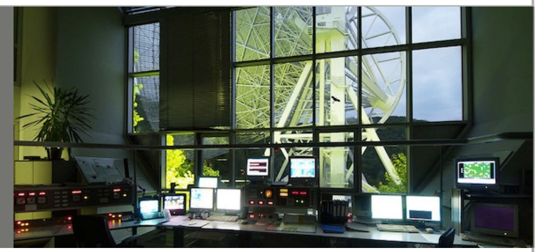
Effelsberg Newsletter

May 2016

Photo Credit: Norbert Junkes

Call for Proposals

Deadline: June 9, 2016, 15:00 UT



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, the Program Committee and selection process can be found at the observatory's web pages:

http://www.mpifr-bonn.mpg.de/effelsberg/astronomers

(potential observers are especially encouraged to visit the wiki pages!).

Observing modes

Possible observing modes include spectral line, continuum, and pulsar observations as well as VLBI. Available backends are several FFT spectrometers (with up to 65536 channels per subband/polarization), a digital continuum backend, a number of polarimeters, several pulsar systems (coherent and incoherent dedispersion), and two VLBI terminals (dBBC and RDBE type with MK5 recorders).

Receiving systems cover the frequency range from 0.3 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 NorthStar proposal tool for preparation and submission of their observing requests. North Star is reachable at

https://northstar.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/

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

http://www3.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) (e.g. to NRAO for the VLBA).

After June, the next deadline will be on October 5, 2016, 15:00 UT.

by Alex Kraus

On the Occasion of the 50th Anniversary of the MPIfR:

Foundation and Early Years of the Max-Planck-Institut für Radioastronomie

By Richard Wielebinski, Norbert Junkes , Bernd H. Grahl and Alex Kraus

Based on the article "The Effelsberg 100-m radio telescope: construction and 40 years of radio astronomy" by Richard Wielebinski, Norbert Junkes and Bernd H. Grahl, in: Journal of Astronomical History and Heritage, Vol. 14, No. 1 (2011)

Introduction

German radio astronomy started late compared to other European countries due to restrictions on radio research after the World War II. The observatories in Kiel and Tübingen did some pioneer-work in the Western part of Germany, while the Heinrich-Hertz-Institut (HHI) in Berlin-Adlershof (Russian occupation zone) started operations in 1946 already and became involved in Solar radio astronomy research. In the 1950s, after the restrictions were lifted in the Western occupation zones, an initiative from the local government of the federal state of Nordrhein-Westfalen led to the funding of a 25-m fully steerable dish. The telescope was built on the Stockert Mountain (near Bonn) and operated by the Bonn University. The Stockert telescope was inaugurated 60 years ago; a report on this will be part of the next issue of this newsletter. At the same time a 36-m transit dish for the HHI, intended for Galactic research, was also funded. In 1962 an important report 'Denkschrift zur Lage der Astronomie' (a 'white paper') was published by the Deutsche Forschungsgemeinschaft (DFG) suggesting the developments for the next decades in astronomy in the Federal Republic of Germany. One of these proposed developments was to build a major instrument for radio astronomy. The erection of the Berlin Wall in 1961 led to the move of Otto Hachenberg, the Director of the HHI in Berlin-Adlershof, to the University in Bonn. This strengthened the Astronomical Institutes of the Bonn University, adding a new independent Radio Astronomy Institute.

Visit of Hans Matthöfer (German science minister from 1974 to 1978) at the Effelsberg Radio Observatory. Richard Wielebinski, director at MPIfR, is explaining a radio astronomy result to the minister. In the background: Otto Hachenberg, also director at MPIfR.

Otto Hachenberg begun, immediately after the move to Bonn, to make plans for a big radio telescope; initially, the goal was to build a dish with a diameter of 80m. Based on the experience with the construction of the 36-m transit dish in Berlin-Adlershof the achievement of good surface accuracy became the main goal. The companies Krupp and MAN became involved in the design and were each asked to make different designs studies. In the design phase the decision was made to go away from a very stiff steel construction to a more. flexible one. It should, however, be assured that the reflector keeps a parabolic shape – though with changing focal point – through the elevation movement due to elasticity. This concept – known as "homologic deformation" was the most important development in the design of the 100-m telescope. Depending on the funding, an extension of the diameter of the dish to 90-m, became a realistic consideration. In 1964, the astronomy professors, Friedrich Becker, Wolfgang Priester and Otto Hachenberg at Bonn University could make a detailed application to the Volkswagenstiftung for funds to build this instrument. Originally a second German radio astronomy project, the construction of a 160-m low frequency transit dish, proposed by Sebastian von Hoerner from the University of Tübingen was also approved by the Volkswagenstiftung. However, this project was not pursued and hence bigger funds became available for the Bonn project. Since the design computations suggested that a very exact surface accuracy could be achieved even for a 100-m reflector it was decided to construct the 100-m radio telescope.

To ensure sufficient operating funds subsequent negotiations led to the founding of the Max-Planck-Institut für Radioastronomie (MPIfR) in Bonn.

The Max-Planck-Institut für Radioastronomie

The decision to finance such a major instrument as the 100-m radio telescope was coupled with finding a research facility that would ensure reliable operations. The Max-Planck-Gesellschaft (MPG), the major German research organization devoted to fundamental research, was willing to take on this role. During its meeting on June 23, 1965, the senate of the MPG decided to establish the Max-Planck-Institut für Radioastronomie in Bonn on July 1, 1966.

