



Shaping the Future of Steel: RINA CSM's Innovation Hub for Green Steel and Hydrogen transition

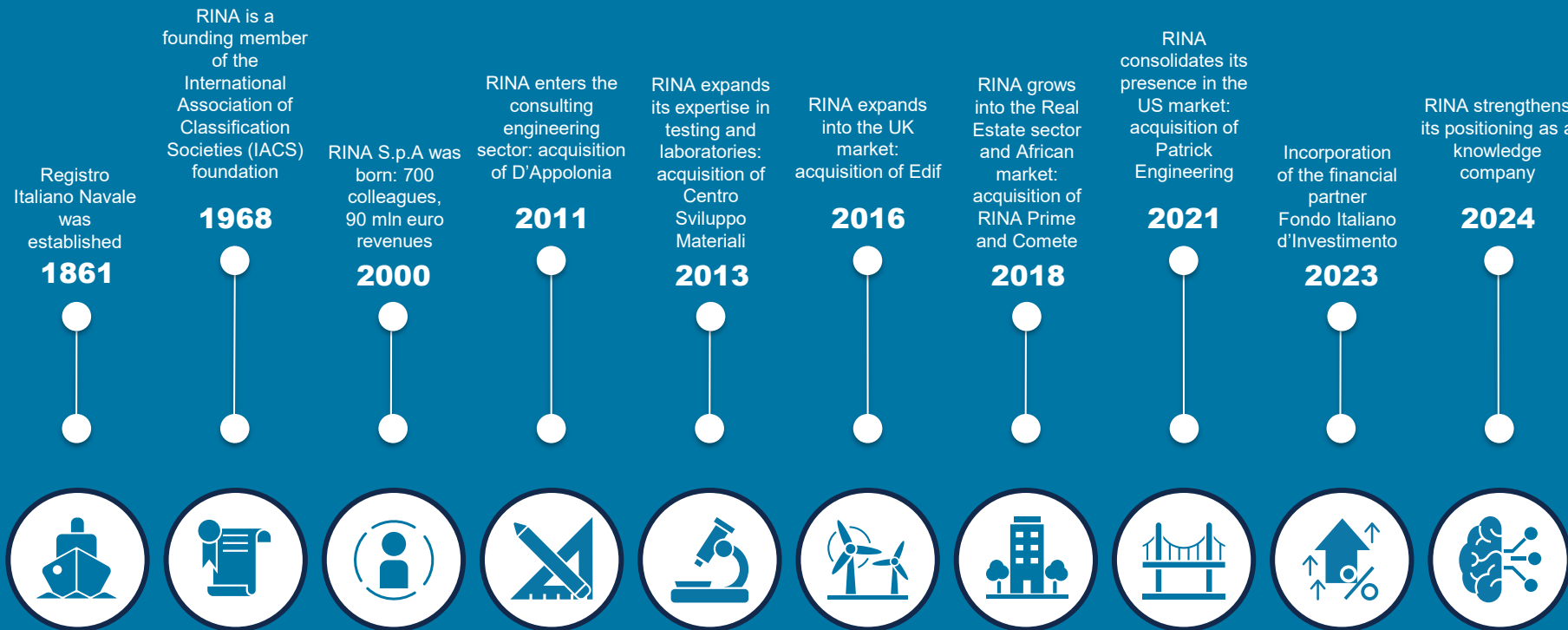
Filippo Cirilli

TECO-58 MEETING

Newcastle, UK 29-30 April 2026

Our experience. Your growth.

A long journey



RINA Today



7,000
colleagues



200
offices



70
countries



>90
nationalities



75%
educated to
degree level



42
average
age



29%
women in STEM
in RINA



28%
women in managerial
positions

Successful growth

Min€



Revenues

*Forecast

Our business unites

Energy

RINA's energy team offers global expertise in site characterization, advisory, engineering, inspections & supervision, supporting energy projects from development to decommissioning, ensuring safety and efficiency.



Industry

RINA's industry team provides highly qualified services, thanks to its multidisciplinary approach and outstanding application expertise across all industrial sectors - including A&D, hard-to-abate industries, management consulting, and cybersecurity.



Infrastructure & Mobility

RINA's infrastructure & mobility team supports the path to the next generation of infrastructures and buildings by ensuring their safety and efficiency.



Marine

RINA's marine team provides ship classification, statutory certification, advisory, digital and technical services for safety, sustainability, and innovation across commercial, naval, and yachting sectors.



Certification

RINA's certification team guides companies on their journey toward continuous improvement and excellence, by certifying organizations' genuine dedication to best practices.



Real Estate

RINA's real estate team supports public and private market operators with innovative services aimed at protecting and enhancing real estate capital value at every stage of the investment.



