PRECISE MACHINING OF CLIC STRUCTURE

1. Presentation of Mecachrome Group

2. Machining and control facilities

3. Focus on machining structure developpement

4. Why a collaboration between designer and manufacturer is necessary?

5. Conclusion

1. Presentation of Mecachrome Group

Activity overview

Mecachrome is a leader in the design, industrialization, machining and assembly of high precision mechanical parts (made of hard materials among other materials) for aerospace, automotive and industrial markets.

MECACHROME

Division Aerostructures

Activities
Machining and Assembling of aircraft parts
Markets
Aerospace, Defense

Employees
575

Sites
Amboise, Mirabel, Tanger

Activities
Sheet metal work, Fabrication, Assembling of aircraft parts
Markets
Aerostructures & electrical furniture

Employees
370

Sites
Toulouse, Tunis

Division Aero Engine & Energy

Activities
Machining & Assembly of parts (assemblies & sub-assemblies)

Markets
Aerospace, Defense, Motor Sport, Nuclear, Medical, Space

Employees
575

Sites
Aubigny sur Nère, Vibraye

Division Automotive

Activities
Machining & Assembly of automotive parts

Markets
Car production & industrial vehicles

Employees
350

Site
Sablé-sur-Sarthe

Production capabilities - Mecachrome

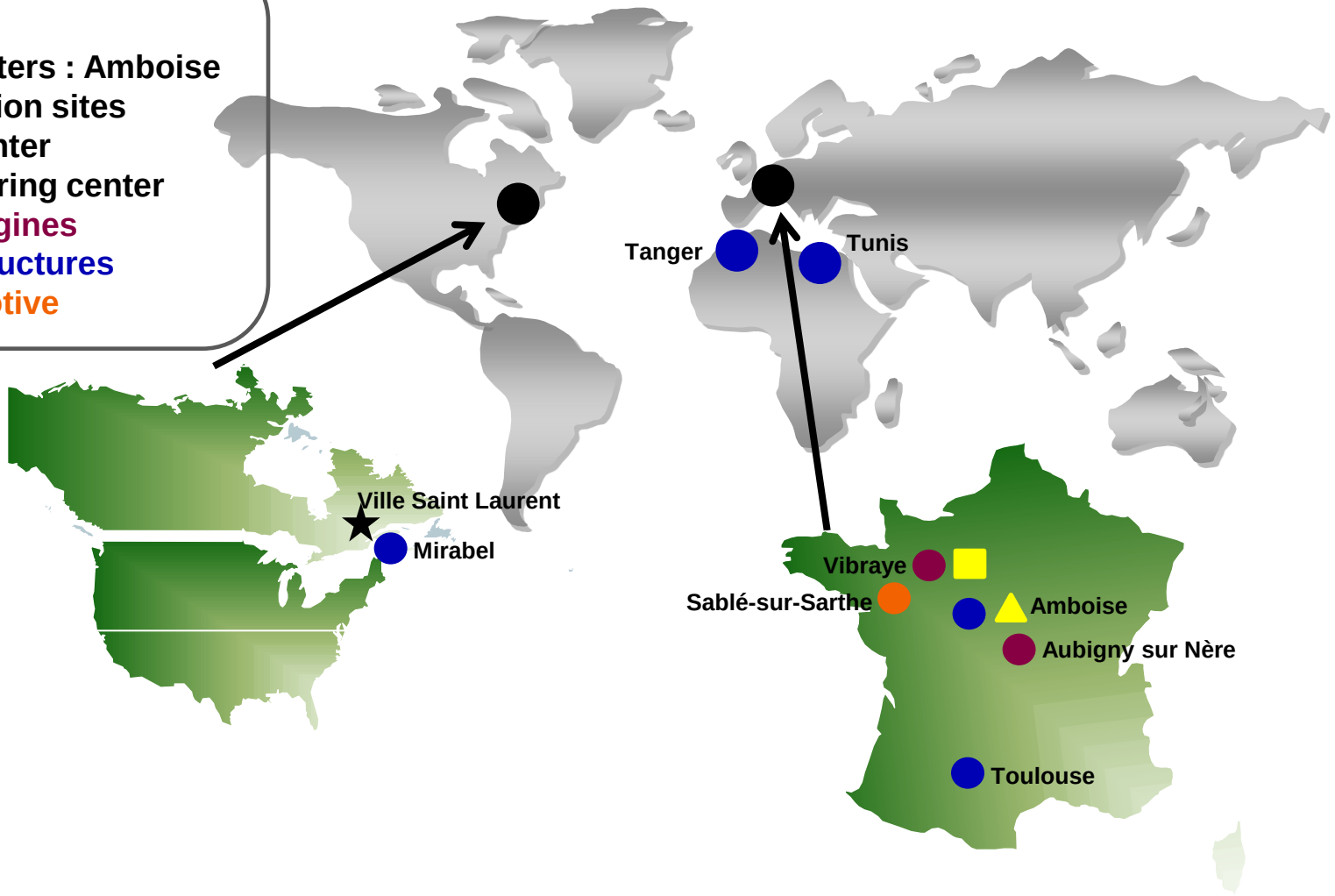
Division Aerostructures	✓ 5 production sites: Amboise, Toulouse, Mirabel, Tangier, Tunis ✓ Equipments: 75 CNC machines
Division Aero Engines & Energy	✓ 2 production sites: Aubigny sur Nère, Vibraye ✓ Equipments: 155 CNC machines ✓ Special process : 75 machines
Division Automotive	✓ 1 production site: Sablé sur Sarthe ✓ Equipments: 127 CNC machines ✓ 51 robots & 49 special machines

