



OPTICAL CONTACTING
BY WINLIGHT OPTICS
15 YEARS OF DELIVERIES

PERTUIS (FRANCE) – MAY 5TH 2020

Winlight System



ENIM

Summary

- Presentation of the company
- Exemples of various assemblies
 - To see how to build systems with multiple stackings
 - To see how to mix optical contacting and bonding
 - To present the results on breadboards and real missions

Static Fourier transform interferometer
Slicer breadboard for SNAP
Image slicers for SWIFT
Image slicers for MUSE
Static Fourier transform interferometers
Bowen image slicer
Image slicer for KCWI
Image slicer for SOLARNET
Pupil slicer for SPIROU
Image slicer for WFIRST
OGSE for EUCLID (telescope simulator)

Note: Some slides are intentionally removed in this printed version

TWO MAIN SECTORS

ENVIRONMENT & ENERGY



Energy production and optimization
Waste recovery
Emission control services

Public organizations and financing companies

Industries

INNOVATION & SYSTEMS



Major high performance systems and fabrication
Equipment and instrumentation systems
Software and innovative engineering

Defense & Security

Nuclear & Big Science

Other industries

OUR INNOVATION & SYSTEMS OFFERING



1

1/ L-CAT®, CNIM



2

2/ Radiation portal monitor - Saphygate®, Bertin



3

3/ Radial plates for ITER, CNIM



4

4/ Motorized Floating Bridge, CNIM



5

5/ Cyber intelligence and cyber security - Bertin



6

6/ Equipment for Megajoule Laser (LMJ)



7

7/ Gas detection camera – Second Sight®, Bertin

BERTIN SYSTEMS & INSTRUMENTATION

Detect, observe, measure



DEFENSE, SECURITY & SAFETY



NUCLEAR & HEALTH PHYSICS



SPACE & BIG SCIENCE



LIFE SCIENCES



HOSPITAL WASTE MANAGEMENT

- ▲ CBRN threat detection
- ▲ Optronics
- ▲ Surveillance sensor networks

- ▲ Products, systems and services for detection, measurement and identification of ionizing radiation

- ▲ High-performance optical and optomechanical systems

- ▲ Laboratory equipment, kits and reagents

- ▲ Systems for treatment of potentially infectious medical waste



WINLIGHT OPTICAL SYSTEM DESIGN & MANUFACTURING



Optical & mechanical design
(12 p.)

Grinding and polishing
(26 p.)

Assembly Integration Tests
(4 p.)

18 years
R&D

46
people

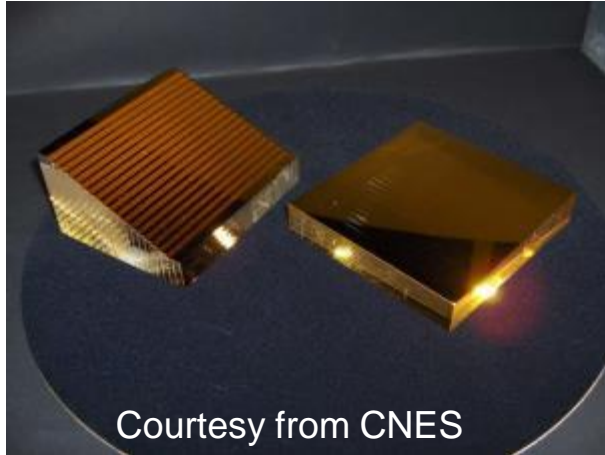
≈ 7 M€
(Sales)

8%
R&D

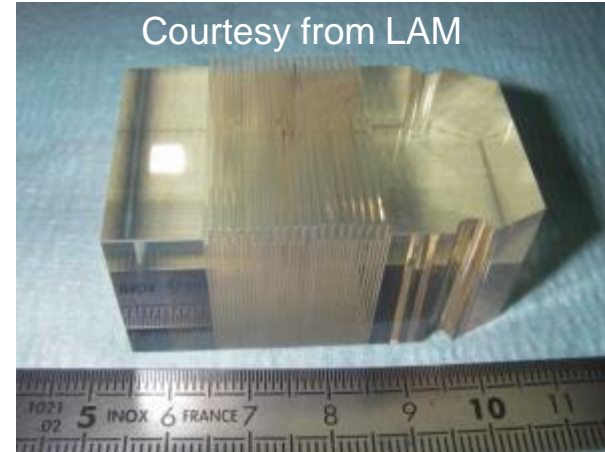
60 %
export

2200 m²
facility

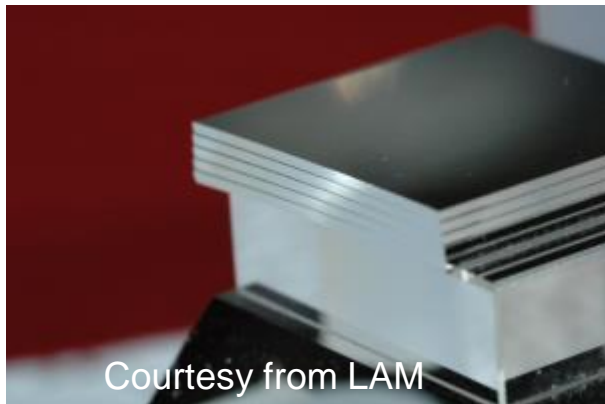
The background of the company on image slicer... 2005-2008



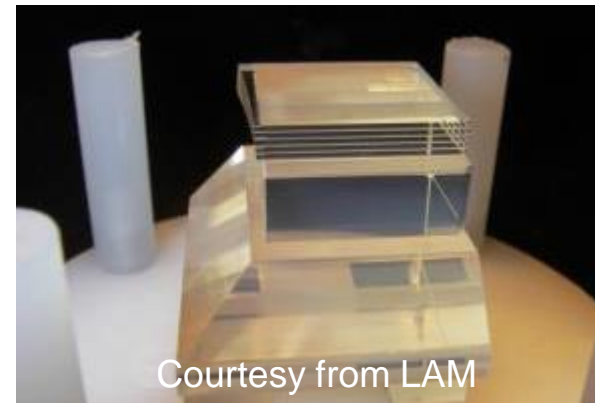
Courtesy from CNES



Courtesy from LAM



Courtesy from LAM



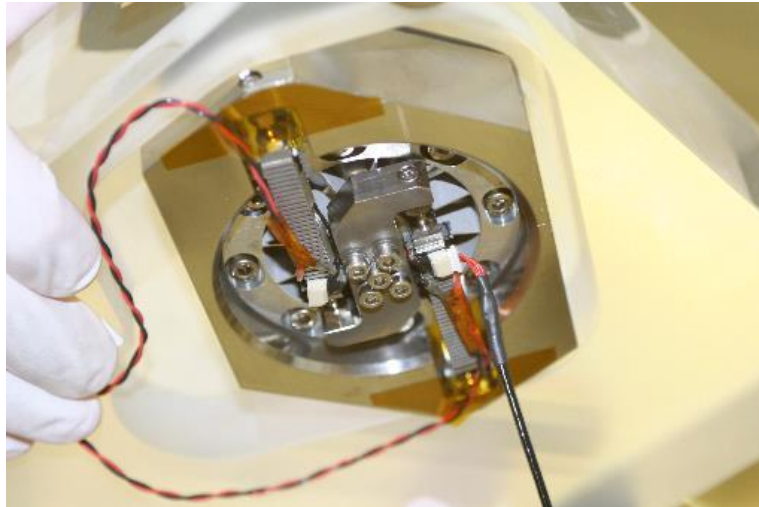
Courtesy from LAM

Static Fourier interferometer

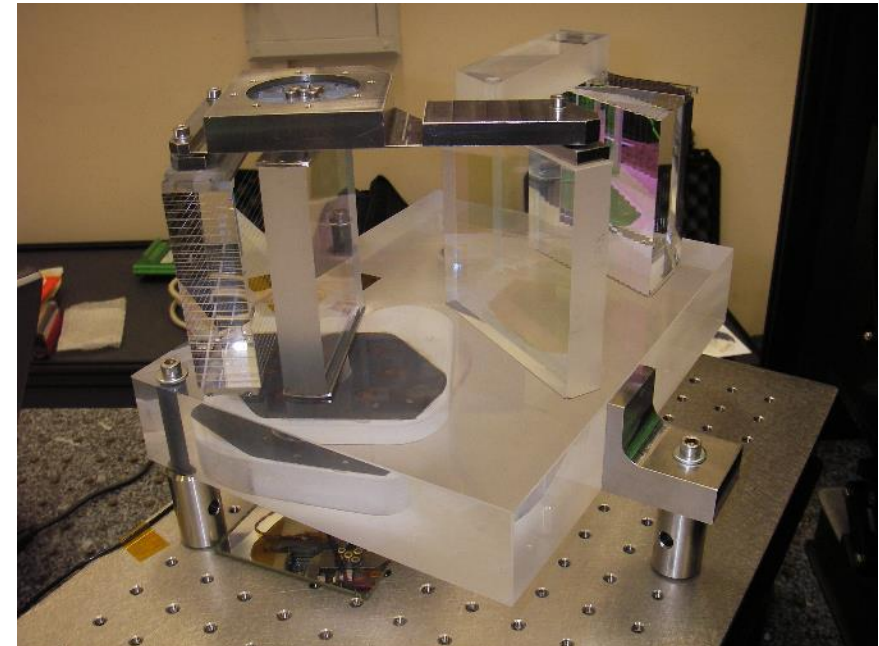
Laboratory environment - 293K

2006 – 2008

- Breadboard model dedicated to environmental tests
 - 24 + 19 step mirrors; Optical contacting technology
 - 1 compensater plate glued with mechanism



