Prototype Multi Frequency Front End ready for use

Gie Han Tan

Official inauguration

With the delivery of the prototype Multi Frequency Front End (MFFE) a major milestone has been achieved within this project. Already from 9 until 11 May at the 49th Nederlandse Astronomen Conferentie held at Boekelo, The Netherlands, the prototype was on display in a fully functional state.

After this conference the front end was brought to the Westerbork Synthesis Radio Telescope for further integration with the rest of the instrument. On May 26 the official inauguration of the prototype MFFE took place at Westerbork. In the presence of NFRA employees and guests from the various Dutch universities, Prof. dr. R. Sancisi revealed a model of the new front end at the foot of Radio Telescope 2 in which the prototype was already mounted.

Test program

Immediately after this inauguration an extensive test program started to assess the design and performance of the MFFE. Most important aim is to investigate the stability and reproducibility of the design, it is not the intention to get the ultimate performance in this phase of the project. Optimization of the performance will be done in the series phase of the project. The test program has been scheduled in the period from end of May until the mid of August.

The preliminary results obtained so far show that the performance in general is satisfactory and no major problems were encountered. Stability and reliability of the prototype MFFE were such that it was decided to use the front end for the unique Jupiter collision observations at 21 cm in June. On the basis of the obtained information already a start has been made with the series MFFE production.
New features
The test period was not only used for the assessment of the prototype MFFE but was also used to experiment with some new features that might be implemented in the series MFFE design. A very interesting experiment had to do with a new configuration of the 92 cm low noise amplifiers (LNA). Instead of a single LNA for each dipole of the feed-system, a configuration which uses two LNAs, one for each of the two probes of a dipole, was tested. In this way a further reduction in system temperature can be achieved. However it was uncertain how exactly this new configuration would influence the radiation pattern of the feed. Measurements showed a system temperature of 99 K at 325 MHz for the new configuration, an improvement of approximately 80 K compared to the original situation. To study the feed performance holographic measurements were made. At the time of writing these measurements were being analyzed so no final results can be published. However it is expected that satisfactory performance can be achieved and that this new configuration will be implemented for the 92 cm and 49 cm wavelengths in the series MFFE. With this improved design system temperatures of 74 K at 325 MHz and 42 K at 605 MHz are our objectives.

Design review
On Thursday, September 15, a design review will be held at Dwingeloo where, among other things, the test results which have been gathered from the prototype MFFE will be presented. More information on this design review is published elsewhere in this newsletter.

Message from the Director
Harvey Butcher

By the time this issue of the Newsletter appears, the XXIInd IAU General Assembly and accompanying sympoia in The Hague will be history. Most of us will have met new people working in our field, renewed old acquaintances, possibly initiated a new collaboration or revived an old, and with luck learned some skill that will be of help to our research. The deadline for observing proposals is appropriately set to follow up on any new possibilities: 15 September (WSRT, ING, JCMT; EVN and ESO are in October), and this year 15 September is also the deadline for applications to NFRA for project and program subsidies. Just enough time to put one's thoughts together, check with collaborators, get the academic year started and write proposals.

At NFRA this has also been a very busy period. As point man for the IAU's Local Organizing Committee, Ernst Raimond kept our FAX machine glowing red from early spring on. René Genee organized a special issue of this Newsletter for IAU participants, posters and with Seth Shostak also prepared the daily IAU newspaper "The Sidereal Times". Simultaneously, Lout Sondaar and Jan Butier delivered the flight models for the 6cm receiver on the RadioAstron VLBI satellite to the Astro-Space Center in Moscow and helped with the (successful) acceptance tests there. The prototype Multi-Frequency Front End spent the summer on telescope RT2 of the WSRT, generally performing well and teaching us just how much better the telescope will be when the whole set of new receivers is in place. The team in Westerbork also succeeded in implementing dual frequency, sub-array operation of the WSRT. This was accomplished just in time for the collision of comet Shoemaker-Levi 9 with Jupiter in July, but is also relevant to our intentions to begin doing high precision VLBI astrometry as well as other applications benefiting from sub-array modes. And the Flexible Filter Bank pulser backend received finishing touches in Pasadena, was shipped to Dwingeloo and is now being installed at the telescope. All in all a hectic summer!

Multi-Frequency Front End project
As noted above and expanded on elsewhere in this issue, the prototype MFFE went to the telescope in May and has been successfully operating since. Following a detour first to the Astronomers Conference in Boekelo, on May 26 an installation ceremony was held at the telescope, attended by representatives of the astronomical, geodetic and collaborating technical university communities in the country as well as by NFRA personnel. A number of minor teething problems have since been found and fixed, and the improved stability relative to the present system has even identified problems that for years have unwittingly been more or less calibrated out.
Extensive test data has been secured and analyzed during the summer, in preparation for a major project review on 15 September in Dwingeloo. All those interested are invited to attend this review, a draft agenda can be found elsewhere in this Newsletter. Representatives of the Dutch user community, of NFRA management, and of foreign groups who have expressed interest in acquiring copies of our design will in any case participate. Following that review, the design of the production units will be frozen and their fabrication begun in earnest. As an aside, I note that the manpower estimates produced in 1988 by project engineer Gie Han Tan for the prototype phase of the project have proved to be accurate to about 10%. Compliments, Gie Han, on a professionally run project!

