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TITLE: THE LASL MEDICAL RADIOISOTOPE RESEARCH PROGRAM: AN OVERVIEW OF LAMPF AND THE ISOTOPE PRODUCTION FACILITY

AUTHOR(S): H. A. O'Brien, Jr., A. E. Ogard, P. M. Grant

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los alamos scientific laboratory
of the University of California
LOS ALAMOS, NEW MEXICO 87545

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The LASL Medical Radioisotope Research Program: An Overview of LAMPF and the Isotope Production Facility

Harold A. O'Brien, Jr., Allen E. Ogard, and Patrick M. Grant
Los Alamos Scientific Laboratory, Los Alamos, NM 87545*

Introduction

In the early part of this decade, a research effort was initiated at the Los Alamos Scientific Laboratory (LASL) to investigate the feasibility of utilizing proton-induced spallation reactions as a means of preparing radionuclides of known or potential value in the health sciences. The irradiation source consists of the excess 800 MeV proton beam that reaches the main beam stop of the Clinton P. Anderson Meson Physics Facility (LAMPF).

This report describes the LAMPF accelerator and the Isotope Production Facility.

The Clinton P. Anderson Meson Physics Facility (LAMPF)[1,2]

The LAMPF is centered around a half-mile long linear accelerator designed to accelerate a high-intensity beam of protons to energies well beyond the pion production threshold. One of the underlying principles governing the design of the accelerator and associated experimental areas was that the facility possess the capability to accommodate ten or more experiments simultaneously without sacrificing beam quality or duty factor. To maximize the number of experiments which can be run simultaneously, the decision was made to accelerate, concurrently, both negative and positive ions.

The accelerator comprises three stages. The first is a pair of almost-conventional Cockcroft-Walton injectors that produce H^+ and H^- ions of 750 keV energy. These ions are made to encounter accelerating fields of opposite

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sign by appropriate longitudinal separation in the linac. The second stage is a modified drift-tube accelerator that provides 100-MeV H^+ and H^- ions. The novel feature of this section is the positioning of copper rods opposite each drift tube, having the effect of converting the structure from a 2π mode to a $\pi/2$ mode. The third stage of the accelerator is the side-coupled waveguide accelerator, an innovation in accelerator technology discovered and developed at Los Alamos. In the $\pi/2$ mode, every other cell contains a node of the electromagnetic wave, providing no acceleration, only unwanted accelerator length. It was found possible to remove the empty cell from the beam line by providing a side-coupling cavity.

The experimental area of the facility is organized to accommodate many experiments concurrently. This is accomplished by the installation of numerous secondary beam lines, by the separation of the H^+ and H^- beams in the switchyard to supply major sections of the experimental area, and by reconstituting the beam after each target transversal.

The Isotope Production Facility (IPF)

The Isotope Production Facility (IPF) represents an addition of about 37 sq. m. to the LAMPF main beam stop structure. Functionally, this facility is designed to enable an operator to: 1) remotely attach a target-containing chamber to the end of a stringer (7.9 m long x 17.8 cm high x 5 cm wide); 2) drive the stringer through a slot in the shielding to a position where the target will intercept the proton beam; 3) perform the irradiation with adequate water cooling of the target; and after an appropriate period, 4) retract the stringer, remove the target chamber, and transfer it to a shielded cask for transport to hot cell facilities located elsewhere in the laboratory for chemical processing.

A conceptual drawing of the IPF is shown in Figure 1. Although significant modifications have been effected since December, 1974, the basic concepts depicted in this drawing remain unchanged. The proton beam is separated from the target handling area by 7.6 m. of concrete and steel shielding. Three aluminium housings, each 16.8 m. long, have been inserted into the cavity of the steel stringer housing. Each aluminum housing contains three rectangular stringers, which, with the aid of roller and chain bearings, are guided along case-hardened rods located in the roof and floor of the housing, as shown in Figure 2. Thus the IPF contains nine independent target stations.

Following the installation of coolant pipes in each stringer, the remaining void was filled with a mixture of high-density grout and lead shot to provide shielding. When completely assembled, a stringer weighs approximately 363 kg.

