

# domminio

Digital method for improved manufacturing of next-generation multifunctional airframe parts

## ATL-FFF multistage manufacturing

### 1st DOMMINIO Open Workshop

November 30<sup>th</sup> 2021

1ST OPEN WORKSHOP  
**DOMMINIO**  
Digital method for improved Manufacturing of next-generation Multifunctional airframe parts  
THERMOPLASTICS • ADDITIVE MANUFACTURING • DIGITALIZATION

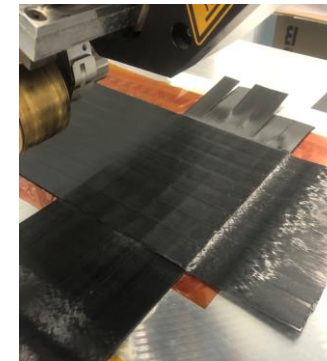


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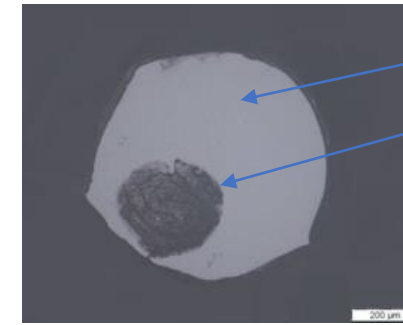


➤ High performance thermoplastics:

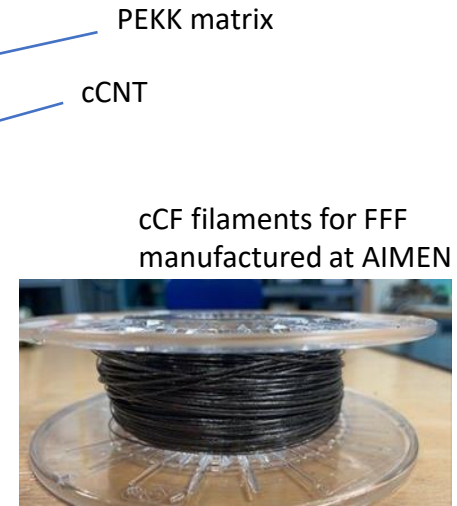
- AFP
  - ❖ UD tapes (LMPAEEK)
- FFF
  - ❖ PEKK Continuous CF reinforced Filaments (**structural**)
  - ❖ PEKK Continuous CNT fibre reinforced Filaments (**SHM**)
  - ❖ PEKK Magnetic NP's reinforced Filaments (**disassembly**)



AFP layup UD tapes



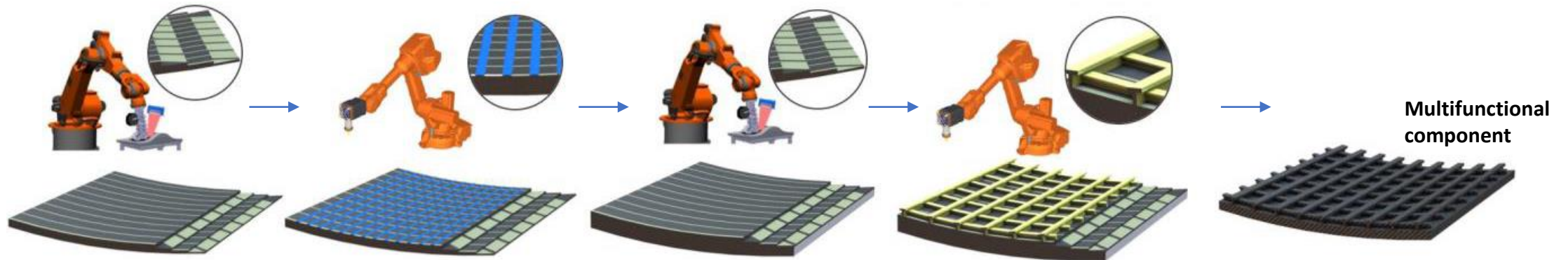
cCNT manufactured for FFF



cCF filaments for FFF manufactured at AIMEN

➤ Flexible multistage robotic-based production processes:

