POLITECNICO DI TORINO

IAM Integrated Additive Manufacturing@PoliTo

Overview vision del Politecnico di Torino per le attività di additive manufacturing del prossimo futuro

Additive Manufacturing @ POLITO

Prof. Luca Iuliano

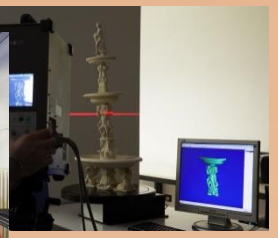
Full Professor

Politecnico di Torino

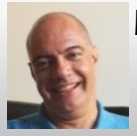
Department of Management and Production Engineering

AMTech Research Group

CAD/CAE/CAM and 3D scanning systems



Advanced CNC machining and additive manufacturing



Prof. Paolo Fino

Full Professor

Politecnico di Torino

Applied Science and Technology Department

Material Science and Technology

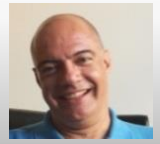
In collaboration with Istituto Italiano di Tecnologia (IIT), in the frame of a partnership with Politecnico di Torino

Additive Manufacturing @ POLITO

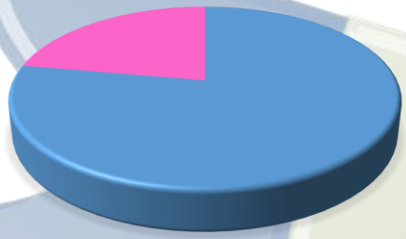
Politecnico di Torino
Department of Applied Science and Technology

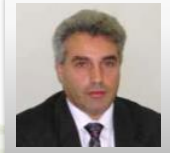
Istituto Italiano di Tecnologia
Centre for Sustainable Future Technologies
CSF@PoliTo

Politecnico di Torino
Department of Management and Production Engineering



Prof. Paolo Fino
Full Professor





Prof. Luca Iuliano
Full Professor

Diego Manfredi
Assistant Professor

Giulio Marchese
Assistant Professor

Sara Biamino
Associate Professor

Marco Actis Grande
Full Professor

Matteo Pavese
Associate Professor

Massimo Lorusso
Researcher

Alessandro Salmi
Associate Professor

Paolo Minetola
Associate Professor

Eleonora Atzeni
Associate Professor

Federica Bondioli
Full Professor

Mariangela Lombardi
Associate Professor

Emilio Bassini
Research fellow

Daniele Ugues
Associate Professor

Enrico Virgillito
PhD student

Flaviana Calignano
Assistant Professor

Manuela Galati
Research fellow

Alberta Aversa
Assistant Professor

Federico Bosio
PhD student

Abdollah Saboori
Assistant professor

Alessandro Carrozza
PhD student

Antonio Sivo
PhD student

Simone Parizia
PhD student

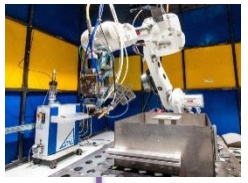
Gabriele Piscopo
PhD student

Aresh Mazdai
PhD student

Additive Manufacturing @ POLITO

ISTITUTO ITALIANO DI TECNOLOGIA
CENTER FOR SPACE HUMAN ROBOTICS

DED



Polito @ Tecnogranda S.p.A.

M250 EOS

M270 EOS

2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015

EBM - TiAl Intermetallics

Avio Aero
A GE Aviation Business

Partnership AVIO – Polito
Regional research project

Blow Powder Tech.
Large components

BOREALIS PRIMA INDUSTRIE

Partnership Prima Industrie – Polito
European research project

- E-Break
- Great2020-F2
- AMAZE
- TiAlcharger
- Getready
- Cluster
- Borealis
- Helmet

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Additive Manufacturing @ POLITO

M2 CONCEPT

M290 EOS
M400 EOS

Arcam A2X

Mlab Laser Cusing

2015 | 2016 | 2017 | 2018

PRIMA INDUSTRIE

Avio Aero
A GE Aviation Business

HUB – DIMA Industria 4.0

Getready

Cluster

Borealis

Helmet

4D-Hybrid

STAMP

ECCO

AMable

Additive Manufacturing @ POLITO

Award from the European Association of Powder Metallurgy as best HIPped component of the year.

3° prize in the **Award for the Best Project from Partners and Consortia** of the European programme **Clean Sky 1**

2015 | 2016 | 2017 | 2018

PRIMA INDUSTRIE

Avio Aero
A GE Aviation Business

HUB – DIMA Industria 4.0

Getready

Cluster

Borealis

Helmet

4D-Hybrid

STAMP

ECCO

AMable

Additive Manufacturing @ POLITO

Mlab Laser Cusing

Print Sharp 250

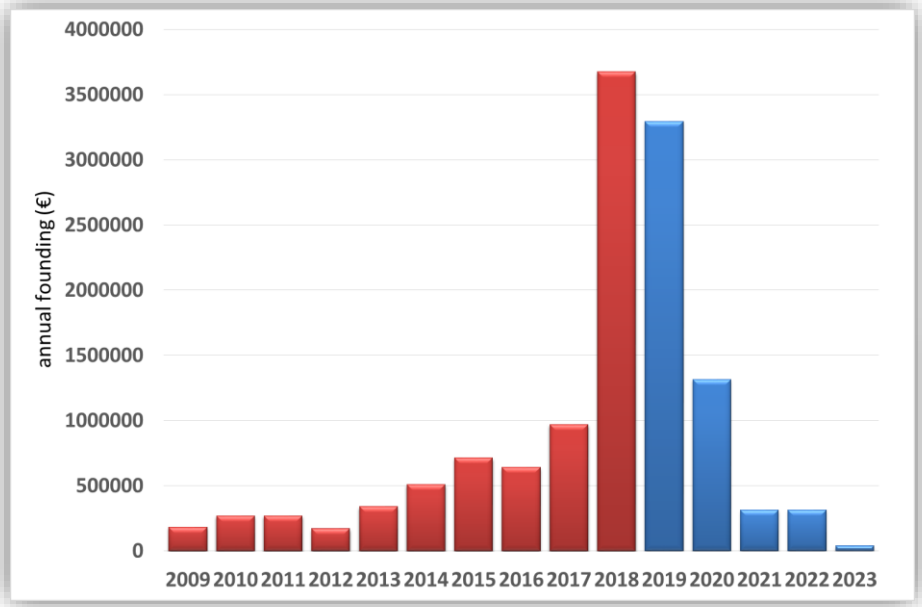
Quintus Hot Isostatic Pressing

PSI Gas atomization system

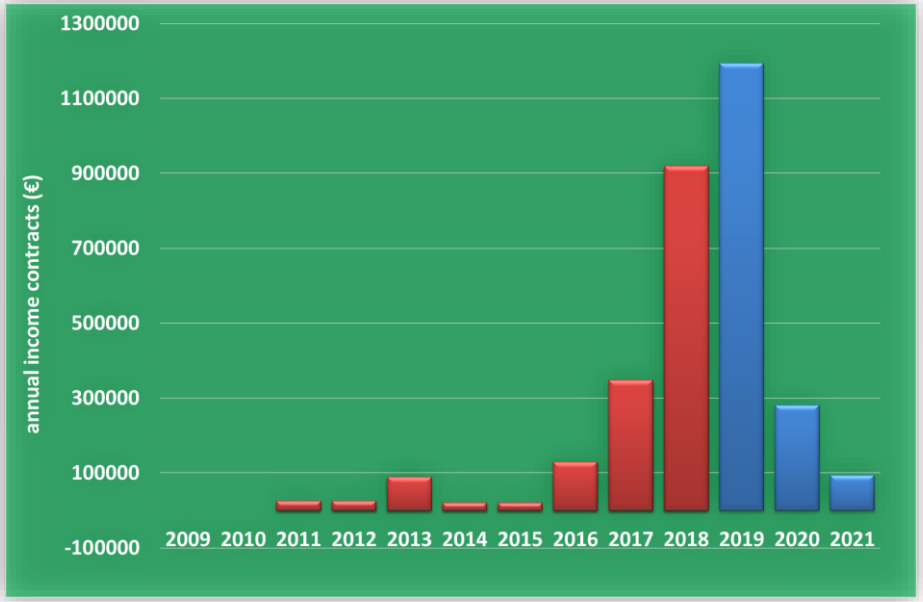
2018 | 2019 | 2020 | 2021 | 2022

- HUB – DIMA Industria 4.0
- 4D-Hybrid
- STAMP
- ECCO
- AMable
- Newteam
- HUC
- MANUELA
- EIT MANUFACTURING
- MAMMA

