Increasing Operational Efficiency by Re-Evaluating and Improving Obsolete Operational Processes

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Introduction

Often in well-established facilities, operational processes have not been re-evaluated since their infancy but should be re-evaluated to increase performance and efficiency and to maintain reliability. The Los Alamos Neutron Science Center started in 1972, and what may have been the best methods to accomplish tasks at the time may not be the best methods now. Through the decades, some methods may have been replaced with more efficient ones, but many may have not been changed. This poster documents a particular operation that was re-evaluated to see if it could be improved.

Background

Los Alamos Neutron Science Center (LANSCE) supports many capabilities. In addition to the Isotope Production Facility, Proton Radiography, Ultracold Neutrons, and the Lujan Neutron Scattering Center, LANSCE supports the Weapons Neutron Research facility (WNR). WNR supports domestic and international defense, academic, and industry research. Target 4 at WNR is a fast neutron spallation target (an unmoderated tungsten target). Neutron energies generated off Target 4 range from 0.1 MeV to more than 600 MeV. Due to regulatory restrictions, Target 4 must be replaced every two years.

Target 4 exists within a large monolith of magnetite concrete, steel shot, and rebar. There are two target access ports that extend down into the target 4 crypt (Figure 1). The beam path runs perpendicular between these access ports as seen in Figure 2. Only one of these ports at a time is used for target placement. The target placement mechanism, inserted into a target port, can reach down within the target crypt and rotate a small target into the beam path.

