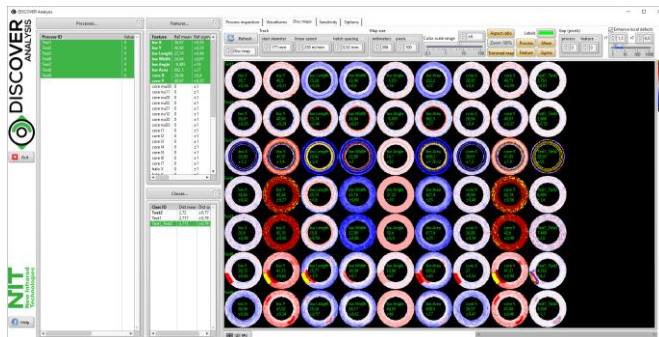




High Speed Monitoring of the Break Discs Coating processes



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CTO
New Infrared Technologies S.L.

1. Introduction

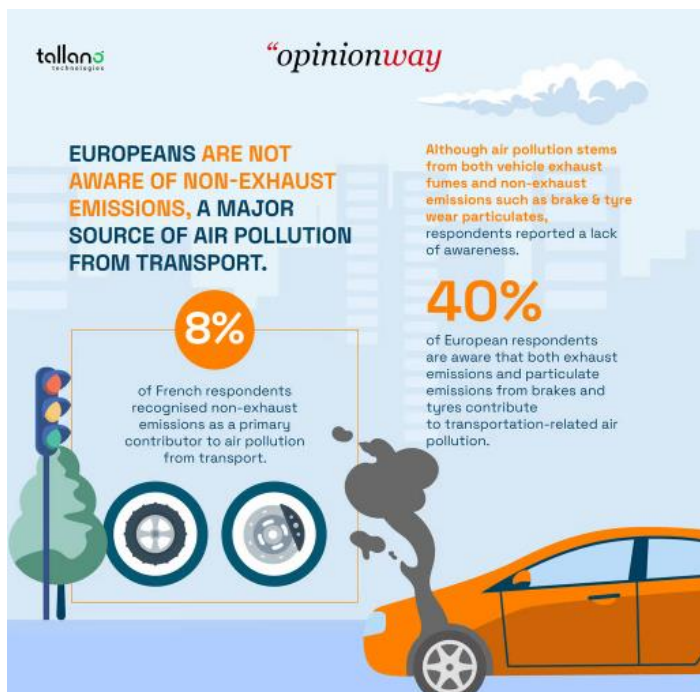
2. HS- MWIR imaging for real time monitoring of HS-LMD brake disc coating processes.

3. Discover IR suite

4. Advancing toward automation

5. Conclusions

Motivation



- Among non-exhaust emissions, brake particles are predominant, They represent up to 55% of PM10 emissions from non-exhaust sources and up to 20% of total PM2.5 emissions from road traffic.
- Up to 97 percent of non-exhaust particle emissions can be eliminated with a combination of technologies — some of which are readily available, affordable and implementable in the near-term.
- As with so many environmental and health issues, the regulators will oblige manufacturers to implement measures.

The new Euro 7 standard will demand a significant reduction of the emitted fine dust particles by cars emitted by disc brakes

HS-LMD for brake disc coating



- HS-LMD technology has been identified as one of the most promising technologies in brake disc coating for reducing the particle emission problems.
- HS-LMD minimizes thermal energy input and dilution into work piece. It is feasible, therefore significant reduction of brittle phases and risk of cracking.
- HS-LMD provides the required corrosion and wear resistance over such a thickness of 150-300 μm as a single-layer solution.
- **Coatings produced by HS-LMD provide long and effective protection emitting a very reduced number of fine particles compatible with Euro 7 requirements**

1. Introduction

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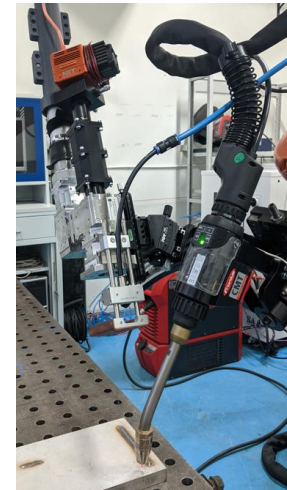
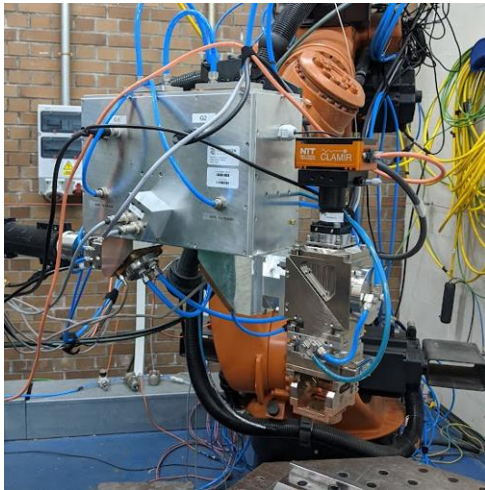
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2. HS MWIR IMAGING FOR MONITORING LMD PROCESSES

- NIT IR technology is recognized as one of the most useful techniques for monitoring and controlling in real time laser based processes.
- It is based in capturing at high framerates and analyzing in real time MWIR images of the melt pool.
- Sensors and systems manufactured by NIT are widely used for in line QA of industrial laser based processes.



