

Bringing 3D Printing into the Metals Age

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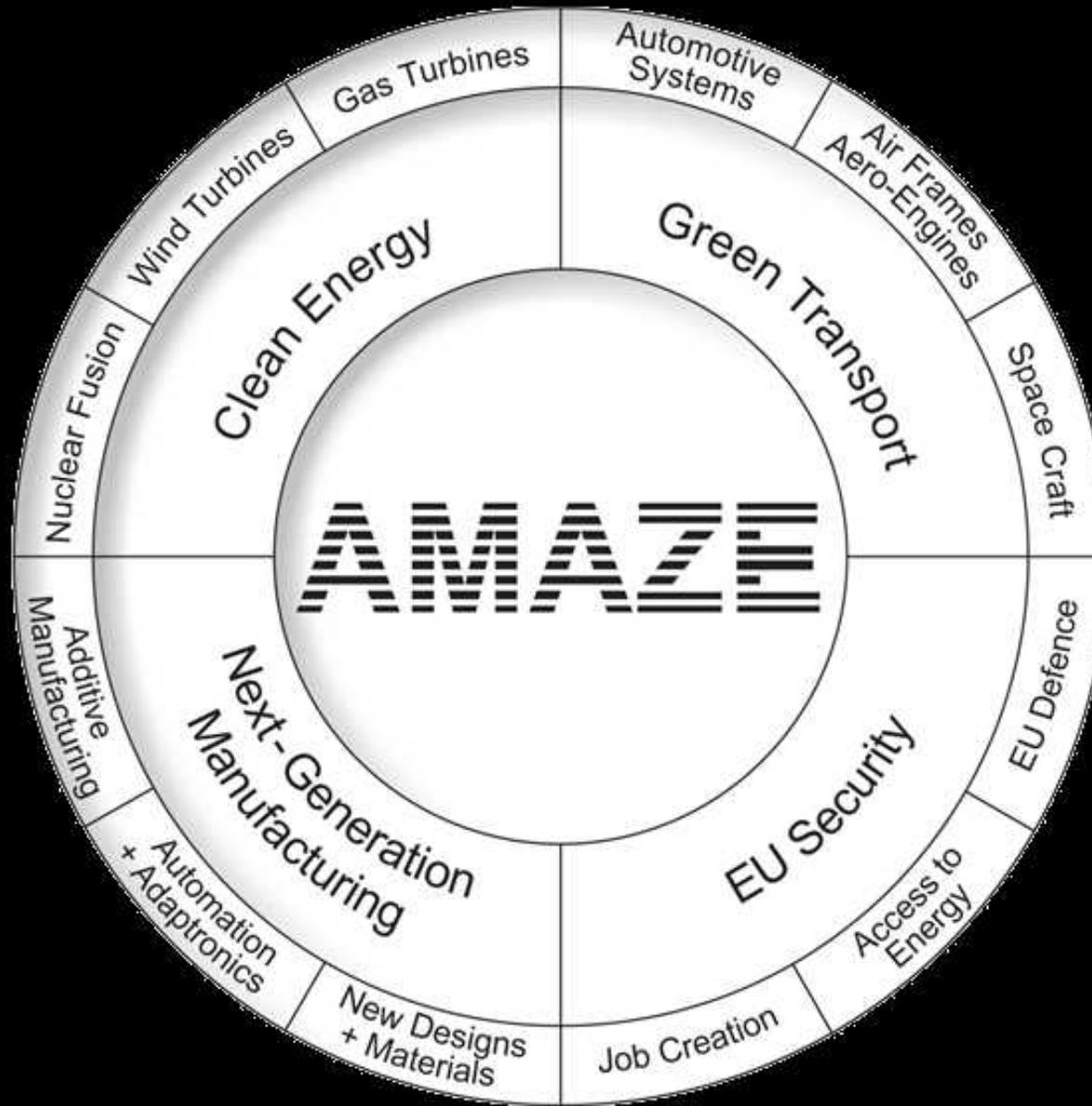
Head of Strategic & Emerging Technologies, ESA

AMAZE Project Manager

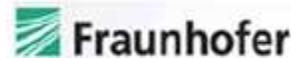
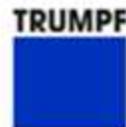
The AMAZE Project

AMAZE is a pan-European research and development project

- 25 million euro project
- funded 50/50 by the European Commission and European industry
- 28 partners (industry, academia, government labs)
- 9 different countries involved (CH, DE, ES, FR, IR, IT, NO, SE, UK)
- 5 years duration (2013-17)



