Laboratories at OABr (Merate)

Bianca Salmaso, Andrea Bianco

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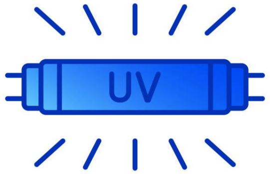
Brera wide spectrum

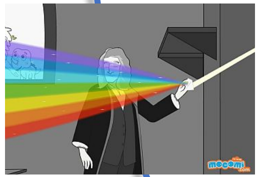
OSSERVATORIO ASTRONOMICO DI BRERA

X-Ray

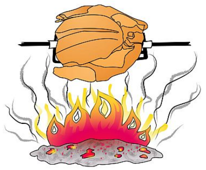
UV

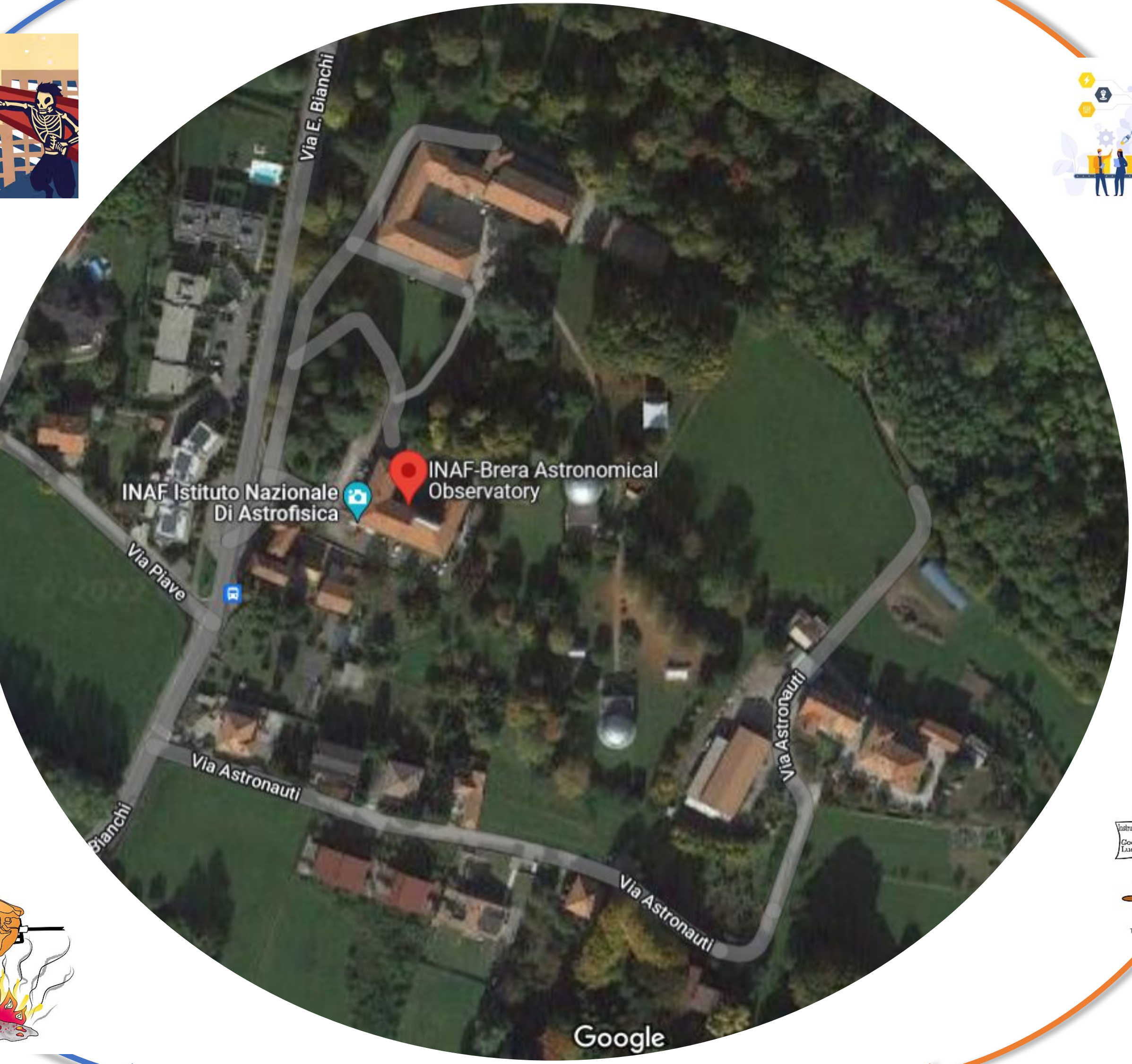


Visible



Infrared





Manufacturing

Characterization

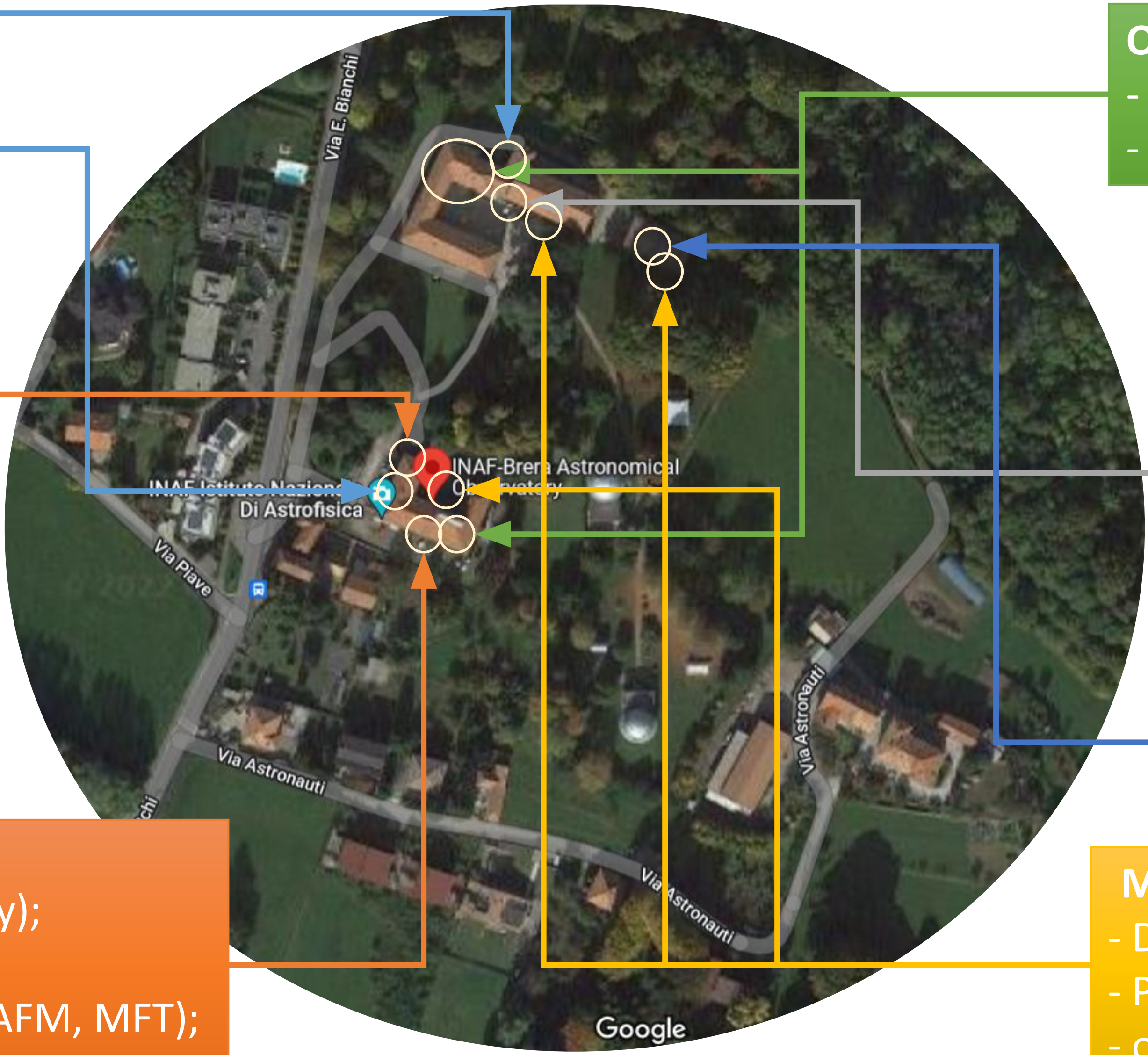
AIT/AIV

Brera wide spectrum

Brera wide spectrum - 1200m^2 lab, 250m^2 «clean»

Workshop
- Mechanical;
- 3D printing.

Optics manufacturing labs
- IBF, Bonnet;
- VPHGs.



Chemical (analytical) lab
- Thin film production;
- Vibrational spectroscopy;
- UV-vis-NIR spectroscopy:
- Spectral reflectance.

BEaTriX

Clean rooms
- Testing (CMM, interferometry);
- Lithography;
- Roughness characterization (AFM, MFT);
- AIV-AIT.

Multi purpose labs
- Deflectometry;
- Profilometry;
- opto-mechanics.

BEaTriX @ INAF-Brera-Merate

Beam Expander Testing X-ray facility

INAF-OAB Leadership	
G. Tagliaferri	PI
G. Pareschi	Deputy PI
B. Salmaso	PM - SE
S. Basso	AIV
D. Spiga	Optical design and calibration
M. Ghigo	Vacuum, IBF, software
G. Vecchi	Polishing
