

Smart diagnostics

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The idea
is included in Work Package 4.3
of FuSuMaTech Initiative

<http://fusumatech.web.cern.ch/>



[wikipedia]

The Internet of things (IoT) is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity which **enables these things to connect, collect and exchange data**.

IoT involves extending Internet connectivity **beyond standard devices**.

Wireless communication, or sometimes simply wireless, is the transfer of information or power between two or more points that are **not connected by an electrical conductor**.

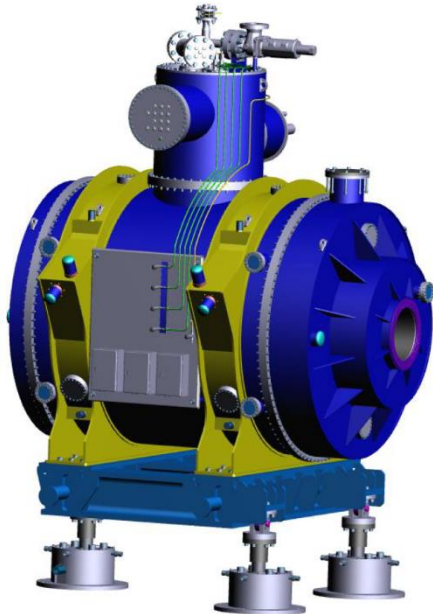


What if ...

What if ...



we treat a superconducting magnet as an IoT device.



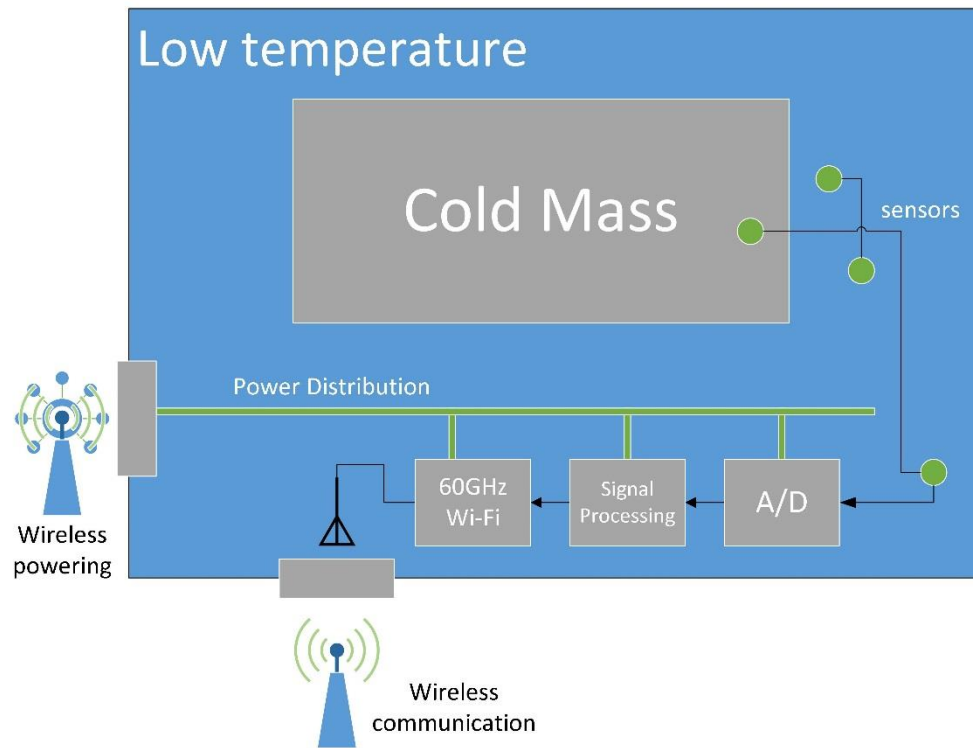
Medical MRI

What if ... refining

What if ...



we **confine** the embedded electronics and sensors for the instrumentation inside the cryogenic vessel with **wireless** transmission for **data and power**.

