

## **JOINT INSTITUTE FOR VLBI IN EUROPE**

### **Report for the first quarter, 1998**

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#### **Summary**

Another significant milestone was passed in the system testing of the Data Processor when fringes were detected from two MkIII tapes in February.

The first four Data Playback Units from Metrum Information Storage were delivered at the end of the quarter.

Tests of a set of Station Unit modules produced by AlliedSignal Technical Services for artwork proving were successful. Delivery of the first four production units is expected in May, and all 18 by mid-July.

Production correlator boards have been delivered from Haystack Observatory. The SUIM boards are now in production in Medicina.

Progress was made in implementing a number of modules in the correlator software to allow control by the Correlator Control Computer.

The high level control software also passed a significant milestone with the two-tape fringe detection. Implementation of further modules of the software continues in Jodrell Bank and Dwingeloo. Implementation of a system status display for the correlator operators has begun.

Work in Dwingeloo on a conversion tool to transform the raw correlator data into an AIPS++ MeasurementSet was completed this quarter. A number of Glish routines have been written to display the raw correlator data for diagnostic purposes. Work has begun on the development and implementation of exporting an AIPS++ MeasurementSet to FITS format for input into Classic AIPS.

Support by JIVE staff for EVN operations continued during the quarter - data correlation in Bonn and Socorro, network monitoring, calibration, telescope support at Cambridge, Westerbork, Onsala, Yebes, and Medicina, and analysis of instrumental polarisation. Support was also provided for individual astronomers in scheduling and data analysis. Support continued for VSOP/HALCA observations with the EVN.

Six research papers were published and eight submitted; one EVN Document and one other report were published.

## 1. Institute

The heads of the four main groups in JIVE plus the director now form the Management Team and meet once per month: Michael Garrett (Assistant to the Director and head of EVN Support), Huib Jan van Langevelde (head of Science Operations), Stephen Parsley (head of Technical Operations), Jean Casse (Project manager Data Processor Construction) and Richard Schilizzi.

### European Commission

The TMR Annual report was submitted to the EC. The negotiation of the TMR extension contract was also completed (including the construction of a new annex detailing travel and subsistence costs). The possibility of supporting EVN PC travel was also investigated and later confirmed by Brussels.

The RTD contract was signed and returned to Brussels.

### Personnel changes

Bauke Kramer started as correlator operator on 1 January. Henk Klijn Hesselink left his position as online software engineer in the Data Processor Group on 1 March. Chris Phillips started as support and data analysis scientist in the Data Processor Group on 15 January. Fredrik Rantakyro completed his term as support scientist at Bologna on 1 February.

### EVN/JIVE Symposium

A start was made on the organisation of the EVN/JIVE symposium (to be held in October this year) for which Garrett is the LOC chair. Leonid Gurvits (JIVE) and Bob Campbell (NFRA) have agreed to co-edit the symposium proceedings.

### Infrastructure

Two new Ultra 10 workstations and peripherals were purchased for the EVN Support Group and a set of rules and regulations w.r.t. Computing and Visitors were drawn up. Garrett added several new pages to the WWW, including a "SVLBI Results" page and a "MkIV Data Processor" page.. Sjouwerman and Philips alternated in writing the minutes of the monthly JIVE institute meetings.

### Publications

Material for the annual report was gathered from the EVN institutes and internally in JIVE. Work began on the EVN poster.

### Visitors:

Roger Noble (Jodrell Bank, UK), Simon Garrington (Jodrell Bank, UK), Ignas Snellen (Inst. Of Astronomy, Cambridge, UK), Wolfgang Tschager (RU Leiden), Pedro Augusto (Madeira, Portugal), Hong Xiaoyu (Shanghai Astronomical Observatory China), Andrew Lobanov (MPIfR, Bonn, Germany), Peter Shepherd, Paul Macguire (Jodrell Bank, UK), Phil Edwards (ISAS Japan), Bram van Dam (RU Leiden).

1. EVNMkIV Data Processor (Anderson, Bos, Buiters, Casse, Klijn Hesselink, Van Langevelde, Macguire, Millenaar, Noble, Parsley, Phillips, Pogrebenko, Shepherd, Tuccari, Verkouter, Zwier)

### **Summary**

On February 17, a new milestone was reached when fringes were detected from 2 MarkIII tapes from Effelsberg and Medicina. The correlation was controlled using a prototype CJD (Correlation Job Descriptor) constructed manually by Paul Macguire. The correlator was set for dynamic phase/ delay correction. Also, on February 17, another FAT on the DPU took place at Metrum UK. This time the tests went satisfactorily. This means that the long standing problem of tracks with poor Parity Error Rate has been solved. At the end of March, the first four DPUs were delivered to JIVE in Dwingeloo.

Van Langevelde finished a document on correlator modes which discusses detailed astronomical configurations that will be possible when projects are recorded in specific VLBA and MkIV modes. The main conclusions are that the planned total output rate of 350 kB/s is sufficient for initial astronomical production. Spectral line configurations will then often require longer than 1s integration times. However, spectral line projects with small bandwidth require the implementation of preferably oversampling or fan-in. The options for implementation were discussed at an international meeting in Washington in February, where it was concluded that slow tape speeds (< 40ips) could be tested for MkIV and VLBA, but that the use of oversampling was considered as the generally preferred mode to deal with bandwidths below 500kHz.

The prototype modules for the data processor have now been all delivered with the exception of 5 serial links (see table 2.1). The delivery dates for the replication of the various modules is given in the table 2.2 which has been updated to the end of March.

The current testing program specifies a number of critical milestones. As can be seen in table 2.3, milestones 6 and 7 have not yet been completed although substantial progress has been made.

### **2.1 Correlator section**

The replication and testing of the various boards at the Haystack observatory is progressing well; at the end of March, some 40 correlator boards had been sent to JIVE. All 20 input boards for JIVE and NFRA had also been tested and dispatched to Dwingeloo. The serial links, of which some 200 are currently being tested at Haystack, are anxiously awaited.

