LA-UR -85-1736

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CONF-850504--112

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LA-UR--85-1736

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TITLE
MAJOR FACILITY OVERHAULS AT LAMPF

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SUBMITTED TO
Particle Accelerator Conference
May 13-16, 1985
Vancouver, British Columbia

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FORM NO. 836 R4
ST. NO. 2629 5/81

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MAJOR FACILITY OVERHAULS AT LAMPF

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Abstract

The Clinton P. Anderson Meson Physics Facility (LAMPF) is a linear proton accelerator designed to operate at 800 MeV and 1.0 mA. It has been operating at power levels above 200 microamperes since February of 1976 and now routinely operates near the design level.

This paper outlines the problems encountered with the original target cell components, the repairs required since 1976, and specifically details the steps involved in the complete replacement of the vital target cell components. These components include target boxes, collimators, main beam line magnets, and the front-end magnets of the secondary beam lines.

The A-2 target cell was replaced in the spring of 1983 and the A-1 target cell was replaced in the spring of 1984. Both have operated satisfactorily since their completion, with only minor difficulties. The overhaul and total component replacement in the beam stop area (A-6) was completed in early May 1985 and has just been placed in operation. The upgrade, in addition to the replacement of the beam stop and the vacuum-to-air window with state-of-the-art designs, provides a greatly increased capability of both proton and neutron irradiation of materials.

Remote Handling System

Previous papers and another paper in these proceedings detail the design and the operational capability of the Monitor remote handling system. Description of Monitor in this paper will be limited to operational descriptions of the target cell replacements.

History Of The Target Cells

The original target cells were designed, fabricated, and installed in 1974 and 1975. Figure 1 schematically depicts a typical target cell, in this case A-2. This figure illustrates the normal elements in the LAMPF cells and their relation to the target box. Since the target box is the key element in the cell, its design, fabrication, and installation will be thoroughly covered.

After a few years of operation, water and vacuum leaks developed at rates that seriously threatened operating schedules. A major portion of the temperature instrumentation became inoperable, which made the reduction of cooling water flow to minimize leakage an unacceptable risk without other measures. The temporary solution was the installation of thinner targets to compensate for reduced cooling. Repairs were made on a continuing basis, but the final solution was the total replacement of the target cell.

The original target box was rectangular in shape with copper cooling coils brazed to the outside surfaces. The primary cause of the uncontrollable water leaks was the cracking of the copper tubes at or near the brazed joint to the stainless steel vacuum box.

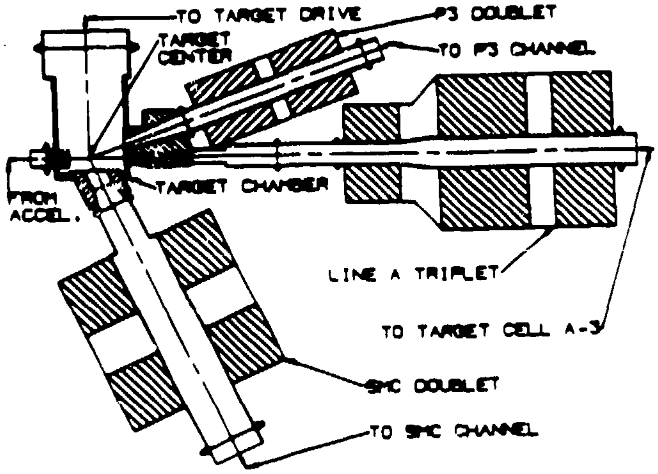

Fig. 1. Target cell layout.

Due to severe thermal cycling, all the vacuum leaks occurred in joints near the target box. The vacuum joints eventually loosened and leaks developed, due to a ratcheting effect in the wedge-type clamps and flanges used.

Planning and Design Considerations

In the design of the new cells, the first problem was to devise a method of remotely matching the new target box to the existing vacuum ports in each of the cells. As shown in Fig. 1, the target box must be aligned to the Line A triplet, two secondary beam line magnets, a target-drive flange, and an existing vacuum line from the upstream target cell.

This alignment was accomplished by designing a fixture that simulated the target box, with adjustable flanges that could be mated to the existing vacuum connections. This fixture would then be used to construct a jig in which the new target box was assembled.