- HS LMD for coating break discs is a specific laser based process which require a new monitorization concept: **DISCOVER** Ir suite.

2. HS MWIR IMAGING FOR MONITORING HS-LMD PROCESSES

The melt pool is the result of the interaction of the two main actors of the coating process: the powder and the laser radiation



HS melt pool imaging provides useful information of HS LMD brake disc coating processes

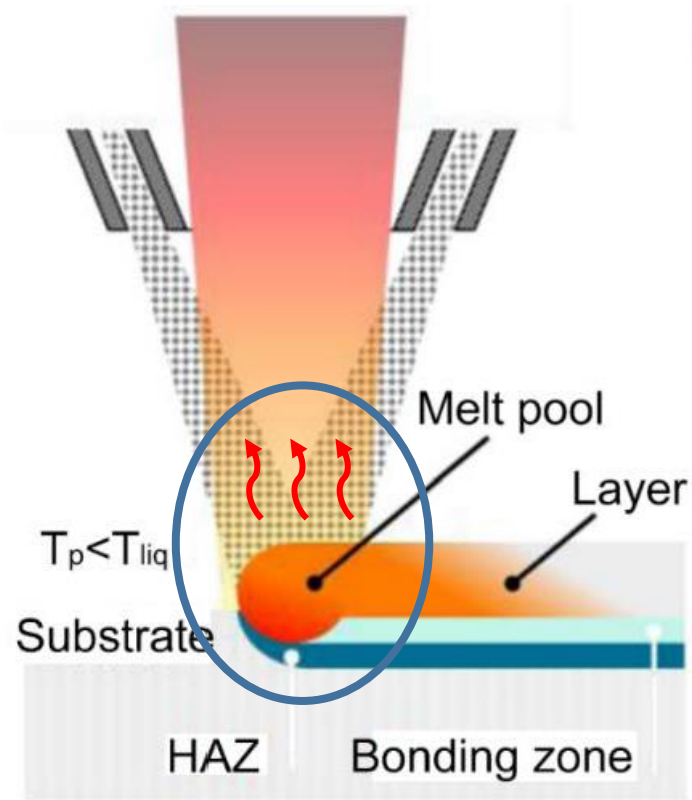
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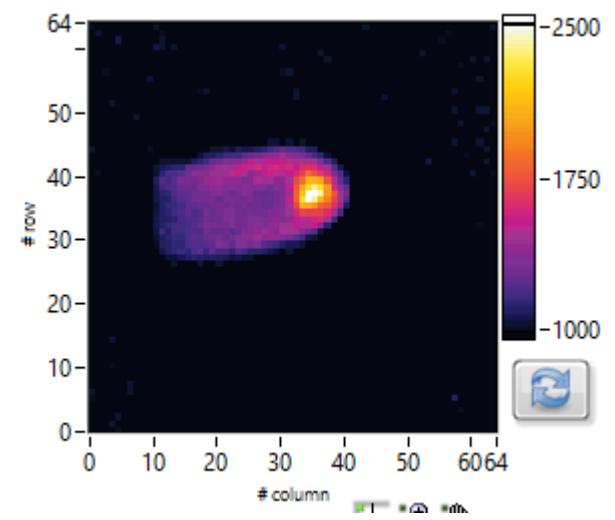
2. HS MWIR IMAGING FOR MONITORING HS-LMD PROCESSES

What we observe?

Conventional LMD



Considerable part of the emitted IR radiation is coming from the melted material on the substrate. More defined and sharp imaging of melt pool area.

