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TITLE: THE REMOTE REPLACEMENT OF A TARGET CELL AT LAMPF

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THE REMOTE REPLACEMENT OF A TARGET CELL AT LAMPF

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ABSTRACT

The Clinton P. Anderson Meson Physics Facility (LAMPF) is a linear proton accelerator operating at 800 MeV and 1.0 mA. It has been operating at substantial power levels since February of 1976. This paper will outline the problems encountered with the original target-cell components, some of the repairs required since, and specifically details the steps involved in the complete replacement of the vital target-cell components. It should be noted that the target cell has been operational since August 1983 without the water- and vacuum-leak problems of the previous components.

REMOTE HANDLING SYSTEM

Previous papers[1-3] have detailed the design and operational capability of the LAMPF remote-handling system (Monitor). References to it in this paper will be limited to descriptions of the operations actually performed.

HISTORY OF THE TARGET CELLS

The original target-cell components were designed, fabricated, and installed in 1974 and 1975. Figure 1 defines the necessary elements and their spatial relationships in the new target box configuration. Since the target chamber is the most critical of the components, primarily due to the high nuclear heating rates, its design, fabrication, and installation will be most thoroughly covered.

In recent years, water and vacuum leaks began developing at a rate that presented serious operating problems. Much of the instrumentation became inoperable, while cooling water flow had to be reduced to minimize leakage. In order to continue running, it was necessary to install a thinner target to compensate for reduced cooling. Although repairs were made on a continuing basis, reliability of the A-2 target cell was compromised to the point where total replacement of the target chamber became the only viable solution.

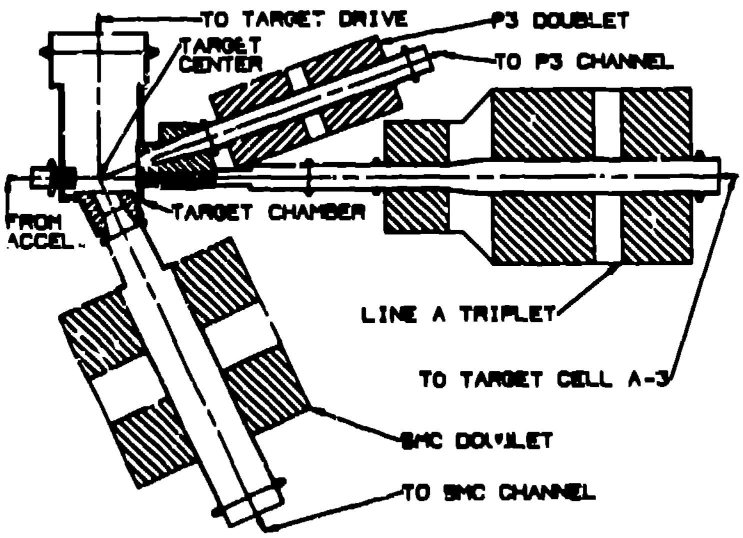

Fig. 1. Horizontal cross section of A-2 cell.

The original target chamber was rectangular in shape with brazed copper cooling coils on the outside surfaces. Most of the water-leak problems were due to cracking of the copper tubes at or near the braze joints. Vacuum leaks at joints connecting to downstream and secondary-line collimators were a common occurrence from high-temperature thermal cycling. Figure 2 is a photograph of the original target chamber taken after installation in 1975.

Figure 3 shows additional detail of the copper cooling tubes and the downstream collimator, which was replaced in 1979.

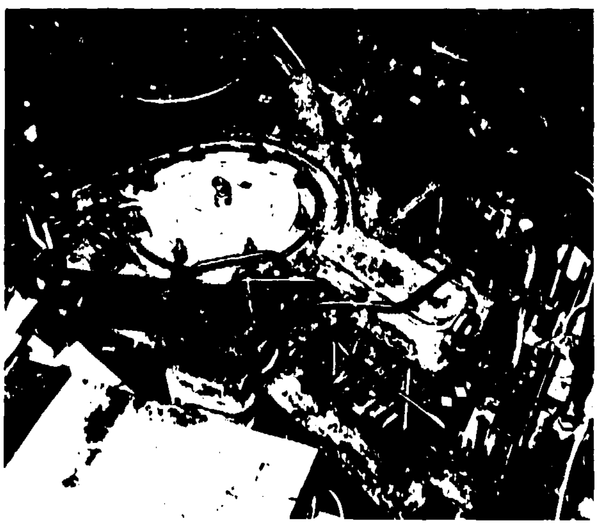

Fig. 2. Original A-2 target chamber.

