

**Fusion** Factory

# The Fusion Factory

## THE IDEA

The FUSION FACTORY is an integrated Additive Manufacturing (AM) based solution for the manufacturing of complex metal and ceramic parts. It integrates the machines for all necessary technological steps in one system.

The result is a complete process chain in one frame. The combined machines fulfil all requirements for an industrial level production and quality control.

The base of the development is XERION's experience for more than 20 years design and production of furnaces for research and industry and the confidence of our customers in four continents.

The idea of modules extend the possibilities of the system. Modules can be substituted or added. Taking inspiration from Metal Injection Moulding (MIM) and the already vast experience gathered over the years in the field, the **Fusion Factory** aims to further ameliorate the MIM technique through the application of the ever-evolving AM technology to produce parts which are technologically or economically (or both) not feasible with the current state-of-the-art.

Such a technology not only extends the capability of desktop printers beyond prototyping but also offers an accelerated and agile solution for the spare parts industry, where downtime of machinery is a critical issue and delivery of parts overseas could sometimes take weeks.

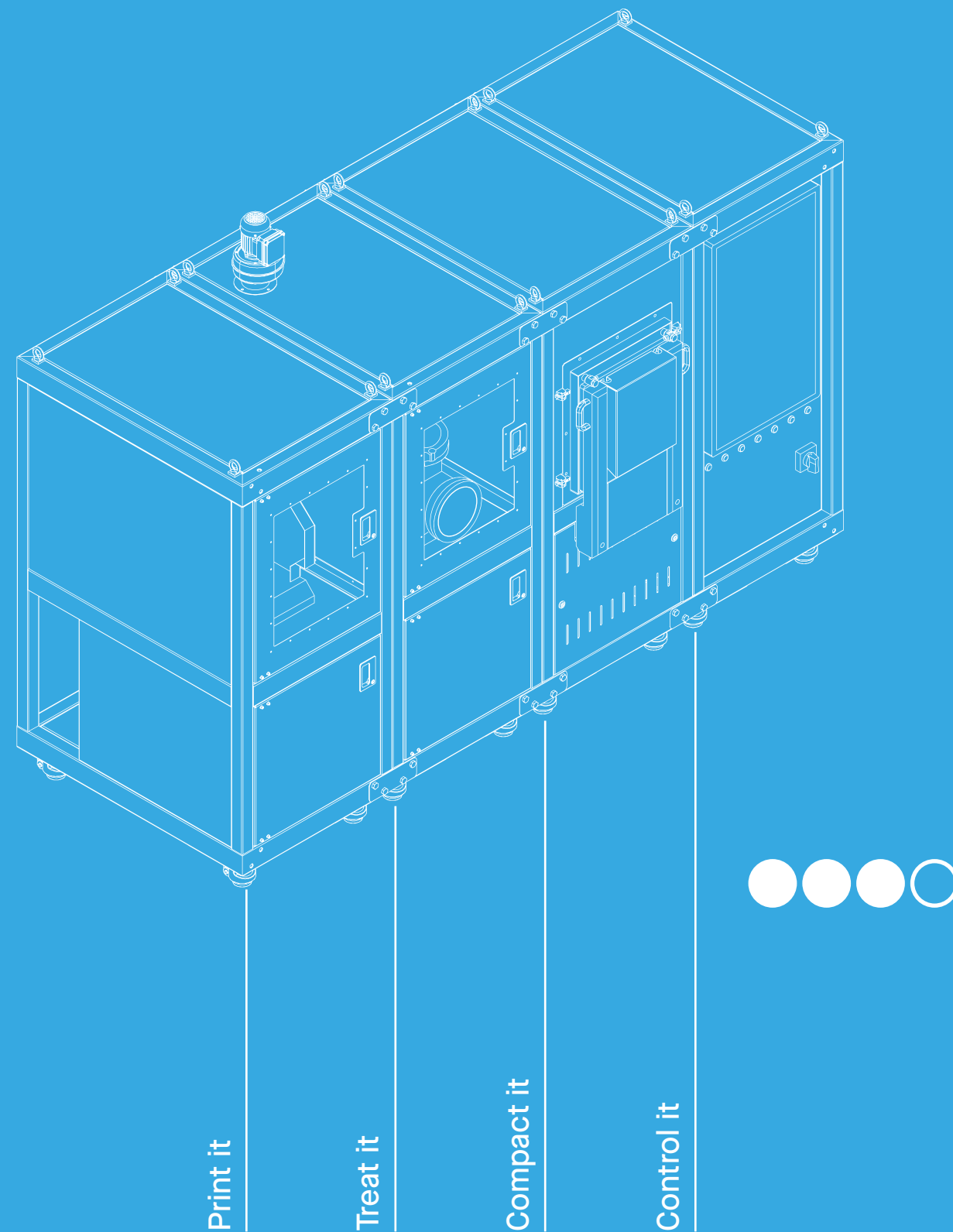
The ability of the system to print with multiple materials further adds to the manufacturing flexibility and makes the creation of composites with complex geometries possible.

