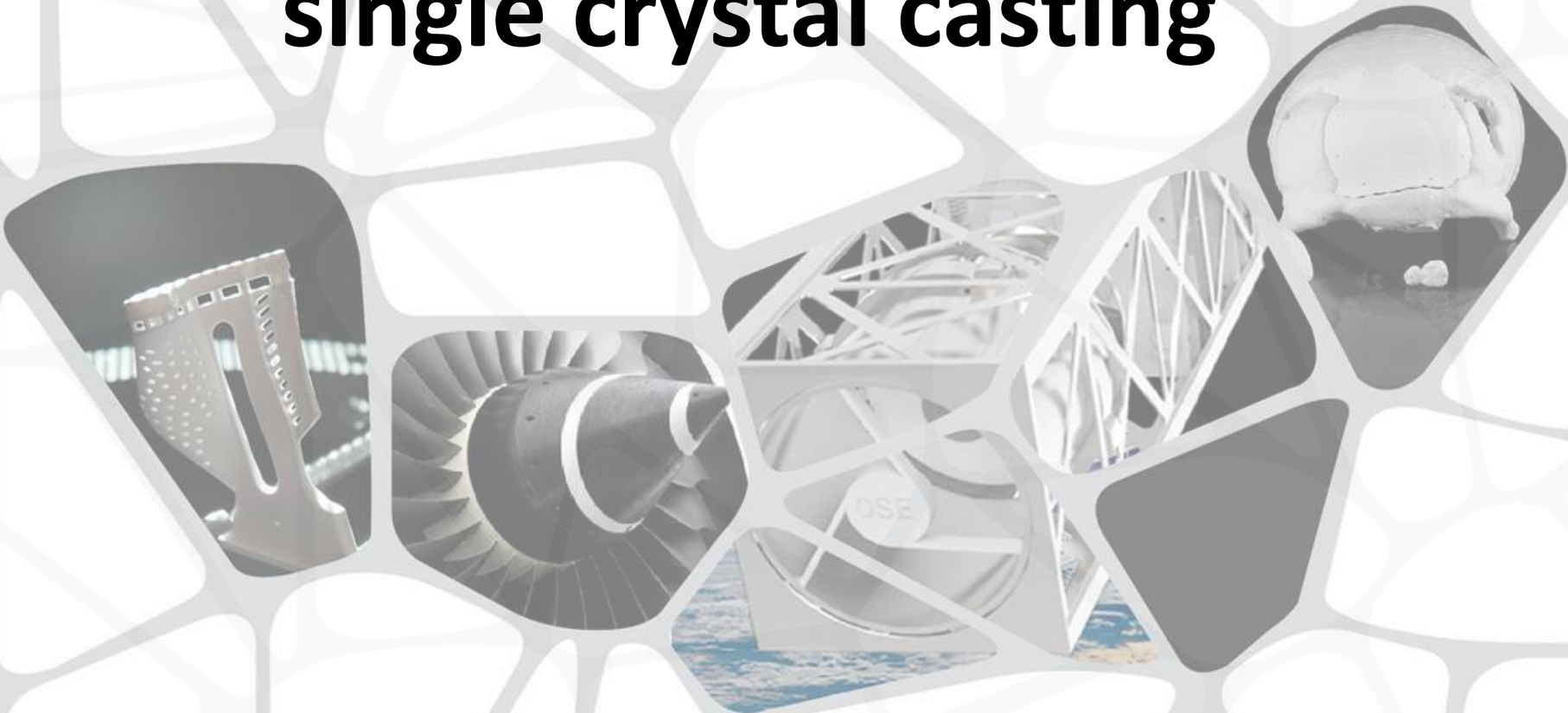


3D printed cores dedicated to single crystal casting



ADDITIVE MANUFACTURING AROUND THE WORLD

- 3DCERAM Inc in Grand Ledge (MI)
- Vcerax (Jpn)



Created in 2001 by
C. Chaput and R. Gaignon



30 people



TO ~5M€ (90% for export)



