Infrastructure for test and material characterization at IFJ PAN

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on behalf of Division of Scientific Equipment and Infrastructure Construction

Test stand for voltage-current characterization of superconductors

- ☑ Agreement between IFJ PAN and OXFORD Instruments for delivery of equipment for voltage-current characterization of superconductors concluded on 22.03.2021

Milestones achieved

- ☑ Technical documentation (PDR): 22.12.2021
- ☑ Delivery of the equipment 22.09.2022
- ☑ Commissioning and final installation 22.11.2022

OXFORD INSTRUMENTS


OXFORD INSTRUMENTS

SO 70137
IFJ-PAN Special 16 T magnet system
Preliminary design review (PDR)

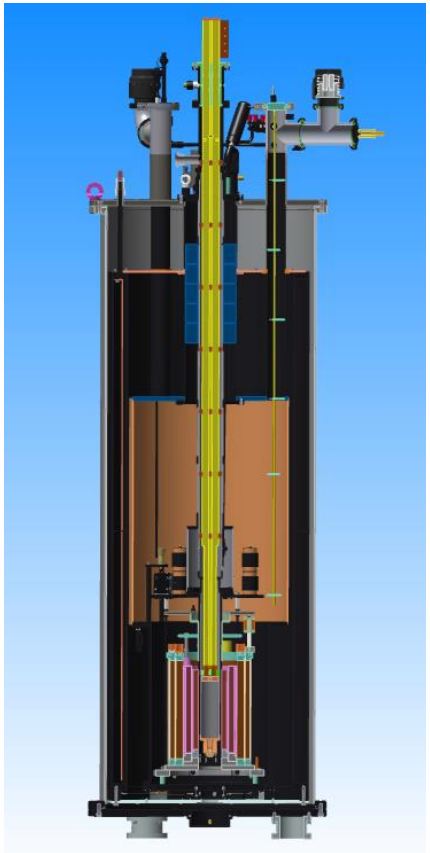
Design Summary

Andrew Winter
Senior Systems Engineer

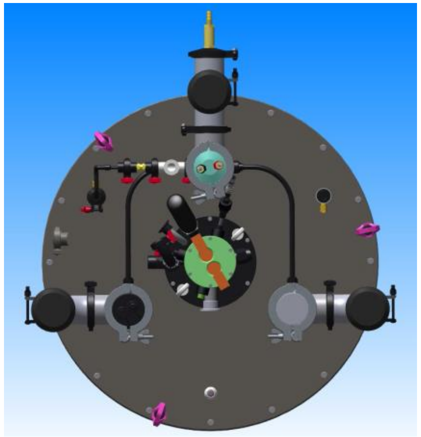
Magnet and Cryostat Requirements

Requirement	Specification
Magnet operating current	≤120 A
Central magnetic field	16 T
Ramp rate to full field	1.0 $Tmin^{-1}$
Magnetic field homogeneity	≤1.0×10^{-3} (0.1%) total variation over a 10mm diameter sphere
Magnetic field stability in persistent mode	≤1.0×10^{-4} (0.01%) relative/hr
Usable liquid helium volume excluding tail and without insert fitted	≥70 litres (nominal)
Liquid helium consumption in static mode with VTI fitted	≤400 cc/hr

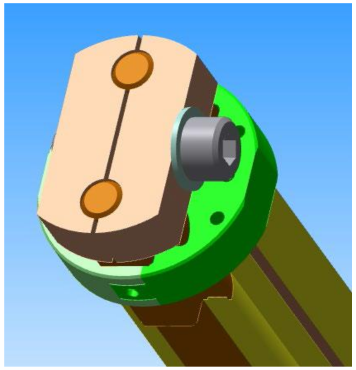
PDR – 3D elements of the designed system - example



