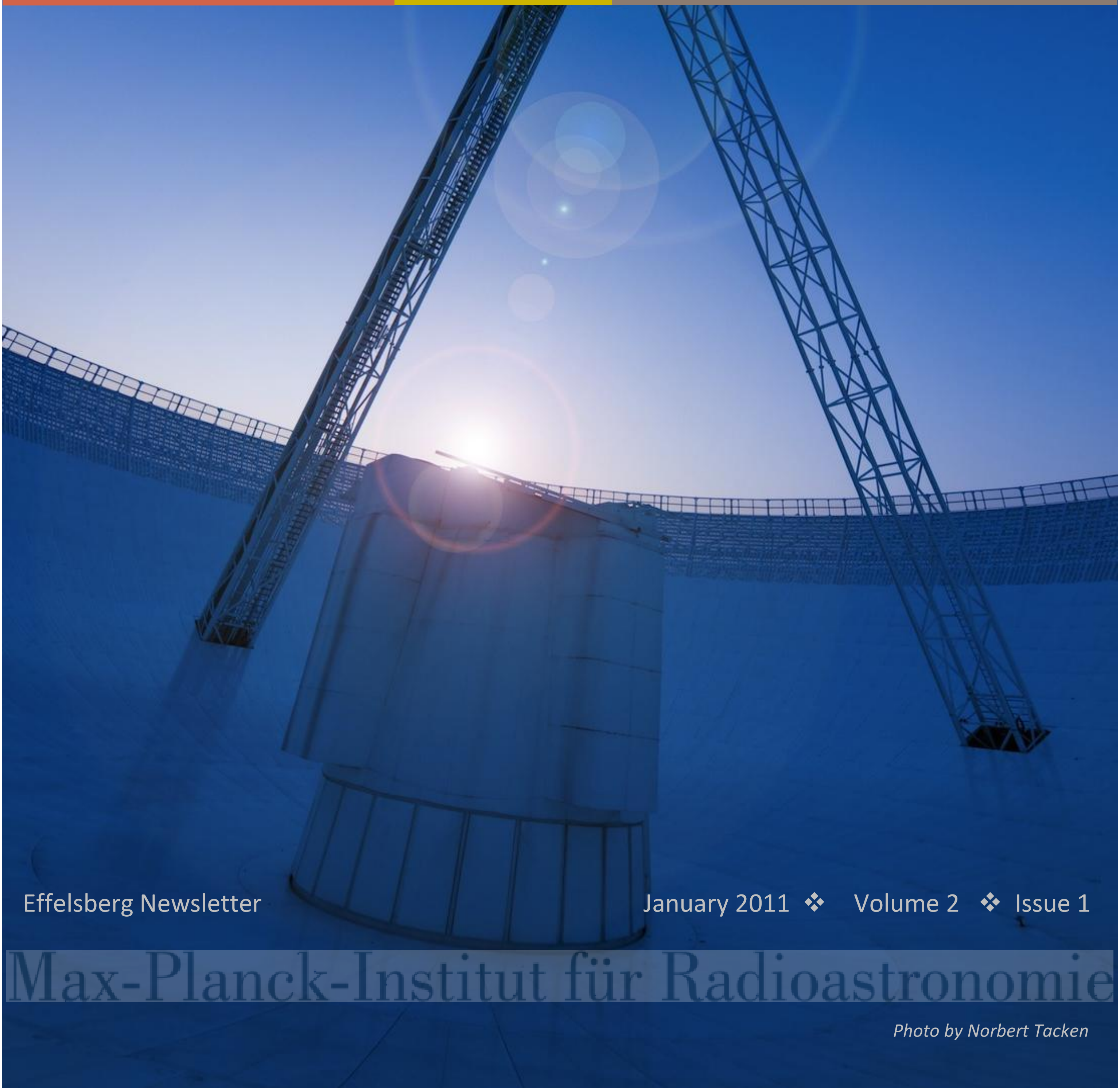
Effelsberg

NEWSLETTER January 2011



Effelsberg Newsletter January 2011 ❖ Volume 2 ❖ Issue 1

Max-Planck-Institut für Radioastronomie

Photo by Norbert Tacken

1971-2011

40 Years of the 100-m Effelsberg Radio Telescope

Greetings from the Director

While the year is still young, I'd like to wish everyone a very happy new year 2011! … >>

This year marks a very special anniversary in the history of the 100-m Effelsberg radio telescope: It was 40 years ago, that first light was received at a wavelength of 11-cm on 23^th April 1971. It was only a couple of weeks later, that the telescope was officially opened in the presence of "presidents and kings" on 12^th May 1971. Normal operations commenced about a year later, in 1972, with the first publication already published in December 1972. Today the performance of the telescope is better than ever, not only but certainly to a large extent, due to the marvelous engineering that made the telescope in many ways exceeding the initial design specifications. In this and the following newsletters we will tell you the story of the telescope, how it was conceived, which innovation were used to realize it and how it was achieved.

In order to mark this 40^th anniversary, we will celebrate this occasion with a large number of events, spread over a period from May this year to autumn next year, marking the exciting period from May '71 to December '72. Activities range from an official opening of the anniversary activities on May, 19^th to a number of exciting events that will in particular involve the general public. These events include a photo contest (see the Newsletter September 2010 Issue), open day activities in September, public science entertainment with Prof. Harald Lesch (an MPIfR alumni and now a well known TV science presenter!) a concert and many more! Stay tuned for a full listing of the events in a later issue and be invited to join the activities!

But 2011 is not only a year to look back but also to look ahead into the future of the 100-m telescope and the observatory as a whole. We will continue to present you with updates on exciting science done at the telescope, introduce you to experienced and also new staff, and keep you informed about the technological developments happening at the telescope. In particular, a number of receiver and backend projects are planned for this year, which we will report on as they come online. As we are continuing to improve the user interaction and user support, in this issue we will introduce a new user support scientist for spectroscopy, and continue to encourage every observer to provide us with feedback and comments about the observing experience. But also items and issues that you want to see being discussed in these newsletters should be forwarded to our editor for future issues.

>> What's left for me to say is a big "thank you" to all the staff working at and on the telescope, the receivers, the backends, the software and the related logistics during the past year. I am looking forward to a new year of stimulating activities and lots of interesting science results.

