Effelsberg Newsletter

Volume 16, Issue 1 -January 2025

Contents

Greetings from the director

Dear colleagues,

It is with great sadness that we begin the New Year by mourning the loss of our colleague Karl Menten.

He died unexpectedly on 30 December 2024, at the age of 67. Karl's research covered a wide range of astrophysical topics, from the birth of stars to the end of their evolution, and from star formation in the Milky Way to the early universe. Early in his career he discovered a widespread methanol maser transition, the brightest of its kind, which has since been used as a signpost for the early stages of massive star formation, as well as a tool for high-precision astrometry.

Karl was a keen observer at Effelsberg and always pushed for it to be equipped with the best possible instruments. He made excellent use of them and also continued a long Bonn tradition of sky surveys. In addition to important surveys with APEX, he combined special surveys with Effelsberg and the Very Large Array in New Mexico to map the hot gas ionised by newly formed stars in massive star-forming regions and their surrounding molecular clouds, and the maser emission from protostars. We have lost not only a brilliant astronomer, but also a wonderful person and colleague.

May all of us use the 100m telescope as successfully as Karl did in his career. He will be greatly missed.

With this, I'd like to add my personal wishes to everyone for a healthy and peaceful 2025.

Michael Kramer

Call for proposals

Deadline Feb 4, 2025, UT 15.00

Observing proposals are invited for the Effelsberg 100-meter Radio Telescope of the Max Planck Institute for Radio Astronomy (MPIfR).

The Effelsberg telescope is one of the World's largest fully steerable instruments. This extreme-precision antenna is used exclusively for research in radio astronomy, both as a stand-alone instrument as well as for Very Long Baseline Interferometry (VLBI) experiments.

Access to the telescope is open to all qualified astronomers. Use of the instrument by scientists from outside the MPIfR is strongly encouraged. The institute can provide support and advice on project preparation, observation, and data analysis.
The directors of the institute make observing time available to applicants based on the recommendations of the Program Committee for Effelsberg (PKE), which judges the scientific merit (and technical feasibility) of the observing requests.

Information about the telescope, its receivers and backends and the Program Committee can be found at
http://www.mpifr-bonn.mpg.de/effelsberg/astronomers
(potential observers are especially encouraged to visit the wiki pages!).

Observing modes

Possible observing modes include spectral line, continuum, and pulsar observations as well as VLBI. Available backends are several FFT spectrometers (with up to 65536 channels per subband/polarization), a digital continuum backend, a number of polarimeters, several pulsar systems (coherent and incoherent dedispersion), and two VLBI terminals (dBBC and RDBE type with MK6 recorders). Furthermore, the new flexible, fully-digital backend system EDD ("Effelsberg Direct Digitization") is currently being implemented and will be available for an increasing number of observations in the near future.

Receiving systems cover the frequency range from 0.3 to 96 GHz. The actual availability of the receivers depends on technical circumstances and proposal pressure. For a description of the receivers see the wiki pages.

How to submit

Applicants should use the NorthStar proposal tool for preparation and submission of their observing requests. North Star is reachable at https://northstar.mpifr-bonn.mpg.de .

For VLBI proposals special rules apply. For proposals which request Effelsberg as part of the European VLBI Network (EVN) see:
http://www.evlbi.org/using-evn.

Information on proposals for the Global mm-VLBI network can be found at http://www3.mpifr-bonn.mpg.de/div/vlbi/globalmm/index.html .

Other proposals which ask for Effelsberg plus (an)other antenna(s) should be submitted twice, one to the MPIfR and a second to the institute(s) operating the other telescope(s) (eg. to NRAO for the VLBA).

Important Remarks

Please note, that the Effelsberg Programme Committee (PKE) is composed of several scientist with different backgrounds. It is hence advisable to write the proposals in a way that they could be understood by readers who are not working in the particular field.
Furthermore, it should be noted that all proposals are treated confidentially. Therefore, it is not necessary to withhold or obscure information, which on the contrary might lead to a downgrading of the proposal.

The following deadlines will be on on May 28th, 2025, and on September 29th, 2025.

