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Advancing towards a swift, deterministic, and reliable process for high-resolution thin monolithic x-ray mirror shells

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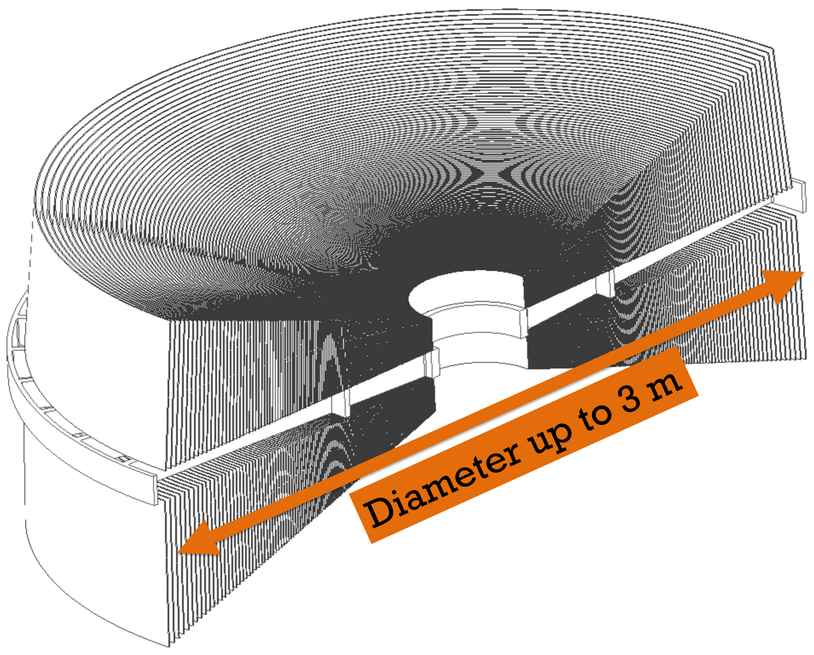
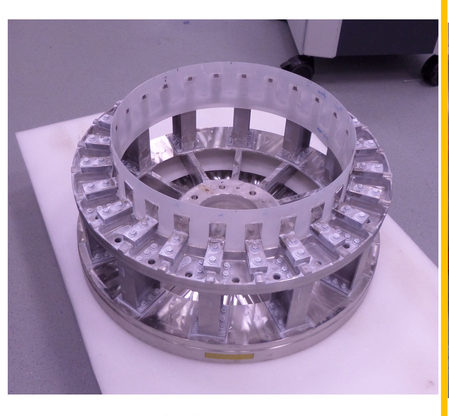
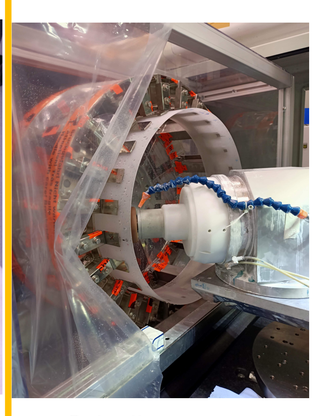
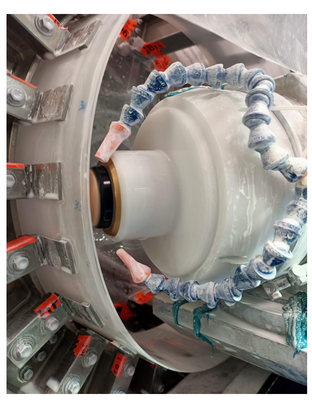