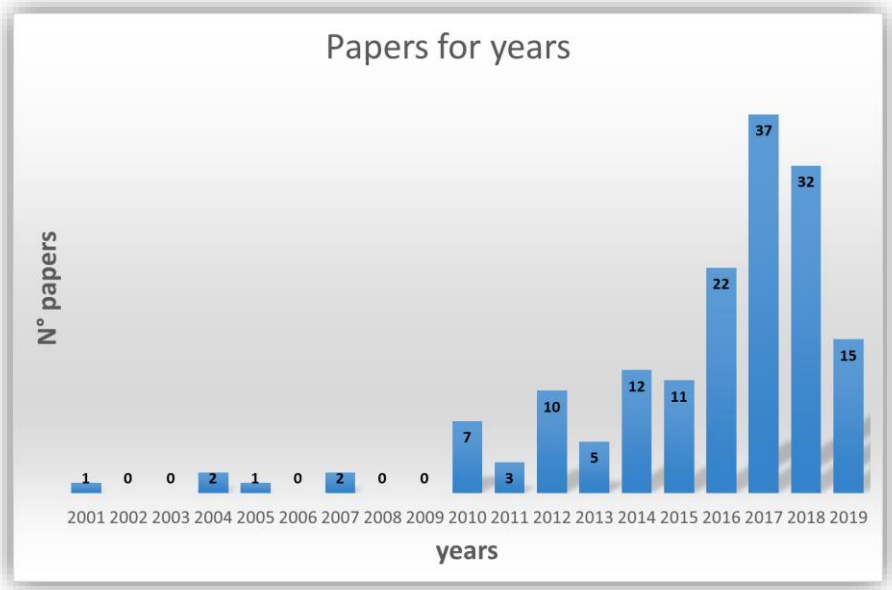
Additive Manufacturing @ POLITO



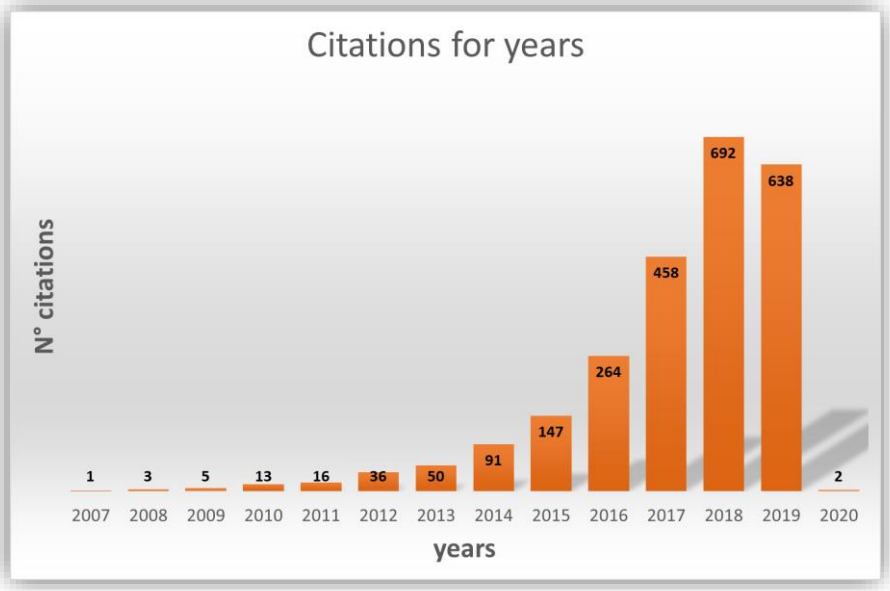
External resources 16'111'762 €
Internal resources for facilities 3'000'000 €



Additive Manufacturing @ POLITO



160 papers on AM topics
2391 citations in the last 10 years



Most cited papers:

2012 International Journal of Advanced Manufacturing Technology	228 citations
2011 Intermetallics	181 citations
2007 Rapid Prototyping Journal	157 citations
2013 Materials	146 citations

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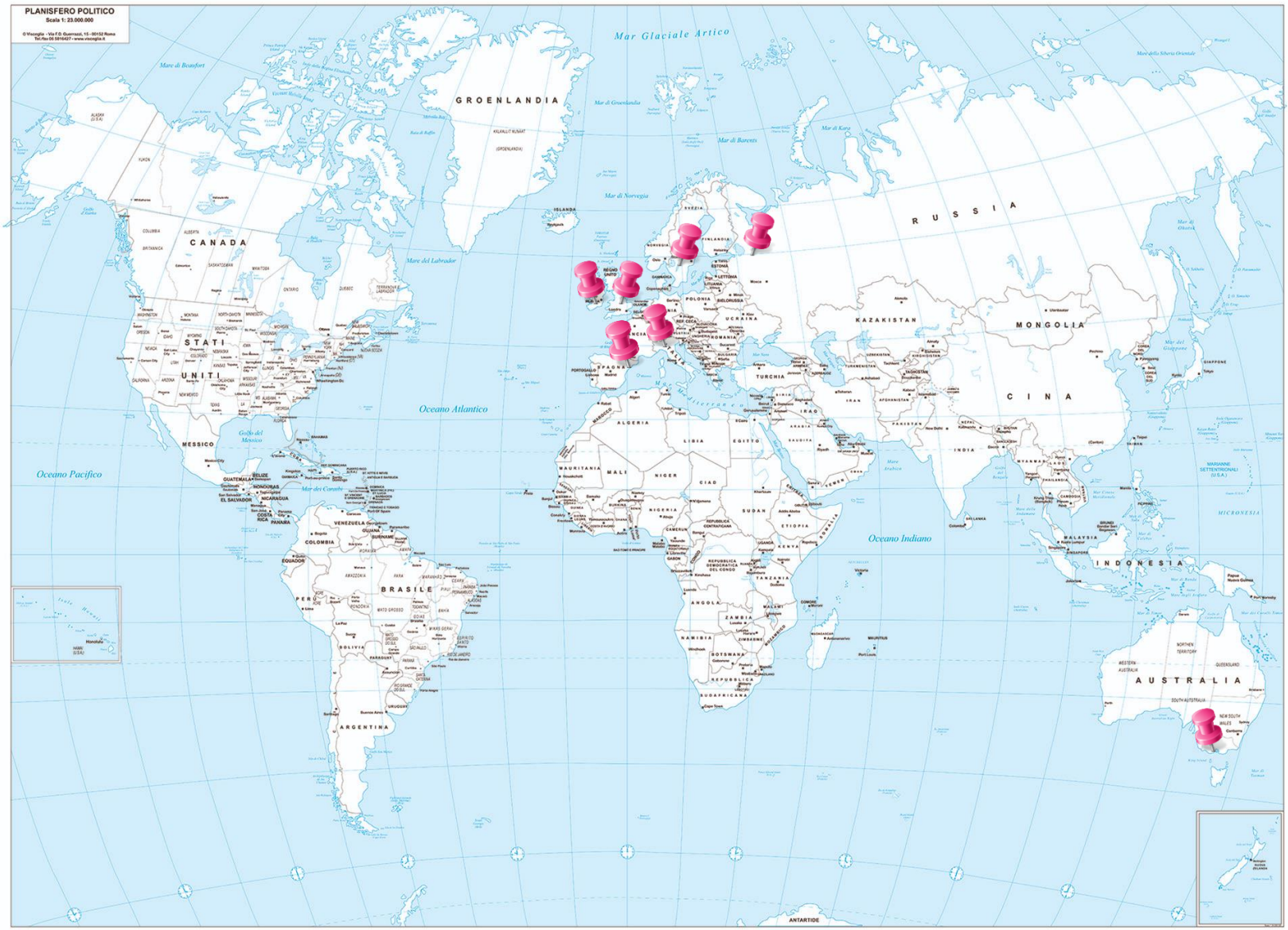
Additive Manufacturing @ POLITO