Michael Kramer

Photo by Norbert Tacken

Photo by Ramiro Franco Hernandez

Call for proposals – Deadline February 9, 2011, UT 13.00

Observing proposals are invited for the Effelsberg 100-meter Radio Telescope of the Max Planck Institute for Radio Astronomy (MPIfR).

The Effelsberg telescope is one of the World's largest fully steerable instruments. This extreme-precision antenna is used exclusively for research in radio astronomy, both as a stand-alone instrument as well as for Very Long Baseline Interferometry (VLBI) experiments. Access to the telescope is open to all qualified astronomers. Use of the instrument by scientists from outside the MPIfR is strongly encouraged. The institute can provide support and advice on project preparation, observation, and data analysis.

The directors of the institute make observing time available to applicants based on the recommendations of the Program Committee for Effelsberg (PKE), which judges the scientific merit (and technical feasibility) of the observing requests. Information about the telescope, its receivers and backends and the Program Committee can be found at

http://www.mpifr-bonn.mpg.de/english/radiotelescope/index.html

Observing modes >> Possible observing modes include spectral line, continuum, pulsar, and VLBI. Available backends are a FFT spectrometer (with 16384 channels), a digital continuum backend, a pulsar system (coherent and incoherent dedispersion), and two VLBI terminals (MK4 and VLBA type). Receiving systems cover the frequency range from 0.6 to 96 GHz. The actual availability of the receivers depends on technical circumstances and proposal pressure. For a description of the receivers see the web pages.

How to submit >> Applicants should use the new NorthStar proposal tool for preparation and submission of their observing requests. North Star is reachable at

https://proposal.mpifr-bonn.mpg.de

For VLBI proposals special rules apply. For proposals which request Effelsberg as part of the European VLBI Network (EVN) see:

http://www.evlbi.org/proposals/prop.html

Information on proposals for the Global mm-VLBI network can be found at

http://www.mpifr-bonn.mpg.de/div/vlbi/globalmm/index.html

Other proposals which ask for Effelsberg plus (an)other antenna(s) should be submitted twice, one to the MPIfR and a second to the institute(s) operating the other telescope(s) (eg. to NRAO for the VLBA).

by Alex Kraus

RadioNet Transnational Access Programme

RadioNet (see http://www.radionet-eu.org) includes a coherent set of Transnational Access programme aimed at significantly improving the access of European astronomers to the major radio astronomical infrastructures that exist in, or are owned and run by, European organizations. Observing time at Effelsberg is available to astronomers from EU Member States (except Germany) and Associated States that meet certain criteria of eligibility. For more information:

http://www.radionet-eu.org/transnational-access

Time on these facilities is awarded following standard selection procedures for each TNA site, mainly based on scientific merits and feasibility. New users, young researchers and users from countries with no similar research infrastructure, are specially encouraged to apply. User groups who are awarded observing time under this contract, following the selection procedures and meeting the criteria of eligibility, will gain free access to the awarded facility, including infrastructure and logistical support, scientific and technical support usually provided to internal users and travel and subsistence grants for one of the members of the research team.

by Alex Kraus

Key Science Projects for the 100-m Telescope

The MPIfR invites scientist to submit Key Science Proposals (KSPs) for the 100-m telescope at Effelsberg. This kind of proposals should obey the following rules:

1. The proposed project should address high-quality and high-impact science that requires significant observing efforts.
2. The observations should utilize the core strength of the 100-m telescope.
3. KSPs should be large projects that cannot be realized (or only with difficulties) with standard observing proposals, i.e. projects requiring between 150 and 500 hours of observing time per year. (The exact amount of time available for KSPs may be limited depending on proposal pressure and requested observing frequency).
4. The project should also have a strong potential for outreach.

Key Science Projects can only be submitted to the February proposal deadline for the 100-m telescope.

They should be submitted using the North Star Tool as normal proposals accompanied by a more extensive justification (up to 10 pages) explaining the

- Scientific background
- Observing procedure
- Data analysis plan and data release policy
- Publication strategy

The proposals will be judged by the Effelsberg PC (PKE) and by the directors of the MPIfR who might consult external referees. The MPIfR expects progress reports periodically and a quick publication of the data (preferably online). In case absentee-observations are desired, clear instructions for the execution of the project (observing strategy, acceptable weather conditions, etc.) have to be given.

by Alex Kraus

Photo by David Champion

Technical News

By Alex Kraus & Reinhard Keller

The implementation of the new control system for the 100-m telescope (see issue 3/2010 of the Effelsberg newsletter) is mostly finished. Currently, the observatory's staff is working on some minor improvements and the incorporation of user comments. Furthermore, the implementation of new hardware (see below) is under preparation.

In summer 2010, the new Multibeam-Filter Backend (MultiFiBa, see picture on the right and schematic diagram below) has been installed at the 100-m telescope. This filterbank is the flexible cross switch between the various IFs used at Effelsberg and the several backends already in use and planned. When choosing a receiver-backend combination, the control system automatically sets the correct switches and filters in the MultiFiBa – no action by the observer is necessary. To adjust the power levels correctly for the various backends remote controlled leveling units are implemented for the narrow band IF channels (10 MHz – 300 MHz). The MultiFiBa has 16x3 input channels (16 channels for 3 IFs) and is connected to the AFFTS, Pulsar backends and to a special continuum backend. In the next weeks a new suite of VLBI backends will be installed at Effelsberg and connected to the MultiFiBa.

Still in time for this winter season, we expect the new broadband FFT spectrometer (XFFTS), with 2 GHz bandwidth and 32768 channels to become operational. It will be used mainly with the 1.3cm prime focus receiver, but will probably be available for other receivers as well. The XFFTS hardware is able to process a maximum bandwidth of 2.5 GHz but up to now no receiver is able to provide this bandwidth.

Additionally, a new long wavelength receiver covering the 300-900 MHz band will be completed in summer this year. It will be located in the prime focus of the telescope and will replace the old 73cm- and 49cm-systems. More details on the XFFTS and the 50cm receiver will be presented in future issues of this newsletter after the commissioning of the systems.