ACME Transnational Access Programme

The ACME (“Astrophysics Centre for Multimessenger studies in Europe”) project (see https://www.radionet-org.eu/radionet/acme-project-started/) enables transnational access (TA) on the basis of scientific merit to a wide range of complementary astroparticle, high energy and astronomical Research Infrastructures to perform new science of multi-messenger astrophysics.

Transnational access to the 100-m telescope is provided to selected user-groups of one or more researchers, with the majority of the users working in EU and/or Associated Countries and not affiliated with German institutes. The access includes the logistical, technological and scientific support and the specific training. Additionally financial support for travel and accommodation could be offered for selected user(s).

Only user groups that are allowed to disseminate the results they have generated under this program may benefit from the access. Publications based on TA programme should be acknowledged accordingly:

This project has received funding from the European Union's Horizon Europe Research and innovation programme under Grant Agreement No 101131928 (ACME).

For more details, please contact the Effelsberg staff under sched100m@mpifr.de .

by Alex Kraus

ACME
Astrophysics Centre for
Multimessenger studies in Europe

News from the observatory

Renewal of the main axes drive control is finally going to finish

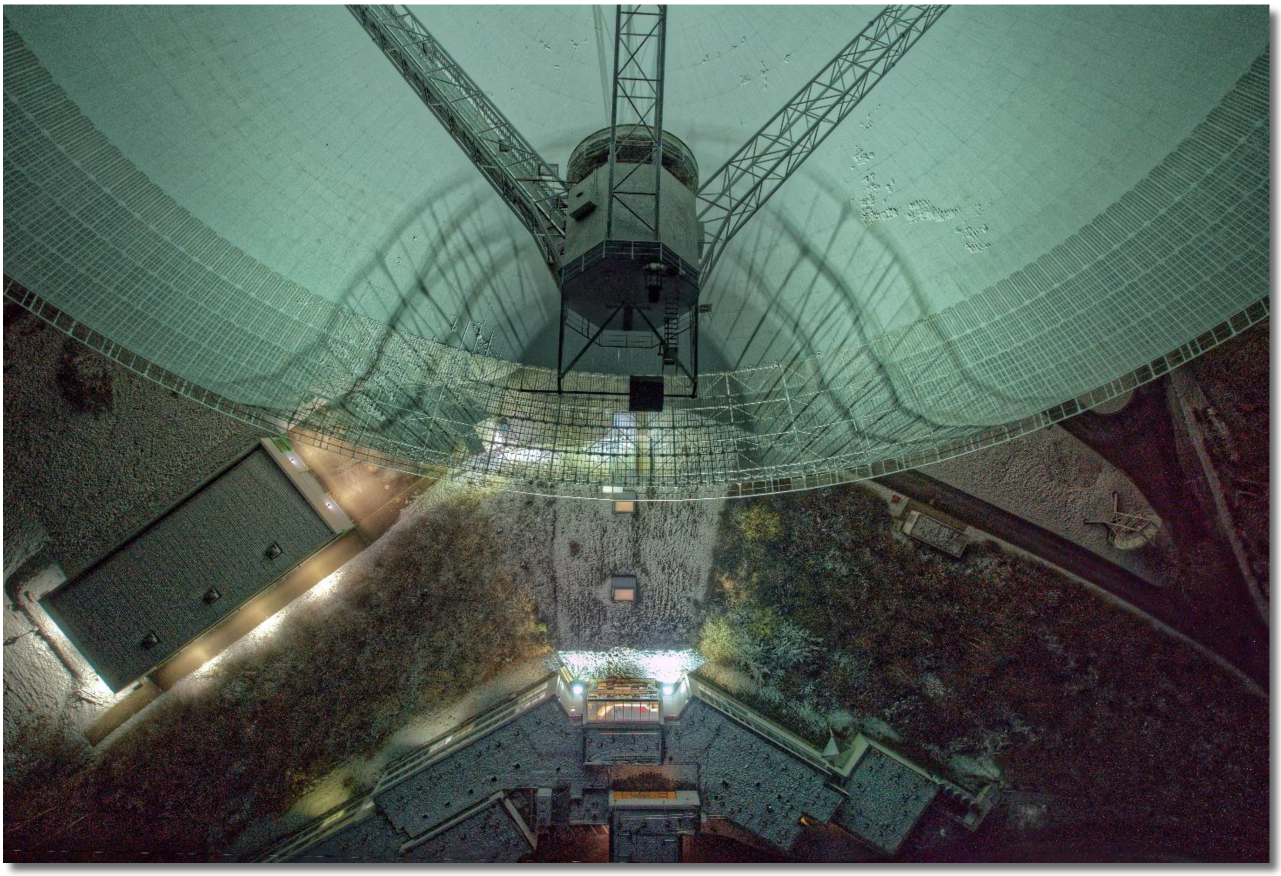
As reported earlier (issues 1/2023 and 2/2024 of this newsletter), we started a project to renovate the main axes drives of the 100-m telescope, including the power units and the corresponding control systems.

