This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under GA No 101004730.

# Additive manufacturing in the accelerator community: where are we

Dr. Andris Ratkus Riga Technical University

iFAST

21.10.2025

# Talks in I.FAST Annual meetings

**Results in details will be presented on 22.10.2025 @10:10**

By **T. Romano.** **The Additive manufactured RFQ prototype: results and perspectives**
https://indico.cern.ch/event/1551239/contributions/6690013/

**Previous AM Talks**

Krakow 2025

M. Vedani. The Additiove manufactured RFQ prototype
https://indico.cern.ch/event/1464979/contributions/6376909/

P. Rebesan. The AMIS IIF and its integration in the SPES facility
https://indico.cern.ch/event/1464979/contributions/6376933/

Paris 2024

A. Pepato. AM manufacturing of Superconducting cavities
https://indico.cern.ch/event/1357302/contributions/5854341/

T. Torims. Additive manufacturing for accelerators - outlook and perspectives
https://indico.cern.ch/event/1357302/contributions/5854761/

# Outline

- **Where we are?**
- LPBF AM
- Metal AM in industries
- AM for accelerators
- Measurements and Datums
- Closing thoughts on AM

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# Where we are?

**It depends on engagement and experience with AM**

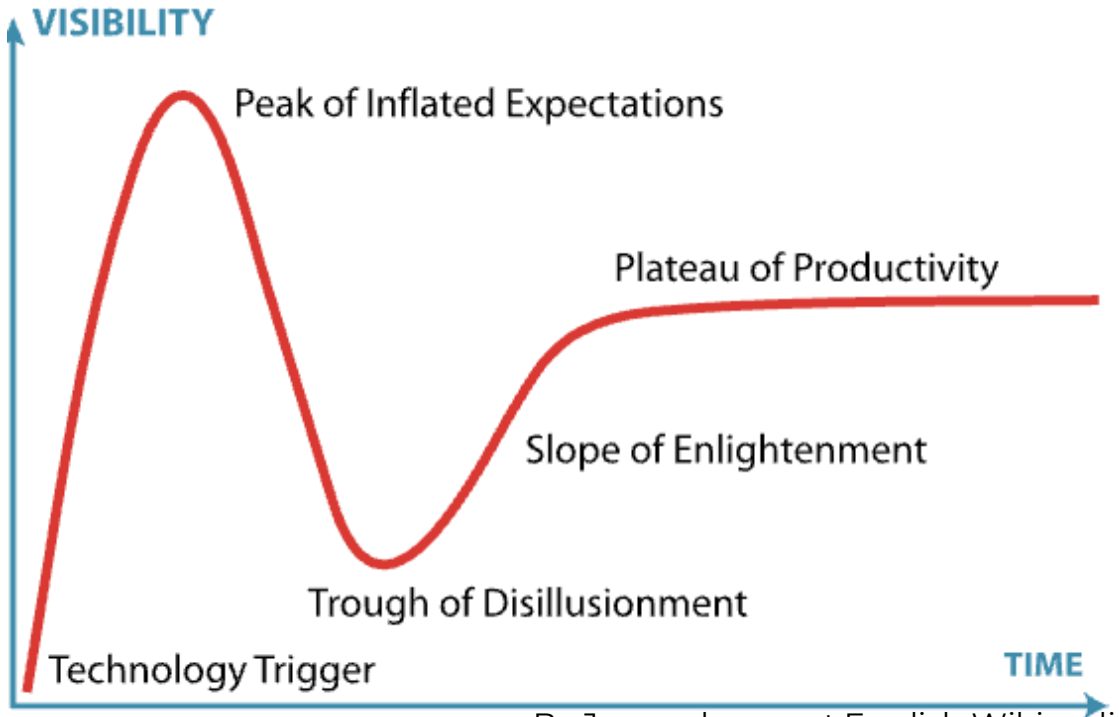
# Where we are?

AM not in a scope

# Where we are?

AM not in a scope

## Cycle of Technology



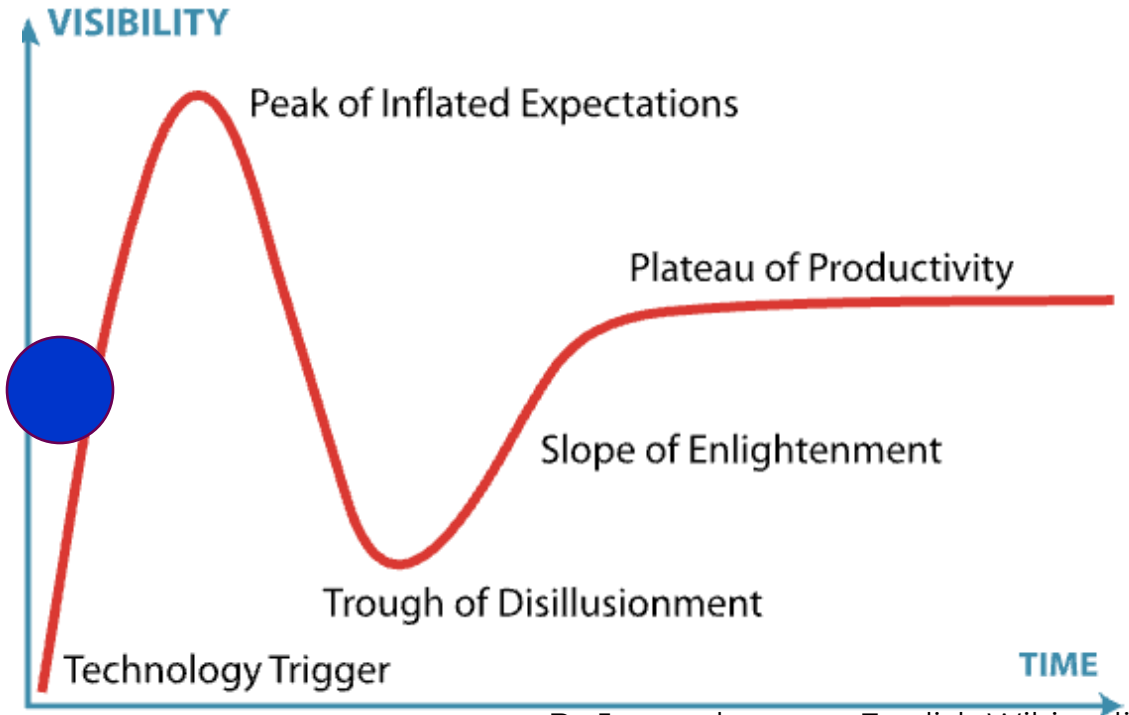

By Jeremykemp at English Wikipedia

# Where we are?

AM can solve everything

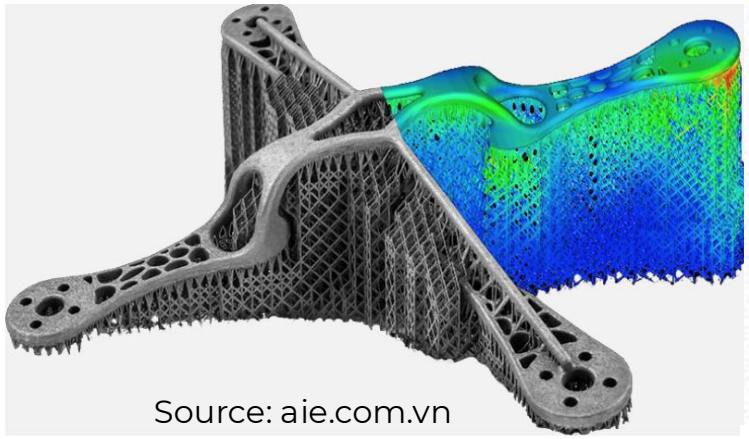
**Only Benefits**

- Design freedom
- Effective material usage
- Weight reduction
- Reduction number of components
- Cost reduction

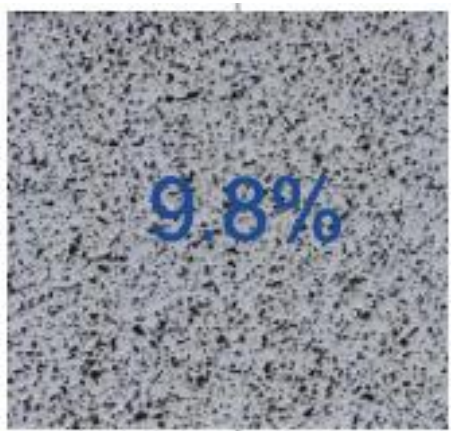



By Jeremykemp at English Wikipedia

# Where we are?



Source: aie.com.vn

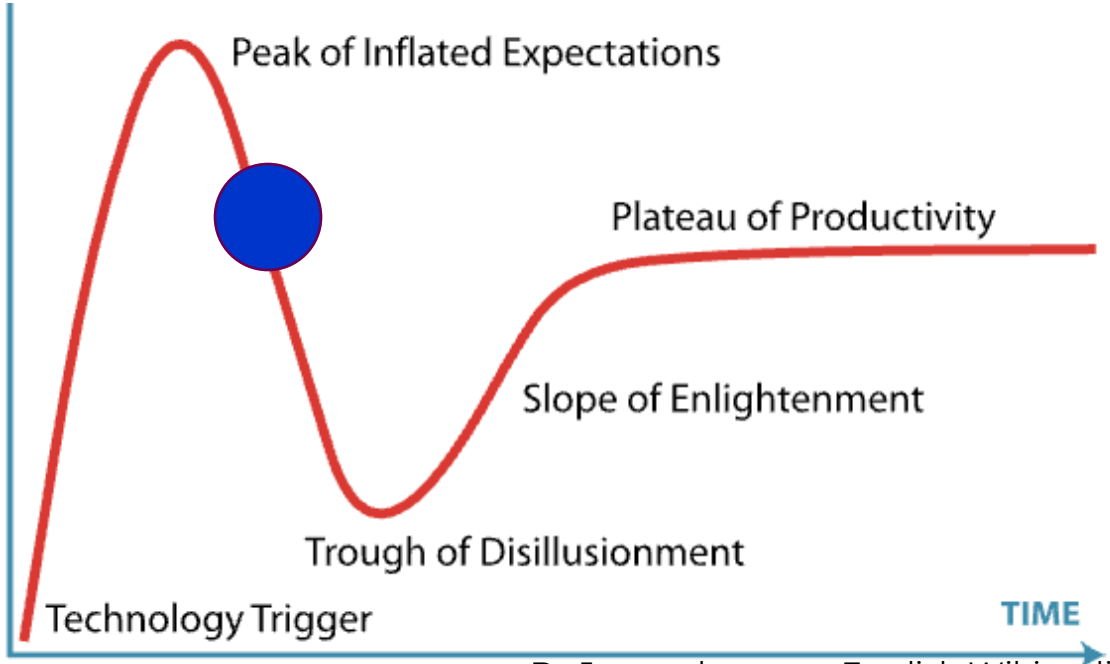



Courtesy: Romain Gerard (CERN)

