



# FAIR Magnet Testing

\*K. Sugita, A. Mierau, A. Bleile / GSI

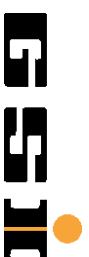
S. Kostromin / JINR

U. Gambardella / INFN Salerno

L. Van Den Boogaard / CERN



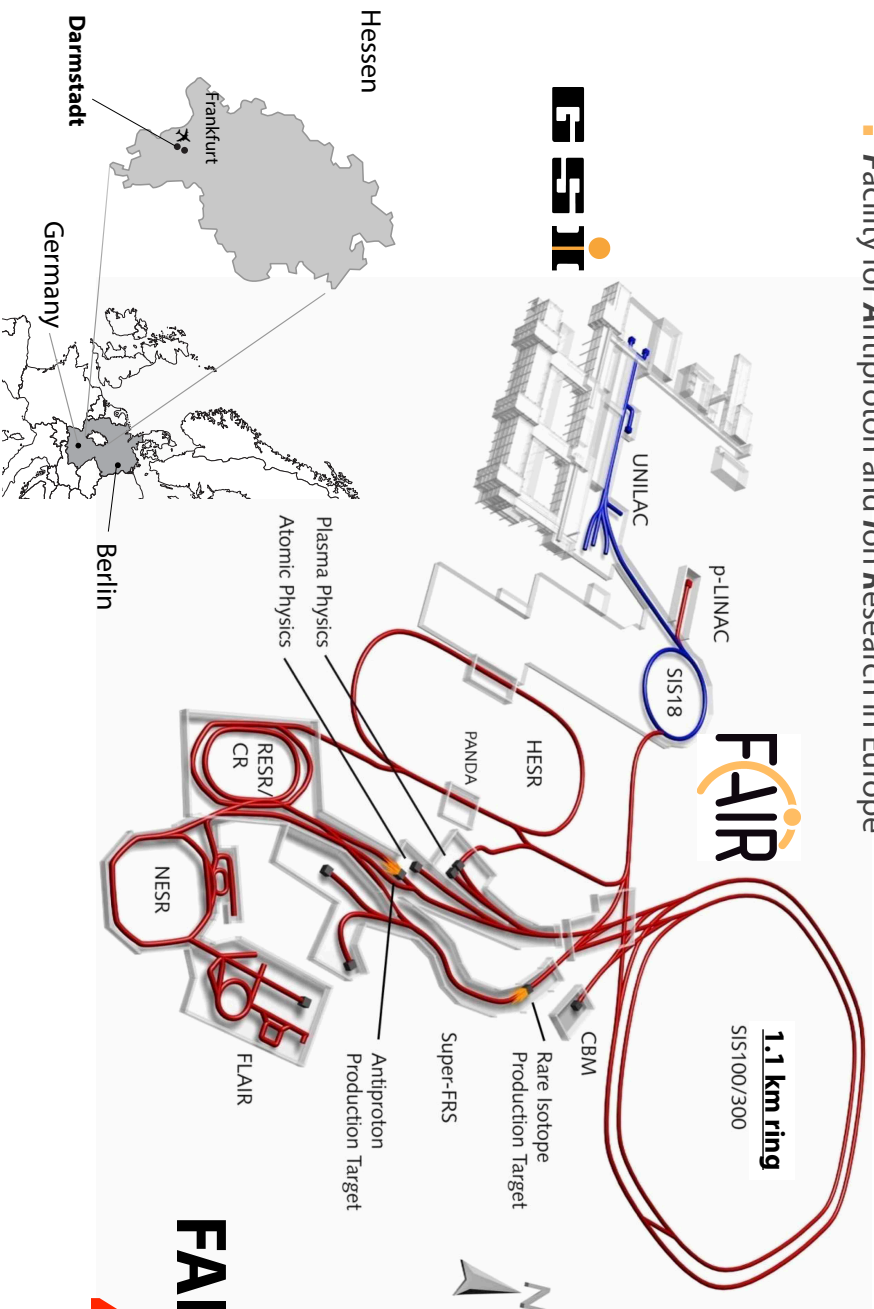
# FAIR Project and Sc Magnet Testing



Gruppo Collegato di Salerno  
Sezione di Napoli  
Istituto Nazionale di Fisica Nucleare



