MERLINnews
MERLIN/VLBI
National Facility

Newsletter

Number 15: September 2006

Editor: T.W.B. Muxlow (twbm@jb.man.ac.uk)

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1. Call for Proposals

The **deadline** for the receipt of proposals for Semester 07A (February 2007 - June 2007) on MERLIN is **September 15th, 2006**. 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 07A*
- 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 2007. Applications to go to the EVN PC (http://www.evlbi.org/)

2. Director's Report

There is life in the old dog yet! As is reported in the article later in this issue and also in O'Brien et al (Nature, 442, 279, 2006) the old MERLIN array, prior to its rebirth as *e*-MERLIN, has provided invaluable observations of the recurrent nova RS Ophiuchi. The MERLIN monitoring data, along with higher-resolution images from the EVN and VLBA, has provided an unique radio view of this panchromatic event; thus demonstrating the great benefit obtained from the ~200km baselines of the array.

There has been considerable progress in *e*-MERLIN construction over the past few months with many aspects of the project now coming together and providing significantly enhanced capabilities. Simon Garrington's article below discusses the work in more detail. Over the next year we will be entering a critical phase of the project as we start testing the broadband equipment in earnest; this will culminate in the expected delivery of a 4-station prototype of the correlator during the final quarter of 2007. Once the correlator is installed we will enter an intense period of testing and there is a strong possibility that we will have to significantly restrict the time available to prospective MERLIN users in Semester 07B. No final decision has yet been made but users should be aware of this possibility.

This is my final Director's report. As of October 1st I will be stepping down as Director of the MERLIN/VLBI National Facility, I will be taking up the position of Head of Astrophysics and Director of Jodrell Bank Observatory at the University of Manchester. Simon Garrington will be taking over as Interim MERLIN Director as we begin a search to fill the position. As I look back over the 7 years of my tenure it has been my great privilege to work with some outstanding and talented people, they have made *e*-MERLIN possible and I am sure will deliver a working and hugely productive scientific instrument.

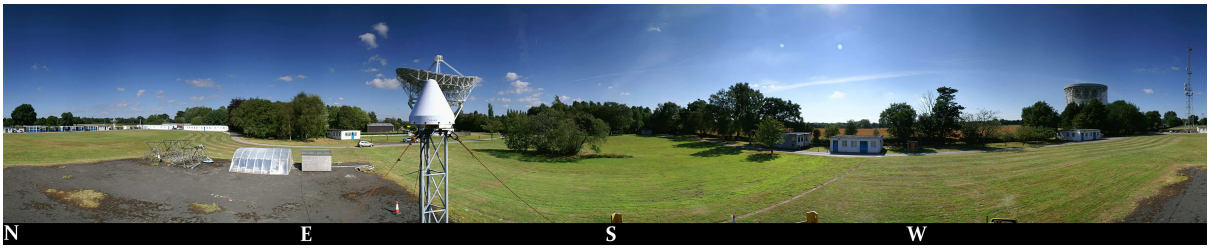
P.J. Diamond (pdiamond@jb.man.ac.uk)

3. *e*-MERLIN Update

There has been further encouraging progress on the *e*-MERLIN construction project over the last 6 months:

- The installation of the replacement L-band lenses at the three E-systems telescopes has been completed. Their performance has been verified and frequency change-over tests have been carried out. The ability to change observing bands within a few minutes allows more frequency flexible operations with EVN and MERLIN. Observing modes which require cycling between observing bands await the completion of the new *e*-MERLIN control software.
- Reflective shielding is being installed inside the vertex cabins at Pickmere and Darnhall to improve the L-band system performance