BARCELONA BARCELONA BARCELONA

BIRMINGHAM BIRMINGHAM BIRMINGHAM

DUBLIN DUBLIN DUBLIN

GÖTEBORG GÖTEBORG

SWITZERLAND LUGANO SWISS CONFEDERATION

MELBOURNE MELBOURNE MELBOURNE

ST. PETERSBURG ST. PETERSBURG ST. PETERSBURG

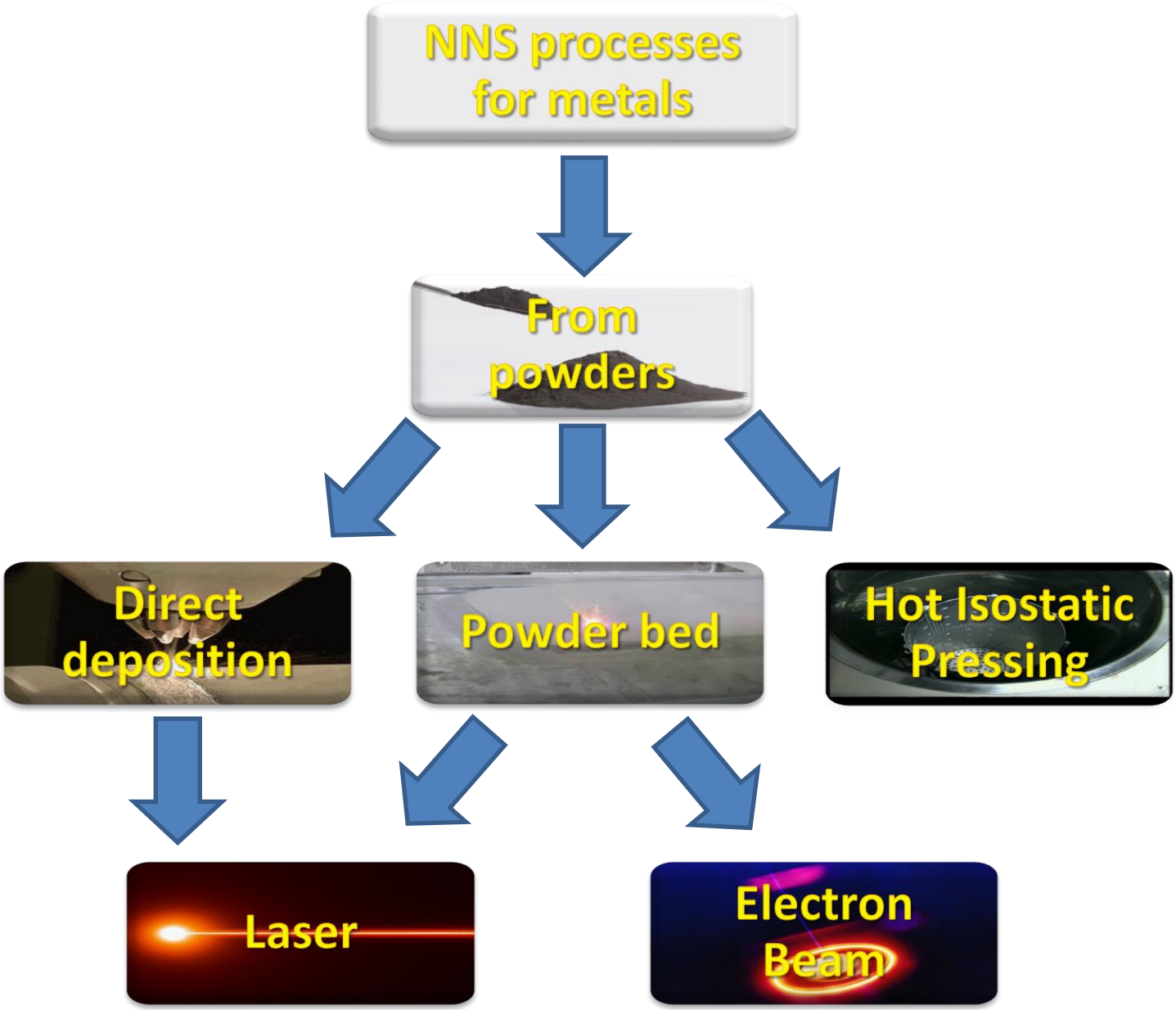
Resources of the Interdepartmental Center

5 Departments involved in the Center:

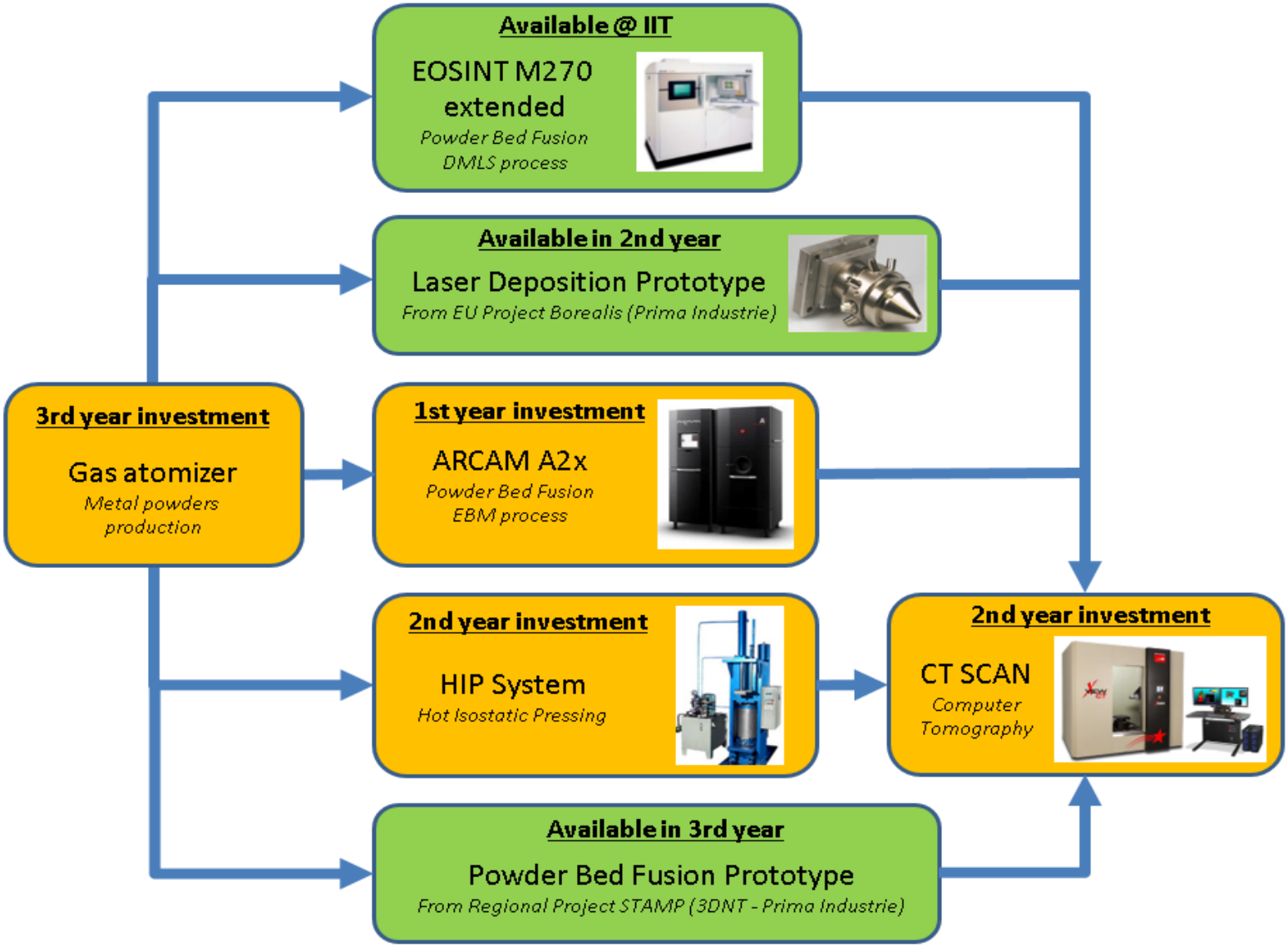
- Department of Applied Science and Technology
- Department of Production Systems
- Department of Computer Science
- Department of Mechanical Engineering
- Department of Electronics

