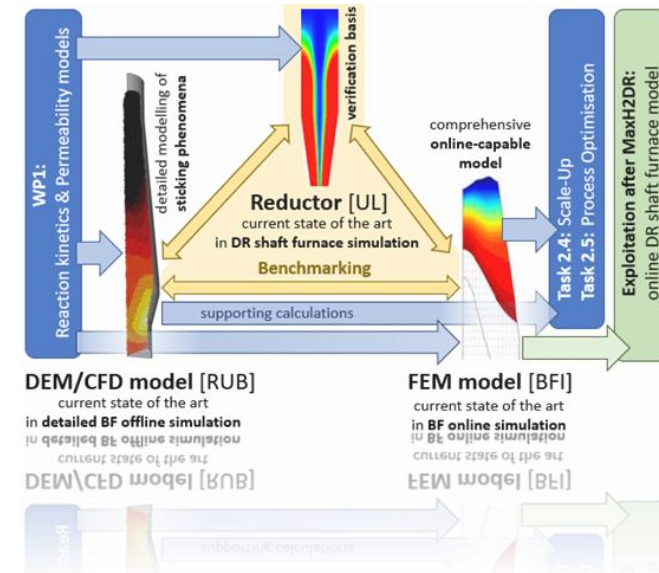


Max [H₂] DR

Maximise H₂ enrichment in Direct Reduction shaft furnaces

Summary of current project state
Estep Dissemination Event 2024, Brussels 14.3.2024

