

Goddard
SPACE FLIGHT CENTER

AMEGO

ALL-SKY MEDIUM ENERGY GAMMA-RAY OBSERVATORY

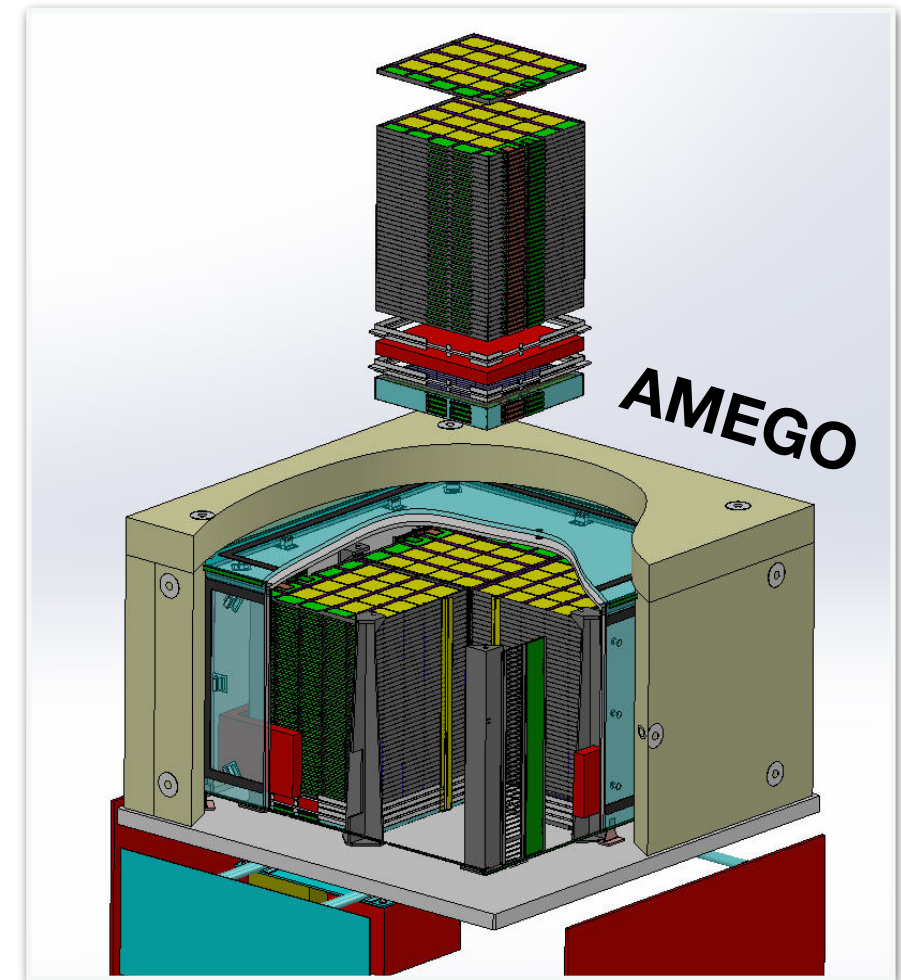
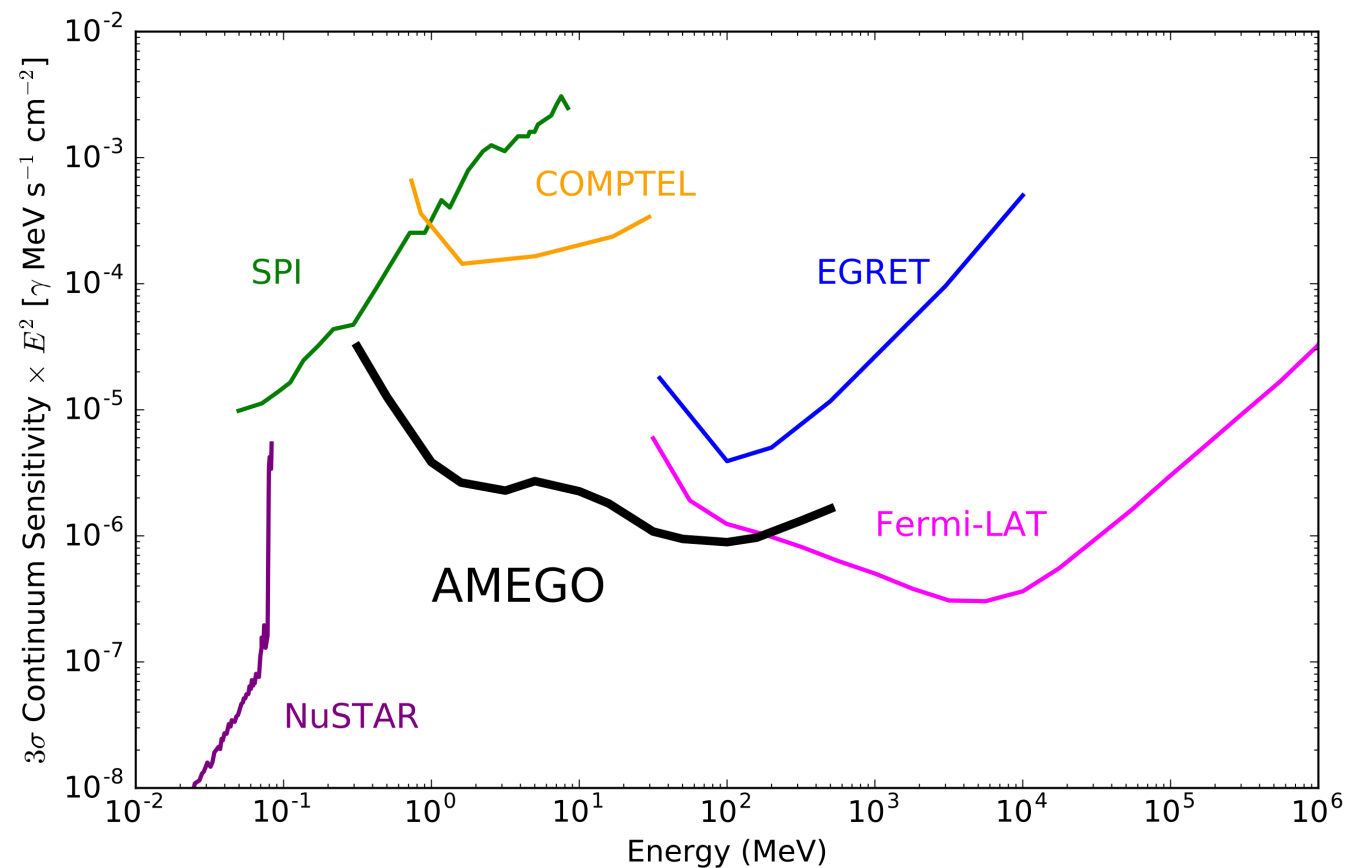
Carolyn Kierans^a on behalf of the AMEGO Team^b