Bos has implemented a number of software modules in order to allow for control from C3. At this stage, it seems that the communication link with C3 is working well. On March 16 and 17 Noble and Macguire visited Dwingeloo to attempt to achieve milestone number 7. Although much progress was made, the milestone was not achieved. At the end of March Bos had succeeded in implementing and testing the start/stop control command (from C3). C3 is also currently able to configure the correlator. The last item on which Bos is currently working, concerns the status messages which the correlator sends back to C3.

Each correlator board houses two DSP processors for which Haystack wrote part of the software. The software specific to our application needs to be written in Dwingeloo. For this, the necessary software environment had to be created. Millenaar spent part of this quarter studying the organisation of the data processing software in the DSPs and how they must communicate with the real time processors.

All postselector boards for the Data Distributor have been delivered by the assembly factory. About one quarter of the boards have so far been tested and accepted. The preselector boards have also come back from the assembly. So far none of these boards have been tested due to higher priority being given to the DSP software. Bos has started with the writing of the test software using the available documentation.

## 2.2 Station Units

Apart from the Phase Cal Module (PCM), the prototype phase of Station Unit development is complete. Tests of the second PCM prototype board were witnessed by Anderson and Parsley in February. The board functioned correctly. Occasional crashes of the micro will be cured by a revision of the PCB power distribution. Formal acceptance testing of the final version is scheduled for the third week of April.

On schedule, at the beginning of March, AlliedSignal produced a set of production Station Unit modules for artwork proving. Tests at Metrum, witnessed by Parsley, found no serious problems with these boards. To enable Data Processor development testing to continue on schedule, AlliedSignal have agreed to expedite the production of four units. Delivery is expected on 18 May 1998.

Some Station Unit software bugs have been discovered during the development of the high level control software. Pogrebenko and Hazell (at Haystack) have a continuing dialogue to solve these problems. Adjustment and re-compilation of the SU code is now a routine procedure at Haystack.

Table 2.1: Delivery dates for the prototypes for the EVN MarkIV Data Processor

Item	Responsibility	Milestone set in January 95	Actual delivery	Milestone set per 1 Jan 98
Play Back Units	P&G	1 Feb 95		
Crate/backplane	Haystack	28 Feb 95	15 May 95	
chip	Haystack	28 Feb 95	October 95	
correlator board	Haystack	28 Feb 95	June 96	
Input board	Haystack	15 May 95	12 Dec 95	
Serial link board	Haystack	15 March 95	1 Sept 97 <sup>1</sup>	
Control board	NFRA/JIVE	15 Feb 95	7 March 95	
SUIM board	JIVE	15 March 95	August 96	
TSPM board	JIVE	15 April 95	1 Nov 97	
System clock board	JIVE	15 April 95	1 Nov 97	
Station units	MIS	1 April 95	22 Dec 97	
Full Software C3	Jodrell Bank	1 March 96		1 Oct 98 <sup>2</sup>
Splitter box	JIVE	1 Oct 97	1 Nov 97	

(1) 5 MRX revision 3 left to be delivered (2) completion of the system meeting the full specification

Table 2.2.: Delivery dates for the replication of the boards for the EVN MarkIV Data Processor

Item	Responsibility	Milestone set @ IACC July 97	Actual delivery	Milestone set per 31 March 98
Backplanes	Haystack		January 97	
Correlator boards	Haystack	1 Dec 97		April 98(1)
Control boards	NFRA		May 97	
Input boards	Haystack	1 Dec 97	March 98	
Station Units	ATSC	TBD		June 98
SUIM boards	JIVE	1 Jan 98		35899

CLKM boards	Medicina	May 97	March 98	
TSPM boards	Medicina	May 97	March 98	
Serial link boards	Haystack	1 Dec 97		April 98
Long ext links	Haystack	1 Dec 97		April 98
short ext links	Haysatck	1 Dec 97	August 97	
Splitters	JIVE	1 Jan 98	Feb 98	

(1) 40 boards delivered before the end of March

Table 2.3: Milestones in the test programme

#### Task Milestone

1. Correlation of the JB-CM tape with constant phase rotation 21 July 97

and using local control software (Achieved)

2. Correlation of the JB-CM tape with continuous phase rotation 26 January 98

and using local control software (Achieved)

3. Correlation of the JB-CM tape controlled from C3 29 January 98

with prototype CJD, data handler from Bos (Achieved)

4. Correlation of two MarkIII tapes using 2 SU/DPU 4 February 98 controlled from C3 with prototype CJD (Achieved 17 February)

Correlator control and data handler from Bos

5. Correlation of two MarkIII tapes controlled from C3 6 March 98

using final CJD fed manually, Data handler from Bos (Achieved 20 February)

simple correlator control from C3

6. Correlation of two MarkIV tapes as in 5. 12 March 98

CJD made at JIVE (Phillips)

7. Correlation of two tapes controlled by C3 20 March 98

correlator controlled by C3

prototype CJD, data handler from Bos

8. AIPS++ to AIPS conversion via UVFITS and fringe 22 April 98

fit of JIVE data

9. Testing of functionality PCM using JB-CM tape 8 April 98

data to be read into C3 (Delayed 28 April)

10. Correlation of two MarkIV tapes 1 May 98

Full correlator control from C3

with CJD fed from VEX

Data handler from C3 (Noble)

11. Correlation in MarkIV and VLBA mode with 4 stations 15 May 98

Test all modes

12. Two station correlation with user interface 1 June 98

13. Full operation simple array (8 stations) 1 August 98

14. Test TSPU control 1 September 98

15. Official opening 22 October 98

At JIVE, Parsley has successfully installed the Orcad tools needed to perform ongoing development of the SU Xilinx designs.

### **2.3 Play Back Units**

At the end of 1997 Metrum UK was still investigating the problem of poor Parity Error Rate (PER) for a number of tracks of the DPUs. This led to a modification in the alignment of the tape path. The tape guiding is now much improved providing a smooth run over the headstacks. The PER problem was however still present. It was finally concluded that the source of the problem was the lateral tape deformation due to the edge guiding and causing the headstacks to wear unevenly over their width. This effect was made worse by having the headstacks kept at a fixed position during the testing phase. By emulating a real run i.e. with the headstacks moving sideways, the effect disappeared.

