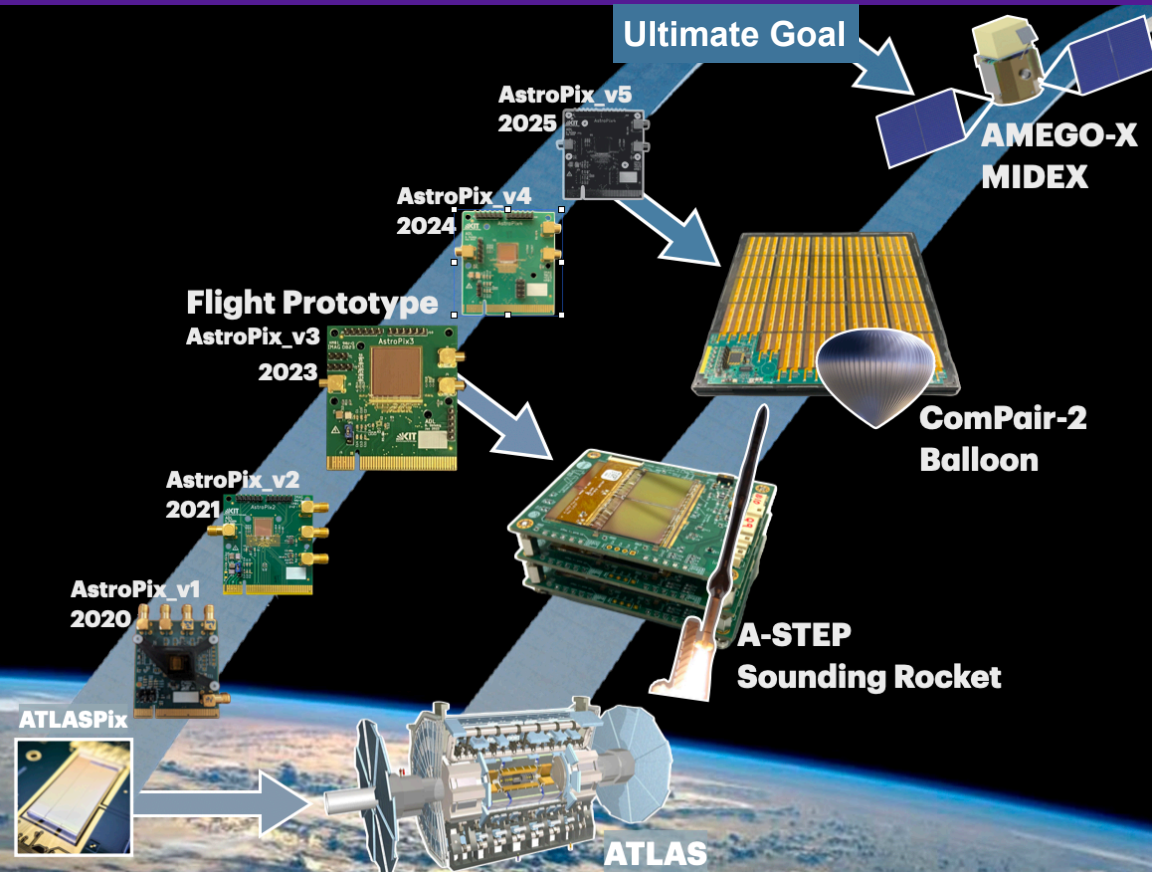




AstroPix: Plans and Schedule

Regina Caputo, NASA GSFC
BIC workshop, April 2025

AstroPix in the context of NASA projects



Area of Silicon required

$\sim 1\text{m}^2 \times 40$

$\sim 0.25\text{ m}^2 \times 10$

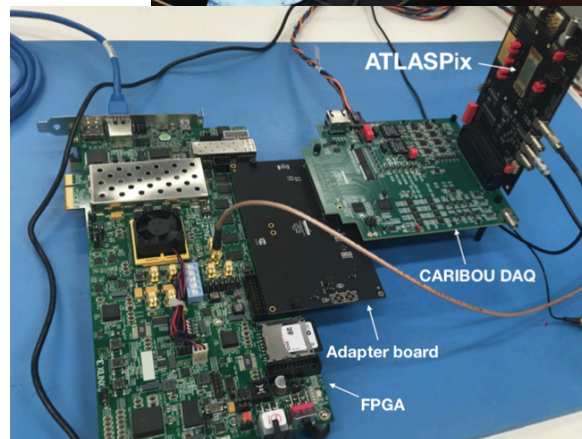
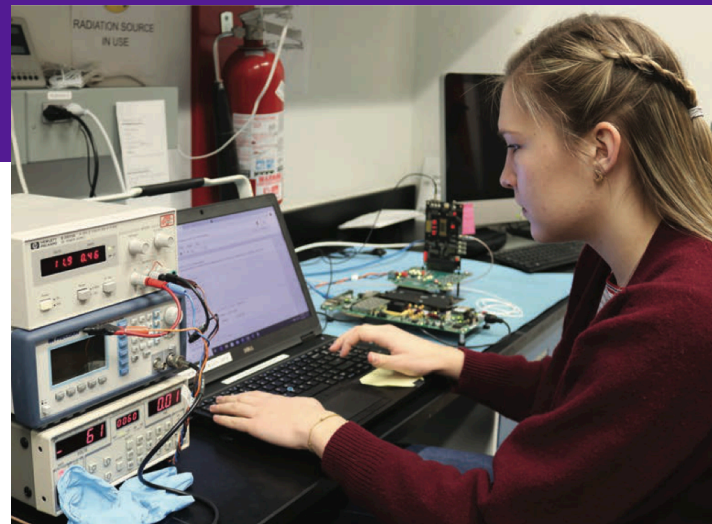
$4\text{ cm}^2 \times 3$

Introduction of AstroPix



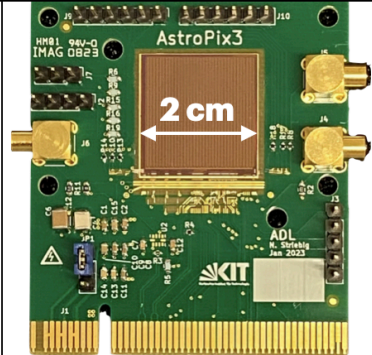
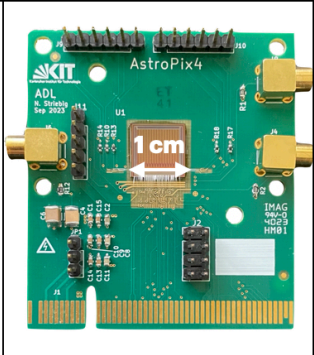

Optimize parameters for large scale instrument

Parameter	Goal
E_{Res}	<10% at 60 keV
Power Usage	<1 mW/cm ²
Passive Material	<5% on the active area of Si
Pixel Size	500 × 500 μm^2
Si Thickness	500 μm
Time Tag	$\sim 1 \mu\text{s}$

From ATLASPix: Benchmark current technology



AstroPix: a brief history to present day

2020 AstroPix_v1	2021 AstroPix_v2	2023 AstroPix_v3	2024 AstroPix_v4	2025 AstroPix_v5
				
1st prototype: incremental design changes from ATLASPix	2nd prototype: Power reduction, Radiation testing '22	Flight prototype: Beam tests '23, '24 Sounding Rocket '26	4th prototype: individual pixel readout, Power reduction	5th prototype: AMS Foundry Energy range, Power reduction, Balloon '28(?)