^aNASA/GSFC, ^b<https://asd.gsfc.nasa.gov/amego/>

12th INTEGRAL Conference, 1st AHEAD Gamma-ray Workshop
February 14th, 2019

AMEGO – An Astrophysics Probe Mission Concept

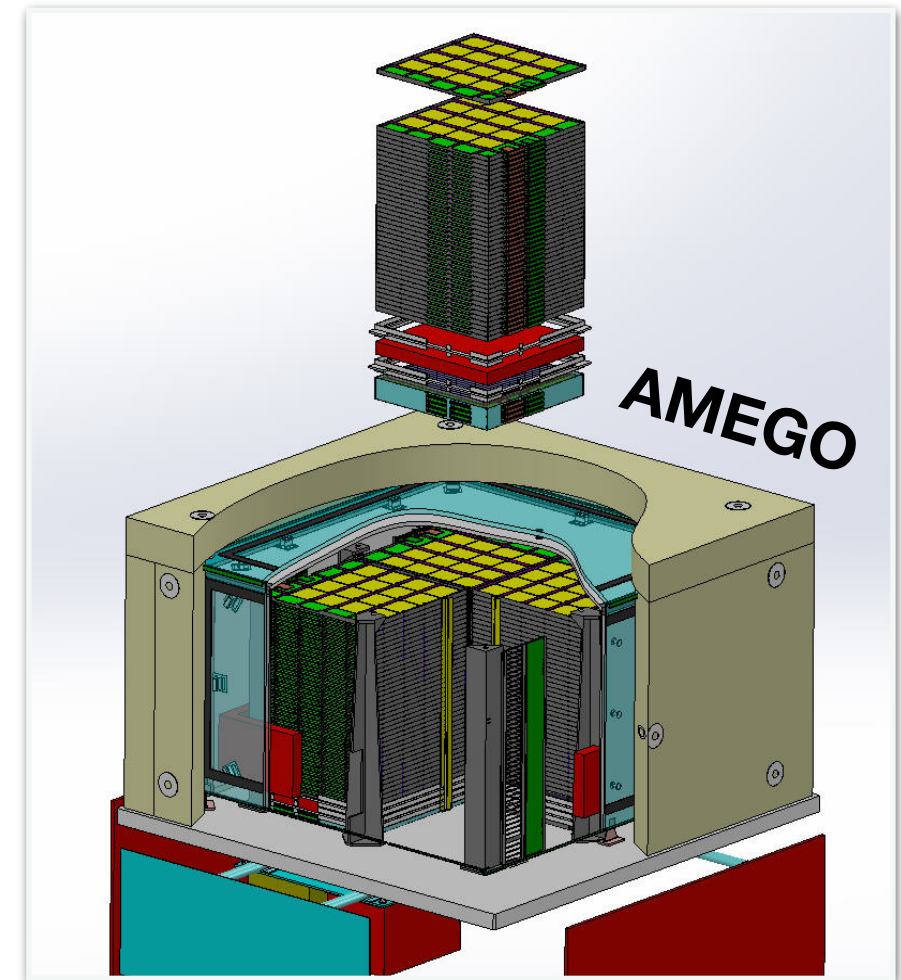
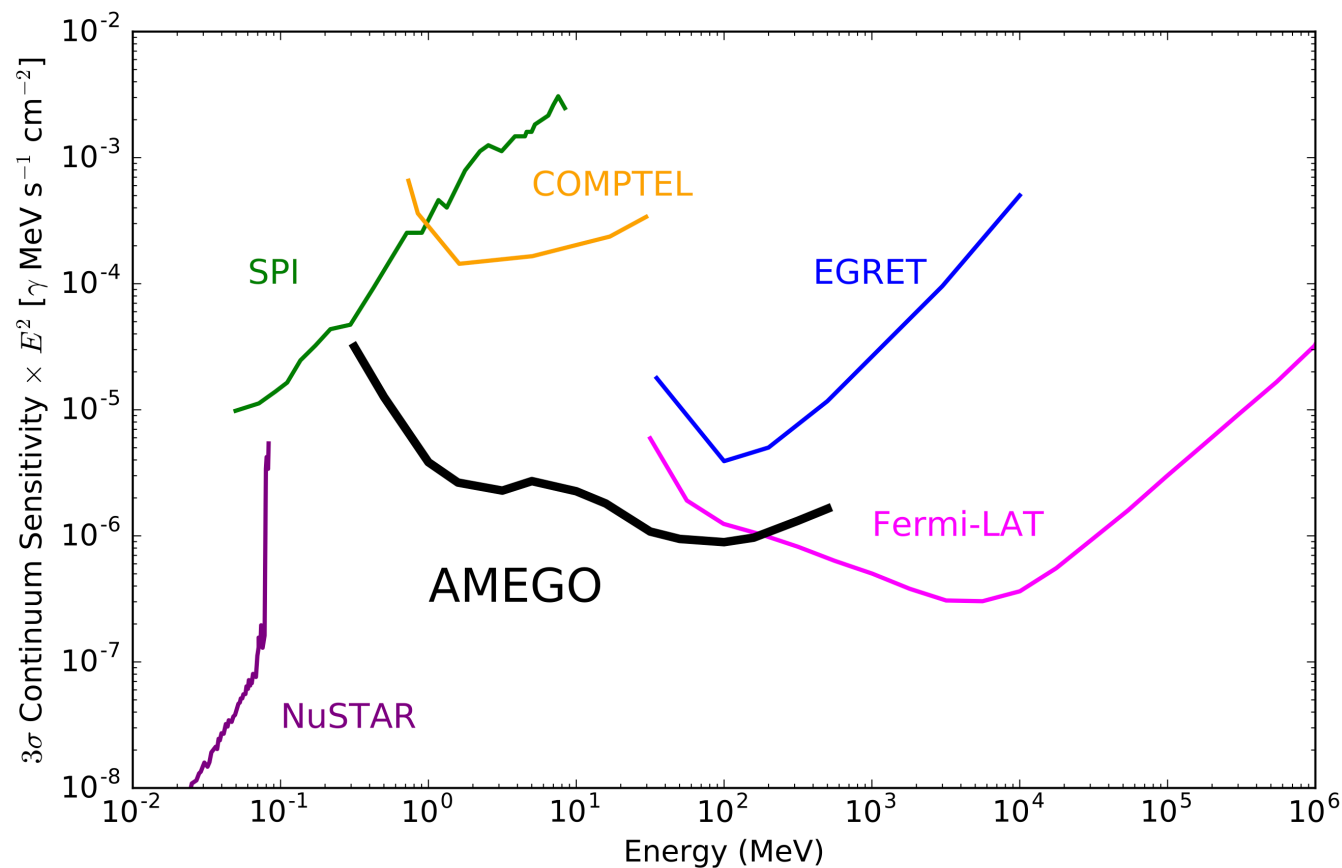
A Compton/pair instrument for future discoveries in multimessenger astrophysics



Energy Range	200 keV — >10 GeV
Angular Resolution	3° at 1 MeV; 10° at 10 MeV
Energy Resolution	1–5% at 0.2-100 MeV; ~10% at 1 GeV
Field of view	2.5 sr
Survey Mode	80% of sky per orbit

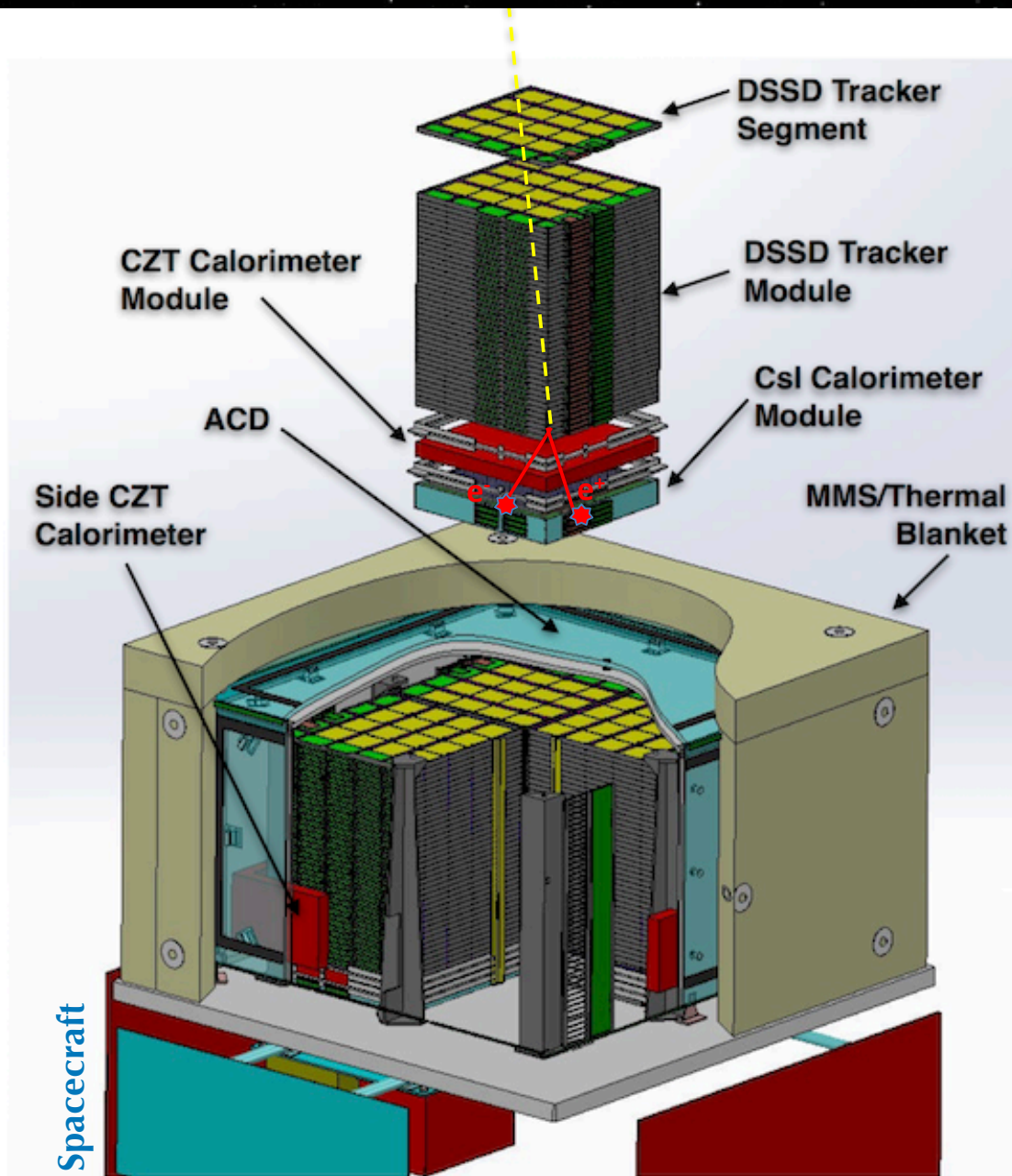
AMEGO – An Astrophysics Probe Mission Concept

A Compton/pair instrument for future discoveries in multimessenger astrophysics



Conclusion: wide field of view, broad energy range, and excellent continuum sensitivity
➡ optimal for multimessenger astrophysics while maintaining capabilities for MeV spectroscopy

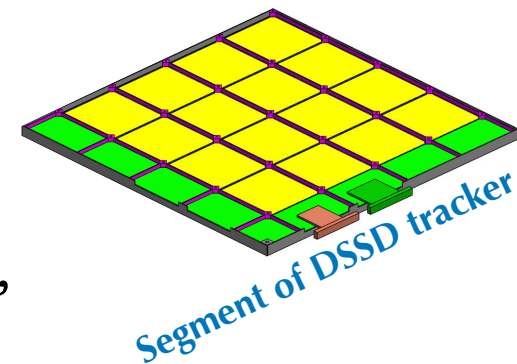
AMEGO – Instrument Concept



Silicon Tracker

Measures position and energy of Compton scattered electron or track of pair products

- 60 layers of 10 x 10 cm x 0.5 mm DSSD, 0.5 mm strip pitch



CZT Calorimeter

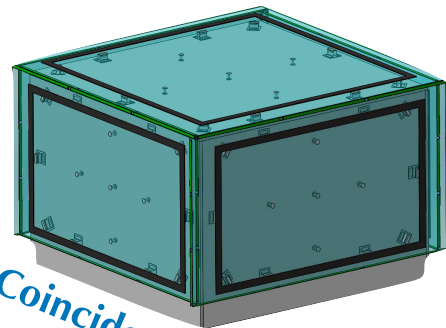
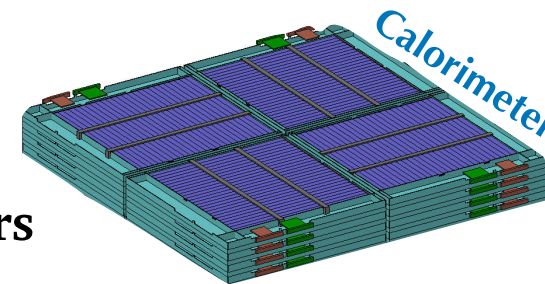
Measures location and energy of Compton scattered photons