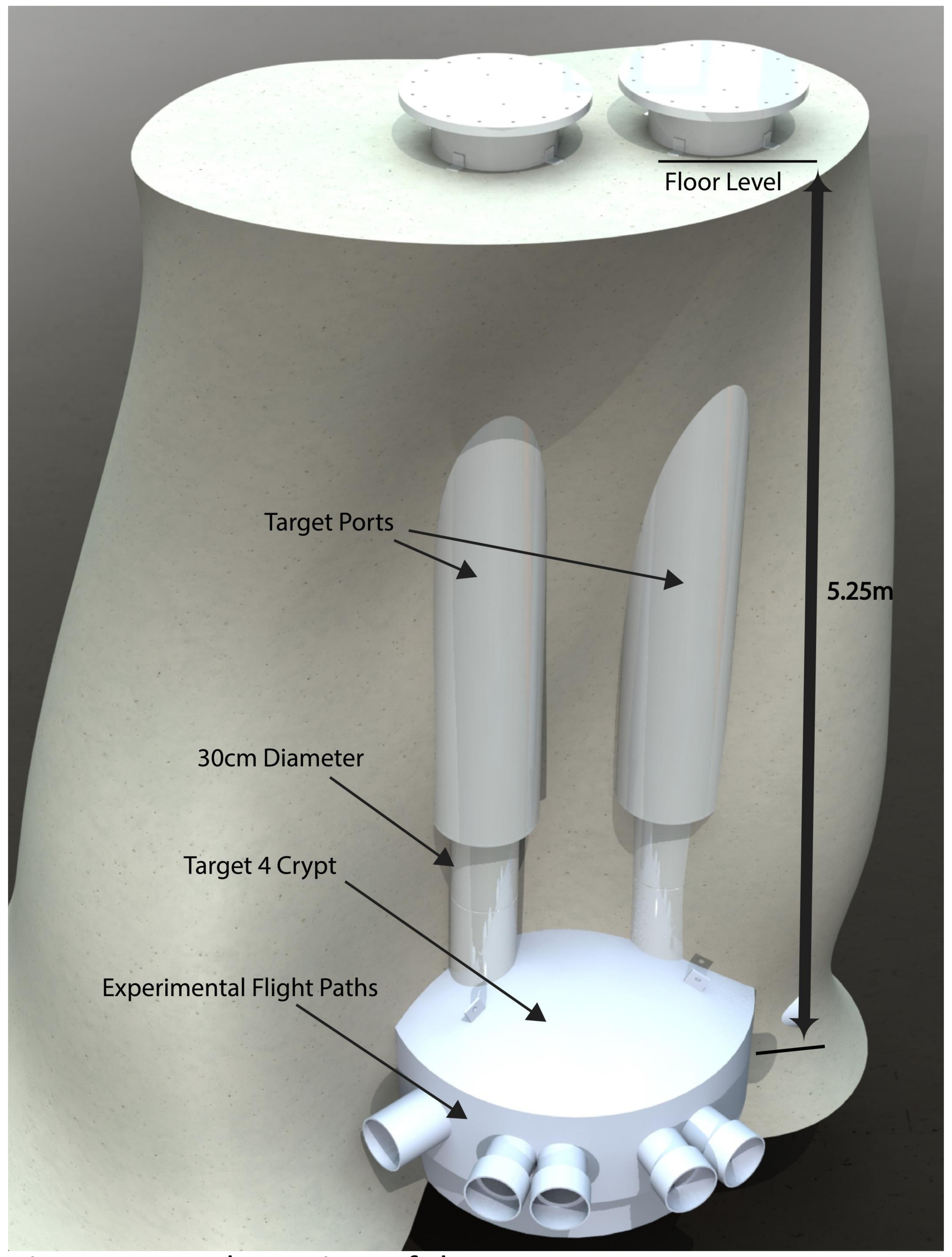

Figure 1. Breakout view of the Target 4 crypt.

Theoretically, a target is placed in the center, at a point of intersection between the experimental flight paths and the beam path (Figure 2). The complexity of the crypt's construction and the experimental flight paths resulted in a non-perfect real-world alignment requiring a compromise on target position between the different experimental flight paths. The method originally developed for aligning Target 4 was optical: aligning the target by looking down the flight paths at the target. This method required shielding to be removed and portions of the flight paths to be disassembled. With this process, aligning and subsequently verifying alignment took weeks and many man-hours. It was noted that this process could be greatly improved, so funds were allocated for the work in 2016 and 2017.

