

MEGA

Planning for an intermediate mission in
Medium Energy Gamma-Ray Astronomy

The MEGA Collaboration

MPE, Garching, Germany

NRL, Washington, DC

CESR, Toulouse, France

U. of Alabama, Huntsville, AL

UNH, Durham, N.H.

U. of California, Riverside, CA

Columbia U., New York, NY

LANL, Los Alamos, NM

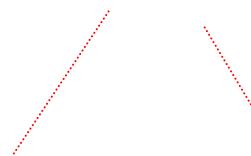
GSFC / NASA, Greenbelt, MD

Scientific Advisory Group with members from
Germany: Ruhr Univ, Bochum, U. Würzburg, MPIfR, Bonn
France: CEA, Saclay, CESR, Toulouse UK: Leeds U., Durham U.
USA: GSFC, Clemson U, SC, Rice U., TX.,
Russia: Ioffe Inst., St. Petersburg Japan: ISAS, Tokyo

Missions and Sensitivities

HESS, Cangaroo, MAGIC, **Agile**

INTEGRAL, SWIFT

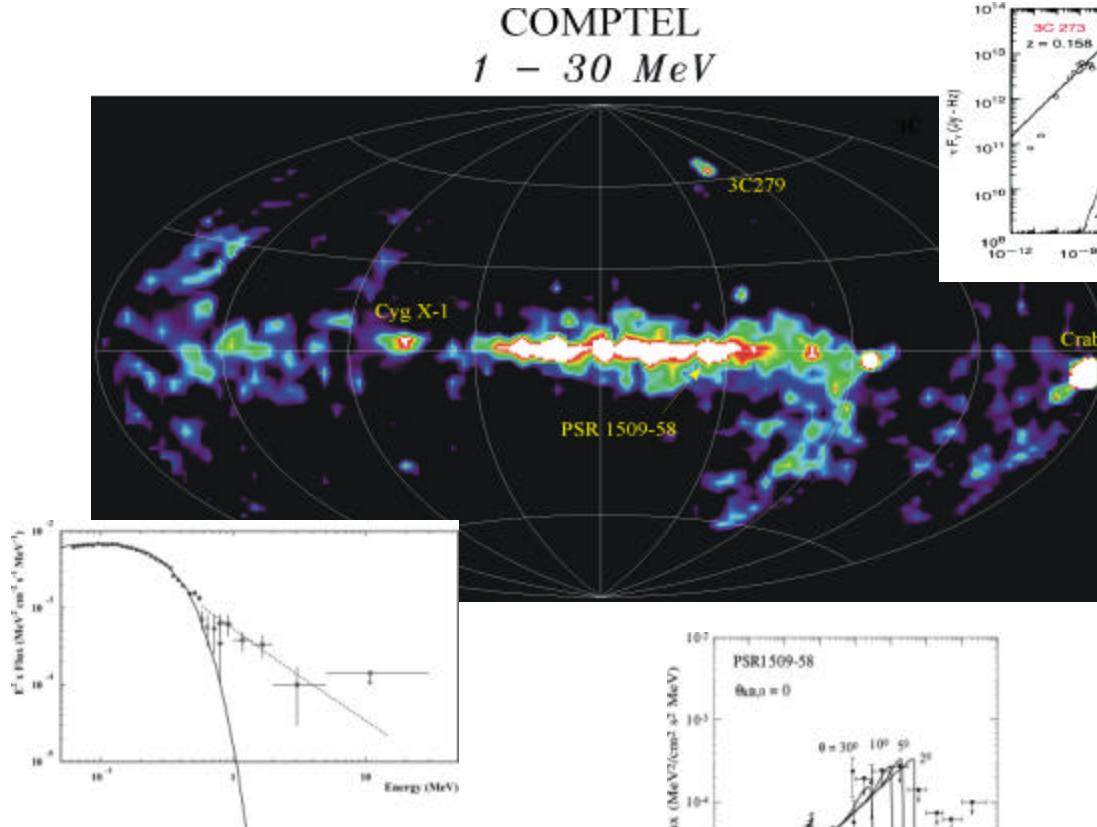


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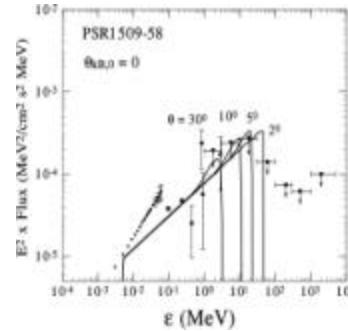
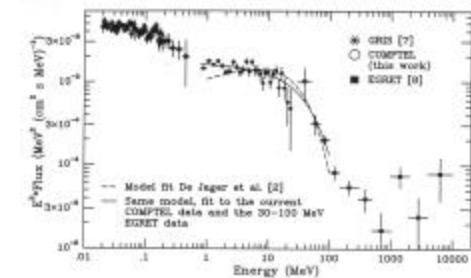
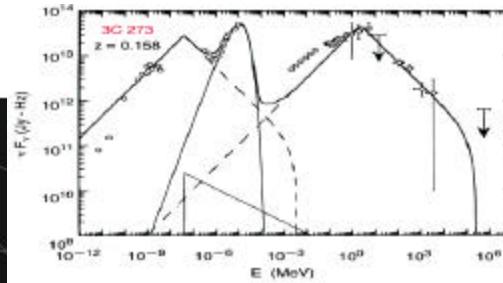
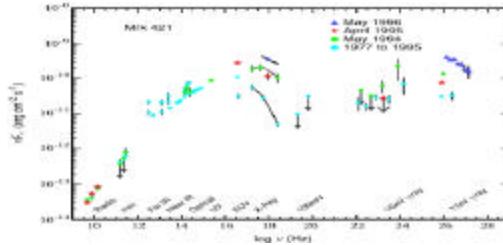
- COS-B X COMPTEL
- EGRET \Leftrightarrow MEGA
- GLAST \Leftrightarrow ACT

Astrophysics in the 0.4 – 50 MeV region

- Cosmic Particle Accelerators
