MERLINnews
MERLIN/VLBI
National Facility

Newsletter

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1. Call for Proposals

The **deadline** for the receipt of proposals for Semester 07B (October 2007 - January 2008) on MERLIN is **March 15th, 2007**. Details in: http://www.merlin.ac.uk/propsub/call Wavebands available:

L-Band: 1.33GHz to 1.43 GHz & 1.57 GHz to 1.73 GHz

C-Band 4.5 GHz to 5.2 GHz & 6.0 GHz to 6.8 GHz

K-Band 22.0 GHz to 24.0 GHz

- The Lovell Telescope will be available for short periods only during Semester 07B*
- It is envisaged that frequency flexibility between complete observing runs will be available

Proposals should be submitted via the new MERLIN web-based proposal tool

Available at: http://www.merlin.ac.uk/propsub/northstar.html

The system parameters for observation of a continuum source in **good weather conditions** are;

	L-Band	C-Band	K-Band
Maximum angular resolution (mas)	~ 150	~ 40	~ 8
RMS for 12 hr. on source (µJy/beam)	~ 60/30	~ 60/30	~ 400
Maximum bandwidth/polarization (MHz)	~ 15	~ 15	~ 15

*The use of the Lovell telescope at L-Band and C-Band reduces the 12 hour RMS noise level from ~60 to ~30 µJy/beam. The maximum rate at which the observing frequency can be switched within an observing band will be approximately once every five minutes for multi-frequency synthesis (MFS) observations. MFS is possible within each C-Band range (eg 4.5 GHz-5.2 GHz), but not possible between 4.5/5.2 GHz and 6/7 GHz. For spectral line work throughout the Semester, users are referred to Table 4.4 of the MERLIN User Guide Version 3 which is now available online. The maximum number of frequency channels per baseline to be divided between the 4 polarizations for bandwidths of 16 MHz, 8 MHz and 4 MHz are 64, 128 and 256, respectively. The number of frequency channels per baseline to be divided between the 4 polarizations will be 512 for bandwidths of 2 MHz or less. The minimum total bandwidth is 250 kHz.

Access to MERLIN for Scientists from EU Countries:

MERLIN is one of the participating institutes in the RadioNet (http://www.radionet-eu.org) project from which transnational access within the EU to existing observing facilities is financially supported.

There will be MERLIN+EVN observations in February / March 2008. Applications to go to the EVN PC (http://www.evlbi.org/)

2. Director's Report

It is an exciting and challenging time to be appointed as the new Director of the MERLIN/VLBI National Facility. In the coming year we expect to bring the first broadband digital signals from remote telescopes via the new fibre network and into a prototype correlator at Jodrell Bank Observatory. Achieving the 'first fringes' with *e*-MERLIN will mark the culmination of years of effort by a wide range of National Facility staff, with input and support from academic and observatory staff, and development by NRAO in Socorro and DRAO in Penticton. This is when the commissioning effort will start to peak, and we are looking forward to involving experts from inside and outside Jodrell Bank as we progress from first fringes to the first test and demonstration observations.

While Jodrell Bank will be the focus of much of this commissioning effort, *e*-MERLIN will also start to establish its presence in our new building in Manchester. From September, this will house the Jodrell Bank Centre for Astrophysics, combining the research activities of the University of Manchester's astronomy and astrophysics groups, under Phil Diamond's leadership. Support for *e*-MERLIN users will be available in Manchester, hopefully alongside the UK's ALMA Regional Centre node, (ARClet), the funding for which is currently being considered by PPARC/STFC. Some aspects of *e*-MERLIN technical operations, will be close at hand in another Faculty building, (Sackville St), where it is planned that Manchester's technical R&D operations will be centred. This re-distribution of effort will bring advantages and new challenges.

The European VLBI Network is also going through a period of rapid development, with 1 Gb/s disk recording now the norm and regular real-time e-VLBI observations, including 512 Mb/s real-time operations recently demonstrated with the Jodrell Bank, Cambridge, Medicina, Westerbork and Onsala telescopes. The closer integration of *e*-MERLIN and the EVN will be enabled by work on digital reformatting and transmission technology being done here, with funding from the EXPReS project. *e*-MERLIN and the EVN provide a powerful combination of baselines from 10km to 10,000km for radio imaging on milli-arcsec to arcsecond scales. A current example of imaging the supernova remnants in M82 is discussed in this Newsletter, while the potential science applications of broadband EVN and *e*-MERLIN were enthusiastically discussed during a two day workshop in Dwingeloo earlier this month.