The AMAZE Team



Top-Level Goals

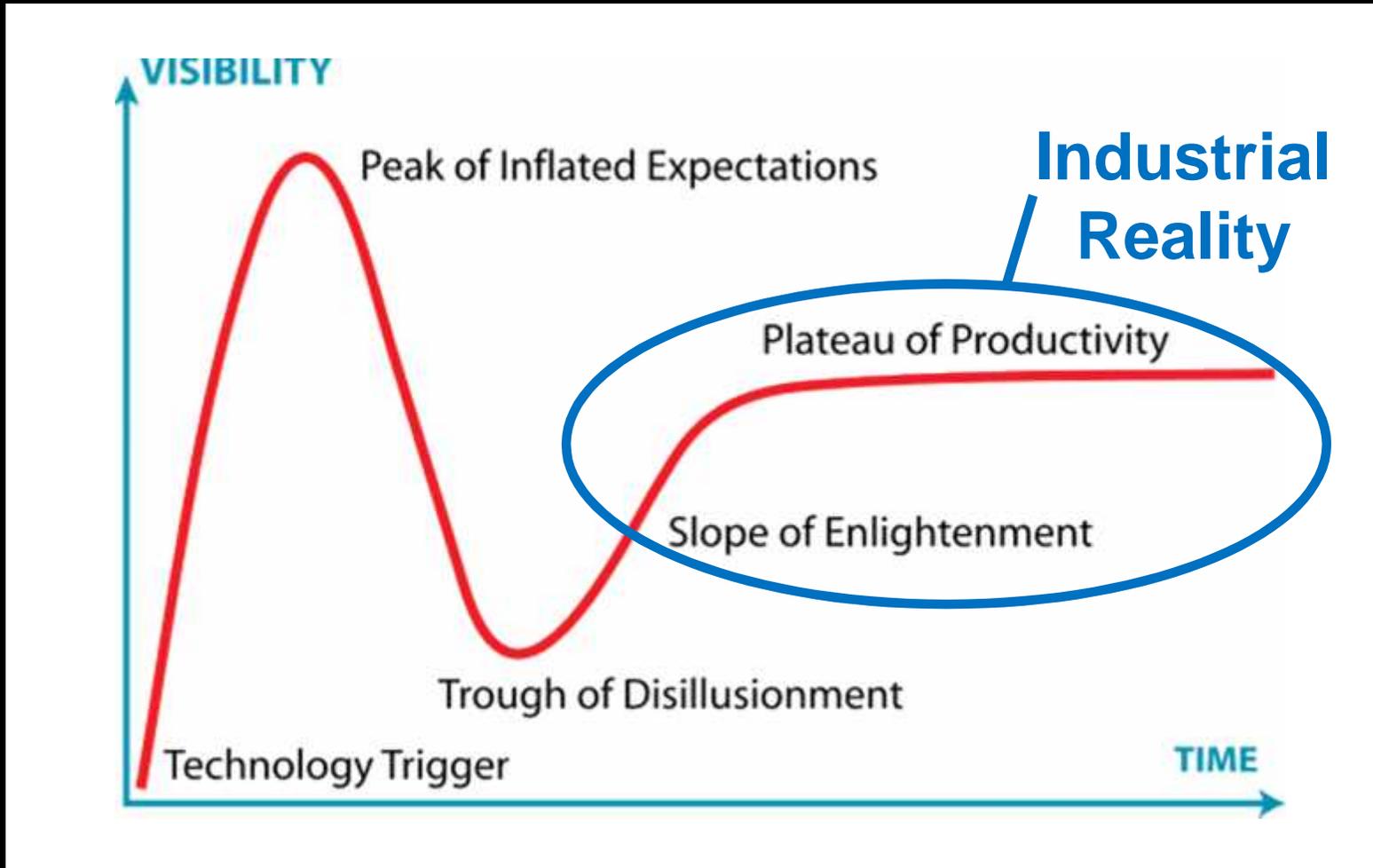
AMAZE has the overall vision and ambition to:

- develop the best quality, best designed and most resource-efficient metal products ever made
- rapidly turn 3D-printing into an automated mainstream process for a broad range of high-tech industries
- make better metal-based engineering systems for aeroplanes, spacecraft, nuclear fusion and road vehicles
- allow Europe to achieve global leadership in this important field of 3D-printing and additive manufacturing

