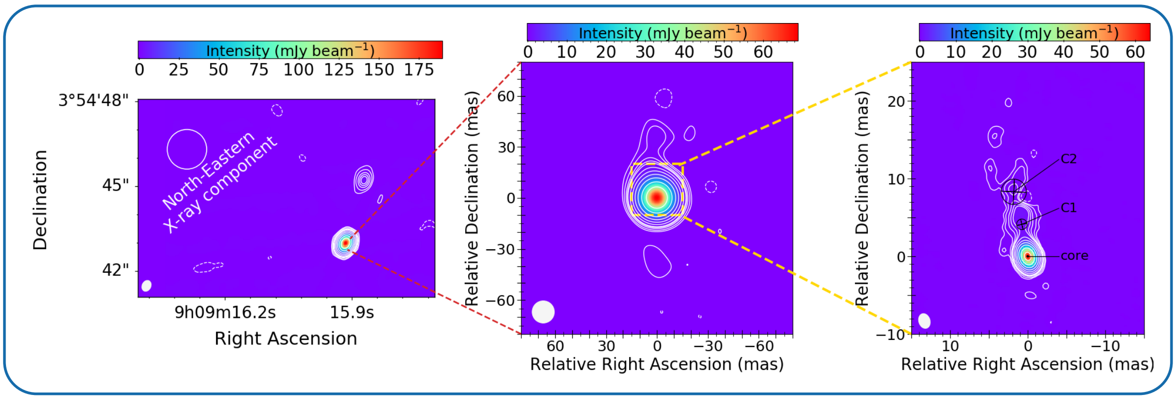
NEWSLETTER

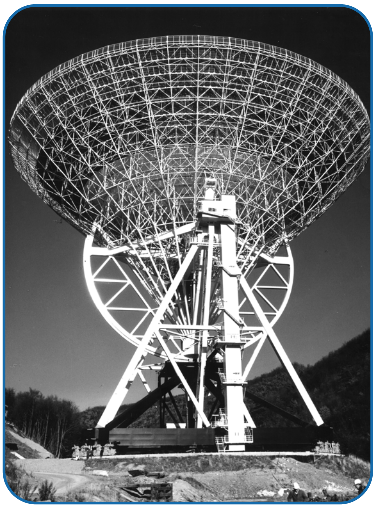
Edition 60
September 2021

CALL FOR PROPOSALS

DEADLINE: 1 OCTOBER 2021, 16:00:00 UTC



A multi-frequency view on the pc- and kpc-scale morphology of the high-redshift quasar J0909+0354



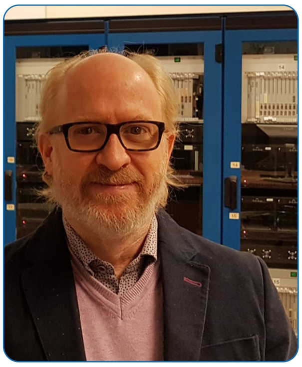
The Effelsberg Radio Telescope turns 50

A Unique EVN Symposium!

IN THIS ISSUE

WELCOME

Tiziana Venturi,
EVN Consortium Board of Directors Chair



Francisco "Paco" Colomer,
JIVE Director

Once the summer is over and many are back from a well deserved vacation, we welcome you to a new issue of the EVN Newsletter, highlighting the Call for Proposals to the EVN (with deadline October 1st), new scientific results on AGNs, SNe and FRBs, and the 50th anniversary of the MPIfR Effelsberg radio telescope, at the time of severe flooding which fortunately have not affected much the infrastructure; the area has however larger damage, and we send our support to all our colleagues and their families.

The EVN Mini Symposium and Users' meeting on 12-14 July (online) turned out to be a unique and very successful event, demonstrating that there is a strong and enthusiastic VLBI community eager to meet and discuss on VLBI science. We are looking forward to meet again face to face in July 2022 at Cork, Ireland.

VLBI was also present at the EAS conference at special session 11 on Extreme astrophysics at extremely high resolution, where close attention was paid to diversity. The continued presence of VLBI astronomy at large meetings is an excellent way to promote the work of JIVE and the unique capabilities of the EVN to a global audience. A full session on VLBI has also been organised at URSI 2021 in Rome, highlighting the relevance of VLBI in the fields of astrophysics, Earth and planetary sciences.

A special milestone is the conclusion of the EC Horizon2020 JUMPING JIVE project, aimed to strengthen JIVE, advocate its services and developments towards global VLBI, and enlarge its partnerships. We can look back of the past 4 years, and see the excellent work and the outstanding results while preparing the final review.

While the health situation is improving in Europe, still issues and unknowns remain. We thank our community for their resilience, producing excellent science even in these difficult times.

CALL FOR PROPOSALS

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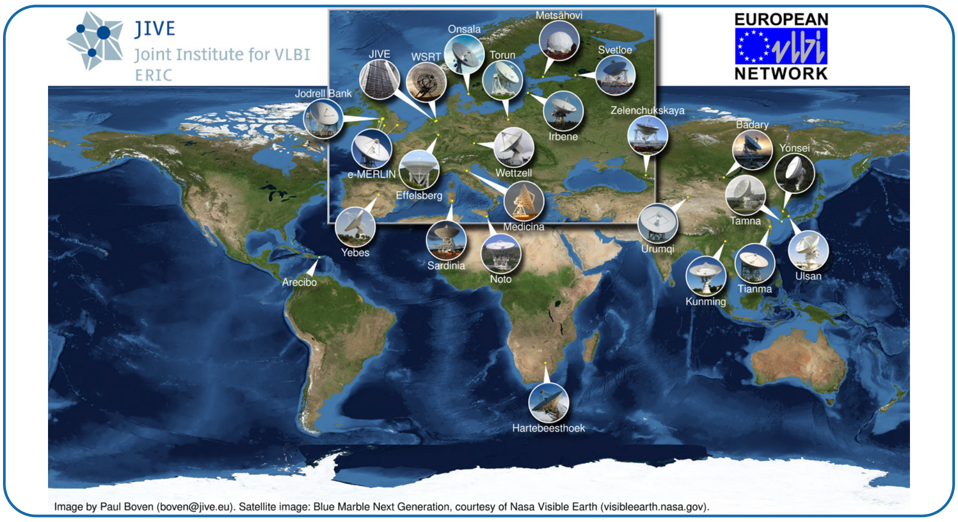
Details of the call: https://www.evlbi.org



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 NRAO/GBO telescopes or with the Long Baseline Array.

EVN observations may be conducted with disk recording (standard) or in **real-time correlation (e-VLBI), which guarantees a rapid turnaround**. Standard EVN observations are available at wavelengths of 92, 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 the EVN website.

Recording capabilities for the next standard EVN and e-VLBI Sessions
Disk recording at 2 Gbps is available at 6, 3.6, 1.3 and 0.7 cm; telescopes that cannot usefully reach this will use the highest possible bit-rate (mixed-mode observation). See the EVN 2 Gbps recording status page for up-to-date information.

Disk recording at 4 Gbps is now available at 6, 3.6, 1.3 and 0.7 cm for a subset of antennas for a limited amount of time and, on a best-effort basis for projects that may need it. Telescopes that cannot usefully reach this data rate will use the highest possible bit-rate (mixed-mode observation). See the EVN 4 Gbps recording status page for the latest updates.

e-VLBI at 2 Gbps is available at 6 cm and 1.3 cm; telescopes that cannot usefully reach this will use the highest possible bit-rate (mixed-mode observation). Network traffic or outages might also impose total bit-rate limitations on a particular e-VLBI day. The current status is given in the 'Operational modes' section in the EVN capabilities page.

Observations at 18/21 cm in either disk-recording or e-VLBI are limited to a data rate of 1 Gbps due to bandwidth limitations. The choice of data rate should be clearly justified in the proposal.

Availability of EVN antennas
The latest status of the EVN antennas can be found on http://www.evlbi.org/capabilities.

The **Sardinia Radio Telescope** will not be offered in the first semester of 2022 due to the planned upgrade at higher frequencies. When more information is available, this will be published at https://www.radiotelescopes.inaf.it/info.html.

