flashcomp
Composite manufacturing, right first time

flashcomp

Flawless and sustainable production of composite parts through a human centred digital approach

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inegi

EFFRA – 07/05/2024

General Data

- **Starting Date: 1st October 2022**
- **Duration: 42 months (30th March 2026)**
- **Project Budget: 6,69 M€**
- **Funding: 5,61 M€**
- **14 partners**

Context

- Transition towards climate neutrality: need to reduce manufacturing waste
- Composites play an important role In EU manufacturing: energy, naval, aerospace sectors…
- Manufacturing of these parts largely based on manual operations (difficult to control)
- Current processes: unsustainable and inefficient (excess of material, need of reparation…)
- Considerable environmental impact (135.000 to 372.000 Tones/year in Liquid resin process)

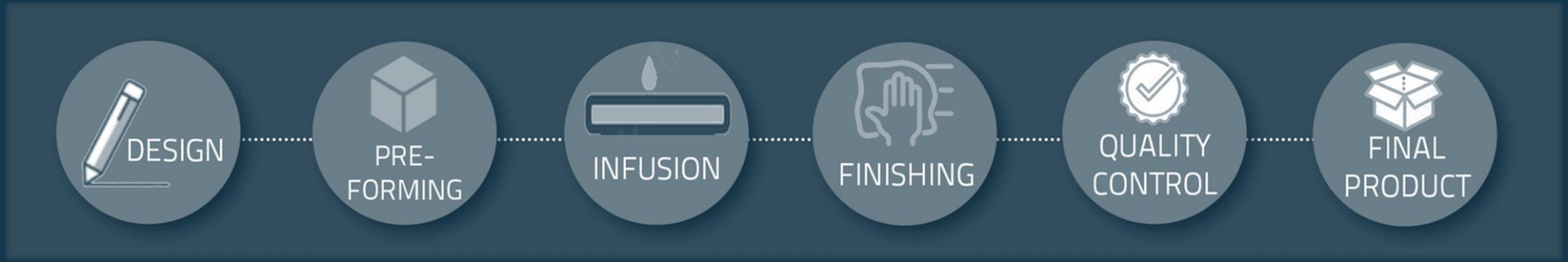
flashcomp

Project Video

Goal of the Project

- The main objective of FLASH-COMP is is to develop a **fast and reliable (FLASH) human-oriented quality control solution** capable of identifying in a timely-manner defectiveness during process and, consequently, to determine the in-situ corrective actions to be implemented.
- Application field will be **composites**, specifically **Liquid Resin Infusion (LRI)** processes, with the objective of reaching the **zero-defects** paradigm thus significantly reducing the generation of polymer composites waste.

LRI Process Steps



Use Cases

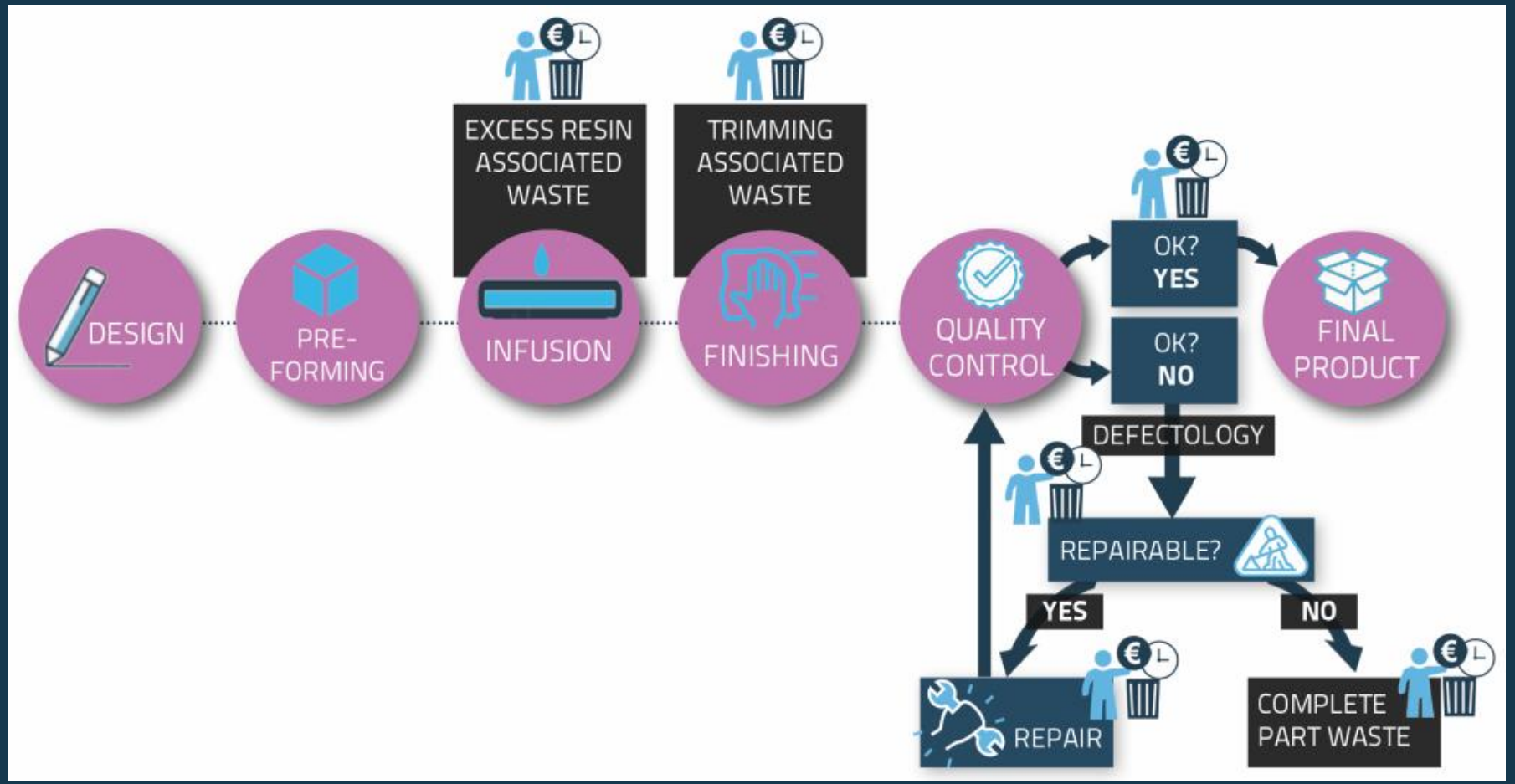
AERONAUTICAL SECTOR: IAI

- **Aircraft structures** manufacturing: wing skin
- Annual Production: 72 wings per year
- **Expected savings:**
  - 30 % reduction resin waste,
  - 100 % reduction in discarded spars and wingboxes

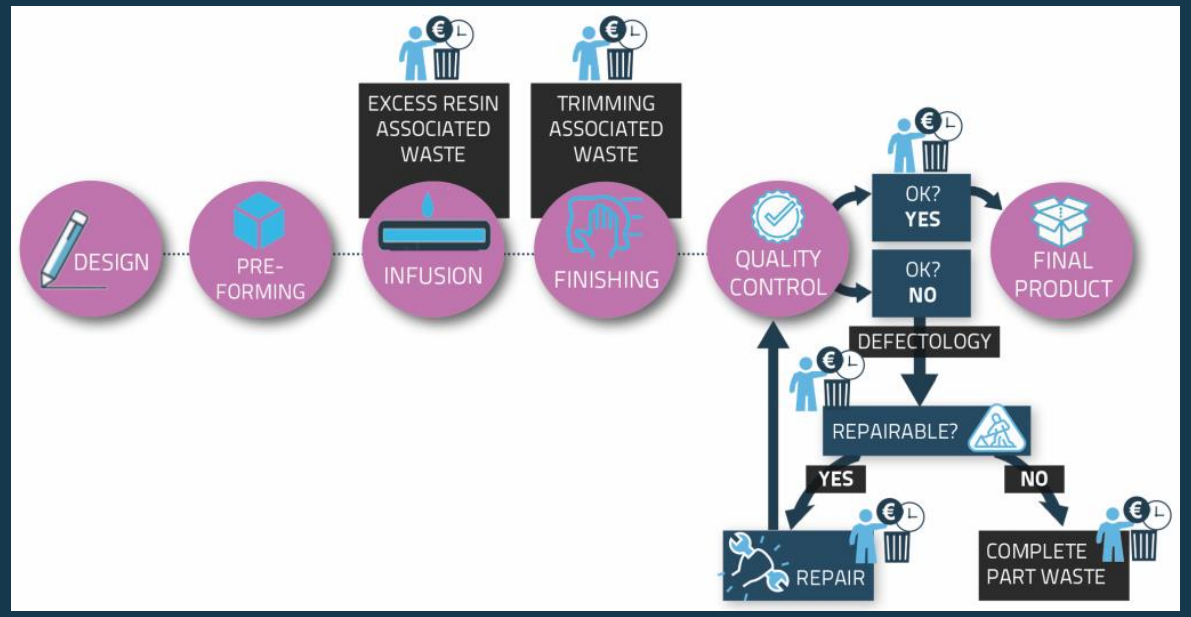
NAVAL SECTOR: AZIMUT

- **Yatch manufacturing** composite: 14-50 m in length
- Annual Production: 250 yatchs, 1400 big components
- **Expected savings:**
  - 30 % resin waste,
  - 20 % repairing materials
  - 808 MWh energy consumption

