Arcam EBM

EBM Applications in the Aerospace Industry

Additive manufacturing workshop II

EASA – Cologne, 27-28 Sept 2017

Additive Manufacturing with EBM®

Mission

“Arcam’s mission is to disrupt the status quo in production by providing leading-edge **metal additive manufacturing solutions.**”

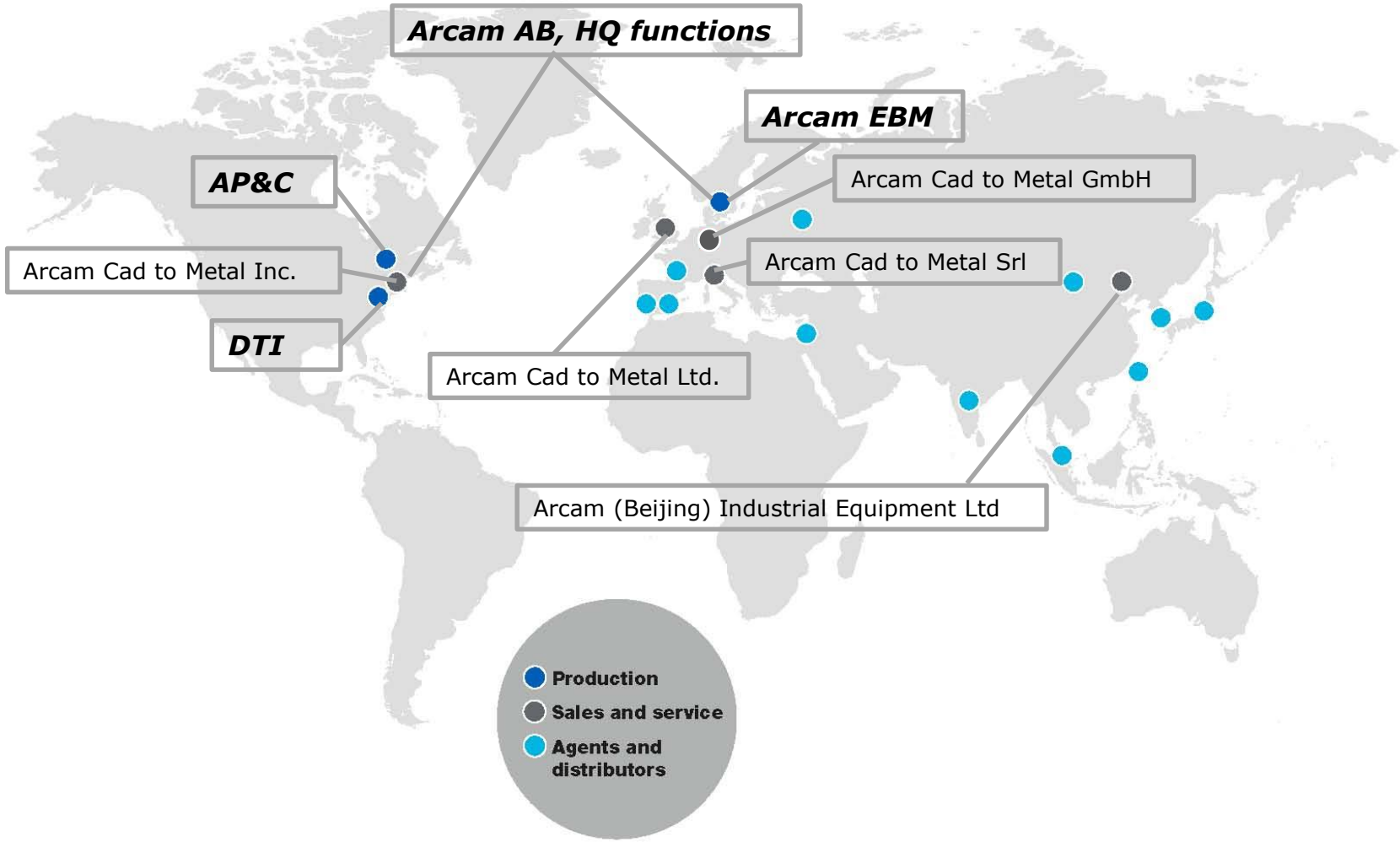
Focusing on:

› **Aerospace** components

› **Orthopedic** implants

Arcam Group – a complete offering

Arcam in the World



Additive Manufacturing (AM)

Benefits

- Unlock design potential
- Reduce time-to-market
- Reduce material costs
- Reduce machining costs

And...

