



State of the art of Additive Manufacturing: yesterday, today, tomorrow

University "La Sapienza" Rome, 20-23 September 2016

Machines: 15 Metal Systems, 5 Plastic, CNC

6DMLS – *Direct Metal Laser Sintering*

Building volume:

X axis 250 mm

Y axis 250 mm

Z axis 300 mm

Raw material:

15-45 μm powder



Machines: 15 Metal Systems, 5 Plastic, CNC

4SLM – *Selective Laser Melting*

Building volume:

X axis 250 mm

Y axis 250 mm

Z axis 360 mm

Raw material:

15-45 μm powder



Machines: 15 Metal Systems, 5 Plastic, CNC

1 **SLM RenAM500M** – *Selective Laser Melting*

New RenAM500M

Building volume:

X axis 250 mm

Y axis 250 mm

Z axis 360 mm

Laser Power: 500W

Raw material:

15-45 μm powder



Machines: 15 Metal Systems, 5 Plastic, CNC

1 **SLM280** – *Selective Laser Melting*

Building volume:

X axis 280 mm

Y axis 280 mm

Z axis 365 mm

Dual Laser

Raw material:

15-45 μm powder



Machines: 15 Metal Systems, 5 Plastic, CNC

1 **DMLS M400** – Direct Metal Laser Sintering

Building volume:

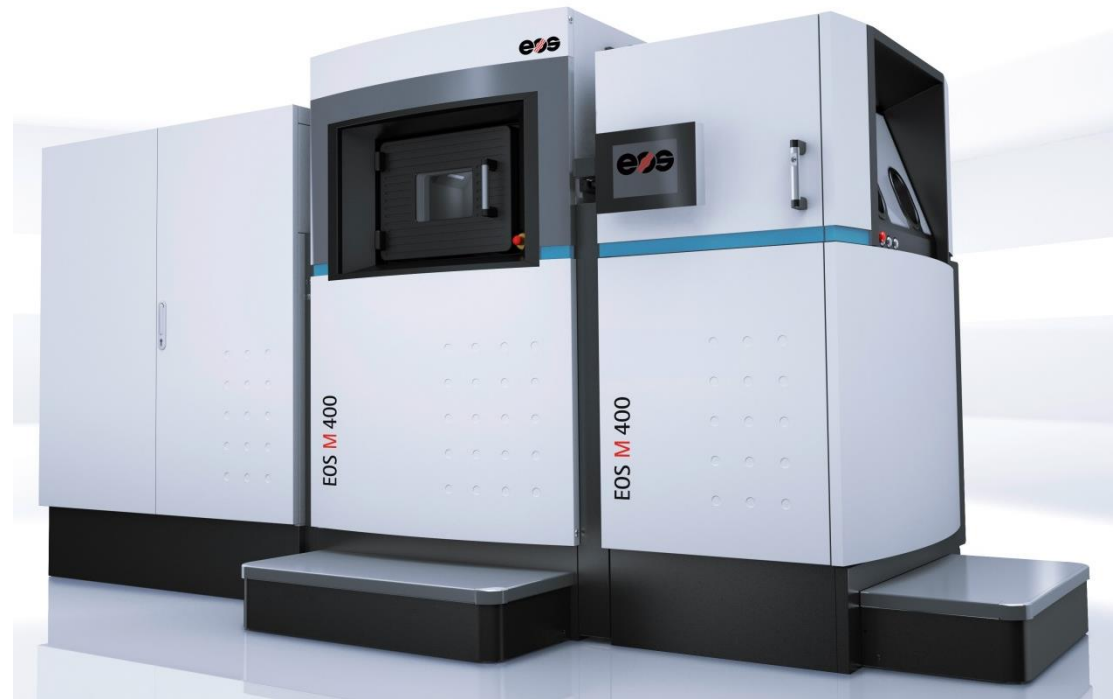
X axis 400 mm

Y axis 400 mm

Z axis 400 mm

Raw material:

15-45 μm powder



Machines: 15 Metal Systems, 5 Plastic, CNC

1 **SLM500 HL** – Selective Laser Melting

Building volume:

X axis 500 mm

Y axis 280 mm

Z axis 420 mm

QUAD Laser

Raw material:

15-45 μm powder



Machines: 15 Metal Systems, 5 Plastic, CNC

EBM Q10 – *Electron Beam Melting*

Building volume:

X axis 210 mm

Y axis 210 mm

Z axis 200 mm

Raw material:

45-93 μm powder



Machines: 15 Metal Systems, 5 Plastic, CNC

5 axis machining center **DMU 65 / *monoBLOCK***

Working volume:

