RHI MAGNESITA
AGELLIS
AN RHI MAGNESITA BRAND

Control slag – stabilize your process

Agellis

Agenda – Slag detection for furnaces

1 Introduction

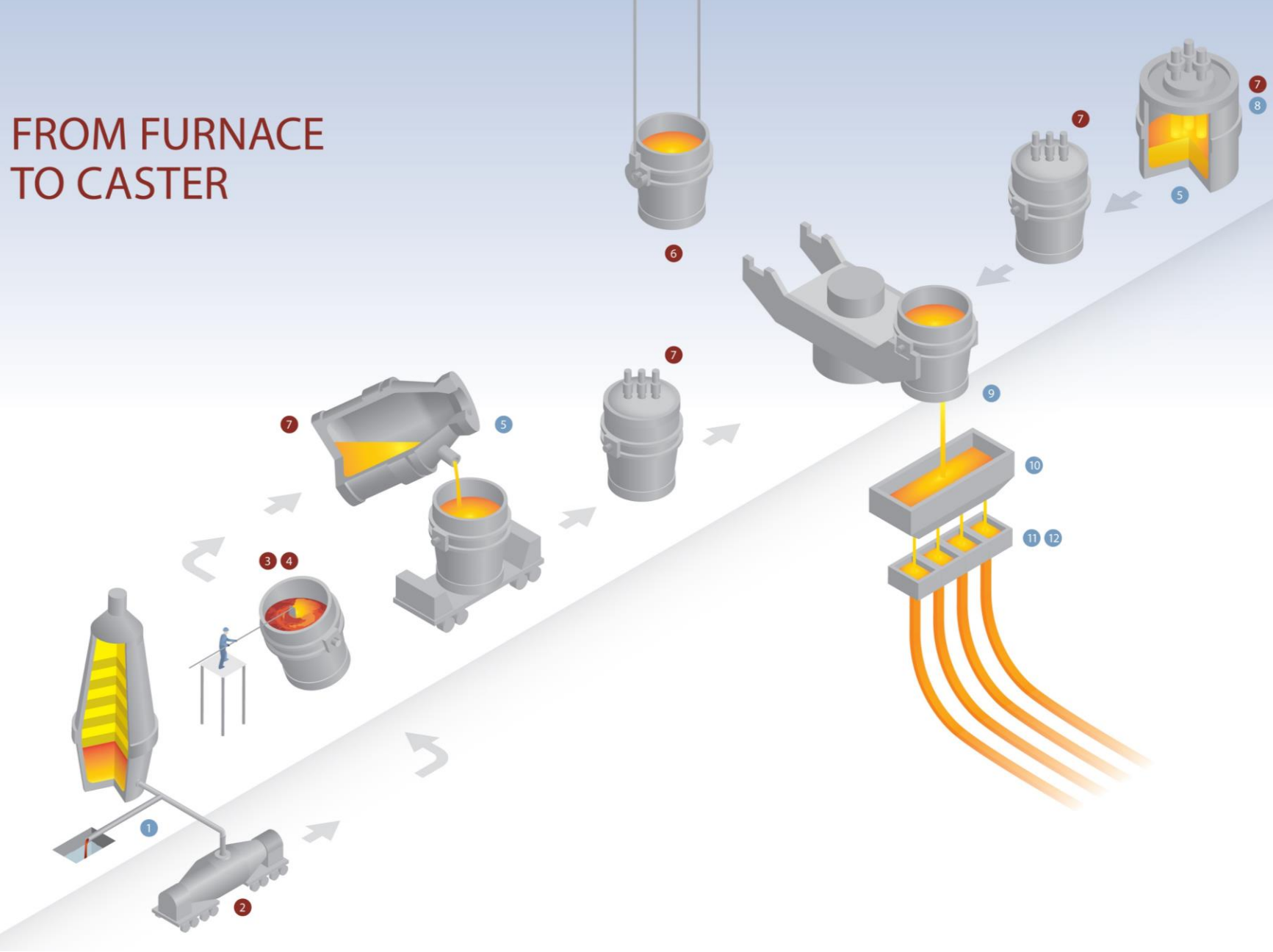
2 Product presentation

3 How does it work?

4 Examples

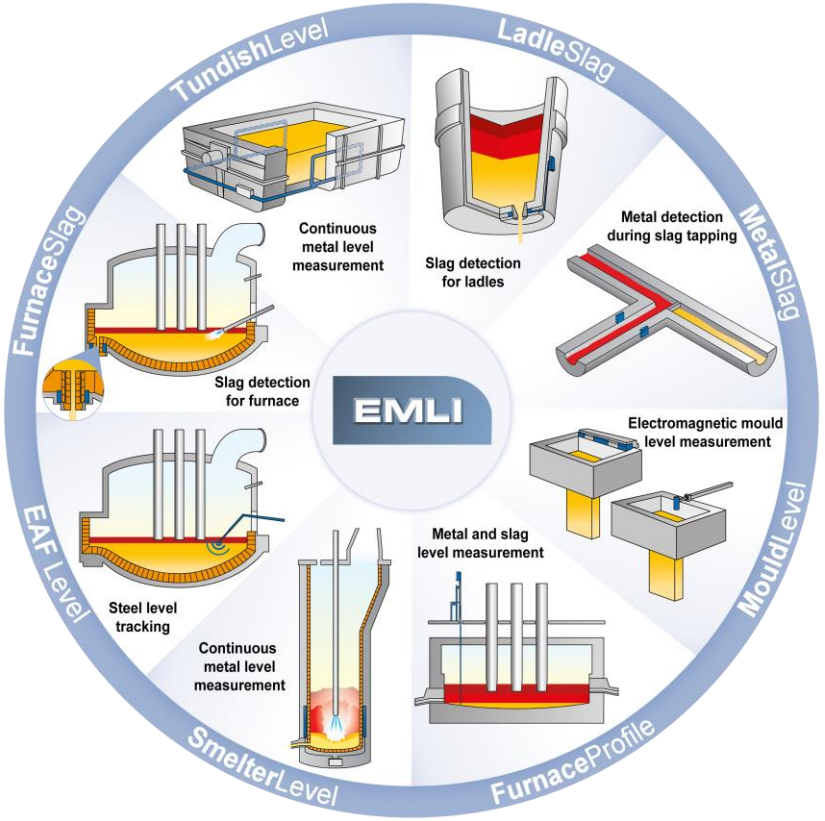
5 Case study results

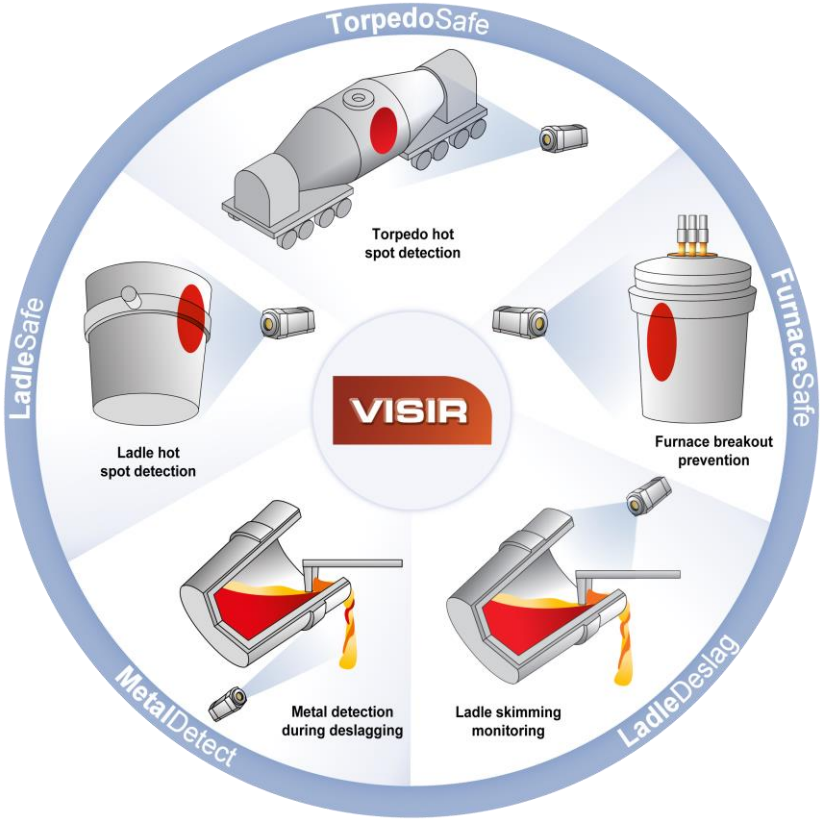
FROM FURNACE TO CASTER



Overview technology platforms

Electromagnetic and Vision





RHI MAGNESITA
AGELLIS
AN RHI MAGNESITA BRAND

Electromagnetic slag detection for furnace

IMPACT OF SLAG CONTROL ON SECONDARY STEELMAKING PROCESS

What is the system engineered for?

EMLI-FurnaceSlag

- To minimize slag carryover -> early detection