Last summer, the final act of the project started. Observations at the 100m-telescope ceased on June 24, 2024, and immediately afterwards, the exchange of the hardware started.

Unfortunately, due to a number of problems, the work was severely delayed. However, considerable progress has been made recently, and observations will likely re-start by the end of January.

We apologize for the long delay, and appreciate your patience!

A more detailed description about the changes made during the project will be given in the next issue of this newsletter.



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Professor Dr. Karl Martin Menten

03 October 1957 — 30 December 2024

January 02, 2025

On December 30, 2024, Professor Dr. Karl Martin Menten, Scientific Member of the Max Planck Society and Director at the Max Planck Institute for Radio Astronomy in Bonn, Germany, died at the age of 67.

Karl Menten's research spanned a wide range of astrophysical topics, from the birth of stars to their end of evolution, and star formation in the Milky Way to the Early Universe. Early on in his career, he discovered a widespread methanol maser transition, the brightest of its kind, that since then has been used as a signpost for the early stages of massive star formation but also as a tool for high precision astrometry.

Karl Menten studied Physics and Astronomy at the Rheinische Friedrich-Wilhelms-Universität in Bonn and earned his doctoral degree in 1987, with a dissertation on "Interstellar Methanol towards Galactic HII Regions". He worked as a postdoctoral research fellow at the Harvard College Observatory at the Harvard-Smithsonian Center for Astrophysics (CfA), Cambridge, MA, USA, later-on as radio astronomer and senior radio astronomer at the Smithsonian Astrophysical Observatory before he was appointed scientific member of the Max Planck Society and Director for Millimeter and Submillimeter Astronomy at the Max Planck Institute for Radio Astronomy in Bonn in 1996.

Menten's groundbreaking career began with two transformative projects during his postdoctoral years. He led the discovery of seven sub-millimeter water vapor maser transitions, including isotopic lines, documented in five landmark papers. These discoveries opened the field of sub-millimeter maser astronomy and advanced the theoretical understanding of radiative transfer in such environments.

His discovery of the 6.7 GHz methanol maser remains one of molecular astronomy's most significant breakthroughs. Methanol masers, intensely bright and prevalent in high-mass star-forming regions, are critical for identifying massive young stellar objects and performing high-precision astrometry. Menten's VLBI imaging revealed their pivotal role in probing galactic structure and dynamics.