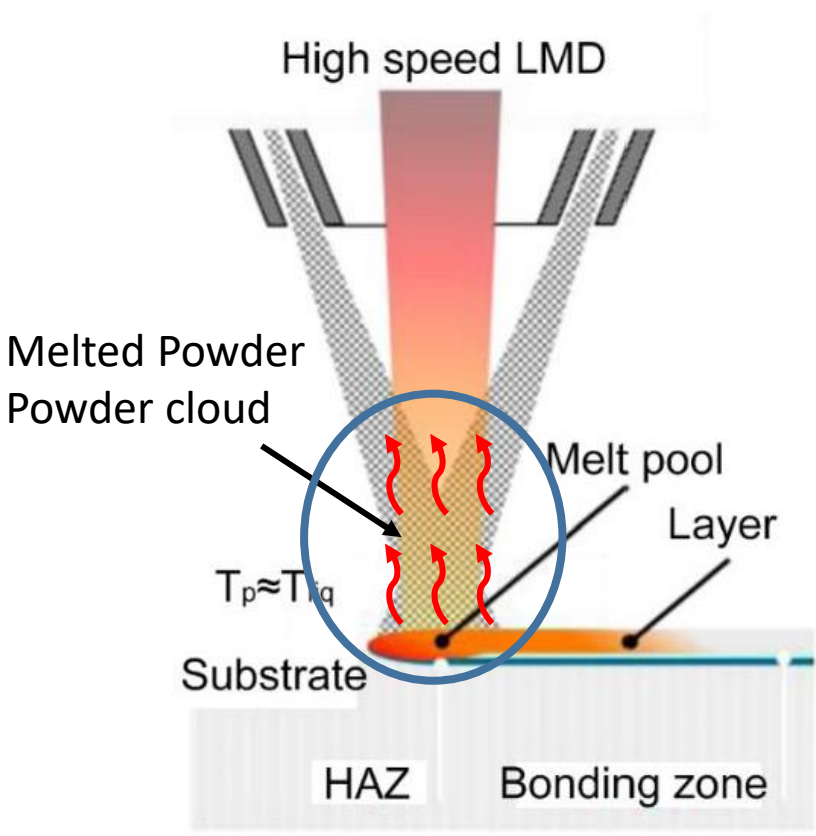


“Sharp” image of melt pool and bead

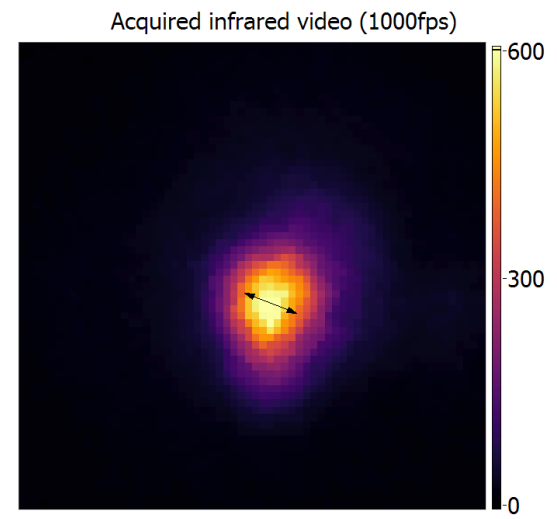
Sketch from Dr. Zhe Sun thesis (Univ. Manchester, 2019)

2. HS MWIR IMAGING FOR MONITORING HS-LMD PROCESSES

What we observe?



Considerable part of the emitted IR radiation is coming from the “powder cloud” which it is a mix of melted powder (very hot) and unmelted material (less hot or even “cold”)



IR images combine signals from melt pool and HAZ

Sketch from Dr. Zhe Sun thesis (Univ. Manchester, 2019)

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3. DISCOVER IR SUITE

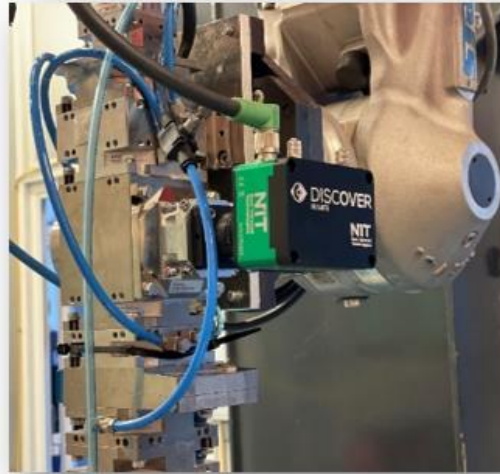
Has been developed by NIT specifically for monitoring in real time coating processes of brake discs using HS - LMD technique.

Continuous monitoring and measurement of the more than 40 features using a MWIR infrared camera (1.1 μm - 5.0 μm), coaxial installation.

Analysis is based in the mathematical treatment of the temporal evolution of more than 40 features extracted of the IR images.