- Array of 0.6 x 0.6 x 2 cm position sensitive CdZnTe bars

CsI Calorimeter

Contains the highest energy pair events

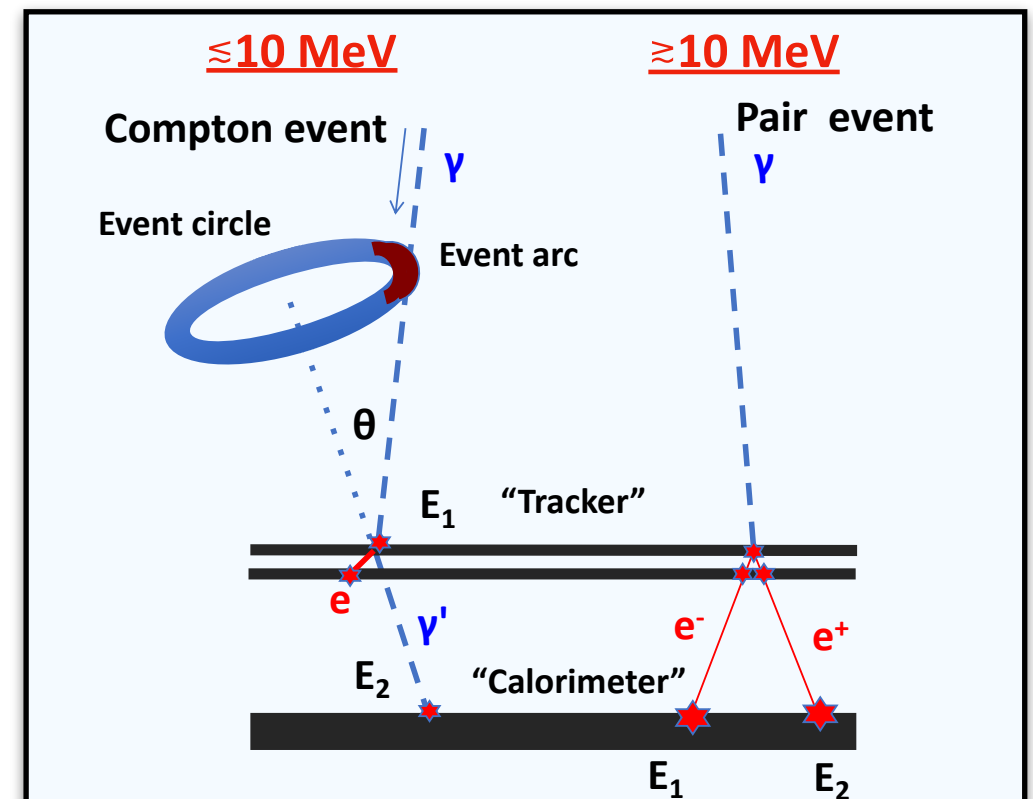
- 6 planes of 1.5 cm x 1.5 cm CsI(Tl) bars



