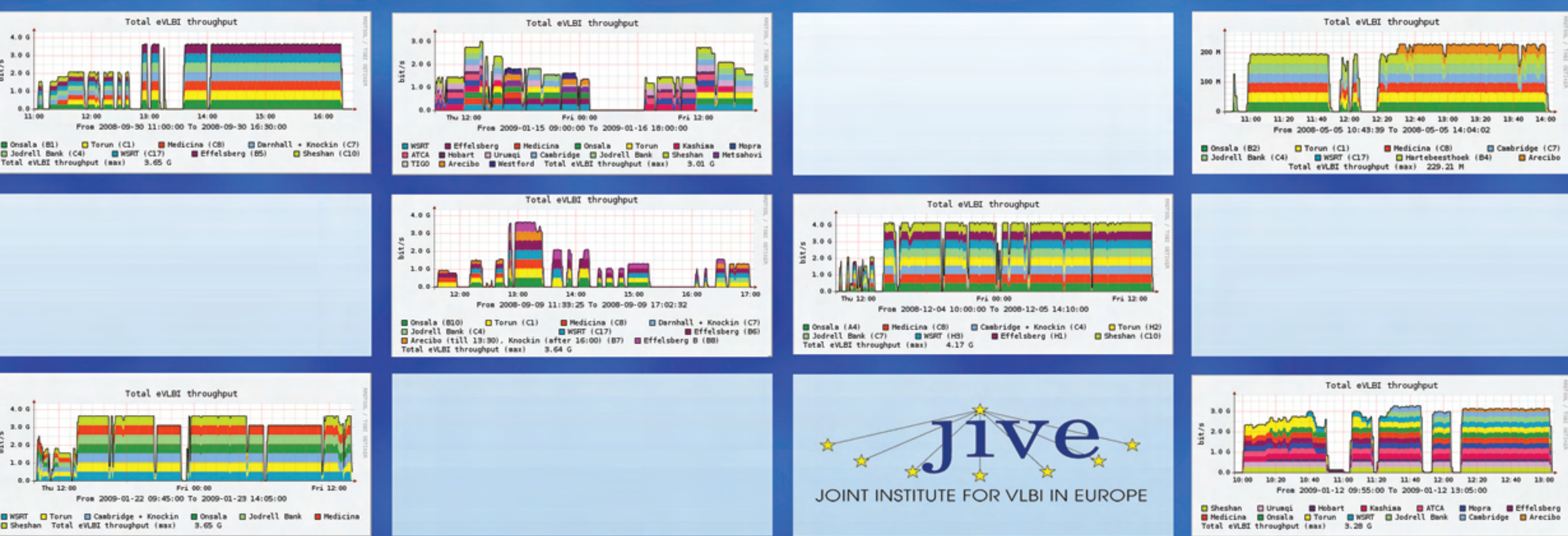
Biennial report 2007-2008

Joint Institute for VLBI in Europe



The Joint Institute for VLBI in Europe (JIVE) was established as a scientific foundation in December 1993. JIVE's mandate is to support the operations of the European VLBI Network (EVN) in the widest sense.

JIVE's operations are supported via multi-national funds from the following organisations:

Netherlands Foundation for Research in Astronomy (ASTRON), the Netherlands;

National Geographical Institute (IGN), Spain;

Italian National Institute of Astrophysics (INAF), Italy;

Max Planck Institute for Radio Astronomy (MPIfR), Germany;

National Astronomical Observatory of China (NAOC), China;

Netherlands Organisation for Scientific Research (NWO), the Netherlands;

Onsala Space Observatory (OSO), Sweden;

Science & Technology Facilities Council (STFC), UK.

Centre National de la Recherche Scientifique (CNRS), France

Foreword

The Joint Institute for VLBI in Europe (JIVE) was founded to support the operations of the European VLBI Network (EVN). The major focus point of this mission is the operation of the EVN data processor and delivering data to the users of the EVN. During the last two years, the data processor has been operating at the peak of its capabilities. A large fraction of the correlator jobs are done at the maximum capacity of 1 Gbps per telescope, often with more than 8 stations participating. The efficiency has also reached a record-high, with disk recording allowing long, uninterrupted playback. The flawless operations of the data processor and the constant data quality are the fundament of JIVE's success.

Although these astronomy services are the key to JIVE's existence, it has been the emergence of e-VLBI which has raised the visibility of the EVN and JIVE in the international arena. During the past two years, many innovations have been introduced to enable real-time VLBI, passing a large number of milestones. Not rarely have these milestones been presented live at international meetings, adding to the excitement of e-VLBI.

With these innovations, VLBI is moving forward, and throughout the last two years the increased use of e-VLBI by astronomers has followed the technical enhancements. Clearly e-VLBI is a mature technique and not only of interest to those studying transient phenomena in the radio sky, but also paving the way for the VLBI standard of the future in terms of reliability, fast turn-around and increasing sensitivity. This new standard calls for a new EVN correlator in order to accommodate more and more bandwidth per telescope, more telescopes and more flexibility for spectral line processing.

In the past years, JIVE has consistently improved the e-VLBI technique and used the PR moments this created to outline its plans for the future. Solid plans have been formulated to deploy software correlation in the mid-term and develop a next generation correlator for the EVN based on FPGA components. Some of the techniques being deployed have a synergy with developments in preparation for the Square Kilometer Array. JIVE recognizes the vital role of the SKA for the future of radio-astronomy and it has the ambition to play a role in the European operations of the SKA, demonstrated by taking on the responsibility of being the legal entity in the European SKA Consortium. Besides e-VLBI and correlator development, space applications and user software are other areas where JIVE is establishing a strong link to the SKA.

Against the changing priorities across Europe for radio-astronomy, the JIVE MOU has been re-negotiated in 2008. This sets a new base for five years of JIVE activities, although it must be recognized that the particular form of the JIVE funding is not very stable against perturbations in the member countries. At the same time the joining of France is recognition of the value of JIVE as a radio-astronomical facility in Europe.

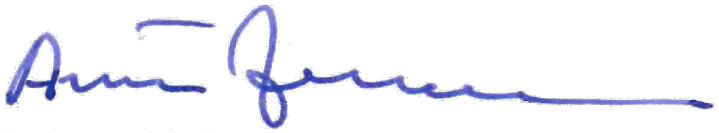
Once again, JIVE is one of the main beneficiaries of the new RadioNet project in the EC 7th framework program and will receive EC funding to support the user access to the EVN. This has been a pillar in maintaining and expanding the EVN's user base, and it is gratifying to see the continuity of this activity guaranteed for the coming years. In the preparation for RadioNet

JIVE has also been granted the leadership for research activities in the domains of user software and digital processing. Project funding is crucial for JIVE in order to continue its leading role in VLBI techniques; we are currently anticipating the decisions on new funding options for the next generation correlator and the further enhancement of e-VLBI.

EC projects have also had their impact on the scientific capability of JIVE. Never in the past has JIVE enjoyed as many PhD students amongst its staff as in the last year. Despite the fact that JIVE has a focus on operations and R&D, its staff manages to produce a considerable amount of excellent scientific research in a broad range of astrophysics topics. This scientific drive is of great importance for the viability of JIVE and the EVN, especially when it comes to defining the priorities for enhancements in VLBI.

With a large portfolio of externally funded activities, JIVE has gone through many personnel changes in the last two years. Under the new directorship of Huib van Langevelde, it has kept its profile of creativity and dedication. It is pleasure to introduce this annual report to you that is a tribute to the work of the JIVE staff.

Prof. Dr. Anton Zenus



Chairman of the board

1 Institute

1.1 Changes & continuity

The international contributions that enable JIVE to fulfil its mission of promoting VLBI in Europe are arranged in an MOU between international parties. The previous MOU ran until the end of 2007. A lengthy process had started in 2005 to negotiate a new MOU for the 2008 – 2012 period. After an extremely successful review carried out by the ESF in 2006, additional documents were provided in 2007 to, among others, the STFC programmatic review. Under the leadership of NWO the process was finally concluded in 2008. This new MOU provides the foundation for JIVE to carry out its central role in VLBI in Europe for another 5 year period. At the same time this process has shown the vulnerability of JIVE as an institute financed by a wide range of different organisations.

At the beginning of 2007 the directorship of JIVE changed hands, with Mike Garrett transferring to ASTRON and Huib van Langevelde taking over, initially as interim director, and from September 2007 on as director. Subsequently, other people within the organisation took on new management responsibilities. Overall JIVE had to deal with some understaffing during the reporting period, notably at the management level.

Despite this shortage, JIVE managed to perform very well in its core tasks and managed to make a very positive impression with the progress of e-VLBI. Through a number of demonstrations and other public appearances the stage has been set for a healthy future of VLBI in Europe. In 2007 and certainly 2008, considerable progress was made with defining the science case for EVN 2015 and defining a future correlator project. JIVE and EVN staff participated in the ASTRONET roadmap exercise and in a number of SKA activities. Although the scene for radio astronomy is changing rapidly, there is a strong scientific commitment across Europe to ensure the continuity of VLBI and JIVE.

1.2 Core business

Delivering scientific data to the EVN user community is JIVE's core business. The operations of the correlator reached new records in efficiency. Prompted by the requirements of e-VLBI, the system became increasingly more reliable, and this, in combination with disk-based processing, has made long unattended correlation possible. As a result of these improvements increasingly complex schedules are being proposed. In this report several new features that were introduced in disk or e-VLBI processing are listed. The EVN correlator at JIVE already is the world leading facility in its sort when it comes to output capacity. With the added option to obtain data over a large field of view, some experiments now result in over a TByte of raw visibilities.

Throughout these years efforts have been made to verify the use of the so-called Mark 5B recording system, both for normal and electronic VLBI. Recirculation in the correlator has been successfully implemented. The introduction of the off-line fractional bit shift correction resulted in an important improvement of the data quality. But probably the most noticeable change in the whole user perception of VLBI has been the introduction of the Northstar proposal facility, which is partly maintained at JIVE.

New features were communicated to the users in various reports and announcements. Moreover they were discussed in the user meeting in Medicina (Italy) in September 2008 (figure 1.1). This meeting is traditionally associated with the EVN symposium. Which in 2008 highlighted many new results from VLBI and the EVN and JIVE in particular. The scientific results range from the solar system to indeed the furthest known radio-loud quasar. Many of the most exciting results have been obtained with e-VLBI. A list of publications based on results obtained with the JIVE correlator is included in this report for the first time (Appendix 9.9.2)

Figure1.1: Bob Campbell explaining correlator features at the EVN user meeting.

1.3 Projects

The project portfolio of JIVE has never been better filled than during the past two years. As a rule, external funds are the main source of JIVE's research and development budget. These projects allow JIVE, along with the EVN partners, to advance the scientific capabilities of the EVN. Traditional areas of expertise are software and digital processing, allowing JIVE to take the lead in matters of data transport, user processing and space applications.

The flagship of these activities in the current period has been the development of e-VLBI. Which has produced a large amount of visibility for the EVN and JIVE. Initially the project was focused on connectivity bandwidth within Europe, but throughout 2007 new grounds were broken with the connectivity to other continents (figure 1.2).

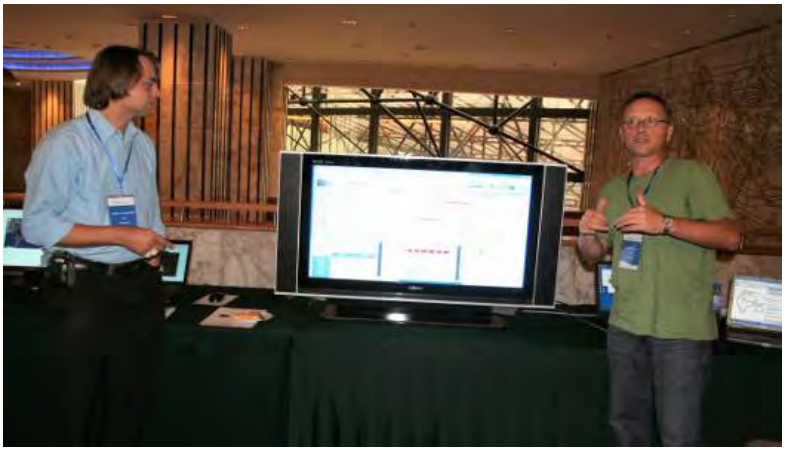


Figure 1.2: Huib van Langevelde and Arpad Szomoru showing off live intercontinental e-VLBI results at the APAN conference in Xi'An, China

JIVE has consciously and consequently taken all opportunities to raise the visibility of e-VLBI in both the astronomical and networking communities. It was felt that this was a necessary activity in order to pave the way for more connectivity in the long run. For example, it is clear that staging a demo in China served as a major catalyst for getting a connection to the Sheshan station through the two Chinese research networks. Later, similar successes could be reported with connections to South Africa and South America.

These activities also caught the attention of the EC. For example, e-VLBI featured at an EC event on the global leadership of GÉANT, at Bled during the Slovenian EC chairmanship. These events have highlighted the success of EXPReS, not only as an astronomical research infrastructure, but moreover as an example of good interdisciplinary collaboration across Europe. In the course of all these events JIVE benefitted greatly from the fact that now – through the EXPReS project – JIVE employs a PR officer.

Figure 1.3: Huib van Langevelde introduces e-VLBI to commissioner Viviane Reding and head of unit "GÉANT & e-Infrastructure" Mario Campolargo

Although some of these demonstrations were addressing a technical audience, for example, at networking conferences, the prime focus was always to enable new astrophysical observing modes. During e-VLBI sessions, astronomical observing always has priority. This was demonstrated during the event that marked the dedication of the high-speed link to Effelsberg. A flare occurred in SS433 and the demo took place with the attendees witnessing the science observations (figure 1.4)

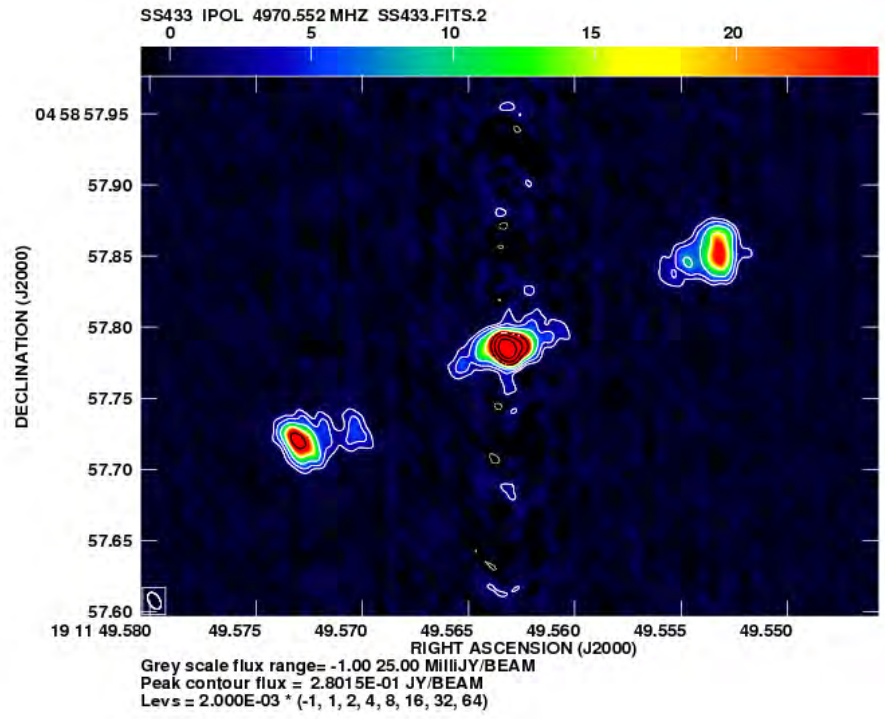


Figure 1.4: SS433 during the November flare, date taken during the Effelsberg e-VLBI dedication event

After a slow start, science observing with e-VLBI really picked up towards the end of 2008. This was partly caused by the enhanced availability of telescopes and bandwidth, but also by the new options for users to apply for e-VLBI time. It took quite some discussion, but in the end a consistent set of guidelines were announced by the EVN to make the e-VLBI available in a flexible way.

Besides the e-VLBI effort, the EXPReS project also deals with the further development of the JIVE software correlator. In 2007 the software correlator was deployed operationally , to handle the fringe checking of the short EVN tests that are carried out at the beginning of observing sessions.

Both in 2007 and 2008, EXPReS issued annual reports and faced a review in Brussels with positive outcome. Similarly, JIVE staff was involved in the reporting of RadioNet FP6 at many levels (Project Scientist, ALBUS, EVN TNA, NA & TNA travel). Consequently a number of JIVE staff travelled to Grenoble for the RadioNet midterm review. Based on the RadioNet FP6 success, a proposal was prepared for RadioNet FP7, in which JIVE participates at a similar

level. Notably, JIVE staff was involved in the definition of the EVN TNA and two JRAs. The first JRA called ALBiUS will build on the success of ALBUS in addressing issues in user software, while the second JRA called UniBoard will develop a platform for intensive digital processing. The latter is an important component in JIVE's ambition to prototype the next generation correlator. A complementary proposal was submitted to NWO, jointly with ASTRON's Apertif team, to develop correlator capacity based on FPGAs.

All these research and development projects are of strategic importance for the future of JIVE. That certainly also holds for JIVE's involvement in SKA related projects. Leonid Gurvits took over many of the responsibilities in this area and was asked to chair the international SKA simulations work-group. This combines well with the management of the local SKADS effort that focuses on array topology. In this area JIVE is also a contributor to the FP7 PrepSKA project, while the main focus is on next generation correlators. In the international SKA arena, JIVE has furthermore assumed the responsibility of being the legal entity for the ESKAC, and is the signatory for the global MOU to support the SPDO. It also collects the European contributions to SPDO and hosts the web site.

In various meetings the role of VLBI in the SKA era was discussed. It has become clear that there is a strong science case for (global) VLBI in the next decades, complementary to the SKA science, especially at higher frequencies. To this ambition, continuing with a Northern hemisphere VLBI, one can add future space applications. Building on the Huygens experience, JIVE has positioned itself very strongly for scientific exploration of VLBI in future planetary missions. With this expertise it continues to be a participant in EuroPlaNet. The same team is also taking the lead in Europe's participation in upcoming space VLBI missions.

1.4 Personnel changes

Besides the management change, there were a large number of farewell parties in 2007 and 2008. Two long-term JIVE employees, Jan Buiter and Nico Schonewille retired, resulting in a joint party (figure 1.5). Their departure led to a restructuring of the operations group and Bert Harms joined in 2008 from ASTRON to complement the new team.

Figure 1.5: Farewell parties at JIVE. Jan Buiter and Nico Schonewille thanking the Dwingeloo cabaret group.

We then had to say goodbye to Hayley Bignal and Cormac Reynolds, taking up jobs at Curtin University, Perth, Australia (figure 1.6). Cormac Reynolds had a leading role in the JIVE software group which proved hard to replace. After some temporary measures, a new structure was put in place, resulting in a management team of van Langevelde, Campbell, Gurvits and Szomoru. Yvonne Kool arrived at JIVE to replace Diana van Dijk and has taken the role of senior secretary, with Aukelien van den Poll assuming responsibilities as Project Assistant.

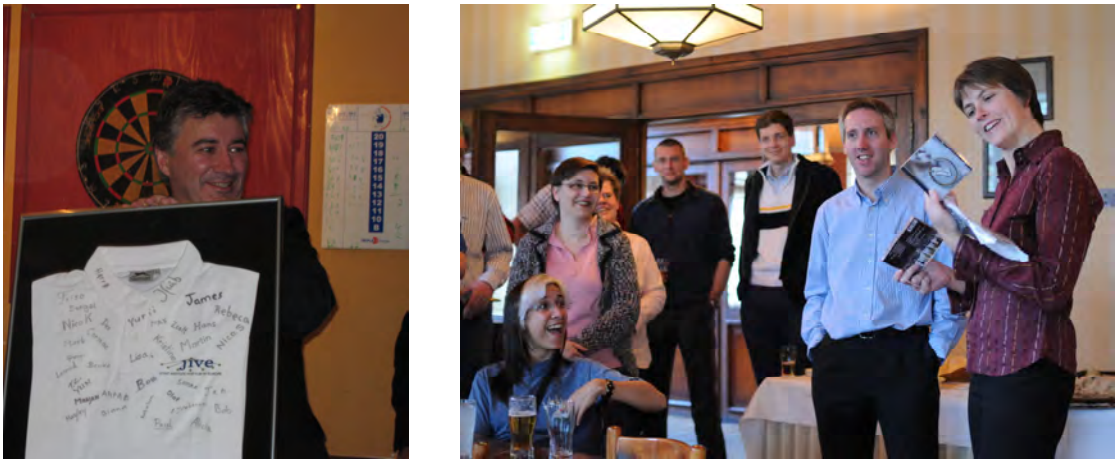


Figure 1.6: Left, Mike Garret accepts the team JIVE jersey. Right, Hayley Bignal and Cormac Reynolds go with some music.

The appointment of Zsolt Paragi to senior support scientists illustrates the importance of astronomical research by the support staff at JIVE. Zsolt will have a coordinating role in the scientific effort of the institute.

JIVE post-docs continue to move on to prestigious positions elsewhere. Olaf Wucknitz was given the opportunity to start his own group at MPIfR in Bonn, Lisa Harvey-Smith departed to the University of Sydney and Rebeca Soria-Ruiz to OAN. James Anderson took up a LOFAR related job at MPI. The departures of many support scientists were not always easy to fill, and left the support group understaffed at times.

Another recognition of JIVE's scientific standing was the promotion of Leonid Gurvits to adjunct professor at Ventspils (Latvia).

During this period JIVE had the responsibility for 4 PhD students, more than ever before. This is largely due to the successful ESTRELA program, funded by the EC under the Marie Curie program and the KNAW-CAS collaborative program. Most of these students reside at Leiden University, while being supervised by JIVE staff.

2 Science Operations and Support

2.1 Production Correlation

2.1.1 Sessions and Their Experiments

Session 1/2007 had a total of 23 user experiments correlated at JIVE. Seven used Gbps recording, and there were nine spectral line experiments (8 of which requiring multiple correlator passes) spread between 22 GHz water and 6.7 GHz methanol masers. There was a welcome lack of station problems: there was only one completely missed station-experiment due to equipment-related casualties, and only three completely missed due to weather (there were additional partial experiments missed by at least one station due to weather). We noticed 180-degree phase jumps between some scans at L-band in Onsala, and the station friend was able to prevent this from occurring further.

Session 2/2007 had 17 user experiments correlated at JIVE, ten of which were spectral line (7 multiple correlator pass experiments) covering L-band OH and 6.7 GHz methanol masers. In the course of correlating this sessions' experiments, we set a longest uninterrupted sub-job record at 10h14m30s. Also, as the unattended operation of the correlator became more robust, we had our first over-100 correlator-hour week.

Session 3/2007 had only 6 user experiments: the Chinese stations were unavailable because of Chang'E obligations, and many PIs preferred to defer their observations until they returned to the array. Four of the experiments were globals, including one in which the EVN stations recorded at Gbps and GBT at 512 Mbps (using 1-bit sampling to keep the number and BW of the subbands the same throughout the global array). In spite of the brevity of the session, it had our first 7 mm experiment and our first experiment to correlate with 1/8 s integrations.

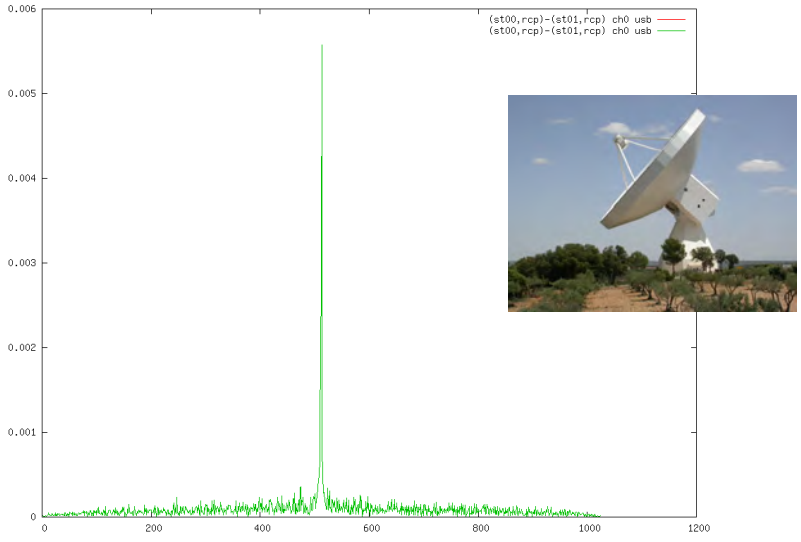


Figure 2.1: First fringe with Yebes telescope

There was also a multiple-record-setting experiment: the most correlator passes (17), correlator hours (153), total hours required to produce (483), and total size of resulting FITS-file data (1028.7 GB). The many passes arose from two correlation phase-centres, each of which required each of the 8 subbands to be correlated separately to reduce bandwidth smearing for a wider field of view. The EVN and VLBA components of the array wound up observing different versions of the schedule, with incommensurate scan-switching schemes. During correlation, the EVN stations were put into the VLBA schedule manually, with their scan start/stop times adjusted to correlate only when they were actually on the same source. It proved more efficient to correlate such a schedule scan-by-scan, which led to the larger, tape-like processing factor of 3. A seventeenth scan was added with only the EVN stations, correlating using the schedule they observed, so that these stations could be calibrated amongst themselves. In the concluding C-band portion of this session, Torun developed phase jumps in all channels on the timescale of minutes; this persisted through the next session, but was repaired before the April 2008 e-VLBI runs.

There were three global Gbps target of opportunity observations on SN2007gr and SN2008d between November 2007 and February 2008 (participating VLBA stations using 1-bit sampling at 512 Mbps). As an example of the turn-around, the first on SN2008d was observed 6-7 February, the last disk-pack arrived at JIVE on 14 February, and the resulting FITS files were placed on the EVN Archive on 17 February. Session 1/2008 itself was seriously affected by winter weather. Three experiments were abandoned outright after consultation with the PIs, and six others missed Effelsberg and/or Jodrell Bank. Azimuth drive problems forced Torun to miss the 5 cm portion of the session. In all, 18 user experiments remained, including 6 Gbps, 6 spectral line (OH, methanol), and 3 globals.

Session 2/2008 had 21 users experiment, including 7 Gbps, 9 spectral line (K-band water, L-band OH, methanol, 6030/5 excited OH, and high-z water observed at 6124 MHz), and six globals coming to JIVE. There were several firsts in this session: the first participation of the new Yebes 40m antenna (at K-band), the first participation of EVLA antennas in some 5 cm experiments, the first time more than one addition MERLIN outstation was included in the Cambridge recording (3 outstations, in a single-pol spectral-line experiment), and our first test at 23.5 GHz consistent with the new VLBA K-band continuum range and also able to look for ammonia. One of the globals set a new record for the highest number of stations correlated in a single experiment at 21. Prior to the session, Cambridge resolved a long-standing data-throttling problem at 1 Gbps recording.

Session 3/2008 had 15 user experiments, all but two at 512 Mbps or 1 Gbps; two of the Gbps were globals in which NRAO stations recorded with 1-bit sampling for 512 Mbps. There were two spectral-line experiments (water, OH), and two other globals. The Yebes 40m antenna continued to participate at K-band, and also joined in at X- and S/X-band. The session also saw the first participation of the three Russian QUASAR stations (Svetloe, Zelenchukskaya, and Badary) in a multi-frequency project at S/X-, C-, and L-bands. One of the globals just missed re-setting the most-stations correlated record: it scheduled 23 stations, but three could not observe. Hartebeesthoek suffered a serious polar-mount bearing casualty, and missed the entire session (nor is it clear exactly when it might return).

e-VLBI made huge strides in 2007-2008; by the end of the period it had become a reliable standard operating mode for the EVN. In 2007 there were 7 user experiments comprising 82 network hours, and in 2008 the corresponding numbers were 16 experiments and 115 network hours. Five of these 23 experiments were target-of-opportunity observations. All e-VLBI observations in 2008 used 512 Mbps, and an experiment in April set a new record for longest sub-job of 12h48m21s. Such long continuous runs have since become routine. A key development was the ability to take care of individual-station problems by taking the affected station out of the correlation temporarily without stopping the job for the whole array. In disk-based correlation, such an occurrence would trigger stopping the job and restarting before the problem, but that is a luxury not afforded to real-time e-VLBI. As an example of the fast turn-around afforded by e-VLBI, there was an observation on 30 September 2008 that was correlated, distributed, and analyzed in time to have its results included in an EVN proposal submitted by the 1 October 2008 deadline.

Tables 2.1 and 2.2 summarize projects observed, correlated, distributed, and released in 2007 and 2008. They list 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., because of continuum/line, separate correlation by subband/pol to maximize spectral resolution, etc.).

	User Experiments			Test & Network Monitoring		
	N	Ntwk_hr	Corr_hr	N	Ntwk_hr	Corr_hr
Observed	53	545	910	47	231	231
Correlated	54	529	718	41	262	286
Distributed	54	529	718	54	265	290
Released	55	533	742	54	257	286

Table 2.1: Summary of projects observed, correlated, distributed, and released in 2007.

	User Experiments			Test & Network Monitoring		
	N	Ntwk_hr	Corr_hr	N	Ntwk_hr	Corr_hr
Observed	72	689	961	48	200	208
Correlated	70	668	1110	47	194	202
Distributed	64	600	1012	45	189	197
Released	60	556	958	48	199	207

Table 2.2: Summary of projects observed, correlated, distributed, and released in 2008.

Figure 2.2 presents the work division among various correlator tasks (production, clock-searching, network/correlator tests) as a number of hours per week, over the past three years (2007-2008 highlighted). A six-week running average is shown. Troughs in the production hours correspond to periods when the correlator queue ran out of possible experiments prior to the start of the next EVN session, during which time we can focus more on correlator testing (e-VLBI, recirculation, fine-tuning the disk-servo'ing algorithm, etc). Bursts of time spent on network tests (cyan) in and immediately following sessions are also apparent.

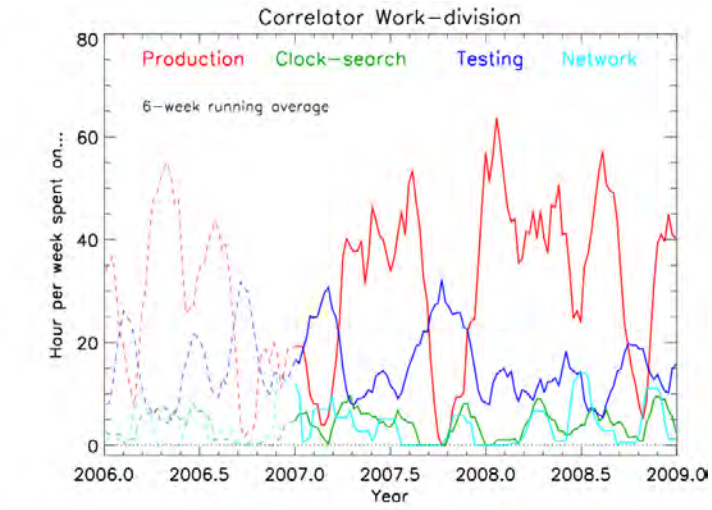


Figure 2.2: Work division among various correlator tasks, in hours per week

Figure 2.3 presents various measures of correlator efficiency. The red line plots the completed correlator hours per time actively devoted to production correlation (the red line in figure 2.2). The green line shows completed correlator hours over the total operating time of the correlator -- the red and green lines diverge more in periods when production takes up a smaller fraction of the total time available. The blue line shows completed network hours over total operating time -- the green and blue lines diverge because some experiments require multiple passes. A twelve-week running average is shown to smooth out spurious peaks caused by periods with no remaining production correlation.

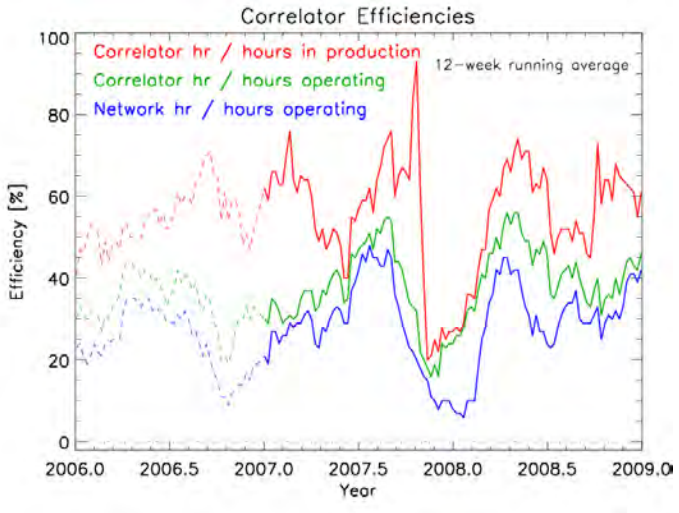


Figure 2.3: Various measures of correlator efficiency.

Figure 2.4 presents the size of the correlator queue at different stages in the processing cycle, showing a snapshot of the status at the end of each week. The red line plots the number of correlator hours that remain to be correlated. The blue line plots the number of correlator hours whose data remain to be distributed to the PI. The green line plots the number of correlator hours associated with recording media that have yet to be released back to the pool (in practice, release occurs prior to the following session, leading to a blocky pattern for the

green line). The weeks of correlation for the 17-pass GC029 can be seen around the end of 2007 and beginning of 2008; it took until just before session 3/2008 to completely empty the correlation queue again (red line to 0).

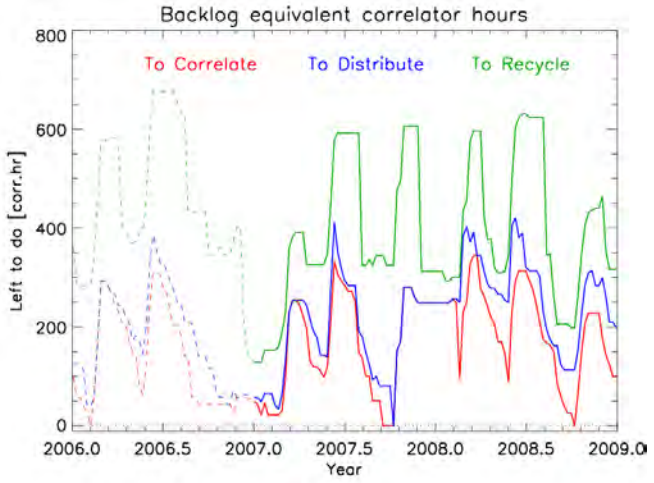


Figure 2.4: Size of various correlator queues, measured in correlator hours

Figure 2.5 shows the number of user experiments and the number network and correlator hours correlated over the past six years, with the hours for user experiments (diamonds) and the combination of user experiments and NME/test observations (squares). Including both user experiments and NME/test observations yields an essentially monotonically increasing output from the correlator. Over the past two years, the number of user experiments has grown strongly thanks to the new e-VLBI observations. Also plotted at the bottom is the number of JIVE support scientists in the Science Operations and Support Group, using the scale on the right-hand ordinate.

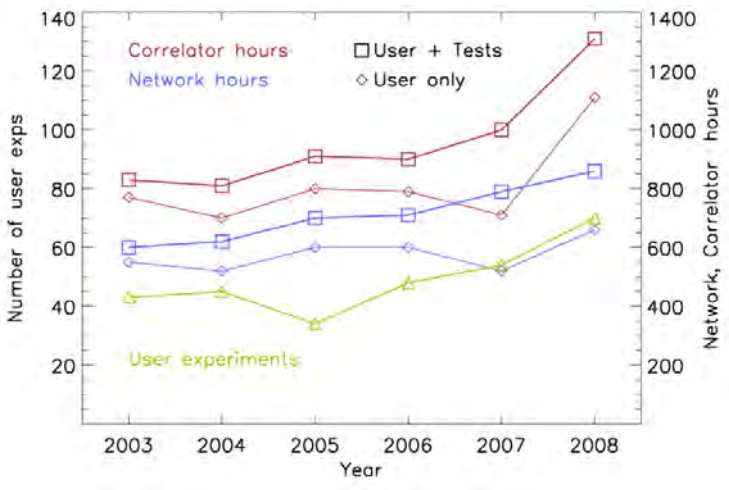


Figure 2.5: Amount of correlator and network hours plus the number of user experiments correlated in each year, together with the number of JIVE support scientists in the Science Operations and Support Group.

2.1.2 Logistics and Infrastructure

The disk-shipping requirements are derived from the recording capacity needed by a session (from the EVN scheduler) and the supply on-hand at the stations (from the TOG chairman). Now that the VLBA has also shifted to Mark 5 recording, the bookkeeping of disk-flux accounting has become more complicated. There are two sets of rules to follow:

a) the EVN policy that stations should buy two sessions' worth of disks, hence the disk flux should balance over the same 2-session interval. Following distribution to the stations for session 3/2008, we had "overdistributed" a net cumulative 191.05 TB of disk-pack capacity.
b) the VLBA's need for sub-session turn-around, which essentially requires pre-positioning the difference between what NRAO stations will observe in globals to be correlated at JIVE and what EVN stations will observe in globals to be correlated in Socorro. Following the shipments in both directions for session 3/2008, we had "overdistributed" a net cumulative 14.33 TB of disk-pack capacity.

In an effort to accelerate recycling packs somewhat faster than the "2nd-following session" rule, we began in session 1/2008 to try consciously to correlate higher data-rate recording experiments first, to maximize the amount of releasable packs per given correlator hour early enough to recycle some packs in time for the next session. This optimization is complicated by fact that many experiments can reside on the same pack, but it has contributed to the large net "overdistribution" with respect to the original guidelines.

The data processor has 16 Mark 5A units, all housed inside temperature-controlled cabinets. Some stations now record exclusively with Mark 5B units, which we can correlate through the Mark 5A units using capabilities of the 5A+ firmware. Work progresses on developing native Mark 5B playback, for which purpose some of the Mark 5A units can be converted to Mark 5B via the insertion of a new I/O card and some cable re-connections. Because Mark 5B units could not play back Mark 5A recordings, we would need to retain enough Mark 5A units to handle NRAO recordings until they move to Mark 5C (which could be played back via a compatibility mode in Mark 5B, but not Mark 5A). Maintaining the proper mix of playback units in light of the phasing of these changes is reminiscent of that required in the initial tape-to-disk transformation.

JIVE continues to encounter the occasional individual bad disk (or two) in an incoming pack. We maintain a small bench stock of disks of various sizes so that we could replace a bad disk locally if that is the most appropriate course of action (in light of warranty status, urgency of recycling, etc.), and then we would get a new disk from the pack's "owner" to replenish our bench stock. All but the highest data-rate recordings generally play back well with a bad individual disk disconnected.

Individual boards in some station units continue to show some symptoms of their advancing age. There are enough DMM's that seem prone to causing byte slips that we actively manage their locations in the SUs to minimize impact on the correlation. There are no other types of boards at this stage, but many have very few or no spares. Native Mark 5B playback would of course by-pass the station units. Currently Yebes 40m and Westerbork array record exclusively

Mark 5B, but Westerbork single-dish may record via their (borrowed from us) Mark 5A unit to allow simultaneous use of the rest of the array as WSRT. With a couple of Mark-5B-only stations, the stock of spare SU boards would increase. There were a couple of instances in 2007-2008 in which specific correlator boards exhibited problems, but these were repaired by ASTRON. Such problems have up to now always been strongly localized, and as long as we have experiments to correlate that do not require the full correlator, we can mask out segments having bad boards.

At the very end of 2008, the (ASTRON) cooling machine received a thorough maintenance cycle, and the cooling fluid was recharged (it had been operating on about 1/4 capacity). There were two instances of power glitches in December 2008, 16 days apart, significant enough to trip everything off-line that wasn't under UPS protection. Fortunately, none of this happened during e-VLBI runs. There hadn't been any such power interruptions for several years, so two so close together was quite unusual.

2.1.3 Astronomical Features

We began applying a better post-correlation fraction bit-shift correction to the phase across the band for each (baseline) visibility for experiments starting in session 1/2007. Figure 2.6 shows an example of vector-averaged amplitude as a function of time on some baselines from the 5 cm NME N06M2.

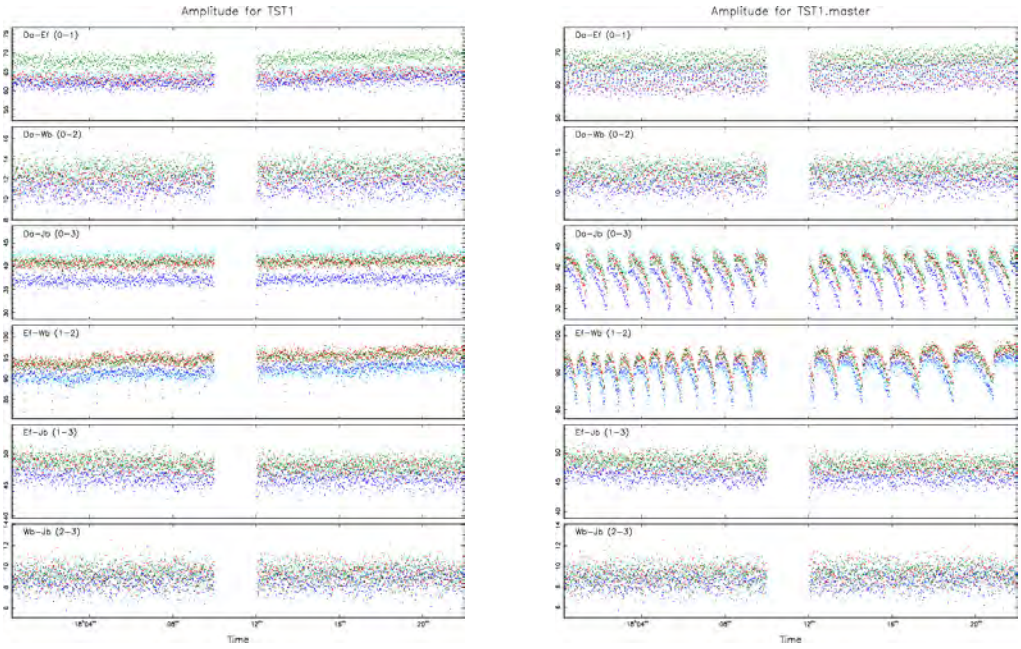


Figure 2.6: Effect of the new post-correlation fractional bit-shift correction on vector-averaged amplitudes as a function of time.

An experiment from session 3/2007 (EP062) was the first to use 1/8 s integrations in production correlation. The correlator can maintain this output, as long as only 4 (of 8) boards per crate are used in the correlation (maintaining the current maximum read-out rate of 6

MB/s). This specific experiment therefore required two correlator passes, each with half (8 of 16) subbands. Subsequent post-correlation processing led to an additional feature in the Measurement Set creation program to accommodate both passes in a single measurement set (thus not requiring the PI to accomplish this in AIPS via VBGLU), and to new glish programs to ensure that there were no "orphan" subbands (data in only one of the two passes for a given integration epoch) and to re-sort the single measurement set such that resulting FITS files would not require any special pre-processing when being read in to AIPS.

Recirculation is a means of time-sharing the correlator resources such that data recorded at sampling rates below 32 Msample/s can achieve higher spectral resolution -- essentially using "idling" correlator chip capacity to process additional lags. The maximum number of frequency points per interferometer remains at 2048 (limited by the requirement that a single interferometer must be processed on a single correlator board), but many spectral-line experiments now have their spectral resolution limited below this by the number of stations or polarizations they use. These many-station/low-BW observations can benefit from recirculation. An example: without recirculation, an 8-station, 1 subband, 2 polarization observation can obtain 1024 points in one correlator pass, but it would not be possible to achieve this with cross-pols or with a ninth station. As long as the subband bandwidth is no more than 8 MHz (for cross-pols) or 4 MHz (for nine or more stations) or 2MHz (for both cross-pols and nine or more stations), recirculation would allow single-pass correlation. All values of recirculation up to 8 have been tested in terms of the resulting amplitudes and phases, with only a few items remaining to test in more detail.

Typically, only the Jb-Cm baseline has been common to both the EVN and MERLIN correlations in combined EVN+MERLIN observations. This can sometimes lead to difficulty in tying the two data-sets together. Because of the 16 MHz bandwidth limit in the MERLIN out-station micro-wave link, the Cm recording has "unused" subbands in recording modes at 256 Mbps and above. For dual-pol observations above this rate, an additional out-station can be recorded onto the unused subbands; single-pol observations can incorporate three additional out-stations. For such "high" data-rate observations, there would be no additional scheduling burden on the PI; all necessary steps can be taken by the VLBI friends at Jodrell Bank. Observations at or below 128 Mbps would require a separate schedule for Cm to accommodate additional outstations. Each recorded MERLIN station would correlate as a separate station at JIVE, thus the additional out-stations may affect the correlator loading (if the number of stations increases to nine or more, four times fewer frequency points would be available in a single correlator pass than with the original VLBI array. e-VLBI has a natural application here, as the signals for the separate out-stations can be separated on their transit to JIVE; for disk-based observations we would need to make copies of the Cm disk-pack prior to correlation, requiring additional disk-pack availability. The additional intra-MERLIN baselines included in the EVN correlation would increase the robustness of the tie between the EVN and MERLIN u-v data sets. Implementation of this scheme in light of the forthcoming roll-out of e-MERLIN remains to be investigated (i.e., the 128 Mbps limit on the micro-wave link will disappear, removing the straightforward existence of "unused" subbands).

2.2 EVN Support

The automatic-ftp feature added to the field system in 2006 is used in all network monitoring experiments (or a separate fringe-test experiment, when an NME is scheduled well outside working hours). This sends a specified portion of a scan directly to the software correlator computer at JIVE. At the beginning of this biennial period, we used a version of the NICT software correlator for these fringe tests. In the middle of 2007, we shifted to the software correlator being developed under FABRIC/SCARIe. This provided us with more control over the development of new modes (VLBA-format data, cross-pols, etc.). Correlation results go to a web page available to all the stations within a couple hours, and Skype chat sessions during the NME provide the station friends with even more immediate initial feedback. The presentation of the results on the web page has also improved considerably, now showing baseline amp and phase across the band as well as autocorrelations, and each plot is accessible by moving the cursor over colour-coded baseline/subband/polarization cell (figure 2.7).

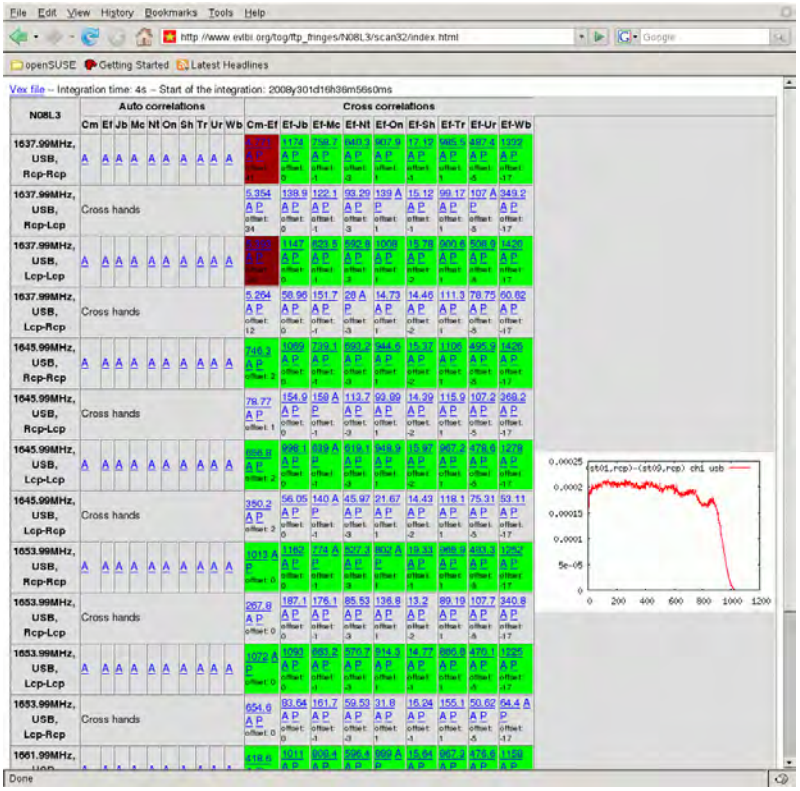


Figure 2.7: An example of the web-page for an ftp fringe-test scan from the NME N08L3. The amplitude-frequency plot is for Ef-Wb SB1 RR.

These ftp fringe tests continue to be very successful in identifying telescope problems and thus have helped to "save" user experiments by providing feedback quickly enough for the telescope staff to effect repairs, especially as we see more new stations begin to participate in EVN observations. An example comes as recently as the very last user experiment of 2008 -- we could not find fringes to Yebes 40m in the ftp fringe-test from the K-band NME N08K4; the

station was able to trace this to an IF local oscillator, which they replaced in time for the following EB037E the next morning, in which Yebes fringes were fine.

The EVN pipeline now runs under ParselTongue (a Python interface to classic AIPS). The new pipeline is considerably easier to use, more robust and has much greater scope for future development due to the improved coding environment. The pipeline scripts are available from the ParselTongue wiki (RadioNet) and should provide a good basis for other (semi-)automated VLBI reduction efforts. We continue to process all experiments, including NMEs, via the pipeline, with results being posted to the EVN web pages. The pipeline provides stations with feedback on their general performance and in particular on their gain corrections, and identifies stations/frequency bands with particular problems. Timely delivery of ANTAB amplitude calibration results from the telescopes seems to be improving, but remains an issue in e-VLBI experiments due to the shorter time-scales involved.

In the course of pipelining, the support scientist also calculates the EVN Reliability Indicator (ERI) for each experiment. This ERI conceptually is the ratio of good to expected visibilities in the distributed FITS files. Two statistics are calculated: one including all losses (including weather), and another that discounts weather and other natural causes over which the EVN has no control (denoted ERI). Figure 2.8 shows the evolution of ERI over time, with each experiment plotted separately. The improvement brought by the shift to disk-based recording (median ERI* not below 84% since session 2/2004) and the even more marked improvement in e-VLBI reliability since its inception at the end of 2006 are apparent.

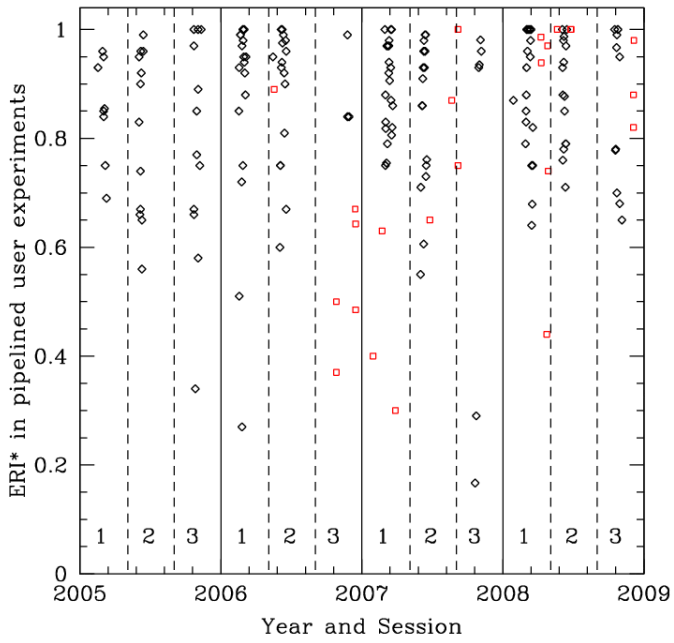


Figure 2.8: Plot of the EVN Reliability Indicator for pipelined user experiments up through session 3/2008. Red squares denote e-VLBI experiments.

A considerable amount of time between October 2007 and July 2008 went into working with Westerbork on operational tests of their new digital TADUmax back end. Thirteen separate test observations were made in that time to check out various modes typically used in VLBI, and to iron out the details of the bit-encodings and sampler statistics. The advantages of TADUmax include full coverage of 128 MHz total bandwidths in Gbps observations (the previous system could get only 7/8 of the coverage) and much more rectangular bandpass shapes. The digital filters do add a channel-bandwidth dependent clock offset; log2vex can now account for this in creating the correlation-controlling vex files.

2.3 PI Support

The EVN Archive at JIVE provides web access to the station feedback, standard plots, pipeline results, and FITS files for experiments correlated at JIVE. Very few PIs request distribution of their FITS files on physical media (DAT or DVD) anymore. There were 3404 FITS files downloaded in 2007-2008, from people in 32 different countries (including 21 non-EVN countries, and 12 of those being outside the EU and associated states. Public access to the FITS files themselves and derived source-specific pipeline results is governed by the EVN Archive Policy --the complete raw FITS files and pipeline results for sources identified by the PI as "private" have a one-year proprietary period, starting from distribution of the last experiment resulting from a proposal. PIs can access proprietary data via a password they arrange with JIVE. PIs receive a one-month warning prior to the expiration of their proprietary period. We have increased the storage available on the archive machine from 4.5 TB to about 16 TB. The total size of the FITS files in the archive at the end of 2008 was about 5.85 TB (a 2.77 TB gain in the two-year period); figure 2.9 shows the growth of the EVN archive size over time.

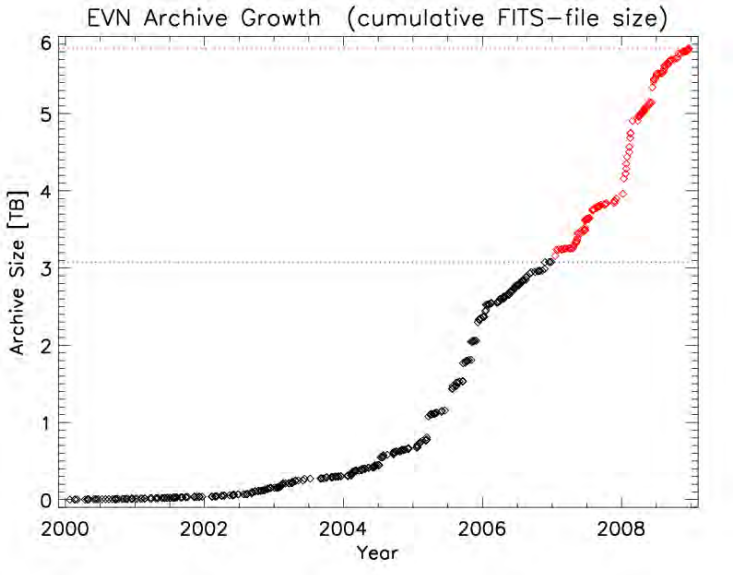


Figure 2.9: Growth in the size of FITS files in the EVN archive. Experiments archived in this biennial period are plotted in red.

The science operations and support group continues to contact all PIs once the block schedule is made public to ensure they know how to obtain help with their scheduling, and to check over schedules posted to VLBEER prior to stations downloading them. In previous years, there had been a handful of instances in which a station observed using a superseded version of an experiment's schedule. New safety features have been incorporated into the pre-observation system that should help avoid such incidents. Indeed, with the glaring exception of GC029, these have not recurred. In GC029, the EVN stations all observed an older version of the schedule while the VLBA stations observed the current one -- and the two versions had decidedly different scan timing patterns. We had to adjust the correlation-controlling vexfile manually to include EVN stations only those portions of scans in which they overlapped with the proper version of the schedule. Efforts to confirm that different parts of global arrays have the same version of the schedule redoubled thereafter. Policy discussions about the dangers inherent in EVN and VLBA stations accessing the schedules from independent locations also got underway. The pre-observation communication also provides the opportunity to inform eligible PIs about the benefits of the RadioNet trans-national access programme, if applicable.

The RadioNet-driven NorthStar web-based proposal tool became the sole means to submit EVN or Global VLBI proposals starting from the 1 February 2007 proposal deadline. Later, e-VLBI proposals joined the fold. Currently, only target-of-opportunity proposals are handled outside of Northstar. Feedback is solicited from proposers after each deadline, and their insights are reviewed to continue to improve the user-friendliness of the proposal tool.

JIVE hosted 16 data-reduction visits in 2007 and 10 in 2006. In addition, through the period of the report there were seven post-graduate students who were co-supervised by members of JIVE staff, and who visited frequently. The visitors room has five dual-processor PCs running Linux, one windows-based PC, and a small cluster of four interconnected top-end workstations, to accommodate processing of very large wide-field data sets (whose monitors occupy an additional two work places.

3 Technical Operations and R&D

3.1 Data Processor Maintenance

3.1.1 Data Playback Units

The DPUs were finally decommissioned in 2007. Several were sold to Metrum, some still remain in place, mainly to preserve the airflow of the system as a whole. Their PR-appeal should not be underestimated, visiting journalists, photographers and TV-crews mostly insist on using the tape units, preferably with tapes spinning, as a backdrop. As more space is needed for other equipment, the DPUs are removed and replaced by new racks.

3.1.2 Station Units

On the whole, the Station Units performed well. Individual components however continue to deteriorate, and the pool of available spare parts has dwindled considerably. Partly switching over to Mark 5B at the correlator would allow us to retire at least a few SUs, but for this JIVE would need more stations to do the same. As it is, too many projects still require 16 Mark 5A playback units to allow the installation of Mark 5Bs on a permanent basis.

3.1.3 Mark 5 Units

The Mark 5 units, both in their A and B personalities, performed reliably. Some minor hardware problems were repaired in-house. A spare Mark 5B was purchased for code development and testing purposes, but was transferred to Westerbork quite soon after arrival, to help with the debugging and commissioning of TADUmax.

3.2 Data Processor Developments and Upgrades

3.2.1 Mark 5

During the period 2007-2008, all Mark 5 units were upgraded. New motherboards, CPUs, memory banks, hard disk drives and power supplies were installed, and several units were equipped with 10 GE interfaces. Noticing large temperature differences within the Mark 5 units, the JIVE operators devised a method to significantly improve airflow inside the Mark 5 housing, thereby reducing the chance of disk pack overheating. This method was later adopted by Conduant and is now implemented in all new Mark 5 units.

3.2.2 Archive

At the start of 2007, the total capacity of the JIVE data archive was 5.7 TByte. Fairly soon it became clear that this space would run out within roughly one year, so the decision was made to replace all 250 MB disks by 500 MB disks, and fill all available slots in the raid cabinets. In order to use the total disk space as efficiently as possible, very large file-systems were needed. This in turn asked for upgrades to both operating system and drivers, which proved problematic. Replacing the aging archive machine with a modern server solved these problems. The total capacity of the archive is now 15 TB, of which 6 TB is currently in use. It is expected that this should suffice for the next 2 to 3 years.

3.2.3 Re-circulation

Re-circulation, which enables one to optimize the use of a correlator through time-sharing its computing resources, was tested and verified and is now considered an operational capability of the EVN correlator.

3.2.4 Replacement of data acquisition platform

A new Solaris server equipped with a high-capacity raid array has replaced the data acquisition machine after a series of correlation tests. This machine is fully interchangeable with the two correlator-control machines, providing extra resilience to the correlator system. With the installation of this machine, a re-circulation enabled version of the correlator code was installed and as a consequence, the whole system now runs permanently at 64 BOCFs. The installation of additional equipment caused the temperature in some racks to reach critical levels. This was solved partly through airflow modifications and partly through redistribution of hardware.

3.2.5 Mark 5A to B upgrade

Although the Station Units have performed relatively well, spare parts are few and replacements unavailable. Upgrading the Mark 5A units currently in use at JIVE to Mark 5B would make it possible to phase out the SUs.

Several Mark 5A units were converted to B and hooked up to the correlator via Correlator Interface Boards and optical serial links, and the Haystack-developed Mark 5B control software was modified for use with the EVN correlator. Testing however was seriously hampered by the initial lack of suitable 5B data. Using modified LBA data, a significant difference was found between correlation using A+ and B. Extensive consultations with Haystack engineers identified a 1-second offset. As usual, fixing proved a lot easier than finding the problem, and new tests showed no significant differences in the results from A, A+ and B playback.

Since these tests, Westerbork, Effelsberg and Yebes have started producing B-data on a regular basis, data that however are usually played back on A+ units at JIVE. As more stations switch to B-recording, it will become possible to permanently install B-units for playback.

3.2.6 PCInt

As a data reduction platform, the PCInt cluster plays a vital role in the correlation process. The control computer of the PCInt subnet also serves as a boot host for the correlator's Linux-based single-board computers. Considering the age and the importance of this system, the decision was made to purchase a back-up control computer. Configuration of this computer however turned out to be quite an effort, as the operating system level had to be upgraded, and moreover, a number of required server applications (e.g. DNS) had changed considerably.

3.2.7 Migration of HP-RT boot environment

The HP real-time computers, located inside the correlator racks, boot from an HP server, which until 2006 used to be the correlator control machine (an HP C240). A new boot environment was set up on a pair of (much newer) HP B2000 machines, with mirrored hard disks. This

setup should provide protection against most types of hardware failure, and limit correlator downtime to a minimum.

3.3 e-VLBI

At the beginning of 2007, the EXPReS project was well underway and gaining momentum. Scientific e-VLBI runs were taking place on a regular basis, albeit at low data rates, and many soft- and hardware modifications, both at the correlator and at the stations, had led to a much-improved operational real-time system. However, some big problems still remained to be tackled, such as the establishment of reliable high-bandwidth data transfers within Europe, long-haul data transport from telescopes on other continents and the efficient use of available bandwidth.

3.3.1 Local network

As a first step, the complete network at JIVE was overhauled. An HP ProCurve 5412zl router was purchased to handle up to 16 1-Gbps lightpaths and one 10-Gbps IP-switched lambda (capped at 5 Gbps) from SURFnet, and all interconnects between SURFnet, Mark 5 units and control- and test computers. A second, smaller, HP switch was installed to deal with all remaining correlator-related network traffic, removing dependencies on the ASTRON internal network. New monitoring software was installed, enabling the generation of graphs of the status and data throughput of the e-VLBI network.

3.3.2 International networks

Several stations in Europe were connected via dedicated 1-Gbps lightpaths across GÉANT2, and new lightpaths to China and Australia were set up through the good services of the GLIF collaboration. South America was connected via GÉANT2 and the EC-sponsored RedClara network. A second connection to China, via the EC-sponsored TEIN2 network, was also established by DANTE.

In 2008 Arecibo re-joined the e-EVN through a 512-Mbps shared connection to mainland USA (with full bandwidth limited to certain timeslots), and a VLAN to JIVE via AtlanticWave and SURFnet. That year the Effelsberg Radio Telescope also came online, providing a second tremendous boost to the sensitivity of the e-EVN.

3.3.3 Software developments

Throughout, efforts continued on monitoring, control and post-processing software tools. Special emphasis was put on improving the robustness and the real-time behaviour of the correlator control software, enabling rapid adjustment of correlator parameters and adaptive observing. Modifications to the correlator control code were implemented which made it possible to remove and add stations in the middle of correlator jobs, without having to restart the entire job. This removed one of the main causes of data loss during e-VLBI runs and resulted in a tremendous increase of productivity.

3.3.4 Data transport issues

When the first e-VLBI experiments started, all data transport with the Mark 5A units was done through the TCP/IP protocol. This protocol is specifically designed to guarantee fairness on the Internet, by throttling back data throughput as soon as packet loss is detected (interpreted as congestion). After such an event, the data rate is slowly increased again and will eventually (in the absence of further packet loss) reach the original data throughput. However, the recovery time increases with RTT (round trip time). As a result, this protocol is particularly unsuitable for intercontinental real-time data transfers such as needed for global e-VLBI.

Two important e-VLBI demonstrations were planned for 2007: a demo at the Asian-Pacific Advanced Networking (APAN) conference in Xi'An, China, which would involve telescopes in China, Australia and Europe, and an e-VLBI run in which data from three Australian telescopes were to be correlated in real-time at the EVN correlator in Dwingeloo (an actual EXPReS deliverable). Very soon after the start of data transfer tests, it was realized that TCP would simply not do; data throughput from Shanghai never reached more than ~20 Mbps.

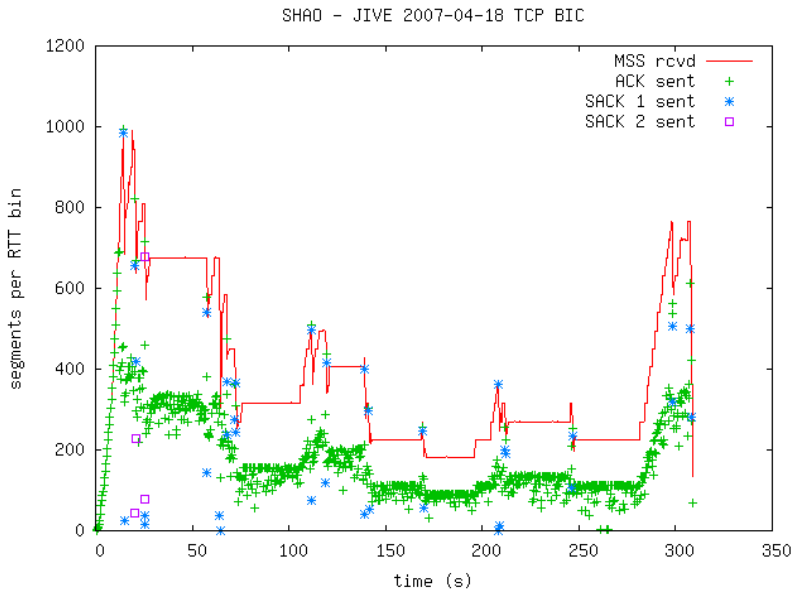


Figure 3.1: results of data transfer tests between Shanghai Observatory and JIVE using TCP

UDP, a connectionless protocol, should in theory perform much better (at the cost of the connectivity of other users) but was disabled in the Haystack-developed Mark 5A control code. Re-enabling UDP transfer gave very poor results, and in the end the decision was made to completely re-write the e-VLBI related portion of the Mark 5A control code at JIVE. This new code features rigorous thread control and options to handle out-of-order packets, to space the packets regularly (in order to prevent bursts of data), and to selectively drop packets at the sending side while padding the data stream at the receiving end with dummy data, optimizing the use of available bandwidth.

Another solution was developed for the Australian disk recording systems (LBADR), in preparation of the EXPReS Australia-JIVE demo (planned for the first week of October 2007). Data from the LBADR units were converted on the fly to Mark 5B format, transferred using the

Circuit TCP (CTCP) protocol and received on Mark 5A+ units at JIVE (CTCP is basically TCP without any congestion control at all). This method was successfully used in the e-VLBI demo at the APAN conference in Xi'An, resulting among others in fringes between Darnhall and Mopra (one of the longest VLBI baselines ever).

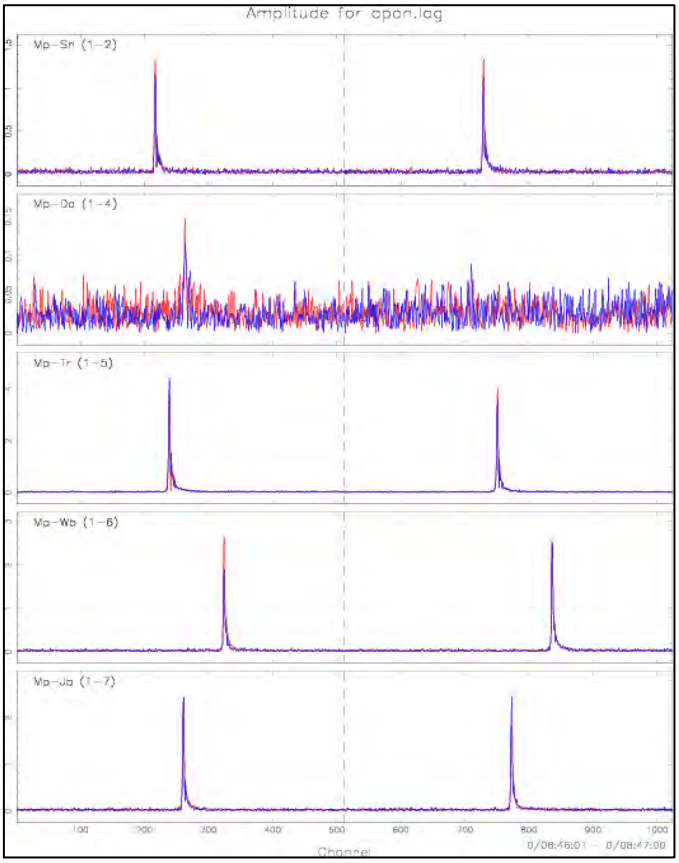


Figure 3.2: Real-time fringes between Mopra, and several EVN telescopes

During the Australia-JIVE demo, data from ATCA, Mopra and Parkes were transferred via three dedicated 1-Gbps lightpaths to JIVE and correlated in real-time. This time the UDP protocol was used, and 512 Mbps per telescope was sustained for 12 hours with hardly any packet loss at all. As with the APAN demo, this demo also generated quite a lot of public attention.

A number of further developments followed. Ensuring that only packets containing data are dropped, while leaving data headers intact, improved the behaviour of the correlator during high data-rate e-VLBI greatly. Although very useful, packet dropping does increase the noise right across the observed bandwidth, and channel dropping, meaning that only specific sub bands are dropped at the stations, would in most cases be preferable. This method was shown to work on local machines, but not used in production because of the high CPU load involved. Implementation will follow when all e-VLBI stations have upgraded their systems with new CPUs and SMP-enabled Linux kernels, to make full use of the available CPU power. Related to this, changes were made to the correlator control software to allow different configurations at different stations, providing an additional tool to adjust data rates. Finally, simultaneous recording and transmitting of data at the station side was enabled, but has not been used

operationally yet. Simultaneous playback and recording at the correlator cannot be done with Mark 5A, but should be possible with Mark 5B.

The JIVE-developed Mark 5 control code was further adapted to work with Mark 5B recording units. The Domino software however, supplied by Haystack for playback with Mark 5B at the correlator, came without any support for e-VLBI. After Haystack engineers had added this functionality, further modifications were made at JIVE. In spite of successful tests with local units, tests with real data so far failed. Progress has been slow, mostly because of the small number of stations with both Mark 5B units and sufficient connectivity. This situation however should improve in the coming year.

3.3.5 Adaptive observing

A first test was done on August 28 2008 with dynamic scheduling, in which a schedule was changed at JIVE during an observation, the new schedule file merged with the old one, distributed to the stations, DRUDG'ed locally (via ssh from JIVE) and run at the stations. The changes were made at Torun and Westerbork, with Jodrell Bank staying on the original schedule, and as planned fringes between Torun and Westerbork reappeared after the change. No new software had to be installed at the stations; the ssh commands were executed at stations using ssh in single-command mode from scripts run at JIVE. In the future, this method could prove particularly important for rapid response observations of transient sources.

3.3.6 Merlincast

On July 22 2008 a special test was done involving the MERLIN telescopes at Cambridge, Darnhall and Jodrell Bank (Mark 2). In the current MERLIN network, the 'out-stations' are connected to Jodrell Bank by microwave links that have about 128 Mbps throughput. For this test, the links from both Darnhall and Cambridge were connected to the VLBA terminal. The VLBA terminal has 4 IF inputs, so each IF received data for one polarization from either Darnhall or Cambridge. The IF sampled data from both telescopes were then run through the formatter and Mark 5 and transmitted to JIVE. At JIVE, the 'port monitoring' functionality of the central JIVE switch/router was used to 'snoop' on all the networking traffic towards one Mark 5 and send duplicates to a second Mark 5. With this setup fringes between all three stations were achieved. This experiment was repeated on the 9th of September, this time using IP Multicast to perform the packet duplication without having to undertake major networking changes at JIVE. This resulted in the first real-time fringes to the Knockin station at MERLIN. This technique, now dubbed ‘Merlincast’, has the potential to significantly improve the sensitivity of the e-EVN to larger scale structures.

3.3.7 Towards true 1-Gbps e-VLBI

Although the use of packet dropping in combination with UDP enables one to (nearly) fill available links to their limit, the full 1024 Mbps of e-VLBI traffic (plus overhead in the form of headers) will simply not fit on a standard 1-Gbps (= 1000 Mbps) connection. Several ways around this problem were investigated.

The Westerbork Radio Telescope is connected to Dwingeloo via dark fiber. Redundant CWDM equipment (kindly provided by the LOFAR group) was installed and equipped with a number of colours, 2 of which were reserved for e-VLBI traffic. In order to reach 1024 Mbps, a single data stream was divided in round-robin fashion over two independent 1-Gbps lightpaths, and recombined at the receiving end. Tests showed that transfers of 1500 Mbps were easily sustained in this way. This same method was applied to the dual 1-Gbps lightpath connections to the UK, and although shown to work in principle, use in production awaits a motherboard upgrade of one of the Mark 5 units at Jodrell Bank.

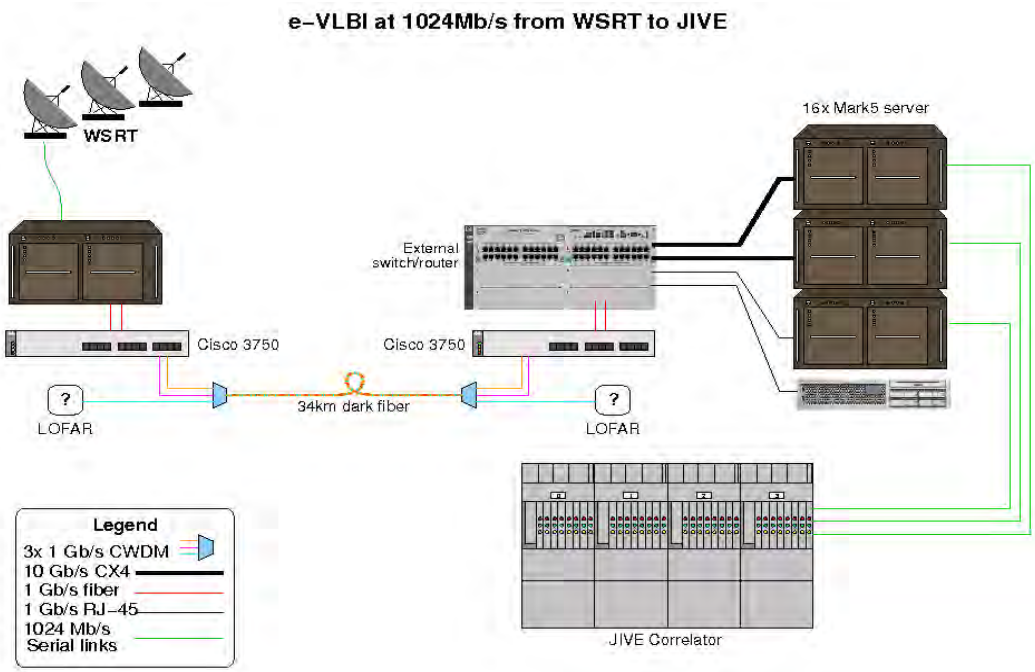


Figure 3.3: Network setup between Westerbork and JIVE

The Effelsberg Radio Telescope came online in 2008, through a dedicated fiber connecting the MPIfR in Bonn to the site. To accommodate both e-VLBI traffic and data transfers from their new e-LOFAR station, a 10-Gbps connection was established via Amsterdam to both Dwingeloo and Groningen. The Effelsberg Mark 5 unit is equipped with two 1-GE interfaces, and the data stream is divided in a similar way as that used for the Westerbork connection. However, the two data streams are recombined on the local switch, and sent as a single data stream through a VLAN on the 10-Gbps link.

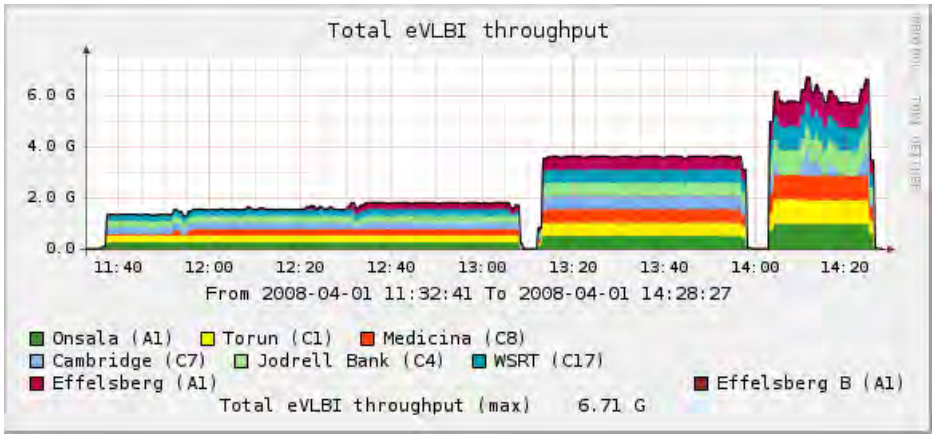


Figure 3.4: Data throughput during first e-VLBI observations with Effelsberg

Onsala Radio Observatory was connected at 10 Gbps, to allow for future e-LOFAR data transfers, and to enable real-time 4-Gbps transfers from Onsala to the e-MERLIN correlator at Jodrell Bank (part of the EXPReS Joint Research Activity FABRIC). Torun Radio Telescope was connected at 10 Gbps to the Poznan supercomputing centre; both Onsala and Torun Mark 5 units are equipped with 10GE interfaces.

This synergy with other projects led to the milestone observations on the 19th of November 2008, during which Westerbork, Effelsberg and Onsala participated at a full 1024 Mbps.

3.3.8 Tests and operations

Slots of 24 hours were reserved at 4 to 6-week intervals for e-VLBI science. The four hours preceding each session were earmarked for setup and testing. Apart from this, many tests took place, depending on the availability of stations and the particular urgency of the test in question. Operational reliability and ease increased steadily throughout the last two years, and many successful science observations were conducted.

3.3.9 Demonstrations

Live demonstrations continued to be an important element of the outreach effort of EXPReS. Although they sometimes pose a big strain on the operational network, and can be quite disruptive, demonstrations are extremely useful in providing a focal point and speeding up developments.

The first demonstration of 2007, at the APAN conference in Xi'An, China, involved telescopes in China, Australia and Europe. Although fringes had been obtained in the past (at very modest data rates) between Arecibo and the European EVN telescopes, the distances in this demo would be considerably longer. What's more, the LBA uses a completely different data acquisition system and data format. As mentioned in section 3.4.4, a large and diverse number of problems were solved, and after the track of the Shanghai telescope was broken and had been fixed (one week before the start of the conference!), the actual demo went without a hitch. For this demo we obtained access to the EC-sponsored trans-Siberian TEIN2 network,

through the services of both Chinese Research Networks, CSTNET and CERNET. Data from the Australian telescopes was transferred via a dedicated lightpath connection provided by AARNET, CANARIE and SURFnet, and via the 'normal' Internet (which failed completely during the demo).

This was followed by the EXPReS-Australia demo, during which data from three telescopes were transferred, at 512 Mbps each, via three lightpaths to JIVE. This demo ran for more than 12 hours and nicely illustrated how VLBI may look in the future, connecting telescopes and correlators on opposite sides of the planet in real-time.

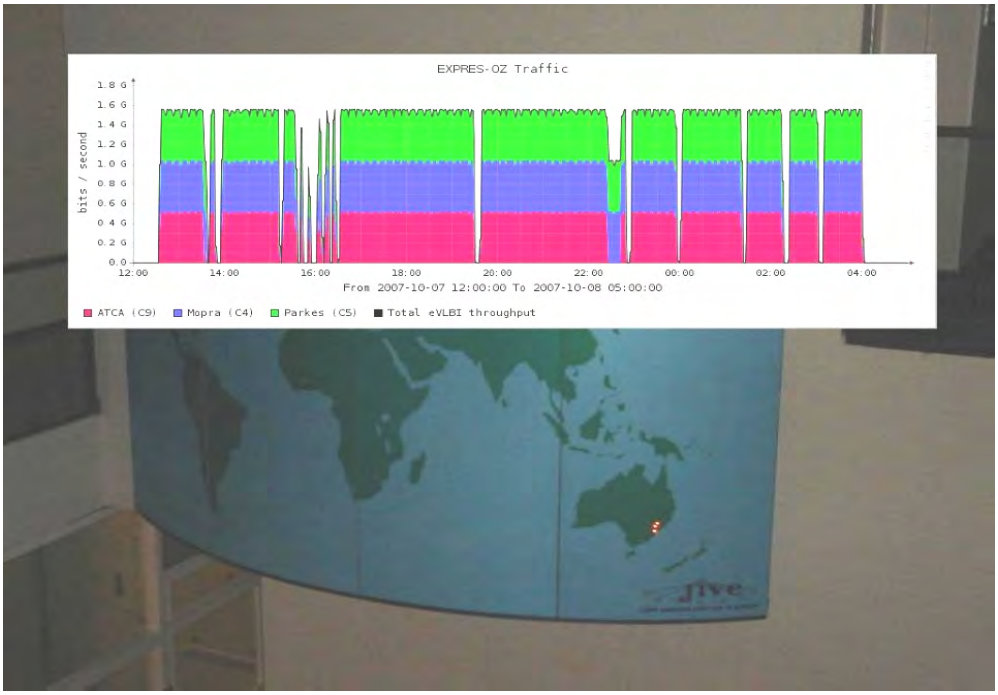


Figure 3.5: data transfer during EXPReS-Oz demo

In an unexpected development, Hartebeesthoek became the next station to join the e-EVN. A 1-Gbps connection between Hh and the nascent South African NREN, SANReN, in Johannesburg, and from there at 64 Mbps via London to JIVE, became available in May 2008. Hh then participated in two very successful demos, of which one was rather ad-hoc, organized for the visit of a high-ranking EC delegation to the Hh telescope site.

The second demo took place at the high-profile TERENA 2008 conference, in Bruges, Belgium, where JIVE director Huib van Langevelde was the keynote speaker at the closing plenary meeting. This demo produced fringes between TIGO, Hh, Ar, Ef, Wb, Mc and On, effectively a 4-continent correlation, with the real-time results displayed by van Langevelde in his presentation.

Figure 3.6: e-VLBI demo display at TERENA conference

A smaller demo was run later in the year, during a presentation by Arpad Szomoru at the GLIF conference in Seattle, USA. By that time JIVE and the EVN had become sufficiently experienced to tackle a far more ambitious project, and towards the end of 2008 preparations started for a 24-hour real-time tracking of a single source, a truly global effort involving many non-EVN telescopes. This was to feature at the opening of the International Year of Astronomy, in Paris, in January 2009, and as such it will be reported on in the next biennial JIVE report.

3.4 EVN-NREN, e-VLBI workshops

In September 2007, the yearly e-VLBI workshop was hosted by the MPIfR in Bonn. With 58 participants it was very well attended, and it covered a large number of technical topics. A half-day EVN-NREN meeting and a one-day meeting on the EXPReS Joint Research Activity FABRIC followed this workshop.

Shanghai Observatory hosted the 7th international e-VLBI workshop in June 2008. Again, attendance was high, and one of the things that became clear through the many excellent presentations was that e-VLBI in Asia is in full development. This workshop featured a live e-VLBI demo involving Shanghai, Kashima and the Australian LBA, with the data being correlated on the Australian DIFX software correlator, and a live 8-Gbps data transfer via the 'normal' (non-lightpath) networks of the Scandinavian NRENs. As a result of an open discussion on data formats, the decision was made to form a task force, led by Alan Whitney, to determine a standard VLBI data format, with the aim of enabling seamless integration of different telescope networks, data acquisition platforms and correlators.

4 Software Development

4.1 Software correlator

In early 2007, the SFXC software correlator produced its first fringes on astronomical data. This was a major milestone, showing that the C++ implementation of the original algorithm developed for the Huygens project was functional. After that the correlator code underwent drastic changes. The code was modularized and further parallelized by using MPI. This made it possible to distribute the correlator over machines within a cluster. A module to generate the delay model was added. This model is based on the same CALC10 code used by the hardware correlator. The original configuration file format had some limitations that made it unsuitable for use in typical astronomy experiments that observe multiple sub-bands and polarizations. It has been replaced with a more flexible (and simpler) format based on Java that supplements information that is now read directly from the VEX file. The output format of the correlator also underwent a complete overhaul. Software to translate the output into an AIPS++ Measurement Set was written. This allows the use of the same tools on SFXC output as used for analyzing and processing the output of the hardware correlator, and also makes conversion to FITS-IDI possible. Data correlated with SFXC was successfully loaded into AIPS, and a preliminary first image was produced. The module that decodes the input data has been extended to accept Mark 5B and VLBA data as well as Mark 5 data, such that SFXC can now handle all data formats handled by the Mark 5 hardware correlator.

Yurii Pidopryhora, who joined the software correlator development team as a support scientist in early 2007, spent quite a bit of effort on verification of the results from the correlator. He has done a statistical analysis of the correlator output and made comparisons with the output of the existing hardware correlator. This work has uncovered several bugs, which since have been fixed. Verification of the results continues as the code continues to evolve as we strive to optimize it and add new features to it.

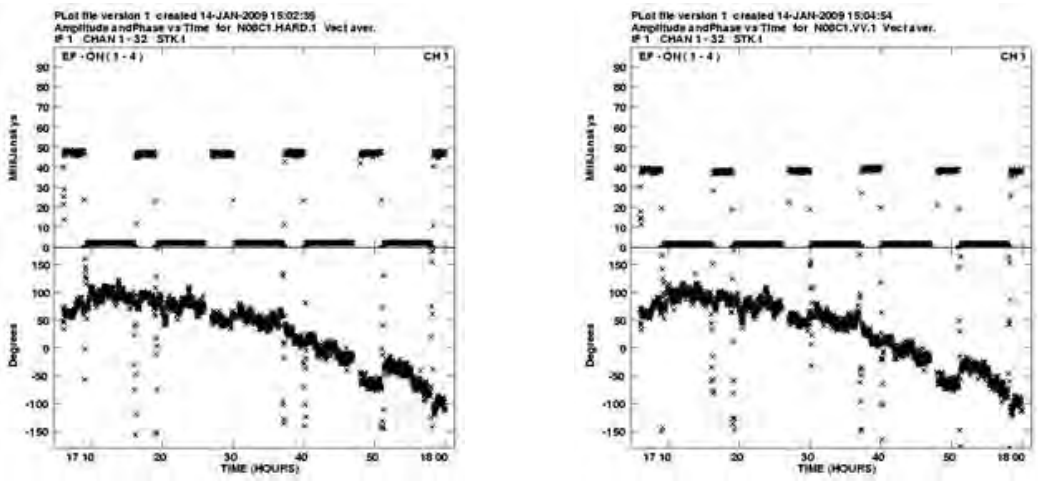


Figure 4.1: Comparison of phase and amplitude from the hardware correlator (left) and the SFXC (right)

The software correlator was first used to process FTP fringe tests in May 2007. The original plan had been to run it in parallel with the NICT software correlator that was used for the fringe tests in previous years. But since the machine hosting the NICT correlator broke down, we had to rely solely on SFXC. It worked well enough that the support group never went back to using the NICT correlator. Quite a bit of effort was spent on making web pages to display the results of the fringe tests in a way that is convenient for the operators at the stations. The new web pages are now automatically generated whenever the correlator runs.

For the EXPReS FABRIC JRA, which aims at running the software correlator in a standard Grid environment, several web services were developed. These web services interact with the workflow manager and VLBI Grid broker being developed by our collaborators at PSNC in Poznan, Poland. The web-services implement some "domain-specific" knowledge such as decoding VEX files and handling data transport. Integration of the various subsystems is still in progress.

Within the SCARIe project, a collaboration was started with the AutoBAHN JRA of the GÉANT2 project. AutoBAHN is developing a system for on-demand allocation of dedicated circuits across the European research networks. This would benefit e-VLBI with a software correlator since there would no longer necessarily be a fixed location for the correlator. This collaboration resulted in a couple of demonstrations during which data were streamed from four sites spread around Europe (Ireland, Poland, Greece, Croatia) and the US (Boston) into the DAS-3 cluster in Amsterdam, correlating in real-time at 256 Mbps. These highly successful demonstrations took place at the GLIF workshop in Seattle (October 1-2, 2008) and at Supercomputing '08 in Austin (November 15-21).

The team working on the software correlator has seen many personnel changes. Mark Kettenis took over day-to-day management from Huib van Langevelde in February 2007. Ruud Oerlemans left JIVE at the end of June 2007. His job was taken over by Huseyin Özdemir, who started in August 2007. Huseyin left at the end of March 2008, and Des Small (who was already working on parts of the EXPReS project) took over most of his duties. Nico Kruithof left at the end June 2008. Aard Keimpema started working for the SCARIe project, taking over where Nico left off, in September 2008.

4.2 Logistics software

An important new responsibility in this area is the maintenance of the Northstar proposal tool for the EVN. JIVE handles the daily running of the tool, while there is also a maintenance fee on behalf of the EVN with the central authors at ASTRON. Among the developments that took place in the reporting period was the validation of uploaded source lists. Bauke Kramer also worked on tools to accumulate statistics of proposal data by using the XML data that the tool generates, such as the names of PIs and other members of the proposal teams, their countries of origin, affiliations and email addresses, these can be selected by PHP code.

Bauke Kramer also worked on the backup program for the EVN Data Archive. The procedure was changed in order to facilitate better incremental back-ups when small changers are made to the data archive. A local webpage was created which keep track of the backups. Other

programs that needed some maintenance were the software to process station logs and the Mark 55 interface program. Further improvements were made to the automated process that synchronizes station information with the repositories in Bologna and NRAO.

4.3 ALBUS

ALBUS (Advanced Long Baseline User Software) is a Joint Research Activity within the RadioNet program in the EC 6th framework. In this project, JIVE has the overall management responsibility and also carries out a large fraction of the work-packages. Principally among these was the development and distribution of ParselTongue, which established a reasonably large user base during this period. There were a number of personnel changes during the period, with James Anderson leaving JIVE and the project, while Mike Sipior and Stephen Bourke joined the team

4.3.1 Ionospheric calibration

The aim of the ALBUS ionospheric calibration project (carried out at JIVE) was to develop improved methods for calibrating the ionosphere for phase-referenced VLBI observations using current data and model products. Two different ionospheric calibration approaches were developed for the ALBUS project.

The first type uses a global ionosphere model to predict the three-dimensional electron density distribution of the ionosphere using a few simple input data. Two such models were implemented using external public software packages, the Parameterized Ionosphere Model (PIM) and the International Reference Ionosphere (IRI) model. Both of these packages are software models which attempt to predict the electron distribution based on past observations and ionospheric physics. They use only a few input data, such as the Solar flux and the strength of the Solar wind, and the date and time of the observation to generate their predictions.

The second approach uses measurements from Global Positioning System (GPS) receivers. By comparing the difference in arrival times of the signals on the two different broadcast frequencies of the GPS satellites (1575.42 MHz and 1227.60 MHz), the path delay of the ionosphere can be measured. Typically, a given GPS receiver can see 5 to 8 GPS satellites at any given time, and various combinations of satellite positions and ionospheric delay measurements can be made to provide calibration information for a specific source direction. Furthermore, by combining measurements from many GPS receivers spread over a surrounding area, a more accurate model of the ionosphere can be formed to make ionospheric calibration predictions. The model used by this ALBUS software is a variation on the Minimum Ionosphere Model.

By combining a physically-based software model (PIM or IRI in this case) with the GPS data modelling, a more refined ionospheric calibration model can be formed. This essentially forms a third type of ionospheric model developed for ALBUS. Most of the underlying software which performs the ionospheric physical modelling or model fitting was written by James Anderson in C/C++/FORTRAN, and a Python layer allows these routines to be run from ParselTongue. In addition to the ionospheric physics and GPS models, the ALBUS ionospheric software also has

options to use the standard AIPS task TECOR (which uses publicly available Ionosphere Map Exchange, IONEX, models of the ionosphere), or to apply no ionosphere model at all. When data files for GPS measurements, or IONEX data, are required, the ALBUS software automatically handles downloading the public files from the Internet, and uncompressing and preprocessing them as necessary.

These calibration models were tested using EVN observations made during the 2005 May EVN observing session. They targeted several bright calibration sources, using standard phase-referencing techniques at L-band. As all target objects were themselves bright calibrators, the coherence loss from phase referencing and ionospheric calibration could be measured by comparing the final measured brightnesses of the targets when using phase referencing and various ionospheric calibration schemes, as compared with direct fringe fitting of the target source. The results of the tests were not very encouraging. On average, all of the ionospheric calibration algorithms from ALBUS and the standard AIPS TECOR task showed no net improvement in the ionospheric calibration. The main reason for this is that the residual ionospheric effects tend to be small-scale features (travelling ionospheric disturbances, TIDs, and other disturbances), which none of the models can accommodate at this point in time.

However, the ALBUS ionospheric calibration routines do seem to make improvements for polarization measurements. In addition to modelling the ionospheric path delay, the ALBUS ionospheric software can also model the ionospheric Faraday rotation. Tests with observations using (individually) Parkes and Westerbork show that the modelled Faraday rotation predictions do make improvements over using no corrections

Future ionospheric calibration developments should concentrate on measuring the small-scale structure of the ionosphere. Test show that this requires a dense network of GPS stations surrounding individual VLBI telescopes, and further software development to properly model wave features in the ionosphere. However, in the near future, the dense GPS receiver networks required for this calibration are unlikely to be present for most VLBI stations. Some of these findings fed into the discussions on the calibration of LOFAR in which James Anderson participated.

4.3.2 Wide Field Imaging

Wide Field VLBI imaging requires observed data to be correlated with high time and frequency resolution. While the EVN correlator has these capabilities, handling the resulting large datasets is not well accounted for in existing software. The work carried out focused on providing software that facilitates the distributed processing of data to enable wide field imaging.

Existing software such as AIPS provides excellent imaging algorithms. The problems that user face when processing their data for the purpose of wide field imaging are largely related to data management, hardware utilisation, processing time, and data inspection analysis. Software components were developed to address these issues.

4.3.2.1 Interacting with high performance computing systems

The target environments for this wide field imaging software are commodity clusters. To attain good utilisation of the underlying hardware, it is essential that the user have control over the allocation of computation and data resources. A python interface to the PBS batch system (used on many clusters) was developed to allow sub-jobs to be allocated to compute nodes at run time. A module (AIPSLite) was developed to allow Python/ParselTongue code to be run in a lightweight environment without the need for a full AIPS install, as one is often not present on shared-use clusters. The AIPSLite module also allows for any directory to be set up and utilised as an AIPS data area at run time. Together, these modules provide a level of control over CPU and disk usage on commodity clusters. Furthermore, software modules were developed by Stephen Bourke that provide functions to determine the properties of datasets and catalogues, perform astronomy-related calculations, carry out various conversions and execute utilities. These libraries, when loaded in Python, complement the ParselTongue infrastructure and facilitate application development.

4.3.2.2 Parallelisation

To accomplish parallelisation, data can be split up in many ways. For imaging, decomposing in the frequency domain is particularly useful for spectral line data. Decomposing by frequency is also useful for continuum imaging since the resulting dirty images can be combined prior to performing a so-called Clark Clean. The performance of the Cotton-Schwab Clean is prohibitively slow on the large datasets that typically result from wide field imaging, so the algorithmic advantages of the latter are compensated by the speed of imaging in parallel followed by a Clark Clean. This approach was implemented and used to image regions of massive star formation observed with the EVN. Fringe fitting is also time consuming on large datasets and is suitable for parallelisation as separate time slices can be processed independently. This method of parallel calibration was implemented, however for currently typical observations the overhead associated with the decomposition of the task are not compensated by the resulting speed up.

4.3.2.3 Automated analysis and visualisation

A follow-on problem from VLBI wide field imaging is analysing the resulting images, which can be extremely large. Stephen Bourke developed automated detection routines, which search the field for sources and create a text file detailing possible sources of emission. The software can also create plots to give an overview of the field.

This approach was extensively tried on a large EVN data-set observing the 6.7 GHz methanol maser line in collaboration with Kalle Torstensson and Huib van Langevelde. The data was sampled at 1024 (2 kHz) channels and 0.25 s integrations, allowing an area of 5 square arc-minutes to be mapped with 4 mas resolution producing a imaged datasets of over 1012 cells (Figure 4.2). The processing was done utilising 128 CPUs of the Walton (opteron) cluster at the Irish Centre for High End Computing (ICHEC). The method proved successful, with the software performing well and in a very stable manner. However, no other maser sources than the known central object was found. In the future more targets can be tried.

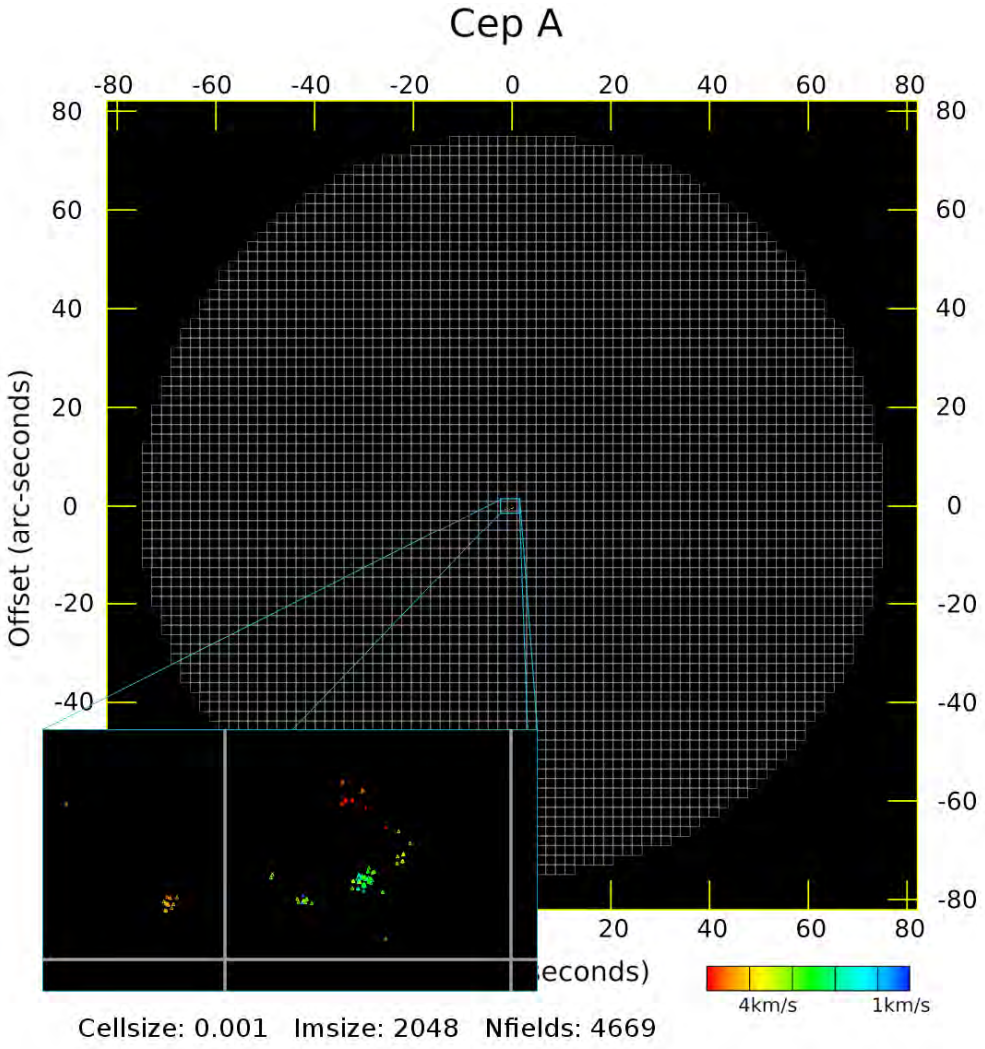


Figure 4.2: Facet layout for a processed data set. Each of the 4669 boxes corresponds to a data cube of dimensions 2048 x 2048 cells with 1024 frequency channels giving a total image size of over 18 tera-pixels

4.4 Infrastructure Software

ParselTongue was developed in the context of ALBUS to define a common interface for developing new algorithms and disseminating the results to the user community. By providing a Python binding for classic AIPS, it allows high-level scripting for a large range of radio astronomy applications. It provides enhanced interface functions between AIPS and the outside world, which has been an important feature for implementing the EVN and MERLIN pipelines.

During this period, ParselTongue has seen a number of features added, both to the code base proper, and to the user support infrastructure around it. Version 1.0.6 of ParselTongue was released in July 2007, and includes support for directly modifying image pixel values, as well as adding arbitrary data keywords to an image, for the purpose of organisation or reference.

Other improvements since include the ability to modify and extend data headers, directly access the AIPS catalogue, and attach and manipulate tables. In 2007 it was made possible to switch from the deprecated numarray Python module to the new NumPy framework. In addition, per-task log files have been added, allowing users more control over their output, especially when running a large number of simultaneous processes. Also, a basic infrastructure to simplify transferring data sets between AIPS installations has been implemented. As with per-task log files, this infrastructure aims at facilitating the use of ParselTongue in large-scale distributed pipelines.

Recent development by Mike Sipior has focused on exploring some new facilities for making simple parallel data reduction possible. This would be a great help for dealing with the very large datasets coming out of wide-field VLBI work, along with the obvious applications for data from large radio surveys. ParselTongue development in 2008 has concentrated on establishing a framework for easily running multiple AIPS tasks simultaneously, from a single control script, using user-specified queues of AIPS tasks. Task queues are simply containers of AIPSTask objects, which, once populated, are executed in a fashion analogous to simple AIPSTasks. Because the data objects supplied as arguments to the individual AIPSTasks contain all of the information required to access the data itself, no extra work is required to run jobs on a remote machine.

The ParselTongue user community has grown substantially to approximately a hundred users, also implying an increasing number of users filing bug reports and feature requests. A great deal of work has been done to streamline the installation of ParselTongue and its dependencies, lowering the bar for new users to get started. In addition, the ParselTongue wiki at the JIVE web site http://www.jive.nl/dokuwiki/doku.php/parseltongue:parseltongue was enhanced and includes a facility for users to share their own scripts and ParselTongue snippets on the aforementioned wiki. The ParselTongue mailing lists serve both to announce new releases and as a forum for users to share experiences and ask questions about the software.

4.5 SKADS

4.5.1 SKA Design Study (SKADS) station beam simulations

The SKADS EMBRACE antenna prototype (a “tile”) for the SKA aperture array station is essentially a square layout of Vivaldi elements of single-polarization. JIVE is involved in simulations of the beam pattern of the aperture array station (SKADS work-package DS2-T2) and conducts this study in close cooperation with ASTRON, MPIfR, Kapteyn Institute (Groningen) and Oxford University. In the course of this activity, data from EM-simulations of the EMBRACE element at ASTRON were used as input. A model for the element beam was derived in the form of a power-law expression. Initial modelling was performed extensively in the IDL environment, and subsequently was implemented in MeqTrees. Figure 4.3 shows a comparison of the EMBRACE-tile simulated to the station level in IDL, and reproduction of the results in a MeqTrees environment.

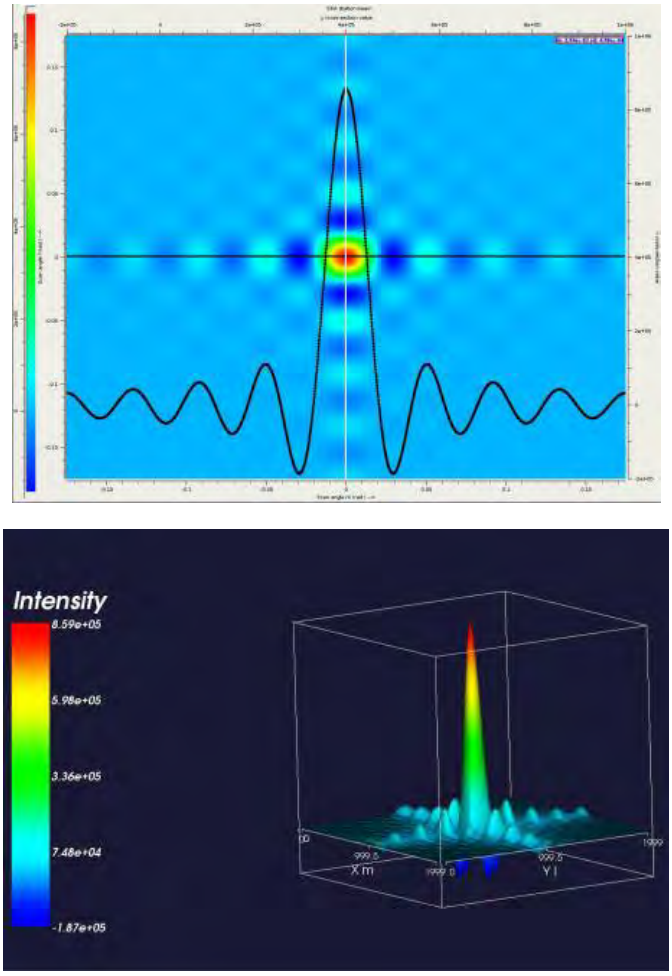


Figure 4.3 MeqTrees visualizations of the SKA station beam, pointed to zenith, incorporating details of the EM-simulated EMBRACE element pattern

4.5.2 SKA Configuration-studies tool integrated to simulations pipe-line

The DS2-T2 group at MPIfR (Bonn, Germany) studied characterisation of SKA antenna and station configurations using the so called "spatial dynamic range" (SDR) criterion. In collaboration with this group, an algorithm calculating SDR for a given SKA configuration was implemented in the MeqTrees software environment. Figure 4.4 shows a screen-shot of a trial run of the MeqTrees implementation of the SDR algorithm. This work also provides an input into the SKA simulations effort coordinated by the SKA Simulation Working Group.

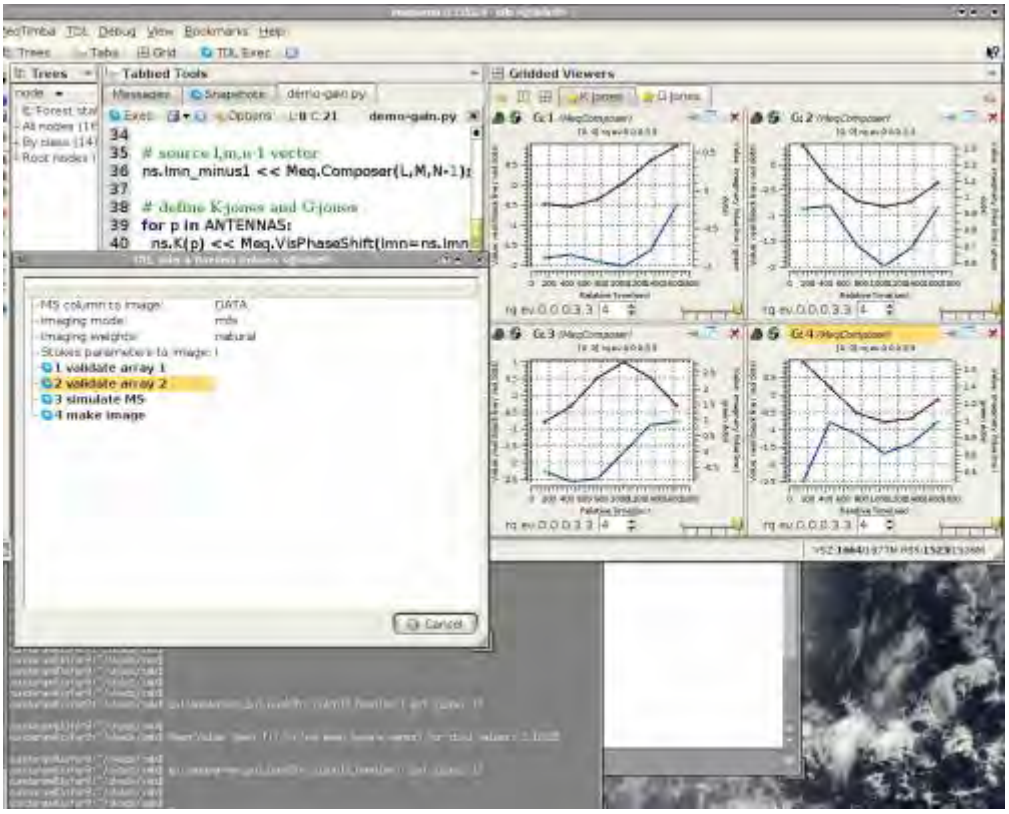


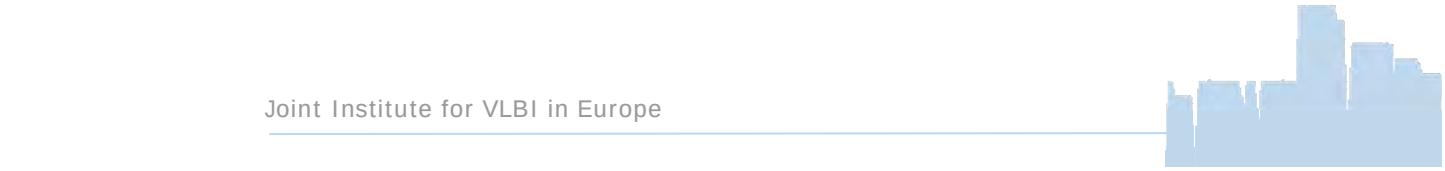
Figure 4.4: A screen-shot of a MeqBrowser run of the MPIfR SDR module. The G-Jones plots on the right, the run-time menu window in the mid-foreground, the simulations script behind it, and the trees / nodes created as listed on the left frame. The two options to validate the array invoke a C++ script external to the browser, results of which appear on the lower-left console window

4.5.3 Computations benchmarking

Simulations of the radio sky in the mid-frequency range currently make extensive use of the MEqTrees software. The simulations require considerable computational resources, in terms of both processor load and memory utilisation. For example, a simultaneous inclusion in the simulation run of a station beam (***E***-Jones) and a visibility kernel matrix (***Kp***) pushes the limits of computational power currently available to the majority of MeqTrees users.

Processor type	Authentic AMD Athlon™
	2 processor siblings
	64 X2 Dual Core 4400+
	i686 architecture
	2211.496 MHz
	1024 KB cache

Table 4.1 Parameters of the processing platform in the MeqTrees SKA simulations benchmarking exercise



A benchmarking exercise of MeqTrees SKA simulator was conducted at JIVE in cooperation with ASTRON in 2008. The parameters of the processing platform involved in benchmarking are listed in Table 4.1. The processor clock-rate and memory usage were assessed for progressively up-scaled quantities of SKA observing stations, frequency channels over the available bandwidth, and the radio sources simulated. The simulated radio signals involved in benchmarking were corrupted by noise.

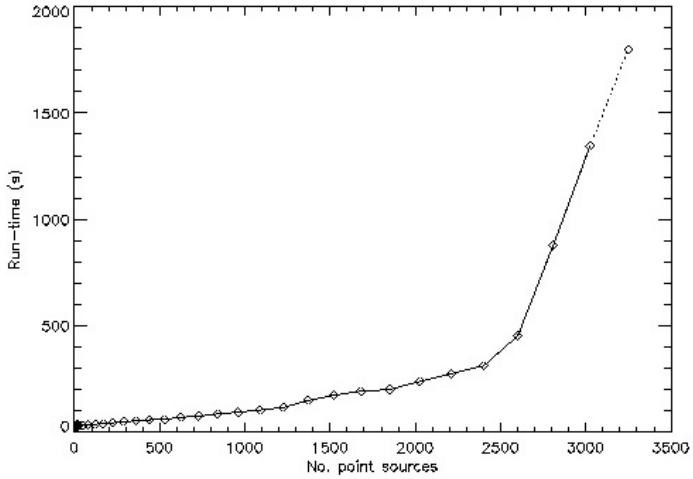


Figure 4.5 Single frequency channel aperture array simulation results: point-source counts vs. simulator run-time, for a 30-station compact array configuration. Dotted lines are extrapolations in the computationally limiting regime of MEqTrees simulator

The benchmarking method involved progressive addition of stations, sources and frequency channels in the simulations. The results of this effort helped to understand better the requirements for the hardware environment for future SKA simulations which include parallel processing. As an example of the benchmarking simulation runs, Figure 4.5 shows the dependence of the simulation run-time on the number of point sources.

5 Scientific Research

5.1 Cosmology and deep VLBI surveys

The first radio-loud quasar at redshift higher than 6 was observed with the EVN at 1.6 and 5 GHz by Sándor Frey (FÖMI SGO), Leonid Gurvits, Zsolt Paragi and Krisztina Gabányi (FÖMI SGO).

The EVN data showed a double structure at 1.6 GHz, while at 5 GHz only the brighter feature was detected. Both components were resolved and apparently steep spectrum. This is unlike the brightest radio quasars at a redshift ~2, which are flat spectrum core dominated sources. The double structure, resolved components and the steep spectrum in fact resembles to the compact symmetric objects (CSO) that are more frequent in the low-redshift Universe. CSO sources are believed to be young, or in some cases they may be small because they are confined by the dense interstellar medium. If J1427+3312 is indeed young, one could detect the expansion of the source by VLBI monitoring. The second highest redshift radio-loud quasar (J0836+0054, z=5.77) has a steep spectrum as well, but it has a single compact component. A deep, dedicated VLBI survey of the highest redshift quasars will show how frequent CSO like structures are in the early Universe.

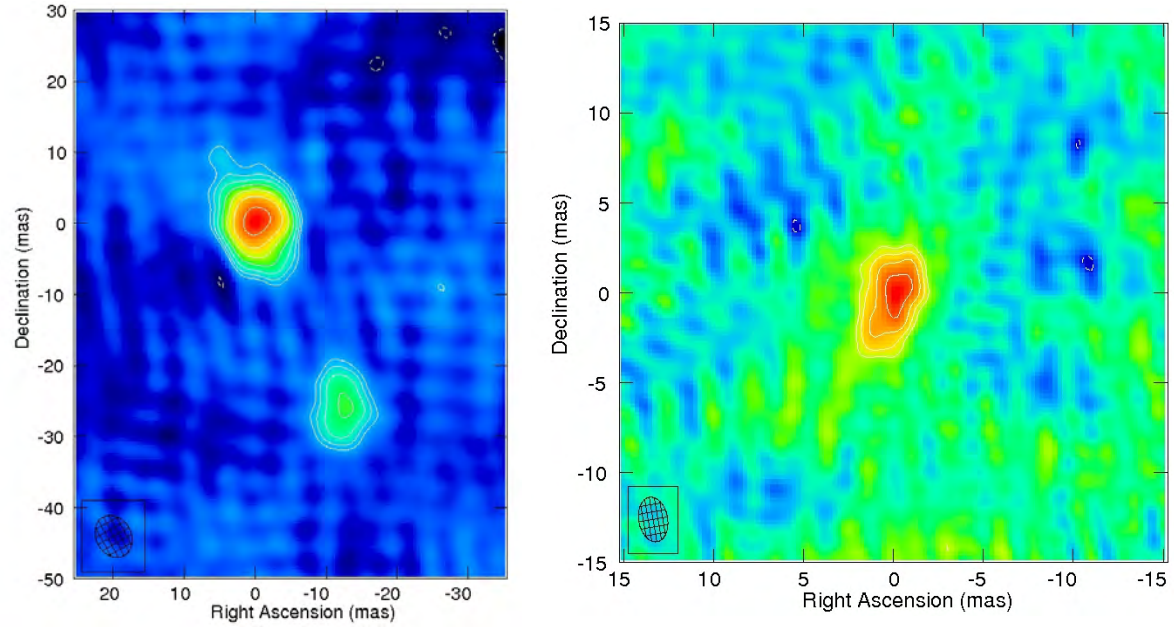


Figure 5.1: EVN images of the highest redshift radio quasar J1427+3312 at 18cm (left) and 6cm (right). The double morphology, steep spectrum and resolved components resemble the structure of CSO sources at much lower redshifts.

The Deep Extragalactic VLBI-Optical Survey (DEVOS), led by Sándor Frey (FÖMI SGO, Hungary) aims at constructing a sample of compact radio sources up to two orders of magnitude fainter than those usually studied with VLBI. The group involves Leonid Gurvits and Zsolt Paragi, László Mosoni (MPA, Heidelberg), Mike Garrett (ASTRON) and Simon Garrington

(JBO, Univ. Manchester). Recent 5 GHz phase-referencing observations with the EVN targeted 26 radio sources around two compact calibrators. Optical identifications were ensured by selecting objects from the Sloan Digital Sky Survey (SDSS). An efficient way to identify potential VLBI targets with mas-scale compact radio structures at >1 mJy flux density level was found. Nearly 90% of the sources that are unresolved both in SDSS (i.e. optical quasars) and in the VLA Faint Images of the Radio Sky at Twenty-centimetres (FIRST) survey (<5", >20 mJy) have been successfully detected with the EVN.

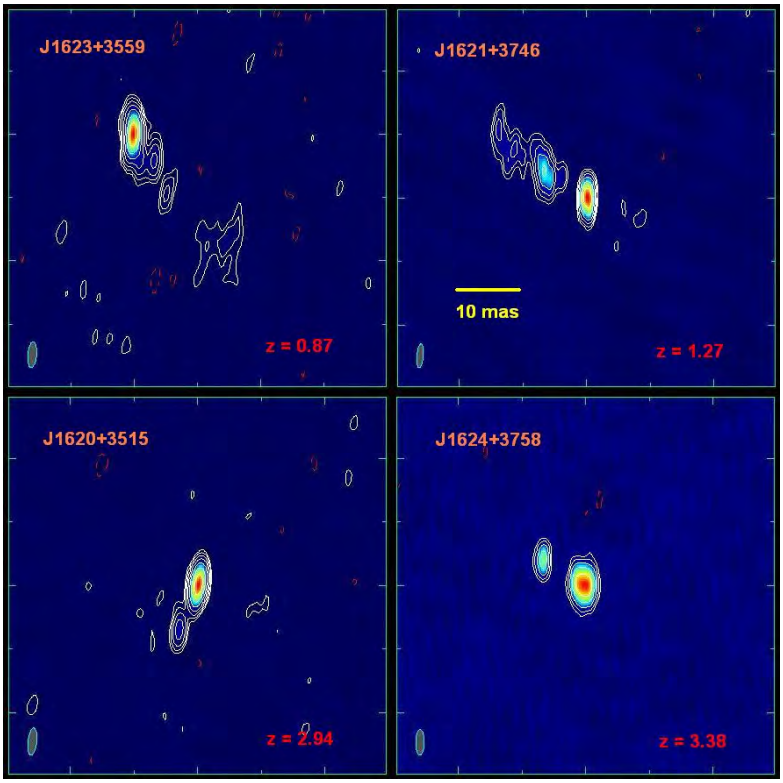


Figure 5.2: Four example sources observed in the Deep Extragalactic VLBI-Optical Survey (DEVOS). Almost 90% of all faint FIRST sources that had pointlike optical counterparts in SDSS were detected.

5.2 Gamma ray bursts and supernovae

On 19 March 2008, NASA's Swift GRB Explorer mission discovered a record breaking gamma ray burst, GRB 080319B. The current understanding is that GRBs produce highly relativistic, collimated outflows, powered by a newly formed black hole. This jet decelerates, expands and interacts with the ISM. The primary emission is due to internal shocks within the jet, while the X-ray/optical/radio afterglow is produced by external shocks due to jet-ISM interaction. Multi-frequency observational campaigns are necessary to distinguish in between various physical scenarios. At its peak, GRB 080319B was the brightest optical and X-ray source measured for a GRB, and one of the highest gamma ray fluences recorded. The optical emission could have been observed by naked eye, without the aid of an astronomical telescope.

A group led by Alexander van der Horst (then Univ. Amsterdam) including Zsolt Paragi observed the source with the WSRT at several epochs. These data put strong constraints on the origin of the afterglow emission. In a broader collaboration, the richest multi-frequency information ever was gathered for this spectacular burst. It was shown that the prompt emission originated in a single physical region implying an extremely relativistic outflow that propagated within the narrow core of a two-component jet.

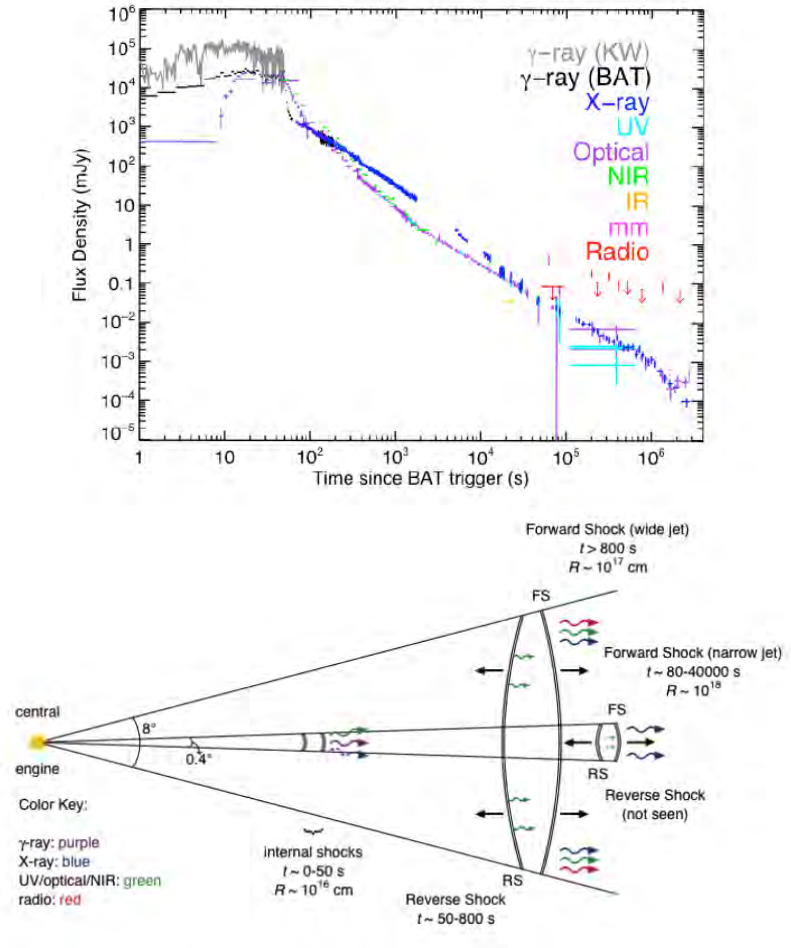


Figure 5.3: The multi-frequency lightcurve of the "naked eye" GRB and the two component jet model that can explain the observed spectral behaviour of this powerful burst.

Gamma ray bursts have been shown to be occasionally associated with type Ib/c supernovae, which are thought to arise from the core collapse of a massive Wolf-Rayet star. This core collapse generates ultra-relativistic jets, which beam gamma rays and all other early emission into a narrow cone. Thus, most of these stars will not have detectable gamma-ray emission although they may still be detectable in optical wavelengths as SNe Ib/c. Direct evidence for the existence of (mildly) relativistic, collimated outflows in these sources may come from VLBI imaging. Making these measurements is extremely difficult because of the large distance and faint emission in the radio regime. So far only one SN Ib/c has been detected with VLBI, SN2001em.

On the 15th of August 2007 SN 2007gr was discovered in the nearby (~7.3 Mpc) spiral galaxy NGC 1058. A group led by Zsolt Paragi observed SN 2007gr at 5 GHz with the e-EVN just a few weeks after its discovery. Collaborators on this project were - amongst others - Huib van Langevelde, Arpad Szomoru, Yurii Pidopryhora, Chryssa Kouveliotou (NASA/MFSC), Mike Garrett (ASTRON), Enrico Ramirez-Ruiz (Univ. Santa Cruz), Michael Bietenholz (Hartebeesthoek) and Megan Argo (JBO). The supernova was detected at a 5.6 sigma level (420 microJy/beam), in agreement with the VLA position. The good sensitivity and the availability of the e-EVN (then still without the Effelsberg telescope) were very important for this result. More sensitive follow-up observations with a global array in November 2007 resulted in a non-detection, while the source was still about 280 microJy at 5 GHz. The initial e-EVN results exclude highly relativistic ejecta because the source appeared unresolved, but the global observations can only be explained if the source expanded with at least mildly relativistic speeds. This clearly demonstrates the importance of early VLBI observations of Type Ib/c SNe. The e-EVN results were quickly published in ATEL #1215.

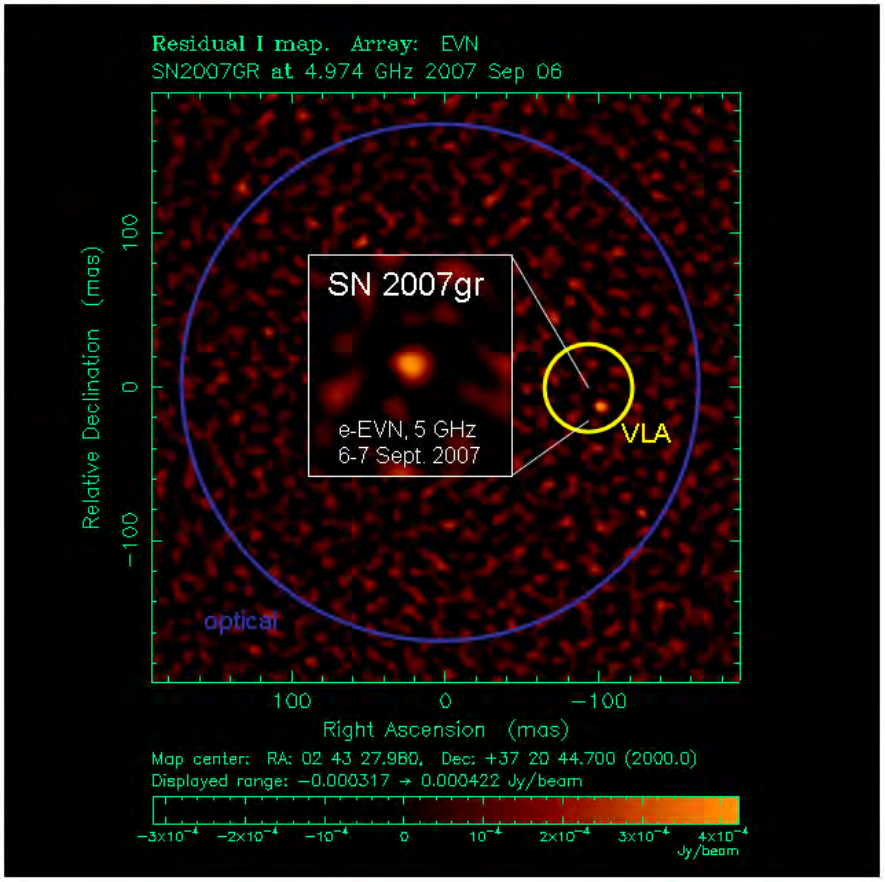


Figure 5.4: The second type Ib/c supernova that was detected with the VLBI technique ever was SN2007gr, observed with the e-EVN shortly after its discovery.

5.3 Scintillation and propagation effects

The refractive component in the interstellar medium acts like the agitated surface of a swimming pool, that bends sunlight to cause an irregular pattern of light and dark bands on the bottom of the pool. In the astronomical case, the Earth moves through an immense pattern of light and dark bands, this causes the variability of the compact radio sources. From the observed scintillation properties one may constrain the structure of high redshift sources, thus using the interstellar medium (ISM) as a magnifying lens to study quasars at resolutions otherwise not available with our astronomical instruments. On the other hand, compact radio sources are ideal tools to investigate the physics of the interstellar medium.

In the course of his work on scintillation, interstellar medium and extragalactic compact sources, Giuseppe Cimò (in a collaboration led by Cliff Senkbeil, Univ. Tasmania) observed an extreme scattering event (ESE) towards the compact BL Lac object AO 0235+164. The scattering material was apparently compact, between 0.09 and 0.9 AU, and it was located at a distance less then 3.6 kpc from the Sun. The density of the cloud was minimum 4 x 10^{13} cm^{-3}. It was suggested that ESE events may be responsible for at least one transient discovered earlier by Bower et al. using VLA archive data.

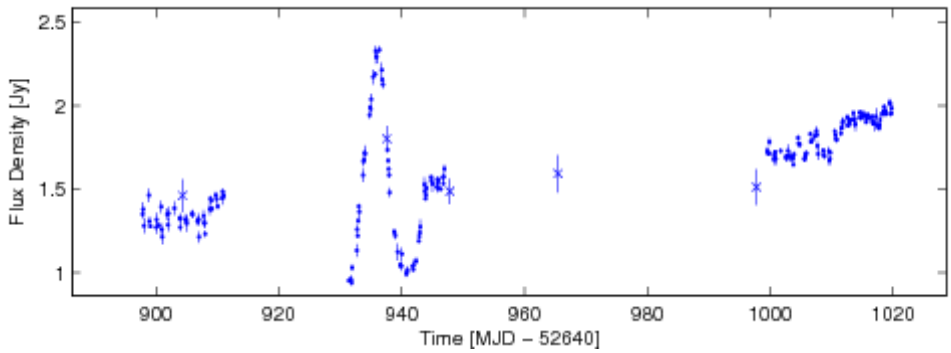


Figure 5.5: The rapid flux variation of AO 0235+164 at 6.65 GHz in 2005. Crosses indicate independent measurements at 8 GHz by Uwe Bach et al.

AO 0235+164 was just one of the sources included in the Continuous Single-Dish Monitoring of Intraday Variability at Ceduna (COSMIC) program, in which Giuseppe Cimò actively participates. The observed modulation of the variability characteristics of compact extragalactic radio sources can be explained by seasonal effects due to changes on the relative velocity between the Earth and the interstellar clouds. Such modulation has been tentatively detected in the source PMN J1326-5256 (see below).

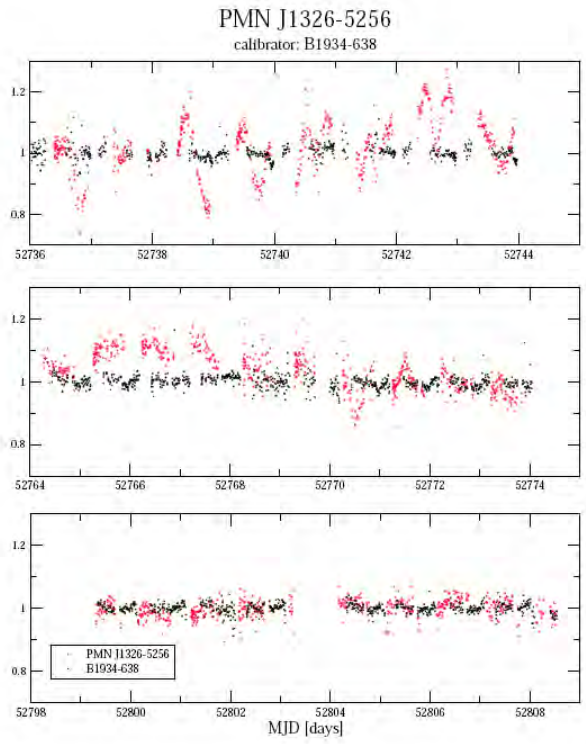


Figure 5.6: Intraday flux variations of PMN J1326-5256 (red) at 6.7 GHz. There was a dramatic change in the temporal behaviour after MJD 52744. The data were normalized for the target and the calibrator (B1934-638, black dots) as well

Besides the single dish observations and data analysis, Giuseppe Cimò initiated a new VLBI project using the EVN in an innovative way, in order to study the ISM. In particular, the aim of the experiment is to measure the distance of the scattering material causing the rapid scintillation of the flat spectrum radio sources. In a pilot experiment the source 1819-3845 has been observed with the EVN array. This quasar has been known as the most extreme scintillator (600% variability within a few hours). The unexpected outcome of this experiment has shown that the extreme variability of J1819+3845 has stopped. Taking into account previous scintillation measurements of this quasar, it has been possible to put a lower limit of 34 A.U. to the size of the electron cloud responsible of the previously observed extreme variations.

Hayley Bignall analysed the first optical spectrum, taken earlier during AAT service observations, for the southern extreme intraday variable radio source PMN J1326-5256 in a collaboration including Giuseppe Cimò, Dave Jauncey (ATNF) and co-authors This object may be associated with an unidentified source in the 3rd EGRET catalogue, based on its multiwavelength properties. The Fermi Gamma-ray Space Telescope (formerly GLAST), will be able to confirm the gamma-ray source association. The optical spectrum is featureless between ~5000 and 9000 Å, with a signal-to-noise ratio of ~15 in the continuum, indicating that the source is mostly likely a BL Lac object. The object was noted to be much brighter than on historical optical plates, indicating that it is highly optically variable. In addition, the sub-arcsecond accurate radio position from ATCA data is coincident with an object in the 2MASS catalogue which has near-infrared colours typical of BL Lac objects.

Hayley Bignall used the Effelsberg radio telescope to measure the rapid 22 GHz maser variability in NGC 3079. Preliminary analysis indicates that while Effelsberg has the sensitivity and stability for the rapid variations to be detected in at least the brightest maser feature, it may not be feasible to measure a time delay in the variability pattern arrival times between Effelsberg and the GBT, which could be used to determine the velocity and other properties of the scattering screen. The very bright, narrow blue-shifted feature observed by Wouter Vlemmings (University of Bonn), which was not seen in earlier data, has continued to fade and was very weak or absent during the observations at Effelsberg.

Hayley Bignall has contributed to some of the analysis of the first four epochs of VLA data from the MASIV Survey, led by Jim Lovell (ATNF), Barney Rickett (UCSD), Jean-Pierre Macquart (Caltech) and Dave Jauncey (ATNF). One of the most far-reaching results to come out of the MASIV Survey is an observed decrease in scintillation at high redshifts, greater than that expected from a cosmological decrease in brightness, implying that the high redshift sources have larger apparent angular sizes, suppressing scintillation in the local Galactic interstellar medium. This effect may be due to scatter-broadening in the ionized intergalactic medium or a redshift dependence of the intrinsic source sizes. Redshifts for the whole MASIV sample are needed in order to separate the various observed effects. An observational programme to measure redshifts of MASIV Survey sources is being led by Tapio Pursimo (NOT). Hayley Bignall assisted with NOT observations during a six-night observing run in September 2007. In addition, the project was allocated two nights on the Palomar 200 inch telescope in the second half of 2007, and has been allocated two more nights on the 200" and three nights on the Keck telescope in the first half of 2008, with J-P. Macquart as the PI for 200" and Keck proposals, to obtain spectra for the remaining optically faint sources.

5.4 Active galactic nuclei

Hayley Bignall and Cormac Reynolds worked with summer student Gabriele Surcis on analysis of EVN+MERLIN data on BL Lac objects identified in the 'Deep X-ray Radio Blazar Survey' (DXRBS). These objects have properties spanning the range between classical X-ray- and radio-selected BL Lac samples. The results show that many of the sources have complex structures between milliarcsecond and arcsecond scales. Lower resolution images obtained with the VLA (by Hermine Landt, CfA) and ATCA (Hayley Bignall) suggest that these sources do not belong to a single parent population viewed at different angles, in accordance with the AGN unification scheme, but there are differences in the intrinsic source properties as well. The VLBI data will reveal similarities and differences in the mas-scale structure of these sources.

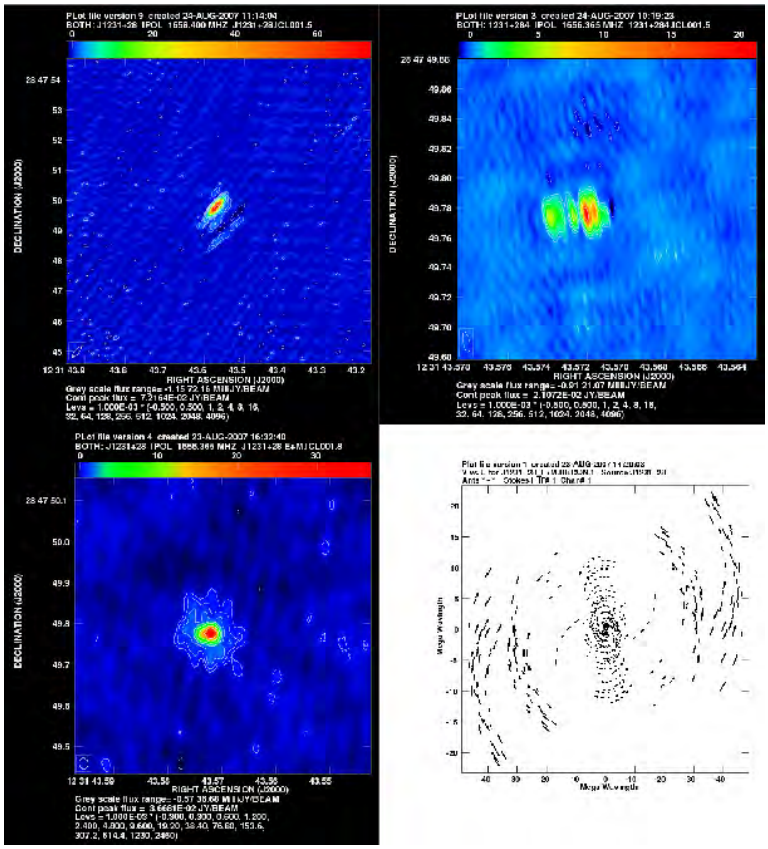


Figure 5.7: High-resolution 18cm images of the BL Lac object thought to be associated with X-ray source WGA J1231+2848. The top right-hand image is from observations using 10 antennas of the EVN. A lower resolution image from simultaneous MERLIN data is shown in the top left panel. An intermediate-resolution image made after carefully combining the data from both arrays is shown in the lower left panel, while the lower right panel shows the combined (u, v) coverage.

Hayden Rampadarath and Antonis Polatidis worked together with Mike Garrett (ASTRON) to obtain a list of potential calibrators and targets for LOFAR and RadioAstron. They analysed VLBA 92 cm archival data of 43 extragalactic sources in order to identify early targets and potential calibrator sources for the LOFAR radio telescope and the RadioAstron space VLBI mission. Some of these sources could also be suitable as "in-beam" calibrators for low-frequency VLBI experiments, permitting deep, wide-field studies of other faint sources in the same field of view. All publicly available VLBA 92 cm data observed between 1 January 2003 and 31 December 2006 were analysed using an automatic pipeline, implemented within AIPS. The vast majority of the data were still unpublished. Of the 43 sources, 40 were detected on at least one VLBA baseline of which 29 had sufficient data to be successfully imaged. Most of the sources were compact, with a few showing extended structures. Of the 29 sources imaged, 13 were detected on the longest VLBA baselines (~9 Mλ), while all were detected on baselines greater than 2 Mλ (the maximum baseline of LOFAR including the current international baselines). A paper describing the results has been accepted for publication in Astronomy and Astrophysics.

With Silke Britzen (MPIfR) and Rene Vermeulen (ASTRON), Bob Campbell completed the statistical studies of the jet-component kinematics of CJF sources. This project had three basic thrusts. First, fitting elliptical Gaussian models to the 3-4 epochs of snapshot observations of the 293 sources, using a Difmap variant he made to output the statistical uncertainties associated with the elliptical Gaussian component parameters as well as the correlation matrix among them. Second, estimating kinematic models from these results for 779 jet components in 266 of the CJF sources, (237 of sources with measured redshifts, comprising 699 components). This large sample provides the basis for correlation analysis of apparent component velocity against other source properties (class, luminosity, etc.), direct comparison with the VLBA 2cm survey, and also compilation of intra-source statistics of acceleration and bending as a function of distance along the jets. Third, investigating the correlations among the radio and ROSAT soft X-ray properties of the sources, such as radio core-dominance and pc/kpc-scale misalignments versus ROSAT detections, as well as computation of both inverse-Compton and equipartition Doppler factors to investigate aspects of the beaming.

With Silke Britzen (MPIfR), Nadia Kudryavtseva (MPIfR), and others, Bob Campbell investigated the kinematics of the pc-scale jet components of the blazar S5 1803+784. Many of the jet components remain at roughly constant radius from the core, but the jet ridge-line itself shows quasi-periodic oscillations in position angle on the order of 10 degrees over the inner 4 mas, with a time-scale on the order of 8-9 years.

5.5 Atomic gas in galaxies

Arpad Szomoru worked on a pilot study of two galaxy clusters at z=0.2, in collaboration with Marc Verheijen (Kapteyn Institute, Groningen), Jacqueline van Gorkom (Columbia University), K.S. Dwarakanath (Raman Research Institute), Bianca Poggianti (INAF) and David Schiminovich (Columbia University). Observations with the powerful new backend of the Westerbork Synthesis Radio Telescope revealed neutral hydrogen emission in 42 galaxies. In Abell 963 most of the gas-rich galaxies are located between 1 and 3 Mpc in projection, northeast from the cluster core. The velocities are slightly redshifted with respect to the cluster, indicating that this is largely a background group. None of the blue galaxies in the core of Abell 963 are detected in HI, although they have colours and luminosities similar to those of the HI detected galaxies in the cluster outskirts and field. Abell 2192 is less massive and more diffuse. Here the gas-rich galaxies are more uniformly distributed. The detected HI masses range from $5x10^9$ to $4x10^{10}$ $M_\odot$. Some galaxies are spatially resolved, providing rudimentary rotation curves useful for detailed kinematic studies of galaxies in various environments. On the long term, the project is aiming at ultradeep integrations down to HI masses $8x10^8$ $M_\odot$, that will provide a complete survey of the gas content of galaxies at z=0.2, probing environments ranging from cluster cores to voids.

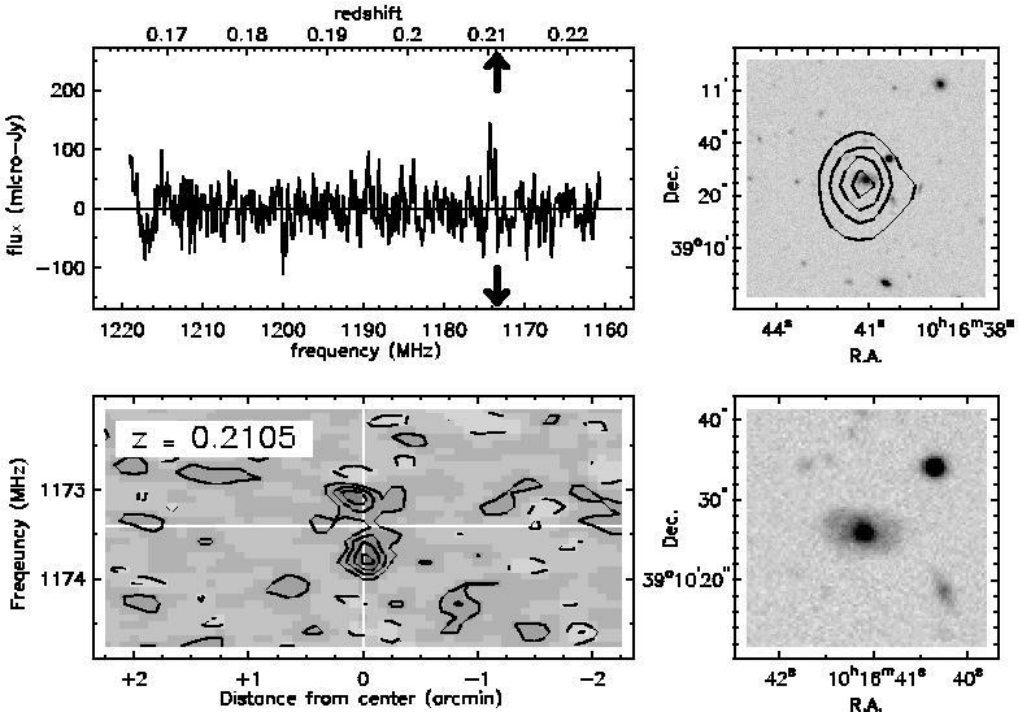


Figure 5.8: An example HI detection: a spatially resolves galaxy at the same redhsift as Abell 963. The HI spectrum is shown top left, the position-velocity diagram, indicating the systemic velocity and the spatial centre of the galaxy is shown bottom left. The integrated HI emission is overlaid on optical R-band image on top right, and a zoomed in version of the optical image showing the morphology of the normal spiral galaxy is shown bottom right.

Yurii Pidopryhora continued his work on the large project to study the extra-planar hydrogen in the inner Milky Way based on the observations of 21 cm HI line with the Green Bank Telescope (GBT), Very Large Array (VLA) and Giant Metrewave Radio Telescope (GMRT) performed earlier in 2003-2006 as a part of his PhD thesis work in the USA. The project is done in collaboration with Felix Lockman (NRAO) and, in parts, with K.S. Dwarakanath (RRI), Harvey Liszt (NRAO), Joseph Shields (Ohio University) and Michael Rupen (NRAO).

Within the framework of this project additional 25 hours of observations with the GBT (proposal GBT06C-038) were performed in 2007. The purpose of these observations was to make high-quality HI maps around clouds in the disk-halo interface of the Galaxy for which there were available VLA HI maps at high angular resolution. The GBT data supply zero-spacing information, constrain the deconvolution of the interferometric data, and detect extended, low surface brightness emission which might not have been detected by the VLA observations. Successful recipes (using procedures of both AIPS and MIRIAD packages) for the combined interferometry - single dish data reduction were developed and employed to make high-resolution maps of two HI halo clouds (G19.4+6.3 and G27.0+6.3) observed with the VLA in both C and D configurations. This has allowed to make unique measurements of the properties of Galactic halo HI. An earlier project on the Ophiuchus Superbubble, discovered in the course of a different vein of the same Galactic halo HI project, was finalized.

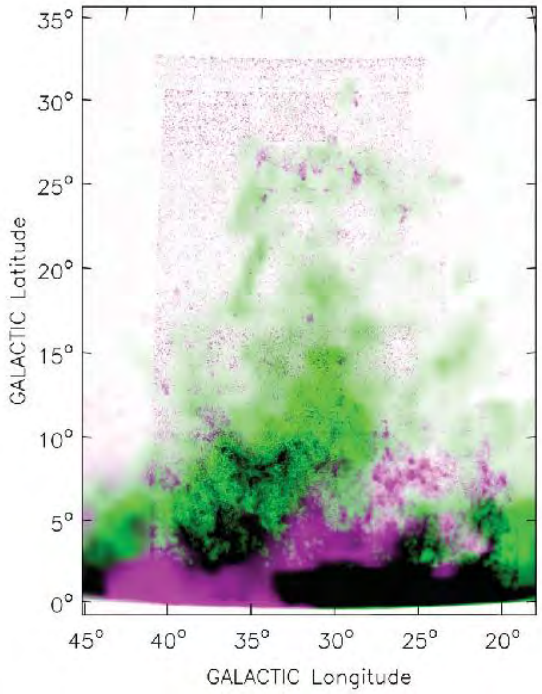


Figure 5.9: The Ophiucus superbubble in HI (purple) and Hα (green). HI spectra (mostly as observed by the Green Bank Telescope (GBT) during a dedicated survey, but data from the lower resolution Leiden-Dwingeloo survey were used around the edges) were integrated over 60-160 km/s LSR (the integration covers all the tangent point velocities at these longitudes), Hα (as observed with the Wisconsin H-Alpha Mapper (WHAM)) integrated over 55-95 km/s LSR (limited by the spectral range of the WHAM Hα survey) The superbubble is a major feature in ionized hydrogen as well as HI, but unlike the neutral hydrogen, the ionized hydrogen fills the area and is not concentrated at its edges. There is detailed correspondence between HI and Hα for many features. The diagonal purple stripe at the bottom results from extinction of the Hα by dust in the Great Rift.

Hayden Rampadarath was involved in a project led by Mike Garrett (ASTRON) to investigate Hanny's Voorwerp. This is a hot, irregular gas cloud located about 60000 light years from the galaxy IC 2497 which apparently does not contain any heating source. WSRT observations of the neutral hydrogen show that Hanny's Voorwerp is embedded in a gas cloud of 5000 million solar masses, which has an extension stretching out to the position of a galaxy group. Hydrogen spectra reveal the connection between the gas around IC 2497 and the galaxy group. The Voorwerp is part of a much bigger gas cloud, the remnant of an interaction between IC 2497 and a galaxy group. The WSRT radio continuum observations show a source at the centre of IC 2497 with a jet-like extension in the direction of the Voorwerp. Short e-EVN observations reveal a very small source at the centre of the galaxy, less than 0.1 light years across. This suggests that IC 2497 contains a supermassive black hole at its centre. The plasma jet emanating from the central engine clears a channel through the thick dust and gas that surrounds the black hole, permitting the intense radiation to reach Hanny's Voorwerp. Hayden Rampadarath was leading the e-VLBI observations, in which Zsolt Paragi participated as well.

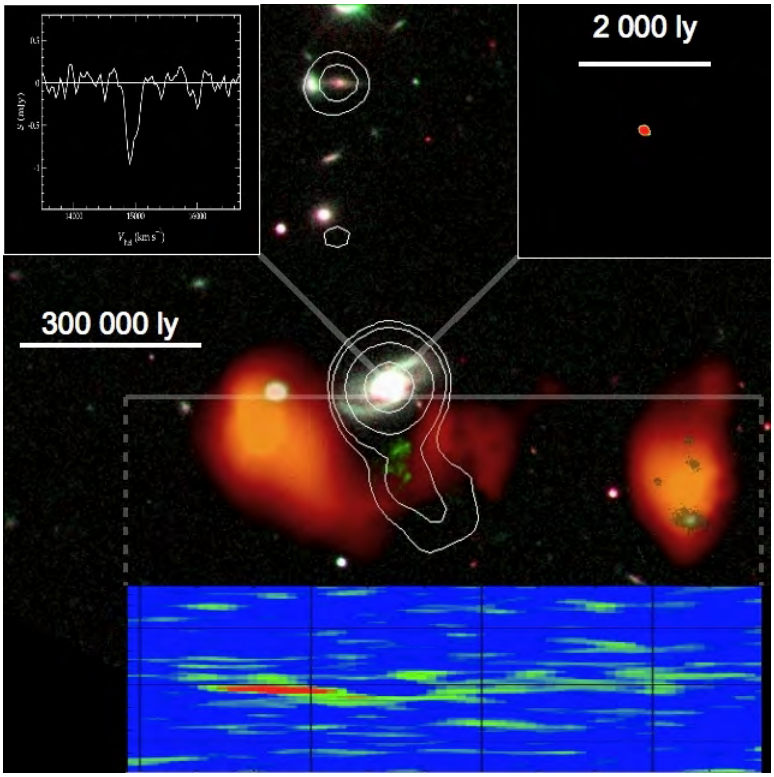


Figure 5.10: WSRT radio continuum observations (white contours) of IC 2497 show a jet-like extension in the direction of Hanny's Voorwerp. The e-VLBI observations reveal a very small source at the centre of the galaxy (top-right image). The WSRT neutral hydrogen show that Hanny's Voorwerp is embedded in a gas cloud of 5000 million solar masses (red in the image), which has an extension stretching out to the position of a galaxy group (to the right). Hydrogen spectra reveal the connection between the gas around IC 2497 and the galaxy group (bottom picture).

5.6 Starburst galaxies

The central regions of many Luminous Infra-red Galaxies (LIRG) are known to host intense bursts of massive star formation, resulting in copious explosions of supernovae. However, the dust-enshrouded ambients where those supernovae explode prevent their detection at optical and near-infrared wavelengths, and the only way to discover them is by means of radio observations. Antonis Polatidis worked together with Miguel Angel Pėrez-Torres (IAA, Granada, Spain) and others on the famous LIRG Arp299. e-EVN observations were carried out on 8-9 April 2008 with Cambridge, Medicina, Jodrell Bank (Lovell Telescope), Onsala, Torun and Westerbork at 5 GHz. During the second observing epoch the array included Effelsberg, Knockin and Shanghai as well. There were 25 compact radio sources detected (above 5 sigma) in the central 500 light years of the galaxy. The only viable explanation for many of the newly discovered sources is that they correspond to recently exploded core-collapse supernovae, and the rest are most likely super star clusters and supernova remnants. This result rules out starburst scenarios with constant star forming rates of massive stars in Arp 299, and yields support for either recent (few Myr), instantaneous starbursts or, alternatively, a top-heavy initial mass function of the stars in Arp 299.

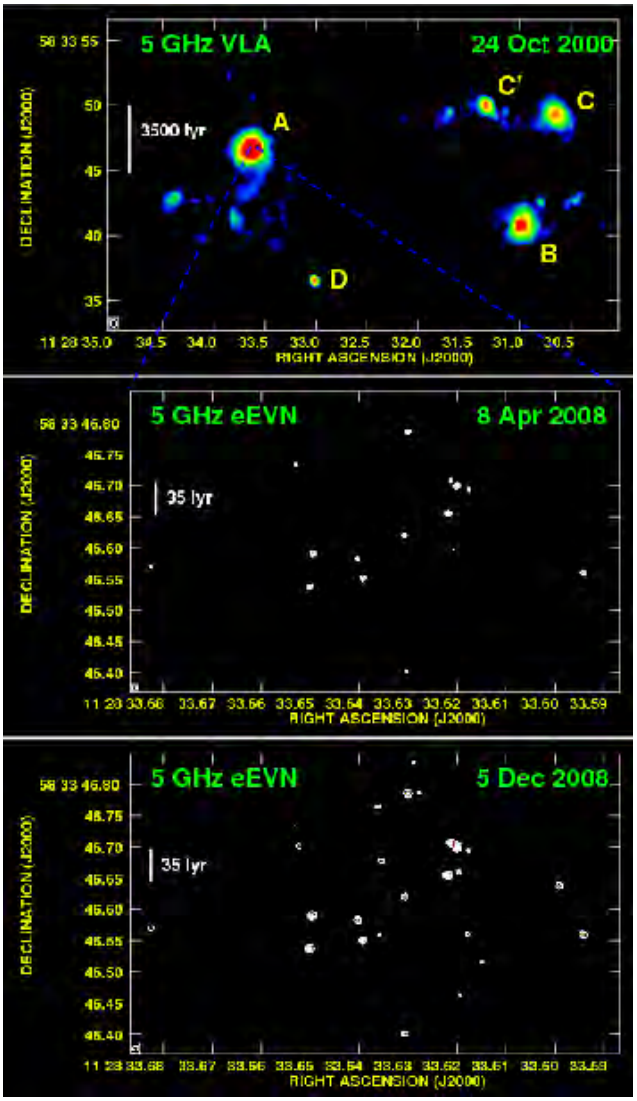


Figure 5.11: Top: 5 GHz VLA archival observations of Arp 299 on 24 October 2000, displaying the four brightest knots of radio emission in this merging galaxy. At this frequency, region A accounts for ~70% of the total VLA emission from Arp 299, and for ~50% of its far infrared emission. Middle and bottom: 5 GHz e-EVN observations of the central 500 light years of the Luminous Infrared galaxy Arp 299 on 8 April 2008 and 5 December 2008. The off-source rms noise is of 39 μJy/beam and 25 μJy/beam for the middle and bottom images, respectively. The appearance and disappearance of several (at least eight) new compact sources between April and December 2008 is evident.

There is growing evidence that the properties of the molecular gas in the nuclei of starburst galaxies may be very different from those seen in Galactic star forming regions. Unfortunately, among the fundamental parameters derived from molecular line observations, the kinetic temperature of the molecular gas in external galaxies is often not well determined. Stefanie Mühle has developed a diagnostic method to derive the physical properties of the molecular gas in external galaxies, in particular its kinetic temperature, using a set of para-formaldehyde

lines and a non-LTE radiative transfer model. As a proof of concept she, in collaboration with Ernest R. Seaquist (Toronto) and Christian Henkel (Bonn), tightly constrained the physical properties of the prototypical nearby starburst galaxy M82. The analysis, which is completely independent of observations of other molecular tracers like ammonia, suggests the presence of an unusually warm, moderately dense molecular gas component in the circumnuclear ring of the starburst galaxy. These findings agree very well with the properties of the high-excitation molecular gas component found in the most comprehensive CO-line studies and further support the emerging picture of molecular gas in active galaxies being very different from that in more quiet environments. The observations also indicate the presence of methanol in at least one of the molecular lobes of M82. Investigations of the properties of the molecular gas in other starburst galaxies and AGN using this new diagnostic tool are underway. Having thus demonstrated the diagnostic power of para-formaldehyde lines, Stefanie Mühle now investigates the diagnostic properties of ortho-formaldehyde lines using VLA data taken at 4.8 GHz and 14.5 GHz.

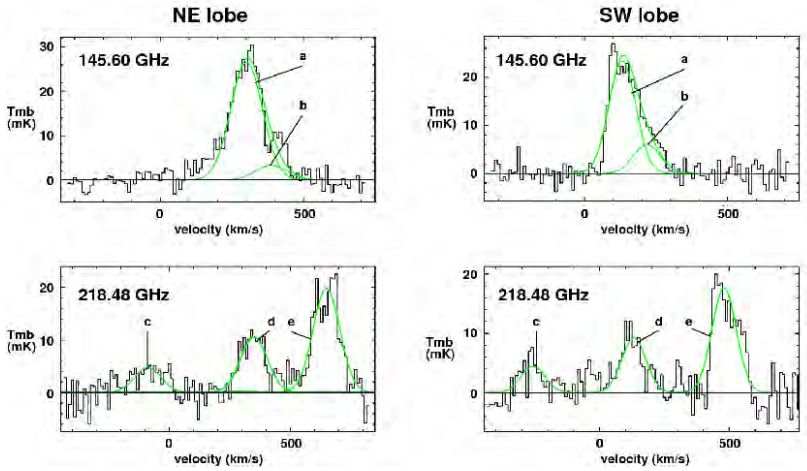


Figure 5.12: Para-formaldehyde lines detected towards the prototypical starburst galaxy M82. The Gaussian fits correspond to the following transitions: a = $H_2CO(2_{02}\rightarrow1_{01})$, b = $HC_3N(16\text{-}15)$, c = $H_2CO(3_{21}\rightarrow2_{20})$, d = $H_2CO(3_{22}\rightarrow2_{21})$, e = $H_2CO(3_{03}\rightarrow2_{02})$.

Stefanie Mühle has participated in a multi-species multi-transition survey of the properties of the molecular gas in a sample of Luminous Infrared Galaxies (LIRGs) with Padelis P. Papadopoulos (Zurich), Thomas R. Greve (Pasadena), Paul van der Werf (Leiden), Kate Isaak (Cardiff), and Yu Gao (Nanjing). For this survey, she analyzed data taken with the recently commissioned ACSIS spectrometer at the JCMT in combination with older JCMT data. First results suggest that the HCN(1-0) and HCO+(1-0) line luminosities alone can be poor estimators of dense molecular gas unless the excitation conditions are accounted for. In Ultraluminous Infrared Galaxies (ULIRGs), the CO cooling of the dense gas may be comparable to that of the CII line at 158 micron. At the same time, the global molecular gas reservoir may still be in a low excitation state.

As a member of the JCMT Nearby Galaxy Legacy Survey (NGLS) team, Stefanie Mühle investigated the molecular gas and dust content of galaxies within a distance of 25 Mpc using new observations at the JCMT and ancillary data. The first phase of the NGLS consists of CO(3-

2) observations for 21 galaxies from the SINGS sample as well as additional galaxies from the Virgo cluster. The subsequent phases, which will begin in 2009, will consist of SCUBA-2 observations of all sample galaxies and possibly CO(3-2) observations of the sample galaxies not yet observed in this transition. CO(3-2) emission has been detected in the Virgo galaxies NGC4254, NGC4321, NGC4569 and weakly in NGC4579. For the three CO-bright galaxies, the molecular gas masses are of the order of 10^9 solar masses and the instantaneous gas depletion times are about one Gigayear.

5.7 Galactic transients

LSI +61 303 is a microquasar candidate that is active from radio wavelength to the gamma-ray regime. The exact nature of the binary system is however not clear, recent VLBA measurements suggested that the activity in fact comes from the interaction of a pulsar wind with its companion's. The MAGIC collaboration carried out an observing campaign with the MAGIC telescope, CHANDRA, VLBA, MERLIN and the e-EVN. The radio monitoring was coordinated by Miguel-Angel Perez-Torres (IAA, Granada, Spain), the e-EVN data were processed by Zsolt Paragi. At the epoch of e-EVN observations the source did not show extended emission from the 10-100 mas scales, which has been seen at earlier epochs. There was a hint of correlation seen between the X-ray and the TeV gamma-rays during the campaign suggesting that in these two high energy regimes the emission comes from the same electron population, which is different from the electron population producing the radio emission.

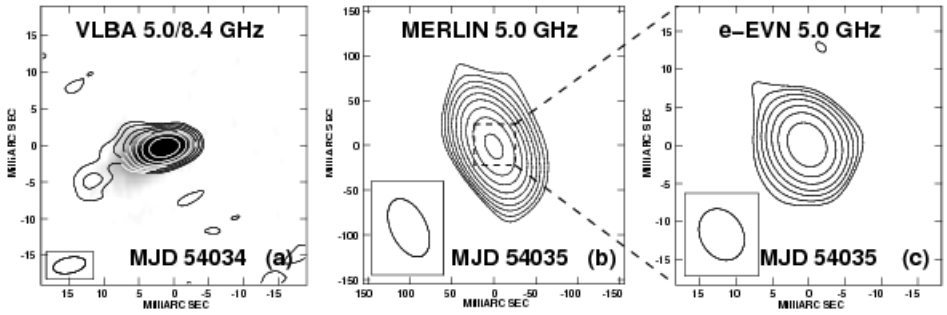


Figure 5.13: High resolution LSI +61 303 images during the MAGIC observational campaign. There was no apparent correlation between radio and X-rays/gamma rays, indicating that the emission is coming from different electron populations.

Microquasar Cyg X-3 has been active in recent years. The triggered e-EVN proposal by Valeriu Tudose (Univ. Amsterdam), Anthony Rushton (JBO), Zsolt Paragi, Rob Fender (Univ. Southampton), Ralph Spencer (JBO) and Mike Garrett (ASTRON) was activated on 9 April 2008 when the source showed signs of an accretion disk state change in the X-rays. This particular state has never been targeted at milliarcsecond resolution in the radio regime. A single radio component (earlier assumed to be a permanent jet-ISM interaction feature) was detected at a lower emission level than in 2007, consistent with the radio core quenching scenario in the soft X-ray state. The identification of the radio core allowed the group to estimate the proper motion of Cyg X-3. As expected following the state change, Cyg X-3 began a strong radio flare which was observed at three epochs separated by a few days. The group uses the e-EVN as

well as archival VLBA data to separate the core flux from the occasional jet emission, which will allow a clearer classification of accretion disk states in the system and measure the proper motion of Cyg X-3.

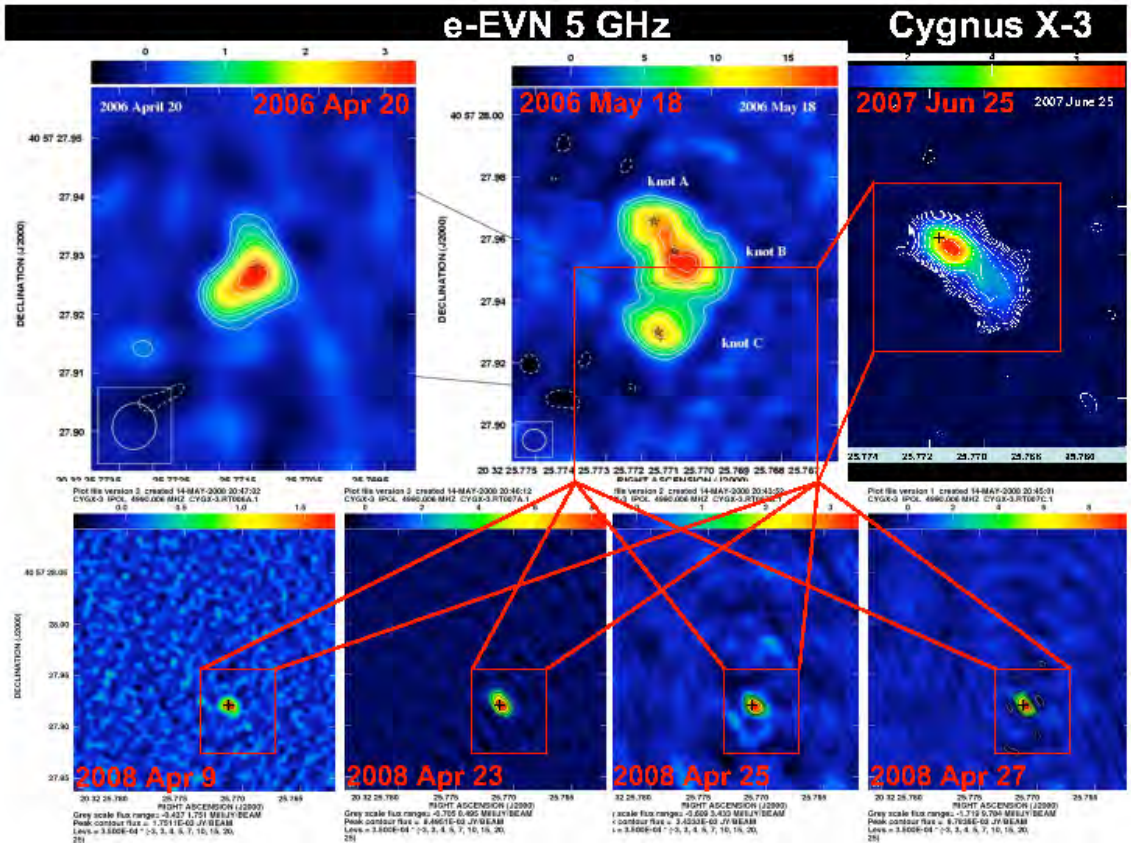


Figure 5.14: e-EVN images of Cyg X-3 during different accretion disk states in the period 2006-2008. With these observations the core of the system was clearly identified.

Gloria Dubner (IAFE, Argentina), Elsa Giacani (IAFE, Argentina), Andrei Bykov (A.F. Ioffe Institute of Physics and Technology, Russia), Zsolt Paragi and Huib van Langevelde observed a radio source in the error box of the 27 May AGILE transient on 24 June 2008 with the e-EVN. The data were analysed by JIVE summer student Alfonso Trejo (UNAM, Mexico). In the AGILE error box there is the brightest, so far unidentified gamma-ray source from the EGRET catalogue as well. Because the radio source observed is positionally consistent with the only hard X-ray source (IGR J20187+4041) in the close vicinity of the transient, it was assumed that they may be related. In the e-EVN observations the radio source was detected on 10-mas scales, but it did not show flaring activity. The results were discussed and followed up in Astronomical Telegrams and it was shown that IGR J2018+4041 is a low-luminosity type-2 Seyfert galaxy at a redshift of z=0.0144. One would not expect flaring gamma-ray activity from normal Seyfert galaxies, which questions the relation of the radio source to the gamma transient. The nature of the high energy source is still not clear.

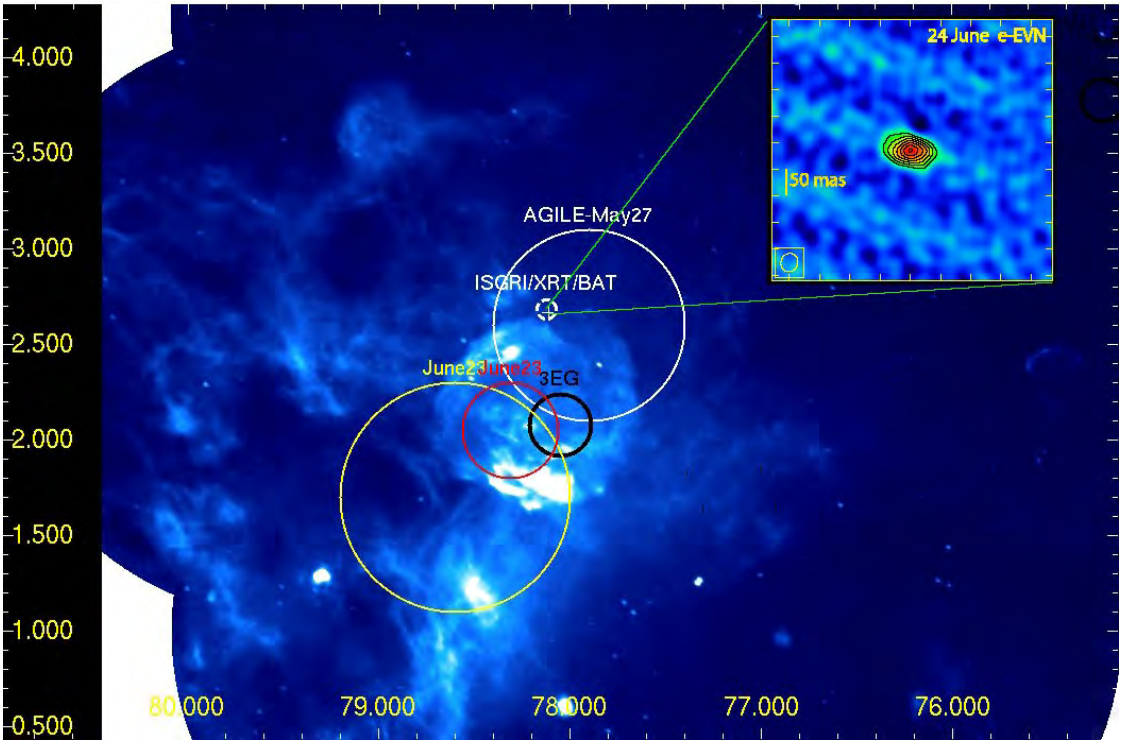


Figure 5.15: The hard X-ray and radio source IGR J20187+4041 was in the error box of an AGILE flare on 27 May 2008. e-EVN observations showed a faint, compact structure, with apparently no flaring activity. Later AGILE observations and analysis showed that the flare was likely not related to IGR J20187+4041.

On 28 October 2008 RATAN-600 reported a major flare in the famous microquasar SS433. Valeriu Tudose (Univ. Amsterdam) and Zsolt Paragi organised e-EVN monitoring observations together with Paolo Soleri (Univ. Amsterdam), Rob Fender (Univ. Southampton), Sergei Trushkin (SAO, Russia), Mike Garrett (ASTRON), Ralph Spencer and Anthony Rushton (JBO). The first epoch data on 6 November showed three pairs of radio components located symmetrically on both sides of the presumed position of the core of the system, two of which were already resolved. Assuming that the radio ejecta were moving at a rate of about 8 mas/day, the furthest components at about 100 mas from the core were ejected at around 24 October and perhaps the RATAN-600 observations on 28 October caught the aftermath of this event. The two components at about 25 mas from the core could have been ejected around November 3, date which also corresponds to the rebrightening event witnessed by RATAN-600. The results were reported in ATel #1836. Continuing observations with RATAN-600 and the e-EVN (on 13 and 19 November) showed a long-lived flaring activity in the system.

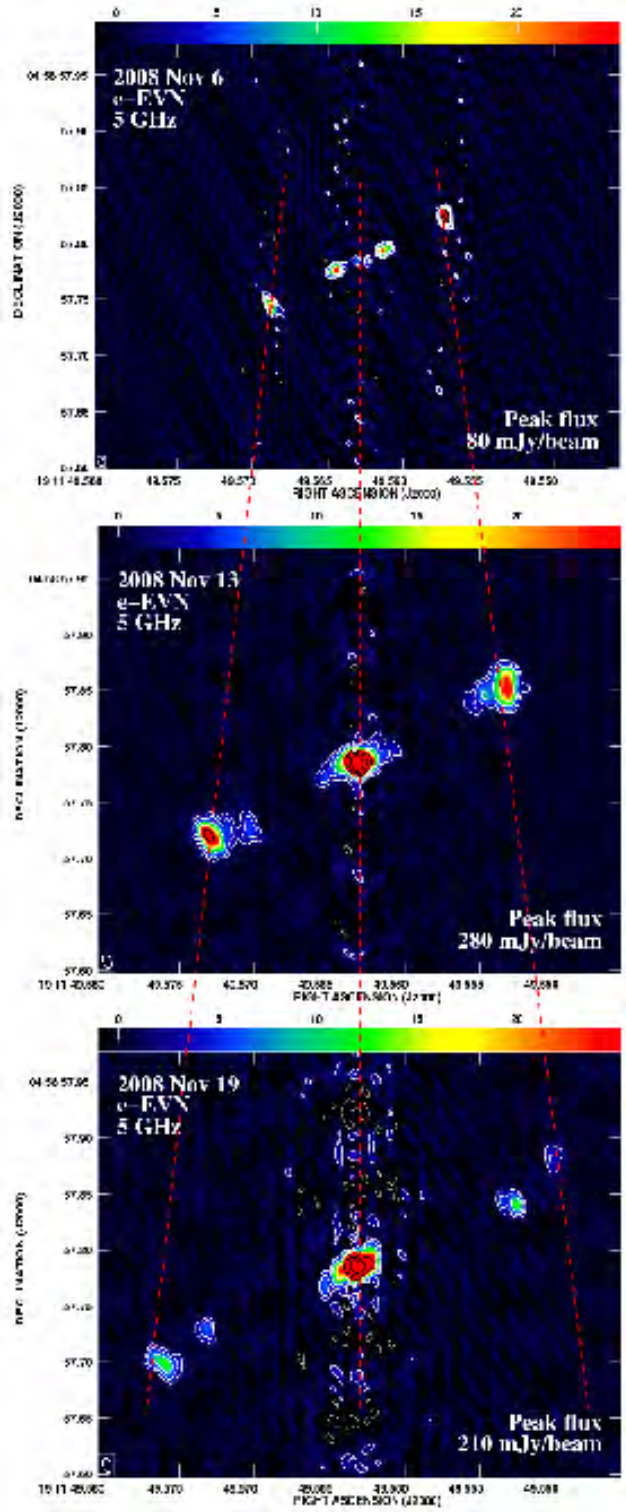


Figure 5.16: e-EVN images of a long-lived SS433 flare.

5.8 Massive star forming regions

Kalle Torstensson and Huib van Langevelde continued their studies of methanol masers associated with high mass star formation. In collaboration with Floris van der Tak (SRON Groningen) and Wouter Vlemmings (Bonn University), interesting results were obtained on the nearest high mass star forming region Cep A, which is studied as the archetypical source in the sample. Analysis of data taken with the JCMT allows the derivation of the rotation temperature and column density of the thermal methanol gas. The methanol is clearly associated with the central source in this famous HII region and the derived temperature peaks at the location where the maser is found. Combined with earlier dust maps, it is possible to get a handle on the abundance. Methanol is believed to be a short-lived species in the gas phase, requiring a shock process to be released from interstellar grains. The data shows a large scale outflow from the central source where also the masers reside, consistent with the masers arising close to the place where the methanol is released.

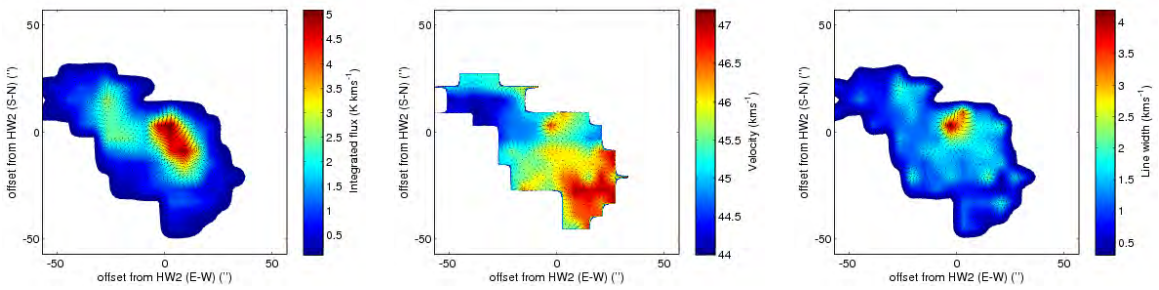


Figure 5.17: Thermal methanol in Cep A, from left to right the integrated flux, the velocity field and the line width of the methanol ($7_{17} \rightarrow 6_{16}$) E-type transition is shown. This is the strongest unblended line in the JCMT Harp spectra.

The direction of the outflow is also roughly perpendicular to the orientation of the methanol masers on a much smaller scale as observed with the EVN. The methanol masers that straddle the waist of Cep A are interpreted to outline a large scale ring structure perpendicular to the outflow axis of the central source. Remarkably, the velocity field does not show a rotation signature, but seems to be dominated by a radial motion. It could be hypothesised that the ring outlines an accretion shock, where in-falling gas hits the accretion disk.

Similar ring structures have now also been found in a larger scale sample studied by Huib van Langevelde and Kalle Torstensson in collaboration with the group in Torun (Anna Bartkiewicz and Marian Szcymcak). Following up a blind survey along the Galactic plane with sensitive observations using the European VLBI Network, a substantial fraction of elliptical sources have been revealed. Also in these sources there is a tendency for the methanol maser structures to be dominated by radial motions, rather than rotation. For both samples of methanol masers, attempts were made to detect Ultra Compact or Hyper Compact HII regions, for example by using the VLA. Some detections were obtained but generally the detection statistics were lower than expected.

In a collaboration with Gary Fuller (University of Manchester), Kalle Torstensson and Huib van Langevelde got involved in the MERLIN follow-up of the methanol multibeam survey. This will allow the study of more complete samples, especially when the current Parkes results will be augmented by a Northern hemisphere survey.

Huib van Langevelde worked with Andreas Brunthaler and Kazi Rygl (MPIfR Bonn) on the use of methanol masers to obtain distances to high mass star formation regions and indeed the overall scale of the Milky Way. In this programme the first EVN parallax measurements were obtained.

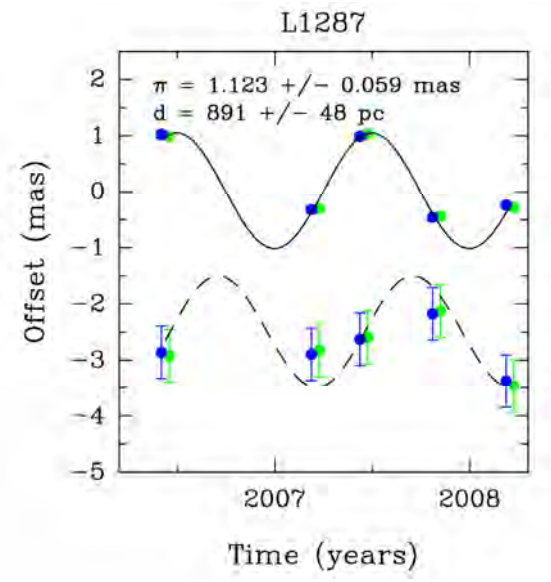


Figure 5.18: The preliminary parallax results for the dark cloud L1287 measured using the 6.7 GHz methanol maser emission. The Right Ascension (solid line) and declination (dashed line) signatures of the parallax are shown. Each maser channel which was used for the parallax fitting is indicated by a different colour.

Lisa Harvey-Smith worked closely with Rebeca Soria-Ruiz on projects to study the structure of masers in regions of massive star-formation at high angular resolution. Their work included discovering several new masers in the DR21 giant molecular clouds and measuring their polarization. They also found a candidate circumstellar disc with a well-sampled Keplerian rotation curve.

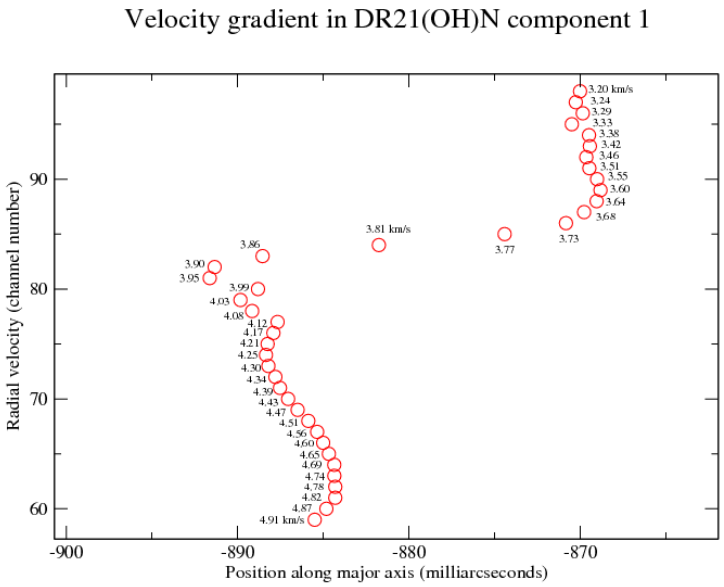


Figure 5.19: The velocity gradient of methanol masers in DR21(OH)N, showing evidence of Keplerian rotation around the massive protostar ERO3

5.9 Evolved stars

Nikta Amiri worked with Huib van Langevelde and Wouter Vlemmings (Bonn University) on the role of magnetic fields in structuring the outflow of evolved stars that are in transition to become a planetary nebula. MERLIN observations of the OH maser in the water fountain source W43A reveal circular polarization. When interpreted as the Zeeman effect, the measured magnetic field is 100 micro gauss. This is consistent with the previous estimate of the magnetic field of 70 micro gauss extrapolated from water maser polarization observations. Together these measurements seem to confirm that magnetic fields play an important role in shaping the circumstellar material in the transition to Planetary Nebulae.

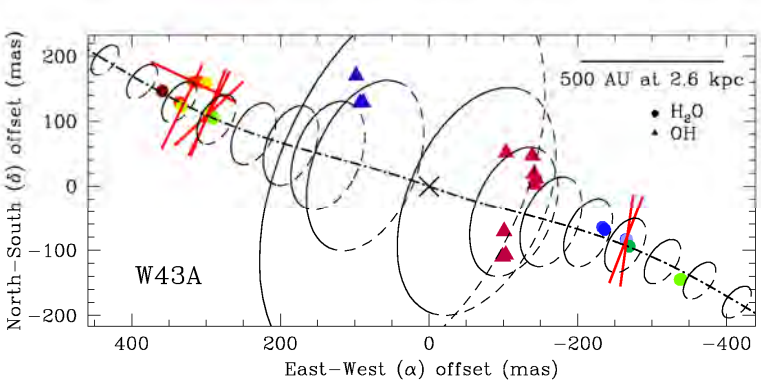


Figure 5.20: Spatial distribution of OH and H_2O maser features in W43A. The offset positions are with respect to the reference feature. H_2O features are indicated by filled circles and OH components are shown as triangles. Red and blue show the redshifted and blueshifted features.

The same team also started a VLBI campaign of OH/IR stars that have a previous distance determination with the so-called phase lag method. The goal is to determine whether these stars have enough compact maser emission to allow a parallax measurement with VLBI. This would be an independent check of the phase lag distance and its underlying assumption. In particular it is interesting to check whether the OH maser shells are spherical. Processing of the data from the first campaign revealed that the masers show dominant structure on the shortest EVN baselines, and the observations were repeated in 2008 using a special mode that combines the EVN with four of the UK based telescopes that participate in MERLIN.

Algol is an eclipsing binary stellar system in which the cool K2 IV sub-giant looses matter through Roche-lobe overflow to the more massive B8 V star. A third star is orbiting around the close binary in a long period orbit. The system is the nearest and one of the most active of its kind. A group led by Szilárd Csizmadia (Konkoly Observatory, Budapest, Hungary) monitored the system with the CHARA optical interferometer, while Zsolt Paragi organised e-EVN observations. During the e-EVN run there was a radio flare. The observed position offset between the total intensity and the circular polarization image indicated that the flare either did not occur in the well-known gyrosycnhrotron radio lobes, or only one of the lobes flared. The optical interferometer data provided the most accurate measurement of the mutual inclination between the close and wide pair orbits. The role of the e-EVN data was to resolve the 180 degrees ambiguity in the longitude of the ascending node of the close pair. Using these latest results for the orbital parameters, Csizmadia et al. investigated the dynamics of Algol with numerical integration of the equation of motions. It was found that the change in inclination of the close pair has a very long period, about 20.000 years. This is in good agreement with the observed small change in the eclipse depth during primary minima.

5.10 Planetary Science

A search for 22 GHz water maser emission from the Saturnian system triggered by the recent discovery of a water plum from Enceladus was conducted by Leonid Gurvits and Sergei Pogrebenko together with an international group of researchers with the Medicina (INAF-IRA, Italy) and Metsähovi (TKK-MRO, Finland) radio telescopes. The experiment employed data handling algorithms and procedures originally developed for the Huygens VLBI tracking experiment. More than 300 hours of "on-Saturn" data were collected during the 2006-2008 observing campaigns. A direct-FFT on-line hardware spectrometer was used at the Medicina Observatory. At Metsähovi, spectral analysis was done off-line: the data were first recorded on disks using different data capture units and then processed with the high performance software spectrometer, developed at the Metsähovi Observatory. The resulting spectra were analysed at JIVE. The water maser emission was detected in the areas associated with different bodies of the Saturnian system: Titan, Hyperion, Enceladus and Atlas (Figure 5.21).

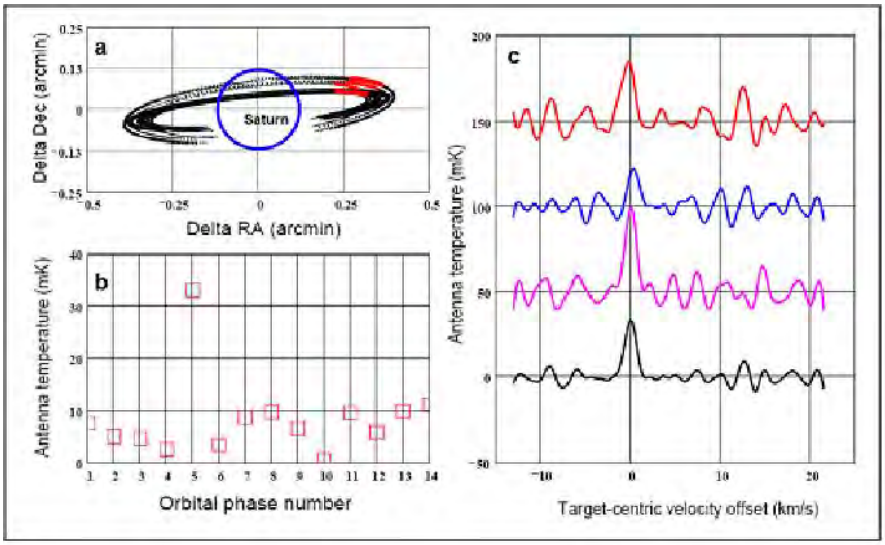


Figure 5.21: The 22 GHz spectra reduced for the orbital motion of Atlas, the most secure detection of the observing campaign. Orbital phase 5, which has the highest SNR detection (6.5σ), corresponds to the orbital segment shown in red in the upper left panel. The high SNR of this detection and its persistence over one year of observation (as illustrated on the right panel) is indicative on a possible association of the maser emission with a spot lagging the position of Atlas by several thousand km along its orbit rather than Atlas itself. The emission might originate in the edge regions of rings A and F, disturbed by the Atlas's motion.

6 Space Science at JIVE

6.1 Huygens aftermath

6.1.1 The Huygens Probe

The ESA Huygens Probe, the European part of the NASA/ESA/ASI Cassini-Huygens mission, was launched toward the Saturnian System in 1997. The Huygens Probe arrived at its final destination, Titan, on 14 January 2005. VLBI observation of its descent and landing were performed with a global array of radio telescopes in Australia, China, Japan and the USA. The Huygens VLBI tracking experiment was led by JIVE. The work was supported by the ESA contract 18386/NL/NR.

The final analysis of the Huygens VLBI tracking data was completed during the reporting period. The results were delivered to ESA and presented at a number of international scientific conferences. Figure 6.1 represents the 3D reconstructed descent trajectory of the Probe.

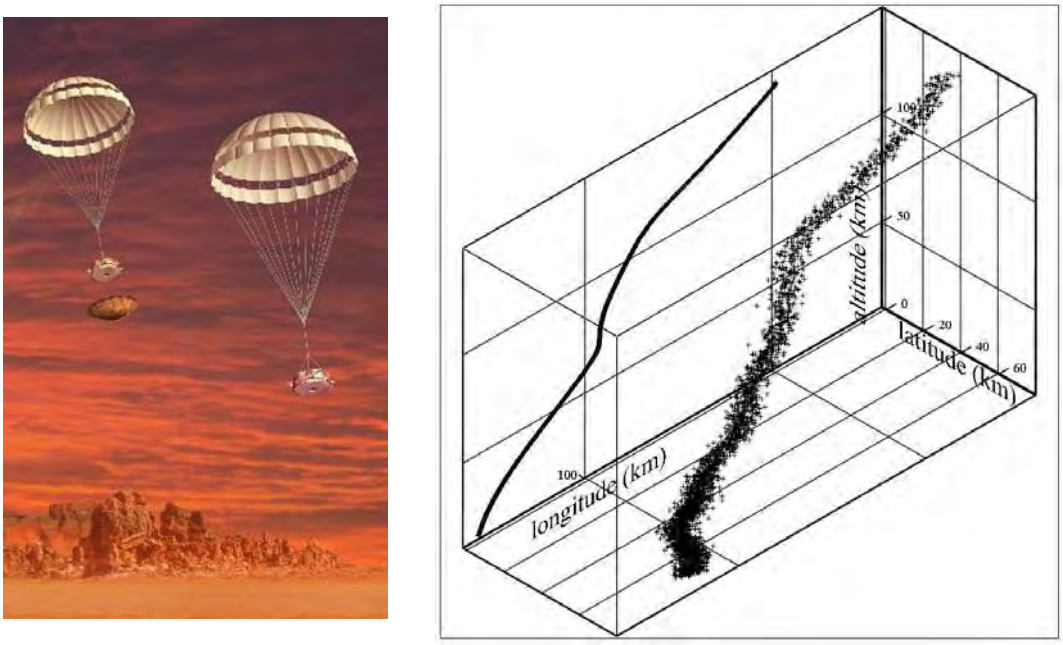


Figure 6.1. An artist impression of the Huygens Probe descent (left) and the VLBI-based reconstructed 3D trajectory of the descent (right).

The 1 σ stochastic scatter ellipse of the position determination in Titanographic coordinates in the reconstructed trajectory is 0.5×2 km, with the minor semi-axis oriented along the longest baseline of the VLBI array - Mopra (Australia) to Green Bank (USA). This translates into the angular accuracy ellipse of 100 by 400 microarcseconds. Such accuracy provides a valuable input to the studies of the air mass dynamics of Titan's atmosphere. The Huygens VLBI tracking experiment paved the way for future multi-task applications of VLBI techniques for planetary and space science missions

6.1.2 High velocity resolution analysis of the Huygens VLBI data

High spectral resolution Doppler data from the Huygens VLBI tracking experiment, obtained by JIVE scientists, made possible investigation of the probe's velocity as a function of time with a sub-cm-per-second accuracy. The velocity data provide valuable input into the study of the flight-dynamics effects of parachute and balloon systems in planetary atmospheres. The results of the study have direct applications to the design of prospective planetary probes on Mars, Venus and Titan.

The results of high velocity resolution study were presented at 4th International Workshop on Tracking, Telemetry and Command Systems Applications (ESOC, Darmstadt, Germany, 2007). Figure 6.2 illustrates the detection of a 1.2 rpm probe's spinning with the rotational velocity of 2 cm/s.

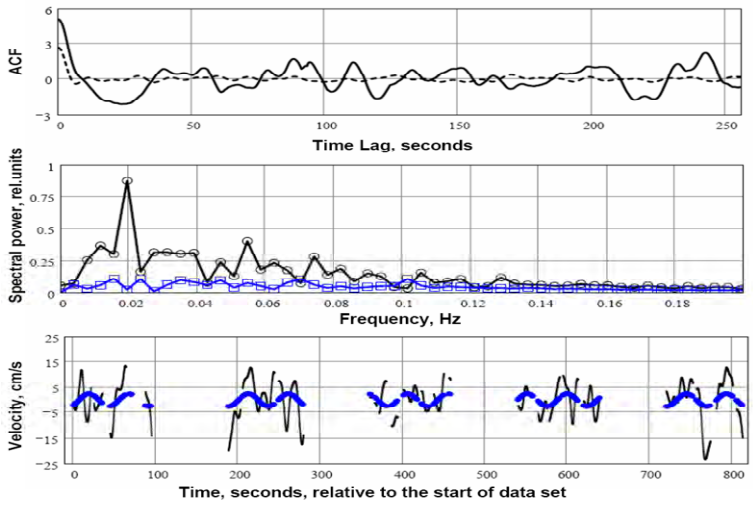


Figure 6.2: Upper panel: Auto-correlation functions (ACF) for the post-landing (dashed line) and parachuting (solid line),from Parkes tracking data. Middle panel: the velocity deviation spectra – for post-landing (boxes) and parachuting (circles) phases, showing the 0.02 Hz and 2 cm/s probe's spin spectral feature. Lower panel: an overlay of the estimated spin-induced radial velocity variation component (blue line) over the parachuting velocity deviation curve (black line)

6.2 Future space projects

6.2.1 Spacecraft radio occultations

The ESA Smart-1 Lunar orbiter was observed with the EVN telescopes Medicina, Metsähovi and Westerbork in 2006. At several occasions, an occultation of the spacecraft by the Moon was observed. High spectral resolution processing was conducted with the Huygens VLBI software correlator. It was fascinating to see the diffraction patterns clearly appearing in the data. A proper description of the VLBI-detected diffraction patterns requires a 3-dimensional wave-optics relativistic model of VLBI delay. Jian Nianchuan, a summer student from the Shanghai Astronomical Observatory (China) visited JIVE in the summer of 2007 and worked under supervision by Sergei Pogrebenko on the first-order approach to the problem. He developed a simulation model of a spacecraft signal diffraction by lunar surface, using a high resolution 3D map of the Moon created by a laser altimeter onboard the USAF Clementine Moon orbiter. The results of the simulation work were in agreement with the experimental data. They were presented at the 9th ILEWG International Conference on Exploration and Utilisation of the Moon (Sorrento, Italy, 22-26 October, 2007).

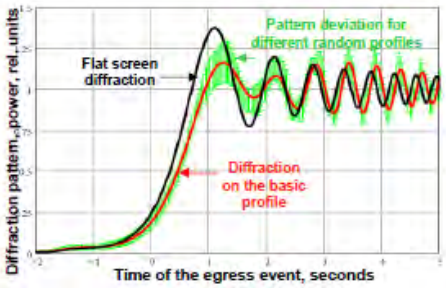


Figure 6.3. A simulated diffraction pattern of a S/C radio signal on different diffraction screens.

6.2.2 Demonstration radio observations of spacecraft

An observing campaign on spacecraft tracking with the Metsähovi (TKK-MRO, Finland) and Medicina (INAF-IRA, Italy) radio telescopes, coordinated by JIVE, has started in 2008 as a part of development activities in preparation for future involvement of EVN and JIVE in ESA/NASA/JAXA deep space missions.

The ESA Venus Express (VEX) spacecraft was observed with the Metsähovi radio telescope at X-band on 11 June 2008 using multi-bit data sampling, a purpose-built data capture instrumentation and high performance processing software, developed at the Metsähovi Radio Observatory in collaboration with JIVE. The data analysis tools were developed at JIVE. Figure 6.4 shows a summary plot of results of this test run.

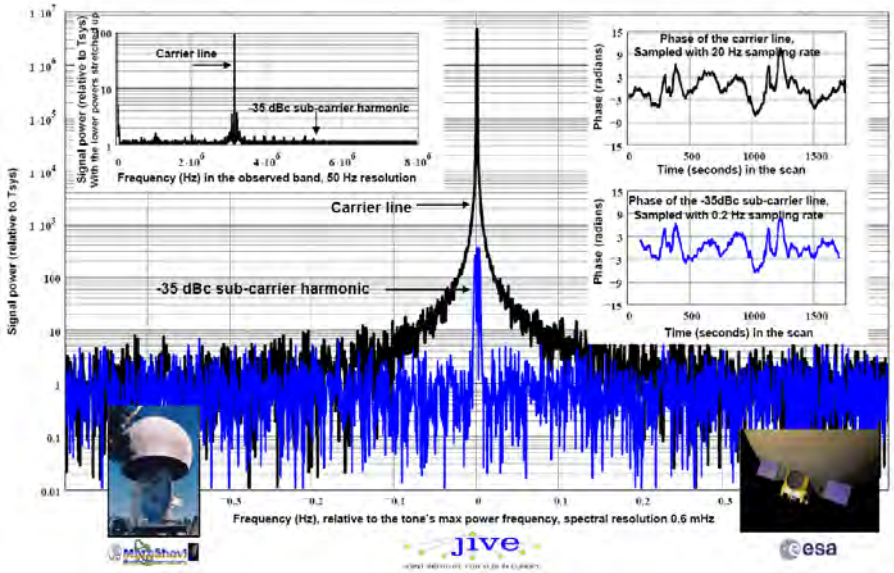


Figure 6.4. Top left corner inset: a preview spectrum of 50 Hz resolution over a 8 MHz video band, with more than 40 dB dynamic range. Top right inserts: the detected phase of the carrier line and sub-carrier harmonic at the -35 dBc level. Central part of the plot: the final spectra of the carrier line and one of sub-carriers with 0.6 mHz resolution and SNR of 5×106.

Successful detection and phase extraction of the -35 dB subcarrier the VEX S/C from the distance of 1.5 AU demonstrates a possibility of scientific experiments with Metsähovi-class telescopes and deep space missions at the distances of up to 50 AU. This is a very encouraging

conclusion in preparation for the EVN participation in deep-space missions testing gravitation theory (Pioneer-anomaly) such as the Odyssey mission, proposed for the ESA Cosmic Vision programme (B. Cristophe, Experimental Astronomy, in press). JIVE scientists involved in this study, showed that high-precision VLBI measurements could measure the anomalous accelerations of spacecraft at high velocities and large distances from Sun.

The NASA/ESA Ulysses spacecraft was observed with the Medicina telescope at S-band on 28 November 2008. For these observations, 8-bit data capture employed a device based on iBob hardware and FPGA firmware developed at Metsähovi. Two hours of captured data were electronically transferred from Medicina to Metsähovi for high performance processing; while intermediate data were send from MRO to JIVE for post-processing and analysis. At the time of the observations Ulysses was 4.5 AU away from Earth, and its signal power level was more than 1000 times less than that from Venus Express. Preliminary results of this test are shown in Figure 6.5.

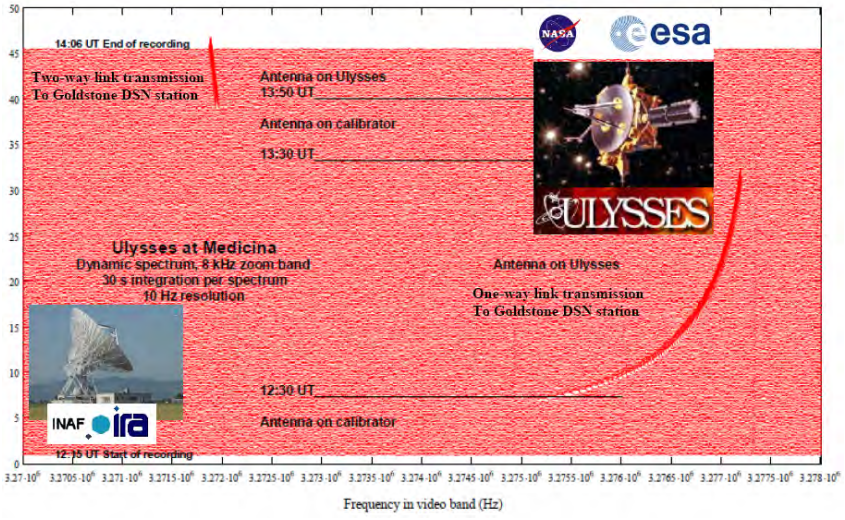


Figure 6.5. A dynamic spectrum of the Ulysses carrier line observed with the Medicina telescope, processed at Metsähovi and analysed at JIVE. The spectral resolution is 10 Hz over the 8 MHz video band. The received signal power was 3 dBTsys in 1 Hz.

6.2.3 Tropospheric limitations on the accuracy of differential VLBI

Several planned ESA/NASA/JAXA/RSA missions will involve multiple spacecraft and planetary probes. VLBI on the multiple transmitters on and around the same planet can provide ultra-precise differential measurements of the state vectors of the S/C and probes. One of the limiting factors in such measurements is the propagation effects in the Earth atmosphere. To characterise these propagation effects one can use simulations of electromagnetic wave propagation through the turbulent media with a Kolmogorov spectrum of density fluctuations. The JIVE summer student Dmitry Duev (Astronomical Department of the Moscow State University), supervised by Sergei Pogrebenko performed these simulations at JIVE in July-August 2008. Figure 6.6 shows the typical case of differential fluctuations of electrical length of the troposphere for 1 arcminute angular separation between two point-like radio sources. A separation of 1 arcminute (or less) is typical for multiple S/C in Mars, Mercury or Venus

environments. It was shown that RMS of differential fluctuations in such cases is at a level of 10 micron, thus adding a positional noise for differential VLBI measurements at the level of sub-microarcseconds, or less than a meter at a distance of 2-3 AU.

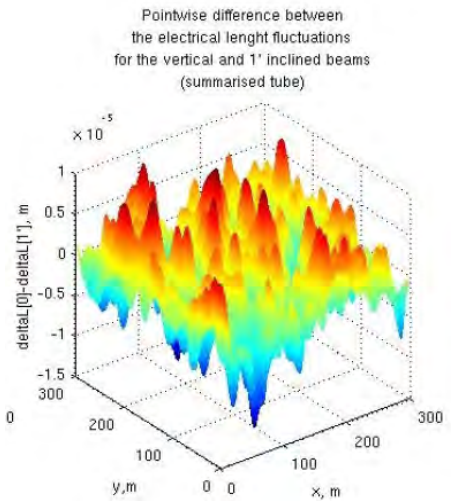


Figure 6.6: Simulated tropospheric differential electrical lengths for 1 arcmin separation near local zenith.

6.2.4 Planetary Radio Interferometry and Doppler Experiment (PRIDE)

An Earth-based global network of radio telescopes and processing facilities will conduct Planetary Radio Interferometry and Doppler Experiment (PRIDE) aimed at providing ultra-precise estimate of the state-vectors of the in-situ elements in the framework of planetary missions proposed for the ESA Cosmic Vision 2015-2025 programme. JIVE-led PRIDE is a component of the following proposals: Kronos (in situ study of Saturn), TandEM (Titan and Enceladus Mission), Laplace (the mission to study Europa and the Jovian system) and EVE (European Venus Explorer). Figure 6.7 presents a generic configuration of PRIDE. PRIDE is based on the heritage of the Huygens Doppler Wind (DWE) and VLBI tracking experiments. Today's technology and very conservative projections of the capabilities of VLBI radio telescopes for the next two decades lead to the following guaranteed 1σ accuracy of positional measurements: 500 m based on S-band (2 GHz signal), 100 m at X-band (8 GHz) and 30 m at K_a-band (32 GHz) at the distance of up to 8 AU. The advantage of PRIDE is that it poses minimal requirements for the on-board instrumentation.

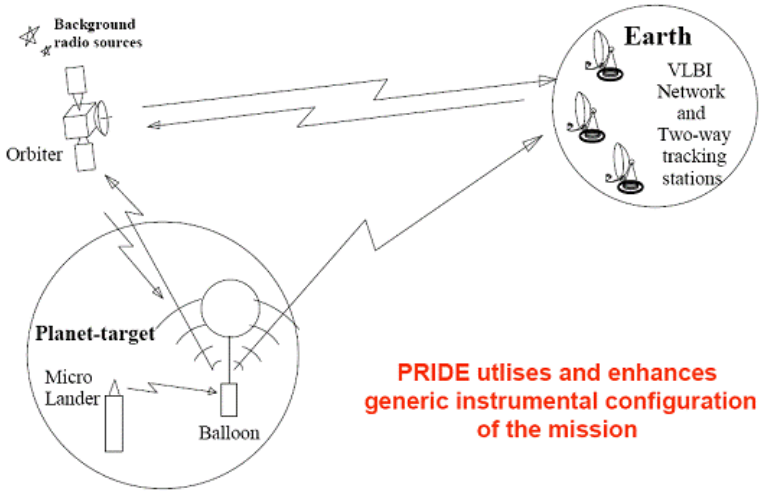


Figure 6.7: A generic configuration of PRIDE, involving an Earth-based VLBI network and planetary spacecraft of probes of different types (orbiter, lander, atmosphere balloon).

Elements of PRIDE will be used in the ESA-JAXA mission BepiColombo on the Japanese-led Mercury Magnetospheric Orbiter (MMO) by the JIVE team in collaboration with the Institute of Space and Astronautical Sciences (Japan) and Shanghai Astronomical Observatory (China) in 2011-2019.

6.2.5 The SKA role in planetary exploration

For many planetary missions, the nominal data broadcast scenario assumes relay of science and house-keeping data from a low-power probe transmitter to an orbiter or fly-by spacecraft, with re-transmission to Earth via a more powerful transmitter and high-gain antenna. Such a scheme can support delivery of large volumes of data to Earth with a data rate of tens of kbps. However, as an efficient backup able to provide support to critical mission operations and experiments, a low data-rate link can be achieved with nominal transmission from the low-power in-situ elements and received by large Earth-based radio telescopes – the so called Direct-to-Earth (DtE) regime. The most attractive option of DtE would involve the Square Kilometre Array as the Earth-based facility able to operate at the S band (2.3 GHz). Figure 6.8 illustrates the potential of SKA as a DtE facility for a mission to an outer planet mission. As shown by preliminary assessment estimates, SKA will be able to receive data streams from such a mission at the rate of 30-100 bps (Fridman, Gurvits, Pogrebenko, 2008, SKA Memo No. 104). The DtE regime is included in the preliminary design study of the ESA Cosmic Vision proposals for the Europa Jupiter System Mission (EJSM) and Titan Saturn System Mission (TSSM). JIVE is involved in both these design studies with PRIDE and DtE components.

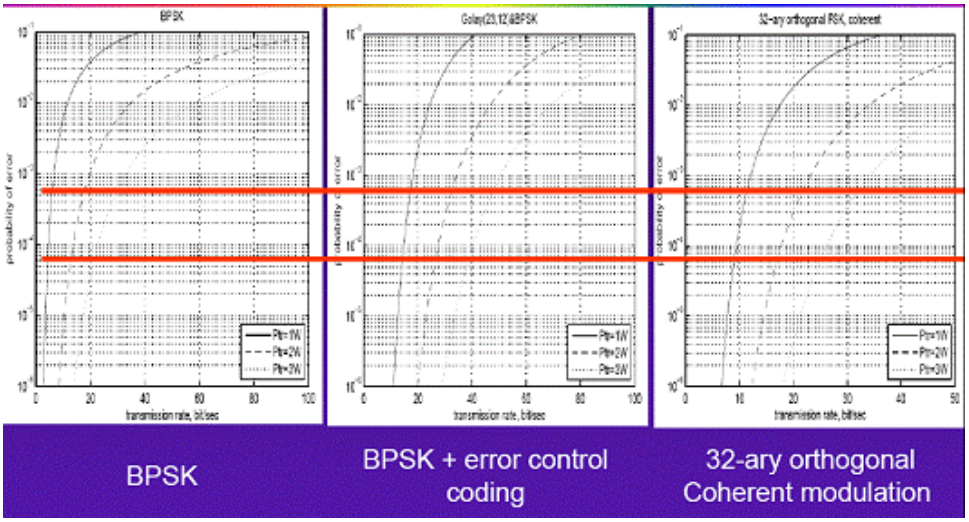


Figure 6.8: Bit error rate (BER) as a function of transmission bit rate (in units of bps) for three different modulation and coding schemes. The bit rate of 30-50 bps with the BER=10-4 – 10-3 can be achieved with SKA receiving a signal from an omnidirectional transmitting antenna at the distance of 5 AU (typical distance to a Jovian probe) and transmitter power 1 – 3 W.

6.2.6 Toward Moon-based Ultra-Long-Wavelength Astronomy (ULWA)

Under a joint project co-funded by the Royal Dutch Academy of Sciences (KNAW) and Chinese Academy of Sciences (CAS) PhD student Linjie Chen co-supervised by Leonid Gurvits (JIVE), Richard Strom (ASTRON and University of Amsterdam), Heino Falcke (ASTRON and Radboud University, Nijmegen), Yan Yihua and Huang Maohai (both National Astronomical Observatories of China, Beijing) works on the demonstrator for a Moon-based radio interferometer for frequencies below 10 MHz. This frequency domain is the last unexplored region of cosmic electromagnetic spectrum. The Moon is an attractive base for an Ultra-Long-Wavelength Astronomy (ULWA) facility and is being considered in preliminary studies of the next wave of lunar missions in Europe, China and other countries.

The work is a natural extension of JIVE and ASTRON expertise since the ULWA facility will be an interferometric system, a kind of LOFAR extension toward ultimately low frequencies unreachable for Earth-based radio telescopes. The PhD project materials provide inputs into pre-design studies conducted by the European and Chinese space agencies.

6.3 Space VLBI

Preparation for the next generation Space VLBI mission Astro-G/VSOP-2, led by the Japanese Aerospace Agency (JAXA) accelerated in the reporting period as the launch date, fixed for 2013 is approaching. In December 2008, the leading mission organization, JAXA's Institute for Space and Astronautical Sciences (ISAS) convened the first meeting of a newly established VSOP-2 International Science Council (VISC-2, Figure 6.9) which involves a representative of JIVE (Leonid Gurvits). The expertise in Space VLBI available at JIVE will be focused at VSOP-2 science operations, data processing and user support.

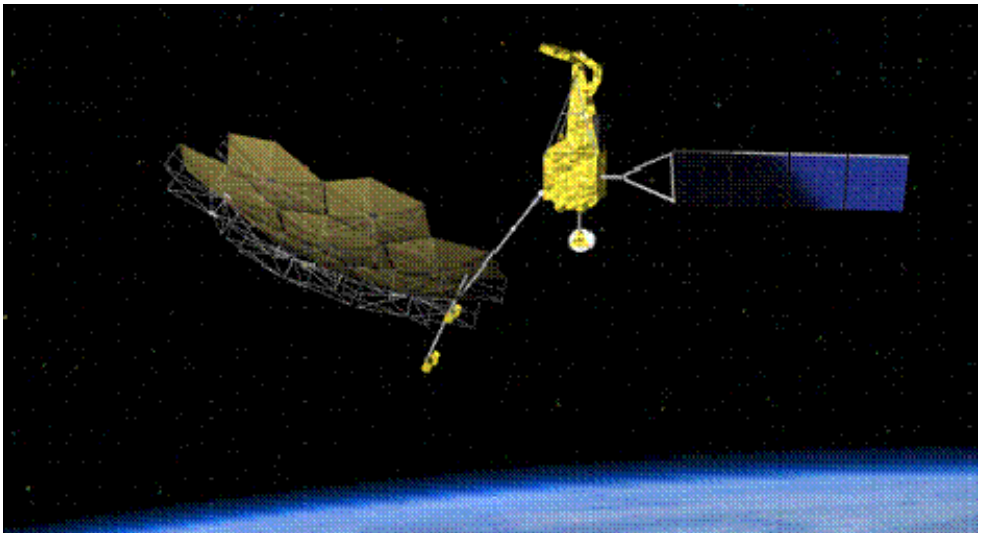


Figure 6.9: Top: artist's impression of the Astro-G VSOP-2 spacecraft. Bottom: VISC-2 members at ISAS in December 2008. In the background – a mock-up of the historic rocket M-V that put in orbit the first dedicated Space VLBI mission HALCA/VSOP in February 1997.

In October 2008, JIVE scientists participated in the conference "Radio Universe at Ultimate Angular Resolution" dedicated to the scientific programme of the Space VLBI mission RadioAstron, held in Moscow, Russia.

7 EC and other international projects

7.1 EXPReS

7.1.1 Overview

JIVE is the coordinating partner for EXPReS (Express Production Real-time e-VLBI Service), an Integrated Infrastructure Initiative (I3), funded under the European Commission's Sixth Framework Programme (FP6). The project began in March 2006 and will end in 2009. There are 19 partners of EXPReS, representing astronomy institutes, network providers and supercomputer centres.

Besides being the coordinator (Huib van Langevelde), JIVE participates in all of project activities below and JIVE staff takes a leading role where indicated. In addition, Zsolt Paragi is the project scientist.

Networking activities

- NA1: Management of I3 (Charles Yun)
- NA2: EVN-NREN Forum
- NA3: e-VLBI Science Forum
- NA4: e-VLBI Outreach, Dissemination & Communications (Kristine Yun)

Specific Service activities

- SA1: Production e-VLBI Service (Arpad Szomoru)
- SA2: Network Provision for a Global e-VLBI Array

Research activities

- JRA1: Future Arrays of Broadband Radio Telescopes on Internet Computing (Charles Yun & Mark Kettenis)

7.1.2 Accomplishments

During 2007 and 2008, EXPReS has made major progress towards the core goal of the project: provide production quality e-VLBI to the community. The EVN started to regularly advertise e-VLBI and the quality of e-VLBI has improved both in terms of reliability and scientific competitiveness. Most of the technical and scientific highlights are reported elsewhere in this report; highlights of the activities during the 2007 and 2008 can be found in figure 7.1

Figure 7.1: EXPReS timelines with major milestones 2007 (top) and 2008(bottom)

7.1.3 EXPReS Meetings

The international consortium of telescope and network providers that collaborate in EXPReS held two business meetings. In 2007 the meeting was hosted by chairman Ari Mujunen in Espoo (Helsinki), Finland on May 29. The 2008 board meeting was hosted by SURFnet in

Utrecht (30 January 2008) (Figure 7.2). In both years the EXPReS management at JIVE compiled extensive annual reports based on input from all partners. Subsequent reviews were held in Brussels with a small team from EXPReS attending. Both reports were well received at these reviews and approved by the reviewers. Much of the presentation and management reporting of these events was done by the EXPReS project manager, Charles Yun. In addition, a number of other EXPReS meetings were organised often sponsored by the Networking Activities. The main global e-VLBI event of 2008 was the Shanghai e-VLBI meeting, sponsored by EXPReS (Figure 7.3). In 2008 work started in 2008 for a final e-VLBI workshop on both techniques and science in summer 2009.

Figure 7.2: Participants of the EXPReS board meeting, 30 January 2008, Utrecht.

Figure 7.3: Participants of the 7th international e-VLBI workshop, 16 June 2008, Shanghai.

Meeting	Date
Annual Review Year 1, European Commission, Brussels, Belgium	17 April 2007
FABRIC Work Meeting, Dwingeloo, The Netherlands	25 April 2007
2nd Board Meeting, Espoo, Helsinki, Finland	29 May 2007
eVSAG Meeting, Gothenburg, Sweden	28 June 2007
6th International e-VLBI Workshop, Bonn, Germany	16 September 2007
Progress Meeting, Utrecht, The Netherlands	29 January 2008
3rd Board Meeting, Utrecht, The Netherlands	30 January 2008
Annual Review Year 2, European Commission, Brussels, Belgium	30 May 2008
7th International e-VLBI Workshop, Shanghai, China	16-17 June 2008
FABRIC Work Meeting, Poznan, Poland	1-2 September 2008
Effelsberg Connection Event, Effelsberg, Germany	19 November 2008

EXPReS featured in a large number of public events throughout 2007 and 2008. Coordinated by the EXPReS outreach officer, Kristine Yun, a large number of press releases were made, often associated with live demos. These events raise the visibility of EXPReS both in the astronomical and networking community. As such, the project obtained a high visibility with the EC and was often used as an example of advanced network use in Europe (for example in the TV item by EuroNews, Figure 7.4). It is hoped that this has paved the way for a follow-up of EXPReS beyond 2009, with even more advanced networking features to be piloted by VLBI.

Figure 7.4: Charles Yun being interviewed by EuroNews in a rather uncomfortable location

7.2 RadioNet

7.2.1 Overview & Management activities

The 6th Framework Programme RadioNet is a so called I3 activity, and it was a vital programme for the JIVE mission. JIVE staff had a leading role in various activities.

- Bob Campbell coordinated the RadioNet Trans-National Activity "Access to the EVN"
- Leonid Gurvits was the project scientist and as such part of the management team
- Cormac Reynolds (later substituted by Huib van Langevelde) was the leader of the Joint Research Activity ALBUS (for Advanced Long Baseline User Software), which activity employed James Anderson, Stephen Bourke and Mike Sipior.
- Aukelien van den Poll is the main person involved in handling the reimbursement of travel and other costs associated with the Trans-National and Networking Activities.

All this staff was closely involved in making sure the annual reports for RadioNet were submitted in time. Most notably they were involved in the RadioNet mid-term review which took part in Grenoble on 11-12 April 2007.

While in 2007 much of the RadioNet management was "business as usual", much of the 2008 activities focused on the definition of the new FP7 proposal and finishing the FP6 work in good order. Notably much effort went into understanding how to finish the FP6 budget on zero, ie not overspending but also not leaving budget unspent at the EC. Some problems were encountered related to the indirect costs related to the NA and TNA funds administered at JIVE. As some of the arrangements for this had not been documented at the start of the project and no detailed budgets were produced for the all activity items, the project encountered some real hurdles in 2008. After a number of iterations compromises were defined that left JIVE responsible for some of the RadioNet activities towards the end of the project.

7.2.2 Access to the EVN

The FP6 RadioNet EVN Trans-National Access (TNA) programme provides funding to EVN telescopes to provide access to eligible projects, and supports travel by investigators from eligible projects to visit JIVE or another EVN institute. An eligible project is one in which the PI and at least 50% of the author list as a whole are associated with institutes in the EU member and associated states, excluding the Netherlands as the host country of JIVE. Table 7.1 summarizes various statistics from the past two years of EVN TNA activity.

	2007	2008
Number of experiments supported	42	44
comprising how many individual researchers	77	78
Number of different PhD students in supported groups	10	12
Total number of access hours	492	490
Number of data reduction visits	8	8
number of data reduction visits made to JIVE	7	5

Table 7.1: Annual statistics for various aspects of the EVN TNA programme over 2007-2008.

7.2.3 ALBUS

ALBUS (Advanced Long Baseline User Software) is one of the three Joint Research Activities of RadioNet. It has been managed by JIVE, initially by Huib van Langevelde, handing over to Cormac Reynolds in 2007, back to Huib van Langevelde in early in 2008. The project combines efforts on radio-astronomy data processing at ASTRON, MPI Bonn, and Jodrell Bank Observatory.

In 2007 James Anderson finished his work at JIVE on ionospheric processing and left for a LOFAR related position at Bonn. Mike Sipior took over the effort from Mark Kettenis on developing and maintaining ParselTongue, the common infrastructure of ALBUS that allows AIPS users to develop new methods in Python. Stephen Bourke worked on wide field imaging in 2008. The results of ALBUS development are listed in chapter 4.

ALBUS featured prominently in all the RadioNet reports and mid-term review, as well as all the board meetings.

7.3 RadioNet in FP7

JIVE will play a similar role in the RadioNet FP7 program which is starting in January 2009. During 2007 and 2008 an effort was made to define a follow-up of the successful RadioNet programme in the 6th framework. The proposal was led by Michael Garrett at ASTRON, and after a lengthy process of peer review, two Joint Research Activities led by JIVE were selected to be part of the proposal. The follow-up of ALBUS is called ALBiUS, where the i emphasizes the fact that this software effort will concentrate on interoperability. This effort was first managed by Cormac Reynolds, but Huib van Langevelde took over in the final definition stages. The other JRA was shepherded by Arpad Szomoru; named UniBoard it focuses on FPGA based digital processing and will develop a common platform for a range of radio-astronomy applications. Of course the successful EVN access program is the most vital part of the new RadioNet formula and this effort was led by Bob Campbell.

The proposal definition was quite an elaborate effort, but the Feb 29, 2008 deadline was met and a strong proposal was submitted. Huib van Langevelde plaid a coordinating role in defining and budgeting the JRA activities. Aukelien van den Poll assisted the ASTRON team in shaping the actual text. There will also, be a substantial role for JIVE in administrating the RadioNet programme, implementing the TNA travel and NA activities and maintaining the wiki.

7.4 ESTRELA

ESTRELA is short for Early Stage Training Site for European Long-wavelength Astronomy, an EC funded Marie Curie network that provides student positions at Manchester, ASTRON, Onsala, Bologna and Bonn. In 2006, Kalle Torstensson joined JIVE and started high resolution studies of methanol masers (page 59). Also under supervision of Huib van Langevelde Nikta Amiri started work on circumstellar masers and the non-sphericity of AGB mass-loss. Hayden Rampadarath works with Mike Garrett on radio studies of deep fields. All three ESTRELA students are based at Leiden University, but employed by JIVE. Through the reporting period

the necessary reports and financial accounts were produced; the scientific output is described in chapter 5.

7.5 ESKAC

In 2008 the European SKA Consortium was established, as a collaboration of European SKA stakeholders. The ESKAC appoints the European delegation to the SKA Science and Engineering Committee (SSEC) and supports the activities of the SKA Programme Development Office (SPDO), currently in Manchester (UK). In the consortium JIVE has adopted the special role of being the legal entity and banker for the ESKAC, collecting the European funds for SPDO. During this period the activities included the establishment of the ESKAC, for which a MoA was formulated. JIVE was also the signatory on the world-wide agreement for the support of SPDO.

In 2008 JIVE collected the ESKAC contributions and transferred the necessary European contribution to SPDO. Aukelien van den Poll is implementing most of the banker activities. She is also responsible for maintaining the web presence of ESKAC, where all the meetings are documented. In the future, JIVE will be more actively involved in ESKAC by administering the European meetings and travel.

7.6 SKADS

JIVE is a partner in the EC FP6 SKADS project, the SKA Design Study and the aligned Marie Curie training network. SKADS started in 2005 and will deliver considerations for the SKA design in 2009. JIVE's major role, reported in chapter 4, is in task DS2-T2 on SKA simulations. As the program leader and board member, Leonid Gurvits and Huib van Langevelde attended various board meetings and other SKADS related events.

7.7 PrepSKA

In 2007 JIVE became a partner in the successful EC FP7 proposal for preparatory studies for the SKA (PrepSKA). This project aims to define and work out budgetary and governance models for the SKA by 2011. JIVE is a minor party in studies of next generation correlator concepts and PrepSKA simulations.

7.8 FP6 EuroPlaNet

The EC FP6 Coordination Action EuroPlaNet completed its activities during the reporting period. JIVE is a member of EuroPlaNet. JIVE's involvement in the project helps to facilitate multi-facet connections with the European and world-wide planetary science community and thus assist in establishing working relations with a broad variety of planetary missions described in chapter 6 of the present report. The success of the FP6 EuroPlaNet CA helped to prepare a successful proposal for continuation of the collaboration in the EC 7th Framework Programme as a full-fledged Research Infrastructure. JIVE is a contractor of the FP7 EuroPlaNet with a specific role in one of the Joint Research Activities aimed at developing VLBI methods of estimating state-

vectors of planetary missions. The project commenced on 1 January 2009 and will focus on the planetary missions described in Chapter 6.

7.9 KNAW-CAS collaboration

In 2007, JIVE in collaboration with ASTRON completed the KNAW-CAS project on collaboration with Chinese radio astronomy institutes. The project was coordinated by Leonid Gurvits (JIVE), Richard Strom (ASTRON) and Xiaoyu Hong (Shanghai Astronomical Observatory). The focus in the reporting period was on VLBI support of the first Chinese Lunar mission Chang'E-1. JIVE assisted Chinese colleagues in the preparation to the experiment, in particular exploiting know-how obtained in the Huygens VLBI tracking project. As part of the Chang'E-1 effort, two new VLBI radio telescopes in China have been brought in operation, Miyun 50-m and Kunming 40-m antennas. JIVE also was involved in training activities of young researchers from the Chinese radio astronomy observatories.

8 Publications

8.1 Refereed publications

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9 Appendices

9.1 JIVE Board

Prof. Dr. J.A. Zensus	Max-Planck-Institute for Radioastronomy, Bonn, Germany Chairman
Prof. J. Gomez-Gonzalez	National Geographical Institute, Madrid, Spain Vice-Chairman
Dr. P. Charlot	Laboratoire d'Astrophysique de Bordeaux, France
Dr. L. Feretti	Institute for Radioastronomy, Bologna, Italy
Prof. Dr. M.A. Garrett	ASTRON, Dwingeloo, the Netherlands
Prof S.T. Garrington	MERLIN/VLBI National Facility, Jodrell Bank Observatory, UK
Prof. Xiaoyu Hong	Shanghai Astronomical Observatory, China
Prof. H. Olofsson	Onsala Space Observatory, Onsala Sweden

9.2 JIVE Financial Report for 2007/2008*

Balance

(amounts x €1000)

ASSETS	**2007**	**2008**
Fixed Assets		
Computer Equipment	54	43
Furniture	37	29
	91	**72**
Current Assets		
Work in Process	250	0
Receivables:		
Debtors	87	81
EU	1,054	643
Other	37	36
Cash at Bank	1,528	2,847
TOTAL	**3,047**	**3,679**

LIABILITIES		**2007**	**2008**
Capital			
General Reserve		2,183	2,123
Other Liabilities			
EXPReS		410	429
ESKAC			100
ASTRON			224
Creditors		243	443
Other		9	9
Received in advance:			
	SKADS	40	55
	ESTRELA	73	40
	Huygens	20	9
	SCARIe	65	71
	KNAW	4	
TOTAL		**3,047**	**3,679**

**provisional, subject to audit*

JIVE Financial Report for 2007/2008 (cont.)

Revenues			
Contributions		**2007**	**2008**
INAF	IT	240	240
MPI	DE	90	90
STFC	UK	240	240
IGN	ES	140	140
OSO	SE	140	140
NAOC	CH	30	40
CNRS-INSU	FR	0	40
NWO	NL	454	450
ASTRON	NL	400	520
		1,734	**1,900**
Projects			
FP6 RadioNet	EU	675	442
ANGLES	EU		259
ALBUS	EU	92	74
EXPReS	EU	688	573
SKADS	EU	68	65
ESTRELA	EU	95	166
Huygens	ESTEC	24	12
NL-China coop.	KNAW	31	34
KNAW-Phd project	KNAW		6
SCARIe	NWO	55	47
Other			
Education	NWO	35	22
Leave debts write back			89
		1,763	**1,789**
Interest			
Interest		61	47
		61	**47**
	TOTAL	**3,558**	**3,736**

Expenditures		
Institute	**2007**	**2008**
Salaries	1,153	1,139
Depreciation	99	40
Other	357	496
ASTRON - Overhead	400	520
	2,009	**2,195**
Projects		
FP6 RadioNet	296	254
ANGLES		229
ALBUS	78	62
EXPReS	586	483
SKADS	58	54
ESTRELA	87	152
Upgrade Projects	22	3
SCARIe	55	47
Huygens	24	12
KNAW-PhD project	0	6
Coop NL-China	39	34
	1,245	**1,336**
TOTAL	**3,254**	**3,531**
Result	**304**	**205**

9.3 JIVE personnel

2007/2008

Prof. Dr. M.A. Garrett*	Director (until 1 Feb 2007)
Dr. H.J. van Langevelde*	Head of Software Development (until 1 Feb 2007)
	Director ad interim (since 1 Feb 2007 until 1 Sept 2007)
	Director (since 1 Sept 2007)
Mrs. N. Amiri	PhD Student (since 15 Sept 2007)
Dr. J.M. Anderson	Postdoctoral Research Assistant (until 1 Dec 2007)
Dr. I.M. Avruch	Data Analysis Scientist (until 1 Apr 2007)
Ms. A. Berciano Alba	Early Stage Researcher (until 1 Sept 2007)
Dr. H. Bignall	Support Scientist (until 15 Feb 2008)
Dr. S. Bourke	Postdoctoral Research Assistant (since 10 Dec 2007)
Mr. E.P. Boven	Network/Linux Specialist
Mr. J. Buiter	Tape Recorder Engineer (until 1 Mar 2008)
Dr. R.M. Campbell*	Head of Science Support and Operations
Mr L. Chen	PhD student (since 1 Jan 2008)
Dr. G. Cimo	Support Scientist
Ms. H.D. van Dijk	Secretary (until 1 Sept 2007)
Drs. B. Eldering	Software Engineer
Dr. L.I. Gurvits*	Head of Space Science and Innovative Applications Group
Mr. B. Harms	Operator (since 1 Sept 2008)
Dr. L. Harvey-Smith	Support Scientist (until 15 Feb 2008)
Dr. Ing. A. Keimpema	Scientific Programmer (since 1 Sept 2008)
Mrs. Y. Kool-Boeser	Senior Secretary (since 14 Jan 2008)
Dr. Ir. M.M. Kettenis	Software Engineer
Mr. B. Kramer	Software Technician
Dr. N.G.H. Kruithof	Postdoctoral Research Fellow (until 1 Jul 2008)
Mr. M. Leeuwinga	Operator (until 1 Mar 2008)
	Hardware Support Engineer (since 1 Mar 2008)
Mrs. S.K. Mellema	Secretary
Dr. S. Mühle	Support Scientist (since 1 Sept 2007)
Ir. R.H.J. Oerlemans	Software Engineer (until 1 Jul 2007)
Dr. F. Olnon	Online Software Engineer
Dr. H. Özdemir	Scientific Programmer (since 20 aug 2007 until 1 Apr 2008)
Dr. Z. Paragi	Support Scientist (until 1 Mar 2008)
	Senior Support Scientist (since 1 Mar 2008)
Dr. Y. Pidopryhora	Software Engineer
Dr. S.V. Pogrebenko	Senior System Scientist
Dr. A. Polatidis	Support Scientist (since 1 Jan 2008)
Drs. A. van den Poll	Office Manager (since 1 Jul 2007 until 1 Jan 2008)
	Project Assistant (since 1 Jan 2008)
Mr. H. Rampadarath	PhD Student (since 1 Sept 2007)
Dr. C. Reynolds*	Senior Support Scientist (until 1 Mar 2008)

Mr. N. Schonewille	Chief Operator (until 1 Mar 2008)
Dr. M.S. Sipior	Software Scientist (since 21 Feb 2007)
Dr. D.M. Small	Scientific Software Engineer (since 12 Jun 2006)
Dr. R. Soria Ruiz	Support Scientist (until 21 Dec 2007)
Dr. G.A.S. Sundaram	Postdoc (since 12 Oct 2006)
Dr. A. Szomoru*	Head Technical Operations and R&D
Mr. H. Tenkink	Operator (until 1 Mar 2008)
	Chief Operator (since 1 Mar 2008)
Mr. K.J.E. Torstensson	PhD Student
Drs. H. Verkouter	Offline Software Engineer
Dr. O. Wucknitz	Postdoc (until 1 Aug 2007)
Dr. J. Yang	Support Scientist (since 1 Nov 2008)
Mr. T.C. Yun	Program Manager
Mrs. K.S. Yun	PR/Outreach

* member of JIVE Management Team

9.4 Visitors to JIVE

2007

M. Argo	Jodrell Bank Observatory, UK
R. Beswick	Jodrell Bank Observatory, UK
S. Bottinelli	Sterrewacht Leiden
S. Bourke	U. Galway, Ireland
P. Charlot	Observatoire de Bordeaux, France
Chi, S.	U. Groningen
R. Dodson	OAN, Spain
N. Douglas	U. Groningen
R. Dutta-Roy	U. Bonn, Germany
S. Fabrika	Special Astrophysical Observatory, Russia
S. Fischer	U. Cologne, Germany
S. Frey	SGO, FOMI, Hungary
D. Gabuzda	U. College Cork, Ireland
Ge J.	CSTNET, China
T. Hill	Sterrewacht Leiden
Jian N.	Shanghai Astronomical Observatory, China
F. Levrier	ENS Radioastronomy Laboratory, France
K. Knudsen	U. Manchester, UK
D. Marchal	U. Amsterdam
J. Moldon	U. Barcelona, Spain
A. Noble	U. Wisconsin, US
M. Okon	PSNC, Poland
M. Pandey	CEA, Saclay, France
R. Parra	Onsala Space Observatory, Sweden
C. Phillips	ATNF, Australia
Ren Y.	CSTNET, China
A. Rushton	Jodrell Bank Observatory, UK
I. Schmeld	VIRAC, Latvia
G. Surcis	U. Cagliari, Italy
D. Stoklosa	PSNC, Poland
W. Vlemmings	U. Bonn, Germany
Wei Z.	Shanghai Astronomical Observatory, China
Yang J.	Shanghai Astronomical Observatory, China
Yong, C.	Urumqi Astronomical Observatory, China
Yusup A.	Urumqi Astronomical Observatory, China
Zhang X.	CSTNET, China
J. Zuther	U. Cologne, Germany

2008

M. Argo	Jodrell Bank Observatory, UK
A. Bartkiewicz	Torun Center for Astronomy, Poland
Chen L.	Beijing Astronomical Observatory, China
R. Dodson	OAN, Spain

D. Duev	Sternberg Astronomical Institute, Russia
S. Frey	SGO, FOMI, Hungary
S. Goedhart	Hartebeesthoek Radio Astronomy Observatory, South Africa
Hong X.	Shanghai Astronomical Observatory, China
D. Lal	MPIfR, Bonn, Germany
A. Lobanov	MPIfR, Bonn, Germany
D. Lommen	Sterrewacht Leiden
A. Marecki	Torun Center for Astronomy, Poland
R. Overzier	MPA, Garching, Germany
C. Romero	IAA, Granada, Spain
I. Shmeld	VIRAC, Latvia
R. Soria-Ruiz	OAN, Spain
A. Trejo	UNAM, Mexico
V. Tudose	U. Amsterdam
M. de Villiers	Karoo Array Telescope, South Africa
C. Walker	NRAO, Socorro, US
Yang J.	Shanghai Astronomical Observatory, China

9.5 Presentations

Nikta Amiri

- *"Circumstellar Masers of AGB stars"*, ESTRELA Workshop, Manchester, UK; 8-11 October 2007

James Anderson

- *"Ionospheric Calibration Using GPS/GLONASS/Galileo Data"*, LOFAR CS1 meeting, Dwingeloo, the Netherlands, 15 March 2007
- *"Imagerie & Interferometrie #2"*, Goutelas Low-Frequency Radioastronomy School, Marcoux, France, 5 June 2007
- *"Progress in GPS Ionospheric Calibration for LOFAR"*, Leiden Ionosphere Meeting, Leiden, the Netherlands, 22 June 2007

Max Avruch

- *"Huygens VLBI Campaign from Start to …"*, ESTEC, Noordwijk, the Netherlands, 8 February 2007

Hayley Bignall

- "Interstellar scintillation of extragalactic radio sources: New results from MASIV", talk in Leiden, the Netherlands, 16 May 2007
- "Interstellar scintillation of extragalactic radio sources: New results from MASIV", colloquium at SRON Utrecht, the Netherlands, 23 May 2007
- *"The flickering megamasers of NGC 3079"*, 'Bursts, Pulses and Flickering: Wide-field monitoring of the dynamic radio sky', Kerastari, Greece, 13 June 2007
- *"The scintillating megamasers of NGC 3079"*, AstroFest, Overcinge, Havelte, 3 July 2007
- *"The nature of gamma ray blazar candidate PMN J1326-5256"* (poster), 'From planets to dark energy: the modern radio universe', Manchester, UK, 1-5 October 2007
- *"Intraday Variability and Micro-Arcsecond Resolution"*, invited talk at 'Approaching Micro-Arcsecond Resolution with VSOP-2: Astrophysics and Technology', Sagamihara, Kanagawa, Japan, 5 December 2007

Stephen Bourke

- *"Recent Results on Ultracool Stars"*, Astrofest, Havelte, the Netherlands, 25 June 2008
- *"AIPSLite"*, Imaging and Calibration Algorithms for EVLA, e-Merlin and ALMA, Oxford, UK, 1-3 December 2008

Paul Boven

- *"e-VLBI Networking Challenges"*, e-VLBI Workshop, Bonn, Germany, 17-18 September 2007
- *"e-VLBI Networking Challenges"*, NORDUnet 2008 conference, Helsinki, Finland, 9 - 11 April 2008
- *"e-VLBI with TCP and UDP"*, EVN-NREN meeting, Bonn, Germany, 19 September 2007
- *"FPGAs in Radio Astronomy"*, Dwingeloo, the Netherlands, 2 November 2008
- *"e-VLBI beyond the 1Gb/s speedbump"*, e-VLBI workshop, Shanghai, China, 16-17 June 2008

- *"International Lightpath Experiences"*, 1st Terena E2E Workshop, Amsterdam, the Netherlands, 1-2 December 2008

Bob Campbell

- "Algorithms & Operations at the EVN Mark 5 Data Processor at JIVE", ESTRELA workshop, Dwingeloo, the Netherlands, 15 January 2007
- *"Recent Results from the EVN Mark 5 Data Processor at JIVE"*, 18th Working Meeting on European VLBI for Geodesy and Astrometry, Vienna, Austria, 12 April 2007
- *"Steps towards ICRF-2"*, ASTROfest, Havelte, the Netherlands, 3 July 2007
- *"Advanced Radio Astronomy in Europe"*, JENAM 2007 SPS1 European Large Facilities for Astronomy, Yerevan, Armenia, 22 August 2007
- "The EVN Mark 5 Data Processor at JIVE and e-VLBI Developments in the EVN", 5th IVS General Meeting, St. Petersburg, Russia, 3 March 2008
- "Recent Results from the EVN Mark 5 Data Processor at JIVE", 9th EVN Symposium, Bologna, Italy, 25 September 2008

Giuseppe Cimò

- "Intraday variability of Active Galactic Nuclei: present (the COSMIC project) and future (LOFAR & SKA) research", NAC meeting. Veldhoven, the Netherlands, 14-16 May 2007
- *"Monitoring the Interstellar Scintillation in the Southern Blazar PMN J1326-5256"*, Bursts, Pulses and Flickering: Wide-field monitoring of the dynamic radio sky, Kerastari, Greece, 12-15 June 2007
- "Long- and short-term variability of the southern blazar 1144-379", Astrofest, Havelte, the Netherlands, 3 July 2007
- "Interstellar Scintillation of Active Galactic Nuclei", YERAC, Bordeaux, France, 4-7 September 2007
- "Annual modulation of the variability time scales on the BL LAC J1326-5256", Bonn-Dwingeloo meeting, Dwingeloo, the Netherlands, 30 October 2007
- *"EVN calibration issues"*, TOG meeting, Yebes, Spain, 12 November 2007
- *"Changes in variability time scales for the southern scintillator PMN J1326-5256"*, Approaching Micro-Arcsecond Resolution with VSOP-2: Astrophysics and Technology, Sagamihara, Kanagawa, Japan, 3-7 December 2007
- *"Variability time scale changes in scintillating radio cores"*, The Universe under the Microscope - Astronomy at High Angular Resolution, Physikzentrum Bad Honnef, Germany, 20-25 April 2008
- *"Rapid Extreme Scattering Events"*, Astrofest 2008, Overcinge, the Netherlands, 25 June 2008
- *"EVN calibration issues"*, TOG meeting, Bologna, Italy, 11 September 2008
- *"Two-dimensional time delay measurement of a fast scintillator using VLBI array"*, The 9th European VLBI Network Symposium on "The role of VLBI in the Golden Age for Radio Astronomy" and EVN Users Meeting, Bologna, Italy, 23-26 September 2008
- *"The EVN calibration"*, The 9th European VLBI Network Symposium on "The role of VLBI in the Golden Age for Radio Astronomy" and EVN Users Meeting, Bologna, Italy, 23-26 September 2008
- *"Two-dimensional time delay measurement of a fast scintillator using VLBI array"*, The Radio Universe at Ultimate Angular Resolution, Moscow, Russia, 20-24 October 2008

Bob Eldering

- *"Update on JCCS"*, EXPReS Progress Meeting, Utrecht, the Netherlands, 29 January 2008

Leonid Gurvits

- *"Cosmological rods of the extragalactic radio sky"*, Astronet SVEA Symposium, Poitiers, France, 24 January 2007
- "Astronet Symposium: A Science Vision for European Astronomy in the Next 20 Years", Astrolunch, Dwingeloo, the Netherlands, 31 January 2007
- "Huygens VLBI tracking experiment (final ESA contract presentation)", ESTEC, Noordwijk, the Netherlands, 8 February 2007
- "The case for enhanced radio astronomy – VLBI experiments with Saturn probes", Saturn-Titam workshop, Meudon, France, 12 February 2007
- "The case for radio astronomy – VLBI experiments with the next generation Titan and Enceladus probes", Saturn-Titam workshop, Meudon, France, 13 February 2007
- *"Astro-G/VSOP-2 in Europe: status report"*, VSOP-2 Meeting, Madrid, Spain, 19 February 2007
- *"VSOP-2/Astro-G: a European perspective"*, CDTI presentation, Madrid, Spain, 21 February 2007
- *"VLBI and the Pioneer Anomaly"*, ISSI Workshop, Bern, Switzerland, 23 February 2007
- *"Advanced Radio Astronomy in Europe"*, ILIAS Board meeting, Chambery, France, 26 February 2007
- *"Advanced Radio Astronomy in Europe"*, EuroPlaNet Board meeting, ESTEC, Noordwijk, 27 February 2007
- *"EuroPlaNet and Radio Astronomy: considerations for FP7"*, EuroPlaNet FP7 planning meeting, ESTEC, Noordwijk, the Netherlands, 27 February 2007
- *"Radio astronomy and space exploration"*, Technical University Delft, the Netherlands, 28 February 2007
- "Considerations for a radio astronomy segment for a Europa-Jupiter mission", ESA HQ, Paris, France, 1 March 2007
- *Radio astronomy course (13 lectures)*, Ventspils University College, Latvia, 26 – 31 March 2007
- *"Radio astronomy and exploration of space"* (public lecture), Ventspils, Latvia, 30 March 2007
- "Planetary science missions as radio astronomy targets: science and technology", Technical University Delft, 4 April 2007
- *"RadioNet networking activities"*, RadioNet Board meeting, Grnoble, France, 11 April 2007
- *"RadioNet Project Scientist report"*, RadioNet Board meeting, Grenoble, France, 11 April 2007
- *"RadioNet networking activities"*, RadioNet mid-term review, Grenoble, France, 12 April 2007
- *"RadioNet Project Scientist report"*, RadioNet mid-term review, Grenoble, France, 12 April 2007
- *"A European perspective on VSOP/HALCA lessons"*, VSOP Lessons Learned meeting, Hakone, Japan, 16 April 2007

- *"Summary of VSOP lessons"*, VSOP Lessons Learned meeting, Hakone, Japan, 17 April 2007
- *"VSOP-2 activities in Europe"*, ISAS colloquium, Sagamihara, Japan, 20 April 2007
- "Planetary Radio Interferometry and Doppler Experiment for TandEM (PRIDE-T)", TandEM workshop, Meudon, France, 14 May 2007
- "Planetary Radio Interferometry and Doppler Experiment (PRIDE-S) and DtE for Kronos", Meudon, France, 15 May 2007
- *"VSOP-2 project status and European outlook"*, EVN CBD meeting, Espoo, Finland, 28 May 2007
- *"VLBI segment of the EVE mission"*, EVE workshop, CNES, Paris, France, 14 June 2007
- *"Advanced VLBI applications in FP7 RadioNet"*, FP7 RadioNet planning meeting, Bonn, Germany, 26 June 2007
- "Fine-time analysis of the Huygens VLBI tracking data", ESTEC, Noordwijk, the Netherlands, 11 July 2007
- "Lunar missions as objects and subjects of radio astronomy", EPSC-2, Potsdam, Germany, 21 August 2007
- *"Very Long Baseline Interferometry (VLBI) for Planetary Science Missions"*, European Planetary Science Congress 2007, Potsdam, Germany, 22 Aug 2007
- *"Space horizons of radio astronomy"*, 7th Conference on Space Research Evpatoria, Ukraine, 04 September 2007
- *"Space horizons of radio astronomy and the world's largest radio telescope"*, Frontiers of Astronomy with the World's Largest Radio Telescope, Washington DC, USA, 12 September 2007
- "Space horizons of radio astronomy in the SKA era: pushing the limits of observational radio astronomy", Modern Radio Astronomy, Manchester, UK, 3 October 2007
- *"The first sentinel of the Huygens mission"*, 10th anniversary of the Cassini-Huygens launch workshop, ESTEC, Noordwijk, the Netherlands, 15 October 2007
- "Space horizons of radio interferometry: the Huygens mission and beyond", Radboud University, Nijmegen, the Netherlands, 16 October 2007
- "Space horizons of radio interferometry: the Huygens mission and beyond", Urumqi Astronomical Observatory, China, 22 October 2007
- "Space horizons of radio interferometry: the Huygens mission and beyond", Beijing Astronomical Observatory, China, 25 October 2007
- *"News from the EVN's Space frontier"*, EVN CBD meeting, Madrid, Spain, 13 November 2007
- *"SPIRIT proposal"*, RadioNet FP7 planning meeting, Madrid, Spain, 14 November 2007
- *"RadioNet Project Scientist report"*, RadioNet Board meeting, Madrid, Spain, 14 November 2007
- "Reflections on the length of baselines in physical and other dimensions", VSOP-2 Symposium, Sagamihara, Japan, 5 December 2007
- "Toward understanding the nature of relativistic objects with a Space VLBI magnifier: the next step", NOVA Network 3 plenary meeting, Nijmegen, the Netherlands, 21 December 2007
- *"SKADS DS2-T2 report"*, SKADS DS2-T1 progress meeting, Lisbon, Portugal, 7 January 2008
- *"Status of VSOP-2 activities in Europe"*, Dwingeloo, the Netherlands, 1 February 2008

- *"Huygens descent trajectory and other VLBI results"*, Huygens DAW, NASA GSFC, Greenbelt, MD, USA, 7 February 2008
- "Radio astronomy experiments with the Huygens mission", SAI Moscow State University, Russia, 7 March 2008
- *"Look, see and measure"* (lecture for astronomy students), SAI Moscow State University, 7 March 2008
- "Planetary Radio Interferometry and Doppler Experiment (PRIDE) for Titan Saturn System Mission", TSSM meeting, Meudon, France, 17 March 2008
- "Decaparsec scale morphology of the most distant known radio quasar at z=6.12", Radio surveys conference, Perth, Australia, 3 April 2008
- *"SKA simulations status"*, SKA meeting, Perth, Australia, 8 April 2008
- *Radio astronomy course (10 lectures)*, Ventspils University College, Latvia, 14 – 19 April 2008
- "Radio Astronomy of the XXI Century: SKA and its pathfinders", Ventspils, Latvia, 17 April 2008
- "Planetary Radio Interferometry and Doppler Experiment (PRIDE) for Jupiter-Europa mission", Europa–Jupiter Science Workshop, Frascati, Italy, 21 April 2008
- "Direct-to-Earth data relay options for the Europa-Jupiter System Mission", Europa–Jupiter Science Workshop, Frascati, Italy, 22 April 2008
- *"Activities at potential new EVN stations"*, EVN CBD meeting, Bordeaux, France, 24 April 2008
- *"SKA(DS) Simulations"*, SKADS Design and Costing Meeting, Dwingeloo, 9 May 2008
- *"VSOP-2/Astro-G over JIVE"*, VSOP-2 meeting, Bonn, Germany, 14 May 2008
- *"VSOP-2/Astro-G in European perspective"*, VISC-2 meeting, Bonn, Germany, 15 May 2008
- *"Space horizons of radio astronomy"*, ESTEC presentation, Dwingeloo, the Netherlands, 13 June 2008
- *"Planetary and space science as a subject of radio astronomy"*, ASTRONET Infrastructure Roadmap Symposium 2008, Liverpool, UK, 17 June 2008
- *"Close (VLBI) look at the EoR border guard"*, Astrofest, Havelte, the Netherlands, 25 June 2008
- "Results of the Huygens VLBI tracking experiment and outlook for VLBI support for future planetary missions", Titan after Cassini-Huygens workshop, Corpus Christi, TX, USA, 8 July 2008
- *"PRIDE generic configuration"*, EuroPlaNet FP7 planning meeting, Corpus Christi, TX, USA, 8 July 2008
- "Moon-based Very Long-Wavelength Astronomy Facility: science drives and technological challenges", 37th COSPAR Scientific Assembly, Montreal, Canada, 15 July 2008
- "Results of the Huygens VLBI experiment and outlook for VLBI support for future missions to outer planets", 37th COSPAR SA, Montreal, Canada, 18 July 2008
- "Radio astronomy in Space and from the Moon – introduction", URSI GA, Chicago, IL, USA, 15 August 2008
- *"Radio astronomy and exploration of Space"* (presentation for press), Dwingeloo, the Netherlands, 1 October 2008
- "Toward redshift-dependent properties of sub-milliarcsecond structures in extragalactic radio sources", Radio Universe at Ultimate Angualr Resolution conference, Moscow, Russia, 20 October 2008

- "V.I. Slysh – in memoriam", Moscow, 21 October 2008
- "Toward Moon-based Very Long-Wavelength Astronomy Facility: science drives and technological challenges", LEAG-ILEWG-SRR meeting, Cape Canaveral, FL, USA, 30 October 2008
- *"Space horizons of radio interferometry"*, Arecibo Observatory, SArecibo, Puerto Rico, 3 November 2008
- *"Status of potential new EVN stations"*, EVN CBD meeting, Arecibo, Puerto Rico, 4 November 2008
- *"Space frontier of EVN"*, EVN CBD meeting, Arecibo, Puerto Rico, 4 November 2008
- "Radio astronomy in space: scientific outlook and technological challenges", University of Puerto Rico, Sah Juan, Puerto Rico, 7 November 2008
- *"From JIVE to Space and back"*, JIVE retraite, Dwingeloo, 17 December 2008

Lisa Harvey-Smith

- *"Masers in star-forming regions"*, ESTRELA Workshop Talk, Dwingeloo, the Netherlands, 16 January 2007
- *"Polarization of 6.0-GHz OH masers in W3(OH)"*, Poster at IAU Symposium 242 Astronomical Masers, 12-16 March 2007, Alice Springs, Australia.
- "Discovery of polarized 6.7-GHz methanol masers in DR21/W75", Poster, Alice Springs, Australia.
- *"A possible circumstellar disc in DR21"*, Astrofest, Havelte, the Netherlands, 3 July 2007.
- *"Astronomical masers and their applications",* ASTRON/JIVE Summer Student Lecture Series, Dwingeloo, the Netherlands, 31 July 2007.

Mark Kettenis

- *"ParselTongue"*, ESTRELA workshop, Dwingeloo, the Netherlands, 16 January 2007
- *"EXPReS & FABRIC at JIVE"*, SCARIe Kick-off meeting, Amsterdam, the Netherlands, 15 May 2007
- *"FABRIC WP2: Distributed Correlation"*, EXPReS Board meeting, Utrecht, the Netherlands, 30 January 2008
- "SCARIe FABRIC: Building a distributed software correlator for e-VLBI", 7th International e-VLBI workshop, Shanghai, China, 16 June 2008
- *"SCARIe FABRIC: Building a distributed software correlator for e-VLBI"*, FABRIC Distributed Correlation meeting, Poznan, Poland, 1 September 2008
- *"VDIF"*, 2nd DiFX software correlator meeting, Bonn, Germany, 9 September 2008
- *"Software Correlation for VLBI"*, I-science workshop on data mining, distributed computing and visualization for astronomy, Leiden, the Netherlands, 14 October 2008
- *"Software Correlation for VLBI"*, IBM, Zürich, Switzerland, 29 Oktober 2008
- *"ParselTongue"*, Imaging and Calibration Algorithms for EVLA, e-MERLIN and ALMA, Oxford, UK, 3 December 2008

Huib van Langevelde

- *"Introduction to MASERs"*, ESTRELA workshop, Dwingeloo, the Netherlands, 15 January 2007
- *"e-VLBI a real-time telescope spanning Europe"*, Leidsche fles, Leiden, the Netherlands, 7 February 2007

- *"ALBUS management report"*, RadioNet board meeting, Grenoble, France, 11 April 2007
- *"ALBUS midterm report"*, RadioNet Mid term review, Grenoble, France, 12 April 2007
- *"EXPReS annual review"*, EXPReS midterm review, Brussels, Belgium, 17 April 2007
- *"FABRIC reports"*, EXPReS midterm review, Brussels, Belgium, 17 April 2007
- *"ALBiUS"*, ALBUS workshop, Bonn, Germany, 8 May 2007
- *"JIVE report"*, EVN CBD meeting, Espoo, Finland, 28 May 2007
- *"FABRIC WP2 first year progress report"*, EXPReS board, Espoo, Finland, 29 May 2007
- "EXPReS 2nd Board meeting, Welcome & Introduction, financial overview", EXPReS board, Espoo, Finland, 29 May 2007
- "EXPReS 2nd Board meeting, NA1 management & NA4 outreach", EXPReS board, Espoo, Finland, 29 May 2007
- *"JIVE Report"*, JIVE Board, Den Haag, the Netherlands, 11 June 2007
- *"Improved distances to OH bearing Mira variables"*, Dwingeloo science fest, Havelte, the Netherlands, 3 July 2007
- "JIVE: progress with e-VLBI and science highlights", Colloquium,Shanghai, China, 24 August 2007
- "e-VLBI a real-time telescope of intercontinental dimensions", APAN, Xi'An, China, 25 August 2007
- *"ALMA"*, ERIS, Bonn, Germany, 12 September 2007
- *"Een telescoop zo groot als Europa"*, Open dag 2007, Westerbork, the Netherlands, 21 October 2007
- *"JIVE report"*, JIVE Board, Madrid, Spain, 12 November 2007
- *"JIVE report"*, EVN consortium board, Madrid, Spain, 13 November 2007
- *"Coordinators report"*, EXPReS board, Utrecht, the Netherlands, 30 January 2008
- *"Improving the parallaxes of OH bearing Miras"*, Poster IAU, Alice Springs, Australia, 1 March 2008
- *"Radio-Astronomy, a telescope larger than Europe"*, GEANT a global leader, Bled, Slovenia, 4 March 2008
- *"eMERLIN, e-VLBI and the distances to evolved stars"*, eMERLIN evolved stars key project workshop, Manchester, UK, 9 April 2008
- *"e-VLBI developments and EXPReS"*, EVN CBD, Bordeaux, France, 24 April 2008
- *"EVN2015 process"*, EVN CBD, Bordeaux, France, 24 April 2008
- *"Management report"*, JIVE board, Bordeaux, France, 25 April 2008
- "e-VLBI: a real-time telescope larger than Europe", NAC 08, Dalfsen, the Netherlands, 9 May 2008
- *"JIVE, een telescoop zo groot als Europa"*, visit Probus club Emmen, Dwingeloo, the Netherlands, 16-May 2008
- *"e-VLBI a telescope larger than Europe"*, TERENA 08, Brugge, Belgium, 22-May 2008
- "e-VLBI a telescope larger than Europe, visit Norwegian ambassador", Dwingeloo, the Netherlands, 28 May 2008
- *"EXPReS progress and science"*, 2nd EXPReS review, Brussel, Belgium, 30 May 2008
- *"WSRT and the EVN"*, WSRT user meeting, Amersfoort, the Netherlands, 4 June 2008
- *"Recent results on Methanol maser disks"*, Astrofest, Havelte, the Netherlands, 25 June 2008
- *"Een telescoop zo groot als Europa"*, public lecture, Middelburg, the Netherlands, 27 June 2008

- "e-VLBI: a real-time telescope of international dimensions", URSI GA, Chicago, USA, 13 August 2008
- *"EXPReS: e-VLBI real time long baseline Interferometry"*, I3Net gathering, Schiphol, the Netherlands, 1 September 2008
- *"Thoughts on the roadmap for VLBI in Europe"*, Meeting on Astronet exercise, Rome, Italy, 3 September 2008
- *"ALBUS and ALBiUS"*, RadioNet board meeting, Rome, Italy, 4 September 2008
- *"The future of the European VLBI Network"*, EVN symposium, Bologna, Italy, 25 September 2008
- *"VLBI, e-VLBI, Science"*, visit journalists VWN, Dwingeloo, the Netherlands, 1 October 2008
- *"VLBI, e-VLBI, Science"*, tour school directors, Dwingeloo, the Netherlands, 7 October 2008
- *"Management report"*, JIVE board, Dwingeloo, the Netherlands, 9 October 2008
- *"e-VLBI a real-time telescope larger than Europe"*, I-Science workshop, Leiden, the Netherlands, 14 October 2008
- *"JIVE, een telescoop zo groot als Europa"*, open dag, Dwingeloo, the Netherlands, 19 October 2008
- *"e-VLBI; an e-Infrastructure success story"*, e-IRG workshop, Paris, France, 21 October 2008
- *"JIVE; developments & plans"*, JIVE visit to IBM, Zurich, Switzerland, 30 October 2008
- *"EVN present and future"*, EVN mini symp, Arecibo, Porto Rico, 3 November 2008
- *"Reports to the board"*, EVN CBD, Arecibo, Porto Rico, 4 November 2008
- *"Words at the Effelsberg e-VLBI dedication"*, Eff e-VLBI dedication, Effelsberg, Germany, 19 November 2008
- *"JIVE: e-VLBI as a SKA pathfinder"*, the Netherlands SKA meeting, Dwingeloo, the Netherlands, 26 November 2008
- *"ALBiUS"*, ALMA/EVLA/eMERLIN software workshop, Oxford, UK, 3 December 2008
- *"Retraite"*, JIVE retraite, Dwingeloo, the Netherlands, 17 December 2008

Stefanie Mühle

- "Starbursts: The Heat is On? --- Formaldehyde as a Tracer of the Molecular Gas in External Galaxies", ASTRON/JIVE colloquium, Dwingeloo, the Netherlands, 25 October 2007
- "FIR Workshop 2007 --- Far-Infrared and Submillimeter Emission of the Interstellar Medium: Models meet extragalactic and Galactic Observations", conference report, Astrolunch, Dwingeloo, the Netherlands, 5 December 2007
- "The Heat is On in Starburst Galaxies? - Tracing the properties of the molecular gas in M82 with Formaldehyde Lines", NAC, Dalfsen, the Netherlands, 7-9 May 2008
- *"The Case of M82: Molecular Gas in a Fever?"*, Astrofest 2008, Overcinge, the Netherlands, 25 June 2008
- *"Properties of the molecular gas in starburst galaxies and AGN"*, The 9th European VLBI Network Symposium on "The role of VLBI in the Golden Age for Radio Astronomy", Bologna, Italy, 23-26 September 2008
- "The Molecular Gas in the Nearby Seyfert 2 Galaxy NGC 1068", Astrolunch, Dwingeloo, the Netherlands, 22 October 2008
- *"Molecules are cool ... aren't they?"*, invited lecture, Kapteyn Institute, Groningen, the Netherlands, 21 November 2008

Zsolt Paragi

- *"Everything you wanted to know about (e-)VLBI"*, ESTRELA Workshop, Dwingeloo, the Netherlands, 15 January 2007
- *"Present and future e-VLBI - EVN2015 Science"*, EVN2015 Vision Brainstorm Meeting, Dwingeloo, the Netherlands, 1-2 March 2007
- *"Targeting transient phenomena with e-VLBI"*, 070228: The Next Decade of GRB Afterglows, Amsterdam, the Netherlands, 19-23 March, 2007
- *"A new era in VLBI astronomy: e-VLBI"*, VLBI in the GLAST Era, NASA - Goddard Space Fligh Center, USA, 23-24 April 2007
- *"Targeting transient sources with e-VLBI"*, Astrophysics in the LOFAR era, Emmen, the Netherlands, 23-27 April 2007
- *"Targeting transient phenomena with e-VLBI"*, Bursts, Pulses and Flickering: Wide-field monitoring of the dynamic radio sky, Kerastari, Greece, 12-15 June 2007
- *"What can we do with e-VLBI?"*, Astrofest, Havelte, the Netherlands, 3 July 2007
- *"e-EVN Science in 2006-2007"*, 6th International e-VLBI Workshop, Bonn, Germany, 17-18 September 2007
- *"Real-Time VLBI observations of compact objects"*, Observational Evidence for Black Holes in the Universe, Kolkata, India, 10-15 February 2008
- *"e-EVN science in 2006-2007"*, EXPReS Progress Meeting, Utrecht, the Netherlands, 29 January 2008
- *"Decaparsec-scale morphology of the most distant (known to date) radio QSO J1427+3312 at z=6.12"*, Frey, S., Gurvits, L.I., Paragi, Z., Gabanyi, K.E. , (poster) Deep Surveys of the Radio Universe with SKA Pathfinders, Perth, Australia, March 31 - April 4, 2008
- *"e-EVN and VSOP-2"*, VSOP-2 Technical Meeting, Bonn, 14-16 May 2008
- "WSRT for EVN amplitude and polarization calibration, and for triggering transients", WSRT users meeting, Amersfoort, the Netherlands, 4 June 2008
- *"e-EVN science in 2006-2008"*, 7th International e-VLBI Workshop, Shanghai, P.R. China, 16-17 June 2008
- *"Type Ib/c supernovae with the EVN"*, 9th European VLBI Network Symposium, Bologna, Italy, 23-26 September 2008
- *"Experience with e-VLBI (from a user's perspective)"*, EVN Users meeting, Bologna, Italy, 25 September 2008

Yurii Pidopryhora

- *"Extra-Planar HI in the Inner Milky Way"*, Astron/JIVE colloquium, Dwingeloo, the Netherlands, 15 February 2007
- *"The Ophiuchus Superbubble: A Gigantic Disk-Halo Transition Phenomenon"*, conference "The Milky Way Halo - Stars and Gas: Locations, Motions, Origins", Argelander-Institut für Astronomie, Bonn, Germany, 29 May - 2 June 2007
- *"The Ophiuchus Superbubble"*, AstroFest, Havelte, The Netherlands, 3 July 2007
- *"FABRIC software correlator status report"*, the 6th International e-VLBI Workshop, Max-Planck-Institut für Radioastronomie, Bonn, Germany, 17 September 2007
- *"The Ophiuchus Superbubble"*, lunch talk, Kapteyn Astronomical Institute, Groningen, The Netherlands, 3 March 2008

- *"Milky Way's HI Halo Clouds: an Overview"*, AstroFest, Havelte, The Netherlands, 25 June 2008
- *"The Ophiuchus Superbubble: Disk-Halo Interaction at Work"*, conference "The Role of Disk-Halo Interaction in Galaxy Evolution: Outflow vs. Infall?", Espinho, Portugal, 18-22 August 2008

Sergei Pogrebenko

- *"Huygens VLBI data processing and results"*, ESTEC, Noordwijk, the Netherlands, 8 February 2007
- "Considerations for Interferometric experiments with the Jupiter-Europa mission", Europa–Jupiter Science Workshop, Frascati, Italy, 21 April 2008
- "Radio tracking of and communication with planetary probes as a space science subject", IPPW-5, Bordeaux, France, 26 June 2007
- "VLBI experimenrts with Moon exploration spacecraft", ILEWG-9, Sorento, Italy, 23 October 2007
- "Case study for the VLBI contribution to Gaia position determination", FP7 RadioNet preparation workshop, Dwingeloo, 19 November 2007
- *"Planetary Radio Interferometer and Doppler Experiments with Europa- Jupiter mission"*, Europa-Jupiter International Science Workshop, ESRIN, Frascati, Italy, 22-23 April 2008
- *"Evaluation of new multi-bit sampling system"*, 7th International e-VLBI Workshop, SAO, Shanghai, China, 16-18 June 2008
- *"Software spectrometer developments at Metsähovi Radio Observatory and JIVE"*, 7th RadioNet FP6 Workshop on Hardware and Software Digital Back Ends for Radio Astronomy, MPIfR, Bonn, Germany, 23-24 June 2008
- *"Search for the 22 GHz water vapour emission from the Kronian system"*, Progress report on the 2006-2008 observational campaign with the Medicina and Metsahovi radio telescopes, ITALSEL-ASI workshop, Medicina, Italy, 16 June 2008

Antonios Polatidis

- *"Expansion velocities and kinematic ages of Compact Symmetric Objects"*, The 4th Workshop on Compact Steep Spectrum and GHz-Peaked Spectrum Radio Sources, Riccione, Italy, 27 May 2008.

Hayden Rampadarath

- "A VLBA Survey at 327 MHz: A catalogue of E-LoFAR calibrators", ESTRELA Workshop, MPIfR Bonn, Germany, 9 April, 2008
- *"An adhoc VLBA 90cm source survey"*, AstroFest, Overcinge, Havelte, the Netherlands, 25 June 2008
- Poster: "Characterising the low frequency sky: a VLBA Archive Survey at 327 MHz, searching for E-LOFAR calibrators", Astrophysics with E-LOFAR, Hamburg, Germany, 16-19 September 2008
- "VLBI studies of Radio Sources at Low-Frequencies: Pathfinders for the LOFAR Long Baseline Array", NOVA Fall School, Dwingeloo, the Netherlands, 10 October 2009

Cormac Reynolds

- *"European VLBI Network"*, European Radio Interferometry School, Bonn, Germany, 11-15 September 2007
- *"Polarization Calibration (ParselTongue Demo)"*, European Radio Interferometry School, Bonn, 11-15 September 2007
- *"ParselTongue Demo"*, RadioNet Midterm Review, Grenoble, France, 12 April 2007
- *"ALBUS Report"*, RadioNet Board Meeting, Madrid, Spain, 14 November 2007

Michael Sipior

- *"Recent changes to ParselTongue"*, ALBUS workshop, Bonn, Germany, 8 May 2007

Des Small

- *"Streamlining eVLBI postprocessing for EXPReS"*, 6th eVLBI Workshop, Bonn, Germany, 17-18 September 2007
- "Towards real-time e-VLBI operation: scheduling, monitoring and calibrating", EXPReS Progress Meeting, Utrecht, the Netherlands, 29 January 2008

Shanmugha Sundaram GA

- Shanmugha Sundaram, G.A. and Reynolds, C. *"MEqTrees Aperture Array Simulations and CPU Benchmarking"*, (poster) Deep Surveys of the Radio Universe with SKA Pathfinders, 31 March - 4 April 2008, Perth, WA, Australia

Arpad Szomoru

- *"EVN and e-VLBI"*, ESLEA Closing Conference, Edinburgh, UK, 26-28 March 2007
- *"SA1: Production e-VLBI service"*, EXPReS Annual Review, Brussels, Belgium, 17 April 2007
- *"e-VLBI Using high-speed networks to enable new astronomy"*, TERENA Networking Conference, Copenhagen, Denmark, 21-24 May 2007
- "SA1: Production e-VLBI service", EXPReS Board meeting, Metsahovi, Finland, 29 May 007
- *"SA1: Technical Progress"*, eVSAG face-to-face meeting, Gothenburg, Sweden, 28 June 2007
- *"EXPReS SA1: at the half-way mark"*, 6th International e-VLBI workshop, Bonn, Germany, 17 September 2007
- *"Update on EXPReS activities in 2007"*, EVN-NREN meeting, Bonn, Germany, 19 September 2007
- "The UniBoard: A multi-purpose scalable computing platform for Radio Astronomy", RadioNet board meeting, Madrid, Spain, 14 November 2007
- *"EXPReS progress, Mark 5 and e-VLBI"*, TOG meeting, Yebes, Spain, 12 November 2007
- *"SA1: Second Year Overview"*, EXPReS Board Meeting, Utrecht, The Netherlands, 30 January 2008
- *"Radio Astronomy in the era of high-speed networks"*, STOA/TERENA Workshop, Brussels, Belgium, 2 April 2008
- *"SA1: Production e-VLBI service"*, EXPReS Annual Review, Brussels, Belgium, 30 May 2008
- "The UniBoard: A multi-purpose scalable computing platform for Radio Astronomy", 7th RadioNet Engineering Forum Workshop, Bonn, 23 June 2008

- *"EXPReS and the e-EVN"*, 7th International e-VLBI Workshop, Shanghai, China, 16-17 June 2008
- *"EVN/JIVE technical developments"*, TOG meeting, Bologna, Italy, 22 September 2008
- *"EXPReS and the e-EVN"*, 9th International European VLBI Symposium, Bologna, Italy, 23-26 September 2008
- *"EVN 2015: The future of European VLBI"*, 8th RadioNet Engineering Forum Workshop, Yebes, Spain, 24-25 November 2008
- *"e-VLBI: real-time radio astronomy"*, 8th Annual GLIF Workshop, Seattle, USA, 1-2 October 2008
- *"EXPReS and the e-EVN"*, EVN Science Day, Arecibo, Puerto Rico, 3 November 2008
- *"Our next correlator"*, JIVE retraite, Dwingeloo, 17 Dec 2008

Kalle Torstensson

- *"Methanol masers - tracers of massive star formation"*, ESTRELA Workshop, Dwingeloo, the Netherlands, 15-18 January 2007
- Poster: *"Where methanol masers spring"*, IAU Symposium 242, Alice Springs, Australia, 12-16 March 2007
- Poster: *"Where methanol masers spring"*, NAC, Eindhoven, the Netherlands, 14-16 May 2007
- *"Methanol masers - tracing high-mass star-formation"*, Young European Radio Astronomer's Conference (YERAC), Bordeaux, France, 4-7 September 2007
- Poster: *"Where methanol masers spring"*, Massive Star Formation: Observations confront Theory, Heidelberg, Germany, 10-14 September 2007
- *"Methanol masers - tracing high-mass star-formation"*, ESTRELA Workshop, Manchester, UK, 8-11 October 2007
- *"Where methanol masers spring"*, Bonn-Dwingeloo High Resolution Radio Astronomy meeting, Dwingeloo, the Netherlands, 30 October 2007

Harro Verkouter

- *"The road to 980Mbps e-VLBI"*, 7th e-VLBI workshop, Shanghai, 16-17 June 2008.

T. Charles Yun

- "Introduction to EXPReS- Beyond production e-VLBI services," Interwork, Santiago, Chile (over video), 17 January 2007
- *"Introduction to EXPReS"*, PPAM 2007, Gdansk, Poland, 11 September 2007
- "EXPReS- Real-Time VLBI: The Current Status and Next Steps", AOGS 2008, Pusan, Korea, 19 June 2008
- "EXPReS- Real-Time VLBI: The Current Status and Next Steps", KVN invited presentation, Seoul, Korea, 20 June 2008
- *"EXPReS- Operationalizing e-VLBI"*, ICT 2008, Lyon, France, 24 November 2008

9.6 Membership of international Boards and committees

Hayley Bignall
SOC, European Radio Interferometry School 2007

Bob Campbell
EVN Technical and Operations Group
European VLBI Group for Geodesy and Astrometry
EVN Programme Committee
EXPReS e-VLBI science advisory group
IAU Div. I working group on 2nd realization of the ICRF

Giuseppe Cimò
EVN Technical and Operations Group

Leonid Gurvits
RadioNet FP6 Management and Executive Team
EuroPlaNet FP6 and FP7 consortia
VSOP-2 International Science Council
IAU Division XI (Space-borne and high-energy astrophysics) Organising Committee
IAU Working Group on Astronomy from the Moon
BepiColombo Science Working Group
ESA Cosmic Vision TandEM and Laplace study teams
SKA Simulations Working Group (Chair since 2008)
SKA Site Characterisation Working Group (since 2008)
Nederlandse Nationaal Platform voor Planeetonderzoek
Nederlandse Vereniging voor Ruimtevaart

Yvonne Kool
LOC "Nederlandse Astronomen Conferentie 2008"

Huib van Langevelde
EVN board
RadioNet Board and Executive Board
EXPReS, board and management team
ESTRELA board
SKADS board
PrepSKA board
European SKA Consortium
ESO STC
ESO VLTI overview committee
NOVA Instrumentation Steering Committee
ESO Dutch contactcommissie
LOFAR DCLA review committee
Dutch URSI committee
member board of directors Leids Kerkhoven Bosscha Fonds

member board of directors Leids Sterrewacht Fonds
member board of directors Jan Hendrik Oort Fonds
NWO I-science program committee
SKA klankbordgroep the Netherlands
Allegro steering committee

Martin Leeuwinga
EVN Technical and Operations Group

Stefanie Mühle
EVN Technical and Operations Group

Zsolt Paragi
EVN Technical and Operations Group
EXPReS e-VLBI Science Advisory Group

Antonios Polatidis
EVN Technical and Operations Group

Arpad Szomoru
EXPReS, board and management team
EVN Technical and Operations Group
EXPReS, e-VLBI science advisory group

Hans Tenkink
EVN Technical and Operations Group

Harro Verkouter
LOC "Nederlandse Astronomen Conferentie 2008"

Charles Yun
RINGRID Advisory Board
DORII Advisory Board

9.7 Membership of professional associations and societies

Hayley Bignall
Astronomical Society of Australia
Australian Institute of Physics
Nederlandse Astronomen Club

Bob Campbell
Sigma Xi
American Astronomical Society
American Geophysical Union
International Astronomical Union
International Union of Radio Science

Giuseppe Cimò
Nederlandse Astronomen Club

Leonid Gurvits
American Astronomical Society
Nederlandse Astronomen Club
International Astronomical Union
COSPAR Associate
International Union of Radio Science

Lisa Harvey-Smith
Nederlandse Astronomen Club
Fellow of the Royal Astronomical Society

Huib van Langevelde
International Astronomical Union
International Union of Radio Science
Nederlandse Astronomen Club

Stefanie Mühle
Astronomische Gesellschaft, Germany
Nederlandse Astronomenclub, the Netherlands

Friso Olnon
International Astronomical Union
Nederlandse Astronomenclub

Zsolt Paragi
Nederlandse Astronomenclub
Eotvos Lorand Physical Society
Hungarian Astronautical Society

Yurii Pidopryhora
American Astronomical Society
American Physical Society
Euroasian Astronomical Society

Sergei Pogrebenko
International Astronomical Union

Antonios Polatidis
International Astronomical Union
Hellenic Astronomical Society
European Astronomical Society

Arpad Szomoru
Nederlandse Astronomen Club

Harro Verkouter
Nederlandse Astronomen Club

9.8 Meetings attended

9.8.1 Scientific conferences

Nikta Amiri

- ESTRELA Workshop, Manchester, UK, 8-11 October 2007,
- Bonn-Dwingeloo High Resolution Radio Astronomy meeting, Dwingeloo, The Netherlands, 30 October 2007
- ESTRELA workshop, Bonn, Germany, 7-11 April 2008
- Nederlandse Astronomen Conferentie, Dalfsen, the Netherlands, 7-9 May 2008
- EVN symposium, Bologna, Italy, 25-26 September 2008
- IRAM mm-interferometry school, Grenoble, France, 6-9 October 2008
- IAU symposium, Tenerife, Spain, 3-8- November 2008

Hayley Bignall

- Astroparticle Physics Symposium, Dwingeloo, the Netherlands, 8 February 2007
- Astrophysics in the LOFAR era, Emmen, the Netherlands, 27 April 2007
- Bursts, Pulses and Flickering: Wide-field monitoring of the dynamic radio sky, Kerastari, Tripolis, Greece, 11-15 June 2007
- Astrofest, Havelte, the Netherlands, 3 July 2007
- From Planets to Dark Energy: the Modern Radio Universe, Manchester, UK, 1-5 October 2007
- Approaching Micro-Arcsecond Resolution with VSOP-2: Astrophysics and Technology, ISAS/JAXA, Sagamihara, Kanagawa, Japan, 3-7 December 2007

Stephen Bourke

- Astrofest, Havelte, the Netherlands, 25 June 2008
- SKA Continuum Imaging Workshop, Cape Town, South Africa, 18-20 February 2009

Bob Campbell

- ESTRELA Workshop, Dwingeloo, the Netherlands, 15 January 2007
- 18th Working Meeting on European VLBI for Geodesy and Astrometry, Vienna, Austria, 12-13 April 2007
- 8th IVS Analysis Workshop, Vienna, Austria, 14 April 2007
- IVS VLBI2010 face-to-face meeting, Vienna, Austria, 15 April 2007
- Astrofest, Havelte, the Netherlands, 3 July 2007
- JENAM-2007, Yerevan, Armenia, 19-23 August 2007
- 5th IVS General Meeting, St. Petersburg, Russia, 3-5 March 2008
- VLBI mini-symposium, MPE, Garching, Germany, 26 June 2008
- 9th EVN Symposium, Bologna, Italy, 23-26 September 2008

Giuseppe Cimò

- NAC meeting, Veldhoven, the Netherlands, 14-16 May 2007
- Bursts, Pulses and Flickering: Wide-field monitoring of the dynamic radio sky, Kerastari, Greece, 12-15 June 2007
- Astrofest 2007, Havelte, the Netherlands, 3 July 2007
- YERAC, Bordeaux, France, 4-7 September 2007

- Bonn-Dwingeloo meeting, Dwingeloo, the Netherlands, 30 October 2007
- Approaching Micro-Arcsecond Resolution with VSOP-2: Astrophysics and Technology - Sagamihara, Kanagawa, Japan, 3-7 December 2007
- The Universe under the Microscope - Astronomy at High Angular Resolution. Physikzentrum Bad Honnef, Germany, 20-25 April 2008
- Space VLBI Science and the VSOP-2 Mission. MPIfR, Bonn, Germany, 14-16 May 2008
- ASTRON/JIVE Astrofest 2008. Overcinge, the Netherlands, 25 June 2008
- The 9th European VLBI Network Symposium on The role of VLBI in the Golden Age for Radio Astronomy and EVN Users Meeting. Bologna, Italy, 23-26 September 2008
- The Radio Universe at Ultimate Angular Resolution. Moscow, Russia, 20-24 October 2008

Bob Eldering

- EXPReS Progress Meeting, Utrecht, the Netherlands, 29 January 2008

Leonid Gurvits

- Astronet SVEA Symposium, Poitiers, France, 24 January 2007
- Saturn-Titam workshop, Meudon, France, 12-13 February 2007
- ISSI Workshop, Bern, Switzerland, 23 February 2007
- European Planetary Science Congress 2007, Potsdam, Germany, 19-25 Aug 2007
- 7th Conference on Space Research Evpatoria, Ukraine, 1-5 September 2007
- Frontiers of Astronomy with the World's Largest Radio Telescope, Washington DC, USA, 10-13 September 2007
- Modern Radio Astronomy, Manchester, UK, 2-5 October 2007
- VSOP-2 Symposium, Sagamihara, Japan, 2-7 December 2007
- Radio surveys conference, Perth, Australia, 31 March - 5 April 2008
- Astrofest, Havelte, NL, 25 June 2008
- Titan after Cassini-Huygens workshop, Corpus Christi, TX, USA, 7-12 July 2008
- 37th COSPAR Scientific Assembly, Montreal, Canada, 14-20 July 2008
- URSI GA, Chicago, IL, USA, 10-16 August 2008
- Radio Universe at Ultimate Angualr Resolution conference, Moscow, Russia, 20-25 October 2008
- LEAG-ILEWG-SRR meeting, Cape Canaveral, FL, USA, 27 Oct – 1 Nov 2008

Lisa Harvey-Smith

- IAU Symposium 242 on Astronomical Masers; Alice Springs, Australia, 12-16 March 2007.
- Astrofest, Havelte, the Netherlands, 3 July 2007

Yvonne Kool

- EXPReS Progress Meeting, Utrecht, the Netherlands, 29 January 2008
- EXPReS Board Meeting, Utrecht, the Netherlands, 30 January 2008
- EXPReS Annual Review, Brussels, Belgium, 30 May 2008
- NAC Nederlandse Astronomen Conferentie, Dalfsen, the Netherlands, 7-9 May 2008

Mark Kettenis

- Lighting the Blue Touchpaper for UK e-Science - Closing Conference of ESLEA Project, Edinburgh, UK, 26-28 March 2007

- Astronomical Data Analysis Software & Systems XVII, London, UK, 23-26 September 2007
- Bonn-Dwingeloo Meeting on "High Resolution Radio Astronomy", Dwingeloo, the Netherlands, 30 October 2007
- The 9th European VLBI Network Symposium on The role of VLBI in the Golden Age for Radio Astronomy, Bologna, Italy, 23-26 September 2008
- I-science workshop on data mining, distributed computing and visualization for astronomy, Leiden, the Netherlands, 13-17 October 2008
- Astronomical Data Analysis Software & Systems XVIII, Quebec, Canada, 2-5 November 2008
- Imaging and Calibration Algorithms for EVLA, e-MERLIN and ALMA, Oxford, UK, 1-3 December 2008

Huib van Langevelde

- eSMA workshop, Leiden, the Netherlands, 1-2 February 2007
- EVN2015 meeting, Dwingeloo, the Netherlands, 28 February - 2 March 2007
- ISM/CSM meeting, Amsterdam, the Netherlands, 5 April 2007
- LOFAR workshop, Emmen, the Netherlands, 23-26 April 2007
- ALBUS workshop, Bonn, Germany, 8 May 2007
- Astrofest, Havelte, the Netherlands, 3 July 2007
- Asian-Pacific Advanced Network conference, Xi'An, China, 25-30 August 2007
- Star formation conference, Heidelberg, Germany, 10-12 September 2007
- European Radio Ineterferometry School, Bonn, Germany, 12-13 September 2007
- e-VLBI symposium, Bonn, Germany, 17-18 September 2007
- Modern radio Universe, Manchester, UK, 1-5 October 2007
- Bonn exchange day, Dwingeloo, the Netherlands, 30 October 2007
- eMERLIN evolved stars key project workshop, Manchester, UK, 8-9 April 2008
- NAC 08, Dalfsen, the Netherlands, 7-9 May 2008
- VSOP2 meeting, Bonn, Germany, 14-15 May 2008
- TERENA 08, Brugge, Belgium, 19 - 22 May 2008
- ASTRONET roadmap exercise, Liverpool, UK, 16-19 June 2008
- Astrofest, Havelte, the Netherlands, 25 June 2008
- URSI GA, Chicago, USA, 10-15 August 2008
- EVN symposium, Bologna, Italy, 22-26 September 2008
- Symposium 400yr telescope, Noordwijk, the Netherlands, 29 September - 2 October 2008
- I-Science workshop, Leiden, the Netherlands, 14-17 October 2008
- ALMA/EVLA/eMERLIN software workshop, Oxford, UK, 1-4 December 2008

Stefanie Mühle

- Bonn-Dwingeloo Meeting on "High Resolution Radio Astronomy", at JIVE, Dwingeloo, the Netherlands, 30 October 2007
- Far-Infrared and Submillimeter Emission of the Interstellar Medium: Models meet extragalactic and Galactic Observations at the Physikzentrum, Bad Honnef, Germany, 5-7 November 2007
- 63rd Nederlandse Astronomen Conferentie, Dalfsen, the Netherlands, 7-9 May 2008
- ASTRON/JIVE Astrofest 2008, Overcinge, the Netherlands, 25 June 2008

- The 9th European VLBI Network Symposium on "The role of VLBI in the Golden Age for Radio Astronomy", Bologna, Italy, 23-26 September 2008

Friso Olnon

- Rudolf LePoole Symposium, Leiden, the Netherlands, 30 November 2007
- Nederlandse Astronomen Conferentie, Dalfsen, the Netherlands, 7-9 May 2008
- Theory in the Virtual Observatory, Garching, Germany, 7-9 April 2008
- Grid and the Virtual Observatory, Garching, Germany, 9-11 April 2008

Zsolt Paragi

- ESTRELA Workshop, Dwingeloo, the Netherlands, 15 January 2007
- EVN2015 Vision Brainstorm Meeting, Dwingeloo, the Netherlands, 1-2 March 2007
- 070228: The Next Decade of GRB Afterglows, Amsterdam, the Netherlands, 19-23 March 2007
- VLBI in the GLAST Era, NASA - Goddard Space Flight Center, USA, 23-24 April 2007
- Astrophysics in the LOFAR era, Emmen, the Netherlands, 23-27 April 2007
- Bursts, Pulses and Flickering: Wide-field monitoring of the dynamic radio sky, Kerastari, Greece, 12-15 June 2007
- Astrofest, Overcinge, Havelte, the Netherlands, 3 July 2007
- 6th International e-VLBI Workshop, Bonn, Germany, 17-18 September 2007
- From Planets to Dark Energy: The Modern Radio Universe, University of Manchester, UK, 1-5 October 2007
- Approaching Micro-Arcsecond Resolution with VSOP-2: Astrophysics and Technology, ISAS/JAXA, Sagamihara, Kanagawa, Japan, 3-7 December 2007
- Observational Evidence for Black Holes in the Universe, Kolkata, India, 10-15 February 2008
- VSOP-2 Technical Meeting, Bonn, Germany, 14-16 May 2008
- 7th International e-VLBI Workshop, Shanghai, China, 16-17 June 2008
- 7th Microquasar Workshop, Foca, Turkey, 1-5 September 2008
- The 9th European VLBI Network Symposium The role of VLBI in the Golden Age for Radio Astronomy, Bologna, Italy, 23-26 September 2008
- LOFAR and the Transient Radio Sky, Amsterdam, the Netherlands, 15-17 December 2008

Yurii Pidopryhora

- The Milky Way Halo - Stars and Gas: Locations, Motions, Origins, Bonn, Germany, 29 May - 2 June 2007
- AstroFest, Havelte, the Netherlands, 3 July 2007
- 6th International e-VLBI Workshop, Bonn, Germany, 17-18 September 2007
- Astron/JIVE AstroFest, Havelte, the Netherlands, 25 June 2008
- The Role of Disk-Halo Interaction in Galaxy Evolution: Outflow vs. Infall?, Espinho, Portugal, 18-22 August 2008

Sergei Pogrebenko

- Europa–Jupiter Science Workshop, Frascati, Italy, 21 April 2008
- IPPW-5, Bordeaux, France, 26 June 2007
- ILEWG-9, Sorento, Italy, 23 October 2007

Antonios Polatidis

- Nederlandse Astronomen Conferentie (NAC), Dalfsen, he Netherlands, 7-9 May 2008.
- The 4th Workshop on Compact Steep Spectrum and GHz-Peaked Spectrum Radio Sources, Riccione, Italy, 26-30 May 2008.
- The 9th European VLBI Network Symposium on "The role of VLBI in the Golden Age for Radio Astronomy", Bologna, Italy, 23-26 September 2008.

Hayden Rampadarath

- The prospects of LOFAR surveys, Lorentz Center, Leiden, the Netherlands, 10-12 December 2007
- Astrophysics with E-LOFAR, Hamburg, Germany, 16-19 September 2008
- The first Science with LOFAR surveys, Lorentz Center, Leiden, the Netherlands, 10-12 December 2008

Michael Sipior

- ALBUS workshop, Bonn, Germany, 8 May 2007
- European Radio Ineterferometry School, Bonn, Germany, 12-13 September 2007
- Astronomical Data Analysis Software & Systems XVII, London, UK, 23-26 September 2007
- Bonn-Dwingeloo Meeting on "High Resolution Radio Astronomy", Dwingeloo, the Netherlands, 30 October 2007
- Astronomical Data Analysis Software & Systems XVIII, Quebec, Canada, 2-5 November 2008

Des Small

- URSI Forum, Brussels, Belgium, 30 May 2008

Arpad Szomoru

- ESLEA Closing Conference, Edinburgh, United Kingdom, 26-28 March 2007
- TERENA Networking Conference, Copenhagen, Denmark, 21-24 May 2007
- Asian-Pacific Advanced Network conference, Xi'An, China, 25-30 August 2007
- 6th International e-VLBI Workshop, Bonn, Germany, 17-18 September 2007
- Modern radio Universe, Manchester, UK, 1-5 October 2007
- Bonn exchange day, Dwingeloo, the Netherlands, 30 October 2007
- STOA/TERENA Workshop, Brussels, Belgium, 2 April 2008
- TERENA Networking Conference, Brugge, Belgium, 19-22 May 2008
- 7th International e-VLBI Workshop, Shanghai, China, 16-17 June 2008
- EVN symposium, Bologna, Italy, 22-26 Sep

Shanmugha Sundaram GA

- Deep Surveys of the Radio Universe with SKA Pathfinders & SKADS Workshop, University of Western Australia, Perth, Australia, 31 March – 5 April 2008

Harro Verkouter

- Bonn exchange day, Dwingeloo, the Netherlands, 30 October 2007

- Nederlandse Astronomen Conferentie, Dalfsen, the Netherlands, 7-9 May 2008

Charles Yun

- EC FP7 ICT Info Day, Koln, Germany, 1 February 2007
- FABRIC Work Meeting, Dwingeloo, the Netherlands, April 2007
- EVN PC, Gothenburg, Sweden, 29 June 2007
- EARNEST Workshop, Brussels, Belgium, 25 September 2007
- E-infrastructure Concertation, Sophia-Antipolis, France, 5 December 2007
- 6th International e-VLBI Workshop, Bonn, Germany, 16 September 2007
- RINGRID, Athens, Greece, 24 January 2008
- TERENA Networking Conference, Brugge, Belgium, 19-22 May 2008
- 7th International e-VLBI Workshop, Shanghai, China, 16-17 June 2008
- AOGS 2008, Pusan, Korea, 19 June 2008
- EC Virtual Forum, videoconfrence, 12 June 2008
- PPAM 2007, Gdansk, Poland, 10 September 2007
- Effelsberg Connection Event, Effelsberg, Germany, 19 November 2008

Kristine Yun

- TERENA Networking Conference, Brugge, Belgium, 19-22 May 2008

9.8.2 Technical and business meetings

Nikta Amiri

- Bonn University, Bonn, Germany, 12-14 December 2007
- Bonn University, Bonn, Germany, 27-28 October 2008

I.M. Avruch

- Huygens VLBI Tracking Project final presentation, ESTEC, Noordwijk, the Netherlands, 8 February 2007

Hayley Bignall

- ESTRELA interviews and selection panel meeting, Bonn, Germany, 5 March 200?

Stephen Bourke

- MCCT Science and Instrumentation workshop, Groningen, the Netherlands, 2-7 March 2008
- CASA Workshop, Bonn, Germany, 2-4 April 2008
- Imaging and Calibration Algorithms for EVLA, e-MERLIN and ALMA, Oxford, UK, 1-3 December 2008.

Paul Boven

- ESLEA Closing Conference, Edinburgh, UK, 26-28 March 2007
- e-VLBI workshop 2007 (including NREN session), Bonn, Germany, 17-19 September 2007
- Lambda Networks in Radio Astronomy, Copenhagen, Denmark, 31 October 2007
- TNC2007, Copenhagen, Denmark, 21-24 May 2007
- TNC2008, Bruges, Belgium, 19-22 May 2008

- Inauguration of the High-Speed Fibre Optic Link for e-VLBI, Effelsberg, Germany, 18-20 November 2008
- NORDUnet Conference, Espoo, Helsinki, Finland, 9-11 April 2008
- Visit to IBM, Zürich, Switzerland, 29-30 October 2008
- EXPReS Progress Meeting, Utrecht, the Netherlands, 29 January 2008
- e-VLBI Workshop 2008, Shanghai, China, 16-17 June 2008
- Terena E2E Workshop, Amsterdam, the Netherlands, 1-2 December 2008

Bob Campbell

- EVN PC Meeting, Jodrell Bank, UK, 21 March 2007
- EXPReS e-VSAG, Gothenburg, Sweden, 28 June 2007
- EVN PC Meeting, Onsala, Sweden, 29 June 2007
- EVN PC Meeting, Cagliari, Italy, 8 November 2007
- EVN TOG, Yebes, Spain, 12 November 2007
- EVN CBD, Madrid, Spain, 13 November 2007
- EVN PC Meeting, Bordeaux, France, 17 March 2008
- EXPReS e-VLBI Science Advisory Group, conference call, 23 June 2008
- EVN PC Meeting, Garching, Germany, 27 June 2008
- EVN TOG, Bologna, Italy, 22 September 2008
- ENV PC Meeting, Barcelona, Spain, 21 November 2008

Giuseppe Cimò

- EVN calibration issues, TOG meeting, Yebes, Spain, 12 November 2007
- EVN calibration issues, TOG meeting, Bologna, Italy, 11 September 2008
- The EVN calibration, The 9th European VLBI Network Symposium on The role of VLBI in the Golden Age for Radio Astronomy and EVN Users Meeting, Bologna, Italy, 23-26 September 2008

Leonid Gurvits

- VSOP-2 Coordination Meeting, Madrid, Spain, 19 February 2007
- VSOP-2/CDTI meeting, Madrid, Spain, 21 February 2007
- Huygens VLBI Tracking Project final presentation, ESTEC, Noordwijk, NL, 8 February 2007
- ILIAS Board meeting, Chambery, France, 26 February 2007
- EuroPlaNet Board meeting, ESTEC, Noordwijk, 27 February 2007
- ESA CV coordination meeting, ESA HQ, Paris, France, 1 March 2007
- FP6 RadioNet Board meeting, Grnoble, France, 11 April 2007
- FP6 RadioNet mid-term review, Grenoble, France, 12 April 2007
- VSOP Lessons Learned meeting, Hakone, Japan, 16-18 April 2007
- TandEM and Saturn missions workshop, Meudon, France, 14-15 May 2007
- EVN CBD meeting, Espoo, Finland, 28 May 2007
- EVE workshop, CNES, Paris, France, 14 June 2007
- FP7 RadioNet planning meeting, Bonn, Germany, 26 June 2007
- 10th anniversary of the Cassini-Huygens launch workshop, ESTEC, Noordwijk, NL, 15 October 2007
- EVN CBD meeting, Madrid, Spain, 13 November 2007
- RadioNet FP7 planning meeting, Madrid, Spain, 14 November 2007

- FP6 RadioNet Board meeting, Madrid, Spain, 14 November 2007
- NOVA Network 3 plenary meeting, Nijmegen, NL, 21 December 2007
- SKADS DS2-T1 progress meeting, Lisbon, Portugal, 7 January 2008
- Huygens DAW, NASA GSFC, Greenbelt, MD, USA, 7 February 2008
- TSSM meeting, Meudon, France, 17 March 2008
- SKA meetings, Perth, Australia, 6-10 April 2008
- Europa–Jupiter Science Workshop, Frascati, Italy, 21-22 April 2008
- EVN CBD meeting, Bordeaux, France, 24 April 2008
- SKADS Design and Costing Meeting, Dwingeloo, 9 May 2008
- VSOP-2 meeting, Bonn, Germany, 13-14 May 2008
- VISC-2 meeting, Bonn, Germany, 15 May 2008
- ASTRONET Infrastructure Roadmap Symposium 2008, Liverpool, UK, 16-21 June 2008
- EuroPlaNet FP7 planning meeting, Corpus Christi, TX, USA, 8 July 2008
- EVN CBD meeting, Arecibo, Puerto Rico, 4 November 2008
- JIVE retraite, Dwingeloo, 17 December 2008

Lisa Harvey-Smith

- e-MERLIN Legacy Program Meeting, Jodrell Bank Observatory, UK, 17 July 2007.

Mark Kettenis

- ITC proposal day, Köln, Germany, 1 February 2007
- FABRIC Distributed Correlation meeting, Dwingeloo, the Netherlands, 25-26 April 2007
- ALBUS meeting, Bonn, Germany, 9-10 May 2007
- SCARie Kick-off meeting, Dwingeloo, the Netherlands, 15 May 2007
- DiFX Software Correlator meeting, Bonn, Germany, 13-14 September 2007
- 6th International e-VLBI Workshop, Bonn, Germany, 17-18 September 2007
- FABRIC Collaboration meeting, Bonn, Germany, 20 September 2007
- EXPReS Progress Meeting, Utrecht, the Netherlands, 29 January 2008
- EXPReS Board Meeting, Utrecht, the Netherlands, 29 January 2008
- PFLDnet 2008, Manchester, UK, 5-7 March 2008
- 7th International eVLBI Workshop, Shanghai, China, 16-17 June 2008
- FABRIC Distributed Correlation meeting, Poznan, Poland, 1-2 September 2008
- FABRIC "e-MERLIN out" meeting, Jodrell Bank, UK, 4 September 2008
- 2nd DiFX software correlator meeting, Bonn, Germany, 8-12 September 2008
- EVN TOG Meeting, Bologna, Italy, 22 September 2008
- Visit to IBM, Zürich, Switzerland, 29-30 October 2008
- NWO Symposium "Parallele Werelden", Amsterdam, the Netherlands, 8 December 2008
- SCARIe Business meeting, Amsterdam, the Netherlands, 18 December 2008
- JIVE retraite, Dwingeloo, 17 December 2008

Bauke Kramer

- NorthStar workshop, Bologna, Italy, 19-21 November 2007
- VO workshop, Garching, Germany, 23-27 June 2008

Nico Kruithof

- INGRID 2007, Portofino, Italy, 16-18 April 2007

- ERIS summer school, Bonn, Germany, 10-15 September 2007
- 6th e-VLBI Workshop, Bonn, Germany, 17-18 September 2007

Huib van Langevelde

- ESTRELA workshop, Dwingeloo, the Netherlands, 15-18 January 2007
- SKADS board, Den Haag, the Netherlands, 18-19 January 2007
- prepSKA definition meeting, Bonn, Germany, 12 February 2007
- Instrument Steering Committee NOVA, Nijmegen, the Netherlands, 9 March 2007
- EXPReS MT, Schiphol, the Netherlands, 22 March 2007
- RadioNet board meeting, Grenoble, France, 11 April 2007
- RadioNet Mid term review, Grenoble, France, 12 April 2007
- EXPReS midterm review, Brussels, Belgium, 17 April 2007
- ESO STC, Garching, Germany, 18-20 April 2007
- MeerKAT presentation, Amsterdam, the Netherlands, 20 April 2007
- LOFAR DCLA review, Dwingeloo, the Netherlands, 10-11 May 2007
- SCARIe meeting, Amsterdam, the Netherlands, 15 May 2007
- EVN CBD meeting, Espoo, Helsinki, Finland, 28 May 2007
- EXPReS board, Espoo, Helsinki, Finland, 29 May 2007
- JIVE Board, Den Haag, the Netherlands, 11 June 2007
- SKADS board, Den Haag, the Netherlands, 28-29 June 2007
- NWO informatica and astronomy meeting, Den Haag, the Netherlands, 27 September 2007
- NOVA Instrument Steering Committee, Groningen, the Netherlands, 15-19 October 2007
- ESO VLTI committee, Garching, Germany, 22 October 2007
- ESO-STC, Garching, Germany, 23-24 October 2007
- JIVE Board, Madrid, Spain, 12 November 2007
- EVN consortium board, Madrid, Spain, 13 November 2007
- RadioNet board, Madrid, Spain, 14 November 2007
- ESO klankboord, Leiden, the Netherlands, 29 November 2007
- ESKAC, Rome Italy, 16 January 2008
- SKADS board, Rome Italy, 17-18 January 2008
- EXPReS board, Utrecht, the Netherlands, 29 - 30-January 2008
- GEANT a global leader, Bled, Slovenia, 2-5 March 2008
- NOVA ISC, Leiden, the Netherlands, 10 March 2008
- ESO STC, Garching Germany, 16-17 April 2008
- EVN CBD, Bordeaux France, 24 April 2008
- 2nd EXPReS review, Brussel Belgium, 30 May 2008
- WSRT user meeting, Amersfoort, 4 June 2008
- NWO open competitie evaluation, Utrecht, the Netherlands, 4 June 2008
- SKADS board, Liverpool, UK, 19-20 June 2008
- I3Net gathering Schiphol, the Netherlands, 1 September 2008
- RadioNet board meeting, Rome, Italy, 4 September 2008
- JIVE board, Dwingeloo, the Netherlands, 9 October 2008
- NOVA ISC, Amsterdam, the Netherlands, 10 October 2008
- e-IRG workshop, Paris, France, 20-22 October 2008
- JIVE visit to IBM, Zurich Switzerland, 29-30 October 2008
- EVN CBD, Arecibo, Puerto Rico, 4 November 2008

- Consultation meeting DG-INFSOC, Brussels, Belgium, 14 November 2008
- Effelsberg e-VLBI dedication, Effelsberg, Germany, 19 November 2008
- the Netherlands SKA meeting, Dwingeloo, the Netherlands, 26-27 November 2008
- Parallel universes, Amsterdam, the Netherlands, 8 December 2008
- Consultation meeting DG RTD, Brussels, Belgium, 15 December 2008
- JIVE retraite, Dwingeloo, the Netherlands, 17 December 2008

Martin Leeuwinga

- Fourth IVS Technical Operations Workshop, Haystack, USA, 30 April -3 May 2007
- EVN TOG Meeting, Yebes, Spain, 12 November 2007
- EVN TOG meeting, Bologna, Italy, 22 September 2008

Stefanie Mühle

- EVN Technical and Operations Group Meeting, Bologna, Italy, 22 September 2008
- Algorithms 2008 - Imaging and Calibration Algorithms for EVLA, e-MERLIN and ALMA, Cambridge, UK, 1-3 December 2008

Friso Olnon

- 6th eVLBI Workshop, Bonn, Germany, 17-19 September 2007
- Dwingeloo-Bonn Meeting, Dwingeloo, the Netherlands, 30 October 2007
- Jaarvergadering Nederlandse Astronomen Club, Utrecht, the Netherlands, 18 January 2008
- EXPReS progress meeting, Utrecht, the Netherlands, 29 January 2008
- Workshop on how to publish data in the VO, Garching, Germany, 23-27 June 2008

Zsolt Paragi

- 2nd eVSAG face to face meeting, Gothenburg, Sweden, 28 June 2007
- EXPReS Progress Meeting, Utrecht, the Netherlands, 29 January 2008
- GEANT2 a global leader EXPReS, Bled, Slovenia, 3-4 March 2008
- WSRT users meeting, Amersfoort, the Netherlands, 4 June 2008
- EVN Users meeting, Bologna, Italy, 25 September 2008
- JIVE retraite, Dwingeloo, 17 December 2008

Sergei Pogrebenko

- Huygens VLBI Tracking Project final presentation, ESTEC, Noordwijk, the Netherlands, 8 February 2007
- FP7 RadioNet preparation workshop, Dwingeloo, the Netherlands, 19 November 2007

Antonios Polatidis

- EVN TOG meeting, Bologna, Italy, 22 September 2008

Aukelien van den Poll

- RadioNet board meeting, Grenoble, France, 11 April 2007
- RadioNet Mid term review, Grenoble, France, 12 April 2007

Yurii Pidopryhora

- The Origin of the Galaxy and Local Group, 37th Saas-Fee advanced course of the Swiss Society for Astrophysics and Astronomy, Mürren, Switzerland, 4-10 March 2007
- MeerKAT Workshop, Amsterdam, the Netherlands, 20 April 2007
- EXPReS Progress Meeting, Utrecht, the Netherlands, 29 January 2008

Hayden Rampadarath

- NOVA Fall School, Dwingeloo, the Netherlands, 8-12 October 2007
- 3rd ESTRELA Workshop, MPIfR Bonn, Germany, 7-11 April 2008
- AstroFest,Overcinge, Havelte, the Netherlands, 25 June 2008
- 2nd MCCT-SKADS Training School, Radio Astronomy: fundamentals and the new instruments, Sigüenza, Spain, 26 August – 4 September 2008
- NOVA Fall School, Dwingeloo, the Netherlands, 6-10 October 2008

Des Small

- 6th eVLBI Workshop, Bonn, 17-18 September 2007
- EXPReS Progress Meeting, Utrecht, the Netherlands, 29 January 2008

Shanmugha Sundaram GA

- MeerKAT Science Workshop, Amsterdam, the Netherlands, 20-21 April 2007
- DS2-T2 meeting & SKADS Workshop and Mid-term Review, Observatorie de Paris, Paris and Meudon, France, 9-12 October 2007
- AstroFest 2007, ASTRON, Havelte, the Netherlands, 3 July 2007
- Comsol Multiphysics Modeling Workshop, VUMC, Amsterdam, The Netherlands, 28 May 2008
- Netherlands SKA Workshop, Dwingeloo, The Netherlands, 26 - 27 November 2008

Arpad Szomoru

- EXPReS MT, Schiphol, the Netherlands, 22 March 2007
- EXPReS midterm review, Brussels, Belgium, 17 April 2007
- SCARIe meeting, Amsterdam, the Netherlands, 15 May 2007
- EVN CBD meeting, Espoo, Helsinki, Finland, 28 May 2007
- EXPReS board, Espoo, Helsinki, Finland, 29 May 2007
- 2nd eVSAG face to face meeting, Gothenburg, Sweden, 28 June 2007
- EVN-NREN meeting, Bonn, Germany, 19 September 2007
- FABRIC Collaboration meeting, Bonn, DE, 20 September 2007
- EVN TOG, Yebes, Spain, 12 November 2007
- EVN consortium board, Madrid, Spain, 13 November 2007
- RadioNet board, Madrid, Spain, 14 November 2007
- EXPReS Progress Meeting, Utrecht, the Netherlands, 29 January 2008
- EXPReS board, Utrecht, the Netherlands, 29-30 January 2008
- 2nd EXPReS review, Brussel Belgium, 30 May 2008
- PFLDnet 2008, Manchester, UK, 5-7 March 2008
- FABRIC "e-MERLIN out" meeting, Jodrell Bank, UK, 4 September 2008
- EVN TOG Meeting, Bologna, Italy, 22 September 2008
- JIVE board, Dwingeloo, the Netherlands, 9 October 2008

- JIVE visit to IBM, Zurich, Switzerland, 29-30 October 2008
- EVN CBD, Arecibo, Puerto Rico, 4 novembro 2008
- Effelsberg e-VLBI dedication, Effelsberg, Germany, 19 November 2008
- JIVE retraite, Dwingeloo, the Netherlands, 17 December 2008

Hans Tenkink

- Fourth IVS Technical Operations Workshop, Haystack, USA, 30 April -3 May 2007
- EVN TOG meeting, Bologna, Italy, 22 September 2008

Kalle Torstensson

- ESTRELA Workshop, Dwingeloo, The Netherlands, 15-18 January 2007
- eSMA Workshop, Leiden, The Netherlands, 1-2 February 2007
- IAU Symposium 242, Alice Springs, Australia, 12-16 March 2007
- NAC, Eindhoven, The Netherlands, May 14-16 2007
- Young European Radio Astronomer's Conference (YERAC), Bordeaux, France, 4-7 September 2007
- Massive Star Formation: Observations confront Theory, Heidelberg, Germany, 10-14 September 2007
- ESTRELA Workshop, Manchester, UK, 8-11 October 2007
- Bonn-Dwingeloo High Resolution Radio Astronomy meeting, Dwingeloo, the Netherlands, 30 October 2007
- ESTRELA workshop, Bonn, Germany, 7-11 April 2008
- NAC, Dalfsen, the Netherlands, 7-9 May 2008
- YERAC, Gothenburg, Sweden, 23-26 June 2008
- 9th EVN Symposium, Bologna, Italy, 23-26 September 2008

Harro Verkouter

- 6-th eVLBI Workshop, Bonn, Germany, 17-19 September 2007
- ASTROGPU workshop on High Performance Computing on graphics hardware, Princeton, USA, 9-10 November 2007
- 7-th eVLBI Workshop, Shanghai, China, 16-17 June 2008

Charles Yun

- EXPReS Annual Review, Brussels, Belgium, 17 April 2007
- eVSAG, Gothenburg, Sweden, 28 June 2007
- EXPReS Board Meeting, Utrecht, the Netherlands, January 2008
- FABRIC Work Meeting, Poznan, Poland, 1-2 September 2008

Kristine Yun

- EXPReS Progress Meeting, Utrecht, the Netherlands, 29 January 2008

9.8.3 Working visits and observing trips

Hayley Bignall

- Observing at Effelsberg (feasibility test for Proposal 93-06) , 23-24 April 2007
- Observing at Nordic Optical Telescope, La Palma, 9-15 September 2007

Stephen Bourke

- Observing at GMRT, Khodad, India, 16 - 23 February 2008

Leonid Gurvits

- Radio astronomy course (13 lectures), Ventspils University College, Latvia, 26 – 31 March 2007
- JAXA-ISAS, Sagamihara, Japan, 19-22 April 2007
- ESTEC, Noordwijk, NL, 11 July 2007
- Radboud University, Nijmegen, NL, 16 October 2007
- Urumqi Astronomical Observatory, China, 20-24 October 2007
- Beijing Astronomical Observatory, China, 24-27 October 2007
- SAI Moscow State University, Russia, 7 March 2008
- Radio astronomy course (10 lectures), Ventspils University College, Latvia, 14–19 April 2008
- Arecibo Observatory, Arecibo, Puerto Rico, 5-8 November 2008

Lisa Harvey-Smith

- Data reduction at Jodrell Bank Observatory, Manchester, UK, 1-4 May 2007
- Observing at the Effelsberg Telescope, Effelsberg, Germany, 28 June-1 July 2007.

Van Langevelde

- Leiden, the Netherlands, 22 February 2007
- Leiden, the Netherlands, 27 March 2007
- Leiden, the Netherlands, 25 April 2007
- Leiden, the Netherlands, 23 May 2007
- Shanghai, China, 22-25 August 2007
- Leiden, the Netherlands, 11 October 2007
- Leiden, the Netherlands, 25 October 2007
- Leiden, the Netherlands, 19 December 2007
- Leiden, the Netherlands, 15 February 2008
- Leiden, the Netherlands, 10 March 2008
- Leiden, the Netherlands, 20 March 2008
- Leiden, the Netherlands, 28-29 July 2008
- Leiden, the Netherlands, 28 August 2008
- Leiden, the Netherlands, 14-15 October 2008

Stefanie Mühle

- Observing at the IRAM 30-m telescope, Pico Veleta, Spain, 12-17 September 2008

Shanmugha Sundaram GA

- SKADS Meeting on Configuration Studies for SKA, Max-Planck Institute for Radioastronomy, Bonn, Germany, 19-21 March 2008

Kalle Torstensson

- JCMT, Hilo, HI, USA, 15-18 June 2007
- ATCA, Narrabri, Australia, 22-24 March 2008

- eSMA, Hawaii, USA, 27-28 July 2008
- JCMT, Hawaii, USA, 29 July – 2 August 2008
- SRON, Groningen, the Netherlands, 8-11 January 2008
- ATNF, Sydney, Australia, 24-28 March 2008
- SRON, Groningen, the Netherlands, 16 June 2008
- Jodrell Bank Centre for Astrophysics, Manchester, UK, 3 September – 18 December 2008

9.9 Correlator activity

9.9.1 Correlator projects

All projects having correlator activity in 2007

Expt name	Obs. date	PI	Type	Correl. date	Distrib. date	Release date	Support scientist
FP001	280500	Campbell	TEST	(080800)	070607	070607	Campbell
FP002	161100	Campbell	TEST	(150301)	070607	070607	Campbell
PAH001	150900	Phillips	TEST	(280901)	(261001)	070607	Campbell
TADU4	281002	Foley	TEST	(041102)	(041102)	070607	Campbell
EB022C	240503	Baan	USER	(250304)	(110504)	070607	Campbell/Avruch
FR006	030806	Reynolds	NME	(240806)	(021006)	190407	Campbell
PC001	201006	Conway	TEST	(071106)	290107	050307	Paragi
RP006	151206	Pandey	USER	(151206)	(261206)	050107	Campbell
RP005	141206	Paragi	USER	(151206)	(151206)	050107	Paragi
N06X2	271106	Soria-Ruiz	NME	(181206)	(191206)	160407	Bignall
N06C3	231106	Reynolds	NME	(191206)	100207	160407	Harvey-Smith
EF017	241106	Frey	USER	050107	190207	160407	Soria-/Cimo
GA023A	271106	Anderson	USER	120107	180107	160407	Campbell
EL033D	241106	Lobanov	USER	160107	120307	160407	Campbell
TE047	170107	Paragi	FORM	170107	220107	220107	Paragi
TE046	170107	Paragi	TEST	170107	290107	090207	Paragi
GA023B	281106	Anderson	USER	180107	280107	160407	Campbell
FR007	131106	Reynolds	NME	230107	280107	190407	Campbell
TE048	250107	Paragi	TEST	250107	290107	090207	Paragi
RR001	290107	Rushton	USER	300107	160207	050307	Paragi
TE049	020207	Paragi	TEST	020207	090207	090207	Paragi
TE050	160207	Paragi	TEST	160207	190207	210207	Paragi
TE051	200207	Paragi	TEST	200207	210207	050307	Paragi
RT001	210207	Tudose	USER	210207	210207	050307	Paragi
N06C4	251106	Graham	NME	270207	060307	160407	Soria-/Reynolds
GC028	281106	Conway	USER	280207	130307	190407	Bignall
F07C1	280207	Paragi	SFTW	280207	010307	010307	Paragi
N06C5	261106	Garrington	NME	280207	090307	190407	Cimo/Reynolds
TE052	050307	Paragi	TEST	050307	060307	060307	Paragi
F07K1	050307	Paragi	SFTW	050307	060307	060307	Paragi
F07L1	070307	Paragi	SFTW	070307	080307	080307	Paragi
F07M1	150307	Paragi	SFTW	150307	160307	160307	Paragi
TE053	230307	Paragi	TEST	230307	080407	160407	Paragi
TE054	230307	Paragi	TEST	230307	080407	160407	Paragi
TE055	270307	Paragi	TEST	270307	080407	160407	Paragi
RM001	280307	Moldon	USER	280307	280307	160407	Paragi
N07K1	050307	Soria-Ruiz	NME	020407	040407	060807	Soria-Ruiz
EF018A	010307	Fender	USER	040407	220407	060807	Campbell
N07C1	010307	Cimo	NME	040407	010507	060807	Cimo
EF016	020307	Frey	USER	060407	030507	060807	Bignall

Expt name	Obs. date	PI	Type	Correl. date	Distrib. date	Release date	Support scientist
EA037A	020307	Alberdi	USER	100407	190407	060807	Soria-Ruiz
EF018B	030307	Fender	USER	110407	270407	060807	Harvey-Smith
N07M1	150307	Harvey-Smith	NME	120407	190407	060807	Harvey-Smith
EM061E	170307	Moscadelli	USER	130407	240407	060807	Cimo
EM064A	170307	Moscadelli	USER	160407	130507	060807	Bignall
EM061F	180307	Moscadelli	USER	180407	260407	060807	Cimo
EM061D	160307	Moscadelli	USER	230407	020507	060807	Cimo
EF020A	030307	Frey	USER	230407	020507	060807	Cimo
EM064B	200307	Moscadelli	USER	250407	300507	060807	Bignall
EM062A	160307	Moscadelli	USER	260407	160507	060807	Harvey-Smith
EM064C	210307	Moscadelli	USER	270407	250607	060807	Bignall
EL034	130307	Lobanov	USER	030507	200507	060807	Campbell
TE056	070507	Paragi	TEST	070507	170507	300707	Paragi
N07L1	080307	Bignall	NME	140507	180607	060807	Bignall
EO005	070307	Olsson	USER	150507	200607	060807	Harvey-Smith
EM059B	060307	Moscadelli	USER	210507	290507	060807	Soria-Ruiz
TE057	220507	Paragi	TEST	220507	180607	300707	Paragi
F07C2	310507	Paragi	SFTW	310507	180607	060807	Paragi
EB032B	180307	Brunthaler	USER	040607	240607	060807	Campbell
EK024A	090307	Kloeckner	USER	050607	260607	060807	Harvey-Smith
F07L2	050607	Paragi	SFTW	050607	180607	060807	Paragi
FR002	040698	v.Langevelde	TEST	070607	070607	070607	Campbell
F07M2	120607	Paragi	SFTW	120607	180607	060807	Paragi
TE058	130607	Phillips	TEST	130607	180607	300707	Szomoru
EA037B	120307	Alberdi	USER	130607	190607	060807	Soria-Ruiz
F07SX1	180607	Paragi	SFTW	180607	220607	060807	Paragi
EF020B	110307	Frey	USER	190607	220607	060807	Cimo
EK024C	110307	Kloeckner	USER	190607	220607	060807	Harvey-Smith
TE059	210607	Paragi	FORM	210607	210607	210607	Paragi
VT11D2	210607	Phillips	TEST	210607	210607	060807	Szomoru
EA036A	120307	Asada	USER	210607	250607	060807	Soria-Ruiz
TE060	220607	Paragi	TEST	220607	220607	300707	Paragi
EF018C	050307	Fender	USER	220607	060707	060807	Campbell
EK024B	100307	Kloeckner	USER	220607	040707	060807	Soria-Ruiz
TE061	250607	Paragi	NME	260607	080707	300707	Paragi
RT004	250607	Tudose	USER	260607	030707	060807	Paragi
N07C2	010607	Cimo	NME	040707	040707	060807	Cimo
EG037A	010607	Giroletti	USER	040707	110707	071207	Cimo
N07M2	130607	Soria-Ruiz	NME	050707	110707	060807	Harvey-Smith
N07L2	060607	Bignall	NME	050707	110707	060807	Bignall
TE062	060707	Paragi	TEST	060707	090707	300707	Paragi
EH020	130607	Harvey-Smith	USER	150707	170807	071207	Harvey-Smith
EB036	160607	Bartkiewicz	USER	240707	160807	071207	Harvey-Smith
EG037B	060607	Giroletti	USER	300707	020807	071207	Cimo
EB032C	170607	Brunthaler	USER	010807	020807	071207	Campbell

Expt name	Obs. date	PI	Type	Correl. date	Distrib. date	Release date	Support scientist
EB034A	130607	Bartkiewicz	USER	020807	030807	071207	Soria-Ruiz
EB034B	140607	Bartkiewicz	USER	030807	030807	071207	Soria-Ruiz
EB034C	150607	Bartkiewicz	USER	040807	070807	071207	Soria-Ruiz
EM063	100607	Marecki	USER	070807	290807	071207	Harvey-Smith
TE063	080807	Paragi	TEST	080807	280807	280807	Paragi
EZ015	070607	Zuther	USER	150807	230807	071207	Cimo
VT11E2	140807	Phillips	TEST	150807	280807	280807	Szomoru
EK025	020607	Kunert-Bajraszewska	USER	160807	050907	071207	Bignall
ES057A	050607	Szymczak	USER	170807	230807	071207	Bignall
TE064	210807	Paragi	TEST	210807	280807	280807	Paragi
RL001	210807	v.Langevelde	USER	220807	230807	280807	Paragi
VT11E3	230807	Phillips	TEST	230807	280807	280807	Kettenis
EI009A	100607	Imai	USER	270807	101007	071207	Bignall
APAN	280807	Phillips	TEST	280807	100907	100907	Paragi
TE066	280807	Phillips	FORM	280807	280807	280807	Paragi
TE065	280807	Phillips	FORM	280807	280807	280807	Paragi
EL035A	080607	Lal	USER	280807	300807	071207	Cimo
EI009B	110607	Imai	USER	300807	121007	071207	Bignall
EL035B	090607	Lal	USER	300807	310807	071207	Cimo
RP006S	060907	Paragi	USER	060907	160907	250907	Paragi
TE067	060907	Paragi	TEST	060907	160907	250907	Paragi
RP007	060907	Paragi	USER	070907	160907	250907	Paragi
TE068	100907	Paragi	TEST	100907	160907	250907	Paragi
TE069	120907	Paragi	TEST	120907	160907	250907	Paragi
GI004	090607	Imai	USER	180907	091007	071207	Campbell
V259A	051007	Phillips	NME	051007	051007	221007	Kettenis/Campbell
V259B1	071007	Phillips	TEST	071007	071007	221007	Kettenis/Campbell
V259B2	071007	Phillips	NME	081007	081007	221007	Kettenis/Campbell
VX999	200607	Phillips	TEST	081007	081007		Kettenis
TADU8	060807	Foley	TEST	081007	081007	071207	Campbell
TE070	091007	Paragi	TEST	091007	101007	221007	Paragi
TADU9	031007	Foley	TEST	161007	171007	071207	Campbell
F07SX2	261007	Paragi	SFTW	261007	131107	201107	Paragi
V230A	240607	Petrov	TEST	261007	291007	291007	Campbell
TE071	151107	Paragi	TEST	151107	221107	031207	Paragi
GP044	051107	Paragi	USER	211107	231107		Paragi
N07C3	021107	Cimo	NME	221107	261107		Cimo/Mühle
N07L3	181007	Bignall	NME	221107	231107		Bignall
N07M3	301007	Mühle	NME	231107	301107		Mühle/Soria-Ruiz
EH022	301007	Harvey-Smith	USER	261107	281107		Soria-Ruiz
TADU11	201107	Foley	TEST	281107	281107	111207	Campbell
TADU12	041207	Foley	TEST	061207	071207	111207	Campbell
TE072	111207	Paragi	TEST	111207			Szomoru
TADU13	121207	Foley	TEST	141207	141207		Campbell

All projects having correlator activity in 2008

Expt name	Obs. date	PI	Type	Correl. date	Distrib. date	Release date	Support scientist
N06C1	160206	Paragi	NME	(150306)	(030406)	300408	Paragi
GP044	051107	Paragi	USER	(211107)	(231107)	230108	Paragi
N07C3	021107	Cimo	NME	(221107)	(261107)	100408	Cimo/Mühle
N07L3	181007	Bignall	NME	(221107)	(231107)	100408	Bignall
N07M3	301007	Mühle	NME	(231107)	(301107)	100408	Mühle/Soria-Ruiz
EH022	301007	Harvey-Smith	USER	(261107)	(281107)	100408	Soria-Ruiz
TE072	111207	Paragi	TEST	(111207)	130108	210108	Szomoru
TADU13	121207	Foley	TEST	(141207)	(141207)	220208	Campbell
TE073	210108	Paragi	TEST	210108	280108	280108	Paragi
TE074	240108	Paragi	TEST	240108	280108	280108	Paragi
TE075B	050208	Paragi	TEST	050208	170208	170208	Paragi
TE075A	050208	Paragi	TEST	050208	170208	170208	Paragi
TADU14	240108	Foley	TEST	120208	260208	300308	Campbell
GP046A	060208	Paragi	USER	170208	180208	100408	Campbell/Paragi
TADU16	150208	Foley	TEST	210208	060308	300308	Campbell
GC029	201007	Chi	USER	220208	140308	100408	Campbell
GB063A	311007	Brunthaler	USER	100308	300308	150408	Campbell
BAH09	050308	Brunthaler	USER	210308	250308	150408	Cimo
GB060A	231007	Bach	USER	310308	070408	220408	Mühle
TE076B	010408	Paragi	TEST	010408	100408	100408	Paragi
TE076A	010408	Paragi	TEST	010408	100408	100408	Paragi
EP061A	290208	Perez-Torres	USER	020408	090408	220408	Polatidis/Campbell
EP062	031107	Petrov	USER	030408	190608	120808	Campbell
EG037C	280208	Giroletti	USER	040408	070408	220408	Cimo
N08L1	280208	Polatidis	NME	050408	140408	220408	Cimo
EM059C	050308	Moscadelli	ABAN	060408	060408	060408	Niemand
EB037B	060308	Brunthaler	ABAN	060408	060408	060408	Niemand
EB037A	010308	Brunthaler	ABAN	060408	060408	060408	Niemand
TE077	080408	Paragi	TEST	080408	100408	100408	Paragi
RT006A	090408	Tudose	USER	090408	100408	100408	Paragi
RP009	080408	Perez-Torres	USER	090408	100408	100408	Paragi
GP046B	180308	Paragi	USER	090408	170408	300408	Paragi
EP061B	290208	Perez-Torres	USER	100408	160408	300408	Polatidis
N08K1	040308	Mühle	NME	100408	140408	220408	Mühle
EP061C	110308	Perez-Torres	USER	140408	180408	020508	Polatidis
EP061D	110308	Perez-Torres	USER	150408	180408	020508	Polatidis
TE078	160408	Paragi	TEST	160408	160408	160408	Paragi
N08C1	100308	Cimo	NME	180408	040608		Polatidis/Mühle
EG037D	100308	Giroletti	USER	180408	230408	090508	Cimo
N08M1	140308	Mühle	NME	210408	280408	120808	Cimo
RT007A	220408	Tudose	USER	230408	240408	300408	Paragi
N08SX1	060308	Polatidis	NME	240408	040608	120808	Polatidis
RT007B	240408	Tudose	USER	250408	260408	300408	Paragi

Expt name	Obs. date	PI	Type	Correl. date	Distrib. date	Release date	Support scientist
RT007C	260408	Tudose	USER	270408	270408	300408	Paragi
EM058B	150308	Moscadelli	USER	270408	270508	120808	Mühle
EM069A	150308	Moscadelli	USER	290408	050508	120808	Cimo
TE079	050508	Paragi	TEST	050508	040608	040608	Szomoru
EM069B	160308	Moscadelli	USER	060508	200508	120808	Cimo
TADU21	150408	Foley	TEST	070508	140708	120808	Campbell
TADU20	140408	Foley	ABAN	070508	070508	070508	Campbell
EA036B	020308	Asada	USER	070508	190608	120808	Mühle
TADU22	210408	Foley	TEST	080508	140708	120808	Campbell
EM069C	180308	Moscadelli	USER	080508	200608	120808	Polatidis/Cimo
TE080	090508	Paragi	TEST	090508	040608	040608	Szomoru/Paragi
TE081	090508	Paragi	TEST	090508	040608	040608	Szomoru
TADU18	200308	Foley	TEST	090508	090508	090508	Campbell
TADU19	270308	Foley	TEST	090508	090508	090508	Campbell
TADU23	090508	Foley	TEST	140508	140708	120808	Campbell
EC026	120308	Cimo	USER	190508	270508	120808	Cimo
EL034B	010308	Lobanov	USER	200508	030708	120808	Polatidis
TE082	200508	Paragi	TEST	200508	040608	040608	Paragi
RSL01	200508	Laine	USER	210508	210508	040608	Paragi
TE083A	220508	Paragi	FMTR	220508	220508	220508	Paragi
TE083B	220508	Paragi	TEST	220508	040608	040608	Paragi
ES058	020308	Szymczak	USER	300508	130608	120808	Campbell
F08L1	020608	Paragi	SFTW	020608	020608	020608	Paragi
GV019A	040308	deVries	USER	040608	030708	120808	Mühle
EM067	191007	Maccarone	ABAN	040608	040608	040608	Campbell
GV019B	130308	deVries	USER	060608	100708	120808	Mühle
F08C1	100608	Paragi	SFTW	100608	100608	100608	Paragi
GB063B	160308	Brunthaler	USER	120608	040708	120808	Campbell
RSW01	240608	Wucknitz	USER	240608	300608	070708	Paragi
RSP02	250608	Trejo	USER	250608	300608	070708	Paragi
RSP01	250608	Dubner	USER	250608	300608	070708	Paragi
N08K2	300508	Mühle	NME	040708	050808	250808	Mühle
N08L2	040608	Cimo	NME	080708	050808	250808	Cimo
N08K3	310508	Mühle	NME	090708	050908	050908	Mühle
EB037C	300508	Brunthaler	USER	110708	190808	050908	Polatidis
N08M2	130608	Polatidis	NME	140708	160908	121208	Polatidis
EO006A	040608	Overzier	USER	150708	050808	250808	Mühle
EO006B	060608	Overzier	USER	180708	070808	250808	Mühle
EO006C	080608	Overzier	USER	210708	080808	250808	Mühle
TE084	220708	Paragi	TEST	220708	220708	120808	Campbell
EP061E	040608	Perez-Torres	USER	230708	300708	250808	Cimo
EP061F	060608	Perez-Torres	USER	240708	300708	250808	Cimo
ES057B	020608	Szymczak	USER	250708	070808	250808	Campbell
N08C2	110608	Cimo	NME	250708	050808	250808	Cimo
EB038A	030608	Biggs	USER	310708	050808	250808	Cimo

Expt name	Obs. date	PI	Type	Correl. date	Distrib. date	Release date	Support scientist
TADU26	250708	Foley	TEST	010808	120908	201108	Campbell
EB038B	050608	Biggs	USER	070808	130808	050908	Cimo
EP061G	120608	Perez-Torres	USER	150808	280808	290908	Polatidis
EP061H	110608	Perez-Torres	USER	180808	280808	290908	Polatidis
GB064A	140608	Brunthaler	USER	270808	110908	121208	Polatidis
TE085	280808	Paragi	TEST	280808	120908	101108	Paragi
EL036A	120608	Liu Xiang	USER	010908	130908	121208	Cimo
GW019A	070608	Wucknitz	USER	020908			Campbell
GB064C	170608	Brunthaler	USER	040908	120908	121208	Polatidis
GB064B	150608	Brunthaler	USER	050908	180908	121208	Polatidis
TE086	090908	Paragi	TEST	090908	120908	101108	Paragi
GB064D	180608	Brunthaler	USER	100908	231008	121208	Polatidis
EV017	140608	Vlemmings	USER	120908	171108	151208	Mühle
EA038	080608	Amiri	USER	170908			Campbell
TE087	190908	Paragi	TEST	190908	220908	101108	Paragi
GC031A	100608	Conway	USER	260908	171108	151208	Mühle
RSG01	300908	Garrett	USER	300908	011008	101108	Paragi
TE088	011008	Paragi	TEST	011008	021008	101108	Paragi
GS029	150608	Sjouwerman	USER	061008	171008	121208	Cimo
TE089	071008	Paragi	TEST	071008	101108	101108	Paragi
TE090	101008	Paragi	TEST	101008	101108	101108	Paragi
RT008	061108	Tudose	USER	061108	101108	201108	Paragi
F08HY1	071108	Lonsdale	TEST	071108	071108	071108	Mühle
RT006B	131108	Tudose	USER	131108	211108	121208	Paragi
RT006C	191108	Tudose	USER	191108	011208		Paragi
N08C3	201008	Cimo	NME	201108	281108	151208	Cimo/Yang
N08Q1	161008	Mühle	NME	241108	161208		Mühle
N08L3	271008	Cimo	NME	261108	261108	151208	Cimo
N08X1	171008	Polatidis	NME	261108	041208		Polatidis
EB037D	301008	Brunthaler	USER	021208	181208		Polatidis
EK026	271008	Kunert-Bajraszewska	USER	031208	161208		Cimo
RP014A	051208	Perez-Torres	USER	051208	121208	151208	Polatidis
EB039A	041208	Brunthaler	USER	051208	101208	121208	Paragi
RK001	041208	Knudsen	USER	051208	101208	121208	Paragi
EZ018B	311008	Zuther	USER	091208	121208		Cimo
EZ018A	261008	Zuther	USER	091208	121208		Cimo
TE091	091208	Paragi	TEST	091208	121208	121208	Paragi
EF021A	221008	Frey	USER	101208			Yang
EL036B	251008	Xiang	USER	111208			Campbell/Yang
TE092	121208	Paragi	TEST	121208			Paragi
EK028C	291008	Kovalev	USER	151208	291208		Polatidis
GP047	211008	Pihlstrom	USER	161208			Campbell
VT12E	191208	Phillips	TEST	191208			Paragi
VT12F	221208	Paragi	TEST	221208			Kettenis
EK028A	191008	Kovalev	USER	231208			Polatidis

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10 List of acronyms and abbreviations

2MASS	-	Two Micron All Sky Survey
AARNET	-	Australia's Academic and Research Network
ACF	-	Auto-correlation functions
ACSIS	-	Auto-Correlation Spectrometer Imaging System
AGB	-	asymptotic giant branch
AGILE	-	Astro-rivelatore Gamma a Immagini Leggero
AGN	-	Active Galactic Nuclei
AIPS	-	Astronomical Image Processing System
ALBiUS	-	Advance Long Baseline Interoperable User Software
ALBUS	-	Advanced Long Baseline User Software
ANTAB	-	file containing apriori station calibration information, used in AIPS
APAN	-	Asia-Pacific Advanced Network
ASI	-	Agenzia Spaziale Italiana
ASTRON	-	Netherlands foundation for Research in Astronomy
ASTRONET	-	Network for Astronomy
ATCA	-	Australia Telescope Compact Array
ATEL	-	Astronomers Telegram
ATNF	-	Australia Telescope National Facility
AU	-	Astronomical Unit
BER	-	Bit Error Rate
BOCF	-	Beginning of Correlator Frame
BW	-	Bandwidth
CALC	-	Program to compute the apriori geometric delay-model
CANARIE	-	Canadian Network for the Advancement of Research Industry and Education
CAS	-	Chinese Academy of Sciences
CERNET	-	China Education and Research Network
CfA	-	Center for Astrophysics (Cambridge, MA, USA)
CHARA	-	Center for High Angular Resolution Astronomy
CJF	-	Caltech-Jodrell Flat spectrum Survey
CNRS	-	Centre National de la Recherche Scientifique
COSMIC	-	Continuous Single-disc Monitoring of Intra-day variability at Ceduna
CSO	-	Compact Symmetric Object
DEVOS	-	Deep Extragalatic VLBI-Opical Survey
DPU	-	Data Playback Unit
DtE	-	Direct to Earth
DVD	-	Digital Versatile Disc
DWE	-	Huygens Doppler Wind
DXRBS	-	Deep X-ray Radio Blazar Survey
EC	-	European Commision
EGRET	-	Energetic Gamma Ray Experiment Telescope
EJSM	-	Europa Jupiter System Mission
EMBRACE	-	Electronic MultiBeam Radio Astronomy ConcEpt
ERI	-	EVN Reliability Indicator

ESA	-	European Space Agency
ESE	-	extreme scattering event
ESF	-	European Science Foundation
ESKAC	-	European SKA consortium
ESOC	-	European Space Operations Centre
ESTRELA	-	Early-Stage Training for European Long-wavelength Astronomy
EVE	-	European Venus Explorer
e-VLBI	-	electronic VLBI
EVN	-	European VLBI Network
EXPReS	-	Express Production Real-Time e-VLBI Science
FABRIC	-	Future Arrays of Broadband Radio-telescopes on Internet Computing
FIRST	-	VLA Faint Images of the Radio Sky at Twenty-one Cm
FITS	-	Flexible Image Transport System
FP6	-	6th Framework Program
FP7	-	7th Framework Program
FPGA	-	Field-Programmable Gate Array
FTP	-	File Transfer Protocol
GBT	-	Green Bank Telescope
GEANT	-	Pan-European Gigabit Research and Education Network
GLAST	-	Fermi Gamma-ray Space Telescope
GLIF	-	Global Lambda Integrated Facility
GMRT	-	Giant Metre-wave Radio Telescope
GPS	-	Global Positioning System
HALCA	-	Highly Advanced Laboratory for Communications and Astronomy
I3	-	Integrated Infrastructure Initiative
IAA	-	International Academy of Astronautics
IAFE	-	Instituto de Astronomia y Fisica del Espacio
ICHEC	-	Irish Centre for High End Computing
IGN	-	Instituto Geografico Nacional (Spain)
ILEWG	-	International Lunar Exploration Working Group
INAF	-	Istituto Nazionale di Astrofisica (Italy)
IONEX	-	Ionosphere Map Exchange
IRA	-	Istituto di Radioastronomia (Italy)
IRI	-	International Reference Ionosphere
ISAS	-	Institute for Space and Astronautical Sciences
ISM	-	Interstellar Medium
JAXA	-	Japan Aerospace Exploration Agency
JBO	-	Jodrell Bank Observatory (Uk)
JCMT	-	James Clerk Maxwell Telescope (Hawaii, USA)
JIVE	-	Joint Institute for VLBI in Europe
JRA	-	Joint Research Activity
KNAW	-	Royal Netherlands Academy of Arts and Sciences
LBA	-	Australian Long Baseline Array
LBADR	-	LBA Date Recorder
LIRG	-	Luminous Infrared Galaxy
LOFAR	-	Low Frequency Array

MAGIC	-	imaging atmospheric Cherenkov telescope
MASIV	-	MicroArcsecond Scintillation-Induced Variability
Mbps	-	Megabit per second
MERLIN	-	Multi-Element Radio Linked Interferometer Network
MMO	-	Mercury Magnetospheric Orbiter
MoA	-	Memorandum of Agreement
MoU	-	Memorandum of Understanding
MPA	-	Max Planck Institute for Astrophysics
MPI	-	Max Planck Institute
MPIfR	-	Max Planck Institute für Radioastronomie (Germany)
MRO	-	Metsähovi Radio Observatory
NA	-	Networking Activity
NAOC	-	National Astronomical Observatory of China
NASA	-	National Aeronautics and Space Administration
NGLS	-	Nearby Galaxy Legacy Survey
NICT	-	National Institute of Information & Communications Technology (Japan)
NME	-	Network Monitoring Experiment
NOT	-	Nordic Optical Telescope
NRAO	-	National Radio Astronomy Observatory (USA)
NREN	-	National Research and Education Network
NWO	-	Netherlands Organisation for Scientific Research
OAN	-	Observatorio Astronomico Nacional (Spain)
OSO	-	Onsala Space Observatory (Sweden)
PCInt	-	Post-Correlator Integrator
PI	-	Principle Investigator
PIM	-	Parameterized Ionosphere Model
PoS	-	Proceedings of Science
PrepSKA	-	Preparatory Phase for the SKA
PRIDE	-	Planetary Radio Interferometry and Doppler Experiment
PSNC	-	Poznan Supercomputing and Networking Center
R&D	-	Research & Development
RATAN	-	Academy of Science Radio Telescope (Russia)
ROSAT	-	Röntgen Satellite
RSA	-	Russian Space Agency
RTT	-	Round Trip Time
SA	-	Specific Service activities
SANReN	-	South African National Research Network
SAO	-	Special Astrophysical Observatory
SCARIe	-	Software Correlator Architecture Research and Implementation for e-VLBI
SDR	-	Spatial Dynamic Range
SDSS	-	Sloan Digital Sky Survey
SFXC	-	Software FX correlator
SKA	-	Square Kilometer Array
SKADS	-	SKA Design Study
SPDO	-	SKA Program Development Office

SRON	-	Netherlands Institute for Space Research
SSEC	-	SKA Science and Engineering Committee
STFC	-	Science and Technology Facilities Council
SURFnet	-	Dutch Research Organisation
TandEM	-	Titan and Enceladus Mission
TB	-	Terabyte
TEIN2	-	Trans-Eurasia Information Network
TERENA	-	Trans-European Research and Education Networking Association
TIGO	-	Transportable Integrated Geodatic Observatory
TNA	-	Trans National Access
TOG	-	Technical Operations Group
TSSM	-	Titan Saturn System Mission
UCSD	-	University of California, San Diego
ULWA	-	Ultra-Long-Wavelength Astronomy
UNAM	-	National Autonomic University of Mexico
USAF	-	United States Air Force
VISC	-	VSOP International Science Council
VLA	-	Very Large Array
VLAN	-	Virtual Local Area Network
VLBA	-	Very Long Baseline Array
VLBEER	-	EVN schedule server
VLBI	-	Very Long Baseline Interferometry
VSOP	-	VLBI Space Observatory Program
WHAM	-	Wisconsin H-Alpha Mapper
WSRT	-	Westerbork Synthesis Radio Telescope

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