The plan was to have strong technical and astronomical divisions. The founding director, appointed in 1966, was Otto Hachenberg who was also a full Professor at Bonn University. His primary astronomical interests were solar research and HI studies of the Galaxy. It was decided, that the institute was to be managed by a board of directors, with two additional scientists beside Otto Hachenberg. The MPG takes great care in the selection of directors based on the 'Harnack Principle'. This principle aims at appointing directors, giving them sufficient staff and funds, to implement a certain field of research. The choice of directors in 1969 was: Peter G. Mezger (whose interest was mainly spectroscopy) coming from the National Radio Astronomy Observatory (NRAO) in the USA and Richard Wielebinski (with interests in radio continuum and pulsars) who came from Sydney University. The three directors were also responsible for different technical divisions: Otto Hachenberg for the Telescope Division, Peter G. Mezger for the Computing Division and Richard Wielebinski for the Electronics Division that constructed the receivers for the 100-m telescope. The three directors were given sufficient new positions to implement both viable technical divisions and their own astronomical research groups. The institute was independent but closely linked to the Bonn University. In fact the two new directors became Honorary Professors of the Bonn University in 1971 giving them the right to hold lectures and supervise PhD students.

The arrival of the two new directors early in 1970 led to a turbulent phase in building up the institute. Otto Hachenberg enlarged his research group mainly from the staff that were previously appointed at the Bonn University Institute of Radio Astronomy. Some new staff members, interested in Galactic HI research, came from the Netherlands. Peter G. Mezger came back from NRAO with several German expatriates. In addition he recruited staff interested in spectroscopy in the USA. Richard Wielebinski brought some Australian researchers as well as some selected people from the Netherlands and from the Jodrell Bank Observatory (UK). In fact, several software specialists, involved in large-scale surveys came from Jodrell Bank and transferred their methods to Effelsberg. The technical divisions were recruited mainly from local engineers, technicians and software specialists. In the final phase of the institute build-up the staff counted some 180 positions. At first the institute was scattered in several buildings in Bonn as well as at the telescope sites on the

Stockert and in Effelsberg. In 1973 a new building in Bonn-Endenich was ready and a move of all groups could be implemented. However, it was decided to keep a strong staff (some 35 positions) at the 100-m telescope site – a decision which guaranteed good support for future observations.

In addition to the permanent staff, positions for students were created. The MPG offered generous scholarships for PhD students. Another scheme of the MPG but also of the Alexander von Humboldt Foundation allowed visitors from outside Germany to come to the institute for various periods of stay. In general some 250 to 300 people were working at the MPIfR. This international mixture of staff and students made an important contribution to the development of the MPIfR.

The construction of the 100-m radio telescope

Main task of the newly founded institute was the planning and construction of the 100-m telescope. The search for a suitable site for the radio telescope started in 1966 already. It was clear that the site should be in a secluded valley and not on a mountain like the 25-m Stockert dish – to ensure protection against man-made interference (a wise decision, given the development in the last 50 years). Several sites were investigated but the final choice fell on an almost north-south valley close to the village of Bad Münstereifel–Effelsberg, which was right at the border between the federal states of Nordrhein-Westfalen and Rheinland-Pfalz (but fortunately on the "right side" of the border). As a result of this choice the local government of Nordrhein-Westfalen in Düsseldorf offered the site to the MPIfR. Considerable time was needed to sort out the land ownership titles and purchase the site. The construction of such a complex structure required many different subcontractors. An association of companies, the ARGE STAR, was formed involving the major partners Krupp (steel elements) and MAN (on site assembly). The first step involved the construction of the foundations which started in fall 1967. A small creek (Effelsberger Bach) marking the boundary between Nordrhein-Westfalen and Rheinland-Pfalz had to be moved. The whole site for the radio telescope was 15.4 hectare in extent, lying in both federal states, but with the telescope itself in Nordrhein-Westfalen.

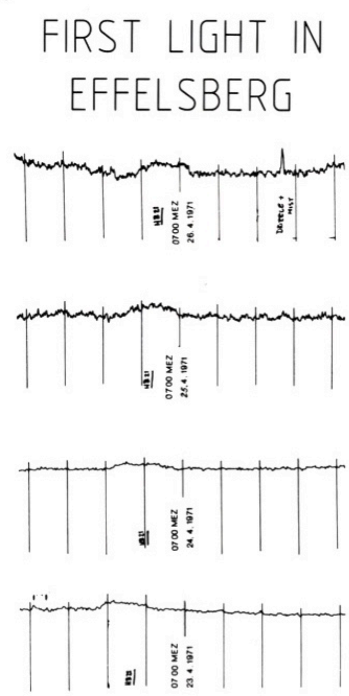


Figure 1: First light obtained with an un-cooled 11-cm receiver in the primary focus. Drift scans through the supernova remnant HB 21.

The beginning of the on-site telescope construction in 1968 required the construction of a 130-m high crane. 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 A-frame 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. At the same time the welding of the reflector support structure was proceeding on ground causing the whole site to be cluttered with telescope sections in various stages of assembly. The mounting of the reflecting panels was partly done on the ground before lifting. The 'orange slice' sections were placed

