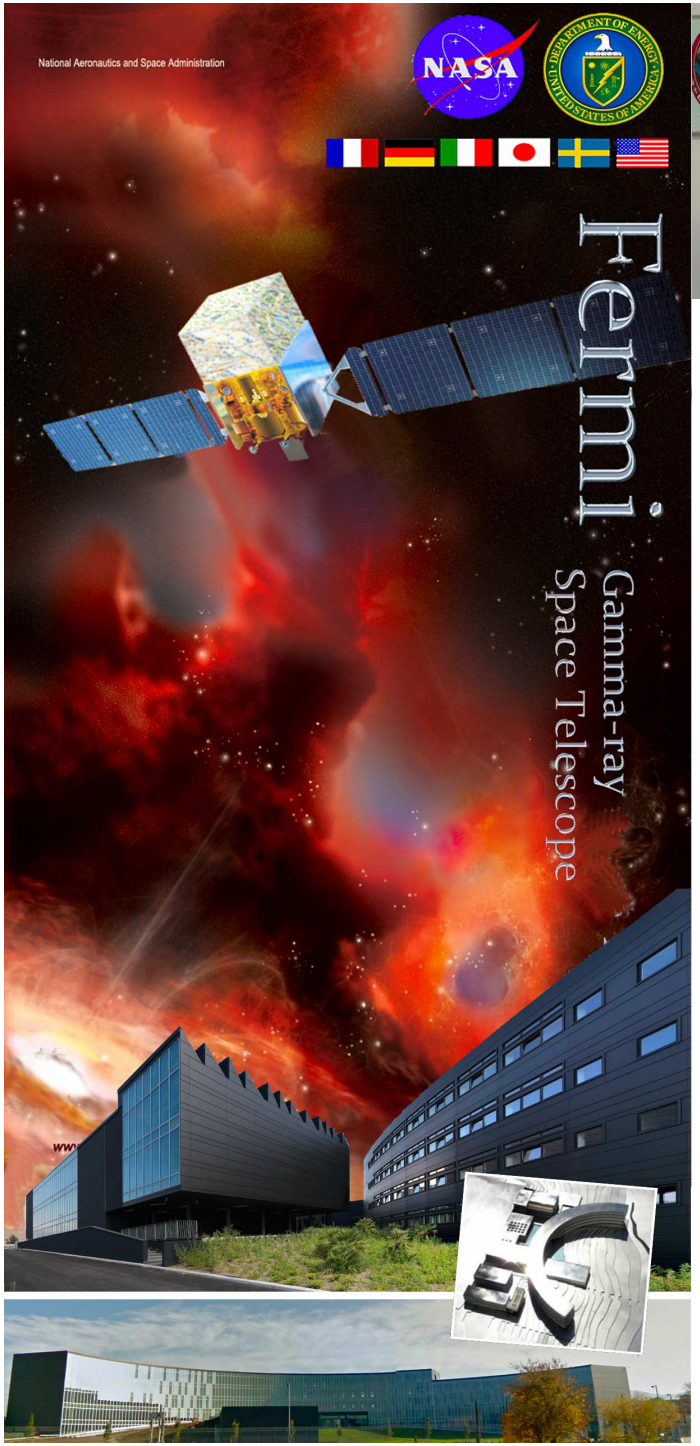


Short introductions of new researchers of 2018: S.C.

Stefano Ciprini

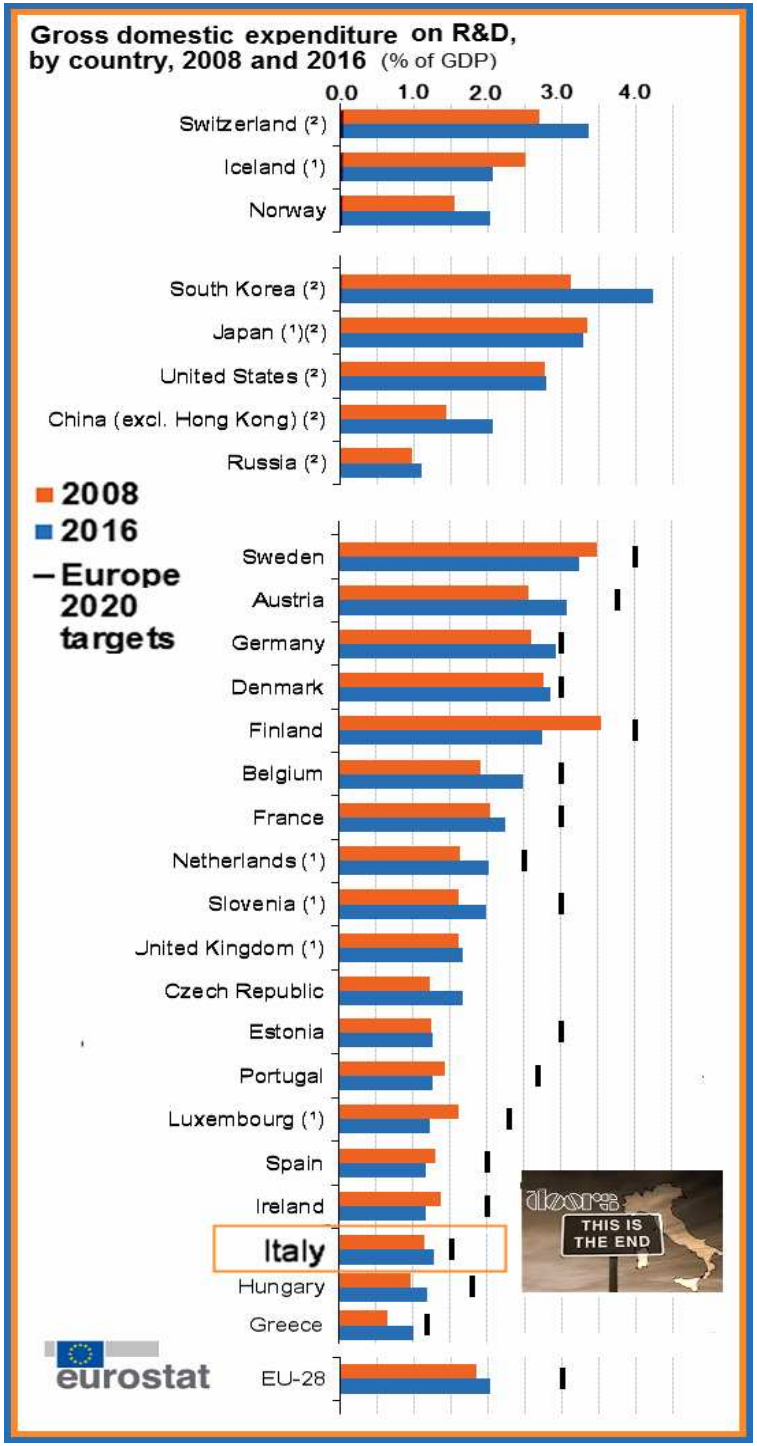
INFN Tor Vergata & SSDC Agenzia Spaziale Italiana

INFN
Istituto Nazionale di Fisica Nucleare

SSDC
SPACE SCIENCE DATA CENTER

Fermi

December 21, 2018 - Presentation of New Researchers
INFN Tor Vergata & Physic Dept. Univ. Tor Vergata, Rome



Short introductions of new researchers of 2018: S.C.

Stefano Ciprini

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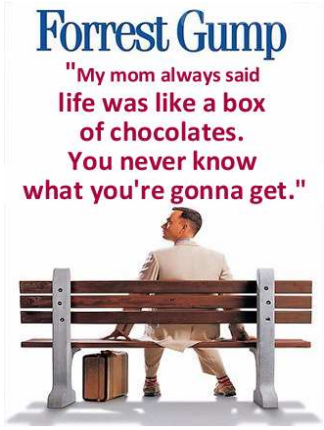

Una pianificazione per quanto attenta, non potrà mai sostituire una bella botta di culo.
(Legge di Murphy)

A Stroke Of Luck

December 21, 2018 - Presentation of New Researchers
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ASI Space Science Data Center (SSDC)

❑ Formerly ASI Science Data Center (ASDC): multi-mission, multi-disciplinary, science operation center, providing data processing and archiving support to several scientific space missions. Center built on the experience acquired within ASI with the management of the *Beppo*-SAX Science DataCenter in the late 1990s. Located at the ESA-ESRIN in Frascati since 2000, then in Rome at the ASI Headquarter from 2013.

❑ ASDC and Earth observation sections merged in the new "Space Science Data Center" (SSDC) ASI facility established in 2016.

❑ SSDC is now: 1) observation of the Universe, 2) Earth observation, 3) information and computing technologies.

❑ SSDC composed by around 40 researchers. Management and organization led by ASI involving national research institutes and industries.

- ASI Italian Space Agency
- INAF National Institute for Astrophysics
- INFN National Institute for Nuclear Physics

Research topics

· Astroparticle physics · X-ray/gamma-ray astrophysics · Stellar astrophysics · Cosmology · Large datasets · Solar system exploration · Time domain astronomy · Exploit of large archives of multifrequency data · X-ray polarimetry · X-ray/gamma-ray cross correlation wrt optical/radio data · Population studies · Multimessenger neutrino astronomy and gravitational wave astronomy. · Cosmic rays. · Technical activities and software development, · Calibrations, simulations, modeling · HPS, computing accelerators, data mining

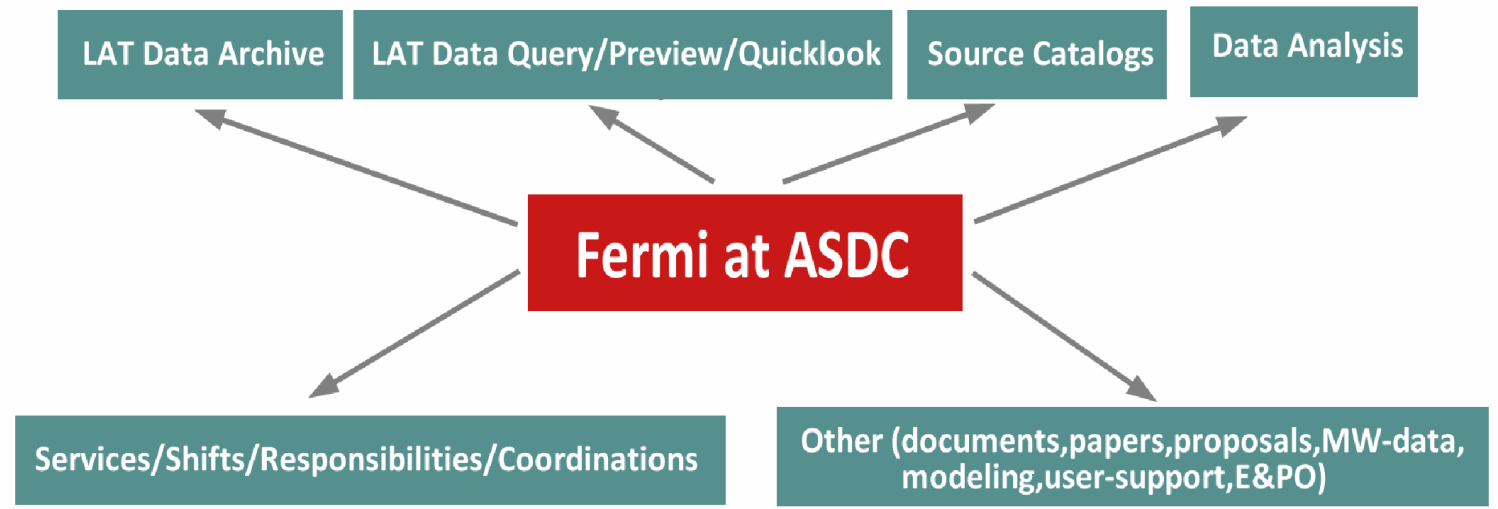
- **Support to scientific operations**
- **Data analysis software, online quicklook analysis, data visualization, pipelines**
- **High level data production (ex.: spectra, light curves, catalogs)**
- **Mission science data archives, mirroring, source catalogs**
- **Data preservation and distribution**
- **Future scientific missions feasibility studies**
- **Data mining including big data (ex.: the Gaia mission)**
- **Education and Public outreach**

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Fermi at ASI SSDC: my tasks and responsibilities

Summary of my current 2018 responsibilities

- ❑ Responsibility of Fermi Scientific Team at SSDC ASI (was 3 persons + 1 ASI, now we are 2, me and Dario G.) and the relative ASI contract Working Package (from 2011).
- ❑ Responsibility for supervision and coordination of the Flare LAT Advocate Gamma-ray Sky Watcher (FA-GSW) service from 2008.
- ❑ Responsibility of the collaborative and citizen science experiment devoted to Spectral Energy Distribution fitting (with SSDC tools) of >3000 Fermi LAT blazar sources aimed to the constructions of the next 4LAC catalog.
- ❑ Responsibility of the more scientific part of the public-outreach of SSDC, pertaining scientific seminars.
- ❑ Responsibility of new web and wiki for the "topical working groups" (TWG) of IXPE mission.

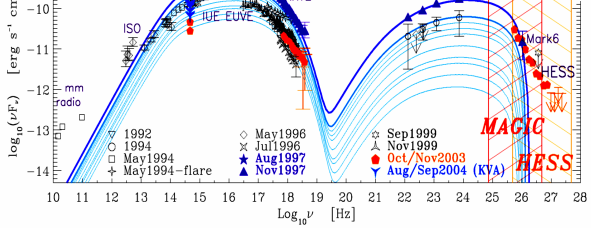


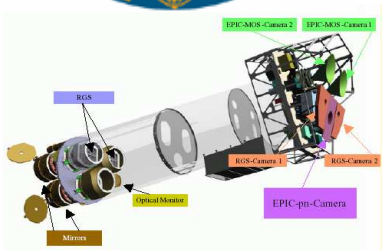
Tasks and activity topics of Fermi at SSDC and its ASI Working package

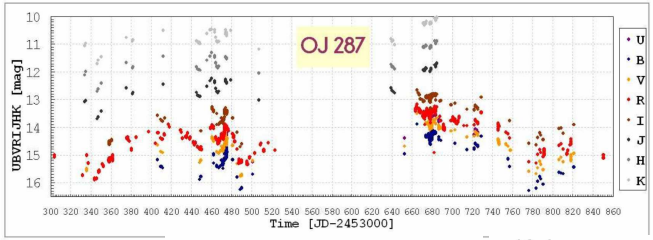
stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

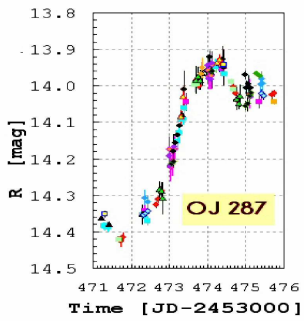
Only a single screenshot on the distant past

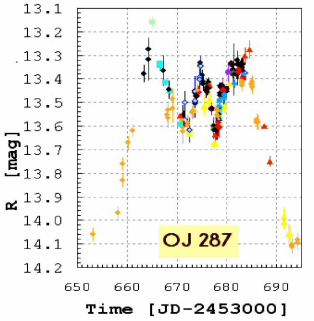
I was member for 2 years (2004-2005) of the Tuorla Observatory
University of Turku – Piikkiö, Turku-Abo in FINLAND within the (European Commission Young Researcher Training Network "ENIGMA")

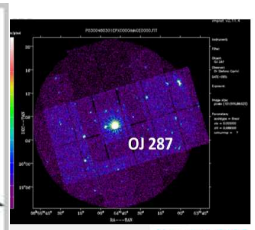


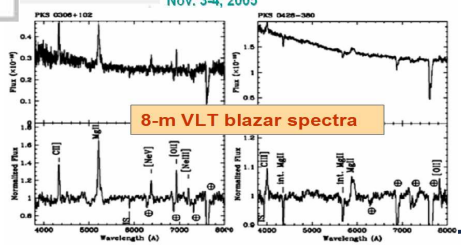


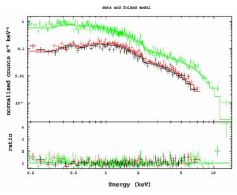










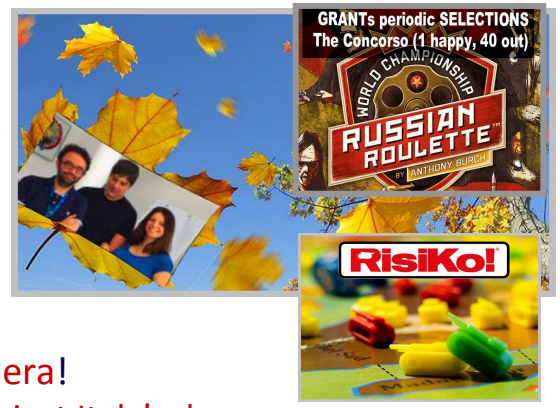


Armenzano
Roque-KVA
Mt.Maidanak
Abastumani
Crimea
Sabadell
Osaka-Kyoiku
Nyrola
KASI
Trebur
Tenagra Arizona
Coyoye Hill
Heidelberg
Xinglong
Xinglong 60/90cm
Xinglong 80cm
ARIES Naini Tal
COMU Ulupinar
Crimean 70cm
Kitt Peak
St. Petersburg
Mt. Lemmon
Sobaeksan
ARIES Naini Tal
Lulin
Rozhen
Perugia

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Fermi mission team era at ASI ASDC(SSDC)

- Several different temporary job contracts during the last dozen years at SSDC, without salary interruptions (but several time/energy/enthusiasm/creativity-consuming steps of selections/concorsos. DarioG, SaraC since 2006, Me since 2011.
- We changed Institutions: University, CIFS, ICRAnet(possibility), INAF, INFN.
- Special thanks to our INFN, INAF, ASI, ASDC/SSDC Institutional Presidents, Directors, Referents/bosses, Councils, Panels, also Trade Unions and our colleagues with the same precariousness/insecurity problem.
- Special thanks for the "stabilizzazioni" (and ad-hoc government funding) to premiers Renzi and Gentiloni, ministers Madia and Fedeli, and possibly to several other politicians that have been active on the background.
- The biggest special thank is for Prof. Bruna Bertucci (Univ./INFN PG) head of our ASI-INFN fund contract (we are INFN-at-SSDC people since January 2015).

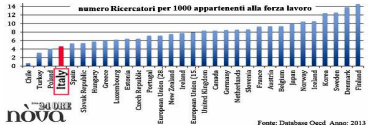


- The last about 25 years: rather complicated social-economic and public budget era! Gulf wars, Tangentopoli/populism, Mafias massacres, political mixtures and real war against Italy's democracy, the 9/11 trade center, the great worldwide financial crisis, 2008-2014(the end?), the "austerity", Italy's national debit crisis, the jobless young generations, the unwise linear cuts and cut throat savings by several past unwise governments...

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

“Stabilizzazioni”:
1 Mozart or “todos cabaleiros” ? → Trade-off

❑ Only visuals. Trade off. We cannot miss any “Mozart”-like genius (we all agree) but also the “others” (i.e. smaller brains, but also potential surprises) are necessary, within budget limits.

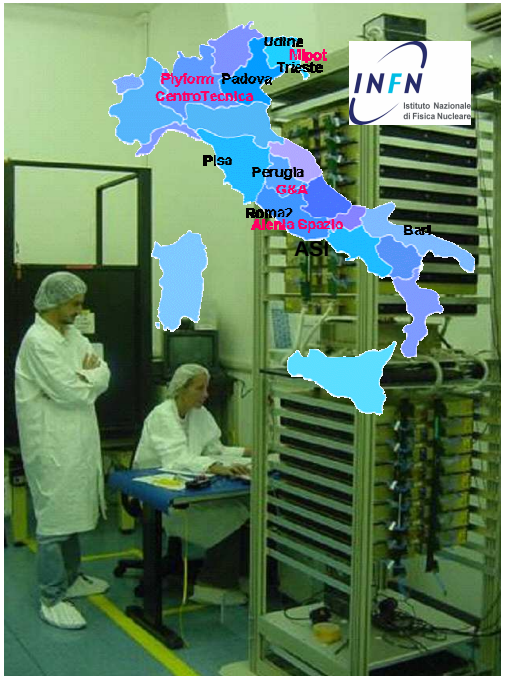


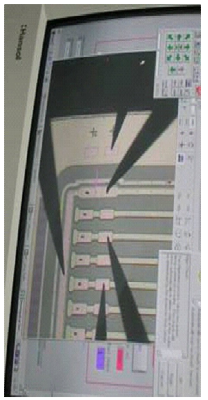
Il successo nutre la fiducia e la capacità di fidarsi nutre il successo. più sei immerso in un contesto di successo, più ti fidi. E viceversa. Diffidare invece secerne la tossina della paralisi

L'ascensore sociale italiano è bloccato
non si riesce a salire quando si parte da sotto
non si rischia di scendere quando si parte da sopra

stefano.ciprini@ssdc.as
INFN Tor Vergata & SSDC AS., Rome

SSDC *Fermi* team: the origins.
Hardware GLAST/*Fermi* LAT tracker group in INFN Perugia





stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

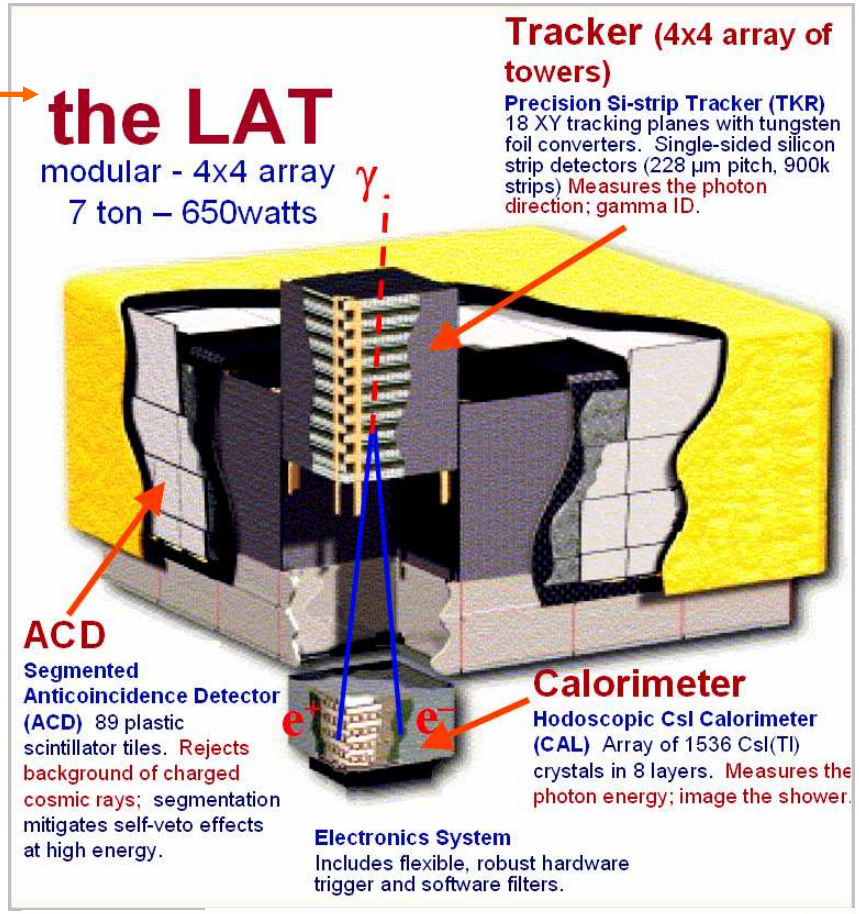
Fermi Gamma-ray Space Telescope

Fermi (formerly GLAST): two Instruments

The Large Area Telescope (LAT)
20 MeV - 300 GeV
>2.5 sr FoV

The Burst Monitor (GBM)
8 keV – 40 MeV
9.5 sr FoV

the LAT
modular - 4x4 array
7 ton – 650watts



Tracker (4x4 array of towers)
Precision Si-strip Tracker (TKR) 18 XY tracking planes with tungsten foil converters. Single-sided silicon strip detectors (228 μm pitch, 900k strips) Measures the photon direction; gamma ID.

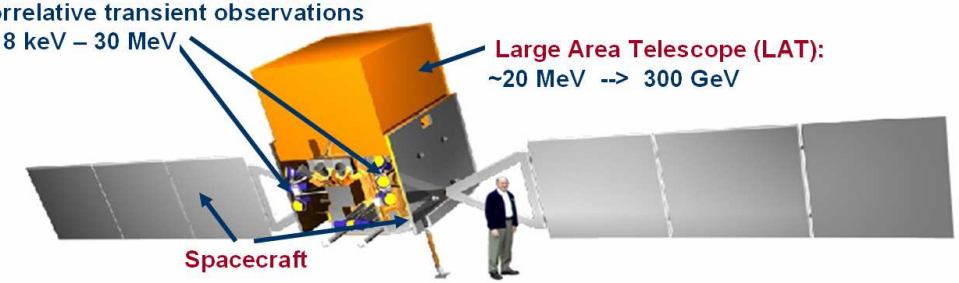
ACD
Segmented Anticoincidence Detector (ACD) 89 plastic scintillator tiles. Rejects background of charged cosmic rays; segmentation mitigates self-veto effects at high energy.

