MM & gamma-rays: challenges and significant results

ACME kick off Meeting

Oscar Blanch, IFAE
Paris 16-17 September

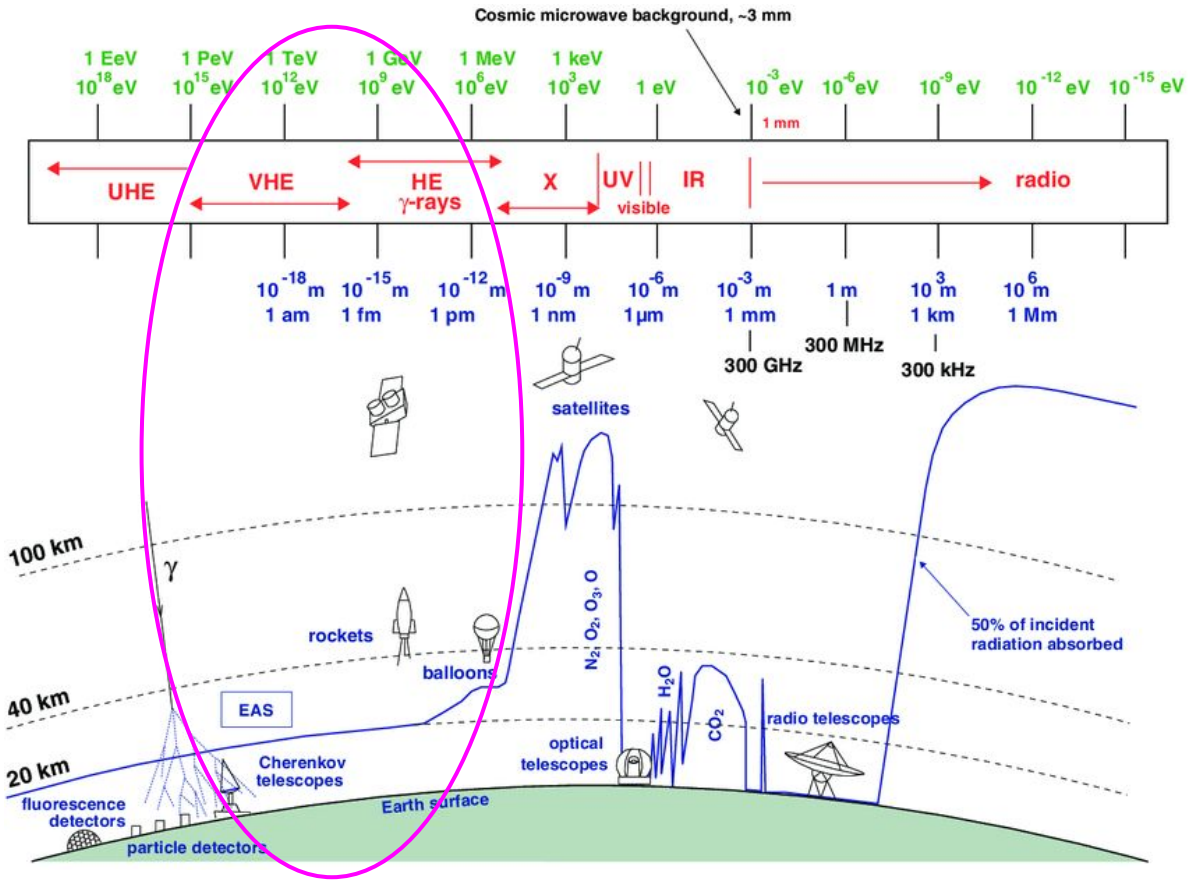
Gamma-ray Astronomy

The atmosphere is absorbing the gamma-rays reaching us, but we can still:

- Go above the atmosphere
- Use the atmosphere as part of the detector

Satellites have been covering the HE gamma-rays and IACTs has been shown to be the most sensitive at VHE gamma-rays.

