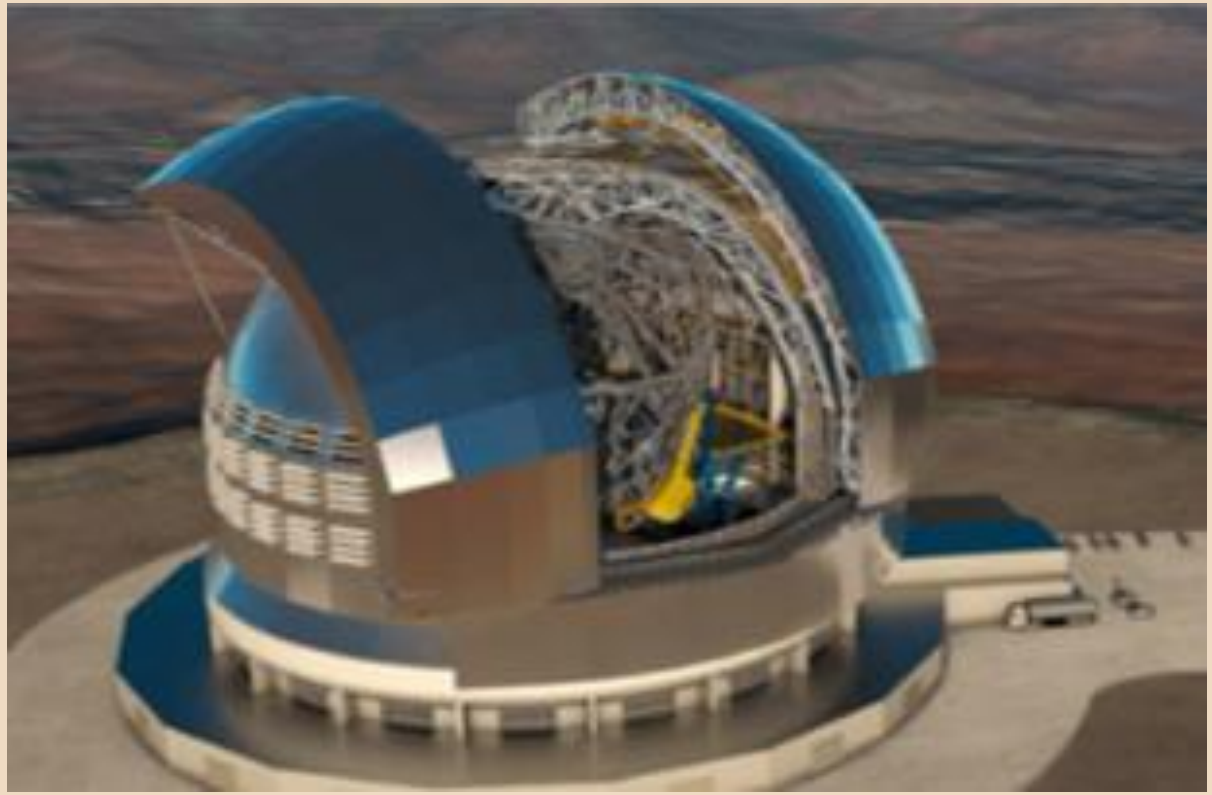
Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
INAF ISTITUTO NAZIONALE DI ASTROFISICA