Locations

10 sites:

- ▲ Headquarters : Amboise
- ● 8 production sites
- ■ 1 R&D center
- ★ 1 engineering center

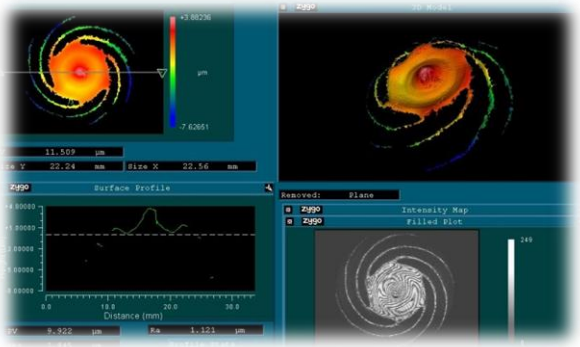
Aeroengines
Aerostructures
Automotive



2. Machining and control facilities

High Precision Machining – Optical Machining Capability

- Machining: Clean Room ISO 9 (according to ISO 14644-1) - Temperature 20 ± 2 ° C
- Programming software upgrated for high accuracy machining
- Control and assembly : ISO 8 (according to ISO 14644-1) clean room - temperature 20 ± 1 ° C
- Green LED micrometer
- Fizeau interferometer ZYGO 6''VeriFire XP / D Dynaflect
- White light interferometer NewView 7300
- Spectra 250 X microscope camera
- 50 X microscope
- Granit 3020mm x 1820mm



High accurate Machining

5-axis CNC turning milling machine

Technical characteristics:

X axis travel **350 mm**
Y axis travel **150 mm**
Z axis travel **300 mm**
B and C axis travel **360 degrees**

Swing capacity up to 20‘‘
Air bearing Turning spindle 10,000 rpm
Air bearing Milling spindle 60,000 rpm

Precision

34 picometers resolution rules (0.034 nanometers)
Incremental programming **0.01 nanometer**
Axial and radial spindle error ≤ **25 nanometers**
B axis axial and radial error ≤ **100 nanometers**

Shape defect ≤ 0.15 µm on diameter 75 mm
Surface finish Ra ≤ 3.0 nanometers

Machine delivered on january 2011
First structure TD24WFM delivered on novembre 2011.

High Accuracy Machining

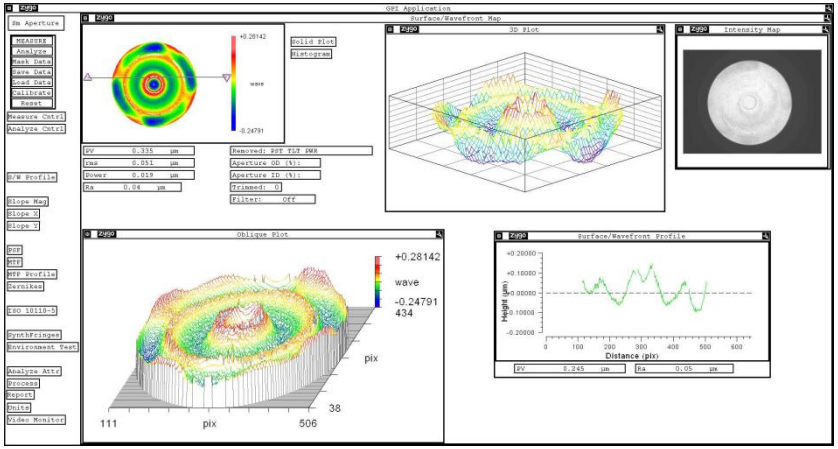
Aluminum mirror for satellite application on its support delivery

Results :

PV = 0.335 µm

Ra = 0.001 µm

RmS = 1,92 nm



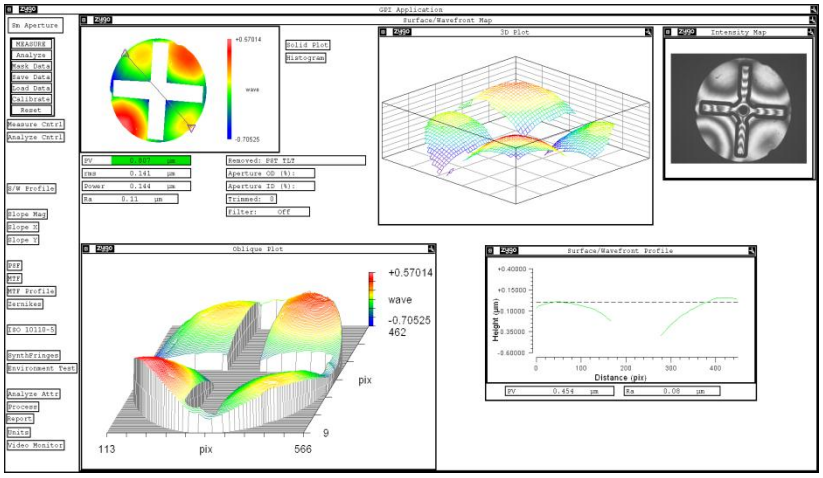
Copper disk - accelerating structure

Results :

