Automation in production integrated NDT using thermography

NDT in Aerospace - Augsburg 2012

Thomas Schmidt, Somen Dutta

DLR

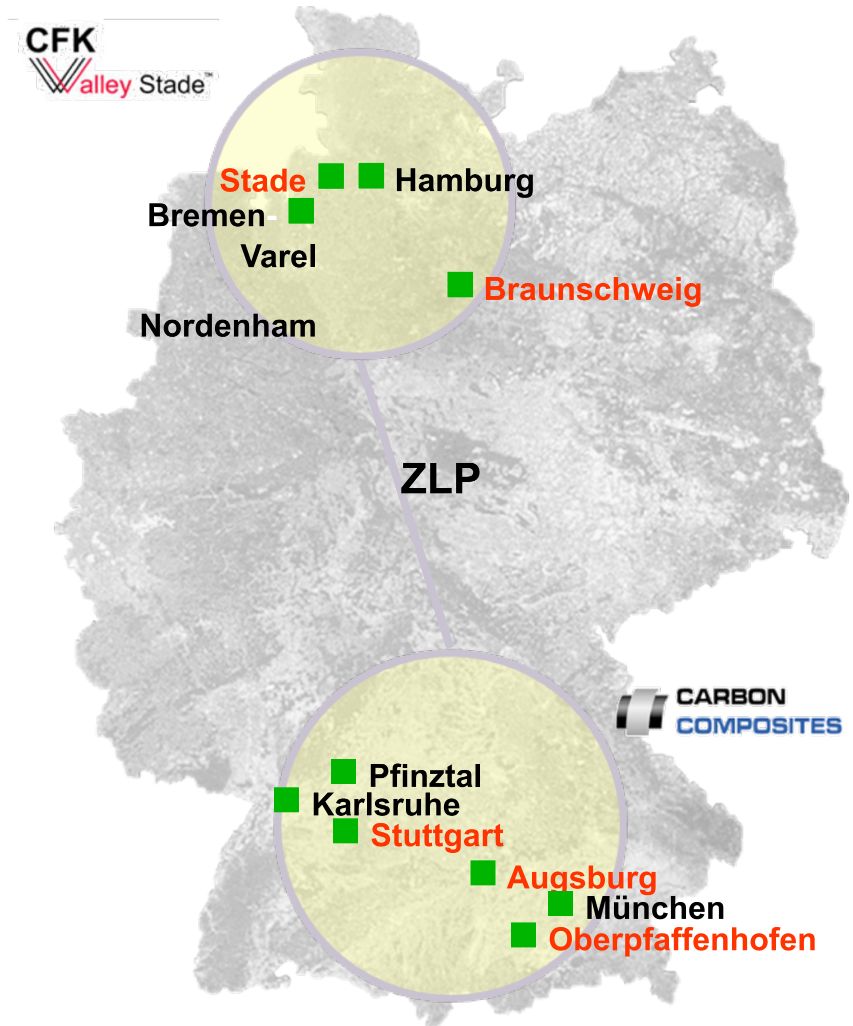
Content

- Introduction
- State of the Art in Aerospace
- Challenges for NDT
- Approach – production integrated, automated Thermography as a choice
- Realisation
- Conclusion

DLR Center for Lightweight Production Technology

ZLP Site Stade

ZLP Site Augsburg



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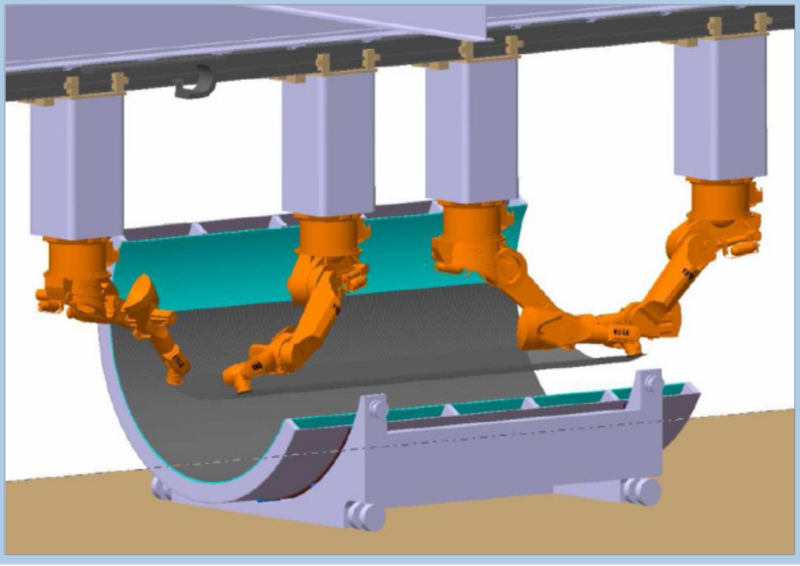
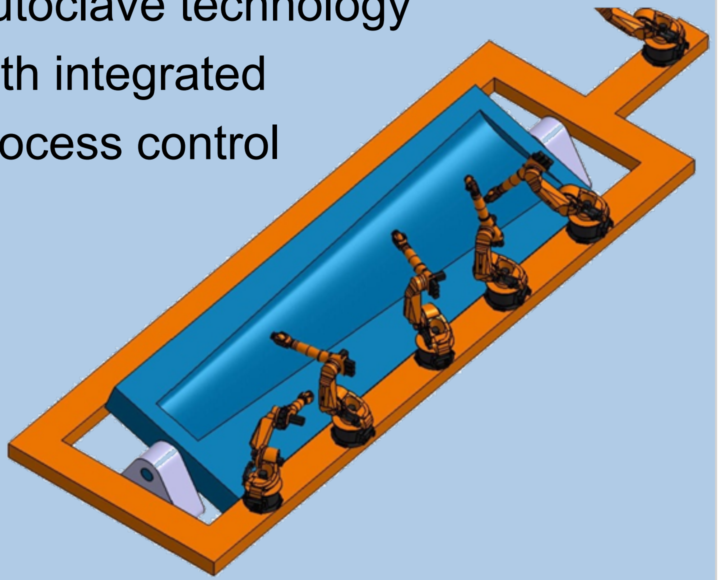
Objectives: Maximum floor-to-floor efficiency by high placement rate and robust placement devices at a **highest quality level**
Placement rate: > 100 kg/h

Augsburg
- Robot based textile placement
- VARI, VAP & Thermoplastics
- Production-Integrated QA



Stade
- Parallel automated fiber placement devices
- Autoclave technology with integrated process control