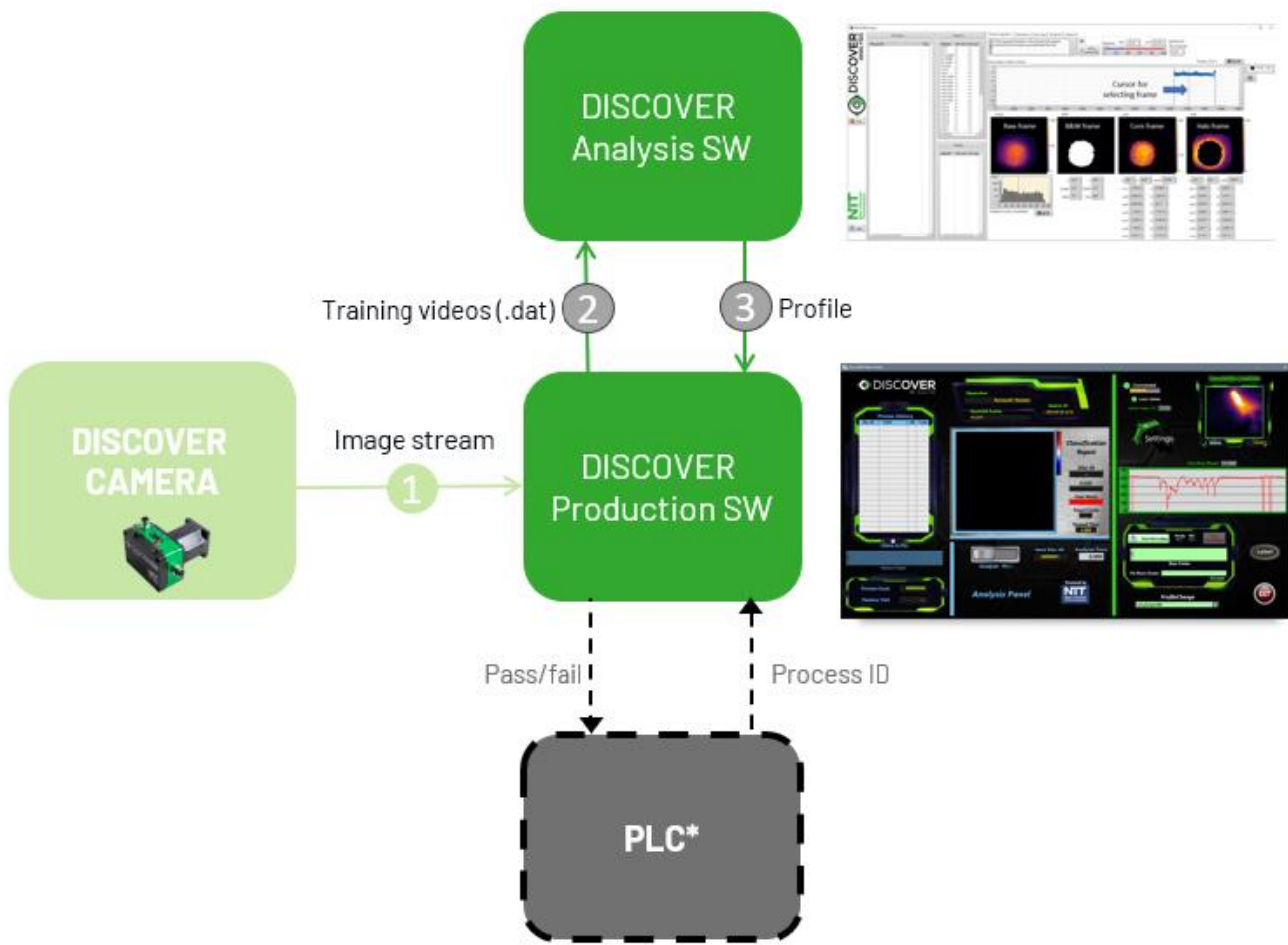
Compatible with most of laser optics and powders.

Easy mechanical integration and quick configuration, allows retrofit.



3. DISCOVER IR SUITE

More info: <https://www.niteurope.com/discover-ir-suite/>



SENSOR HEAD



Hardware

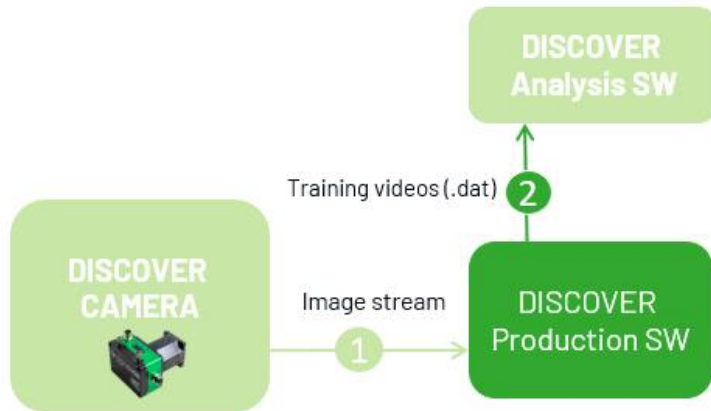
- **Sensor chip.-** Double bus for faster data transfer
- **Ethernet connector.-** M12 x-cod 8 poles shielded
- **Cooling.-** Water circuit up to 6 bars.
- **Optics.-** Manual focus / Beam bender with image centering mechanism (optional) / Adaptor for installing a VIS camera (optional)

Firmware

- Data transfer rate increased
- Internal processing on SoC (FPGA+ARM)
- PLC communication (Sinumerik-Siemens)