SINTO – Main shareholder –
4000 people. & 1 billion \$

30 PARTNERS WORLDWIDE

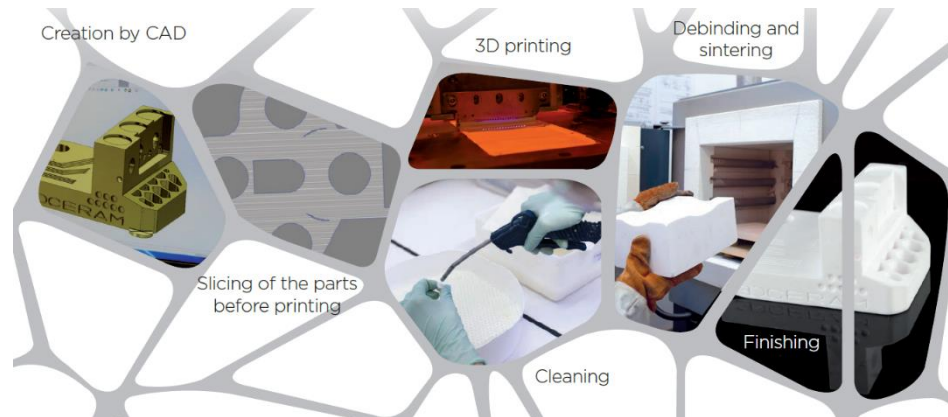


New building (more than
3000 m²) since February
2021

3DCERAM

A COMPLETE RANGE OF PRINTER

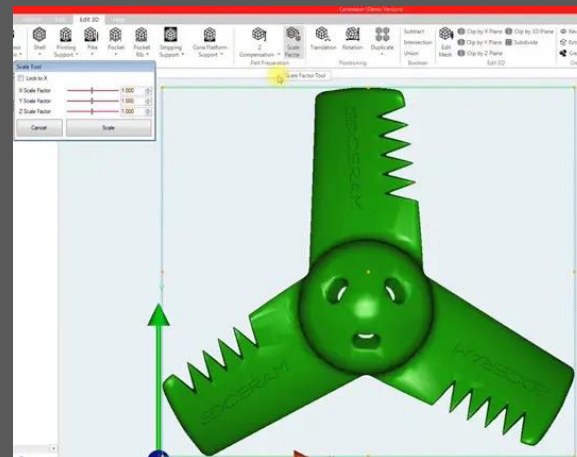
PROCESS PROVIDER



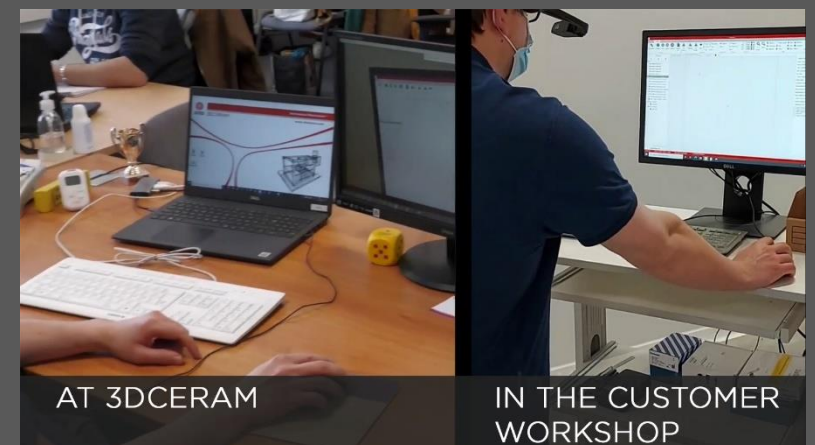
MIX for CERAMAKERS



SOFTWARE

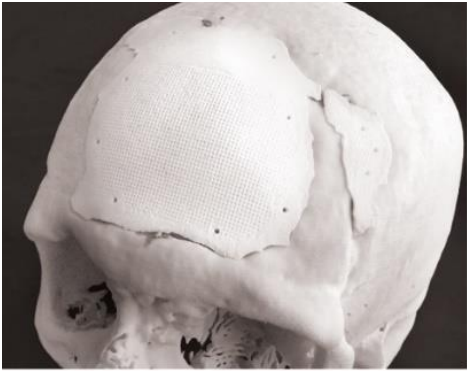


DEDICATED SERVICES



MAIN APPLICATIONS

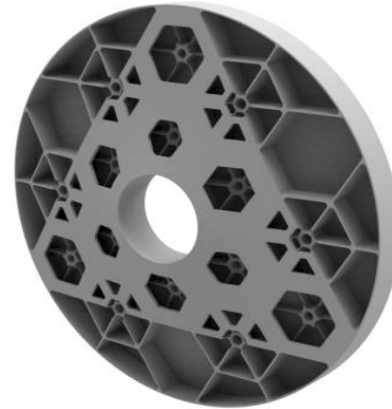
Biomedical



Industry



Aerospace



Aircraft



Ceramic material for cores: Development since 2021