The **Tianma 65m telescope** (Tm65) is located about 6 km away from the 25m 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 for some reason. If you select both, you should also discuss the motivation for the very short baseline in the proposal.

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: http://radio.kasi.re.kr/kvn/main_kvn.php.

User support and the Transnational Access Programme
Please contact the JIVE support scientists at usersupport@jive.eu in advance, if you need help with preparing your proposal. User support is available in all stages of preparations, observing and data reduction. Travel support through the Trans-National Access Programme returns starting on 1 March 2021 through the new OPTICON RadioNet Pilot project – see the EVN Travel support pages.

'EVN ideas mailbox'
Please share your ideas, comments and suggestions for improvement regarding, for example, the EVN programme possibilities, the observing capabilities, the availability of information online, and the utility of the EVN tools such as Northstar with the EVN PC Chair though this webform.

SCIENCE HIGHLIGHTS

A MULTI-FREQUENCY VIEW ON THE PC- AND KPC-SCALE MORPHOLOGY OF THE HIGH-REDSHIFT QUASAR J0909+0354

Krisztina Perger, Konkoly Observatory, ELKH CSFK, Hungary

Active galactic nuclei (i.e. accreting supermassive black holes in centres of galaxies) are powerful objects exhibiting strong emission at various wavebands. It is well established that radio emission originates from the synchrotron processes in a pair of relativistic jets. However, the origins of X-ray radiation are still under debate (e.g. self- or external inverse Compton scattering of the charged particles in the jet).

To date, imaging observations for less than twenty high-redshift ($z>3$) quasars are available with the 0.5″ resolution Chandra X-ray space telescope. The quasar PMN J0909+0354 (at $z=3.288$) is among this scarce sample. This quasar was known to have a double radio morphology at kiloparsec scales resolved with the Very Large Array (VLA): a compact core and a secondary component to the north-northwestern direction (NNW).

In the framework of pilot observations of high-redshift quasars with Chandra, apart from the two components coinciding with the radio structure, an additional X-ray-emitting region was identified towards the north-eastern direction (NE) with respect to the core. To uncover the relation between the three components, follow-up observations were conducted with Chandra (P.I.: D. Schwartz) in the 0.5-7 keV energy range, and with the European VLBI Network (EVN; P.I.: K. Perger) at 5 GHz. Additionally, archival global VLBI network, Very Long Baseline Array (VLBA), and VLA data sets were utilized in the study.

Fitting Gaussian model components to the visibility data of the milliarcsecond-resolution VLBI measurements resulted in multiple jet components on pc scales. The quasar core (i.e. the synchrotron self-absorbed base of the radio jet) shows ~30% flux density variability, and has brightness temperatures exceeding both the theoretical equipartition (5×10^{10} K) and the empirical (3×10^{10} K) limits, thus showing Doppler-boosted emission at all epochs of the VLBI observations (Doppler factor $\delta>2$). Assuming various values for the bulk Lorentz factor ($5\leq\Gamma\leq25$), the estimated jet inclination angle to the line of sight was found to be $\Theta<23°$. All VLBI observations support the finding that the jet propagates towards the north, implying a connection between the pc-scale jet and NNW. The detailed EVN radio map shows that with

In press: [Perger et al, 2021, ApJ, 915, 98]

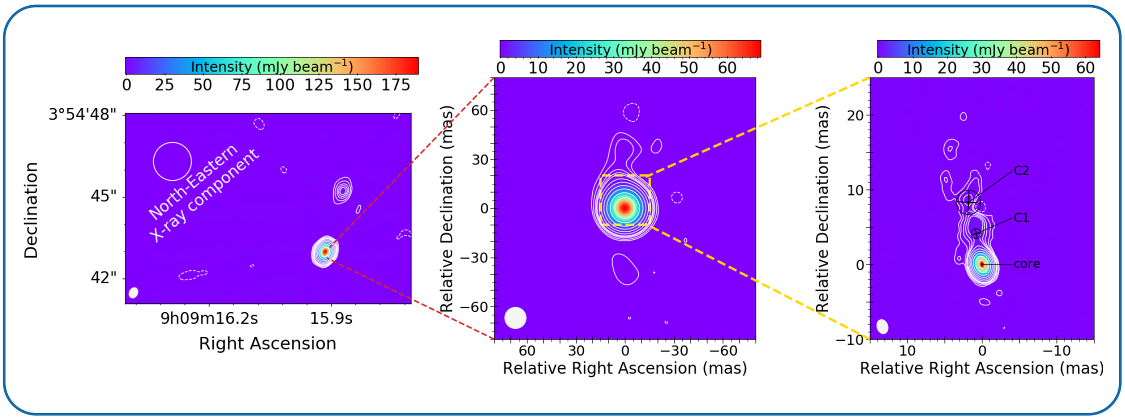


Figure 1: Radio maps of J0909+0354. Left: 6.2-GHz VLA map of the quasar and its surroundings. The maximum intensity is 190 mJy/beam, the rms noise is 0.13 mJy/beam. Right: 5-GHz EVN map of the pc-scale structure. The peak intensity is 64.09 mJy/beam, the rms noise is 0.03 mJy/beam. Middle: radio map of the EVN observations using a Gaussian (u,v) taper. The peak intensity is 68.72 mJy/beam, and the rms noise is 0.07 mJy/beam. The first contours are shown at ±3 times the rms noise, and the positive levels increase by a factor of two. The Gaussian restoring beams indicating the angular resolution are shown on the bottom left corners.

increasing distance with respect to the pc-scale core, the radio emission becomes more diffuse, and apparently splits into two branches at ~75 pc (hinting a spine-sheath morphology). Applying a Gaussian (u,v) taper of 0.2 at 10 million wavelength radius to the EVN data set, the pc-scale jet can be traced up to ~250 pc, and bends by ~30° between the pc and kpc scales.

Data from archival VLA measurements at 1.5, 6.2, and 8.5 GHz showed that the kpc-scale radio morphology of the quasar consists of a flat-spectrum core and steep-spectrum NNW component, the latter showing a spectral steepening with increasing frequency, i.e. radiation losses due to spectral aging. Photon counts of the Chandra data give further confirmation on the physical connection of the core with NNW, as an enhanced jet-like emission can be identified in the region between the two components. The detection of X-ray and radio emission, the steep radio spectral index, the jet-like feature in the 1.5 GHz VLA and 0.5-7 keV Chandra images all support the idea of NNW being the kpc-scale hotspot of the quasar on the approaching side of the jet.

From data sets of all the VLBI networks, Chandra, and VLA, it was concluded that J0909+0354 shows characteristics of blazars (e.g. compact, variable, Doppler-enhanced pc-scale core, small jet inclination angle), its pc-scale jets propagates towards the north, and is most likely fueling the NNW component at kpc scales, which is believed to be a

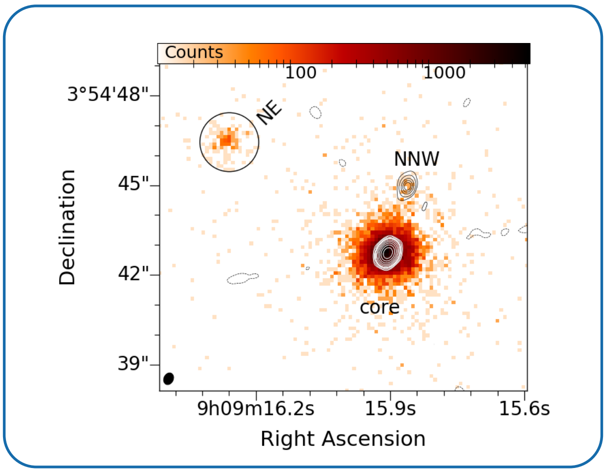


Figure 2: 0.5-7 keV Chandra X-ray image of J0909+0354 with overlaid contours indicating the 6.2-GHz VLA observations.

hotspot of the quasar. Optical identification in DECaLS and Pan-STARRS, and the direction of the pc-scale jet suggests that NE is most likely a foreground or background object. On the other hand, mid-infrared emission extending up to ~160 kpc surrounding all three regions on kpc scales identified in maps observed by the Wide-field Infrared Survey Explorer might suggest some kind of physical interaction between J0909+0354 and NE.