PV = 0.807 µm

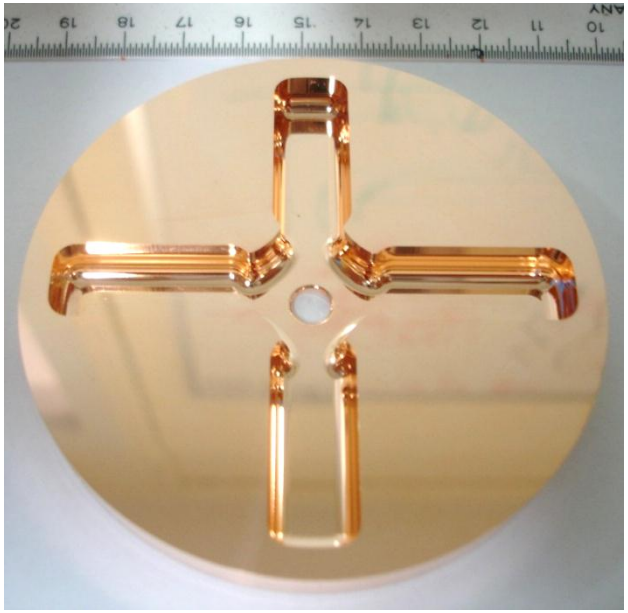
Ra = 0.002 µm

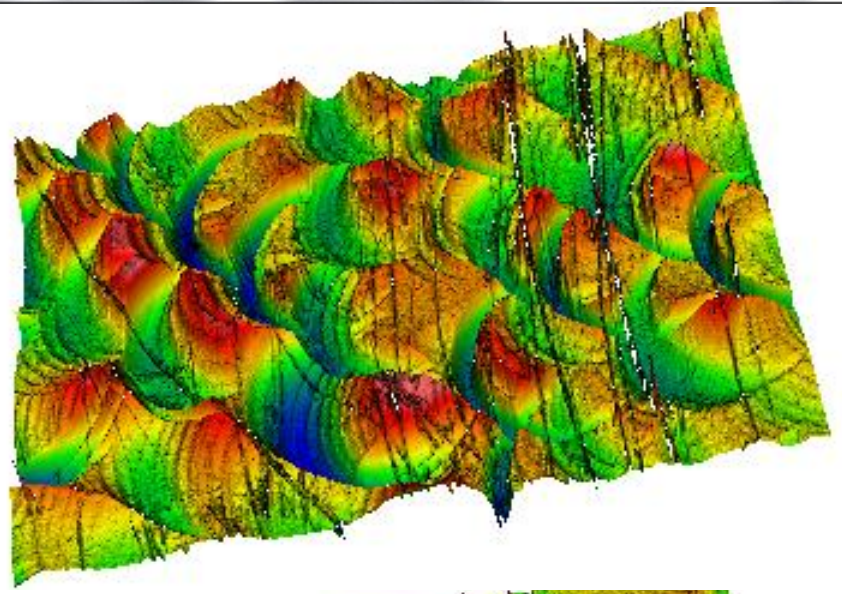
RmS = 1,72 nm

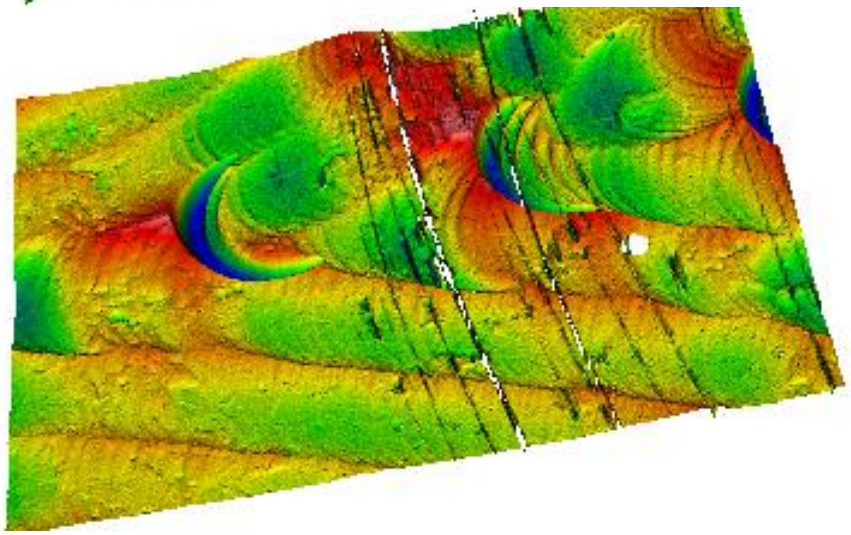


3. Focus on machining structure developpement

Milling surface finish improvement

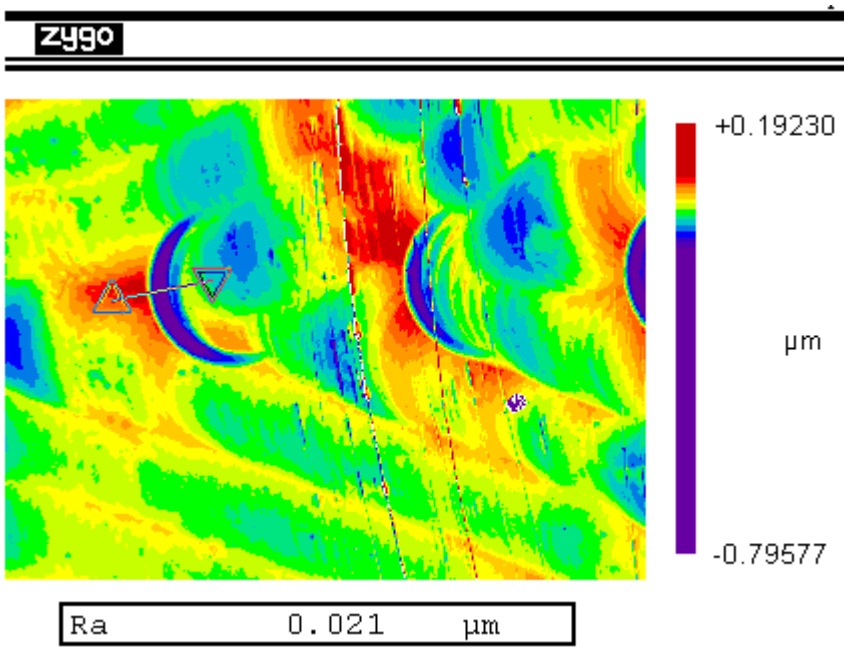




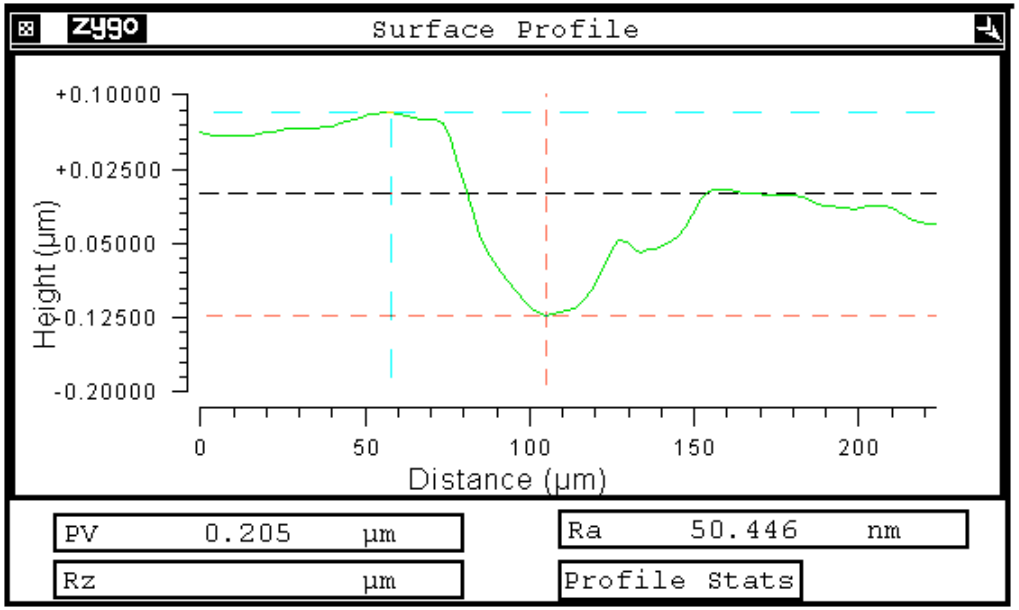


