



The extragalactic sky in the *Fermi* era

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LAPP

On the behalf of the
Fermi collaboration



FFP14 » Frontiers of Fundamental Physics
Marseille, July 15-18, 2014

Main topics

- non-perturbative quantum gravity
- beyond the Standard Model
- loop quantum gravity
- pedagogy
- epistemology
- black holes & Quantum cosmology
- problem solving
- philosophy of physics
- progress in Lattice QCD
- mathematical methods & applications
- high energy astrophysics & cosmic rays
- noncommutative geometry
- heavy ion physics
- dark ages, dark matter & dark energy
- renormalization

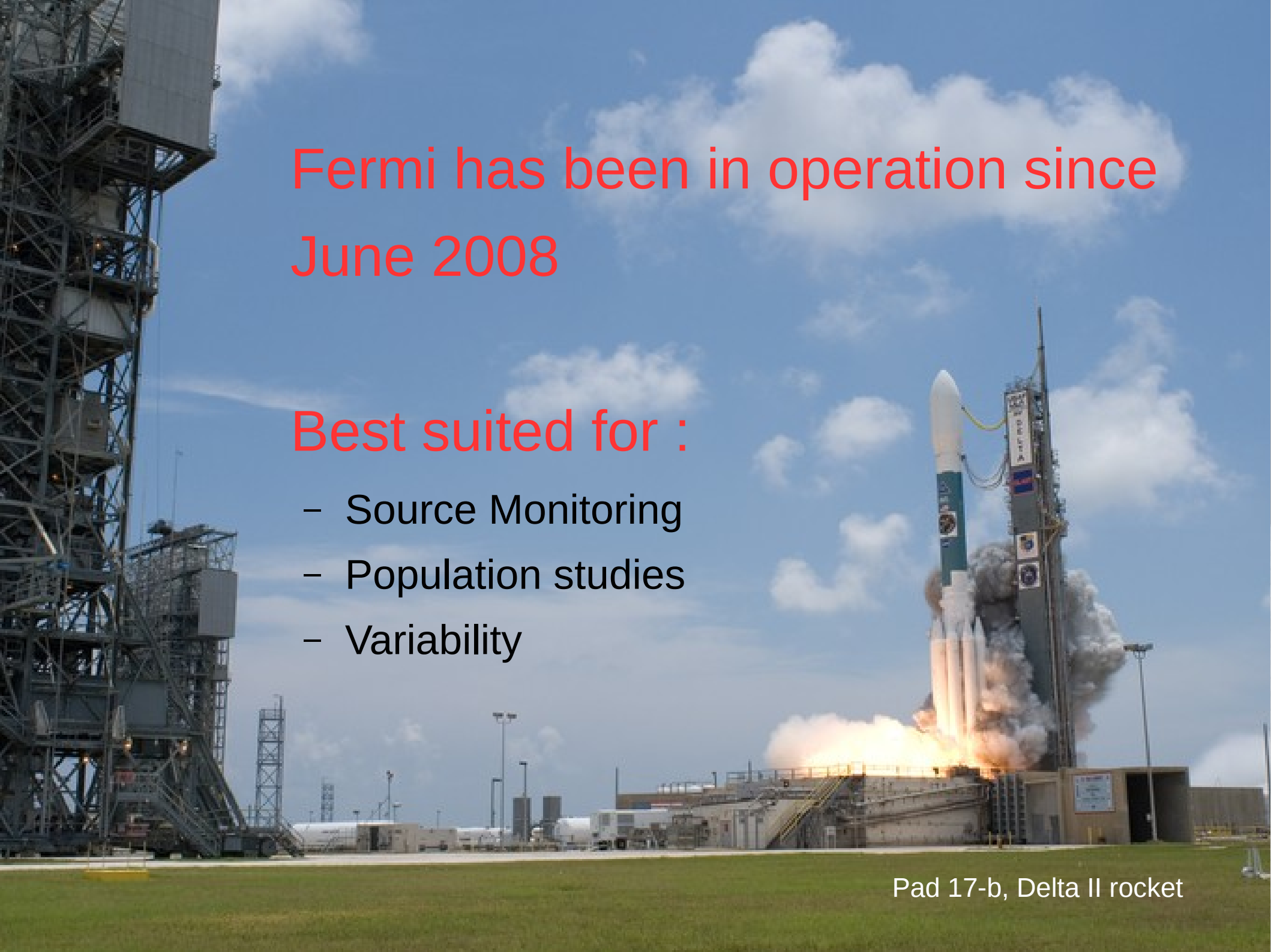
Scan and get all information
<http://ffp14.cpt.univ-mrs.fr>

Fermi has been in operation since
June 2008

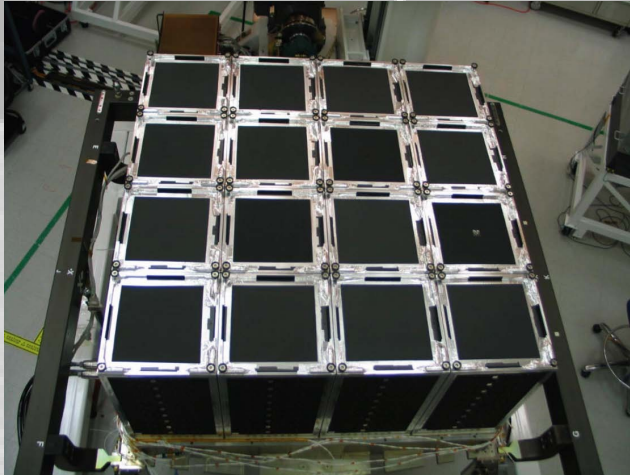
Best suited for :

- Source Monitoring
- Population studies
- Variability

Pad 17-b, Delta II rocket



The Large Area Telescope



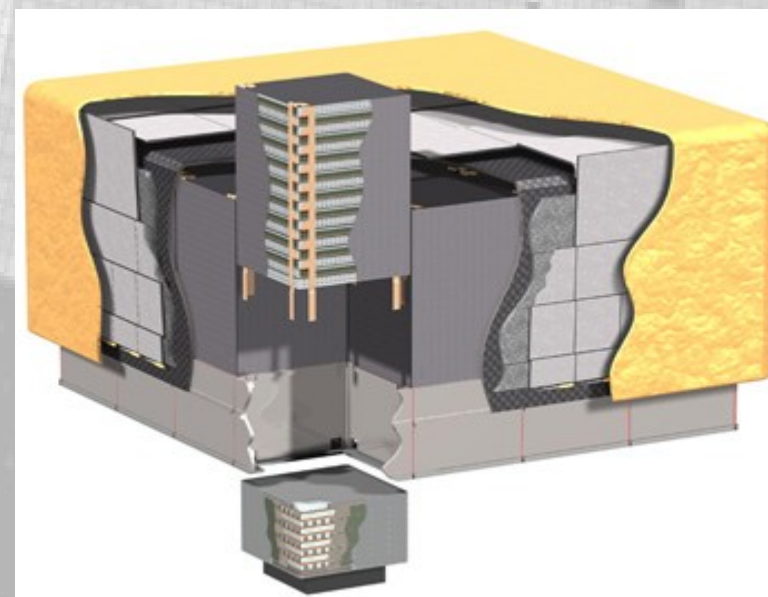
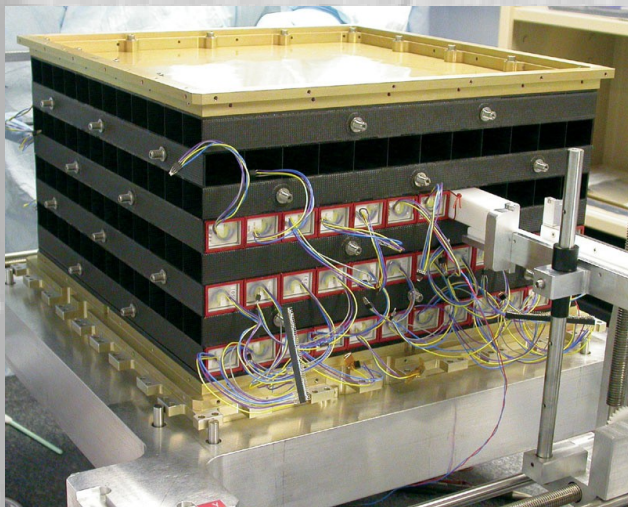
- Tracker
 - gamma conversion $\rightarrow e^+e^-$
 - Reconstruction of the Direction

