NEWSLETTER

Edition 55
January 2020

EUROPEAN VLBI NETWORK

JIVE
Joint Institute for VLBI ERIC

CALL FOR PROPOSALS - FEBRUARY 2020

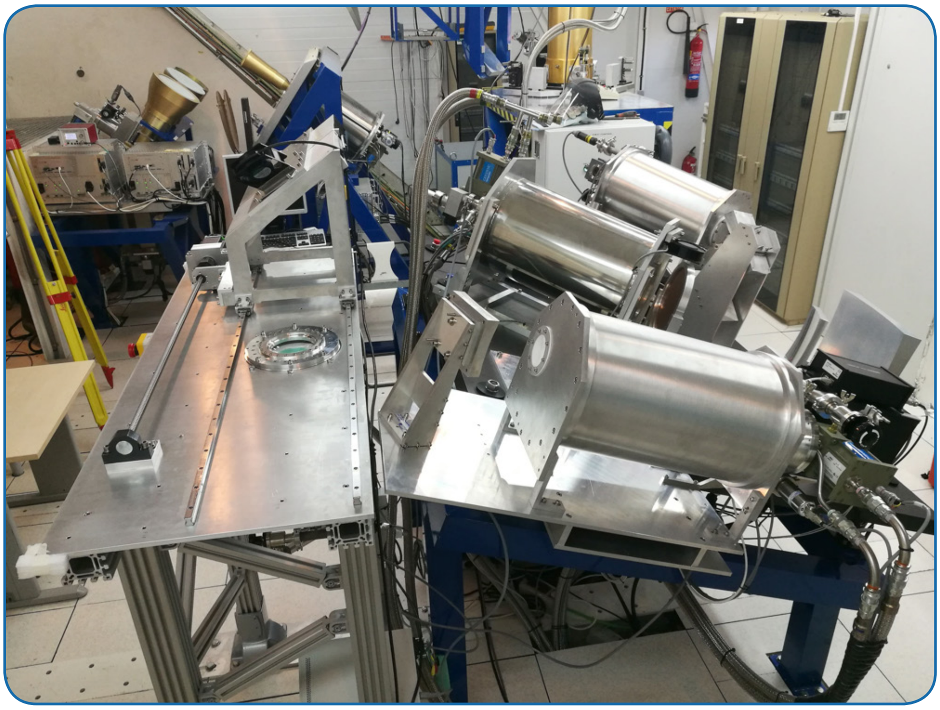
DEADLINE: 01 FEBRUARY 2020, 23:59:59 UTC

Mysterious Fast Radio Bursts

Telescopes in the European VLBI Network (EVN) have observed a repeating Fast Radio Burst (FRB) in a spiral galaxy similar to our own. This FRB is the closest to Earth ever localised and was found in a radically different environment to previous studies. The discovery, once again, changes researchers' assumptions on the origins of these mysterious extragalactic events.

New high-frequency receivers at Yebes 40-m radio telescope

At the beginning of last year, the IGN Yebes Observatory in Spain installed new K band (21-24.5 GHz) downconverter with a broader bandwidth and replaced their Q (31.5-50.0 GHz) and W band (72-90.5 GHz) receivers. In its full configuration, the quasi-optical system comprises a set of three mirrors and two dichroic filters that allow simultaneous observing at three different bands.



WELCOME

Rafael Bachiller, Chairman of the European VLBI Network Consortium Board of Directors

Paco Colomer, Director of the Joint Institute for VLBI-ERIC

This first issue of the EVN/JIVE Newsletter in 2020 is a good place to reflect upon the past year, which has seen remarkable scientific and technical developments. Many exciting results have highlighted VLBI among peers and general public (including, but not only, the first image of the shadow of a black hole, facilitated by the know-how and participation of the EVN/JIVE community).

With the full integration of e-MERLIN into the regular EVN operations, including real time observations, a superb unique instrument is realized, and, for the first time, the data flow into JIVE cannot be accommodated by the current internet connections! (will be solved at the beginning of 2020).

The EVN/JIVE community starts the new year committed to continue producing excellent science while enhancing and advocating the potential of VLBI ("What can VLBI do for your research?"). The new EVN Science Vision document is being completed, and a technological roadmap will follow, which will take into account the new functionalities requested by the users, including more frequent and flexible modes of operation. These are challenges that can only be overcome by a mixture of expertise, very hard work, and lots of passion!

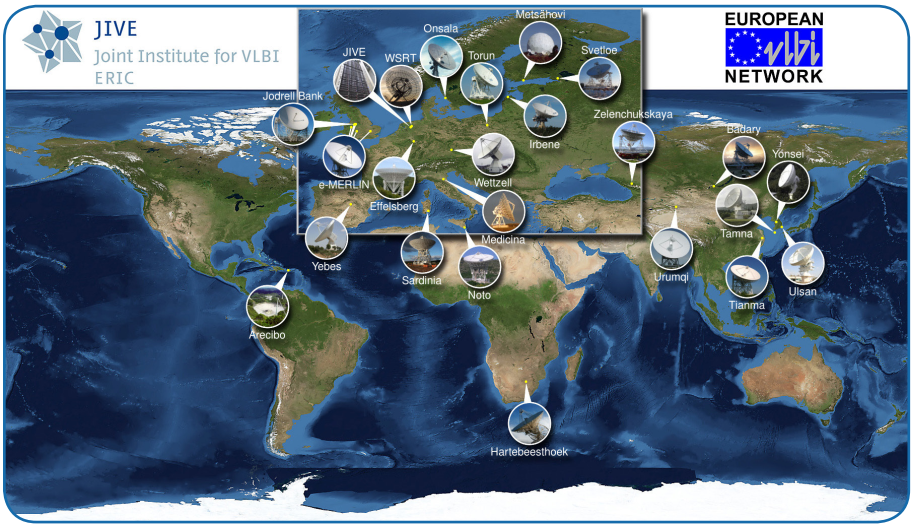
We look forward as well to continue growing the EVN and JIVE with new members, and collaborating with other VLBI arrays. A new 40-m radio telescope in Thailand will see its first light in 2020. Towards the development of a Global VLBI Alliance, it will be a great pleasure to meet users from around the world attending the 15th EVN Symposium in Cork, Ireland on 6-10 July, 2020. Registration will open soon!

Stay tuned to this newsletter. You will not regret it.

CALL FOR PROPOSALS

DEADLINE: 01 FEBRUARY 2020, 23:59:59 UTC

Details of the call: https://www.evlbi.org/call-proposals



The European VLBI Network. Image by Paul Boven (boven@jive.eu). Satellite image: Blue Marble Next Generation, courtesy of Nasa Visible Earth (visibleearth.nasa.gov).

Observing proposals are invited for the European VLBI Network (EVN). The EVN facility is open to all astronomers. Astronomers with limited or no VLBI experience are particularly encouraged to apply for observing time. Student proposals are judged favorably.
Support with proposal preparation, scheduling, correlation, data reduction and analysis can be requested from the Joint Institute for VLBI-ERIC (JIVE).
The EVN is a Very Long Baseline Interferometry (VLBI) network of radio telescopes operated by an international consortium of institutes. It is located primarily in Europe and Asia, with additional antennas in South Africa and Puerto Rico. The EVN provides very high sensitivity images at angular scales of (sub-)milliarcseconds in the radio domain. EVN proposals may also request joint e-MERLIN and EVN observations for an improved uv-coverage at short spacings, significantly increasing the largest detectable angular size to arcsecond scales. Further improvement of the uv-coverage may be achieved in global VLBI observations when the EVN observes jointly with National Radio Astronomy Observatory/Green Bank Observatory telescopes or with the Long Baseline Array.
EVN observations may be conducted with disk recording (standard) or in real-time correlation (e-VLBI). Standard EVN observations are available at wavelengths

of 92, 50, 30, 21/18, 13, 6, 5, 3.6, 1.3 and 0.7 cm. e-VLBI observations can be performed at 21/18, 6, 5, and 1.3 cm. e-MERLIN can be combined with the EVN in both standard and e-VLBI observations. Global observations are performed only with standard observations. Every year standard EVN observations occur during three sessions of approximately 21 days each and ten separate days are available for e-VLBI observations.
More information regarding the EVN capabilities, observing sessions, proposal guidelines, and user support can be found at www.evlbi.org.