HMI

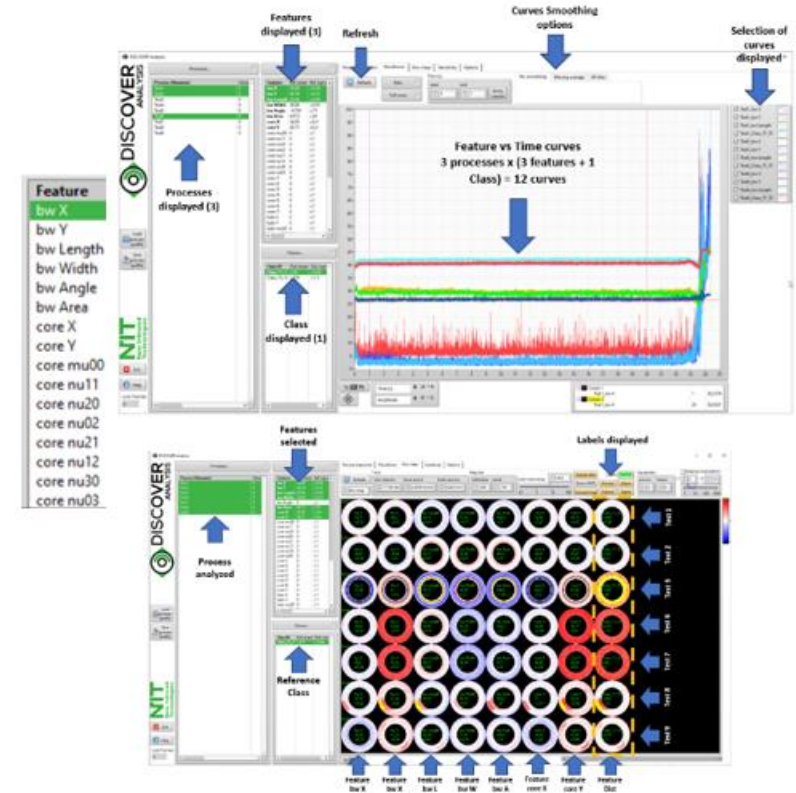
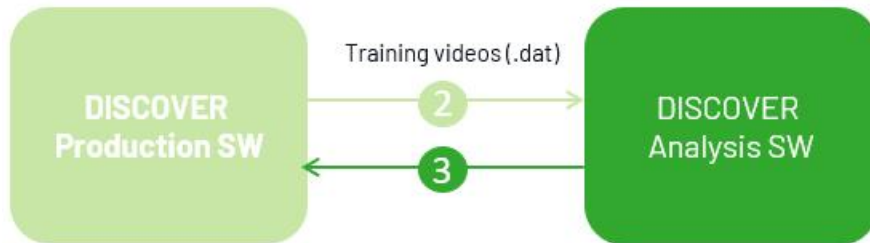
DISCOVER HMI will initially be used to record videos of the disc coating process from the **DISCOVER** camera. These videos will be used to train the program.



ANALYSIS

DISCOVER ANALYSIS SOFTWARE for a deep analysis, is designed to examine the videos generated by the **DISCOVER** production and select specific features from these videos to characterize the profile.

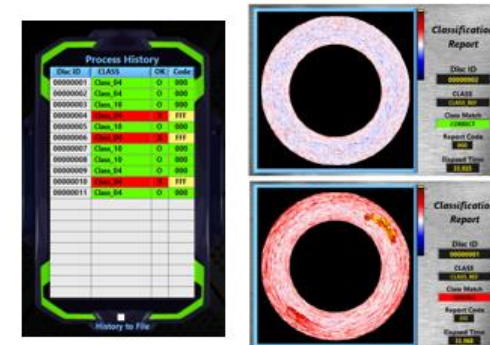
The profile is then transferred to the production software. The analysis software is used as a characterization tool.