- ❖ Combining AFP and FFF for selective deposition



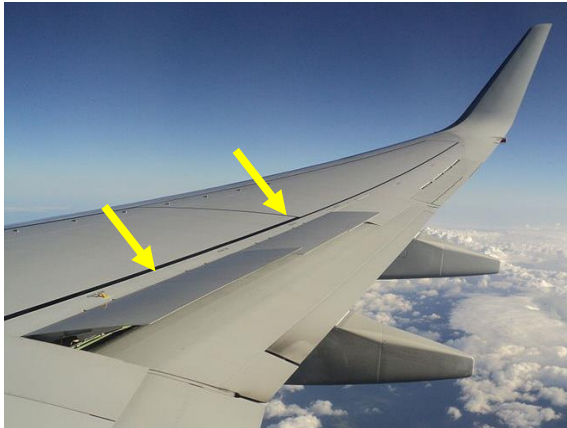
1- AFP. Laying up UD tapes. LM-PAEK matrix

2- FFF. cCNT reinforced filaments for SHM (PEKK)

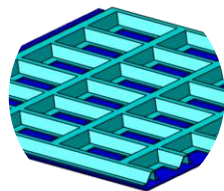
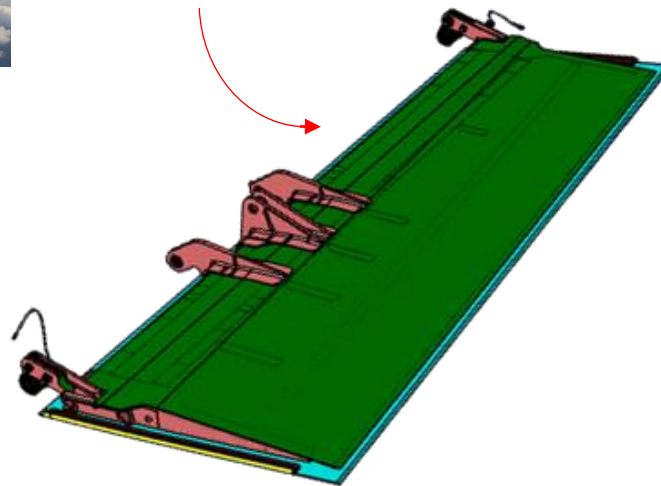
3- AFP. Laying up UD tapes

4- FFF. Layer of Magnetic NP's + Layer of CCF filament  
Easy to disassembly, reduction of the maintenance and reparation costs

## Spoiler – Aciturri DEMO concept

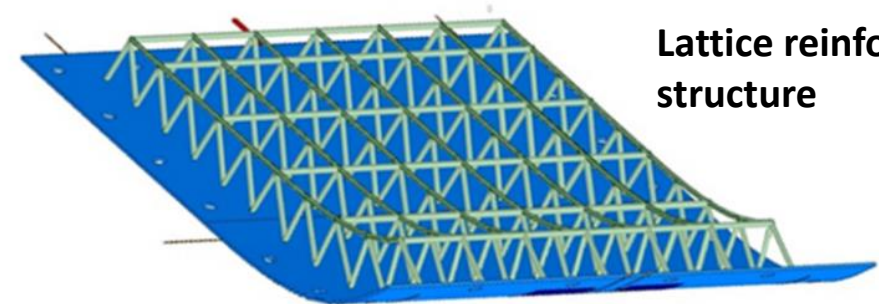


Outer skin panel



Stiffener: omega grid

## Landing gear door – BAE DEMO concept

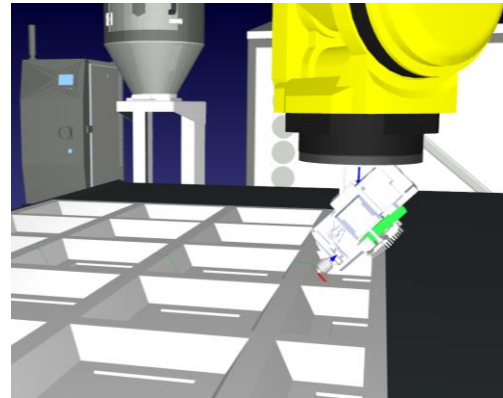
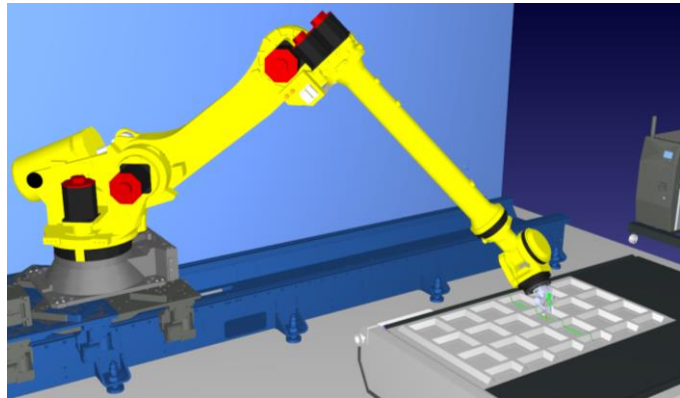


