Effelsberg

NEWSLETTER September 2011

Effelsberg Newsletter September 2011 ❖ Volume 2 ❖ Issue 3

Max-Planck-Institut für Radioastronomie

Call for proposals – Deadline October 11, 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) (e.g. to NRAO for the VLBA).

The next deadline will be on Feb 8, 2012, 13.00 UT.

by Alex Kraus

RadioNet Transnational Access Programme

RadioNet 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

Technical News

Back to Low Frequencies: An Ultra-broadband Receiver System for the 100-m Telescope.

By Paulo Freire and Reinhard Keller

The Max-Planck-Institut für Radioastronomie has started a new European-funded project that aims to carry out the most precise tests of Einstein's general relativity ever. This will be accomplished with extremely accurate astronomical observations of binary pulsars using the 100-m Effelsberg radio telescope. General relativity (GR) is the current, unsurpassed description of gravity. It accurately predicts the results of all current gravity experiments to very high precision, including all Solar System tests plus the extremely stringent tests introduced by timing the double pulsar (PSR J0737-3039, Kramer et al. 2006, Science, Volume 314, Issue 5796, pp. 97-102) and PSR J1738+0333 (Antoniadis et al. 2011 and Freire et a. 2011, in preparation).

So why do we want to keep testing GR to ever higher precision? First, GR is fundamentally incompatible with quantum mechanics. This makes any attempts at unifying gravity with the other forces of Nature – the supreme goal of current research in Physics - extremely problematic. Second, alternative theories of gravity have been proposed to explain the rotational curves of galaxies and clusters without the need for Dark Matter, universal acceleration without the need for Dark Energy and Cosmic Inflation (fundamental for understanding the origin of the Universe). Is gravity really responsible for these phemomena? Clearly, knowing the answer to this question is important not only for understanding the laws of Nature, but also the origin, evolution and contents the Universe.

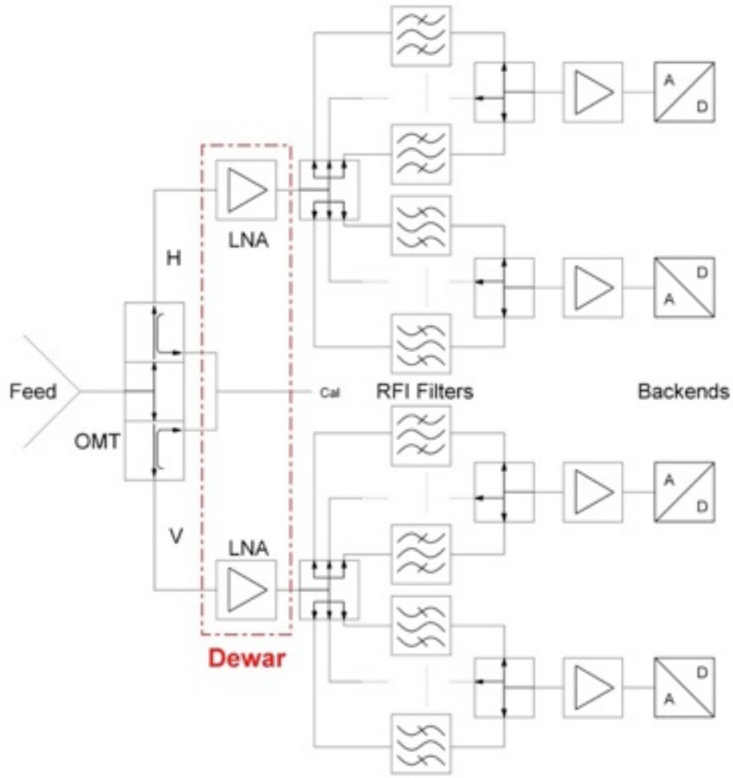
Feed horn design

The great news for us is that some of these alternative theories of gravity can be tested using binary pulsars! This is the fundamental aim of project BEACON (P.I. Freire), which has just been funded 1.8 M€ with top marks! - by a prestigious ERC grant. Binary pulsars enable these tests because of their large gravitational fields and astounding binding energy: they provide the only strong-field tests of gravitational theories. Russell Hulse and Joe Taylor earned the Nobel Prize in Physics in 1993 for their discovery of the first binary pulsar, PSR B1913+16. Precise measurements of the orbital motion of this object with the Arecibo radio telescope confirmed the existence of gravitational waves (GWs), a fundamental prediction of GR. Furthermore, Arecibo and Effelsberg measurements of the radio emission of this pulsar by M. Kramer confirmed the existence of geodetic precession, a fundamental demonstration that gravity is curved space-time! The same sort of experiments in more recently discovered systems, carried out at a much higher level of timing precision, will be able to exclude some alternative theories of gravity (and possibly show that Dark Matter is real) or, otherwise, show that Einstein is wrong!

