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DRYSMES4GRID

Superconducting Energy Storage for Smart Electrical Grid

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Outline

DRYSMES4GRID
Superconducting Energy Storage for Smart Electrical Grid

- The DRYSMES4GRID Project
- Objective
- The DRYSMES4GRID system
- First test results
- Conclusions

The DRYSMES4GRID Project

DRYSMES4GRID
Superconducting Energy Storage for Smart Electrical Grid

MISE - Italian Ministry of Economic Development

Competitive call: research project for electric power grid

- Transmission and distribution
- Dispersed generation, active networks and storage
- Renewables (PV and Biomass)
- Energy efficiency in the civil, industry and tertiary sectors
- Exploitation of Solar and ambient heat for air conditioning

Project DRYSMES4GRID funded

- **Budget: 2.7 M€**
- **Time: June 2017 – June 2020**
- **Extended to September 2021**

Project Coordinator:

- **ASG Superconductors SpA, Genova, Italy**

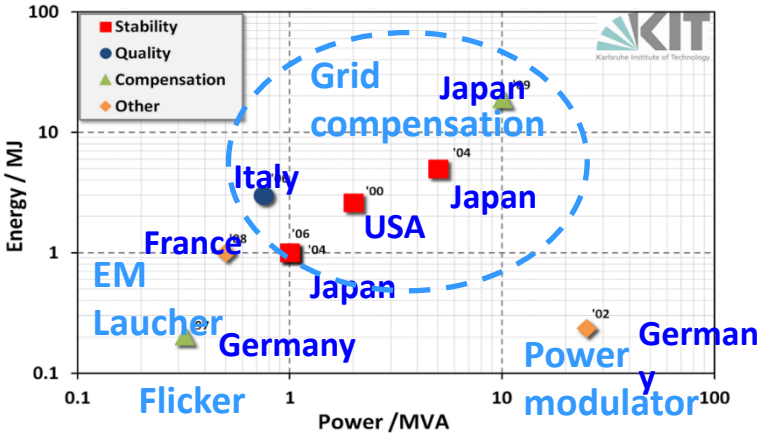
Partners

- **University of Bologna**
- **RSE S.p.A - Ricerca sul Sistema Energetico, Milan**
- **CNR – SPIN, Genoa**

Objective and state of the art of SMES technology

DRYSMES4GRID
Superconducting Energy Storage for Smart Electrical Grid

The design of a **SMES**
(Superconducting Magnetic Energy Storage)
based on Magnesium Diboride (**MgB2**) to be connected to a LV distribution grid



to demonstrate the **feasibility of a SMES** for achieving, with the same device, **Power Quality** and critical load protection functions.

The DRYSMES4GRID project:

- **21 kJ / 7 kW SMES**
- **MgB_2 material**
- **Cryogen free cooling**

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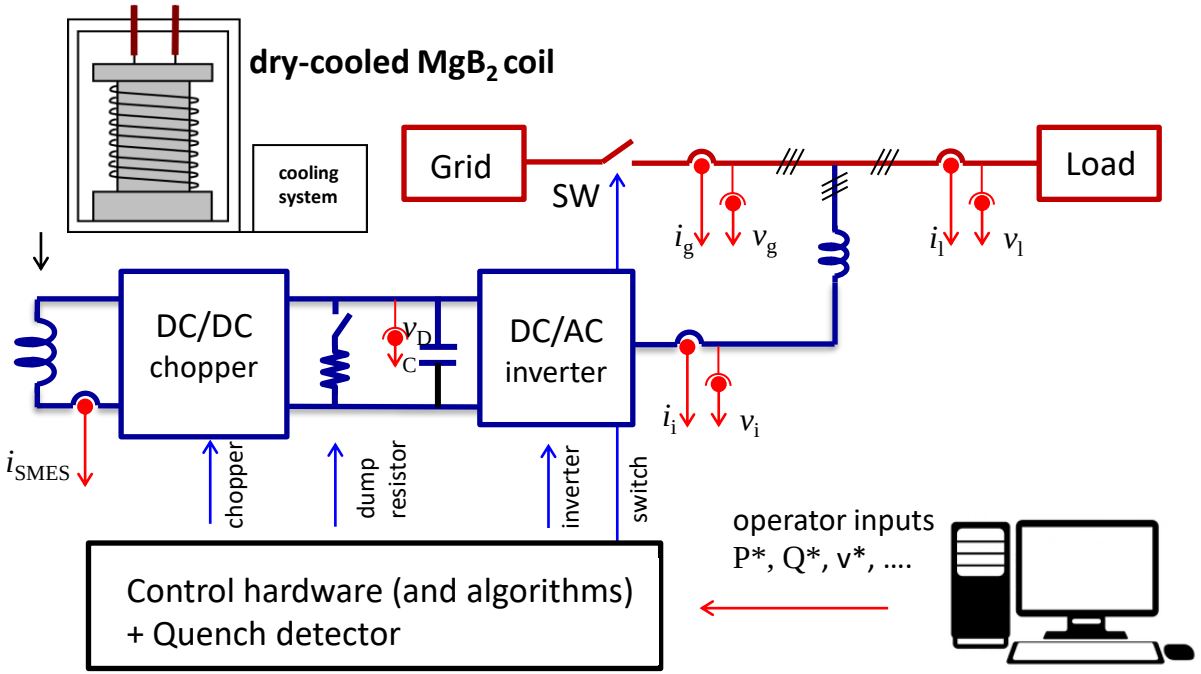
- **Power Quality functions** supporting grid and loads both grid connected and islanding operation