- Nucleosynthesis, Cosmic Radioactivity



Black Hole Binaries (Cyg X-1)
- transition thermal – non-thermal



Supernova Remnants
(Plerions, Crab-Nebula):
- Electron Accelerators
- Synchrotronemission

Pulsars and Magnetars (PSR 1509-58):
- PSR Electrodynamics
- Photons in extreme magnetic fields

AGN and Blazars
(Mkn 421/3C273)
- Relativistic Jets
- supermassive
black holes

INTEGRAL vs. MEGA

	INTEGRAL	MEGA
Field of View	16°	~130°
Energy Range	0.05-8	0.4-50 MeV
Mode	targeted	survey
E/ΔE	~ 500	~20
Imaging strength	pointsources	pointsources extended sources diffuse emission

MEGA (0.4 – 50 MeV) Key Science Objectives

Structured continuum spectra, gamma-ray lines, temporal and spectral variability, polarization at MeV energies in an all-sky survey:
Cosmic Accelerators

- **Rotation powered Neutron Stars/Magnetars**
- **Stellar mass Black Holes, Accretion powered binaries**
- **Galactic mass Black Holes and their Jets**
- **Unidentified EGRET sources**
- **Gamma Ray Bursts/spectral shape at MeVs**
- **Solar Flares**

Nucleosynthesis

- **Explosive Events: Novae, Supernovae**
- **Radioactive Debris: SNRs, galactic diffuse radioactivity**