X axis 735 mm

Y axis 650 mm

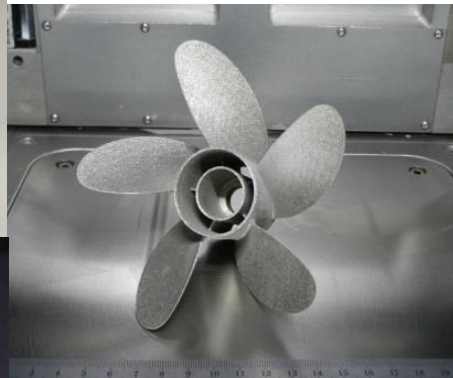
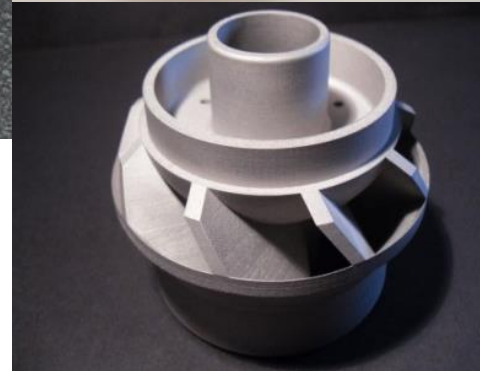
Z axis 560 mm



Processed Materials

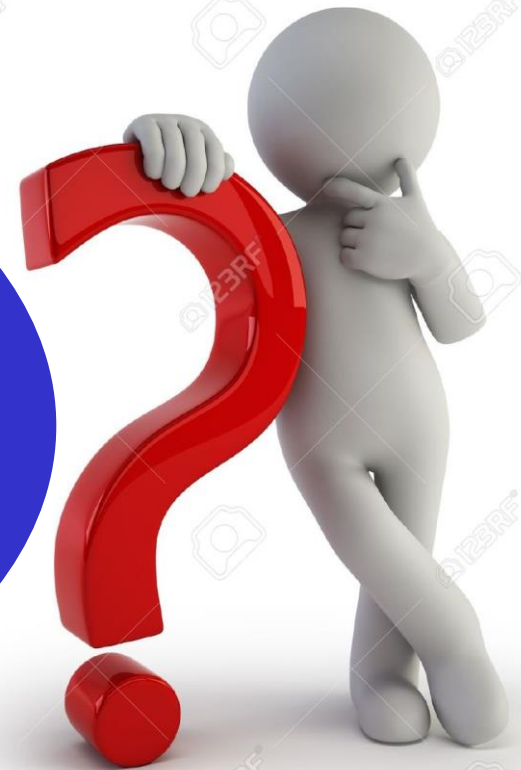
DMLS – SLM – EBM

- 17-4 PH
- CoCrMo
- AlSi10Mg
- Ti6Al4V
- AISI 316L
- Inconel 718
- Inconel 625
- Hastelloy X



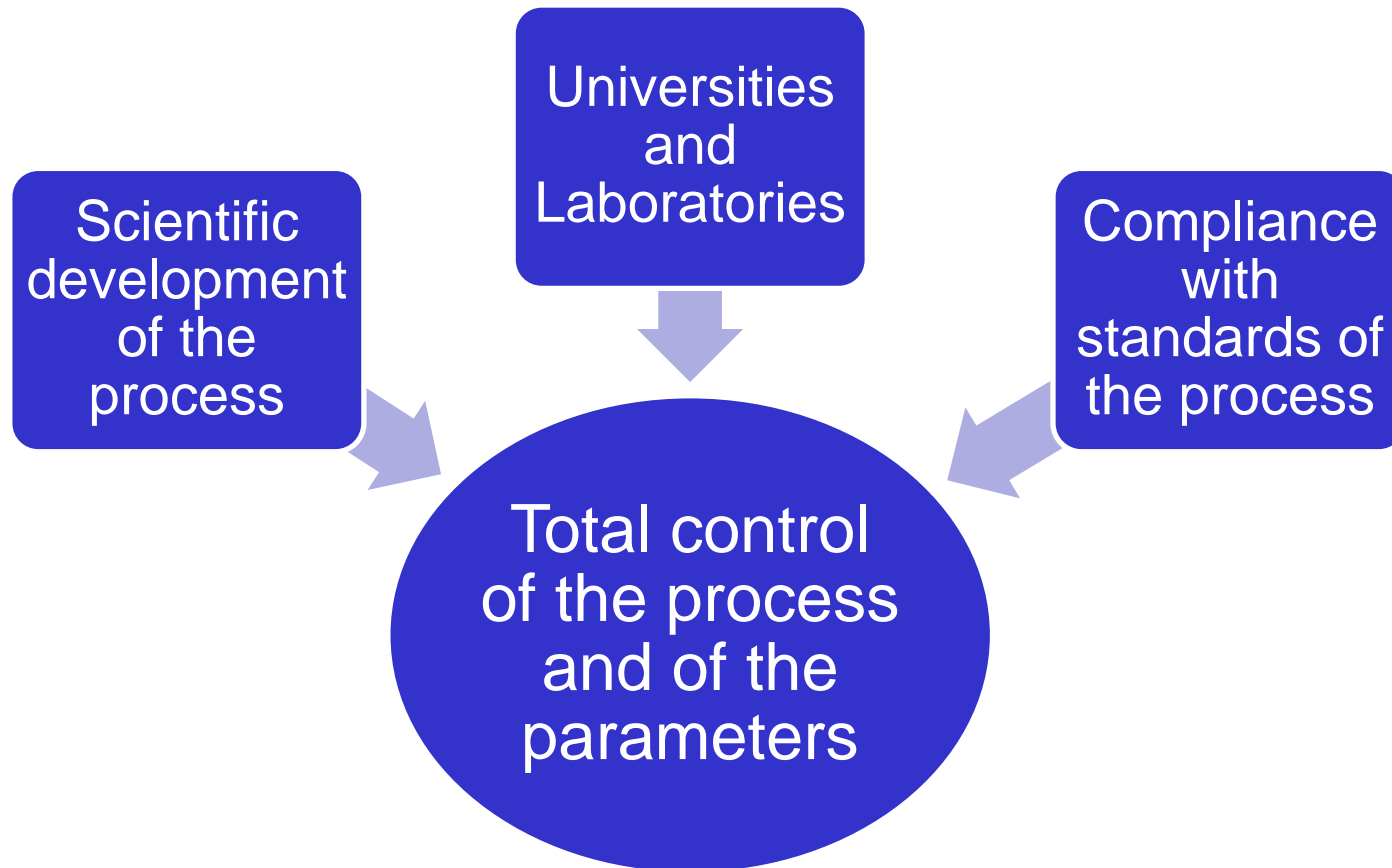
Can the process be considered :