On February 17 and 18 Buitter, Casse and Parsley witnessed the acceptance tests for 4 DPUs at Metrum UK. A new tape had been written for this test by George Peck at the VLBA. The tests concentrated on the measurement of the Parity Error Rate at all tape speeds, in forward and reverse. The units were well within specification, with PERs at 160 ips in the range 1 to 10 ppm. The four DPUs were delivered to JIVE in the beginning of March. They then underwent Site Acceptance Tests (SAT) which were conducted by Buitter assisted by Leeuwina and

Schonewille. Four more units were demonstrated on March 16 and 17. They were also found to be within specification.

On March 18 to 20 Casse visited Haystack in order to attend a tutorial on the adjustment of headstacks and on acceptance measurements on triple cap headstacks from Spin Physics. The specification for the contour for these triple cap headstacks had been prepared by Hans Hinteregger. Three headstacks were checked and the results showed a number of discrepancies which were reported to Spin Physics.

The set up for measuring head profiles at Haystack has now been reproduced at Dwingeloo.

The problem of mounting and aligning headstacks on the P&G play back units has been investigated at both JIVE and Metrum UK. The problem is well understood and is caused by the mechanism which moves the headstacks laterally. The necessary tolerance needs to be minimised in order to keep the path stable. An insert has been developed and a procedure for its installation has been defined.

#### **2.4 SUIM/TSPU (Station Unit Interface Module/ Test Synchronisation Pulsar gating Unit)**

All TSPM and CLKM boards have been replicated, tested and accepted at the Institute of Radio Astronomy in Medicina. The boards for Haystack were received at the end of March.

The second revision of SUIM boards has been extensively tested in Dwingeloo together with the Station Units. The SUIM boards were successfully used in the fringe test. The design phase is now finished, and the replication of the boards for both JIVE and Haystack has been initiated in Medicina.

#### **2.5 High level control software**

A number of milestones were passed this quarter, in particular the first fringes from two separate tapes were obtained in February, and the first control messages were sent from CCC to the Correlators.

Macguire has spent most of his time with these milestones and other tests, as well as supporting people at Dwingeloo in attempting to do other tests. An attempt was made to achieve more control of the Correlators from CCC in March, but the lower level code to control the correlators was not sufficiently far advanced. Some of Macguire's time was also spent in updating and maintaining existing code. He has produced a prototype GUI interface to the Experiment Database and is now implementing it. The Experiment Database is an important part of the final system: it maintains a summary of the experiments that are to be, and have been processed. It is from this that the jobs that prepare and process experiments will be initiated by the operators.

In preparation for the two-tape tests at Dwingeloo, Shepherd updated the SU monitoring process, some test programs, and modified the ROT Clock to broadcast clock messages. He also implemented the Job and Processor Logs. These will be used in the final system to keep records of what has been done during the preparation and processing of a job and of events on the whole Correlator System.

Shepherd has also modified the persistence classes (used for storing objects in databases) so that multiple objects can be selected from a single query, and carried out minor modifications to enable the use of the mSQL2 database management system. He has now started on the implementation of the Data Handling code, starting with the layer that obtains the data for all jobs from the Correlators (the Correlator Data Interface).

In addition to the usual design work including the adding and modification of messages for communications between the various components of the software, Noble has started on the implementation of the Status Display for the whole system. This provides a display for the operators of the current status of the hardware and of any running processing jobs, and provides a means of controlling them. A demonstration version of the GUI for this is complete apart from one item still to be added, and work in progressing on linking this into the rest of the system.

Klijn-Hesselink worked on Preparation Job, the part of the on-line software which digests schedule and log files and produces the Correlation Job Descriptor (CJD) which is required to control all the correlator elements. The effort concentrated on transforming the information present in VEX formatted schedule files. Several simplifying assumptions have been made to have this path in place for controlling the prototype in various tests. After Klijn Hesselink left, Van Langevelde took over this effort. A C++ wrapper around the VEX parsing routines by Himwich now exists and a complete CJD for simple experiments is a goal for one of the upcoming milestones.

Phillips has adapted existing software to write a CJD to allow correlation of two MarkIV test tapes for the first time. Initial tests of this have identified complications with a number of assumptions built into the high level control software.

## 2.6. Post correlation software

Verkouter spent a large fraction of his time working on software development in order to translate the raw correlator data into an AIPS++ MeasurementSet. This task was completed. Although it is now possible to produce a MeasurementSet containing spectra (rather than lags) not all of the peripheral information is written into the MeasurementSet because it is still unavailable in the correlator output and there is no way yet to retrieve this information.

In a meeting with Noble, Van Langevelde and others, the overall structure of the correlator output format was agreed on. A file structure for DDD was developed, which is self-contained on sub-job level and has separate files for job information, data, phase cal and statistics, hardware mapping and UVW axes. The correlator job descriptor will be transformed into VEX format and part of the output structure.

Phillips (with assistance from Van Langevelde and Verkouter) has written a number of Glish routines within AIPS++ to plot the raw data from the correlator for diagnostic purposes. These routines were applied to the data from the first two-station experiment. The diagnostic routines identified a number of minor problems, including a problem in the configuration of the SU and a problem translating the lag data into the spectral domain. The cause of the second problem is thought to be due to the lack of fractional-bit-shift corrections within the correlator.

In order to meet the goals on the critical path to the opening of the correlator, Verkouter started work on the development and implementation of exporting an AIPS++ MeasurementSet to FITS format, in such a way that Classic AIPS recognizes the data and enables the users to calibrate/image their data. This work is being done in cooperation with the AIPS++ consortium and it has been agreed that Verkouter will spend approximately 50% of his time for the consortium.

Kramer worked on an archiving program for the JIVE correlator output. Most of the time was used to write interface classes for an archiving program that can store correlator data on a DAT tape or a different medium such as CD-ROM or DVD (Digital Video Disk) The interfaces that were developed are:

- An interface to DAT tapedrives.
- An interface to the database miniSQL (Msql2).
- An interface to a layer for human communication.

A test program with command line options has been made to test the interfaces. Kramer has begun the development of a CGI user interface based on html pages. Interesting possibilities are offered by the language perl and the CGI perl library found on the Web.