Cosmic Rays and the interstellar medium

- **Galactic diffuse radiation / sources vs. diffuse?**

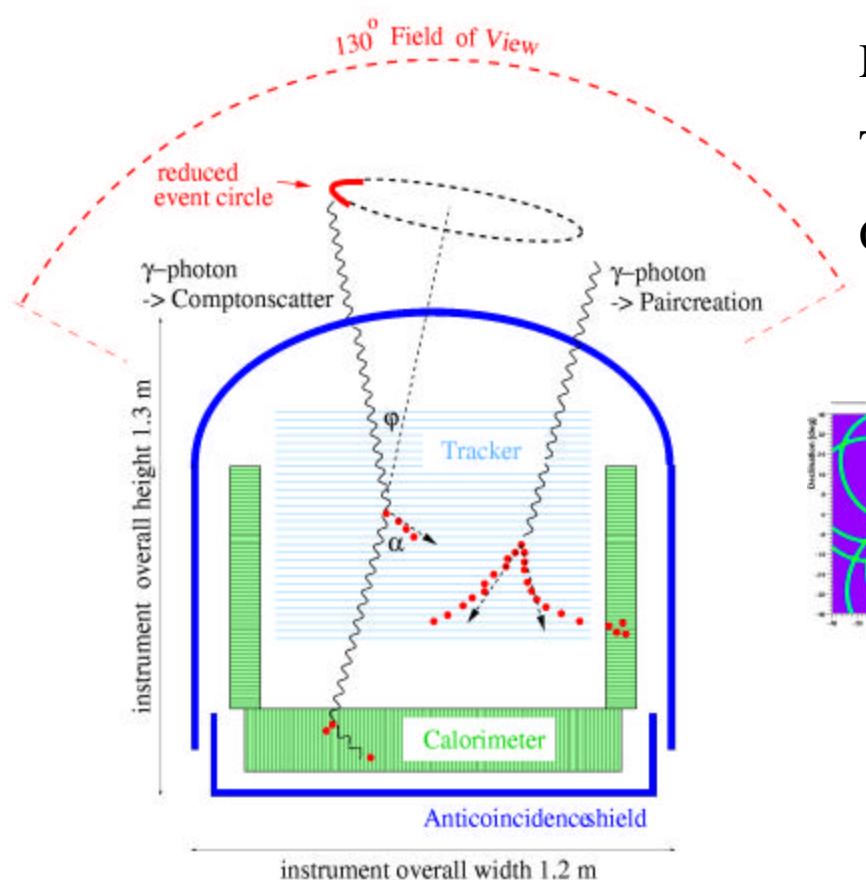
Cosmology

- **Extragalactic diffuse radiation / sources vs. diffuse?**
- **cosmological SN Ia / GRBs**

What Detector Technology is required for a new 0.5 to 50 MeV telescope?

Principal Interactions: Compton Scattering < 8 MeV < Pair Creation (in Silicon)

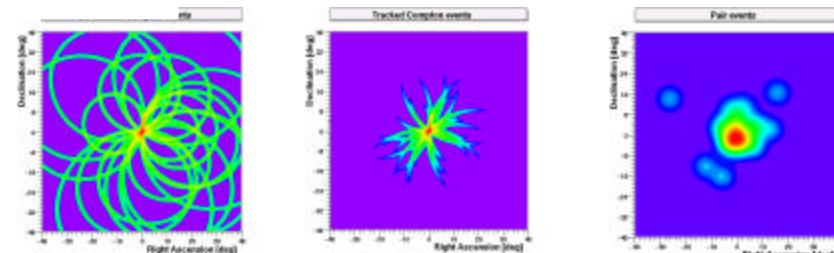
► Measure Energy and tracks of secondary »MeV electrons



MEGA:

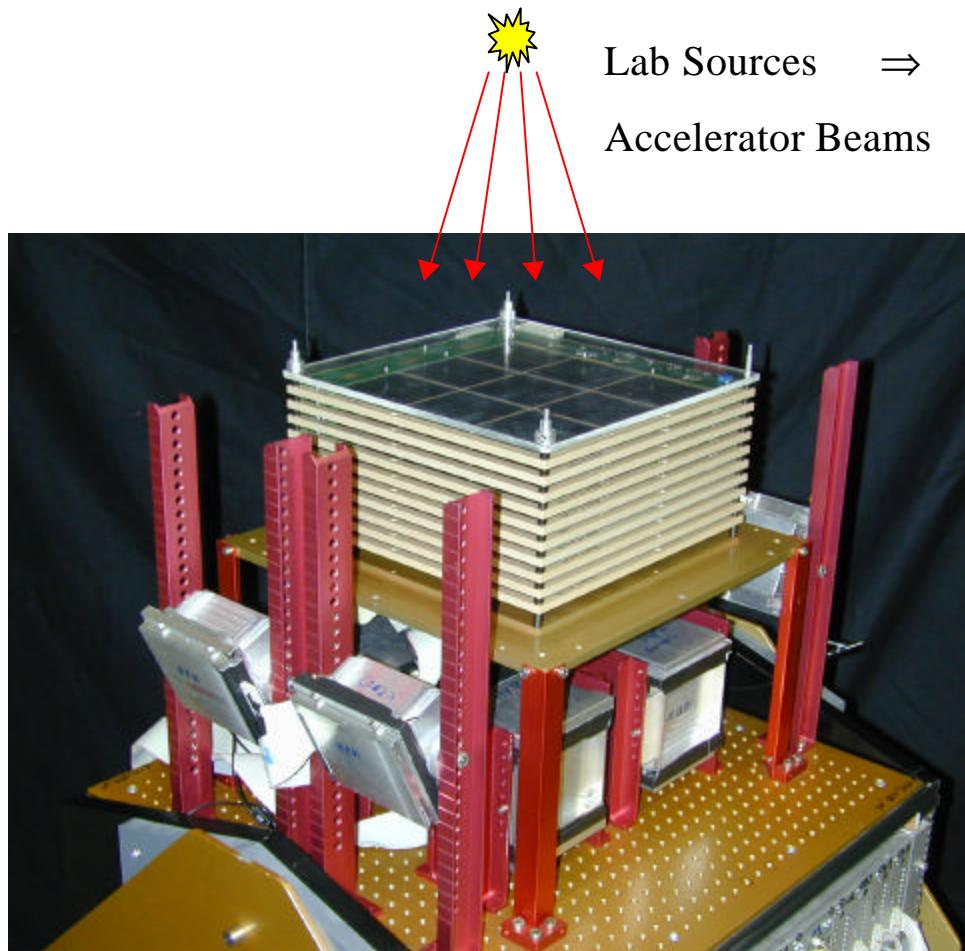
Tracker: double sided Si strip detectors