Availability of EVN antennas

The three Quasar antennas of the Russian VLBI Network (Badary, Svetloe and Zelenchukskaya) are now available for e-VLBI. Their participation is planned for the 2020 e-VLBI days in March, April, September, November and December.
The Kunming 40 m telescope, operated by the Yunnan Astronomical Observatory, became a regular EVN station and can be requested for EVN disk-recording observations at 13, 6, 5 and 3.6 cm wavelengths.
The Arecibo Observatory is available for VLBI observations. However, severe flooding following Hurricane Maria, has caused a deformation of a localised area of the dish affecting its exact sphericity. This has resulted in a drop of Arecibo's high-frequency gain that can be quantified at 18 cm as an SEFD of ~3.1-3.5 Jy (cf. an SEFD of ~2.2-2.5 Jy normally expected for zenith angles less than 16 deg) and at 6 cm as an SEFD of ~7.3 Jy (cf. an expected SEFD of ~3.5 Jy between zenith angles 3 and 15 deg). Until readjustment of the dish surface will be realised, proposers should take the above SEFD values into account when writing a proposal.
The Tianma 65m telescope (Tm65) is located about 6 km away from the 25 m Seshan Itelescope (Sh). The 2-letter abbreviation for Tm65 telescope is T6. Both of these telescopes can observe at 18, 13, 6, 5 and 3.6 cm. Tm65 can also observe at 21, 1.3 and 0.7 cm. Tm65 is the default telescope; Sh will be used if Tm65 is not available. If both telescopes are selected in the proposal, the motivation for the very short baseline has to be discussed.
The Korean VLBI Network (KVN) is an Associate Member of the EVN. KVN telescopes may be requested for EVN observations at 1.3 cm and 7 mm wavelengths. For more details regarding the KVN, see: https://radio.kasi.re.kr/kvn/main_kvn.php

Integration of e-MERLIN telescopes into the EVN

Integrated e-MERLIN + EVN observations are now available using up to five e-MERLIN outstations (Pi, Da, Kn, De, Cm) at 512 Mbps; in addition to the selected Jodrell Bank home station (Jb1 or Jb2).
It is essential that e-MERLIN+EVN proposals provide clear scientific/technical justification for the inclusion of e-MERLIN outstation telescopes, including why e-MERLIN outstation antennas are required for the delivery of the scientific goal. This is because in addition to EVN Programme Committee (PC) approval, the e-MERLIN outstation contribution has to be approved by the e-MERLIN Time Allocation Group (TAG). For e-MERLIN TAG approved projects e-MERLIN outstation data will then be available for full correlation with other EVN antennas at JIVE. Note that EVN proposals requesting only Jb1 or Jb2 are still considered as standard EVN proposals and will only require approval by the EVN PC.
The PI may request up to five outstation telescopes in dual polarization mode with a bandwidth of 64 MHz per polarization in addition to the e-MERLIN home station antenna at up to 1 Gbps depending on the observing wavelength (2 polarizations at 128 MHz bandwidth).
For further enquiries regarding e-MERLIN + EVN observations please see the e-MERLIN Contact Webpage, or alternatively email: vlbi@jb.man.ac.uk

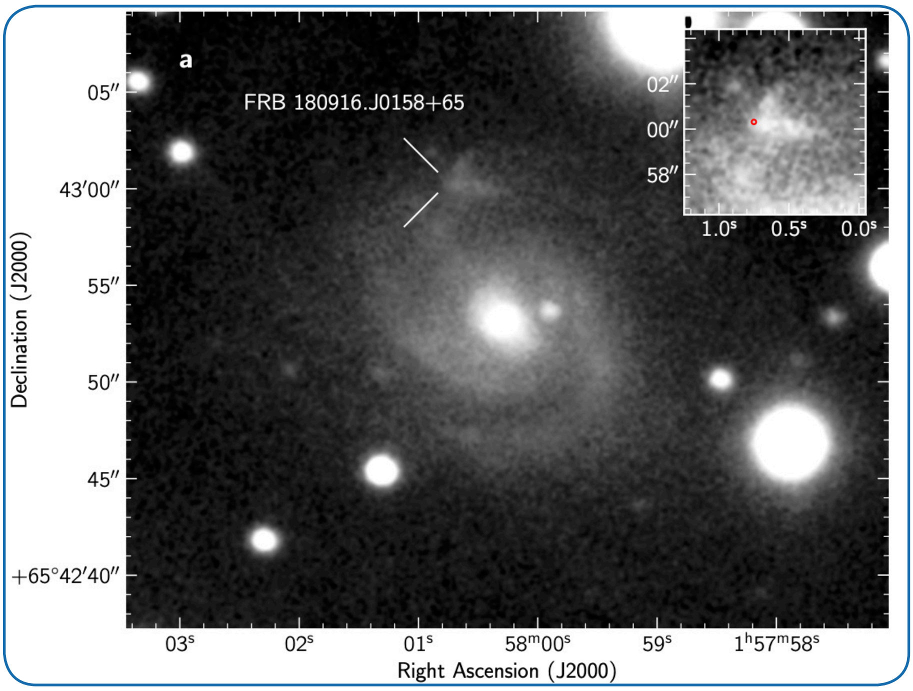
SCIENCE HIGHLIGHTS

A REPEATING FAST RADIO BURST FROM A SPIRAL GALAXY DEEPENS THE MYSTERY OF WHERE THESE SIGNALS ORIGINATE FROM

Benito Marcote, Joint Institute for VLBI-ERIC

Artist impression of all EVN antennas that participated in the observation plus the Gemini North used to obtain the optical data. The real image of the host galaxy of FRB 180916.J0158+65 appears in the sky. Credit: Danielle Futselaar (www.artsource.nl).

Telescopes in the European VLBI Network (EVN) have observed a repeating Fast Radio Burst (FRB) in a spiral galaxy similar to our own. This FRB is the closest to Earth ever localised and was found in a radically different environment to previous studies. The discovery, once again, changes researchers' assumptions on the origins of these mysterious extragalactic events. At this point in time, one of the greatest mysteries in astronomy is where short, dramatic bursts of radio light seen across the universe, known as Fast Radio Bursts (FRBs), are originating from. Although FRBs last for only a thousandth of a second, there are now hundreds of records of these enigmatic sources. However, from these records, the precise location is known for just four FRBs - they are said to be 'localised'. In 2017, one of these four sources was observed to repeat, with bursts originating from the same region in the sky, in a non-predictable way. This resulted in researchers drawing distinctions between FRBs where only a single burst of light was observed ('non-repeating') and those where multiple bursts of light were observed ('repeating'). The discovery of this FRB and its very particular and extreme environment inside a dwarf galaxy raised several questions, such as whether there was a fundamental difference between repeating and non-repeating FRBs. On 19th June 2019, eight telescopes from the European VLBI Network (EVN) simultaneously observed a radio source known as FRB 180916.J0158+65. This source was originally discovered in 2018 by the CHIME telescope in Canada, which enabled the team, led by Marcote, to conduct a very high resolution observation with the EVN in the direction of FRB 180916.J0158+65. During five and a half hours of observations the researchers detected four bursts, each lasting for less than two thousandths of a second. The resolution reached through the combination of the telescopes across the globe, using a technique known as Very Long Baseline Interferometry (VLBI), meant that the bursts could be precisely localised to a region of approximately only seven light years across. With this location the team were able to conduct observations with one of the world's largest optical telescopes, the 8-m Gemini North on Mauna Kea in Hawaii. Examining the environment around the source revealed that the bursts originated from a spiral galaxy at redshift of ~0.0337, specifically, from the apex of a prominent v-shaped star-forming region. The found location is radically different from the previously located repeating FRB, but also different from all previously studied FRBs. The differences between repeating and non-repeating fast radio bursts are thus less clear, suggesting that these events may not be linked to a particular type of galaxy or environment. It may be that FRBs are produced in a large zoo of locations across the Universe and just require some specific conditions to be visible. While the current study casts doubt on previous assumptions, this FRB is the closest to Earth ever localised, allowing astronomers to study these events in unparalleled detail. Continued studies will unveil the conditions that result in the production of these mysterious flashes. More precise localizations of FRBs would, ultimately, allow astronomers to understand their origin.