Current LRI Process

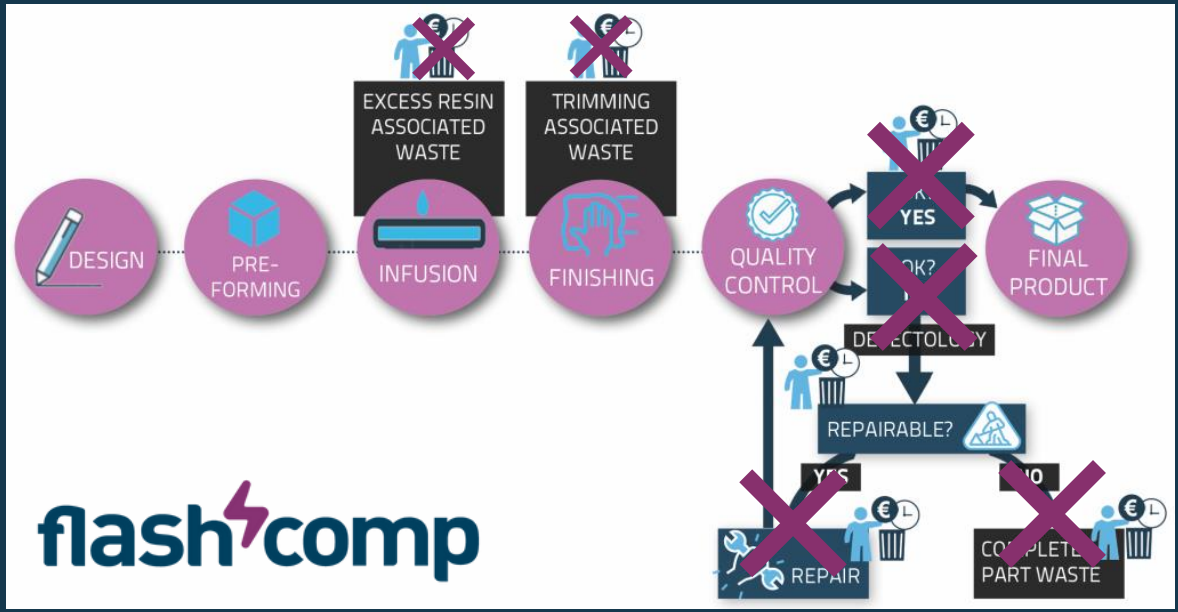


Current LRI Process



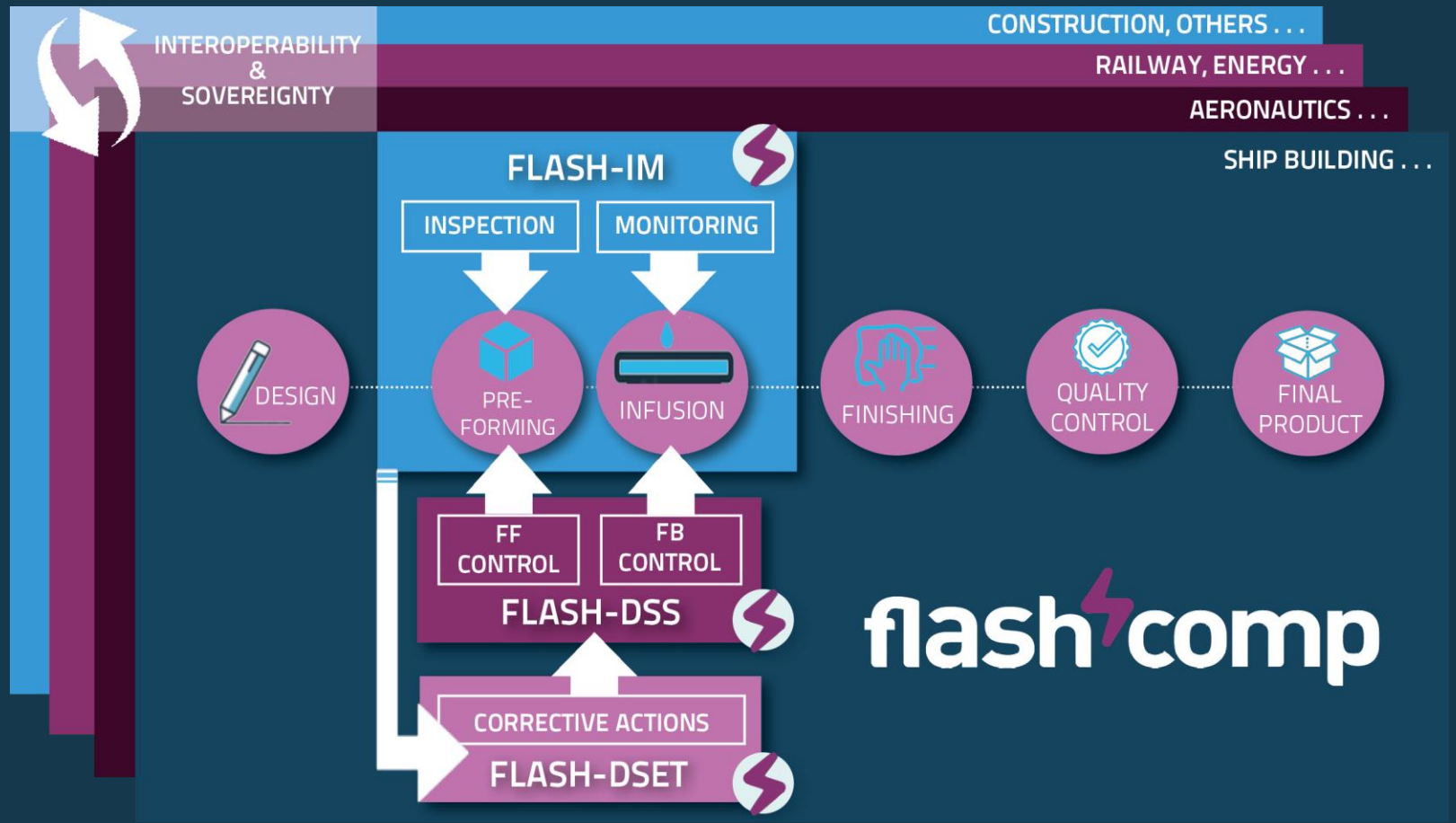
- Defectiveness occurs (mainly) due to issues in the Pre-Forming and Infusion stages.
- Difficult to act over the Infusion process during production.
- Feasible defectiveness (voids, dry zones) is avoided by introducing resin in excess:
  - waste within the Infusion and Finishing process
  - complex and expensive quality control loop after the part is finished
- **Possible to reduce costs from waste and the quality control loop by "simply" establishing corrective actions over the resin-infusion stage.**

Flash-Comp Concept



- **Quality control and repairing are substituted by corrective actions that take place within the production process**
- **Corrective actions** within the Infusion stage will allow:
  - Manufacturing with **no defects**.
  - **Reducing** excess resin and trimming associated **waste**.
  - Eliminating the Quality Control stage.
  - Producing “**right-first-time**” products.

Flash-Comp Concept

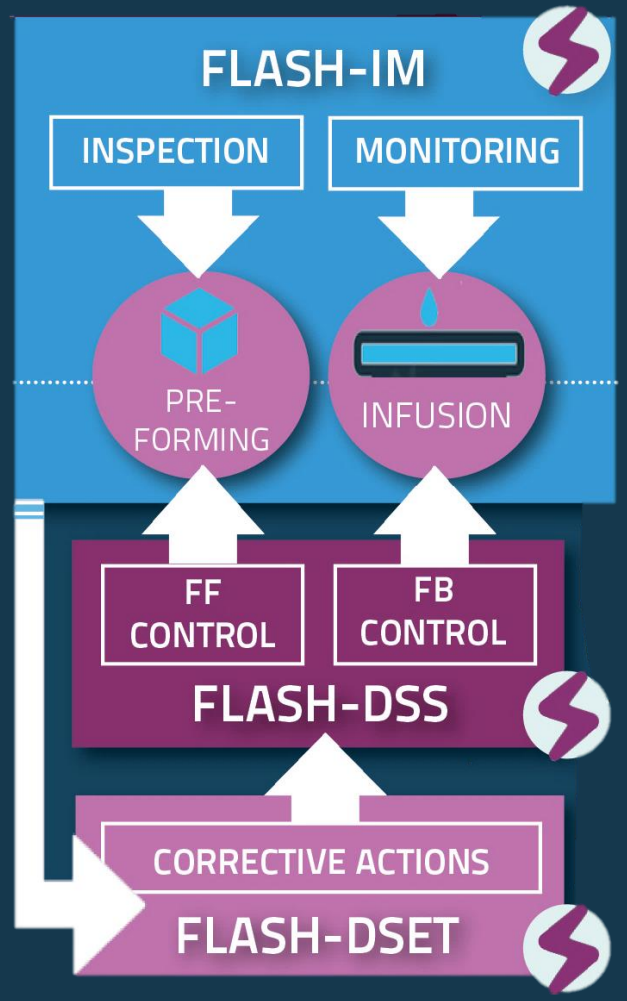


Flash-Comp Concept

- **FLASH-IM: FLASH-COMP** will employ novel, fast and accurate **Inspection and Monitoring techniques** within the most critical manufacturing stages (Pre-Forming and Infusion), to retrieve key process parameters.

- **FLASH-DSET:** This data will feed an **AI-based Defect Severity Estimation Tool**, capable of estimating the generation of defects and, in consequence, determining if and what kind of corrective actions should be adopted.