In order to achieve this, a new, ultra broadband low frequency receiver for the 100m radio telescope is currently under construction. To observe pulsars with high accuracy, and accurately remove the ever-changing effects of interstellar dispersion, a large bandwidth - from 600 MHz to 3 GHz in a single receiving system with high spectral resolution is needed. The system requirements claim for sophisticated - and challenging - solutions for the feed, the low noise amplifier (LNA), the noise figure and the dynamic range. Major components (feed, LNA) of this systems where designed by Sander Weinreb and Ahmed Akgiray at the California Institute of Technology who has world leading experience in this kind of components. In fact, the feed is a result of technology research for the Square Kilometre Array (SKA), as the research was partially funded by the NSF via the Technology Development Project (PI J. Cordes).

The polarisation of the receiver will be two orthogonal linear polarisations divided into sub-bands to feed appropriate wideband and high resolution back-ends. Due to the RFI situation the band has to be split into different sub-bands to suppress the worst RFI bands preventing the system from saturation.

The main driver for this receiver is, as for all pulsar-related projects, sensitivity; this means lowest noise figure at maximum bandwidth. Therefore the system will be cryo cooled, having the first amplifier at 15 K temperature. However the noise figure won't be as good as achieved with typical cryo cooled L- or S-band receivers due to the very different broadband feed system. Tradeoffs have to be investigated between minimum receiver noise figure and bandwidth. The mechanics of the receiver will be a challenge due to the sheer size of the feed system incorporating ridged type feed horn and quadruple waveguide ortho-mode transducer.



Block diagram of the ultra broad band Receiver

If all the technical challenges can be vanquished, the consequences for pulsar timing will be revolutionary. Not only will we be able to carry out the most precise tests of GR ever made, but we will be able to directly detect gravitational waves by ultra-precise timing of millisecond pulsars. Furthermore, a side consequence of our new tests of general relativity will be the precise measurement of neutron star masses. This might have revolutionary implications for the study of the behaviour and composition of super-dense matter that lies in the centre of neutron stars, with widespread implications for nuclear physics. A great scientific bonanza might lie just around the corner.

SCIENCE HIGHLIGHTS

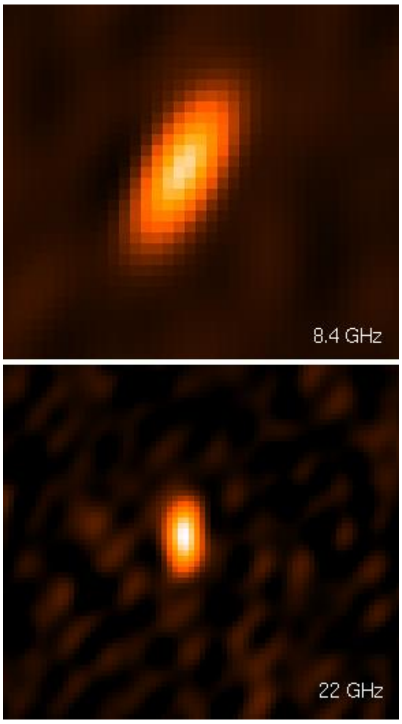
VLBA and Effelsberg observations of GRB110328A

Brunthaler A., Soderberg A., Rupen M., Bietenholz M., Frail D., Zauderer A., & Berger E.

On 2011 March 28, the Swift satellite discovered discovered a highly unusal transient source (Burrows et al.). The X-ray lightcurve of this source, GRB110328A shows strong variability for several days, making it a unqiue event in the history of gamma ray burst (GRB) observations. Based on this behaviour, the first interpretations favoured a Galactic origin (Barthelmy et al. GCN 11824). Archival optical images showed a small galaxy within the 1.4" error circle of the Swift observations (Cenko et al. GCN11827), which was found to have a redshift of z=0.35 (Levan et al.). However, it was not clear whether the transient was associated with this galaxy, or just a chance alignment. One day after the discovery, the source was observed and detected in the radio band with the Expanded Very Large Array (EVLA). A careful astrometric alignment of the radio, optical, and near-infrared images showed that the radio transient source is associated with the nucleus of the faint galaxy (Zauderer et al.), providing strong evidence for an extragalactic nature.

The most likely explanation for this source is an abrupt accretion event onto a (otherwise dormant) super massive black hole, likely prompted by the tidal disruption of a star in the vicinity, and giving rise to a relativistic jet. Hence, this might be a unique opportunity to study the birth of a relativistic outflow from a supermassive black hole (e.g. Bloom et al.). This hypothesis is also supported by the fact that no AGN activity was found in archival data.

After the detection with the EVLA, VLBI observations were initiated to follow the evolution of this transient at sub-milliarcsecond resolution. The first observation with the Very Long Baseline Array was conducted on 2011 April 2, only



five days after the first detection. Fortunately, the Effelsberg 100m telescope was able to join this observation on short notice. The observation was conducted at 8.4 and 22 GHz with the highest possible data rate of 512 Mbps. The source was detected with high signal-to-noise ratios at both frequencies. GRB110328A is brighter at 22 GHz, indicating that it was optically thick at the time of the observation. The source was unresolved at both frequencies, and thanks to the long baselines provided by the Effelsberg telescope, one can give an upper limit on the size of ~ 1 pc. The source will be monitored over the next months with the VLBA plus Effelsberg. This will allow accurate measurements or set strong limits for the proper motion and the expansion speed of the source.

