

# Ressoucenschonung durch laserbasiertes Präzisionsrecycling –

1 Erfolgsgeschichte einer  
Ausgründung aus der TU  
Clausthal

Dr. Christian Bohling  
Geschäftsführender Gesellschafter

[christian.bohling@secopta.de](mailto:christian.bohling@secopta.de)  
[www.secopta.de](http://www.secopta.de)

**SECOPTA**  
Fast. Precise. Robust.



## History

- **1998** Spin-off Clausthal University of Technology
- **2001** LIBS mine detection by Secopta
- **2010** Market introduction of FiberLIBS
- **2014** Market introduction of MopaLIBS (Recycling)
- **2017** Change of Shareholder structure, Business Angles,  
New Facilities in Teltow (south of Berlin) focus on  
industrial applications
- **2021** SlagLIBS, New PMI Applications, New Mineral Applications,  
18 employee's turnover 2.3Mio.€

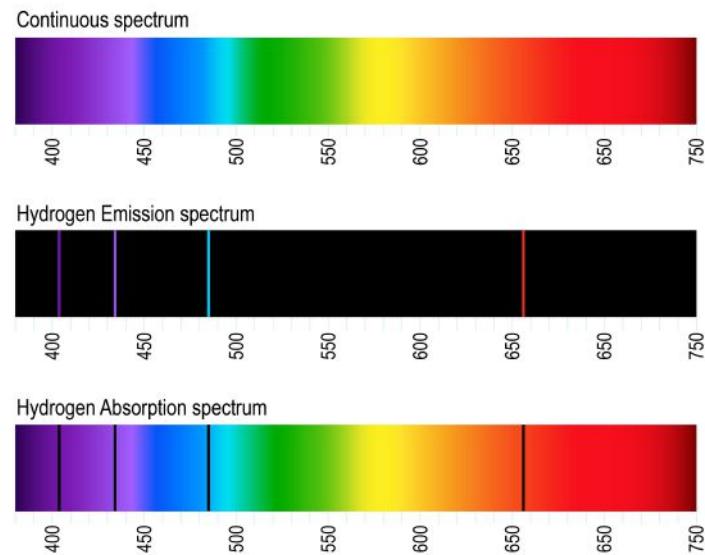
**SECOPTA**  
Fast. Precise. Robust.



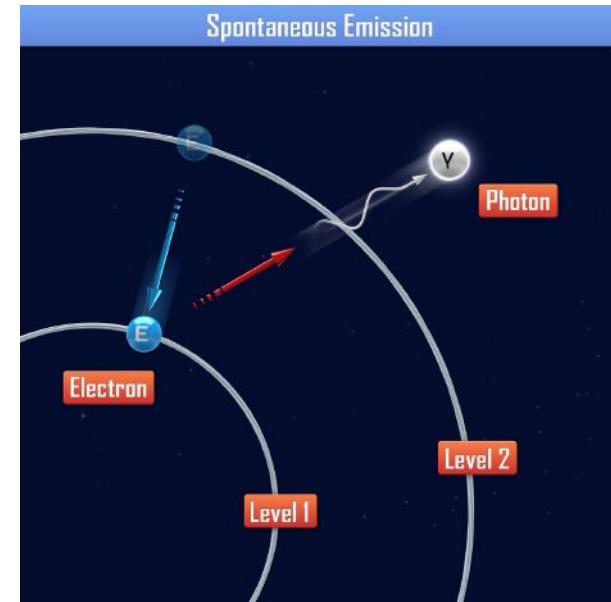
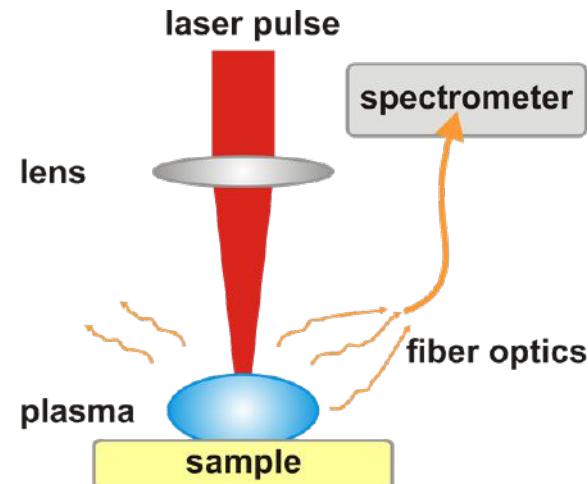
# Content

- 1. LIBS Basics**
2. Application: Metal Recycling
3. Application: Refactory recycling
4. Application: Construction waste recycling
5. Application: melt LIBS

## SPECTRUM

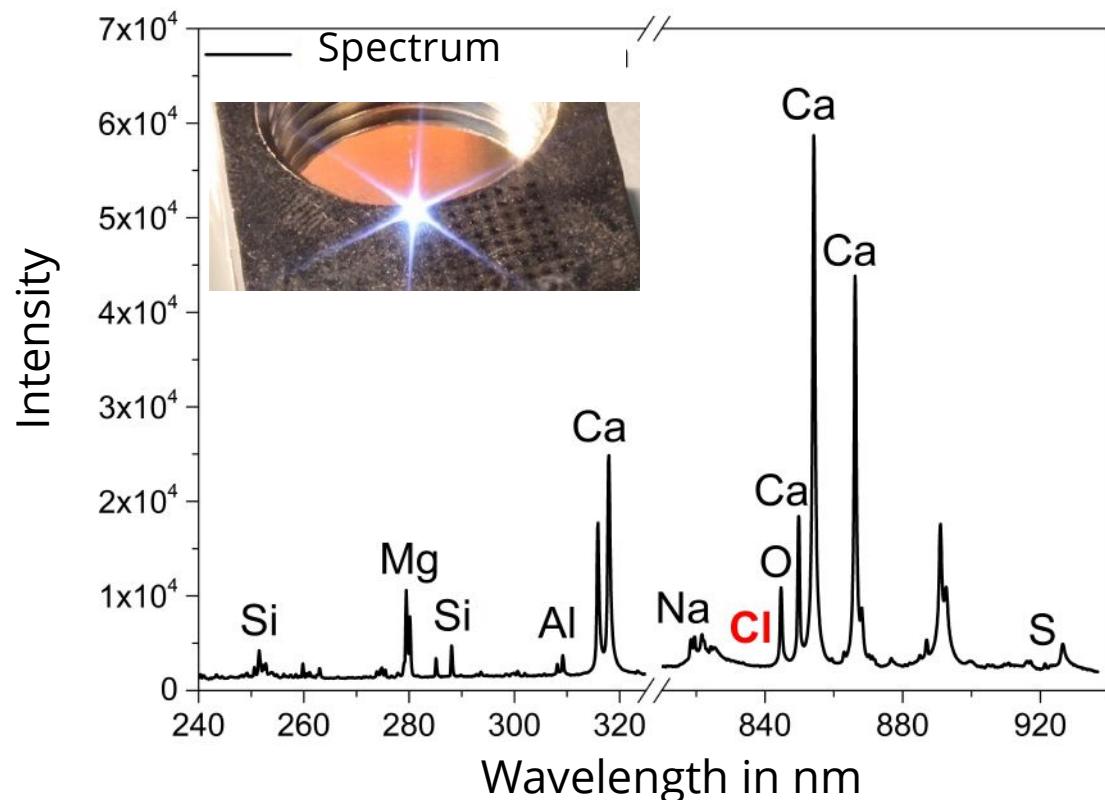


# Laser Induced Breakdown Spectroscopy (LIBS)



# Laser Induced Breakdown Spectroscopy (LIBS)

- All elements
- Within ms
- Inline
  - no sampling
  - no staff needed
- Insitu
  - no sample preparation
- Long term stable



# USPs SECOPTA LIBS Technology

fast.

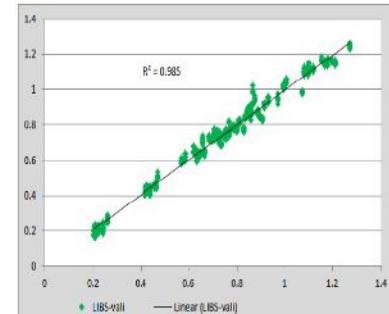
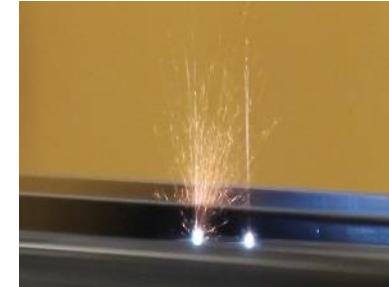
- Results within milliseconds
- 1000 measurements / s
- Up to 20.000 measurement points / s

precise.

- Quantitative Measurements <0,1 wt%
- Typical error of approx. 5% rel. possible @ 3m/s
- Simultaneous measurement of all elements (even lightweight)

robust.

- SECOPTA sensors in industry quality
- IP67, sealed in clean room environment, air stream
- Connection to PLC via common industrial interfaces



# SECOPTA Products and Applications

				
<b>FiberLIBS inline</b> <ul style="list-style-type: none"><li>• Fast, without sample preparation</li><li>• PMI Steel</li><li>• PMI Aluminum</li><li>• PMI NDT finishing line</li><li>• black bar</li><li>• bright bar</li><li>• billets</li></ul>	<b>FiberLIBS inline SP</b> <ul style="list-style-type: none"><li>• Non metal applications</li><li>• Volume flows on belt conveyors</li><li>• Metal industry</li><li>• Glass industry</li><li>• Ore, coal, slag</li><li>• Coating thickness</li></ul>	<b>MopaLIBS</b> <ul style="list-style-type: none"><li>• Extreme fast</li><li>• Autofocus</li><li>• Applications:<ul style="list-style-type: none"><li>• Al-Recycling</li><li>• Stainless steel</li><li>• ZORBA</li><li>• Non-Iron</li><li>• Copper</li><li>• Zn</li></ul></li></ul>	<b>meltLIBS</b> <ul style="list-style-type: none"><li>• Analytics on molten metals</li><li>• distance 700mm</li><li>• automated distance control</li><li>• applications:<ul style="list-style-type: none"><li>• cast iron, pig iron.</li><li>• aluminium, copper, slag</li></ul></li></ul>	<b>Lab solutions</b> <ul style="list-style-type: none"><li>• 2D- and 3D mapping</li><li>• Segregations (Steel/Al)</li><li>• Inclusions</li><li>• concreteLIBS</li><li>• concrete analysis</li><li>• slagLIBS</li><li>• slag without sample preparation</li></ul>

## Materials recycled by LIBS



Aluminium  
(Si, Mg, Mn, Cr, Zn,... alloys)



Titanium Classification  
(Ti Al6 V4, Ti Al3 V2.5, Ti 99, ...)