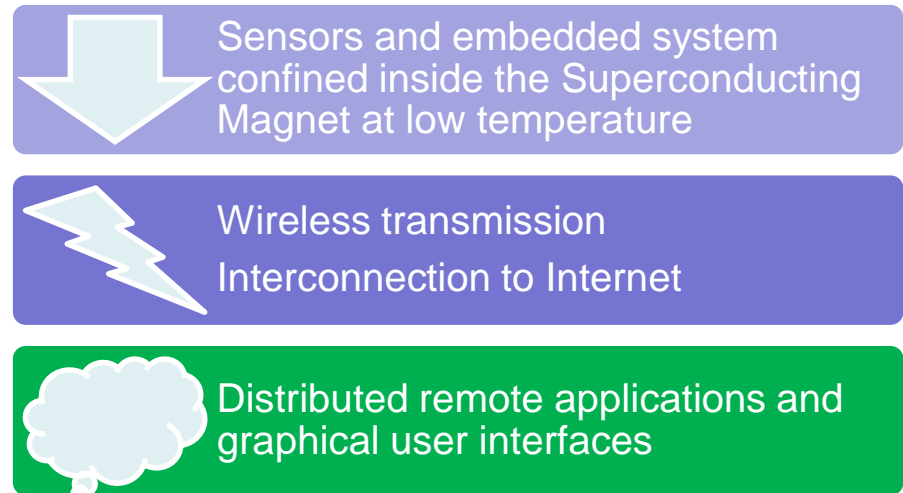


low temperature : in the order of the thermal shield levels, 50 K to 70 K, or below

Considering the superconducting magnet as an IoT (Internet of Things) device, the **Smart Diagnostics** is the set of systems and functionalities which makes the enhanced remote monitoring and diagnostic of the superconducting magnets via the wireless and internet technologies possible. Allowing the data to be collected and analysed by remote devices, connected to internet running graphical user interfaces (like smart phones, tablets or intelligent screens).

This can be structured in 3 layers:

- confined electronics (+sensors)
- interconnection to internet
- remote applications



The actual solutions for the instrumentation are based on electronics located outside the cryogenic vessel. The diagnostic systems are connected to the few sensors at low temperature by wires which cross the different temperature layers and mechanical interfaces up to the sensing point. This is because the existent electronics is designed to work at ambient temperature, 300 K ~ 27 C and not at low temperature.

Confined electronics at low temperature **is not restricted to superconducting magnets**. Can be used for Quantum computers, Space applications or any equipment requiring instrumentation at low temperature. The mastery of electronics inside these environments will become a key element to achieve the industrialisation in these fields.