## THE WORKING PRINCIPLE

The FUSION FACTORY employs a three-step process, also termed as the trinity of Metal or Ceramic AM, to convert an elastomeric-metallic filament to the desired pure metallic part.

- PRINT IT!
- TREAT IT!
- COMPACT IT!

All three technological steps are controlled by a central unit.



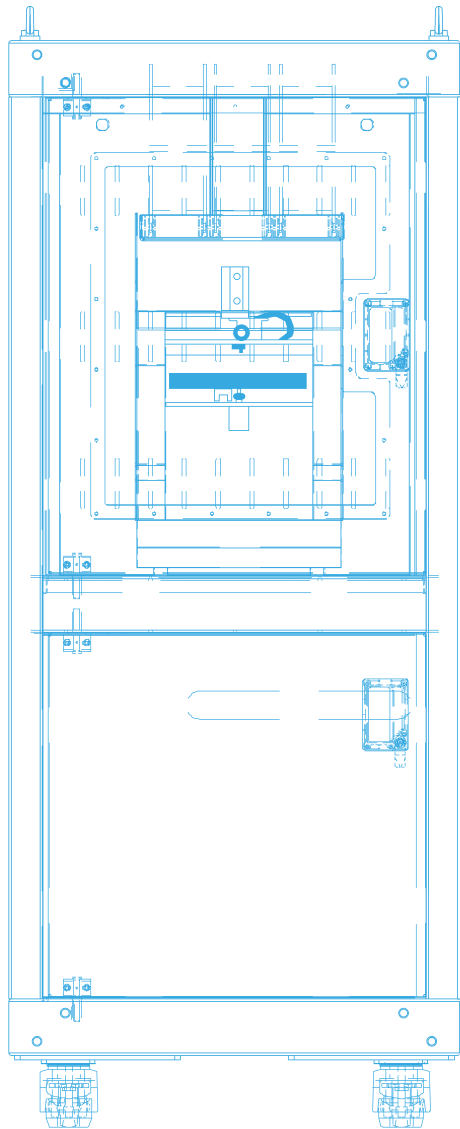


- ① 3D Printer for metal / ceramic filament
- ② Storage for filament rolls
- ③ Debinding station
- ④ Fan for ventilation of debinding unit
- ⑤ Room for solvent canisters
- ⑥ Sinter furnace
- ⑦ Cooling trap (behind the cover)
- ⑧ Control unit
- ⑨ Connection between the modules and crane eyes
- ⑩ Machine feet (Rollers)