All information about the telescope, its receivers, backends, control system etc. can be found on the Effelsberg web pages at

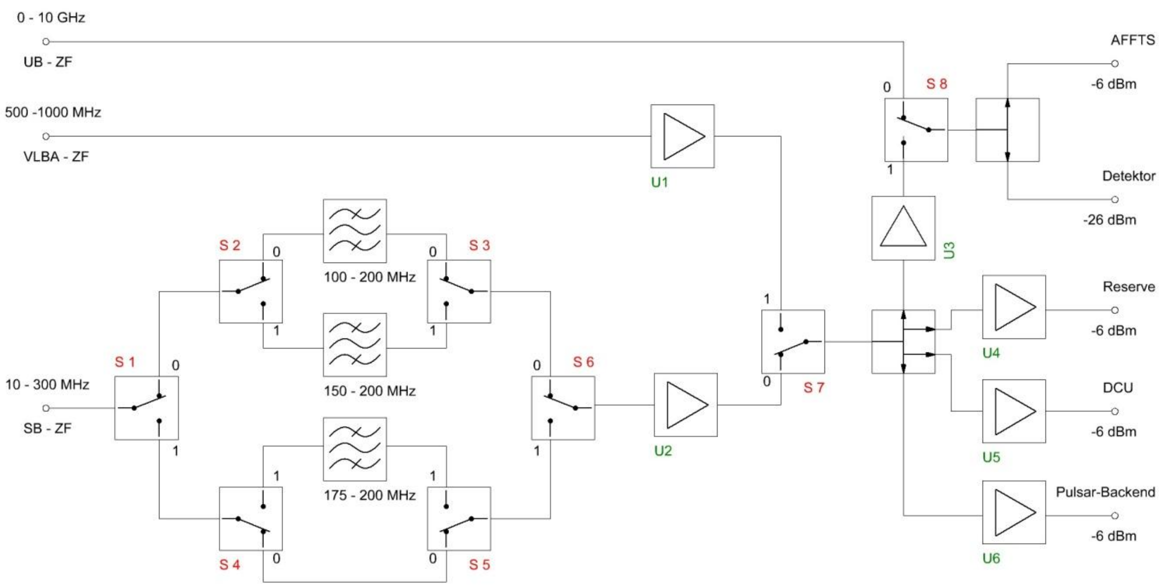
http://www.mpifr.de/english/radiotelescope/informationAstronomers/index.html

Among this information, one can also visit the newly designed Wiki pages, which will contain (among other things) the documentation of the new control system and the user guide – these pages are supposed to be develop fast in the near future. The wiki will also provide detailed documentation of the receiving systems and backends provided by the Electronic Department. See:

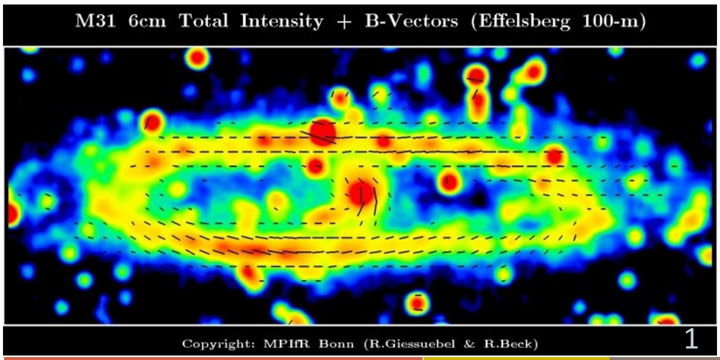
https://eff100mwiki.mpifr-bonn.mpg.de/doku.php

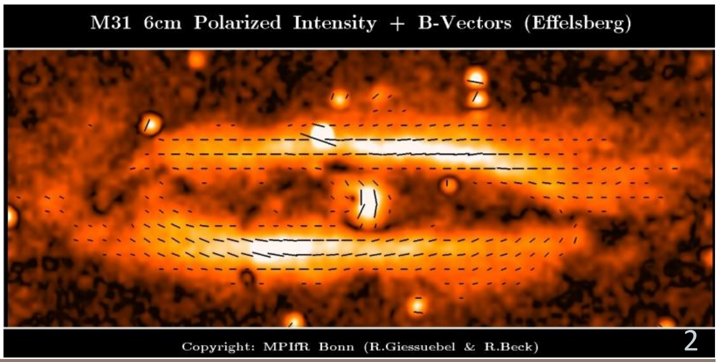
If you encounter problems during your observing run or you want to suggest improvements to us, please send an email to the Effelsberg "ticketing system":

eff-support@mpifr-bonn.mpg.de



SCIENCE HIGHLIGHTS





Deep Effelsberg survey of magnetic fields in the Andromeda galaxy

By René Gießübel & Rainer Beck

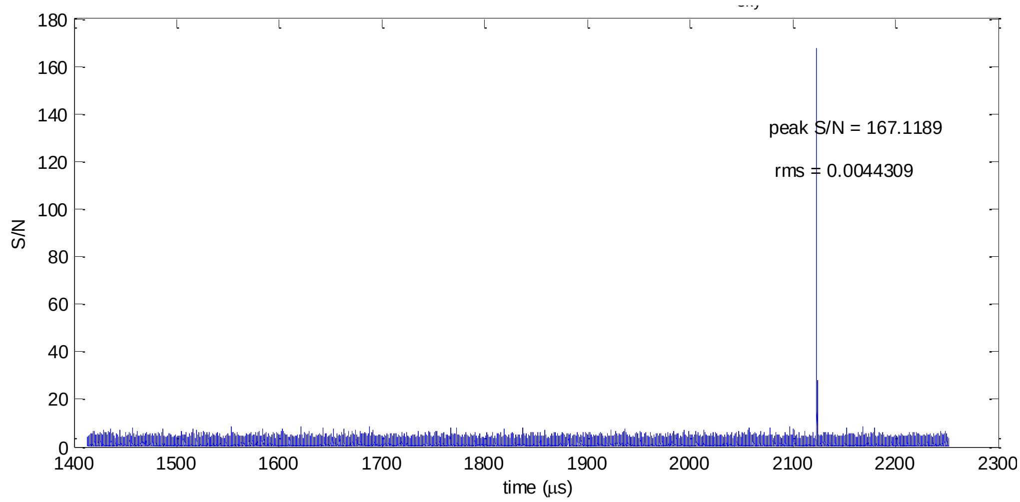
The Andromeda galaxy (M31) is the nearest spiral galaxy, only 780 kpc (2.5 million light years) away. This allows us to thoroughly study the structure of its magnetic field using single-dish observations.

