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# Additive Manufacturing Applications for Accelerator Technologies (I.FAST)

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iFAST

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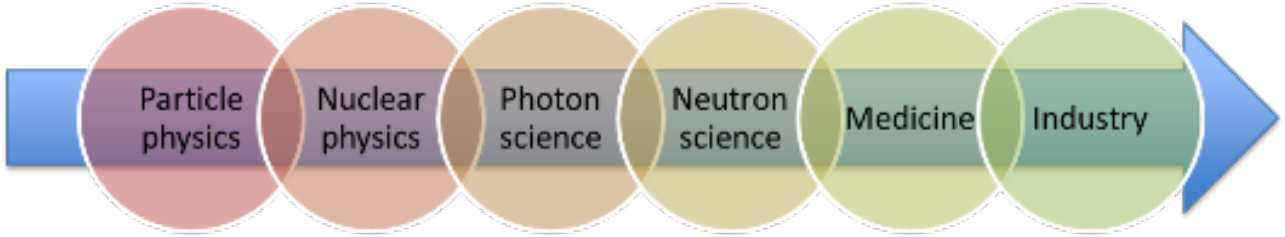
# What is I.FAST ?

**Innovation Fostering in Accelerator Science and Technology,** an Innovation Pilot Project of Horizon 2020 Framework Programme for Research and Innovation, addressing Research Infrastructure Advanced Communities.

- Goal: demonstrating the role of Research Infrastructure in the translation of Open Science into Open Innovation.
- How: **48 beneficiaries**, jointly at **14 WP** and **56 tasks** to developing technologies for the next generation of particle accelerators.
- Timeline: **4 years**, starting 1 May 2021.

# Additive Manufacturing Partnership and Collaboration in I.FAST

Experience and know-how in additive manufacturing (AM)

- Fraunhofer IWS
- PoliMi

"Production"

- RTU
- TalTech

Design
Digitalization

- Rösler Surface Technology Srl.
- TANIOBIS GmbH - supplier of feedstock powders

Industry

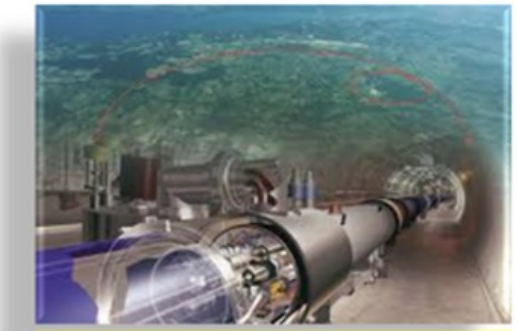
Leading accelerator labs which are doing R&D within AM

- CERN
- CNRS + CEA
- INFN – Padova

Accelerator expertise

# Accelerator Technologies in use

- Globally around ~ 40,000 accelerators
  - Demand increasing
  - Cost–effective technologies are needed



Fundamental science

~1%

Societal applications (medicine, industry, environment, etc.)