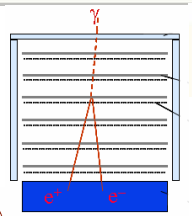
Calorimeter
Hodoscopic CsI Calorimeter (CAL) Array of 1536 CsI(Tl) crystals in 8 layers. Measures the photon energy; image the shower.

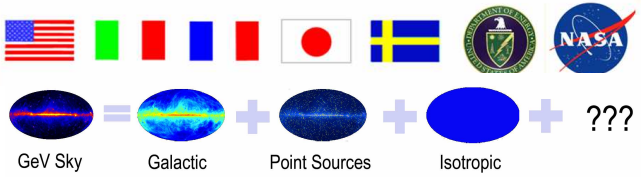
Electronics System
Includes flexible, robust hardware trigger and software filters.

Gamma Ray Burst Monitor (GBM):
correlative transient observations
~ 8 keV – 30 MeV

Large Area Telescope (LAT):
~20 MeV --> 300 GeV

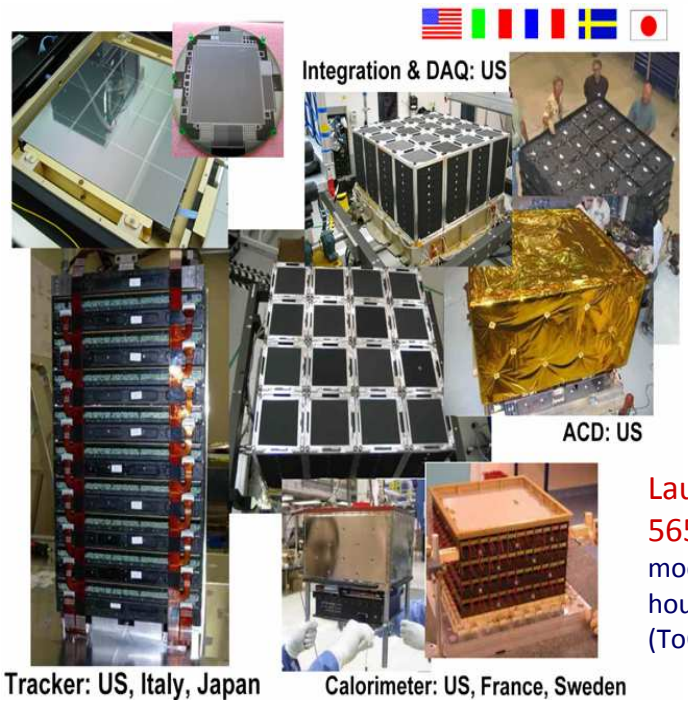


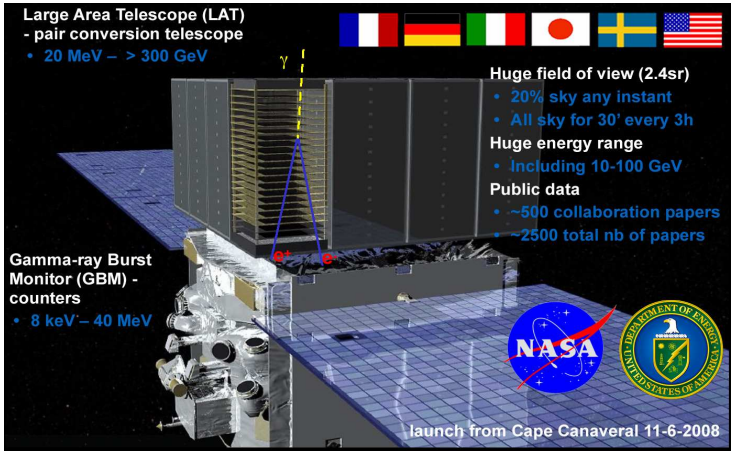


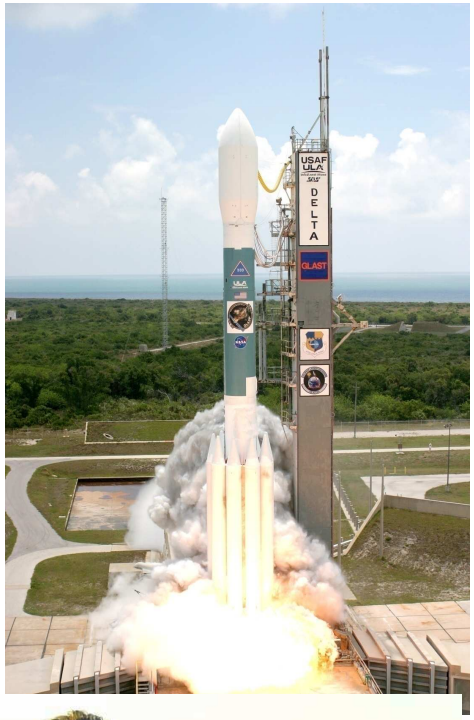


stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

GLAST/*Fermi* launch 11 June 2008



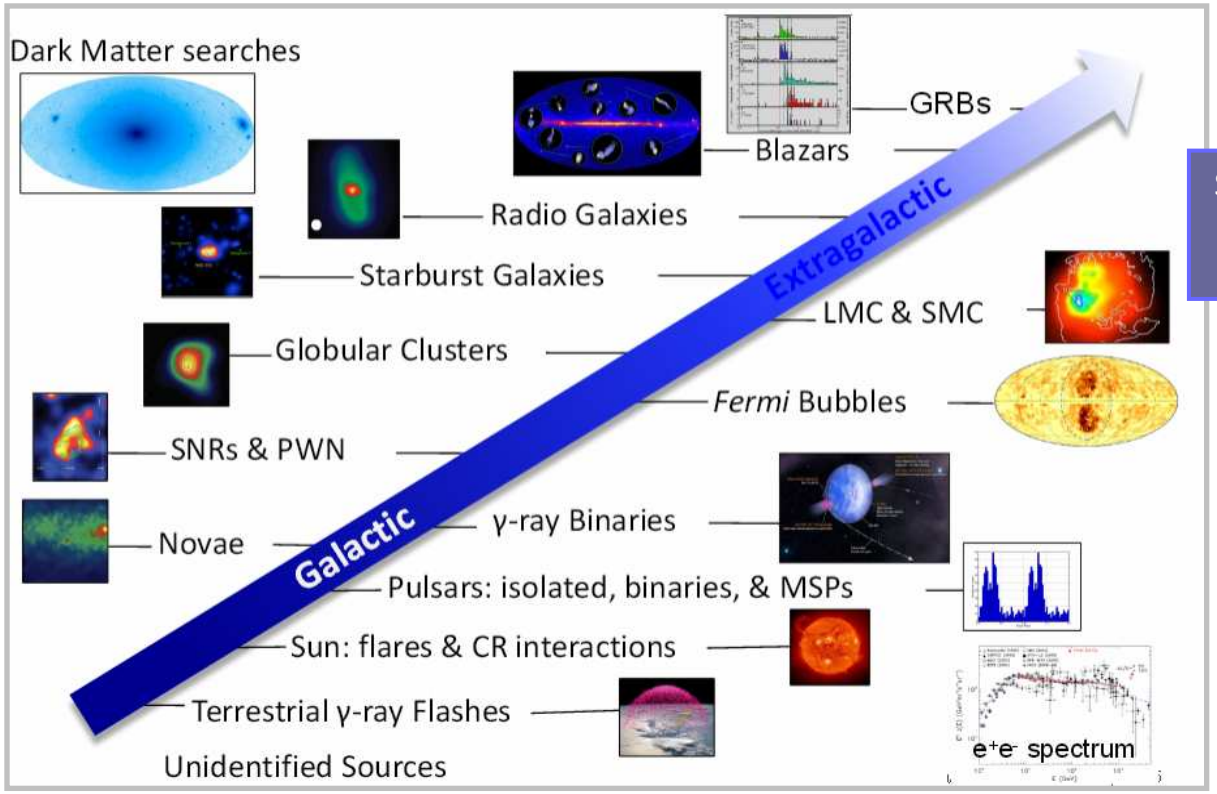




Launched 11 june 2008, Delta II Rocket, circular orbit, 565km altitude, 25.6 deg inclination. Operations. Primary mode: all-sky survey with scan of the entire sky for 30min every 3 hours. Autonomous Repoint Request (ARR). Target of Opportunity (ToO). Huge field of view (2.4sr).

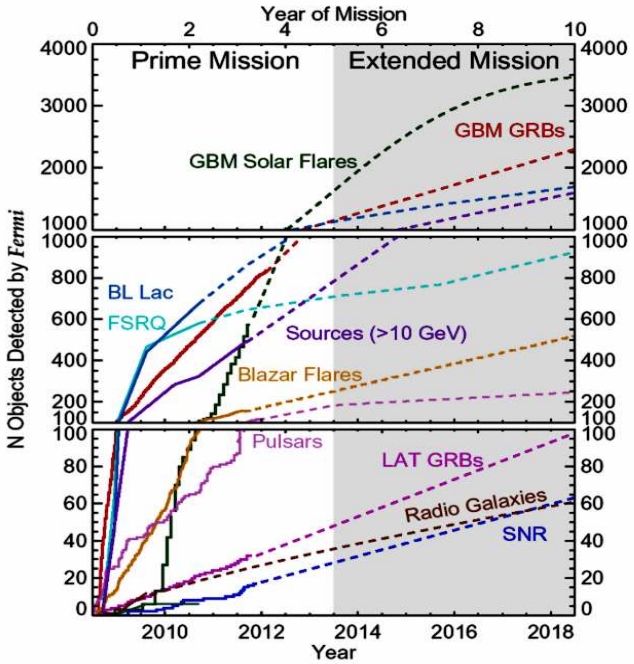
stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Fermi Science Menu



ALL-SKY + ALL-TIMES (i.e. spatial SURVEY + TIME-DOMAIN monitor) mission for the HE g-ray Universe.

SURVEY → uniformity, serendipity, variability, transients, cross-corr, cross-match, time domain monitor.



Fermi increased the number of known gamma-ray emitting objects by nearly one order of magnitude compared to previous experiments, and has added several new source classes not previously known in this energy range.

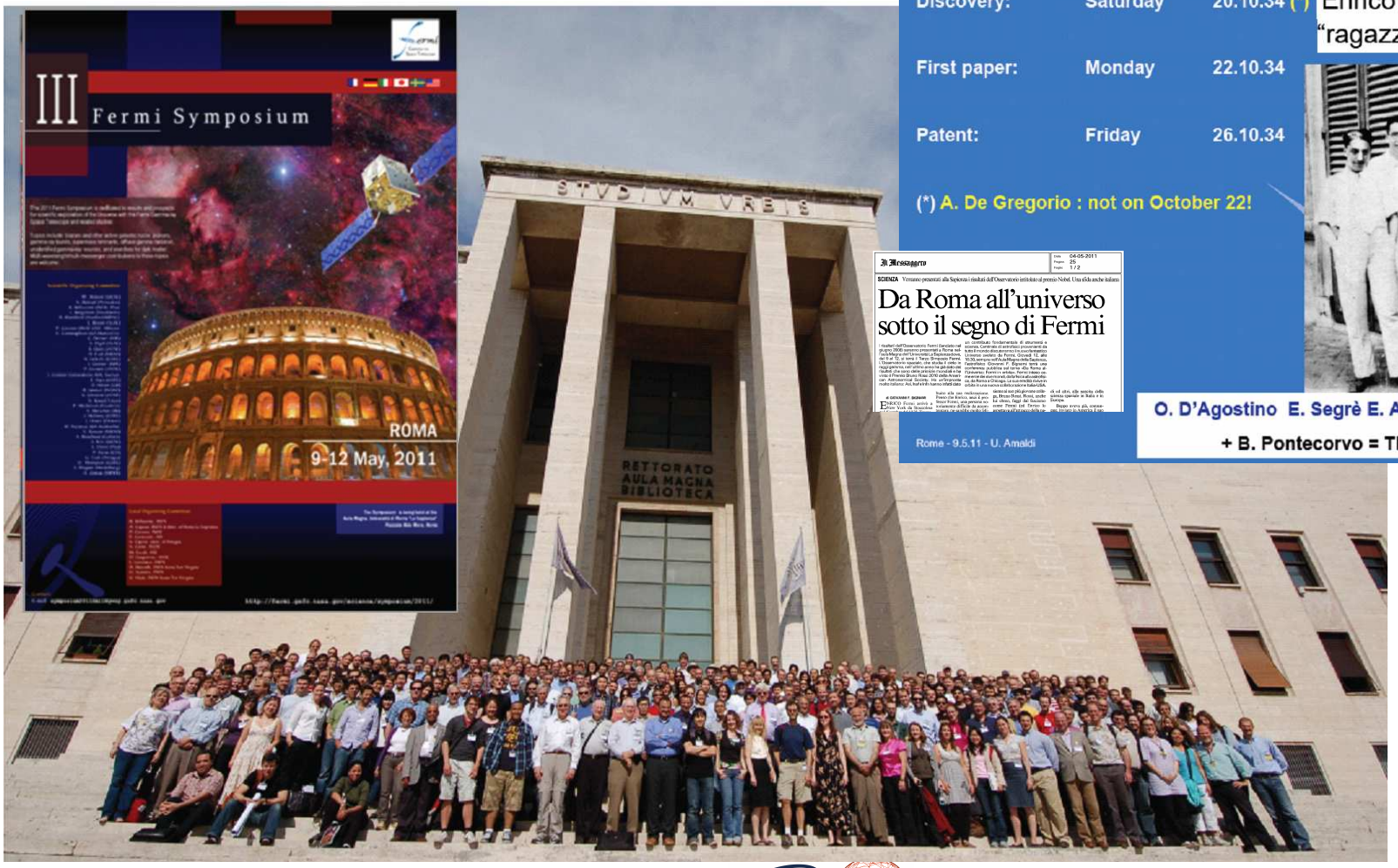
Fermi mission operations: 1) primary mode (sky survey): scan entire sky every 3 hours. 2) Autonomous Repoint Request (ARR) for GRB/transient on-board sw triggers. 3) Target of Opportunity (ToO) following GI proposals/notes. 4) Modified survey profile (e.g. Galactic center biased in Dec.2013-Dec.2014).

Fermi: a tool to study cosmic accelerators
in energy, time, sky position/distribution, cosmic distance

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

III *Fermi* Symposium in Rome (May 2011)

❑ **SSDC team participation to the organization (led by Aldo Morselli) of this beautiful 3rd Fermi Symposium (*Fermi* met *Fermi* in Roma)**



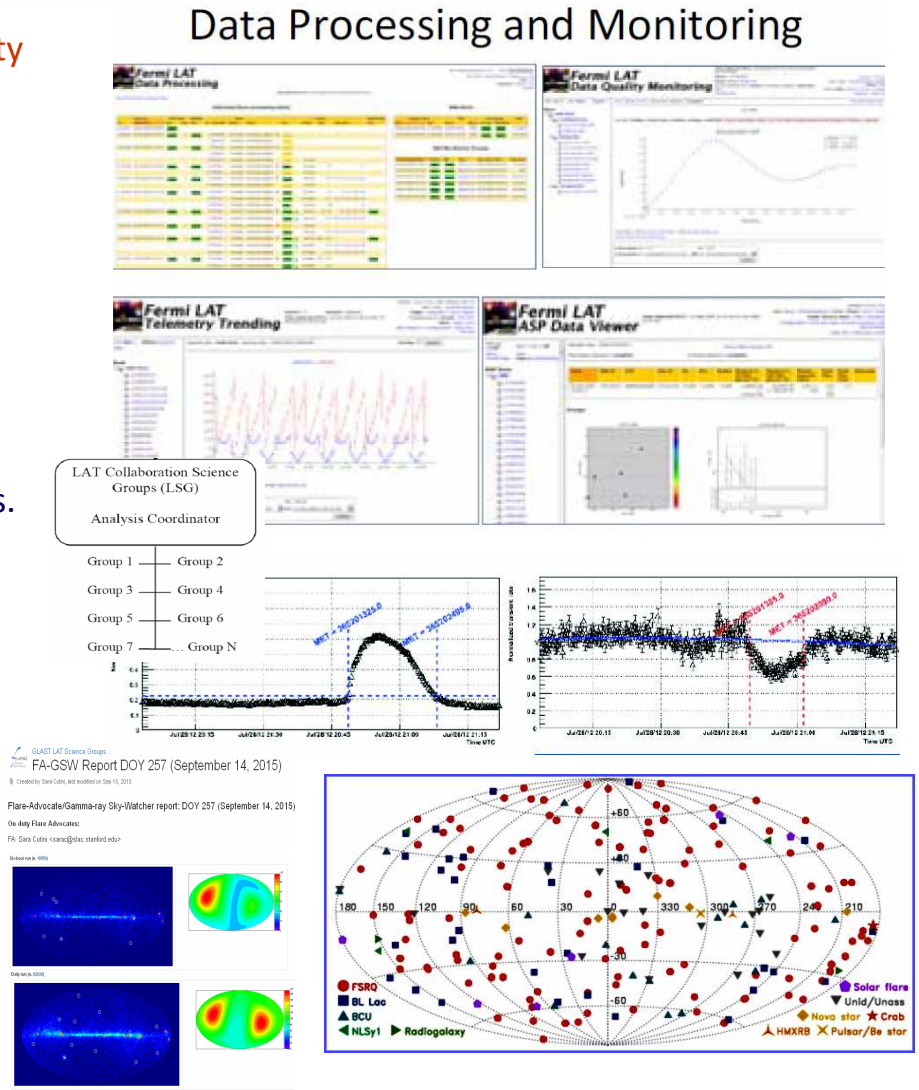
Il Messaggero
SCIENZA
Da Roma all'universo sotto il segno di Fermi

The new name, *Fermi* Gamma-ray Space Telescope, honors Enrico Fermi (1901-1954), a pioneer in high-energy physics.

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

My (and SSDC team) contribution to Fermi LAT Services, Responsibilities, Analysis

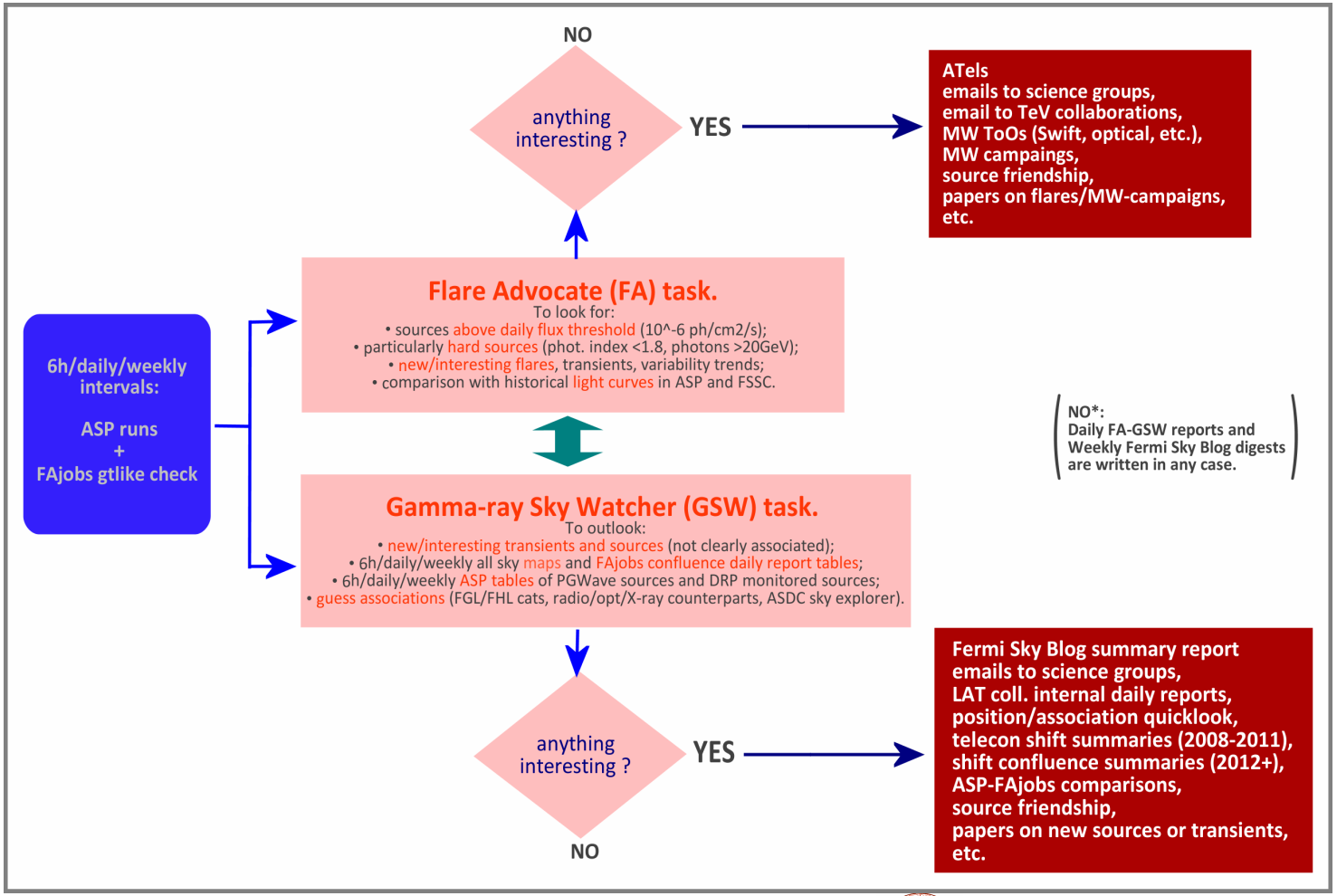
- At least a dozen of weekly shifts per year in: LAT Data Quality Monitor (DQM); Flare Advocate/Gamma-ray Sky Watcher (FA-GSW); in the past also GRB Burst Advocate (BA).
- Supervision of the DQM shifts as DQM expert.
- Some 1 year-long coordinations of LAT Blazar & Other AGN Science Group.
- Supervision and coordination of the FA-GSW service from Aug. 2008. Quicklook results (ex. ATels).
- Contribution within the LAT instrument collaboration to cooperative LAT data analysis and technical and scientific tasks. Paper internal refereeing. Telecons with working groups.
- NASA Fermi GI proposals. ToO and GO proposals to other satellites (Swift, XMM-Newton, NuSTAR etc.).
- International collaborations with (SLAC, Goddard GSFC, Clemson Univ., Bordeaux Univ., Stockholm Univ., Washington state Univ.) for data analysis and scientific papers.
- Organization of international multi-wavelenght (MW) observing campaigns on blazars/AGN. LAT data collections and MW analysis joined with the LAT (Planck, Swift, NuSTAR, MAGIC, ground-based telescopes).
- Start of neutrino multimessenger AGN astro-particle physics with Active Galactic Nuclei



stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Fermi Flare Advocate Gamma-ray Sky Watcher (FA-GSW)

Twofold role of the FA-GSW duty: 1) Flare Advocate (FA). 2) Gamma-ray Sky Watcher (GSW).
The aim is to try to timely identify something interesting on the day-by-day LAT sky.



The FA-GSW LOOKS FOR:

- ❑ flares of LAT sources;
- ❑ slower brightening of LAT sources;
- ❑ variability trends, and state changes of LAT sources;
- ❑ new (wrt LAT catalogs) gamma-ray sources / transients (on daily scales).

The FA-GSW WATCHS and OUTLOOKS:

- ❑ tables of results by FA scripts analysis (to be launched day by day);
- ❑ ASP runs and ASP sources in SLAC ASPDataViewer tables

The FA-GSW CHECKS:

- ❑ preliminary detection and localization;
- ❑ preliminary guess association with radio/IR/opt./X-ray counterparts and multiwavelength catalogs.

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Gamma-ray blazars/AGN, jets, supermassive BHs, binary SMBH → multifreq. + multimessenger astroparticle + axionic-BHs DM ?