New capabilities in optomech manufacturing and testing

Andrea Bianco
INAF-OAB



Workshop STILES: risultati e prospettive future
Napoli, March 16 – 18, 2026

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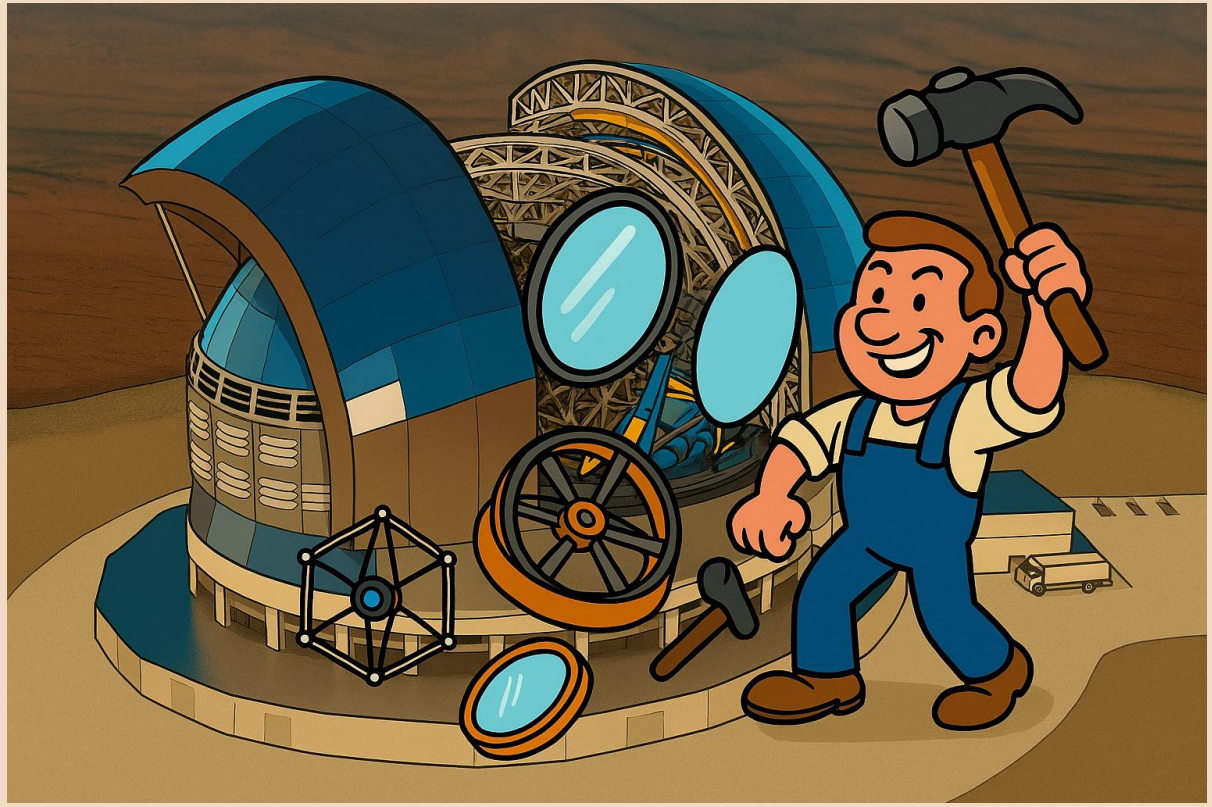
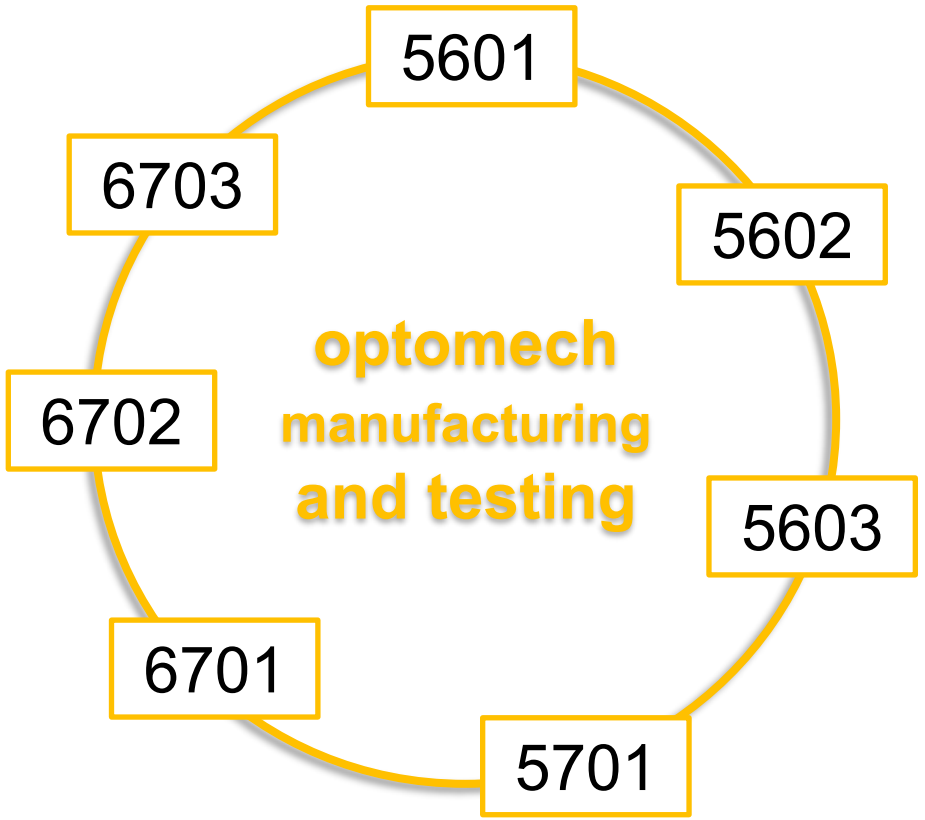