- Calorimeter

- measure of the energy

- ACD

- reject charged background



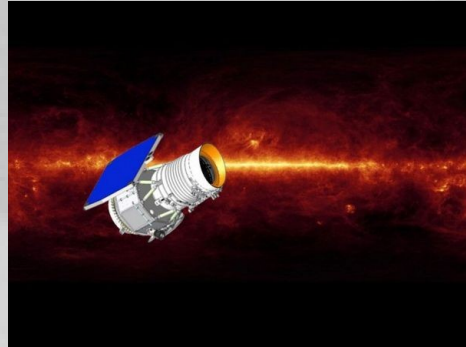
Atwood, W. B. et al. 2009, ApJ, 697, 1071

Synergy with other instruments

From radio to TeV



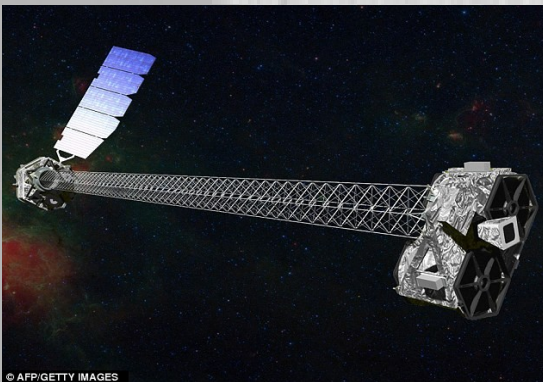
Radio: high resolution imaging of jets
AGN host galaxies



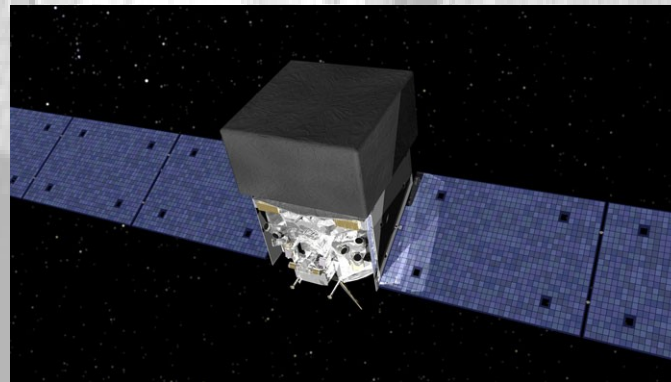
IR: AGN/GRB host galaxies...



Optical: AGN redshifts/GRB afterglows



X-ray: GRB & Flare, HE electrons



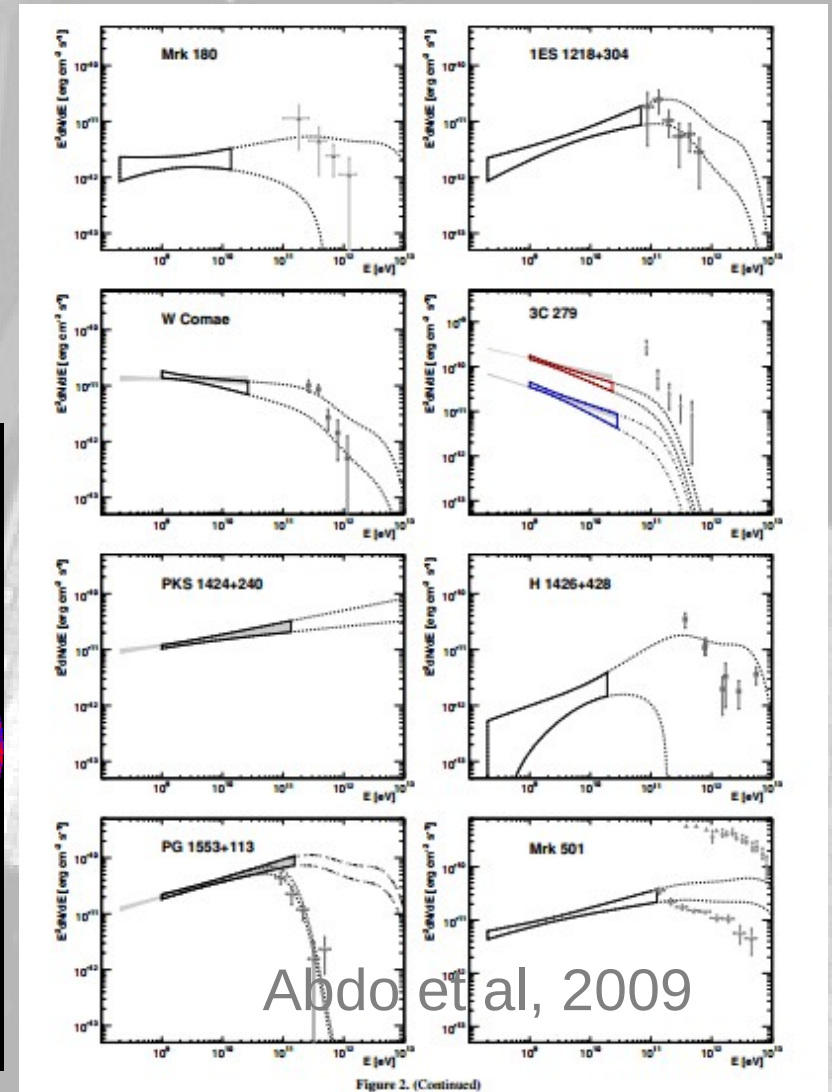
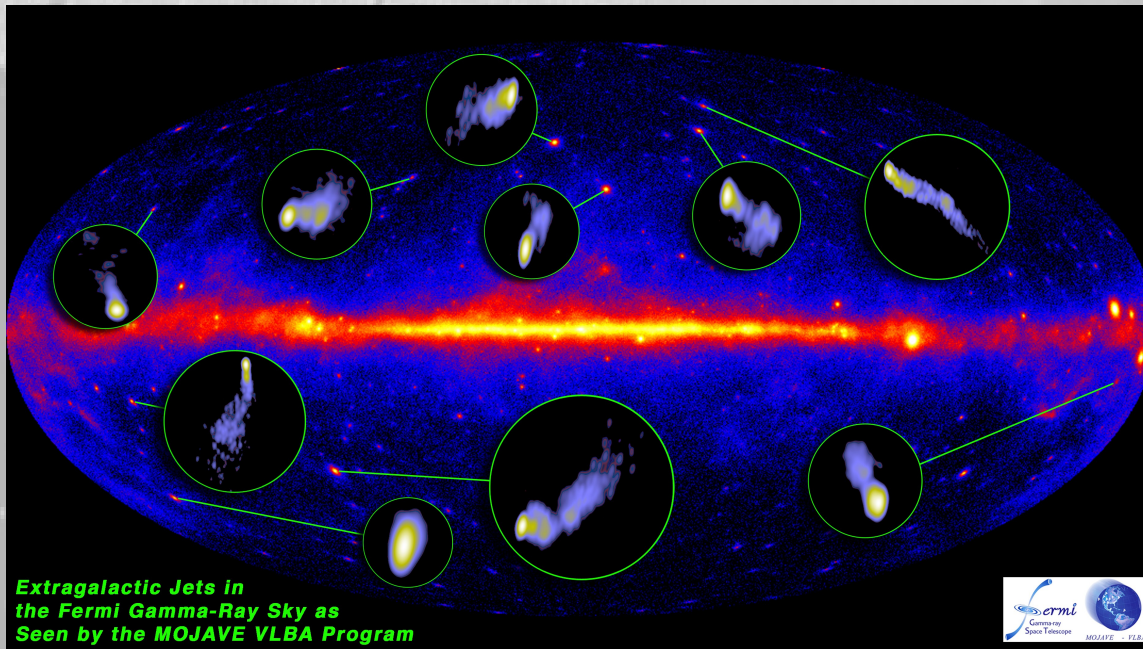
GeV by the LAT