More than 40 permanent researchers and other 60 PhD students, post doc and visiting researchers.

Near-Net Shape technologies



The main Research Platform of IAM



Yellow boxes indicate the instruments that will be acquired by the Center in the next 3 years
Green boxes indicate the instruments that are already at disposal of the Center

IAM@POLITO – future acquisitions

In 2019:

2nd year investment

HIP System

Hot Isostatic Pressing

3rd year investment

Gas atomizer

Metal powders production

2nd year investment

CT SCAN

Computer Tomography

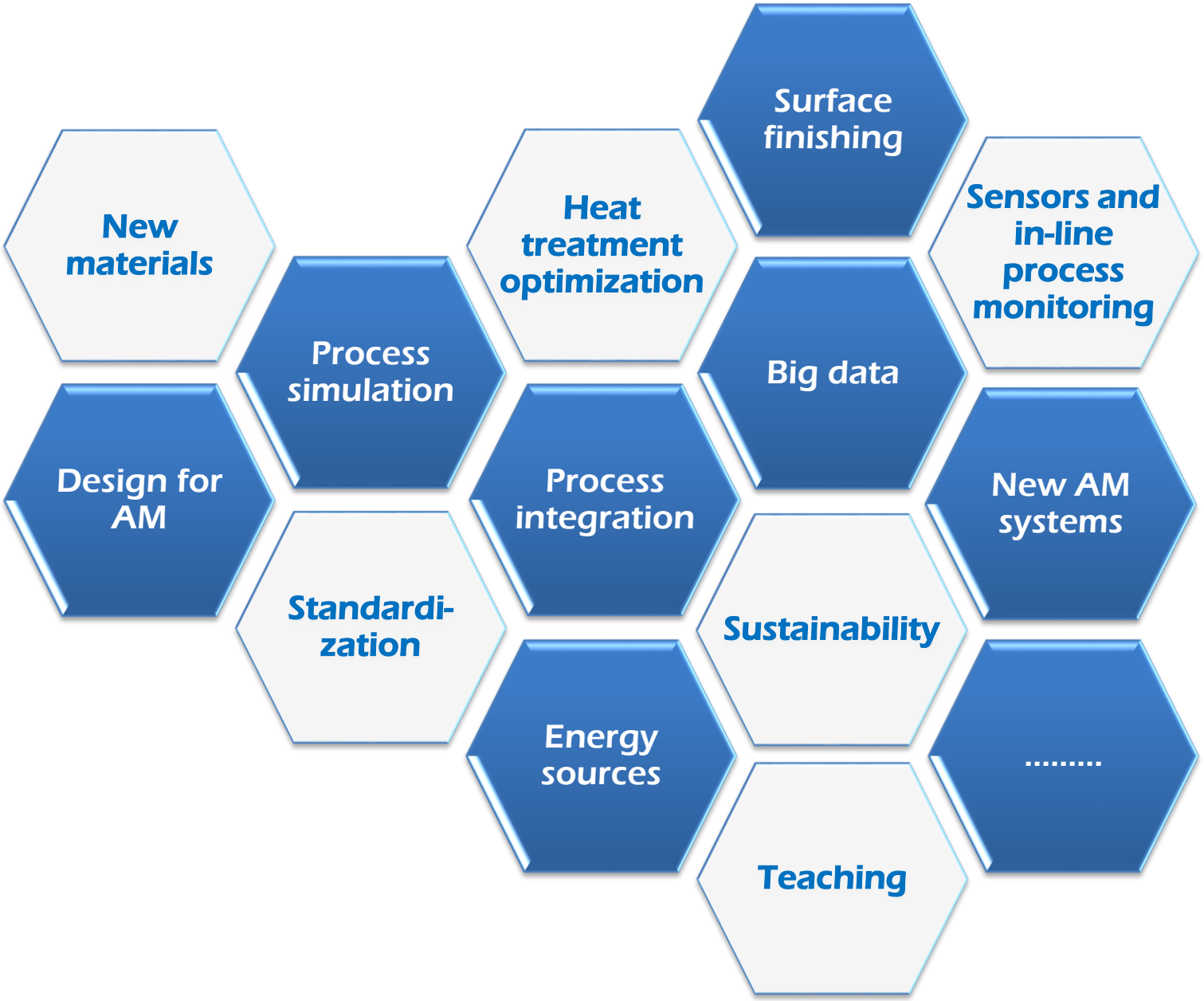
In order to complete the supply chain

- Powder production
- Design optimization
- Part production
- Post-processing (HIP, heat treatments, surface finshining)
- Characterization

