Magnet Testing

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SC Magnet Division – S&T Committee Program Review
Magnet Testing

- Overview
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- Power Supply Systems
- Data Acquisition and Control Systems
- Summary

SC Magnet Division – S&T Committee Program Review
Magnet Testing - Overview

- **"Vertical Testing"**
  - **Test magnet cold mass in liquid helium in vertical dewar.**
  - **Cold mass attached to a thick metal plate that carries the weight and has warm-cold feedthroughs for cryogens,power and instrumentation.**
  - **There are five vertical dewars- 4.5 meters max. cold mass length.**
  - **Faster and easier then "horizontal testing" .**
- **"Horizontal Testing" = Mag-cool**
  - **Test magnets in their own cryostats.**
  - **The longest magnets tested were 15 meter SSC dipole magnets.**
  - **There are four working test bays.**
- **Other major components**
  - **2 refrigerators that are interconnected**
  - **6 helium compressors**
  - **6 high current power supply systems**
  - **Multiple anti-cryostats for installing room temp. measuring devices in magnet bores.**

Magnet Testing – Cryogenic Systems

CTI MODEL 4000 REFRIGERATOR/LIQUEFIER

Primary source of liquefaction

1500 W at 4.5K

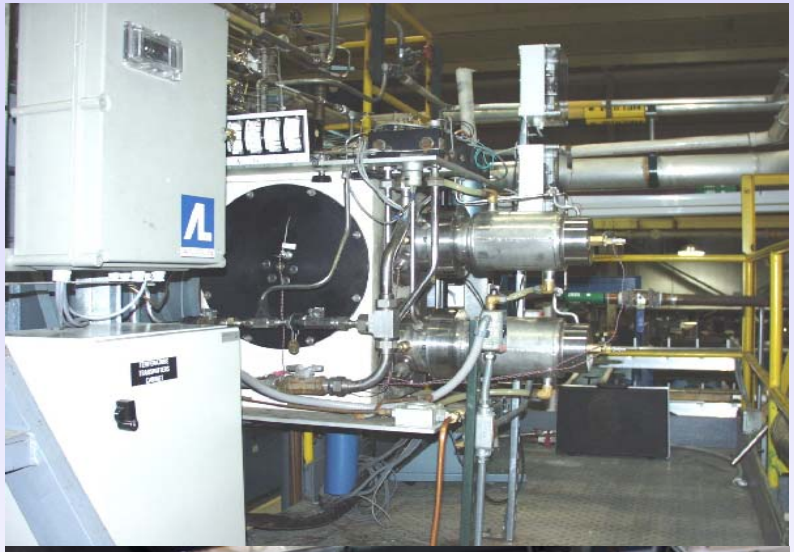
Two reciprocating expansion engines rated at 250 rpm

70 g/s forced flow capacity at 11 - 13 atm in HTF-Mag-cool

He liquefaction: 270 L/hr (with both expansion engines and a Koch Model 1600 Wet Expander)

Recently upgraded with a new LN_2 heat exchanger and diagnostics for expanders

Magnet Testing – Cryogenic Systems



CVI – L'AIR LIQUIDE REFRIGERATOR/LIQUIFIER

700 W at 4.5K

Two turbine expanders rated at 130000 rpm

In-line gas purifier (Contamination can cause significant damage to the turbines)

Recently upgraded with new instrumentation and PLC controls for turbine protection

Can produce 160 L/hr

Currently not operational due to a compressor problem

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Magnet Testing – Cryogenic Systems

Helium Compressors

- **Mycomm**
  - Power = 600 kW
  - Discharge pressure = 18atm = 1.83MPa
  - Delivers 160 g/s

  Can supply either the CTI Model 4000 or the CVI refrigerator
  Built ~ 1975 re-built - 1991

- **Dunham-Bush (Out of service)**
  - Power = 522 kW
  - Discharge pressure = 14.5atm = 1.47MPa
  - Delivers 128 g/s

  Supplies the CVI refrigerator only
  Built ~ 1979 re-built - 2001
  controls are being refurbished

- **Sullair 350**
  - Power = 261 kW
  - Discharge pressure = 18atm = 1.83MPa
  - Delivers 51 g/s

  All-purpose, supplements Mycomm; sub-cooling vertical dewars (2K)
  Built ~ 1982

- **Sullair 100 (three units)**
  - Power = 74.6 kW
  - Discharge pressure = 12 atm = 1.2 MPa
  - Delivers 20 g/s (80 g/s @ 8 atm input)