G. Sironi	Metrology
V. Cotroneo	Figuring

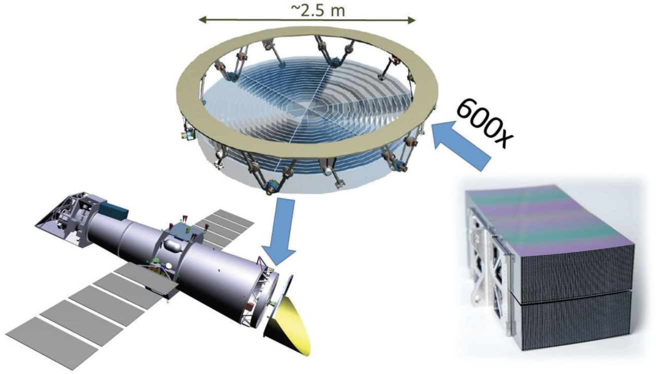
This project has received funding from:

- AHEAD-1 grant # 654215
- ESA contract # 4000123152/18/NL/BW
- ASI accordo attuativo # 2019-27-HH.0
- AHEAD-2 grant # 871158
- INAF

Reference space mission: **ATHENA**

Energy band : **X**

Scope: **acceptance X-ray test** before integration of the 600 Mirror Modules composing the optics



Mirror Module

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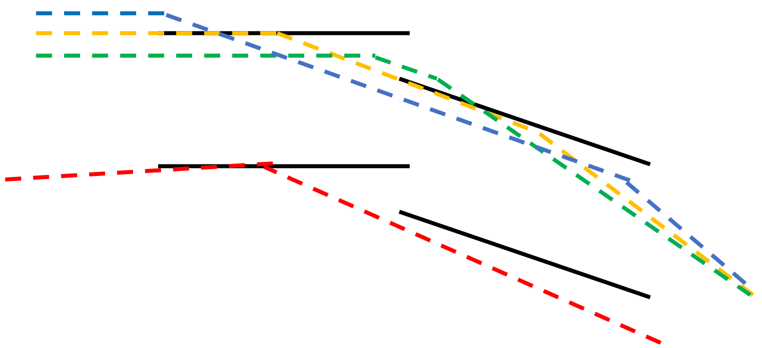
INAF - OAB WEB page: http://www.brera.inaf.it/beatrix-facility/

AHEAD TransNational Access facility WEB page: http://ahead.astropa.inaf.it/index.php/infrastructures-ahead-2020/beatrixinaf-oab-ahead-2020/

BEaTriX @ INAF-Brera-Merate

In a small lab, we create an X-ray beam that simulates an astronomical source

- Expanded: to illuminate the entire entrance pupil of the optic
- Collimated: to have double reflection from the entire optic

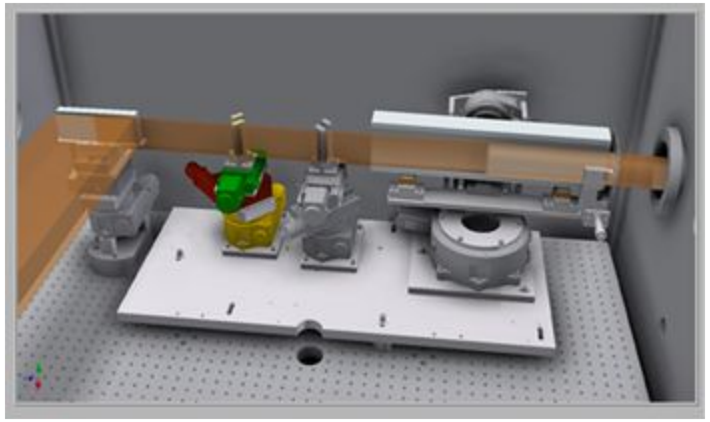


Vacuum is needed to propagate X-rays of 1.5 and 4.5 keV.
Since the lab is small

⇒ evacuation time is small (30min)
⇒ test rate is high (2MM/day)

How do we create an expanded collimated beam ?

