SINTEF

75

1950 – 2025

Technology for a better society

History

SINTEF was founded in 1950 by professors at NTNU as an opposition to the government putting the national technical institute in Oslo.

That institute later merged into with SINTEF.

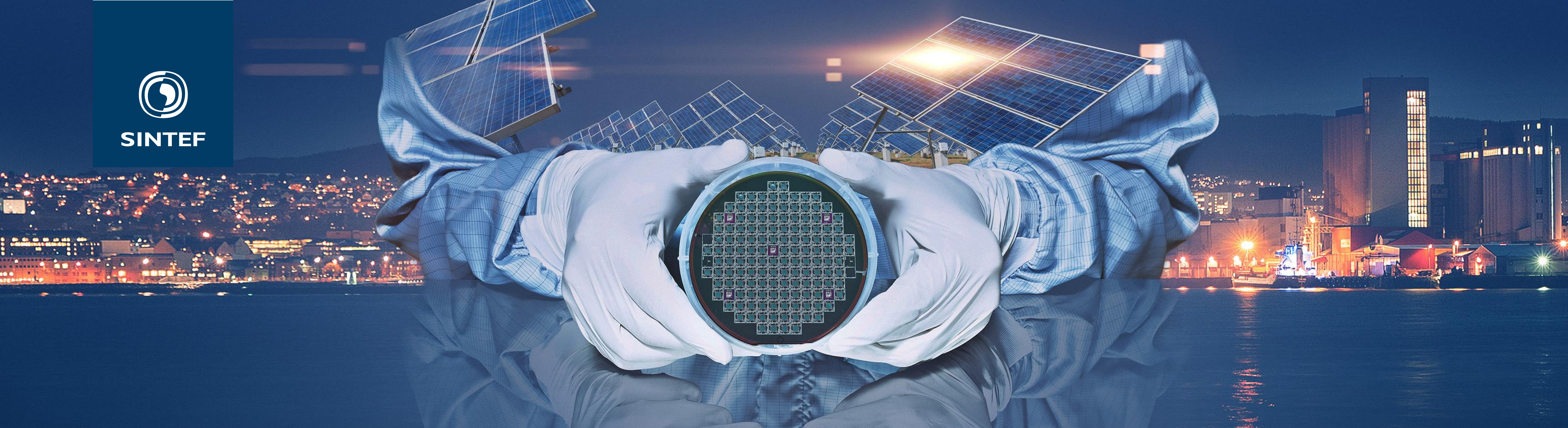
Bildekreditt: [Fjellanger Widerø/UBiT]

Partnered with NTNU

SINTEF and NTNU have had a strategic and operative collaboration since 1950

Foto: Thor Nielsen/NTNU

Technology for a better society



SINTEF

ONE OF EUROPE'S LARGEST INDEPENDENT RESEARCH ORGANISATIONS

367,5 million
EUR turnover

2200
employees

6400
projects

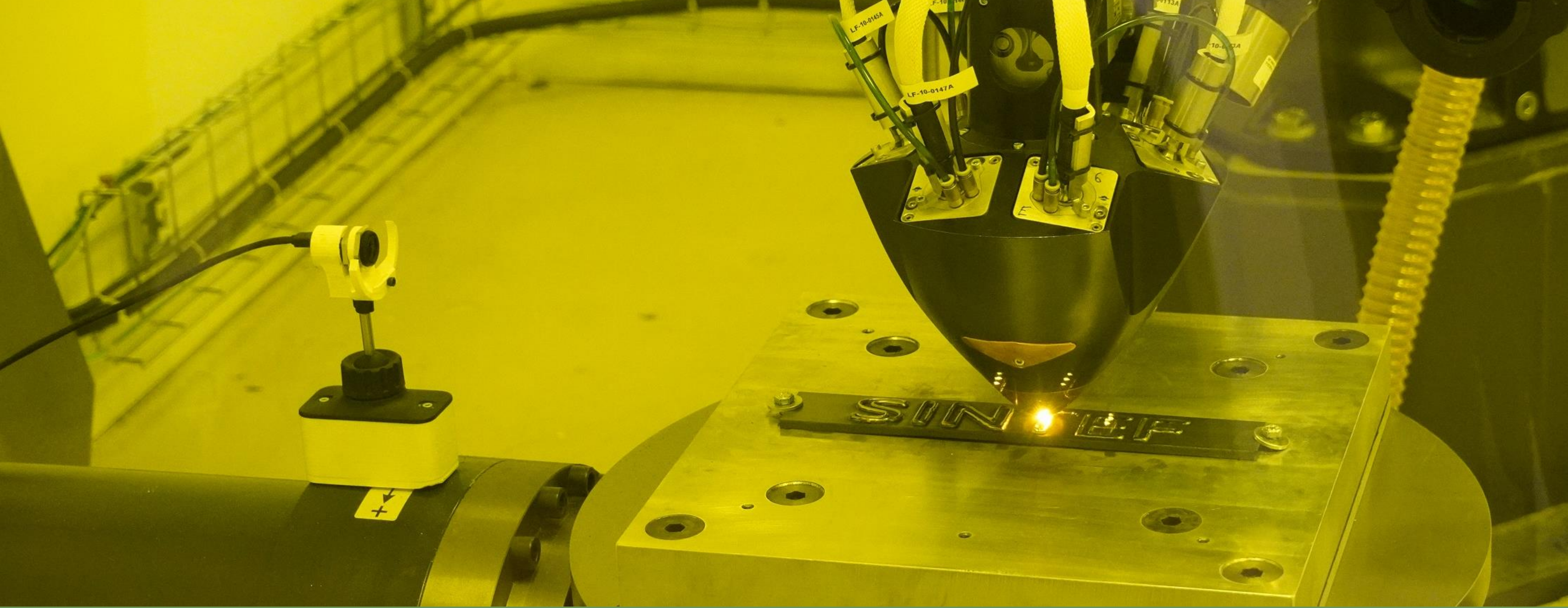
3300
customers

INTERNATIONAL
70,7 million EUR

NATIONALITIES
80

PUBLICATIONS (INCL. DISSEMINATION)
6200

CUSTOMER SATISFACTION
4,6 / 5



Process monitoring and material testing of advanced Laser-Based Additive Manufacturing applying the VMAP Interface

Vegard Brøtan

2024-02-18

ALABAMA
Co-funded by the European Union

GEAR-UP
Funded by the European Union

Horizon ALABAMA - Adaptive Laser Beam for AM
Jan 2024 – Dec 2027 - 4 years

(Adaptive Laser Beam for additive manufacturing) investigates directed energy deposition of metals with laser beam (DED-LB/M), where a laser melts feedstock (either powder or wire) in a stepwise fashion. Metals deposited by this method tend to struggle with anisotropy, and can contain internal stresses and imperfections.

The project aims to ensure good properties through the development of highly customized laser-based production, and new adaptive multi-laser-beam technology. This is accomplished by adjusting lasers both temporally and spatially. Adaptive laser technology will be tested on products made from different alloys in three use-cases, namely aerospace, maritime and automotive. These industries account for a large production volume across Europe and the projected impacts are profound:

- 10-33% in cost savings
- Reduction of defects by ~50% in deposited materials
- Reduction in material waste of 10-50%
- Reduction in CO_2 emissions of 5 million tons/year

Partners

SINTEF

FLOWPHYS

eurecat

aerobase

TECHNOVATIVE SOLUTIONS

FCA
FIAT CHRYSLER AUTOMOBILES

CRF

MANUFACTURING TECHNOLOGY
NORWEGIAN CATAPULT CENTRE

IRIS
PLAYGROUND FOR NEW IDEAS

Fraunhofer
SCAI

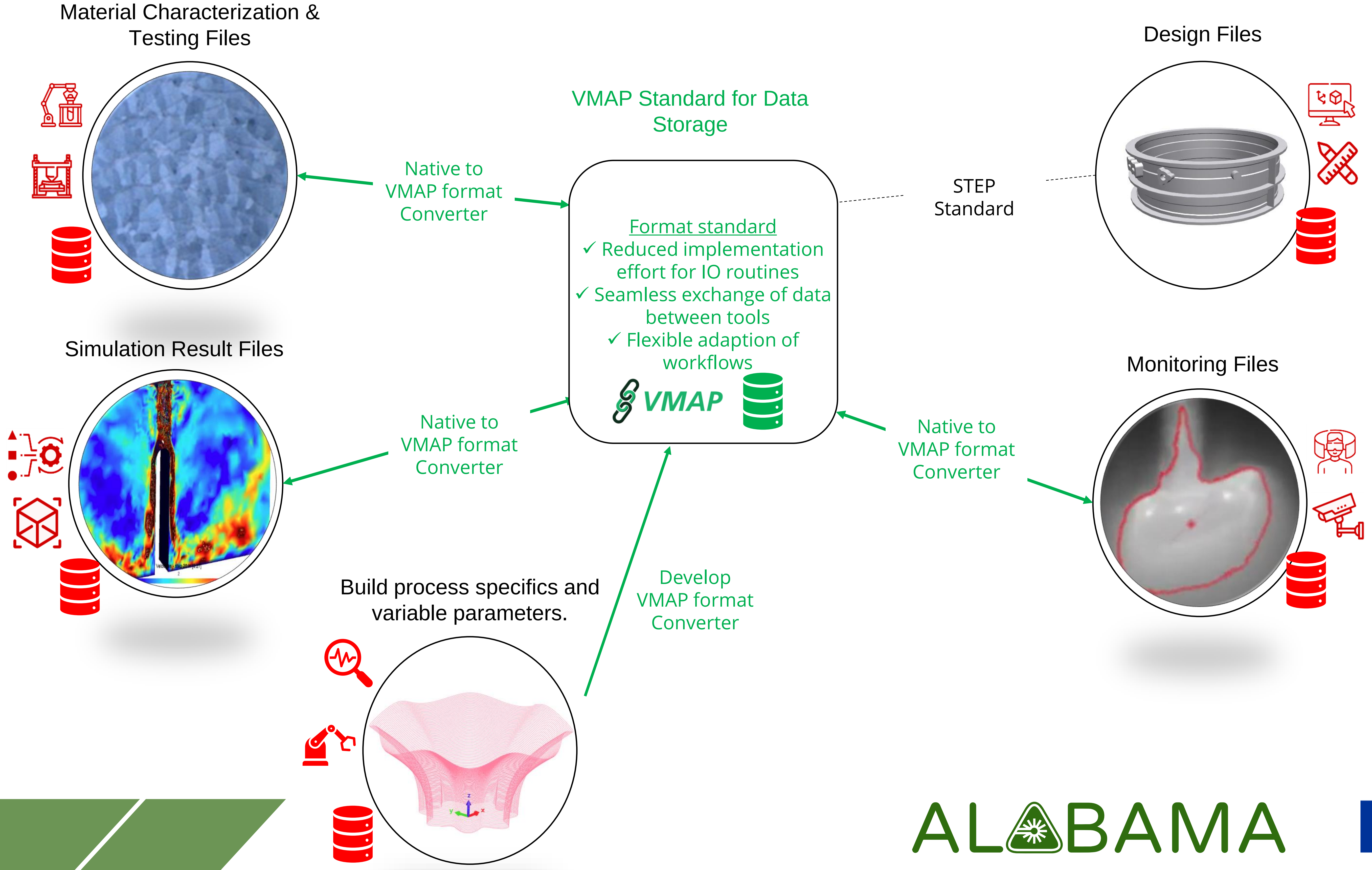
Fraunhofer
IWS

LULEÅ UNIVERSITY OF TECHNOLOGY

NAM
NORDIC ADDITIVE MANUFACTURING

GKN AEROSPACE

VMAP data handling and storage



ALABAMA

Co-funded by the European Union

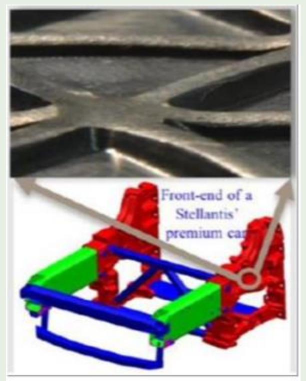
Use cases

DEMONSTRATOR

Compressor Casing

Impeller

Automotive



MATERIAL (RAW MATERIAL FORM)

Ti-6Al-4V
(Wire)

Super Duplex Stainless Steel
(Powder)

AlSi10Mg
(Powder)

APPLICATION AREAS (STANDARDS)

Aerospace
(Tests according to AMS4992)

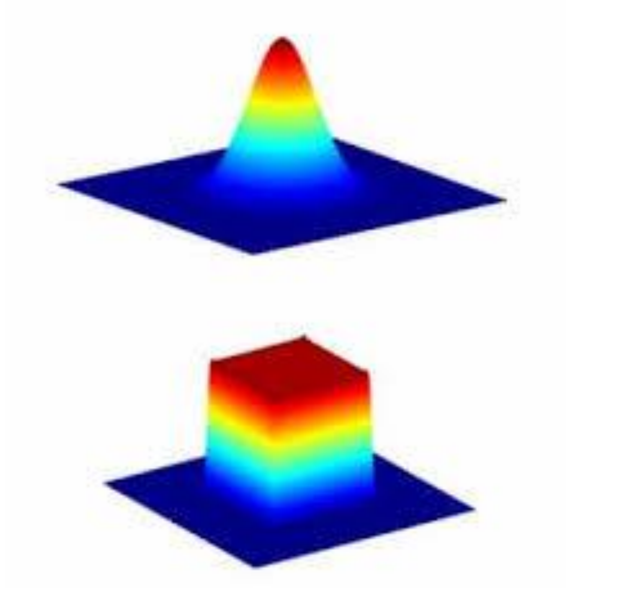
Marine
(Building process and qualification according to DNV ST-B203 (AMC2)

Automotive
(Tests according DNV B203)

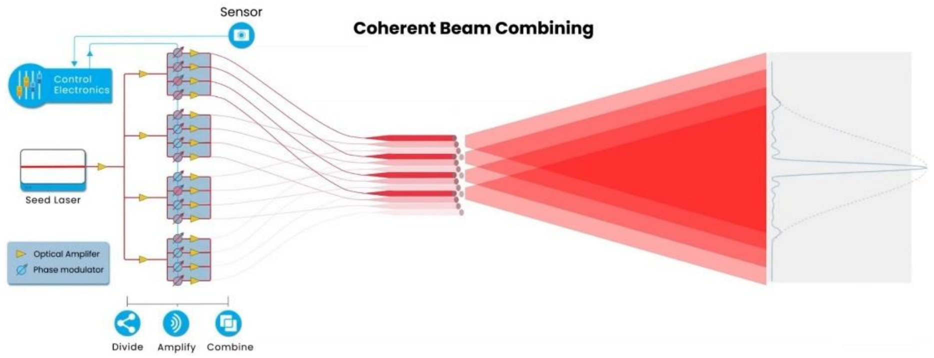
Co-funded by the European Union

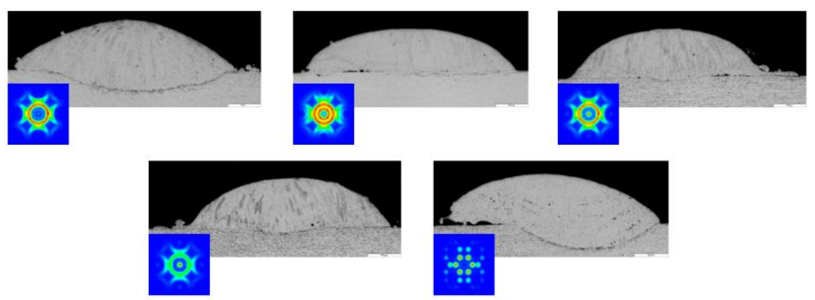
ALABAMA

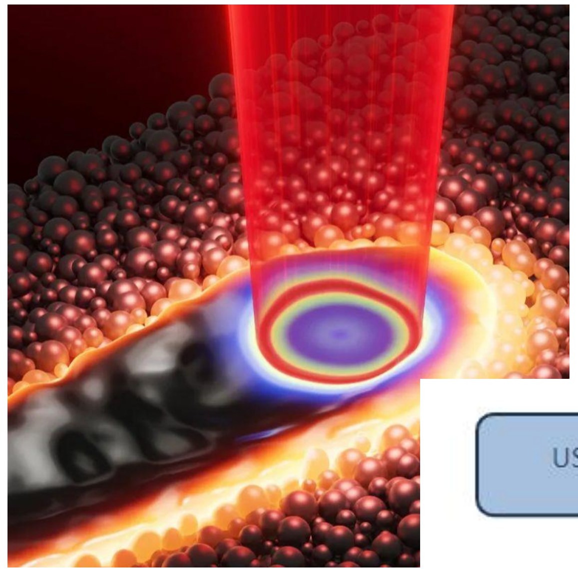
Standard laser beam-intensities



Coherent beam combining

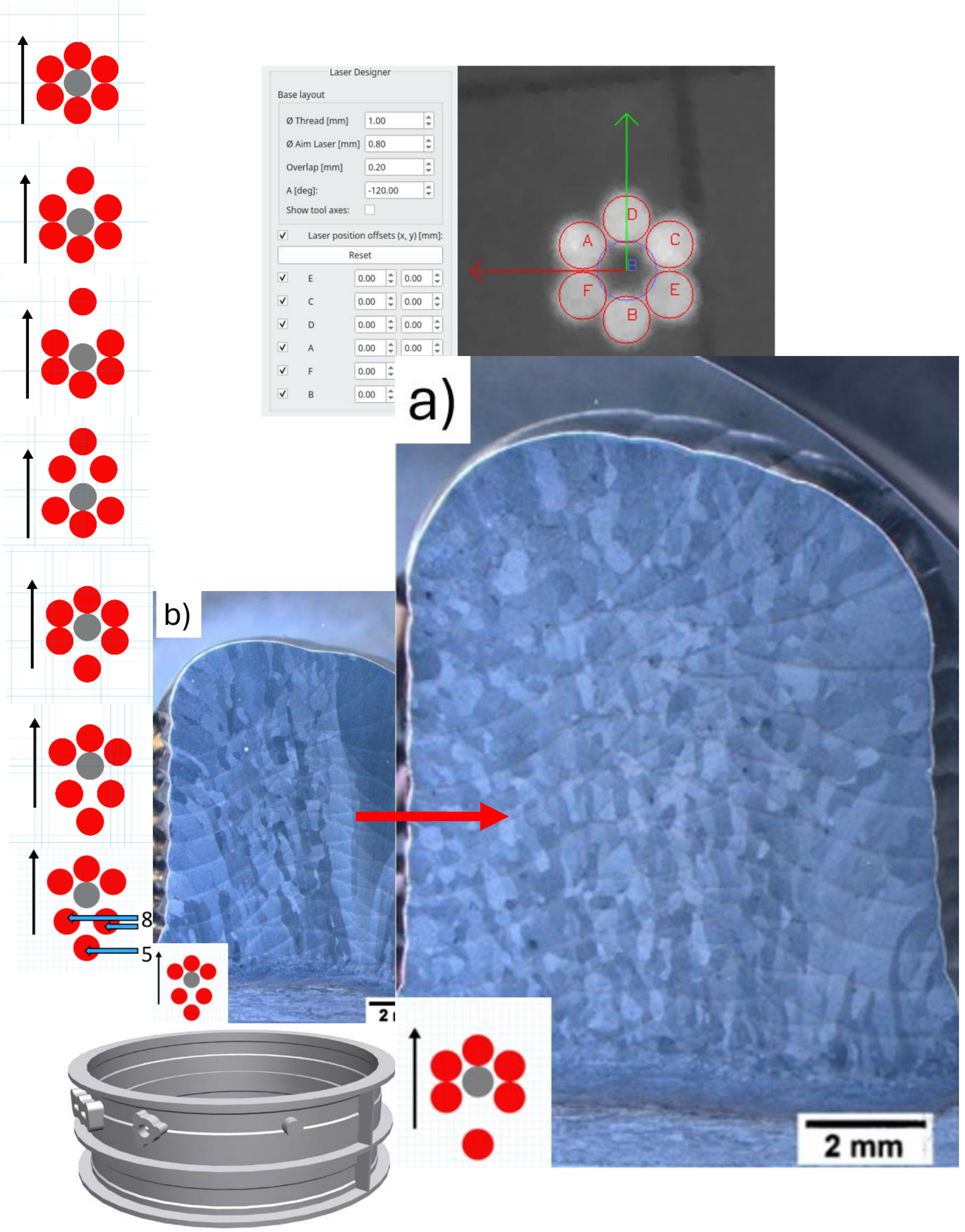




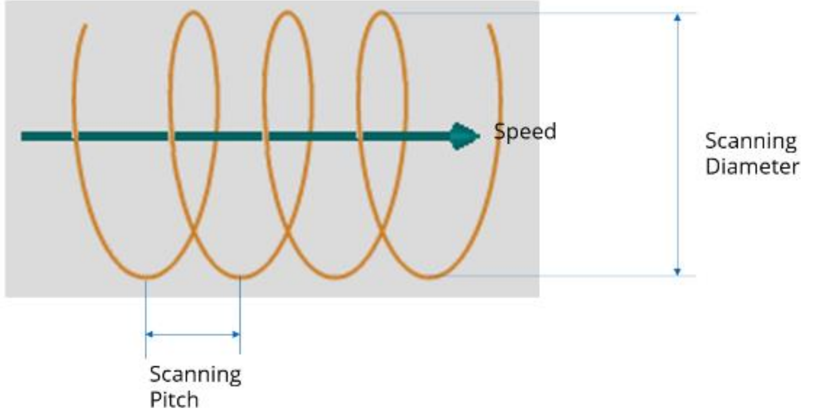


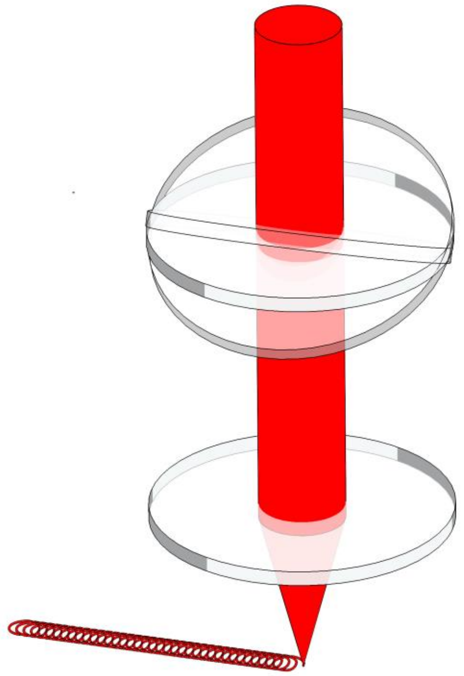
USER CASE 2 : Propeller
NAM, FHG

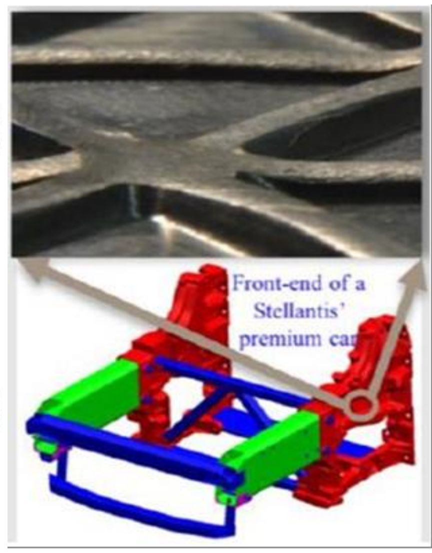
Multi-laser fomrations

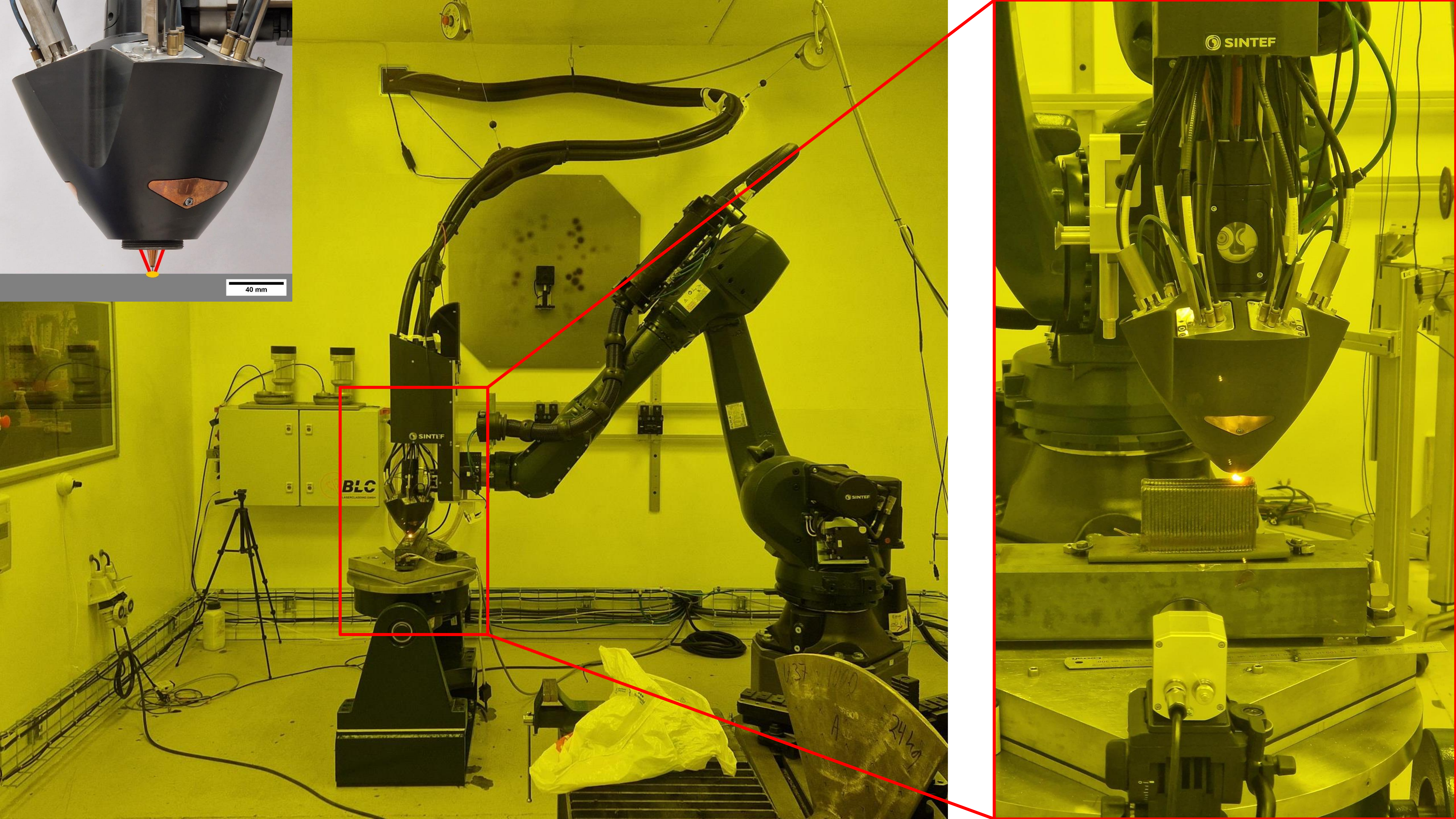


High speed wobble head

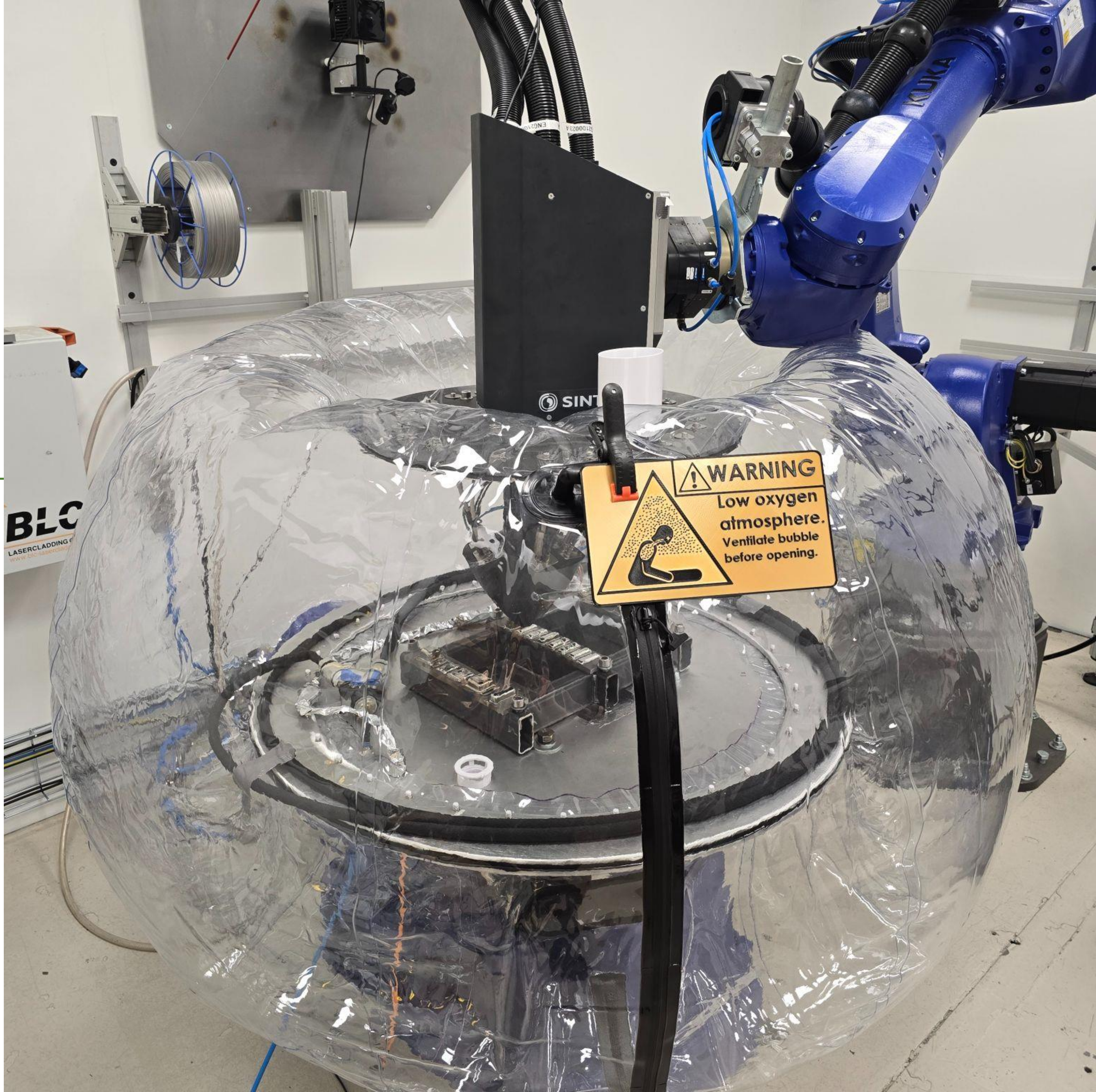


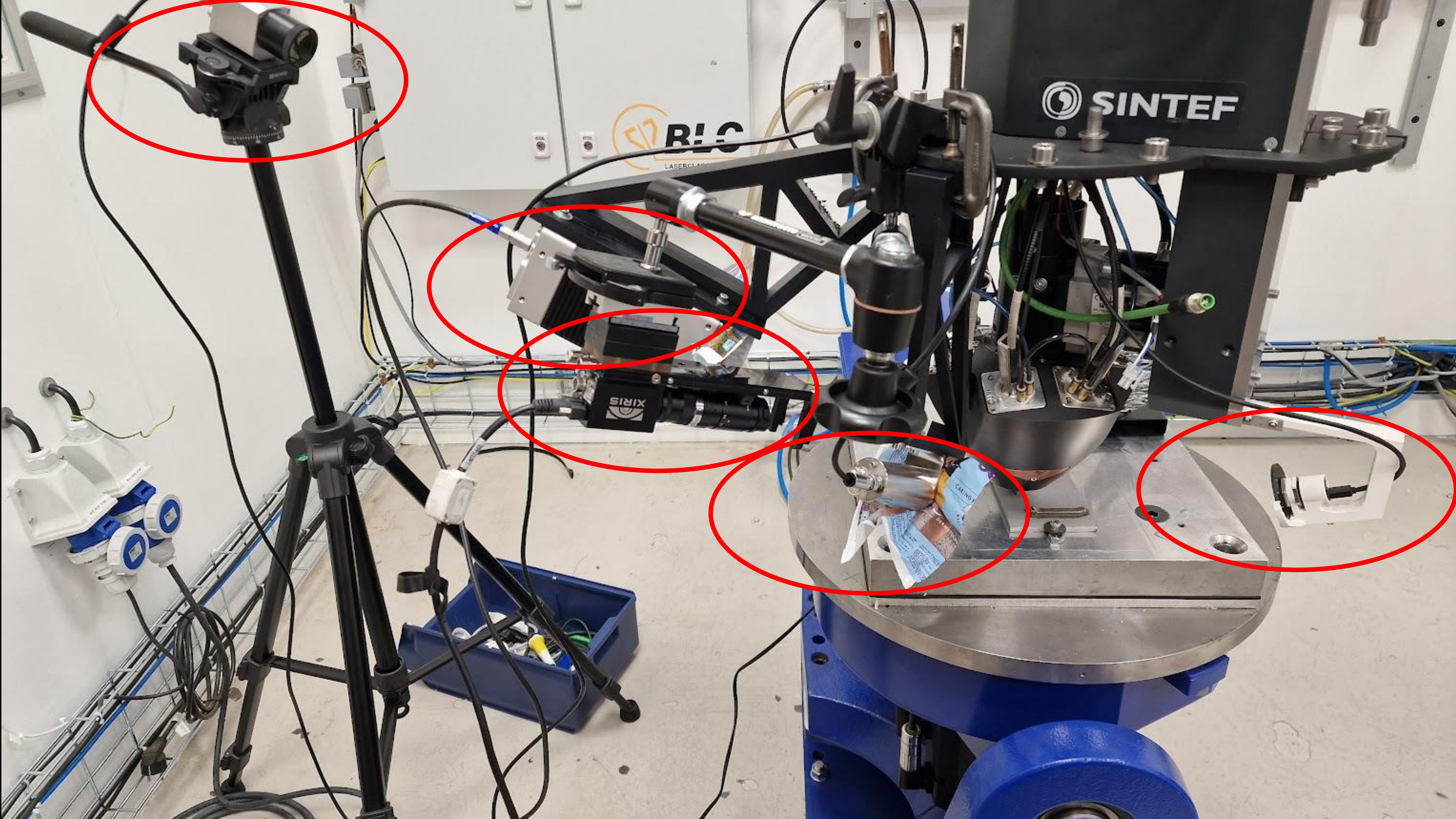





40 mm
SINTEF
BLC
SINTEF
SINTEF

Flexible argon chamber




SINTEF
BLC
XIRIS

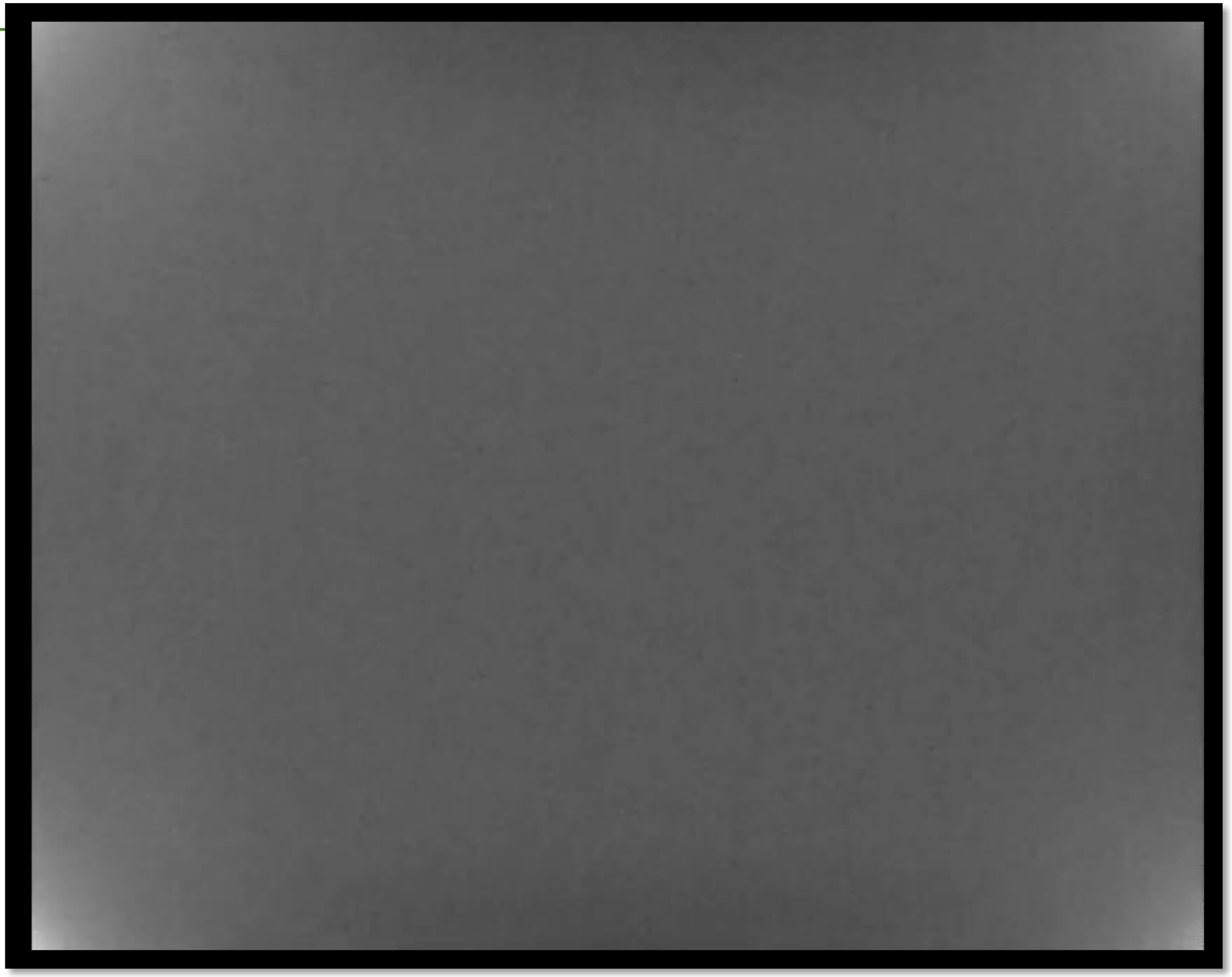
SINTEF

Melt pool monitoring for understanding of meltpool dynamics

Understanding the events in the melt pool to capture the high-speed dynamic process.

After a build, the test parts will be examined and any errors found will be traced back to the build process to find what generated the error.

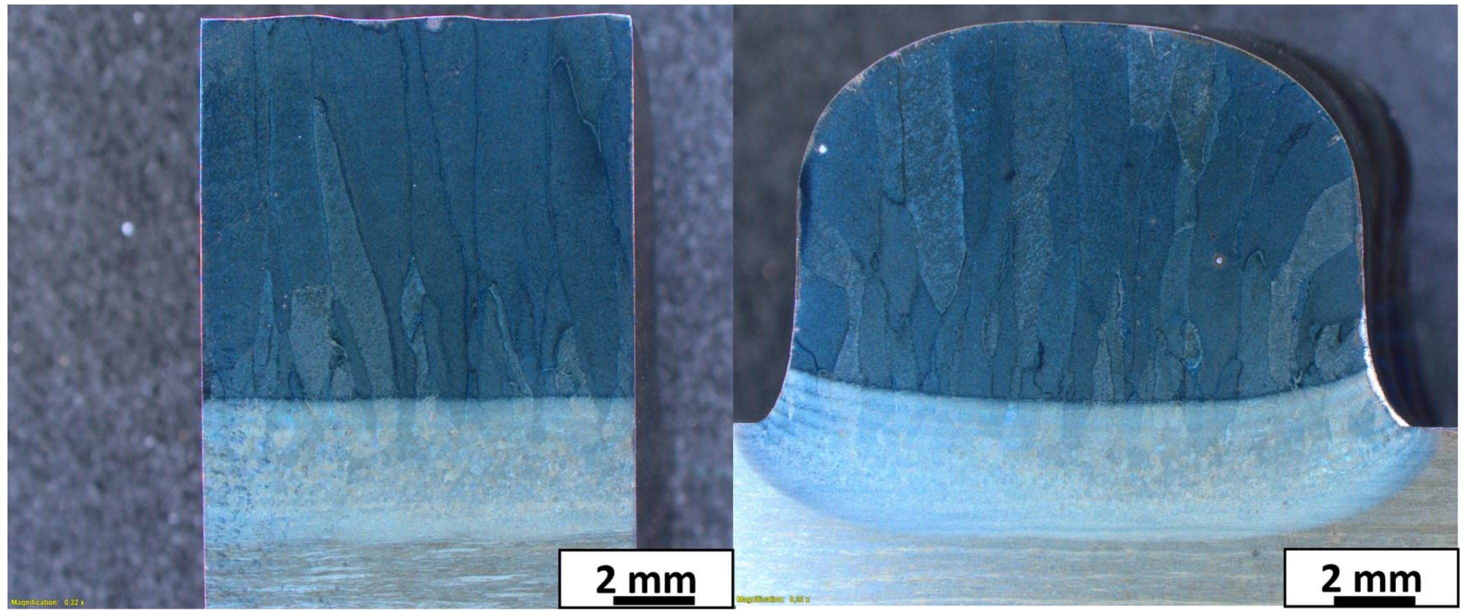
A camera is used to capture the process here using a standard laser position build.

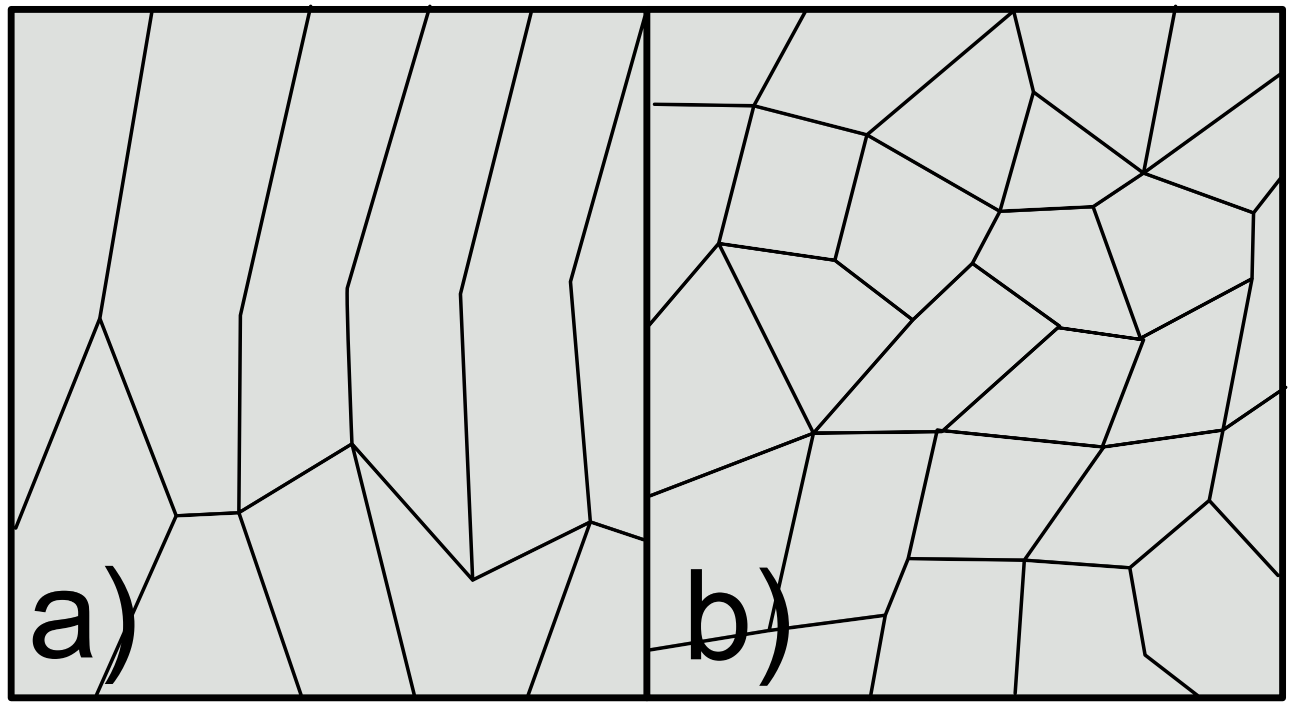


Columnar to equiaxed transition

- Directed Energy Deposition (DED) typically produces an elongated grain structure due to epitaxial growth of columnar grains during primary solidification. These columnar grains grow epitaxially parallel to the thermal gradient, i.e. along the build direction of the part. In DED-LB/M, columnar microstructure may lead to anisotropy, porosity, cracks, and poor bonding.

- Microstructures with an equiaxed pattern are usually preferred. It was believed that epitaxial growth can be disrupted by controlling laser positioning and process parameters. This will result in nucleation of equiaxed grains, which will in most metals improve both strength and ductility when compared with more coarse-grained microstructures dominated by columnar grain growth.

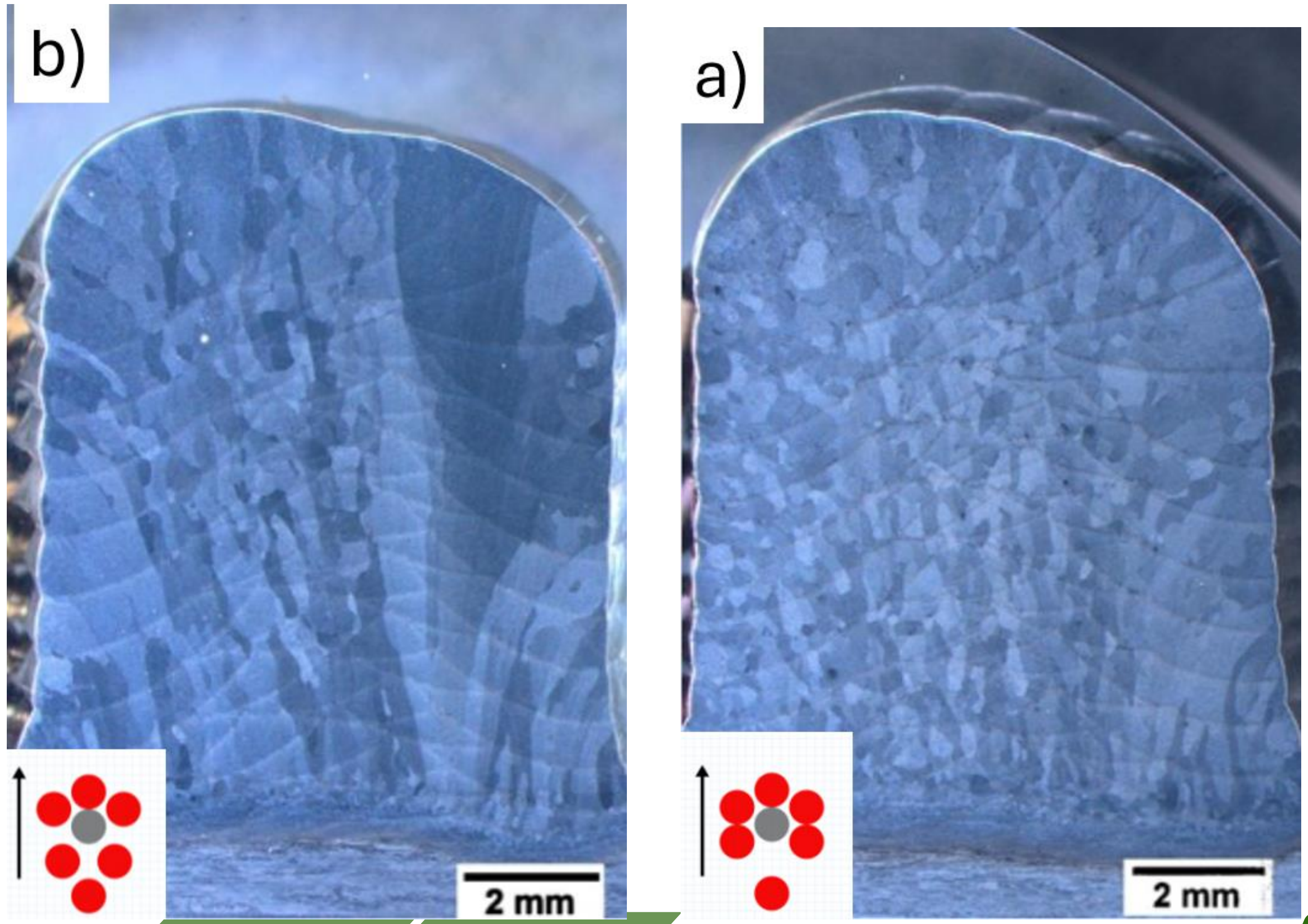


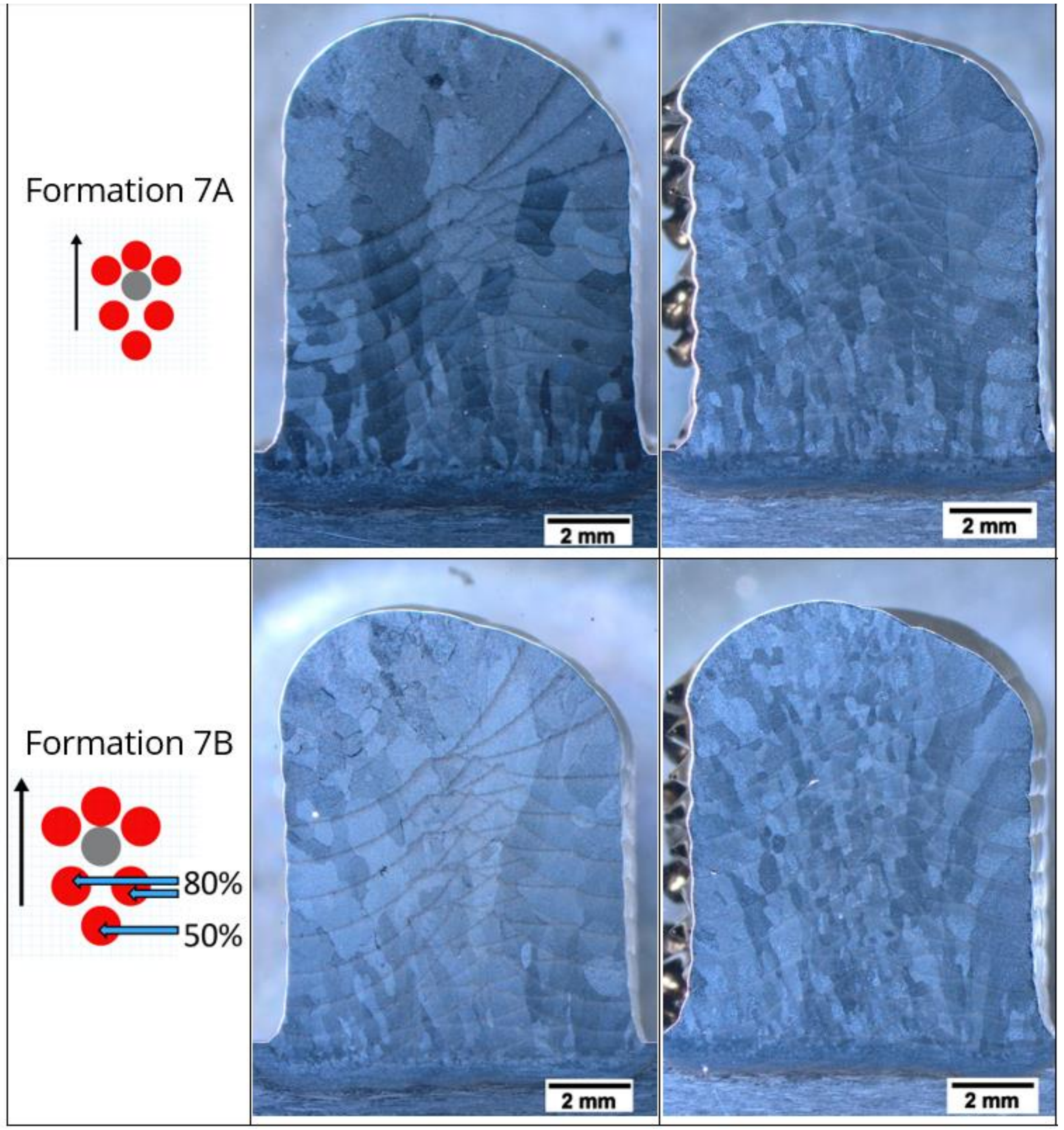


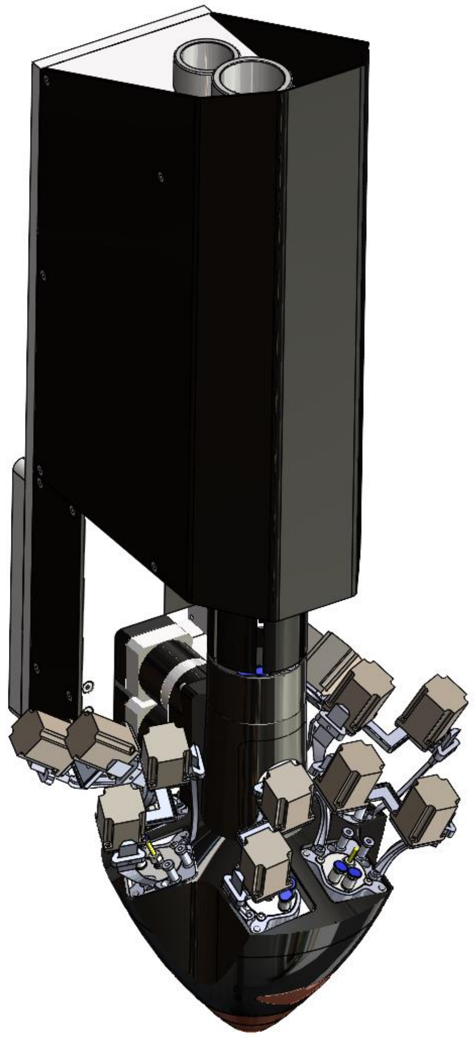
Results: material grain-structure

Building coupons:

- There are interesting preliminary results on trailing lasers with less energy input, although more testing is needed to conclude.





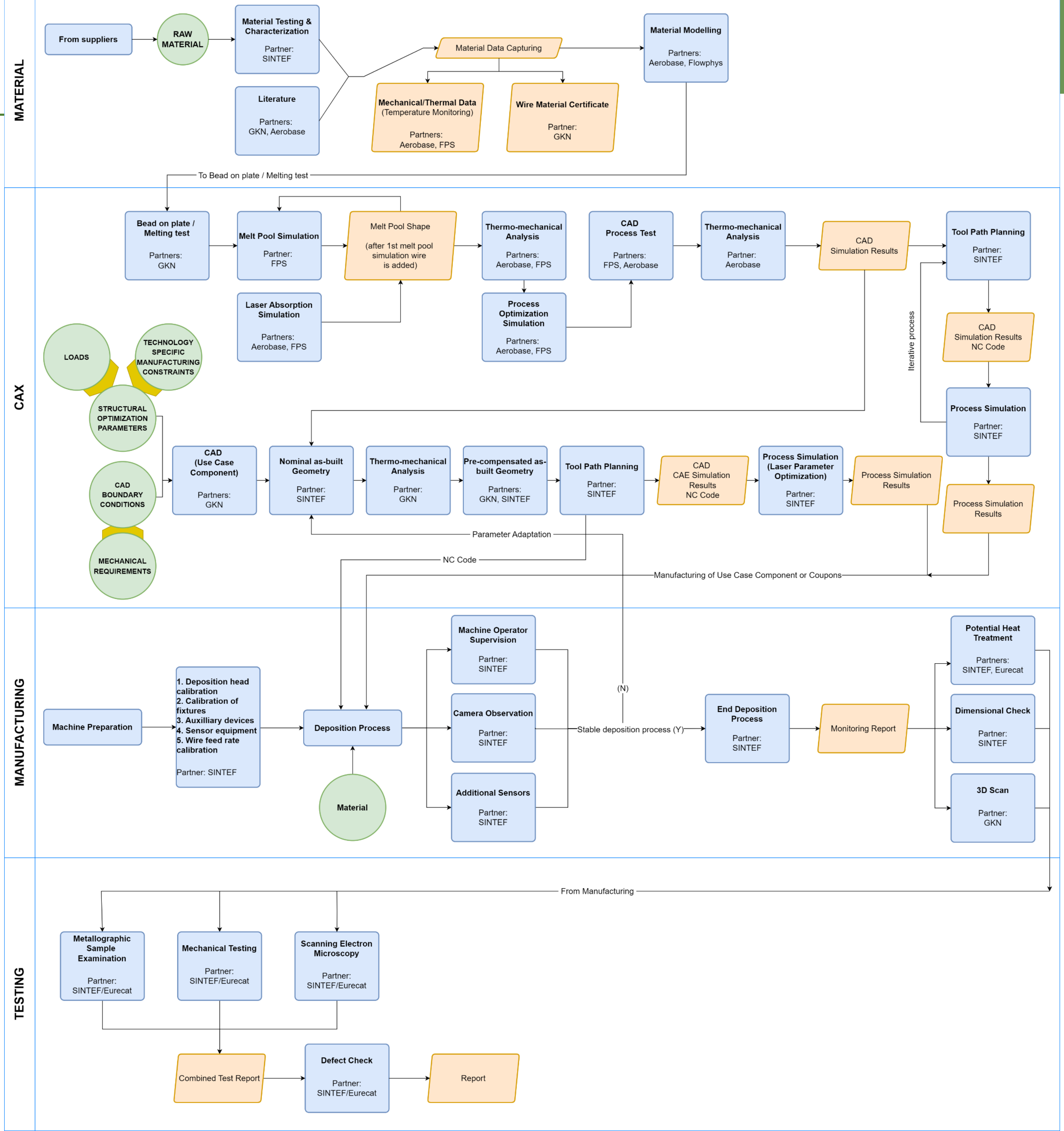


SLM Solutions

6/10

Workflow:

Process overview with input and outputs for Aeroengine use case



Horizon Europe - GEAR-UP

The GEAR-UP project tackles sustainable manufacturing in **three additive manufacturing processes**. Metal Laser Beam **Powder Bed Fusion** (PBF-LB/M), Metal Laser Beam **Directed Energy Deposition** (DED-LB/M) and Fiber-reinforced polymer **Material Extrusion** (MEX-FPR). The project has material producers to recycled materials for off-chemistry testing.

Effects of high trace elements in secondary alloys on material behavior during DED-LB/M and PBF-LB/M is then tested. In the MEX-FRP case the aim is to increase the use of recycled carbon and textile fibers in ME-FRP of composites.

Thereby the project aim to foster human involvement in advancing circularity and sustainable technology adoption through training and global collaborative networks.

- 10-33% in cost savings
- Reduction of defects by ~50% in deposited materials
- Reduction in material waste of 10-50%
- Reduction in CO_2 emissions of 5 million tons/year

Partners GEAR-UP

COLFEED4Print

eit Manufacturing

FLOWPHYS

aerobase

CelluCircle
Cellulose for Circularity

3D Production

Welding Alloys

Fraunhofer

Aker Solutions

TECHNOVATIVE SOLUTIONS

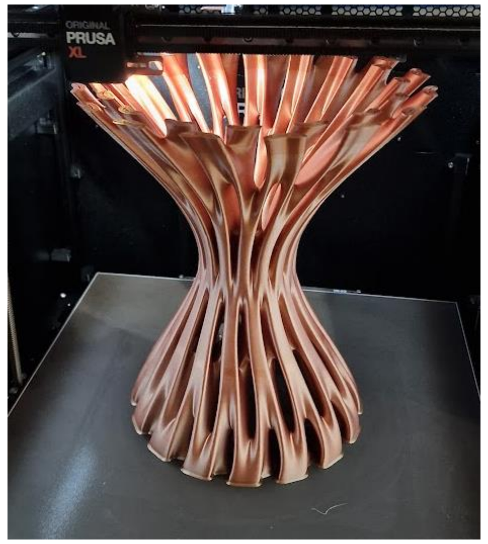
eurecat
Centre Tecnològic de Catalunya

SINTEF

SINTEF

Horizon GEAR-UP - Green Engineering, Analysis, & Reskilling for Unbounded Production

Oct 2024 – Sept 2028 - 4 years – 6 MEUR



CCP, C4P

User case: 3 compositions in 2 material systems fiber reinforced polymers

3DP, SIN

User case: From titanium to recycled Aluminum

AKS, SIN

User case: Repair and production of Pelton bucket

Circularity training in selected value chains — EIT

LCA and AI combined in a circularity platform based on DPP — TVS, SIN

Material modeling and process simulation — FPS, AER

Recycling of material for fiber reinforced polymer for Additive Manufacturing

CCP, C4P

Recycling of Aluminum for powder bed fusion

EUT

Recycling of steel wires for Additive manufacturing

WAG

Benchmarking, Requirements, and KPI elaboration — FHG

https://gearup-project.eu/

GEAR-UP

Green Engineering, Analysis, & Reskilling for Unbounded Production

Central objective:

Develop digital tools and methodologies that address recycled materials variability address recycled materials variability, optimizing additive manufacturing processes, and enhancing sustainable product design. It emphasizes environmental conservation, cost savings, increased productivity, and significant reductions in defects, material waste, and CO2 emissions.

Funded by
the European Union

GEAR-UP VMAP

Non-standard Processes:

As the projects employ **unique methods** and **custom add-ons**, **ontologies** must be developed to represent these within the VMAP structure.

Process Monitoring:

Integrating various process monitoring results with process parameters, specifics, and further testing is crucial for development.

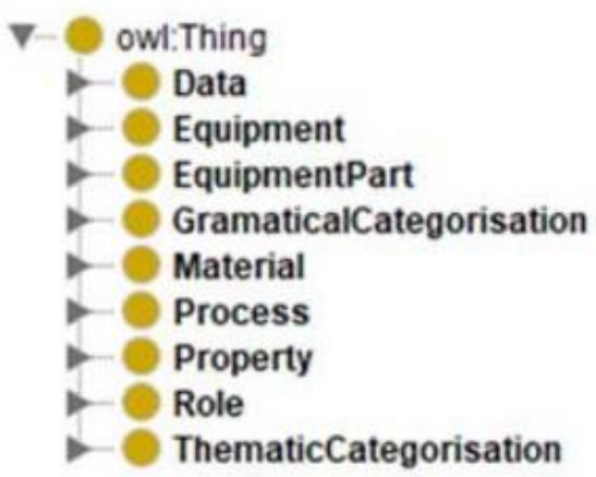
Material Testing:

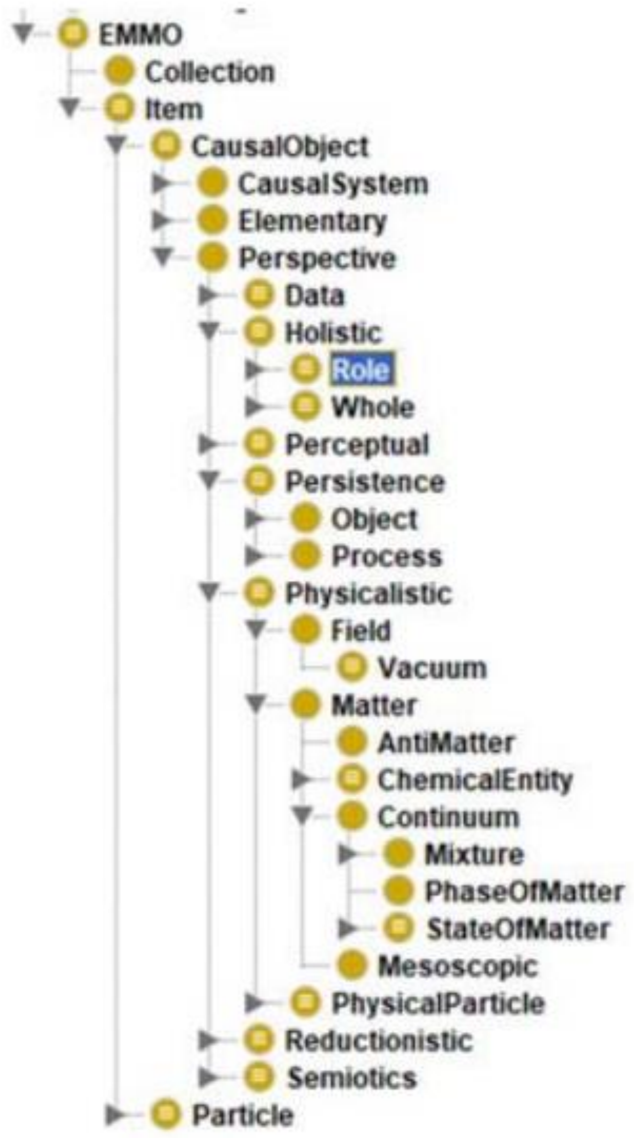
Extensive optical and mechanical investigations are conducted on test specimens in both projects. Standardizing the connection between each sample's performance, process monitoring and specifics, and special parameters will ensure seamless data flow and exchange.

VMAP Wrapper:

The VMAP wrapper can serve as an integrator, facilitating the exchange of monitoring data, material testing results, and performance metrics with processing data.

EMMO – ontology





Main classes for the domain ontology for Additive manufacturing (left) and the top ontology EMMO (right)

ALABAMA

GEAR-UP

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Funded by
the European Union