Repeatable
Reliable
Robust
Qualifiable



Process Development

Additive Manufacturing has to be treated as a special process



Process Development

Total control of
the process and
of the
parameters



Process Development

- 1) Selection of the right AM machine
- 2) Selection of the right material
- 3) Selection of the right geometry to be melted
- 4) Topological Optimization
- 5) **Scientific development of the process:**
 - 1) Internal LAB
 - 2) Collaboration with Universities
 - 3) Special collaboration for challenging projects (KET-LAB)
 - 4) Operators qualified directly by the Suppliers to develop new parameters and new processes



Process Development

Internal LAB

1. Sudden feedback for the analysis:

- Micrography
- Metallurgical Analysis
- Density/porosity
- Chemistry

2. Powder Analysis:

- Granulometry
- Flowability
- Presence of satellites
- Chemistry
- Oxygen level analysis



Process Development

3. Mechanical Analysis:

- Tensile strength, deformation, fatigue

4. Test on thermally treated coupons

(Important to have a vacuum furnace for the thermal treatment of the melted parts, according to AMS 2750)



BEAM-IT Method

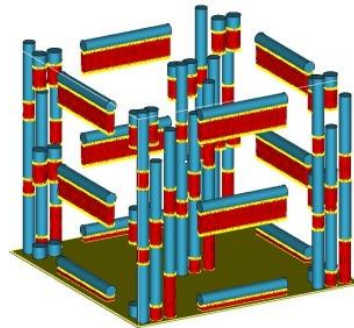
IQ

INSTALLATION
QUALIFICATION



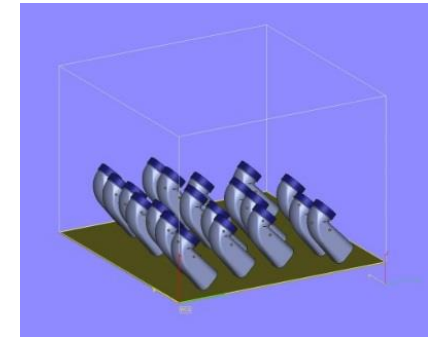
OQ

OPERATION
QUALIFICATION



PQ

PROCESS
QUALIFICATION



Qualification: Machines and Process

Installation Qualification
achieved by means of:

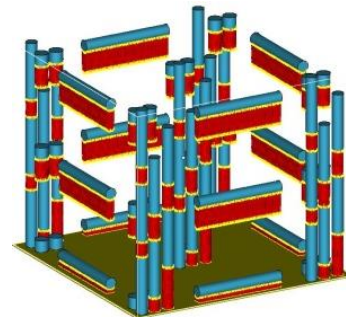
- Control of the process and of the parameters
- Stable behaviour
- Output feedback



Qualification: Machines and Process



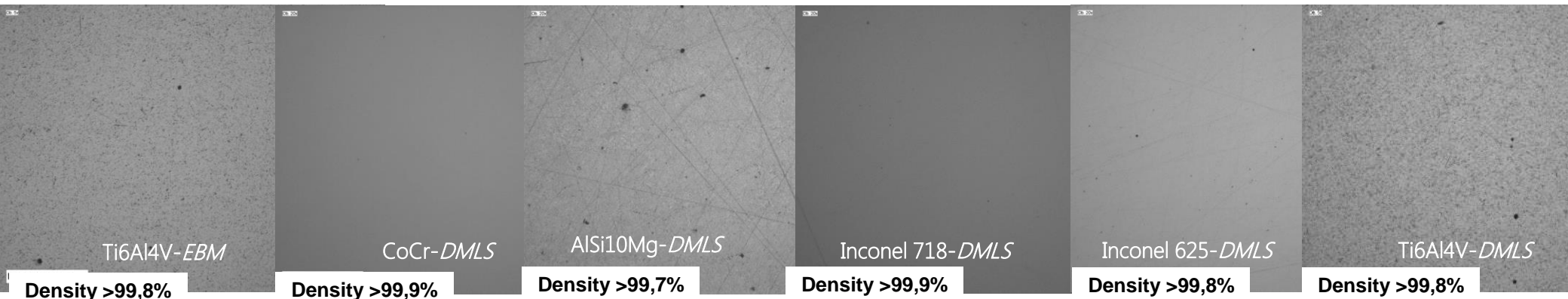
- Production of coupons in 3-axis
- Test on coupons in qualified laboratories
- Compliance with the ASTM standards



