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Joint Institute For VLBI in Europe
Biennial report 2011-2012

JIVE
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 Institute for Radio Astronomy (ASTRON), the Netherlands,
National Center for Scientific Research (CNRS), France
National Geographical Institute (IGN), Spain,
Italian National Institute of Astrophysics (INAF), Italy,
Max Planck Institute for Radio Astronomy (MPIfR), Germany,
National Astronomical Observatories of China (NAOC), China,
National Research Foundation (NRF), South Africa
Netherlands Organisation for Scientific Research (NWO), the Netherlands,
Onsala Space Observatory (OSO), Sweden,
Science & Technology Facilities Council (STFC), UK

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Foreword

The years 2011 – 2012 have been a period in which the board has been, more than usually, involved in the JIVE institute developments. In 2011 the board took charge of defining an external review of JIVE, which was due five years after the establishment of the, then current (2007 – 2011), MoU. Moreover, in preparation of this exercise, the board worked with the JIVE director to formulate the strategy and roadmap for the next years. The board also took a close look at the financial situation of JIVE, and how the organisation is targeted towards its mission. In particular, the board had extensive discussions whether a transformation of JIVE into a European Research Infrastructure Consortium (ERIC) would be beneficial to JIVE and its partners. The conclusion was that this is indeed the way forward for JIVE.

It was rewarding to see a smooth visit by the external review panel (its composition was agreed by all the JIVE stake holders, and its chairman was Malcolm Longair) resulting in a report that gave an excellent rating of JIVE as well as gave constructive suggestions towards the development of the institute and the European VLBI Network (EVN). Clearly, the efficiency of the JIVE activities, and the wealth of modern radio science possible with the EVN, put an onus on the JIVE partners to continue provide a structure that plays a key role for the EVN. Against the background of the European economic reality, and the high ambitions of our community to build and operate new facilities, defining this continuity has by no means been an easy task.

However in the end, all the partners were able to make a commitment, a very significant signal indeed, also amplified by the joining of South-Africa's National Research Foundation to the collaboration. I think these commitments are not only based on the desire of all partners to have their telescopes participating in the European-scale VLBI facility, but also on the fact that there is now a promising path forward that securely roots JIVE as a European research facility.

The pivotal role that JIVE has played in attracting external funding for enhancing the science return of the European VLBI network is of course also a recognized strength of the institute. The board appreciates the complex issues that the JIVE management deals with in aligning externally funded projects with the institute priorities and arriving at some continuity in the scientific and technical expertise. At the same time these activities are balanced against the responsibilities JIVE has processing EVN data and interacting with the user community. Indeed, it has been very impressive to see how the scientific community has been able to exploit the new and existing capabilities that VLBI offers nowadays.

Although there is a need for JIVE to implement some savings in 2013 and 2014, I think we can be confident that we are on course for a new organisation to take shape in 2014. At this point, it looks like the JIVE foundation will celebrate its 20th anniversary in December 2013, just before a new legal entity will come into action. I am happy that we have come this far and this report, covering the years 2011 – 2012, is an important record of the JIVE staff's efforts during this important stage,

Hans Olofsson, chairman of the board
May 2013

1. INSTITUTE

1.1. PREPARING FOR THE NEXT FUNDING CYCLE

The Joint Institute for VLBI hosted an international review in March 2012, as a first step to arrive at a new funding agreement between its partners. The preparations in 2011 for this review included formulating the long-term strategy and writing various evaluation documents. Also, discussions concerning whether JIVE should transform into an ERIC (European Research Infrastructure Consortium, a legal entity with an EC basis) continued. The panel, made up of respected international experts, visited JIVE and evaluated the operations, research and development programme (Figure 1.1), as well as the scientific potential of the EVN and JIVE. In its report the panel expressed great confidence in JIVE, stating, "We cannot imagine the job being done more effectively". The panel endorsed the strategic priorities that JIVE set for its future development. Most notable was the observation of the panel that "VLBI has a very exciting and broad science case that the EVN can exploit, particularly in synergy with other SKA pathfinders". The details of the process and the report can be found at http://www.jive.nl/jive-review-2012.

Fig. 1.1 Demonstration of the UniBoard prototype during the review of JIVE on March 5, 2012

After a number of meetings and negotiations, the positive outcome of the review was followed by a decision of the international partners to sign a two-year extension of the JIVE contributions agreement, recognizing this period as a transition to the establishment of an ERIC.

Very relevant in this process was the positive decision by the South-African NRF to become a member of JIVE in May 2012. The Hartebeesthoek telescope has been a long-standing member of the EVN. However, with the construction of the MeerKAT and the ambition to start an African VLBI Network, this formal partnership could be the starting point for building up important new VLBI capabilities during the years that the SKA is being constructed, and even during its operation.

Fig 1.2 The JIVE board at the occasion of NRF South Africa joining JIVE.

1.2. ENHANCING THE VLBI CAPABILITIES

An outstanding fact in the operations of JIVE in the years 2011 and 2012 was the transition of EVN correlation from the Mk4 to the EVN software correlator at JIVE (SFXC). As a consequence an increasing number of VLBI capabilities could be offered by the EVN facility. The software correlator started with a focus on special modes, like wide field, pulsar gating and spectral line modes, but with increasing computing resources becoming available, it had taken over all correlation by the end of 2012, including e-VLBI. Notably, the results of the first tests of new VLBI digital equipment at the telescopes were obtained on the SFXC, considerably improving the sensitivity by capturing data at 2 and 3 Gbps.

These correlator upgrades have a strong synergy with JIVE's on-going push to make e-VLBI a more robust, flexible and sensitive technique. This effort is subsidised by the EC through the FP7 NEXPReS project. This project has been focusing on methods to implement the best of both worlds: e-VLBI data streaming in real-time, as well as transparent caching if the data is needed (again) in a later stage. In this project the consortium members are also pioneering methods to allocate connectivity bandwidth on demand. The progress of the project was rated excellent by the EC's review panel in September 2012 (figure 6.2).

A highlight for the NEXPReS participants and all e-VLBI operators around the world was the global e-VLBI meeting in November 2011 in South Africa (figure 3.10). The meeting and its location were particularly suitable in view of the regional ambitions to develop an African VLBI Network based on decommissioned communication dishes in various African countries.

With considerable help of the JIVE management in shaping the proposal, the RadioNet3 project launched in January 2012, seamlessly connecting with the RadioNet FP7 programme. Both provide the vital Trans National Access funds, which are deployed to implement user support for VLBI in Europe. Besides, RadioNet3 also supports JIVE's efforts in developing user software and in commissioning an FPGA based correlator, based on the so-called UniBoard concept. In 2011, the first prototype was delivered and first fringes were reported in

2012. As part of the follow-up RadioNet3 programme, UniBoard^2 will investigate even more powerful and energy efficient solutions for future correlator and beam-forming applications, for example for the SKA.

Several externally funded programmes support the development of techniques for near-field VLBI observations of planetary and other space missions. JIVE collaborates with international partners to facilitate such experiments in order to enhance the science return of current and future space missions. Among the experiments carried out were the measurements of the orbit of the Venus Express (e.g. Fig 1.3). Later experiments measured the aerodynamical forces on the Venus Express while skimming the Venus upper atmosphere

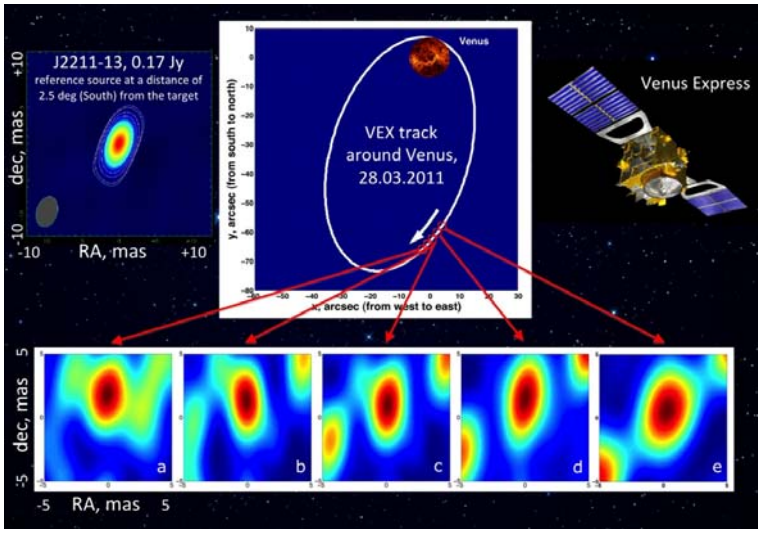

Fig 1.3 Accurate VLBI observations of the Venus Express spacecraft X-band radio signal demonstrate the capabilities of obtaining spacecraft state-vectors with unsurpassed accuracy

Major efforts also went into preparing the science case for various future missions, such as the Marco-Polo-R and JUICE (Fig. 1.4). Actual measurements were made of the RadioAstron orbiting radio telescope, in order to refine its state vector and obtain fringes on space baselines based on these precise determinations.

Fig.1.4 Giuseppe Cimó and Dmitry Duev discussing details of the Space application programme; still from the JIVE movie available at http://www.jive.nl/jive-movie

1.3. JIVE EVENTS

The review panel was of course also presented with the science output of the EVN and the JIVE staff. In 2011 and 2012 there was a considerable output to report on, and it was notable that the delays between observations and presentation have become shorter than before, probably due to the impact of e-VLBI real-time observing on the scientific process. With the advance of e-VLBI and the software correlator, the number of different astronomical topics that were addressed increased, as was also noticed by the review panel.

The productivity of the JIVE staff was very high in 2011 and 2012. This was emphasized by to the fact that during these two years 7 students co-supervised by JIVE senior staff finished their projects and obtained their PhD's (Fig 1.5)

Fig. 1.5 Seven students receiving their PhD's with JIVE-related topics. Nikta Amiri in Leiden, Linjie Chen in Beijing, Jintao Luo in Shanghai, Kalle Torstensson in Leiden, Stephen Bourke in Galway. Guiffré Molera in Turku, Dmitry Duev in Moscow.

With more than 35 people employed at JIVE in 2012, the number of employees was at its highest ever, many of the staff members however were paid from external, temporary projects. It seems likely that these levels will not be sustainable in the near future and despite some flexible arrangements, we had to say goodbye to a number of fine colleagues. It was good to see that they all found new and interesting jobs, sometimes close, sometimes faraway.

The early 2012 review was held after serious construction work had started in Dwingeloo. Several JIVE staff members moved to temporary offices in the spring of 2012, and during the summer there were considerable further disturbances as the old building was prepared for integration with the new wing. And by the end of 2012 JIVE staff were saying farewell to their old offices.

Fig. 1.6 From old to new, the last JIVE Management Team meeting in the old wing and the first use of the new offices in the 2012 building.

After having been for almost 19 years in the 1980 wing of the ASTRON buildings, JIVE moved to the new 2012 wing in December. The new wing has room to house all JIVE staff on a single corridor and will have better meeting and visitor facilities.

2. SCIENCE OPERATIONS AND SUPPORT

2.1. PRODUCTION CORRELATION

2.1.1. SESSIONS AND THEIR EXPERIMENTS

The most significant feature of the correlation environment over this biennial period has been the shift away from the MkIV correlator to the EVN software correlator at JIVE (SFXC) as the primary workhorse for EVN correlation. Figure 2.1 shows the evolution of the fraction of (disk-based) experiments per session correlated on the MkIV and on SFXC. SFXC was already processing its first experiments (requiring pulsar gating) in the latter half of 2010. The transition to SFXC over 2011 was gradual, because the MkIV continued to process multi-epoch projects that had begun on it; only one such observation remained in the first session of 2012. By session 2/2012, all disk-based observations were correlating on SFXC. e-EVN observations took longer to shift away from the MkIV, because of concerns about the ability of SFXC to keep up with 9-10 stations at 1 Gbps. The Technical Operations and R&D group had overcome those concerns by the regularly-scheduled e-EVN day in December 2012, and all e-EVN observations since then have also correlated on SFXC. The section "Astronomical Features" (2.1.3) discusses the new kinds of experiments that SFXC permits the users to conduct.

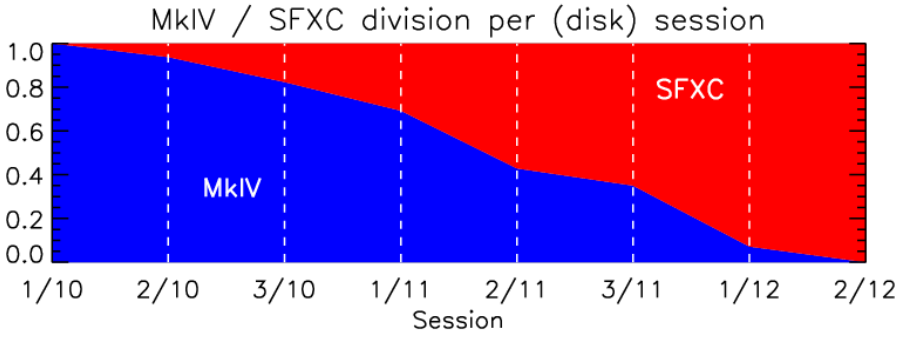

Fig. 2.1 Fraction of disk-based experiments correlated on the MkIV and on SFXC, per session.

- Session 1/2011 had a total of 16 user experiments correlated at JIVE, including 3 e-EVN experiments conducted during the session. Four user experiments were correlated on SFXC (pulsar gating, cross-pol spectral line). Kunming had its first Gbps fringes in the X-band NME. VERA Ishigaki-jima participated for the first time in an EVN experiment (5cm methanol maser observation).
- Session 2/2011 had a total of 21 user experiments correlated at JIVE. Twelve user experiments were correlated on SFXC (cross-pol spectral line, pulsar gating, wide-field mapping, global spectral line). This was the first session in which SFXC correlated the majority of the experiments. SFXC also provided the first correlation of 32MHz subbands at JIVE, in a test of 2 Gbps recording using the CDAS digital back-end on the Chinese stations.
- Session 3/2011 had a total of 25 user experiments correlated at JIVE, including 5 e-EVN experiments conducted during the session. Thirteen user experiments were correlated on SFXC, including the first time that the capabilities for 8192 frequency points, multiple phase-centres, and more than 16-station single-pass correlation were used (among different experiments).

In 2011, there were 38 e-EVN user experiments, eight of which were conducted during the regular disk sessions. There were seven target-of-opportunity experiments, and two triggered observations.

- Session 1/2012 had a total of 14 user experiments correlated at JIVE, 13 done on SFXC. Kunming participated in an X-band user experiment. The KVAZAR stations began using their R1002 digital back-ends in all observations. This session saw the last disk-based user experiment to correlate on the EVN MkIV data processor (EM071D).
- Session 2/2012 had a total of 18 user experiments correlated at JIVE, including five e-EVN experiments conducted during the session. This was the first session in which all disk-based observations correlated on SFXC. A record for largest network size (20 stations) was attained in GF018B.
- Session 3/2012 had a total of 31 user experiments correlated at JIVE. Torun participated for the first time in K-band experiments. Irbene participated for the first time in NMEs, and all three KVN stations participated in the K-band NME. GM070 broke the record for largest network size (23 stations). During this session, the Science Operations and Support group re-made a large number of observing schedules after they had been uploaded by PIs, to accommodate separate last-minute casualties (i) requiring Jodrell2 to replace Jodrell1 and (ii) preventing Gbps recording at Medicina.

In 2012, there were 29 e-EVN user experiments, five of which were conducted during the regular disk sessions. There were four target-of-opportunity experiments, and a triggered observation.

Figure 2.2 (left) shows the evolution of annual EVN network hours since 2004, with the contribution of e-EVN represented by the shaded area (the green line denotes the number of e-EVN hours by itself). Figure 2.2 (right) focuses on the e-EVN experiments, showing a division of annual e-EVN observing hours into different categories: target-of-opportunities (ToO), triggered observations, short (≤2hr) exploratory observations, experiments proposed for disk recording, but conducted in e-VLBI (after consultation with the PI), and the standard e-EVN observations in regularly scheduled sessions. By their nature, all e-EVN observations correlate at JIVE, and occupy a single correlator pass.

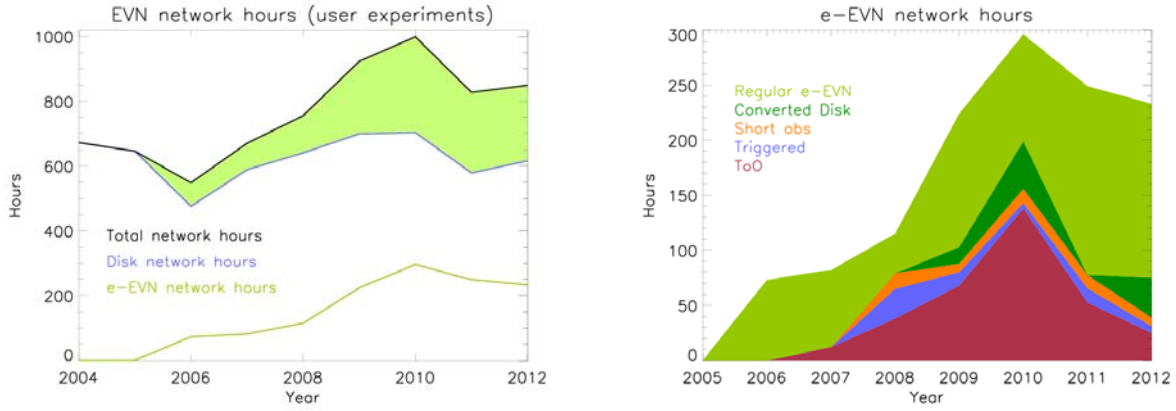

Fig. 2.2 left: Annual EVN network hours, with the contribution by e-EVN observations shown by the shaded area. Right: Division of annual e-EVN network hours into categories

Tables 2.1 and 2.2 summarize projects observed, correlated, distributed, and released in 2011 and 2012. 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.). Note that the instances of multiple correlator passes is largely reduced when using SFXC, since it does not have the explicit maximum spectral capacity limitation of the MkIV. Some experiments still have separate continuum and line passes, to keep the output FITS file size more manageable. Thus the "Network hours" and "Correlator hours" values have grown closer together. The "Correlator hours" statistic for SFXC does not reflect the fact that, unlike the MkIV, SFXC may correlate some experiments faster or slower than real-time depending on their sizes; this is reflected in the efficiency plot below.

	User Experiments			Test & Networking Monitoring		
	N	Network hours	Correlator hours	N	Network hours	Correlator hours
Observed	89	701	979	28	91	91
Correlated	71	535	728	28	92	92
Distributed	76	585	797	24	80	80
Released	77	619	789	27	88	88
e-EVN experiments	38	249	249			
e-EVN ToOs	7	53	53			

Table 2.1 Summary of projects observed, correlated, distributed, and released in 2011.

	User Experiments			Test & Networking Monitoring		
	N	Network hours	Correlator hours	N	Network hours	Correlator hours
Observed	87	711	801	31	96	96
Correlated	85	728	916	26	82	82
Distributed	76	673	861	31	94	94
Released	72	634	828	30	91	91
e-EVN experiments	29	233	233			
e-EVN ToOs	4	25	25			

Table 2.2 Summary of projects observed, correlated, distributed, and released in 2012.

Figure 2.3a presents various measures of correlator efficiency. The red line plots the completed correlator hours divided by the time actively devoted to production correlation. The green line shows completed correlator hours divided by 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 divided by the total operating time—the green and blue lines diverge because some experiments require multiple passes.

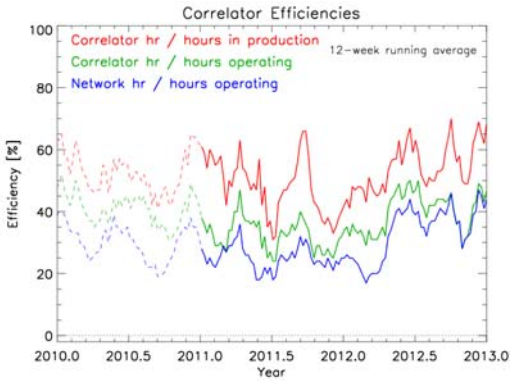

Fig. 2.3a Various measures of correlator efficiency.

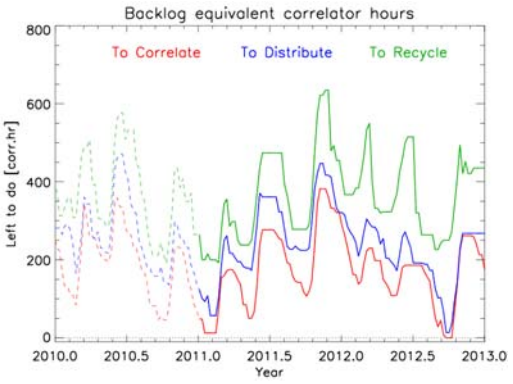

Fig. 2.3b Size of various correlator queues, measured in correlator hours.

Figure 2.3b presents the size of the correlator queue at different stages in the processing cycle, showing a snapshot at the end of each week. Three experiment statuses are plotted, in units of correlator hours summed over all the experiments in each status. The red line shows the experiments that remain to be correlated. The blue line shows the experiments whose data (FITS files) remain to be distributed to the PI. The green line shows the experiments that have yet to be released (in principle, release can happen 2 weeks after release, but in practice it is delayed closer to the time before the following session when packs are needed to replenish the stations, leading to a blocky pattern for the green line).

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). The EVN and VLBA stations follow different sets of guidelines:

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.
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 distribution to the stations for session 3/2012, the cumulative flux-balance summing over both EVN and NRAO stations was with 10 TB of zero (a typical EVN session has been in the range 600-700 TB).

There were unusual problems receiving packs after session 3/2011 from Japanese and VLBA stations. These packs were returned to Japan/the U.S. by the shippers after having entered the Netherlands, without JIVE's knowledge. The Japanese data were eventually e-shipped (data divided into 10-second segments, made available to ftp, and reconstituted onto packs) and successfully correlated. Some of the returned VLBA packs were re-recorded before the situation was recognized (3 stations entirely lost, 3 partially lost, 4 unaffected).

In this period, EVN experiments have continued to go to three different correlators (JIVE, Socorro, Bonn). A principal goal in planning the pre-session disk-pack distribution is to avoid individual packs containing data for more than one correlator. Thus in the disk-distribution plan the load for each target correlator for each station is computed separately. Packs on-hand at a station are applied to one of these individual-correlator loads prior to calculating what replenishment is required from JIVE. The specific set of packs (how many of each of the various available capacities) for each station/target correlator then takes into account minimizing both shipping costs and unused capacity.

The current play-back line-up is 14 Mark5As, 2 Mark5Bs, 1 Mark5B+, and 7 Mark5Cs. The MarkIV correlator is still limited to a maximum of 16 stations. Correlation on SFXC bypasses the station units, so is entirely divorced from the 16-station limitation. Further, the A/B/C flavour of the Mark5 unit is immaterial to SFXC correlation. Thus the effective maximum array-size for single-pass correlation is currently 24. Among the standard EVN stations, Effelsberg, Westerbork, Yebes, Urumqi, Shanghai, Hartebeesthoek, Badary, Zelenchukskaya, and Svetloe currently provide Mark5B recordings (as do typically Irbene, Kunming, the Japanese stations, and KVN stations among the non-EVN stations correlated in this biennial period). The need to retain a number of

Mark5A units depends only on the contingency that the MkIV correlator would be needed (e.g., e-VLBI with more stations than SFXC could handle at a given time). Since SFXC can now keep up with 12 stations at 1 Gbps, this eventuality is not particularly pressing.

Occasionally an incoming pack may have an individual bad disk. JIVE maintains a small bench stock of disks of various sizes, to be able to replace a bad disk locally if that is the most appropriate course of action (in light of warranty status, urgency of recycling, etc.). In such cases, the pack's "owner" would provide a new disk to replenish the bench stock.

2.1.3. ASTRONOMICAL FEATURES

e-VLBI observations have remained a cornerstone of the EVN. The total e-EVN hours were down somewhat from their high in 2010, arising mostly from fewer Target-of-opportunity (ToO) observations using e-VLBI. There were 11 of these (but also 11 disk-based ToO observations—ones requiring multiple correlator passes or stations not having e-VLBI connections). Still, over the biennial period, 34% of the observed EVN network hours correlated at JIVE were e-EVN observations. There were a growing number of e-EVN observations conducted during regular EVN (disk) sessions. This can provide the opportunity to get longer e-EVN observations than would be possible in the regularly-scheduled e-EVN days. A 48-hour e-EVN observation took place in session 1/2011. In terms of e-EVN network improvements, Noto joined for the first time in June 2012 at 512 Mbps, and by September 2012 could sustain 896 Mbps (i.e., channel-dropping one of eight 16MHz subbands in a Gbps mode). Hartebeesthoek, Medicina, and Yebes all improved to being able to sustain a full Gbps.

SFXC has now correlated many user experiments that would have been impossible or at best much less efficient on the MkIV:

- 4 spectral-line experiments having more than 2048 frequency points per subband/polarization (record so far = 8192)
- 17 spectral-line experiments with cross-polarizations, which are done more accurately in SFXC
- 7 pulsar gating experiments (record minimum period so far = 16.45 ms)
- 15 experiments with multiple phase centers (spanned fields range from 25" to 10'; record number of multiple phase centers so far = 50)
- 4 experiments having more than 16 stations (record so far = 23)

There is some overlap among the above list (e.g., an experiment used both pulsar gating and multiple phase centers). There have been 22 other user experiments that SFXC was able to correlate in a single pass, but which would have required multiple MkIV passes, even though they exceeded no individual MkIV limitation in terms of only number of stations or frequency points.

SFXC avoids a physical limit of the MkIV, in which a single interferometer (baseline/subband/polarization) could not exceed the capacity of a single correlator board. In local validity, this meant no more than 2048 frequency points per interferometer. With SFXC, the selection of observing/correlation parameters is greatly simplified for the PI: one now can set the subband bandwidth and number of frequency points directly from the desired velocity spacing and continuum sensitivity. Besides the possibility of increased spectral resolution, SFXC also offers spectral-line observations the advantages of station-based fringe-rotation and the ability to select the spectral-windowing function (default = Hanning, but uniform, Hamming, and cosine are available—the MkIV provided only uniform). A more esoteric improvement pertains to cross-pol spectral-line observations, which are growing in popularity with the demonstration that methanol and OH masers provide the ability to map out

the magnetic fields around massive proto-stars. The MkIV applied (baseline-based) fringe-rotation entirely to one station (always the first station as fed to the correlator from the station units), but for the fourth polarization, it would swap the order of the stations in the baseline (e.g., in Ef-Wb, polarization LR would be Ef(L)-Wb(R) with fringe rotation done to Ef; but RL would be Wb(L)-Ef(R) with fringe rotation done to Wb). This asymmetry between the fringe-rotation zero-point for the two cross-hands polarizations was never repairable in AIPS. It is avoided altogether in SFXC.

The combination of an essentially arbitrarily large number of frequency points and an arbitrarily small integration time in SFXC makes it a much more powerful wide-field mapping correlator, one that could map an area on the sky on the order of the single-dish beams without appreciable bandwidth- or time-smearing. The price of course is huge data sets (one can see in the growth of the archived FITS files in figure 2.7 that there are a higher number of very large experiments once the transition to SFXC has been completed). Multiple phase-centre correlation performs an "internal" correlation with a very large number of frequency points and a very small integration time (current records are 32k frequency points and 4.864ms), but then outputs only subsets of this initial wide field using more traditional values for frequency points and integration times. The most popular applications for multiple phase-centre correlation have been following an in-beam phase-referencing calibrator (this sometimes requires different schedules for the small and large telescopes, the latter ones still having to slew between the two close sources) and investigating a population of sources (e.g., from FIRST or NVSS) that happen to lie in the field of the principal VLBI target.

SFXC provides pulsar-gated correlation, which never attained operational availability on the MkIV. A number of independent bins can be placed within a single gate, defined by a start/stop phase with respect to the pulsar period. Each bin could produce a separate FITS file. Traditional gating corresponds to 1 bin.

With the transition towards e-MERLIN and the removal of the microwave links connecting the out-stations to Jodrell Bank, the ability to include out-stations in the EVN correlation has been temporarily lost. Jodrell Bank and JIVE personnel are working to develop the ability to include the fiber-connected out-stations (after having passed through the e-MERLIN correlator) in an EVN correlation.

2.2. EVN SUPPORT

Automatic-ftp fringe tests are included in all network monitoring experiments (NMEs) at the beginning of each new frequency sub-session within EVN sessions, or as a separate fringe-test observation when the NME does not appear first in the schedule or falls well outside working hours. Under the control of sched and the field system, a specified portion of a scan is sent directly to the SFXC cluster at JIVE. Multiple ftp transfers per experiment provide the opportunity to iterate with the stations in investigating any problems identified. Use of ftp transfer and near-real-time correlation permits stations that don't have a full e-VLBI connection to participate. A Skype chat session during the ftp fringe-test observations provides even more immediate feedback between the station friends and the JIVE support scientists. Correlation results go to a web page available to all the stations, showing baseline amplitude and phase across the band as well as autocorrelations. The web-based results from the first and probably the second ftp transfer would be available to the stations before the end of the NME. These ftp fringe tests continue to be very successful in identifying telescope problems and helping to safeguard user experiments by allowing the station friends to take care of any such problems before the actual astronomical observations begin.

The EVN pipeline runs under ParselTongue (section 3.5.1), providing 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. All experiments, including NMEs, run through the pipeline, with results being posted to the EVN Archive. The pipeline also provides stations with feedback on their general performance and in particular on their gain corrections, and identifies stations/frequency bands with particular problems.

The transition from the analog mark4/vlba4 formatters to digital back-ends has gathered pace in this biennial period. Effelsberg recorded session 1/2011 in parallel onto the DBBC, and has used the DBBC for all observations starting in session 2/2011. Further parallel-DBBC testing has taken place in Onsala, Hartebeesthoek, Noto, Yebes, and Metsahovi. This has been in the "Digital Down-Converter" personality, which can mimic the BBC-tuning and subband-bandwidths available on the existing back-ends. Figure 2.4 shows a comparison of Ef-On and Ef-Od baselines (comparing the mark4 formatter and DBBC back-end at Onsala, while Ef is using the DBBC). The passband is flatter on the DBBC-DBBC baseline, and the phase across the entire range of BBCs is much flatter, with no phase shifts between BBCs apriori (no phase-cal alignments applied in this plot). Extracting calibration information remains one of the last stumbling blocks for more stations permanently moving over to the DBBC. 2 Gbps fringes on the Chinese digital back-end CDAS were achieved in October 2011. The KVAZAR stations shifted to their R1002 digital back-ends in session 1/2012. Previously, they each had a unique configuration, so this transition improves consistency – especially avoiding Gbps C-band quirks such as the Svetloe cut-off at 5000 MHz and internal down-converter interference costing one of eight subbands at Zelenchukskaya.

