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ULTRA-TM: Progress towards hardware demonstrations of critical component-level technologies for ultra-stable optical systems

The NASA-funded ULTRA-TM Program enables high-contrast imaging of Exo-earths through **hardware demonstrations of key technologies** for large, picometer-stable space-based telescopes and **provides significant risk reduction** for LUVOIR/HabEx and similar mission concepts.

This work is the first step in **technology development roadmap** to mature components and sub-systems to ultimately demonstrate an ultra-stable telescope and coronagraph at TRL6.

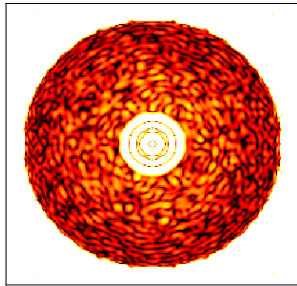
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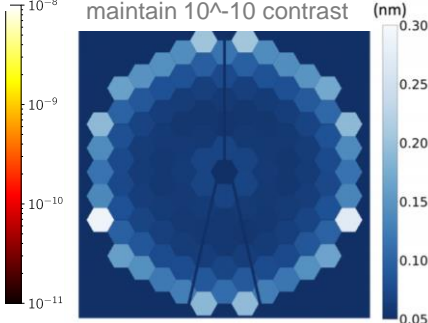


The Ball-led Industry Consortium is working to mature critical component-level technologies across the ultra-stable architecture to demonstrate performance in the picometer regime and/or with path-to-flight properties.

Contrast change from correlated segment modes

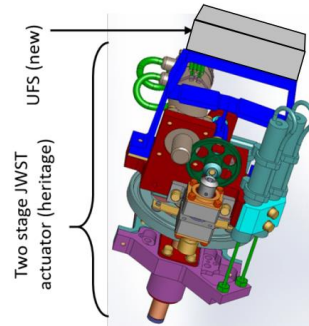


Allowable segment piston to maintain 10^{-10} contrast (nm)



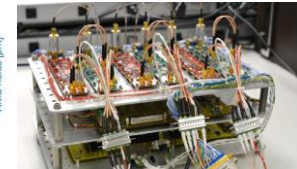
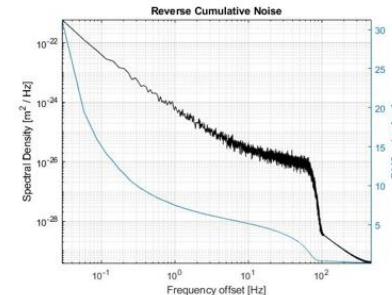
*Science-driven coronagraph simulations set the **performance requirements** for components and systems. (STScI)*

*Picometer-capable actuators and sensors build on existing hardware and will enable **active wavefront sensing and control** orders of magnitude beyond the current state of the art. (Ball)*



3-stage Actuator leverages JWST design with an added ultra-fine stage.

PSD and Reverse Cumulative Noise for the expected measurement (modeled capacitor).



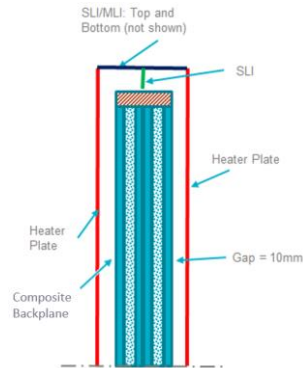
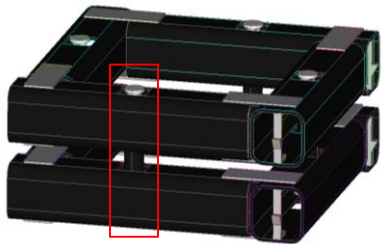
Heritage picometer-capable capacitive sensing electronics are adapted for mirror edge sensing.



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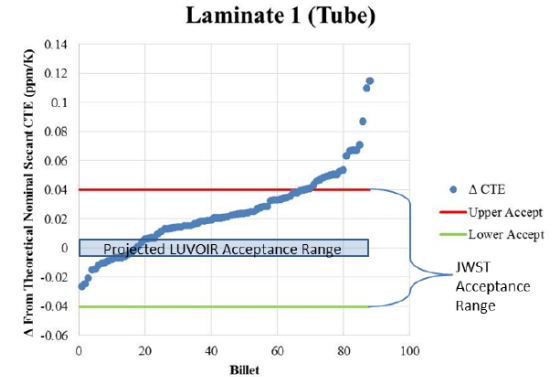
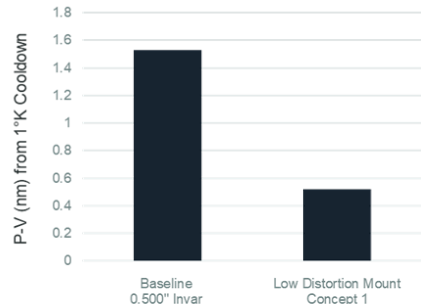
Innovative approaches to mirror mounting, structural joining and thermal control can **improve passive stability** and provide performance relief (NGSS/SAO/L3Harris)

Redesigned latch planes use low CTE materials and neutral plane interfaces to improve thermal/dynamic stability.



Radiative heating approach attenuates structure response to heater fluctuations.

Novel mount pads reduce segment figure distortion and registration of edge metrology features.



Improved metrology of component properties can reduce scrap rates and **improve cost/schedule for manufacturing** (Intuitive Machines)