# Minutes of the TWG meeting

Dwingeloo, 8/9 September 1995

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**Attachments:**

List of participants

Station reports

VSOP related output

**Agenda**

**Friday, September 8**

9.00 Station Reports (technical friends)

9.30 (future of??) Cal Reports (Rioja/Sanghera)

10.00 Correlator Reports
- Bonn (Moscadelli/Ruf)
- Soccorro (van Langevelde)

10.30 Coffee break

10.45 **Station Performance**

- Centralisation of station check (Tuccari)
  -group of experts for periodic tests
- Manual and automated hardware checks (Mujunen)
- Critical parts (spares) with MkIV and VLBA recorders and acquisition racks (Foley)
  - who buys what where?
- What documentation will be needed in future and who will look after it? (Foley)

12.30 lunch break

13.30 **Network Performance**

-VSOP test run (input required to GVWG-TWG!!) (Porcas/Ruf)
-Schedule preparations for MkIV, VLBA, and VSOP (Foley)
  - which program preferred (PC-Sched, Walker-Sched, GNOMES)
  - impact on EVN operations
  - centralised scheduling ?
- Standard set-ups for global continuum obs. (Foley)
  - who will do an arrangement with the VLBA and other interested parties?
  - what are current and future constraints?
- EVN calibration (Sanghera)
- Polarisation calibration (Massi)
- May data in ancal format (Rantakyro)
- Current and future calibration data (Conway)

15.30 coffee break

15.45 **Field System**

- Automation of calibration data in field system (Mujunen)
- Writeable CD ROM (Burgess)
- GPS data (van Langevelde)
- Migrating to FS9 (Himwich/Mujunen)

18.00 adjourn

**Saturday, September 9**

| | | |
|---|---|---|
| 9.00 | Mark IV Upgrade | (Ruf) |
| 9.30 | EVN Upgrade Phase II | (Schilizzi) |
| 10.00 | coffee break | |
| 10.15 | Action Items | (Ruf) |
| 10.45 | a.o.b. and date of next meeting | (Ruf) |
| 11.30 | adjourn | |

## Date and place of next meeting

The next meeting of the TWG was planed to be on September 8 and 9, 1996 in Bologna.

## Discussion of topics

The meeting was opened by its chairman, Klaus Ruf. The director of J.I.V.E., Richard Schilizzi, welcomed the TWG&friends in Dwingeloo, also on behalf of NFRA. He gave a short report on the progress of the correlator centre. Ground work for construction of the new building had just started. The first correlator board could be visited during the meeting.

**Station reports** were given by the technical friends. The written reports are attached to these minutes.
Luca Moscadelli reported from the correlation at the Bonn correlator of the May session experiments EM012, EM013, and EM014. The results are summarised in the following table.

### May Session Antenna Performance at 6 cm

(from experiments EM012, EM013, and EM014)

| Antenna | Discarded Data | Parity Error | Tracks Behaviour | Cal Amplitude |
|---|---|---|---|---|
| Effelsberg | (reference) | $10^{-5}$ - $10^{-6}$ | No Problem | 50 - 90 |
| Medicina | <2% most scans | $10^{-5}$ | TK1: AP0 in some scans of EM014 | 31 - 44 |
| Jodrell Bank (Mark 2) | 3 - 11% | $5x10^{-5}$ | TK26: AP0<br>TK19, 20: U>L | 38 - 54 |
| Onsala | 2 - 10% | $10^{-4}$ | TK9: AP0<br>TK 26, 28: P.E.=$10^{-3}$ | 23 - 37 |
| Noto | 2 - 4% | $5x10^{-5}$ | No Problem | No Cal |
| Westerbork | 2 - 9% | $10^{-4}$ | EM013:TK22: AP0<br>EM012: TK28: U>L | No Cal |
| Crimea | 1 - 3% | $5x10^{-6}$ | No Problem | 51 - 147 |

Shanghai: C95L2: 1 tape > D.D.=100%, Times lost
EM014: 3 tapes > 1st tape: data from Feb., 2nd and 3rd tape: no data
EV003: > no data

Urumqi: Because „break down“ only C95L2, EC005B, EP012, ER002B, EM014

Cambridge test: All passes in the right positions, D.D.< 1%, ,P.E. = $10^{-5}$,
all tracks without problems, TK28: P.E. = $10^{-4}$, Cal Amp. < 10