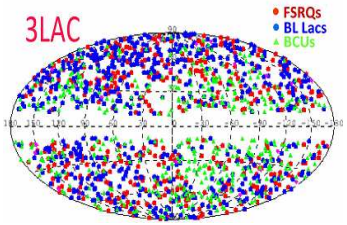
❑ AAS press release of 2016 with me and collaborators

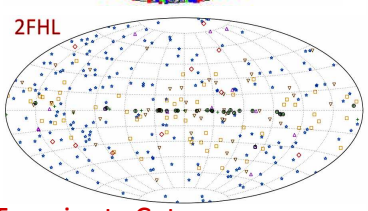
❑ NASA press release of 2015 with me and S Cutini (a SSDC team led work) and collaborators

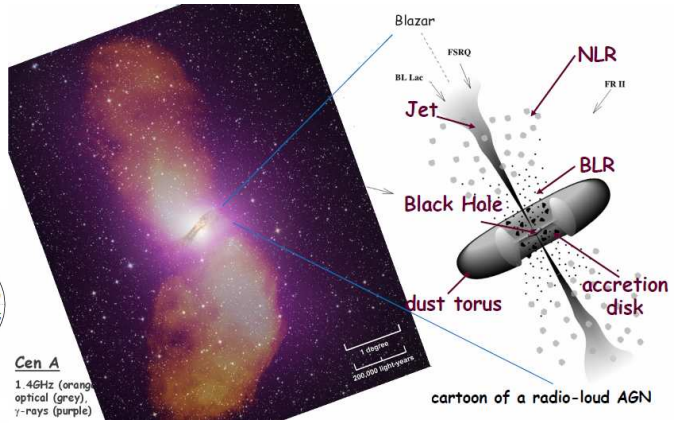
stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

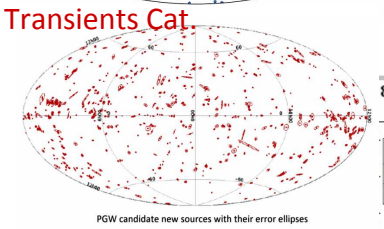
Fermi LAT Data Analysis: blazars and others

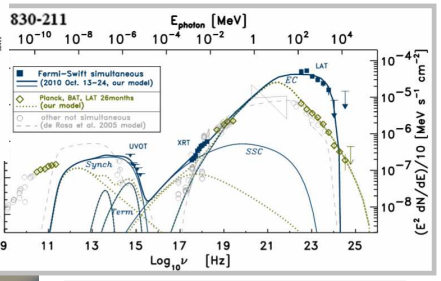
- Fermi covers a huge swath of the EM spectrum: crucial and unique spectral coverage. Complement the large number of upcoming new survey instruments from radio to VHE photon energy bands. Fermi is also participating to the dawn of time domain astrophysics.
- Huge data volume produced by space borne, ground based missions/experiments is increasing. Many science cases take advantage from the multifrequency studies.
- SSDC Fermi Team involved in the analysis of LAT gamma-ray data (gamma-ray spectral energy distributions SED analysis, flux time series analysis, extragalactic source population properties studies, cosmological AGN evolution, EBL , EGB, source detection and catalogs, source association/identification analysis ,simulations).
- SSDC Fermi Team involved in the analysis of LAT+Multifrequency data (multifrequency data and catalog studies, SED studies, blazar science, GRBs).
- Multi-mission/frequency ToOs, AO-proposals, radio/optical/X-ray/ data analysis, cross correlation analysis, modeling, theory.
- SSDC Fermi Team involved in service analysis of LAT gamma-ray data as validation, catalog construction, development of analysis tools and higher-level data.

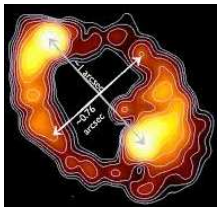


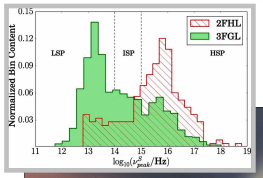


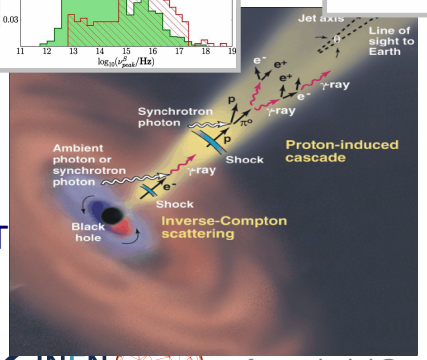


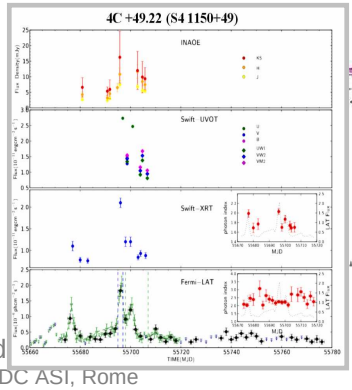


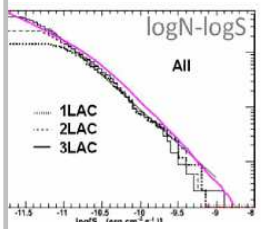










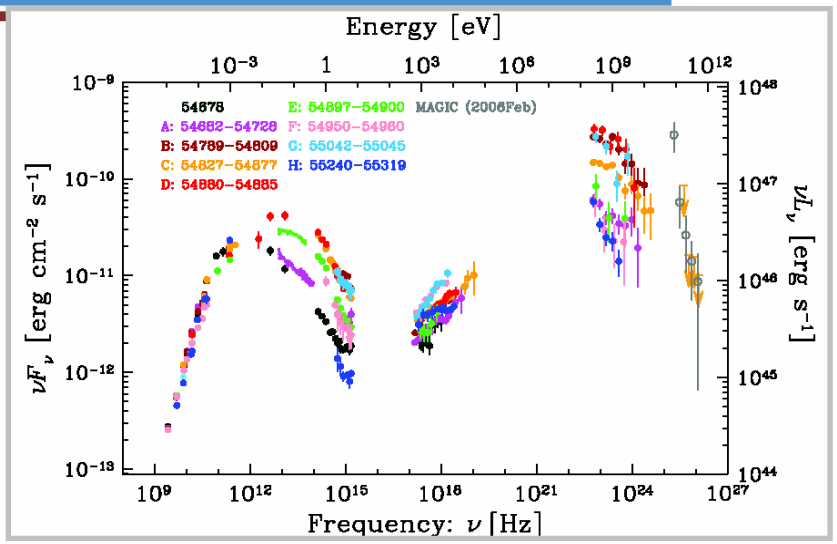


stefano.ciprini@ssdc
INFN Tor Vergata & SSDC ASI, Rome

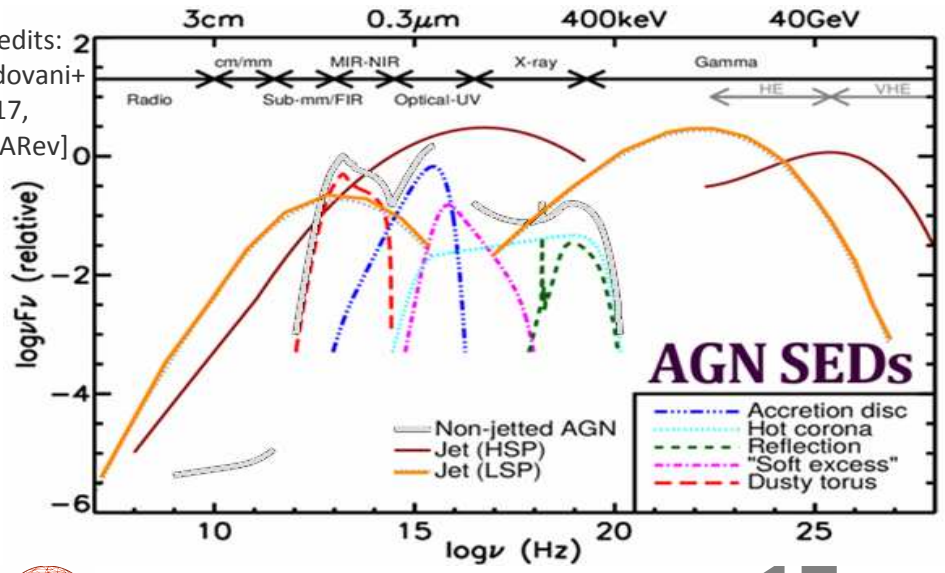
SMBHs and jets (blazars, radiogalaxies…)

- "Extremely rich , multifrequency, data sets on blazars (intensive/extensive observing campaigns/monitor, flux/structure data).
  - Recent progress in polarization measurements.
  - Theoretical models need to describe better the observations.
  - Most outbursts and flares occur on, compact, parsec scales.
  - Sources of seed photons for gamma-ray emission still a problem.

- Blazars are jetted AGN which the jet pointing directly at us, with appearance of large-scale jet in radio, optical, X-ray bands.
- Relativistic motion of jet components Doppler-boosts the emission in the direction of motion and, within this, misaligned-blazars, are types of radio galaxies.
- Bright inverse Compton peak in SEDs in addition to typical synchrotron peak.
- Prominent point sources, dominating the census, in the gamma-ray sky.
- Compact radio source (not always resolved) and polarization in radio/optical.
- Many show that they are hosted in galaxies (but not always detected).



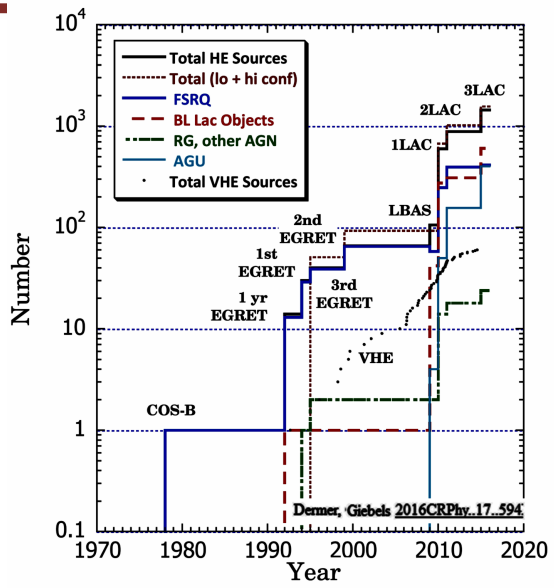
[Credits: Padovani+ 2017, A&ARev]

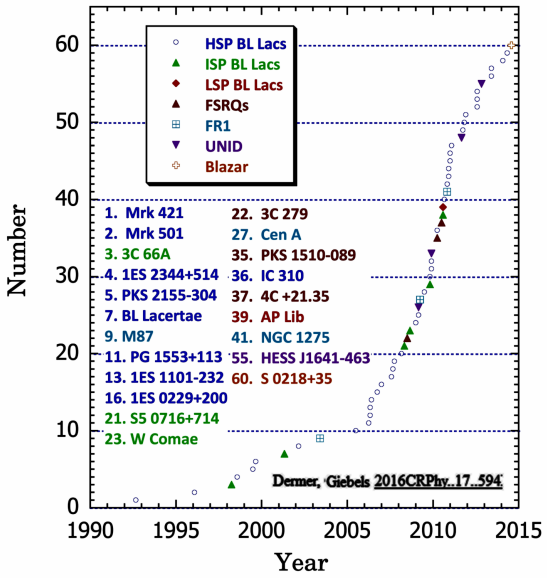


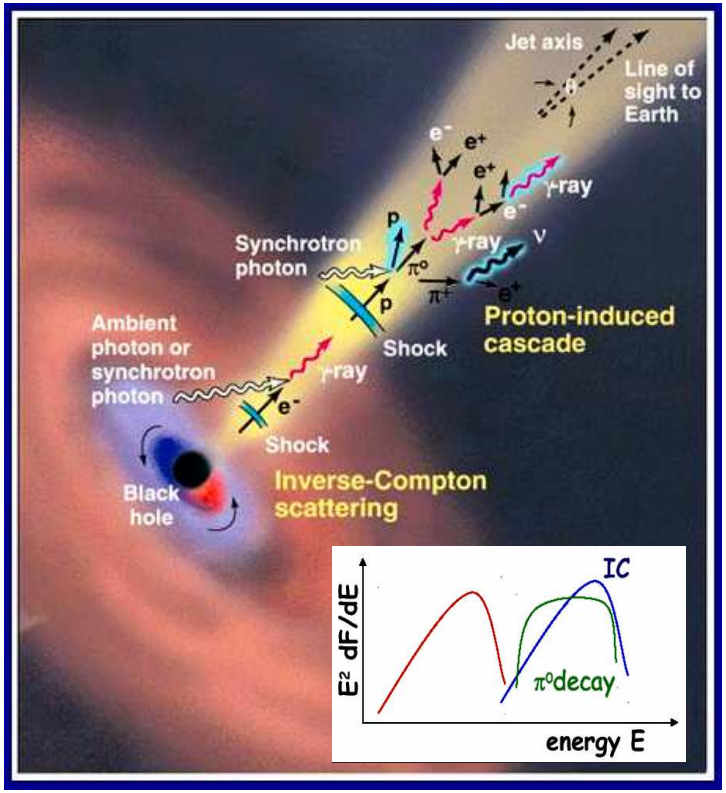
stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

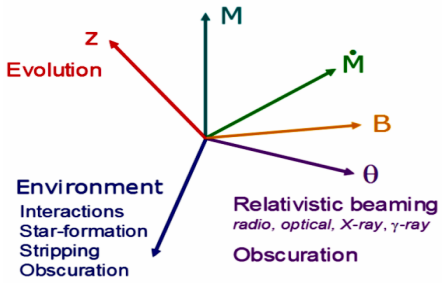
Natural beacons and rich laboratories for MW-astrophysics and MM-astroparticle physics

- Emission mechanisms (especially for high energy component)
  - -- Leptonic (IC of synchrotron or external photons) vs hadronic ($\pi^0 \rightarrow \gamma\gamma$, proton synchrotron). Hadronic models foresee the emission of HE neutrinos.
- Emission location
  - -- Single zone for all wavebands (completely constraining for simplest leptonic models)
  - -- Opacity effects and energy-dependent photospheres
- Particle acceleration mechanisms
  - -- Shocks, Blandford-Znajek
- Jet composition
  - -- Poynting flux, leptonic, ions
- Jet confinement
  - -- External pressure, magnetic stresses
- Accretion disk-black hole-jet connection
- Blazars as probes of the extragalactic background light (EBL)
- Effect of blazar emission on host galaxies and galaxy clusters.







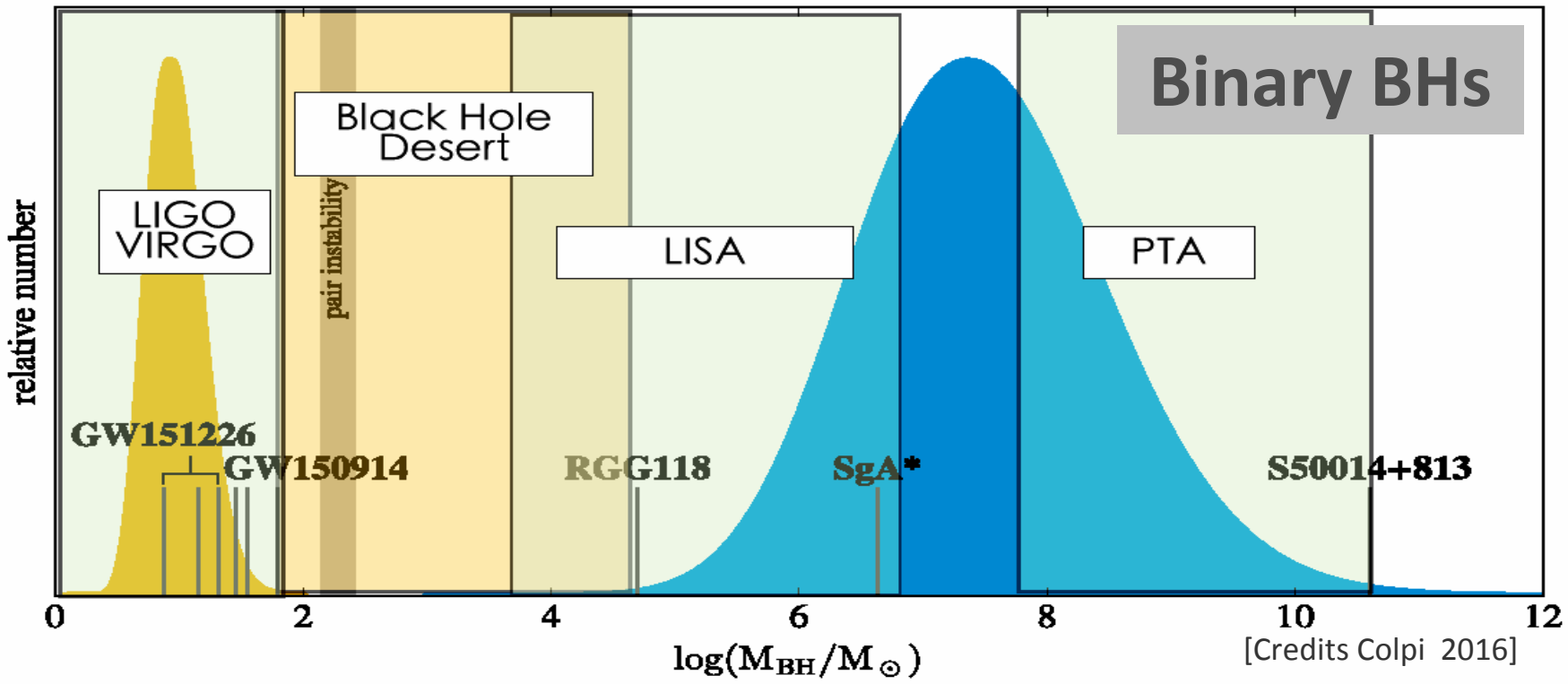


ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Black holes in the Universe: stellar and supermassive sizes

- is the “black hole desert" inhabited by black holes which we still do not detect ?
- is there a natural real genetic divide ?
- is the desert consequent to the "migration" of seeds into the domain of the massives ?
- is the desert populated by transition objects (from clustering/aggregation/accretion of stellar objects as single building blocks ?

- Binary black holes → the gravitational waves universe



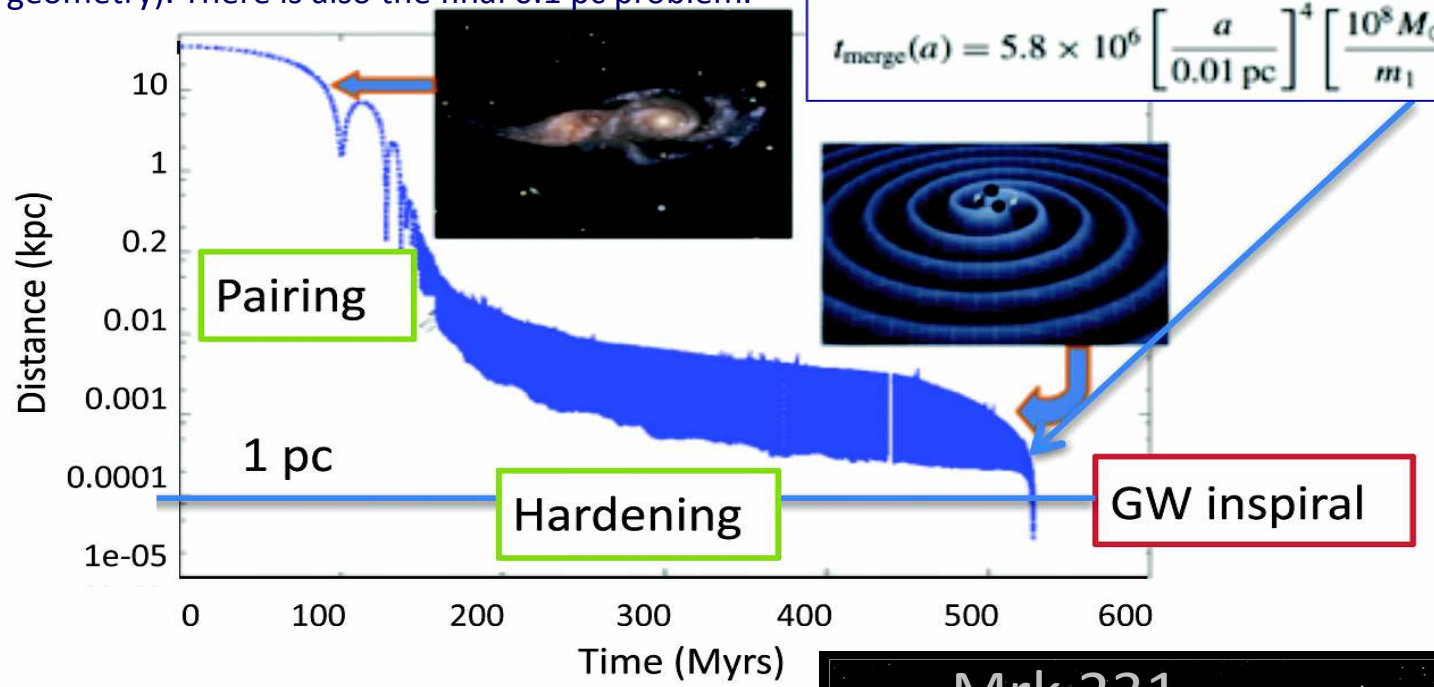
[Credits Colpi 2016]

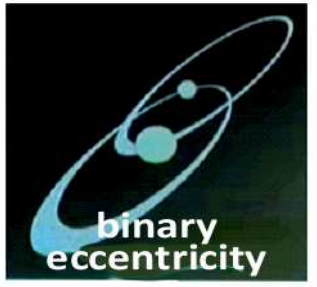
stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Evolution and timescales of binary SMBHs

❑ Observational evidence is important to solve the theoretical "final parsec problem" in GR (solved by non spherical geometry). There is also the final 0.1 pc problem.

$$t_{\rm merge}(a) = 5.8 \times 10^6 \left[\frac{a}{0.01\,{\rm pc}}\right]^4 \left[\frac{10^8 M_\odot}{m_1}\right]^3 \frac{m_1^2}{m_2(m_1+m_2)}\ {\rm yr}$$



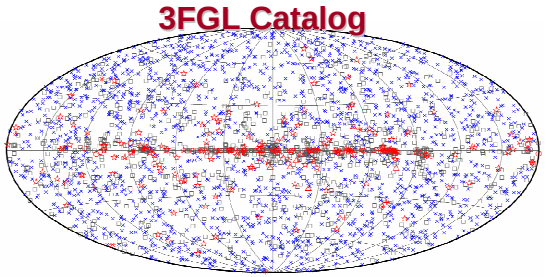


Timescale from two galaxy merger to their central SMBH merger
is in the range 10^8-10^9 years

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

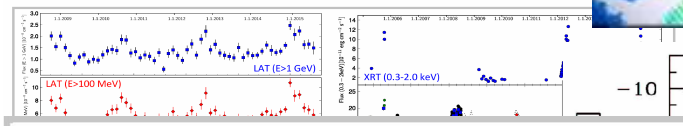
Fermi LAT Data Analysis at SSDC

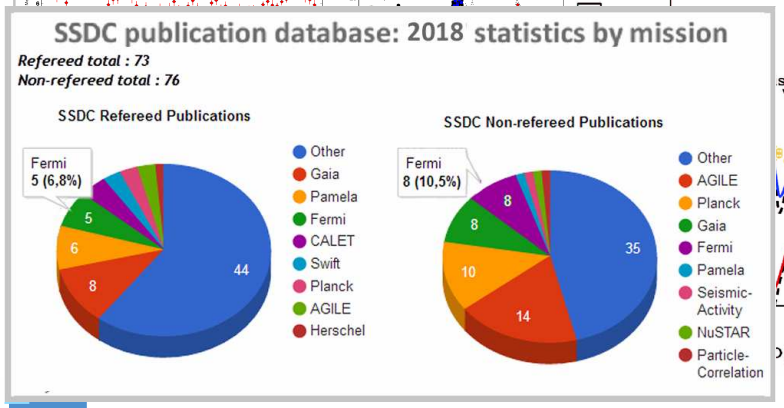
❑ Topics: blazar/AGN spectral-temporal (SED/light curves) studies, multifrequency analysis, variability analysis, timescales studies, gamma-ray source detection, gamma-ray source counterpart association studies, correlation studies, hard-spectra source studies, quicklook analysis, redshift studies, AGN classification, gravitational-lensed AGN, multifrequency data and catalog construction, analysis tools, scientific papers, ATels, news, talks, meetings, E&PO.
PeV neutrino multimesseger astronomy with neutrinos

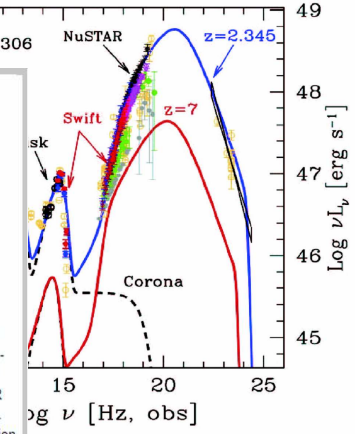


3033 sources >4.1σ Acero et al. (2015)

Quasi-periodicity in AGN PG 1553+113







LAT Coll. Publications 2015

- Ackermann, M., ... S. Ciprini, ... S Cutini, ...D. Gasparrini,... et al. 2015, "The Spectrum of Isotropic Diffuse Gamma-Ray Emission between 100 MeV and 820 GeV", The Astrophysical Journal 799, 86.
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- Troja, E., Piro, L., Vasileiou, V., Omodei, N., Burgess, J.~M., Cutini, S., Connaughton, V., McEnery, J.~E. 2015, "Swift and Fermi Observations of X-Ray Flares: The Case of Late Internal Shock", The Astrophysical Journal 803, 10.
- Acero, F., ... S. Ciprini, ... S Cutini, ...D. Gasparrini,... et al. 2015, "Fermi Large Area Telescope Third Source Catalog", The Astrophysical Journal Supplement Series 218, 23.
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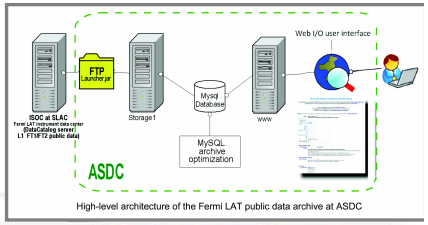
- Clark, C.~J., ...S. Ciprini, ... S Cutini, ...D. Gasparrini,... et al. 2015, "PSR J1906+0722: An Elusive Gamma-Ray Pulsar", The Astrophysical Journal 809, L2.
- Ackermann, M., ...S. Ciprini, ... S Cutini, ...D. Gasparrini,... et al. 2015, "The Third Catalog of Active Galactic Nuclei Detected by the Fermi Large Area Telescope", The Astrophysical Journal 810, 14.
- Ackermann, M., ...S. Ciprini, ... S Cutini, ...D. Gasparrini,... et al. 2015, "Search for Extended Gamma-Ray Emission from the Virgo Galaxy Cluster with Fermi-LAT", The Astrophysical Journal 812, 159.
- Ackermann, M., ...S. Ciprini, ... S Cutini, ...D. Gasparrini,... et al. 2015, "Multiwavelength Evidence for Quasi-periodic Modulation in the Gamma-Ray Blazar PG 1553+113", The Astrophysical Journal 813, L41.
- Ackermann, M., ...S. Ciprini, ... S Cutini, ...D. Gasparrini,... et al. 2015, "An extremely bright gamma-ray pulsar in the Large Magellanic Cloud", Science 350, 801-805.
- Ackermann, M., ...S. Ciprini, ... S Cutini, ...D. Gasparrini,... et al. 2015, "Searching for Dark Matter Annihilation from Milky Way
- Dwarf Spheroidal Galaxies with Six Years of Fermi Large Area Telescope Data", Physical Review Letters 115, 231301.