Calorimeter: 2(3)D resolving CsI/PIN diode detect.



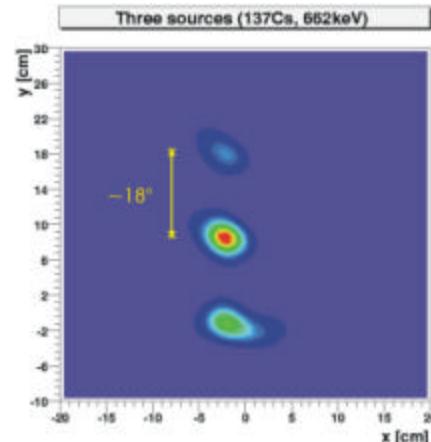
- Selective / good Background Suppression
- Large and Sensitive
- Adequate Resolution (Angular and Energy)

MEGA Prototype Detector Development (status March 2001, MPE)

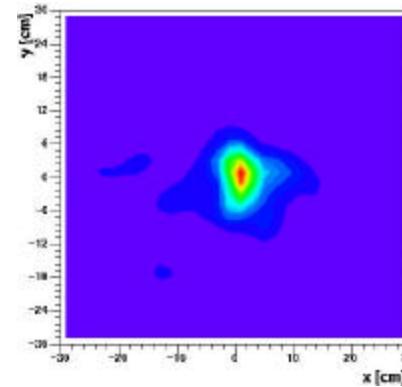


Calibration with:

Lab Sources \Rightarrow
Accelerator Beams

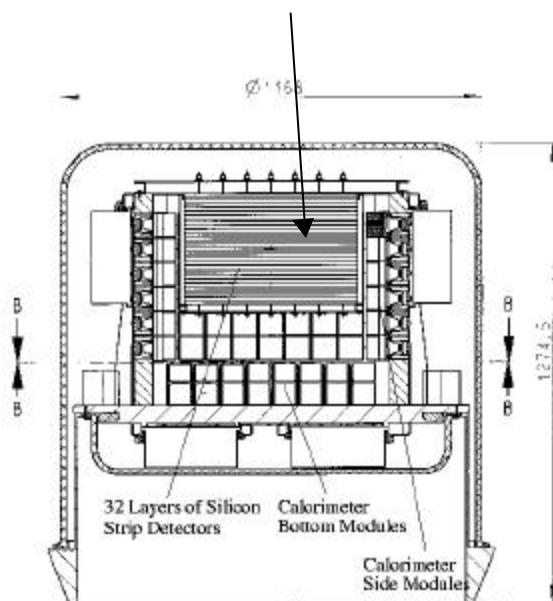
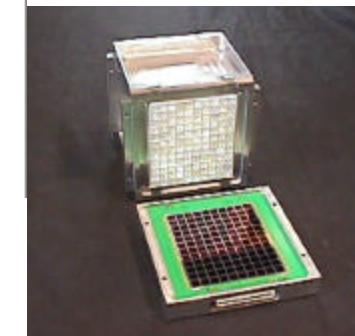
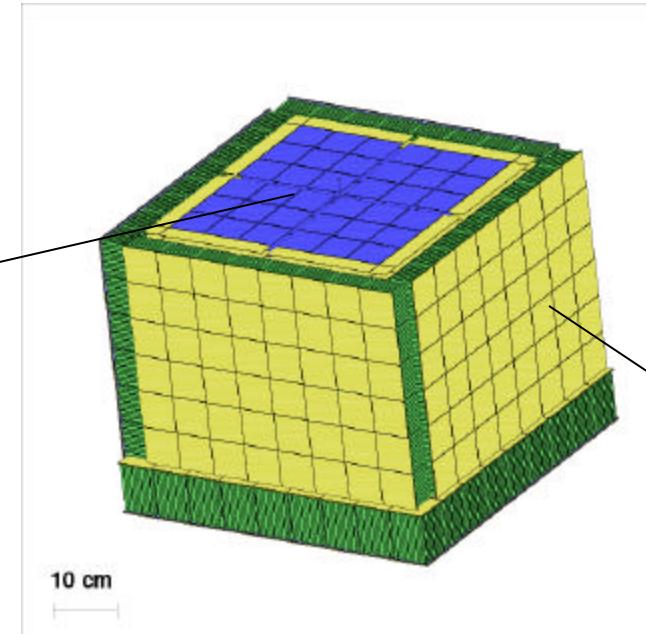
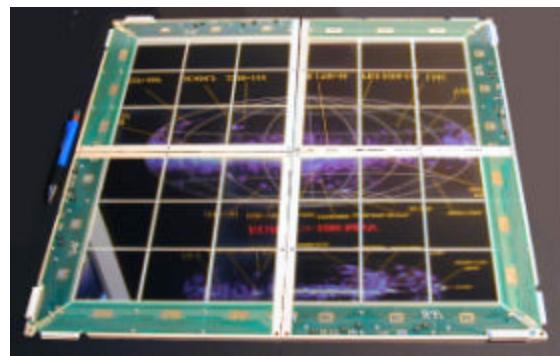