- FAIR
  - Facility for Antiproton and Ion Research in Europe



## Superconducting magnets & testing

### Heavy ion synchrotron SIS100

**GSI** 108 Dipoles

**JINR** 166 Quadrupole Units

**INFN/Uni. Salerno**

81 Quadrupole Doublet Modules

### Super Fragment Separator (Super-FRS)

**CERN** 24 Dipoles and 33 Multiplets

**FAIR magnets will be tested at**  
**4 cryogenic test facilities**

# GSI: SIS100 Dipole Magnets



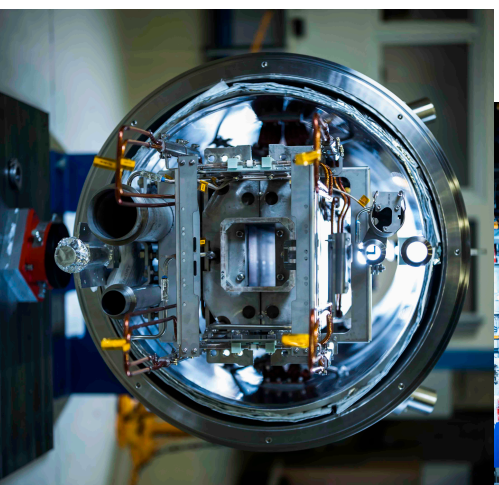
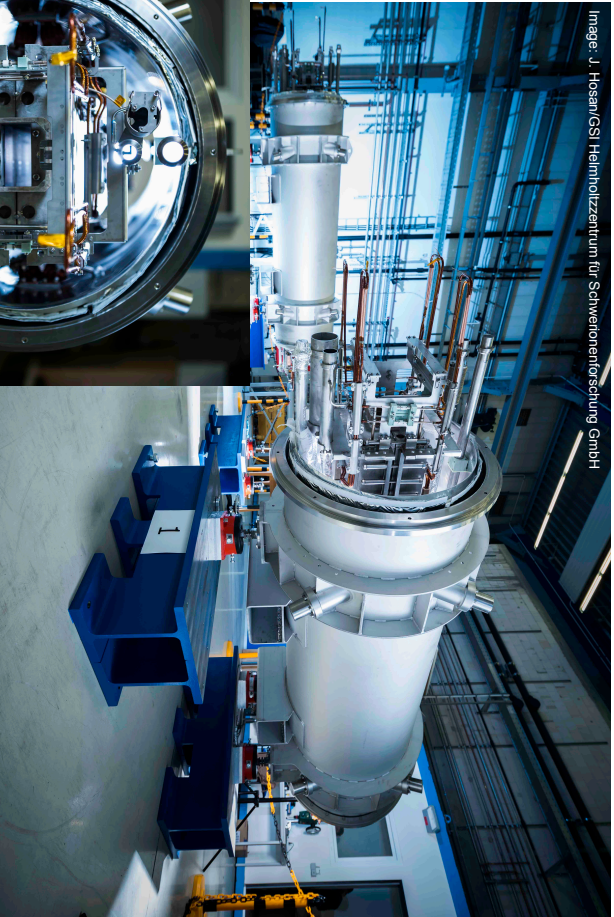
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- Superferric, fast ramped magnet

- Series Test Facility (STF)

Image: U. Hosan, GSI Helmholtzzentrum für Schwerionenforschung GmbH



110 magnets to be tested  
Length: 4.3 m incl. busbars  
Weight: 3.5 ton  
13.2 kA, 27 kA/sec.

The cooling capacity is  
1.5kW equivalent



Test program:

- Electrical integrity, leak tightness
- Instrumentation (temperature sensors, helium heaters) tests
- Magnet training
- Power test (ramping) and AC loss measurements
- Helium mass flow rate measurements and hydraulic adjustment
- Geometrical measurements
- Magnetic measurements (integral field, harmonics at DC, AC)

## JINR: SIS100 Quadrupole Units



- Quadrupole plus corrector magnets
- JINR Test Facility (for FAIR and NICA)



166 quadrupole units to be tested, 17 configurations.  
Length: 5.2 m incl. bus bars.  
Weight: 1 ton

- Test program:
- Electrical integrity, leak tightness
  - Instrumentation tests
  - Magnet training
  - Power test (ramping) and AC loss measurements
  - Helium mass flow rate measurements and hydraulic adjustment
  - Magnetic measurements (integral field, harmonics, axis position)

# Salerno: Quadrupole Doublets



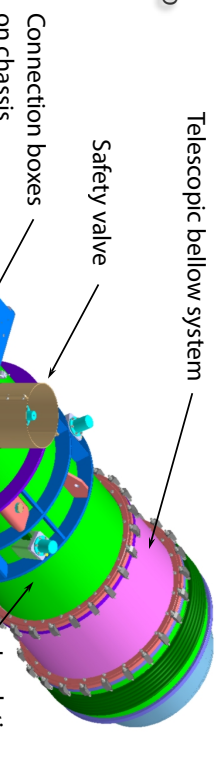
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## Integrated modules

