Fermilab Cryomodule Test Stand Design and Plans

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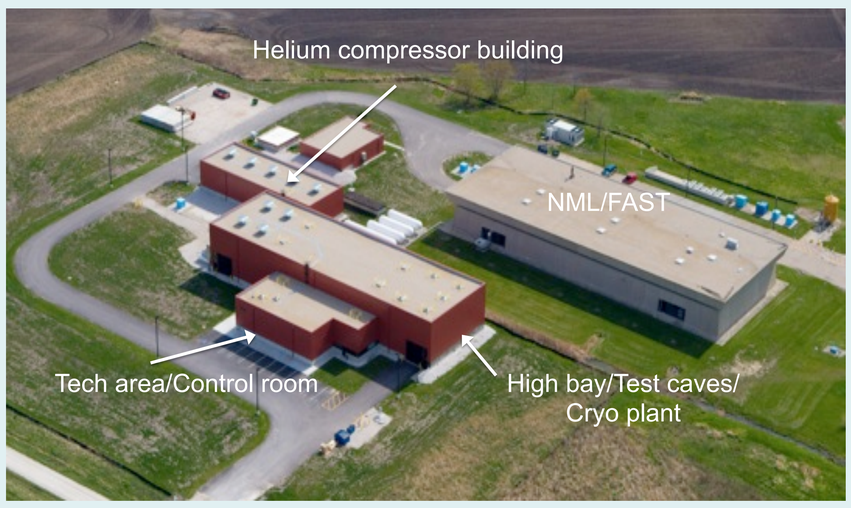
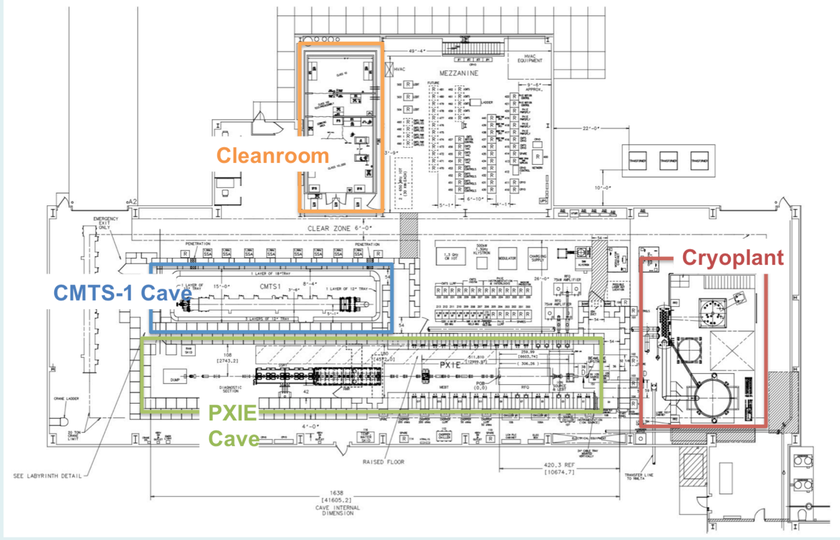
A facility dedicated to SRF cryomodule testing is under construction at Fermilab. The test stand has been designed to be flexible enough to cool down and power test full length TESLA-style 8-cavity cryomodules as well cryomodules for low-β acceleration. We describe the design considerations, status, and near future plans for utilization of the test stand.

CMTF building & Layout

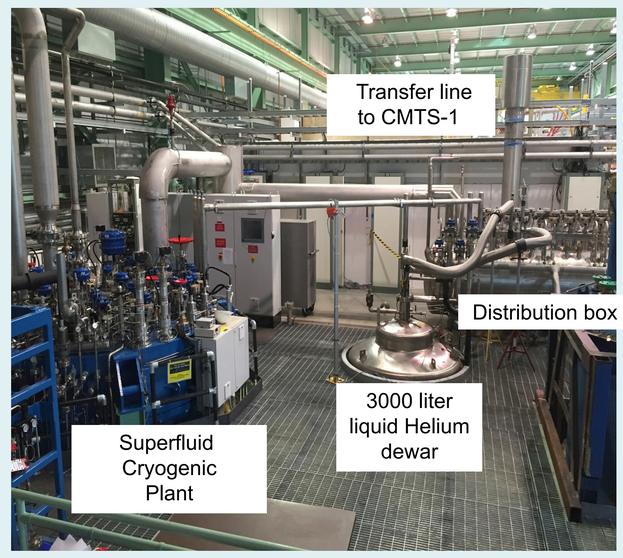




CMTF consists of two new adjoined buildings located adjacent to the existing NML building, and together with NML comprises a world-class facility for testing SRF components with and without beam.

- a 4,000 square foot Compressor Building houses the warm compressors, vacuum pumps, water cooling system and utilities for the entire facility
- a 15,000 square foot high-bay with a 20-ton overhead crane and contains two liquid helium refrigerators, two Cryomodule Test Stands (CMTS), a test area for RF components and electrical systems, a cleanroom area for particle-free preparation of SRF components, and a control room/office area.