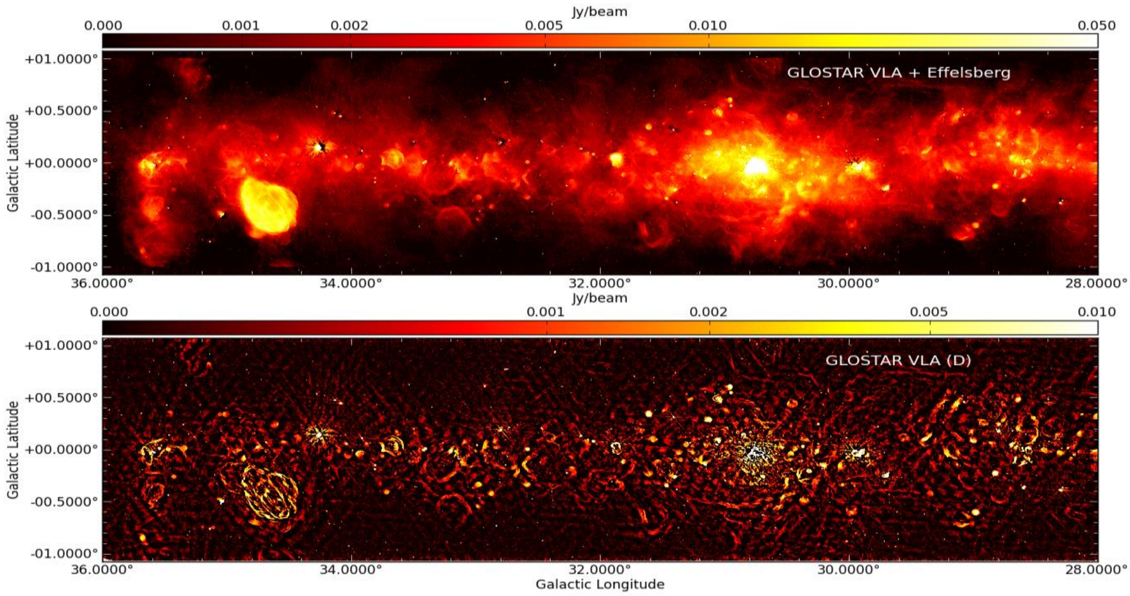
In 2010, Karl Menten co-founded the Bar and Spiral Structure Legacy (BeSSeL) Survey with Mark Reid, mapping over 150 methanol maser sources with trigonometric parallaxes accurate to ±10 microarcseconds. BeSSeL confirmed the Milky Way's four-armed spiral structure, refined the Sun's distance from the Galactic center to 8.15 kpc, and determined the Galaxy's rotation speed to 236 km/s. This work surpassed Gaia's capabilities in the Galactic plane and contributed to refining orbital decay measurements of the Hulse-Taylor binary pulsar.

His contributions to the study of the Galactic Centre have been equally transformative. He developed a calibration grid linking radio and infrared images with milliarcsecond precision using radio interferometry. This grid was used in the interpretation of the Nobel Prize-winning observations of stellar orbits around Sgr A* by Genzel and Ghez.

As director of the Max Planck Institute for Radio Astronomy, Karl Menten championed millimeter and submillimeter astronomy, driving the construction of the Atacama Pathfinder Experiment (APEX), which has yielded over 1000 peer-reviewed papers. He also secured European participation in ALMA, revolutionizing studies of molecular and dust emissions in galaxies and shaping our understanding of star formation and galaxy evolution across cosmic time.

He made important contributions to astrochemistry through his observations and initial discoveries of a large number of hydrides, the simplest building blocks of interstellar molecular chemistry. In addition to APEX, he also drove the construction of instruments for these studies at the Herschel Space Observatory and the Stratospheric Observatory for Infrared Astronomy (SOFIA).

He also continued a long Bonn tradition of sky surveys: the observations of cold dust and molecules in the Milky Way with APEX allowed a complete census and characterization of the massive star-forming regions and their surrounding molecular clouds. By combining the Effelsberg radio telescope and the Very Large Array in New Mexico, it was also possible to map the hot gas ionized by newly formed stars in these clouds, as well as the maser emission from protostars.



Brunthaler et al. 2021

Menten's stellar astrophysics contributions include determining the Orion Nebula's distance and studying red giants with masers near the Galactic center, advancing knowledge of stellar mass loss and interstellar medium enrichment.

By integrating observational, theoretical, and technological advancements, Menten has inspired a generation of scientists and revitalized radio astronomy. His unparalleled achievements made him a towering figure in modern astronomy.