References:

Burrows et al. 2011, Nature 476, 421
Zauderer et al. 2011, Nature 476, 425
Levan et al. 2011, Science 333, 199
Bloom et al. 2011, Science 333, 203

High resolution VLBI images of GRB110328A, obtained with the VLBA plus Effelsberg on 2011 April 2, only five days after the outburst.

First pulsars from the Northern HTRU Pulsar Survey

Ewan Barr, David Champion, Michael Kramer

From the discovery of a rapidly rotating millisecond pulsar which could, with careful study, divulge information on subjects ranging from the equations of state for super-dense matter to the existence of gravitational waves, to the discovery of a highly polarised “normal” pulsars that enable mapping of the galactic magnetic field with rotation measures, the discovery of new pulsars will always add to what we know about our universe and the physical laws that govern it.

With this in mind, a major all-sky survey is undertaken jointly with the Parkes telescope in the South and the 100-m Effelsberg telescope in the North. After an intensive period of constructing hardware, software and developing data reduction pipelines, the first northern discoveries are coming in! The newly discovered PSR's J2334+6148 and J2216+5800 are both weak, isolated neutron stars with rotational periods of 735ms and 419ms respectively. By examining the degree of signal dispersion for these pulsars and combining this with a galactic free electron density model we can infer distances of ~ 5 kpc to both pulsars, suggesting that they belong in the gas rich stellar birthing grounds of the Perseus arm.

View onto the 7-beam receiver mounted in the prime focus, as viewed from the secondary focus.

These discoveries represent the first science output of the High Time Resolution Universe North (HTRU-North) pulsar survey. This survey will cover the whole sky north of -20 degrees declination, using the state-of-the-art Effelsberg 21cm multi-beam receiver and PFFTS backends to provide, together with the Parkes telescope, the most sensitive all-sky survey ever conducted. Data with the Effelsberg system is processed both in-house, with the MPIfR's VLBI cluster, and externally on Manchester University's Hydra cluster.

With the pipeline now filled with lots of sensitive data, we hope for many more discoveries in the coming weeks (NB: While writing these lines, #3 was discovered....). Stay tuned!

VLBI at Effelsberg: Looking Back and Looking Forward

by Richard Porcas

VLBI (Very Long Baseline Interferometry) provides the highest angular resolution measurements of fine-scale structure in astronomy. It uses the same principles as other radio interferometers but in 1967 (when the Effelsberg telescope was under construction; see January and May 2011 Newsletters) radio astronomers in the US and Canada successfully formed interferometers between ”unconnected” telescopes, recording their signals on magnetic tape and producing interference fringes off-line. Effelsberg first took part in VLBI in June 1973 together with telescopes in Green Bank and Goldstone (USA); the earliest plot of a visibility function I could locate (from January 1974) is shown in Fig. 1 (left).

Early VLBI was extremely sensitivity-limited since the maximum signal bandwidth which could be recorded (MkII system) was 2 MHz (with 1-bit sample representation), and relatively few strong continuum sources could be observed. Nevertheless the phenomenon of faster-than-light (superluminal) motion of structural features was established in a number of these sources, and this still remains a central feature of current AGN studies. Because of its large collecting area, Effelsberg was soon seen as a highly desireable partner for VLBI, and MPIfR staff became fully involved in the development and exploitation of the technique. The importance of VLBI resulted in the formation of the VLBI Group in Bonn on the retirement of Prof. Hachenberg in 1977, first under the Directorship of Ken Kellermann and now under Anton Zensus. In late 1977 the MPI brought into operation a VLBI correlator (MkII; a new MkIII correlator followed in late 1982) and these remained the only such facilties in Europe until 1999.

