



Star Trackers For Suborbital Applications STWG 2026

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Introduction

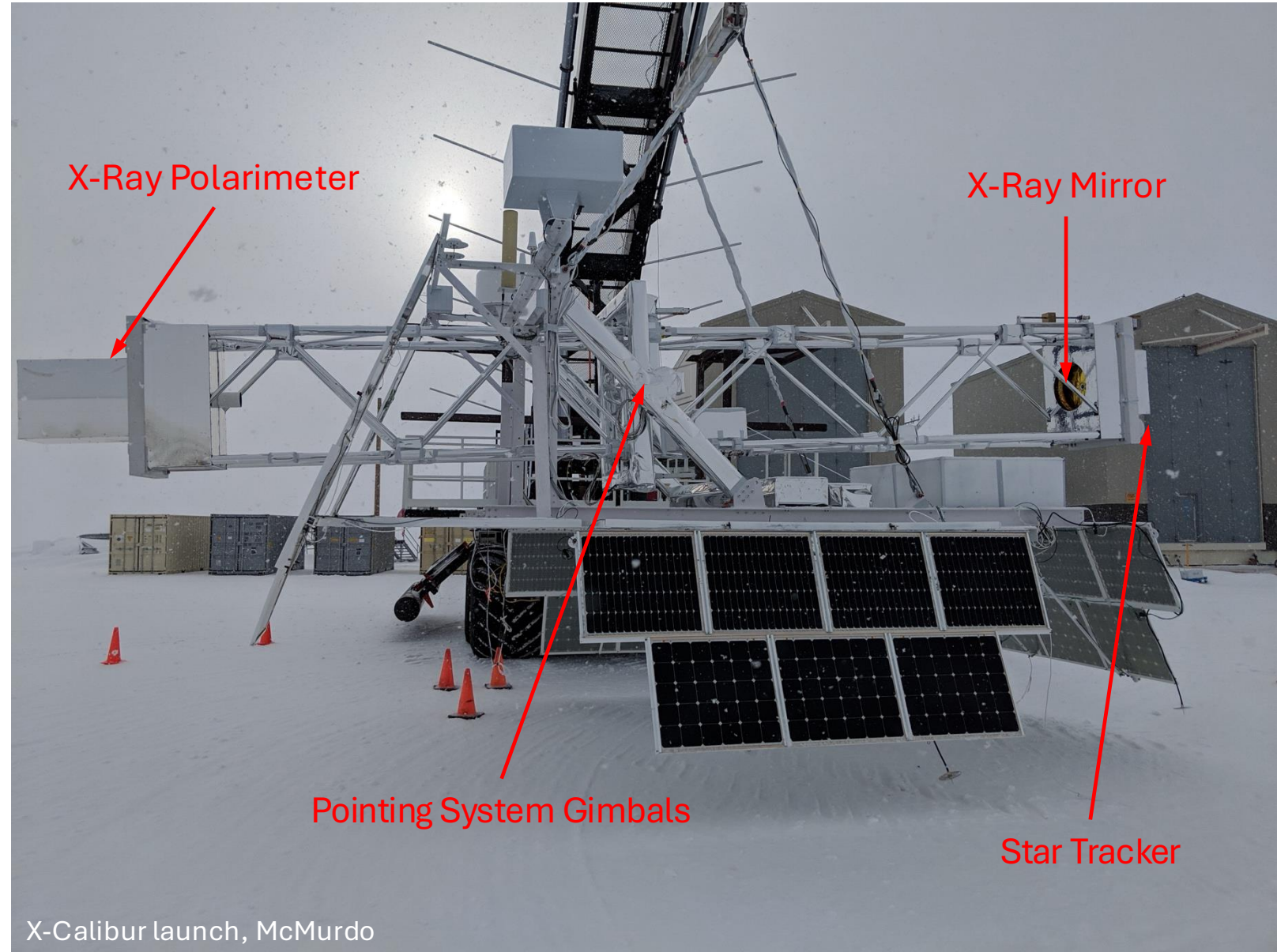
- Talk will focus on two new star tracker developments for suborbital platforms
 - Sounding rockets
 - High altitude balloons
- Covered here
 - Design of the systems
 - Test and Flight test results
 - WaIST
 - Sounding rocket star tracker
 - ST!NG
 - Balloon daytime star tracker





Balloon Platforms

- Balloons up to 40mcf
 - Payloads up to 5000 lbm
 - Altitude up to 130kft
- WASP pointing system
 - Point instruments to arcsecond level
 - Subarcsecond jitter
 - Uses a daytime star tracker developed at Wallops Flight Facility