= 2015 published papers led, co-led, or with important direct contribution by the SSDC Fermi Team

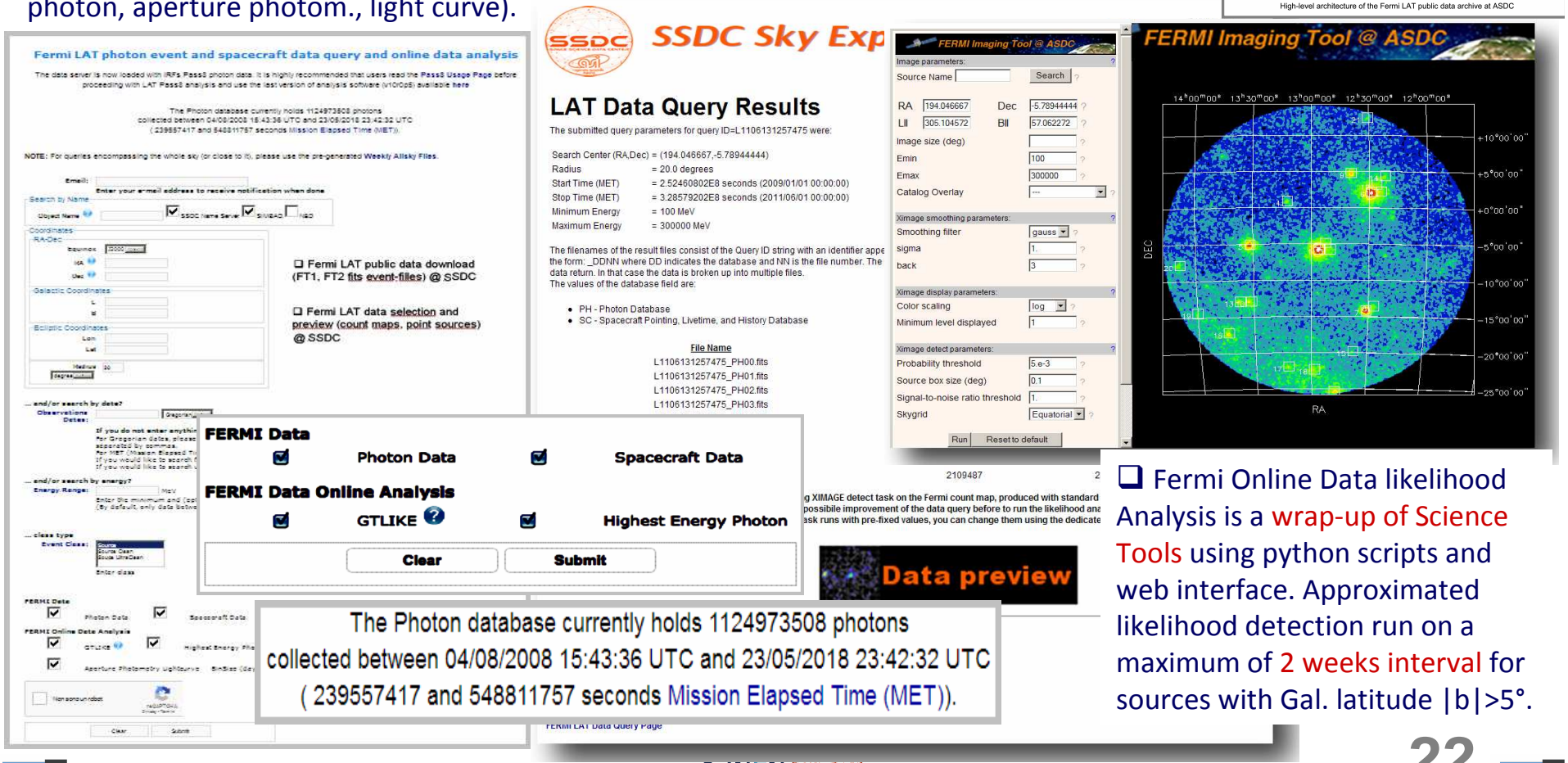
stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Fermi LAT public data archive at SSDC

❑ LAT photon data rate: about 4.4 Hz → 120 million photons per year (1% of total data rate sent to the ground). New data available every 2, 3 hours (ISOC SLAC, then NASA GSFC FSSC).
❑ SSDC public FT1/FT2 science FITS Pass-8 data. 1) Photon data circular region data retrieval and count map preview. 2) Basic simplified online data analysis (gtlike, highest energy photon, aperture photom., light curve).



High-level architecture of the Fermi LAT public data archive at ASDC



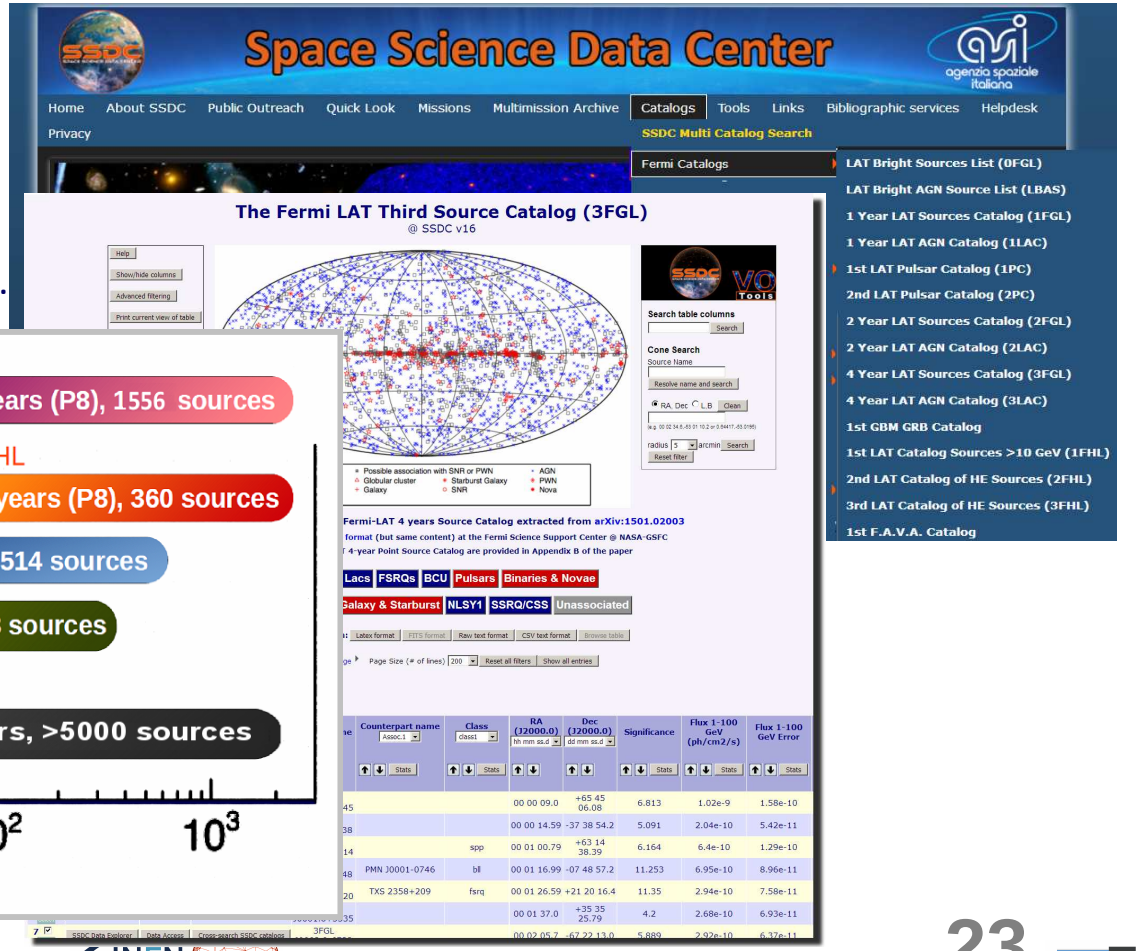
❑ Fermi Online Data likelihood Analysis is a wrap-up of Science Tools using python scripts and web interface. Approximated likelihood detection run on a maximum of 2 weeks interval for sources with Gal. latitude |b|>5°.

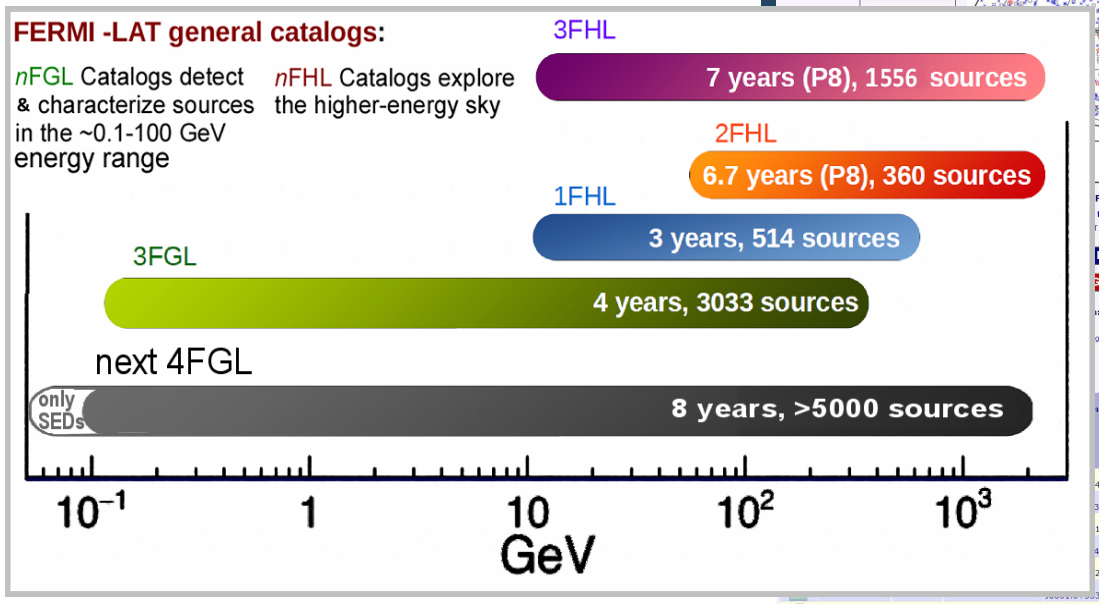
stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Fermi catalogs web tables and tools at SSDC

- The general nFGL and nFHL catalogs are analyses over successively deeper data sets, and also represent successive analysis refinements, from event classification on up. There are also class-specific catalogs (AGNs, pulsars, GRBs, SNRs, transients, spatially extended sources, TGFs, solar flares, etc.).

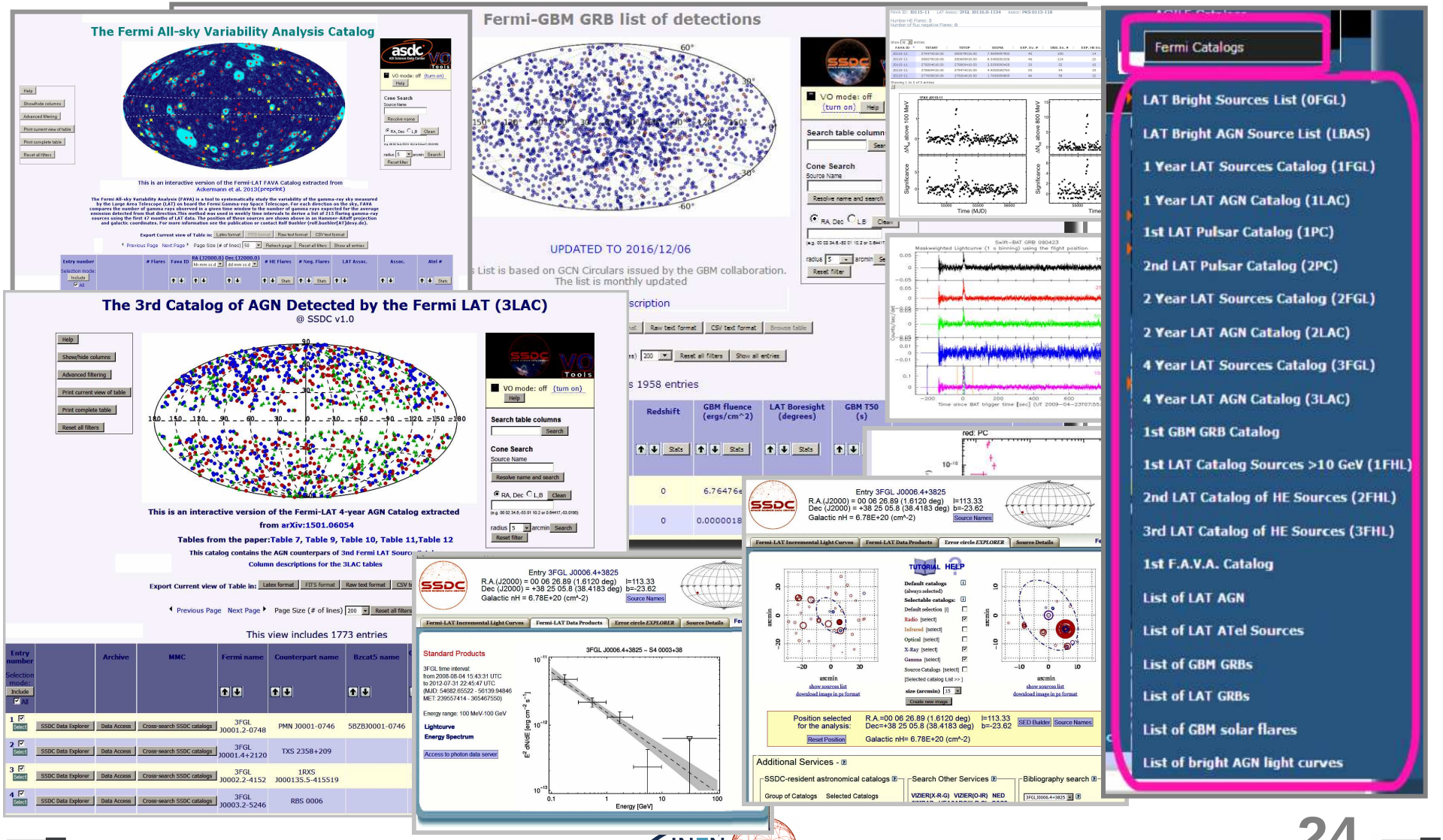
- Interactive tables of these catalogs are implemented in SSDC web pages with links and button to tools like the sky-region data explorer. More (incremental) lists are implemented at SSDC (GRBs, solar flares, ATel sources lists, not very regularly updated).





stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Fermi catalogs web tables and tools at SSDC



stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

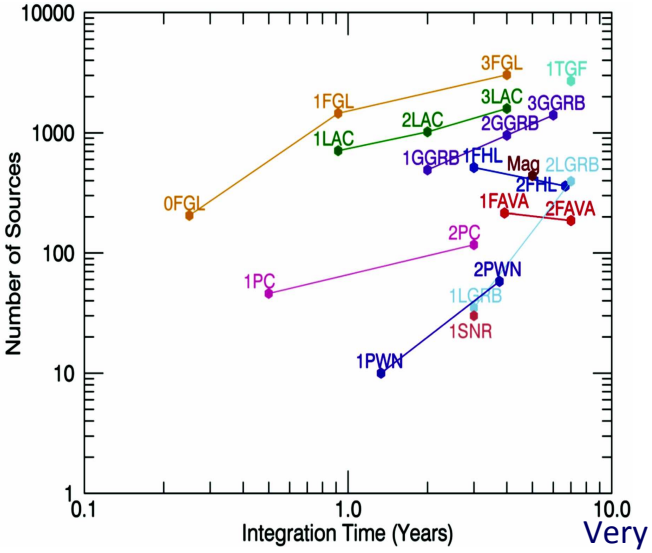
Fermi Catalogs

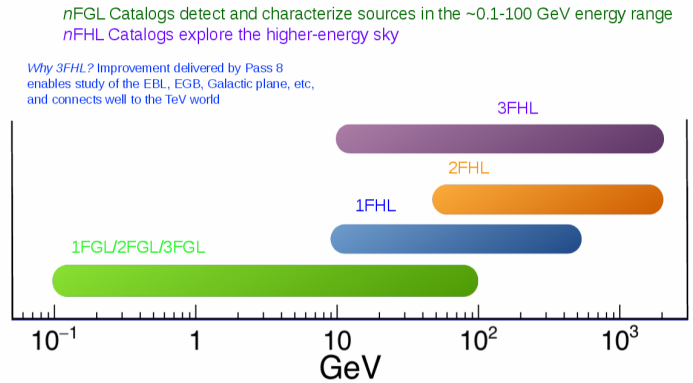
Fermi at ASDC | Source Catalogs

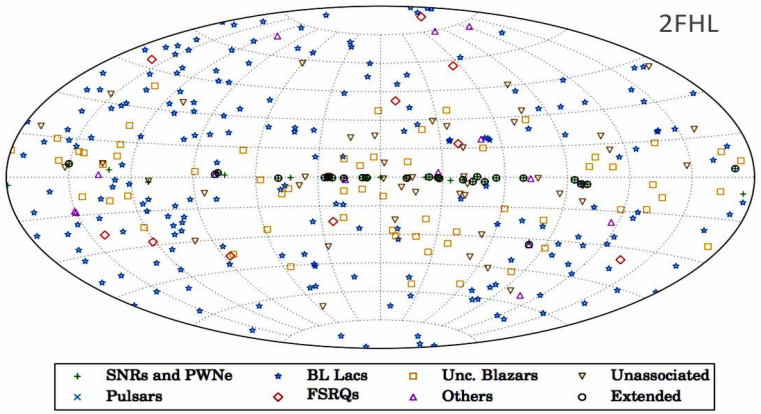
❑ Contribution to parts of the analysis for catalogs development and catalogs construction (ex: statistical studies of blazar/AGN-type source associations, candidate counterparts, blazar population and classification studies, blazar multifrequency SED studies and classification, redshift studies, in some cases likelihood detection runs of the seed-candidate sources).

Fermi Catalogs
- **LAT**
  - FGL (General)
  - FHL (High-energy)
  - LAC (AGN)
  - PC (Pulsars)
  - LGRB (GRBs)
  - FAVA (Flaring sources)
  - SNR (supernova remnants)
  - Solar flares (upcoming)
- **GBM**
  - GGRB (GRBs)
  - Mag (Magnetar bursts)
  - TGF

The Catalogs are analyses over successively deeper data sets, and also represent successive analysis refinements, from event classification on up.





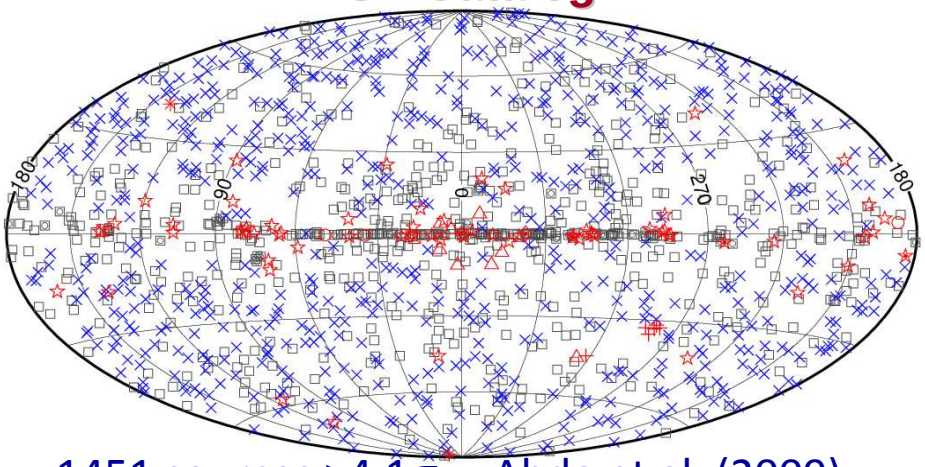


Very recent example: 2nd Catalog of Hard Fermi LAT Sources (2FHL) detected in the 50 GeV-2 TeV energy range in the first 80 months (6.7 years) of all sky survey. 360 sources.

