

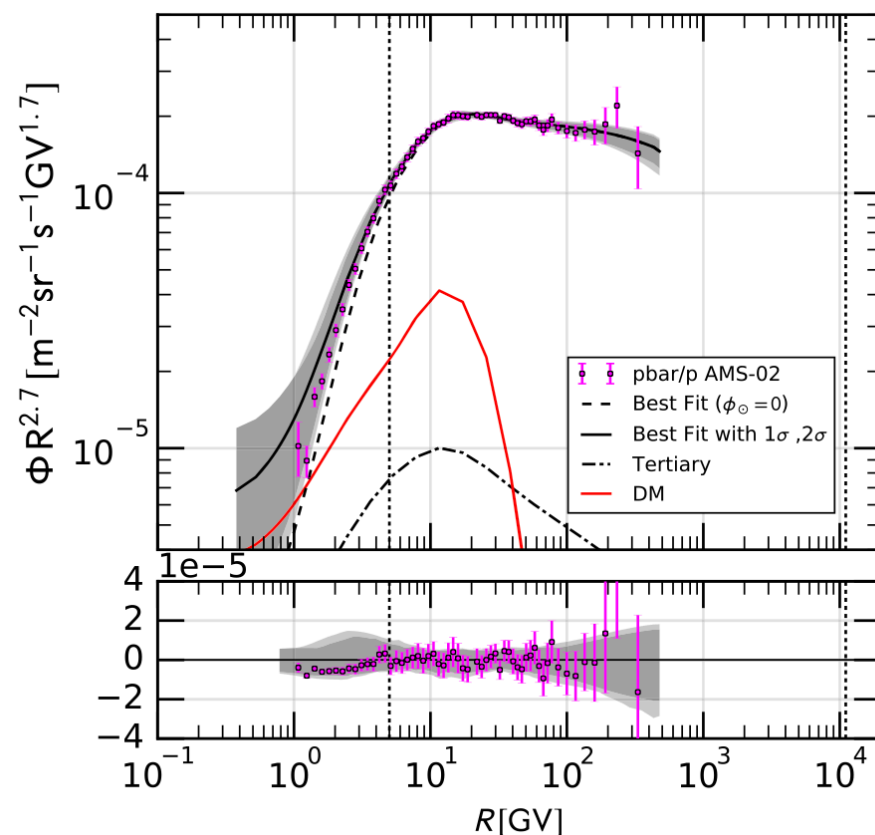


The GAPS Experiment:

An Antarctic Balloon Mission Searching for Dark Matter with Cosmic Antinuclei

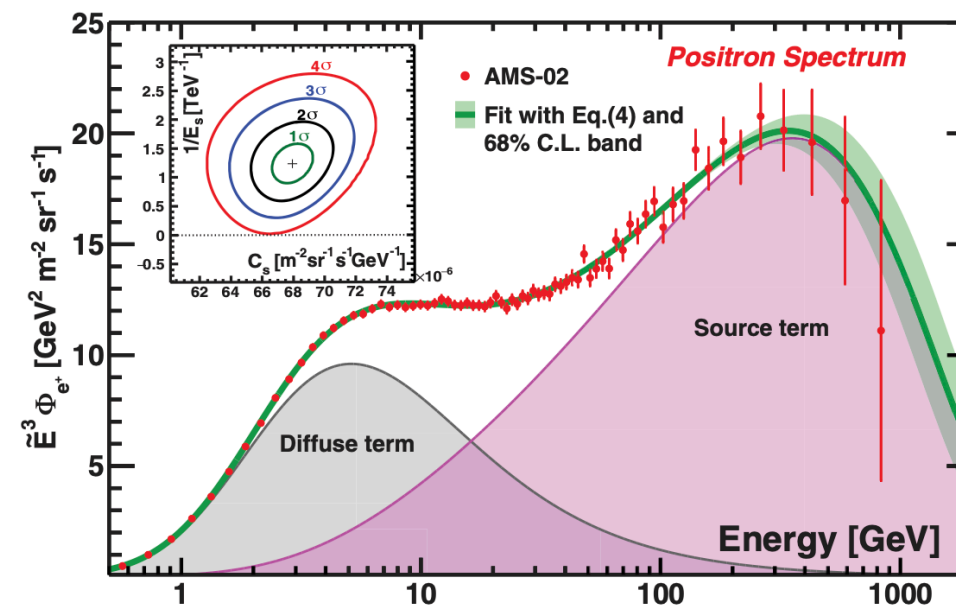
Gabriel Bridges on Behalf of the GAPS Collaboration

Antiprotons



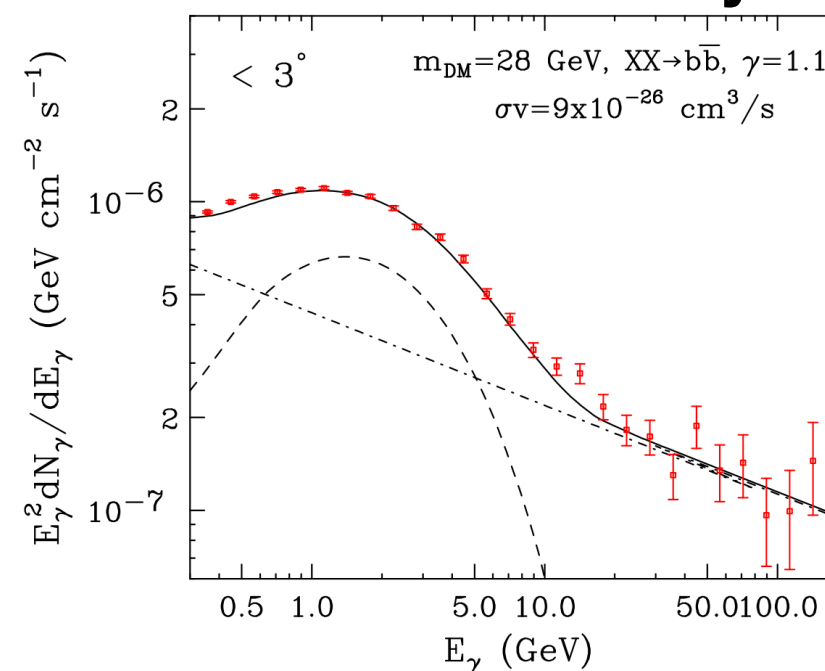
Cuco et al. (2017)

Positrons



AMS Collaboration (2019)

GC Gamma Rays

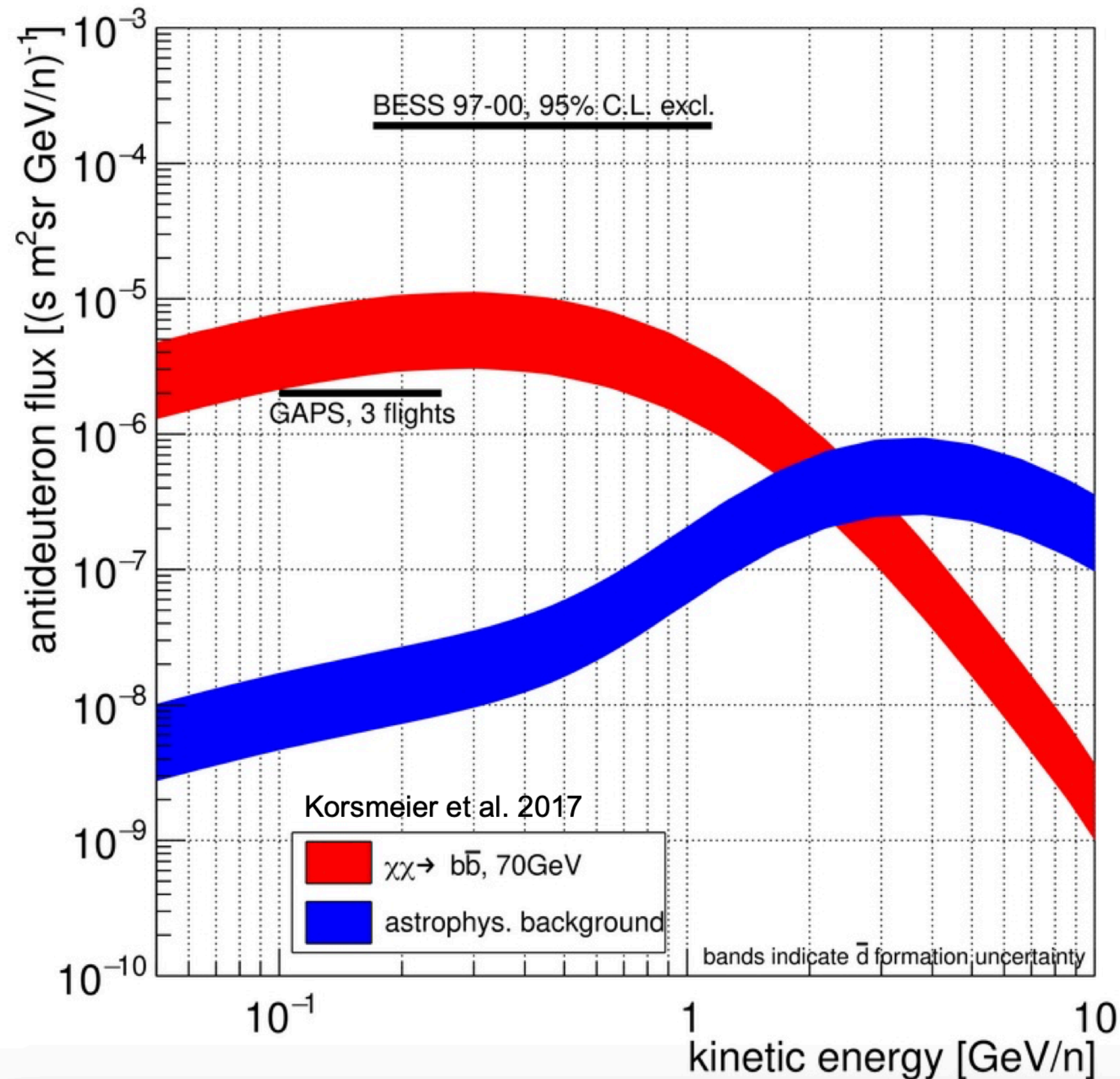


Goodenough and Hooper (2009)