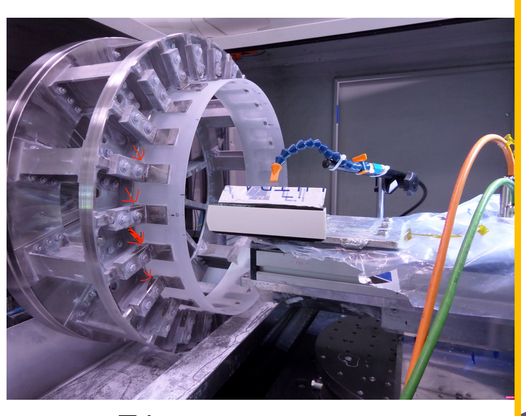
The traditional approach for creating very large X-ray mirror modules (with diameters exceeding 1 meter) involves dividing the optics into azimuthal and radial modules, similar to the Silicon Pore Optics used in Athena. While this method addresses the initial challenges of procuring and handling very large substrates, it introduces complexities in the later stages, particularly when thousands of segments must be assembled without compromising their optical performance. In contrast, a simpler design for large mirror modules could involve fewer than a few hundred thin monolithic shells (2-4 mm for mirror shells ranging from 0.4 to 3 meters in diameter). This configuration offers the dual benefits of design simplicity and high-resolution capability, achieved through direct polishing. Additionally, it significantly reduces the polishing time.
In Italy, a technology development roadmap for this approach is being funded by ASI and led by INAF-OABrera.

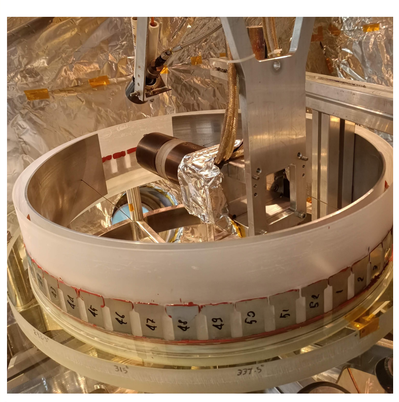

Raw shell


Shell Support System (S3)


Grinding


Bonnet


Trizact

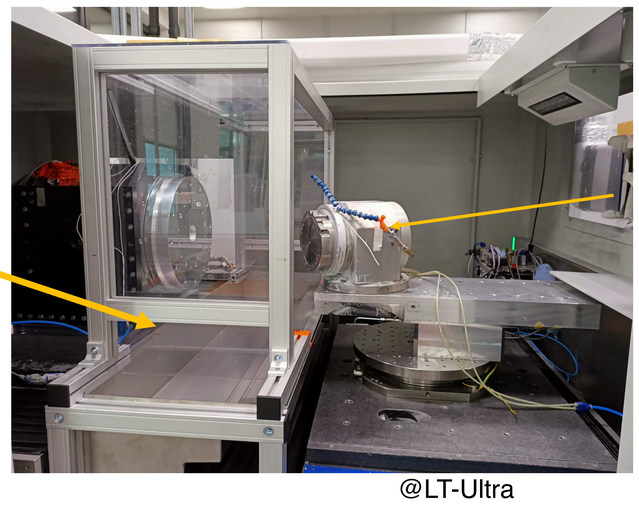

Ion Beam Figuring

On Adapted Diamond Turning lathe @LT-Ultra (Germany)

RAW Mirror shell Manufacturing DMG Mori @Officina Stellare

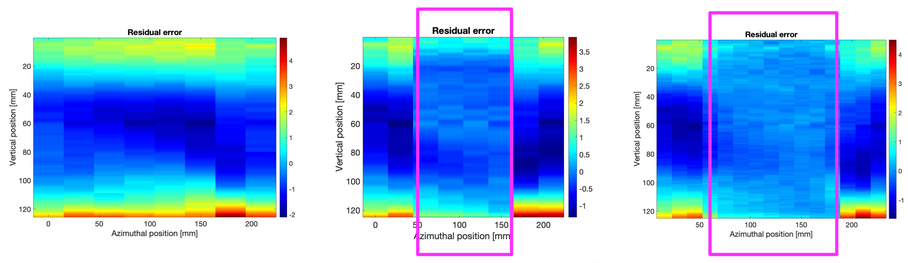

First small scale prototype realized


New Raw shell 500 mm diameter during manufacturing



@LT-Ultra (Germany)