TeV: GeV-TeV connection

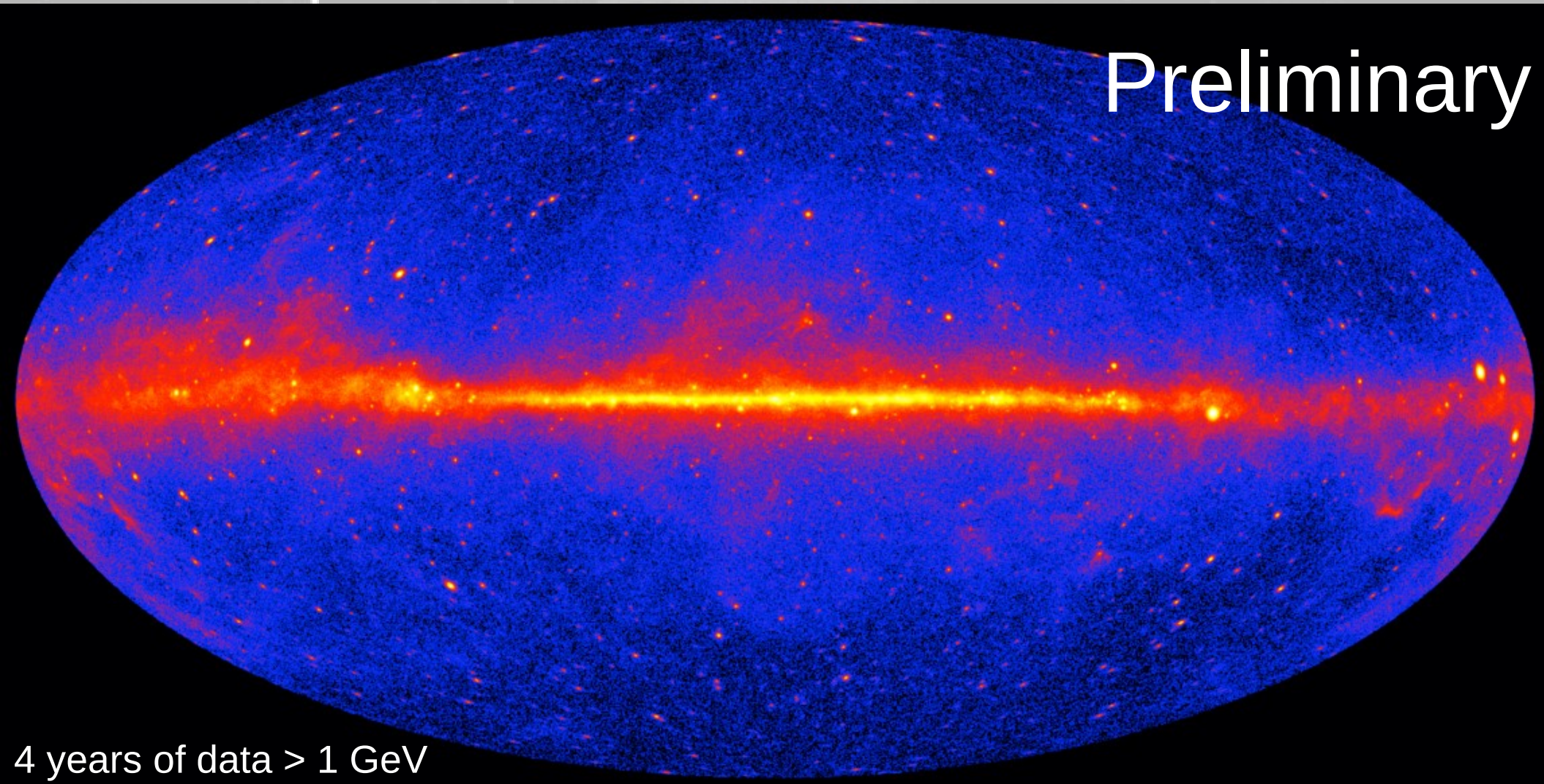
Synergy with other instruments

- MOJAVE program
- GeV-TeV connection
 - Most of the TeV sources are GeV emitters