I tried,
Nothing works

## Disadvantages

- Support are needed (>45deg)
- Residual stresses
- Deformation, defects
- Porosity
- Surface roughness (Ra ~15$\mu m$)



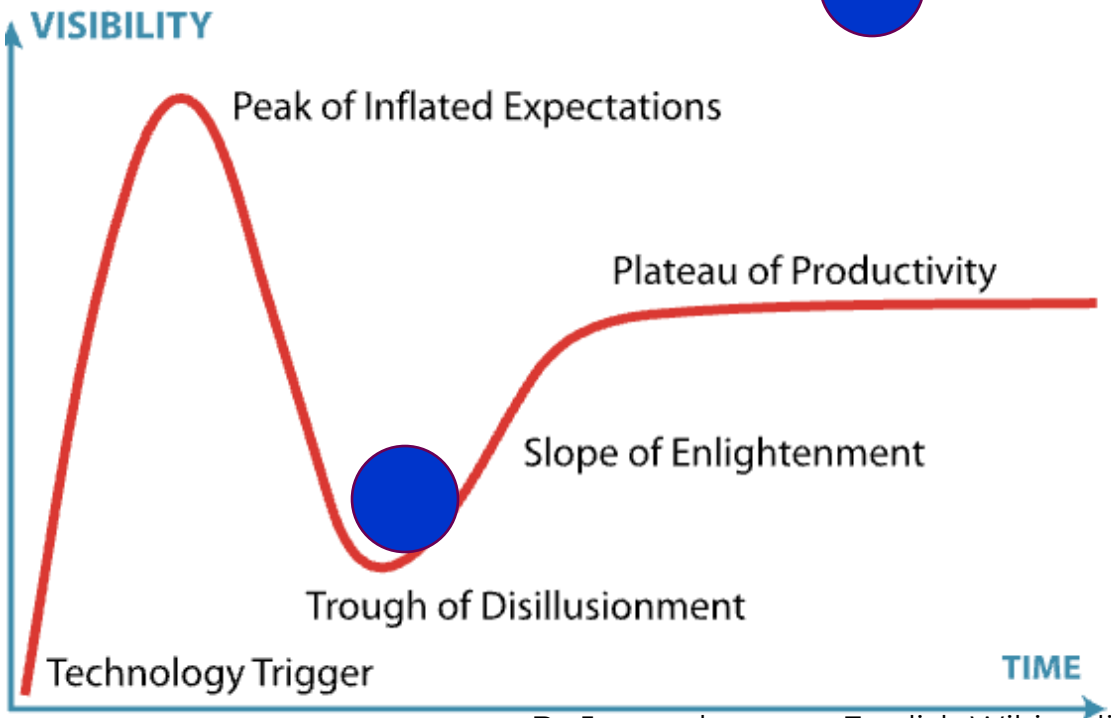

By Jeremykemp at English Wikipedia

# Where we are?

| AM not in a scope | AM can solve everything | I tried, Nothing works | One additional tool in ToolBox |
|---|---|---|---|

**Disadvantages > challenges with potential solutions**

- Roughness > Postprocessing
- Porosity > Process characterisation
- Defects > Design changes

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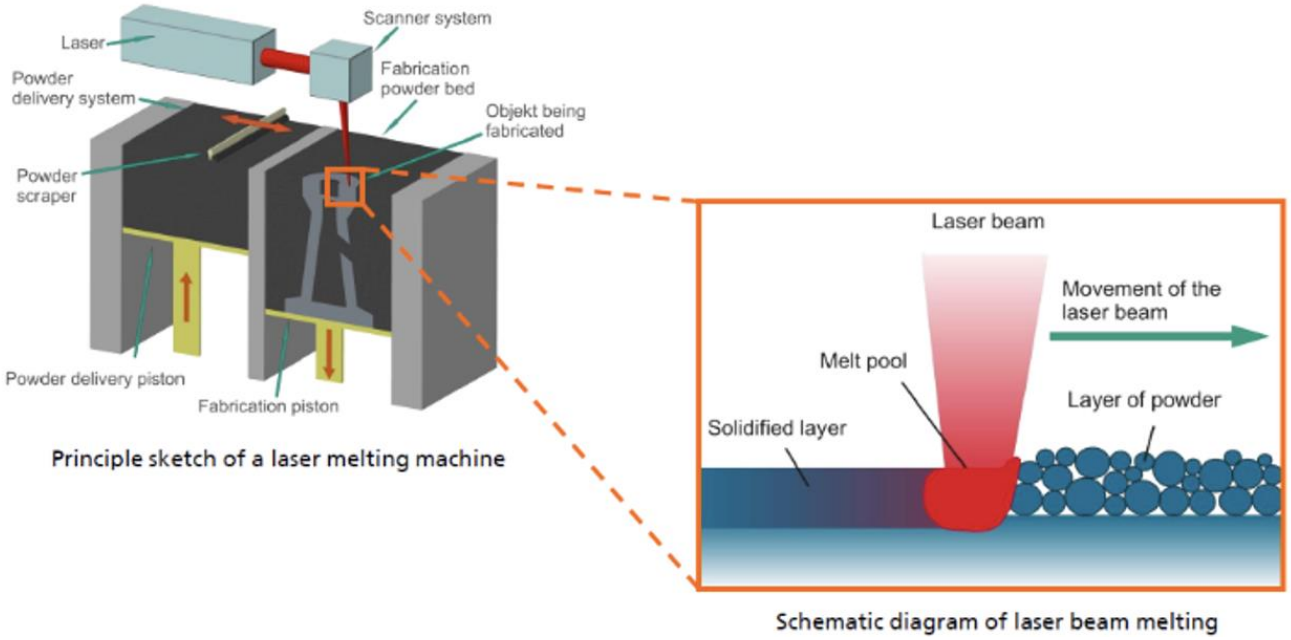
# Metal AM technologies - Laser Powder Bead Fusion




Principle sketch of a laser melting machine

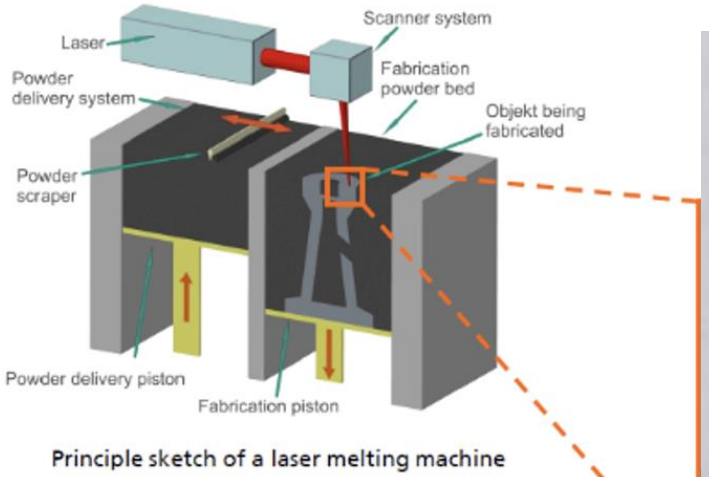
Schematic diagram of laser beam melting

Source: Fraunhofer IWU

https://kdmfab.com/laser-powder-bed-fusion/

# Metal AM technologies - Laser Powder Bead Fusion

- Automaised AM process

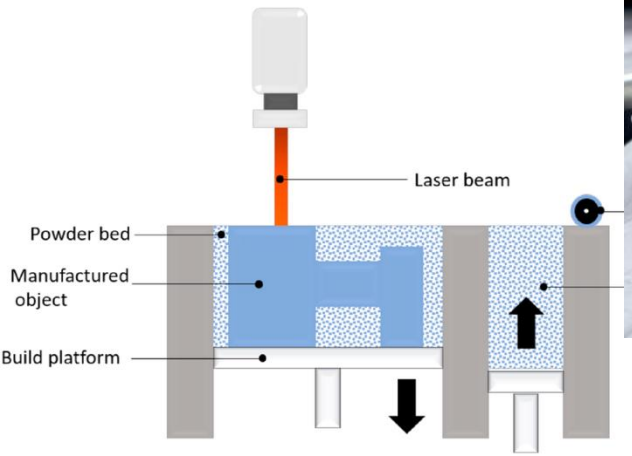



Principle sketch of a laser melting machine

Source: Fraunhofer IWU

# Metal AM technologies - Laser Powder Bead Fusion

- Automaised AM process
- Still a lot of manual work




https://doi.org/10.3390/met13020424

www.makerverse.com

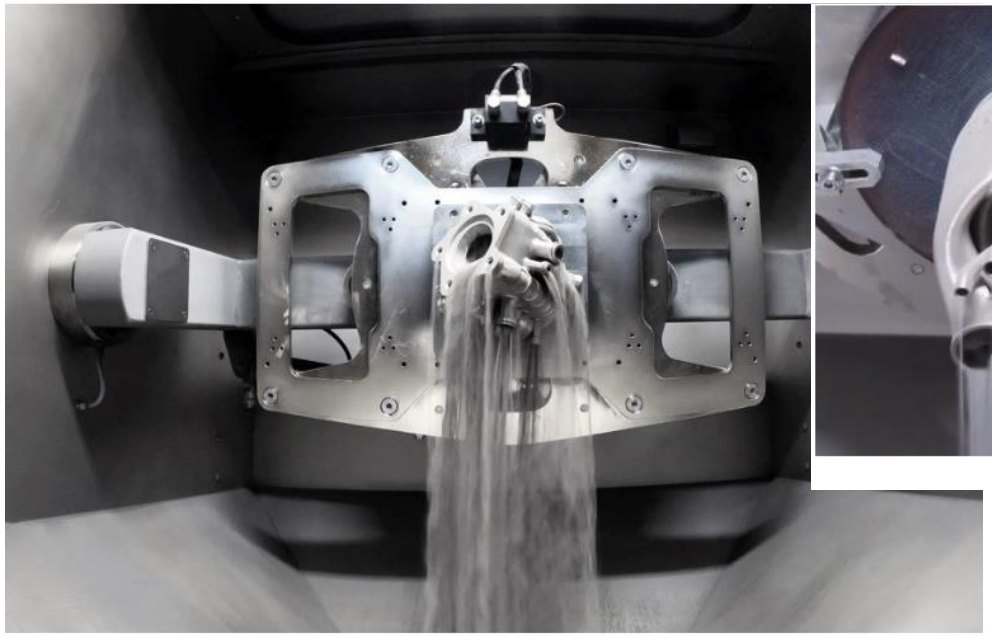
**Powder removal**

Hyliion (www.tctmagazine.com)