## 2.7 Infrastructure

Van Langevelde drew up a plan for the JIVE Ethernet and UNIX network. The plan shows a separate local Ethernet environment with two main machines the Correlator Control Computer (CCC), an HP responsible for correlator control, and DDD, presumably a Sun, responsible



for data gathering. A router and a new CCC were ordered.

Verkouter spent two weeks developing the UNIX part of the software to interface the Correlator Control Computer with a Windows 95 machine, according to a protocol that was drawn up together with Raimund Weiss during his last visit to Dwingeloo. Tests were conducted and the approach looks promising. However, more streamlining and bug finding needs to be done. The interface to the Paternoster control computer's database appears to be working. The binary file transfer (needed in order to be able to backup the Paternoster control computer's database to the UNIX machine) does not seem to work completely yet.

The production of all the coaxial cables (total length of 2km) for the JIVE Data-processor was completed by the beginning of March.

Buiter prepared a report discussing the electrical grounding situation of the equipment in the JIVE correlator room. The report proposed to install an independent "clean" ground system for the DPU's and the correlator racks. Work to carry this out started at the end of March.

During January and February, JIVE employed a mechanical Engineer in the workshop to assist in mechanical work for JIVE. Work carried out included:

- production of all parts related with the mounting of the Station Unit in the DPU rack
- production of all parts for the SUIM connector panel and belongings.
- production of mechanical belongings for TSPM , CLKM and Splitter board frontpanels.
- production of DPU frontpanels for monitor / control purposes (Eye pattern, dry air system)
- construction of 2 carts for open reel tape transport in the JIVE correlator room and one for transport of tapes in their boxes.

## 2.8 Thin Film head array project (Hinteregger, Goodman, Muftu)

Seagate delivered four thin film Peregrine head-array subassemblies in August last year as part of the feasibility phase. Each sub-assembly contains a single head-bar, that is, a monolithic 64-channel array comprised of 4 adjacent sub-arrays of 16 channels each. Two subassemblies have been joined together in order to form a 128 head module.

Casse and George Peck (VLBA) witnessed a demonstration given by Hinteregger at the Haystack Observatory. A tape written at a density of 56 kbp was used to demonstrate the performance of the new heads. It was shown that the system was getting tape-noise limited analog performance through a new preamplifier, in forward and reverse direction at 80 ips. The width of the write heads is 38 micrometers, of the read heads 12 micrometers. The test tape was recorded with both a standard headstack and also the thin film inductive head array. The tests showed that in the latter case the measured signal to noise was about 6 dB lower. This was explained by the gap length of the thin film write heads which was about 1 micrometer, much larger than the expected .25 micrometers. Discussions are taking place with Seagate in order to change this parameter for the future heads.

The SNR measurements at 80 ips indicated that the read heads were performing well. A SNR of 26 dB was measured which should be compared with the 19-20 dB currently measured with "standard" headstacks. The PER measured at that tape speed was close to a few parts per million.

For the next prototype phase of the project, Haystack expects to be able to choose one of three different array formats to be produced. Seagate still has not clarified format options for prototype phase 2 which have a high probability of going to volume production. It is likely to be whatever the Seagate/HP/IBM joint venture has decided to prototype. These prototypes may become available in the April 98 timeframe.

## 2.9 Preparing for correlator operations

Van Langevelde drafted a document that describes all the operational procedures for the correlator. This document was discussed in some detail, first in the "Software interfaces meeting" in Dwingeloo, when discussion mainly focussed on the software tools necessary for operations. After that the logistic aspects were discussed in bi-weekly Jive Operations meetings.

As part of the operations discussion Kramer made an inventory of all the tapes currently at JIVE. An html page was created with a list of tapes that are currently at JIVE (<http://www.nfra.nl/jive/correlator/tapes.html>). The administration in program TRACK of NRAO was brought up to date for JIVE.

Kramer investigated the use of an NRAO facility to print bar code labels. A program that gives the possibility to print bar-codes of VSN numbers was received from NRAO (Ron Heald). It was tested and the bar-codes appeared to be readable.

Van Langevelde participated in a 2 day meeting on VLBI Software interfaces in Washington. This meeting discussed schedule, log and calibration formats between the communities that use 1 inch tape

recorders. Many of the compatibility issues for machine readable formats are now being solved in the VEX format. Progress on VEX reading and writing was discussed. Other items on the agenda were

global naming conventions and the situation with fan-in recording.

Van Langevelde, Phillips and Schilizzi worked out a proposal to the EVN and VLBA to participate in a 16+ station test observations. This experiment will produce data to be used for the first image produced

by the MkIV correlator at JIVE. Proposed were global 6cm observations of 3C380, which will produce an interesting image. The correlated results will be publicly available to anybody interested.

#### 1. Recording terminal upgrade, MkIII to MkIV (Spencer et al)

The upgraded MkIII to MkIV equipment continues to be successfully used for EVN observing sessions in both MkIII and VLBA modes.

The problems at low bandwidths when 500 kHz clocks are used in the formatter have been identified, new software developed by Haystack, and proms blown by Arno Freihold at MPI and distributed to the observatories. It should now be possible to run narrow band line experiments.

The formatter manual is still in production by GMR associates, and some discussion on the format and contents has taken place. Delivery of the manual is expected soon.

Seven MkIV formatters for the upgrade of the VLBA stations have been ordered from AlliedSignal. Delivery is expected in the summer.

Michael Wunderlich upgraded the recorder at Shanghai to run thin tape and was able to calibrate the head successfully. It should now be possible to run thin tape at Shanghai. A number of other problems were also fixed, which should result in improvements in recording quality. The recorder at Urumqi was also examined in detail in view of its non-standard hybrid nature. He concluded that the upgrade should use VLBA read/write electronics.

Funds for the support of two Chinese engineers, Wei Wenren (Shanghai) and Zhang Hongbo (Urumqi) for a 3 month visit to Jodrell Bank have been applied for from the UK's Royal Society. A work programme involving the modification of some base-band filter boards and familiarisation with MkIV and VLBA equipment has been agreed.