Anti-Coincidence Detector

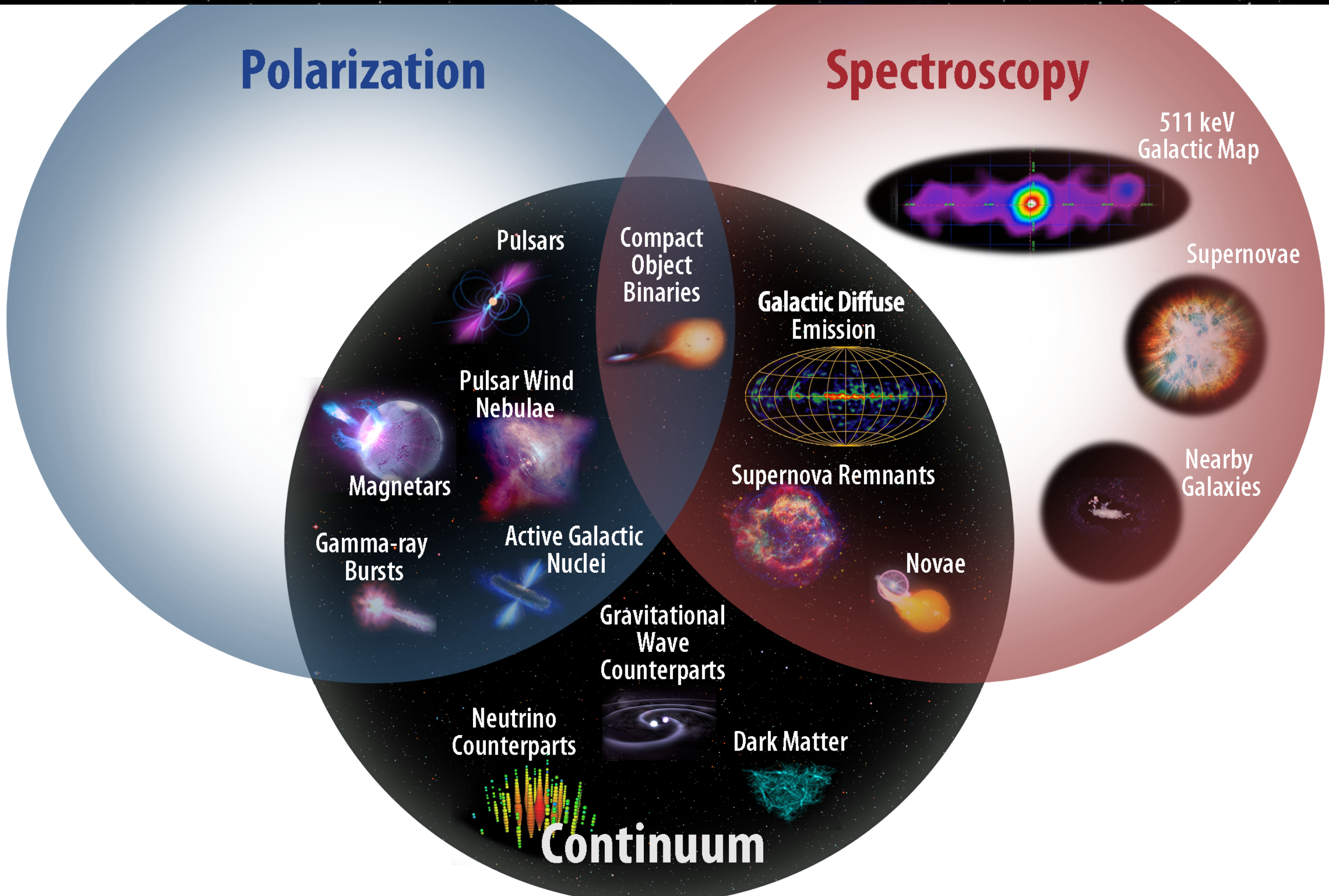
Vetos cosmic ray events

- plastic scintillator with SiPM readout



Polarization

Spectroscopy



AMEGO – Science: Gravitation Wave Counterparts

Polarization

Spectroscopy

**Gravitational
Wave
Counterparts**

Pulsars

Compact
Object
Binaries

Galactic Diffuse
Emission

511 keV
Galactic Map

Supernovae

Nearby
Galaxies

Remnants

Novae

Neutrino
Counterparts

Dark Matter

Magnetars

Gamma-ray
Bursts

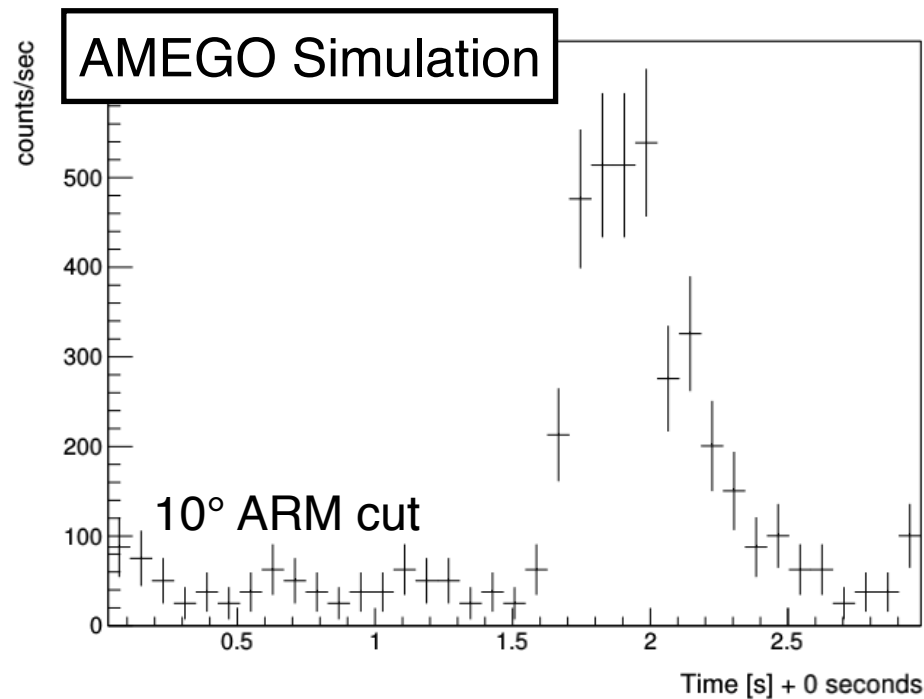
Pulsar
Nebulae

Continuum

AMEGO – Science: sGRBs as GW Counterparts

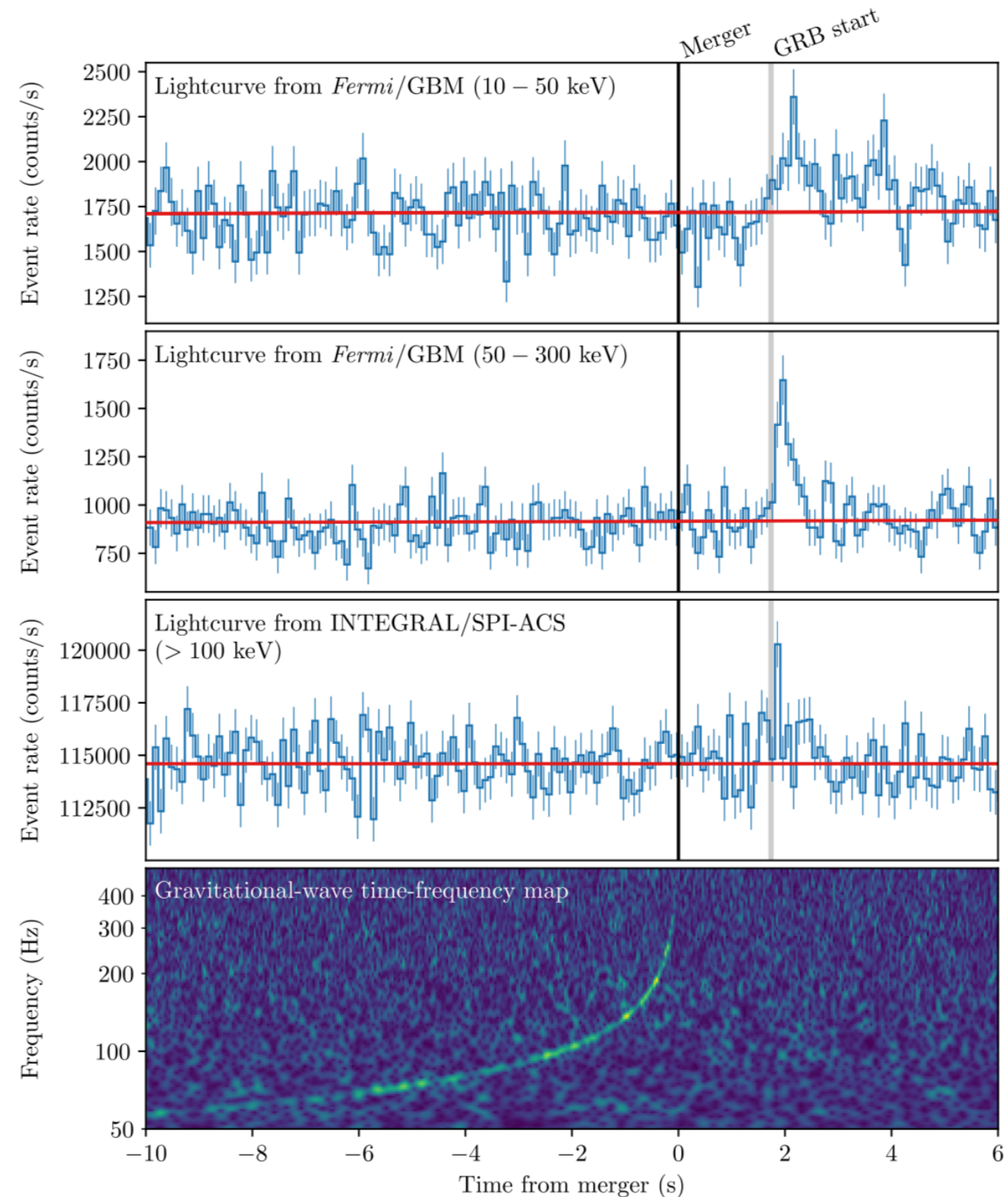
Detection of GW/GRB 170817A confirmed binary neutron stars as a progenitor to short GRBs

- Fermi/GBM onboard trigger out to 50 Mpc



- AMEGO detection out to 130 Mpc with $\sim 1^\circ$ localization

Larger detection volume;
 ~ 60 sGRB/year with localization

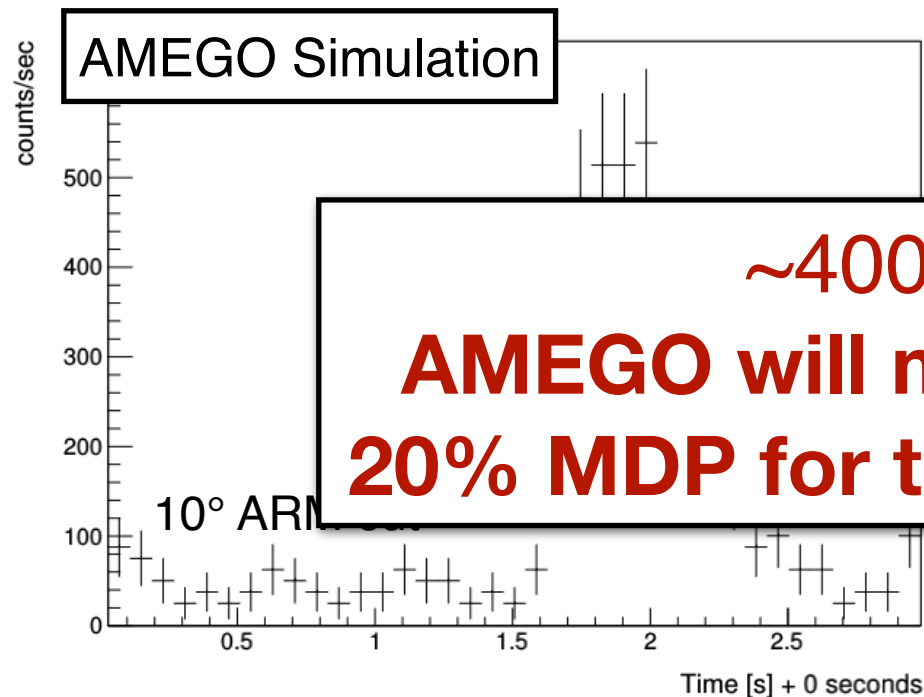


Abbot et al. 2017

AMEGO – Science: sGRBs as GW Counterparts

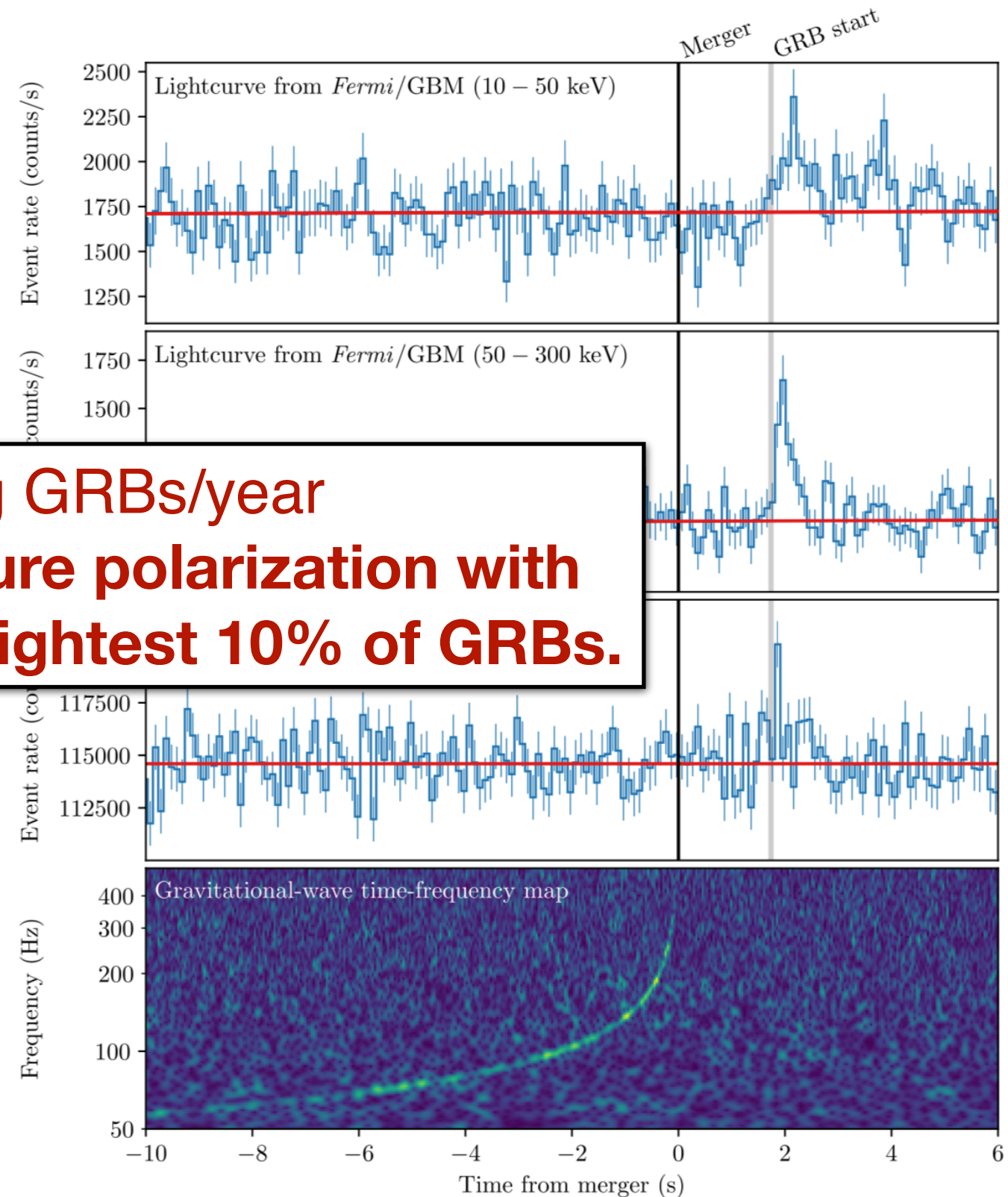
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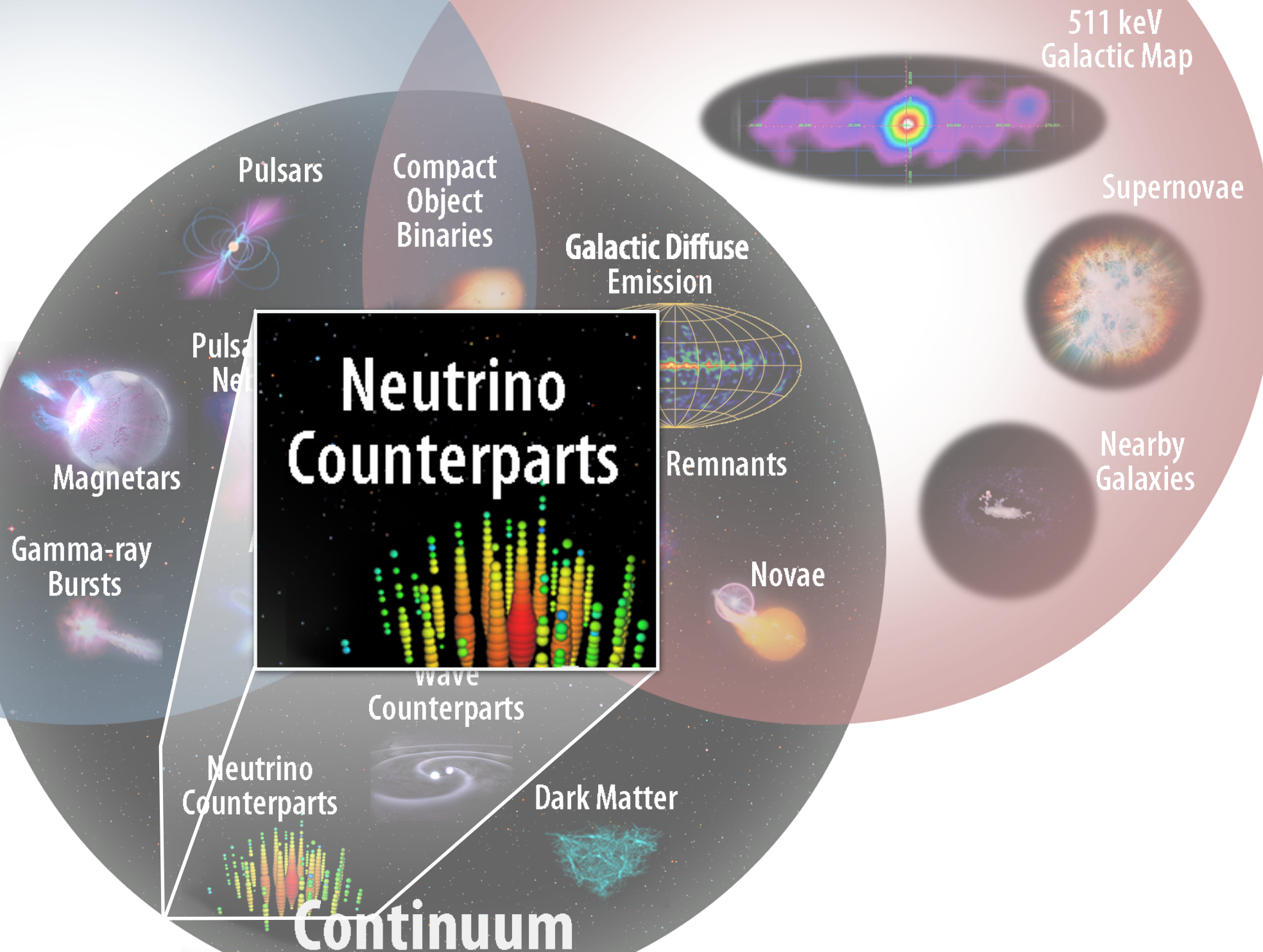
AMEGO – Science: Neutrino Counterparts