Project's status

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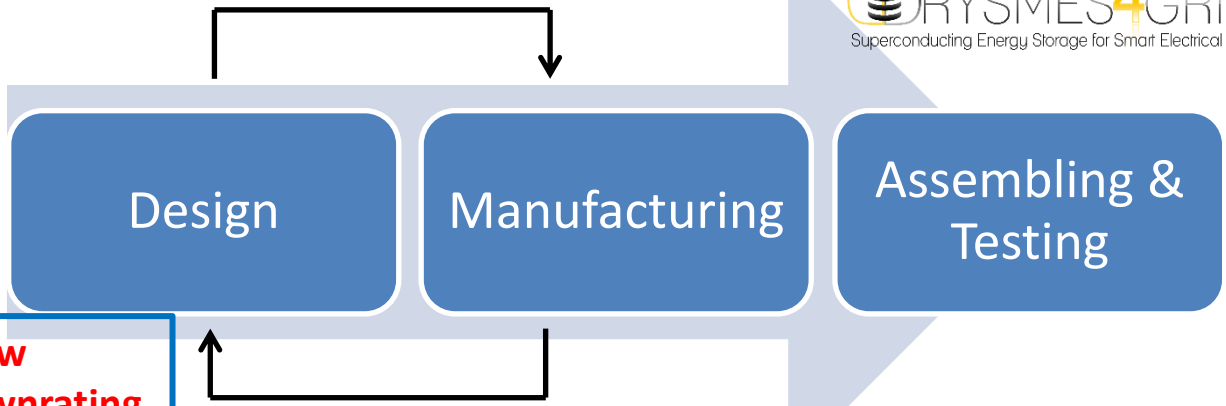
The original DRYSMES4GRID:

500 kJ / 200 kW SMES



New size:

21 kJ / 7 kW SMES

Review & downrating

- Electromagnetic & Mechanical design of the coil
- Thermal design (connection to cryocooler/s)
- AC Loss computation
- Control algorithms (logic, schemes, parameters)
- Design of Power Hardware &Control

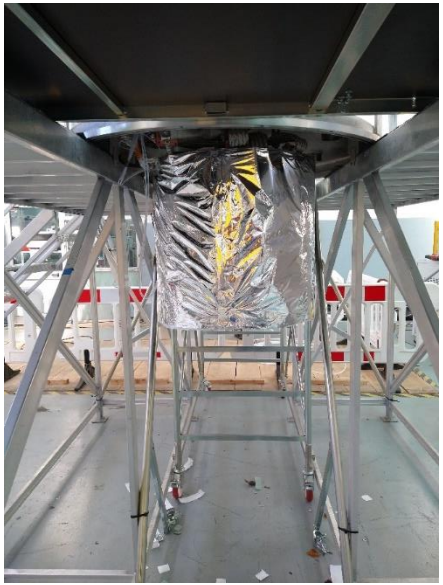
- Manufacturing of the coil & cooling system
- Manufacturing of Power Hardware&Control

- Assembling
- **Testing**

Accomplished activities

On going activities

Manufacturing and assembling of the 21 kJ SMES coil completed during April-August 2021