## 1. Network Support Group Activities (Garrett, Aaron, Desmurs, Fridman, Gurvits, Van Langevelde, Massi, McKay, Mioduszewski, Polatidis, Rantakyrö, Sjouwerman)

### 4.1 Network Monitoring, Reliability and Performance:

Aaron carried out the test correlation of data from the first project of the February 1998 session, to check on data quality from as many telescopes as possible during the session. Tapes were received from Westerbork, Effelsberg, Jodrell Bank, Cambridge, and Onsala shortly after completion of project EM025A. Good fringes were found to all stations.

Sjouwerman (in collaboration with colleagues at MPIfR, Bonn) scheduled and correlated the Network Monitoring Experiments (NME) for the February EVN session. In this session, he scheduled with PC- SCHED the 18cm NME observations with simultaneous use of thin and thick tape recordings at different stations. This 18cm mixed tape NME was scheduled, observed and correlated without significant problems.

Aaron has supervised the correlation of the 6cm NME projects from the February and May/June 1997 sessions. From these data, accurate determination of the instrumental polarization terms will be made. The proposal that these values may be supplied to observers to improve their data will be tested. Three of the four projects have been fully correlated, the fourth is awaiting final recorelation.

From the 6cm NME project of February 1998, Aaron made a very rough estimate of the instrumental polarization of some EVN stations. The new receiver at Onsala was found to have about an amplitude of about 10%, a substantial improvement over the old receiver which had about 25%. The strong gradient of D-term amplitude with frequency at Westerbork was again demonstrated, though encouragingly the average amplitude is down to a few percent at that station.

The relationship between the single dish instrumental polarization, obtainable at those stations equipped by a polarimeter, and VLBI D-terms has been determined by Massi, Tuccari, Orfei (EVN doc. 81/1997)

This relationship should be useful for monitoring the D terms at the various telescopes through the polarimeter only and therefore without depending on VLBI observations.

McKay is in consultation with JPL concerning an existing software correlator for the proposed EVN real- time fringe checking project.

### 4.2 Calibration

Rantakyrö has sent out a "final" version of log2ant via the EVN exploder. This version is tested and in principle can handle all the EVN stations and produce the requested ANTAB files. Rantakyrö also went through all the ANTAB files on ASTBO1 checking and corrected some known problems.

Desmurs produced and edited the ANTAB files of the first EVN session of 1998. He updated the program log2ant to correct a few minor problems.

Garrett has started a dialogue between NRAO, Desmurs, Himwich (GSFC) and Conway (Friend of EVN Calibration) regarding the move in Socorro towards incorporating amplitude calibration table (amongst other things) in the data exported from the correlator to the PI.

Mioduszewski facilitated communication

between the VLBA correlator staff and the EVN in order to set up a specification for EVN calibration information.

Rantakyro has been in contact with Dr Li Suqin on how to use the log2ant software with the Chinese antennas. Tests performed by Rantakyro have shown that the software works well with these antennas.

#### **4.3 Data Correlation**

Aaron supervised the correlation of ER004A, GG030, EZ005, ES016B, ES014A, EH001, EG015A, ER004B, ES014B, EG015B, GR014, and EV006 from the February 1997 session. The correlation of the projects from that session is approaching completion.

Steps were taken to investigate how much support is required to support the correlation of spectral-line projects in Bonn. J-F Desmurs (JSS at OAN) will visit Bonn in order to assess the scale of the problem in April this year.

#### **4.4 Space VLBI**

Gurvits monitored operations and logistics of EVN participation in VSOP observations during and outside the EVN observing session 1998-1 (February 1998).

Gurvits prepared a report on the EVN/VSOP Operations for the EVN TWG meeting (Alcala, January 1998). The report was used in the preparation of the EVN TWG proposal on restructuring of the EVN TWG.

#### **4.5 Telescope and Observing Support:**

OAN, Yebes.

J-F Desmurs supported a 2 day geodetic VLBI session at Yebes. VLBI observations are limited at the moment because of problems with the VLBA formatter.

NFRA, WSRT

Peter Fridman has investigated the technical aspects of the apex signal injection system. A block-diagram and the main components of the system are now determined. A broadband conical spiral antenna and comb generator have been chosen. The signal-to-noise ratio at several points of the

1- GHz band has been calculated.

WSRT test observations have been made in tied-array mode using a computer controlled CIH unit. Total-power measurements in the UHF band were shown to be consistent with precalculated values.

Data processing of the compound interferometer (CI) UHF test observations were also made. These observations demonstrated the right value and correct growth of the correlator output signal-to-noise ratio proportional to the number of antennas in each of the CI arms.

OSO

Polatidis supported the setup, observations and the antenna calibration at Onsala for the February 1998 EVN session and the Target of Opportunity HALCA-EVN observations (vt714) on Mar 17, 1998.

NRAL, Cambridge

McKay supported observations at Cambridge and Jodrell Bank for the February 1998 EVN session. New telescope monitoring software has been implemented to allow the extension of existing telescope parameters. Work also continues on the Cambridge phase correction project.

IRA, Medicina

Rantakyro with G Maccaferri has published the manual for the control software for the Medicina antenna (ANTM5) as an Internal Report ("ANTM5, Programma di controllo della parabola di Medicina", IRA/CNR

251/98).

#### **4.6 General Network Support**

Sjouwerman generated the Experiment Feedback Facility web pages for the February EVN session. In addition, Sjouwerman maintained the EVNtech VLBI exploder, and updated the PC-SCHED codes file (maintained by R.W. Porcas), on the NFRA ftp server. Garrett began constructing an EVN User: Guide to be made available via the EVN web pages.

## 4.7 EVN PI support

### 4.7.1 Scheduling

Desmurs helped Yu Zhi-yao to submit a proposal for the EVN at 18cm. Mioduszewski was contact for experiments V018D, V018A, V043C and V053F1. This involves checking schedules, facilitating correlation and checking correlator output. Mioduszewski also tested new AIPS space VLBI capabilities. Polatidis, Aaron, Garrett and Sjouerman supported experiments GM033, EF005A, GL20 and EM028.

### 4.7.2 Support of Visitors to JIVE:

During this period there were 5 visitors to JIVE for EVN data analysis including W. Tschager, X. Hong,

C. Jin, F. Wesseling, P. Augusto, W. van Dam. They were supported by Garrett, Sjouerman and Gurvits.

Sjouerman updated and maintained the standard JIVE visitor workstation environment and some of the JIVE/EVN web pages. Sjouerman also maintained the test version of AIPS (15APR98) and oversaw the weekly 'midnight job' updates.

