



ADDITIVE MANUFACTURING TAKING-OFF

EASA WORKSHOP - 2019

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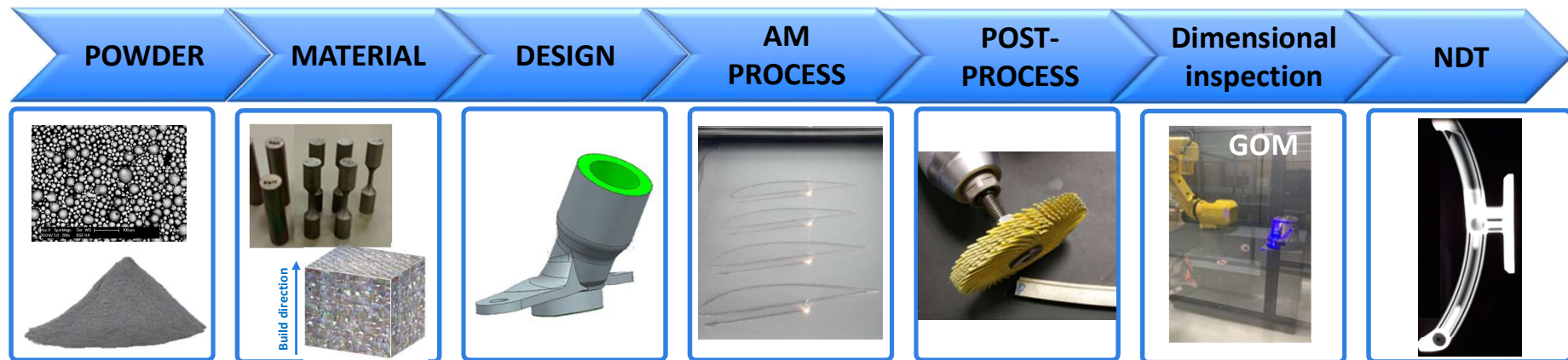


A Rolls-Royce
company

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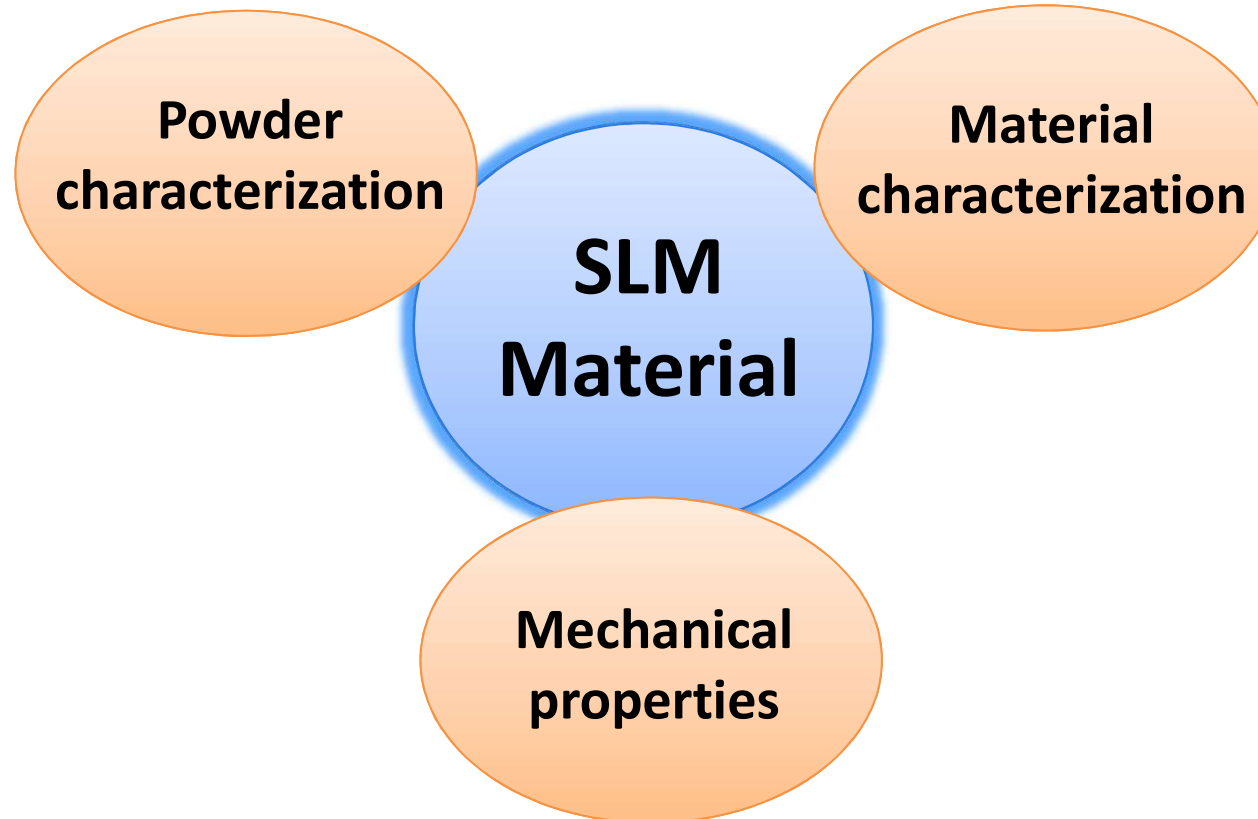
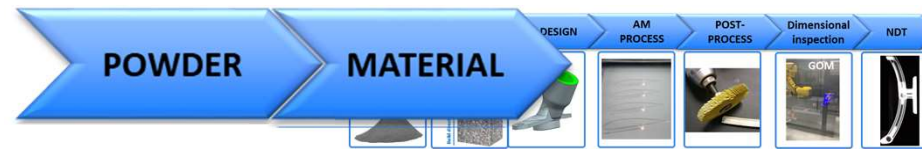
- ❖ ITP Aero AM Technology Development
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- ❖ Additive Manufacturing Process
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ITP Aero AM Technology development



