PURE SCRAP

Purity Improvement of Scrap Metal

HORIZON-CL4-2022-TWIN-TRANSITION-01-13
Raw material preparation for clean steel production
Period: 2023.01.01 – 2026.06.30, GA n. 101092168

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The Clean Steel Partnership

SWERIM

Installation of sensors for scrap composition at the recycling plant

Jonas Petersson

2025.04.02

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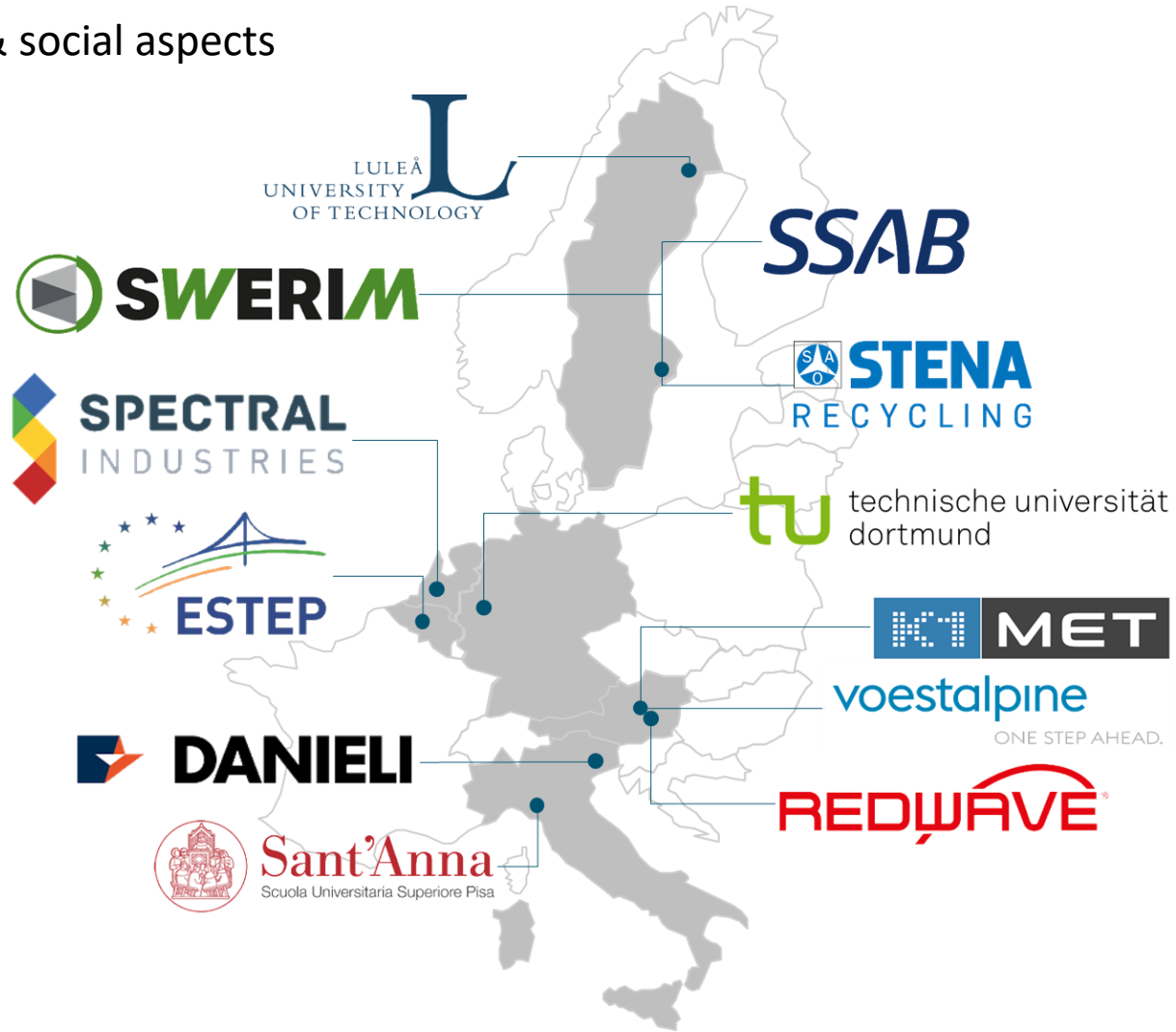
Tech partners (RTO and Industry)
Steel producers
Scrap recycler
Economic, Environmental & social aspects



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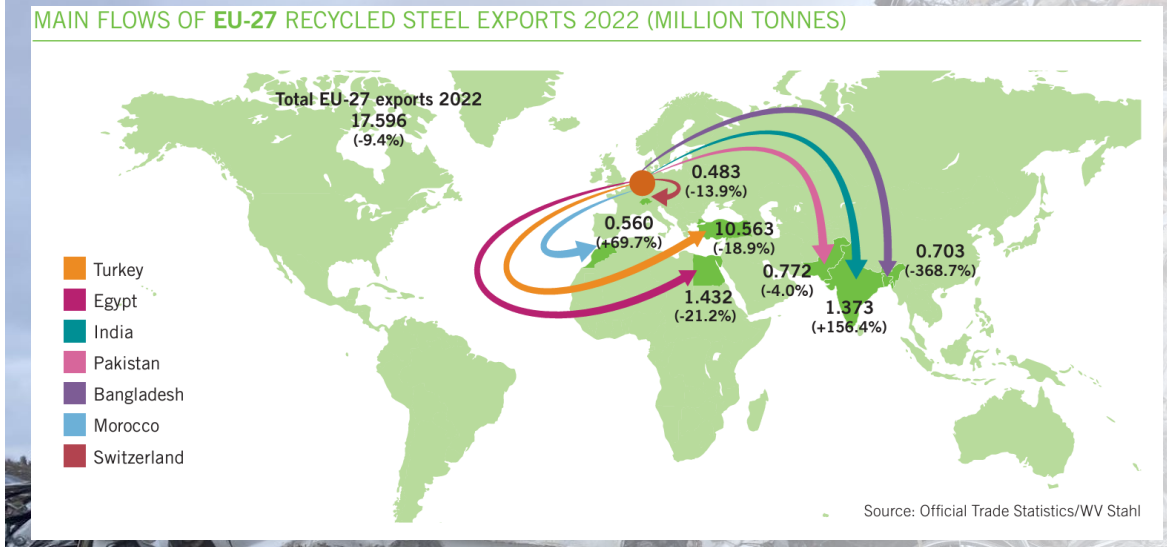
OBJECTIVES

Why sensors for scrap analysis



Objectives

- Enable increased use of post-consumer scrap in the steel industry

How

- Enhanced **scrap analysis** to enable charge planning

Because

- If the scrap has the right composition 1t scrap can result in 1t steel
- But input of **tramp elements** such as Cu, Sn, Ni, Mo limits the scrap use

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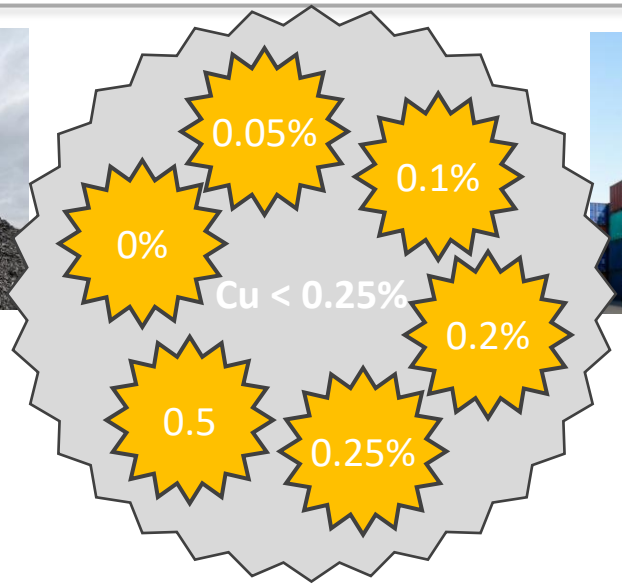
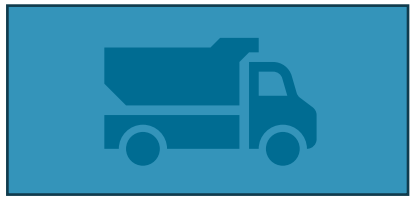
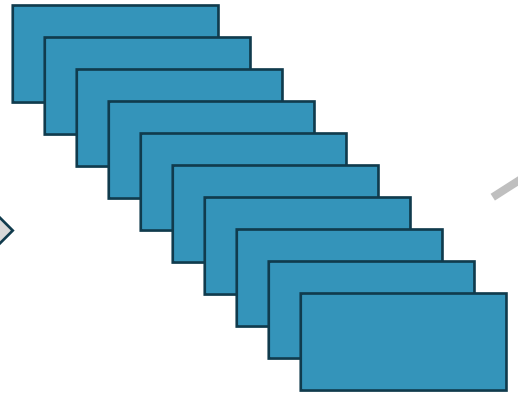
THE PURESCRAP CONCEPT

Batch analysis with chemistry and size information



Element	Range (wt%)
Cu	0.05 – 0.10 – 0.15 – 0.20 – 0.25
Ni	0.05 – 0.15 – 0.25 (max 1)
Mo	0.05 – 0.25 – 0.45
Sn	0.005 – 0.008 – 0.010





Recycler

Steelworks

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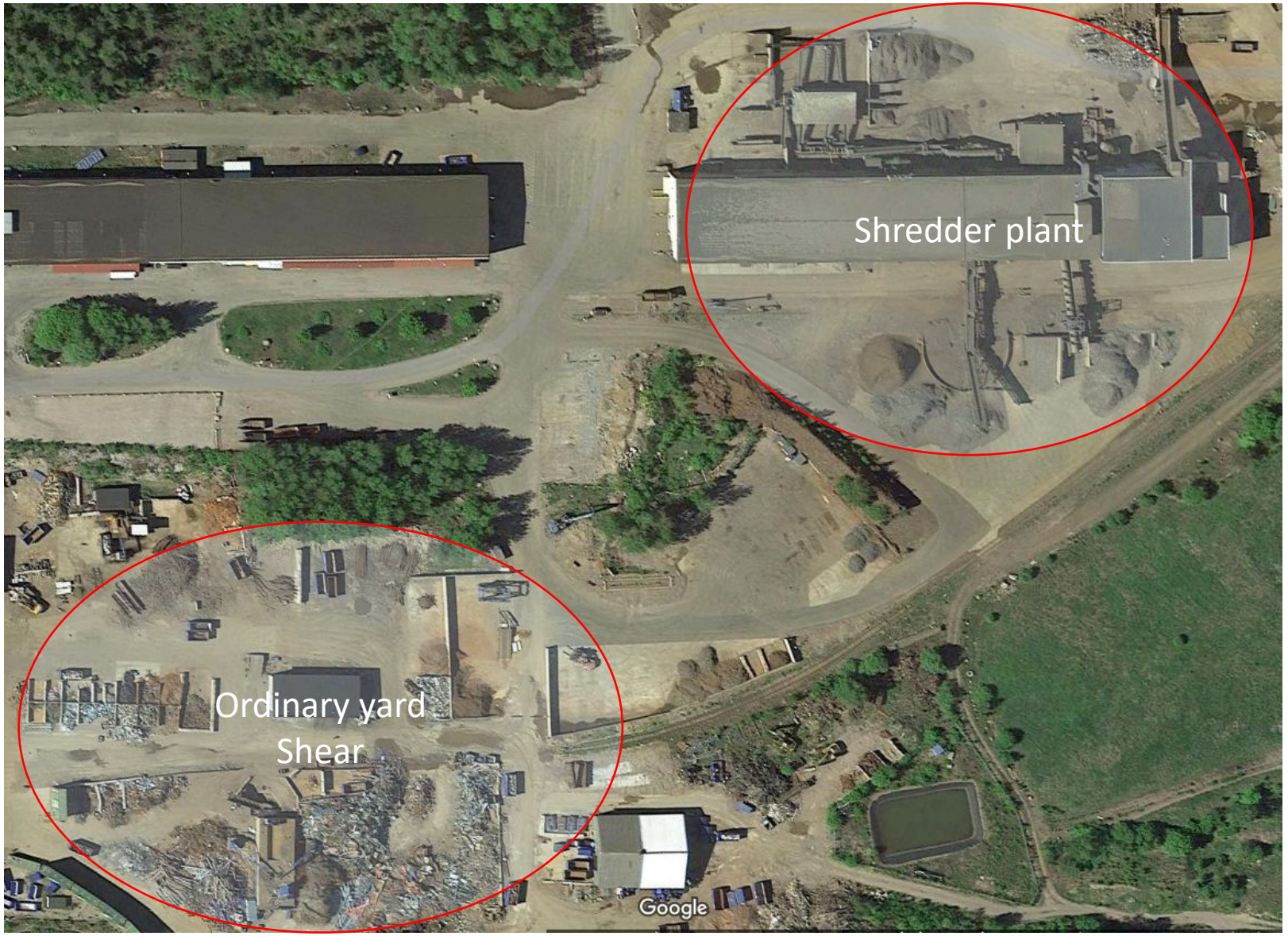
TWO APPROACHES

Shredded scrap and heavy (cut) scrap



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TWO APPROACHES

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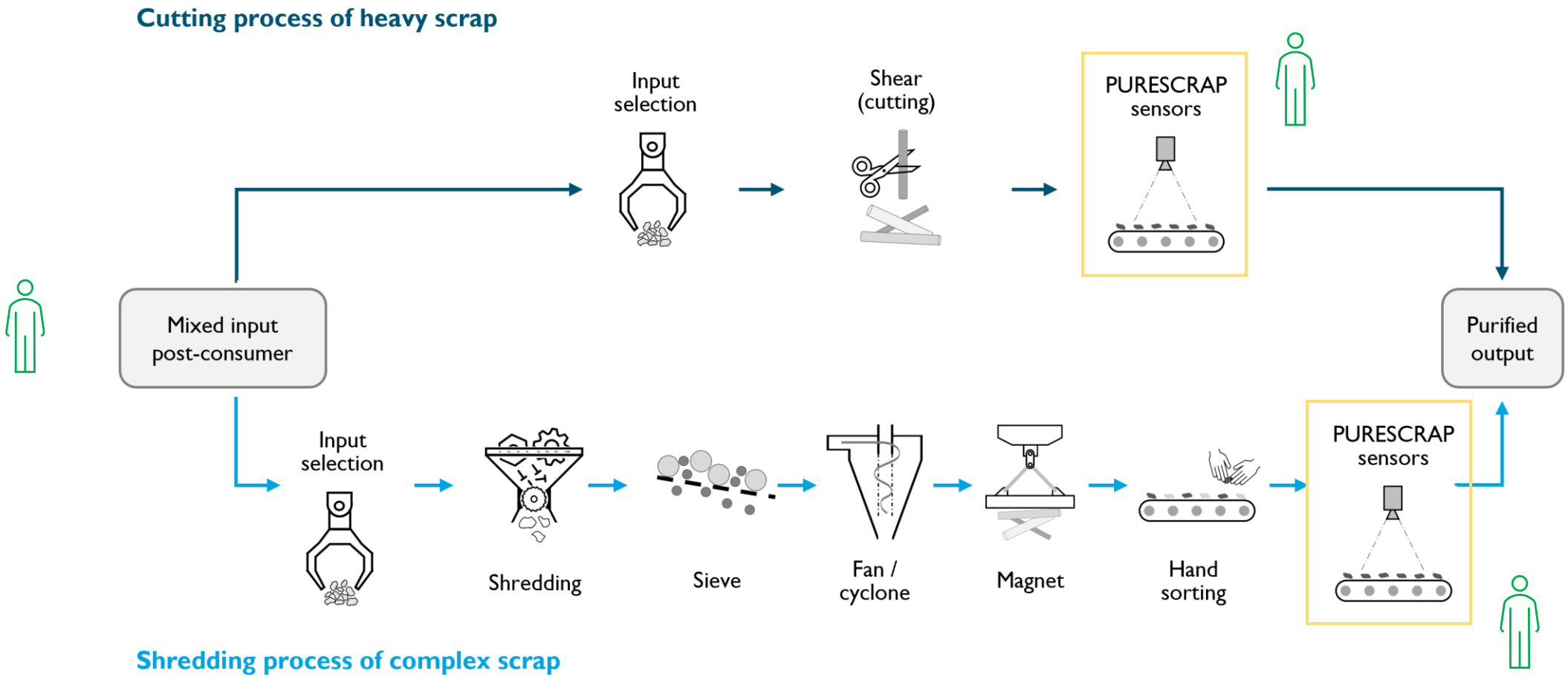

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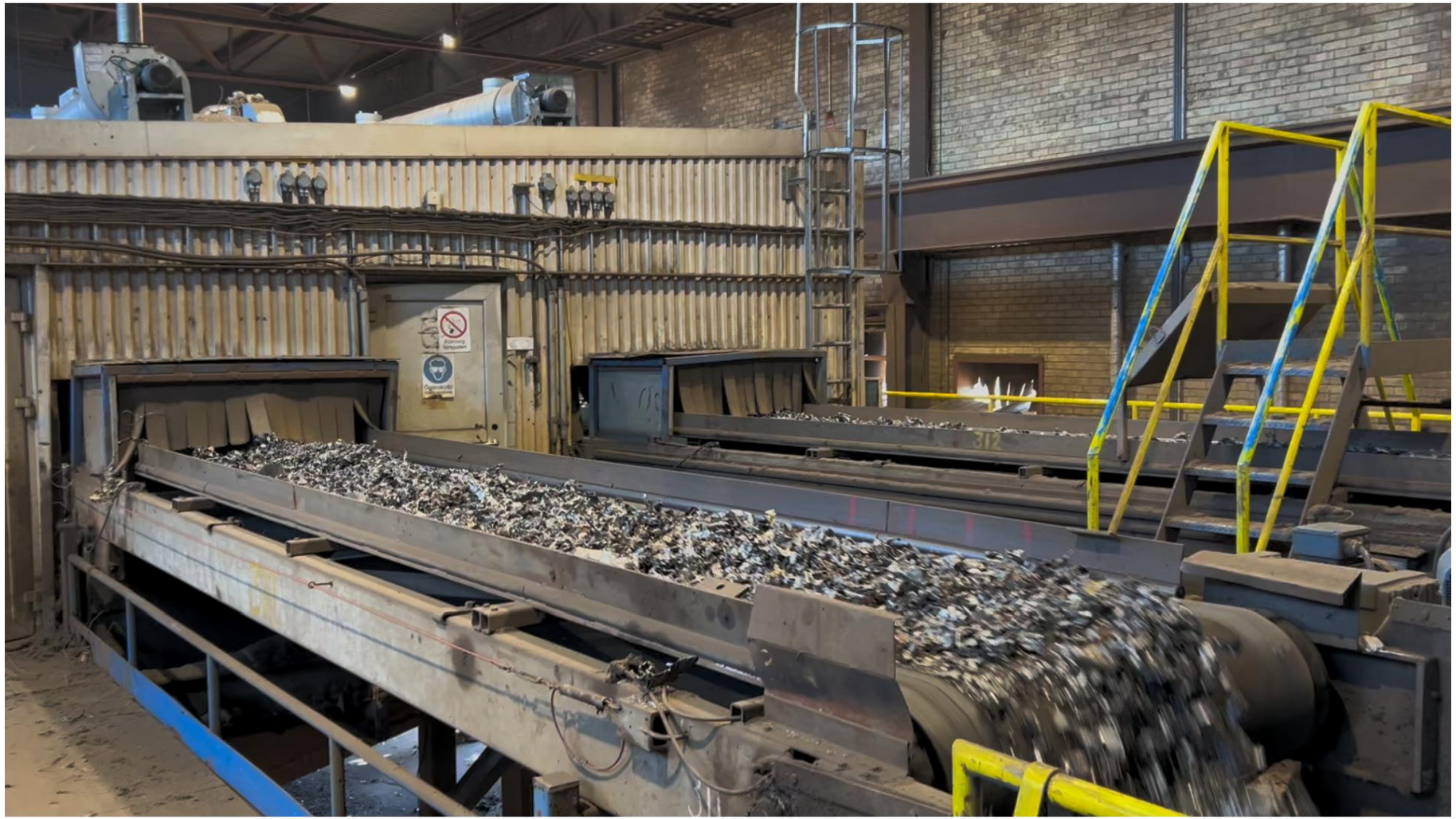
SHREDDED SCRAP

Production > 100 ton/h



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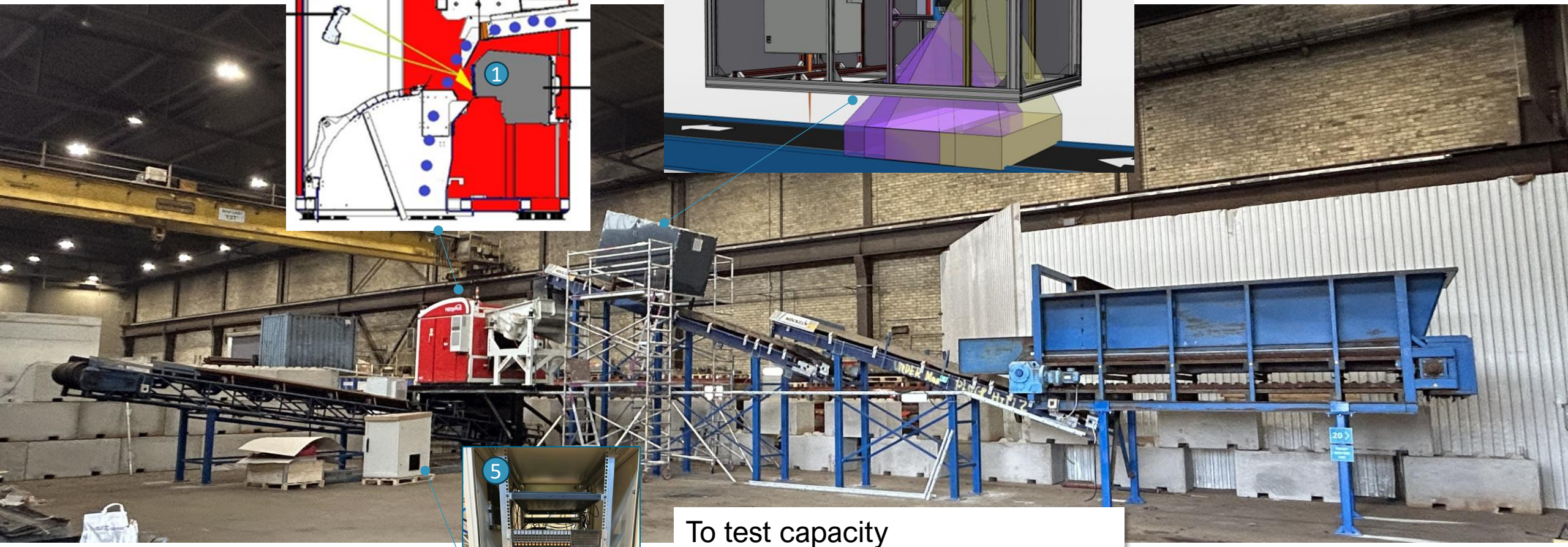
SHREDDED SCRAP

Test station



To test capacity

- Belt speed
- Material flow / belt coverage
- Repeatability

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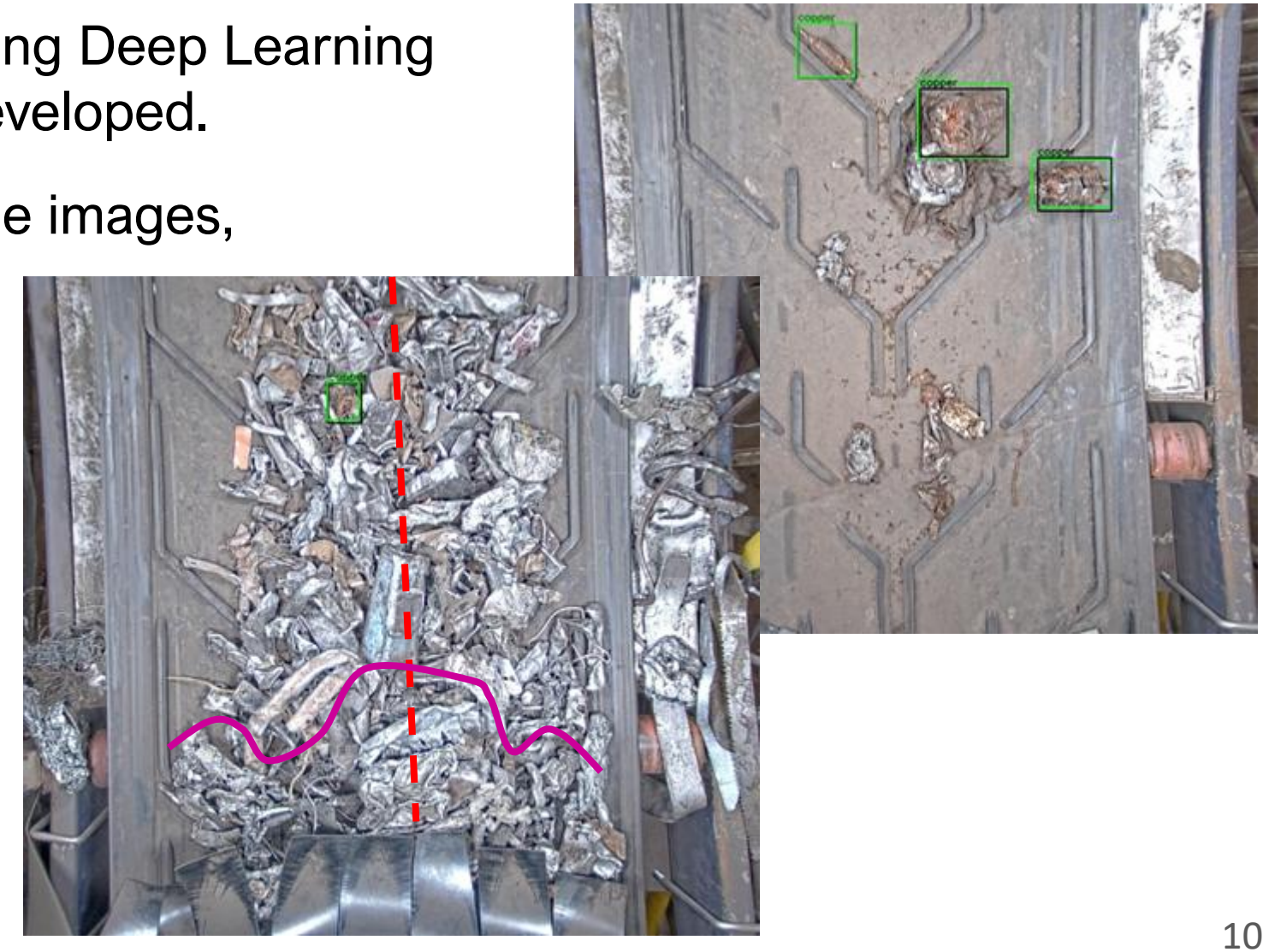
SHREDDED SCRAP

Result of images processing model

Image processing models exploiting Deep Learning solution to identify copper was developed.

After collection and labelling of the images, the model was train and test.

The model reach a mAP equal to 0.93.



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SHREDDED SCRAP

Scrap types

- Main target is the shredded scrap type E40
- Detect both the non-ferrous metals and the alloy elements within the steel

Testbatches are recorded to compare the sensor results

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Scrap Melting Tests

Bag 2

Type E40 scrap (Swedish scrap class 117)

- Target Grade: 42CrMo4

Scrap analysis

in m.%	C	Si	Mn	P	S	Cr	Cu	Ni	Mo	Sn
	0.07			0.0259	0.011	0.12	0.15	0.07	0.025	0.015

Resulting alloy – scrap mixed with other raw material

in m.%	C	Si	Mn	P	S	Cr	Cu	Ni	Mo	Sn
	0.39	0.8	0.74	0.011	0.006	1.01	0.03	0.02	0.176	0.002

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CUT SCRAP

Heavy crap and home scrap

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CUT SCRAP
Sensor configuration

- Depthcamera + LiDAR provides 3D image
- LIBS provides chemical analysis
- Combined for complete average analysis

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TARGET TEST MATERIAL

Home scrap and post consumer

Internal

Internal

Industry waste

E3 / Klass 11

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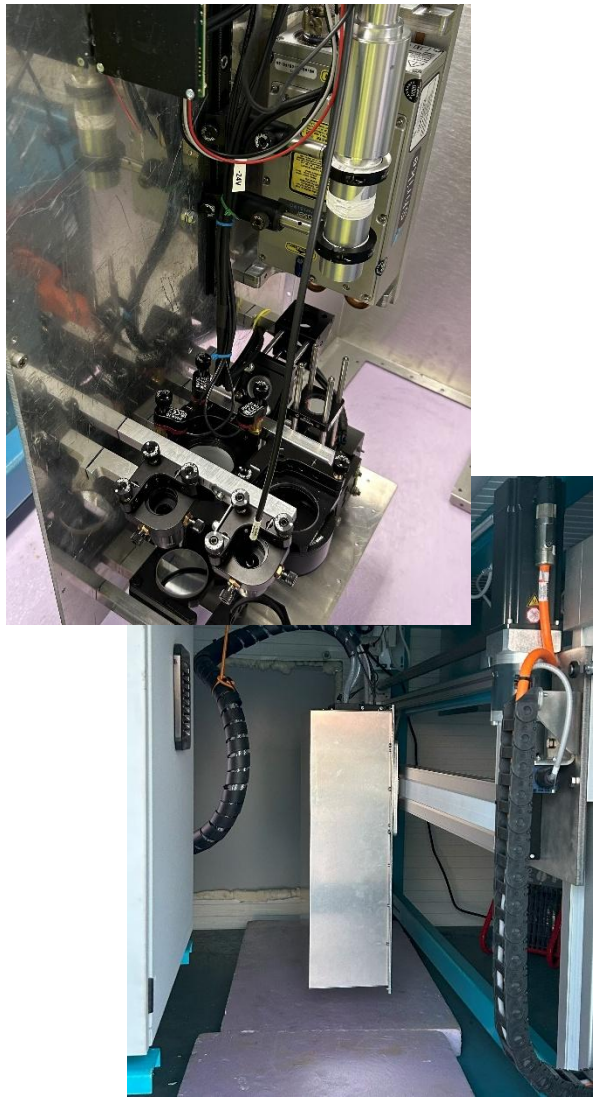
LIBS SENSOR

Element	Low-alloyed		Stainless	
	<X> (wt%)	error (wt %)	<X> (wt%)	error (wt %)
Fe	97.0	0.15	57.6	0.6
Mn	1.04	0.04	1.33	0.09
Ni	0.64	0.02	15.9	0.5
Mo	0.25	0.01	2.8	0.1
Cr	0.50	0.02	21.4	0.8
Cu	0.10	0.005	0.48	0.02
Si	0.21	0.01	-	-
V	0.029	0.008	0.051	0.003
Ti	0.008	0.001	-	-
Al	-	-	0.019	0.003

Performance on reference samples



LIBS-sensor is installed

Scrap campaigns are awaiting

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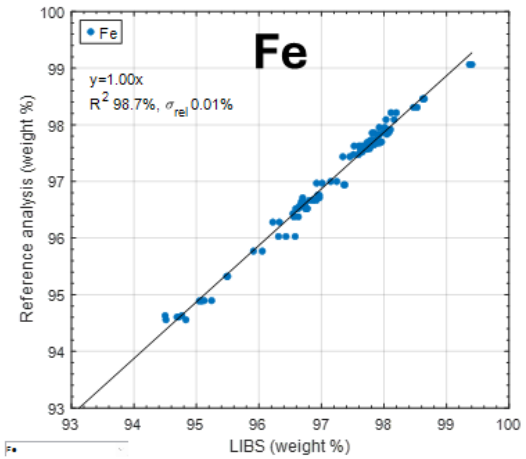
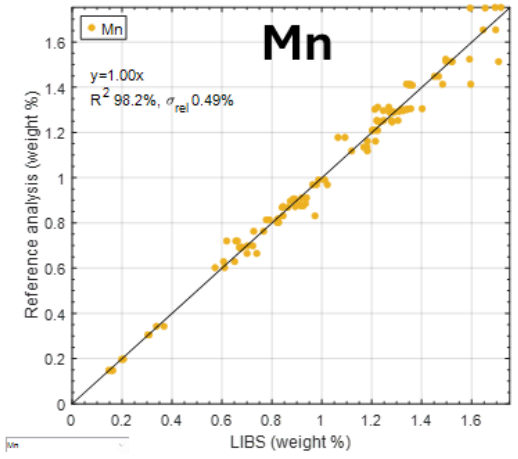
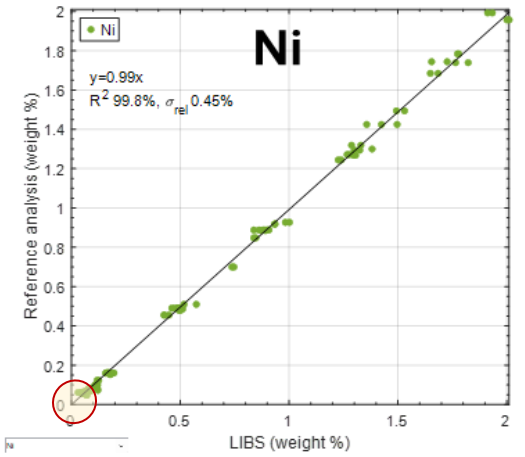
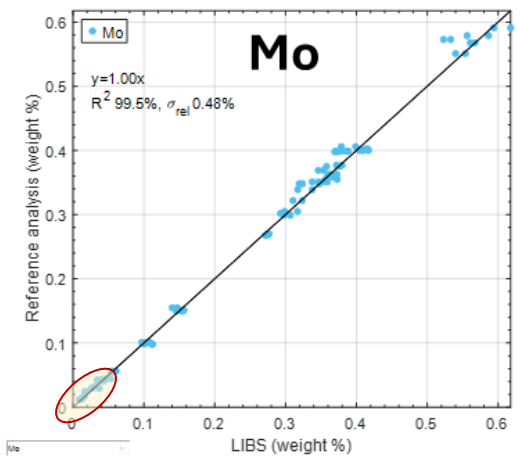
LIBS CALIBRATION RESULTS

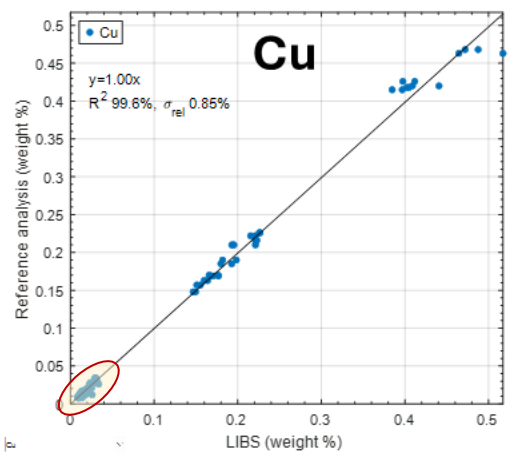
Low alloyed steel

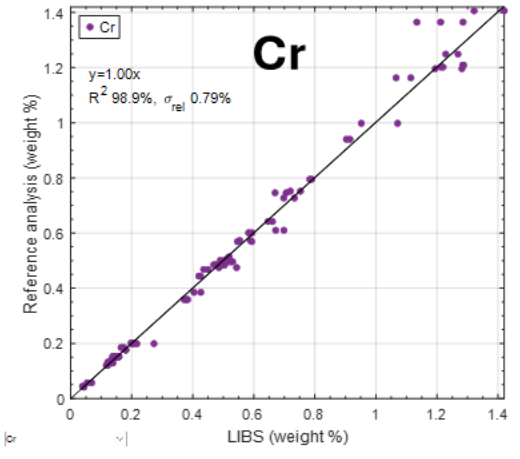


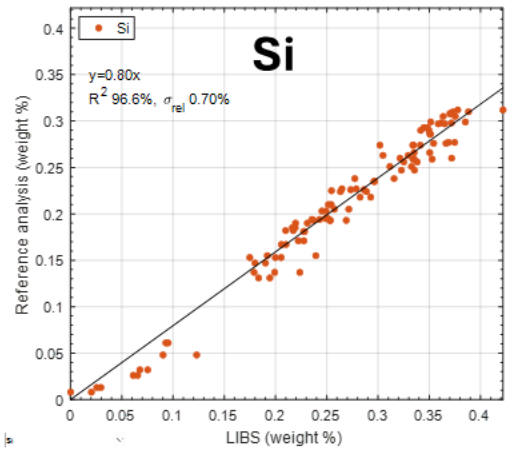


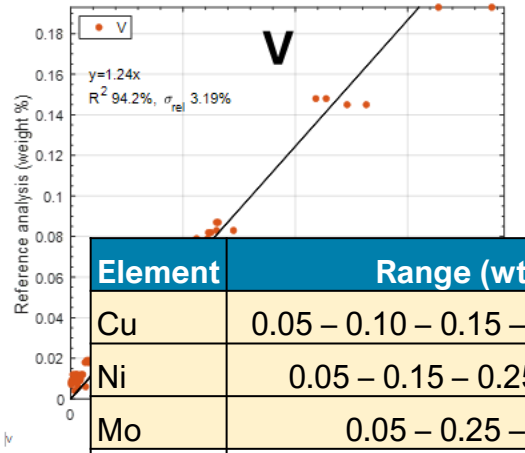












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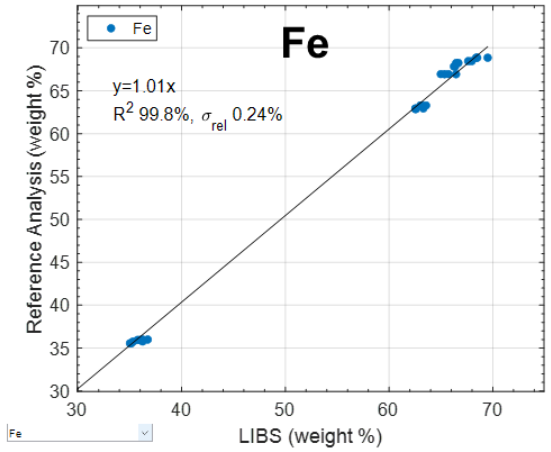
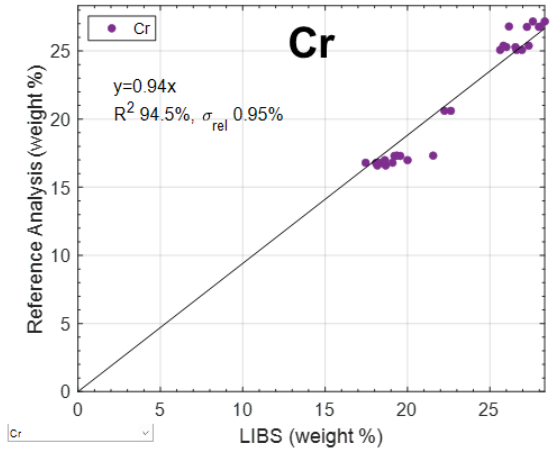
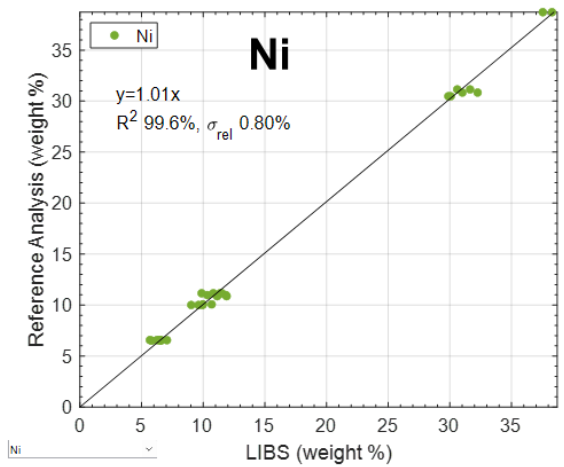
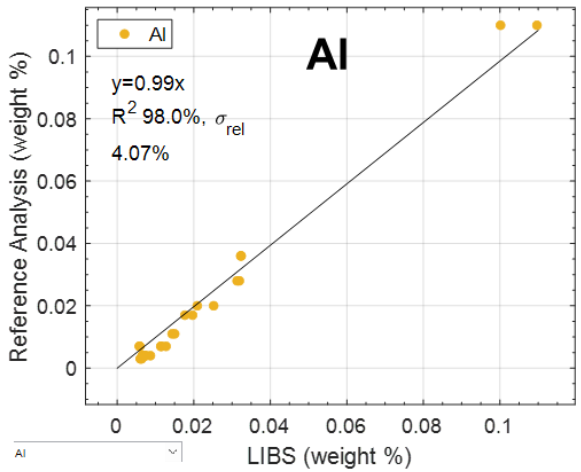
LIBS CALIBRATION RESULTS