MAGNET CHARGE RATED CURRENT

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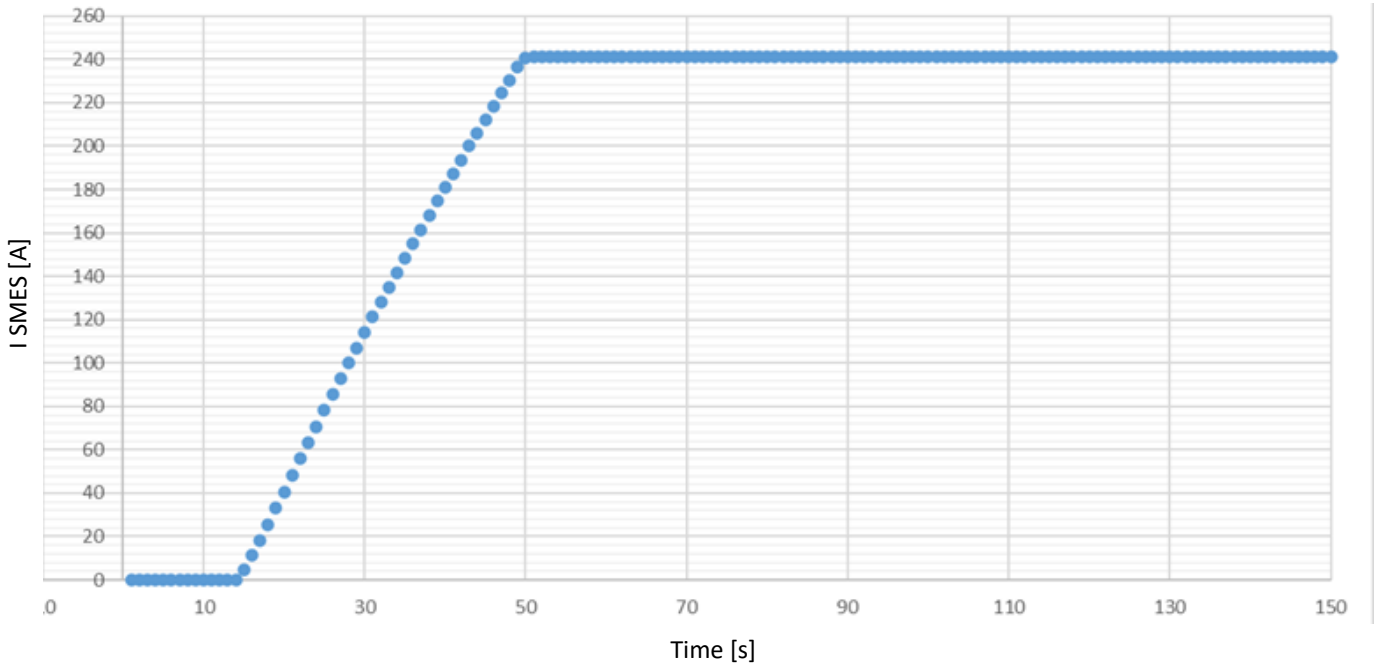
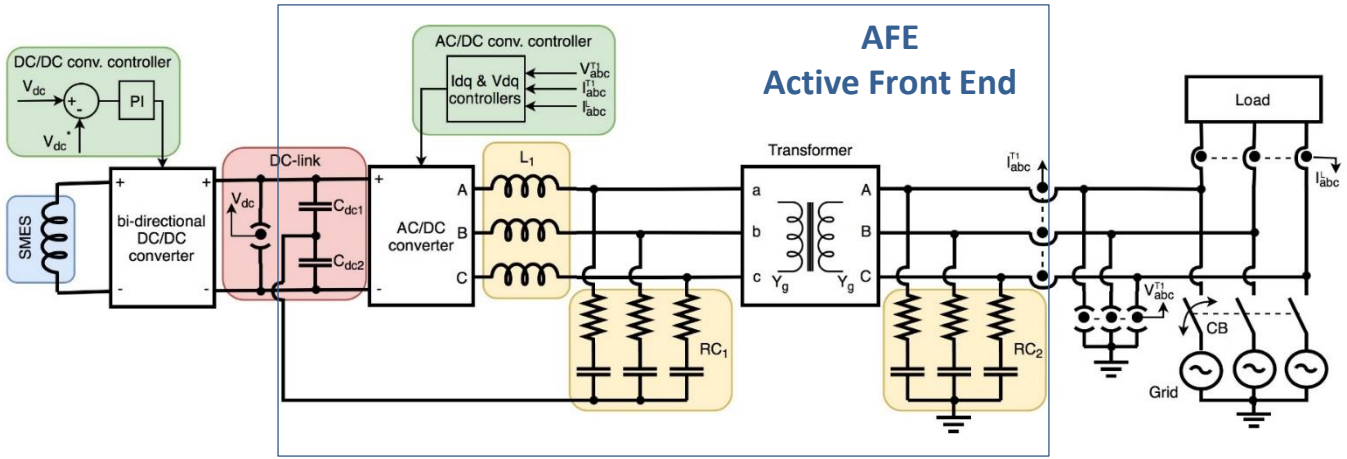
Controlled charge up to 20 kJ



