

Improvement of molecular adhesion for spatial applications at Thales SESO over the past 20 years

COCHETEAU Natacha,
thales seso, france

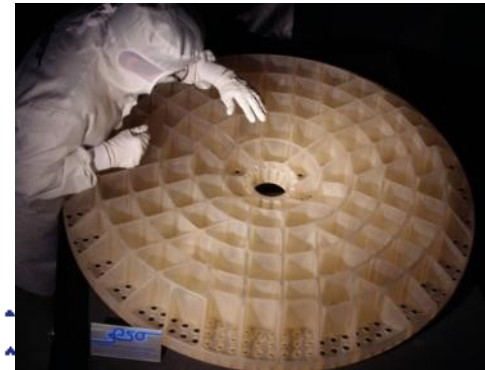
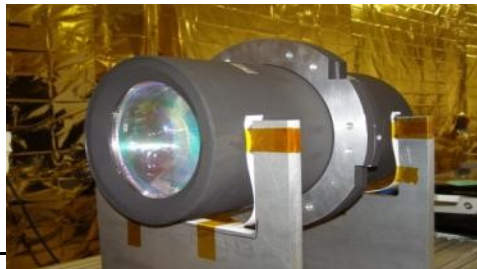
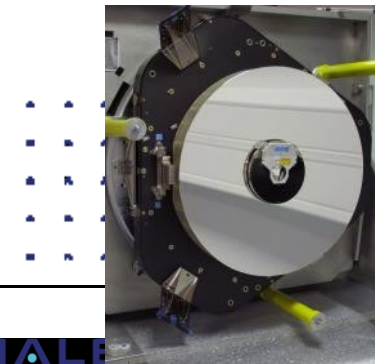
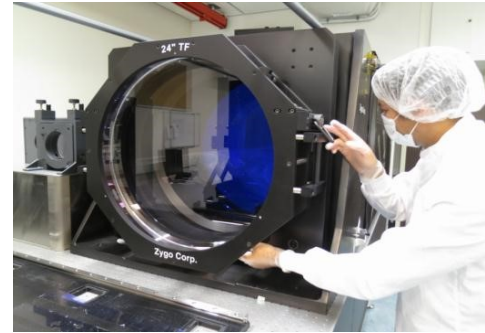
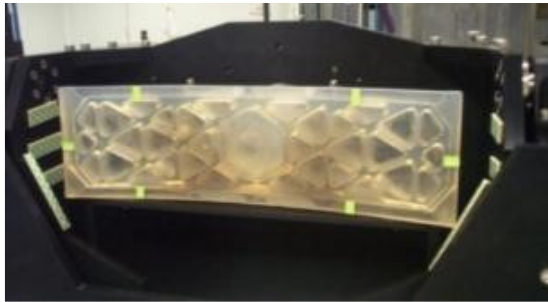
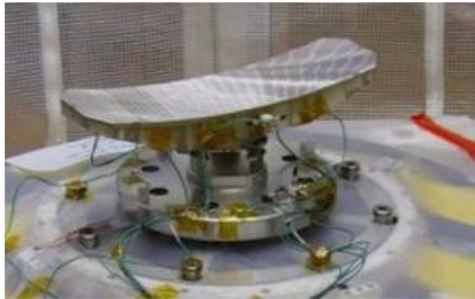
www.thalesgroup.com



Introduction

➤ Thales SESO:

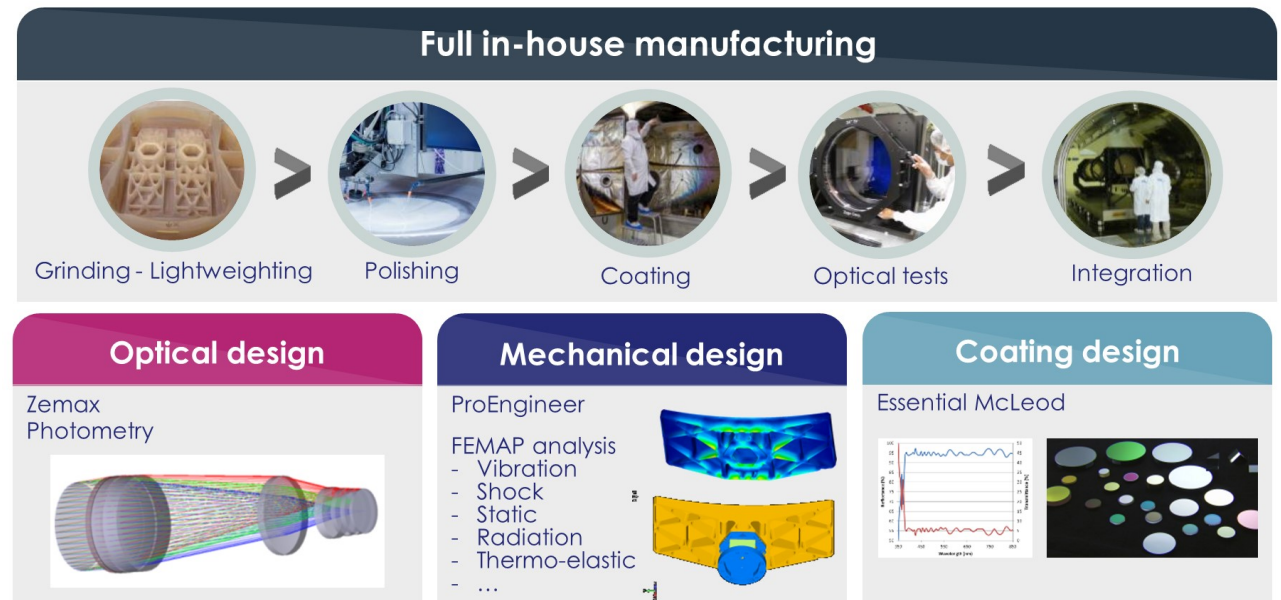
- Part of the Thales Group, managed by Thales Alenia Space
- Specialist in large precision optics manufacturing
 - Space
 - X-ray beam line
 - Astronomy
 - Lasers



Introduction

► Thales SESO:

- Part of the Thales Group, managed by Thales Alenia Space
- Specialist in large precision optics manufacturing
 - Space
 - X-ray beam line
 - Astronomy
 - Lasers
- Large production capacity
- Full range of polishing technologies
- Optical & mechanical metrology equipment





Introduction

➤ **Molecular adhesion consists in joining two surfaces without any use of any adhesive or additional materials.**

➤ **Advantages:**

- High-precision production process, dimensional stability of assemblies
- Risks of contamination associated with degassing are avoided
- Several materials can be adhered, adherences can be used under cryogenic environment