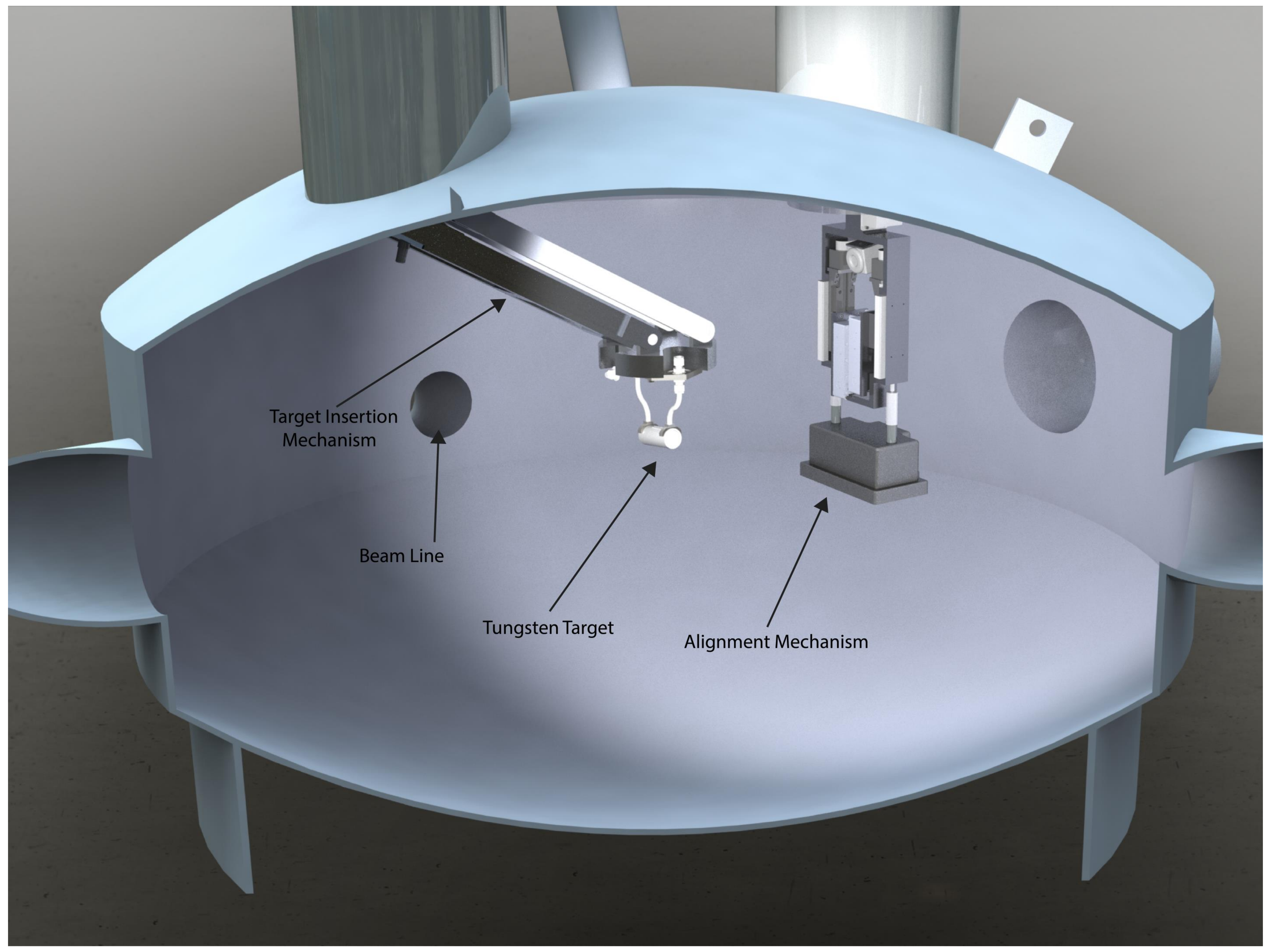

Figure 2. Breakout view of Inside the Target 4 crypt. The target cylinder is approximately 85mm long and 35mm in diameter.

The Best Solution

A design process was initiated to find the best solution based on stakeholder design parameters, which included that one of the target ports could be used, but not as a permanent installation. A particular design was chosen based on design parameters and their relative importance using decision analysis methods. The design that was selected was a device that could enter the un-used target port, make measurements on where the current target is located, and then use this as a reference for a new target.

The device incorporates three stepper motorized linear rails with laser displacement sensors to precisely measure the spatial location of Target 4 at a distance of approximately 460mm. This device must be able to be reinserted into the shaft without significantly altering the original measurement. Even a small movement between the top of the device and the shaft could translate into significant movement on the sensing heads.

Target 4 Alignment Device

To improve repeatability, the number of contact locations between the device and the shaft's inner surface was limited. The shaft itself has a series of cone-like collars that decrease the diameter of the shaft from approximately 305mm to 280mm over a length of 1m. In addition to the collars, there are four vertical posts, 5cm in diameter, within the shaft. The device uses four wedges near the bottom to correspond with one of the collars and a top mechanism to space off the vertical posts. The top mechanism uses a pneumatic cylinder to apply pressure equally on each of the vertical posts. The device includes the ability to retract the sensor package into itself, exposing only the bottom radiation shield to inside the crypt.

Device Specifications:
Weight: 110kg
Height: 121cm collapsed, 188cm extended
Width: 297cm diameter
Sensors: ILD 1700-500 Laser Displacement Sensors by Micro-Epsilon
Cameras: (1) 1080p HD 5x zoom camera
Linear motion devices: Pneumatic cylinder, (1) 610mm stepper motor linear rail, (2) 50mm stepper motor linear rail
Power: 24VDC, 90VDC, 12VDC, 550kPa

A test stand was constructed in order to test and practice operating the alignment mechanism. The testing indicated that the mechanism would work as designed.