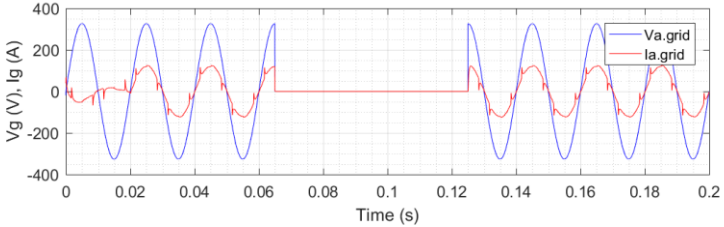
Power conditioning system – control hardware and algorithms



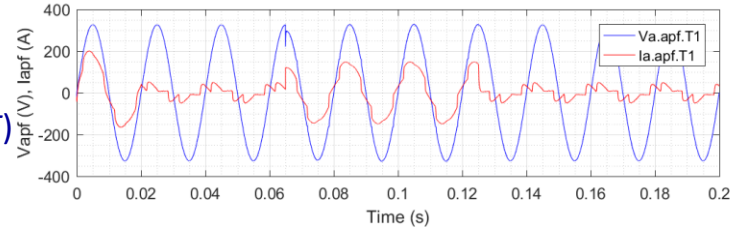
- **Detailed definition of control algorithms (logic, schemes, parameters) completed by means of SIMULINK and ATP simulations**
  - Grid connect operation (power compensation) and islanding operation
- **Integration of the magnet protection system**

Active filter UPS Active filter

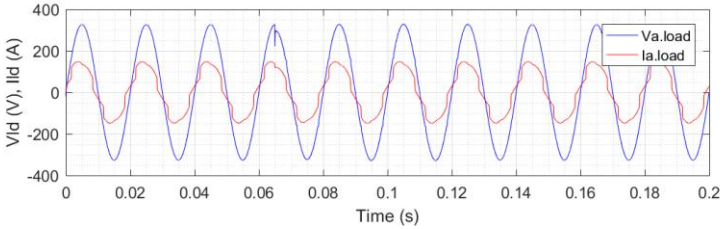
GRID



SMES
(*AC SIDE*)



LOAD



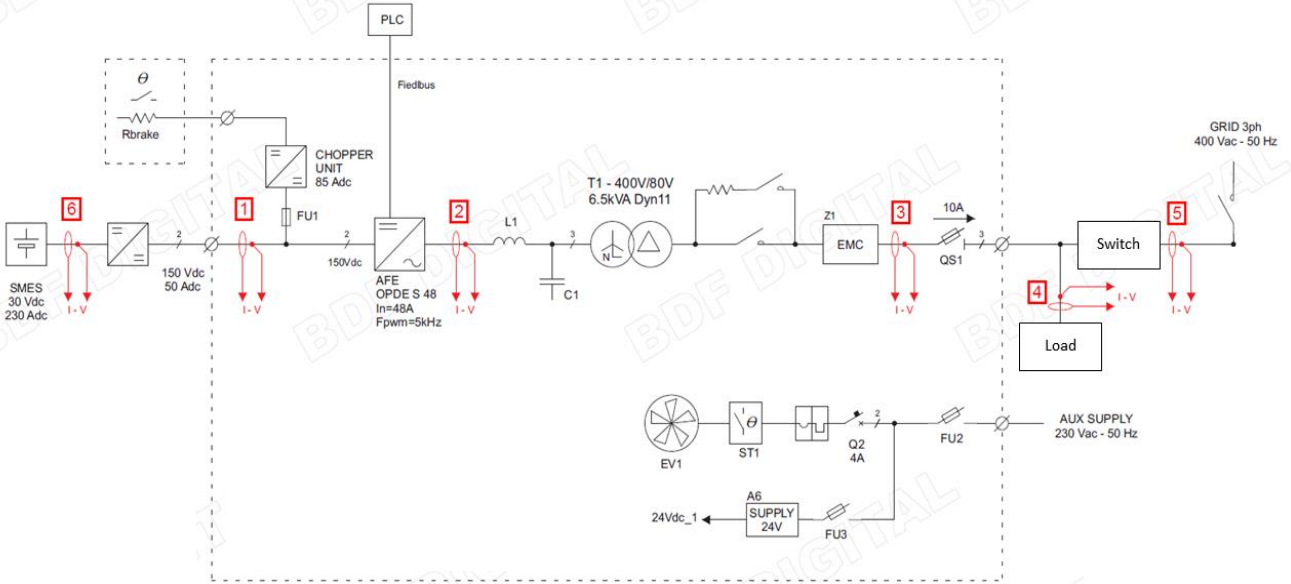
- **Effective compensation of load current harmonics and reactive power (SAPF)**
- **Effective compensation of voltage interruption (UPS)**
- **Smoot transition (small current and voltage surges) between SAPF and UPS**