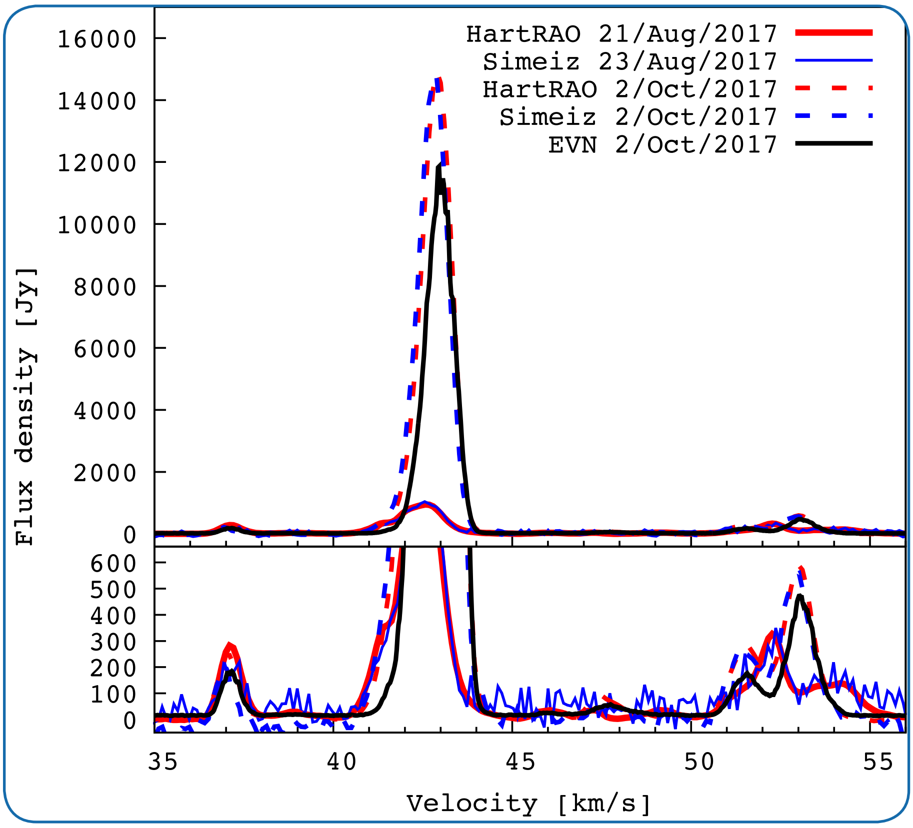


Optical image from Gemini North (r' band) of the host galaxy of FRB 180916J0158+65 and a zoom-in of the star-forming region from where the bursts arise. The location of FRB 180916.J0158+65 is highlighted by the white cross and the red circle. The uncertainty in the position of FRB 180916.J0158+65 derived from the EVN data is smaller than the resolution of the optical image.

Published in: Marcote et al. 2020

IMAGING A WATER MASER SUPERBURST

Ross Burns, National Astronomical Observatory of Japan, Japan



The scalar averaged, cross-power water maser spectrum measured with the EVN (solid, black line) is shown in comparison to single-dish spectra provided by the M2O on the same date (dashed red and blue lines), and (solid red and blue lines) pre-flare. The panel below highlights the low-flux density maser features.

In September 2017, during the IAU Symposium 336 "Astrophysical masers: Unlocking the mysteries of the Universe", reports surfaced of two water maser sources going "superburst". The Maser Monitoring Organisation (M2O), a team of astronomers led by Ross Burns (a JIVE support scientist at the time), conducted a rapid follow-up study to image the superburst in detail. Their findings clarify that the observed superburst was the result of a rare spatial alignment of two maser cloudlets.

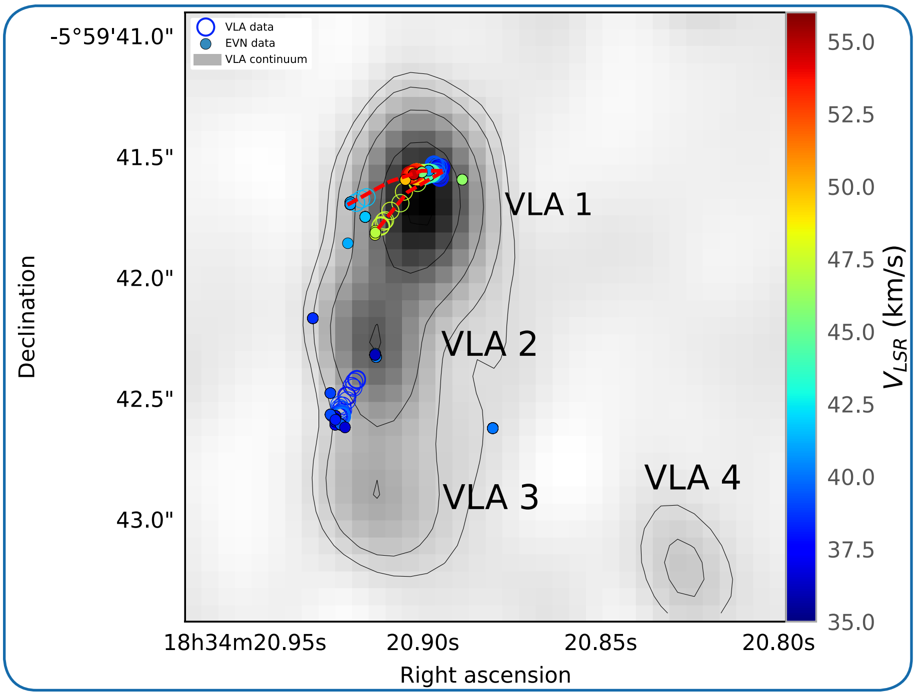
Masers are invaluable tools for the study of star formation. Their bright, compact emission outlines disks and bowshocks associated with the accretion and ejection structures of protostars, and can be used to derive accurate source distances via annual parallax measurements. However, while maser amplification has a well established theoretical background some aspects of astrophysical maser behaviors still defy firm explanation, referring in particular to their notoriously extreme variations in brightness. The superbursts detected with single-dish telescopes and reported during the IAU symposium 336 "Astrophysical masers: Unlocking the mysteries of the Universe", identified a sudden raising in brightness by several orders of magnitude in two maser sources, reaching flux densities of tens of thousands of Janskys (Jy). In an attempt to tease out the process by which such extreme variability can occur, a team of astronomers requested target-of-opportunity observations with the European VLBI Network (EVN) to image the superburst masers with milliarcsecond resolution.

A few days later electronic Very Long Baseline Interferometry (e-VLBI) spectral line observations were successfully conducted, with the observing session split across the two targets. The array contained both short and long baselines, comprised of Effelsberg, Jodrell Bank (MkII), Onsala (20 m), Torun, Yebes and Hartebeesthoek. By the scheduled date of the observations one of the superburst sources had already abated and rapidly returned to its pre-burst state, however, the other superburst source, a massive star forming region called G25.65+1.05, was still fully active at a flux density of almost 12,000 Jy.

The data revealed a complex distribution of maser emission, tracing two arcs presumably associated with shocks in a protostellar jet or outflow. The superburst maser was found to reside in one of the arc structures that comprised around seven other maser cloudlets which had not changed in their flux density. A comparison of the superburst flux density on the long and short EVN baselines revealed sub-milliarcsecond structure which aligned on the sky with two spatially separated regions of maser emission which flanked the position of the superburst.

The team concluded that the superburst maser had occurred as a result of a rare spatial alignment of two maser cloudlets along the observer's line of sight in which the background maser was subsequently amplified by the foreground maser. The two stage amplification lead to a spectacular surge in the measured flux density, most of which originating from a sub-milliarcsecond scale region.

Several weeks after the EVN observations the G25.65+1.05 water maser had returned to its quiescent phase, only to go superburst yet again, reaching a flux density of 130,000 Jy and making it one of the most powerful sources of maser emission in our Galaxy. The EVN investigation gleaned essential insights into the mechanism of action of the superburst class of maser sources, of which only two other maser sources are known.