# Step 1 Print it



**right page / top left:**  
*The printer unit with filament roll*

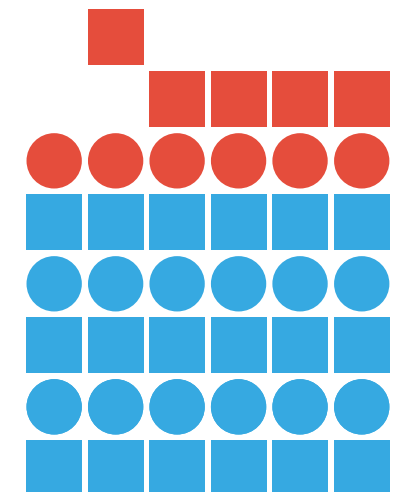
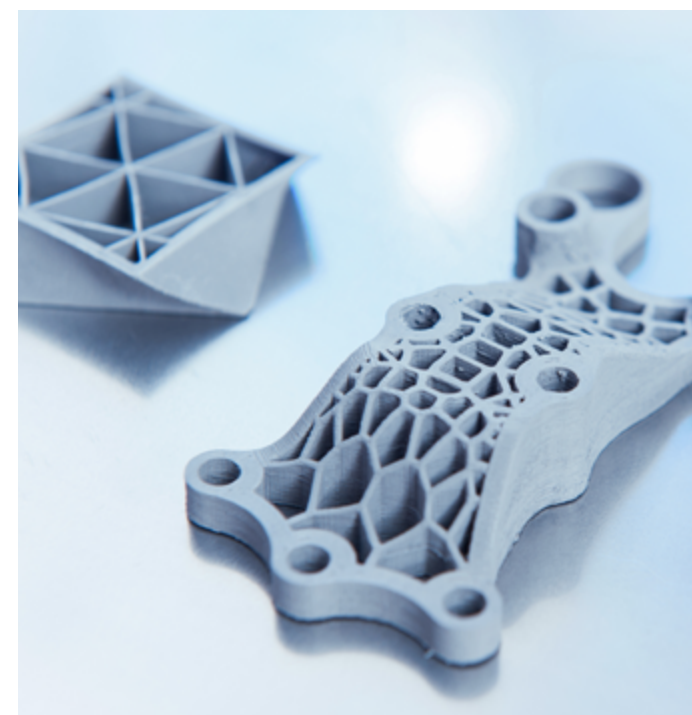