- Significant Backgrounds
- Uncertainty in CR propagation
- Complex sources of CRs

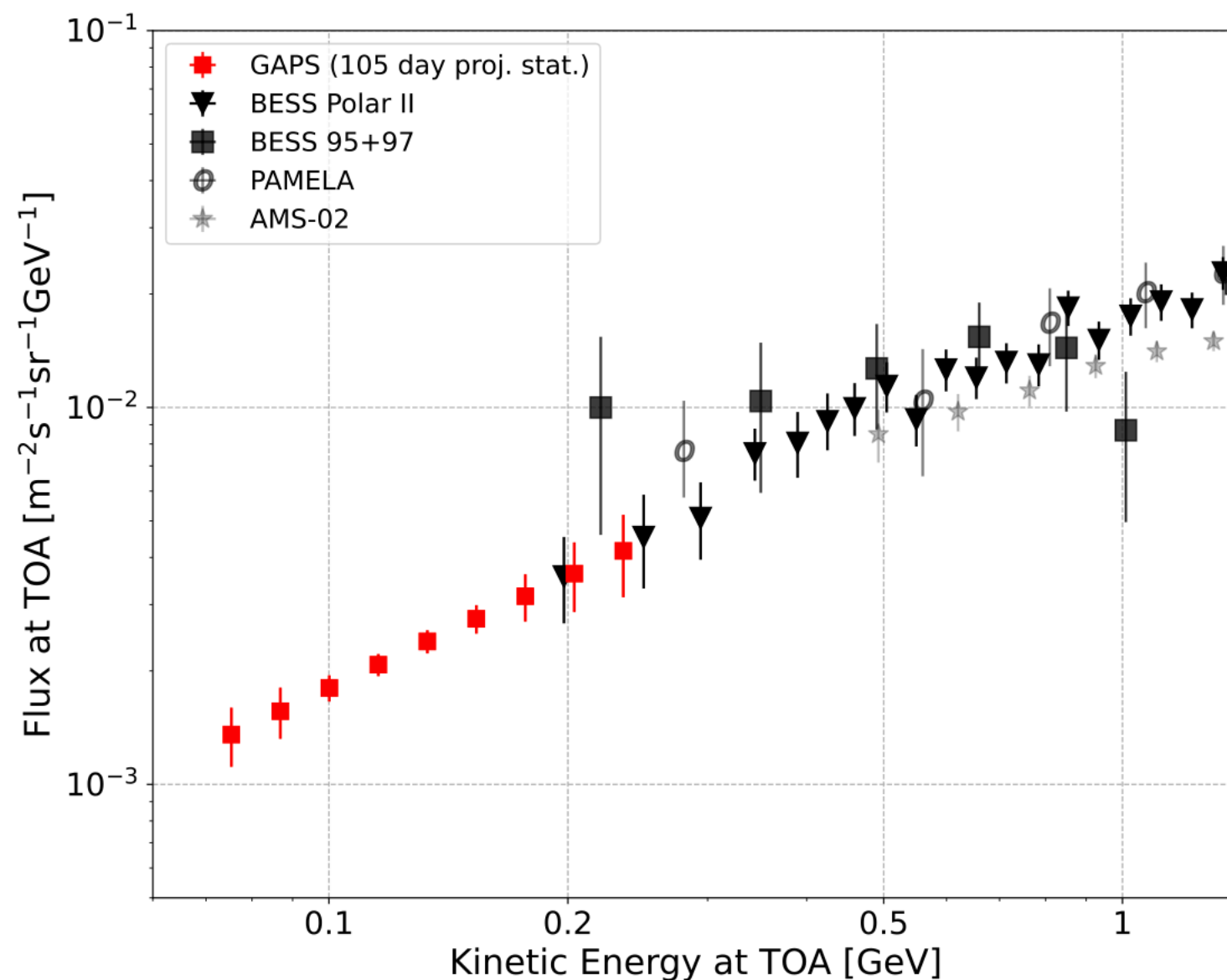
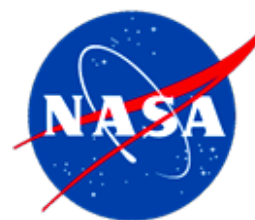


Antideuteron are a smoking gun of DM





GAPS will measure \bar{p} in unexplored low-energy range



Rodgers et. al. (2022)

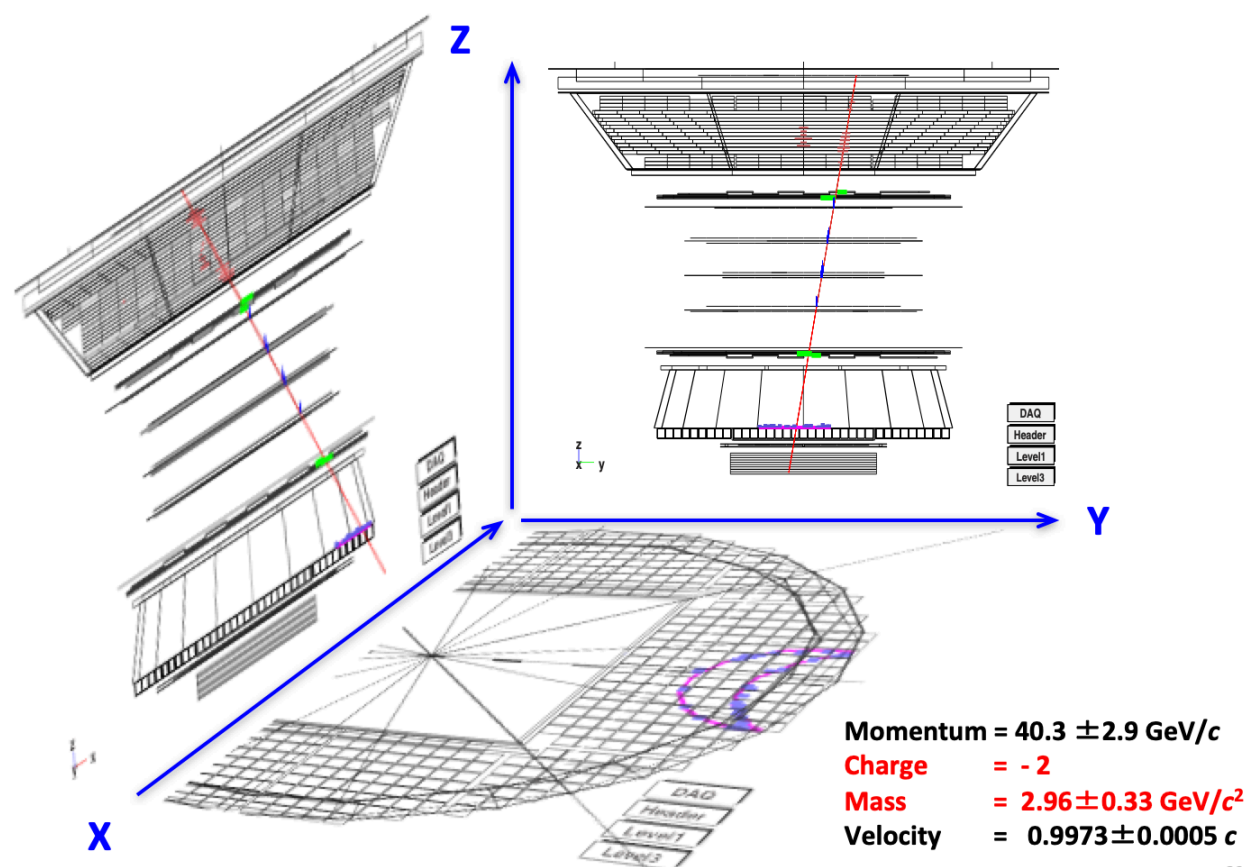
- Reduce systematics for \bar{d} search
- Probe light DM candidates



