ESTEP SPRING DISSEMINATION EVENT

5-6 JUNE 2025 KRAKOW (POLAND)

DiGreeS – DEMONSTRATION OF DIGITAL TWINS FOR A GREEN STEEL VALUE CHAIN

Madalina Rabung
Fraunhofer Institute for Nondestructive Testing

ESTEP

Co-funded by the European Union

"Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Health and Digital Executive Agency (HADEA). Neither the European Union nor HADEA can be held responsible for them."

HOTEL ★★★★ GALAXY JORDAN GROUP

Łukasiewicz GIT

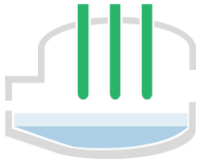
The project at a glance

Aim: Development of an user-friendly digital platform for networked production based on novel & soft sensors and related approaches and models

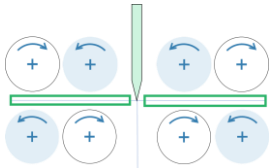
3 use cases /
3 segments of the steel value chain

Use Case 1:
Heavy melting scrap verification

Use Case 2:
Energy efficiency for EAF



Use Case 3:
Final product quality



Duration: 01.11.2024 – 30.04.2028
Budget: 4,98 Mil Euro

Topic: HORIZON-CL4-2024-TWIN-TRANSITION-01-44 - Digital transformation and ensuring a better use of industrial data, which can optimise steel supply chains (CSP)

UC1: Heavy melting scrap verification

Current process:

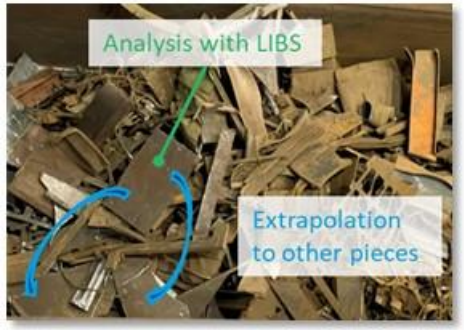
- **HMS scrap: ~ 25 tonnes / truck**
- visual inspection by experienced employees
- **random sample spectroscopic** analysis – handheld X-Ray fluorescence

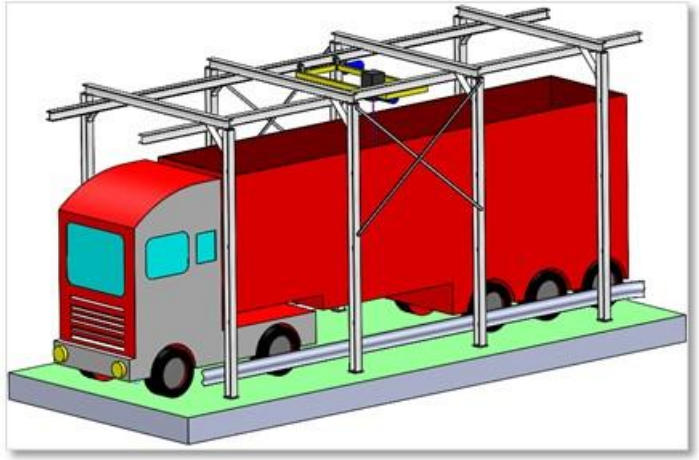
NEED: An **improved and reliable scrap characterisation** to allow operator-friendly sorting and better separation to reduce impurities in the targeted steel heat

New process: data from **LIBS, height measurement and camera**

- Use camera for object recognition
- Classify scrap by shape and size
- Align LIBS and camera data and extrapolate
  → Surface information
- Use camera and height data for estimation of volume of objects → Volume information