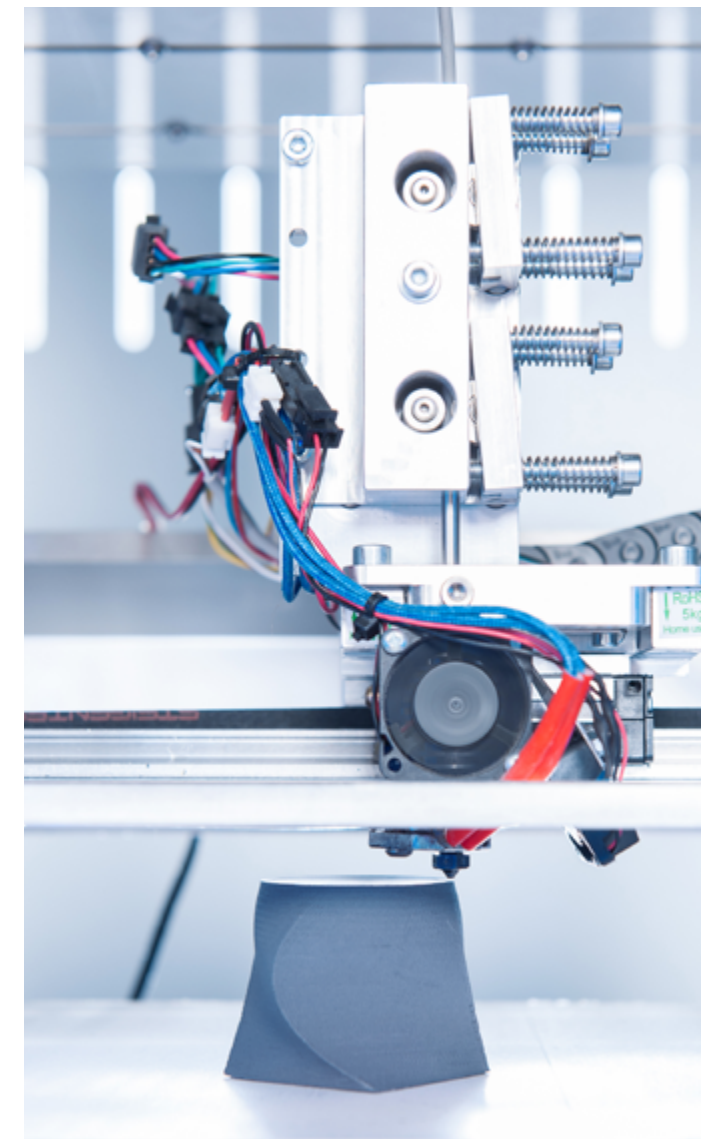
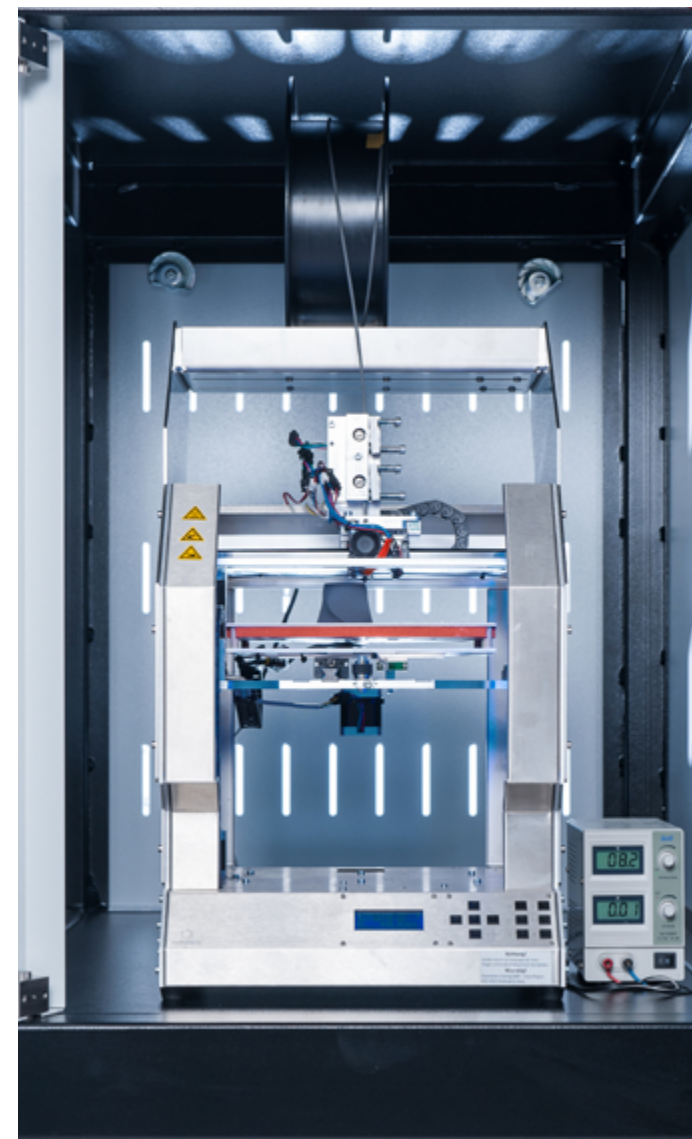
**right page / top right:**  
*The printing process*