Makes it possible to manufacture parts with lattice and cellular structures!

AM Driver

Cost reduction

Arcam’s EBM technology is used to **replace present technology**

› Minimal material use

› No tooling cost

› Shorter lead time

Our customers will make their production **more efficient,** thus **reducing their costs**

AM Driver

Design optimization

Arcam’s EBM technology is used to produce products with **new, unique properties**

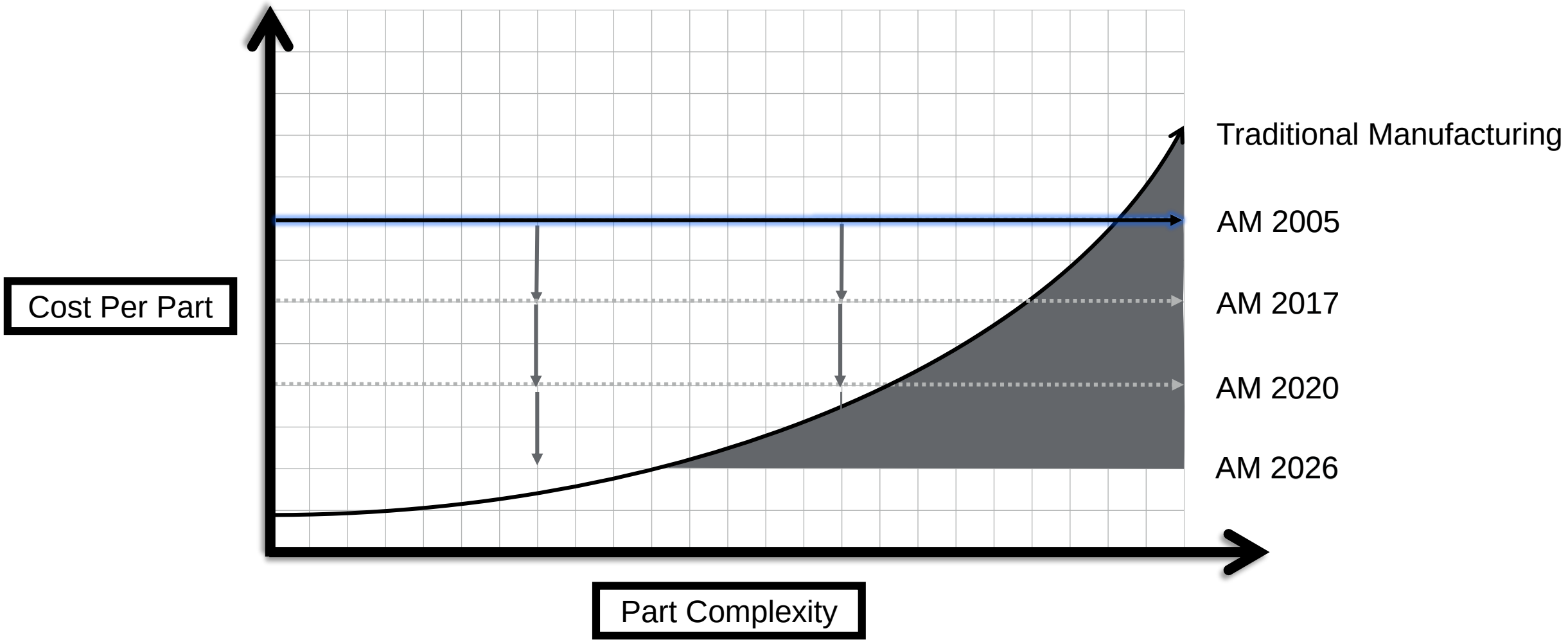
› Weight reduction (aero)

› Advanced cooling (aero)