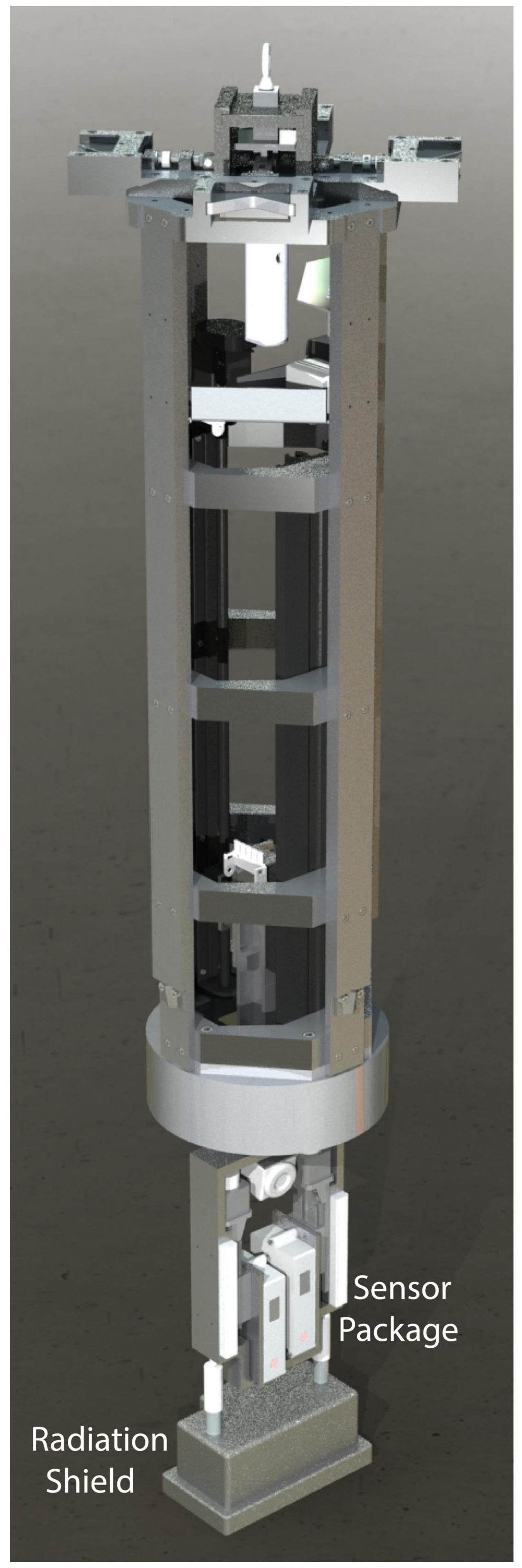

Figure 3. Alignment Mechanism.

Results and Conclusion

Even with preparations and mockups, aligning the target was not free of problems, and adjustments had to be made to the mechanism. Because the mechanism was designed to be as adaptable as possible, these adjustments were easy to make. The following shows the precision of the new target's position in reference to the original with 95% confidence.

X axis (horizontal)= ±0.60mm
Y axis (leading edge) = ±0.35mm
Y axis (trailing edge) = ±0.81mm
Z axis (along the beam line)= ±1.27mm

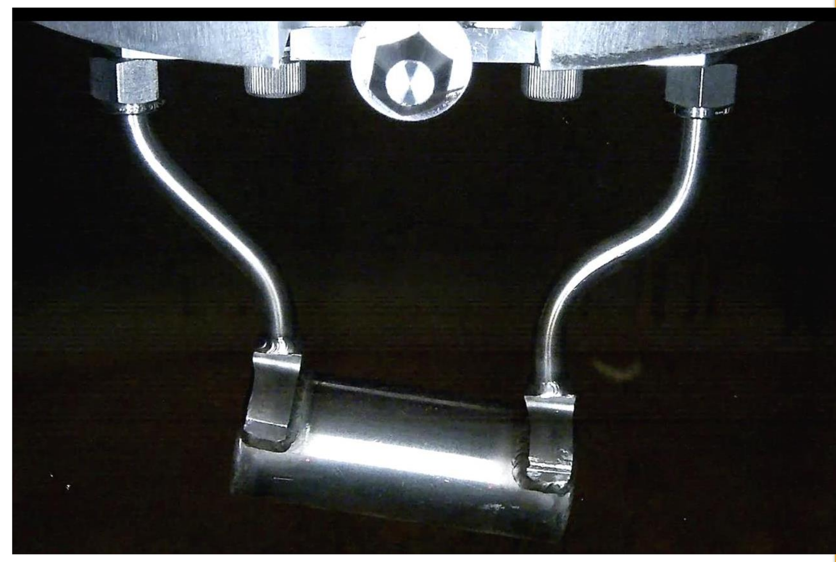

Figure 4. New Target 4 within the crypt.

The final operation to align the target took a matter of hours versus the weeks that the previous method required. Where time is often the most important commodity when improving reliability, it is prudent to re-evaluate longstanding operational processes.