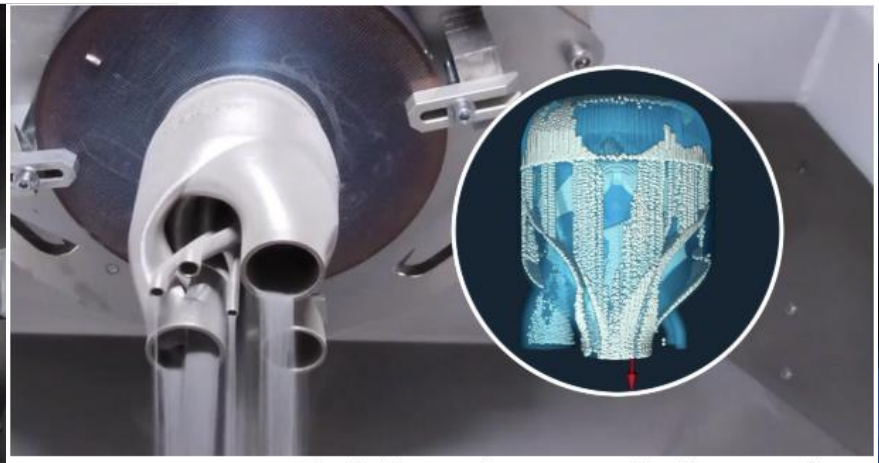
# Metal AM technologies - Laser Powder Bead Fusion

- Intermittent processes in different machines

**Depowdering**



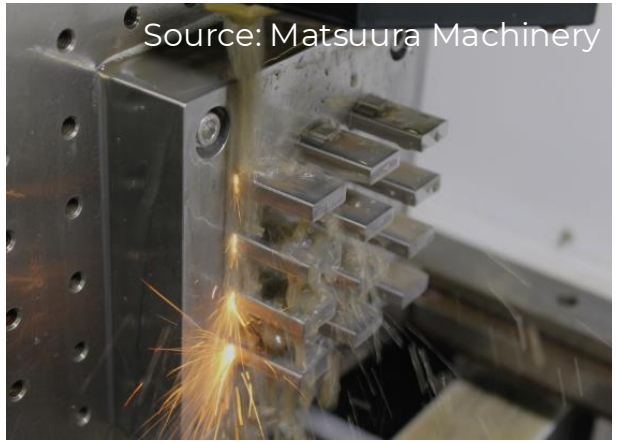
*Automated powder removal in progress in a Solukon SFM-AT800*



The Solukon system, powered by Siemens software

**Sandblasting**

**EDM wire**




iFAST

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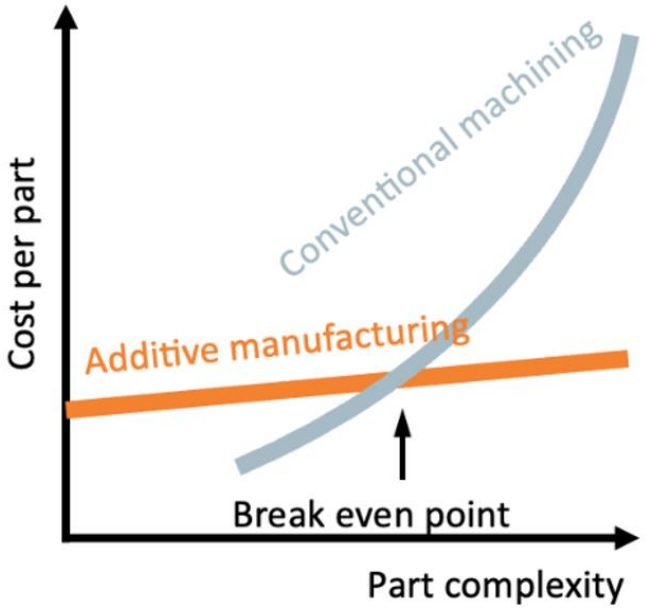
# Metal AM

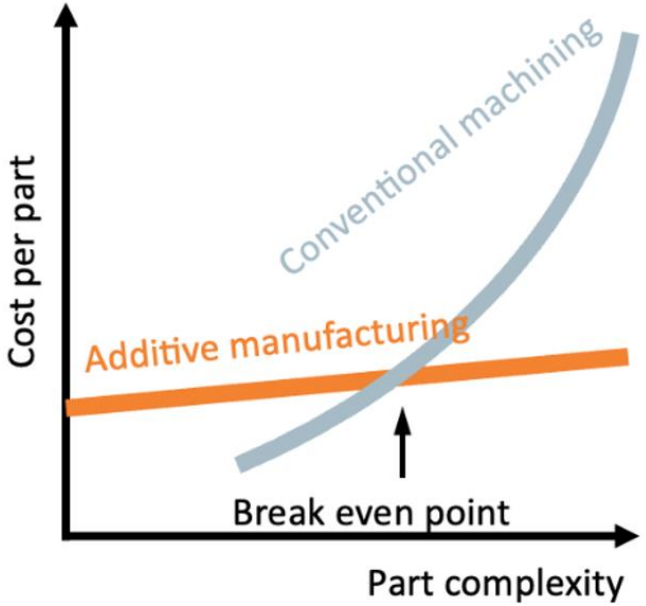
**Complexity**



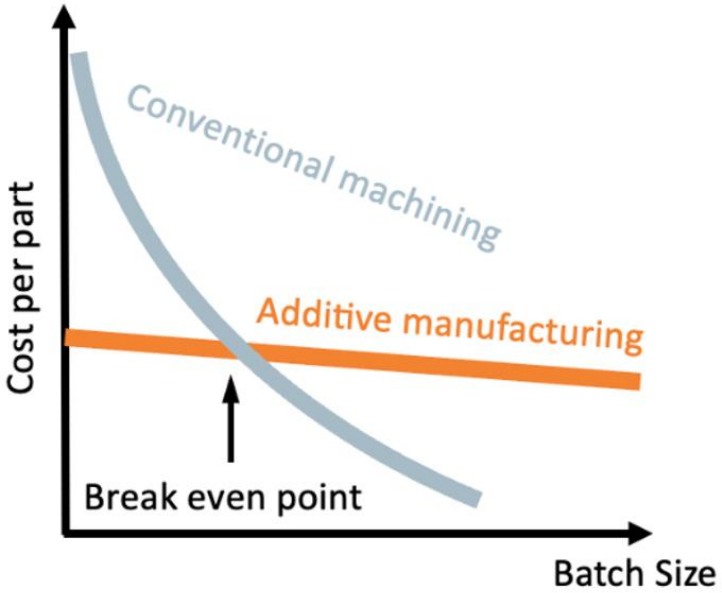
Courtesy of Lukas Stepien

# Metal AM

**Complexity**



**Bath size**

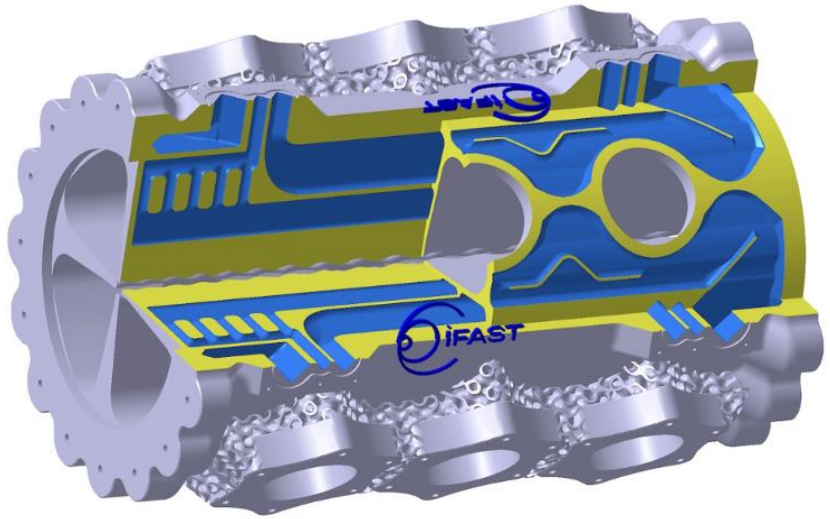



Courtesy of Lukas Stepien

# Metal AM Provides

## Implement AM features into design

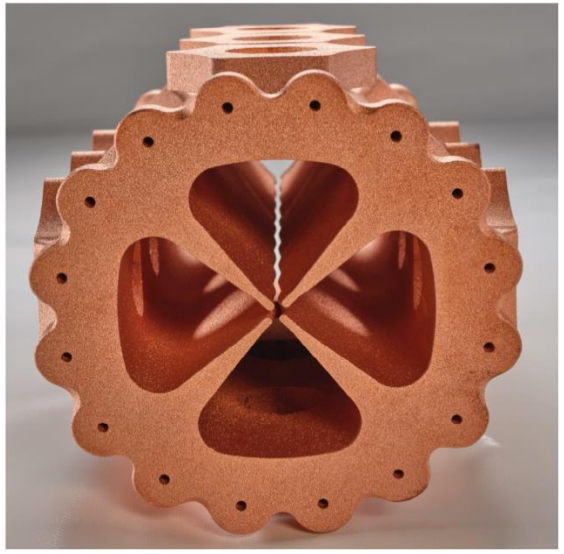
- Add material where it should be
- Cooling channels (closer to heat source)

