MICE Coupling Coil Test System Cryogenics

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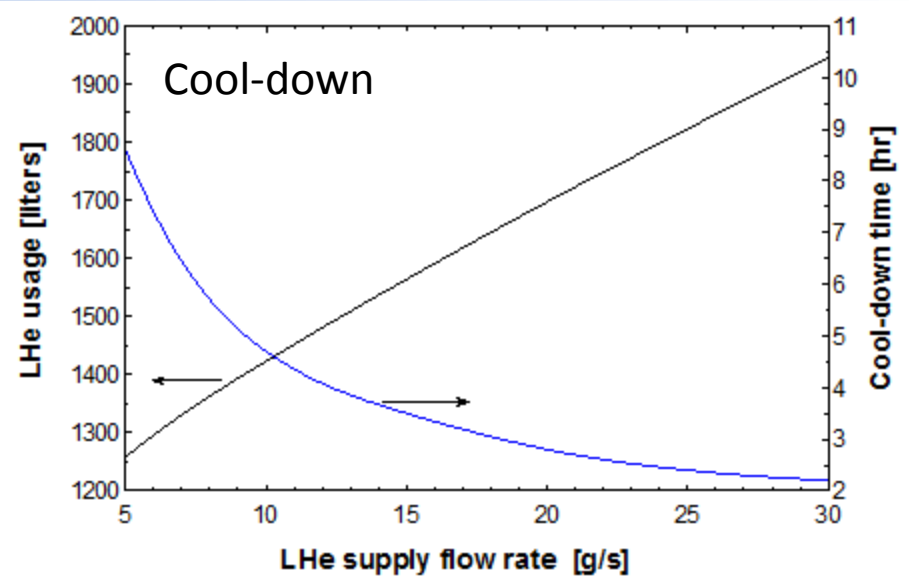
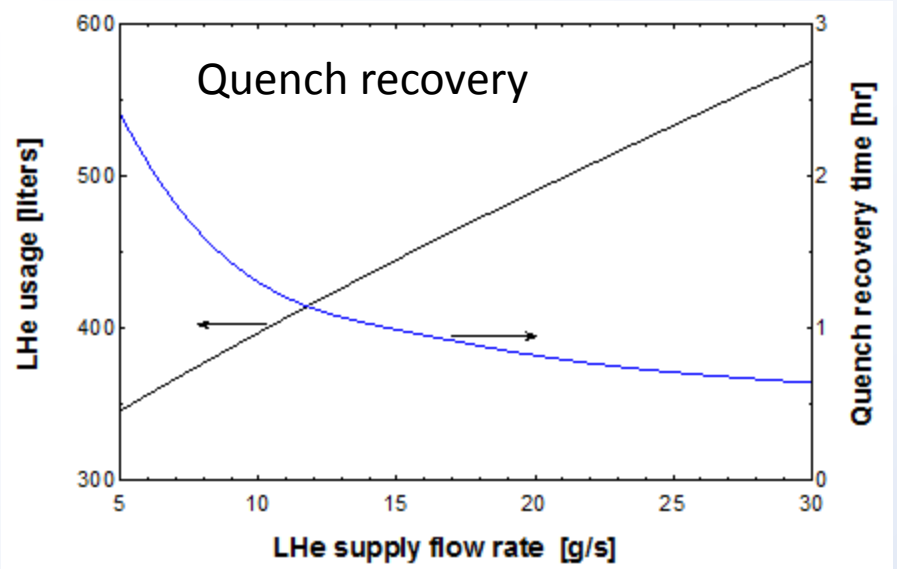
Cooling Method Selection

- Compared LHe usage and cooling time for 300-4.5 K cool-down time and quench recovery for bath cooling (with displacers to direct the boiloff) and conduction cooling for 5-30 g/s LHe flow rates.





Cooling Method Selection (cont'd)

- Conduction cooling offers significant advantages.

	Bath cooling with directed boil-off	Conduction cooling	Conduction cooling savings factor
Cool-down			
LHe usage (k-liters)	25-43	1.25-1.95	20-22
Hours	50-100	2-8.5	11.8-25
Quench recovery			
LHe usage (k-liters)	3.2-4.6	0.35-0.58	7.9-9.1
Hours	5-13	0.5-2.5	5.2-10

Cryogenic Requirements

- Cool-down and warm-up
  - Cool-down flow rate of 20 g/s with a specified ΔT between the measured magnet hot spot and the GHe supply
    - An unlimited ΔT_{max} cool-down requires ~3 hr and 1700 liquid liters LHe
    - A 40 K ΔT_{max} cool-down requires ~13 hr and 5100 liquid liters LHe, for example
    - What ΔT_{max} is allowable during cool-down and warm-up between 300 K and 80 K?