Integrated processing

All areas affect the final result
ITP Aero own technology and standards already developed

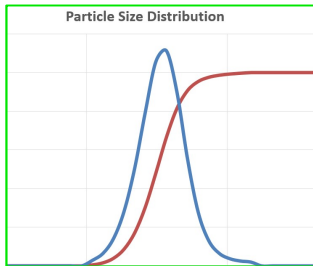


Powder



➤ Detailed characterization:

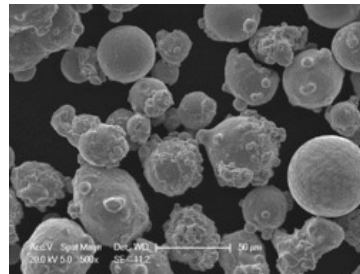
PSD



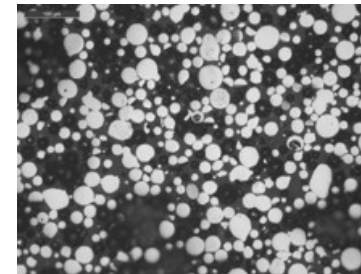
Flowability



Morphology



Porosity



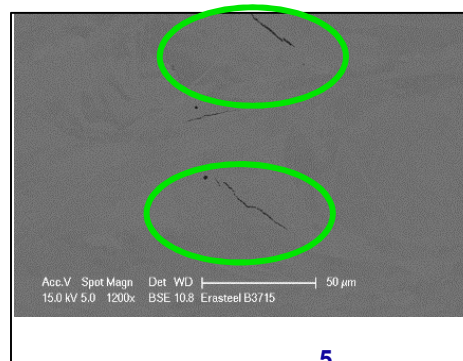
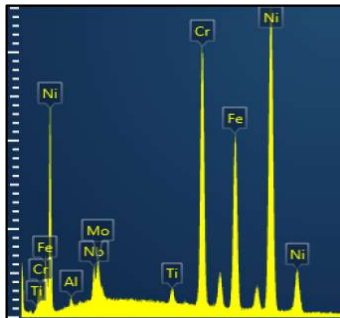
Ap. density