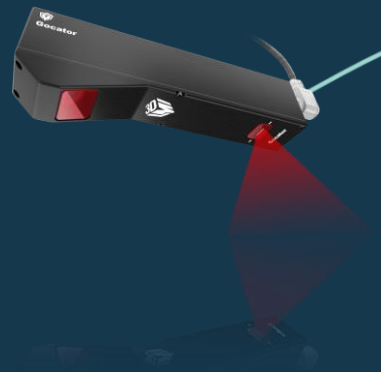
- **FLASH-DSS:** Instructions will be linked to **real-time feedforward and feedback (FF/FB) control strategy Decision Support System**.
  The solution will **increase its knowledge** by sharing **interoperable and sovereign data** among different **sites and factories**.

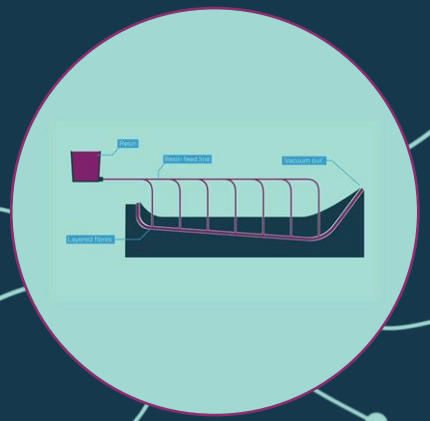


Flash-IM | Monitoring Technologies

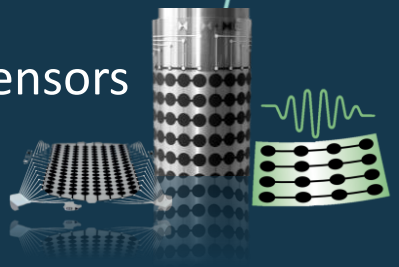
Hyperspectral Camera

Perfilometer





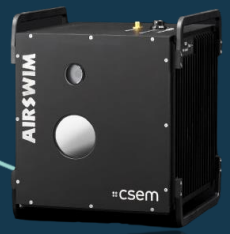
Pyzoflex Sensors



Fibre Optic Sensors

Matrix/Linear Camera

LiDAR



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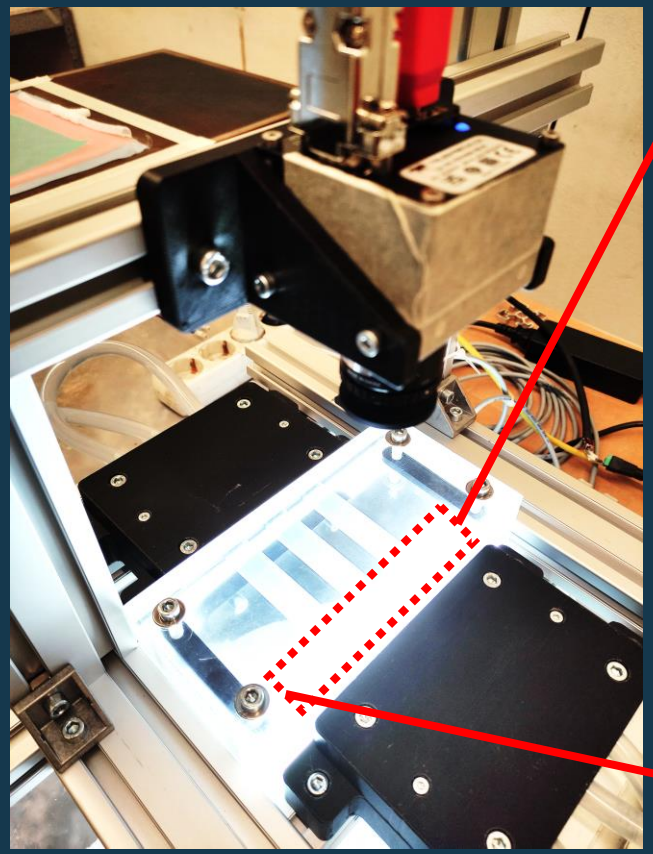
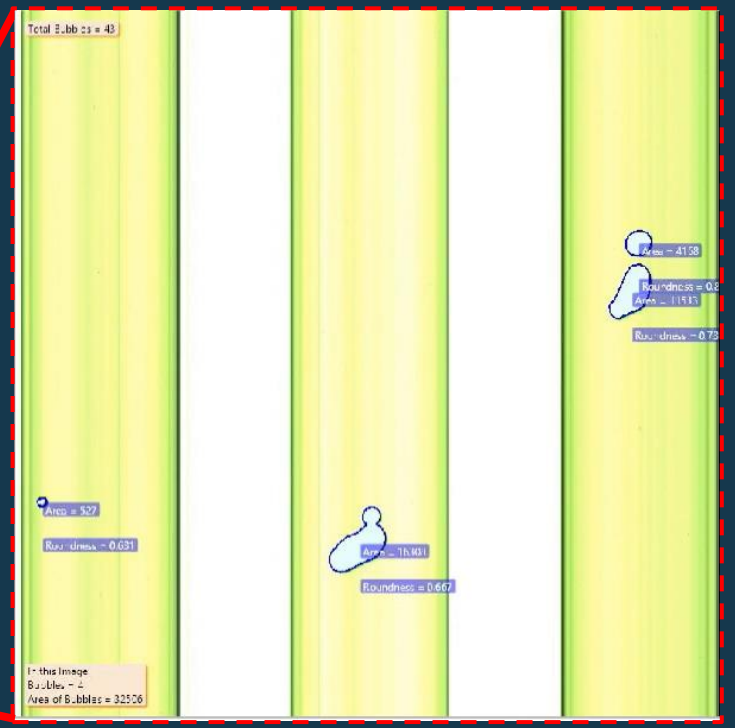
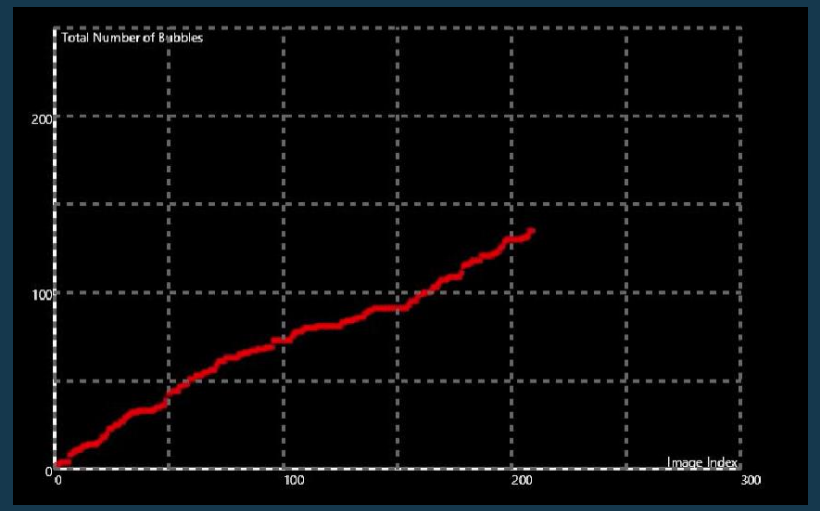
Matrix/Linear Camera

Flash-IM | Bubble Counting

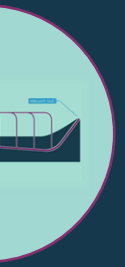




Bubble Count and Plotting



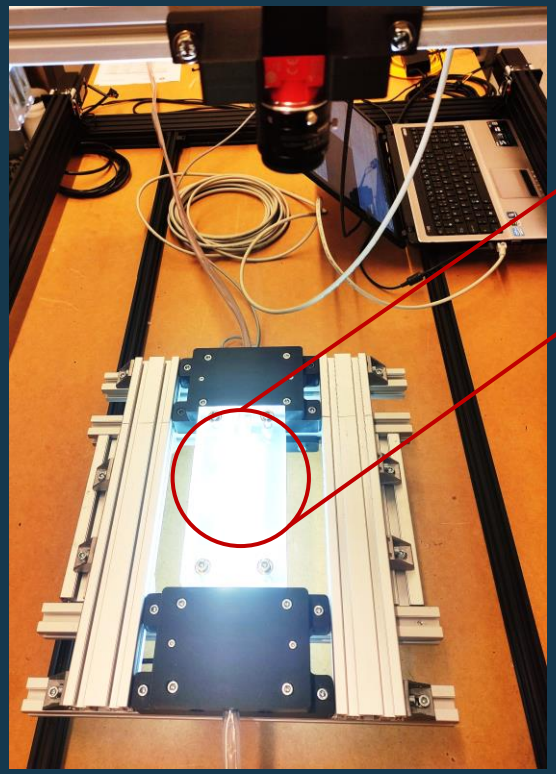
Objective: Monitoring of resin transport tubes, to check for air ingress into the laminate.