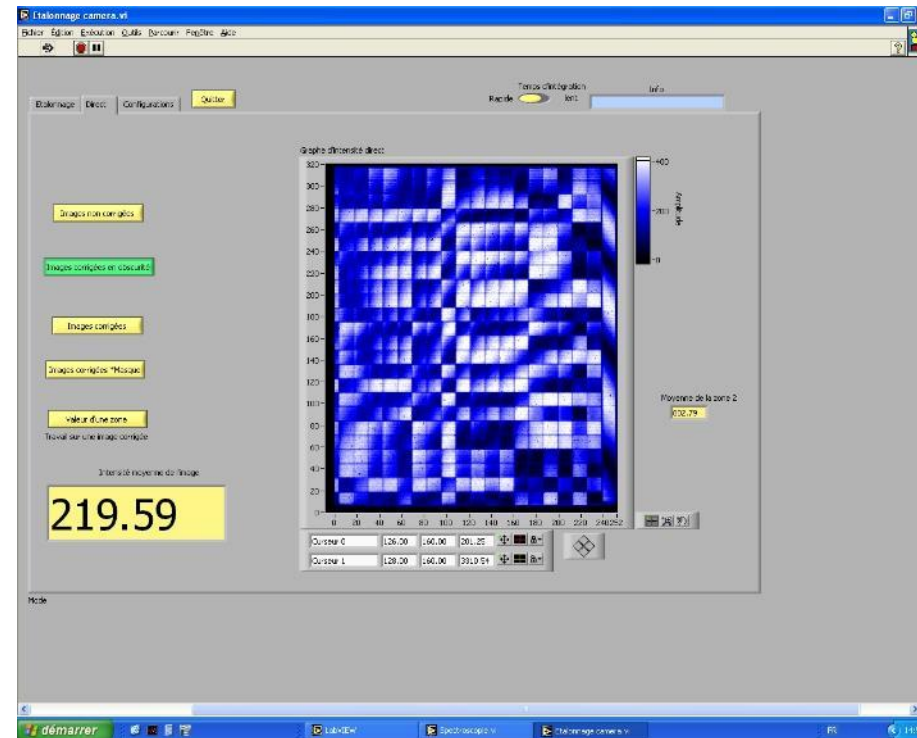
- 3 mechanical holders



Static Fourier interferometer

Laboratory environment - 293K

2006 – 2008



- Positioning
 - +/-1µrd; +/-1µm

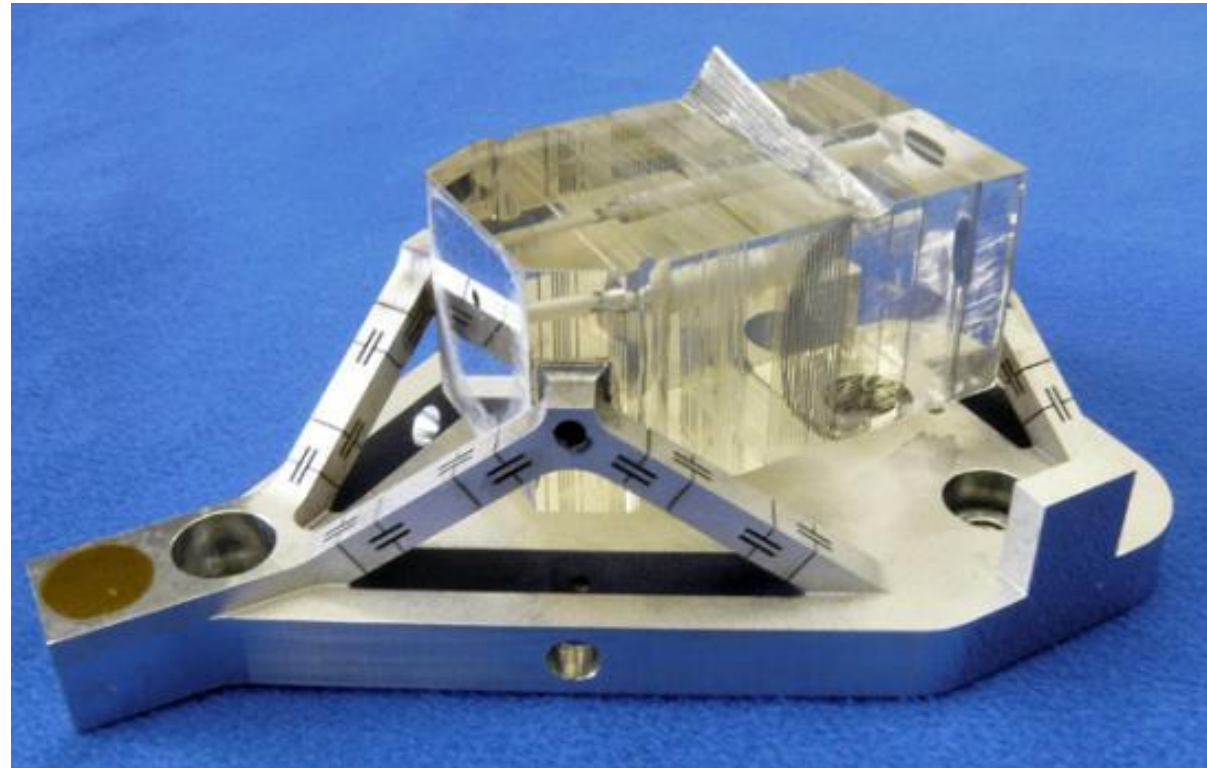
Example of measurement during the alignment

SNAP image slicer

Space environment - 100K

2006 – 2009

- Engineering model dedicated to environmental tests
 - 60 Slices assembly; Optical contacting technology
 - Thickness 500 μ m
 - Mechanical holder
 - 3 bipodes



SNAP image slicer

Space environment - 100K

2006 – 2009

- ▲ Mechanical and thermal tests realized at LAM
 - Thermal vacuum : 8 cycles 300°K – 100°K
 - Random vibrations : 20Hz – 2000Hz ; 14g RMS

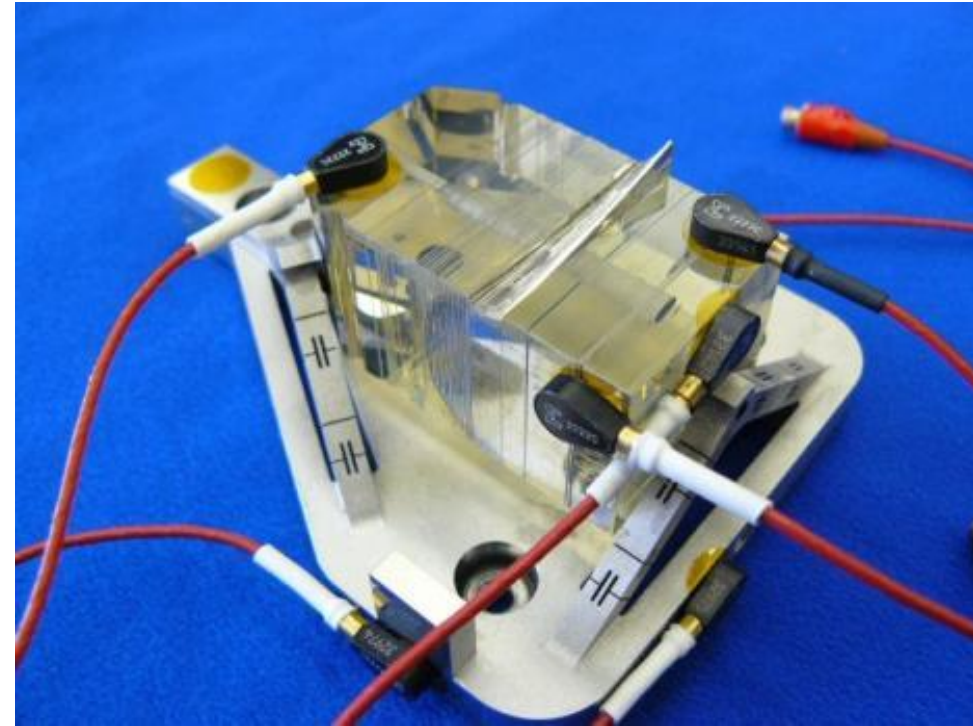
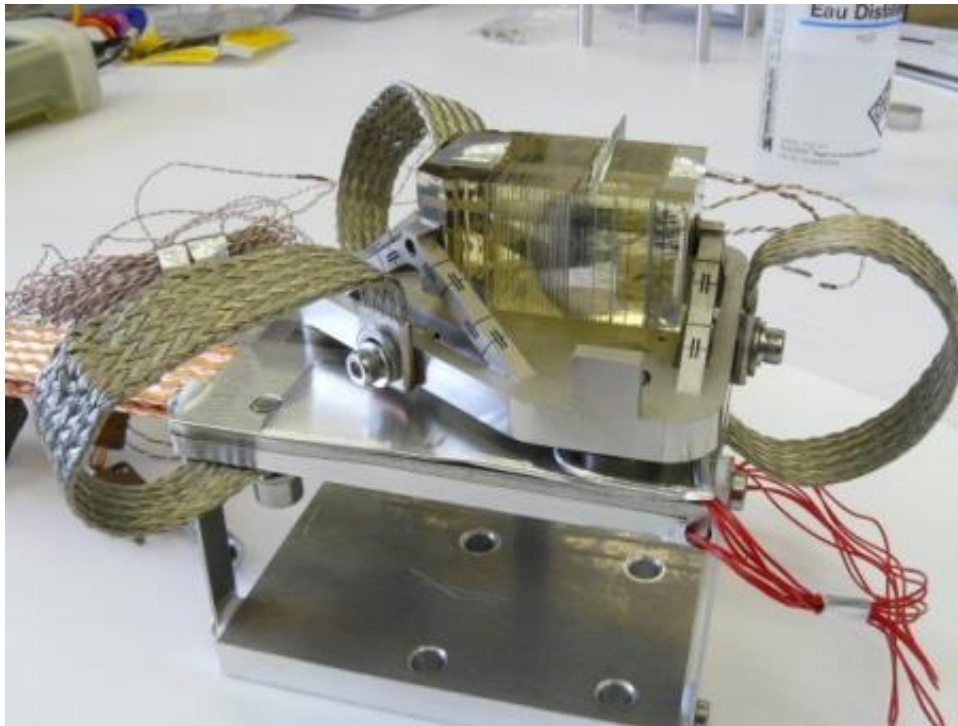
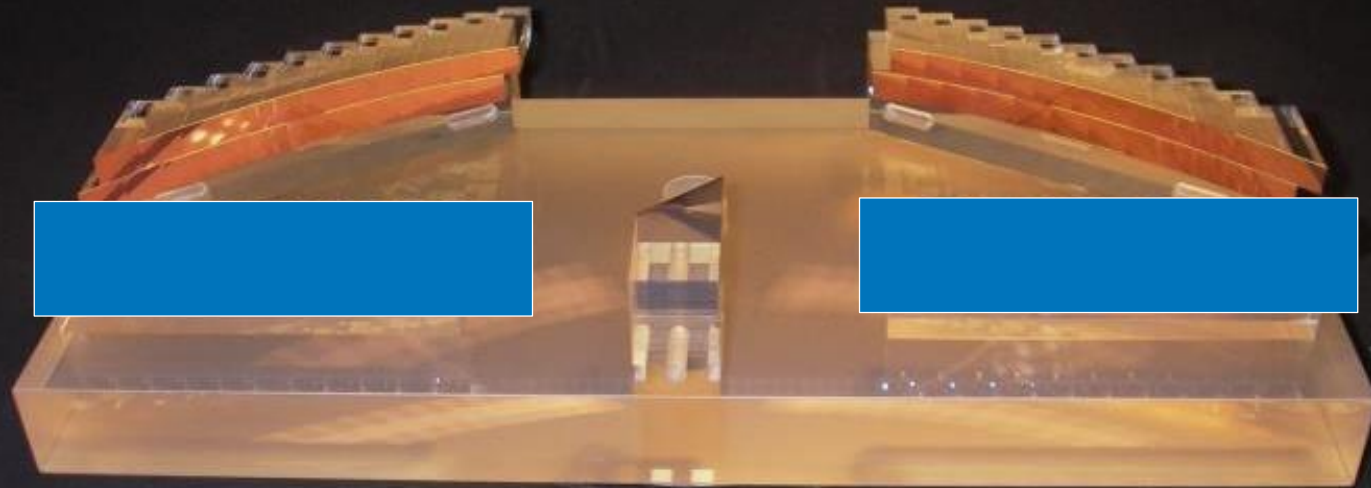


