ASTRON

Annual report 2012

Cover photo: a small window onto the 150 MHz sky, as viewed by the LOFAR Multifrequency Snapshot Sky Survey (MSSS). This image shows the central 150 square degrees of a 32-field mosaic produced using MSSS data, at 2 arcminute resolution and with an image noise of 10 mJy/beam. The full MSSS survey covers an area over 100 times larger, and the survey observations at these frequencies are projected to be completed by mid-2013. Credits: George Heald (ASTRON) and the MSSS Team.

Photo on this page: Low Band Antennas of the LOFAR telescope with deer grazing in between them.

Facts and figures of 2012

Contents

Director's Report

2012 has seen a strong focus within ASTRON on getting the LOFAR telescope ready for the winter observing campaign. A priority has been to ensure that we are ready to take science quality data over a broad range of different Key Science Projects, with a particular emphasis on the EoR (Epoch of Reionisation) experiment. Over the summer and autumn period, various aspects of the LOFAR hardware were upgraded; in particular a problem distributing time coherently across the antennas has been solved by the addition of new hardware at all of the stations. This fix has improved the performance of individual stations by a substantial factor in some cases. In addition, a new 8-bit observing mode was tested and successfully introduced to the system - the advantage here is that we can trade bits for instantaneous bandwidth, the latter being important for many science applications and crucial for the EoR. In a single observing run, it is now possible to observe across almost the full HBA observing band, bringing the early HI Universe into view, from redshift 6 to 12. The first deep images coming from early observations of the North Celestial Pole (NCP) suggest that all these upgrades are paying dividends with noise levels continuing to scale with observing time in the expected way.

This year has also seen a huge amount of progress being made by the Square Kilometre Array (SKA) project. The SKA will be the next big radio astronomy project involving partners from all over the world. The Dutch community is keen to play a major role in the project, especially in the area of Low and Mid-frequency Aperture Arrays, not to mention the expertise we have in handling Big Data and calibration issues. In 2012, several major decisions were made in the SKA project. A dual site decision was adopted with the main dish and Mid-Frequency Aperture Arrays located in South Africa and a Low Frequency Array in Western Australia. ASTRON hopes to bring the expertise we have built up in LOFAR to the SKA table – especially in the area of Aperture Arrays, including systems that can work at GHz frequencies. Other major SKA milestones were the appointment of a new Director General (Philip Diamond) and the establishment of a new SKA Office at Jodrell Bank. For most of 2012, Michiel van Haarlem served as interim DG.

While LOFAR was surely ASTRON's main priority in 2012, the Focal Plane Array (FPA) upgrade of the Westerbork Synthesis Radio Telescope (APERTIF) also made good progress. One disappointment was the need to insert an uncooled filter in the APERTIF front-end, this has reduced the overall performance of the system by 20% and also limited the full observing band. This was necessary due to the need to suppress very strong radio frequency interference induced by nearby radio and TV transmitters. Nevertheless, the aim is to achieve a system temperature of ~75K on the new FPAs, and this, coupled with the greater field of view (and indeed dish efficiency), makes APERTIF a very competitive survey instrument. ➔

Another high point this year was the continued collaboration between ASTRON and IBM. This has now developed into the establishment of a Center for Exascale Technology in Dwingeloo, otherwise known as DOME. Via DOME, ASTRON and IBM jointly carry out fundamental research into the technologies needed to develop the next generation radio telescopes, such as the SKA. The research addresses three main areas: green computing, Nano-photonics and Data & Streaming. Towards the end of the year, the South African SKA team also joined the project. DOME is supported by grants from the Dutch EL&I Ministry and the Province of Drenthe, and is part of ASTRON's contribution to the 'top-sectoren'.

Finally, I want to end on another high note - we were delighted to hear in 2012 that Prof. Raffaella Morganti (Head of the Astronomy Group) was awarded an ERC Advanced Grant worth 2.5 MEuro. This is yet another individual award secured by our staff over the last few years and with more ERC applications already in the pipeline, our policy of growing the Astronomy Group via external funding is beginning to really bear fruit. In 2012, I was extremely proud to note that the institute published almost 200 refereed papers- that's about five times more than in 2007 and makes us one of the largest and most successful astronomy and technical research centres in the Netherlands. We've come a long way but perhaps the best is yet to come!

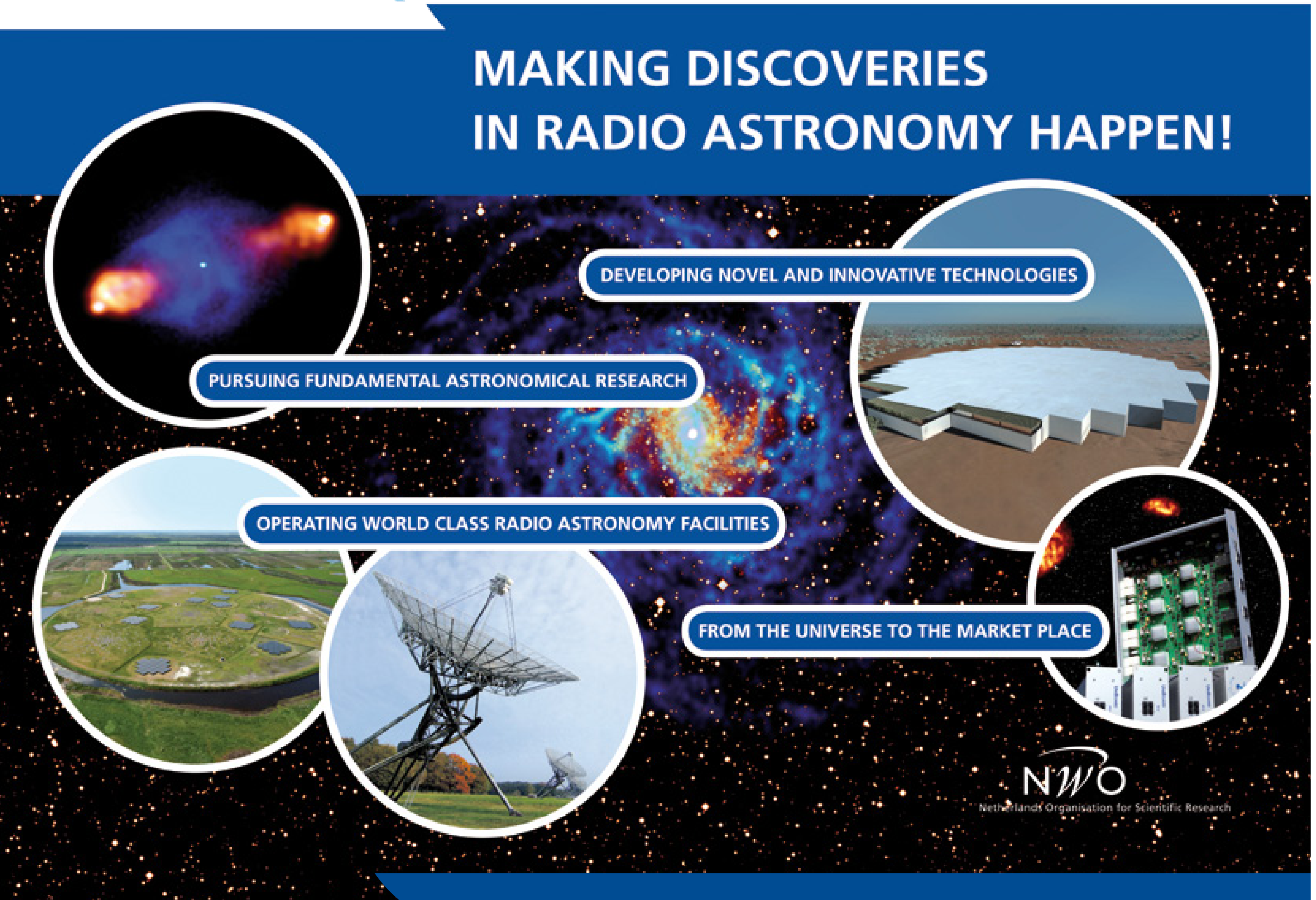
Prof. Mike Garrett
General Director, ASTRON