Fattoria degli animali

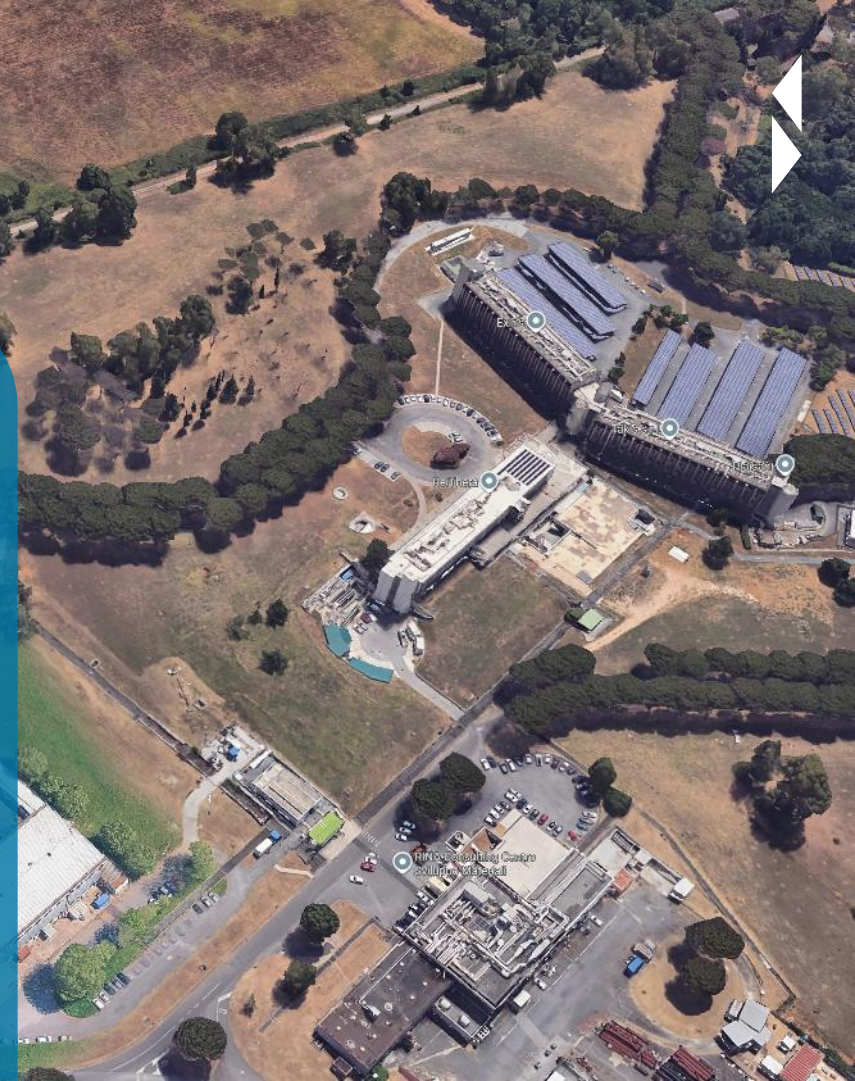
World
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RINA Consulting Centro Sviluppo Materiali

RINA CSM

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00100 Roma

Google

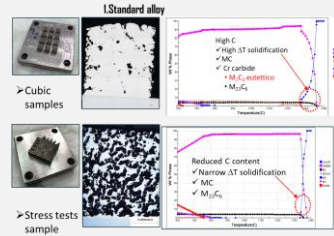


RINA CSM

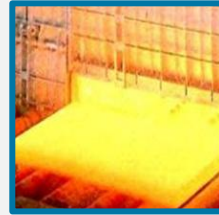
- The **Rina Industry Business Unit** provides high-added value integrated services with a special focus on manufacturing, steel and heavy industry, aerospace and defense.
- **Whitin this BU, RINA CSM** is the Company devoted to the Steel Industry and manufacturers in sectors such as Oil&Gas, Power Gen and Automotive.
- **RINA CSM** was founded in 1963 by Italian Government and since 2013 incorporated in **RINA Group**.
- More than **270** highly trained and **experienced resources** and **11 laboratories and pilot plants**
- More than **300 R&D projects per year** for the most important European steel makers, plant suppliers, Oil&Gas majors.



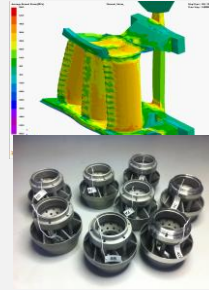
From Raw Material to Final Product



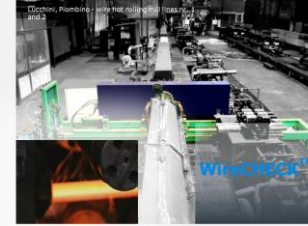
MATERIAL DEVELOPMENT



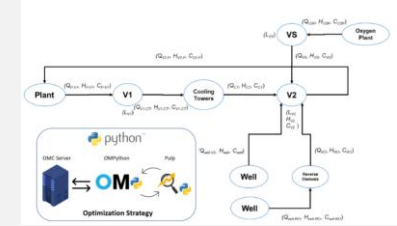
PROCESS DEVELOPMENT



PRODUCT DEVELOPMENT



CROSS - CUTTING TECHNOLOGIES



ENVIRONMENTAL SOLUTION



- Alloys Design for new materials at higher performance
- Alloy Design for Powders for Additive Manufacturing
- New special coatings

- Steelmaking & Casting & Rolling & Forging
- Additive Manufacturing
- Heat treatment & Surface conditioning
- Combustion
- Welding and Joining