Tap density

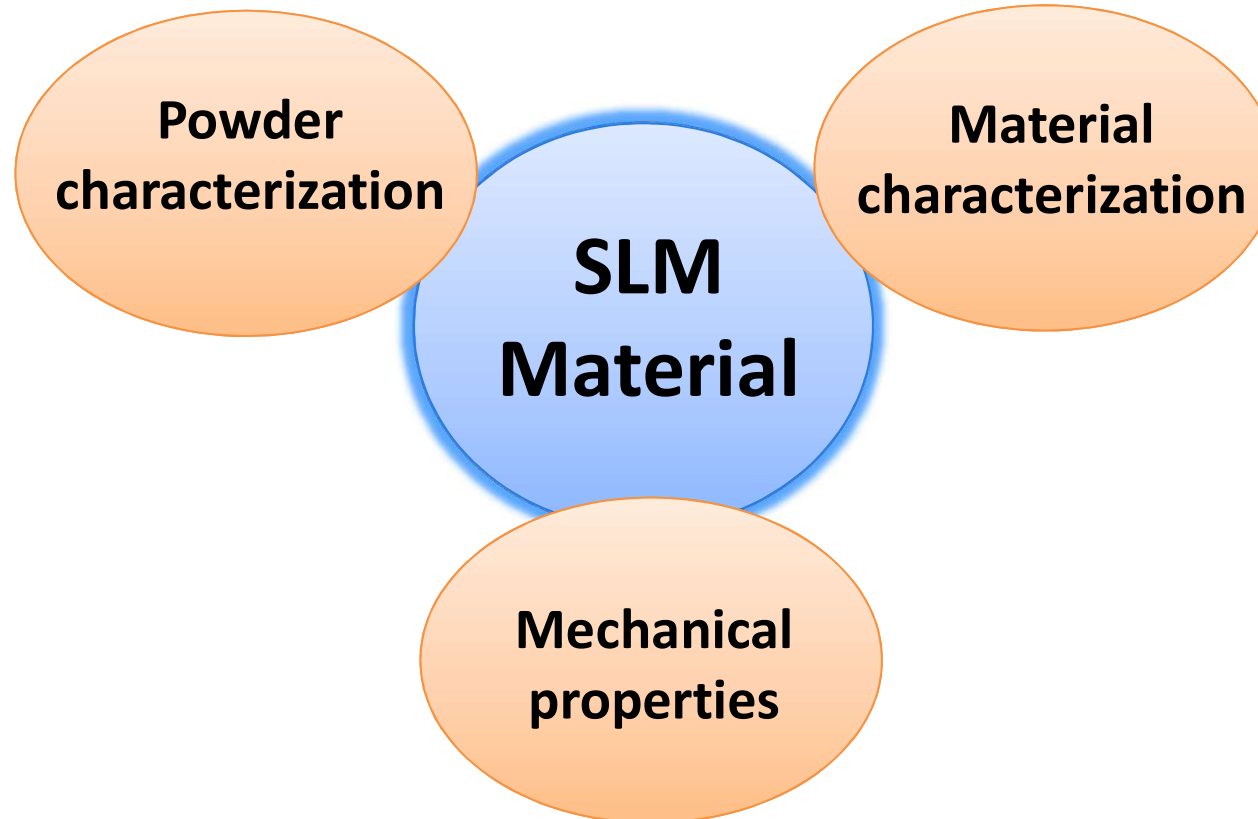
Moisture

...