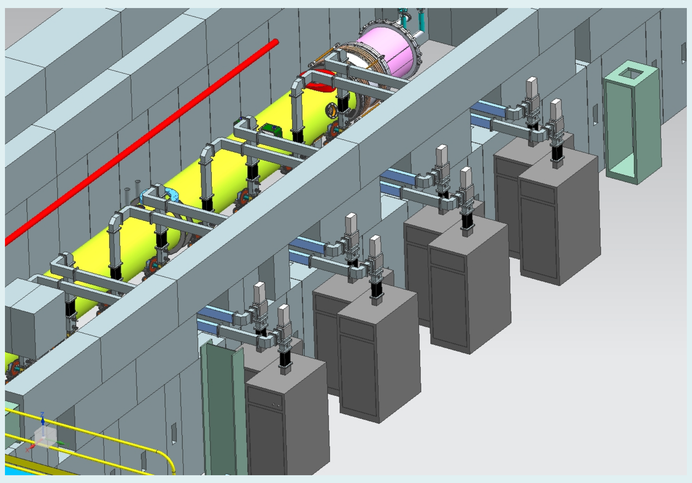
Cryogenics Plant



The major components in support of CMTS-1 include

- Cryoplant – 500 Watts at 2 Kelvin
- Distribution box – independent
- Transfer line
- Valve box
- Feed and Endcap – designed & fabricated by Bhabha Atomic Research Centre (BARC).

RF Layout



Each cavity will have its own RF source. Solid state amplifiers (SSA's) will be located outside and immediately adjacent to the test cave. Circulators to minimize reflected power back to amplifiers are mounted above each SSA. Individual waveguide runs will enter the cave near the cave ceiling height and then drop vertically above the respective coupler port. The vertical sections are designed for rapid removal to allow sufficient clearance to crane cryomodules in and out between tests.

RF Interlocks system will provide system protection by treating each of the eight RF feeds as stand-alone units. Inputs include PMT's, e- probes, temperature sensors on coupler windows, reflected power.

Specified (Spec) and Experimentally Tested (Test) Refrigeration Capacity of the CMTF Superfluid Cryogenic Plant

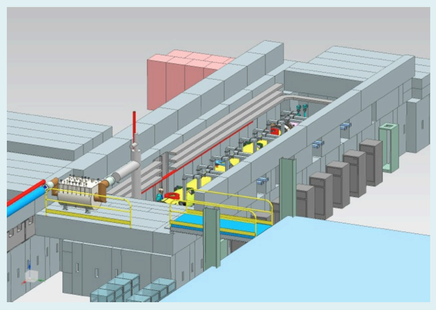
Nominal Temperature	Unit	Mode 1		Mode 2		Mode 3	
		Spec	Test	Spec	Test	Spec	Test
1.8 Kelvin	W	250	257	n/a	n/a	n/a	n/a
2.0	W	n/a	n/a	500	527	n/a	n/a
5 K to 8 K	W	600	619	600	619	100	118
40 K to 80 K	W	5,000	6,136	5,000	6,136	700	720
Liquid Helium	g/s	n/a	n/a	n/a	n/a	16	25

Support Girders

To minimize stray magnetic fields, the cryomodule support girders and hardware within them are fabricated from 316L stainless steel. Each girder bears half of the cryomodule weight, 8,130 lbf.

Test Cave

The CMTS-1 test cave is a shielded enclosure sized to house cryomodules as large as TESLA-style 8 cavity 1.3 GHz ones. Inner dimensions are 64' 9" (19.74 m) long by 15 feet (4.57 m) wide with a height of 10-1/2 feet (3.2 m) as shown in Fig. 2. The walls are composed of shielding blocks and are 3 feet (0.914 m) thick with integrated penetrations for RF waveguide, cabling, etc. The roof is removable in order to move cryomodules in and out of the cave and is similarly composed of blocks with a total thickness of 3 feet (0.914 m).



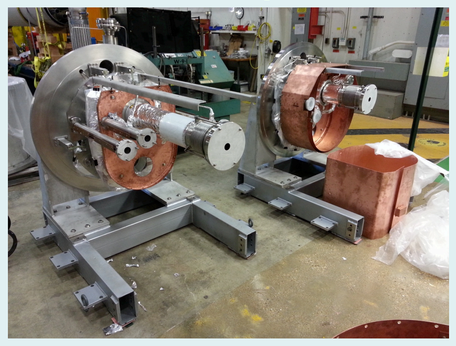
Status & Plans

The first use of CMTS-1 will be for the seventeen 1.3 GHz and two 3.9 GHz cryomodules being assembled at Fermilab for the LCLS-II project. Prior to transport to SLAC, all of them will be cooled down and verified to meet specification. A test plan is in the process of being developed which draws on previous cryomodule experiences and will allow consistent evaluation among the LCLS-II partner labs. LCLS-II cryomodule testing is planned from early 2016 through 2018.

The test cave has been installed and the bulk of the major components received including the girders, feed and end caps and other cryogenic components. Integration of the cryogenic feed from the SCP into the cave is in progress. Commissioning of the test area is expected in late 2015. The completed cryogenic system will be commissioned in parallel with the RF and interlock systems.

Feed & End Caps

Feed and endcaps designed and fabricated at BARC, India and recently delivered to Fermilab.



Summary

Fermilab is constructing a facility dedicated to testing SRF cryomodules. CMTS-1 is now being assembled to qualify both 1.3 and 3.9 GHz cryomodules for LCLS-II. Commissioning is expected to commence in late 2015 with testing of the first cryomodule expected in the first half of 2016. Production cryomodules are expected to be tested on a 28-day cycle including 8 days of cold testing.

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