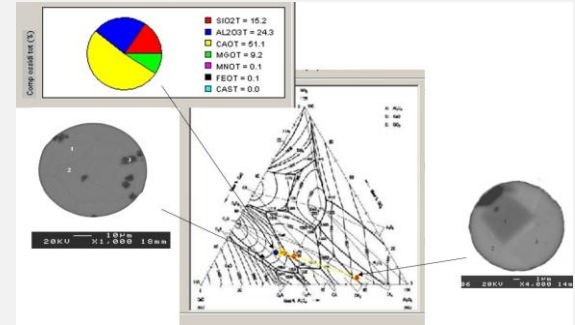
- Net shape and near net shape products
- Semi-products
- Coatings
- Flat, Long Products and Tubes
- Application Engineering
- Prototyping

- Through process approach
- L2/L3 Control Systems
- Tailor made tools
- Customized sensors
- Technological DB

- Solid Waste Valorization
- Water Management
- Emission Reduction
- Energy Recovery

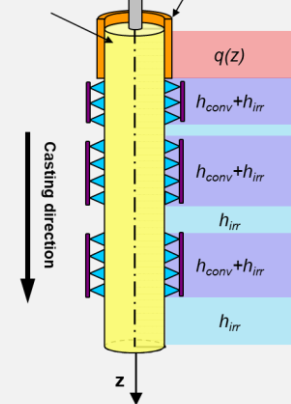
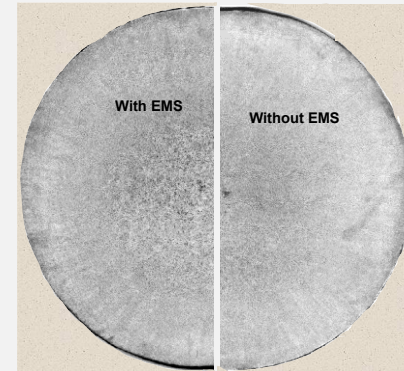
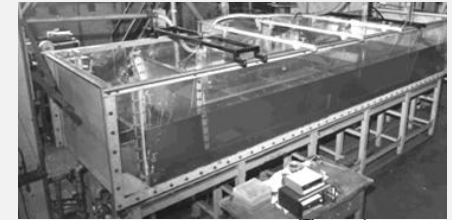
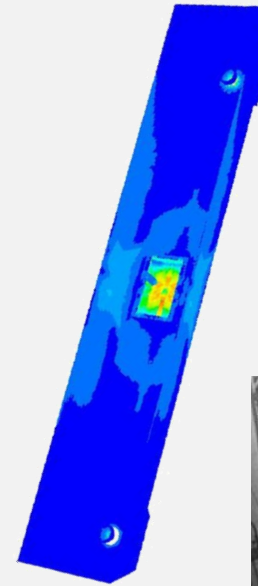
Steelmaking & Casting

- **BF/BOF** process optimization; onsite expert
- **EAF** process model for operating practice optimization. Utilization of secondary carbon carriers as fossil substitute. Slag design. Dephosphorization.
- **EAF scrap** analysis and sorting. Onsite support
- **Secondary metallurgy and steel cleanliness**, slag design, desulphurization; modeling of vacuum treatment, inclusion engineering, operating and stirring practices definition
- **Steel / slag / refractory** interaction with thermodynamic modelling and purposely designed tests
- **Metallurgical design**, definition of steel grades, alloying practice; metallurgical models and production of innovative steel grades



Steelmaking & Casting

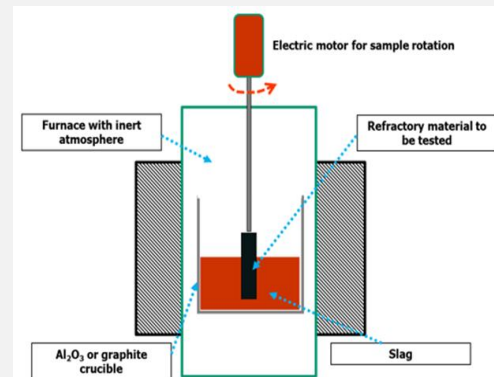
- **CFD tundish** analysis: flow field, temperature distributions, inclusion patterns. Optimization of tundish design.
- **Tundish powders** simulation and steel interaction.
- **Mould simulation activities**: flow field definition, slag entrapment, heat exchange phenomena. Electro magnetic stirring effect simulation
- **Casting powders** characterization and design. Steel/powder chemical interaction.
- **Solidification model** for different steel grades and shapes; calculation of solidification pattern, segregation phenomena, coupling with metallurgical models



STEEL/SLAG/Refractories interactions

Development of dedicated Laboratory Methodologies for evaluating the corrosion behavior of **refractories** in contact with **slag** and **liquid steel** with the aims of:

- **Comparative assessment** of different refractory materials
- Support of the **optimization** of existing solutions
- Contribution to the development of more effective **refractory formulations**



Reheating and Rolling

Reheating and thermal treatment

- Burner testing up to 3 MW
- Feasibility study for the utilization of natural gas and hydrogen blends on industrial furnaces
- Reference industrial scenario
- Development of furnaces digital twin