ASTRON Board and Management Team

The ASTRON board members, NWO and ASTRON MT members. From left to right: Prof. dr. J.T.M. de Hosson, Prof. dr. J.C.M. van Eijndhoven, Prof. dr. ir. J.A.M. Bleeker, Drs. J.P. Rijsdijk, Drs. S.B. Swierstra, Drs. P.G. Vogel, Prof. K.J.F. Gaemers, Prof.dr. M.A. Garrett, Dr. C.M. de Vos.

The ASTRON MT and the head of the SKA NL office, from left to right: Dr. René Vermeulen, Prof.dr. Michael Garrett, Dr. Marco de Vos, Prof.dr. Raffaella Morganti, Dr. Michiel van Haarlem (head of the SKA NL office) and Dr.ir. Albert-Jan Boonstra.

ASTRON Netherlands Institute for Radio Astronomy



ASTRON in brief

ASTRON is the Netherlands Institute for Radio Astronomy. Its main mission is to make discoveries in radio astronomy happen, via the development of new and innovative technologies, the operation of world-class radio astronomy facilities (the Westerbork Synthesis Radio Telescope and the International LOFAR Telescope), and the pursuit of fundamental astronomical research. Engineers and astronomers at ASTRON have an outstanding international reputation for novel technology development and fundamental research in galactic and extra-galactic astronomy. ASTRON hosts the Joint Institute for VLBI in Europe (JIVE) and the Optical/Infrared instrumentation group of NOVA (the Netherlands Research School for Astronomy).

ASTRON is an institute of the Netherlands Organisation for Scientific Research (NWO).

Organisation & Governance

ASTRON is a foundation under Dutch law with an oversight Board. Executive authority is vested in the directorate consisting of Prof.dr. Michael Garrett, Scientific Director and Director General, and Dr. Marco de Vos, Managing Director and Deputy Director General. They report to both the ASTRON Board and the Director of NWO. NWO is also the formal employer of ASTRON staff.

The ASTRON Director General is advised by an international Science Advisory Committee (SAC) on all aspects of the institute's programme. A telescope Programme Committee sets priorities for allocating observing time on ASTRON's telescopes.

The ASTRON Management Team consists of the directorate and department heads.

The International LOFAR Telescope

ASTRON designed and built the International LOFAR Telescope (ILT). LOFAR, the Low Frequency Array, operates at the lowest frequencies that can be observed from Earth. With LOFAR astronomers can look back billions of years to a time before the first stars and galaxies were formed, the so-called 'Dark Ages'. Much of the infrastructure that was needed to build this new radio telescope can also be used by other applications. The common theme throughout is the collection, transport and real-time processing of enormous quantities of data from sensors distributed over a large area.

LOFAR will address some of the most important questions in modern astronomy and astrophysics. The key science projects are:

- The Epoch of Reionization
- Deep extragalactic surveys
- Transient sources and pulsars
- Ultra high energy cosmic rays
- Solar science and space weather
- Cosmic magnetism

The Westerbork Synthesis Radio Telescope

ASTRON operates the Westerbork Synthesis Radio Telescope (WSRT). The WSRT has been built in 1969-1970. The WSRT is one of the most sensitive radio telescopes in the world and offers astronomers the chance to study a wide variety of astrophysics problems. The telescope consists of fourteen parabolic (dish) antennas of 25-meter in diameter.

In the APERTIF project, advanced receiver technology is developed for the WSRT, creating a two-dimensional radio 'camera' in the focal point of twelve of the dishes. This will increase the field of view of all the antennas by a factor of almost forty. Astronomers can thus quickly survey large parts of the sky, leading to a dramatic increase of the discovery space. With APERTIF, the WSRT will be once more brought to the forefront of radio astronomical facilities. →

Astronomy Group

The Astronomy Group is engaged in many frontline research areas. Hydrogen is studied in both nearby and the most distant parts of the Universe. The Transient Universe is characterized at the shortest possible time-scales. The magnetic Universe is studied, from galaxies to clusters. The group is involved in the commissioning of LOFAR and in all LOFAR key science projects, as well as in the development of other new instruments like the pulsar machine PuMa-II and the APERTIF system mentioned above.

Research & Development laboratories

The ASTRON Research & Development (R&D) laboratories focus on innovative instruments for existing telescopes, such as the Westerbork telescope and LOFAR, as well as on developing technologies for future observing facilities, such as the Square Kilometre Array. The technical laboratory has several unique facilities at its disposal, such as an anechoic chamber, a clean room facility and an outdoor antenna test location. These serve both research and development of astronomical instruments and other product development.

Target areas in R&D for the Square Kilometre Array are Smart Antennas (Aperture arrays and Phased Array Feeds) and Science Data Processing (Calibration and Data Intensive Computing).