ASSESSMENT

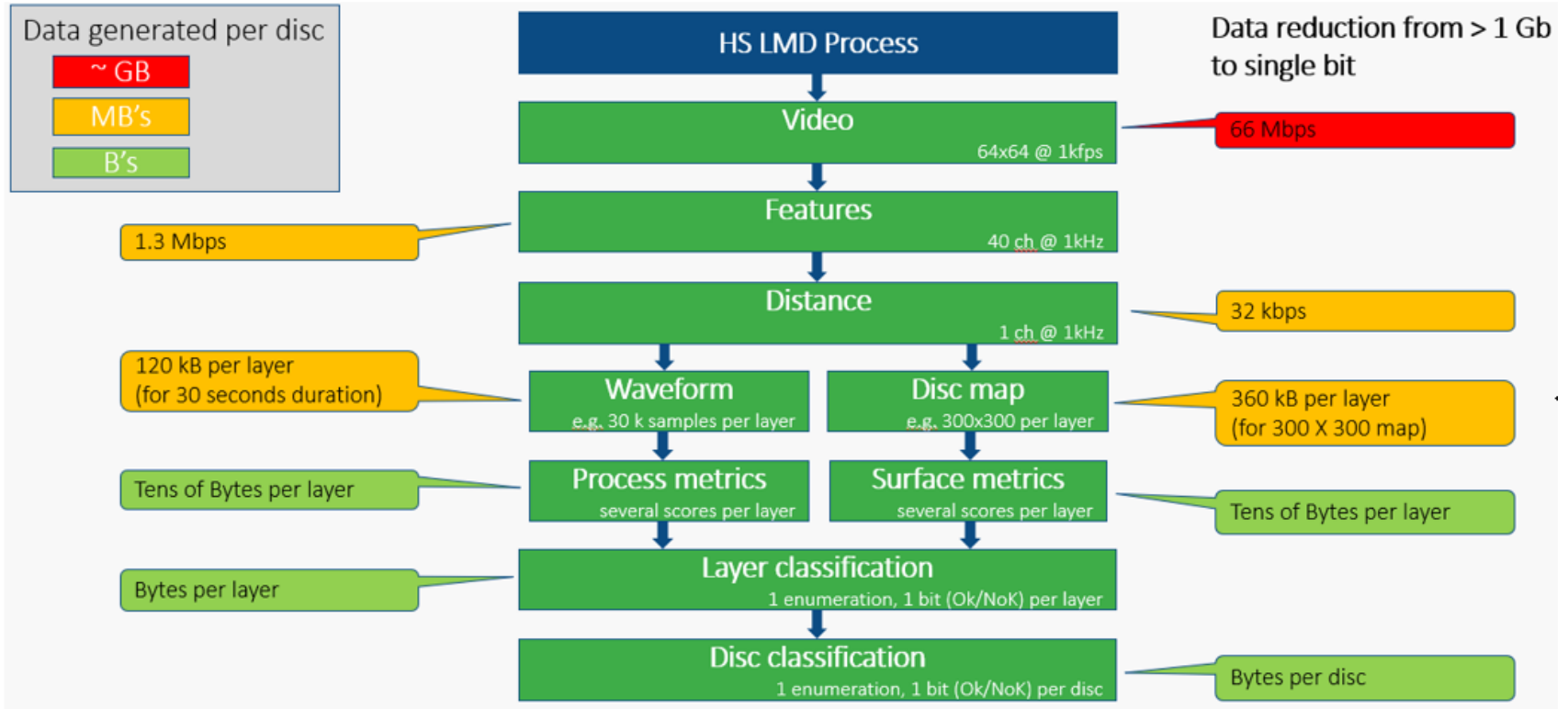
Once trained, the production software can analyze the discs using the user information (parameters) and provide quality assessment (Ok, NOK) of a brake disc coating process.

Additionally, it includes the features for analysis and classification, as well as maintaining a report history.