STILES activities



Improve the optomechanical manufacturing capabilities for:

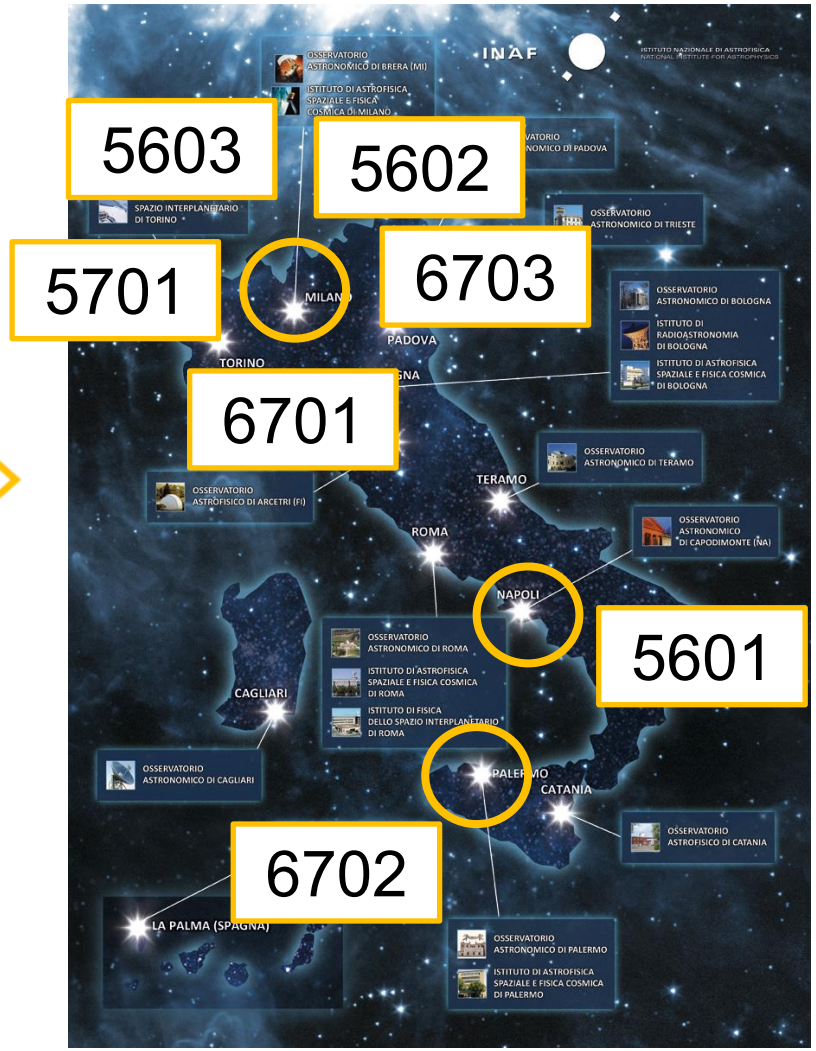
- Prototyping;
- Precise mech and glass components production;
- Holo optical elements.

Distributed testing tools for:

- Optical metrology;
- Optomechanical alignment;
- Experimental modal analysis
- Dynamic characterization of lightweight structures.

