



Introduction to Past and Future MeV Missions

Xilu Wang (王夕露)

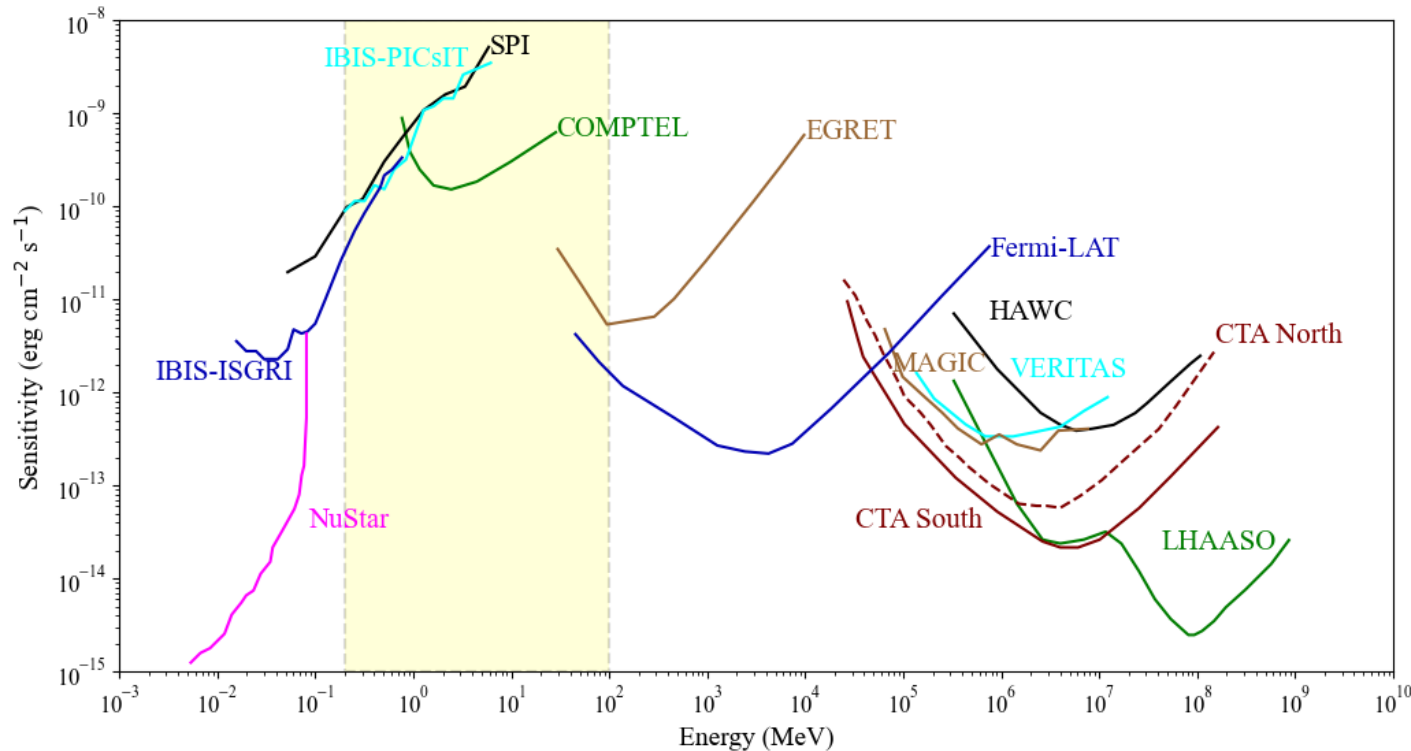
Institute of High Energy Physics, CAS

wangxl@ihep.ac.cn