The other problems were to design the new components to reduce the possibilities of water leaks and vacuum flange thermal cycling. Figure 2 is a sectioned isometric sketch of the new A-2 target chamber (the A-1 box is similar). The cylindrical design is better than the original rectangular one from a thermal gradient and an associated thermal stress standpoint. The cooling of the copper collimators is by helical water passages machined in the copper. The main box shell is cooled by flowing water in the annular space between the inner and outer shell. Vacuum joints, previously subjected to extremely high heating rates, were moved to a much lower heating rate region outside the copper collimators. This move has so far eliminated the vacuum leak problem.

Actual Target Cell Replacements (A-1 And A-2)

The actual remote replacement of the target cells consisted of the following steps:

- remove all of the existing equipment from the cell and transport it to the disposal site;
- install new magnets in the main and secondary beam lines and match the alignment fixture to the flanges as shown in Fig. 3;
- construct an assembly jig matched to the alignment fixture and assemble the new target box;
- install the new target box in the cell and remotely mate it to the other flanges; and
- install and checkout cooling water and thermocouple systems as well as check all vacuum joints for leaks.

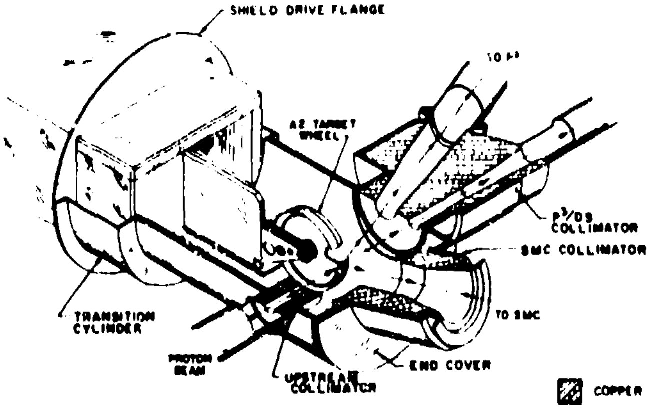

Fig. 2. A-2 target box.

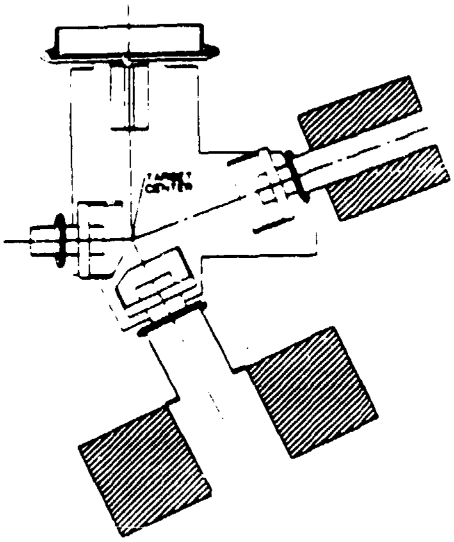

Fig. 3. Alignment jig schematic.

Target Cell A-6 Replacement

The A-6 cell was originally designed with a beam stop, an air-cooled vacuum-to-air window, nine stringers for medical isotope production, and three radiation damage stringers for neutron irradiations. Eventually a water-cooled vacuum-to-air window and 20 cm water degrader, to enhance neutrino production, were added. Since access to these components required about ten shifts to move the shielding door and the stacked steel shielding, the turnaround time for repairs was almost two calendar weeks.

In recent years, there has been considerable interest in developing a larger scale capability to do both neutron and proton irradiations of materials. This has been partly driven by a collaboration between LAMPF and the West German designers of the spallation neutron facility (SNQ).

The result is the new A-6 area shown in Fig. 4. It provides the previously mentioned facilities, minus the original radiation damage stringers, but adds three proton-irradiation and twelve neutron-irradiation ports.