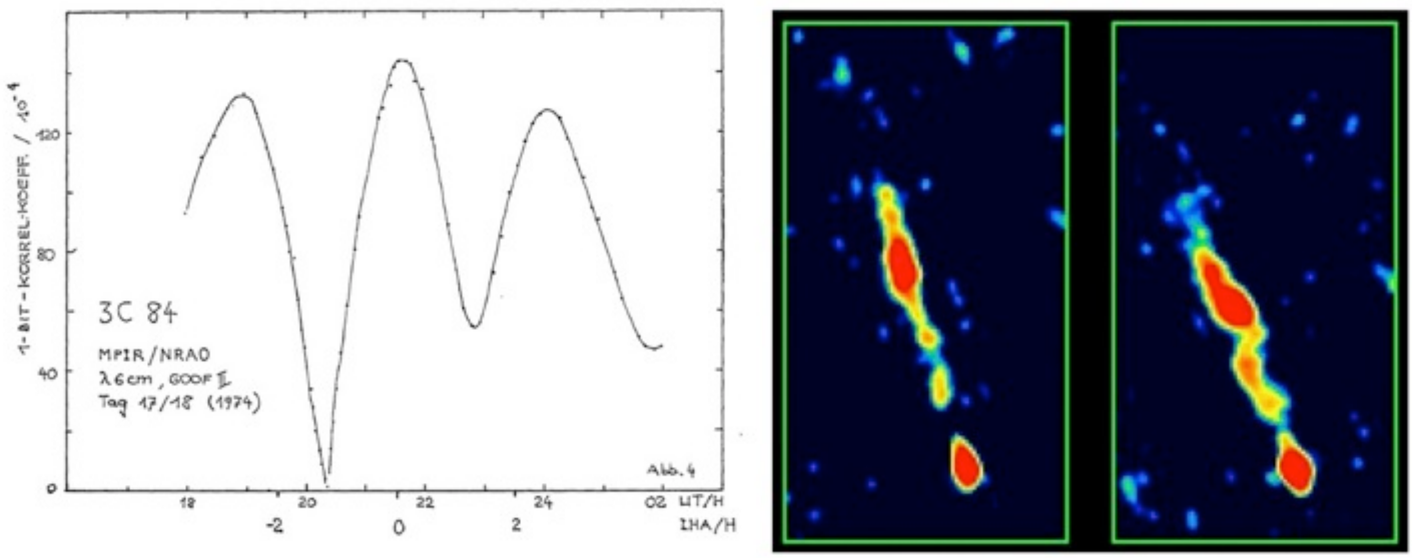


Figure 1: (Left): Interferometer visibility function of 3C84 measured at 5 GHz on the baseline Effelsberg to Green Bank, January 1974 (from Preuss et al, 1974 Mit.AG 34, 237) (Right): EVN + US-Network 9–station 1.6GHz observation of gravitational lens 0957+561 from November 1989; image B on left, image A on right. Each panel is 60 × 120mas. Note the opposite image parities. (From Garrett et al.,1994, MNRAS 270, 457)

VLBI arrays formed from existing telescopes were soon set up; Effelsberg joined the US VLBI Network in 1979 and has been the mainstay of the European VLBI Network (EVN) since it was founded in 1980. The two networks also worked together to form a Global VLBI array; Fig. 1 (right) shows an example of what it could produce by 1989. One of many early Effelsberg VLBI achievments was performing the first VLBI experiment with China in November 1981, the partner telescope being a small 6m telescope in Shanghai.