中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

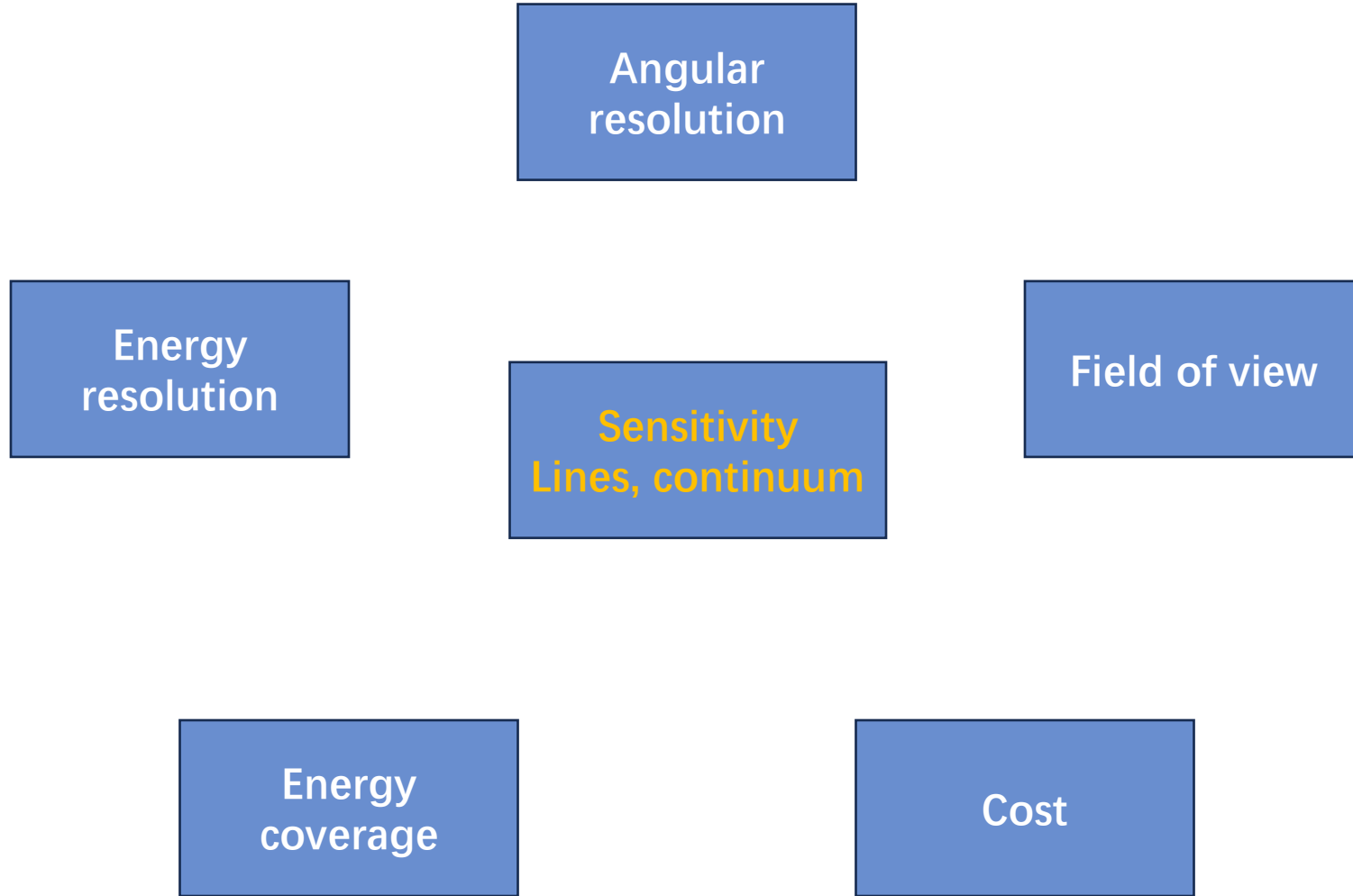
MeV Gamma Ray - An important window in multi-messenger observation



