Low-Energy, High-Intensity Muon Beam (LEHIM-B)

Joseph Rupsis, working with Carol Johnstone and Robert Ridgway

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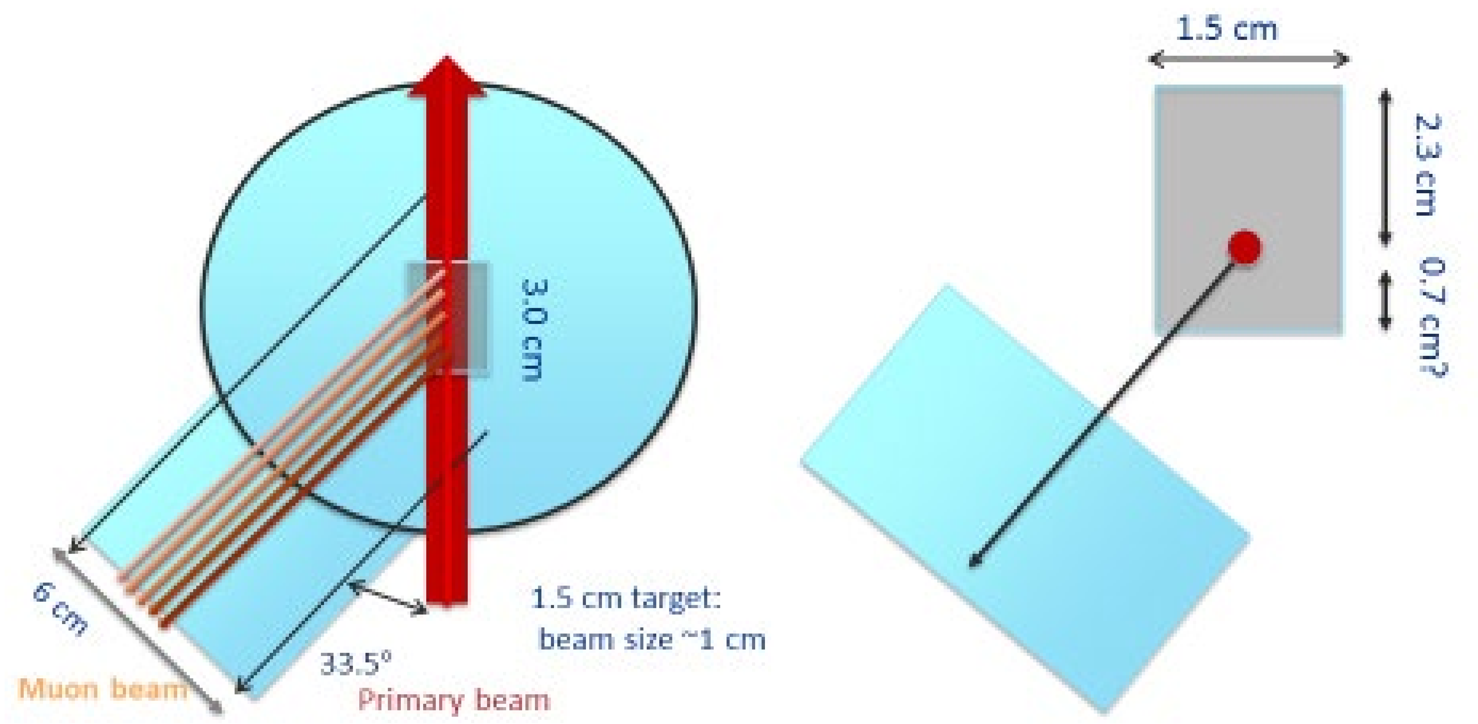
Background