- X-ray micro source
- Parabolic mirror figured @ INAF-OAB with Zeeko and IBF
- Crystals with symmetric cut for monochromation
- Crystals with asymmetric cut for expansion



BEaTriX @ INAF-Brera-Merate

Beam characteristics

- energy-present = 4.5 keV
- size = 170 mm × 60 mm
- collimation ~ 2 arcsec

- energy-next = 1.5 keV / 6 keV

Possible measurements

- PSF and Effective Area
- thermal range 20 ± 25 °C
- optics up to about 5 kg

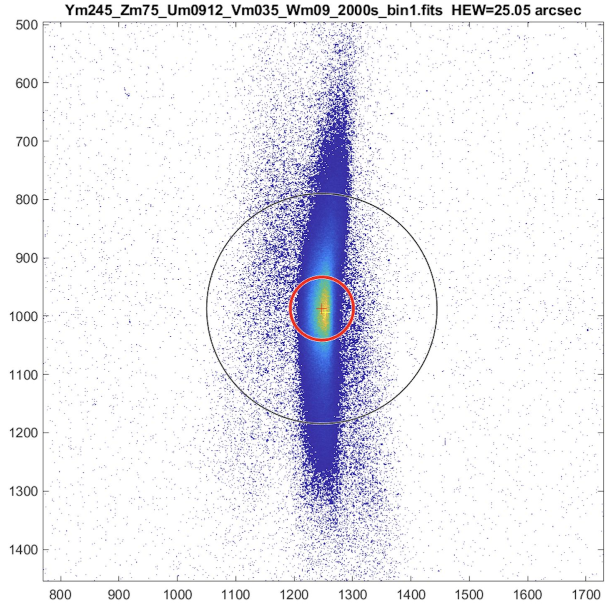
First light with ATHENA Mirror Module on March 2022

Early inner SPO MM, uncoated

HEW = 25.24 ± 0.89 arcsec

Effective Area = 6.84 ± 0.35 cm^2 (expected 6.72 cm^2)

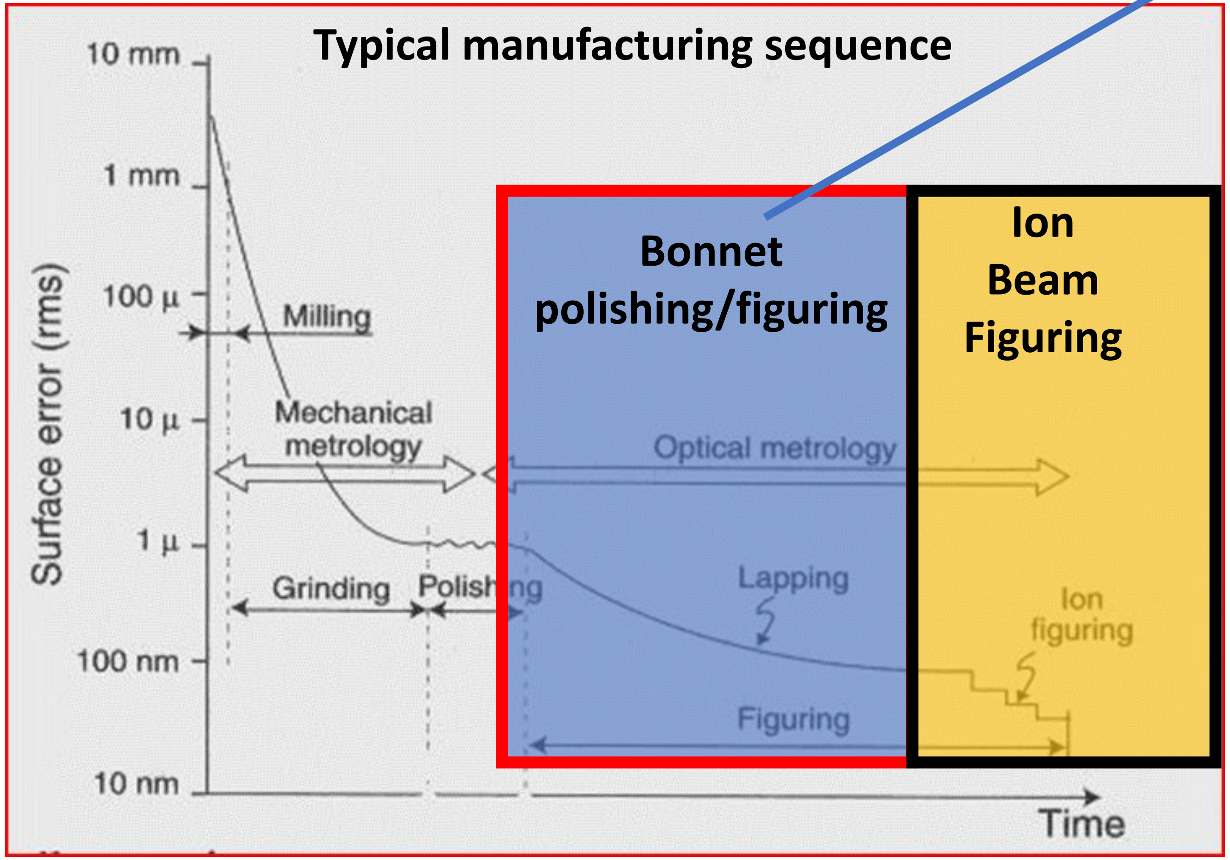
A good quality MM is expected by the end of 2022