Klaus Ruf reported that the Bonn correlator continues to run smoothly. Early 1995 the upgrade of the third tape drive to VLBA type control electronics could be completed. The status is now: 3 H96 tape drives upgraded in Bonn, 3 new VLBA tape drives from Interferometrics, 2 old H96 still running unchanged, 1 H96 in the lab undergoing upgrade, and 1 P&G tape drive running again after replacement of the capstan motor.
The correlator efficiency, measured as fraction of total time, during which the program „corel“ produces archived data, is 62% (magic number!: see also Hub's presentation on Soccorro correlator!). Nevertheless, the backlog is back! We had started correlating the February session as soon as the tapes arrived, but we are still

correlating February experiments and will start the May session in November. Only Cal experiments and two experiments, for which the PI had come to Bonn, are already correlated.
Huib van Langevelde gave the Soccorro correlator report. Handouts were distributed and are not reproduced here. Three action items arose from his report: label polarisation in the logs!, note in the logs, when their is no valid data!, record GPS time! (See also list of action items!)

## Cal Reports

Hardip Sanghera presented the Cal Report 2/95. It was agreed that the Cal experiments should be continued for all three sessions in 1996. Cal tapes still arrive late at the Bonn correlator, especially from the more remote stations Shanghai, Urumchi, and Simeiz. Therefore Hardip will write a plan for the Cal experiments for 1996, which will include deadlines for tape shipment and writing comment to the logs.. As a general rule it was accepted to write comments to the logs and deposit them on Astbo1 within two weeks after the end of a session. Additionally Huib was asked to report the relevant information from global experiments back to the Bonn correlator, in order to avoid duplication of efforts.

## Station Performance

Gino Tuccari and Ari Mujunen had produced proposals for EVN-common test procedures. The idea is to go through the checklist 1-2 weeks before each session and every month, when idle. The forms shall be filled, dated, and signed. They are kept at the stations as log-book.
Gino and Ari were asked to combine their proposals, send the result out to the stations for comments, and produce the final official EVN Station Checklist.
Additionally it as proposed to from a team of experts to travel through the EVN and check the terminals thoroughly. Much improvement, however, is expected from the common test procedure as well as from the move to a common field system (see below). Also a lot of critical hardware will be new and the same at most EVN stations, after the MkIV upgrade is completed in 1996. Therefore a decision on the travelling team was postponed to the next meeting, if it still seems necessary.

The problem of expensive spare parts with long delivery times was again discussed. A pool of such parts in the EVN was thought to be necessary.
Headstacks: They cost >9500$, last 5000 hours, if nothing goes wrong before, and delivery time can be ½ year. 5000 h may translate to >3 years at a station, too long for having one spare everywhere, but delivery is too long to wait until it fails and then buy a new one. At least 3 headstacks should be in the pool.
The EVN has made money available for the development of mass produced thin film heads to overcome the difficult and expensive production of the special headstack used today. Thin film heads also offer the future possibility of further increased track density. The TWG, however, would prefer the immediate availability of a cheaper replacement rather than long experimenting to improve the tracking of the tape drives.
Capstans: They cost >8000$, but they last much longer. A broken capstan can be reworked at a somewhat lower price, nevertheless one spare in the EVN pool would make us feel safer.
Inchworm motors: They cost >2000$. In an emergency action earlier this year 5 inchworm motors were purchased for the EVN and prepaid by JIVE. From the TWG point of view no action is required at that time.

Some stations expressed the wish to have more easy access to all technical documentation. A library of technical papers will be built up on a JIVE computer.

## Network Performance

The Network Performance session had to produce an input paper for the GVWG-TWG. Based on preparatory work done mainly by Richard Porcas, the TWG meeting came to a set of comments on the possible impact of the VSOP experiment and a VSOP test run to EVN operations. The paper produced for the GVWG is also attached to this report. Urgent items are:

**The program TRACK has to be usable easily and reliably.**
**There will be a shortage of thin tapes,**

depending on whether the EVN will (have to) use thin or thick tapes.
The main problem for us with TRACK is the overloaded transatlantic Internet connection. A second data base in Europe, which updates at regular intervals with the Soccorro data base, could be a solution.

No progress could be reported from the development of scheduling programs**.** The GNOMES project, presented at the previous meeting is delayed. Not only for VSOP, however, new and better scheduling programs are needed. Centralised scheduling, however, is not supported by the TWG.