- To monitor the entire tapping stream -> vortex
- To work flawlessly with flames and fumes
- To work with any steel, alloys and metal grades
- To be easy to use and maintain
- To calculate slag transfer amounts

How does the system improve production?

EMLI-FurnaceSlag

- By stabilizing the slag carry over amount
  - ➢ Minimized variations of the pre-conditions in LF
  - ➢ Avoid time losses due to unwanted deslagging operations

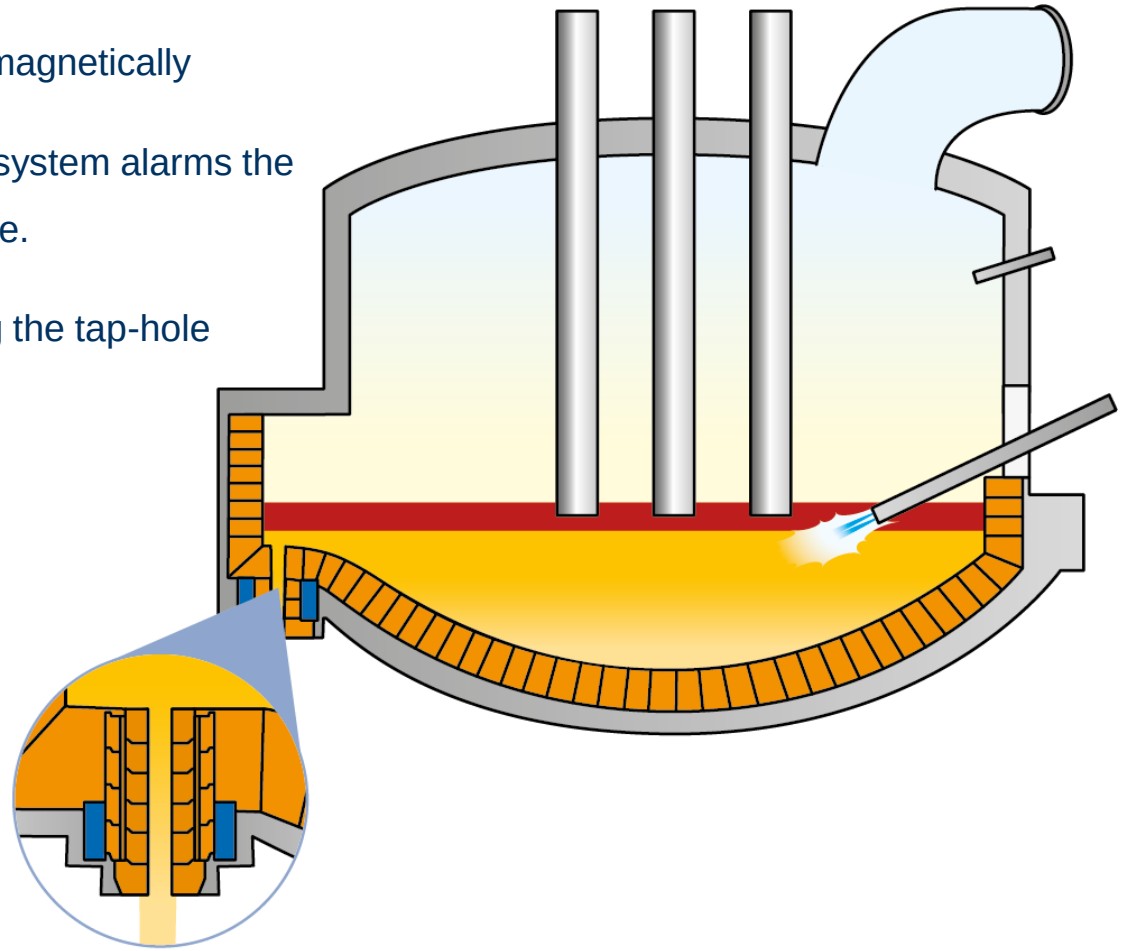
- By indicating optimal tapping stream
  - ➢ Minimized transfer of unwanted elements to LF
  - ➢ Lower alloying additive cost

- Reduce tap hole wear and wear in ladles
  - ➢ Reduce costs

How does it work?