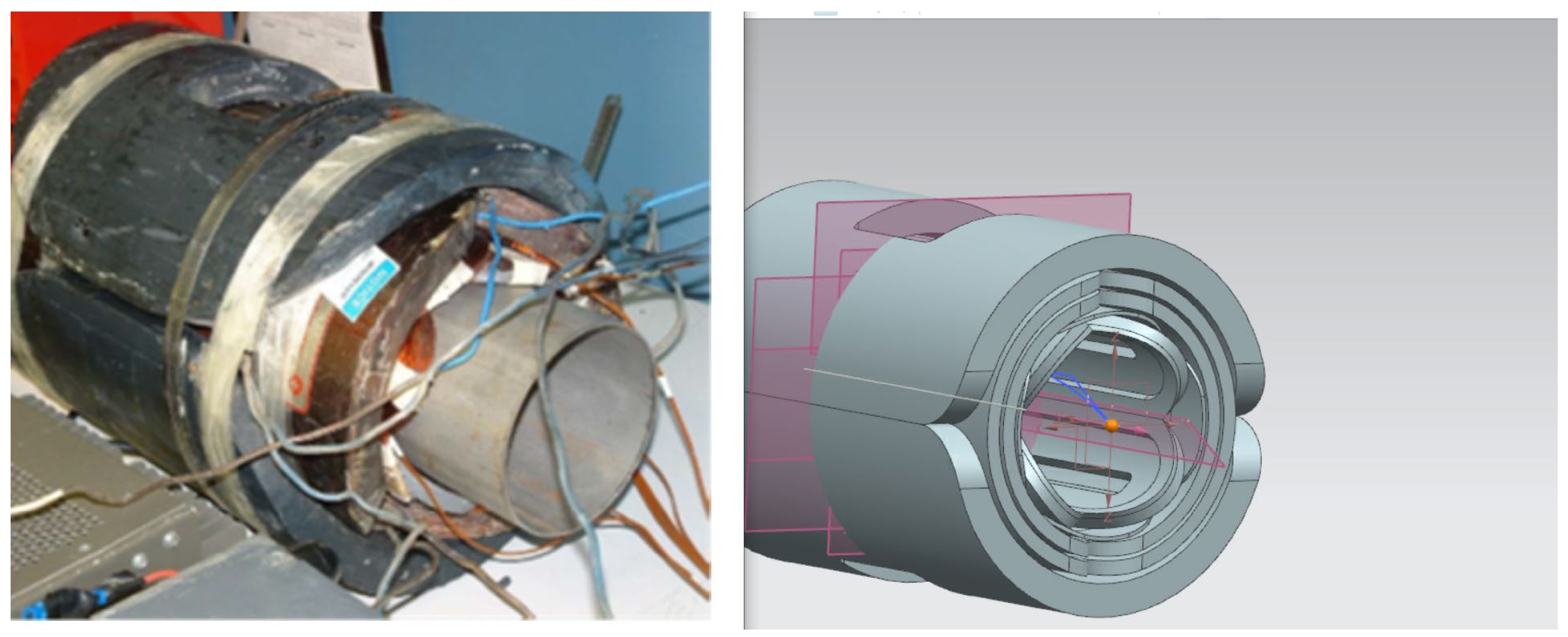
Low-Energy, High-Intensity Muon Beam (LEHIM-B) is a project in the MTA hall, designed to be cost-efficient & be multipurpose. It utilizes the 400 MeV Linac which interacts with a tungsten target. It has a 3 cm, 30% nuclear interaction length, which is greater than other similar facilities at other Labs. (PSI has a 4% interaction length) If LEHIM-B eventually utilizes the future PIP-II beam, then the target can expand to 6-8 cm or 60-80% interaction length. Part of LEHIM-B's goals is investigating the production of pions/muons from the target design.



LEHIM-B uses a 3 cm tungsten target with a 30% interaction length. The secondary muon beamline exits at a 33.5 degree angle.