CHANGES IN THE RADIO STRUCTURE AFTER MAJOR γ-RAY FLARES IN THE BLAZAR S5 1803+784

Carlo Stanghellini, INAF/IRA, Italy
Roberto Nesci, INAF/IAPS, Italy

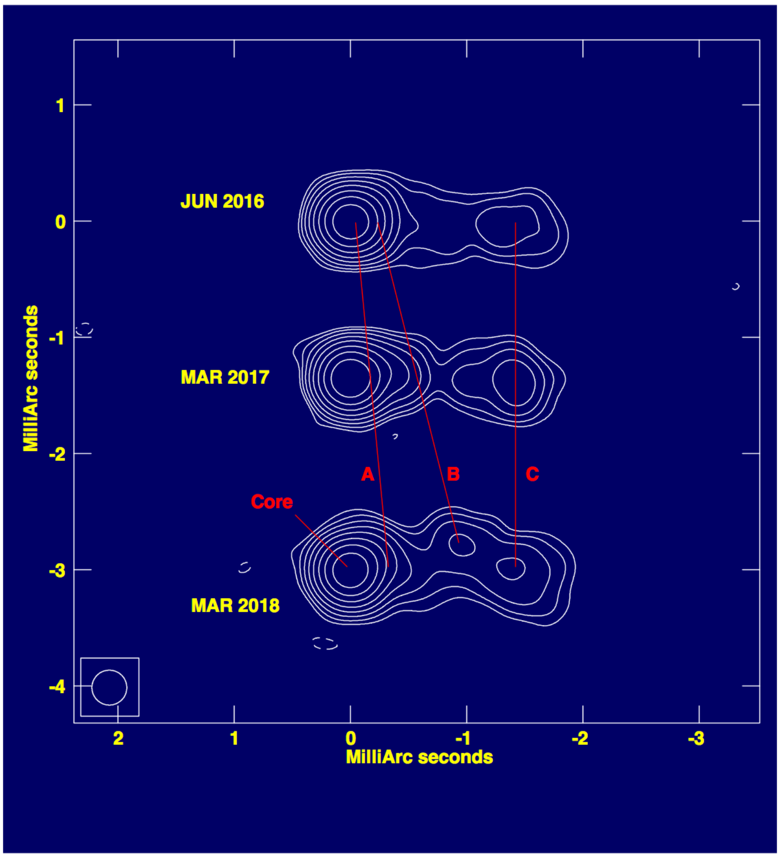


Figure 1: EVN images at 22 GHz with components A, B, C as identified by model fit of the visibilities with gaussian components.

S5 1803+784 is a BL Lac object characterized by large variations in the optical range, well detected at γ-ray energies by the Fermi Large Area Telescope (LAT), from the first LAT Catalog of AGN up to the most recent one. The γ-ray light curve shows a flat, oscillating behaviour and several large flares, irregularly spaced, whereas the largest flares are up to 10 times brighter than the quiescent state and range between 20 and 90 days.

The morphological radio structure of S5 1803+784 at milliarcsecond scale can be described as a diffuse emission from an opening jet, directed East-West, with knots and brightness enhancements in several locations along the jet (see Roland et al. 2008 and references therein). The interpretation of the radio structure as a helical jet has also been suggested by Britzen et al. 2010 and Kun et al. 2018, following a long-term monitoring at different frequencies.

To further understand if the strong γ-ray flares of the years 2014 and 2015 produced detectable changes in the structure of the

Published in: [Nesci et al. 2021, MNRAS, 502, 6177]

inner part of the source, observations of this object have been performed with the European VLBI Network (EVN) at 22 GHz on June 2016, March 2017, and March 2018 (Figure 1), and with the Very Long Baseline Array (VLBA) at 15 and 43 GHz on September 2016, March 2017, and November 2017. Fourteen antennas participated in the EVN observations, including the three antennas of the Korean VLBI Network (KVN) which provided the longest baselines. Seven additional epochs (2019/2020) of VLBA data at 15 GHz from the MOJAVE project (Lister et al. 2018) were added to the analysis.

Fitting discrete gaussian components to the visibilities the following components have been identified: component A, very close to the dominant core; component B, further away; and component C, at about 1.4 mas West of the core. Despite the difficulty to relate such components at different epochs, with differing UV coverage and different observing frequencies, the overall results show components A and B with a clear outward motion with respect to the core. This is already seen from the EVN images at 22 GHz (Figure 1) and is more clearly noticeable taking into account all the frequencies and epochs (Figure 2).

As to components C, it is stationary or oscillating around a fixed position, well in agreement with previous studies on this radio source (Roland et al. 2008).

The derived proper motion of component A is (0.088±0.011)mas/yr, corresponding to an apparent velocity of (4.18±0.54)c and an estimated epoch of passage through the core at 2015.44±0.44 (i.e. between January and November 2015), consistent with the epoch of a γ-ray flare seen on August 2015. Component B is moving at (0.195±0.014) mas/yr, corresponding to an apparent velocity of (9.27±0.67)c, and the estimated epoch of passage through the core at 2014.67±0.28 (i.e. between May and December 2014), consistent with a γ-ray flare seen on July 2014.

Therefore, the scenario suggested by the VLBI radio observations covering a span of several years, indicates that the two more recent γ-ray flares have generated radio components moving along the jet at relativistic speed. This strongly supports a causal connection between the mechanisms producing the high-energy and the radio-band radiation in blazars.

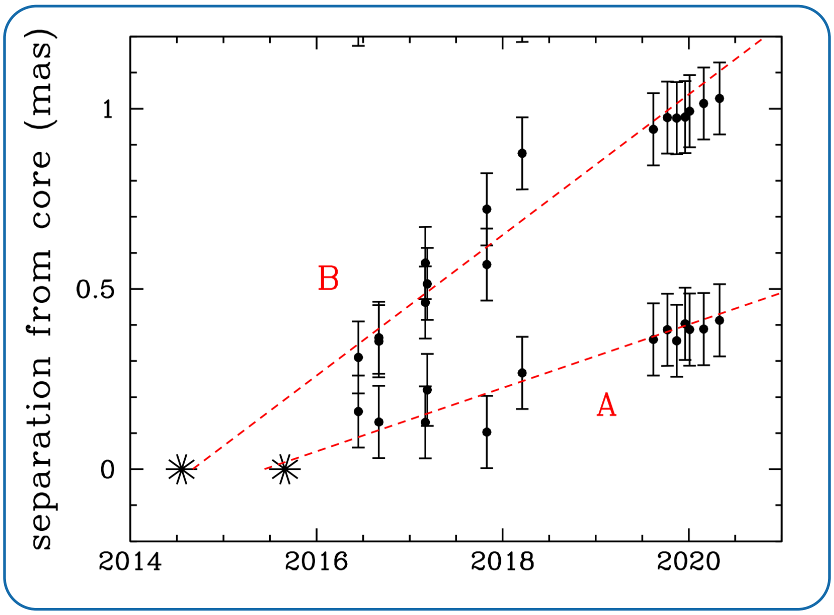


Figure 2: Evolution of separation from the core with time for components A and B. The epochs of the two large γ-ray flares are marked with asterisks located at the core position.

SN 2014C: SHELL STRUCTURE RESOLVED IN A COMPLEX SUPERNOVA

Michael F Bietenholz, York University, Canada

We report on the very unusual supernova (SN) 2014C. Over the course of a few months, it evolved from an H (hydrogen)-poor Type Ib to an H-rich Type IIn, showing strong interaction with dense circumstellar medium. Intense observations at radio, optical and X-rays have led to the conclusion that the supernova exploded in a low-density cavity as a Type Ib originating from a progenitor that had lost most of its H envelope. As the shock moved outward a few months after the explosion, it encountered a dense, H-rich shell of circumstellar medium. This shell, with a mass of ~1 $M_{\odot}$, was the product of an episode of intense mass-loss from the progenitor, which must have occurred in the period a decade to a few centuries before the explosion.