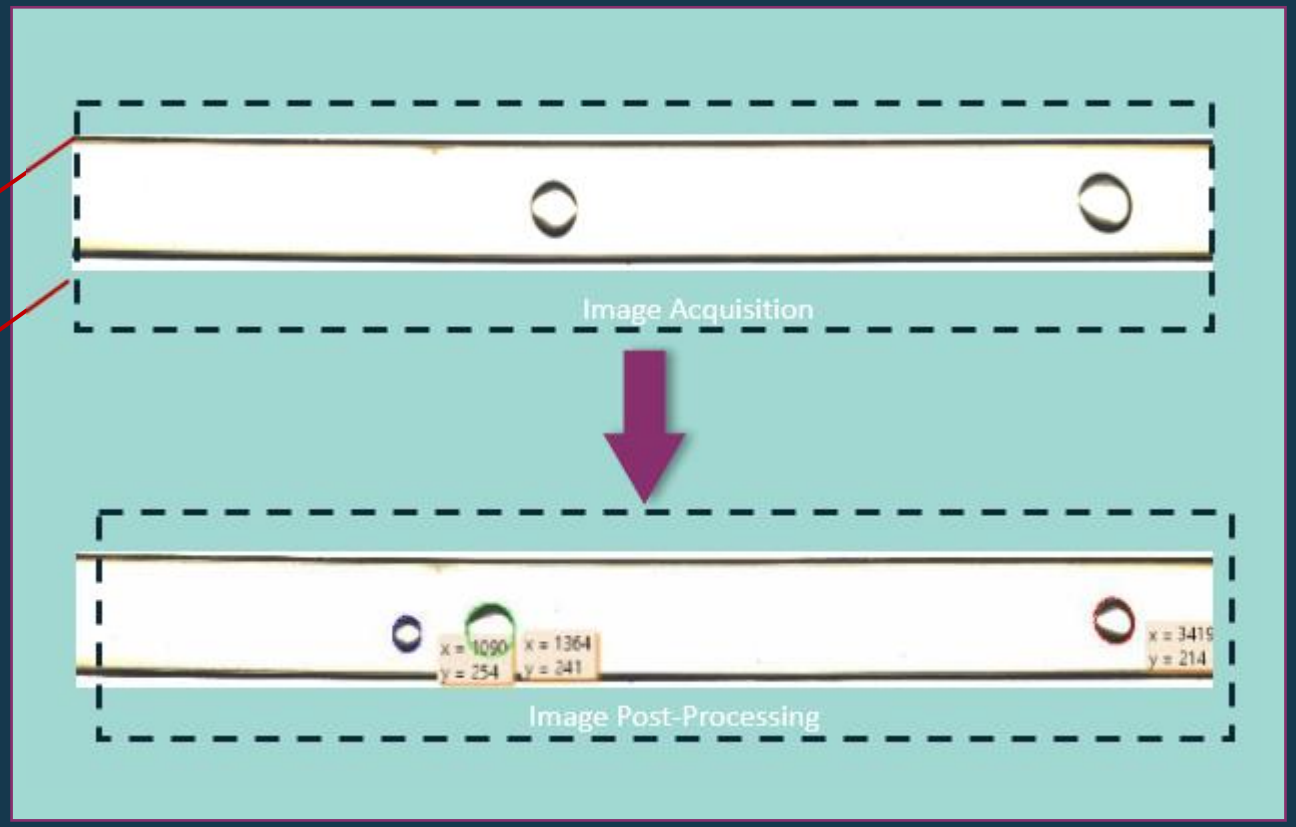


Matrix/Linear Camera

AR

Flash-IM | Bubble Tracking





Objective: Monitoring of bubble velocity and size to calculate the flow of injected resin and air.

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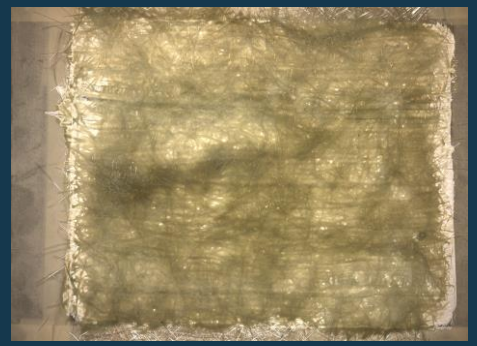
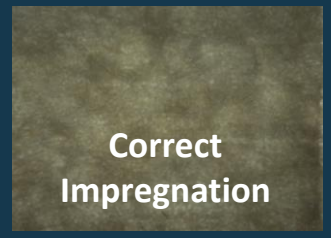
Matrix/Linear Camera

Flash-IM | Skincoat Curing

First Frame



Last Frame

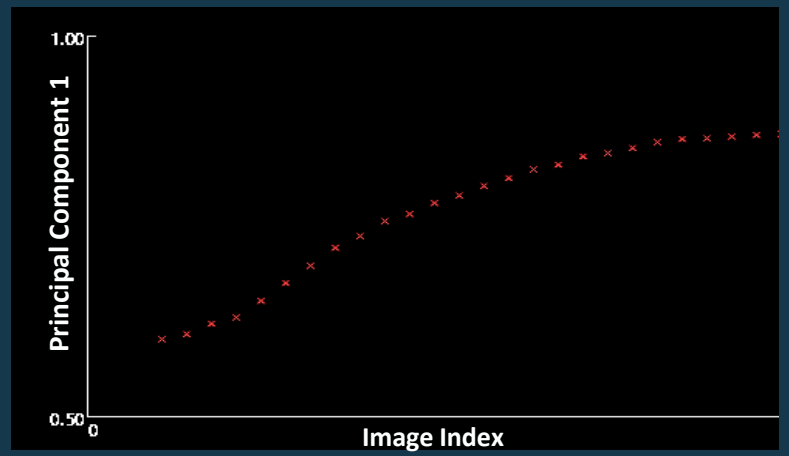


- The **colour** of the images acquired is correlated with the **level of impregnation** of the laminate

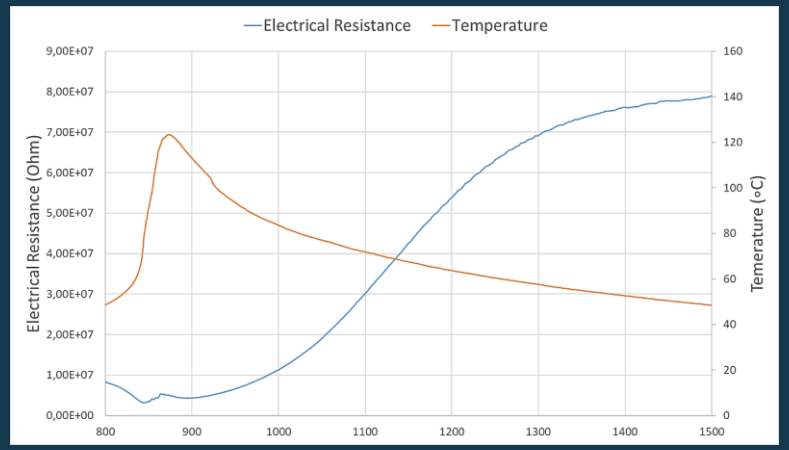
Matrix/Linear Camera

Flash-IM | Gelcoat Curing

- **Principal Component Analysis (PCA)** on Image subtraction result



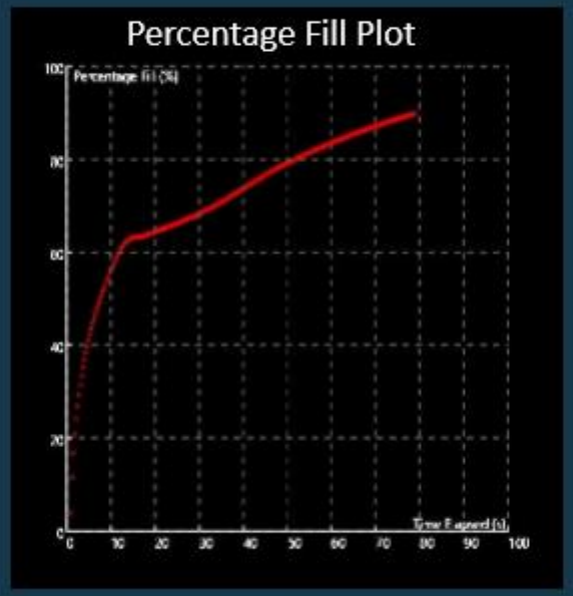
Typical Curing Evolution



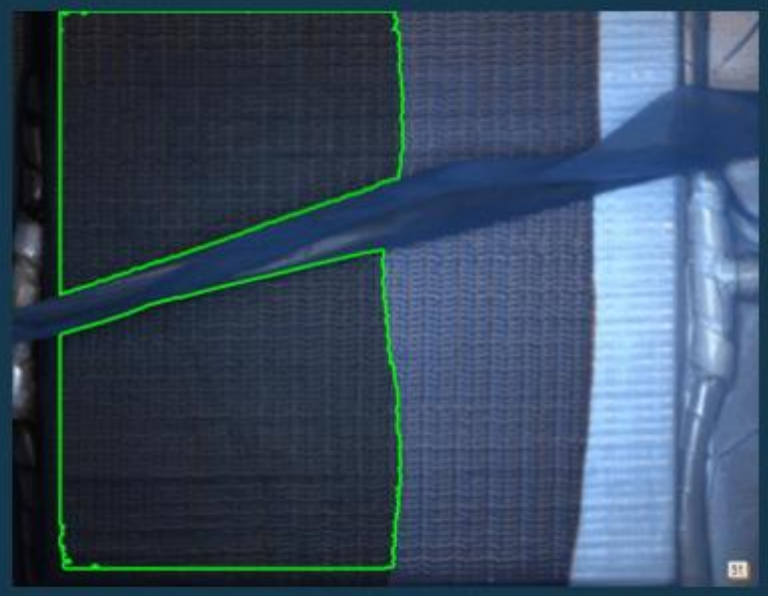
Matrix/Linear Camera

Flash-IM | Flow Front Monitoring

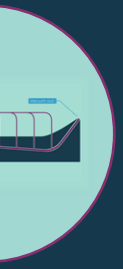
Permeability Changes



Obstacles on ROI (Tubes and pleats)



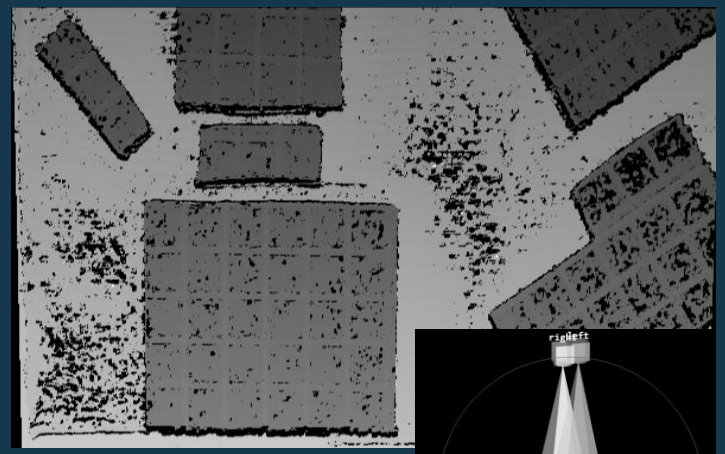
- The flow front pattern/position is one of the most important process parameters, since its assessment can help prevent the most severe defects that may occur during infusion.



