



Interoperability Consideration Silicon mirror polishing for ETpathfinder

The ETpathfinder project is an R&D-field laboratory for the Einstein Telescope, aiming to demonstrate key-technologies for Einstein Telescope, such as ultra-low-noise laser interferometry with cryogenic silicon test masses.

Recently the first batch of super-polished silicon substrates (see detailed specifications in the in “ETpf_Specifications.pdf” and “ET-0345A-21_v3.pdf”) was obtained from Zeiss SMT. These complex substrates have 4 surfaces requiring super polishing. The obtained substrates feature flatness of better than 1nm rms (piston, tilt and curvature removed) and have been demonstrated to not show any excess surface absorption after the polishing.

The two main surfaces of the ETpathfinder mirror substrates require very accurate and strong curvatures: Each main surface requires a concave radius of curvature of 14.5m +/- 0.1m, the rear surface a convex radius of curvature of 9.0m +/- 0.1m and a horizontal wedge of 0.007deg + 0.002deg -0.0 deg between these two surfaces. The curvatures of the 4 main test masses determine the optical mode in the two Fabry Perot arm cavities of the ETpathfinder interferometer. Matching these two arm cavity modes as close as possible is essential in order to obtain perfect destructive interference at the output of the interferometer. Non-identical radii of curvature¹ will create reduced interference and hence reduced common mode noise suppression.

Hence, for reasons of interoperability, we plan to award a second contract to Zeiss SMT for polishing of additional mirror substrates for ETpathfinder, using the exact same reference spheres as were used for the first batch of mirrors and hence guaranteeing that the radii of curvatures of the existing and to be produced polished silicon substrates are compatible for installation the main ETpathfinder interferometer.

Footnotes:

¹ It should be noted that the state of the art procedure employed by LIGO and Virgo of in-situ adjustment and matching of radii of curvature of interferometer mirrors based on ring heaters is not possible in ETpathfinder. This is due to the much higher thermal conductivity of cryogenic silicon (used in ETpathfinder) compared to room-temperature fused silica (used by LIGO and Virgo).