Image Slicer for SWIFT

Astronomy– 273K /323K
2006 – 2007

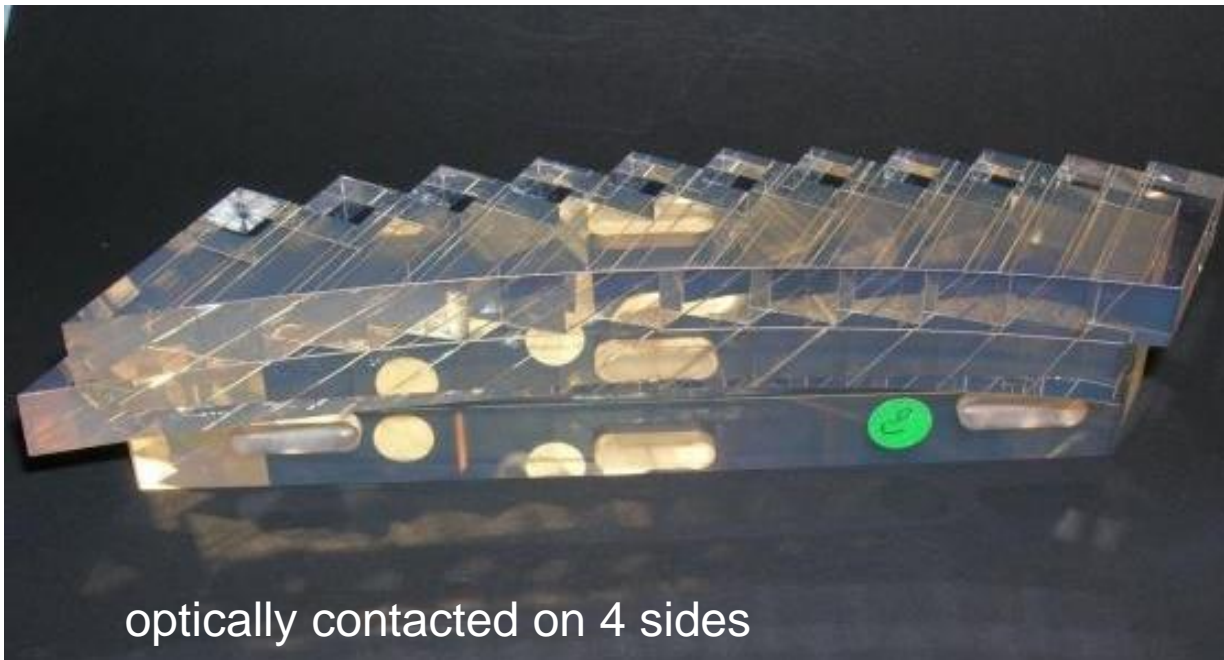
- 93 Zerodur components with **optical contacting technology**
- 44 doublets (glued)
- No mechanical part except at the base plate interface



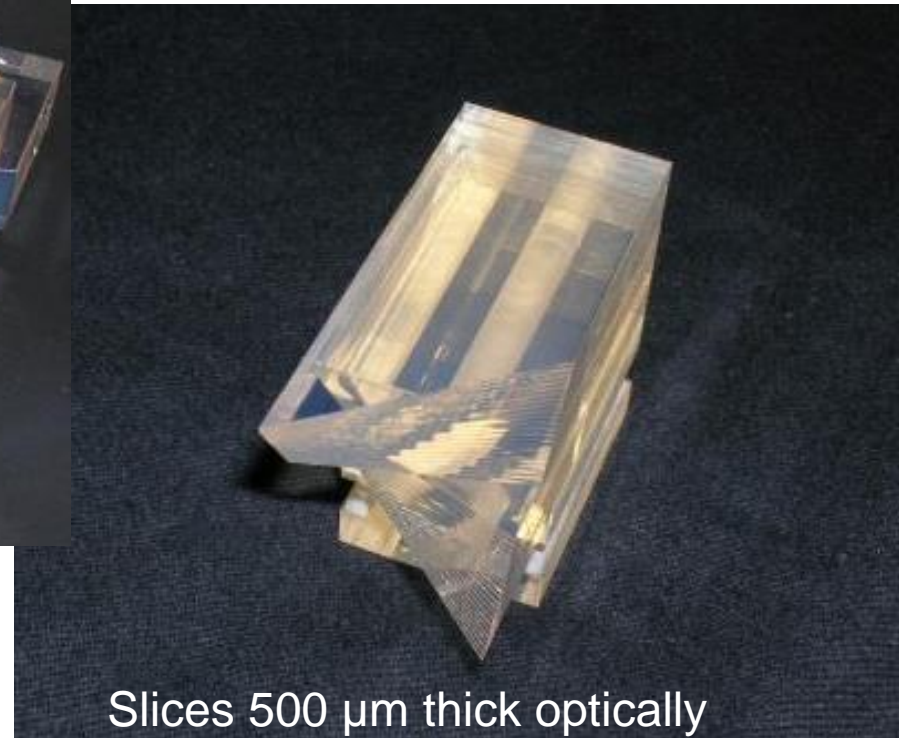
- Quality after assembly
 - $< 150/250\text{nm}$ PTV
 - $R_q < 0.6\text{nm}$ RMS
 - Sharp edges

Image Slicer for SWIFT Astronomy– 273K /323K 2006 – 2007

2 x 22 plane mirrors distributed along a parabolic shape



optically contacted on 4 sides



Slices 500 μm thick optically

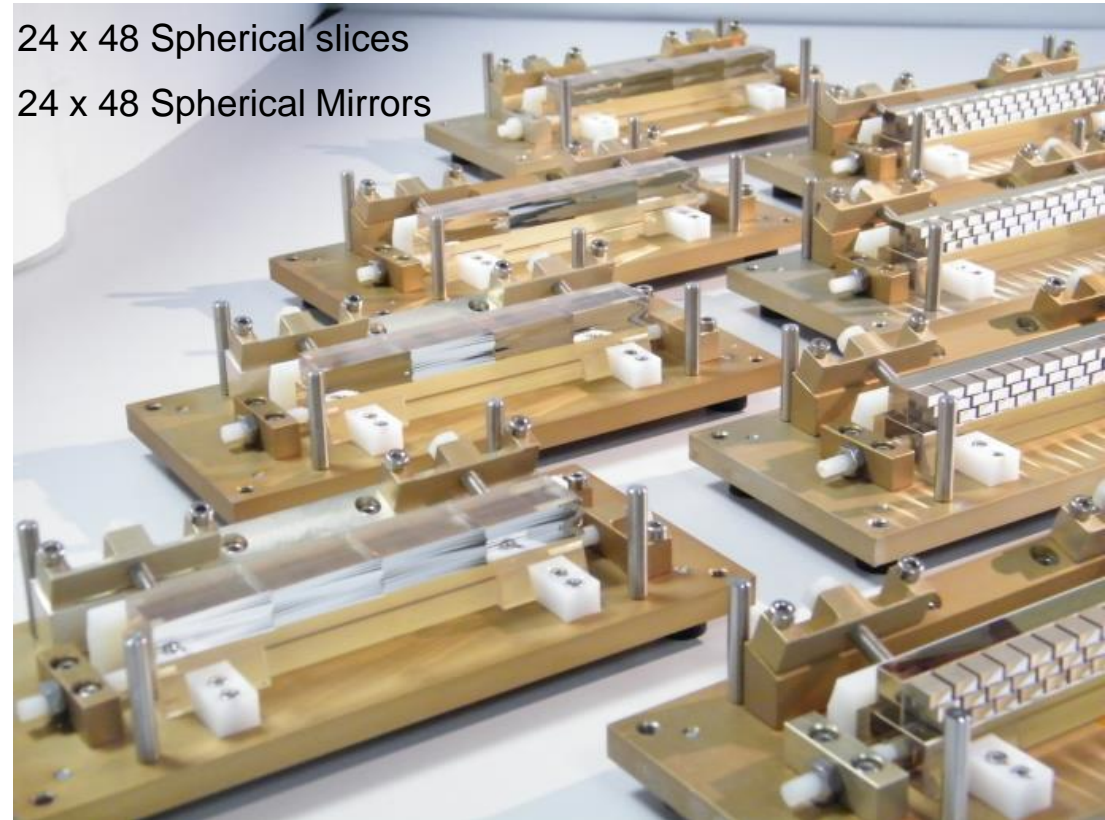
44 slices with sharp edges distributed like spiral staircase

24 Image Slicers for MUSE Astronomy– 273K /323K 2009 – 2012

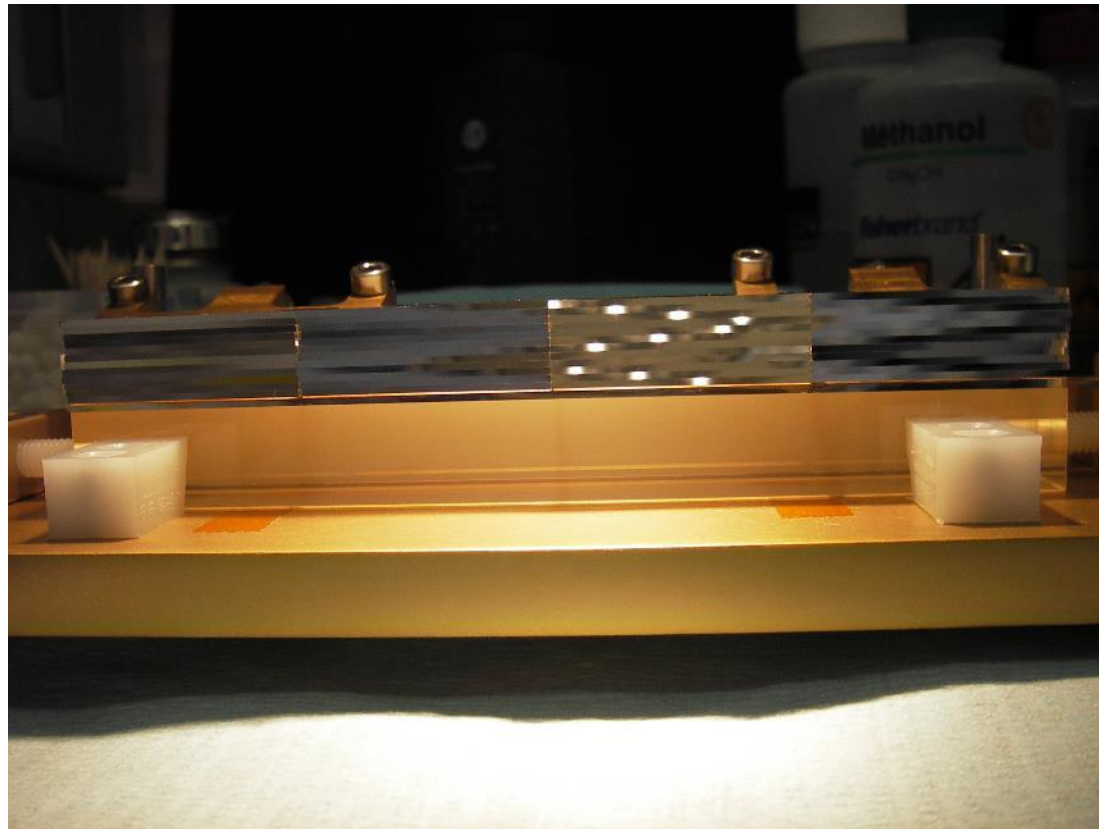


- 1176 Zerodur components
 - Optical contacting technology
- 1176 Zerodur components glued
- No mechanical part
- Reproducible interfaces
 - (+/-30 μ m X, Y and Z)
- Quality after assembly
 - < 150/250nm PTV
 - Rq < 0.6nm RMS
 - Sharp edges