Matrix/Linear Camera

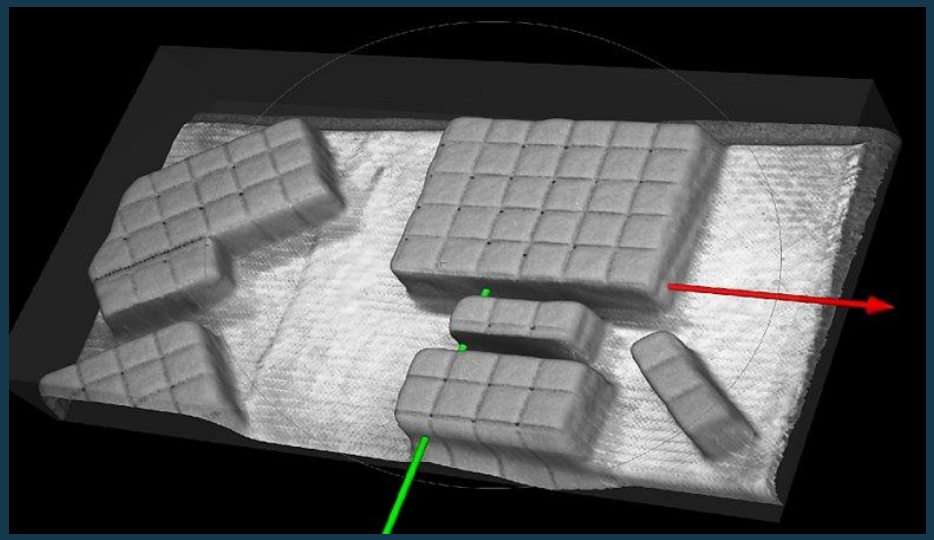
AR

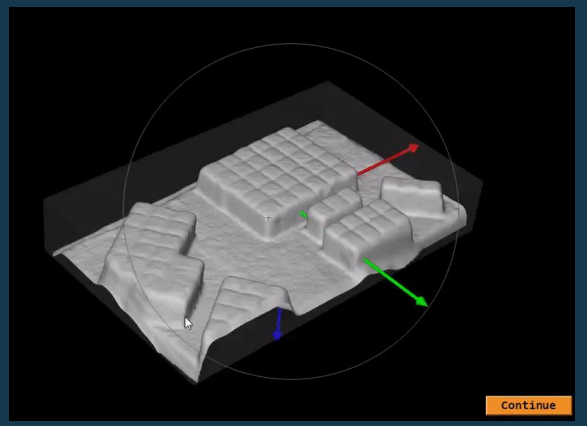
Flash-IM | Core Placement



Disparity Image

Cameras Pose



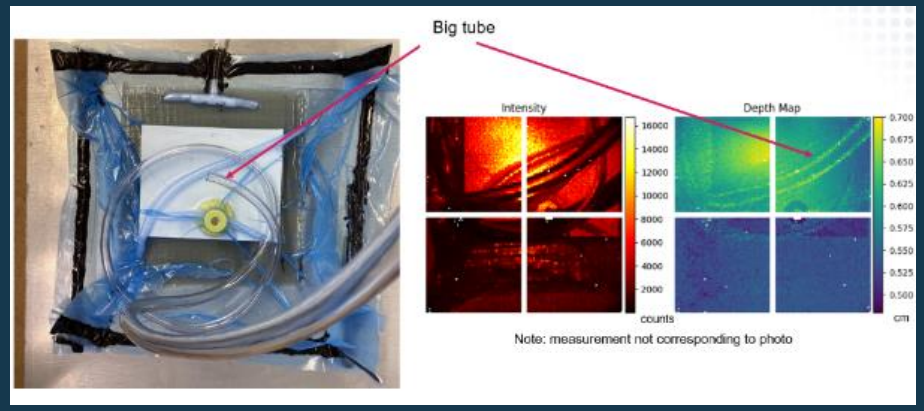


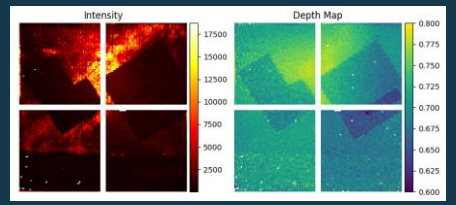
LiDAR

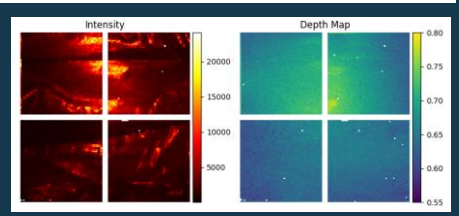
Perfilometer

Flash-IM | Infusion Features Detection

LiDAR



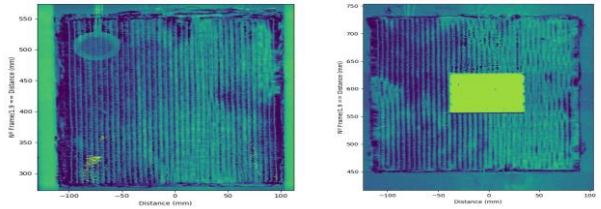




- Integration of new laser (low FWHM and multi pulse feature) enhance precision to 0.58 cm

Perfilometer

Elements positioning/ Feature Detection

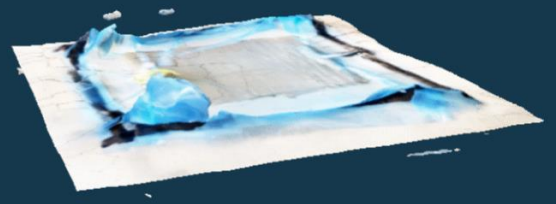


Matrix/Linear Camera

LiDAR

Perfilometer

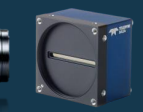
Flash-IM | Infusion Features Detection



3D MODEL
-Pleats
-Inlets/Outlets
-Pipes
-Clean Areas

Hyperspectral Camera

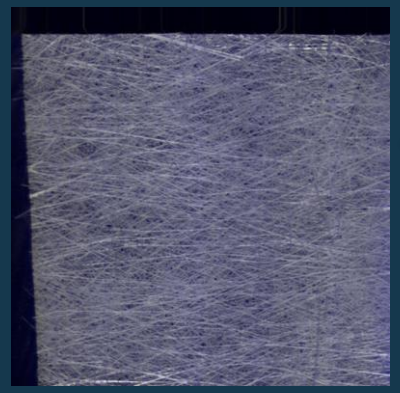
ear Camera



Flash-IM | Binder Application

Hyperspectral Images (**False Color**) - **NIR**

Glass fiber (CSM)



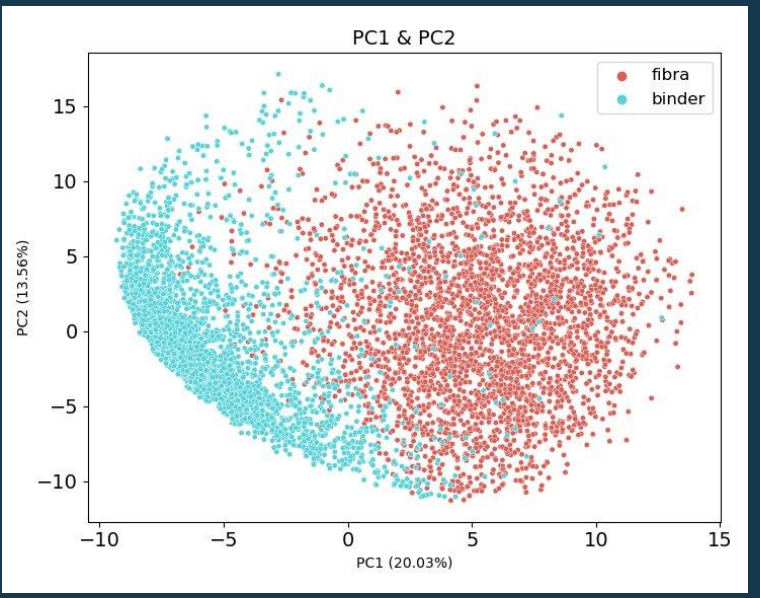
Gfiber (CSM) with binder

PCA

PCA analysis:

- Good discrimination between the spectra of the **fiber** and the spectra of the fiber with **binder**.