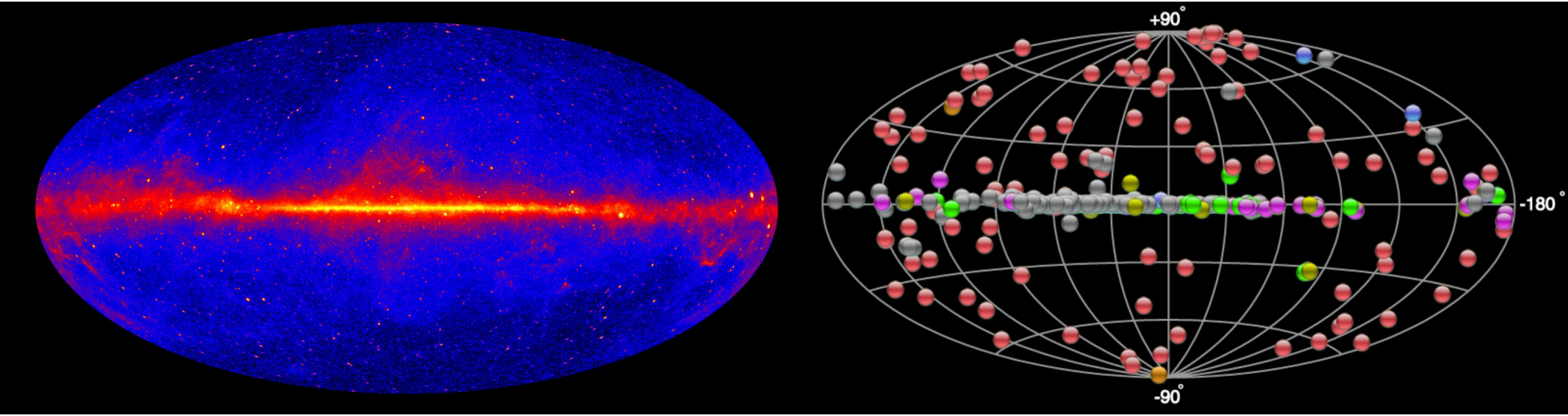
Searches for UHE gamma-rays have not been yet successful



Gamma-ray Astronomy

12 year Fermi Sky Map above 1 GeV (HE)
(Credit:NASA/DOE/Fermi LAT Collaboration)

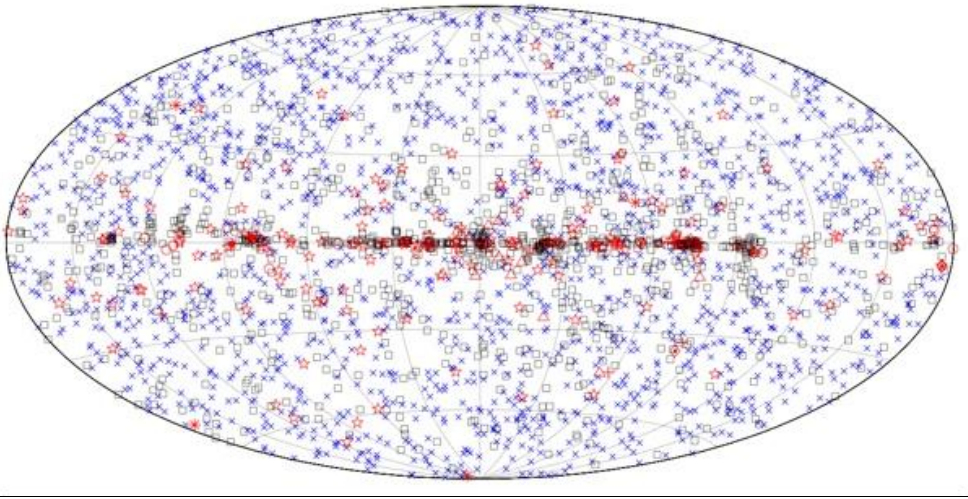
TeV Sky Map (VHE)
(TeVCat online source catalog, http://tevcat.uchicago.edu)



Spectra extension to and behaviour at highest energy has been made available for many type of sources (Binary, FSRQ, FR I, GRB, Halo, HBL, IBL, Pulsar PWN, Shell, Starburst, … as well as unidentified).

Gamma-ray Astronomy

The 3033 gamma-ray sources from 3FGL above 100 MeV



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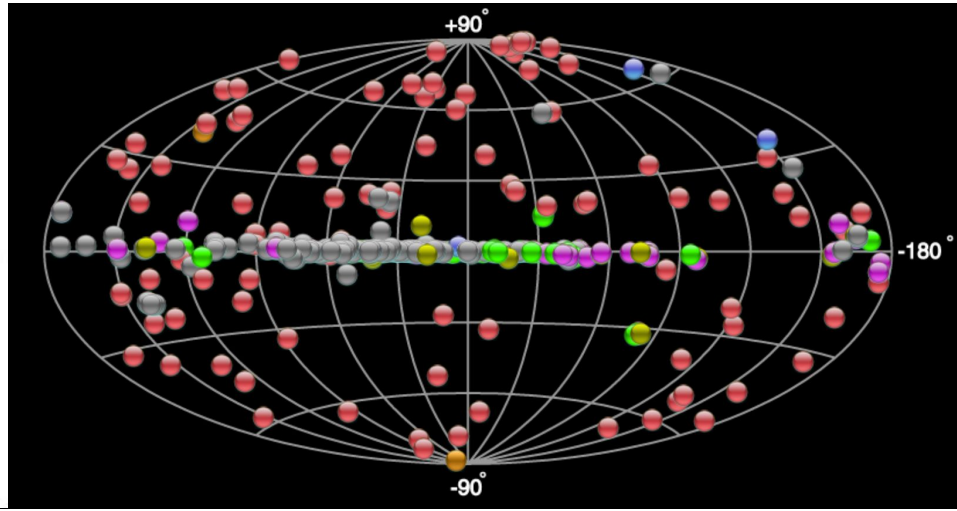