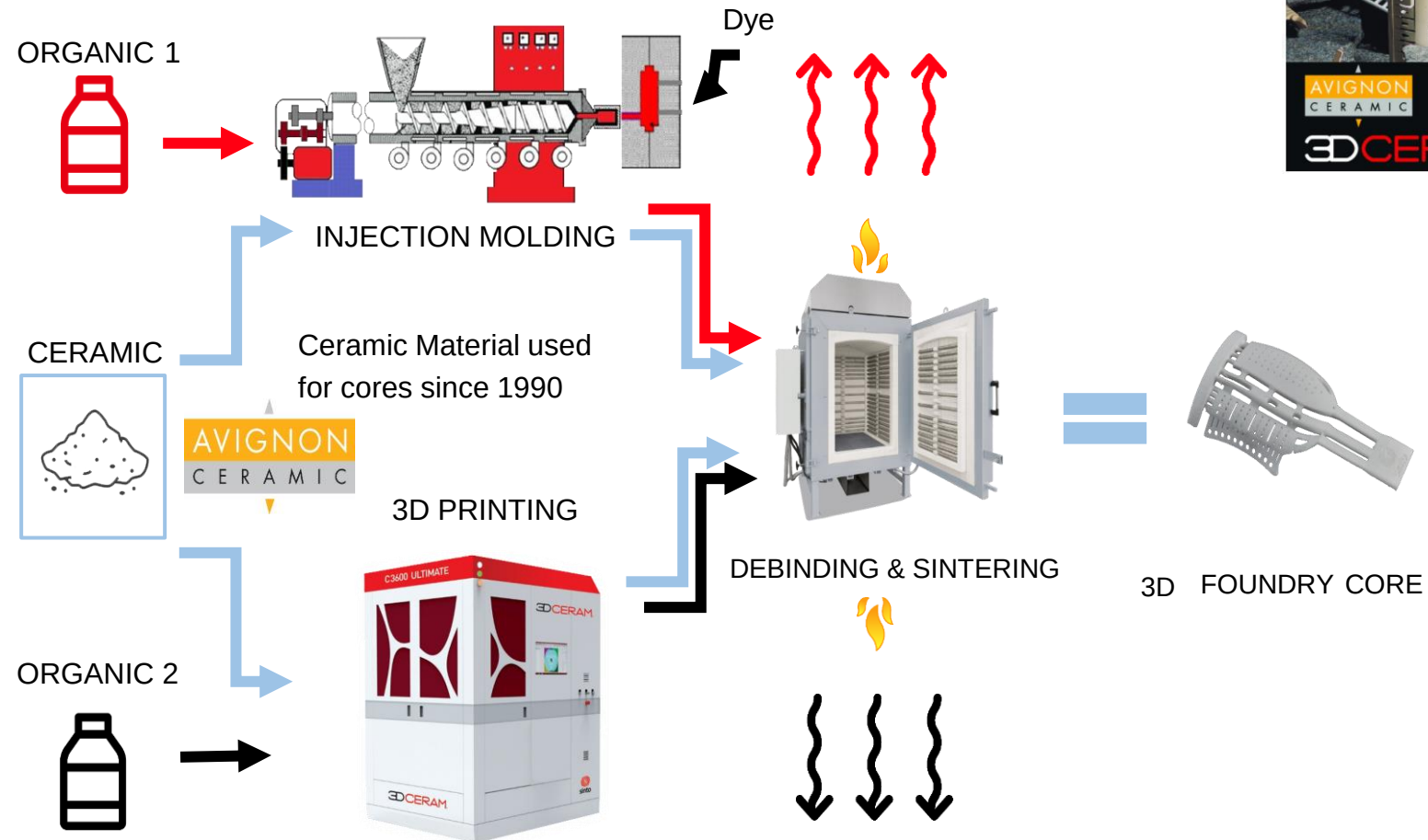


- Chose a ceramic material already used and qualified with another technology which has been successfully used for many years for core manufacturing
- Sintering process is already known
- Properties of cores are also known
- Qualification through the foundry process is way easier. As they are coming from the ceramic already used since years in core foundry industry

Main Properties

We chose to:

- Work with a well known core manufacturer: Avignon Ceramic
- Use their Ceramic in our 3D formulation