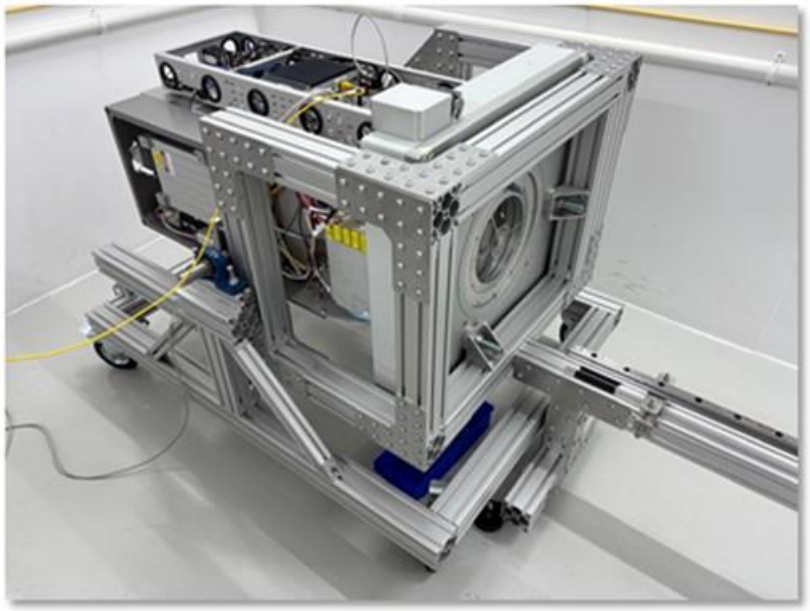
Digital twin for the characteristics of the HMS truckload



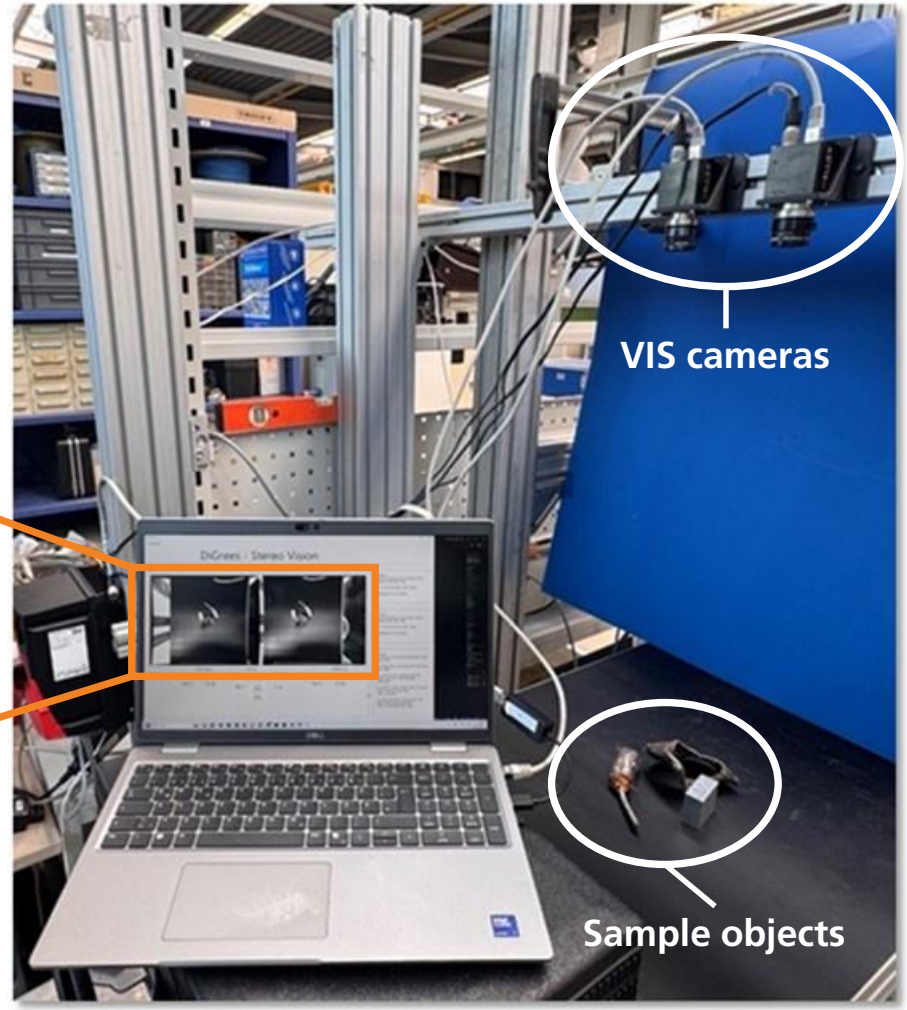


UC1: Heavy melting scrap verification

Work progress: sensor customisation – lab tests



LIBS sensor in horizontal position of lab testing (without dust cover housing)