Some advantages

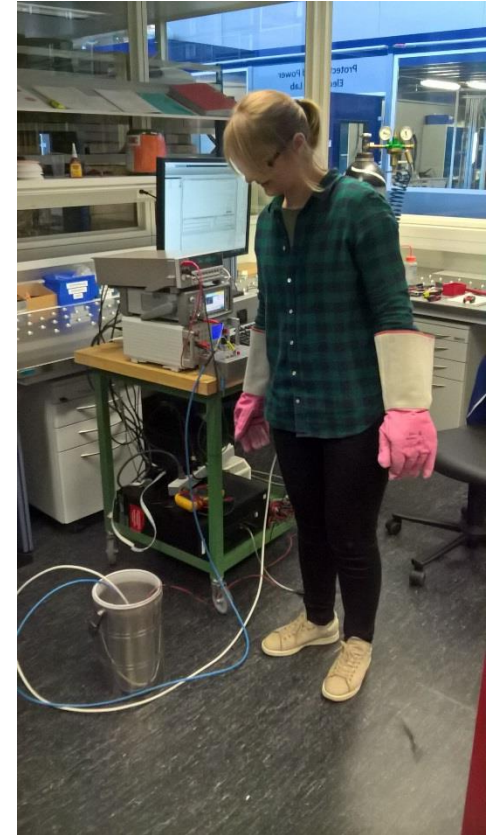
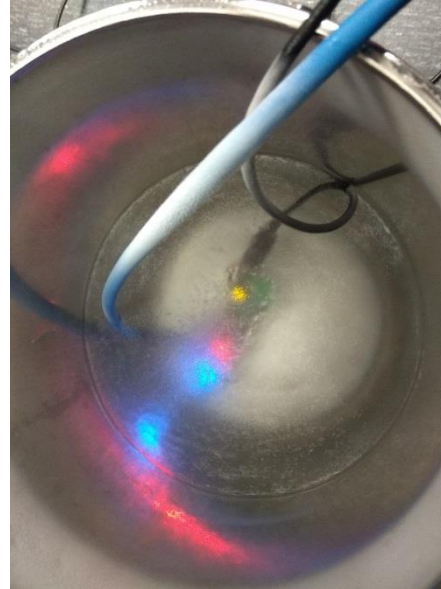
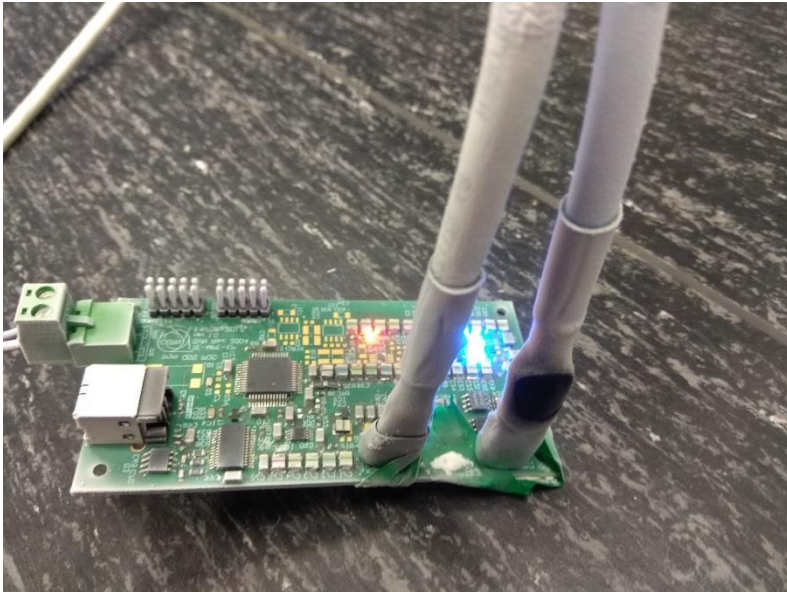
- a) Simplifies and gives **more freedom** to the mechanical and thermal design of the cryogenic vessels as we **do not need inserts** for the instrumentation.
- b) Instrumentation gets closer to the physical source. Measurement will be more accurate, **more precise** and with less noise. Also opens the possibility to have **more measurement points** because each additional sensor does not add wires to the exterior of the vessel.
- c) **Instrumentation IS the equipment**. In the sense that the confined electronics is always easily ready for use (once installed in the cryostat), independent of the equipment being at the factory, at the workshop, in transport or in operation. With just a Wi-Fi link, you can connect and monitor/control the equipment.
- d) Data storage, monitoring, analysis and processing are decentralized and accessible via internet.

The main challenges in front of us are:

- to develop a working electronic data acquisition system of high precision at low temperature
- to develop a working wireless electronic communication link at low temperature
- to develop a working wireless powering system at low temperature
- to develop a radio frequency transparent material to build a “window” or an antenna, at the wall of the cryogenic vessel, for the wireless communication link and for the wireless powering system
- to develop materials and assembly technologies to build flexible PCBs (printed circuit boards) for the confined electronics at low temperature



We have some confidence because
the very first trials give some promising results.



Thank you

Questions?