Sounding Rocket Platforms

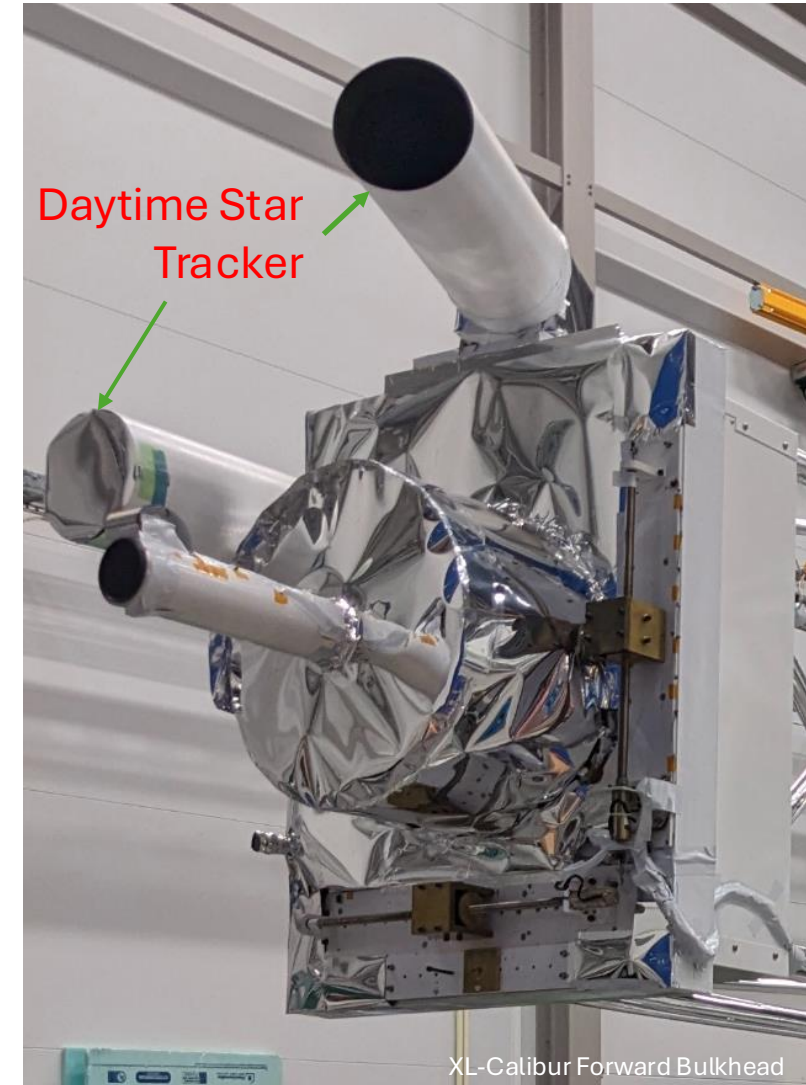
- Sounding Rockets
 - Mostly DoD surplus rocket in 2-4 stage stacks
 - Payloads up to 1500 lbm to several hundred km
 - Hang times above 100km from 5-20minutes
- Celestial Attitude Control System (CACS)
 - Subarcsecond pointing with cold gas thrusters
 - Uses a star tracker
 - UWisc ST5000 star tracker





Reason For New Developments

- Sounding Rockets
 - UWisc ST500 is obsolete. No longer supported
 - New star tracker need as a replacement
 - CACS is being updated to modernize electronics (CACS-GT)
- Balloons
 - WASP daytime star tracker is currently in use with over a number of successful flights
 - CARDS system which started with industrial cameras and separate flight processor box
 - 7 flights (2016-2025)
 - Design being updated to fix a number issues





Design Approach

- Hardware
 - COTS COTS COTS
 - Lost cost a priority
 - Rugged industrial components wherever possible
- Software
 - In-house software to keep the system nimble to meet the changing needs of customers
 - Common software shared between the two projects
 - Heavy abstraction in algorithm and interface classes in order to make system highly configurable
 - XML configuration file
 - Allows for code to load only what is needed for a given configuration



Design for Sounding Rocket CACS

- Evolution of the design
 - Started with industrial cameras (FW and USB3) and separate computer
 - Test flights in 2017 and 2019
 - COTS high speed interfaces an issue for sounding rockets
 - No room for processor in the telescope with camera and lens meant expensive interfaces at multiple bulkheads
- Current design
 - Vision components VCSB nano Z-RH 0252
 - Xilinx Zynq with dual-core ARM Cortex A9 (866 MHz) with integrated FPGA
 - Image sensor: Sony IMX 252 with remote head
 - Lens
 - Schneider Optics Tele-Xenar 70mm/F2.2 Ruggedized
 - FOV = 5.8×4.3 deg
 - Star Tracker Algorithms
 - Pyramid style Lost-In-Space
 - Nearest neighbor tracking

