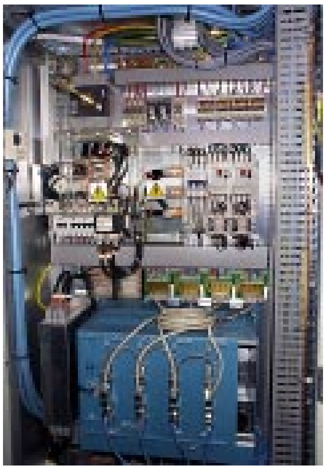
DEVELOPMENTS

Telescopes & Receivers

Telescope Control

A major part of the MERLIN Restructuring Grant to enhance the reliability of MERLIN was the replacement of the main axis drives on the three E-Systems telescopes together with their associated servo-control systems. The E-systems servo-control hardware has now been replaced on all three telescopes and the servo loop closed by their on-site computers, so removing a life expired system and thus improving system reliability. The replacement of the drive motors and associated power control systems were implemented for two of the telescopes in the summers of 1999 and 2000. The third is to be replaced during the summer of 2001. A Programmable Logic Controller (PLC) based system, located in the Pedestal Room of the telescopes as part of the monitoring and control of the drive system, has greatly reduced the wiring between the telescope structure and control room, thus ensuring improved system reliability. A working group has been looking at the phased replacement of the telescope control computers with new computer systems suitable for the greater role that they would be called upon to play in the additional control and monitoring of the Optical Fibre Link systems envisaged in *e*-MERLIN.



Above: New drive system for the E-systems telescopes.

Frequency Flexibility

Frequency flexibility, in particular the ability to switch quickly between C-Band (5GHz) and K-Band (22GHz) to take advantage of suitable periods of weather for K-Band observations, has now been achieved, with remotely controlled frequency changing in operational use on all 5 MERLIN telescopes capable of operating at K-Band. To this end, three nonstandard C-Band cryostats have been rebuilt to provide full interchangeability. The opportunity has also been taken to improve their sensitivity. A new focus box has been designed and built for the Defford Telescope. This will allow almost instantaneous switching between L-Band (1.3 to 1.7 GHz) and C-Band receivers. As the new box (and contents) will be substantially heavier than the existing (single frequency) box it has been necessary to assess its effect on the structure of the telescope, design and build new hoisting arrangements and obtain new certification for the entire focus box handling system.

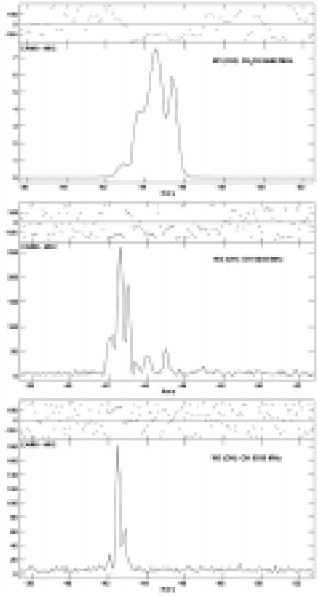
Above: Building the new Defford dual band focus box.

L-Band Lens

At present, the L-Band feeds on the E-Systems telescopes are mounted at the prime focus. To allow full frequency flexibility they will need to be mounted on the carousel at the secondary focus. However, it is not possible to mount a sufficiently large feed to illuminate the secondary reflector efficiently so a lens will have to be incorporated into the feed system. The lens will be mounted on a swing arm at the side of the carousel and swung into position when the L-Band observations are made. Development work on the design of a suitable lens and the associated feed horn is taking place and tests have been made using a small prototype system scaled to K-Band.

Above: Scaled L-Band horn and lens.

Methanol Receivers

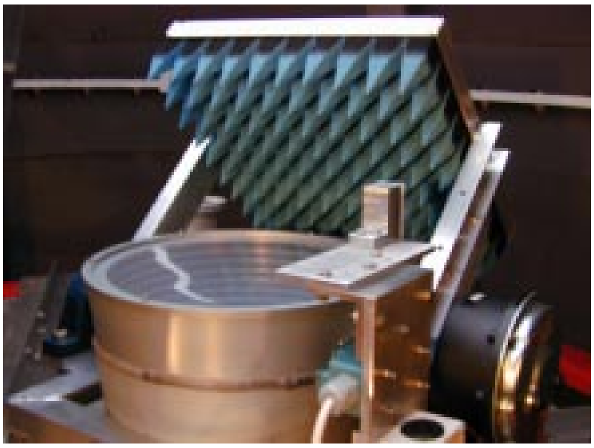


Above: MERLIN spectra of excited-state OH at 6030 and 6035MHz (bottom two frames) and methanol at 6668MHz from W3(OH).