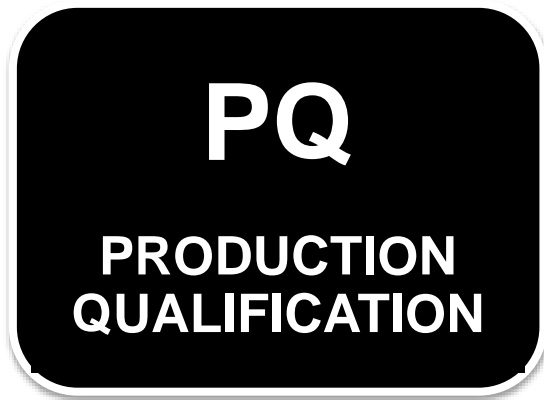
Qualification: Machines and Process



- Density from 99,7% to 99,9% (depending on the material)

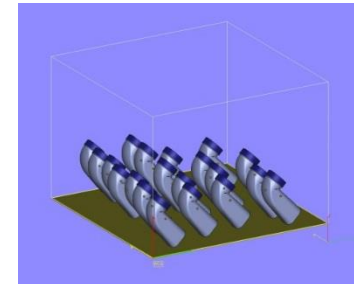


Qualification: Machines and Process



- Feasibility and repeatability for the customer projects
- Traceability of the products

