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Refrigeration of Superconducting Solenoids

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MICE CM27



Introduction

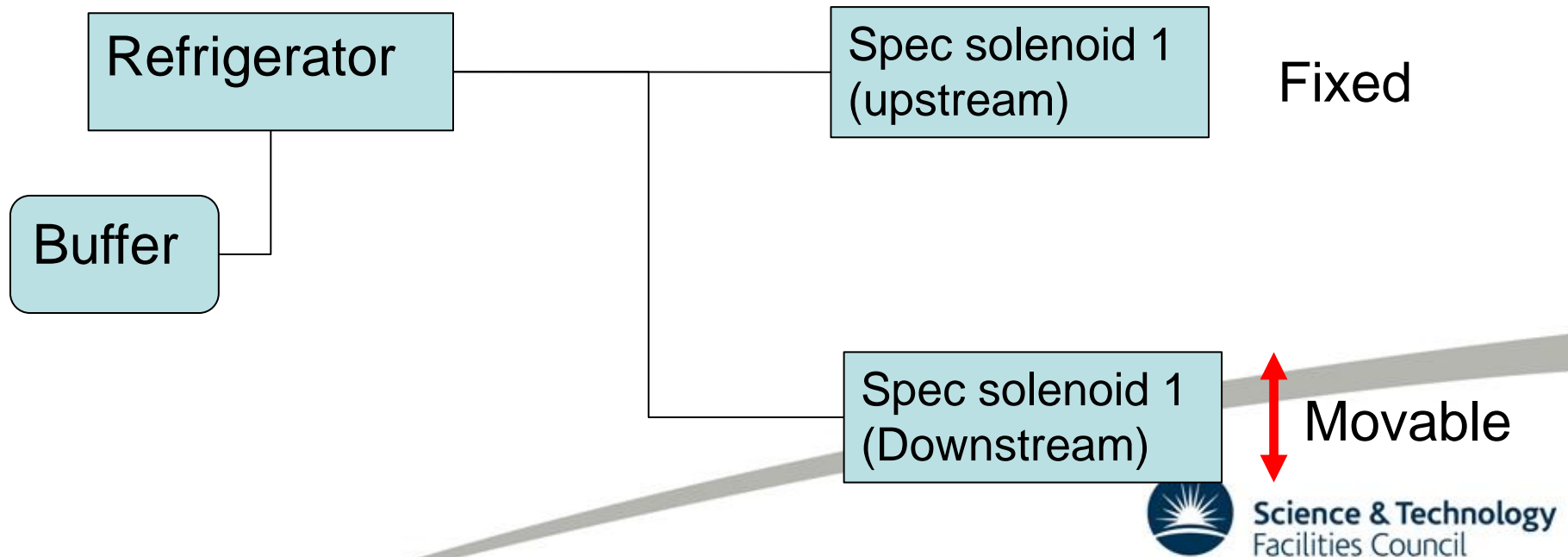
- Short discussion on what would be required to cool the existing spectrometer solenoids with an external cryogenic plant
- Magnet requirements:
 - 65K refrigeration for HTS leads
 - 4 K refrigeration for the cold mass



Elements

The need to provide refrigeration at 4K and 65K implies that a helium liquefier won't do unless:

- a) Enough boil-off to have vapour cooling of the leads and shields*
- b) Leave single stage cryocoolers in place*



Requirements

Gedanken experiment on refrigerating spectrometer solenoids

	Temp	Load
2 nd stage	4K	7.5W
1 st stage	65K	277 W

For each solenoid *

Temp	Magnets	Transfer Line	Total
4K	15	12 (??)	27W
65K	524	?	524+

To put a scale on this, the 27W is similar to the Decay Solenoid 23 W@4K 100W@65K (not including vapour cooled leads....

Transfer lines at 4K are around 1W/m (although I would take any arguments on this figure ..) lengths are guesses

Heat load from HTS leads high
1st stage heat load high
2nd Stage heat load high

* From M Green note 292

Magnet modifications

Need to accommodate a bath in the turret with level sensor

Heater etc..

(suspect that this could be accommodated in the existing turret – although turret would have to be re-designed)

Current lead cooling would have to be addressed



MICE – old Slide

Cryocooler Option

Coil	Heat load at 4K	Coolers	Cost k£
Coupler A	1.6	1	25
Coupler B	1.6	1	25
Focus magnets A	1.7	2	50
Focus magnet B	1.7	2	50
Focus magnets C	1.7	2	50
Detector Magnet A	1.4	4	100
Detector Magnet B	1.4	4	100
Detectors		4	100
Totals	11.1	20	500
Refrigerator			324
Grand total			824

Refrigerator Option

Item	Cost k£
TCF50	782
Compressor Building	300
Control dewar	10
Valve box	20
Transfer lines	20
Installation	80
Grand total	1212

Refrigeration system - key points

- a) Staging of MICE will mean that we will have large cryogenic plant standing idle for long periods.
- b) Cost - there will be a large cost associated with the purchase of the cryogenic system.
- c) Testing - If cryocoolers are used then each of the MICE "modules" can be tested independently and verified before shipping to RAL for integration.
- d) Design - The cryocoolers can provide intermediate stages of cooling at low temperatures e.g. a three stage cooler could provide 3.8K, 14K and 90K. Can use high T_c current leads to minimise heat loads. These low intermediate temperatures reduce 4K heat load in many designs



Summary

- *Jumping ship and changing to the use of a liquefier will open up new cans of worms*
- *Cost likely to be of the order £700k + significant hall re-engineering e.g. Transfer line installation, space for liquefier, power in the hall etc...*
- *Best to sort out what you've got rather than invent new problems.....*





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