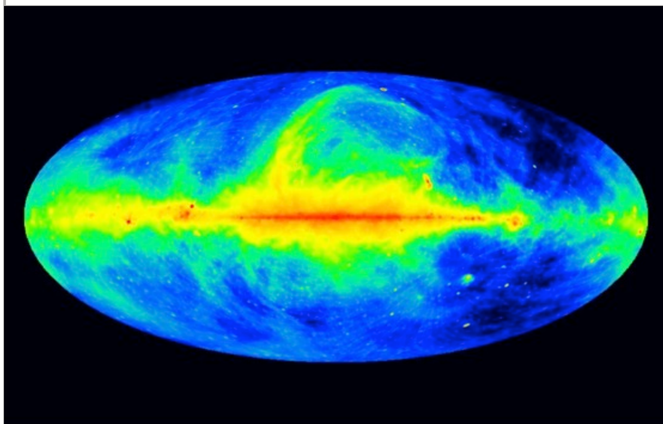


Figure 2: The 408 MHz all-sky radio continuum survey (Haslam et al., 1982, Astronomy and Astrophysics Supplement Series, vol. 47, p. 1), based on a combination of observations with radio telescopes in Effelsberg, Jodrell Bank and Parkes.

alternatively on opposite sides of the dish. For this purpose the azimuth drive had to be installed in the earliest construction stage. The final section of the reflector was hoisted in 1970, with a gap of less than 0.5-cm in the final assembly, marking a remarkable achievement in steel construction accuracy. Final surface adjustments were made after all the panels were in place.

First light was received at 2.7 GHz (11-cm wavelength) on 23 April 1971 when a simple dipole was inserted in the prime focus (Figure 1). The official opening took place on 12th May 1971. Already in the early days (during the final stages of the construction), observations at 408 MHz started. These led ultimately to the very famous all sky radio continuum survey (Haslam et al., 1982), in some way a logo of the MPIfR (see Figure 2).

Further development

The main reason for the founding of the MPIfR was the wish to build and operate the 100-m telescope at Effelsberg. Even after more than four decades of operation, the telescope is still going strong. Due to its continuous modernization, it is still a "workhorse" for astronomers from the institute, but also from abroad. Nevertheless, the scientific interests of the institute and its directors have always been and are still going beyond the operation of the 100-m telescope only.

Already soon after the completion and the commissioning of the Effelsberg telescope, the MPIfR became involved in the design and construction of the 30-m telescope for mm-wavelength on the Pico Veleta (now operated by IRAM). In the 1980s, considerable effort was undertaken to support the building and operation of the sub-mm Heinrich-Hertz-telescope on Mount Graham (Arizona), USA. This development of going to higher frequencies culminated in the construction of the sub-mm APEX telescope (Atacama Path Finder Experiment) in Chile.

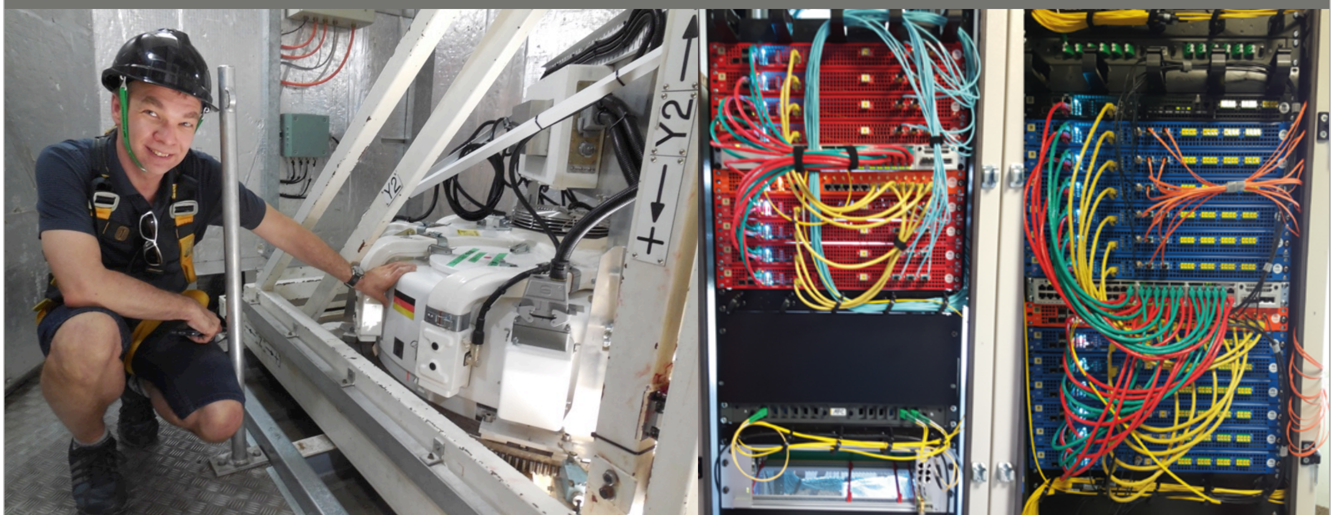
The continuous high level of scientific output of the institute was ensured by the several directors who led the MPIfR in the last five decades. The "father of the 100-m telescope", Otto Hachenberg, was retired in 1977, only six years after the inauguration of the telescope. At the same time, Kenneth I. Kellermann came for two years as director and head of the research department "Very Long Baseline Interferometry" (VLBI); he left the institute in 1979. In 1988, Gerd Weigelt was appointed as director and head of the research department "Optical Interferometry" (later: "Infrared Astronomy"). His arrival led to a further extension of the scientific interests of the institute. When Peter G. Mezger was retired in 1996, Karl M. Menten became his successor as head of the "Millimeter and Submillimeter Astronomy" research department. Also in 1996, J. Anton Zensus was appointed as director responsible for the "Radio Astronomy / VLBI" research department. Finally, after Richard Wielebinski's retirement in 2004, Michael Kramer was appointed as director and head of the "Fundamental Physics in Radio Astronomy" research department in 2009.

In retrospective, it can undoubtedly be concluded that the foundation of the Max-Planck-Institut für Radioastronomie constituted a success story in Radio Astronomy, also beyond Germany.