We obtained new, 8.4-GHz, VLBI observations of SN 2014C on 30 and 31 October 2018, using 13 stations of the EVN. The VLBI image we obtained is displayed in Figure 1. It shows a structure that is at least approximately circular in outline, with a minimum in the center, and with enhancement to the east and west, with the one in the east being about 25% brighter. The enhancements to the east and west are largely due to the convolution of an intrinsically circular structure with the north-south elongated beam (see Bietenholz et al. 2021 for details), although the east-west asymmetry is real. The minimum in the centre suggests a spherical shell morphology, which has not clearly been seen for this SN before. Since only about 10 SNe are close enough and bright enough that the morphology can be clearly resolved with VLBI, the addition of SN 2014C represents a significant increase to this group of supernovae of which the size, shape and morphology and expansion can be studied in detail.

To determine parameters of the shell of SN 2014C, we fit a geometrical, spherical-shell model in the Fourier transform or u-v plane. We found that the shell of emission is relatively thin. The angular outer radius is 0.89 ± 0.08 mas, corresponding to a linear radius of (20.1 ± 1.7) × 10^{16} cm at a distance of 15.1 Mpc. Along with radii we measured with VLBI at previous epochs (see Bietenholz et al. 2021), the new measurement implies that SN 2014C has been significantly decelerated since its explosion. There is a suggestion that the deceleration is increasing since the previous measurement at t~3 yr. New EVN observations already planned will help to shed more light on the development of this supernova.

SN 2014C joins a growing list of SNe that show complex patterns of mass-loss before the SN explosion. Our VLA measurements show that SN 2014C's flux density has remained relatively constant since t ~ 1 yr (Bietenholz et al. 2021). The sustained radio emission since then suggests that the progenitor went through a period of steadily decreasing mass-loss before ejecting the dense shell and then subsequently exploding as a SN. The mass-loss history of SN 2014C

Published in: [*Bietenholz et al. 2021, MNRAS,502, 2, 1694–1701*]

was therefore quite complex, with a period of likely 1000's of years of decreasing mass-loss rate, followed by a period of very high mass-loss rate in the decades to centuries before the explosion, which produced the dense CSM shell, followed by a period of very low mass-loss for the remaining time till the explosion finally occurred.

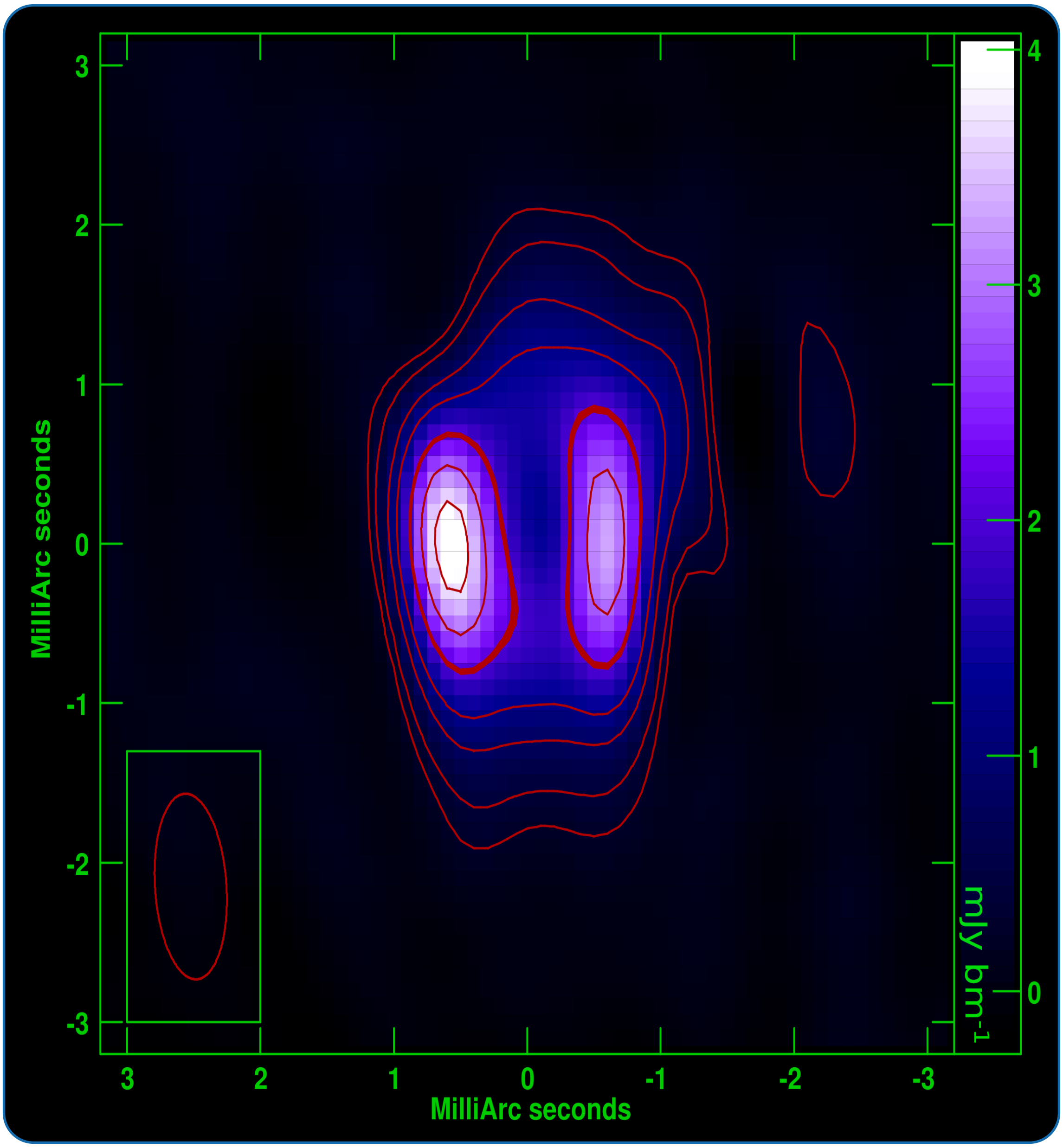


Figure 1: The VLBI image of SN 2014C on 31 October 2018, at age, t = 4.8 yr after the SN explosion. Both the contours and colour scale show the brightness. The contours are at −6, 6, 10, 30, 50 (emphasised), 70 and 90% of the image peak brightness of 4080 μJy beam−1. The rms background brightness is 51 μJy beam−1. The full-width at half-maximum (FWHM) resolution of (1.17 × 0.54) mas at p.a. 5° is indicated at lower left. North is up and east is to the left. Our observations were phase-referenced to VCS1 J2248+3718 and subsequently self-calibrated in phase. Imaging and deconvolution was done with multi-scale CLEANing using the AIPS task IMAGR.

VLBI LOCALISATIONS OF FAST RADIO BURSTS

Franz Kirsten, Chalmers / OSO, Sweden
Benito Marcote, JIVE, The Netherlands
Jason Hessels, ASTRON/UVA, The Netherlands