Low-alloy steel  
(Mn, Cr, Ti, Al, Si, Cu,... alloys)



High-alloy steel  
(Mo, Cr, Ni, Si, Mn, Cu, P, ...  
alloys)



Minerals / material  
mixes  
(furnace refractories, sinter,...)



Building material  
(concrete, Gypsum)

# Content

1. LIBS Basics
2. **Application: Metal Recycling**
3. Application: Refactory recycling
4. Application: Construction waste recycling
5. Application: melt LIBS



## (Keine) CO<sub>2</sub> Einsparung durch Gewichtsreduktion: Neu-Aluminium

Eingesetztes Aluminium	500 kg Primäraluminium
Gewichtsreduktion	225 kg
CO <sub>2</sub> Zusatzbedarf für Produktion	6.850 kg (CO <sub>2</sub> )
Reduktion Kraftstoffverbrauch	8,0 l → 6,8 l /100
Ersparnis CO <sub>2</sub>	2,8kg/100km
Break Even	245.000 km
Ersparnis CO <sub>2</sub> bei Gesamtlaufleistung 250.000 km	136 kg (CO <sub>2</sub> )

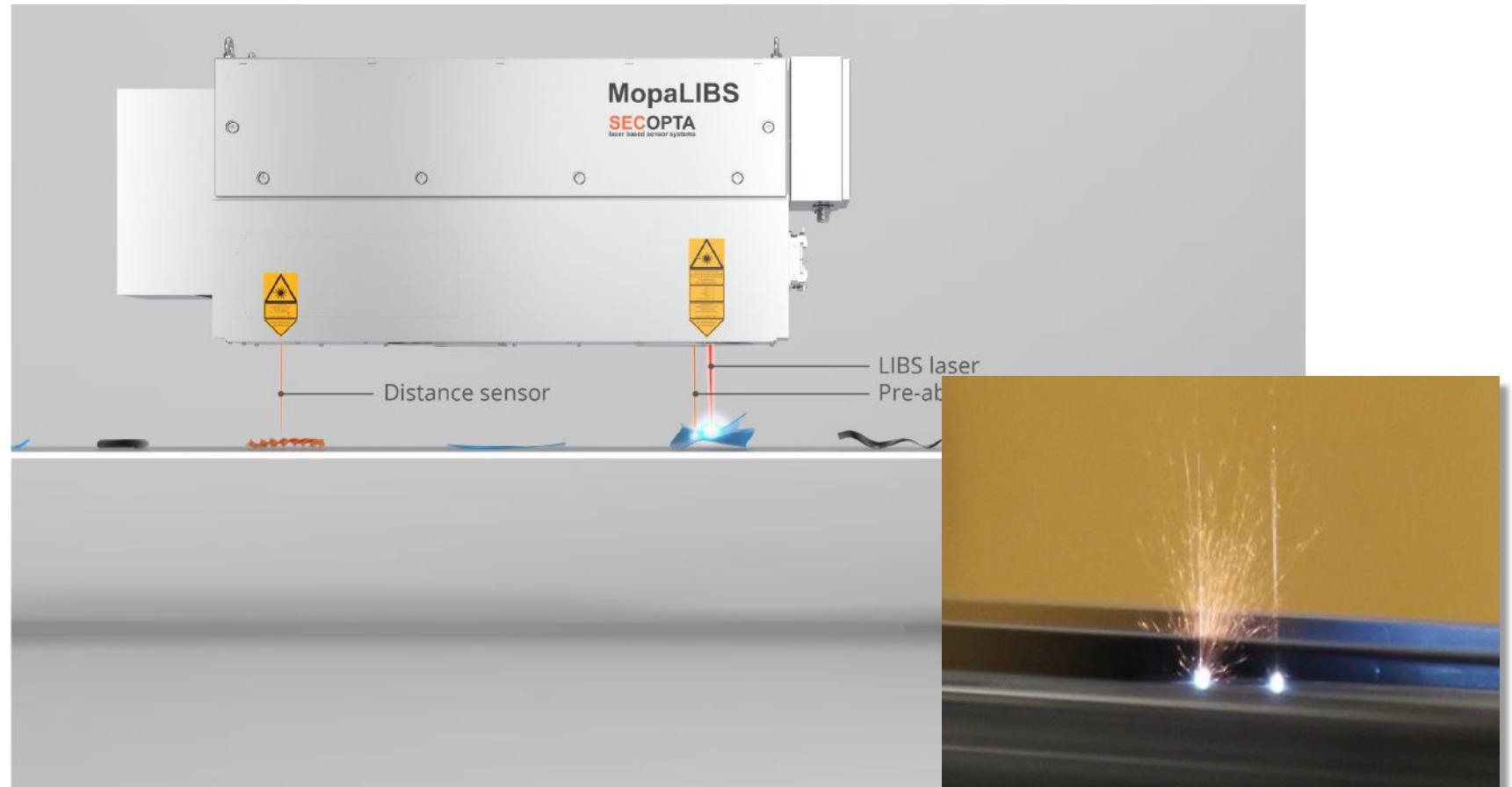


Audi A2, Quelle: Audi A2 Museum

## CO<sub>2</sub> Einsparung durch Gewichtsreduktion: Recycled Aluminium

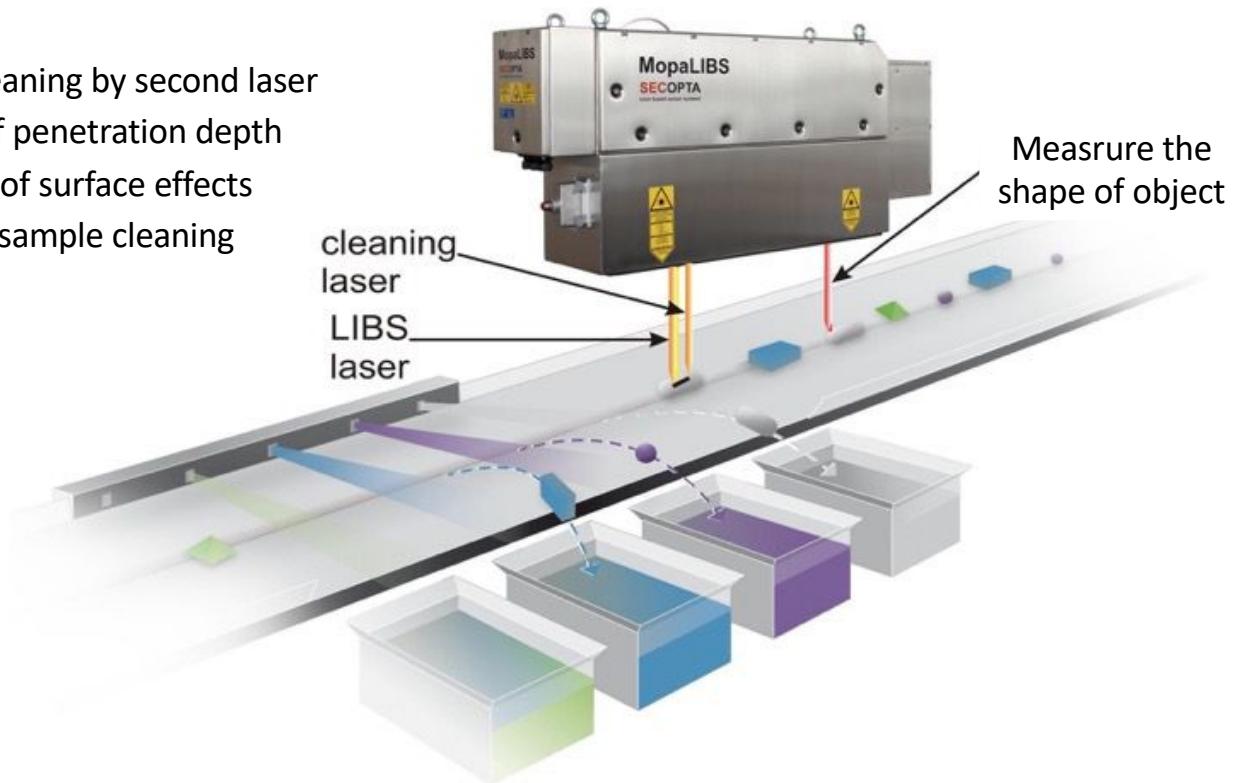
Eingesetztes Aluminium	500 kg 75% Sekundär-Al
Gewichtsreduktion	225 kg
CO <sub>2</sub> Zusatzbedarf für Produktion	1.420 kg (CO <sub>2</sub> )
Reduktion Kraftstoffverbrauch	8,0 l → 6,8 l /100
Ersparnis CO <sub>2</sub>	2,8kg/100km
<b>Break Even</b>	<b>50.800 km</b>
Ersparnis CO <sub>2</sub> bei Gesamtlaufleistung 250.000 km	5.570 kg (CO <sub>2</sub> )