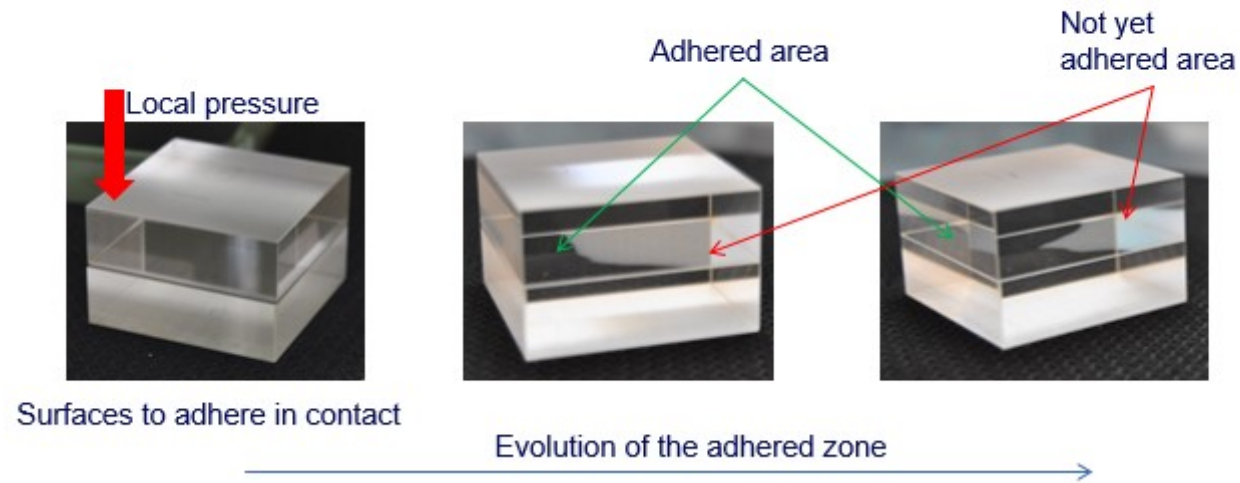


Based on these benefits, this process is of particular interest for optical system for space applications

Molecular adhesion process

➤ General description of process:

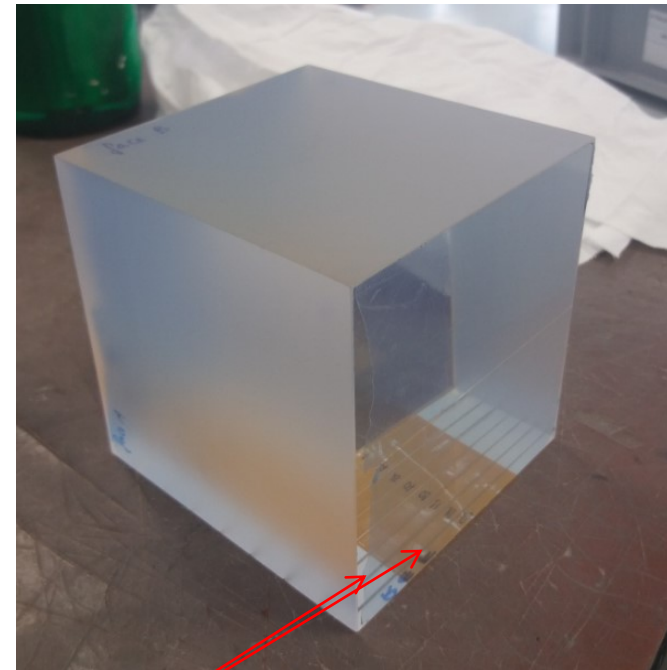
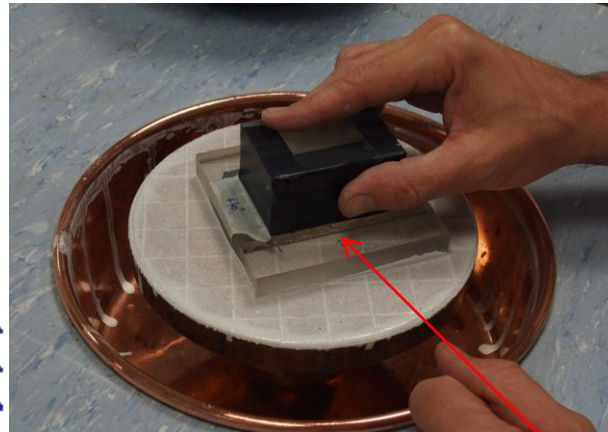
- ▶ Polishing of surfaces:
 - To obtain the exact surface roughness (here, roughness is always less than 1 nm RMS), flatness and deflection required When the roughness is too great, bonding becomes impossible
- ▶ Surface cleaning:
 - To eliminate any contaminating particles. With ambient humidity, free silicon surfaces are recovered by silanol (Si-OH) groups which are the precursor of the bonding.
- ▶ Surface contacting



