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NEUTRON CROSS-SECTION MEASUREMENTS WITH NUCLEAR DEVICES

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MASTER

I would like to mention briefly some of the possibilities of using nuclear explosions as sources of neutrons for cross-section measurements. Basically the method is to detonate a nuclear device underground and bring the neutrons to the surface through a vacuum pipe 200 to 400 meters long. This is really a single-pulsed reactor with a quite high flux; the flux from a typical low-yield bomb is as much as could be produced in 25,000 years with an accelerator. I would like to show slides depicting such an experiment conducted in 1964 by Los Alamos; this marked the first time that the test of a weapon was so highly instrumented for scientific purposes. Many laboratory groups cooperated with the various experiments; the one on which I am working was directed by B. C. Diven and A. Hemmendinger.

The first slide (#645468) shows part of our target and detector array. The beam of neutrons passes upward through the target foils; the targets in this stack were all fission foils: Pu^{239} , Pu^{240} , Pu^{241} , Pu^{242} , U^{235} , and Li^6 . Fission products were detected by solid state counters at 90° , 55° , and 15° . In another target stack we also had Moxon-Rae type solid state detectors to measure (n,γ) reactions in hopes of developing the technique to be able to measure cross-sections significant in nucleosynthesis. With the high neutron fluxes, by the way, we did not count individual events, but rather recorded the current in our detectors.

The next slide (#645055) shows some of the logarithmic amplifiers mounted on a sled. The amplifiers let us measure signals from 1 mV to 10V; the sled is in effect a "recovery vehicle" for the amplifiers and the target chamber. The sled straddles the hole, and is pulled away by a winch immediately after the shot.

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The next slide (#J641491) shows the target stack inside the vacuum chamber mounted on the sled. The radioactive target foils are being put in place. Our foils were so hot that they would quickly damage the detectors if left exposed. Therefore we had shutters over the foils which only opened 2 seconds before the shot. The α -activity of these foils causes serious background difficulties in laboratory experiments on these nuclides, but is negligible with the flux available from bombs.

The next slide (#641493) shows the sled in place over the hole. Additional experiments were placed on a tower.

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The next slide (~~#J641500 with symbol removed~~) shows the tower. The sled sits at ground level and is pulled away to the left. It took about 40 seconds to get clear of the calculated crater radius. In order to be sure to recover the equipment, we wanted it out from under the tower when the crater formed about $3\frac{1}{2}$ minutes after the shot. We also had experiments on the third level of the tower, and fortunately we were able to recover those also.

The next slide (#J641497) is a view from the top of the tower showing the cables leading back to the recording stations. You also get a view of some Nevada desert, and this serves as a reminder that this is a field operation, without all the comforts of home.

The next slide (#641506) shows how we recorded our data, on 13 moving-film cameras from as many oscilloscopes. The cameras were started one second before the shot, and reached a speed of about 100 feet/second by shot time. All of the data were recorded in about 4 msec after the shot.

Finally, I have a couple of slides to show what our data looks like. The next slide (Film 07 with 1 trace removed) is from one of our moving film cameras. The signal is fission of U^{235} . The oscilloscope was free running with 50 μ sec sweeps, so we can measure baselines before the shot. A small mirror

reflecting a portion of the trace defines a reference line. The first trace with signal on it has been removed from this print because it contains information relating to the bomb, but the signal from 100 keV down is shown.

Next is a slide (1-15-65, 13:01.77) showing the γ -signal from a U^{235} target in the energy range 10-50 keV, an energy region of prime ^{interest} in nucleosynthesis. These are still raw data, without correction for background or flux; the conclusion I wish to draw here is that good data can easily be obtained in this energy range. The absorption dips in the curve are due to Ni windows on the vacuum chambers, and to oxygen.

Finally, to show the lower limit of energy reached in this experiment, the last slide (1-11-65, 20:12.11) shows the U^{235} fission signal in the range 10-25 eV.

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Fig. 4. Logarithmic amplifiers mounted on sled.

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1-15-65
13:01.77

1-11-65

20, 12, 11

517 *same*
Rpt. No. _____

Std. C- ☐ ; MC- ☒ ; PNT C- ☐ ; LTD ☐ ; PBL ☐ ; BK ☐ ; Und. ☐

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