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

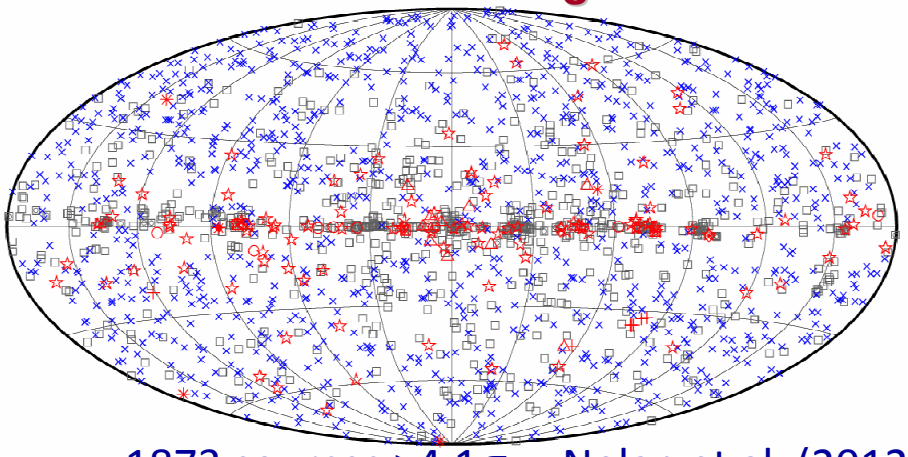
Fermi LAT general catalogs (1/2/3FGL)

1FGL Catalog



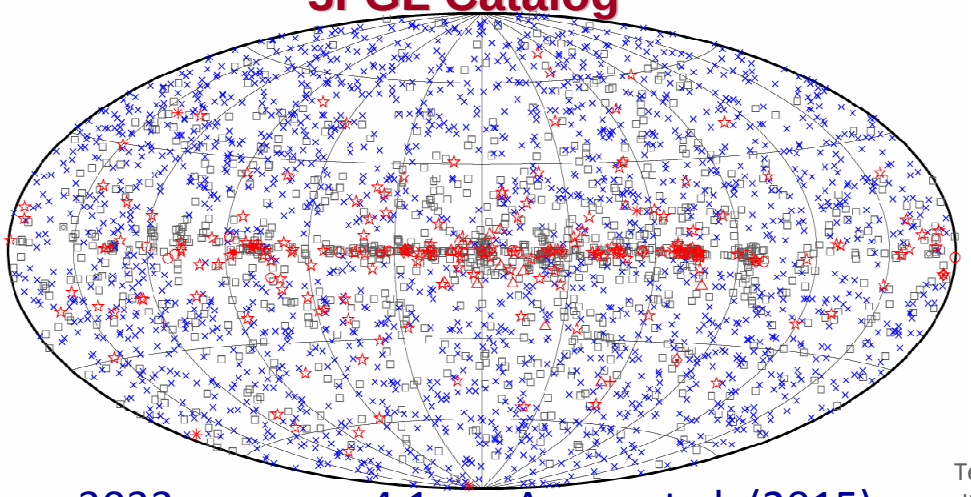
1451 sources >4.1σ Abdo et al. (2009)

2FGL Catalog



1873 sources >4.1σ Nolan et al. (2012)

3FGL Catalog



3033 sources >4.1σ Acero et al. (2015)

LAT catalogs:

- To know what the LAT has detected
- Approach for finding new gamma-ray source classes
- Population studies
- Systematic analysis of the sky
- Standard model-fitting LAT source analysis → the catalog is initial guess for detailed study of any source

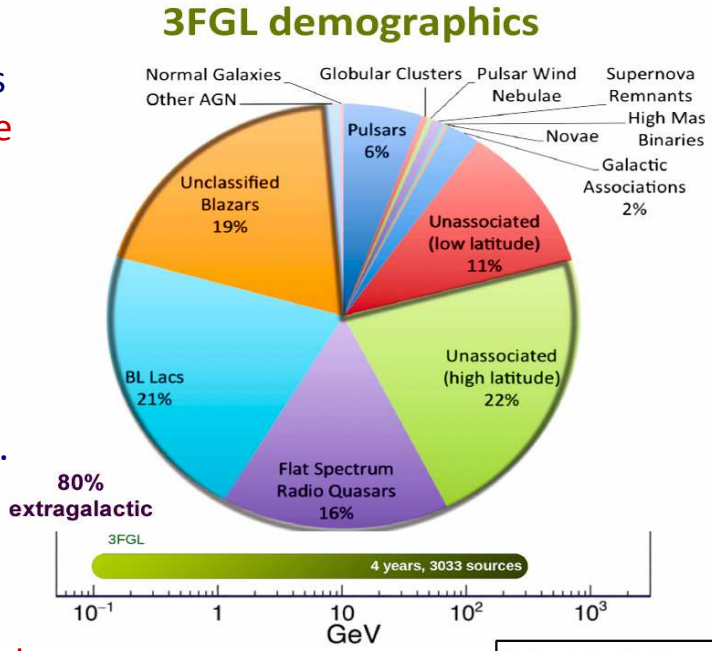
No association	Possible association with SNR or PWN		AGN
Pulsar	Globular cluster	Starburst Galaxy	PWN
Binary	Galaxy	SNR	Nova
Star-forming region			

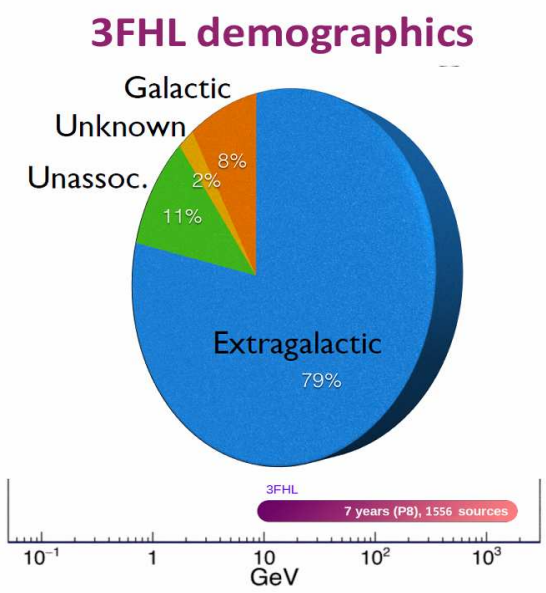
Test statistics TS>25 corresponds to a significance >4.1σ evaluated from the chi^2 distribution (4 degrees of freedom position, spectral parameters, Mattox et al. 1996).

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Fermi LAT as an AGN and blazar telescope

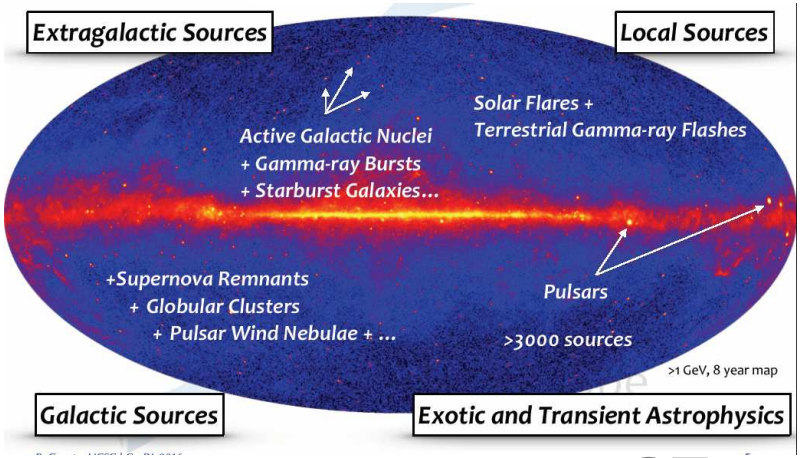
- Active Galactic Nuclei (AGN) and blazars in particular (they represents the extragalactic sky), dominated the gamma-ray source counts in Fermi LAT general (nFGL) catalogs.
- The 3rd LAT AGN catalog (3LAC) follows in the footsteps of the 3FGL catalog. It has 1773 AGN (1591 located at high (|b|>10°) Gal. lat.). 71% increase over the 2LAC. 2% are associated with non-blazar sources.





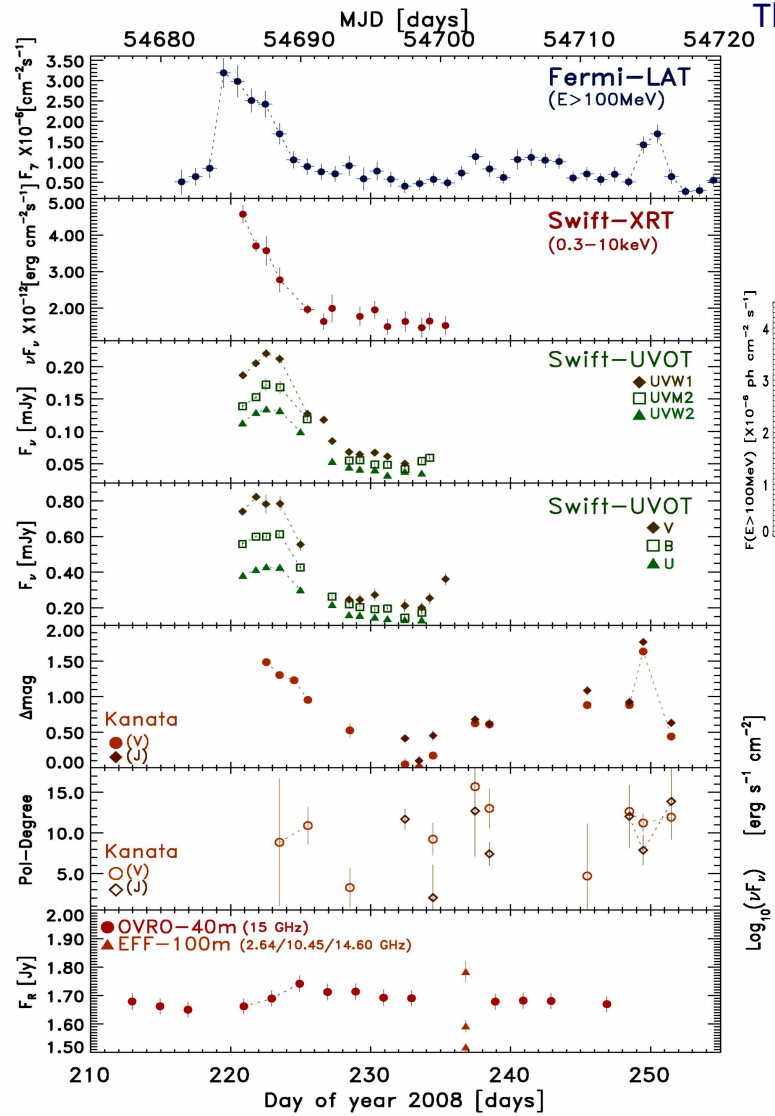
- Association of e.m. astrophysical source counterparts (radio/optical/IR/X-ray) is generally the strongest statement that we can make: two quantitative methods, Bayesian method (BM) likelihood ratio method (LRM), for assignment of associations in the 3FGL/3LAC.

Catalog	Energy Range (GeV)	Data Interval (months)	Sources	Event Selection	Release Date
3FGL	0.1-300	48	3033	P7V15 SOURCE	Jan.2015

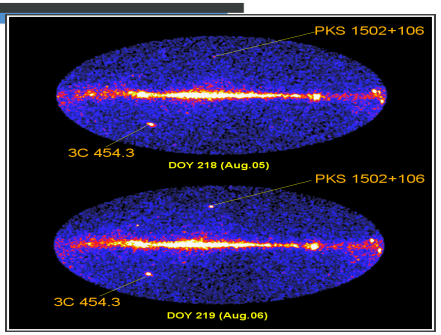


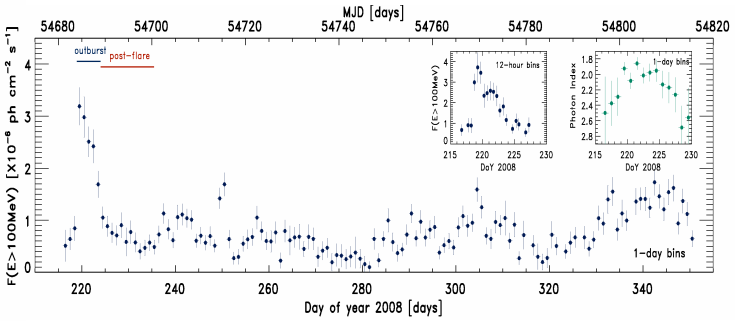
stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

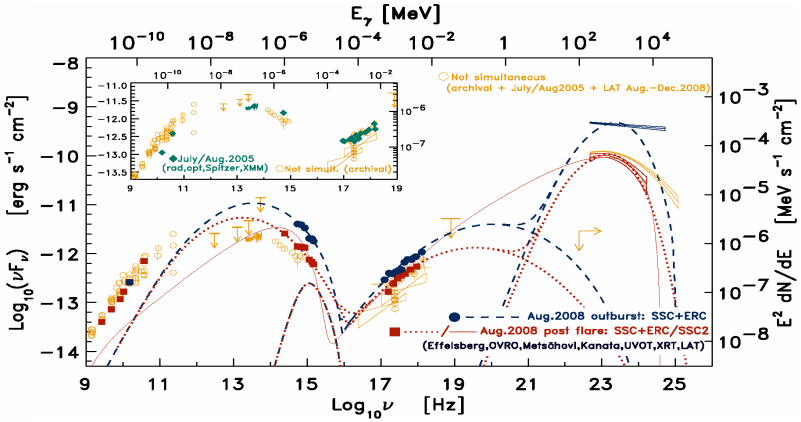
First discoveries: PKS 1502+106 a new flaring blazar at z=1.8

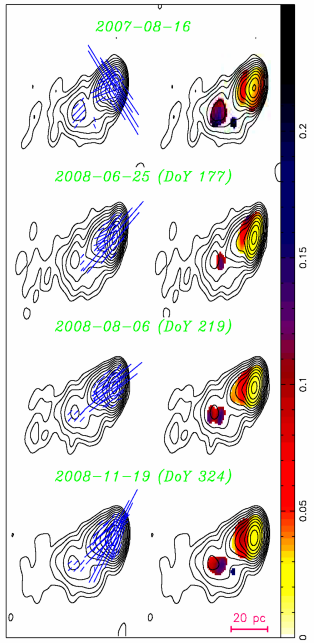


This is a new and luminous gamma-ray blazar. Identification, MW SED analysis, long-term gamma-ray light curve analysis, cross correlation MW analysis. Peculiar properties (high gamma-ray flux dominance & high z)



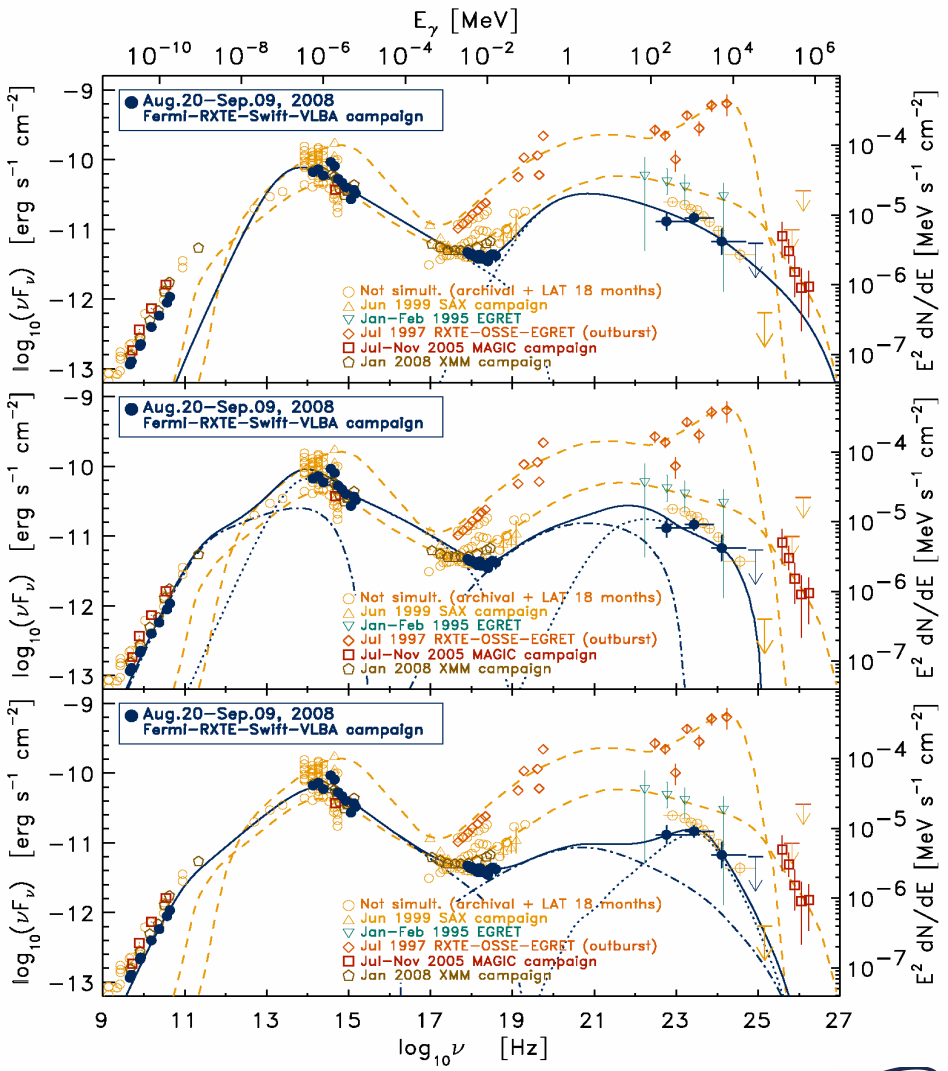






stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

MW campaign on BL Lacertae on low-activity state



1) Factor 20 below in gamma-ray flux density between the Aug.20-Sep 9, 2008 measured by the LAT and the 1997 EGRET outburst. A significant shift toward lower energies (maximum photon energy detected in 18-months is about 20 GeV) preventing detection by ground-based TeV telescopes.

2) During the 48 days of the 2008 campaign, at this lower gamma-ray luminosity state for does not correspond the lowest luminosity state for near-IR and optical emission. No variability in LAT data, and uncorrelated and moderated variable UV and X-ray variability is seen.

3) BL Lac continued to show a relatively flat (possible also concave) X-ray spectrum as observed by both RXTE and Swift-XRT, with also small day-by-day photon index variations and uncorrelated variability with respect to the optical-UV flux.

4) Both single zone SSC plus ERC model and single process SSC over two zones can represent the averaged radio-to-gamma-ray SED during the campaign. Parameters in with values calculated by the VLBA snapshot.

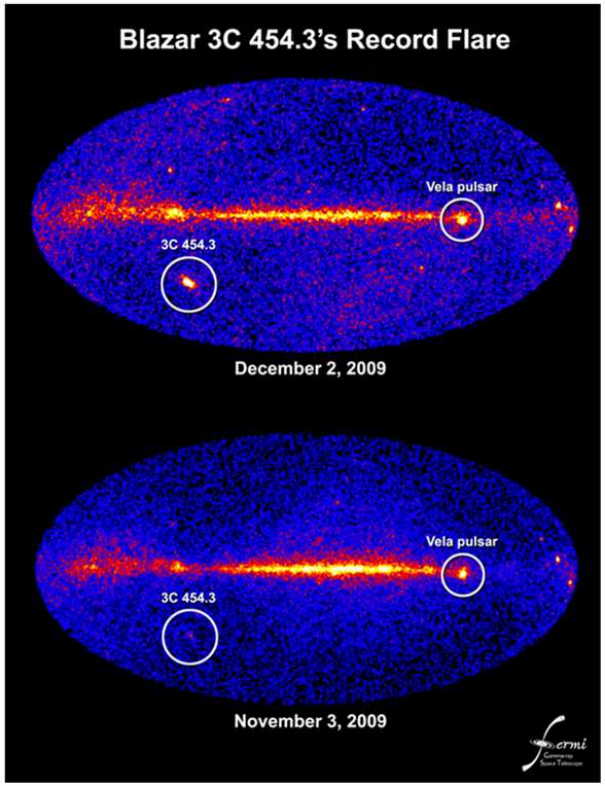
5) 2 innermost components resolved by the VLBA to the radio emission at 43 GHz.

6) Our analysis does not ruled out a possible UV excess also during this low-activity, non-variable, gamma-ray state.

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Big GeV outbursts: the case of 3C 454.3

- Correlated spectral-temporal properties of 3C 454.3 during two very strong flaring episodes (it was the brightest object in the gamma-ray sky during the peak) studied.



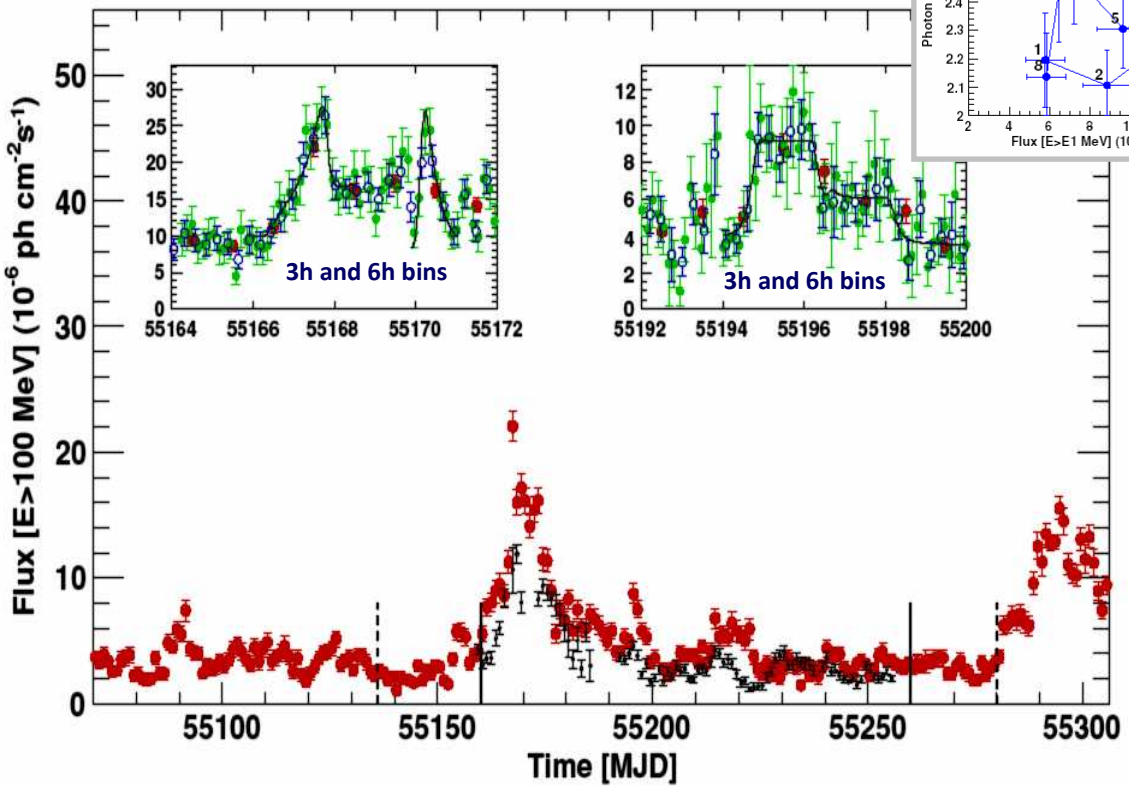


Figure 1. Light curve of the flux of 3C 454.3 in the 100 MeV–200 GeV band (red) between MJD 55,070–55,307 (2009 August 27–2010 April 21). The solid (dashed) lines mark the period over which the PSD (CWT) analysis has been conducted. The light curve of the 2008 July–August flare, shifted by 511 d, is shown for comparison (black). The insets show blow-ups of the two periods when the largest relative flux increases took place. The red, blue, and green data points in the insets correspond to daily, 6 hr, and 3 hr averaged fluxes, respectively. The fit results discussed in the text are displayed as solid curves.

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Big GeV outbursts: the case of 3C 454.3

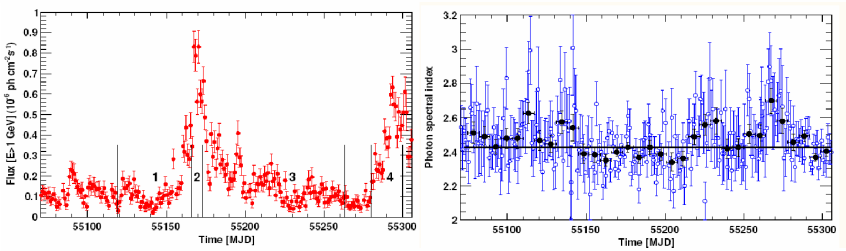
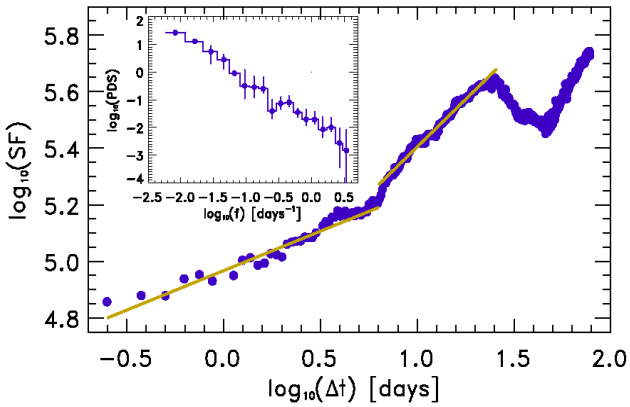


Figure 3. Top: light curve of the flux in the 1–200 GeV band. Bottom: variation of the daily (blue points) and weekly (black points) photon spectral index derived from a PL fit. The black line depicts the mean weekly spectral index.