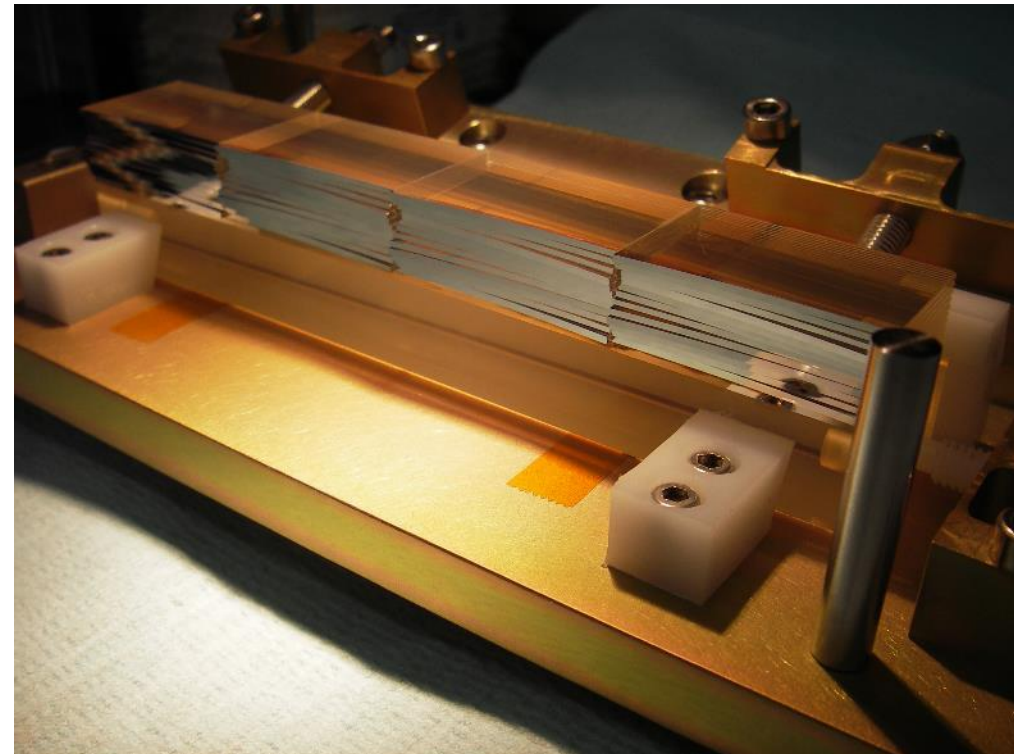
24 x 48 Spherical slices
24 x 48 Spherical Mirrors



24 Image Slicers for MUSE Astronomy– 273K /323K 2009 – 2012



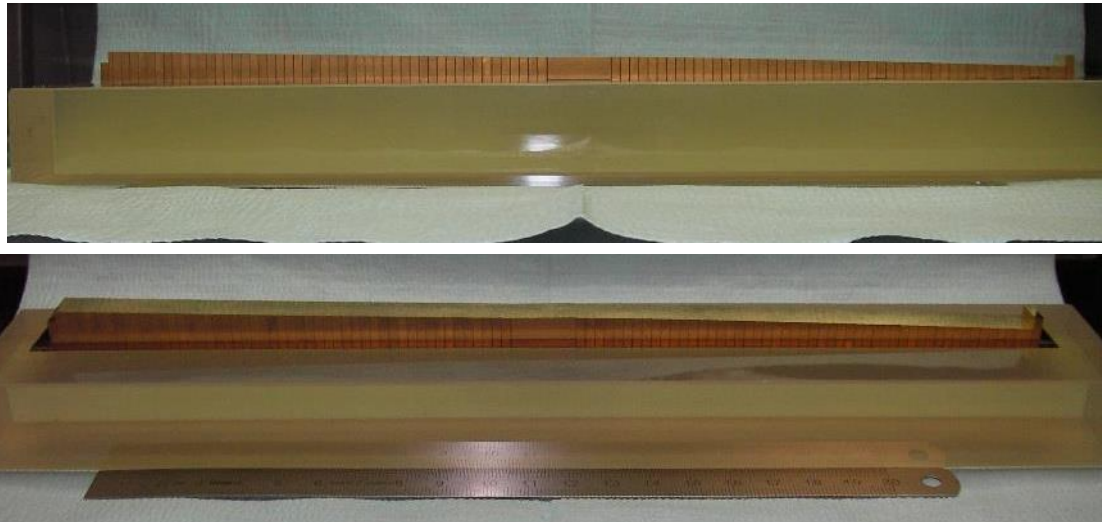
1 slicer = 4x12 Spherical slices



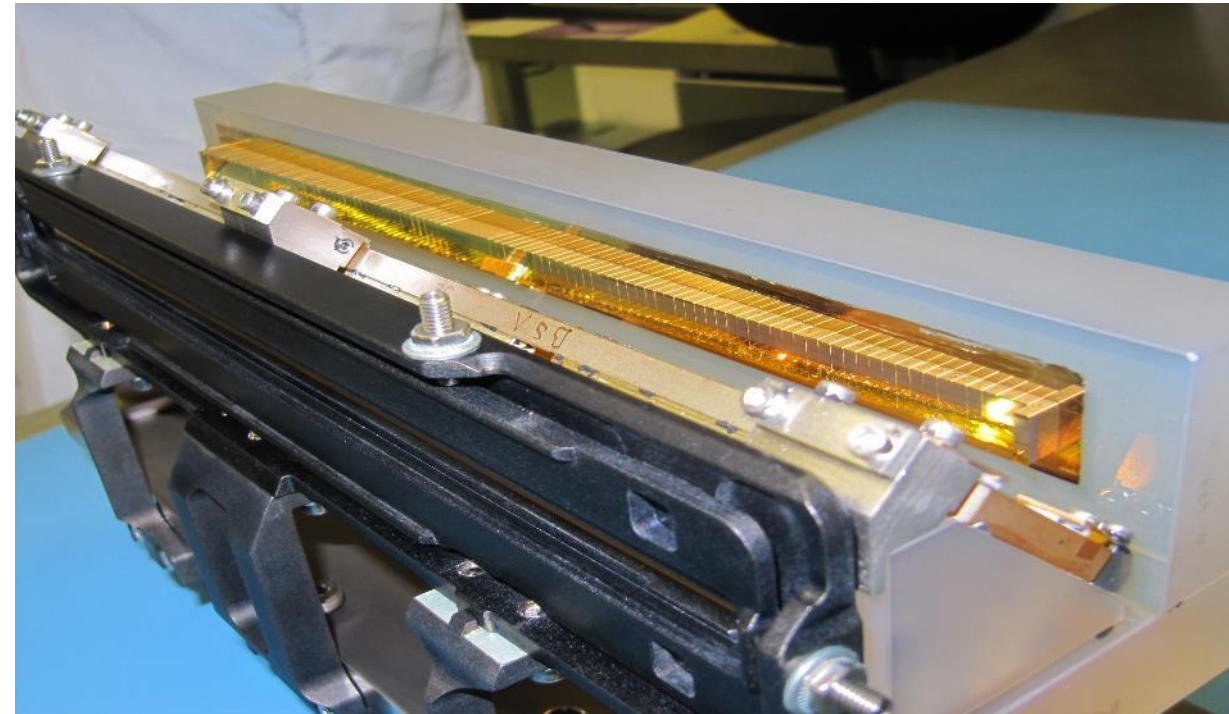
Static Fourier interferometer

Laboratory environment - 80K
2008 – 2010

- Breadboard model dedicated to environmental tests and demonstrate a patent from A&DS
 - 2x 103 step mirrors; Optical contacting technology
 - 1 ZnSe separator and compensator plate

