
Innovative Research Infrastructure on applied Superconductivity
IRIS

SCARLET
Superconducting CAbles foR sustainabLe Energy Transition

# MVDC 1 GW-SCALE $MgB_2$ POWER CABLES FOR THE GREEN SUPERCONDUCTING LINE OF THE ITALIAN IRIS FACILITY AND FOR THE SCARLET EU PROJECT

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A. Marian RIFS - GFZ

M. Statera INFN-LASA
L. Rossi INFN-LASA and University of Milan

www.asgsuperconductors.com

*IEEE-CSC, ESAS and CSSJ SUPERCONDUCTIVITY NEWS FORUM (global edition), Issue No. 61, Nov. 2025. Presentation given at EUCAS 2025, Porto, Portugal, Sept. 2025.*


**Introduction to ASG superconductors SBUs**
**$MgB_2$ wires for cables**
**Characteristics of $MgB_2$ cables**
**SC link at CERN**

**Running project**
SCARLET EU Project
GSL – Green Superconducting Line for IRIS

**Conclusions**

www.asgsuperconductors.com

ASG SUPERCONDUCTORS

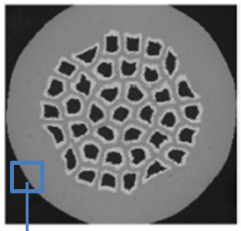
Headquarters in Italy
Offices in France, USA & UK
200+ DEDICATED PEOPLE

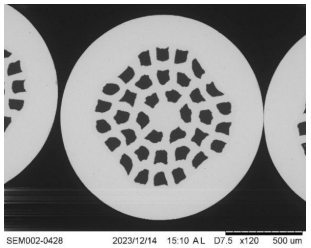
Four **STRATEGIC BUSINESS UNIT**

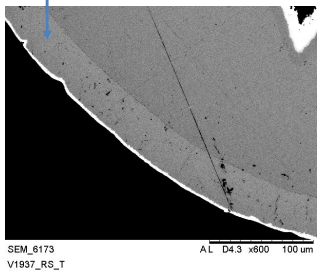
- **Medical:** MRI, cyclotron, UHF imaging)
- **Big science:** HEP, Research facilities, Fusion Energy (Iter and DTT TF coil)

- **Superconducting materials**: Manufacturing of $MgB_2$ superconducting wires
- **Industry&Energy:** cables, SFCL, SMES, magnet systems based, services

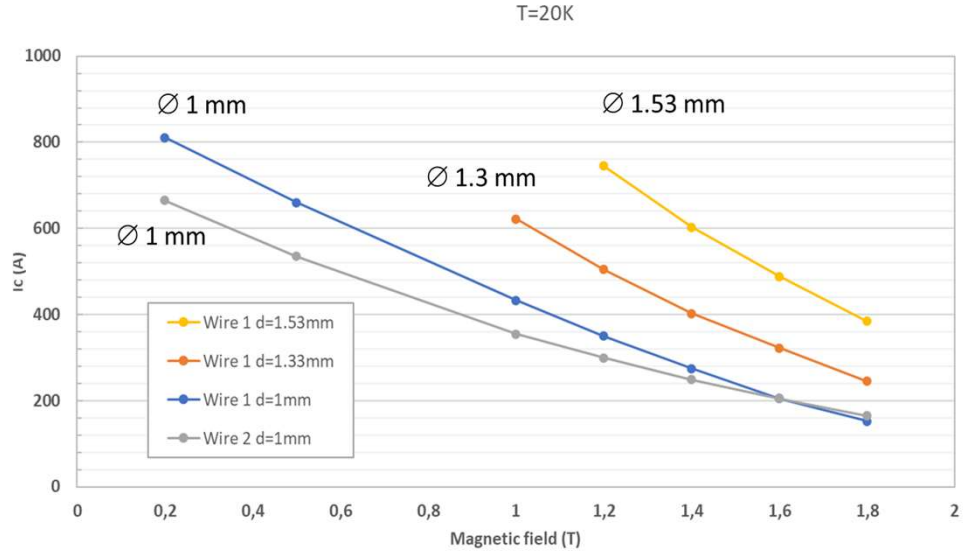

# WIRES FOR CABLES





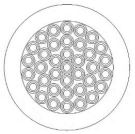




HILUMI wire developed with CERN

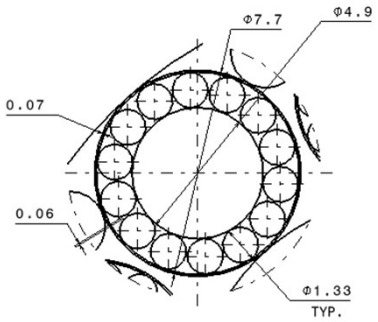



Reacted wires
with mechanical properties suitable for
cabling operation using industrial machine