The rack-and-pinion drive mechanism, originally located within the main structure as shown in Figure 1, is now situated immediately exterior to the building to provide ready access for maintenance ease. This modification necessitated the installation of a 9.8 m rectangular steel extension to the original stringer. The steel rack portion of the drive mechanism is located on the top side of this extension.

The relative locations of the proton beam, isotope target chamber, and beam stop are shown schematically in Figure 3. A cantilevered arm is permanently fixed to the end of the stringer, and the removable target chamber attaches to the arm as shown in Figure 4. An exploded view of a target, target chamber, and cantilevered arm can be seen in Figure 5. Maximum target dimensions are 2.3 cm thick x 7.6 cm diameter, allowing 1 mm coolant channels across each target face.

Shielding of an activated target chamber during transport from the IPF to the chemical processing cells is provided by a 5.9 t, depleted uranium shipping cask. This is shown in Figure 6. Note the trap door located at the bottom of the cask facilitates target transfer from the IPF handling pit into the cask. The target handling tool can be seen at the top of the cask.

Program Status and Schedule

The mechanical targeting system is 95% complete, with final checkout scheduled to begin in early June. The electrical and plumbing systems should be ready for testing by late July or early August. As soon as all systems are completed and checked, studies of radiation damage, thermal stability, and corrosion in potential targets will begin. We anticipate this will occur by September or early October. The initial targets planned for study are lanthanum and molybdenum.

Since the accelerator resumed operations during the last quarter of 1975, it has operated quite reliably and the beam is expected to reach the beam stop by the first of April. The plan is to operate at an initial intensity of 10 μA, with step increases to 100 μA by late August. The latter intensity is scheduled to be maintained during the next six-month period.