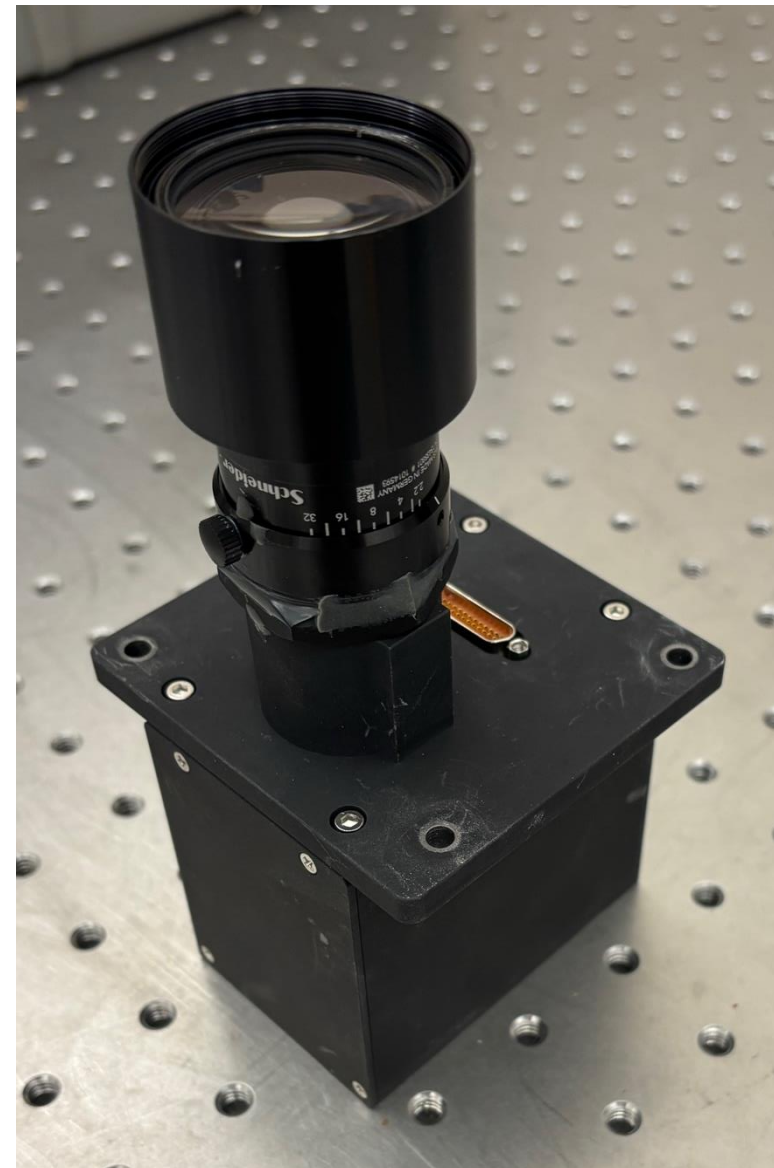


Schneider Lens



VCSBC nano Z-RH 0252

- Wallops Integrated Star Tracker
- Volume
 - 3.1" x 3.0 x 6.4"
- Mass
 - 1.06 lbm
- Power
 - Avg 4.6W
 - Peak 5W
- FOV
 - 5.0 x 3.7 deg



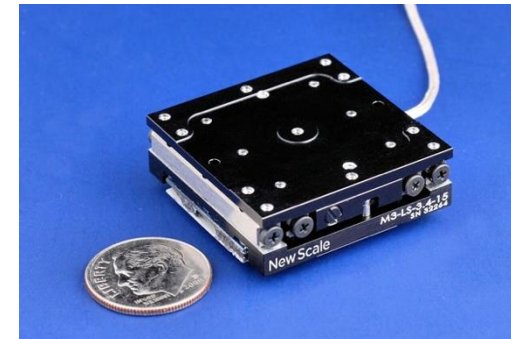


Design for WASP Daytime Star Tracker

- Evolution of the design
 - COTS high speed interfaces an issue for long runs (need head integrated with processor)
 - USB3 connection dropouts with long runs
 - Focus issues
 - Thermal shifts in lens changing focus
- New Design
 - Vision components VCSB nano Z-RH 0252
 - Xilinx Zynq with dual-core ARM Cortex A9 (866 MHz) with integrated FPGA
 - Image sensor: Sony IMX 252 with remote head
 - Lens: StingRay 100mm/F1.5 (SR4522-A01)
 - Filter: MidOpt LP465 long pass filter
 - Focus Stage: New Scale Technologies M3-LS-3.4-15, 15mm stroke with 0.5 micron resolution
 - Star Tracker Algorithms
 - Pyramid style Lost-In-Space
 - Nearest neighbor tracking