Our previous analysis of total and polarized radio emission showed that the turbulent and large-scale magnetic field is concentrated in a ring-like structure. The "ring" is a superposition of several spiral arms with small pitch angles. Most of the radio emission is synchrotron emission by cosmic-ray electrons spiraling in the interstellar magnetic fields. Cosmic rays originate from the remnants of supernova explosions. Faraday rotation measures (RM) show that the regular field of M31 is coherent, i.e. it preserves its direction around 360° in azimuth and across a wide region in radius. Thus the structure of the large-scale magnetic field of M31 is unusually simple – such an almost purely axisymmetric field was not yet found in any other spiral galaxy. This is not an effect of angular resolution because the Effelsberg beam at 6 cm wavelength corresponds to 0.5 kpc in M31, which is a spatial resolution similar to that obtained with the VLA D-array in the spiral galaxies M51 and NGC 6946.

Thus we profit from a cosmic conspiracy: The nearest spiral galaxy has the simplest field structure known so far. Galactic dynamo theory can explain such a coherent field structure from a weak seed field with help of differential rotation and turbulence. Supernova explosions or magnetic instabilities are discussed as the source of turbulence.

The figures show a 140’ x 60’ cutout of the new, deep survey of M31 at 6cm wavelength, searching for total and polarized emission up to ± 40’ from the major axis. The rms noise of the polarization map (Figure 2) is 55 µJy/beam, making it one of the deepest polarization maps ever obtained with the Effelsberg 100-m dish. The vectors in both figures show the orientation of the magnetic field lines, highlighting the exceptional ring-like magnetic field structure at a radius of about 30.000 light years from the galaxy’s center. The weak, diffuse polarized features far away from the ring indicate that the magnetic fields extend much further out, but are difficult to observe because they are hardly illuminated by cosmic-ray electrons.

It is possible that the whole intergalactic space is magnetized. Several projects with the low-frequency radio telescope LOFAR, the planned Square Kilometre Array (SKA) and its precursors are dedicated to the detection of intergalactic magnetic fields.



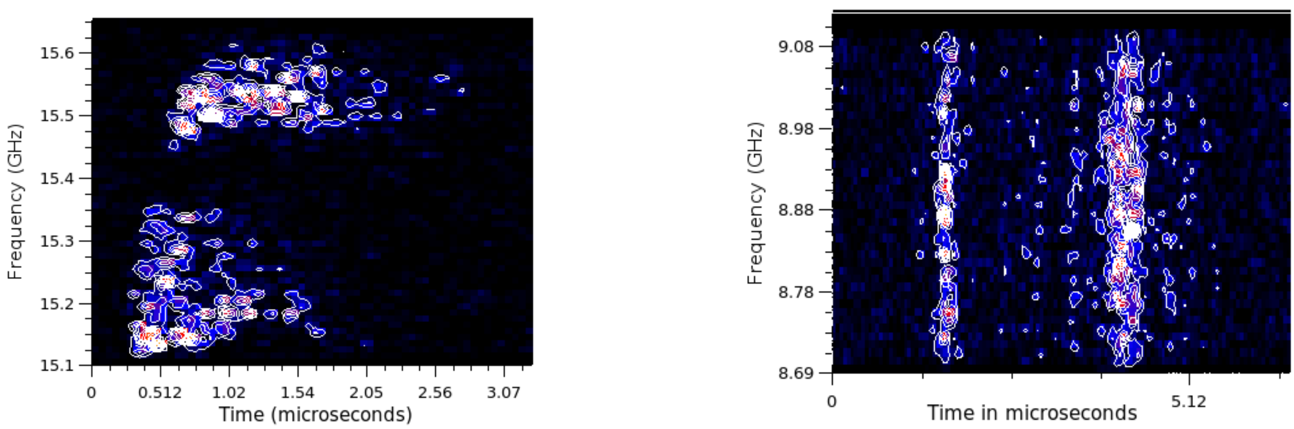
A strong (60 kJy) Giant Pulse at 15 GHz after coherent de-dispersion.

CRAB Giant Radio Pulse (GRP) detections ...

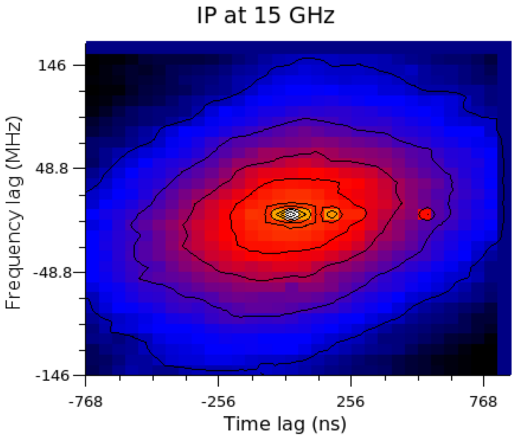
by Axel Jessner

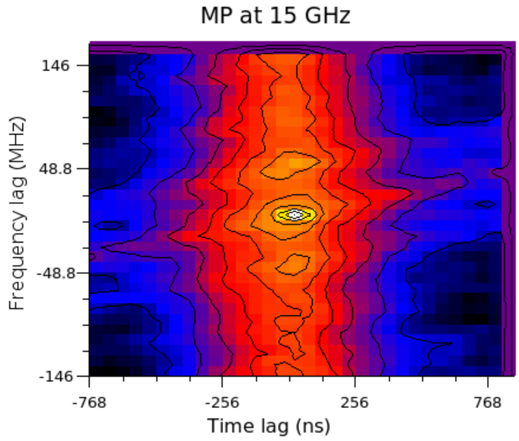
have been accomplished at 8.5 and even at 15 GHz in Effelsberg using a Tektronix DPO 7254A digital storage oscilloscope. The principles of the technique have been described in Hankins et al. (2003). The 500MHz wide VLBI–IF signals corresponding to right-hand circular (RHC) and left-hand circular (LHC) polarizations were directly connected to the inputs (channel 1 and channel 2) of the oscilloscope. The 12.5 Msamples (8-bit) were recorded for each channel at a rate of 2.5 Gsamples/s giving a time window of 5 ms around the trigger epoch. A trigger signal was derived from the RHC IF signal by detection in a square-law detector. The detector output was low-pass filtered using a commercial HP5489A filter unit which had a cut-off at 10 kHz. That signal was supplied to channel 3 of the DPO 7254A which was set to trigger on the falling flank at a level exceeding by 5–6 times the typical fluctuation in the signal. The trigger sensitivity was about 1 kJy (asuming a GRP lasting for at least 3 µs). We measured typically 150 events during a session lasting for six hours and a third of the received triggers turned out to be GRPs.