During milling operation, the tool have got flexion and create circles on the surface, due to the cutting force.

Milling surface finish improvement



Although the Ra is according to the drawing, we observe a groove on the surface.

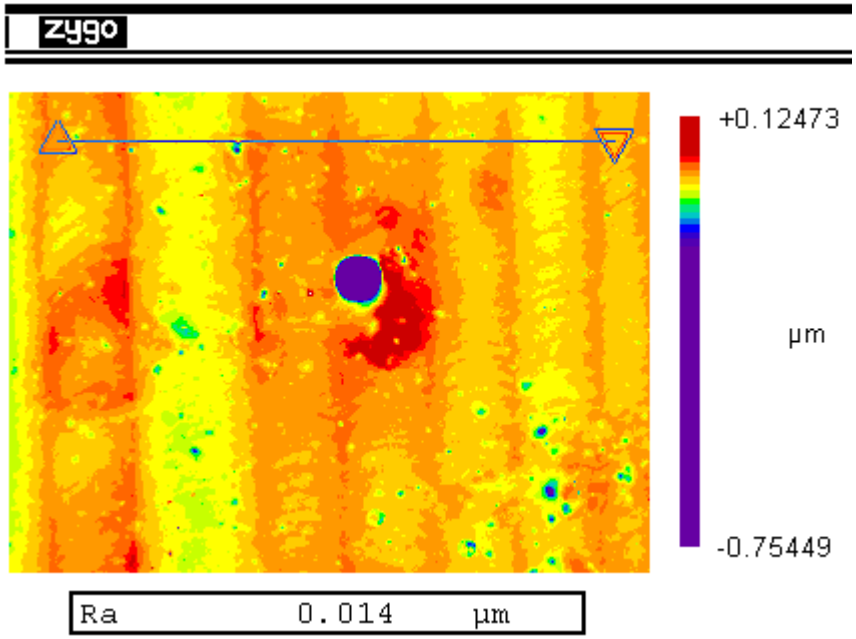


We can adjust parameters:

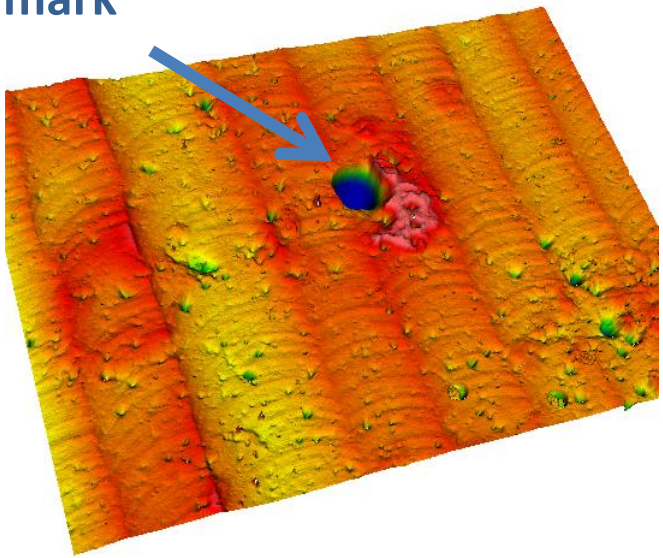
- Increase cutting speed
- Decrease tool speed
- change depth of cut
- Change tool cutting angle
- Optimize tool path