➤ Focus on composition



Satisfactory
experience with
tailored
composition



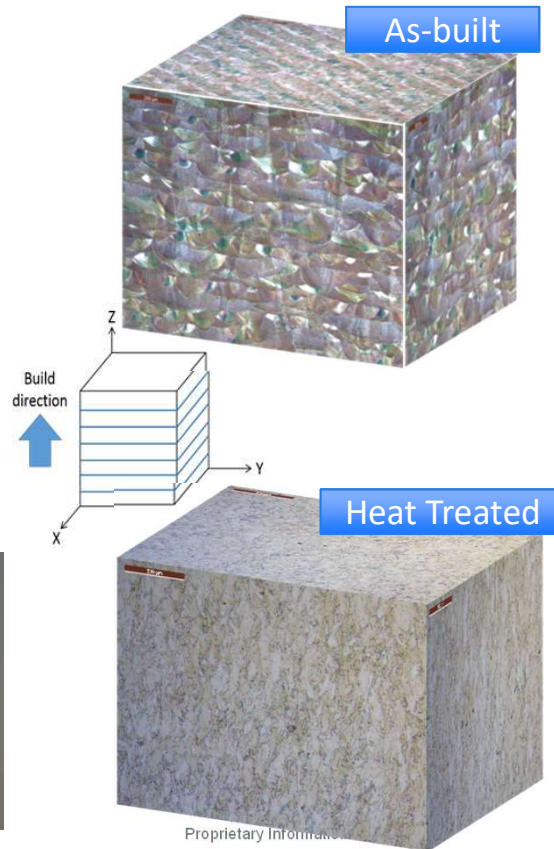
Material characterization



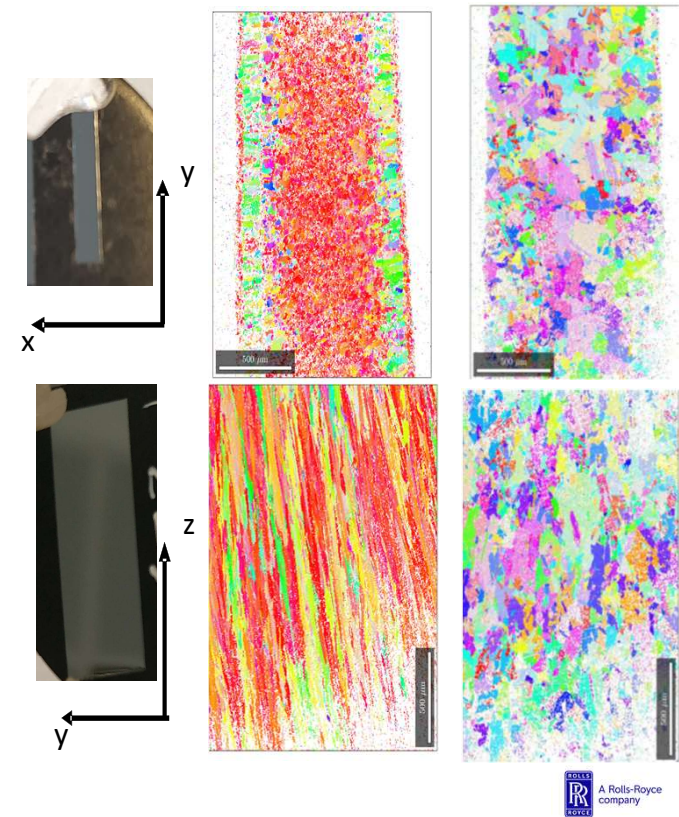
Defectology

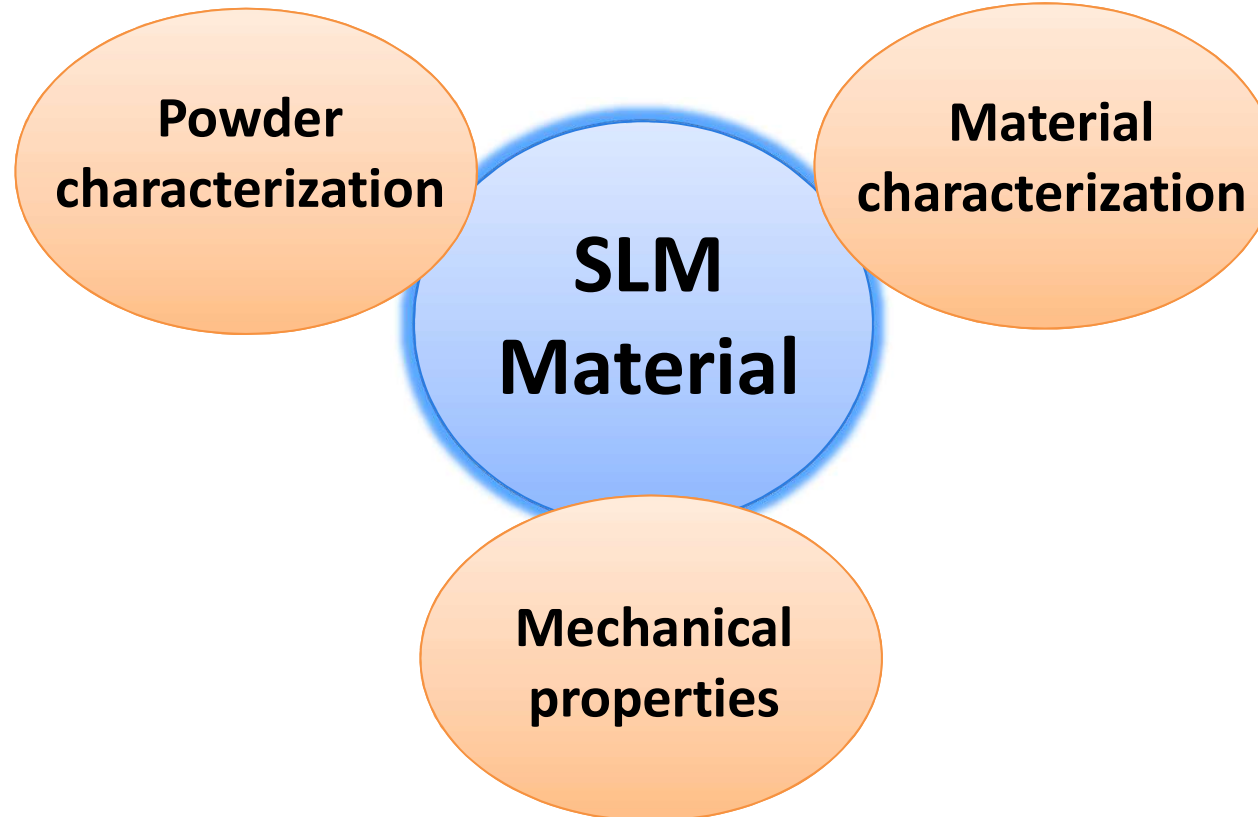


Microstructure

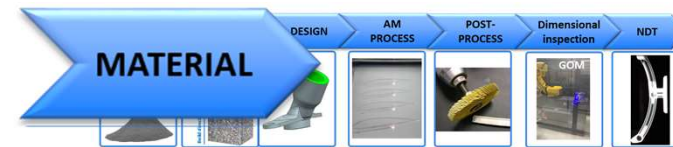


Anisotropy