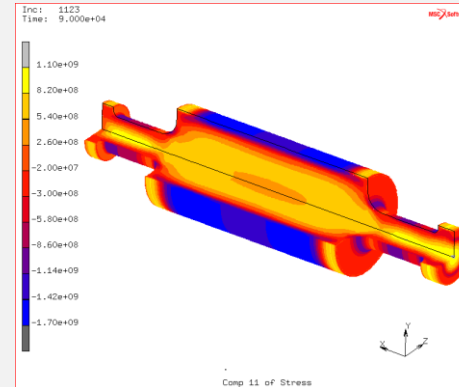
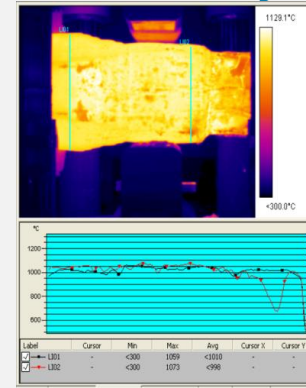
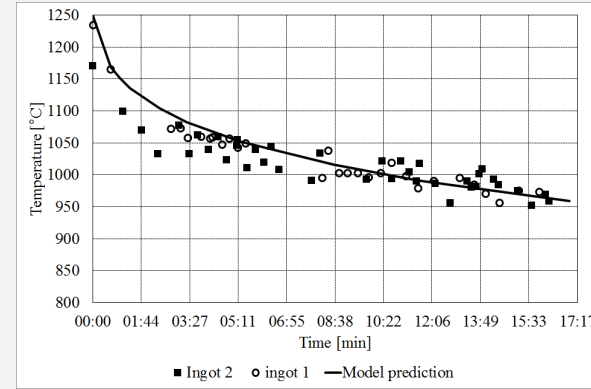
Rolling and annealing

Advanced automation and process control models of hot, cold rolling and annealing, able to integrate their conventional functions with dynamic metallurgical models to allow a very refined on-line process / product properties control.

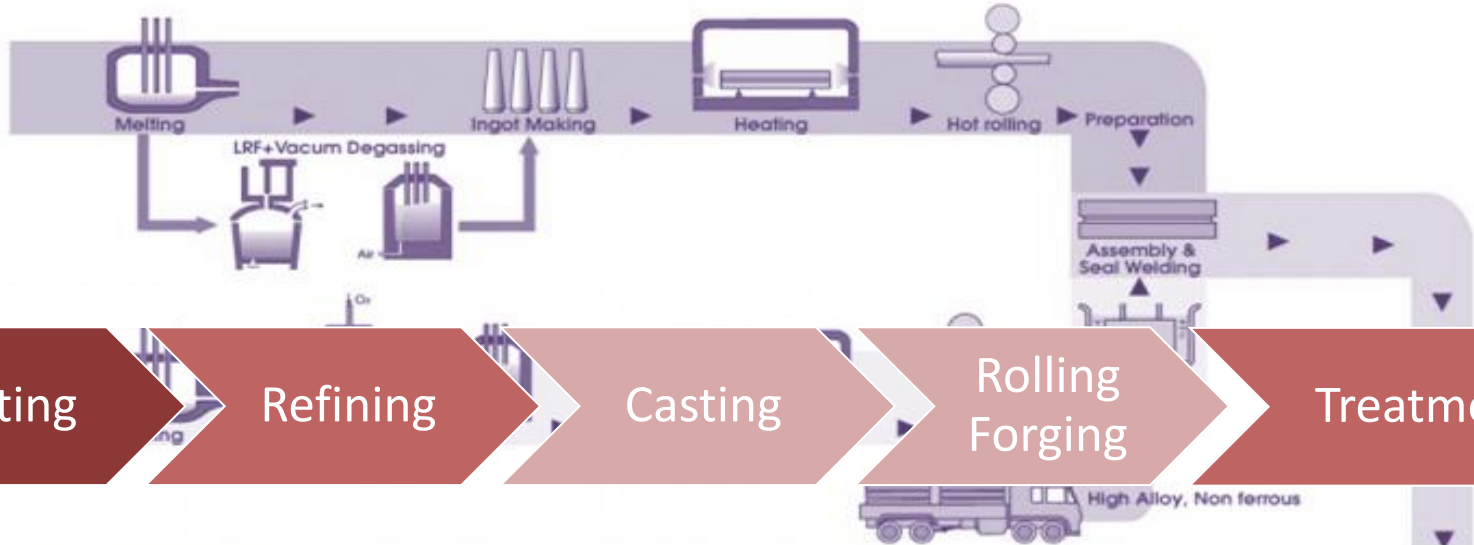
- **Off-line simulations** of hot rolling and annealing processes in different plant configurations and auto adaptive on-line models for rolling mill and annealing temperature pre-setting
- **Metallurgical modeling** to predict microstructure/texture evolution during hot / cold rolling and annealing processes
- **Second Phase precipitation modeling** for grain growth process control
- **Primary and secondary recrystallisation modeling** for product optimisation

Forging

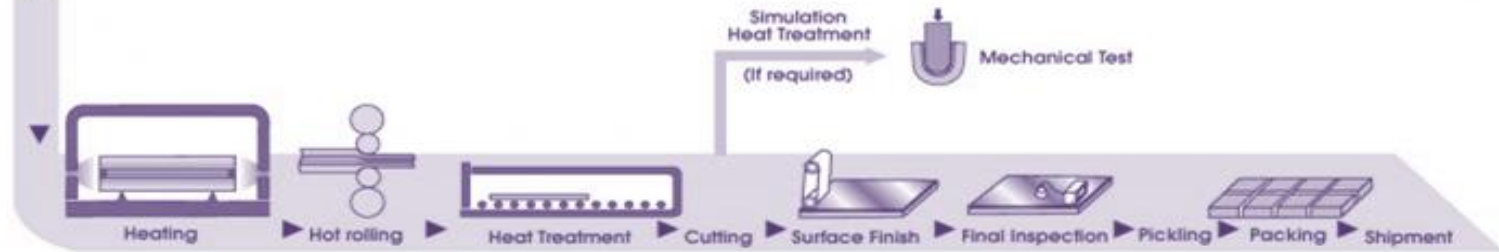
- **3D thermo-mechanical** forging modelling and microstructural fully coupled and implemented in the commercial finite element (FE) software allowing the prediction of **temperature**, **strain**, **grain size** and pressing loads during open die forging.
- **Recrystallization** and grain size evolution prediction
- **Definition of the** operating practice, heat treatment, process design according to product specification
- **Consultancy** on plant and equipment design
- **Support on plant start up** and acceptance