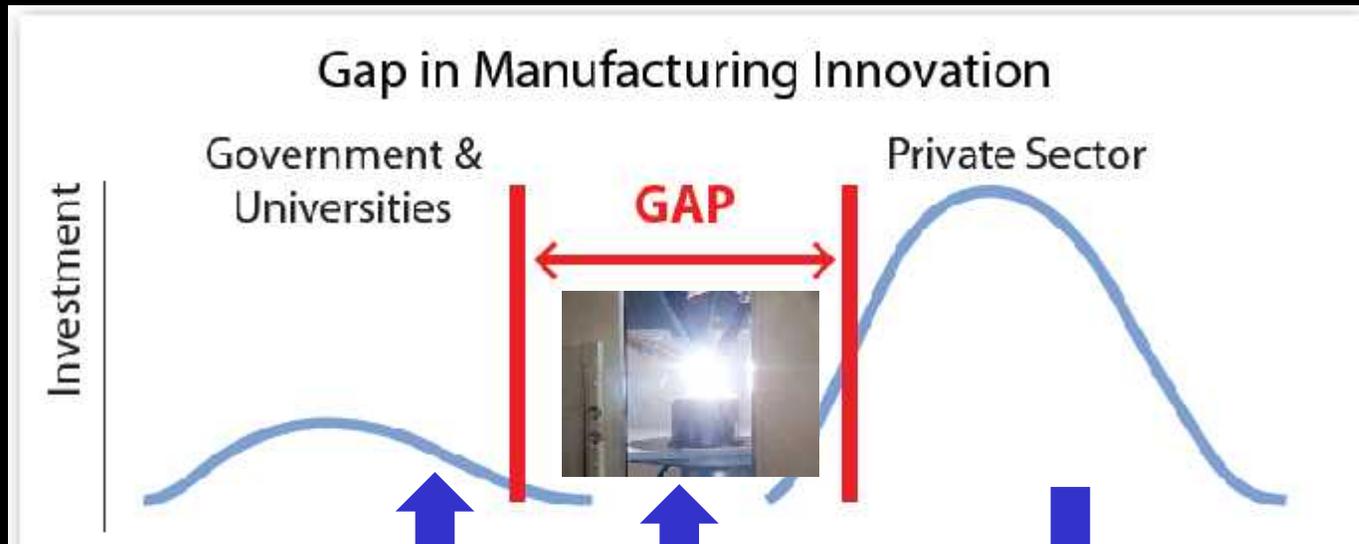
The industrial impact in the near future will be large

However, there are two important things to avoid...