Source: KUKA, DLR

Composite Production Technology @ ZLP Augsburg

Enablers for integrated process development

-Materials & Processes

-Handling devices

-Placement devices

-Tooling concepts

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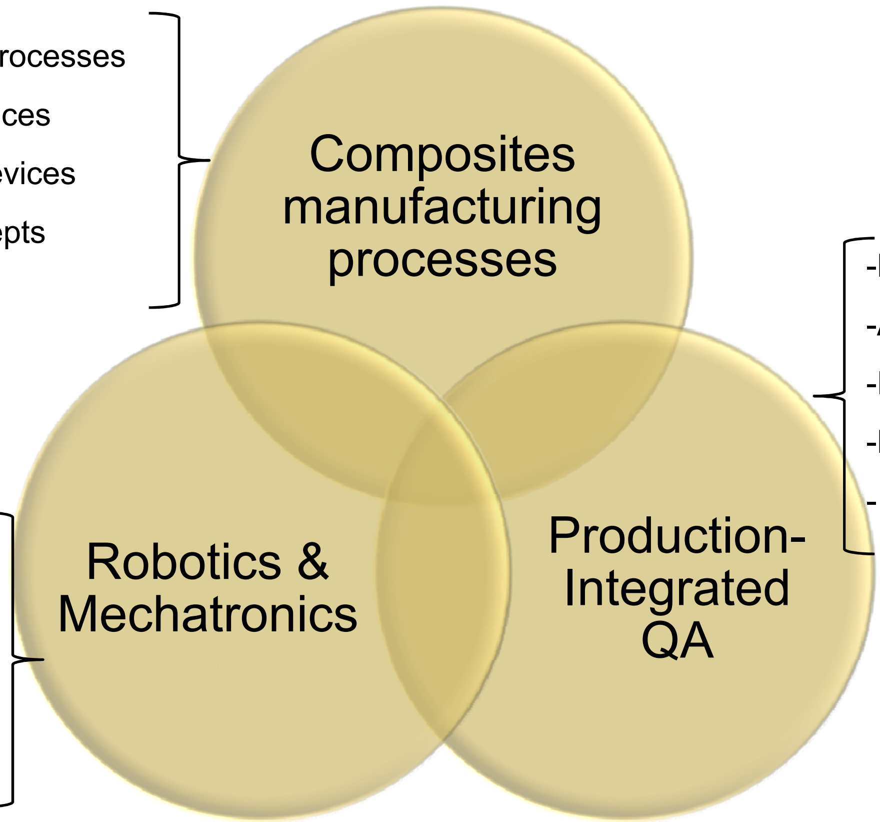

-Development of QA strategies

-Assessment of NDT methods

-Integration of NDT and corrections

-Data management for closed loop

-…

-Robot-robot collaboration

-Robot-human cooperation

-Offline programming strategy

-Device integration

-…

All enablers are inseparably linked to get an optimised composite production

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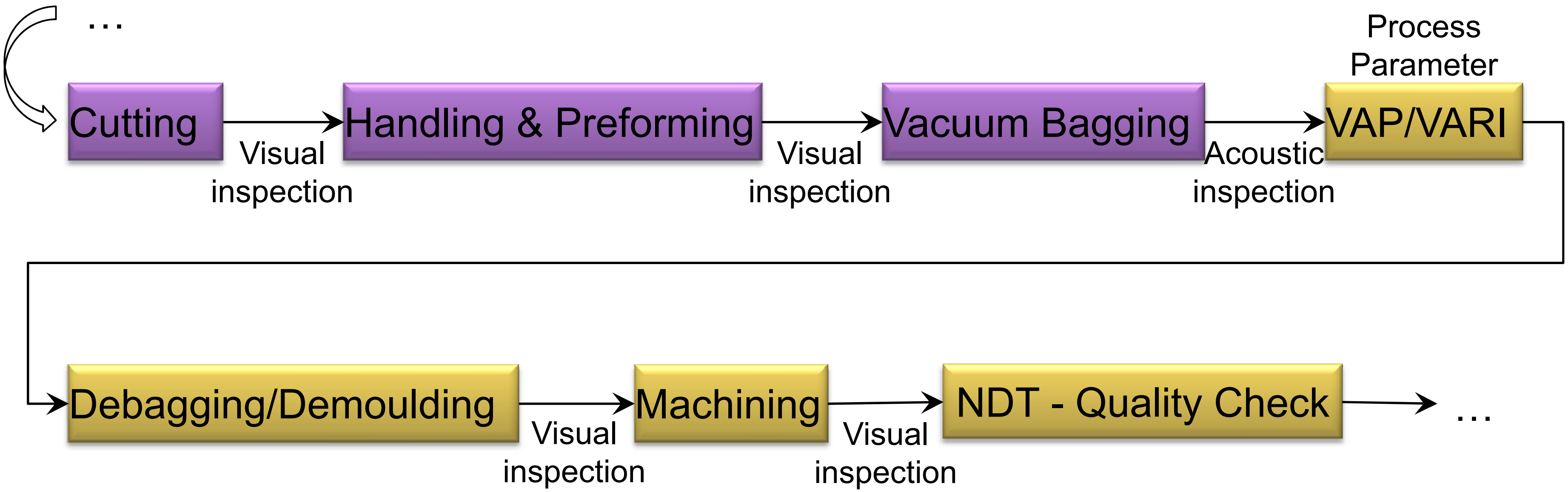
State of the art in aerospace

Present production and quality strategy (large components)



Present process chain dominated by manual work incl. human senses with one physical quality check (NDT) at the end

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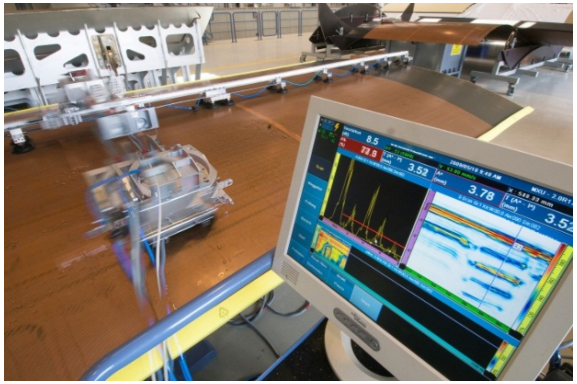
State of the art NDT in aerospace

- Water coupled ultrasonic inspection
  - Submersion technology
  - Squirter technology
  - Sampled Phased Array
  - Transmission and Impuls/Echo
- Gantry solutions with linear and rotational axis



Sources: National Composites Network, Premium Aerotec, IntelligeNDT, HPI

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Challenges for NDT

Improving production and quality strategy

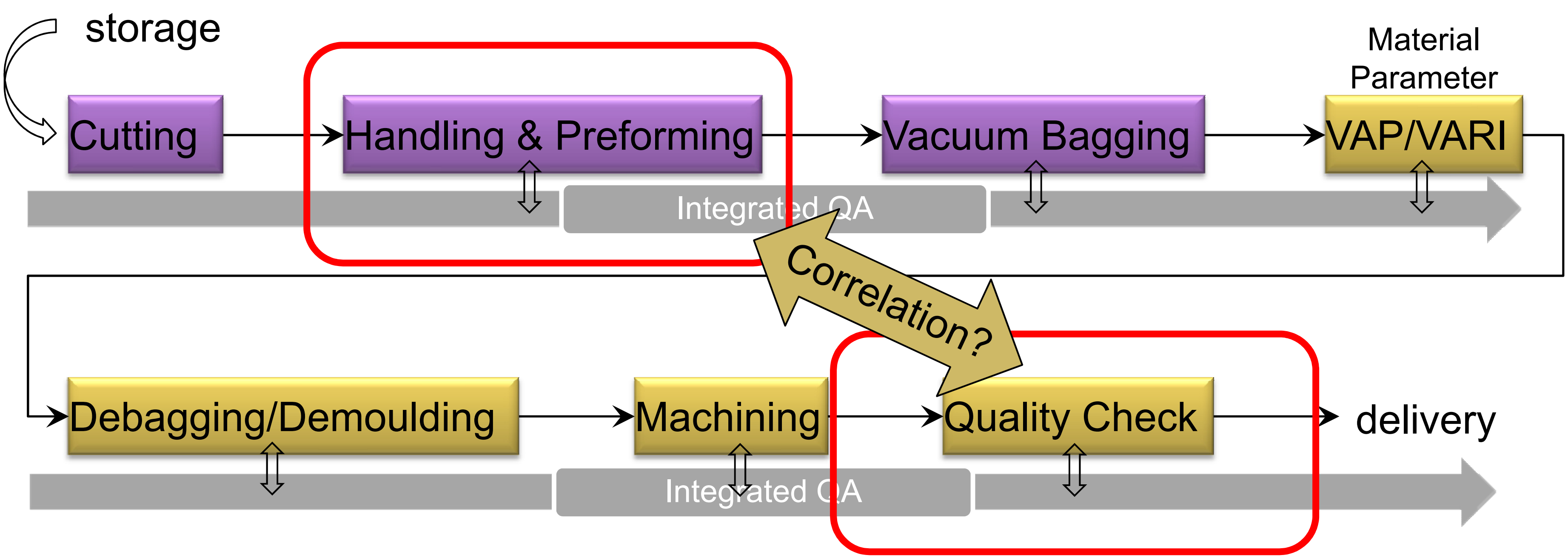
- Quality
  - Improved rework rate
  - Detailed documentation (engineering loop & continuous improvement)
  - Control proper quality indicators
- Cost efficiency
  - Improved output rate (parts/h)
  - Improved rework rate
  - Final quality check on samples → to be certified
  - Higher degree of automation → optimum to be adapted to SOA
  - Enable continuous improvement