BEaTriX is now available for X-ray test for the community

Polishing and Figuring facility
@ INAF-Brera-Merate

Reference people
Gabriele Vecchi (Zeeko)
Mauro Ghigo (IBF)



- 7 axis CNC polishing/figuring of optics up to 1.2m diameter
- Any shape (aspheric, free form)

- The bonnet is the spinning tool in contact with the optical surface and abrasives
- Metrology-driven iterative process

G. Vecchi et al., Mem. S.A.It. Vol. 86, 408 (2015)

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Bonnet Polishing/Figuring

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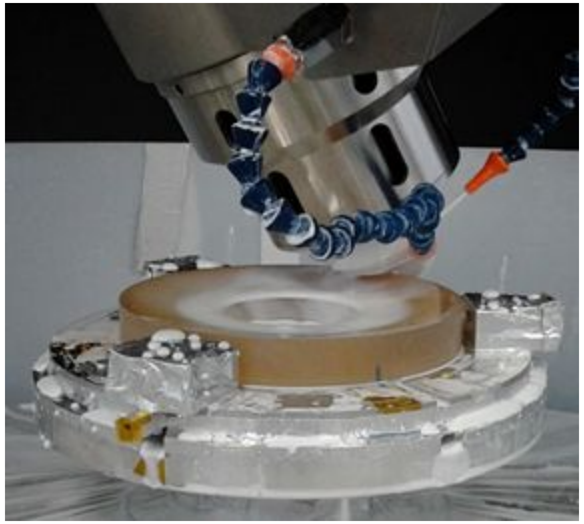
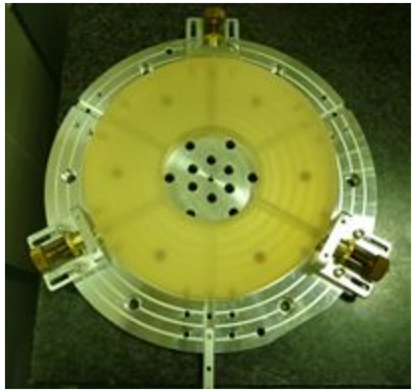
Aspheric mirror for COSMOS project



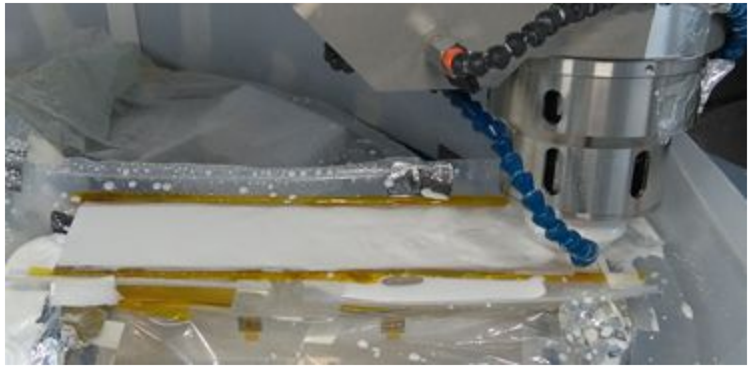


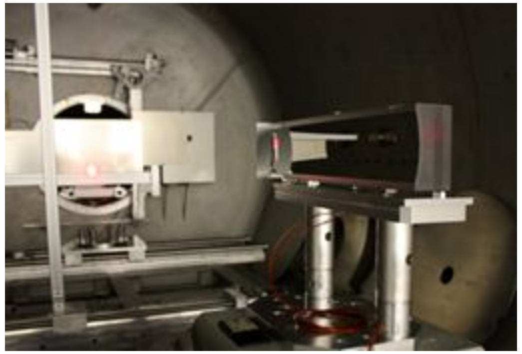
G. Vecchi et al., SPIE 1056254 (2017)

Regione Lombardia

fondazione cariplo

Collimating X-ray mirror for BEaTriX facility



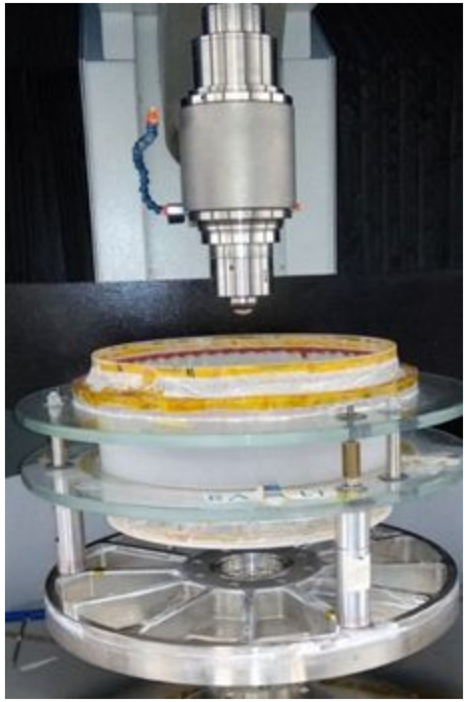


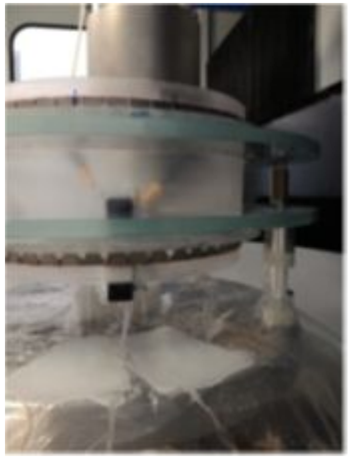
G. Vecchi et al., SPIE 111191J (2019)
G. Vecchi et al., SPIE 118220N (2021)