The R&D department is organized along the main disciplines: antennas, low noise systems, digital and embedded signal processing, computing, mechanics and system design and integration.

Technology Transfer

ASTRON implements its mission in such a way that the benefit for industry and society is maximised. Partnerships in large development projects are a key aspect of ASTRON's Technology Transfer strategy. ASTRON is a top international research institute and as such offers its partners access to knowledge, expertise and networks. From the perspective of the Top sectors in the Netherlands a project such as the Square Kilometre Array (SKA) is primarily an international technology programme based on a challenging case: a global consortium to build the world's largest and most sensitive radio telescope. Such a 'Big Science PPP' (Public-Private Partnership) offers unique possibilities for technology development and human capital development.

The ASTRON organisation in 2012.

Contribution to top sectors

In addressing the big questions of physics, ASTRON is facing the big challenges of technology. We therefore organize our projects such that they contribute maximum value to society and economy. This way, astronomy makes things happen in unexpected areas.

This is primarily achieved through 'Big Science Public Private Partnerships', where industrial partners benefit from the technology development required for large research infrastructures. Such collaborations lead to mutual benefit from the technology developments required by our new instruments. They also serve to interest young people in science and technology. Together with private partners, we bring technologies developed for radio astronomy 'from the edge of the Universe to the market place'.

This approach had been extended in the past years in line with the Dutch programme of top sectors. As an NWO institute, ASTRON is deeply committed to this strategy, within the boundary conditions of its mission. ASTRON contributes primarily to the top sector High Tech Systems and Materials (HTSM), where ASTRON is involved in the Components, Embedded Systems, Photonics and Space Roadmaps, as well as in the ICT Roadmap. The main projects through which a contribution could be made in 2012 were SKA-NN and DOME. SKA-NN is a Public-Private Partnership (PPP) consisting of ASTRON and four industrial partners, jointly developing technology and prototypes for SKA Aperture Array systems. The DOME project is executed by the ASTRON and IBM Center for Exascale Technology.

In all industrial collaborations and the economic valorization of our research, we consider it important to remain true to our mission and identity. ASTRON wants to be an excellent knowledge institute rather than a mediocre entrepreneur. Our gain in economic valorization is most often knowledge and reputation, private partners gain from the new business potential directly. We work both with techno-starters and medium-sized production companies. In our valorization activities, we cover both academic, polytechnic (Dutch HBO) and engineering (Dutch MBO) skill levels.

An important role of our valorization programme is to stimulate young people to choose a career in science and technology. Here we use the full appeal of both our astronomy and technology programme. We are convinced that society needs scientific and technical skills at all levels and of all kinds. Without fundamental science, applied sciences come to a halt very soon. Therefore we highly value our astronomical outreach programme and consider it our responsibility to contribute to the wider community in this way.

Top sectors in the Netherlands

The Dutch cabinet invests in research and innovation within a number of top sectors. NWO links the ambitions of the top sectors to the financing of scientific research within the top sectors. In 2012-2013, NWO invests 225 million euro from its own funds in fundamental research within the top sectors. A large part of this contribution concerns theme programmes, focused on the top sectors. Many of these programmes are aimed at public-private partnerships and demand a financial contribution of the participating private parties.

Besides this, the NWO institutes contribute considerably with their research lines and national research facilities, and the associated first-rate technology development. They actively cooperate with different companies in and outside their region. ASTRON contributes primarily to the top sector High Tech Systems and Materials (HTSM).

Photo: ASTRON headquarters before the building process, as seen from above.

Connected legal entities

ASTRON has three connected legal entities: AstroTec Holding B.V. (ATH), the LOFAR Foundation/Limited Partnership and the International LOFAR Telescope Foundation (ILT).

AstroTec Holding B.V.

ATH is a wholly owned subsidiary of ASTRON to facilitate commercial activities that require a joint venture or private partner. ATH is governed by a small Board of Commissioners who report to the shareholder, ASTRON. In 2012, ATH participated in three companies, all start-ups that originated from ASTRON or LOFAR developments. Filitron, developing RF-ID technology, continued to be dormant in 2012. Two of the shareholders (ATH and S&T) are considering a restart focusing on embedded processing applications, rather than on the radio component. DySI, developing software for dynamic system intelligence, continued its steady growth, broadening the technical basis to data analysis in the health care sector and introducing new hardware/service combinations. Dutch Sigma is working towards market introduction of the optical precision scanner in 2013.

In 2012, two RF Courses were offered by ATH, which were again evaluated very positively by the participants. ATH is now also responsible for the handling of export and installation of international LOFAR stations. Especially as new manufacturing tenders are needed for additional stations, this is better handled through a private company than through ASTRON. The Hamburg station was the first LOFAR station handled in this way.

