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Magnet Sector

HFVMTF
FNAL-LBNL Mechanical Interface Document

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Revision History

Revision	Date	Section No.	Revision Description
1.0	12/02/19	All	Initial Release
1.1	02/19/20	Add section 4	Add a section describing current magnet interface parameters, according to GianLuca Sabbi e-mail from Jan 9th 2020
1.2	06/03/20	All	Cleaning the text and add symmetric grounding of the dump, G. Velev
1.3	06/04/20	3	Updated cryostat dimensions – Sergey Koshelev
1.4	06/04/20	All	Text cleaning and specifying magnet OD of 1300 mm G. Velev
1.5	2/15/23	4	Updated key magnet parameters based on preliminary design and to reflect new cryostat location on the centerline of the pit and heat exchanger design symmetrical on the bottom of the cryostat.

1. Introduction

This document specifies the interface between Lawrence Berkeley National Laboratory (LBNL) supplied items for testing and Fermi National Accelerator Laboratory (FNAL) High Field Vertical Magnet Test Facility (HFVMTF).

LBNL will deliver a dipole magnet ~~cold mass~~ assembly ready for installation in the FNAL supplied Test Cryostat for testing. At FNAL, plans for the civil construction to develop the area where the Test Cryostat will be suspended are about to be finalized followed by the initiation of a Request for Proposals (RFP). The size of the fiberglass lined concrete shaft is based on a preliminary cryostat design which is sized to accommodate the present dimensional parameters of the high field dipole magnet. To assure a seamless integration between the LBNL magnet ~~cold mass~~ the and FNAL facility, the details of the civil construction (shaft size) and the preliminary cryostat design are presented for review and approval by representatives from each Laboratory.

2. Civil Construction

A new pit and shaft for the High-Field Vertical Magnet Test Facility (HFVMTF) at FNAL is planned for the south end of Industrial Building 1 (IB1), west of the existing Vertical Magnet Test Facility (VMTF). The location of this new pit/shaft relative to the existing test facilities and the preliminary cross-section are shown in Figures 1 and 2, respectively.

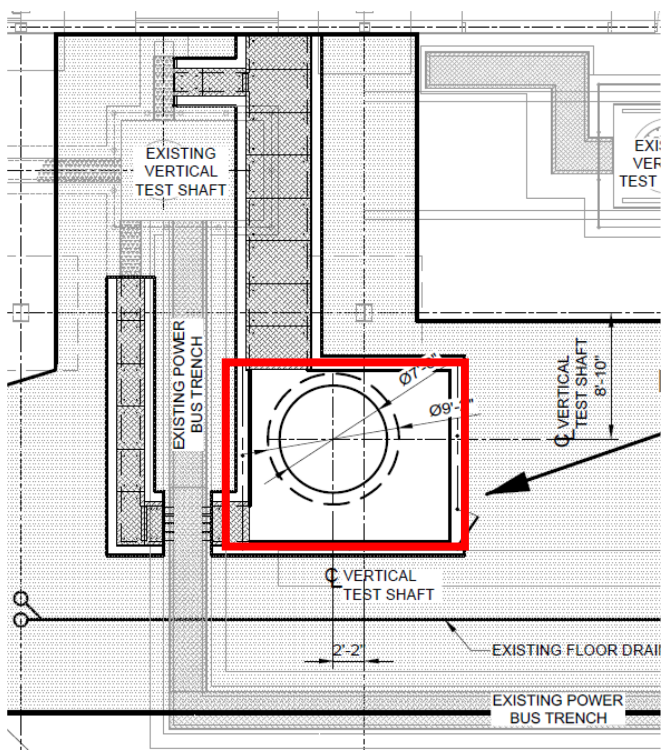

Figure 1 Location plan of the IB1 HFVMTF, from FESS drawing 10-1-223 S-1.