Not for all VLBI continuum bands good standard observing modes are defined in the EVN. This is, however, desirable to make operations easier and safer. Going through the band from 92cm to 7 mm the current standard was discussed. Proposals are made and will be combined to a set of EVN standard continuum observing modes.

Calibration of EVN observations was discussed at length. A program was presented, which produces a calibration file in Ancal format from the log files. The latest gain curves of the telescopes must be edited in. $T_{sys}$ measurements are a remaining problem. They are still done differently at different stations. The best common solution would be a mulitone phase cal extractor board, the development of which had been started by Lars Baath. One of the former obstacles, slow reading out of the data buffer, is overcome with the new field system and a minor hardware change. In the meantime, continuous calibration via TPI measurement shall be tried.

A presentation followed on the polarisation calibration of the EVN, given by Maria Massi. The discussion showed that several (of the worse) stations are in the process of upgrading their telescopes/receivers. Throughout the EVN instrumental polarisation will improve**.**

The advantage at the Soccorro correlator of having GPS time monitored and logged was again stressed. In the paper a concise recommendation is given, which shall be followed in the EVN from the February session on.

## FS9

The FS9 session started with a discussion of the possible automation of calibration in the field system, e.g. measuring $T_{sys}$ in schedule gaps. This is not yet implemented in the FS. Again the future use of the phase cal tone amplitude for continuous calibration was favoured.

The NASA/Goddard Field System program is now running under Linux! What is now called FS9 will be the common field system throughout the EVN**!** Even though Linux is not a real time Unix**,** no problems are expected, at least on modern (fast enough) machines**.** Migrating to the new field system is easy, due to the combined effort of GSFC/NVI and J.I.V.E. It can even be installed via the net. Updated releases are expected semi-annually, but probably not all new releases of Linux will be followed. When the MarkIV hardware is ready and tested, a new release of the field system will be available also.

## Closing of the Meeting

The meeting was closed with short reports on the MarkIV upgrade progress and the status of the EVN Upgrade Phase II.

**List of action items**

FRIENDS to send station reports to me within two weeks;

LIANG SHIGUANG to inform the TWG via its chairmen when Urumqi has an e-mail address;

HUIB VAN LANGEVELDE to establish a feed back from Soccorro correlator to Bonn correlator after correlation of global experiments;

HARDIP SANGHERA to write a plan for 1996 Cal experiments with deadlines for tapes and logs to be sent;

GINO TUCCARI and ARI MUJUNEN to merge their checklists and send to the friends within two weeks. FRIENDS to add their station specific comments until mid of October;

KLAUS RUF to get a quote for capstan repair;

KLAUS RUF to set up a list of necessary spares with a proposal to the directors;

KLAUS RUF to put minutes of the TWG meeting as PS-file onto JIVE data base;

FRIENDS to send technical papers to Hardip, HARDIP SANGHERA to categorise and make a list available on the J.I.V.E. data base;

TONY FOLEY, WALTER ALEF, and DAVE GRAHAM to propose standard set-ups for 92cm S/X, and 7mm respectively. within September to friends (partly done already!), TONY FOLEY to produce a list of standard modes of observing until mid November;

JOHN CONWAY and FREDRIK RANTAKYRO to produce a proposal on getting gain curves and calibration values and on the use of Fredrik's program until mid October, FRIENDS to comment until mid NOVEMBER;

FRIENDS to send the most recent version of telescope gain curves to Fredrik within two weeks;

FRIENDS to follow recommendations in Huib's GPS proposal and have GPS- minus formatter time monitored during February session;

KLAUS RUF to alert directors to a shortage of tapes for VSOP observations;

ARI MUJUNEN to formulate TPI cal procedure by mid October, FRIENDS to prepare to try this out in February session;

TONY FOLEY, HUIB VAN LANGEVELDE, and KLAUS RUF to ring the alarm bells in the EMU meeting re. BBC filter upgrade;

KLAUS RUF to write letter to GVWG, including concerns about TRACK until end of September.
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**List of Participants**
(partly only part time)

| | |
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## Effelsberg Station Report

Telescope track replacement delayed, instead of planned start in August 95 this will now start in APRIL 96. This means the work will probably not be finished for the May/June session.

A new 6cm receiver with 30K noise is now in use. Installation of new 2cm, 1.3cm and 7mm secondary focus receivers is expected in time for the February session.

