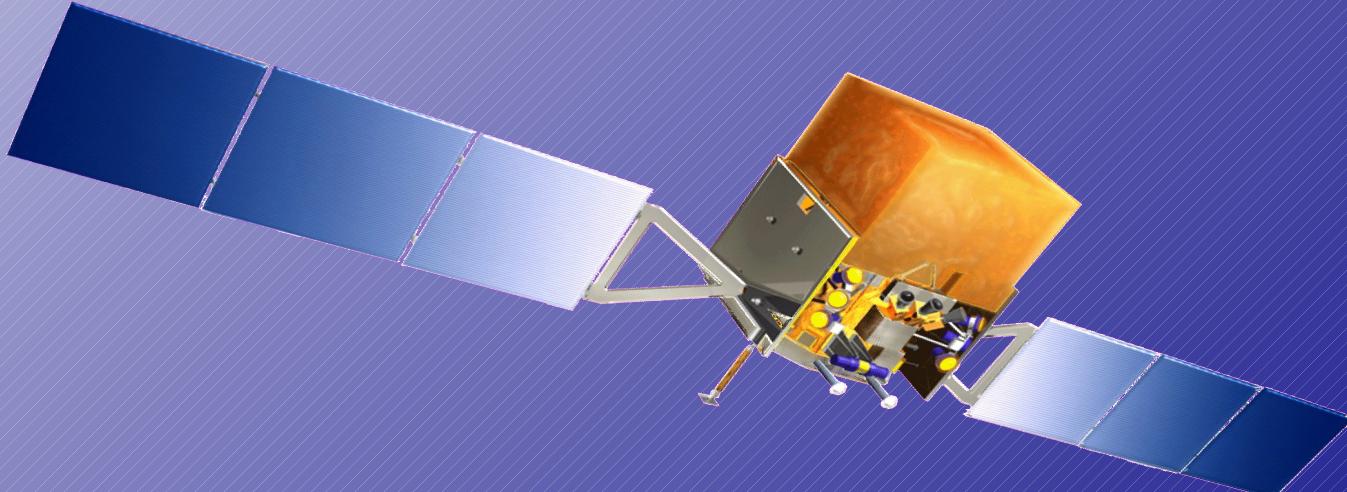




GLAST and the future of High Energy Gamma Ray Astronomy

V.Vitale for the GLAST LAT Collaboration



Vincenzo Vitale, Dip di Fisica & INFN Roma Tor Vergata, PIC08 Perugia

Outline

- The LAT instrument
- The H.E. Gamma ray astrophysics
- The Indirect Search for Dark Matter
- GLAST in orbit

GLAST: Gamma-ray Large Area Space Telescope

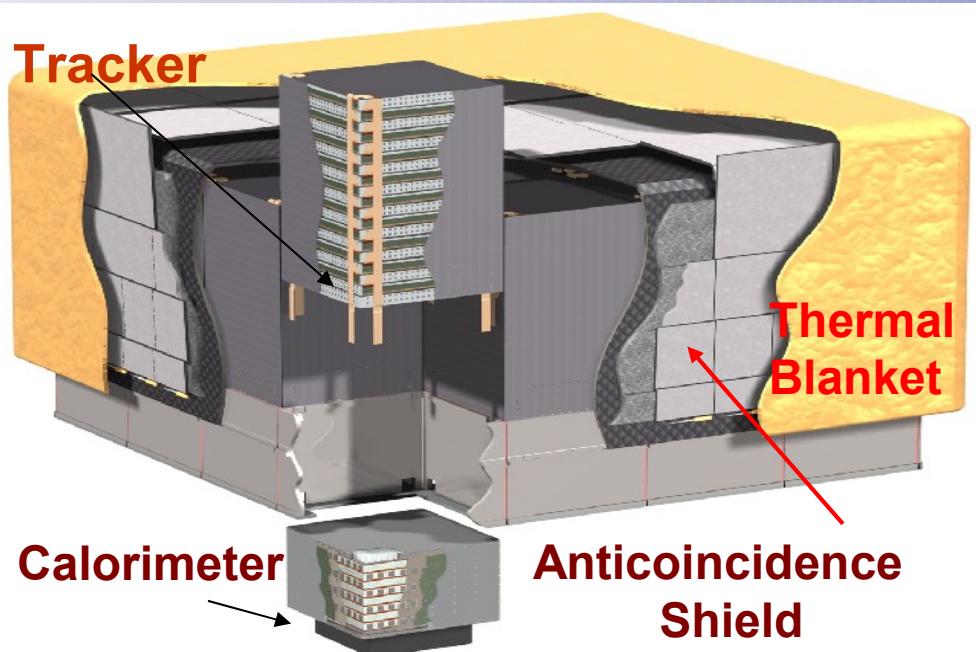
- Two GLAST instruments:
- LAT: 20 MeV - 300 GeV
- GBM: 10 keV - 30 MeV
- 5-year mission (10-year goal)
- LEO @ 550km, $\sim 26^\circ$