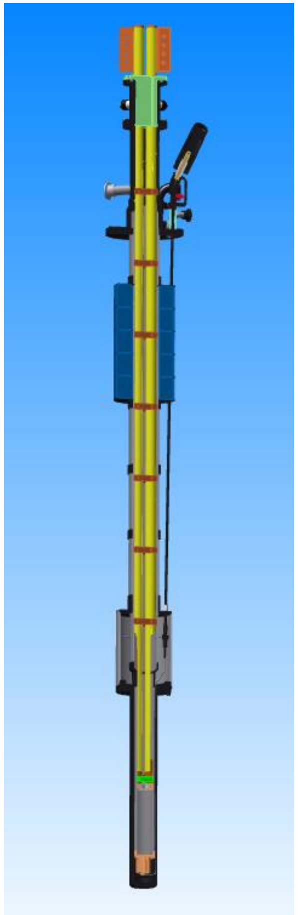
Cross Section of the ordered system



TOP VIEW



Sample Insert



VTI - variable temperature insert

Some basic facts

Specification of the ordered equipment

SPECIAL superconducting magnet system with special VTI with 1000 A current lead sample insert as described in our accompanying Proposal ref. RFQEB6726 Rev. 6 dated 20 January 2021.

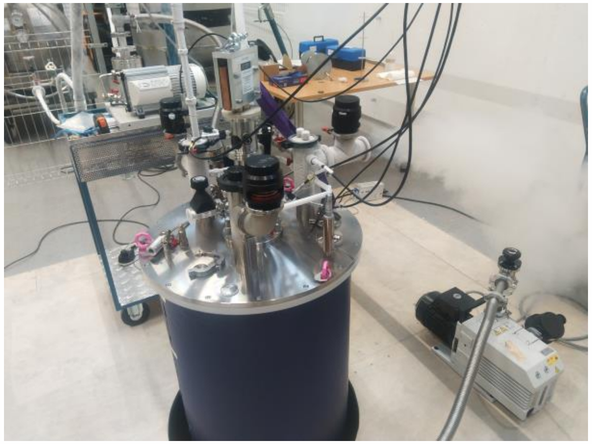
Complete system comprising:

- SPECIAL 16 Tesla superconducting magnet and 49 mm sample space variable temperature insert (VTI) combination
- SPECIAL 1000 A current lead sample insert
- Liquid nitrogen shielded cryostat
- MercuryiPS 120 A, 10 V superconducting magnet power supply
- MercuryiTC temperature controller

<u>Second milestone – **Delivery *according to the schedule***</u>

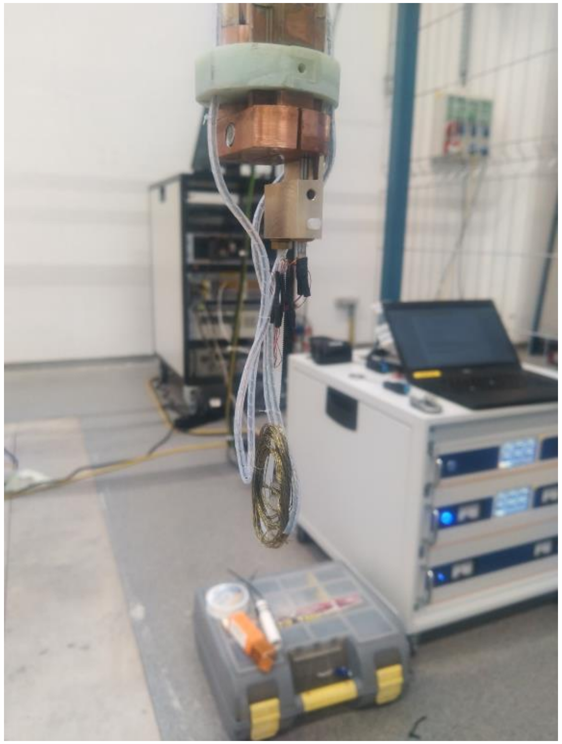
Some basic facts

Third milestone – Commissioning of delivered components *according to the schedule*



Vacuum pumping

Installation in the pit



Sample simulation measurements

Cryogenic Infrastructure

Turbine helium liquefier system:

- Able to liquefy up to 35l/h with LN_2precooling
- Able to liquefy helium without LN_2 precooling (with reduced performance).
- Able to operate with helium contaminated by atmospheric air up to 1%.
- 1000 dm^3 storage Dewar

Recovery system:

- Helium balloons, 2 x 15 m^3 and 1x 80 m^3
- 70 m^3/h and 200 m^3/h recovery compressors
- 3 helium high pressure storage groups, containing 108 90l bottles operating at 200 bar