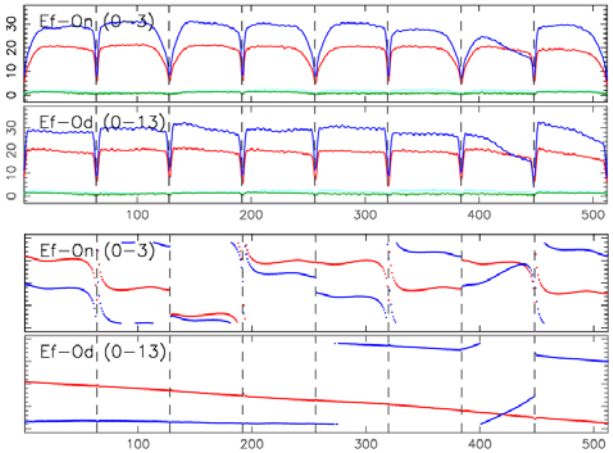

Fig. 2.4 Amplitude and phase vs. frequency on the baselines Ef-On (Onsala with a mark4 formatter) and Ef-Od (Onsala with a DBBC) for the session 1/2012 L-band fringe-test experiment F12L1.

2.2.1. NEW STATIONS

There have been quite a few new VLBI stations participating in user experiments. VERA Ishigaki-jima participated for the first time in some methanol-maser astrometric observations, starting in session 1/2011 and continuing throughout all of 2011. Like the other VERA stations, this is not under field-system control, and provides Mark5B-format disk-packs generated by translating from their native VERA recording tapes. Without a field-system log to control the antennas or associate bytes on the pack with scan start times, they record continuously, moving the antenna under local control to match the schedule. For correlation, the byte/scan

associations were computed from knowing the begin/end times of the recordings (per individual original VERA tape). Kunming obtained Gbps fringes in the X- and S/X-band NMEs in session 2/2011, using the Mark4 back-end that was originally at Wb. The first K-band fringes from the KVAZAR stations Svetloe and Zelenchukskaya came in a ToO in September 2011. Two Korean VLBI Network stations (Yonsei, Tamna) participated in their first test with EVN stations in October 2011, an e-VLBI observation at 512 Mbps. All three KVN stations (also Ulsan) got fringes in the K-band NME in session 3/2012. Figure 2.5 shows the fringes on the baselines formed among the three KVN stations and Shanghai (fringes were also visible on Korean-European baselines, but were weaker due to the length of these baselines). Irbene obtained its first fringes during a test observation in April 2012 (C-band, 512 Mbps), and got fringes in both the C- and L-band NMEs in session 3/2012. Figure 2.6 shows the fringes on the baseline Effelsberg-Irbene, with both stations having a DBBC back-end.

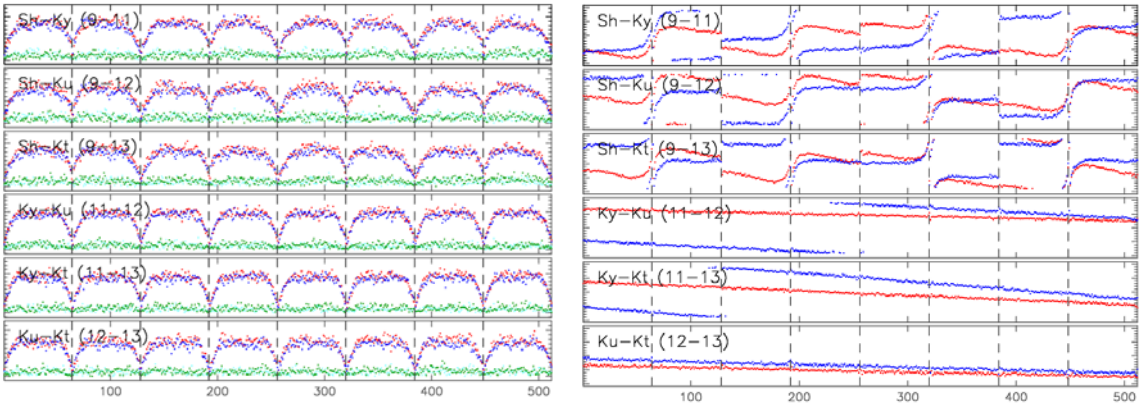

Fig. 2.5 Amplitude and phase vs. frequency on the baselines among the three KVN stations and Shanghai for the session 3/2012 K-band NME N12K4.

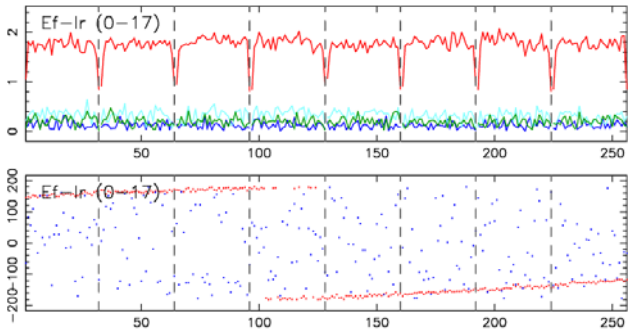

Fig. 2.6 Amplitude and phase vs. frequency on the baseline Effelsberg - Irbene for the session 3/2012 C-band NME N12C4. Irbene had only RCP available, a known feature of these observations.

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. 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.

The Archive moved onto a bigger, more powerful machine (the EVN pipeline also runs on this machine). It has 33 TB of available disk space, which it shares with the pipeline work area (currently using around 2.3 TB). The total size of the FITS files in the archive at the end of 2012 was 14.84 TB (a 5.87 TB gain in the two-year period); figure 2.7 shows the growth of the FITS-file size in the EVN archive size over time. A pick-up in the number of very large experiments can be seen following completion of the transfer to SFXC.

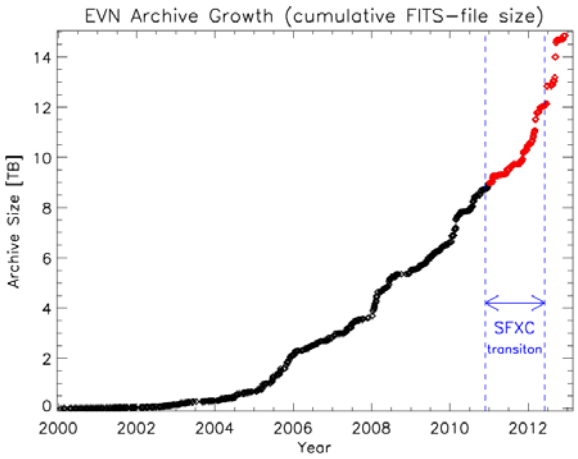

Fig. 2.7 Growth in the size of FITS files in the EVN archive. Experiments archived in this biennial period are plotted in red. Vertical blue lines demark the date of archiving the FITS files from the first SFXC correlation and that from the last MkIV correlation of a disk-based observation, bounding the transition period in populating the archive from the two correlators.

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. There were 12 first-time EVN PIs in 2011 and another 9 in 2012. The group also checked schedules that PIs had posted to VLBEER, before the stations downloaded them. In some cases, this led to a dialogue with a PI about fixing a specific problem or improving some observational tactic. There were a couple instances in which last-minute casualties at the stations led the group to re-make schedules after the PIs had already uploaded them, most notably in session 3/2012. Jodrell1 suffered an azimuth wheel casualty, so all of its schedules (24) were shifted to Jodrell2, including re-introducing the smaller antenna into scans that Jodrell1 intentionally missed in fast cycle-time phase-reference observations. Medicina saw in the L-band sub-session that they were not able to record Gbps observations, so the schedules for their remaining C-band and X-band Gbps observations were remade using 1-bit sampling (hence, bit-rate falling to 512 Mbps).

The preferred IF/BBC associations for stations using digital back ends can fail the various checking rules in the NRAO scheduling program “sched”, so the Science Operations and Support group have continued to provide PIs of experiments with plug-ins for their sched-input files each session that properly specify the current station set-ups while allowing sched to run without complaint. JIVE personnel provided new code to sched to handle the KVAZAR R1002 digital back end, and are working towards the same for the DDC personality of the DBBC.

JIVE continued to provide maintenance for the EVN-specific portion of the NorthStar Proposal Tool. The most significant action in this area was in the organization of the available "facilities" within the EVN portion: merging the separate EVN+MERLIN and e-EVN facilities into one. Now e-EVN observing can be requested on an "observation" basis within a single EVN+MERLIN proposal, allowing proposals that contain some parts using e-

VLBI and some parts using disk-based observations, presenting the correct choice of frequencies and telescopes for each such observation.

Fig. 2.8 Participants at the 11th EVN Symposium at Place de la Bourse in Bordeaux, 9-12 October 2012

A notable event showcasing the efforts of the JIVE and EVN teams was the 11th EVN symposium. In the great setting of Bordeaux the EVN users demonstrated the breadth of modern VLBI science, showing the latest scientific progress with e-VLBI and software correlation.

3. TECHNICAL OPERATIONS and R&D

As in previous years, the staff members of the Technical Operations and R&D group were involved in many nationally and internationally funded projects during the period 2011 - 2012. The EC-funded NEXPReS project, which kicked off in July 2010, picked up steam with the hiring of two software engineers at JIVE. Through the ShAO-NWO collaborative agreement, which was set up in order to stimulate the technical and scientific collaboration between Shanghai Observatory and JIVE, a Chinese PhD student spent most of these two years at JIVE working on, among others, pulsar gating modules for the next generation EVN correlator, successfully defending his thesis at ShAO along the way. The RadioNet FP7 UniBoard project formally ended June 30 2010, to be followed by the start of RadioNet3 UniBoard^2 on the first of July 2010. The NWO-funded ExBoX project, aimed at creating larger computing systems for correlation and beamforming based on the UniBoard, ran its course by the end of 2012.

On top of their regular activities, several staff members were in charge of work packages in these projects, including the management of deliverables, the organisation of demonstrations often involving many international partners and the writing of quarterly and yearly reports. In addition staff members were involved in liaising with research networks and EVN partners, participation in international panels and representations at many international meetings.

Traditionally, the maintenance and improvement of the MarkIV hardware correlator and supporting hard- and software has been at the center of activities of the Technical Operations and R&D group. Throughout the reporting period however operations have shifted from the MarkIV to the EVN software correlator at JIVE (SFXC) to such a degree that all efforts are now geared towards the development of new SFXC features and the debugging and commissioning of the UniBoard-based next generation EVN correlator.

3.1. DATA PROCESSOR MAINTENANCE

With the actual use of the MarkIV hardware correlator limited to e-VLBI by early in 2012, maintenance of the correlator and associated hardware like the Station Units dwindled to the occasional replacement of a power supply. Supporting systems like the cooling system, paternoster, fire alarm and extinguishing systems were maintained and regularly serviced. A replacement of the JIVE correlator cooling system was discussed with ASTRON, in view of the installation of a heat exchanger servicing the entire Dwingeloo building complex including the new wings that are currently under construction. With the doubling of the SFXC hardware and addition of many new computer systems, replacement of the somewhat underprovisioned power supply to the JIVE cellar became necessary. The migration of equipment to the newly installed electricity distribution board with its own high-capacity connection to the central mains was done in-house over a period of several months, to minimize disturbances to the operational system.

3.2. DATA PROCESSOR DEVELOPMENTS AND UPGRADES

3.2.1. MARK5 AND JIVE5AB

The Mark5 units at JIVE performed reliably. The upgrade from Mark5A to B was halted when it was realized that the insistence of the Mark5B firmware on "perfect" data made the units in practice unusable for correlation of astronomical data on the MarkIV correlator. This issue has become moot however, as the SFXC correlator reads in data directly via the StreamStor boards. Without need for synchronicity and without dependence on I/O boards, the type of Mark5 has become irrelevant for correlation. Newer Mark5s do have relatively powerful CPUs though, and the application of this "free" computing power to the software correlation process is being considered.

Jive5AB, the locally developed Mark5 control code, was originally aimed at enabling high-bandwidth UDP-based e-VLBI. Over the years its functionality has increased tremendously, with many useful features such as on-the-fly cornerturning, smart memory management, the capability to send chunks of data to different destinations for distributed correlation and simultaneous recording/transmitting. One often voiced wish of the Technical and Operations Group (TOG) of the EVN has been the availability of one single control code for all VLBI operations, both recorded and real-time. To this purpose, a large effort was put into implementing the complete Mark5 command set into Jive5AB. By the end of 2012, this was mostly completed and undergoing field tests.

Using Jive5AB for all VLBI in the EVN will enable e-VLBI during standard disk recording, using standard schedules, without interrupting recording or any special actions by the station operators. This capability is in fact one of the stated goals of the NEXPReS project.

3.2.2. ARCHIVE

A replacement archive machine with a total of 33TB of storage (expandable) was purchased and installed in 2011. The archive backup machine, located in one of the Faraday cages at the WSRT, was finally repaired after a long down-time and is fully operational again. Besides the daily mirror of the archive on this backup machine, incremental tape backups are made on a daily basis and regularly shipped to Westerbork.

3.2.3. PCINT

The ageing PCInt cluster, the institute's common data processing platform, was replaced by a platform combining fast disk access, 16 TB of storage and high performance. After the transfer of the many bits of different user software, this new machine has been used operationally since early 2011. One computing node of the old PCInt was re-used as a host for web services.

3.3. SFXC SOFTWARE CORRELATOR

The speed of development and deployment of the SFXC correlator over the past two years has surpassed anyone's expectation. In 2011 additional hardware was purchased to double the number of cores, increasing its real-time capacity to nine stations at 1 Gbps, including cross-pols. This also involved a complete re-design and extension of the local network, accommodating connectivity to three correlators (the still-functional MarkIV, the extended SFXC and the UniBoard correlator) as well as to several new pieces of equipment like the

NEXPReS WP8 FlexBuff, and an extra 10G connection to SURFNet, meant for high-speed Bandwidth-on-Demand tests.

Fig. 3.1 Re-arranging equipment in the JIVE cellar during the SFXC upgrade

After an extended period of in-depth comparisons of the results of the MarkIV, SFXC and DIFX correlators, SFXC was taken into full operational use in 2011. Its reliability and ease of operation rapidly made SFXC the preferred correlator at JIVE for all disk-based correlation, although the limitation of 9 stations in real-time meant that the MarkIV correlator was still needed for e-VLBI sessions.

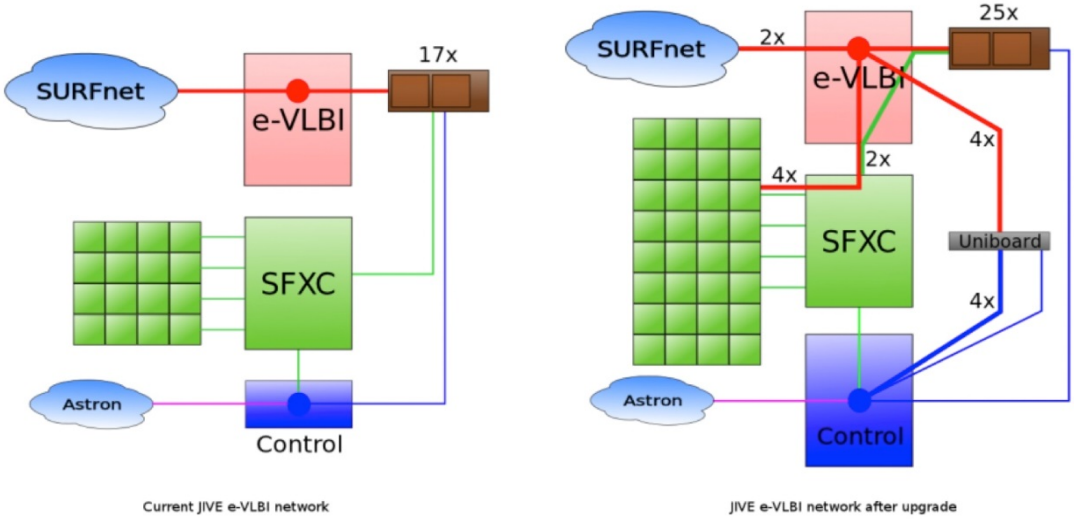

Fig. 3.2 Re-design of local JIVE network

Many new features were added to SFXC. These included components like online fringe and weight plots, different spectral windowing modes, application of a near field delay model developed by the Space Science Group of JIVE, and a phased array mode in which the stations are coherently summed. Correlating multiple phase centers was offered as an operational mode to the community, and work began on defining the primary beam shape of the EVN, needed for the correction of wide-field data.

e-VLBI support was implemented and tested, with an on-line clock search utility. Towards the end of 2012, additional hardware was bought which should allow JIVE to shift all correlation, both recorded and real-time, to the SFXC in 2013. The first operational e-EVN using SFXC took place in December 2012.

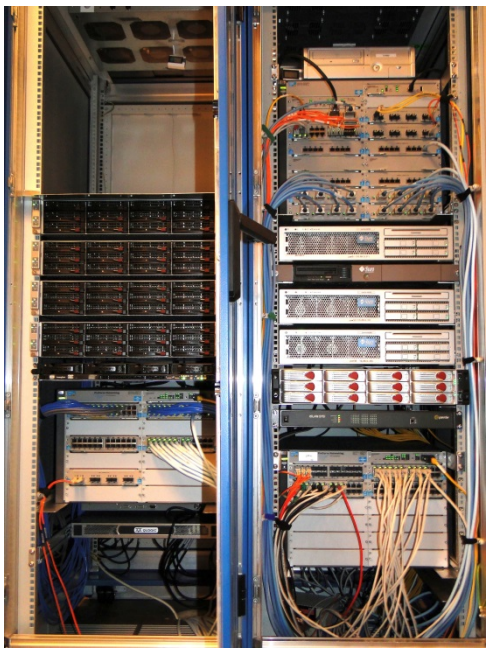

Fig. 3.3 New networking equipment at JIVE

3.4. NEXT-GENERATION FPGA-BASED EVN CORRELATOR

3.4.1. THE UNIBOARD

The UniBoard project, a Joint Research Activity in RadioNet FP7, had as its aim the creation of a generic high-performance FPGA-based computing platform for radio astronomy, along with the implementation of several firmware personalities. A major milestone was reached in the first half of 2011 with the production and delivery of eight boards to the project partners.

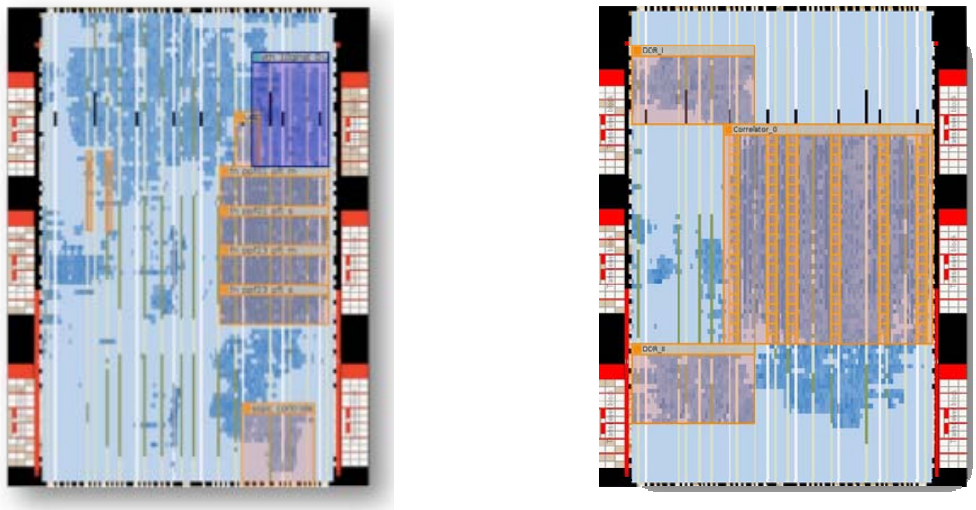

Fig. 3.4 Physical layout of EVN correlator design on UniBoard FPGAs

Although a good deal of effort was spent by the JIVE engineers on hardware tests and providing a suite of test firmware for the partners, correlator development progressed at a good pace. Filterbank, correlator engine and delay modules were designed and integrated, as were interface modules to transfer data from front to back nodes and an output module to select and transmit specific correlation products over 10G Ethernet ports. A design to add pulsar gating was proposed and documented.

The code footprint of the NIOSII embedded soft-core CPU was significantly reduced, making more real-estate on the FPGAs available for the firmware engineers. An Erlang-based interface was created, enabling highly efficient communication with one or all FPGAs on any number of UniBoards. Erlang was also used to create a correlator control system, used for correlator configuration, synchronization of data and delay model sources and the handling of the final products on the output side. All these efforts resulted in first fringes in June 2012, just before the formal end date of the project.

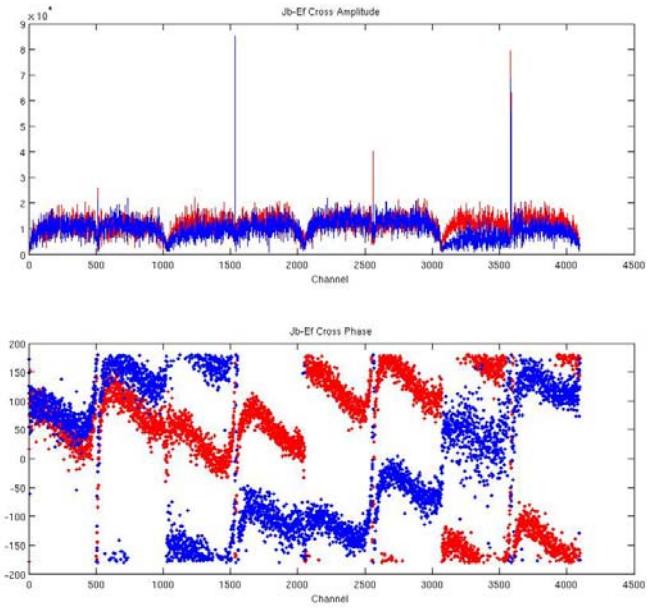

Fig. 3.5 First fringes with UniBoard next generation EVN correlator

Although the project has ended, much development is still ongoing and many more UniBoards have been produced, for use at ASTRON (APERTIF beamformer and correlator, AARTFAAC correlator), MPG in Bonn (filterbank for the pulsar machine on the Effelsberg 100m telescope), Shanghai Observatory (VLBI correlator, receiver for the new 65m telescope at Sheshan).

Fig. 3.6 EVN next generation correlator: two UniBoard units with clock generator and power supply

3.4.2. UNIBOARD^2

UniBoard^2, a Joint Research Activity in RadioNet3, is in a sense a direct continuation of UniBoard. But while the first UniBoard was aimed at a number of instruments currently under development, UniBoard^2 is explicitly meant for future large instruments, with the SKA as obvious example.

With this in mind, an even larger emphasis will be put on power efficiency. This will be done through the use of the latest technologies, the potential use of (partial) hardcopy (turning a re-programmable FPGA into an ASIC with the same footprint but far lower power consumption), and the use of clever programming techniques to balance performance and power consumption optimally.

The UniBoard^2 project timeline however straddles two FPGA technologies, 28 and 20nm. To make a platform that will be a serious contender for any SKA-related instrumentation, one has to use the latest technology: going from 40nm (used for the first UniBoard) to 20nm would mean skipping one generation, and probably result in an increase in computing power of about one order of magnitude.

As a consequence, the decision was made to delay the choice of device as long as possible, but no more than one year after the official start of the project, 1 July 2012. This meant of course that only preparatory work was done during the first half year. However, at the end of 2012 it became clear that the newest devices would be available in time for the UniBoard^2 project, and the expectation is that the actual hardware design will start in Q3 of 2013.

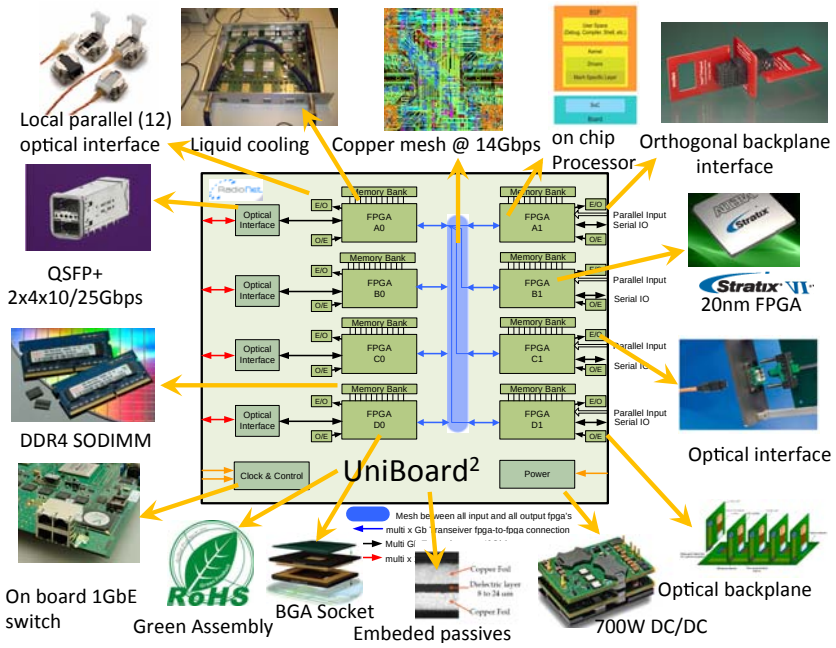

Fig. 3.7 Various options under consideration for UniBoard²

3.5. USER SOFTWARE DEVELOPMENTS

3.5.1. PARSELTONGUE

ParselTongue has grown to be an important tool for VLBI astronomers around the world, and has been adopted by several VLBI astrometry programmes, such as the BeSSeL survey, <http://www3.mpifr-bonn.mpg.de/staff/abrunthaler/BeSSeL/index.shtml>, as a basis for their data reduction. ParselTongue is also used by the e-MERLIN pipeline, which has its roots in the ParselTongue-based EVN pipeline developed at JIVE. In the past two years JIVE continued to provide user support for ParselTongue through the ALBiUS (RadioNet FP7) and HILADO (RadioNet3) projects. In HILADO the focus will be on integrating new developments in ParselTongue with High Performance Computing (HPC).

3.5.2. ALBIUS

Within ALBiUS an attempt was made to bring VLBI data reduction capabilities into CASA. During the seccond part of the project, work focussed on implementing fringe fitting in CASA. A new fringe fitting algorithm was investigated and prototyped. Unfortunately this work was not concluded by the end date of the ALBiUS project.

3.6. E-VLBI DEVELOPMENTS

Throughout the period 2011 – 2012 the e-EVN facility operated at an unprecedented level of reliability, with smooth 24-hour (and more) observing runs and only very occasional network failures. Unfortunately, the MERLIN out-stations were, at least temporarily, lost for e-VLBI when e-MERLIN came online. In the second half of 2012 tests got underway to re-introduce MERLIN stations and once again provide the short baselines which are very much appreciated by e-EVN observers.

Also during this period, the KVAZAR network joined the EVN. While these stations have brought about a fantastic improvement in UV coverage, their lack of connectivity has meant that e-VLBI did not benefit from this. However, the KVAZAR network is moving towards higher connectivity too, and a real boost for the e-EVN is expected once this happens.

Another important milestone was the first EVN-KVN e-VLBI test run in 2011, resulting in K-band fringes between the two Korean telescopes of Yonsei and Tamna and Yebes, Onsala and Metsahovi (in spite of the rain at Onsala and Metsahovi!). Note that these real-time fringes were the first ever for KVN telescopes at JIVE, without any recorded data having been correlated previously.

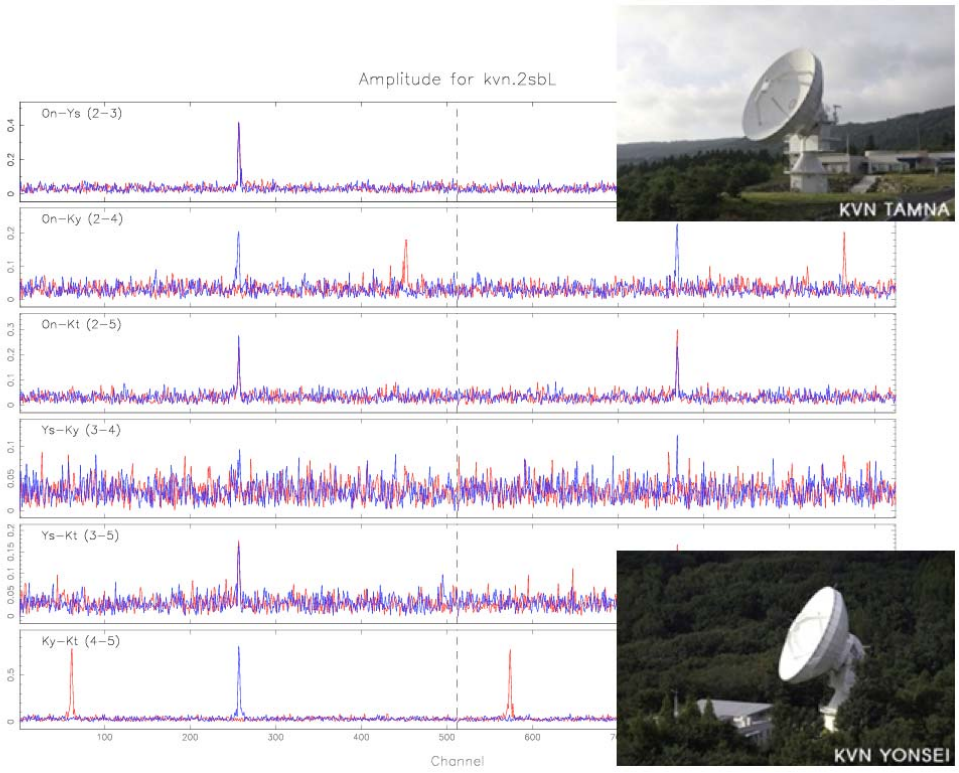

Fig. 3.8 Amplitude fringe plots of first EVN-KVN e-VLBI

3.7. NEXPReS

Much of the effort of the Technical Operations and R&D group was related to the NEXPReS project in this period; of the four Service and Joint Research Activities in NEXPReS three were led by JIVE staff. In spite of a slow start in 2010, speed picked up considerably with the hiring of two software engineers at JIVE in the first half of 2011.