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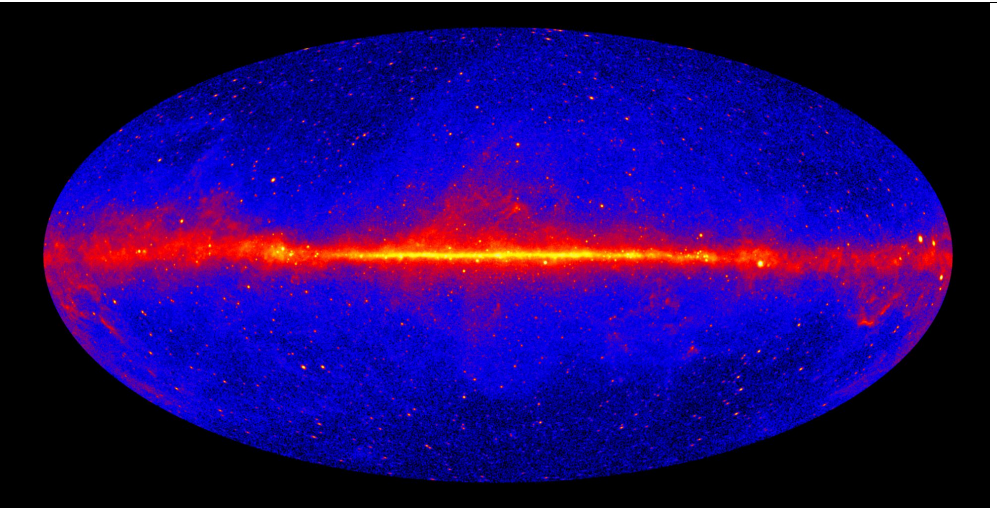

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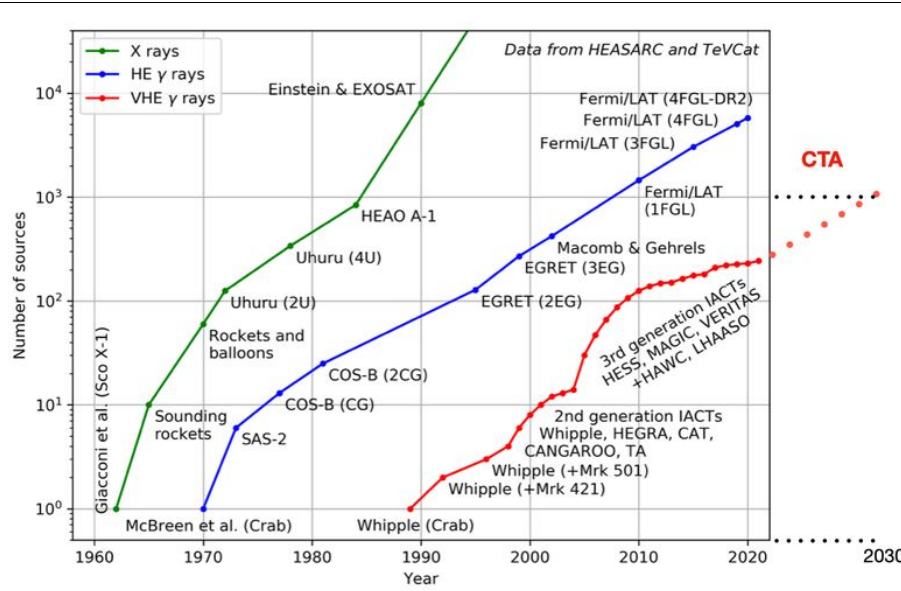