- First-order structure function (SF), power density spectrum (PDS), global methods, and Morlet continuous wavelet transform (CWT), local method, are applied to the unprecedented-resolution gamma-ray light curve of 3C 454.3 (interval MJD 55140-55260).
- Break around 6.5 days is hinted (power-index slopes $\alpha = 1.29 \pm 0.10$ between 3 hr and 6.5 days and $\alpha = 1.64 \pm 0.10$ between 6.5 and about 26 days. PDS confirms values ($\alpha = 1.40 \pm 0.19$ and $a = 1.56 \pm 0.18$).
- Steepening toward longer lags (flattening toward higher frequencies).
- Morlet-CWT (best tradeoff between localization and period/frequency resolution), showed only marginal features below timescales of 1 day. The
- big outburst of Dec.2009 well localized and decomposed in a chain of mino CWT power peaks. 6.5 day timescale confirmed by the major power peak still out of the finite-series cone of influence (at about MJD 55166)
- Another energetic peak in this period is found with scale of about 2.5 days

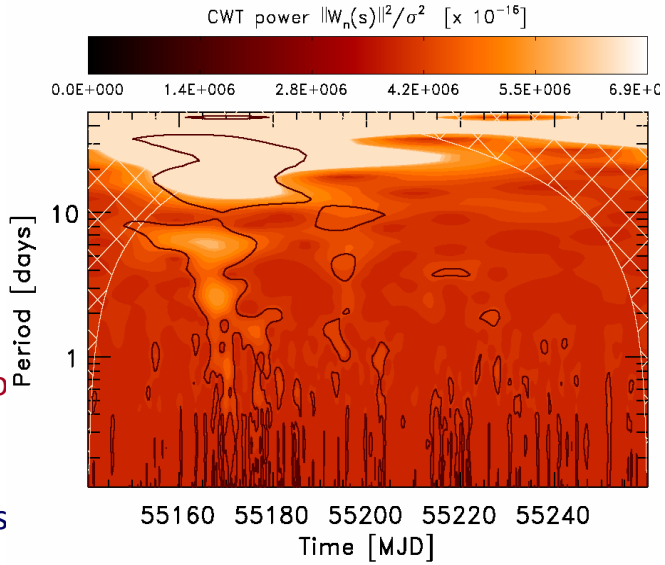
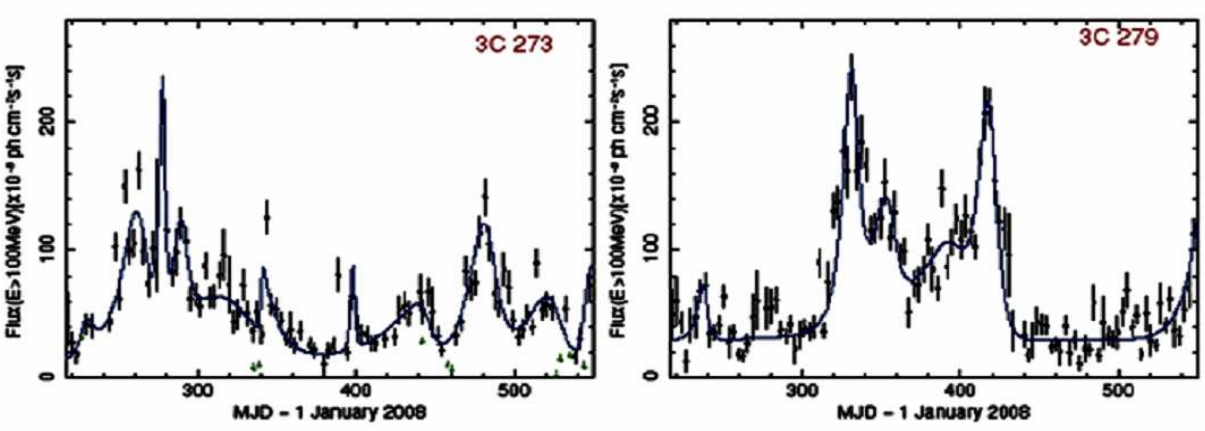
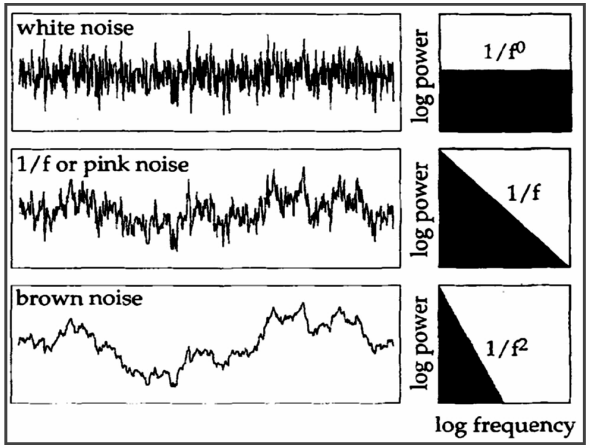


Figure 2. Top panel: SF of the 3 hr bin flux light curve for the period MJD 55,140–55,260 and corresponding PDS (inset). Bottom panel: plane contour plot of the continuous Morlet wavelet transform power density for the same light curve. Thick black contours are the 90% confidence levels of true signal features against white/red noise background, and cross-hatched regions represent the "cone of influence," where spurious edge effects become important.

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

SF, DACF, PDS, Wavelet of LAT blazar gamma-ray time series





❑ Very Brownian variability (more power is observed on long term time scales / lower frequencies) for blazars like 3C 434.3, and AO 0235+164, for example.

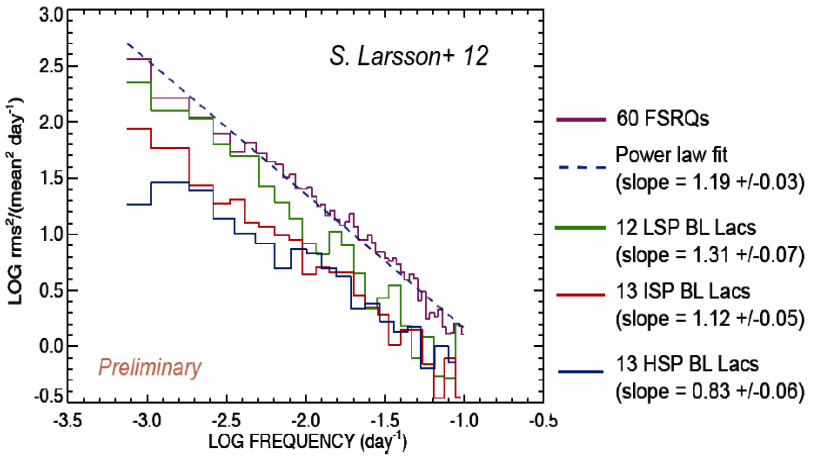
❑ Hint for gamma-ray periodicity in AGN very rare and difficult to assets

❑ Blazars: irregular/aperiodic variability, at all the frequencies, also seen in GeV-energy gamma-ray emisson (observed by CGRO-Egret, Agile and Fermi missions).

❑ Irregular blazar variability is boring (no correlation, no memory, full random behavior…) or is interesting (the power of unexpected, emergence of complexity, modulations, characteristic timescales, long-term memory…) instead?

❑ Observed flux temporal variability (radio, optical, X-ray bands) of blazar-like AGNs shows 1/fa power spectrum decline in a wide range of frequencies f=1/t. Power/scaling law index a generally is placed between about 1 and 3. → Between flickering (pink-noise) to shot-noise (red/brown/Brownian/relaxation noise).

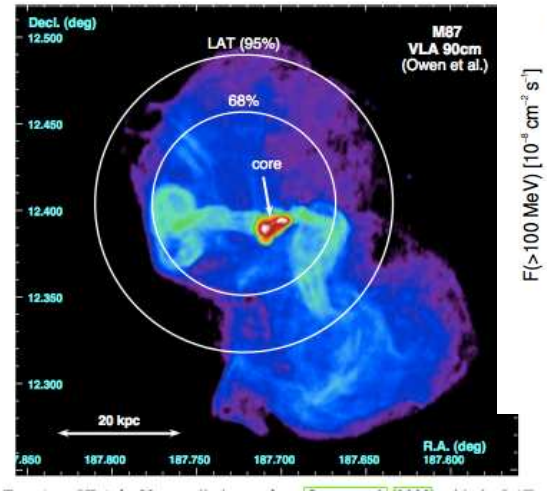
Averaged Power Density Spectra

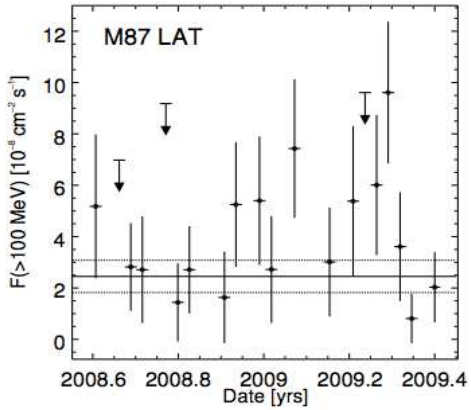


Produced with 5-day light curves of ~80 brightest LAT blazars
No persistent breaks found in PDS of individual sources

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

GeV-TeV (Fermi- MAGIC/CTA) gamma-ray connection





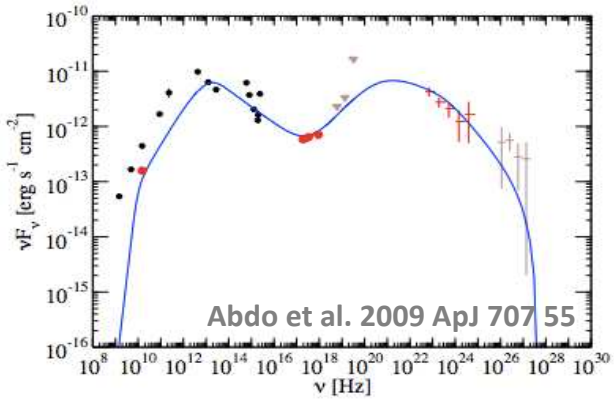
The case of M 87

❒Single SSC with a viewing angle > 10 deg. Bulk lorenz factor ~ 3

❒ Such SSC model also reproduce well the broad band SED of Per A (NGC 1275) and Cen A.

❑ No significant variability in the MeV/GeV regime

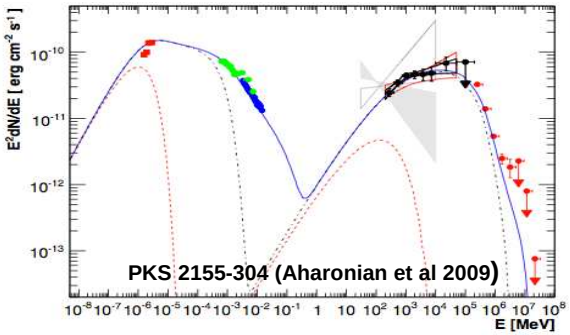
❑ Gamma-ray emission appears to be correlated to the compact radio core.



The case of PKS 2155-304:

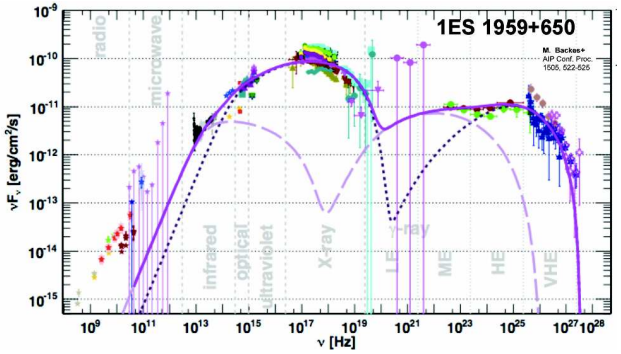
❑ one of few cases with SED modeled with one-zone leptonic SSC

❒Indication of a correlation between optical and VHE. Anticorrelation between X-ray fluxes and LAT spectral indices.



The case of 1ES 1959+650:

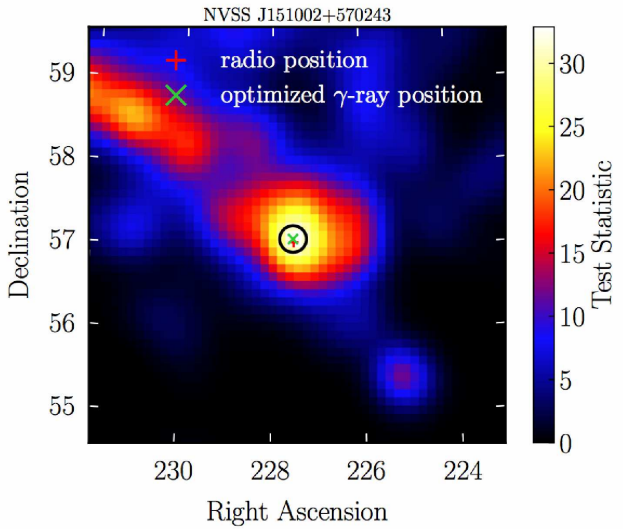
❒a “standard” blazar (no EBL, no hard TeV...), a High Synchrotron Peaked source with an hadronic VHE bump? Leptonic multi-zones emission? Challenging the one zone leptonic model: Flat VHE spectrum

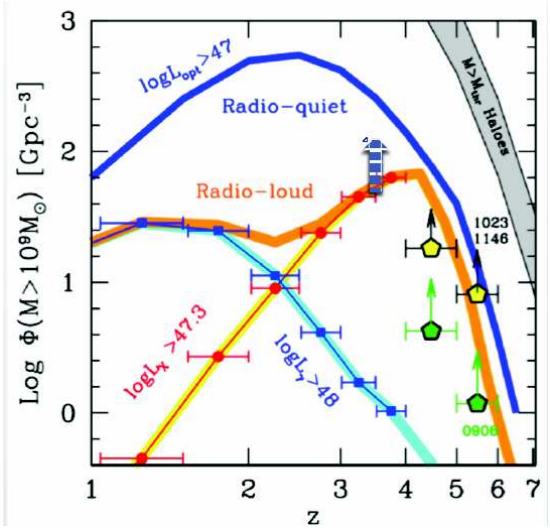


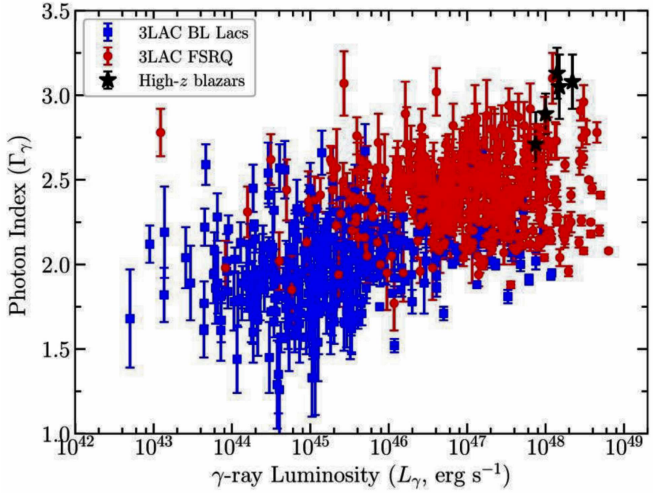
stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

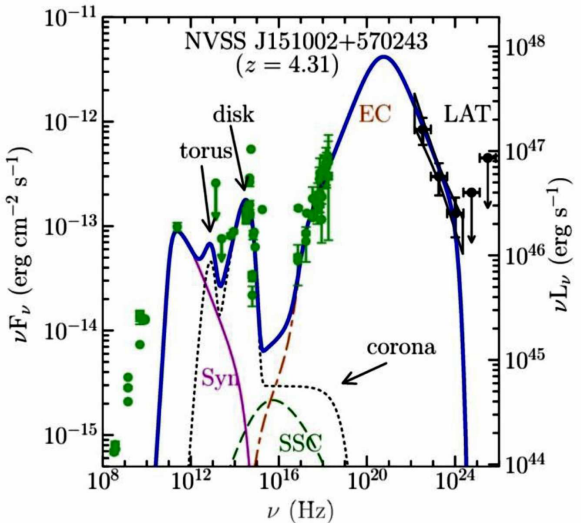
Gamma-ray blazars within the first 2 billion years

- 5 new gamma-ray emitting blazars at redshift higher than z = 3.1 have been detected by Fermi-LAT using 92 months of Pass 8 data.
- The farthest is at z = 4.31! (Ackermann et al. 2017, ApJL, 837, L5)
- These are placed within the first two billion years sinc ethe Big Bang. → cosmological beams/probes.
- Fermi LAT found two of the newly detected MeV blazars to host >10^9 M_sun SMBH.
- This has increased the space density of billion solar mass black holes in radio-loud sources to 70 Gpc^-3, compared to ~50 Gpc^-3 known earlier.
- This implies that the radioloud phase may be a key ingredient for a quick SMBH growth in the early Universe.



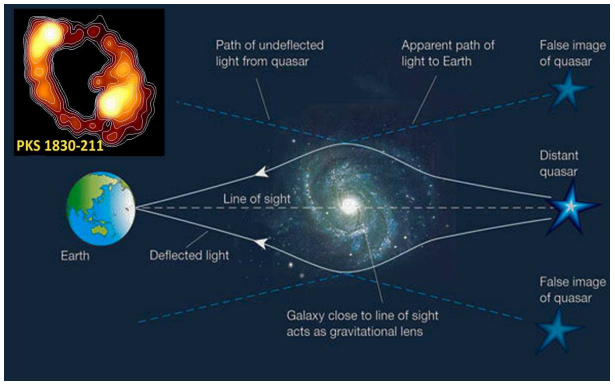


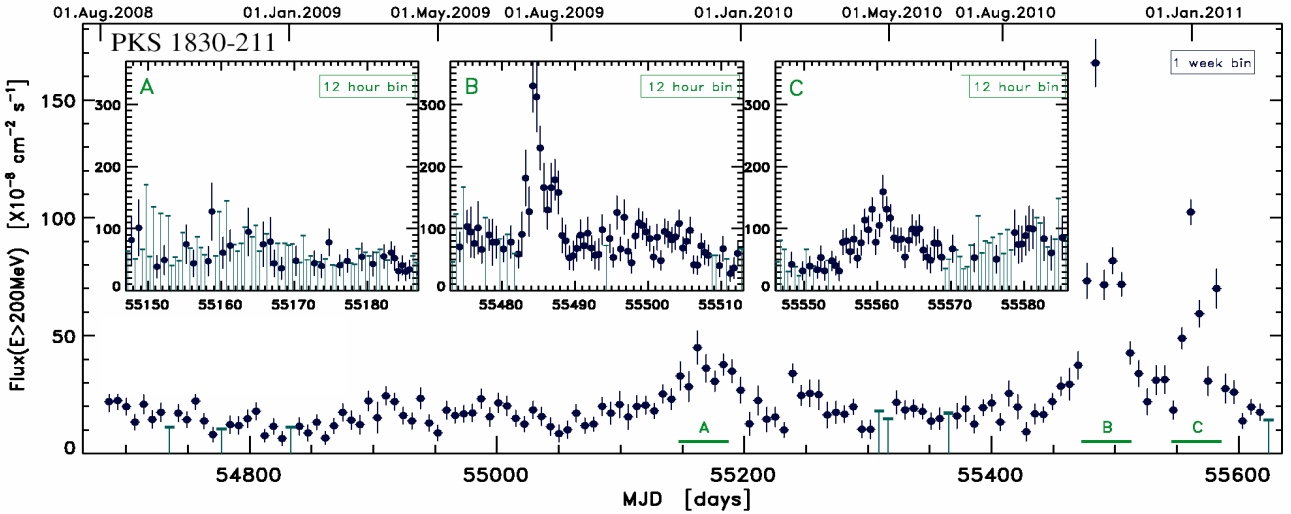




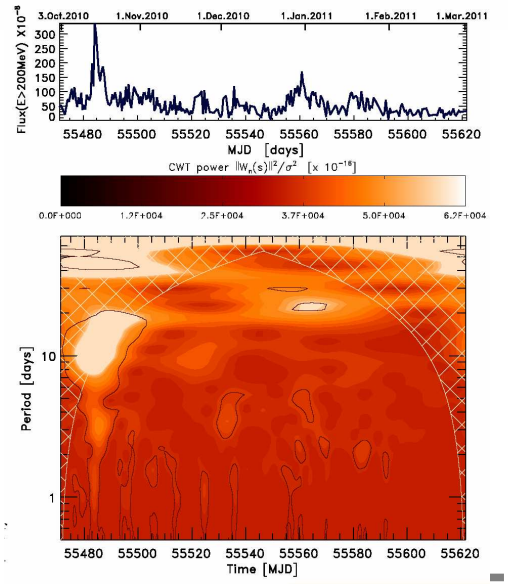
stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Gravitationally lensed gamma-ray blazar: PKS 1830-211





- Intense gamma-ray outburst from the blazar PKS 1830-211 (z =2.507) in October 2010, followed by high activity and other flares.
- A gravitationally lensed, highly dust-absorbed and reddened (by our Galaxy) flat spectrum radio quasar, peaked at MeV energy band.
- Analysis of 3-year Fermi LAT observations and simultaneous Swift data.
- No evident sign of echo gamma-ray flares caused by the lens.
- External-Compton (where seeds photons are from dusty torus) can fit the collected SED data. X-rays data are very similar to what was seen by Chandra in 2005 while gamma-rays are flaring → X-rays can origin from a different region or radiation mechanism. (Abdo et al. 2015, ApJ, 799, 143).

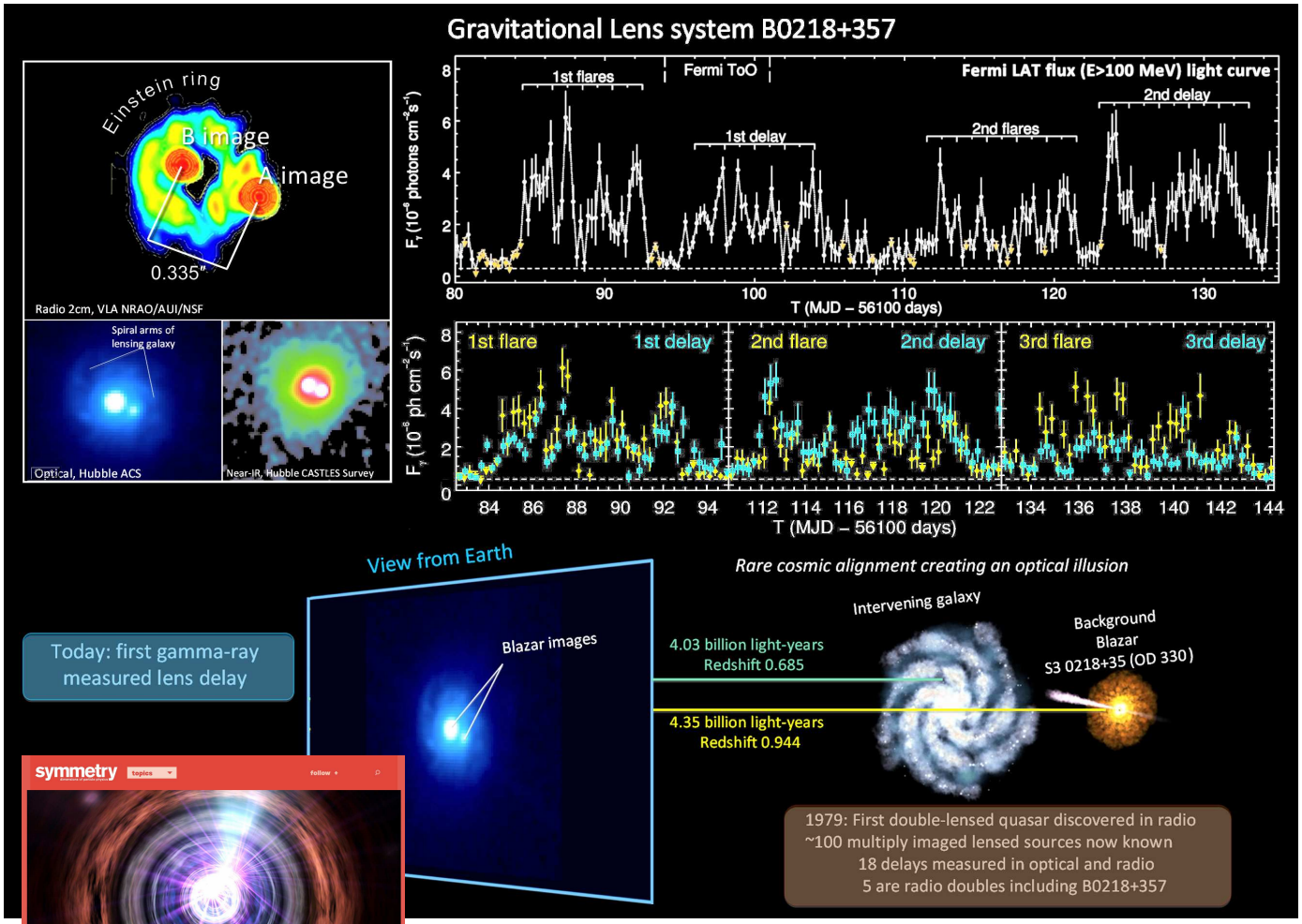


stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Gravitationally lensed gamma-ray blazar: S3 0218+35

- S3 0218+35 (lens B0218+357) discovered as a strong radio source in 1972.
- Revealed in 1990s as smallest-separation gravitational lens known.
- Brighter radio A image leads B image by 10.5±0.2days (1σ) by Biggs et al. (1999)

- Gamma rays detected by Fermi LAT since 2008.
- Fermi LAT made the first gamma-ray delay measurement for a gravitationally lensed system: 11.46±0.16 days (1σ).
- Possible probe of blazar jet structure through independent gamma-ray and radio delay measurements.
- Showcases LAT capability to obtain delay measurements for other gamma-ray gravitationally lensed systems.



Cheung et al. 2014, ApJ, 782, 14.