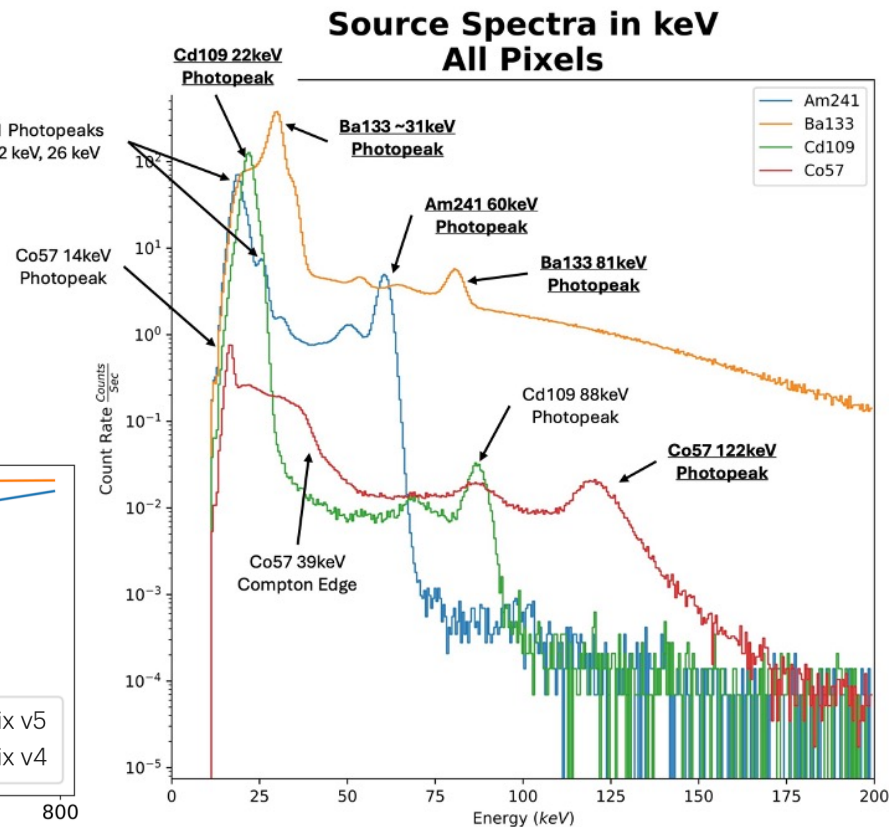
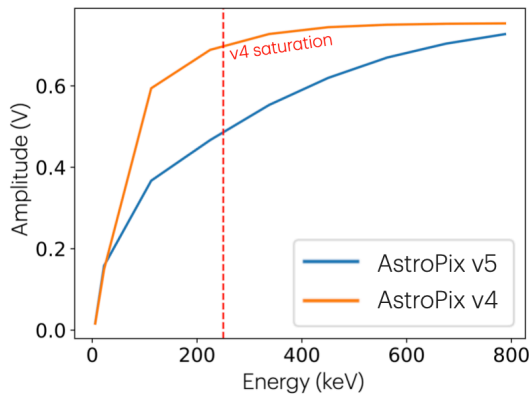
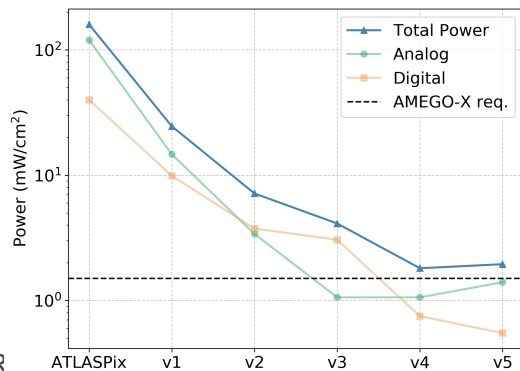
AstroPix Production Foundry (TSI) Status (10/23)

- AstroPix_v1 to v4 produced by TSI Semiconductor
- Purchased by Bosch Semiconductor LLC in August 2023
- Bosch is ceasing production of all Si CMOS technologies in favor of silicon carbide in January 2024
- 25 v3 wafers for ComPair; plus MPW run containing v4
- Alternative foundries: AMS, design modifications + contract issues ~1 year delay

