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Additive Manufacturing, Reverse Engineering and Metrology to support mechanical design: new post-PNRR scenario among the INAF facilities

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INTRODUCTION

In the framework of **Next Generation EU funds** with the **National Recovery and Resilience Plan** (PNRR), Project IR0000034 - **"STILES - Strengthening the Italian Leadership in ELT and SKA"** and as a natural evolution of the **INAF Minigrant project** on the "Integrated approach to the mechanical design for Astronomical Instrumentation", was funded an advanced mechanical engineering laboratory inside the **INAF - Observatory of Naples**.

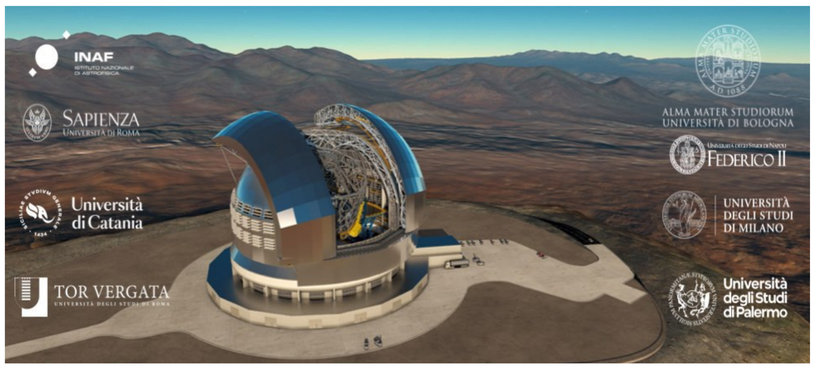


Fig. 1 STILES - PNRR Project.

This facility represents a leap forward in technological research applied to design and development of Ground-based Telescope Instrumentation for the INAF researchers. The role of the new laboratory for mechanical engineering is essentially to support the advanced design, prototype with different **Additive Manufacturing** 3D printers, maintain state-of-the-art for astronomical instruments / equipment and revamp & retrofit the existent facilities utilizing also the **Reverse Engineering** approach. The real innovation of this laboratory is represented by the technologies and techniques that will be implemented inside it. Another focus is on **Metrology** applied to characterize, control and accept the mechanical items designed validated by FEA approach. The synergy between these disciplines promises to improve the scientific collaboration and the technological expertise for the INAF group of Naples's researchers involved in these activities.

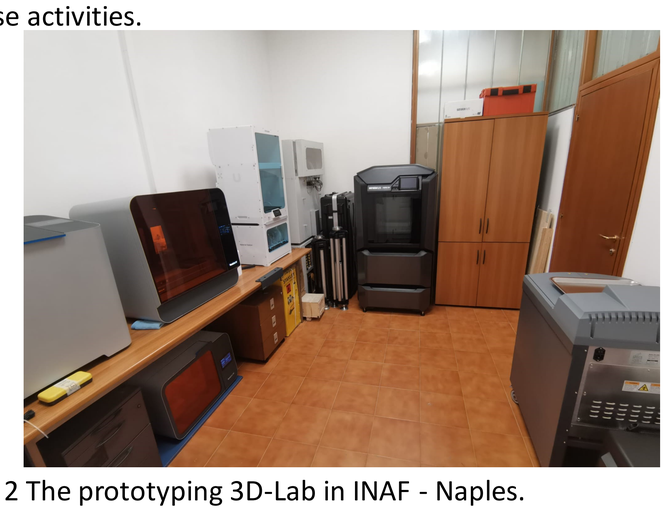


Fig. 2 The prototyping 3D-Lab in INAF - Naples.

INVOLVED PROJECTS

Several project are already benefitting of the laboratory, since some activities in the production of opto-mechanics was made as soon as the facility was set up. The prototyping activities have seen the printing and testing of mechanical supports in PLA and ABS materials for the MORFEO (Multi-conjugate adaptive Optics Relay For ELT Observation) and the MUAM in the framework of EMM (Earth-Moon-Mars) PNRR project.

PROTOTYPING FACILITY

The **prototyping facility** is made of three 3d printers covering 2 different technologies FDM (Fused Deposition Modeling) and SLA (Stereo Lithography Apparatus):

- The **Stratasys F370CR** printer, a FDM printer, with a 355 x 254 x 355 mm printing volume. It is characterized by a high precision and resolution and the low customization guarantee reliable results.
- The **Ultimaker S7-Pro** printer, still a FDM printer, with a comparable printing volume (330 x 240 x 300 mm). Is the quicker and most customizable printer, helping in making the first attempt prototypes with a satisfactory resolution.
- The **Formlabs Form 3L**, a SLA printer, with a printing volume of 335 x 200 x 320 mm. Thanks to a different technologies and the dedicated washing & post-curing cycle, was brought as alternative to the Stratasys to produces finalized pieces with an excellent surface finish.