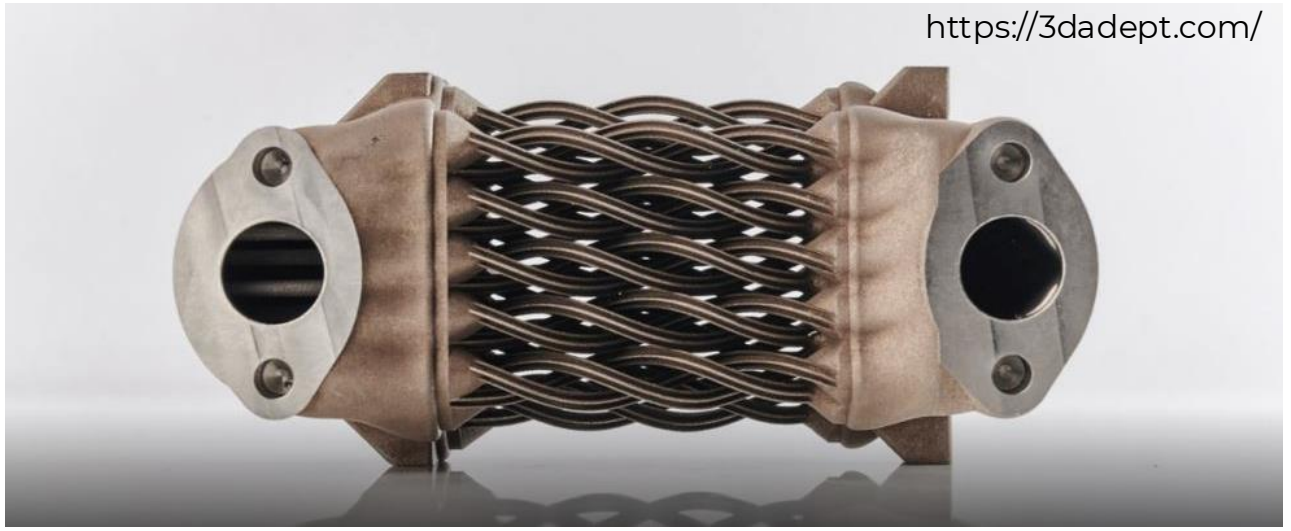


# Metal AM Provides

## Implement AM features into design

- Reduce number of components
- Reduce need for Assembly



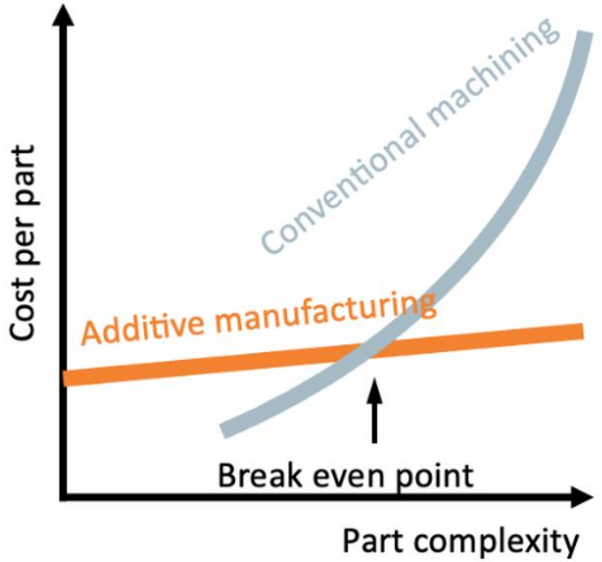


# Metal AM Provides

## Implement AM features into design

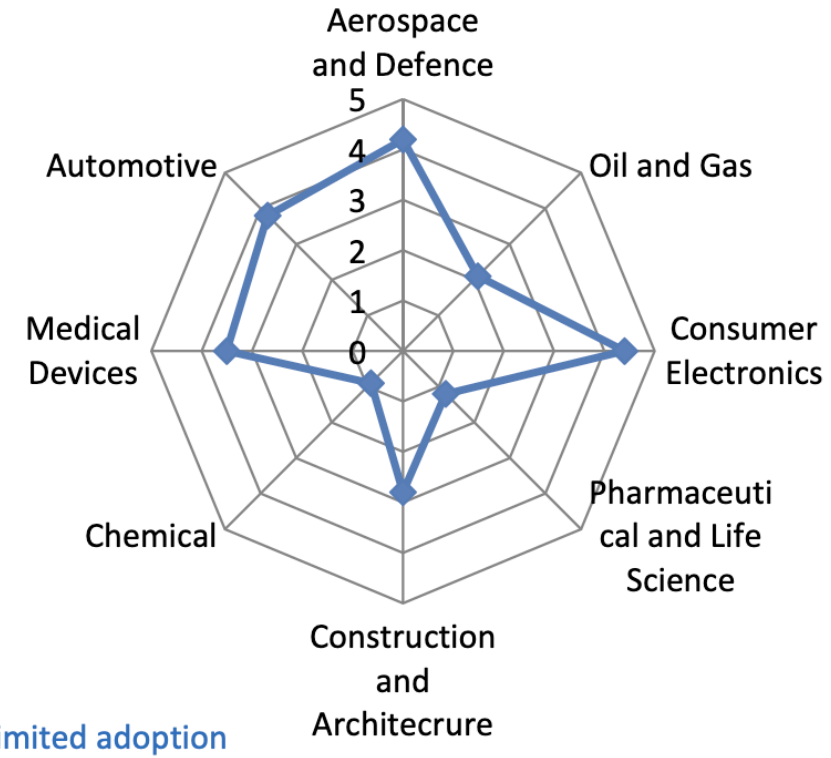
- Add material where it should be
- Cooling channels (closer to heat source)
- Reduce number of components
- Reduce need for Assembly

**By doing all of that we adding complexity to our objects!**



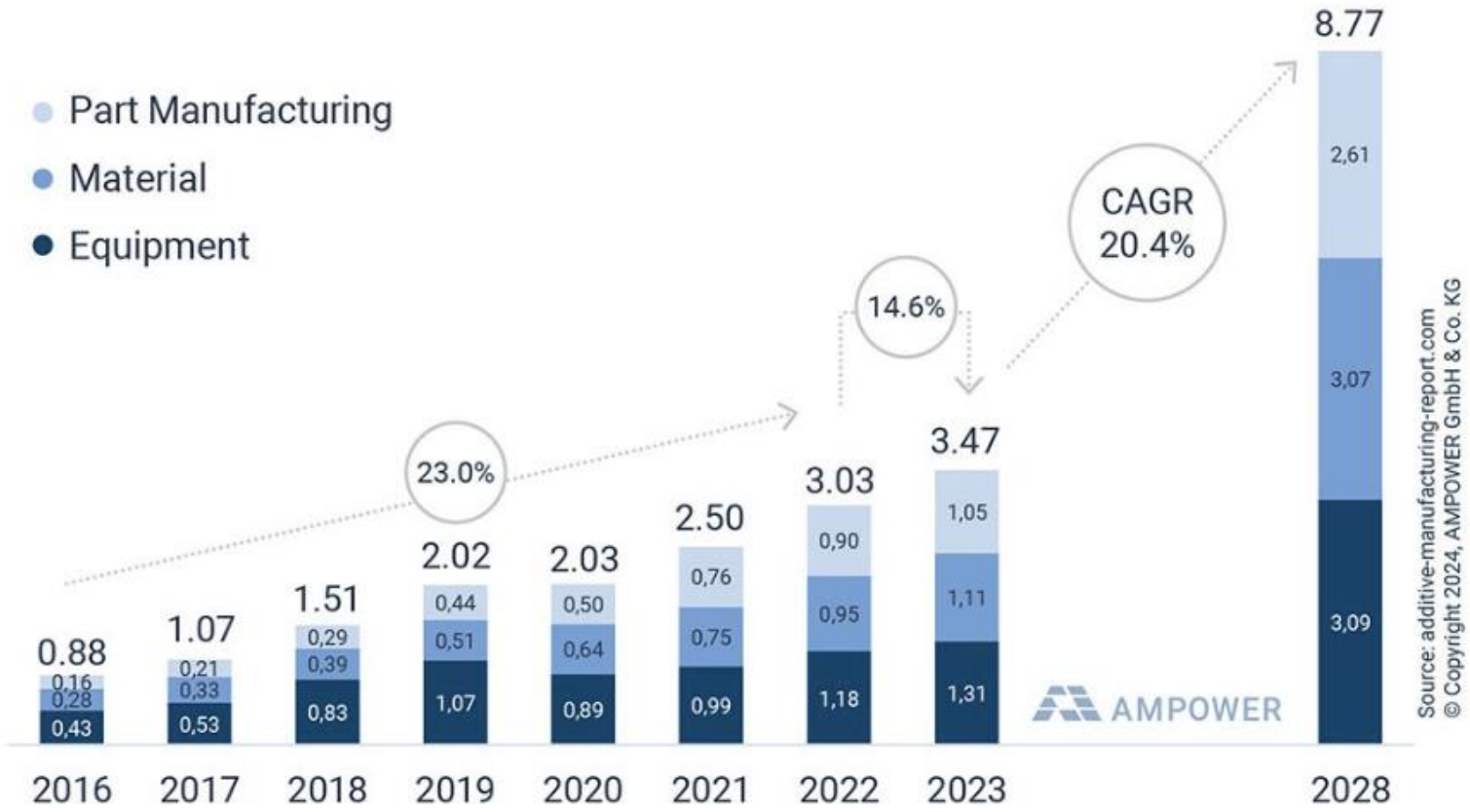

Courtesy of Lukas Stepien

# Metal AM markets




0 - limited adoption
5 - maximum adoption

DOI: 10.21533/pen



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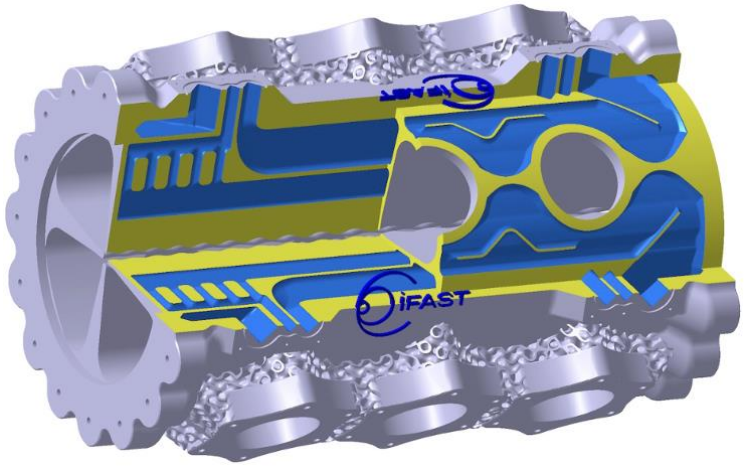
# AM for accelerators