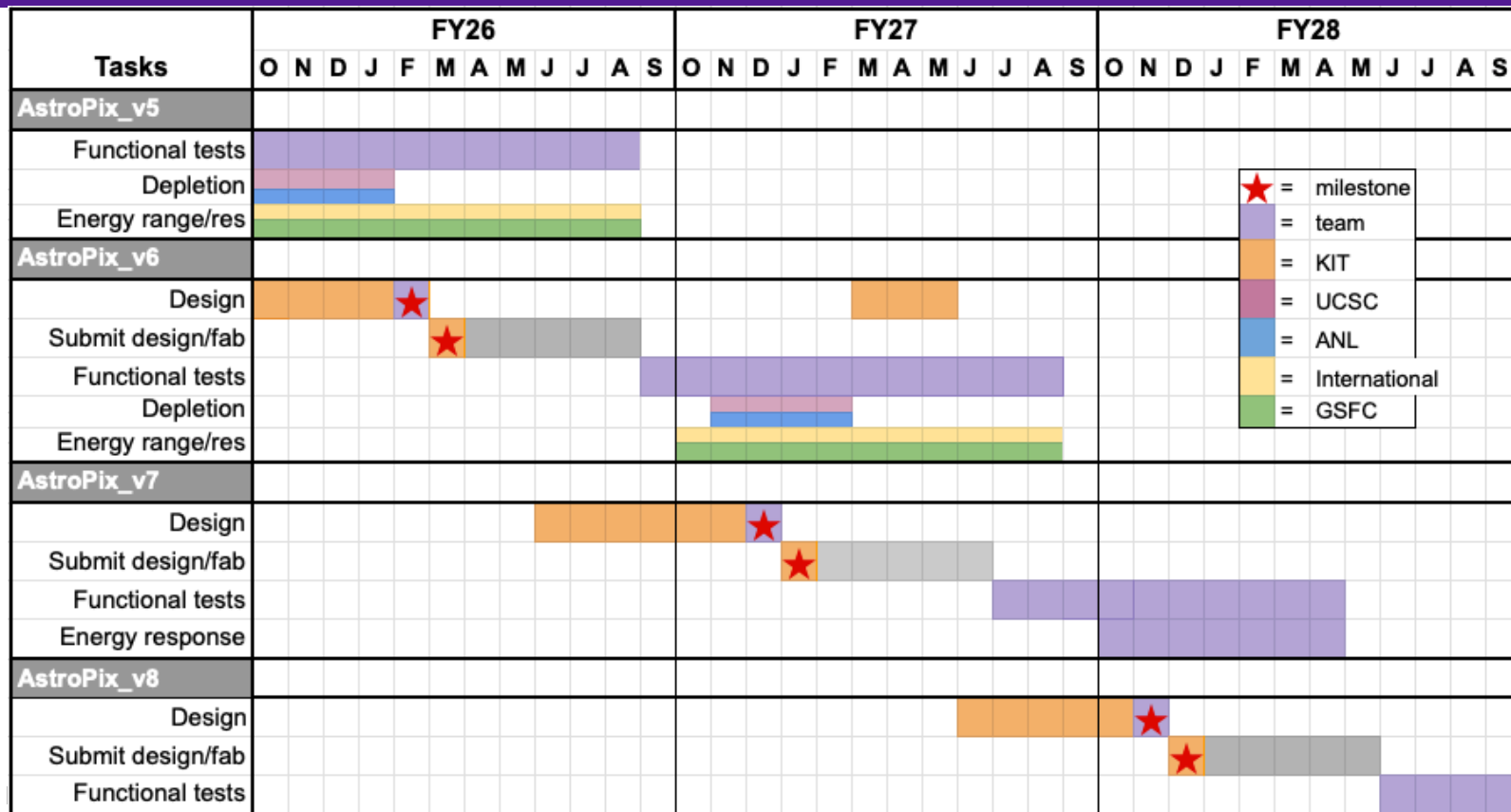


AstroPix: Current and Proposed Future Work

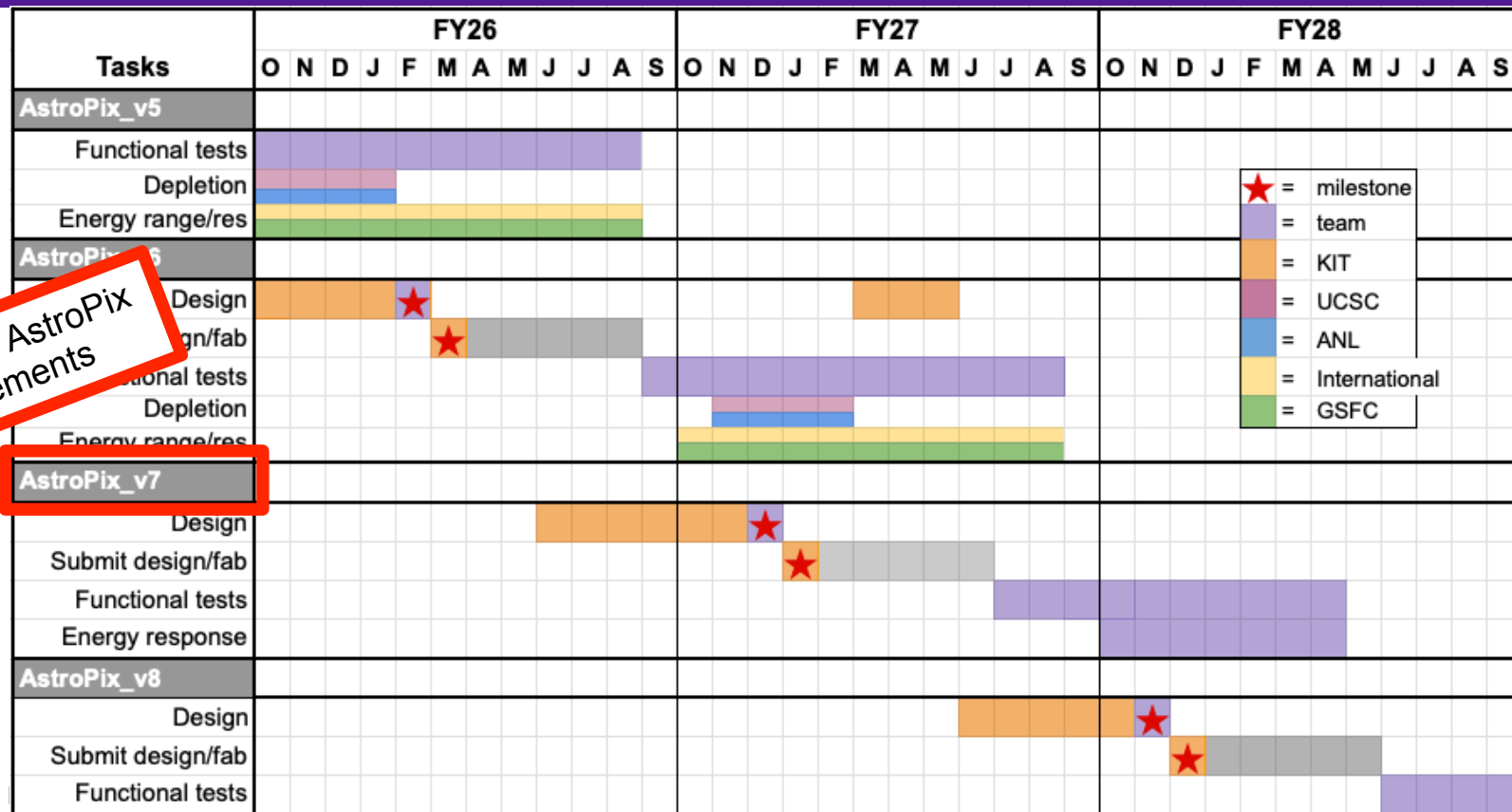
- Characterize AstroPix_v5
- Meet AMEGO-X requirements
 - Full depletion (updated guard ring design, backside bias - v6)
 - Reduce power (better routing, move pixel components to periphery - v6)
 - Energy resolution (PHA and NNR circuits - v7)
- Additional Foundries



