The CHIMP: Chip-scale Hyperspectral Imaging MISSE Payload

ISS NATIONAL LABORATORY®

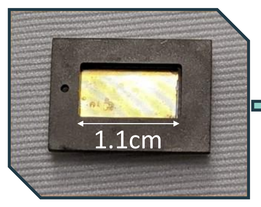
Mission objective

Monitor the calibration stability of the Nanohmics's Lambda-Cam, a novel integral field spectral imager, in space over an extended duration, then recalibrate the system post-flight to search for any calibration drift and identify any sources of degradation.

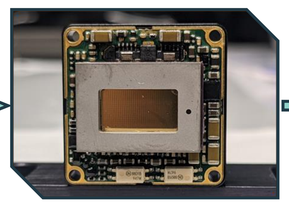
Mission timeline

- July 24, 2020, Proposal selected
- Aug 6, 2020, Authorization to proceed from ISS National Lab
- Oct 21, 2020, Official kickoff with integration team
- Mar. 21, 2021, Flight micro-optical chip completed
- Apr. 22, 2021, Camera calibration and checkout complete
- May 7, 2021, Delivered to Aegis Aerospace for integration
- July 1, 2021, NOAA imaging license issued
- Aug. 29, 2021, Launched on CRS-23
- Nov. 20, 2021, Out the airlock
- Jan 10, 2022, First light
- Jan 21, 2022, Communications lost after a solar event
- Aug 20, 2022, Splashdown on CRS-25
- Sept 9, 2022, Back to Nanohmics for post-flight inspection

The instrument



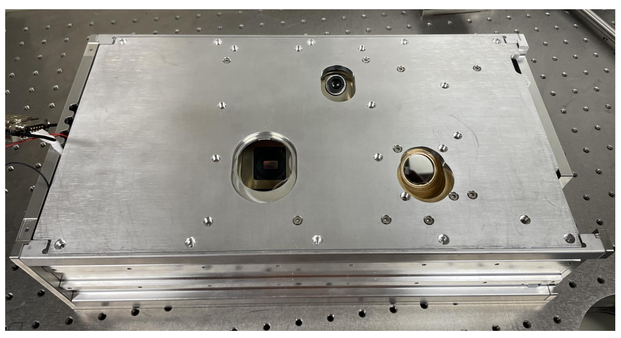
Custom spectral chip

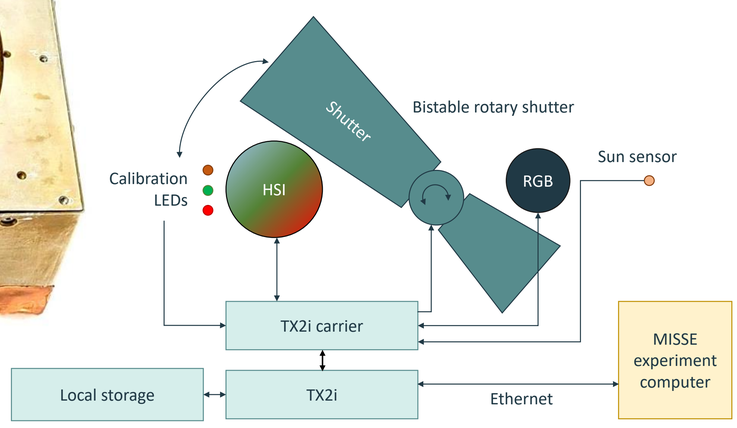

Bond to COTS camera core


Integrate with COTS optics


Installed on ISS

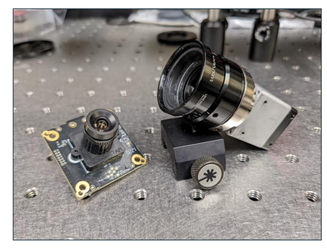
•Entire carrier cycled from -40°C to +60°C
•Entire carrier shock-vibe 4.5g RMS in all three axes





What's in the box?

