Arcam Group & Additive Manufacturing in Aerospace
Scope

- Arcam
- Electron Beam Melting
- Industry Applications
- Products
Mission Statement

"Arcam provides cost-efficient Additive Manufacturing solutions for production of metal components”

Focusing on:
- Aerospace components
- Medical implants
Arcam briefly

- Arcam AB incorporated 1997
- Listed on NASDAQ OMX Stockholm
- First EBM system delivered in 2003
- About 250 systems installed worldwide
- 320 people, in Sweden, US, UK, Italy, Germany and China
- Sales partners in Europe and Asia

3D-Dagen, Kista Nov 23, 2016
Arcam Group

AM Systems

Contract Mfg

Metal Powders

3D-Dagen, Kista Nov 23, 2016
Financials

“Strong increase in revenue and sound finances give us a solid foundation for continued growth”
Ownership structure

General Electric controls approximately 74% of the Arcam shares.

General Electric further extend the acceptance period for the tender offer to November 29 to allow remaining shareholders to accept the offer.

General Electric has launched GE Additive to further develop and drive sales of machines, powders and more.

www.geadditive.com
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**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 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 martensitic structures /No heat treatment
- Faster melting

3D-Dagen, Kista Nov 23, 2016
EBM build cycle
The EBM® Machine

- Control Unit
- Build Chamber
- Powder Container
- Powder Rake
- Build Platform
- Build Tank
- Heat Shield
- EB Gun
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Customer benefit - Cost

Arcam’s EBM technology is used to replace present technology

- No tooling cost
- Shorter lead time
- Less material use, more efficient

Our customers will make their production more efficient, thus reducing their costs
Customer benefit - Performance

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

- Weight reduction (aero)
- Advanced cooling (aero)
- Bone ingrowth (implant)

Our customer will **increase the performance** of their product, thus making their product **more valuable**
Arcam in Orthopedics

Around 100 **EBM** systems **in production**

**AP&C** preferred powder supplier for AM and coatings

**DiSanto** provides contract manufacturing
CE-certified & FDA-cleared Implants

- CE-certified since 2007
- FDA clearance since 2010
- CFDA clearance since 2015
- > 80,000 cups implanted
- 3% of the global production of acetabular cups is now manufactured with EBM®
Broad market acceptance
Arcam in Aerospace

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

- Brand new facility dedicated to AM
- Hosts 15 EBM machines, room for 60!
- Holistic approach
  Powder production >> EBM >> Heat Treatment >> Post processing
Avio Aero

- Low Pressure Turbine Blade for GE9X
- Produced in $\gamma$-TiAl with EBM, 380 mm height
- Extremely difficult to cast
- 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*
Rolls Royce

- Project with Rolls-Royce
- 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 Q20
Pratt & Whitney

Present

- Non-critical component
- Synch Ring Bracket
- For the PW1000G Geared Turbofan
- Start of Production 2016
- Machine model: Arcam A2X
Pratt & Whitney

Future

• Prototyping > Low Rate Production > Full Rate Production
• Non-Critical >> Critical Components

Freeform Fabrication Methods
Greatest benefit by designing for the process

Additive Manufactured Parts
Metallic part examples
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
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Machine Portfolio

Arcam Q10
- Build envelope: 200 x 200 x 180 mm
- Materials: Titanium, CoCr (soon)
- Primary use: Production
- Arcam LayerQam™
- Arcam MultiBeam™

Arcam Q20
- Build envelope: Ø350 x 380 mm
- Materials: Titanium
- Primary use: Production
- Arcam LayerQam™
- Arcam MultiBeam™

Arcam A2X
- Build envelope: 200 x 200 x 380 mm
- Materials: Titanium, CoCr, Inconel 718, TiAl & non-standard materials
- Primary use: Production and R&D
- Arcam MultiBeam™
Arcam LayerQam™

Camera-based quality verification system

- Full build area with 100 µm resolution
- Each layer captured, analyzed and stored
- The optical system is optimized for typical defect sizes
- The contrast is very good for defects on a hot surface
- Now complemented with a Defect Detection report
Arcam LayerQam™
- Defect Detection report

Layer 52,29: Good layer

Layer 98,64: Bad layer

Bad component

Good component
Arcam xQam

EBM has several fundamental benefits

• Some of them are well known
  • High power >> high productivity
  • Vacuum >> clean process
  • High temp >> no residual stresses

• Others are less known - but just as important
  • Low reflection/high energy absorption, compared to laser
    Key to the high productivity of EBM
  • X-rays emission, carrying vast amount of useful information about the process

• X-ray emissions provides an excellent opportunity for process monitoring - if captured

• The Arcam xQam™ is capable of doing exactly that!
Arcam xQam™

What is it?
Arcam xQam is an X-ray detection system for powerful process monitoring
Over time, various functionality will be developed on it

Today: xQam Auto-calibration
Offers automatic, quick, high precision calibration and system diagnostics that is completely operator independent. Frequent high precision calibration is crucial for a robust and predictable operation.

Tomorrow: xQam SEM
Imagine the power of doing In-Situ SEM on every production part
What Arcam xQam can potentially do is principally the same as a Scanning Electron Microscope (SEM). Coming functionality will include in-situ monitoring of both powder bed topography, chemical composition and defects.
The Arcam xQam opens up for future in-situ SEM-validation of every built component, in an industrial environment.
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Thank you for your attention!

Arcam - CAD to Metal®
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