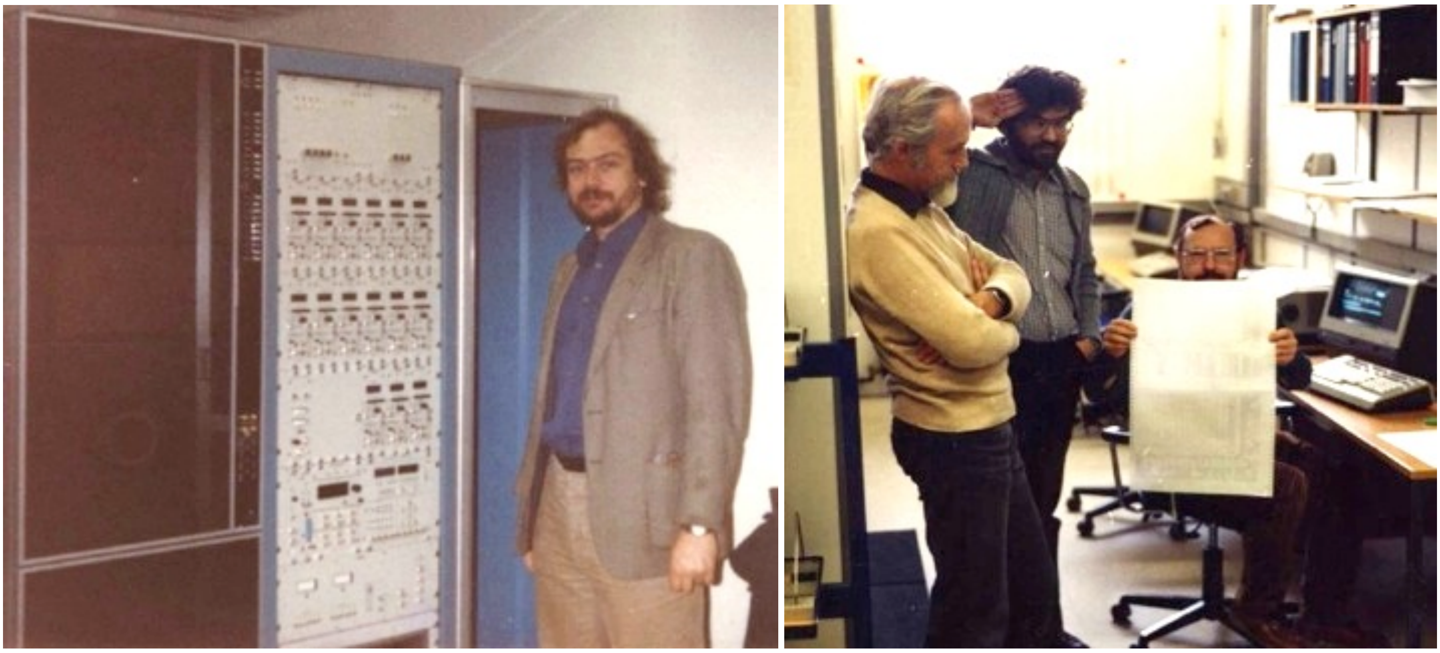


Figure 2: (Left): The author poses next to the Effelsberg MkIII record terminal, Spring 1981. (Right): First detection of Effelsberg 7mm fringes at the MPIfR MkIII correlator, October 1984.

The role of the VLBI observer - at Effelsberg as at any other telescope - is a soulless affair because there is no immediate result to see; one is ”flying blind”. The only task is to point the telescope in the correct direction and pray that the correct signal is being recorded, a process analogous to taking a photograph with a (film) camera without a viewfinder, and having to wait for a few weeks until the film is developed ! Or, as our Italian colleague told the TV cameras in September 1989 (when the Los Angeles PBS station KCET filmed how a VLBI experiment is done in Effelsberg, Medicina and Owens Valley for their ”Astronomers” series): ”Oh, it’s so BORING........”. In the early days there was no computer control of Effelsberg receivers or VLBI recording. Receiver control and LO settings were done by hand. In 1978 MkII was recorded on TV studio recorders with reels of 1”-wide tape which lasted 1 hour. By international convention tapes were rewound and changed on the full hour, with any pointing checks, source changes or system temperature measurements (manual ”S7”) performed in the break in recording. The observing schedule was generally provided as a printout, from which source coordinate punch cards had to be produced, and read into the Effelsberg Argus-500 telescope control computer at the appropriate time by the telescope operator, first into the ”passive field” and then activated by the GO button. A great advance was the implementation of the ANGLE command, which would set a time at which the next card should be read in automatically, directly into the ”active field”.

Very accurate values for the length and orientation of VLBI baselines are necessary to form ”fringes” and, consequently, VLBI became the premier technique for global geodesy and Earth rotation studies via the determination of precise telescope locations on the Earth’s surface. In 1979 US institutes developed a wideband (up to 112 MHz) recording system (MkIII) for this purpose, at the same time providing nearly an order of magnitude sensitivity increase. First geodetic and astronomical MkIII observations in Effelsberg took place in 1979, using a record terminal on loan from the US. Our own terminal followed shortly afterwards. Scientists at the Bonn University Geodetic Institute were quick to become involved in VLBI, performing their own geodetic experiments with Effelsberg in the early 1980’s. A long and fruitful collaboration with the MPI thus started, maintained today with the joint operation of our current VLBI correlator in Bonn. Effelsberg is not the most suitable telescope for geodetic VLBI, however (it has relatively slow drive rates and its ”position” for geodetic purposes varies with elevation due to its homology design), and since 1984 most geodetic VLBI observations in Germany have been made at the Wettzell telescope in Bavaria. However, a few such measurements are made in Effelsberg each year. Their precision is such that the raising of the telescope by 13mm, resulting from the replacement of the azimuth track in 1996, could be detected.

In the early days, VLBI observations were performed by researchers working at the participating telescopes, resulting in large collaborations. With the coming of the VLBI networks this gave way to the appointment of the Effelsberg ”VLBI Friend” in 1979, whose job was to supervise observations for investigators who were ”in absentia”, working closely with the telescope operators. Until 1987 this task was performed by members of the MPI VLBI Group; thereafter the VLBI Friend role was taken over by Effelsberg staff. The coming of the MKIII system brought not only a huge increase in sensitivity but also an increase in recording complexity. The recorder used 1" tape on 12" reels running at 10ft (~ 3 m)/s, using 28 parallel longitudinal tracks; at maximum normal data rate the reel was full after 13 minutes. Unlike MkII, the MkIII system was embedded in a computer environment to control tape motions, track assignments, LOs and other settings. Regrettably, no control computer was acquired for Effelsberg and, unique amongst MkIII stations, Effelsberg ran observations using manual control, requiring double operator shifts and increased support from the VLBI group. (This was just as reliable as computer-controlled stations !) It was left to a student in the VLBI group in 1986 to write his own control software on one of the newly introduced PCs.

A new era for VLBI started with the construction by NRAO of the Very Long Baseline Array (VLBA), including a set of 10 new 25m telescopes on US territory; it superceded the US Network in 1992. The Effelsberg telescope naturally provided a highly sensitive additional telescope to add to the VLBA, also forming even longer baselines. MPI signed an agreement with NRAO in November 1992, making available up to 20 days per year for joint observations. (This agreement also covers observations with the HSA (High Sensitivity Array), set up in May 2004, which also includes the GBT, VLA and Arecibo). A new VLBA record terminal was purchased (complete with computer..), and first successfully tested in 1995, and a link with the Effelsberg control computer was established, allowing entirely automatic, schedule-driven observations to be made. A new 3-frequency receiver (43, 22 and 15 GHz) was brought into operation in 1996 to allow frequency-agile operation together with the VLBA. Shortly afterwards the MkIII record terminal was up-graded to MkIV and brought under similar computer control.