→ Integrated production and quality assurance rather than local improvements

Automated production with integrated QA is needed to meet market expectations

Challenges for NDT

Future production and quality strategy



Future process chain needs optimised degree of automation with integrated physical quality checks along the process

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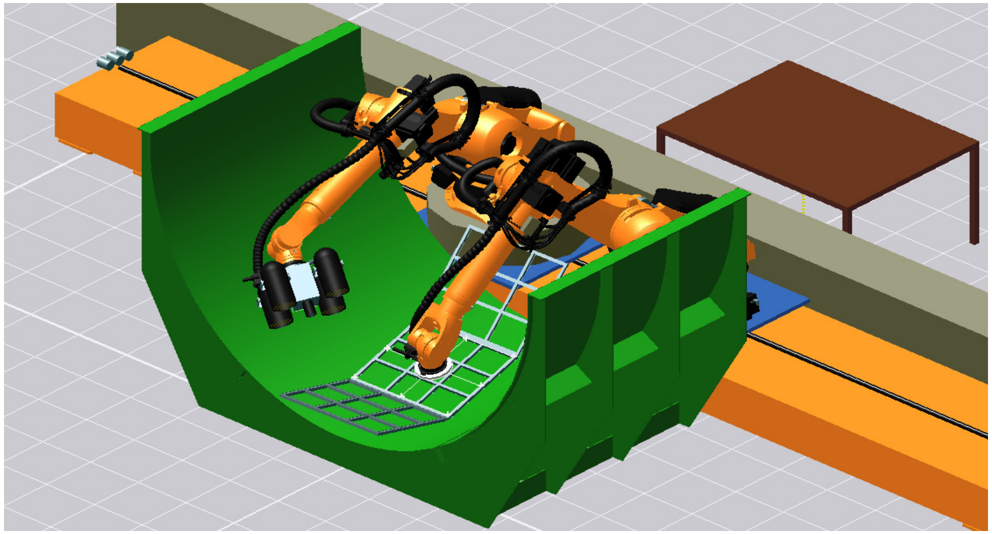
Approach – production integrated, automated Thermography as a choice

Objectives: Reduction of QA cost (today 20% of component RC)
Reduction of QA lead time
Reduction of rework after final NDT check
Integration into manufacturing process
Achievement of robust processes

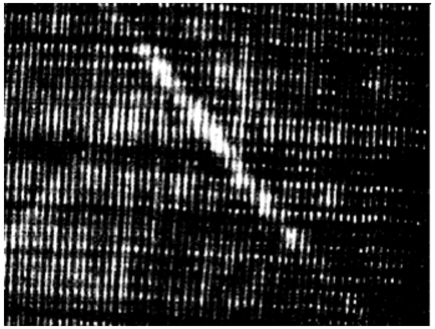


- Point-to-point analysis along production chain
- Thermography as a contactless method
- Able to measure textile preforms as well as cured composite parts
- Failure analysis and interpretation
- Defect localization even on large structures

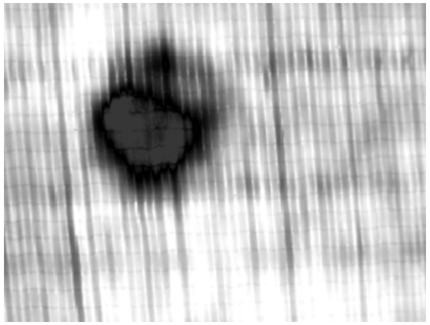
Integrated QA is a key factor for cost efficient, high quality composite production