20 years of adherence at Thales SESO

► The use of molecular adhesion:

- ▶ Precision polishing process:
- ▶ To polish a thin piece with high precision without inducing deformation
- ▶ To polish angles with precision



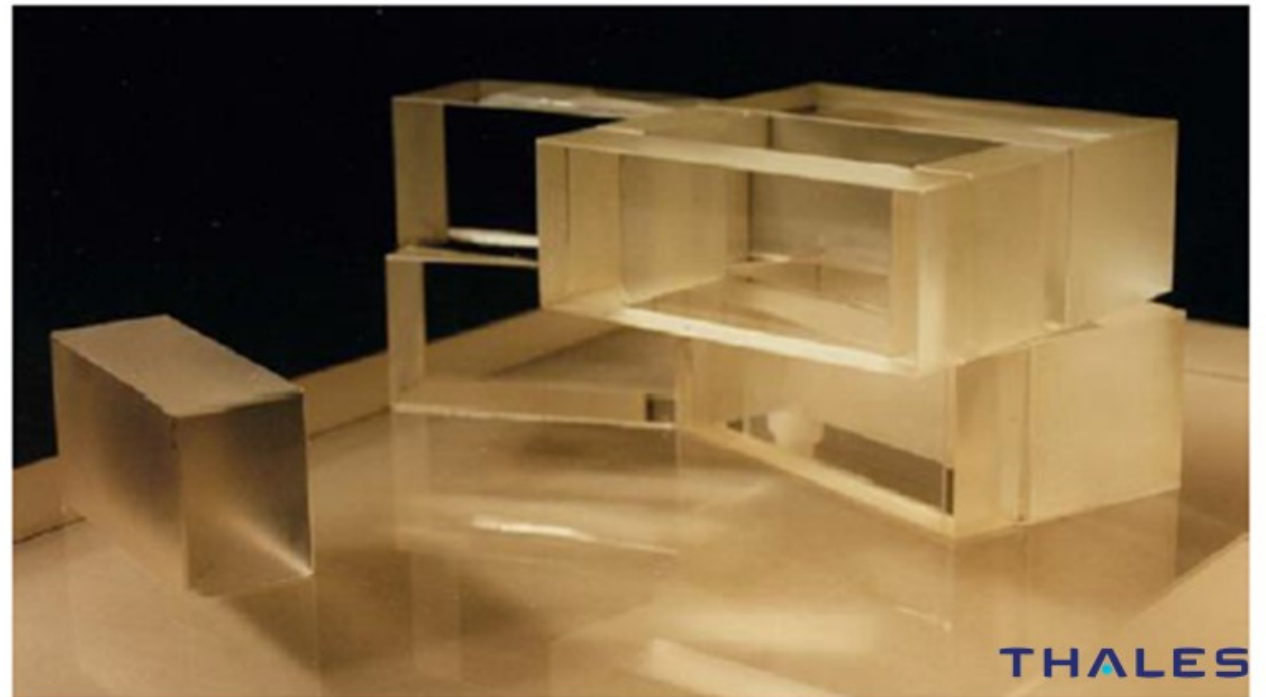
20 years of adherence at Thales SESO

➤ The use of molecular adhesion:

- ▶ Precision polishing process:
- ▶ Terrestrial application:
 - THALES SESO manufactured interferometers for terrestrial applications using different materials - fused silica, Zerodur® - using molecular adherence for different applications.