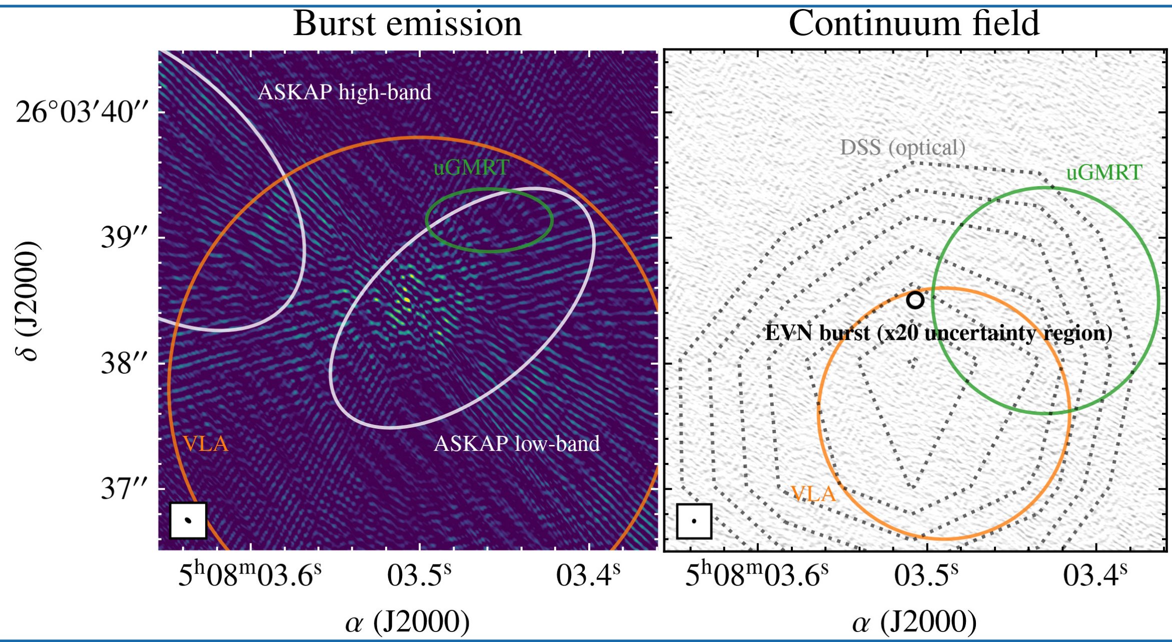


Figure 1: Localisation of FRB 20201124A performed within the PRECISE project. On the left we show the dirty map (color scale) compared to the previous localisations of the bursts performed by ASKAP, uGMRT, and VLA (ellipses). Note that the VLBI localisation is about thousand times more precise (down to 4 mas). On the right we show the continuum map (gray scale), showing absence of significant radio emission and confirming that the previously reported one by the VLA and uGMRT (circles) is actually associated with star formation within the optical galaxy (dotted contours), and not to FRB 20201124A (Marcote et al. 2021, ATel #14603).

Fast Radio Bursts (FRBs) are bright and brief (lasting milliseconds or less) flashes of radio light of unclear nature and cosmological origin. Firstly discovered in 2007, we have now detected hundreds of FRBs. Among those, only a small fraction are known to repeat, although it still remains unclear if there are different types of FRBs or all belong to the same population.

During the past years our group has used the EVN to localise repeating FRBs to milliarcsecond precision, studies that led to the first ever localisation of a FRB, the first known repeating FRB, 20121102A, and the localisation of the second repeating FRB, 20180916B. These two localisations revealed surprising scenarios and only thanks to the accuracy of the localisations, we could constrain the local environments where the bursts were produced. However, the physical conditions found in these two FRBs were radically different, and they did not allow us to trace a common scenario where these events are produced. To fully understand where FRBs can be found, a large number of localisations is clearly required. However, this also implies a large amount of observing time.

Pinpointing **RE**peating **C**h**I**me **S**ources with **E**VN dishes (PRECISE) is a project to monitor repeating FRBs, aiming at localising them with milliarcsecond accuracy. By using an ad-hoc array of EVN dishes upon availability, we are able to target a large number of known repeating FRBs. The data recorded from the individual dishes are searched for the presence of FRB emission and, in case of detection, are correlated at JIVE through an accepted correlation-only proposal.

During the last couple of years we have been able to observe for hundreds of hours with up to ten antennas on each run. This year, we started producing the first results within PRECISE, localising new repeating FRBs to milliarcsecond precision.

FRB 20200120E was found in a radically different environment than the previous FRBs: inside a globular cluster associated to the M81 galaxy (Kirsten et al. 2021), and with burst components as narrow as 60 ns (Nimmo et al. 2021), the narrowest features observed to date in a FRB. While most FRB models predicted very young objects, the presence of this FRB inside a globular cluster challenges most of these scenarios.

On the other hand, the localisation of 20201124A (see Figure 1) clearly demonstrated the importance of milliarcsecond-precision localisations. This FRB was already localised to the arcsecond level with ASKAP, FAST, GMRT, and the VLA, allowing the identification of the host galaxy. Furthermore, a persistent radio source, detected by the VLA and GMRT, was coincident with such position. However, the VLBI localisation allowed us to pinpoint the bursts with a precision over thousand times better than the previous ones, clarifying that FRB 20201124A is placed outside the center of the host galaxy.

Additionally, the persistent emission is completely resolved out on these scales, implying that its origin is related to galactic star formation, and thus unlikely to be associated with FRB 20201124A.

THE EFFELSBERG RADIO TELESCOPE TURNS 50

Norbert Junkes, MPIfR, Germany
Alex Kraus, MPIfR, Germany

The 100-m radio telescope of the Max Planck Institute for Radio Astronomy (MPIfR) in Bonn (Germany) celebrates its 50th anniversary in 2021. The construction of the telescope in an Eifel valley about 40 km southwest of Bonn started in 1967. On 12 May 1971, the official inauguration was celebrated at the telescope site, close to the two Eifel villages named Effelsberg and Lethert, which are now districts of the town of Bad Münstereifel.

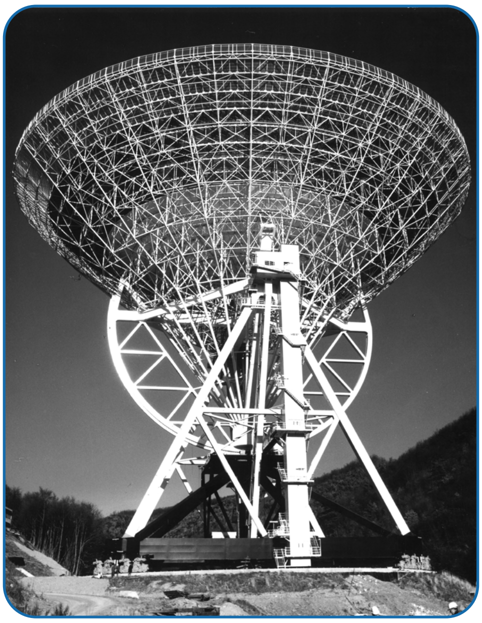


Figure 1: The 100-m radio telescope Effelsberg shortly before its opening in May 1971. The first scientific observation ("First Light") already took place on 23 April 1971. Note that the lower part of the supporting structure was initially painted in dark blue. Because that led to thermal deformations, it was quickly re-painted in white. Credit: Max-Planck-Institut für Radioastronomie (MPIfR).

Figure 1 shows the 100-m radio telescope shortly before its opening in 1971. Figure 2 was taken in the marquee during the inauguration ceremony on 12 May 1971 showing a number of guests of honour in the first row.

Starting from 1 August 1972, the Effelsberg telescope became fully operational. Due to its large frequency coverage (300 MHz to 95 GHz) and versatility, it contributed heavily to many fields of astronomical research. The special design ("homologous deformation") which causes the main mirror to deform in a controlled way when tilting, and keeping a well-defined parabolic shape, allows sensitive observations up to the highest frequencies.

An important project in the early years (together with the telescopes in Jodrell Bank

Figure 2: Guests of honor at the inauguration ceremony of the Effelsberg 100-m radio telescope on 12 May 1971. Front row, far left: Reimar Lüst, chairman of the Science Council. Second from left: Otto Hachenberg, Founding Director of the MPIfR. Fourth from left: Johannes Rau, NRW Minister of Science. Fifth from left: Hans Leussink, Federal Minister of Research. Eighth from left: Richard Wielebinski, member of the MPIfR Board of Directors. In the seat between Mr. Rau and Mr. Leussink: MPG President Adolf Butenandt, who gave a ceremonial address while this photo was taken. The third director at the MPIfR, Professor Peter G. Mezger, is not visible in this photo. Credit: Max-Planck-Institut für Radioastronomie (MPIfR).

and Parkes) was the 408 MHz survey of the full sky, which resulted in an iconic and still widely used map of the radio sky at 73 cm wavelength (Figure 3). Radio continuum observations (including polarization measurements) were one major observational field of the 100-m telescope for many years, resulting not only in several surveys of the Galactic Plane, but also in mappings of a number of galaxies, most prominently the work on the Andromeda galaxy (M31).