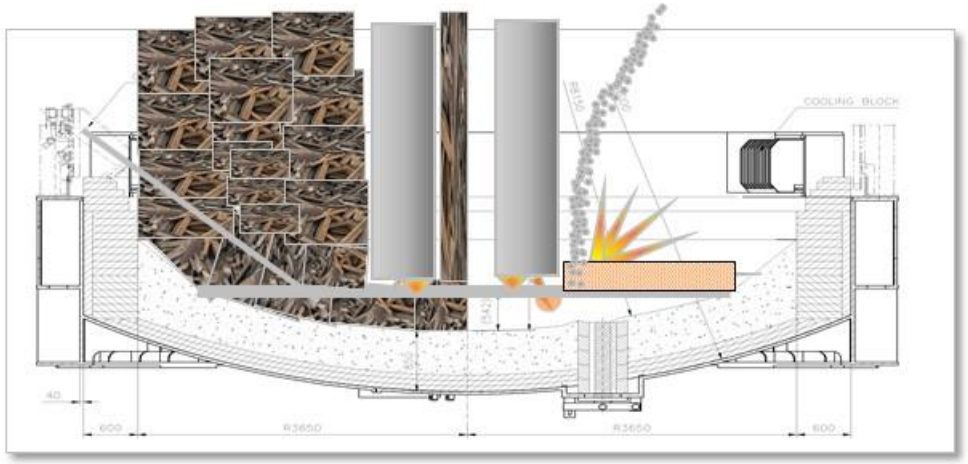


Use case 2: Optimisation of the EAF processes

Current process:

- Steel production at EAF mainly by scrap melting - controlled by stepwise fixed parameters (electrical power, O2 and C injection rate).
- The judgement of the foaming slag quality, crucial for effective power input, depends on the operator's experience.

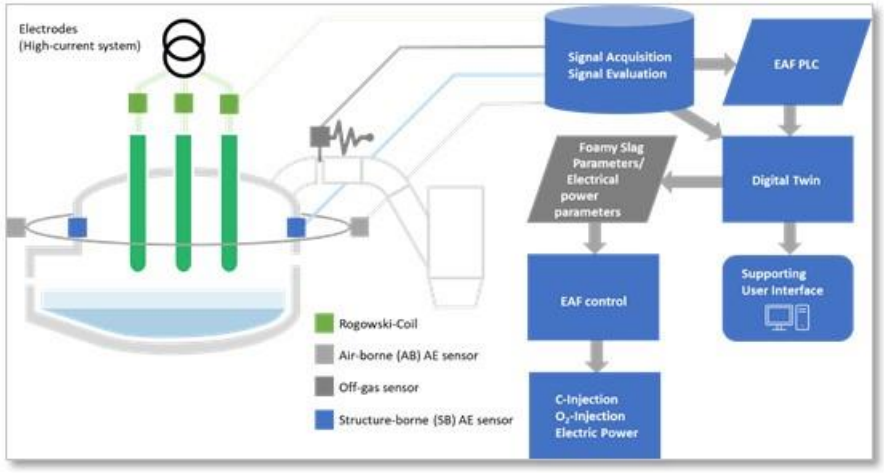
→ limitations on the possible power input (safety margin).



New process:

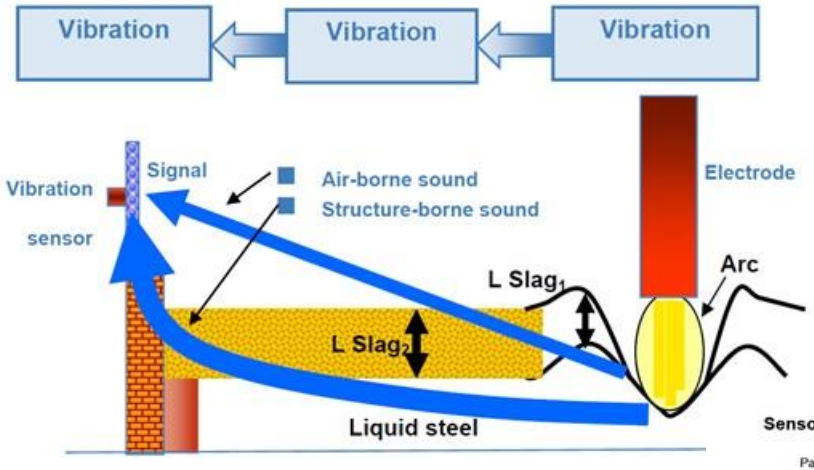
Determination of the quality of the foamy slag in real-time using signals from newly installed sensors and an off-gas measuring system, feeding a dynamic process model for EAF operation

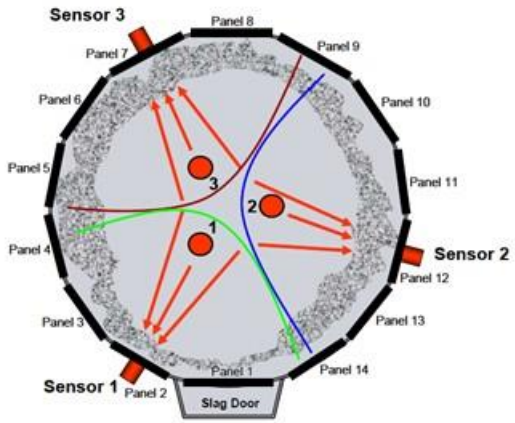
- Enhance the efficiency of the electrical power input
- EAF steel production by combining scrap and DRI as input materials, with a DRI range of 10-80% to achieve the desired steel quality.
- Improve the production planning, the procurement of energy and the input materials



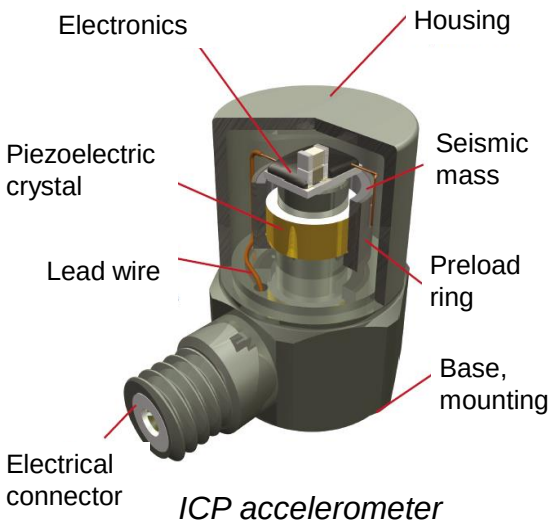
Use case 2: Optimisation of the EAF processes

Work progress: sensor definition / placement at EAF / preparatory activities, tests



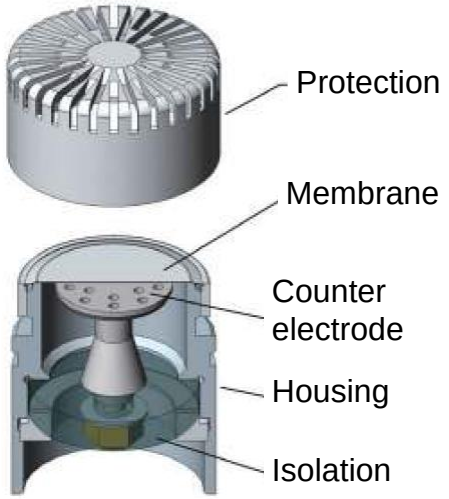


Vibration sensor
(structure-borne AE)



ICP accelerometer
Source: PCB

Microphone
(air-borne AE)