3.7.1. CLOUD CORRELATION

This work package was primarily aimed at introducing transparent buffering in EVN operations and removing the distinction between real-time and recorded VLBI. To this purpose many additions to and modifications of existing tools were made, enabling automated job scheduling, mixed recording/streaming of data at the stations and at the correlator, on-the-fly corner turning and automated delayed correlation. Two major new

software packages were designed and tested. The first, called the Continuous Automated Intelligent Monitoring (CAIM) package, will monitor weights of incoming data but also the quality of fringes on selected baselines, and generate warnings via email or sms when certain adjustable thresholds are crossed. It uses the functionality of the open source Zabbix monitoring software, which is also being used for more straightforward monitoring of the health of the hardware components of the SFXC software correlator.

The second package is called the Automated Fringe Test pipeline (AFT). Currently, a few Network Monitoring Experiments (NME) take place during each EVN observing session, in which small amounts of data are ftp'd to JIVE for quality control and early detection of technical problems. The purpose of this new tool is to enable observers to schedule as many fringe tests as wanted, without having to interrupt science observing. The tool can automatically select a bright calibrator per experiment, record several seconds of data on a local Mark5 disk (without disrupting the recording to disk pack) and trickle the data to the SFXC at JIVE at whatever bandwidth is available. Once all data have arrived, a correlation job is fired off automatically. In principle, the observer can decide to do this test for every calibrator in the schedule, or not at all. This step can be nearly trivially extended to continuous streaming/recording, one of the stated goals of the NEXPReS project.

All of these developments depend on the many new features of the Jive5AB code, as described in a previous section, and assume EVN stations to adopt Jive5AB as the control code for all VLBI operations, both recorded and real-time.

3.7.2. HIGH BANDWIDTH ON DEMAND

This package was to extend the still largely experimental and local bandwidth-on-demand services to a high-speed, inter-domain capability, suitable for transporting data streams of 1, 4 and even 10Gbps from the telescopes to the correlator. Joining an effort by several NRENs and GEANT towards the establishment of a standard protocol in the form of the Network Service Interface (NSI), JIVE engineers implemented a local NSI-requester, with a web-based BoD reservation tool and a scheduler to run automated tests, as well as a basic NSI-aggregator, for reservations spanning multiple NSI domains.

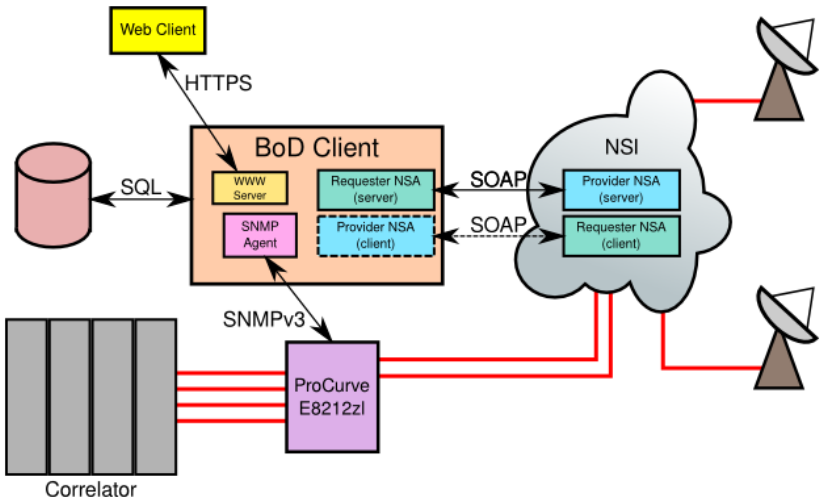

Fig. 3.9 Schematic overview of BoD implementation at JIVE

Several demonstrations took place during this period. The first, in March 2012, combined NSI paths between JIVE, Torun and Onsala with an AutoBahn path between Onsala and Jodrell Bank, over which 4Gbps of traffic was sent. In December 2012, international BoD connectivity at a full 10Gbps was demonstrated between JIVE, Torun and Onsala, followed by, also in December 2012, automated performance verification of BoD paths, integrated with the NEXPReS BoD client software.

3.7.3. COMPUTING IN A SHARED INFRASTRUCTURE

The aim of this work package was to create an automated distributed correlator using the global, shared infrastructure of the EVN and its associated global partners. One use for such a system could be the deployment of a sub-array of less heavily subscribed EVN telescopes, for example for monitoring campaigns.

As such an instrument would have to run in parallel to the existing EVN operations, recording was not considered an option; all observing would be done in real time. For this the e-VLBI capabilities of SFXC were developed, first used in production in December 2012. In addition, both SFXC and Jive5AB were adapted and extensively tested for use of the VDIF data format.

At Onsala, a station module was developed which automatically schedules the preparation and execution of an observing schedule at the telescopes. A webservices-based e-VLBI system was also created, coordinating schedule distribution and execution, data transfer and correlation. These tools make it possible to stop an ongoing observation at a pre-approved trigger, and re-start a new observation, without the need of any intervention by telescope operators. The functionality of these components was successfully demonstrated in May 2012, albeit with off-line correlation.

3.7.4. FLEXBUFF: HIGH-BANDWIDTH, HIGH-CAPACITY NETWORKED STORAGE

This package, under the lead of Metsahovi Observatory, set out to create a high-speed, simultaneous read/write buffer for use at telescopes and correlator, using COTS components and clever programming. After a careful selection of hardware components a configuration was proposed which was then implemented at several EVN sites. JIVE staff participated in the testing of this hardware, streaming data between various telescopes and correlator, using both existing and newly developed code.

3.8. E-VLBI WORKSHOPS

The 10th (and last) international e-VLBI workshop was held in November 2011 in Amanzingwe, South Africa. With more than 50 participants it was, as in past years, very well attended. Many topics were discussed, covering the progress made in NEXPReS and e-VLBI efforts around the world. During a half-day meeting at Hartebeesthoek Observatory its director Mike Gaylard explained the potential of refurbishing retired 32m telco dishes across the continent for radio astronomy in order to create an African VLBI array. Several presentations about radio astronomy in various African countries illustrated the impact VLBI and the SKA can have in Africa, both scientifically and educationally.

Fig. 3.10 Participants of 10th International e-VLBI Workshop

In October 2012 the workshop took place at the Haystack Observatory, USA. As had been decided in the previous year, the focus of the workshop was broadened to encompass other technical VLBI developments than e-VLBI, such as the many different digital backends currently being developed and rolled out. Consequently the title became "The First International VLBI Technology Workshop". Directly following this meeting an in-depth DBE compatibility testing workshop was set up, with many groups taking their digital backend hardware along for zero-baseline testing.

As a result of this change of focus towards pure engineering, the composition of the audience changed somewhat. Unfortunately this also meant that only very few science talks were given, while many of the astronomers that would in past years give updates on e-VLBI science did not show up.

3.9. TOWARDS 4GBPS E-VLBI: A DEMO

Although live e-VLBI demonstrations played a less prominent role during NEXPReS than they did in the EXPReS years, one particular demo in 2012 is well worth highlighting. It involved the use of new equipment in new modes, new firmware, hardware, software, and real-time data transmission and correlation at higher bandwidths than ever before attempted.

3.9.1. OBJECTIVES

As part of NEXPReS deliverable D5.2 an observing session was proposed during which the new capabilities of the EVN developed through Work Package 5 (Cloud Correlation) would be showcased. It was to be a live demonstration and to take place before the end of year 2 of the project (July 1, 2012). The aim of the demo was to exercise some new observational modes that will become the standard in the EVN in the next years, namely high-speed recording (2 and 4 Gbps) at the stations while simultaneously transferring a subset of the

data in real time to the correlator in Dwingeloo, and the real-time correlation of the full data streams, with or without recording at the stations.

Three telescopes, the 100m Effelsberg telescope in Germany (Ef), the 20m Onsala telescope in Sweden (On) and the 40m Yebes telescope in Spain (Ys) participated. Results (throughput, fringes, live webcams) would be instantly shown on a demonstration web page specifically created for this event.

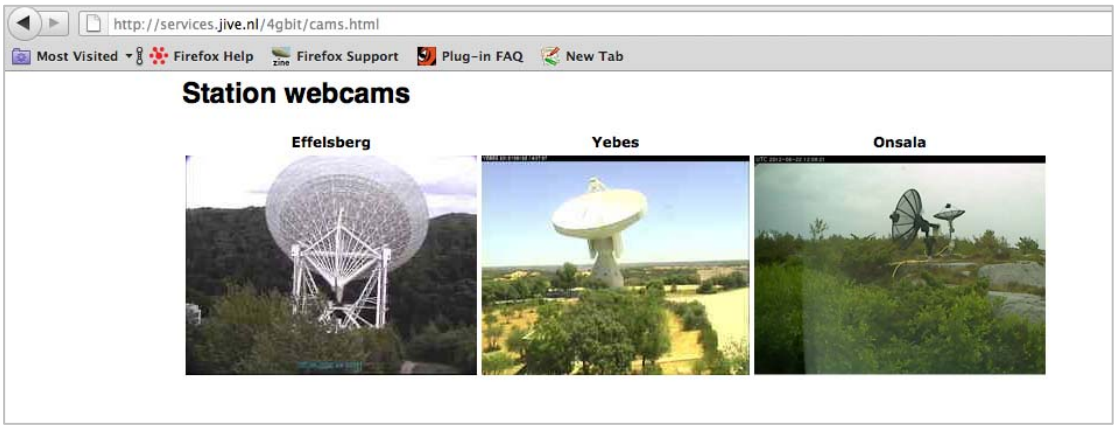

Fig. 3.11 Webpage with live webcams of participating telescopes

The preparation of the demo started in December 2011. As it was clear that the effort would be considerable, the date was set as late as possible in year two of NEXPReS, that is, end of June 2012. Test time was found in gaps in the EVN session that ran prior to this date.

3.9.2. INITIAL SITUATION

At the onset, many technical aspects were still unclear.

- Mark5C recorders would be needed to record at 4 Gbps, but this recording mode was neither fully developed nor tested. What was more, its 10G interface was limited to one-way traffic and had no filtering capability.
- The DBBC, the European-developed digital baseband convertor, had so far only been used at Ef for EVN operations. Only 2 Gbps had been tested in the previous year, while the firmware had changed considerably since then.
- 10G connectivity was only freely available to Ef, via the connection shared with the International Lofar Telescope. For On a bandwidth cap needed to be removed, Ys had dark fibre and network equipment in place, but the equipment was not lit yet.
- SFXC, the EVN software correlator at JIVE, would have to process three times 4Gbps data streams, which meant some way had to be found to split up these streams in 1Gbps chunks (or smaller) to make real-time processing on the cluster nodes possible.

3.9.3. PRACTICAL SOLUTIONS

- As a first step, a JIVE engineer was sent for two weeks to Haystack Observatory to assist with the completion, testing and debugging of the 4Gbps-recording mode. A complete Mark5C unit was sent from JIVE to Ys, as it was certain they would not be able to purchase their own unit in time.
- The DBBC at On suffered from clock jumps, but this was fixed on site; the one at Ys had to be shipped to the Max Planck Institute in Bonn for troubleshooting.

- The firmware of the Fila10G boards, needed to output 4Gbps data streams on 10G Ethernet, was overhauled to produce the same data stream on both of its 10G ports. The Ef board that was sent along with a DDBC to Chile for tests with the APEX telescope was taken back to Germany as hand luggage (and was promptly impounded by customs for about one week). Both On and Ys received boards on loan from other EVN observatories.
- A new piece of hardware was introduced, which became known as the HarroBox (named after a certain software engineer at JIVE). These small (1U) but very powerful servers with multiple 10G interfaces were equipped with software (a modified version of the locally developed Jive5AB Mark5 control software) that could accept a 4Gbps Mark5B-format data stream from a Fila10G, chop it into 4 chunks on the fly and send these chunks to different cluster nodes.
- Software functionality was added to the SFXC to corner turn 1Gbps chunks on input nodes and send them to the right correlator nodes. 10G interfaces were added.
- The decision was made to observe at X-band (3.6 cm wavelength), as On has a second telescope used for this frequency, eliminating the need for changing. A common LO setting of 7650 MHz was chosen.
- By the end of May the 10G connection from On to JIVE was finalised. The Spanish NREN and the European backbone GÉANT decided to move the e-VLBI traffic to a secondary 10G link, in order to make sure the capacity would be sufficient. SURFNet accommodated all the traffic in Amsterdam, where a BoD connection was set up to allow using the 10G connection between Amsterdam and Dwingeloo normally reserved for BoD testing and development.

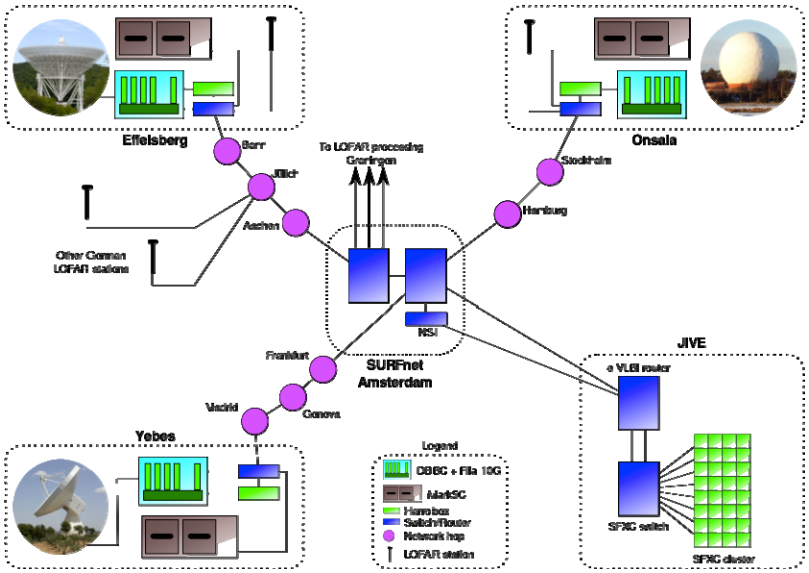

Fig. 3.12 Network connectivity between stations and JIVE

3.9.4. RESULTS AND CONCLUSIONS

The demo took place on 20 June 2012. A number of minor issues had to be dealt with immediately, after which everything worked more or less out of the box. Unfortunately, no fringes were found. Most of the time this day was spent on trying to find fringes, ftp'ing bits of data from the Mark5C recorders to JIVE to explore different combinations, different time delays, but, to no avail.

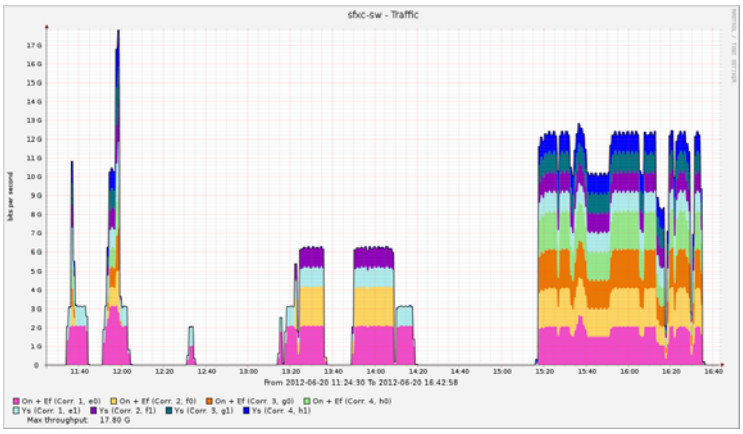

Fig. 3.13: Data throughput at JIVE. The peak of 18Gbps is caused by internal flooding at the correlator

In spite of the lack of fringes, this demo showed conclusively that the EVN is ready for both recorded and real-time 4Gbps observations. However, finding the right configuration of a very complex, flexible and practically unknown piece of equipment like the DBBC will clearly take some more careful thought. It was also an excellent opportunity for the EVN staff to showcase their technical competence and inventiveness as well as a demonstration of the strength of the international collaboration that forms the basis of the EVN.

At the second year NEXPReS review the results of this demo were presented and much appreciated by the review panel. At the end of the review the decision was made to re-do the demo, this time obviously with fringes and phase closure between three EVN stations at 4Gbps, during the final project review. This final review will be held in September 2013, in Dwingeloo.

4. SCIENTIFIC RESEARCH

4.1. HIGH-MASS STAR-FORMATION

Kalle Torstensson and Huib van Langevelde obtained some significant results comparing data from the EVN on 6.7 methanol masers with the large-scale thermal methanol distribution, using JCMT HARP data at 338 GHz. For these sources an analysis was made of the methanol excitation and this was also interpreted in terms of an outflow originating from the central object, presumably where methanol is released into the gas phase. In a sub-sample with confined (young) outflows, their direction appears to be along the axis of the rings of methanol that were detected in collaboration with Anna Bartkiewicz (Torun) (Fig. 4.1). Although limited to a few sources, this result constrains the motion of the methanol in these rings to be dominantly in-fall, as was earlier found for the archetypical source Cep A.

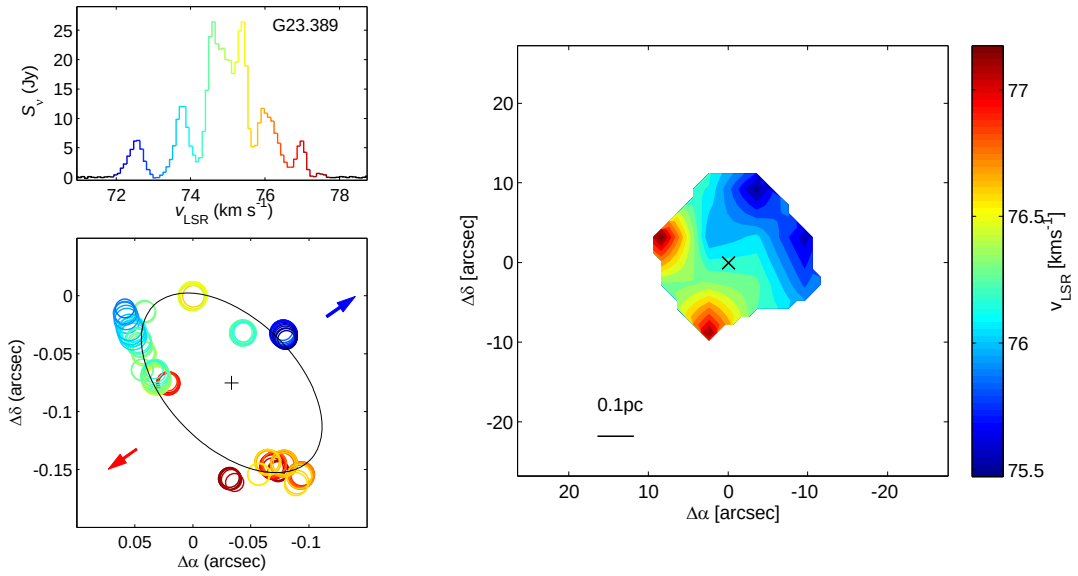

Fig. 4.1 The ring of methanol masers (left) of G23.389+00.185 is oriented perpendicular to the much larger-scale outflow detected in thermal methanol lines (right)

The methanol masers feature in several other projects by Huib van Langevelde and Kalle Torstensson. Together with Wouter Vlemmings (Bonn/Onsala) and Gabriele Surcis (Bonn, now JIVE) progress was made in interpreting the methanol and water maser Zeeman effect and observed linear polarization, for example in the source NGC7538-IRS1. This was a first step in trying to observe a statistically significant sample of sources with outflows and magnetic fields. Possibilities were explored to make laboratory measurements of the methanol Lande factors, necessary to interpret the Zeeman measurements quantitatively.

In collaboration with Bartkiewicz (Torun) further measurements were made on the outflows; water masers observed with the EVN seem to trace outflow structures perpendicular to the methanol structures. Similar findings obtained on thermal methanol were used to prepare for ALMA observations.

In addition in a project with Kazi Rygl (INAF-IFSI, Rome) and Andreas Brunthaler (MPI, Bonn) parallax distance measurements have investigated the membership of methanol maser complexes in the Cygnus X region,

demonstrating that AFGL 2591 is in fact a background object (Fig. 5.2). Huib van Langevelde joined the Bessel programme that aims to measure the kinematics of the Galactic spiral structure, by methanol maser parallax observations. Preparations were made to start a large-scale programme on the VLBA. In addition some effort was made to explore measuring the inner Galaxy masers with VLBI telescopes under construction in Africa.

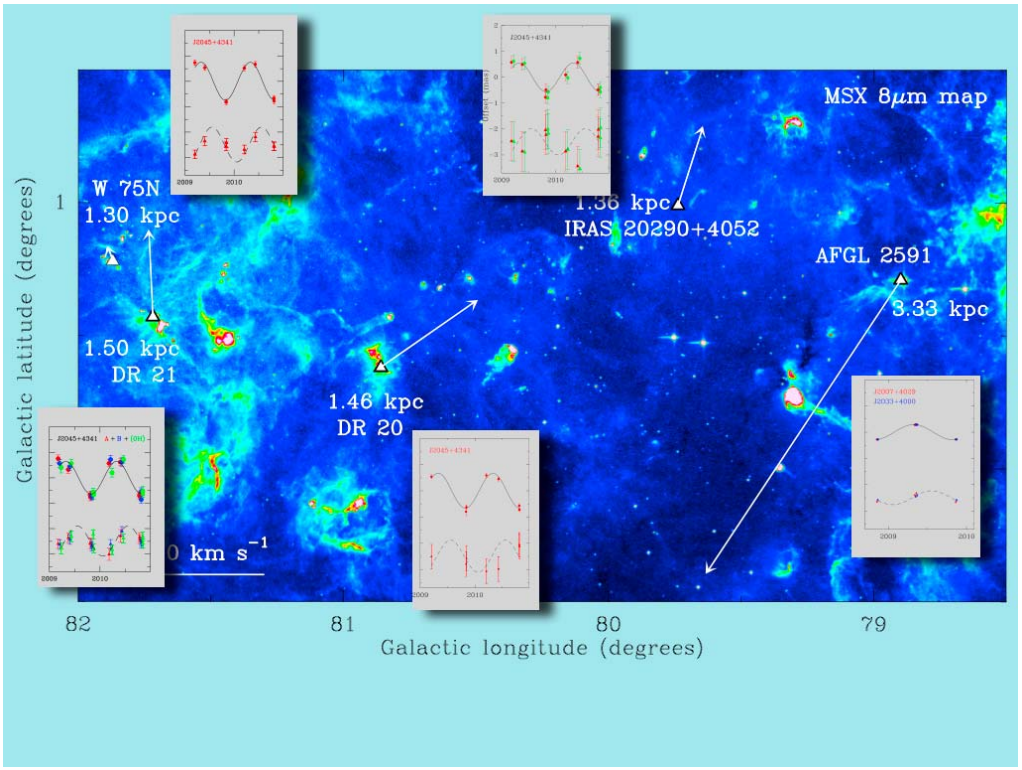

Fig. 4.2 Parallaxes of methanol masers in the Cygnus X region demonstrate that notably AFGL2591 is not at the same distance. Therefore it is demonstrated that these star forming regions do not belong to the same large-scale structure in the local spiral arm (Rygl et al. 2012, A&A 539 79).

Gabriele Surcis and Huib Jan van Langevelde together with Wouter Vlemmings (Chalmers University of Technology) and Busaba Hutawarakorn Kramer (MPIfR) continued their work on measuring magnetic fields morphology close to massive protostars by using 6.7-GHz methanol masers. The eight massive protostars observed with the EVN showed magnetic fields preferably aligned with the massive outflows that are launched from the protostars. In particular, the results obtained for the massive protostar W51-e2 is of great importance, indeed the morphology of the magnetic field measured with the methanol masers (angular resolution of 1 mas corresponding to about 5 AU) is consistent with the hourglass morphology determined by observing the dust emission with the SMA by other authors. Moreover, by measuring the Zeeman-splitting it has been found that the momentum of the outflows increases when the magnetic field strength decreases. All the results are in agreement with the recent theoretical simulations of massive star formation (Surcis et al. 2012, A&A, 541, 47).

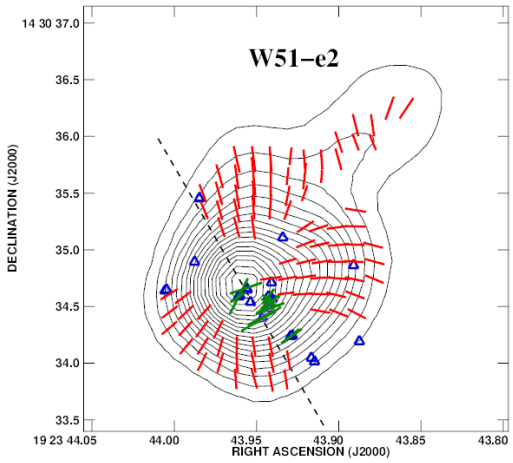

Fig. 4.3a: The magnetic field orientation around W51-e2 measured with the methanol masers (green segments) and with the dust (red segments).

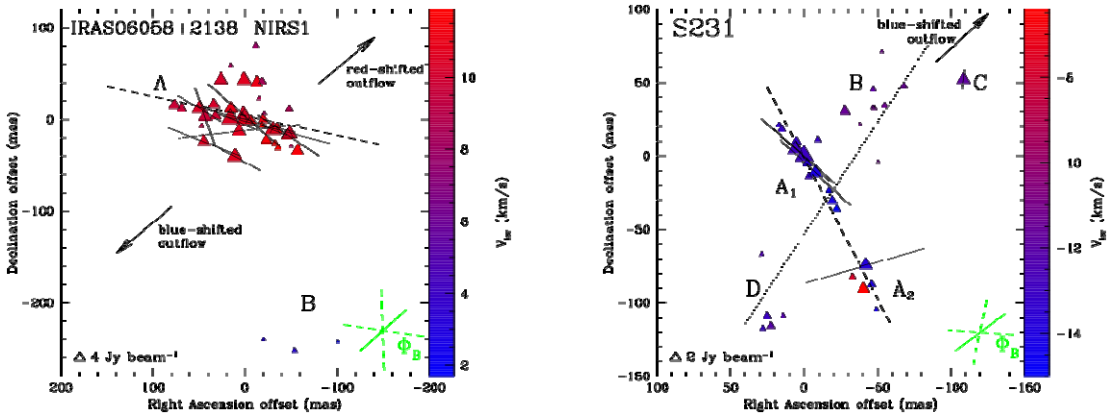

Fig. 4.3b Left: View of the methanol masers detected around IRAS06058+2138-NIRS1. On the right-bottom corner the weighted orientation of the magnetic field is also reported. Right: View of the methanol masers detected around S231. In the right-bottom corner the weighted orientation of the magnetic field is also reported.

Gabriele Surcis together with Soon-Wook Kim and Jeong-Sook Kim (Korea Astronomy and Space Science Institute) observed the water masers around the massive protostar W75N-VLA2. The water masers detected around W75N are tracing the expansion of an early shell structure that might be interpreted as an early outflow. The theoretical simulations of the last 2 years show that the formation of an early outflow is strictly necessary in order to form massive protostars. W75N is the first case in literature where the formation of an early outflow can be observed.

4.2. EVOLVED STARS

Nikta Amiri completed her studies of the shaping of evolved stars circumstellar material using masers, together with Huib van Langevelde and Wouter Vlemmings (Bonn). They processed data from a multi-epoch survey on water masers in evolved stars. In this project 6 new water fountain candidates were identified. In particular, the detection of H_2O masers of the supposedly dead OH/IR star IRAS 18455+0448 are intriguing. As expected, they also found significant variability in flux density and spectral profile for the H_2O masers. The observations

likely indicate a good correlation between the stellar pulsation and the H_2O maser variability and a lifetime of 60 years for the H_2O masers in the post-AGB phase was estimated.

4.3. GALACTIC PULSARS, VARIABLE AND TRANSIENT RADIO SOURCES

Jun Yang, Zsolt Paragi, Bob Campbell and Leonid Gurvits continued their studies on the black hole binary candidate XTE J1752-223 in collaboration with Stéphane Corbel (Paris Diderot University, France) and Catherine Brocksopp (University College London, UK). Earlier the team reported strongly decelerating ejecta within a few hundred mas of the black hole. New EVN and VLBA images showed additional transient ejecta, and the occurance of the radio core/compact jet at late epochs (Figure 4.4). In their re-analyzis of earlier VLBI data they show that the transient ejecta closer to the core position had at least mildly relativistic motion, further strengthening the case for strongly decelerating ejecta on the scale of a few hundred milli-arcseconds from the core.

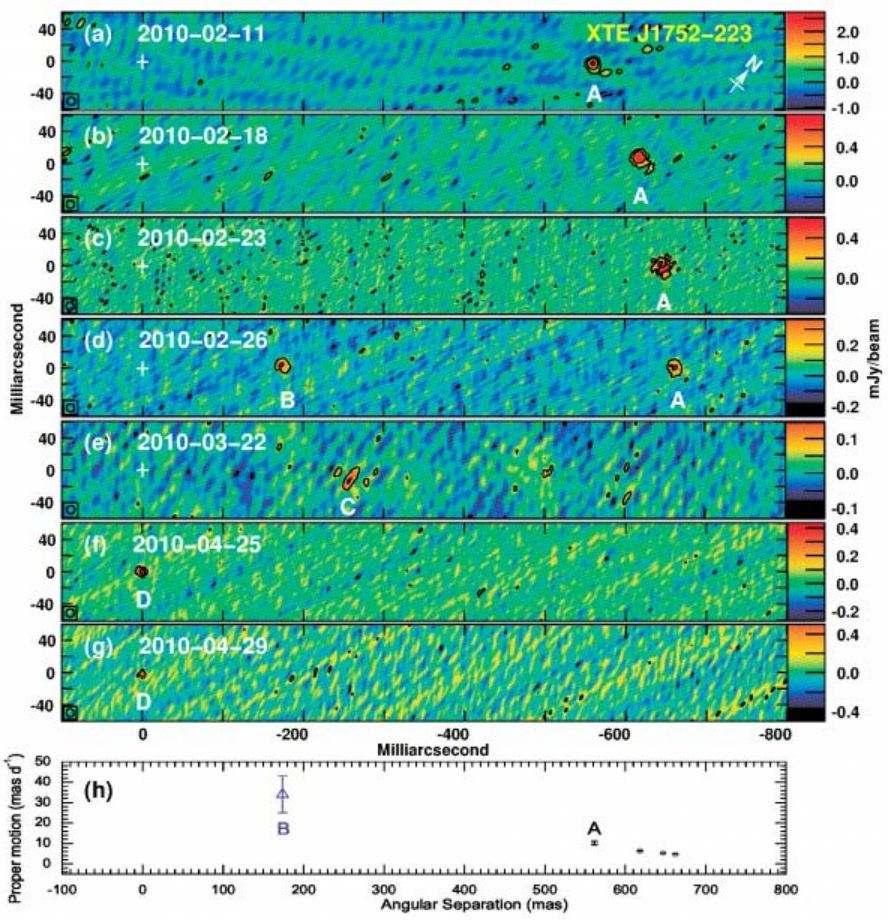

Fig. 4.4 VLBI images of the transient jets components A, B, C, and the re-activated compact jet D in XTE J1752–233. The bottom panel shows the proper motion versus angular separation for components A and B. All the images are centred at the compact jet (0,0) and rotated clockwise by 39◦. The contours start from 3sigma off-source noise level and increase by a factor of -1, 1, 2, 4. The size of the restoring beam is 10 mas.