Fast band change for VLBA operation (0.7, 1.3, 2, 4, 6, 13cm) is under development.

The VLBA terminal now seems to work reliably, continuous calibration is used, the clock against GPS is continuously recorded. Seven programs have been observed so far . Reporting back of telescope position and weather to the VLBA computer is still under development. We plan to change to FS9 this year when the Mk3 terminal has been upgraded. GPS logging will then be added for Mk3.

Recent single-dish measurements at 390-440MHz showed that no useful observations in this band are possible at Effelsberg.

## Jodrell Bank Station Report (VLBI) 29th August 1995.

### MK3 Terminal.

The Video Converter Filter Boards have been replaced by the Haystack-designed 'MK4' compatible boards. The read-write modules from Metsahovi have arrived but will not be installed until the rest of the upgrade is ready. The recorder mechanics have not yet been modified. The recorder has been checked and used since the problems last year and is currently in good order, although we still have a problem getting the decoder oscillator to lock. Part of this circuit will be replaced this year. The first of the new Field System 9 PCs, running the Linux operating system, has been ordered by us and has been checked out at GSFC by Ed Himwich. We expect to install it on one of our terminals in October.

### VLBA DAR.

We continue to experience difficulties both with the terminal and with the 'switchover' from MERLIN to VLBI for the Cambridge IF Path. We have continue to install upgrades in hardware and software intended to improve the latter. The DAR itself proved to have an intermittently sticking head (Inchworm) motor: this has been cleaned and now works but may need to be replaced. We have replaced the old 'A/D' Formatter module with the new Digital Switch board, as required for phasecal extraction. We have also purchased a Data Buffer module, allowing fringe/data checking. Both these modules are from Penny and Giles. It is hoped to buy a second FS9 PC for the VLBA terminal very soon, i.e. well before the next session including Cambridge.

### General.

We have purchased two of Tom Clark’s GPS Clocks (the 'Totally Accurate Clock'), which are currently on test.

A few weeks ago the Lovell Telescope narrowly avoided being 'put into mothballs', i.e. operationally suspended, by the University. The problem has been resolved for the immediate future and hopefully for the next three years at least.

Paul Burgess.

**TWG95 - Medicina station report**

Frequency agility at Medicina.

-Now we are able to switch among the following receiver configurations in six minutes as a maximum:
13cm band, 3.6cm band, 13/3.6cm band, 1.3cm band, 21cm band, 18cm band

All configurations are double channel, except S/X of course. All of these are located in primary focus. From a remote control point of view all of these configuration are set using a snap procedure only.

- The new subreflector mechanics project is in the middle of its development. When completed we will be able to switch among all receivers (primary and secondary focus located) in a minute as a maximum.

PC Field System

The Medicina antenna control programs implementation on the PC Field System is completed, so the HP1000 system has been virtually removed. The first VLBI observation by new FS was the geodetic experiment Europe2_95 and it was successful.

MK4 upgrade

The new read/write electronics for the tape unit has been delivered and the video converter bandwidth upgrade is completed.

Miscellaneous

-A new +- 0.1 C temperature conditioning system of the H-maser room has been implemented.

-Two prototypes of linear mechanical actuator to be used to move the panels of the dish are ready to undergo heavy reliability and functioning tests. In a final release our goal is to use many of them to correct gravity deformation of the primary mirror of the parabolic antenna.

-A new generation spectrum analyser for spectral line observation is now available at the station. It is a high time and frequency resolution digital spectrometer capable to perform directly the FFT of the incoming analogue signal in 33msec up to 20MHz bandwidth with selectable channels from 256 to 128k. Exploiting this high time resolution we discovered a water line emission coming from Shoemaker-Levy comet/Jupiter impact of the last year. With the incoming upgrade will be possible to process two signals at the same time (20MHz each one) taking 10msec for one spectrum.

- In the MK3 recorder has been implemented a system, similar to that Noto one, to inject dry air in the surroundings of the heads to maintain at low level the humidity.

- The rail of the antenna is very degraded. Some funds are now available to buy another one and we plan to substitute it next year. Causes of the damage was fixed in the loss of wheels alignment respect to the track and holes under the rail. Now we have realigned the camber angle of all wheels but much more work is
needed to restore a good situation.

- The crosstalk polarisation is not very good for the Medicina receivers, so an upgrade is necessary. First results are about X band receiver that shows 4.1% in the RCP channel. No data are available about LCP channel, but it is made the same as RCP so I'm confident that the performance is similar.

