Series Test Facility for FAIR.

Cryogenic Infrastructure & Configuration.

Hildenbeutel J.

Tucson, June 30th, 2015

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Content.

Content.

Plant design.
Requirements.

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Refrigeration System

Flexible system for test facility to perform the acceptance test for the SIS100 dipole magnets

- Subcooled Helium at 4.5 K and 1.8 bar.a
- Shield cooling between 50 K to 80 K
- Liquefaction at constant level

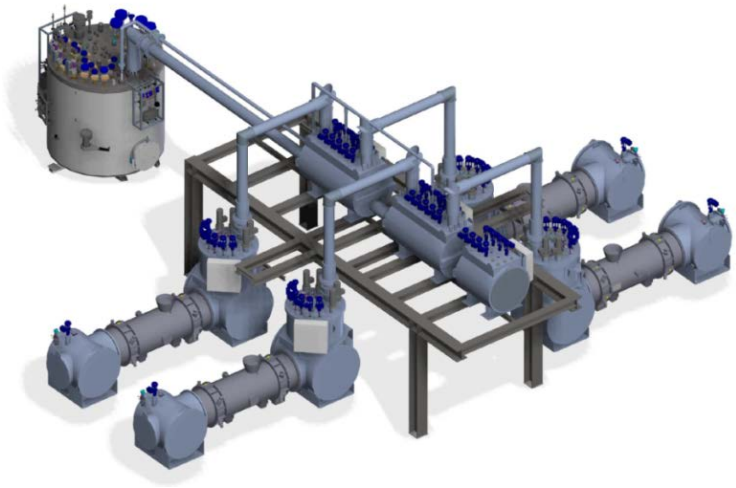
Test benches

Different operating modes and test scenarios

- Transient operation
- Frequent magnet exchange
- Recovery system

General

- Automatic load adaptation
- Delivery time



Plant design.
Challenges and solutions – System setup.

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Coldbox setup

Use of standardized modules ensures compact and cost efficient design

— Double bed adsorber

— Phase seperator and subcooler

— Cold gas return

— Shield cooling

Test bench setup

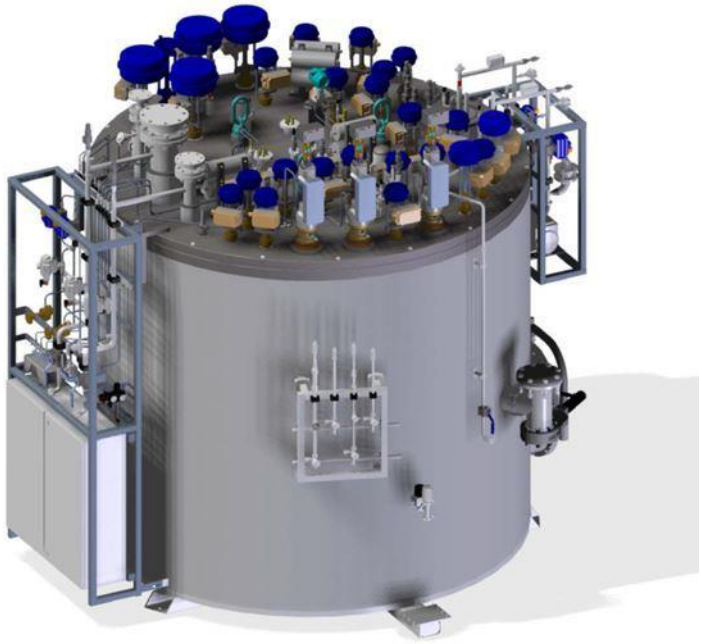
Customized distribution system, test benches and recovery system

— Two valveboxes

— Four feedboxes

— One string test box

— Recovery system with double bed dryer



Plant design.
Challenges and solutions – Transient operation.