Letters of condolence can be sent to condolence-Karl-Menten@mpifr.de

The Directors at the Max Planck Institute for Radio Astronomy

Michael Kramer
Amélie Saintonge
J. Anton Zensus

M87's Powerful Jet Unleashes Rare Gamma-ray Outburst

Multi-wavelength Campaign with Effelsberg and mm-VLBI Arrays Reveals a High-energy Gamma-ray Flare

The shadow of the black hole in Messier 87 has been imaged by with global radio array telescopes over the last years. Joint campaigns have been coordinated annually ever since. An international team of researchers has just released the results of a large campaign on M87 of Event Horizon Telescope and Global mm-VLBI Array observations in 2018, involving over twenty-five ground-based and space-based telescopes. The team, including a number of researchers from the Max Planck Institute for Radio Astronomy in Bonn, Germany, report a spectacular flare at multiple wavelengths from the powerful relativistic jet emanating from the very centre of the same galaxy. This study reveals the first observation in over a decade of a high-energy gamma-ray flare. Photons up to thousands of billions of times the energy of visible light from the supermassive black hole M87* were detected after obtaining nearly simultaneous spectra of that galaxy with the broadest wavelength coverage ever collected.

The results are published in Astronomy & Astrophysics. Vol. 682, A140, 2024

Millimetre VLBI facilities, represented by two arrays, the Event Horizon Telescope (EHT) and the Global mm-VLBI Array (GMVA), the latter coordinated by the Max Planck Institute for Radio Astronomy (MPIfR), are global networks of radio telescopes regularly interconnected to observe the innermost structures of galactic nuclei and to image the shadows of supermassive black holes.

"*We were fortunate to detect a gamma-ray flare from M87 during the EHT's multi-wavelength campaign—the first such event in over a decade*," says Giacomo Principe, publication coordinator and researcher at the University of Trieste. "*This rare event allowed us to pinpoint the region producing the gamma-ray emission. Recent and upcoming observations with a more sensitive EHT array will provide critical insights into the physics around M87's supermassive black hole, exploring the disk-jet connection and the origins of gamma-ray photons.*"

Messier 87, also known as Virgo A or NGC 4486, is the brightest object in the Virgo cluster of galaxies, the largest gravitationally bound type of structure in the universe. The relativistic jet examined by the researchers is surprising in its extent, reaching sizes that exceed the black hole's event horizon by tens of millions of times (7 orders of magnitude) - akin to the difference between the size of a bacterium and the largest known blue whale.