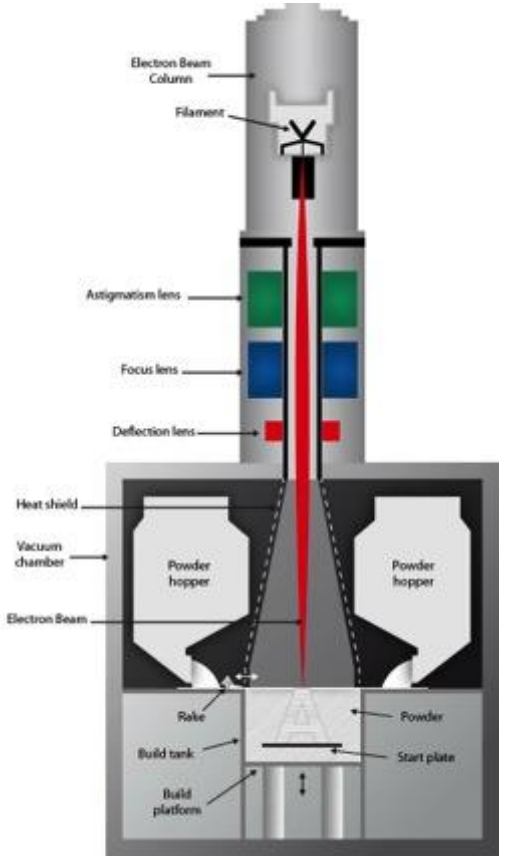
› Bone ingrowth (implant)

Our customers will **increase the performance** of their product, thus making their product **more valuable**

Complexity for Free



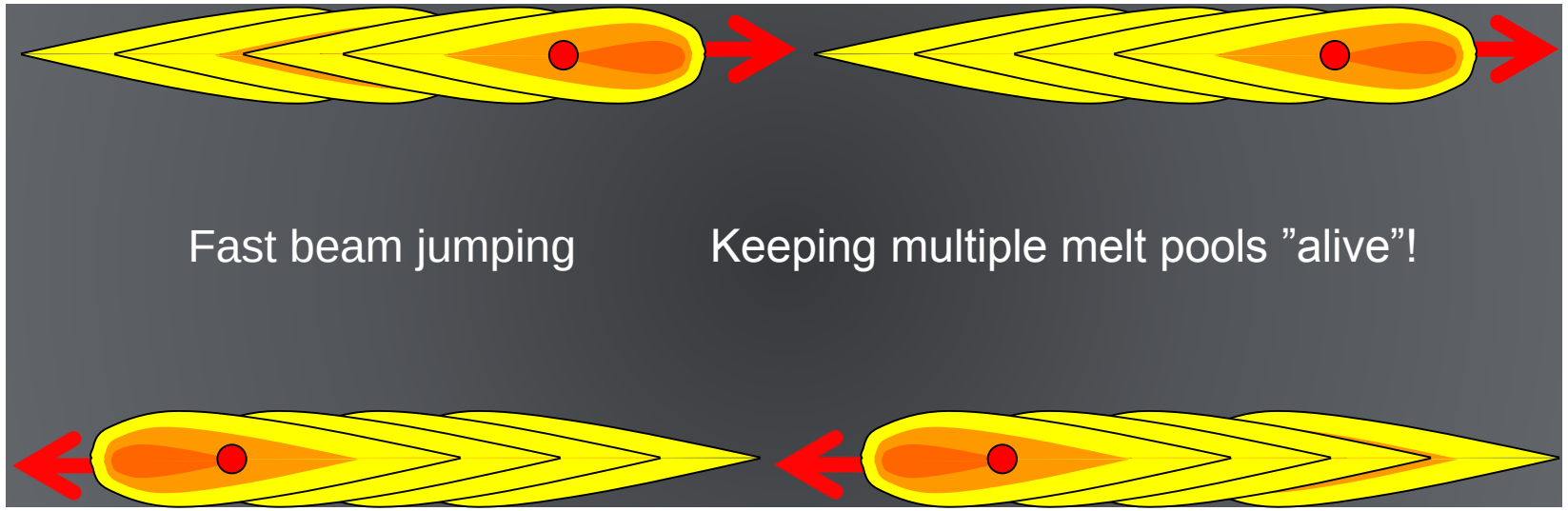
Electron Beam Melting (EBM)



- **High power (3.000 W)**
  - Allows for high melting capacity
  - High productivity
- **No moving parts in the EB-gun**
  - Extremely fast & accurate beam control
  - Power & focus continuously varied
  - Enables EBM MultiBeam™
- **Vacuum process**
  - Clean & controlled environment
  - Allows processing reactive materials
- **Hot process (650ºC for titanium)**
  - No residual stresses
  - No heat treatment (of titanium)
  - Faster melting