Polarization

Spectroscopy

Neutrino Counterparts

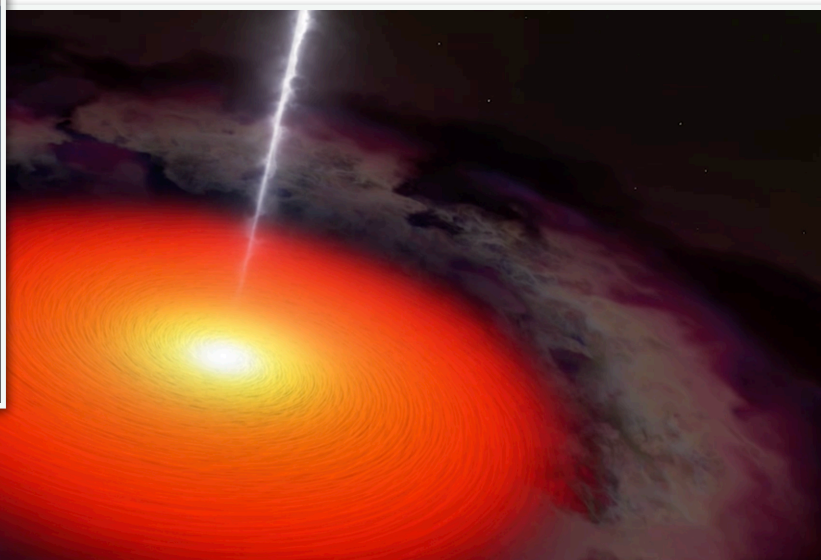
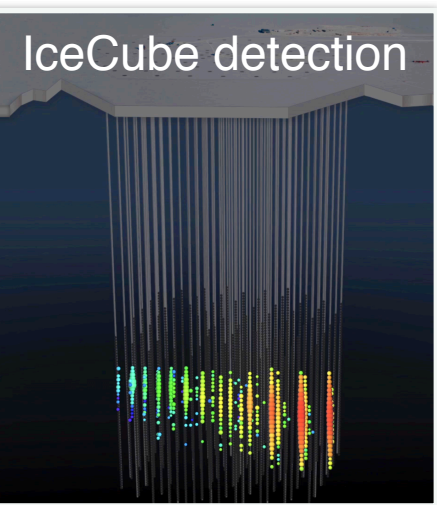
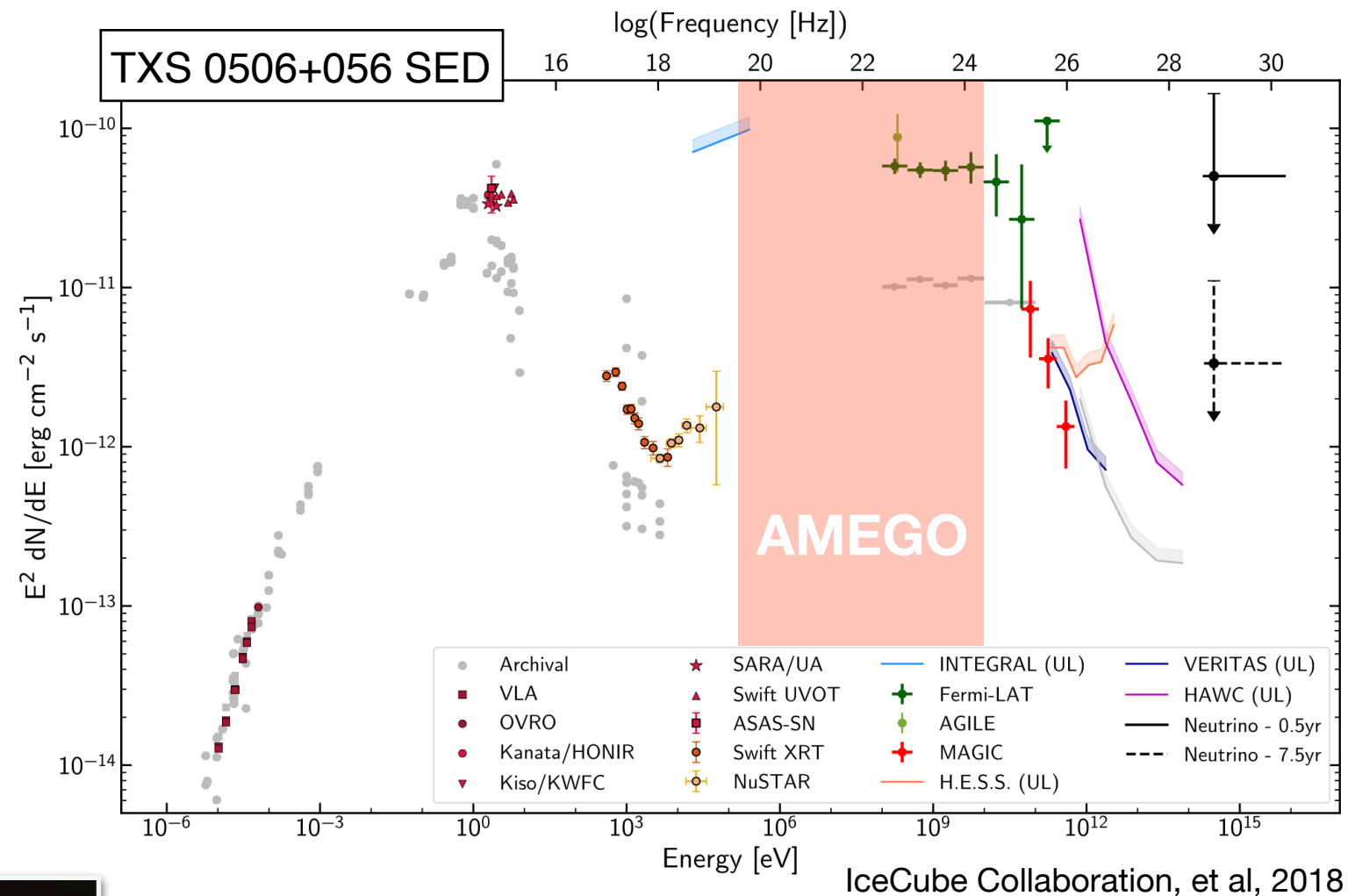
Continuum



AMEGO – Science: Neutrino Counterparts - Blazars

IceCube neutrino spatially and temporally coincident with Fermi/LAT flaring blazar detection

- the first known source of high energy astrophysical neutrinos
- indicates hadronic production in the jet
- SED peaks in the MeV



TXS 0506+056 flaring since April 2017

High redshift blazars population

- harbor most massive black holes
- persistent gamma-ray sources unobserved by Fermi/LAT
- peak power output $\sim 1\text{MeV}$