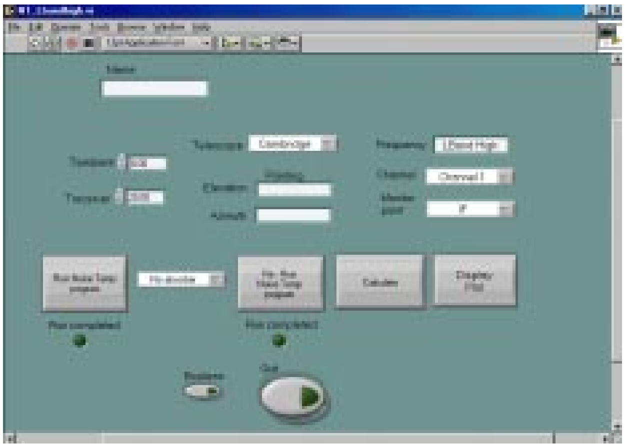
To enable Jodrell Bank Observatory to take part in VLBI methanol observations, a room temperature methanol receiver for the Mk2 telescope had been produced at very low cost. This receiver has now been improved by replacing the LNAs to give an estimated noise temperature of 75-85K. In a further development, a cooled receiver with an estimated noise temperature of 35-40K has been completed for the Cambridge 32m telescope. Both the Mk2 and Cambridge telescopes are therefore available for VLBI methanol observations, a considerable enhancement to the system. The Cambridge - Jodrell Bank baseline can also be used independently for both methanol and excited OH detection and astrometric measurements. Some of the first results using these receivers are shown opposite. Many MERLIN observations have already been proposed for the use of this new system in Semester 01A.

Receiver Remote Diagnostics

Limited monitoring and diagnostic information for the receiver in use at each MERLIN outstation is sent back over the telephone landline used for telescope control. However, in the event of a receiver fault, it is often necessary for engineers and/or technicians to visit the remote site (the furthest being 160 miles away by road) in order to determine the cause. Once diagnosed, a second visit is commonly required. Recently, a comprehensive remote diagnostic system for the MERLIN receivers, based on National Instruments LabVIEW software, has been developed and a prototype system installed at the most distant site - Cambridge. This allows engineers and technicians to perform a range of investigations and measurements on the telescope receivers from JBO, or from any location with a telephone line, simply using a PC and modem. The system provides a number of measurement facilities which were previously only available to engineers and technicians visiting the remote sites. These include spectrum analysis of the receiver pass bands, measurements of the system noise temperature, system sensitivity, antenna gain and system power stability. There are substantial benefits of this scheme: causes of faults can be determined remotely, allowing repairs to be carried out more efficiently, and so reducing the number of costly site visits; routine testing of receivers is made very easy, allowing faults to be picked up early and facilitating the detection of degraded receiver performance.



Below left: The mechanical absorber arm mounted on the 5 GHz feed at Cambridge. This is used for noise temperature measurements and is rotated away when not in use.



Below right: Example front panel of a LabView program. Once the user has chosen from various options on the panel, the program calculates and displays the results.

Control & Observing Room Integration

The (renamed and regraded) Telescope Array Controllers have already made significant contributions to both MERLIN and VLBI operations and this experience has been used to assess the additional displays, alarms, security measures, etc. needed to ensure efficient, safe and secure operation. Detailed plans have been developed for the creation of the Extended Control Area, which will form the Controllers' future working environment, and this will be implemented during summer 2001. An internal retraining programme has been established to give the Controllers the additional skills they need as their new role develops. Software developments to support this reorganisation are in hand.

VLBI Developments

The MKIV - VLBA tape recording system upgrade has been completed over a period of approximately four months in a European collaborative effort. A Formatter was supplied by external contractors and tested by colleagues at the Max Planck Institute for Radioastronomy in Bonn. The recorder read/write electronics were supplied by the Metsahovi Observatory, Finland, in a partly assembled form. These have been completed, installed and tested as have the head drivers which have been built up from components at Jodrell Bank Observatory. The upgrade increases the recorded data rate from 128 Mbit/sec to 512 MBit/sec and thus provides a factor of two increase in sensitivity. Fringes have been obtained from data recorded with the finished system during the most recent VLBI session.

There have been two major initiatives to increase operational reliability:

(1) A program to automate the switching of intermediate frequency (IF), local oscillator (LO) and calibration (CAL) signals between single-dish, MERLIN and VLBI observations. This has required the construction of active splitter units, LO and CAL switches and computer-controllable filters along with development of suitable control software. The system has substantially reduced the need to carry out re-routing of cables when observations change, thus helping to elimininate a possible source of error which could cause failure of the VLBI observations.