Fig. 3 From left to left to right: Stratasys F370CR and Ultimaker S7-Pro connected to mobile workstation.

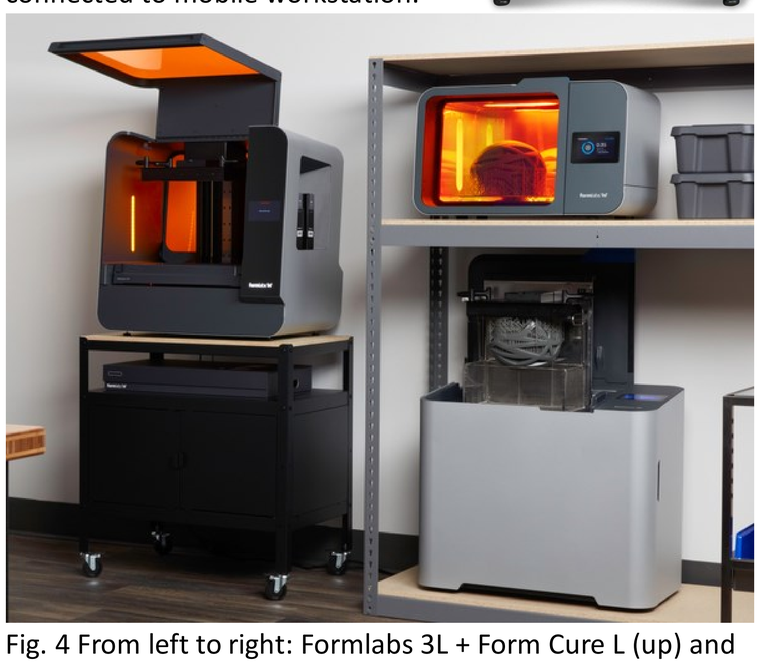
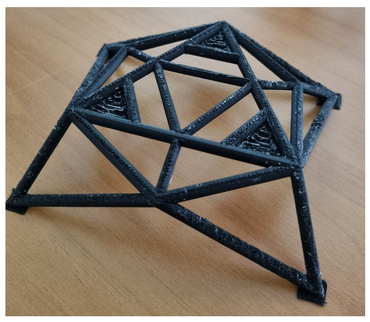


Fig. 4 From left to right: Formlabs 3L + Form Cure L (up) and Form Wash L (down).

The first **prototyping activities** have regarded the conversion of the CAD models in printable objects, with a deep focus on the defeaturing and the conversion of the design in order to fit the features and characteristics of these technologies. As interesting result for the first attempt printings, it was seen that for the typical opto-mechanics shapes (tubes and solids), different materials and technologies are needed.

- ✓ Truss structures, as the MORFEO opto-mechanical mountings, were produced in scale 1:20, with all the technologies and the materials available. The FDM models, due to the thickness and the shape of the truss, suffered of the resolution limits due to the printing filaments width, while the prototypes made by the SLA printer gave promising results with the right defeaturing.
- ✓ Solid structures, like the MUAM cylindrical coils, were successful prototyped with the FDM, showing the best results with the PLA material.



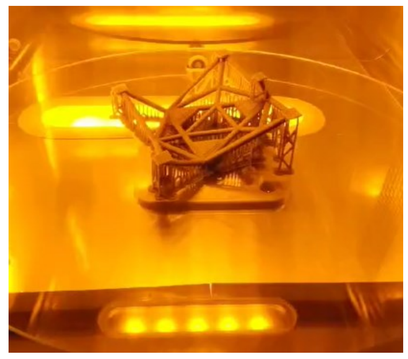


Fig.5 Prototypes examples: FDM (left) post-curing SLA (right).

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 next image) will be used to support the metrology activities related to the test of combination of the mechanical mounting combined with the optics.

Fig.6 Metrology facilities.

CONCLUSIONS

In a few weeks of work, the facility has already demonstrated its capacity to give fast and effective results supporting the improving technological needs of the INAF observatories. The first results have shown that the production and implementation of manufacts shall be made in house in the future, allowing a huge degree of freedom in the mechanical mounting development.

AKNOWLEDGEMENTS

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