An important approach to maximising the future scientific potential of *e*-MERLIN is to encourage large, consortium-based Legacy projects. A panel to oversee the development and assessment of such a Legacy programme, led by Rob Ivison (ROE), has just been appointed by the MERLIN Steering Committee.

Finally, I'd like to take this opportunity to thank Phil Diamond for his tremendous work in leading the National Facility over the last seven years and his vision and commitment to establishing the *e*-MERLIN project, developing MERLIN and Jodrell Bank's VLBI operations as a National Facility and supporting the development of the European VLBI Network.

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3. *e*-MERLIN Update

- Further optimisation of the L-band and C-band systems is continuing. The thermal performance of the C-band cryostat has been studied and improved by about 3K. Individual C-band LNAs are now being tuned and optimised and achieve 5K or below, over the 5-7 GHz band. Fitting of enhanced reflective screening has been completed in the vertex cabins of two of the three E-systems telescopes. On these telescopes, and with a better OMT in the L-band receiver, the L-band system, including the lens, shows significantly better performance than the previous prime focus system.

- The final part of the analogue IF electronics is now under construction. The LO multiplier, phase-lock, and up-conversion stages have been tested and perform well. The final down-conversion stage will be completed and tested shortly. The 1 GHz sampler board prototype is being assembled.
- DRAO are now testing the first prototype station boards and baseline boards, including the protototype custom correlator chips.
- An implementation of the L-band link, which synchronises the LO at each remote telescope using pulsed transmissions at 1486.3 MHz, has been tested in the lab using optical fibre. This work is being funded by the SKADS project as a prototype of phase transfer for the SKA.

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4.Topical News and Recent Science

I'll see you after CLASS: a new gravitational lens candidate

Edward Boyce, Neal Jackson, Ian Browne (JBO)
and Steven Myers (NRAO).

We have used MERLIN to discover a strong candidate for a new gravitational lens, F03284347. If confirmed, this lens has the largest flux density ratio and is the second-smallest separation of any two image radio lens. Gravitational lenses occur when a foreground galaxy closely aligns with a background source (either a quasar or a galaxy), so that its gravitational potential distorts the passing radiation and forms multiple images of the source. Lenses are useful both for investigating galactic structure at z ~1 and for measuring the Hubble constant.

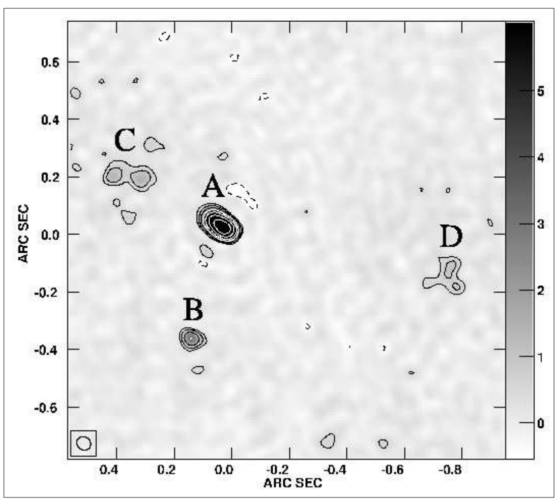

Figure 2: 6 GHz MERLIN map of F03284347, greyscale in mJy/beam, CI=0.4mJy/beam x -1,1,2,4… Component A is slightly extended, and component B is still compact. The flux density ratio between components A & B is ~20 at both 6 and 22 GHz implying that they are lensed images of the same QSO. Components C & D are clearly resolved and are like to be extended lobes around the same source QSO which lie too far from the lensing galaxy to form multiple images.