POLITECNICO DI TORINO

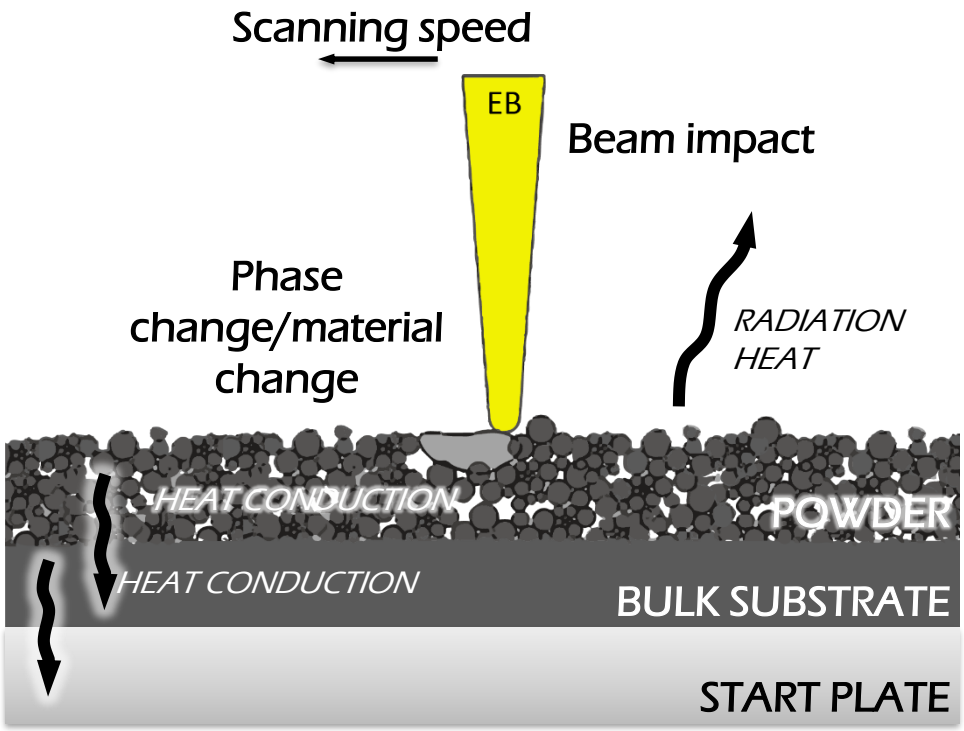
IAM Integrated Additive Manufacturing@PoliTo

Activities IAM@POLITO

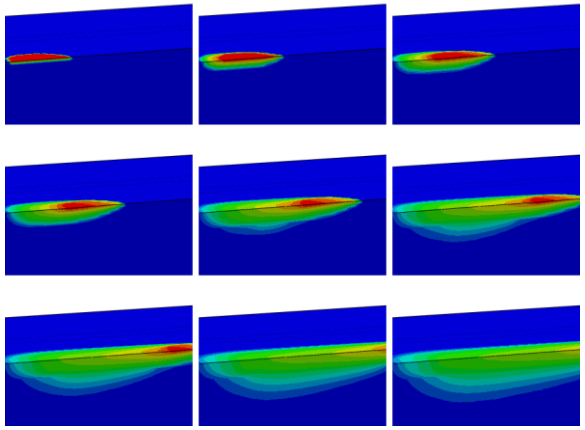


Activities IAM@POLITO

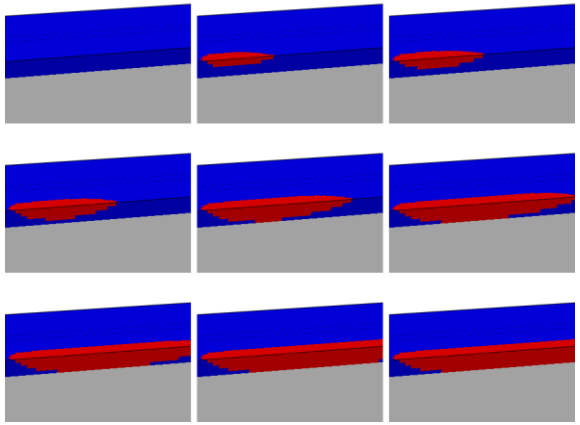
- **Process simulation**



Study of temperature distribution



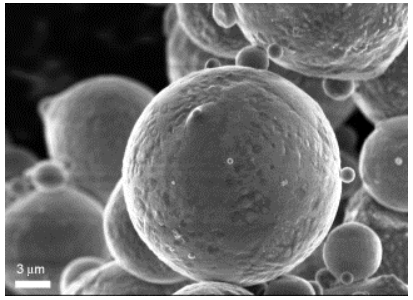
Study of solidification evolution



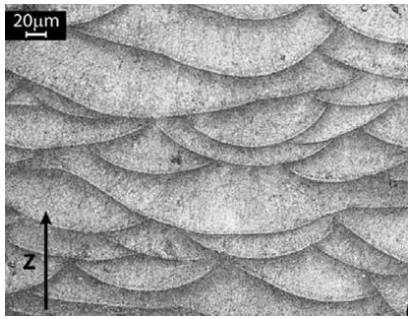
Activities IAM@POLITO

- **Process optimization**

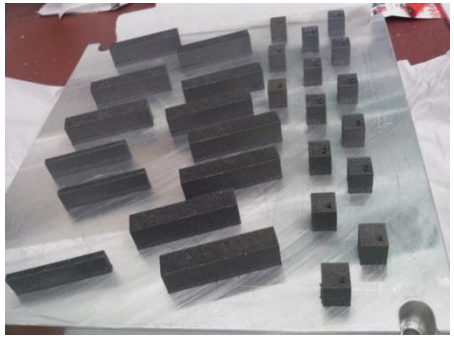
Design and production → Alloy selection or production → Process optimization



Post - processing → Heat treatment setup → Surface finishing

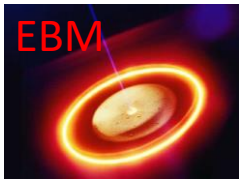


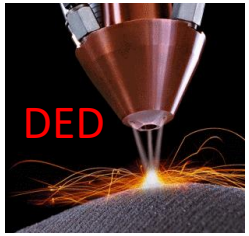
Mechanical and thermal characterization



Activities IAM@POLITO

➢ **Process optimization**





High Temperature alloys (> 600 °C)

Light alloys

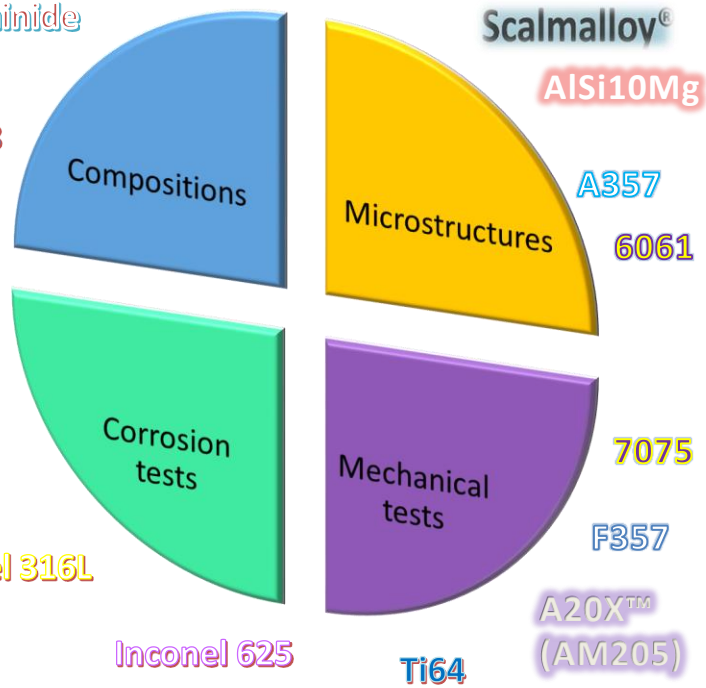
Biomedical alloys

Raw materials (Powders)

Machines

Parts

Additive Manufacturing

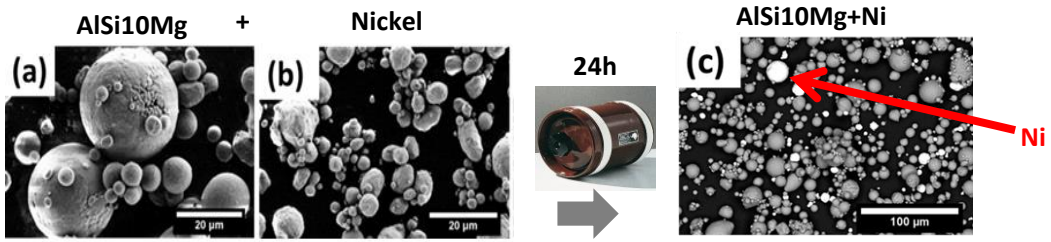


Activities IAM@POLITO

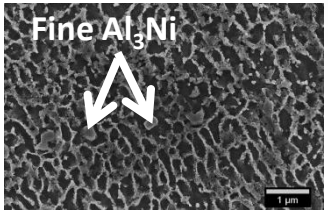
- **Development of customized compositions of AM powders**