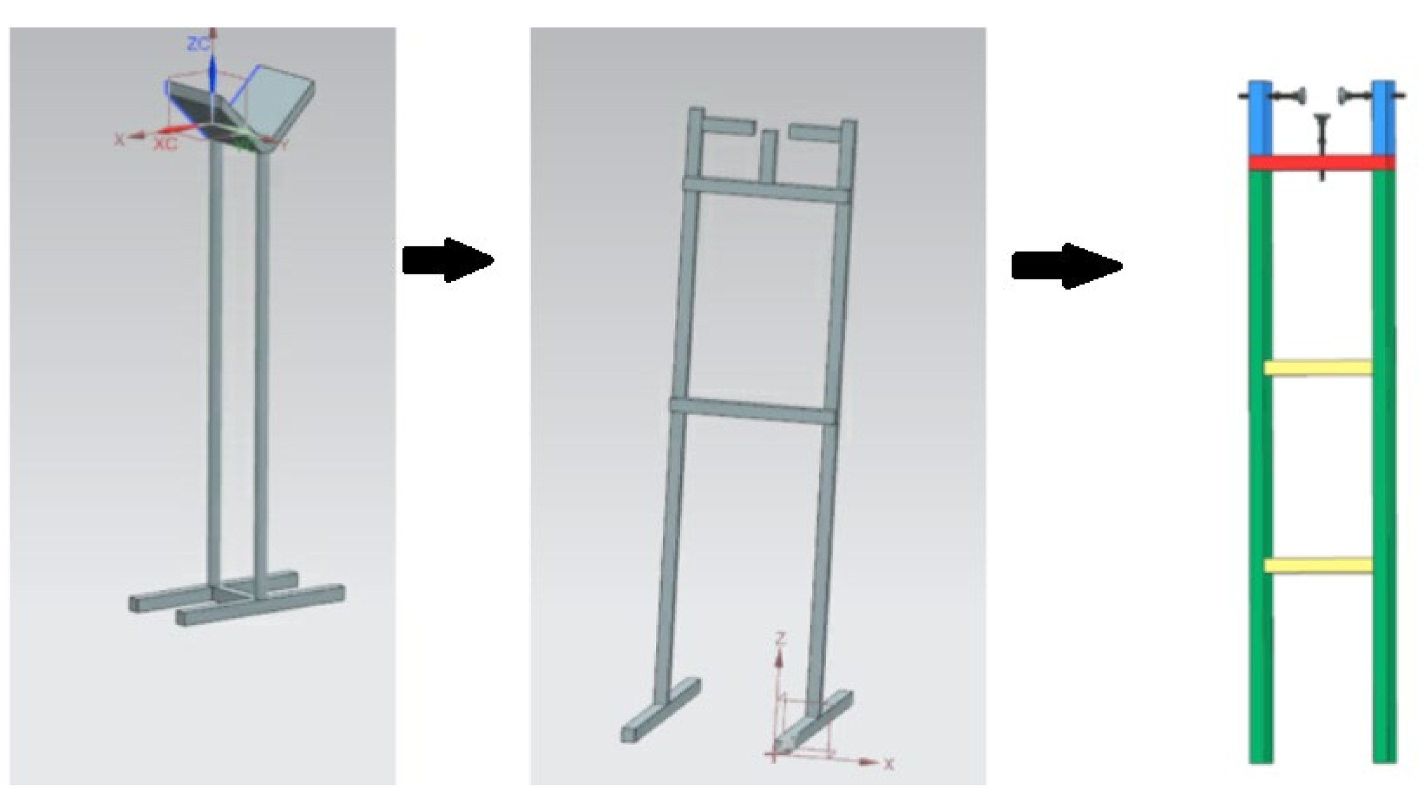
The 400 MeV Linac beam which interacts with the target to produce pions, which then become muons. The muons leave the target chamber in a secondary beamline. The muon beamline then enters a DOE-initiated Muon catalyzed fusion experiment. The muon beam is controlled by 10 booster corrector magnets made in the 1970s. They do this by focusing the beam in either the horizontal or vertical plane in each group of correctors. These magnets did not have any 3-D CAD models as they have been in storage for a long time.

3-D Modeling and Stand Designs



A side-by-side picture of the old booster corrector magnet (left) and a new CAD 3-D model that can be used to make a layout using this part.

My project involved creating 3D models of the old booster correctors, based off the original drawings. In addition to the booster correctors, LEHIM-B also needed a way to hold up the beamline with ten correctors. My project also had me help create stand models in NX for the beamline. Initially, the concept for the stands was a V shape that were placed under the old booster correctors to support the line. Later on, the V shape was changed into a three point adjustable stand.



The initial V design concept (Left) was ultimately changed to a three point adjustable stand (Middle), which was adjusted until the final design was reached (Right). All three versions were modeled in NX, just like the booster correctors were.