Preliminary discussion of the likely timescales for production of the series units have led to a decision to implement the final front end units in two phases: in early 1996, the tunable UHF systems will go to the telescope, to be followed by production and installation of 3.6cm, 6cm, 13cm, 18-21cm, 49cm and 92cm fixed band systems some 20 months later. This strategy should permit H I observations at arbitrary redshift before the competition elsewhere in the world can come on-line with similar capability. Phased implementation also has the practical advantage that it will give the operations and software teams a chance to get the new control system thoroughly wrung out before the final Front Ends arrive.

Telescope maintenance

Both the 25-m Dwingeloo telescope and the WSRT are some years overdue for major maintenance. It is characteristic of structures exposed to the elements that the state of repair seems fine until a certain point, after which it very rapidly deteriorates. Both of our telescopes are littering on the brink, and we have had to make plans to carry out major maintenance. Luckily work on the 25-m telescope can be financed over several years from our regular budget: last year the telescope electronics were cleaned up and the control system was removed from the so-called "zonehuisje" (which was then torn down and taken away) and placed in the telescope's cabin, and this summer we are repairing the main azimuth rail, grinding out accumulated rust and dirt from between base and rail followed by welding the rail to the base. In addition to retarding deterioration of this support system, we expect the pointing of the telescope to improve substantially as a result. That these activities are worthwhile is amply demonstrated by the discovery this summer in the course of the Dwingeloo Obscured Galaxies Survey (DOGS) of a hitherto completely unknown large spiral galaxy just outside the Local Group. More on this object in our next Newsletter!

The results of an extensive analysis of the state of the WSRT by Jan Pieter de Reijer, backed up by an finite element structural analysis by Wim van Emden, are reported elsewhere in this Newsletter. One anecdote is perhaps interesting to relate. The telescopes were designed in the era before computers, with the result that no account was taken of the metal fatigue that would occur after 25 years of continuous operation. Wim examined the question, and found that the extra weight of the new front ends should give no problem, but that considerable credit should go to the welders involved in the original construction: it would not be unreasonable to expect that one or more of the heavy (33 tonne) counter weights should have broken off before now!

In any case, we have determined that roughly MF 3.3 new money will be necessary to give all the telescopes another fifteen years of life. A considerable fraction of this total is unavoidably required for hiring a large crane to remove the dishes from the telescopes for treatment. Negotiations with NWO have led to a grant of in total MF 1.0 to start the work. We will begin by treating one telescope (RT5) and then assess how we can proceed with the rest.

Mining the northern sky

The Westerbork Northern Sky Survey is now 75% complete. Project scientists George Miley and Ger de Bruyn have begun organizing teams to begin mining this unique data set. The initial search for maser pulsar candidates in the data is being carried out in Utrecht under the supervision of Frank Verbunt. The new Flexible Filter Bank built as part of the NFRA-Caltech collaboration in pulsar astrophysics will come on-line at Westerbork during the fall, and Michiel van der Klis (Amsterdam) together with Lodi Voute, Will Deich and the team in Westerbork, will begin observing them for pulses shortly thereafter. Candidate high redshift galaxies and clusters of galaxies are being selected and studied under George Miley's supervision in Leiden. The WENSS should yield on the order of twenty new gravitationally lensed radio sources. Collaborators at Jodrell Bank and Caltech will be imaging candidates in the radio and optical, and taking optical spectra for verification of lensing. Already, at least one candidate from this effort, having a separation of 1.5 arcsec, seems nearly certain to be a lens. New giant radio sources -- where giant really means big: total dimensions on the order of a Mpc! -- are being looked for under Harry van der Laan's supervision in Utrecht. The wide field mosaicking technique, whereby a particular field is synthesized from data taken over minutes to weeks, makes sources variable on a timescale of an hour and less immediately obvious. At the initiative of Bert van den Oord (Utrecht), a survey of the WENSS data set for RS CVn variables (and other variable sources) is under way. Readers interested in these or in other uses of the WENSS data set are invited to contact one of the project scientists, Miley or de Bruyn, to discuss the possibilities.