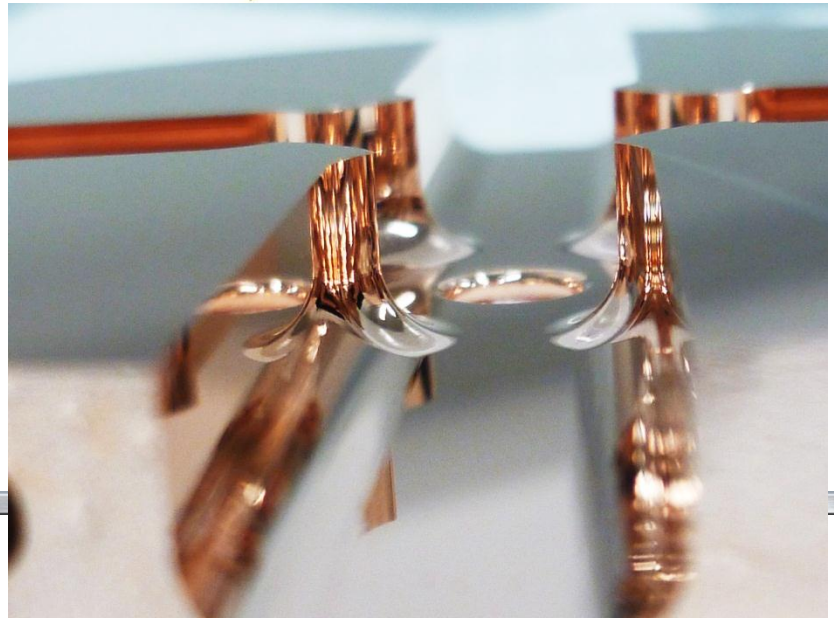
Milling surface finish improvement

Results



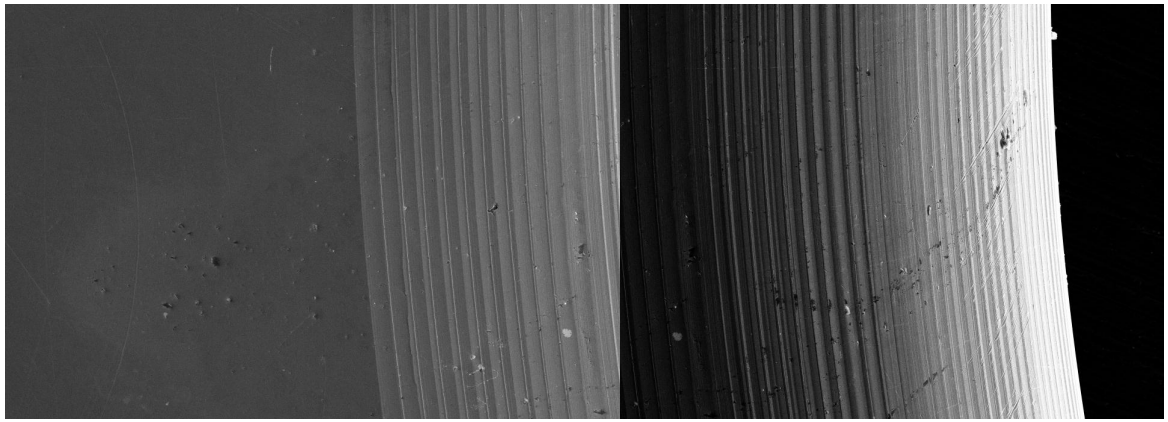
Métrology mark



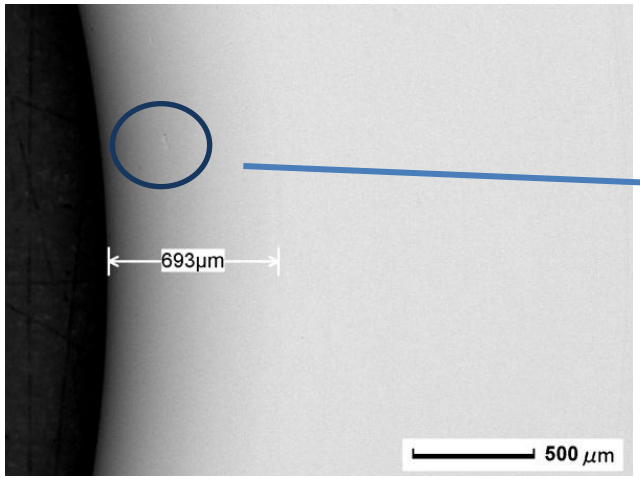


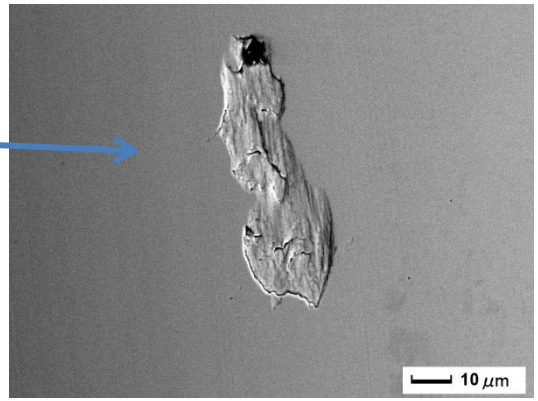
Iris machining

The machine is unable to understand and follow an elliptical shape.
We have to convert into linear or circular command with programming software.



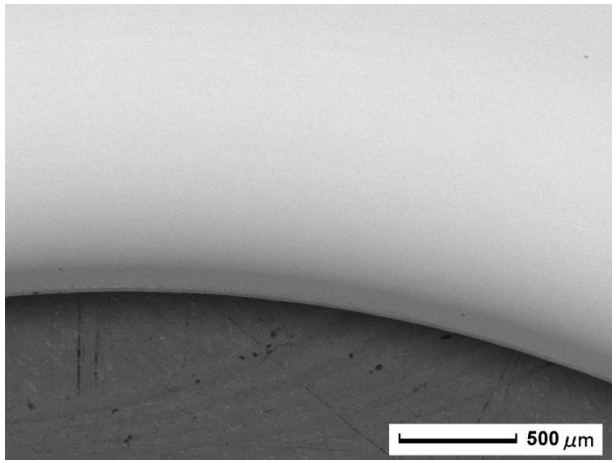
First tests were made with linear tool path.