REFERENCES

1. ROSEN L, Proc. Nat. Acad. Sci. USA, 70 (2): 603-610 (Feb. 1973).

2. ROSEN L, Kerntechnik, 15 (7): 319-324 (1973).

FIGURE CAPTIONS

Figure 1. Conceptual Drawing of the Isotope Production Facility

Figure 2. Isotope Stringer and Aluminum Housing

Figure 3. Conceptual Drawing of An Isotope Production Target and Beam Stop

Figure 4. Target Chamber and Stringer Attachment Arm: Semi-Assembled

Figure 5. Target, Target Chamber, and Stringer Attachment Arm: Exploded View

Figure 6. Target Transport Shield

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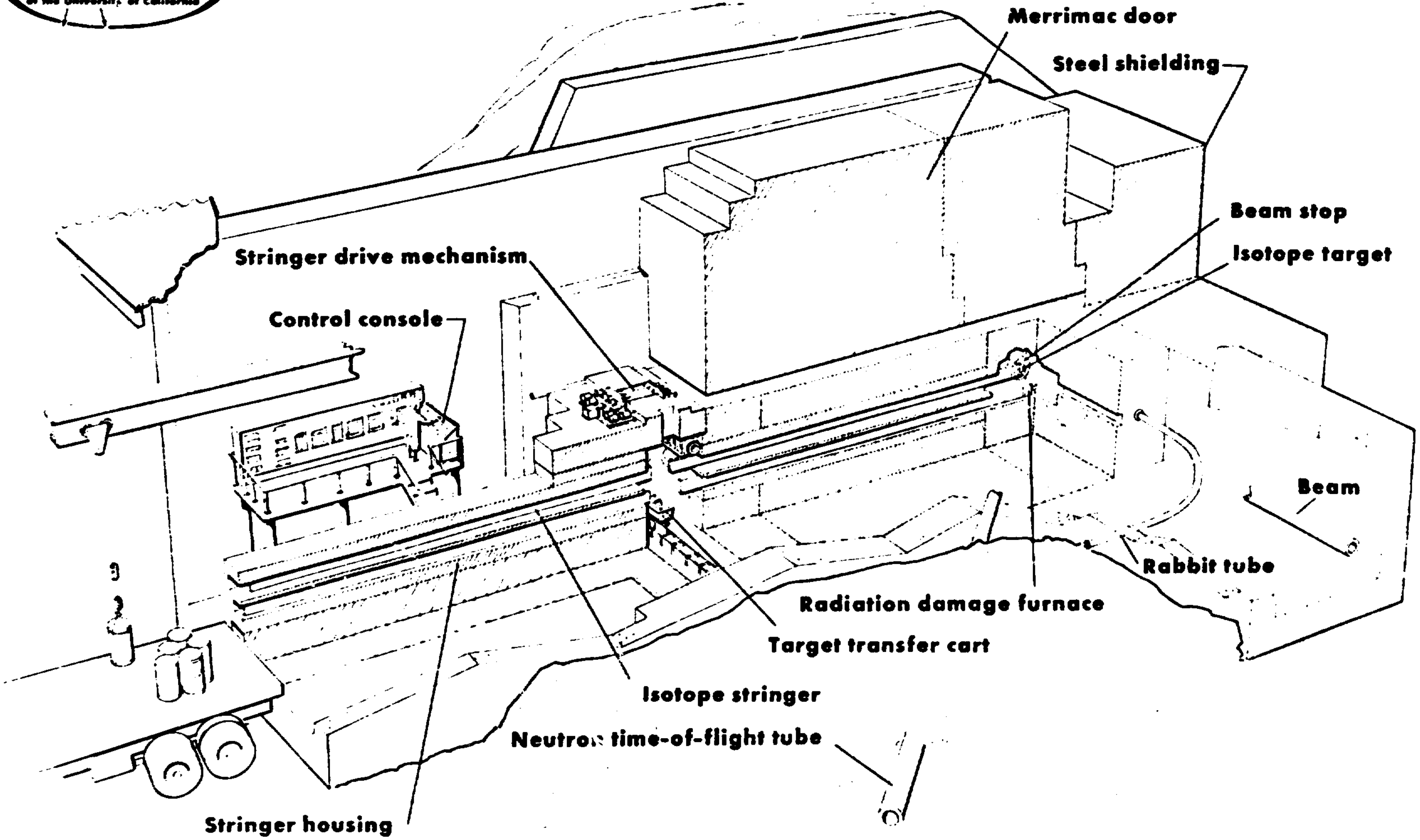
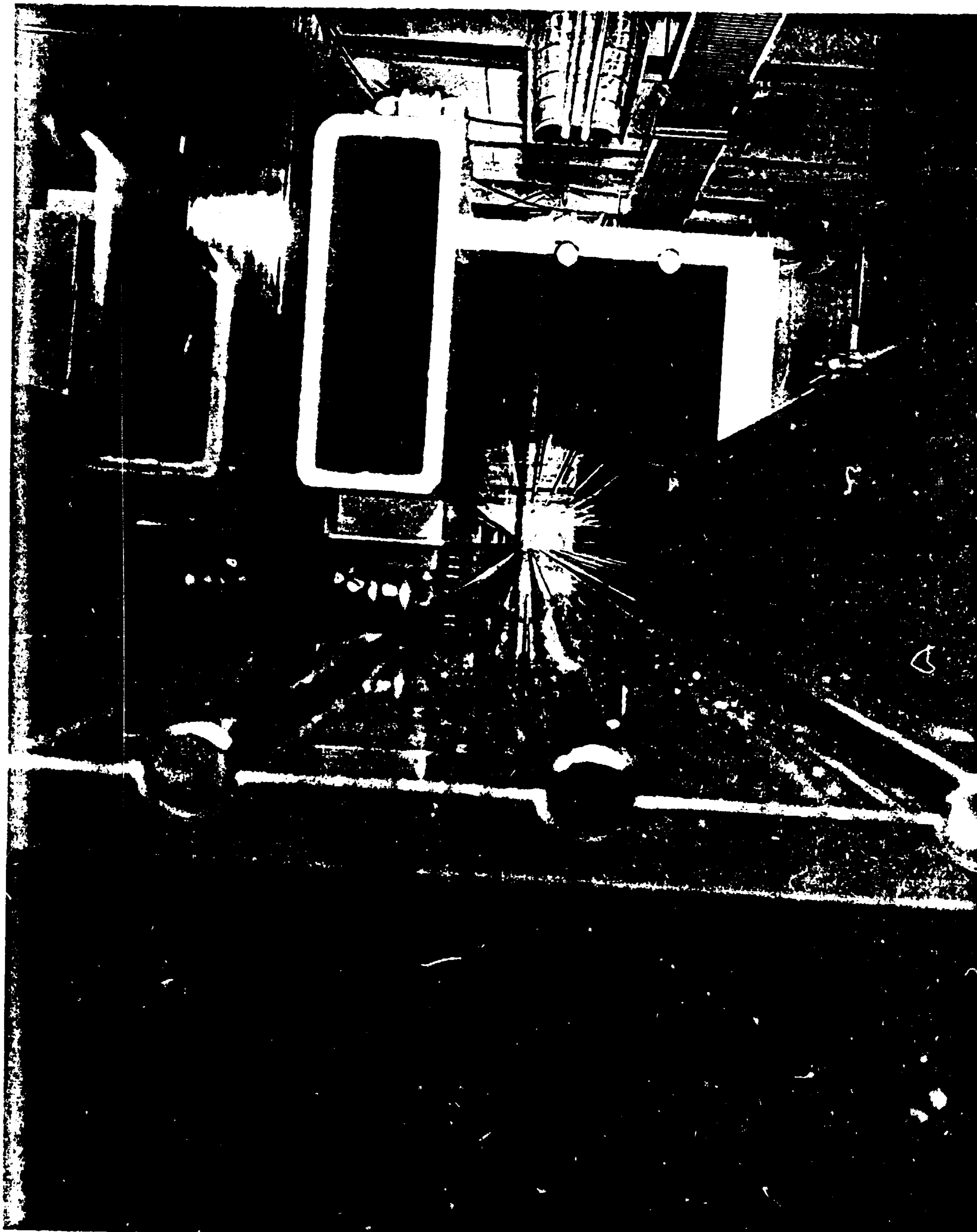
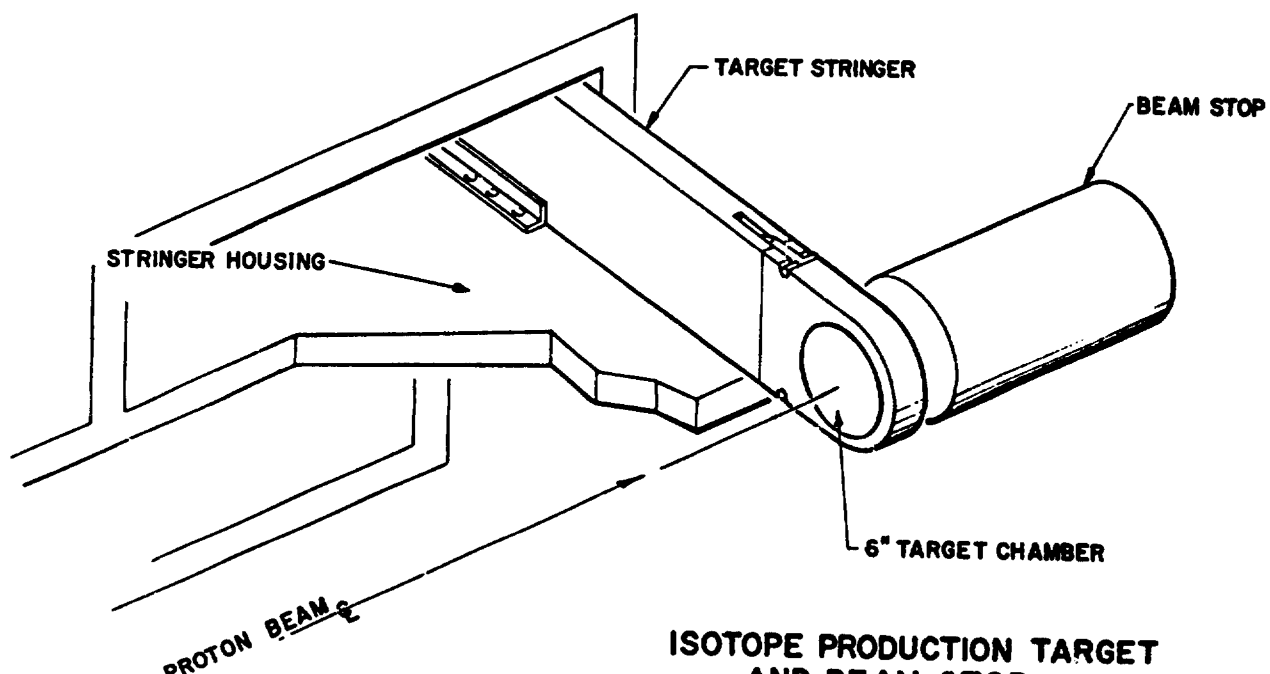
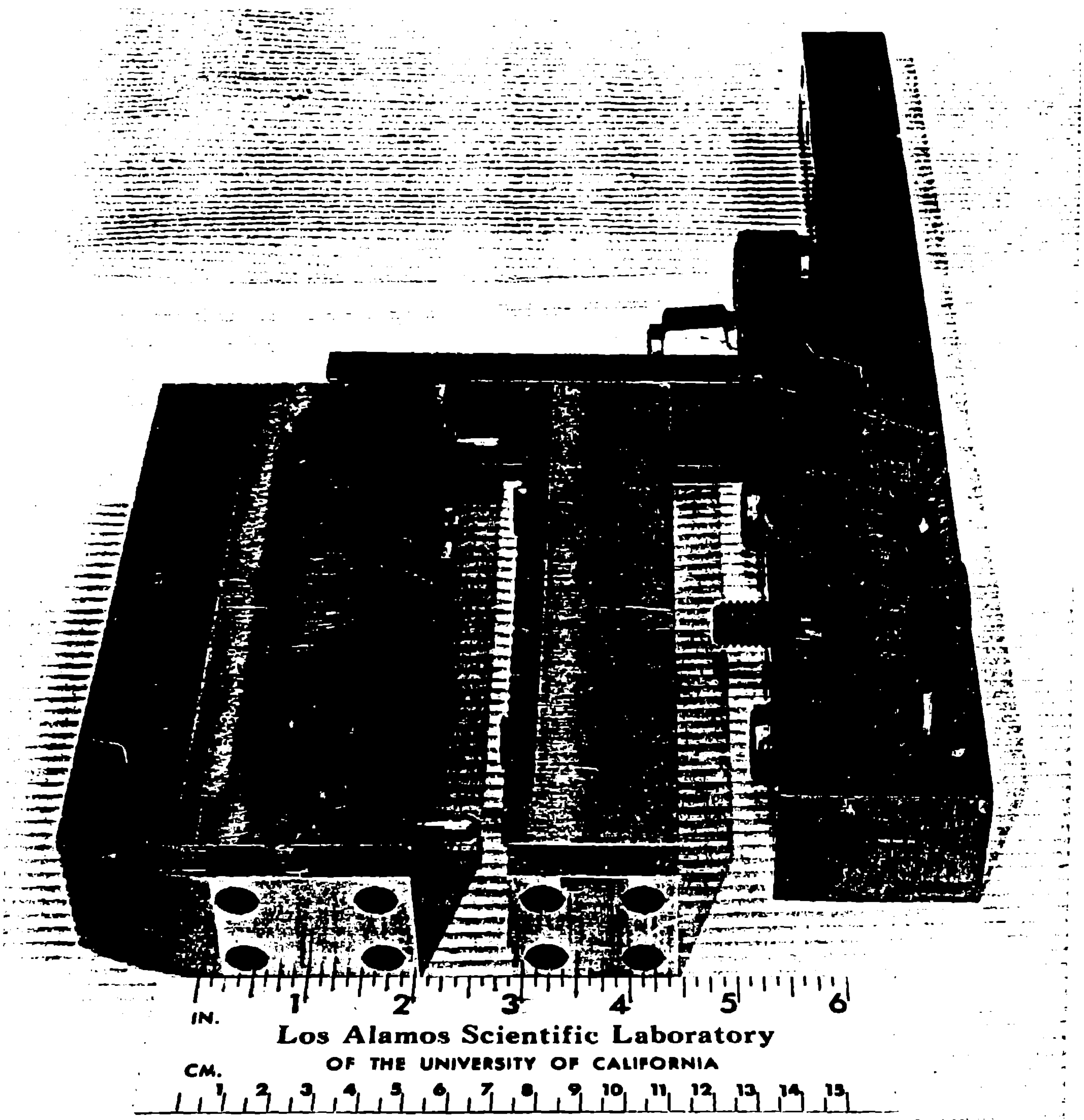