New laboratory building in Dwingeloo

For some time we have been aware that maintenance of the older buildings in Dwingeloo is no longer cost effective. Additional lab space is also a matter of some urgency, both because of the presence of JIVE personnel and because hardware for the JIVE correlator and tape units will begin arriving early in 1995. Plans for integration of the Kapersterrnwerk Werkgroep also require additional lab space. During the spring we received word that financing is available for a new building and for renovation of the newer of the existing buildings. An architect has been engaged and plans are being made to begin construction early in 1995. The new building will be put up next to our current technical laboratory, and the latter will then be razed. We hope to move into our new quarters during the summer of 1996.
Summer school, summer research
A part of building for the future involves training the next generation of astronomers. Indeed, the primary users of a next generation giant radio telescope are now in their teens. While the mission of NFRA is research, we want to do our bit when we can to promote and nurture potential Dutch astronomers of the future. To this end, NFRA hosts the NOVA Autumn School for Dutch graduate students, and each summer also an international group of university students who spend some months working with NFRA staff on particular research projects. This year, by way of experiment, we have collaborated with Walter Jaffe (Leiden), Frank Verbunt (Utrecht) and Vincent Icke (Leiden/Amsterdam) to host a set of even younger students: seventeen high school students with (very) high average grades from around the Netherlands spent three weeks camping, hearing talks and doing practical work in Dwingeloo. The main theme was stars and their evolution; the Planetary made a telescope available to the group, and we contributed the CCD system used for SCASS (see Newsletter no. 5, page 14, August 1993), to allow observation and analysis of real star clusters under real conditions.

An era passes
Jean Casse has led the R&D division of NFRA for over 25 years. Some time ago he indicated he would prefer to relinquish his responsibilities in this regard in the near future. During the spring we undertook a recruiting exercise to this end, that I am pleased to report ended successfully. As of 1 September Jean will move to JIVE, to work on the EVN's advanced correlator project. I join his many friends and acquaintances around the world in thanking him for his technical contributions to radio astronomy through the years, for his thorough dedication to promoting our subject, and for his kind and consistently gracious collegiality that has won many friends for NFRA. In a real sense, 1 September will be the end of an era at NFRA.

On 1 September Arnold van Ardeel will (re)join NFRA as new Head of the R&D. Arnold's background includes low noise receiver technology and systems for meter to millimeter wavelengths. VLBI techniques, and synthesis and phased array applications. He comes to us most recently from Eriks Radio Systems, where he developed a new generation of pocket pager and was a member of the management team.

Welcome aboard, Arnold!

The RadioAstron Project

Jean Casse

In the middle of May 1994 the two Flight Models of the 6 cm RadioAstron receiver were delivered to the Astro Space Center (ASC) of the Lebedev Physical Institute of the Academy of Science in Moscow. On June 4, after extensive acceptance tests, the receivers have been formally accepted. This event concludes the construction phase for this receiver. In the coming period, between now and the launch which is planned for 1997, the various receivers will be integrated in the spacecraft and as a whole thoroughly tested. Extensive tests on the complete system will be conducted in the course of next year at the ASC Radio Astronomy Station in Pushchino, some 100 km south of Moscow.

Our involvement in the RadioAstron project dates officially from April 1987 when Prof. G. Setti, at the time Chairman of the EVN directorate, signed with Prof. N. Kardashev from IKI (Institute of Space Science of the USSR, now of Russia) and presently at the ASC the Memorandum of Understanding. This action had been triggered by ESA who had received a request for cooperation from IKI and had notified the EVN community.

The RadioAstron Project involves a spacecraft with a deployable parabolic radio reflector of 10 meters diameter for VLBI purposes. The one day orbit of the spacecraft is highly elliptical with an apogee height of 80000 km and a perigee height of 2500 km. The orbit inclination is 51.6 degrees. The satellite is built for reception of radio waves in 4 different bands: 92 cm, 18 cm, 6 cm and 1.35 cm. Except for the low frequency option, all receivers are meant to be cooled to about 80 K by combined passive and active cooling. All receivers have dual channel capability. The receiver channels are connected to circularly polarised antenna probes. This novel feed, developed at the St. Petersburg Polytechnical University consists of concentric rings and allows simultaneous reception in the planned radio bands. For the shortest wavelength the feed consists of a waveguide mounted at the center of the multiband feed.

While the construction of the satellite, including support and communication hardware, remained a Russian responsibility, the design and construction of the receivers became a task for the international community: the 18 cm receiver was allocated to the CSIRO Division of Radiophysics, Sydney, Australia, the 1.35 cm option went to the University of Technology, Helsinki, Finland and the 92 cm receiver became a joint effort between Russia (KB Gorizont in Nizhniy Novgorod) and India (Tata Institute). EVN accepted the task of building the 6 cm receiver. In practice the task went to NFRA in Dwingeloo and MPIfR in Bonn. The receiver is built up by two main items: a Low Noise Amplifier (LNA) and an IF module. In total EVN delivered three 6 cm recei
vers: an engineering model and two flight models. Next to that, for testing purposes in the Netherlands and in Russia, two Test Sets have been designed, constructed and delivered to the ASC. The engineering model and the first Test Set were delivered in 1990.

Considering the limited funds available for the project and after consultation with experts, it was decided to build the 6 cm receiver out of conventional components instead of space qualified components. In order to meet the reliability requirements set in the contract, special care needed to be taken in the design and the selection of the components. The theoretical reliability of the receiver system needed to be demonstrated. Based on theoretical grounds one could show that the receiver with its reliability factor of .987 does meet the specification of .95 as set in the IKI specification document for a mission planned for 3 years and a 60 % active time.

