



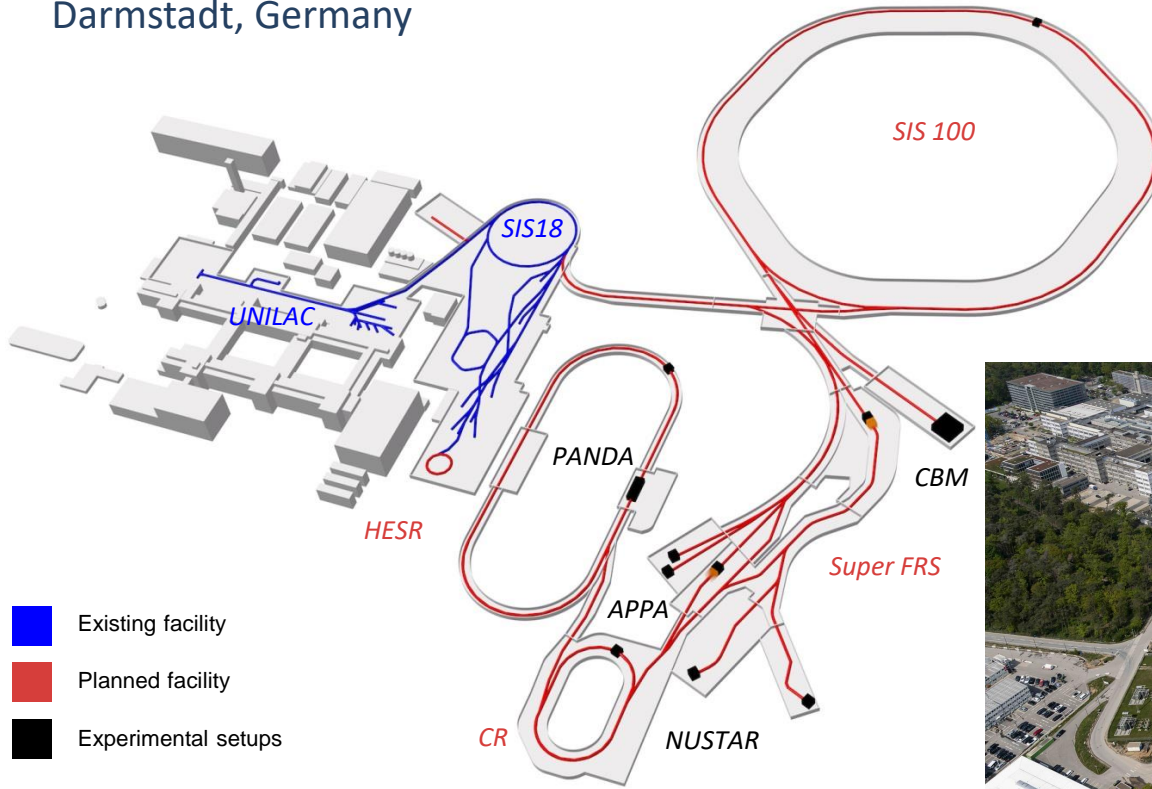
Test Facility for Superconducting Devices @GSI