Power conditioning system – power hardware

Definition of power hardware

- Converters architecture
- Switch technology
- Capability
- Filter
- Measurment points

Technical specifics for commissioning and type testing issued



Measuring points:

1. **DC-bus**
2. **AFE input**
3. **Transformer (Grid side)**
4. **Load**
5. **Grid**
6. **SMES**

Power conditioning system (PCS)

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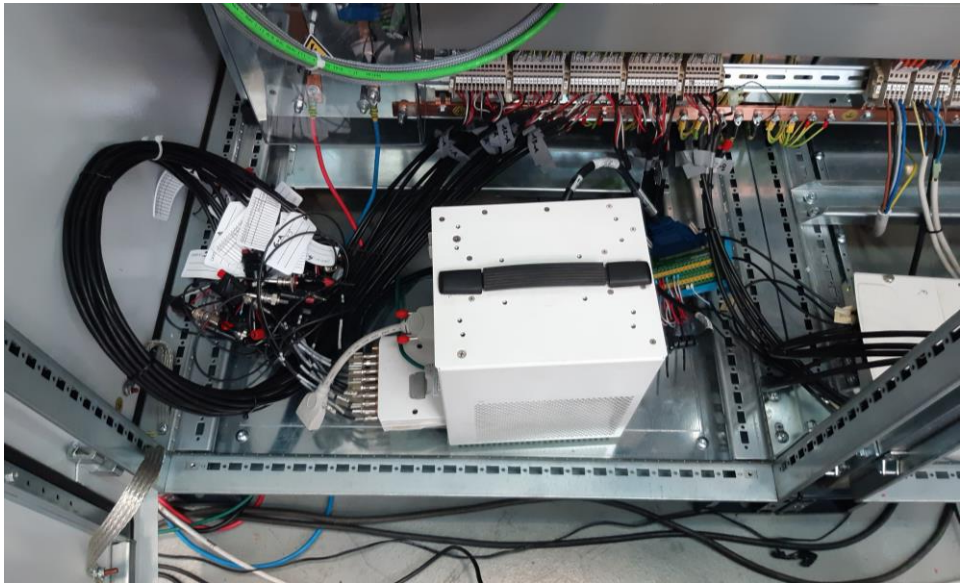
Manufacturing and assembling of the PCS completed during April-August 2021

Three-phase voltage and AC current acquisition system

- Device National Instruments: NI-PXI-1031
- 24 channels: 6 measures (3 currents and 3 voltages) for each measuring point
- Sampling frequency: 30 kHz