The signals were later coherently de-dispersed so that our time resolution of 2 ns was only limited by the available bandwidth. The observations showed that the GRPs received during the phase of the main pulse (MPGRP) differ strikingly from those arriving at the phase of the interpulse (IPGRP): IPGPs are always smooth in shape and typically asymmetric, with a rather sharp leading edge with a rise time of 0.6-0.2 µs and gradual decay of about 2.5 s at the trailing edge. MPGPs however demonstrate a large variety of shapes containing one or several microbursts of emission with a duration of less than a microsecond. The bursts can occur intermittently at random time intervals of several microseconds duration. The total time envelope of a given GP can extend over hundreds of microseconds. Microbursts



Typical examples of dynamic spectra for IPGPs (left) and MPGPs (right).





Average 2-D cross-correlation functions between dynamic spectra for RHC and LHC polarization channels at the frequency of 15.1 GHz for IPGPs (left) and MPGPs (right).

can often contain isolated or overlapping unresolved nanoshots of great intensity. MPGPs are composed of distinct unresolved small spikes but IPGPs are filled with pure noise well described by the AMN model (Rickett 1975).

IPGPs exhibit a high degree of linear polarization with essentially a constant position angle (PA), restricted in the range of ±5°, similar at both 8.5 and 15.1 GHz. In contrast to that the MPGPs show a significant diversity of polarization parameters, with linearly and circularly polarized spikes being present in roughly equal proportions. The distribution of linearly polarized spikes (nanoshots) over PA looks uniform in the whole range of 0–180°. In the case of well separated microbursts, the PA demonstrates a rapid but smooth regular variation inside a microburst, very similar to that observed for integrated profiles of many pulsars.

Radio spectra of IPGPs consist of emission bands at 8.5 and 15.1 GHz as was first reported by Hankins & Eilek (2007). The half-width of the emission bands was found to be equal to 40 and 60 MHz for 8.5 and 15.1 GHz, respectively. Dynamic spectra of MPGPs are broad-band, filling the entire observing bandwidth of 0.5 GHz. MPGPs show additional regular spiky frequency patterns with a separation of about 40 MHz in their dynamic spectra and several similar successive microbursts with the same spectrum. These also show up in the cross-correlation between LHC and RHC polarization signals.

The cross-correlations between LHC and RHC polarization signals are also very different for different rotation phases and may provide an insight into the small-scale emission and propagation mechanisms in the pulsar magnetosphere. For the interpulse we find a central broad 40 MHz wide Gaussian and several 'echos' with a 200 and up to 600 ns separation in time or 60-180 m path difference. The main pulse however shows repetitive and drifting frequency patterns with a 40 MHz spacing and no 'echos'. These can be interpreted as a diffraction pattern resulting from closely spaced (d≈7-8m) coherent emission zones.

Such sharp contrasts between MPGPs and IPGPs are not observed at lower frequencies. On the other hand it seems unlikely that the emission mechanism of GPs is very different at high and low frequencies, hence the reason for the widely different GP characteristics at different pulse phases remains unknown. But high time resolution giant pulse observations may serve as a microscope for the still enigmatic pulsar emission mechanism.

Literature:

Jessner, A., Popov M.V., Kondratiev, V.I., Kovalev, Y.Y., Graham, D., Zensus, A., Soglasnov, V.A. , Bilous, A.V. & Moshkina, O.A., 2010, A&A 524, A60

Hankins, T. H., Kern, J. S., Weatherall, J. C., & Eilek, J. A. 2003, Nature, 422, 141

Hankins, T. H. & Eilek, J. A. 2007, ApJ, 670, 693

Rickett, B. J., 1975, ApJ, 197, 185

Effelsberg Teams Up with Fermi to Map Pulsar Geometry Across the Spectrum

by Aris Noutsos

The recently installed FPGA-based Pulsar Digital Filterbank (PDFB) has enabled astronomers at the Max-Planck Institute to perform precise polarimetric observations of pulsars. The PDFB is capable of recording full-polarisation, with an instantaneous bandwidth of up to 1 GHz, split into 4,096 frequency channels and 2,048 time bins across the pulsar profile. Recently, this system was used together with the 7-beam, 21-cm receiver at Effelsberg to map the emission geometry of one of the oldest and fastest, non-recycled, γ-ray pulsars detected last year with Fermi: PSR J2043+2740. All results from this study will appear in February issue of the "Astrophysical Journal" [1].

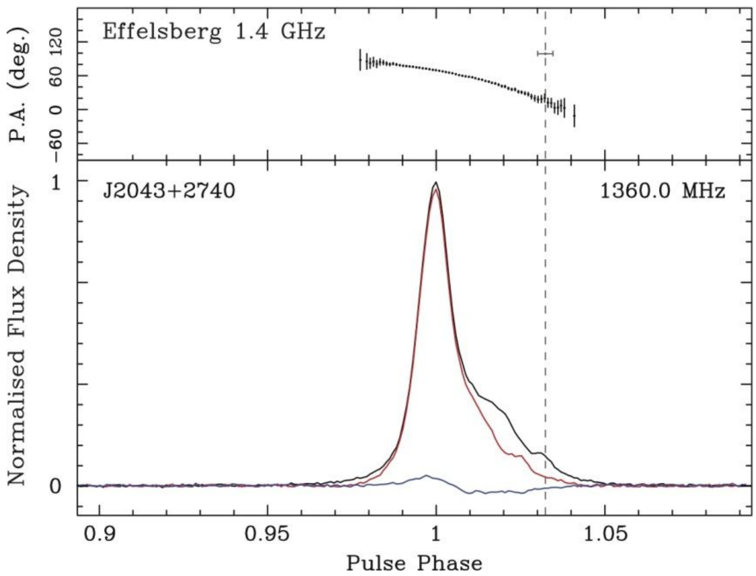


Figure 1. Polarisation profile of PSR J2043+2740, obtained with the 7-beam receiver at Effelsberg and the PDFB. Bottom: total-flux (black line), linear- (red line) and circular-polarisation (blue line) pulse profiles. Top: orientation of the linear-polarisation plane across the radio pulse (P.A.). The phase at the closest approach to the magnetic pole is shown with a dashed line.