Together with Chinese astronomers from Shanghai (Zhiqiang Shen, Xiaoyu Hong, Bo Xia, Fengchun Shu) and Yunnan Astronomical Observatories (Zhixuan Li, Yonghua Xu), Jun Yang, Zsolt Paragi, Leonid Gurvits and Bob Campbell investigated a newly-identified Galactic black hole binary candidate MAXI J1836-194 (figure 4.5) with

the e-EVN and the Chinese VLBI Network. The team successfully detected the low-declination source with a high confidence level in both observations. The source was unresolved, which is in agreement with an AU-scale compact jet.

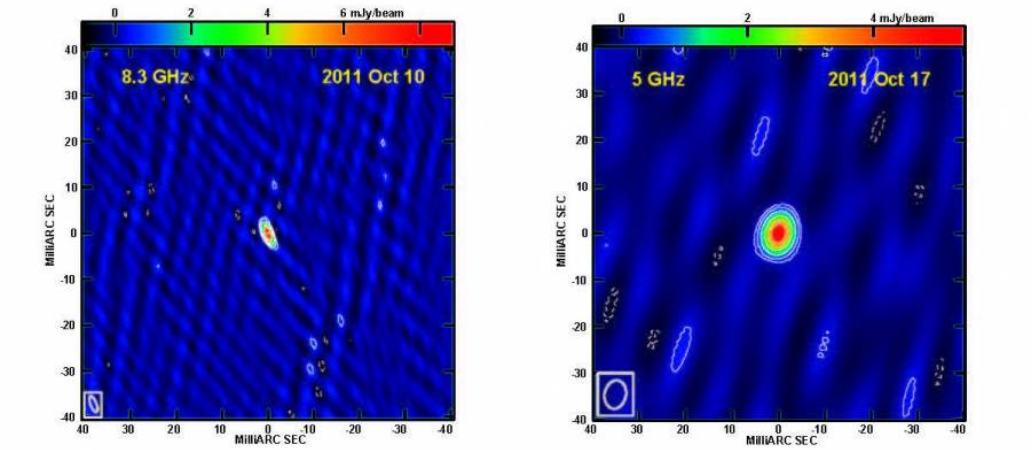

Fig. 4.5 VLBI total intensity images of MAXI J1836−194. The synthesized beams are plotted in the bottom left-hand corner. The contours start from 3 sigma off-source noise level (0.54 mJy/beam at 8.3 , 0.24 mJy/beam at 5) and increase by a factor of 2.

Giuseppe Cimó has worked together with Lisa Zimmermann and Maria Massi of MPIfR (Bonn, Germany) on the Quasi Periodic Oscillations observed in the radio wavelengths of the Gamma-ray Binary LSI+61303. Observations have been carried out using the Westerbork Synthesis Radio Telescope at the end of 2011.

Jun Yang (Co-PI) and Zsolt Pargi observed Nova Mon 2012 in collaboration with Tim O'Brien (PI, University of Manchester, UK) and Laura Chomiuk (NRAO, US). A nova is a cataclysmic nuclear explosion in a white dwarf star, caused by the accretion of hydrogen on to the surface of the star. Nova Mon 2012 was first identified as a gamma-ray transient, but it was subsequently associated with an optical nova in Monocerotis – it was only the third classical nova detected by Fermi. In multi-epoch real-time e-VLBI observations Nova Mon 2012 was found to have ejected a pair of hot spots moving out in NW-SE direction (figure 4.6). A transient hot spot that was only seen in the second epoch. A significant fraction of the radio emission was resolved out with the e-EVN.

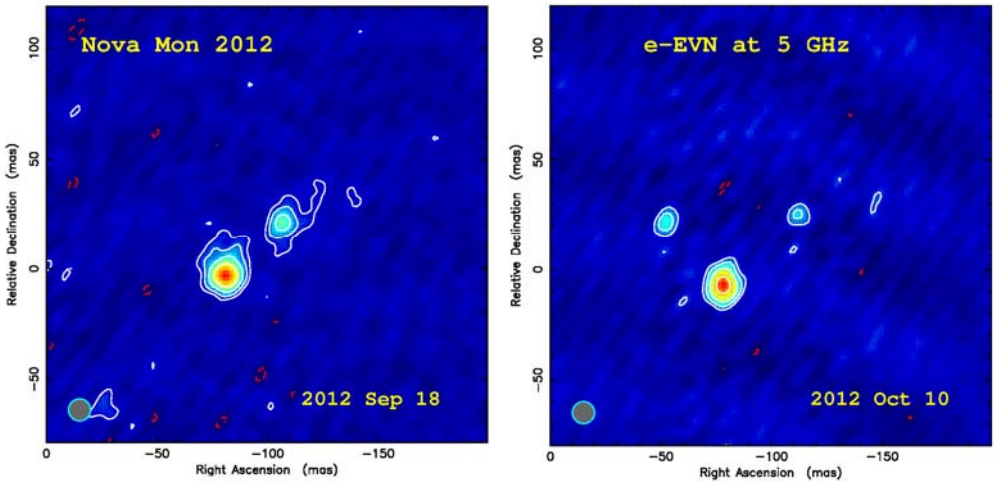

Fig. 4.6 The e-EVN images of Nova Mon 2012. The contours started from 3-sigma noise level (left: 0.08 mJy/beam, right: 0.12 mJy/beam) and increase by a factor of 2 in each image. Both images have a similar peak brightness ~1.2 mJy/beam.

Ding Chen (National Space Science Center, China) and Jun Yang have performed astrometric observations of the bright X-ray millisecond pulsar PSR J0218+4232 to measure its proper motion and parallax. All the monitoring observations have been finished.

Zsolt Paragi worked in collaboration with Anthony Rushton (ESO) and his group on VLBI studies of Cyg X-1. There is evidence for the presence of a weak compact jet during a soft X-ray state of this BHXRB. Very-high-resolution radio observations were taken with the VLBA, EVN and MERLIN during a hard-to-soft spectral state change, showing the hard state jet to be suppressed by a factor of about 3-5 in radio flux and unresolved to direct imaging observations (i.e. ≲1 mas at 4 cm). VLBI astrometry residual positions show a scatter of ˜0.2 mas (at 4 cm) and ˜3 mas (at 13 cm) along the position angle of the known jet axis; these residuals suggest that there is a weak unresolved outflow, with varying size or opacity, during intermediate and soft X-ray states. Furthermore, no evidence was found for extended knots or shocks forming within the jet during the state transition, suggesting that the change in outflow rate may not be sufficiently high to produce superluminal knots.

Zsolt Paragi (PI) and Jun Yang carried out e-EVN and VLBA monitoring observations of the hard X-ray transient MAXI J1659-152, in collaboration with Alexander van der Horst (UvA), Tomaso Belloni (INAF, Brera), James Miller-Jones (CIRA) and others. The overall source properties (polarization, milliarcsecond-scale radio structure, flat radio spectrum) are described well with the presence of a compact jet in the system through the transition from the hard-intermediate to the soft X-ray spectral state (figure 4.7). The apparent dependence of source size and the radio core position on the observed flux density (luminosity-dependent core shift) supports this interpretation as well. Just like in Cyg X-1 mentioned above, there is no evidence for major discrete ejecta during the outburst. For the source proper motion they derived 2σ upper limits of 115 μas/day in right ascension, and 37 μas/day in declination, over a time baseline of 12 d. These correspond to velocities of 1400 and 440 km/s, respectively, assuming a source distance of ~7 kpc.

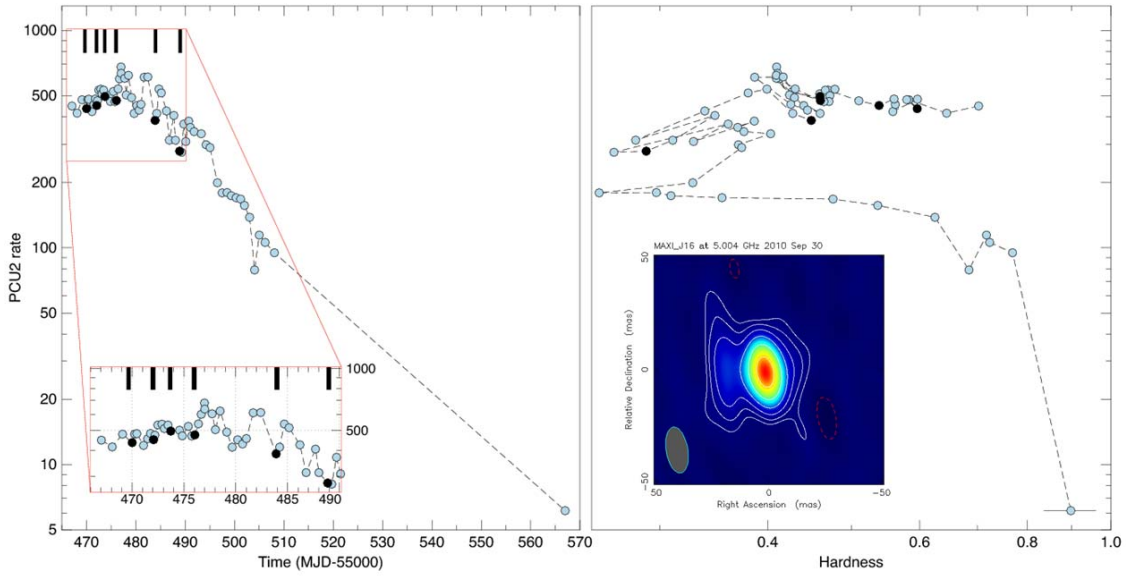

Fig. 4.7 The first epoch e-EVN map of MAXI J1659-152 is shown with the resolved structure as an inset to the RXTE X-ray lightcurve (left) and the hardness-intensity diagram (HID, right). The closest VLBI epochs to RXTE measurements are indicated by the filled black circles.

Zsolt Paragi was a member of a group led by Dávid Cseh (Univ. Paris Diderot) to study the radio emission in and around the ultra-luminous X-ray source IC 342 X-1. While with the VLA compact structure was observed, it was not detected in deep EVN observations. They estimated an upper limit of about 1000 Solar masses to the black hole powering the ULX nebula.

4.4. ACTIVE GALACTIC NUCLEI AND DEEP EXTRAGALACTIC SURVEYS

Working with Fang Wu (ShAO, China) and Tao An (ShAO, China), Jun Yang and Zsolt Paragi imaged the jet in the broad absorption line quasar PG 1700+518. They imaged the jet structure on scales of parsec to kiloparsec for the first time. The source shows two distinct jet features in East-West direction with a separation of around 4 kpc in the VLA image. They identified the radio core and found a symmetric jet morphology in the western jet feature with the EVN observations (figure 4.8). The jet axis is nearly parallel to the scattering plane revealed earlier by optical polarimetry. They conclude that the jet likely has a viewing angle around 45 degrees by analogy to polar-scattered Seyfert 1 galaxies. Furthermore, their observations have confirmed the earlier finding that the majority of radio emission in this galaxy arises from AGN activity rather than star-formation.

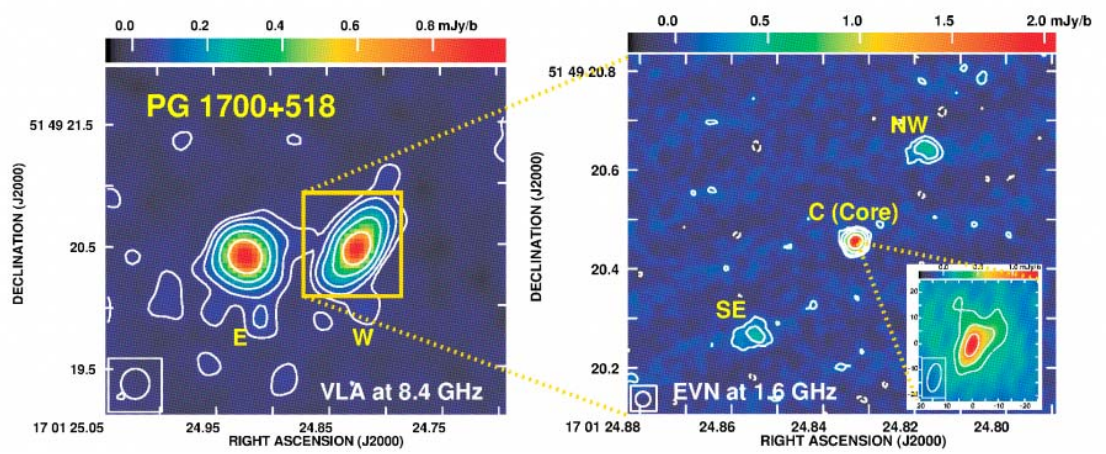

Fig. 4.8 The VLA and EVN intensity images of PG 1700+518. The contours start from 3σ off-source noise level (VLA: 0.036 mJy/beam, EVN: 0.15 mJy/beam) and increase by a factor of 2.

Jun Yang, Zsolt Paragi, Leonid Gurvits, Bob Campbell, and Alexander van der Horst (University of Amsterdam) have initiated a campaign to directly observe the proper motion of relativistic jet ejecta in the tidal disruption event Swift J1644+57. Up to date they have observed the transient AGN at four epochs. The preliminary results show that a position precision of ~15 micro-arcseconds can be achieved with respect to an in-beam calibrator (FIRST J1644+5736, 2.8 arcmin away, figure 4.9). With more epochs of similarly high-precision observations, the question whether there is a superluminal jet in Swift J1644+57 can be answered in the near future.

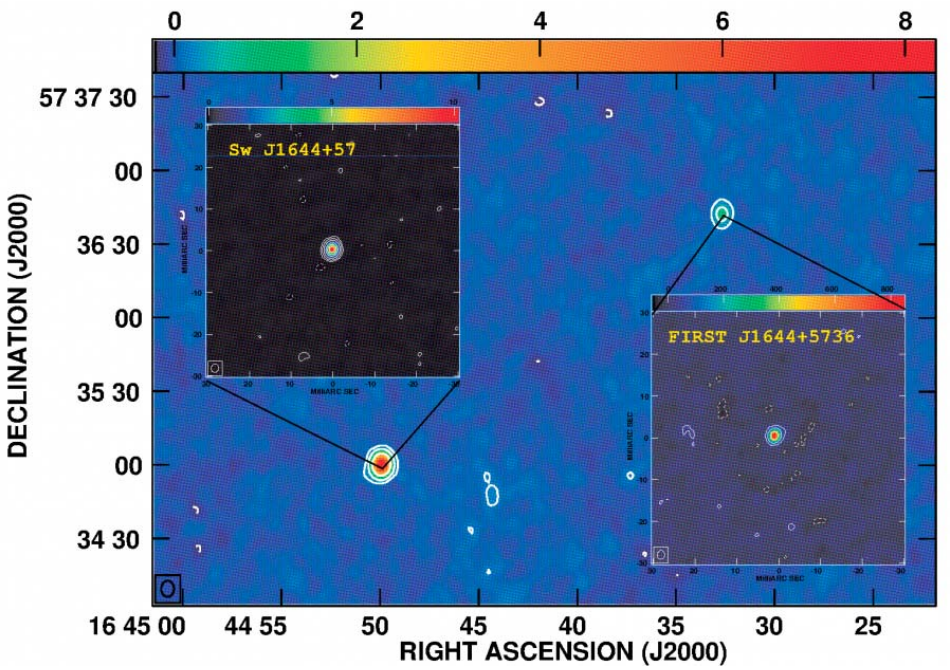

Fig. 4.9 The EVN phase-referencing observations of Swift J1644+57 and its in-beam calibrator FIRST J1644+5736 (separated by 2.8 arcmin). The background color image is the WSRT map (no primary beam correction). Contours start at the 3 noise level. Each contour level increases by a factor of 4. Natural weighting was used.

Rachael Alexandroff (Univ. Princeton, former JIVE summer student supervised by Zsolt Paragi and Stephen Bourke) and collaborators. have used the EVN to observe a sample of Lyman break analogue galaxies (LBAs) at low redshift ($z < 0.3$). The eight targets of this VLBI experiment possessed emission-line properties between starbursts and Type 2 (obscured) AGN. One star-forming LBA and one composite LBA were detected above 5σ at 1.7 GHz (only), while one AGN was detected at 5 GHz (figure 4.10). In both LBAs, the radio luminosity (L_R) exceeds that expected from supernovae (remnants) based on a comparison with Arp 220, Arp 229A and Mrk 273. The composite LBA exhibited a compact core emitting around 10 per cent of the VLA flux density. The high T_b of 3.5×10^7 K and excess core L_R with respect to the L_R/L_X relation of radio-quiet AGN indicate that this LBA possesses an obscured AGN ($M_{BH} \sim 10^{5-7}$ $M_\odot$). In three other composite LBAs detected previously in the X-ray, no radio sources were detected, indicating either variability or the presence of an obscured AGN below our radio sensitivity. While weak AGN may coexist with the starbursts as shown in at least one of the LBAs, their contribution to the total radio flux is fairly minimal. The results show that the detection of such weak AGN presents a challenge at radio, X-ray and optical emission-line wavelengths at z~0.2, indicating the great difficulties that need to be overcome in order to study similar processes at high redshift when these types of galaxies were common.

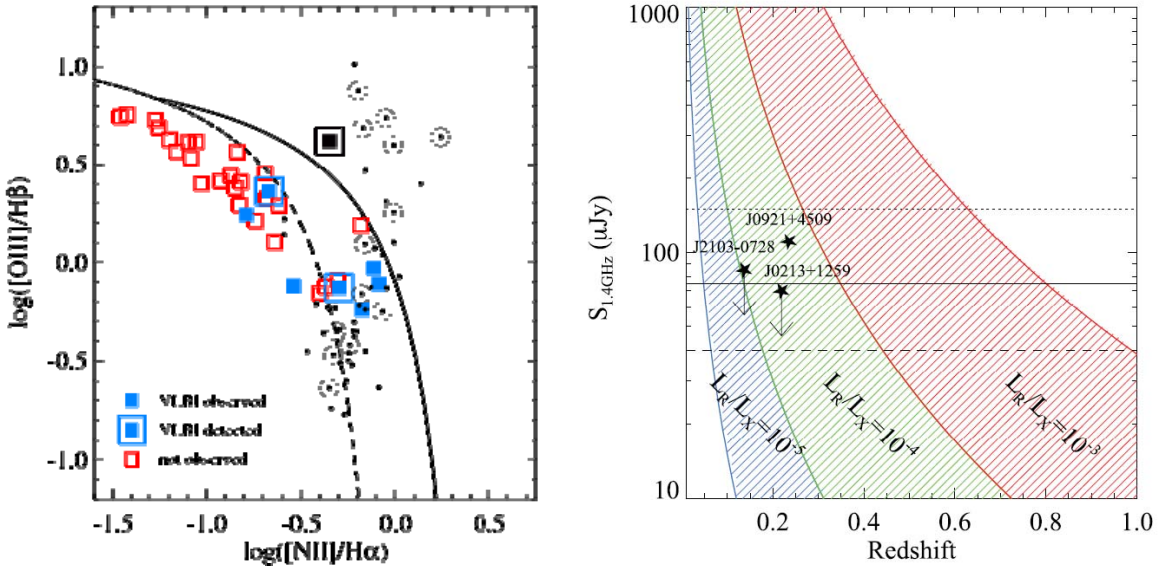

Fig. 4.10 Left: BPT diagram of the LBA sample. Right: Predicted flux densities of low-luminosity radio AGN as a function of redshit, for various L_R/L_X ratios.

In collaboration with Sándor Frey (PI, FÖMI SGO), Krisztina Gabányi (FÖMI SGO) and Dávid Cseh (Univ. Paris Diderot), Leonid Gurvits and Zsolt Paragi observed the highest-redshift radio quasar known to date, J1429+5447 (z = 6.21) with the EVN at 1.6 and 5 GHz. These rare, distant, and powerful objects provide important insight into the activity of the supermassive black holes in the Universe at early cosmological epochs and into the physical conditions of their environment. Based on its observed radio properties, the compact but somewhat resolved structure on linear scales of <100 pc, and the steep spectrum, the quasar J1429+5447 is remarkably similar to J0836+0054 and J1427+3312 at similar redshifts. To answer the question whether the compact steep-spectrum radio emission is a "universal" feature of the most distant radio quasars, it is essential to study more yet to be discovered radio-loud active galactic nuclei at z > 6.

Zsolt Paragi studied the radio-emitting quasar SDSS J1425+3231 (z = 0.478) with the EVN, in collaboration with Sándor Frey (PI, FÖMI SGO), Tao An (ShAO) and Krisztina Gabányi (FÖMI SGO). The target was recently found to have double-peaked narrow [O III] optical emission lines and was suggested to harbour a dual AGN. The EVN observations revealed compact radio emission at sub-mJy flux density levels from two components with a projected linear separation of ~2.6 kpc (figure 4.11). These two components support the possibility of a dual AGN system. The weaker component remained undetected at 5 GHz due to its steep radio spectrum. Further study will be necessary to securely rule out a jet-shock interpretation of the less dominant compact radio source.

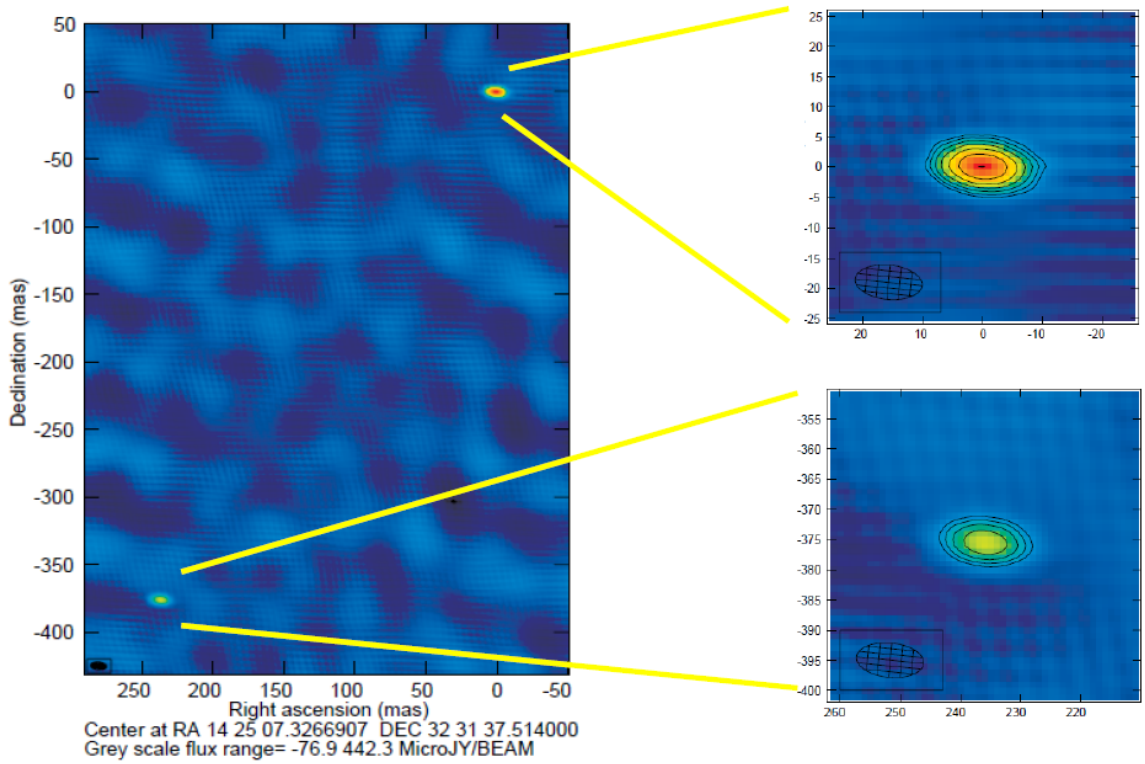

Fig. 4.11 Left: Two compact components detected with the EVN in the dual-AGN candidate source SDSS J1425+3231.

4.5. SCINTILLATION AND PROPAGATION EFFECTS

Giuseppe Cimó with collaborateurs continued his work on interstellar scintillation. He studied the VLBI characteristics of quasar J1819+3845. This quasar has shown extreme variability with flux density variations in the radio regime up to 600% in less than one hour. The extreme variability of J1819+3548 has been observed since its first observation in 1999 and it has continued for more than 8 years until 2006. Observation taken with VLBA in 2007 and with EVN in 2008 have shown that the source scintillation has entered in a quiescent phase and the rapid variability has stopped. A number of VLBI arrays have been used to image the scintillator J1819+3845 during both extreme and quiet scintillation phases. The data reduction and interpretation of the past VLBI observations of the extremely scintillating J1819+3548 do not present any clear indication for any structural changes with time. However the imaging process has been limited by the interstellar scattering. The lack of variability in the recent years, however, has made possible to image the source without the disrupting effects of the interstellar scattering screen. The results show that, after a year from the last observed scintillation, the source is still unresolved at VLBI scale. Local ISM changes (such as the screen moving out of the line-of-sight) can explain the termination of the extreme scintillation of J1819+3845. Taking into account previous intraday variability measurements of this quasar, it has been possible to put a lower limit of about 60 AU to the size of the cloud responsible of the previously observed extreme variations.

Related to scintillation though much closer to Earth, Giuseppe Cimó has been involved in scintillation studies of the interplanetary plasma via VLBI observations of spacecraft. Together with Guifré Molera, Sergei Pogrebenko, a number of Venus Express observations have been used to study the Interplanetary plasma scintillations. The phase fluctuations of the spacecraft signal carrier line have been used to characterise the

interplanetary plasma density fluctuations along the signal propagation line at different spatial and temporal scales, and at different Solar longitudes. The spectrum of the density fluctuations appeared to be near-Kolmogorov.

5. SPACE SCIENCE

5.1. VLBI AND SPACE SCIENCE

The Space Science and Innovative Applications (SpaSIA) group continued developments of the new technique of near-field VLBI for multi-disciplinary scientific applications. The method allows researchers to determine state-vectors of target sources (at present – spacecraft) with high accuracy. The interest of the scientific community traditionally not involved in radio astronomy studies (e.g. planetary scientists) to this technique is expected to translate in the near future into an enlargement of the user base of VLBI facilities.

Over the reporting period, the SpaSIA group developed several key components of the near-field VLBI technique. These include all steps of near-field VLBI experiments, from experiment planning to post-processing. In particular, the team has developed a set of scripts, which allow efficient scheduling of near-field VLBI tracking experiments. In collaboration with the R&D group of JIVE, the software correlator SFXC has been upgraded with a set of special near-field modules. These modules include the correlator delay model able to support VLBI data processing of targets at distances from several astronomical units down to LEO satellites. The overall approach to near-field VLBI developed at JIVE is described in detail in the paper published by the SpaSIA group in 2012 (Duev et al. 2012, AA 541, A43).

Over the reporting period, most of the JIVE activities in the area of space science applications of VLBI were supported via EC FP7 projects EuroPlaNet (grant agreement 228319, completed in December 2012) and ESPaCE (grant agreement 263466, on-going) as well as collaborations between JIVE and Chinese radio astronomy observatories co-sponsored by the Royal Dutch Academy of Arts and Sciences (KNAW), the NWO, the Chinese Academy of Sciences (CAS) and Shanghai Astronomical Observatory (ShAO).

5.2. VLBI TRACKING OF PLANETARY AND SPACE SCIENCE MISSIONS

The developments mentioned above enabled the JIVE team to carry out a number of VLBI experiments with various planetary and other space science missions. All these experiments are unified under the name PRIDE – Planetary Radio Interferometry and Doppler Experiment.

Over the reporting biennial period, the SpaSIA group continued PRIDE monitoring of the ESA's Venus Express (VEX) mission (see the JIVE Biennial Report 2009-2010 where these experiments were introduced). In the context of his PhD project (the thesis defended at the Aalto University, Helsinki, Finland, in April 2012), Guifré Molera Calvés worked on VLBI and radio spectroscopy studies of Solar System by means of VLBI tracking of the ESA's planetary science missions., Venus Express (VEX) and Mars Express (MEX). Most of the observational work was conducted with the Metsähovi radio telescope but also involved other EVN stations and was coordinated by JIVE. The three-year observing campaign resulted in a development of a model of the interplanetary plasma turbulence distribution at various distances and solar elongations of Venus with respect to the Earth. The results of the study are useful not only as a diagnostics of the interplanetary medium but also help to calibrate the near-field (and other) VLBI experiments. The extensive VEX observing campaign served as a means of verification and end-to-end test of future applications of PRIDE in other planetary and space science missions. The ultra-high-resolution spftware spectrometer developed as a part of the VEX observing campaign

also contributed to a detection of a 22 GHz water maser line in the Saturnian system. It is currently used at JIVE for various applications.

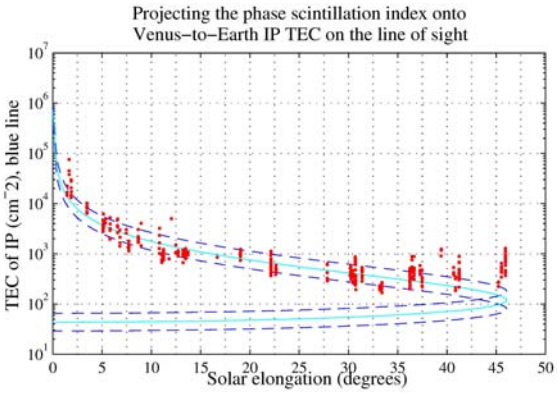

Fig. 5.1. Total Electron Contents (TEC) along the line of sight toward the Venus Express spacecraft as a function of the Solar elongation angle. Blue lines correspond to the currently accepted theoretical model, red dots – PRIDE measurements based on the estimates of the scintillation index of the VEX' carrier signal at .4 GHz.

In 2012, JIVE was invited by the Gaia Data Processing and Analysis Consortium (DPAC) to join preparatory activities for the ESA's astrometric mission Gaia scheduled to blast off in the second half of 2013. This mission will put on the 3D celestial map one billion stars. It will also charter extremely distant extragalactic objects as well as an order of ten thousand small bodies in the Solar System. Several scientific topics of the Gaia mission require a better-than-nominal accuracy of determination of the Gaia spacecraft state-vector during its 5-year tour of duty near the second Lagrangian (L2) point of the Earth-Sun system (about 1.5×10^6 km from Earth in the anti-Solar direction). The task will be addressed by both optical and PRIDE observations of Gaia. In order to test the PRIDE technique for a target located in the vicinity of L2, a special test observation of another ESA spacecraft, Herschel, was conducted at 8.4 GHz in November 2012 as the EVN project EC040 (PI G. Cimò). The results of this test (Fig. 5.2) prove that PRIDE tracking of Gaia should meet the DPAC specifications and will be ready for support of Gaia science operations.

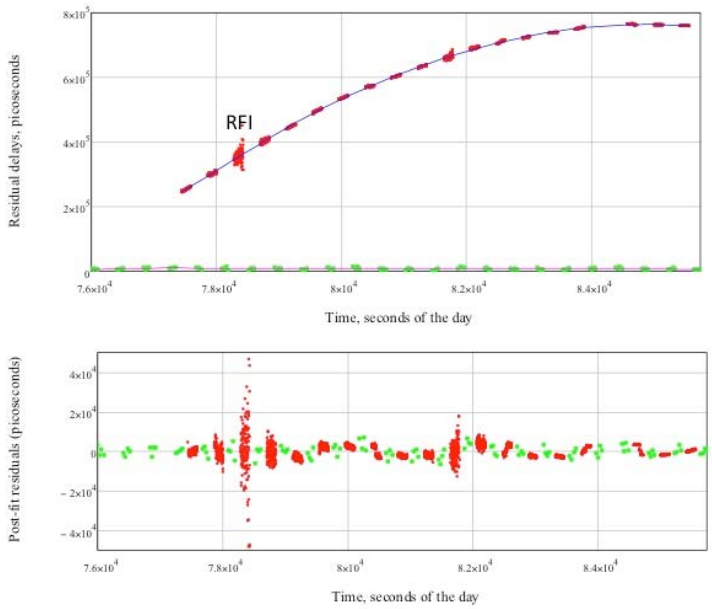

Fig. 5.2. PRIDE tracking of the Herschel spacecraft at 8.4 GHz on the baseline Medicina-Wettzell (EVN experiment EC040, November 2012). Top: Residual baseline delay measurements for Herschel S/C (red) and Ref. Source (green). Bottom: Post fit residuals for the reference source (red), RMS noise ~270 ps, and Herschel spacecraft (green), RMS noise ~60 ps.

In a longer perspective, PRIDE technique has been proposed as a multi-disciplinary enhancement of the ESA large-scale JUpiter ICy moons Explorer mission, JUICE. The mission is scheduled to be launched toward Jovian system in 2022 and reach the destination around 2030. At the vicinity of Jupiter, the mission will conduct studies of the physical environment of the largest planet of the Solar System and investigations of the three Galilean moons, Ganymede, Europa and Calisto.

PRIDE-JUICE (Fig. 5.3) will contribute into precise spacecraft trajectory measurements of the mission spacecraft as a multidisciplinary component of the JUICE science suite. Its prime "deliverable", a highly accurate determination of the spacecraft state vectors, will be used for a variety of applications, ranging from celestial mechanics and astrometry to geodynamics and studies of the Jovian plasma environment. PRIDE-JUICE will also provide input into making ephemerides of the Jovian system more accurate – an important prerequisite for future exploration of the Solar System. PRIDE-JUICE is a direct descendant of the Huygens VLBI tracking experiment conducted under the JIVE's leadership in 2005.

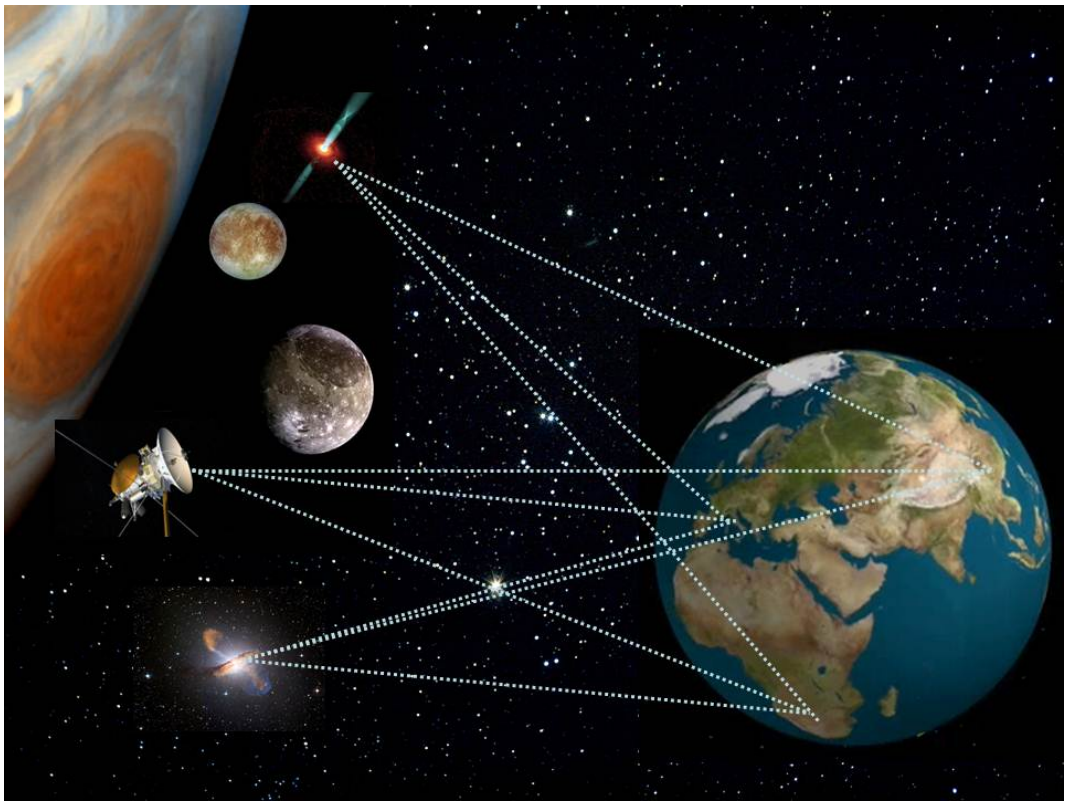

Fig. 5.3 A generic configuration of PRIDE-JUICE.

At the time of this report writing, in addition to the JIVE contingent, the PRIDE-JUICE team included scientists from Belgium (Royal Observatory), France (Laboratoire d'Astrophysique de Bordeaux, Observatoire de Paris and CNES), Germany (DLR and TU Berlin), Hungary (FÖMI Satellite Geodetic Observatory), The Netherlands (TU Delft), Romania (Institute for Space Sciences), and the USA (UC Berkeley). But the team is likely to grow, not least via very natural involvement of EVN institutes.

The work of Dmitry Duev focused on astrometric applications of Space VLBI, using observations of several spacecraft including the ESA's Venus Express, RFSA's RadioAstron and GLONASS satellites. He developed an advanced signal delay model for near-field VLBI observations (including a tropospheric delay model based on ray-tracing through the Numerical Weather Models) together with the Jacobian formalism (first suggested by Sergei Pogrebenko) for spacecraft state vector estimation based on VLBI and Doppler observations. The software has been successfully tested in various spacecraft VLBI tracking sessions. The research culminated in a successful PhD thesis defense at the Lomonosov Moscow State University (Russia) on 1 November 2012.

Applications of PRIDE technique for studies of gravity field were analysed in connection with the Phobos-Soil mission. In particular, the error propagation model through the PRIDE data processing pipeline was studied by Tatiana Bocanegra Bahamon as a part of her MSc thesis. The results of this work proved to be useful for analysis of applicability of PRIDE to other planetary missions.

5.3. SPACE VLBI: RADIOASTRON

On 18 July 2011, after several decades of development, the Russian Space VLBI mission RadioAstron was launched from the Baikonur spaceport in Kazakhstan (figure 5.4).

Fig. 5.4 The launch of RadioAstron, 11 July 2011, Baikonur, Kazakhstan (the image courtesy of the Russian Federal Space Agency).

In the following 17 months through the end of 2012, the mission has successfully completed in-orbit check-out tests and switched to the Early Science Programme and later the Key Science Programme. The PRIDE technique described above was used for independent verifications of the RadioAstron orbit determination (OD) crucial for getting VLBI fringes on Earth-Space baselines (Fig. 5.5). Moreover, by the end of 2012, it has become clear that the SFXC software developed at JIVE for near-field VLBI tracking can be used as a base for Space VLBI "incarnation" of SFXC. The work toward demonstrating RadioAstron VLBI fringes on extraterrestrial baselines using the SFXC software has begun at JIVE in the fall of 2012. The first tests of the SFXC in the SVLBI mode provided positive results. They pave the way for offering support to RadioAstron-EVN users in correlating their experiments at JIVE once the mission becomes open for users' observing proposals. All these topics are discussed between the RadioAstron mission and JIVE (together with EVN and other international partners) at the RadioAstron International Science Council (RISC) that has JIVE representatives since its formation in the late 1980s.

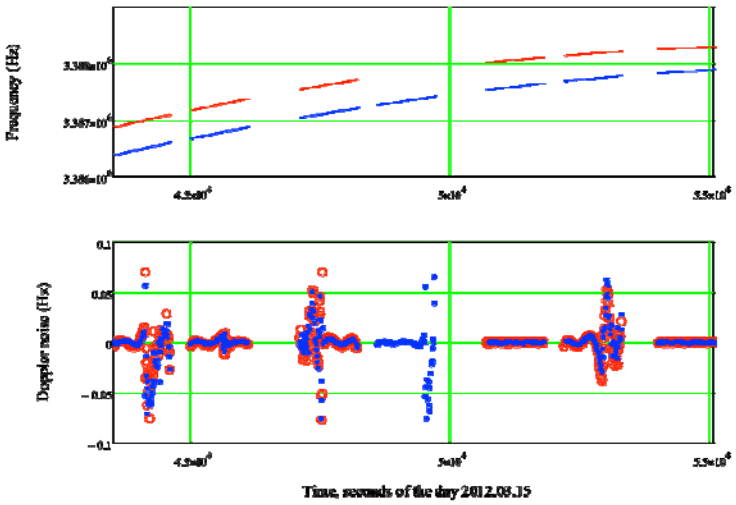

Fig. 5.5 An example of PRIDE tracking of RadioAstron at 8.4 GHz during the experiment EK032 (March 2012). Top: Frequency detection within video-band (Wettzell – red, Onsala – blue) as a function of time. Bottom: Doppler noise of the post-fit residuals.

5.4. NEXT GENERATION SPACE VLBI

The success of three Space VLBI missions, TDRSS (1986), VSOP/HLCA (1997-2003) and the currently operational RadioAstron trigger a significant interest in the radio astronomy community to further enhancement of VLBI of extra-terrestrial dimensions. The current initiative of a project study for the next generation SVLBI comes from China. During the IAU General Assembly in Beijing in August 2012, a broad international group of scientists and engineers discussed perspectives of this study (Fig. 5.6). The long-standing collaboration between JIVE and the Shanghai Astronomical Observatory (ShAO) in VLBI studies, supported via the agreement between the Royal Dutch and Chinese Academies of Sciences as well as the joint collaborative grant of the NWO and ShAO facilitate joint work of JIVE and ShAO in the area of space science VLBI applications and next generation SVLBI project study.

Fig. 5.6 Participants of the 2nd International meeting on the Next Generation Space VLBI project, Beijing, China,

5.5. TOWARD MOON-BASED ULTRA-LONG-WAVELENGTH INTERFEROMETER

The last unexplored window to the electromagnetic emission of the Universe at frequencies below ~15 MHz promises new insight in astrophysics and cosmology. This challenging area of new radio astronomy has been addressed at JIVE in collaboration with ASTRON, Radboud University (Nijmegen, The Netherlands) and National Astronomical Observatories of China (Beijing, China) supported by the KNAW and the CAS. As a part of this study, a PhD student from China Linjie Chen based in The Netherlands in the period 2008-2011 conducted a study of antenna concepts for prospective Moon-based ULWA facilities that included theoretical modelling, laboratory and field tests (Fig. 5.7). The study culminated with successful defending a PhD thesis "*Design and study of Moon-based very low frequency radio interferometer"* at the National Astronomical Observatories of China (Beijing) in November 2011. The study served as input into White Papers on prospective space missions prepared for submission to ESA in 2013.

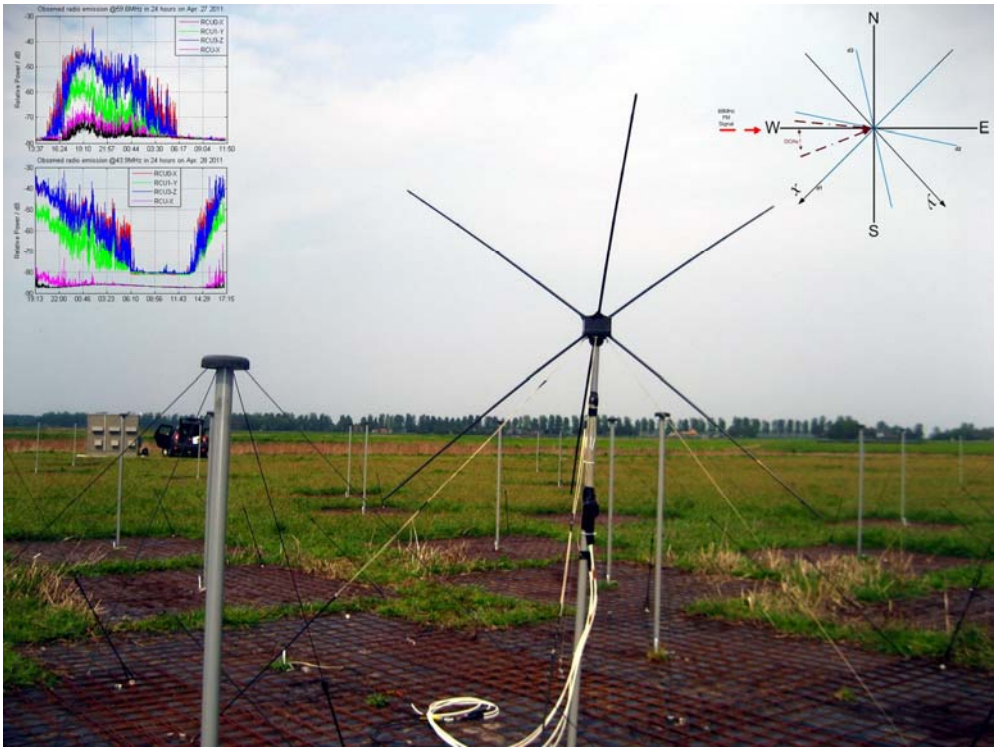

Fig. 5.7 A test tripole antenna during the field measurements at the LOFAR station CS011 (ASTRO and JIVE Daily Image by L. Chen, 30.09.2011).

6. EXTERNALLY FUNDED PROJECTS

6.1. RADIONETFP7

In 2011 and the first half of 2012 RadioNetFP7 (grant number 227290) was in full swing, it was continued and partly overlapped with a new programme, which was named RadioNet3, although it also originates from the 7th Framework Programme. In RadioNetFP7 JIVE managed the EVN TNA programme and the JRA projects ALBiUS and UniBoard. Several JIVE staff members participated in management team, board and executive activities. On 30 June 2012 the project formally ended.

6.1.1. EVN TNA

This biennial period saw the final year of RadioNetFP7 (2011) and the first year of the follow-on RadioNet3. The RadioNet EVN Trans-National Access (TNA) programme provides funding to EVN telescopes and the correlator to provide access to outside users and support for travel by European investigators 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 or associated states. Table 6.1 summarizes various statistics from the past two years of EVN TNA activity.

	2011	2012
Number of eligible observations	58	87
comprising how many proposals	36	48
Total number of access hours	466	738
Number of data reduction visits	7	6
number of data reduction visits made to JIVE	5	4

Table 6.1 Annual statistics for various aspects of the EVN TNA programme over 2011-2012

6.1.2. ALBIUS

The objectives of ALBiUS (Advanced Long Baseline interoperable User Software) were to develop key algorithms required for the successful exploitation of the upgraded and new generation of RadioNet telescope facilities (eMERLIN, LOFAR, APERTIF, ALMA, e-EVN etc). These new telescopes started to deliver explosive data rates, and an expansion in the continuum spectral window of one to two orders of magnitude. The focus was on the production of new algorithms that address issues of calibration (both in the *uv* and image plane) and sky modelling. The need for identifying bad data and the issue of data quality control in general, was also addressed. The goal was to make these algorithms available in a modern, distributed computing environment, and to provide transparent interoperability between the different software suites. At JIVE the efforts concentrated on usage of the ParselTongue platform for calibration transfer and fringe fitting. The deliverables were mostly assessment documents and prototype software.

6.1.3. UNIBOARD

The UniBoard project aimed was to design and develop a generic, high-performance, scalable, FPGA-based computing platform for radio-astronomical applications. Along with the hardware a number of different

firmware applications, or board personalities, were to be developed. At the start these included a VLBI and WSRT-Apertif correlator, a digital receiver and a pulsar-binning machine, with one group implementing RFI mitigation algorithms specifically for the pulsar binning personality. As the project developed and the number of participants grew several applications were added, including an Apertif beam former, an all-dipole LOFAR correlator, RFI mitigation for the digital receiver, a pulsar binning backend for the Effelsberg 100m telescope, a digital receiver for the new 65m Shanghai telescope and a Chinese VLBI network correlator. Boards were produced for the various applications and the prototypes applications reached a demonstration level.

The projects original duration of three years was extended by one half year. As some of the partners initially had experienced problems with hiring personnel, this extension allowed them to make up for the resulting delays. Throughout the project, JIVE and ASTRON were quite successful in acquiring matching funds, and with several projects that make use of the UniBoard hard- and firmware now underway, the UniBoard development at these institutes continued at full speed right until the formal end of the project, and fed into the new RadioNet3 project.

6.2. RadioNet3

The successful proposal effort for the continuation of RadioNet FP7 resulted in the project RadioNet3 (grant number 283393), which started on 1 January 2012. JIVE staff is, as in RadioNet FP7, participating in the management team, the executive team and the RadioNet3 Board.

Fig. 6.1 The RadioNet3 board present at the Kick off meeting in Bonn (28 February 2012)

6.2.1. EVN TNA

Again, the RadioNet3 EVN Trans-National Access (TNA) programme arranges a commitment to the European astronomy community to make the scientific capabilities of the EVN available to scientists outside the EVN institutes and countries that harbour VLBI telescopes. In return the EVN operational elements receive funding that in case of the EVN is largely used to implement user services at JIVE. Through the support scientists EVN users can receive support in all stages of their VLBI proposal, starting from proposal writing to detailed help in data processing. Often new users visit the facilities at JIVE to get hands-on help with analysing their data. Bob Campbell at JIVE manages the programme and collects the use statistics of the EVN by outside groups.

6.2.2. QUESERA

The QueSERA (Questions on Structuring European Radio Astronomy) Network Activity (NA) is aimed at advocating radio astronomy to various levels of target audiences. JIVE director Huib van Langevelde is the overall task leader for this work programme. At JIVE also task 2 of QueSERA is managed which aims at "Advertising Radio Astronomy capabilities". This task aims at areas in Europe that do not have established communities in radio astronomy. The others tasks of QueSERA focus on the governance structure of European radio astronomy, aiming to structure the discussion on future collaborations, and on dealing with true outreach issues, raising the interest in radio astronomy with the general public.

6.2.3. UNIBOARD^2

UniBoard^2 is deploying an FPGA-based, generic, scalable, high-performance computing platform for radio-astronomical applications, using the next-generation chip architecture. This WP consolidates and builds upon the experience obtained through the UniBoard project to create a completely re-designed platform with several innovative features, that will be ready for the next generation of astronomical instruments (notably the SKA), at the end of 2015. Power efficiency is going to be a crucial issue for future instrumentation. Arpad Szomoru at JIVE coordinates this international research activity.

6.2.4. HILADO

JIVE has also attracted responsibilities in the RadioNet3 Research Activity on software. The scientific and technical goal for Hilado is to create optimized software libraries that improve the processing characteristics of existing and emerging radio telescopes. JIVE is mostly involved in configuring the existing applications for astronomer-side usage, building on previous experiences with the ParselTongue software.

6.3. NEXPRES

6.3.1. OVERVIEW

NEXPReS (Novel EXplorations Pushing Robust e-VLBI Services, http://www.nexpres.eu/) is a three year project aimed at further developing e-VLBI services of the European VLBI Network (EVN), with the goal of incorporating e-VLBI into every astronomical observation conducted by the EVN. The project is an e-Infrastructure project funded by the European Union's Seventh Framework Programme under Grant Agreement RI-261525.

NEXPReS consists of 15 partner organizations. JIVE is the coordinating institute partnering with ten astronomy institutes and four NRENs (national research and educational network).

Fig 6.2a first NEXPReS review

Fig 6.2b second NEXPReS review

NEXPReS began in July 2010 and is on schedule to be completed by July 2013. The project has been making excellent progress in meeting all its technical deliverables, while at the same time e-VLBI continues to be a scientific success. As a final milestone, the Commission Science Officer and external reviewers will be shown a demo of the e-VLBI process at 4Gbps by September 2013. During the review, each of the eight work package leaders will present their work. The work packages are organized similarly to other EC funded projects: 4 Network Activities, 2 Service Activities and 2 Joint Research Activities.

wp#	Type	WP Title (WP Leader, Organization)
WP1	NA	Management (T. Charles Yun, JIVE)
WP2	NA	EVN-NREN (Richard Hughes-Jones, DANTE)
WP3	NA	eVSAG (Francisco Colomer, FG-IGN)
WP4	NA	Communication (Kristine Yun, JIVE)
WP5	SA	Cloud Correlation (Arpad Szomoru, JIVE)
WP6	SA	High Bandwidth on Demand (Paul Boven, JIVE)
WP7	JRA	Computing in a Shared Infrastructure (Mark Kettenis, JIVE)
WP8	JRA	FlexBuff: Provisioning High-Bandwidth, High-Capacity Networked Storage on demand (Ari Mujunen, AALTO)

6.3.2. HIGHLIGHTS AND ACTIVITIES

As a project, NEXPReS has been very successful, it has been frequently and favourably mentioned by the commission and connectivity experts, both as a project and as a community. The 2011 and 2012 yearly period reviews were completed smoothly, even earning an "Excellent" mark for the second period. Indeed many of the newly developed tools have already proven useful. WP5 has developed many tools that support operational correlation. WP6 has written bandwidth on demand tools that have supported "real" observations. WP7 has matured the software correlator to a point that we can consider retiring the hardware correlator. WP8 has built and tested the fast read/write disk buffers that will work in conjunction with future distributed systems. Over the course of the project, NEXPReS has hosted and participated in a wide variety of meetings, organised as part of its Networking Activities. In addition to presentations, NEXPReS has sent the project's display as well as copies of the JIVE video (figure 6.2) which was developed by WP4- Communications.

Fig 6.3 Still of the JIVE movie

6.4. ESPACE

The ESPACE project started on 1 June 2011. The project aims at strengthening the collaboration and development of new knowledge, new technology and products for the scientific community in the domains of the development of ephemerides and reference systems for natural satellites and spacecraft by conjugating expertise of main European research centres involved in space science and dynamics. JIVE is the work package leader for workpackage 4 “VLBI”. The objective of this wok package is to provide the residuals of spacecraft tracking data with respect to an a priori given state vectors of the spacecraft using the European and Global VLBI network observations, data processing and analysis.

6.5. EUROPLANET

JIVE participated in the EC FP7 project EuroPlaNet. The project aimed at helping planetary scientists to get the best out of their research on the Solar System by organising networking activities, meetings and conferences, providing access to laboratories and field sites in Europe, developing new facilities and field sites and creating online access to planetary science data. The specific task of JIVE within the EuroPlaNet project was related to the development of the PRIDE methodology (see section 5.2). The project supported a fraction of a postdoc FTE within the Space Science and Innovative Application group at JIVE for 3 years. The EuroPlaNet project was completed by 31 December 2012.

6.6. NWO-EXBOX

The NWO-M programme EXBOX, in which JIVE and ASTRON collaborated on the development of an "Expandable Box for X-correlation" ran throughout 2011 and 2012. Through this programme a very important contribution was made to the development of a next generation FPGA-based EVN correlator, as well as to the creation of the APERTIF beam former sub-rack.

6.7. NWO-SCARIE

The NWO SCARIe project (Software Correlator Research and Implementation for e-VLBI), which was originally proposed in 2006, finally ran its course in 2012. Through this project, a number of software engineers at JIVE and the Amsterdam University (UvA) did some very successful work on software correlation, pioneering the use of computing clusters for distributed software correlation.

6.8. NWO-CHINA

Under the auspices of a memorandum of Understanding between the NWO and Shanghai Astronomical Observatory (China), JIVE collaborated with the Shanghai Astronomical Observatory on development of a next generation VLBI correlator, applications of new VLBI techniques, including those related to the commissioning of the new 65-m radio telescope near Shanghai, and space science VLBI applications. By exchanging experts both partners are enhancing their expertise in this strategic area, developing FPGA-based computing platforms that can be deployed in large-scale, future radio instruments.

The space science component of the collaboration focused on joint PRIDE (see chapter 5.2) observations of planetary missions. This work offered an efficient test-bed for future science applications of the PRIDE technique for European and Chinese planetary and space science missions, such as Mars Express, Gaia, Chang'E-3, ExoMars and JUICE. In the framework of this collaboration, a PhD project jointly co-supervised by the JIVE and ShAO senior scientists was supported. A postdoc VLBI scientist position at JIVE is also supported in the framework of this collaboration.

Fig. 6.4 Jintao Luo is leaving JIVE after working on the NWO-China project

6.9. KNAW-CEP

The main goal of the project was to further improve the scientific cooperation between Dutch and Chinese researchers working in the field of VLBI. As a central theme, we chose the VLBI studies of active galactic nuclei (AGN), to study how they fit in the standard unification of radio-loud AGN in general, as well as the less powerful so-called compact symmetric objects (CSO), that are most likely young, evolving AGN that have

recently shown to have significant cosmological relevance (black hole growth, AGN feedback). Another important objective was to help the development of VLBI technology, and especially to support the Chinese VLBI Network (CVN). As part of these efforts, the Westerbork Mark4 VLBI backend was moved to Kunming, eanbling the first high-bandwidth (up to 1 Gbps) observations at the telescope. Observations of GPS/CSOs including Miyun and Kunming were initiated, as well as a pilot project to detect a millisecond (ms) pulsar, which was one of the first projects that benchmarked the (then) new EVN Software Correlator at JIVE (SFXC). The absolute technological highlight was a test during the Summer of 2011 in which a fringe test was carried out at a data rate of 2 Gbps, using the new Chinese Data Acquisition System (CDAS).

During the implementation period of the project, there were several short-term and long-term visits from all the partner institutes. The young Chinese researchers that spent longer time at JIVE included Hongmin Cao (ShAO, 8 Months), Yonghua Xu and Zhixuan Li (Yunnan Astronomical Observatory, 3 months). An Tao visited several times and there were a number of shorter visits as well. From JIVE, Leonid Gurvits, Arpad Szomoru, Giuseppe Cimó, Tatiana Bocanegra and Zsolt Paragi visited ShAO and other Chinese institutes.

6.10. ESKAC

During 2011 and 2012 JIVE continued its role as the secretary and banker of the European SKA Consortium (ESKAC). Originally JIVE had an important role as the ESKAC banker and legal basis, when through JIVE the European contribution to the international SKA office was paid. When the SKA office came into existence, ESKAC refocused its attention on building up the European science community. It continued supporting European project scientist efforts and a number of meetings and conferences.

6.11. PREPSKA

In 2011 JIVE continued to actively participate in the governance of the EC FP7 programme PrepSKA. Although almost all resources of the programme were used at the project office in order to define the SKA technology baseline, JIVE was represented in the board. With the site selection and the establishment of the SKA organisation, most activities in PrepSKA finished in 2011.

7. PUBLICATIONS

7.1.1. JOURNAL ARTICLES

- Alexandroff, R., Overzier, R.A., **Paragi, Z.**, et al. (including **Bourke, S.**), *"A search for active galactic nuclei in the most extreme UV-selected starbursts using the European VLBI Network"* , 2012, Monthly Notices of the Royal Astronomical Society, 423, 1325-1334
- **Amiri, N.**, Vlemmings, W.H.T., Kemball, A.J., **van Langevelde, H.J.**, " VLBA SiO maser observations of the OH/IR star OH 44.8-2.3: magnetic field and morphology", 2012, Astronomy and Astrophysics, 538, 136
- **Amiri, N.**, Vlemmings, W.H.T., **van Langevelde, H.J.**, *"The kinematics and magnetic fields in water-fountain sources based on OH maser observations"* , 2011, Astronomy and Astrophysics, 532, 149
- An, T., Wu, F., **Yang, J.**, et al., *" VLBI Observations of 10 Compact Symmetric Object Candidates: Expansion Velocities of Hot Spots"* , 2012, Astrophysical Journal Supplement Series, 198, 5
- Ao, Y., Henkel, C., Braatz, J. A., et al (including **Mühle, S.**), *"Ammonia (J,K)=(1,1) to (4,4) and (6,6) inversion lines detected in the Seyfert 2 galaxy NGC 1068"*, 2011, Astronomy & Astrophysics, 529, 154
- Bartkiewicz, A., Szymczak, M., Pihlström, Y. M., et al (including van **Langevelde, H. J.**), *"VLA observations of water masers towards 6.7 GHz methanol maser sources"*, 2011, Astronomy and Astrophysics, 525, 120
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8. APPENDICES

8.1. JIVE BOARD

Prof. H. Olofsson	Onsala Space Observatory, Onsala, Sweden *Chairman*
Dr. L. Feretti	Institute for Radioastronomy, Bologna, Italy *Vice chair*
Prof. J. Gómez González	Instituto Geográfico Nacional, Madrid, Spain
Dr. P. Charlot	Laboratory of Astrophysics of Bordeaux, Floirac, France
Prof. Dr. J.A. Zensus	MPIfR, Bonn, Germany
Prof. Dr. M.A. Garrett	ASTRON, Dwingelo, The Netherlands
Prof. X.-Y. Hong	National Astronomical Observatories, Chinese Academy of Sciences, Shanghai, PR China
Prof. S.T. Garrington	Jodrell Bank Centre for Astrophysics, Manchester, UK
Dr. M.J. Gaylard	National Research Foundation, Pretoria, South Africa

8.2. JIVE FINANCIAL REPORT FOR 2011-2012

Balance

(amounts x €1000)

ASSETS	2011	2012*	LIABILITIES	2011	2012*
Fixed Assets			***Capital***		
Computer Equipment	59	54	General Reserve	1.293	1.149
Furniture	14	10	Designated funds	800	1.004
Instruments	4	3		**2.093**	**2.153**
	77	**67**			
Current Assets			***Other Liabilities***		
Receivables:			EXPReS	9	8
			NEXPReS		641
Debtors	49	55	ESKAC	115	106
EU	799	1.115	ASTRON	149	
Other	166	712	Accounts payable	471	398
	1.014	**1.882**	Leave debts	204	225
			Other	6	4
Cash at Bank	**2.023**	**2.471**	Received in advance	67	885
				1.021	**2.267**
TOTAL	**3.114**	**4.420**	**TOTAL**	**3.114**	**4.420**

**provisional, subject to audit*

JIVE Financial Report for 2011-2012 (cont.)

Revenues			
Contributions		**2011**	**2012***
INAF	IT	240	240
MPI	DE	90	90
STFC	UK	240	240
IGN	ES	140	140
OSO	SE	140	140
NAOC	CH		40
CNRS-INSU	FR	40	40
NRF	SA		50
NWO	NL	450	450
		1.340	**1.430**
ASTRON	NL	520	520
		1.860	**1.950**
Projects			
EU financed projects		1.408	1.289
NWO financed projects		434	246
KNAW financed projects		35	14
Other		16	4
Other			
Various		1	4
		1.894	**1.557**
	TOTAL	**3.771**	**3.513**

Expenditures		
Institute	**2011**	**2012***
Personnel	1.434	1.422
Depreciation	45	48
Office costs	104	109
Other	354	300
ASTRON - Overhead	520	520
	2.457	**2.399**
Projects		
EU financed projects	794	789
Special projects	485	265
	1.279	1.054
TOTAL	**3.736**	**3.453**
Result	**35**	**60**

**provisional, subject to audit*

8.3. JIVE PERSONNEL

Mr. F. Bloemhof	Scientific Programmer (from 11 June 2011)
Ms. T.M. Bocanegra	Researcher in training (from 1 Aug 2011)
Dr. S. Bourke	Postdoctoral Research Assistant (until 15 June 2012)
Mr. E.P. Boven	Network/Linux Specialist
Dr. R.M. Campbell*	Head of Science Support and Operations
Dr. G. Cimó	Space VLBI Scientist
Mr. D. Duev	Trainee (14 Jan 2011 – 24 Jan 2012)
Dr. D. Duev	Research Assistant
Drs. B. Eldering	Software Engineer
Dr. C. Goddi	Support Scientist (from 1 Oct 2012)
Prof. Dr. L.I. Gurvits*	Head of Space Science and Innovative Applications Group
Dr. J.E. Hargreaves	Digital Engineer
Mr. B. Harms	Operator
Dr. Ing. A. Keimpema	Scientific Programmer
Dr. Ir. M.M. Kettenis	Software Engineer
Mrs. Y. Kool-Boeser	Senior Secretary
Mr. B. Kramer	Software Technician
Mr. M. Leeuwinga	Hardware Support Engineer
Mr. J. Luo	Researcher in training (until 14 Dec 2012)
Dr. M. Mahmud	Support Scientist (until 15 Feb 2012)
Mrs. S.K. Mellema	Secretary
Dr. G. Molera Calvés	Postdoc Space VLBI (from 10 Jan 2012)
Dr. S. Mühle	Support Scientist (until 7 Sept 2011)
Dr. Z. Paragi*	Head of User Support
Dr. Y. Pidopryhora	Support Scientist (until 15 Aug 2012)
Ing. S.P.E.L. Pirruccio	Digital Engineer
Dr. S.V. Pogrebenko	Senior System Scientist
Drs. R.A. Schoenmaker	Scientific Programmer (from 11 Apr 2011)
Dr. D.M. Small	Scientific Software Engineer
Dr. I.M. Stewart	Software Scientist (17 Jan – 17 May 2011)
Dr. G. Surcis	Support Scientist (from 19 Sept 2011)
Dr. A. Szomoru*	Head Technical Operations and R&D
Mr. H. Tenkink	Chief Operator
Dr. K.J.E. Torstensson	Research Assistant (1 Sept 2011 – 1 March 2012)
Drs. A. van den Poll	Project Assistant
Dr. H.J. van Langevelde*	Director
Drs. H. Verkouter	Offline Software Engineer
Dr. J. Yang	Support Scientist
Mr. T.C. Yun	Program Manager
Mrs. K.S. Yun	PR/Outreach

8.4. VISITORS TO JIVE

2011

Name	Institute	Period	Host
C. Romero	IAA Granada, Spain	16-22 January	Mühle
A. Tarchi	Cagliari Observatory, Italy	16-22 January	Mühle
Z. Shen	Shanghai Astronomical Obs., China	17-19 March	Paragi
X. Zhang	Shanghai Astronomical Obs., China	2-7 April	Szomoru
A. Bartkiewicz	Torun Center for Astronomy, Poland	4-15 April	Paragi
D. Stoklosa	PSNC, Poland	23-24 April	Kettenis
S. Mueller	PSNC, Poland	23-24 April	Kettenis
S. Casey	Onsala Space Obs., Sweden	23-24 April	Kettenis
S. Frey	FÖMI, SGO, Hungary	10-18 May	Paragi
R. Deane	Univ. Of Oxford, United Kingdom	15-20 May	Paragi
Y. Chen	Shanghai Astronomical Obs., China	17 May - 2 June	Paragi
Z. Xu	Shanghai Astronomical Obs., China	15 August - 15 October	Szomoru
R. Zhu	Shanghai Astronomical Obs., China	15 August - 15 October	Szomoru
Y. Xu	Yunnan Astronomical Obs., China	1 September - 1 December	Paragi
H. Cao	Shanghai Astronomical Obs., China	1 September - 1 May 2012	Gurvits
G. Molera	Metsähovie Radio Obs., Finland	1-4 November	Pogrebenko
V. Avotins	Ventspils Augstskola, Latvia	24-25 November	Gurvits
J. Berka	Ventspils Augstskola, Latvia	24-25 November	Gurvits
N. Kozlovs	Ventspils Augstskola, Latvia	24-25 November	Gurvits
Z. Li	Yunnan Astronomical Obs., China	1 December - 1 March 2012	Paragi

2012

Name	Institute	Period	Host
W. Vlemmings	University of Bonn, Germany	17-19 January	Campbell
F. Kirsten	University of Bonn, Germany	17-19 January	Campbell
S. Frey	FÖMI, SGO, Hungary	5-15 March	Paragi
P. Kharb	Rochester Institute of Technology	4 July - 30 September	Gurvits
T. An	Shanghai Astronomical Inst., China	25 July - 3 August	Paragi
M. Altmann	University of Heidelberg, Germany	1-3 August	Gurvits
P. Rosenblatt	OMA, Belgium	9-10 August	Gurvits
M. Chen	Shanghai Astronomical Obs, China	1-30 September	Gurvits
A. Sanna	MPIfR Bonn, Gemany	2-8 September	Surcis
T. An	Shanghai Astronomical Inst, China	4 September	Paragi
X. Lu	Shanghai Astronomical Inst, China	4 September	Paragi
J. Zhu	Shanghai Astronomical Inst, China	4 September	Paragi
X. Wang	CETGC no. 54 Inst. Shanghai, China	4 September	Paragi
X. Su	CETC54 Shanghai, China	4 September	Paragi
R. Xu	Shanghai Major Constr. Proj. Office, CH	4 September	Paragi
S. van Velzen	Radboud Univ. Nijmegen	26-28 September	Paragi
A. Arana Antelo	European Commission, Belgium	25 October	v. Langevelde
C. Reynolds	Curtin University, Australia	5-7 December	Kettenis
A. Matala	VTT, Finland		Molera

8.5. PRESENTATIONS

Nikta Amiri

- ★ *"Magnetic Fields And Developing Asymmetries In Circumstellar Masers"*, AAS meeting, Boston, USA, 24 May 2011
- ★ *"Magnetic Fields And Developing Asymmetries In Circumstellar Masers"*, IAUS 283 meeting, Tenerife, Spain, 27 July 2011
- ★ *"Magnetic Fields And Developing Asymmetries In Circumstellar Masers"*, NRAO, Socorro, USA, 14 July 2011
- ★ *"Magnetic Fields And Developing Asymmetries In Circumstellar Masers"*, University of New Mexico, Albuquerque, USA, 15 July 2011

Tatiana Bocanegra Bahamon

- ★ *"Radio Science Applications of Planetary Radio Interferometry and Doppler Experiment (PRIDE)"*, XLII Young European Radio Astronomers Conference, September 2012, Puschino, Russia.

Paul Boven

- ★ *"The NEXPReS project"*, TNC2011, Prague, Czech Republic, 2011-05-18
- ★ *"WP6 Update"*, The Growing Demands on Connectivity and Information Processing from VLBI to the SKA - Aveiro, Portugal, 2011-05-25
- ★ *"NEXPReS WP6 High Bandwidth on Demand - NSI Implementation"*, GLIF2011, Rio de Janeiro, Brasil, 2011-09-13
- ★ *"Netwerken op Astronomische Schaal"*, NLUUG fall conference 2011, Ede, The Netherlands, 2011-10-20
- ★ *"Networking for NEXPReS"*, 10th e-VLBI Workshop, Hartebeesthoek, South Africa, 2011-11-14
- ★ *"NEXPReS NSI client demonstration"*, OGF34, Oxford, UK, 2012-03-14
- ★ *"An NSI client for e-VLBI"*, TNC2012, Reykjavik, Iceland, 2012-05-21
- ★ *"WP6: High Bandwidth on Demand"*, NEXPReS Board Meeting, NORDUnet Copenhagen, 2012-06-20
- ★ *"The NEXPReS project, WP6: High Bandwidth on Demand for Radio Astronomy"*, VU Laserlab, Amsterdam, The Netherlands, 2011-06-24
- ★ *"Bandwidth on Demand and e-VLBI: Progress in NEXPReS"* - 1st International VLBI Technology Workshop, Haystack Observatory, USA, 2012-10-22
- ★ *"Use case: Bandwidth-on-Demand in NEXPReS"*, GÉANT BoD workshop, Utrecht, The Netherlands, 2012-12-03
- ★ *"e-VLBI: Dynamic circuits for Radio Astronomy"*, remote presentation for LHC ONE meeting, CERN, Geneva, 2012-12-13

Bob Campbell

- ★ *"Pointing and single-dish amplitude calibration"*, 6th IVS Technical and Operations Workshop, Haystack Observatory, USA, 9 & 11 May 2011
- ★ *"Generating antabfs files"*, 6th IVS Technical and Operations Workshop, Haystack Observatory, USA, 10 May 2011
- ★ *"VLBI: Arrays and Techniques"*, 4th European Radio Inteferometry School, Rimini, Italy, 7 September 2011
- ★ *"Correlator Operations"*, JIVE Quinquennial Review, Dwingeloo, the Netherlands, 5 March 2012
- ★ *"Real-time e-VLBI in the EVN and Software Correlation at JIVE"*, 7th IVS General Meeting, Madrid, Spain, 8 March 2012
- ★ *"Software Correlation at JIVE and real-time e-VLBI in the EVN"*, 11th EVN Symposium, Bordeaux, France, 11 October 2012
- ★ *"EVN Proposal Tool (NorthStar)"*, 11th EVN Symposium, Bordeaux, France, 11 October 2012
- ★ *"EVN b2e Data Flow and Pypeline"*, Advanced Radio Astronomy, Commissioning Skills and Preparation for the SKA", Manchester, UK, 15 November 2012

Giuseppe Cimó

- ★ *"VLBI" view on the extreme scintillator J1819+3845"*, EVN Symposium 2012, Bordeaux, France, October 2012.
- ★ *"PRIDE and MarcoPolo-R: VLBI applications for Near-Earth Asteroids science"*, at EPSC 2013, Madrid, 23-28 September 2012
- ★ *"PRIDE: the technique and the results"*, poster presented at the Netherlands Astronomy Conference (NAC) 23-25 May, 2012, Ameland, the Netherlands, May 2012
- ★ *"VLBI and Doppler Tracking of Venus Express spacecraft"*, at the "International Planetary Probe Workshop", Toulouse, 16-22 June 2012
- ★ *"Accurate astrometry for Planetary Radio Interferometry and Doppler Experiments"*, at QSO astrophysics, Fundamental Physics and Astrometric Cosmology in the Gaia era, Porto, 6-9 June 2011
- ★ **"** *Planetary Radio Interferometry and Doppler Experiment (PRIDE)"*. In GREAT-EST workshop, 6-9 June 2011, Porto, Portugal, 2011.
- ★ **"***Planetary Radio Interferometry and Doppler Experiment for Current and Future Martian Missions"*, at the "Exploring Mars Habitability" conference in Lisbon, 13-15 June 2011
- ★ **"***Planetary Radio Interferometry and Doppler Experiment for Near-Earth Asteroids ESA mission MarcoPolo-R"*, at the "International Planetary Probe Workshop", Toulouse, 16-22 June 2012
- ★ **"***Space science applications of the VLBI technique"*, lectures to ASTRON/JIVE summer students, Dwingeloo, August 2011 and July 2012

Dmitry Duev

- ★ *"Radio View of the Universe"*, Lecture at the Lyceum "School No. 2", Moscow, Russia, 25 October 2012
- ★ *"Status of the Planetary Radio Interferometry and Doppler Experiment (PRIDE): Applications for the Phobos-Soil and Other Planetary Missions"*. In 2nd Moscow Solar System Symposium, 10-14 October 2011, Space Research Institute, Moscow, Russia, 2011.
- ★ *"Near Field VLBI Observations of Spacecraft"*. ASTRON/JIVE AstroFest 2011, 29 June 2011, Exloo, The Netherlands, 2011.
- ★ *"Planetary Radio Interferometry and Doppler Experiment (PRIDE) with Planetary Missions"*. 3rd Moscow Solar System Symposium, 8-12 October 2012, Space Research Institute, Moscow, Russia, 2012.
- ★ *"A Tropospheric Signal Delay Model for Radio Astronomical Observations"*. 20th EVGA Meeting & 12th Analysis Workshop, 29-31 March 2011, MPIfR, Bonn, Germany, 2011.
- ★ *"Near Field VLBI Experiments"*. NOVA Fall School 2011, 3-7 October 2011, Dwingeloo, The Netherlands, 2011.
- ★ **"***Ultra Near Field VLBI Experiments"*. YERAC-2012, Young European Radio Astronomers Conference, 18-21 September 2012, Pushchino, Russia, 2012.
- ★ *"VLBI Observations of Spacecraft with EVN Radio Telescopes"*. YERAC-2011, Young European Radio Astronomers Conference, 18-21 July 2011, Jodrell Bank Centre for Astrophysics, University of Manchester, UK, 2011.
- ★ *"VLBI and Doppler Tracking of Spacecraft"*. Poster at the 67th Dutch Astronomy Conference NAC-2012, 23-25 May 2012, Ameland, The Netherlands, 2012.
- ★ *"VLBI Observations of GLONSASS Satellites"*. International youth science forum "LOMONOSOV-2011", April 2011, Lomonosov Moscow State University, Russia, 2011. MAKS Press.

Ciriaco Goddi

- ★ *"Detailed structures of accretion and outflow probed by molecular masers in high-mass protostars"*, 11th European VLBI Network Symposium & Users Meeting, Bordeaux (France), October 2012
- ★ *"Structures of accretion and outflow on small scales in high-mass protostars"*, NOVA network II meeting, Groningen (NL), December 2012
- ★ *"Structure and Effects of Environment in the Outflow from Massive YSO Orion Source I revealed by ALMA"*, Conference 'The First Year of ALMA Science', Puerto Varas (Chile), December 2012

Leonid Gurvits

- ★ *"Space-related opportunities for VLBA: VLBI and beyond"*, NRAO VLBA Workshop, Charlottesville, VA, USA, 27-28 January 2011
- ★ *"Radio Universe"* (a popular lecture), Moscow Lyceum "School No. 2", Moscow, Russia, 2 February 2011
- ★ "*VLBI and planetary science"*, NWO Workshop, The Hague, NL, 16 February 2011
- ★ *"VLBI and space science"*, New Worlds, New Horizons, Santa Fe, NM, USA, 7-10 March 2011
- ★ *"Radio astronomy segments of prospective planetary science and exploration missions",* EGU Assembly, Vienna, Austria, 3-8 April 2011
- ★ *"Space science update"*, EVN CBD meeting, Toruń, Poland, 11 May 2011
- ★ *"Radio astronomy experiments with the MarcoPolo-R mission"*, MarcoPolo-R meeting, Frascati, Italy, 9-10 June 2011
- ★ *"Space frontier of VLBI"*, TU Delft ADSM colloquium, 16 June 2011
- ★ *"Euro-African cooperation in VLBI: evolution toward SKA",* African-European Astronomy Partnership meeting, Brussels, Belgium, 20 June 2011
- ★ *"ESPaCE WP4 (VLBI) implementation outlook"*, FP7 ESPaCE kick-off meeting, Paris, France, 23-24 June 2011
- ★ "*The most distant quasars under the VLBI magnifier",* New Horizons for High Redshifts, Cambridge, UK, 25-29 July 2011
- ★ *"RadioAstron (in-orbit!) news",* Astro-lunch, Dwingeloo, NL, 27 July 2011
- ★ *"Introduction of PRIDE"*, URSI GA Comm. J meeting, Istanbul, Turkey, 17 August 2011
- ★ *"Perspectives of SVLBI"*, 1st International meeting on the Chinese SVLBI mission, Shanghai, China, 13 September 2011
- ★ *"PRIDE-Phobos status"*, ESPaCE Phobos-Soil meeting, Dwingeloo, NL, 28 September 2011
- ★ *"Space VLBI news"*, Astro-lunch, Dwingeloo, NL, 3 October 2012
- ★ *"55 years of space launches: the legends and present day of Baikonur"*, lecture for the Leonardo da Vinci Society, TU Delft, 6 October 2011
- ★ *"Space science review"*, EVN CBD meeting, Bologna, Italy, 14 October 2011
- ★ JUICE Instruments workshop, ESOC, Darmstadt, Germany, 9-11 November 2011
- ★ *"News from the space frontier of radio astronomy"*, ASTRON Lunch talk, Dwingelo, NL, 21 November 2011
- ★ *"VLBI news from the opposite hemisphere"*, AUT-IRASR colloquium, Auckland, New Zealand, 20 Dec 2011
- ★ *"PRIDE for MarcoPolo-R mission"*, 3rd MarcoPolo-R Symposium, Manchester, UK, 26 March 2012
- ★ *"Status of RadioAstron PRIDE tracking"*, RadioAstron operations meeting, Moscow, Russia, 7 April 2012
- ★ *"Space radio astronomy in the next 100001_2 years"*, Resolving The Sky (RTS) 2012 conference, Manchester, UK, 20 April 2012
- ★ *"VLBI support for Gaia"*, Gaia GBOT meeting, Torino, Italy, 15 May 2012
- ★ *"Status of ESPaCE WP4 (VLBI)",* FP7 ESPaCE annual meeting, Dwingelo, NL, 30-31 May 2012
- ★ *"Introduction to VLBI, EVN and JIVE (a lecture for Dwingeloo summer students)",* Dwingeloo, NL, 26 June 2012
- ★ *"PRIDE tracking and OD of RadioAstron"*, RadioAstron International Science Council meeting, Pushchino, Russsia, 18 June 2012
- ★ *"PRIDE: a multidisciplinary enhancement of space science missions"*, COSPAR Assembly 2012, Mysore, India, 16 July 2012
- ★ *"Technical requirements for the Next Generation SVLBI: a template for brainstorming"*, 2nd International meeting on the Chinese SVLBI initiative, Beijing, China, 25 August 2012
- ★ *"VLBI: from z=0 to z>5 and back"*, Colloquium at the Bucharest Observatory, Bucharest, Romania, 6 September 2012
- ★ *"Very Long Baseline Interferometry in space and for space exploration"*, International Academy of Astronautics meeting, Naples, Italy, 30 September 2012
- ★ *"PRIDE: a multi-disciplinary enhancement of space science missions"*, EVN Symposium, Bordeaux, France, 9-12 October 2012

- ★ *"The case for off-session EVN observations",* EVN CBD meeting, Madrid, Spain, 7 Nov 2012
- ★ *"VLBI segment of GBOT: progress report",* Gaia GBOT meeting, Heidelberg, Germany, 19-20 Nov 2012
- ★ *"Euro-African cooperation in radio astronomy as seen from space: evolution toward SKA and beyond"*, EU-African SKA meeting, Lisbon, Portugal, 30 November 2012
- ★ *"Zooming into the high-redshift Universe"*, RadioAstron Key Science Programme workshop, Bonn, Germany, 3-4 December 2012

Jonathan Hargreaves

- ★ *"Recent Developments with UniBoard"*, Casper 2011 Workshop, Pune, India, 10-14 Oct 2011
- ★ *"UniBoard: generic hardware for radio astronomy signal processing"*, Poster at SPIE 2012 Astronomical Telescopes and Instrumentation, Amsterdam, The Netherlands, 2-6 July 2012

Mark Kettenis

- ★ *"Real-Time e-VLBI with the SFXC Software Correlator"*, 10th e-VLBI workshop, Broederstroom, South Africa, 14 November 2011
- ★ *"The SFXC Software Correlator and other e-VLBI developments at JIVE"*, New Technologies in Astronomy, Shanghai, China, 23 June 2012
- ★ *"Software Correlation and e-VLBI in NEXPReS"*, DiFX users meeting, Sydney, 24 September 2012

Huib van Langevelde

- ★ *"Retraite"*, Groningen, the Netherlands,07 January 2011
- ★ *"EXPReS & NEXPReS, an evolution pathway for VLBI into the SKA era"*, VLBA workshop "Future of the VLBA", Charlottesville VA, USA, 28 January 2011
- ★ *"Radio Astronomy, connectivity, signal transport and data handling from e-VLBI to SKA"*, GEANT expert group,Brussels,Belgium,10 March 2011
- ★ *"Introducing JIVE, VLBI, e-VLBI"*, SNN ambassadors visit, Dwingeloo ,the Netherlands,07 April 2011
- ★ *"JIVE and eVLBI"*, EVN CBD, Torun,Poland, 11 May 2011
- ★ *"JIVE management report"*, JIVE board, Warsaw, Poland,12 May 2011
- ★ *"Some notes on ParselTongue and the parallax of Cep A"*, BeSSel project meeting, MPI Bonn, Germany, 25 May 2011
- ★ *"Current status of the EVN"*, NRAO AOC Colloquium, Socorro NM,USA,12 July 2011
- ★ *"Progress with e-VLBI in the EVN and correlators at JIVE"*, URSI General Assembly, Istanbul, Turkey, 18 August 2011
- ★ *"Magnetic field measurements around young and old stars using masers"*, JAN65 symposium, Nijmegen, the Netherlands, 26 August 2011
- ★ *"Coordinator's introduction"*, NEXPReS review, Brussels, Belgium, 08 September 2011
- ★ *"Introducing activities at JIVE"*, VIP journalists visit, Dwingeloo, the Netherlands, 27 September 2011
- ★ *"JIVE and eVLBI"*, EVN CBD, Bologna, 13 October 2011
- ★ *"NEXPReS"*, eVSAG meeting, Madrid, Spain, 04 November 2011
- ★ *"ALBiUS progress report"*, RadioNet board, Cape Town, South Africa,11 November 2011
- ★ *"Global eVLBI; an evolution pathway for VLBI into the SKA era"*, 10th e-VLBI workshop, Broederstroom, South Africa, 15 November 2011
- ★ *"The European VLBI Network and the Joint Institute for VLBI in Europe"*, Meeting with the ERTRC AstroNet panel, Schiphol, the Netherlands, 1 December 2011
- ★ *"JIVE management report"*, JIVE board, Dwingeloo, the Netherlands,12 December 2011
- ★ *"NEXPReS"*, JIVE/ASTRON lunch talk, Dwingeloo, Netherlands,16 January 2012
- ★ *"Masers in star formation"*, IAU Symposium 287: Cosmic masers - from OH to H_0, Stellenbosch, South Africa,31 January 2012
- ★ *"QueSERA: Questions on Structuring European Radio Astronomy"*, RadioNet3 kick-off, MPI Bonn, Germany, 28 February 2012

- ★ *"Introducing JIVE"*, *"Progress report 2011"*, *"Management"*, *"Strategy"*, JIVE review, Dwingeloo, Netherlands, 05 March 2012
- ★ *"The Future of VLBI"*, Resolving the Sky 2012, Manchester, UK, 20 April 2012
- ★ *"HILADO Task 4: Bringing it to the user"*, HILADO kick-off, Zaandam, Netherlands, 26 April 2012
- ★ *"JIVE report"*, EVN CBD, MPI Bonn, Germany, 10 May 2012
- ★ *"JIVE management report"*, JIVE board, MPI Bonn, Germany, 11 May 2012
- ★ *"The development of Global VLBI"*, AERAP meeting, South-African embassy, Brussels, Belgium, 29 May 2012
- ★ *"Coordinator's view"*, NEXPReS board, Copenhagen, Denmark, 20 June 2012
- ★ *"VLBI in Europe"*, mm-VLBI with ALMA workshop, ESO,Garching, Germany, 26 June 2012
- ★ *"Introducing JIVE"*, ERIC committee, Brussels, Belgium, 29 June 2012
- ★ *"Introducing JIVE"*, STFC, Swindon, UK, 17 July 2012
- ★ *"Introducing JIVE"*, NWO, Den Haag, Netherlands, 10 August 2012
- ★ *"Zooming in on star formation with radio telescopes"*, Frontiers of star formation, ESTEC Noordwijk, the Netherlands, 17 August 2012
- ★ *"Introducing JIVE"*, Shanghai delegation visit, Dwingeloo, the Netherlands, 03 September 2012
- ★ *"Connecting telescopes for global VLBI"*, NorduNET 12 meeting, Oslo, Norway, 18 September 2012
- ★ *"Coordinator's introduction"*, NEXPReS review, Brussels, Belgium, 21 September 2012
- ★ *"Introducing JIVE"*, LOFAR/EVN, Warsaw, Poland, 04 October 2012
- ★ *"JIVE: what's next?"*, 11th EVN symposium, Bordeaux, France, 11 October 2012
- ★ *"Astronomy with e-VLBI"*, VLBI technology workshop, Haystack Obs., USA, 22 October 2012
- ★ *"JIVE report"*, EVN CBD, Madrid, Spain, 07 November 2012
- ★ *"JIVE management report"*, JIVE board, Madrid, Spain, 08 November 2012
- ★ *"The AVN, why this is a great idea"*, AERAP meeting, Brussels, Belgium, 14 November 2012

Guifré Molera Calvés

- ★ *"VLBI Tracking of the Phobos Soil Mission"*. 8th International Planetary Probe Workshop, June 6-10, 2011, Portsmouth, Virginia, USA, 2011.
- ★ *"Tracking of Planetary missions with GPS-like accuracy"*, Seminar presented in the Institut d'Estudis Espacials de Catalunya (IEEC), Bellaterra, Spain, September 2012.
- ★ *"PRIDE contribution to the European VLBI Network"*, 11th EVN symposium 2012, Bordeaux, France, October 2012.
- ★ *"Spaceccraft VLBI and Doppler tracking of Venus Express"*, presented at the European Planetary Science Congress (EPSC) 2012, Madrid, Spain, September 2012.
- ★ *"VLBI and Doppler tracking of Venus Express spacecraft"*, presented at the Interplanetary Probe Workshop (IPPW-9), Toulouse, France, June 2012.

Zsolt Paragi

- ★ *"e-EVN: a SKA pathfinder for high resolution probing of the radio continuum sky"*, (invited talk, substituting for H. van Langevelde), SKA Workshop, 25 February 2011, Leiden, NL
- ★ *"The European VLBI Network and e-VLBI: developments and results",* 4th East Asia VLBI Workshop, 18 April 2011, Lijiang, P.R. China
- ★ *"Constraints on early expansion in Type Ib/c SNe with VLBI",* 21 April 2011, Yunnan Astronomical Observatory, Kunming, P.R. China 25 April 2011, Shanghai Astronomical Observatory, Shanghai, P.R. China
- ★ *"VLBI observations of the shortest orbital period black hole binary"*, (poster) HEPRO III, 27 June - 1 July 2011, Barcelona, Spain
- ★ *"Compact objects near and far with the European VLBI Network"*, Third Galileo - Xu Guangqi meeting 11-15 October, 2011, Beijing, P.R. China
- ★ *"e-VLBI follow-up of Galactic, unidentified TeV sources"*, (invited) 10th e-VLBI Workshop, 13-16 November 2011, Broederstroom, SA

- ★ *"SS433 and other transients"*, Resolving the Sky, 18-20 April 2012, Manchester, UK
- ★ *"e-VLBI at the European VLBI Network"*, (invited) ShAO Symposium, 23 June, 2012, Shanghai, P.R. China
- ★ *"Jet scaling relations in LLAGN: a VLBI view"*, COSPAR, 16 July 2012, Mysore, India
- ★ *"e-EVN for transients and surveys"*, (invited) EMU Consortium Meeting, 27 July 2012, Bochum, Germany
- ★ *"Locating Transients with the e-EVN"*, The third Gaia Science Alerts Workshop 6-7 September 2012, Bologna, Italy
- ★ *"Jet scaling relations in LLAGN: a VLBI view"*, 11th EVN Symposium, 9 October 2012, Bordeaux, France
- ★ *"e-VLBI developments at JIVE and (e)-EVN science"*, 18 October 2012, NWO/NRF workshop, Cape Town, South Africa
- ★ *"Jet scaling relations in LLAGN: a VLBI view"*, Nuclei of Seyfert galaxies and QSOs, 6 November 2012, Bonn, Germany

Gabriele Surcis

- ★ *"High resolution magnetic field measurements in high-mass star-forming regions using masers"*, IAU Symposium 287: Cosmic masers - from OH to H0, Stellenbosch, South Africa,30 January 2012
- ★ *"High resolution magnetic field measurements in high-mass star-forming regions using masers"*, 11th EVN symposium, Bordeaux, France, 10 October 2012

Arpad Szomoru

- ★ *"Technical Operations and R&D at JIVE"*, EVN Technical and Operations Group meeting, Dwingeloo, The Netherlands, 28 January 2011
- ★ *"The UniBoard: a RadioNet FP7 Joint Research Activity"*, ASTRON/JIVE lunch presentation, Dwingeloo, The Netherlands, 28 March 2011
- ★ *"The UniBoard: a RadioNet FP7 Joint Research Activity"*, prepSKA Signal Processing CoDR, Manchester, United Kingdom, 14-15 April 2011
- ★ *"NEXPReS: The future of European VLBI"*, The Growing Demand on Connectivity and Information Processing in RadioAstronomy from VLBI to SKA, Aveiro, Portugal, 24-25 May 2011
- ★ *"e-VLBI: Using high-speed networks to enable new astronomy"*, Vrije Universiteit Amsterdam, The Netherlands, 24 June 2011
- ★ *"VLBI and atomic clocks"*, SuperGPS match making meeting, Vrije Universiteit Amsterdam, The Netherlands, 1 July 2011
- ★ *"Technical Operations and R&D at JIVE"*, EVN Technical and Operations Group meeting, Arecibo Observatory, Puerto Rico, 29-30 August 2011
- ★ *"EXPReS and NEXPReS, The Future of European Radio Astronomy"*, Florida International University, Miami, USA, 2 September 2011
- ★ *"WP5: Cloud Correlation"*, NEXPReS first year review, Brussels, Belgium, 8 September 2011
- ★ *"WP6: High Bandwidth on Demand"*, NEXPReS first year review, Brussels, Belgium, 8 September 2011
- ★ *"The e-EVN"*, PrepSKA WP2 Annual Meeting, Manchester, United Kingdom, 20 October 2011
- ★ *"The UniBoard: a RadioNet FP7 Joint Research Activity"*, RadioNet FP7 Board Meeting, Cape Town, South Africa, 11 November 2011
- ★ *"e-RemoteCtrl: Concepts for VLBI station control as part of NEXPReS"*, 10th International e-VLBI Workshop, Amanzingwe, South Africa, 13-16 November 2011
- ★ *"The UniBoard: a RadioNet FP7 Joint Research Activity"*, 10th International e-VLBI Workshop, Amanzingwe, South Africa, 13-16 November 2011
- ★ *"The UniBoard: a RadioNet FP7 Joint Research Activity"*, AAVP 2011: Taking the AA programme into SKA Pre-Construction, Dwingeloo, The Netherlands, 12-16 December 2011
- ★ *"UniBoard2, A multi-purpose scalable computing platform for Radio Astronomy"*, RadioNet3 kickoff meeting, Bonn, Germany, 28 February 2012
- ★ *"JIVE and UniBoard"*, visit Xilinx representatives, Dwingeloo, The Netherlands, March 2 2012
- ★ *"The development of e-VLBI at JIVE and the EVN"*, JIVE review, Dwingeloo, the Netherlands 6 March 2012

- ★ *"The e-EVN"*, EVN Board Meeting, Bonn, Germany, 10 May 2012
- ★ *"WP5: Cloud Correlation"*, NEXPReS Board Meeting, Copenhagen, Denmark, 20 June 2012
- ★ *"Technical Operations and R&D at JIVE"*, Technical and Operations Group Meeting, Onsala, Sweden, 28 June 2012
- ★ *"UniBoard and UniBoard^2"*, Meeting with Altera representatives on SKA, AAVP, UniBoard^2, University of Manchester, United Kingdom, 3 July 2012
- ★ *"RadioNet3: future plans"*, JENAM-2011, European Week of Astronomy and Space Science, St. Petersburg, Russia, 6 July 2011
- ★ *"RadioNet - current status and future developments"*, JENAM-2011, European Week of Astronomy and Space Science, St. Petersburg, Russia, 6 July 2011
- ★ *"WP5: Cloud Correlation"*, NEXPReS Second Annual Review, Brussels, Belgium, 21 September 2012
- ★ *"WP6: High Bandwidth on Demand"*, NEXPReS Second Annual Review, Brussels, Belgium, 21 September 2012
- ★ *"NEXPReS and the EVN, Towards 4 Gbps operational VLBI"*, 1st International VLBI Technology Workshop, Haystack Observatory, 22-24 October 2012
- ★ *"UniBoard^2, A multi-purpose scalable computing platform for Radio Astronomy"*, RadioNet3 Executive meeting, Madrid, Spain, 6 November 2012

Kalle Torstensson

- ★ *"Tasseomancy of methanol masers – early stages of high-mass star formation"*, NAC Texel, Netherlands, 20 May 2011
- ★ *"Methanol masers and millimetre lines: a common origin in protostellar envelopes"*, IAU Symposium 287: Cosmic masers - from OH to H_0, Stellenbosch, South Africa, 1 February 2012

Harro Verkouter

- ★ *"The Mark5C recorder"*, EVN TOG, Onsala, Sweden, 28 June 2012
- ★ *"jive5ab - the Swiss army knife of (e-)VLBI"*, 1st International VLBI Technology Workshop, MIT Haystack Observatory, USA, 22-24 October 2012
- ★ *"Erlang in global radio astronomy"*, Erlang Factory Lite, London, UK, 8 November 2012

Jun Yang

- ★ *"A decelerating jet in the Galactic black hole candidate XTE J1752-223"*, 4th East Asia VLBI Workshop – Sciences and Technology by now and future EAVN 18-20 April 2011, Lijiang, PR China
- ★ *"EVN in-beam phase referencing observations of the relativistic jet in the tidal disruption event Sw J1644+57"*, 11th European VLBI Network Symposium and Users Meeting 9-12 October 2012, Bordeaux, France

Charles Yun

- ★ *"Network Connectivity with China via ORIENTplus, e-VLBI User Perspective",* ORIENTplus Meeting, Brussels, BE, 13 May 2011
- ★ *"eVLBI and Shared Infrastructures"*, EVALSO, Rio de Janeiro, Brazil, 17-18 September 2011
- ★ *"Collaboration with Eastern Europe"*, Internet2 2012 Fall Member Meeting, Philadelphia, PA, 30 September - 4 October 2012

8.6. MEMBERSHIPS OF PROFESSIONAL BOARDS AND COMMITEES

Paul Boven
NEXPReS e-VLBI Science Advisory Group (eVSAG)

Bob Campbell
4th European Radio Interferometry School Scientific Organizing Committee
European VLBI Group for Geodesy and Astrometry (EVGA)
EVN Programme Committee (EVN PC)
EVN Technical and Operations Group (EVN TOG)
NEXPReS e-VLBI science advisory group

Ciriaco Goddi
EVN Technical and Operations Group
NRAO proposal review, star formation panel

Leonid Gurvits
ESA BepiColombo Science Working Group
ESA Gaia GBOT group
ESA JUICE Science Working Team (PI of PRIDE-JUICE)
ESPACE FP7 consortium board and executive
EuroPlaNet FP7 consortium board
IAU Working Group on Astronomy from the Moon
IAU Working Group on History of Radio Astronomy
RadioAstron International Science Council

Mark Kettenis
NEXPReS e-VLBI Science Advisory Group (eVSAG)

Huib van Langevelde
Chairman board of directors Leids Kerkhoven Bosscha Fonds
Coördinator NEXPReS, board and management team
Member board of directors Jan Hendrik Oort Fonds
Member board of directors Leids Sterrewacht Fonds
Member board PrepSKA (Prepatory SKA studies)
Member consortium board European VLBI Network
Member Dutch URSI committee
Member European SKA Consortium
Member NOVA Instrumentation Steering Committee
Member RadioNet Board and Executive Board
PI, RadioNet FP7 research activity ALBiUS (Advanced Long Baseline Interoperable User Software)
SKA klankbordgroep NL
SOC “Resolving the Sky 2012”, Manchester
SOC 11th EVN symposium, Bordeaux
SOC IAU Symposium 287: “Cosmic masers - from OH to H0”, Stellenbosch

Martin Leeuwinga
EVN Technical and Operations Group

Zsolt Paragi
EVN Technical and Operations Group
NEXPReS e-VLBI Science Advisory Group (e-VSAG)

Gabriele Surcis
EVN Technical and Operations Group

Arpad Szomoru
EVN Technical and Operations Group
NEXPReS e-VLBI Science Advisory Group (eVSAG)
PI of NEXPReS Work Package 5 “Cloud Correlation”, member of executive board
PI of RadioNet3 Work Package 8 “UniBoard^{2}”, member of executive board
SOC 10th International e-VLBI Workshop
SOC 1st International VLBI Technology Workshop
Vice-chair EVN Technical and Operations Group

Jung Yang
EVN Technical and Operations Group

8.7. MEMBERSHIPS OF PROFESSIONAL ASSOCIATIONS AND SOCIETIES

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

Leonid Gurvits
American Astronomical Society
Committee on Space Research (COSPAR) Associate
European Geosciences Union
International Academy of Astronautics (corresponding member)
International Astronomical Union
International Union of Radio Science (URSI)
Nederlandse Astronomen Club
Nederlandse Vereniging voor Ruimtevaart

Aard Keimpema
Nederlandse Natuurkundige Vereniging

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

Zsolt Paragi
Eotvos Lorand Physical Society
Hungarian Astronautical Society
Hungarian Astronomical Society
International Astronomical Union
Nederlandse Atronomenclub

Arpad Szomoru
International Astronomical Union
International Union of Radio Science (URSI)
Nederlandse Astronomen Club

8.8. MEETINGS ATTENDED

8.8.1. SCIENTIFIC CONFERENCES

Nikta Amiri

- ★ AAS meeting, Boston, USA, 24 – 26 May 2011
- ★ IAUS 283: Planetary Nebulae: an Eye to the Future, Tenerife, Spain, 25-29 July 2011

Bob Campbell

- ★ 4th European Radio Interferometry School, Rimini, Italy, 5-9 September 2011
- ★ 7th IVS General Meeting, Madrid, Spain, 8 March 2012
- ★ 13th IVS Analysis Workshop, Madrid, Spain, 8 March 2012
- ★ 11th EVN Symposium, Bordeaux, France, 9-12 October 2012
- ★ Advanced Radio Astronomy, Commissioning Skills and Preparation for the SKA, Manchester, UK, 13-16 November 2012

Bob Eldering

- ★ 13th Synthesis Imaging Workshop, Socorro, USA, 29 May - 5 June 2012

Ciriaco Goddi

- ★ 11th European VLBI Network Symposium & Users Meeting, Bordeaux (France), October 2012
- ★ NOVA network II meeting, Groningen (NL), December 2012
- ★ ”The First Year of ALMA Science”, Puerto Varas (Chile), December 2012

Leonid Gurvits

- ★ NRAO VLBA Workshop, Charlottesville, VA, USA, 27-28 Jan 2011
- ★ NWO Planetary Science Workshop, The Hague, NL, 16 February 2011
- ★ New Worlds, New Horizons, Santa Fe, NM, USA, 7-10 March 2011
- ★ EGU Assembly, Vienna, Austria, 3-8 April 2011
- ★ URSI General Assembly, Istanbul, Turkey, 14-20 August 2011
- ★ 2nd Moscow Solar System Symposium, 10-13 October 2011
- ★ Resolving The Sky (RTS) 2012 conference, Manchester, UK, 18-20 April 2012
- ★ New windows on transients across the Universe, London, UK, 23-24 April 2012
- ★ EWASS-2012, Rome, Italy, 2-6 July 2012
- ★ EVN Symposium, Bordeaux, France, 9-12 October 2012
- ★ COSPAR Assembly 2012, Mysore, India, 14-21 July 2012
- ★ IAU General Assembly, Beijing, China, 20-31 August 2012

Aard Keimpema

- ★ URSI Benelux Forum, Noordwijk, NL, June 6 2011
- ★ 13th Synthesis Imaging Workshop, Socorro, USA, 29 May - 5 June 2012

Huib van Langevelde:

- ★ “The Future of the VLBA”, Charlottesville VA, USA, 24 - 31 January 2011
- ★ “Probing the Radio Continuum Universe with SKA Pathfinders”, Leiden, the Netherlands, 20 – 25 February 2011
- ★ IAU symposium 280: “The molecular universe”, Toledo, 29 May - 01 June 2011
- ★ SKA 2011 forum, Banff, Canada, 2 – 8 July 2011
- ★ URSI General Assembly, Istanbul, Turkey, 16 – 20 August 2011
- ★ “JAN65”, Nijmegen, the Netherlands, 24 – 26 August 2011

- 10th e-VLBI workshop, Broederstroom, South Africa, 13 – 20 November 2011
- IAU Symposium 287: "Cosmic masers - from OH to H0", Stellenbosch, South Africa, 29 January - 4 February 2012
- "370 years of astronomy in Utrecht", Noordwijk, Netherlands, 2 - 5 April 2012
- "Resolving the Sky 2012", Manchester, UK, 17 – 20 April 2012
- "mm-VLBI with ALMA" workshop, Garching, Germany, 26 – 28 June 2012
- "Frontiers of star formation", Noordwijk, the Netherlands, 15 – 17 August 2012
- 11th EVN symposium, Bordeaux, France, 08 – 12 October 2012
- VLBI technology workshop, Haystack, USA, 20 – 23 October 2012

Zsolt Paragi

- Probing the Radio Continuum Universe with SKA Pathfinders 21-25 February 2011, Lorentz Center, Leiden, Netherlands
- 4th East Asia VLBI Workshop – Sciences and Technology by now and future EAVN 18-20 April 2011, Lijiang, PR China
- High Energy Phenomena in Relativistic Outflows (HEPRO III) 27 June - 1 July 2011, Barcelona, Spain
- Black Hole Astrophysics: Tales of Power and Destruction 18-22 July 2011, Winchester, United Kingdom
- Third Galileo - Xu Guangqi meeting 11-15 October, 2011, Beijing, P.R. China
- Towards Global Real-Time e-VLBI: the 10th International e-VLBI Workshop 13-16 November 2011, Broederstroom, South Africa
- First Dutch Gravitational Wave Meeting 19 January 2012, Amsterdam, Netherlands
- Resolving the Sky - Radio Interferometry: Past, Present and Future 17-20 April 2012, Manchester, United Kingdom
- New windows on transients across the Universe 23-24 April 2012, London, United Kingdom
- Shanghai Astronomical Observatory "New Technologies in Astronomy" Symposium 2012 23-25 June, 2012, Shanghai, P.R. China
- COSPAR, 14-22 July 2012, Mysore, India
- Evolutionary Map of the Universe (EMU) Consortium Meeting 26-27 July 2012, Bochum, Germany
- The third Gaia Science Alerts Workshop 6-7 September 2012, Bologna, Italy
- 11th European VLBI Network Symposium and Users Meeting 9-12 October 2012, Bordeaux, France
- Nuclei of Seyfert galaxies and QSOs - Central engine & conditions of star formation 6-8 november 2012, Bonn, Germany

Gabriele Surcis:

- IAU Symposium 287: "Cosmic masers - from OH to H0", Stellenbosch, South Africa, 29 January - 4 February 2012
- 11th EVN symposium, Bordeaux, France, 08 – 12 October 2012

Arpad Szomoru:

- RTS 2012 - Resolving The Sky - Radio Interferometry: Past, Present & Future, Manchester, United Kingdom, 17-20 April 2012
- JENAM-2011, European Week of Astronomy and Space Science, St. Petersburg, Russia, 6 July 2011
- The XXX General Assembly and Scientific Symposium of the International Union of Radio Science, Istanbul, Turkey, 13-20 August 2011
- IAU XXVIII General Assembly, Beijing, 20-31 August 2012
- 11th EVN Symposium, Bordeaux, France, 9-12 October 2012

Kalle Torstensson

- NAC 2011, Texel, 18-20 May 2011

- ★ IAU Symposium 287: Cosmic masers - from OH to H0, Stellenbosch, South Africa, 29 January – 4 February 2012
- ★ ARC Retreat, Desenzano del Garda, Italy, 14–17 February 2012

Harro Verkouter

- ★ ADASS XXI, Paris, France, 6-10 November 2011
- ★ EVN TOG meeting, Onsala, Sweden, 27-28 June, 2012
- ★ 1st International VLBI Technology Workshop, MIT Haystack, USA, 22-24 October 2012

Jun Yang

- ★ 4th East Asia VLBI Workshop – Sciences and Technology by now and future EAVN 18-20 April 2011, Lijiang, PR China
- ★ 11th European VLBI Network Symposium and Users Meeting 9-12 October 2012, Bordeaux, France
- ★ IAU XXVIII General Assembly, Beijing, 20-31 August 2012

Charles Yun

- ★ The Growing Demands on Connectivity and Information Processing in Radio Astronomy from VLBI to the SKA, Aveiro, Portugal, 24-26 May 2011
- ★ TNC2011 (TERENA Networkers Conference), Prague, Czech Republic, 16-19 May 2011
- ★ 10th International eVLBI Workshop, Johannesburg, South Africa, 13-16 November 2011
- ★ TNC2012 (TERENA Networkers Conference), Rekyavik, Iceland, 21-14 May 2012
- ★ 27th NORDUnet Conference & eVSAG, Oslo, Norway, 16 September 2012
- ★ Internet2 2012 Fall Member Meeting, Philadelphia, PA, 30 September - 4 october 2012
- ★ 1st VLBI Technology Workshop, Haystack Observatory, MA, USA, 22-24 October 2012
- ★ DANTE BoD Workshop, Utrecht, NL, 3 December 2012

8.8.2. TECHNICAL AND BUSINESS MEETINGS

Fedde Bloemhof

- ★ OGF34, Oxford, UK, 12-15 March 2012
- ★ TNC2012, Reykjavik, Iceland, 20-24 May 2012
- ★ OGF35, Delft, The Netherlands, 17-19 June 2012
- ★ GÉANT BoD Workshop, Utrecht, the Netherlands, 3-4 December 2012

Paul Boven

- ★ EVN TOG, Dwingeloo, The Netherlands, 28 Januari 2011
- ★ TNC2011, Prague, Czech Republic, 16-19 May 2011
- ★ The Growing Demands on Connectivity and Information Processing from VLBI to the SKA - Aveiro, Portugal, 24-26 May 2011
- ★ SKA Signal Transport and Networking Concept Design Review, Manchester, United Kingdom, 28-30 June 2011
- ★ GLIF 2011, Rio de Janeiro, Brasil, 13-14 September 2011
- ★ NLUUG fall conference 2011, Ede, The Netherlands, 10 October 2011
- ★ 10th e-VLBI WS, Hartebeesthoek, South Africa, 13-16 November 2011
- ★ OGF34, Oxford, UK, 12-15 March 2012
- ★ TNC2012, Reykjavik, Iceland, 20-24 May 2012
- ★ OGF35, Delft, The Netherlands, 17-19 June 2012
- ★ NEXPReS Board Meeting, NORDUnet Copenhagen, Denmark, 20 June 2012
- ★ 1st International VLBI Technology Workshop, Haystack Observatory, USA,22-24 October 2012 (+ DBE Compatibility testing, 25-26 October)

- ★ Optical Networks for Accurate Time and Frequency Transfer, Hoofddorp, The Netherlands, 20-21 November 2012
- ★ GÉANT BoD Workshop, Utrecht, the Netherlands, 3-4 December 2012
- ★ LHC ONE Architecture, Point-to-Point Workshop (remote participation), CERN, Geneva, Switzeland, 13-14 December 2012

Bob Campbell

- ★ EVN TOG meeting, Dwingeloo, the Netherlands, 28 January 2011
- ★ EVN PC meeting, Noto, Italy, 15 March 2011
- ★ 6th IVS Technical and Operations Workshop, Haystack Observatory, USA, 9-12 May 2011
- ★ EVN PC meeting, Gothenburg, Sweden, 7 July 2011
- ★ EVN TOG meeting, Arecibo, Puerto Rico (vido-conferenced), 27-28 August 2011
- ★ EVN PC meeting, Madrid, Spain, 3 November 2011
- ★ eVSAG meeting, Madrid, Spain, 4 November 2011
- ★ RadioNet FP7 TNA meeting, Schiphol, NL, 30 November 2011
- ★ JIVE Quinquennial Review, Dwingeloo, the Netherlands, 5-6 March 2012
- ★ EVN PC Meeting, Bonn, Germany, 20 March 2012
- ★ EVN TOG meeting, Onsala, Sweden, 27-28 June 2012
- ★ EVN PC Meeting, Athens, 3 July 2012
- ★ EVN PC Meeting, Manchester, UK, 12 November 2012

Bob Eldering

- ★ NEXPReS WP8 face-to-face meeting, Schiphol, The Netherlands, 10 December 2012
- ★ Course “The programming language Python”, Dwingeloo, The Netherlands, 30 November - 2 December 2011

Leonid Gurvits

- ★ ESA presentation of L-class missions (CV L1 cycle), Paris, France, 3 February 2011
- ★ Planetary science tracking for science applications, Flagstaff, AZ, USA, 14-15 March 2011
- ★ BepiColombo SWT meeting, Noordwijk, NL, 30-31 March 2011
- ★ VLBI progress at VIRAC (Irbene), Ventspils, Latvia, 14 April 2011
- ★ EVN CBD meeting, Toruń, Poland, 11 May 2011
- ★ JIVE Bard meeting, Warsaw, Poland, 12 May 2011
- ★ MarcoPolo-R meeting, Frascati, Italy, 9-10 June 2011
- ★ African-European Astronomy Partnership meeting, Brussels, Belgium, 20 June 2011
- ★ FP7 ESPaCE kick-off meeting, Paris, France, 23-24 June 2011
- ★ RadioAstron (RISC) meetings, Baikonur, Kazakhstan and Moscow, Russia, 17-20 July 2011
- ★ 8th BepiColombo SWT meeting, Kanizawa, Japan, 8-10 September 2011
- ★ 1st International meeting on the Chinese SVLBI mission, Shanghai, China, 13 September 2011
- ★ ESPaCE Phobos-Soil meeting, Dwingeloo, NL, 28 September 2011
- ★ EuroPlaNet Assembly and Board meeting, Nantes, France, 4-5 October 2011
- ★ EVN CBD meeting, Bologna, Italy, 14 October 2011
- ★ Phobos-Soil meetings, Baikonur, Kazakhstan and Moscow, Russia, 7-9 November 2011
- ★ JIVE Board meeting, Dwingeloo, NL, 12-13 December 2011
- ★ VLBI support for Gaia, technical meeting, Dwingeloo, NL, 5 March 2012
- ★ 3rd MarcoPolo-R Symposium, Manchester, UK, 26 March 2012
- ★ RadioAstron operations meeting, Moscow, Russia, 6-8 April 2012
- ★ EVN CBD meeting, Bonn, Germany, 10 May 2012
- ★ JIVE Board meeting, Bonn, Germany, 11 May 2012
- ★ Gaia GBOT meeting, Torino, Italy, 15-16 May 2012

- ★ FP7 ESPaCE annual meeting, Dwingelo, NL, 30-31 May 2012
- ★ RadioAstron International Science Council meeting, Pushchino, Russsia, 18-20 July 2012
- ★ 2nd International meeting on the Chinese SVLBI initiative, Beijing, China, 25 August 2012
- ★ 9th BepiColombo SWT meeting, Stockholm, Sweden, 18-20 September 2012
- ★ EuroPlaNet Assembly and Board meeting, Madrid, Spain, 24-25 September 2012
- ★ International Academy of Astronautics meeting, Naples, Italy, 30 September 2012
- ★ Gaia GBOT meeting, Heidelberg, Germany, 19-20 Nov 2012
- ★ EU-African SKA meeting, Lisbon, Portugal, 29-30 November 2012
- ★ RadioAstron Key Science Programme workshop, Bonn, Germany, 3-4 December 2012

Jonathan Hargreaves

- ★ SKA System CoDR, Manchester, UK, 22-25 Feb 2011
- ★ SKA Signal Processing CoDR, Manchester, UK, 13-15 April 2011
- ★ SKA AAVP progress meeting, Bologna, Italy, 22-25 Oct 2012

Aard Keimpema

- ★ NEXPReS WP7 face-to-face meeting, Poznan, Poland, 19-20 April 2011
- ★ NEXPReS WP7 face-to-face meeting, Dwingeloo, The Netherlands, 24 April 2012
- ★ EVN Technical and Operations Group Meeting, Onsala, 28 June 2012

Mark Kettenis

- ★ NEXPReS WP7 face-to-face meeting, Poznan, Poland, 19-20 April 2011
- ★ The Growing Demand on Connectivity and Information Processing in RadioAstronomy from VLBI to SKA, Aveiro, Portugal, 24-25 May 2011
- ★ 10th International e-VLBI Workshop, Amanzingwe, South Africa, 13-16 November 2011
- ★ NEXPReS WP8 face-to-face meeting, Schiphol, The Netherlands, 23 April 2012
- ★ NEXPReS WP7 face-to-face meeting, Dwingeloo, The Netherlands, 24 April 2012
- ★ eAsronomy kickoff meeting, Amsterdam, The Netherlands, 12 June 2012
- ★ NEXPReS Board Meeting, Copenhagen, 20 June 2012
- ★ New Technologies in Astronomy, Shanghai, China, 23-25 June 2012
- ★ DiFX Users Meeting, Sydney, Australia, 24-28 September 20122
- ★ NEXPReS WP8 face-to-face meeting, Schiphol, The Netherlands, 10 December 2012

Huib van Langevelde

- ★ GEANT expert group, Brussels, Belgium, 09 – 10 March 2011
- ★ PrepSKA board and associated meetings, Rome, Italy, 28 – 31 March 2011
- ★ ERIC meeting, Brussels, Belgium, 19 April 2011
- ★ EVN CBD, Torun, Poland, 10 – 11 May 2011
- ★ JIVE board, Warsaw, Poland, 12 – 13 May 2011
- ★ BeSSeL project meeting, Bonn, Germany, 24 – 25 May 2011
- ★ NEXPReS review, Brussels, Belgium, 8 September 2011
- ★ EVN CBD, Bologna, 13 – 15 October 2011
- ★ eVSAG meeting, Madrid, Spain, 3 – 4, November 2011
- ★ RadioNet FP7 board, Cape Town, South Africa, 11 -12 November 2011
- ★ Meeting with the ERTRC AstroNet panel, Schiphol, the Netherlands, 1 December 2011,
- ★ JIVE board, Dwingeloo, the Netherlands, 12 - 13 December 2011
- ★ RadioNet3 kick-off, Bonn, Germany, 27 – 29 February 2012
- ★ JIVE review, Dwingeloo, Netherlands, 05 – 07 March 2012
- ★ PrepSKA board, Schiphol, Netherlands, 3 April 2012
- ★ HILADO kick-off, Zaandam, Netherlands, 26 April 2012

- EVN CBD, Bonn, Germany, 09 – 10 May 2012
- JIVE board, Bonn, Germany, 11 May 2012
- AERAP meeting, Brussels, Belgium, 28 May 2012
- ESKAC, Schiphol, 07 June 2012,
- NEXPReS board, Copenhagen, Denmark, 19 – 20 June 2012,
- ERIC committee, Brussels, Belgium, 28 – 29 June 2012
- STFC-JIVE meeting, Swindon, UK, 16 – 17 July 2012
- AERAP, Brussels, Belgium, 6 September 2012,
- NorduNET 12 meeting, Oslo, Norway, 17 -18 September 2012
- NEXPReS review, Brussels, Belgium, 21 September 2012
- LOFAR/EVN discussion, Warsaw, Poland, 3-4 October 2012
- RadioNet Executive board, Madrid, Spain, 6 November 2012
- EVN CBD, Madrid, Spain, 7 November 2012
- JIVE board, Madrid, Spain, 8 November 2012
- AERAP, Brussels, Belgium, 13 November 2012
- JIVE board and stakeholders, Schiphol, the Netherlands, 19 November 2012

Martin Leeuwinga:

- EVN TOG meeting, Dwingeloo, the Netherlands, 28 January 2011
- 6th Technical Operations Workshop, Haystack, USA, 7-14 May 2011
- EVN TOG meeting, Onsala, Sweden, 26-29 June 2012
- EVN TOG workshop, Onsala, Sweden, 27 June 2012

Zsolt Paragi

- NWO/NRF Workshop on Areas of Mutual S&T Interest
- 18 October 2012, Cape Town, South Africa

Aukelien van den Poll

- EUPMAN meeting, Eindhoven, the Netherlands, 5 April 2011
- RadioNet FP7 Board meeting, Cape Town, South Africa, 11 November 2011
- RadioNet3 kickoff meeting, Bonn, Germany, 28 February 2012
- RadioNet3 NA/TNA workshops, Bonn, Germany, 29 February 2012
- EUPMAN meeting/Agentschap NL networkmeeting, Utrecht, 13 December 2012

Des Small

- Erlang Factory, San Franciso, USA, 21-25 March 2011,
- Erlang Factory Lite, London, UK, 05-08 November 2012.

Arpad Szomoru

- EVN Technical and Operations Group meeting, Dwingeloo, The Netherlands, 28 January 2011
- PrepSKA Signal Processing CoDR, Manchester, United Kingdom, April 14-15 2011
- The ICT Proposers' Day, Budapest, Hungary,19-20 May 2011
- The Growing Demand on Connectivity and Information Processing in RadioAstronomy from VLBI to SKA, Aveiro, Portugal, 24-25 May 2011
- NEXPReS First year review, Brussels, Belgium, 8 September 2011
- RadioNet FP7 Board Meeting, Cape Town, South Africa, 11 November 2011
- 10th International e-VLBI Workshop, Broederstroom, South Africa, 13-16 November 2011
- EVN Technical and Operations Group meeting, Arecibo Observatory, Puerto Rico, 29-30 August 2011
- PrepSKA WP2 Annual Meeting, Manchester, UK, 20 October 2011

- ★ AAVP 2011: Taking the AA programme into SKA Pre-Construction, Dwingeloo, The Netherlands, December 12-16 2011
- ★ RadioNet3 kickoff meeting, Bonn, Germany, 28 February 2012
- ★ JIVE review, Dwingeloo, 6 March 2012
- ★ NEXPReS WP8 face-to-face meeting, Schiphol, The Netherlands, 23 April 2012
- ★ EVN Board Meeting, Bonn, 10 May 2012
- ★ NEXPReS Board Meeting, Copenhagen, 20 June 2012
- ★ EVN Technical and Operations Group Meeting, Onsala, 28 June 2012
- ★ NEXPReS Second Annual Review, Brussels, Belgium, 21 September 2012
- ★ 1st International VLBI Technology Workshop, Haystack Observatory, 22-24 October 2012
- ★ RadioNet3 Executive meeting, Mardrid, Spain, 6 November 2012
- ★ EVN Board meeting, Mardrid, Spain, 7 November 2012
- ★ JIVE Board meeting, Mardrid, Spain, 8 November 2012
- ★ Workshop on Optical Networks for Accurate Time and Frequency Transfer, Hoofddorp, The Netherlands, 20-21 November 2012
- ★ NEXPReS WP8 face-to-face meeting, Schiphol, The Netherlands, 10 December 2012

Harro Verkouter

- ★ NEXPReS WP8 face-to-face meeting, Schiphol, The Netherlands, 23 April 2012
- ★ NEXPReS WP8 face-to-face meeting, Schiphol, The Netherlands, 10 December 2012
- ★ Erlang Factory 2011: Three day Erlang university followed by two day Erlang conference, San Francisco, USA, March 21-25 2011
- ★ Erlang User Conference, Stockholm, Sweden, 28-31 May 2012
- ★ Erlang Factory Lite, London, UK, 8 Nov 2012

Jun Yang

- ★ EVN TOG meeting, Dwingeloo, the Netherlands, 28 January 2011
- ★ EVN TOG meeting, Arecibo, Puerto Rico (vido-conferenced), 27-28 August 2011
- ★ EVN TOG meeting, Onsala, Sweden, 27-28 June 2012

Charles Yun

- ★ 3rd meeting of the High Level Expert Group on GÉANT, Brussels, BE, 10 March 2011
- ★ ORIENTplus Meeting, Brussels, BE, 13 May 2011
- ★ NEXPReS review, Brussels, Belgium, 8 September 2011
- ★ NEXPReS review, Brussels, Belgium, 21 September 2012
- ★ NEXPReS board, Copenhagen, Denmark, 19 – 20 June 2012,
- ★ EVALSO, Rio de Janeiro, Brazil, 17-18 September 2011
- ★ 9th eConcertation, Lyon, France, 22 September 2011
- ★ FP7 ICT Coordinators' Day, Brussels, Belgium, 28 November 2011

8.8.3. WORKING VISITS AND OBSERVING TRIPS

Nikta Amiri

- ★ NRAO AOC, Socorro NM, USA, 8 - 14 July 2011
- ★ Effelsberg observing “On the life time of H2O masers at the tip of the Asymptotic Giant Branch (45 hrs/3 nights), March & April 2011

Bob Campbell

- ★ Haystack Observatory, 16 November 2011
- ★ Haystack Observatory, 7 December 2012

Ciriaco Goddi:

- Science visit, University of Barcelona, Spain, 26-27 October 2012

Leonid Gurvits

- Institute of Radio Astronomy and Space Science, Auckland University of Technology, New Zealand, 14 Dec 2011 – 13 January 2012.

Huib van Langevelde:

- NRAO AOC, Socorro NM, USA, 8 - 12 July 2011

Salvatore Pirruccio

- Altera seminar, Antwerpen, 29 Nov 2011
- Shanghai Astronomical Observatory, Shanghai, 20 Mar - 2 Apr 2012
- Altera seminar, Eindhoven, 29 Nov 2012

Arpad Szomoru

- Visit Xilinx representatives, Dwingeloo, The Netherlands, March 2 2012
- Meeting with Altera representatives on SKA, AAVP and UniBoard^2, Manchester, United Kingdom, July 3 2012

Harro Verkouter

- Haystack Observatory, 22 Jan - 4 Feb 2012

Jun Yang

- Shanghai Astronomical Observatory, CAS, P.R. China, April, 2011
- National Space Science Center, CAS, P.R. China, August, 2012

8.9. EDUCATIONAL RESPONSIBILITIES

PhD projects supervised

- L. Chen – by L.I. Gurvits, Graduate University of the Chinese Academy of Sciences (completed in Nov 2011)
- G. Molera Calvés – by S.V. Pogrebenko (completed in 2012)
- D.A. Duev – by L.I. Gurvits and S.V. Pogrebenko, Moscow Lomonosov State University (completed in November 2012)
- T.M. Bocanegra Bahamon – by L.I. Gurvits, TU Delft (completion in 2015)
- N. Amiri – by H.J. van Langevelde, University of Leiden (completed in 2011)
- K. Torstensson – by H.J. van Langevelde, University of Leiden (completed in 2011)

Lecturing:

- L.I. Gurvits, Ventspils University College, Latvia, 16 hours, Radio Interferometry (2011 and 2012, Spring semesters)
- L.I. Gurvits, Moscow State University, Russia, Astronomy Department, 30 hours, Space-borne astrophysics (2012, Spring semester)
- L.I. Gurvits, XVI IAG/USP School on Advanced Astrophysics, Itatiba (Sao Paulo), Brazil, Radio interferometry: a view in the XXI century, 8 hours (November 2012)

Secondary affiliations:

Huib van Langevelde – affiliated with Leiden University
Leonid Gurvits – affiliated with Delft University and Ventspils University College

8.10. CORRELATOR ACTIVITY

All projects having correlator activity in 2011

Expt.	Obs	PI	Type	Correl	Distrib	Release	Support
N10C1	180310	Pidopryhora	NME	(120410)	(150410)	240111	Pidopryhora
N10K1	291010	Muehle	NME	(241110)	(091210)	110111	Muehle
N10L3	011110	Mahmud	NME	(251110)	(221210)	110111	Mahmud
ER025A	291010	Romero	USER	(261110)	(141210)	110111	Muehle
ER025B	301010	Romero	USER	(291110)	(141210)	110111	Muehle
ED030A	021110	Deane	USER	(011210)	(131210)	110111	Mahmud
ED030B	031110	Deane	USER	(031210)	(201210)	110111	Pidopryhora
EL040B	031110	Liuzzo	USER	(061210)	(141210)	110111	Mahmud
EL040C	041110	Liuzzo	USER	(071210)	(201210)	110111	Mahmud
EY012	051110	Yang	USER	(091210)	(281210)	270311	Yang
EA044	311010	Amiri	USER	(101210)	170811	020911	Campbell
N10SX2	081110	Yang	NME	(131210)	(291210)	250211	Yang
EY011	041110	Chen	USER	(131210)	190511	090811	Yang
EB047	301010	Bartkiewicz	USER	(131210)	200111	250211	Pidopryhora
N10M3	211010	Pidopryhora	NME	(141210)	010211	250211	Pidopryhora
N10C3	261010	Pidopryhora	NME	(141210)	110211	150411	Pidopryhora
EE006	031110	Engels	USER	(171210)	(171210)	110111	Pidopryhora
EL040F	071110	Liuzzo	USER	(201210)	240211	270311	Muehle
EB039H	221010	Brunthaler	USER	(221210)	(281210)	250211	Campbell
EZ020B	251010	Zhang	USER	(271210)	040111	250211	Yang
EB039I	231010	Brunthaler	USER	040111	140111	250211	Campbell
GV020D	021110	Vlemmings	USER	180111	040211	140411	Campbell
RE002	250111	Etoka	USER	250111	040211	040211	Paragi/Yang
EM090A	260111	Moldon	USER	260111	010211	010211	Paragi
RSF04	260111	Frey	USER	260111	310111	310111	Paragi
RR005	150211	Moldon	USER	160211	160211	170211	Paragi
EM090B	160211	Moldon	USER	160211	160211	170211	Paragi
EV018B	271010	Vlemmings	USER	080311	050411	200411	Campbell
EG051B	090311	Giroletti	USER	090311	110311	270311	Paragi
EG051C	100311	Girolettii	USER	100311	110311	270311	Paragi
EG053	100311	Gawronski	USER	120311	230311	270311	Mahmud/Paragi
EA047	220311	An	USER	220311	240311	270311	Paragi
EB050	220311	Bondi	USER	230311	240311	270311	Paragi/Pidopryhora
RR006	230311	Romero	USER	230311	240311	270311	Paragi/Yang
N11M1	010311	Muehle	NME	280311	180511	070611	Muehle
N11C1	070311	Pidopryhora	NME	290311	180411	070611	Pidopryhora
N11L1	240211	Mahmud	NME	300311	210611	090811	Mahmud
RT010	310311	Tudose	USER	310311	310311	140411	Paragi
FP003	081109	Campbell	TEST	040411	040411		Campbell
N11SX1	150311	Yang	NME	050411	240511	070611	Yang
N11X1	140311	Yang	NME	060411	240511	070611	Yang
RM006	170311	Moldon	USER	080411	160411	070611	Pidopryhora
EG051D	120411	Giroletti	USER	130411	140411	170411	Paragi
RP017	120411	Paragi	USER	130411	140411	170411	Paragi
ED035A	120411	Deane	USER	130411	140411	170411	Paragi
EM090C	280211	Moldon	USER	140411	260411	070611	Pidopryhora
EG049A	080311	Giroletti	USER	140411	020511	070611	Mahmud
EL040G	280211	Liuzzo	USER	190411	170611	090811	Muehle

GV020E	270211	Vlemmings	USER	270411	160611	090811	Campbell
EM071C	020311	Moscadelli	USER	290411	280711	190811	Muehle
ER026A	050311	Rygl	USER	090511	100811	250811	Mahmud
EM085	150311	Moldon	USER	100511	100611	090811	Yang
ED035B	170511	Deane	USER	170511	200511	070611	Paragi
RSG03	180511	Gabanyi	USER	180511	200511	070611	Paragi
EZ020C	060311	Zhang	USER	240511	100611	090811	Yang
EG052B	040311	Gan	USER	240511	260711	190811	Campbell
EG052A	030311	Gan	USER	240511	260711	190811	Campbell
F11L1	090611	Yang	NME	090611	090611	100711	Muehle
CHIN02	140611	Yang	TEST	140611	140611	180711	Yang
CHIN03	220611	Yang	TEST	220611	220611	180711	Yang
FR008	070711	JIVE	TEST	070711	070711	180711	JIVE
CHIN04	070711	Yang	TEST	070711	070711	180711	Yang
N11M2	260511	Muehle	NME	180711	091111	051211	Muehle
N11L3	090611	Yang	NME	180711	080811	250811	Yang
RT011	170611	Tudose	USER	210711	260711	051211	Yang
RM008	170611	Marti-Vidal	USER	210711	260711	051211	Yang
N11C2	310511	Pidopryhora	NME	220711	150811	310811	Pidopryhora
EV018C	090311	Vlemmings	USER	290711	100811	250811	Campbell
N11P1	030611	Mahmud	NME	030811	150811	310811	Mahmud
EG051F	020611	Giroletti	USER	030811	200911	051211	Paragi
EG051E	020611	Giroletti	USER	030811	190911	051211	Paragi
N11L2	070611	Yang	NME	050811	120811	250811	Yang
ES066A	280511	Surcis	ABAN	080811	080811	080811	niemand
ES066B	290511	Surcis	ABAN	080811	080811	080811	niemand
EC032	150611	Cseh	USER	090811	150811	310811	Pidopryhora
EM084A	150611	Martinez-Sansigre	USER	100811	220811	050911	Mahmud
EM084B	160611	Martinez-Sansigre	USER	110811	170811	020911	Yang
EP068C	010611	Perez-Torres	USER	190811	161211		Mahmud
EG049B	030611	Giroletti	USER	220811	160911	051211	Yang
RSP05	260811	Porcas	USER	260811	260811	290811	Paragi
EM094A	250811	Miller-Jones	USER	260811	260811	270811	Paragi
EG058A	250811	Giroletti	USER	260811	270811	270811	Paragi
EZ020D	260511	Zhang	USER	300811	231111	211211	Yang
ES067	290511	Sanna	USER	010911	281011	051211	Surcis
ES066C	300511	Surcis	USER	020911	311011	051211	Campbell/Surcis
FT005	060911	Muehle	NME	060911	060911	181011	Muehle
ER026B	300511	Rygl	USER	090911	091111	051211	Mahmud
EM081C	280311	Molera	USER	150911	160911		
TE102	220911	Paragi	TEST	220911	220911	220911	Paragi
CHIN05	060811	Yang	TEST	260911	260911	260911	Yang
GG074	080611	Gupta	USER	270911	281011	051211	Pidopryhora
FR009A	041011	Yang	NME	041011	061011	061011	Yang
GV021	040611	Vlemmings	USER	041011	061211		Campbell
EY015A	100611	Chen	USER	061011	141011	051211	Yang
EG058B	171011	Giroletti	USER	171011	241111	091211	Paragi
RSY01	171011	Yang	USER	171011	311011	311011	Paragi
RP018A	171011	Paragi	USER	181011	311011	311011	Yang
EF023A	181011	Frey	USER	181011	271011	271011	Paragi
TE103	191011	tester	TEST	191011	241011	311011	Campbell
ET018A	211011	Tudose	USER	221011	041111	061211	Paragi
ET018B	221011	Tudose	USER	231011	041111	061211	Paragi
ET018C	231011	Tudose	USER	241011	041111	061211	Paragi

ET018D	241011	Tudose	USER	251011	041111	061211	Paragi
ET018E	261011	Tudose	USER	271011	041111	061211	Paragi
EC033	130611	Chapman	USER	071111	231111	211211	Yang
ET017A	231111	Tudose	USER	231111	241111	051211	Paragi
RP018B	241111	Paragi	USER	241111	241111	051211	Paragi
EV018D	010611	Vlemmings	USER	301111	131211		Campbell
EE008A	070911	Etoka	USER	301111	231211		Surcis
CHIN06A	101011	Yang	TEST	011211			Yang
CHIN06B	101011	Yang	TEST	021211			Yang
EP068D	120611	Perez-Torres	USER	071211	231211		Pidopryhora
FR010A	091211	Mahmud	ABAN	091211	091211	091211	Mahmud
FR010B	091211	Mahmud	NME	091211	131211	201211	Mahmud
RSP06	141211	Paragi	USER	141211	161211		Paragi
RSK01	151211	Komossa	USER	151211	151211	211211	Paragi
ED037A	141211	Deane	USER	151211	151211	211211	Paragi
N11K1	091111	YANG	NME	211211			Yang
RM007	060611	Muehle	USER	231211	271211		Campbell
N11C3	201011	Mahmud	NME	291211			Mahmud
N11L4	311011	Pidopryhora	NME	301211			Pidopryhora
N11M3	271011	Surcis	NME	301211			Surcis

All projects having correlator activity in 2012

Expt.	Obs	PI	Type	Correl	Distrib	Release	Support
EP068C	010611	Perez-Torres	USER	(190811)	(161211)	030112	Mahmud
GV021	040611	Vlemmings	USER	(041011)	(061211)	090112	Campbell
EV018D	010611	Vlemmings	USER	(301111)	(131211)	030112	Campbell
EE008A	070911	Etoka	USER	(301111)	(231211)	090112	Surcis
CHIN06A	101011	Yang	TEST	(011211)	050112	090112	Yang
CHIN06B	101011	Yang	TEST	(021211)	050112	090112	Yang
EP068D	120611	Perez-Torres	USER	(071211)	(231211)	090112	Pidopryhora
RSP06	141211	Paragi	USER	(141211)	(161211)	100112	Paragi
N11K1	091111	YANG	NME	(211211)	060112	220312	Yang
RM007	060611	Muehle	USER	(231211)	(271211)	120112	Campbell
N11C3	201011	Mahmud	NME	(291211)	170112	220312	Mahmud
N11L4	311011	Pidopryhora	NME	(301211)	020212		Pidopryhora
N11M3	271011	Surcis	NME	(301211)	180112	220312	Surcis
N11X2	071111	Yang	NME	020112	060112	220312	Yang
EA046	081111	An	USER	050112	200112	220312	Mahmud
EI011	031111	Ibar	USER	060112	010212	220312	Campbell
EY015B	021111	CHEN	USER	090112	100112	220312	Yang
RSF05	100112	Frey	USER	100112	110112	220312	Paragi
EG058C	110112	Paragi	USER	110112	110112	220312	Paragi
RSG04	110112	Guirado	USER	110112	110112	220312	Paragi
RSO01	110112	Orienti	USER	110112	110112	220312	Paragi
EP075A	211011	Perez-Torres	USER	120112	050412	200412	Pidopryhora
EF023B	041111	Frey	USER	130112	180112	220312	Paragi
EG049C	201011	Giroletti	USER	130112	180112	220312	Mahmud
EZ020E	301011	Zhang	USER	170112	120312	280312	Yang
EM084D	031111	Martinez-Sansigre	USER	190112	090212	220312	Pidopryhora
EM084C	021111	Martinez-Sansigre	USER	200112	090212	220312	Pidopryhora
RE003A	041111	Etoka	USER	230112	270212	280312	Surcis

ES066D	271011	Surcis	USER	230112	260112	220312	Surcis
ES066E	301011	Surcis	USER	230112	230212	220312	Surcis
GV020F	110611	Vlemmings	USER	310112	160212	220312	Campbell
ED037B	070212	Deane	USER	080212	080212	220312	Paragi
EY017A	080212	Yang	USER	080212	080212	220312	Paragi
EE008B	091111	Etoka	USER	140212	160312	120412	Surcis
RE003B	091111	Etoka	USER	140212	050312	280312	Surcis
GM068	061111	McKean	USER	220212	060312	300312	Yang
EP077	311011	Pidopryhora	USER	240212			Pidopryhora
GV020G	051111	Vlemmings	USER	070312	230412		Campbell
RAFS08	140112	Kovalev	TEST	150312	150312	150312	Campbell
EG057	011111	Gurvits	USER	160312	210312	300312	Yang
EG058D	200312	Giroletti	USER	210312	230312	230312	Paragi
ER026C	281011	Rygl	USER	300312	120412	090712	Campbell
FR012A	120412	Pidopryhora	TEST	120412	120412	130412	Pidopryhora
FR012B	120412	Pidopryhora	TEST	120412	120412	130412	Pidopryhora
ER026D	291011	Rygl	USER	160412	160512	090712	Campbell
N12M1	230212	Surcis	NME	160412	090512	090712	Surcis
N12C1	080312	Pidopryhora	NME	160412	110712	130712	Pidopryhora
F12L1	020312	Pidopryhora	NME	160412	210512	090712	Pidopryhora
N12L1	050312	Pidopryhora	NME	180412	040712	130712	Pidopryhora
EG064	170412	Garrett	USER	180412	270412	090612	Paragi
EM071D	240212	Moscadelli	USER	190412	060612	130712	Campbell
N12K1	290212	YANG	NME	200412	160512	090712	Yang
F12X1	240212	YANG	NME	230412	210512	090712	Yang
F12C1	070312	Pidopryhora	NME	230412	210512	090712	Pidopryhora
F12K1	280212	Surcis	NME	230412	210512	090712	Surcis
N12X1	260212	YANG	NME	240412	180512	090712	Yang
EL042	260212	Lobanov	USER	260412	080512	090712	Pidopryhora
EY018A	080312	Yang	USER	020512	310512	130712	Yang
EG061A	280212	Gomez	USER	070512	220512	130712	Surcis
EB051	080312	Brunthaler	USER	110512	150612	130712	Campbell
EM094B	160512	Miller-Jones	USER	160512	210512	090612	Paragi
EG065A	150512	Gawronski	USER	160512	210512	090612	Paragi
EP081A	070312	Porcas	USER	210512	180612	230712	Pidopryhora
EG049D	130312	Giroletti	USER	220512	010612	130712	Surcis
EP081B	110312	Porcas	USER	240512	200612	230712	Pidopryhora
FR013A	250512	Szomoru	NME	250512	250512	250512	Pidopryhora
FR013B	250512	Szomoru	ABAN	250512	250512	250512	Pidopryhora
EP081C	120312	Porcas	USER	290512	180612	230712	Pidopryhora
EM095A	010612	Mezcua	USER	020612	040612	090612	Paragi
ET024A	260212	Tudose	USER	050612	080612	130712	Yang
FR014A	050612	Szomoru	NME	050612	050612	050612	Surcis/Campbell
FR014C	050612	Szomoru	ABAN	050612	050612	050612	Surcis/Campbell
FR014B	050612	Szomoru	NME	050612	050612	050612	Surcis/Campbell
EJ010	130312	Jackson	USER	080612	250612	230712	Campbell
EM095B	080612	Mezcua	USER	090612	020712	090712	Yang
FR011	220212	YANG	NME	090612	090612	090612	Yang
EM095C	090612	Mezcua	USER	100612	020712	090712	Yang
RY003	120612	Paragi	USER	120612	130612	090712	Yang
EP083	110612	Paragi	USER	120612	130612	090712	Paragi
EE008C	280212	Etoka	USER	140612	050712	230712	Surcis
EG063A	190612	Giroletti	USER	190612	210612	090712	Campbell
RSF06	190612	Frey	USER	190612	210612	090712	Yang

EG065B	190612	Gawronski	USER	200612	250612	090712	Pidopryhora
FR015	200612	Szomoru	NME	200612	210612	210612	Campbell
N12SX1	250512	SURCIS	NME	120712	190712	051112	Surcis
N12K3	060612	YANG	NME	200712	100912	051112	Yang
N12C2	310512	Pidopryhora	NME	200712	270712	051112	Pidopryhora
N12L2	120612	Pidopryhora	NME	230712	270712	051112	Pidopryhora
N12X2	240512	SURCIS	NME	230712	300712	051112	Surcis
RO004A	060612	Orienti	USER	310712	310712		Surcis
ET024B	240512	Tudose	USER	020812	100912	051112	Yang
EG049E	050612	Giroletti	USER	030812	140812		Surcis
EG061B	070612	Gomez	USER	090812	150812	051112	Surcis
EBOBWB	160812	Eldering	ABAN	160812	170912	170912	Eldering
EY018B	310512	Yang	USER	160812	200912		Yang
ED038	100612	Deller	USER	200812	270812	051112	Campbell
EY015C	140612	CHEN	USER	220812	100912		Yang
EE008D	070612	Etoka	USER	230812	240912		Surcis
EP076A	050312	Perez-Torres	USER	240812	280812	310812	Yang/Campbell
EP076B	120312	Perez-Torres	USER	280812	290812	310812	Yang/Campbell
GF018B	130612	Fenech	USER	300812	040912		Campbell
GF018A	030612	Fenech	USER	060912	210912	051112	Campbell
TE104	130912	Paragi	TEST	130912	170912	170912	Paragi
EY017B	170912	Yang	USER	170912	241012	051112	Yang
RO005	180912	OBrien	USER	180912	180912	051112	Paragi
TE105	180912	Mark-Paul	TEST	180912			Kettenis/Campbell
EG065C	170912	Gawronski	USER	180912	270912	051112	Paragi
EP075B	270512	Perez-Torres	USER	200912	240912	051112	Pidopryhora/Campbell
EP075C	040612	Perez-Torres	USER	210912	250912		Pidopryhora/Campbell
EP075D	140612	Perez-Torres	USER	250912	270912		Pidopryhora/Campbell
EG065D	091012	Gawronski	USER	091012	261012	051112	Paragi
RO006	101012	OBrien	USER	101012	161012	051112	Yang
EG063B	091012	Giroletti	USER	101012	261012	051112	Paragi
TE106	231012	Kettenis-Harrison	TEST	231012	231012	131112	Kettenis
EM101A	131112	Miller-Jones	USER	141112	151112	211112	Paragi
EG065E	131112	Gawronski	USER	141112	151112	211112	Paragi
RO006B	141112	OBrien	USER	151112	161112	211112	Paragi
TE107	221112	Kettenis-Harrison	ABAN	221112	221112	221112	Kettenis
EO011A	041212	OBrien	USER	051212	071212		Paragi
EG069A	051212	Gawronski	USER	051212	071212		Paragi
EG066B	201012	Giroletti	USER	061212			Surcis
RM009A	071112	McHardy	USER	111212			Yang
RM009B	081112	McHardy	USER	121212			Yang
EG066E	271012	Giroletti	USER	131212			Surcis
EG066C	211012	Giroletti	USER	131212			Surcis
EG066F	281012	Giroletti	USER	141212			Surcis
ES070	191012	A.Shulevski	USER	171212			Surcis
ED039	241012	Deane	USER	191212			Duev

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9. LIST OF ACRONYMS AND ABBREVIATIONS

AARTFAAC	Amsterdam—ASTRON Radio Transients Facility and Analysis Centre
AAS	American Astronomical Society
AAVP	Aperture Array Verification Program
ADASS	Astronomical Data Analysis Software and Systems conference
AERAP	African-European Radio Astronomy Platform
AGN	Active Galactic Nuclei
AFT	Automated Fringe Test
AIPS	Astronomical Image Processing System
ALBUS	Advance Long Baseline User Software
ALMA	Atacama Large Millimeter Array
AOC	Array Operations Center
ASIC	application-specific integrated circuit
BAL	Broad Absorption Lines
BBC	Baseband Channel
BPT	Baldwin, Phillips & Terlevich diagram
CAIM	Continuous Automated Intelligent Monitoring
CAS	Chinese Academy of Sciences
CBD	Consortium Board of Directors
CDAS	Chinese Data Acquisition System
CEP	Chinese Exchange Program
CNES	Centre national d'études spatiales
COSPAR	Committee on Space Research
COTS	Commercial off the shelf
CPU	Central Processing Unit
CSO	Compact Symmetric Objects
CVN	Chinese VLBI Network
DBE	Digital Back End
DDBC	digital baseband converter
DIFX	Distributed FX correlator
DLR	German Aerospace Center
DPAC	Data Processing and Analysis Consortium
DPS	American Astronomical Society's Division of Planetary Sciences
EAS	European Astronomical Society
EAVN	East Asia VLBI Network
EGU	European Geosciences Union
EMU	Evolutionary Map of the Universe
EPSC	European Planetary Science Congress
ERIC	European Research Infrastructure Consortium
ERTRC	European Radio Telescope Review Committee
EUPMAN	EU Project Managers Association
EVALSO	Enabling Virtual Access to Latin-America Southern Observatories
EVE	European Venus Explorer
EVGA	European VLBI Group for Geodesy and Astrometry
EVN	European VLBI Network
EWASS	European Week of Astronomy and Space Science
FITS	Flexible Image Transport System
FPGA	Field Programmable Gate Array
GETEMME	Gravity, Einstein's. Theory, and Exploration of the. Martian Moons' Environment
GLIF	Global Lambda Integrated Facility
GLONASS	GLObal Navigation Satellite System
HARP	Heterodyne Array Receiver Programme
HEPRO	High Energy Phenomena in Relativistic Outflows
HID	Hardness-Intensity Diagram

HALCA	Highly Advanced Laboratory for Communications and Astronomy
HPC	High Performance Computing
IAU	International Astronomical Union
IEEC	Institut d'Estudis Espacials de Catalunya
IPPW	Interplanetary Probe Workshop
ISM	Interstellar Medium
IVS	International VLBI Service
JCMT	James Clerk Maxwell Telescope
JENAM	Joint European and National Astronomy Meeting
JUICE	JUpiter ICy moons Explorer mission
JVN	Japanese VLBI Network
KNAW	Royal Netherlands Academy of Arts and Sciences
KVN	Korean VLBI Network
LBA	Australian Long Baseline Array
LEO	Low Earth Orbit
LLAGN	Low Luminosity AGN
LO	Local Oscillator
LPI	Lunar and Planetary Institute
MEX	Mars Express
MHD	MagnetoHydroDynamic
MIT	Massachusetts Institute of Technology
MWL	Multi-WaveLength
NA	Network Activity
NAC	Netherlands Astronomy Conference
NLUUG	Netherlands Local Unix Users Group
NREN	National Research and Education Network
NSI	Network Service Interface
NVSS	NRAO VLA Sky Survey
PI	Principle Investigator
PRIDE	Planetary Radio Interferometry and Doppler Experiment
PSNC	Poznan Supercomputing and Network Center
QSO	Quasi-stellar object
RFI	Radio Frequency Interference
RMS	root mean square
RTS	Resolving The Sky
RXTE	Rossi X-ray Timing Explorer
SA	Service Activities
SFXC	software correlator at JIVE
SKA	Square Kilometre Array
SNN	Samenwerkingsverband Noord-Nederland
SOC	Scientific Organizing Committee
SPIE	Society of Photo-Optical Instrumentation Engineers
SVLBI	Space Very Long Baseline Interferometry
SWT	Science Working Team
TB	Terabyte
TDRSS	Tracking and Data Relay Satellite System
TEC	Total Electron Contents
TERENA	Trans-European Research and Education Networking Association
TNA	Trans National Access
TOG	Technical Operations Group
UDP	User Datagram Protocol
ULWA	Ultra-long-wavelength astronomy
ULX	Ultra Luminous X-ray
URSI	International Union of Radio Science
VDIF	VLBI Data Interchange Format
VERA	VLBI Exploration of Radio Astrometry
VEX	Venus Express

VHE	Very High Energy
VIRAC	Ventspils International Radio Astronomy Centre
VLA	Very Large Array
VLBA	Very Long Baseline Array
VLBEER	EVN's Central Anciliary Data Server
VLBI	Very Long Baseline Interferometry
VSAG	VLBI Science Advisory Group
VSOP	VLBI Space Observatory Programme
WSRT	Westerbork Synthesis Radio Telescope
YERAC	Young European Radio Astronomy Conference
YSO	Young Stellar Object

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