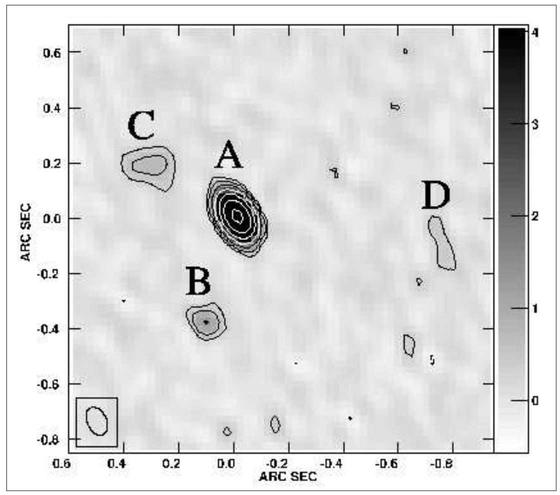

Figure 1: 22GHz VLA map of F03284347, greyscale in mJy/beam, CI=0.3mJy/beam x -1,1,2,4… Components A and B are compact; components C and D are extended

The CLASS survey found 22 gravitational lenses in which the source is a radio-loud quasar, accounting for most of the radio lenses. F03284347 was a marginal candidate in the initial CLASS observations, and has recently been followed up. We made 8 GHz VLA observations in February 2006, 22 GHz VLA observations in April 2006 and 6 GHz MERLIN observations in December 2006.

All three maps show two compact components A and B at a separation of 0.40". These have a flux density ratio 19.6 +/- 1.7 at 22 GHz and 19.2 +/- 0.8 at 6 GHz. At the MERLIN resolution of 0.05" component A shows a 0.05" extension, with 75% of the emission from a central point source. Both A and B appear to be point-like quasars; the matching flux density ratios at different frequencies imply that they are lensed images of the same quasar. At 8GHz the components are barely resolved with a separation of 0.40" and a beam of

0.25"x0.20". The 8GHz flux density ratio is 17, possibly due to a bit of image A flux density contaminating image B at the marginal resolution.

We see two faint components C and D with steeper spectra than A and B, which are extended with the VLA and resolved by MERLIN. These could be lobes associated with the source quasar. In the lensing interpretation, the source is a linear triple radio galaxy with a compact central quasar and two extended outer lobes. The quasar is lensed to form images A and B, while the lobes lie too far from the lens galaxy to form multiple images.

We will make VLBI observations of this candidate soon. If the lensing hypothesis is correct, components A and B should again appear as two compact components at a flux density ratio of about 19. With milli-arcsecond resolution, the structure within A should be well resolved and may also appear in B, at a smaller scale and with the parity reversed.

If confirmed, this lens extends the parameters of lens systems. The small separation of 0.40" argues for a smaller lens galaxy than the typical large elliptical which gives images separated by 1-3". The flux density ratio of 19-20 is considerably higher than the next highest value for a two image lens (15 in CLASS B1030+074). Such "asymmetric double" lenses give the best constraints on the lens galaxy's central density profile.

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The M82 Starburst

Danielle Fenech, Alan Pedlar, Tom Muxlow and Rob Beswick (JBO).

M82 is a nearby starburst galaxy undergoing an intense, unsustainable, burst of star-formation induced by its gravitational interaction with M81. Previous radio studies using MERLIN at 5GHz (Fenech et al, 2005, Muxlow et al, 1994) have shown compact radio features within the central starburst identified as HII regions and supernova remnants (SNR), the evolved remains of the core collapse supernova occurring as a consequence of the increased star formation. The remnants are similar to those found in the Large Magellanic Cloud and our own galaxy but are more compact and younger, with ages ranging from a few hundred to a thousand years.

New observations of the central kiloparsec of M82 were made in March 2005 at a frequency of 1.6GHz, using the MERLIN array and Global VLBI simultaneously. The use of wide-field mode for the Global observations and data analysis expertise have enabled the combination of these two datasets to produce images of the population of ~35 sources showing their shell and partial shell structures in unprecedented detail (see figure 3).

The wide range in spatial frequency coverage of the combined arrays has produced images at angular resolutions ranging from ~4mas to 130mas which not only allow the study of the evolution of the most compact sources, such as 41.95+57.5, and their interaction with the interstellar medium but has revealed for the first time, the detailed structure of the population of SNR at 1.6GHz.

Studies of the SNR 43.31+58.3 using these combined data have confirmed its continued expansion at 10,000km/s, which is close to free expansion. These studies have also shown that the radio morphology of the unusual double-lobed source 41.95+57.5 is changing and evolving dramatically. It is possible that this object is the late stage radio afterglow from a misaligned Gamma-Ray-Burst event which may have occurred in M82 many decades ago (Muxlow et al, 2005).

As well as the study of the individual sources at 1.6GHz, a comparison of these data with sensitive MERLIN 5GHz observations has revealed the detailed spectral distributions of a large number of the SNR for the first time. These are the first MERLIN and Global VLBI combination images of M82; however in the future, combination imaging with *e*-MERLIN and enhanced wide-bandwidth VLBI will become routine, revealing a wealth of structural detail with milli-arcsecond angular resolution and sub µJy sensitivity.