- Medicine ~33%

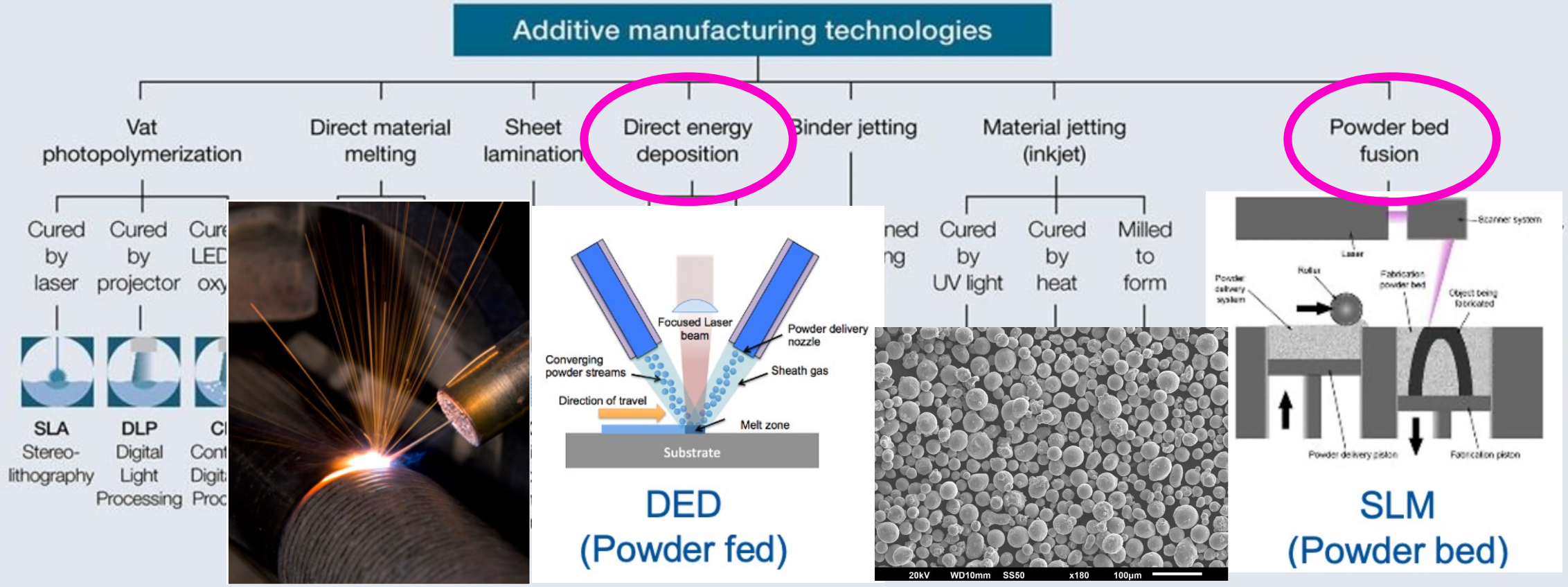
- Industry ~66%

✓Ion Implantation
✓ Electron beam materials processing
✓Electron beam irradiation
✓Ion Beam Analysis
✓X-ray inspection etc.



Source: Maurizio Vretenar (CERN)

# Additive manufacturing




https://www.thefabricator.com/

DOI: 10.3389/fpubh.2020.608718

Source: Antonello Astarita (DICMAPI)

Source: Ana Miarnau (CERN)