Lattice reinforcement structure

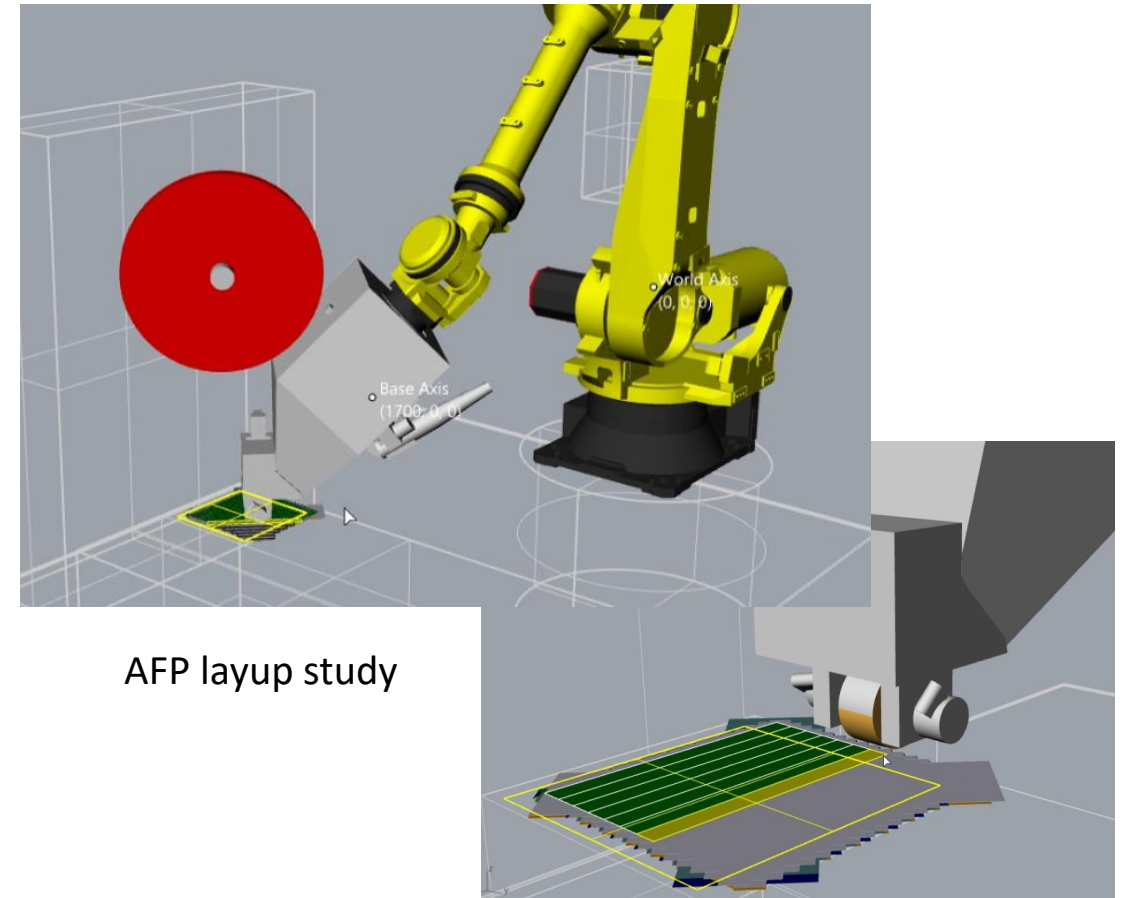
Skin panel

## Manufacturability studies:

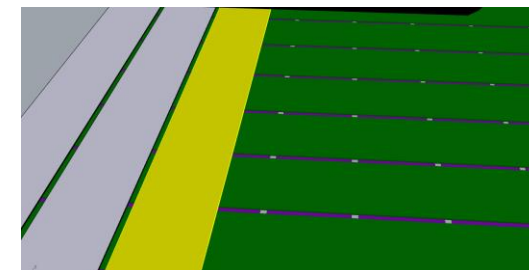
- Head accessibility
- Curvatures
- FFF deposition head orientation
- AFP compaction roller deformation
- Minimization of defects (gaps, overlaps...)
- ...