Microphone cap
Source: PCB

Special hardware challenges

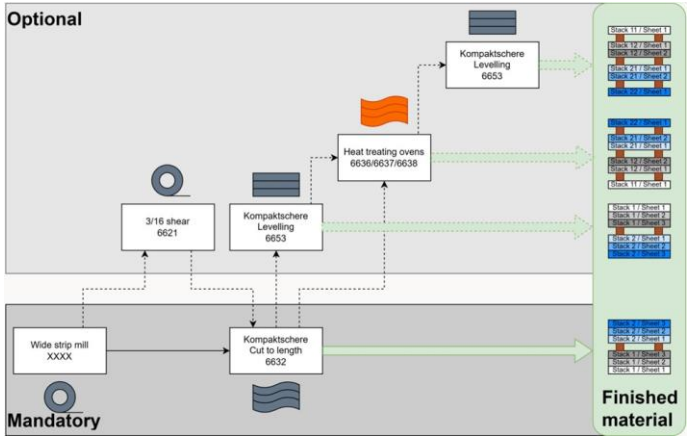
- Dirt/dust - Protecting sensors and electronics
- Temperature - High-temperature sensors
- Strong electromagnetic fields - Minimizing electromagnetic interference; shielding

Source:
Hubmer, R., Döbbeler, A. (2013). Improved performance with modern automation solutions for electric steelmaking. Proceedings of the 17º Seminário de Automação, São Paulo, Brazil, 318-328.

Use case 3: Final product quality

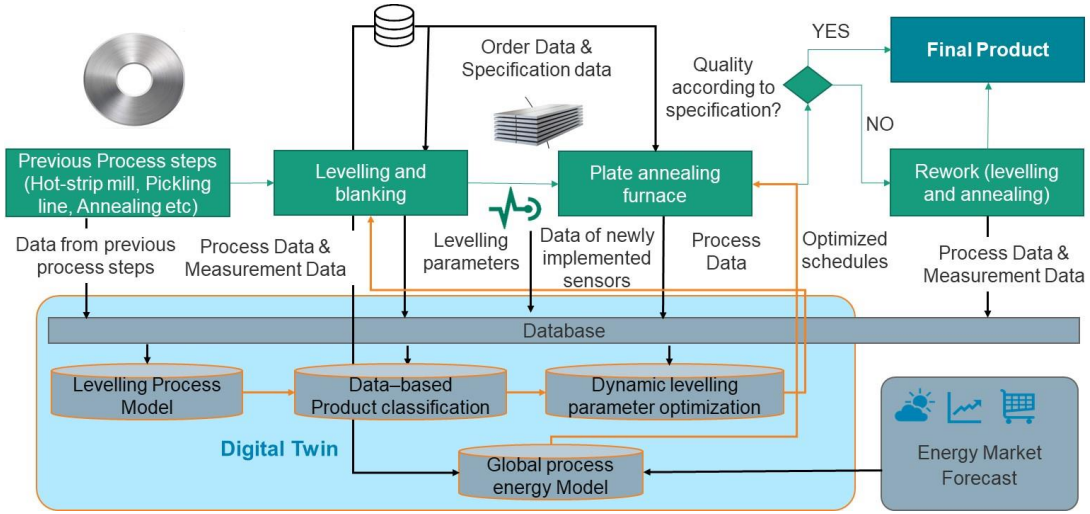
Current basic production process (simplified):

- **Cut to length:** Uncoiling of coils / Cutting of sheet material / Formation of sheet packages / Packaging of sheet packages
- **Leveling operation:** Placing of sheet packages / Straightening of sheet material / Formation of sheet packages / Packaging of sheet packages
- **Sheet annealing** (heat treating)



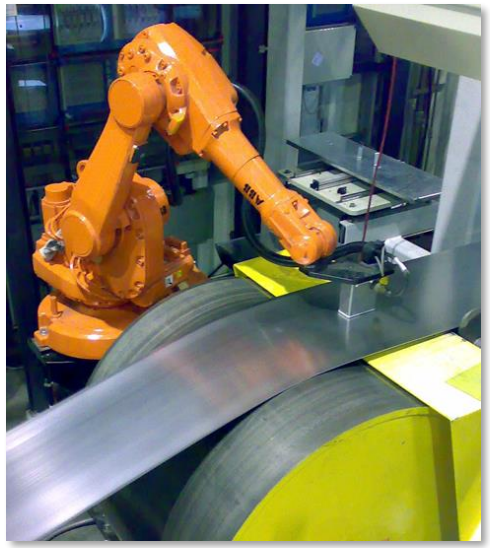
New process:

- Evaluation of (inline) **sensors for determining residual stresses**
- Data-based **classification of final product quality** (flatness)
  - Reduction of reworking (leveling) rate
  - Optimized leveling campaigns
- Dynamic **adjustment of leveling settings** based on
  - Reduction of quality deviations
  - Increasing productivity
- **Energy model** for the shear cutting centre for steel sheets

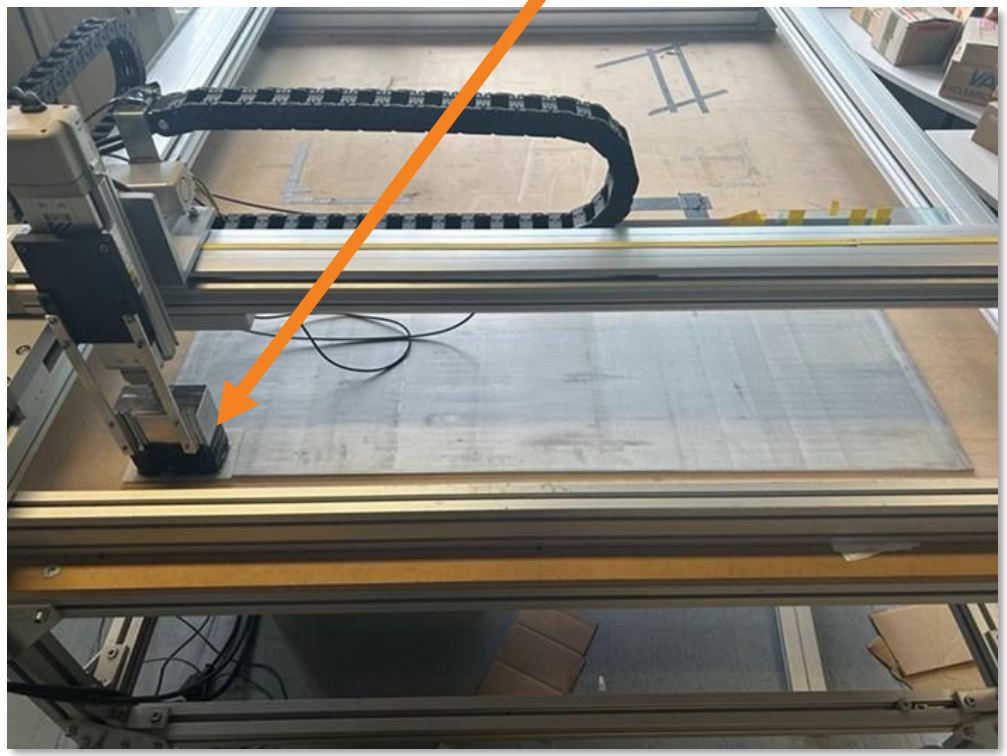


Use case 3: Final product quality

Work progress: sensor customization



2D meander scan with 3MA-X8 probe head on 5 OK and 5 NOK sheets



General progress

Analysis of the status quo with respect to existing data sources, data sets and interfaces / Identification of gaps and needs

Determination of UC specific requirements for the integration of the developed models, data sources and sensors, and the IT infrastructure.

Identification (and customisation) of hardware components and sensors

Preparatory activities:

- Identification and implementation of suitable communication interfaces,
- Structuring of the data sets,
- Networking of the local data archives - offline and online data sharing among industrial use-case parties and modelling experts.
- Central data source of the project for analysis and digital twin information and as central data target.
- Realization of the offline and online data architecture.
- Adaption of existing models for scrap characterisation, EAF operation and final product quality:
    - Training of an image analysis software – shape of the analysed scrap pieces (using the camera)
    - Adaption of a process model to the UC2-EAF – data of electric energy input

General progress

Project identity:

- Templates for internal and external use,
- Webpage: www.digrees-horizon.eu
- Flyer,
- Poster
- Communication activities

Project management:

- Management structures
- Internal project management and communication rules
- Project intranet
- Submission of due deliverables in time

Thank you for your attention on behalf of the DiGreeS consortium.

Madalina.rabung@izfp.fraunhofer.de