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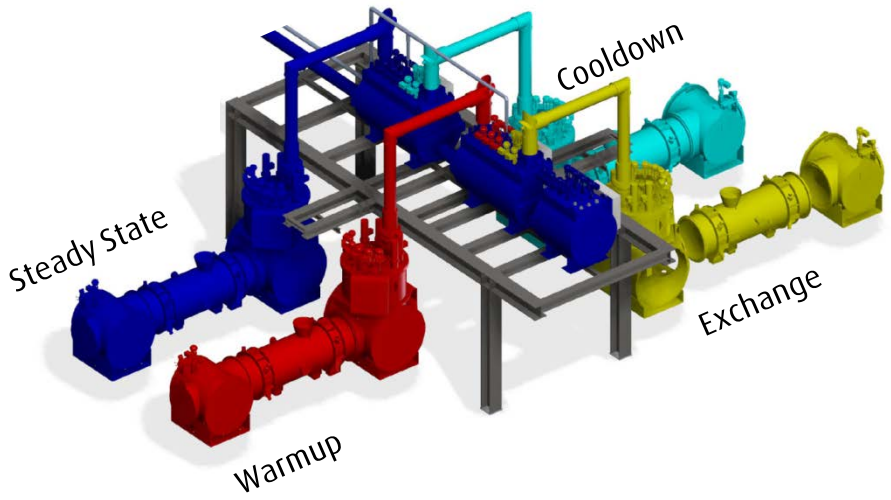
Transient operation of test benches

— Different operating modes - Throughput of one magnet per week

— Main transferline and valvebox system which can be kept at operating temperature forms the core of the test bench

— Cold gas return to handle transient operation like cooldown, warmup and quench



Plant design.
Challenges and solutions – Magnet exchange.

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Warmup

— Isolation of test bench by closing valves in valvebox

— Warmup of isolated system via purge panel

Isolation of magnet by closing valves in feedbox

— Reduction of contamination

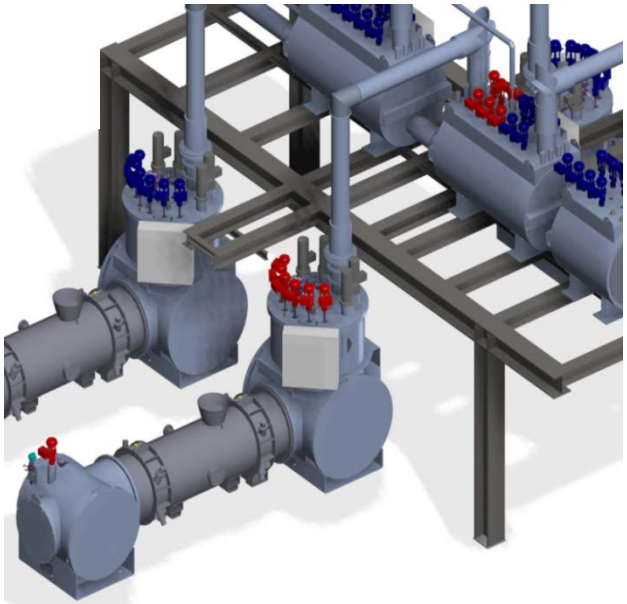
— Avoid condensation due to valve arrangement

Magnet exchange

— Rail system for easy access (by GSI)

Cleanup prior to cooldown

— Separate purge panels for each feedbox



Plant design.
Challenges and solutions – Quench gas recovery.

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Recovery system

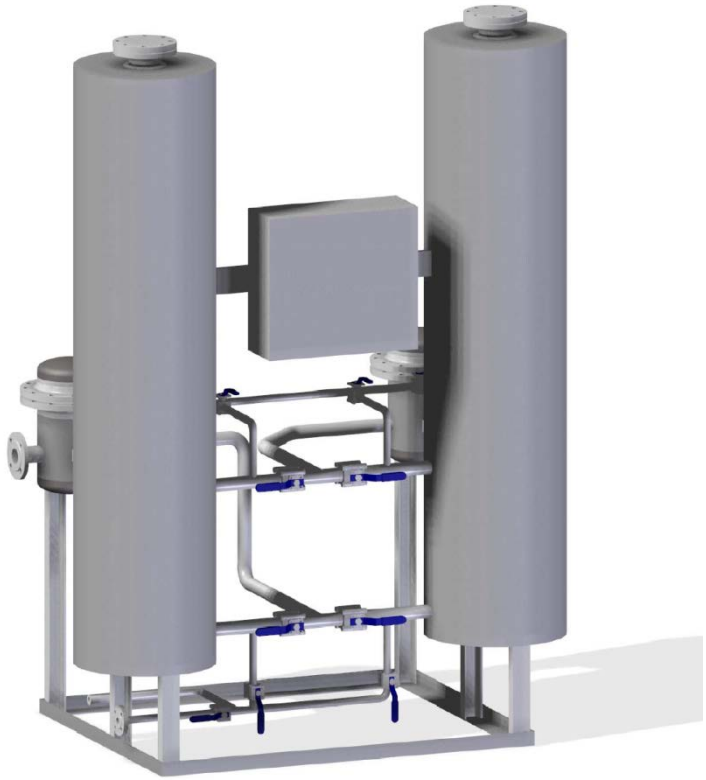
— Cold gas return

— Ambient heater

— Impure storage system (buffer)

— Double bed dryer

Transient operation and magnet quench shall not influence the operation of the refrigeration system



Plant design.
Challenges and solutions – Load adaption.