GAPS will independently verify AMS $\overline{\text{He}}$

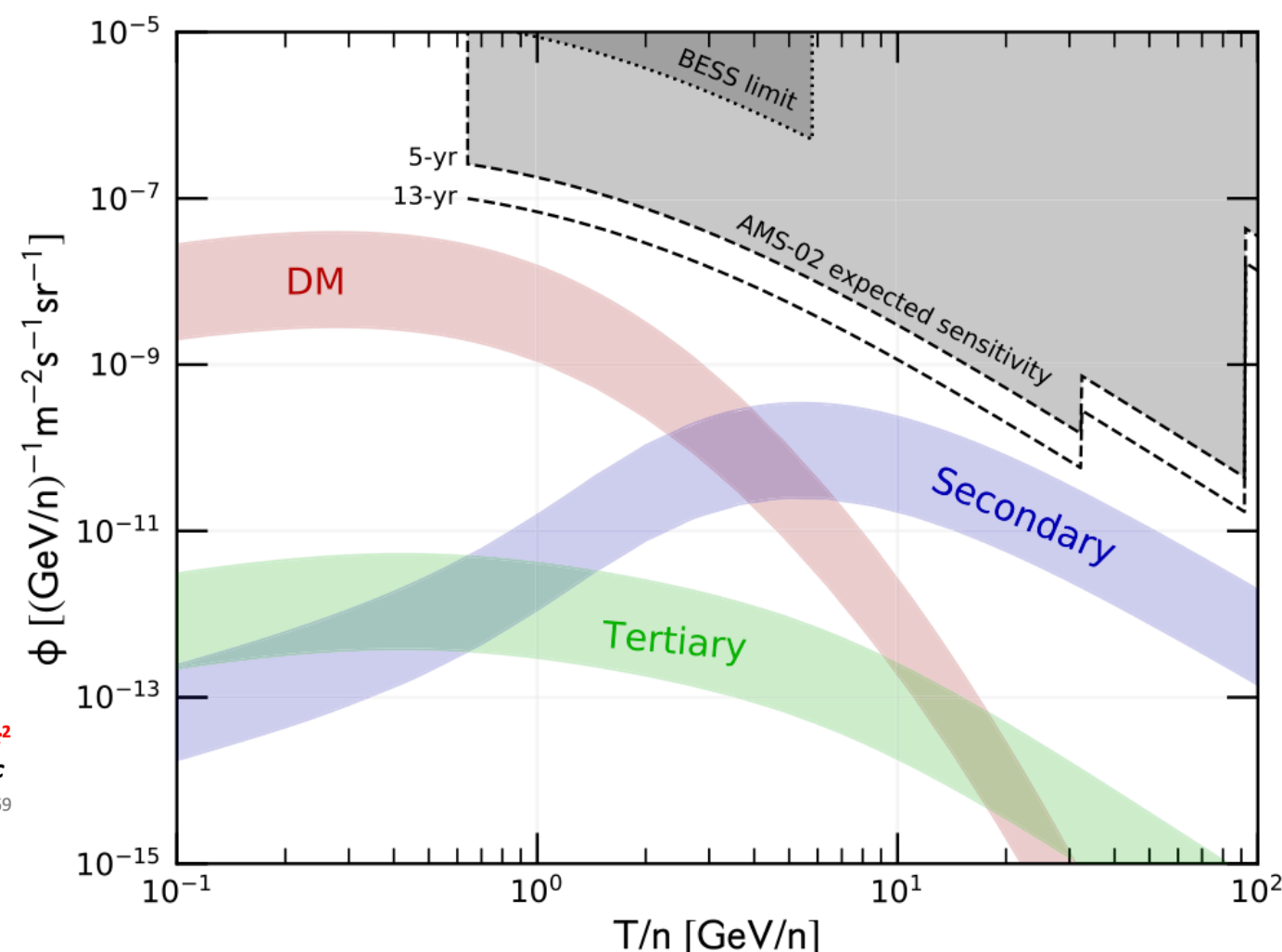


An anti-Helium candidate:



Ting (2016)

69



Korsmeier, Donato, and Fornengo (2018)

- GAPS offers independent verification of AMS candidate events
- Low energy sensitivity can help distinguish origins



GAPS Detection: Exotic Atom Capture and Decay

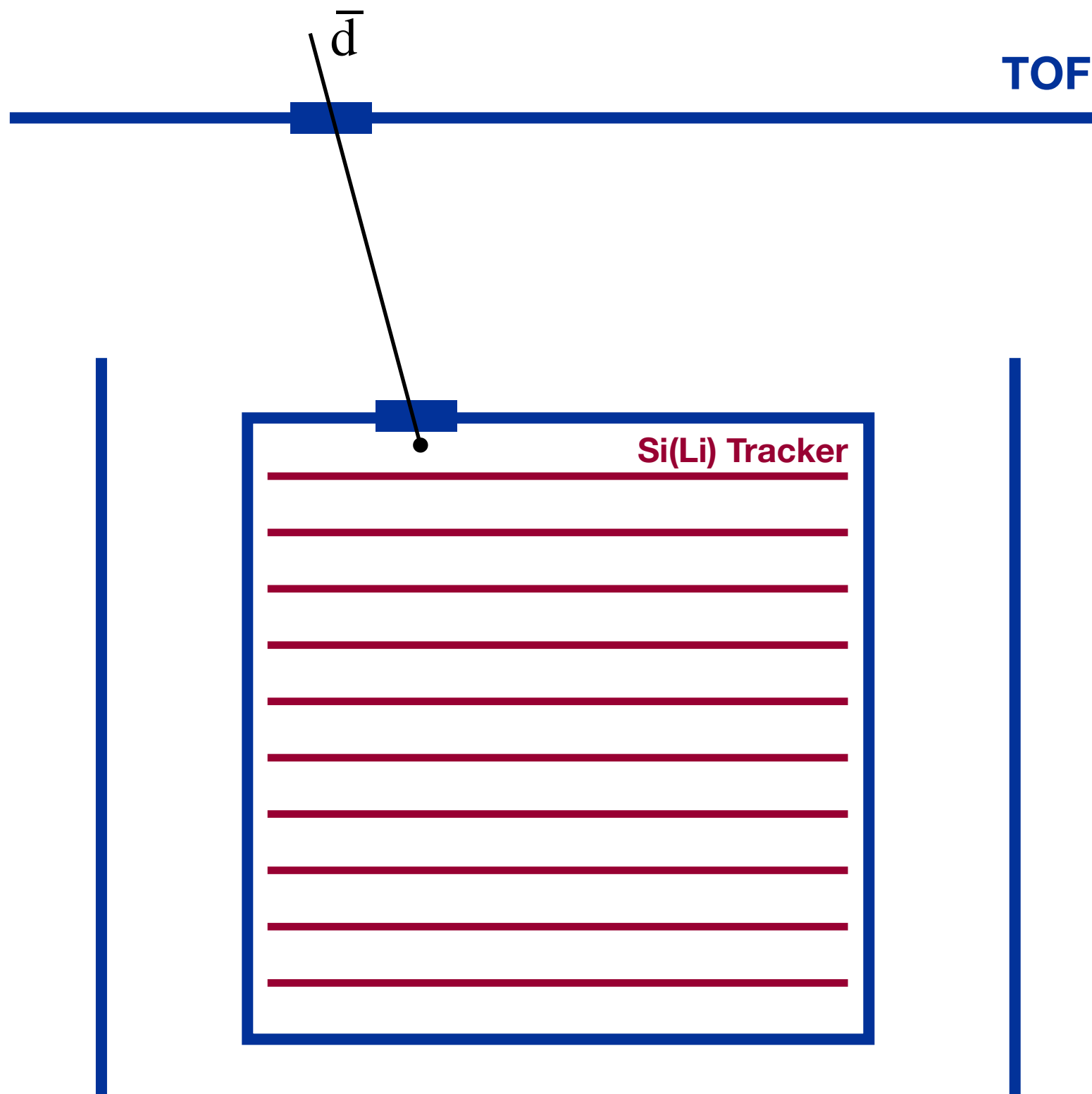
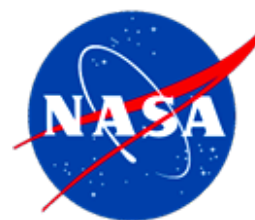


TOF

Si(Li) Tracker



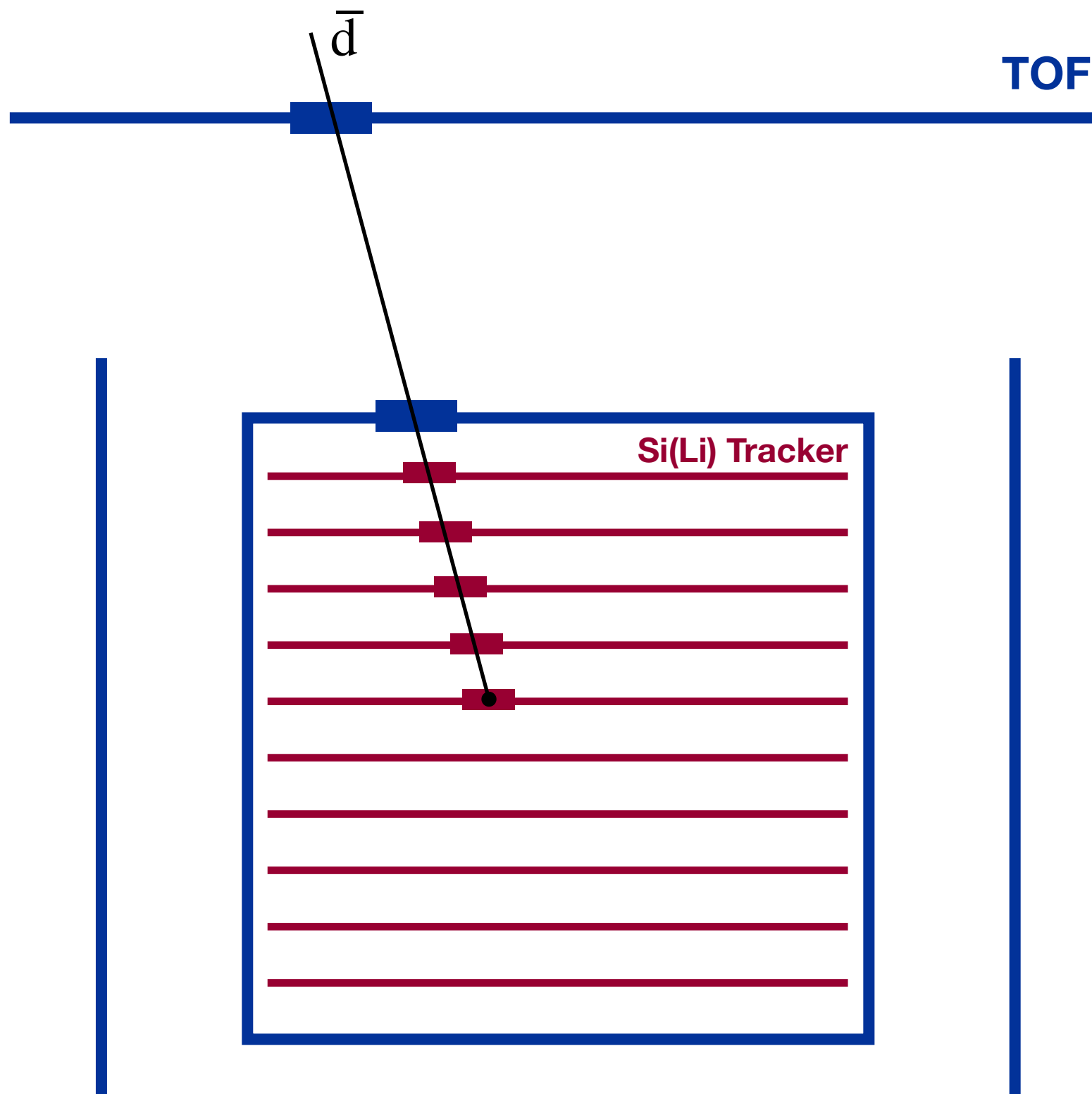
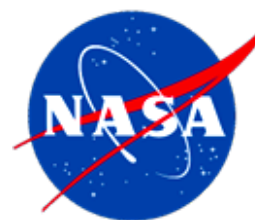
GAPS Detection: Exotic Atom Capture and Decay