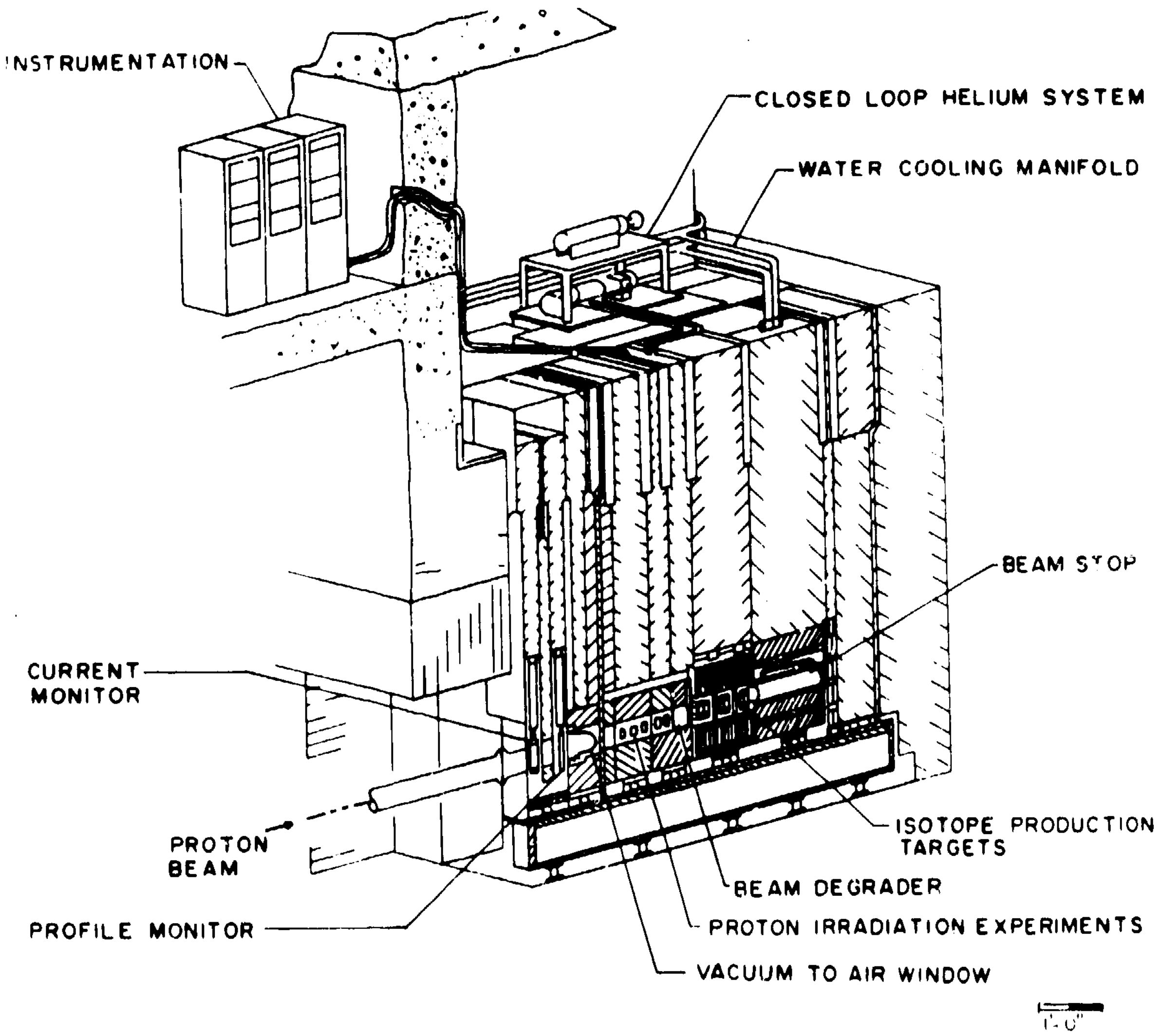

Fig. 4. New A-6 target cell.

The operational capability is enormously enhanced because the vertical insert design provides one to four shift turnaround times for replacement of any component or experiment in the target cell.

The new system is now installed and is operational with all components and three proton irradiation experiments from SNQ in place. Details of the remote handling to construct the new facility are given in another paper in this proceedings.

Conclusions

The overhaul and complete replacement of highly radioactive target cells and other large facilities can be successfully performed using remote handling systems like Monitor. This technology is applicable to waste disposal and the decommissioning of nuclear facilities.