Furthermore, an extensive test program which lasted nearly one year was undertaken.

Some of these tests have been carried out cost free at ESTEC in Noordwijk, the Netherlands. They concerned mainly the vibrational and electromagnetic compatibility (EMC) tests. The receivers had to pass both tests which meant for instance that no change in behaviour should be detected after dynamic loading up to 40 G and 2 KHz. The EMC tests concerned the measurement of the emission level from the receivers up to 300 MHz and the susceptibility of the receivers for outside radio radiation. The complete receiver is shown in the figure mounted on the vibration jig at ESTEC. The receiver lifetests consisted of a specified series of varying surrounding conditions during which the receiver functions needed to be accurately measured. These tests were specified to last more than 6 months and were carried out using the specially made computer controlled Test Set. The Test Sets have the possibility to measure and control all functions of the receivers; they in fact simulate the satellite Service Module. They are meant to accompany the receivers up to the launch in Baikonur.

Measurement of the noise temperatures of the 6 cm LNA’s yielded 17/25 K and 22/22 K, for the X and the Y channels of model one and two respectively. Taking into account the antenna and cable losses, this leads to a system temperature for the two channels of about 40 K. The output level of both channels is remote controllable from the earth. The receiver system can be calibrated using the stable noise source in the IF module. The LNA’s are to be mounted on the coolable radiation plate at the prime focus of the antenna. They are connected to the IF unit in the Focal Container installed on top. The temperature of the gas filled container is expected to vary between 0 and 40 degrees centigrade. Under these severe circumstances good amplitude and phase stability had to be secured. This was taken care of by mounting the critical units on miniature thermostats.

The project has been conducted under the leadership of L. H. Sondaar. For his contribution to the project Sondaar was awarded in 1992 the Gagarin medal of the Russian Cosmonaut Federation. In Bonn at MPIfR, A. Schmidt organized the design, construction and testing of the LNA’s. The project has been made difficult as a result of language problems (the receiver specification had to be translated from Russian, for instance) and poor communications. Confrontation of receiver builders with the Russian satellite experts could only take place once a year and needed to be carried out in the presence of interpreters. The project nevertheless took place in great spirits thanks to the enthusiasm of the construction team.

The total project has cost EVN 330 Kf; this includes all the receivers (thus also the prototypes), the test sets and the travel costs. The project has been financed from the contributions of the EVN member Institutes. It has been made possible thanks the support of ESTEC in Noordwijk and the advices from SRON in Utrecht.

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**Report of PC-meeting 94-1**

Since the last PC meeting a large number of observations at 21 and 92 cm have been carried out. In February and March 1994 a number of observations have been done at 21 and 92 cm, respectively, in preparation to the observations of the
collision of the comet Shoemaker-Levy-9 on Jupiter in July 1994. Various tests are going on to enable 21/92 cm dual frequency observations with an integration time of both 1 minute and 0.1 msec. During 1994 various tests are planned for the multi-frequency frontend and pulsar backend. The reduction has a backlog of about 2 weeks. Ionospheric information is regularly supplied by the military (The Hague) for use in the standard reduction of low frequency data. The Deutsche Bundespost continues the distribution of data taken in Ruenen, but the distance between the Ruegen station and the WSRT exceeds the coherence length of ionospheric electron density variations. Consequently, the Ruegen data show large discrepancies with the chirpsounder data from Havelte.

The JCMT works very well (about 4% of the time is lost due to system problems). Last year the weather was rather bad. Sometimes there are not enough backup and/or low frequency proposals which are needed because of weather conditions. The DAS works fine (incl. the software).

Since 1992, the JCMT time allocation committee has regularly allocated several shifts per semester for service observing. These observations are done for test programs, small programs (< 8 hr), targets of opportunity, monitoring programs, student thesis material, unfinished programs requiring small amounts of data. The JCMT service program seems to be a successful and efficient use of the telescope. Everybody is encouraged to apply.

### WSRT allocations

<table>
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<tr>
<th>Number Pl</th>
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<th>Wavelength</th>
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<th>21</th>
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<th>92</th>
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<td>WHISP</td>
<td>van Albeda</td>
<td>HI Spiral Gal Survey</td>
<td>30x12 l, 10x12 II</td>
<td>3 wk l</td>
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<tr>
<td>WENSS</td>
<td>de Bruyn</td>
<td>Continuum Survey</td>
<td>7x12h 1 1/2</td>
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<td>de Paer</td>
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<td>de Bruyn</td>
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<td>UMa Cluster</td>
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<td>Schaefer</td>
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<td>Chingalur</td>
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<td>Braun</td>
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<td>Brunner</td>
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<td>Schilizzi</td>
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<td>Polarization in M51 and N6946</td>
<td>1x12h 1 1/2, 1x12h 2 1/2</td>
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<td>Singh</td>
<td>HI early type galaxies</td>
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<td>1043</td>
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<td>1x6h 1</td>
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<td>1167</td>
<td>Hardon</td>
<td>BL Lac objects</td>
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<td>1109</td>
<td>Speckstra</td>
<td>Nova Cas 1993</td>
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Notes: 1) + INTERIM proposal when needed, project be combined with 1111: 21x12h at 49/92 cm: 2x12h at 21 cm: 3) + INTERIM proposal when needed, project be combined with 1140; 4) possibly during May 1994 VLBI period; 5) best time November/December; 6) pulsar backend, not before fall 1994; 7) avoid shadowing, 8) night time; 9) schedule during a weekend in September/November