➤ Example:

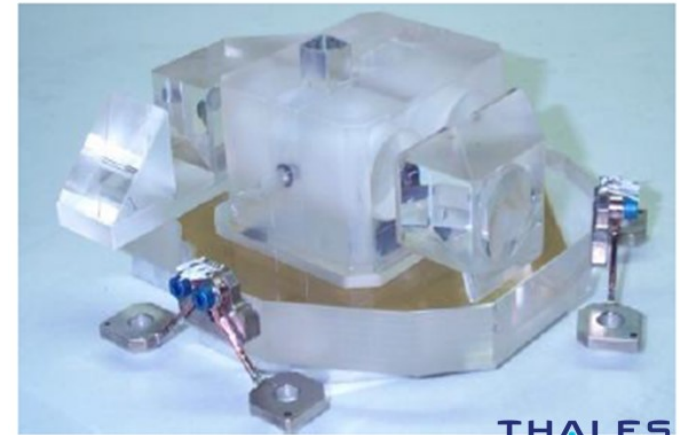
- ▶ Double Fizeau interferometer:
- ▶ fused silica component
- ▶ Angular tolerances obtained were 5''
- ▶ Surfaces performances around $\lambda/100$ nmPTV



20 years of adherence at Thales SESO

➤ Space applications: Aladin program

- ▶ Thales SESO developed a Mie Fabry Perot made out of fused silica plates and zerodur® spacer and a Rayleigh fused silica “Double Channel” Fabry-Perot assembly qualified for Space Application.
- ▶ This double cavity Fabry Perot includes :
 - Double Fabry Perot with a difference of thickness of 80 nm between the two cavities..
 - 4 prisms, 4 waveplates and one lens completed the optical setup.
 - The Fabry-Perot was also adhered on a base plate and its fixture.
 - The molecular adherence was reinforced using an external glue joint
- ▶ Environments:
 - Static accelerations > 30 G on all axes
 - Thermal environment -20°C to 50°C.



➤ Launched in August 22, 2018. Only two months after launch, Aladin has already



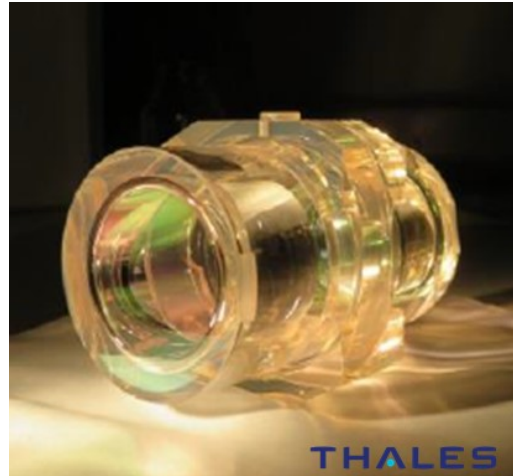
delivered excellent results

*Thales SESO, TAS, EADS, ESA

20 years of adherence at Thales SESO

► Space applications: EarthCARE mission

- ▶ THALES SESO developed the ATLID* Fabry-Perot which consists in an assembly made with Zerodur® and fused silica with a cavity under vacuum. The sealing of the vacuum cavity was also made using molecular adhesion. For this application, external glue joint was forbidden



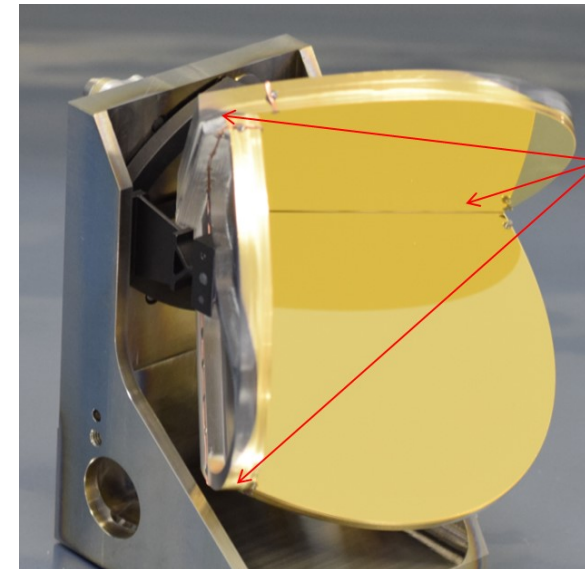
Through all those programs, THALES SESO qualified its molecular adherence process for space applications, the molecular adhesion admissible mechanical strength was 1 Mpa.