Fig. 3. Details of original target chamber.

PLANNING AND DESIGN CONSIDERATIONS

The first problem to be addressed, in planning the remote installation of a new target chamber, was a method of constructing the new chamber to match exactly the five existing vacuum ports in the cell (see Fig. 1). This was accomplished by designing a fixture (to simulate the target chamber) with flanges that could be remotely adjusted to match existing flanges when remotely positioned in the target cell with Monitor. Figure 4 is a photograph of the alignment fixture.

Figure 5 is a sectioned isometric sketch of the new A-2 target chamber. The cylindrical design is superior to the original rectangular design from the standpoint of thermal gradients and associated thermal stresses. The cooling of the copper collimators is by helical water passages machined in the copper. The main shell is cooled by water passages in the annular space between the inner and outer jackets. Vacuum joints in high heating areas (near the target) were eliminated by moving them to the outer end of the collimators that were made an integral part of the chamber.

ACTUAL TARGET CELL REPLACEMENT

During the period of January through August of 1983, the A-2 target cell was totally rebuilt using Monitor. Major improvements included the newly designed target chamber, a new P^3 doublet, a new SMC doublet, and a new downstream triplet (see Fig. 1).

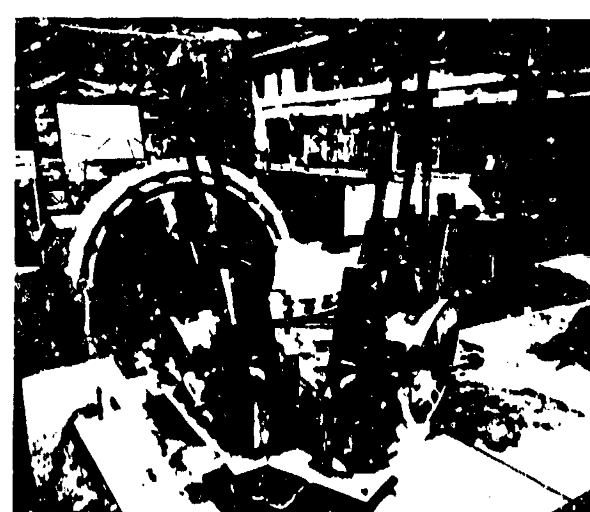

Fig. 4. Alignment fixture.

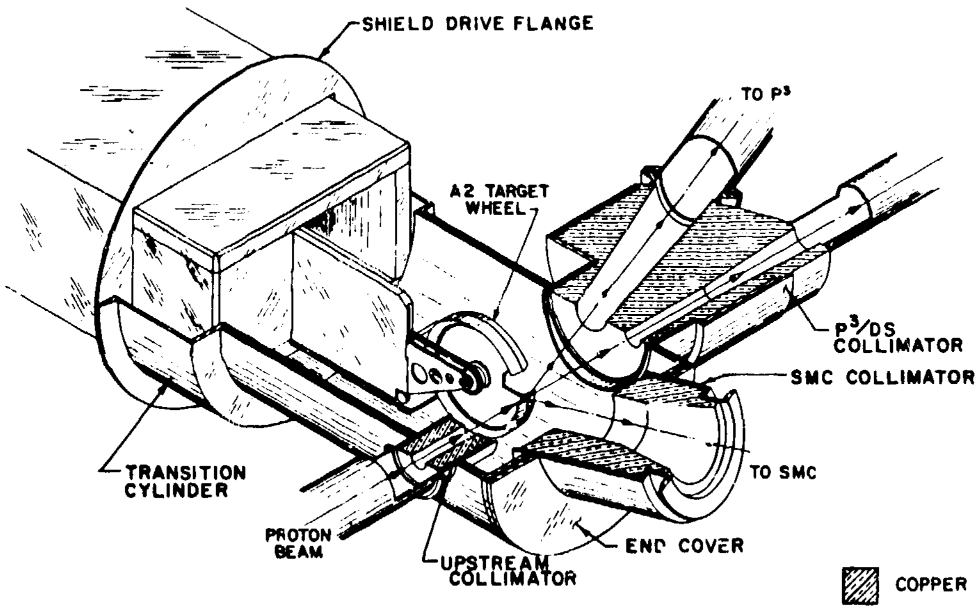

Fig. 5. Isometric of A-2 target chamber.