- **Time-of-flight:** Measure velocity and generate trigger



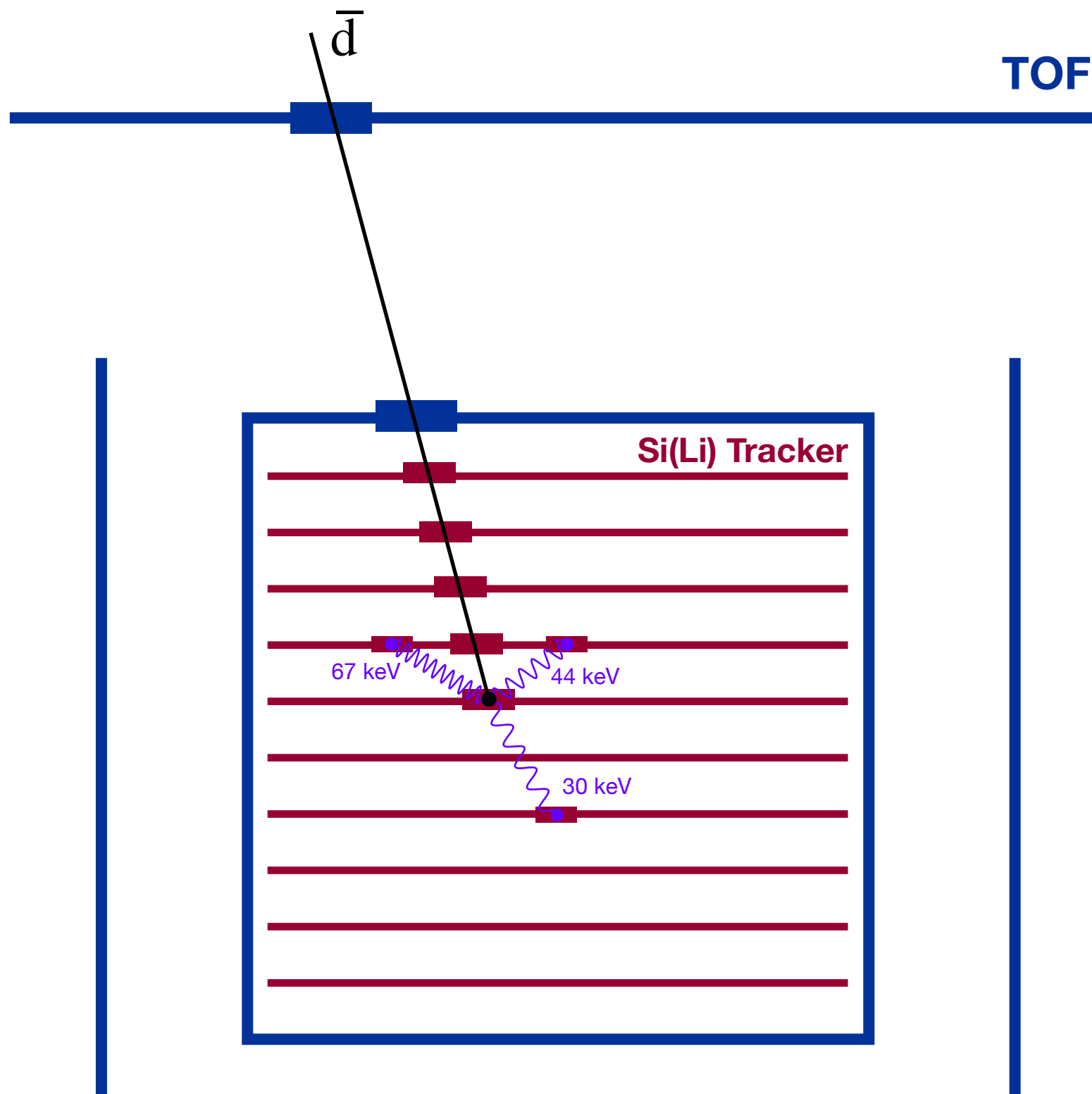
GAPS Detection: Exotic Atom Capture and Decay



- **Time-of-flight:** Measure velocity and generate trigger
- **Si(Li) Tracker:**
 - Measure dE/dx
 - Target for exotic atom formation



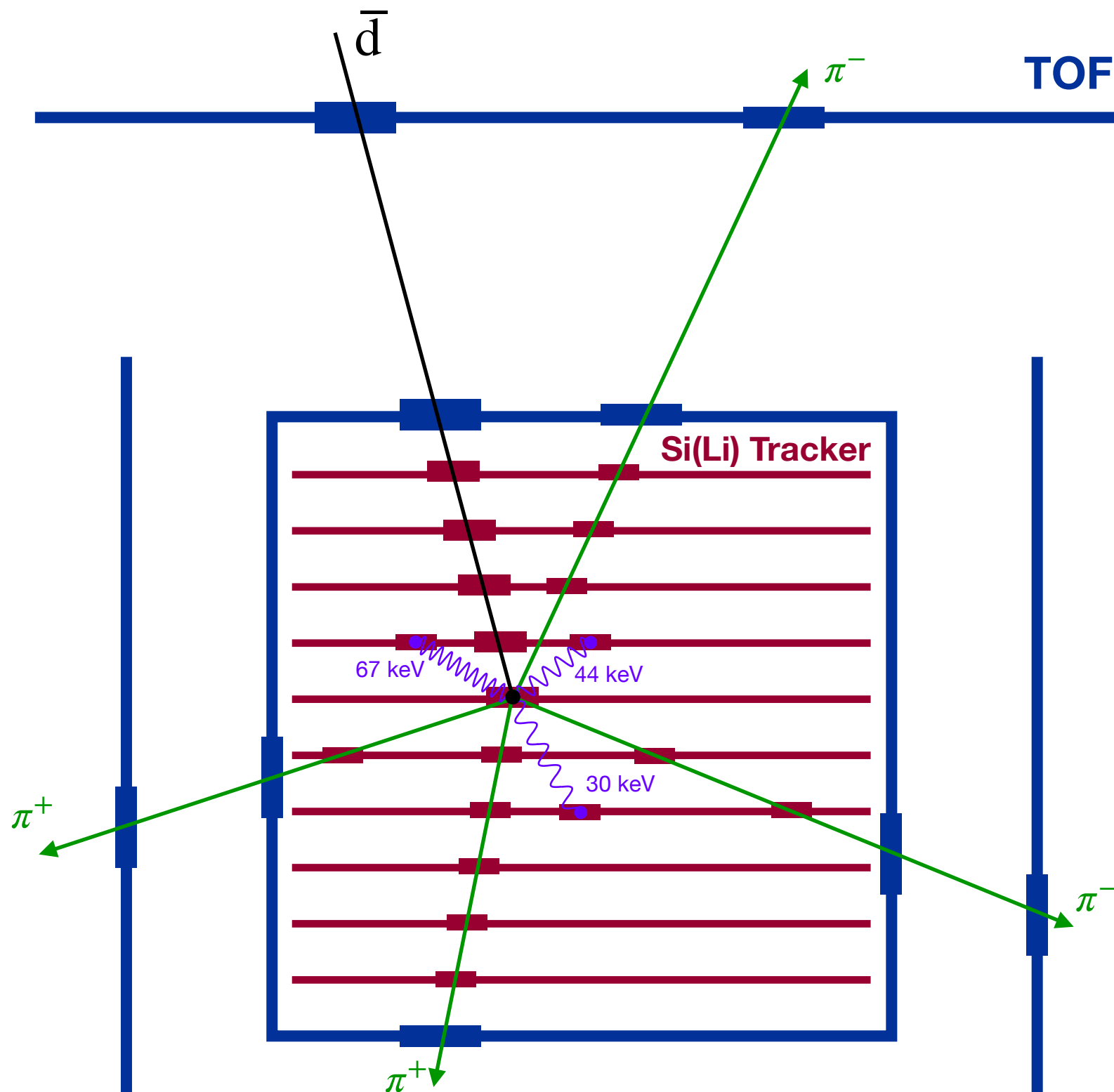
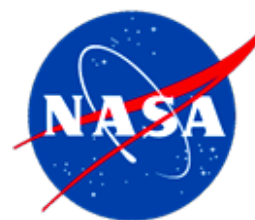
GAPS Detection: Exotic Atom Capture and Decay



- **Time-of-flight:** Measure velocity and generate trigger
- **Si(Li) Tracker:**
 - Measure dE/dx
 - Target for exotic atom formation
 - X-Ray Spectrometer



GAPS Detection: Exotic Atom Capture and Decay



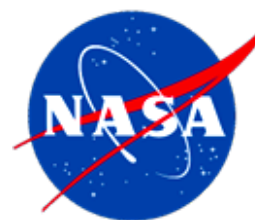
- **Time-of-flight:** Measure velocity and generate trigger