# AM applications and potential developments

**TWO potential directions**

- Additive manufacturing **production**

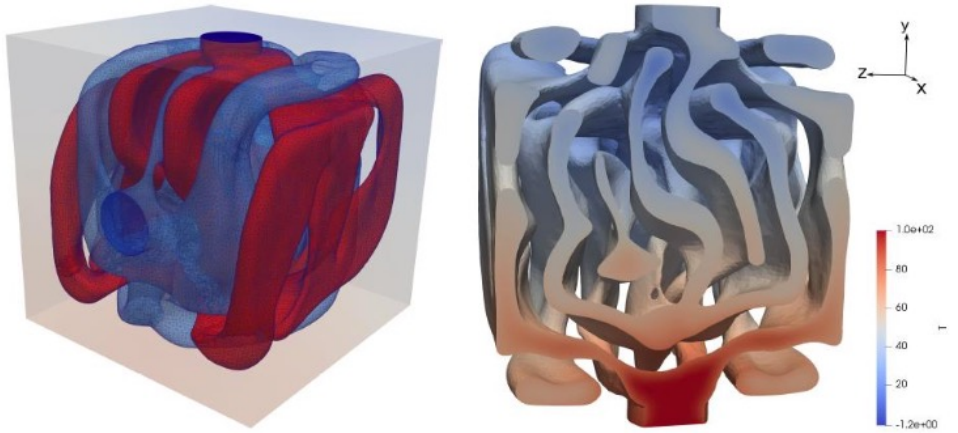
Source: INFN PD

- Additive manufacturing **repairs**

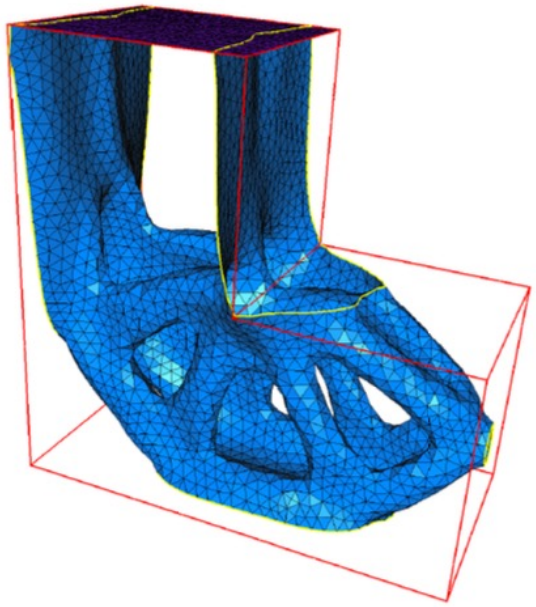
Source: Fraunhofer IWS

# AM production benefits

- **Design** – add material where it's needed




Heat exchanger design



Minimal weight and compliance

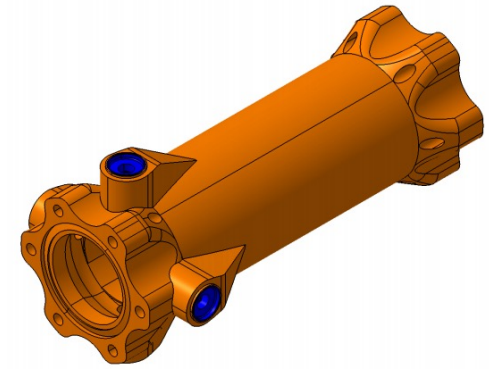
Source: Grégoire Allaire, Laboratoire CMAP, Ecole Polytechnique, France

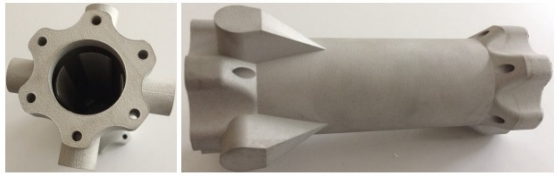
Hydraulic bloc

Source: Yicha Zhang, UTBM

# AM production benefits

- Exotic materials
- Reduce number of components
- Cost–effective solution
- Individual series