- Different Materials
- Features
- Defects

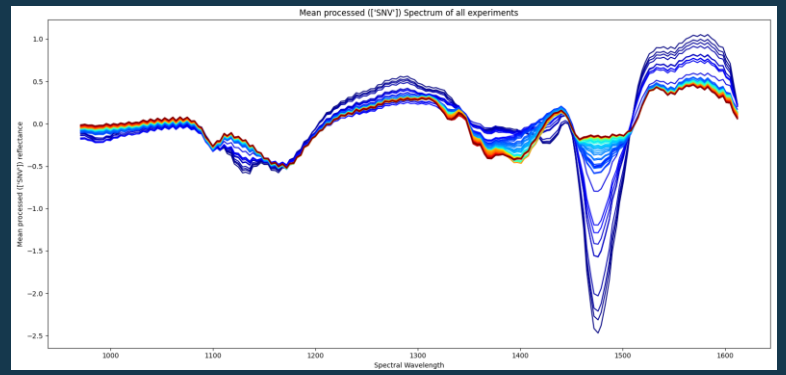


Flash-IM | Resin Curing Degree

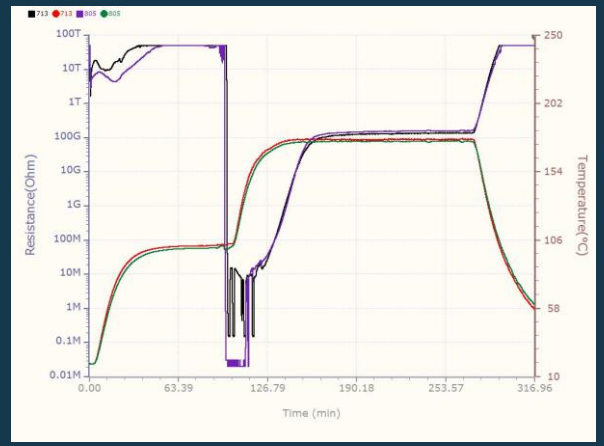
Hyperspectral Camera

ear Camera

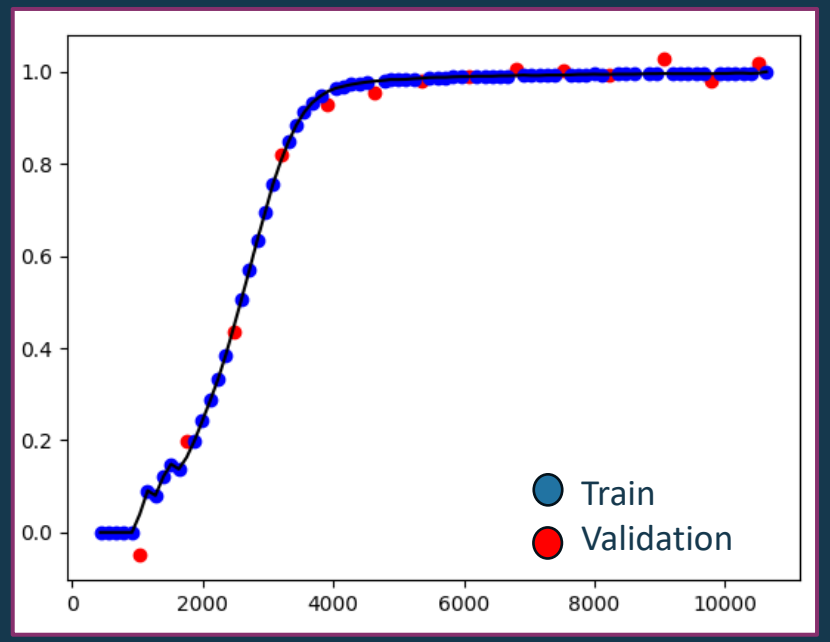
Pre-processed reflectance mean data of each acquisition



Dielectric sensor data as ground thruth for regression model

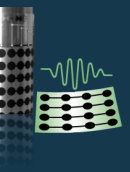


PLS-Regression



- Good fit between dielectric and spectral results

x Sensors

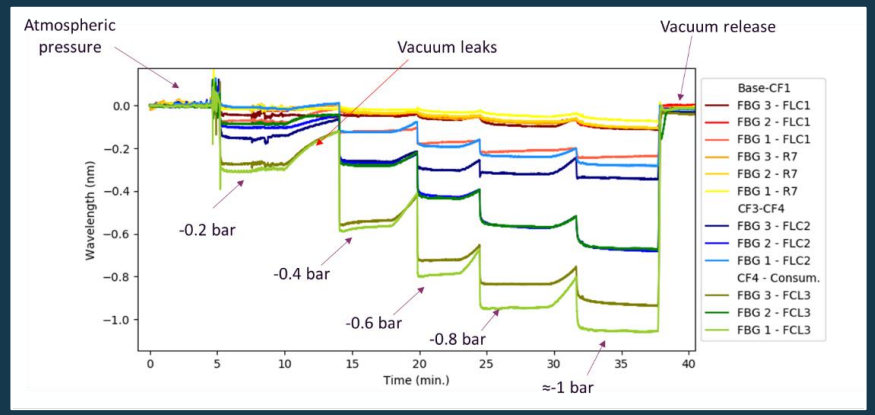


Fibre Optic Sensors

Flash-IM | Process Variables

Fibre inserted into Laminate

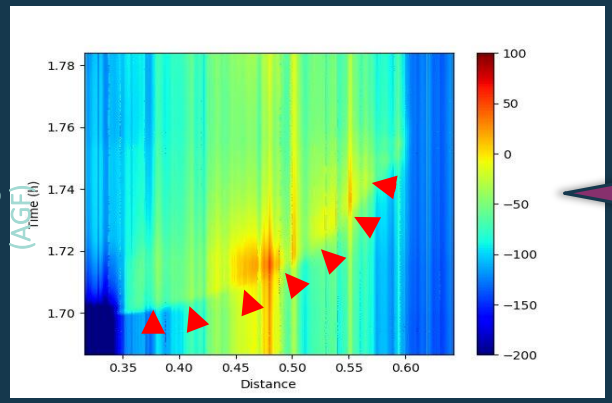
Fiber Bragg Grating (FBG)

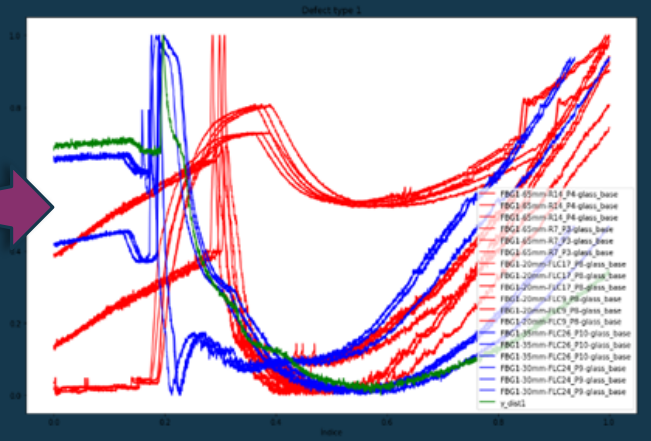


During Preforming

- Pressure
- Leaks
- Temperature

All Grating Fiber (AGF)

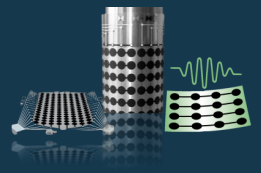




During Infusion

- Flow Front Position
- Temperature
- Pressure

Pyzoflex Sensors



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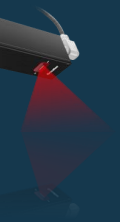
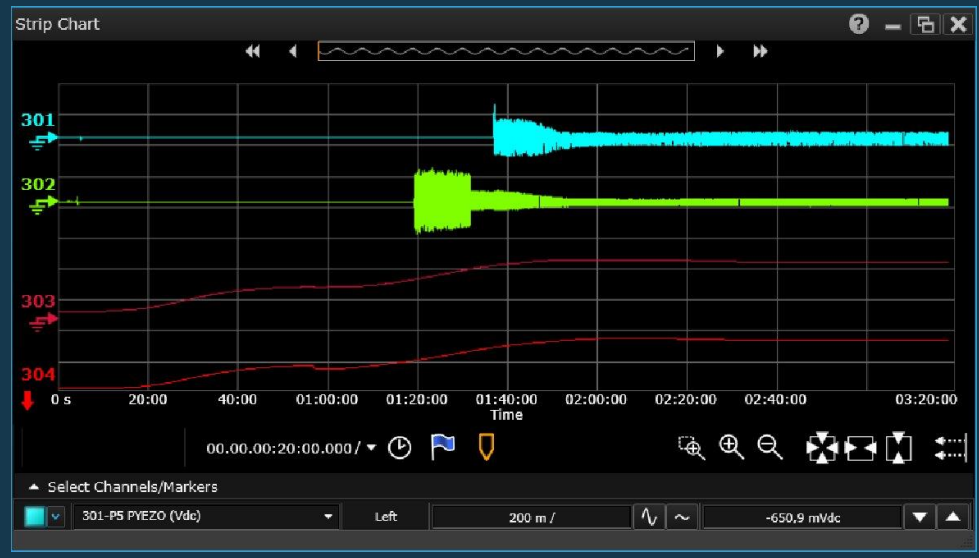
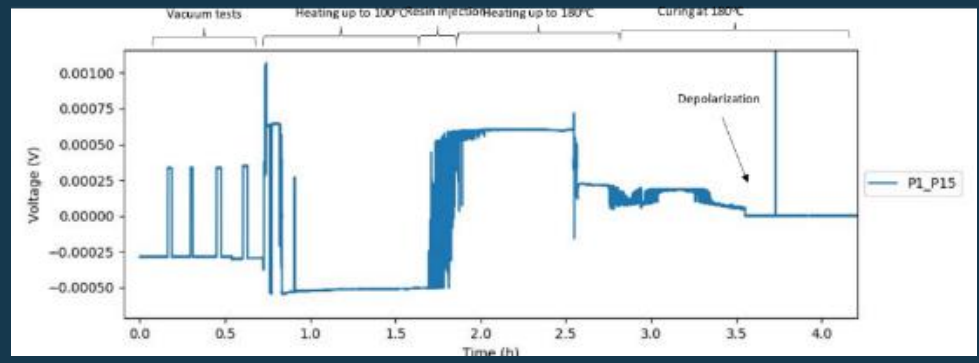