Dr. Thorsten Hauck



THE CONSORTIUM

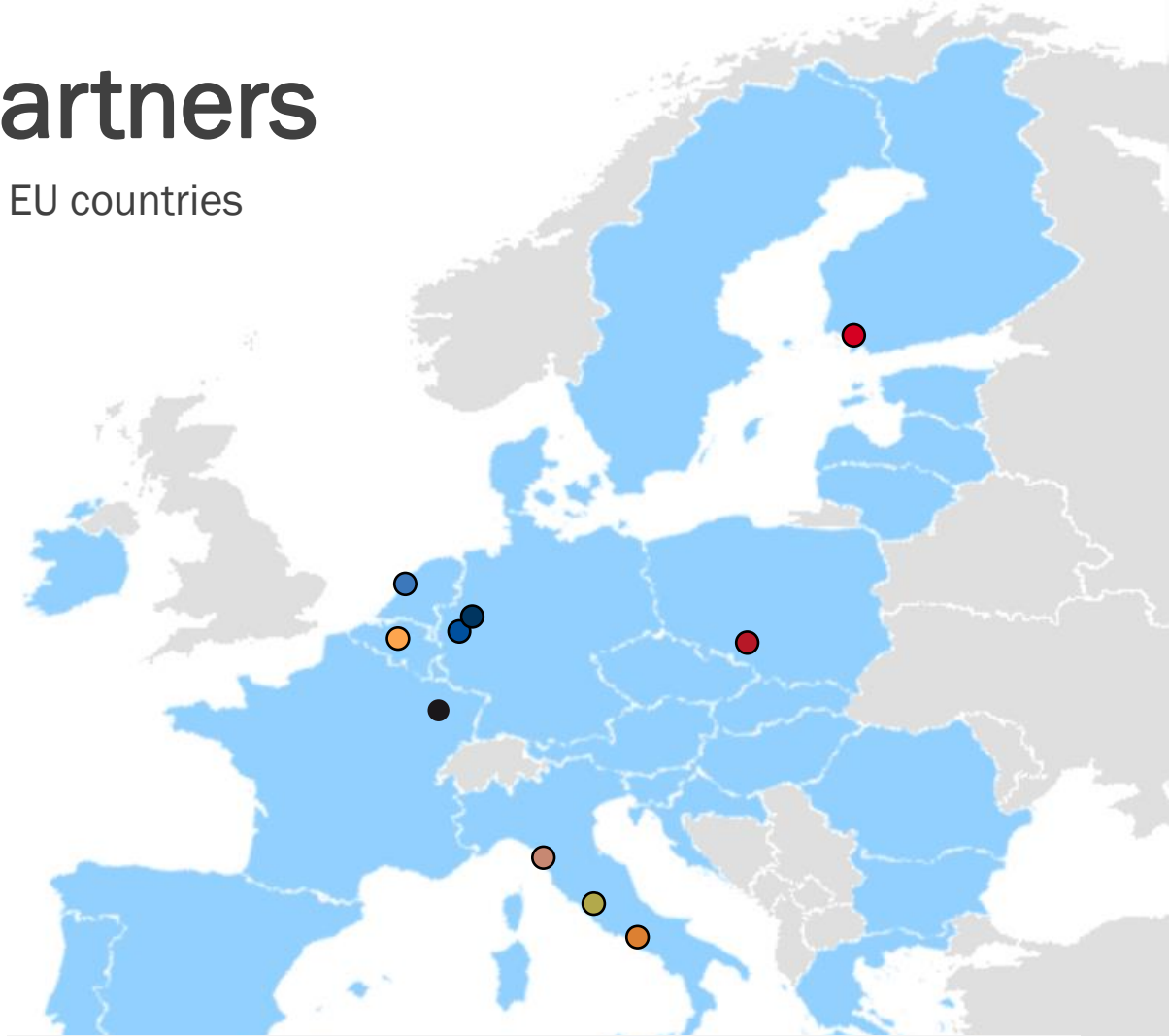


10 partners

from 7 EU countries



TATA STEEL

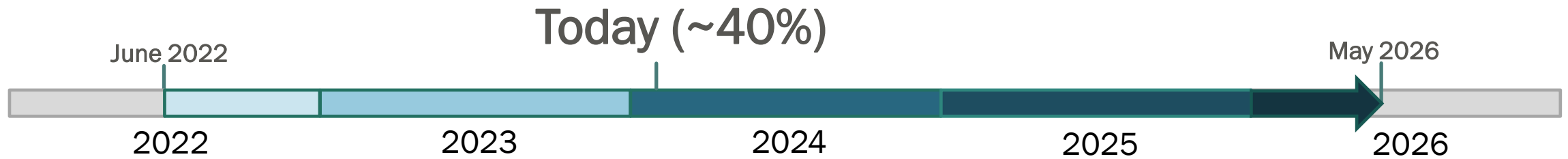


Formal coordinator: Prof. Valentina Colla, Pisa



This project has received funding from the European Union under grant agreement NUMBER – 101058429 – MaxH2DR

OVERVIEW OF CURRENT PROJECT STATE



Max [H2] DR

Maximise H2 Enrichment in Direct Reduction Shaft Furnaces

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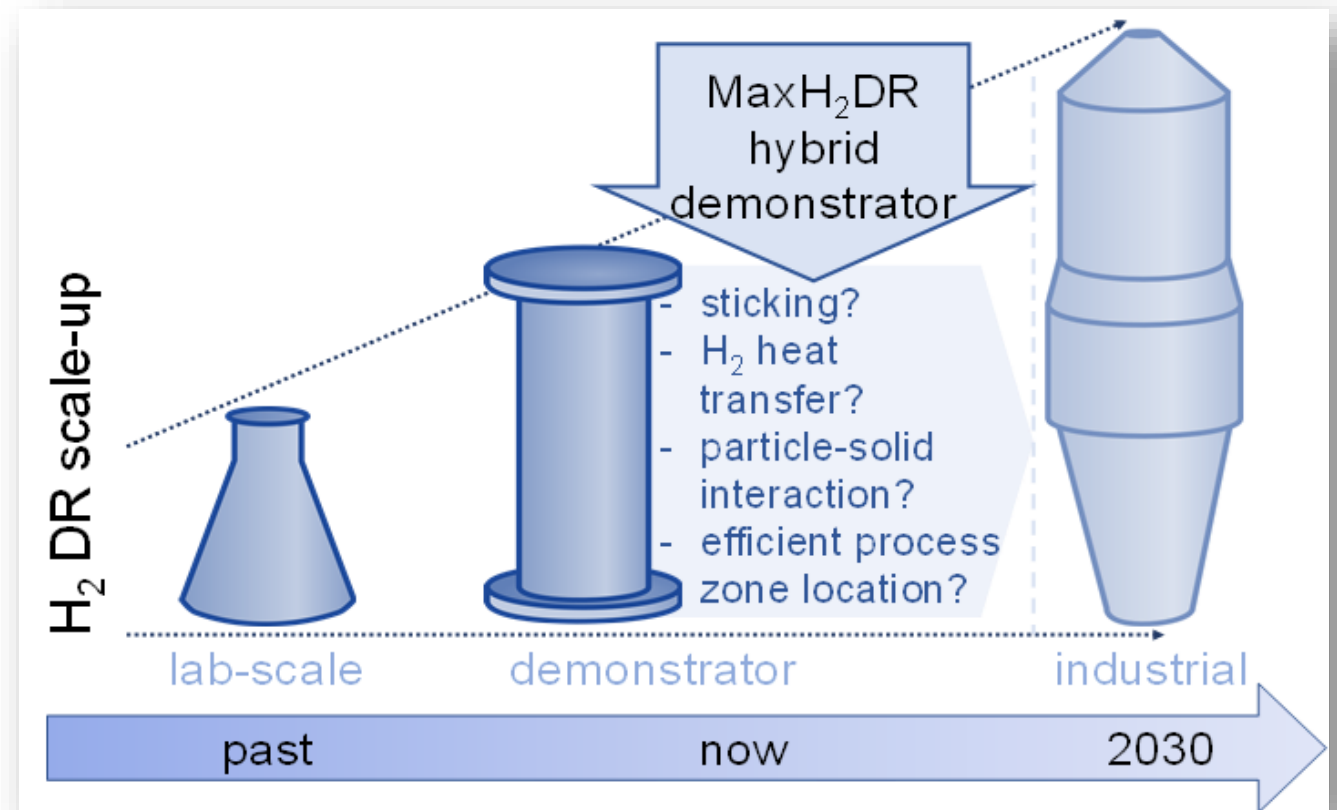
MAXH2DR OVERVIEW: WHAT AND WHY ?