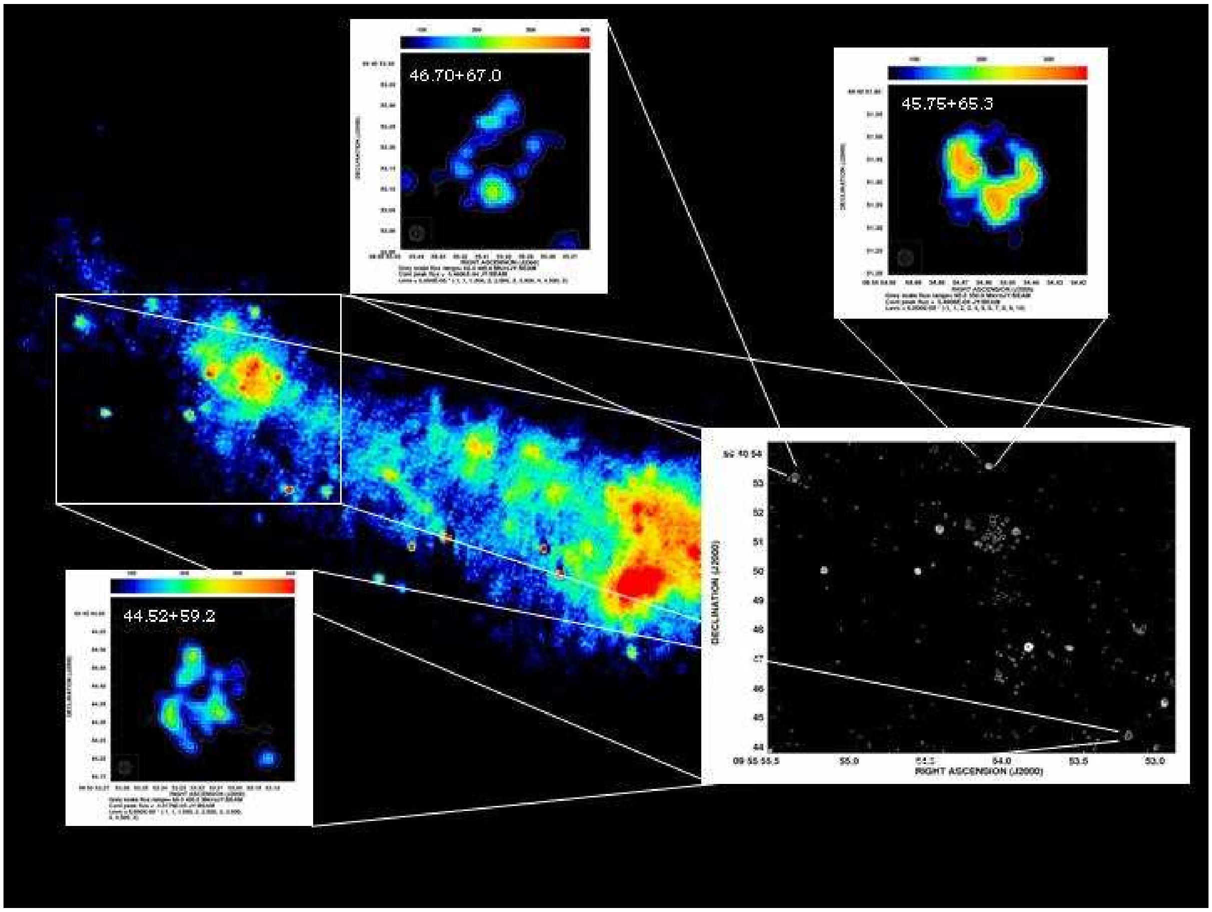

Figure 3: Montage of a VLA and MERLIN combined image at 5 GHz with an angular resolution of 35mas shown with a partial field image of the MERLIN and Global VLBI observations at 1.6 GHz (insert). The overlaid individual sources are imaged with 35mas angular resolution and give an example of the detail achieved with the combined data.

References:

Fenech et al, 2005, MmSAI, 76, 583.
Muxlow et al, 1994, MNRAS, 266, 455.
Muxlow et al, 2005 MmSAI 76, 586.

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