Accessibility assessment for 3D printed reinforcements (FFF with continuous fiber)

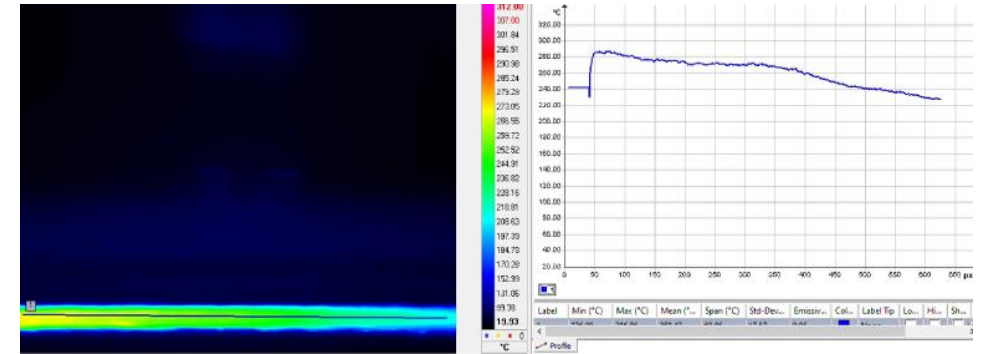
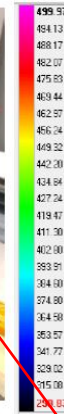
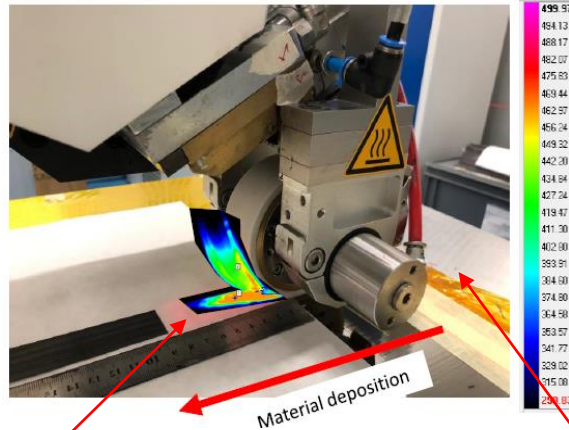
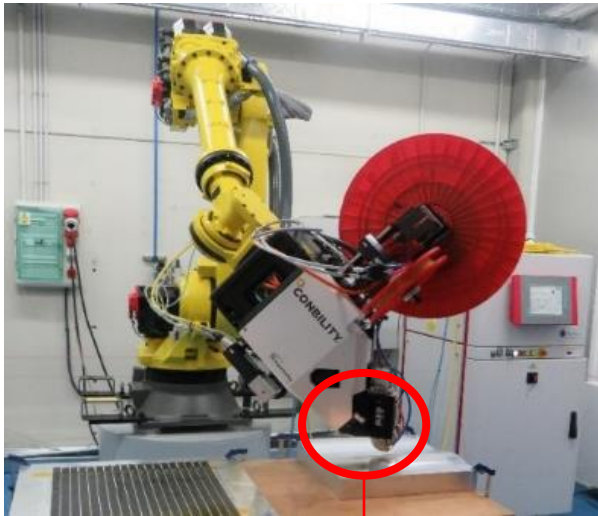