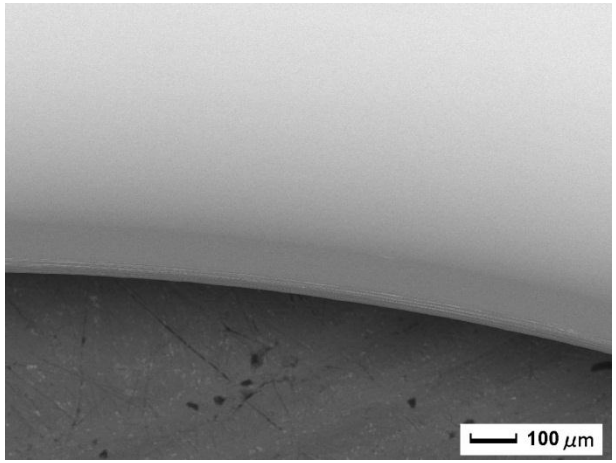


Working on cutting parameters to avoid grain pullout

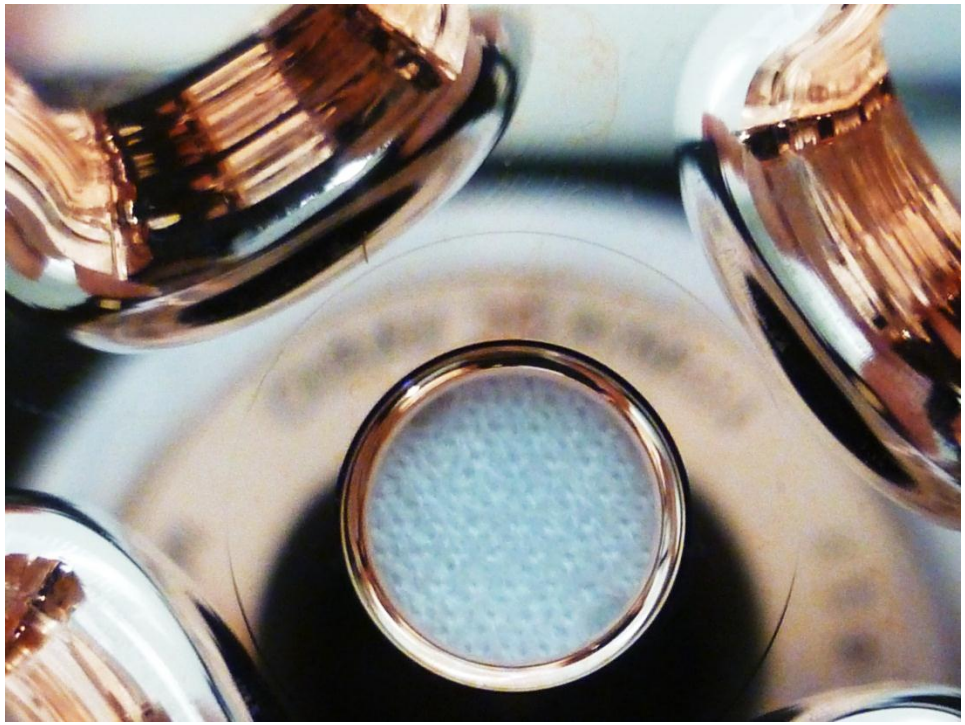
Iris machining



Ra between 2nm to 5nm



The machining of the iris start from diameter 20mm to erase milling perturbation in the center.
The height of the step is about 1µ.



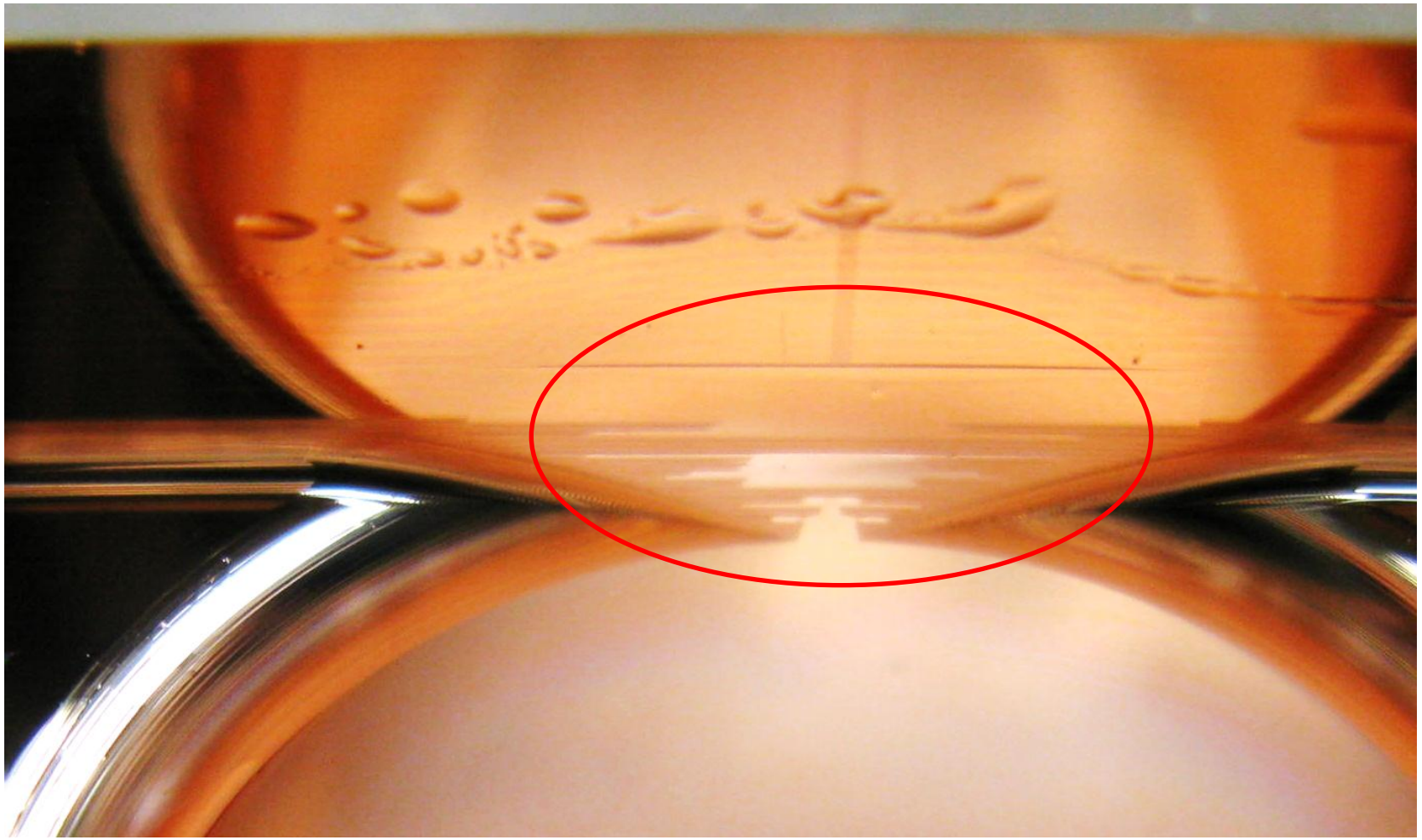
3. Why a collaboration between designer and manufacturer is necessary?

Why a collaboration between designer and manufacturer is necessary?