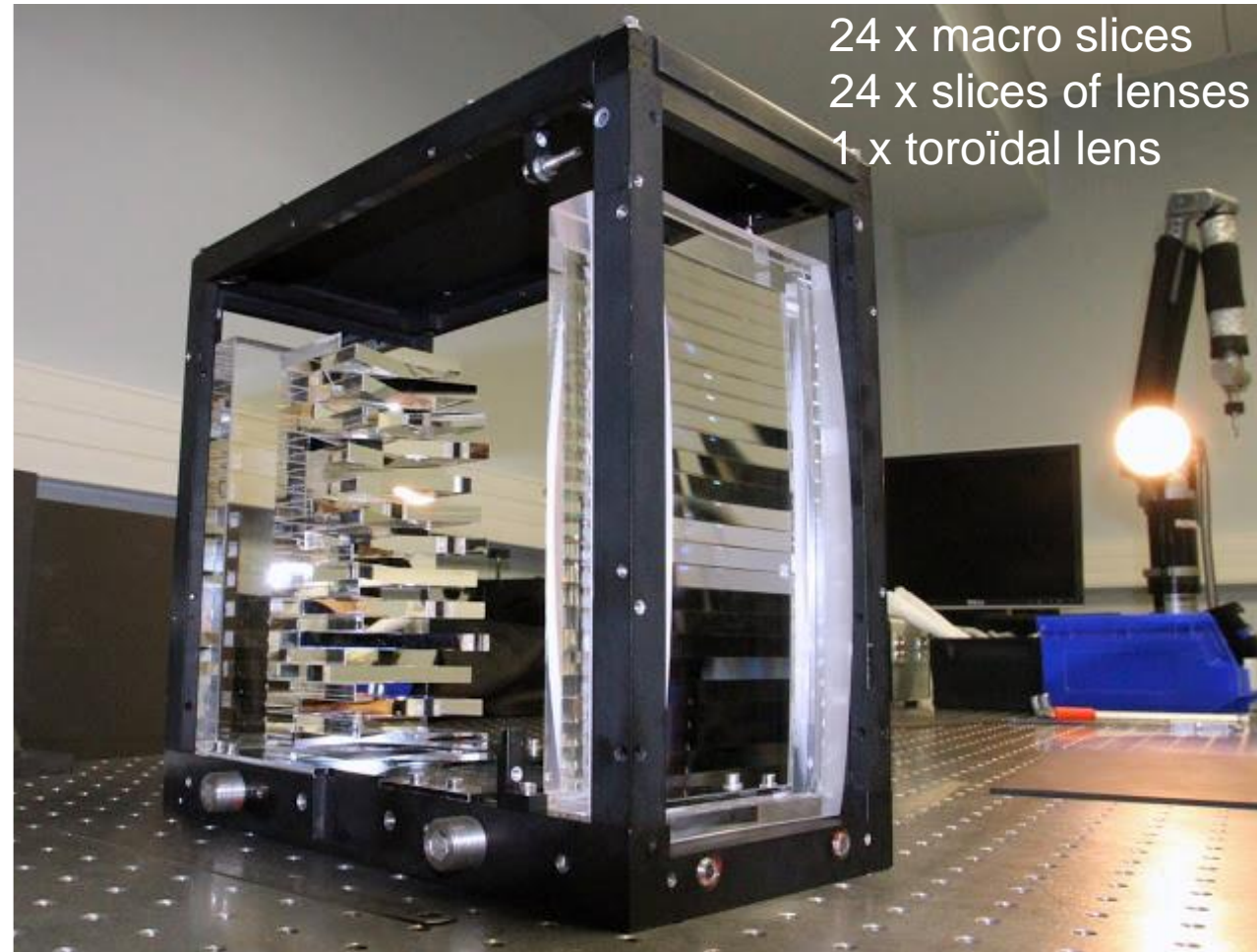


103 mirrors optically contacted

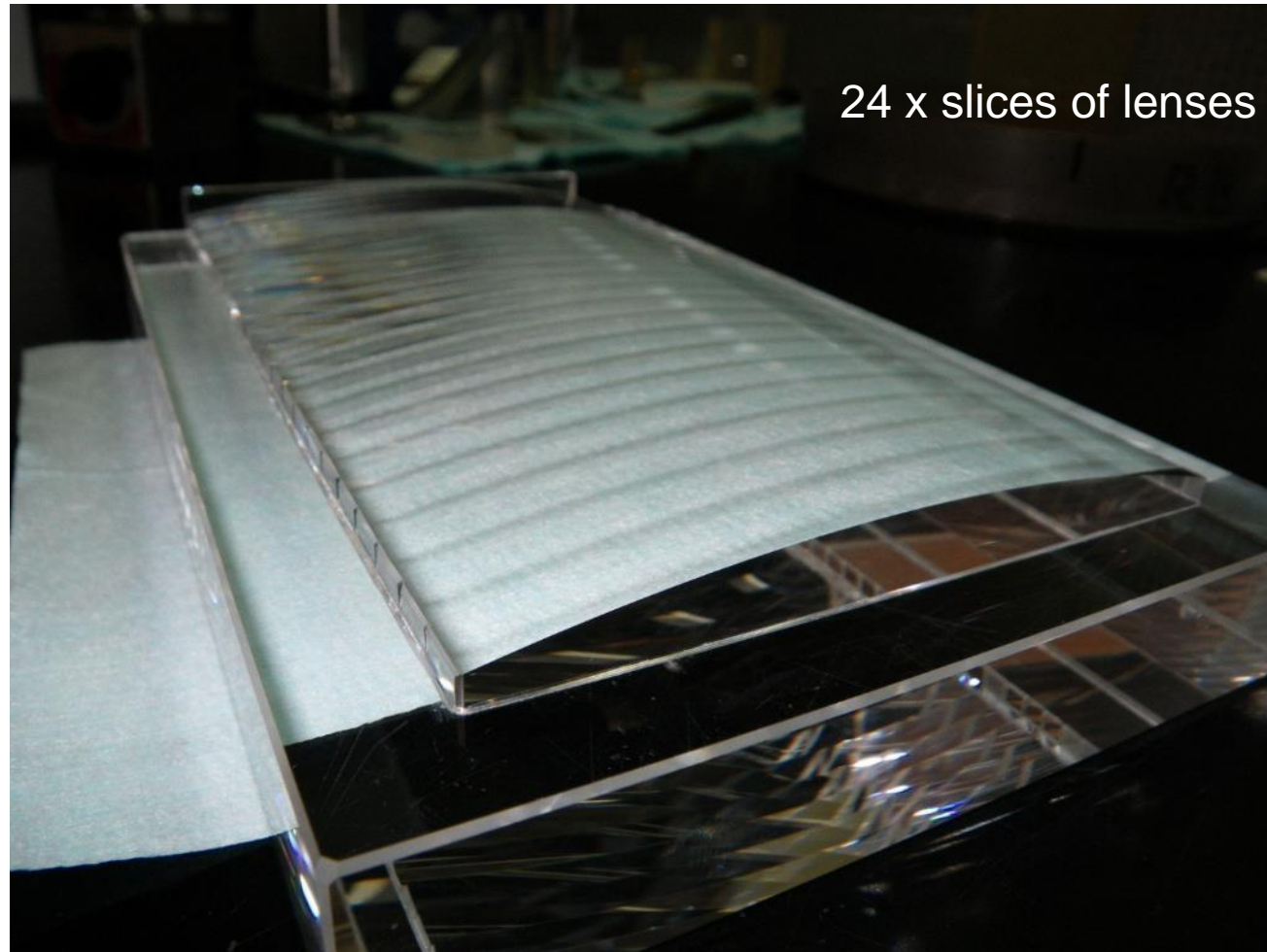


1 Field Splitter for MUSE Astronomy– 273K /323K 2012- 2013

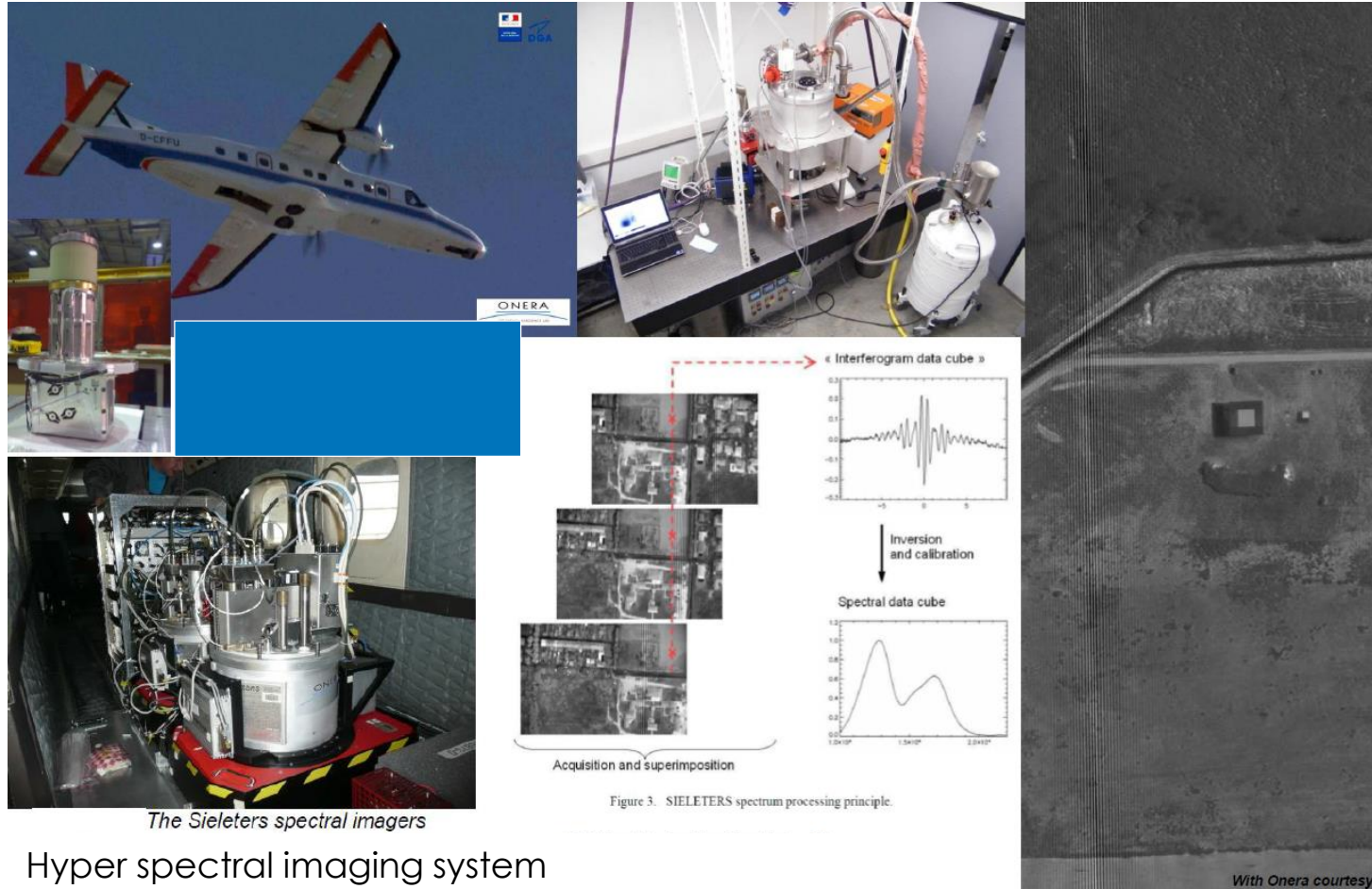
- 54 Fused silica components
 - 24 with optical contacting technology
- No mechanical parts
- Lenses array assembly to make Cross-talk possible btw the 24 beams
- Location ($\pm 30\mu\text{m}$ X, Y and Z)
- Quality after assembly
 - $< 250\text{nm}$ PTV
 - $R_q < 0.6\text{nm}$ RMS
 - Sharp edges



1 Field Splitter for MUSE Astronomy- 273K /323K 2012- 2013



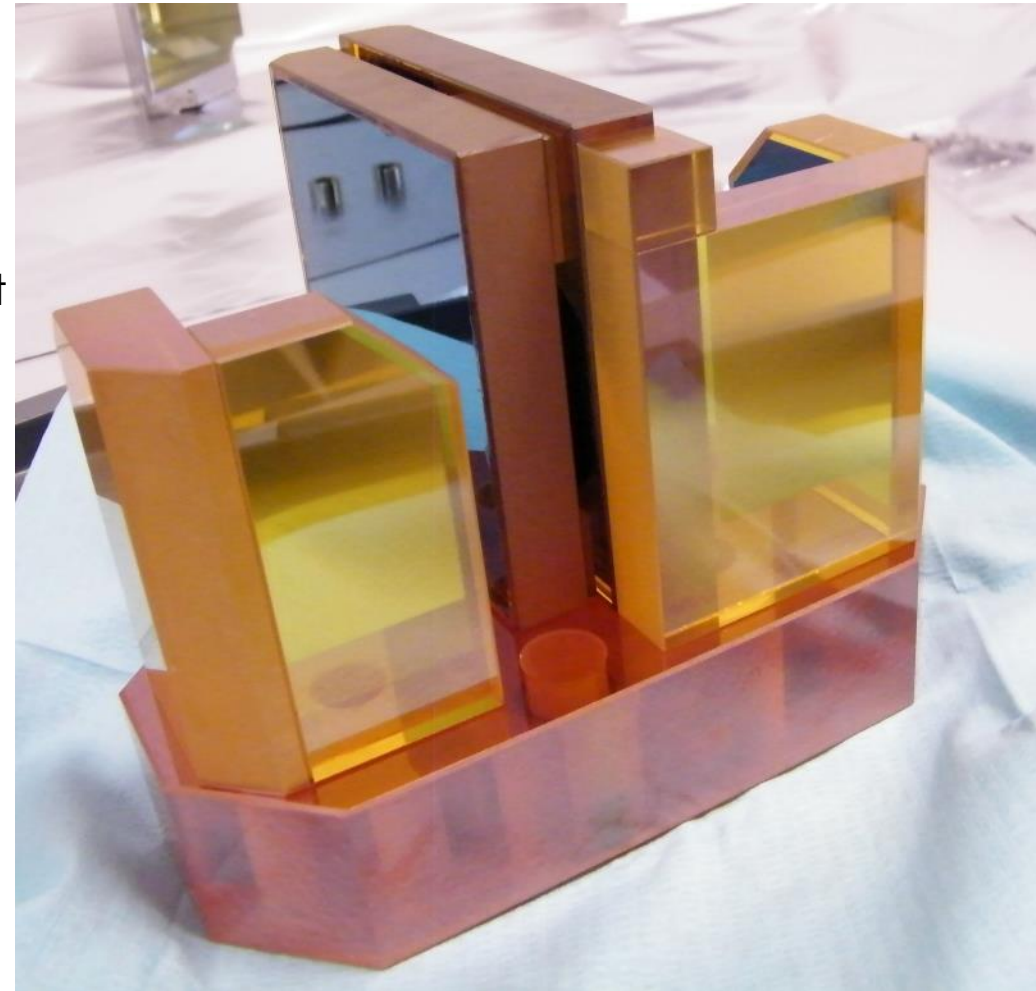
2 imaging static Fourier transform spectrometers Aircraft environment– 100K /323K 2012- 2013