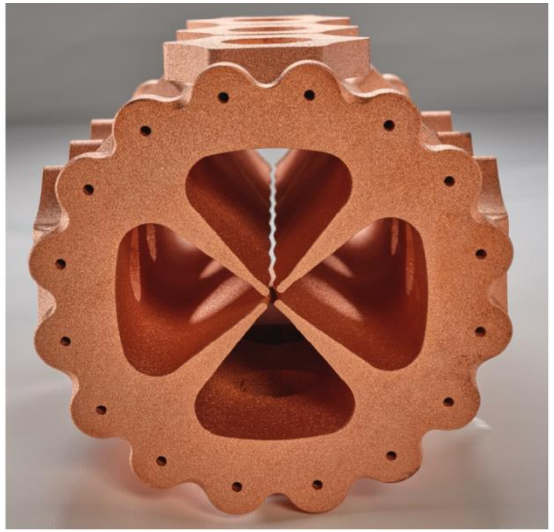
*Picture from 2021

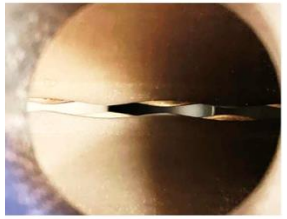


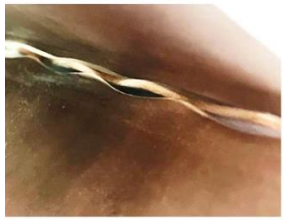
Courtesy of Guntis Pikurs

# AM for accelerators

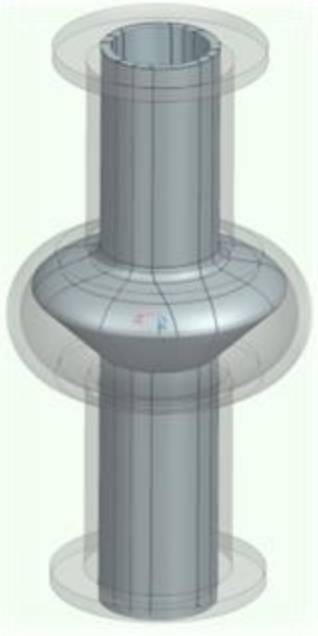


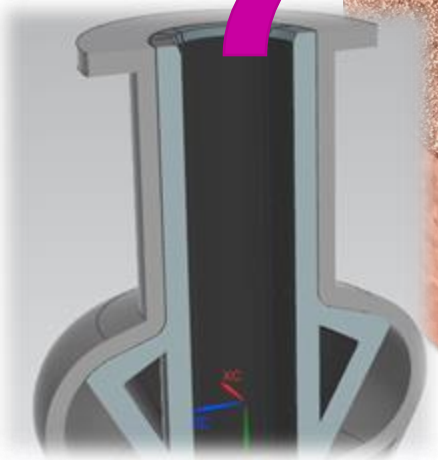


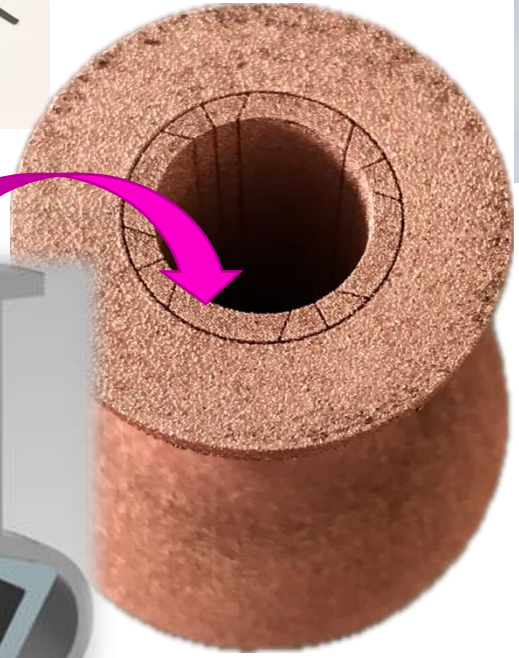




# AM for accelerators







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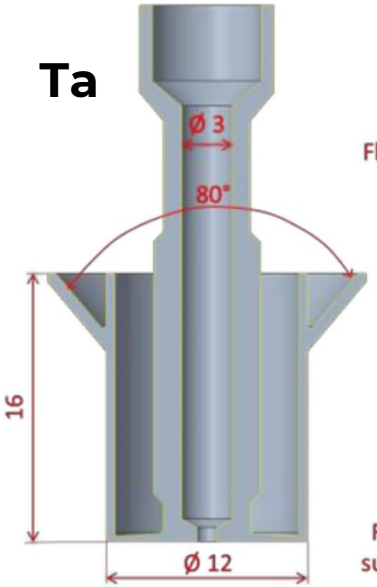

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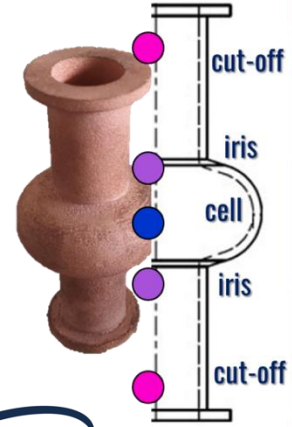
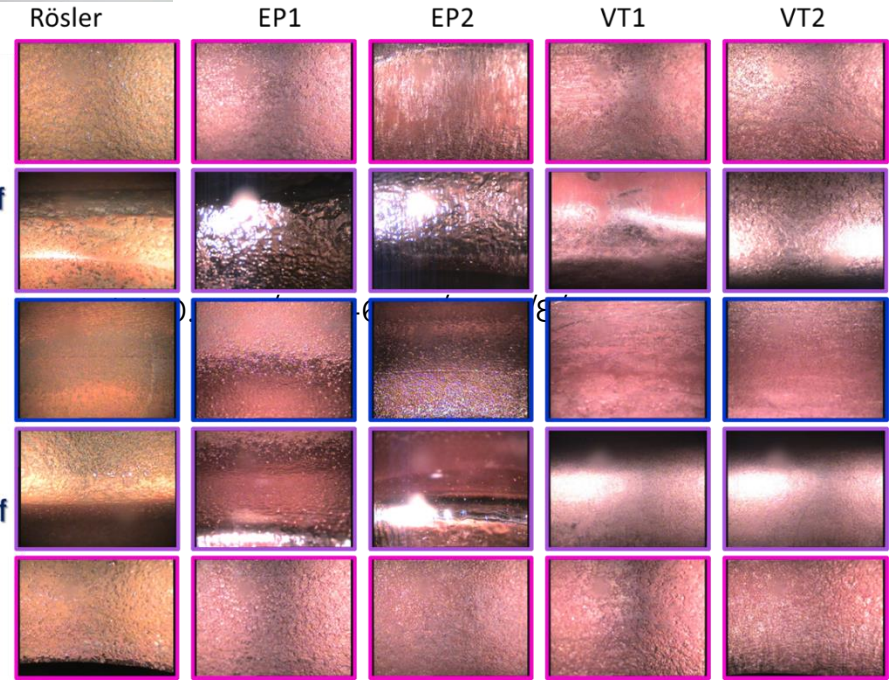
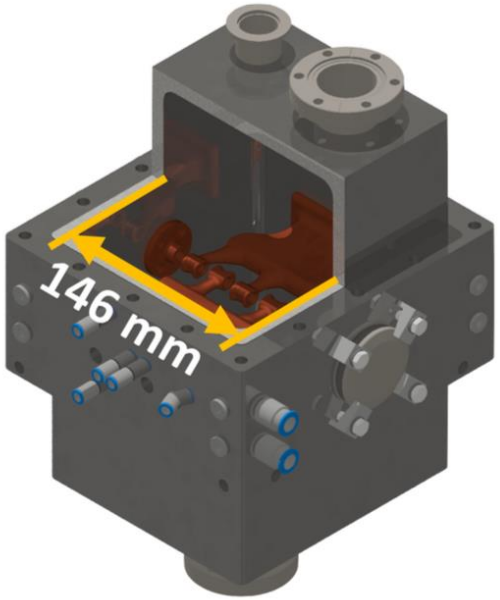


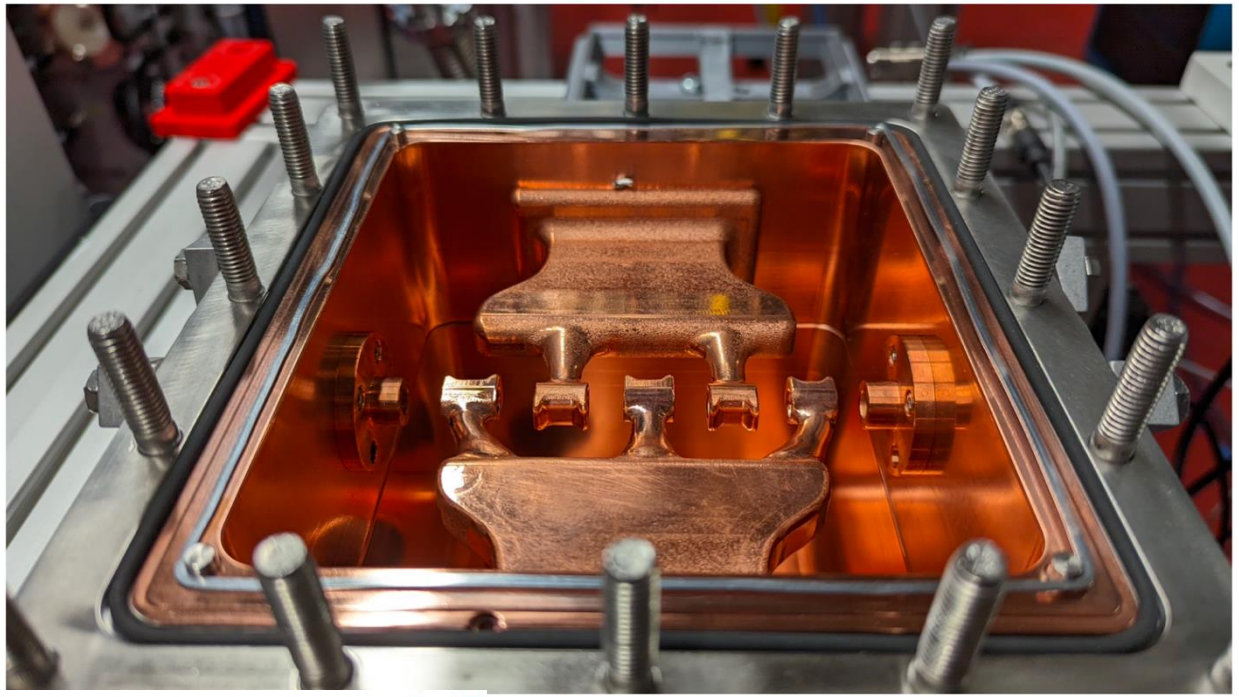




Courtesy of A. Pepato

(results outside of I.FAST)