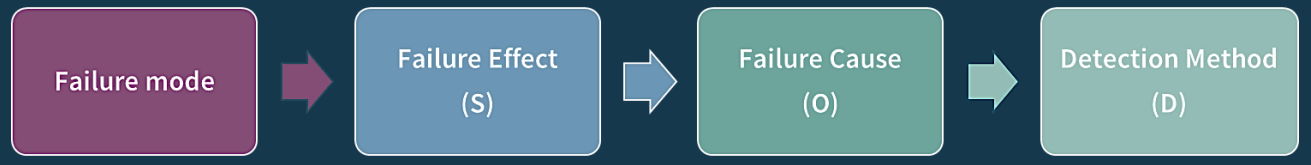
Flash-IM | Process Variables

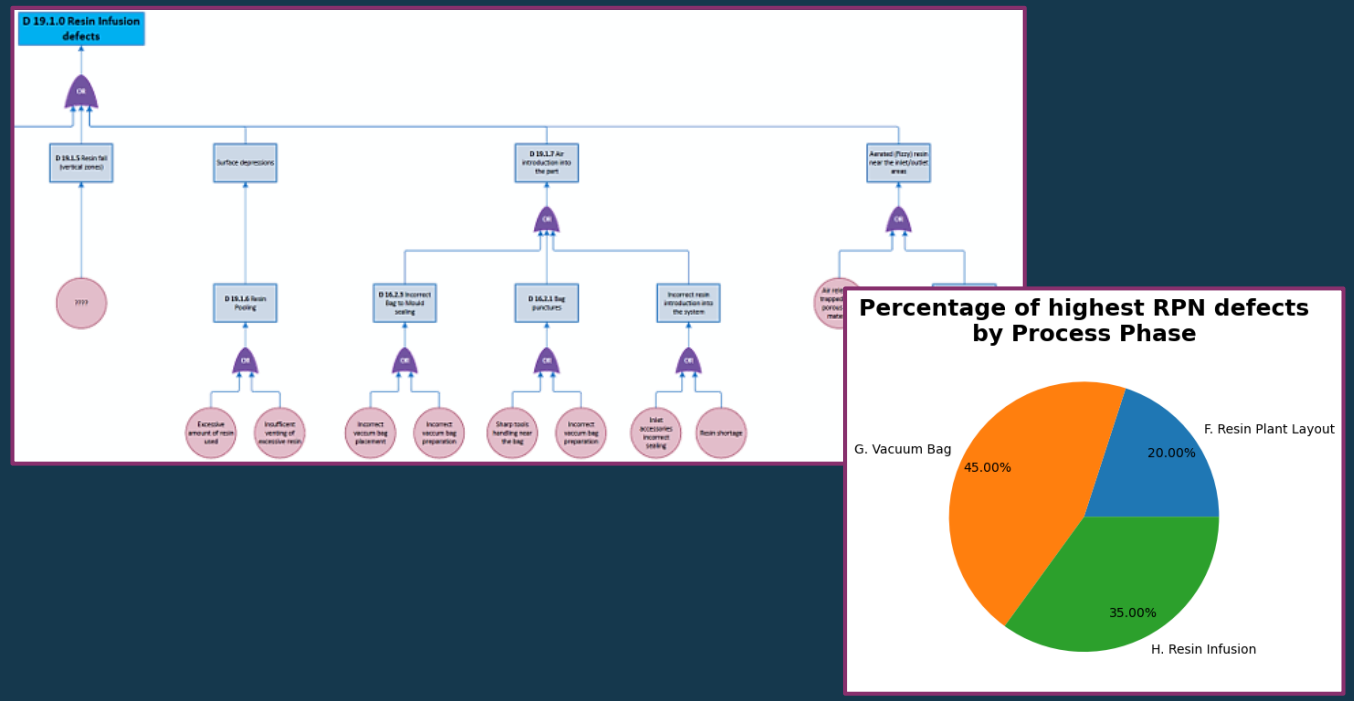
Pressure Monitoring





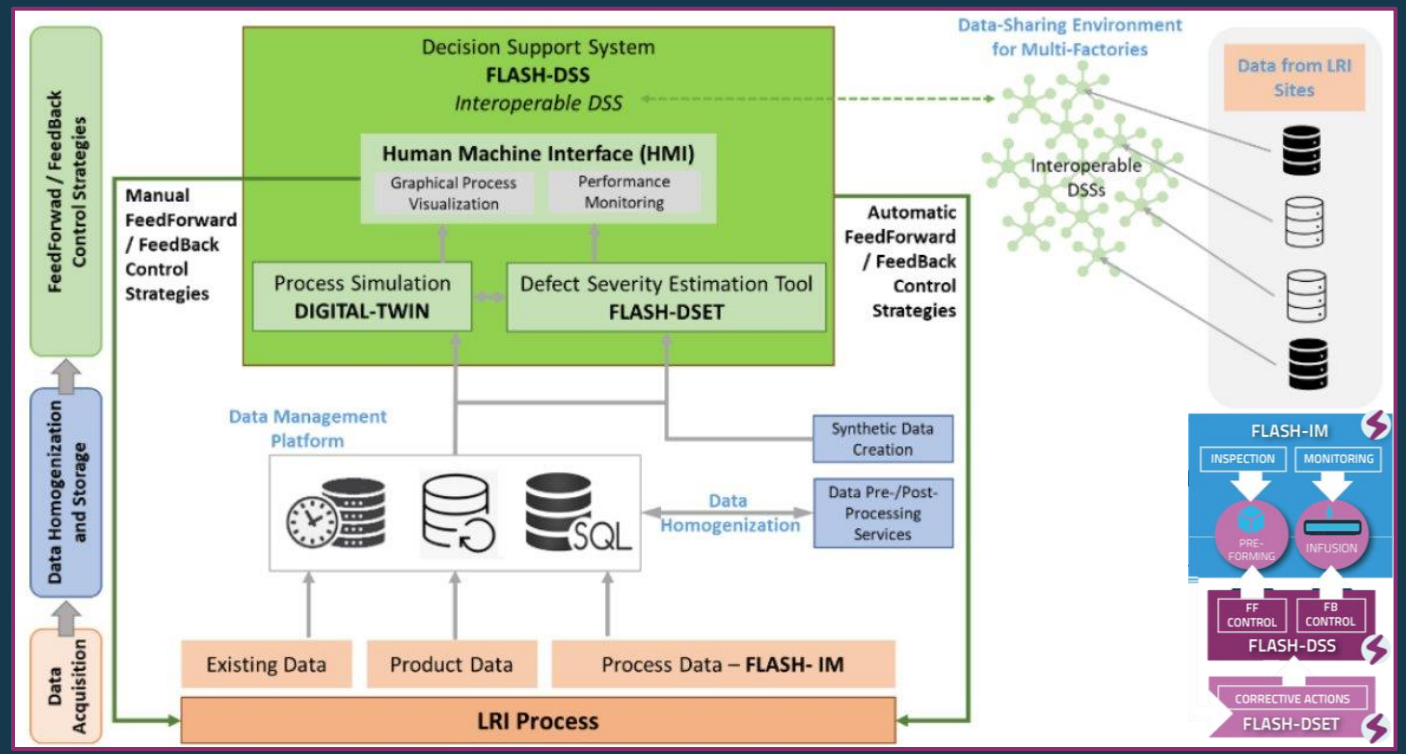
Flash-DSET | FMEA





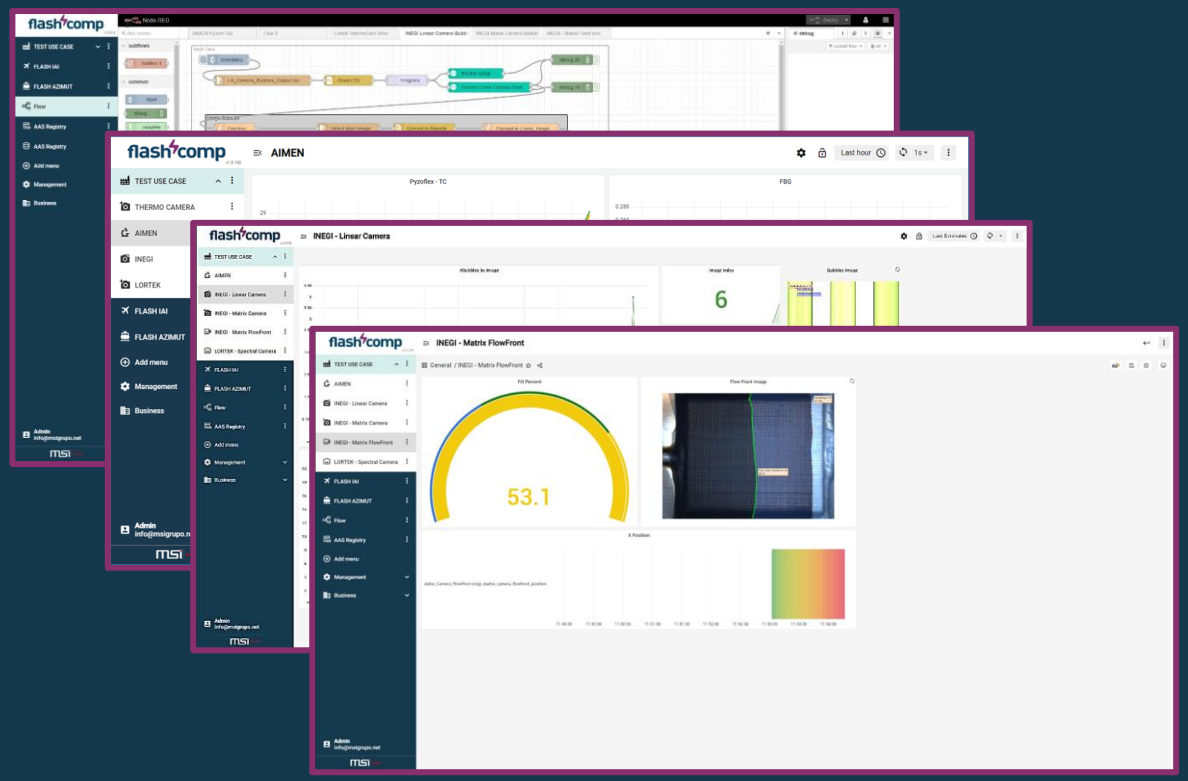
- **FMEA** process steps:
  - Identify **Modes of failure**.
  - Identify **Consequences**
  - Rate the **Severity (S)**
  - Identify the potential **Root Causes**
  - Rate the probability of **Occurrence**
  - Identify **Process controls and Indicators**.
  - Rate **Detectability (D)**
  - Calculate **Risk Priority Number** (RPN) and **Criticality**.
  - Mitigate **High-risk** or **Highly critical failures**

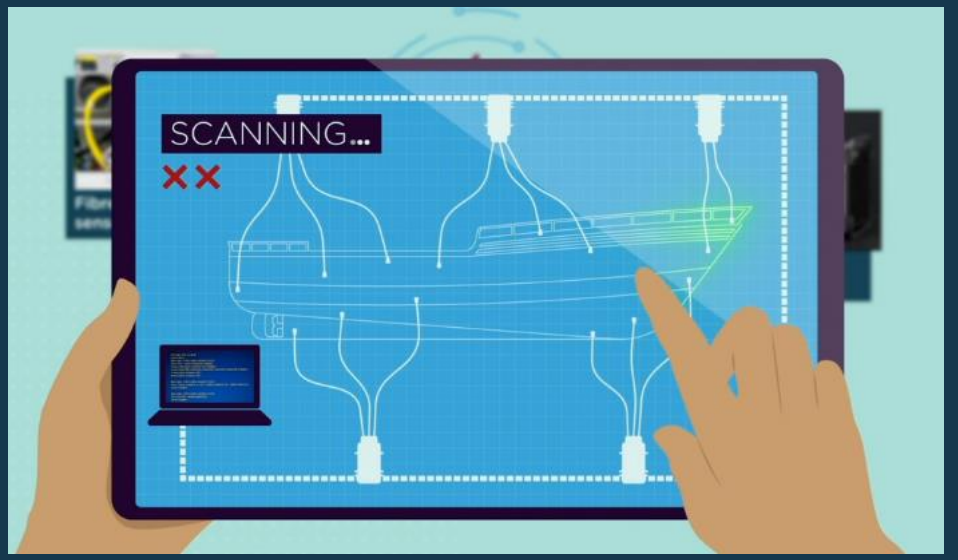
Flash-DSS | Interoperability



- **Ingest and process** FLASH-IM Data
- **Digital Twin** of the process
- **Decision** Support System (DSS)
- User Interface (**HMI**)
- **Defect Severity** Estimation Tool
- **FB/FF Control** strategies
- **Data Governance**