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Overview of LAT

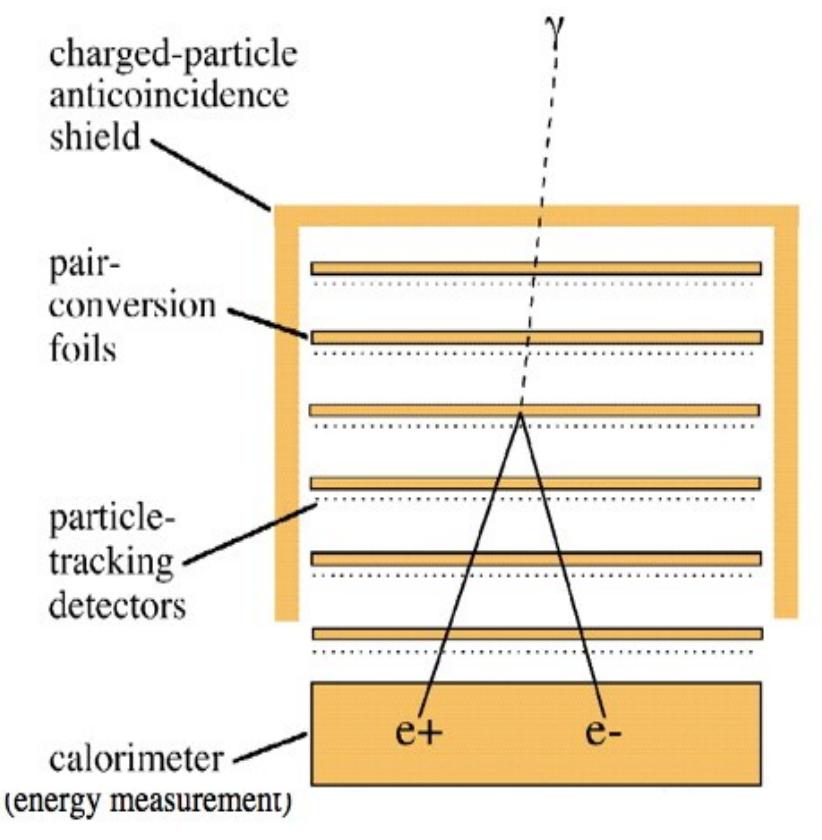
16 towers-TKR+CAL+DAQ



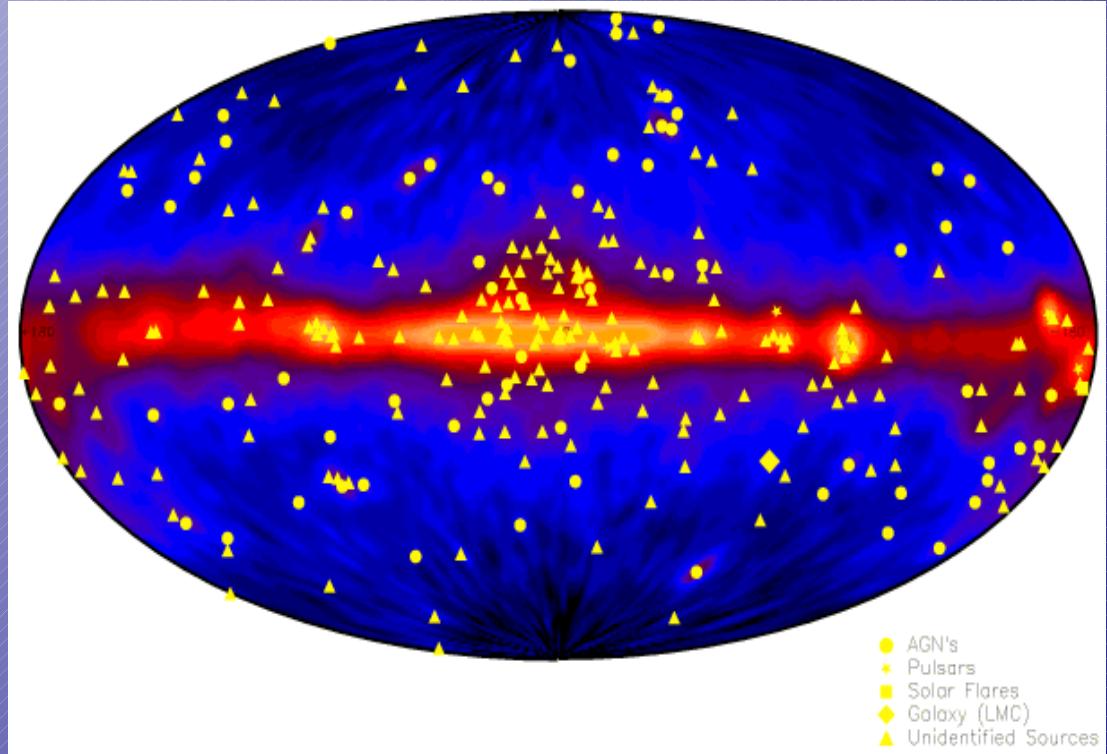
- Electronics System Includes flexible, robust hardware trigger and software filters in flight software.