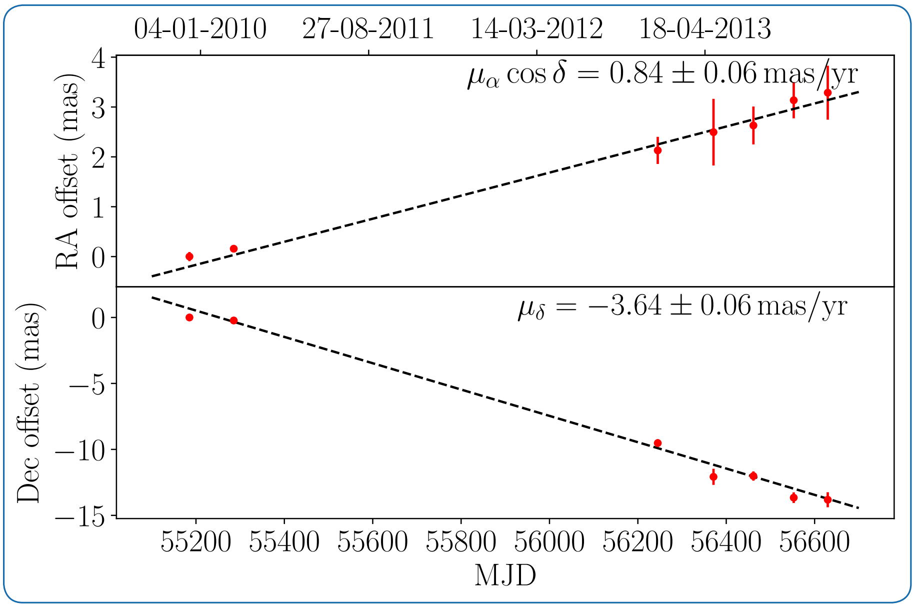


Visual summary of the water maser and 22 GHz continuum emission in G25, comparing results from this work with VLA data from Bayandina et al. (2019), taken on the 9th of December 2017, from which the continuum sources VLA 1, 2, 3, and 4 are labelled. Open circles indicate maser emission.

Published in: Burns et al. 2019

ASTROMETRY: A LOOK INTO BLACK HOLE BIRTH

Pikky Atri, International Centre for Radio Astronomy Research, Australia



Proper motion of Swift J1753.5-0127. The first two epochs were measured with the VLBA and the last five with the EVN.

The birth of stellar mass black holes can be unraveled by studying black hole X-ray binaries (BHXBs), a binary system of a star and a stellar mass black hole wherein the black hole is accreting matter from the star. Theoretical models suggest that black holes (BHs) are born when a massive star dies, either with or without a supernova (SN) explosion. When a compact object (e.g., black hole or neutron star) is born with a supernova explosion, we expect asymmetries in the explosion to give the remnant object a large recoil velocity. On the contrary, if the star collapses onto itself, without a SN, then the remnant BHXB does not incur large kick velocities.

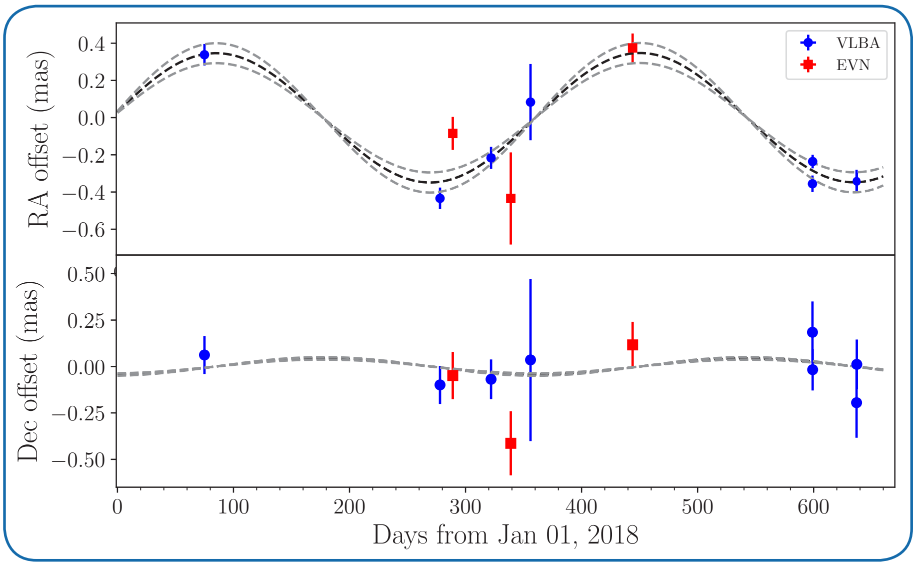
Studying and measuring the kick velocities of BHXBs gives us an insight into the final living moments of the massive star that gave birth to the black hole. Combining the proper motion with the systemic radial velocity and distance of the source enables us to measure the full three-dimensional motion of the system. Integrating the orbit of the BHXB back in time to the moment of birth can thus help us estimate the velocity of BHXB right after the BH was born.

BHXBs are usually faint, but sometimes go through a period of high activity (lasting months or years) and become bright at X-rays and radio wavelengths. We use this momentary brightness of BHXBs in the radio regime to pinpoint the system's location in our Galaxy and measure its proper motion. Typical BHXBs are a few kpc away and move a few milliarcseconds per year, and so Very Long Baseline Interferometry (VLBI) is essential for high precision astrometry of this order. The European VLBI Network (EVN) has been highly instrumental in conducting high precision astrometry of BHXBs and has aided the successful proper motion measurement of two BHXBs and the parallax of one.

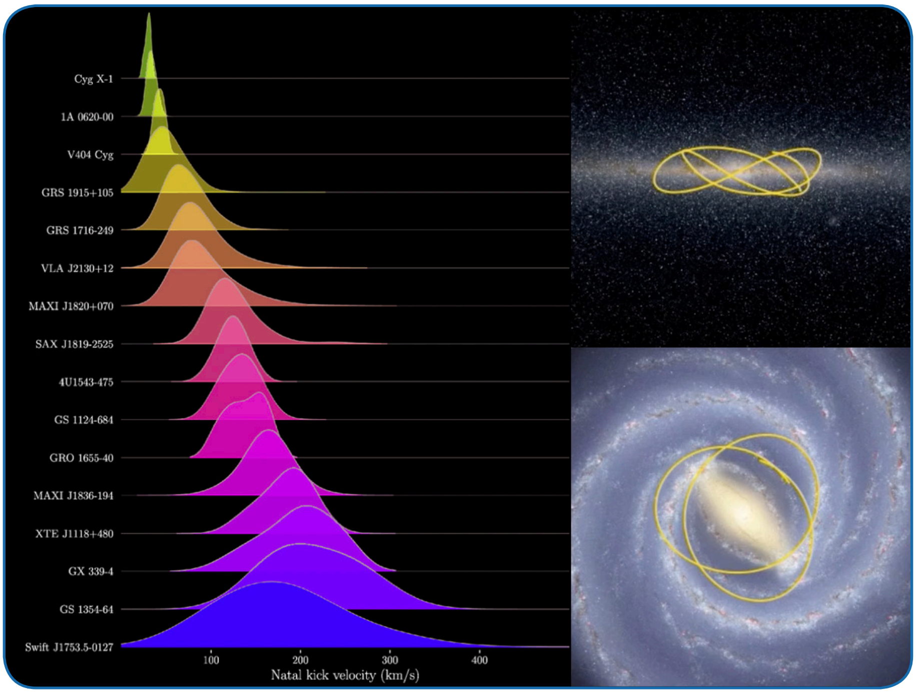
We used the EVN along with the Very Long Baseline Array (VLBA) to measure a highly precise proper motion of Swift J1753.5-0127 and MAXI J1820+070. We observed Swift J1753.5-0127 for five epochs separated by a few months for a long time baseline to obtain strong constraints on the proper motion. Combining this proper motion with the systemic radial velocity and the distance of the source we measured a kick velocity distribution with a median of 177^{+135}_{-103}

km/s, where the error bars are the 5th and 95th percentile. We suggest that this high velocity is because the BH was born with a SN explosion. We used these constraints along with measurements of 15 other systems to report the first observationally constrained BHXB kick distribution.

MAXI J1820+070 stayed bright for almost a year, thus enabling not only a proper motion measurement but also a highly precise 10σ parallax measurement of the source, improving the 3σ measurement obtained by Gaia. This gave a highly constrained distance to the source of 2.96±0.33 kpc. We used this newly constrained distance to obtain updated mass estimate of the BH in the system (9.5±1.4 solar masses) and also to obtain a kick velocity distribution (120^{+30}_{-25} km/s) that suggests the BH was born with a SN explosion in MAXI J1820+070.