- The C-band system performance is being improved with further characterisation and tuning of the receivers. An internal C-band lens has been tested, which improves performance in the lower part of C-band.
- Work continues on the LO multipliers and the IF conversion stages, which will be tested on Mk2 later this year. The 1 GHz sampler board design and layout have been completed.
- The digital transmission equipment (developed by NRAO) has been commissioned in the lab and tested at 30 Gb/s across the *e*-MERLIN optical fibre network on looped spans up to 90km.
- Work on the WIDAR correlator at DRAO, Penticton is progressing well: the first batch of correlator chips has been delivered and the first prototype station and baseline boards are being assembled.
- A more efficient means of bringing digital signals in and out of the *e*-MERLIN correlator for VLBI and real-time e-VLBI observations has been proposed and will now be developed as part of the EC-funded ExpreS project.
- A new dual channel geodetic GPS receiver, funded by the Liverpool John Moores University contribution to *e*-MERLIN has been installed and commissioned. This will be used to provide tropospheric delay estimates for *e*-MERLIN (see below).



Picture by Anthony Holloway (JBO)

In order to provide accurate atmospheric delay calibration for *e*-MERLIN a new dual channel geodetic GPS receiver and antenna have been installed at Jodrell Bank Observatory The equipment was purchased using the contribution to *e*-MERLIN made by Liverpool John Moores University. Dual channel GPS receivers can produce range measurements which are not contaminated by the (frequency dependent) ionospheric delay and this type of geodetic receiver is capable of tracking the GPS carrier phase, allowing positional measurements at the sub-centimetre level.

The primary residual in the range measurements is due to the troposphere, which causes a delay of about 2.5m in the zenith, of which about 15cm is due to water vapour. The 'dry delay' can be accurately determined from the surface pressure and hence the 'wet delay', which can vary by a factor of 3 from day to day can be determined with a precision of a few mm.

Two analysis techniques are currently being tested: using the GIPSY software developed by JPL to reduce data from this single receiver in conjunction with accurate GPS satellite ephemerides provided by JPL, and network processing using the Bernese software, carried out in near real time by the IESSG at the University of Nottingham. The network approach can, in principle, provide tropospheric delay estimates at each of the *e*-MERLIN sites. The receiver has its own internet connection and sends its data directly to IESSG via ftp.

These delays can then be used to remove the tropospheric delay from MERLIN and *e*-MERLIN data. At high frequencies (≥5 GHz) this is the primary limitation on the astrometric precision of MERLIN and *e*-MERLIN. Together with improved ionospheric calibration, using a similar technique, it is hoped that *e*-MERLIN will be able to achieve sub-mas astrometric precision (relative to nearby phase calibrators).

We are grateful to LJMU for their financial contribution and to the IESSG for their collaboration in this project.

S.T. Garrington (stg@jb.man.ac.uk)