## 1. Space VLBI

### *VSOP/HALCA*

Van Langevelde interacted with P. Edwards at ISAS on Space VLBI GRT scheduling issues, involving S2 recording and other observing parameters of EVN telescopes.

As EVN representative in the VSOP In-orbit Checkout (IOC) group, Gurvits continued to participate in scheduling and preparation of the VSOP in-orbit operations and evaluating their quality. Other work by Gurvits included:

- help in preparation of the Second VSOP Announcement of Opportunity (AO-2) and the VSOP

Proposers Guide released in February.

- re-activation of the regional VSOP help desk for Europe and China for AO-2.

- participation in the VSOP Survey Working Group workshop at ISAS (Japan) in March at which a standard procedure for Survey data post-processing was developed. Gurvits is leader of one of six regional centers for VSOP Survey data processing.

### *RadioAstron*

Gurvits carried out various organizing tasks in preparation for the RISC meeting in Neuchatel (Switzerland, February). After the meeting, he prepared an executive summary of the proceedings.

### *Next generation space VLBI*

Gurvits participated in the meeting of the Space VLBI panel of the Inter-Agency Consultative Group (IACG) and preparation of its working documents.

A concept for a future mission based on a Free-Flying module of the International Space Station was presented in brief form at the IACC Space VLBI Panel meeting.

#### 1. Research

##### **Aaron**

Aaron has analyzed new VLBA+VLA+Effelsberg data on the BL Lac object 0814+425 at 2 and 6 cm. Processing of the data at 18cm has not yet been completed. The 2cm data showed that the Effelsberg receiver was linearly polarized at the usual VLBA operating frequency of 15.3 Ghz. The observatory staff have corrected this problem. The structure of the source was found to be qualitatively similar to that found in Mrk 501, namely the jet consists of a series of straight jet segments, connected by sharp bends. The jet rapidly broadens about 5 mas from the core, suggestive of a disruption in the jet flow, similar to that found in Mrk 501 and 3C48.

##### **Desmurs**

Desmurs has written three proposals for the Effelsberg antenna to make new OH maser surveys. He has also been involved in a project of V. Bujarabal concerning SiO masers around late type stars observed with the VLBA at 43GHz. The data on two sources in this project have been reduced and he has been able to measure the polarization angle of the linear polarization in SiO masers. There still remains an uncertainty about the polarization angle calibration but with the calibration used so far, the results are in agreement with the model developed by Bujarabal.

##### **Garrett**

Garrett helped prepare a Global VLBI proposal on M82 (Pedlar et al.) which was submitted on the 1 Feb 1998 deadline. Garrett scheduled GG034 for session 1/98; the experiment will attempt to image ~ 40 faint radio sources which lie within a few degrees of a bright calibrator J1159+291.

Garrett continued to analyse wide-field EVN observations of 2016+112 and 0957+561. In the latter case, a map of the entire 15 arcsec square field was made with 15 mas resolution. For the first time relatively compact structure in the arcsecond scale jets are detected and imaged, in addition to the main quasar images and galaxy G1. The results were presented at a NFRA/JIVE open podium session.

Together with PI X. Hong, Garrett analysed MERLIN data on 1159+291. An impressive 25000:1 dynamic range map was produced showing the main features of the NE arcsecond scale jet. A proposal (PI Hong) was submitted to MERLIN, seeking observations of several EGRET radio source

candidates. Garrett continued to supervise the work of Jin Chengjin. By the end of this quarter 5 epochs of 7mm, dual polarisation data on 1830-211 had been reduced.

##### **Gurvits**

Study continued of the cosmological applications of VLBI surveys data at 6 cm with K.Kellermann and S. Frey. A paper is in a final stage of preparation. A global VSOP observation (V047r) of the high-redshift quasar 2215+020 at 1.6 GHz revealed an unprecedentedly rich core-jet structure in a quasar at  $z=3.5$ . A paper by A. Lobanov and Gurvits is in preparation.

With A.Lobanov (PI) and M.Rioja, Gurvits conducted a multifrequency phase-referencing VLBA observation of 3C345 in order to investigate

frequency-dependent effects in the geometrical properties of parsec-scale structures in quasars. The data are in the post-processing phase.

Several VSOP Survey observations with limited (up to four) ground radio telescopes have been reduced.

Schedules for VLBA survey observations at 15 Ghz were prepared in support of the VSOP Survey Programme and data from earlier observations reduced. Results so far were presented at the VSOP Survey Working Group meeting at ISAS in March. Gurvits also participated in finalizing the "first VSOP science" paper (to be submitted in the second quarter of 1998).

Gurvits and Schilizzi prepared a first draft of a section on "Active Galactic Nuclei" for the scientific proposal of the SKAI/1kT project.

### **Masheded and van Langevelde**

As a visitor at Jive, Masheded has continued to work with Van Langevelde on VLBI data taken in March 1997 on three OH stars, S Per, VX Sgr and OH53.6-0.2. The aim is to investigate the OH main line maser emission from these objects especially that coming from close to the star, where the emission mechanisms are very different from that arising from the outer layers of the circumstellar envelope. The project is in collaboration with Co-I's at Jodrell, Bristol and the CfA. One of the Co-I's, AMS Richards of Jodrell Bank visited JIVE in February to assist in interpreting the data of S Per.

The problems with cross-calibration between the four line-polarisation combinations have been overcome, resulting in some beautiful data in S Per showing the relationship between the main-line OH masers and the H<sub>2</sub>O masers at about 100 AU from the central star. A feature matching process resulted in some magnetic field estimates from Zeeman pairs and also confirmed the frame alignment from fringe-fitting. In all, about 100 components have been identified and positioned to within 1 mas.

Whilst in S Per the two main lines show similar structure, in OH53.6-0.2, the story is very different. The 1667 MHz emission is unpolarised well resolved and comes from just two positions. The 1665 Mhz emission, however, is polarised and is distributed within about 1 arcsec.