### JCMT allocations

<table>
<thead>
<tr>
<th>No.</th>
<th>Project Leader</th>
<th>Title</th>
<th>Rec.</th>
<th>Allocation (8 shifts)</th>
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<tr>
<td>N01</td>
<td>Hogerheidej</td>
<td>HCO+ in YSO's</td>
<td>8 (+5 backup to N02)</td>
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<td>N02</td>
<td>Miley</td>
<td>CI in High-z Galaxies</td>
<td>A</td>
<td>11 (backup rejected)</td>
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<td>Israel</td>
<td>CI and CO(4-3) in Galaxies</td>
<td>C/B/S</td>
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<td>Heiling</td>
<td>CS in Stellar Disks</td>
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<td>Israel</td>
<td>CO(3-2) Maps of Galaxy Centres</td>
<td>(combined with N03)</td>
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<td>N06</td>
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<td>Chemistry in W3</td>
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<td>N11</td>
<td>v. Langenfeld</td>
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### La Palma allocations

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Scientific Support at JIVE

**Maria Rioja**

At present the main role of the EVN Support Scientists appointed by JIVE is: a) improve the performance of the EVN, and b) provide user support. Since September last year monitoring runs are being routinely scheduled in each VLBI session at all observed frequencies. They include calibrator observations using the gaps left between scientific programs. The tapes are quickly sent to the MPHFR correlator in Bonn and systematically processed within three weeks after the end of the session. Each telescope receives then quick feedback on its technical performance during this session, well before the next one starts. This scheme makes a real difference compared to the increasing delay between observation and correlation stages of scientific programs since high density MK3 tapes began to be recorded in the 90’s. In fact, this continuous interaction has led to relevant improvements in some antennas. Other telescopes that are willing to participate in EVN projects are previously contacted and welcome to join these observations.

Moreover, these monitoring programs intend to test the array in its various configurations where the performance is poor, and monitor the progress of work to improve them. In the February 1994 session non-standard spectral line observations of the maser OH127.9 at 1.6 GHz were done. Preliminary indications are that they were successful, and the maser line was detected on the available baselines. In June 1994 the unpolarized source OQ208 was observed at different parallactic angles with dual polarization set up at 5 GHz. The data analysis to derive polarization impurities at each telescope is in progress. The possibility of optimal polarization measurements with the EVN depends on whether instrumental polarization can be kept to a minimum (5%).

One of the weaknesses of EVN is the reliability of some of the calibration information provided, i.e. gain curves, antenna-gain factors and/or system temperatures. For example, the analysis of the monitoring observations in February 1994 at 5 GHz showed that calibration information provided by some EVN telescopes can be off by 30%. We are trying to improve this. Previous long monitor observations of calibrators during September and November sessions last year have been used as an independent way to derive gain curves for each telescope. Also, the analysis of the maser line observations in February this year will provide similar calibration information. It is our present intention to concentrate efforts in this issue and include specific calibration procedures in the monitoring runs. All this work is done in close collaboration with the VLBI friends at each antenna.

We want to make the EVN more 'user friendly'. A Support Scientist is allocated to each approved project. The PI may ask for assistance at any or all stages involved in the realization of a VLBI experiment: scheduling, processing at the correlator and posterior data reduction. Also the Support Scientist may provide any up-to-date information on the status and facilities of the array. We aim to simplify and expand the use of VLBI techniques among non-expert users. At present three Support Scientists are appointed at JIVE, two at the MPI and VLBA correlator sites in Bonn and Socorro, and one at the JIVE headquarters at Dwingeloo. Further information can be required via electronic mail (internet) to jive@nfra.nl. Two new Support Scientist positions are being filled, located at the Institute of Radio Astronomy in Bologna (Italy) and at the Onsala Space Observatory in Onsala (Sweden).
A number of scientists are expected to visit Dwingeloo for the data reduction of their VLBI data during this summer, making use of the facilities there. As a result we expect to learn a lot from the most experienced users and provide help to other less experienced ones. PI's are encouraged to visit Dwingeloo for the data analysis making use of travel funds from EC grants.