Design of a new composition through 2 strategies:

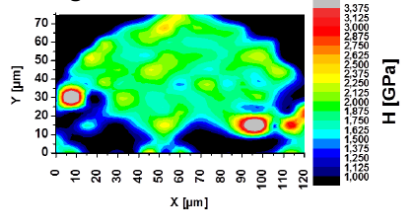
Powder mixing



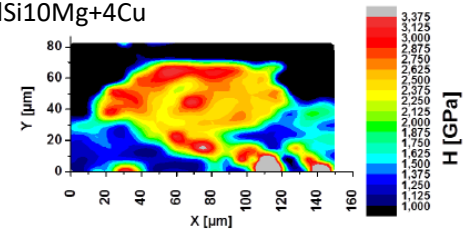
Alloy	HB		HV	
	Value	St. Dev.	Value	St.Dev.
AlSi10Mg	128.6	1.9	135.0	0.9
Al-Si-Ni	158.7	3.0	179.5	3.0
Al-Si-Cu	149.2	2.0		



AlSi10Mg



AlSi10Mg+4Cu



Gas-atomization

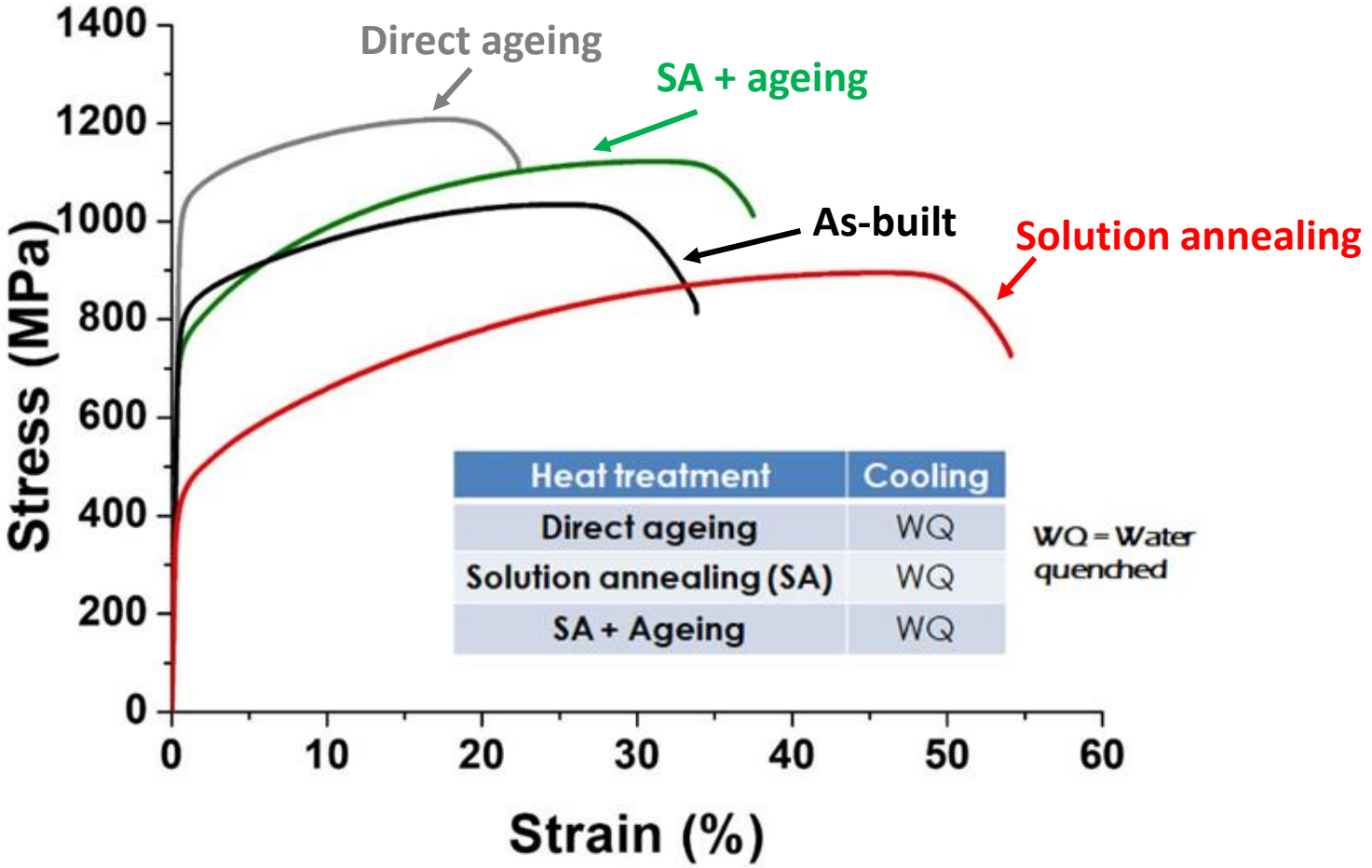
Starting from ingots, pellets, powders, wires

(8-10 kg)

Activities IAM@POLITO

- **Thermal treatments and surface finishing**

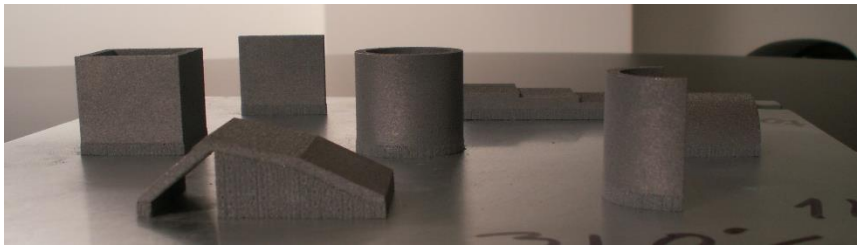
Study of the effect of heat treatments on tensile behaviour of Inconel 625