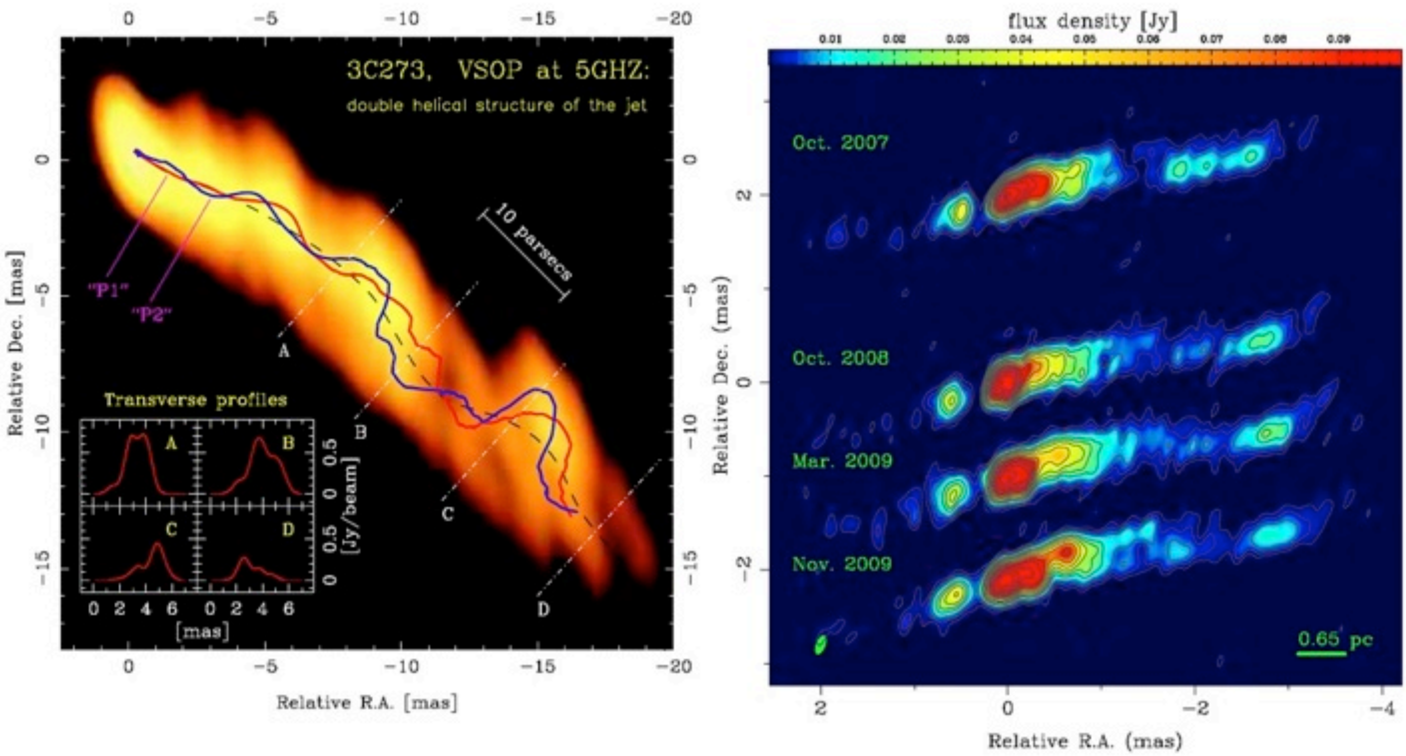


Figure 3: (Left): HALCA+VLBA+Effelsberg 5 GHz Space-VLBI image of the inner-most jet regions of 3C273, December 1997 (courtesy Andrei Lobanov). (Right): Sequence of images of the nucleus of CygnusA made from 43GHz EVN+VLBA VLBI observations. The vertical spacings between the images are proportional to the epoch separations (courtesy Uwe Bach).

Since the angular resolution of an interferometer is proportional to observing frequency there has always been an understandable push for VLBI at higher frequencies. First Effelsberg fringes at 43 GHz were obtained in October 1984, and at 86 GHz in July 1992. In 1996 Effelsberg joined US mm observatories and IRAM in the formation of the Coordinated Millimeter VLBI Array, achieving angular resolutions of ~ 50μ-arcseconds. Since 2003 MPI has lead the operation of its successor, the Global 3 mm VLBI Array (GMVA), with observing sessions twice a year. Higher resolution at cm wavelengths can only be achieved with baselines to space antennas. The era of Space VLBI started in 1997 with the launch of the Japanese 8-m telescope HALCA, under their VLBI Space Observatory Program (VSOP). During the 3-year mission, Effelsberg was a much-used ground telescope for observations with HALCA. On 18th July this year the Russian space-VLBI telescope Radioastron was launched. It has a 10m diameter and orbits the Earth every 8.3 days. It is expected that Effelsberg will play a key role for some of the observations to be done with this mission