3DCERAM

New Harmony>> New Solutions™

3dceram.com



+



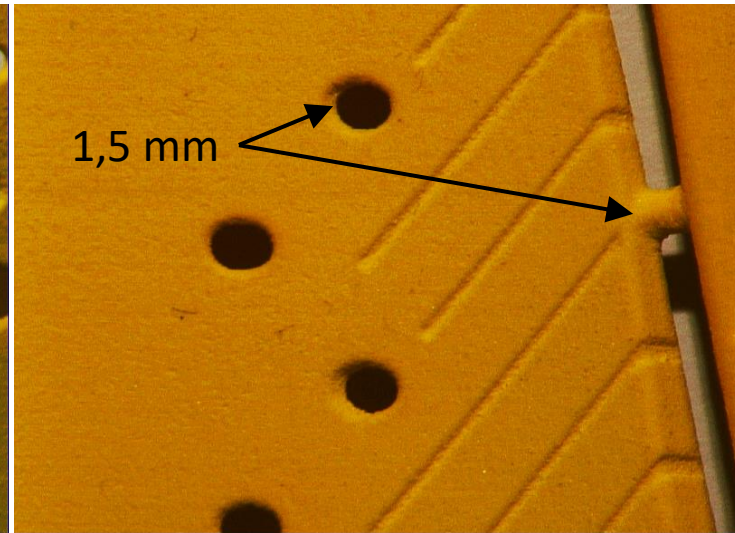
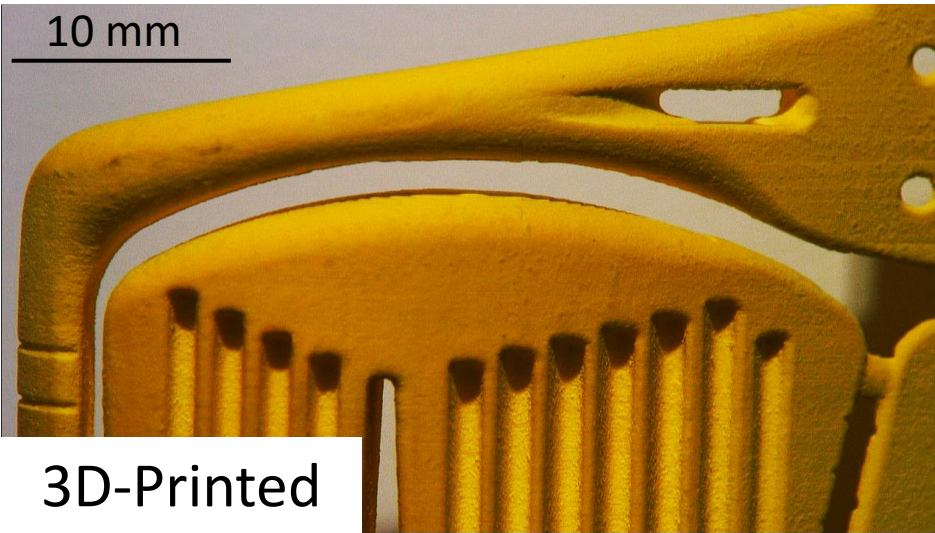
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SLURRY