PQ repeated n-times

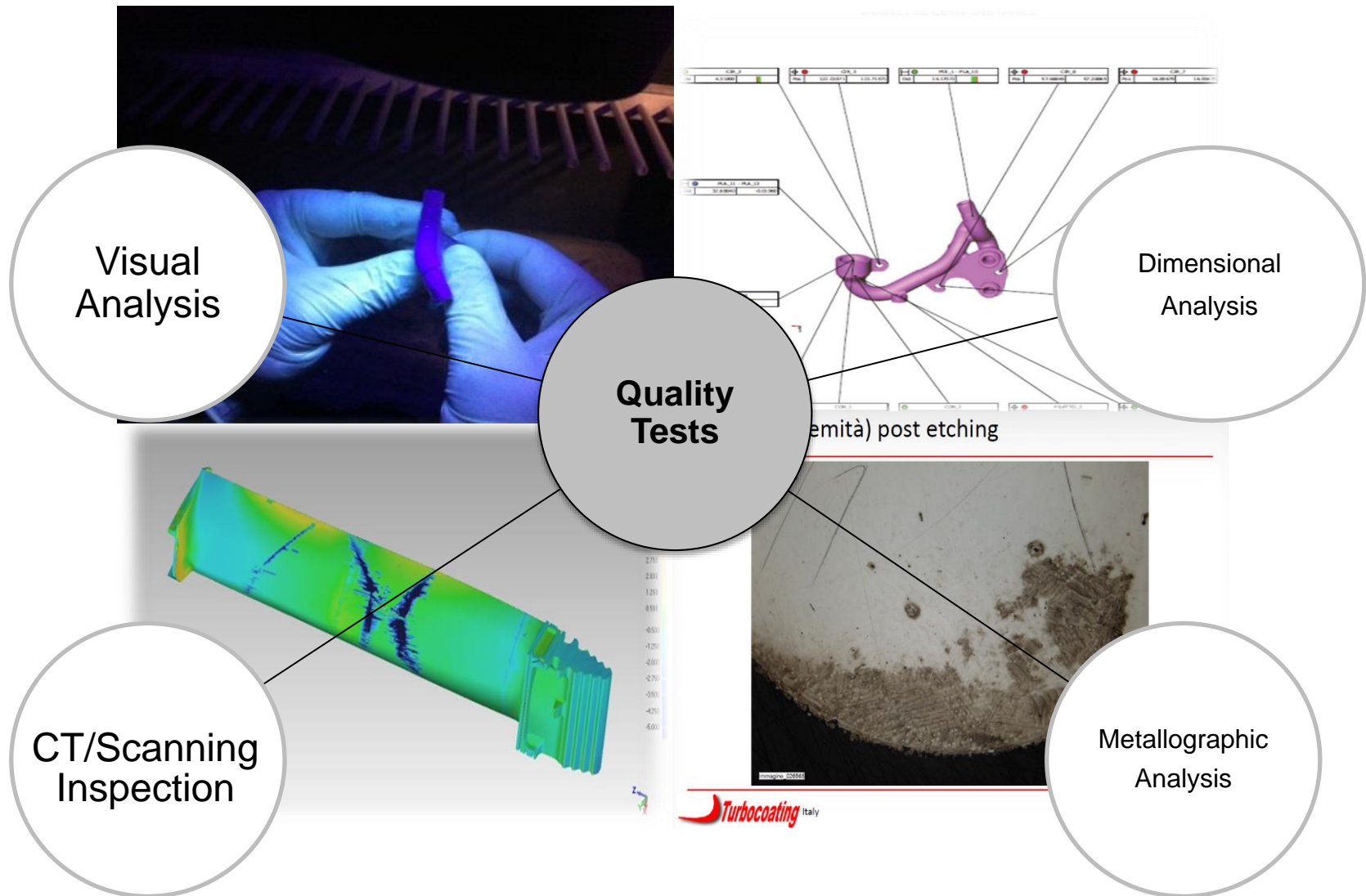


Qualification: Machines and Process



Hi-Vacuum treatment available according to AMS2750 standard

Quality Controls

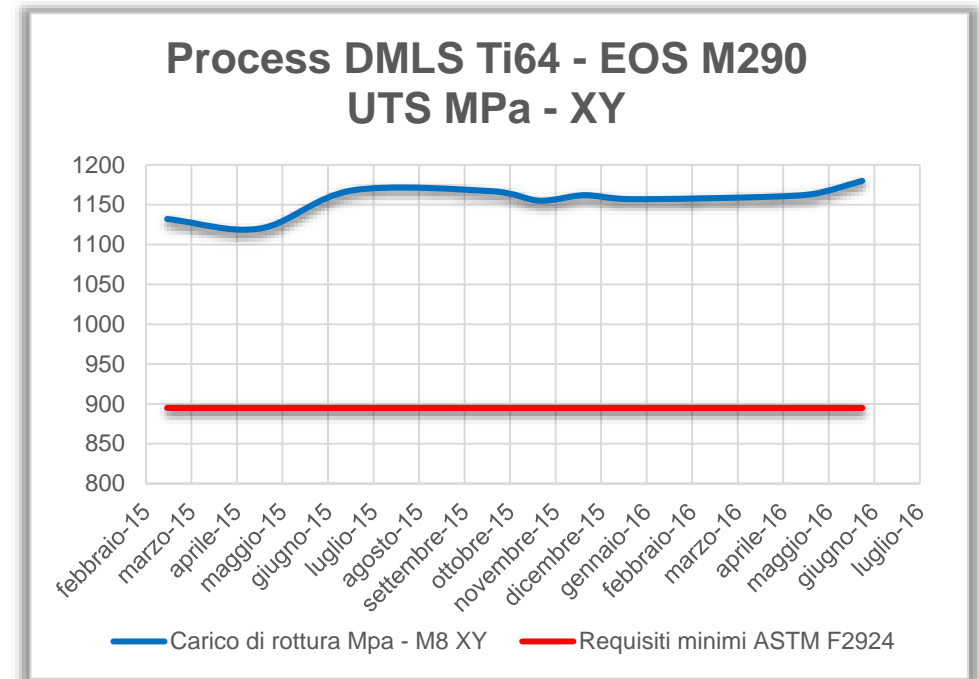
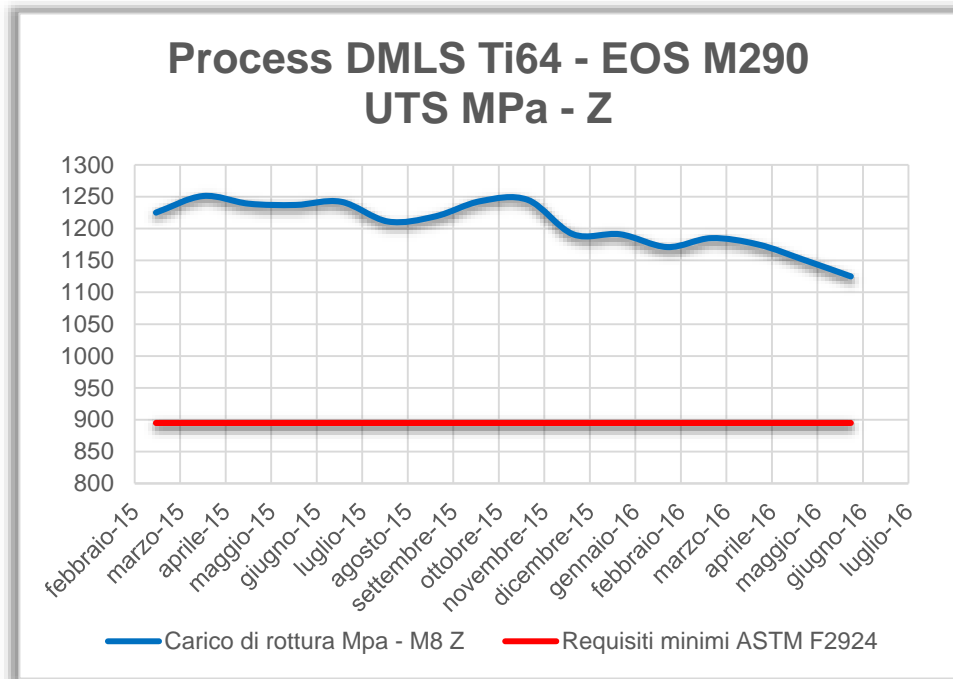


CERTIFICATION ROADMAP, results:

Keeping the process under control for years, respecting these control standards, we have created an archive collecting all the results:

ASTM F2924 standard achieved :