BEaTriX

esa

Monolithic thin glass shells for X-ray telescopes





M. Civitani et al., J. Astron. Telesc. Instrum. Syst. 5(2), 021014 (2019)

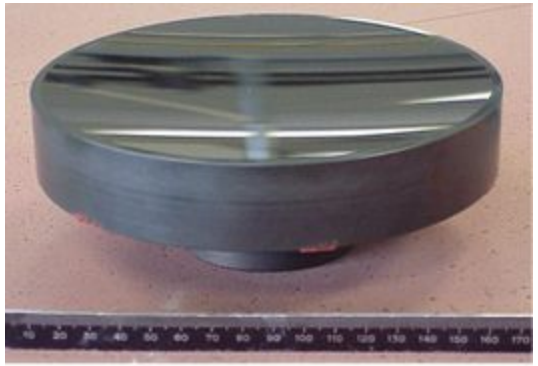
TAO-X

asi agenzia spaziale italiana

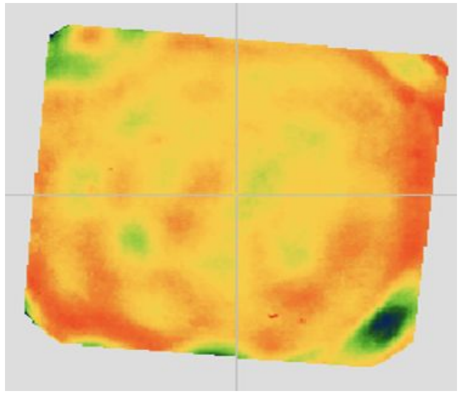
IBF @ INAF-Brera-Merate
Ion Beam Figuring

Demonstrative sample for ELT
Glyndŵr University, N. Wales
1m hexagoal Zerodur mirror
Figuring time = 19 hours
Final error = 13 nm rms / 4 nm rms
after removal of ELT permitted errors

ESA FlyEye, devoted to the search of NEO and Space Yunk
1.2 m mirror
Figuring time = 21 hours
Initial error = 85 nm rms
Final error = 35 nm rms
(requested spec <40 nm)



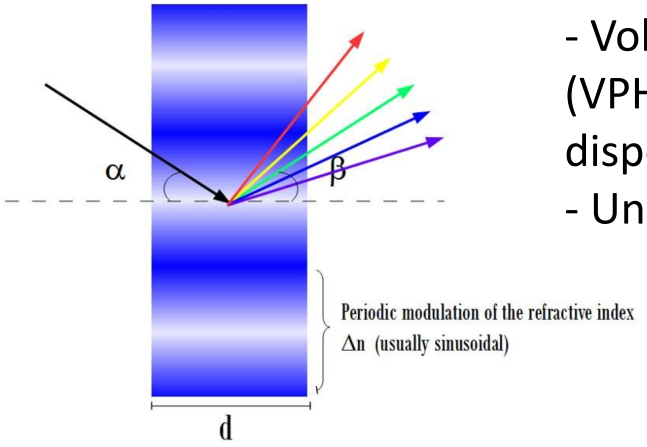
Demonstrative sample for NIRSPEC (JWST) ir
Siliconcarbide, 150 mm
Initial error = 22 nm rms
Final error = 8 nm rms



RM2-SN2 mirror for NIRSPEC (JWST)
Initial error = 81 nm rms
Final error = 5.6 nm rms

BEaTriX parabolic mirror
Final error =25 nm rms
Tested in X-ray in PANTER ~ 3 arcsec HEW @ 1.49 keV

Grating production



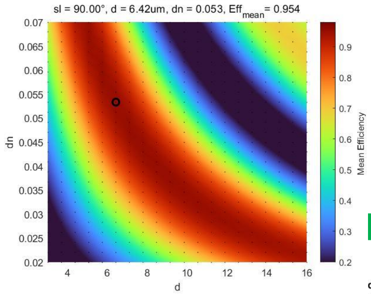
- Volume Phase Holographic Gratings (VPHG) are considered the baseline for dispersing elements in spectrographs.
- Unique production facility in Europe.

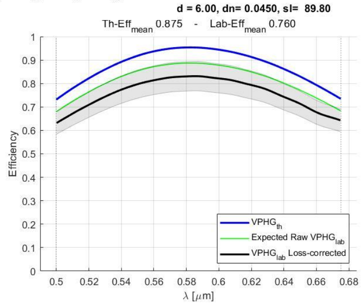
Manufacturing Capabilities

Property	Value
Spectral range	0.35 – 2.40 micron
Line density	200 – 3500 l/mm
Maximum clear aperture	190mm x 240mm
Configuration	Plane grating, GRISM
Innovative configurations*	Multi-order VPHGs, multiplexed VPHGs