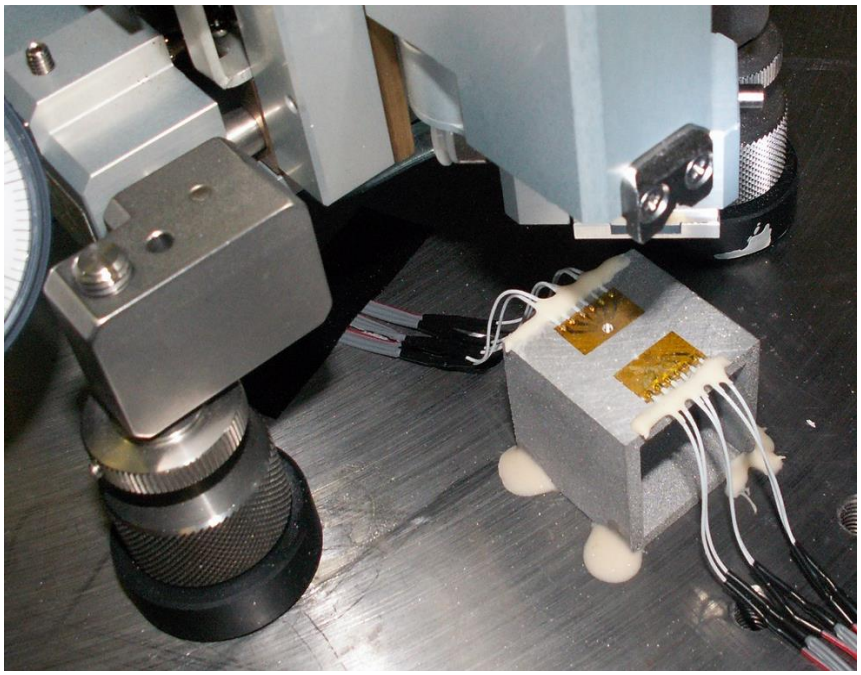


Activities IAM@POLITO

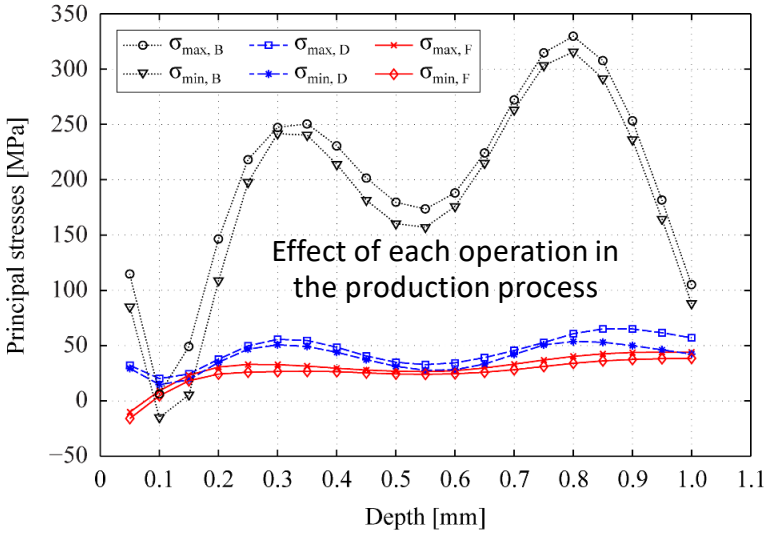
➢ Thermal treatments and surface finishing

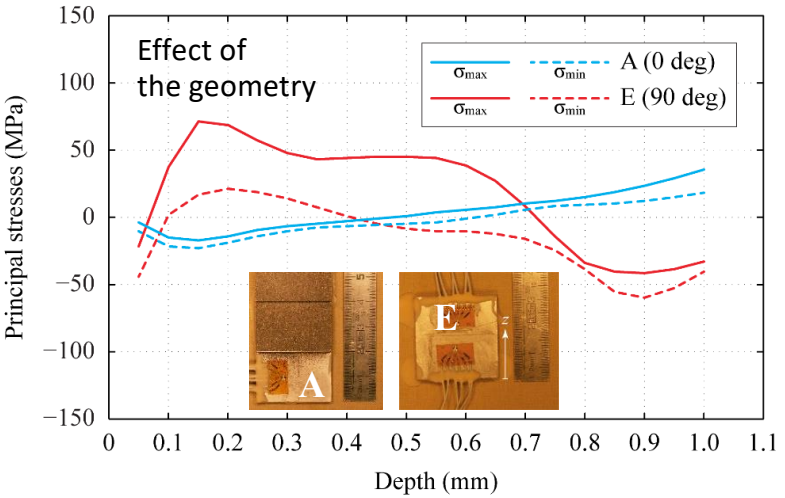
Evaluation of residual stresses at the macro-scale by hole drilling strain gauge method





as-built | post thermal treatment | after the shot-peening

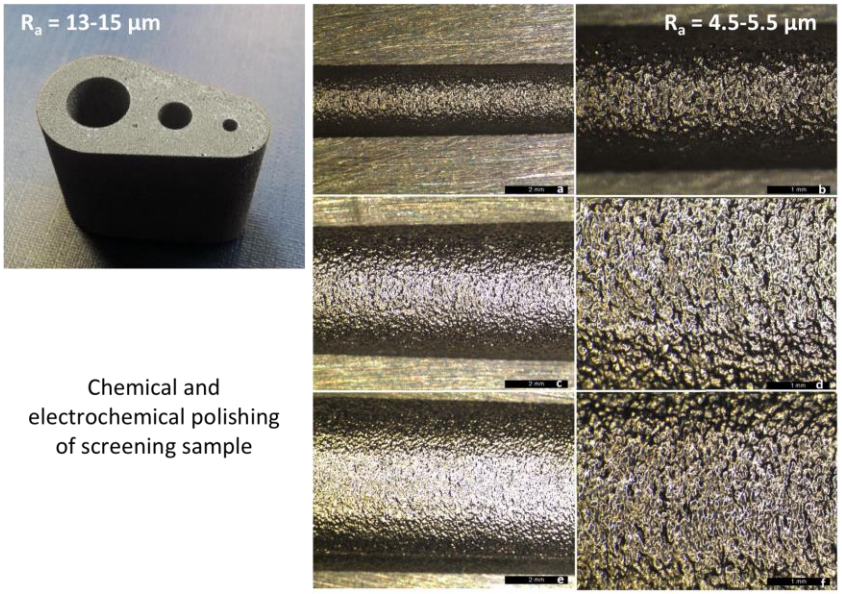




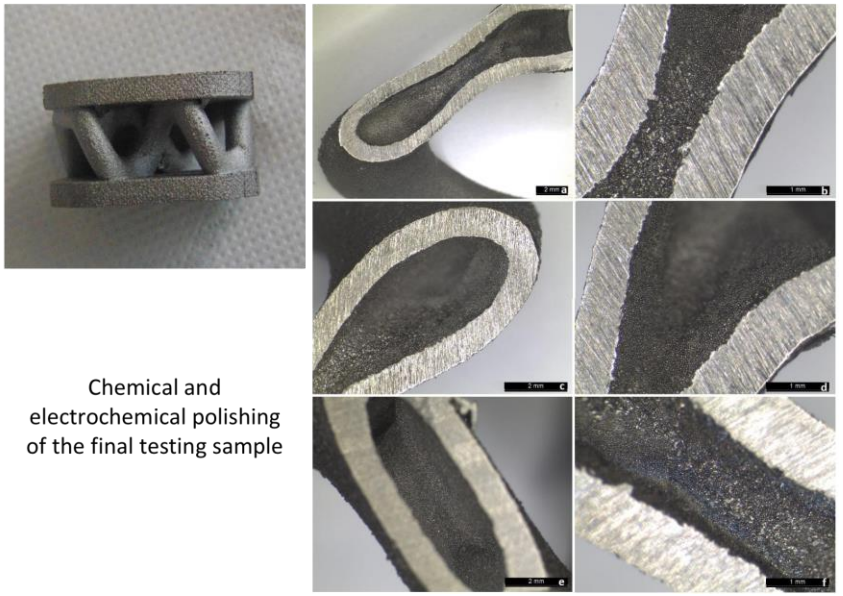
Activities IAM@POLITO

➢ Thermal treatments and surface finishing

Study of the effect of thermal treatments on tensile behaviour



Chemical and electrochemical polishing of screening sample



Chemical and electrochemical polishing of the final testing sample

Finishing to improve:

- Aesthetic features
- Dimensional tolerances
- Roughness
- Specific functionalities
- Fatigue resistance

Set-up of conditions for traditional and not traditional methods

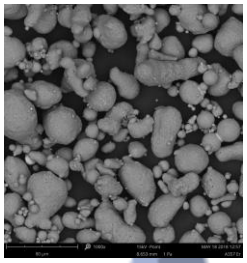
Activities IAM@POLITO

➢ New Materials for AM

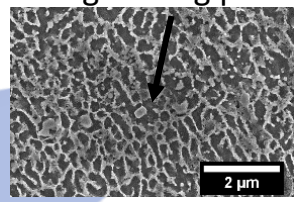
The advances of AM technologies open the possibility to develop new materials specifically designed for AM. This opens the way for a new metallurgy.