Source: N.Delerue

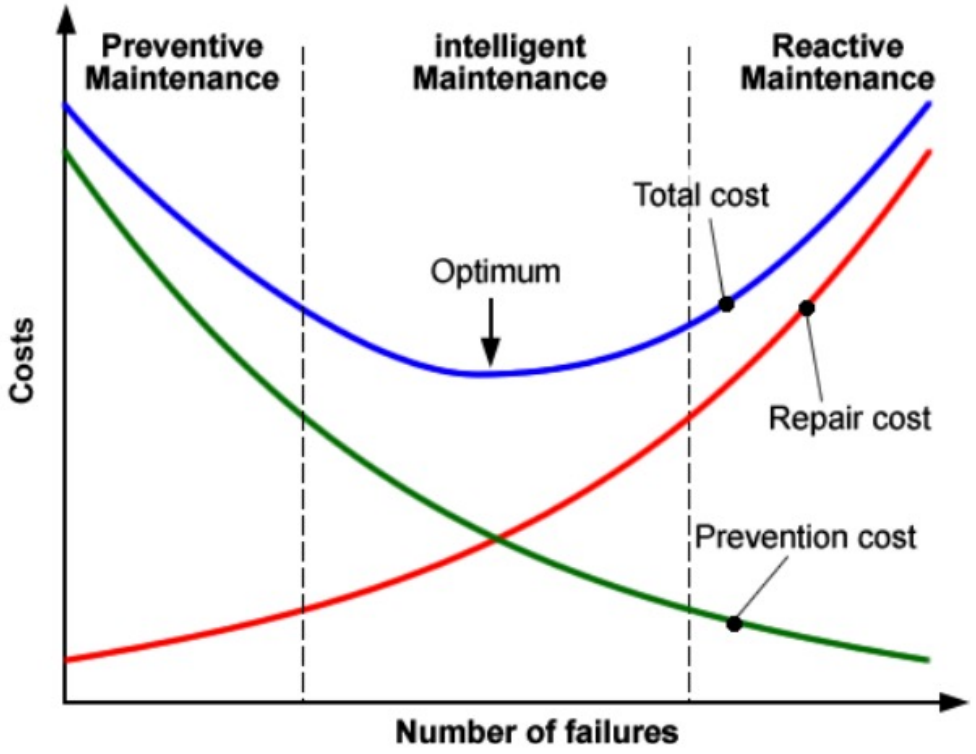


Source: GE

# AM repair benefits

## Potential advantages

- Can be done in hostile environments (radiation ...)
- In-situ repairs
- Wide range of materials
- Micro and macro scale repairs
- Repair as a part of maintenance
- **Time and money Saving technology**



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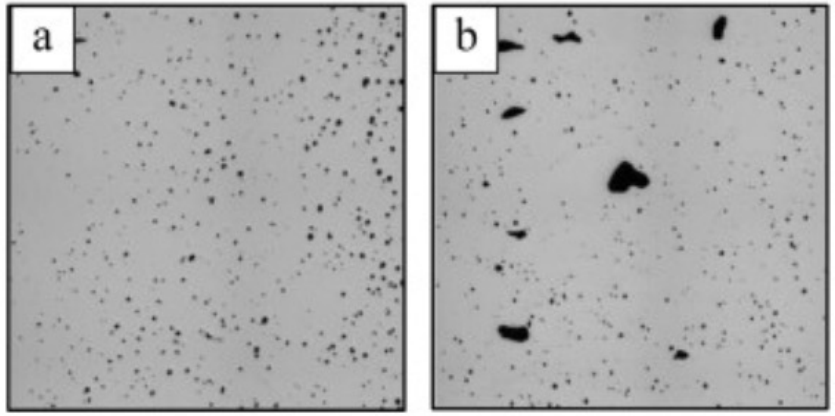
# Accelerators requirements

$7.5\times10^{-10}$Torr

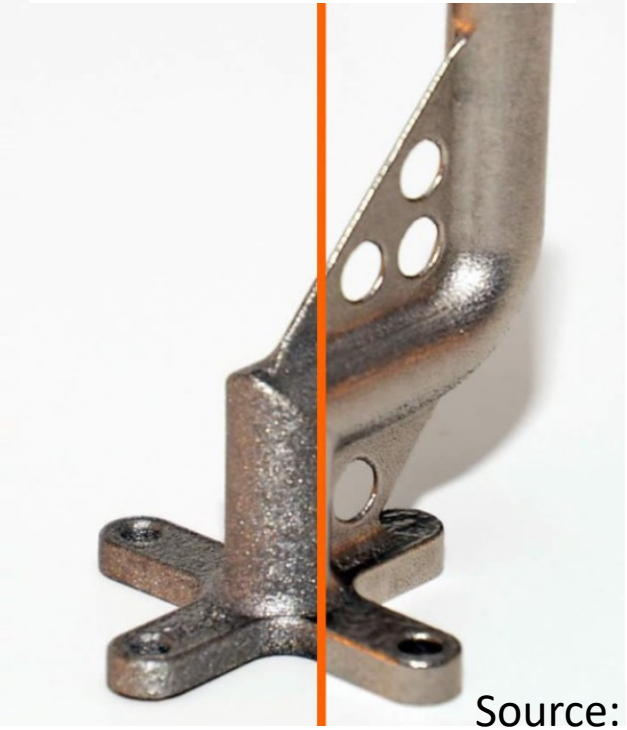
**RadioFrequency**
Cleanliness ?
High shape accuracy ?
Surface roughness?