- **Synthetic** data creation

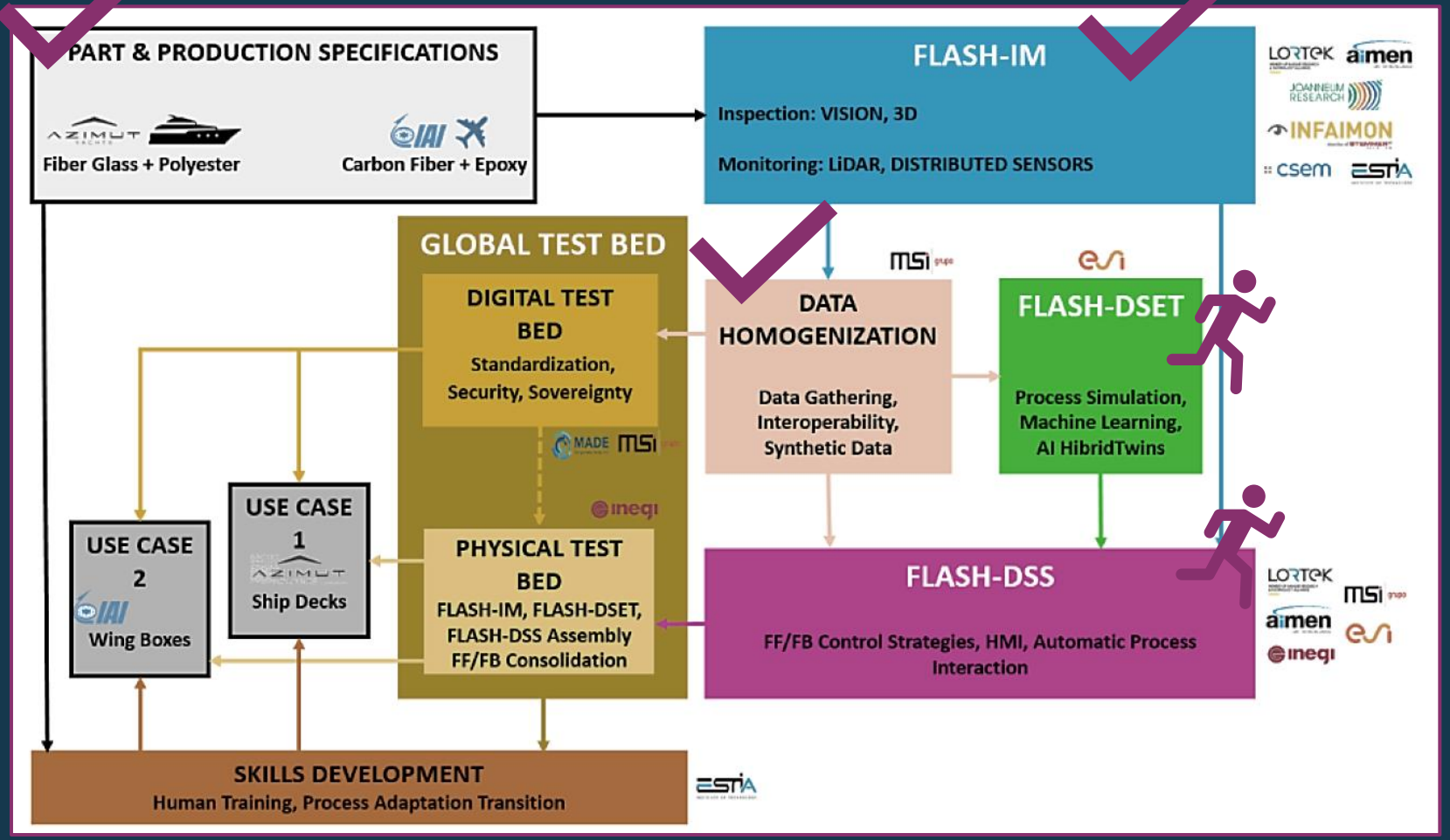
Flash-DSS | Digital Platform





- **Display Realtime** data of the process
- Help the operator to make **decisions**
- **User friendly** Interface

Next Steps


PART & PRODUCTION SPECIFICATIONS
Fiber Glass + Polyester
Carbon Fiber + Epoxy
FLASH-IM
Inspection: VISION, 3D
Monitoring: LiDAR, DISTRIBUTED SENSORS
GLOBAL TEST BED
DIGITAL TEST BED
Standardization, Security, Sovereignty
DATA HOMOGENIZATION
Data Gathering, Interoperability, Synthetic Data
FLASH-DSET
Process Simulation, Machine Learning, AI HibridTwins
USE CASE 2
Wing Boxes
USE CASE 1
Ship Decks
PHYSICAL TEST BED
FLASH-IM, FLASH-DSET, FLASH-DSS Assembly FF/FB Consolidation
FLASH-DSS
FF/FB Control Strategies, HMI, Automatic Process Interaction
SKILLS DEVELOPMENT
Human Training, Process Adaptation Transition

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Any questions?

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