# AM for accelerators



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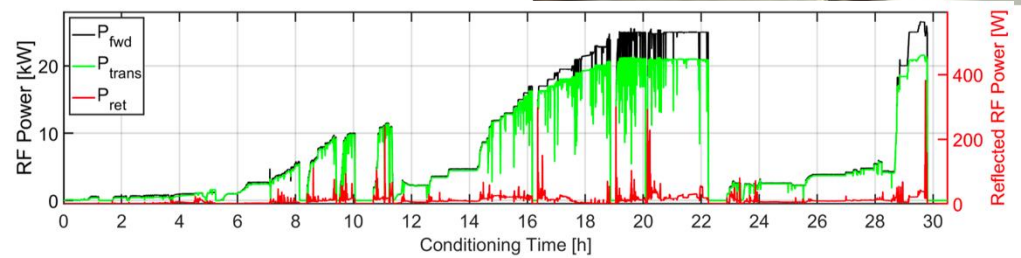
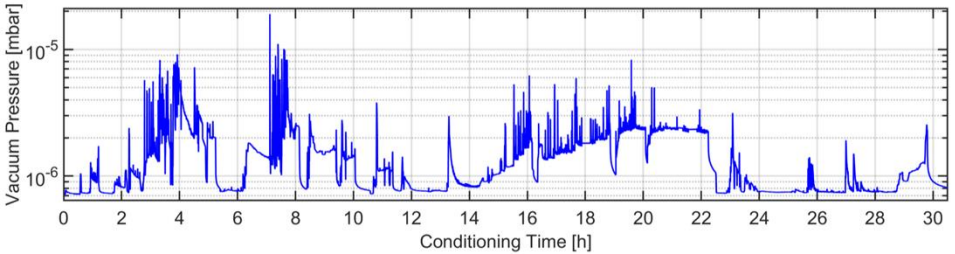
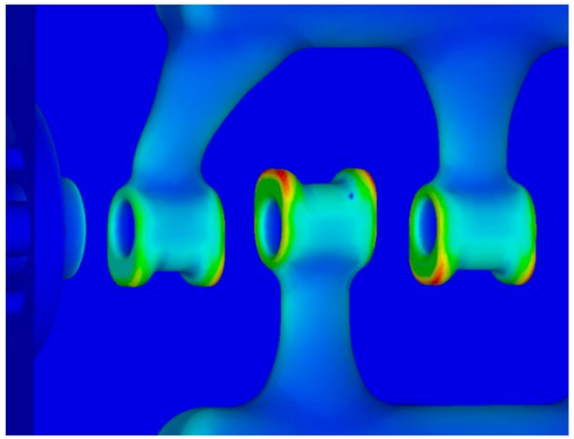


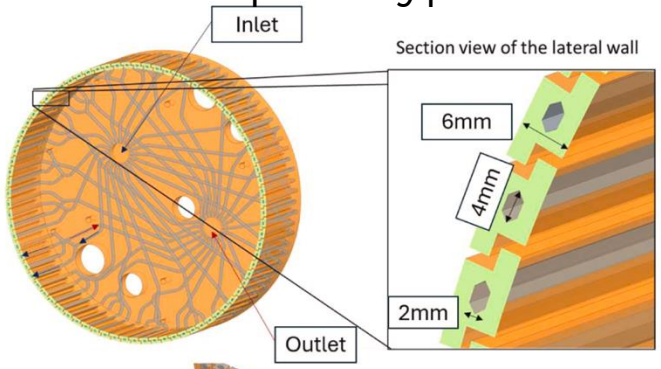


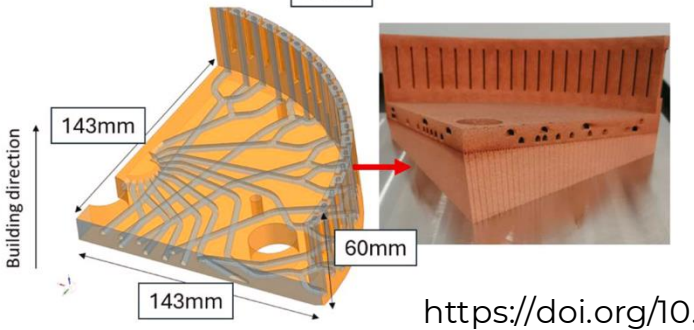
doi: 10.18429/JACoW-LINAC2024-FRXA001

(results outside of I.FAST)

# AM for accelerators

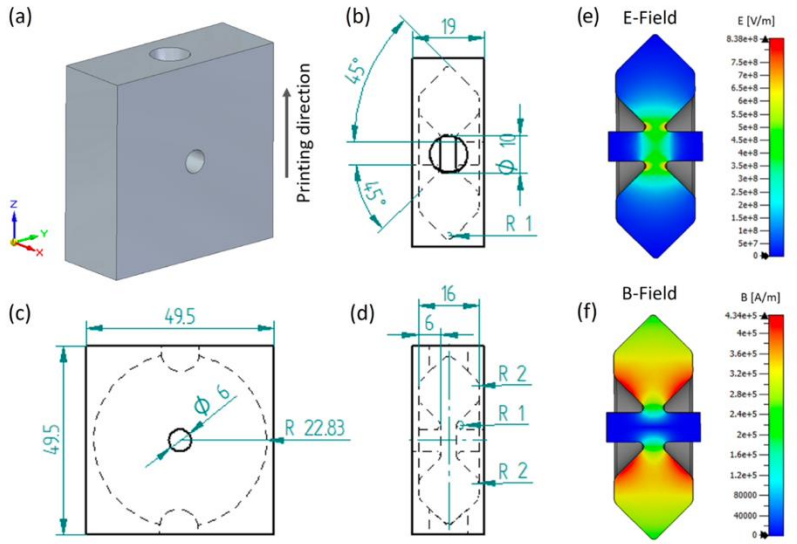
Mirror prototype



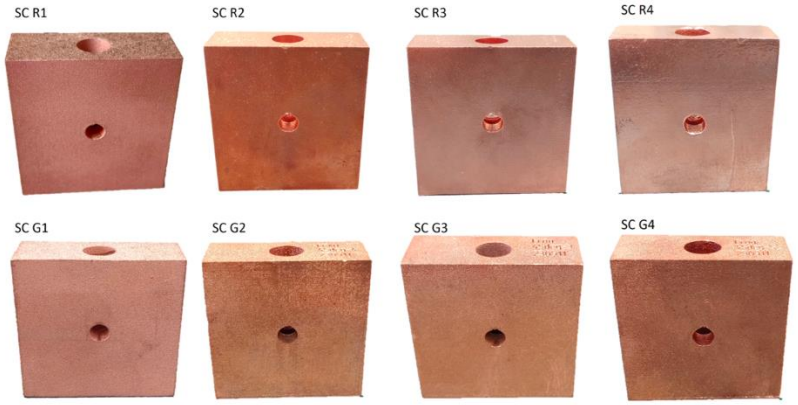




Faraday shielding prototype

https://doi.org/10.1016/j.fusengdes.2025.115238




der Bundeswehr Universität München




https://doi.org/10.3390/instruments8030039

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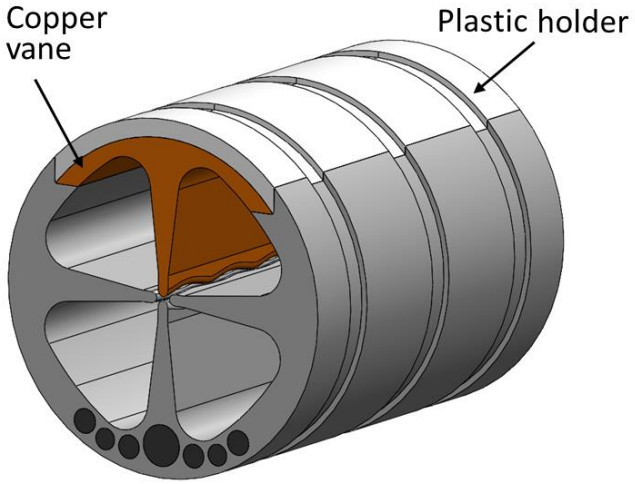
# Measurements and Datums

## Challenges

**AM objects usually are not ” free-standing objects”**

**Control functional interfaces (internal):**

- Roughness – make a tests
- Datums
- Measurements




**Talk on 22.10 @ 10:10 by Tobia**

# Measurements and Datums

**AM objects usually are not ” free-standing objects”**

- Compatibility with conventionally built objects
- Machining
- Fixing points

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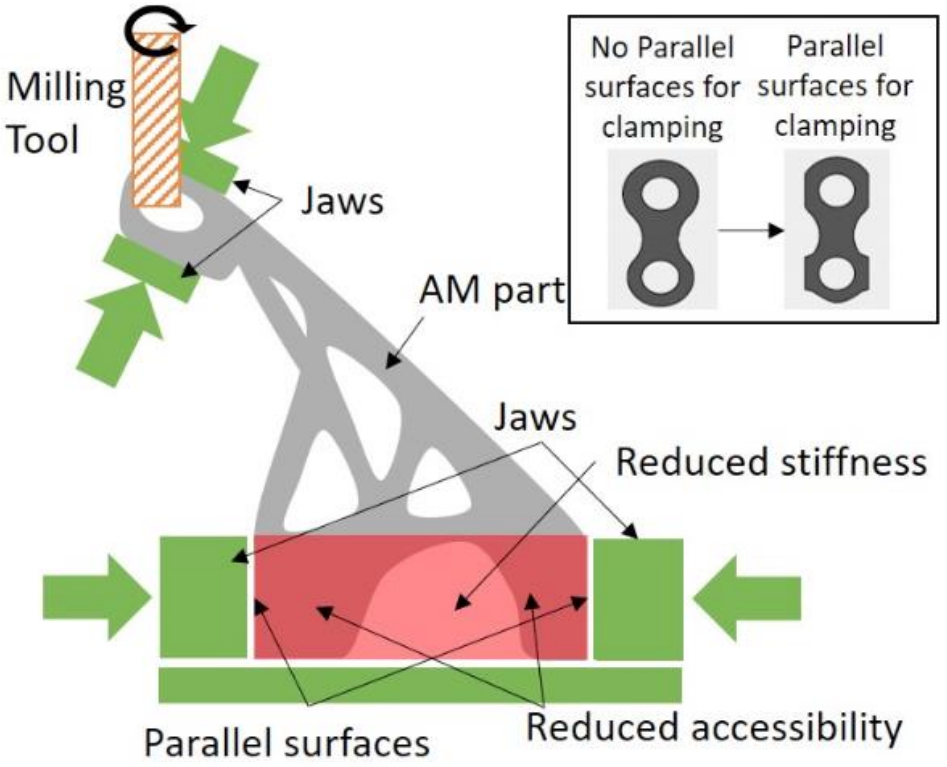




