

INTRODUCTION

MERLIN (Multi Element Radio Linked Interferometer Network) is one of the five common-user ground-based astronomical facilities operated either wholly or in part by the United Kingdom, the other four being GEMINI, in Hawaii and Chile, the Isaac Newton Group on La Palma, the Anglo Australian Observatory at Siding Spring and the Joint Astronomy Centre in Hawaii. The MERLIN and VLBI National Facility is the only one of these facilities located in the UK. These world-class instruments enable UK astronomers to carry out leading-edge science across a wide range of the electromagnetic spectrum. The recent announcement that the UK intends to join the European Southern Observatory (ESO) will result in a major enhancement of the level of optical, IR and sub-mm facilities available to UK astronomers and will also enable the UK to play a major role in the Atacama Large Millimetre Array (ALMA). This initiative means that UK astronomers will have access to sub-arcsecond imaging capabilities from optical to radio wavelengths. MERLIN is the radio cornerstone of this suite of instruments and, through the e-MERLIN upgrade, is poised to become one of the most powerful astronomical instruments in the world.



Above: The Mk2 telescope at Jodrell Bank.

MERLIN is an array of six radio telescopes distributed over central England and controlled from Jodrell Bank Observatory. Five of the telescopes are 25m diameter antennas. The sixth, which is located at Cambridge and anchors MERLIN's longest baselines, is a 32m diameter antenna. For highly rated proposals at wavelengths longer than 6cm, the 76m Lovell Telescope at Jodrell Bank can be added to the array, more than doubling its sensitivity. The outlying telescopes are connected via microwave links to a central correlator situated at Jodrell Bank. At the present time the telescopes can be equipped with receivers covering six observing bands (see Table below). Frequency flexibility is currently available between 5 and 22GHz, but it is not yet possible to switch between these bands and 1.4/1.6GHz across the whole array.

Below: Capabilities of MERLIN.

Band (Wavelength)	K (1.3 cm)	C (5 cm)	C (6 cm)	L (18/21 cm)	P (73 cm)	VHF (2 m)
Frequency Range (MHz)	21 - 24 GHz	6000-7000	4500-5200	1300-1430 1550-1730	406-410	150.5-151.5
No. of Telescopes	5	2	6	6 (7) ^a	6 (7) ^a	6 (7) ^a
Resolution (arcsec)	0.008	0.04	0.04	0.15/0.13	0.5	1.4
RMS Noise Level ^{b,c} after 12 hours (μJy/beam)	400	500	50	60 (35) ^d	700	7000

(a)The Lovell Telescope can be used instead of, or as well as, the Mk2 telescope at Jodrell Bank at the lower frequencies.

(b) Subject to a maximum dynamic range. This depends on source structure, declination and u-v coverage, but is typically 10,000:1 (peak:RMS) for full track observations.

(c) Adverse weather conditions can significantly degrade the performance, especially at the highest frequencies.

(d) Inclusion of the Lovell Telescope reduces the RMS noise to ~35 μJy/beam.



MERLIN is a unique facility for subarcsecond radio imaging, playing an invaluable role in being the only sensitive ground-based facility at any wavelength that routinely matches the angular resolution of the Hubble Space Telescope (HST). It is also the only radio interferometer that enables high quality imaging on spatial scales between that of the VLA and VLBI. When data from MERLIN is combined with that from the VLA or VLBI it is possible to produce combined-array images with high sensitivity and excellent image quality on all angular scales from many arcseconds to less than a milliarcsecond. With these capabilities, MERLIN enables UK astronomers to study a wide range of astronomical targets including stars, circumstellar envelopes, stellar winds, novae, planetary nebulae, the interstellar medium (ISM), the interplanetary medium, both nearby and distant radio galaxies, quasars and gravitational lenses.

VLBI achieves the highest angular resolution of any branch of astronomy, enabling imaging at angular scales as small as 100 microarcseconds. Such capabilities enable astronomers to probe targets at sub-AU scales within our galaxy and sub-parsec scales in other galaxies. The National Facility regularly contributes two or more telescopes to European and global VLBI networks and also, in one or more sessions per year, takes part in coordinated MERLIN+VLBI observations. The VLBI capabilities of the European VLBI Network (EVN) are listed below. EVN activities are coordinated by the EVN Consortium Board of Directors and its associated Programme Committee and Technical & Operations Group. In 1993 the EVN Board of Directors set up the Joint Institute for VLBI in Europe (JIVE) based in Dwingeloo, the Netherlands, as the home of the new EVN data processor. This became operational in July 1999. The newly-upgraded MkIV tape recording system and data processor provide the world's first 1 Gbit/sec VLBI system. This major transformation of European VLBI capabilities will be of great benefit to all astronomers. The EVN data processor, together with the large radio telescopes at Effelsberg, Jodrell Bank and Westerbork, make the EVN the instrument of choice for high sensitivity VLBI.

Below: Capabilities of the EVN. Note that the EVN also observes at 30cm, 3.6/13cm and 7mm but the National Facility telescopes are not equipped at these wavelengths. The sensitivity estimates are from the EVN User Guide and assume 8 hours on source with 128 Mbit/sec data rate (equivalent to 4 x 16 MHz with 1 bit sampling). The 92 and 49cm values are based on these but scaled using estimates of system performance and available bandwidth at these wavelengths.

The MERLIN/VLBI National Facility is operated by the University of Manchester on behalf of the Particle Physics and Astronomy Research Council (PPARC). The remit of the National Facility is to operate MERLIN for nine months of the year and to provide the support necessary to ensure participation in European and global VLBI observations. The operation and development of the facility are monitored by the MERLIN Steering Committee. Observing time for MERLIN is allocated on an open-access peer-review basis by the MERLIN Time Allocation Group of the Panel for Allocation of Telescope Time (PATT). Observing time for VLBI, or for MERLIN with VLBI, is allocated separately by an international time allocation group that is independent of, but liaises with, PATT.

Wavelength	1.3 cm	5 cm	6 cm	18 cm	49 cm	92 cm
No. of EVN Telescopes	10	5	10	10	4	5
EVN Resolution (mas)	0.3	5	1.5	5	16	30
Global Resolution (mas)	0.25	-	1.0	3	10	19
EVN Sensitivity (μ Jy/beam)	200	160	38	45	300	1000