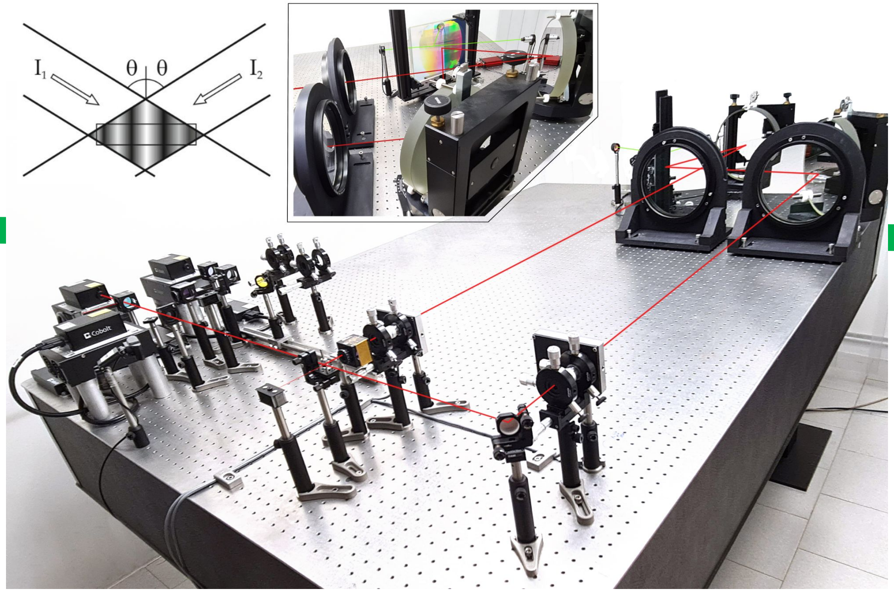
https://www.orp-h2020.eu/vphgs-orp

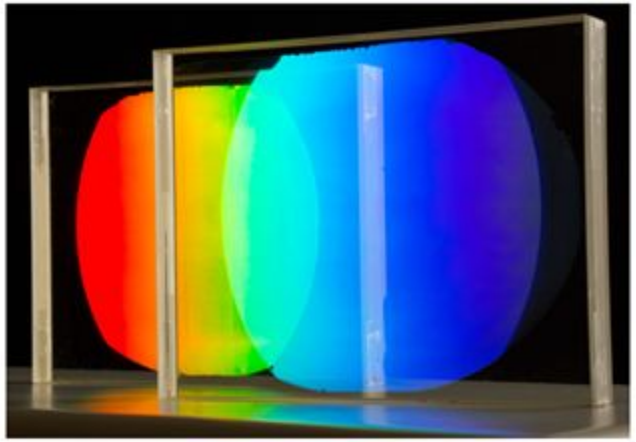
Design





Writing



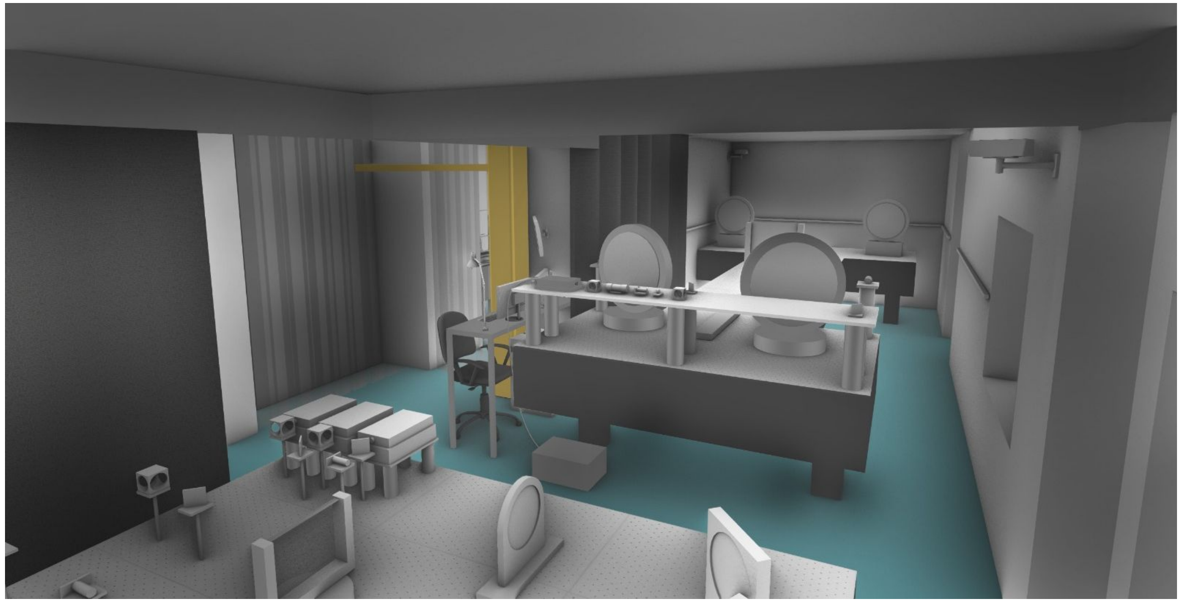


OPTICON

OPTICON RadioNet Pilot

Future grating production (our hope)

Property	Old Holo Lab	New Holo Lab
Spectral range	0.35 – 2.50 micron	0.330 – 2.50 micron
Line density	200 – 3500 l/mm	250 – 3500 l/mm
Maximum clear aperture	200mm x 230mm	450mm x 550mm
Configuration	Plane grating, GRISM	
Innovative configurations*	Multi-order VPHGs, multiplexed VPHGs, …	



The new setup based on very large parabolic mirrors to match the requests of the astronomical community.
The small set-up will remain active for smaller devices.

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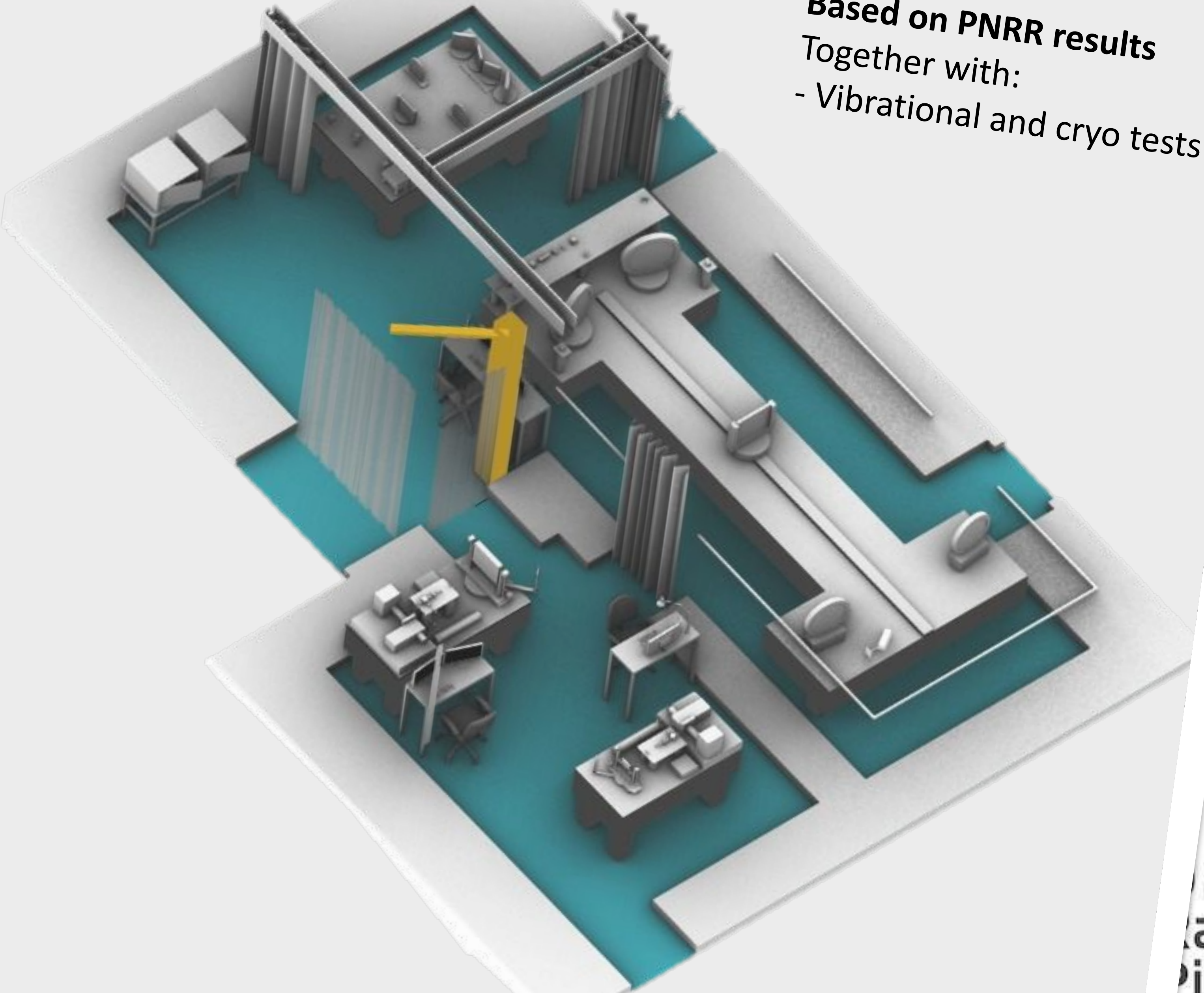
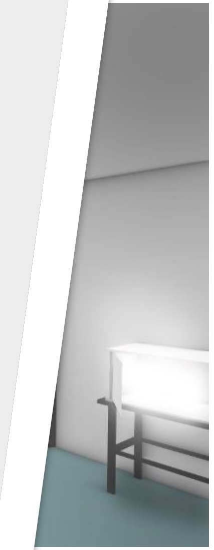
Property
Spectral range
Line density
Maximum clear aperture
Configuration
Innovative configuration