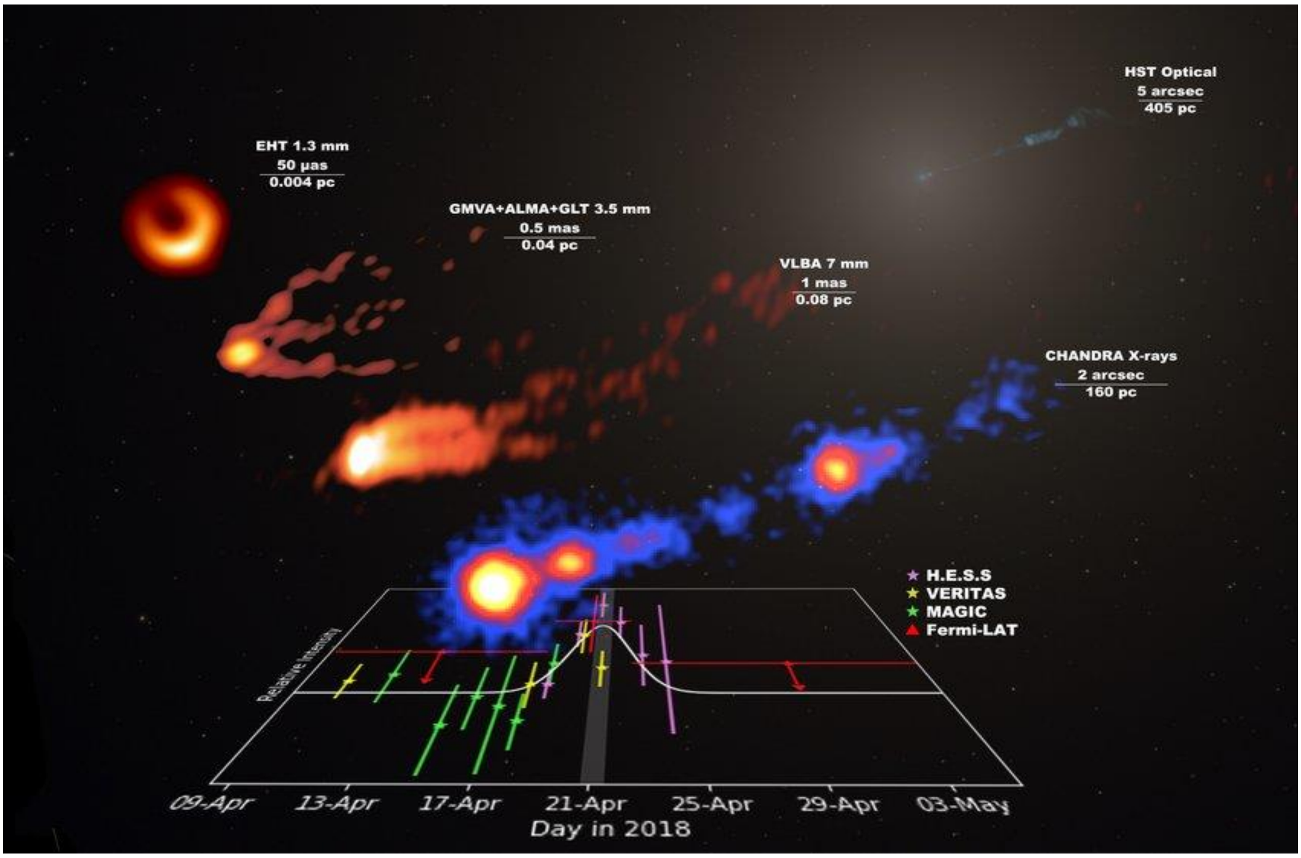


Fig. 1: *Light curve of the gamma-ray flare (bottom) and collection of quasi-simultaneously observed images of the M87 jet (top) at various scales obtained in radio and X-ray during the 2018 campaign. The telescopes, the wavelength observation range and scale are shown at the top right of each image.*

The energetic flare, which lasted approximately three days and suggests an emission region of less than three light-days in size (~170 AU, where 1 Astronomical Unit is the distance from the Sun to Earth), revealed a bright burst of high-energy emission—well above the energies typically detected by radio telescopes from the black hole region.

"*High-cadence very-high-energy gamma-ray observations during both a steady state and a rare short-term flare—the first in over a decade—were achieved through the collaboration of three imaging high-energy telescope arrays*", explains Alexander Hahn from the Max Planck Institute for Physics, a co-author of the study. "*Combined with simultaneous multi-wavelength data at lower energies, these observations offer crucial insights into the extreme processes powering these cosmic events.*"

During the campaign, the LAT instrument aboard the Fermi space observatory detected an increase in high-energy gamma-ray flux with energies up to billions of times greater than visible light. The satellites Chandra and NuSTAR then collected high-quality data in the X-ray band. Radio observations with VLBI arrays such as the GMVA, the Very Long Baseline Array (VLBA) and the East Asian VLBI Network (EAVN) show a relativistic jet and an apparent annual change in the jet's position angle within a few milliarcseconds of arc from the galaxy's core.