G&H StingRay Lens



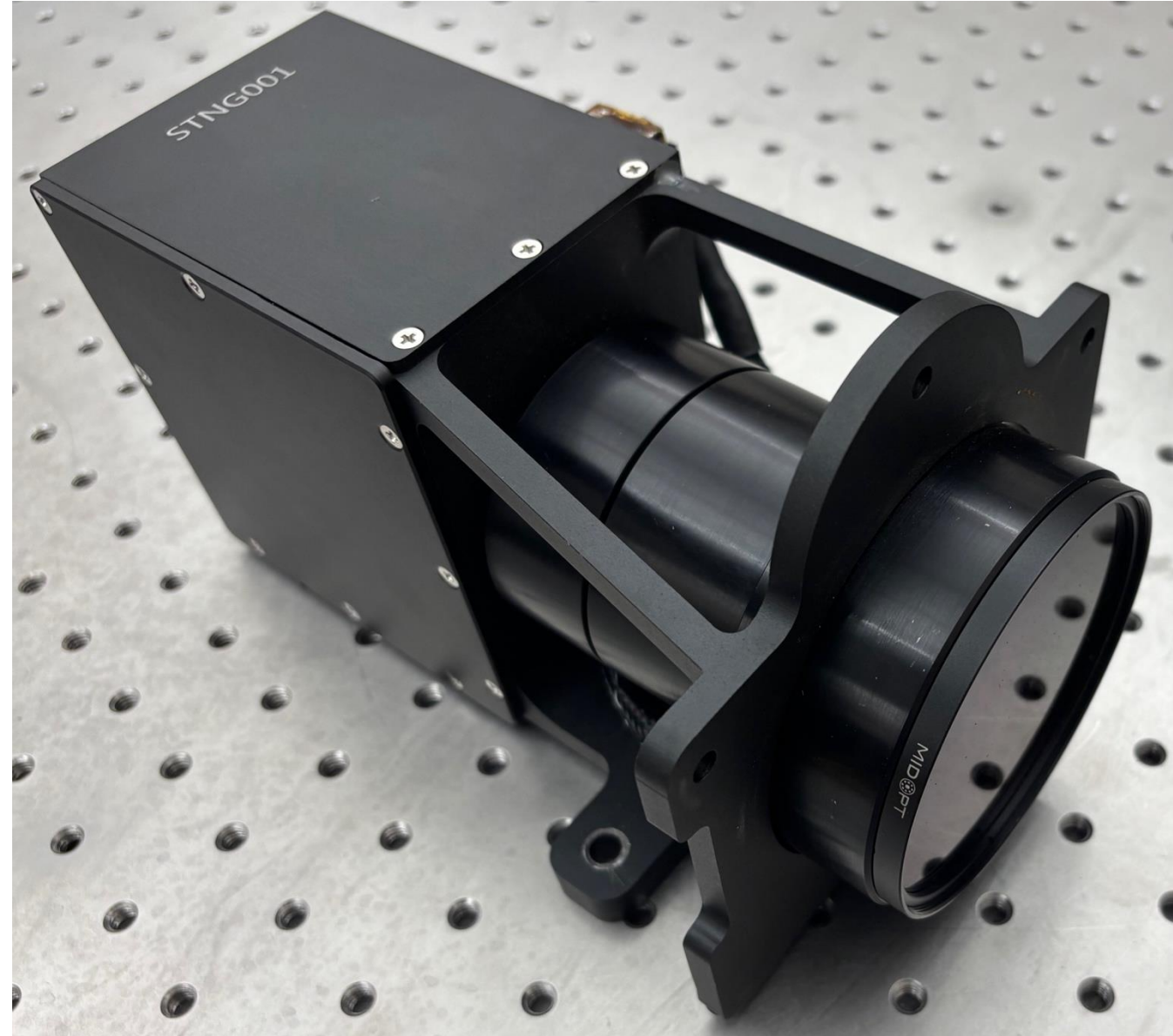
New Scale Stage



STiNG



- No acronym just STiNG
- Volume
 - 3.1" x 3.0 x 6.4"
- Mass
 - 1.06 lbm
- Power
 - Avg 4.6W
 - Peak 5W
- FOV
 - 5.0 x 3.7 deg