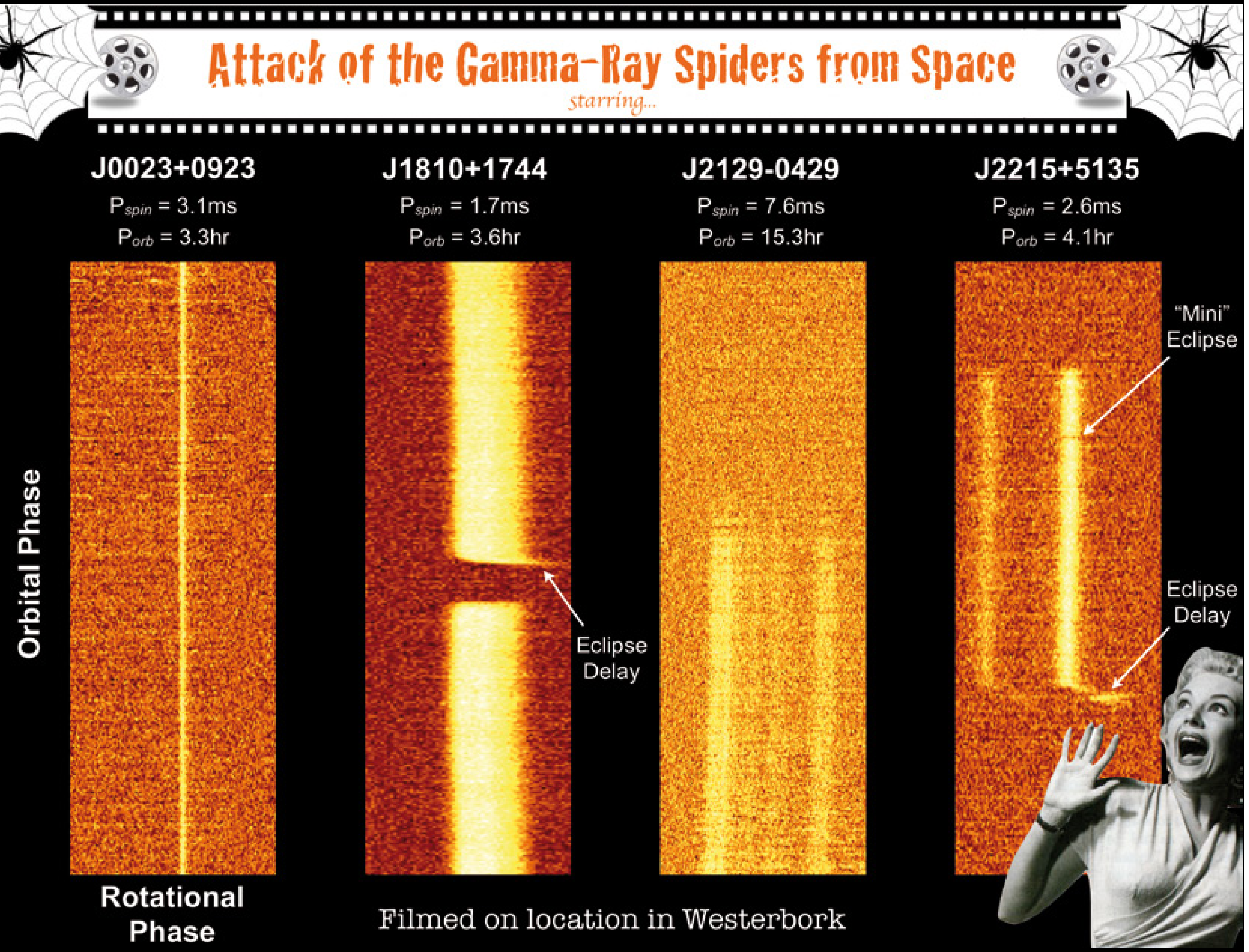
ATH was further involved in several technology transfer initiatives that are likely to result in new business initiatives and gave support to an ASTRON startup (MCC), as yet without taking a share in the company.

LOFAR Foundation/Limited Partnership

To develop, operate and exploit the LOFAR sensor network, a Limited Partnership (Dutch: Commanditaire Vennootschap) was established by the partners. The LOFAR Foundation is the sole general partner ('beherend vennoot'). With LOFAR being an operational entity, the role of the LOFAR Foundation is primarily to handle contracts. The LOFAR infrastructure is rented out commercially to various users, including the ILT. In 2012, the contract with the ILT was completed. Contracts with TU/Delft (Geophysics) and KNMI (Infrasound) were negotiated. The contract with TU/Delft is expected to be processed early 2013. The LOFAR Foundation will search for new potential users of the infrastructure, in particular to help continue that Infrasound application. Limited capacity is available however, and new applications will have to be developed through the technology transfer offices of the partners.

International LOFAR Telescope Foundation

The ILT has been established for the operation of LOFAR as a radio telescope. The ILT was founded in November 2010 as a Foundation under Dutch law. International partners joined in June 2011: the German GLOW consortium, the French FLOW consortium, LOFAR Sweden and LOFAR-UK. All these consortia own one or more LOFAR stations, which are used in connection with the fourty LOFAR stations in the Netherlands and the central computing facilities. The partners share the cost of the central functions in an agreed ratio and support their national stations. ASTRON provides the staff for the central support. The General Director of ASTRON is member of the ILT Board. The ILT Director is seconded from ASTRON, the current director is dr. René Vermeulen.



Millisecond pulsars spin hundreds of times a second. Some millisecond pulsar binary systems also show eclipses and other timing irregularities, which are due to the strong wind of the pulsar ablating material from its companion and thereby creating a cloud of gas that can affect the observed radio pulsations. Such systems are traditionally referred to as 'black-widows', in analogy to the cannabalistic, companion-eating spider of the same name. As part of a coordinated survey of unidentified Fermi gamma-ray sources by the 'Pulsar Search Consortium', astronomers discovered upwards of ten black-widow pulsars. This image shows ~5-hr Westerbork observations of four of the new pulsars, using the PuMaII pulsar backend. These reveal the eclectic eclipsing behavior of these sources.

Performance indicators

Publications

The pie chart below shows the number of publications, such as refereed articles and conference proceedings, published in 2012 by the astronomers and engineers of ASTRON.

#ASTRONtweets

ASTRON - Mike Garret @ASTRON_LOFAR 31 may
'ASTRON listed in top 10 knowledge and research institutes in the Netherlands 2012 - 'nough said!'
technischweekblad.nl/Uploads/2012/4/07-TW14-Tabel-Top-30.pdf

Observing time on the Westerbork telescope

The Westerbork Synthesis Radio Telescope (WSRT) again achieved a very satisfactory 70% yield net 'science time': 6114 hours (69.6% of the year) were observed, excluding all overheads. Only 51 hours needed to be repeated because of failures. An additional 1134 telescope hours were spent on general calibration, tuning, regular maintenance, and limited software development work; the remaining 1560 hours were unallocated due to inevitable gaps related to scheduling mostly 12-hour full synthesis observations on this east-west array. Of the science time, 890 hours were for participation in (e)EVN and Global VLBI projects (648 disk-recorded, 242 e-VLBI).

