Test Progress at CERN

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TE-MSC-TF

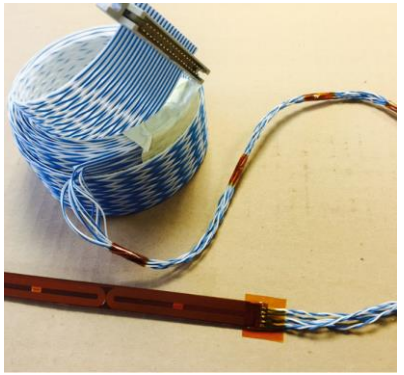
Test Progress at CERN

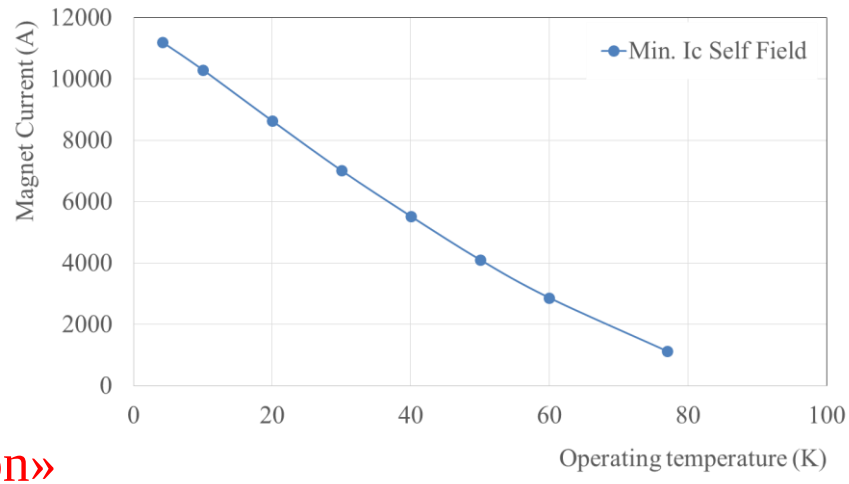
- Feather_0 Magnet
- Variable temperature 20 kA test facility at SM18
- Magnet-Facility connection issues
- Magnet protection strategy
- Data monitoring systems

Test Progress at CERN

Feather_0 Magnet

- Magnet characteristics
  - Geometry (90x500mm)
  - HTS
    - easy to be burnt
    - μH inductance
  - Instrumentation
    - Voltage taps, T-sensors array, Fiber optic, Hall probe, Quench Antenna
    - Spot heater
- Operating conditions
  - T = [4.2 – 80] K
  - I_{mag} = [0 - 10000] A





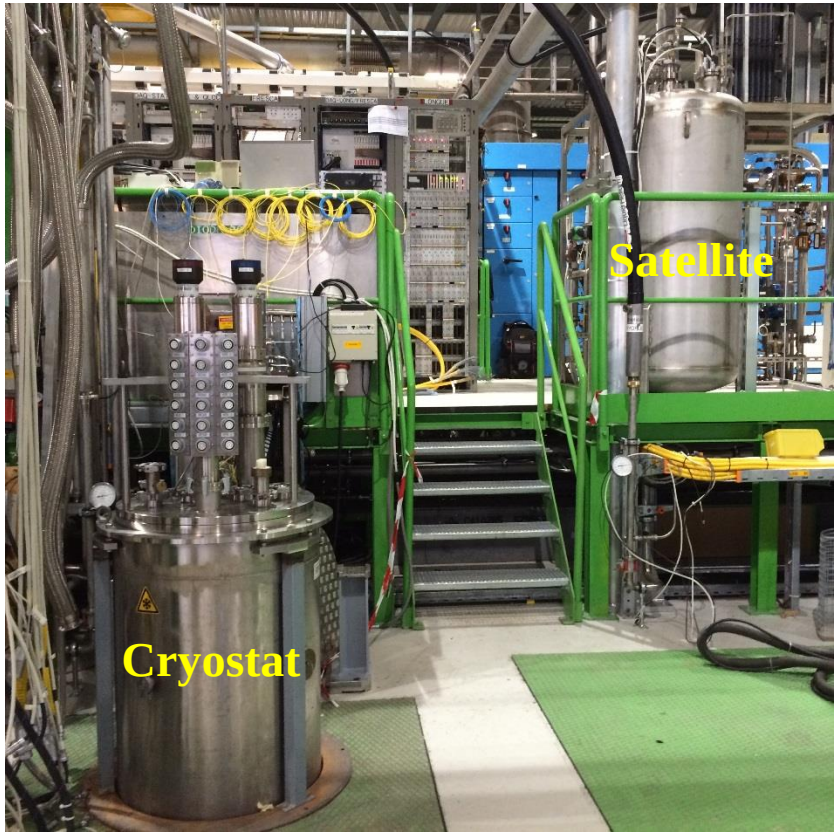
SM18 «Diode test station»