Avoid “Overhyping” 3D-Printing



Avoid “Death Valley” for 3D-Printing

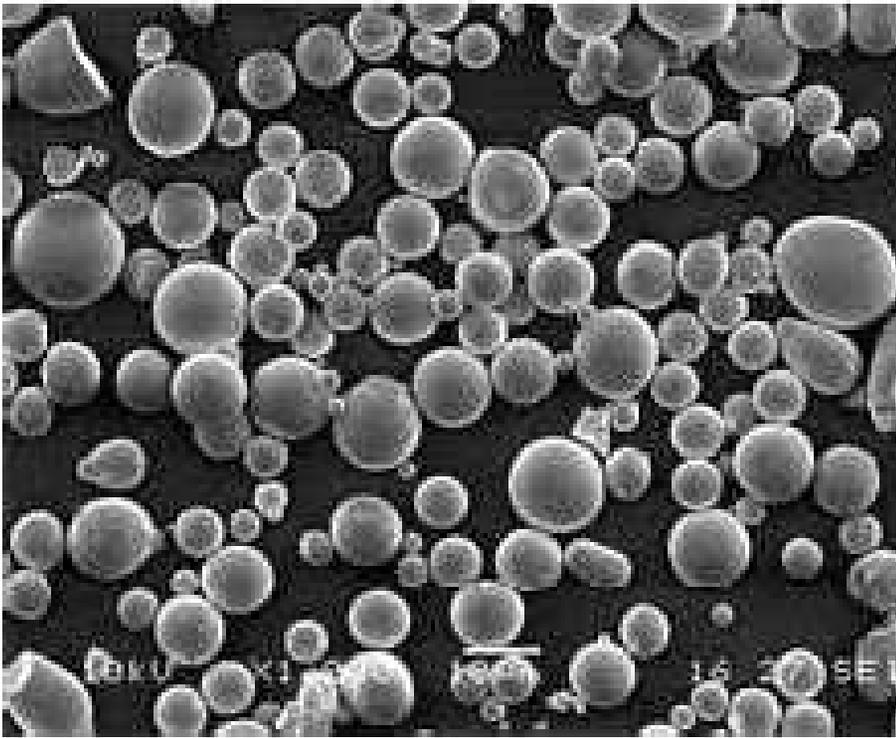


Outstanding
R&D
Papers
Patents

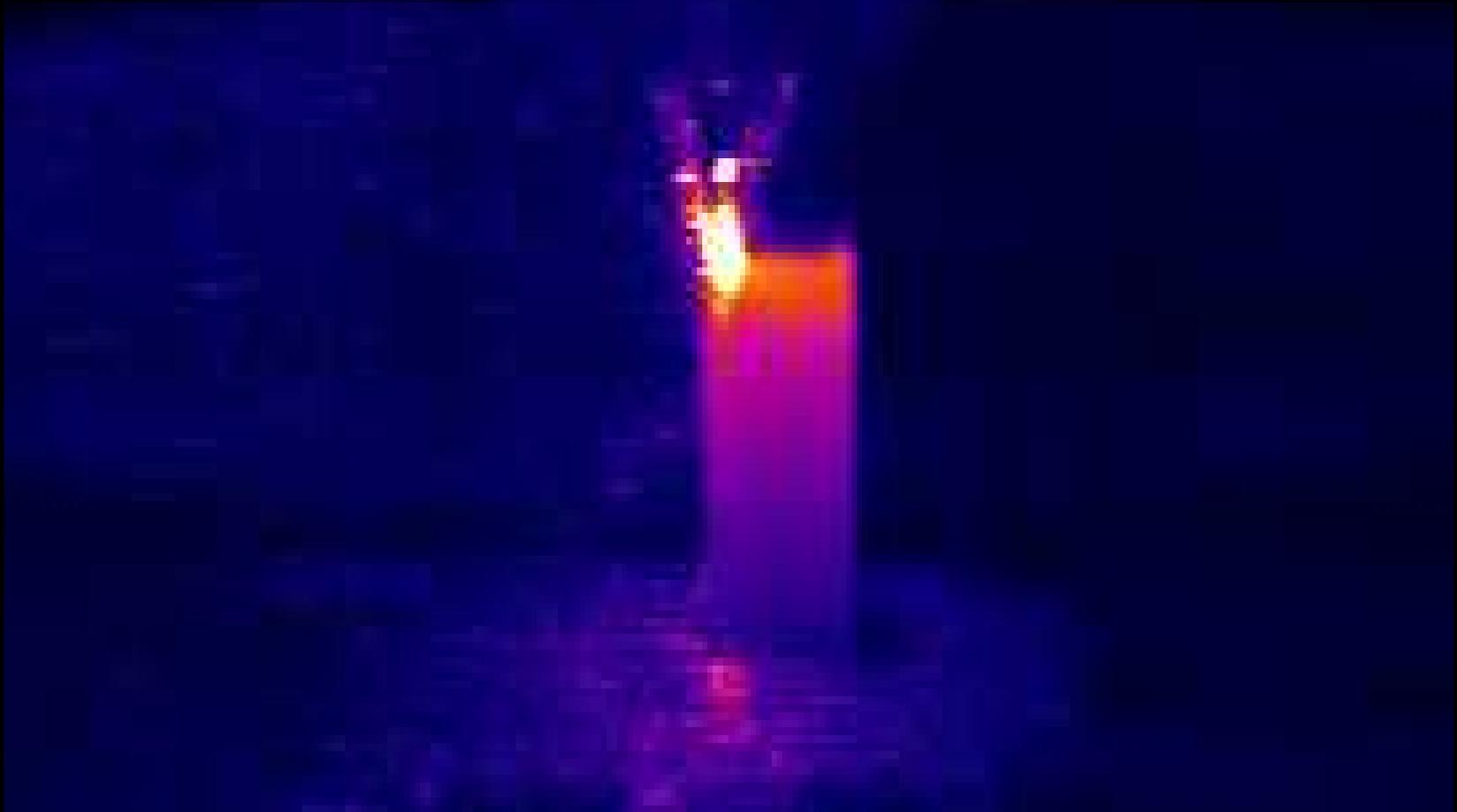
Pilot-scale
demonstrators
Tech start-ups
New AM factories
New AM standards