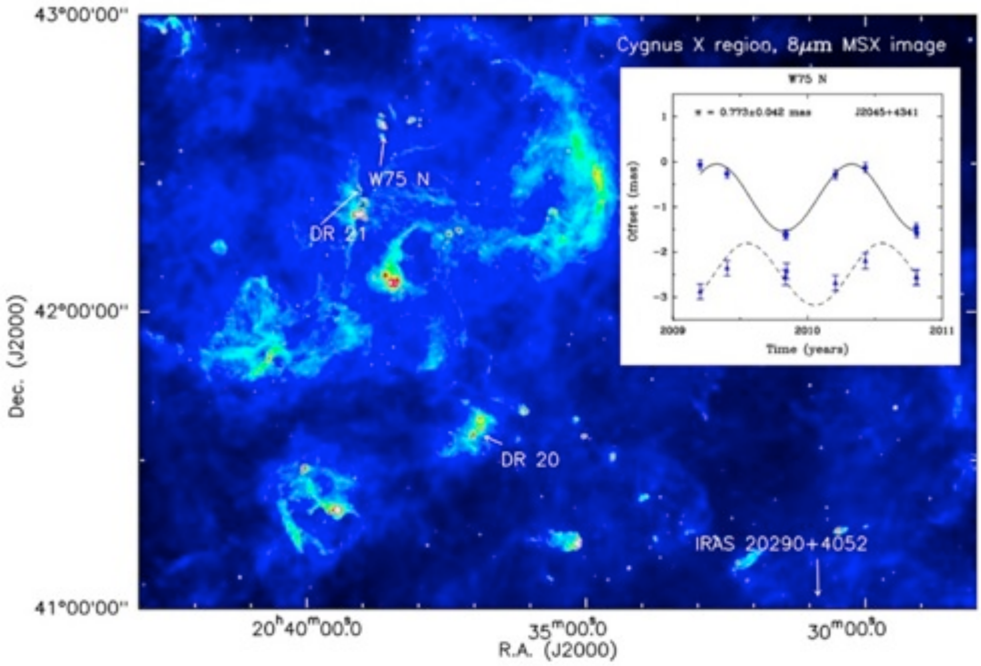


Figure 4: The inset shows the parallax fit for 8 epochs (2009-2011) of EVN 6.7 GHz methanol maser observations of W75N in the Cygnus X region (shown as an MSX 8 micron map as the background). The solid line represents the fit in right ascension and the dashed line in declination. A preliminary distance estimate is 1.3 ± 0.07 kpc (courtesy Kazi Rygl).

The last decade has seen further growth in Effelsberg's VLBI capabilities. In 2004 recording on tape gave way to recording on computer disks using the Mk5(A,B,C...) system. VLBI with NO RECORDING at all started in Effelsberg in 2008, with the completion of the optical fibre link to Bonn, allowing real-time VLBI to be made, together with some of our EVN partners and the EVN correlator at JIVE, in Dwingeloo. This EVN e-VLBI network is an officially designated SKA Pathfinder. This year the analogue electronics rack of the MkIV system has been replaced by the DBBC (Digital Base Band Converter; see article in May 2011 Newsletter) and a similar transformation for the VLBA rack will happen soon. In the coming years Effelsberg can look forward to a very productive contribution to VLBI, with its partners in the EVN, with the VLBA, the HSA, the GMVA and Radioastron.

Who is Who in Effelsberg ?

Ralf Kisky >> Telescope Operator

Ralf Kisky is member of the Effelsberg telescope operator's team. Before he started working for the MPIfR in 2007 he was employed in the biggest electronic company in Germany for 25 years. In this company he trained for a profession in telecommunications. After three and a half years training he started as field service technician for telephone systems.

A few years later he changed from field service technician to an office-based employee and worked as remote specialist for supporting customer systems (installation and maintenance). In the following years he worked as product specialist in the service department together with the development division. The products were designed for the international market and were tested at customers in Germany to generate best quality. On the base of his experience he started to work as project manager and editor for technical publication in the same department. Now he makes use of his skills in daily work as telescope operator at the MPIfR.

Ralf lives in Bonn with his wife and in his spare time during the three shift system he loves to take a ride with his motorbike or to go in for sports. He likes to work at the computer, enjoys hiking in a beautiful piece of nature, to meet friends, to do a lot of other things or simply tries to relax ...

Public Outreach

Effelsberg in the Cartoon

by Norbert Junkes

The radio observatory and the 100 m radio telescope were featured in two succeeding issues of "Weite Welt", a monthly magazine directed at kids of age 11 to 16. The May issue presented the telescope even on its title page. This issue also contained an article, entitled "Auf dem Weg zu den Sternen" (On the Way to the Stars), describing the cosmic distance ladder and the astronomical walks near the radio telescope (see previous issue of this Newsletter).