Parallax measurement of MAXI J1820+070. The top and bottom panel show the offset of the object from the reference position after removing the proper motion.



Left: Kick velocity distribution of 16 black hole X-ray binary systems. Modelling all these distributions together we found an observationally constrained, best-fit distribution of the black hole X-ray binary population. Right: Edge-on-view (top) and face-on-view (bottom) of the Galaxy superposed with one realisation of Galactocentric orbit of Swift J1753.5-0127 (in yellow), a black hole X-ray binary system that reaches a height of ~2 kpc from the Galactic plane, suggesting that the system received a strong natal kick that put it in its current orbit.

Published in: Atri et al. 2019 and Atri et al. 2020

NETWORK HIGHLIGHTS

EVN/JIVE GLOBAL RELATIONS

Paco Colomer, Joint Institute for VLBI-ERIC

Participants in the 12th EAVN workshop (Mito, Japan).

The last quarter in 2019 has been very busy in establishing or reinforcing global relations for EVN and JIVE. On September 24-26, the 12th East Asian VLBI Network (EAVN) held its scientific workshop in Mito, Japan. The EAVN array is now operating with 10 stations (KaVA, Tianma, Nanshan and Nobeyama). The workshop gathered a vibrant community of more than 100 scientists primarily from Japan, China, Korea, but also Thailand, Malaysia, Indonesia, Australia, Europe, and USA. Many presentations of studies performed with EAVN/KaVA as well as by individual VLBI facilities (VERA, KVN, CVN, JVN), also in combination with European telescopes, highlighted various science topics including active galactic nuclei, star formation, evolved stars, astrometry, microquasars, pulsars, transients, multi-messenger science, as well as technological developments – many of interest to the European VLBI Network (EVN; SKA, EHT, KVN tri-band receiver, calibration, etc).

The workshop was an opportunity to present and discuss the concept of a Global VLBI Alliance, to foster communication and coordination among VLBI networks (and in particular EVN and EAVN) to exploit synergies, ensure maximum compatibility, potential joint observations, and prepare for common global challenges such as SKA-VLBI.

There were also other important meetings where the EVN was featured: the International Technical Advisory Committee (ITAC) for the 40-m NARIT radio telescope (see next article), and a workshop in Zolochiv (Ukraine) to assess a project to refurbish a decommissioned 32-m telecommunications antenna which could be used for radio astronomy. The concept is similar to others in Africa (AVN), Greece, Azores, or South America (IVIA).

NARIT AND JIVE SIGN A MEMORANDUM OF UNDERSTANDING

Phrudth Jaroenjittichai, National Astronomical Research Institute of Thailand, Thailand

Upper left: Signing of the NARIT-JIVE Memorandum of Understandung during the TNRO-ITAC 2019/2 meeting at Kantary Hills Chiang Mai Hotel, Chiang Mai, Thailand. Lower left and right: Status of construction of the 40-m Thai National Radio Telescope (TNRT) at the National Radio Observatory (TNRO), Chiang Mai, Thailand (November 2019).

The National Astronomical Research Institute of Thailand (NARIT) and the Joint Institute for VLBI-ERIC (JIVE) signed a Memorandum of Understanding in Chiang Mai, on November 7th 2019, to set the framework for a collaboration in scientific and technological development. JIVE Director Paco Colomer will become a member of the International Technical Advisory Committee for System Integration & VLBI Development of the Thai National Radio Observatory (TNRO-ITAC) and NARIT intends to become an associated member of EVN and JIVE.

The construction of a new 40-m Thai National Radio Telescope (TNRT) is very advanced. The instrument, being built by MT Mechatronics, is an upgraded version of the 40-m radio telescope at IGN Yebes Observatory (Spain). The prime focus facility has been designed to accommodate the L-band receiver and a future phased array feed. The TNRT operation frequencies will range from 300 MHz to 115 GHz (starting with L and K band), and it will include a strong VLBI component. First light for TNRT is expecting by the end of 2020.

THE SKA-VLBI WORKSHOP: THE WORLD'S EYE ON THE SKY

Zsolt Paragi, Joint Institute for VLBI-ERIC

Participants of the SKA-VLBI workshop

The SKA-VLBI Key Science Projects and Operations workshop gathered together 65 scientists from 18 different countries. These included both experienced researchers who have been developing very long baseline interferometry (VLBI) and/or the Square Kilometer Array (SKA) for many decades, and a great number of young people, some also from countries that have no VLBI facilities.

The first day of the workshop was devoted to the introduction of different aspects of the SKA Observatory, focusing on the VLBI capability and the portfolio of SKA-VLBI science cases recently compiled with the help of the SKA VLBI Science Working Group and coordinated and realized by the JUMPING JIVE project. The latest developments in the SKA project were presented by Phillip Diamond and Robert Braun, both from the SKA Organisation.

The rest of the workshop was organised into sessions focused on different science topics: active galactic nuclei, transient events, pulsars and fast radio bursts, stellar astrometry and prospects for SKA-VLBI including African telescopes. The main topics were selected in the areas of SKA high priority science objectives. The talks highlighted the need for very high angular resolution that can only be achieved by including the phase 1 SKA telescopes in VLBI arrays. It was agreed that simulations will be an important tool to demonstrate how to achieve the ambitious science goals. Anna Bonaldi from the SKA Science Team presented options about how to include VLBI in the SKA data challenges.

The discussion about how to realize SKA-VLBI Key Science Projects continued in four working groups based on the workshop's main science topics. The outcomes of the break-out sessions were presented on the last day of the workshop by the chairs. Some very interesting ideas emerged during these discussions. The possibility of achieving record relative astrometric precisions down to 1 microarcsecond was one of these. It was also argued that individual outrigger SKA antennas should be made available for VLBI together with the phased-up core, which would naturally provide the short spacings needed in support of VLBI imaging and calibration. The idea of piggy-backing some of the SKA1 surveys on SKA-VLBI observations (rather than the other way around) received much attention. And, of course, increasing the number of tied-array VLBI beams available in the SKA1 telescopes came up often.

The wrap-up of the workshop was presented by Richard Schilizzi, who summarised the various lessons learned from the European VLBI Network and other global initiatives and provided very good suggestions for harmonizing the VLBI world with the SKA. The workshop was a great success and a number of participants signed up for the SKA VLBI Science Working Group to contribute to the SKA-VLBI effort.

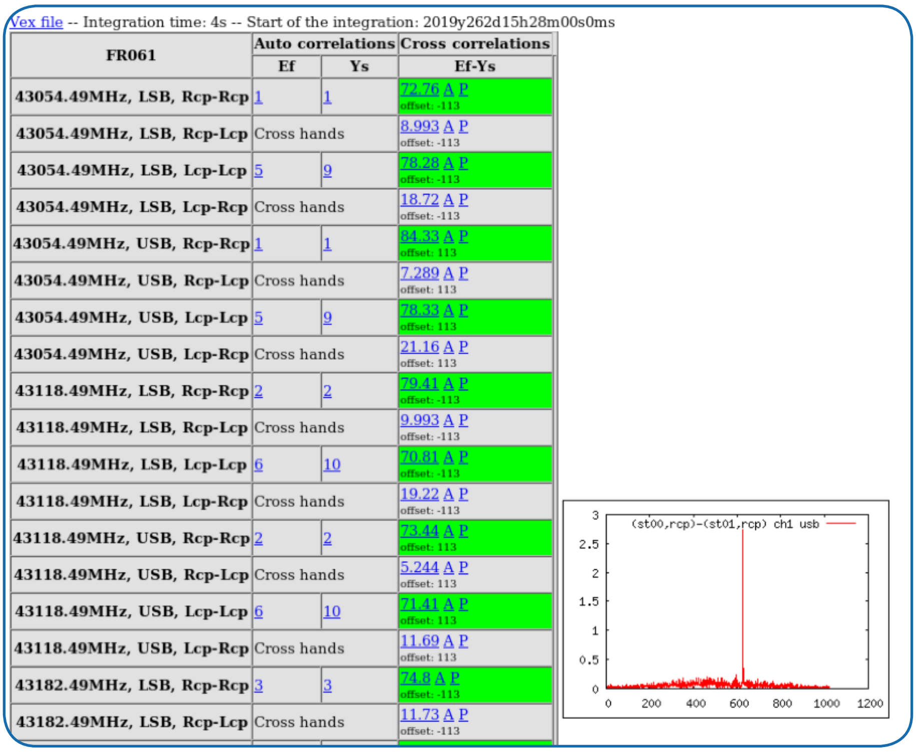
SKA-VLBI is supported by the European Union's Horizon 2020 research and innovation programme JUMPING JIVE [grant agreement No 730884] and the SKA VLBI Working Group. We thank the SKA Organization for making this event possible. Complementary support is acknowledged from RadioNet [grant agreement No 730562].