- Precision Si-strip Tracker (TKR)
 - ◆ ~80 m² Si, 18 XY tracking planes.
 - ◆ Single-sided silicon strip detectors (228 μm pitch)
 - ◆ Measure the photon direction; gamma ID.
- Hodoscopic CsI Calorimeter(CAL)
 - ◆ Array of 1536 CsI(Tl) crystals in 8 layers.
 - ◆ Measure the photon energy; image the shower.
- Segmented Anticoincidence Detector (ACD)
 - ◆ 89 plastic scintillator tiles and 8 ribbons.
 - ◆ Reject background of charged cosmic rays;
 - ◆ segmentation removes self-veto effects at high energy.

Pair Conversion Telescope



■ What you can do with a p.c.telescope

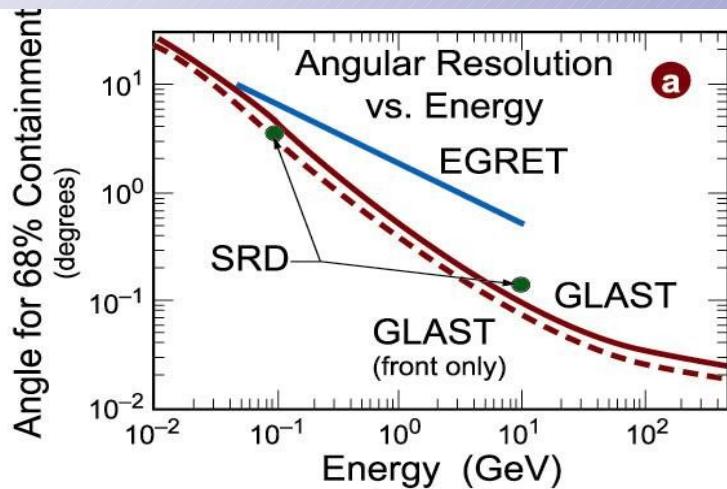


- gammas go in e^-e^+ pairs:
- Pair → parent direction, energy and polarization

Tracker Performances

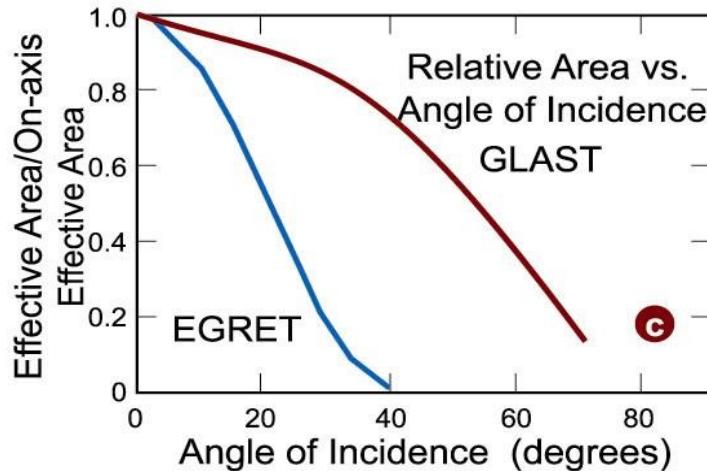
MC derived

Optimized Point Spread Function

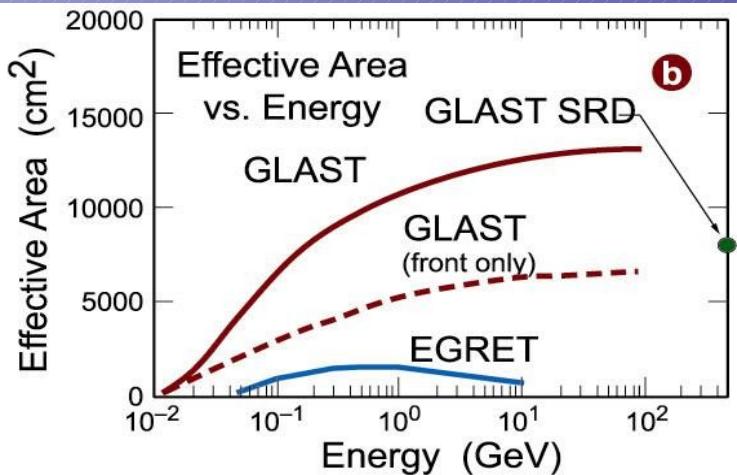


Wide Field of View

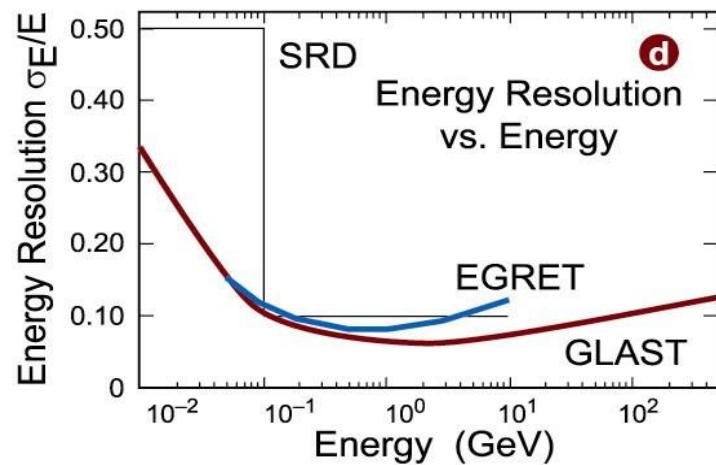
FOV: 2.4 Sr
SRD: 2.0 Sr



Large Effective Area

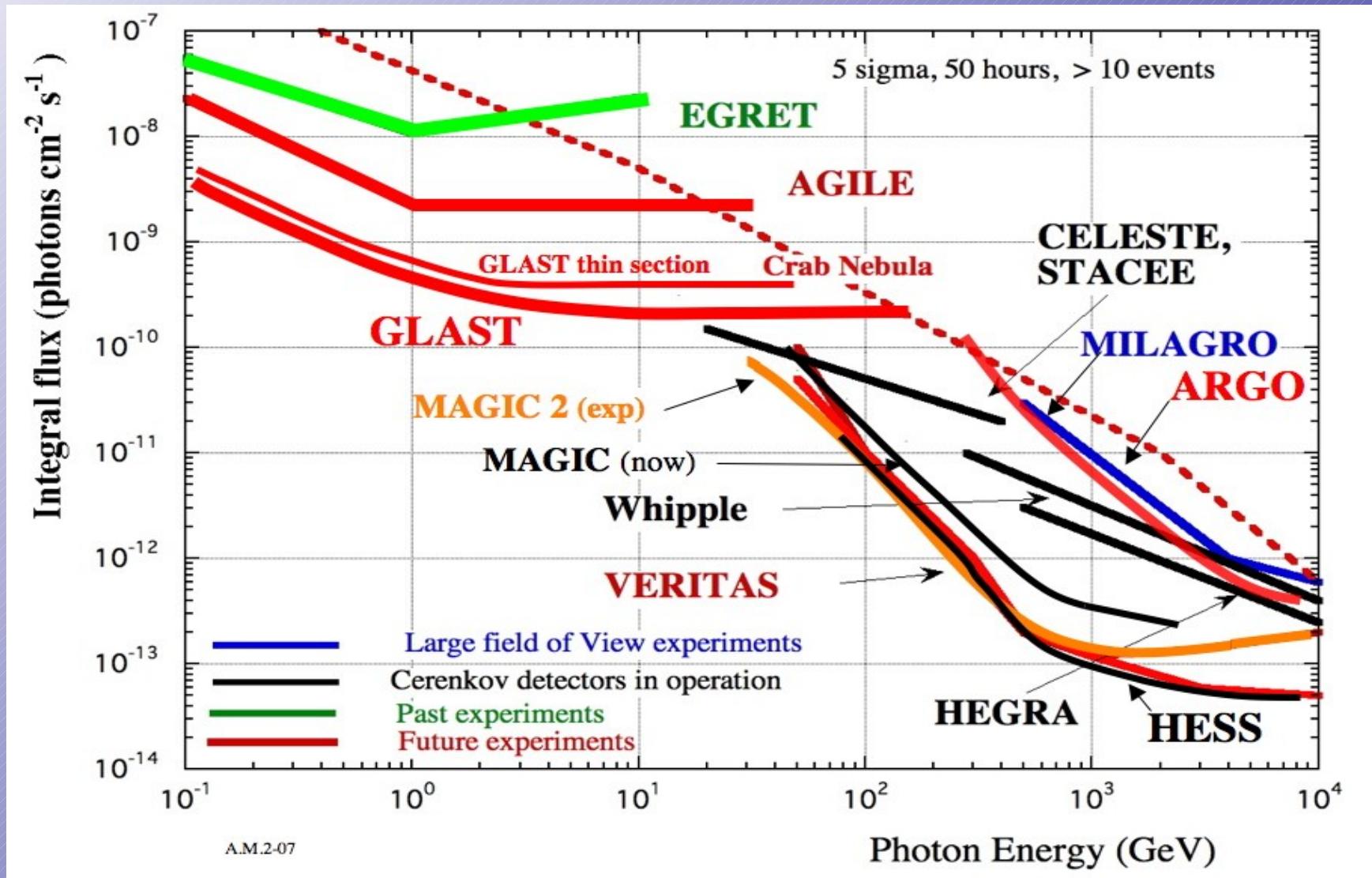


Good Energy Resolution



Point Source Sensitivity (high latitude)
Two Years: = 1.6×10^{-9} ph/cm²/s (> 100 MeV)