ISOTOPES PRODUCTION FACILITY





ISOTOPE PRODUCTION TARGET
AND BEAM STOP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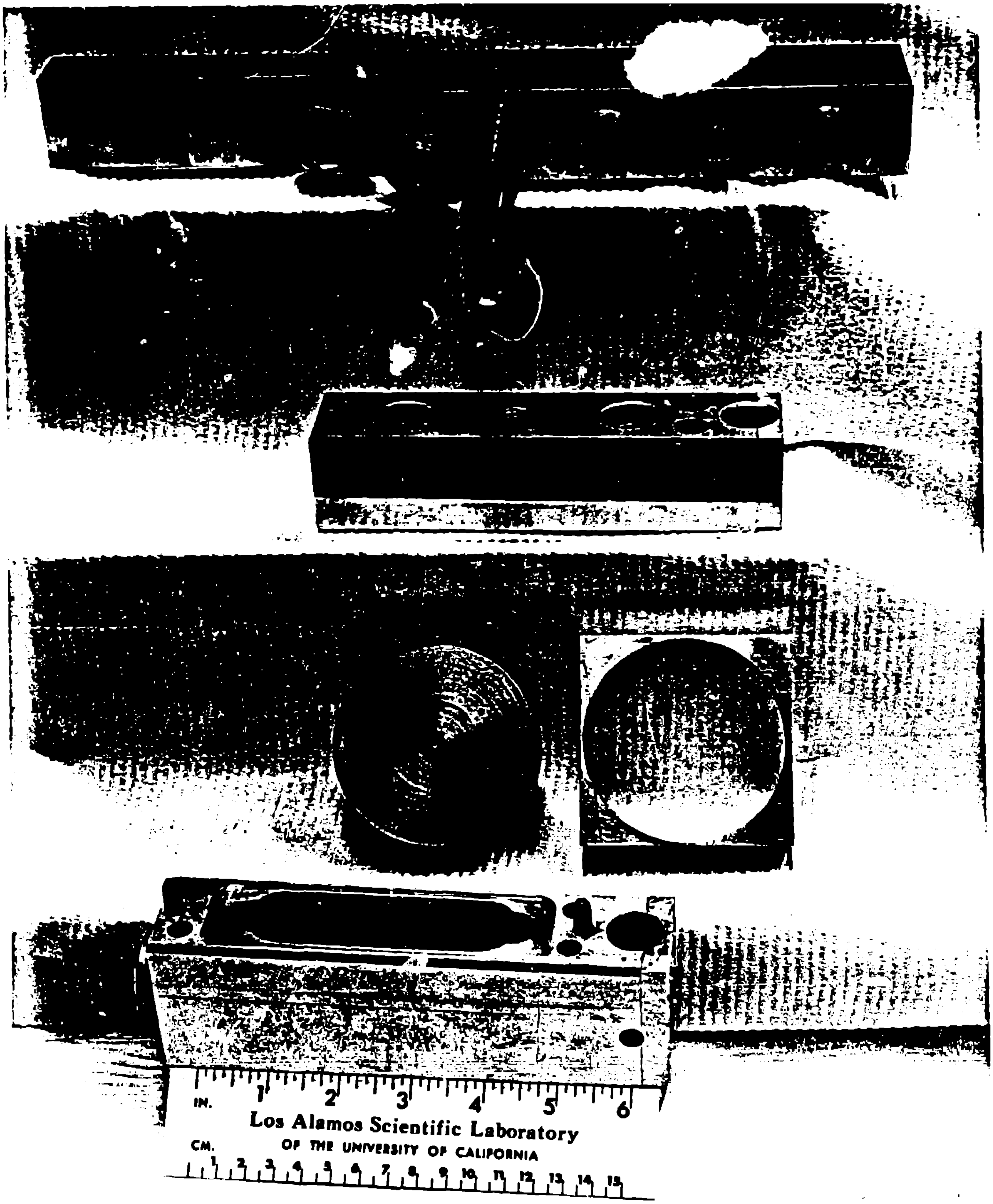
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