Lawrence Berkeley National Laboratory

Recent Work

Title

NEUTRON SOURCE FOR USE WITH A VARIABLE ENERGY CYCLOTRON

Permalink

<https://escholarship.org/uc/item/02v577k1>

Author

McKee, J.S.C.

Publication Date

1967-08-09

University of California

Ernest O. Lawrence Radiation Laboratory

NEUTRON SOURCE FOR USE WITH A VARIABLE ENERGY CYCLOTRON

J. S. C. McKee

August 9, 1967

RECEIVED

UNIVERSITY OF CALIFORNIA
RADIATION LABORATORY

OUT 3

LIBRARY
DOCUMENTS

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*

UCRL-17675
cy. 2

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.

UCRL-17675
UC-28 Particle Accel.
and High Volt. Mach.
TID-4500 (50th Ed.)

UNIVERSITY OF CALIFORNIA

Lawrence Radiation Laboratory
Berkeley, California

AEC Contract No. W-7405-eng-48

NEUTRON SOURCE FOR USE WITH A VARIABLE ENERGY CYCLOTRON

J. S. C. McKee

August 9, 1967

Printed in the United States of America
Available from
Clearinghouse for Federal Scientific and Technical Information
National Bureau of Standards, U.S. Department of Commerce
Springfield, Virginia 22151
Price: Printed Copy \$3.00; Microfiche \$0.65

NEUTRON SOURCE FOR USE WITH A VARIABLE ENERGY CYCLOTRON

J. S. C. McKee

Lawrence Radiation Laboratory
University of California
Berkeley, California

August 9, 1967

Recent theoretical work on the three nucleon problem by Faddeev¹⁾, Omnes²⁾, Sitenko and Kharcenko³⁾ and others, indicates that a solution to the problem may be expected in the not too distant future⁴⁾.

For this reason, there is a pressing need for accurate experimental data on the n-d system, involving both polarization and cross section measurements; and this article suggests a design for a neutron source suitable for use in either type of experiment. The source produces polarized neutrons from the $^2\text{H}(d,n)^3\text{He}$ reaction, with $Q=3.266$ MeV, and is intended for use with cyclotron beams of 10 MeV energy and upwards.

The principle source of contamination of such a neutron beam lies in the (d,n) reaction which will occur at the exit window of the gas target. This design seeks to minimize the problem.

It is well known that a suitable window material must possess the qualities of high mechanical strength, thermal conductivity and melting point; while being available in a form that is both uniform and hole free. The additional property for present purposes is that the exit window from the target be made from a material of high atomic number, in order to ensure a reasonably low neutron background in associated experiments.

Of the commonly used foil materials, Aluminum, Nickel, Molybdenum and Tantalum; only the latter can simultaneously satisfy all requirements. Dubbledam

and Walter⁵⁾ have shown that for 7 MeV deuterons a tantalum foil gives an order of magnitude fewer neutrons than a molybdenum foil of equal thickness, and sixteen times fewer than an equivalent foil of nickel. At 11 MeV⁶⁾ incident energy Livermore workers have also shown tantalum to be highly preferable to nickel in this respect.

The technical problem, however, with the heavier material is to keep the window thin enough to take advantage of the lower reaction cross section, while containing a suitable pressure of gas. Fortunately, the high tensile strength of tantalum suggests a method of doing this, and the resulting design is shown in Figure 1.

This figure shows a target suitable for use with cyclotron beams collimated to 1/4" diameter or less. The beam enters through a 1/2" diameter hole in the front wall over which a 2 mil. molybdenum window has been secured by an electron beam welding technique. The main body of the chamber comprises a 2" long hollow cylinder of 1/16" wall, machined from solid tantalum rod 1-5/8" in diameter and to which the front wall is electron welded. To the open end of this cylinder is further welded⁷⁾ a hemisphere of 4 mil. tantalum formed by a process already described in the literature, in another connection^{8,9)}. This hemisphere acts as an exit foil both for the neutron beam, and for the deuteron beam as it passes through the target. As there are no flanges on the chamber, the neutron beam can be taken off at any angle up to 90° with respect to the incident beam direction, making the target a suitable one with which to study the variation in neutron polarization with angle of emission. The cell can be operated at pressures in excess of 10 atm, and in conjunction with beams of 100 W dissipation when adequate provision is made to refrigerate and circulate the gas while under pressure. In addition, the high flux of 0° unpolarized neutrons can be used to

obtain high precision cross section data when used in conjunction with a suitable fast neutron spectrometer¹⁰⁾. In this case the source pressure should be reduced to around one atmosphere in order to keep the energy spread of the resulting beam to within 2% at 10 MeV. All charged particles must, of course, be removed magnetically from the experimental area. It should be borne in mind that if tantalum is heated to a temperature of several hundred degrees centigrade by high beam currents, it may become transparent to hydrogen. Because of this, the provision for adequate cooling is regarded as a necessity.

Thanks are due to G. H. Guest of Birmingham University, England, for the idea, and to R. J. Slobodrian, (LRL), and J. E. Simmons, (LASL) for helpful comments and advice, and to E. McLaughlin, and J. Huguley (LRL) for constructing the prototype domes.

REFERENCES

1. L. D. FADDEEV, Soviet Phys. - JETP 12, 1014 (1961)
2. R. L. OMNES, Phys. Rev. 134, B1358 (1964)
3. A. G. SITENKO and V. F. KHARCENKO, J. Nucl. Phys. (USSR) 1, 994, (1965)
4. H. P. NOYES, SLAC -PUB- 256
5. P. S. DUBBELDAM and R. L. WALTER, Nucl. Phys. 28, 414 (1961)
6. J. B. MARION and J. L. FOWLER, Fast Neutron Physics, Part 1, 706 (1960)
7. W. POPE, LRL (Berkeley) Engineering Note, AT0102 -M3252 (1964)
8. W. POPE and F. VALLEDON, LRL Engineering Notes, AT0102. -M3235 (1964)
AT0102 -M3180 (1963)
9. W. POPE and J. HUGULEY; and E. McLAUGHLIN, LRL Engineering Note AT0102
-M3197 (1964)
10. R. J. SLOBODRIAN, H. BICHSEL, J. S. C. MCKEE and W. F. TIVOL, UCRL-17507
(1967)

NEUTRON SOURCE
FIGURE 1

XBL 678-4740

Fig. 1. Schematic diagram of neutron source.

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

- A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or
- B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.