- **Prototype spectral camera**
  - Nanohmics-manufactured micro-optical chip
  - Ximea MQ022MG-CM camera core
  - Schneider Kreuznach Xenon-Topaz f/2 30mm lens with fixed f/4 stop
  - USB3 data interface
- **HD context camera**
  - Modified version of a Leopard Imaging LI-IMX274-MIPI-M12
  - Sony IMX274
  - AICO ACHF1225FM lens
  - MIPI interface
- **Calibration LEDs**
  - 4 Cree xpe2 LEDs (red, green, amber, far-red)
- **Bistable rotary shutter with Lambertian coating on backside for *in situ* calibration testing**
  - Takano vacuum rotary solenoid
  - Home-made Lambertian coating, titania in low-outgassing epoxy
- **Instrument computer**
  - Nvidia TX2i (industrial temperature range)
  - CTI Spacely carrier board for TX2i
- **SSD local storage**
  - Delkin Utility+ Industrial mSATA Solid State Drive
  - Samsung microSDXC memory card
- **Sun sensor**
  - Home-built photodiode and aperture pair
- **Power conditioning and distribution electronics**
  - CUI Inc DC-DC converters, 5V and 12V
- **Communication interface to MISSE experiment computer**
  - Ethernet with hand-twisted cables, Teflon coated

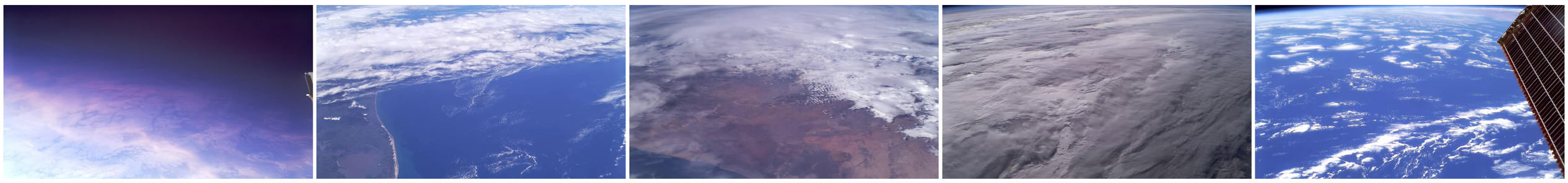


Nanohmics

is a small business located in Austin, Texas. Our 45 staff members work with customers, collaborators and partners across a wide range of industries to design and develop smart technology solutions that improve your product, technology or system performance.

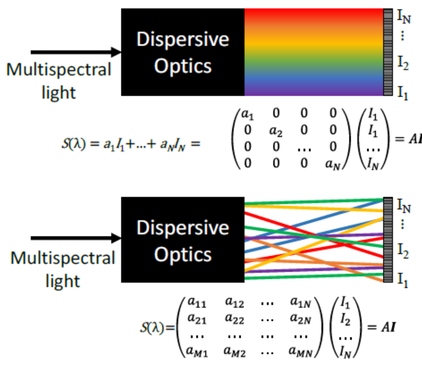
From concept to benchtop and borehole to orbit, we provide custom research and engineering for hard problems.

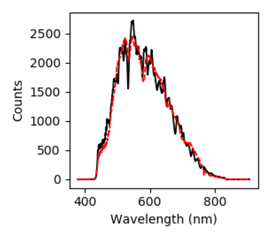
Context camera highlights



Novel camera technology

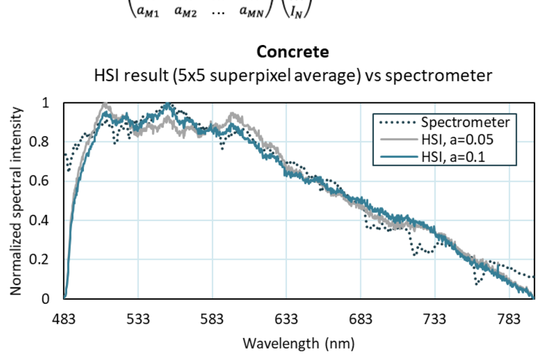
The Lambda-Cam uses reconstructive spectroscopy methods to achieve the form factor. This adds computational complexity and has reduced spectral accuracy compared to bandpass filters or gratings, but shrinks the entire integral field spectrometer down to ~1mm thick!