Digital Technologies – Process Modelling



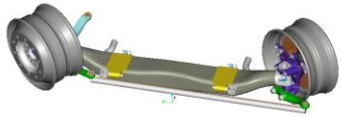
• Numerical modeling through process



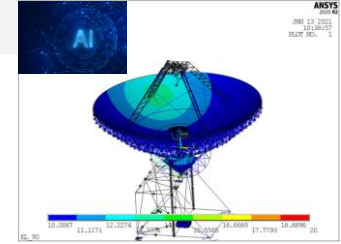
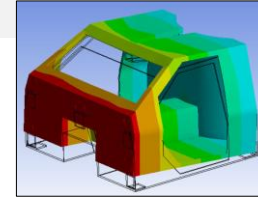
Digital Technologies – Process Modelling



Multi-body simulations

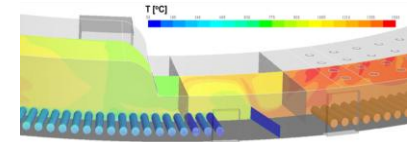
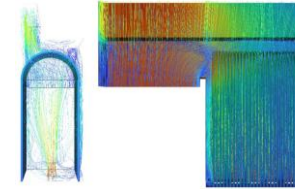


FEM Simulations



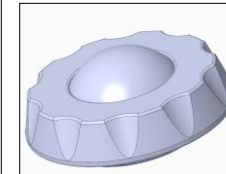
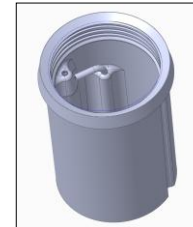
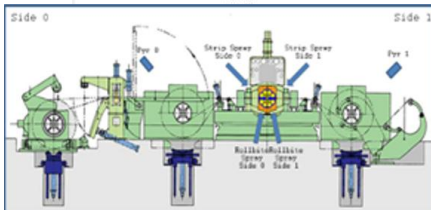
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CFD Simulations



Mechanical Design/ Product development

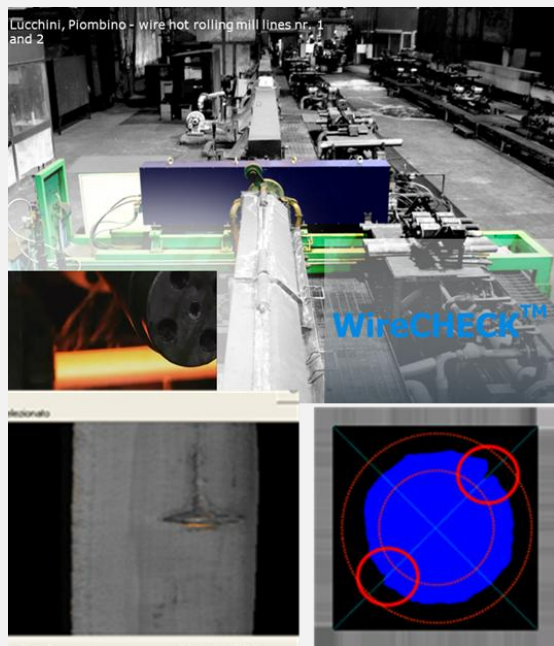
Process Optimisation



Monitoring and inspection

Analysis, application and development of advanced monitoring and inspection systems for process and quality control.

Solutions are developed and tested in Rina labs and pilot plants and then applied on industrial plants



WireCHECK – wire automatic inspection @ hot rolling

- the system optically inspects the wire out-coming from the hot rolling mill
- the system makes use of high speed cameras & high power LEDs
- each single defect is pointed out with different colors
- the system can estimate the wire cross-section and highlight longitudinal defects.

Monitoring and inspection

Safety@Work Plant Showcase

Real-Time Data Management Dashboard

Your eyes on field: Cloud based Data Platform to see & analyze all data coming from different IOT sources



Anti Collision

Avoid incidents thanks to IOT and wearable techs via pre-warnings & alarms systems

Drone Monitoring



PPE Monitoring

Ensure correct usage of personal protective equipment: Helmet, harness, shoes, etc.

