Target Survey Info

For SpinQuest it will be difficult to get the positioning of the target perfectly aligned with the beam. This is because all fiducials that we can get while the system is warm and open will change once we are running with liquid helium. Target cells and inserts are also expected to change with in the sub-mm level just from the insertion process. This is part of the experiments intrinsic systematic error.

Small pitch, roll, and yaw in target cell will be unpreventable but the contributions to the asymmetries of these are small and can be studied as part of the commissioning run and compared to simulations.

It is also critical to precisely locate the center of the target cell in the beam. Before this stage the beam should be tuned with the SC magnet off but the system cooled and ready. The target ladder and cell can be reasonably surveyed in X and Y during the final open survey. The Z axis on the other hand will be coupled to the actuator positioning. A high density sheet or pencil type target will be used to locate the beam on the target using scalar counts. This should give us sub-mm positioning on X, Y and Z.

The Dock survey was performed to get fiducials set on the magnet outside can and top flange. The magnet pole faces were measured and this data can be use to reference the aperture relative to the Hall fiducial network once the target is in position. When the magnet is cooled with liquid helium the movement from contraction will be primarily upwards (~1.6 mm). But the measurements of the aperture itself will remain mostly constant.

For preparation for the next survey the target must be positioned and the

The next survey will be another open survey like the one on the dock but with shell and fridge in place and the target insert in position with the actuator fully functioning. The vacuum can will be on with the beam windows open and the nose of the fridge off. Liquid nitrogen can be put into the SC magnet to get approximately 90% of the contraction. This survey can be completed to get the cold magnet contraction measurements plugged into the fiducial network. This survey also serves as the first step in mapping the target insert into the fiducial network.

The actuator has a power stepper motor that 5 time per 1 gearbox rotation. One gear box rotation results in a target insert movement of 0.2". This is approximately 0.00056" per degree. Each step (before micro-stepping) is 1.8 degrees.

This results in each stepper motor step moving the table 0.001".

The repeatability of the string potentiometer that will be use to encode

position is 0.02% of full length motion (15"). So the absolute reproducibility

will be approximately 0.003".

The vacuum can then be seal and the nose installed. The target must be positioned with the roots pumps connected and tied down permanently. This survey is done in conjunction with the table tuning that the target magnet sits on.

Long term running information will also provide X, Y positioning measured from averaged vertex reconstruction but this takes at least 1 month of data to produce and only give the mean with a very large variance. The precision in the target cell to beamline positioning needs to be good to mitigate large absolute errors while running. This is estimated to be on the sub-millimeter level (based on simulations being confirmed). There are several factors that can lead to false asymmetries relating to this precision. There can be a bias produced in the detector if the beam is off center. There can also be less polarized scattering if the beam is not aligned and missing part of the target material (beam profile dependent, also being checked).

There can be greater scattering off the aluminum ladder on one side as compared to the other. Most of these manifest from X being off but if Y is off over 1 mm then the same issues start to manifest with the ladder as well but this may not result in false asymmetry and only result in additional heat load to the coils.

Once the close survey is complete the only additional information must come from radiography or from running the beam.

An X-ray survey while cold would be the next step if possible. We may not needed it if we achieve good results from the above. It may also be possible to use a special insert with fitted with film to check beam position on a special target insert without depending on the magnet or nose having LHe in them. We might also find something that discolors or burns in the beam so we can make an insert that will be use over the experiment to confirm beam position over time.

Documents:

First Survey: Dock Survey

September 2023 Survey