*Thales SESO, TAS, EADS, ESA

20 years of adherence at Thales SESO

▶ Corner cubes, improvement of mechanical resistance of adherence and MTG program*

- ▶ Through lot of collaborations with CNES and other partners, Thales SESO works on the development of cube corner assemblies using molecular adherence. This works leads to the spatial qualification of an hollow corner cube and an increase of the mechanical resistance by a factor 4,5.
- ▶ MTG program:
- ▶ Thales SESO develop a large hollow lightweighed corner cube
- ▶ Main performances required:
 - Each angle of the cube corner need to be at $90^{\circ} \pm 1''$
 - Wave Front Error (WFE) < 250 nm RMS
 - Mass < 250g



Adhered zone

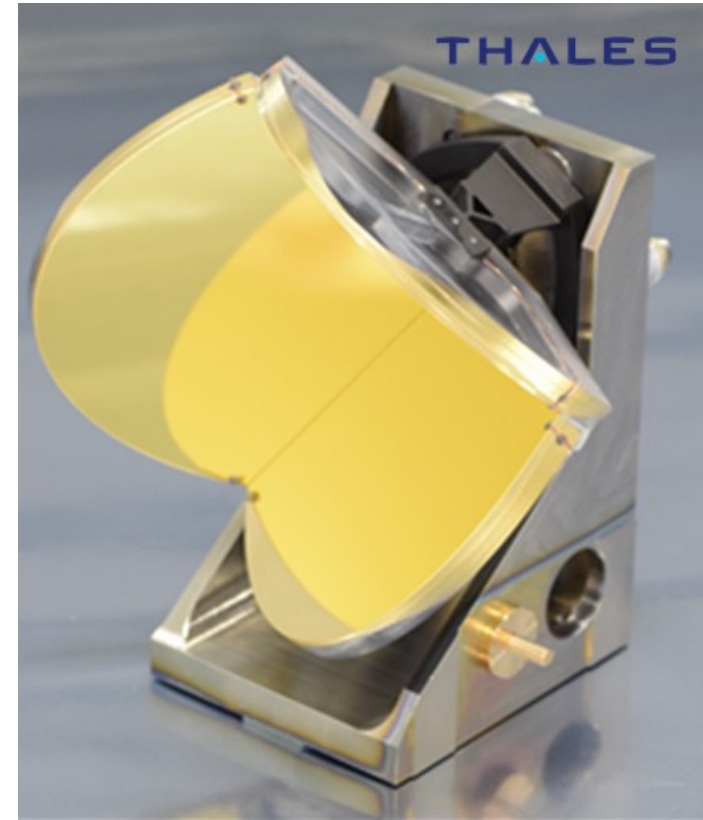
no adhesive used to bond the three mirrors of the corner cube

*Thales SESO, Thales Alenia Space, OHB, ESA

20 years of adherence at Thales SESO

➤ Corner cubes, improvement of mechanical resistance of adherence and MTG program

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- ▶ **Fully qualified:**
 - Dynamic test:
 - › 60 gRMS in sine test
 - › Random solicitations
 - › Shock solicitations (123g)
 - Thermal test
 - › Between -12° and $+40^{\circ}$



