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Sapphire-Based Suspension at ARC-ETCRYO Laboratory: Ongoing Test Campaigns

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At the ARC-ETCRYO laboratory in Rome, a full-scale (1:1) cryogenic payload is being developed to investigate conductive cooling techniques for the Einstein Telescope. Materials with outstanding mechanical and thermal specifications are required to meet both suspension and test mass substrate requirements.

Sapphire is a very promising optimal candidate at least for the suspension elements, primarily due to its excellent thermal conductivity at cryogenic temperatures (10–20 K), which facilitates effective heat extraction during cooldown and operation, and its high quality factor.
Multiple test campaigns are currently underway and continuously evolving to characterize the sapphire components considered for integration into the payload. These include:
• Sapphire Rods with Half-Cone Locking: designed to suspend the marionette to the platform;
• Sapphire Ribbon Mirror Suspension: designed to suspend the mirror from the marionette.
Mechanical characterization includes tensile strength tests, conducted at room temperature, and Q-factor measurements, conducted both ar room and cryogenic temperature. Material analysis (optical measurements, spectrometry, laser ablation) and fracture analysis on broken samples are also planned to be done-
Parallel efforts are also focused on overcoming manufacturing challenges. Producing sapphire samples both long and with relatively large cross-sections remains not-trivial, due to limitation in current fabrication processes.
These ongoing developments aim to define a scalable solution for the sapphire suspension systems, laying the groundwork for future implementation for the Einstein Telescope.

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