https://doi.org/10.3929/ethz-b-000514979

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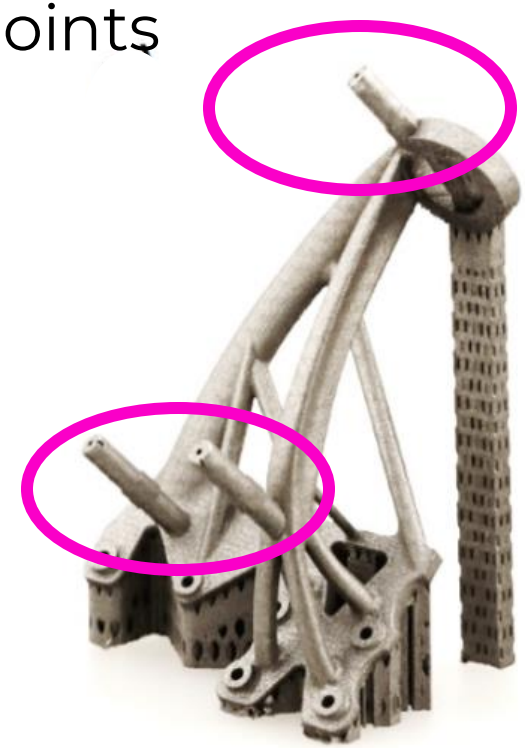
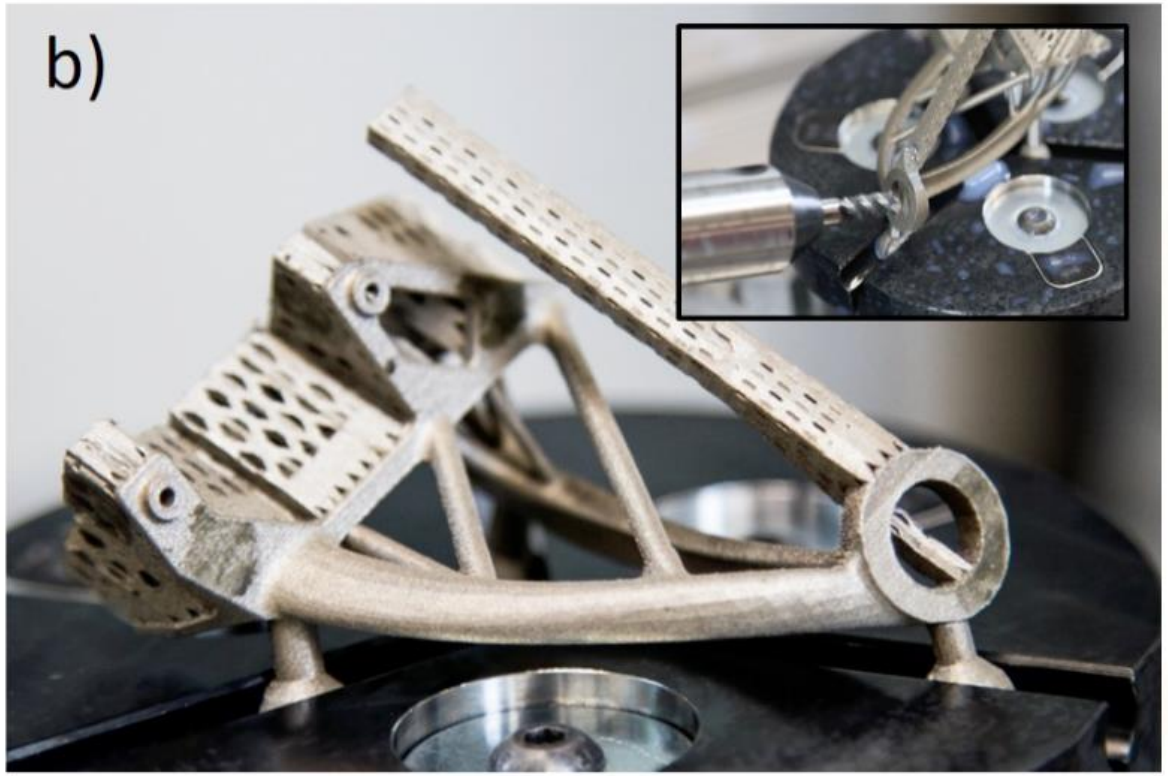
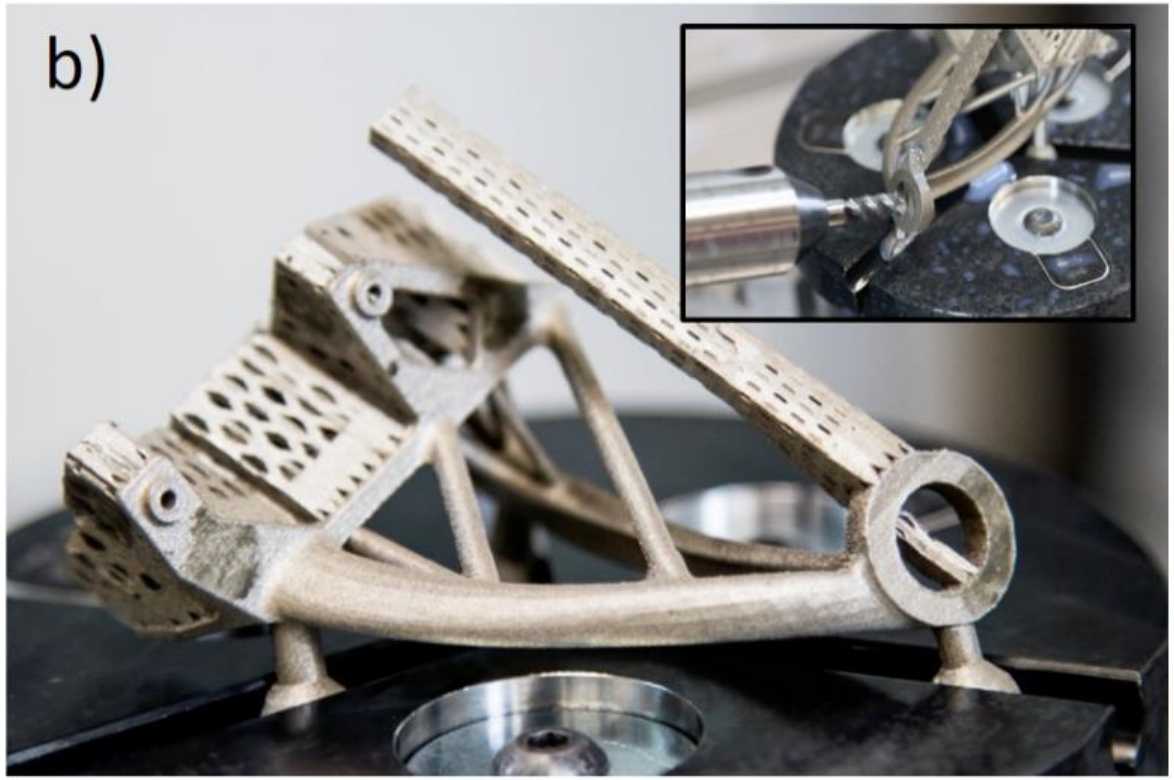





https://doi.org/10.3929/ethz-b-000514979

# Measurements and Datums

With the **Datums** and GD&T* SHOULD NOT be an issue if **ALL functional interfaces** are accessible for machining

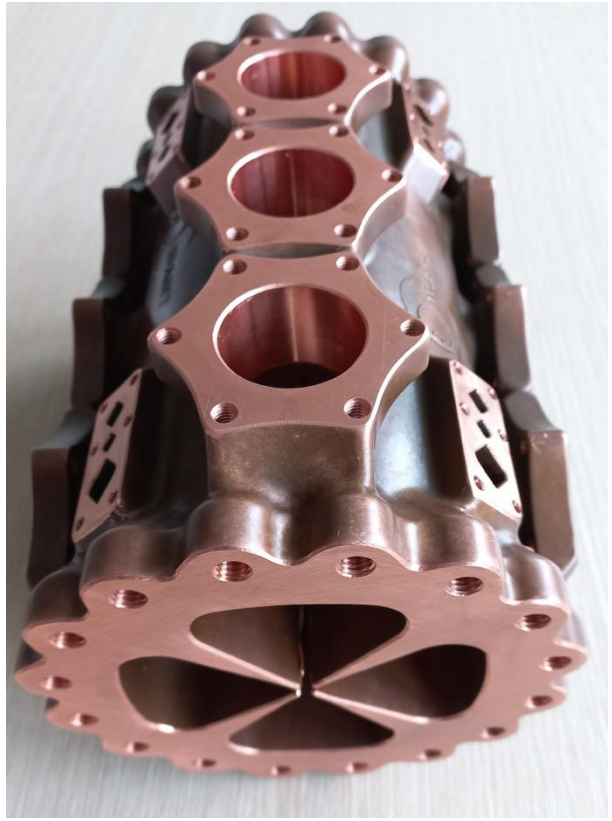



https://doi.org/10.3929/ethz-b-000514979

*Geometric Dimension and Tolerances(GD&T)

# Measurements and Datums

But how to refer on **datums** if **NOT all functional interfaces** can be reached for machining?



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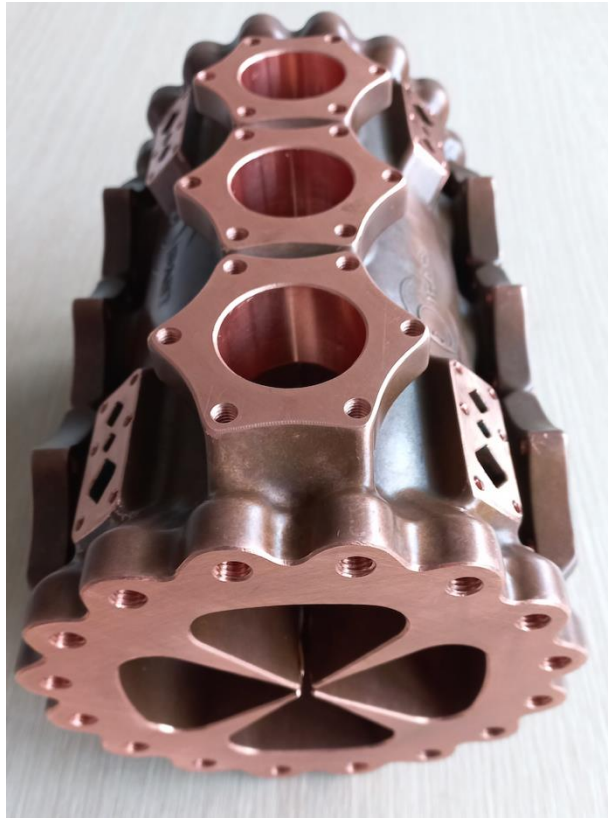