AFP layup study



AFP gaps/overlaps detail

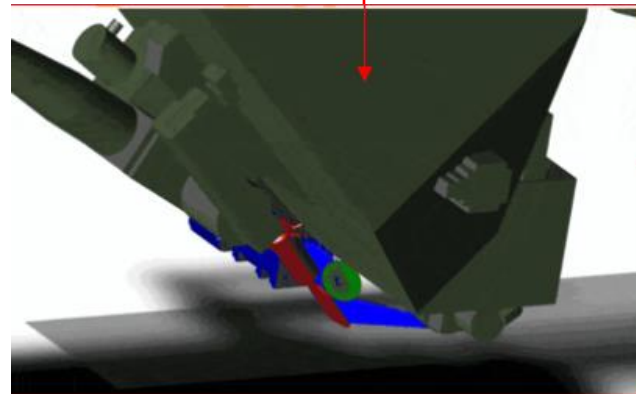
AFP (automated fibre placement): Monolithic structures, great structural performance



IR thermocamera: cooling monitoring

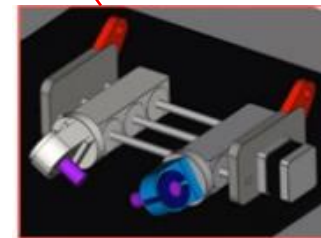
Heated lay-up mould will be used to control cooling and achieving In-Situ Consolidation.

Correlation between cooling rates, crystallinity and mechanical properties.



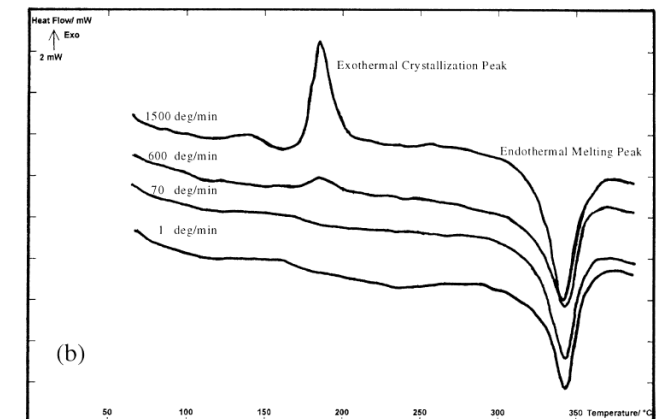
Controlled temperature at nip point

Laser heating system  
Scanning laser beam (blue)  
controlled by steering mirror (red)



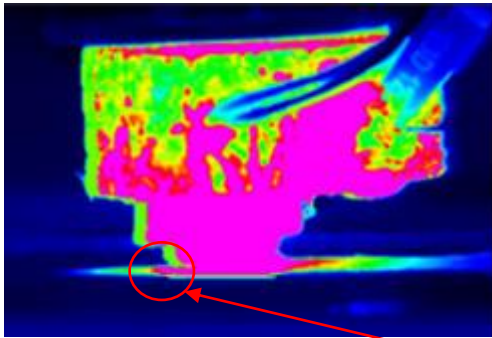
In-line non-contact ultrasound NDT based on Lamb waves