Stellar astrometry working group

TECHNICAL HIGHLIGHTS

NEW CAPABILITIES OF THE YEBES 40M RADIO TELESCOPE AT 22, 43 AND 86 GHZ OBSERVING FREQUENCIES

Javier González-García, Yebes Observatory, Spain



Vex file -- Integration time: 4s -- Start of the integration: 2019y262d15h28m00s0ms

FR061	Auto correlations		Cross correlations
	Ef	Ys	Ef-Ys
43054.49MHz, LSB, Rcp-Rcp	1	1	72.76 A P offset: -113
43054.49MHz, LSB, Rcp-Lcp	Cross hands		8.993 A P offset: -113
43054.49MHz, LSB, Lcp-Lcp	5	9	78.28 A P offset: -113
43054.49MHz, LSB, Lcp-Rcp	Cross hands		18.72 A P offset: -113
43054.49MHz, USB, Rcp-Rcp	1	1	84.33 A P offset: 113
43054.49MHz, USB, Rcp-Lcp	Cross hands		7.289 A P offset: 113
43054.49MHz, USB, Lcp-Lcp	5	9	78.33 A P offset: 113
43054.49MHz, USB, Lcp-Rcp	Cross hands		21.16 A P offset: 113
43118.49MHz, LSB, Rcp-Rcp	2	2	79.41 A P offset: -113
43118.49MHz, LSB, Rcp-Lcp	Cross hands		9.993 A P offset: -113
43118.49MHz, LSB, Lcp-Lcp	6	10	70.81 A P offset: -113
43118.49MHz, LSB, Lcp-Rcp	Cross hands		19.22 A P offset: -113
43118.49MHz, USB, Rcp-Rcp	2	2	73.44 A P offset: 113
43118.49MHz, USB, Rcp-Lcp	Cross hands		5.244 A P offset: 113
43118.49MHz, USB, Lcp-Lcp	6	10	71.41 A P offset: 113
43118.49MHz, USB, Lcp-Rcp	Cross hands		11.69 A P offset: 113
43182.49MHz, LSB, Rcp-Rcp	3	3	74.8 A P offset: -113
43182.49MHz, LSB, Rcp-Lcp	Cross hands		11.73 A P offset: -113

SFXC FTP fringe webpage showing fringes at 43 GHz between Yebes and Effelsberg. Credits: JIVE

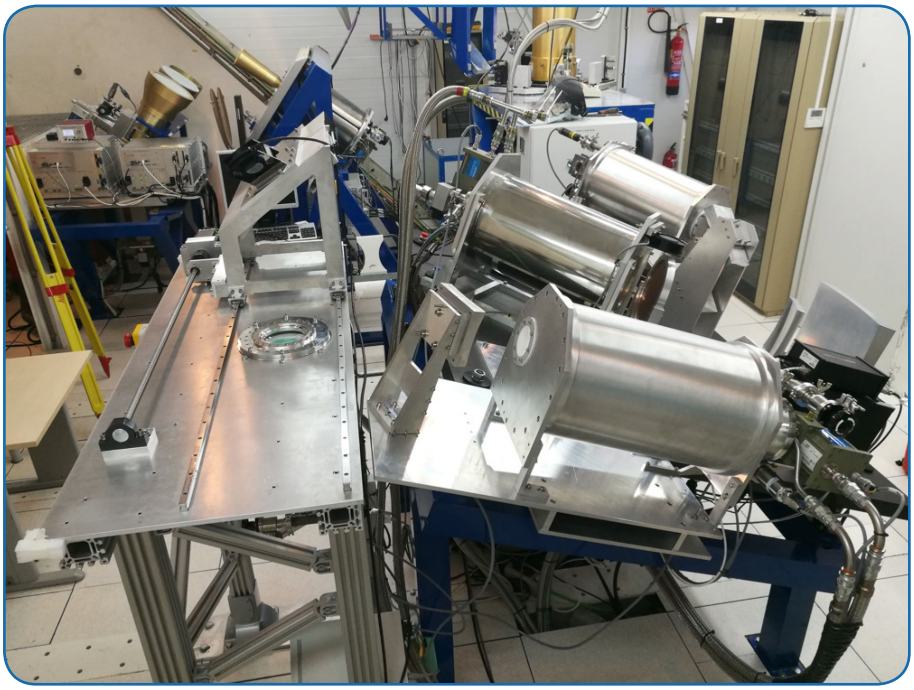
At the beginning of 2019, the Observatory of Yebes upgraded its high-frequency capability with the installation of a new K band downconverter with a broader bandwidth and the replacement of the Q and W band receivers. The three receivers (K, Q and W) are assembled on a quasi-optics table with a mirroring system. In its full configuration, the quasi-optical system comprises a set of three mirrors and two dichroic filters that allow simultaneous observations at three different bands. Currently, the system is in an intermediate stage with only two simultaneous receivers since the W filter is still being designed.

During 2019, the Q and W band receivers have been fine-tuned to optimize their main characteristics: noise temperature and gain stability. Each receiver has been validated both in single-dish and in VLBI observations. VLBI observations with the W band and the Q band receivers require a lambda quarter plate in front of the feed to convert from linear to circular polarizations. These plates, which are

optimized for narrow frequency bands, increase the noise temperature by 8 K approximately. When deployed in VLBI observations, both receivers use a downconverter unit, with an instantaneous bandwidth of 2 GHz centered at 42 GHz for the Q band receiver and 2.5 GHz tunable between 81.7 and 87 GHz for the W band receiver, respectively. The IF can be injected either into a DBBC2 unit or into a DBBC3 unit.
The W band receiver yielded its first fringes in a test with Effelsberg and Pico de Veleta in April and has successfully taken part in the Global mm VLBI Array (GMVA) fall session. The Q receiver also yielded fringes in its validation test in September on the Yebes-Effelsberg baseline. The K band receiver is regularly used in the EVN sessions. Regarding the simultaneous frequency observing mode, the KVN correlator found fringes on May 24th in a fringe-test experiment between the KVN network and Yebes, at a data rate of 4 Gbps with a setup of 2 x 512 MHz channels, one polarization per frequency band.
Future works include the installation of a dichroic low band pass filter that allows simultaneous observations of K, Q and W bands and the expansion of the K band receiver bandwidth to 18-26.5 GHz. We also plan the upgrade of our DBBC3 to have six modules that will allow the injection of six IFs simultaneously.

Band	Frequency span (GHz)	Instantaneous bandwidth (GHz)	Polarization	Trx (K)
K	21.0 - 24.5	2.5	Circular (RCP / LCP)	50
Q	31.5 – 50.0	18.5	Linear (H / V)*	50
W	72 - 90.5	18.5	Linear (H / V)*	60

