全天MeVガンマ線衛星計画AMEGO-Xの現状 Status of an All-Sky MeV Gamma-ray Satellite, AMEGO-X

Background image by NASA, ESA, CXC, SSC, and STScl

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AMEGO-X: All-Sky MeV Gamma Satellite



- All-sky Medium Energy Gamma-ray Observatory eXplorer (PI: R. Caputo, GSFC/NASA) is a proposed MeV gamma-ray mission

 - structure of those jets?
 - Where are the **cosmic rays** accelerated in the **Galaxy**?

• Do supermassive black holes accelerate cosmic rays and produce neutrinos?

• How do binary **neutron star mergers** produce relativistic jets and what is the



AMEGO-X Gamma-Ray Telescope



Yusuke Suda

Status of an All-Sky MeV Gamma-ray Satellite, AMEGO-X

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AstroPix: Novel HV-CMOS Pixel Sensor 4/11



Pixel pitch Full depletion $500 \times 500 \ \mu m^2$ 500 µm Goal

- Designed by KIT
- Charge collection/amplification/readout co-integrated in substrate in pixel matrix







AstroPix Series

AstroPix2 AstroPix1



- AstroPix was developed based on MuPix and ATLASPix experience
- AstroPix3 is a full 2x2 cm² reticle chip with 500 μ m pixel pitch (= target values) and full digital readout capability
- Quad-chip (V3 x4) will be tested in space with a sounding rocket which will be launched in 2026 to increase the technical readiness level

AstroPix3

Quad-chip (Flight prototype)













AstroPix4



- capacitance \rightarrow Lower noise floor and better energy resolution
- Pixel-by-pixel comparator threshold tune \rightarrow ToT variation to be suppressed
- Individual hit buffer \rightarrow No identification problem with multiple hits in Row/Col
- Improved time stamp structure \rightarrow 3 ns for timing and ToT

• Reduced input capacitance by optimizing the routing and minimizing the metal-to-n-well



AstroPix4: Performance 1

Energy spectra in ToT



- Photopeaks in 14 122 keV (89% of pixels)
- Dynamic range: 14 ~250 keV



Energy spectra





AstroPix4: Performance 2

Energy resolutions



- Energy resolution: 14% @ 122 keV \leftrightarrow Goal: 10%
- Depletion depth: ~90 μ m \leftrightarrow Goal: 500 μ m Need higher resistivity chips for full depletion

Depletion depths





Next AstroPix

	Pixel pitch	Depletion de
Goal	500×500 µm²	500 µm
AstroPix4	500×500 µm²	~90 µm @ 24

- AstroPix5 is submitted
 - Full 2x2 cm² reticle chip
 - Updated guard ring design for higher breakdown voltage
 - Two test columns with high dynamic range CSA that should not saturate until > 700 keV
 - Reduced pixel capacitance





Prototype Telescope



- Demonstration of Compton and Pair reconstructions • Instrument integration, environmental testing in **2026**
 - → Long duration balloon flight



Tracker Segment — (10x per Tower) Connector Backplane Pre-Loaded Tension Rods Joining Plate Calorimeter Module



• ComPair-2 (PI: R. Caputo (GSFC/NASA)): AstroPix tracker + CsI calorimeter



Summary

- and the acceleration of cosmic rays in the Galaxy
- Development of the key component, AstroPix, is going well. AstroPix5 will come soon. Sounding rocket test flight in 2026
- We will build the prototype telescope in 2026 and demonstrate the **AMEGO-X** concept
- Resubmit in next MIDEX call, expected to happen in ~2027



• AMEGO-X will provide unique insight into the acceleration of protons and production of neutrinos near SMBHs, the nature of BNS mergers,

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