Based on PNRR results

Together with:

- Vibrational and cryo tests





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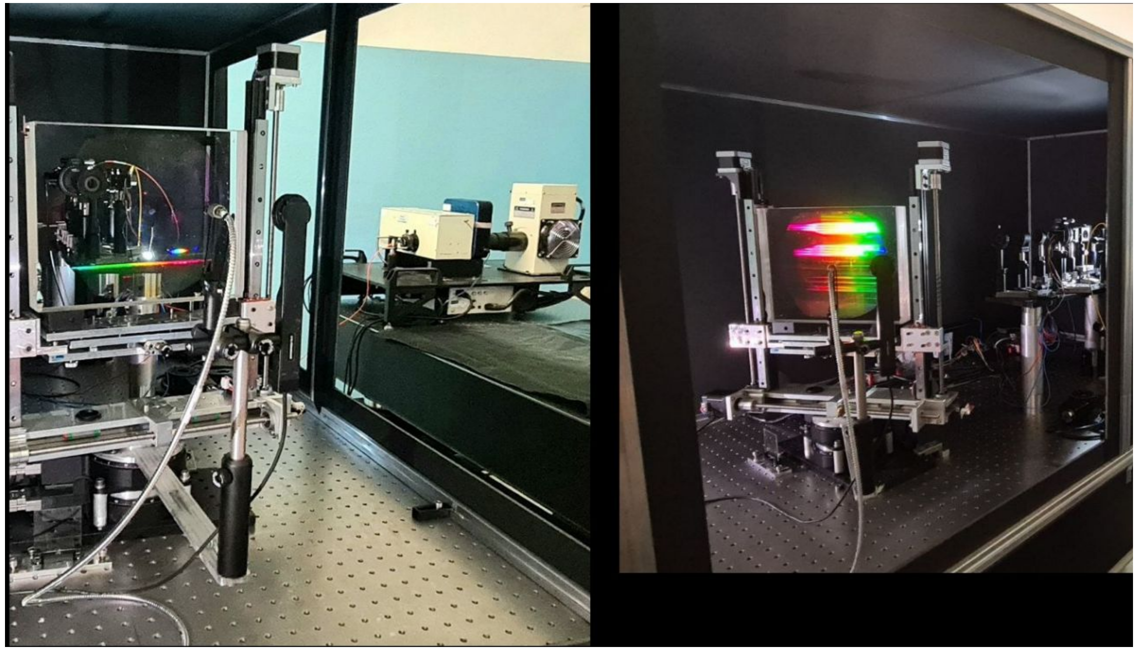
PTICON
RadioNet
Pilot

OPTICON

Grating characterization

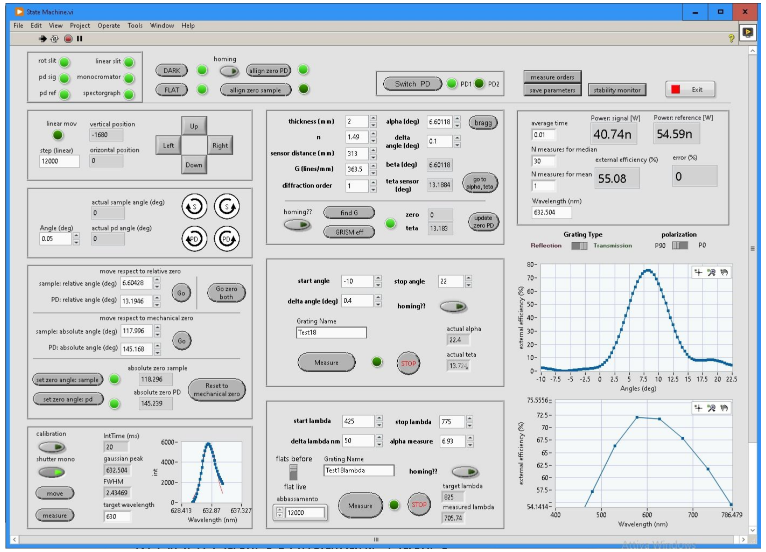
A characterization setup is available to:

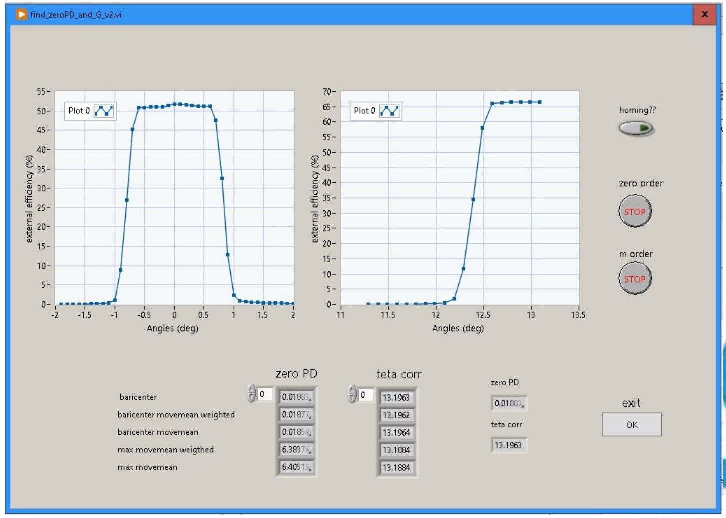
- Measure the diffraction efficiency at a set AOI (from 0.3 to 2.5 um);
- Measure the diffraction efficiency as function of the AOI;
- Measure the line density;
- Make efficiency maps of the grating surface.