**Ultra High Vacuum**
Outgassing rate?
Leak tightness?




Source: Nesma T. Aboulkhair

$\sim$Ra12.5$\mu m$



Source: javelin-tech.com

**Table 2**
Typical surface finishes for classical machining operatio

| SURFACE FINISH |
| --- |
| Ra (μm) |
| PLANING |
| DRILLING |
| TURNING |
| DIAMOND TURNIN |
| MILLING |
| LAPPING |
| POLISHING |
| Roughness obtai |
| Roughness obtai |

Pure CU

Source: I.Wilson (CAS)

**Electromagnetic properties**
Impedance ?
Conductivity?

Source: Fraunhofer IWS

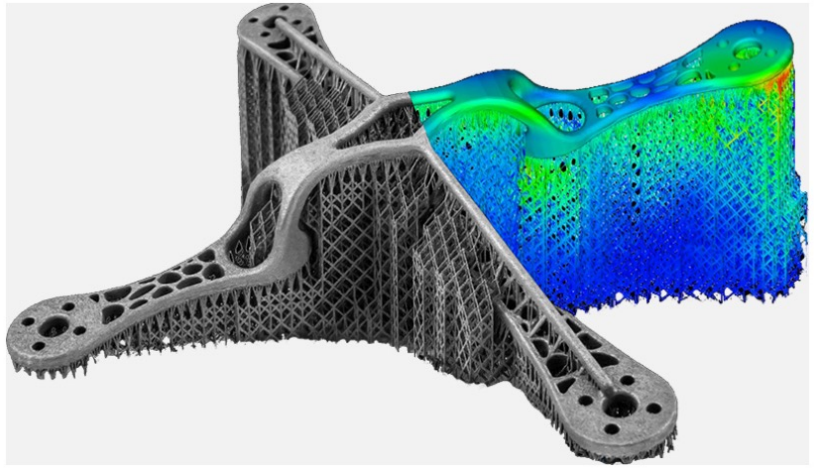
Source: G. Sattonnay (IPAC19)

# State of play

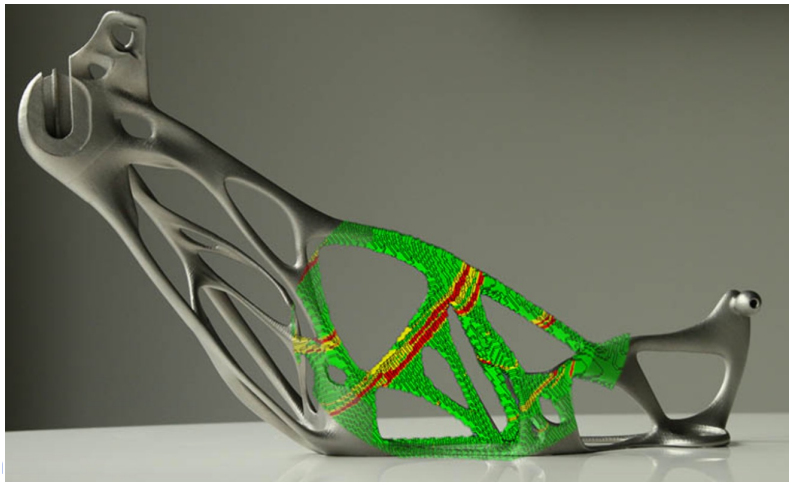
- Fraunhofer IWS
- PoliMi

"Production"

- Collaboration with accelerator physicists and accelerators engineers
- Work on several **design proposals**
- Create **simulation** to test the new design
- **Simulate AM process** to overcome first iteration issues
- Study of **CERN measurement requirements** and procedure