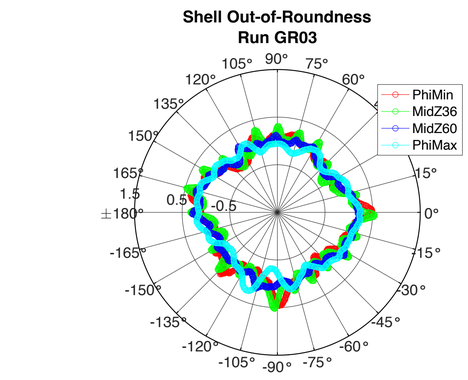
Ion Beam figuring correction @INAF-OABrera

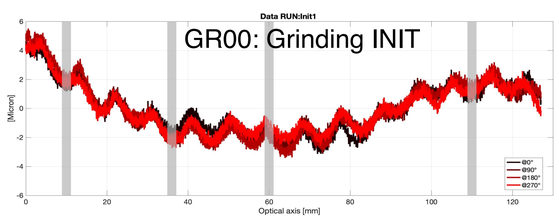


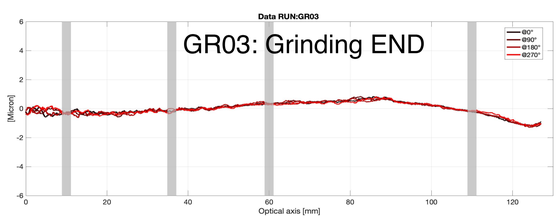
T_max = 180°
Duration = 9.5 hours
1200 nm RMS –> 300 nm RMS

T_max = 140°
Duration = 6.5 hours
300 nm RMS –> 200 nm RMS

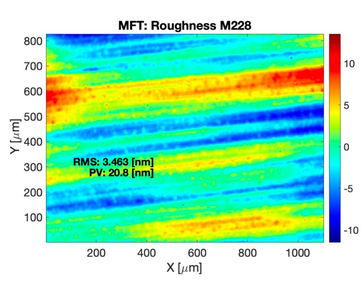
Grinding: Out of roundness correction

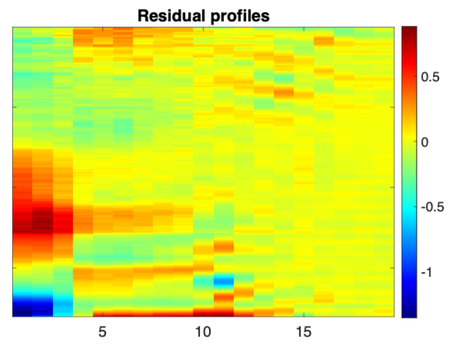




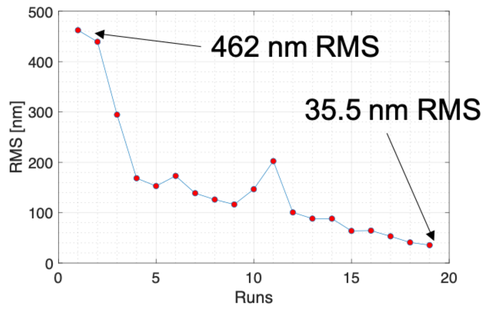


Bonnet polishing: SSD Removal + Profile correction

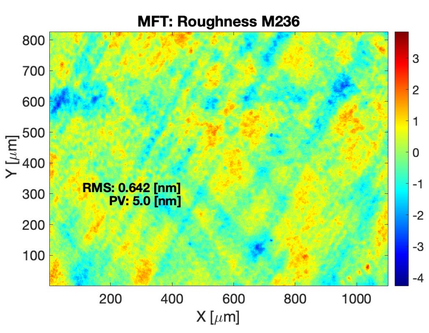




Total time:
82 hours (21 run)



Trizact High speed Pitch polishing



Before: 3.66 ± 0.26 nm (RMS)
After: 0.78 ± 0.14 nm (RMS)

In 2 Hours!

This work was supported by ASI (contract ASI-INAF 2022-31-HH-0).
The authors acknowledge LT-Ultra GmbH and Officina Stellare S.p.A for their valuable technical support.