Alessandro Orfei

**Metsahovi Station report**
21 Sep 1995

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## VLBA terminal

The head positioning motor (inchworm) slowed down and eventually stuck during the December 86 GHz session. After the inchworm was cleaned and the head cables were loosened, positioning system started to show nominal speeds and errors.

## Receivers

The 22 GHz receiver is continuing to perform well.

Design of the 43 GHz receiver continues and some key components have been ordered. The personnel of the receiver group will be increased by 300% from 1 October, this will hopefully speed up the completion.

The 86 GHz receiver is modified to enable VLBI observations. However, no fringes have been found in the first experiment. A polariser plate has been designed and manufactured to enable LHCP operation.

## Antenna

Beam pattern and aperture efficiency measurements confirm that the overall RMS surface error should be around 100 microns at $45^{o}$ elevation. The antenna servo and specially the inductosyn encoders are showing ageing symptoms. A periodical error of ~ 10 $m^{o}$ in azimuth and ~ 3 $m^{0}$ in elevation was measured. If no quick cure is found to this problem, Metsahovi will be useless in the December 86 GHz session.

## Maser

The EFOS-9 maser has become somewhat unreliable. The emission has ceased several times for some hours without any obvious cause. Fortunately this has always happened outside of the VLBI sessions. A decrease of the maser room temperature to $18^{o}$C is performed (suggested by Dave Graham) and hopefully this will cure (or at least hide) the problem.

# NOTO REPORT 1995

VLBA acquisition terminal in Noto now has 12 BBCs, indeed 6 more units have been added this year. Moreover we borrowed a Delay Cal Unit in June that will be available up to December 1995 for geodetic experiments.

The new TAC (Totally Accurate Clock) GPS receiver was bought and it will be delivered in the next weeks. A comparison test with our Loran C receiver will be performed, then it will be included in our Time & Clock station.

A new equipment to produce dry air has been installed in order to keep dry conditions in the recorder headstack cabinet and to maintain clean the receivers windows. It is in substitution of dry nitrogen and it allows to use greater gas quantities in despite of the reduced cost.

New calibration equipment has been used to maintain and check the meteo station and new parameters are available as wind speed and direction.

A more complete pre-observative check was adopted in order to monitor the points considered "hot" in the station.

Plans for Noto station are:
-to buy 2 BBCs and Delay Cal Unit;
-to build a new S/X/L receiver for primary focus;
-implementation of the automatic replacement of subreflector as developed in Medicina;
-interferences station construction;
-to use the new FS9.

## ONSALA STATION REPORT

### MK3 TERMINAL

New read and write heads have been installed at the recorder. The old ones were over 3 years old and worn and were the main source of the high parity errors reported in the May session (and recent Geodetic sessions). The heads were supplied via Tom Clark. In addition new control and I/O boards from Haystack were installed just prior to the last geodetic session (at the end of August).

The first step in the upgrade to MkIV, the installation of new filter systems is scheduled for the end of September when Dave Holland from Jodrell will visit Onsala.

### 25m TELESCOPE

It is clear that the tracking performance of the 25m at 6cm is marginal. The reliability of the ageing telescope control electronics and the manpower costs in fixing problems are also significant problems. We have therefore decided to;

i) Get the tracking motors operational, instead of using the slew motors for tracking (as has been done for at last 20 years), this should improve tracking on this polar mounted telescope.

ii) Replace critical components in the electronics connecting the telescope control computer to the telescope motors.

iii) Change the control computer to a Linux based system and use the same telescope control software as used for the 20m control.

### ANTENNA CALIBRATION.

A program has been begun this summer to measure the gain-el curves of the two antennas at all the operating bands.

Initial measurements of the 25m at 6cm have been frustrated by failures in the telescope control system, but these measurements should be completed by next month. We also intend to measure the high frequency gain curves of the 20m before single-dish millimetre observations begin in earnest in December.

**Report from Torun**

32m antenna is being tested on various ways. The control system is not yet ready so we can move the telescope in both axis with position information available but tracking is not yet ready (might be within few days). The new contract with local company sets time for full operation in December. This will include motion of subreflector and receivers diagnostics.