Production integrated, automated Thermography

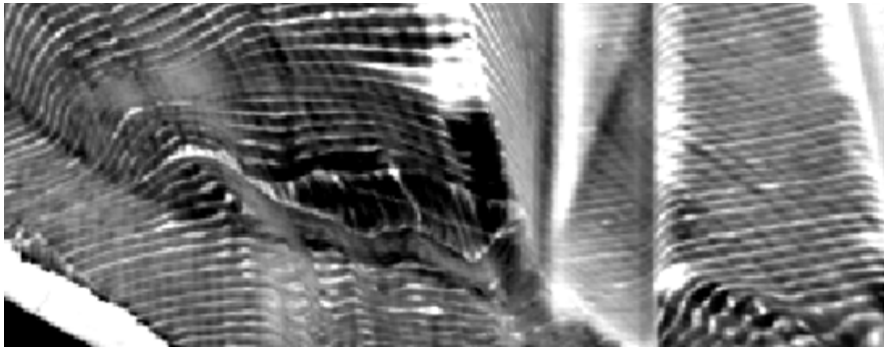
Optically excited Lockin-Thermography



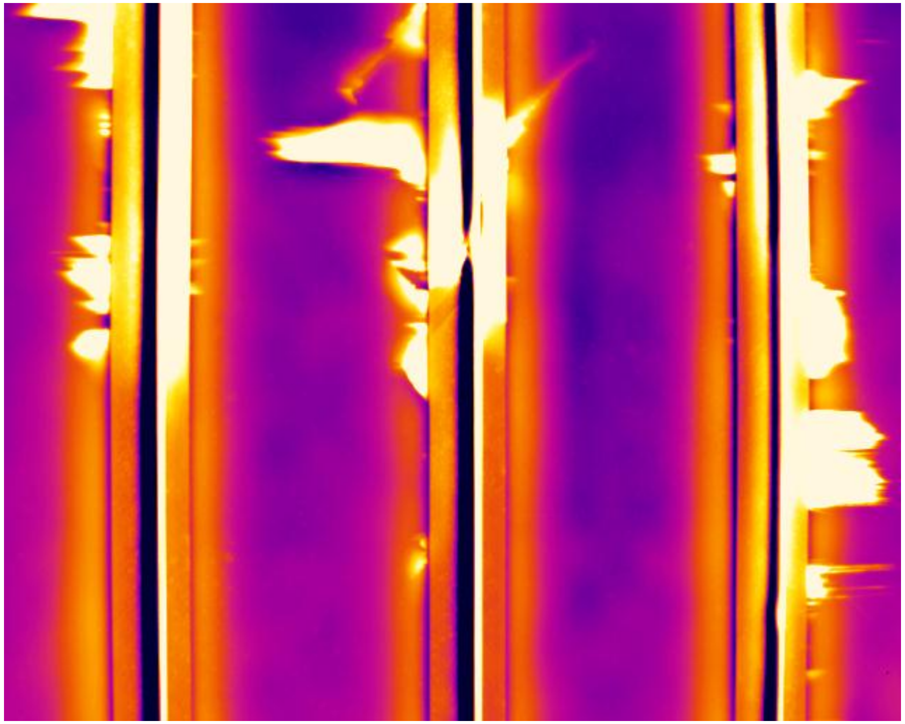
(a) Missing Roving



(b) Fuzzball



Source: edevis (c) Roving orientation on curved parts



Source: DLR

Ply location & orientation

Rovings' orientation

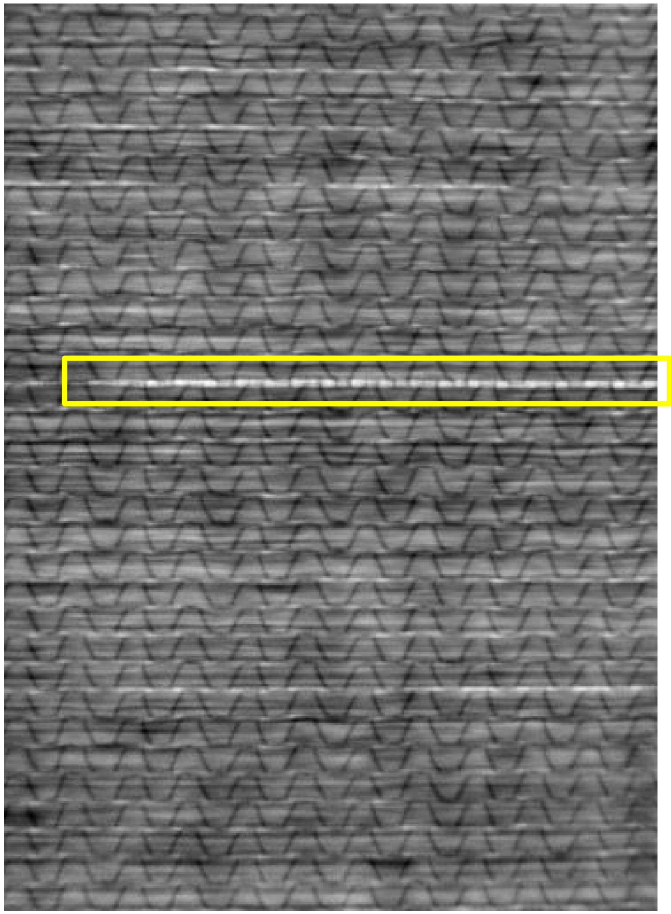
2D- Defects

3D- Defects with limitations

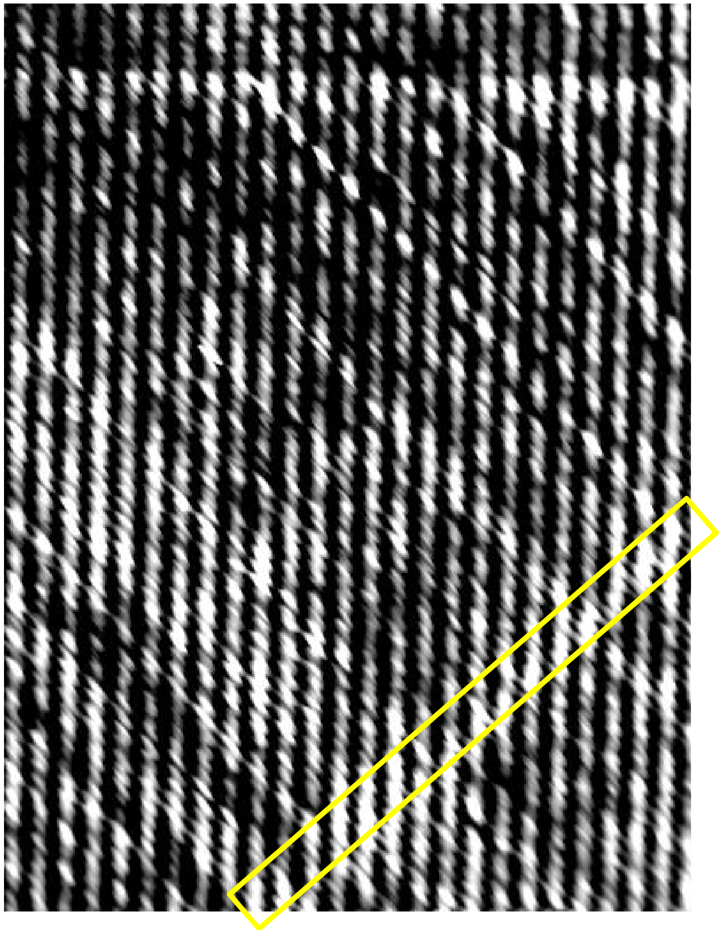
NDT methods need just the right abilities to deliver the specified quality