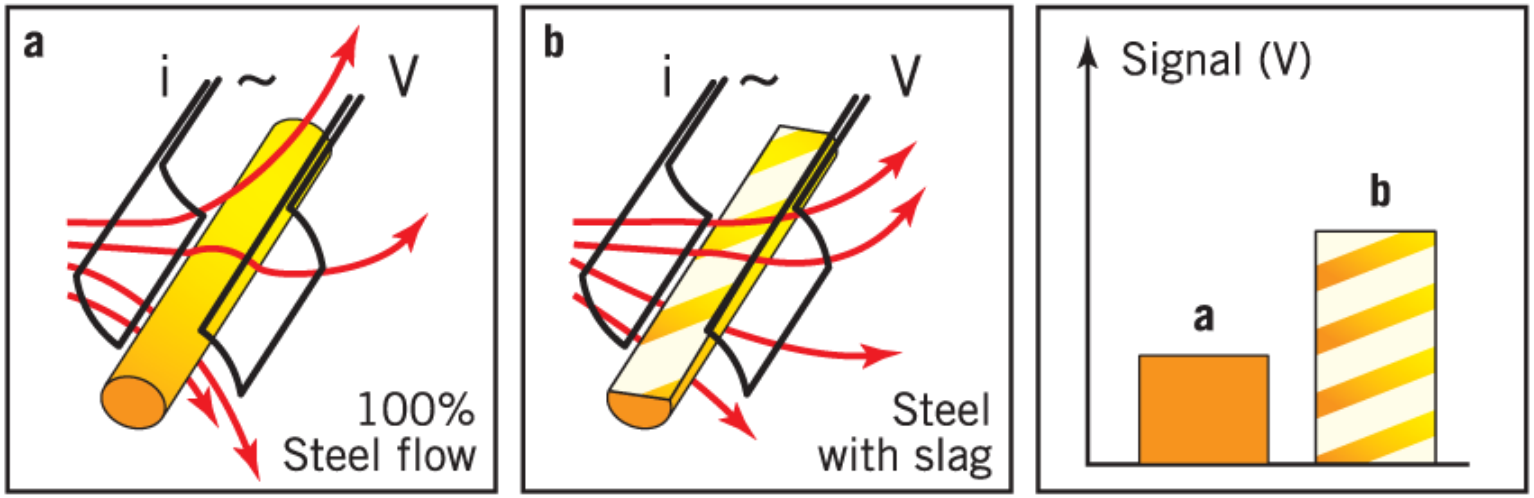
EMLI-FurnaceSlag

- Non balanced sensors are installed around the tap-hole
- The entire tapping stream is monitored electromagnetically
- When a preset signal change is measured the system alarms the operator and/or trigger a tilt back or gate closure.
- The signal change corresponds to slag passing the tap-hole



Principle of operation

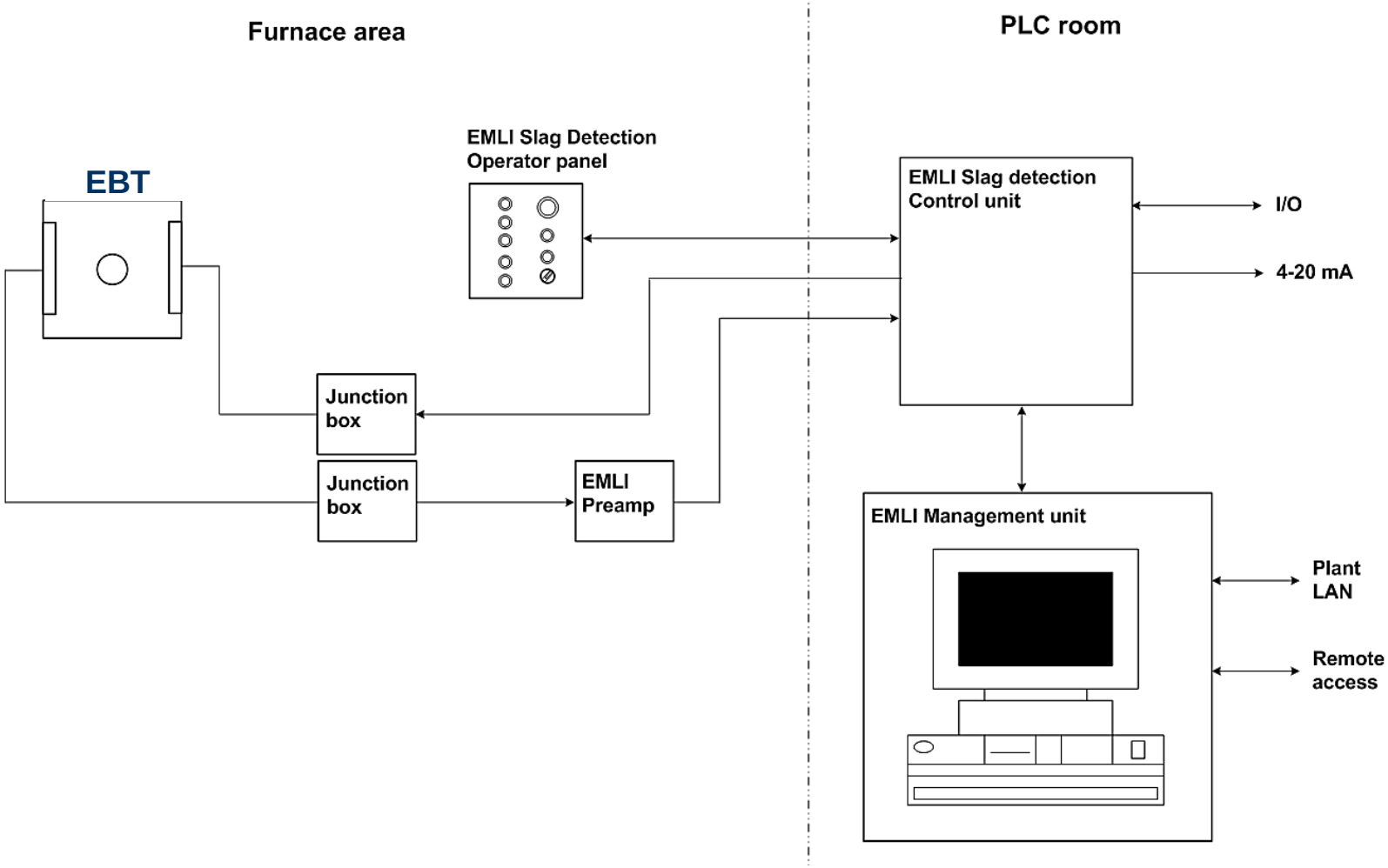
EMLI-FurnaceSlag



- A magnetic field is created around the tapping stream and continuously monitored
- The presence of steel affects the magnetic field greatly and slag does not
- The system is automatically calibrated on a full stream of steel
- As soon as slag appears in the stream, the magnetic field signal changes
- The change in the magnetic field is analyzed and related to the onset of slag in the stream