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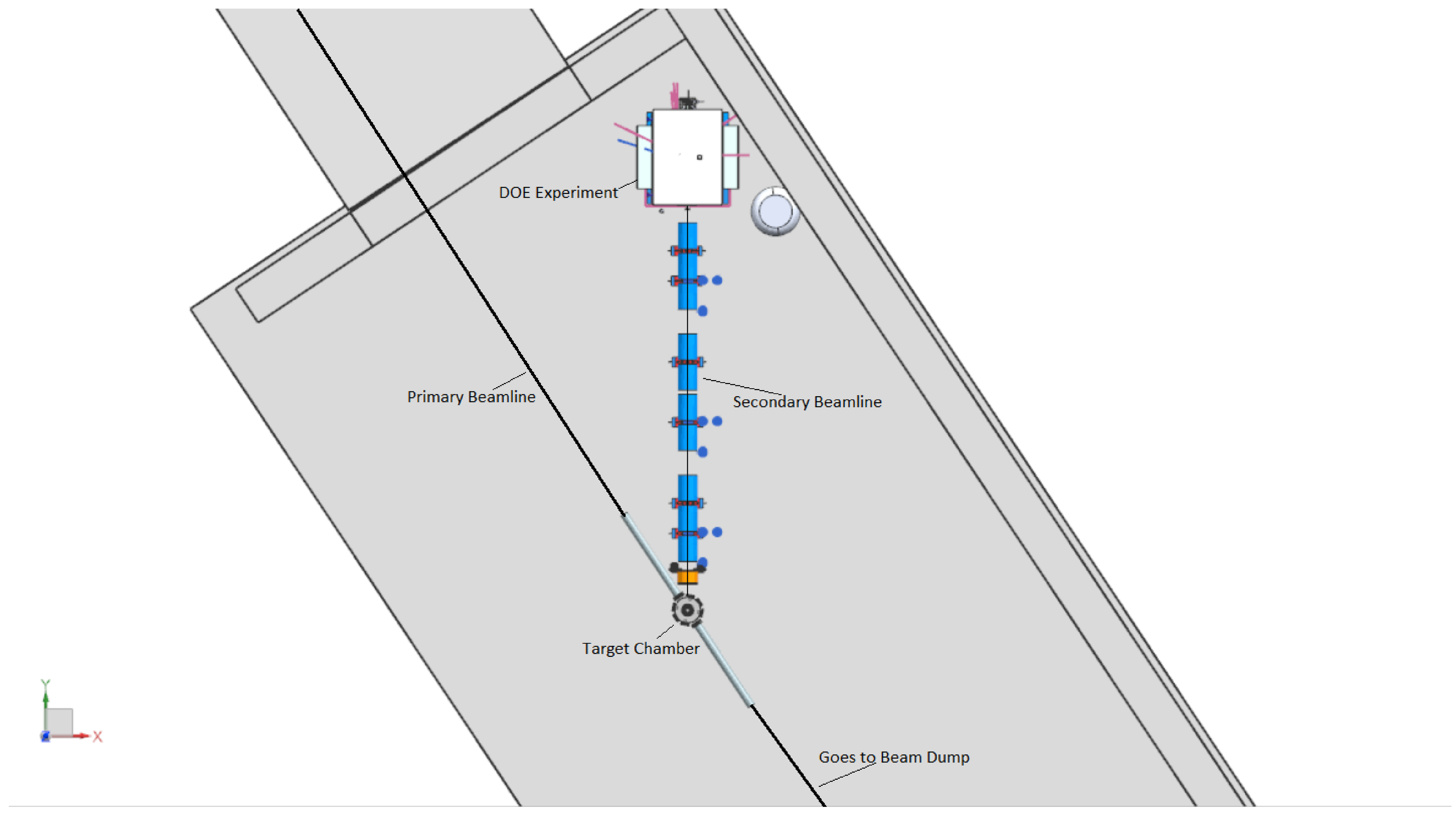
The Beamline Layout

The layout of LEHIM-B makes use of the modeled booster correctors and stands. The boosters are laid out in a 3-4-3 scheme. This allows the beam to stay parallel to the beam pipe that the beam travels in. The stands are placed between the booster correctors and onto the beampipe (not shown in picture). Originally, the V shaped stands were going to be placed under the booster correctors. Creating a proper layout is critical, because it allows you to see where parts interfere with each other and it helps the installation process by giving exact positions to go off of. My project had me assist in creating an initial layout (shown below) to help along the design & future installation process.



The layout in the MTA experiment hall. The 400 MeV Linac beam goes down and right and interacts with the target. The secondary muon beam goes up and into the DOE fusion experiment. Any leftover 400MeV beam goes down to the beam dump (not shown)

LEHIM-B will lead the way to the next generation of nuclear research due to its flexible multipurpose design. In addition to using the 400-MeV Linac beam, it can also make use of the future 800-MeV PIP II beam as mentioned in the target design. The PIP-II would allow for a longer target and a greater interaction length (6-8 cm or 60-80% interaction length, for a factor of two). This allows for various research projects such as: muon catalyzed fusion, charged lepton flavor violation, and analysis of surface damage in SRF cavities.