**right page / down:**  
*Close-up of printed parts*

The specially fabricated filaments, which are a mixture of organic compounds and metal / ceramic powder, is fed to a modified Fused Filament Fabrication based printer through which the green part, as it is technically christened, is printed.

This process is no different from the one that is used to produce plastic models, with the exception of the special filaments and the specially designed printer nozzle and feed mechanism.

The feed mechanism is 100% made from steel, so the stability and lifetime is very high.





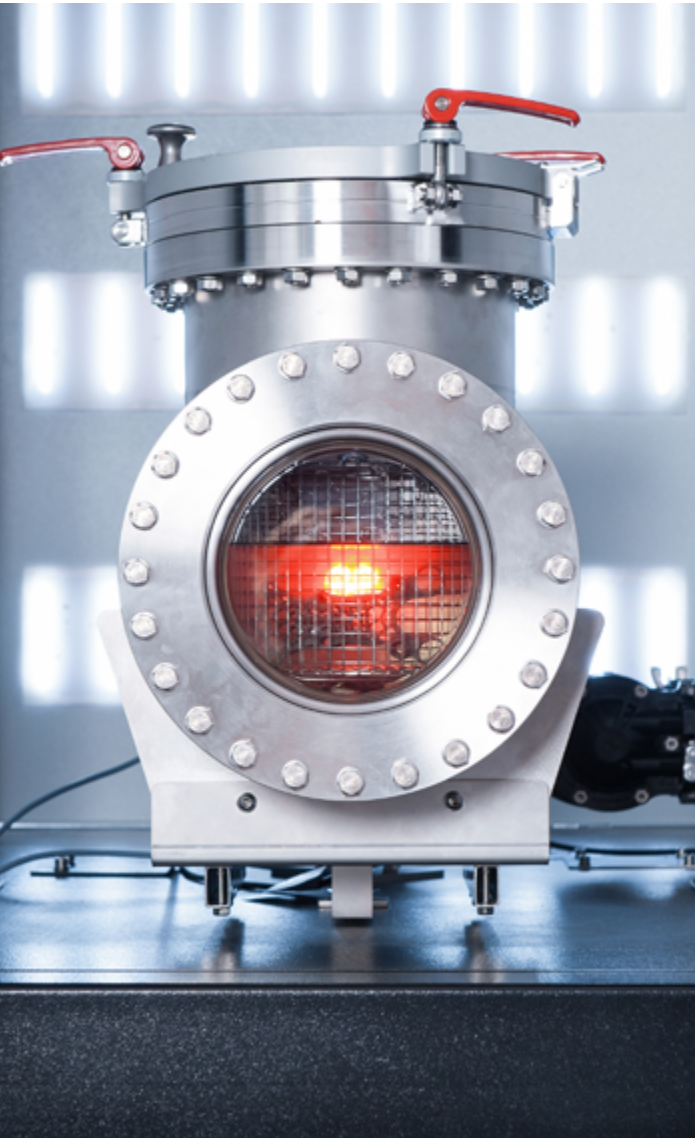
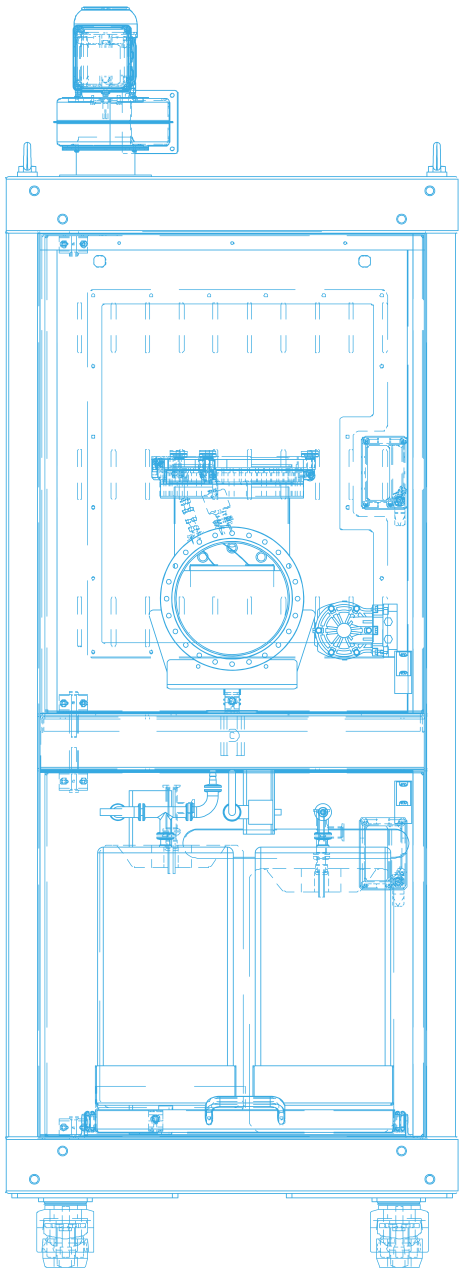
# Step 2 Treat it

The process of binder elimination begins with submerging the green part inside the chemical bath of the FUSION FACTORY’s very own customized Debinding station.

The solvent reacts with the materials on the surface, creating microchannels that further allow it to diffuse deeper into the solid matrix, eliminating the organic compound from deep within. Most of the binder is eliminated this way and the microscopic channels created further act as an outlet for the thermal vaporisation of the remaining organic chemicals in the next step.

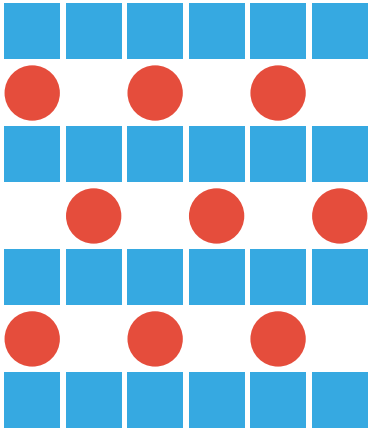
The process is highly automated, the operator will not come in contact with the solvent or with solvent vapour and all standards are strictly observed.

The Debinding process lasts for several hours and we are just one step away from the part being ready.