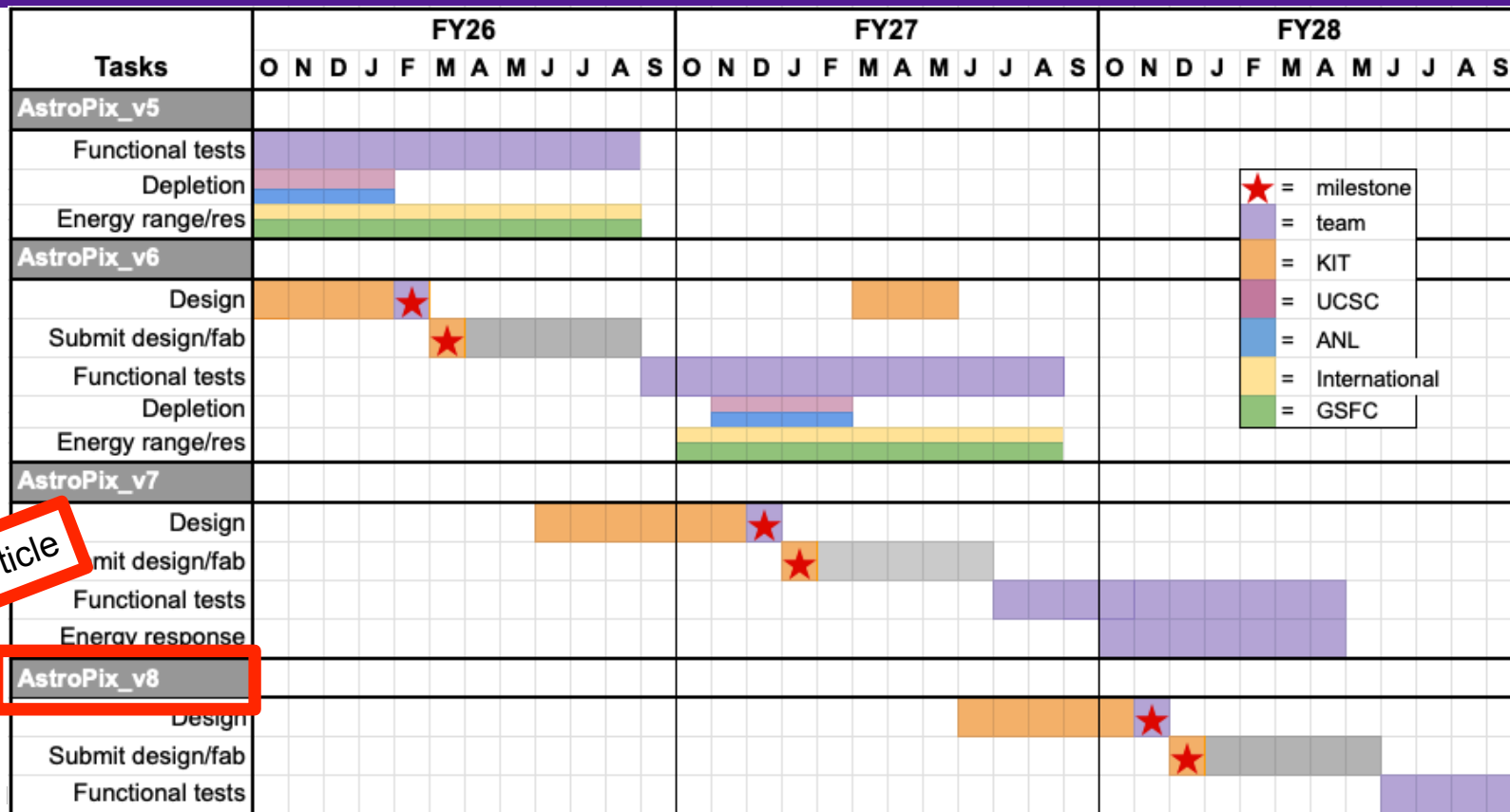
AstroPix Proposed Schedule



AstroPix Proposed Schedule



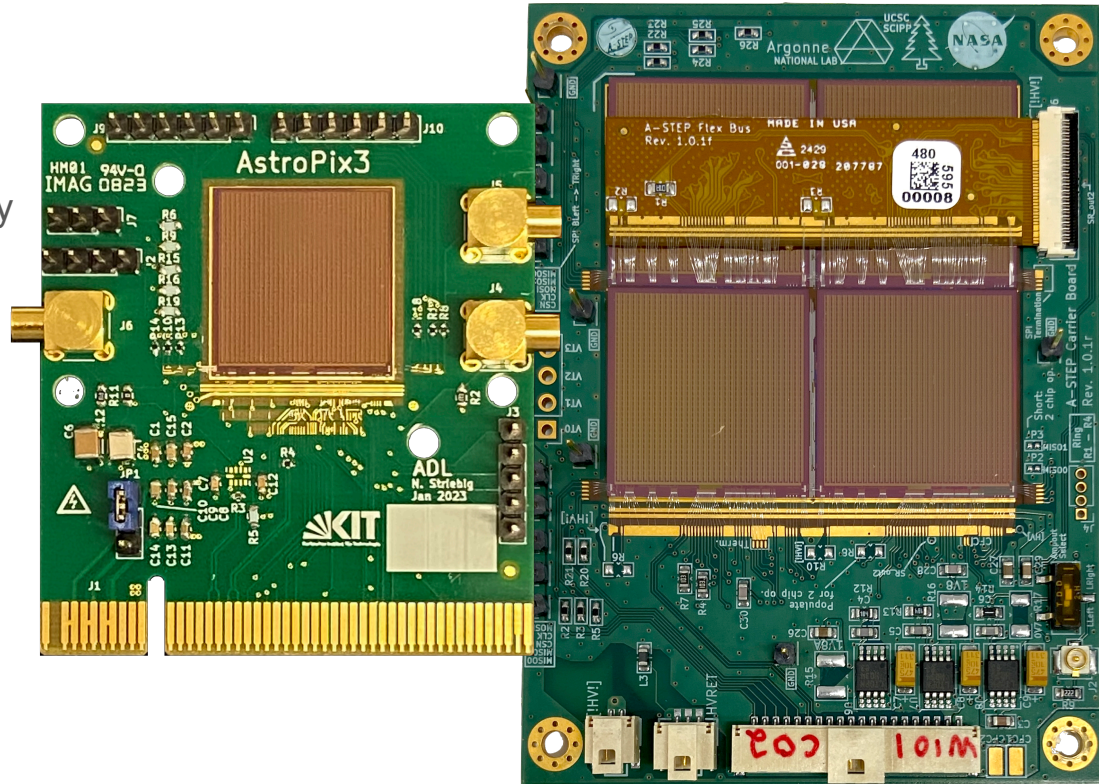
AstroPix Proposed Schedule



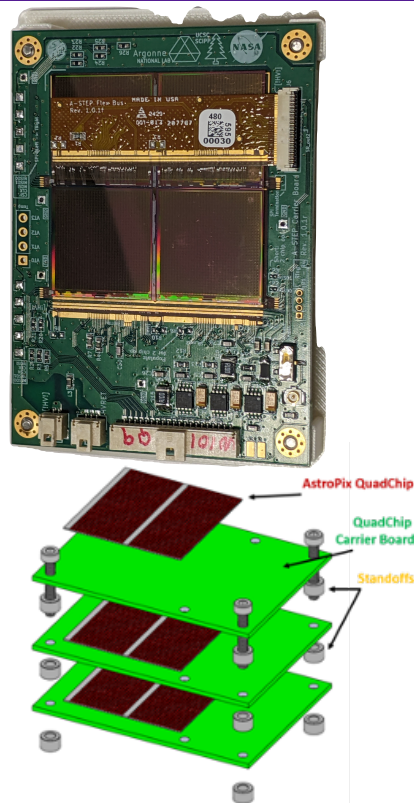
Full Reticle

Projects implementing AstroPix

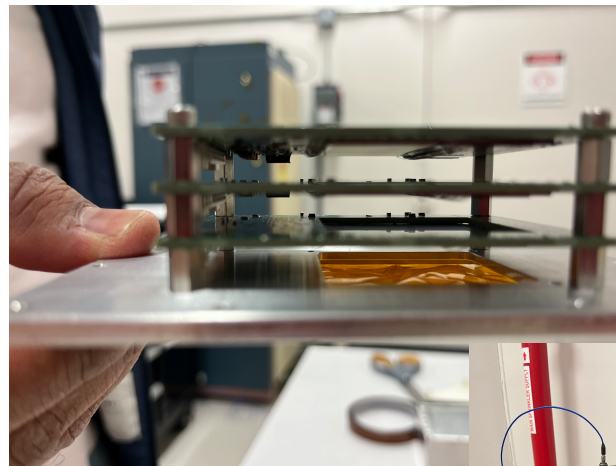
- AstroPix_v3: First “Production run”
 - Full reticle from TSI
- Row/column readout
- AstroPix Sounding rocket Technology dEmonstration Payload (A-STEP)
- ComPair-2 - balloon payload
- **See Dan’s talk on Wednesday for more details and performance



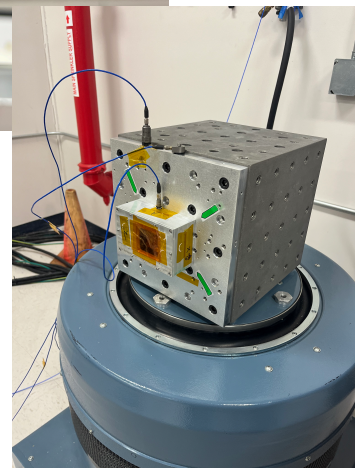