System layout

EMLI-FurnaceSlag



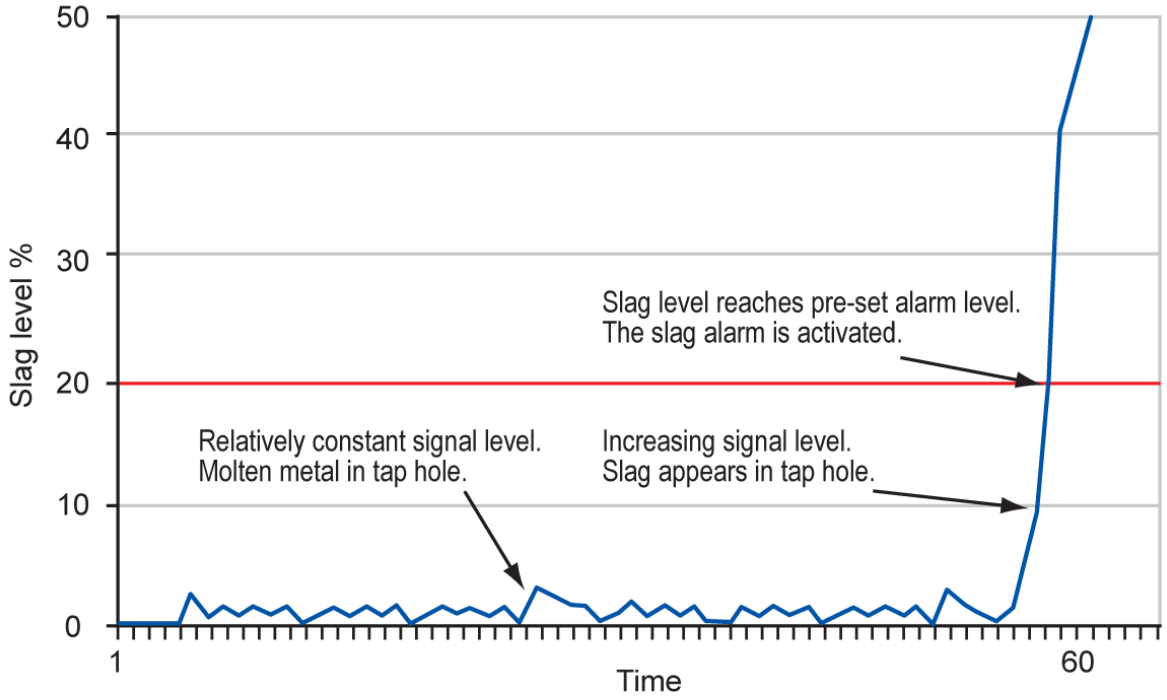
Installation of sensors

EMLI-FurnaceSlag

- The sensors are specifically engineered for the furnace conditions
- Placed around the EBT stones during furnace reline
- Placed out of the way, no interference with tap-hole replacement
- Require no cooling and engineered to work in up to 900ºC

How does it work?

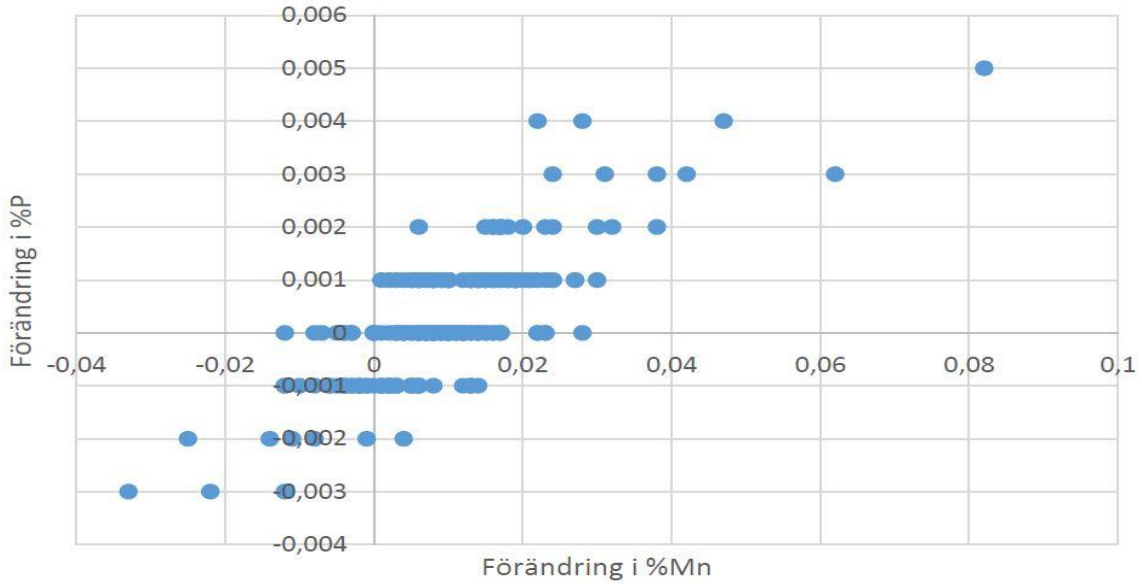
EMLI-FurnaceSlag



- The alarm level can be set in the system or via the plant overlaying control system
- The alarm level setting is not dependent of the steel grade
- This means, customer can adjust when the alarm should be triggered depending on tap-hole wear and hot-heel practices.

Independent case study on 50T EAF

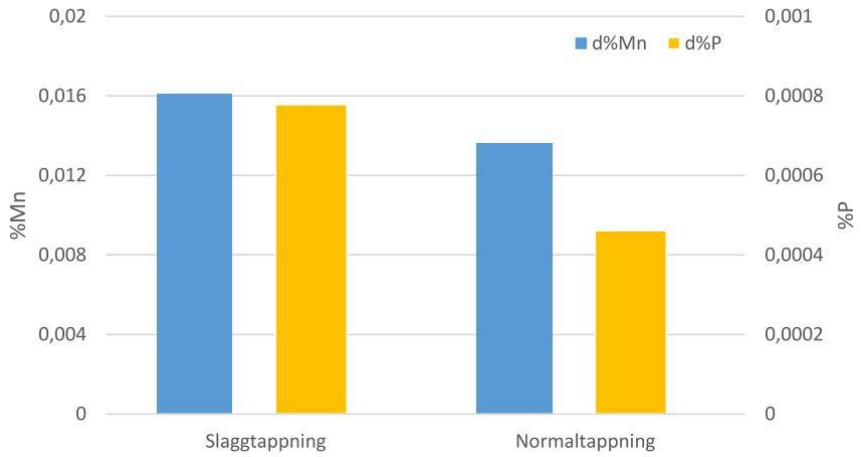
EMLI-FurnaceSlag



- Over a tap-hole campaign (225 charges), the tapping's where rated with the EMLI-FurnaceSlag system as “Slag tappings” or “Normal tappings”
- Comparing samples from EAF with LF, Manganese and Phosphorous oxides rates were studied
- The chart shows the changes in Phosphorous elements versus the changes in the element Manganese

