Preliminary Closeout

Spinquest Installation Readiness Review
Dec 1,2 2020

Preliminary Words

- The committee was pleased with the information presented and the frank and open discussion about the challenges facing the collaboration in the endgame of installation and transition to operations
- This is a complex project, with a host lab that has admittedly has other priorities, two funding agencies, and a fairly young but growing collaboration. There has been a lot of impressive work to get this far, which should not go without notice
- However, these reviews tend to dwell on the problems rather than successes, so despite what may seem like a deluge of criticism, please keep up the good work

Infrastructure Completion -- Comments

- The main hurdle to complete the infrastructure appears to be not the actual work required, but mostly the amount of documentation and validation of performance still to be done in order to commence operations (similarly for the Target Cryogenics review)
- There is a detailed list of tasks to complete, which seems appropriately budgeted in terms of resources; however, the schedule to complete these items to allow sufficient time for Target installation and a spring commissioning period including beam is optimistic, given the issues in securing resources due to a convolution of the funding shortage and competing priorities within Fermilab.
- The project estimates a need for about 1 FTE-month of a welder to perform approximately equal amounts of pipe welding and brazing. Most of this work is scheduled to occur in the month of January. Welders are a very scarce resource at Fermilab and it is very unlikely that welders will be available at this level. Previously the brazing was done by a technician but this person is now on extended medical leave and there is currently no other trained technician. The project has considered having a 2nd technician trained to braze which is expected to take less than 1 FTE-week but about 6 weeks of calendar time.
- Completion of the cryogenics safety review is a critical path item to start commissioning. The project is appropriately concerned about preparation for this review and lack of dedicated engineering effort of a person with full system knowledge. Lacking an engineer with full system knowledge could significantly delay the completion of the safety documentation for the review committee. It could also result in delays during review if insufficient documentation is identified late in the process. The project did not originally budget for this engineering oversight. During the Q&A, the project proposed an additional $45k for a dedicated cryo engineer. We think this is an underestimate and suggest about 3 FTE-months would be appropriate. The schedule should not assume that the duty factor for this engineering is 100%.

Infrastructure Completion -- Recommendations

1. The installation schedule should be updated assuming that only a limited amount of welder time will be available. Suggest assuming no more than 20% maximum duty factor.

2. Consider pursuing brazing training of an additional technician as a mitigation for welder shortages.

3. Add the necessary funds for engineering to support cryogenics review to the budget request and initiate discussion with division management to identify an appropriate engineer.

Target Completion -- Comments

- Although the thermal modelling of the magnet was made with great diligence, it inevitably comes with a significant degree of uncertainty. Commissioning the magnet with beam to determine the upper threshold for quenches and their mitigation should take highest priority.
- The vacuum pump indicated for use with the magnet will not be capable of cooling the helium bath below about 3.5 K. A pump with better performance below 100 torr is required.
- Pumping the magnet bath below atmospheric pressure will also impact the operation of the 1 K refrigerator, which receives its liquid from that bath. The pump used to force the siphon from the bath will need to be upgraded as well
- Consider other potential performance improvements, such as implementing a lambda refrigerator to cool the magnet below 4.2 K
- The proton beam will create a non-uniform gradient of radiation damage along the length of the polarized ammonia sample, with a subsequent polarization gradient which regular annealing may not eliminate. The collaboration may wish to periodically rotate the sample 180 degrees about the vertical access to make the radiation damage more uniform.

Target Completion -- Recommendations

4. Develop a quantified plan to address the risk associated with improving the vacuum systems in order to achieve higher target performance

Commissioning, Operations, Organization -- Comments

- While roles and responsibilities are well defined, there are a small number of individuals with multiple roles in the organization, resulting in a few critical people responsible for much of the leadership of the effort. While this is somewhat natural for this early stage of an experiment, there should be an effort in the future to spread these responsibilities to a wider number of collaborators.
- The commissioning plan for the polarized target as presented does not include polarizing the target with a proton beam on the target. Demonstrating the polarized target's performance (NH3) in a beam close to what's required and/or have a realistic path forward to achieve the projected physics measurements is crucial to the success of the experiment

Commissioning, Operations, Organization -- Recommendations

5. Include the demonstration of the in-beam target polarization from NH3 to the minimal goals of the commissioning plan.

Charge responses

Charge Question 1: Remaining work

1. Does the collaboration have an achievable, sufficiently detailed, resource-loaded schedule for the remaining target construction and experimental installation work, which will lead to completion by mid-2021, in time for initial commissioning with beam before the Summer 2021 accelerator shutdown?