3D-Printing in Metals

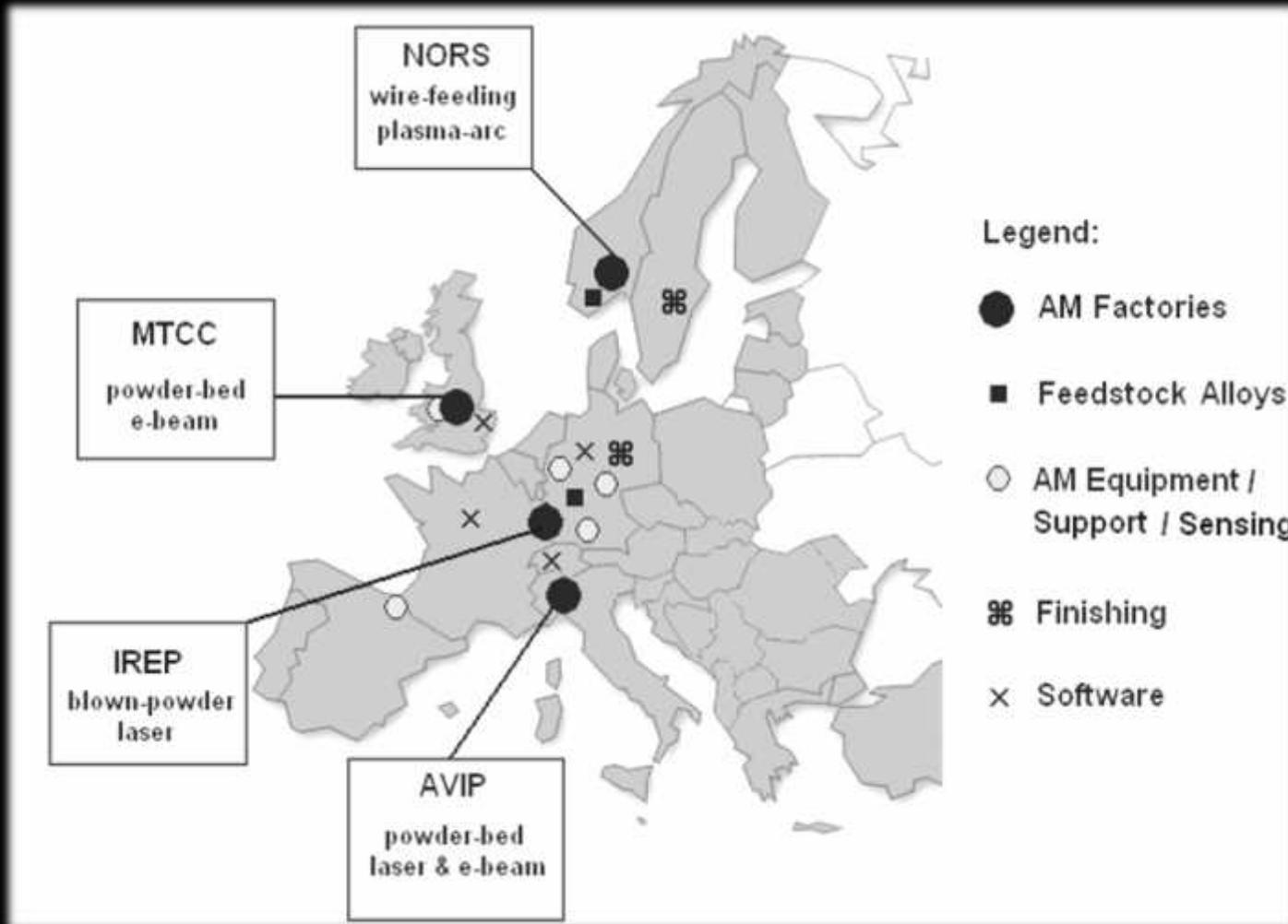


Commonality: melting one layer of metal alloy on top of another layer to make a 3D shaped part



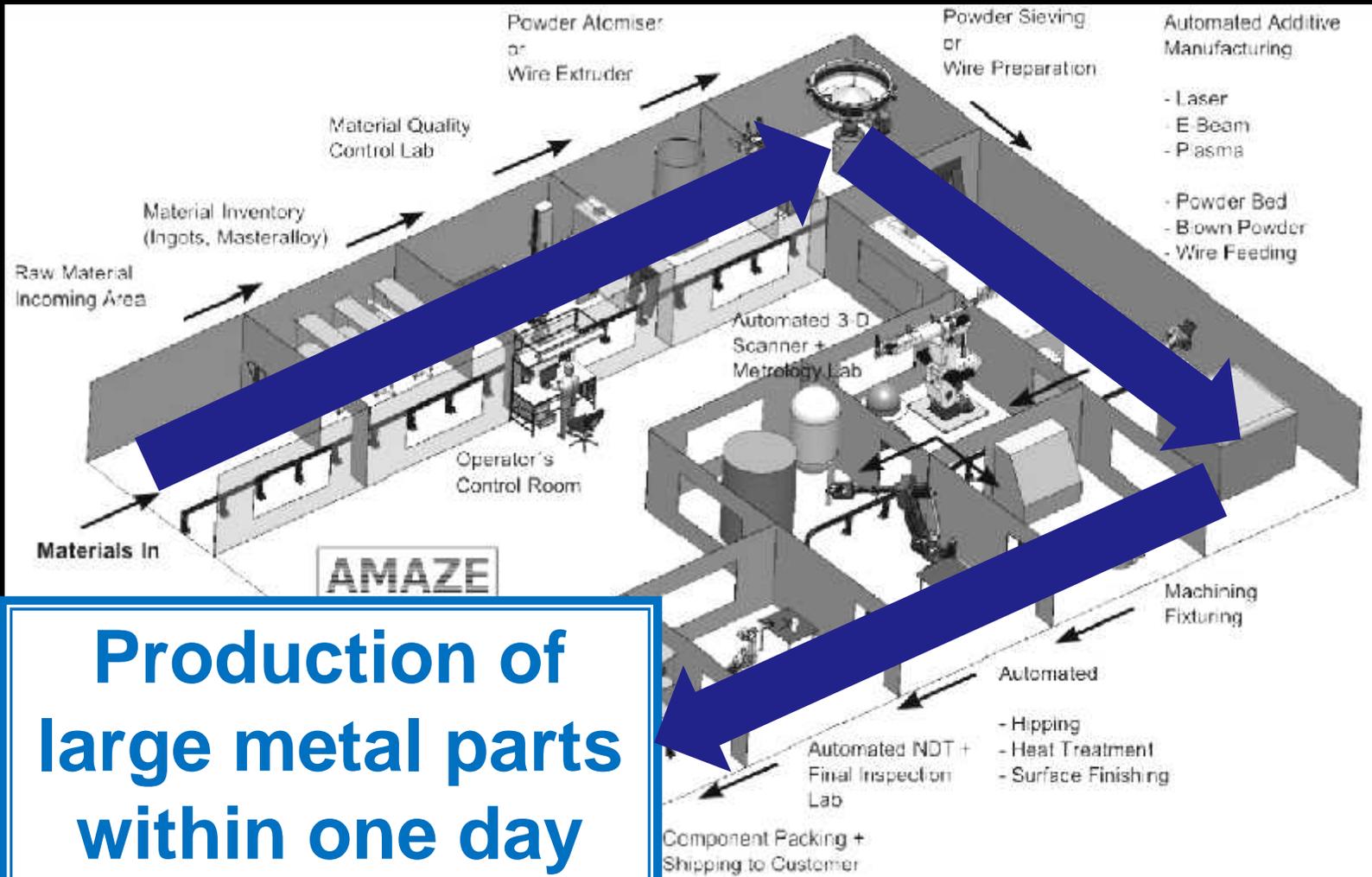
Understand, control and scale-up industrially