TECHNICAL NEWS

A Phased Array Feed Receiver (PAF) for the Effelsberg Telescope

By Gundolf Wieching



Left: Michael Kramer inspecting the MPIfR Phased Array Feed at the focus cabin of the Parkes telescope. Right: PAF Digitizer (blue), beamformer (red) and auxiliary devices as installed at the PAF telescope. The RFI fibers to the Digitizer as well as the data link from the beamformer to the GPU cluster is not connected

Phased Array Feed (PAF) receiver systems can provide several new observing features to future and existing radio telescopes. This includes but is not limited to multiple beam observations, covering the full field of view of the telescope or mitigating radio interference. The latter is especially true for PAFs with the implementation of a flexible digital beamformer.

As part of the MPIfR Effelsberg 100m instrument renewal plan, funds have been made available to realize the installation and operation of a state-of-the-art Phased Array Feed (PAF). A detailed analysis of the available systems led to a collaboration with the Australian Telescope National Facility (ATNF-CASS), currently leading the word-wide efforts in the design of such systems for radio astronomical use. CASS has developed and is in the process of distributing up to 36 PAFs on the ASKAP antenna array.

To ensure operation on a single dish telescope and, even more challenging, within the RFI environment of Effelsberg, we started a close interaction with our Australian colleagues, resulting in dedicated site tests and modifications for the 100-m telescope.

The required modifications to the PAF are mostly due to changes on the RF filtering (see Figure 1) and changes to the data interface. The latter ensures that the raw voltage stream of all 36 dual-polarization beams coming from the PAF beam-former (approx. 960 GB/s of data) can be distributed via a commercial network switch to the processing GPU cluster.

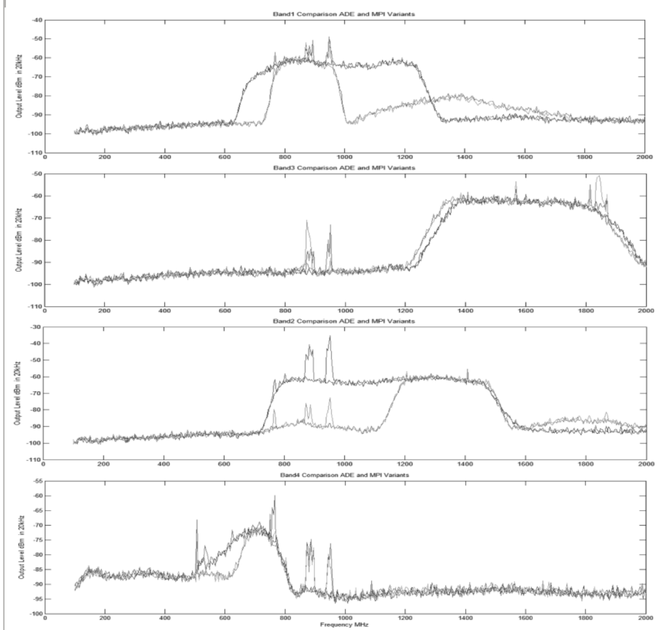


Figure 1 Test spectra of the modified PAF RF bands (band 1 to 4). The light blue and red traces show the modified MPI filters, while the green and dark blue are default ASKAP filters. For the light blue and green traces Sydney RFI pollution is intentionally leaked into the measuring chamber (R. Beresford CASS)

In addition to the mentioned changes, a cooperation with ANTF has been initiated to verify the performed modifications, as well as the single dish operations at the ATNF Parkes Telescope before installing the PAF at Effelsberg. This led to an installation run of the MPIfR PAF at the Parkes telescope during Feb. 2016 followed by a science run of 6 months duration. Early results of the commissioning are very encouraging, showing that all 188 PAF Feeds operate as expected and that the beamformed signal is successfully processed by the GPU cluster.

Currently we are able to make use of the two higher frequency bands (band 2: 1200-1480MHz and band 3: 1350-1720MHz), while the other lower frequency bands are saturated with RFI. This has been expected, but shows that the modifications to "save" the higher bands were necessary and successful. Nevertheless the two lower bands can be used in the future as a valuable source to test and improve RFI mitigation techniques. First sensitivity data from the boresight beam is given in Figure 2.

Preparation work to operate the PAF at Effelsberg in Q4 2016 is on-going and comprises dedicated mechanical mounting structure, sufficient power (max. 13.5 kW) and cooling capacity at the Effelsberg Faraday room, as well as an integration of the PAF into the Effelsberg telescope control and monitoring system.

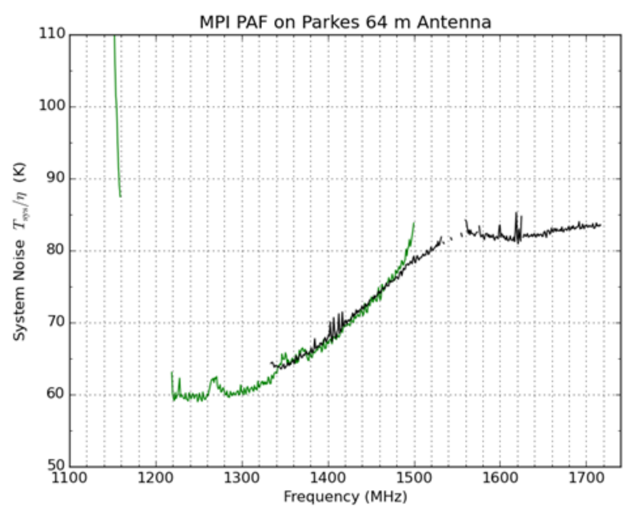


Figure 2 Sensitivity of the MPIfR PAF on Parkes measured via Virgo A, (Ott et al., 1994), off-source - 1°46'30" arcdeg RA offset, A-polarisation shown, gaps are where RFI is strong (provided by A. Chippendale CASS)

