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Small Compact Optical Telescope Test in Laboratory for Astrometry Nano Glass

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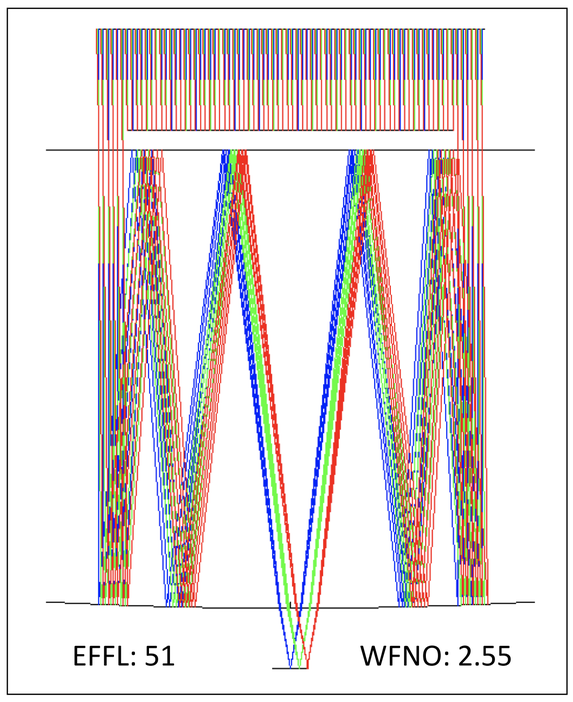
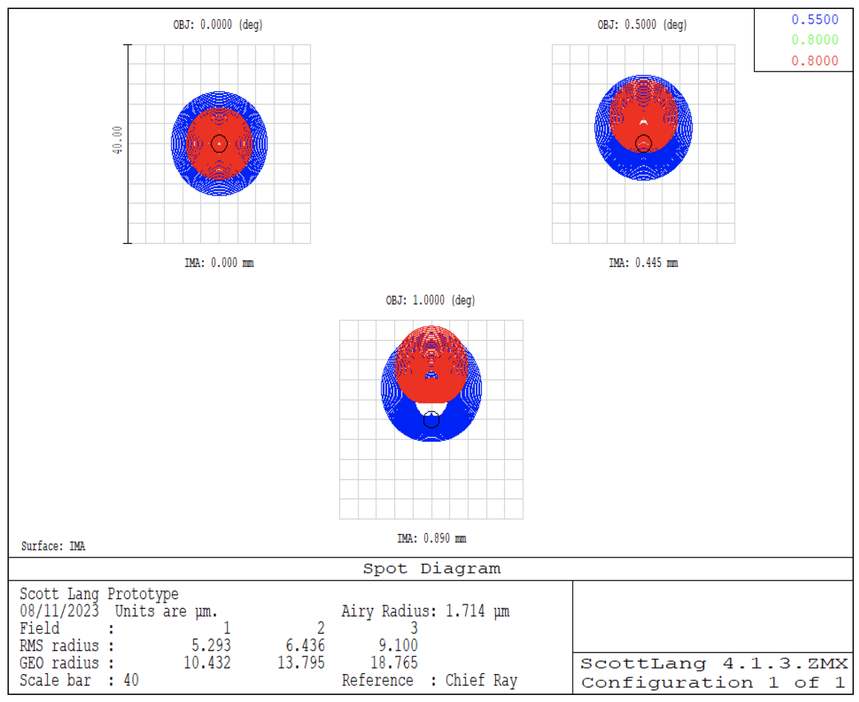
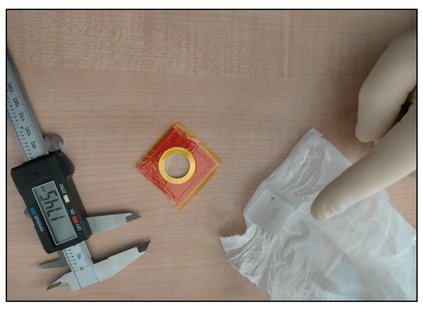
Small and compact optics are a key element for future small missions, in particular cubesat. We started the miniaturization concept study in order to adapt the idea to the small cubesat envelope; lab tests on representative units are in progress, as part of a INAF Mini Grant awarded in 2022. In particular, we aimed at simplification of the initial design, in order to cope with costs and available space. We characterize the telescope and put it into the experimental perspective of a ground based instrument, trying to identify and solve the main issues towards the subsequent spatialization.