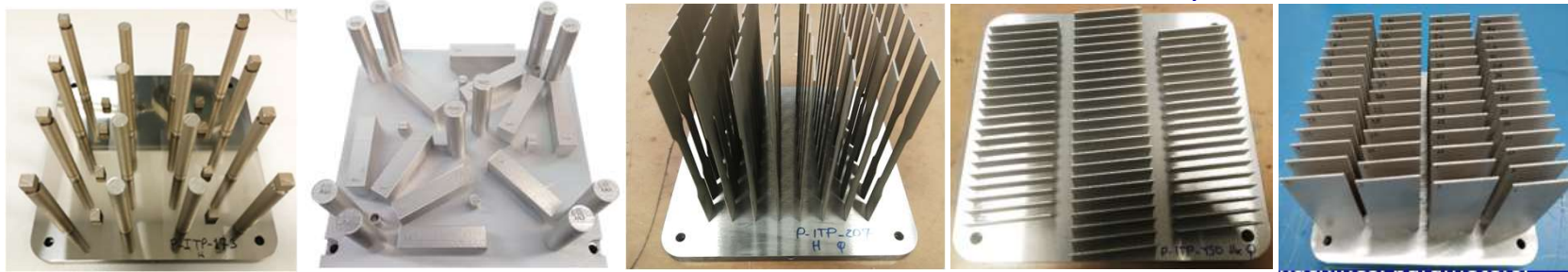




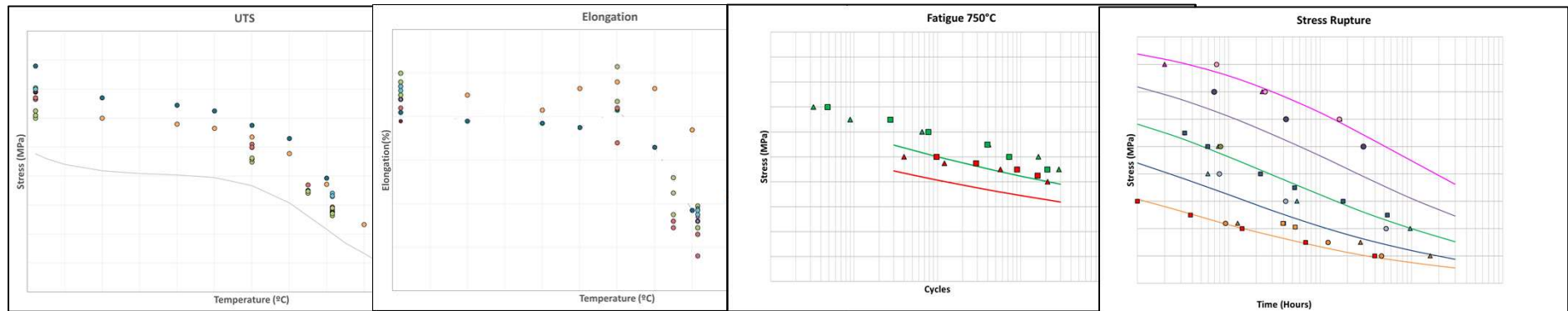
Mechanical Properties



- **Robust MdB to capture:** Orientation, thickness, machines, powder batches



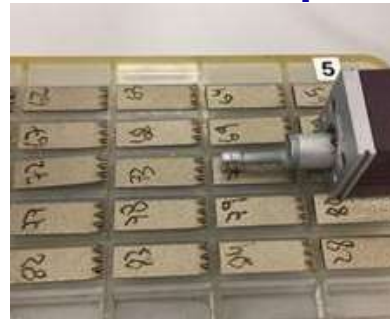
- **Design allowable to cover:** variability, roughness, thickness, defectology