A-Sounding rocket Technology dEmonstration Payload (A-STEP)



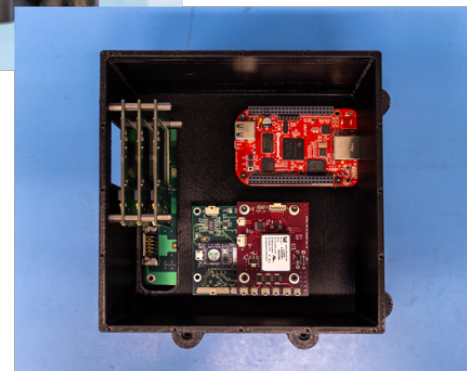
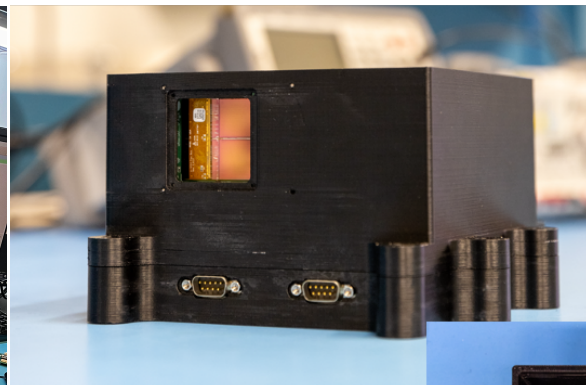
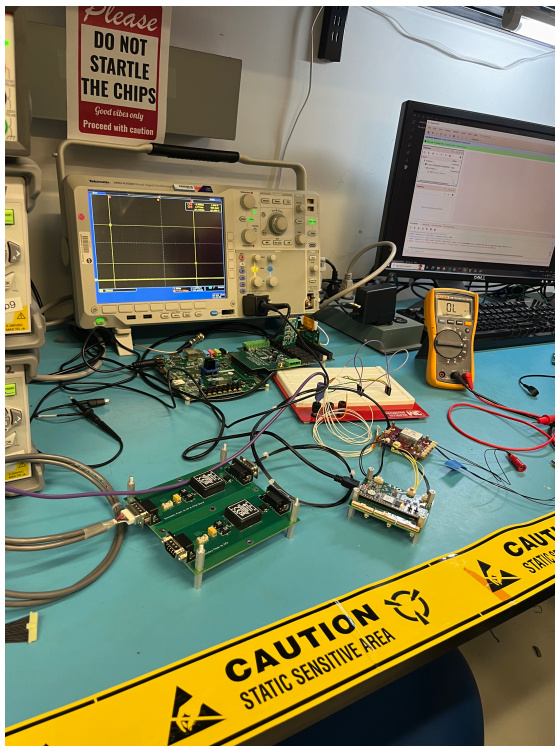
Instrument: 3 layers of AstroPix



Vibration testing at
Wallops Flight Facility



A-Sounding rocket Technology dEmonstration Payload (A-STEP)



Payload: ~20 x 20 x 20 cm

Launch from Wallops Flight Facility in ~Spring 2026

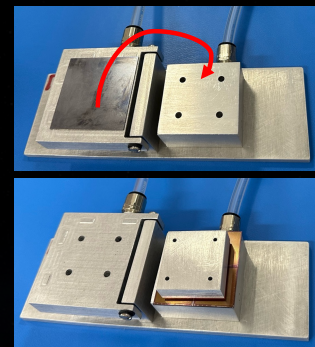
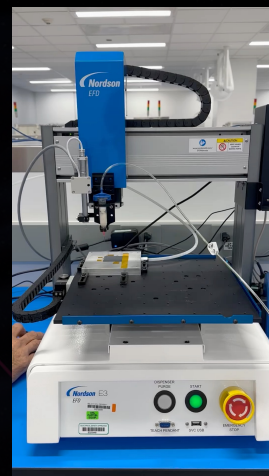
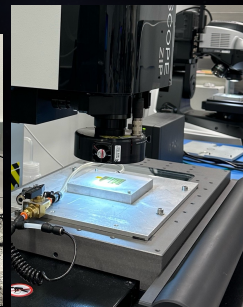
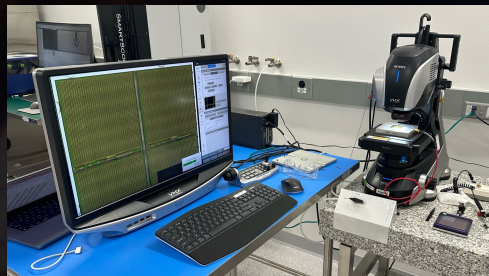
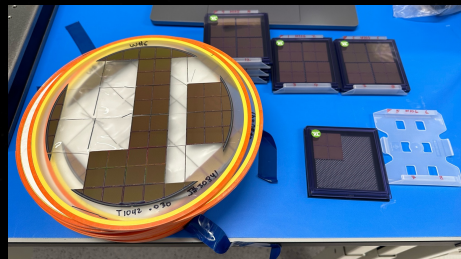
Diced Wafers