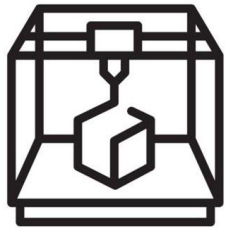
STILES activities

optomech manufacturing and testing

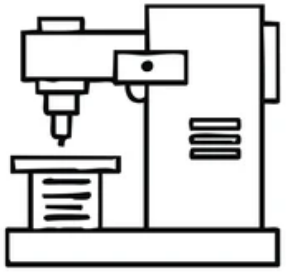


STILES activities

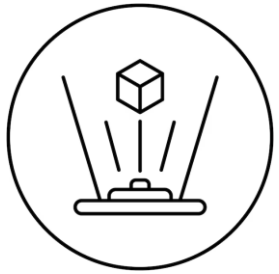
Manufacturing



3D printing



5 axis CNC machine



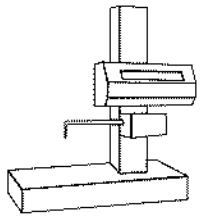
holography

optomech manufacturing and testing

5601
5602
5701

5603
6701
6702
6703

Testing

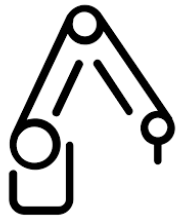


Profilometer

Interferometer

Cryo vacuum

Shaker

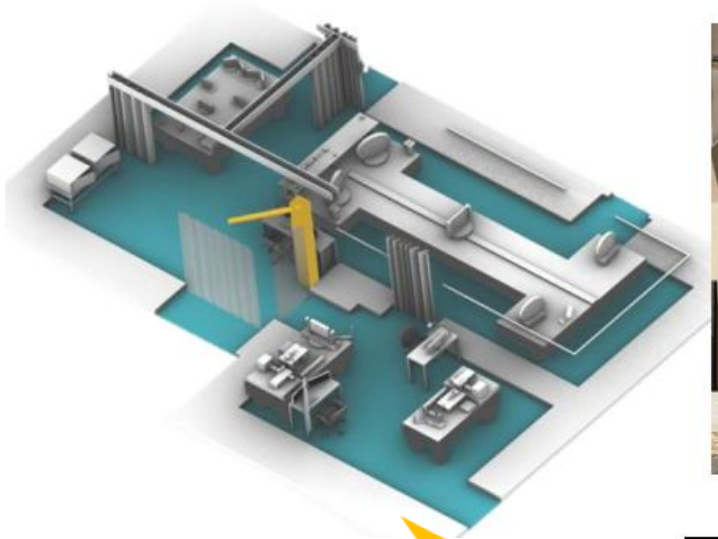


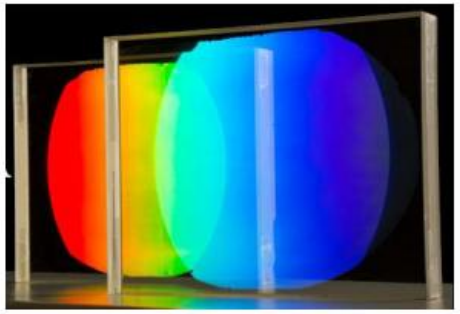
CMM

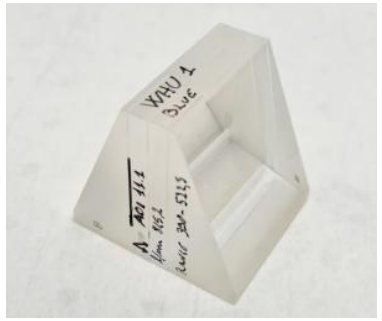
Laser tracker

Modal tracker

Holographic Laboratory – 5701