CTAO is coming with ~10 fold improved sensitivity for VHE gamma-rays

MWL & MM in Gamma-ray Astronomy

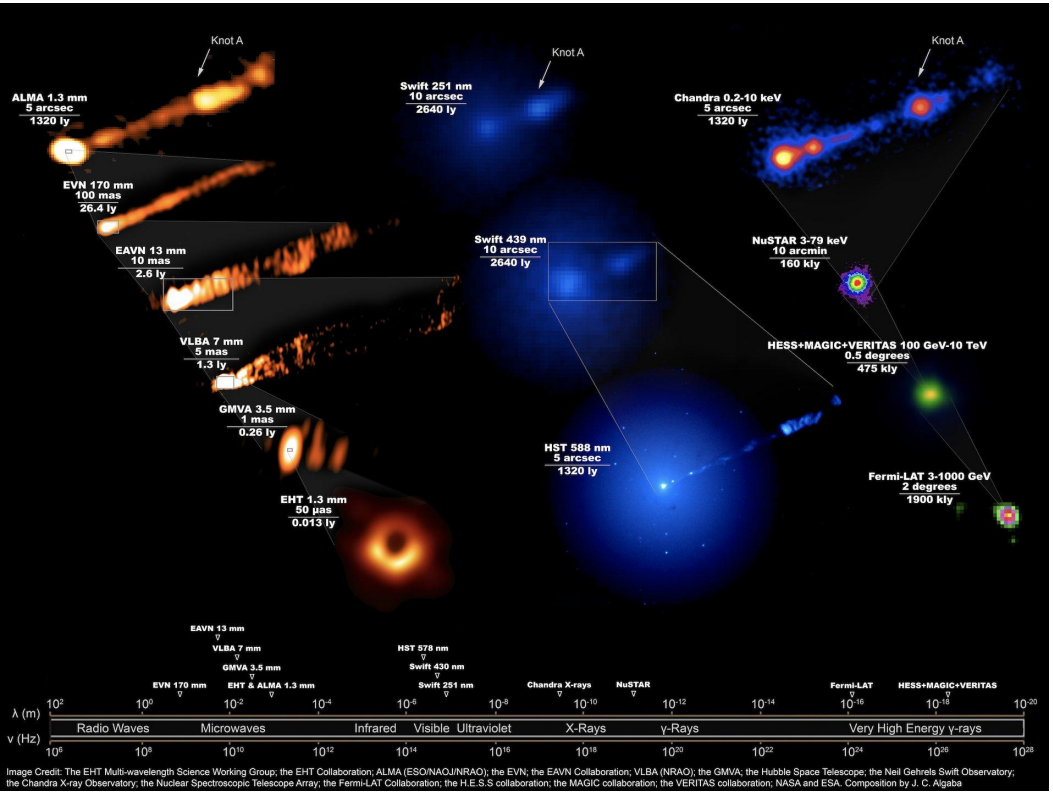
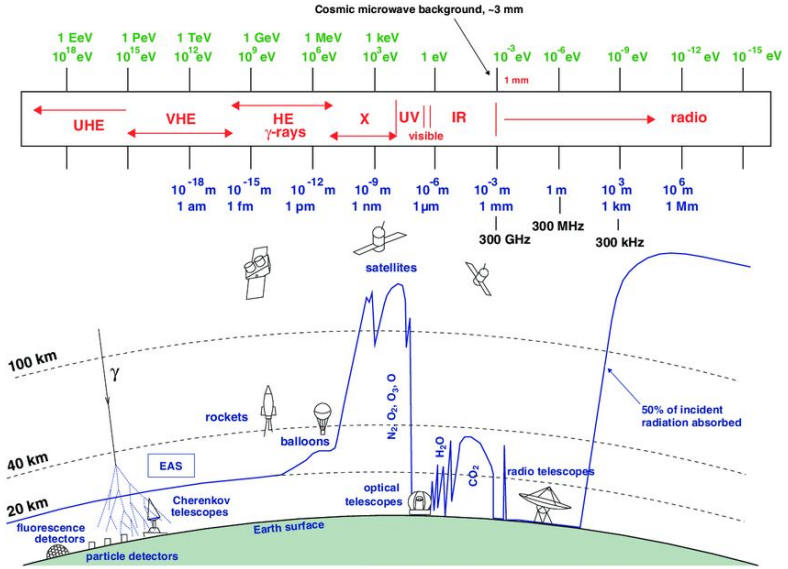
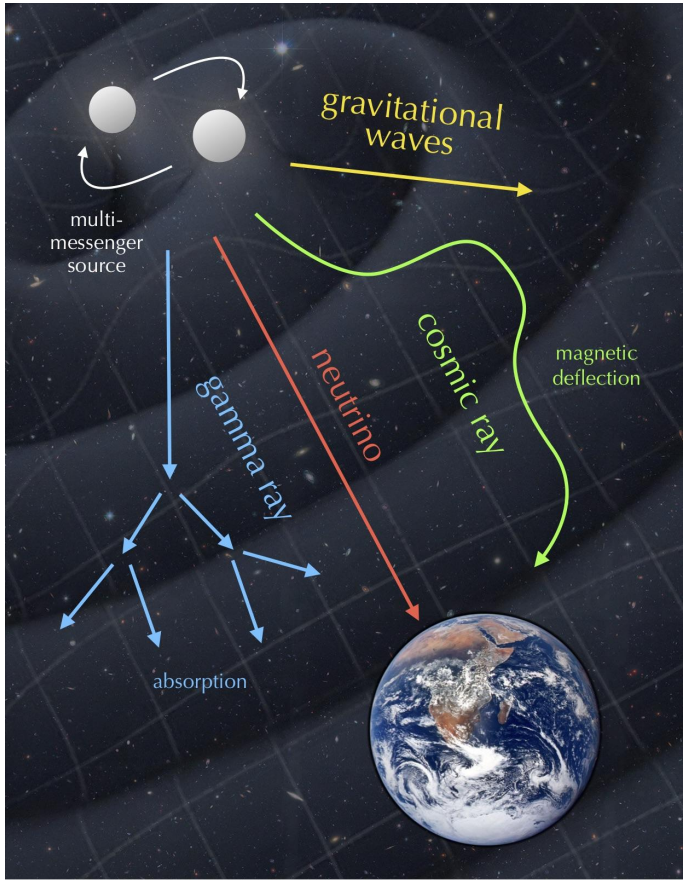