The collaboration does have a resource-loaded schedule for the completion of the work, which includes the actual remaining technical work needed to bring the target and infrastructure through installation. However, there is very little float with several areas (see report) with substantial potential for delay. In addition, the project foresees needing funds beyond the original guidance, and there may be missing resources for the successful completion of the reviews required before initial commissioning and operations. Therefore, while completion in time for initial commissioning is not ruled out, it is by no means guaranteed either, based on the information presented in the review.

Charge Question 2: Fermilab resources

2. Are the requirements on Fermilab staff and resources and on collaboration personnel for completion of the remaining experimental installation work well understood? Have the required personnel been identified and allocated for the installation in FY21? Is the remaining cost to complete installation well understood, and is there an adequate estimate of the contingency on the remaining work?

The project has a good understanding of what is required from Fermilab resources to complete the project, and with some exceptions (see report) this is incorporated in the plan and has been budgeted with sufficient contingency. However, there are specific issues where either a key resource is missing entirely or is not available to the project due to funds and perhaps availability, which leads to possible schedule delays.

Charge Question 3: Commissioning Plan

3. Has the experiment developed a sufficiently detailed plan for commissioning the detector in preparation for physics data-taking? Are the roles and responsibilities of collaboration members and Fermilab staff well-defined for this commissioning period?

There is a detailed plan for commissioning the detector, which appears to be sufficient for physics data-taking. Of particular importance will be the commissioning with beam of the magnet, to get experimental results on the so far simulated performance and operational parameters. The commissioning plan for the polarized target as presented does not include polarizing the target with a proton beam on the target. Demonstrating the polarized target's performance (NH_3) in a beam close to what's required and/or have a realistic path forward to achieve the projected physics measurements is crucial to the success of the experiment. The roles and responsibilities of the collaboration and Fermilab staff are well defined for the commissioning period.

Charge Question 4: Experimental Operations

4. Has the collaboration prepared an initial run plan for experimental operations to record the data required to achieve the desired sensitivity? Is there sufficient margin in this plan to reach the desired sensitivity with an achievable operational efficiency? Are the roles and responsibilities of collaboration members and Fermilab staff well-defined for the run period?

The collaboration presented an initial qualitative run plan for experimental operations with a table of relevant experimental parameters to achieve the desired sensitivity. However, it is difficult to address whether there is sufficient margin in the plan to reach the desired sensitivity because the initial run plan is not detailed enough and there are a number of unknowns associated with the target in-beam performance and to a lesser extent also the desired number of protons/spill. We encourage the collaboration to work with Fermilab AD to explore potential avenues to increase the margin as experience with the target and experiment is gained.

The current roles and responsibilities for the collaboration and Fermilab are well defined; however, with the complexity of coordination with Accelerator Operations as well as the active target maintenance regime, the collaboration would benefit from additional Host Lab involvement in operations, in terms of standard safety, coordination, and oversight issues.

Charge Question 5: Polarized Target

5. The new polarized target is critical to the success of the experiment. Have sufficient resources been allocated to install, commission, and maintain the target throughout SpinQuest running? Have the technical risks been identified and mitigation plans developed?

The group responsible for the polarized target has thus far done an admirable job preparing it for the experiment. However a shortage of engineering expertise may threaten its schedule. Additional resources in this area are recommended to ensure that its operation is approved on time. Technical risks have been identified, with the greatest being the performance of the 5 T magnet. One path to mitigate this risk, reducing the magnet temperature, has been identified.

A plan for adequate staffing has been presented, but not all personnel have been hired yet. Hiring under current visa policies and COVID delays may impact the speed with which personnel are brought on board.

Charge Question 6: ESH

6. Are the ES&H (Environment, Safety, and Health) aspects of all anticipated work during the completion of installation, initial commissioning, and initial running being properly assessed and managed, with clear roles and responsibilities? Did the polarized target get the required special attention?

The project is basically on track for final Operational Readiness Clearance, having achieved partial ORC on several systems and on the path for the rest, with the exception of the Cryo-Operations Safety Review, which pertains to the polarized target. There is a concern here that the budget and time allocated to perform this review is not consistent with the current schedule.