Image: DSC in CF-PEEK composite at different cooling rates

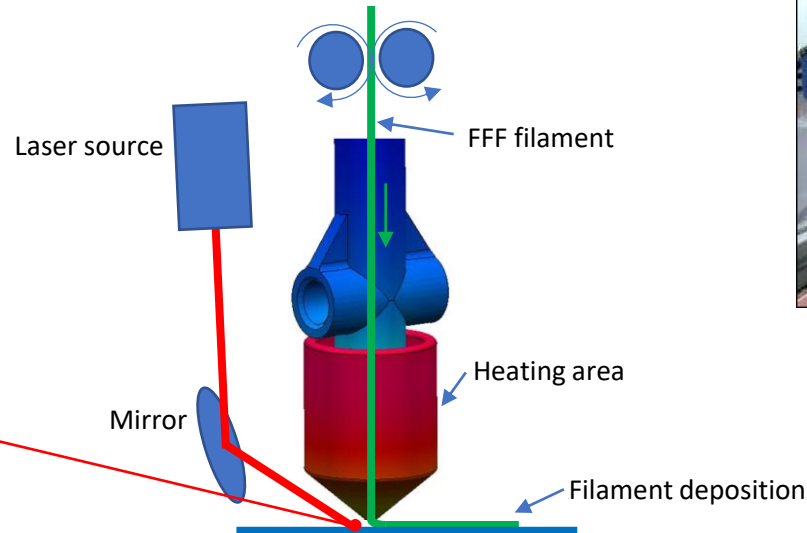


## FFF (fused filament fabrication): Selective deposition, lightweight structures

IR themocamera images of AIMEN trials



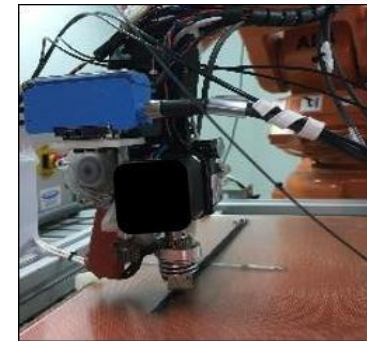
Laser heated spot to melt substrate



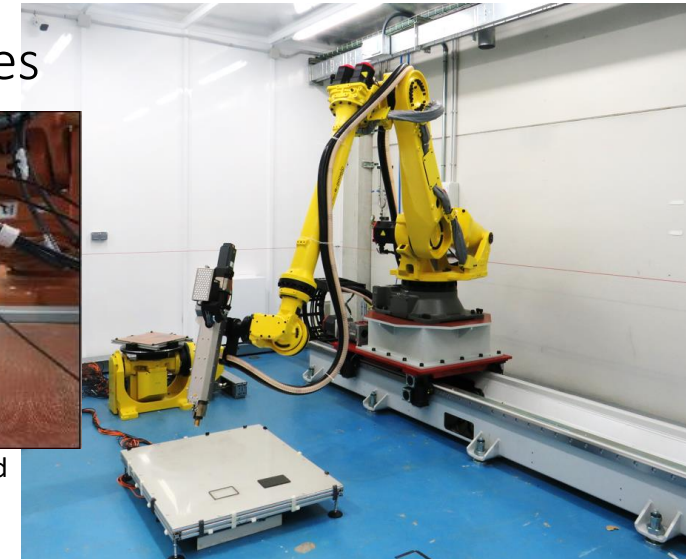
AIMEN Laser system and IPC nozzle concept: improved thermal and pressure management



