FERMILAB

325 MHz Cavity Test Cryostat
2 K Conversion
Functional Requirements Specification

Prepared by: Date: Tom Nicol, 325 MHz Cavity Test Cryostat Engineer	**Organization** TD/SRF Dev	**Extension** 3441
Reviewed by: Date: Robyn Madrak	**Organization** APC	**Extension** 6668
Reviewed by: Date: Bob Webber, Project X Project Engineer	**Organization** TD/HQ	**Extension** 5415
Reviewed by: Date: Mark Champion, TD/SRF Department Head	**Organization** TD/SRF Dev	**Extension** 3906
Reviewed by: Date: Arkadiy Klebaner, MDB Cryogenic Coordinator	**Organization** AD/Cryogenics	**Extension** 8357
Reviewed by: Date:	**Organization**	**Extension**
Reviewed by: Date:	**Organization**	**Extension**
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Revision History

Revision	Date	Section No.	Revision Description
0.0	11-OCT-2010	All	Initial Release

INTRODUCTION

The 325 MHz cavity test cryostat is a facility located in the Meson Detector Building (MDB) for testing dressed 325 MHz spoke resonators. The purpose of these tests is to measure the performance of the cavity, tuners, and input coupler prior to installation into a longer multi-cavity cryomodule. The test cryostat was completed in 2009 and installed at the Magnet Test Facility in Industrial Building 1. The test configuration there was designed to test the effectiveness of a magnetic shield design for the superconducting solenoid magnets that will be part of the same cryomodule assembly. Following that test, the cryostat was returned to the Industrial Center Building for piping modifications needed for integration into the cryogenic system at MDB. The move to MDB was completed in late 2009 and the first cold test of a single spoke resonator was completed in September 2010. In its initial and current configuration the cryostat is capable of cooling down and operating a single dressed cavity nominally to 4.5 K. The scope of this project is to retrofit the facility to enable operation of all single spoke resonators envisioned for Project X at temperatures down to 2 K in CW mode. The design utilizes many of the features found in the current 1.3 GHz horizontal test facility in the cave adjacent to the 325 MHz cavity test cryostat. The current installation is shown in Figure 1.

Figure 1. Current 325 MHz Test Cryostat Installation in MDB

SCOPE OF WORK

The following are the major tasks to be completed to bring the facility back into operation following completion of the conversion.

1. Design and fabricate a new "top hat" and internal piping assemblies.
2. Design and fabricate three new transfer lines to connect to the existing feed can.
3. Modify the piping external to the cryostat to facilitate the new operation. This work primarily involves the pumping line for 2 K operation and the pressure relief circuit.
4. Modify the cryogenic control system to include the 2 K pumping circuit and added instrumentation.
5. Complete new piping and system engineering notes.
6. Test and commission.

INTERFACES

The existing 325 MHz cavity test cryostat has interfaces to the MDB cryo system, laboratory data acquisition systems, and the MDB RF system. This will continue to be the case with after the 2 K conversion is complete. The major interface will be to the MDB cryo system. It is assumed these systems are in place and operational to realize the full potential of this facility. Although there is no direct tie to other similar systems at MDB, all these facilities will compete for cavity installation resources, have conflicting test schedules, etc. There appears to be sufficient capacity in the MDB cryo system, however, the potential exists for these various independent operations to impact one another.

REQUIREMENTS

Operational Requirements

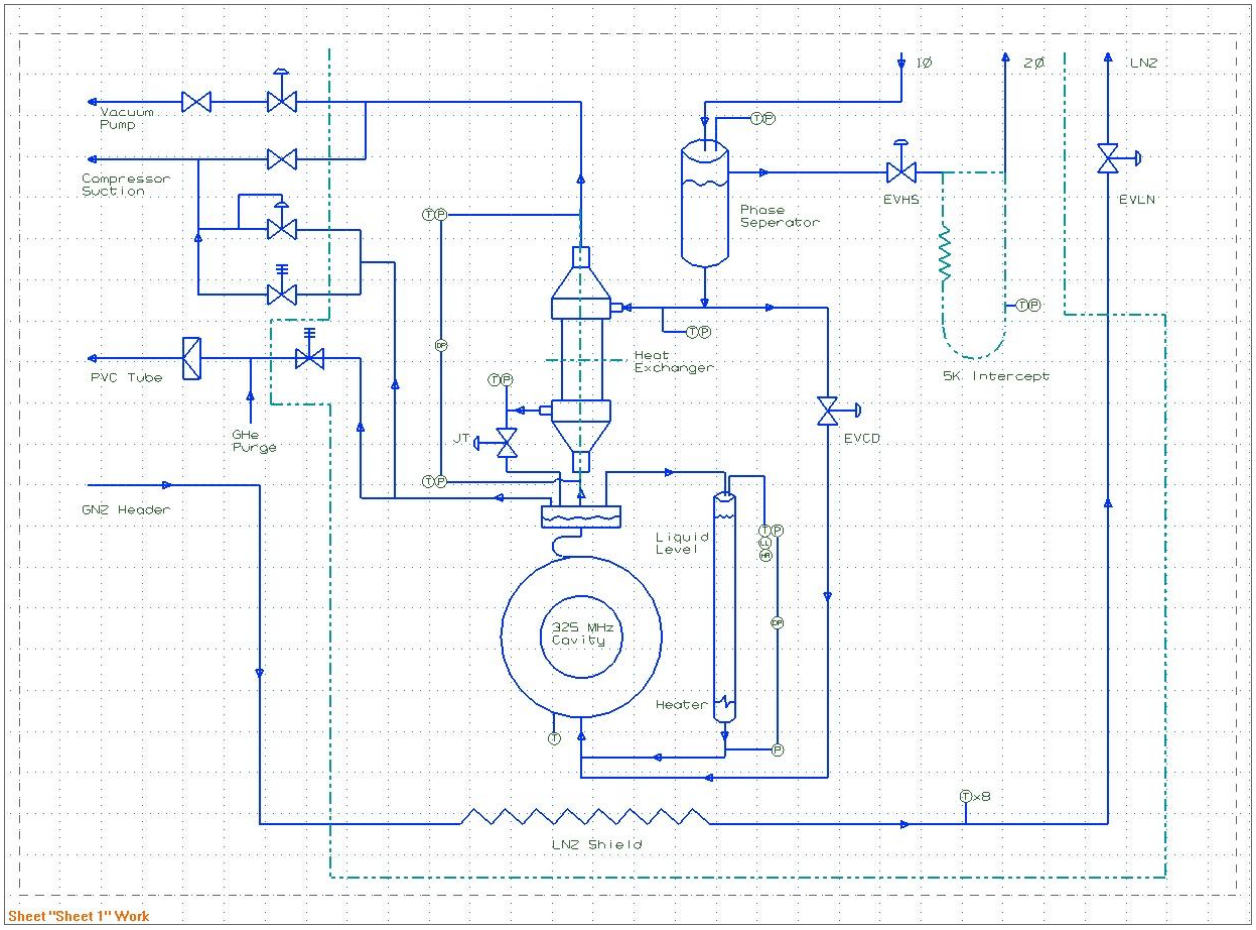
The test facility should accommodate the following tests at a minimum.