CERAMIC

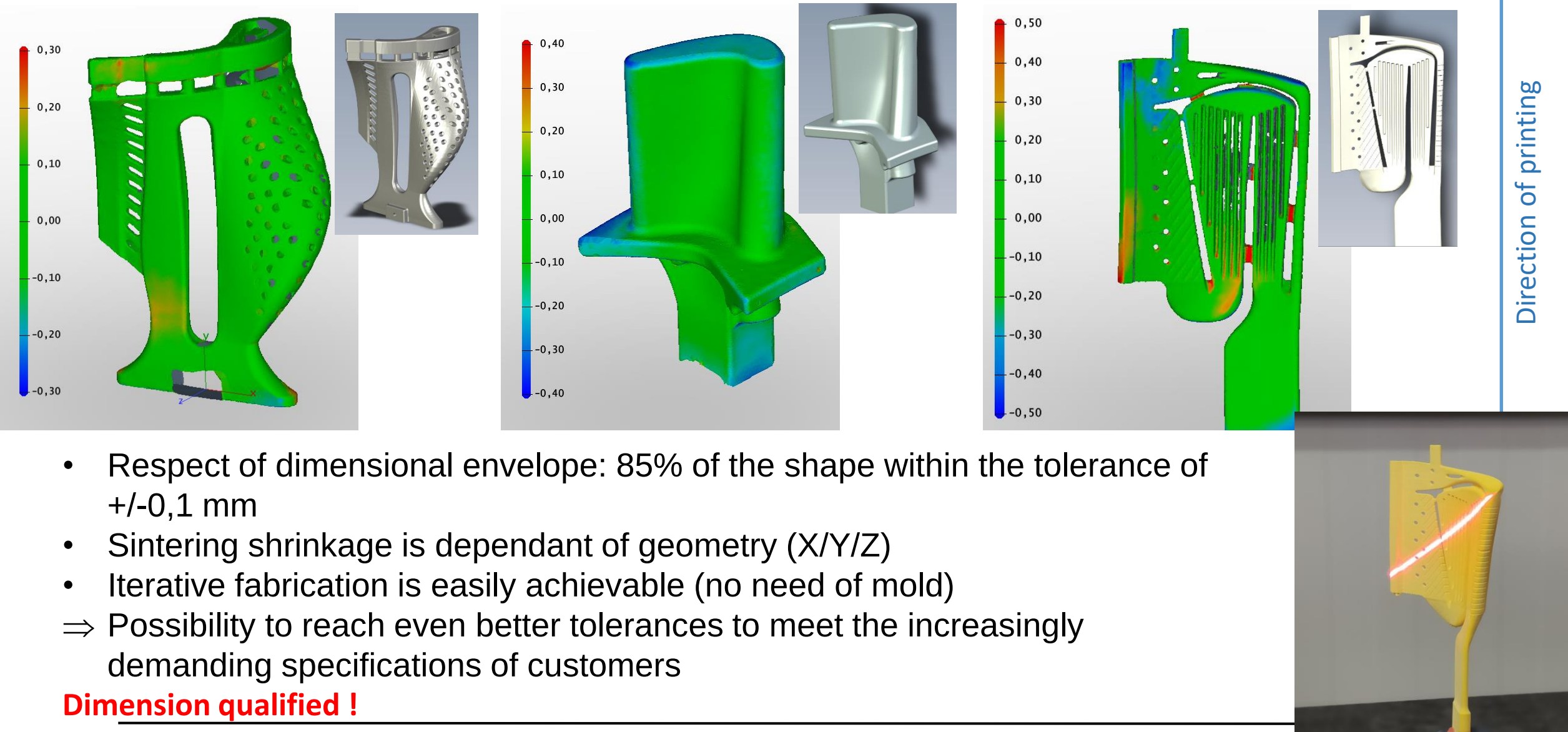
ORGANIC

SHAPE: INJECTION / 3DPRINTING COMPARISON

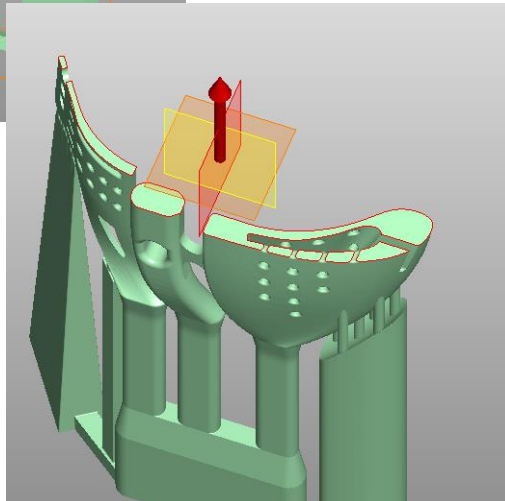
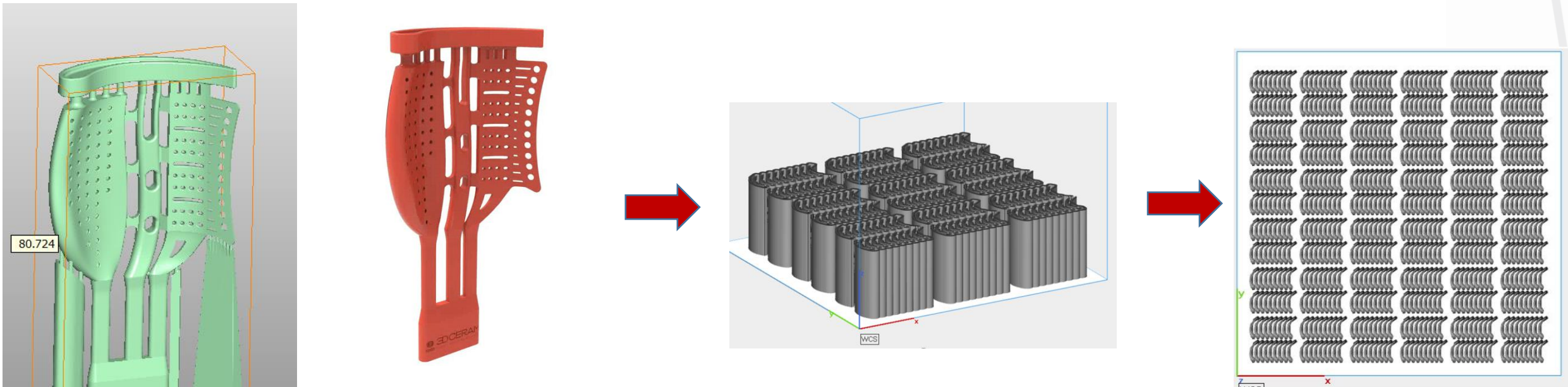


- High resolution achieved by laser shaping
- Limited surface roughness (no finition)
- Layer stacking barely not visible

CORE DIMENSIONNAL EVALUATION



PROCESS INDUSTRIALISATION



Core Weight: 10,8 gr	C100	C1000	C3600
Platform size	10*10*15 cm	32*32*20 cm	60*60*30 cm
Nb of parts / run	18	162	648
Total printing time (h)	26	80	182
Printing time / part (min)	87	29	17
Material cost (€)	3	2,9	2,9

MATERIAL: INJECTION / 3DPRINTING COMPARISON

	AVIGNON CERAMIC	U3DC Silicore
Shaping	Injected	3D printed
Silica / Zircon	80/20	80/20
Porosity	29%	30%
MOR 20°C	12 MPa	9 MPa
Impregnated MOR 20°C	25 MPa	20 MPa
Surface Roughness (µm)	2 µm	2 µm