At the moment 5 GHz (500 MHz BW) uncooled HEMT system is available for one polarisation, with uncorrugated primitive horn. This allows us to do tests on pointing and tracking. We can observe sources down to 1 Jy in transit mode. Scans on Cyg A or Cas A and other strong sources show good performance of the antenna (as expected). The sensitivity, beam width, side lobes are as in the text-book. There is noise diode calibration with known level. This 5 GHz system has LO (HP Synthesiser) lock to the H-maser and can in principle be used for test VLBI observations.

In parallel we are building vacuum enclosures for L band and C band cooled receivers. The cooling machines are ready for use. If everything is going fine we might have both receivers on telescope (~ 30-40 K Tsys) early 1996. Two polarisation's, 21, 18 and 6 cm. Simple horn (Jodrell design) is built for L band a corrugated one for 5 GHz.

To test quality of the surface we are constructing (in collaboration with Lars Baath - now in Halmstad University) 12 GHz interferometer for methanol lines and satellite signals. Plan is to do the measurements in January 96. The system is based on cheap satellite TV LNC.

VLBI terminal has been accepted at P&G on beginning of August. There are some small modifications needed before transportation to Torun. SAT will be performed in Torun with local training as well probably in September. I expect that we might do first tests in November.

The H-maser is working well, the frequency and time distribution units are ready. Meteo station of our own design is partially operational.

Computing facilities have been improved. C120 has now 128 MB memory, two SUN 10 were bought, HP735i is used for new telescope. VXI unit connected to HP735i record signals from the receiver and controls digital I/O states of various units in the control room.

Last weak was rather busy. We had organised Summer School on Radio Astronomy. 30 participants and 10 lecturers spent their time in TRAO delivering/listening to high quality lectures and discussing various topics of modern Radio Astronomy. Because of activities related to the School some work with the 32m telescope was delayed.

I have always been an optimist and would like to see real world in bright colours. Maybe what I write now will have to be corrected within next few month but to my knowledge spring 1996 must be the final time for full operation of 32m radio telescope.

With best regards

Andrzej

**Station Report for Westerbork**

## VLBI Hardware

Since the end of 1994 there have been a number of hardware changes:

The tied-array IF system used by VLBI has been reconfigured to make simultaneously 64MHz of Left Circular and 64MHz of Right Circular polarisation available at the terminal. This has had some side-effects The previous phase-calibration signal cannot be used. Work is in progress to introduce a new phasecal injection system. The manner of making circular polarisation from the linear polarisation has changed. The details of the mixing scheme have changed (but note that there is still no equivalent single equivalent "LO" at the Mk3 rack). Only the first of these should have consequences for astronomers. There is now a GPS time receiver in Westerbork. The clock offset between GPS time and the maser time is regularly monitored and written to file. This data should prove useful in speeding fringe searches at the correlators in future. The Mk3 video converters have been upgraded to Mk4 as part of the 'EMU upgrade'. Thus 8MHz and 16MHz filters are available, although they have no practical use until the rest of the upgrade is complete. Previously available 1 and 0.25MHz filters have been removed from the video converters, but could be made available as external filters if there were a convincing case for their need.

There have also been the following repairs made:

The worn Metrum write headstack was replaced in January by a new Penny and Giles headstack. This gave moderate performance with parity error rates typically of 10**-4 to 10**-5. This Penny and Giles headstack has since been taken out again in July and will be swapped for the new Metrum headstack bought by JIVE. The (write head) inchworm motor broke during the May VLBI session and was replaced by one brought from Bonn.

## VLBI Software

As part of the EMU upgrade Westerbork has changed the Field system used to the new (LINUX) version, also known as FS9.

## Receivers

The first VLBI test observation with the prototype Multi-Frequency Frontend at 3.6cm was made in February 1995. This observation showed fringes, but this frontend series will not be available for general observations until the end of 1997. Those wanting more details on theMFFE should consult the MFFE entry on the NFRA www page at: http://www.nfra.nl/nfra/projects/mffe.html

## Observing modes

The first test observations in the 'Cluster-Cluster' VLBI observing mode have been made between Westerbork and the VLBA. This mode involves putting 4 separate datastreams (from 4 separate subarrays at the two ends of the VLBI baseline) onto one VLBI tape. This mode was originally proposed for accurate geodetic and astrometric observations, as most observing errors are in common to these data streams and can be removed during analysis. Those wishing to know more about the astronomical use of this mode should contact Leonid Gurvits (LGurvits@nfra.nl).

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