## MopaLIBS, how it works

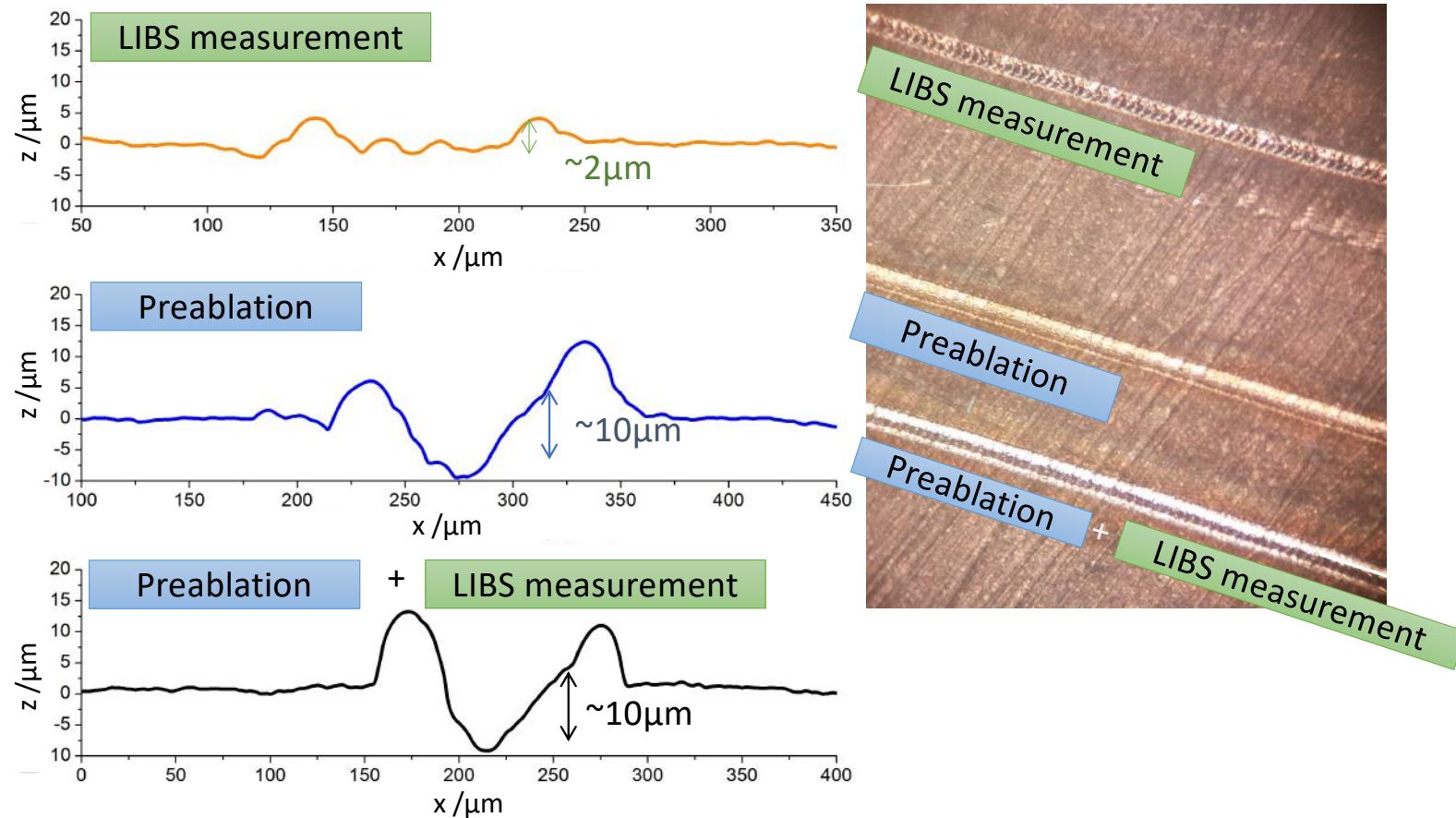


# MopaLIBS *line PA*

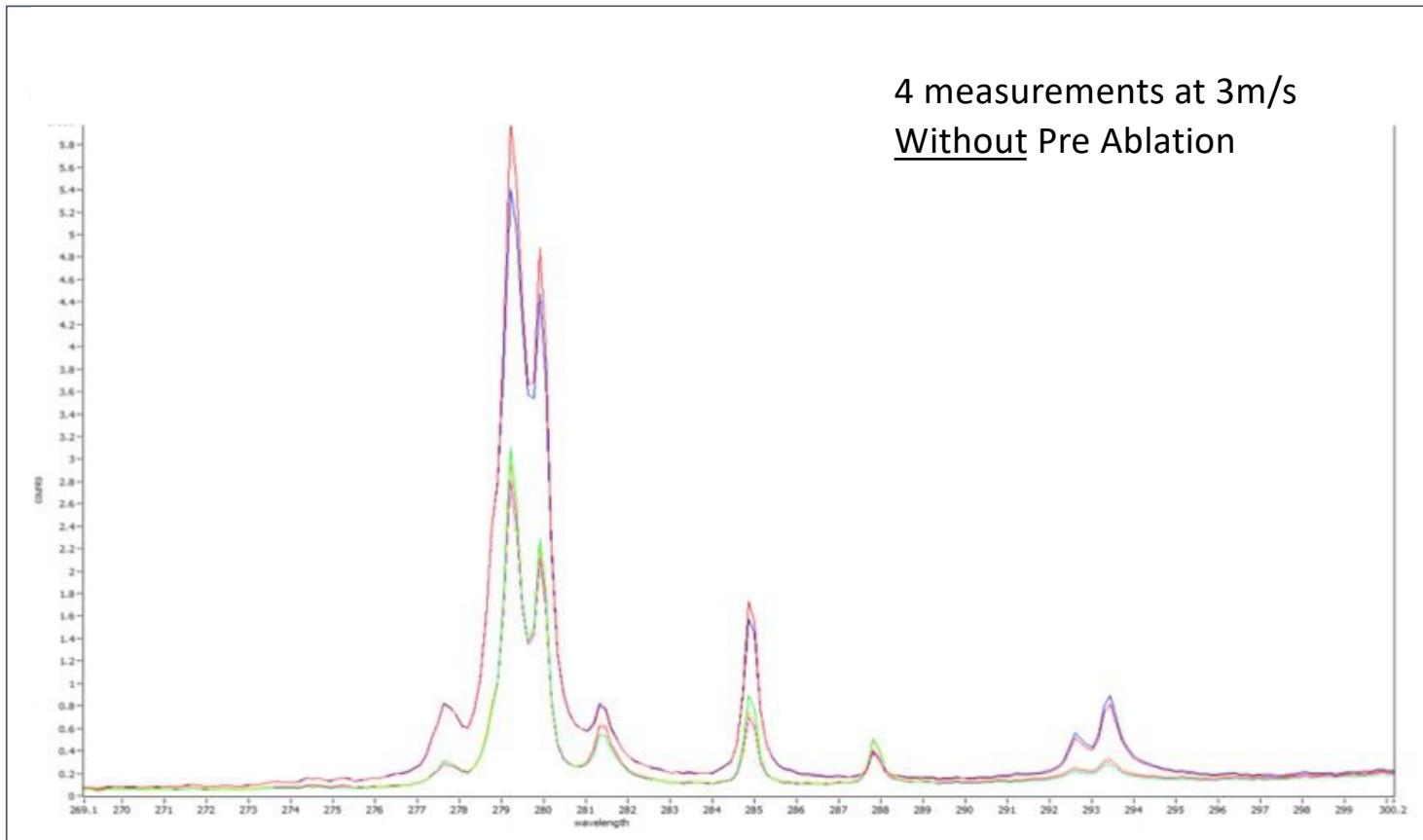
- Surface cleaning by second laser
- Increase of penetration depth
- Reduction of surface effects
- Waving of sample cleaning



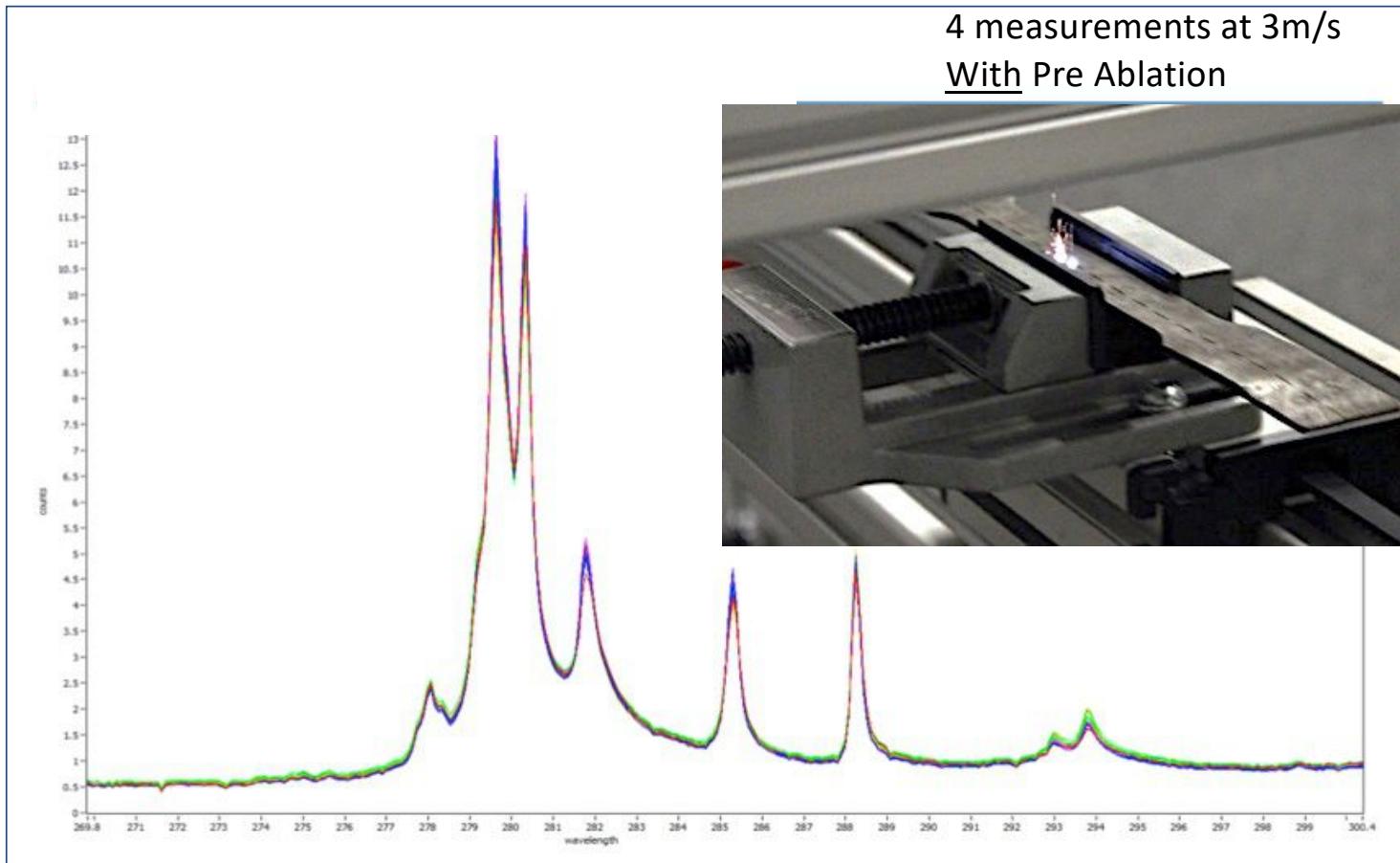
## Depth of penetration into material (steel)



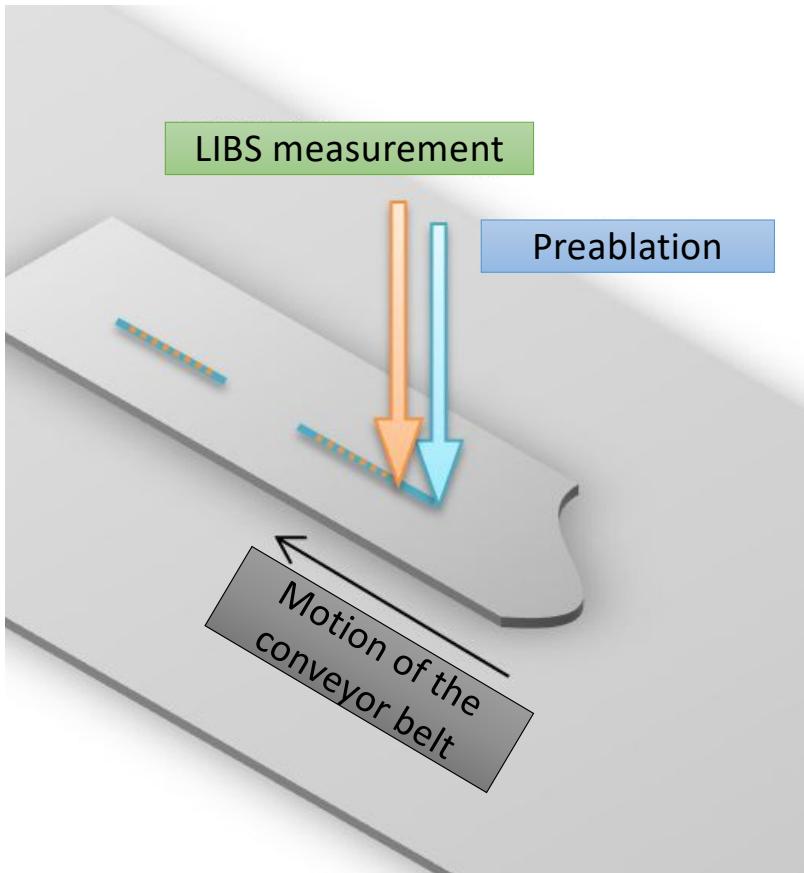
## LIBS Spectra – same sample – rolled product