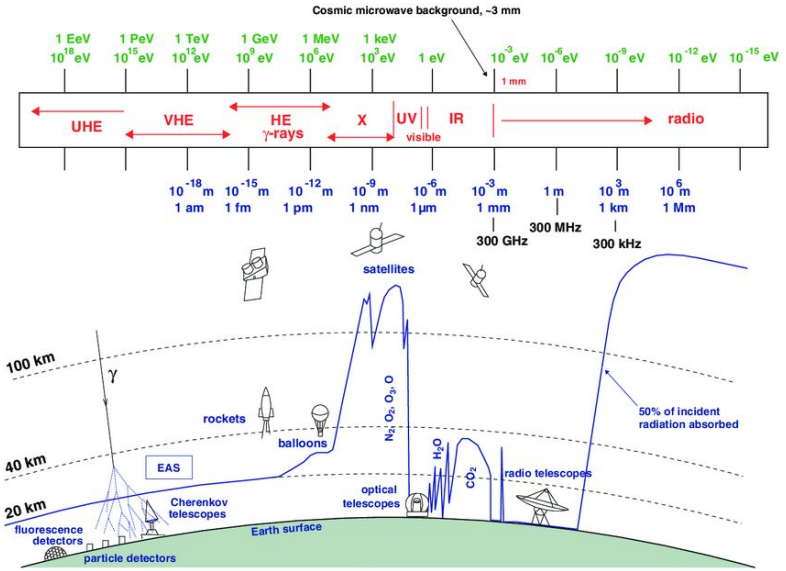
Image Credit: The EHT Multi-wavelength Science Working Group; the EHT Collaboration; ALMA (ESO/NAOJ/NRAO); the EVN; the EAVN Collaboration; VLBA (NRAO); the GMVA; the Hubble Space Telescope; the Neil Gehrels Swift Observatory; the Chandra X-ray Observatory; the Nuclear Spectroscopic Telescope Array; the Fermi-LAT Collaboration; the H.E.S.S collaboration; the MAGIC collaboration; the VERITAS collaboration; NASA and ESA. Composition by J. C. Algaba



MWL is on the game since long, although we can still improve

MWL & MM in Gamma-ray Astronomy



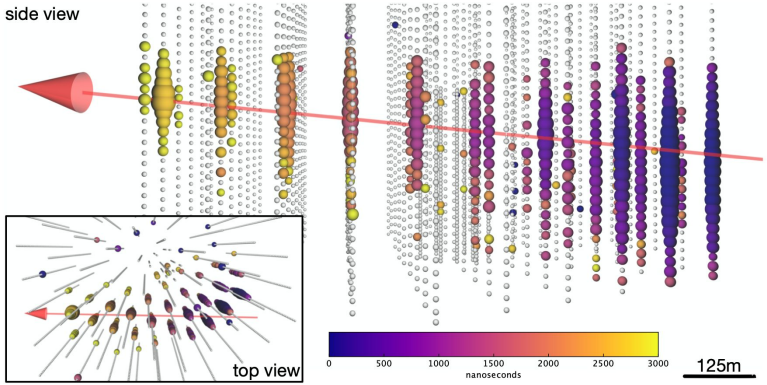


And MM is not any more the future but already the present.