AM Process



➤ Machine qualification required:



Roughness
Evaluation



Metallography
Consistency



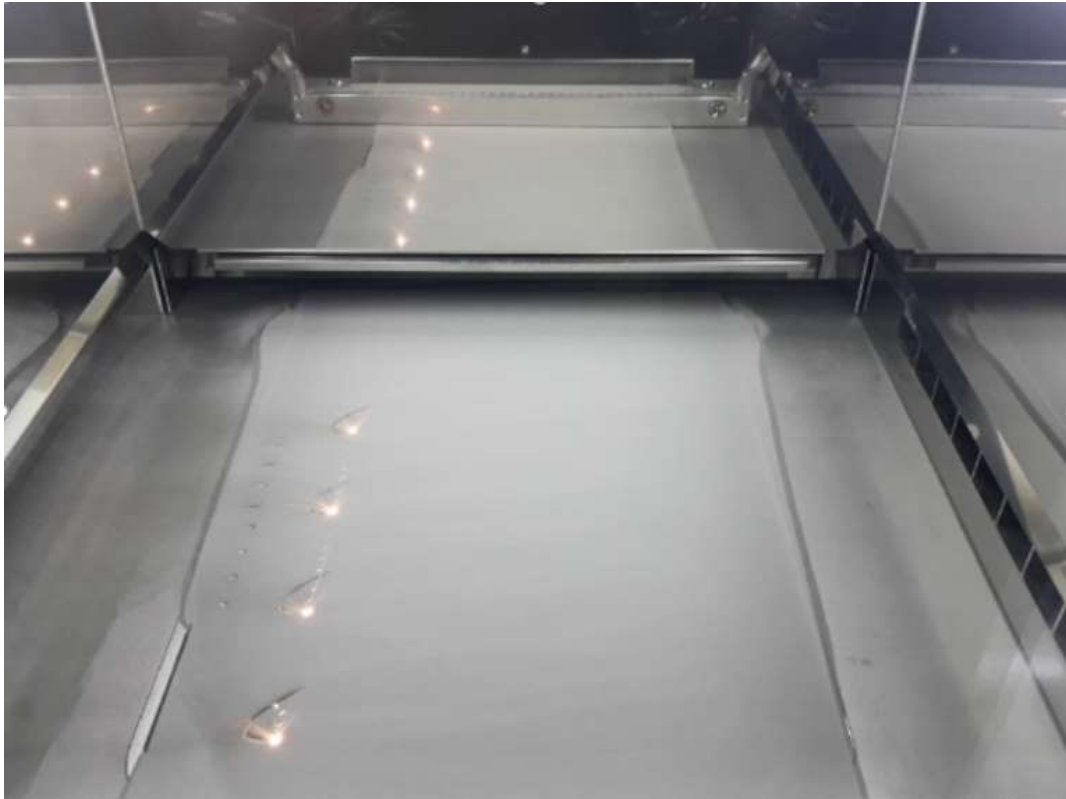
Overall Z axis
evaluation

➤ Qualified Operators & Engineers

➤ Continuous Process control:

- Consistency between machines
- Stablished periodic controls
- Calibration procedures and limits