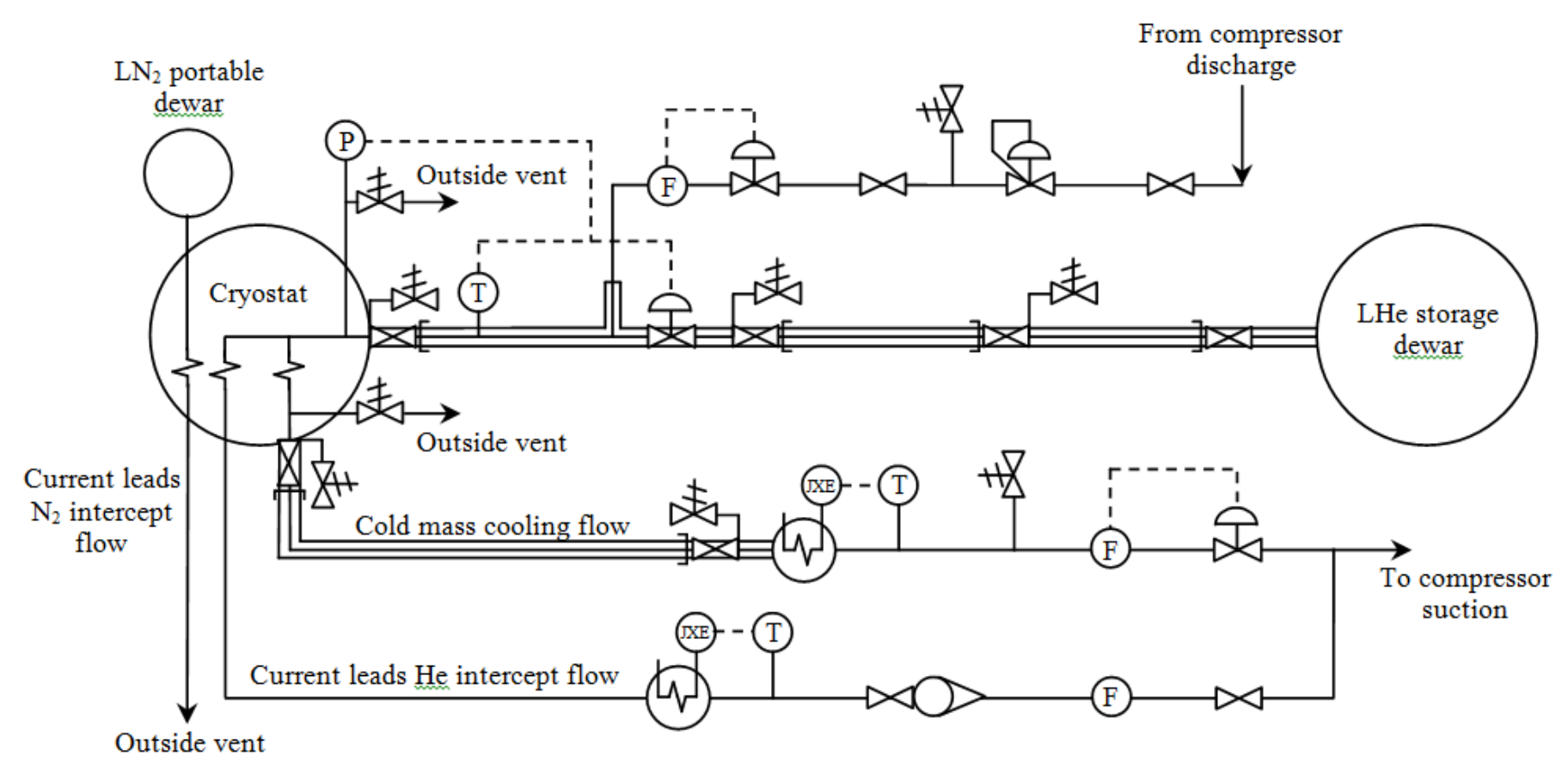
Cryogenic Requirements (cont'd)

- Quench recovery
  - Quench recovery flow rate of 20 g/s with no ΔT restriction below 80 K.
    - Calculated uniform temperature of 87 K after a quench with all stored energy dissipated in magnet coils.
    - Quench recovery with no ΔT restriction requires ~1 hr
    - Quench recovery with ΔT_{max} based on measured magnet hot spot might be expected to require 2-3 hr

Cryogenic Requirements (cont'd)