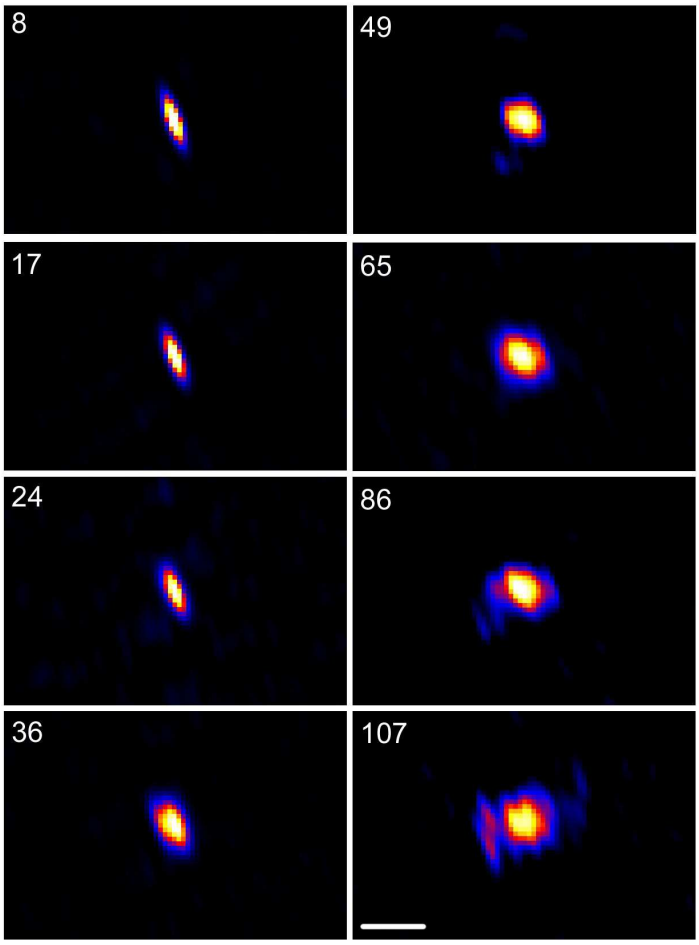
4.Topical News and Recent Science

RS Ophiuchi (2006) – what a blast!

T.J. O'Brien, R. Beswick, T.W.B. Muxlow, S.T. Garrington, R.J. Davis (JBO); S.P.S. Eyres (UCLAN); M.F. Bode (LJMU); R.W. Porcas (MPIfR); A. Evans (Keele).

In the previous issue of this newsletter we reported on the first few weeks of radio observations of the 2006 outburst of RS Ophiuchi. Well, 6 months on there's a much bigger story to tell. For the uninitiated, RS Ophiuchi is a recurrent nova comprising a red giant and a white dwarf. Every 10-30 years or so, a thermonuclear runaway in material accreted from the red giant onto the white dwarf results in a nova eruption and the object brightens significantly, becoming visible to the naked eye. If the white dwarf, thought to already be close to the Chandrasekhar limit, grows in mass as a result of this accretion then it will eventually explode as a supernova. Its latest outburst, the first since 1985, was spotted on 2006 Feb 12th. An international team including the authors of this article, plus groups at Leicester University, Arizona State University and other US and German institutions, have obtained a series of observations with MERLIN, VLA, VLBA, EVN, Swift, Chandra, XMM-Newton, HST and Spitzer.

Highlights of these observations were the earliest resolution of structure in any nova (or indeed supernova) explosion, just 2 weeks after the explosion. A VLBA image showed non-thermal emission in a roughly circular structure, far brighter on its eastern side, interpreted as the shock wave expanding through the wind of the red giant. A follow-up EVN image a week later saw the emergence of a second component to its east and subsequent imaging with VLBA and MERLIN (see accompanying figure) saw the source expand into an east-west structure suggesting the explosion was not symmetric but could be well have been in the form of jets (O'Brien et al 2006). Regular MERLIN imaging from only 4 days after the outburst to the end of June and the beginning of the summer maintenance period allowed the creation of a movie showing the source peaking rapidly (probably as a result of the rapid reduction in overlying absorbing wind as the shock moved outwards) and then fading as it expanded into an east-west structure. At the same time X-ray observations tracked the growing bubble of hot gas behind the expanding shock wave (Bode et al 2006). Velocities inferred from the X-ray temperatures were consistent with the 1700 km/s measured from the VLBI imaging. Observations of RS Ophiuchi are continuing with Swift, VLA, Chandra, XMM, Spitzer and HST as we follow the nova back to quiescence. For the detailed MERLIN press release on RS Ophiuchi, see:



Sequence of MERLIN 6 GHz images of RS Ophiuchi labelled by day number after outburst (Feb 12th 2006).The source is just becoming resolved about day 17 and subsequently expands into a multi-component structure extended approximately East-West. The beam in each case is 121x31 mas at a position angle of 19 degrees. The scale bar in the final epoch is 0.2 arcseconds

http://www.jb.man.ac.uk/news/rsoph-radio where there are links to a movie showing the development of the radio structure over the 107 days between the outburst and the end of May 2006.

Tim O'Brien (tob@jb.man.ac.uk)

MERLIN/VLBI National Facility, Jodrell Bank Observatory, University of Manchester,
Macclesfield, Cheshire SK11 9DL, United Kingdom
Telephone: +44 (0)1477 571321, Facsimile: +44 (0)1477 571618
e-mail: merlin@jb.man.ac.uk