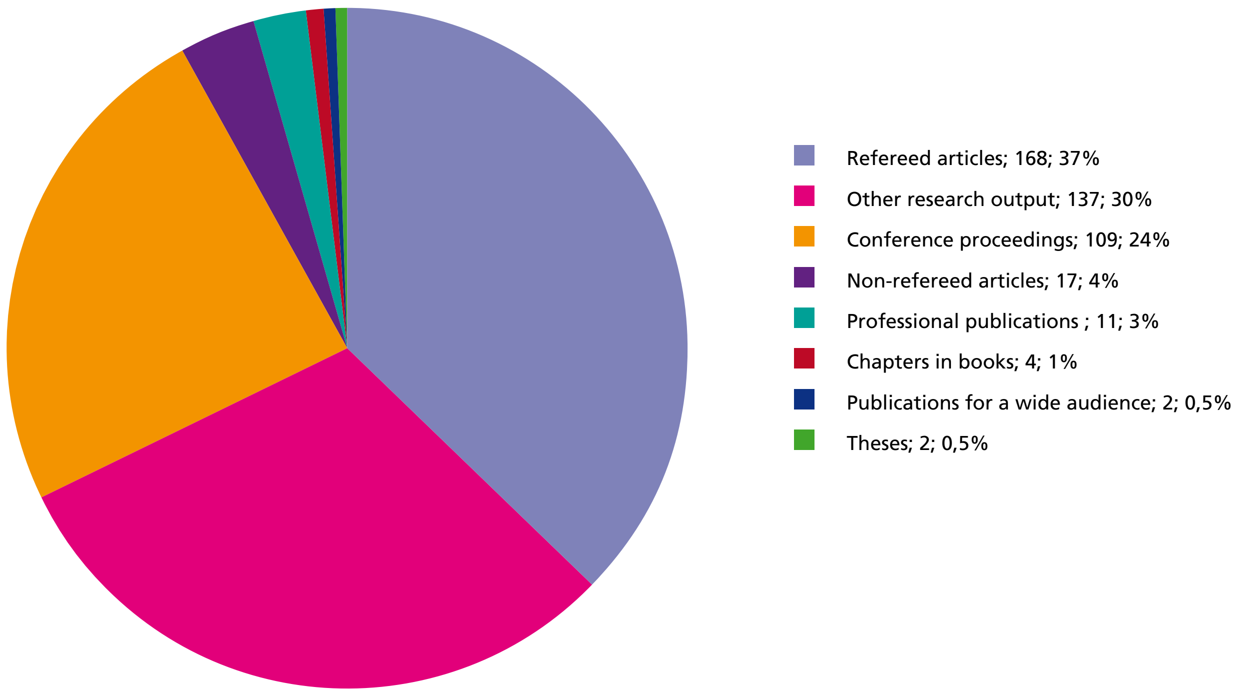
The International LOFAR Telescope

Operations with the International LOFAR Telescope (ILT) in 2012 were mostly devoted to supporting coordinated system development and integration tests. Still, 1786 hours were spent in production mode on Beam Formed, TBB, and interferometric observing runs. The latter were divided among commissioning projects (376 hours) and the ongoing Multifrequency Snapshot Sky Survey (MSSS, 566 hours). Cycle 0 production observing, which started on 1 December 2012, took up 205 hours.

Time allocation on the telescopes

Time allocation on the Westerbork Synthesis Radio Telescope

The Westerbork Synthesis Radio Telescope (WSRT) followed the customary semi-annual observing proposal cycle. As illustrated in the first two diagrams on page 16, there were only 19 proposals in semester 12A; an unusually small number. →



The different research output of ASTRON in 2012. Behind each category, the number of publications in that category is listed as well as the percentage. Legend:

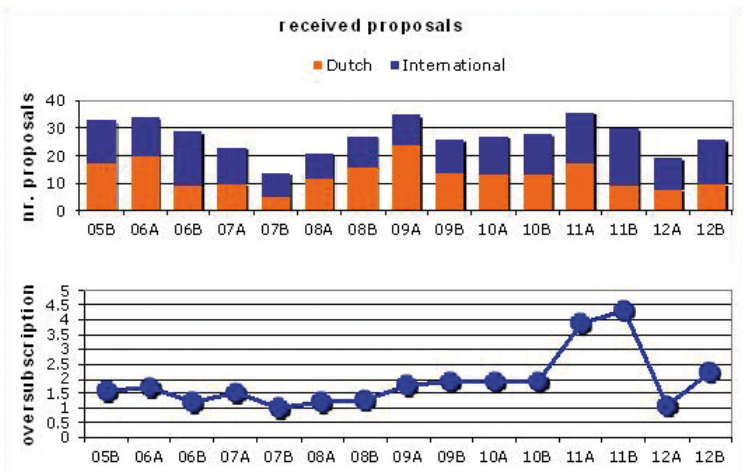
Refereed articles:	articles published in scientific journals that use an anonymous peer review system, which is separate from the editors.
Non-refereed articles:	publications in journals that are non-refereed, but considered important by the field.
Chapters in books:	contributions to scientific books aimed at an audience of scientists and researchers.
Theses:	publications in which the doctorate was obtained.
Conference papers:	complete articles published in the context of a conference (proceeding).
Professional publications:	publications intended for professionals in the public and private sectors including annotations.
Other research output:	abstracts, editorships, inaugural lectures, designs and prototypes and media appearances.
Publications for a wide audience:	popular publications on results of scientific research.

This recovered to the more typical number of 30 proposals in semester 12B. Correspondingly, the oversubscription rate, which in 2011 had been sharply above the long-term average factor of 2, fell below average for semester 12A, but then recovered in Semester 12B. The temporary dip in demand for Semester 12A can be interpreted as an after-effect of the surge in 2011 of large legacy projects that were kicked off before the planned replacement of the current generation of multi-frequency frontend receivers by Apertif: many groups were apparently so heavily engaged in processing and interpreting their legacy datasets, that they postponed the submission of new proposals. As shown by the oversubscription and allocation statistics diagrams, however, the demand still outstripped the available time throughout the year, and several proposals had to be rejected or trimmed down. The receiver usage statistics (see figure bottom right) show the classical preponderance of 21+18 cm observing, playing to the dominant strength of the WSRT for line and continuum imaging in this band, plus a somewhat higher than usual fraction of 6 cm observing, mostly related to transient source follow-up, which is increasingly occurring on the WSRT.

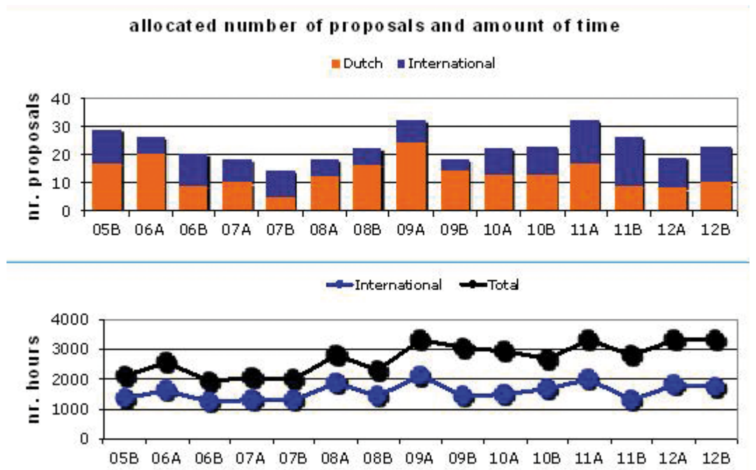
Time allocation on the LOFAR telescope

LOFAR early access proposals, submitted in 2010, continued to serve as the basis for the early-science observing programme in 2012. The Technical Advisory Group (TAG) and the LOFAR Commissioning Coordination Group (LCCG), which also met regularly with the PIs of the LOFAR Key Science Projects, carefully monitored the commissioning needs. A total of 33 commissioning projects, which combine commissioning goals with early science potential, were submitted for approval to the Technical Advisory Group (TAG) in 2012. Of these, 30 were observed and by the end of the year, 21 commissioning reports had been delivered by the teams either in written form to the TAG or presented at LOFAR Status Meetings.