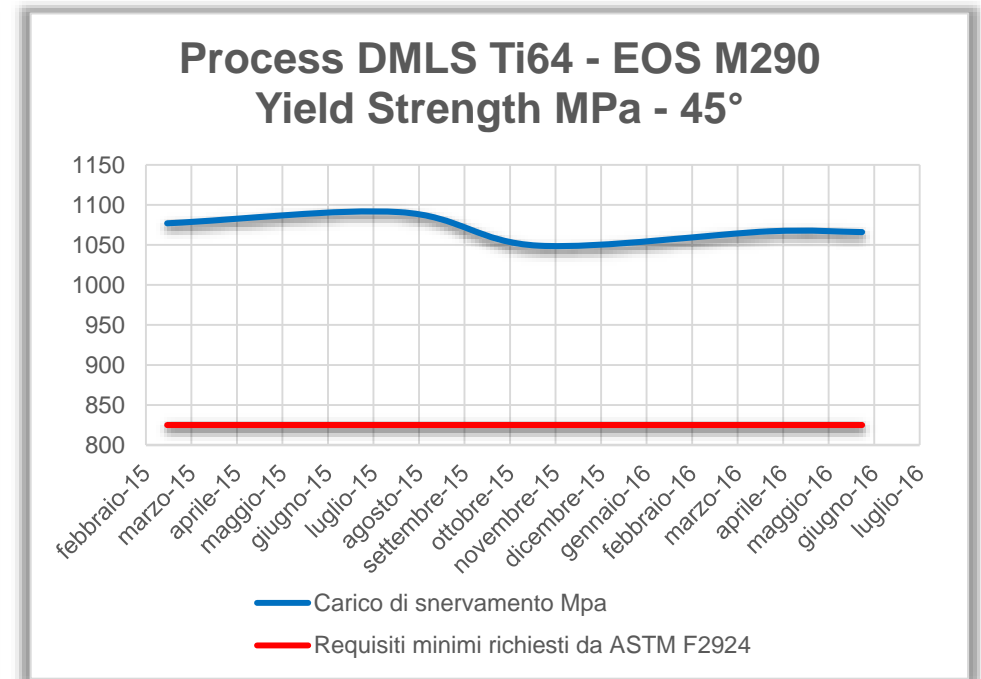
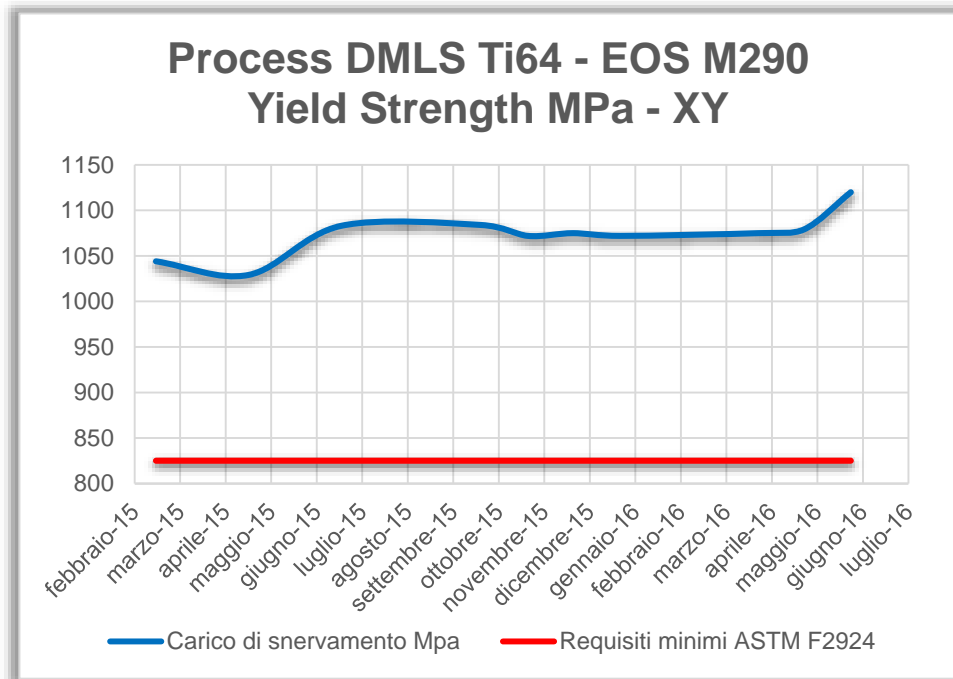
1. Ultimate Tensile Strength



CERTIFICATION ROADMAP, results:

ASTM F2924 standard achieved:

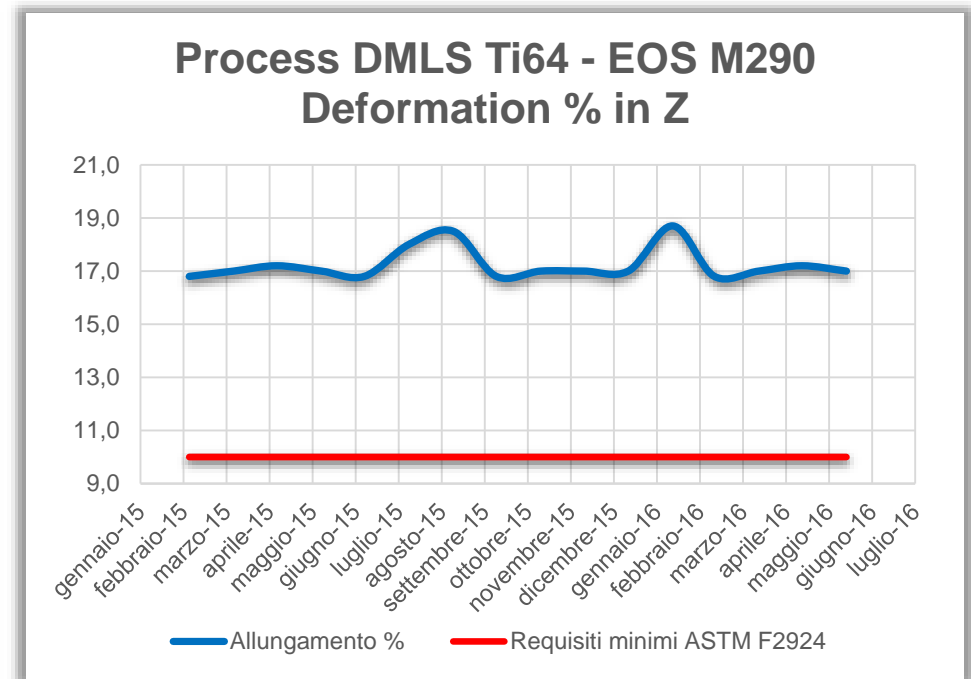
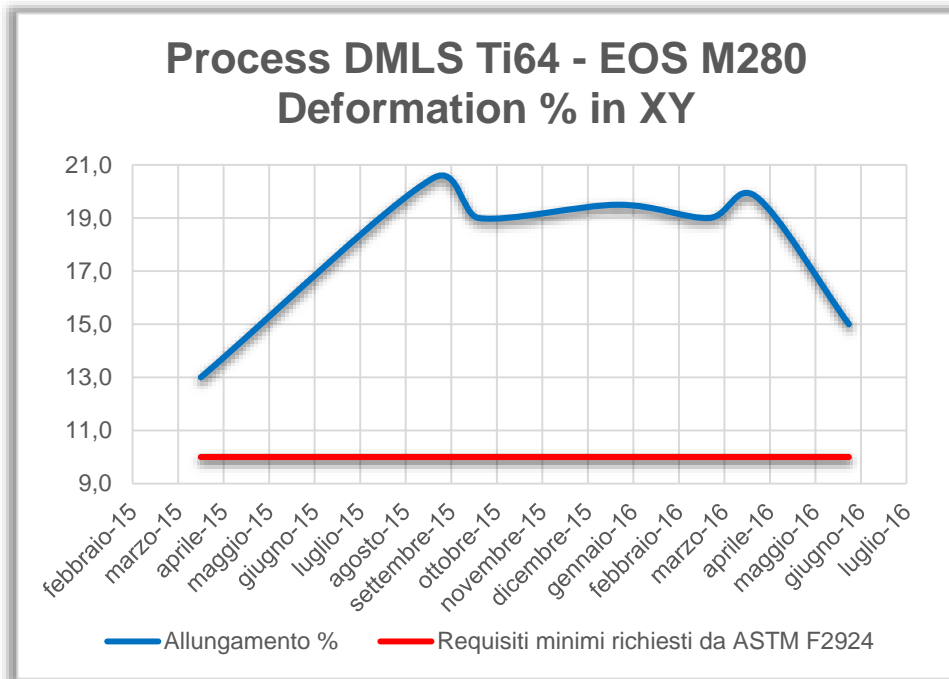
2. Yield Strength



CERTIFICATION ROADMAP, results:

ASTM F2924 standard achieved:

3. Deformation %



In conclusion:

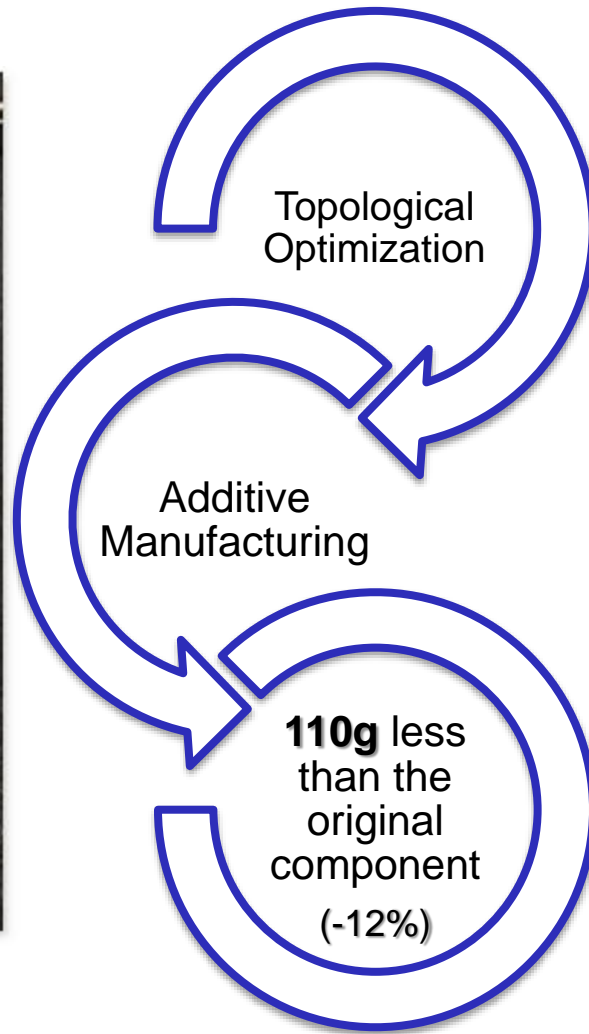
If the process is developed and kept under control following the previous guide-lines, the process can be considered:

Reliable

Repeatable

Robust

Example: Optimized Pump (Aeronautical Industry)



New Plant

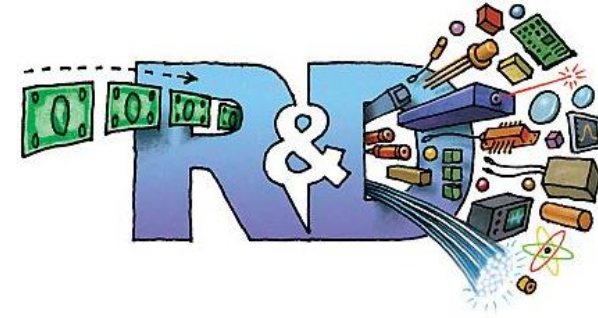


Last but not least, *R&D* Activities

R&D:

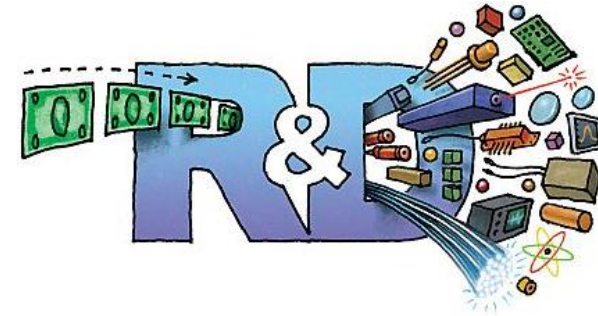
Part of an industry dedicated to:

- Improve the products
- Create new products
- Improve the production process



Last but not least, *R&D Activities*

Short and medium term technological innovation



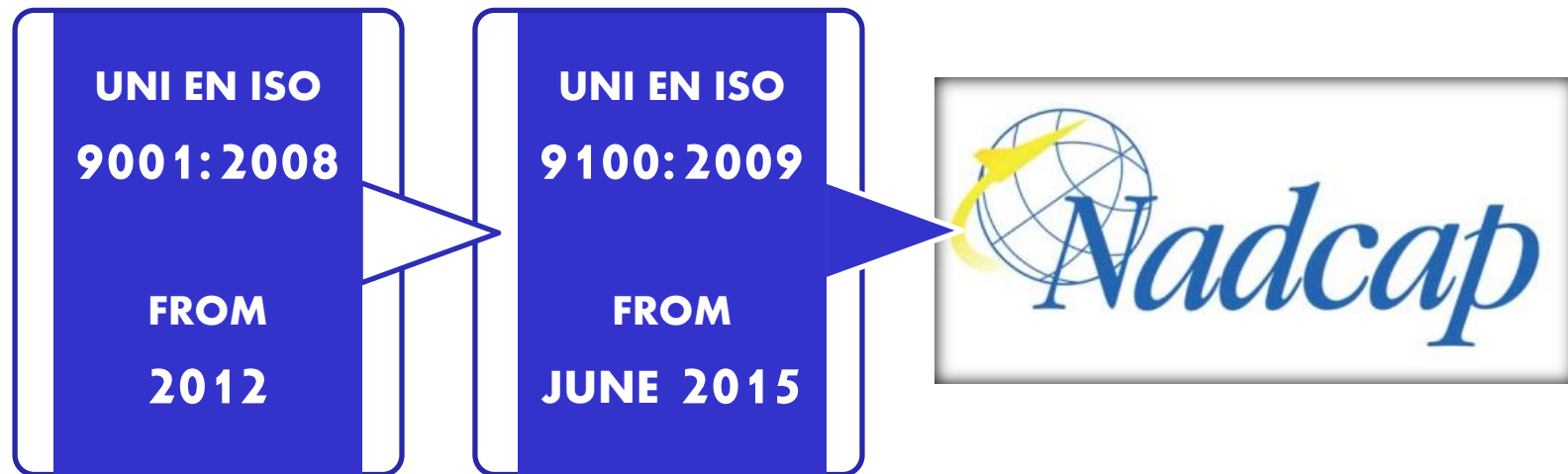
From 6 to 18 months, after which all the R&D projects become production solutions

Totally self-financed (15% of the sales volume)

R&D projects :

- Aluminium: YIELD STRENGTH > (650MP +/-50 MPa)
- Development of Copper Alloy
- PEEK (PolyEther Ether Ketone)
- Development of Ceramic (TiO_2 , Al_2O_3)
- Nickel Super-alloy: In738 - In939

CERTIFICATION ROADMAP



Thank you for your attention

BEAMIT SpA

Mauro Antolotti (*President, founder*)

Michele Antolotti (*Plant Manager, co-founder*)

Maurizio Romeo (*R&D Manager*)