Efforts on going all across astronomy, including gamma-ray astronomy

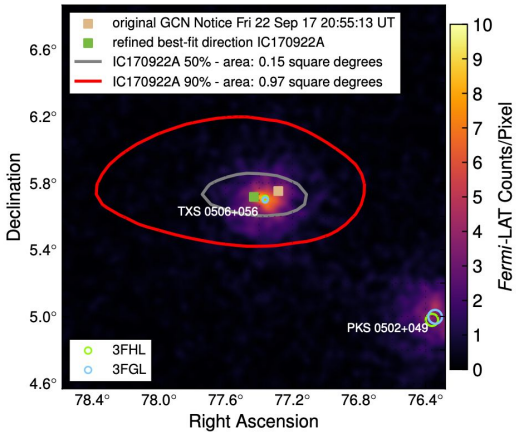
MM Results: IceCube 170922A

Neutrino 170922A, ~290 TeV

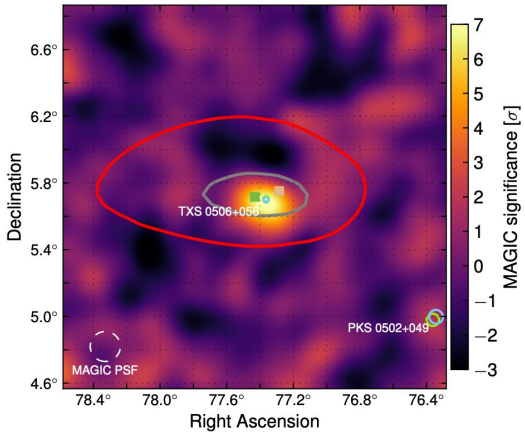


Coincident with TXS +0506 056 flaring at:

HE



VHE



The IceCube event 170922A had special coincidence with the AGN TXS +0506 056, which showed enhanced activity around that time both at HE (Fermi) and VHE (MAGIC)