Chip Characterization

Glue Robot

"Chip Flipper"

- IV Measurements
- Metrology
- Imaging



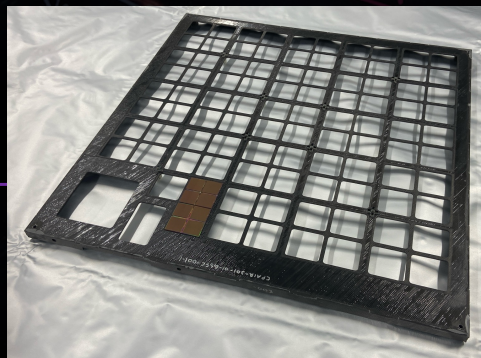
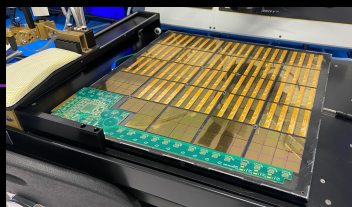
Wirebond
Encapsulation

Wirebonding

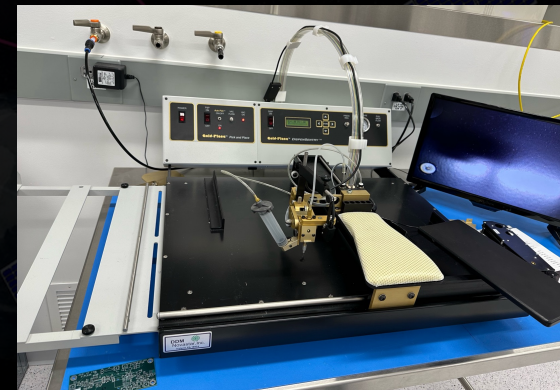


ANL Tracker Segment Assembly Process

Bus bar and FEE
integration



Chip Pick-and-Place



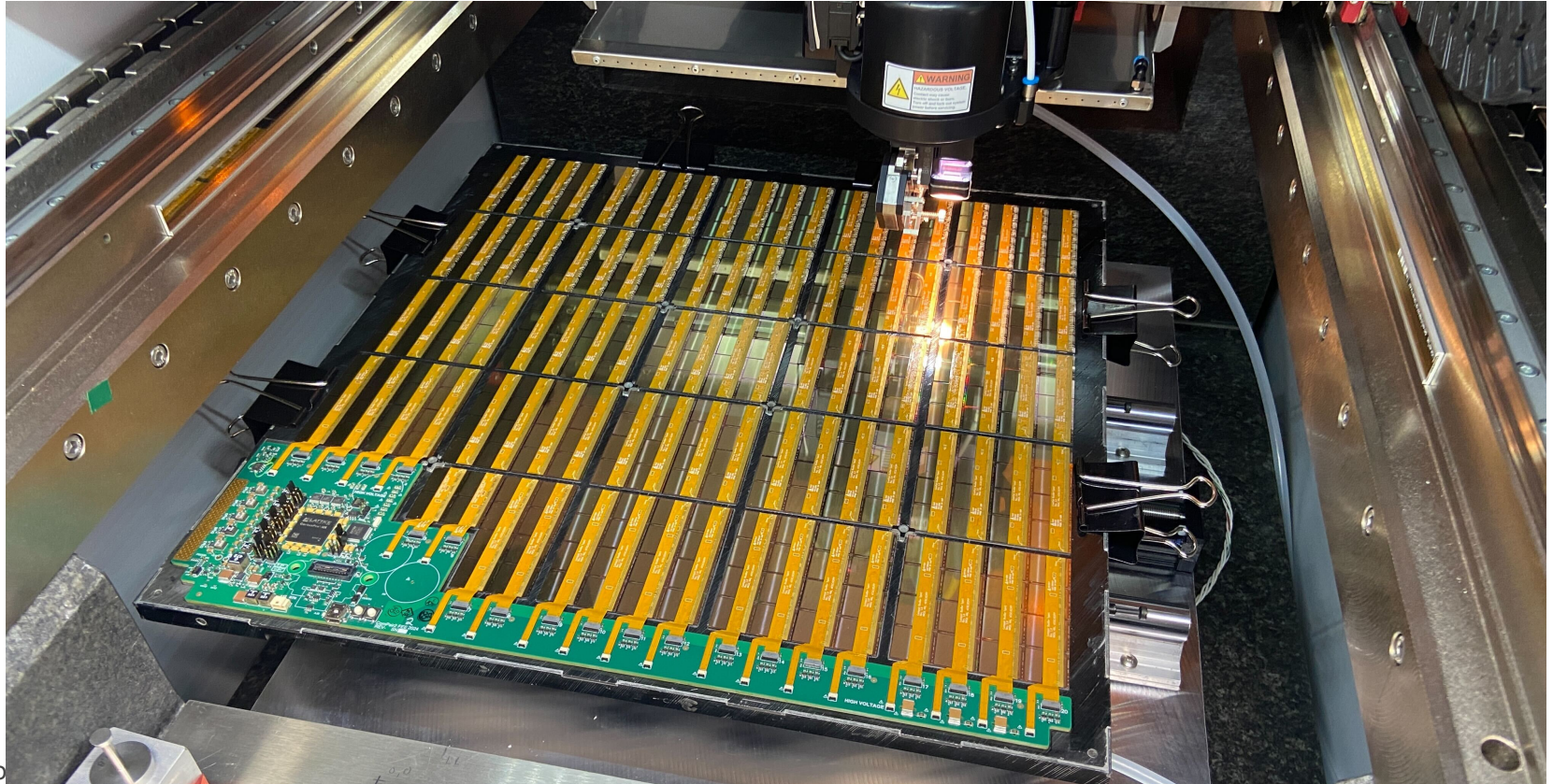
ComPair: Integration and Testing

- ANL developing segment assembly process & tools
 - 2nd segment integration occurring now
 - Manoj might be willing to show you in the lab
- Initial phases of planning for environmental testing
 - TVAC/thermal cycling, vibe
 - Developing testing needs & goals
 - Defining facility & GSE needs