GLAST ans the gamma ray sky coverage



GLAST Institutions

American Institutions

SU-HEPL Stanford University, Hanson Experimental Physics Laboratory , SU-SLAC Stanford Linear Accelerator Center, Particle Astrophysics group, GSFC-NASA-LHEA Goddard Space Flight Center, Laboratory for High Energy Astrophysics , NRL - U. S. Naval Research Laboratory, E. O. Hulbert Center for Space Research, X-ray and gamma-ray branches, UCSC- SCIPP University of California at Santa Cruz, Santa Cruz Institute of Particle Physics, SSU- California State University at Sonoma, Department of Physics & Astronomy , WUStL-Washington University, St. Louis, UW- University of Washington , TAMUK- Texas A&M University-Kingsville, Ohio State University



Italian Institutions

INFN - Istituto Nazionale di Fisica Nucleare and Univ. of Bari, Padova, Perugia, Pisa, Roma2, Trieste, Udine, ASI - Italian Space Agency, IASF- Milano, Roma



Japanese Institutions

University of Tokyo, ICRR - Institute for Cosmic-Ray Research, ISAS- Institute for Space and Astronautical Science, Hiroshima University



French Institutions

CEA/DAPNIA Commissariat à l'Energie Atomique, Département d'Astrophysique, de physique des Particules de physique Nucléaire et de l'Instrumentation Associée, CEA, Saclay, IN2P3 Institut National de Physique Nucléaire et de Physique des Particules, IN2P3, IN2P3/LPNHE-X Laboratoire de Physique Nucléaire des Hautes Energies de l'École Polytechnique, IN2P3/PCC Laboratoire de Physique Corpusculaire et Cosmologie, Collège de France, IN2P3/CENBG Centre d'études nucléaires de Bordeaux Gradignan, IN2P3/LPTA Laboratoire de Physique Théorique et Astroparticules, Montpellier



Swedish Institutions

KTHRoyal Institute of Technology, Stockholms Universitet

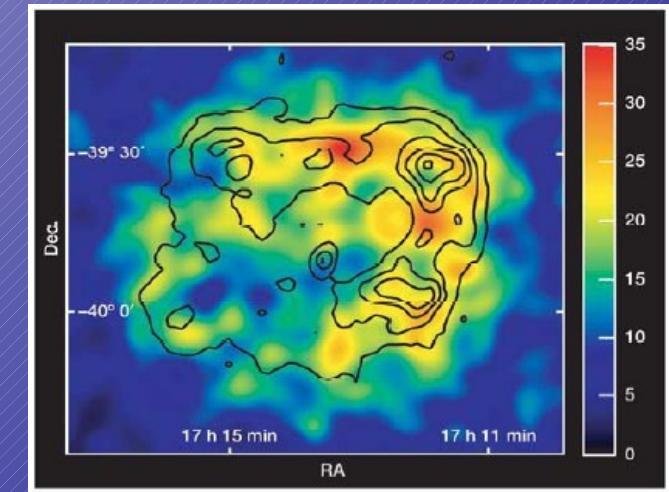
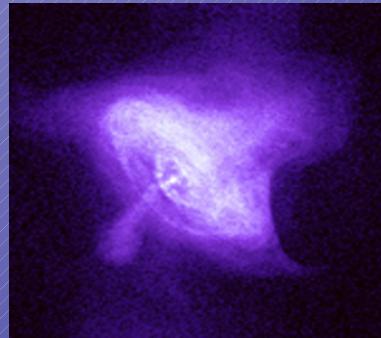
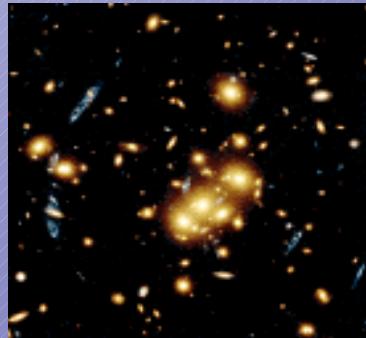


Why study gamma rays

- Gamma rays offer a direct view into Nature's largest accelerators.
- the Universe mainly transparent to gamma rays with $< 20 \text{ GeV}$
- they can probe cosmological volumes.
- Any opacity is energy-dependent for higher energy.
- Most particle relics of the early universe produce gamma rays when they annihilate or decay.

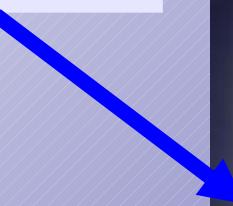
GLAST Main Science Topics

- (super-massive) Black Holes and relativistic jets
- Pulsars, Super-Nova Remnants and Origin of Galactic Cosmic Rays
- Gamma Ray Binary Systems
- Gamma-ray bursts (GRBs)
- New Source Classes
- Particle Dark Matter
- Exotics