Potential defects

At preform stage

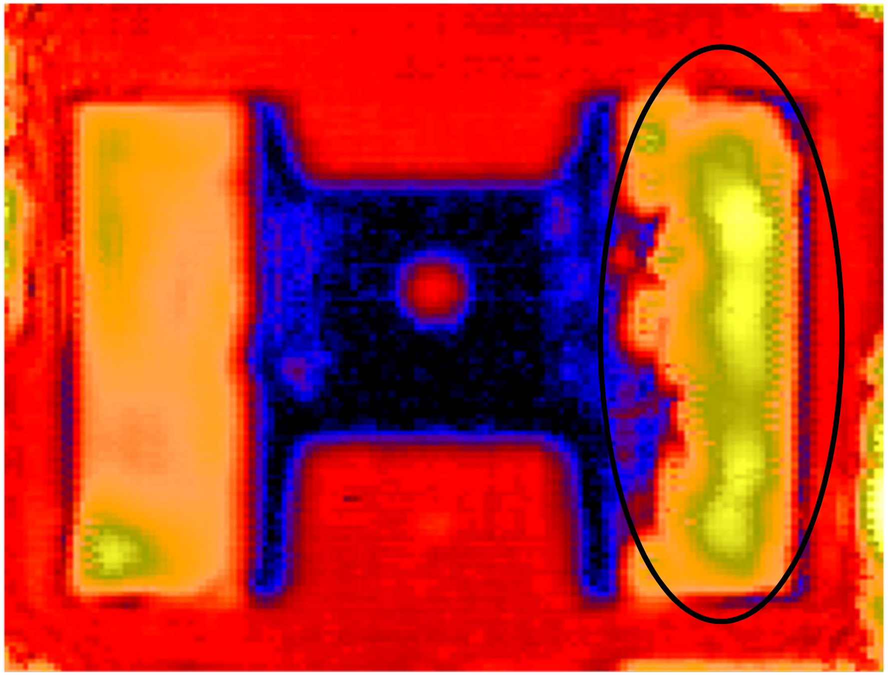


Roving gaps

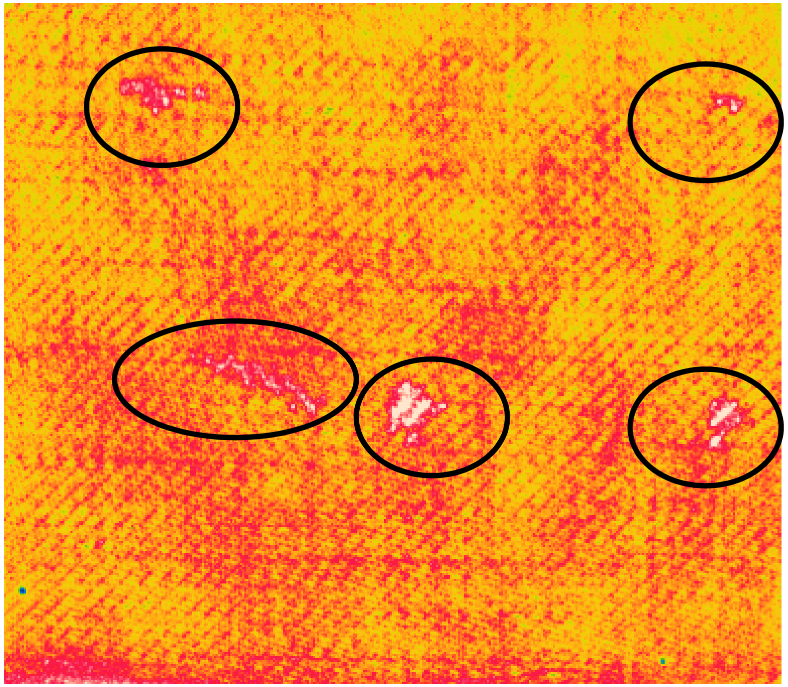


Roving accumulation

Potential defects
Cured parts



Delaminations



Porosity

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Realisation

Integration into Manufacturing Cell (MFZ)

Source: DLR/KUKA

Flexible infrastructure for a wide range of lightweight structure production technologies

Realisation

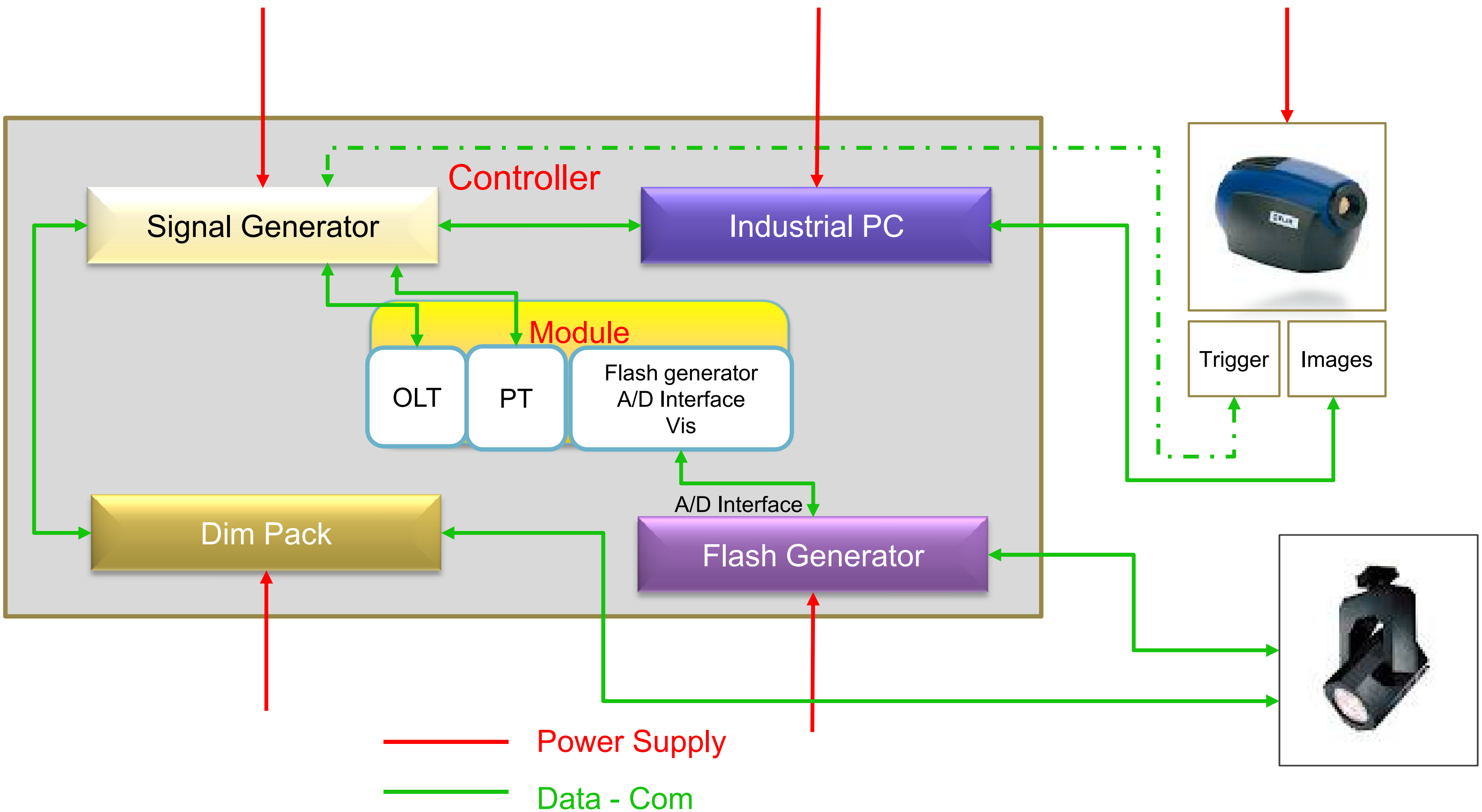
Integration into Manufacturing Cell (MFZ)

Flexible infrastructure for a wide range of lightweight structure production technologies

-DLR/KUKA

Realization

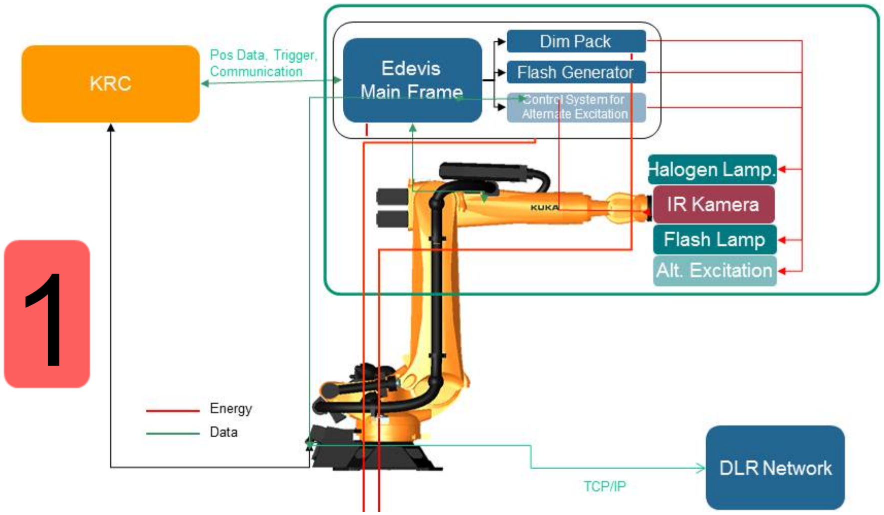
Principal design of a thermography system



