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RADIATION LABORATORY

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Radiation Laboratory

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SUMMARY OF THE RESEARCH PROGRESS MEETING OF APRIL 3, 1952

S. Shewchuck

April 23, 1952

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Berkeley, California

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I. European Laboratory for Nuclear Physics. E. Regenstreif

Under auspices of UNESCO, E. Regenstreif of France visited the University of California Radiation Laboratory and consented to give a few comments on the proposed plans of that organization in regards to nuclear research in Europe.

UNESCO has been endeavoring since 1949 to set up a European nuclear research laboratory and has finally reached the planning stage. Since obviously no single European country could support such a laboratory by itself, cooperation between the various small nations was essential. The countries which agreed to participate in such a project are: Norway, Sweden, Holland, Belgium, West Germany, France, Switzerland, Italy and Yugoslavia. Yugoslavia is the only country participating from "behind the iron curtain" though others had been invited. About a year ago such eminent European physicists as Bohr of Norway, Thomson of England, Perrin of France, Heisenberg of Germany, Amaldi of Italy, Schläfer of Switzerland and Bakker of Holland had held a meeting and decided on what should be included in the program.

Present plans call for a 10 Bev proton synchrotron and a 500-600 Mev cyclotron. The laboratory is probably going to built near Geneva, Switzerland. The cyclotron is expected to take three to four years to build, and the work is to begin in July or August. The 10 Bev synchrotron is estimated

to take six to seven years to build. Money for design and preliminary stages has already been available since December of last year. The total budget has been set at $20,000,000. Bohr is going to head a theoretical group soon in Copenhagen, which will be moved later to the laboratory. The cost of running the laboratory will be about $1,000,000 per year, and it is hoped that eventually there will be room for a staff of 100 physicists.

II. Energy Spectrum of the 184 in. Cyclotron High Energy Neutron Beam.

William P. Ball

Two of the difficulties in doing many experiments in the high energy neutron beam formed from the p,n reaction in the 184 in. cyclotron are: 1) Low counting rates and 2) Large energy spread of the neutron beam, i.e. about 40 to 70 Mev half width.

Two attacks that may be made on the latter of these difficulties are:

a. Try to decrease the energy spread of the beam itself.

b. Measure the energy spectrum accurately so that its effect on experimental results may be calculated.

The main causes of the energy spread are: 1) Radial oscillations in the circulating proton beam 2) Finite thickness of the neutron producing target nucleus.

Regarding 3) above, consider Be as the neutron producing target. The binding energy of its "loose" neutron is about 1.6 Mev. Its potential well depth is about 20 Mev. Since the neutrons in Be spend most of their time inside the nuclear potential well the average internal momentum of, say the loose neutron will correspond to a kinetic energy which will be the difference of the above energies or about 18 Mev. Figure 1a tries to give a graphic representation using a "ball" in a "valley" comparison of the

potential and kinetic energy status of a neutron in a Be nucleus. The binding energy of deuterium is 2.2 Mev and its well depth in the ^3S state is about 20 Mev. The neutron in deuterium, however, spends most of its time outside the well where its internal momentum is very low, corresponding to an average kinetic energy only of the order of its binding energy. See Figure 1b. Thus from internal momentum considerations one may expect deuterium to be a good neutron producing substance.

Deuterium alone being a gas is not easy to handle, so LiD was used to test it as a neutron generating substance. The specimens of LiD were one half inch thick and painted with glyptal to prevent decomposition in air.

The first data for the spectrum were obtained by Ball, Dixon, Neher, Richardson and Whitehead using Lee Neher's time of flight equipment. These data had a very poor energy resolution with $\Delta E > 100$ Mev. The details of the spectrum were not evident from these data; however, indications about the total relative neutron yield from several targets were obtained. These showed that the 2 in. Be target produced more neutrons than did the 1/2 in LiD, which in turn produced more neutrons than did a 3/16 in Be target. The comparison between the latter two was especially significant since they both expose approximately the same number of nucleons to the circulating proton beam. The greater efficiency of the LiD indicates that it has a larger differential p,n cross section in the forward direction, $d\sigma_{(0^\circ)}/d\Omega$. The 3/16 in. Be may produce just as many neutrons as the LiD, but they may be spread out more thinly over a wider forward angle due to their greater internal momentum inside the nucleus.

The latest and most accurate measurement of the neutron energy spectrum from 2 in. Be and 1/2 in. LiD was obtained by Ball, Cladis, Hess and Wilcox using the 35 channel magnet spectrometer developed by Cladis, Hadley and Hess.

This apparatus has been described in UCRL-1621. These data had an energy resolution of about $\Delta E \cong 25$ Mev. Figure 2 shows the yield curve after both curves had been normalized to the same proton beam. The spectrum from the 1/2 in. LiD indicated a more defined and narrower peak than from the 2 in. Be. The average half widths of the curves are 70 Mev for Be and 42 Mev for LiD. LiD has an appreciably lower low energy tail. The location of the peaks is significant, being 315 Mev for the 1/2 in LiD and 295 Mev for the 2 in. Be. Previous experiments had reported the peak for 2 in. Be to be between 270 and 280 Mev.

It is planned to try 1 in. and 2 in. thick LiD targets in the future. The use of a thicker LiD target, it is hoped, may give a larger number of neutrons above 300 Mev than 2 in. Be does.