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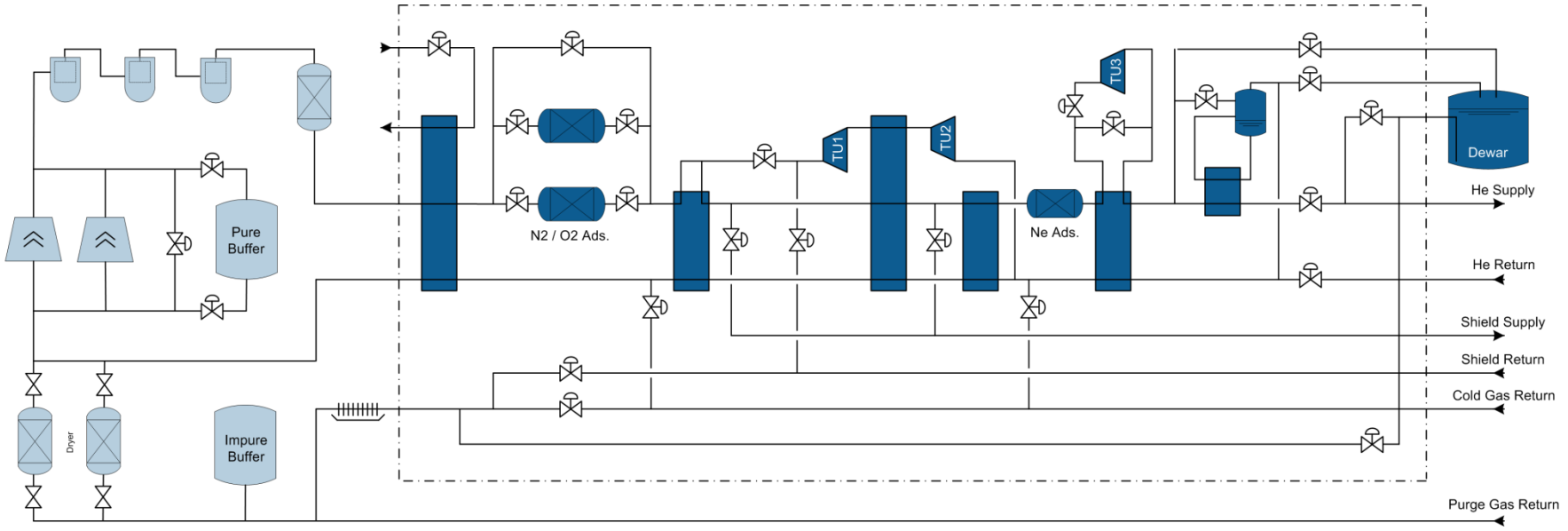
Automatic load adaptation

Huge operating range between peak capacity and standby operation of single test benches.