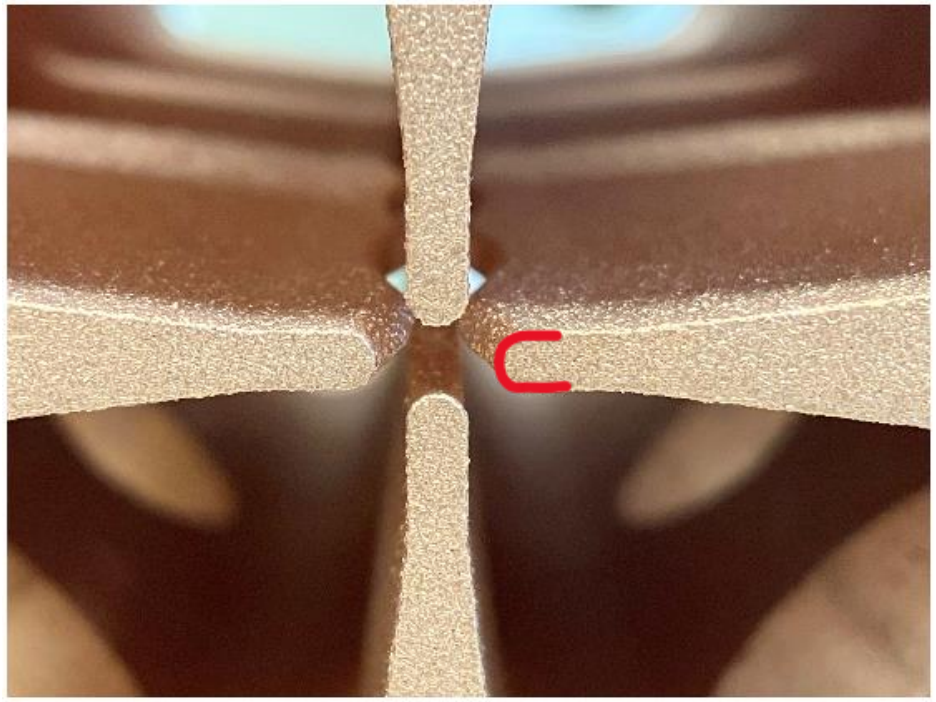

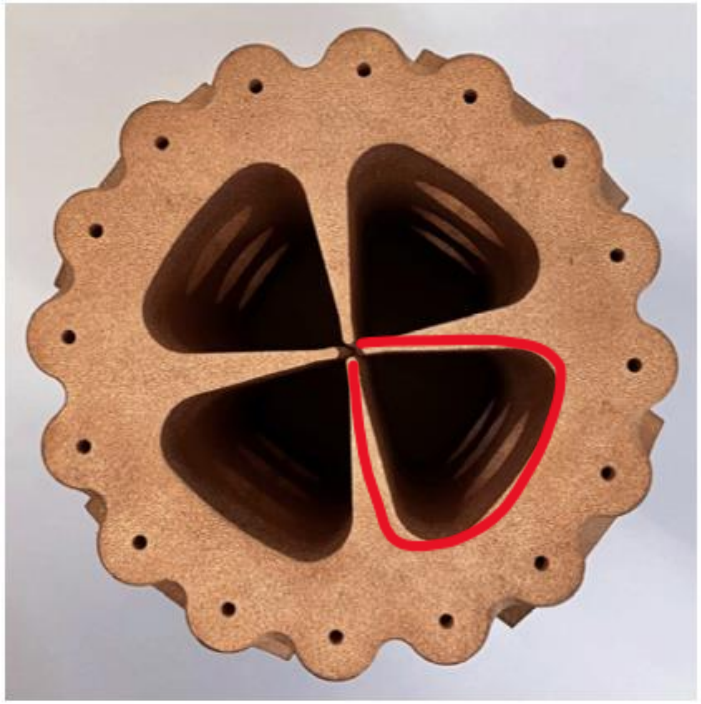

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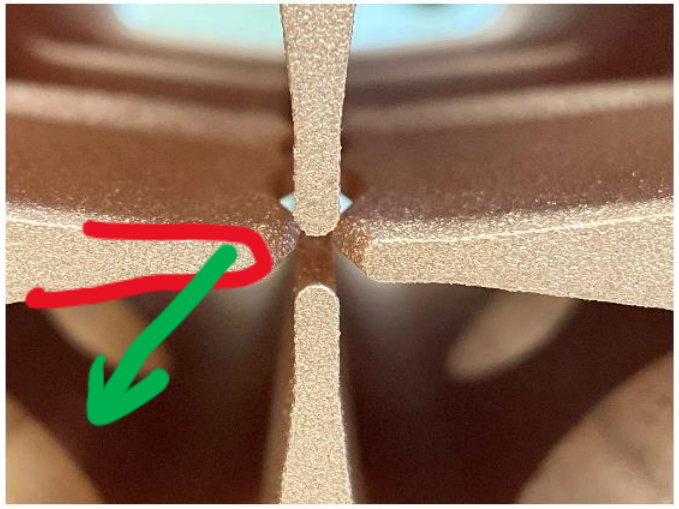
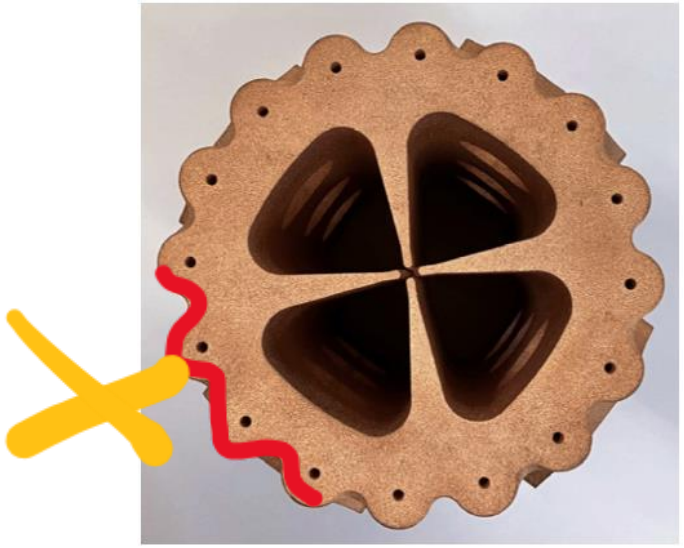
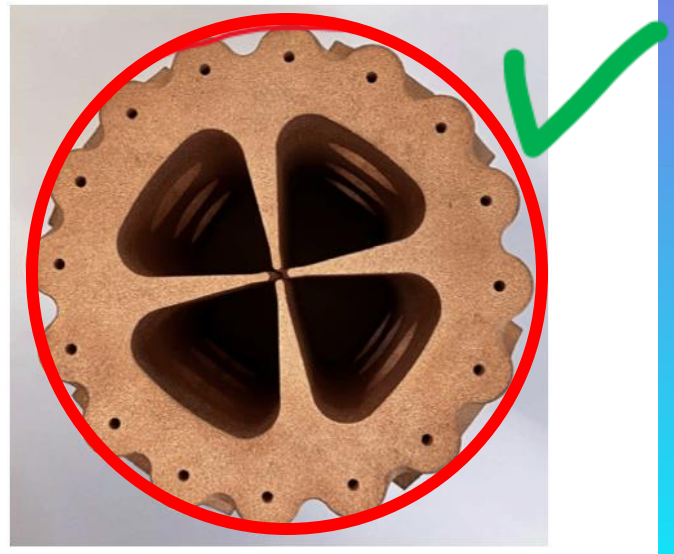


**Expose critical surfaces** for post-build measurements

**Design in datum** features



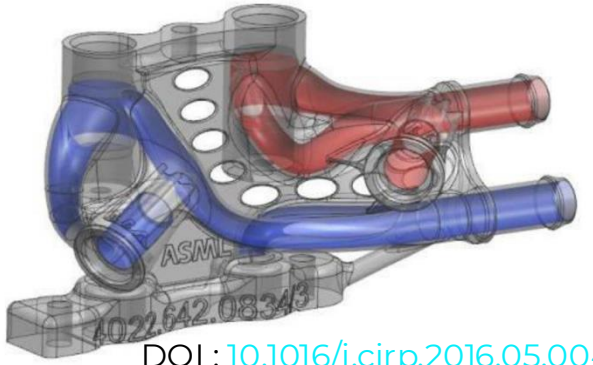


# Outline

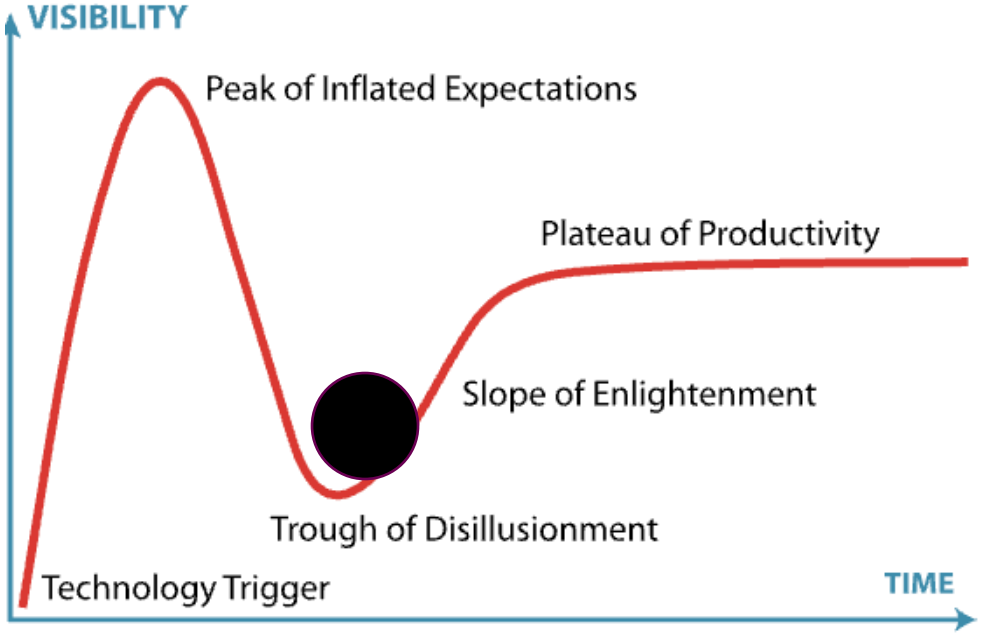
- Where we are?
- LPBF AM
- Metal AM in industries
- AM for accelerators
- Measurements and Datums
- **Closing thoughts on AM**

# Closing thoughts on AM

- AM is not a “Magic Stick”
- AM is a useful tool
- Try out AM, if some **design benefits** can be applied




DOI : 10.1016/j.cirp.2016.05.004




By Jeremykemp at English Wikipedia

Source: www.3dmpmag.com

https://3dadept.com/

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- Add in **design** special features as **datums and fixing** points
- Make R&D to test it

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**Need to: Reach TRL 5-6**
**Attract the End User for faster learning**

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# Thanks for the collaboration

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