$3 \times ^{137}\text{Cs}$
662 keV
untracked



^{22}Na
1.275 MeV
tracked

Realisation of a Satellite Telescope



Technical Data

Instrument:

Mass: 650 kg

Power: 214 W

Channels: 134120

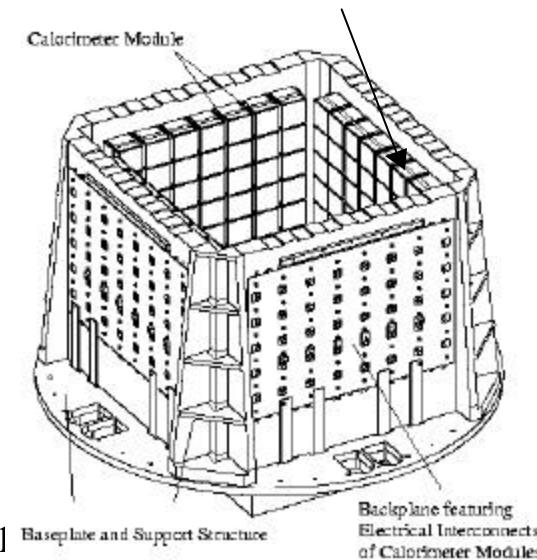
Satellite:

Mass: 950 kg

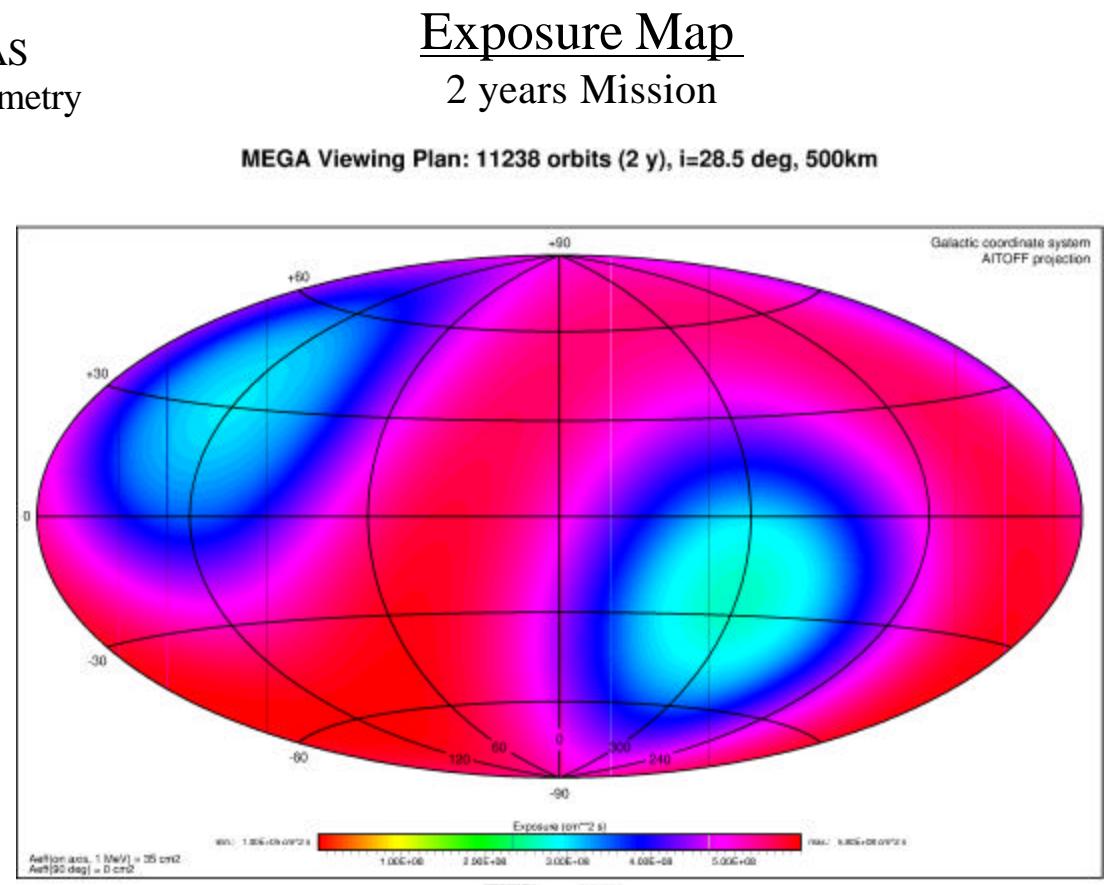
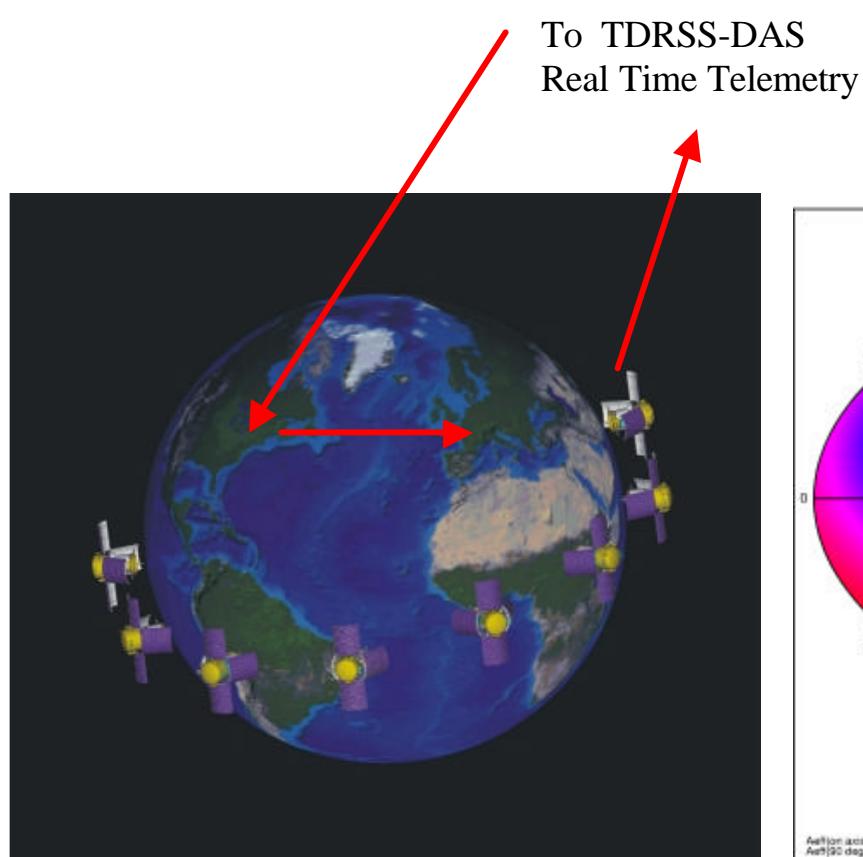
Size: 2m dia., 2.4m height

Orbit: ~500 km, circ., low inc.