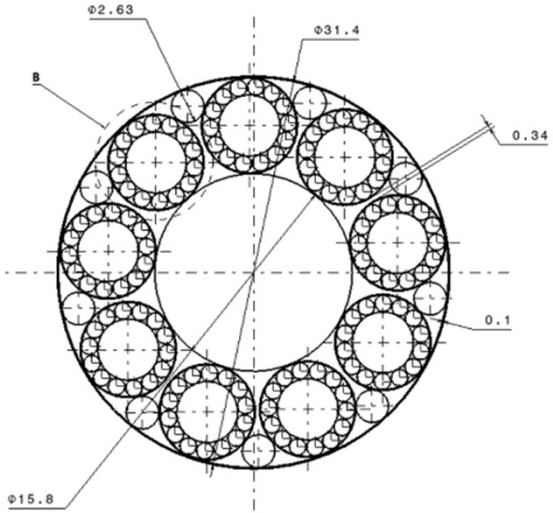
# MGB2 SUPERCONDUCTING CABLE CONDUCTOR



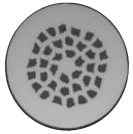
Wire

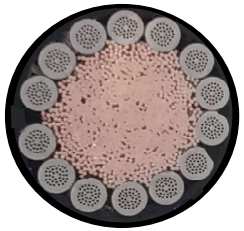


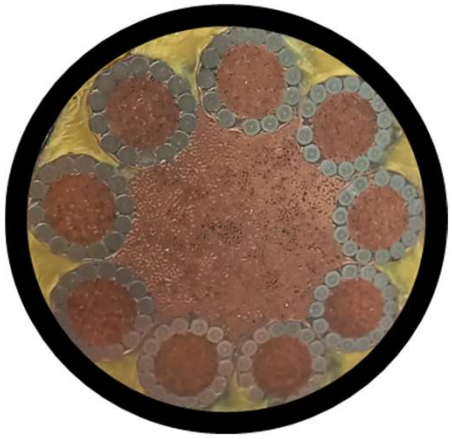

Single layer cable




Multi petals cable







Different design
- single layer
- coaxial
- multi petal

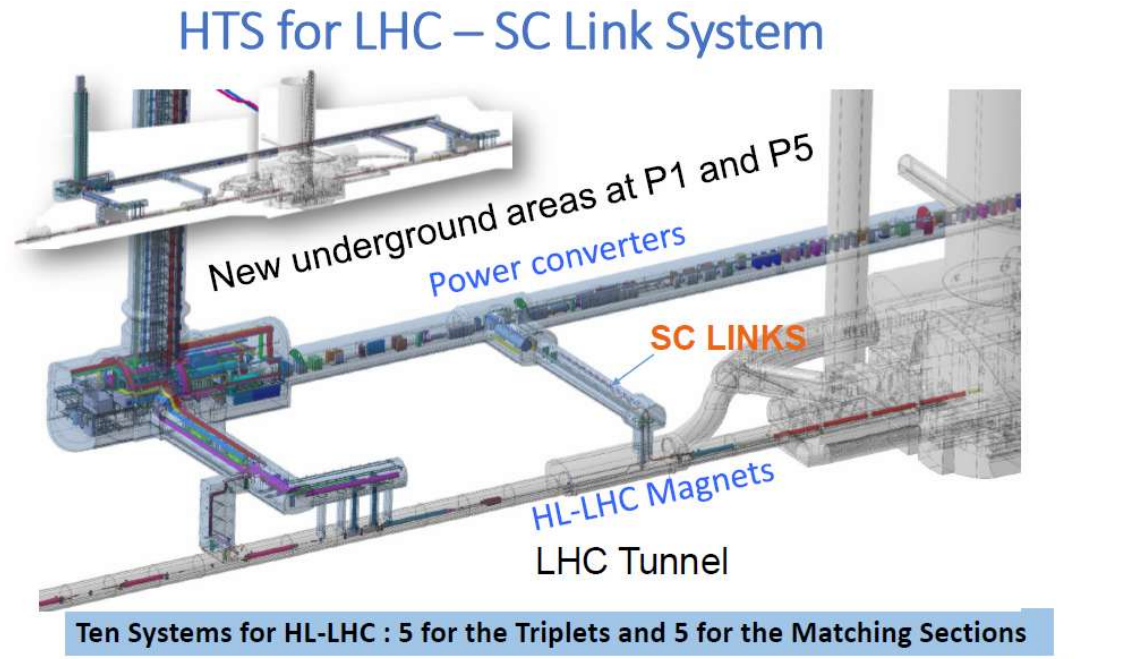
Modularity:
It's possible to optimize the design with the operating current (and temperature margin)

Possibility to assemble different insulated cable in the same structure to feed different point (umbelical cable), like in the SC link of CERN HiLumi

$MgB_2$ Vs ReBCO

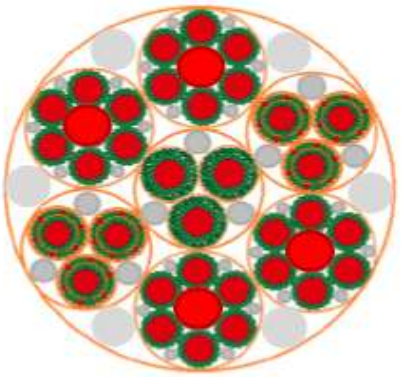
Wire is flexible, bending in all the direction ($r<R_c$)
Cost/m of $MgB_2$ is lower
Unit length up to 4-6km, less than 3-5% deviation on Ic
No Ic drop
No need of junction

# SC LINKS AT CERN



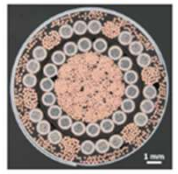

**Ten Systems for HL-LHC : 5 for the Triplets and 5 for the Matching Sections**

A. Ballarino

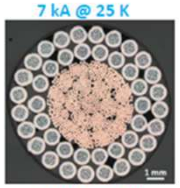


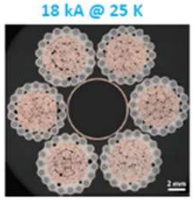

Cabling made from reacted wire

Series cabling at TRATOS/ICAS









**More than 1500km of $MgB_2$ wires delivered by ASG and fully qualified**

**1-MO-MG.1I First large-scale production of $MgB_2$ round wire: the Superconducting Links for the HL-LHC Project at CERN**

Presenter: Amalia Ballarino, CERN, Geneva, Switzerland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**LVDC application**
**Conclusions**

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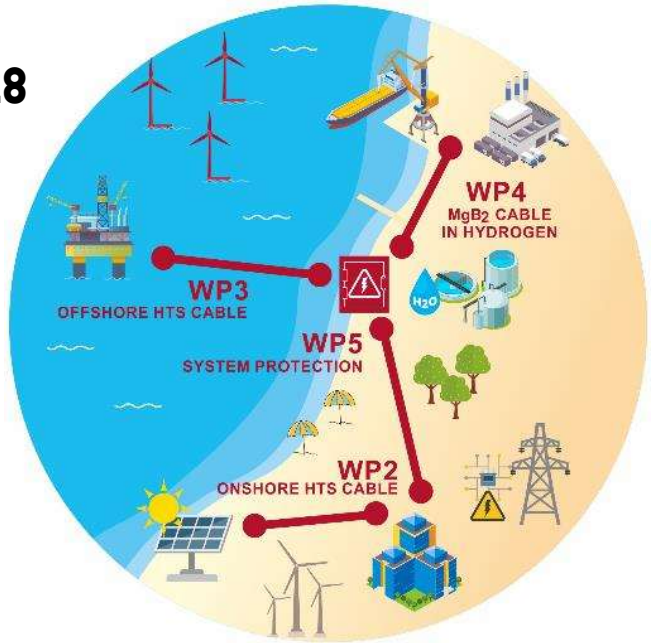
# EUROPEAN PROJECT SCARLET 2022-2028

SCARLET
Superconducting CAbles foR sustainable Energy Transition




Expertise from 15 industry and research organisations in the fields of material sciences, cryogenics, energy systems and electrical engineering

**Goal:** develop and industrially manufacture superconducting cable systems at the gigawatt level, bringing them to the last qualification step before commercialization

- 1 work package on architectures of offshore superconducting cable systems
- 1 work package for integration studies and economic evaluation
- work packages for communication and coordination

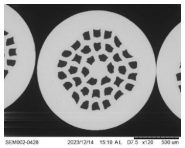
- 3 demonstration work packages
  - long-length onshore superconducting cable systems
  - system protection
  - **$MgB_2$ cables in liquid hydrogen**

Funded by the European Union

The SCARLET project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101075602.

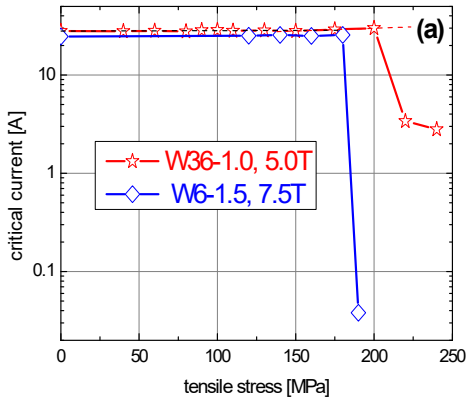
# WIRES SELECTION AND CABLE DESIGN

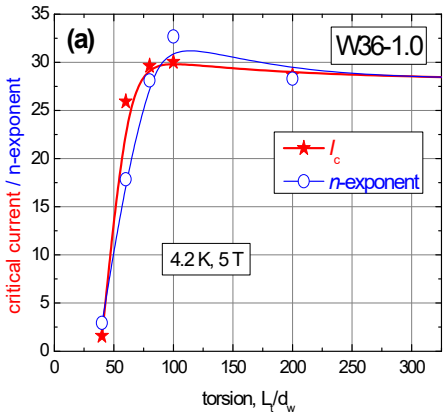
| | SCARLET |
|---|---|
| **Current** | 20kA |
| **Voltage** | +/- 25kV |
| **Coolant** | $LH_2$ |
| **Length** | 150 m |
| **End of Project** | Ott-28 |

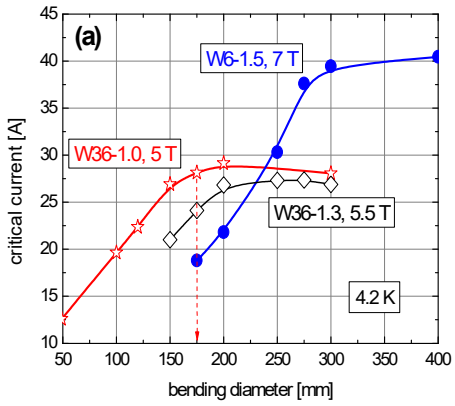


Monday, September 22, 2025
MgB2 Wires & Tapes
15:15 – 15:30
**$MgB_2$ wires and tapes at ASG Superconductors: state of the art and future perspectives**
Matteo Tropeano, ASG Superconductors Spa, Genova, Italy

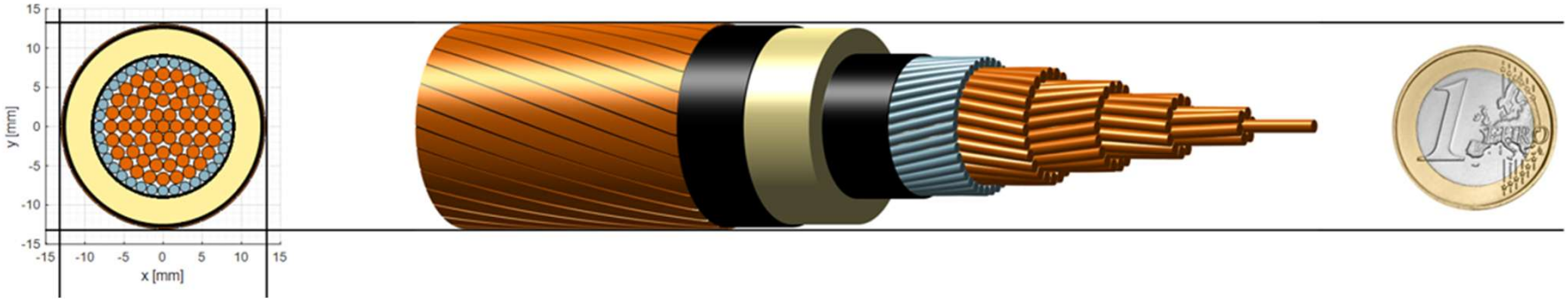
65004 P Kováč *et al*




INSTITUTE OF ELECTRICAL ENGINEERING SAS




A.Morandi

Very compact and fault tolerant cable design

IEEE TRANSACTIONS ON APPLIED SUPERCONDUCTIVITY, VOL. 35, NO. 5, AUGUST 2025

## VOLTAGE INSULTATION IN LH2

First step has been done to mimic H2 by LN2 to compare Kapton, PPLP and KraftPaper

LH2 Tests possible in the next month with a new set-up

ESPCI PARIS
EDUCATION SCIENCE INNOVATION

Poster
Monday, September 22, 12:00 – 13:15 | East Ground Floor
**1-MP-CT Characterization Techniques**

**Novel setup for measuring lapped insulation at cryogenic temperature**

*Luhan Zu*[1], *Stéphane Holé*[1], *Nicolas Lallouet*[2], *Georg Gamper*[3], *Adela Marian*[4], *Christian-eric bruzek Bruzek*[3]
[1]ESPCI, Paris, France, [2]Nexans France, Calais, France, [3]ASG superconductors, Genova, Italy, [4]RIFS, Potsdam, Germany

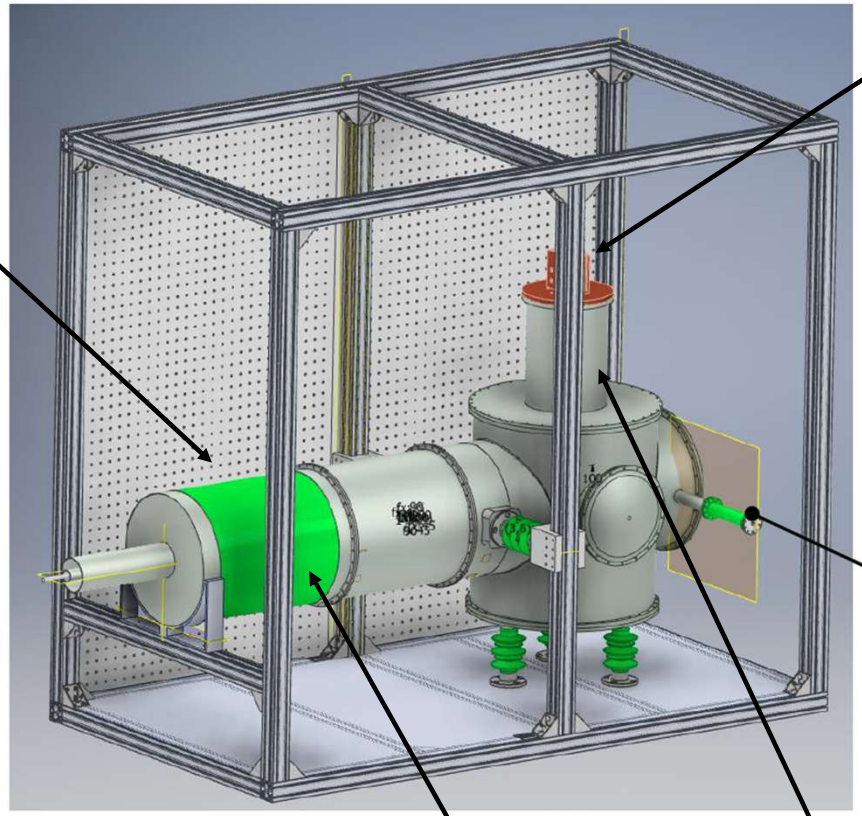
EUCAS 2025

## 2 WALLS CRYOGENICS ENVELOPE

Commercial product with material compatible with $LH_2$

Compared to the 4-wall alternative,
it's more compact and asier to handle and install

# TERMINATION AND JOINT



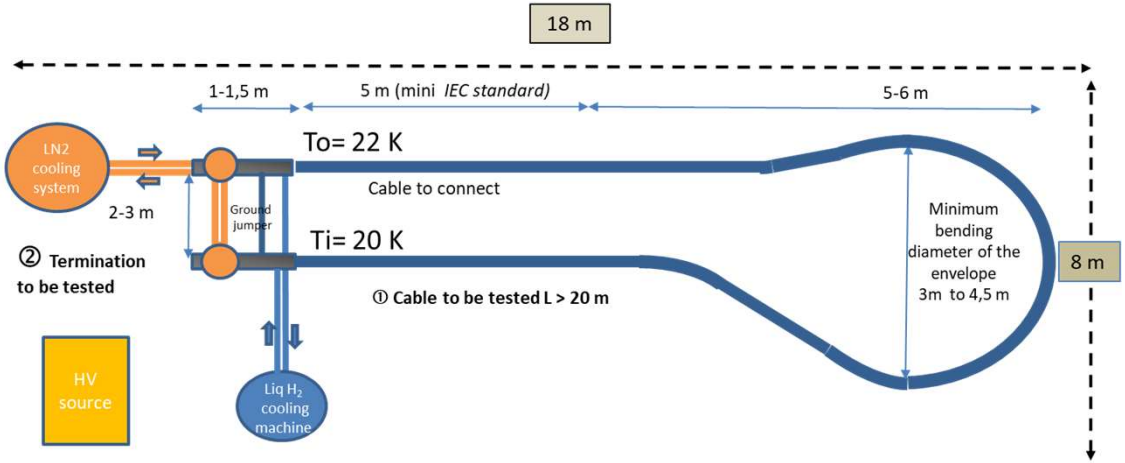

ASG, NEXANS Fr and VESC are collaborating to define a modular design of the termination and to integrate the connection.

Thermal shield structure has been developed to avoid MLI in the EF management (green part)

Stress cone is foreseen to be built with the same material as the one used for the cable insulation (insulation tapes that will be impregnated with LH2 to have the same permittivity and limit the local electrical field stress.

Design phase foreseen to be closed Sept 2025

# LH2 COOLING AND TEST LOOP


Not easy to purchase LH2 for the test (below 200kg).

The cooling system will be probably based on closed cooling loop, to recycle Hydrogen during the test with a RHCL (Rempote Helium Cooling loop) subcooling the LH2.

The decision will be taken by the end of the year based on LH consumption evaluation and delivery possibility.

Type test at Sintef followed by long duration test at Abslout System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# IRIS PROJECT

IRIS is a project funded by the Italian Minister for University and Research, in the frame of a large recovery effort called *PNRR,* the Italian branch of the Next Generation EU framework.

IRIS (Innovative Research Infrastructure on applied Superconductivity) is led by INFN (through its LASA lab in Milan) and includes also CNR-SPIN and 5 Universities).

**Goal:** developing applied superconductivity for HEP future collider (FCC-hh) and **exploiting potential applications to society in green energy** (higher sustainability) and in medical field.


- 60 M € including taxes (39 M € scientific instrumentation)
- Geographical distribution 45% North 55% South
- 36 Fixed-term positions (50% academic) 5 PhD

- Project duration: started on 1 Nov 2022, ending by 30 Apr 2026 (42 months)

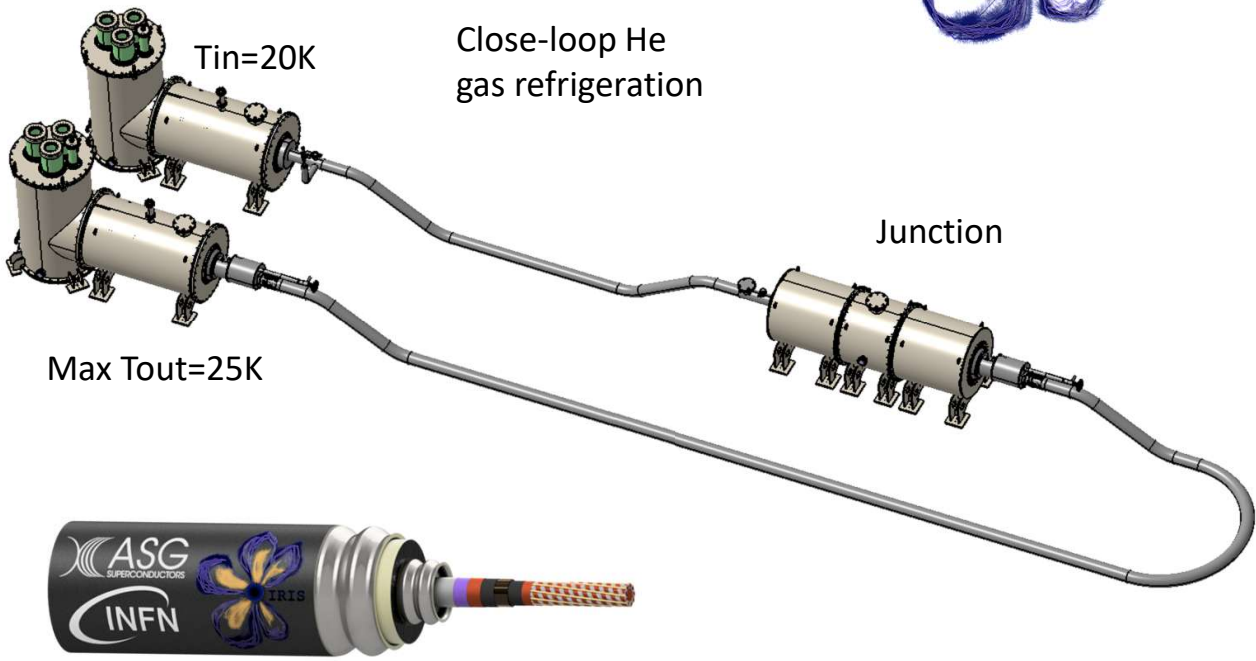
*IEEE-CSC, ESAS and CSSJ SUPERCONDUCTIVITY NEWS FORUM (global edition), Issue No. 61, Nov. 2025. Presentation given at EUCAS 2025, Porto, Portugal, Sept. 2025.*

# GREEN SUPERCONDUCTING LINE

ASG is involved in the IRIS project as supplier.

We will supply the complete cable systems: design, construction and installation on site

| IRIS | |
|---|---|
| Power rating | 1 GW |
| Voltage | 25 kV |
| DC current | 40 kA |
| Operating temperature | 20 K |
| Cooling medium | He gas |
| Superconductor | $MgB_2$ |
| Line length | 130 m |
| Inner pressure | 10 bar |

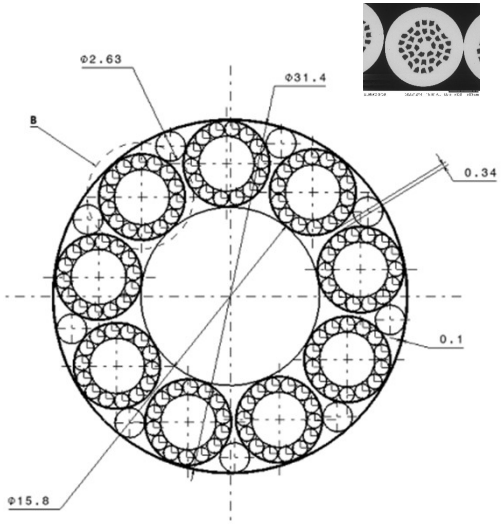



Monday, September 22, 16:45 – 18:15 | Arrábida Hall (154)
**1-LO-PT Power Transmission Lines and Cables (AC and DC)**

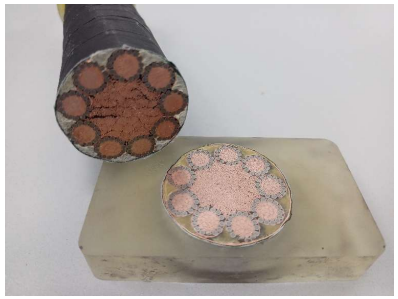
Monday, September 22, 17:00 – 17:15 ... , Arrábida Hall (154)
Final design and first performance tests on short-length prototypes of the Green Superconducting Line for the Italian facility IRIS
**Presenter: Carlo Santini, INFN Milan, Milan, Italy**

The line will be installed in the IRIS laboratory of Salerno, to commission the new **SC cable test facility**

# CABLE DESIGN AND TEST VALIDATION




1.3mm wire

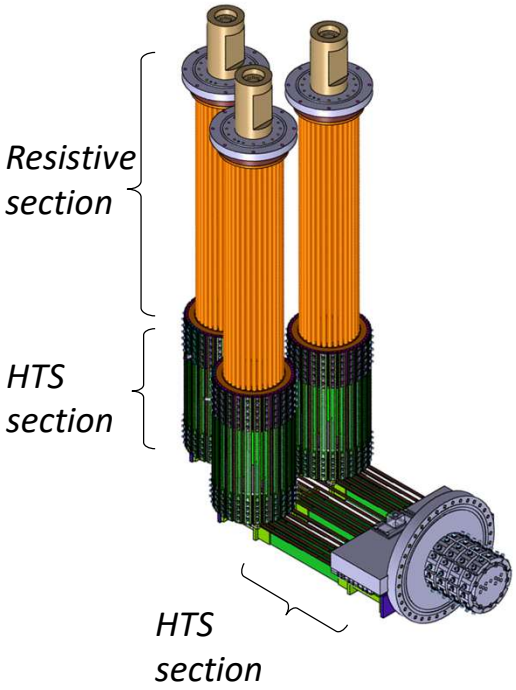


The cable has been designed in the multi-petals configuration
Able to carry 40kA with an operative margin higher than
25% at 25K and 50% at 23K

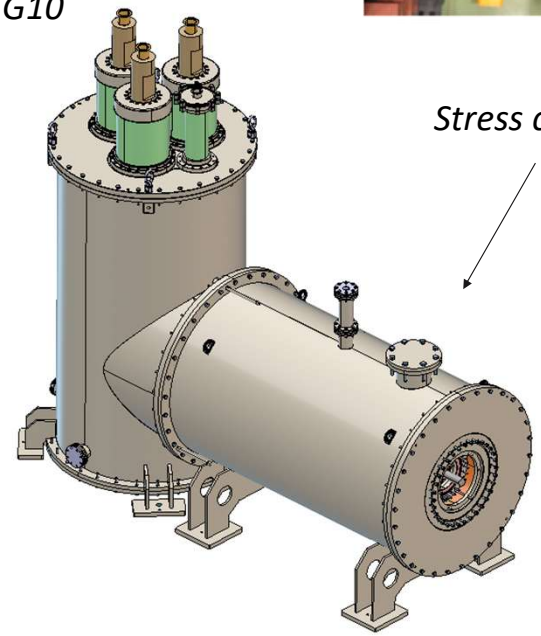
More than 100km of MgB2 wires has been produced
to validate the cabling process and to manufacture the cable
Cabling and insulation activities has been completed

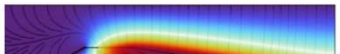
In the next weeks 20m long full cable will be
tested at ASG plant

# TERMINATION AND JUNCTION

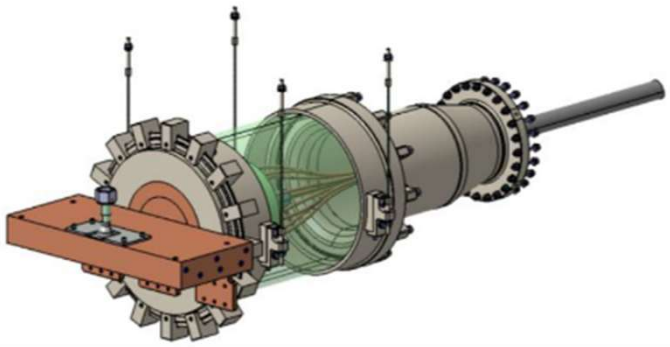


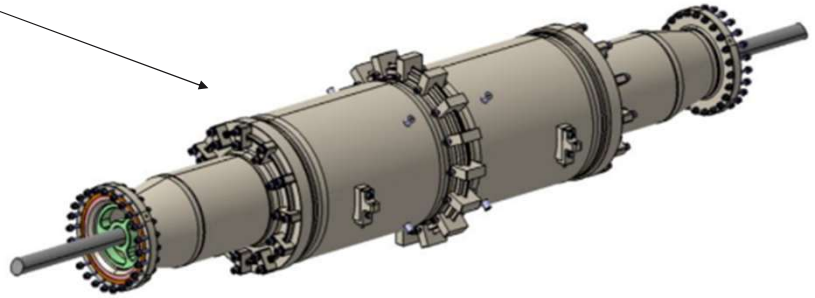

Electrical insulated G10





Stress cone zone





Design phase completed,
now in construction with most of the materials already supplied

# SALERNO TEST FACILITY

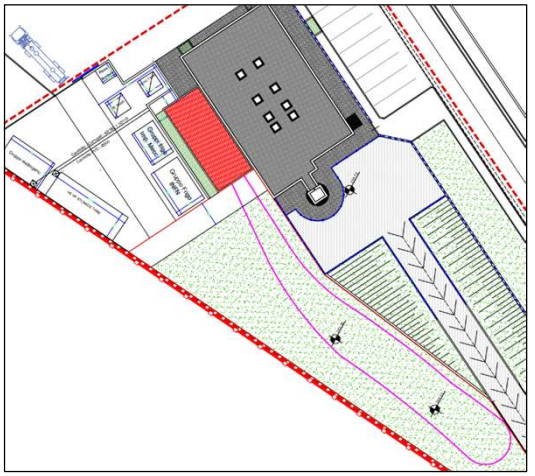
Salerno Facility will be ready for installation by end of 2025,
SGL testing are foreseen for the first part of 2026.

- Powering

- 40 kA/10 V power converter placed on an insulated platform + 600 kVA 3PH transformer
- 10 m copper bus bars to the current leads
- 50 kV DC power supply for operation at 25 kV
- Voltage divider and 50 kV Impulse generator for lightening tests
- Data acq monitoring and control and quench detection system
- 350 kW UPS battery

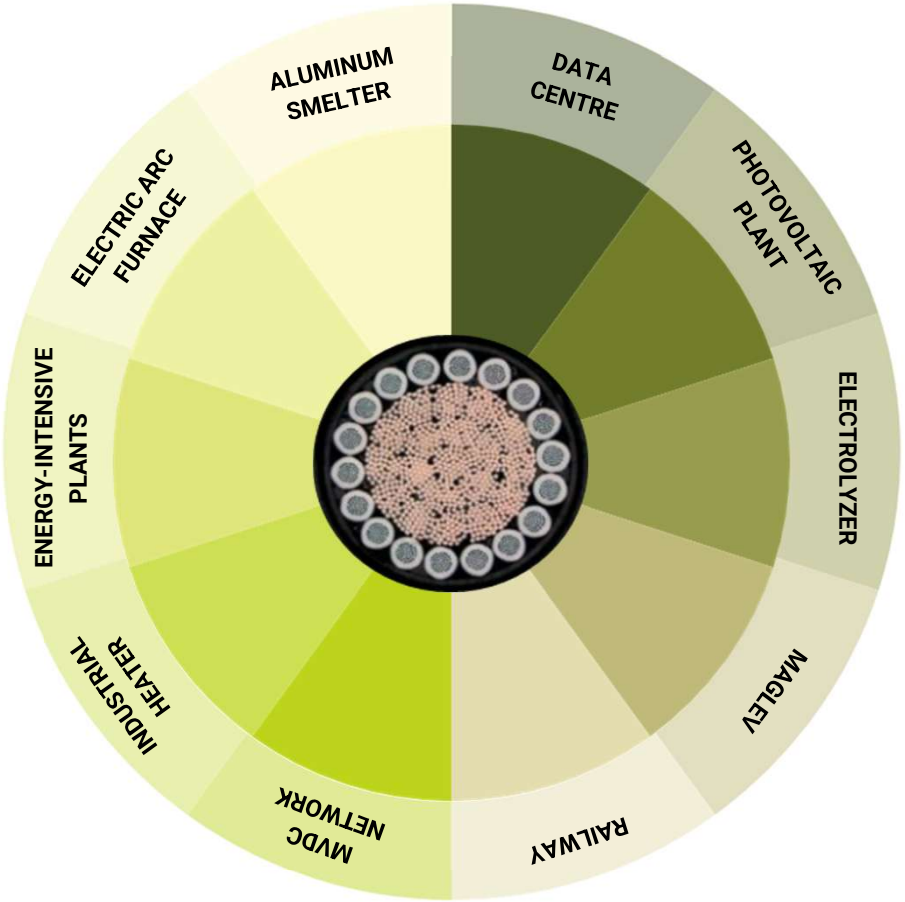
- Cryogenics

- Refrigerator: cooling power 500 W @ 20 K He gas (22 g/s)
- Helium gas tank (30 $m^3$@ 15 bar)
- Liquid Nitrogen tank (30 $m^3$) for current leads cooling
- 20m He gas transfer line for the flexible cryostat
- Commercial vacuum systems
- Liquid Helium dewars (1000 L)
- He gas recovery system (compressor, balloon, 200 bar tanks)



*Inner Cold Box – Vorbuchner Refrigerator*

It will be open for external user




# CONCLUSION

MgB2 wire manufacturing is a mature technology.

Round wires can be used for designing and manufacturing really compact and robust high power cable.

There are many use cases where the MgB2 solution is really competitive with HTS, even if the operating temperature is lower.

Ongoing projects are demonstrating the technology, with cooling in $LH_2$ and He gas.

At the END of the IRIS project, a power cable test facility will be available to esternal user.