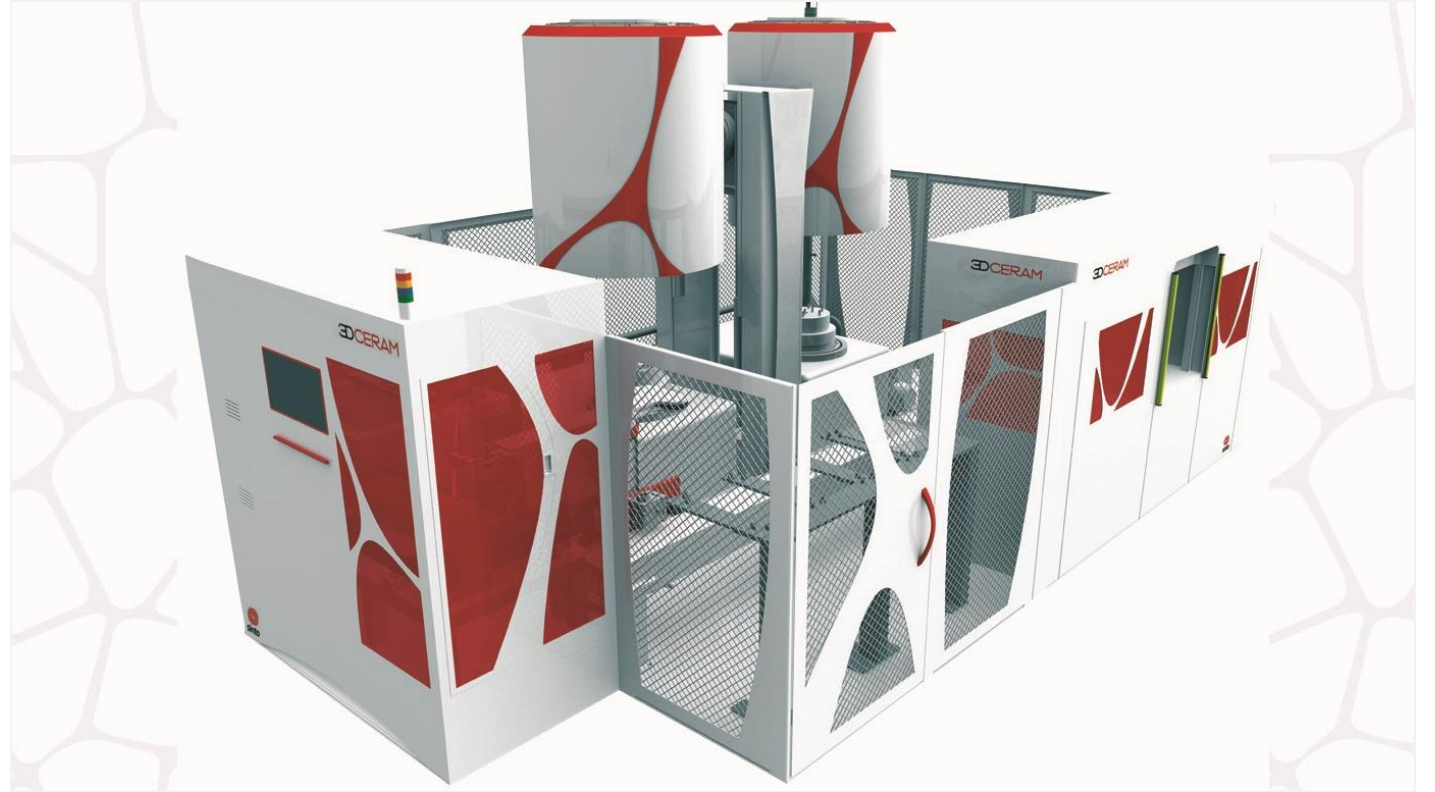
- 4 bending points test

MATERIAL: INJECTION / 3DPRINTING COMPARISON

		AVIGNON CERAMIC	U3DC Silicore
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Impregnated MOR 20°C		25 MPa	20 MPa
Surface Roughness (µm)		2 µm	2 µm
Thermal Expansion	20 - 1000°C	< 0,2%	< 0,2%
	20 – 1500°C	< 0,4%	< 0,4%
Cristobalite content	As fired	> 8%	> 8%
	After 1530°C	> 60%	> 60%



- Debinding Nitrogen: MAX 20 mm
- Debinding Air : 10 mm



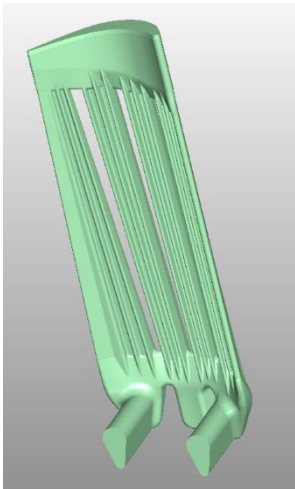
Foundry process qualification

VALIDATION OF BLADE PRODUCTION

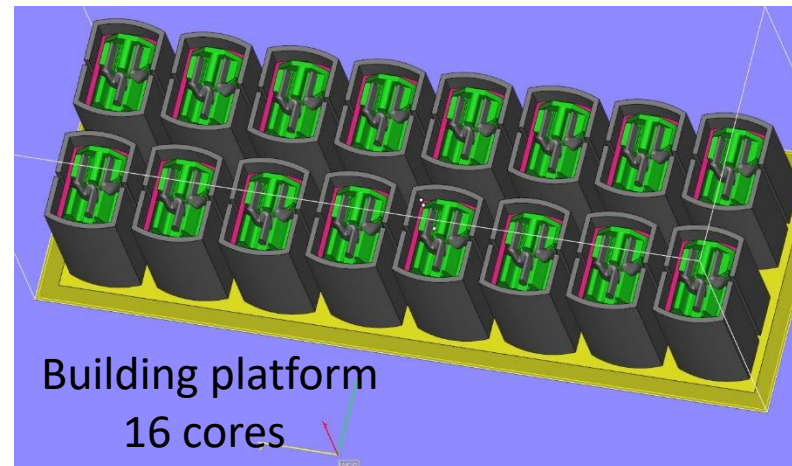
The 3DMix Silicore formulation has been tested for the manufacturing of cores made by 3d printing for turbine blades production by SX investment casting.