Independent case study on 50T EAF

EMLI-FurnaceSlag



- An element reversion (reduced back to the steel), indicates a negative impact on the secondary metallurgy process
- It was observed that the group rated “slag tapping” had a larger reversion rate than “Normal tapping”
- Clear correlation between heats with detected slag tapping's and undesired element reversion

Independent case study - conclusions

EMLI-FurnaceSlag

- EMLI-FurnaceSlag system effectively helps achieving more reproducible taps

  -> Greater production stability

- Used in production it is an effective and direct operator support indicating:

  ✓ **Slag tapping alarm (in time!)**

  ✓ **Vortexing alarm**

  ✓ **Insufficient tapping angle**

  ✓ **Slag amount calculation index**

  ✓ **Partial openings**

RHI MAGNESITA
AGELLIS
AN RHI MAGNESITA BRAND

Electromagnetic slag detection for ladles

CONTINUOUS CASTING

Agenda – Slag detection for ladles

1 Product presentation

2 How does it work?

3 Examples

4 Conclusions

What is the target?

EMLI-LadleSlag

- To minimize slag carryover
- To increase production yield (all steel is transferred)
- To work with all steel grades
- To work with open and shrouded tapping
- To have a very high availability
- To be easy to use and maintain
- To withstand degasser conditions (high temperatures)

Technology comparison

EMLI-LadleSlag

	EMLI (Heavy Duty Cassettes)	Vibration
Method	Direct slag measurement	Indirect vibration of shroud
Steel grade	Independent of steel grade	Need calibration for each steel grade/slag type
Slag detected	In the tap hole before sliding gate.	When passing the shroud after sliding gate.
Sliding gate plate wear	Reduced by typically 50%	No change, same as before
Sensitivity	Very good steel/slag ratio sensitivity = reliable	Very low steel/slag ratio sensitivity = unreliable due to indirect and late detection
Availability	Typically better than 98%	Typically 70%
External influences	None	Many other vibrations in the caster = false alarms
Response time	0,05 Seconds (effective detection) = small slag transfer	1-4 Seconds (effective detection) = large slag transfer
Commissioning time	3-5 days	15 - 25 days or more (all steel grades need calibration)
Maintenance	Sensors are changed every 2-3 years	Direct cost is about 15-20 000€/caster/year + loss of availability (system non availability during maintenance).
Vacuum Degassing	Yes. The sensor is not temperature sensitive	Yes. The system is located at the caster.

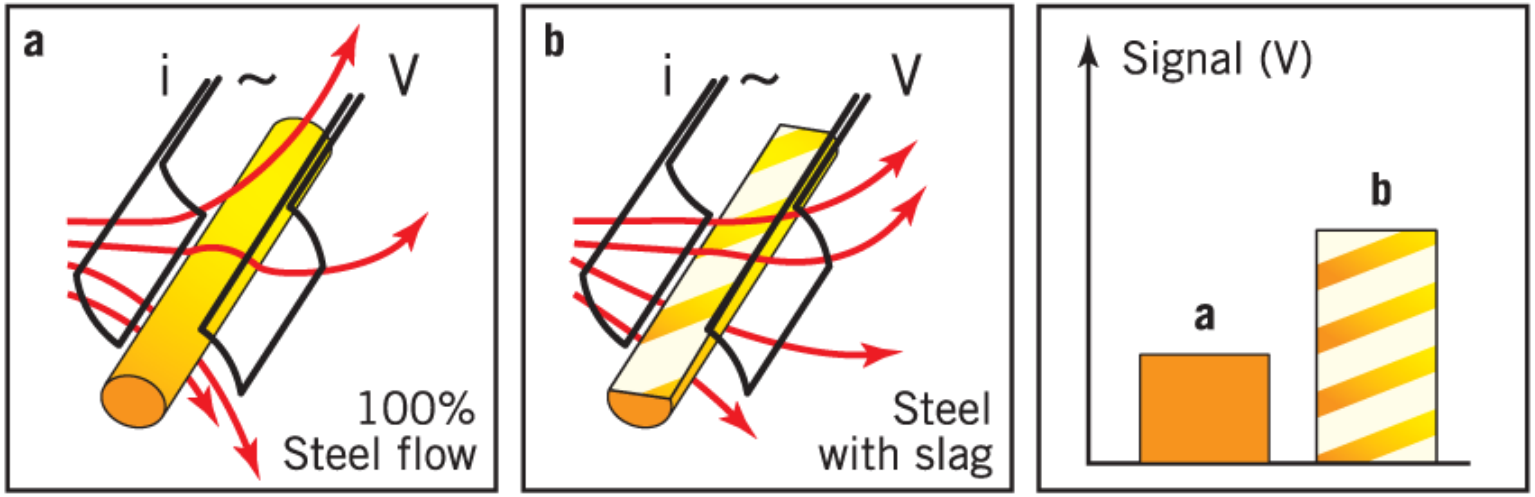
Technology comparison

EMLI-LadleSlag

	EMLI (Heavy Duty Cassettes)	Ring shaped balanced electromagnetic sensors
Method	Direct slag measurement	Direct slag measurement
Steel grade	Independent of steel grade	Independent of steel grade
Slag detected	In the tap hole high above sliding gate	In the tap hole close to sliding plates
Max sensor temp	900 degrees Celsius	450 degrees Celsius
Sensitivity	Steel/slag ratio sensitivity = 5-7%	Steel/slag ratio sensitivity = 1-2%
Availability	Better than 98%	Typically 90-95% (mainly due to heat issues)
External influences	None	Gate movements and heat can be problematic
Response time	0,05 Seconds = small slag transfer	similar= small slag transfer
Commissioning time	3-5 days	3-5 days
Maintenance	Sensors are changed every 2-3 years	Typically changed every year. Sensors changed more often, additional work.
Vacuum Degassing	Yes. The sensor is not temperature sensitive	Preferably not. Heavy wear due to elevated temperatures.