Dark Matter

- Baryons 4% of the Universe



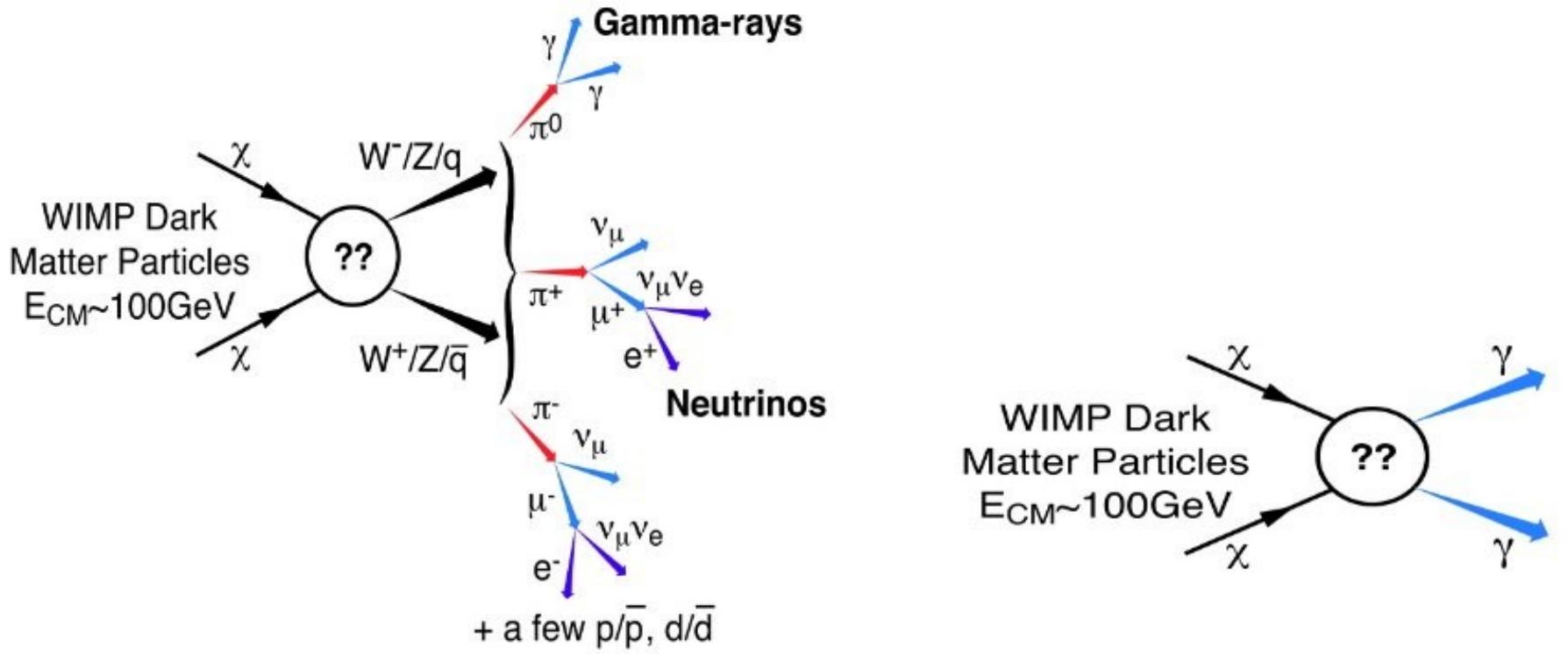
- Dark Matter 23% of the Universe

- Evidences of gravitational Dark Matter interaction

- Dark Matter is cold

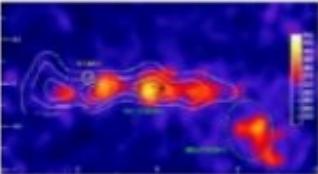
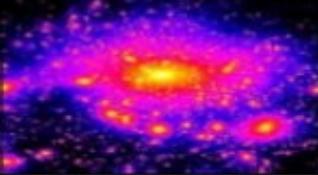
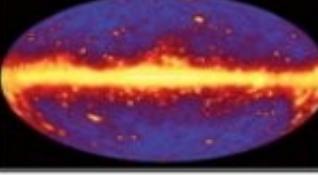
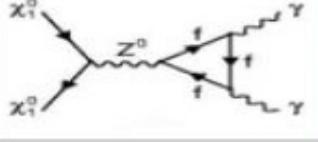
- Most favoured are Weakly Interacting Massive Particles (among which neutralinos χ)