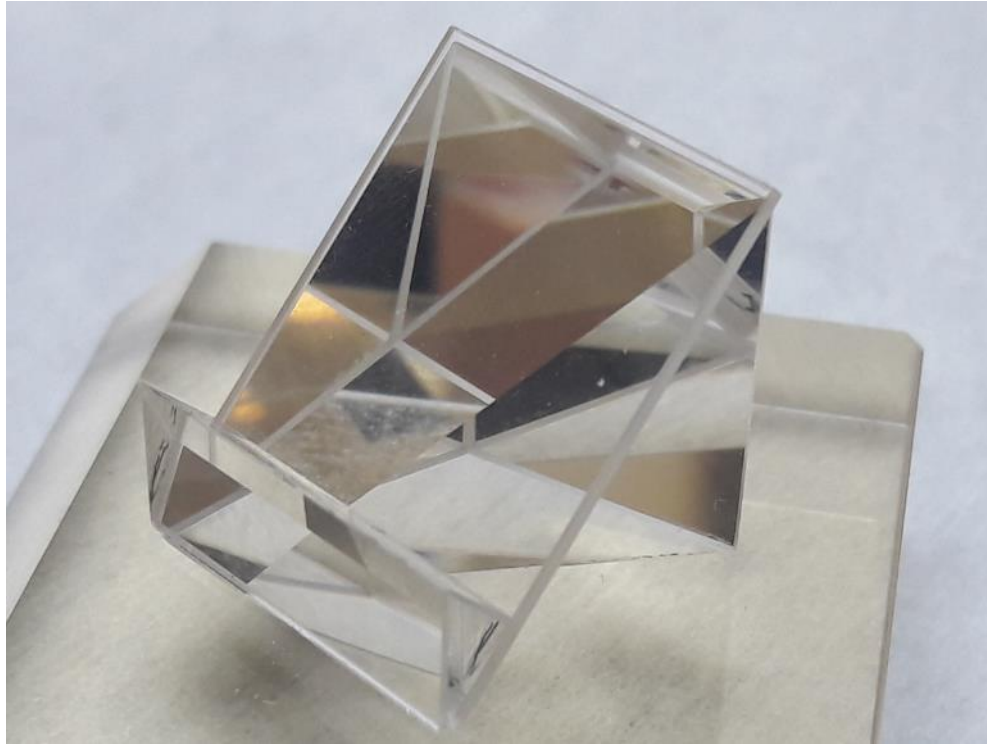
2 imaging static Fourier transform spectrometers

Aircraft environment– 100K /323K
2012- 2013

- 2X 12 ZnSe components
 - 2X 12 with optical contacting technology
- No mechanical parts except for the cryo environment
- Location ($\pm 0,5\mu\text{m}$ X, Y and Z)
- Quality after assembly
 - Centered within 1 fringe shifting



Bowen-Walraven Image Slicer for GRACES Astronomy– 240K /323K 2012 – 2013



2 prisms and 1 plate 1mm thick **optically contacted**

- Quality after assembly
 - < 250nm PTV
 - $R_q < 0.6\text{nm}$ RMS
 - Sharp edges on prisms

Slicing effect

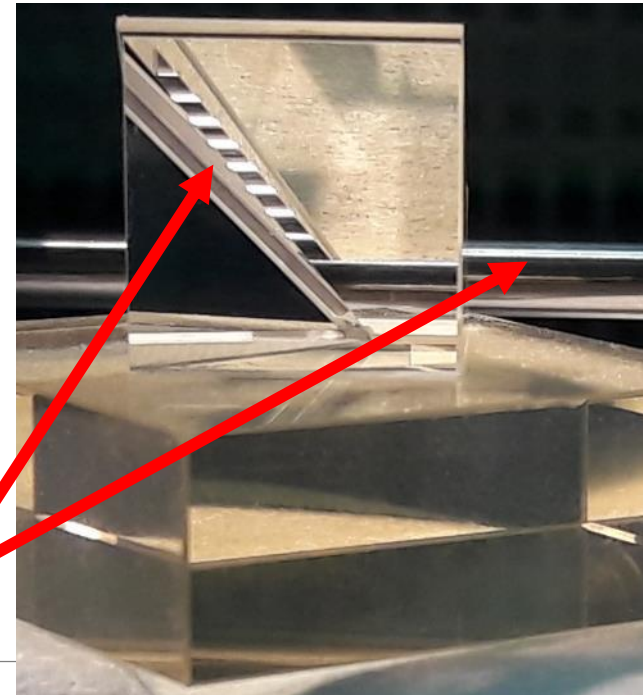
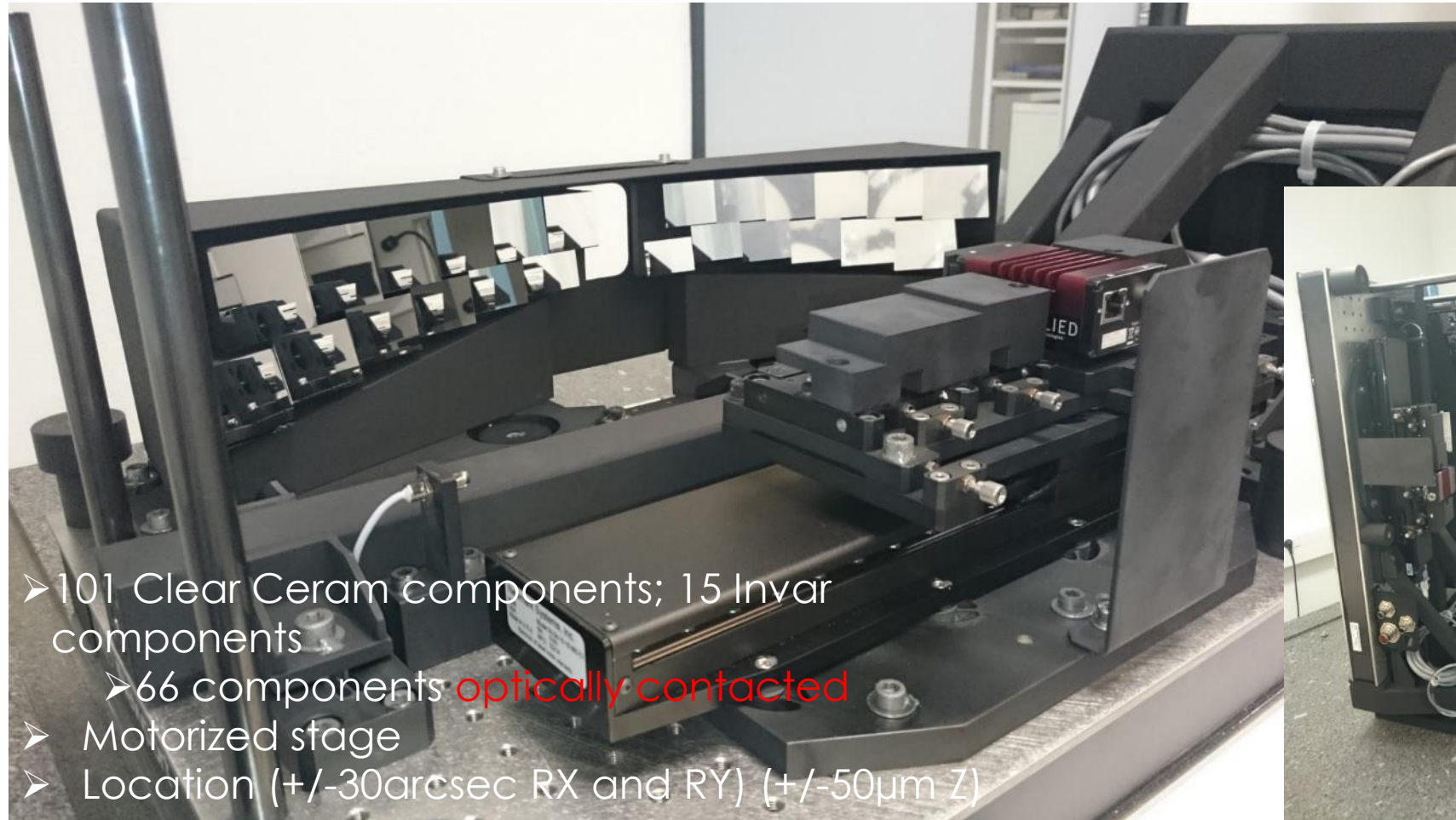


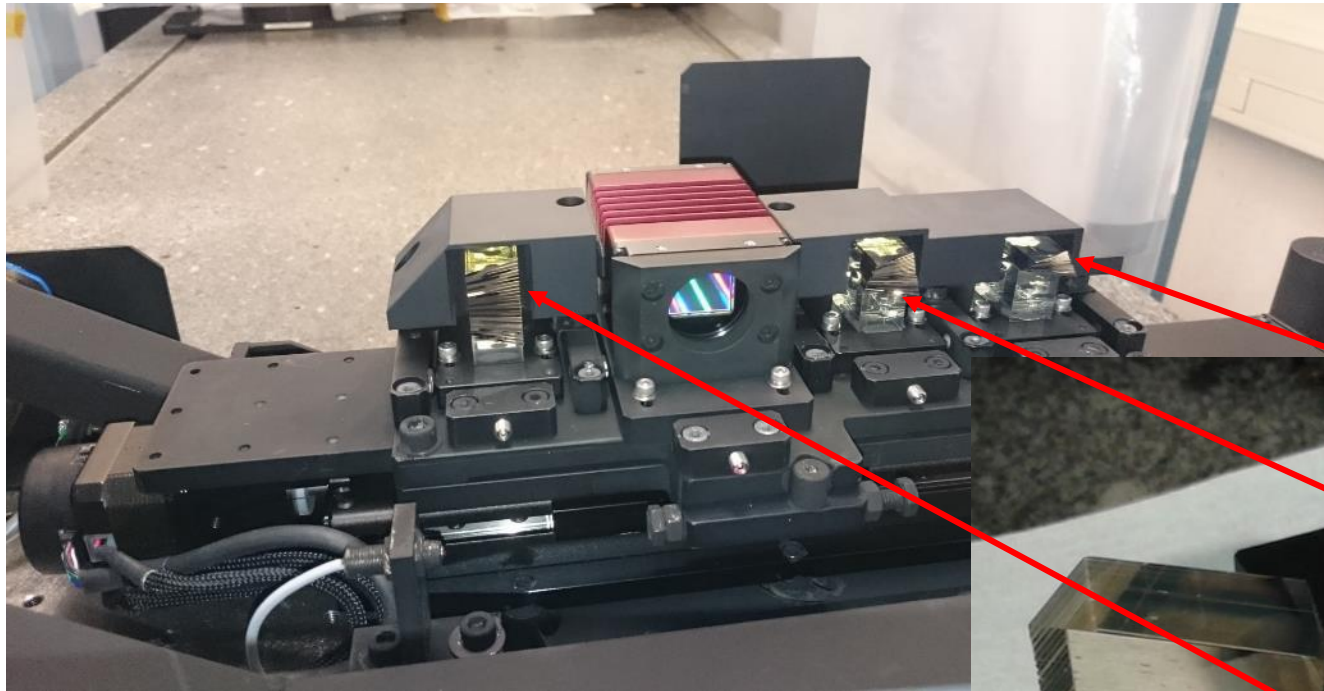
Image Slicer for KCWI Astronomy– 240K /323K 2013 – 2015