Supply Chain Developments



4 new 3D-printing factories are being established and enhanced to create a unique, European-autonomous supply chain for the first time

3D-Printing Factory of the Future



Production of large metal parts within one day



Main Applications:

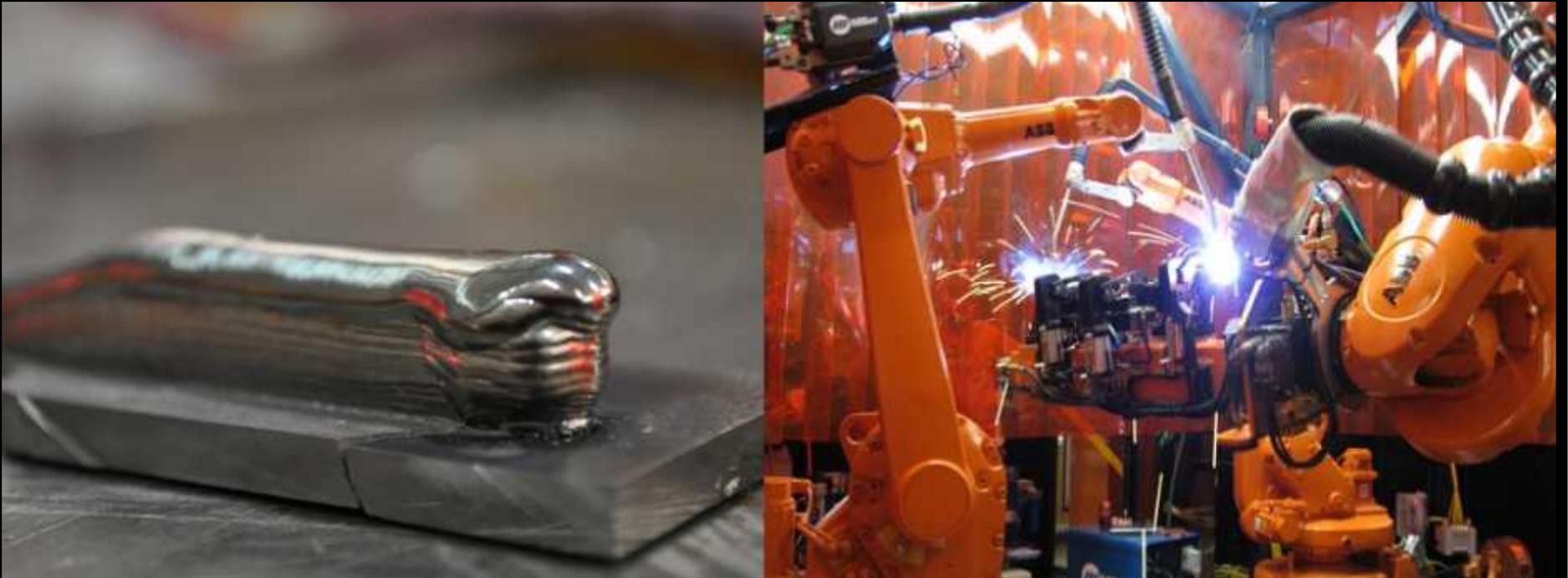
- Airframe / aero-engine technology
- Nuclear fusion tokamak components
- Spacecraft / satellites
- High-tech automotive parts
- Robotic systems
- Catalytic devices
- Manufacturing tooling



Selected Achievements

Fusion tokamak:

- Probably the most extreme, most challenging, engineering component in the world today
- The divertor component needs to survive conditions of 3000 °C
- The kind of component that can enable fusion and hence deliver unlimited, clean energy for humankind, forever...