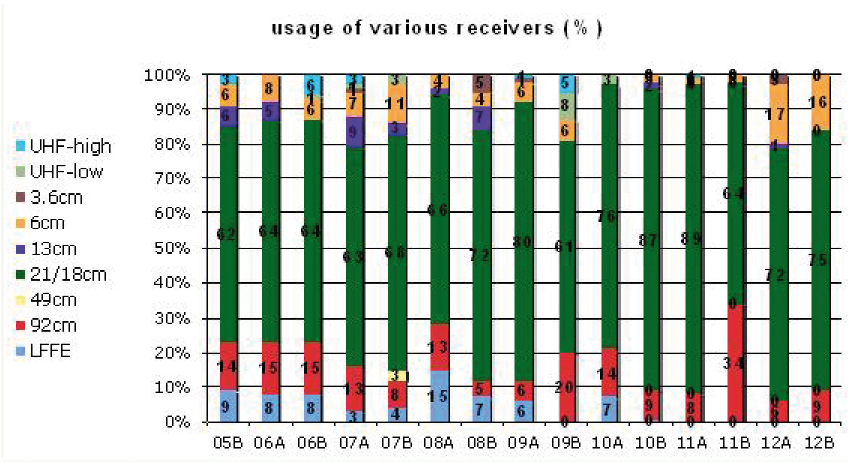
The first operational cycle of LOFAR, Cycle 0, was started on 1 December 2012, after thorough characterization ➔



Proposal Statistics



Allocation Statistics



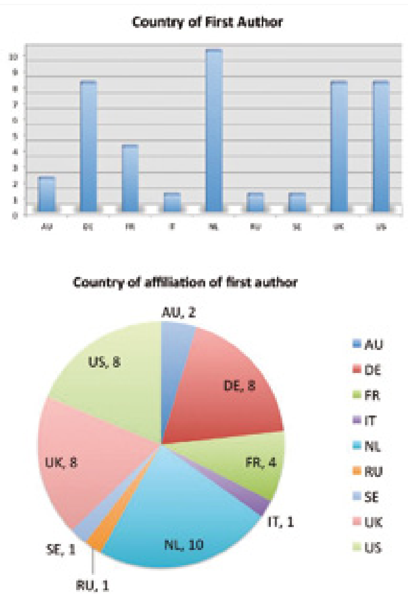
Receiver Usage Statistics

of the functional modes and system performance. To kick-start the operational period of the International LOFAR Telescope (ILT), the ILT Board mandated an iterated cycle of proposal calls, open to the worldwide astronomical community. For Cycle 0, 10% of the time was distributed purely on scientific merit, with the remaining allocations in part reflecting national interests in each of the LOFAR national consortia that participate in the ILT.

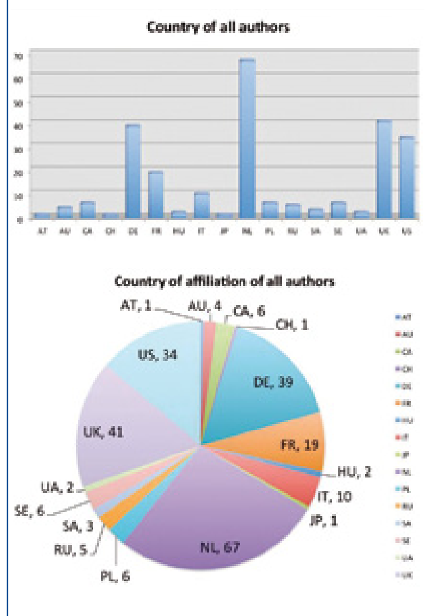
First, Reserved Access Proposals were solicited for a deadline of 5 March, to describe long-term, large-scale, astrophysically and observationally cohesive programmes. Seven proposals were received; all were from (groups within) the LOFAR Key Science Project teams. Review involved the observatory-led Technical Review Panel, that met face-to-face, and the independent ILT Program Committee, that met via telecon. The National LOFAR Consortia (GLOW, FLOW, NLLAC, LOFAR-Sweden, and LOFAR-UK) then decided on 'umbrella' observing and processing time reservation for these projects, using part of their reserved access quota for Cycle 0.

Regular Proposals for specific focused observing projects to be carried out in Cycle 0 were then solicited in a follow-up proposal call, with deadline 17 September. In total, 43 proposals were received. The Technical Review Panel produced reports on each Regular proposal. The 229 individual authors (some participating in more than one proposal) had affiliations in 16 countries. In the figures above we show the country of affiliation of the first authors of each proposal and of all individual authors.

Between them, the seven individual Reserved Access project leaders found a total of 33 of the 43 Regular Proposals to be eligible to receive a part of an 'umbrella' allocation for Cycle 0 (some were found eligible by more than one Reserved Access PI). The 'umbrella' shares were then distributed in detail by the national LOFAR consortia. With so-called 'may-sponsor' flags, each national consortium also decided which of the full