Looking elsewhere and not strictly simultaneously → Association at 3σ

MM Results: IceCube 170922A

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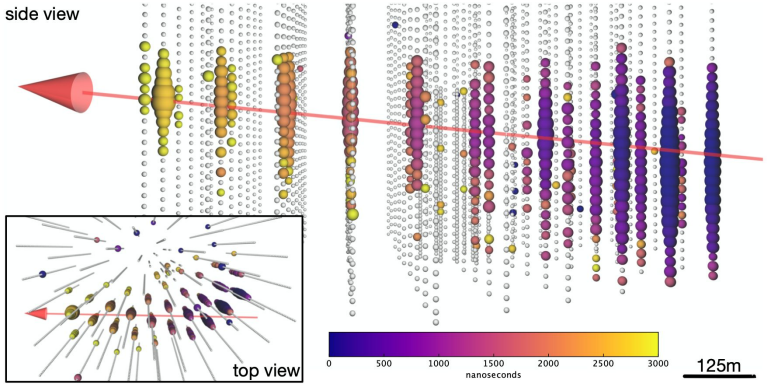
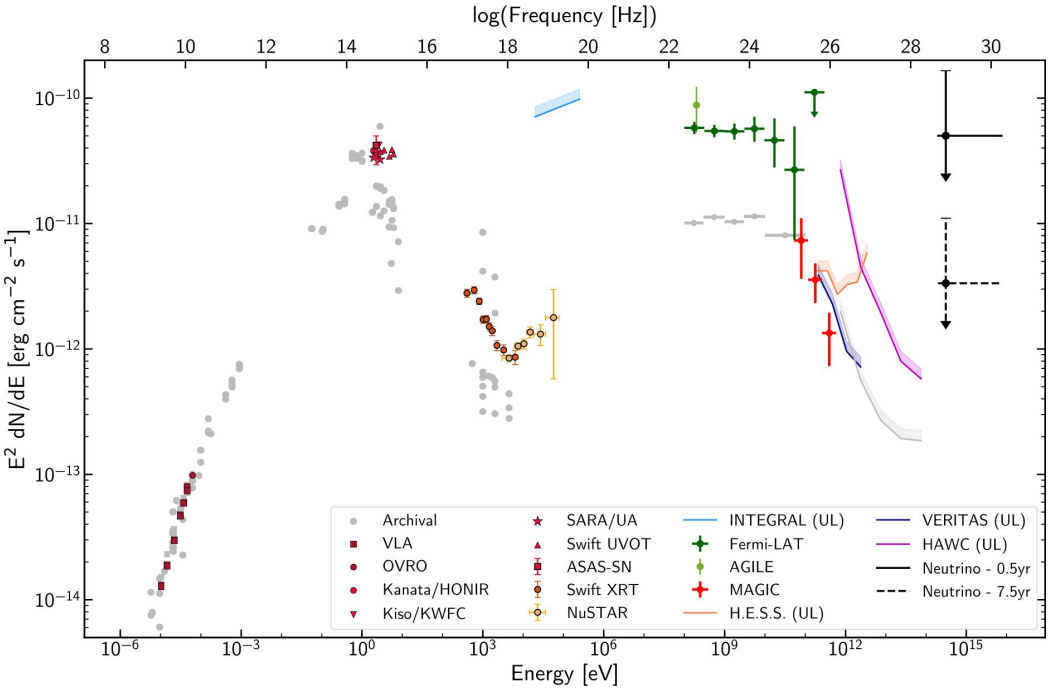
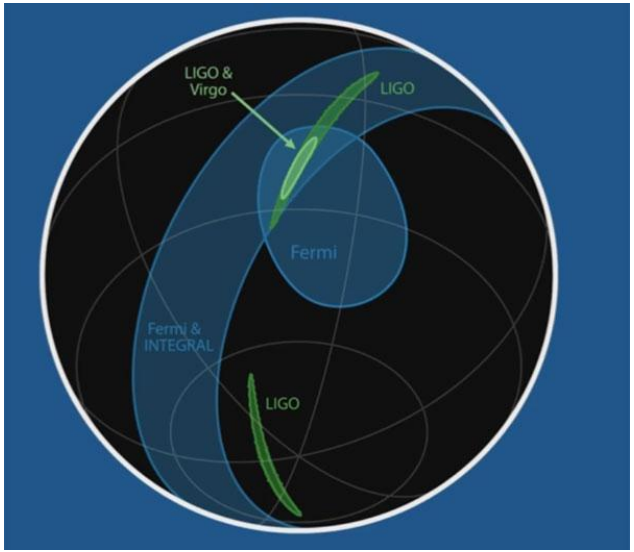
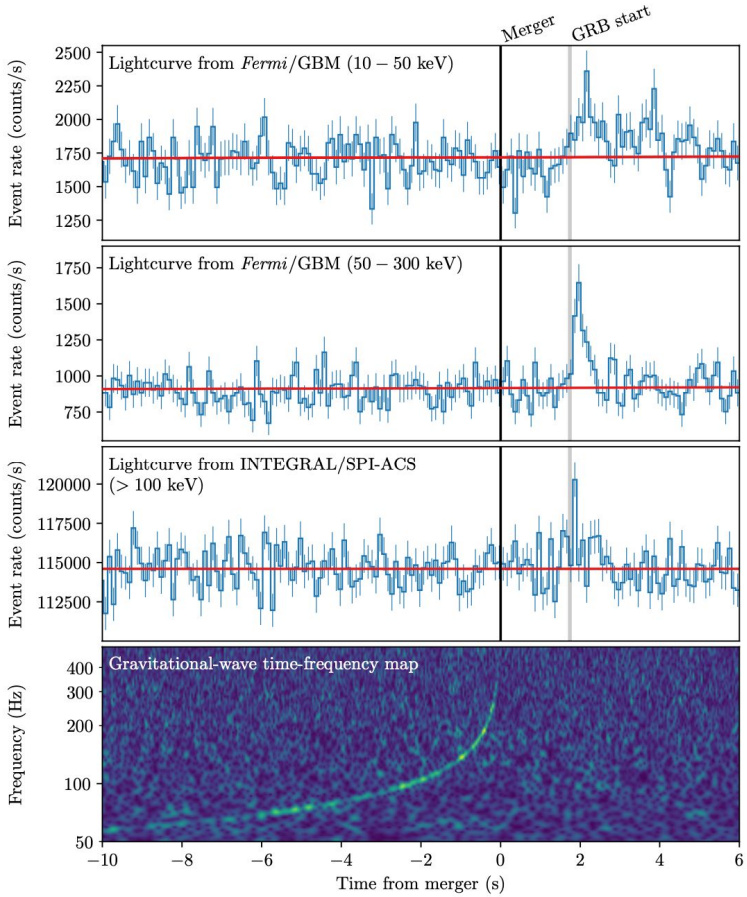