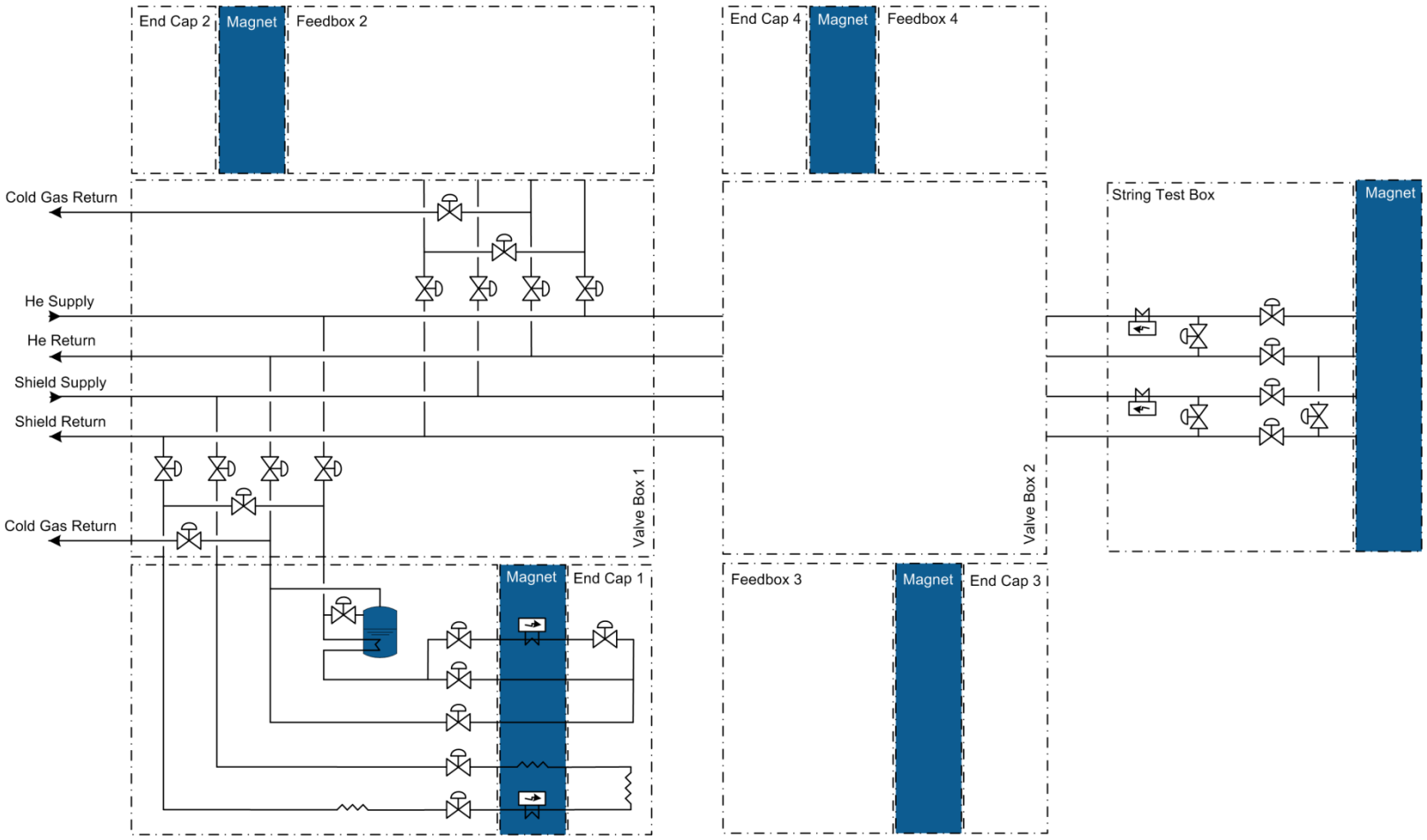
Warm System	Compressor	Frequency converter High pressure adaptation
Cold System	Coldbox	JT-Turbine with bypass
	LHe Dewar	Compensation of overcapacity
	Distribution system	Bypass flows and heaters

Content.

Process flow diagram.
Coldbox.



Process flow diagram.
Distribution system.



Content.

Performance data.

Plant Performance	Guaranteed	Measured	Surplus
Cooling power @ 4.5 K	700 W	778 W	+11.1 %
Cooling Power @ 50 K - 75 K	2000 W	2030 W	+1.5 %
Liquefaction @ constant level	6.0 g/s	6.0 g/s	± 0.0 %
Equivalent overall capacity @ 4.5	1500W	1580 W	+5.3 %

Utilities	
Maximal electrical power consumption	434 kW
LN2 consumption per 1 W @ 4.5 K	< 0.1 l/h

Content.

Summary.

Linde Kryotechnik AG has successfully designed, supplied and commissioned a dipole magnet test facility for FAIR.

Equipment

— Combination of standardized modules and customized solutions

— Compact and cost efficient design

Flexible operation

— Compressor with frequency converter

— JT-Turbine with bypass

— LHe storage dewar

— Heaters for load compensation

— Four independent test benches and one string test bench

Design for high availability

— Redundant line dryers and 80 K adsorbers

— Maintenance free dynamic gas bearing turbines

Thank you for your attention.

Special thanks to the Contributors:
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