Effelsberg Water Vapour Radiometer

By Ute Teuber & Alan Roy

Figure 1: *The WVR is installed permanently on the Effelsberg on focus cabin roof and is oriented boresight to the observing beam. The radiometer beam is conical with FWHM of 2.6° matched to the cylindrical Effelsberg main beam for maximal beam overlap in the first 1 km of atmosphere where most of the water vapour typically lies.*

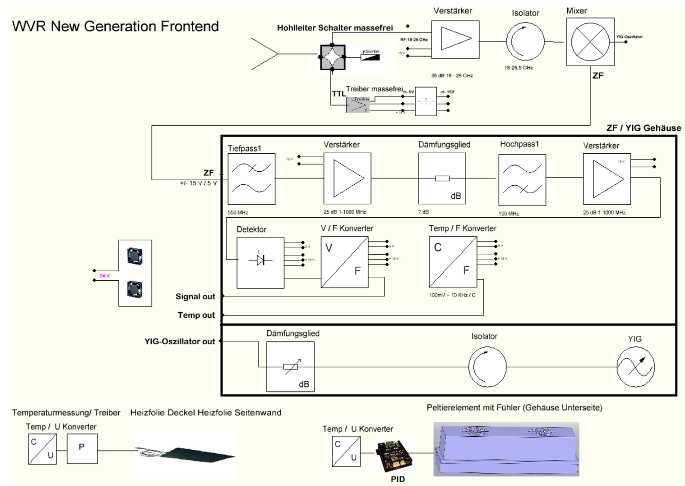


Figure 2: *Block schematic of WVR RF signal chain.*

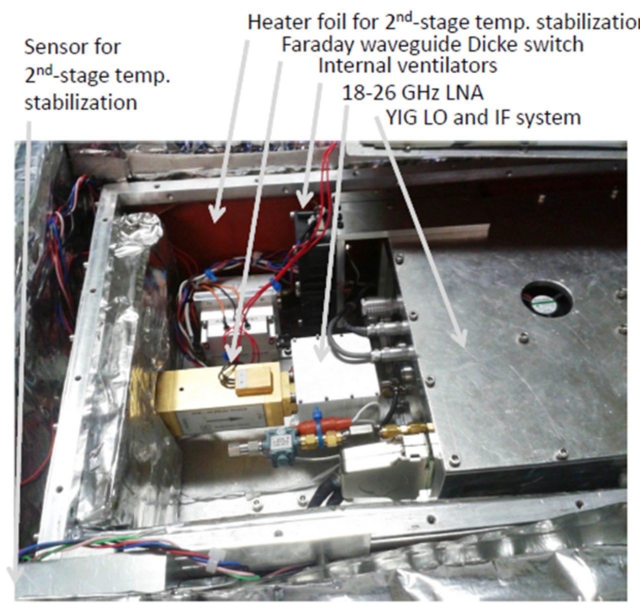


Figure 3: *Internals showing vacuum insulation panels, which give excellent insulation in the smallest thickness, RF components on temperature-stabilized plate.*

Tropospheric water vapour causes signal absorption and phase instability at Effelsberg, especially when observing at higher frequencies for single dish and VLBI, and these effects can be calibrated using a water vapour radiometer. The first generation WVR at Effelsberg operated from 2004, and lessons learned were adapted into the present second generation WVR installed March 2013.

The primary goals are phase correction of 3 mm VLBI observations, correction of atmospheric absorption in single-dish and VLBI observations, provision of zenith tropospheric delay for the correlator model in phase-referencing experiments, and experimental tropospheric measurement for geodetic VLBI.

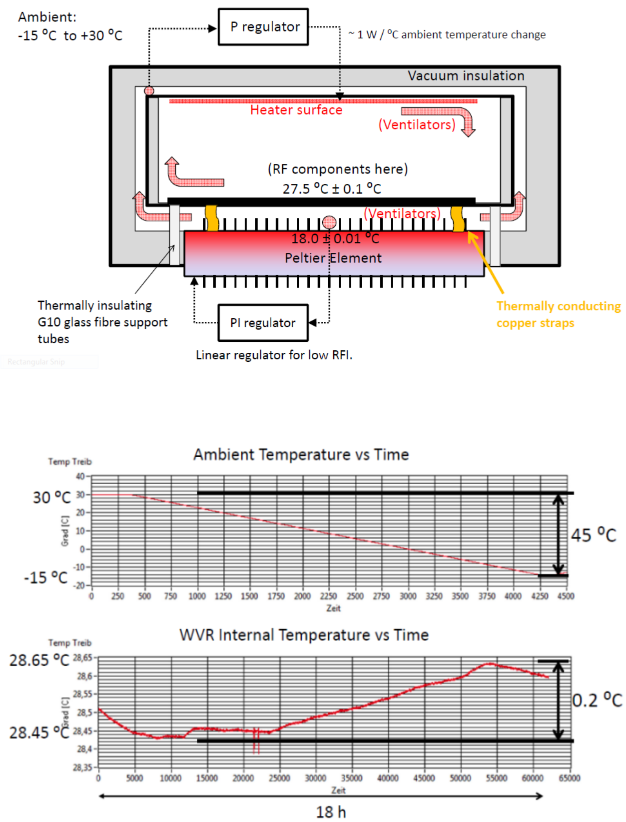


***Figure 4:** Top: Thermal design of the WVR: a box within a box, two stages of temperature regulation, ventilators to circulate air. Bottom: Final temperature stability in environmental chamber with two-stage temperature stabilization, showing ±0.1 °C internal variation for 45 °C ambient temperature variation.*

The radiometer measures the strength of the 22 GHz water line, sweeping a single 900 MHz bandwidth total power channel across the line under software control. Compared to its predecessor, the radiometer has improved temperature stability (±0.1 °C) from two-stage temperature regulation, waveguide Dicke switch to internal absorber for calibration under software control, and faster frequency sweep through dual data acquisition systems in parallel for commanding the YIG oscillator frequency and for reading out the total power. Software controls the sweep and logs data, presently into ascii file, and later into an SQL database with web interface for data browsing and download. Output formats for path lengths and opacities are for AIPS, CLASS, and ascii.