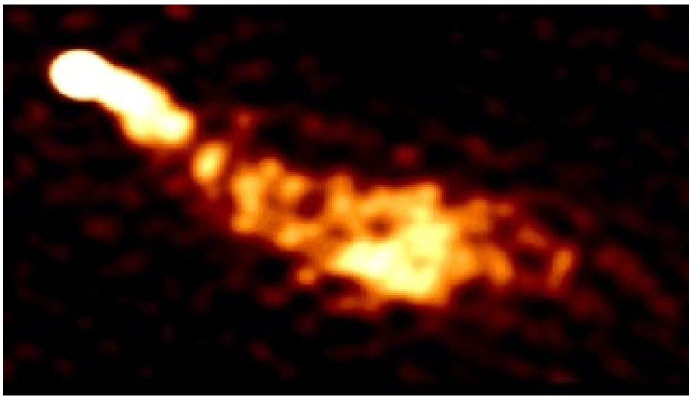
(2) The antenna control and monitoring software for the VLBI 'Field System' at Jodrell Bank has been redesigned and reimplemented to produce a much more robust and better-integrated control system which includes additional checks and monitoring of antennae and receiver/LO hardware. Additional computer-based monitoring and control procedures have allowed relatively complex receiver setups to be pre-programmed, so reducing operator intervention and possible consequent errors.

In addition, the VLBI operations team have been working closely with the Telescope Array Controllers to enable them to play a major role in the supervision of day-to-day observations and tape changing. This is providing continuity in the running of the VLBI system and greatly helping in the smooth running of the observing sessions.

Above: A VLBI technician installs the Mk IV recording upgrade.

MERLIN Data Archive

MERLIN, like almost all other major national facility telescopes, has a policy of placing data in the public domain roughly one year after the observations are taken. Over the last few years, the use of archive data from optical, IR and X-ray telescopes has grown enormously, thanks to the web-based archive browsers and sufficiently fast connections to allow users rapid access to the images.

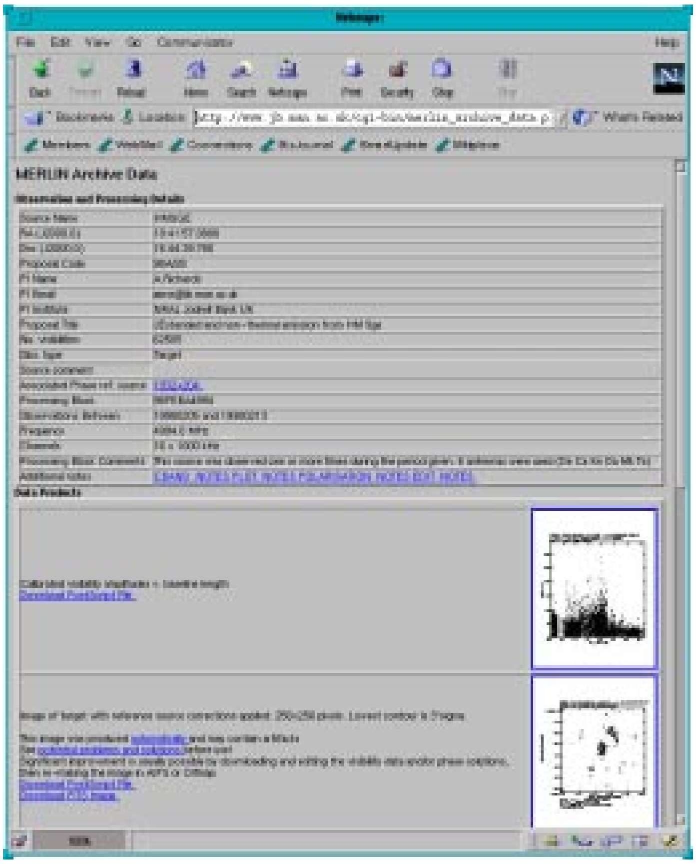


Above: 3C371 image recently made with MERLIN archive data by Cheung et al.

However, the hurdle of reducing the raw data as archived for radio interferometers like MERLIN, the VLA or the EVN, means that only the most committed users make use of archive data. Over the last two years, we have therefore started a project to make all MERLIN continuum data available via a simple web browser both as processed images and calibrated datasets.

The calibration and production of reference images is done by a semi-automatic pipeline (in order that intelligent editing of the data can be done). These reference images are not designed for publication (although in many cases the image quality is perfectly adequate) but primarily for archive users to make a quick decision on whether to download or request the calibrated visibility data and produce an image which meets their requirements. The pipeline process retains the data in their original multi-channel form in order to maximise the field of view available for future serendipitious use. The MERLIN Archive web pages (http://www.merlin.ac.uk/archive) allow users to search for archive data in various ways and allow preview images to be retrieved in various formats.

Below: Example of web-based access to the new MERLIN data archive.



The MERLIN Archivist also supports idividual requests for data. Cheung et al. obtained MERLIN archive data to support analysis of an X-ray jet in the blazar 3C371 newly discovered by *Chandra*. This continuum image, showing a radio jet extending for more than 5kpc to the west, goes much deeper than any published radio map of 3C371. These data were originally taken in order to map HI absorbtion in the central regions.

Jodrell Bank is now a partner in AVO and AstroGrid. Work done as part of these projects will concentrate on interoperability issues of using radio aperture synthesis data and on-the-fly imaging to allow archive users to produce small images from large visibility datasets held at Jodrell Bank.