Superconducting Magnet Workshop, LASA, Milan, 17th of November, 2022

Christian Roux → Anna Szwangruber

FAIR – superconducting magnet's point of view

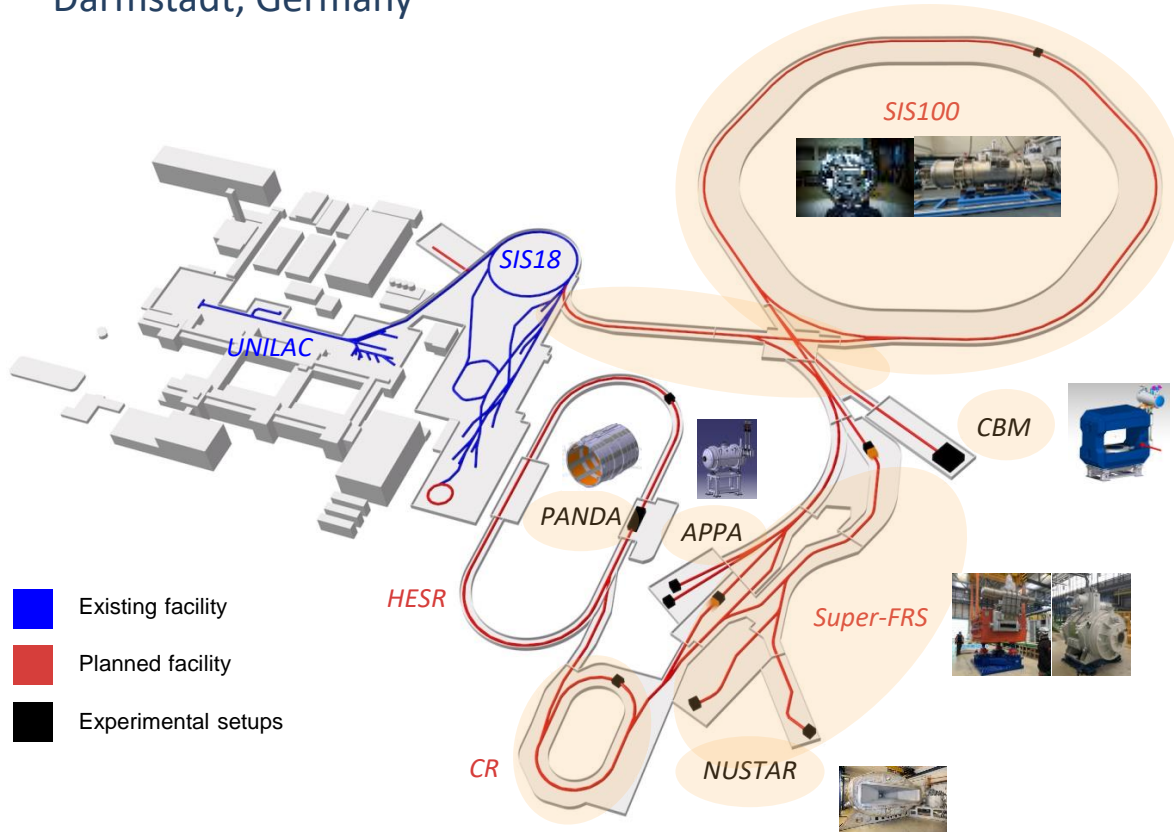
Darmstadt, Germany



Current construction status of FAIR facility

FAIR – superconducting magnet's point of view

Darmstadt, Germany



- Existing facility
- Planned facility
- Experimental setups

SIS100 – 427 sc magnets

- 108 dipoles
- 83 quadrupole doublets

Super-FRS – 194 sc magnets

- 24 dipoles
- 33 multiplets with up to 9 magnets

experimental setups

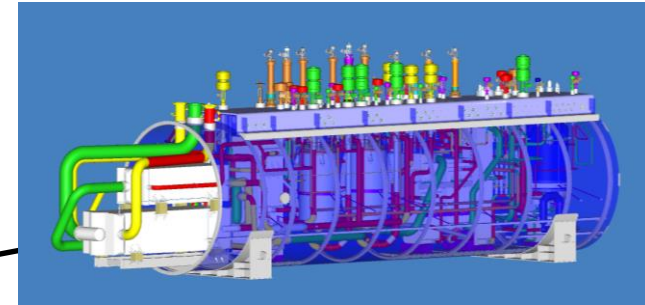
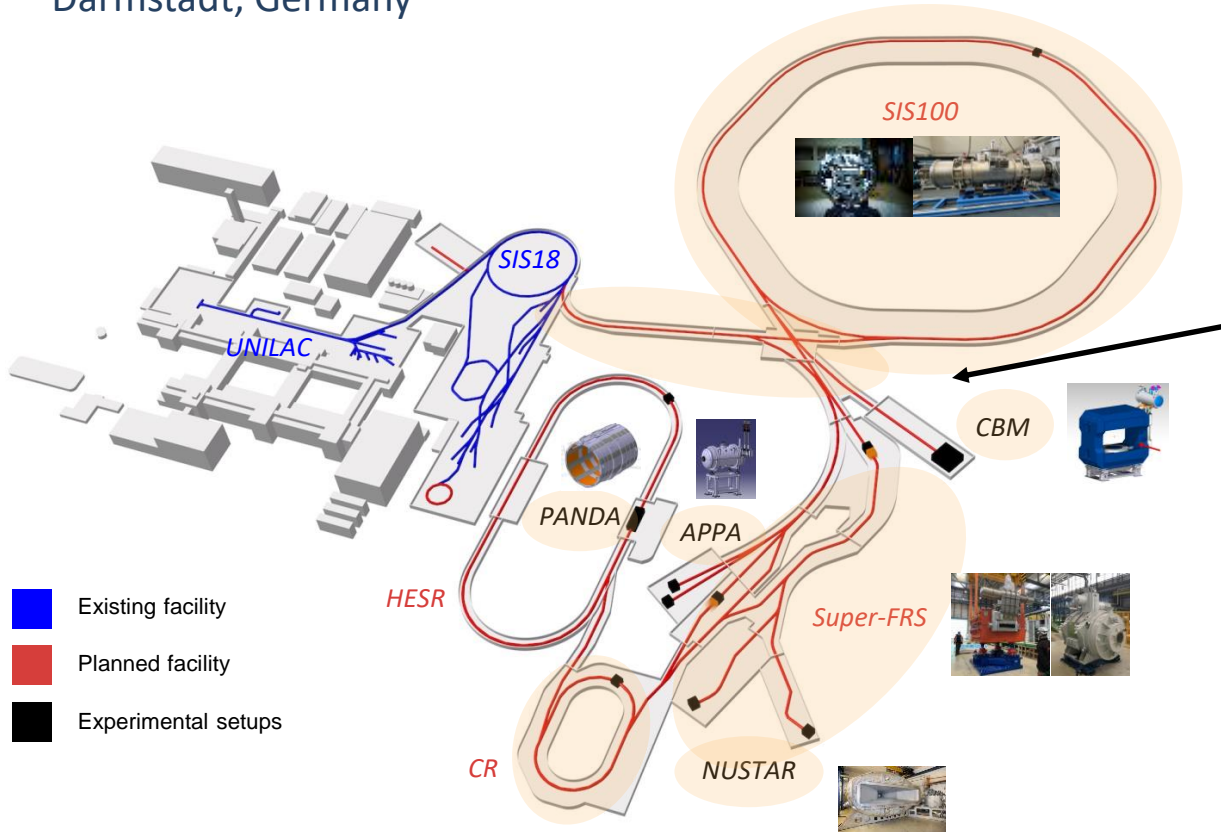
CBM, APPA, PANDA, NUSTAR

under consideration