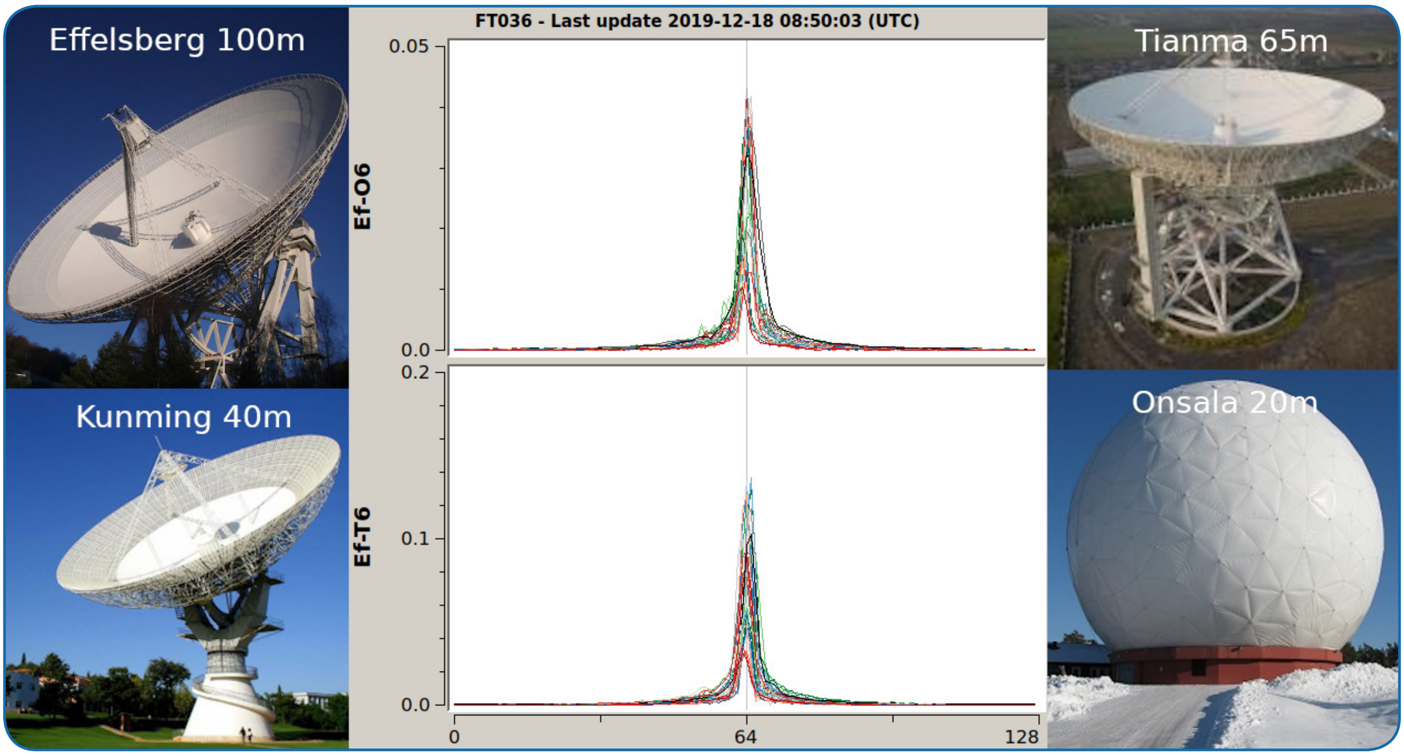
*Receiver characteristics. * A lambda quarter plate is available for narrow band observations, typically for VLBI observations.*



The high frequency receivers at the 40m RT receiver cabin. On the left, the hot and cold calibration system. The W band receiver is the one closer to the observer. The farther one is the Q band receiver and in between both, the K band one is located.

8 GBIT/S FRINGE TEST

Aard Keimpema, Joint Institute for VLBI-ERIC



Fringes between the stations Effelsberg (Ef), Onsala (O6), and Tianma65 (T6) together with pictures of all stations involved in the test. Note that there are no fringes to Kunming due to a recorder failure at the station.

On Friday, November 8th 2019, an important milestone was achieved by the European VLBI Network (EVN). For the very first time, the EVN performed a successful test observation at 8 Gbps data rate per station, giving a full 1 GHz of observing bandwidth using dual polarisations.

This test is an important step towards upgrading the EVN sensitivity. Compared to the current maximum data rate of 2 Gbps this new mode can potentially double the continuum sensitivity of the EVN especially at higher frequencies.

The observation involved the stations at Effelsberg (Germany), Kunming (China), Onsala (Sweden), and the Tianma65 antenna at Shanghai (China), which observed the strong calibrator source J1800+3848 at X-band. The observing bandwidth was split into 32 sub-bands of 64 MHz bandwidth each with dual circular polarisations being observed.

During the observation, short segments of data were transferred to the Joint Institute for VLBI-ERIC (JIVE) where they were correlated by support scientist Dhanya Nair to give near real-time feedback to the stations during the observation. After the test, all data was transferred to JIVE where it was analysed in full.

CRAF

COMMITTEE ON RADIO ASTRONOMY FREQUENCIES REPRESENTED THE EUROPEAN RADIO ASTRONOMY OBSERVATORIES IN THE ITU WORLD RADIOCOMMUNICATION CONFERENCE 2019

Waleed Madkour, Committee on Radio Astronomy Frequencies, Joint Institute for VLBI-ERIC

The Committee on Radio Astronomy Frequencies (CRAF), an expert committee of the European Science Foundation (ESF), participated in the International Telecommunication Union (ITU) World Radiocommunication Conference, WRC19, held in Sharm El-Sheikh, Egypt for four weeks from 28th of October to 22nd of November 2019. The conference was attended by a record number of more than 3500 participants from more than 190 ITU member states, in addition to sector members representing major telecommunication companies and scientific organizations. CRAF, as an ITU sector member, represented the European radio astronomy observatories through the CRAF Chairman Michael Lindqvist from Onsala Space Observatory in Sweden and the Frequency Manager Waleed Madkour hosted at JIVE in Dwingeloo, Netherlands. CRAF teamed up with other radio astronomy groups and sector members at the conference such as the scientific committee on frequency allocations for radio astronomy and space science (IUCAF) and the Square Kilometre Array Observatory (SKAO) to align the radio astronomy activities.

WRCs are held every four years to revise and review global radio regulations based on proposed new spectrum allocations to radiocommunication services. Since its recognition as a radiocommunication service by ITU in 1959, the Radio Astronomy Service (RAS) has been allocated multiple frequency bands for astronomical observations over the consecutive WRCs. While no additional frequency allocations for RAS were included in the WRC19 agenda, the protection of the existing allocations from harmful interference was the main objective for RAS at this conference.

The agenda items of WRC19 covered frequency allocations proposed for a wide range of radiocommunication services. On top of these is the new 5G frequency allocations identified by the conference in the bands 24.25–27.5 GHz, 37–43.5 GHz and 66–71 GHz. The compatibility studies carried out by CRAF and other RAS groups showed the potential interfering impact of these allocations on the RAS observations using the 23.6–24 GHz and 42.5–43.5 GHz bands. The studies recommended introducing separation zones around radio observatories away from the 5G services to mitigate interference. The final acts agreed by the conference invited the national administrations to take the necessary actions in order to protect the RAS observatories from potential interference expected from the 5G services.

The radio interference to the RAS 1612 MHz band by Iridium satellites for more than 21 years now was one of the complex issues discussed at the conference. The Iridium satellite services will start operating for the Global Maritime Distress and Safety System (GMDSS), a safety service that is primarily provided by Inmarsat. The service was alloted a limited allocation of 5 MHz in the band 1621.35–1626.5 MHz and prevented from an additional 5 MHz allocation down to 1616 MHz. The European position supported by the RAS group opposed the full allocation in order to keep the frequency separation between the two services as far as possible. Moreover, hard regulatory limits were added in the final acts to urge Iridium satellite services to keep the interference levels to the RAS band within the defined thresholds.