### **Massi (report for 1997 Q4 and 1998 Q1)**

By analysing long term radio observations of the binary system UX Arietis (AA in press), activity cycles have been discovered which are strongly reminiscent of those present in the Sun. It is well known that the activity cycle in the Sun is 11 years, while the general magnetic field reverses every 11 years, returning to its initial configuration after 22 years, namely after two consecutive cycles of activity.

An activity cycle of 25.5 days has been discovered in UX Arietis during which the polarization reverses and returns to its initial value after about two consecutive cycles of activity. In addition, the 25.5 days activity cycle in UX Arietis is modulated with a period of 158 days similar to the 90-110 year modulation of the 11 year cycle of the Sun. The solar activity cycle is related to the dynamo at work in the sun's interior. The fact of having, in UX Arietis, the same phenomena as in the Sun but on much shorter time scales (i.e. days instead of years) should make it possible to acquire better statistics in the future and improve our understanding of the dynamo processes.

The short period flaring activity of UX Arietis has been investigated by analysing radio spectra acquired by the Effelsberg 100-m radiotelescope (Torricelli et al). These spectra are characterized by positive spectral indexes and show the evolution of the emission during the rising phases of the flare. The usual interpretation in terms of gyrosynchrotron emission from relativistic electrons trapped in a bipolar magnetic field and undergoing collisional and radiative losses does not fit these data. For this reason a continuous injection of accelerated particles has been included in the model. The computed spectra evolve in time in agreement with the available observations.

Spurious symmetrization, an artefact of VLBI data processing in which false features are introduced into the image, was first analyzed by Linfield (1986). He demonstrated, for example, the appearance of false counter-jet features in model data with a core-jet morphology. Massi and Aaron show how this effect appears when the u-v coverage has a large central hole AND a point-like source is used as usual starting model. This is relevant for arrays which include a space telescope such as HALCA as well as for some ground-based arrays. Massi and Aaron show why the standard self calibration procedure produces these false features and how a slightly modified procedure can circumvent the symmetrization completely.

### **McKay**

McKay continued work on the recent observations of GRS1915+105. He gave a presentation of this work in March at the National Astronomy



Meeting the UK.

### **Mioduszewski**

Mioduszewski wrote a program to model relativistic precessing jets in order to fit a model to her Cygnus X-3 and SS433 observations. Mioduszewski, in collaboration with M. Rupen (NRAO) and Katherine Blundell (Oxford) received simultaneous VLBA, VLA and MERLIN observations of SS433.

### **Phillips**

Phillips used the ATCA to observe methanol masers with declinations between +10 and +45, to obtain positions of the sources with arcsecond accuracy. There are no instruments in the northern hemisphere which are capable of this accuracy at the rest frequency of methanol, 6.7 GHz. The accurate positions will be used for VLBI observations of these sources using the EVN. Reduction of the data is continuing.

He also continued processing VLBI observations of methanol masers obtained using the Australian LBA at 6.7 and 12.2-GHz. These observations are part of a multi-epoch proper-motion study of methanol masers.

### **Polatidis**

Polatidis analyzed 43 GHz VLBA observations of the quasar 1928+738, which is a part of the first epoch multi-wavelength observations with HALCA at 22 GHz, the CMVA (86 GHz) and the VLBA (43 GHz) in collaboration with D. Murphy (JPL) and J. Conway (OSO). He also scheduled the second epoch of the VLBA 43 GHz observations (BP039B).

He also made CO observations of a sample of Ultraluminous Infra-Red Galaxies with the SEST telescope in Chile. Although the weather was not ideal, CO was detected in all the nearby objects ( $v < 10000$  km/s). The more distant objects require longer integration time and will be the subject of a new proposal.

Polatidis visited M. Marcha at the Observatory of Lisbon, Portugal, to work on optical observations of a sample of flat spectrum radio galaxies and BL Lac objects. They also submitted an EVN observing proposal to complete the study of that sample at mas-scale resolution.

### **Rantakyö**

Simultaneous dual frequency (22/46 GHz) VLBA observations were made of CTA102. The aim of these observations is to obtain high dynamic maps of the central structure of this peculiar source with sufficiently high resolution to accurately determine the degree of structural changes in the source and determine the rate of superluminal expansion. The spectral evolution of components will be followed as they propagate down the jet, and the physical parameters of the plasma jet and its components determined.

The VLBA proposal has been followed up with a 3mm VLBI proposal that will be observed during the same time as the VLBA proposal and the accepted and scheduled VSOP observations. The mmVLBI proposal is further complemented with simultaneous single dish monitoring of this source.

Rantakyö et al has also submitted a continuation of the mm VLBI monitoring of the quasars 3C273 and 3C279. This is a 3 session observation campaign that will be probing optically thin emission while the 22/43 GHz VLBA observations will be looking at optically thick emission. Differences seen in the size and shape of the shocked regions at the different frequencies might be able to constrain the orientation and nature of the shocks as they leave the core.

### **Sjouerman**

Sjouerman worked on the evidence from OH/IR stars, older than one Giga-year, for an epoch of enhanced star formation in the Galactic center. This epoch possibly outlines a period in which our Galaxy could have been classified as a starburst galaxy.

## 1. Education and training

Schonewille attended a course on the basics of UNIX and a course in English.

Gurvits began to supervise a masters degree project on high redshift galaxies by B. van Dam (Leiden University), and continued to supervise S.Frey and Z.Paragi (former JIVE fellows) on their PhD Theses.

Sjouwerman continued to supervise Liu Xiang (Urumqi, China) during his three month visit to JIVE and helped Pedro Augusto (Madeira, Portugal) with the reduction of his EVN data.