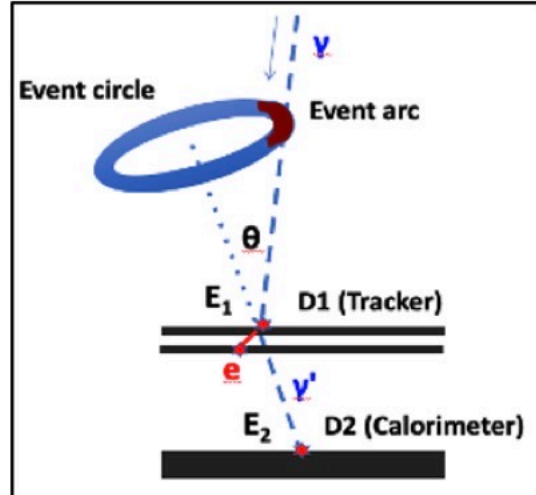
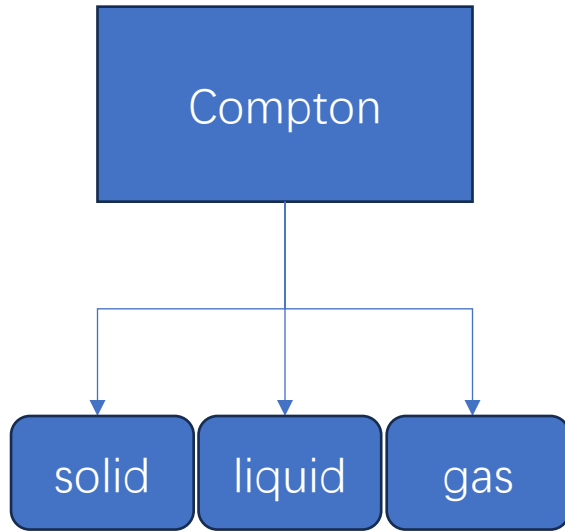
“MeV Gap”:
sensitivity gap in
MeV band (~ 0.2 -
100 MeV)

- Many multi-messenger sources' **peak** radiation power is expected to be in the MeV band: blazars, pulsars, gamma-ray bursts (GRB) ...
- MeV gamma rays can provide unique information to help address the **frontiers**: the origin of cosmic rays, dark matter, the radiation mechanisms of compact objects ...
- MeV band is the region of **gamma-ray nuclear lines**, providing a unique and direct probe of the nuclear process in the universe $\rightarrow$ the origin of heavy elements & stellar evolutions

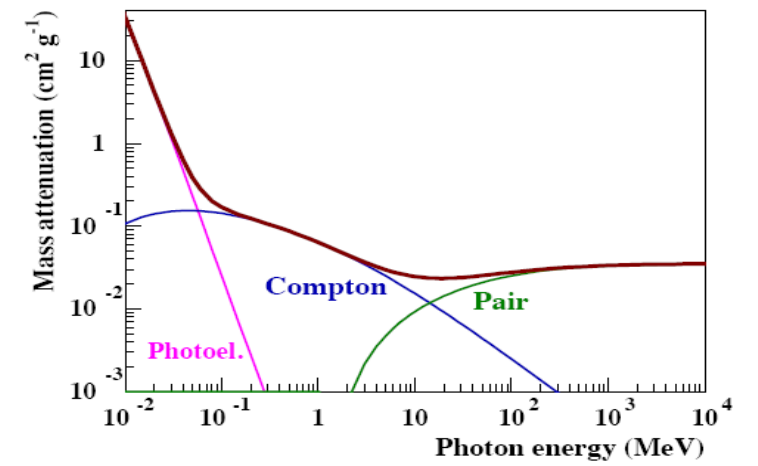
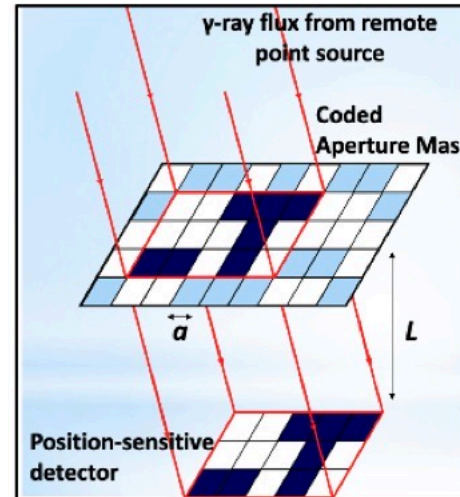
MeV missions --- important factors



