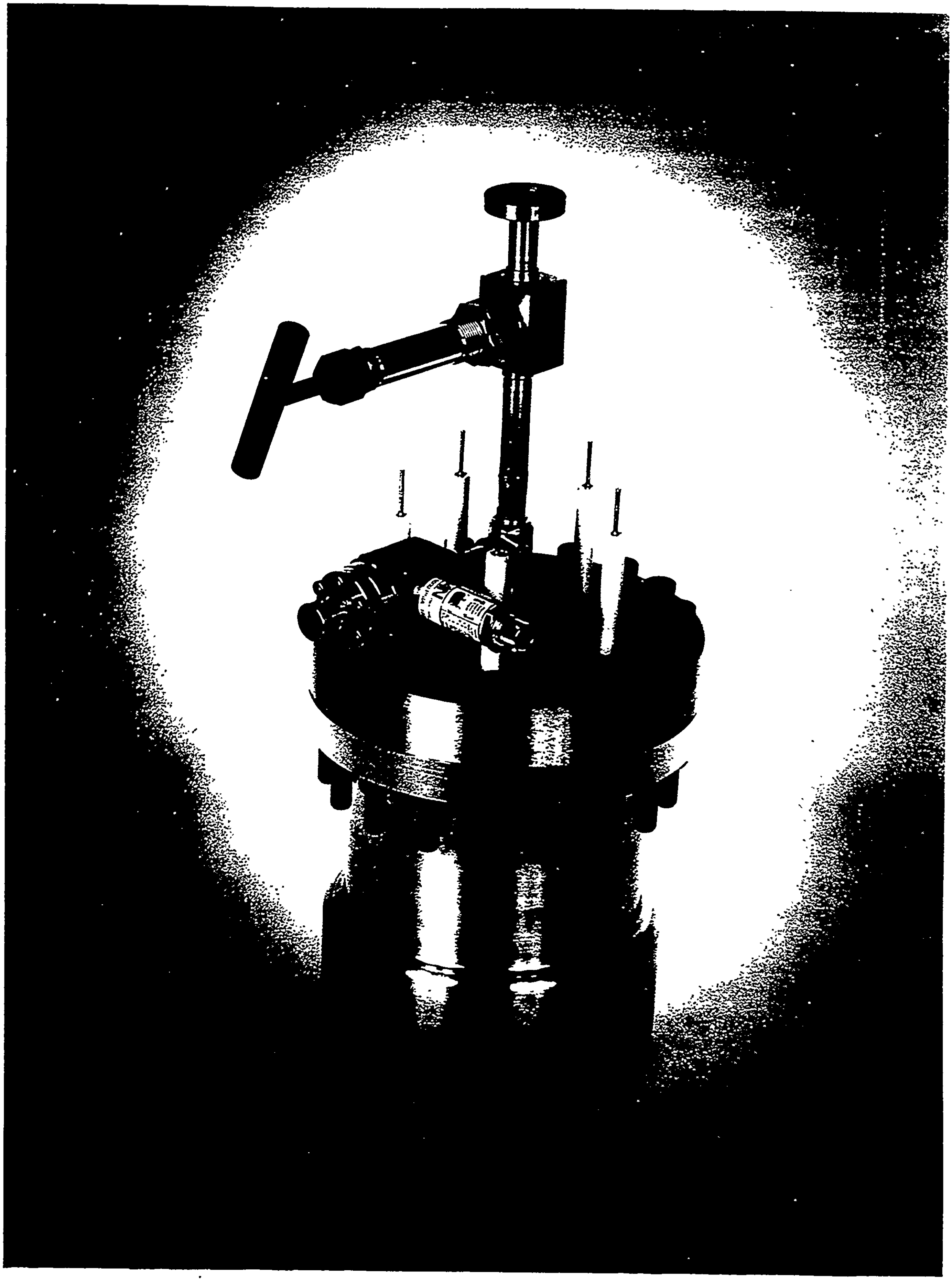

Fig. 1. Field Deployable Xenon Ionization Chamber.