Radiometer type	Scanning
Frequency range	18 GHz to 26.0 GHz
Noise-equivalent bandwidth (IF bandwidth)	900 MHz
Spectral resolution	1100 MHz
Treceiver	230 K to 500 K
Sensitivity	45 mK rms in 1 s for a single frequency
Channels	Software controlled, YIG commanded with 8 bit word yields 256 steps across 18 GHz to 26 GHz. Eg 3 channels (Bremer retrieval) or 24 channels (Tahmoush & Rogers retrieval).
Sweep period	Software controlled, 7 s for 3 channels with integration time on sky of 1 s / channel
Calibration	Dicke switch to waveguide load
Internal temperature	Stabilized at 27.5 °C ± 0.1 °C
Beamwidth	2.6° matched to Effelsberg near-field beam
Monitor and control	TCP
Database access	Web-interface, Effelsberg data archive records

Commissioning Tests:

Allan Deviation

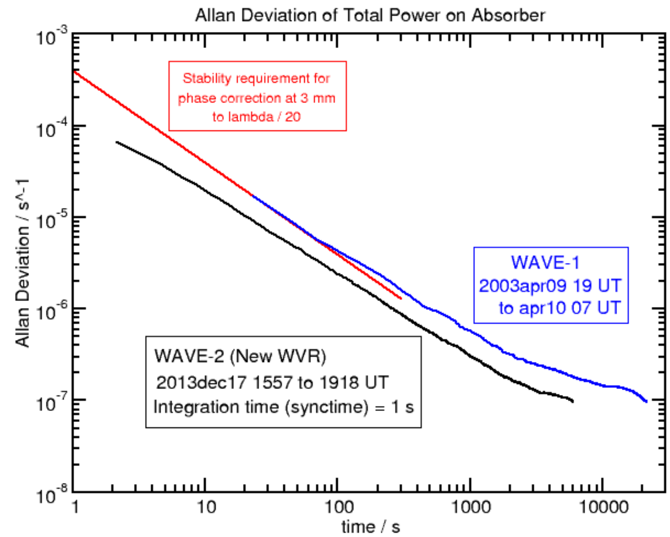


Figure 5: *Black: Allan deviation measured on absorber at fixed frequency (22.235 GHz) and integration time of 1 s. Turnover time is > 3000 s. Blue: Allan deviation for WAVE-1 (original Effelsberg WVR) measured on absorber, shown for comparison. Red: Allan deviation required for phase correction to λ/20 at 3 mm in 5 min. The present radiometer is better than the requirement for phase correction and better than the first generation WVR, as a result of temperature stabilization.*

Tropsopheric Wet Path Length Time Series:

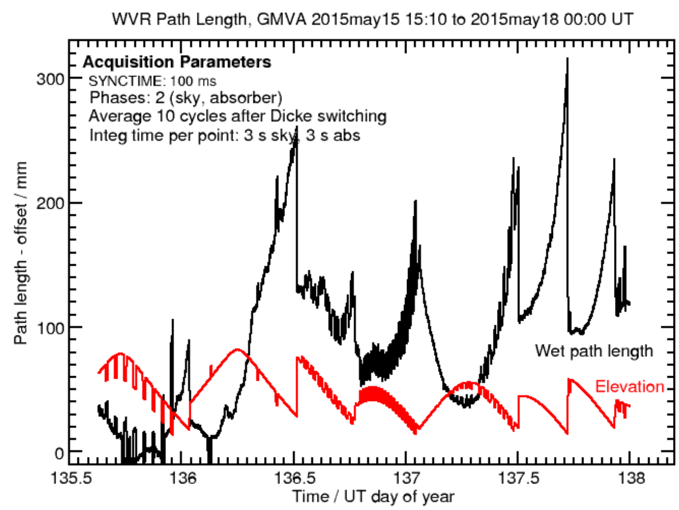


Figure 6: *Shows an example time series of line-of-sight wet path length (black) and telescope elevation (red) for 2.5 days during a GMVA 3 mm VLBI observation. At low elevation the path length is large due to the greater slant path through the atmosphere. At close inspection, the target RMS of < 180 µm path length noise needed for VLBI phase correction is reached on 10 s time-scale with smoothing.*

Stability Improvement with Dicke Switching

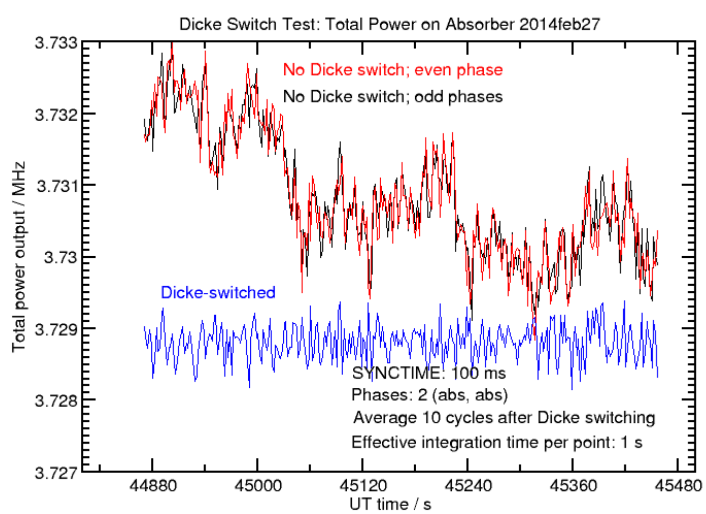


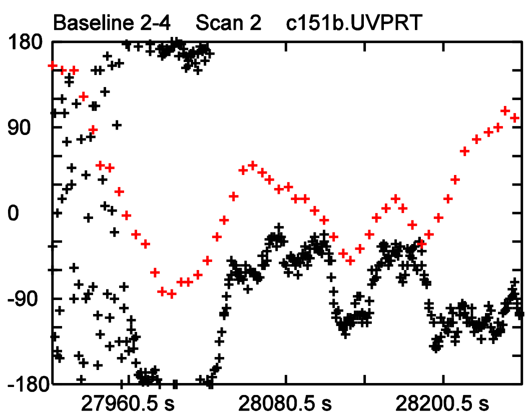
Figure 7: *Shows the time series of total power when the Dicke switch remains on absorber for both Dicke phases. Black and red show the odd and even phases – one sees long-term drift and short-term fluctuations are highly correlated between the Dicke phases giving good prospects for stabilizing the fluctuations using Dicke switching. After applying Dicke gain stabilization from one phase to the other phase yields the blue line – one sees the long-term drift is remove by Dicke switching as expected.*

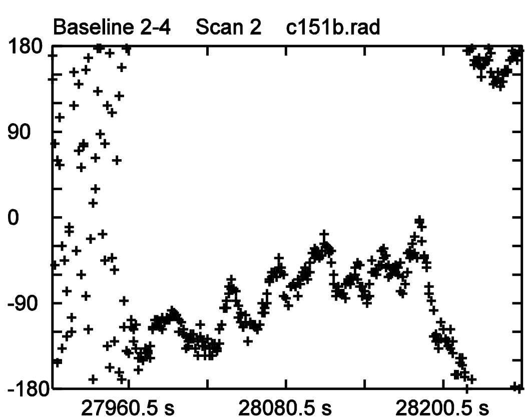
Retrieval Algorithm: Bremer T_{triple}

The radiometer measures sky temperature at the three frequencies sequentially, with 1 s integration on sky and 1 s on absorber per frequency for Dicke switching, plus settling time makes 7 s per frequency sweep. The water line temperature, Ttriple, is calculated using the following formula, which removes cloud emission (has a frequency-squared emission law) and contributions with constant temperature versus frequency.

$T_{triple} = \left(T_1 - T_2\left(\frac{\nu_1}{\nu_2}\right)^2\right) - \left(T_2 - T_3\left(\frac{\nu_2}{\nu_3}\right)^2\right)$, where ν_1 = 19.175 GHz, ν_2 = 21.971 GHz, and ν_3 = 25.175 GHz, and T_1, T_2, and T_3 are the antenna temperatures at the three frequencies.

T_{triple} is converted into a path length by multiplying by a conversion factor of ~ 4.2 mm/K that comes from integrating the refractive index and emissivity up through the atmosphere. T_{triple} can also be converted into an opacity at 22.2 GHz at which the line temperature measurement was made. Approximately opacity is given by $T_{triple}/T_{atmos} = 1 - e^{-\tau}$ where T_{atmos} ~ 250 K. For opacity at other observing frequencies one uses an atmospheric model, like am or atm.





Phase Correction Demonstration

***Figure 8**: Phase correction of a 7 min long 86 GHz VLBI scan on 3C 454.3 on the baseline Effelsberg – GBT on 2015May17 at 07:45 UT. Top: the VLBI phase time series (black) and the WVR-derived phase correction at Effelsberg (red) show good correlation. Bottom: After subtracting the WVR-derived phase from the baseline phase, the tropospheric fluctuations are reduced leading to improved coherence. Residual tropospheric fluctuations will remain due to the atmosphere over GBT which is not corrected in this test.*

Conclusion

The WVR has been operating continuously since early 2015, acquiring data for RadioAstron and GMVA, with data delivery via ascii files. Algorithm development for retrieval and phase correction demo is ongoing. With the coming implementation of database and web access the data will become available on demand, which will provide the basis for real-time display of opacities for dynamic scheduling (weather decisions), and with data flow into MBFITS the opacities will be available for use in routine analysis.

Other News in Brief

With sadness, we learned about the death of Dr. Kurt W. Weiler who died on April 17, 2016 in Alexandria, VA, USA after a long illness. Kurt Weiler was working at the Max-Planck-Institut für Radioastronomie between June 1976 till October 1979. He is well-known for his many scientific contributions, among them detailed investigations of the polarization properties of AGN. Kurt Weiler was also part of the team which detected Formaldehyde absorption against the core of M82 with the 100-m telescope. Our thoughts are with his family and friends.

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On March 19, the "Day of Astronomy" took place in Germany. At Effelsberg, a team of scientists (D. Champion, E. Fürst, N. Junkes, P. Müller, A. Kraus) presented public observations of the Tycho SNR, selected pulsars and ammonia lines in the star forming region S140. About 100 interested viewers followed the observations as well as the subsequent data analysis and used the opportunity to ask many questions about the presentations and other astronomical topics.