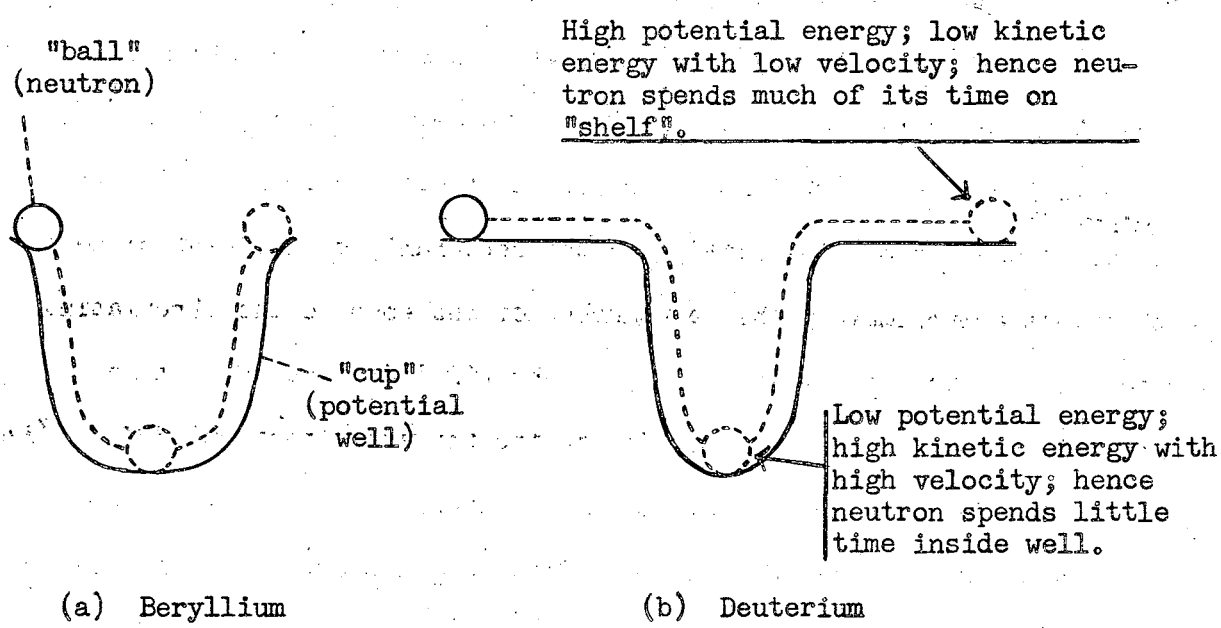

Figure 1

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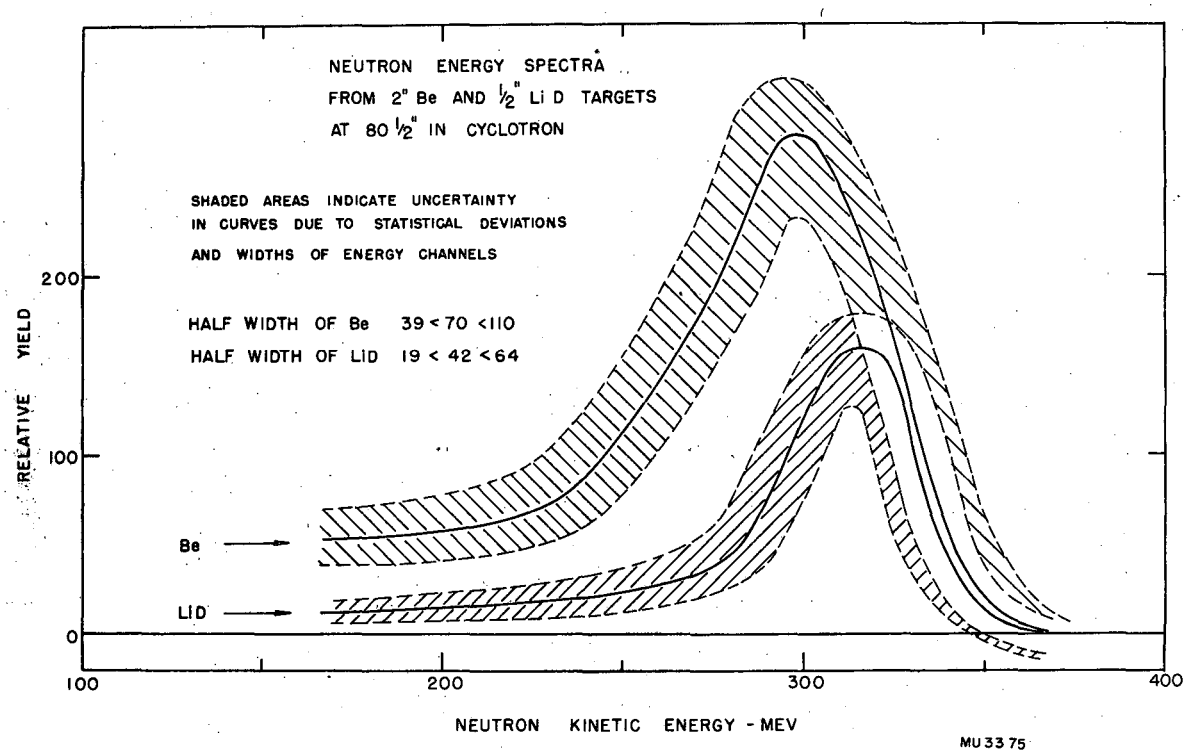
NEUTRON ENERGY SPECTRA
FROM 2" Be AND ½" Li D TARGETS
AT 80 ½" IN CYCLOTRON
SHADED AREAS INDICATE UNCERTAINTY
IN CURVES DUE TO STATISTICAL DEVIATIONS
AND WIDTHS OF ENERGY CHANNELS
HALF WIDTH OF Be 39 < 70 < 110
HALF WIDTH OF LiD 19 < 42 < 64
Be
LiD
RELATIVE YIELD
200
100
0
100
200
300
400
NEUTRON KINETIC ENERGY - MEV
MU 33 75

Fig. 2