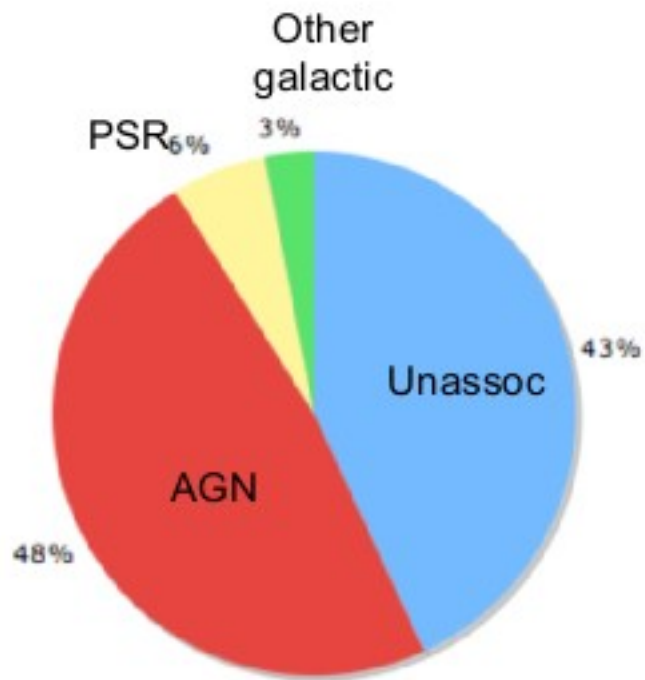


Third Fermi catalogue 3FGL

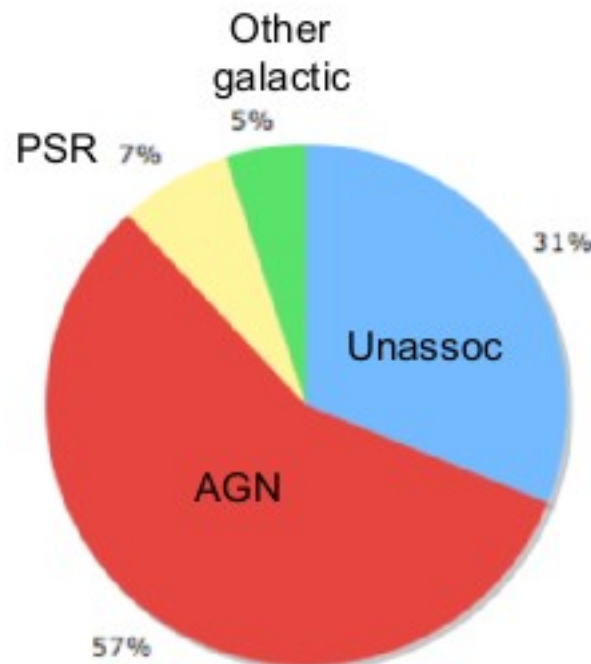
Preliminary



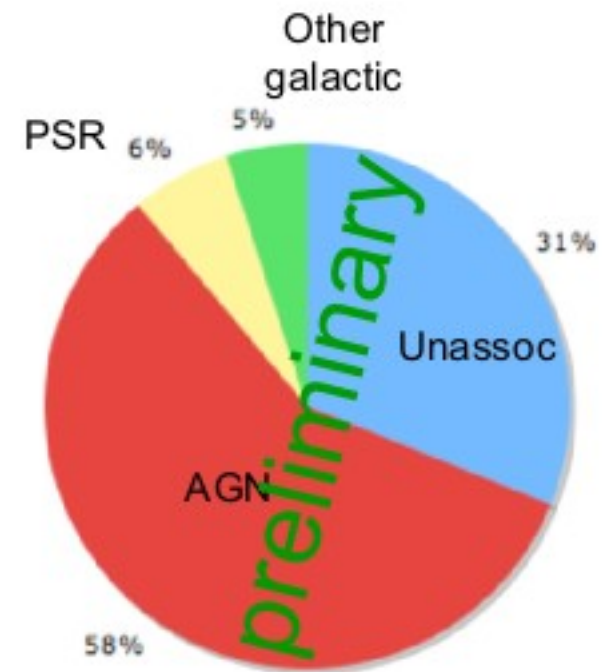
1FGL – 2FGL – 3 FGL



1FGL



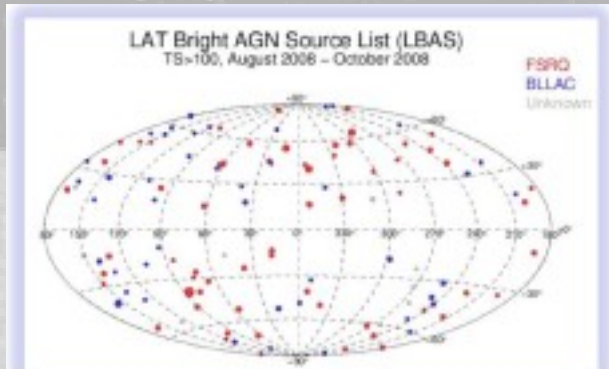
2FGL



3FGL

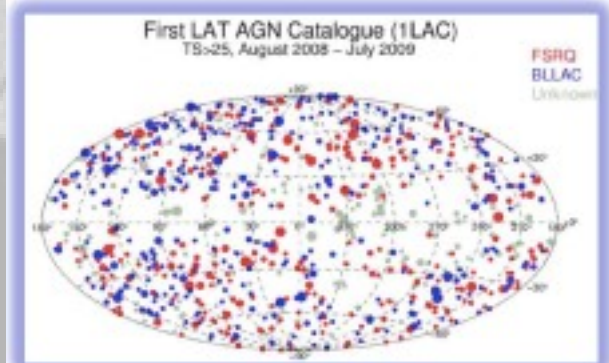
N. sources	1FGL	2FGL	3FGL
Total	1451	1873	~ 3000
High/Low b	72%/28%	71%/29%	~ 72%/28%

Blazars seen by LAT



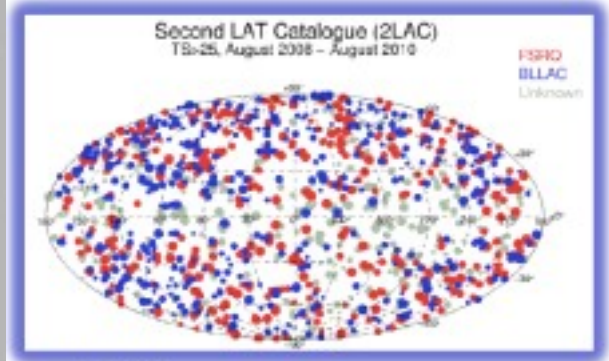
LBAS-high latitude:

- 58 FSRQs
- 42 BL Lacs
- 6 AGNs



1LAC-clean sample:

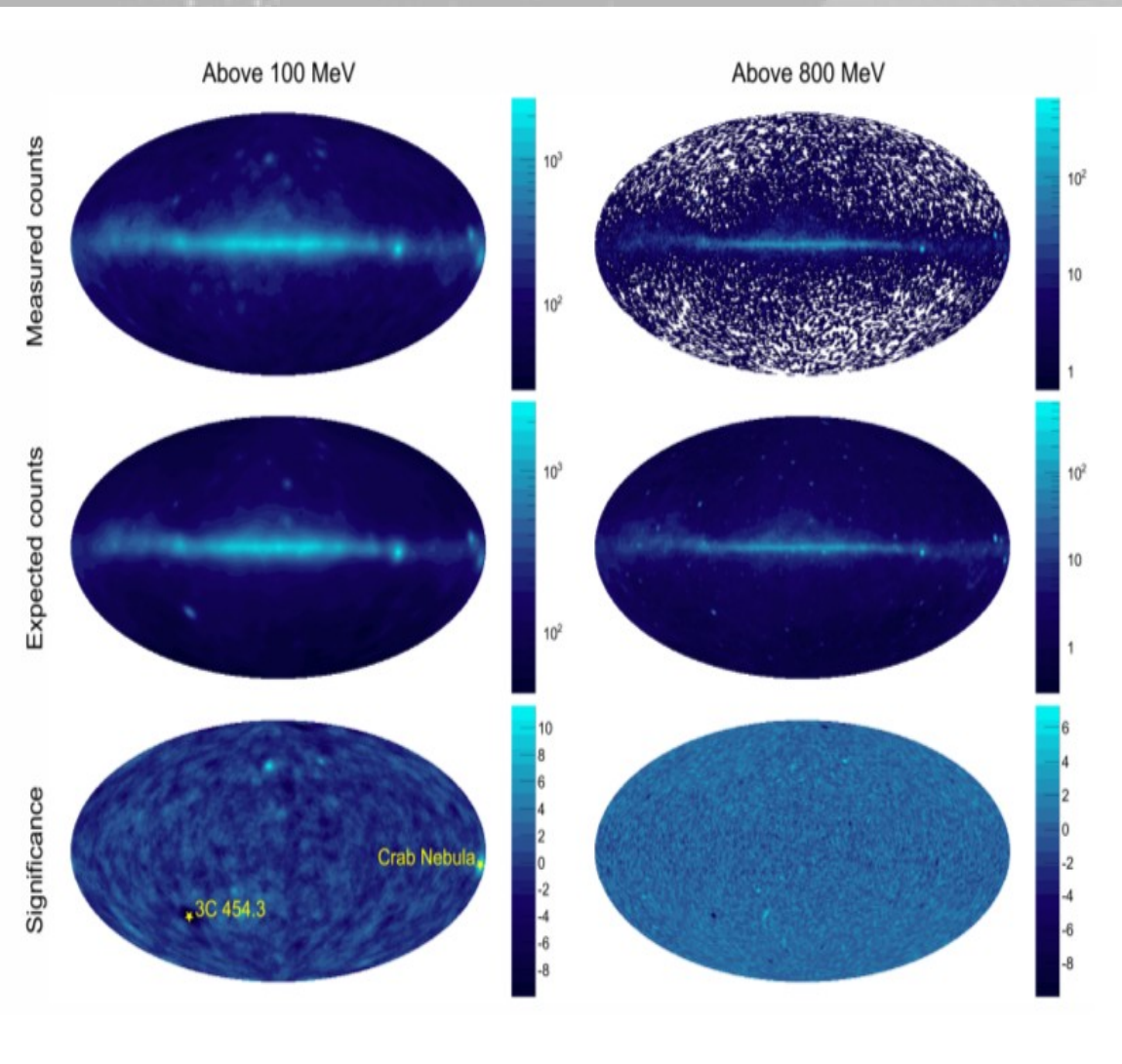
- 248 FSRQs, 275 BL Lacs
- 50 unknown type Blazars, 26 AGNs



2LAC-clean sample:

- 310 FSRQs, 395 BL Lacs
- 156 unknown type Blazars, 24 AGNs

Fast Variability Analysis (FAVA)



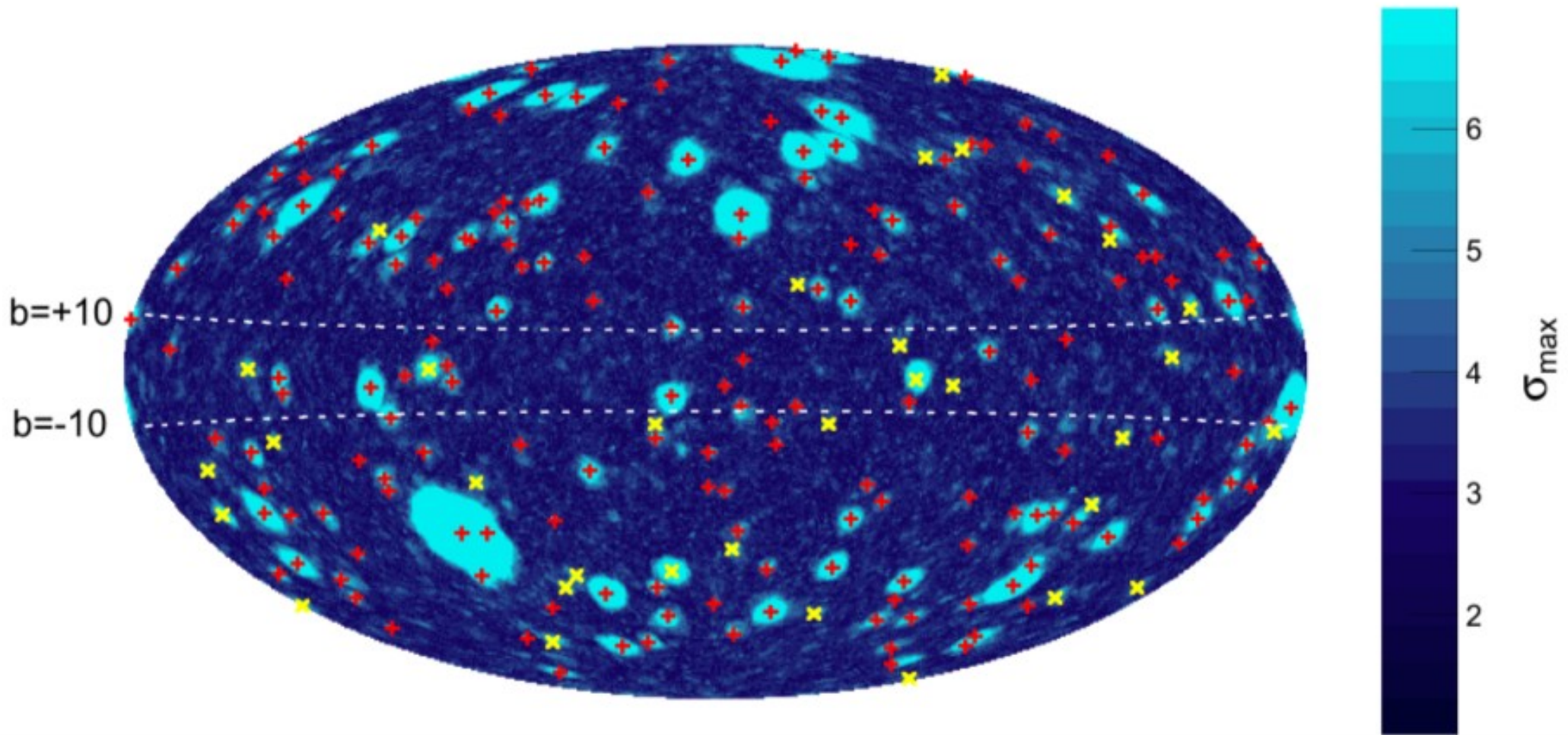
of gamma rays observed / # of gamma rays expected (average emission)

- Weekly time intervals
- 2 energy ranges (E>100MeV & E>800MeV)

Flare of the Crab and a negative flare (quiescence) for 3C 454.3

Ackermann et al.
2013, ApJ, 771, 57

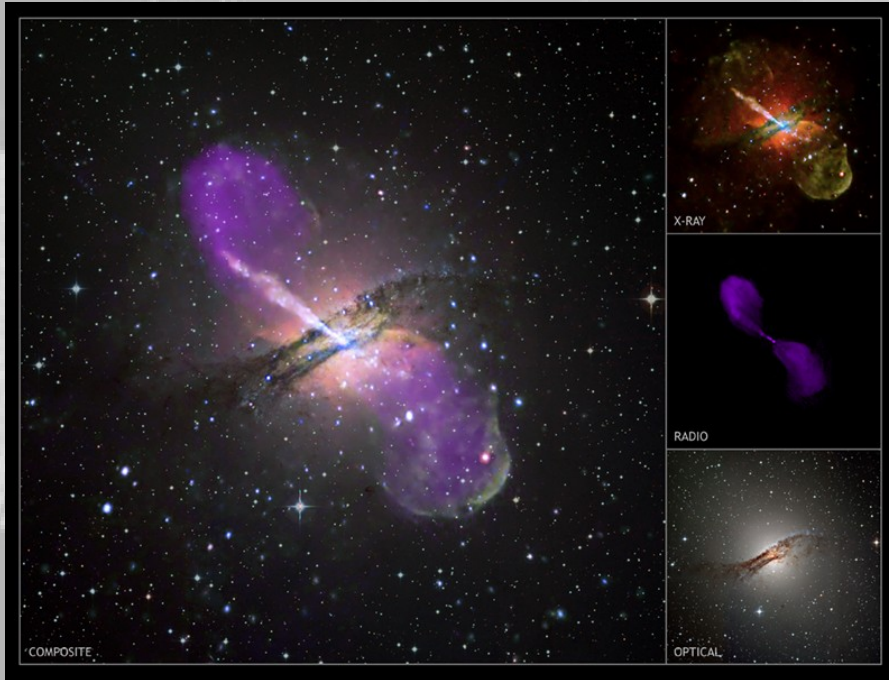
Fast Variability Analysis (FAVA)



215 sources, the bulk of sources below $|b| < 10$ are likely extragalactic

Ackermann et al.
2013, ApJ, 771, 57

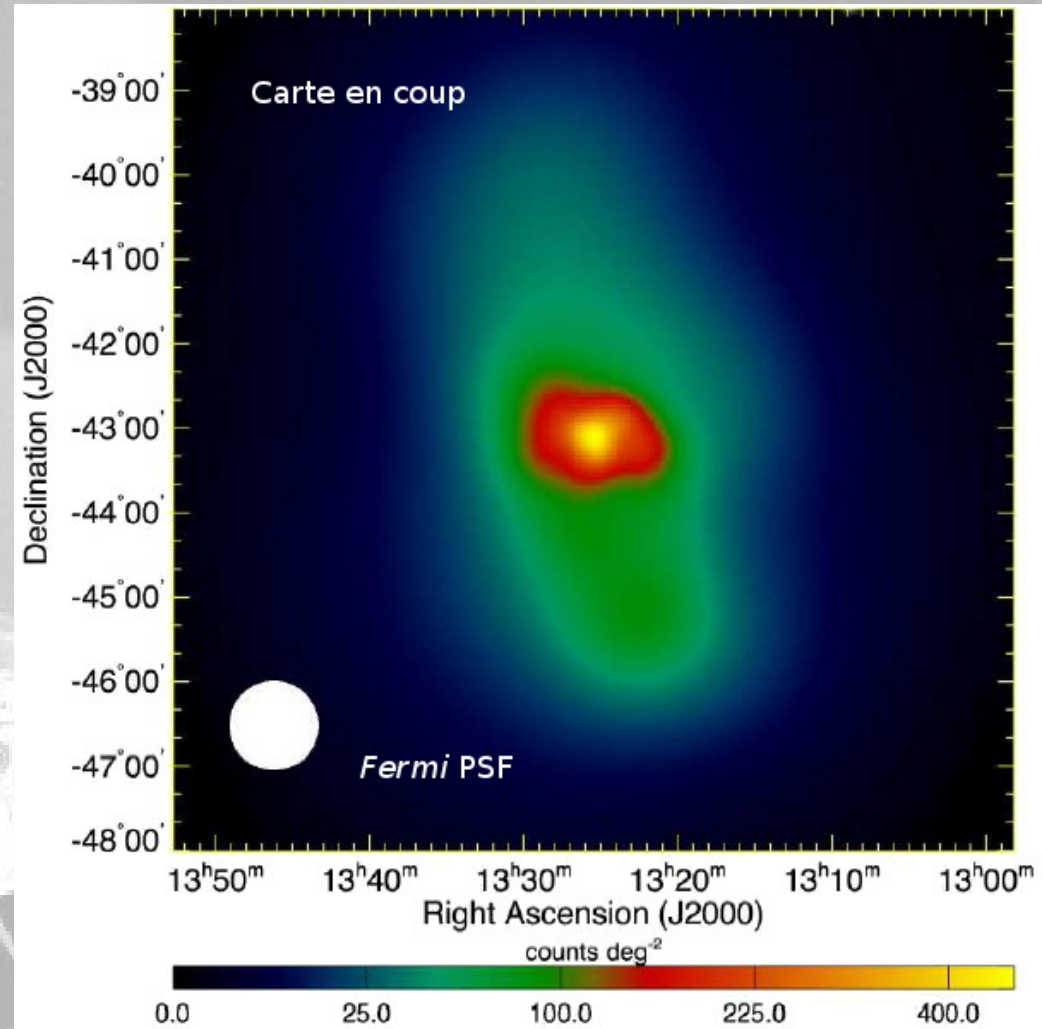
Centaurus A lobes'



- Closest Radio-Galaxy
- pair of extended radio lobes (total angular extent of $\sim 10^\circ$)
- Lobes detected in Gamma: IC on the CMB
(Requires 0.1-1 TeV electrons)