- **Key facts:**

- HORIZON-IA: 4 years from June 2022 to May 2026, budget: 4.5 million Euro
- Financial & formal coordination: SSSA
- Technical coordination: BFI

- **Background:**

- Natural gas based direct reduction industrially established
- Hydrogen based direct reduction is ground-breaking technology for climate neutral steelmaking
- No industrial experience with DR using >80% H₂ content
- Operational problems and needed process optimisations unknown yet



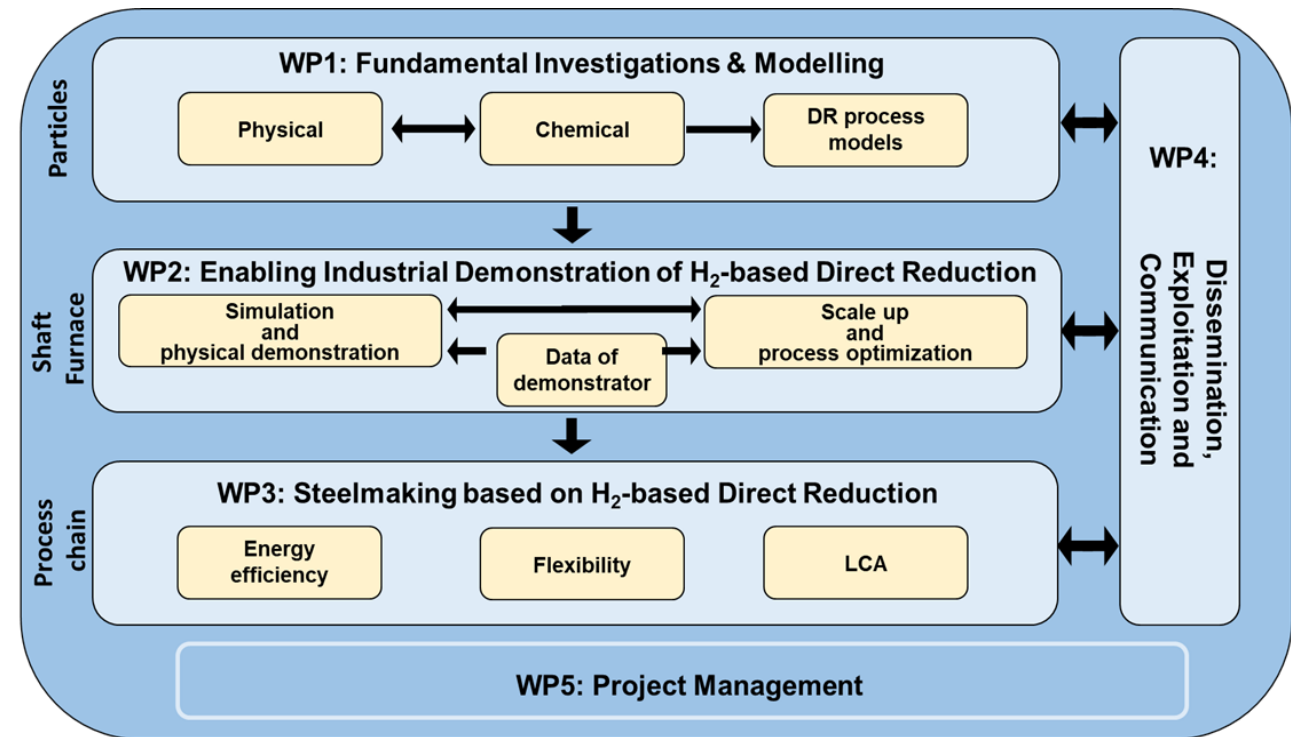
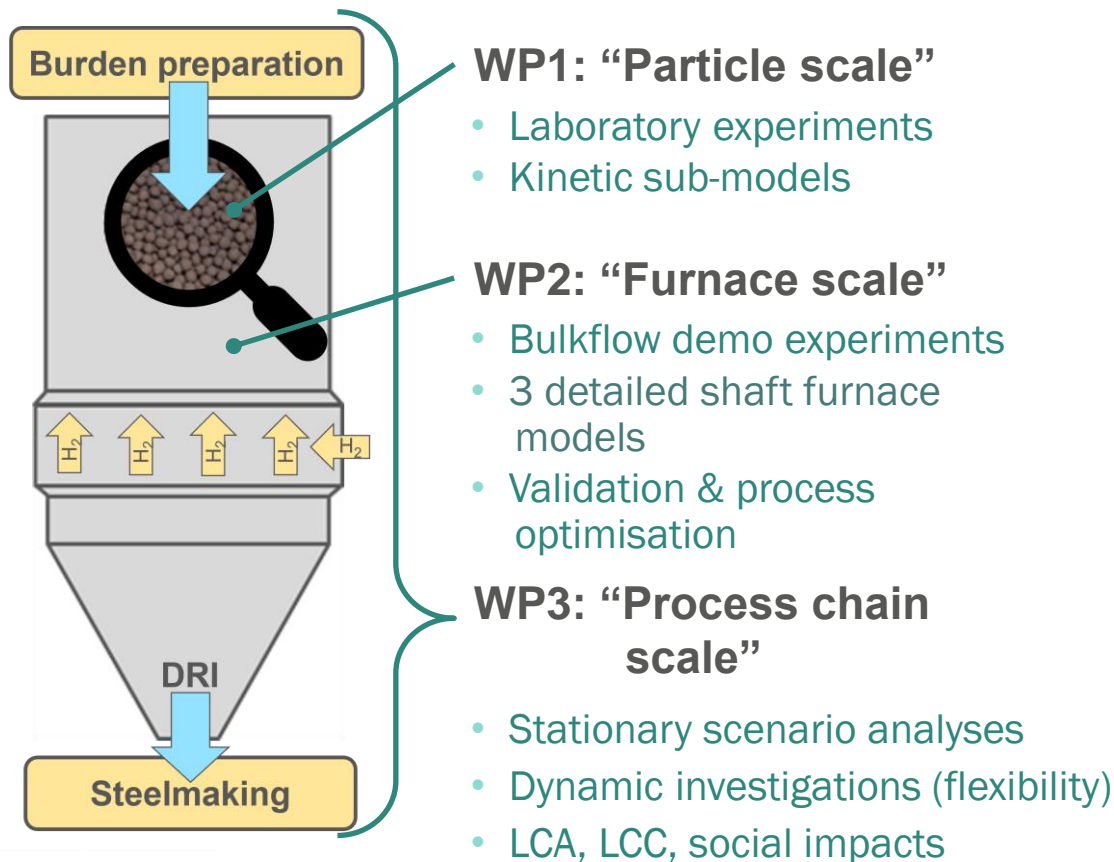
MAXH2DR OBJECTIVES:

- Crucial aspects:
 - Cinetics and material properties at H₂ enrichment > 80%
 - Flow of gas and burden
 - Process stability and efficiency issues
- ... and in particular the corresponding impact of H₂ enrichment > 80%
- MaxH2DR objectives:
 - ... provide missing physical and chemical data
 - ... close the current knowledge gaps
 - ... exploit new knowledge+data into comprehensive models (“hybrid demonstration”)
 - ... deliver the tools needed for process optimisation and investment planning

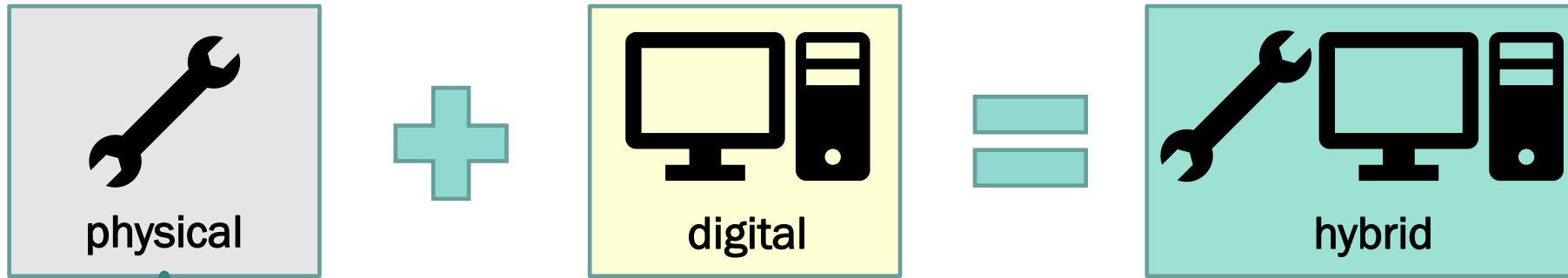
MAXH2DR OVERALL CONCEPT

- Approach: hybrid demonstration of steelmaking via H₂ based direct reduction
 - validating and fusing DR furnace models with physical demonstration into a “hybrid demonstrator”

Three perspectives of investigation:

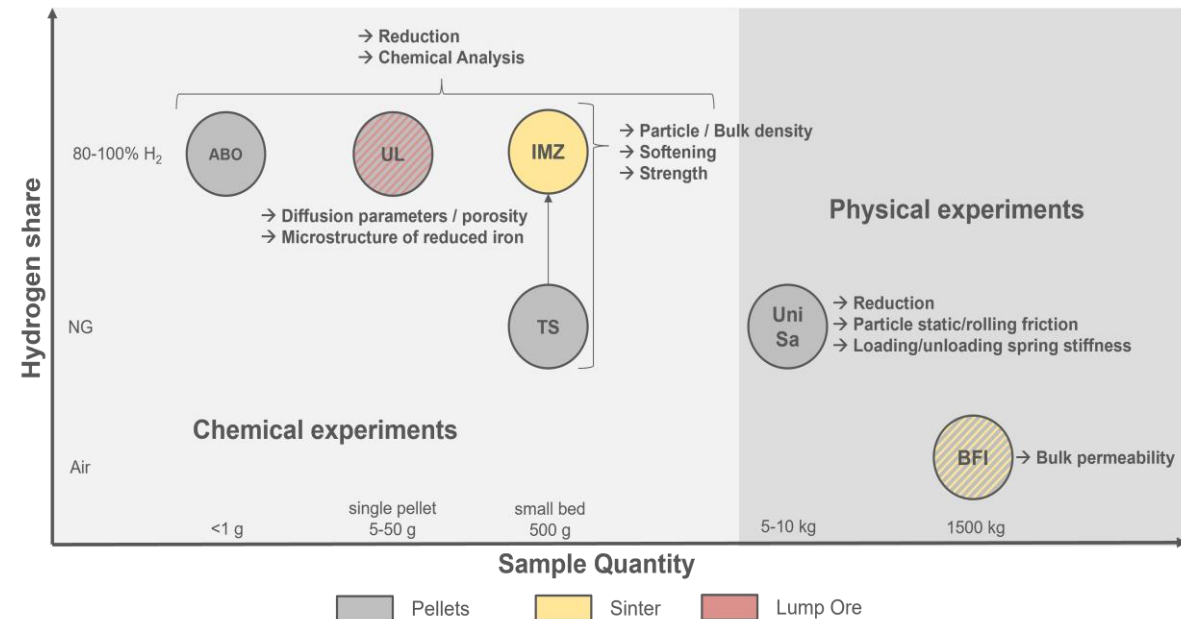


MAXH2DR HYBRID DEMONSTRATION APPROACH

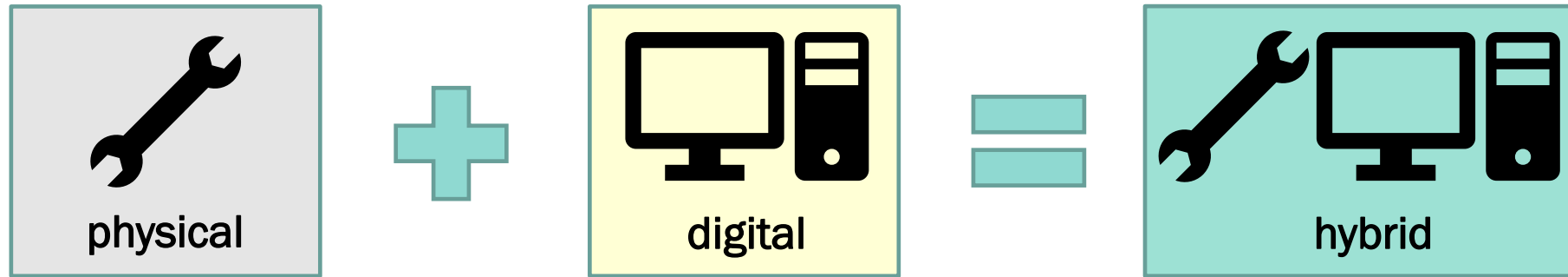


Physical component:

- Physical and chemical laboratory experiments focussing on reaction kinetics [0.001 – 10 kg material at various partners]
- Bulkflow experiments with gas counterflow focussing on flow investigations [1 – 1.5 t material in BFI plant]

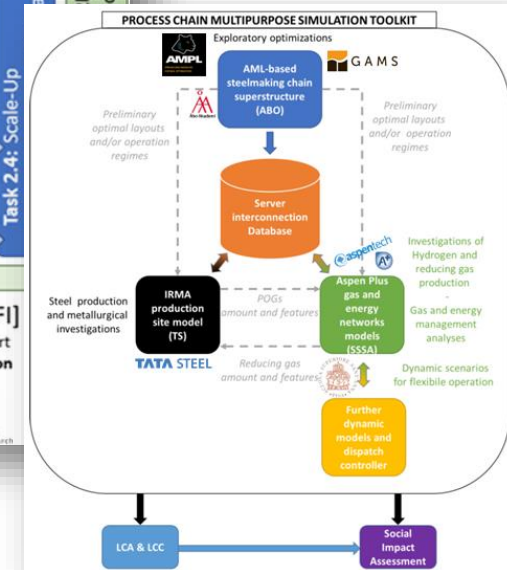
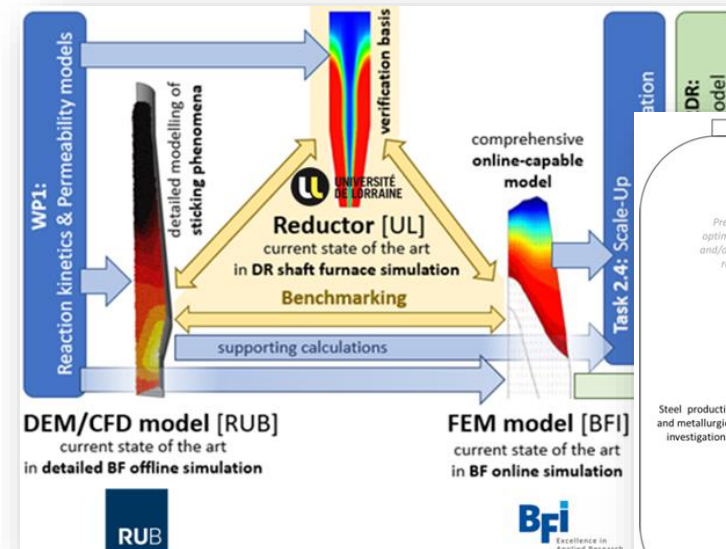


MAXH2DR HYBRID DEMONSTRATION APPROACH



Digital component:

- Digital simulation tools for H₂-based DR Shafts
- Combined utilisation of 3 DR Shaft Furnace models
- Steelmaking Chain Process Simulation tools
- Long-term goal:
Development of online monitoring and control



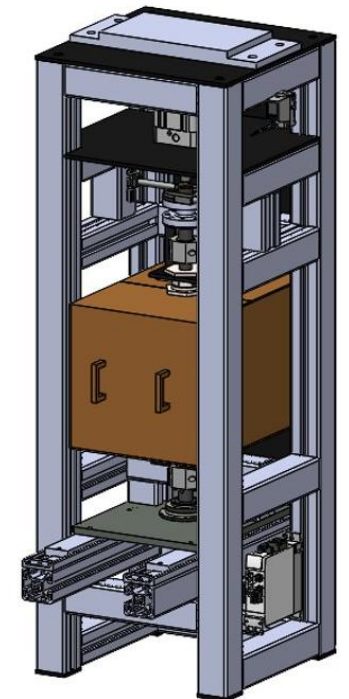
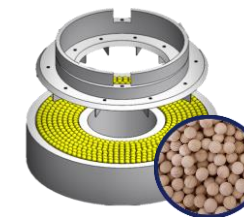
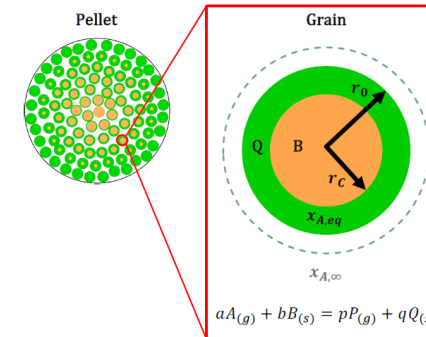
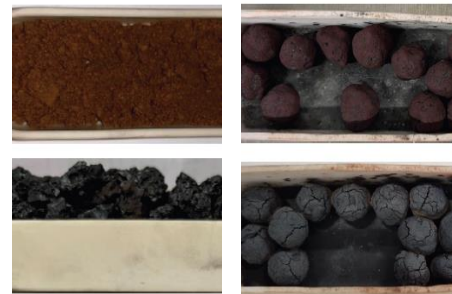
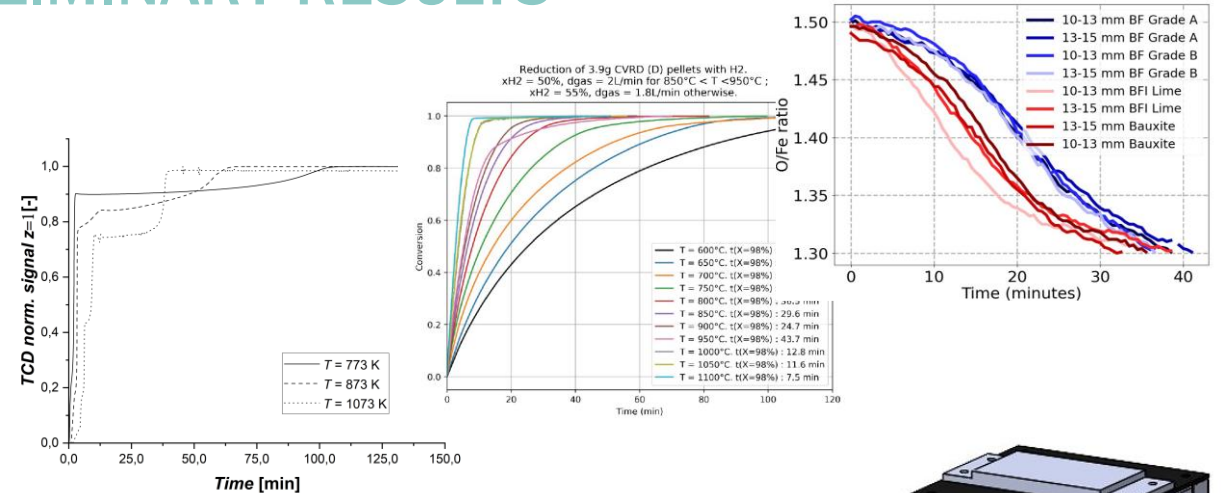
WP1: SELECTED OBJECTIVES AND PRELIMINARY RESULTS

■ Key-Objectives:

- Reduction experiments for H₂-enriched DR and new sophisticated kinetic model
- World-first test rig for adhesive forces of pellet bulks at industrial conditions

■ Planning tests & construction:

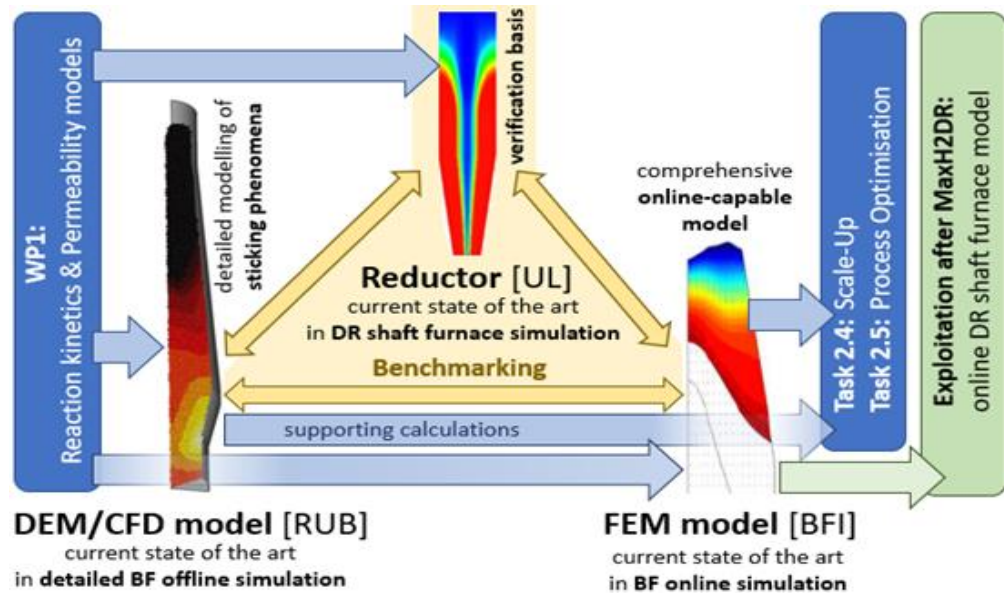
- Coherent materials & conditions for tests with powder (AAU), single pellets (UL) and bulk material (TS, IMZ)
- Preliminary cold tests and concept development of world-first test rig for adhesive forces of moving bulk materials



WP2: SELECTED OBJECTIVES AND PRELIMINARY RESULTS

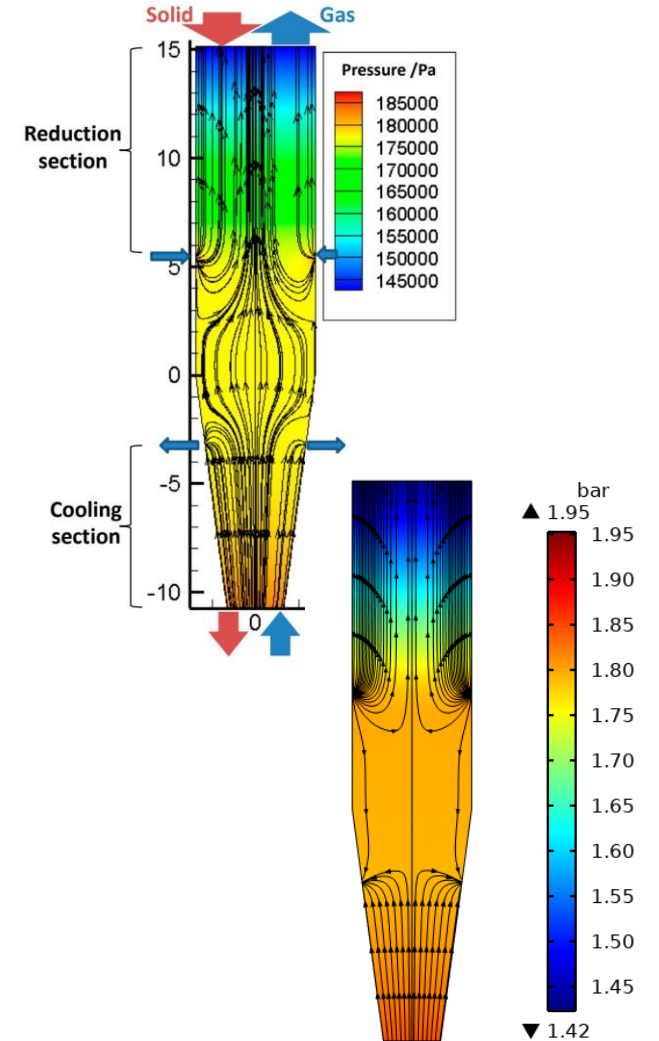
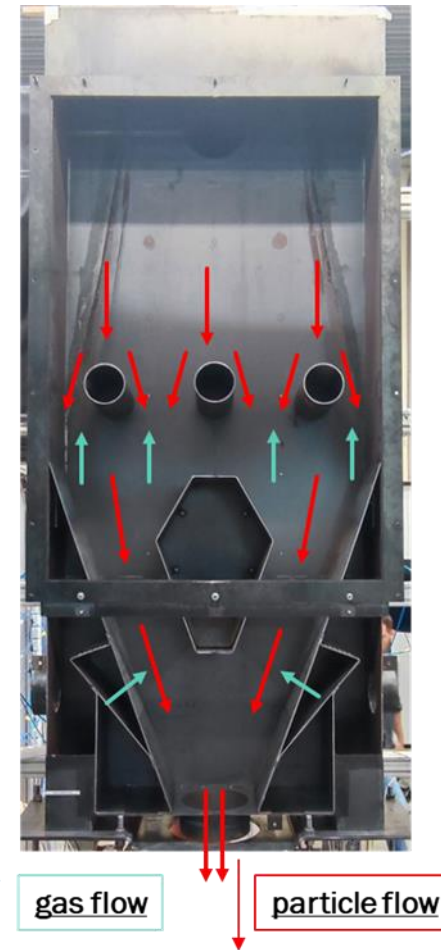
Key-Objectives:

- Demonstration scale test rig for solid+gas flow
- Synergistic combination of DR shaft models