Variable temperature 20 kA test facility («Diode» bench)

- Purpose
  - Test of: HTS current leads test, Diodes pulse test,
  - Optical Fiber calibration, others cryo-devices

- 20 kA Power Convertor
  - very low magnet inductance might require fine-tuning of its setting (need check…)
  - Shared with 3 other benches (availability…)

- Cryostat Gas-Liquid Helium supply
  - Helium inlet temperature controlled by He gas preparation in an external tank hosting heaters
  - LHe valve opening and heater power regulation based on thermometry and manometry in the He circuit
  - 4.2 – 100 K stable but need careful set of PID regulation (good experience so far…)
  - Cryostat temperature uniformity not fully insured (need check…)
  - Current leads in the gas (Need shunted-lead test…)



Magnet-Facility connection issues

- Holding plate
  - Need of 20 kg magnet support
  - Rods, thrilled yoke, etc
  - Need to agree on and machining pieces
- Instrumentations
  - Insert able to host several tens of wires
  - Need check for connection interfacing
  - Numbers of sensors **(68)**

Magnet-Facility connection issues

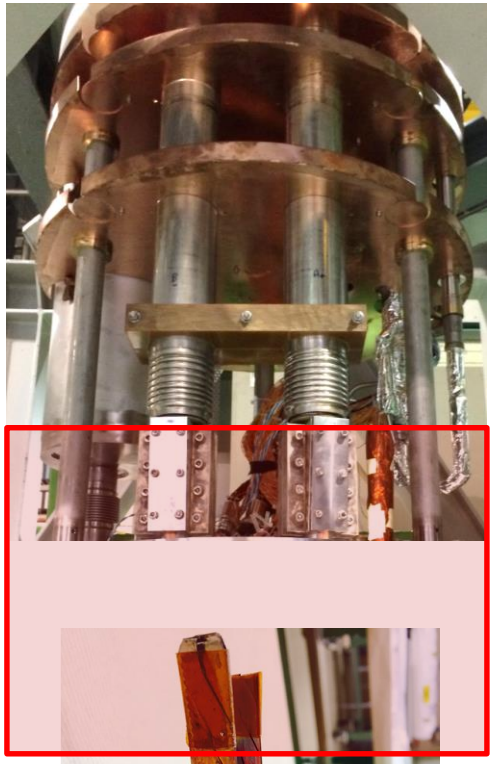
- Instrumentations

List of instrumentations/ Feather M0 / 27.11.2015

Device	Type	Number	Comments	Number of wires total
Coil spot heaters				
Coil end heater	smaller one	2		8
Heater on straight part	larger one	2		8
Each spot heater needs 4 wires (2 for current and 2 for voltage).				
Temperature sensors				
Non-calibrated	CCS	40		8
Calibrated	CCS	3		12
Calibrated temperature sensors need 4 wires each (2 for current and 2 for voltage).				
Non-Calibrated temperature sensors are in 2 arrays connected in parallel and need 4 wires each array (2 for current and 2 for voltage).				
Voltage taps				
Current leads		4	Two taps on each lead for redundancy	4
Roebel inside the magnet		4	Two taps on each Roebel for redundancy	4
Hall Probe	TBD	1		4
Hall probes need four wires (2 current and 2 voltage).				
Quench antenna arrays	Array of 5 coils on PCB	4		20
Arrays top to bottom counterwound, this means we have 10 Coils in total in Feather M0. We need 10x2 wires for these coils.				
Acoustic		1 to 3	Need 3 holes for optional locations	???
Optical fiber		1	(Only one survived from impregnation out of 2)	???
				Total
				68

Magnet-Facility connection issues

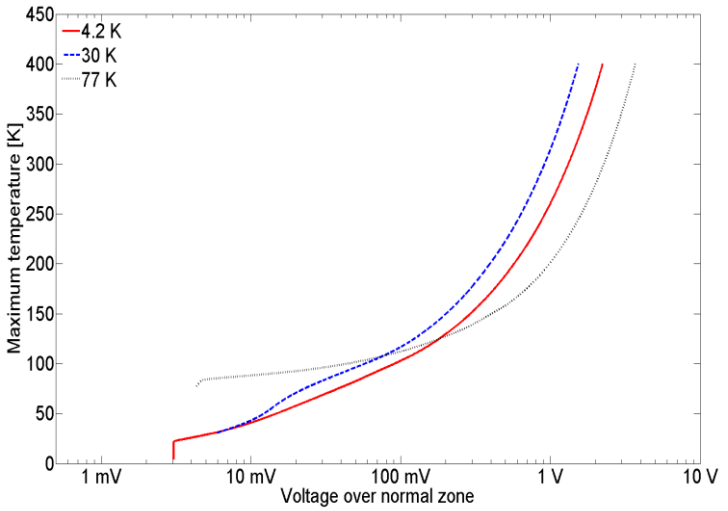
- Powering
  - Joint current-lead to magnet
    - HTS to cylindrical Copper bar with clamping box & Indium sheet
    - The two leads from the magnet should come with the right angle
    - Need to stiffen the two leads (no motion allowed)
    - Need to agree on and machine pieces