Report on NFRA support post-doc research
The equivalence principle and a freely falling charge in a uniform gravitational field

Ashok Singal

In the case of a free fall of an electric charge in a static uniform gravitational field, the strong principle of equivalence appears to be violated. On the one hand, as seen by an observer stationary in the gravitational field, a freely falling charge is accelerated 'downwards' and should radiate at a rate proportional to the square of the acceleration due to gravity, according to Larmor's formula for radiation from the classical electromagnetic theory. On the other hand such a charge is stationary with respect to an observer also falling freely in the same uniform gravitational field. From the strong principle of equivalence a freely falling observer is in an inertial frame of reference and according to the classical electromagnetic theory such an inertial observer should see no radiation emitted by a charge stationary in his/her frame. Since the electromagnetic radiation, as commonly understood, cannot be eliminated by a change of frame of reference (radiation could cause some physical effects which should be visible to all observers; photons may get Doppler-boosted or even red-shifted but not eliminated altogether, etc.), an inference of radiation from a charge should not depend upon our choice of the observer. Thus the strong principle of equivalence and the classical electromagnetic theory may appear to be incompatible in this case.

A resolution of the problem of radiation from a charge falling freely in a uniform gravitational field has traditionally been thought to be related to the problem of whether or not does a uniformly accelerated charge radiate. However, it may be pointed out that in spite of their apparent similarity, the case of a freely falling charge is rather different in its nature from that of a charge uniformly accelerated with respect to an inertial frame. While in the former case there is an inertial frame available in which the charge remains at rest, no such inertial frame exists in the latter case. Therefore one should be able to resolve the case of a freely falling charge independently from that of a uniformly accelerated charge.

The results derived in classical electromagnetism are valid strictly only for observers stationed in inertial frames of reference. Therefore the conclusions of an observer in the freely falling frame (an inertial frame) should, in general, be correct and there should be no electromagnetic radiation from a freely falling charge. But the main problem is how to reconcile this result with the one expected by an observer stationary in the gravitational field? For that we need to look more careful-ly at the exact findings of such an observer. From the theory of relativity, all forms of energy (including that of the electromagnetic fields) have an associated inertial mass and which, by the principle of equivalence, will fall in a gravitational field in the same way as any other matter. This has been amply tested by the bending of light ('fall' of photons) in the gravitational field of the sun.

\[ \gamma = 1 \]
\[ \beta = 0 \]

\[ \gamma = 1.5 \]
\[ \beta = 0.745 \]

\[ \gamma = 3 \]
\[ \beta = 0.943 \]

\[ \gamma = 10 \]
\[ \beta = 0.995 \]

Now even the electric field of a charge has a well-defined energy density and hence a mass density, and there is no reason why this field also should not be considered to 'fall' along with the charge (after all from the principle of equivalence, everything falls in a gravitational field). This can be seen also from the fact that in the case of a uniform gravitational field, the space and time coordinate transformation, from the freely falling inertial frame to the supported frame, for all events that are simultaneous in a horizontal plane (perpendicular to the direction of fall), is the same. Thus an observer stationary in a static, uniform gravitational field will find that, as a charged particle falls, it can pass through the bundle of electric field lines without being disturbed by the gravitational field.
Now in the standard picture for radiation from a charge accelerated with respect to an inertial frame, because of the finite value of the wave propagation speed $c$, the electric field values at a distance $R$ respond to any change in the motion of the charge, only at a time $R/c$ later. Thus while the field values in regions near to the charge ($R < ct$) will have adjusted to a change in motion (acceleration) of the charge, the fields in far away regions would still correspond to a previous unchanged motion of the charge. Electromagnetic radiation (in the famous J. J. Thomson picture) is supposed to represent the transverse fields in the transition zone between the nearby regions (where electric field vectors point in radially outward directions from an actual present position of the charge) and the far-off regions (fields in radial directions from a would-have-been charge position, assuming a uniform velocity for the charge). But as we discussed above, in the case of a freely-falling charge in a uniform gravitational field, the electric field around the charge everywhere keeps 'in step' with the charge motion (i.e. field lines everywhere will be along radial directions from the instantaneous position of the charge, figure) and accordingly no transverse field (radiation) rises to bring about any changes in the existing field to make it adjust to the changing velocity of the charge. Thus from the strong principle of equivalence the electric field of a freely falling charge in a static, uniform gravitational field would appear to fall along with the charge, remaining everywhere in a radial direction from the instantaneous position of the charge. Therefore even an observer stationary in the gravitational field will see no transverse fields (radiation) from a freely falling charge.

A question however may be raised whether one can still apply the standard formulae to calculate radiation from a freely falling charge in the more realistic case of a static but non-uniform gravitational field by using the value of $g$ (at the charge location) as the acceleration parameter in Larmor's formula. It is obvious that the answer cannot be a generic yes. As we have already seen above, at least in one case (i.e. in a 'uniform' gravitational field case) radiation is not determined by the value of $g$. It is true that in the case of a non-uniform gravitational field, the electric field lines may not 'fall' perfectly in step with the charge. But then any distortions in the field lines in such a case would depend only upon the departure of $g$ from the uniform gravitational field case (tidal-effects of gravity!) implying that these distortions arise primarily not because of $g$ itself but rather depend upon its spatial differentials and are thus only of a second order in nature. Any consequential transverse bending in field lines will vary from case to case and could be totally different for different tidal fields, even for similar local values of $g$ (as measured, say, by locally supported observers). This picture is qualitatively different from the standard picture of radiation where the transverse bends in the field lines are determined by the actual acceleration of the charge, and where the radiated power at any instant is calculated from the value of the charge acceleration at that moment.