FFF CCF manufacturing

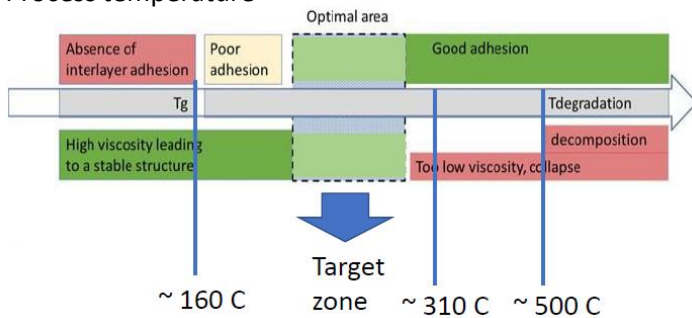


AIMEN FFF Head

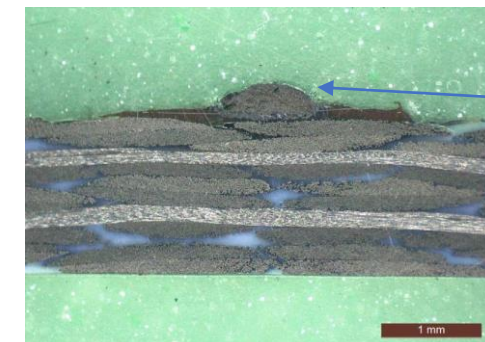


FFF manufacturing cell

Process temperature



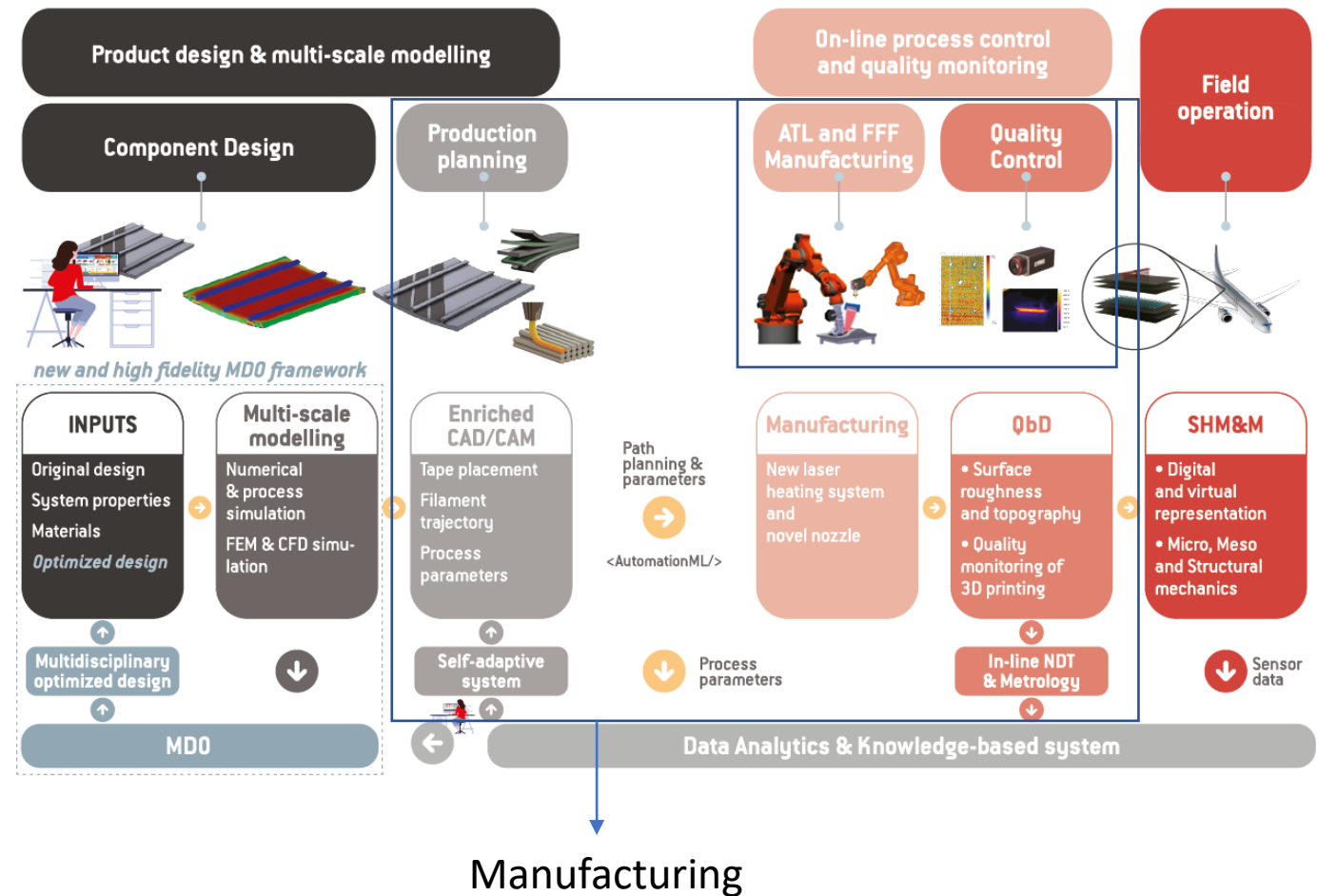
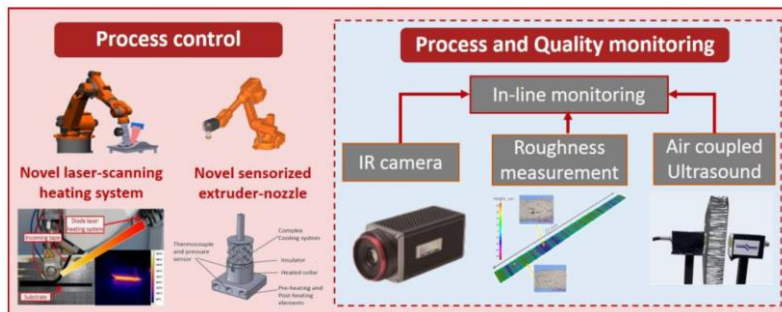
FFF PEKK printed filament on LM-PAEK laminate



Single reinforcement filament  
Laminate

## DIGITAL THREAD

- Data-driven pipeline supporting the design, simulation and production planning
  - ❖ AFP and FFF numerical simulation
  - ❖ Data interoperability and knowledge based system



# Thank you for your attention

## Questions?

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