Electromagnetic principle of operation

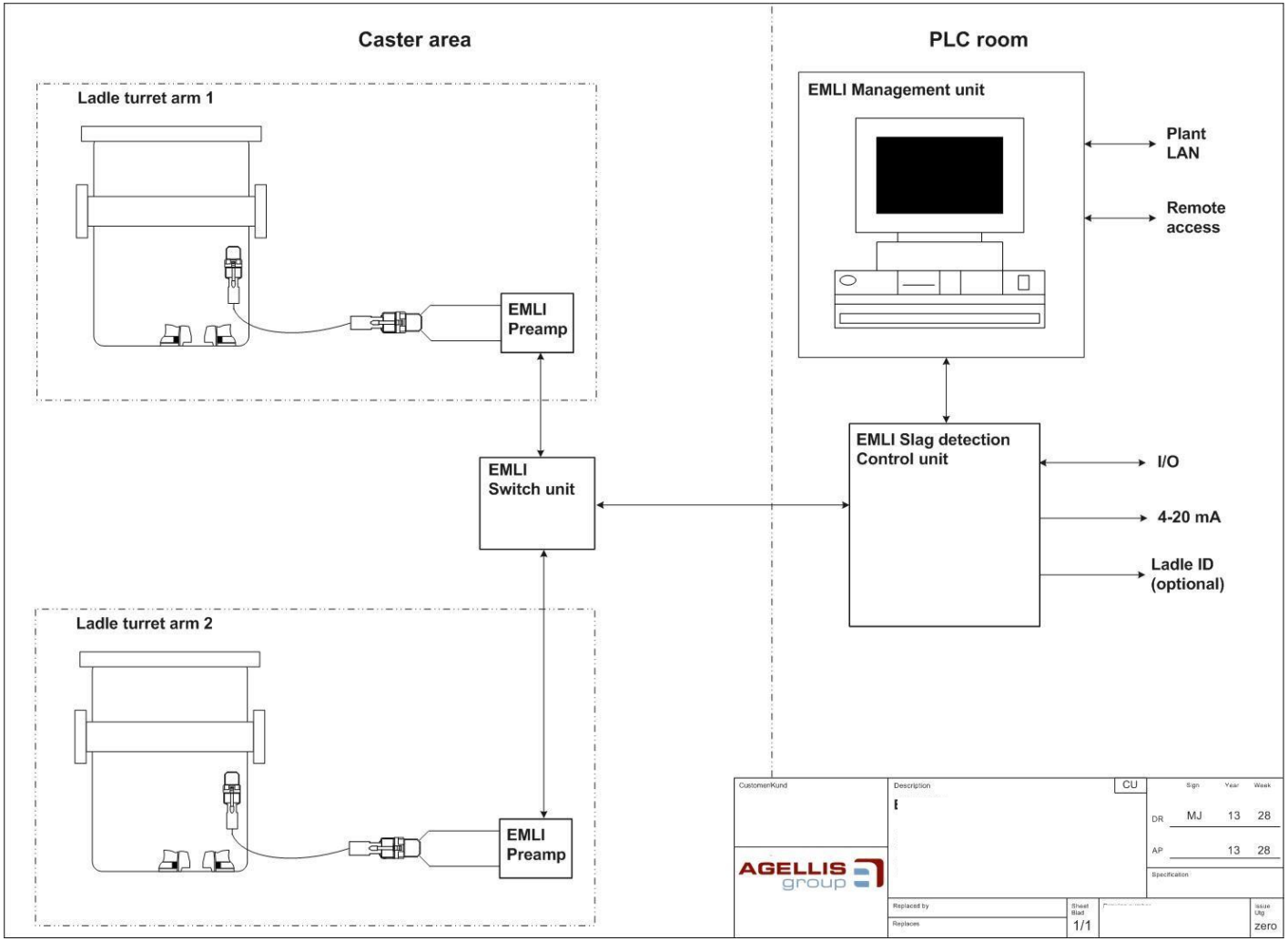
EMLI-LadleSlag



- A magnetic field is created around the tapping stream and continuously monitored
- The presence of steel affects the magnetic field greatly and slag does not
- The system is automatically calibrated on a full stream of steel
- As soon as slag appears in the stream, the magnetic field signal changes
- The change in the magnetic field is analyzed and related to the onset of slag in the stream

System overview - How does it work?