Source: aie.com.vn

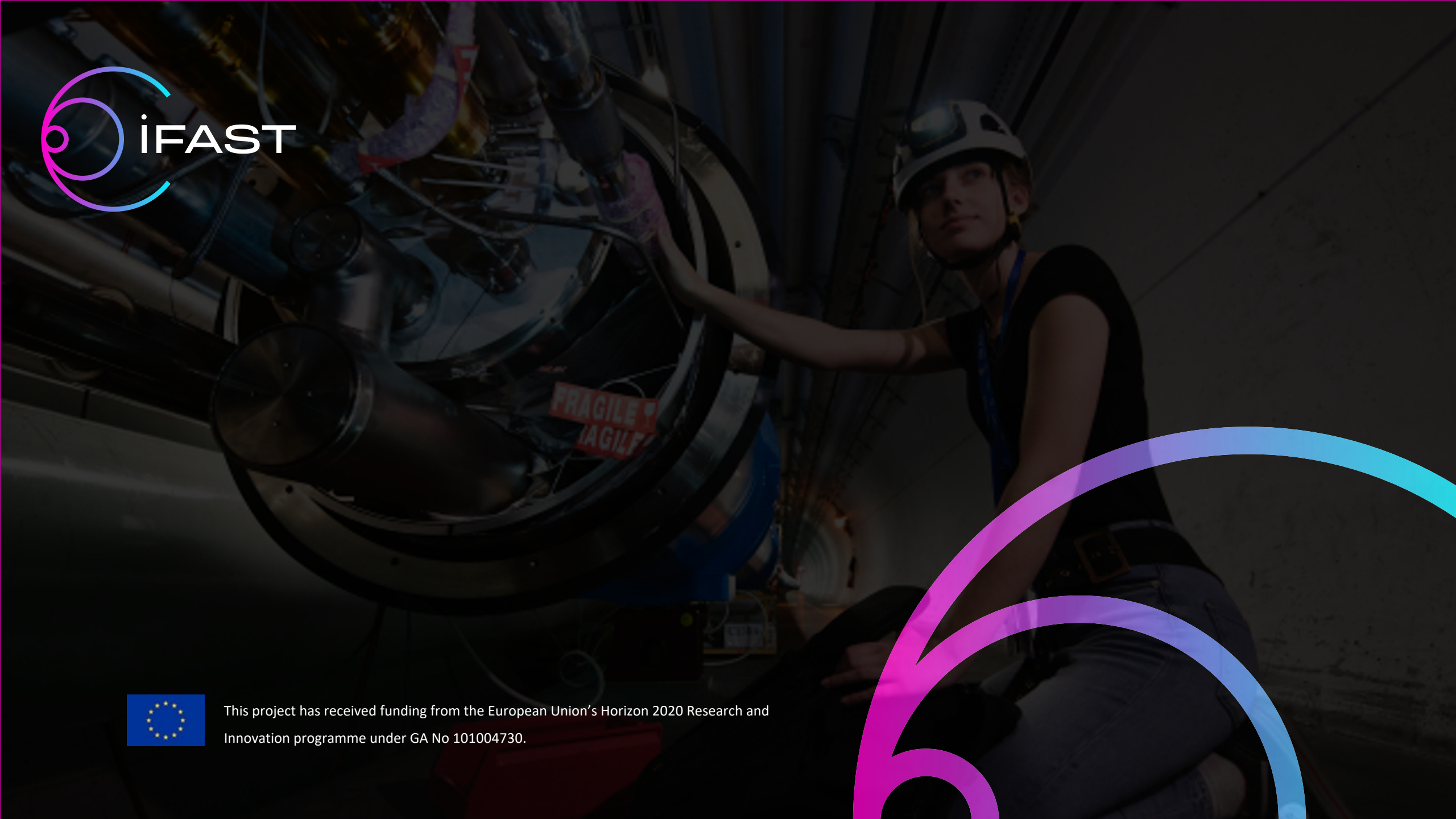


Source: 3dnatives.com (Carlota V.)

# Planed outcomes in two years

- AM – **Survey** of applications and potential developments
- **Promote** – how **AM** can address needs of **Accelerator Community**
- Additive manufacturing opens up new prospects at **CERN**
- **Demonstrator, prototype**

**Way to Innovation – Roadmap for AM**

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