- collector ring (CR)
- beam lines (SIS18 – SIS100)

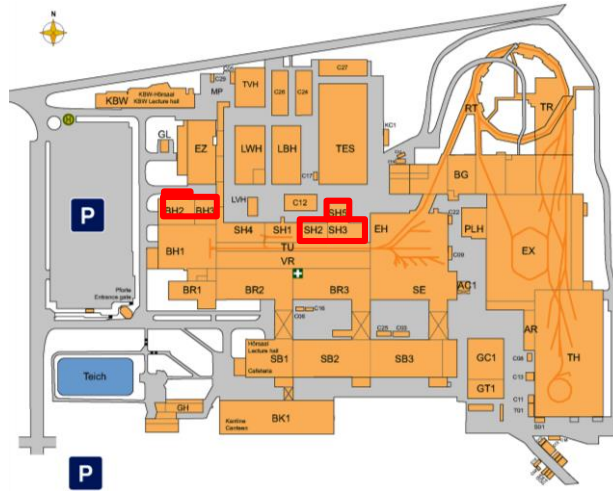
FAIR – superconducting magnet's point of view

Darmstadt, Germany



Cold Box FAIR (SIS100 & Super-FRS)

- 9 turbines: 8 MW
- 50 kW @50 K
- 14 kW @4 K



Prototype Test Facility (PTF)

- one magnet test bench
- one universal cryostat
- annex building: compressors and transformer



Serial Test Facility (STF)

- four magnet test benches
- annex building: compressors, transformer, power supply
- 1.000 m³ Helium storage @300 K

Specs

Cooling power @4.5 K	300 W
He liquefaction rate	2 g/s
Max. power consumption	250 kW
Helium inventory (warm)	300 m ³
Power converter	20 kA
Quench detection	KIT
Area	150 m ²