- **Si(Li) Tracker:**

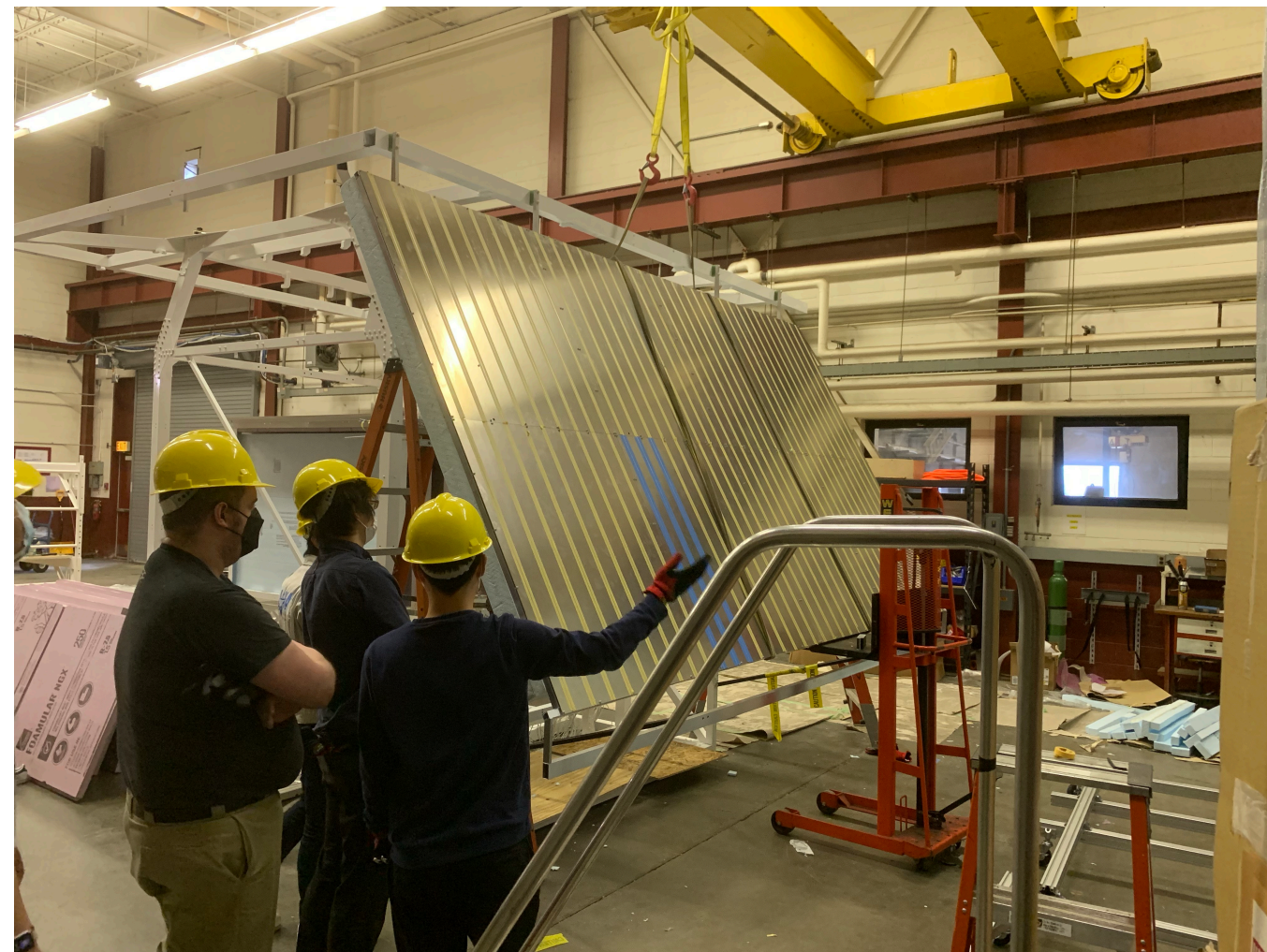
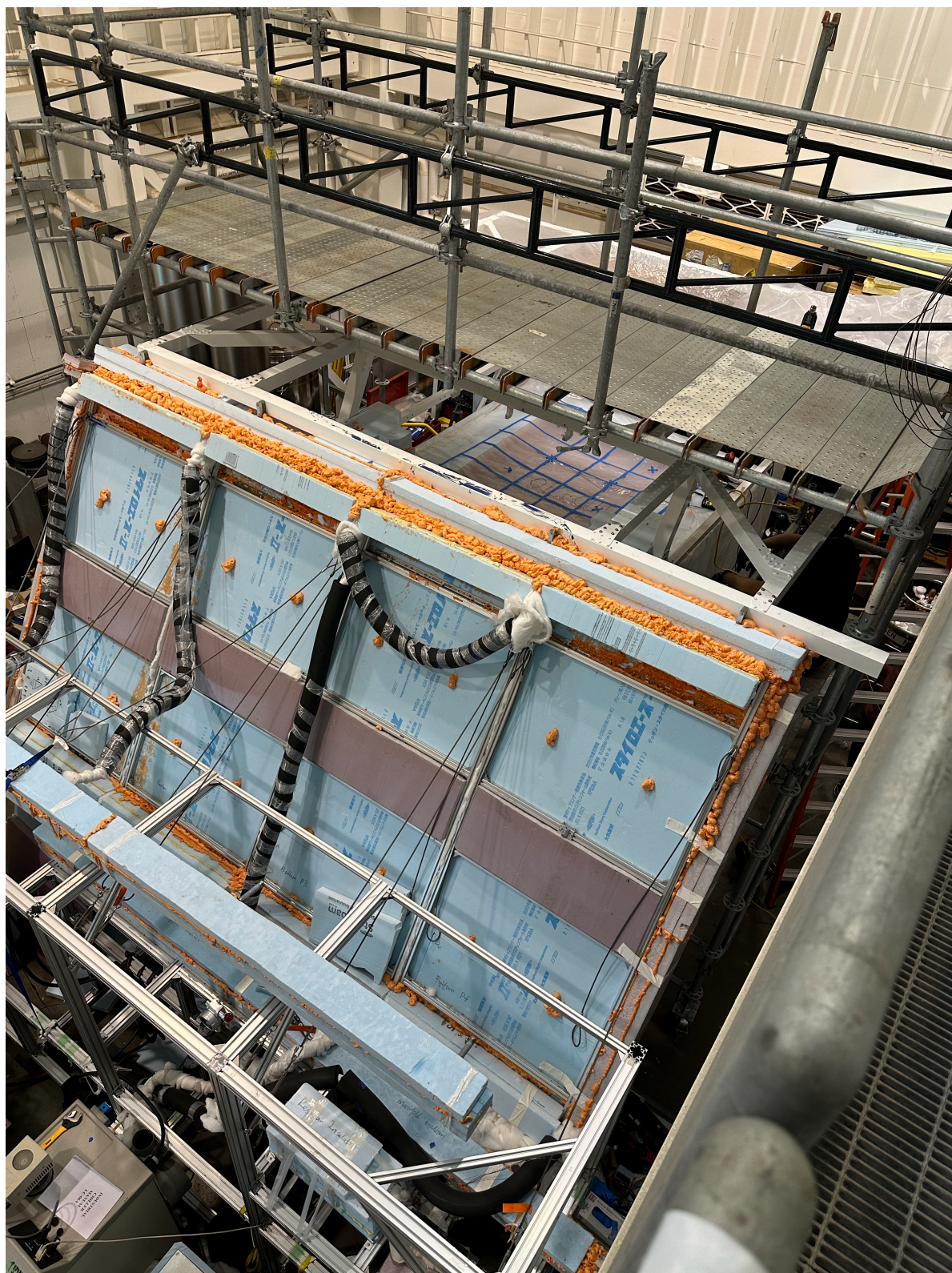
- Measure dE/dx
- Target for exotic atom formation
- X-Ray Spectrometer
- Particle tracker