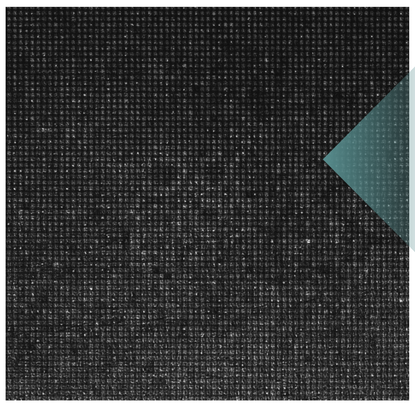




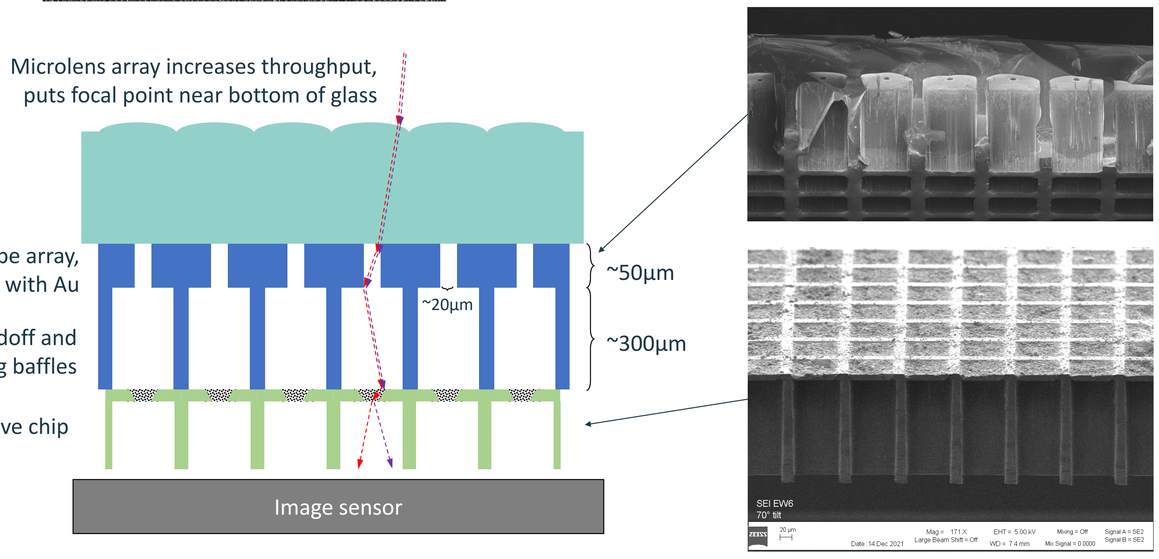
Concrete

HSI result (5x5 superpixel average) vs spectrometer

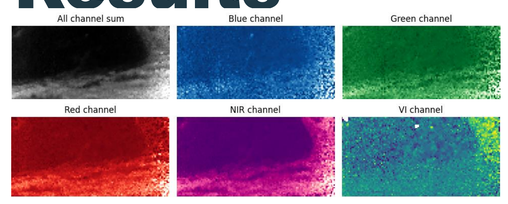




- Sub-field from 2019 NASA prototype, raw data
- Each cluster represents one **superpixel** (one spatial sample)
- Uses "speckle spectroscopy" to achieve form factor



Results



The flight camera was the best-available unit at the time of delivery and was known to have poor uniformity, but was successful in recovering vegetative indices (VI channel above) during full-frame video captures. More importantly, the spectral performance pre- and post-flight were the same to within experimental error!