Realization

Evaluation on multiple Scenarios

1



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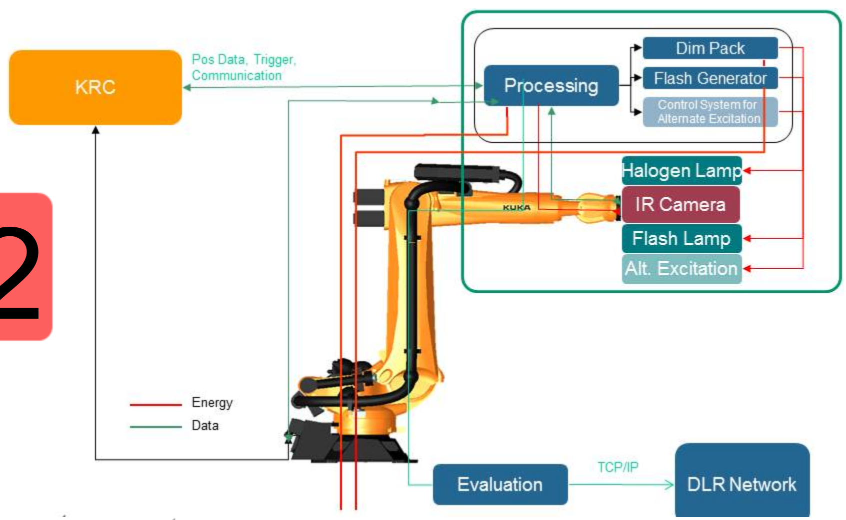


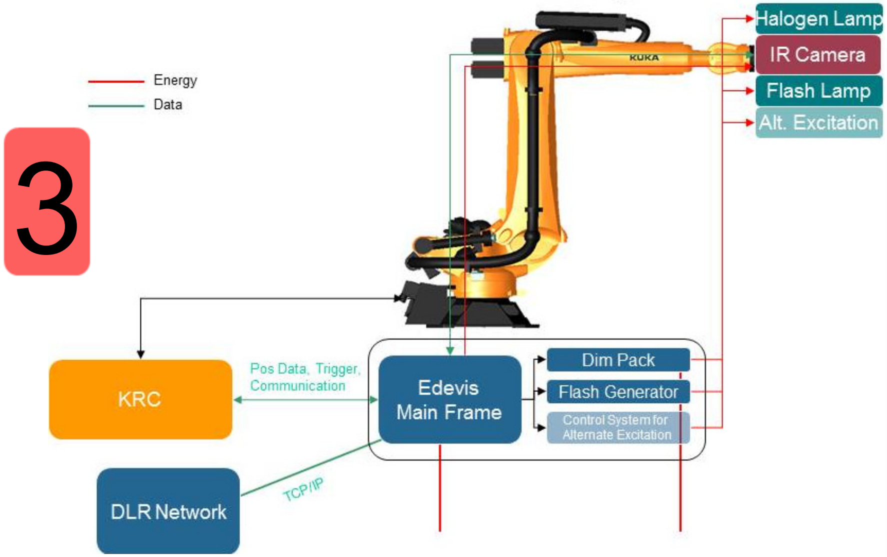
Advantage

- Easy to integrate in robotic cell
- Measurement & data analysis in real time

Drawback

- To locate the center of gravity of endeffctor→robot inaccuracy
- Required more than 50m long cable for data transmission
- No more flexible enough to measure complex parts
- Required special heavy weight robot

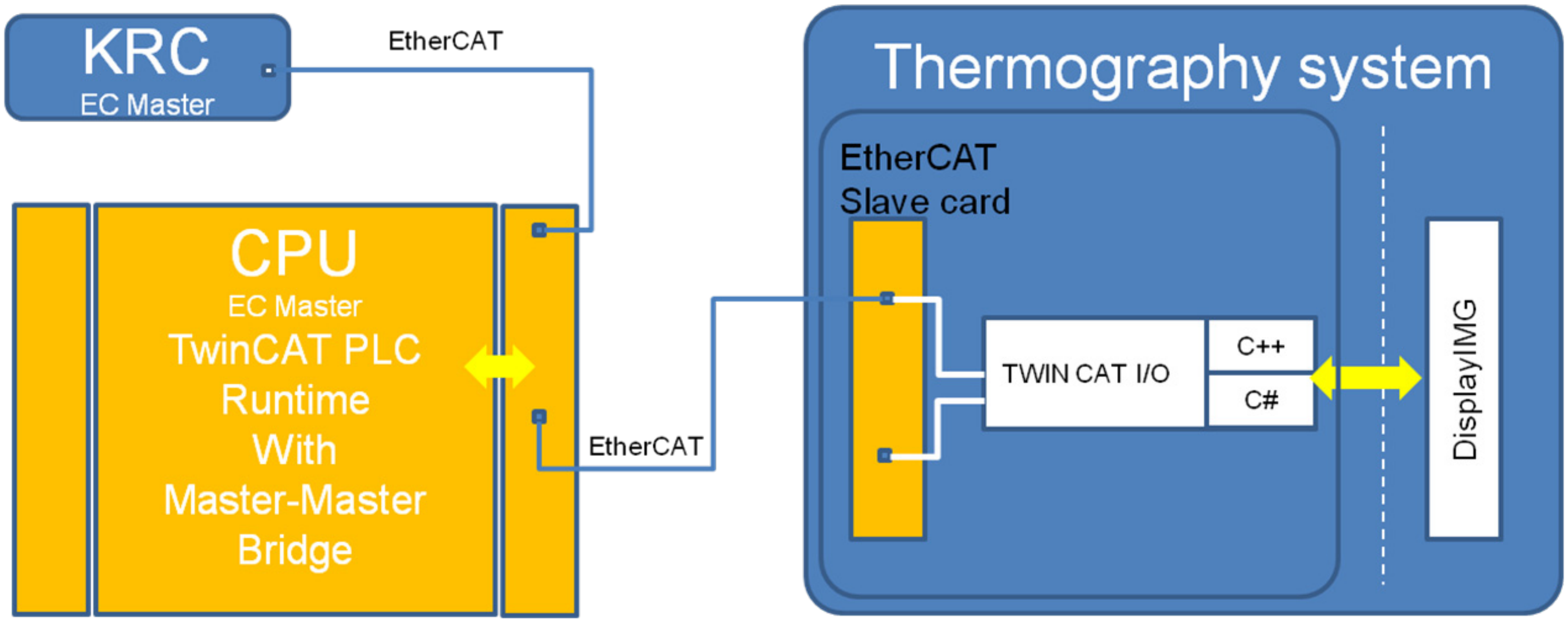
Realization
Evaluation on multiple Scenarios



Advantage
- Measurement & data analysis in real time
- Accessibility through lean end effector
- Less change to existing configuration
- High system accuracy due to low weight and moment of inertia

Drawback
- Requires more than 50m long cable for data transmission
- Complex solution to integrate into large robotic working cell (MFZ)