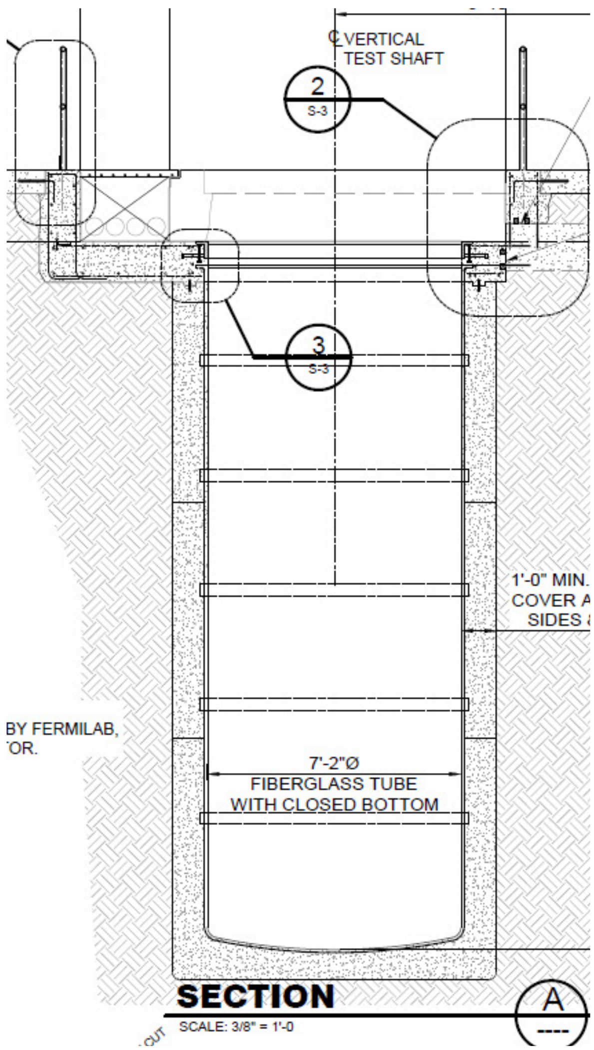

Figure 2 Section of the IB1 HFVMTF, 20 ft deep, from FESS drawing 10-1-223 S-2.

3. Test Cryostat

The Test Cryostat design features will be like those in the existing VMTF Cryostat with a scaled-up helium test volume and an appropriate heat exchanger. Above the Lambda plate, the helium vessel will be a minimum of two (2) inches larger in inner diameter than the section below the Lambda plate which is sized to accommodate the High Field dipole magnet with a maximum outside diameter of 1300 mm.A preliminary dimensional layout of the helium and vacuum vessel shells is shown in Figure 3 and the dimensions are summarized in Table 1.

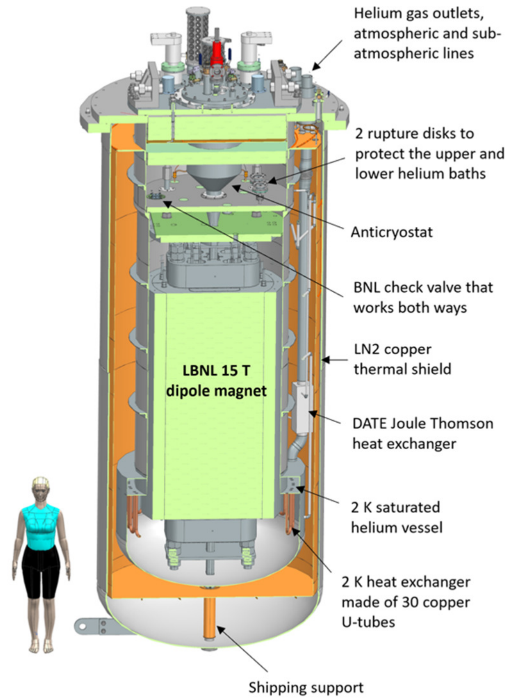

Figure 3 Cross-section of the conceptual design of the cryostat with the magnets in-side.

Table 1 HFVMTF Dimensions		
	HFVMTF	**VMTF (for Reference)**
LHe vessel – ID of upper part (above lambda plate)	57.1 in	28 in
LHe vessel – ID of lower part (below lambda plate)	55.1 in	28 in
Sidearm HX – OD of bellows	12 in	6.8 in
80 K shield - OD	78 in	39 in
Vacuum vessel - OD	82 in	42 in
Vacuum vessel top plate feet – bolt circle (BC) diameter	95 in	54 in
Vacuum vessel top plate - OD	96 in	56 in
Distance between LHe vessel centerline and sidearm HX centerline	~0 in (TBD)	18.88 in
Distance between LHe vessel centerline and centerline of 80 K shield and vacuum vessel	~0 in (TBD)	4.06 in

4. Magnet interface parameters

The magnet parameters needed to describe interface to the Test Cryostat are specified in Table 2.

Table 2 Magnet Parameters – Interface by the Cryostat

Specification	**Value**	**Approved by FNAL**	**Approved by LBNL**
Magnet Shell Outer Diameter not larger than	1.3m	yes	yes
Total Magnet Length	3.0 m	See Note 2	yes
Total Magnet Weight	20000 kg	yes	yes
Magnet Stored Energy	<20 MJ	yes	yes

Notes:

1. Magnet Shell Outer diameter: 1.3m is agreed between FNAL and LBNL. The cryostat ID should be 1.4 m to have some additional space for strain gauges and wiring, and for clearance during insertion.

2. Total Magnet Length: 3.009 m based on the final coil length presented and approved by EOC2 and IPT6 meetings (August 2022). This value is close to final. A 9 mm reduction to formally meet the 3.0 m specification could be implemented if needed.

3. Weight: 18050.9 kg based on the final coil length as presented to the EOC2 and IPT6 meetings (August 2022). This value is still preliminary as details of the magnet components are being finalized, but is expected to remain well below the 20000 kg. specification. If the total weight of the structure (magnet + lambda plate + top plate) is above 25 US tons, two 25 tons cranes should be used simultaneously.

4. Magnet Stored Energy: design stored energy is 12 MJ at 16 T, well below the 20 MJ limit from the initial specification. Quench protection calculations show that the magnet can be protected by either energy extraction or a CLIQ system. A combination of both systems is being considered for full redundancy.

5. To keep the maximum voltage at the terminals below 1 kV, Fermilab will design the quench protection system with symmetric grounding of the dump resistor.