**top left:**  
*Green part in solvent*

**top right:**  
*The debinding station with canisters  
for pure and used solvent*





# Step 3

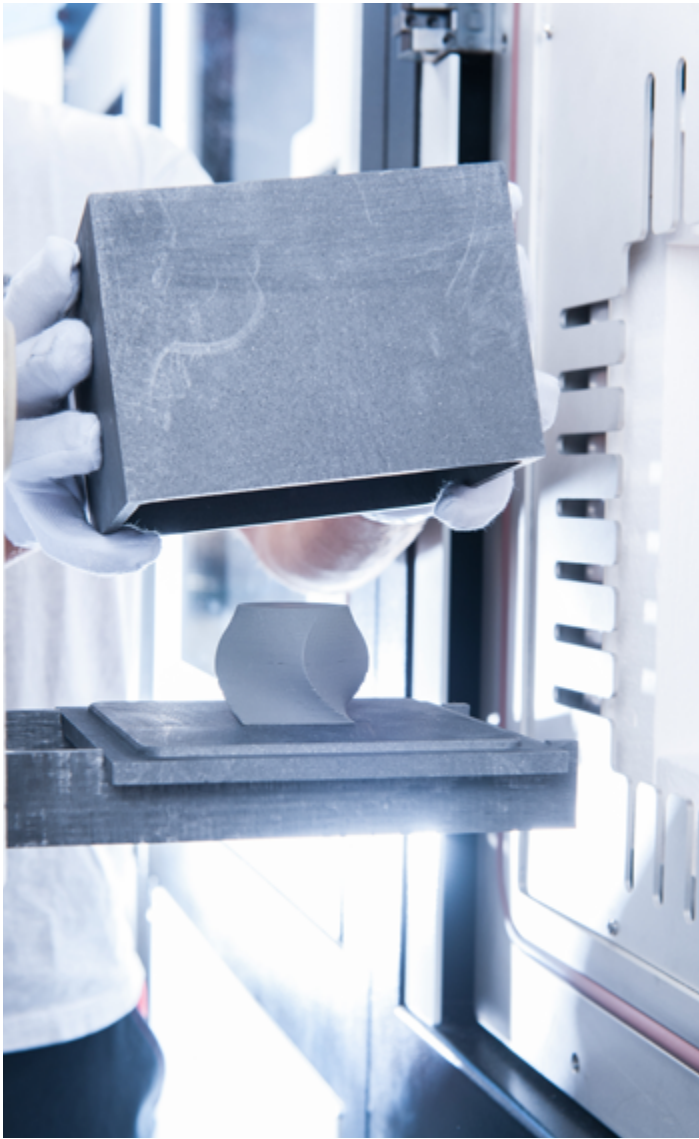
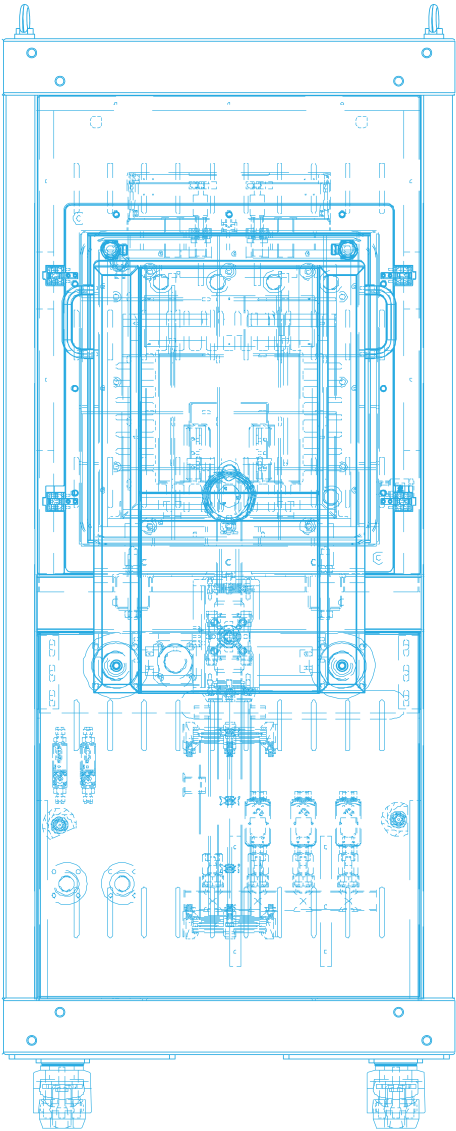
## Compact it

With the elimination of the organic component, the new matrix of the material is now porous with empty spaces evacuated by the binding agent via debinding. Such a part is merely metal powder held loosely together and would break if not handled gently. And that is why we need to compact or sinter it!

In such a process, the material is heated to very high temperatures (>1.000°C) causing the outer shell of the metal powders to melt and fusing them together (a bit like welding). This now makes the material compact and dense, and results in slight shrinkage, which can be precompensated in software prior to carrying out the process.

The sintering process is done under a protective atmosphere, for stainless steel, mostly under 100% hydrogen.