## LIBS Spectra – same sample – rolled product with PA



# Principle of preablation

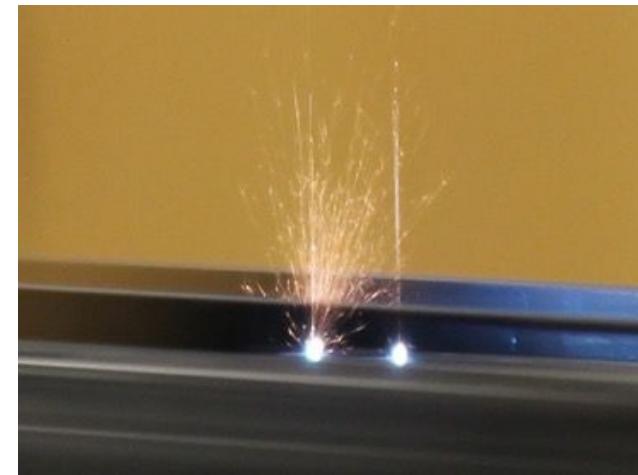


**Laser Preablation: 100 kHz**

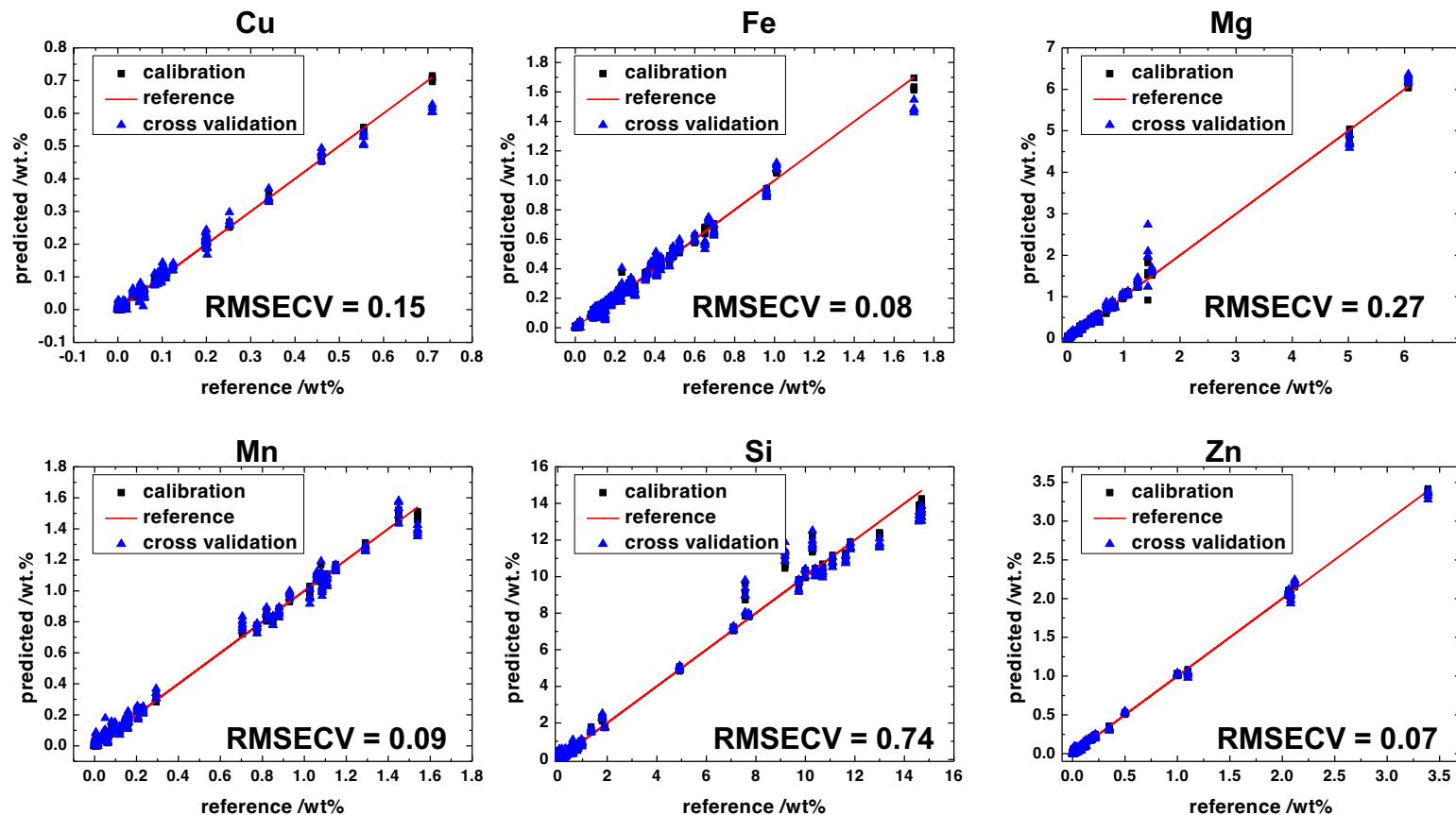
Belt speed: 3m/s  
spatial resolution between laser shots: 30 µm

**Measurement laser: 20 kHz**

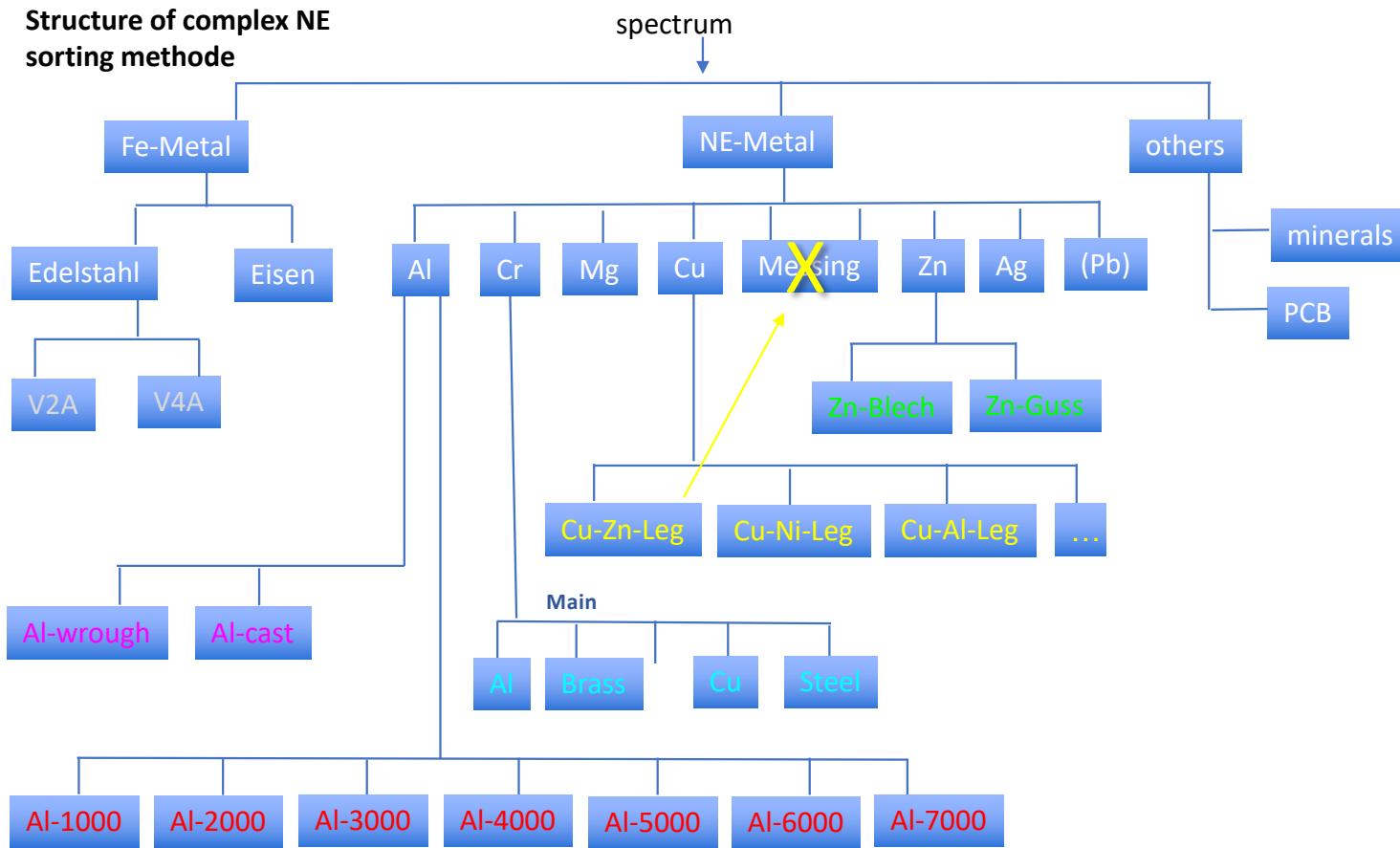
Belt speed: 3m/s  
spatial resolution between laser shots: 150 µm