1. Q vs. E for fast and slow cooldown, especially between 150 K and 70 K.
2. Cavity magnetic field sensitivity – repeatedly quench cavity in the presence of a magnetic field to determine effect on Q vs. E.
3. Cavity magnetic field sensitivity – expose cavity to small magnetic field during cooldown below 10 K to determine effect on Q vs. E.
4. Measure pressure fluctuations at 2 K and determine cavity frequency sensitivity.
5. Measure f vs. E2 to obtain Lorentz force detuning coefficient.
6. Full range of slow and fast tuner tests including microphonics compensation.
7. Maintain the potential for testing a cavity and solenoid combination although the present and planned configurations of the cryostat do not include current leads for magnets. Magnet testing at 2 K would likely require significant alterations to the cryostat to accommodate conduction cooled current leads presently in development.

Technical Requirements

The following are general requirements of the overall installation.

1. Support cavity and/or magnet testing to 2 K with a total heat load up to 30 W.
2. The facility will incorporate three separate vacuum systems for the insulating vacuum, cavity vacuum, and warm coupler vacuum.
3. Cooldown from room temperature to operating temperature should be completed in 24 hours or less. Warmup to room temperature should also be completed in 24 hours or less.
4. Stable operation must be possible at both 4.5 K and 2 K.
5. During cooldown, the transition from 150 K to 70 K should be made in 1 hour to minimize the effects of Q-disease.
6. Every effort should be made to keep the static heat load to 2 K to a minimum.
7. An integral magnetic shield to minimize residual magnetic field at the cavity due to the Earth's field.
8. Flexible transfer lines should be permanently connected to the cryostat and utilize Fermilab-style bayonets at the bayonet can end.
9. Instrumentation to monitor the insulating vacuum pressure should be available.
10. Instrumentation must be available to measure head load to 2 K and to fully monitor cryogenic operation.
11. Instrumentation will include, but not be limited to, the following
    a. Cavity vacuum, insulating vacuum, and input coupler vacuum indication.
    b. Helium bath pressure, temperature, and liquid level.
    c. A heater to facilitate calorimetry measurements.
    d. Input coupler temperature.
    e. Thermal shield temperature.
    f. Diode x-ray detectors.
    g. Capability to power coils for magnetic field tests.
    h. Coil temperature.
    i. Cavity field probe.
    j. Coupler e-probes.
    k. Tuner diagnostics.
12. Testing all spoke cavity types, i.e. SSR0, SSR1, and SSR2.



Safety Requirements

1. All existing safety procedures relating to the original test cryostat installation will remain in place.
2. All existing training requirements relating to the original test cryostat installation will remain in place.
3. All existing interlock procedures relating to the original test cryostat installation will remain in place.
4. A piping engineering note will be written, reviewed, and approved prior to operation as outlined in Fermilab ES&H Manual chapter 5031.1. The completed piping system will be pressure tested and documented as outlined in Fermilab ES&H Manual chapter 5034. The original existing vacuum vessel engineering note will be modified to incorporate any changes resulting from the new top hat assembly.

Test and Commissioning Requirements

When the 2 K conversion is completed, the installation will be commissioned by cooling down a dummy load and measuring the static heat load to 2 K. Integrated commissioning of the cryogenic and RF systems will be carried out using a completed dressed cavity and running through the full suite of cavity tests. Commissioning will be complete upon successful completion of that series of tests.