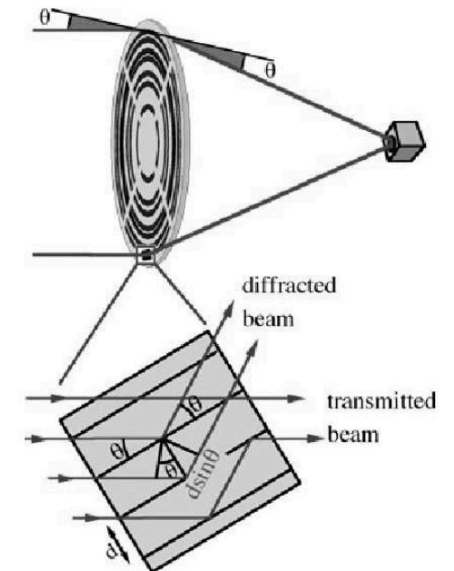
MeV Detection Techniques



Coded Mask

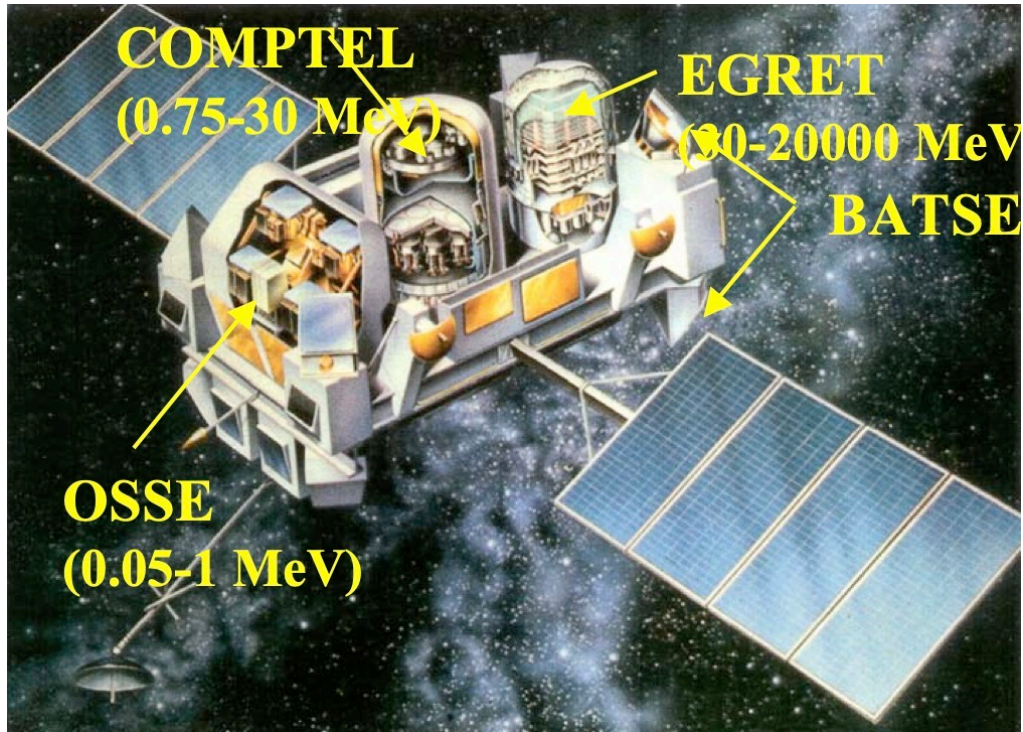


Concentrator

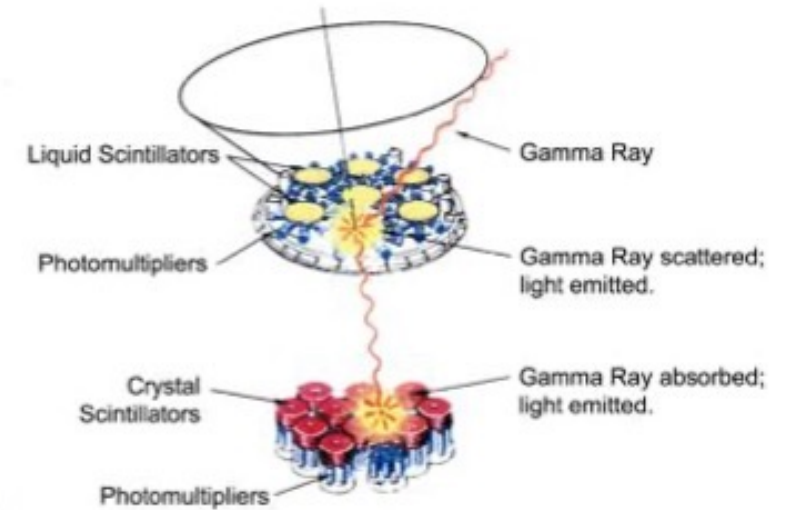


MeV Missions - Compton - COMPTEL

Compton Gamma Ray Observatory (CGRO)
1991/4/5– 2000/06/04



COMPTEL