Track & Trace

Localize workers & vehicles in the workplace

Geofencing + ManDown + SOS

Localization and ManDown for faster save and rescue. SOS for voluntary emergency condition signaling

Virtual Boundary

Area Boundaries to help safety procedures implementation





Labs and facilities



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Foundry labs/pilot lines, ESR VAR/Powder



PRIMARY MELTING

SECONDARY MELTING

NEAR NET SHAPE TRANSFORMATION

THERMO- MECHANICAL TRANSFORMATION

VACUUM INDUCTION MELTING



VACUUM INDUCTION GAS ATOMISATION

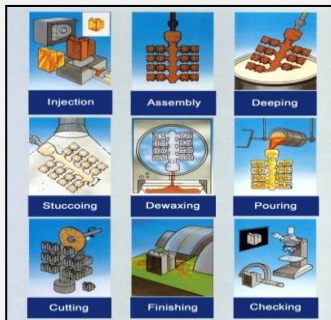


VACUUM ARC / ELECTRO SLAG REMELTING



COATING:
HVOF, CAPS, PVD, Cold Spray

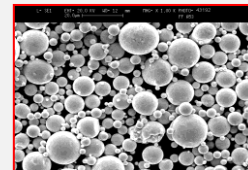
SINTERING:
HIGH ISOSTATIC
PRESSURE
ADDITIVE
MANUFACTURING
SINTERING:
METAL INJECTION
MOLDING
INVESTMENT CASTING



HOT / COLD ROLLING FORGING



RINA VIGA PLANT (VACUUM
INERT GAS ATOMIZER) FOR
POWDER PRODUCTION WITH
SIGNIFICANT NUMBER OF
CHEMICAL COMPOSITIONS



Hydrogen labs



Test on materials
SMALL SCALE unit



H₂ test pressure
up to 1000 bar

Test on components
FULL SCALE unit
(Full Scale)



H₂ test pressure
up to 1000 bar

Δ H Lab SMALL SCALE testing unit

The small-scale testing unit is equipped with 3 testing frame: a SSRT servo-mechanic testing machine and 2 servo-hydraulic machines
Following tests can be performed:

- Slow Strain Rate tests
- Tensile tests at different strain rates
- Crack propagation tests
- Fatigue tests

Applicable test conditions

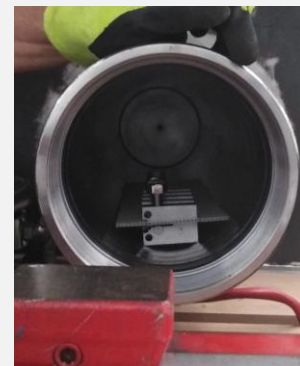
Temperature	-10 °C ÷ 150 °C ⁽¹⁾
Pressure	0 ÷ 1000 bar
Max Load	100 kN ⁽²⁾
Strain rate	10 ⁻⁶ s ⁻¹ ⁽³⁾
Max Frequency	20 Hz ⁽⁴⁾
Crack propagation monitoring	ACPD or DCPD

Picture above

- (1) temperature range of vessel. Currently test performed at RT
(2) max axial load applicable by testing frame without the external chamber
(3) referred to the SSRT testing frame
(4) referred to the hydraulic testing frames



Vertical servo-mechanic Italsigma SSRT testing frame equipped with 1000 bar vessel for hydrogen application.



Vessels ready for test, placed into the safety chambers and loaded samples placed into the vessel

FULL SCALE TESTING IN HYDROGEN

- ❑ A **state-of-the-art laboratory** able to test full scale components (bottle, vessel, fitting, valve, pipe) subjected to different types of loading and H₂ mixtures.
- ❑ **Safety chamber:** a steel chamber (56" diameter, 12 m length) can accommodate big samples with the required safety requirements
- ❑ **Mixtures:** pure H₂ and H₂-Natural Gas blends
- ❑ **Loading:** static, monotonic till failure, fatigue
- ❑ **Instrumentation:** defects growth monitoring through strain gauges and semi-continuous ultrasonic TFOD technique
- ❑ **Max pressure:** 500 bar static/monotonic increase, 200 bar pressure cycling
- ❑ **Lab team** with high skilled competences covering test design (fatigue and fracture mechanics expertise, FEA), test monitoring and execution and post test analysis (failure analysis)

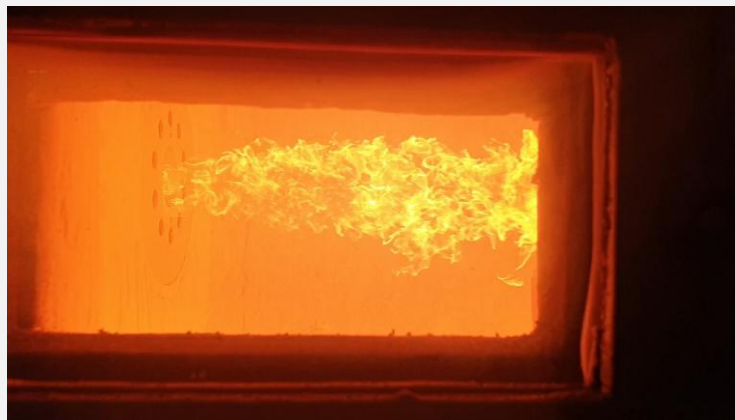


FULL SCALE BURST TESTING WITH ANTHROPOGENIC CO₂



Combustion Station

1. Max power burner 3 mw
2. Fuel: NG, H₂ and SYNGAS (any blends)
3. Fuel feeding by plant pipeline, gas bombs and wagon tank
4. Max fuel flow rate:
 - 300 nm³/h of NG,
 - 2000 nm³/h SYNGAS
5. Max air flow rate: 3000 nm³/h
6. Air preheater: max temperature 550 °c
7. Pollutants monitoring and recording: O₂, CO, CO₂ & nox
8. Flow rate, pressure and temperature monitoring and recording
9. Continuous video monitoring