EBM Build Cycle

Arcam EBM MultiBeam™



In reality: ~70 spots, one sequence 35 ms

The high power electron beam jumps repeatedly between different melt pools to keep all of them active

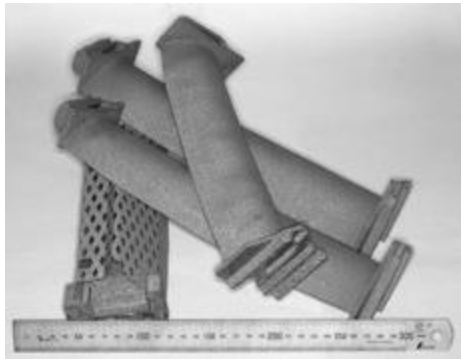
- **High Beam Energy** – High productivity with rough surfaces
- **Low Beam Energy** – Low productivity with fine surfaces
- **High Beam Energy/ Multiple Melt Pools** – High productivity and fine surfaces

Cost-efficiency of EBM

- High productivity
- No heat treatment (titanium & CoCr)
- No wire EDM cutting (titanium & CoCr)
- Allows stacking in Z-direction/full utilization of build volume
- Aggressive powder pricing strategy to compete with conventional processes
  - **Arcam owns powder producer AP&C**
  - **Thicker layers allow for courser powder size distribution**
  - **Course size distribution – powder at lower price**
- Low consumption of consumables

Arcam EBM Applications

Aerospace



Medical

Arcam in Aerospace

Arcam serves most major aerospace companies with **EBM systems** and **metal powders**

Honeywell

AIRBUS

Avio Aero
A GE Aviation Business

GKN AEROSPACE

Rolls-Royce

Pratt & Whitney
A United Technologies Company

SAFRAN
AEROSPACE · DEFENCE · SECURITY

Aerospace Challenges

The aerospace industry

- Extreme requirements on product performance
- Geometric design complexity
- Extensive use of Ti alloys
- Use of advanced high-temp materials
- Small/Medium production series

Arcam EBM is the ultimate Additive Manufacturing solution for the aerospace industry

- Freedom in design
- Cost-efficient production
- Excellent material properties
- Proven process for volume production

AM Drivers in Aerospace

Freedom in design

- Optimize geometry for weight savings
- Optimize geometry for improved function

Cost reduction

- Buy-To-Fly ratios of 20 not uncommon >> 95% scrapped mtrl
- For Arcam EBM® the Buy-To-Fly ratio is close to 1

Excellent material properties

- Compliant with relevant industry standards
- Better than cast, comparable to wrought material
- Suitable for static as well as dynamic/fatigue components

Proven process for volume production

- Flight-tested
- Chosen technology for production of critical Aerospace components

Avio Aero
A GE Aviation Business

- State of the art manufacturing facility dedicated to AM
- Increasing capacity for EBM, now hosts 20 EBM machines and growing
- Holistic approach
  - **Powder production >> EBM >> Heat Treatment >> Post processing**

Avio Aero
A GE Aviation Business

- Low pressure turbine blade for GE9X
- Produced in γ-TiAl with EBM, 380 mm height
- Supply agreement with GE Avio
- Stage 5 and 6, each with 114 blades
- 228 blades for each engine
- Production ramp up 2017-2018, EIS 2019
- Machine model: Arcam A2X