Aeroplane Structures:

- Working closely with Bombardier, Airbus and BAE
- 3D printing large structures, metre sized, in titanium alloy
- Landing gear and undercarriage components now being made



AMAZE Value Chain

1,000x added value is gained across the entire supply chain



Final Integration into End-User System

Ready for Service

2,000-5,000 € / kg

AMAZE



AM-Processed Component

Plus Finishing, NDT, Inspection, Packaging, Shipping

1,000-2,000 € / kg



Feedstock Material for AM Processing

Atomised Ti64 Powder

1164 Wire

50-250 € / kg



Masteralloy Production

Ti64 Ingot

20-50 € / kg



Metal Production

Pure Ti Sponge
Pure Al Ingot
Pure V Ingot

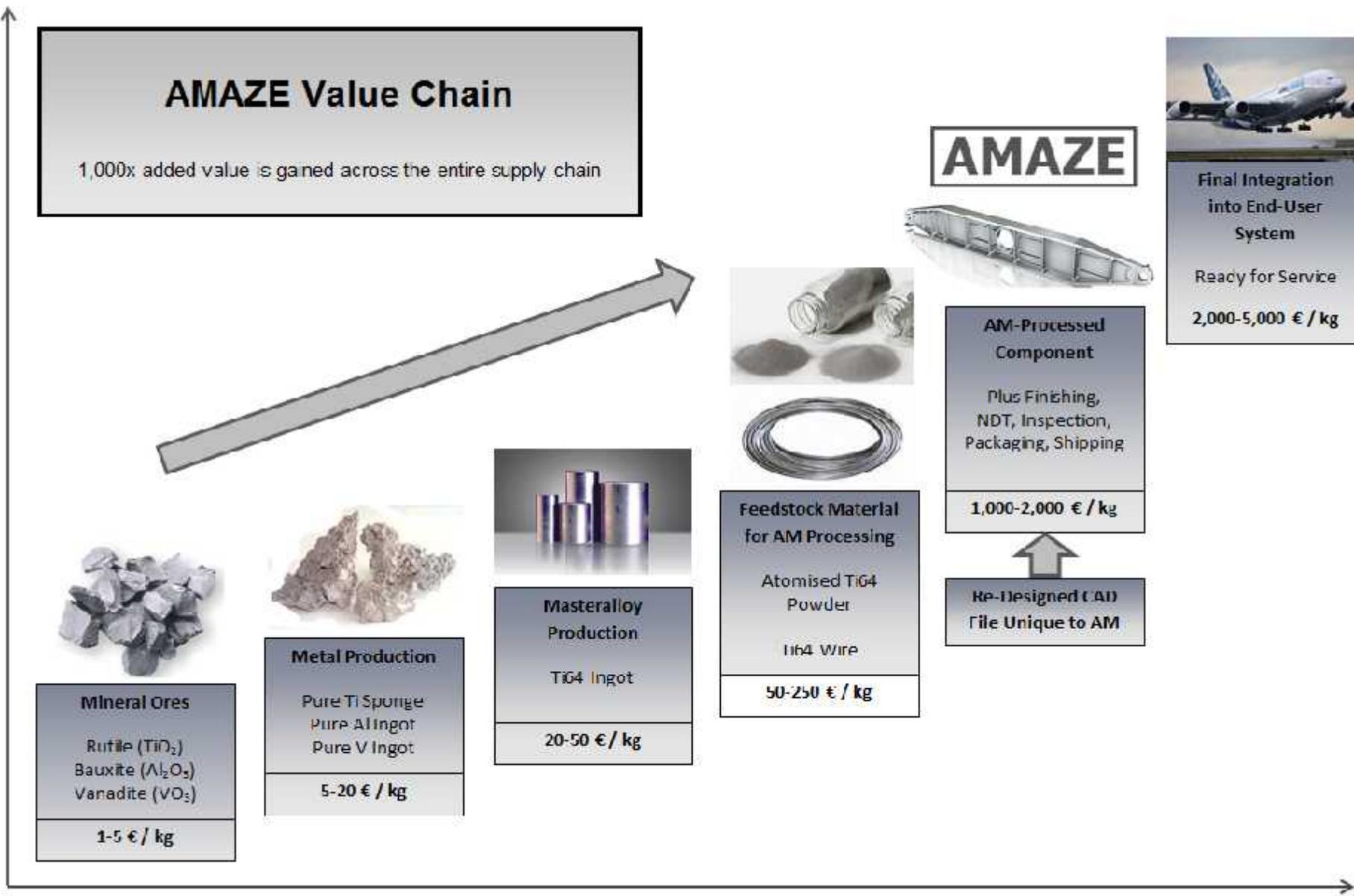
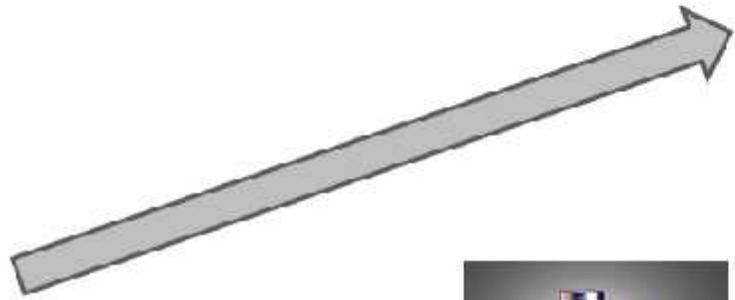
5-20 € / kg