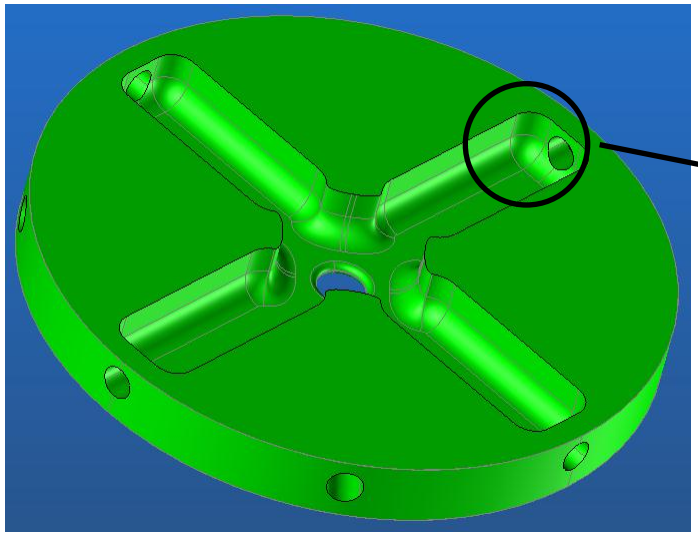
Coupler : this part is a very good example which highlights the importance of discussions before implementation. In fact, we had a radius that would be connected with a face. And it was not easy to do that.

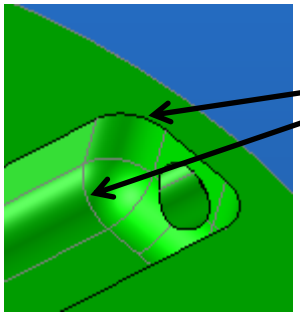
Why a collaboration between designer and manufacturer is necessary?

On this photo, we can see the area. An improved design would allow an easier implementation.



Why a collaboration between designer and manufacturer is necessary?

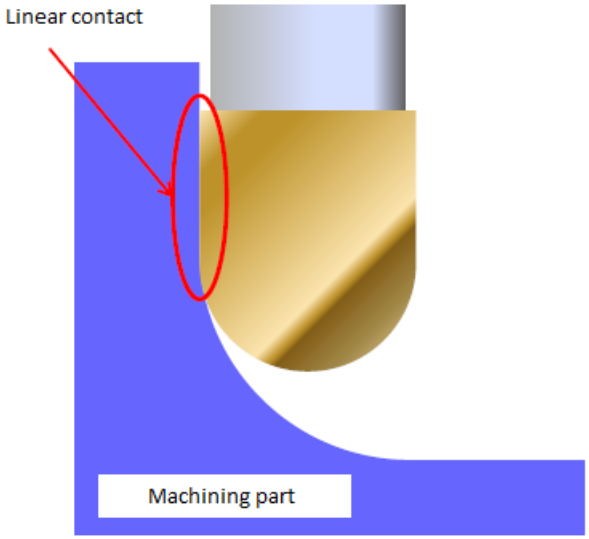


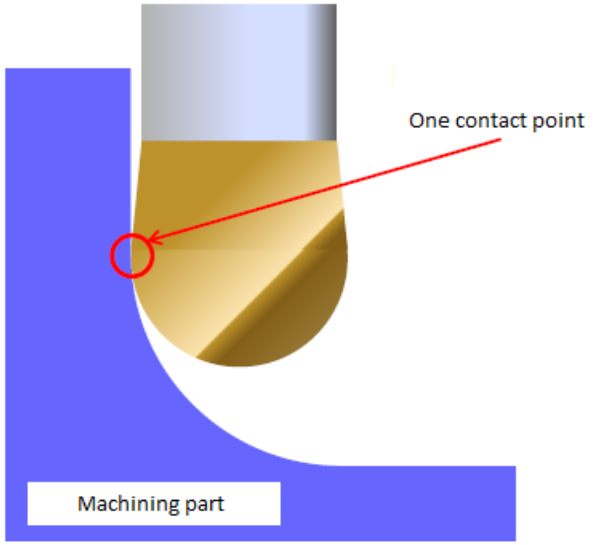


Same radius

In this case we have 2 solutions but we never use the optimum tool

For the TD24 we have made 17 steps to machine the bottom radius instead of only 1!!





5. Conclusion

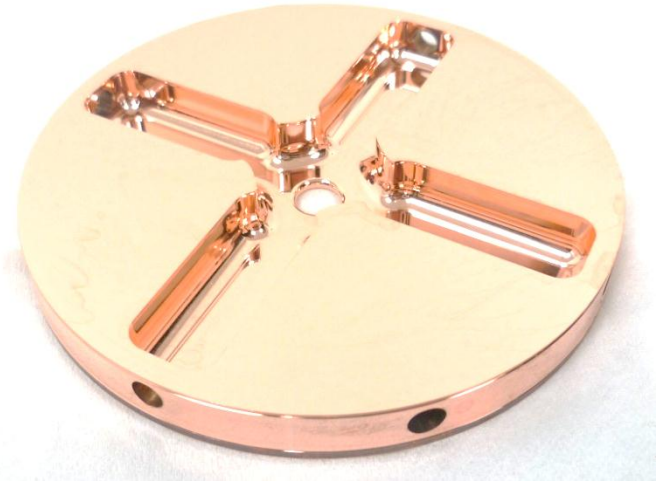
Turning surface finish are more easier to obtain

Milling need more set up to improve surface finish

Manufacturer and designer should collaborate

How to keep skills and knowledge to machine structure ?

THANK YOU FOR YOUR ATTENTION



If you have any question, don't hesitate to contact us:

Sandrine.lecureuil@fr.mecachrome.com
Fabien.chartrain@fr.mecachrome.com