The neutron star that is PSR J2043+2740 completes roughly 10 rotations every second and is about 1.2 million years old; yet, it is as energetic as pulsars that are 10-times younger: its total energy output exceeds a billion billion gigawatt (≈ 10^{34} erg/s)! The radio emission from PSR J2043+2740 is almost 100% linearly polarised, with a small fraction being circularly polarised (see figure 1). By modelling the changes in the orientation of the plane of linear polarisation, as the pulsar's radio beam sweeps past the observer's field of view, it was possible to determine the orientation of the magnetic and spin axes on the sky. Furthermore, it was possible to derive confidence limits for the angular separation of the above axes in 3D-space, and their relation to our line of sight.

Due to polarisation ambiguities, the above measurements alone typically result in a broad determination of the pulsar's emission geometry. The Fermi detection of PSR J2043+2740 presented an exciting new prospect of combining the geometrical constraints from modelling the shape of the pulsar's γ-ray lightcurve with the radio constraints. The overlapping regions of valid geometries provided a set of values for the relative angles, which were determined to within roughly 10° (see figure 2).

The success of combining radio and γ-ray data in determining pulsar geometry has encouraged further investigation of more γ-ray pulsars with Effelsberg. Later this year, a planned polarisation survey of Fermi pulsars is expected to produce new and potentially exciting evidence regarding the reasons behind the lack of observed γ-ray emission from a number of energetic pulsars ($\dot{E} > 10^{34}$ erg/s): those reasons may well be geometric.

[1] Noutsos, A., et al. 2011, ApJ, 727(2):

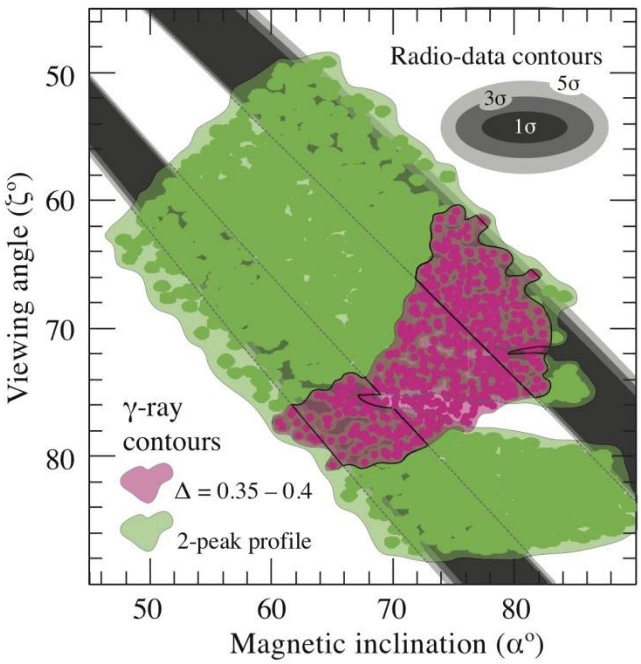


Figure 2. Confidence contours, from radio and γ-ray data, of the magnetic inclination angle, α (between the magnetic and spin axes), and the viewing angle, ζ (between the observer's line of sight and the magnetic axis), corresponding to the possible geometries of PSR J2043+2740.

Who is Who in Effelsberg ?

Jörg Barthel >> Head Operator

Jörg Barthel is the head of the operators group. Apart from participating in the shift work his responsibilities include the organisation of the telescope operations and the supervision of the station's clock.

Jörg is married and has a 22-year-old son. After school, he went to sea and became a sailor on a merchantman. After several sea trips, he joined the navy where he fulfilled the duty of a radio operator. After his army time, he began to study electronics (with emphasis on its usage on ships) and telecommunication engineering.

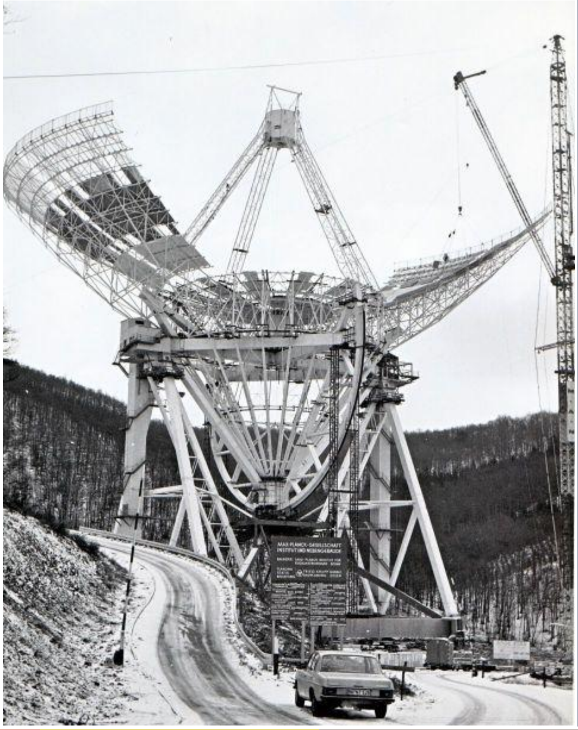
He started to work as telescope operator at Effelsberg in August 1990. In May 2000 he succeeded H.M. Koch as head of the team of operators.

Benjamin Winkel >> New Support Scientist for Spectroscopy

As of January 2011, Benjamin Winkel, joined the science team at the 100-m telescope. He will be mainly responsible for spectroscopic observations and is going to study standing waves and radio frequency interference. During his Diploma thesis and Ph.D. he acquired decent expertise in these fields, being crucial aspects of his work: the design and implementation of the data reduction pipeline for the new Effelsberg-Bonn HI Survey (EBHIS; see previous issue, September 2010). EBHIS is a new project initiated to map the neutral hydrogen in the Local Volume (out to a redshift of z~0.07) including the Milky Way emission.

After studying physics and astronomy in Bonn (1998-2005), Benjamin was accepted by the International Max-Planck Research School (IMPRS) for Astronomy and Astrophysics and finished his Ph.D. in February 2009. The main topics of the Ph.D. thesis were the scientific and technical preparations and the assessment of the data reduction software using simulations and precursor observations, necessary to assure the success of the EBHIS.