18/07/14

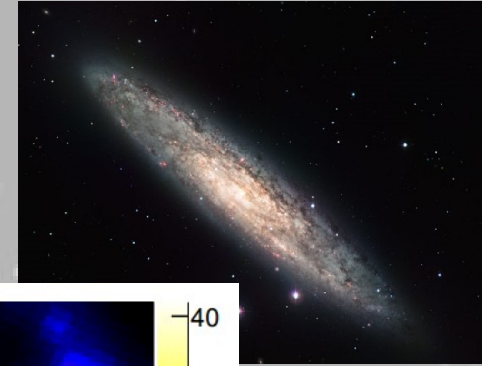
D. Sanchez, LAPP



Abdo, A. A. et al. 2010, Science, 328, 725

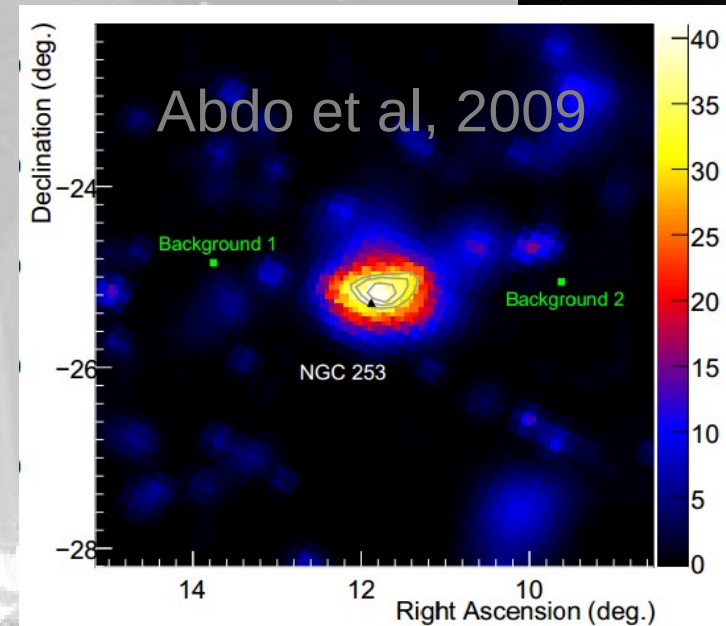
12

Star-burst Galaxies

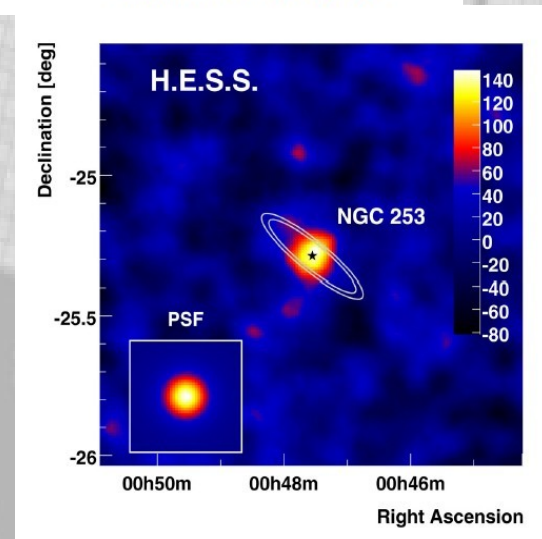


First detection

- M82 and NGC 253
(+ Veritas and H.E.S.S.)



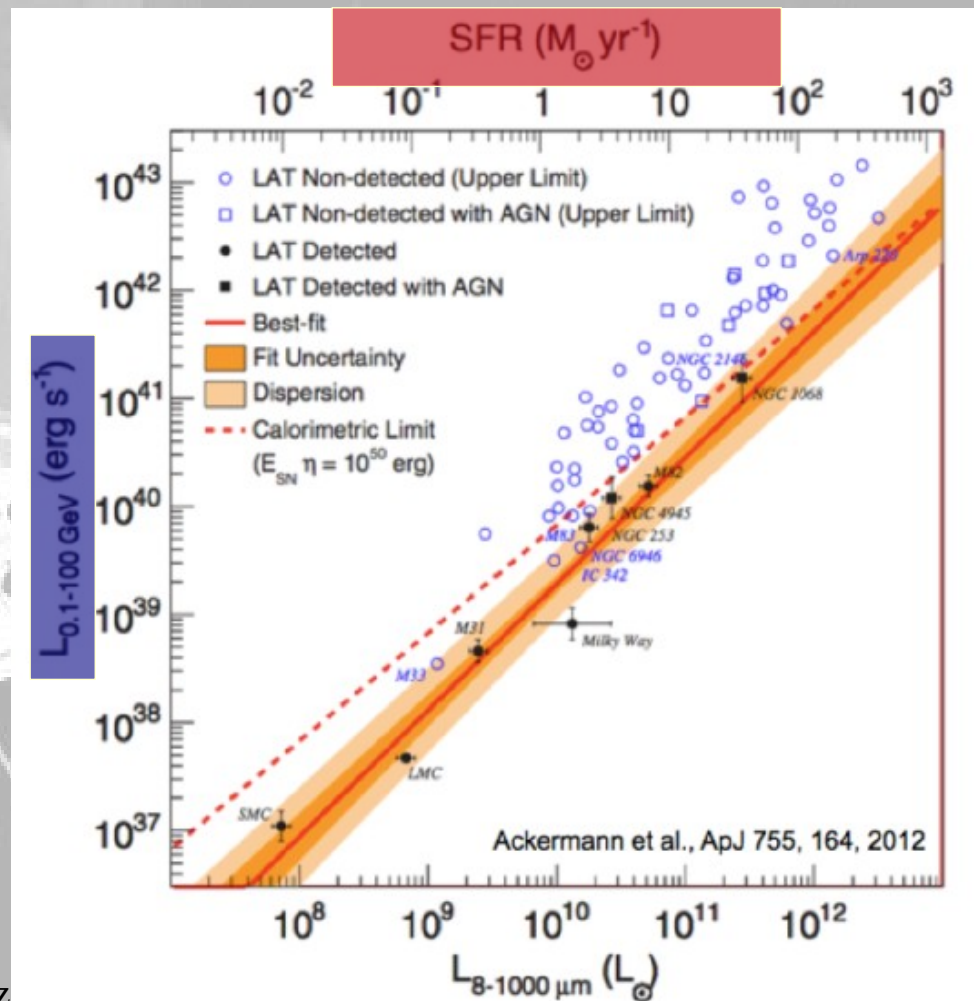
Star forming \rightarrow cosmic rays \rightarrow interact with interstellar gas and radiation \rightarrow production of diffuse gamma rays