Three-phase voltage and AC current acquisition system: RL load and AFE insertion

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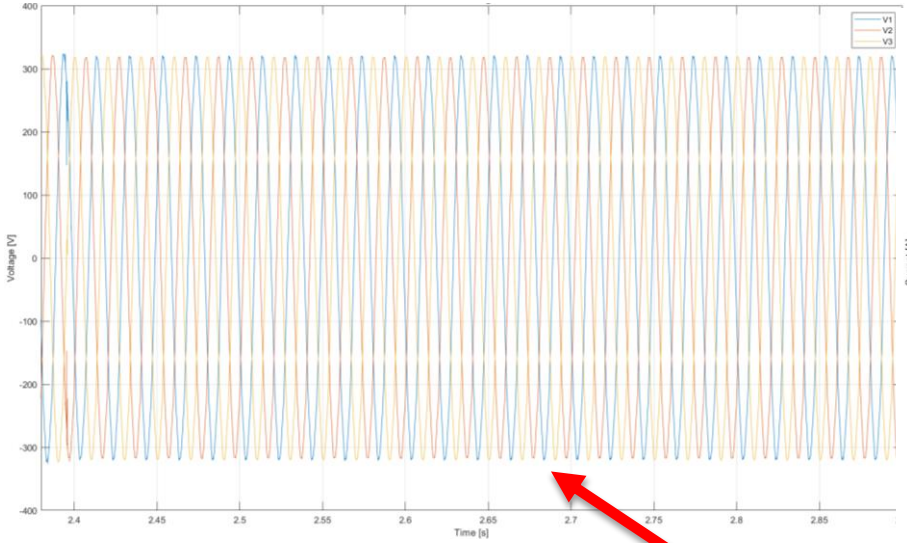
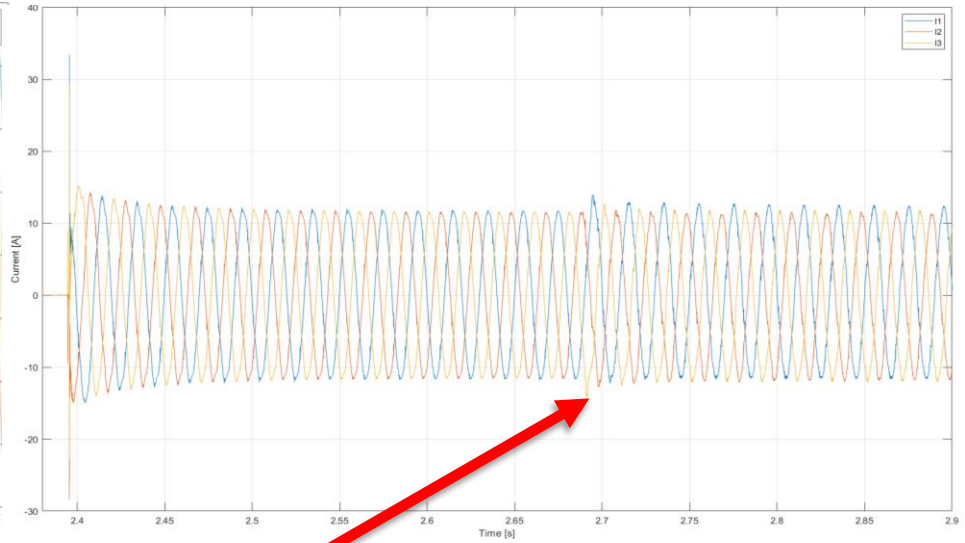
Grid Phase Voltage