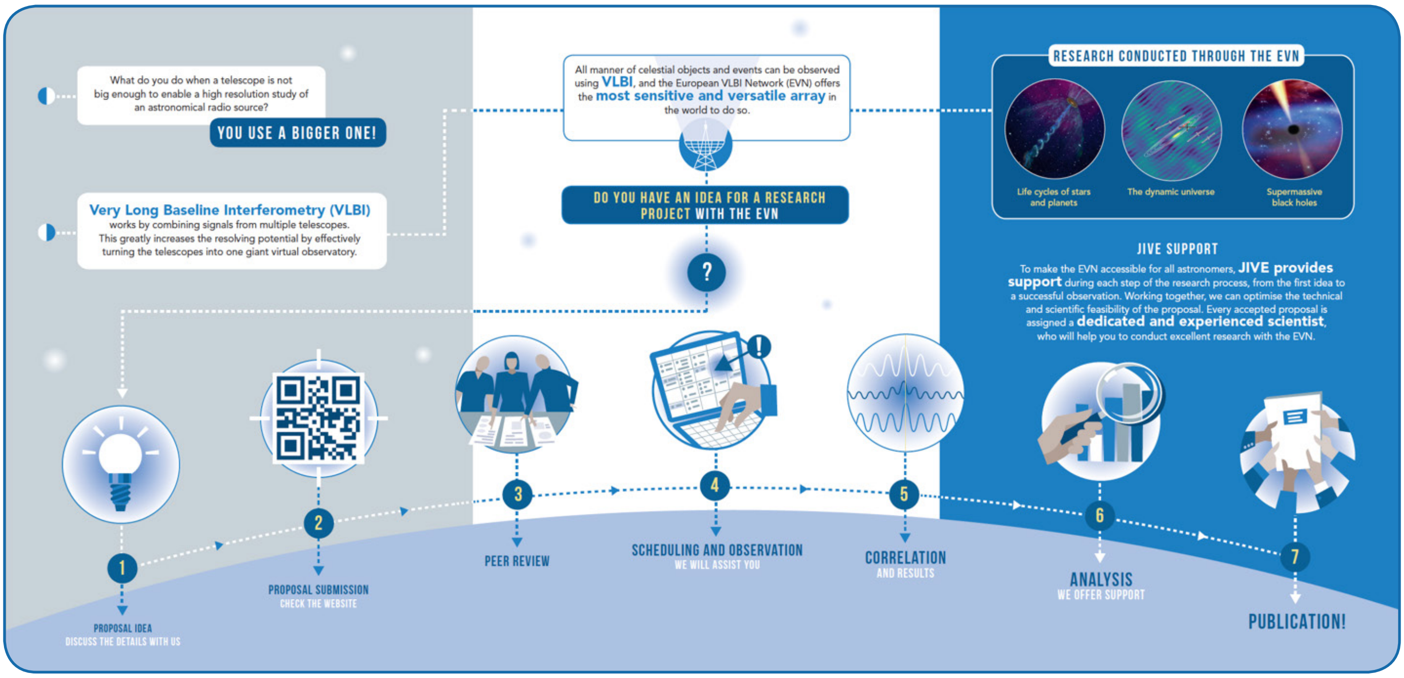
The conference concluded several frequency allocations and regulations for other emerging radiocommunication services such as the High Altitude Platform Systems (HAPS) and land mobile and fixed services above 275 GHz. The regulatory protection conditions for the impacted RAS frequencies was correspondingly added.

The overall results of WRC19 are satisfactory for CRAF and the RAS community in general. The agenda of the next world radiocommunication conference WRC23 was also approved at the end of the conference. It is now necessary for the radio astronomy observatories to closely coordinate with their national administrations in order to follow up with the WRC19 results and prepare for the next cycle towards WRC23.

CRAF Chairman Michael Lindqvist and Frequency Manager Waleed Madkour at WRC19.

JUMPING JIVE

Giuseppe Cimò, Joint Institute for VLBI-ERIC



How to VLBI: a brochure for non-VLBI astronomers.

With only one year remaining in the Horizon 2020 JUMPING JIVE project, it is time to look at the excellent effort of the past three years in Joining up Users for Maximizing the Profile, the Innovation and Necessary Globalization of JIVE (JUMPING JIVE).

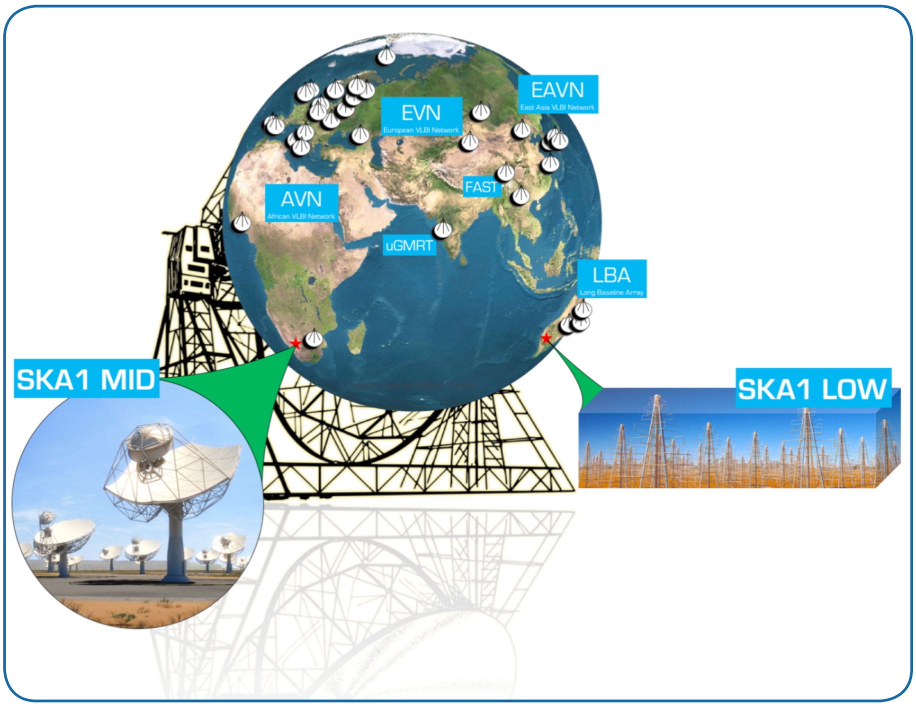
In order to maximize the JIVE profile, the project has worked on building new partnerships including the exploration of synergies and common challenges between JIVE and the International LOFAR Telescope. At the same time, JUMPING JIVE is exploiting the knowledge and the materials developed in the first three years to attract new partners and users. A clear example is the outreach and advocacy work that has produced a number of tools to introduce JIVE and the EVN to prospective users. In 2020, an European Astronomical Society (EAS) special session on "Registering the Universe at highest special accuracy", organized by JUMPING JIVE, will give us the opportunity to further advocate the EVN to non-VLBI astronomers. Brochures, banners and other promotional materials (pens, stickers, business cards) are available for all EVN institutes to use. Feel free to contact us at communications@jive.eu and the JUMPING JIVE outreach team will be happy to assist you.

JUMPING JIVE focused also on developing new capabilities for the EVN. A system for remote monitoring and controlling of radio telescopes was developed and is currently being tested. Also, new and old users can now use a python-friendly version of Sched. pySched (github.com/jive-vlbi/sched) is a re-factoring of the National Radio Astronomy Observatory's Sched software that uses modern python plotting modules and the possibility of adding python code to your key file. Another important work developed within JUMPING JIVE is the implementation of correlating geodetic observations with the JIVE software correlator (see issue 54 of the EVN newsletter).

We are in the era of multi-messenger astrophysics and new big astronomical facilities, such as the Square Kilometer Array (SKA), are coming online this decade. It is therefore important to look towards the future of VLBI. JUMPING JIVE has organized a very successful meeting at the SKA headquarters that gathered experts from around the world to discuss VLBI in the SKA era and the scientific cases of SKA as a VLBI element (see the full article in this EVN newsletter). Moreover, many activities have been carried out in Africa towards the development of VLBI expertise, communities, and infrastructures. Radio astronomy and VLBI schools in a number of African countries combined with training exchanges in Europe are contributing to develop VLBI in Africa, which will also help to fill the coverage gap in the era of SKA-VLBI. Finally, JUMPING JIVE is facilitating the work of VLBI experts in finalizing the scientific roadmap of VLBI in Europe, and globally, for the next decade.

JUMPING JIVE, with all its work-packages, partners and people, is looking forward to the challenging and exciting work of its last year as a project. Stay tuned for a year full of JUMPING JIVE results and achievements.

Left: JUMPING JIVE logo.
Right: Astronomers at work during the ASTRON-JIVE traineeship in Dwingeloo.



The VLBI landscape in the SKA era.

UPCOMING MEETINGS

- **EVN Technical and Operations Group & GMVA Technical Group meeting**: 5-6 May 2020, MPIfR, Bonn, Germany; https://events.mpifr-bonn.mpg.de/indico/event/144/
- **15th EVN symposium**: 6-10 July 2020, Cork, Ireland; https://www.ucc.ie/en/evn2020/

EVN OUTREACH WORKSHOP

PLANNED FOR APRIL 2020

Two days to explore existing communication between EVN institutes, hear lessons learnt from other networks and develop approaches to publicising scientific results obtained using the EVN.

For more information, please contact Gina Maffey (communications@jive.eu), Science Communication Officer at JIVE

Next Newsletter: May 2020

Contributions can be submitted until **10 April 2020**.

Newsletter edited by Katharina Immer, Support Scientist at JIVE (communications@jive.eu).

Follow JIVE/EVN on social media via: