HALF-YEARLY REPORT

Report for the period January – June 2004
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1. Institute and Summary of Activities

First Real-Time e-VLBI Astronomical Image

There can be little doubt that the first half of this year was dominated by various successes in the field of e-VLBI, both for JIVE specifically and the EVN generally. In April the first real-time e-VLBI image was generated, representing an important milestone on the path towards using this new technique as an operational scientific tool. By the summer 5 EVN telescopes were “on-line”, including the Torun 32-m telescope in Poland. Progress has been so rapid in this area, that the EVN board of directors instructed John Conway (OSO) to arrange the first real-time e-VLBI science tests – to be conducted in September 2004. These science tests will focus on spectral-line observations where data rates of 32 Mbps/telescope are typical. The final goal is to realise 128 Mbps data rates in order to demonstrate the feasibility of using real-time e-VLBI for wide-band continuum experiments. It’s thought that even higher data rates should be possible in the short-term but this awaits some of the telescope connections to be upgraded. JIVE has played a central role in organizing various e-VLBI technical tests and significant effort has also gone into upgrading the correlator on-line software in order to be able to handle real-time data flows. JIVE has also been active in seeking support for e-VLBI activities at the European funding level – in particular we have participated in various IST related meetings and an EU delegation to North America. Our long-term goal is to see if we can get funding to support the current level of e-VLBI activities and significantly expand upon them.

Correlator hardware and software

As e-VLBI came of age, the first of the original Penny & Giles tape recorders were retired. This has been necessary in order to make room for the new Mk5 units. The correlator can now be configured to process data in one pass from 14 tape units plus 2 Mk5 units, 10 tape units and 6 Mk5 units or anything in between these two extremes. Several improvements have been made to the correlator software, in addition to making it e-VLBI capable. A new feature is the correction for LO-offsets which is used to compensate for occasional errors in the frequency setting of telescopes in a VLBI experiment. This allows us to salvage important observations that otherwise would not yield the full scientific output. In addition improvements were made to the efficiency of Mk5 processing, and the behaviour of the correlator under a new compiler was successfully tested. A particular highlight of this reporting period was the start of the ALBUS (FP6 RadioNet) project. Several excellent applicants applied for the ALBUS post-doc and software engineering positions and appointments are in the process of being made. The PCInt hardware was installed in March and apart from a few teething problems the performance looks good. There is still a lot of software and hardware development required before the system can become operational.

Software Correlation

Over the last year, JIVE has taken the lead within the EVN regarding the use of the CRL Software Correlator, in conjunction with ftp-VLBI observations. These ftp-VLBI observations are now standard features of EVN sessions and permits us to provide feedback to the telescope staff on time scales of 24 hours or less (depending on the telescope internet connection). The arrival of a new Linux PC cluster (funded by the NL-GRID project, ASTRON & JIVE) has speeded-up the ftp-VLBI processing by a factor of 30, by spreading the data by baseline/CPU node.

RadioNet FP5 & FP6

The RadioNet FP6 I3 formally started on the 1 January 2004. JIVE’s role in RadioNet is substantial. The network is coordinated by Prof. Phil Diamond (JBO) and Leonid Gurvits (JIVE) is the RadioNet Project Scientist. Although the main project administration is located at Jodrell Bank, Marjan Tibbe (JIVE) also provides additional administrative support, in particular for those aspects of the RadioNet administration for which JIVE is responsible – this includes the management of the RadioNet travel funds for the Transnational Access Programmes and Network Activities. JIVE is also responsible for the EVN Access Contract. As RadioNet FP6 started, so RadioNet FP5 ended with the successful submission of the RadioNet and EVN Access FP5 annual and final year reports.
SKA Design Study Proposal

JIVE was involved in the preparation of the proposal to the European Commission on the SKA Design Study (SKADS) project. The Institute's specific task deals with the SKA science and technology simulations for which it is the coordinator. The overall coordinators are Arnold van Ardenne (ASTRON) and Peter Wilkinson (JBO). The proposal was submitted to the Commission in March 2004. It is crucial for JIVE and the future of European Radio Astronomy in general, that the proposal is funded. A decision is expected by the end of 2004.

ESA-JIVE Huygens Contract

At the JIVE board meeting in Onsala in May, the board decided that JIVE should continue to pursue a contract with ESA that would see JIVE lead an international effort to track the decent of the Huygens planetary probe onto the surface of Titan. This is undoubtedly one of the most ambitious space missions to date, and at JIVE we are delighted to play a part in it. The contract with ESA will also have very important spin-off benefits for JIVE’s core activities, in particular it will permit us to begin work on our own Software Correlator and replace all the tape units with Mk5 systems. By employing the technique of VLBI, we hope to be able to pin-point the location of Huygens probe to a ~ km precision throughout the period of its descent (expect to last 1.5 – 4 hours). This, plus other developments at JIVE, is expected to bring our staff complement to a record high of 28 employees by the end of the year.

Related to the ESA Huygens contract, JIVE was recently invited to join a new EC funded Coordinated Activity project called EUROPLANET. This is similar in scope to RadioNet but the topic here is planetary science. Together with ESTEC, JIVE represents the Netherlands contingent in this interesting new project.

Figure 1: Artists impression of Huygens descending onto the surface of Titan by parachute.

Astronomical Molecules Workshop

A European workshop entitled “Astronomical Molecules” was recently held in Zwolle. The meeting co-sponsored by ASTRON & JIVE was the first meeting to also be supported by RadioNet. Yoshiaki Hagiwara (a.k.a.”Hagi”) and Hiroshi Imai came up with the original concept for the meeting, while Hiroshi was working
for JIVE last year. The meeting (co-chaired by Willem Baan and Huib Jan van Langevelde) was a great success, with many participants noting the excellent atmosphere that pervaded the entire meeting. All the presentations in the Workshop will be published in the Proceedings as a special issue of Astrophysics and Space Science.

Figure 2: Group photo of the participants of the Astronomical Molecules Workshop

Workshop on "Interstellar Scintillation of Extragalactic Radio Sources"

A small, international scientific workshop was held at ASTRON/JIVE, Dwingeloo, from 5-7 April 2004. The workshop was sponsored by NOVA, JIVE and ASTRON. The aim was to gather researchers interested in current problems relating to scintillation, in particular of intraday variable quasar, BL Lac and Gamma-Ray Burst sources, and to address directions for future research. Members of the SOC were Hayley Bignall (JIVE), Ger de Bruyn (ASTRON, Chair), Leonid Gurvits (JIVE), Dave Jauncey (ATNF) and Jean-Pierre Macquart (Kapteyn Institute, Groningen). The LOC was made up of the SOC members from Dutch institutes, as well as Nanuschka Csonka (ASTRON) and Marjan Tibbe (JIVE). There were around 25 participants (pictured), plus other interested “locals” sitting in for some sessions. This was a small enough group to allow all participants the opportunity to give a talk, with plenty of time for fruitful discussions. Presentations are available on the workshop web-site: http://www.jive.nl/meetings/iss_workshop/
Staff Science Output

JIVE staff led or were involved in several exciting new results, including a fantastic EVN 1.4 GHz image of the gravitational lens system CLASS B0128+437 (Biggs et al). Other highlights included the completion of Brunthaler’s PhD thesis and Van Langevelde’s leading role in evaluating the possibility of JCMT participation in the eSMA (extended Sub Millimetre Array) project. During the period of this report 9 papers were published in scientific journals or conference proceedings, and a further 12 were submitted for publication. 24 oral and 4 poster presentations were made at scientific meetings/colloquia, as well as a number of other presentations at management meetings and during tours of the correlator.

The institute was happy to host 17 visitors during the semester, many of whom made extensive use of the support facilities.
2. **Science Operations and Support**

2.1 **Production correlation**

**Sessions and their Experiments:**

The February 2004 EVN session had a total of 13 user experiments. A notable milestone was the first sub-second integration-time user experiments (5). Six experiments required multiple correlation passes:

- 512Mb/s experiments using at least one tape (3)

- Experiments whose requested correlator load required separate correlation passes by subband/polarization (3).

Three stations were regularly recording onto Mk5 disks.

The May 2004 EVN session had a total of 14 user experiments. A UHF session was included for the first time since September 1999. A wheel girder on the Lovell telescope showed early signs of a fatigue crack, which limited its slewing during the session to 1 source-change cycle per 10min, so many PIs opted to use Jb2 for phase-referencing observations, even at L-band. There was a large fraction of global experiments (more than half of the non-UHF experiments). Several experiments used ambitious frequency schemes within L-band to attack redshifted HI and OH. There was an additional sub-second integration time experiment, and one experiment that required multiple passes (continuum/line, with the line pass itself requiring separate passes by polarization). Up to eight EVN stations regularly recorded onto Mk5 disks, but there were no all-disk user experiments yet (a couple of 8-disk/1-tape).
The table below summarises projects correlated, distributed, and released this half-year. The tale lists the number of experiments as well as the network hours and correlator hours for both user and test/NME experiments. Here, correlator hours are the network hours multiplied by any multiple correlation passes required (e.g., continuum/line, >16 station, 2 head stacks, different phase centers, etc.)

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Not reflected in the table is GI001A, which was abandoned with the agreement of the PC, because it was scheduled in a way that would have required correlation with over-sampling x8 - not a feature we currently have available nor have ever advertised.

The following table summarizes by session the user experiments still in the queue (entries = remaining to do / total). Here, the time units are different from "Corr_hr" above; they approximately incorporate known overheads in starting jobs. The actual correlator time is typically between 1.5-2.5 times these estimates, depending on the number of re-dos or other problems.

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<td>0/9 0/161 hr *totals adjusted for the abandonment of GI001A</td>
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<td>May'04</td>
<td>11/14 220/264 hr</td>
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Experiments remaining from previous sessions are described below:

May'03:
EM048 - awaiting PIs to provide revised coordinates for their targets based on a preliminary correlation pass we did for them using only short baselines and a short integration time.

Feb'04:
EA029 - currently running its second and third correlator passes, after the PI had reviewed the initial correlation pass.
GG053a/b/c - require 4 passes each (each subband/polarization uses the full correlator). Awaiting >2GB correlator output-file support and small upgrades to the PCInt network infrastructure.

Part of one old user experiment remains on hold because it used 40 ips recording, which would require speed-up to correlate, for some modes.

The table below provides a more detailed listing of all projects having any activity -- correlation, distribution, or release - during the year.

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<td>F04M1</td>
<td>240204</td>
<td>Paragi NME</td>
<td>190304</td>
<td>130404</td>
<td>260404</td>
<td>Paragi</td>
<td></td>
</tr>
<tr>
<td>F04U1</td>
<td>260204</td>
<td>Paragi NME</td>
<td>100304</td>
<td>130404</td>
<td>260404</td>
<td>Paragi</td>
<td></td>
</tr>
<tr>
<td>TE010</td>
<td>250304</td>
<td>Reynolds TEST</td>
<td>250304</td>
<td>250304</td>
<td>250304</td>
<td>Reynolds</td>
<td></td>
</tr>
<tr>
<td>TE011</td>
<td>250404</td>
<td>Paragi TEST</td>
<td>200404</td>
<td>260404</td>
<td>030504</td>
<td>Paragi</td>
<td></td>
</tr>
<tr>
<td>TE012</td>
<td>230404</td>
<td>Paragi TEST</td>
<td>230404</td>
<td>260404</td>
<td>030504</td>
<td>Paragi</td>
<td></td>
</tr>
<tr>
<td>TE013</td>
<td>230404</td>
<td>Paragi TEST</td>
<td>230404</td>
<td>260404</td>
<td>030504</td>
<td>Paragi</td>
<td></td>
</tr>
<tr>
<td>TE014</td>
<td>230404</td>
<td>Paragi TEST</td>
<td>230404</td>
<td>260404</td>
<td>030504</td>
<td>Paragi</td>
<td></td>
</tr>
<tr>
<td>TE015</td>
<td>230404</td>
<td>Paragi TEST</td>
<td>230404</td>
<td>260404</td>
<td>030504</td>
<td>Paragi</td>
<td></td>
</tr>
<tr>
<td>R04N2</td>
<td>260404</td>
<td>All telescopes NME</td>
<td>140504</td>
<td>240504</td>
<td>220604</td>
<td>Schonewille</td>
<td></td>
</tr>
<tr>
<td>TE016</td>
<td>280404</td>
<td>Paragi TEST</td>
<td>280404</td>
<td>030504</td>
<td>100504</td>
<td>Biggs</td>
<td></td>
</tr>
<tr>
<td>TE017</td>
<td>280404</td>
<td>Paragi TEST</td>
<td>280404</td>
<td>030504</td>
<td>100504</td>
<td>Biggs</td>
<td></td>
</tr>
<tr>
<td>TE018</td>
<td>280404</td>
<td>Paragi TEST</td>
<td>280404</td>
<td>030504</td>
<td>100504</td>
<td>Biggs</td>
<td></td>
</tr>
<tr>
<td>TE019</td>
<td>280404</td>
<td>Paragi TEST</td>
<td>280404</td>
<td>030504</td>
<td>100504</td>
<td>Biggs</td>
<td></td>
</tr>
<tr>
<td>F04C2</td>
<td>170504</td>
<td>Polatidis NME</td>
<td>140604</td>
<td>200404</td>
<td>260404</td>
<td>Paragi</td>
<td></td>
</tr>
</tbody>
</table>
The following plots show (a) the work division among various correlator tasks (production, clock-searching, network tests, correlator tests) as a number of hours per week; (b) correlator efficiencies (completed correlator hours per production time, completed correlator hours per total time, completed network hours per total time) as percentages; and (c) backlogs of the various experiment statuses (correlation, distribution, release), expressed as the sum of correlator hours. All plots cover the past three years, with Jan-Jun'04 highlighted. Plots (a) and (b) show 6-week moving averages; plot (c) shows a snapshot every week. In plot (a), you can see the drop in production hours at the time we cleared the backlog and construction in the basement was proceeding. Further, the bursts of time spent on network tests in and immediately following sessions are apparent. In plot (b), the ratio between the production yield (red) and correlator yield (green) lines is simply another measure of the ratio between production and total hours. The difference between the correlator yield (green) and network yield (blue) lines stems from experiments that need multiple passes (around autumn 2003 we were correlating the >16-station experiments from the May'03 session).
Logistics/Infrastructure

We currently have 14 working tape playback units (DPUs) and eight Mk5A units attached to the station units (SUs) for operations - 2 fully connected to their SUs and 6 sharing an SU with a DPU. Another two Mk5A units are in house. We have a medium-term plan to shift to a 12-12 DPU/Mk5 mix (4 Mk5s fully connected, 8 sharing with a DPU), but this needs to wait for completion of the last three experiments (these have 13 stations recorded on tape).

Shipping tapes prior to the 2004 sessions has proven very simple. The explanation is of course that more stations are going over to disk, so the demand for tapes is decreasing (only 88 tapes had to be shipped for the May/June’04 session, out of a total of 236 free to ship). The situation of a disk-based EVN and a tape-based VLBA, where most global-experiment correlation occurs at JIVE, raises the need to balance the trans-Atlantic tape flux by sending tapes to NRAO; we sent 60 tapes to Socorro to cover the May/June 2004 session. This should not affect EVN operations in terms of tape supply, but does incur a cost for the shipping, which we can reduce by anticipating the need and sending fewer shipments, each of a larger number of tapes by sea.

Shipping disks is somewhat more complicated, because disk-packs aren’t all identical. Currently, the scheduler and TOG chairman determine how much data storage is required by each station in the upcoming session, and we are told how much to ship to meet the shortfall. Using the policy that stations should buy two sessions’ worth of disks, for the May/June’04 session we should have replenished disks received from November’03. The following table compares this with what we actually shipped:

<table>
<thead>
<tr>
<th>N_pk</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rcvd Nov’03</td>
<td>20</td>
</tr>
<tr>
<td>shipped May’04</td>
<td>28</td>
</tr>
</tbody>
</table>

We distributed more disks than conventionally required to allow a couple of stations to try to record on Mk5 for at least part of the May’04 session. This sort of indulgence isn’t sustainable, but the hope is that the longer-than-average gap between the May and November sessions will allow stations to get the disks they’re responsible for in time to preclude a similar situation arising then.

Further, with multiple experiments recorded on disk-packs, releasing disk-packs is no longer a one-to-one function of completing experiments. Currently, we prioritize correlation for network tests, experiments with PhD-student authors, experiments for which people want to visit at a specific time, etc. And of course, some experiments have to be kept longer because of capability issues. Only after such experiment-specific factors do observing chronology enter in. An illustrative example: in Feb’04, there were 9 test experiments, and three stations were disk-only throughout the whole session. The table below summarizes disk usage and “releasability” at the time of completing all the test experiments for these stations:

<table>
<thead>
<tr>
<th>Total number of disk-packs in session</th>
<th>Ef</th>
<th>On</th>
<th>Wb</th>
<th>tot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of disk-packs involved in tests</td>
<td>6</td>
<td>7</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>Releasable disk-packs after finishing tests</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

We may have to put higher weight to chronology in determining correlation sequence, in order to release disk-packs at a reasonably constant rate. The real test will come prior to the May 2005 session when stations will expect their Nov’04 recordings back:

- by then the whole EVN should be disk-based, and
- of the pairs of sessions separated by two, Nov->May has the shortest gap.
2.2 EVN support

Network Monitoring, Reliability, and Performance

We continue to process NMEs via the pipeline, with results being posted to the EVN web pages and EVN Reliability Indicators (ERI) calculated. There were considerably more NMEs and fringe tests in the past two sessions than usual. The February 2004 NMEs focused on 1Gb/s – actually observed as 512Mb/s one-bit experiments to allow stations without a Mk5 to participate. A key goal was to characterize the available bandwidth at the four common bands (L, C, X, K). There were an additional two new-receiver fringe tests: at UHF (Wb, On, Nt, Ur, Tr fringes) and 5cm (Wb, Nt, Hh fringes, but not to Mc). In May 2004, the C- and L-band NMEs doubled as phase-reference tests, and there was an additional 1Gb/s test for stations who weren’t able to participate in the previous session, as well as a special test experiment investigating a phase-referencing tactic using both Jb1 and Jb2, in light of Jb1’s reduced slewing capabilities.

The ftp fringe tests continue for stations equipped with Mk5 units. Fringes were not seen to Effelsberg in F04C1; the quickness of the feedback allowed them to find an LO problem and repair it before the C-band session itself started. In the May 2004 session, both dedicated fringe-tests and NMEs had ftp scans scheduled. Fringes can typically be reported back the same day, provided that stations send their file(s) in time. We have ported the NICT (formerly CRL) software correlator in routine use for processing ftp'd data to the JIVE/ASTRON NL-GRID cluster computer.

Table: Reponse times & ERIs for Fringe-Tests & NMEs

<table>
<thead>
<tr>
<th>Expt</th>
<th>Obs. Date</th>
<th>Feedback</th>
<th>Report</th>
<th>Pipeline</th>
<th>ERI</th>
</tr>
</thead>
<tbody>
<tr>
<td>F04K1</td>
<td>4 Feb</td>
<td>2 days</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>N04K1</td>
<td>11 Feb</td>
<td>15 days</td>
<td>19 days</td>
<td>27 days</td>
<td>0.32</td>
</tr>
<tr>
<td>F04C1</td>
<td>12 Feb</td>
<td>1 day</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>N04X1</td>
<td>12 Feb</td>
<td>12 days</td>
<td>18 days</td>
<td>26 days</td>
<td>0.53</td>
</tr>
<tr>
<td>N04C1</td>
<td>14 Feb</td>
<td>4 days</td>
<td>154 days</td>
<td>25 days</td>
<td>0.74</td>
</tr>
<tr>
<td>N04L1</td>
<td>20 Feb</td>
<td>10 days</td>
<td>11 days</td>
<td>47 days</td>
<td>0.57</td>
</tr>
<tr>
<td>F04M1</td>
<td>24 Feb</td>
<td>16 days</td>
<td>-</td>
<td>22 days</td>
<td>-</td>
</tr>
<tr>
<td>F04U1</td>
<td>26 Feb</td>
<td>10 days</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>F04C2</td>
<td>17 May</td>
<td>same day</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>N04C2</td>
<td>20 May</td>
<td>1 day</td>
<td>9 days</td>
<td>Nyd</td>
<td>nyd</td>
</tr>
<tr>
<td>N04U1</td>
<td>30 May</td>
<td>1 day</td>
<td>14 days</td>
<td>31 days</td>
<td>0.32</td>
</tr>
<tr>
<td>N04L2</td>
<td>3 Jun</td>
<td>same day</td>
<td>nyd</td>
<td>20 days</td>
<td>0.67</td>
</tr>
</tbody>
</table>

The ERI (EVN Reliability Indicator) is the ratio of:

\[
ERI = \frac{\text{No. of visibilities contributing to final image}}{\text{No. of visibilities expected from the block schedule}}
\]

or \( ERI^* = \frac{N_e(N_e - 1)}{(N^*(N-1))} \)

where N is the number of telescopes in the block schedule and Ne is the number of antennas producing good visibilities, which can be a mixed number reflecting partial losses (e.g., a subset of subbands were bad, a fraction of time was lost to station problems). ERI takes into account all failures that were detected while reviewing the data. ERI* excludes problems that were outside of the EVN’s control (e.g., bad weather) or associated with the nature of NME correlation (e.g. sometimes tapes do not arrive in time to be processed – even for production correlation). For the experiments above, \( ERI^* = ERI \).
Stations have made strides in measuring their $T_{\text{cal}}$ as a function of time and frequency, although of course improvements could still be made, especially in the timeliness of creating the RXG files. We have compiled median gain corrections over the past few sessions, and the overall situation is improving, especially for the most-used bands. K-band is still a problem, and there is a tentative suggestion that stations with VLBA racks seem to require larger corrections than stations with MkIV racks. The pipeline provides stations with feedback on gain corrections for all experiments correlated, both NMEs/fringe-tests and user experiments.

A new release of the field system is expected soon. It should provide more transparent control of e-VLBI operations, improves the monitoring of remaining disk capacity, and continues progress towards continuous $T_{\text{sys}}$ measurements at EVN stations. A new release of SCHED is expected shortly after the May 2004 session. It should provide full support for disk scheduling, and for scheduling ftp transfers and e-VLBI operations directly.

2.3 PI Support

The EVN archive at JIVE is up and running. This provides web access to the standard plots, pipeline results, EVN feedback reports from the stations, and following a 1-yr proprietary period, the FITS data themselves and automatically generated images of target sources. There are capabilities to search by experiment or by source (via the Bologna web page). All user experiments distributed to the PIs continue to be pipelined; no PIs have requested that their data not be pipelined. Off-source flagging files generated from the field-system logs are also available to PIs via the pipeline results. The pipeline scripts are being modified to be able to distinguish between individual sources identified by PIs as being immediately public or subject to the 1-year proprietary period.

We have overhauled the JIVE web pages and given them a more user-friendly and attractive appearance; a similar review of the EVN pages is in progress. Much of the content is being updated, including a new document going over the field-of-view improvements resulting from the shorter integration times. We tested the wider fields of view enabled by the shorter integration times by correlating an NME with coordinates offset by 120° and comparing the resulting image with that from the original correlation; loss of peak brightness and image broadening were consistent with expectations. The February'04 session marked the first opportunity to request sub-second integration times; five user experiments did so (one of these experiments holds a new JIVE record for resulting-FITS-size: 93.998 GB). We have also added some field-of-view capabilities to the “EVN calculator” on the EVN web pages. These are currently reported as the FoV having <10% reduction in the response to a point source for the specified observing/correlation configuration; we aim to add more flexibility by allowing computations of percent loss at a specified radius as well as considering image broadening. The EVN calculator also shows whether the specified correlation configuration can be processed in a single pass.

Together with the EVN scheduler, we made a targeted effort to initiate PI help with scheduling for the May 2004 EVN session. This was useful, especially in light of the experiments at unusual frequencies (UHF, highly red-shifted HI, OH) and the number of inexperienced PIs. All PIs were contacted a couple weeks prior to the schedule due-date, and all but one received help in some form in the scheduling process. Nonetheless, post-schedule-deposit review caught a couple problems that could have compromised observations. These were cleared up following some iterations with the PIs. There is currently no known loss of data resulting from these problems. The relative success of this evolution, which was compressed into a day-and-a-half around the schedule due-date, gives rise to some optimism for the future idea of having a few-day period to check over schedules once deposited by the PIs and prior to the stations beginning to download them.
We have began a process of replacing outdated workstations in the visitors' room.

### 3. Software Development

#### 3.1 Correlator software

Work continued on porting the correlator control software to a modern compiler. By the end of June this resulted in a new version of the JIVE Correlator Control Software (JCCS) built with the GNU3.2 compiler. This should have allowed the use of the Purify package to check against run-time problems, but unsupported platform features (HP-UX 10) frustrated this. We encountered similar problems with C++ constructs, QT interfaces (for graphics) and socket++ interfaces.

The operational flexibility for mixed disk/tape configurations was improved by initiating a database, which describes the tape- or disk drive connection of each station unit. This allows changes of the correlator set-up without modifications to the project description files. Furthermore the ability to handle gaps in the observation schedule of Mark5 observations was improved, as well as the logic to servo disk units.

Several smaller processing control problems were also fixed. This included the configuration for 16MHz/LSB measurements, polynomials around midnight, and mixed fan-outs in a single job. The correlator at JIVE can now deal correctly with LO offsets. A problem with timing mismatches in reading data frames from the correlator occurred several times, requiring the attention of the software group.

An effort was made to support data files larger than 2GB. At the highest dump-rate 8-minute scans would run into this problem. This was not a trivial change because in the previous data format only 32bits were reserved for file-offsets. The upgrade to 64bits thus required a change of the layout of the files.

The software to exercise the station units in an offline fashion was upgraded to work with disk systems as well. The software that maintains the correlator logbook was upgraded to use a proper database and can now be accessed over the web.
3.2 Logistic software

Work on the data archive focused on protection issues for web access. The archive web pages were upgraded to include the pipeline products. Work started to build up a collection of the meta-data of the archive.

3.3 ALBUS

Work on the ALBUS project started this semester with a kick-off meeting at Schiphol, attended by all participants. Several guidelines for running the project were accepted. This resulted in an effort to adopt the Primavera system for hour registration for the software group at JIVE.

Two new employees were expected to start employment at JIVE in the second half of 2004.

As agreed, initial work started on user requirements. There was also attention for the issue of a common software platform for ALBUS deliverables. An international meeting to discuss the options with other parties was organized in Dwingeloo.

4. Technical Operations and R&D

4.1 Data Processor Maintenance

Data Playback Units

Problems with failing capstan motors continued. In total five motors were returned to Metrum IS for repair. One reel motor also failed, and two headstacks wore out and had to be replaced. Aided by the growing use of Mark5, it was possible to juggle available working units to avoid any serious impact on the production schedule. One of the headstacks purchased from Metrum IS was found to be faulty. This was returned and replaced under warranty. With the exception of capstan motors, all problems were repaired in-house.

Metrum IS announced that they would be moving premises in the next few months but assured JIVE that there would be minimal interruption in service. As a consequence of the move Metrum IS have offered for sale a large stock of redundant components. A list was placed on the JIVE web pages and some interest has been shown in the UK and China.

Station Units

Reliability problems with TRMs persisted. One of the spare Station Units was commissioned and set to work as a test bed. Mark5 provides a convenient data source and off-line test software enables a thorough checkout of TRMs in an operational state. Cleaning the contacts on the DRAMs produced some improvement but plans to find a more “scientific” approach to trouble-shooting were made. The TRMs, and other boards in the SU, use a Motorola microcontroller that has an on-board, Background De-bug Mode (BDM) facility. Via a port on the micro it is possible to view and control the processor externally from a PC. The BDM port is bought to a front panel connector on all of the relevant SU boards. A special interface and software are also needed; these were "rescued" from Metrum IS last year. One of the original SU software designers was contacted and has accepted a contract to set up a test station using the BDM facility and to write some test software.

The 6.25s low-weight, high auto-correlation problem identified at the end of 2003 was traced to “feature” of byte slip fix. Before Mark5 all byte-slips were +ve and the Xilinx modification was able to repair the offset in one track frame. With Mark5 data -ve byte slips also occur, and these take 2499 frames to be repaired. Why the use of Mark5 provokes -ve byte slips is unknown. Possibly the highly synchronised transitions in the data cause a different kind of cross-talk. A new design, able to fix any byte-slip within a single frame was prepared and deployed throughout. Other Mark4 correlators were notified of the change.
## Hardware Failures & downtime

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Failures/Downtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPU</td>
<td>6 failures/6h 0m downtime</td>
</tr>
<tr>
<td>Mark5</td>
<td>2 failures/16h 0m downtime</td>
</tr>
<tr>
<td>SU</td>
<td>1 failures/3h 30m downtime*</td>
</tr>
<tr>
<td>Correlator</td>
<td>1 failures/12h 0m downtime</td>
</tr>
<tr>
<td>Totals</td>
<td>10 failures/37h 30m downtime</td>
</tr>
<tr>
<td>Number of infrastructure breakdowns</td>
<td>2 failures/41h 0min downtime</td>
</tr>
<tr>
<td>Mean operational time between re-starts of online control software</td>
<td>No statistic for this period</td>
</tr>
<tr>
<td>Projected life-time of heads</td>
<td>2043 hours</td>
</tr>
</tbody>
</table>

* Includes 3h TRM PROM upgrade, all units
Includes individual board failures.

## Number of damaged thin tapes

<table>
<thead>
<tr>
<th>Status</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damaged during correlation</td>
<td>4</td>
</tr>
<tr>
<td>Received damaged</td>
<td>13</td>
</tr>
<tr>
<td>Not certain when damaged</td>
<td>3</td>
</tr>
</tbody>
</table>

## Production Mark5s

The total number of Mark5 units at JIVE grew to nine during the period, four purchased by JIVE and five donated by other EVN institutes. One unit was loaned to Torun to allow them to take part in Mark5 tests during the May session and to participate in FTP fringe tests. Torun have ordered their own Mark5; the JIVE unit will be returned when this is delivered.

Generally the Mark5s performed reliably and became a stable platform for production correlation. Some initial problems were related to the variety of software and firmware versions in use. Action was taken to ensure that all were brought to a common standard and that future revisions would be applied universally.

The only major failure was in one of the backplanes. Just as one of the disk packs was being withdrawn the "lock" and "power" LEDs on the front panel turned on again, accompanied by a smell of burning insulation. Later it was found that the right-hand backplane connector on this unit was powered-up all the time. The problem was traced to a missing a solder connection that made the electronics on the backplane and the StreamStore card think that there was a diskpack inserted all the time. Removing the 8-pack under these circumstances from the Mark5 unit caused the destruction of several other components. JIVE personnel made good the missing connection, replaced the damaged components and the unit worked normally. Conduant were informed. After some investigation they acknowledge that the failure was thoroughly diagnosed by JIVE and the fault was probably a manufacturing/inspection error at the company they use for PCB assembly.
Infrastructure

There was some down-time due to failures of the cooling system. Most of these were trivial but one occurred at the weekend and temperatures in the data processor began to climb enough to cause concern. One set of alarms produced by the cooling machine itself had been switched off to inhibit false alarms from the humidity control system. This is safe because another system automatically switches off power if the temperature gets too high. Nevertheless it was decided that an advance warning would be useful so additional sensors were installed and connected into the alarm system. Subsequent similar failures were indeed alerted to the standby personnel.

4.2 Data Processor Developments and Upgrades

Mark5

A small modification to the Mark5 I/O board was devised to allow re-programming of the on-board logic without removing the board. The I/O panel was also re-positioned to allow access to the Gigabit Ethernet boards installed in JIVE Mark5s for eVLBI.

Infrastructure

A start was made on the major changes needed to accommodate Mark5 (see figure 5). The oscilloscope cabinet was disconnected and removed and two DPUs were taken out of service. This left enough room for two new cabinets to be installed. A total of six Mark5s were installed in these two cabinets, two with their own, dedicated Station Units and four sharing the SU in adjacent DPUs. Eventually, as more DPUs are removed, more new cabinets will be added, each housing two Mark5s and their respective SUs. The dimensions of the new cabinets do not match the footprint of the DPUs so changes in cable and cooling air routing are also required.
Other infrastructure changes:

Fibre-optic lines were installed under the floor, and into the adjacent computer room for the eVLBI, Gigabit Ethernet connections to Amsterdam and Westerbork.

A new UPS with more power was installed. This UPS is able to drive all the network stations that are in use in the processor room.

Further modifications were made to the Paternoster to accommodate Mark5 disk-packs and the chain was re-tensioned.

The upper room of the Paternoster was modified, largely to create better storage space for Mark5 shipping boxes.

All thick tapes were removed from the paternoster and disposed of.

One of the tape trolleys was modified to make it suitable for the transport of hard disk modules.

4.3 Technical R&D Projects

PCInt hardware

In March 2004, the PCInt cluster was delivered by TTEC (see figure 6). After some days of configuring and experimenting with the setup the delivery was accepted. The hardware performs very well. Measured transfer speeds to disk are at least 160 MByte/s/unit (we required 40 MByte/s/unit) so this is well beyond our specification. Gigabit Ethernet links were installed and measured performance from the SBCs to the cluster nodes is ~ 80 MByte/s average speed (under ideal circumstances). We require 20 MByte/s for reliable operation. The performance of the inter-cluster node InfiniBand link is high but not optimal yet: we measured transfer speeds up to 270 MByte/s, but not all links show the same speed. All links performed at well over 200 MByte/s. It should be noted that this speed is over an emulated link (TCP/IP over InfiniBand) which means that we'll never reach the maximum link speed (>1 GByte/s!). Using lower-level protocols (i.e. link-native protocol) can increase link-performance (>700 MByte/s is measured by various others) but the downside is that simple Ethernet configuration and usage is NOT available.

Cables were constructed that connect up to four correlator boards to one High Speed Serial Link module. One correlator rack is now fully wired up (eight correlator boards connected to two HSSL modules) for testing. Initial tests with the Linux device driver outside the test-environment revealed some bugs. They were fixed and then we started testing the data path from correlator board to the SBCs main memory. Some bottlenecks were found and it was decided to break up testing of the full data path into its separate steps. It was found that the necessary data rate across the links into the HSSL module can be barely sustained (with no other activity going on besides transferring data from the links into the module's memory). Testing continues.

PCInt software

Small updates for a start-up script were made. We switched to newer XML-parsing library (this is needed some work because of stricter namespace usage). The different development trees were merged and some issues were resolved with timing (starting up processes for multiple hosts takes more time than for a single host).
Intel Xeon Serverboards purchased at the end of 2003 were installed in two Mark5 units. This took some time due to problems with incorrect connectors and memory devices. Apart from this the change was straightforward and both Mark5s operated normally afterwards. The intention was to use these to see if they would influence the data rate limitations of Mark5. Also, these motherboards come with on-board Gigabit Ethernet interfaces that operate independently of the PCI bus. In fact no great improvement in transfer data rate was observed when Mark5 disks were involved. Transfers to normal disks however were much faster. Copper to optical interface converters are required before the Gigabit Ethernet performance can be evaluated.

**eVLBI**

*First EVN eVLBI Image*

On 15th January, Onsala, Cambridge and Westerbork observed 207+777 at 6cm, in an eVLBI test that yielded the first EVN eVLBI image (see figure 7). Onsala and Westerbork data were sent directly to JIVE, without local buffering, and recorded on Mark5 disk units. Due to the slower link to Jodrell Bank, data from Cambridge were sent directly at 64 Mb/s only, and higher rate data were recorded and transferred overnight. In all cases the custom-Mark5, TCP based, data transfer processes were used. Good fringes were detected between Onsala and Cambridge at 256Mb/s, and on all baselines at 128 Mb/s allowing an image to be formed less than 24 hours after the observation. The production, European research networks (SUNET, NORDUnet, UKERNA, SURFnet and GÉANT) were used in this experiment without any special action or provision.
The second meeting of the EVN-NREN proof-of-concept project was held at Schiphol in the last week of January. The overall conclusion was that the project was on schedule. Developments for real-time operation were seen as the next priority. Prospect for high bandwidth connections to participating telescopes had changed somewhat in the year since the first meeting. It was clear that there were good prospects for a Gigabit connection to Torun, but other telescopes, including Jodrell Bank and Medicina, did not expect to get a Gbps connection until the end of 2004. Effelsberg was the least optimistic case. DANTE and the NRENS continue to support the project via GEANT2 - enabling UK and Italian telescopes to participate in early 2005.

The technical objectives of the project were also reviewed. The meeting agreed that the original goal of six telescopes in real-time at 1Gb/s was unrealistic. Many stations are unlikely to get more than one Gigabit Ethernet connection, and Gigabit Ethernet is actually limited to something less than 1Gb/s. The existing VLBI system with Mark5 is also restricted to fixed octaves- 64 Mb/s, 128 Mb/s, 256 Mb/s, 512 Mb/s, 1024 Mb/s.
The revised goals agreed were real-time eVLBI at 512Mb/s with at least three telescopes participating. Non real-time tests will be performed to maximise network loading up to the limits of Mark5 and Gigabit Ethernet.

Real-Time eVLBI Development

In February and March work continued in the laboratory at JIVE to explore the problems of streaming data into the correlator directly from the network: so-called real-time eVLBI. A bench test environment was created using three Mark5s, one acting as a dummy formatter and the others representing the telescope and correlator network interfaces. In this way it was possible to simulate the data path at up to 256 Mb/s, proving that data transmitted over a network and sent directly to the Mark5 output arrived in tact. Further development was possible when Haystack released a version of Mark5 software and firmware that enabled control of the output buffer in net2out mode.

Figure 8: First real-time eVLBI image
First Real-Time EVN eVLBI Image

The image in Figure 8 of the gravitational lens system 0218+357, was produced from data transferred directly from telescope to data processor and correlated in real-time. The observation took place on Thursday 28th April. Participating telescopes were Onsala, Jodrell Bank and Westerbork, observing in RR & LL polarisations, each with a bandwidth of 4 MHz, resulting in a total data rate of 32 Mb/s per station. Time synchronisation between incoming data and the correlator observe-time clock was achieved in two stages. First the observe-time clock was set to UT minus a few seconds. Fine-tuning was then implemented using the normal servo system operating between the Mark5 output buffer and the Station Unit. No intermediate recording of the data was used. Good quality data were received from all three telescopes throughout the 1.5 hours of observation.

Figure 9: The visibilities (correlated in real-time) showing beat characteristic of a double source
Figure 10: The Real-time eVLBI bench testing setup

Telescope connections

Torun’s fibre connection was completed early in the year. Data transfer tests to JIVE became possible in May when Torun received a Mark5 unit, on-loan from JIVE. In June a network test was performed between JIVE and three “telescopes”. Onsala and Torun participated using Mark5s and their direct network connections, whilst, in lieu of Medicina, GARR installed a suitable machine at their POP in Bologna. The test used IPERF, and so measured memory-to-memory performance using test data and no disk access.

Results are summarised below:

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<thead>
<tr>
<th>Source</th>
<th>Destination</th>
<th>Data Rate - Mb/s</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min</td>
</tr>
<tr>
<td>Onsala</td>
<td>JIVE</td>
<td>40</td>
</tr>
<tr>
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<td>JIVE</td>
<td>68</td>
</tr>
<tr>
<td>Bologna</td>
<td>JIVE</td>
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<tr>
<td>JIVE</td>
<td>Bologna</td>
<td>109</td>
</tr>
</tbody>
</table>

The above results were for TCP tests. UDP tests failed due to a configuration error. The network providers assisted during the test, helping to establish the connection to Torun, and after the test they provided expert advice that may enable us to understand the results obtained.
5. EC and International Projects

Access to the European VLBI Network

In February 2004, the EC FP5 IHP contract HPRI-CT-2001-00142 “Access to the European VLBI Network” was completed. Within its framework, in the period from February 2002 through February 2004, EVN delivered 185.5 hours of observing time via this contract. The minimum deliverable was 181 hours. A total of 9 different users directly benefited from the contract. In addition, many other external users (who did not make a visit and therefore do not appear listed in Annexes 3, 4 & 5 of the Second Annual Report) also benefited. The users came from six different EU and Associate state countries. In total, 182 person-days of visits to the infrastructure were associated with the contract. By April 2004, 5 papers (published or in press) were directly associated with observing time supported by this contract. Many more publications are expected over the next few years.

The last Annual and Final reports were submitted in April 2004 and accepted by the Commission two months later.

FP5 RadioNET

The EC Contract N HPRI-CT-1999-40003 “Infrastructure Cooperation Network in Radio Astronomy. RadioNET” was completed. It ran during the period March 2000 through February 2004. The RadioNET (FP5) tasks included enhancing the quality of operations and making more effective use of the existing European VLBI Network of radio telescopes (EVN), and building up the necessary scientific, technical and organizational consensus for the two major future radio astronomy facilities, the Atacama Large Millimetre Array (ALMA) and the Square Kilometre Array (SKA).

During the four years of the FP5 contract, RadioNET supported coordination activities at nine EVN institutes aimed at improved quality and interoperability of the network and improving the access to the research infrastructure. Special operations training workshops were held over the period of the contract to exchange best practices of VLBI operations, specifically focusing on the modern data acquisition procedures and calibration procedures. The contract supported two EVN Symposia (2000 and 2002) and one EVN VLBI School (2001). In addition, RadioNET participated in sponsorship of the JENAM-2003 Symposium "Radio Astronomy at 70: from Karl Jansky to microjansky" (Budapest, August 2003). The network supported publication of the book of proceedings, which contains materials directly related to and based on studies conducted at the institutes RadioNET supported in part a number of meetings on ALMA science, operations and management. These meetings produced documents which created a basis for the ALMA project implementation commenced in 2003.

Finally, RadioNET supported participation of the European radio astronomical community in the worldwide effort of designing the Square Kilometre Array. The major events included International (worldwide) SKA Science meetings. The meetings helped to work out major topics which would form the science case for the SKA project and be published as a book in 2004.

The overall ICN FP5 RadioNET contract was implemented on schedule and on budget. It also has enabled the European radio astronomy community to get the award under the FP6 programme (the much larger FP6 RadioNET I3 project).

The Fourth Annual and Final reports on the contract were submitted to the Commission in June 2004.

FP6 I3 Project RadioNet

JIVE is actively involved in the implementation of the EC FP6 I3 Project RadioNet. The contract commenced in January 2004. The Institute is involved in the following RadioNet tasks:

- L. Gurvits is the RadioNet Project Scientist and member of the RadioNet Management and Executive teams;

- H.J. van Langevelde is the leader of the RadioNet Joint Research Activity ALBUS (development of user data reduction software for radio astronomy, see section 3.3 of the present report) and a member of the RadioNet Executive team;
- M. Tibbe is a secretary of the RadioNet Management and Executive teams;
- L. Gurvits coordinates the RadioNet Trans-National Activity "Access to the EVN". This activity is a natural contribution of the previous Access contracts.

The Institute acts as the banker for the RadioNet travel budget (Networking Activities and Transnational Access).

**EUROPLANET**

From June 2004, JIVE is involved in the EC FP6 Coordination Action EUROPLANET. The project is related to the JIVE involvement in the ESA/NASA mission Cassini/Huygens. In particular, JIVE participates in the coordination of the ground-based observations in support to the Cassini/Huygens mission. The project also considers several prospective ESA missions e.g. the Mercury BepiColombo mission.

**SKA Design Study**

JIVE was involved in the preparation of the proposal to the European Commission on the SKA Design Study (SKADS) project. The Institute's specific task deals with the SKA science and technology simulations. Representatives of the Institute (M. Garrett, L. Gurvits) participated in several preparatory meetings on this project. JIVE is the coordinator of SKA Design Task 2 – Science and Array Simulation. The overall coordinators are Arnold van Ardenne (ASTRON) and Peter Wilkinson (JBO). The proposal was submitted to the Commission in March 2004.

**ESA-JIVE Huygens Project**

During the first half of 2004, JIVE has completed two contracts with ESA on the preparation for the Huygens VLBI tracking Project. The first contract (period October 2003. February 2004) dealt with preparatory observations of the "Huygens Field" using WSRT, VLA, ATCA, MERLIN and EVN. The second contract (March-June 2004) was used to outsource development of Huygens-related data processing algorithms to Astro-Tech Holding BV (supporting the employment of Max Avruch). Reports on both contracts were submitted and accepted by ESA in due time. The report’s conclusion confirms feasibility of VLBI tracking of the Huygens probe in the atmosphere of Titan with kilometre accuracy.

In March-June 2004, two other contracts between ESA and JIVE were under preparation. The first one dealt with the main body of work on the Huygens VLBI tracking project. It is expected to run for one year beginning in the third quarter of 2004. The other project addresses potential applications of the VLBI technique for future ESA missions as a tool for precise interplanetary navigation. The project is expected to commence in August 2004 and run for 9 months.

JIVE Personnel involved in the Huygens VLBI Tracking project include L. Gurvits (Project Manager), S. Pogrebenko (Project Scientist), M. Avruch, H. Bignall, A. Brunthaler, R. Campbell, M. Garrett, M. Tibbe.

"Cosmic Vision" programme

JIVE participated in the preparation of the proposal to ESA "Cosmic Vision" programme. The theme of the proposal is Long Wavelength radio astronomy in space. The proposal was submitted to ESA in May 2004. JIVE personnel involved included L. Gurvits (coordinator of the proposal in collaboration with G. Miley, Leiden) and M. Garrett.

**KNAW-CAS**

JIVE continued active participation in the collaboration with the radio astronomy groups in China under the KNAW-CAS contract. L. Gurvits coordinated this contract together with R. Strom (ASTRON). The highlight of the first half of 2004 was delivery to the Shanghai Observatory of a new dual-polarisation L-band receiver developed and build in Dwingeloo by the Dutch-Chinese team of engineers. The receiver will become involved in EVN operations in the second half of 2004.
Following the decision by the EVN Consortium Board of Directors, L. Gurvits continued to coordinate EVN efforts to assist the Ventspils International Radio Astronomy Centre (Latvia) and the Institute for Radio Astronomy of Ukraine to upgrade the telescopes in Irbene (32 m) and Evpatoria (70 m) respectively, to EVN compatibility and operational standards.

6. Research

Avruch
Avruch has been involved in the studies for VLBI tracking support of the Huygens Probe on Titan. EVN experiment EA029, an investigation of potential phase reference sources in the Titan field, was performed in February, using six Mk5 recorders and three tapes. As an employee of AstroTec Holding on contract to JIVE, Avruch supervised the first correlator pass with the six disk-based stations (Ef, Wb, Jb, Mc, Nt, On), completed by the end of March, and started analysis in AIPS in early April. The results so far have confirmed as a suitable reference source J0744+2120, 40 mJy and 30arcmin from Titan. A second correlator pass including the tape stations (Hh, Sh, and Ur) was completed in early July and is currently being analysed. Recording tests and preparations for rehearsal observations in August are also underway.

Biggs
Biggs’ VLBI observations of the gravitational lens system CLASS B0128+437 have been published in MNRAS and have also appeared as the “VLBA Image of the Month” for March 2004. Work continues apace on this system, with new EVN and HST NICMOS data having been acquired in the last six months. The new EVN data (Project code EB025) were observed at a wavelength of 21cm, the longest to date for this system (13, 6 and 3.4cm having already been observed) and where the source is brightest and the postulated scatter broadening greater.

The most striking aspect of maps made from these data is the continued increase in size of the images towards longer wavelengths (Fig 11). One result of this is that the two merging images are now actually seen to merge, with a pair of components marking the probable location of the critical curve (Fig 12). This will lead to better mass models. The scattering region is clearly visible as a pronounced “hole” in image B. Preliminary analysis of the HST data is underway and shows that image B is completely extincted, presumably due to dust associated with the gas responsible for the scattering.

Fig 11: VLBA maps of image A of B0128+437 at 2.3 GHz (left), 5 GHz (middle) and 8.4 GHz (right)
Bignall is PI on a project using the Nancay Radio Telescope (NRT) to study refractive scintillation of intraday variable (IDV) radio sources. Pilot observations were carried out in Feb-March 2004. Bignall visited the NRT in June 2004 in order to reduce these data with the assistance of P. Colom (Observatoire de Paris-Meudon). Further calibration and analysis is continuing at JIVE. To complement the NRT observations, a monitoring campaign was conducted with the Goldstone-Apple Valley Radio Telescope (GAVRT) in California. Bignall and D. Jauncey (ATNF) attended a teleconference in April with US school students and teachers involved in this GAVRT program. A VLBA proposal was submitted by Bignall, R. Ojha (ATNF) & Reynolds, to observe the IDV quasar PKS 1257-326. Observations and correlation were done in June 2004. Bignall continued work to complete a paper on the scintillation parameters of this source, in collaboration with J-P. Macquart (Kapteyn Inst.). A proposal to continue ATCA monitoring of PKS 1257-326, and to search for possible diffractive scintillation, was submitted (PI Kedziora-Chudczer). Bignall is also co-author on an ATCA proposal (PI Cim`o) to investigate changes in the IDV behaviour of two southern sources, and on a NOT proposal (PI Pursimo) to obtain redshifts of scintillating sources found in the MASIV Survey.

Bignall is PI on an ATCA proposal to observe a faint sample of BL Lac objects, part of a project in collaboration with H. Landt (CfA) et al. Observations of the remaining southern objects in the sample were done in January 2004, and preliminary calibration, imaging and analysis was done in order to include preliminary results in a VLA proposal (PI Landt) to image the remaining objects in the sample.

Bignall is involved in the preparation for the Huygens Probe VLBI tracking experiment, in particular, she contributed to an ATCA proposal (PI Pogrebenko) to check variability of background sources in the "Huygens Field", submitted for the June deadline.
Bignall is a co-author on a paper submitted to the AJ by J. Winn ( CfA) et al., presenting results of an ATCA campaign to monitor the two images of gravitational lens PMN J1838-3427.

Brunthaler
Brunthaler finished and submitted his PhD thesis “Proper Motions in the Local Group” and passed the required exams at the University of Bonn.

Brunthaler is PI on a VLBA proposal to search for calibrator sources with small angular separations to known IDV sources. The goal of this project is to search for position wander of IDV sources, caused by interstellar scattering.

![Figure 13: The positions of two regions of maser activity and their proper motion relative to the nucleus of M33 as measured by the VLBA.](image)

Brunthaler is involved in the preparation for a VLBA+GBT+VLA experiment to detect water vapour maser emission in the nucleus of 3C403 (PI Tarchi). This source is the first radio-loud quasar with water vapour maser emission in the nucleus. Brunthaler is PI on a complementary EVN proposal at 6
cm of the same source to study the morphology of the jet in the nucleus of 3C403. This observation was conducted in the May/June session and is waiting for correlation.

Brunthaler is PI on three VLA and one VLBA proposal, submitted for the June deadline, to search for water vapour maser emission in M31 and M33 as well as background calibrator sources for future phase referencing observations to improve the proper motion and distance measurement of M33 and measure a proper motion of M31.

Brunthaler is a co-author on a paper submitted to the ApJ by M. Reid (CfA) & A. Brunthaler, presenting results of an proper motion study of Sgr A*, the radio source at the Galactic Center.

**Campbell**
Campbell continued to provide ionospheric simulations to D. Lebach (CfA) in support of VLBI astrometry related to the Gravity Probe-B guide-star program (the satellite launched on 20apr; see einstein.stanford.edu, particularly FAQ #6 and the Launch Companion for a description of the astrometry effort). Collaborated with S. Britzen (MPIfR) on statistical studies of the jet-component kinematics of CJF sources. Work focussed on estimating proper motions for each jet component from the elliptical Gaussian component parameters, uncertainties, and correlation matrices derived by our difmap variant, including means of taking individual-epoch behavior of specific components into account in the ensemble statistics.

**Garrett**
Garrett produced a first draft of the Deep GBT & VLA 1.4 GHz observations of the NOAO Bootes field (see Figure 14). Two of the VLBI detected sources have no optical identification in very deep I and K-band optical images. This suggests that a significant fraction of the faint AGN radio population may be located at high-z. In addition, he was involved in the preparation of a paper presenting deep WSRT observations of the Spitzer First Look Survey (Morganti et al.). Another paper was submitted with Wrobel et al., concerning VLBA observations of bright mJy sources in the same field – these will be used as in-beam calibrators in planned Global VLBI Deep Field observations. A paper with Frayer et al. concerning the IR properties of radio-selected submillimeter galaxies (SMG) in the Spitzer FLSv field was also submitted. Monica Orienti visited JIVE as a summer student to work on a detailed comparison of the Spitzer Mid-IR and WSRT faint radio source populations in the FLSv.

**Gurvits**
Gurvits continued to work on various aspects of massive VLBI surveys of extragalactic radio sources. These included the VSOP Survey Programme (three papers with his participation submitted during the first half of 2004), the VLBA 15 GHz survey and the Deep Extragalactic VLBI-Optical Survey (DEVOS). Results of these studies found their application in the paper to be published in the new book "Science with SKA" (eds. C. Carilli and S. Rawlings, New Astronomy Review, 2005).

Several recent global and Space VLBI surveys of quasars, AGN or other types and starburst galaxies provide a wealth of material on milli- and sub-milliarcsecond radio structures in hundreds of sources. Results of these projects are presented with an emphasis on the statistics of redshift- and angular-scale-dependent properties of the milli- and sub-milliarcsecond radio structures. These studies make possible disentanglement of intrinsic (possibly, evolutionary) phenomena of parsec-scale radio structures and the imprints of the cosmological model. The studies indicate a very promising potential of high-resolution applications of the Square Kilometre Array. Based on our pilot projects we estimate that a sample containing of the order of $10^4$ faint radio sources in the luminosity range $10^{22} - 10^{26}$ W/Hz can be surveyed with a high-resolution SKA with the milliarcsecond resolution at cm wavelengths. Such the high resolution radio survey, including those conducted jointly by SKA and Space VLBI missions, in conjunction with data from other domains, will provide a new basis for extragalactic studies.
Van Langevelde continued to work on his project in collaboration with Pihlström (NRAO), which deals with molecular absorption against the CenA core. Progress was made on the interpretation side and several presentations were made in lunch talks and conferences.

With Vlemmings (Cornell) van Langevelde continued to work on the parallax of OH bearing Mira’s. To improve on the results data were taken with in-beam calibrators.

Anna Nierzurawaska visited JIVE from Torun to collaborate with van Langevelde on Methanol maser observations. Several detections were made and initial maps produced. There remained problems with the astrometry and fringe-rate mapping was explored, but this proved of little use for the objects close to the equator. Further MERLIN observations were deemed necessary.

Van Langevelde started collaboration with Phillips (ATNF) and Hogerheijde and van Dishoeck to follow up Methanol maser work with (sub)-millimeter interferometry. This project focuses on masers with no obvious radio continuum counterpart, assuming that the Methanol abundance and excitation at these sites must be indicative of activity associated with very early high mass star formation. Funding for a PhD student was requested.

Van Langevelde was asked by NOVA to visit Hawaii in order to investigate a possible Dutch contribution to the eSMA project. He visited the JCMT and evaluated the required engineering to make the JCMT compatible for observing with the Sub-Millimeter Array. Two documents were produced, one dealing with the detailed project plan for the first phases, the other with recommendations for the Dutch role in this project.
Paragi
With Yang Jun and Leonid Gurvits, Paragi worked on VSOP data reduction of high redshift quasars. Data from two experiments were fully processed.

Paragi was co-I on the EVN project EF0011. The goal was C-band follow-up observation of the very high redshift quasar J0836+0054. The experiment was observed in session 3/2003. The data were processed together with Sandor Frey and Leonid Gurvits in JIVE. The target source is detected at 6cm with the EVN. Interpretation of the data is under progress.

Paragi showed that intermediate-mass black holes (IMBH), if they exist, might be detected in nearby galaxies. If these systems produce radio jets analogous to microquasars and active galactic nuclei, we can estimate their radio flux. The EVN has the sensitivity to detect an IMBH with masses of several 100s to 1000s of Solar mass. This result was presented at the 5th Microquasar Workshop.

![Figure 15: The minimum detectable mass of an intermediate-mass black hole in nearby galaxies with the EVN (1.6 GHz, 1 Gbps recording rate). The minimum black hole mass is given for distances up to 10 megaparsec, for on-source integration times 2.5 hours, 10 hours, and 24 hours.](image)

Reynolds
A VLBA proposal was submitted by Reynolds in collaboration with Bignall and R. Ojha (ATNF) to observe the IDV quasar PKS 1257-326. Observations and correlation were performed in June 2004.

Reynolds also participated in a proposal in collaboration with Zhang (SHAO), Gabuzda (UCC), Nan (SHAO), Gurvits and Jin (SHAO) to observe rotation measures in sources with very bent jets. The experiment was observed and correlated in February 2004.

Reynolds carried out analysis on low frequency VLBA observations of BL Lac objects. Preliminary results will be presented at the EVN symposium in October 2004.

Reynolds was involved with Liu Xiang (UAO) in reduction of EVN project ES044.
7. Publications

7.1 Refereed publications

Published


Submitted


Morganti, R., Garrett, M.A., Chapman, S., Baan, W., Helou, G., Soifer, T., "A Deep WSRT 1.4 GHz Radio Survey of the Spitzer Space Telescope FLSv Region", Accepted for publication in A&A


7.2 Publications in Conference Proceedings

Published


Submitted:


Other

Paragi, Z., Microquasars (in Hungarian), Annual of the Hungarian Astronomical Society, p. 238, Budapest, 2004
### Appendices

#### 1. Table of staff activities & responsibilities

<table>
<thead>
<tr>
<th>Staff member</th>
<th>Activity</th>
</tr>
</thead>
</table>
| Garrett               | Director  
Chairman of JIVE Management Team  
ASTRON Management Team (by invitation)  
RadioNet FP5 Coordinator  
JIVE/RuG/ASTRON Node PI - ANGLES RTN  
Astronomical Research |
| Campbell              | Member of JIVE Management Team  
Head of Science Operations and Support  
Astronomical Research |
| Gurvits               | Member of JIVE Management Team  
Programme Manager  
FP6 RadioNet Project Scientist  
Manager EC ICN contract (RadioNET)  
Manager EC ARI contract (EVN Access)  
Huygens VLBI Tracking, Project Manager  
Co-coordinator KNAW-CAS (China) grant  
Coordinator space VLBI activities  
Secretary for JIVE Board meetings  
Astronomical Research |
| Van Langevelde        | Member of JIVE Management Team  
Head of Software Developments  
RadioNet ALBUS PI  
RadioNet executive committee  
Astronomical Research |
| Parsley               | Member of JIVE Management Team  
Head of Correlator Maintenance, R&D  
Coordinator of EVN-NREN eVLBI Proof of Concept prog. |
| Avruch, Biggs, Signal, Brunthaler, Paragi | JIVE Support Scientists.  
Correlator, Network and Astronomer Support  
Astronomical Research |
| Buiter                | Data Processor Engineering & Maintenance  
ASTRON/JIVE ARBO committee  
JIVE Infrastructure |
| Leeuwinga, Nijk, Tenkink | Correlator Operator Team  
Data Processor Engineering Development |
| Reynolds              | Senior Support Scientist  
Sched – EVN related Developments and Maintenance  
EVN Pipeline Developments  
AIPS Manager, EVN Tests and Development  
Astronomical Research |
| Olnon, Kramer, Verkouter, Szomoru | Software Development Team |
| Schonewille           | Chief Operator  
ASTRON/JIVE Ondernemingsraad |
| Tibbe, Mellema        | Office Manager  
Secretary |
2. **Visitors to JIVE**

Steven Tingay  Swinburne Center for Astrophysics and Supercomputing, Australia  
Zhang Xizhen  Beijing Astronomical Observatory, China  
Jin Chengjin  Beijing Astronomical Observatory, China  
Jamie McCollum  University of Tasmania, Australia  
Chris Phillips  ATNF, Australia  
Lorant Sjouwerman  NRAO, USA  
Anna Niezurawska  Torun Center for Astronomy, Poland  
Kazimierz Borkowski  Torun Center for Astronomy, Poland  
Yang Yun  Urumqi Astronomical Observatory, China  
Richard Porcas  Max Planck Institute for Radio Astronomy, Bonn, Germany  
Alan Roy  Max Planck Institute for Radio Astronomy, Bonn, Germany  
Bill Cotton  NRAO, Socorro, USA  
Carmen Blasco  LAEFF, Madrid, Spain  
Monica Orienti  IRA, Bologna, Italy  
Sandor Frey  FOMI Satellite Geodetic Observatory, Budapest, Hungary  
Philip Hazell  Avonsoll Ltd, UK  

3. **Supervision**

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<tr>
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<th>Student</th>
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<td>Bignall, Van</td>
<td>Mari Carmen Blasco Fuertes (summer student)</td>
<td>LAEFF/INTA, Spain</td>
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<td>N/A</td>
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4. **Presentations**

**Biggs**  
"B0128+437 -- recent VLBA results", ANGLES inaugural meeting, Bonn, Germany, 5-6 Apr
Bignall
"The microarcsecond-scale evolution of quasar PKS 1257-326", workshop on ‘Interstellar Scintillation of Extragalactic Radio Sources’, Dwingeloo, 6 Apr
"The ‘Interstellar Telescope’: scintillation as a high resolution probe of AGN radio jets",
ATNF, Sydney, Australia, 16 Apr
University of Melbourne, Australia, 20 Apr
University of Adelaide, Australia, 30 Apr
Kapteyn Institute, University of Groningen, 7 Jun
"Interstellar scintillation and the sub-pc scale structure of quasar PKS 1257-326" (poster), NAC 2004, Vlieland, 26-28 May

Brunthaler
"Detections of Proper Motion in the Local Group", PhD colloquium, Bonn, 21 Jun

Campbell
"Recent Results from the EVN Mk4 Data Processor at JIVE", IVS 3rd General Meeting, Ottawa, Canada, 10 Feb
"eVLBI Developments in Europe", IVS 3rd General Meeting, Ottawa, Canada, 10 Feb

Garrett
Various presentations at the EVN CBD and JIVE Board Meetings, Onsala, May 2004.
"Introduction to JIVE and the EVN", Colloquium, Shanghai Astronomical Observatory, Shanghai, April 2004.
Various presentations about eVLBI and e-Science within the EU IST Delegation to North America, June 2004.

Van Langevelde
"Molecular absorption in CenA on VLBI scales", lunch talk 13 Jan, Leiden
"ALBUS", ALBUS kick-off meeting, 30 Jan, Schiphol
"Molecular absorption in CenA on VLBI scales", conference talk 18 Feb, Zwolle
"ALBUS" RadioNet Board meeting, 11 Mar, Tenerife
"Fundamental properties of Mira Variables through VLBI observations” Science talk at RadioNet Board, Tenerife, 12 Mar
"ALBUS", lunch talk 25 Mar, Dwingeloo
"Astrometry of circumstellar masers", colloquium, JAC Hilo 21 Apr
"ALBUS", Inter Group Lunch, 29 Apr Dwingeloo
"eSMA", lunch talk, 12 May, Dwingeloo
"Computing at JIVE", at NWO meeting astronomy- informatics, 25 May Utrecht
"The extended Methanol maser in W51", poster NAC, 26-28 May, Vlieland
"eSMA” a Dutch opportunity for sub-mm interferometry” NOVA ICM meeting, 14 Jun Amsterdam
"Options for user software", ALBUS meeting, 18 Jun Dwingeloo
"eEVN: a Pan-European radio-telescope” SPIE conference talk, 22 Jun, Glasgow
"Een telescoop zo groot als Europa” rondleiding Probus club, 28 Jun

Paragi
"Performance and reliability of the EVN", TOG Meeting, Wettzel, Germany, 1-2 Apr
"Detecting sub-mJy sources with the EVN", (poster by Paragi, Garrett and Biggs), 5th Microquasar Workshop, Beijing, 6-12 Jun
"eEVN: a Pan-European radio telescope”, (poster by Van Langevelde, Garrett, Parsley, Szomoru, Verkouter, Reynolds, Olnon, Biggs, Kramer, Paragi and Pogrebenko) SPIE Europe International Symposium, Glasgow, Scotland, United Kingdom, 21-25 Jun

Parsley
"eVLBI Developments in Europe", Third IVS General Meeting, Ottowa, Canada, 10 Feb (presented in absentia by R. Campbell)
"EVN-NREN Project Status Report", EVN Technical and Operations Group Meeting, Wettzell, Germany, 1-2 Apr
"Very Long Baseline Interferometry (VLBI) and the European VLBI Network-National Research and Education Networks (EVN-NREN) Project", Networkshop 32, Keele University, UK, 8 Apr
"High Bandwidth, Radio-Astronomy Data Transport" TERENA Network Conference, Rhodes, Greece, 7-10 Jun

Reynolds
presentation and workshop on amplitude calibration, and a presentation on scheduling, EVN TOG meeting, Wettzell, 1-2 Apr

5. Membership of committees

Garrett
- SKA International Science Advisory Committee
- EVN CBD
- IAU Division X Organizing Committee

Gurvits
- RadioNet Management Team
- Global VLBI Working Group (GVWG)
- IAU Division XI Organizing Committee
- VIRAC (Latvia) Advisory Board

Van Langevelde
- EVN Program Committee
- NWO Beoordelings Commissie Astronomie
- NOVA Education Committee

Parsley
- Global VLBI Working Group (GVWG)

6. Membership of professional associations and societies

Bignall
Australian Institute of Physics (1997-)
Astronomical Society of Australia (1998-)

Brunthaler
Deutsche Physikalische Gesellschaft (1995-)

Campbell
Sigma Xi (1983-)
American Geophysical Union (1996-)
International Astronomical Union (2000-)
URSI (2002-)

Garrett
International Astronomical Union (1997-)

Gurvits
Nederlandse Astronomen Club (1994-)
International Astronomical Union (1997-)
7. Membership of scientific organizing committees

Bignall
“Interstellar Scintillation of Extragalactic Radio Sources” workshop held in Dwingeloo, 5-7 Apr

Gurvits
“Interstellar Scintillation of Extragalactic Radio Sources” workshop held in Dwingeloo, 5-7 Apr

8. Meetings attended

8.1 Scientific conferences attended by JIVE staff members

Bignall
‘Interstellar Scintillation of Extragalactic Radio Sources’, ASTRON/JIVE, Dwingeloo, NL, 5-7 Apr
Dutch Astronomers Conference, Vlieland, NL, 26-28 May

Bruntitheral
“European Workshop 2004 on Astronomical Molecules”, Zwolle, NL, 17-20 Feb
“Interstellar Scintillation of Extragalactic Radio Sources”, ASTRON/JIVE, Dwingeloo, NL, 5-7 Apr

Campbell
IVS 3rd General Meeting, Ottawa, Canada, 9-11 Feb
IVS 5th Analysis Workshop, Ottawa, Canada, 12 Feb

Garrett
“Exploring the Cosmic Frontier”, Berlin, Germany, 18-21 May

Gurvits
“The Interplay among Balck Holes, Stars and ISM in Galactic Nuclei”, IAU Symp 222, Gramado, Brazil, 27 Feb – 7 Mar
Titan conference, ESTEC, Noordwijk, NL, 13-16 Apr

Van Langevelde
“Dense Molecular Gas around Protostars and in Galactic Nuclei”, European Workshop on Astronomical Molecules, Zwolle, 17-20 Feb
“Nederlandse Astronomen Conferentie”, Vlieland, 26-27 May
“Astronomical Telescopes”, SPIE International Symposium, Glasgow, 21-24 Jun

Olnon
Dutch Astronomers Conference, Vlieland, NL, 26-27 May

Paragi
5th Microquasar Workshop, Beijing, China, 6-12 Jun

Reynolds
“Interstellar Scintillation of Extragalactic Radio Sources”, ASTRON/JIVE, Dwingeloo, NL, 5-7 Apr

8.2 International meetings attended by JIVE staff members

Biggs
ANGLES inaugural meeting, MPIfR, Bonn, 5-6 Apr

Campbell
Mk5a,b/DBBC Meeting, Bonn, Germany, 29 Mar
EVN TOG Meeting, Wettzell, Germany, 1-2 Apr

Garrett
FP6 SKA design study meeting, Oxford, UK, 29 Jan
FP6 SKA design study meeting, Madrid, Spain, 3-4 Feb
FP6 RadioNet board meeting, Tenerife, Spain, 11-13 Mar
Launch fo ARTI project, Dublin, Ireland, 26 Mar
ANGLES Consortium kick-off meeting, 5-6 Apr
Workshop on eInfrastructures, Dublin, Ireland, 15-16 Apr
EVNCBD meeting, Gothenburg, Sweden, 14 May
JIVE Board meeting, Gothenburg, Sweden, 15 May

Gurvits
FP6 RadioNet Board meeting, Tenerife, 11-13 Mar
AMSTAR kick-off meeting, Oxford, UK, 26 Apr
ILIAS kick-off meeting, Paris, France, 29 Apr
EVNCBD meeting, Gothenburg, Sweden, 14 May
JIVE Board meeting, Gothenburg, Sweden, 15 May

Van Langevelde
RadioNet ALBUS kick-off meeting 30 Jan
RadioNet Board meeting, Tenerife, 11-12 Mar
EVN Discussion on Mk5 and DBBC systems, Bonn, 29 Mar
LOFAR calibration meeting, Dwingeloo, 10 May
NWO computing meeting Utrecht 24 May
NWO beoordeling 25 May
ICM meeting Amsterdam 14 Jun
ALBUS discussion on the future of user software for radio data reduction, Dwingeloo, 18 Jun

Leeuwinga
TOG meeting, Wettzell, Germany, 1-2 Apr

Olnon
Data Processing Future, Dwingeloo, 18 Jun

Paragi
TOG Meeting, Wettzel, Germany, 1-2 Apr

Parsley
EVEN-NREN Meeting, Schiphol, 28 Jan
DBBC Operative Meeting, Wettzell, Germany. 31 May 2004
EVEN Technical and Operations Group Meeting, Wettzell, Germany. 1-2 April 2004
Neworkshop 32, Keele University, UK, 8 April 2004
TERENA Network Conference, Rhodes, Greece, 7-10 June 2004

**Reynolds**
ALBUS kick-off meeting, Schiphol, 30 Jan
EVEN TOG meeting, Wettzell, Germany. 31 Mar - 2 Apr

**Szomoru**
EVEN-NREN meeting, Schiphol, 28 Jan
ALBUS meeting, Schiphol, 30 Jan
ALBUS meeting, Dwingeloo, 18 Jun

8.3 Working visits by JIVE staff members

**Bignall**

**Garrett**
DANTE, Cambridge, UK, 20 Jan
Shanghai Astronomical Observatory, Shanghai, China, 30 Mar – 2 Apr
Meeting with European Commission, 8 Jun
Participant in EU delegation on eInfrastructures, Washington-Chicago-Ottawa, 20-27 Jun

**Gurvits**
Beijing and Shanghai Astronomical Observatories, China, 11-19 Feb

**Van Langevelde**
Leiden, 13 Jan
Leiden, 13 Apr
JAC Hilo, 5-23 Apr
Groningen, 8 Jun
Leiden, PhD defense Messineo, 30 Jun