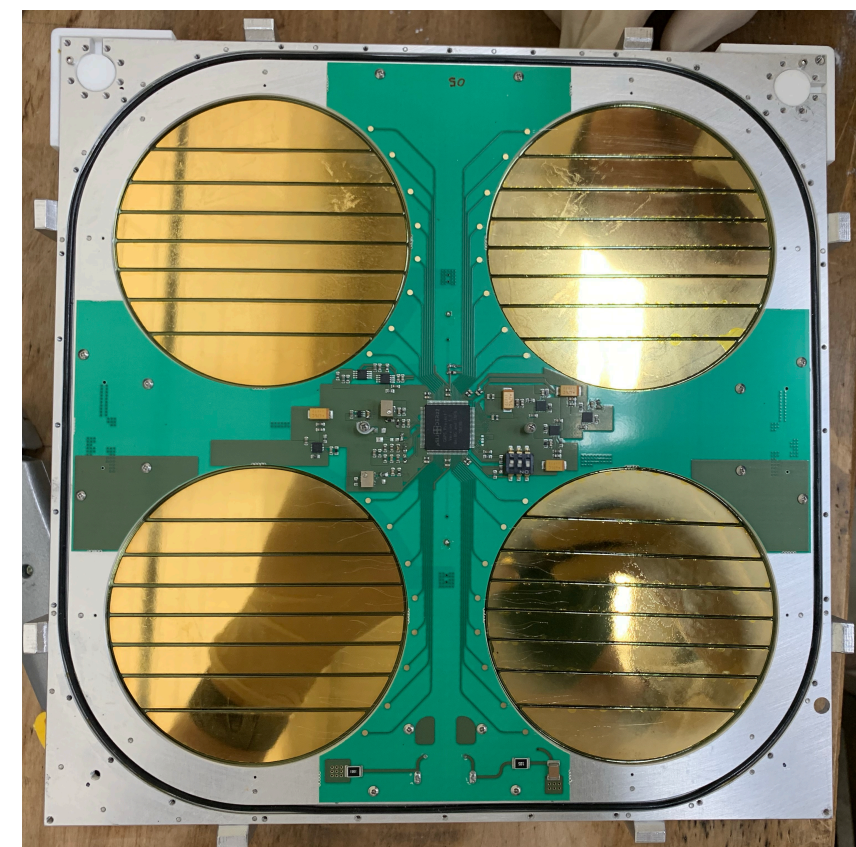
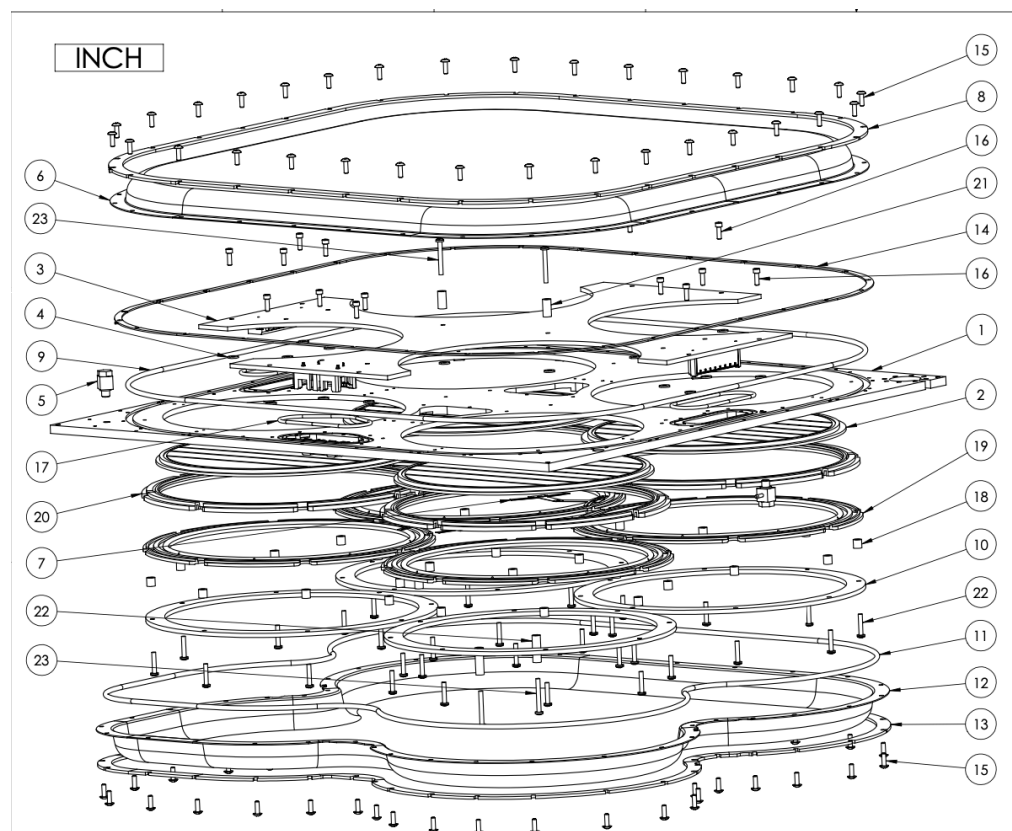
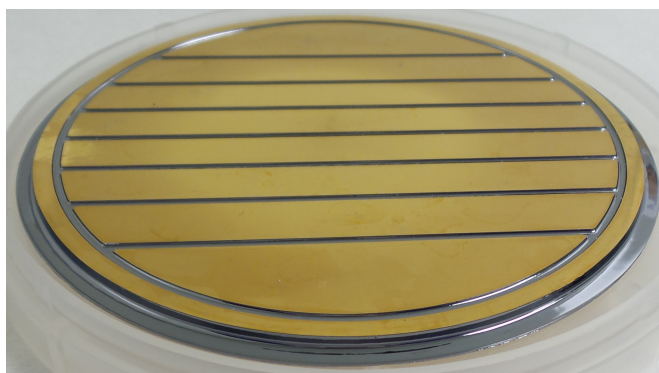
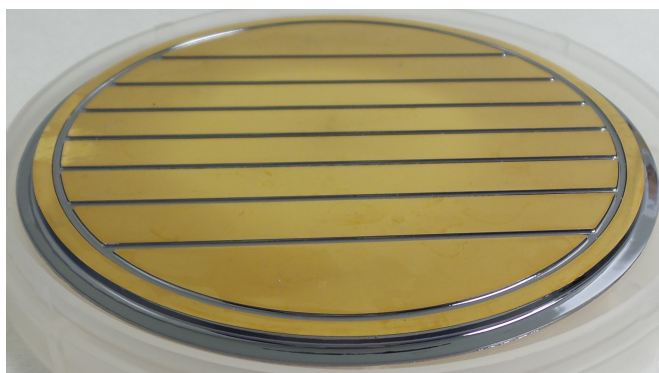
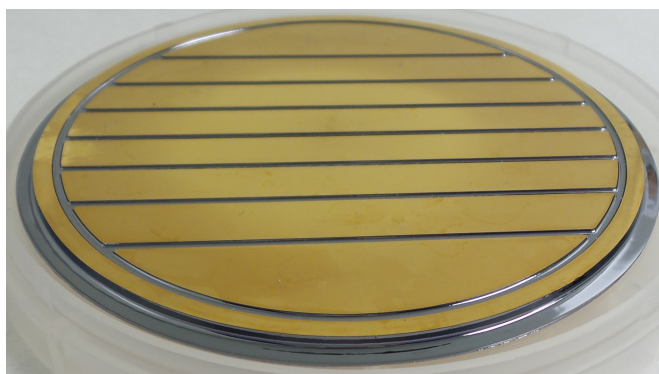
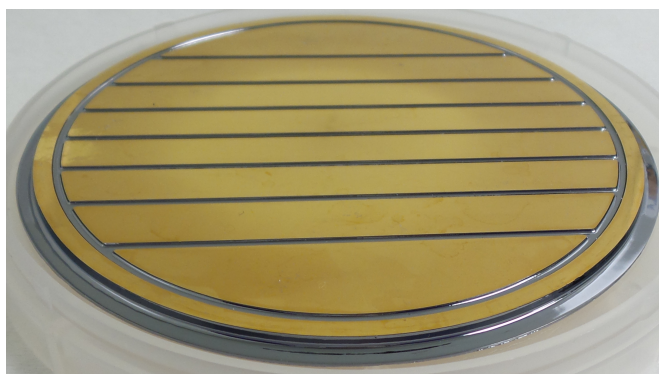
Building GAPS - Radiator



agenzia spaziale
italiana



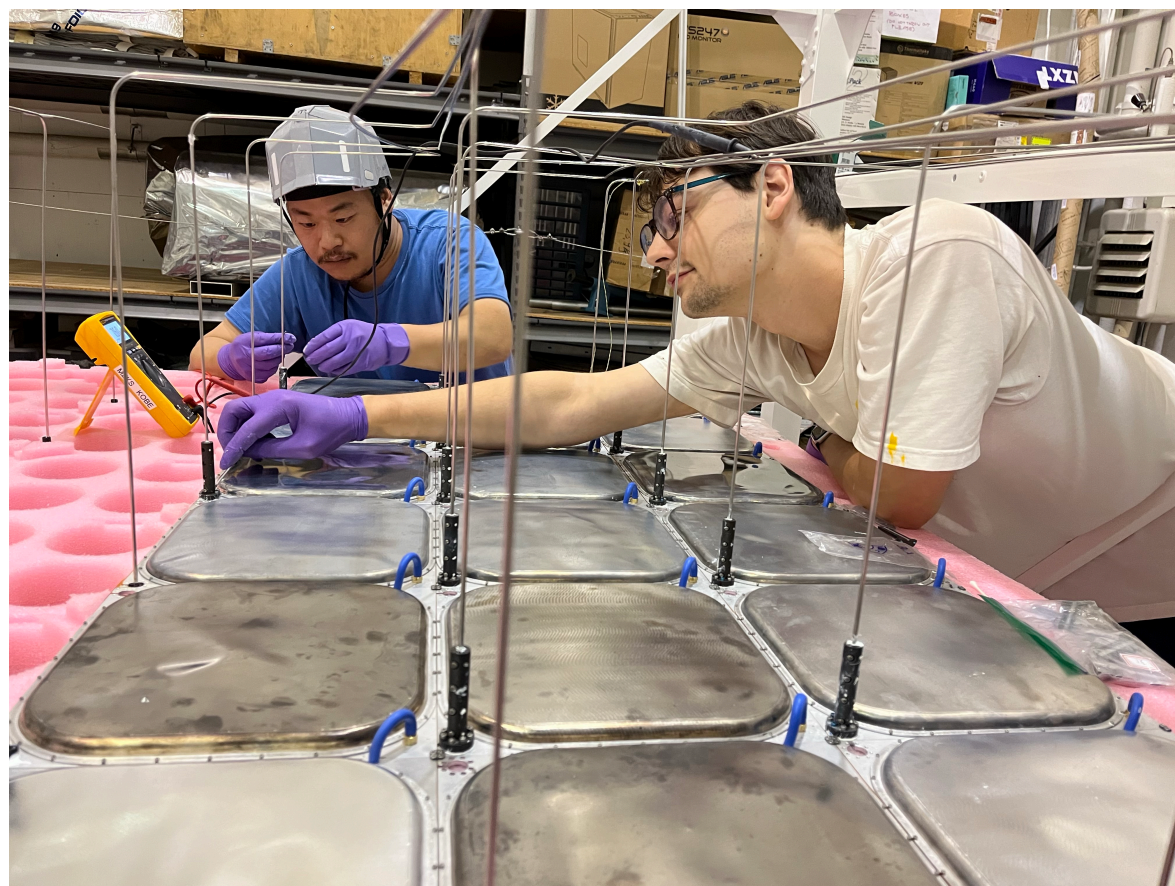
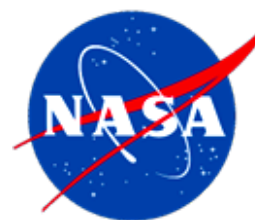
- 2x4 meter radiator to cool GAPS tracker
- Ground-cooling-system to cool the radiator on ground



- Detector modules with 4 Si(Li) detectors and front-end-board
- Modules assembled by Columbia in advance of and in parallel with integration



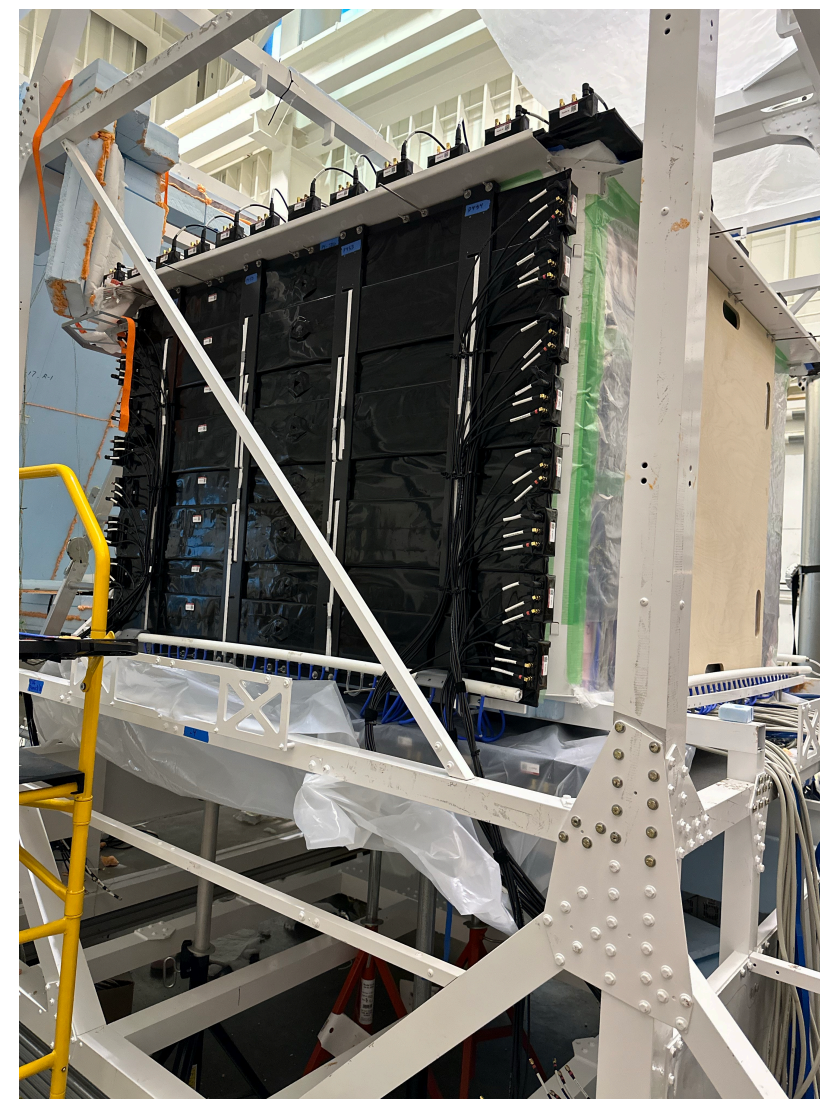
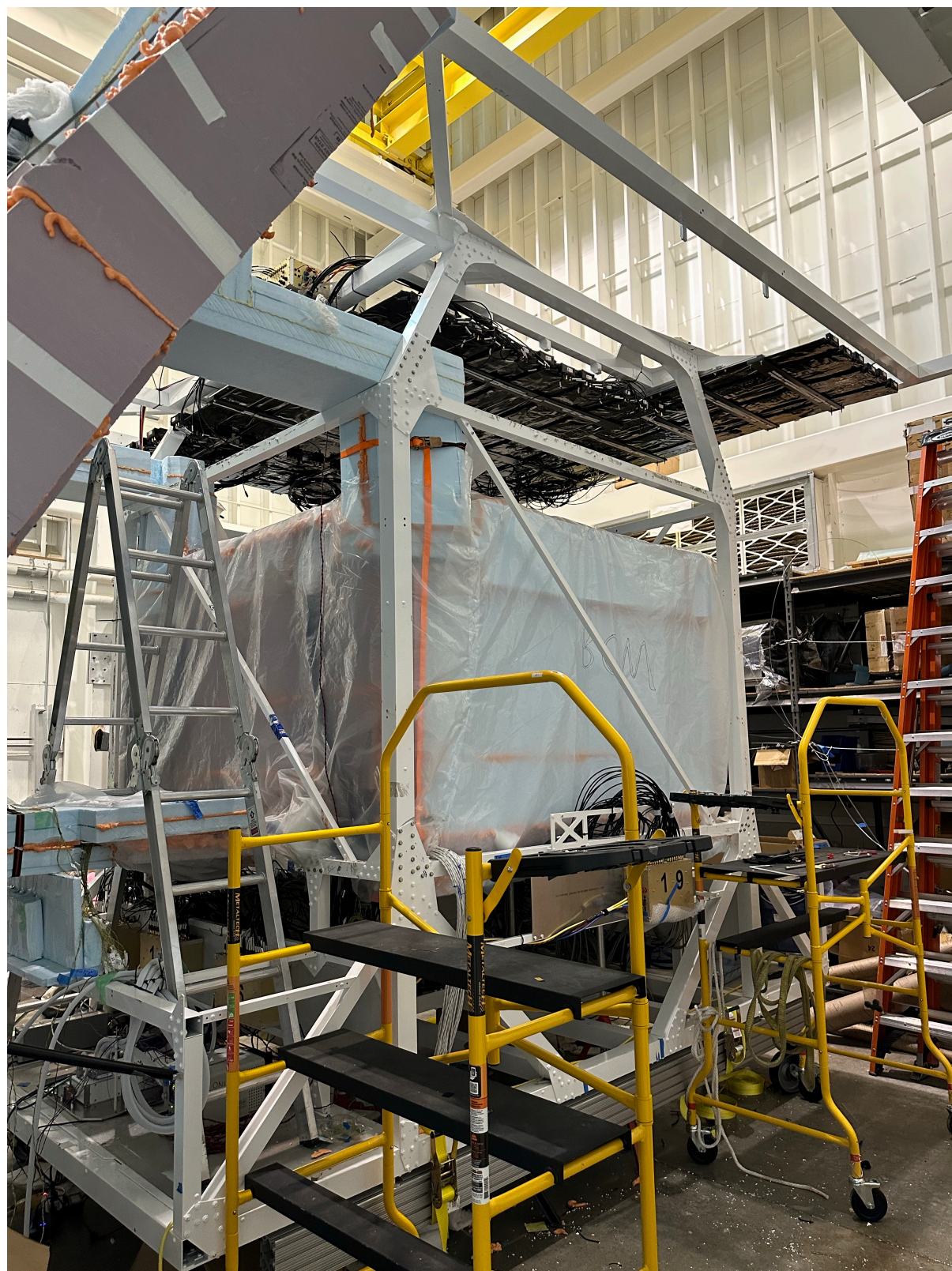
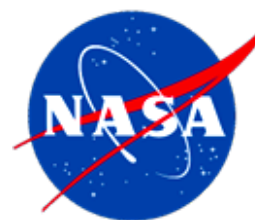
Building GAPS - Tracker



- 7 active layers * 36 modules * 4 detectors * 8 strips = 8,064 channels
- Successfully cool instrument on ground to operational temperatures (-25° C to -40° C)
- Gathered extensive calibration data on every channel during integration



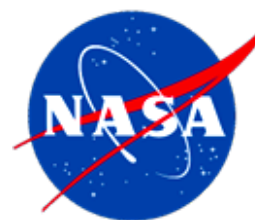
Building GAPS - TOF



- TOF Panels assembled at UCLA, integrated at UCB
- Partially assembled TOF Umbrella



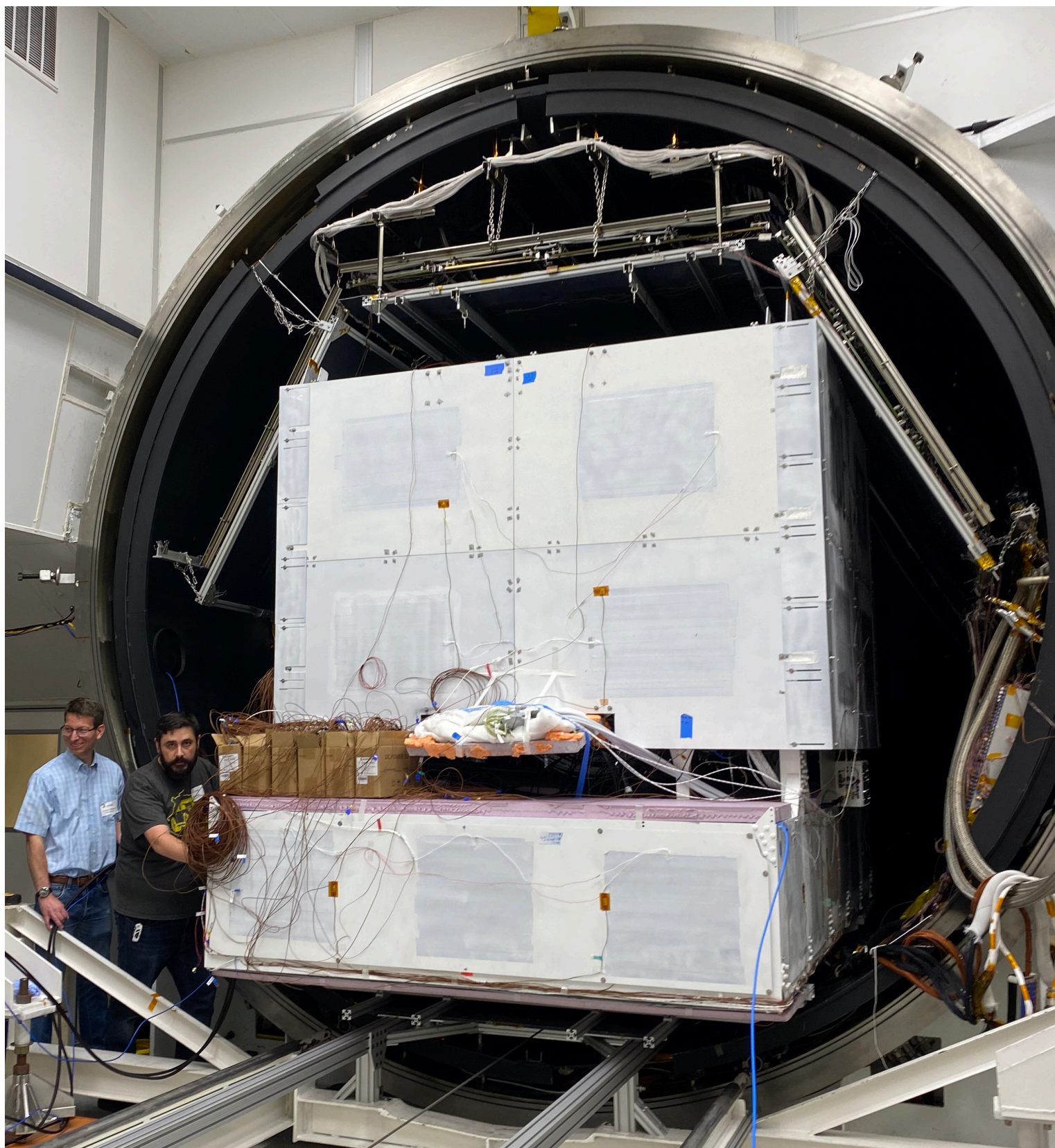
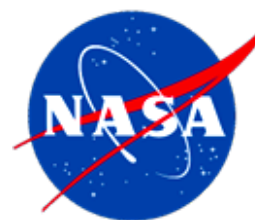
Building GAPS



- March 2022 -> May 2023 for Integration
- Subsystem calibrations
- Joint operation of TOF and Tracker with triggering and event merging



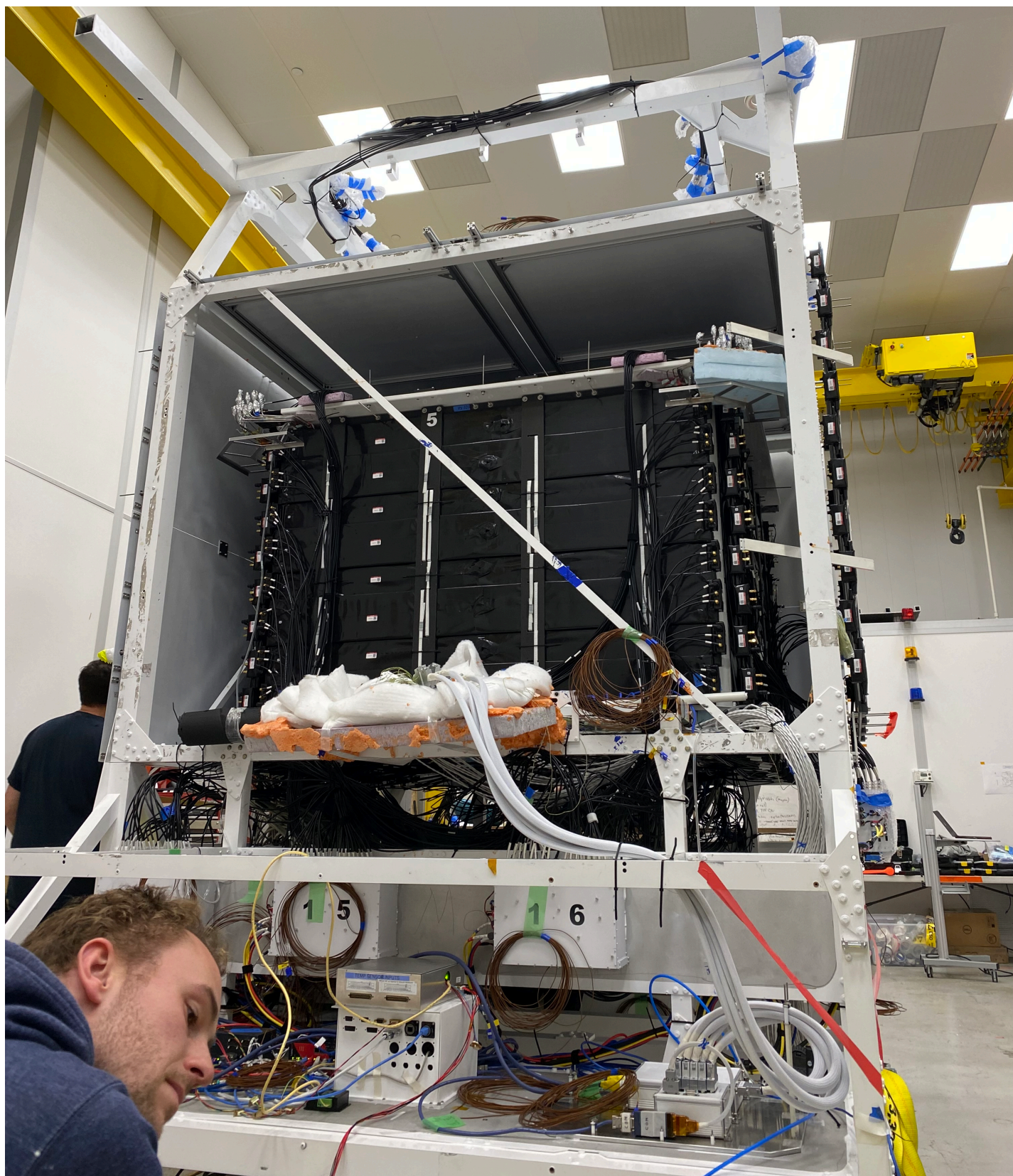
GAPS has been successfully TVACed



- Reduced payload: Inner TOF, tracker, and flight electronics
 - No outer TOF, Radiator, or solar array
 - Radiator tested at JAXA, TOF at Palestine
 - Heater panels to control thermal environment
- Two tests: test of full system and test of tracker cold (without TOF)



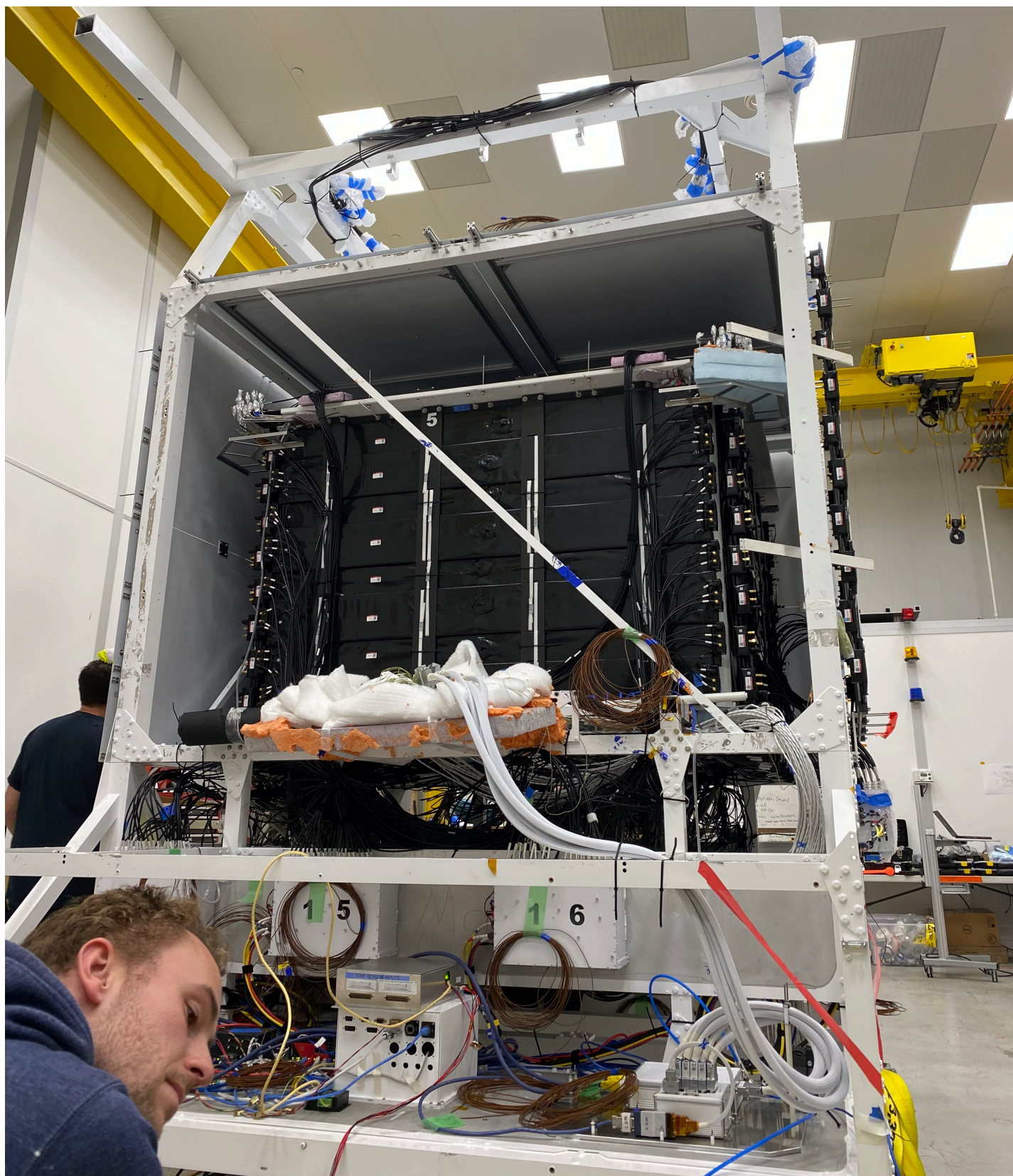
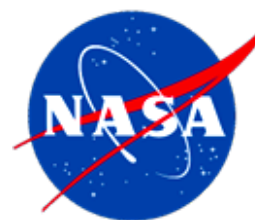
GAPS has been successfully TVACed



- **Test 1: Full reduced payload**
- Operate payload in 'hot' and 'cold' case (defined by limits of expected temperatures in flight)
- Trigger and read out data from TOF + Tracker
- Unable to bias tracker detectors



GAPS has been successfully TVACed



- **Test 2: Reduced payload without TOF**
- **Cool all layers down to operational temperatures (-25° C max)**
- **Measure cosmic muons on all layers**



GAPS has been successfully TVACed



GAPS Thermal Model Validated

- ~72 hours of full-instrument operation
- Temperature range between +20° C and -20° C
- Radiator TVAC testing done by JAXA
- Every component has been independently TVACed

GAPS Operated in Vacuum

- ~48 continuous hours of tracker operations during test 2 (~ 1 TB of data)
- Preliminary results: no significant changes in detector performance at vacuum

GAPS Operated Remotely

- Controlled entire payload through flight computer for duration of test
- Successfully power cycle payload



GAPS will fly in 2024