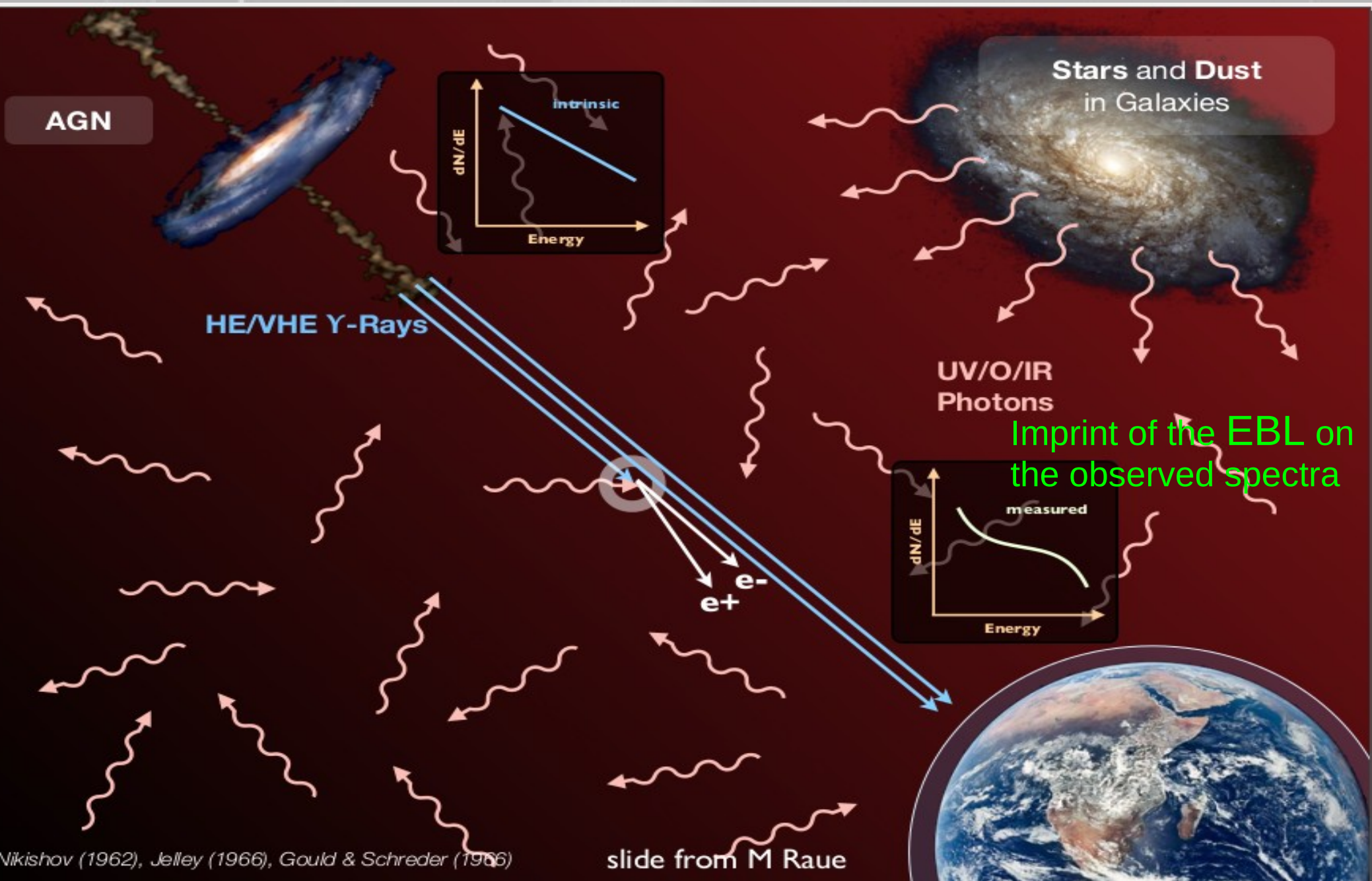
Star-burst Galaxies

Several detected by the LAT

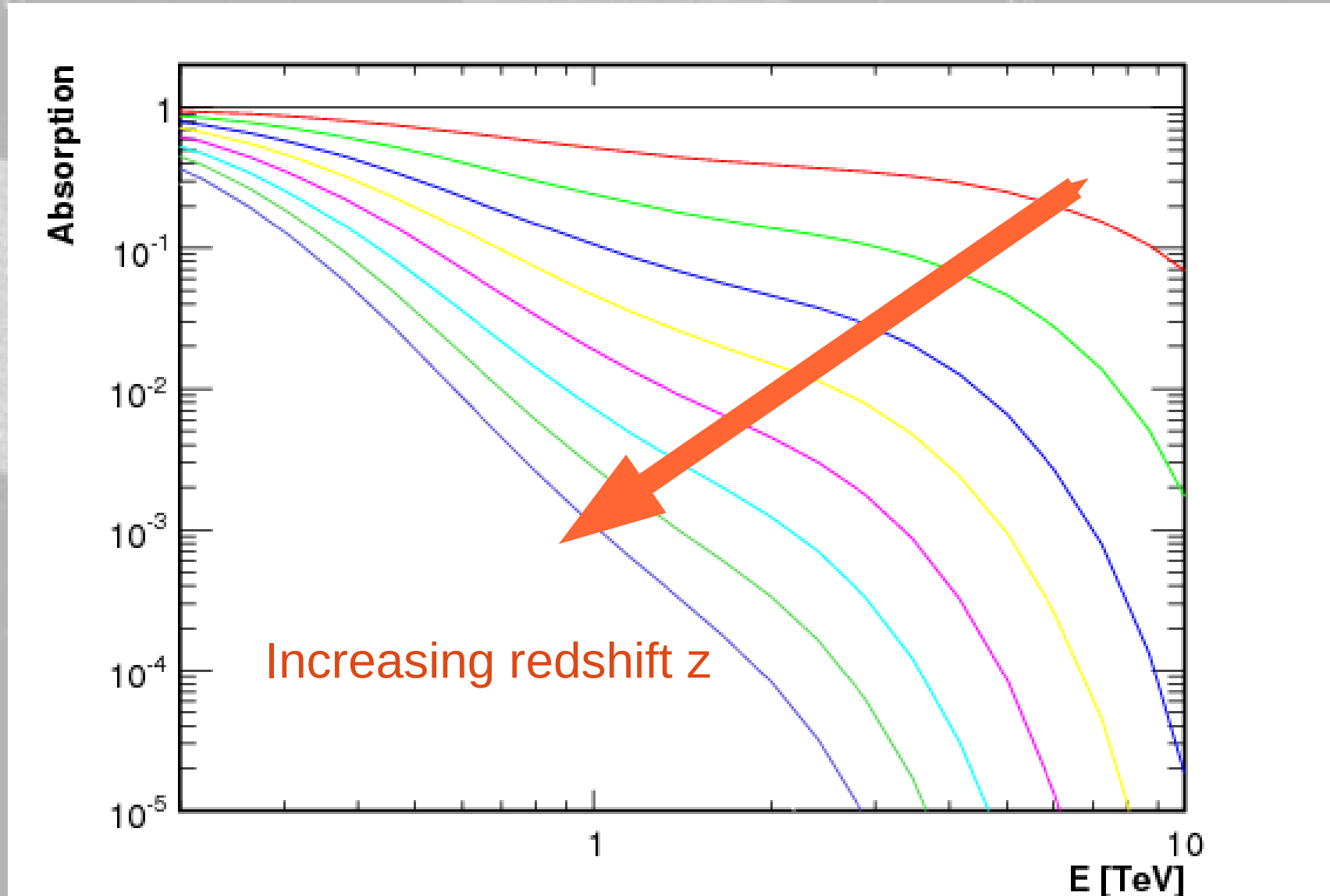
→ Almost linear correlation between γ -ray luminosity and tracers of star formation



The Extragalactic Background Light



Imprint of the EBL

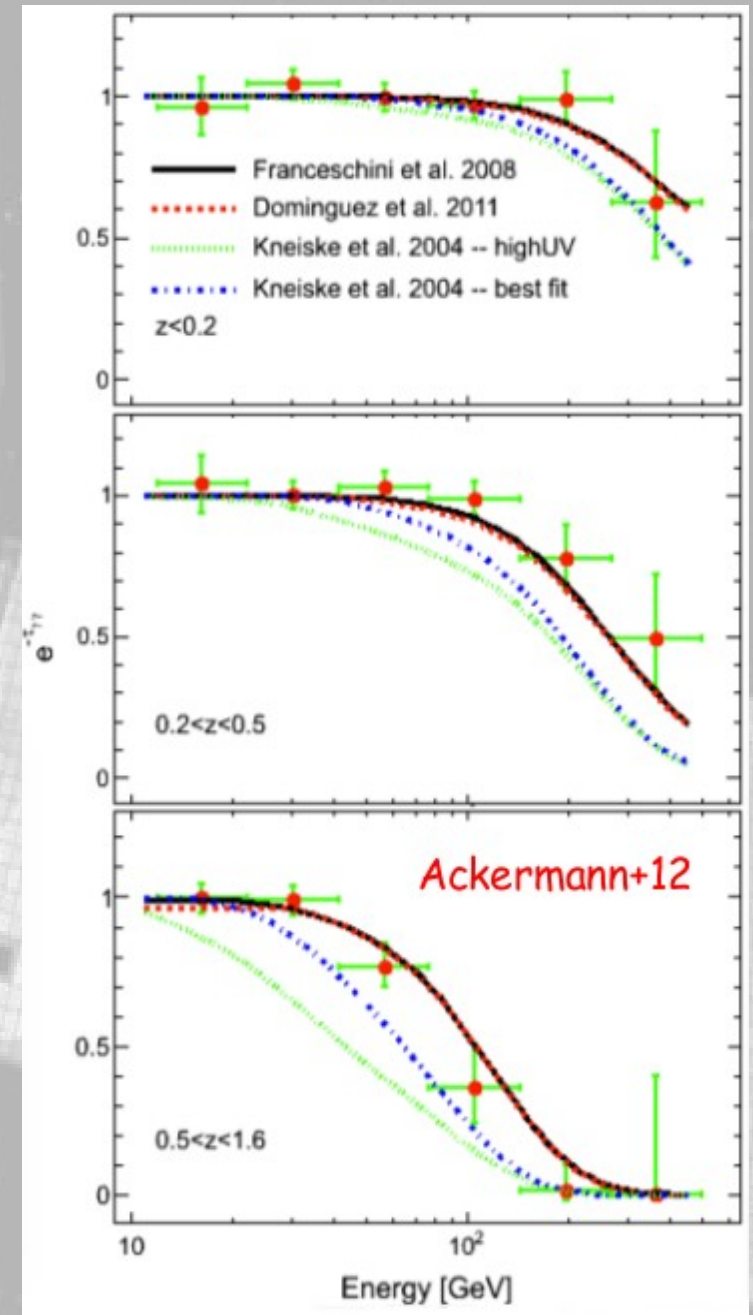


Imprint of the EBL

- search for collective behavior
- 3 redshift bins
 - $Z = 0-0.2, 0.2-0.5, 0.5-1.6$
- Sources spectra