Already in the early days, first pulsar observations took place. Today, regular pulsar studies are carried out, for example, in large collaborations such as the "European Pulsar Timing Array" (EPTA), which ultimately looks into the detection of gravitational waves. A current focus of the observing program for the 100-m radio telescope is on fast radio bursts (FRBs) and their identification by interferometric observations. An example is shown in Figure 4.

Spectroscopic observations are one important part of the observational activities at the Effelsberg telescope. Some highlights of these observations include the first detection of water vapor maser emission outside the Galaxy (in M33, 1977), or the discovery of a water maser in a galaxy with redshift 2.64 – corresponding to a light travel time of more than 11 billon years; this was a world record at that time (2008).

Recently, the results of the first coverage of the Effelsberg-Bonn-HI survey (EBHIS) has been published, the most sensitive HI-all sky

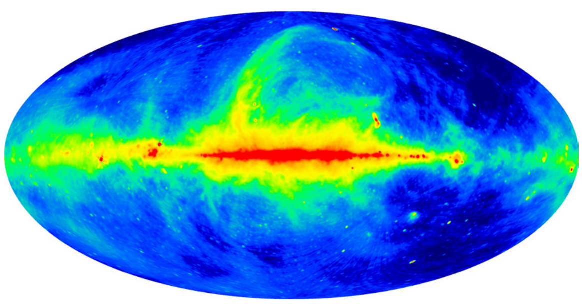


Figure 3: Image of the complete radio sky, created from radio observations with Effelsberg/100 m, Parkes/64 m and Jodrell Bank/76 m at 73 cm wavelength (frequency: 408 MHz). Credit: P. Reich/MPIfR, based on C.G.T. Haslam et al., A&AS 47, 1 (1982).

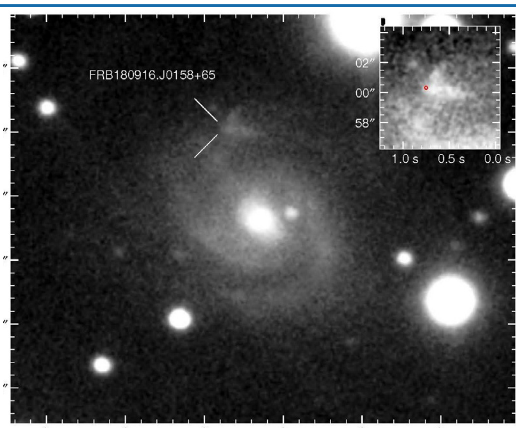


Figure 4: Image of the host galaxy of the Fast Radio Burst (FRB) 180916.J0158+65 as seen with the Gemini-North telescope. The position of the FRB, derived by EVN observations, is marked. The inset is a higher-contrast zoom-in of the star-forming region containing the FRB (marked by the red circle). Credit: B. Marcote et al, Nature 2020.

survey of the northern hemisphere so far. Later on, the data was also combined with the corresponding Parkes survey of the southern sky (HI4PI).

The first (transatlantic) VLBI observations were already performed in 1973, and showed a significant gain of the network's sensitivity by adding the 100-m telescope to it. Nowadays, a considerable amount of time in the observing schedule for the 100-m radio telescope Effelsberg goes to observations within international VLBI networks like the EVN or the GMVA. Among recent results with the EVN and the GMVA is the multi-frequency and multi-resolution image of the active galactic nucleus of M87, leading to the first image of the shadow of a black hole for that galaxy (Figure 5).

As a retrospective of 50 years of successful research work with the 100-m radio telescope Effelsberg, a new hiking trail, the "Time Travel Trail", was opened in the neighbourhood of the Effelsberg telescope in May 2021.

Several initiatives were planned in the context of the 50th anniversary, however,

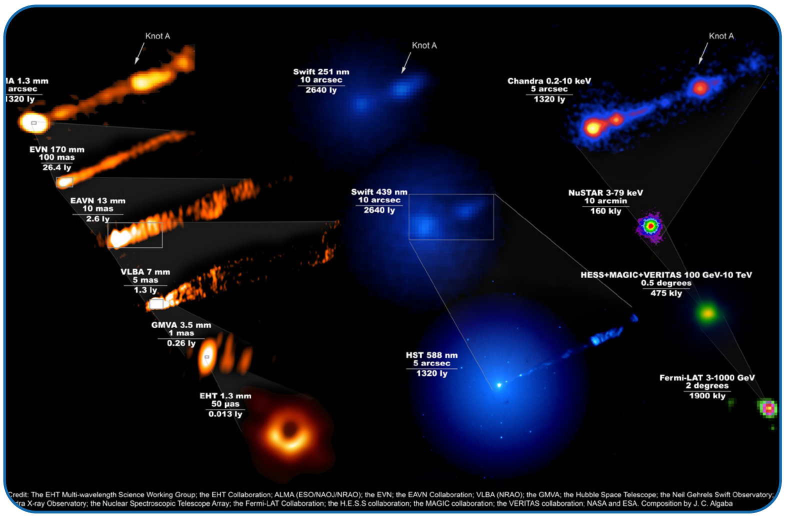


Figure 5: Composite image showing how the M87 system looked, across the entire electromagnetic spectrum, during the Event Horizon Telescope's April 2017 campaign to take the iconic first image of a black hole. Credit: the EHT Multi-Wavelength Science Working Group; the EHT Collaboration; ALMA (ESO/NAOJ/NRAO); 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.

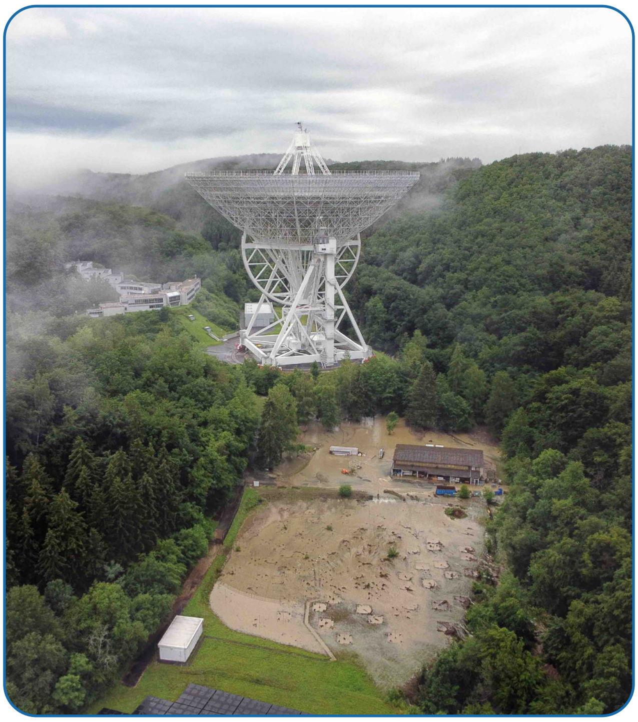
like an Open Day scheduled for 2021 had to be postponed because of the impact of the COVID-19 pandemic.

During the last five decades, the instrument underwent many technical upgrades and was continuously modernized. In 1996, the circular rail carrying the full weight of the telescope had to be replaced. A few years later, the mesh-type panels in the three outer rings were replaced by perforated aluminum panels. A huge improvement in sensitivity and operations was the installation of a new secondary (Gregorian) subreflector in 2006. The new system has an active surface and a hexapod adjustment system. Furthermore, it allows an automatic change between observations with primary and secondary focus receivers and thus more flexibility in short-time adaptations of the observing schedule.

Therefore, it is fair to say that the 100-m telescope is still one of the most powerful radio telescopes on Earth today and a central part of the scientific work of the institute.

AFTERMATH OF THE FLOODING EVENT IN JULY 2021 AT EFFELSBERG OBSERVATORY

Norbert Junkes, MPIfR, Germany
Alex Kraus, MPIfR, Germany



Aerial view of the Effelsberg radio observatory on the morning of 15 July 2021. The left image shows in the foreground the completely flooded "low-band" part of the Effelsberg station of the European LOFAR telescope network. The right image shows the access road to the 100 m radio telescope Effelsberg. Credit: Norbert Tacken/MPIfR.