Energy Range: 0.8-30 MeV

Energy Resolution: $\sim 8.8\%$ @ 1.27 MeV

Spatial Precision: $\sim 1^\circ$

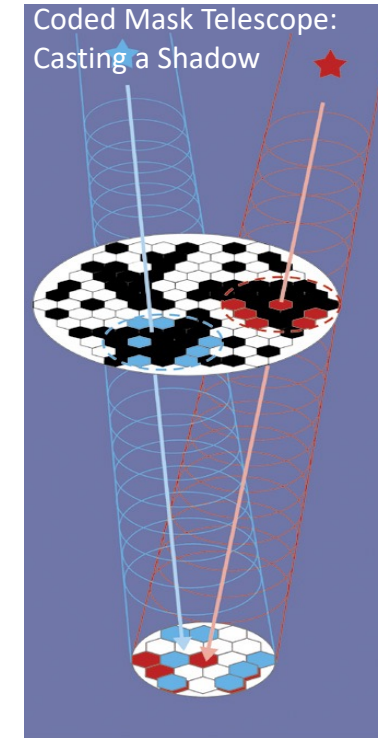
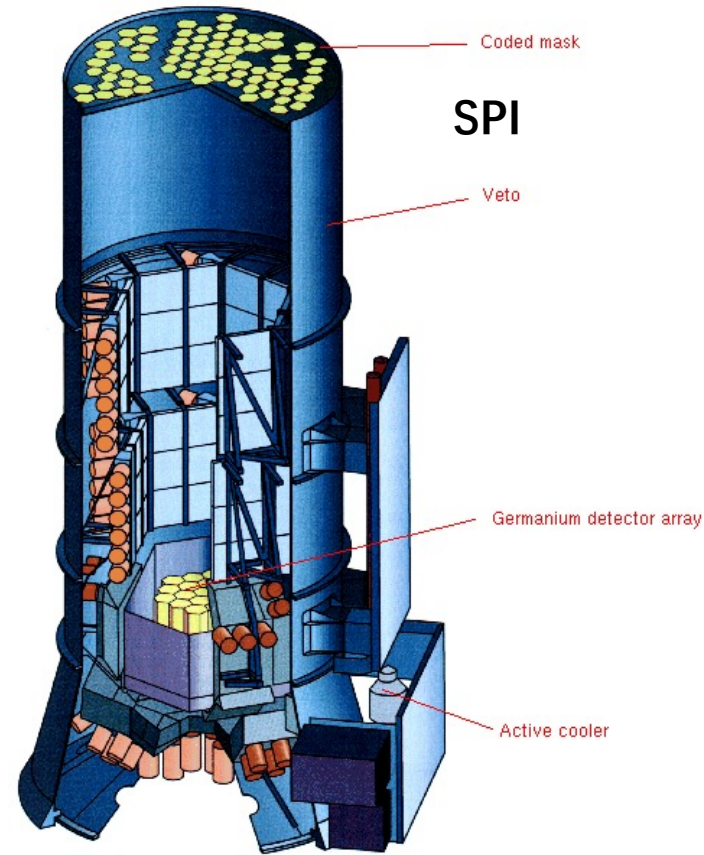
Field of View: 64°

Line sensitivity (5×10^5 sec): $\sim 1.5 - 6 \times 10^{-5} \text{ cm}^{-2} \text{ s}^{-1}$