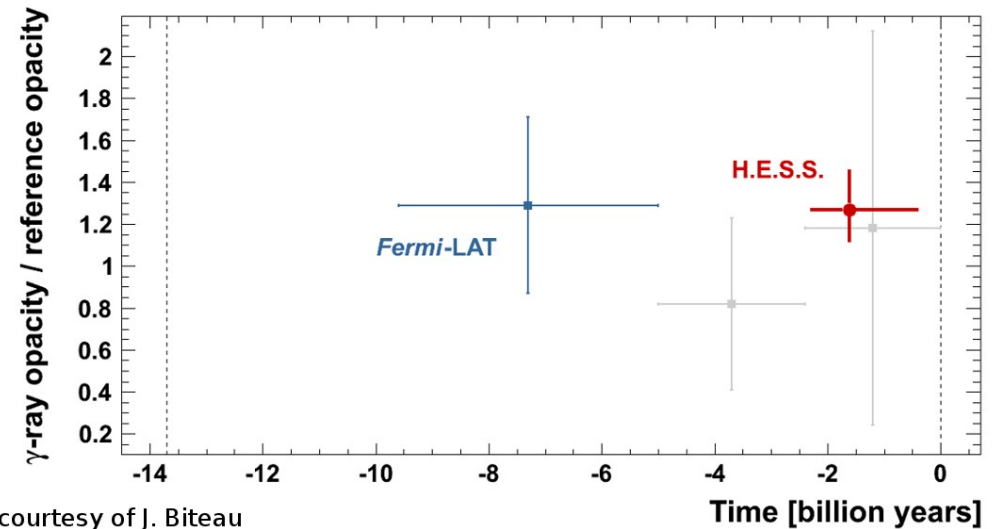
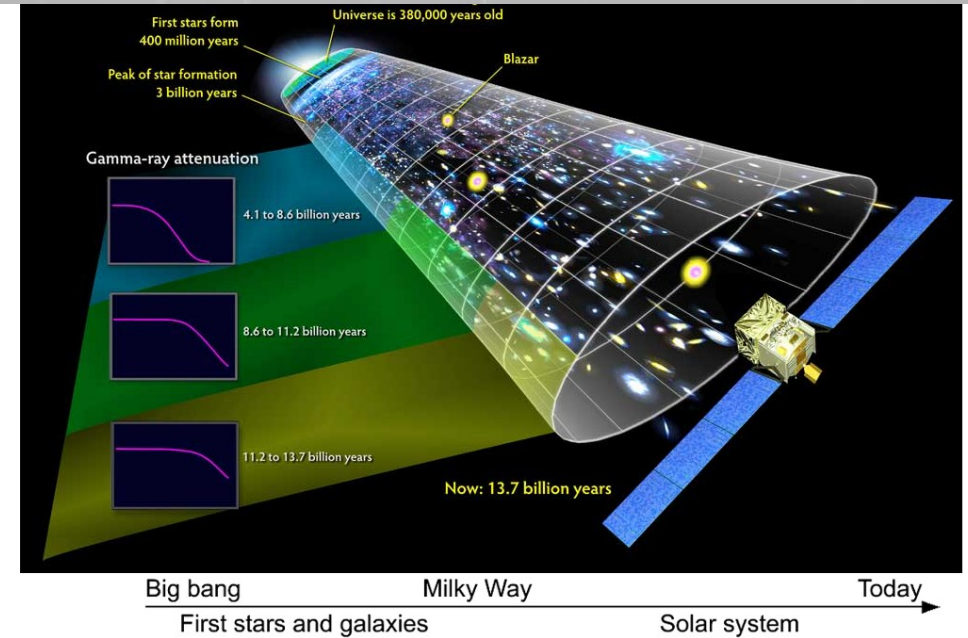
$$F(E)_{\text{absorbed}} = F(E)_{\text{intrinsic}} \cdot e^{-b \cdot \tau_{\text{model}}}$$

b tells the validity of a given model



Imprint of the EBL

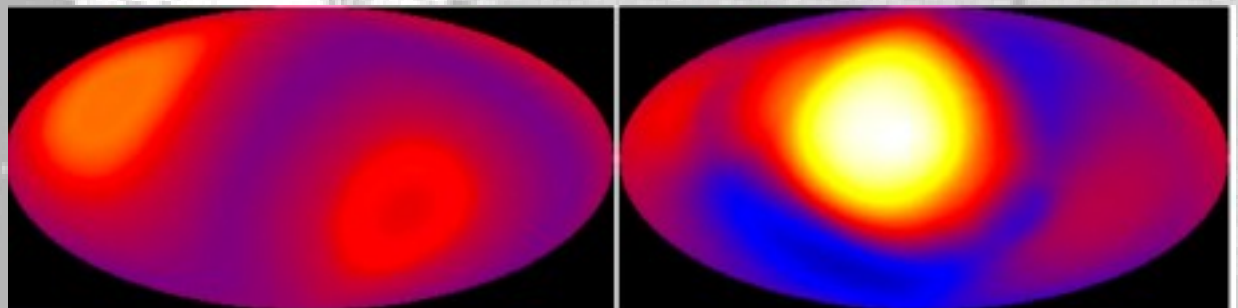
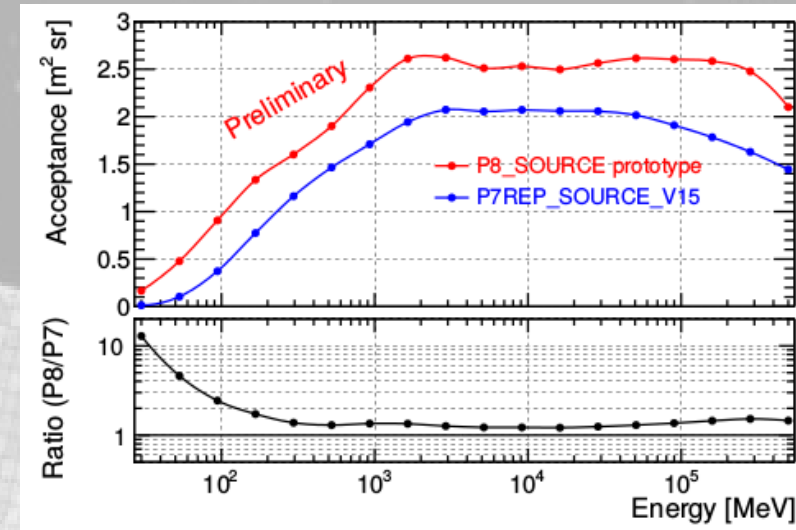
- 4 models rejected
- EBL at the galaxy count level
- Nice agreement with the H.E.S.S. measurement



courtesy of J. Biteau

Conclusions

- The LAT has been collecting data for almost 6 years
 - Operation goes smoothly
- What's new after 6 years
 - Time-domain astronomy (FAVA, FA)
 - Pass 8 IRFs
- New default observing mode in December 2013
 - GC observations



Fifth International Fermi Symposium



5TH FERMI SYMPOSIUM

October 20-24 2014, Nagoya, Japan

The 5th International Fermi Symposium will focus on new results and prospects for the Fermi Gamma-ray Space Telescope and related multi-wavelength and multi-messenger studies.



Topics include:

- Blazars and Other Active Galaxies
- Cosmic Rays
- Dark Matter
- Diffuse γ -ray Emission
- Gamma-ray Bursts
- Galactic Sources and Transients
- Pulsars
- Solar System γ -ray Sources
- Supernova Remnants and Pulsar Wind Nebulae

<http://fermi.gsfc.nasa.gov/science/mtgs/symposia/2014>