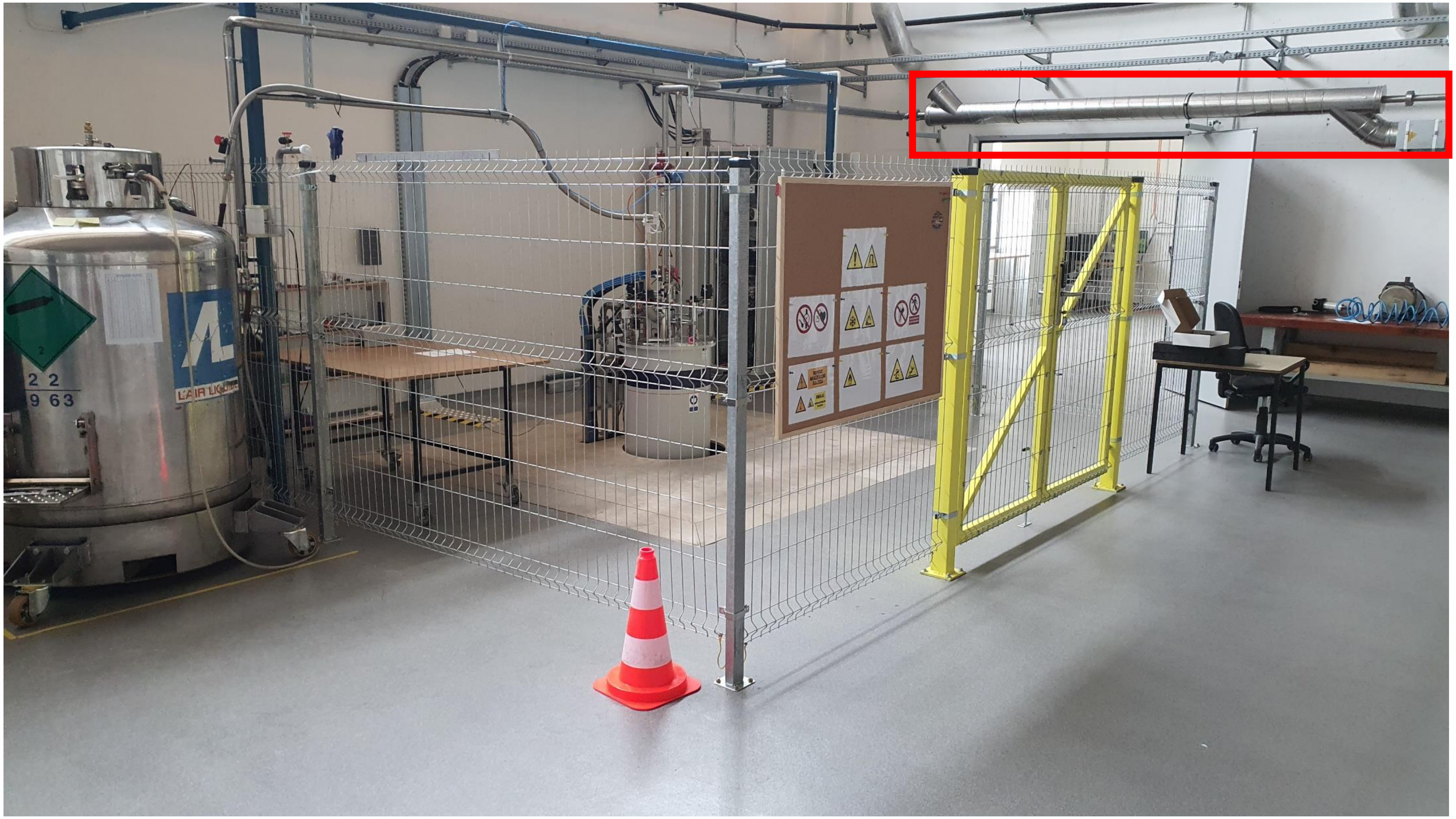
Cryogenic infrastructure integrated with the test stand