1. Validation of printing and firing

CAD



PRINTING



FIRING



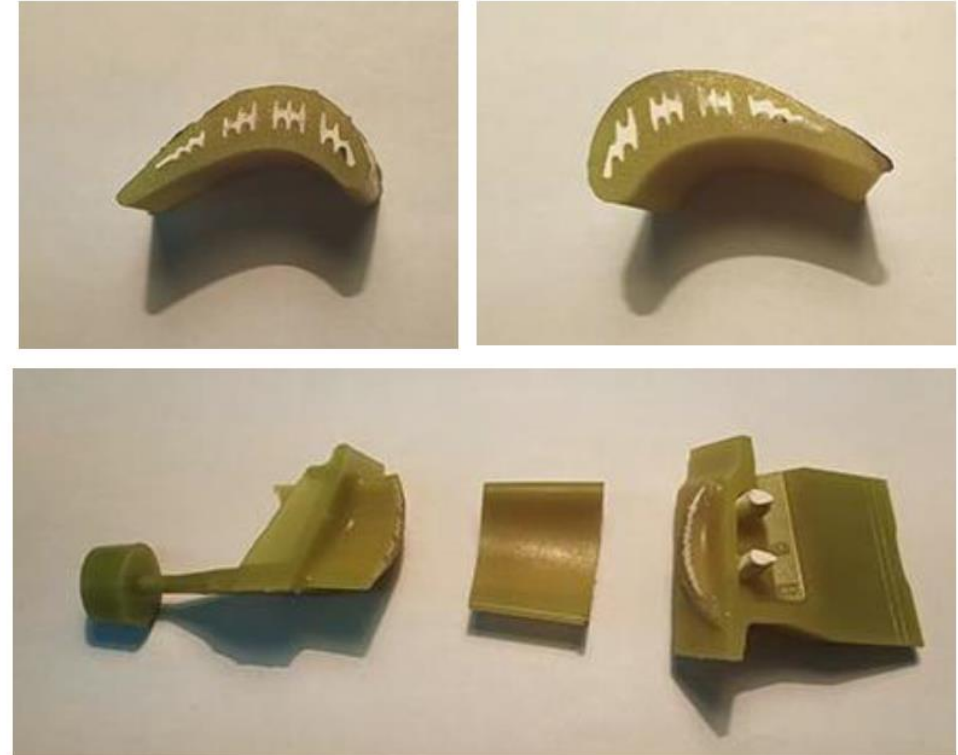
VALIDATION OF BLADE PRODUCTION

2. Wax injection

Core in the
wax mould:



**SECTIONS
ANALYSIS**



After wax casting,

Good positioning and no deformation controlled by ultrasonic measures of the thickness of different sections of the blades

➔ Accepted by client on internal standard tolerances for this type of blade

1. Xrays controls (internal procedure) on wax patterns => no cracks of the ceramic cores

VALIDATION OF BLADE PRODUCTION

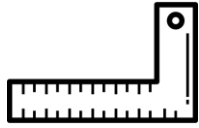
3. Validation of foundry moulds casting



4. After casting

- No defect controlled by x-ray by client after SX casting
- No creeping
- Leachability time similar to injected ceramic cores with SAME client process

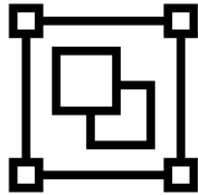
Our solution meet the process specifications:



Respect the tolerances /dimension



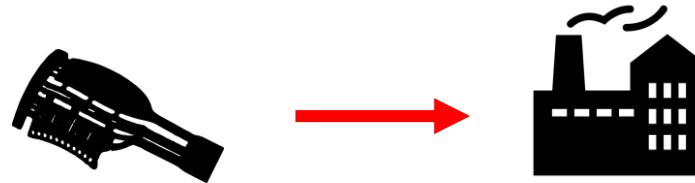
Qualify the material



Get the right surface rugosity



Meet price constraints



Make tests with investment casting foundries

SILICORE FOR INVESTMENT CASTING

Silicore is a Silica-based compositions :

- ⇒ Extensively used in the casting of Ni-based turbine blades (casting temperature around 1500°C)
- ⇒ Good thermal stability (low CTE)
- ⇒ Excellent thermal shock resistance
- ⇒ High leachability