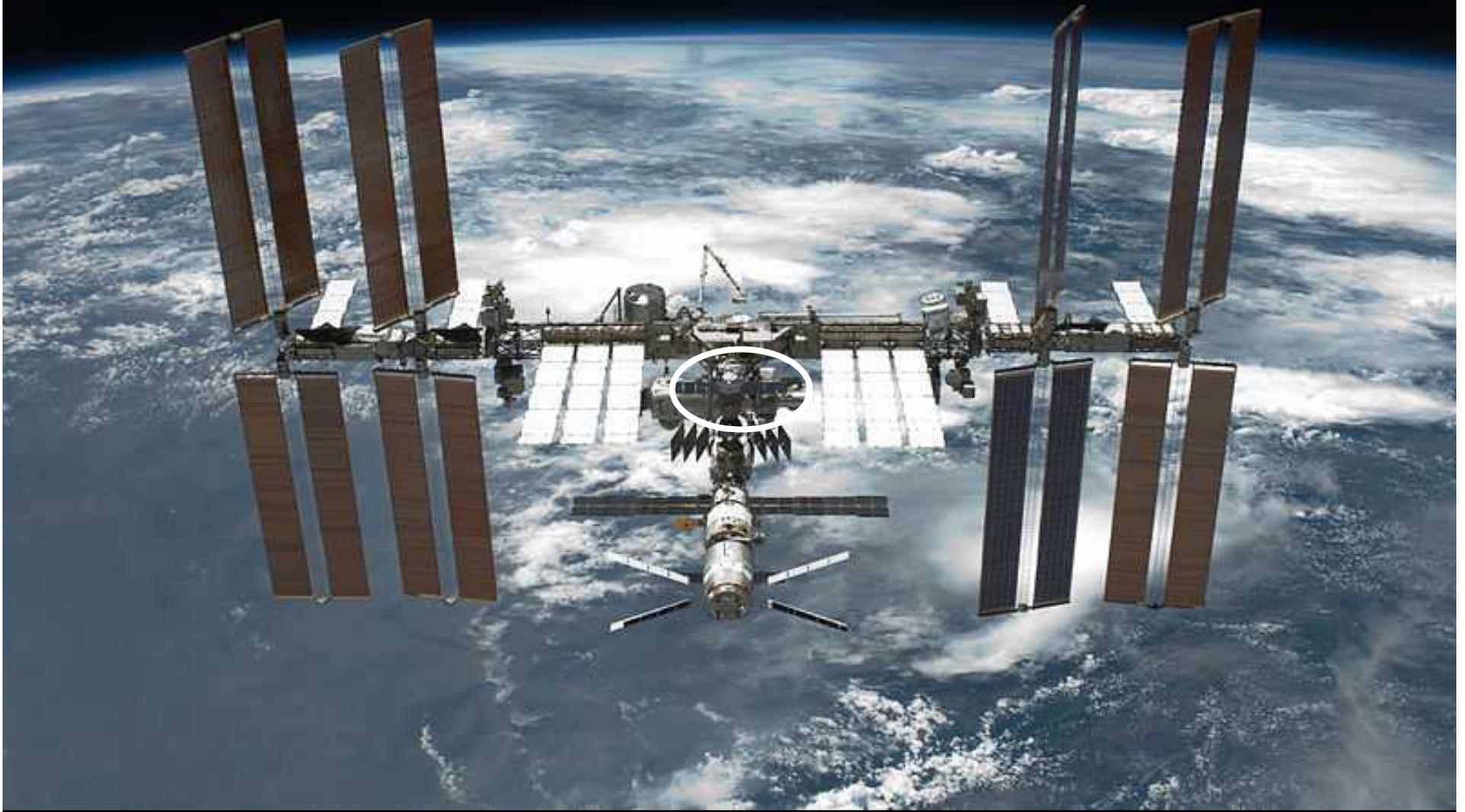
Mineral Ores

Rutile (TiO₂)
Bauxite (Al₂O₃)
Vanadite (VO₂)

1-5 € / kg



In-Orbit Space Manufacturing



Conclusions

- **AMAZE is currently the largest metal-AM project in the world**
- **Team-work, industrial leadership and multi-sectoral cooperation have been very impressive so far**
- **Nothing moves forward without passion for 3D printing**
- **New follow-on projects are already conceived and waiting in the wings**
- **The one billion euro Metallurgy Europe Programme will be the vehicle for industrialisation (more on that in tomorrow's presentation)**
- **Norway is a major player in this important field, with global outlook**
- **Special thanks to our sponsors at the European Commission (FP7) and the numerous AMAZE companies involved**

Thank you for listening



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