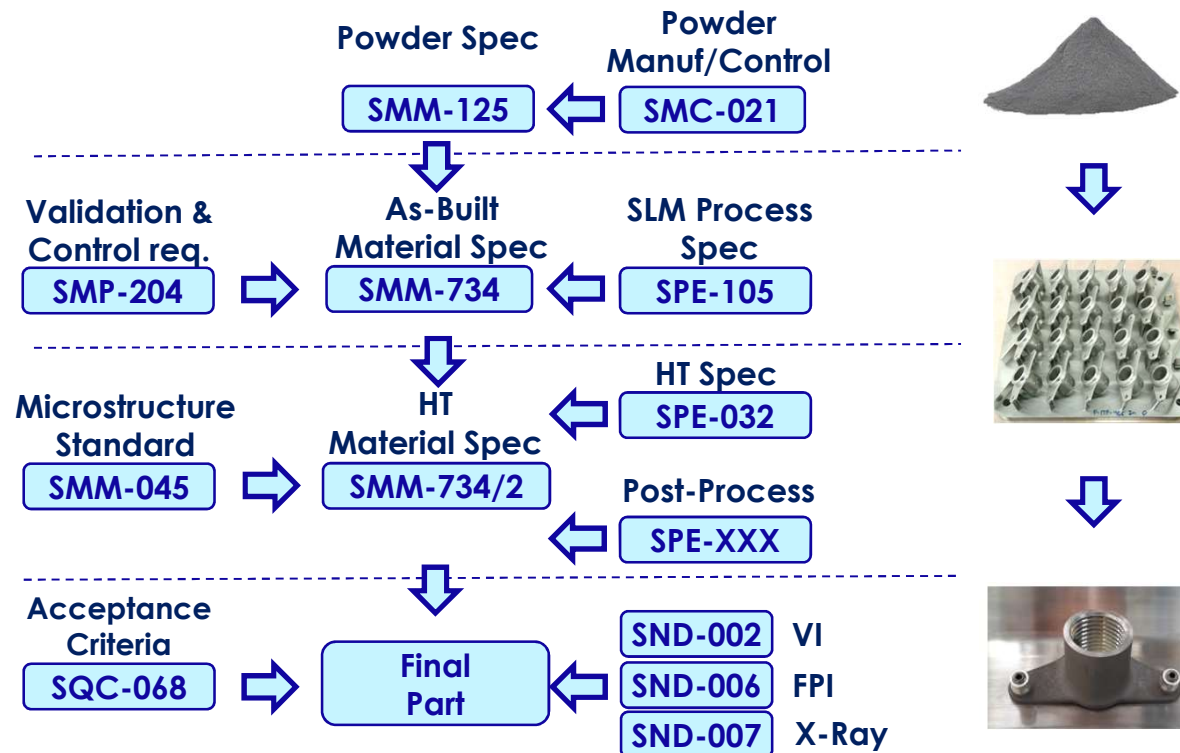
AM Process



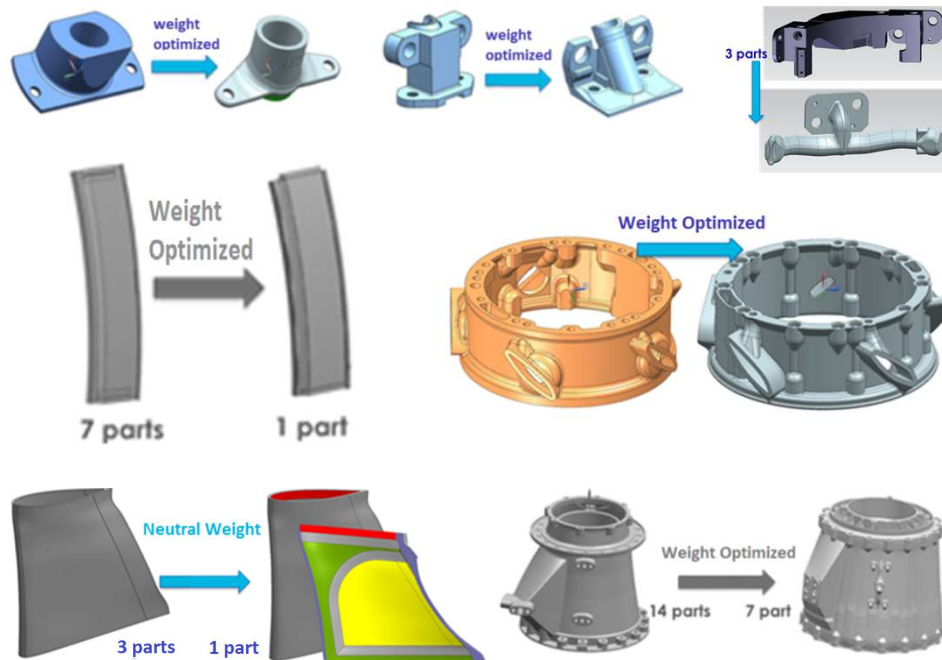
- **Main Challenges:**
 - Repeatability
 - Multi-laser on part
 - Bigger platforms
 - On-line monitoring

Our Own Standards

SMM: Materials Standard
SMC: Material Control Standard
SMP: Validation & Control Standard
SPE: Special Process Standard
SND: Non Destructive Testing Standard
SQC: Component Quality Standard