Funded by
the European Union
NextGenerationEU

HYDRA

An Open R&D Platform
for Steel Decarbonization



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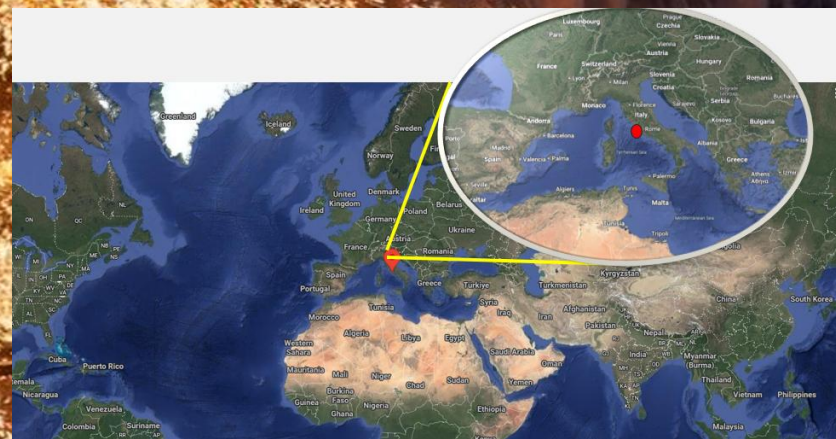
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HYDRA – An industrial open living platform



A RINA CSM open R&D facility and relevant processes for GREEN STEEL production

HYDRA aims at developing an **industrial open living platform** in which **develop, qualify and validate** the use of **hydrogen in steel industry** to support and boost the decarbonization in the steelmaking processes, with two main target:

- ✓ The development of a first-of-a-kind experimental pilot line of DRI and EAF
- ✓ The acquisition of deep industrial knowledge in the metallurgical aspects related up to 100% hydrogen steel production



HYDRA will represent a **catalyst and booster** for the acceleration of the European Hydrogen-based Steel Industry development

HYDRA - Development of green hydrogen use in steelmaking

Materials Testing & Qualification - Standardization

- Selection of materials and components
- Functional compatibility of pipelines, components/fittings, equipment
- Performance and reliability in the different operational scenarios
- Pipeline and fitting integrity status (requiring through integrity assessment)
- Assessment and certification of an existing network
- Support on Design and construction of new lines, equipment in the plants

HSE and LOGISTICS

- Risks associated to hydrogen properties requires:
- The upgrading of standards and regulation framework
- The definition of guidelines and procedures

RINA CSM as Reference Center & Training HUB

The transition to hydrogen steelmaking will be gradual and distributed over time and therefore has the goal of providing knowledge and technologies to better manage the coming transitional phase. RINA will also establish a training centre to gather and disseminate know-how related to the design, implementation, and deployment of hydrogen-based decarbonization technologies.



HYDRA - DRP

The pilot plant has been designed to investigate Direct Reduction process, **simulating in a reliable scale what occurring** in industrial plants

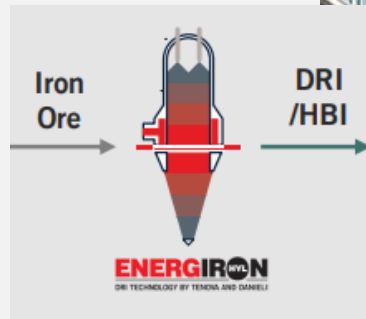
The technical objective is to define relationships between process performance and operating conditions.

Process performance are:

- DRI **production rate**
- **Metallization** degree
- **Carbon** content in DRI

Operating conditions are:

- **Pellet** dimensions and quality
- Reducing **gas** mixture ($H_2/CH_4/CO$)
- gas flow rate and temperature
- Ratio O_2 /reducing gas



The long campaigns will allow to investigate stability and reliability of:

- process performances
- System & components
- Process gas usage and recycling
- Innovative pre-heating systems for reducing gas (indirect and direct electrical heating)
- The pilot plant, with capacity of **100 kg/h**, shall supply DRI for the EAF melting process

HYDRA – EAF pilot plant

The DRI melting will be investigated with a state-of-the-art EAF pilot plant, of capacity of 7 t/heat.

Main characteristics of the furnace are:

- AC three electrode
- Scrap and DRI charge
- Continuous charging of DRI
- Injection of solid materials (additive, coal, alternative carbonaceous materials)
- KT lance working as Hydrogen burner or Oxygen injector

Experimental activities:

- Test with scrap + DRI at different C percentage
- H₂ Burning
- Alternative fossil materials addition: biochar, polymers,...