Gamma rays from WIMPs



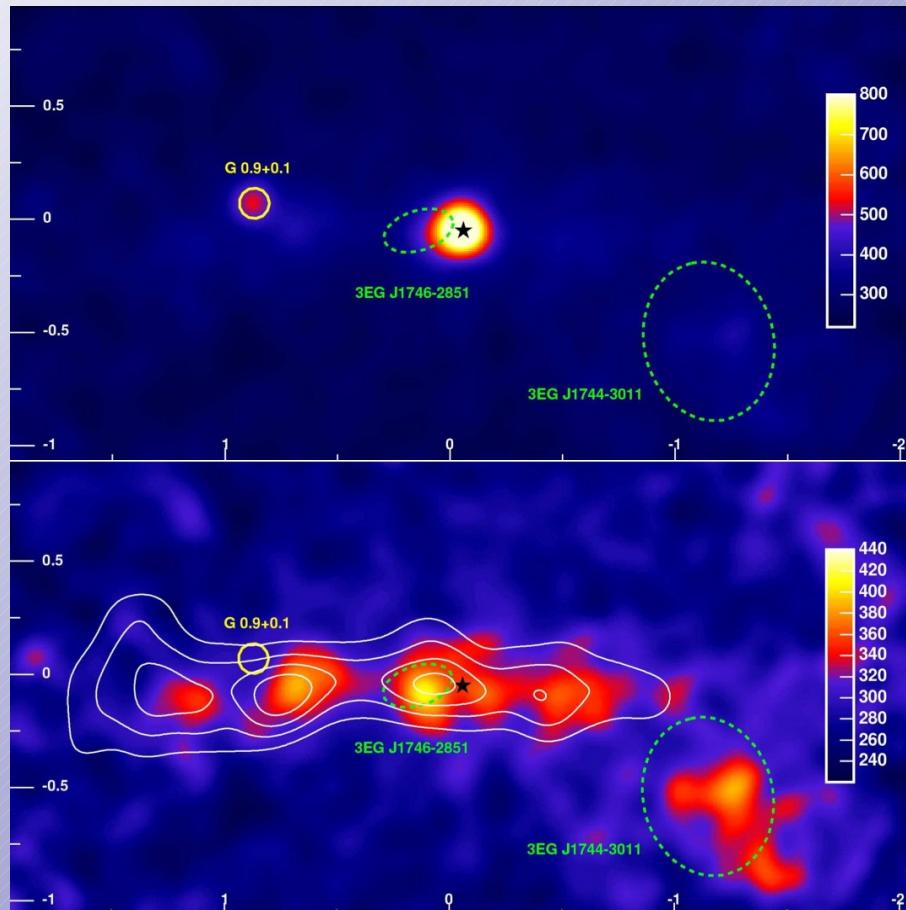
$$\phi(E, \Delta\Omega) \propto \left(\frac{\sigma v}{m_\chi^2} \right) \int_{l.o.s} \int_{\Delta\Omega} \rho^2(l) dl d\Omega)$$

DM Observations

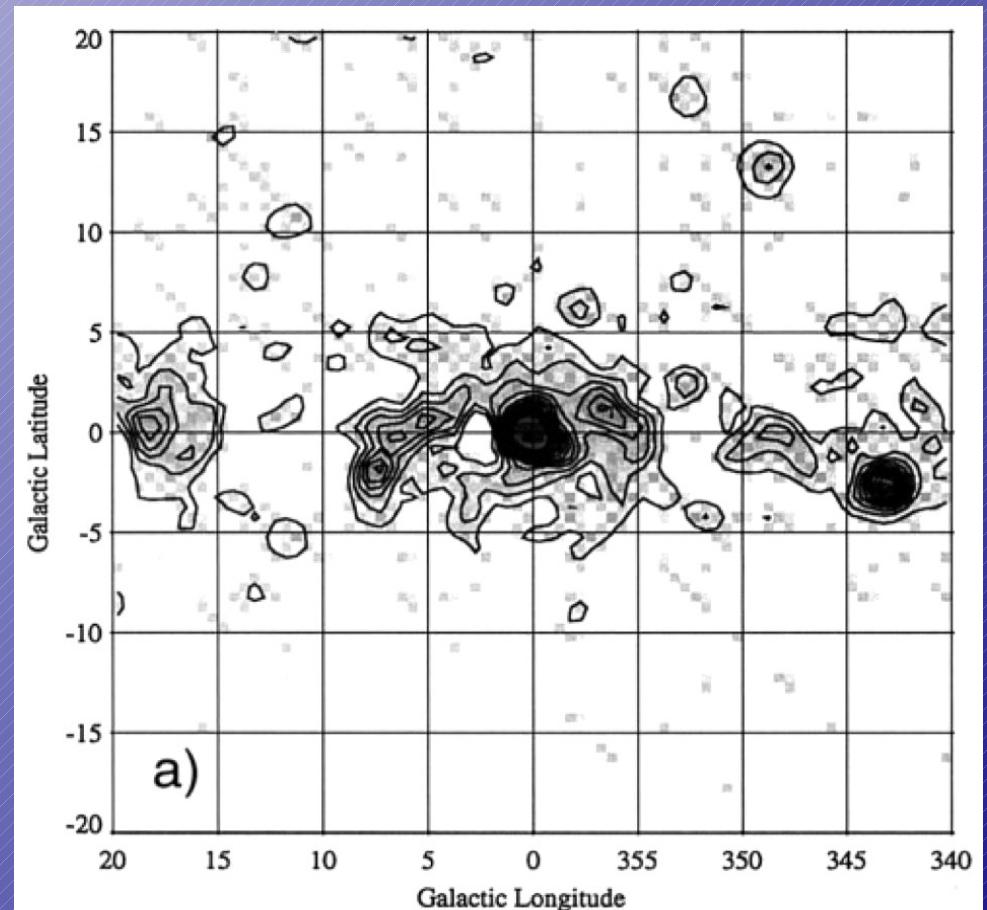
Search Technique		advantages	challenges
Galactic center		Good Statistics	Source confusion/Diffuse background
Satellites, Subhalos, Point Sources		Low background, Good source id	Low statistics
Milky Way halo		Large statistics	Galactic diffuse background
Extra-galactic		Large Statistics	Astrophysics, galactic diffuse background
Spectral lines		No astrophysical uncertainties, good source id	Low statistics