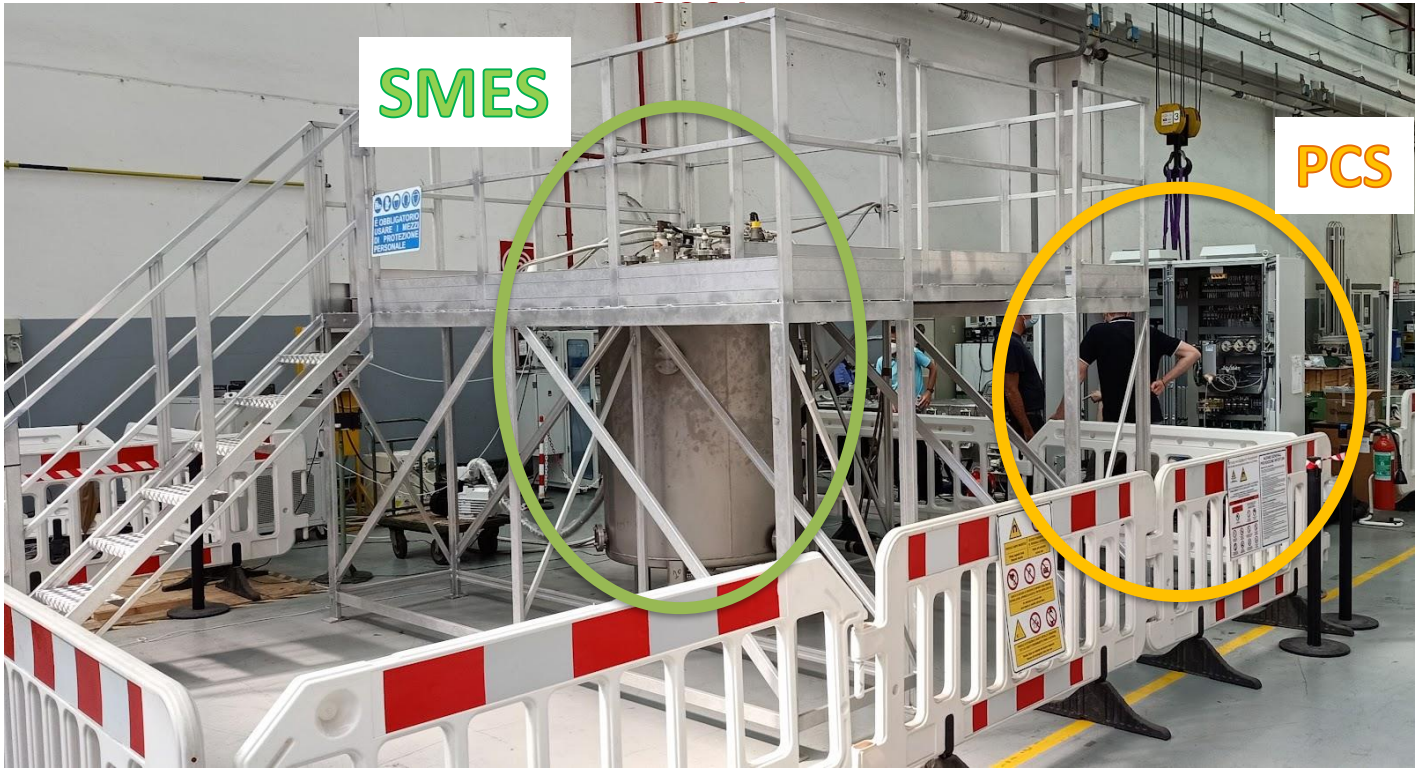


Grid Current



AFE power on

Assembling of the 21kJ / 7 kW SMES system completed at ASG premise in August



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Preliminary testing / 1

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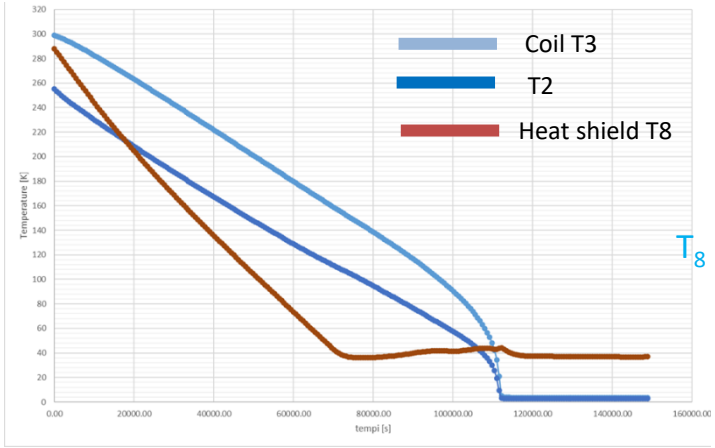
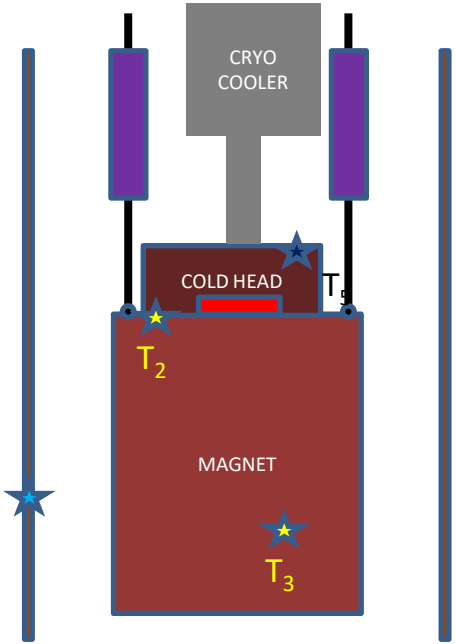
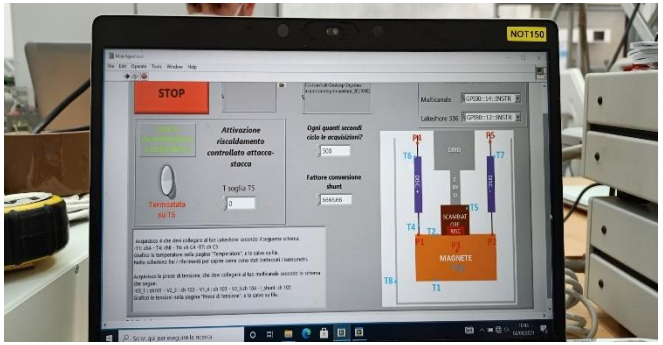
Magnet cooldown successfully completed in September 2, 2021