MeV Missions - Coded Mask - SPI

INTEGRAL

2002/10/17– 2025/02/28



Energy Range: 15keV-8 MeV

Energy Resolution: ~ 2.2 keV @ 662 keV

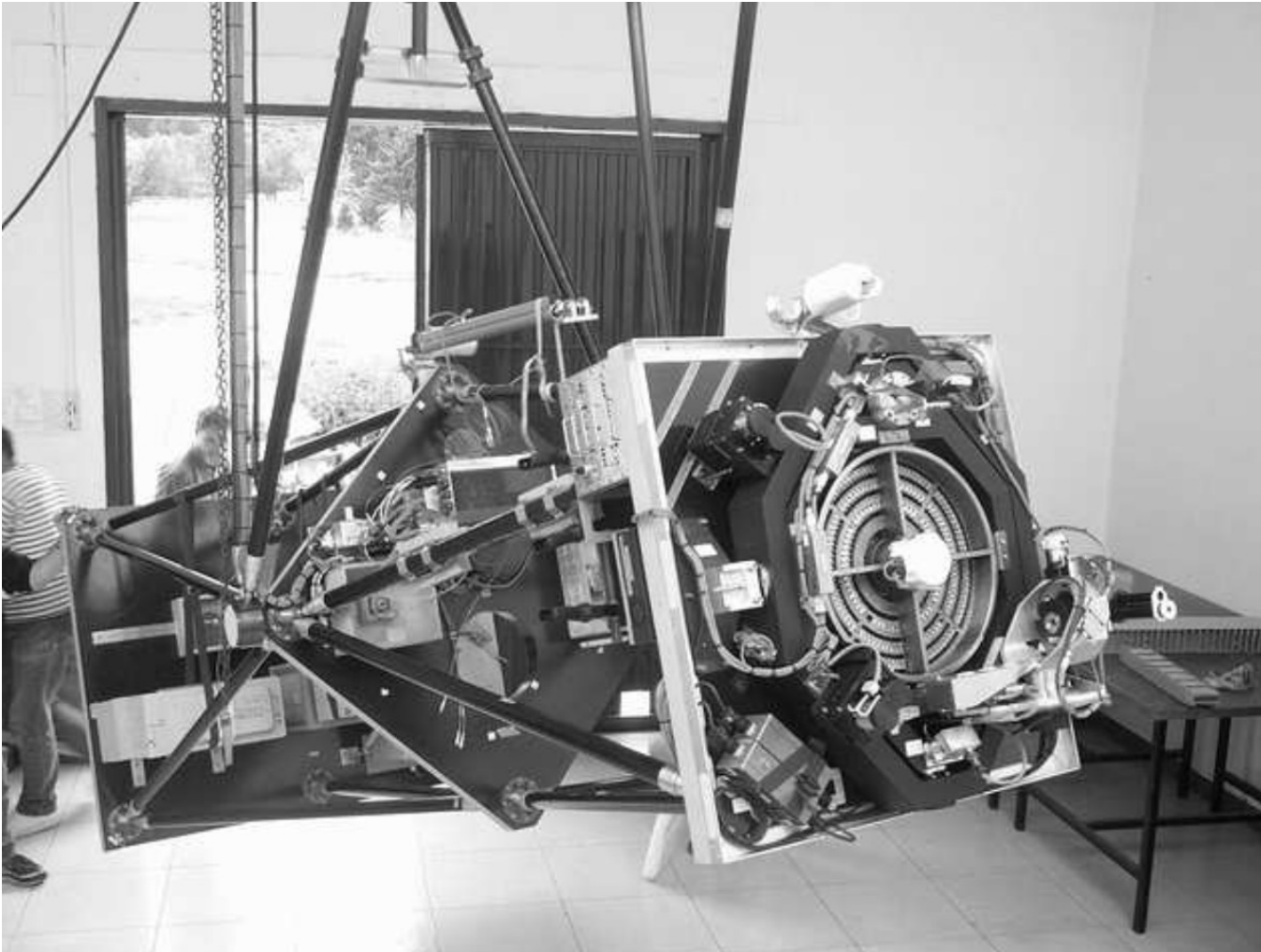
Spatial Precision: 2.6° / ~ 2 arcmin

Field of View: $16 \times 16^\circ$ (fully coded)

Line sensitivity (10^6 sec): $\sim 2.4 \times 10^{-5}$ cm $^{-2}$ s $^{-1}$ @ 1MeV

MeV Missions - Concentrator - CLAIRE

CLAIRE – balloon experiment
2001/06/14



- Lens: 556 Ge-Si crystals (45cm)
- Focal length: 2.77 meter
- focusing 170 keV gamma-ray photons onto a 3x3 matrix of HPGe detectors
- Angular resolution: 18 arcmin @ 170keV
- The float altitude was 41 km and lasted about 5 hours.

