

Lawrence Berkeley National Laboratory
LBL Publications

Title

A HIGH PRECISION PARTICLE DETECTOR USING NOBLE LIQUIDS

Permalink

<https://escholarship.org/uc/item/7s89507n>

Authors

Derenzo, Stephen E.

Smadja, Gerald

Smits, Robert G.

et al.

Publication Date

1971-09-01

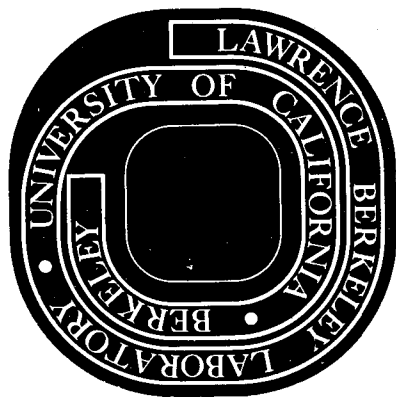
Submitted to Letter
to the Editor of Nature

LBL-372 *c.2*
Preprint

A HIGH PRECISION PARTICLE DETECTOR
USING NOBLE LIQUIDS

Stephen E. Derenzo, Gerard Smadja, Robert G. Smits,
Haim Zaklad, Luis W. Alvarez, and Richard A. Muller

September 1971



AEC Contract No. W-7405-eng-48

TWO-WEEK LOAN COPY

*This is a Library Circulating Copy
which may be borrowed for two weeks.
For a personal retention copy, call
Tech. Info. Division, Ext. 5545*

78

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

A HIGH PRECISION PARTICLE DETECTOR USING NOBLE LIQUIDS

We agree wholeheartedly with Peter Rice-Evans¹ and the Editors of Nature² that there exists a need for higher resolution particle detectors at the new synchrotrons. Following a suggestion by one of us,³ we are working toward the development of a thin multi-conductor chamber filled with a noble liquid. Our initial efforts with liquid argon have been described in several NAL Summer Studies Reports⁴ and the successful operation of a liquid xenon proportional counter is the subject of a recent paper.⁵

We briefly summarize what has been learned thus far:

- (1) A liquid xenon proportional chamber with an 8mm diam cathode and a single 4 μm anode detects charged particles with nearly 100% efficiency. The pulse rises in less than 150 nsec and is typically 0.15 pC in size. (Using liquid argon all our chambers have been sensitive only at scattered points along the wire.)
- (2) The electric field necessary for electron avalanche is approx 2 million V/cm. (Consequently the central wire must be the anode in order to avoid field emission.)
- (3) For the detection of ionization pulses (liquid gain = 1) produced by a moveable collimated source of alpha particles, a 700 μm thick chamber having 5 wires spaced 25 μm apart has a spatial accuracy better than 15 μm rms.
- (4) A series of parallel conducting strips mounted on a substrate is capable inducing electron multiplication.
- (5) Severe electronegative contamination of liquid xenon (due to unknown impurities) can occur even when the oxygen and nitrogen is held below 0.1 parts per million.⁶

We are now working to improve our control over electronegative impurities, to show that a series of substrate mounted conductors has high precision in the avalanche mode, and to develop a practical read-out scheme.

While the liquid xenon multi-conductor chamber provides accurate spatial information in its "thin" form, it also provides efficient, rapid X-ray and γ -ray detection in its "thick" form. The former should prove invaluable in the fields of high energy and cosmic ray physics, while the latter holds equally great promise in the field of radiology.

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

Lawrence Berkeley Laboratory
University of California
Berkeley, California 94720

Stephen E. Derenzo
Gerard Smadja
Robert G. Smits
Haim Zaklad
Luis W. Alvarez

Space Science Laboratory
University of California
Berkeley, California 94720

Richard A. Muller

- ¹ Rice-Evans, P., Nature, 232, 625 (1971).
- ² Editorial, Nature, 232, 599 (1971).
- ³ Alvarez, L. W., Group A Physics Note 672, University of California Lawrence Radiation Laboratory, Nov. 1968.
- ⁴ Derenzo, S. E., et al., National Accelerator Laboratory, Batavia, Illinois, Summer Study reports SS-154 (1969) and SS-181 (1970).
- ⁵ Muller, R. A. et al., Phys. Rev. Letters, 27, 532 (1971).
- ⁶ Many of our purification techniques are described in Zaklad, H. (D. Eng. Thesis), Lawrence Radiation Laboratory Report UCRL-20690 (1971).

LEGAL NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

TECHNICAL INFORMATION DIVISION
LAWRENCE RADIATION LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720