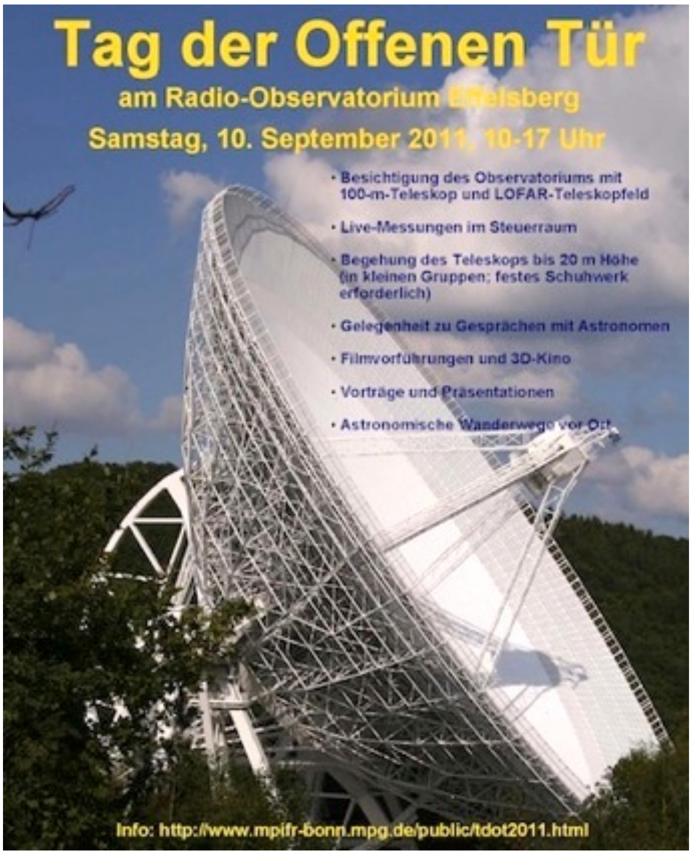
Moreover, two photo stories with pictures taken at the 100 m telescope and the control room of the radio observatory covered the following topics: 1) Sabotage at the radio telescope (May 2011) and 2) visitors from space (June 2011). According to the target audience of the magazine, both stories were told from the point of view of a group of kids visiting the radio telescope.

Open Door at the Effelsberg Observatory

September 10, 2011

On September 10, an Open Door took place at the Effelsberg Observatory. Having perfect weather, about 2500 visitors came to see the 100-m telescope, the LOFAR antenna field and the labs. Members of the MPIfR prepared an interesting program with scientific talks, and various scientific and technical presentations. Guests at the observatory could attend live pulsar observations in the control room of the 100-m telescope while listening to the explanations of Michael Kramer and his colleagues. The younger visitors could train their manual skills by soldering an electronic circuit under the guidance of colleagues from the receiver division. The highlight for most visitors was the possibility to enter the telescope towards the platform with the elevation drive in 20 meters height.

by Alex Kraus

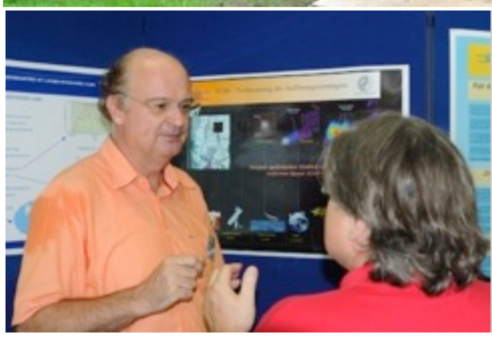
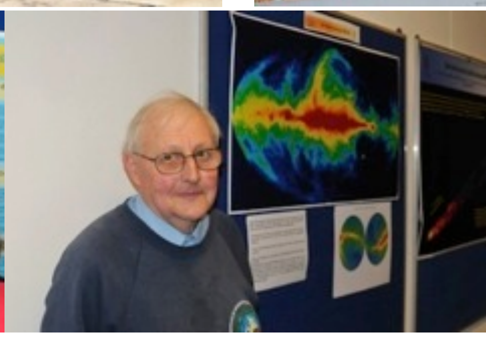


Open Door at the Effelsberg Observatory

September 10, 2011






Photos taken by Sener Türk, Karl Grypstra and Norbert Junkes


DMC

Front Cover Image: The winning image of the Effelsberg 40th Anniversary Photo Contest was taken by Stefan König. A number of finalist photos are shown below. All images can be viewed via:

http://www.mpifr-bonn.mpg.de/div/effelsberg/40years/gallery.html

"Das Radioteleskop in der Landschaft"


2. Klaus Völkel


3. Marcel Pawlowski


4. Katharina Pingel


5. Reinhard Simmuteit


6. Gerd Fingerhuth


7. Marcus Schwabe


8. Gerhard Henning


9. Nicole Merkes


10. Abdyl Berisha

Effelsberg Newsletter

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