After the removal of all original components from the cell and installation of the new magnets, the alignment fixture was positioned to match the shield drive flange. Using the shield drive flange as datum, the upstream main beam line, P^3 doublet, and SMC doublet flanges on the fixture were adjusted to match their respective mating flanges. Prior to removal of the alignment fixture from the cell, all adjusting screws were remotely tack-welded to preserve the alignment.

Figure 6 is an illustration showing the alignment fixture mated to the respective flanges in the target cell just before removal.

After the alignment fixture was removed from the cell, it was used to construct an assembly jig for use in constructing the new target chamber. At this point it should be noted that alignment of the downstream main beam-line port depends on alignment of the P^3 port (see Fig. 1 for clarity).

When the assembly jig was completed, the alignment fixture was removed and again positioned in the target cell as a final check.

Assembly operations started by positioning the main shell, upstream collimator, and P^3/DS collimator in the fixture. Then the P^3 and upstream flanges were mated to their respective jig flanges. The transition cylinder was then trimmed to fit the assembly and welded in place. The alignment between the upstream and downstream collimator bores was verified with a transit. Tack welding of the collimator subas-

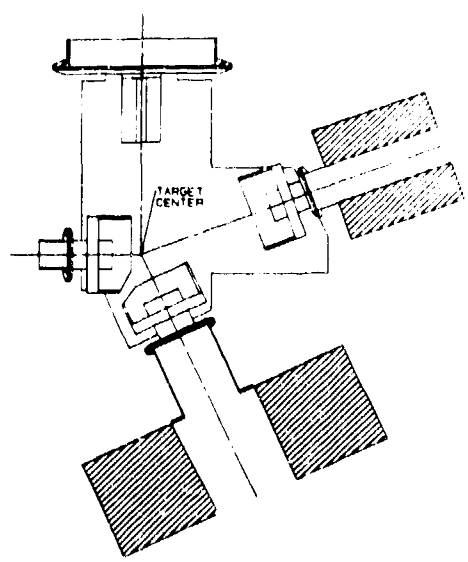

Fig. 6. Schematic of alignment fixture in target cell.

semblies was performed in skip fashion to minimize distortion.

The penetration in the end cover (for the SMC collimator) was located by drilling a pilot hole through a special drill bushing in the SMC flange in the jig. The cover plate was then taken to the machine shop to bore the collimator penetration. Next, the components were again positioned in the jig and tack-welded in place. The entire assembly was then removed and positioned in the target cell with Monitor to verify alignment with the SMC channel.

Upon removal from the target cell, final welding and leak-check operations were completed. Figure 7 is a photograph of the final target-chamber assembly before installation.

Figure 8 shows the target with all components removed. Figure 9 shows the target-chamber location with the water-cooled base support plates in position. Figures 10 and 11 show the target chamber installed in the hot cell with some of the vacuum joints completed.

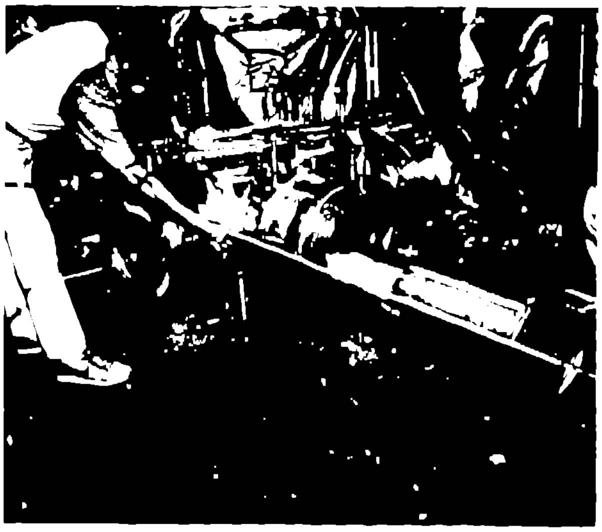

Fig. 7. Target chamber just before installation.