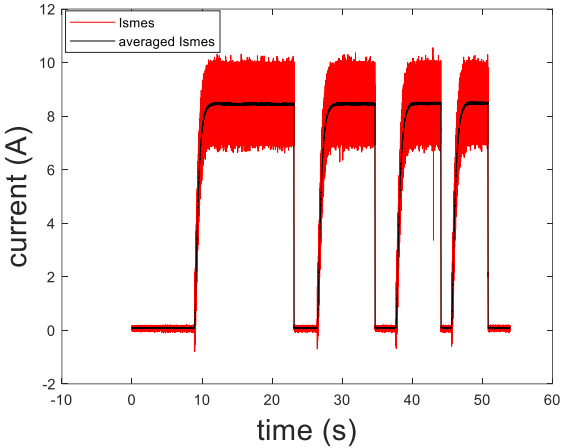
3.9 K reached on the coil in no load condition



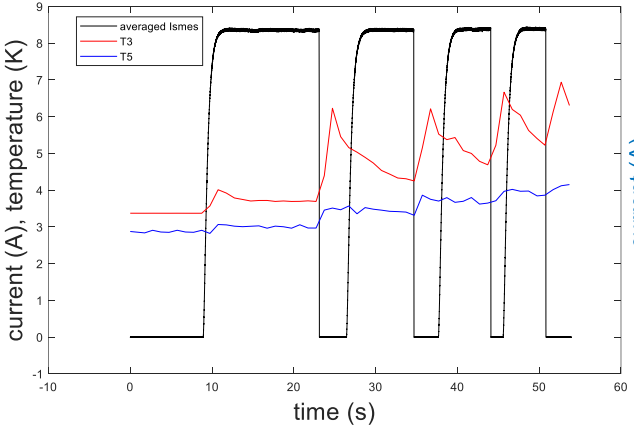


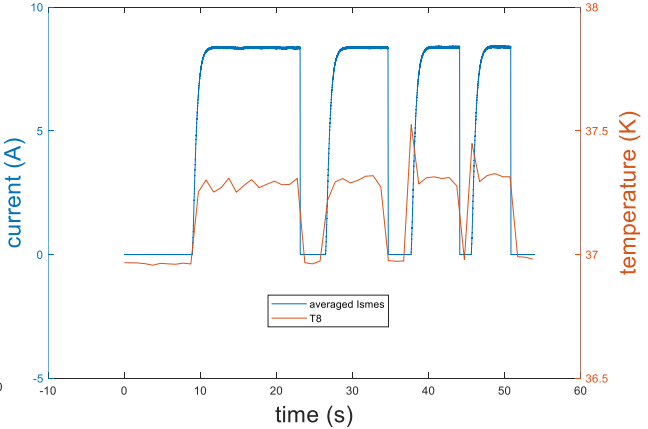


Preliminary testing / 2



Controlled charge up to 5%In reached via the PCS





During week 36: SMES **energization up to 35 A (15%In)** via PCS.

Conclusions

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In these weeks the final experimental tests are ongoing, in particular:

- Grid connect operation to compensate active and reactive power variations
- Islanding operation to supply “critical loads”

The demo size can be considered as a **scalable and replicable power module** useful **to demonstrate the feasibility** of SMES in the short/medium term at competitive cost based on Magnesium Diboride (MgB2).

The DRYSMES4GRID project shows the benefits related to the **synergy between the world of research and the national industry.**

Thanks for your attention

http://drysmes4grid.spin.cnr.it/

This work has been financed by the Research Fund for the Italian Electrical System in compliance with the Decree of Minister of Economic Development June 30, 2014.