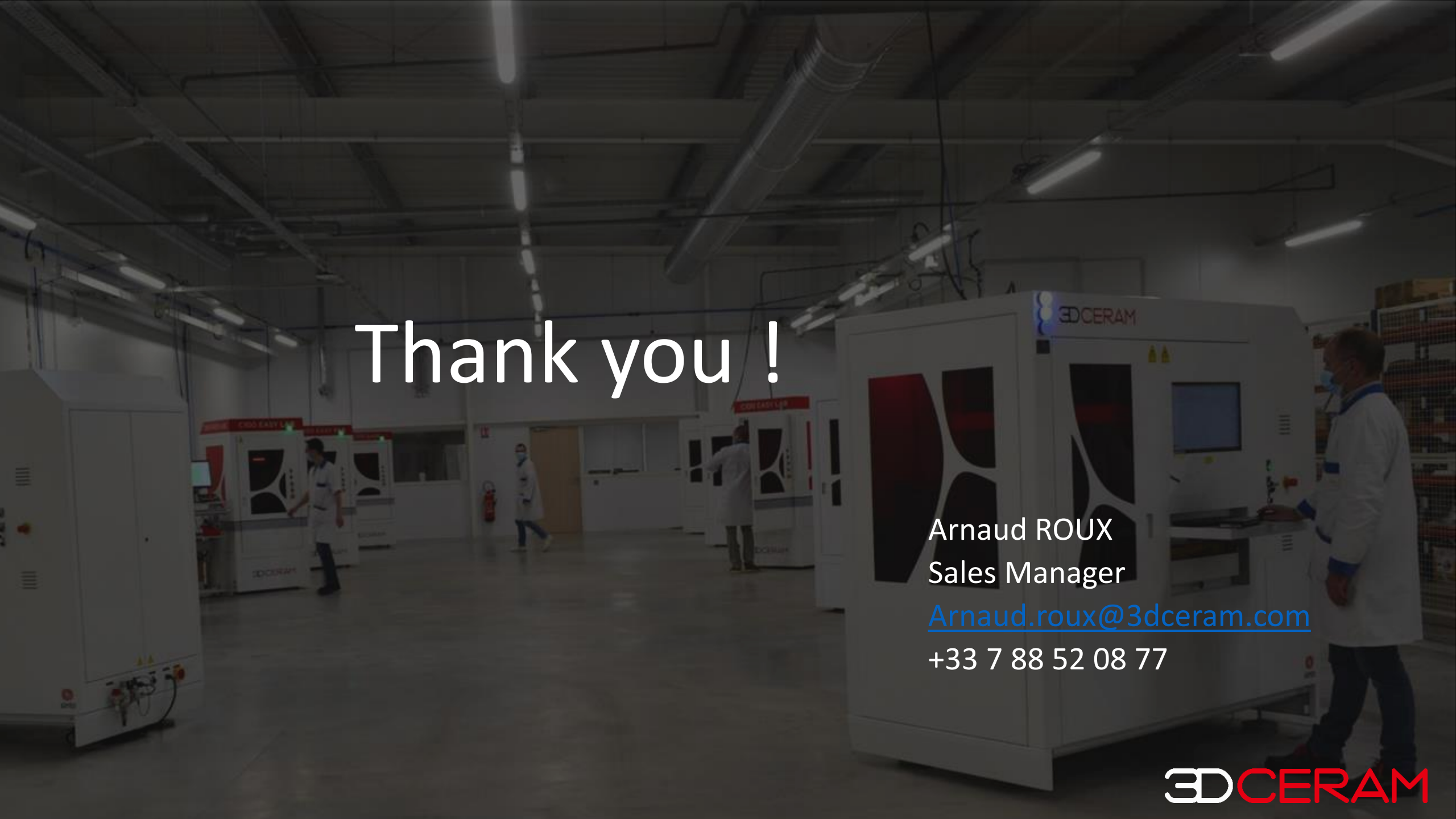


CONCLUSION & PERSPECTIVES

CONCLUSION & PERSPECTIVES

After 18 months of collaboration, 3DCS through U3DC has developped a turn key solution for the core industry:

- Qualify the material ok
- Respect the tolerances /dimension ok
- Get the right surface rugosity ok
- Meet price constraints ok
- Tests with investment casting foundries ok
- Possible scale up on industrial machines : more cores printed all together
- Next step : LARGE Cores for IGT
- A partner to transfer the process : remote support, ceramists engineer as interlocutors, machines at 3DC to carry out tests in parallel if needed.

The background image shows a spacious industrial manufacturing environment. Several large, white, box-like machines with red and black graphics and the '3DCERAM' logo are arranged in a row. Workers in white lab coats are visible, some standing near the machines and others walking in the background. The ceiling is high with exposed ductwork and industrial lighting. The overall scene conveys a professional and high-tech manufacturing setting.

Thank you !

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Sales Manager

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3DCERAM