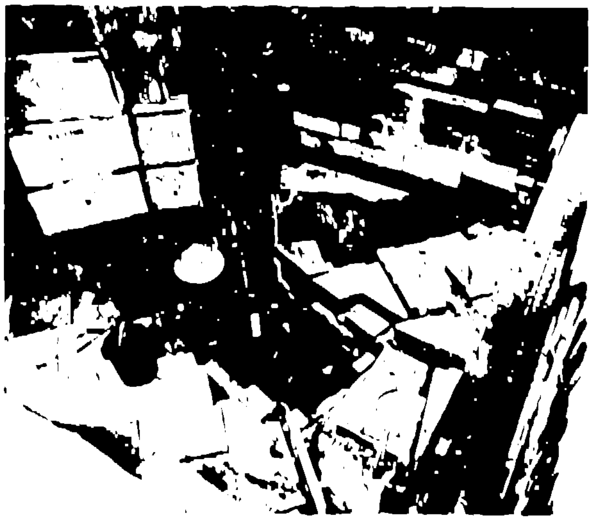

Fig. 8. Target cell with all components removed.

Fig. 9. Cell just before target-chamber installation.

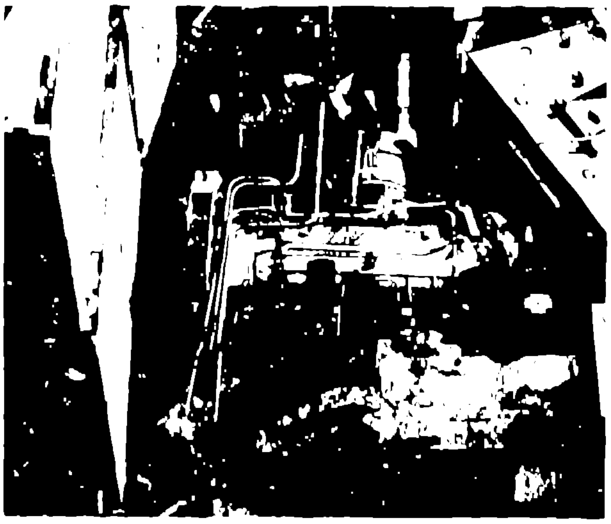

Fig. 10. Target chamber after installation.

Figure 12 shows the completed cell just before closing the shield doors.

CONCLUSIONS

The completion of the A-2 target cell replacement and the subsequent successful operation illustrates the advanced state of remote handling technology in the Monitor system. This technology, operational expertise, and the ability to plan and execute large-scale remote operations can and should be transferred to other installations, especially where large unstructured operating areas are involved. This technology and operational experience also

Fig. 11. Target chamber after installation.

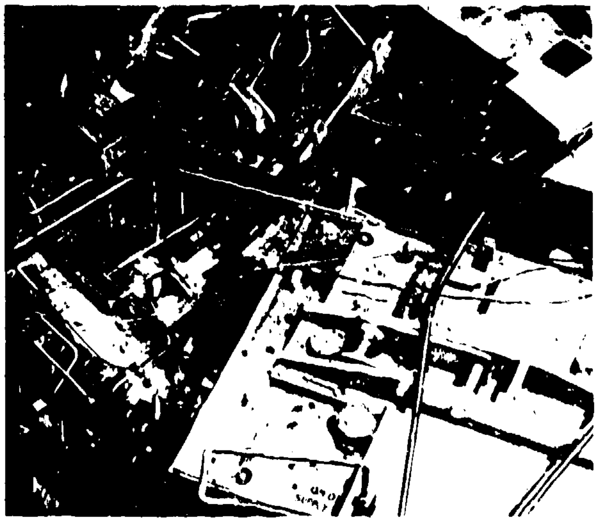

Fig. 12. Completed target cell.

offers the base for development of more advanced systems.

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