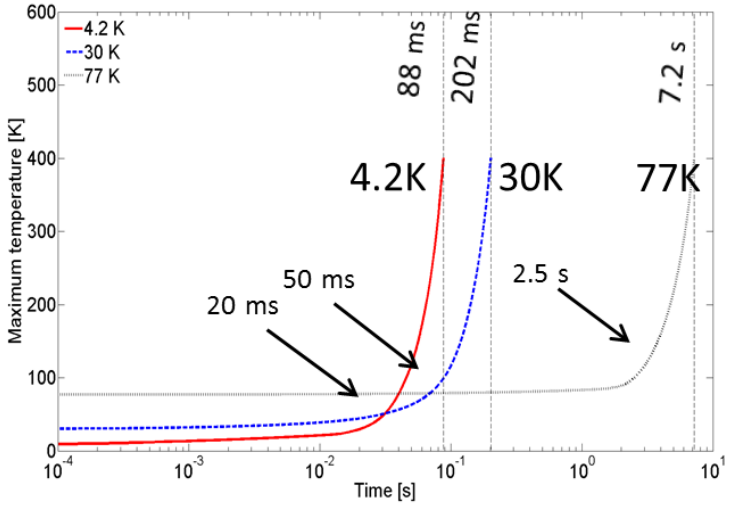
- Heat load from the resistive lead to HTS cable
  - May quench the HTS cables by heat propagation
  - Need to optimize the join thermal behavior
  - Fast and accurate protection for the connections
    - (extra-voltage taps)

Magnet protection strategy

- Quench detection
  - Based on voltage signal
  - Linked to safety matrix (triggers)
  - Need to define threshold and time window
  - First guess from simulation result



- Energy extraction
  - With 1-2 mΩ from the powering circuit, the time constant of the current decay with be few tens of ms.
  - No need of dump, current turn off trigger



Data Acquisition systems

- PXI-DAQ
  - Acquires voltage taps signal from “Potaim cards” (40 taps)
  - Acquires Temperature (40 sensors)
  - Connection to safety matrix (triggers protection)
  - Baseline for facility connections

- cRio-FBGA
  - New data acquisition system
    - Low frequency-long aquisition time
    - 112 channels
  - Can produced trigger
    - need connection to Protection System
  - Need wiring and cabling work
  - Just monitoring at the start

Conclusion

- Feather_0 can be tested in the «Diode Test» Bench
- Use of the «satellite» for Helium inlet liquid/gas temperature control
- Instrumentation connections requieres cabling preparation
- Current lead joint requieres relevant solution
- Current lead in the gas should be tests
- New DAQ has to be implemented in parralel to classic system
- New DAQ asks for important cabling work.

  → Test in January 2016 before shut-down is challenging

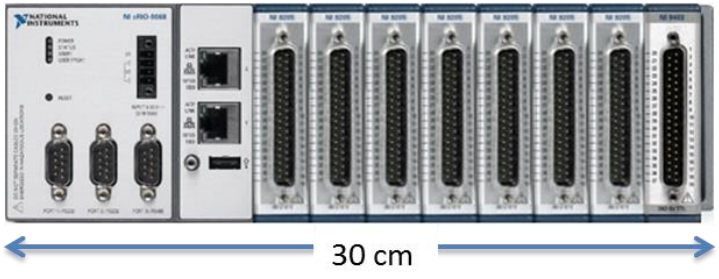
  → Cryo-shut down from the 1st of February.

Thank you for your attention,

Test Progress at CERN

HTS Quench DAQ

NI-CompactRIO | 224 total | Received at CERN March 2014



7 modules: 16 differential analog inputs each
- +/- 200 mV till +/- 10 V input range
- 7.8 kS/s per channel, 16 bits

1 module: 32 digital outputs
- 5 V TTL
- 7 µs response time

Recording:
Continuous streaming of all channels to external 3 TB disk for 12 hours tested.

Also available: **high speed module**
- 4 differential analog inputs, 1 MS/s, 16 bits simultaneous sampling

Processor:
- 667 MHz dual-core ARM
- 512 MB RAM
- 1 GB storage
- NI Linux Real-Time OS

FPGA:
- Xilinx Artix-7
- 2 M cells

A similar system is used by the EL group to capture voltage transients on the electrical network caused by EDF switching, thunderstorms and internal load changes.