Cryogenic Testing of Fast Ramping Superconducting Magnets for the SIS100 Synchrotron

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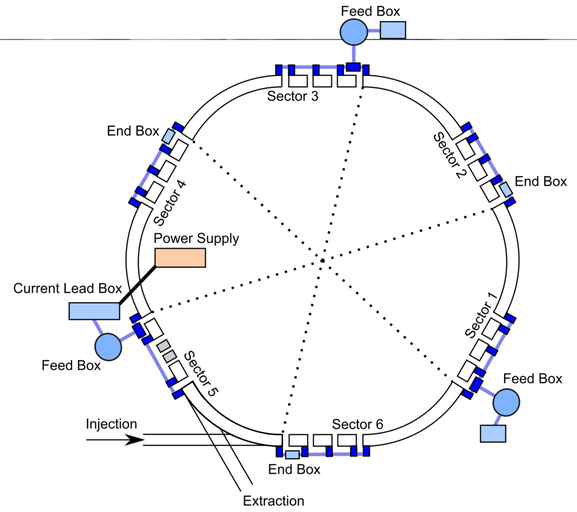
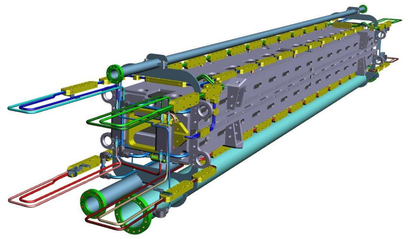
Abstract. The international Facility for Antiproton and Ion Research FAIR is currently under construction at GSI, in Darmstadt, Germany. The core component of FAIR, the superconducting SIS100 synchrotron will operate with a high repetition rate of up to 1 Hz. The SIS100 ring with a circumference of 1083 m contains 108 main dipole magnets with a maximal field of 1.9 T. The ion-optical lattice of SIS100 contains also 166 main quadrupoles and 137 corrector magnets. The quadrupole and corrector magnets are assembled in the quadrupole units which are pair-wise integrated in the quadrupole doublet modules. All superconducting magnets will be tested at helium temperature to assure their compliancy with the specification. The main dipole modules are being tested at the magnet test facility at GSI. Cold testing of the quadrupole doublet modules is split in the testing of the quadrupole units at JINR, Russia and in testing of fully assembled quadrupole doublet modules at INFN, Italy. The cold testing program includes dynamic AC loss measurements and hydraulic adjustment of the parallel cooling channels of SIS100 next to the training, magnetic field measurements and other tests. We present the scope of cold testing of different types of magnet modules as well as the test results

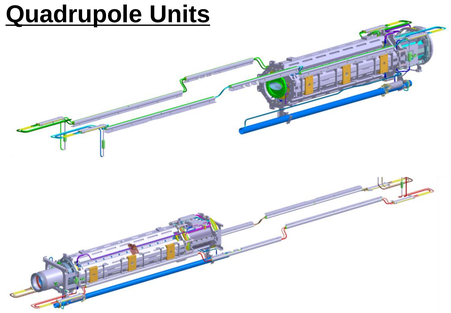


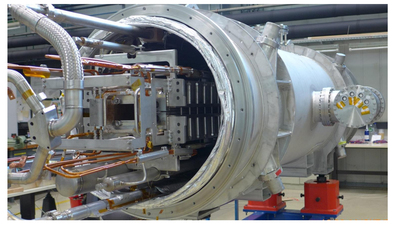
	main dipole	main quad	chrom. sextupole	steerer (hor./vert.)	nested multipole (quad/sext./oct.)
number of magnets	108	166	42	83	12
maximal current, kA	13.2	10.5	0.25	0.25	0.25
ramp time to max, s	0.5	0.5	0.175	0.2	0.175

Cryogenic Dipole Module

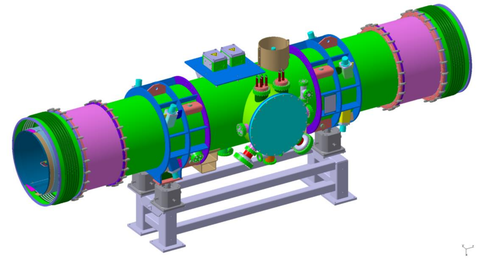


Quadrupole Units

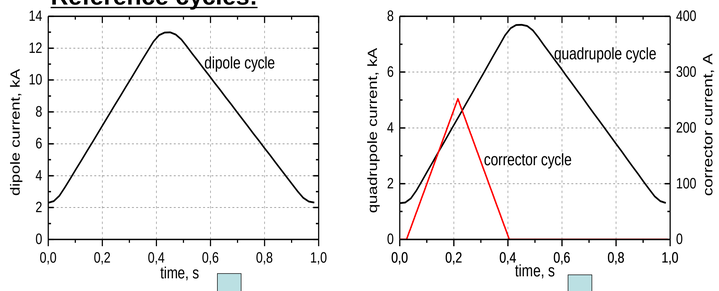




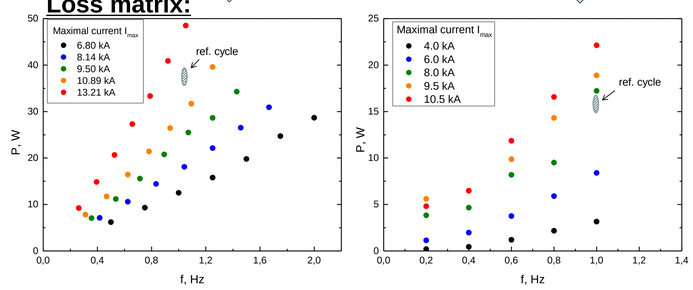
Quadrupole Doublet Module



Reference cycles:



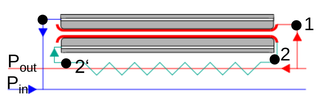
Loss matrix:



Measured heat load for dipole modules for 1 Hz reference cycle:

static:	5.1 W ± 0.3 W (stat.)
dynamic (calorimetric)	34,4 W ± 0.5 W (stat.)
dynamic (VI method)	34.7 ± 0.3 W (stat.)
estimated systematic error:	about 10%

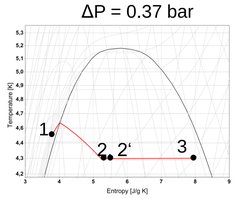
Cooling concept:



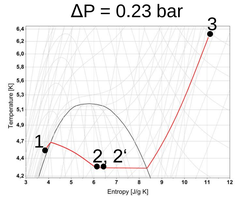
point 1: – sub-cooled helium
P_{in} = 1.5 – 1.8 bar, T_{in} = 4.5 K
P_{out} = 1.25 bar
static heat load : 5 W
dynamic heat load: up to 35 W

Dipole magnet without flow impedance:

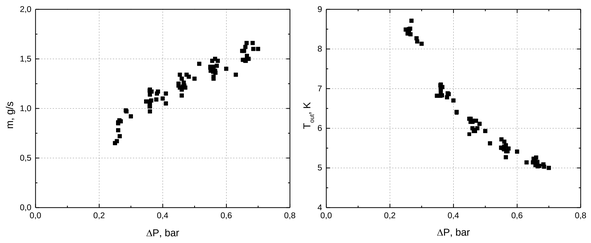
ΔP = 0.37 bar



ΔP = 0.23 bar



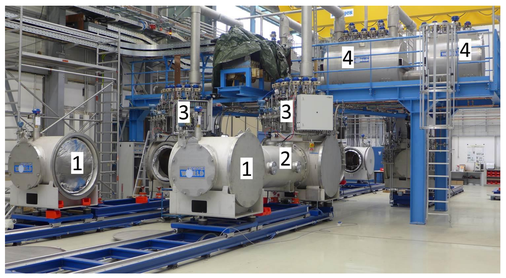
With capillary tube on inlet Di = 2.0 mm, L = 3.5 m:



Acknowledgment - The authors would like to thank colleagues of GSI who contributes to the testing of series dipole magnets. Authors acknowledge the collaboration partners from JINR to afford the tests of SIS100 series quadrupole units.

Conclusions -Site Acceptance Tests of SIS100 magnets are executed at three magnet test facilities, at GSI, JINR and INFN. Presently about 50% of dipole magnets are successfully tested and accepted. All tested dipoles fulfil the specified values for the magnetic field quality and show a good reproducibility with respect to the hydraulic behaviour and heat load. Two pre-series quadrupole units have been tested at JINR and accepted. Testing of pre-series doublet at GSI and testing of series quadrupole units at JINR is in preparation as well as testing of series doublets at INFN.

Series Test Facility STF, GSI



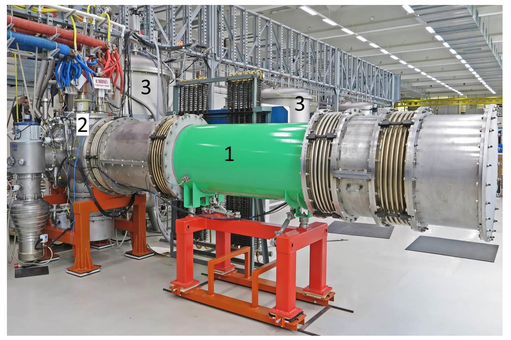
GSI Testing Facility for SIS100 series dipoles

1. End Boxes, 2. Universal Cryostat,
3. Feed boxes, 4. distribution boxes.

Infrastructure:

Cryo plant with a cooling power of 1.5 kW
Two 20 kA power converters
14 kA HTS Current Leads
Four test benches (two benches per cluster)

FAIR / GSI Test Facility, JINR



JINR / FAIR Test Facility for SIS100 quadrupole units and for the magnets for the NICA-Project

1. Testing cryostat, 2. Feed Box,
3. Satellite helium refrigerators.

Infrastructure:

Cryogenic system based on satellite helium refrigerators
Two 15 kA power converters, 12 kA DC HTS Current Leads
six test benches (two benches per cluster)