AMEGO will detect >500 blazars to $z \sim 6-8$

AMEGO – Science: γ -ray Line Spectroscopy

Polarization

Spectroscopy

511 keV
Galactic Map

Supernovae

Nearby
Galaxies

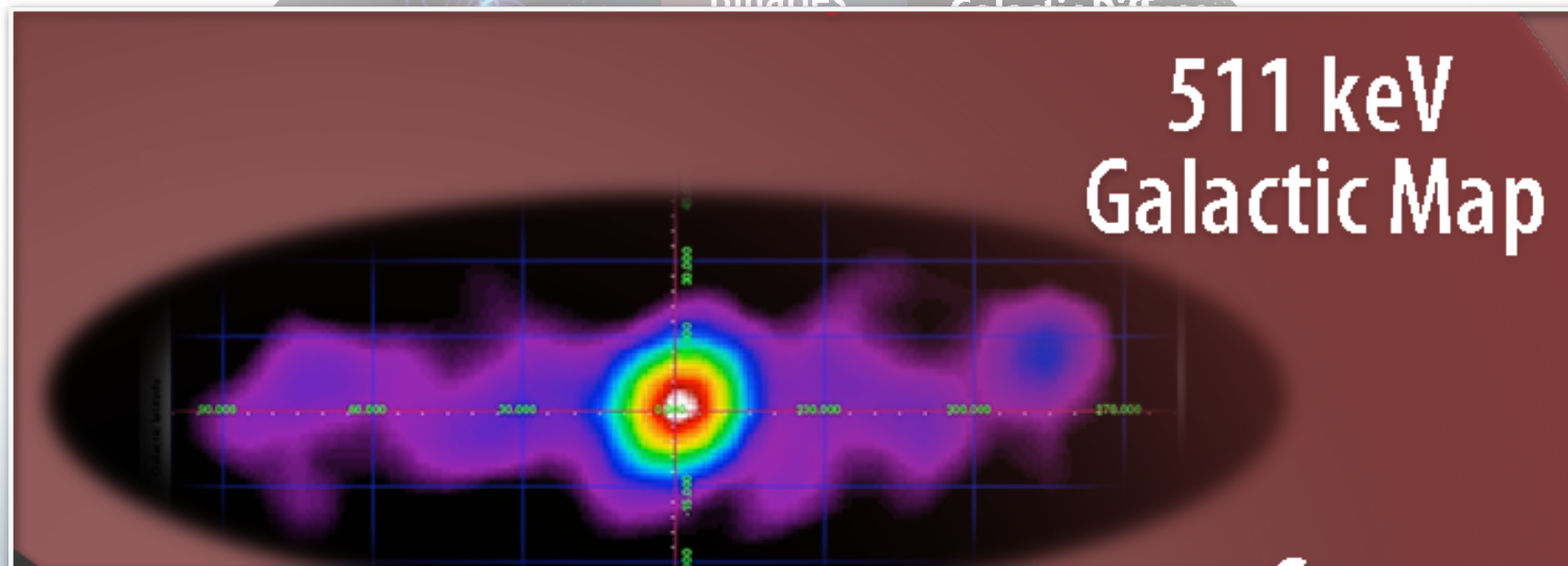
**511 keV
Galactic Map**

Gravitational
Wave
Counterparts

Neutrino
Counterparts

Dark Matter

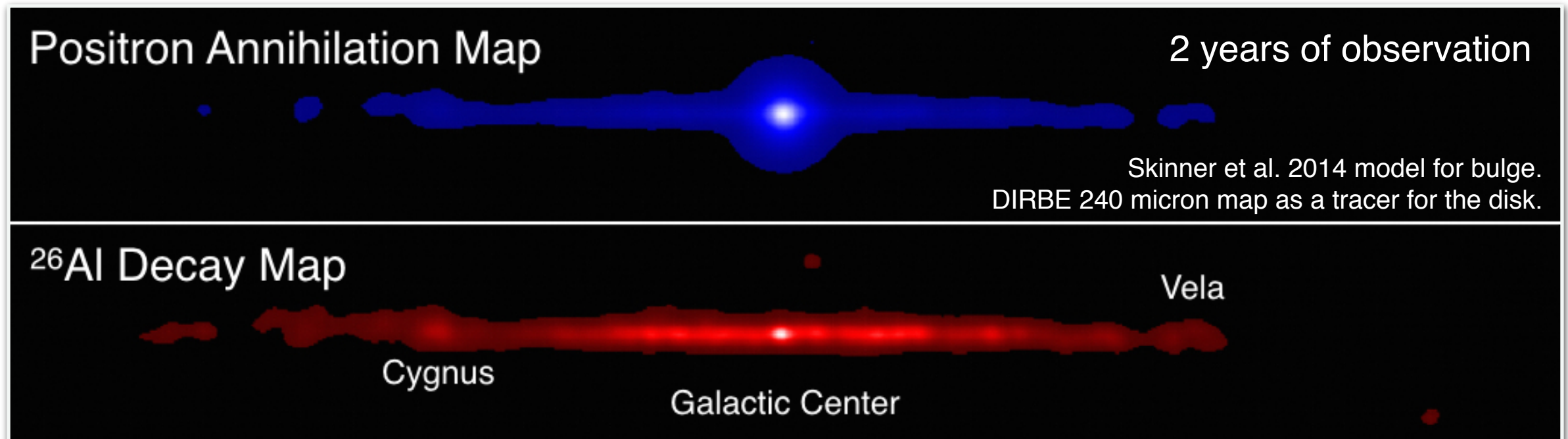
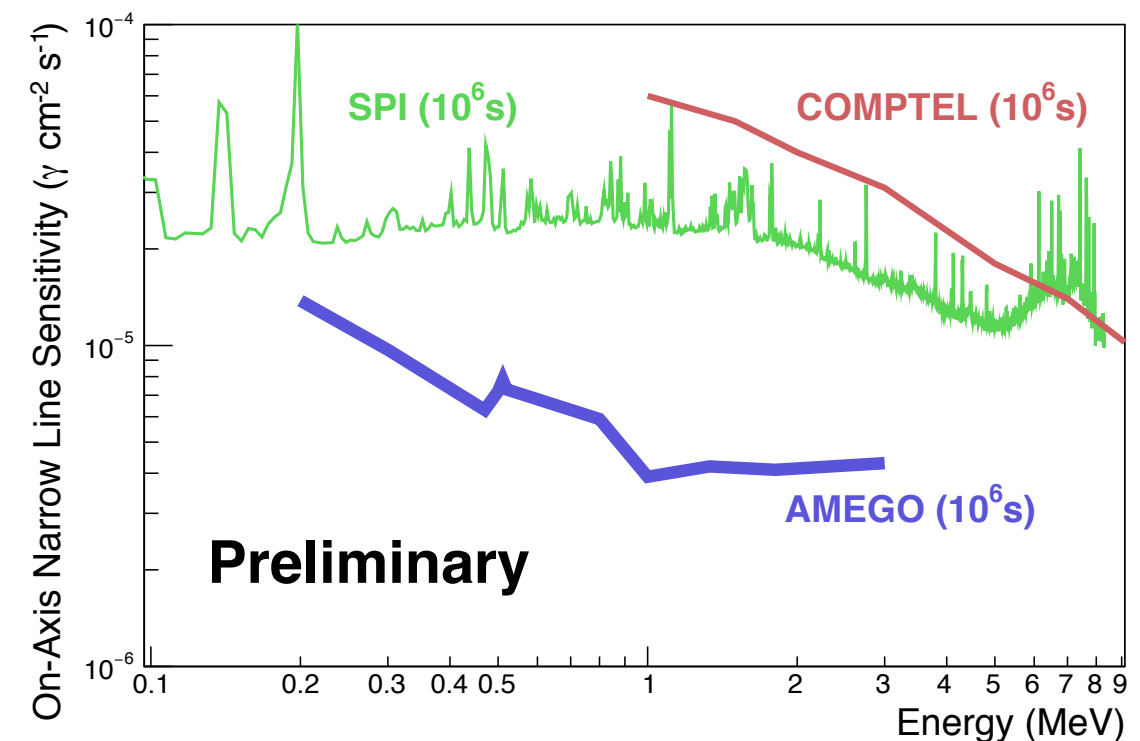
Continuum



AMEGO – Science: γ -ray Line Spectroscopy - 511 keV

Measurements from INTEGRAL/SPI show a strong 511 keV line from annihilation of Galactic positrons

- the source of positrons is highly contested
- propagation distances are unknown
- spatial distribution not well constrained

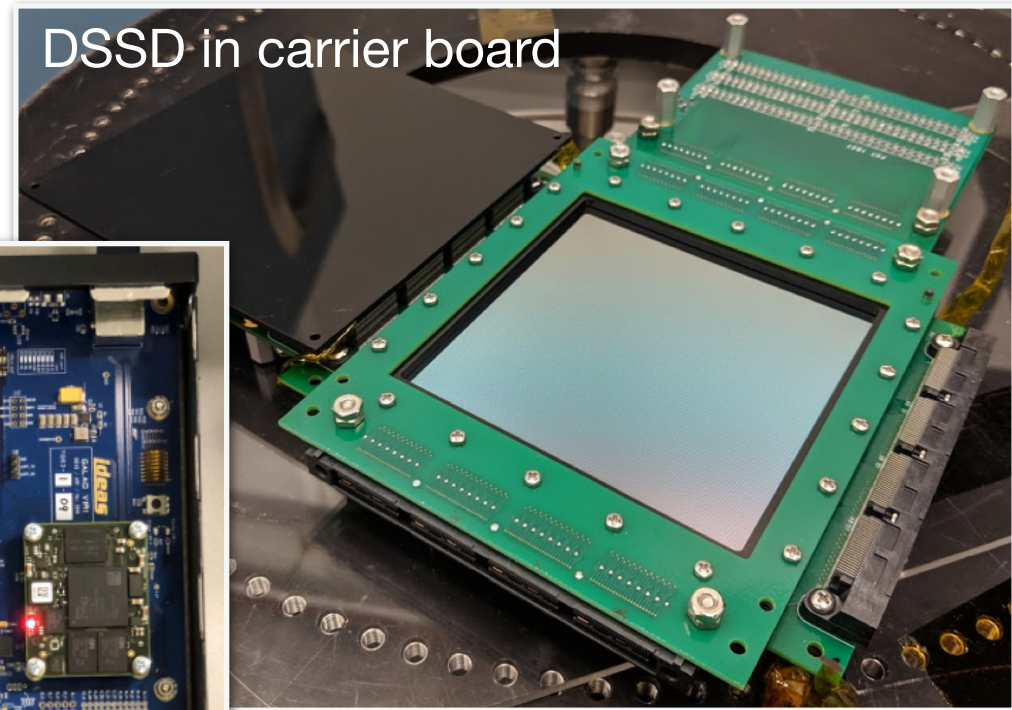
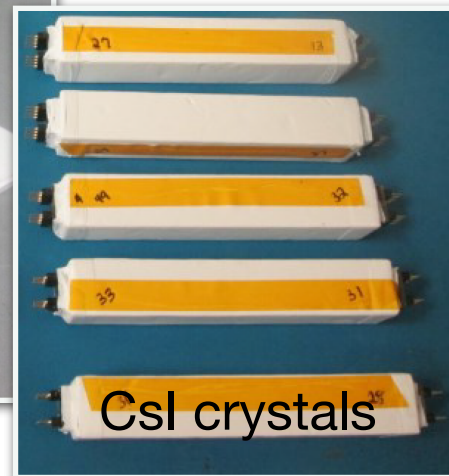
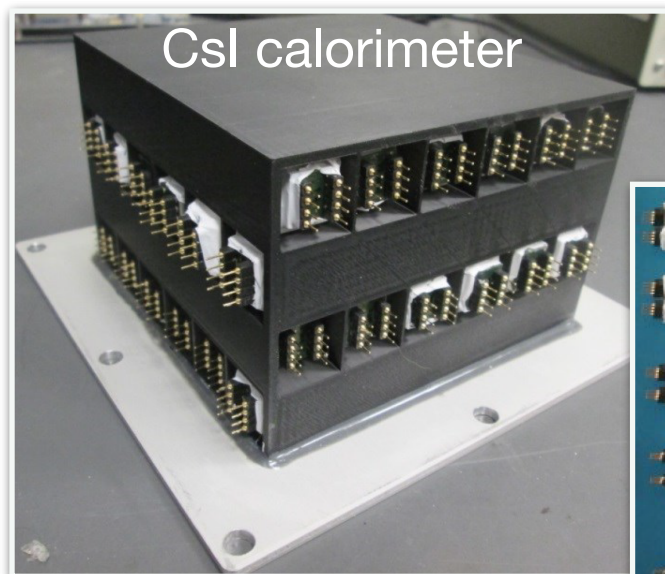