- Design of a new composition
- Powder production and characterization
- Feasibility of AM processing
- Microstructural and mechanical characterization of as-built parts

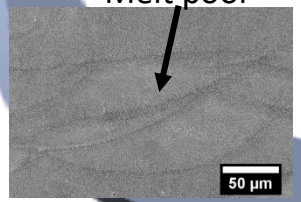
Gas-atomized powder



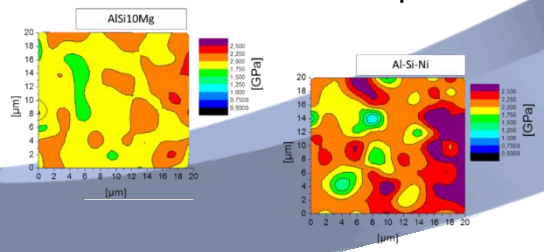
Strengthening phase



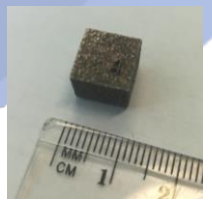
Melt pool



Nanoindentation maps



AM materials



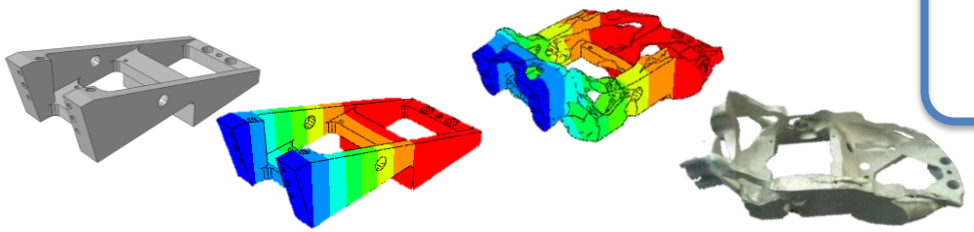
Activities IAM@POLITO

- **Integration with traditional processes**

AM production of spare parts

Reverse engineering

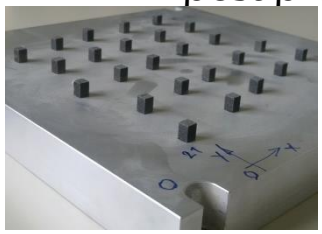
From scan to CAD-CAM



Support for design and topological optimization

Production

Parameter optimization and post-processing



Support for definition of production process

Support for products for

Standardization

Process and product quality

Aeronautics

Energy

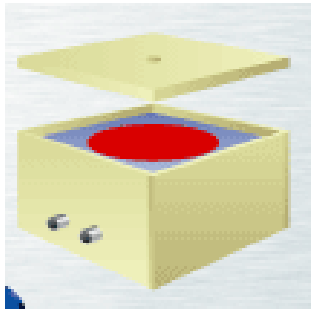
Biomedical

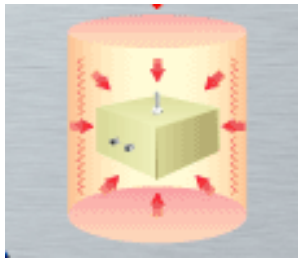
Activities IAM@POLITO

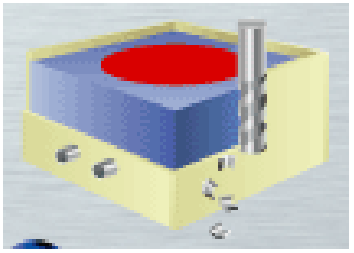
- **New processes of NNS**

Main steps:

- Definition of line-guides for component design
- Development of simulation models
- Development of moulds and tools for production
- Optimization of HIP conditions
- Optimization of strategies for mould removal
- Optimization of thermal treatment of the final component.







Activities IAM@POLITO

➢ Teaching

Career in AM in the frame of Master of science in Mechanical engineering; specialized courses about:

- Design for Additive Manufacturing,
- Materials for Additive Manufacturing,
- Technologies for Additive Manufacturing.

https://didattica.polito.it/pls/portal30/gap.amds.espandi2?p_sdu=32&p_cds=37

Course (in English) in the frame of Master of science in Mechanical engineering about Additive Manufacturing Systems and materials

https://didattica.polito.it/pls/portal30/gap.pkg_guide.viewGap?p_cod_ins=04SQSOD&p_a_acc=2019&p_header=S&p_lang=EN

Specializing master in AM with courses about:

- Design,
- Materials,
- Systems,
- Production management,
- Supply chain management,
- ICT platforms.

https://didattica.polito.it/master/additive_manufacturing/2017/introduction

https://didattica.polito.it/master/additive_manufacturing/2018/at_a_glance

Projects

- **GREAT 2020** – GReen Engine for Air Traffic 2020 – Regional project (2009-2012)
- **ProTiAl** – Developing of a new concept for optimal Production and machining of aerospace components in TiAl (2009-2012)
- **AMAZE** – Additive Manufacturing Aiming Towards Zero Waste and Efficient Production of High-Tech Metal Products – UE Project, VII FP (2012-2015)
- **E-BRAKE** – Demonstration of breakthrough sub-systems enabling high overall pressure ratio engine – UE Project, VII FP (2012-2015)
- **TiAl Charger** – Titanium Aluminide Turbochargers – Improved Fuel Economy, Reduced Emissions – UE Capacities Project, VII FP (2012 – 2014)
- **HELMET** – Integrated High-Temperature Electrolysis and Methanation for Effective Power to Gas Conversion - New generation of high temperature electrolyser, UE Project, VII FP (2014-2016)
- **BOREALIS** – the 3A energy class Flexible Machine for the new Additive and Subtractive Manufacturing on next generation of complex 3D metal parts – UE Horizon2020 Project (2015-2018)
- **GETREADY** – HiGh spEed TuRbinE cAsing produced by powDer HIP technologY – UE JTI Cleansky (2014-2015)
- **GREAT 2020 phase 2** – GReen Engine for Air Traffic 2020 – Regional project (2009-2012).
- Cluster Aerospazio – Greening the propulsion – National project (2014-2017)
- **POP3D** – Progetto ASI – Validazione del livello di maturità tecnologica di un sistema di fabbricazione additiva polimerica in microgravità per utilizzo a bordo della Stazione Spaziale Internazionale (2014-2016)
- **STAMP** - Sviluppo Tecnologico dell'Additive Manufacturing in Piemonte (Technological Development of Additive Manufacturing in Piedmont), Regional project (2016-2019)
- **ECCO** - Energy Efficient Coil Coating Process, UE Horizon 2020 Project (2017-2019)
- **4D HYBRID** - Novel ALL-IN-ONE machines, robots and systems for affordable, worldwide and lifetime Distributed 3D hybrid manufacturing and repair operations, UE Horizon 2020 Project (2017-2019)
- **NEWTEAM** - Next gEneration loW pressure TurbinE Airfoils by aM, H2020 Clean Sky project (2018-2020)
- **HUC** - Development and validation of a powder HIP route for high temperature Astroloy to manufacture Ultrafan® IP Turbine Casings, H2020 Clean Sky project (2018-2021)
- **MANUELA** - Additive Manufacturing using Metal Pilot Line, UE Horizon 2020 Project (2018-2022)

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