Testing of sc prototypes, long term powering tests on series components

Serial Test Facility - STF

Specs

Cooling power @4.5 K	700 W
Cooling power @50 K	2000 W
He liquefaction rate	6 g/s
Max. power consumption	434 kW
Helium inventory (warm)	1000 m ³
Power converters	20 kA (66V)
Quench detection system	KIT
Area	687 m ²



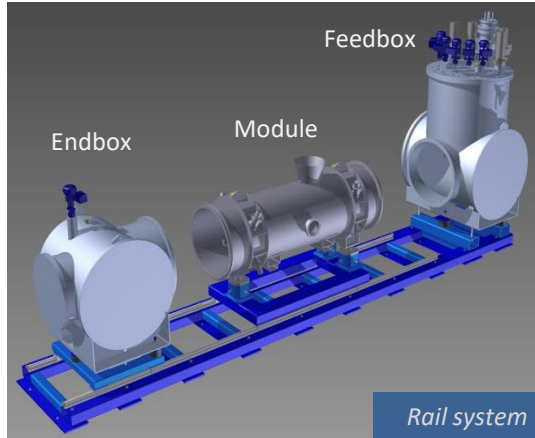
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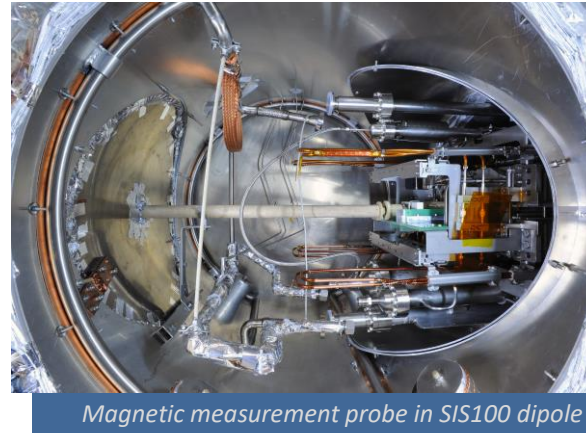


- Testing of series cryo magnetic modules, local-cryo components and main current leads for SIS100
- Super-FRS local- cryo



Test bench:

- rail system
- easy mounting of the module to the feed and end box
- good access to hydraulical and electrical connections
- module positioning:
 ± 0.1 mm horizontal, ± 1 mrad



Electrical setup – Power supply & Current Leads

High Current and
Fast Ramped
Power Supplies

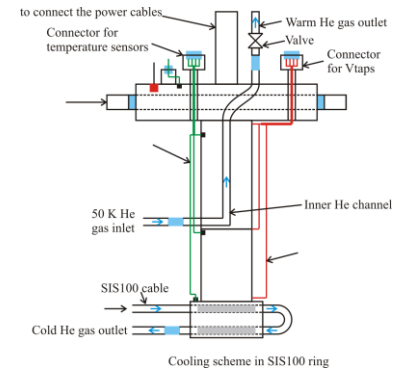
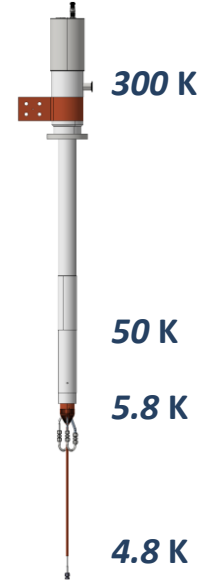


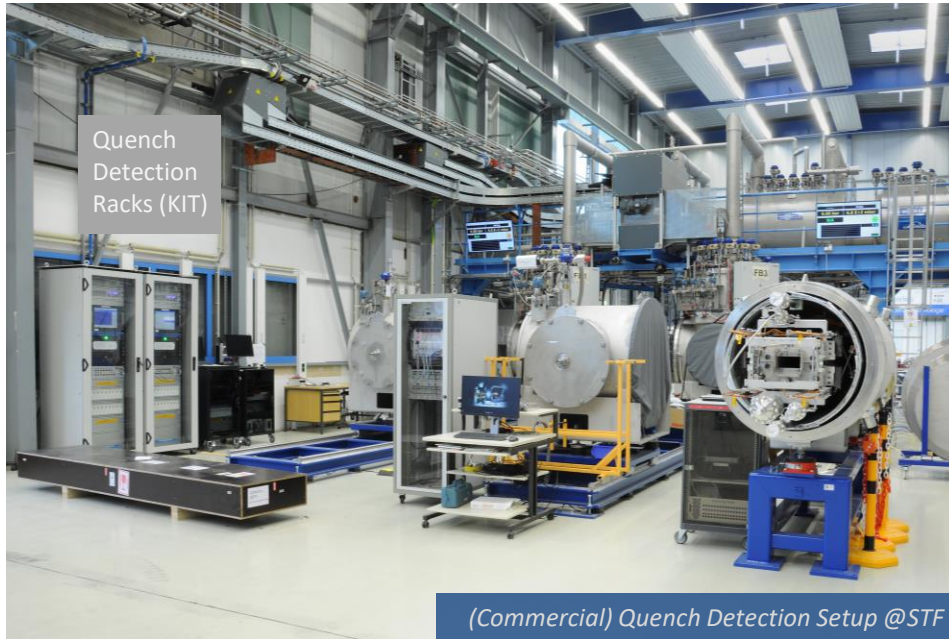
Specs

Max. Load Current	20 kA
Max. Load Voltage	66 V
Max. current ramping rate	30 kA/s
Cycle Frequency	1 Hz



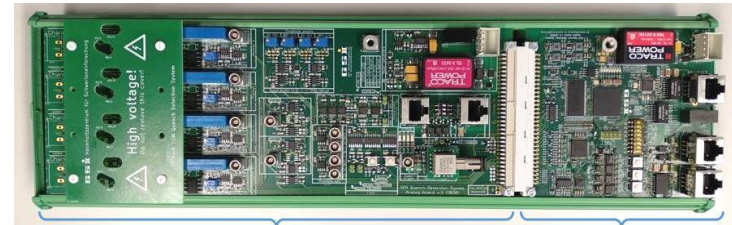
14 kA DC
Current
Leads (HTS)





In house development

- Analog input (bridges), digital processing (FPGA)
- Few analog variants: magnets, busbars, current leads etc.
- Specs:
 - 100 mV quench signal on 100 V inductive base
 - 10 ms validation time



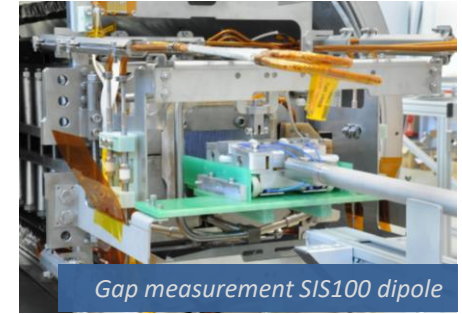
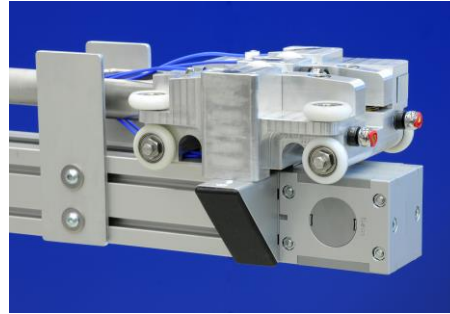
QuD-A

QuD-D

Quench Detection Unit

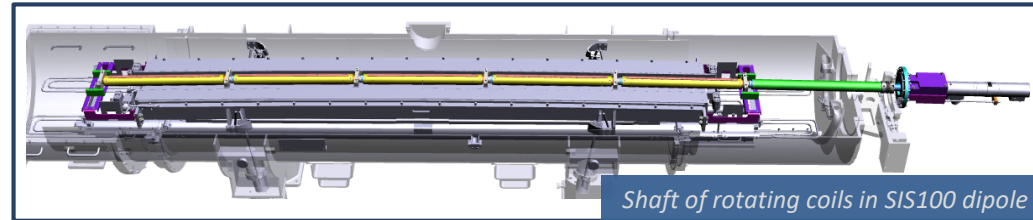
High precision gap height measurements

- capacitive sensors
- absolute precision $15\mu\text{m}$
- relative precision $< \pm 3\mu\text{m}$



Magnetic field measurements

- shaft of rotating coils
- field measurements in vacuum @4K
- calibration bench



Electrical measurements

- turn to turn insulation
- HV-, LV- test

Series testing @STF: SIS100 dipoles

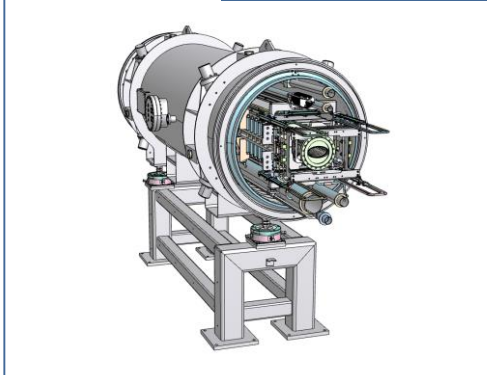
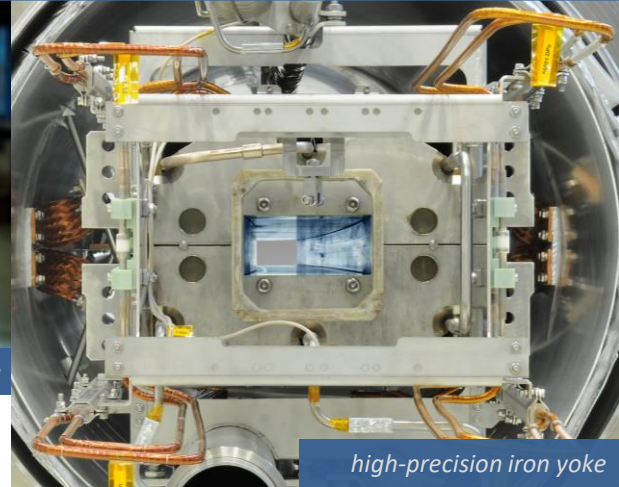
SIS100 dipole

design	<ul style="list-style-type: none">• <i>superferric, Nuclotron cable</i>• <i>forced-flow two phase cooling</i>• <i>fast ramped</i>
dimensions	<ul style="list-style-type: none">• <i>aperture: $h = 68$ mm</i>• <i>effective length $L = 3.062$ m</i>• <i>3 t</i>
field	<i>1.9 T with 4 T/s</i>
current	<i>13.2 kA</i>

spent effort

- up to 50 SATs/year
- ~ 100 steps/SAT
- ~ 30 parameters/SAT including field measurement @4 K

110 modules tested in time



Series testing @STF: SIS100 dipoles

SIS100 dipole

design

- *superferric, Nuclotron cable*
- *forced-flow two phase cooling*
- *fast ramped*

dimensions

- *aperture: $h = 68$ mm*
- *effective length $L = 3.062$ m*
- *3 t*

field

1.9 T with 4 T/s

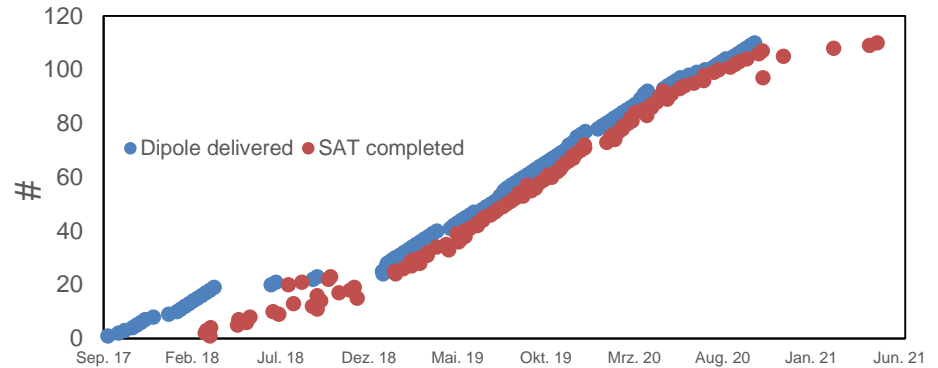
current

13.2 kA

spent effort

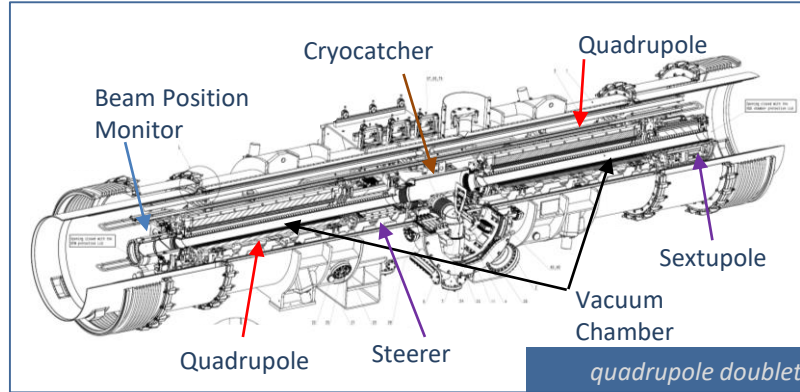
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SIS100 Quadrupole Doublets

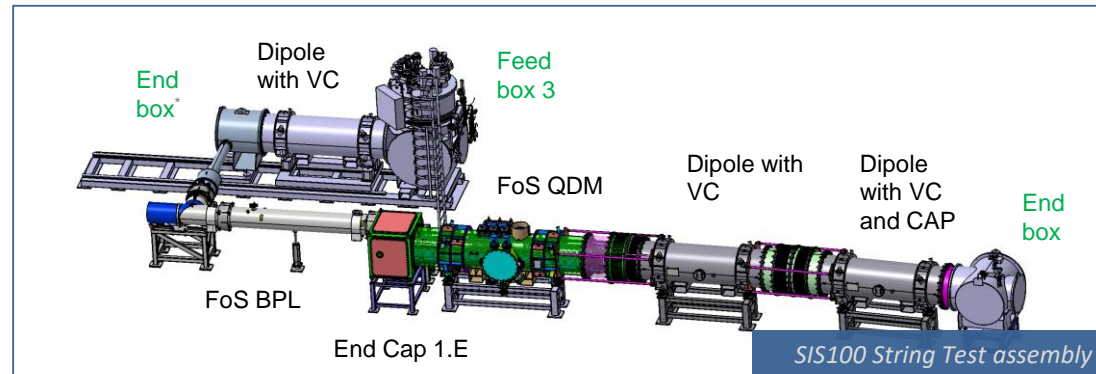
- at least first of each type (11)
- standard tests
- systematic studies on:
 - position stability of the cold mass
 - electrical insulation



SIS100 String Test

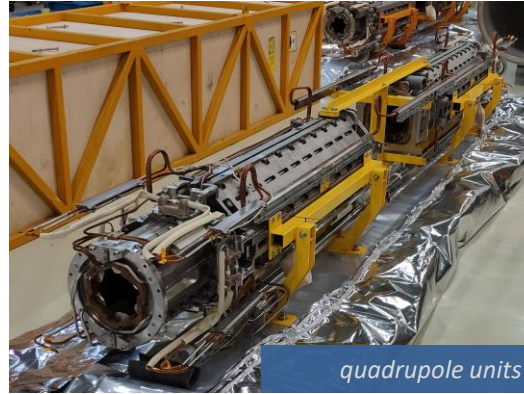
assembly representing a one cell of SIS100

- collective studies on mechanic, cryogenic, electric, UHV etc.
- evaluation of the QD, local-cryo and power converter controls



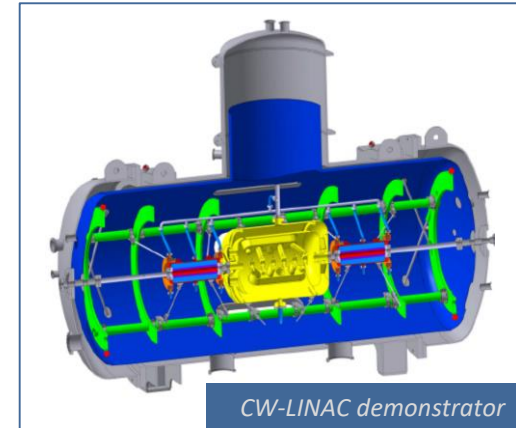
Upcoming:

- Quadrupole Units for SIS100
- Feed and Current Lead boxes for SIS100
- Local-Cryo components for Super-FRS



Long Term:

- Testing on demand
- Supply of CW linac: utilization of SC solenoids in LINAC setup



thank you very much