## Crossvalidation Al at 3m/s (with pre-ablation)



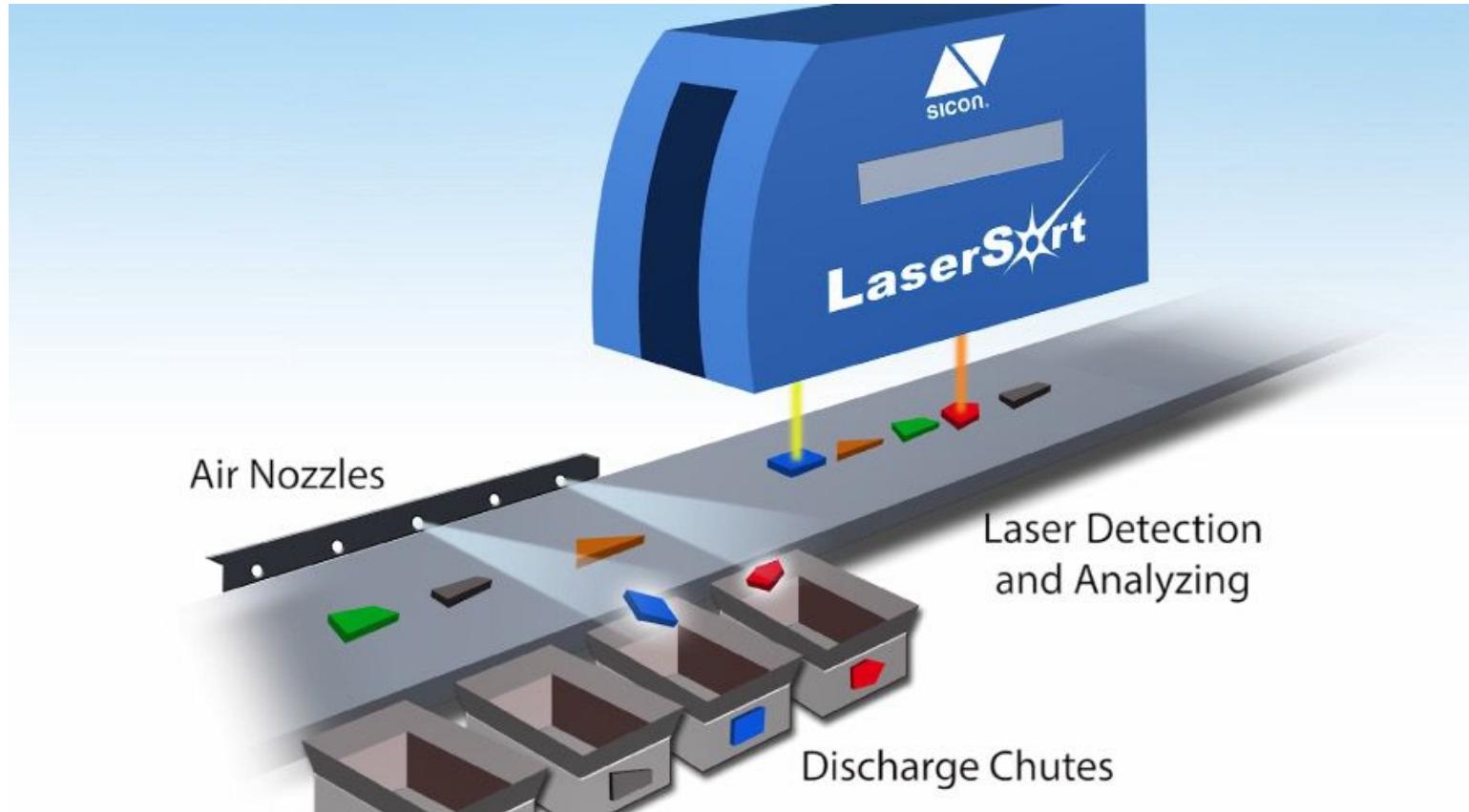
# Sorting NE-Metals



## Sotieranlage eines Partners



**STEINERT**   
MAGNETIC + SENSOR SORTING SOLUTIONS



# Presentation at G20 in Hamburg



## The World's First LIBS Sorter Machine Successfully Developed for Commercialization

— Using a laser for individual item screening enables precise sorting of materials, for the ultimate in recycling technology —

Copyright (c) Harita Metal Co.,Ltd. All Rights Reserved

We create.  
**HARITA-METALS**

8  
6



LIBS prototype sorter is made by Pellenc ST Japan

## Simple sorting setup for heavy metal sorting



# Content

1. LIBS Basics
2. Application: Metal Recycling
3. **Application: Refactory recycling**
4. Application: Construction waste recycling
5. Application: melt LIBS

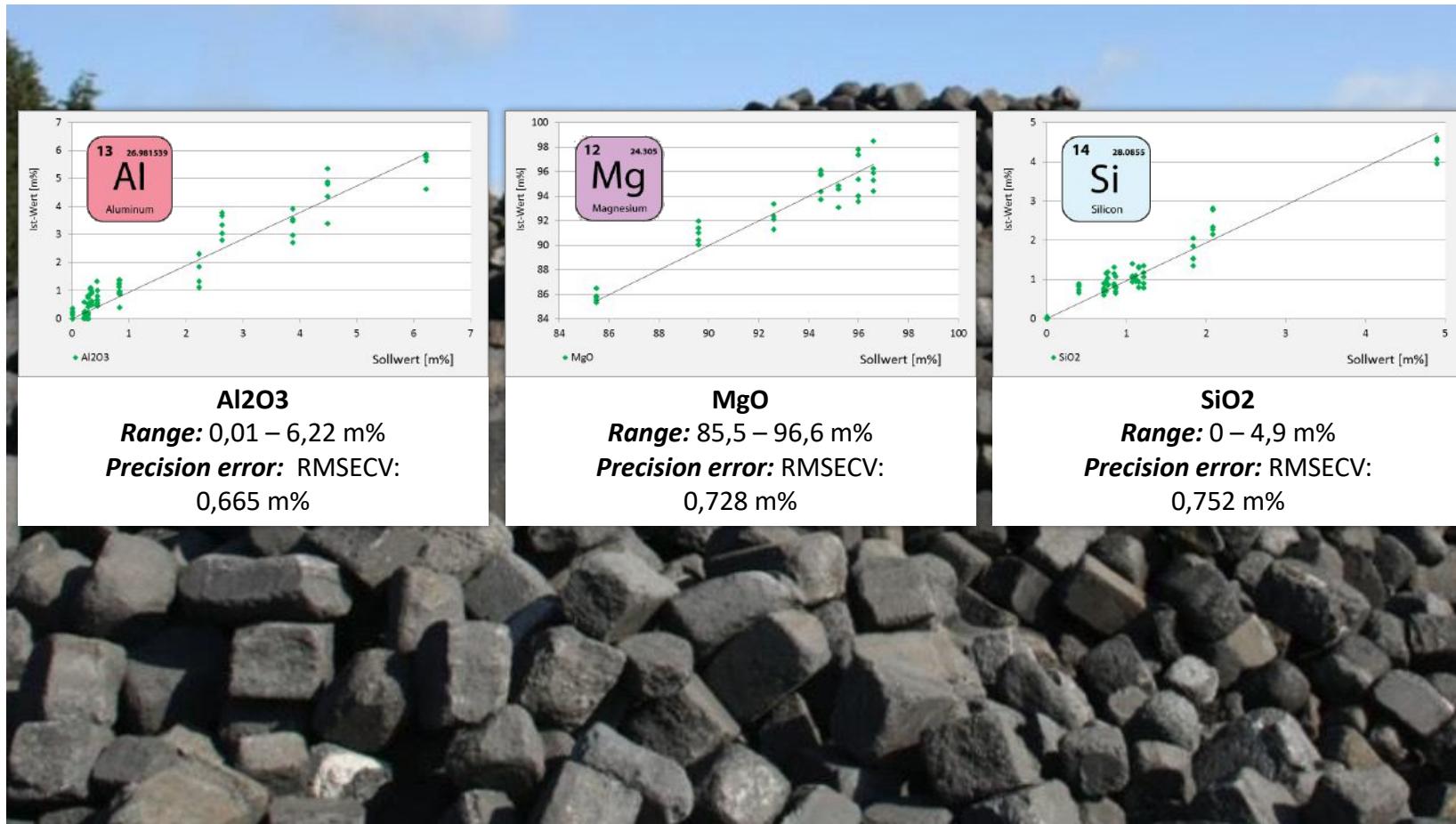


## Recycling of refractory materials

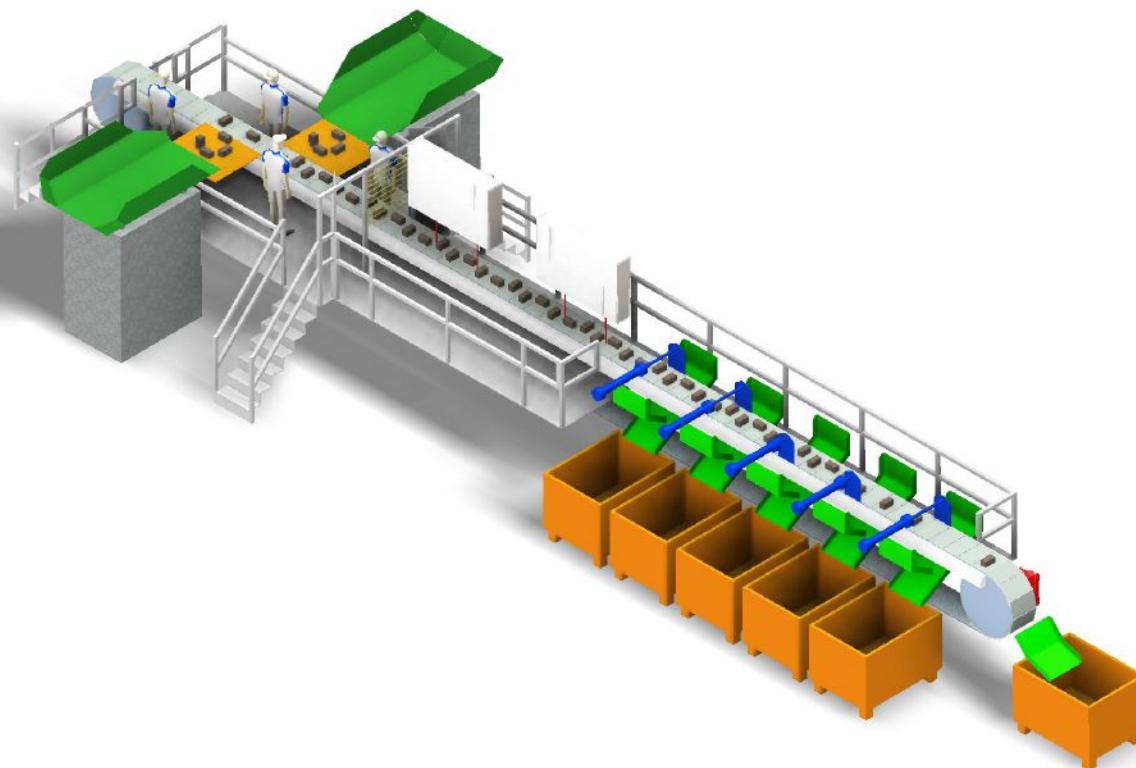
- Used for
  - Steel, metal, cement and glas-industries
  - Oven, converter, transportation, ...
- Consists of:
  - MgO (with  $\text{Al}_2\text{O}_3$  content 0-30%)
  - $\text{Al}_2\text{O}_3$  (with MgO content 0-20%)
  - Three component mixtures:  $\text{Al}_2\text{O}_3$ , MgO,  $\text{SiO}_2$
  - AlCr, MgCr
  - ZrO
  - Many, may more...
- State of the art:
  - Analysed by XRF in lab, after complex treatment (shutter plates for steel-oven)
  - Recycling: Sorted by hand, black (much carbon): not possible