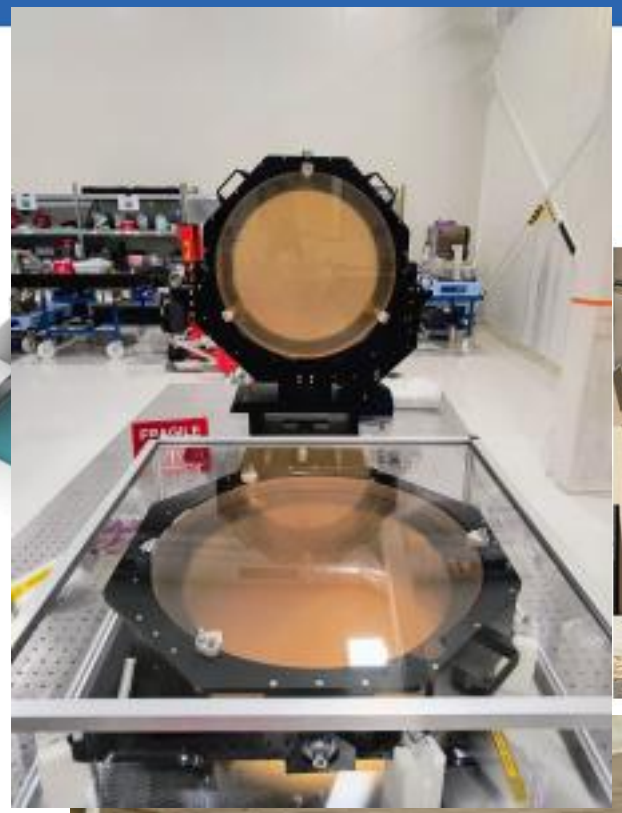


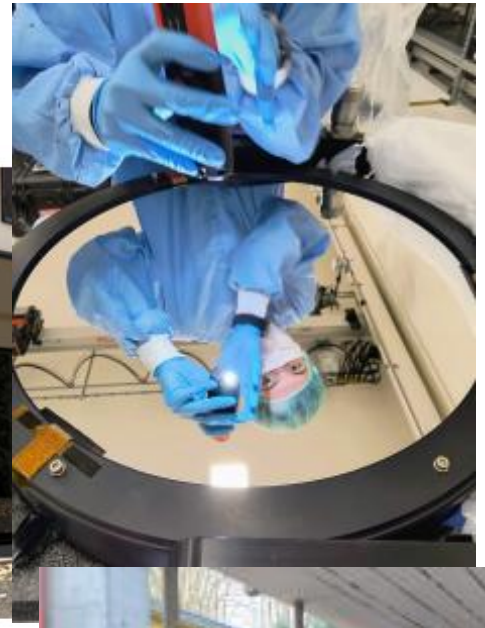
Main lab features:

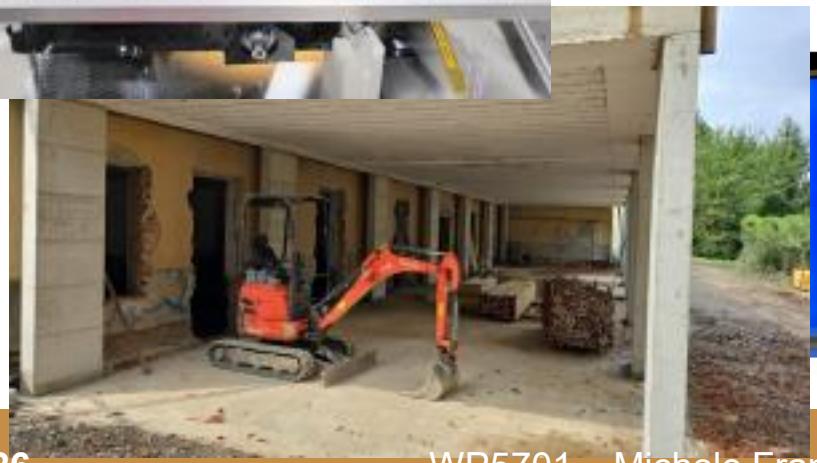
- Stable holo set-up in clean room based on 3W laser;
- Hosted in brand new laboratory;
- One of the largest holo facilitity in the world.

Main activity/product:

- Suitale for VPHG up to 450 mm in diameter;
- Custom grating for VLT and ELT spectrographs and more;
- Work as a company, or key partecipation to small/big projects.






Main activity/product:

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Ready in April
…stay tuned!

5 axis CNC machine – 5602

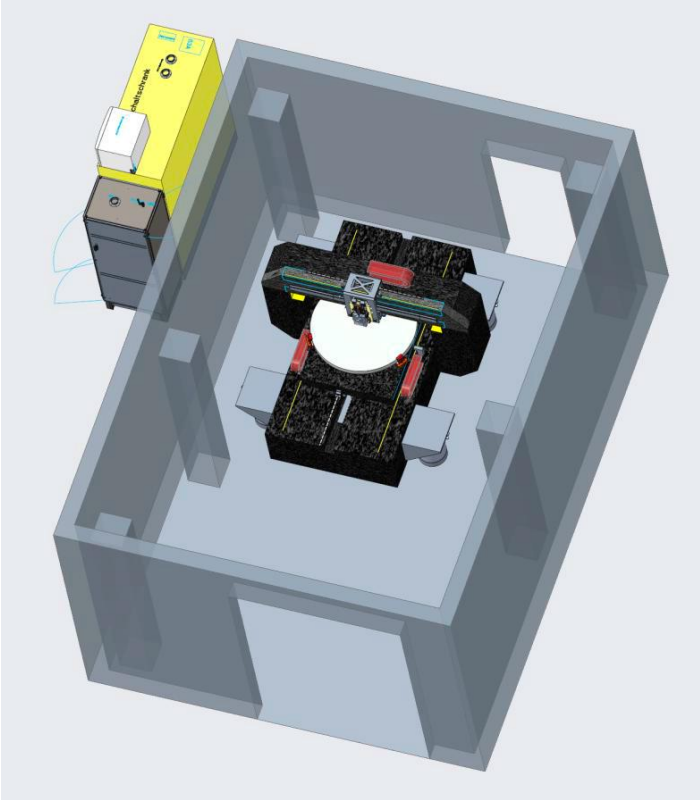
Main lab features:

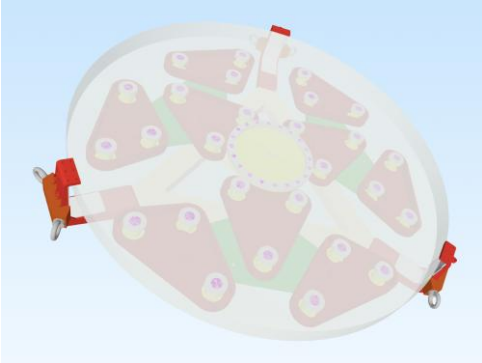
- **ULTRASONIC-hard-machining of Brittle Materials and milling on one machine**
- Strong speedMASTER®-Spindle with 20.000 rpm
- Large door opening of 1,310 and unique access to the working area.
- Range: X=735 mm Y=650 mm Z=560 mm
- Max load: 600 kg
- Direct Drive table (C axis) for continuous machining

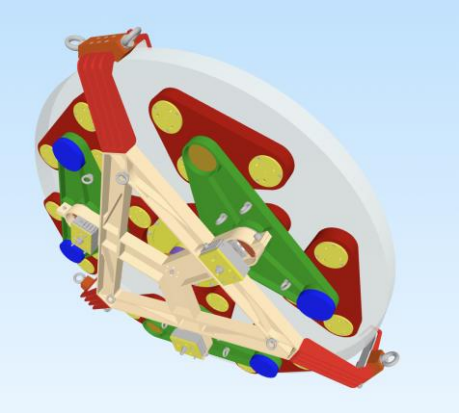
Main activity/product:

- Replacement of old CNC machine;
- Subitale for mirror manufacturing up to 800 mm in diameter;
- Multipurpose for several project and prototypes.

Profilometer – 6703







Main lab features:

- Measurement volume: X=1200 mm Y=1200 mm, Z=60 mm
- Max load: 400 kg
- Maximum mirror slope 20°
- Suitable for integrated mirror measurement (distance 300-400 mm)
- Accuracy <10 nm rms

Main activity/product:

- Subitale for Morfeo mirrors
- Large normal incidence mirror/mandrel
- Segmented X-ray optics, including mandrels pseudocylindrical configuration.

Optomechanical metrology - 5603

Main facility goal: expanding our capabilities in the field of optical metrology for alignment.

New equiments:

- Alignment system – Optical Perspectives Group based on:
- Point Source Microscope and an axicon grating;
- Laser Tracker – Leica AT930 SA
- Articulated Arm CMM – Quantum S MAX 2.5m with 8 axis
- Laser Line System – Attocube, 12 channels with PLC interface
- Software for data processing – Spatial Analyzer
- Built a custom Twyman-Green interferometer based on 4DTechnology camera;
- Built an optical test setup, with collimated beam, 400 mm diameter using SH WFS – Optocraft, 131x131 subapertures;
- Alignment telescope – Moller-Wedel AKRV 300/65/25 CCD.

Optomechanical metrology - 5603

Target projects (ground based spectrographs). Accurate mechanical aligment to minimize the optical part and reduce the degree of freedom.

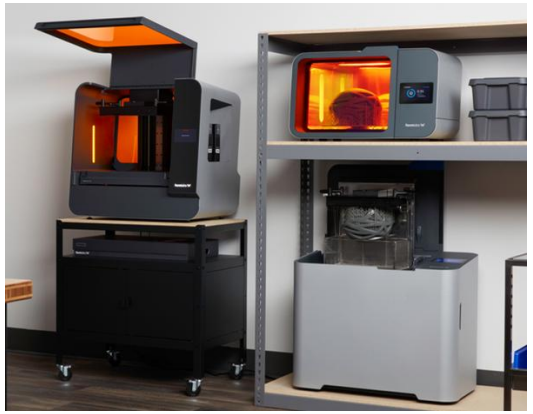
CUBES: Cassegrain U-Band Efficient Spectrograph
MORFEO: Multi-conjugate adaptive Optics Relay For ELT Observation
ANDES: ArmazoNes high Dispersion Echelle Spectrograph