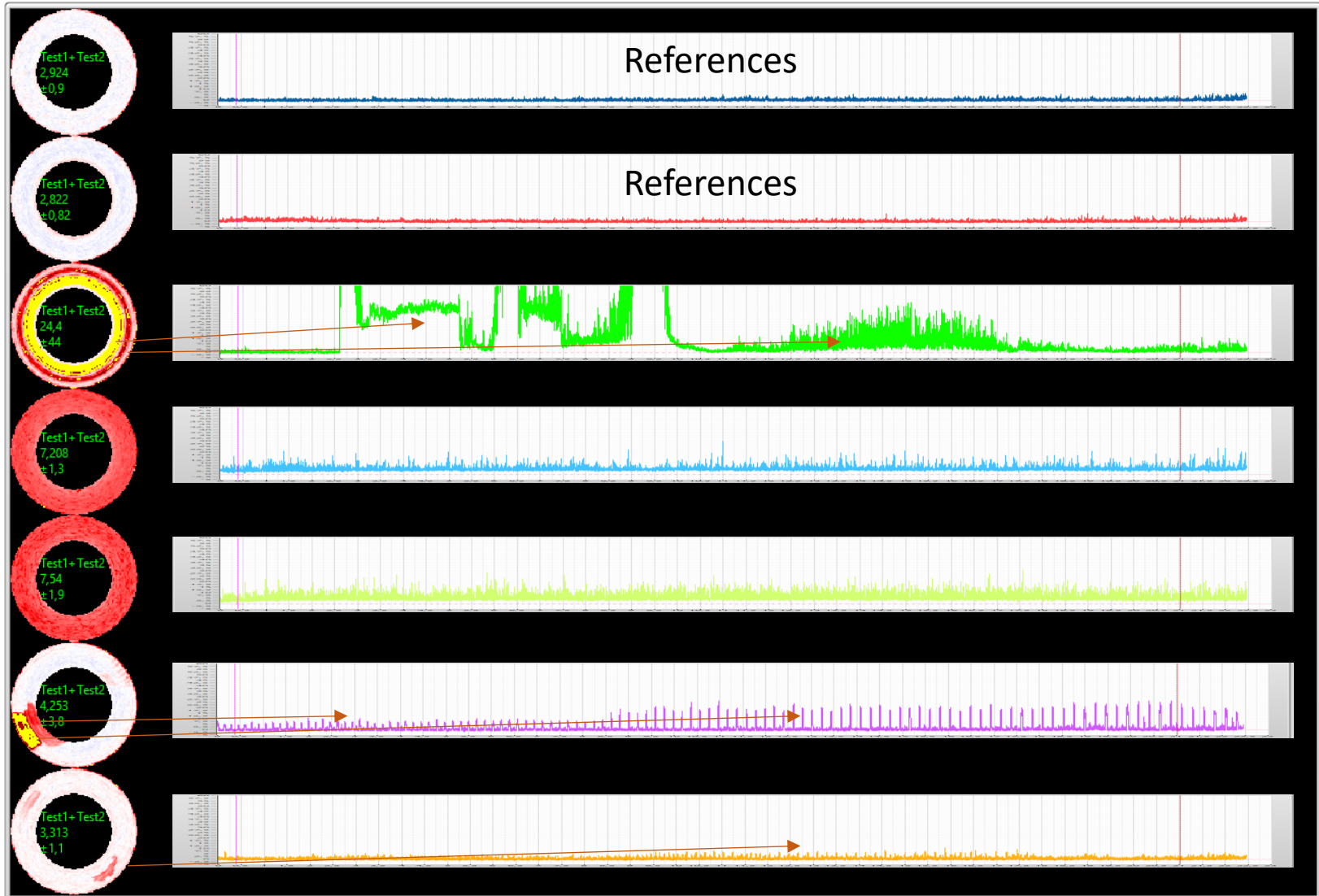


ASSESSMENT

Data reduction strategy



SOFTWARE. ANALYSIS



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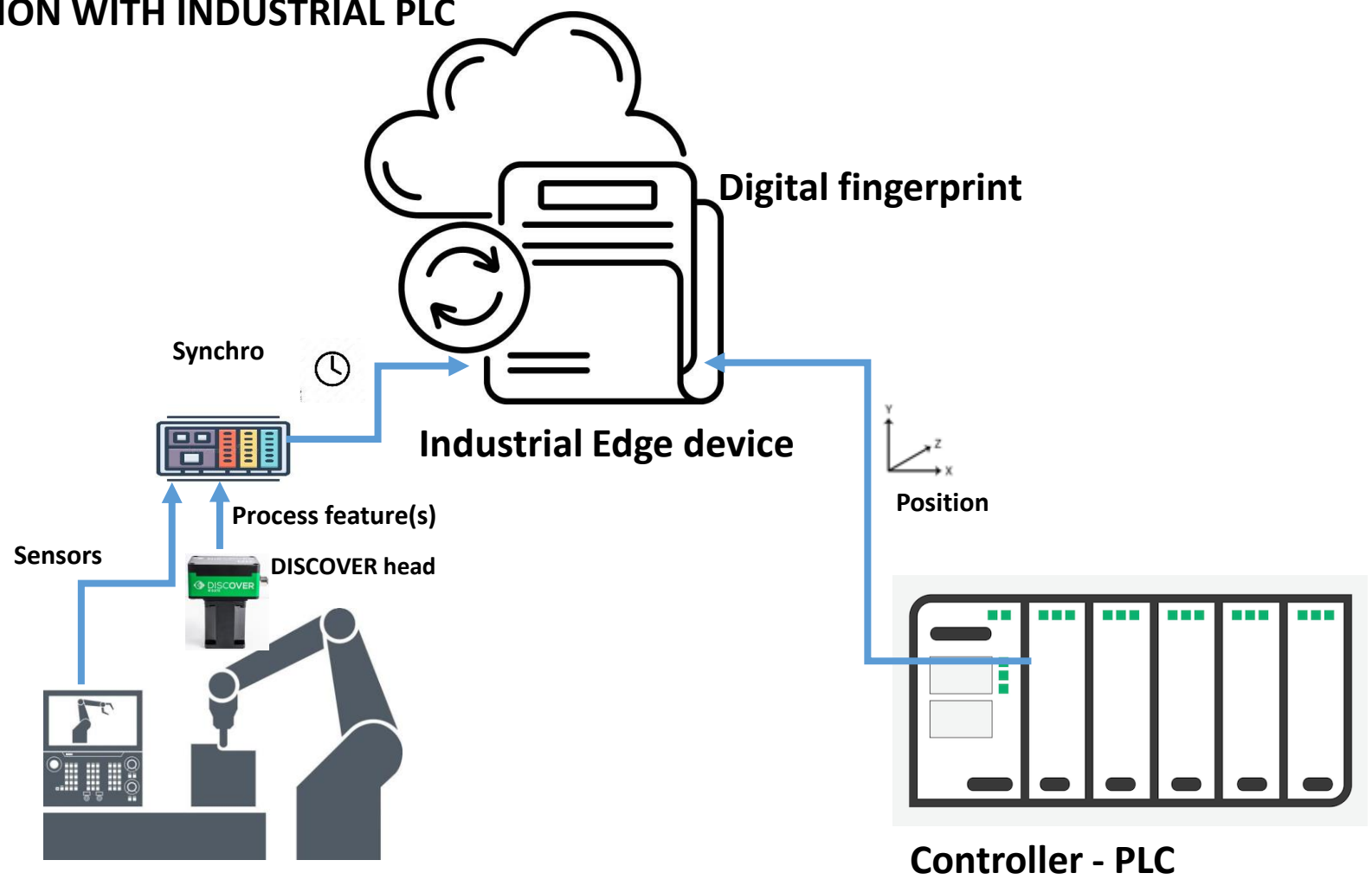
HS-LMD suitable for mass production



- The process can be scaled up with more laser power, higher process speeds, and powder flow rates.
- possible innovative machine designs to shorten the coating cycle time
- Continuous processing
- It can be fully automated using robots and set production lines.
- Efficiency is higher than 93% and is suitable for the scaling up and industrialization phase

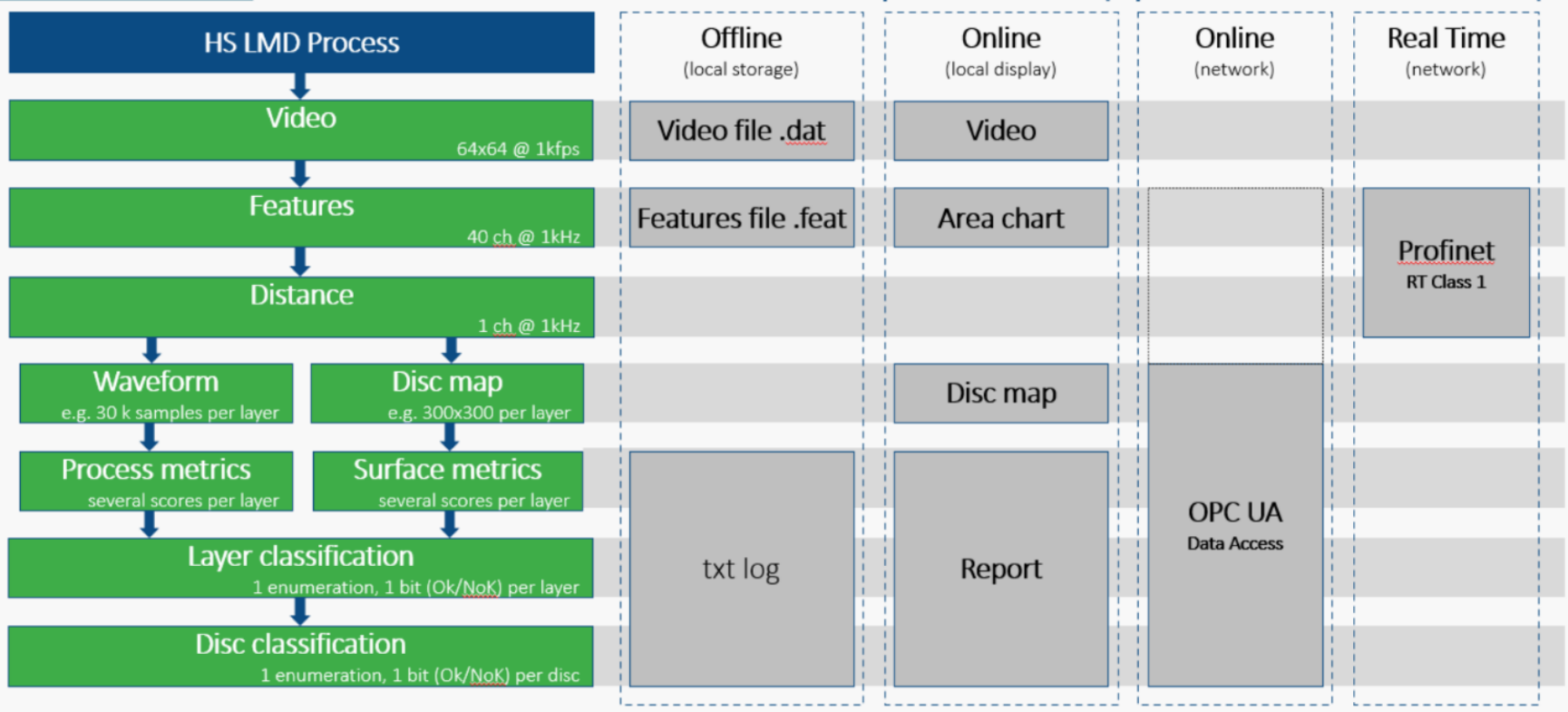
In regard to industrialization for mass production scenarios, the economic advantages of HS-LMD technology are far ahead of the competing technologies

INTEGRATION WITH INDUSTRIAL PLC





DISCOVER Data availability



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5. CONCLUSIONS

- The new Euro 7 standard will demand a significant reduction of the emitted fine dust particles by cars including the emitted by brake discs.
- HS-LMD provide long and effective coatings emitting a reduced number of fine particles compatible with Euro 7 requirements.
- In regard to industrialization for mass production scenarios, the economic advantages of HS-LMD technology are far ahead of the competing technologies
- HS-LMD process monitoring using HS MWIR imaging is compliant with the requirements demanded by application and by the industry.
- HS MWIR imaging is suitable for real time detection of unstabilities and process parameter variations respect standard conditions predefined during coating of brake disc processes using HS-LMD.
- DISCOVER IR suite is an excellent production and R&D tool for QA and setting up HS-LMD brake disc coating processes

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