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After 45 years of reliable operation, the emergency diesel generator of the observatory has been replaced by a new one. Being responsible for a continuous receiver cooling and the possibility to drive the telescope to a safe position even in case of a power failure, the generator was carefully maintained over all these years. In the context of the modernisation of the observatories power supply, the old generator has been replaced by a modern one.

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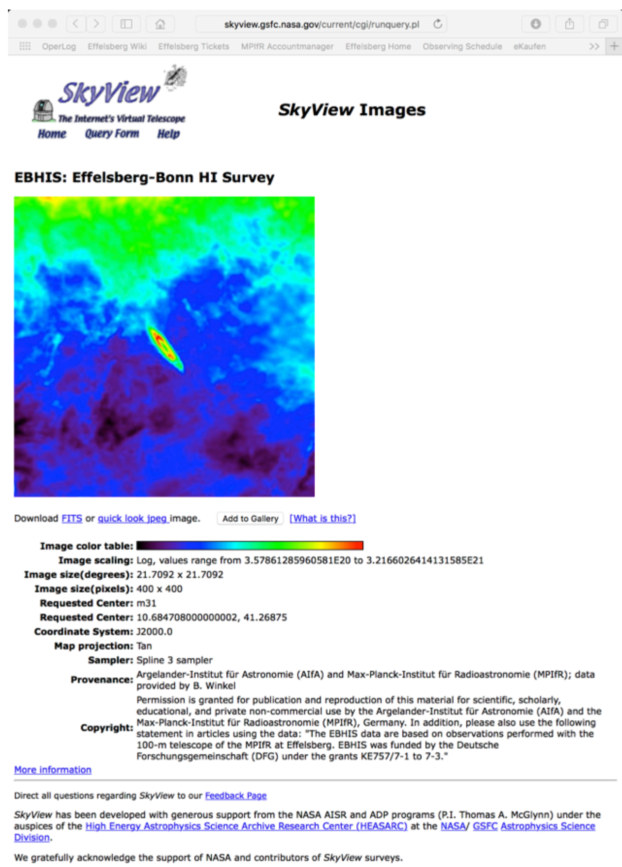
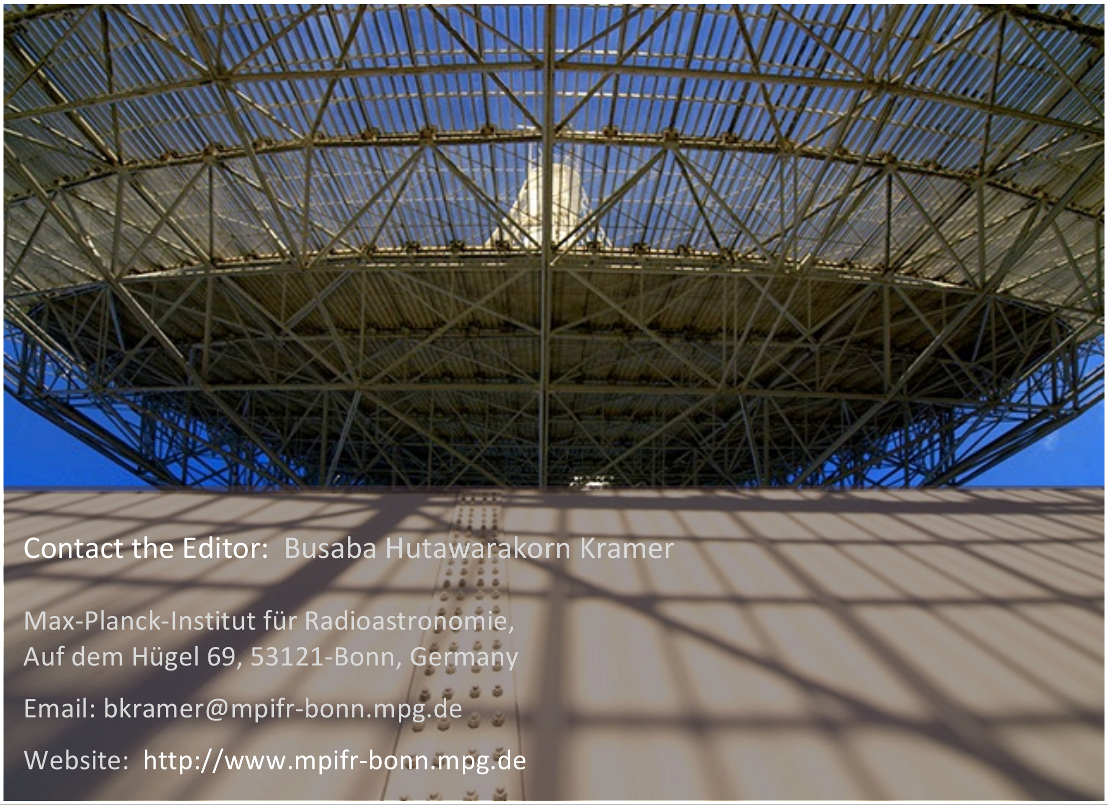
Recently, the first data release of the Effelsberg-Bonn HI survey (EBHIS) has been published (Winkel et al., A&A **585**, A41, 2016 – see also the January issue of this newsletter). The data has meanwhile been included into Skyview (a virtual telescope hosted by NASA). Besides many other surveys, like e.g. the famous 408 MHz survey by Haslam et al. (with data from Effelsberg, Parkes, Jodrell Bank) data from EBHIS could be found at http://skyview.gsfc.nasa.gov/current/cgi/query.pl.





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