STiNG Testing

- Test Flight on the Picture-D mission out of Ft. Sumner, NM on October 1, 2025
- As a piggyback, could not be mounted along the boresight
 - Ended up pitched up 90deg
 - No daytime stars due to closeness to sun due time of year and daytime science calibration target
 - Able to successfully track at night once the sun set and pointing moved to science targets
- Test Flight on CORSAIR mission in Ft. Sumner this September
 - Similarly mounted 90deg pitched up relative to the boresight
 - Better conditions since CORSAIR boresight is sun pointed



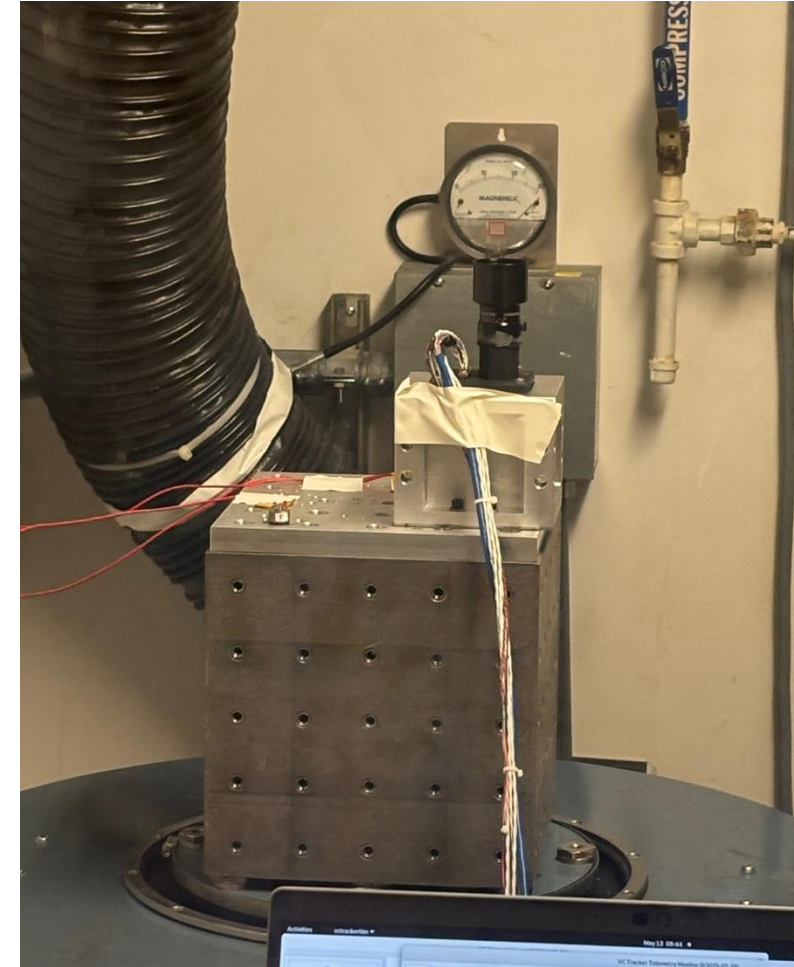
Picture-D, Ft. Sumner, NM

STiNG mounted
point to zenith



WaIST Testing

- Sounding Rocket Qual testing completed Aug 2025
 - Thermal
 - 6 Thermal cycles in air at operating temperatures (-24C to +61C)
 - 1 Thermal cycle in air at storage temperatures (-54C to +85C)
 - 1 Thermal vacuum cycle at operating temperatures
 - Vibe
 - All +/- for X,Y and Z axes to Sounding Rocket Component Qualification Levels
 - Sine, Shock and Random
 - Acceleration
 - 60g in +/- for X,Y,Z axes
- Waiting on test flights
 - Plans for rideshare on Dr. Galeazzi's LXT mission in August 2027
 - Plan for a technology flight with WaIST feeding quaternions into CACS-GT in late 2027



WaIST on Vibe Table



Future Work

- STjNG
 - Need a successful test flight during daytime before declaring flight ready
 - If CORSAIR mission is not successful, XL-Calibur 2027 in McMurdo would be next opportunity
- WaIST
 - After successful test flight, move to build 10 units for supporting future new missions and start retiring ST5000





Questions?