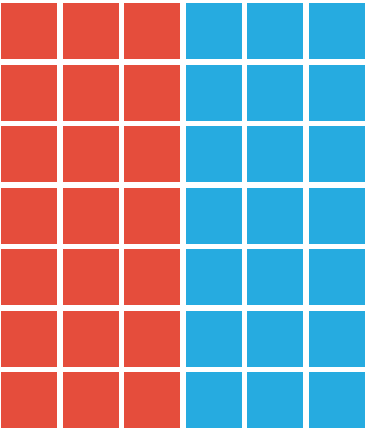
This is the longest process in the manufacturing chain of the FUSION FACTORY and takes usually more than 10 hours.



**top left:**  
*Preparing a green part for sintering by placing it under a graphite cover*



**top right:**  
*Opening / closing the sinter furnace*







*left page:*  
The user-interface of the Control Unit

# Control Unit

The Control Unit is the centralized processor of the FUSION FACTORY, carefully co-ordinating and synchronizing every step in the process chain with utmost precision, while complying to the necessary industrial standards.

The Control Unit has built in fail-safe features ensuring redundancy and is complemented with a touch screen for the user-friendly experience of the operator.

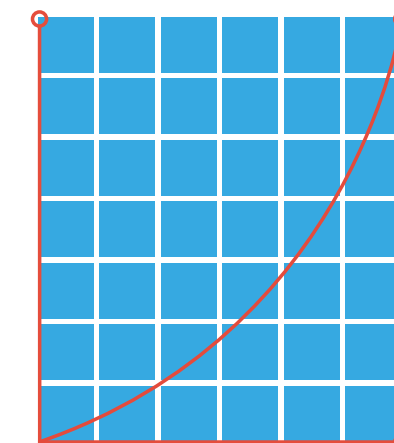
The database management system on-board enables the storage of pre-programmed “recipes”, automising laborious task of working with multiple machinery, and in the process ensuring excellent quality and repeatability of the manufactured parts.

In addition to this, the Graphical User Interface enables a complete supervision and control of all processes and even permits multi-tasking through network-assisted communication between the FUSION FACTORY and your desktop.

**The salient features of the Control Unit are:**

- Overview of all process parameters through user interface.

- Capable of storing and implementing optimised “recipes” from Print It! (Step 1) to Compact It! (Step 3)
- Capable of creating a complete report of the entire process chain incl. the lot numbers, all physical data and the names of the operators.
- Ability to run multiple part cycles in parallel to speed up production.
- Built-in redundancy against failure.
- Optical and acoustic signals for warnings and alarms.
- Remote access to the FUSION FACTORY.





# The Advantages

## ... OF FILAMENT BASED 3D-PRINTING OF METALS AND CERAMICS:

- Highest percentage of powder utilization of all AM techniques
- Cost effective solution as compared to other contemporary AM methods
- Relatively short printing times
- Cavities and infill profiles (with controllable infill percentage) can be manufactured
- Easy way of producing multi material components
- High Technology Readiness Level (TRL) of printing process

## ... OF THE FUSION FACTORY:

- Automated process chain from filament to ready-to-use component
- Concept applicable for metals and ceramics
- Production of all sorts of complex geometries within appr. 2 working days
- Lower cost of production as compared to contemporary AM systems

- High TRL of debinding and sinter process through technological maturity achieved with MIM/CIM manufacturing techniques
- Minimum technician intervention from the point of upload of computer file to the part being manufactured
- Open system permitting use of filaments from other suppliers
- High precision of manufactured parts with little or no need of further machining to improve product quality.
- Robust and industry-friendly design of the machine
- Control with fail-safe industrial Siemens S7-1500 Controller
- User-friendly recipe creation for all technology steps
- Automatic report generation with all relevant parameters including Operator names based on a professional data management system
- Remote access to system eliminating need for on-floor supervision
- Machinery compliance with all relevant national and international standards
- Compact design suitable for all workshops and laboratories
- Robust frame with crane eyes for easy transport of the system

- System completely designed and manufactured in Berlin / Germany, therefore a deep understanding of the technology and it's state-of-art
- As an option, execution in accordance with the standard „AMS2750E“ possible

# Our Services

With the FUSION FACTORY comes not only a state-of-the-art AM solution but also a dedicated commitment from XERION, with more than 20 years of experience in supplying and maintaining industrial systems, to ensure a transfer of knowledge and support to the customer for its optimal use.