The extreme weather situation with heavy rainfalls on 14-15 July 2021 caused serious flooding in the Ahreifel and neighboring regions, with sometimes devastating inundations. To a relatively small extent – compared to the neighboring valleys of the Ahr and Erft – the observatory was also affected. Due to its location in a valley, with the Effelsberger Bach and the Rötzelbach (normally tiny creeks), there was also massive flooding here.

Part of the ground was overflowed, including the access road and the storage building south of the telescope. A container with technical equipment was washed away and some low-band-antennas of the LOFAR field were destroyed (see figures). Fortunately, no-one was harmed during this event. The institute, however, was without electricity, water and telephone for a few days. Thanks to the energetic efforts of many colleagues, the situation could soon be eased. Astronomical observations with the 100 m telescope could also be re-started after just five days.

The just resumed lecture program in the visitors' pavilion in direct sight of the telescope had to be cancelled and a food path connecting the astronomy trails built by the institute in collaboration with local tourist initiatives was washed away.

In the immediate vicinity of the observatory, both in the district of Euskirchen and in the district of Ahrweiler (the observatory is located directly on the state border between North Rhine-Westphalia and Rhineland-Palatinate, which separates the two districts), the extreme weather conditions on 14-15 July 2021 had devastating effects. The entire observatory crew, a good portion of whom live in the immediate vicinity of the telescope, is very concerned about the neighborhood, which has been hit hard by the effects of the heavy rain.

A UNIQUE EVN SYMPOSIUM!

Denise Gabuzda, University College Cork, Ireland

The EVN Symposium and Users' Meeting usually takes place every two years. It was to take place at University College Cork in Ireland in July 2020, but, like so many events in that year, had to be cancelled due to the Covid-19 pandemic.

We will be holding the 15th full EVN Symposium in Cork, Ireland in July 2022. However, the four years between the previous EVN Symposium in Granada in 2018 and the Cork Symposium in 2022 was felt to be too long – the solution was to organise an online "EVN Mini-Symposium and Users' Meeting" on 12-14 July 2021, at which 39 scientific and technical talks and 16 posters were presented. This event was well attended with about 80–120 participants at each session.

This was quite a creative adventure in many ways. Due to the need to limit screen time, fewer talks were presented, and the organisers needed to take into account the time zones of the speakers to ensure that they did not have to make their presentations in the middle of the night (we succeeded in nearly all cases – apologies to Sravani Vaddi and Venkatessh Ramakrishnan!). Each session had two chairs, to ensure smooth running if one of the chairs had difficulty with their internet connection, and to make sure there were two pairs of eyes to look for people wishing to ask questions. Another innovation was that the programme included time for a two-minute talk for each poster. A lively series of discussions was carried out using the platform Discord, and a virtual poster reception was held in gather.town. Thanks to Benito Marcote and Ilse van Bemmel for setting up and monitoring Zoom, Discord and gather.town! Thanks also to Olga Bayandina for a unique conference photo.

It is interesting that feedback received from the participants suggests that, although these innovations were introduced to compensate for the fact that the mini-symposium was online, some of them may well be worthwhile implementing even when we are able to meet in person again. For example, the Chairs mostly had a positive experience working in pairs, and feel it could be quite useful to have two rather than one Chair for each session even for in-person symposia. Keeping the sessions a bit shorter with more free time between them was also felt to be positive, providing more time to look at the posters, hold discussions with colleagues, and just socialise. It was also suggested that the mini-symposium was made richer by the participation of colleagues from different time zones, some of whom would not be able to attend in person due to financial constraints, etc. This led to the suggestion that we should try to retain the option of online participation

EVN Mini-Symposium & Users' Meeting group picture. Credit: Olga Bayandina.

in future EVN symposia held in person. Of course, this would also be highly desirable from the point of view of carbon footprint and sustainability. The continued inclusion of an online discussion platform such as Discord would help facilitate discussions and commentary from a wider number of participants – those present both in person and online.

All in all, the online EVN Mini-Symposium and Users' Meeting held during 12-14 July 2021 can be considered a success, and will hopefully help inspire some innovations that help ensure the ongoing EVN Symposia remain scientifically rich, inclusive and sustainable.

You can get a better idea of the various topics considered at the EVN Mini-Symposium and Users' Meeting at the website https://www.ucc.ie/en/evn2021/ – links to recordings of all the talks are given on the "Links" page, and downloadable versions of all the posters are available on the "Posters" page.

NEWS FROM JUMPING JIVE

Giuseppe Cimò, JIVE, The Netherlands

July 31st was the last day of JUMPING JIVE. After four years plus a six-month extension due to the COVID-19 pandemic, we can look back and see the excellent work and the outstanding results of the Horizon2020 JUMPING JIVE project.

The aim of the collaboration was to **J**oining **U**p users for **M**aximising the **P**rofile, the **I**nnovation and the **N**ecessary **G**lobalisation of **JIVE**. To achieve its acronym's goals, **JUMPING JIVE** has worked to strengthen JIVE, advocate its services and enlarge its partnerships, in preparation for global VLBI in the SKA era.

Advancing the sustainability of JIVE, developing new capabilities for JIVE and the EVN, and moving towards the future of VLBI have been identified as the main objectives of the project. Ten work packages worked in synergy to reach those objectives.

In the past few years, JUMPING JIVE has been instrumental in moving towards a sustainable JIVE. The outreach and advocacy of JIVE and the EVN has been built up from scratch. Different audiences (peers, policymakers and public) have been identified and we developed materials aimed mostly at peers, but also at the public and policymakers.

Figure 1: Outreach and Advocacy – Roll-up banners and EVN table-cloth map at the EWASS2019 in Lyon.

Our outreach and advocacy activities have reached thousands of astronomers, hundreds of policymakers, and the general public. JIVE had a very visible spot at the table (Figure 1) in many outreach-related conferences and workshops, from local to a global level, where the scientific capabilities of VLBI and the EVN have been disseminated to a wider audience of non-radio astronomers.

At a policy level, there have been constant efforts to expand the membership of JIVE. Earlier this year Italy joined as a full ERIC member and negotiations with other countries are ongoing. This was a long process independent of JUMPING JIVE. However, JUMPING JIVE has contributed to elevating the profile of JIVE (Figure 2) and it created a solid basis for strengthening European and global cooperation in VLBI research with leading positions occupied by EVN and JIVE.

With regard to the technical development for the EVN and the VLBI community, JUMPING JIVE has provided the resources and the technical expertise for developing new capabilities (Figure 3). New tools for astronomers, such as pySCHED for a more modern scheduling interface and the successful correlation of geodetic

Figure 2: New partnerships and new elements – The 32-m antenna in Charco Madeira, Azores, Portugal.

observations with the EVN correlator are a direct contribution of JUMPING JIVE to the whole VLBI community. JUMPING JIVE, in close cooperation with the EVN Technical Operations Group (TOG), has also been instrumental in identifying potential new telescopes and providing technical assistance for the various aspects they need to address to join the European VLBI Network.