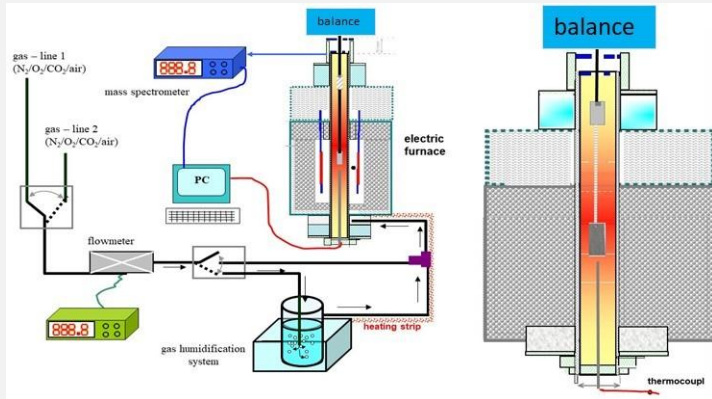
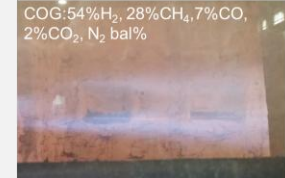
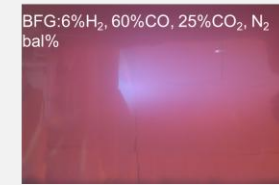
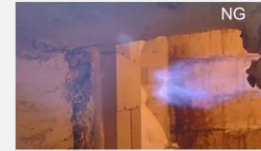


HYDRA – Use of hydrogen in furnaces

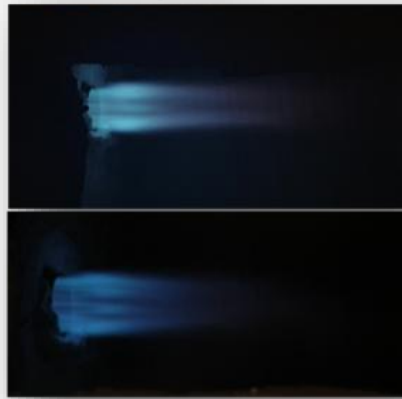
Task focused on the use of hydrogen in **furnaces** for re-heating and treatment of the steel.

Flexible burners, able to operate with any mix of H_2/CH_4 , up to 100% H_2 have been already developed and experimented.

The aim is supporting the diffusion of the technology and investigating the effect of H_2 combustion both on the products quality and performance/life of the plant components.



In furnace - 30% H₂ 70% NG



Steel Makers - Expected Industrial needs

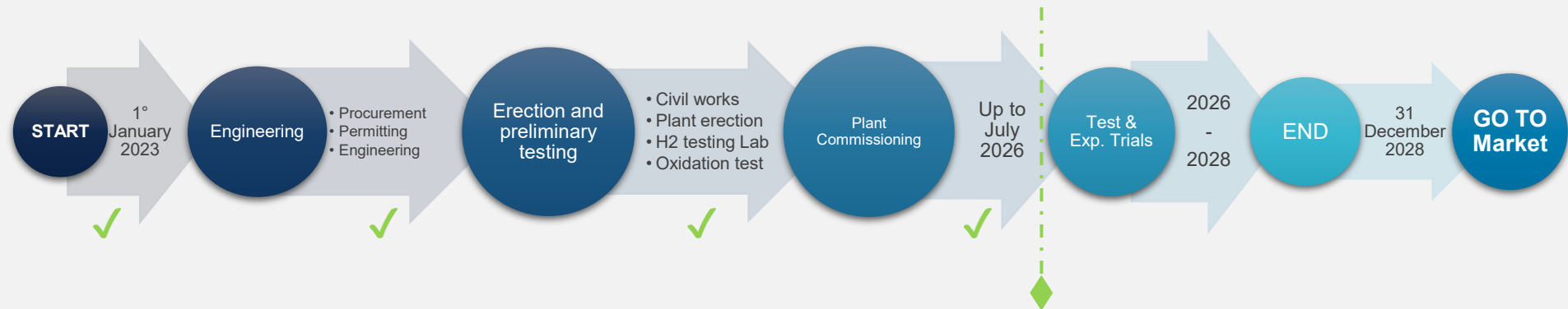


Industrial Process/Plant Type	RINA support
Existing / New Steel Complex based on Primary BF that will transitioning to DRP/SAF processes	✓ Specialized support including pilot-scale trials to define operating procedures for new melting plants and raw materials. ✓ The SAF configuration allows for full-scope support, from feasibility studies through commissioning and production ramp-up, including preliminary metallurgical design and technological validation.
Existing / New Steel Complex SAF based Introducing DRI/HBI	✓ Metallurgical and technological support for the set-up of production procedures and quality optimization on selected products. ✓ Global assistance for the introduction of new raw materials through pilot-scale trials (DRI, HBI, fossil alternatives), combined with SAF pilot testing and on-site support.
Existing / New Steel Complex based on SAF Developing new products	✓ Pilot-scale SAF trials and on-site activities to support metallurgical design, process definition, and industrial validation. ✓ Dedicated testing campaigns, including the use of alternative and fossil-free materials.
Existing DRP Steel Complex Converting from CH ₄ to H ₂	✓ Experimental campaigns aimed at assessing final DRI quality (metallization degree) as a function of: ▪ Process procedures ▪ Process gas blending ▪ Iron Ore quality (BF / DR)

HYDRA – Project timing

Project officially started on the 1^o January 2023 and will last six years

- Procurement steps: major contracts concluded
- Permitting steps: on ongoing
- DRP and EAF plants detailed Engineering & design: January 2024 – December 2024
- Realization of H2 testing lab and facilities: June 2024 – December 2025
- DRP and EAF plants erection: January 2025 – March 2026



For more info:



**Thank you for your
attention**

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