Attitude: Zenith scan



MEGA Mission: All Sky Monitor

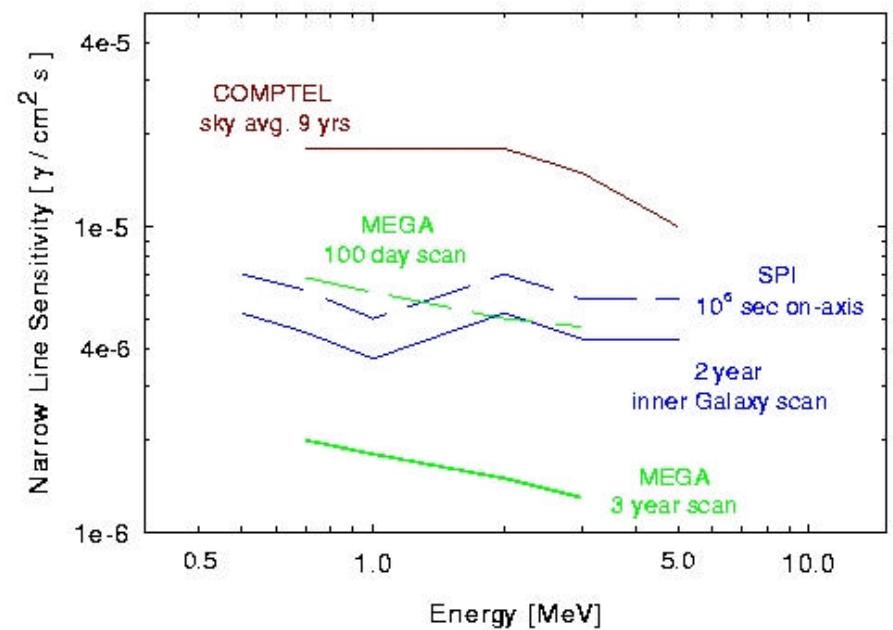
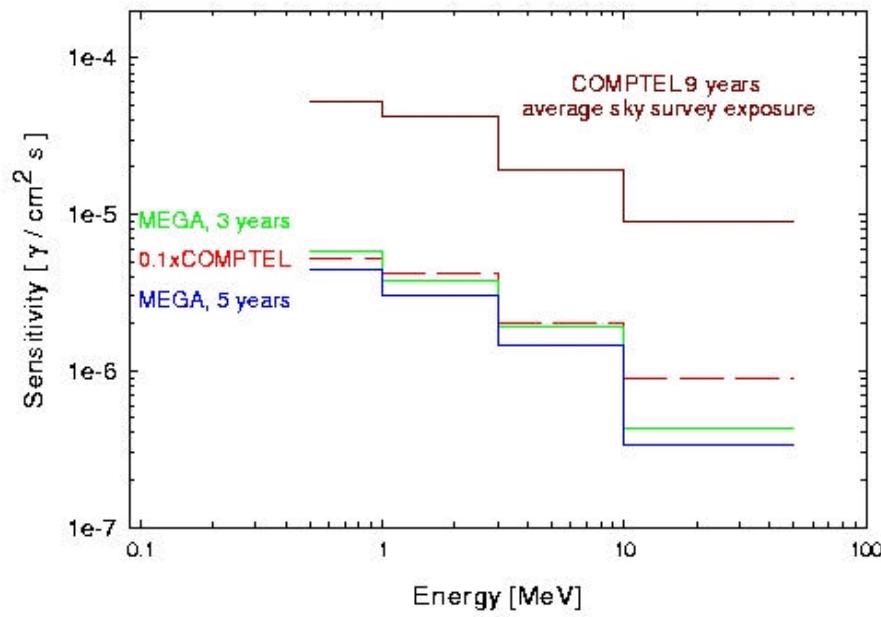


- Transient sources are detected in real time
- Prompt follow-up observations
- Homogeneous exposure with slight tilting of attitude