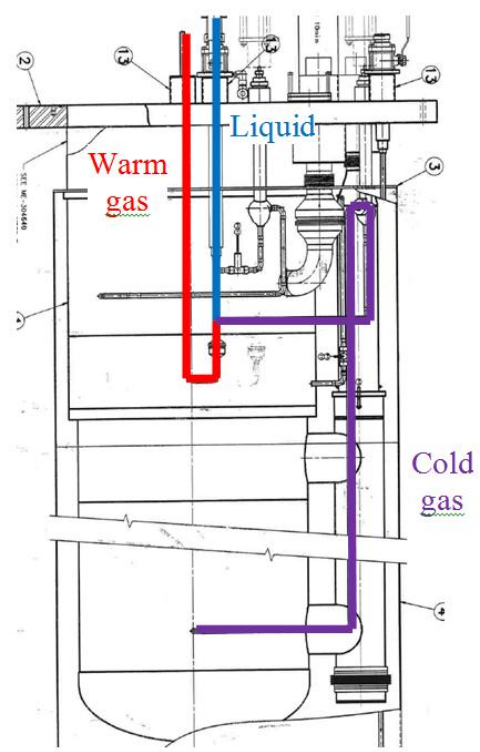
- Cold operations
  - Estimated static heat load (radiation from MLI-insulated vacuum vessel, conduction down magnet support structure) to magnet is 20-25 W.
  - Steady flow of 5 g/s provides plenty of margin for transfer line heat loads, current lead thermal intercepts, and heat load uncertainties. It is well below 22 g/s CHL liquefaction rate with one compressor and no LN_2 pre-cooling
  - Storage dewar operates at 10 psig (4.82 K), compressor suction operates at 1 psig (4.29 K) so a stable 4.5 K (4.2 psig) can be provided.

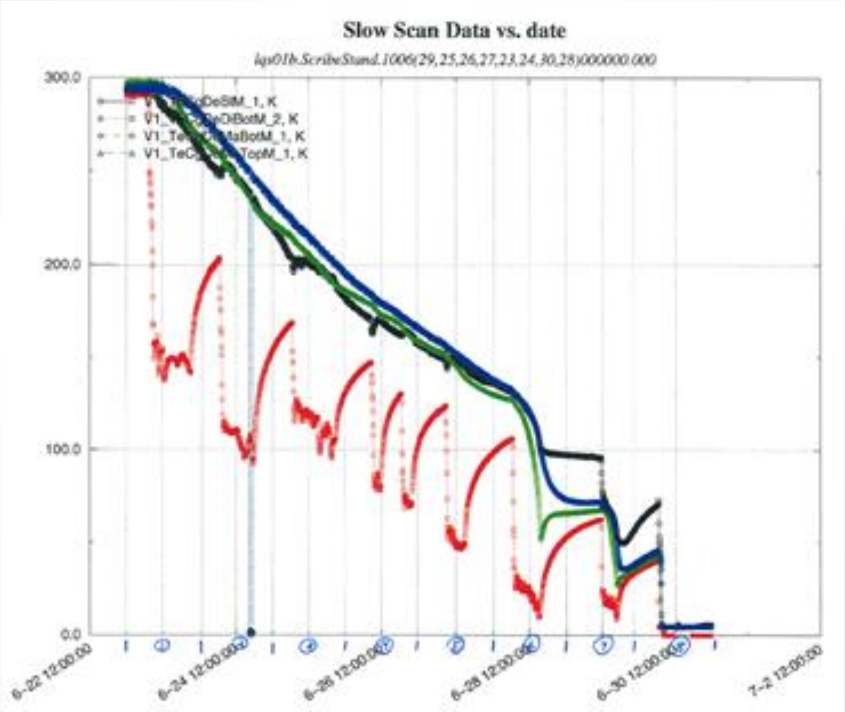
Cryogenic Process



Cryogenic Process (cont'd)

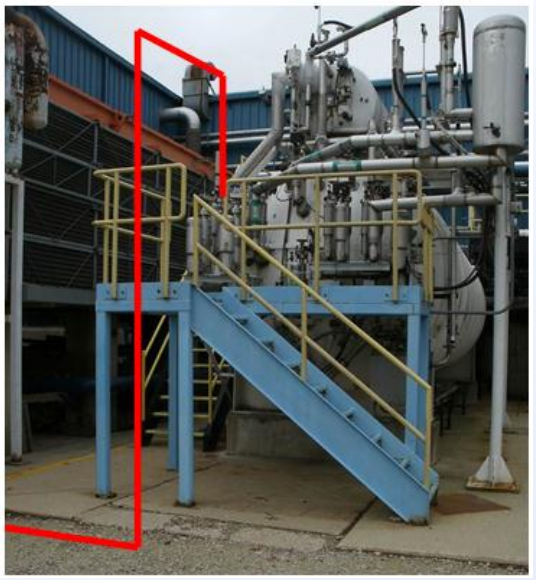
- A similar method of controlled cool-downs of large magnets have been accomplished in Fermilab's Vertical Magnet Test Facility (VMTF)





Cryogenic System Integration

- Series of bayoneted transfer line sections will connect the cryostat to the CHL 10kl LHe dewar (final layout TBD)



Cryogenic System Integration (cont'd)