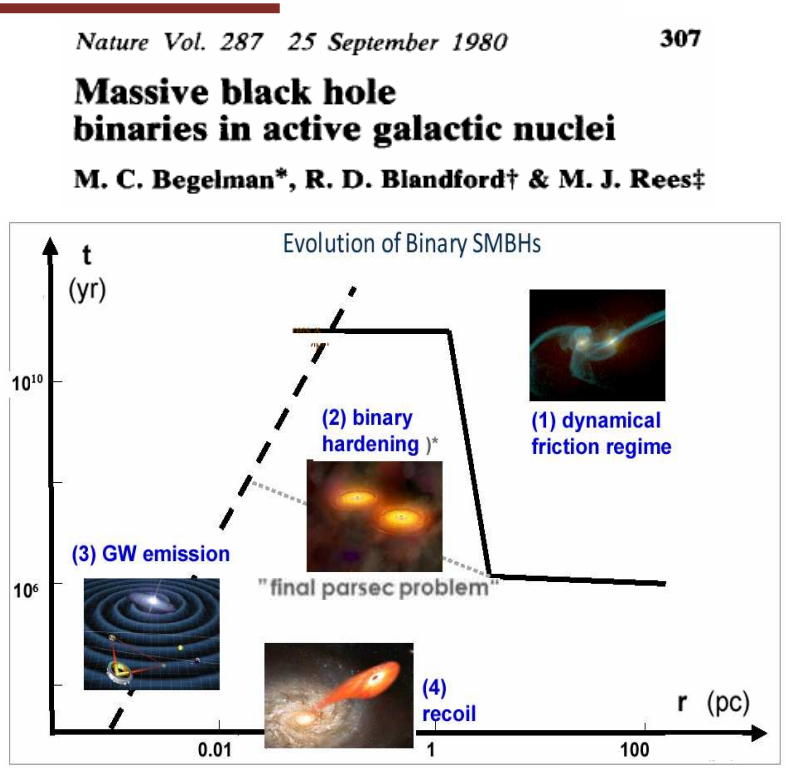
stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Supermassive BHs pairs/binaries

Observational evidence for SMBH pairs and gravitationally bound binary systems:

r/pc
1000
100
10
1
0.1
0.01

- ❑ quasar pairs, AGN in clusters of galaxies
- ❑ pairs of active galaxies, interacting galaxies in early phase of interaction/merging (double-peaked narrow optical emission lines, if both galaxies have NLR)
- ❑ SMBH pairs in "single" galaxies and advanced mergers, kpc/100-pc scales (ex.: two accreting SMBHs spatially resolved, often heavily obscured --> X-ray/radio observations)
- ❑ spatially unresolved binary-SMBHs candidates (1. pseudo/quasi/semi-periodic signals in radio/optical flux light curves; 2. pc-scale spatial radio-structures distorted/helical-patterns in jets; 3. double-peaked broad lines)
- ❑ a few post-merger candidates (X-shaped radio sources, galaxies with central light deficits, double-double radio sources, recoiling SMBHs)

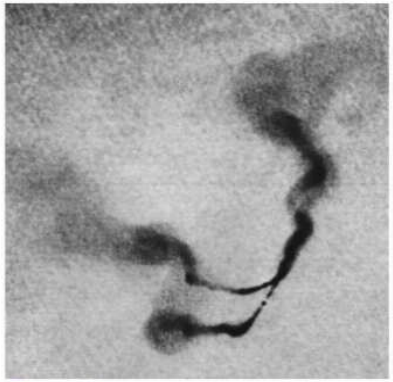


[Credits S. Komossa 2014]

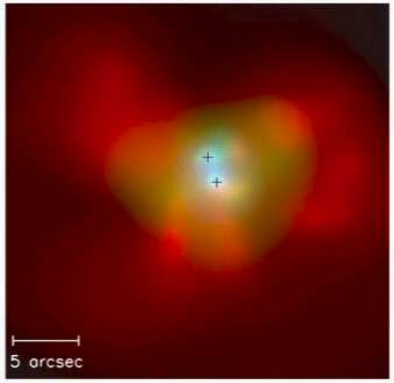
- Galaxy mergers. Sites of major BH growth & feedback processes.
- Coalescing binary SMBHs. Powerful emitters of GWs and e.m. radiation.
- GW recoil. SMBHs oscillate about galaxy cores or even escape.

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

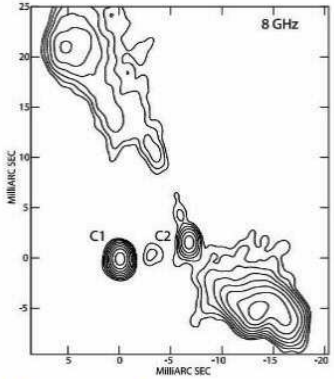
Observational evidence for SMBHs pairs/binaries



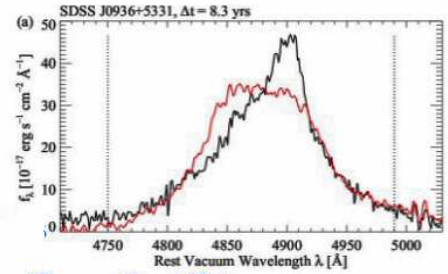
Dual jets (3C 75, a~7kpc)
[Owen+ 1985]



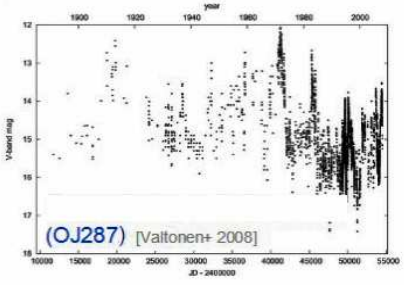
Dual X-ray sources
(NGC 6240, a ~ 1.5 kpc) [Komossa+ 2003]

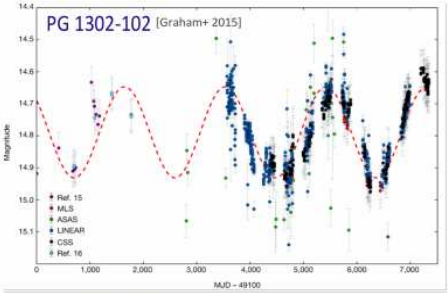


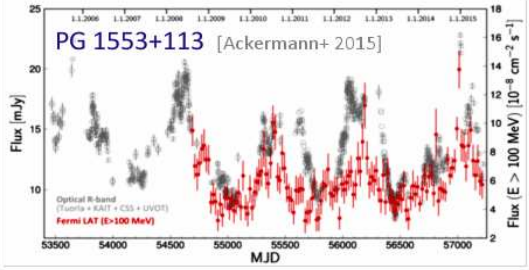
Binary radio sources
(0402+379, a ~ 7pc) [Owen+ 1985]

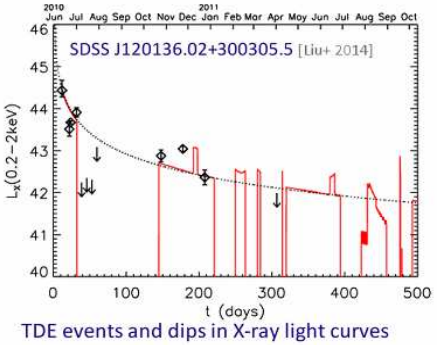


Kinematic shift in
multi-epoch observations
[Liu+ 2013]









TDE events and dips in X-ray light curves

Quasi periodicity in light curves (still controversial topic)

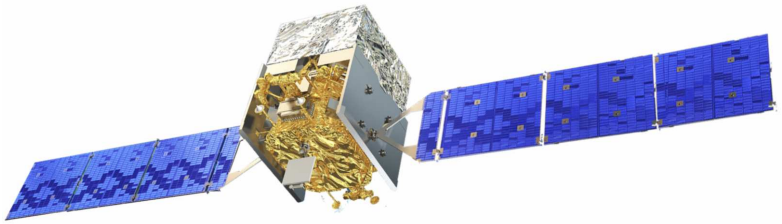
- Many binary SMBHs candidates but few non-controversial confirmations! Why so few ?

Large distances (difficult to resolve). Perhaps obscured. Need to distinguish other phenomena (in-jet knots, lensing, ...). In close pairs most current methods require at least one SMBH to be active (many may not be).

- Perhaps the greatest challenge is to identify the inactive binary SMBHs which might be the most abundant, but are also the most difficult to identify. Most binary SMBHs may form quiescently either in gas-poor or minor galaxy mergers without driving AGN activities.

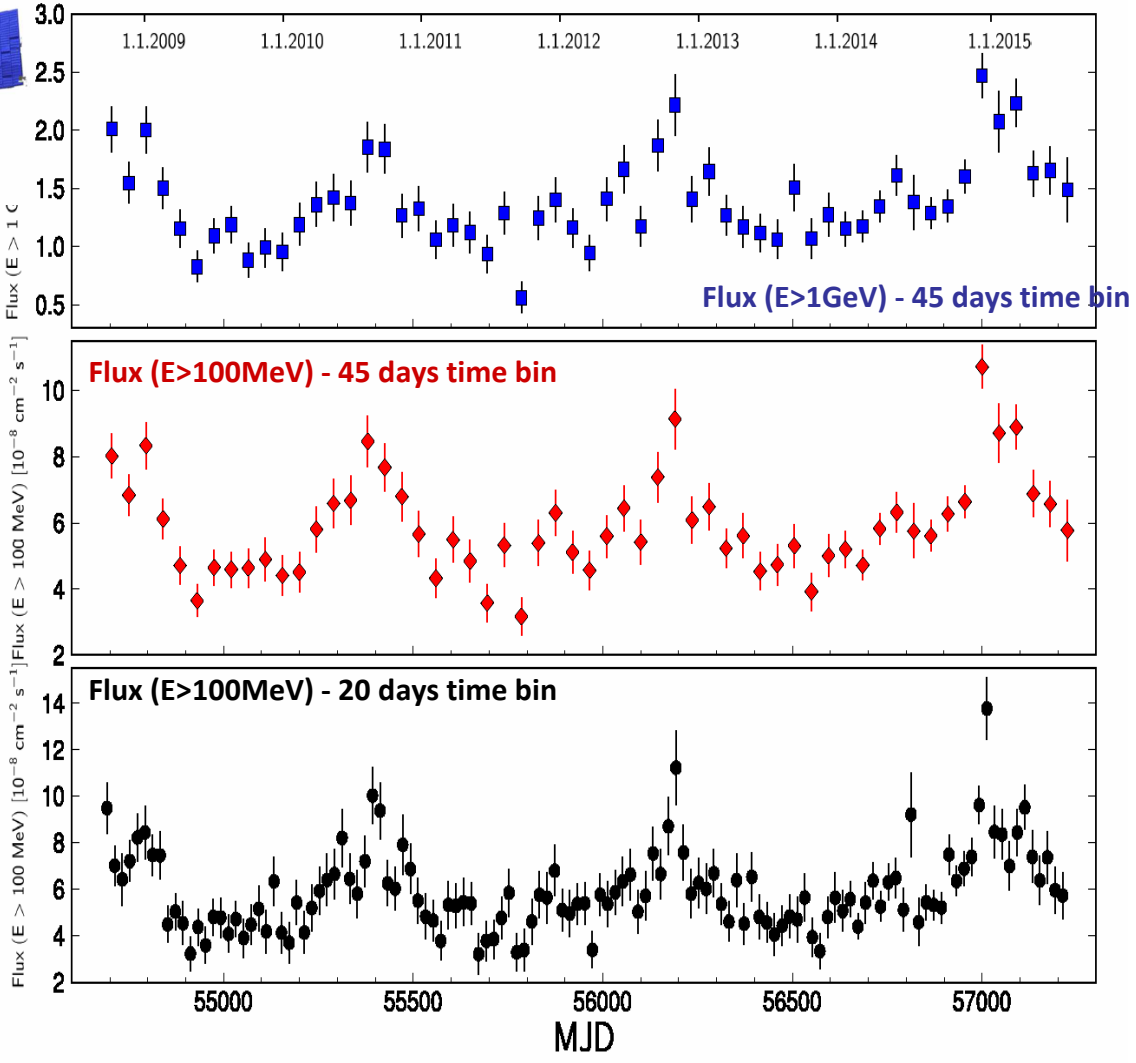
stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

PG 1553+113: Fermi LAT gamma-ray light curves (E>100 MeV, E>1 GeV)



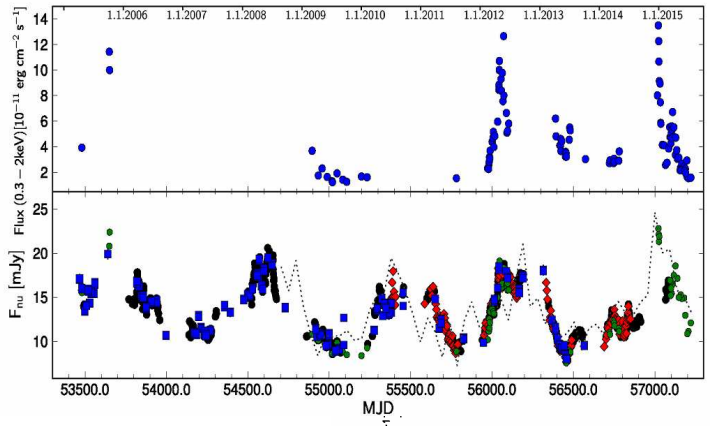
- *Fermi* LAT gamma-ray flux (E>100MeV and E>1GeV) light curves of PG 1553+113 based on Pass 8 dataset up to July 19, 2015, produced in regular-size time bins of 45-day and 20-day size.
- A long-term oscillating trend is visually evident. Sinusoidal modulation (using magnitude-like, log-flux scale). Rather regular periodicity in about 3.5 cycles. Significance still marginal against red-noise but strengthen by MW cross-correlations and a similar oscillatory trend in optical data.

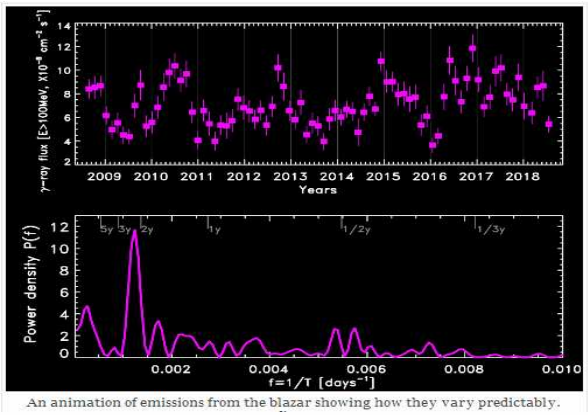
➔ In case of long-lived coherence in this oscillation/modulation the next quasi-periodic GeV peaks are foreseen in 2016-2017 and 2018-2019.



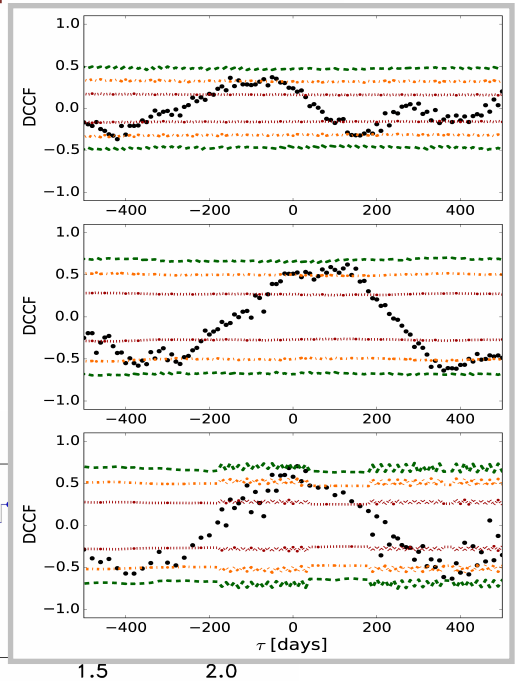
stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

PG 1553+113: temporal variability and cross-correlation analysis

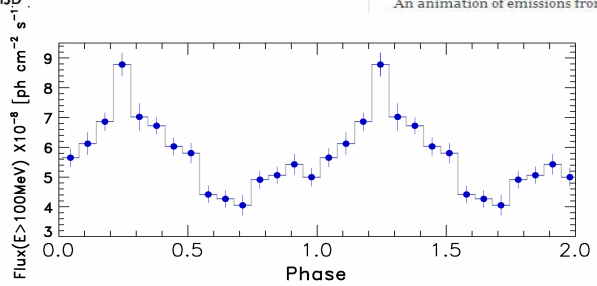


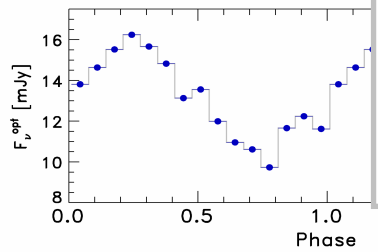


An animation of emissions from the blazar showing how they vary predictably.

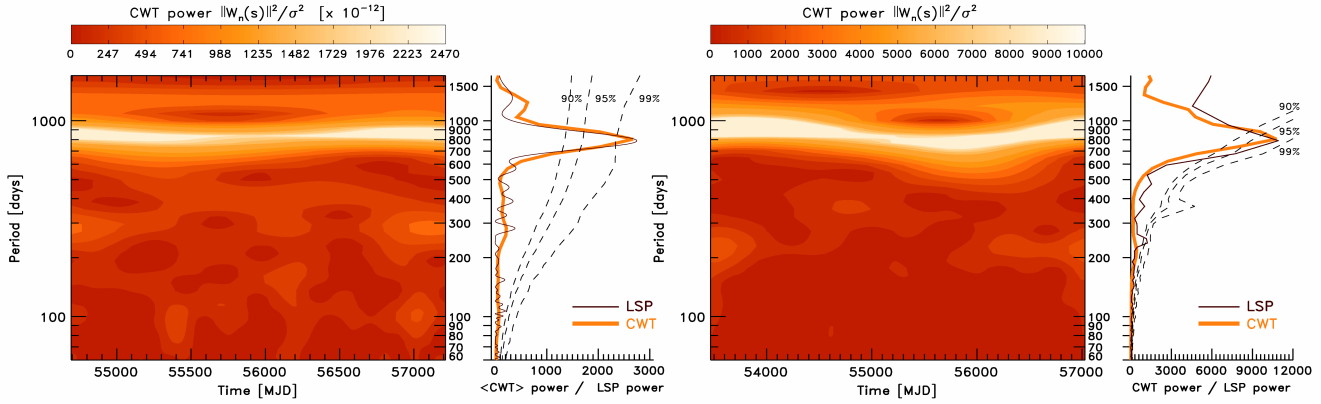


Epoch folding (pulse shape analysis)





Continuous Morlet Wavelet Transform 2D scalogram + LSP + red noise contour lines



stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

PG 1553+113: speculations and open scenarios

❑ 1) Pulsational accretion flow instabilities, approximating periodic behavior, are able to explain modulations in the energy outflow efficiency. Magnetically arrested and magnetically dominated accretion flows (MDAFs) could be suitable regimes for radiatively inefficient TeV BL Lacs (Fragile & Meier 2009), characterized by advection-dominated accretion flows and subluminal, turbulent, and peculiar radio kinematics.

❑ 2) Jet precession, jet rotation, or helical structure in the jet (geometrical models), the presence of a jet wrapped by a sufficient strong magnetic field, could have a net apparent periodicity from the change of the viewing angle (Doppler magnification changes periodically).

❑ 3) Similar mechanim to low-frequency QPO from Galactic high-mass binaries/microquasars (Fender & Belloni 2004, King et al. 2013). PG 1553+113 has a low accretion rate. QPO Lense–Thirring precession requires that the inner accretion flow forms a geometrically thick torus rather than a standard thin disk as the latter warps (Bardeen–Petterson effect, Bardeen & Petterson 1975) rather than precesses (Ingram et al. 2009). ADAF-disk anyway can give precessing jet (Fragile & Meier 2009). Lense–Thirring precession could affect the jet direction, giving the QPO.

❑ 4) Binary, gravitationally bound, SMBH system (total mass of 1.6X10^8 Msun, milliparsec separation, early inspiral gravitational-wave driven regime. Keplerian binary orbital motion --> periodic accretion perturbations or jet nutation. Significant acceleration of the disk evolution and accretion onto a binary SMBH system is depicted by modeling. Probability of observing such a milliparsec system, estimated from the binary mass ratios ~0.1–0.01 and the GW-driven regime lifetime (Peters 1964) = 10^5−10^6 years, might be too small.
If the periodic flux modulation is real and coherent then subsequent maxima would be expected in 2016-2017 and 2018-2019.

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Example of 2018 competitions for observing time and funds

Proposte ad AO di altri satelliti ed osservatori del 2018				
Satellite / Osservatorio	**AO & ID**	**Titolo**	**PI-ship / CoI-ship**	**Esito**
Fermi GI Program 2018	Cycle 11	Increasing the discovery potential of Fermi-LAT through midterm and long-term time domain analysis	Co-I (PI ufficioso)	Approvato
Fermi GI Program 2018	Cycle 11	Bridging the gap in the census of gamma -ray variable sources	Co-I	Approvato
Fermi GI Program 2018	Cycle 11	Unidentified Fermi LAT sources	Co-I	Approvato
Fermi GI Program 2018	Cycle 11	Fermi-NOAO joint program for blazar candidates	Co-I	Approvato
INTEGRAL	AO 16	3C 279 observations	Co-I	Approvato
Spitzer DDT Proposal	#14206	Predicted Eddington Flare from Blazar OJ 287 and the First Observational Test of the Black Hole No-Hair Theorem	Co-I	Approvato

Proposte al satellite Swift di tipo Target of Opportunity (ToO) del 2018		
Swift ToO ID e data sottomissione	**Nome sorgente/target**	**Esito**
11489 12/10/2018	OQ 334	Approvato /eseguito
11476 12/06/2018	TXS 0506+056	Approvato /eseguito
11447 11/29/2018	TXS 0646-176	Approvato /eseguito
11473 12/05/2018	PKS 2134+004	Approvato /eseguito
10743 05/24/2018	87GB 134142.5+691018	Approvato /eseguito
10742 05/24/2018	TXS 1339+696	Approvato /eseguito
10690 05/15/2018	PKS 0903-57	Approvato /eseguito
10688 05/15/2018	PKS 2134+004	Approvato /eseguito
10343 02/22/2018	OQ 334	Approvato /eseguito
10302 02/08/2018	PKS 0514-459	Approvato /eseguito
10300 02/08/2018	PKS 0226-559	Approvato /eseguito

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Example of 2018 seminars organized in SSDC ASI

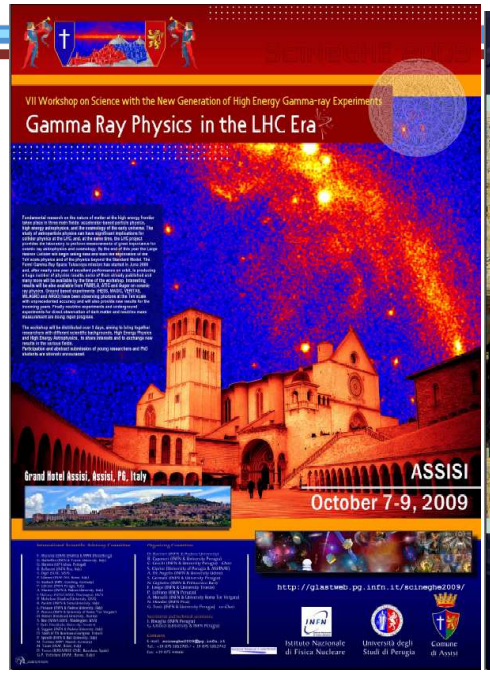
Data	Speaker - Institute	Location	Seminar title
2018-12-19	Daniela Billi - Univ. Tor Vergata, Rome	Sala CASSINI	Astrobiology experiments in ground-based and low-orbit conditions: implications for searching life elsewhere
2018-10-05	Vincenzo Carbone - Università della Calabria, Cosenza, Italy	Sala CASSINI	Turbulence: the last unsolved problem of classical physics. The interplanetary space and other examples.
2018-09-20	Giulio D'Agostini - Univ. La Sapienza, Roma & INFN Roma 1	Sala CASSINI	Incertezze nei risultati di misure fisiche. Inferenza probabilistica illustrata con un toy experiment
2018-09-19	Giulio D'Agostini - Univ. La Sapienza, Roma & INFN Roma 1	Sala CASSINI	Scoperte annunciate a colpi di sigma
2018-07-30	Paolo Padovani - ESO Garching, Muenchen, Germany & INAF OAR, Monteporzio Catone, Italy	Sala CASSINI	The birth of (non-stellar) neutrino Astronomy: story of a discovery
2018-06-27	Enzo Pascale - Univ. La Sapienza, Roma & INFN Roma 1	Sala CASSINI	Exoplanet atmospheres in the ARIEL mission era
2018-06-22	Yu Ling Chang - ASI SSDC; Univ. La Sapienza Rome; ICRANet Pescara	Sala CASSINI	Multifrequency studies of very high energy peaked blazars
2018-06-06	Paolo Pani - Univ. La Sapienza, Roma & INFN Roma1	Sala CASSINI	Testing fundamental physics with gravitational waves
2018-04-27	Frédéric Thévenin - Observatoire de la Cóte d'Azur, France	Sala CASSINI	Gaia Data Release 2: new data for understanding stars & galaxies structures and evolutions
2018-04-18	Massimo Brescia - INAF Oss. Astron. Capodimonte, Napoli	Sala CASSINI	Astroinformatics, a Data-driven Science
2018-03-19	Fabio Del Frate - Univ. Tor Vergata	Sala CASSINI	Neumapper: a user friendly software package to design neural networks
2018-03-08	Giulio D'Agostini - Univ. La Sapienza Roma & INFN Roma1	Sala CASSINI	An introduction to R for data science
2018-02-21	Giancarlo Ghirlanda - INAF Brera	Sala CASSINI	Gamma Ray Bursts: from observations to theory. Facts open questions and future perspectives