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**News on Newstar**

*Marco de Vos*

Newstar is the data reduction package for WSRT data that is currently supported by the NFRA. If you want to use the Westerbork array, your observations will always pass Newstar (if only to convert them to UVFITS, in case you insist on using AIPS).

Most of you may be aware of the fact that observational data can seldom be interpreted without detailed calibration and analysis. This conversion process from raw experimental output to usable information is conventionally called data reduction (information procution might be a better term). This data reduction depends one the one hand on the objects under study, on the other hand on the conditions of the experiment. It is for this reason that there can be no such thing as "the" reduction software for the WSRT. People tend to observe different objects all of the time, and if they have some more knowledge of the WSRT itself, they tend to propose different (and always more complex) observing modes. This causes calibration strategies to develop, it gives different constraints on data quality and puts increasing demands on analysis tools like parameterised modelling. The current NFRA strategy is to handle these ever changing needs on the short term in Newstar as much as possible, and on the longer term accomodate them in the forthcoming AIPS++ package.

Now this was probably old news to most if not all of the readers. Since I do not want to loose all of my audience, I will now turn to some less general information. At our Newstar user-meeting in the fall of 1993, most people demanded new functionality. We seem to have had some success in handling these demands, because at the user-meeting at March 15th 1994 the big cry was for documentation, in particular simple recipes.

In this respect, I am proud to announce the new release of our (on-line) documentation. Do not jump to your terminal with too much enthusiasm, because many things still remain to be done. However, we now have an improved framework for the documents and the text on some programs (most notably NCLEAN and NMODEL) has been thoroughly revised already. I may also draw your attention to the sections on WSRT Polarisation Calibration, which have been greatly improved by our guest Bob Sault from the AT. Work on other sections
is on-going and should be released within the remainder of this year.

I feel deeply ashamed to say that the number of good and simple recipes has not yet increased significantly. We do have one for making a simple uncalibrated map (a job comparable to cooking an egg). Anything going somewhat beyond that quickly gets you in the regime of making a hoentjebvnausae, a job not easily described in a short number of steps. Within the next few months though, we will release the above mentioned egg-cooking thing, as well as an update of the excellent reduction guide written last year by Marc Verheijen (Kapteyn Lab, RuG). Of course we try to write down as much simple procedures as possible, but as said, this is not an easy job.

Over the last few months we have been working to implement a lot of wishes from people inside and outside the NFRA. Since most of them where rather specific, I will not bore you with the details. You can find a brief description in the News section of the on-line documentation. Newstar can now handle Total Power data (load your data with NSCAN option LOADIF to get them with your visitibilities). This offers new options for data quality analysis and calibration. Also, you might be interested in the "Job Summary Logs" that are stored with maps made by NMAP (a single log for an entire set of channel maps or mosaic positions, use NMAP option SHOW, map_option JOB to inspect them). You may also like to type a ** in response to a question for a SCN, WMP or MDL node, since this will give you a listing of available files. One of the things we are currently working on is Scissor, a Science Support Organiser, which will include the database of WSRT projects and observations (current ARCOQUERY). You will read more on that in the next issue of the ASTRON Newsletter.

We recently changed our network configuration for the Newstar User Feedback system and other information servers. You can now find us by using the following address in Mosaic or Lynx: http://www.nfraz.nl/newstar/homepage.html. General NFRA information can be found at http://www.nfraz.nl/home_nfraz.html. This change has caused some hickups in the old configuration (which will remain active until October 1st), for which we apologise. Users who access us through the hypen command will get to the new system automatically if they have the latest Newstar release.

I will conclude with some old news: should you have any wishes or complaints, please let us know. We commit ourselves to respond to requests from outside users within two working days (this will of course not always give the solution to your problem). You can contact us either through the Newstar User Feedback System (hypen or the above mentioned address), by eMail to newstar@nfraz.nl (or devosm@nfraz.nl), or by just calling upon me in Dwingeloo. If you want more information on Newstar, please don't hesitate to ask for our information package through any of the above channels.

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**Developments at the Isaac Newton Group of telescopes**

René Rutten

The telescopes on La Palma which are part of the UK/NL collaboration are now in an advanced state of development. The 1 meter Kapteyn telescope and the 2.5 meter Isaac Newton telescope have now been producing many high quality scientific papers for several years. These telescopes have settled onto a stable and reliable instrument package for spectroscopic and imaging observations. The 4.2 meter William Herschel telescope, on the other hand came later into operation and consequently has more advanced equipment and is still in a situation where its suite of instruments is expanding. Below I give a short overview of the improvements and extensions which are planned for the near future; I will concentrate on projects which have a direct impact on observational practice and possibilities. More details will follow in forthcoming issues of this newsletter.