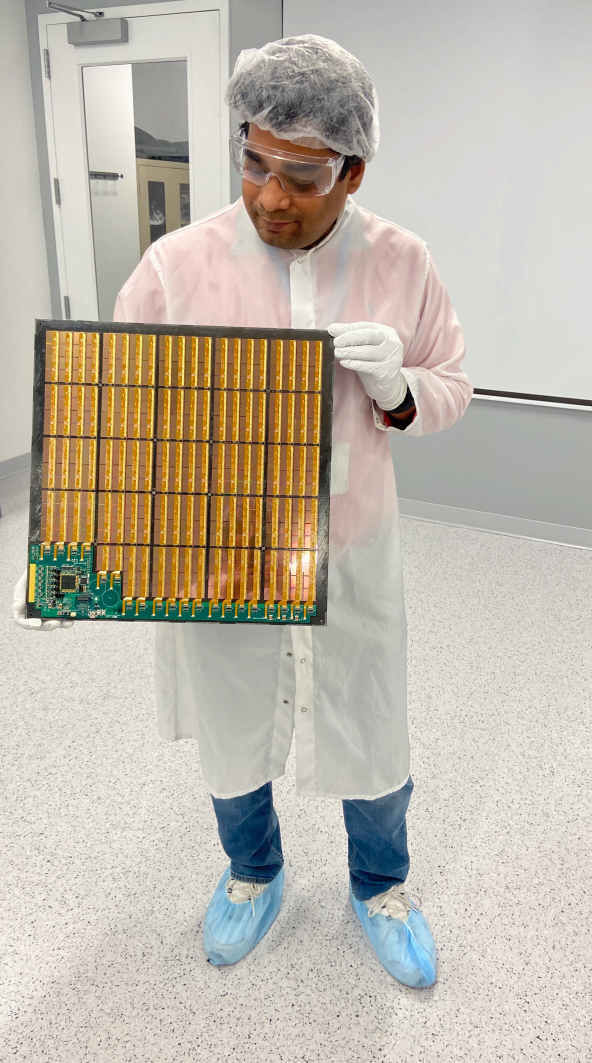
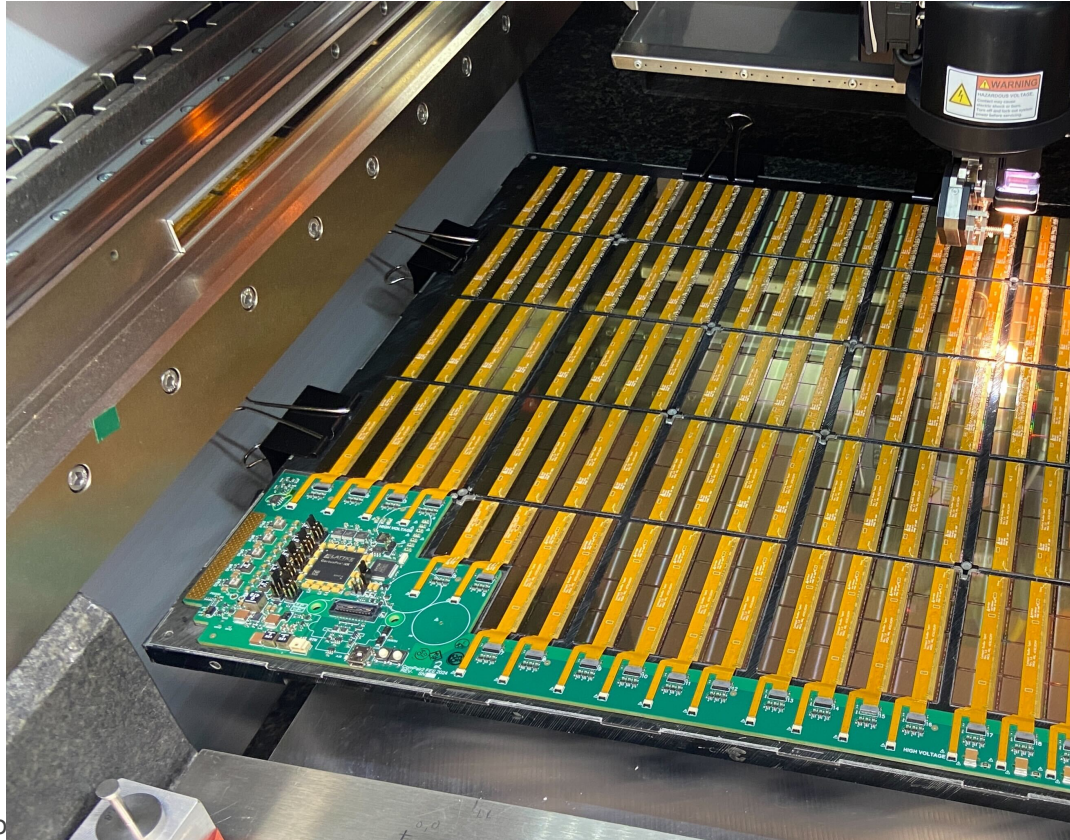


Argonne Micro-Assembly Facility (AMAF)