After-sales-support and periodic software updates shall further complement the transfer of know-how in addition to the possibility of having regular maintenance conducted by XERION on the system.

The various services have been summarised below:

- Close working co-operation with clients after delivery of system
- After-sales-support worldwide through XERION's network of partners
- Periodic software update to improve system performance within guarantee period

- Extensive consulting thanks to over 20 years of experience in furnace construction
- Short delivery times through the most extensive in-house production
- Possibility of remote diagnostics of the system
- Short response times in case of problems, thus high system availability
- Advice and assistance in the development of new metallic or ceramic filament systems
- Possibility of printing and treating 3D printed parts (as service) in XERION's Laboratories in Berlin
- Optional maintenance contracts

# Our Materials

Material	Ø Filament	Remarks
17-4P	2.85 mm	Stainless steel
316 L	2.85 mm	Stainless steel
Al <sub>2</sub> O <sub>3</sub>	2.85 mm	Ceramic
ZrO <sub>3</sub>	2,85 mm	Ceramic

... and many other filaments on request.





# Tech specs



## GENERAL DATA

**Dimensions:**  
W 3,200 mm x D 1,200 mm x H 1,800 mm

**Weight:**  
1,300 kg

**Electrical Connection:**  
CEE plug: 400 V / 32 A / 50 Hz

**Gas connections:**  
Nitrogen: 3 bar, max 20l/min  
Hydrogen: 3 bar, max 10l/min  
Emergency bottle: Nitrogen  
Pressed Air: 6 bar, oil free

## PRINTER UNIT

**Dimensions:**  
W 800 mm x D 1,200 mm x H 1,800 mm

**Working space:**  
W 245 mm x D 230 mm x H 200 mm

**Printer:**  
3 axis industrial filament printer

**Printing table:**  
Ceramic plate with heating element

**Table maximum temperature:**  
120 degree Celsius

**Extruder type:**  
Duplex with All-metal-double gear for filament transportation

**Extruder maximum temperature:**  
270 degree Celsius

**Filament diameter:**  
2,85 mm

**Noozle diameter:**  
0.3, 0.4, 0.5 mm

**Installed power:**  
620 W

## DEBINDING UNIT

**Dimensions:**  
W 800 mm x D 1,200 mm x H 1,800 mm

**Working space:**  
150 mm x D 150 mm x H 150 mm

**Debinding method:**  
Solvent debinding

**Solvent:**  
*Aceton / Isopropyl alcohol*

**Tanks:**  
30 l for pure solvent  
30 l for impure solvent

**ATEX conformity:**  
Yes

**Protective gas:**  
Nitrogen

**Gas flow:**  
0 ... 10 l/min

**Level control in vessel:**  
Digital weighing scale



**Level control of used acetone:**

Digital weighing scale

**Heating:**

Electric heating system

**Temperature range:**

10 ... 90°C

**View glass::**

Diameter 160 mm on the front

**SINTER UNIT**

**Dimensions:**

W 800 mm x D 1,200 mm x H 1,800 mm

**Working space:**

150 mm x D 150 mm x H 150 mm

**Furnace heating:**

Electrical

**Heating elements:**

Cermet material

**Charging samples:**

Drawer type with electropneumatic clamps

**Max. temperature:**

1.550°C

**Atmospheres:**

N<sub>2</sub>, H<sub>2</sub>, Vacuum, Air

**Pumping system:**

Rotary vane pump with cooling trap

**Pressure regulation:**

10 ... 500 mbar (only Nitrogen atmosphere)

**Final Vacuum:**

5 × 10<sup>-2</sup> mbar

**Gas flow Nitrogen:**

0 ... 10l/min

**Gas flow Hydrogen:**

0 ... 10l/min

Option instrumentation and documents according to standard “AMS2750E” and “Title 21 CFR Part 11“

**CONTROL UNIT**

**Dimensions:**

W 800 mm x D 1,200 mm x H 1,800 mm

**Controller:**

Siemens S7 - 1500 controller partially fail-safe

**HMI:**

42“ Touch screen

**Screen:**

- Process visualisation for all 3 units
- Editing of „recipes“ for all 3 units

**Report:**

In PDF form with information from all technological steps

**Alarm:**

Optical and acoustical indication

**Data download interface:**

USB

# Contact Us

If you have any specific questions or interest in a customized solution for your business, we look forward to hearing from you.

FUSION FACTORY is a product brand of  
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