The four and a half years of JUMPING JIVE have also been a significant point for moving VLBI towards the future. JUMPING JIVE coordinated the effort of addressing the scientific, technical and societal challenges that VLBI will face in the next decade. The document VLBI20-30: a scientific roadmap for the next decade – The future of the European VLBI Network has been presented to the community and has already increased the awareness of the potentials of VLBI,

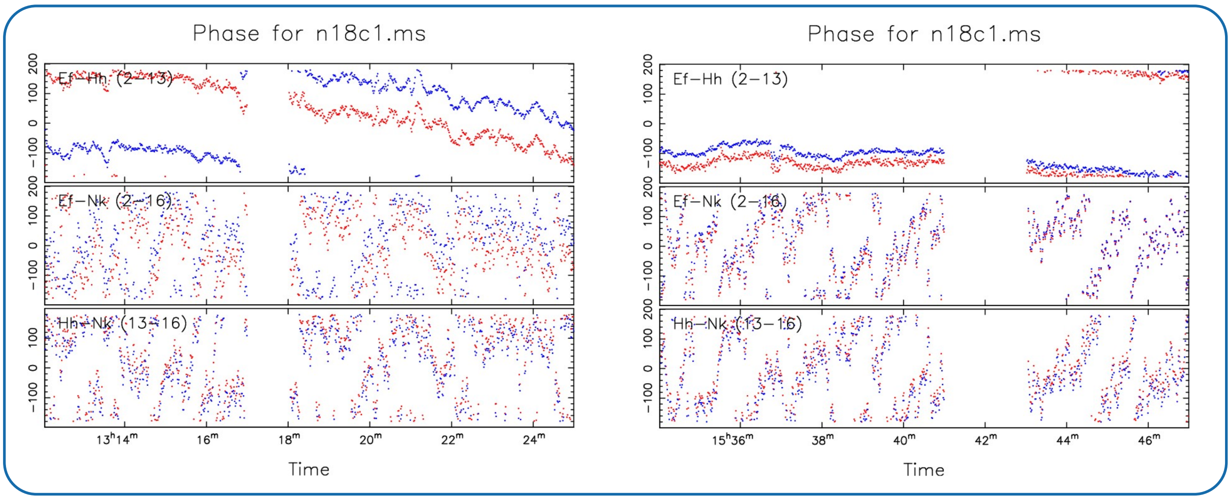


Figure 3: New elements and VLBI in Africa – Phase vs. time for both polarizations of a single sub-band, for two time-intervals from the March 2018 5 GHz NME, showing baselines in the triangle Effelsberg--Hartebeesthoek--Kuntunse.

and most of all of the role VLBI can play in the forthcoming decade, with several new facilities in many other bands becoming operational.

In collaboration with the DARA project, JUMPING JIVE has fostered new relationships between European and African Institutes and their staff to bring awareness of the potentials of VLBI science to Africa: a necessary step to ensure that the African VLBI Network project is completed and in view of the VLBI capabilities of SKA. JUMPING JIVE has also played a key role in seeding the new development of training initiatives, both in Europe and Africa (Figure 4). These are providing long-term and sustainable opportunities, beyond the current funding envelope of the JUMPING JIVE programme, which span both technical and operational skills development to provide necessary skills for the future development and operations of infrastructures being developed in Africa such as the AVN, MeerKat and the phase-2 of the SKA.

JUMPING JIVE has also demonstrated leadership in developing VLBI capabilities and science cases for the SKA. During JUMPING JIVE, a direct liaison with the SKA engineers and scientists was fundamental to guide the successful design and definition of the requirements and interfaces. The knowledge about the VLBI capability and its full potential was transferred to the VLBI science working group for the elaboration of the portfolio of SKA-VLBI science cases. The contribution of JUMPING JIVE to SKA-VLBI culminated in the presentation of an Engineering Change Proposal for the alignment of the VLBI requirements with the actual design of the VLBI capability. Its successful approval by the SKA Project in November 2020 allows the realisation of most science cases.

Figure 4: VLBI training in Africa – JUMPING JIVE Lecture, Sarrvesh Sridhar (ASTRON) teaching Interferometric data.

The past four and a half years have been very exciting. JUMPING JIVE allowed the development of activities that are essential to the sustainability of JIVE and it enhanced the profile and visibility of JIVE and the EVN to the user community. This effort will not end with the project. All activities are strictly connected with the evolution of JIVE and the EVN. The success of JUMPING JIVE will continue to be inspiring for the cooperation of networks in global scenarios and it will position JIVE, the EVN and VLBI highly in the global astronomical landscape.

EXTREME ASTRONOMY AT EAS 2021 - A REPORT ON THE EAS 2021 SPECIAL SESSION 11: EXTREME ASTROPHYSICS AT EXTREMELY HIGH RESOLUTION

Ilse van Bemmel, JIVE, The Netherlands

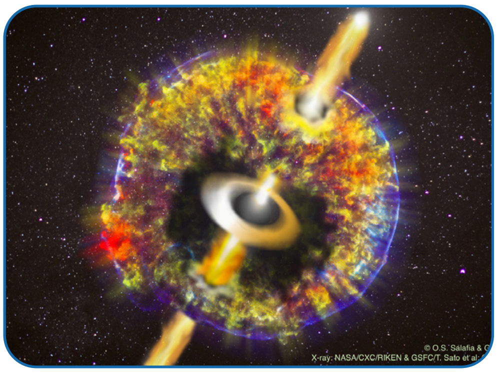


Figure 1: Artist's impression of a jet piercing the material that is launched into space during the merging of two neutron stars. After the merger a black hole is formed, surrounded by a disk of hot matter, from which the jet is launched. This model is based on actual EVN observations of GW170817. Credit: O.S Salafia & G. Ghirlanda | X ray: NASA/ CXC/RIKEN & GSFC/T. Sato et al. | Optical: SDSS.

One of the main drivers of VLBI is the extremely high spatial resolution it can achieve. This makes it an ideal instrument to study the most extreme physical events in the Universe, from Galactic star-forming regions to accretion processes onto supermassive black holes. JIVE and the EVN are committed to advocating VLBI to a broader astronomical audience, and the European Astronomical Society (EAS) Conference provides an excellent platform for this.

Like last year, the EAS Conference was a fully virtual event organized by Leiden Observatory. In the organisation for the special session *S11: Extreme astrophysics at extremely high resolution*, close attention was paid to diversity, both for invited speakers and SOC members. For contributed talks, an additional weighting was done regarding career level and origin, favouring early career researchers and those from under-represented countries. The special session took place on 29 July 2021, and included longer invited talks, shorter contributed talks, and brief poster pitch-talks.

The first block focused on results from and synergies with the Event Horizon Telescope and other studies of black hole accretion. A highlight of this block was the presentation of the recent Nature publication of new EHT results on Centaurus A. Other talks covered multi-wavelength and polarization studies of M87, and the physics of relativistic jets.

Multi-messenger astronomy featured in the second block. The ongoing studies of neutrino associations with active galaxies and tidal disruption events were presented, a field that is still very young but showing great promise. This was followed by a talk on gravitational wave astronomy and its synergy with VLBI.

The final block had a mix of transient and Galactic science. Presentations on the latest results from Fast Radio Bursts were presented. Galactic star-formation was captured in presentations about the Maser Monitoring Organisation (M2O), synergies between Gaia and VLBI, and detailed studies of the Orion star-forming region.

The attendees were treated to an extremely high standard of talks, which made it somewhat disappointing that their numbers were lower than last year, ranging from 40 to 60 people. Nevertheless, the continued presence of VLBI astronomy at large meetings like the EAS Conference is an excellent way to promote the work of JIVE and the unique capabilities of the EVN to a global audience.

UPCOMING MEETINGS

- **7th International Scientific Conference "Baltic Applied Astroinformatics and Space date Processing (BAASP)":**
  23 - 24 September 2021, online;
  https://www.virac.eu/en/baasp2021
  Deadline registration 21 September 2021
- **76th United Nations General Assembly (UN76GA) Science Summit:**
  14-30 September 2021, online;
  https://unga76sciencesummit.sched.com/
- **Dark and Quiet Skies for Science and Society II Conference:**
  3-7 October 2021, La Palma, Canary Islands, Spain;
  http://research.iac.es/congreso/quietdarksky2021/pages/home.php
- **10th IRAM 30-meter School on Millimeter Astronomy (Virtual Edition)**
  15-19, 22 and 23 November 2021, online;
  https://www.iram-institute.org/EN/content-page-435-7-67-435-0-0.html
- **International VLBI Service for Geodesy and Astrometry (IVS) 2022 General Meeting:**
  27 March - 1 April 2022, Helsinki, Finland
- **European Astronomical Society Meeting 2022 (EAS 2022):**
  27 June - 2 July 2022, Valencia, Spain;
  https://eas.unige.ch/EAS2022/

Next Newsletter:

January 2022

Ideas for contributions can be submitted until **15 November 2021** *by contacting the JIVE communications officer at rivero@jive.eu / communications@jive.eu*

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