## Calibations for sorting of refractories



## Sorting Plant refractories









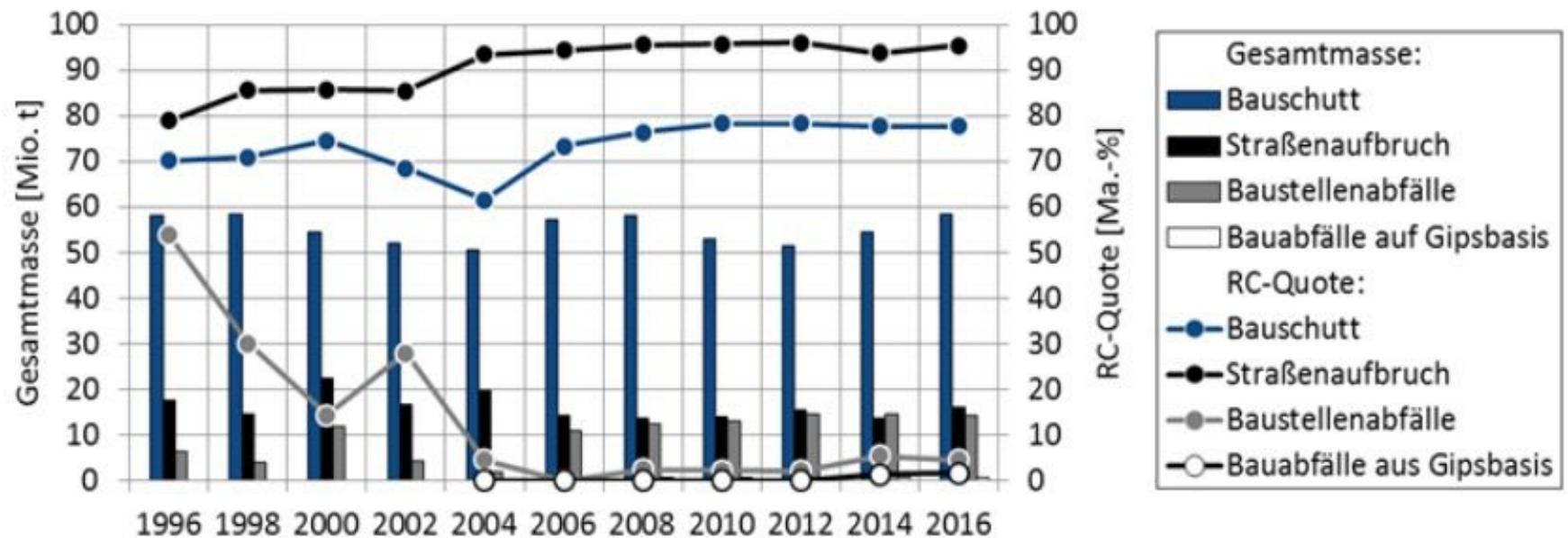


# Content

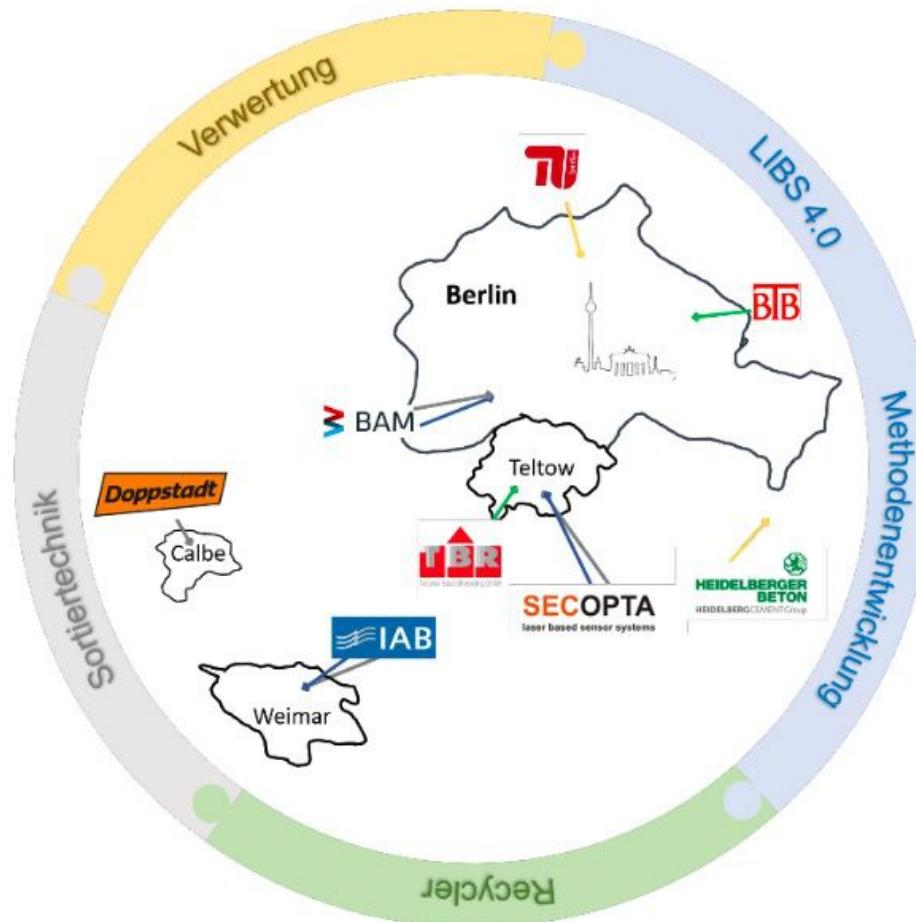
1. LIBS Basics
2. Application: Metal Recycling
3. Application: Refactory recycling
4. **Application: Construction waste recycling**
5. Application: melt LIBS



## Stoffströme aus Abbruchmaterial



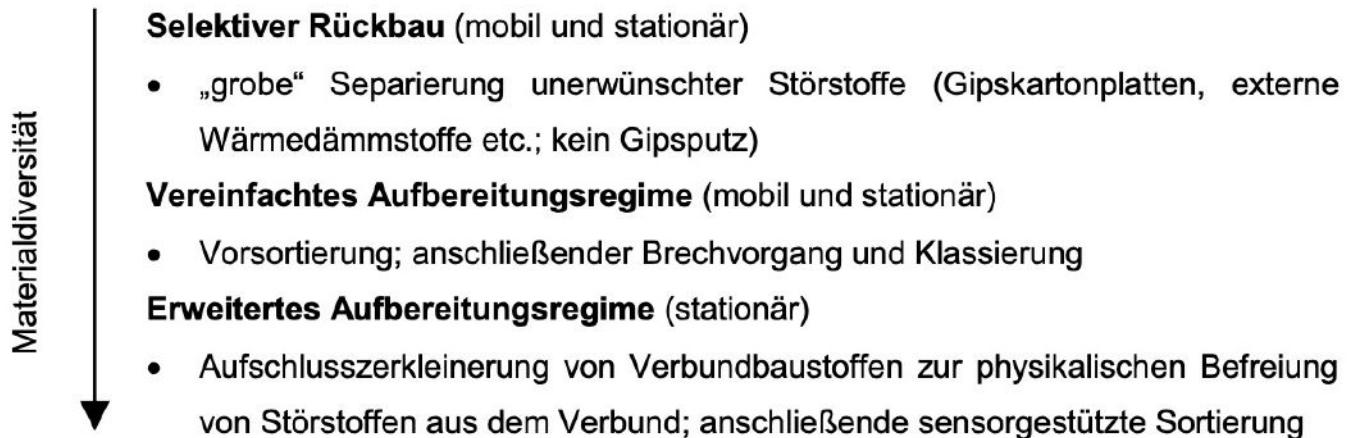
## Partner im Projekt ConSort



### Assoziierte Partner



# Ablauf Baustoffrecycling



# Zwischenergebnisse Übersicht der Proben



**SECOPTA**  
Fast. Precise. Robust.

**Anzahl Proben: 55**

- 1 Beton
- 4 Kalksandsteine
- 6 Leichtbetone
- 5 Porenbetone
- 10 Vormauerziegel
- 7 Dachziegel
- 11 Hintermauerziegel
- 2 Schlacken
- 2 Asphalte
- 7 Putze

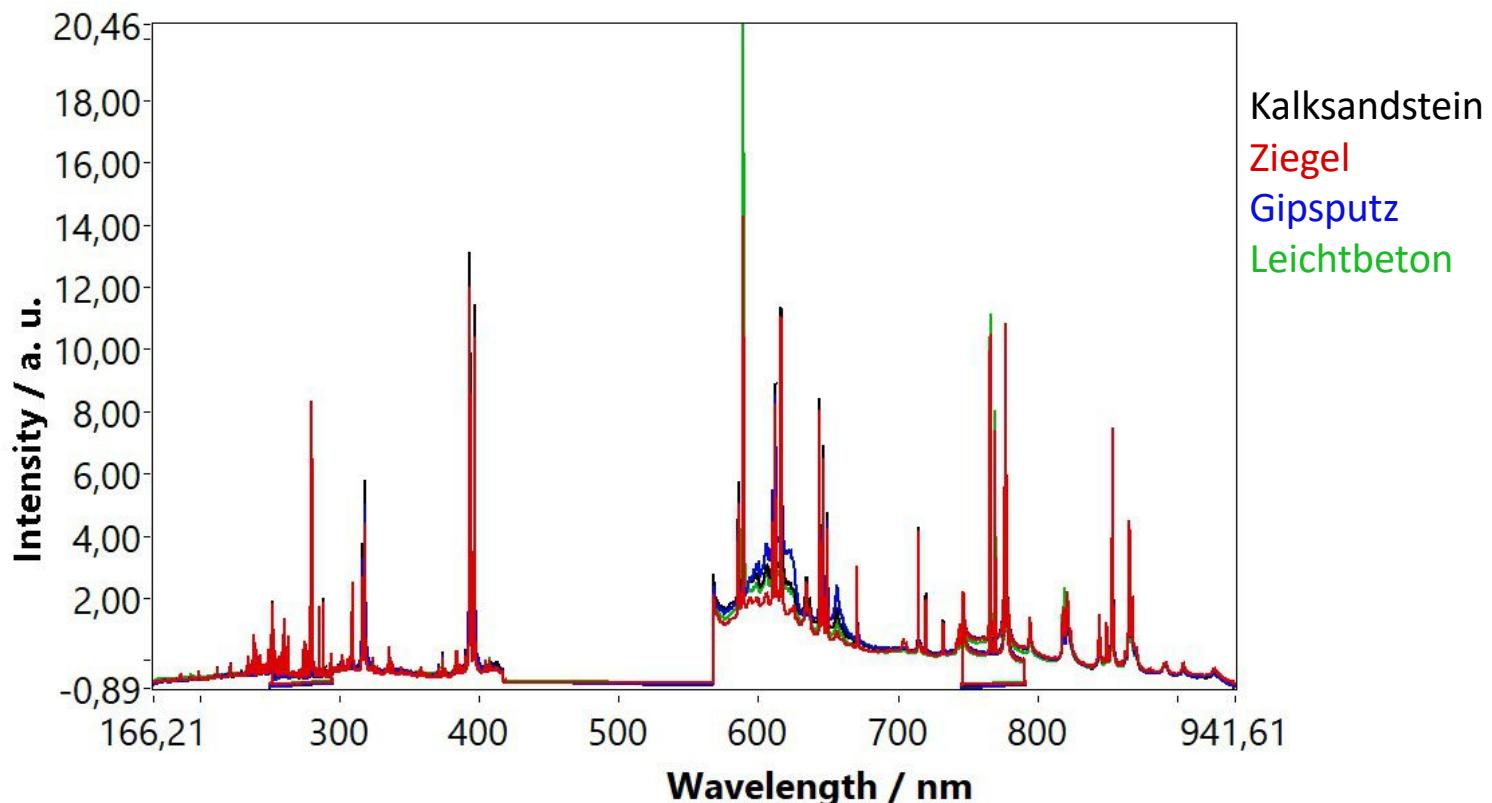




## LIBS Spektren



**SECOPTA**  
Fast. Precise. Robust.

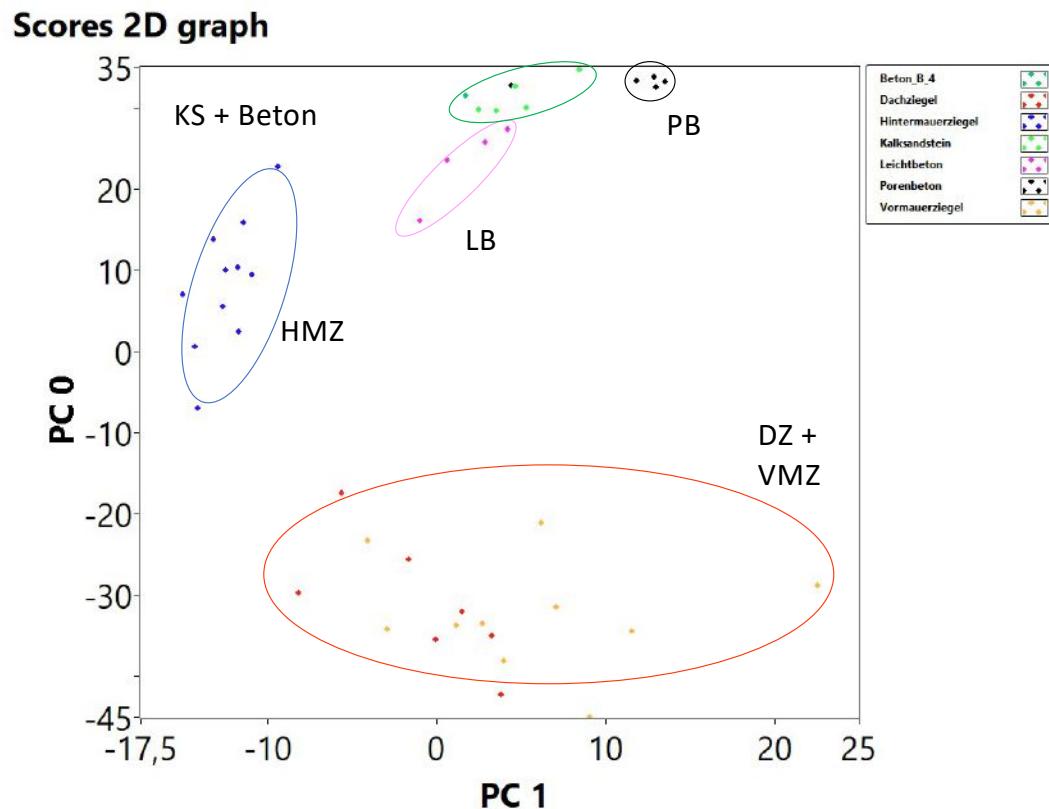


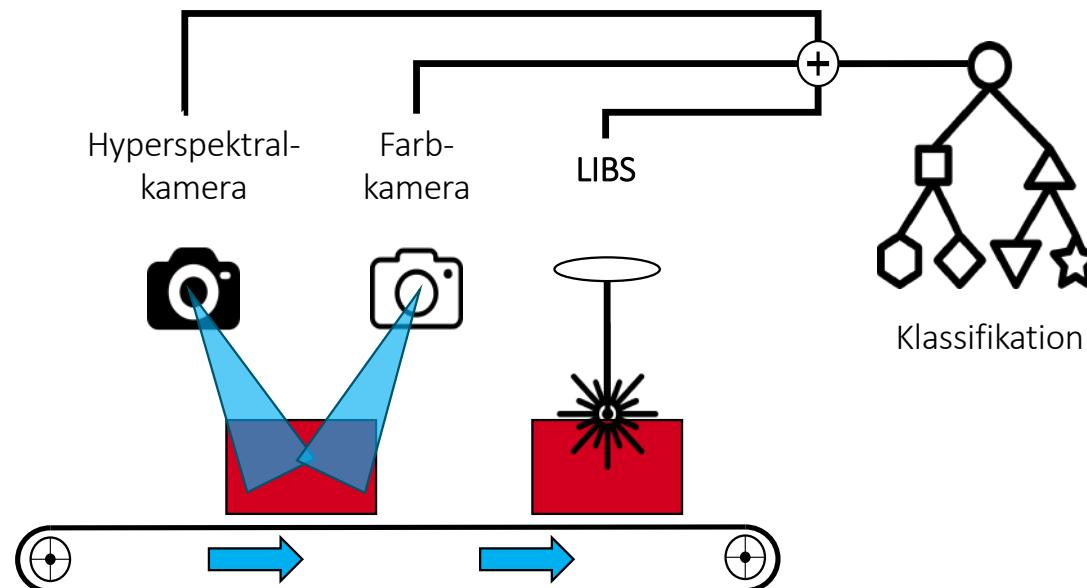
# Hauptkomponentenanalyse



**SECOPTA**  
Fast. Precise. Robust.

- PCA Analyse ermöglicht erste Gruppierung der Proben in verschiedene Baustoffklassen



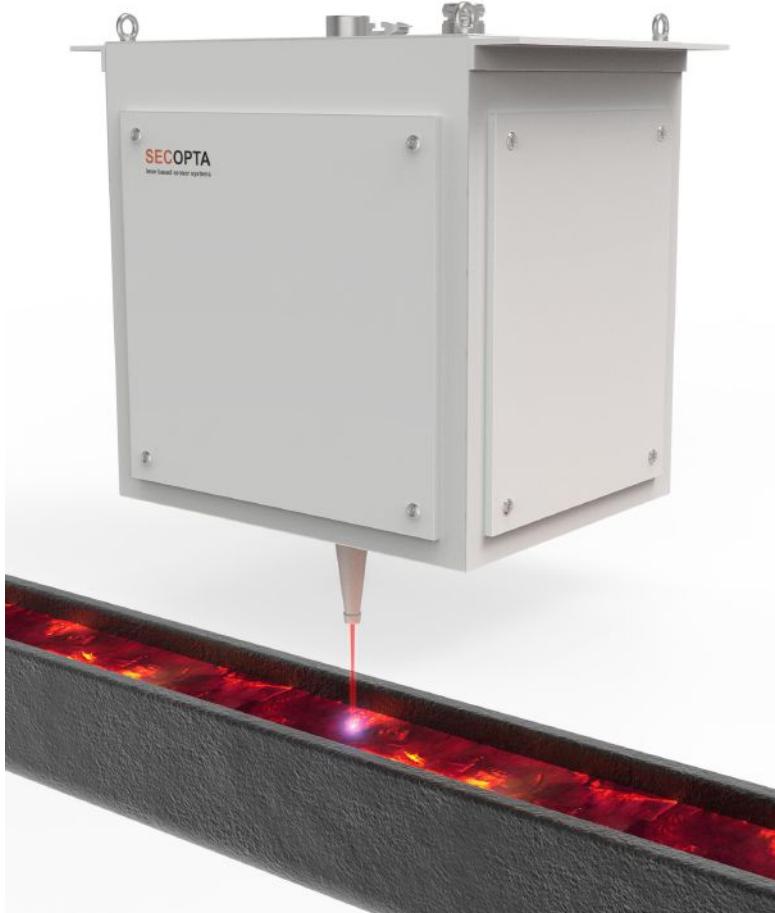


# Content

1. LIBS Basics
2. Application: Metal Recycling
3. Application: Refactory recycling
4. Application: Construction waste recycling
5. **Application: melt LIBS**

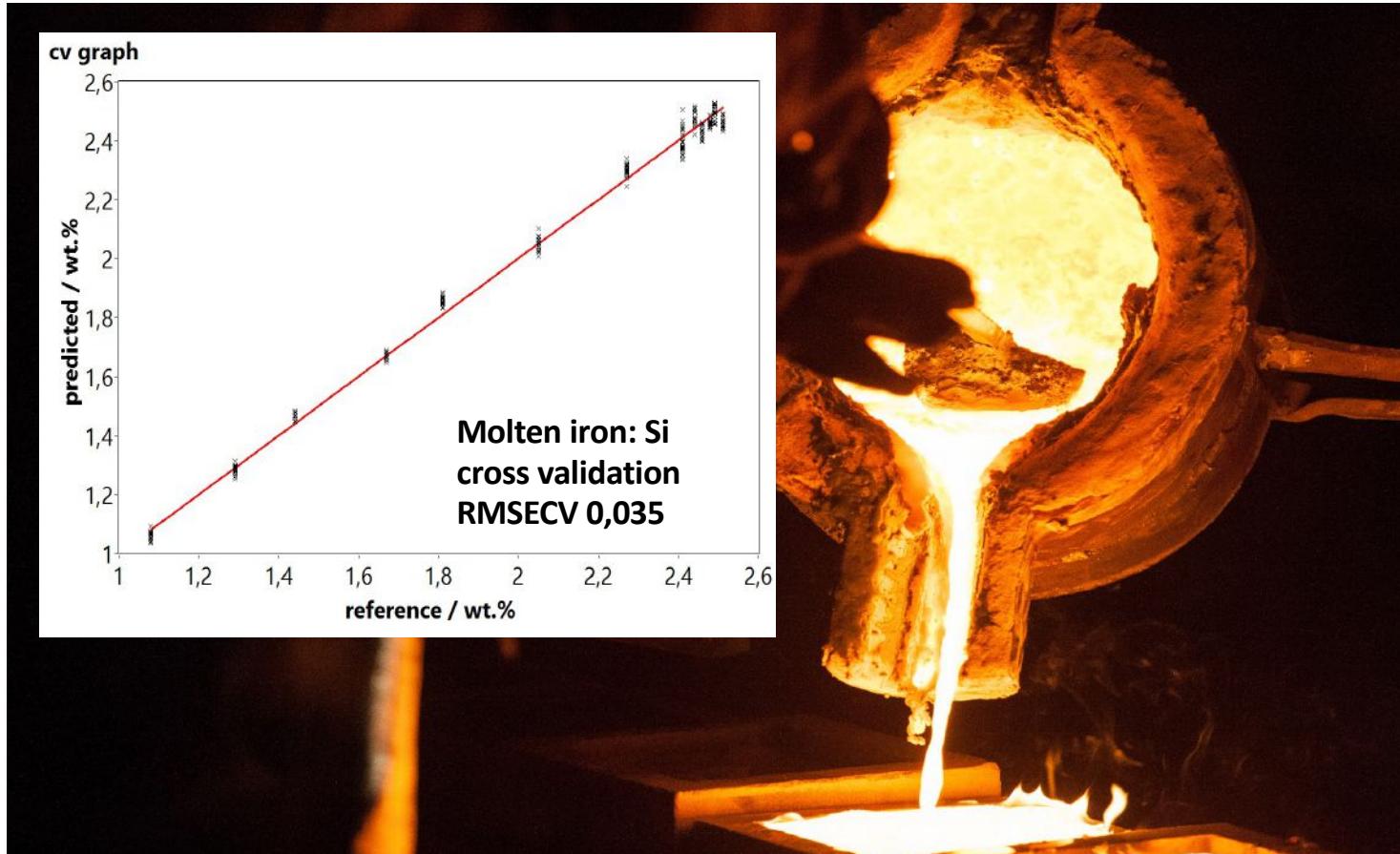


## MeltLIBS – in process

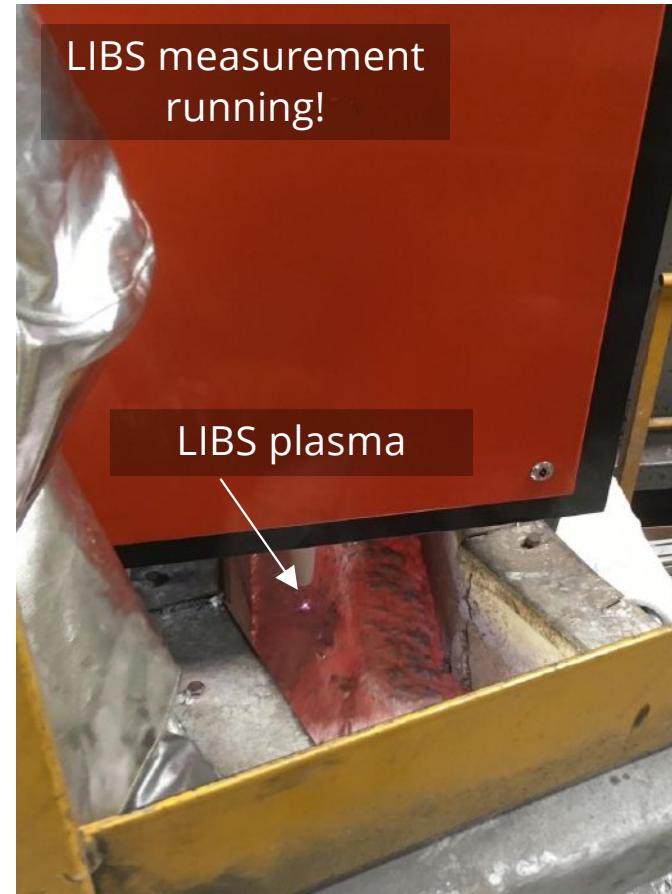
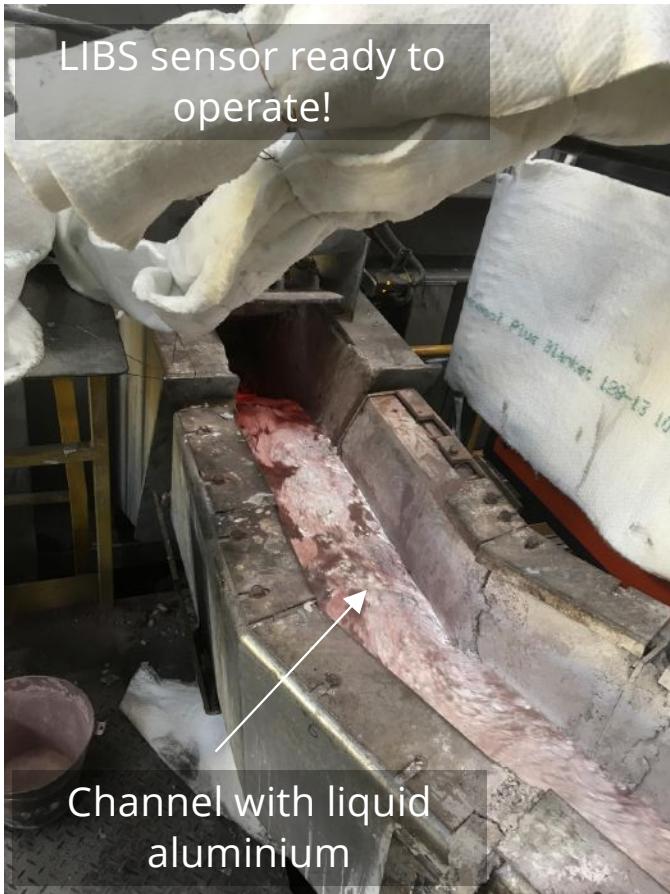


**SECOPTA**  
Fast. Precise. Robust.

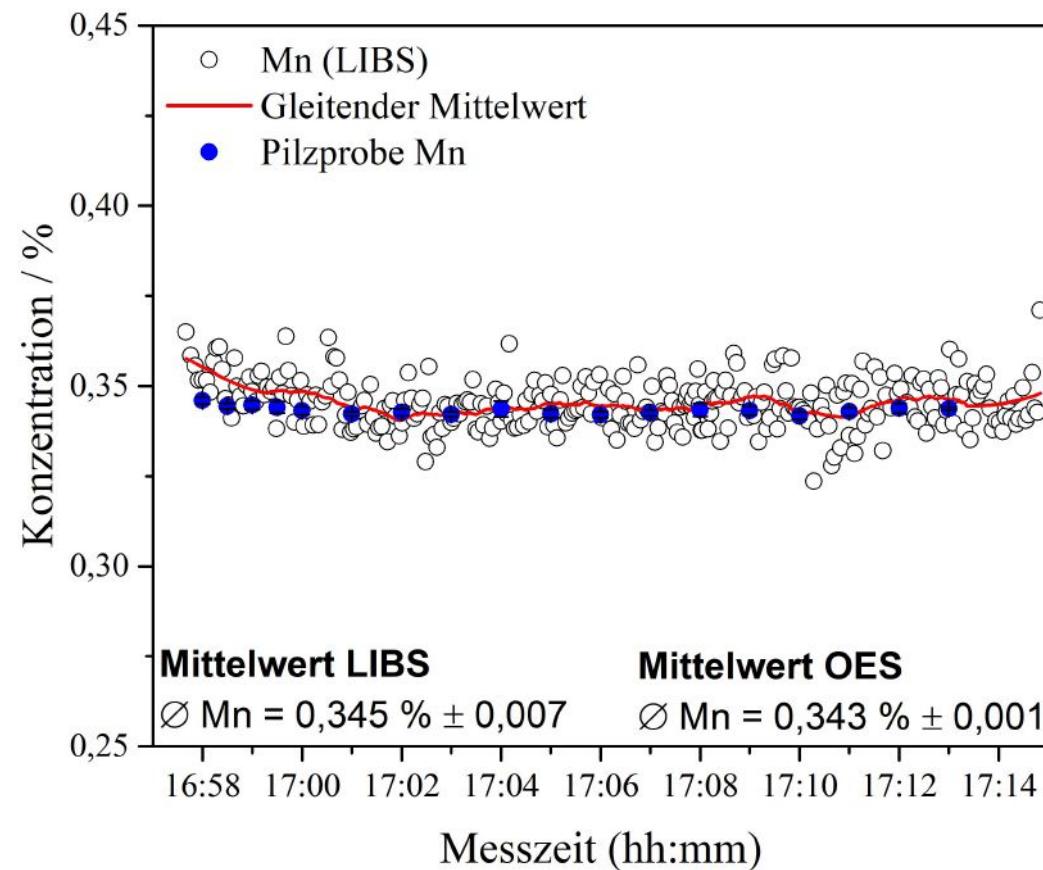
## Liquid iron: calibration Si



## MeltLIBS inline measurements



## LIBS results of inline MeltLIBS measurements



# Analytical performance of MeltLIBS

*SECOPTA analytics standard calibration*

	Element	Min. wt.%	Max. wt.%	Precision
Based on standard calibration (quantitative calibration)	Si	0	1.50	4 %
	Cu	0	0.32	6 %
	Fe	0	1.20	6 %
	Mn	0	2.25	4 %
	Mg	0	5.60	5 %
	Cr	0	0.24	5 %
	Zn	0	0.30	5 %
	Ti	0	0.34	6 %
Alarm thresholds (semi-quantitative)	V	> 1000 ppm	-	1σ
	Sn	> 1000 ppm	-	1σ
	Pb	> 1000 ppm	-	1σ
	Zr	> 1000 ppm	-	1σ
	Na	> 1000 ppm	-	1σ
	Ca	> 1000 ppm	-	1σ

## References



We create.  
**HARITA METALS**



Horn & Co.  
Group



**SECOPTA**  
Fast. Precise. Robust.



**DANIELI**

The reliable innovative  
partner to be front runners  
in the metals industry



**binder+co**

# Summary



LIBS is an innovative universal elemental analysis technique



LIBS is extreme fast, results within ms, >350 measurements/s



LIBS is much more precise than other process measurement techniques like XRF or neutrons



LIBS systems from Secopta are extremely robust: Low maintenance



LIBS can be used under harsh industrial environmental conditions, e.g. for primary raw materials - sorting or quality control



LIBS can be used quantitative or qualitative (classification), Secopta provides standard applications as well as individual chemometric models

Thank you for your attention...



Your contact:

**Dr. Christian Bohling**  
[Christian.bohling@secopta.de](mailto:Christian.bohling@secopta.de)  
mobile: +49 (0)151 16 93 59 07  
phone: +49 (0)3328 35403-21

© SECOPTA GmbH, May 22