First all-sky, model-independent image of 511 keV emission

AMEGO – Current Development

Design and development of prototype instrument

- silicon tracker and ACD at Goddard Space Flight Center
- CZT calorimeter at GSFC and Brookhaven
- CsI calorimeter at Naval Research Laboratory

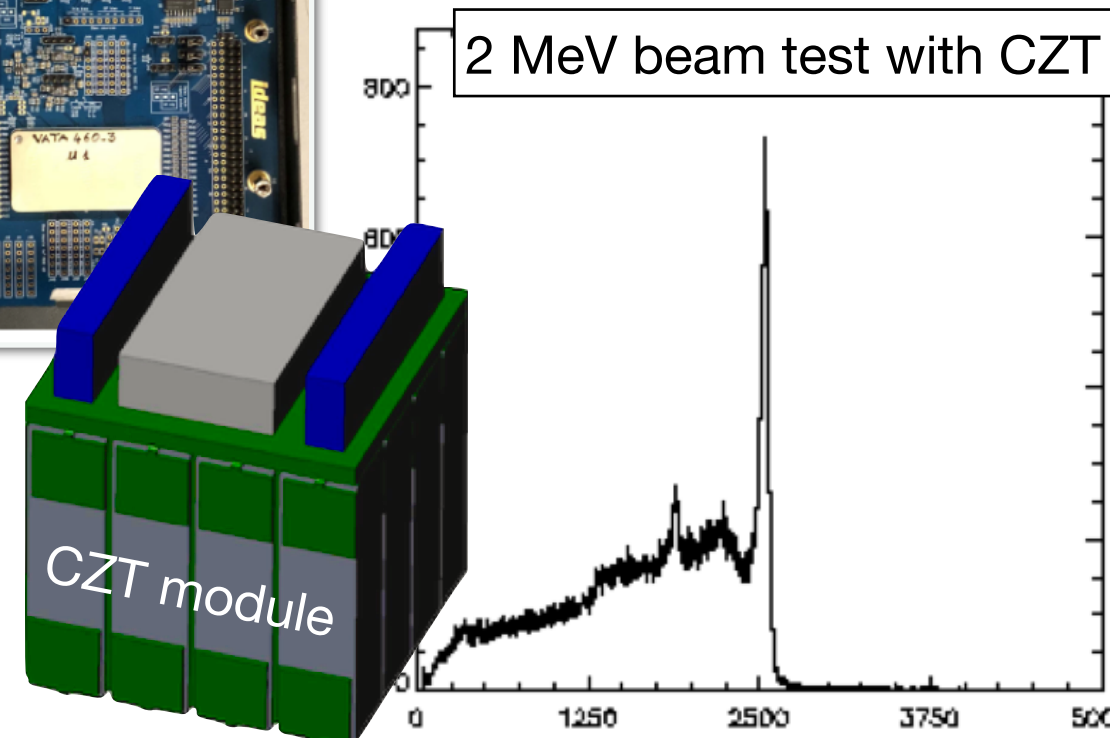


Beam tests in Fall 2019

- verify hardware and ability to reconstruct Compton and pair events
- validate performance and simulations

Balloon flight in Summer 2020

- verify operations in a space-like environment
- study backgrounds



AMEGO – Current Efforts

Astro2020 Science White Papers

- Positron Annihilation in the Galaxy
- Prospects for AMEGO Studies of Pulsars
- Neutrinos, Cosmic Rays, and AMEGO
- Gamma rays and Gravitational Waves Events
- Supermassive black holes at high redshifts
- Prospects for AGN Studies at Hard X-ray through MeV Energies
- A Summary of Multimessenger Science with Neutron Star Mergers
- Prospects for Galactic Cosmic Rays, Interstellar Medium, and Associated Gamma-Ray Emission Studies at MeV-GeV Energies
- Magnetars as Astrophysical Laboratories of Extreme Quantum Electrodynamics: The Case for a Compton Telescope
- Prospects for detection of synchrotron halos around middle-age pulsars
- High-Energy Polarimetry as A New Window to Unveil Cosmic Rays and Neutrinos in AGN Jets
- Catching Element Formation In The Act: The Case for a New MeV Gamma-Ray Mission: Radionuclide Astronomy in the 2020s
- etc...

AMEGO Mission White Paper to be submitted Summer 2019

Report to be released ~2022



AMEGO – Conclusions

AMEGO is a mission concept designed for multimessenger astrophysics.

Conclusion: wide field of view, broad energy range, and excellent continuum sensitivity

➔ **optimal for multimessenger astrophysics**
while maintaining capabilities for MeV spectroscopy

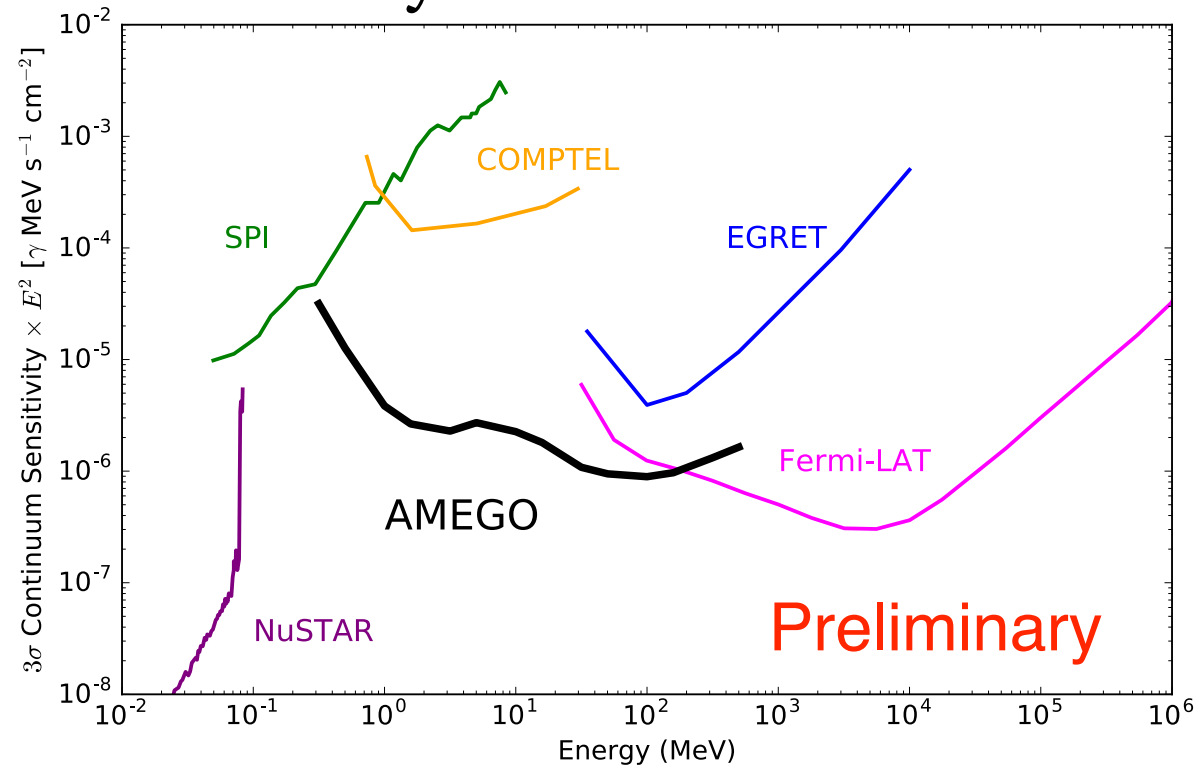


AMEGO
ALL-SKY MEDIUM ENERGY GAMMA-RAY OBSERVATORY

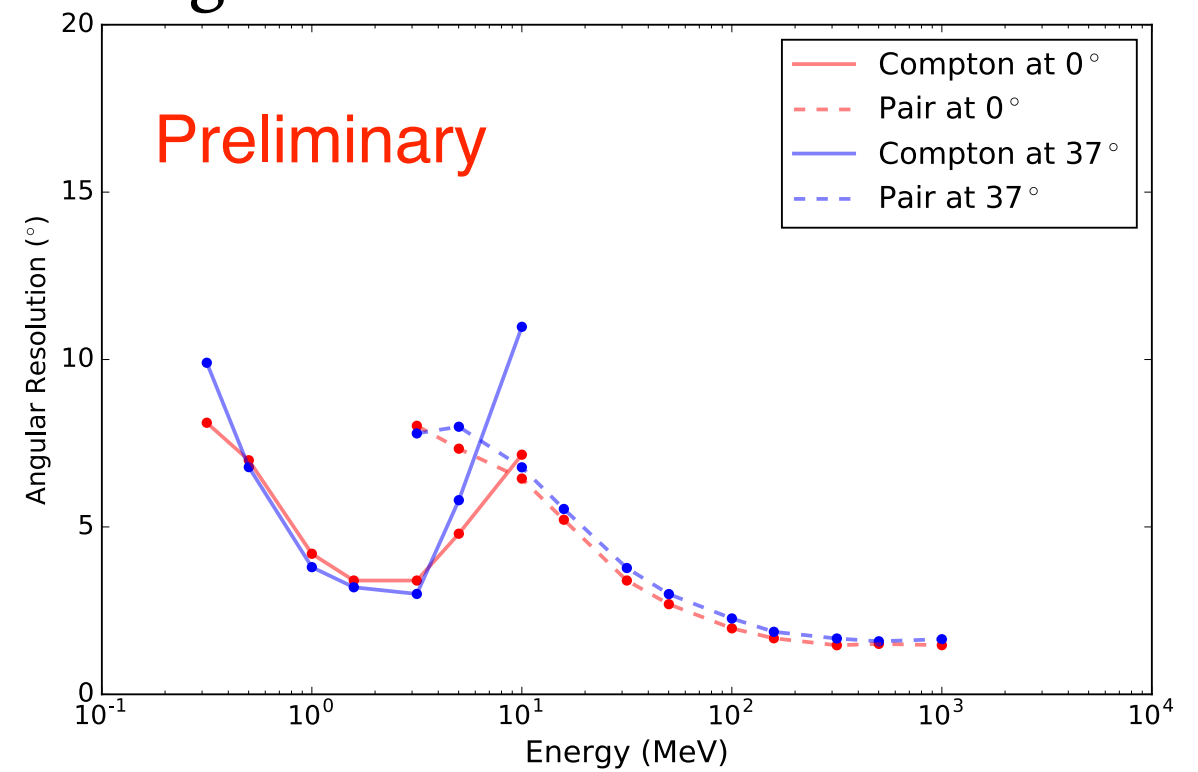
The logo features the word "AMEGO" in large, bold, black capital letters. To the right of the letters is a vibrant blue and purple nebula. Below the main text, the full name "ALL-SKY MEDIUM ENERGY GAMMA-RAY OBSERVATORY" is written in a smaller, blue, sans-serif font. The entire logo is set against a dark background filled with numerous small, distant stars.