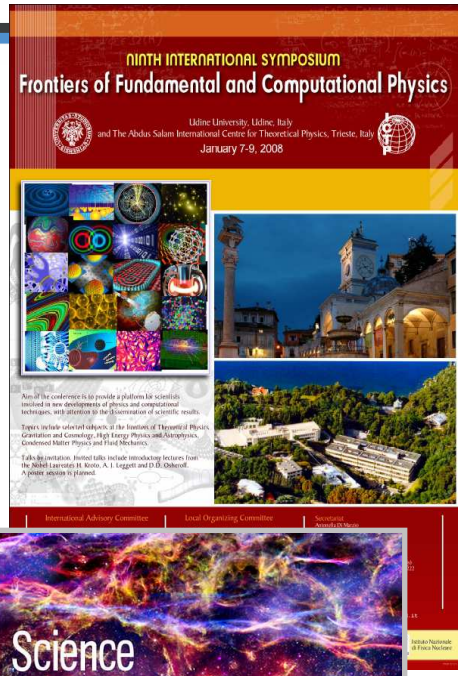
stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

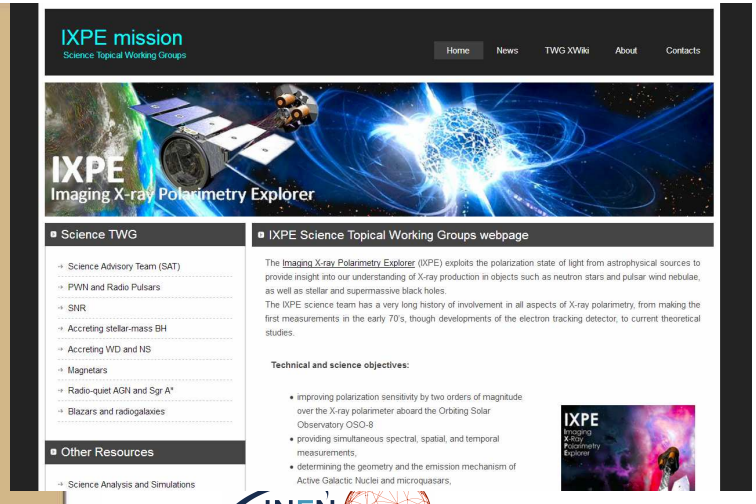
Example of past E&PO: physics communication, conference co-organization, web construction, artist-view releases

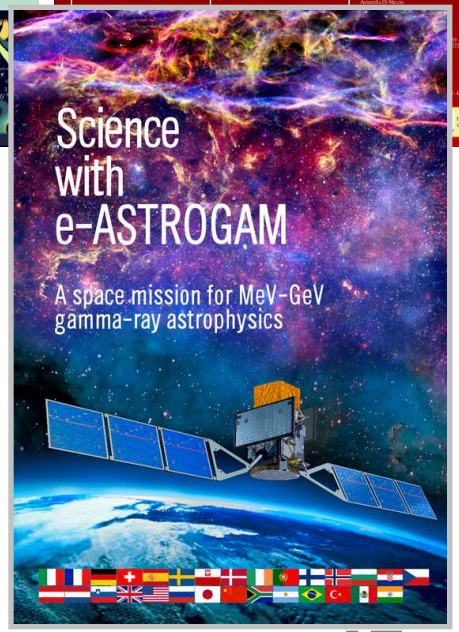
stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Example of past E&PO: physics communication, conference co-organization, web construction, artist-view releases









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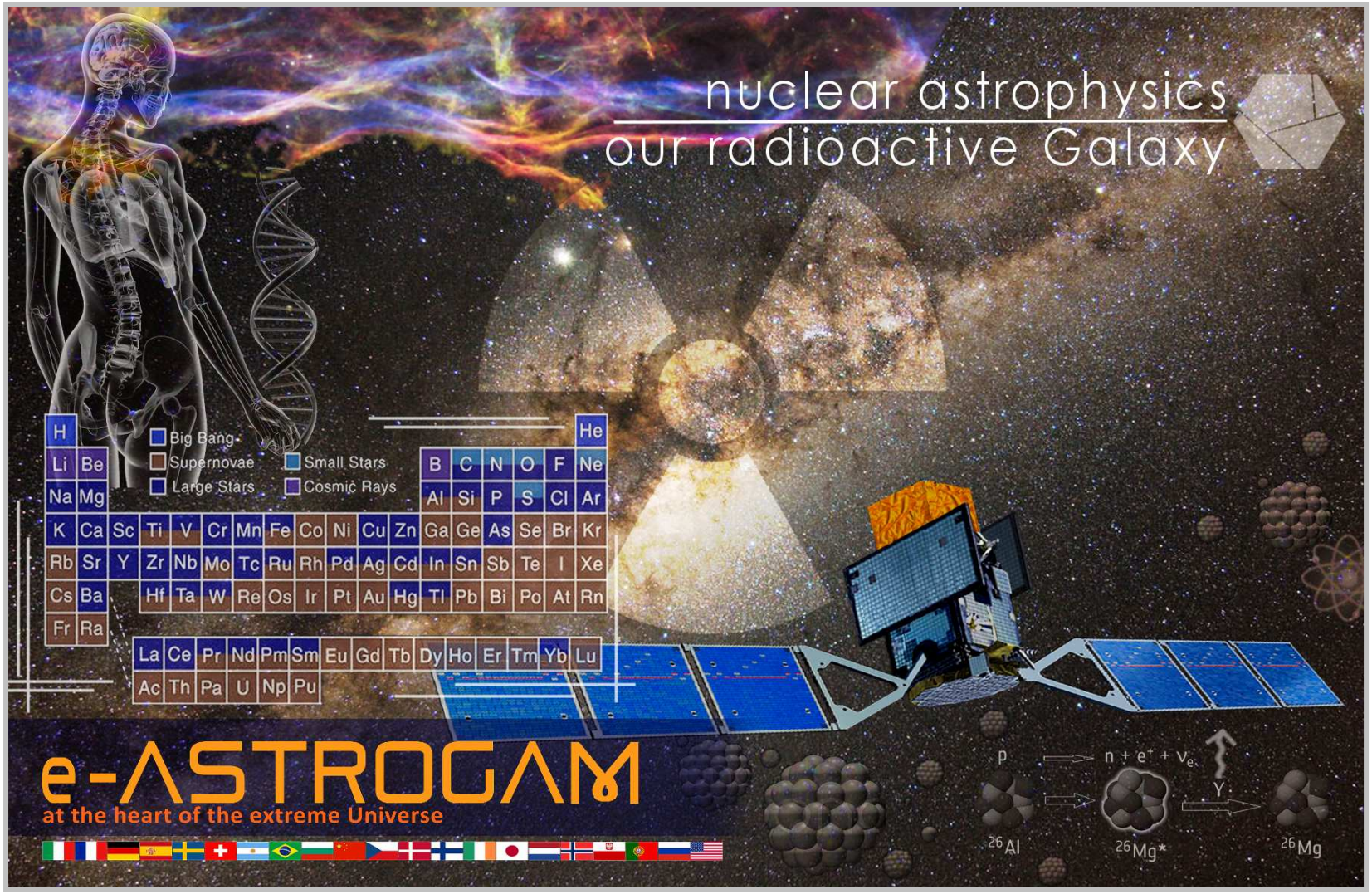
INFN Tor Vergata & SSDC ASI, Rome

Example of past E&PO: physics communication, conference co-organization, web construction, artist-view releases



stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

New space mission projects example: e/as-ASTROGAM

- e-ASTROGAM designed to be optimized for simultaneous detection of Compton and pair-producing photon events.

- Unprecedented capabilities in
  - → gamma-ray continuum
  - → gamma-ray line spectroscopy
  - → gamma-ray imaging
  - → gamma-ray large FoV for sky survey
  - → gamma-ray time-domain monitor
  - → gamma-ray polarization

Key characteristics

- Best PSF in MeV-GeV → resolve sources
- High-resolution calorimetric measurements of MeV lines:
  - → positron detecon (511 keV line)
  - → measurements of isotopic contents with highest sensitivity
  - → hadronic collisions of LE cosmic rays with molecular clouds
- Capability of measuring polarization (marks Compton interactions at the sources and magnetic fields)
- SED resolution in the GeV range: allows to reconstruct the pion bump, characteristic of the decay $\Pi^0 \rightarrow \gamma\gamma$ and thus indicator of hadronic processes

e-ASTROGAM line sensitivity (3σ in 10^6 s) compared to that of *INTEGRAL*/SPI

E (keV)	FWHM (keV)	Origin	SPI sensitivity (ph cm^{-2} s^{-1})	e-ASTROGAM sensitivity (ph cm^{-2} s^{-1})	Improvement factor
511	1.3	Narrow line component of the e+/e- annihilation radiation from the Galactic center region	5.2×10^{-5}	4.1×10^{-6}	13
847	35	^{56}Co line from thermonuclear SN	2.3×10^{-4}	3.5×10^{-6}	66
1157	15	^{44}Ti line from core-collapse SN remnants	9.6×10^{-5}	3.6×10^{-6}	27
1275	20	^{22}Na line from classical novae of the ONe type	1.1×10^{-4}	3.8×10^{-6}	29
2223	20	Neutron capture line from accreting neutron stars	1.1×10^{-4}	2.1×10^{-6}	52
4438	100	^{12}C line produced by low-energy Galactic cosmic-ray in the interstellar medium	1.1×10^{-4}	1.7×10^{-6}	65

e-ASTROGAM performance in the Compton domain simulated with MEGAlib v2.26.01.
3σ continuum sensitivity for detection of a point source on axis after an observation time $T_{obs} = 10^6$ s.

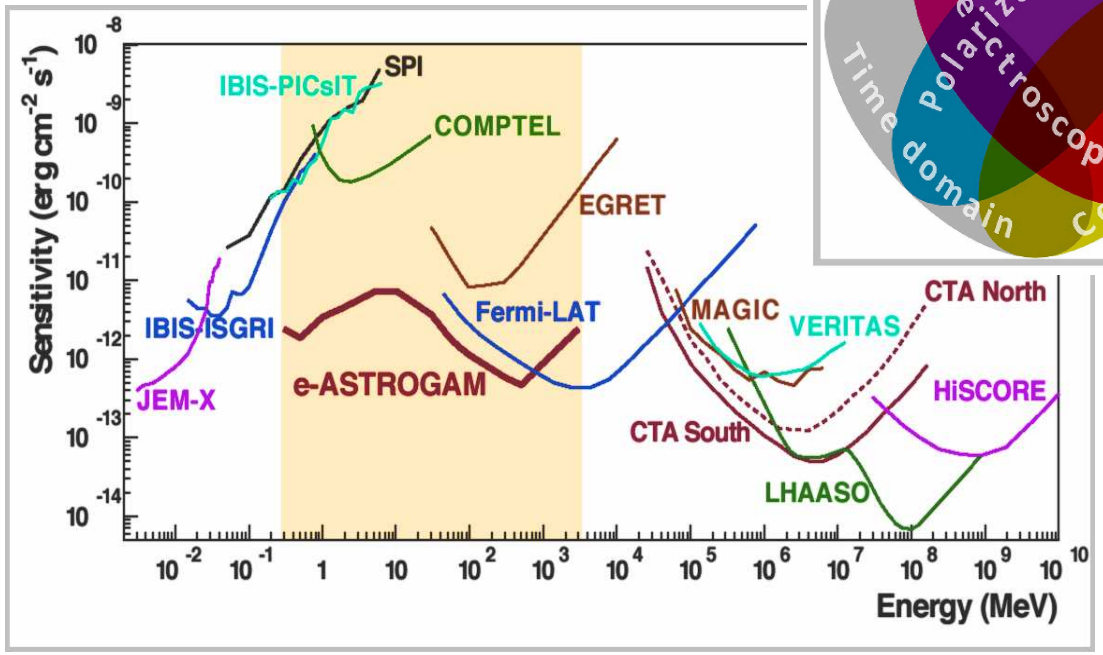
E (MeV)	ΔE spectrum[a] (MeV)	Angular selection[b]	Effective area after selection[c] (cm^2)	Background rate after selection[d] (count s^{-1})	Sensitivity (photon cm^{-2} s^{-1})	Notes
0.3	0.15 – 0.45	4.3°	560	28	2.8×10^{-5}	Without e-tracking
0.5	0.25 – 0.75	2.5°	446	3.5	1.3×10^{-5}	Without e-tracking
1	0.5 – 1.5	1.5°	297	1.4	1.2×10^{-5}	Without e-tracking
2	1.0 – 3.0	1.1°	117	0.097	8.0×10^{-6}	With e-tracking
5	2.5 – 7.5	0.8°	105	0.031	5.0×10^{-6}	With e-tracking
10	5 – 15	0.8°	50	0.007	5.0×10^{-6}	With e-tracking

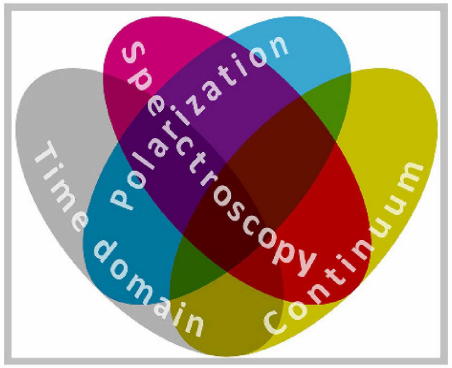
(a) Source spectrum is an E^{-2} power-law in the range ΔE.
(b) ARM radius. Note that the best sensitivity results are obtained for a selection on the ARM radius slightly larger than the optimal ARM.
(c) Effective area after event selection optimized for sensitivity.
(d) Total background including the atmospheric γ-ray background, the cosmic γ-ray background, the activation induced by primary and semi-trapped particles (mainly protons), and the prompt reactions from primary (i.e. cosmic-ray) protons, as well as from secondary protons and leptons (electrons and positrons).

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

New space mission projects example: e/as-ASTROGAM

- Sensitivity = 20 to 100 times better than INTEGRAL and CGRO-COMPTEL in the range 0.2 – 30 MeV
- gamma-ray polarization: for transient and steady sources
- improved angular resolution (e.g., about 10 arcmin at 1 GeV)
- large field of view (about 2.5 sterad) for sky survey and time-domain monitor of sources
- sub-millisecond trigger and alert capability for transients
- re-pointing in 6-12 hours (goal 3-6 hours)





- Webpage: http://eastrogam.iaps.inaf.it
- Detector paper:
  - https://arxiv.org/abs/1611.02232

  https://link.springer.com/article/10.1007%2Fs10686-017-9533-6

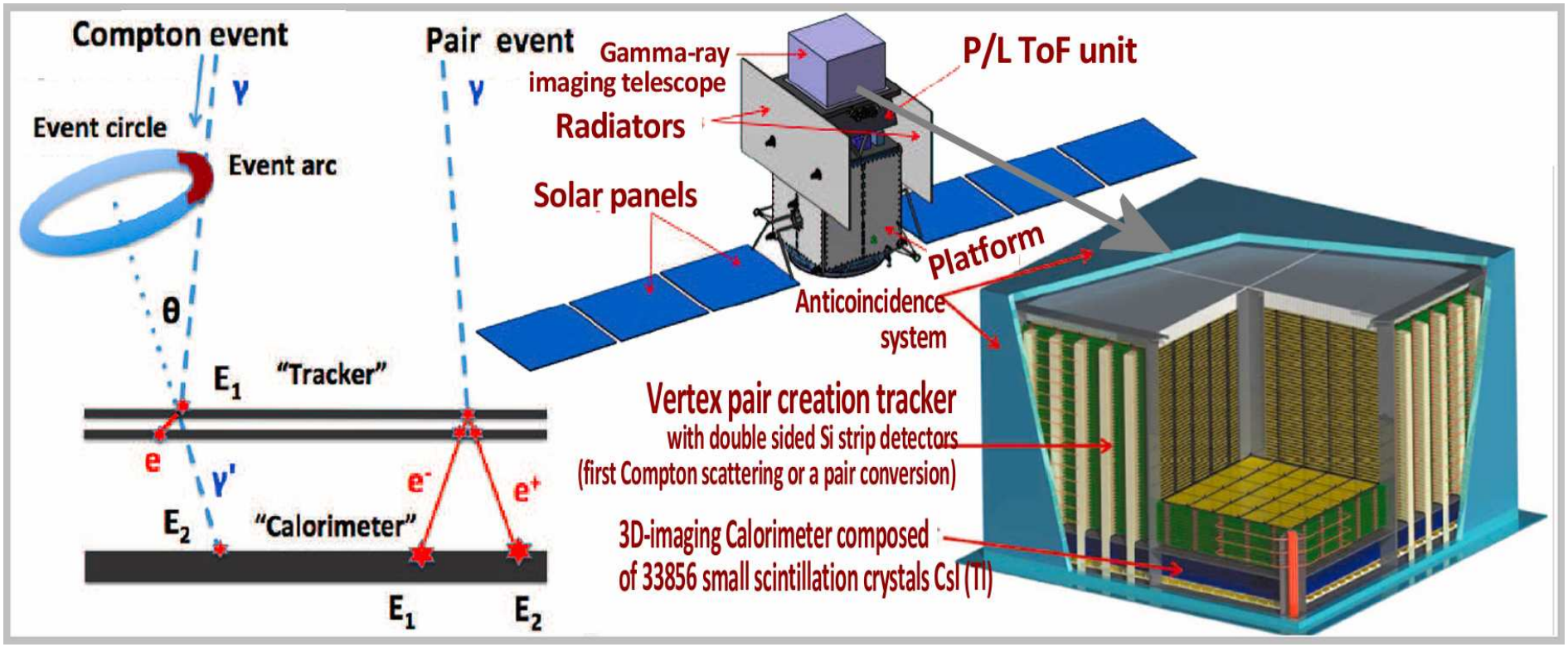
  Experim. Astron. 2017, 44, 25
- Science White Book:
  - https://arxiv.org/abs/1711.01265

  https://www.sciencedirect.com/science/article/pii/ S2214404818300168

  Journal of High Energy Astrophysics

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

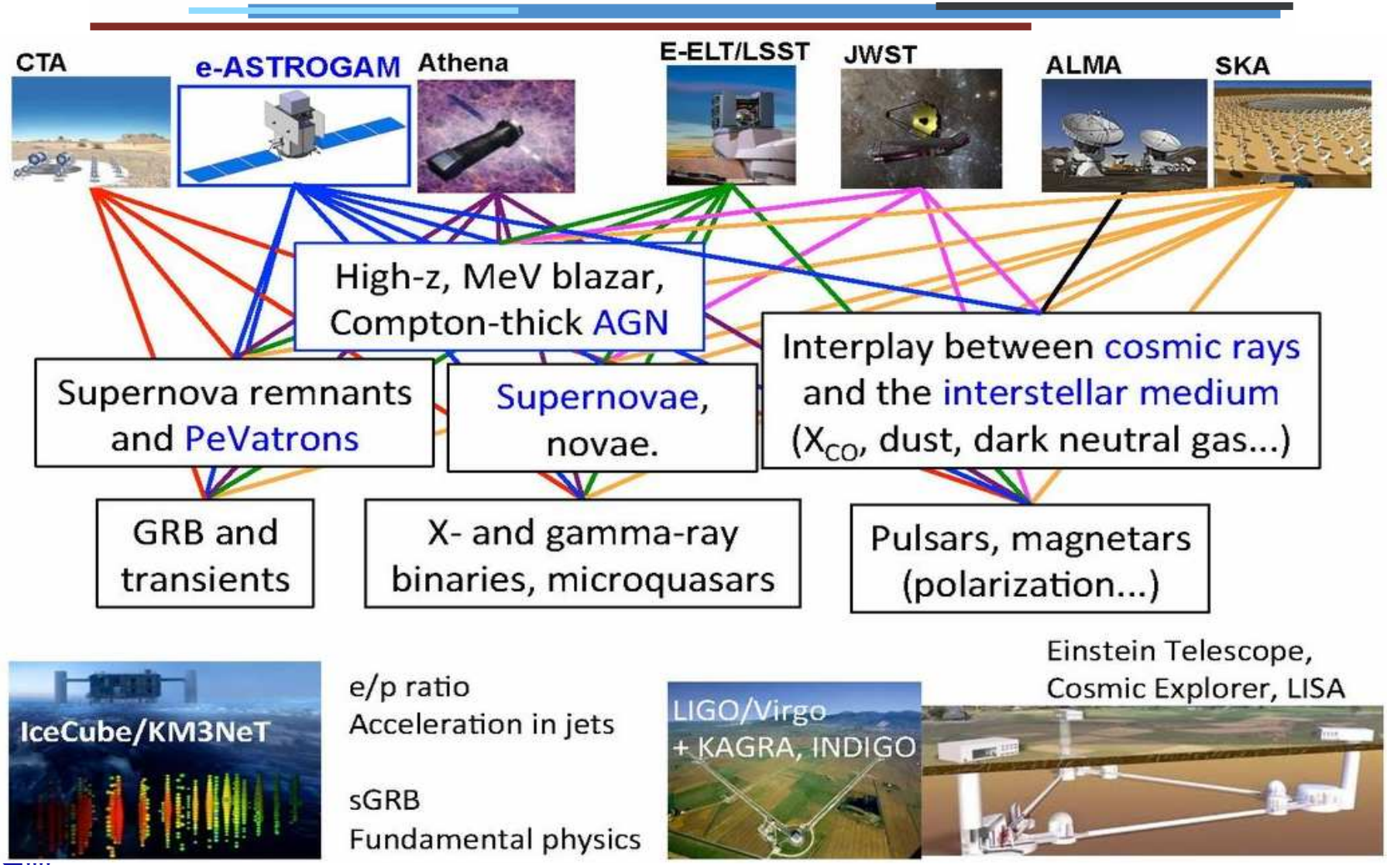
e-ASTROGAM design concept



Left : representative topologies for a gamma-ray Compton scattering event and for a pair creation event. Gamma-ray photon tracks are shown in pale blue, dashed, electron and/or positron tracks are in red solid.
Center: e-ASTROGAM spacecraft concept with solar panels deployed.
Right: Overview of the e-ASTROGAM detectors composing the science instrument payload.

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

e-ASTROGAM science menu



stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome

Conclusions

❑ Scientific success: education + motivation + economics + academic culture + creativity + experience + mentoring + funding trends + …reasonable dose of luck.

❑ Rather difficult situation in Italy for R&D, science, and scientific culture. Too low R&D gross domestic budget. Too low number of researchers. Growing populism and anti-scientific feeling. Political class unfamiliar with science. Enormous public debit and unwise linear cuts to education, formation, university and research institutes. Too much (overwhelming!) bureaucracy.

❑ Young researcher are better (creative/fluid intelligence prior to about 35, then crystalline intelligence), but it is never too late (please have a plane B). Truth is, some landmark scientific work has been done by people older than 50 for centuries. (Fleming's penicillin at 47, Wiles Fermat'theorem dem. at 42, Montagnier HIV at 51. Also what about current creativity of Armani 84, Camilleri 93, etc. ?).

"Never cut a tree down in the wintertime. Never make a negative decision in the low time. Never make your most important decisions when you are in your worst moods. Wait. Be patient. The storm will pass. The spring will come." – Robert H. Schuller

❑ **I was several things (ex. carabiniere, high school teacher) but I always liked science and research. I was Univ., INFN, INAF then again INFN. I worked abroad 2 years (Finland, Univ. Turku), I was in an EU training research network. I worked on IR telescope/detectors for observations from Antarctica, optical astronomy, spectral/temporal analysis, SSD tracker hardware tests, gamma-ray astrophysics, multi-frequency (photon) astrophysics, and now ready for multi-messenger neutrino astrophysics and GWs. I was in MAGIC and Fermi Collaborations.**

I am in SSDC-ASI. There are ASI funds here (in principle). I am in the international Fermi LAT project/mission since 1998. I am in possible future projects (next IXPE, possible e-ASTROGAM / AMEGO / GammaMeV missions). I am happy to find interest/collaboration here in Tor Vergata INFN/Dept.

stefano.ciprini@ssdc.asi.it
INFN Tor Vergata & SSDC ASI, Rome