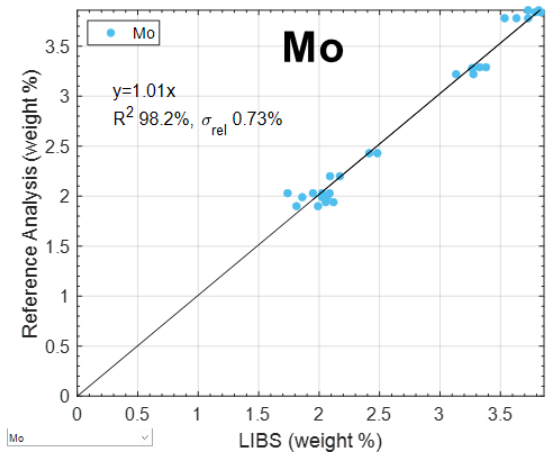
Stainless steel

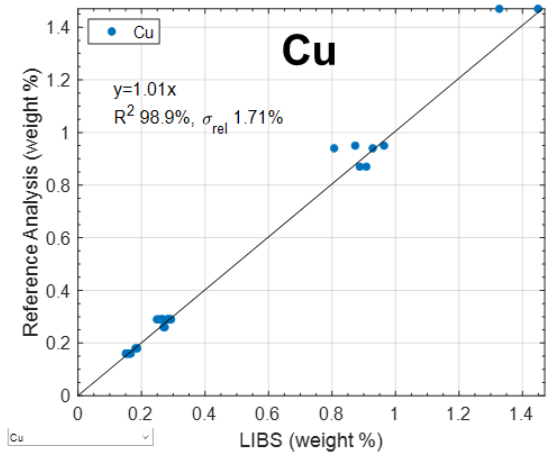


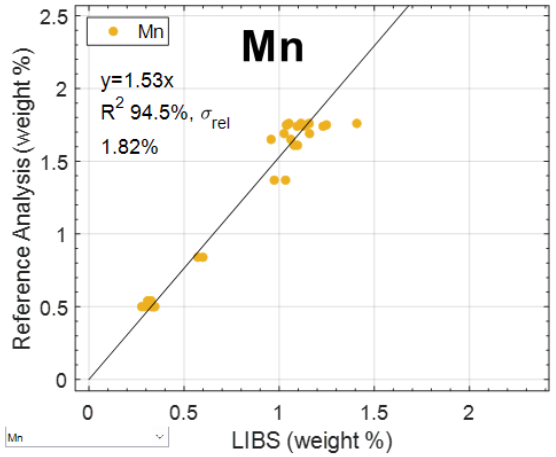


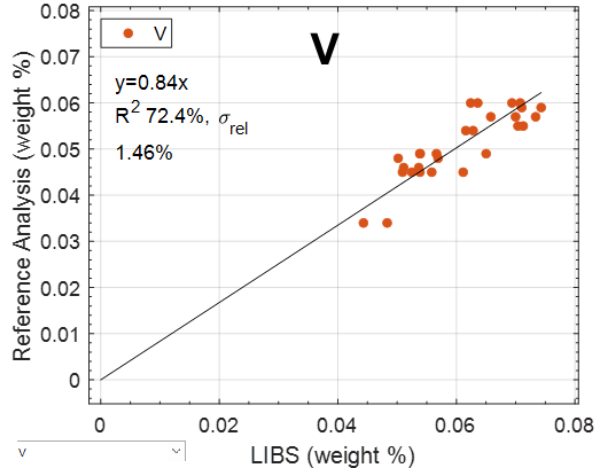












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FIRST FUNCTIONAL TEST

Internal scrap

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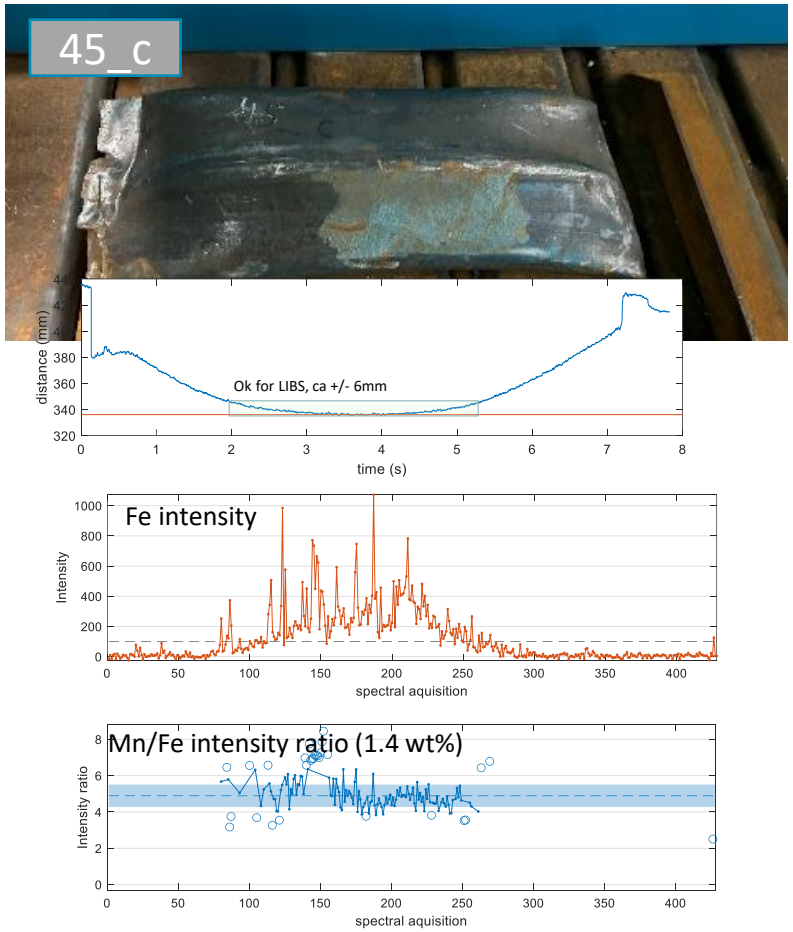
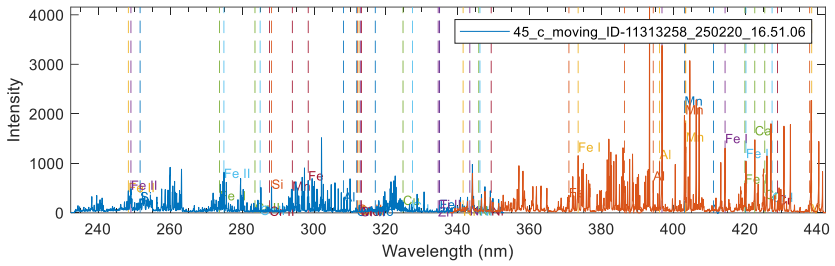
LIBS ANALYSIS OF SCRAP



Fe	Cr	Cu	Ni	Mo	Mn	Co	Si	Ti	V	Zn	Al
97.81	0.01	0.02	0.00	0.00	1.35	0.09	0.40	0.07	0.00	0.00	0.28



- The analysis of scrap works just as well as for reference materials when the samples are fixed.
- Moving materials provide a greater challenge

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STATUS OF THE PROJECT

- Sensors are installed but complete system still not fully functional and operational
- First batches of shredded scrap has been recorded but not analysed
- Final installation at the production line will be done in autumn 2025

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