In the meantime the first coverage of the Northern sky is 50% complete providing already a huge amount of high-quality data awaiting analysis. The EBHIS team works on several projects studying the Milky Way halo and galaxies in the Local Universe using the new data. Benjamin is also involved in a couple of international collaborations aiming to use the SKA pathfinders (ASKAP, WSRT/APERTIF) for galactic and extragalactic science. As these projects are currently in the design



The Construction of the Effelsberg 100-m Radio Telescope Part I <<

by Richard Wielebinski & Bernd Grahl

German radio astronomy started late compared to other European countries due to restrictions on radio research after World War II ... >>

First smaller radio astronomy observatories started observations in Kiel and Tübingen. In the 1950s, after the restrictions were lifted in the Western zones, a strong initiative from the local government in Land Nordrhein-Westfalen led to the funding of a 25-m fully steerable dish on the Stockert mountain for the Bonn University. A 36-m transit dish for the Heinrich-Hertz-Institut in Berlin-Adlershof (Russian zone) was also funded. In 1962 an important report 'Denkschrift zur Lage der Astronomie' was published by the Deutsche Forschungsgemeinschaft suggesting the developments for the next decades in astronomy. One of these planned developments was to build a major instrument for radio astronomy in Germany. The construction of the Berlin Wall in 1961 was the reason why Prof. Dr. Otto Hachenberg, the Director in Berlin-Adlershof, moved to the University in Bonn thus giving the astronomy department new impetus.

Building on the experience of the 36-m transit dish in Berlin-Adlershof Prof. Hachenberg begun with plans for an 80-m radio telescope. Ing. Bernard G. Hooghoudt was involved as consultant in this early stage of planning. German steel firms were contacted and asked to submit designs for such an instrument. The Stockert 25-m dish was an enlargement of the 7.5-m Würzburg Riese radar dish design. It could just operate at 11-cm wavelength. One of the important design specifications for the new large telescope was that it should operate at higher radio frequencies, possibly even at 1-cm wavelength. This specification was a result of the rapidly expanding field of radio spectroscopy. The symmetrical structure of the 36-m dish in Berlin-Adlershof was a firm guide for Prof. Hachenberg in his design considerations. The supporting structure of this 36-m telescope was placed on concrete supports and load tests were made at the Gresse Kranbau Company in Dessau before mounting. It became clear that a symmetrical structure could have predictable deflections under gravity. At first the firms Krupp and MAN made each two different designs but soon one proposal was preferred. The antenna division in the Krupp Company led by Dipl-Ing. E. Geldmacher submitted a design of Dipl-Ing. Helmut Altmann that met (exceeded) the desired specifications. In the design phase the decision was made to go away from a very stiff steel construction to a flexible one but with the parabolic shape remaining through elevation movement due to elasticity.

Depending on the funding, an extension of the diameter of the dish to 90-m became a realistic consideration. Initial funding in the design phase of the Hachenberg telescope came from the local government of the Land Nordrhein-Westfalen in Düsseldorf. In particular strong support came from Dr. Leo Brandt, a state secretary in the Düsseldorf government. The Bonn University astronomers: Profs. F. Becker, W. Priester and O. Hachenberg could as a result of this design support make a robust application in 1964 to the Volkswagenstiftung for funds to build the large radio telescope.

At the same time Dr. Sebastian von Hoerner (working at Green Bank, USA) developed a theoretical approach to the realization of the flexible structure with high surface accuracy under elevation movement now known under the term of 'Homology'. Dr. Sebastian von Hoerner applied also to the Volkswagenstiftung to build a 160-m low frequency radio telescope using his theoretical approach. He was also appointed to a professorship at the Tübingen University and asked to be a founding director of a Max-Planck-Institut für Radioastronomie (MPIfR). At first both projects were to be founded by the Volkswagenstiftung but the provision of operating funds was left open. To ensure sufficient operating funds subsequent negotiations led to the founding of the MPIfR in Bonn instead of Tübingen. This led to the withdrawal of the 160-m project by von Hoerner. As a result of this development bigger funds were offered to the Bonn project and since the design computations suggested a very exact surface accuracy it was decided to construct a 100-m diameter dish.

It must be said at this point of time (1965) the details of the dish design were a complete departure from classical dish design, from stiff steel structures such as the Jodrell Bank Mark I or the Parkes radio telescopes. The 100-m dish was to have a surface with better than 1-mm r.m.s. accuracy. The small division led by Dipl-Ing. E. Geldmacher in the Krupp company studied symmetrical structures with radial symmetry suspended at two points of the elevation structure. In addition a separation of the tipping structure (including the prime focus cabin) from the reflecting dish was incorporated in the design. This allowed an easier computation of deformations that were caused by the gravity by the changing elevation of the reflector. In this process the ‘soft spots’ of the complex grid of tubes could be found and the dimensions of the tubes changed to optimize the overall surface deformation. In end effect this trail and error procedure came close to the more theoretical ‘homology’ design.

In 1965 Dipl-Ing. H. Altmann submitted a patent application for his construction. The final step in the design was the use of the new IBM software (FRAN) to check the final deflection performance of the 100-m dish. These calculations could be made only for sections of the reflector due to limited computer power at that time. Later re-calculation with full computer power confirmed these results.

The search for a suitable site started in 1966 already. It was clear that the site should not be on a mountain like the Stockert, exposed to man made interference, but in a secluded valley. Several sites were investigated but the final choice fell on a near north-south valley near Bad Münstereifel - Effelsberg. This site had the additional advantage that it was just on the right side of the border of Land Nordrhein-Westfalen. As a result of this choice the local government in Düsseldorf offered the site to the MPIfR. Considerable time was needed to sort out the land ownership titles and to purchase the site. The construction of such a complex structure required many different subcontractors. An association of companies, the ARGE STAR, was formed involving as major partners Krupp (steel elements) and MAN (on site assembly). The first step involved the construction of the foundations. A small creek (Rothbach) that was the boundary between the Land Nordrhein-Westfalen and Land Rheinland-Pfalz had to be moved. The whole site for the radio telescope was 15.4 hectare in extent, lying in both local Länder, but with the telescope itself in Land Nordrhein-Westfalen.