MeV Missions - Proposals

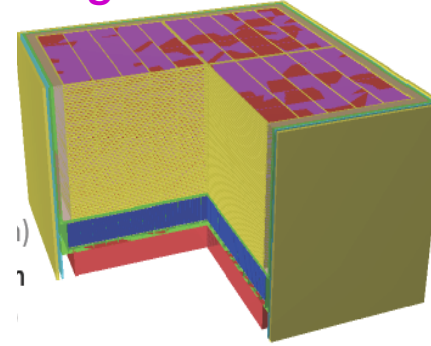
Observatory:

- eAstrogam (ESA)
- AMEGO/AMEGO-X (NASA)
- *MeVGRO*
- VLAST
- SRG-M (Russia)

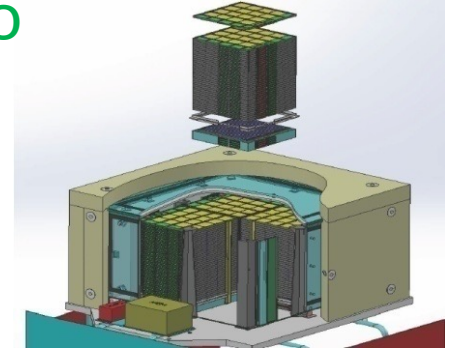
Small-Mid:

- MASS, **COSI** (funded in 2021, 0.2~2.5MeV; launch in 2027)
- GECCO—Coded mask
- GRAMS, GammaTPC—LAr-TPC
- MeGaT, SMILE, Adept — Gaseous-TPC
- DUAL, CLAIRE, 511-cam, *PAIRS*-- Concentrator