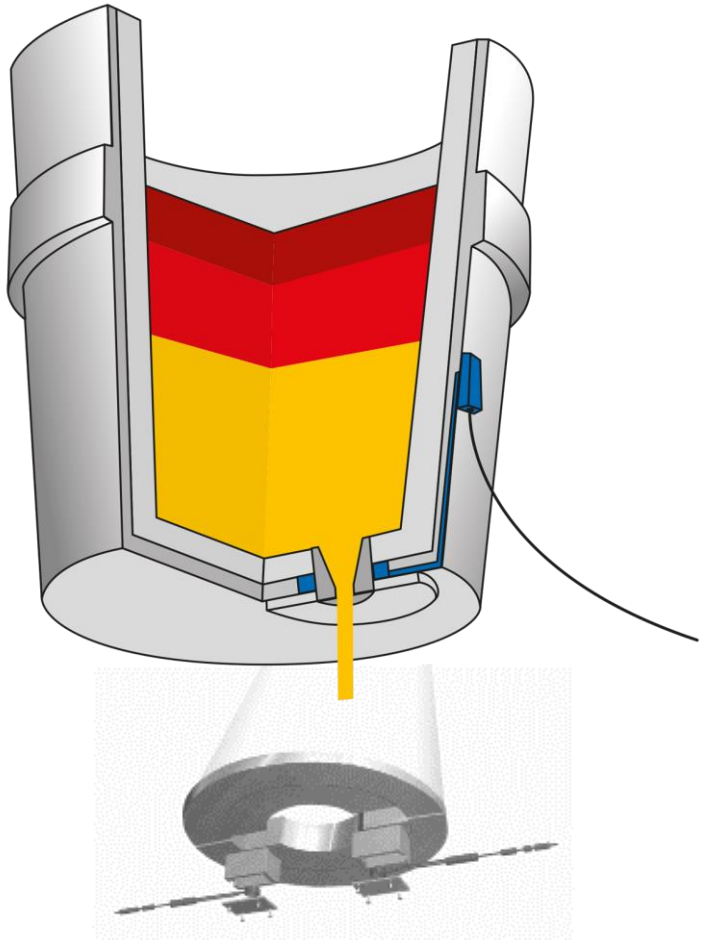
EMLI-LadleSlag



How does it work? – Sensors

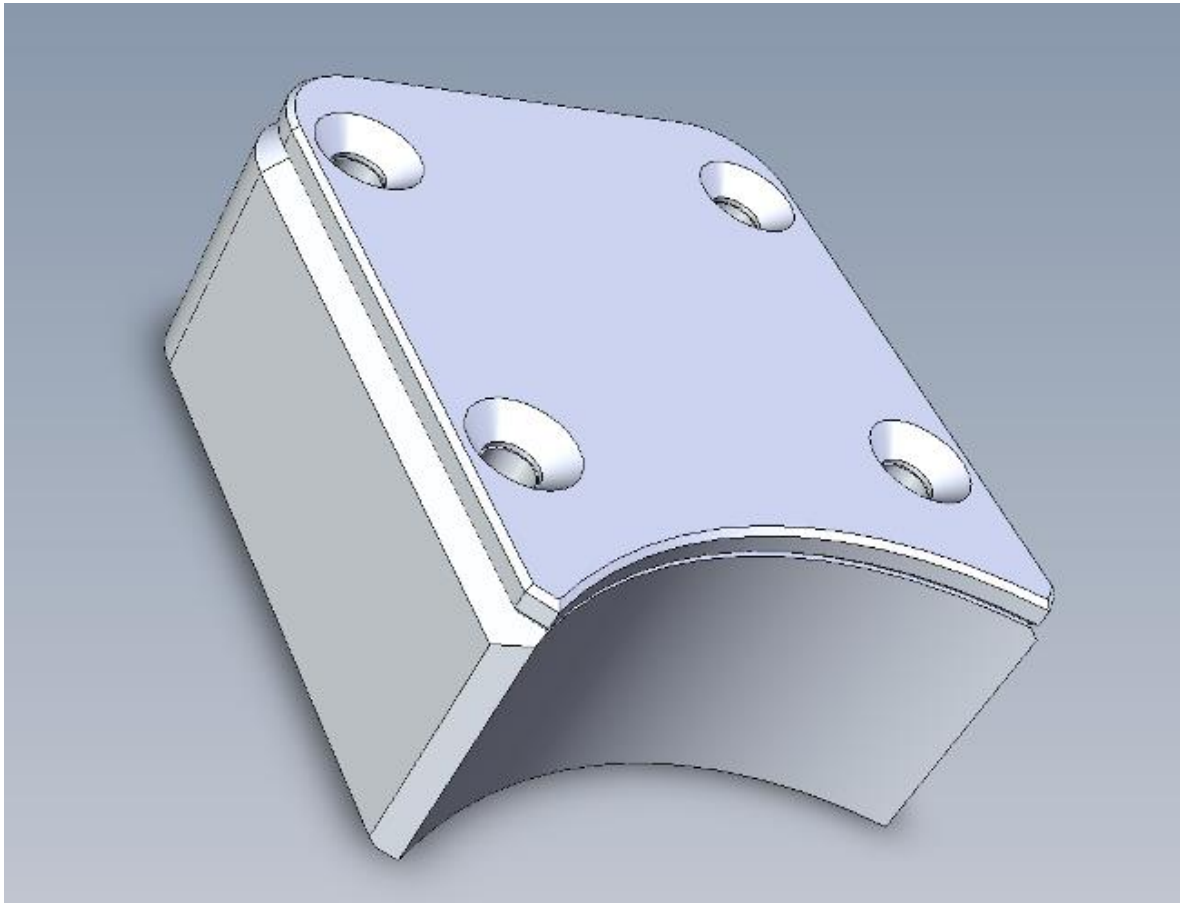
EMLI-LadleSlag

- Sensors are usually installed in the ladle bottom plate
- No cooling is required
- Directional sensing above the sensors
- Sensors & leads are protected
- Long-life sensors accessible for maintenance



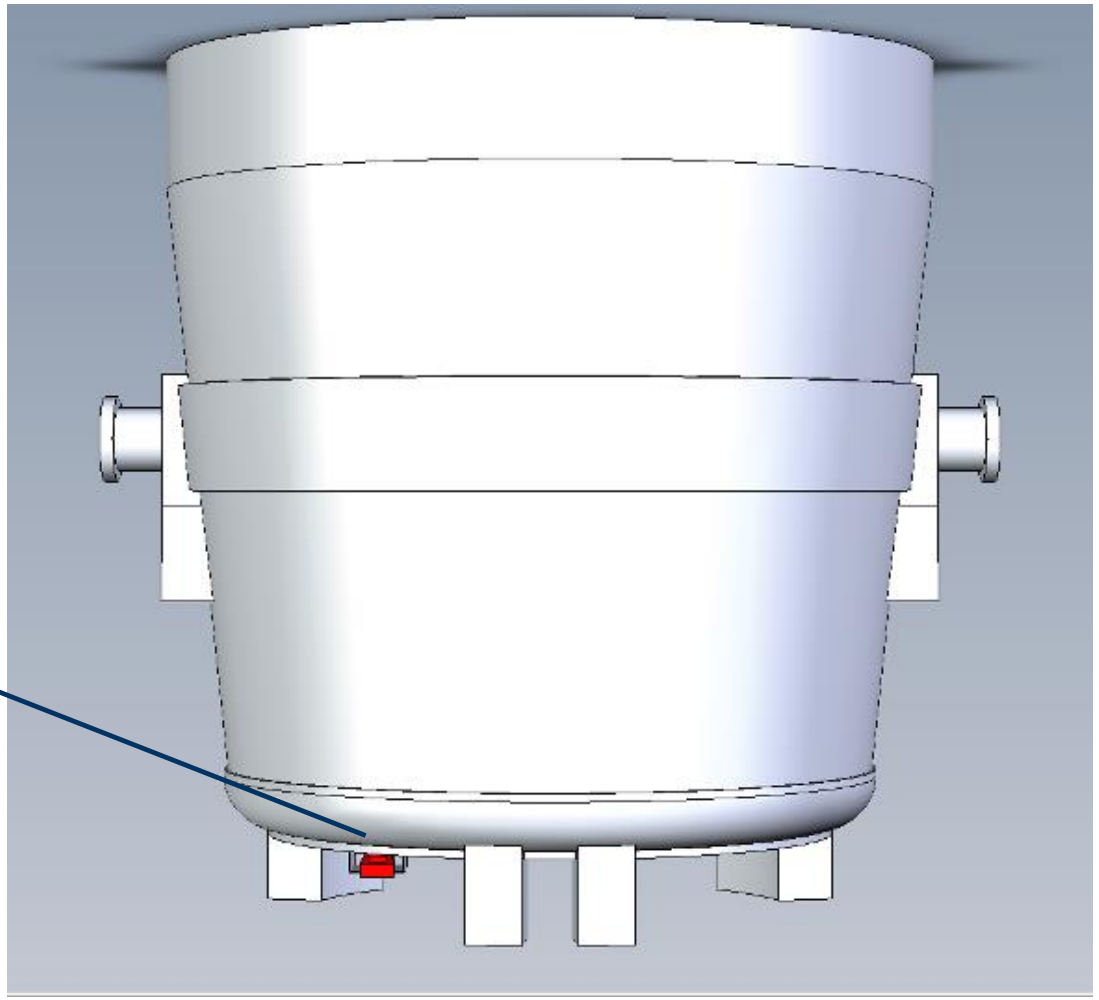
How does it work? – Sensor Cassette for easy access