Features:

- Fully automated instrument (LabView based software);
- Versatile (useful also for filters, prisms,…);
- Optical elements up to 250 mm in diameter.





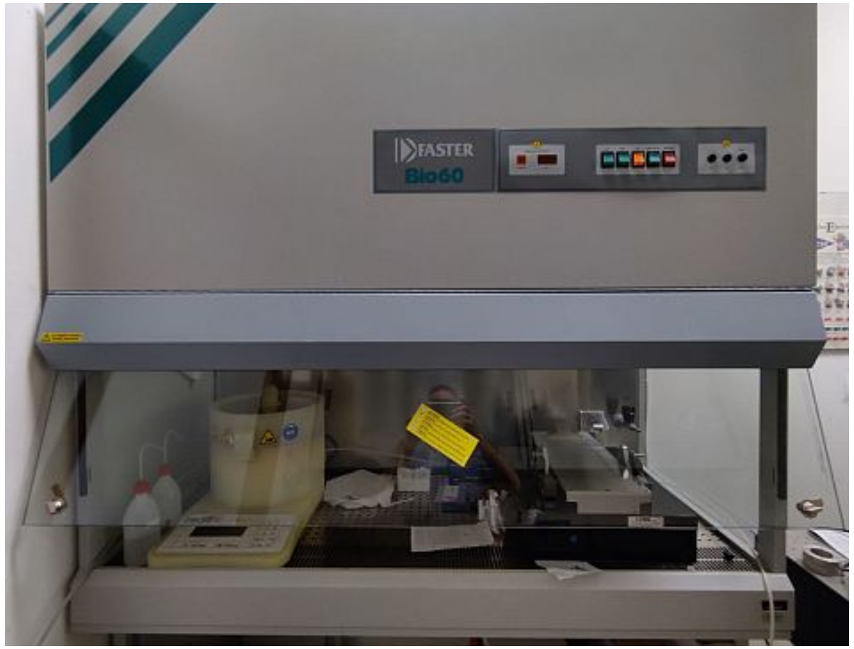
OPTICON

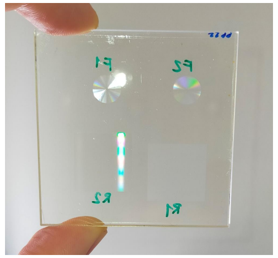
OPTICON RadioNet Pilot

New Materials and Chemistry at OABr

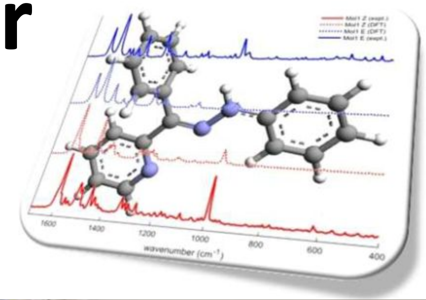
Chemical laboratory:

- Chemical hood;
- Chemical refrigerator;
- Sonicators, oven, stirrers, analytical balance;
- Spin coater and blade coater under laminar flux hood for thin film production.



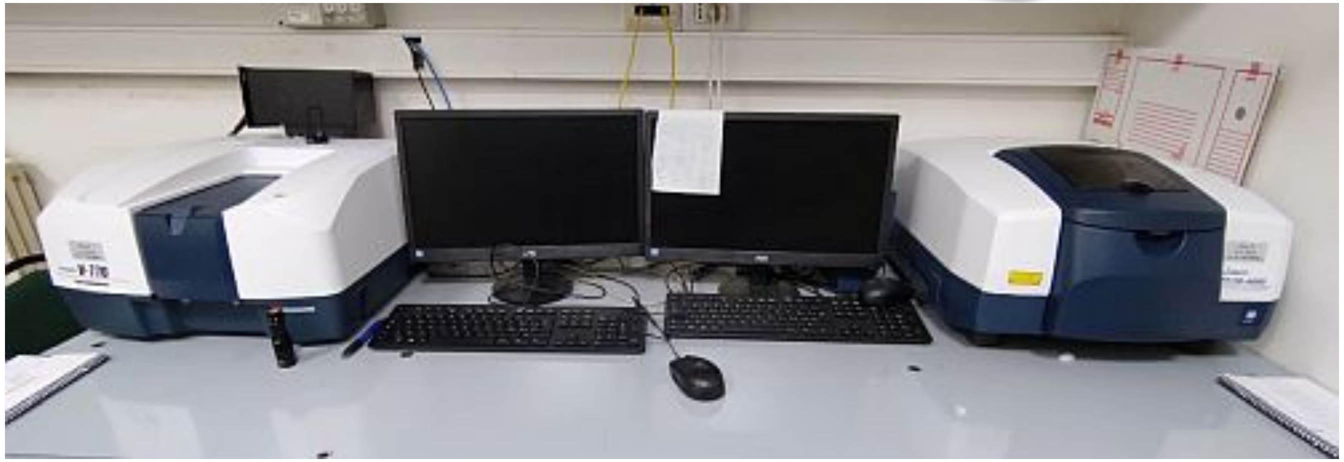


Analytical Chemistry at OABr



Vibrational spectroscopy:

- FT-IR with ATR for composition analysis and transparency measurements (2.5 – 25 um)
- Portable Raman spectrometer (macro) for composition analysis



Molecular electronic spectroscopy:

- UV-Vis-NIR with integration sphere (for diffusive samples) for measuring the transparency in the 0.19 – 2.70 um range;
- Spectral reflectometer for measuring the refractive index and thickness of thin layers and the reflectance in the 0.35 – 1.70 um range.