Country affiliation of the first author of the LOFAR Cycle 0 projects

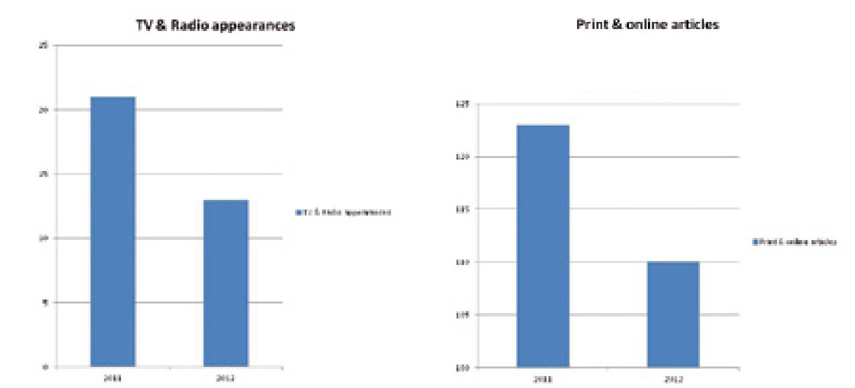


Country affiliation of all authors of the LC0 projects

set of 43 Regular Proposals were eligible for further detailed allocations from the remainder of its national quota for Cycle 0, made by the ILT PC in its face-to-face meeting on 28-29 November. Taking into account scientific merit and overall schedule productivity, the LOFAR PC also distributed the 10% Open Skies time available for Cycle 0. In view of the predicted ramp-up in observing efficiency, and also to accommodate night-time observing for a larger fraction of the proposed targets, the ILT Director decided during the PC meeting that Cycle 0 would run for nine months (1 December 2012 through 31 August 2013), whereas a half-yearly cycle had originally been anticipated. Even using this extended period, the total oversubscription in observing and CEP2 processing time still came to 133% and 169%, respectively. Of the 43 proposals, 38 were awarded some fraction of their requested time.

Public Relations activities

The year 2012 was, among other things, dominated by the launch of the ASTRON & IBM Center for Exascale Technology



In 2012, ASTRON staff was interviewed for radio and TV thirteen times, as opposed to 21 times in 2011. And in 2012, ASTRON appeared in print and online articles roughly 110 times. In 2011, this was about 123 times.

and the renovation of the old Dwingeloo Telescope. This in combination with the developments around the LOFAR telescope generated much media attention.

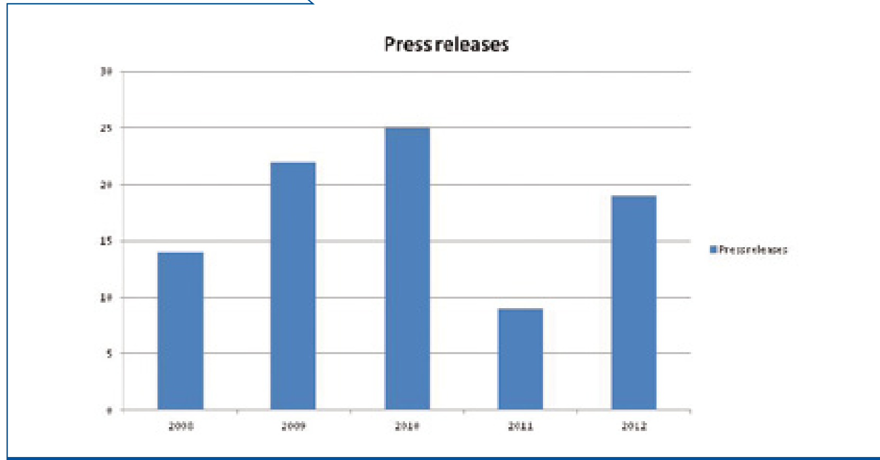
ASTRON issued nineteen press releases in 2012 and appeared roughly 110 times in print (newspapers and magazines) and online articles, and thirteen times on TV and radio. In the charts, we made a comparison with the number of press releases and media appearances of 2012 with the years 2008-2011.

ASTRON/ JIVE Daily Image

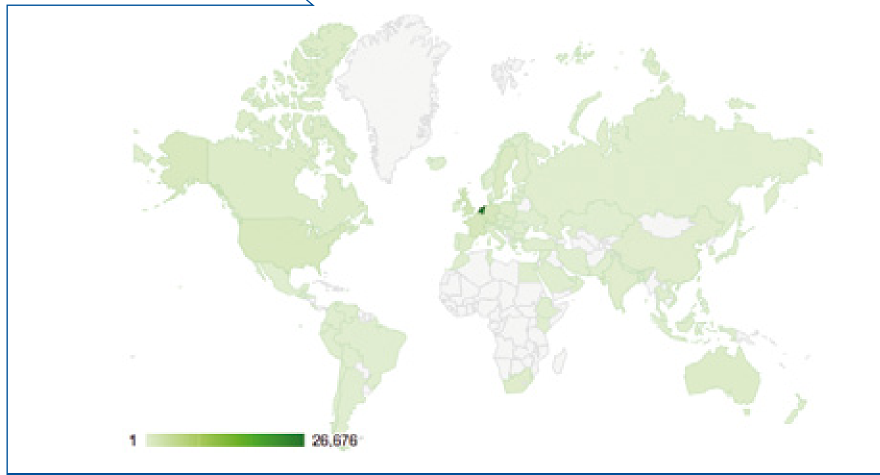
In 2012, the ASTRON/JIVE Daily Image counted 37,397 visits of which 7,957 are unique. The total number of page views is 265,221. The visitors came from 87 countries. Most visits are from the Netherlands, the UK, France, Germany, and the US.

The map shows the division of people all over the world visiting the daily image in 2012. Compared to 2011, overall visits have decreased by about 20%, unique visits by 30%. The reason for this decline is not clear.

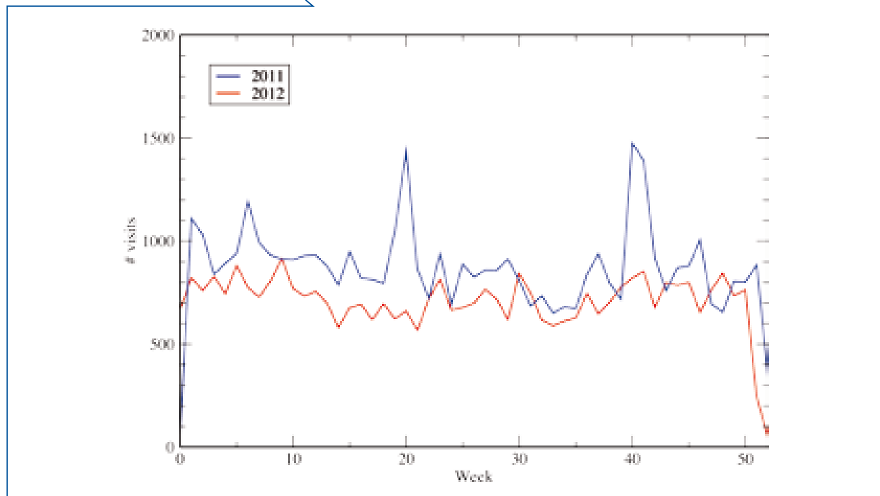
In the plot you can see a comparison between the weekly visits of 2011 and those of 2012. 2011 showed two weeks with very high 'scores' (around week 20 and week 40, after the outcome of the institute evaluation was made public), but they do not explain the difference. Somewhere halfway 2011, the number of visits to the daily image decreased and stayed more or less constant since then.