Courtesy of GE Aviation

Courtesy of GE Avio

Rolls-Royce

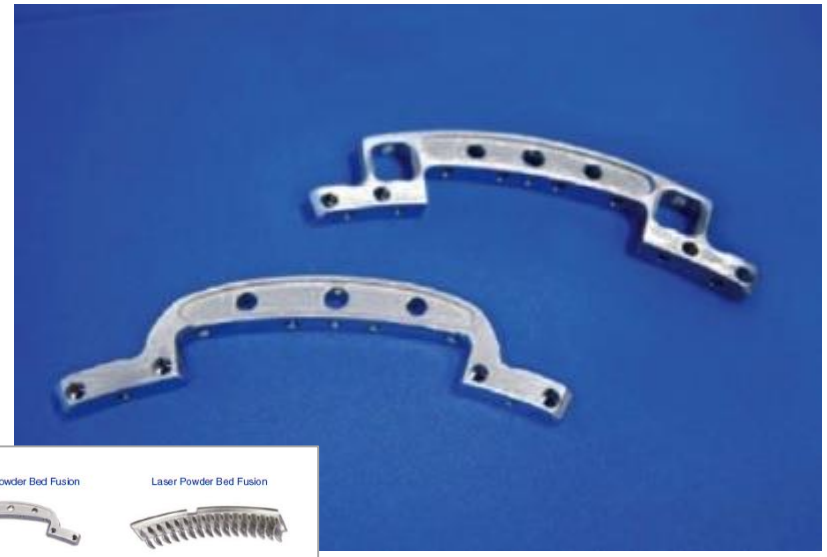
- Vane segments for front bearing house for Trent XWB
- Produced in Ti6Al4V with EBM
- Each front bearing housing contains 48 vane segments welded together
- With 1,5 m in diameter it is claimed to be "the largest component ever built using Additive Layer Manufacturing."
- Flight-test Nov 2015
- Arcam Q20plus

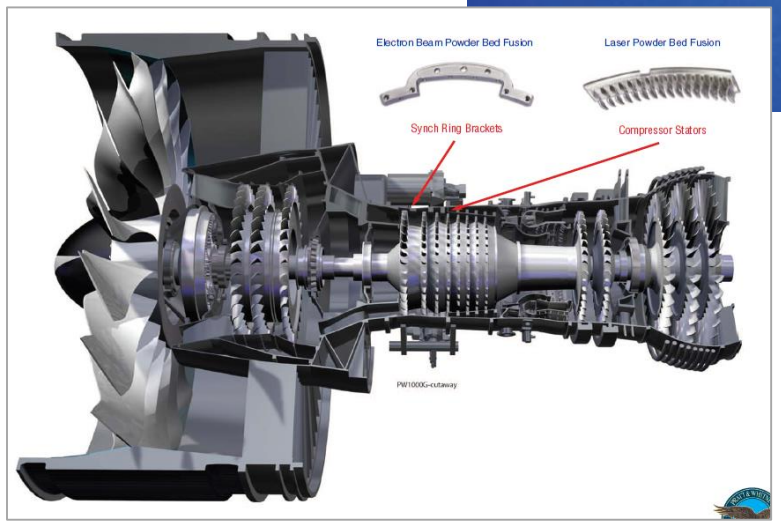
Courtesy of Rolls-Royce

Pratt & Whitney
A United Technologies Company

For the PW1000G-series

- Synch ring bracket
- Start of production 2017
- Machine model: Arcam A2X





AIRBUS

- Airbus has been using and evaluating EBM technology for several years
- Airbus is currently qualifying the Arcam Q20plus and AP&C metal powder for their supply chain
- This will lead to powder and process specifications for Airbus parts supply in Ti64 using Arcam EBM
- Also individual part qualification ongoing with selected suppliers

GKN AEROSPACE

- GKN has several Arcam EBM machines
- Currently exploring and qualifying different applications
- GKN and Arcam entered into a strategic partnership in 2015
- Machine model: Arcam Q20

GKN Aerospace | GKN Driveline | GKN Powder Metallu

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GKN Aerospace agrees strategic 'additive manufacturing' partnership with Arcam

16/03/2015 09:00
Aerospace

• GKN Aerospace and Arcam move towards fully industrialising electron beam melting

GKN Aerospace has entered a strategic partnership with additive manufacturing specialist, Arcam AB, to develop and industrialise one of the most promising of the new 'additive' processes to meet the needs of the expanding future aerospace market.

The joint technology development (JTD) partnership is focused on developing electron beam melting (EBM), a process in which metal components are built up, layer-by-layer, using a metal powder that is melted by a powerful electron

http://www.materialsforengineering.co.uk/engineering-materials-features/the-long-road-to-qualification/86548/

Core Benefits with Arcam EBM

Freedom in design

- Design for optimal function
- Light-weight structures
- Integrated trabecular structures for improved bone ingrowth

Cost-efficient production

- High productivity
- High material utilization

Excellent material properties

- Compliant with relevant industry standards
- Better than cast, comparable to wrought material

Proven process for volume production

- Regulatory-approved implants in production since 10 years
- Chosen technology for production of critical Aerospace components

Arcam EBM

Thank you for your attention!

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Arcam - CAD to Metal