New equipments – 5601

PROTOTYPING FACILITY

Three 3D printers, 2 technologies:
- FDM (Fused Deposition Modeling)
- SLA (Stereo Lithography Apparatus):

- Stratasys F370CR printer, a FDM printer, with high precision and resolution and low customization guarantee reliable results.
- Ultimaker S7-Pro printer, still a FDM printer, with a comparable printing volume (330 x 240 x 300 mm). Quick forfirst attempt prototypes with a satisfactory resolution.
- Formlabs Form 3L, a SLA printer, with a printing volume of 335 x 200 x 320 mm. Different tech, and the dedicated washing & post-curing cycle, alternative to the Stratasys to produces finalized pieces with an excellent surface finish.



METROLOGY FACILITY

The main metrology tools available at the laboratory are:

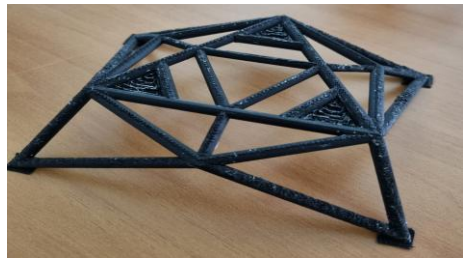
- Leica Absolute Tracker AT-500 + B-Probe Plus.
- Hexagon Absolute Arm 8320 + RS5 Laser Scanner.

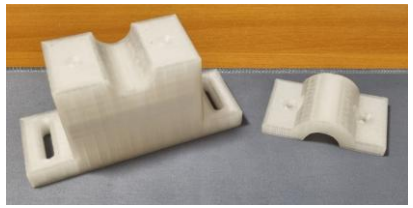
These tools (in the right image) will be used to support the metrology activities related to the test of combination of the mechanical mounting combined with the optics.

Projects and first results – 5601

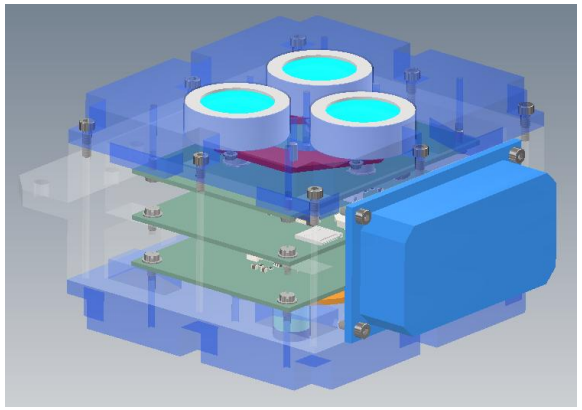
MORFEO:

- Prototypes of the opto-mechanical mountings (1:20), using the two different technologies.
- Mechanical shaft support for some electronic test.



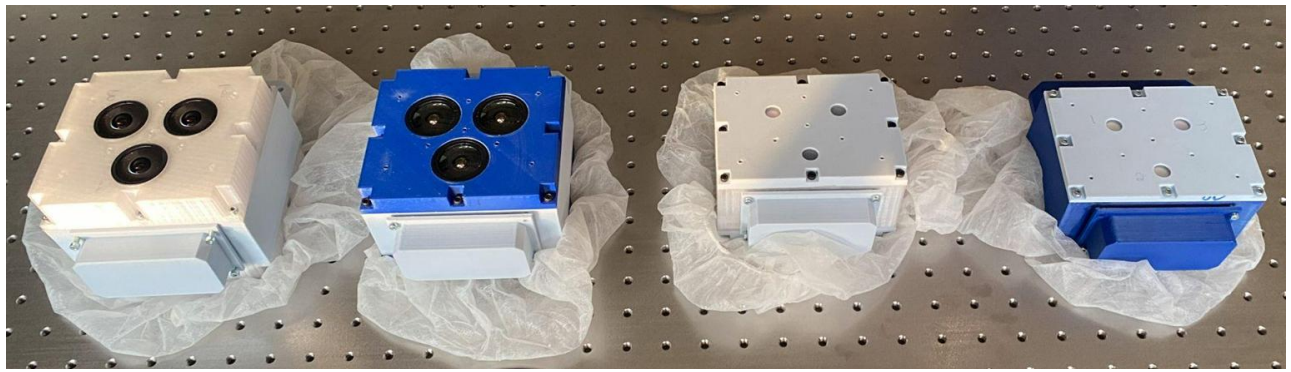


MUAM (Moon UV Albedo Measurement): Project proposal (PNRR Earth - Moon - Mars (**EMM**) for a lunar albedometer.
Four prototypes (for different optical elements) have been designed and "machined" using one of the new printing machine.