- 70 m^3/h and 200 m^3/h recovery compressors

- Helium balloons, 2 x 15 m^3 and 1x 80 m^3

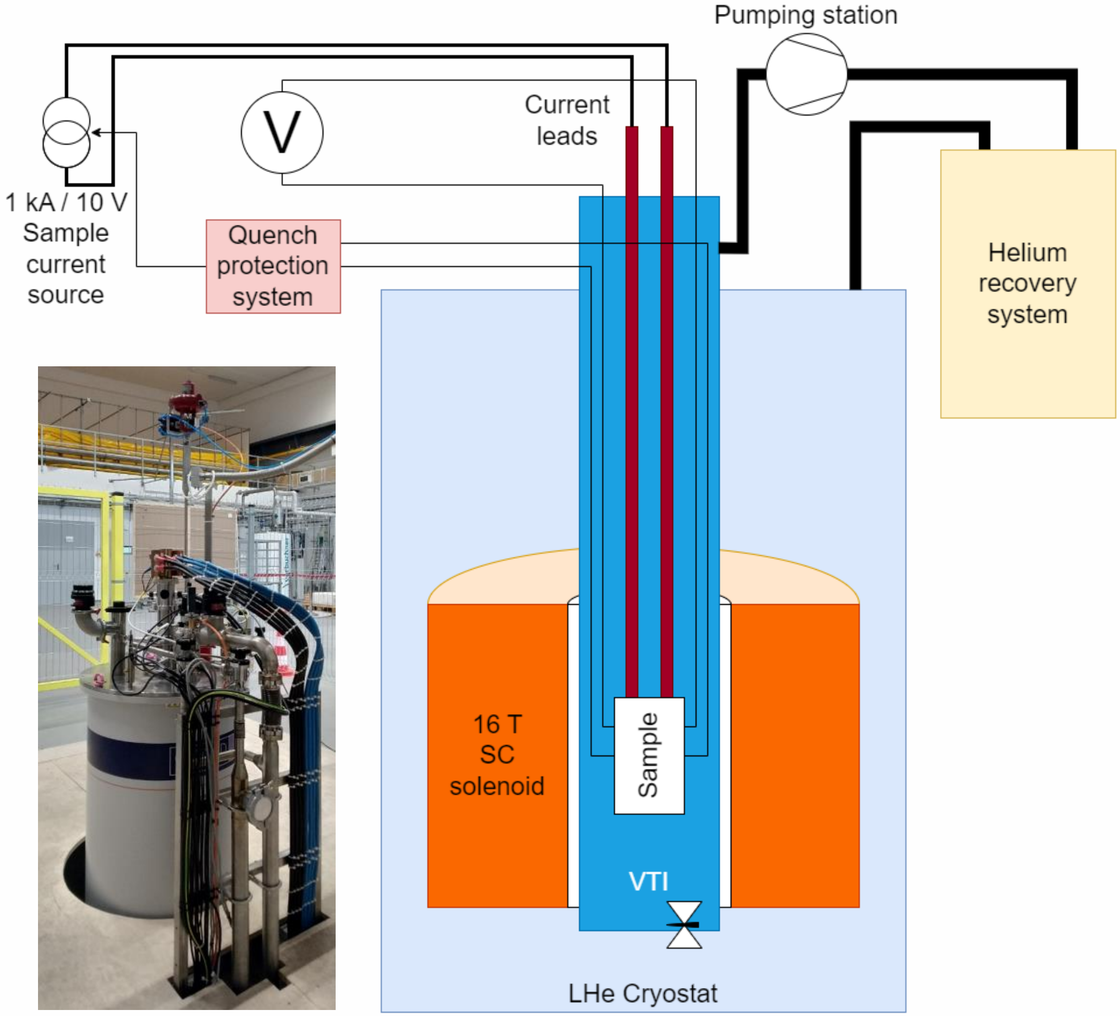
- 30 mbar system – during commissioning

Cryogenic infrastructure integrated with the test stand



Dedicated heat exchanger equipped with heaters and air flow speed control system. Designed and manufactured in IFJ PAN at DAI

Commissioning of the test stand at IFJ PAN - <u>currently</u>



Fully operational components:

- Magnet with Variable Temperature Insert (VTI)
- Liquid helium refilling installation
- Sample Current Source
- Helium recovery system
- Data acquisition system based on 7 ½ digit digital multimeters

Components being assembled/commissioned:

- New pumping station
- Sample quench protection system

Components in purchasing process:

- Nano voltmeter

Measurements performed during Commissioning of the test stand

with using of copper sample mock-up

Nb_3Sn sample on CERN type holder

Sample mock-up attached at the bottom of current leads

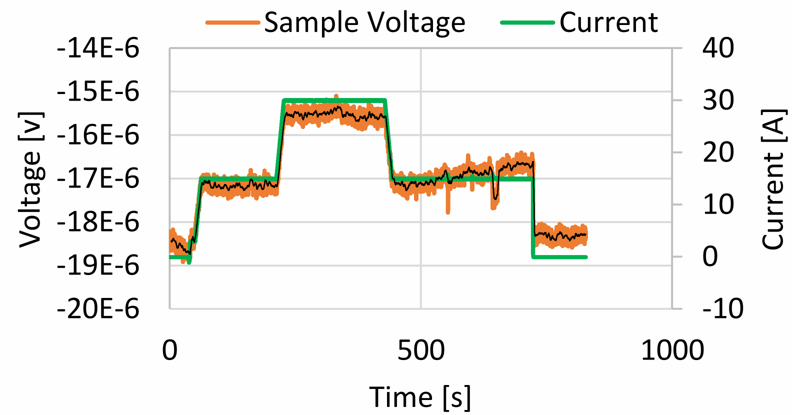
The test stand is being developed in close collaboration with CERN and it is meant to be compatible with CERN type sample holders. Other sample holder types can also be fitted in the sample space.

Measurements

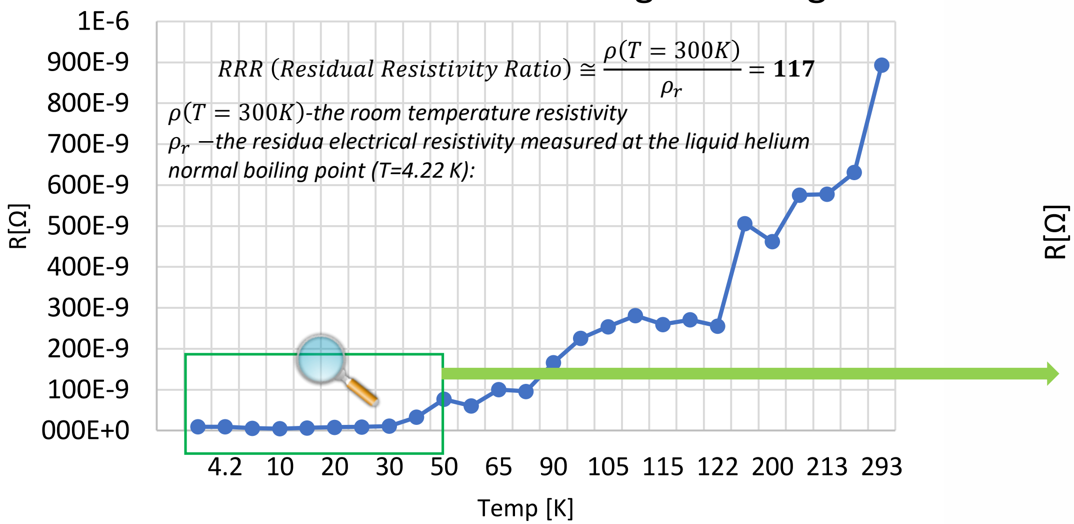
first approaches

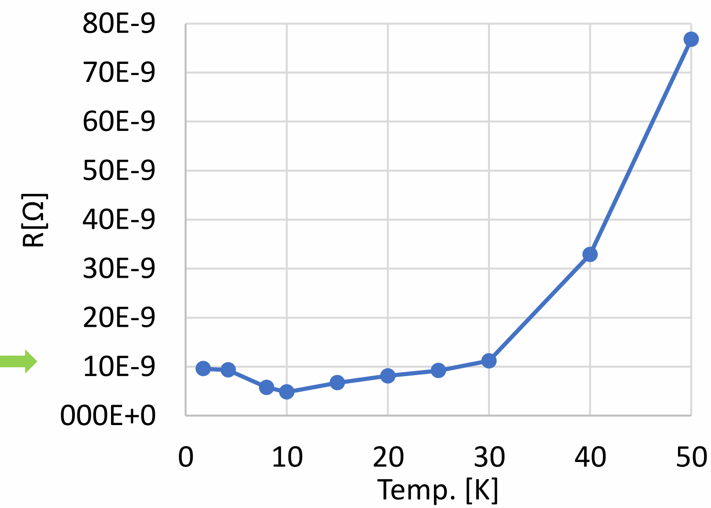
*Residual resistance ratio measurement of copper sample mockup – first result during **commissioning***

View of the data logging system during RRR measurements



Resistance calculated using linear regression from Voltage/Current measurements





Future

Full operation of the test stand is foreseen on January 2024

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