Realization
System Integration



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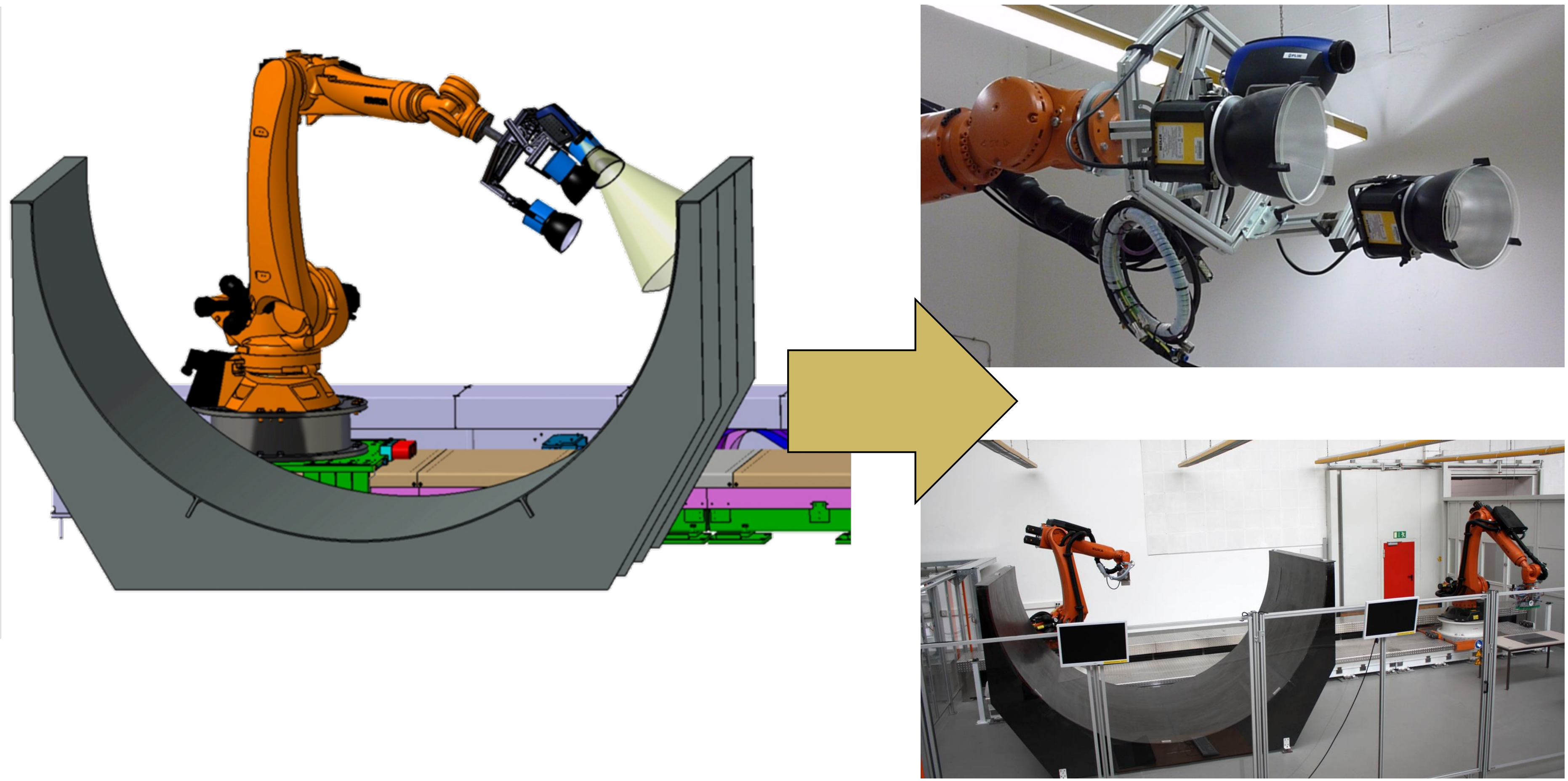
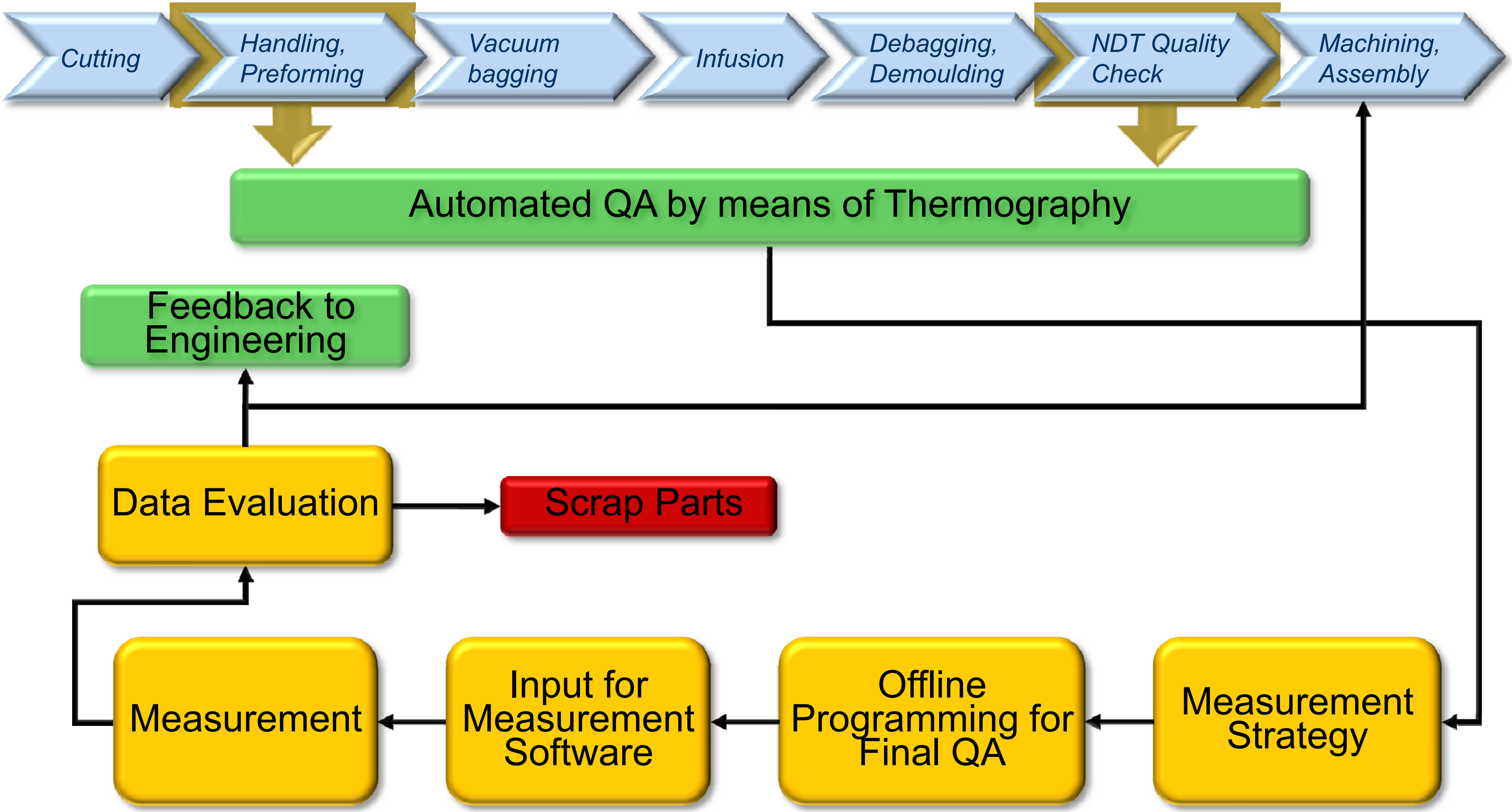
Experimental tools: Concept of measurement scenario