The initial idea was to study a 1” diameter prototype and fully characterize it. We started with a design with two aspheric surfaces with a significant level of complexity of the two side of the lens. Given the improvement in free form optic materialization, we started from the EX1.3 design proposed in the 2011 paper, introducing the aspheric terms. For such configuration and all the following ones reported in the present paper, except the last one (i.e. the fourth, the one we assembled) we explored SILICA as material.



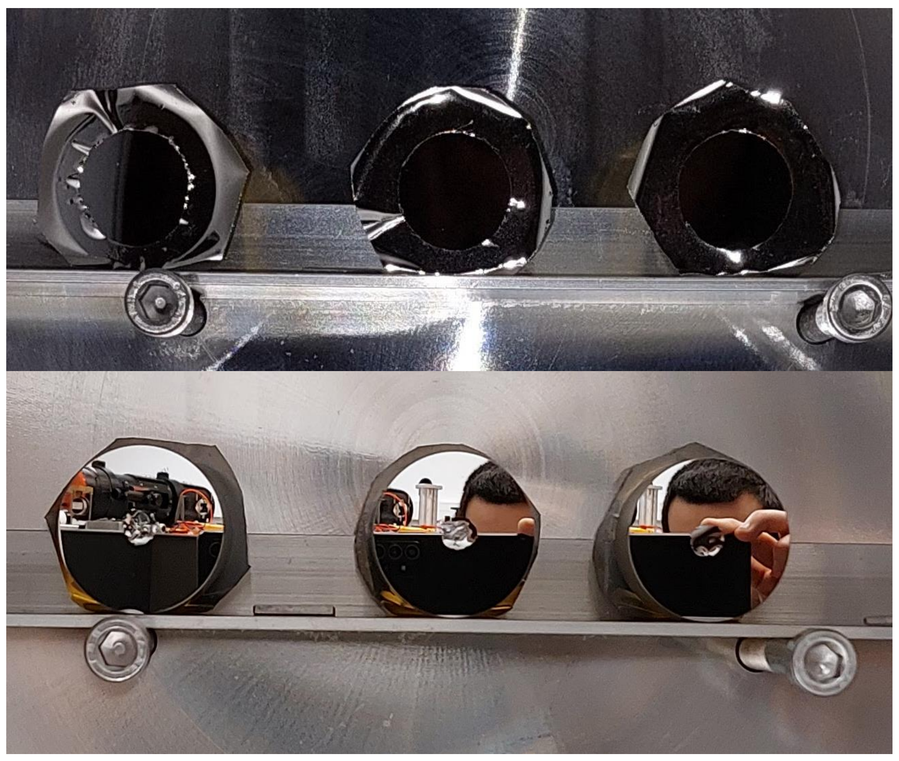


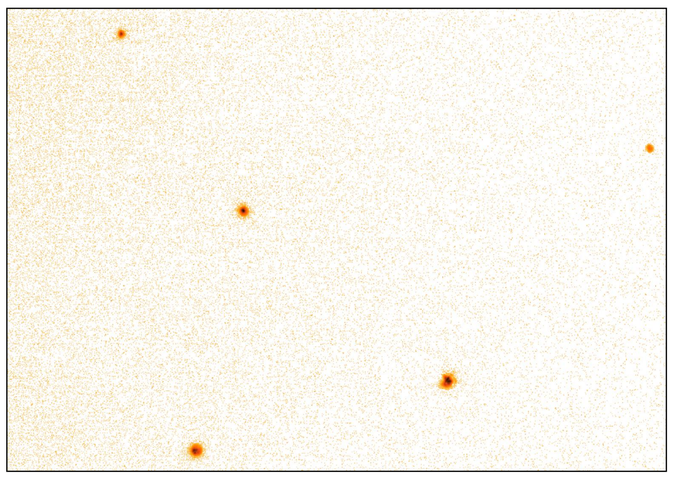


FIRST PROTOTYPE: The final design is the very basic concept of a plano convex lens in BK7. The resulting design is represented in Figures above. While still the PSF stays around 10 µm in radius, and the Airy Radius remains around 1.7 µm.

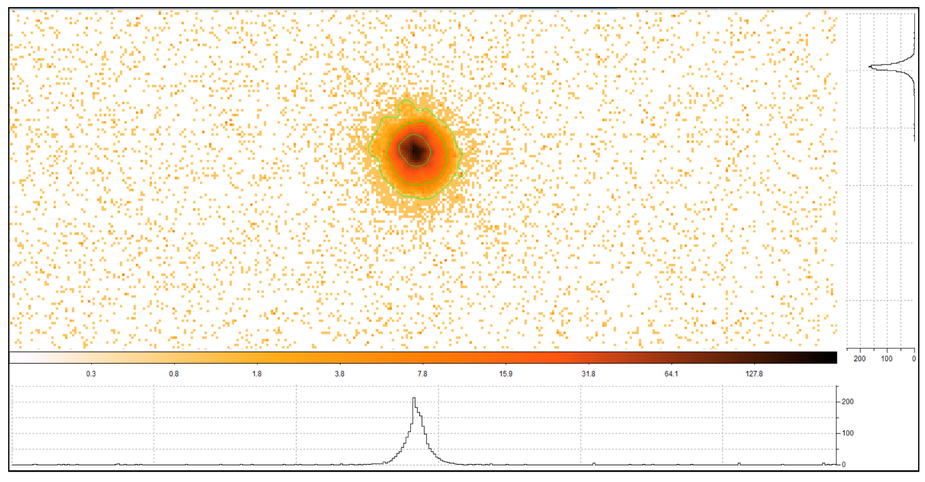
The experimentation of the initial idea (Riva, AO, 2011) was stuck due to the lack of funds. The format of a small funding for prototypes is very important for such fundamental projects. The outcome of Mini Grant is the first materialization of the original idea and its tailoring for small-satellites. Thanks to this funding we were able to establish a fruitful collaboration with Italian and Dutch companies for the future developments and application for innovative instrumentation. We strongly encourage the prosecution of such funding scheme for basic ideas development.

COATING: For the entrance surface we need an outer annular transmissive ring, and the inner part must be reflective, while for the exit surface we need an inner transmissive small disc, whereas the outer part of the surface must be reflective. In order to do that, as first approach, we manage to apply dedicated profiles made in Kapton, protecting the surface from aluminum deposition. We manually produced the two masks and aligned it using the edge of the lens as mechanical reference.





RESULTS: we used an EO-5012M CMOS camera (pix size: 2.2 x 2.2 µm; 2560x1920 pix). Left panel shows a laboratory stellar field in white light of 5° x 5°. Right panel shows a single source with horizontal and vertical graphs. FWHM is around 6 x 6 pixels, in good agreement with the design.



CONCLUSIONS: The first laboratory experiment with the prototype of Solid Telescope appears to be robust and coherent with the simulations. The main issue we found is related to the artisanal production of the Kapton masks used in the aluminization procedure. Another improvement will come from the usage of aspherical terms at least in one of the surfaces. Other issues that will be studied are the straylight produced by the mask and the field stop for external soruces.

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References: Riva, A., Applied Optics, 2011
Riva, A., et al., SPIE Proceedings, 2024

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