## 1. Meetings, work visits, symposia, conferences

<b>Meetings, work visits, symposia, conferences</b>		
First Quarter 1998		
<b>meetings, work visits, symposia, conferences</b>	<b>date</b>	<b>name</b>
American Astronomical Society Meeting, Washington DC	6-10 Jan	Mioduszewski
Software tools for correlator operations, Dwingeloo	13-14 Jan	see below (1)
Manchester, Jodrell Bank; Ph.D. examination	19-20 Jan	Schilizzi
TWG meeting, Alcalá de Henares, Spain	19-20 Jan	Mioduszewski, Parsley, Polatidis, Gurvits, McKay, Buiters, Garrett
Observatorio Astronomico de Lisboa/Iniversity of Lisbon, Portugal, work visit.	21-31 Jan	Polatidis
Metrum, UK	31 Jan - 8 Feb	Parsley
Observations with SEST, ESO/La Silla, Chile	1-14 Feb	Polatidis
PCM tests, Metrum, UK	3-6 Feb	Parsley
Software interfaces/VEX meeting, Washington	5-6 Feb	van Langevelde
AIPS++ Scientific and Technical Advisory Group, Socorro	9-10 Feb	van Langevelde
Bristol; Ph.D. examination, work visit	13-19 Feb	Mashedier
DPU FAT, Metrum, UK	16-18 Feb	Parsley, Casse, Buiters
RISC meeting, Neuchatel, Switzerland	23-25 Feb	Gurvits, Schilizzi
SVLBI IACG meeting Neuchatel, Switzerland	25 Feb	Gurvits, Schilizzi
VISC meeting, Neuchatel, Switzerland	26 Feb	Gurvits, Schilizzi
Working visit, MPIfR, Bonn, Germany	9-12 Mar	Sjouwerman, McKay
DPU FAT, Metrum, UK	12-13 Mar	Parsley, Buiters
Station Unit tests, Metrum, UK	16-17 Mar	Parsley
Thin film array headstacks, Boston USA	17-22 Mar	Casse
VSOP Survey Workshop Sagami-hara, Japan	23-30 Mar	Gurvits
National Astronomy Meeting, UK	30-31 Mar	McKay

(1) Van Langevelde, Noble, Verkouter, Klijn Hesselink, Garrington, Parsley, Casse, Schonewille, Kramer, Leeuwinga, Buiters, Schilizzi

## 1. Presentations

**Garrett:**

"Wide-field EVN observations of 2016 + 112 and 0957 + 561", Open Podium, Dwingeloo

**Gurvits:**

"EVN/VSOP operations" EVN TWG meeting, Alcalá, Spain, 19 January

"A concept of the next generation SVLBI mission SVLBI IACG panel", Neuchâtel, Switzerland,  
25 February

"Postprocessing of VSOP data with a limited number of ground radio telescopes". VSOP Survey workshop Survey data, Sagamihara, Japan,  
25 March

**Massi:**

"Activity Cycles in UX Arietis-comparison with the Sun" MPIfR, Bonn, 6 February

**McKay:**

"Recent MERLIN observations of GRS 1915 + 1-5", National Astronomy Meeting, UK, 31 March

**Pogrebenko:**

"Kirchhoff Integral Direct Digital Imaging" Presentation at SKAI Lunch, 30 January, Dwingeloo

**Schilizzi:**

"Status of the EVN Data Processor at JIVE", VISC meeting, Neuchâtel, Switzerland 24 February

**Sjouwerman:**

"Ancient starburst activity in the Galactic center", NFRA, Dwingeloo, 13 March

1. Publications

**Published:**

J.A.D.L. Blommaert, W.E.C.J. van der Veen, H.J. van Langevelde, H.J. Habing, L.O. Sjouwerman, "The Nature of OH/IR stars in the Galactic centre", 1998, A&A, 329, 991

L.I. Gurvits, J. Roland, K. Demyk, "VLBI surveys as a tool for cosmological tests", 1998, in *Observational Cosmology with the New Radio Surveys*, eds. M.N. Bremer, N. Jackson and I. Pérez-Fournon, Kluwer Acad. Publishers, 227-232

H.J. van Langevelde, J.A. Brauher, P.J. Diamond, R.T. Schilizzi, "Phase-referenced VLBI observations of the OH masers around U Her", 1998, in the Proceedings of "Planetary Nebulae, IAU 180", eds. H.J. Habing & H.J.G.M. Lamers, Kluwer, p. 373

C.J. Phillips, R.P. Norris, S.P. Ellingsen and D.P. Rayner, "A comprehensive search for extragalactic 6.7-GHz methanol masers" 1998,

MNRAS, 294, p265

A. Polatidis, P.N. Wilkinson, "Superluminal motion in the parsec scale jet of 3C380", MNRAS, 294, 327

L.O. Sjouerman, H.J. van Langevelde, A. Winnberg, H.J. Habing, "A new sample of OH/IR stars in the Galactic center", 1998, A&AS 128, 35-65

**Submitted:**

Rantakyro et al: "50  $\mu$ s resolution VLBI Images of AGN's at mm", 1998, A&AS, accepted

C.Cosmovici, S.Montebugnoli, S.Cortiglioni, S.Pogrebenko, "The puzzling detection of the 22 GHz water emission line in the comet Hyakutake at perihelion", Planetary and Space Science, in press.

J.-F. Desmurs, A. Baudry, T.I. Wilson, R.J. Cohen & G. Tofani, 1997,, "VLBI Maps and Properties of the 6 GHz OH Masers in W3(OH)" A&A accepted

M. Massi, J. Neidhöfer, G. Torricelli-Ciamponi, F. Chiuderi-Drago "Activity Cycles in UX Arietis" in press A&A

I. Owsianik, J.E. Conway, A.G. Polatidis, "An extragalactic radio source of age 370 years: a recently reborn source?", submitted to A&A Letters.

C.J. Phillips, R.P. Norris, S.P. Ellingsen and P.M. McCulloch "Methanol Masers and Their Environment at High Resolution" submitted to MNRAS

L.O. Sjouerman, H.J. van Langevelde, P.J. Diamond, "Stellar positions from SiO masers in the Galactic center", submitted to Astronomy and Astrophysics.

G. Torricelli, E. Franciosini, M. Massi, J. Neidhöfer "Radio flares from the active binary system UX Arietis" A&A in press

Other papers

M. Massi, G. Tuccari, S. Orfei "Project for a Digital Polarimeter. Part I: Relationship between D terms and the instrumental polarization vector" EVN Doc 81/1997

Maccaferri, G., Rantakyro, F.T., 1998, "ANTM5, Programma di controllo della parabola di Medicina", Internal Report, IRA/CNR 251/98