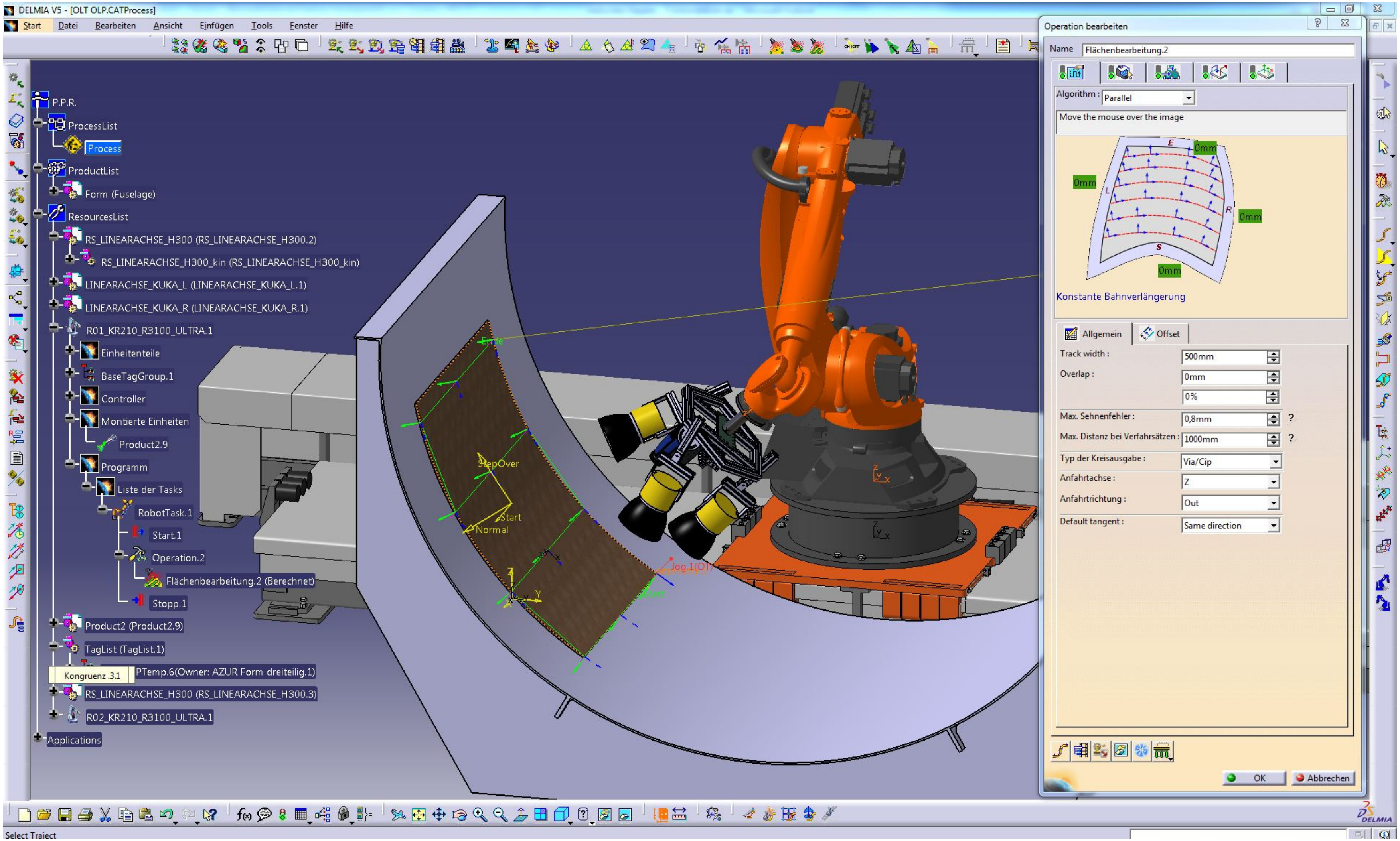


Automation along the process chain

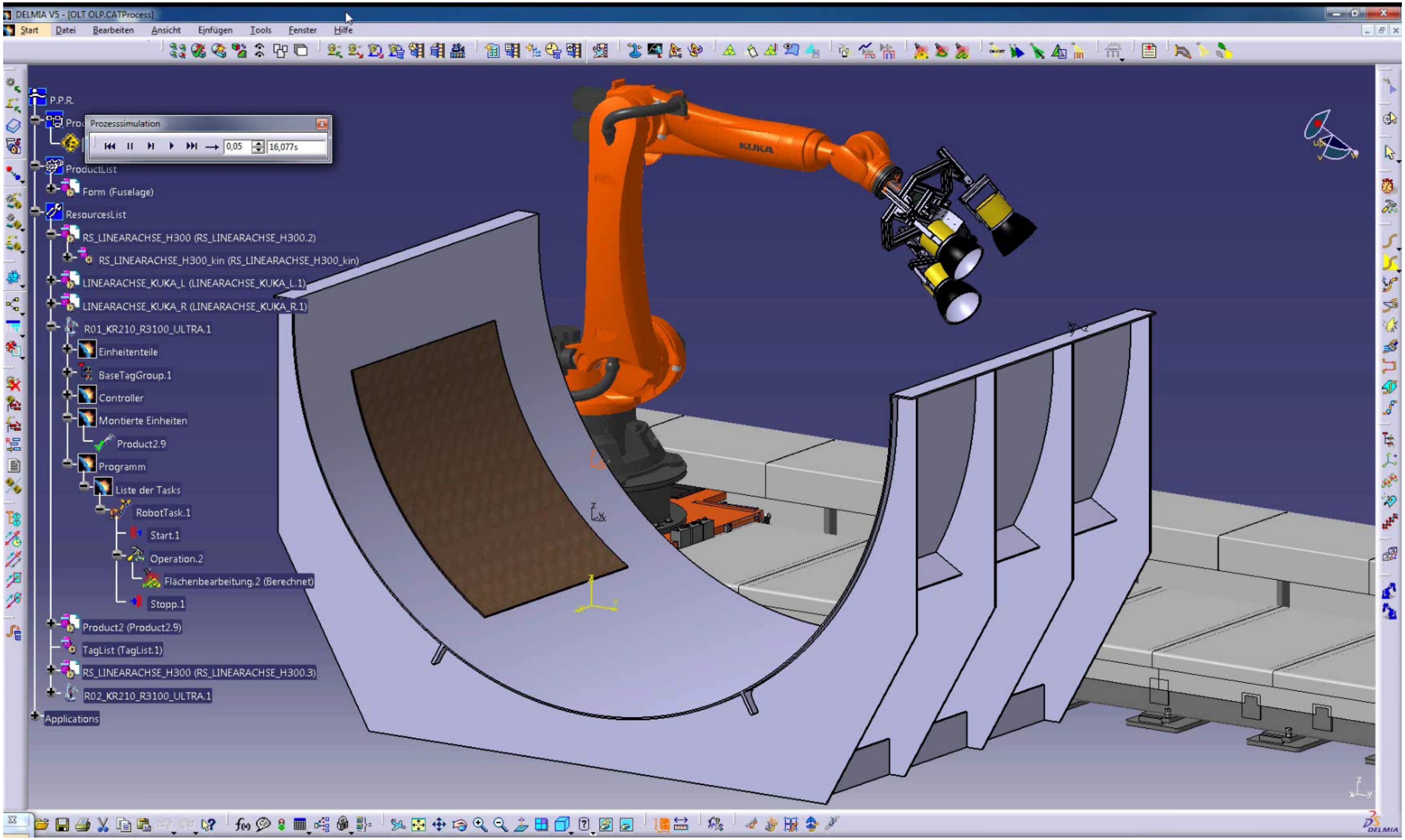
Process preparation for quality check



Offline Programming



Offline Programming



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Conclusion

- Enormous challenges ahead for lightweight structure production
  - Need for cost efficient composite production for aircraft Industry
    → automation of production and quality assurance
  - Steep and robust ramp-up essential for future aircraft programs
    → mitigation of industrial risks
  - Increasing rate of aircrafts and parts to be expected
- Local improvements in quality assurance are not sufficient to fulfill needs
  - Next step of innovation: Integration and overall optimization of processes
  - New production, quality (and engineering) strategies to be developed
  - Emphasize research on relevant process sensitivities
- Facing the challenges
  - Know-How & Infrastructure being built to cover required technology readiness level
  - Production processes and integrated QA are permanently under development

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Stadt Augsburg

AUGSBURG INNOVATIONS PARK

Bundesministerium für Wirtschaft und Technologie

…and to our partners in industry, research and science as well as the team of ZLP Augsburg

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