  Used for Mag-cool operations
  Nitrogen cool-down, warm-up & pump and purge

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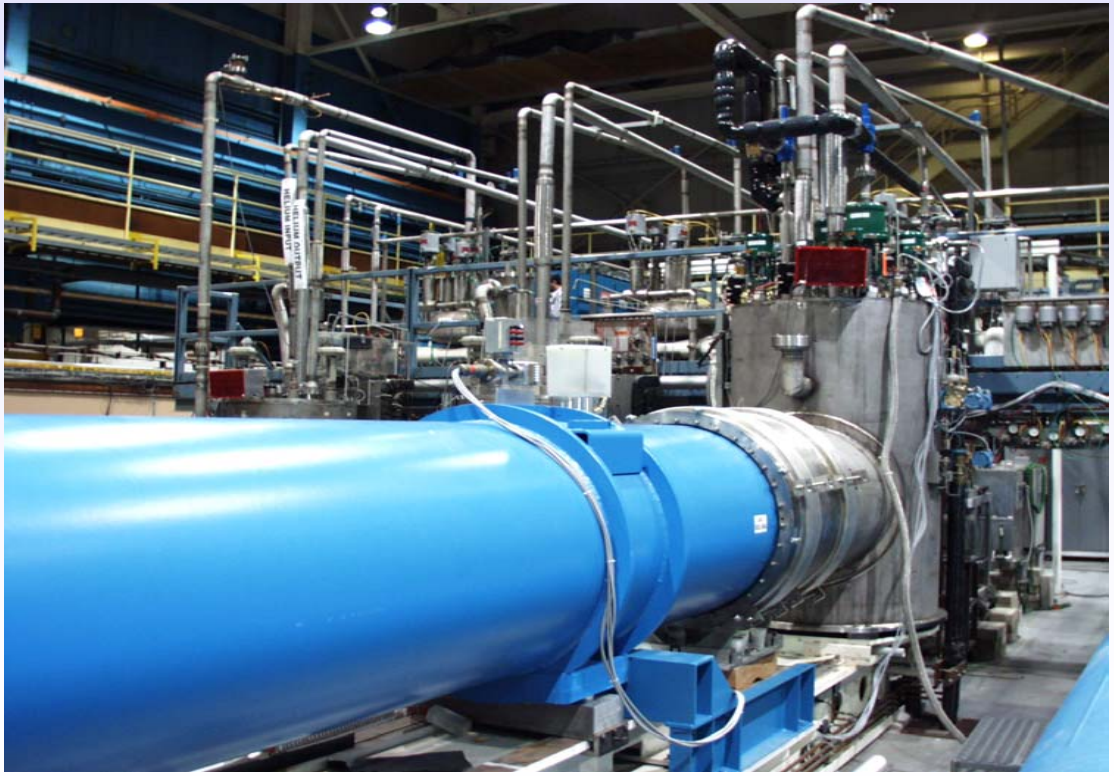
Magnet Testing – Cryogenic Systems

Horizontal Test Facility – MAG-COOL

Four horizontal test stands – Bays B-E

CTI Model 4000 Refrigerator can provide 70 g/s forced flow supercritical helium at 11 atm or liquid helium cooling



Previous tests have included:

- 15 m and 17m SSC arc dipoles
- 10m RHIC arc dipoles
- 4.5m RHIC arc CQS
- 10m LHC dual aperture dipoles

Test temperatures can be down to 3.5 K with peripheral precooler and subcooler pots and cold pump system.

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Magnet Testing – Cryogenic Systems

VERTICAL TEST DEWARS:

DEWAR #	DEPTH m	WIDTH cm	VOLUME L
2	6.1	60.96	1779
3	6.1	71.12	2422
4	2.68	60.96	753
5	2.74	60.96	801
6	2.68	60.96	786

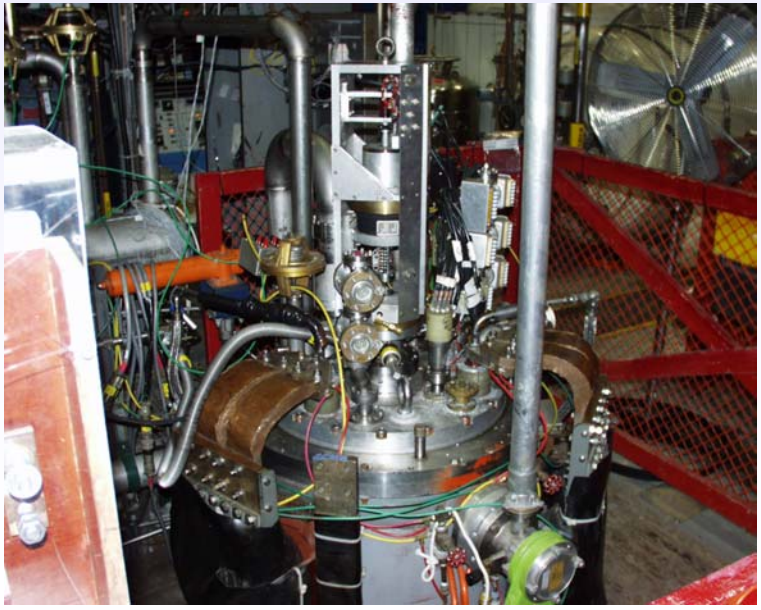
Present configurations:

Dewars 2 and 3: Magnet Testing

Dewar 3 is wider to accommodate larger magnets

Dewars 4 and 5: Cable Short Samples

Dewar 6: Common Coil type magnets (Nb3Sn and HTS)



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Magnet Testing – Power Supply Systems

- **10kA @ 50VDC** – Two 5 kA 12 Pulse Converter in parallel with an Energy Extraction System - used by Horizontal Test Facility (HTF).
- **8.5kA @30VDC** – 12 Pulse Converter – used by Vertical Test Facility (VTF).
- **25kA @ 24VDC** - Two 15 kA 6 Pulse Converters in parallel with an energy extraction system (presently configured for 15 kA) – used by Short Sample Test Facility (SSTF) for powering short cable samples.
- **8.5kA @ 30VDC** - 12 Pulse Converter (presently configured for 6.5 kA) - used by Short Sample Test Facility (SSTF) for powering back ground field magnets.
- **5kA @ 100VDC** - 12 Pulse Converter – Used for "Fast Ramp" magnet test in the VTF and for powering room temperature magnets.
- Dual Acme **5500A @ 125V** –Two 2 kA 6 Pulse Converters Configured in parallel through a phase shift transformer - Used for powering room temperature magnets.
- **Variety of smaller power supplies (bipolar and unipolar)**

Magnet Testing – Power Supply Systems

- All power supplies have precision current regulators with DCCT as the current sensing device.
- All power supplies are computer controlled.
- All power supplies have been modified or rebuilt by SMD personnel during the last 25 years.

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Magnet Testing – Data Acquisition and Control Systems

- Distributed computer system is used to control the magnet under test and to acquire magnet test data. This is a Windows based pc system that uses in house programming in Visual Basic for controls. Some systems also use HP Basic for Windows and Lab View.
- IEEE-488 interfaces are used for power supply and DAQ control.
- Fast data loggers are used to record magnet signals (Voltage Taps, P.S.), that occur during a magnet quench. Isolation amplifiers are used on the input to the loggers because of the high common mode voltage that develops during a magnet quench. There are 288 channels divided between the HTF and VTF.

  The fast loggers have 12 bit resolution, 5 kHz max. sampling rate, and 4096 sample length per channel.
- Slow data loggers are also used during magnet tests. These loggers use high precision relay scanners and Digital Multi-Meters to read these slow signals (Temperature Sensors, Strain Gauges, etc.) These loggers have 22 bit resolution and a scanning speed of 20 channels per second. There are 320 channels distributed between the HTF and VTF.

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Magnet Testing – Summary

- Even though the main compressors have been rebuilt within the past 15 years, the rest of the cryogenic plant is quite old (25 to 35 years). A large number of control valves need to be replaced.
- The controls for some of the simpler cryogenic systems are starting to be replaced, but the Mag-cool computer controls that are 25 years old, are in desperate need of being upgraded.
- Many of the large power supplies will need new controls because of lack of available obsolete spare parts. These controls were built over twenty years ago.
- The data acquisition devices are about 20 years old. They are obsolete and need to be replaced.
- The computer controls for the HTF and VTF were upgraded just three years ago and already some of the operating systems are no longer supported.
- **SMD uses a lot of resources to maintain cryogenic testing.**