Gamma 2001, Baltimore, April 4-6, 2001

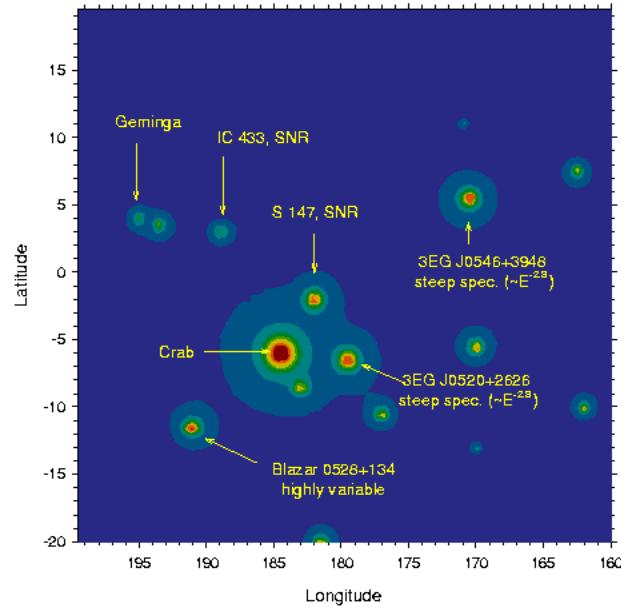
MEGA Sensitivity : Continuum and Linesources

GEANT Simulations incl. Orbital Background



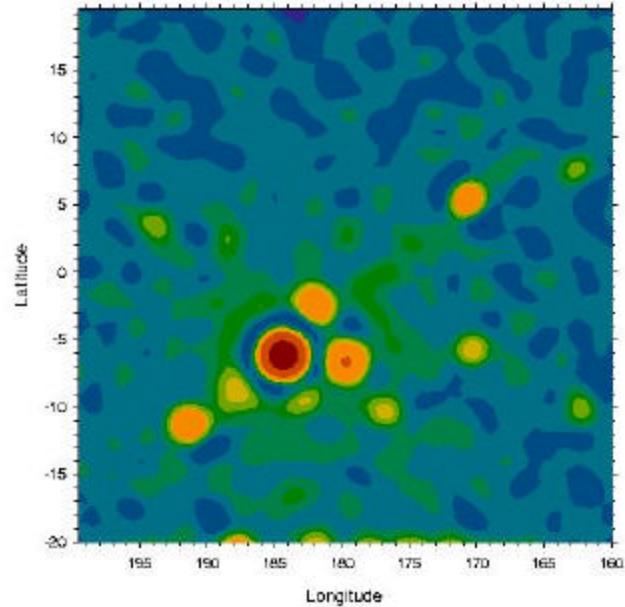
Angular Resolution 2.4° FWHM @ 2 MeV / Source Location: < 2 arcmin
 Energy resolution 3% FWHM @ 2 MeV
 Polarization 10% (Crab in 100 h)

‘EGRET’ Anticenter



MEGA Simulation

6 weeks
orbital scan



**Maps of this quality will be achieved over the entire scan path of MEGA in 6 weeks
MEGA will detect at least 200 3EG sources !**

What will we see with MEGA?

Nature of Source	Typical Representatives	MEGA	COMPTEL
Neutron Stars (rotation powered)	Pulsars: Radio, ms, Magnetars	10	3
Stellar Mass Black Holes (accretion powered / binary systems)	Binary Systems Binary Novae Micro-Blazars, Jet Sources	5 5 5	1 (Cyg X-1) 1 (N Per 91) 1?
Unknown (galactic?) population	Unidentified EGRET Sources	100	4
Galactic Mass Black Holes (galactic accretion, relativistic jets)	Radiogalaxies / Seyfert Galaxies Blazars	10 - 15 100	1 (OSSE: 4 / 25) 10
Explosive Nucleosynthesis (Gamma Ray Lines)	Novae (^{7}Be , ^{22}Na , $e^+ e^-$ Ann.) Supernovae Ia (^{56}Ni , ^{56}Co , ^{57}Co)	5 / year 2-3 / year	0 1(+1987a, SMM)
Galactic star formation / SN history	Radioactive Debris: SNR (^{44}Ti) ISM (^{26}Al , ^{60}Co , ^{60}Fe , $e^+ e^-$ Ann)	5 ? detailed	1(+ 1?) P
Cosmic Rays in ISM / Sources AGN, SNe or cosmological origin	Galactic Diffuse Emission Extragalactic Diffuse Background	detailed detailed	P P
NS/NS or NS/BH coalescence Hypernovae	Gamma Ray Bursts	~0.5 / day	39 (total)
Solar dynamics and particle acceleration	Solar Flares: continuum and lines	depends on cycle	27

MEGA Project Status

August, 2000:

MEGA proposal submitted to German Small Satellites Programm (DLR Kleinsatellitenprogramm) by a German, US and French collaboration

September, 2000:

The Proposal Science Peer Review ranked MEGA in second place after an astrometry mission (DIVA)

April, 2001:

Continuing efforts to establish MEGA as a multinational project to observe the gamma-ray sky simultaneously with GLAST