Other projects of future interest:

- Rapid prototyping is an additional source of collaboration with the **University** (research activities, training undegraduated students).
- Additive manufacturing well integrated in all **INAF (or not INAF) projects** for rapid prototyping validation of design choices according to the various design features.



Gravitational, dynamical and earthquake characterization in Merate- 6701

What we want to do

- Characterization of the dynamic behaviour of mechanical and optomechanical systems
- 'Close the loop' with the FEM for mass optimization and instrument robustness
- Transportation and earthquake survivability and alignment tests

What we have

- Shaker HBK V850-440 SPAK16 (max 11.5kN (~95g) sine, 13.3kN (~50g) random, 22.2kN shock)
- Strain Gauge system 16 channels both in air and cryo-vacuum
- Impulse hammer for modal characterization (2.2kN and 22kN + 4x triaxial accelerometers)
- 4x environmental recorders
- Test stand for stress-strain characterization (up to 1kN)

Who can do it: Simone Doniselli simone.doniselli@inaf.it

Vacuum and cryogenic characterization in Merate- 6701

What we want to do

- Characterization of VPHG in cryogenic environment
- Cryogenic and cryo-mechanical performance characterization of innovative 3D printed materials
- Manufacturing and procedures characterization for long term stability of optical elements/systems
- Alignment of cryogenic instruments

What we have

- Custom Vacuum vessel with internal volume of 1430 mm (diameter) and 700mm (height)
- 2X Cryogenic cold heads down to 5-7K
- Cryogenic strain gauges
- 2x NIR technical cameras to be adapted for vacuum compatibility
- Lakeshore controllers with 28 inputs and 4 output for precise temperature control
- Residual gas analyzer

Who can do it: Matteo Aliverti matteo.aliverti@inaf.it

Dynamic Testing Facility

Electrodynamic shaker

TIRA TV56280 / LS-340

- Frequency range: 2–3000 Hz
- Max sinusoidal force: 8000 N
- Max random force: 7200 N

Compact acoustic excitation system

- Broadband acoustic excitation (white/pink noise)
- Portable high-power acoustic source
- Localized excitation of test structures
- Operates without a dedicated acoustic chamber

METALab
Mechanical and Environmental Testing for Astrophysics Laboratory

WP 6702

Measurement systems

Laser vibrometry systems – POLYTEC

- Scanning Laser Doppler Vibrometer – **PSV Qtec**
- Single-point Laser Doppler Vibrometer – **VibroFlex** Connect + **VibroFlex Neo**

Additional instrumentation

- Miniaturized tri-axial and uni-axial accelerometers
- **Modal hammer** for experimental modal analysis
- **Vibration Research** measurement and control

How we use these equipments

Projects

- Support to ground-based instrumentation development within STILES
- Contribution to the development for ANDES

METALab
Mechanical and Environmental Testing for Astrophysics Laboratory

WP 6702

Synergies within INAF laboratories

- Integration with other STILES facilities (WP6701)
- Complementary measurements with optical and cryogenic testing infrastructures
- Support to instrumentation development at INAF observatories

External collaborations

- Potential measurement services for industry
- Interest from Vacuum FAB (https://www.vacuumfab.com/)

Conclusions

- Improved capabilities for prototyping (3D), complex mechanical components and even glass based items;
- Becoming one of the reference point for VPHG manufacturing worldwide;
- Distributed optomech alignment tools mainly for ground based instrumentation;
- Complete mechanical testing (vibrations, modes) for diverse structures;
- **Crucial to develop a "sustainable" strategy:**
  - Ground based and space project stronger roles;
  - Industrial collaboration in and out astronomical enclosure.

Thanks (and more details!) to…

- *Vincenzo De Caprio, Vincenzo Cianniello, Mina Sibalic (OACN, 5601);*
- *Stefano Basso (OAB, 5602);*
- *Giorgio Pariani, Luca Oggioni, Edoardo Redaelli (OAB, 5603);*
- *Michele Frangiamore (OAB, 5701);*
- *Matteo Aliverti, Simone Doniselli, Marco Riva (OAB, 6701);*
- *Alfonso Collura, Fabio D'Anca (OAPa, 6702);*
- *Marta Civitani, Marco Riva (OAB, 6703).*