Galactic Center

■ Background for DM in GC



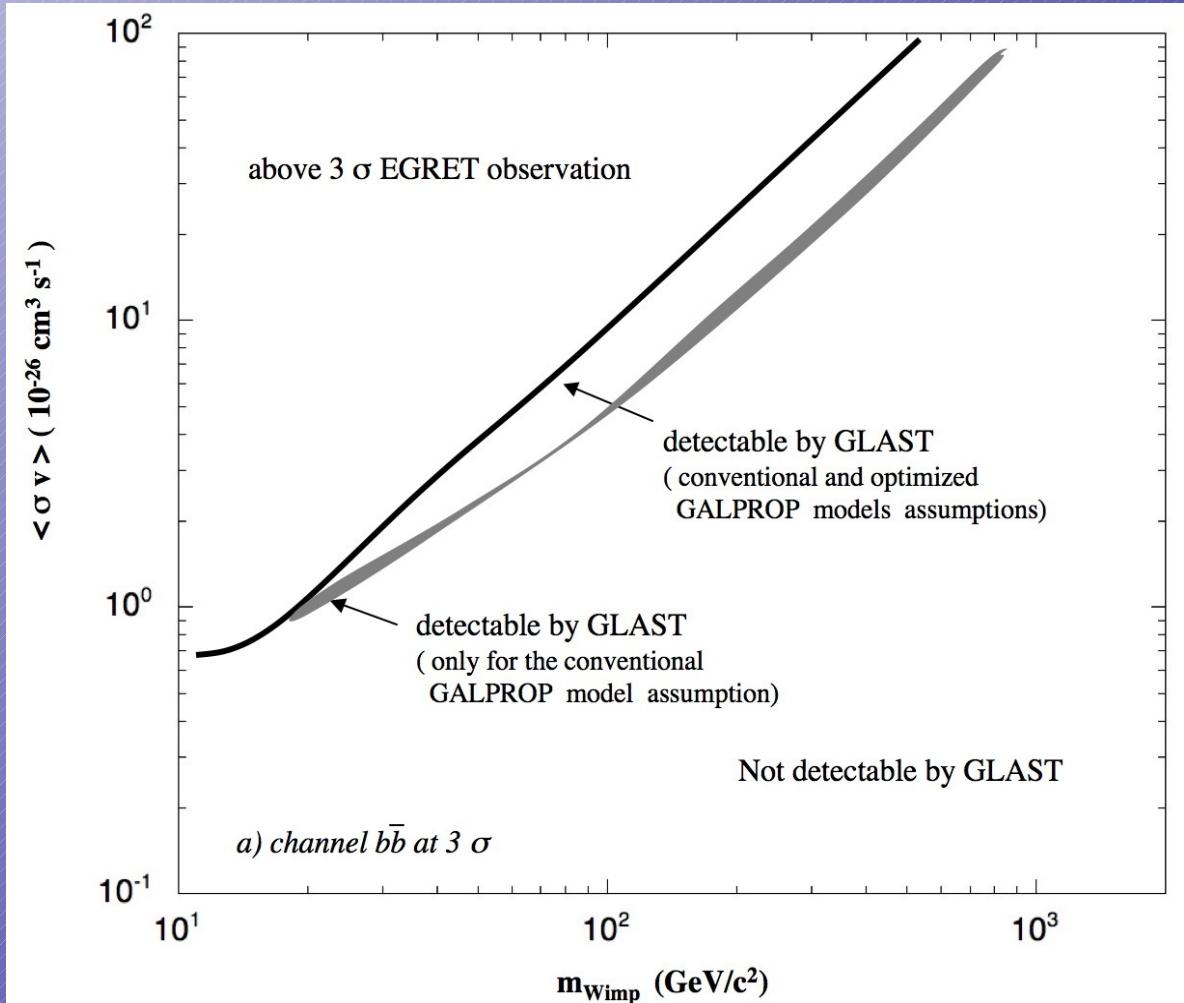
■ HESS point source and diffuse



■ EGRET GC map

Galactic Center

- Sensitivity to DM annihilation gamma signal from GC
- Exposure = 5 years
- NRW truncated profile
- b-anti b channel
- (Baltz et al. ArXiv 08062911, JCAP in press)



Summary



- **GLAST was successfully launched the 11th of June 2008**
- **GLAST will explore the HE gamma ray sky with a sensitivity 30 times better than EGRET**
- **A wealth of astro-particle and astrophysics can be addressed by means of GLAST observations**
- **GLAST will perform an indirect search for Dark Matter annihilation, with best sensitivity to date in the HE gamma ray band**