First ComPair-2 Layer



First ComPair-2 Layer

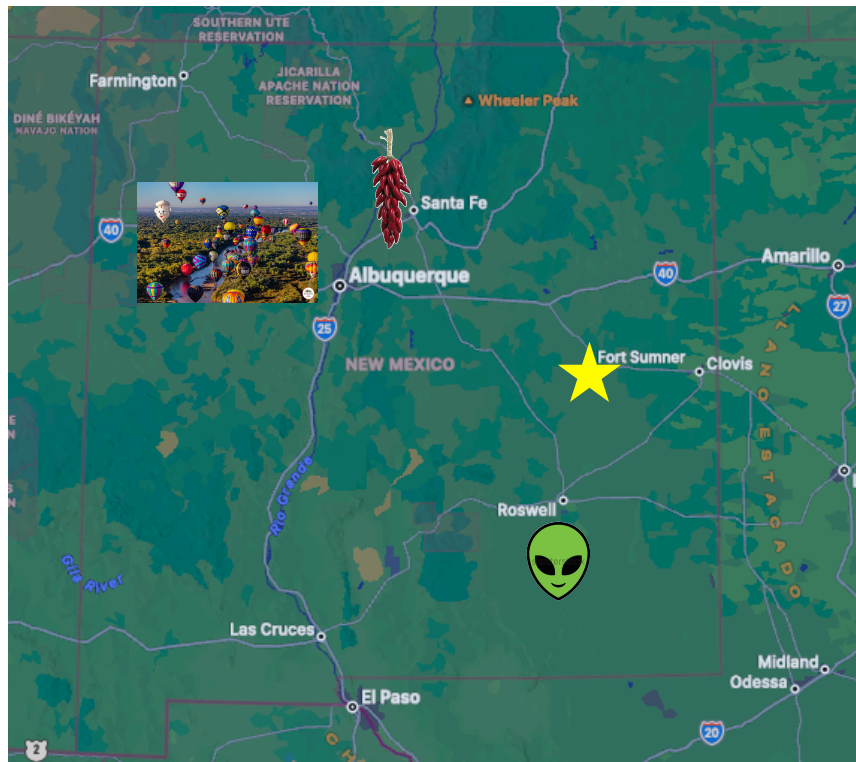


Backups

ComPair: Integration and Testing in Fort Sumner



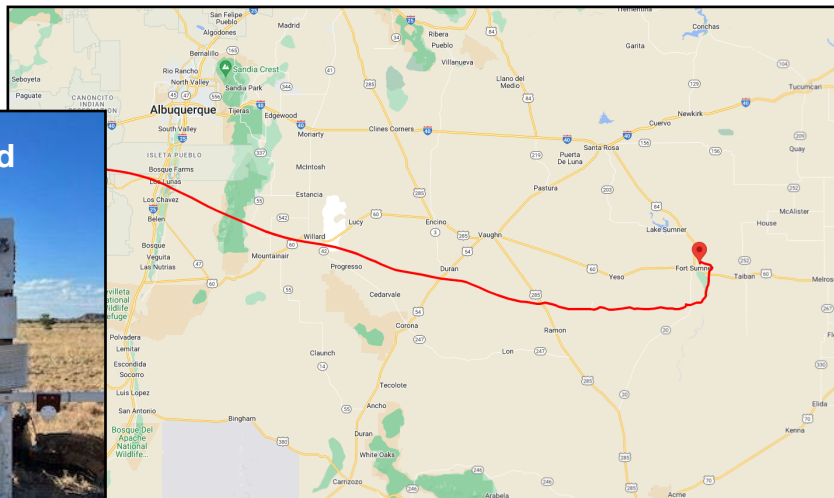
ComPair: Launch on August 27th, 2023



Flight Summary

Date/Time Launched: 27 August, 2023 / 08:57:20 MT

Launch Site: Ft Sumner, NM



Experiment Weight: 2,385 lbs

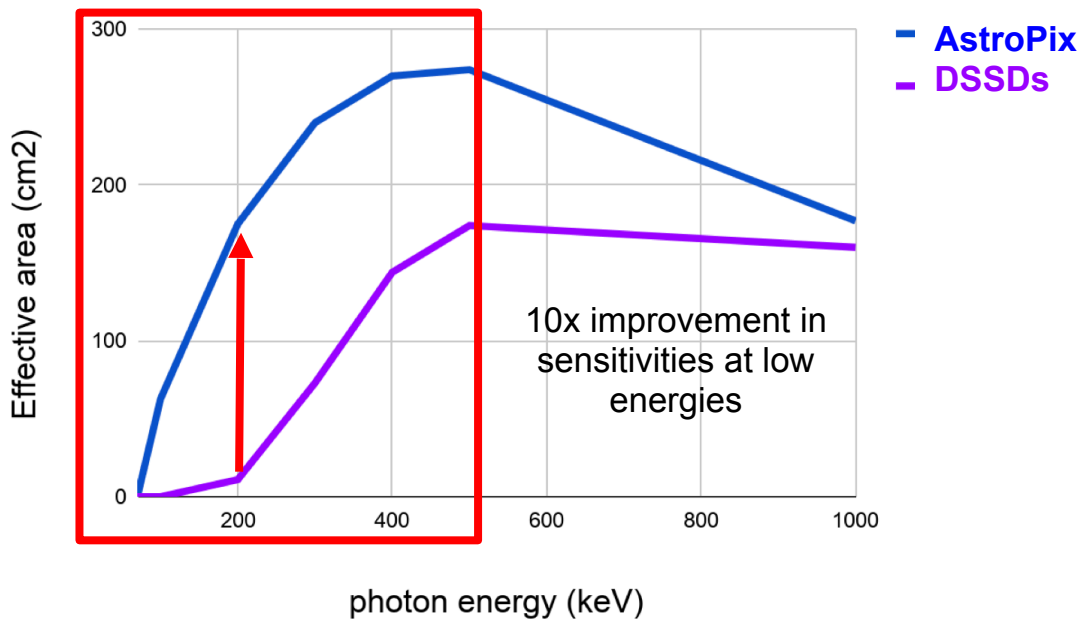
Float Altitude: 132 kft

Total Flight Time: 5 hours 31 minutes

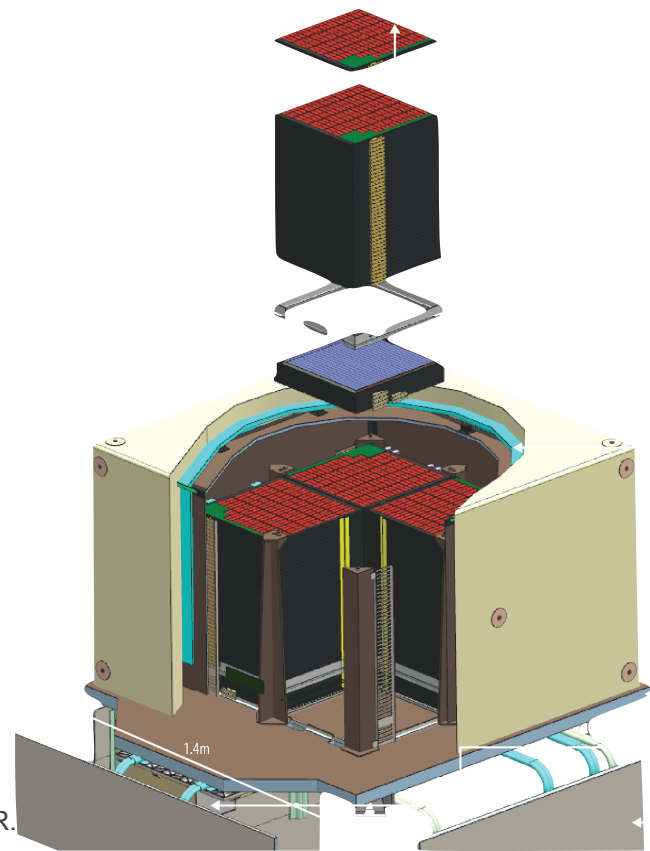
Total Float Time: 3 hours 06 minutes

Combining forces: AstroPix as an Enabling Technology

Pixels vs. long daisy chained strips



AMEGO-X: The Next Generation of AMEGO



Single instrument with 2 subsystems:
Gamma-Ray Detector (GRD) and the Anti-
Coincidence Detector

Tracker: 40 layers AstroPix per tower; 4 towers

Calorimeter: 4 layers of Cesium Iodide bars per tower; 4 towers

Submitted NASA MIDEX AO in 2021, reviewed well but
not selected. Resubmit 2027

AMEGO-X Team



With collaborators at INFN, U. Hiroshima, U. Johannesburg, KIT,

R. Caputo | NASA GSFC U. Western Australia, Georgia Tech, Drexel, UNH and members of LIGO, IceCube, CTA

AMEGO-X: An All-sky Gamma-ray Survey

