Annual report

Name and surname: Chiara Scandaglia
Cycle and a.a.: XL cycle – 2024/2025
Supervisor: Runa Briguglio, Marco Xompero

- ## Research activity carried out during the year

The current main task of my PhD project is to develop a parametric integrated model of an active optics system for space applications, namely a telescope equipped with a segmented deformable primary mirror and a relative contactless actuator array, and to simulate the effects of the orbital environment on its optical performances. The model is meant to take into account several parameters with the aim to set trade-offs at the system level, such as number, geometry and arrangement of segments, number of actuators, orbital parameters. The simulator will compute the deformations and displacements of the support (reference body) due to the thermal loads, the propagation of the disturbance to the optical surface and the wavefront correction to deliver through the deformable mirror (DM) at the focal plane level, to estimate the final performance.

My work focuses in particular on the thermo-mechanical component of the simulator, from the definition of the telescope opto-mechanical model, comprehensive of the mirror and its reference body with their geometrical and physical parameters, to the determination of the orbital thermal loads acting on the system, up to the actual thermo-structural analysis for the deformation calculations. The resulting maps of the deformed optical surface and the in-plane displacements will then be passed to a code for the computation of the DM correction loop. The goal is to have a simulation pipeline which is as automatized as possible, so that the environmental condition and mirror configuration parameters can be autonomously switched in background and the analysis re-run.

I devoted the first part of my first year of PhD studies to an extensive literature research, which allowed me to understand the features of the contactless active mirror technology and the science-driven requirements it is expected to fulfil. I then began to design the simulation pipeline for the integrated model, which, starting from the parametric CAD model of the mirror and its reference body, synergistically leverages Ansys Thermal Desktop and Ansys Workbench software respectively to determine the thermal loads in orbit and calculate the temperatures reached by the components, and to perform the actual structural analysis of the system once the temperature distribution maps have been received as input. Subsequently I carried out some preliminary runs on a test model to verify the robustness of the approach and, having proved its success, I started to develop the Python architecture with the aim of automating the process of exchanging the information between multiple software and converting the resulting deformations into wavefront maps that could be processed by the DM correction code. I thus proceeded to build a parametric test model of the reference body on Autodesk Inventor to study how to automatically incorporate the parameter variation in the analysis settings and seamlessly update the simulation.

In addition, I've been collaborating on several laboratory activities currently being carried out on the deformable mirror segment prototype for space telescopes LATT, equipped with a contactless voice-coil actuator system. Thermal tests in vacuum chamber are in progress to verify that mirror corrections can be executed with zero fitting error, being the deformations on the shell due to incorrect actuator commands caused by the thermal deformations of the reference body.

The next steps include the finalization of the opto-mechanical model and the Python automation architecture. An extensive simulation phase on the actual model and relative result evaluation will follow, carried out in parallel with the laboratory tasks. The overall activity will be part of and coordinated with the ULAOPS research project, funded in Q4 by ASI.

A period of study and research abroad during the second year is also foreseen, but not yet defined. The ESA OSIP program is one of the proposed options.

- ## List of attended courses and passed exams

1. Fundamentals of system engineering and project management for large scientific projects – **Passed**
2. Adaptive Optics for Astronomy I – **Passed**
3. Adaptive Optics for Astronomy II – **Attended**
4. Methodologies and techniques for the analysis of experimental data – **Attended**
5. Coupled electrical-thermal-structural Finite Element Analyses – **Passed**
6. Random Excitation and response of structures – **Ongoing**

Total credits: 12 (>10 required credits)

- ## List of attended conferences, workshops and schools, with mention of the presented talks

TECH-FPA PhD Retreat 2025 – *Laboratori Nazionali del Gran Sasso, L'Aquila*, 17–21 February 2025
Workshop on Innovative Technology for Space Optics (WITSO) 2025 – *ESA/ESTEC, Noordwijk*, 13-17 October 2025 – Abstract for poster presentation already accepted

- ## List of published papers/proceedings

None

- ## Thesis title (even temporary)

"Multi-parametric thermal-mechanical modeling and analysis of high order active mirrors for space telescopes"

Date, 20/09/2025 **Signature…**

Chiara Scardaglia

Seen, the supervisor

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