AMEGO – Simulated performance via MEGAlib

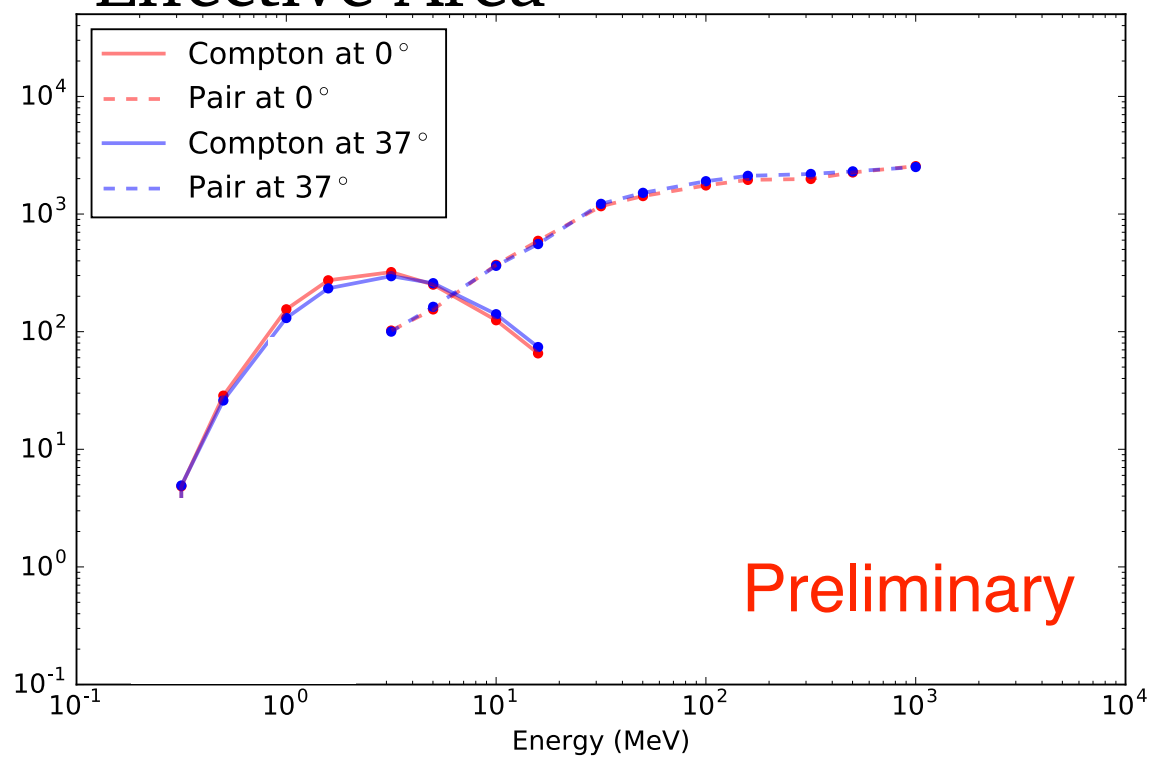
Sensitivity



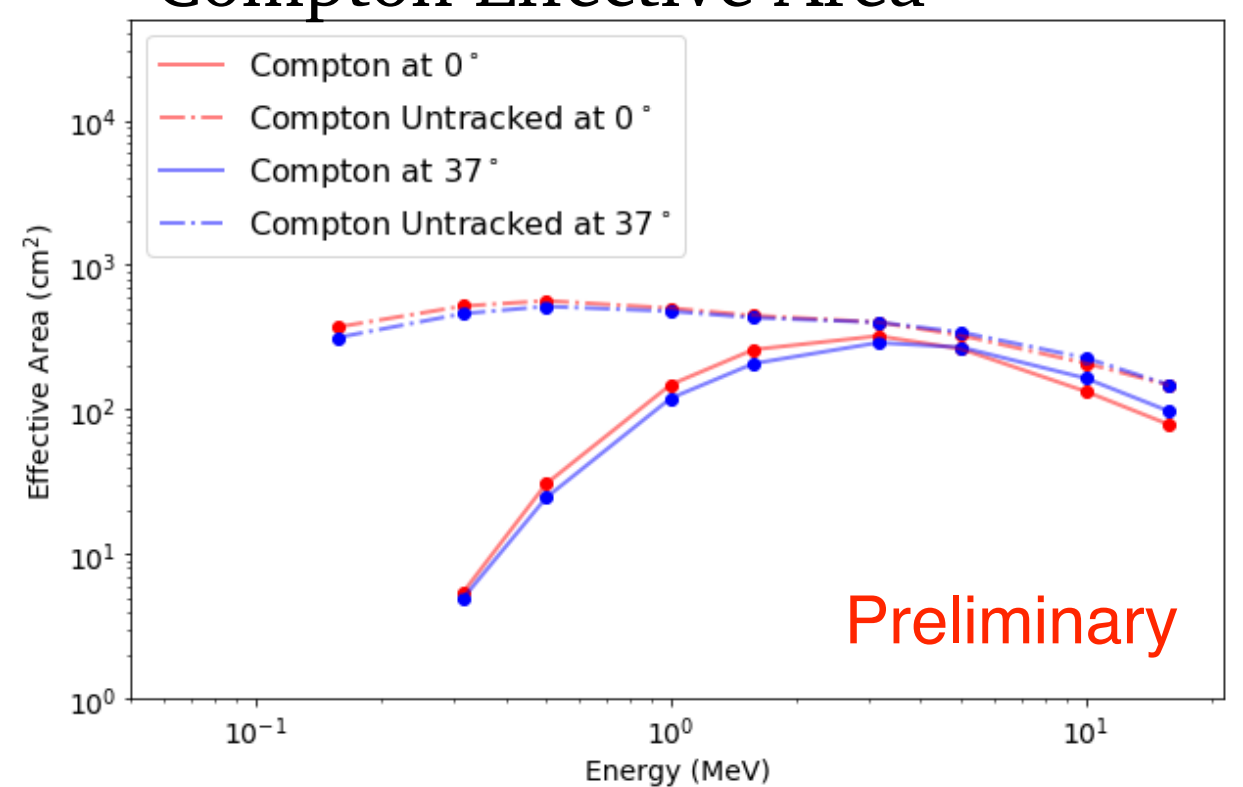
Angular Resolution



Effective Area



Compton Effective Area

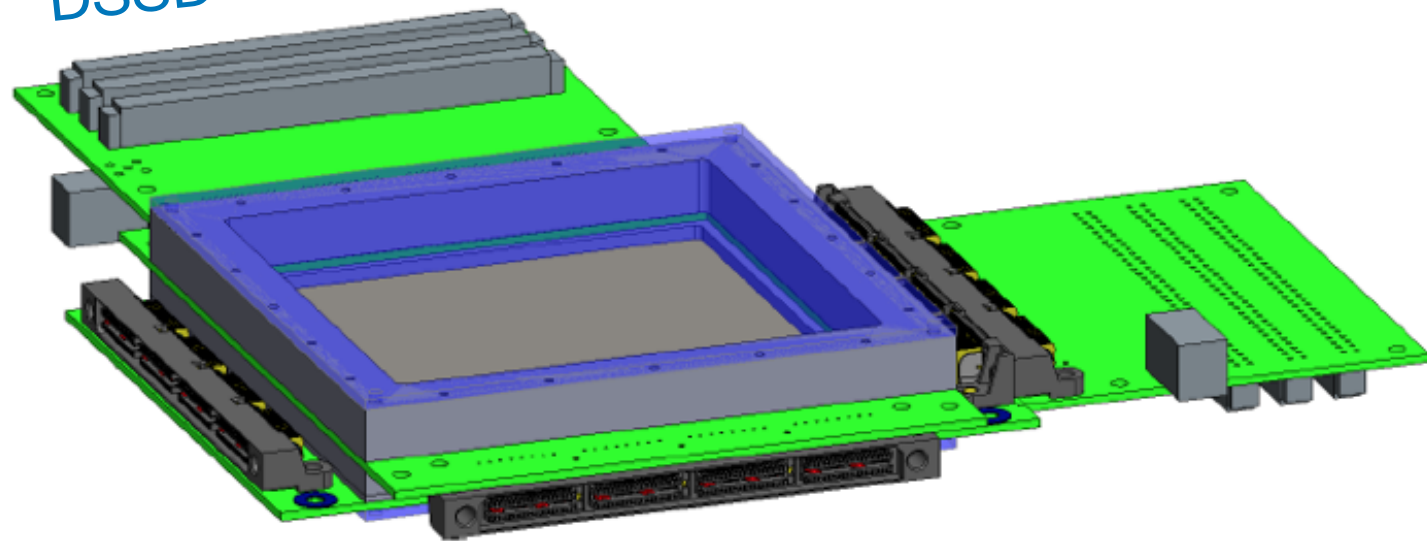


AMEGO – Prototype DSSDs

First wafers arrived September 2019 and testing is underway

- 10 x 10 cm x 500 μm
- AC coupled
- 192 strips
- 500 μm strip pitch

DSSD “carrier”



- electrical connections with elastomeric connectors
- detectors are removable and interchangeable
- designed to be daisy-chained