Design for Additive Manufacturing



Competitive products

THINKING DIFFERENT IN AM

✓ From conventional to AM seal segment

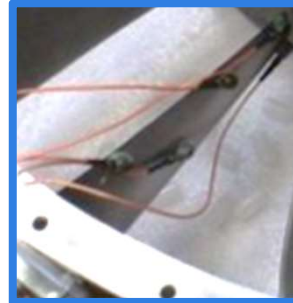
- ✓ Weight reduction
- ✓ Cost reduction
- ✓ Reduction in part count
- ✓ Reduction in the supply chain
- ✓ Interchangeable design (conventional set & new AM set)
- ✓ Significant reduction of peak stress values

✓ DfAM considerations

- ✓ Manufacturing Lay-out to maximize production and avoid defects
- ✓ Designed to minimize distortions
- ✓ Designed for minimum post-process

Component Experience

RAKES

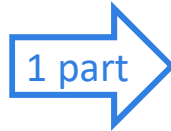
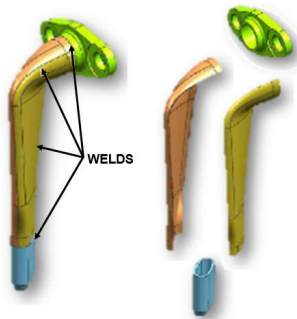


✓ +1000 Engine test Hrs



Rakes Design & Deliveries consolidated

MILITARY AIR/OIL TUBES CERTIFIED - Military certification (MTRI) → DELIVERED TO SERVICE
First Part - Q4 2018



Military Tube certified (MTRI)

Component Manufacturing

NEW PARTS IN DEVELOPMENT

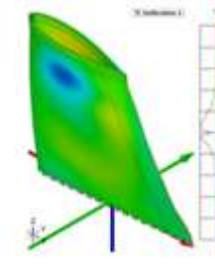
Turbine Seals



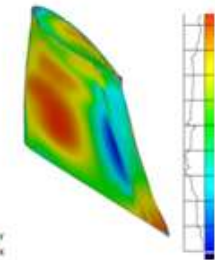
Unloaded Parts



Non Structural Vanes



AM Vane



Conventional

Validation Strategy

- Strategy based on part classification and function



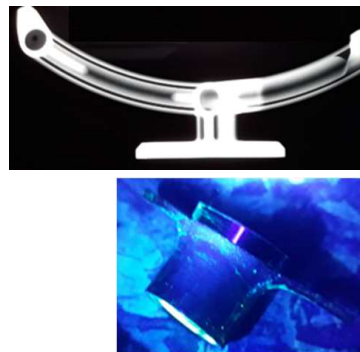
Specimen



Feature testing



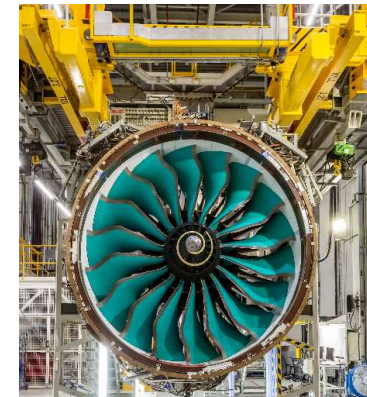
Cut-Ups



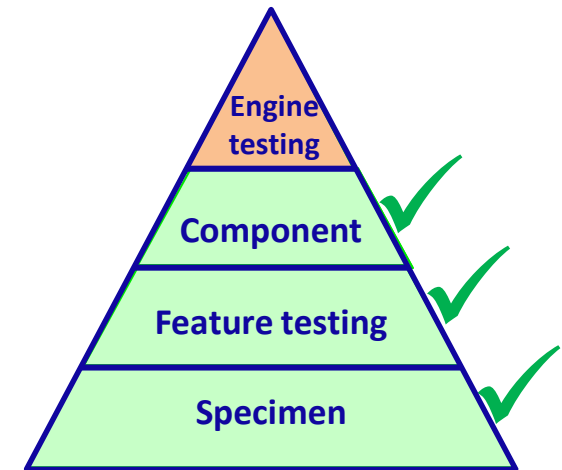
NDT



Rig Test



Engine Test



Summary

- ❖ Our own specification: International **Standards** not currently a solution
- ❖ Anisotropy: **Manageable** with appropriate process treatment
- ❖ Process Control: **No significant differences** with respect to other special processes.
- ❖ Machine Capability: Close **collaboration** with AM machine supplier is a good advantage
- ❖ Design for Additive: Key for **competitiveness**
- ❖ Part Classification: **Key driver** to define validation strategy and process control



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