- 101 Clear Ceram components; 15 Invar components
 - 66 components **optically contacted**
- Motorized stage
- Location (± 30 arcsec RX and RY) ($\pm 50 \mu\text{m}$ Z)



Image Slicer for KCWI Astronomy– 240K /323K 2013 – 2015



- Quality after assembly
 - < 250nm PTV
 - $R_q < 0.6\text{nm}$ RMS
 - Sharp edges
- Final test at room temperature
 - WFE, tilts deviations

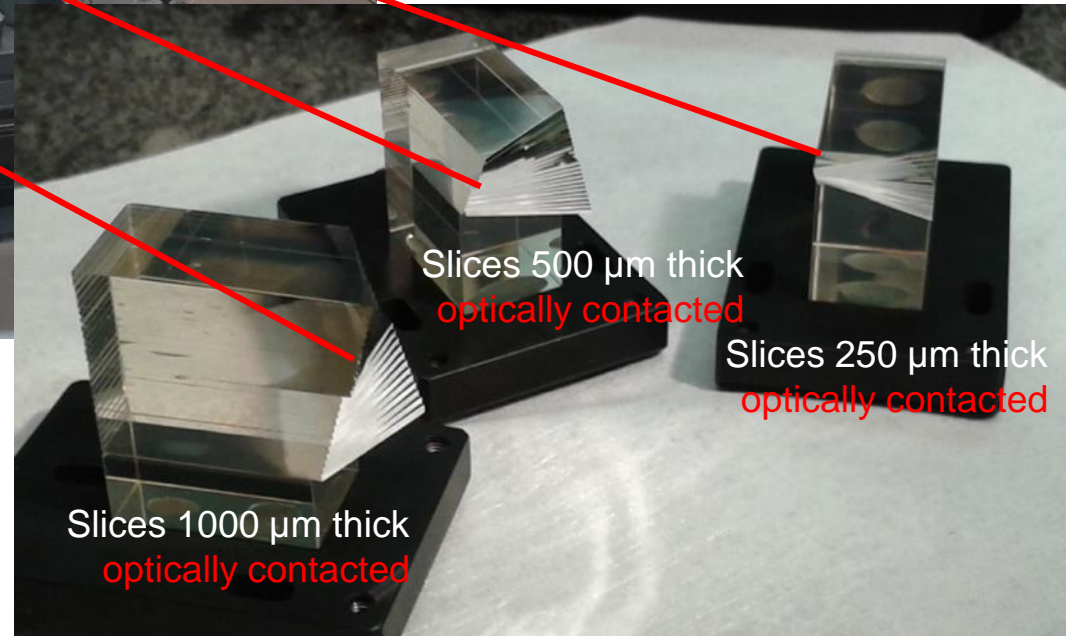
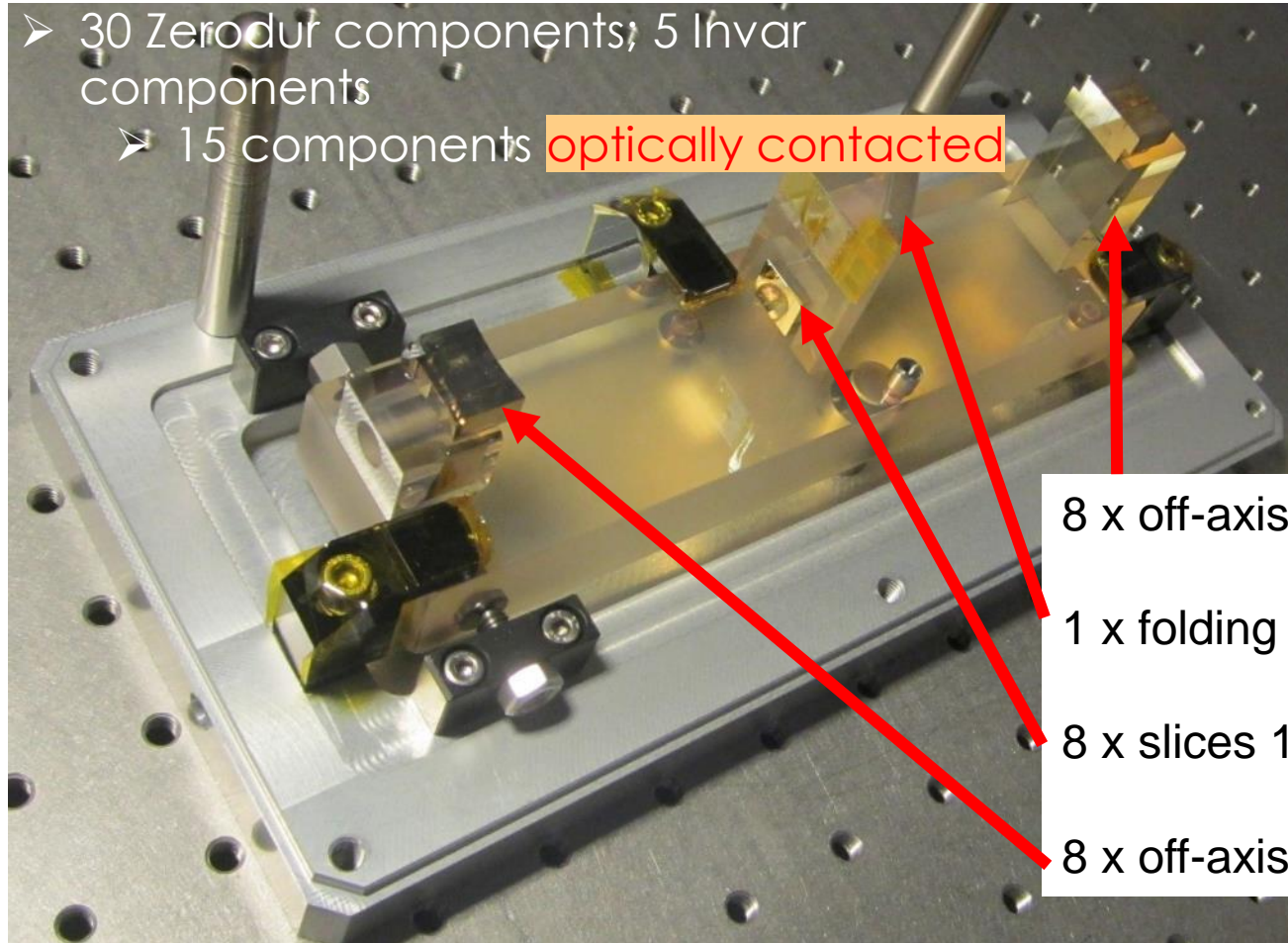


Image Slicer for SOLARNET Astronomy– 273K /323K 2015 – 2017

- 30 Zerodur components; 5 Invar components
 - 15 components **optically contacted**



8 x off-axis camera mirrors

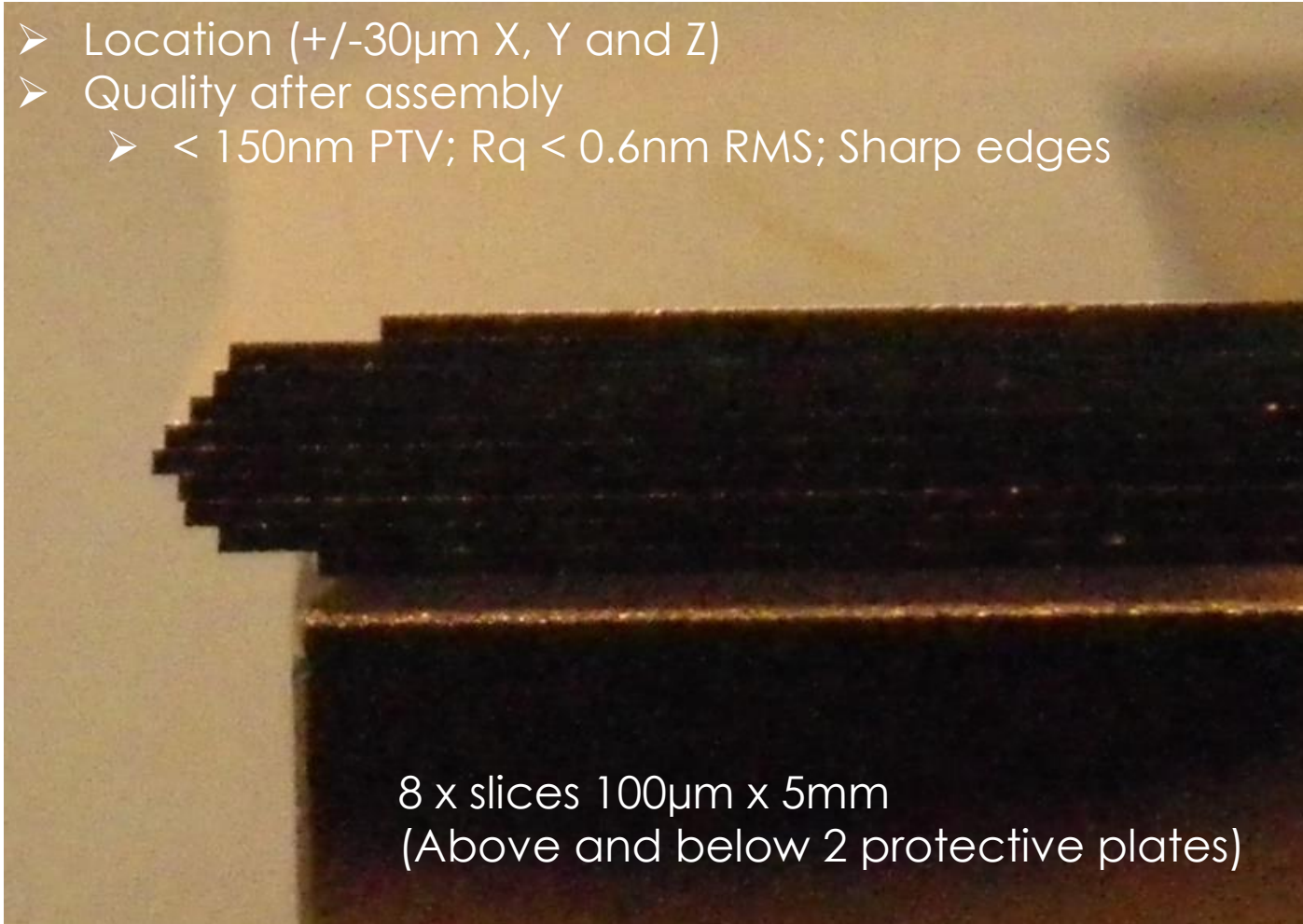
1 x folding mirror

8 x slices 100µm x 5mm

8 x off-axis collimator mirrors

Image Slicer for SOLARNET Astronomy– 273K /323K 2015 – 2017

- Location (+/-30μm X, Y and Z)
- Quality after assembly
 - < 150nm PTV; Rq < 0.6nm RMS; Sharp edges