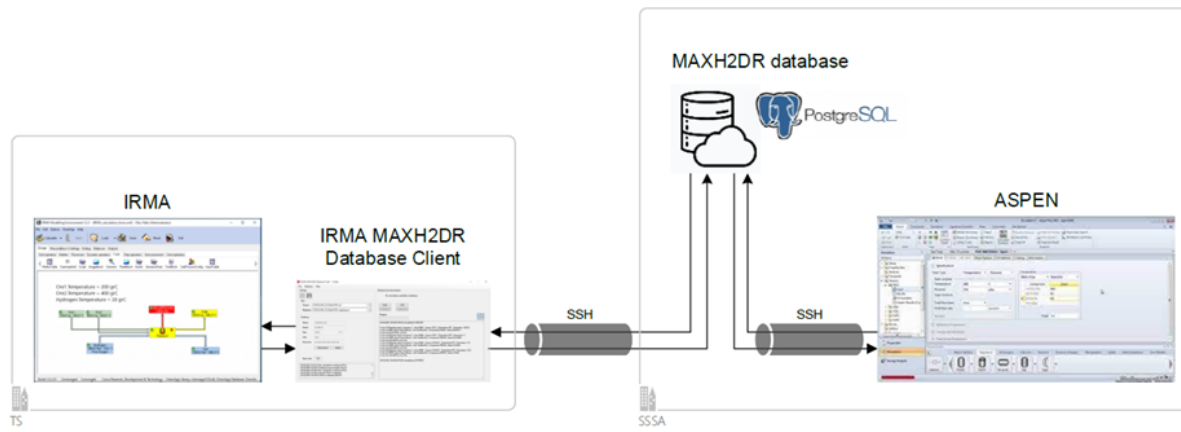
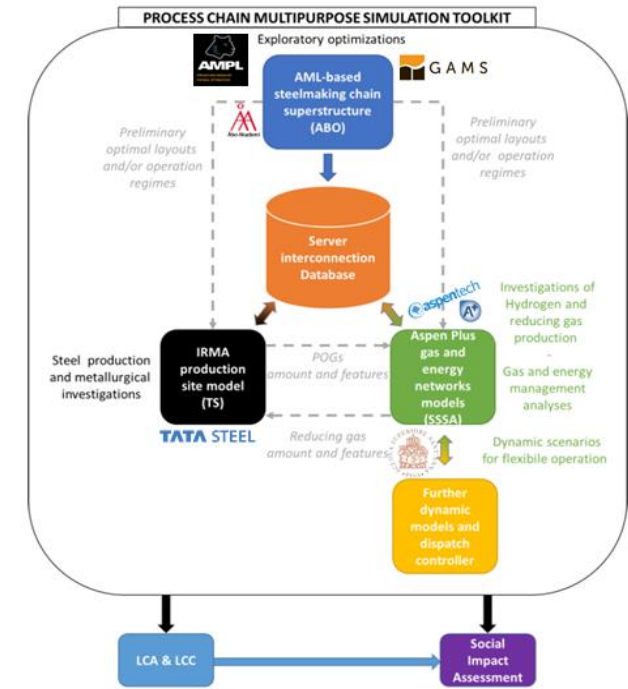
State of work:

- Preliminary tube tests, demo test rig ready
- First model versions ready and benchmarking started

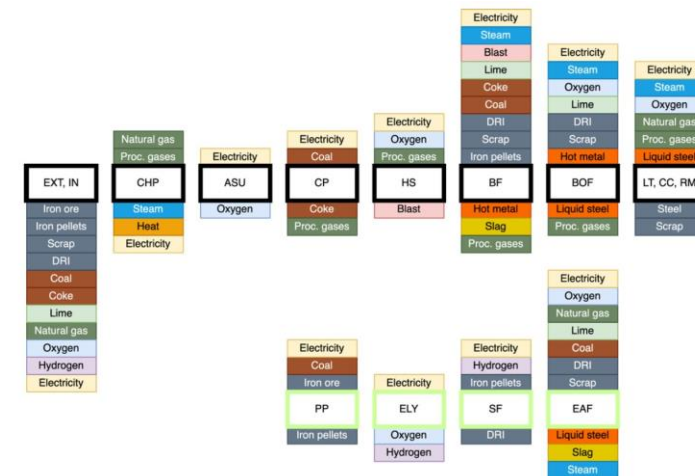


WP3: SELECTED OBJECTIVES AND PRELIMINARY RESULTS

- **Key-Objectives:**
 - Process chain simulation toolkit combining AML, IRMA and ASPEN
 - Promising future plant states including H₂-enriched DR
- **State of work:**
 - Simplified prognosis of transition routes using AML
 - Benchmarking of models for standard integrated steelworks
 - Database and IT architecture available and interconnection demonstrated



System overview (left TS and right SSSA parts)

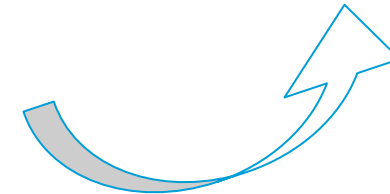


CONCLUSIONS

- MaxH2DR integrates ...
 - ... investigations on different scales from powder to steel plant
 - ... different model approaches for maximum synergy
 - ... digital with physical-chemical investigations for „hybrid-demonstration“
- MaxH2DR provides ...
 - ... a lot of new data and knowledge
 - ... world-first test rigs and models

*Project website via estep.eu
Follow us on [Twitter](#) and [LinkedIn](#)*

➤ **Stay tuned for upcoming results !**



THANK YOU FOR YOUR ATTENTION!



Max [H2] DR

THANKS TO THE COLLEAGUES FOR THE GREAT COOPERATION !