EMLI-LadleSlag



How does it work? – Ladle view from side

EMLI-LadleSlag

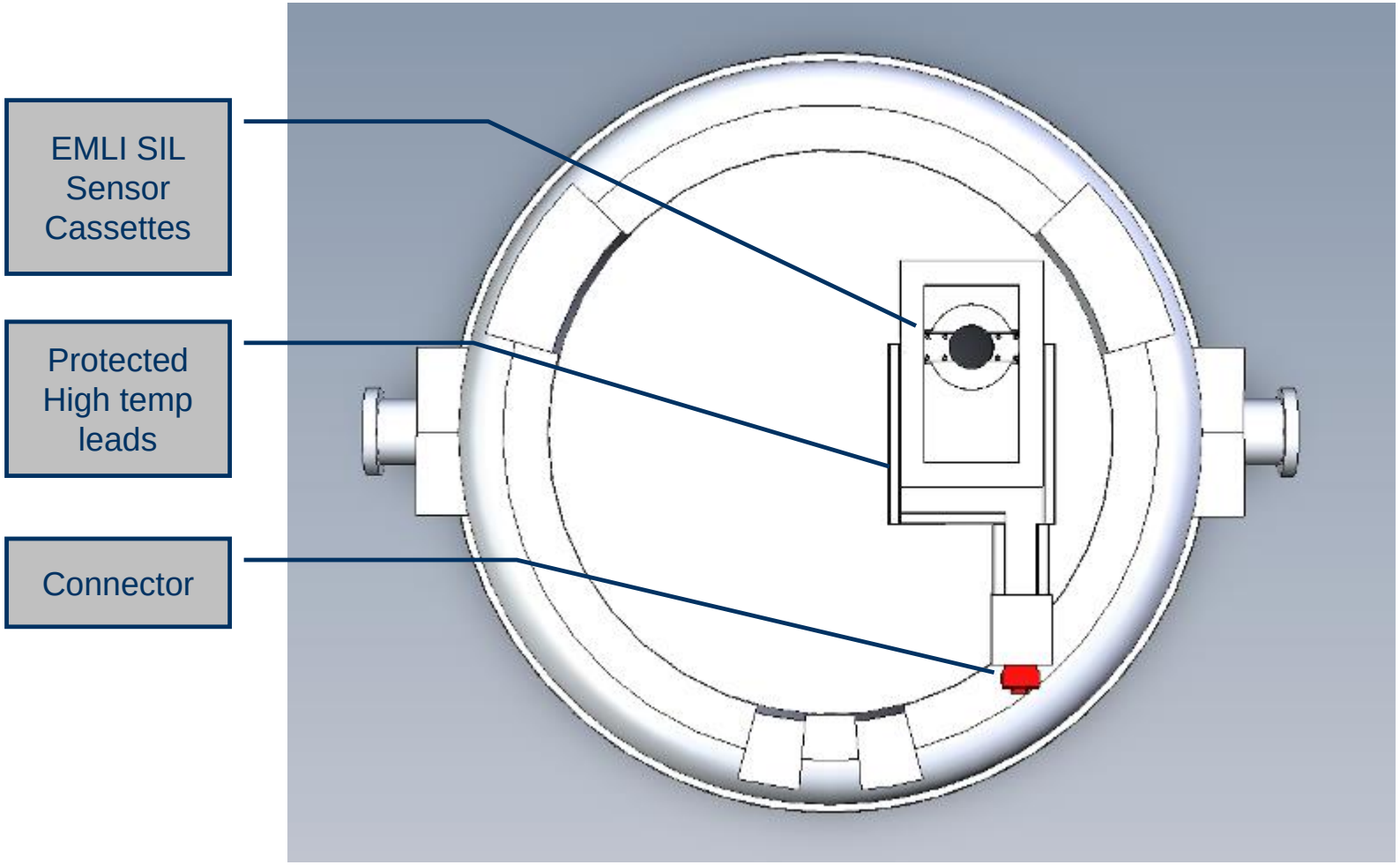


Connector

Example of connector position

How does it work? – Ladle view from below

EMLI-LadleSlag



Some example cases

EMLI-LadleSlag

North-American EAF plant, above 1MT

- EAF 100T
- 2xLF and 2xVD
- Billet caster

- **Previous method used for slag detection:**

- Manual operator decision
- Average yield loss **1,2% (1200kgs per heat)**

- **Installed EMLI-LadleSlag:**

- Sensors installed in ladle mounting plate with Interstop sliding gate
- Connection made at the turret during ladle preparation
- Average yield loss **today 0,35% (350kgs per heat)**

Yield increase 1,2%-0,35% = 0,85% (850kgs per heat)

Some example cases

EMLI-LadleSlag

North-American EAF plant, above 1MT

- EAF 160T
- 1xLF and 1xVD
- Bloom caster

▪ Previous method used for slag detection:

- Manual operator decision
- Average yield loss **0,95% (1500kgs per heat)**

▪ Installed EMLI-LadleSlag:

- Sensors installed in ladle mounting plate (10 ladles) with Interstop sliding gate
- Connection made casting position
- Average yield loss **today 0,4% (640kgs per heat)**

Yield increase 0,95%-0,40% = 0,55% (880kgs per heat)

Some example cases

EMLI-LadleSlag

European Integrated plant, above 2,5MT

- 3x160T converters
- 3xLF and 1xVD
- Slab caster

▪ Previous method used for slag detection:

- Manual operator decision based on load cells
- Average yield loss **1,5% (2400kgs per heat)**

▪ Test made with EMLI-LadleSlag:

- Sensors installed in ladle mounting plate with Vesuvius sliding gate
- Connection made casting position
- Average yield loss **during test 0,45% (720kgs per heat)**

Yield increase 1,50%-0,45% = 1,05% (1680kgs per heat)

Some typical benefits

EMLI-LadleSlag

- Improves yield between 0,2% – 1,1%
- Minimise the slag amount in the tundish
- Reduce ladle slide-gate plate wear
- Reduce tundish refractory wear
- Increase the casting sequence length
- Minimize slag in mold situations
- Reduction in manpower if automation is used

Conclusion – to be efficient

EMLI-LadleSlag

- Must be working every heat
- Must have a high slag to steel signal ratio
- Must be able to handle high temperatures > 500C
- Must be unaffected by gate movements
- Must be accessible for maintenance

Get in Touch!

Agellis – An RHI Magnesita Brand
Tellusgatan 15, SE-224 57
Lund, Sweden
Phone: +46 46 10 13 60
E-mail: info@agellis.com
sales@agellis.com

www.agellis.com

www.rhimagnesita.com