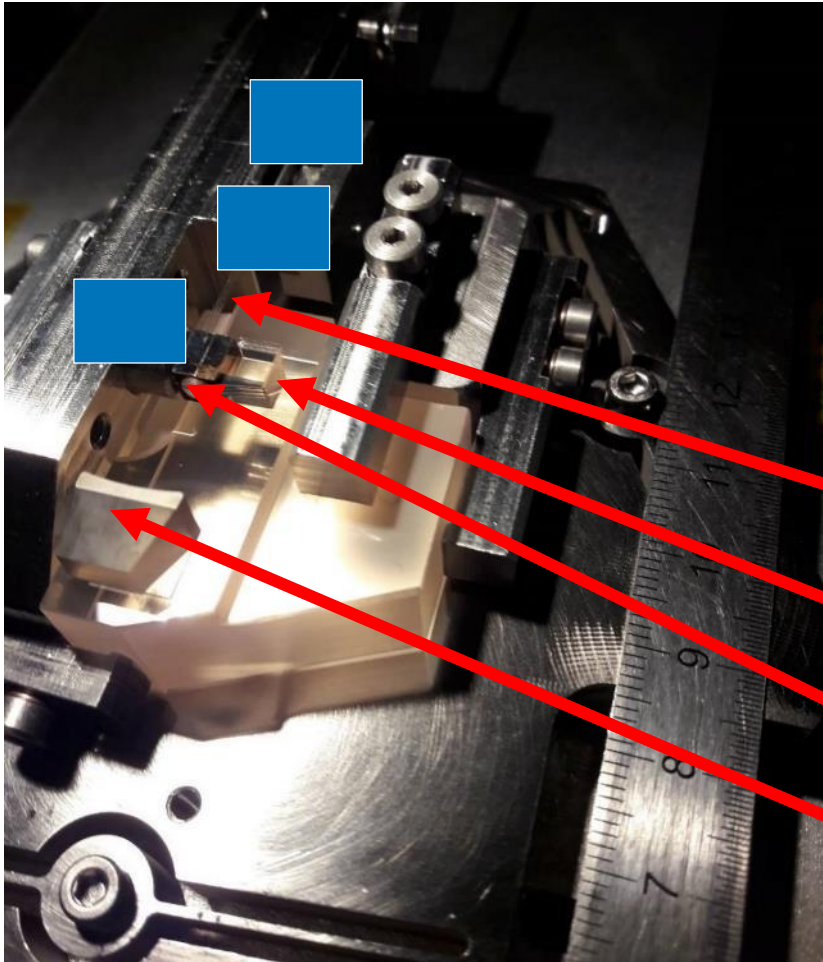


8 x slices 100μm x 5mm
(Above and below 2 protective plates)



New development done for SOLARNET II
Profile of 5 slices 70μm thick

2 X Pupil Slicers for SPIROU Astronomy– 77K /323K 2014 – 2017



- 23 Zerodur components optically contacted
- 5 Invar components; 3 Optical Fibers
- Location(+/-15arcsec RX and RY)(+/-30 μ m Z)
- Quality after assembly
 - WFE < 30nm RMS, Rq < 0.6nm RMS
 - Sharp edges

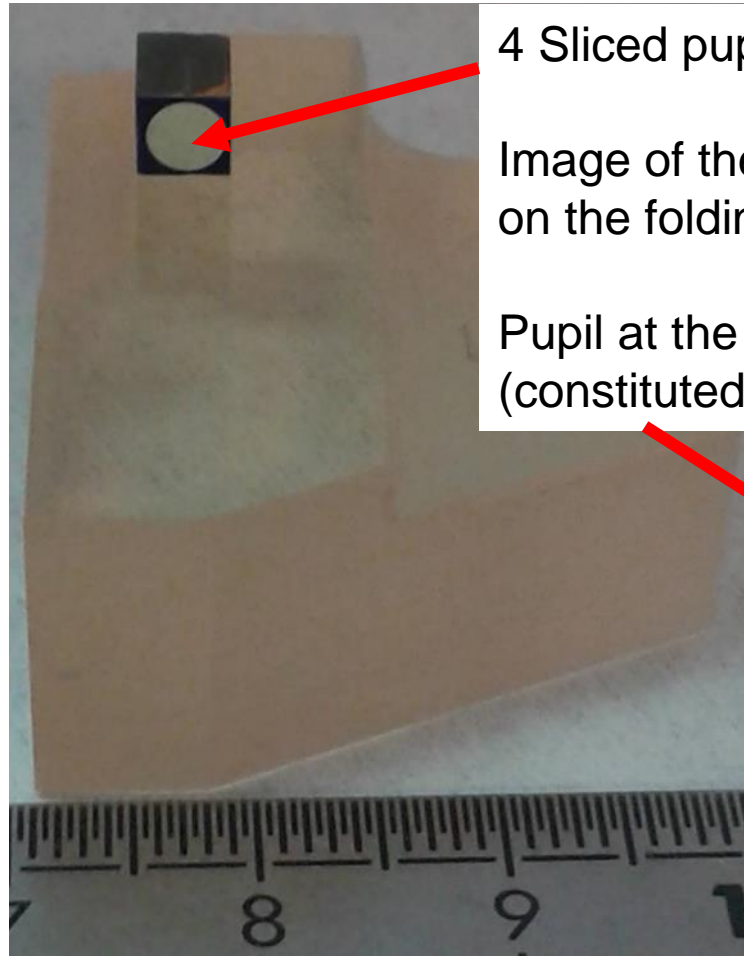
3 x Optical Fibers \varnothing 90-200 μ m

12 x Folding mirrors (slices 110 μ m x 5mm)

4 Sliced pupil mirrors

1 Collimator mirror

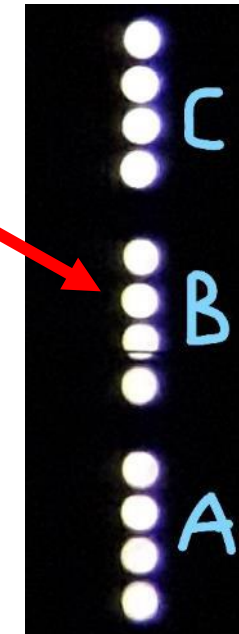
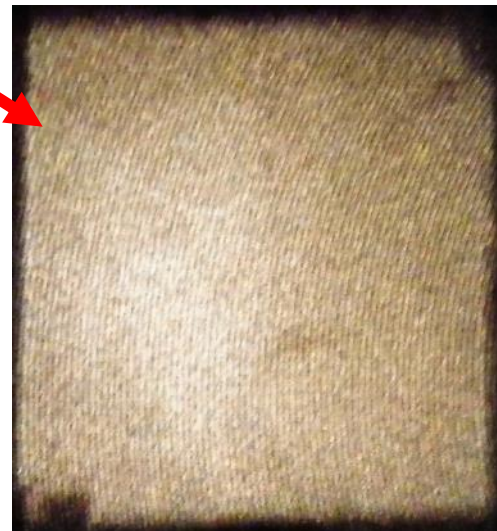
2 X Pupil Slicers for SPIROU Astronomy– 77K /323K 2014 – 2017



4 Sliced pupil mirrors

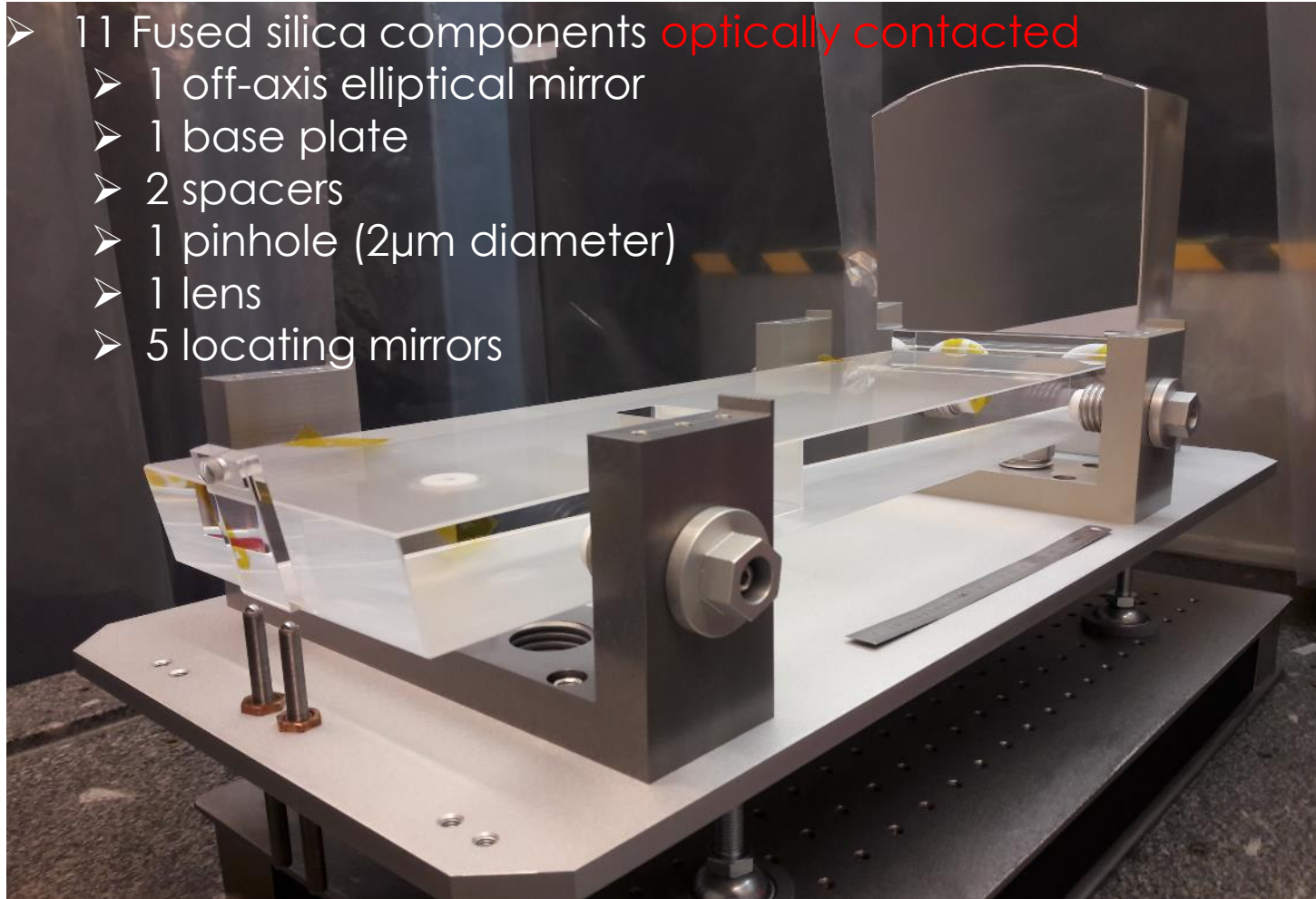
Image of the 3 optical fibers $\varnothing 90\mu\text{m}$
on the folding mirrors (slices $110\mu\text{m}$)

Pupil at the exit of the slicer
(constituted with 3Fo x 4 pupil mirrors)



Telescope simulator OGSE for EUCLID – 165K /323K 2016 – 2017

- 11 Fused silica components **optically contacted**
 - 1 off-axis elliptical mirror
 - 1 base plate
 - 2 spacers
 - 1 pinhole (2 μ m diameter)
 - 1 lens
 - 5 locating mirrors



Conclusion

Since the beginning of WINLIGHT:

- Close to 2000 components have been optically contacted
 - Close to 500 breadboards have been contacted
 - For characterization and/or tests
- Without any damage

And now:

- We follow our processes development
 - To improve the performances withstanding the thermal and mechanical environments

Thank you for your attention

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