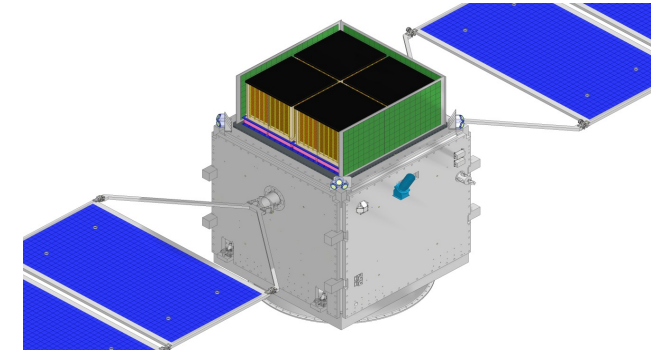
eAstrogam



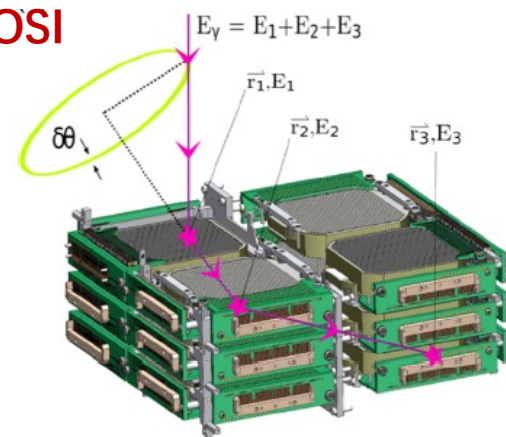
AMEGO



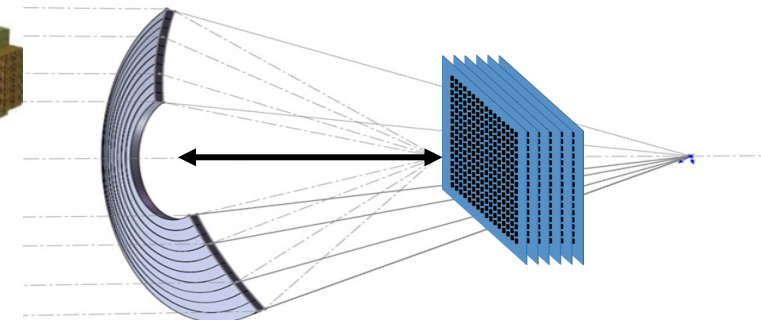
MeVGRO



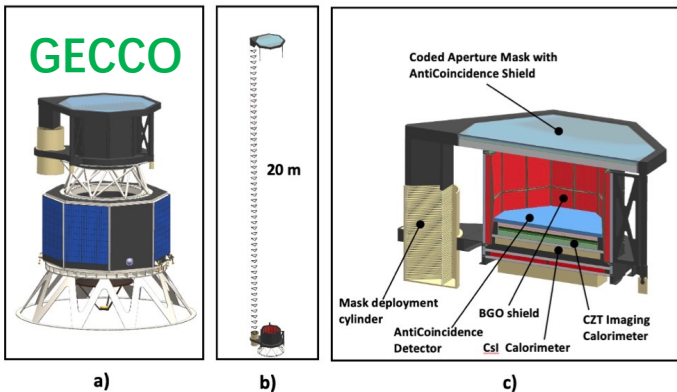
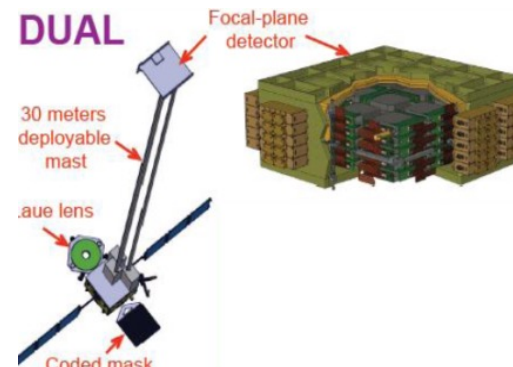
COSI



PAIRS

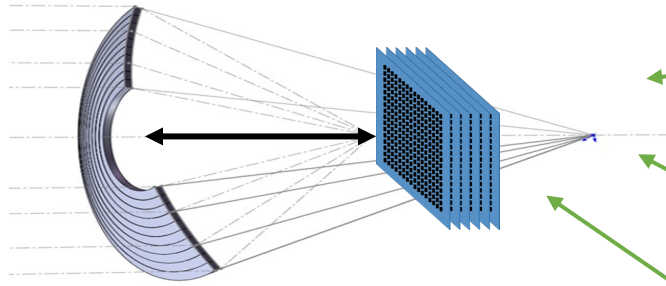


DUAL



Future MeV missions

PAIRS



Angular
resolution

Energy
resolution

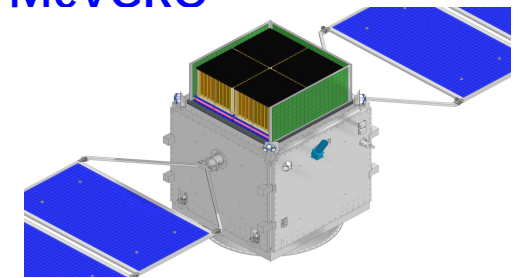
Sensitivity
Lines, continuum

Field of view

Energy
coverage

Cost

MeVGRO



□Line sensitivity:

$\leq 7.9 \times 10^{-6} \text{ ph/cm}^2/\text{s}$ @511keV,

$\leq 1.7 \times 10^{-6} \text{ ph/cm}^2/\text{s}$ @1.8MeV

(2yrs survey of COSI)

□Continuum sensitivity:

$\leq 2 \times 10^{-11} \text{ erg/cm}^2/\text{s}$ @1MeV,

100MeV

Line detection:
 $\leq 0.1\%$ @ 511keV,
Angular resolution
 $\leq 2'$
Energy band:
450~550keV

Line detection:
 $\leq 1\%$ @ 662keV,
Field of View:
 $\pm 65^\circ$,
Energy band:
0.2~5MeV