MWL is still instrumental to recover full SED and better understanding of mechanism in place → MM does not substitute MWL but adds to it

MM Results: GW170817 + GRB 170817A





Probability of change time and spatial coincidence ~5×10^{-8}

Confirmation of binary neutron star mergers as progenitors of short GRB

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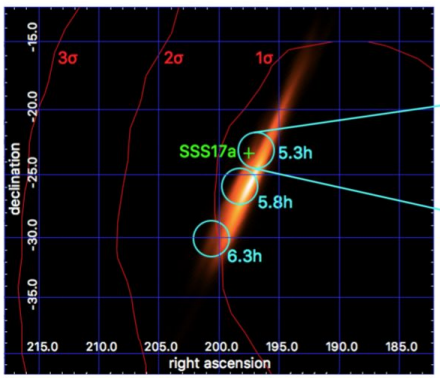

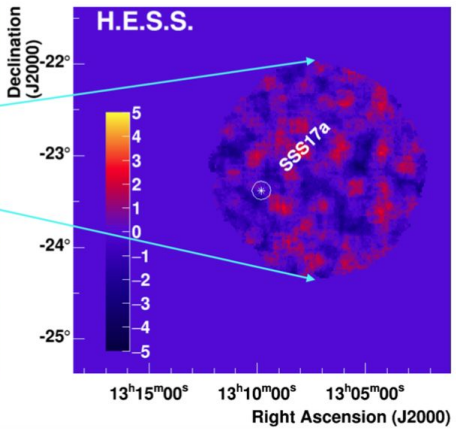

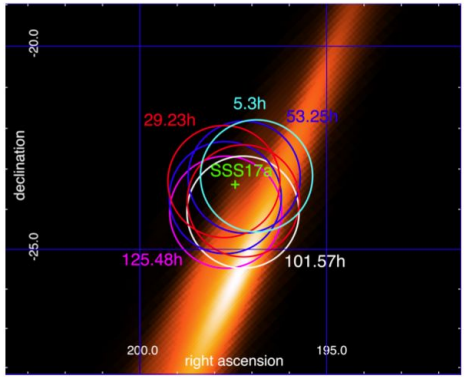

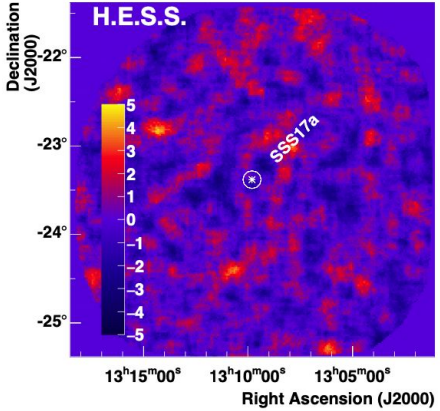

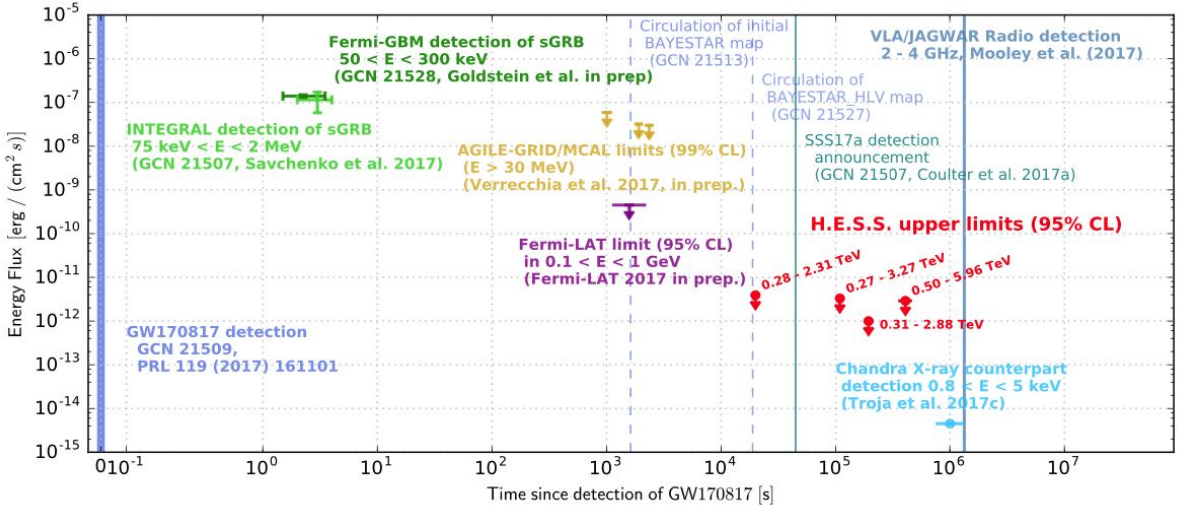

HE data from satellites (Fermi-LAT, AGILE)

Follow up at VHE (HESS)

- Fast after short GRB
- Extended after optical transient SSS17a announcement.

Again both MM and MWL coverage

Challenges for MM with gamma-rays

- IceCube 170922A and GW170817+GRB170817A were the smoking gun for MM and they had relevant gamma-ray (HE+VHE) contributions

BUT

- They were in 2017 and since then … nothing really relevant
- Multiple archival searches and follow ups of GW and Neutrinos with HE and VHE instruments without positive results

What is next?

- Improve strategy to follow up large regions of interests (and hope for better resolution in the alerts)
- Improve reaction time by common management of alerts ongoing both in the instruments and more global initiatives like Colibri or AMON (and hope for faster delivery of alerts)
- Improve treatment of additional information after initial alerts
- Be prepared for the start of CTAO with improved sensitivity at VHE

(And of course get another lucky year like 2017!!!)

Conclusion

We need: better **coordination** among messengers and wavelength, **common strategies** among messengers and wavelength, increased **exchange of information** among messengers and wavelength, facilitate **joint analysis** among messengers and wavelength

The gamma-ray community will benefit to get involved in Transnational and Virtual access

ACME is the ideal project in the right time

(... but we knew that when we proposed it …)

BACKUP

HESS Galactic Plan Survey