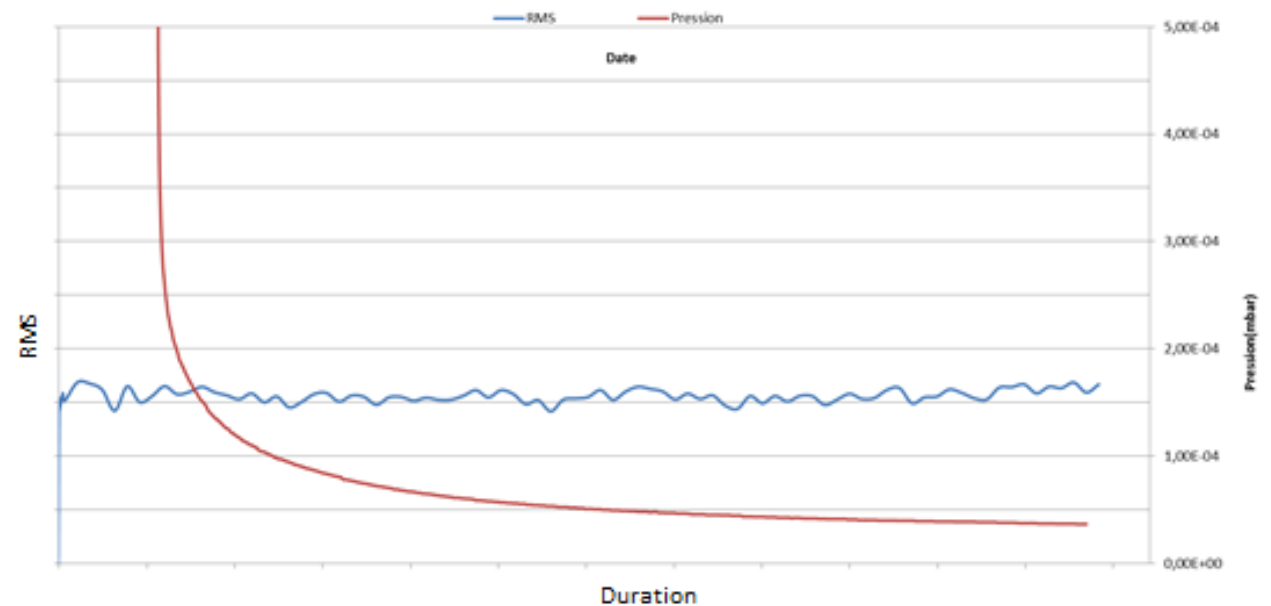
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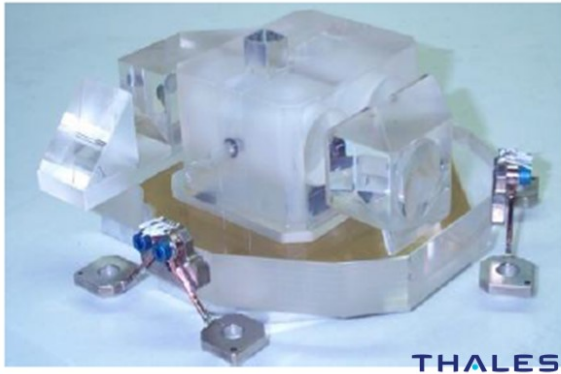
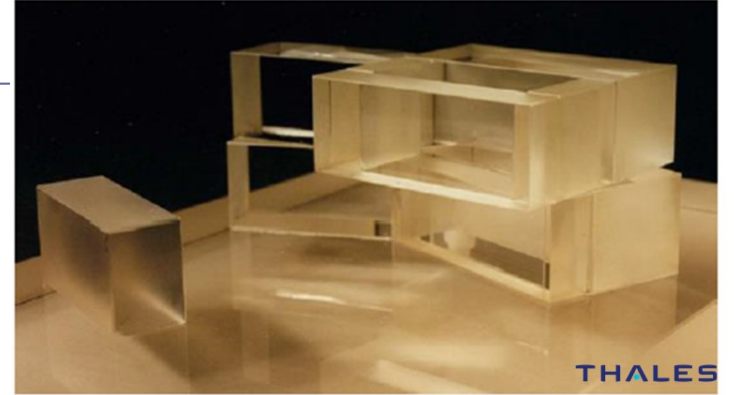
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High WFE stability under vacuum



THALES
Building a future we can all trust



Merci

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