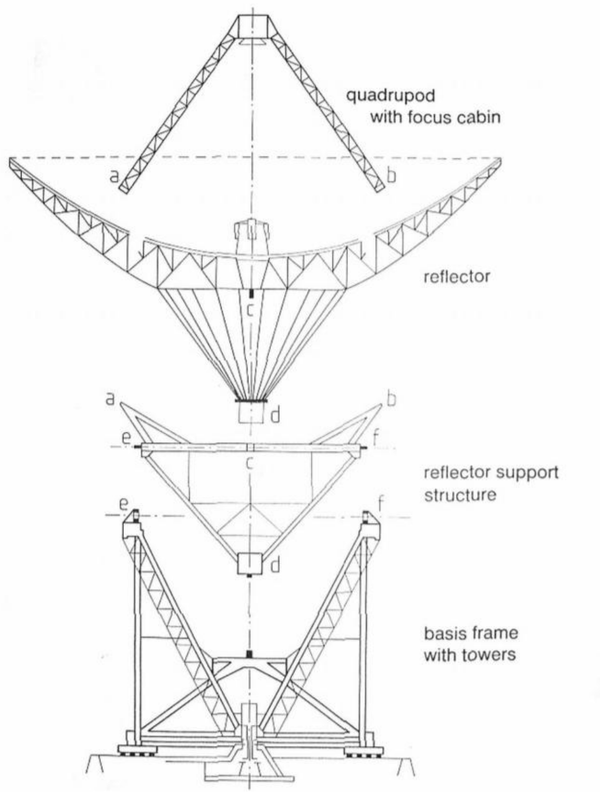


Figure 1. The basic construction design of the 100-m dish.

The design of the 100-m telescope included several novel features. The tipping structure was an octahedron that was held at two points. In these points the elevation bearings were included in the A-frame support structure. It must be pointed out that in this design the quadrupod leg structure supporting the prime focus cabin and the tipping section (holding the ballast load), in end-effect an octahedron, were independent of the reflector. The elevation drive was by means of a large tooth rack shaped to a wheel and floating wheel gear drive in one of the octahedron arms. Originally four elevation drive units were planned but oscillations forced a reduction to two drive units. The azimuth drive was by means of 16 motors with 32 wheels bringing ~100 tons load through each wheel on the rail track. The reflector, an umbrella-like structure, was held in the ballast point and contacted the tipping structure in a flexible joint in the apex point only, an idea of Dipl-Ing. H. Altmann.

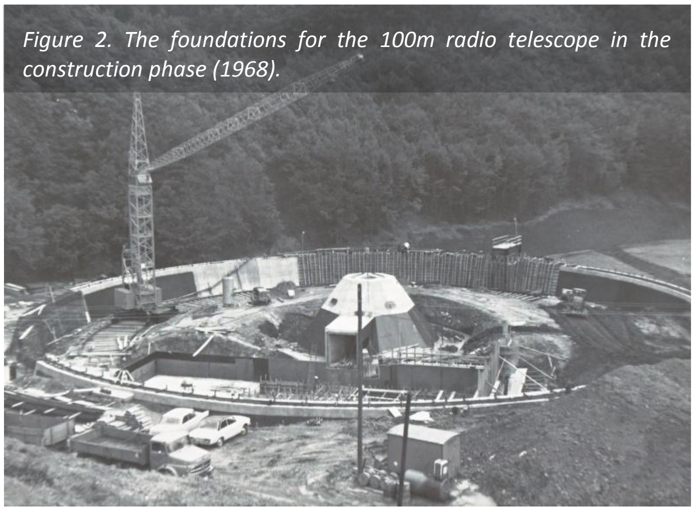


Figure 2. The foundations for the 100m radio telescope in the construction phase (1968).

The foundations for the telescope were a concrete ring supported on concrete piles. The ring was to take the 64-m azimuth drive track. In addition in the centre of the ring foundation a pyramid-like 'Königszapfen' was constructed. This central section was to position the telescope on the 64-m track in the azimuthal direction. In addition underground rooms for the electrical supply and workshops were constructed in the Königszapfen. In the centre of the Königszapfen the azimuth encoders were to be placed and the cable twist was to be installed to allow for the azimuth movement. A tunnel was also constructed from the Königszapfen to the control building where all the cables could be placed. These cables were placed in soft iron ducts with the intent to reduce all local interference. The elevation cable twists were constructed in the elevation bearings area.

Figure 3. The A-frame support structure and the tipping section being assembled (1969)

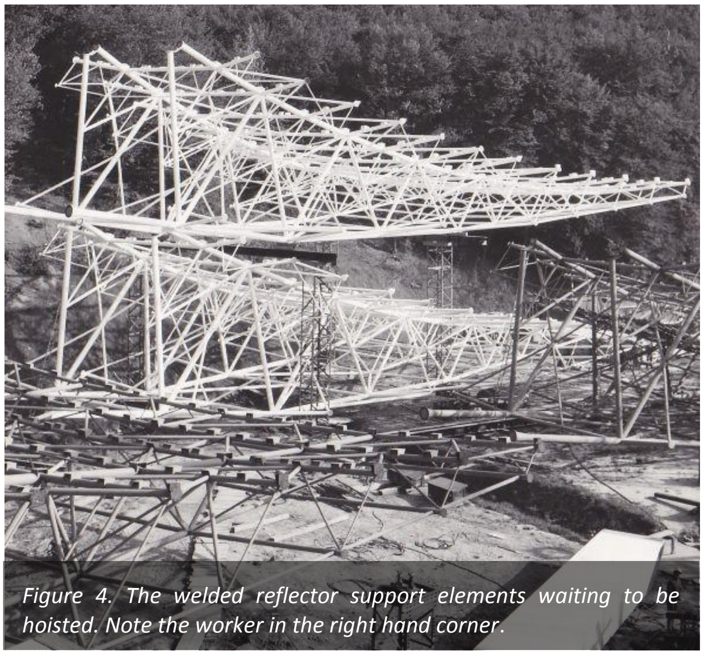


Figure 4. The welded reflector support elements waiting to be hoisted. Note the worker in the right hand corner.

The beginning of the on-site telescope construction required the erection of a 130-m high crane. This part of the telescope assembly was the responsibility of the MAN Company. A level area was made available for the welding of the individual ('orange slice') reflector sections. A hut was build where a cutting machine could produce the complex tube parts for the reflector. The supporting structure, a more massive steel construction, was made at Krupp workshops and brought by road to the site. By 1969 the A-frame support structure was being assembled (see figure 3). Note that the A-frame structure is a box-line construction made of large welded steel sheets, not of many pipe elements. At the same time the welding of the reflector support structure was proceeding on ground. Great care was taken in the welding of the tubes since it was clear that high accuracy was needed to produce a successful structure. The angles at which the individual tube elements were joined in a weld were critical. The whole site was cluttered with telescope sections in various stages of assembly (see figure 4).

>> How the various telescope sections were finally put together will be described in Part II, May 2011 Issue…

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40 Years of the 100-m Effelsberg Radio Telescope

Effelsberg Newsletter

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