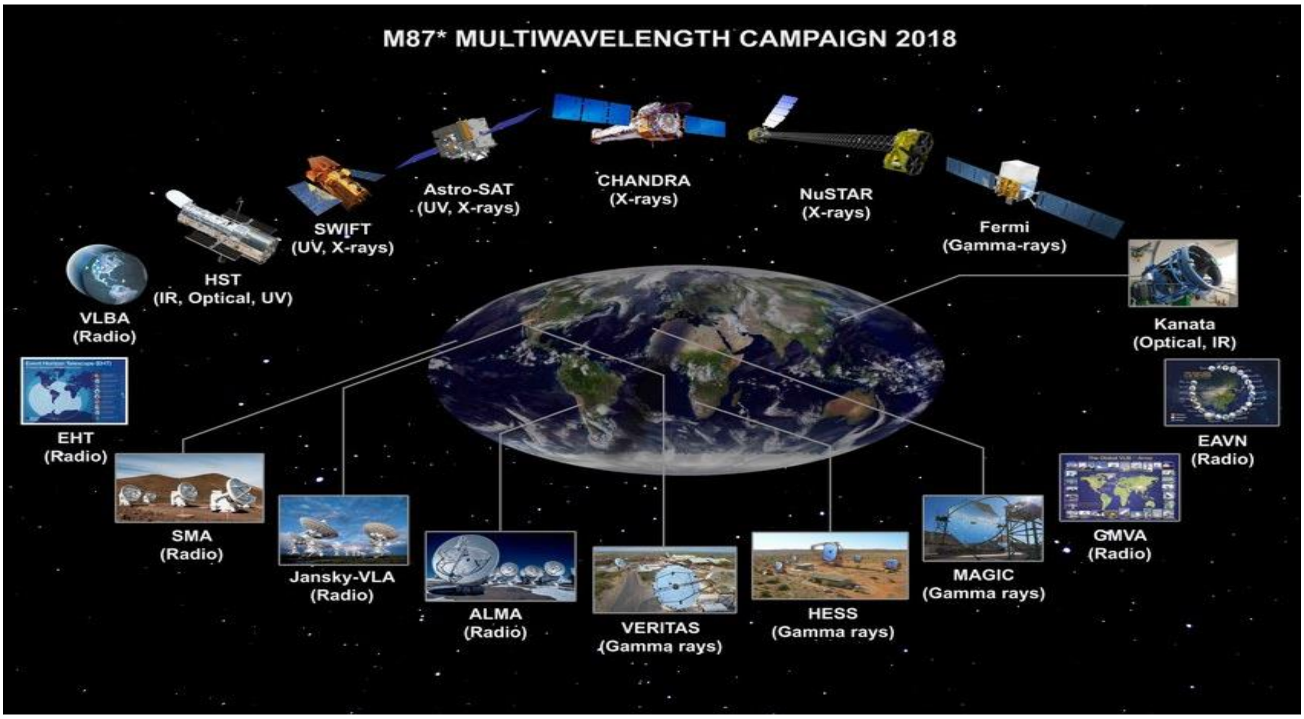


Fig. 2: *The observatories and telescopes that participated in the 2018 multiband campaign to detect the high-energy gamma-ray flare from the M87* black hole.*

"*The radio imaging provides a unique perspective, allowing astronomers to track the structural and temporal evolution of the jet at unprecedented angular resolutions*", says Thomas Krichbaum of the MPIfR. "*In this campaign, radio data not only constrained the jet geometry but also served as a vital reference for correlating the gamma-ray emission with the relativistic jet dynamics.*"

Observations show changes in the position of the ring's asymmetry (the black hole's event horizon) and the jet's position. This suggests a physical link between these structures on very different scales. "*The first image from the 2017 observational campaign showed that the ring's emission was uneven, with brighter areas indicating asymmetries. Subsequent 2018 observations confirmed these findings, showing that the* *position angle of the asymmetry had shifted*”, says Daryl Haggard, professor at McGill University and co-coordinator of the EHT multi-wavelength working group.

This is a prime example of how radio observations of the most violent objects in the Universe are complemented by high-energy telescopes like those used in this major campaign. The MPIfR participates in this effort with observations performed with the GMVA and the EHT. These radio data were, among other, postprocessed at the MPIfR correlator facility in Bonn. MPIfR radio telescopes participating in these arrays are the 100-m telescope in Effelsberg and the 12-m APEX telescope in Chile. The 30-m IRAM telescope in Pico Veleta, Spain, recently complemented by the IRAM/NOEMA telescope array in the French Alps, added substantial sensitivity to these observations.

“*This observing campaign produced the first image ever showing both the black hole shadow and the jet in M87, presented in April 2023, and now we see that new, exciting results are coming from the coordinated observations carried out around the second global EHT campaign*”, recalls Eduardo Ros, astronomer at the MPIfR and European scheduler of the GMVA.

J. Anton Zensus, director at the MPIfR and founding chair of the EHT collaboration, concludes: "*The contribution of cutting-edge technology in radio astronomy, in coordination with different facilities on Earth and beyond, shows here in a special way how multi-band studies of sources such as Messier 87 pave the way for stimulating future research and potential breakthroughs in understanding the Universe*".