**New instruments for the WHT**

The 4.2 meter telescope already has a range of spectroscopic and imaging common-user facilities for its Cassegrain and Nasmyth foci. The main instruments are: a low/intermediate dispersion spectrograph (with polarimetric and imaging capabilities), a high dispersion spectrograph, a multi-object spectrograph and a Fabry-Perot imaging interferometer. Recently the WHT prime focal station came into use for wide field imaging.

The prime focus imaging unit basically consists of a CCD detector unit, a filterwheel, a CCD autoguider unit, and optics to automatically correct for atmospheric dispersion. The dispersion correction optics ensure high quality images are obtained even when observing at high airmass.

Use of the WHT prime focus platform will be extended when the robotic multi-fibre positioning unit, AUTOFIB, will come on line. Commissioning of AUTOFIB is scheduled to take place in the fall of 1994. The fibre unit will be able to position up to 150 object fibres and 10 guide star fibres over a one degree field. At a later stage the fibres will feed a purpose built spectrograph, WYFFOS, to be situated in one of the Nasmyth foci. Commissioning of the spectrograph is expected to take place in 1995/6. The multiplexing advantage of this unit in combination with the large field of view at the prime focus makes it an ideal tool for survey spectroscopy of large numbers of objects.

Although the WHT is not designed as an infra-red telescope,
several IR projects have been carried out successfully at the telescope, covering imaging, spectroscopy and polarimetric measurements at IR wavelengths. The WHT and the observing site have demonstrated to be excellent for observations in the near-IR. However, these projects are carried out with instruments brought out by the visiting observers as no IR common-user facility exists yet. However, advanced plans exist to deliver a dedicated IR camera to the WHT in the near future.

**Detector development**

With the instruments mentioned above all being available in the near future the basic instrument configuration of the WHT will be completed. This, however, does not imply that developments will stop! For instance, the purchase, testing and installation of the best available CCD detectors is actively being pursued. Detector developments are mainly driven by specialists from the Royal Greenwich Observatory at Cambridge. These developments have now resulted in the availability of high quantum efficiency TEK 1024 x 1024 CCDs on all three telescopes which has boosted the efficiency of the telescopes by a large factor (up to 4 in the near UV!). The availability of detectors which combine even larger format with high quantum efficiency is being investigated. Also new modes of reading out our CCDs are being investigated. Particularly interesting are readout modes for very high time resolution (time series with sampling speed of 1 Hz or more) which open up the road to measuring rapid variations in astrophysical objects. Such a high speed readout mode may become a standard feature of our CCD detectors if the interest expressed by the user community is large enough to warrant development along these lines.

**Data collection system**

The advent of ever larger detectors has a drawback on the short term, as existing computer facilities at the INT and JKT are too slow to cope with the vast amount of data in an efficient way. Therefore, there are plans to route the data stream directly into a SPARCstation which will reduce the overhead for reading out the CCD and at the same time the data can be accessed much faster and more easily by the observer. For instance, the observer may use IRAF to analyse or even reduce the data while observing, without having to transfer the data between machines. This will result in a further increase of the efficiency of these telescopes and allow quick assessment of data quality. We hope to have a working system available on the INT soon, but limited resources makes it difficult to set a precise date now.

**New INT prime focus camera**

In collaboration with the University of California at Berkeley and the Kapteyn Observatory at Roden a new prime focus imaging unit is being designed and build. The core of this camera will consist of a composite of large format, thinned CCD devices to yield a very large field of view and high quantum efficiency. The camera will make the INT into a very powerful tool for wide field imaging. Commissioning is expected to take place in late 1995.

With currently available common-user instruments and the new instruments which will come on line in the near future the telescopes of the ING offer a wide range of state-of-the-art tools for astronomical observations to the Dutch community. However, if you feel that particular instrumentation could allow you to do your research better but is not part of our current instrumentation plan, I would like to receive your comments on that.

More about developments at the ING in coming Newsletters!
Applications for new project subsidies

The Dutch astronomical community is invited by both the NFRA and NOVA to apply to a new round of subsidies for oio or postdoc positions. Forms for application are available upon request at NFRA. Deadline is 15 September 1994. The Boards of NFRA and NOVA will take their decision before 15 January 1995.

Staff changes

As of 1 June 1994 William Deich (formerly of Caltech) has taken a post-doc position in Dwingeloo. He will be the project manager of pulsar observing activities with the Westerbork Telescope.

On 1 September Arnold van Ardenne will (re)join the NFRA. He comes from Ericsson Radio Systems and will be the new head of the R&D lab in Dwingeloo.

Proposal deadlines

Proposal deadline for the WSRT, the ING and the JCMT is 15 September 1994.

MFFE Design Review

Dwingeloo, 15 September 1994, 11:00

All interested are invited to participate in the design review meeting of the prototype Multi Frequency Front End.

The objective of this review is to discuss the MFFE design and its specifications with the Dutch astronomical community. This discussion should result in a recommendation for the specifications of the MFFE series project.

Transportation from Hoogeveen station to the Dwingeloo observatory is available upon request.