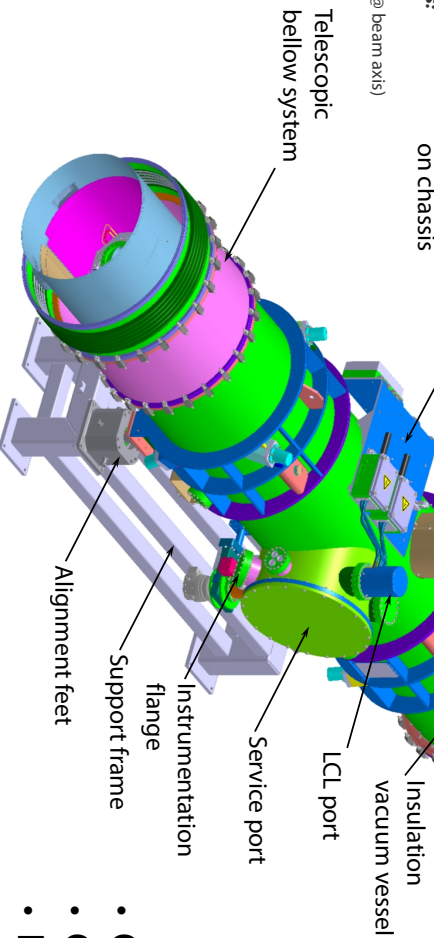
Tested units (JINR) is integrated into doublet module (in Germany) and transported to Salerno, Italy.

- Arc section QDM, type 2.9D
- Complete ODM including alignment feet and support frame



**Main dimensions:**  
 $l_{max} \approx 6110 \text{ mm}$   
 $h = 1400 \text{ mm}$  (@ beam axis)  
 $h_{max} \approx 2100 \text{ mm}$   
 $w_{max} \approx 1280 \text{ mm}$

**Weight:**  
 $m_{total} \approx 6220 \text{ kg}$



All arc and straight modules, but the special ones (total 81 QDM) Test program is under discussion.

## Salerno Cryogenic Facility



- Operating temperature and phases: 4.5K He at 3-7 bar
- Cooling capacity: 16 g/s 7 bar 4.5 K, 1.5 g/s 4.5K for leads, 17 g/s 60 K
- Power converter: 2 x 10 kA +25/-20 V (series/parallel operation)
- One feed box with HTS 20 kA current leads
- Quality control/measurement system: to be implemented

## CERN: Super-FRS Magnets



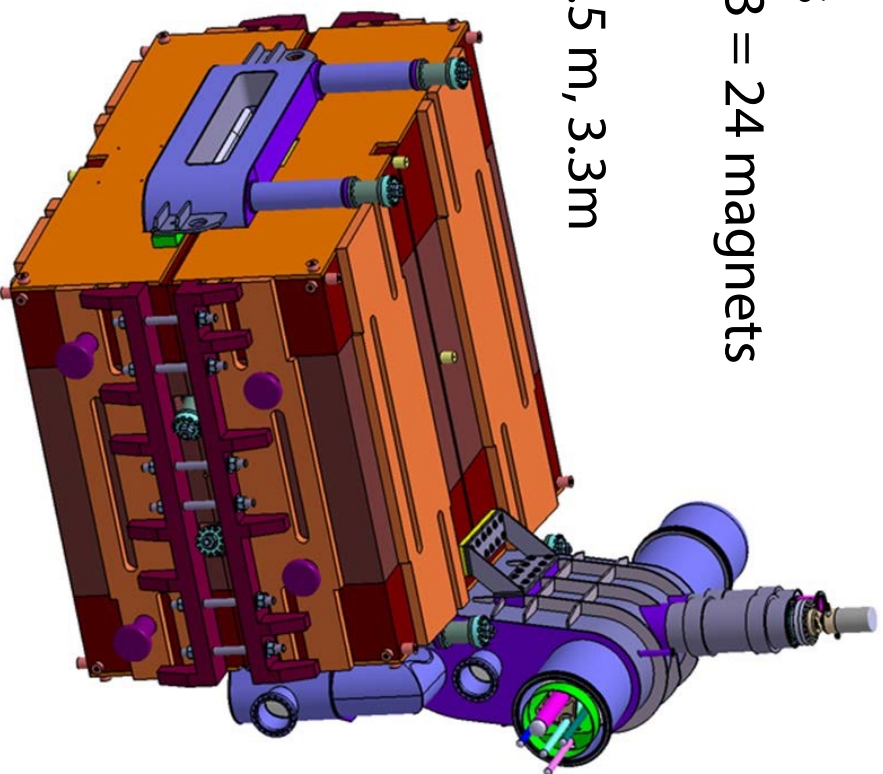
- Dipoles

3 types

18+3+3 = 24 magnets

3.2 m, 2.5 m, 3.3m

50 ton

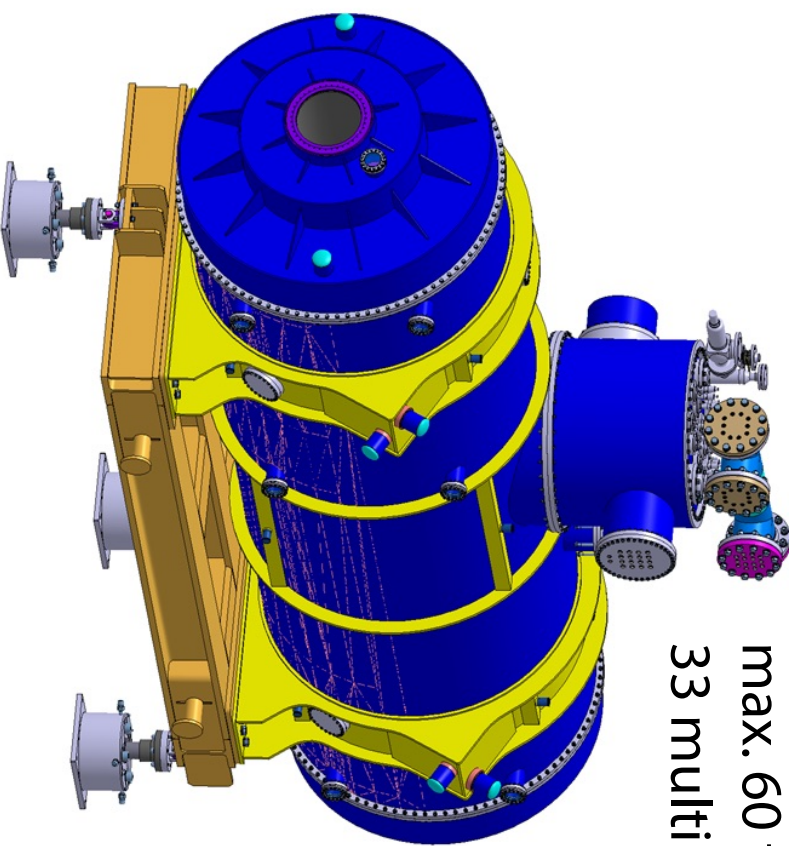


- Multiplets

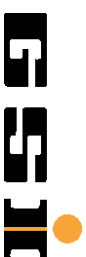
7m, 2.7 m, 4.3 m

max. 60 ton

33 multiplets



# CERN: Super-FRS Magnets



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- CERN Building 180

CERN-GSI collaboration since 2012.

**Table:** Summary of the main performance of the test facility cryogenic system.

Functionality / device	Performance
Cooldown 293 K – 90 K / CWU1	9 kW cooling power, 50 g/s at 10 bar
Cooldown 293 K – 90 K / CWU2	15 kW cooling power, 50 g/s at 10 bar
LHe dewar capacity	5 m <sup>3</sup>
Refrigeration/liquefaction	1.2 kW at 4,5 K, 5,6 g/s liquefaction
Thermal screen cooling	1 kW, 60 K – 70 K
Warm-up 90 K – 293 K / CWU1 & 2	15 kW heating, 50 g/s at 10 bar



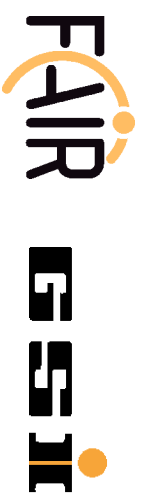
## Test program:

- Electrical integrity, leak tightness
- Tests of instrumentation
- Cryogenic tests (current lead heater control, static heat load)
- Magnetic measurements (integral field, harmonics, axis position, mapping)

	Magnets	Project Leader	Status	Project End	Remarks
<b>GSI</b>	SIS100 Dipoles	A. Mierau	Series testing is ongoing.	2021	2 shifts foreseen in near future
<b>JINR</b>	SIS100 Quadrupole units	S. Kostromin A. Bleile	First units test is successfully done.	2021	In parallel, NICA magnet testing
<b>Salerno</b>	SIS100 Quadrupole modules	U. Gambardella A. Bleile (interim)	In preparation.	2021	Waiting a contract on the testing.
<b>CERN</b>	Super-FRS Dipoles and Multiplets	L. Van Den Boogaard K. Sugita	Commissioning. Pre-series magnet testing starts in summer 2018.	2023	Collaboration agreement for operation phase signed in Jan. 2018.

**International collaboration on magnet testing is a key challenge for the successful FAIR Project!**

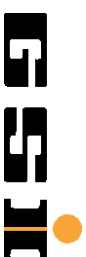




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**Thank you very much for your attention!**



## References

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