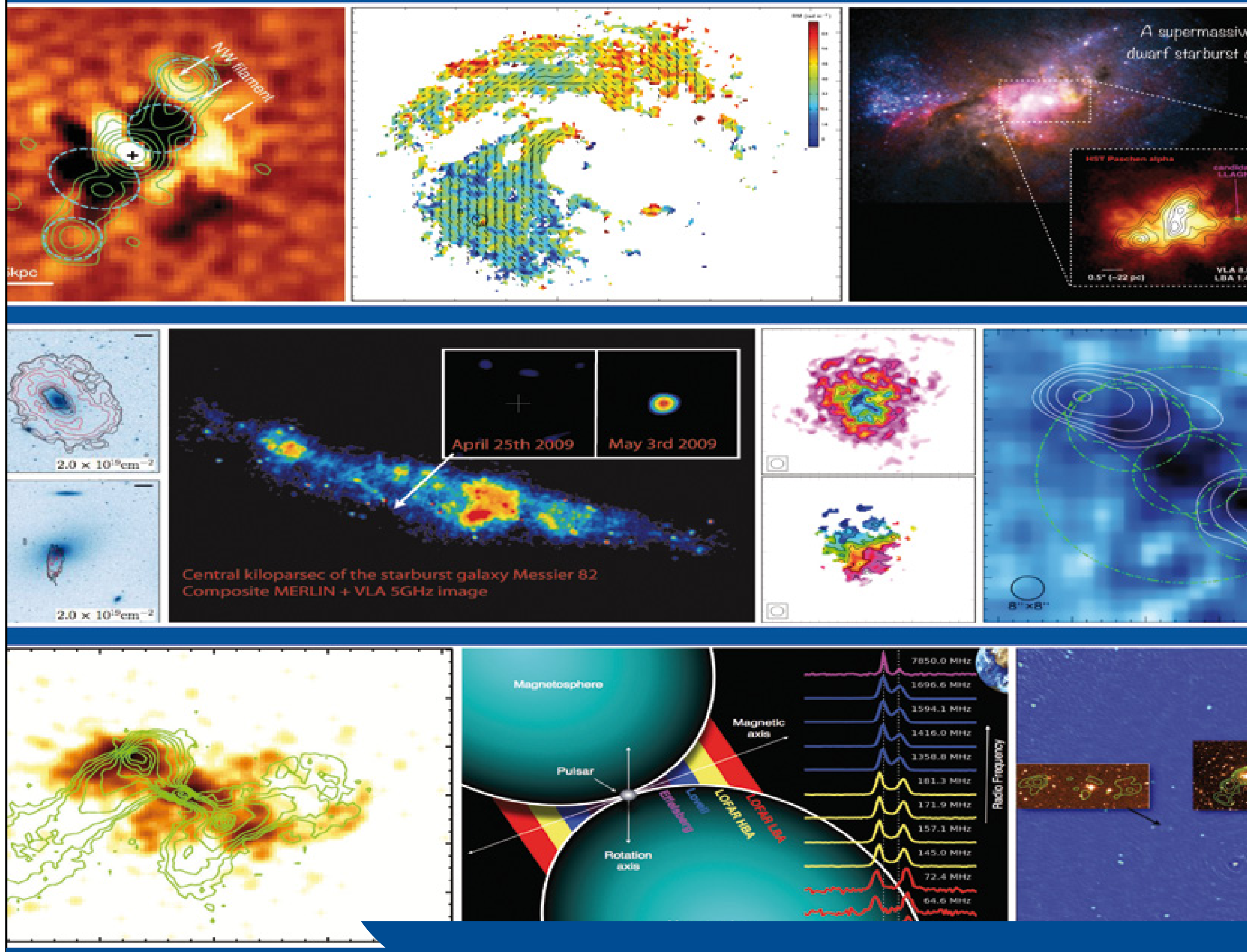
ASTRON issued nineteen press releases in 2012. In the chart you can see the number of press releases issued in previous years. Outliers are 2009 (the International Year of Astronomy) with 22 press releases, and 2010 (the year in which Queen Beatrix of the Netherlands officially opened the International LOFAR Telescope (ILT)) with 25 press releases.



The map shows the division of the number of people all over the world visiting the ASTRON / JIVE daily image in 2012.



Comparison of the weekly visits to the ASTRON/ JIVE Daily Image in 2011 and 2012.



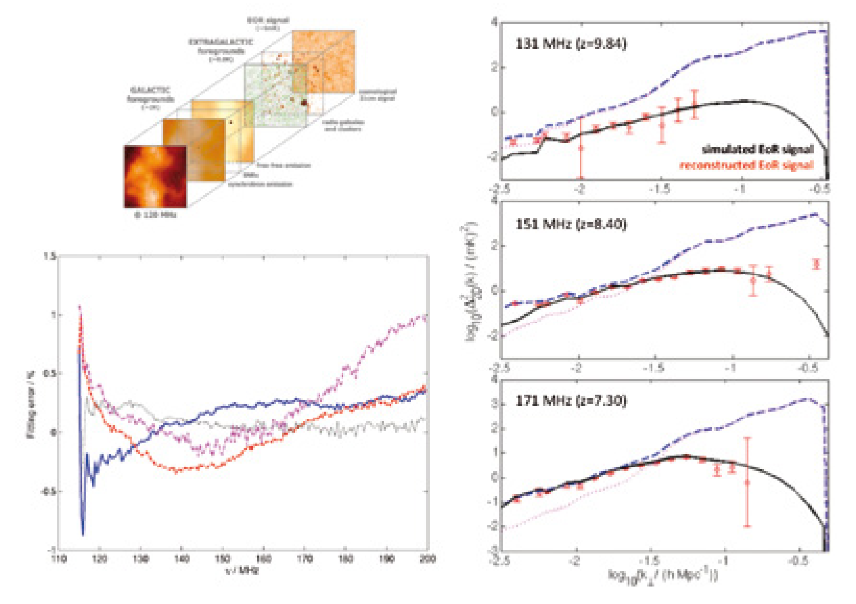
Astronomy Group

Science

For the fourth year in a row, the astronomy group publication list reached a record high. In 2012, 158 refereed papers were published in a series of high-impact journals: 2 in Nature, 39 in ApJL/ApJ/ApJS, 42 in MNRAS, and 29 in A&A. The highlights:

Epoch of Reionization and LOFAR

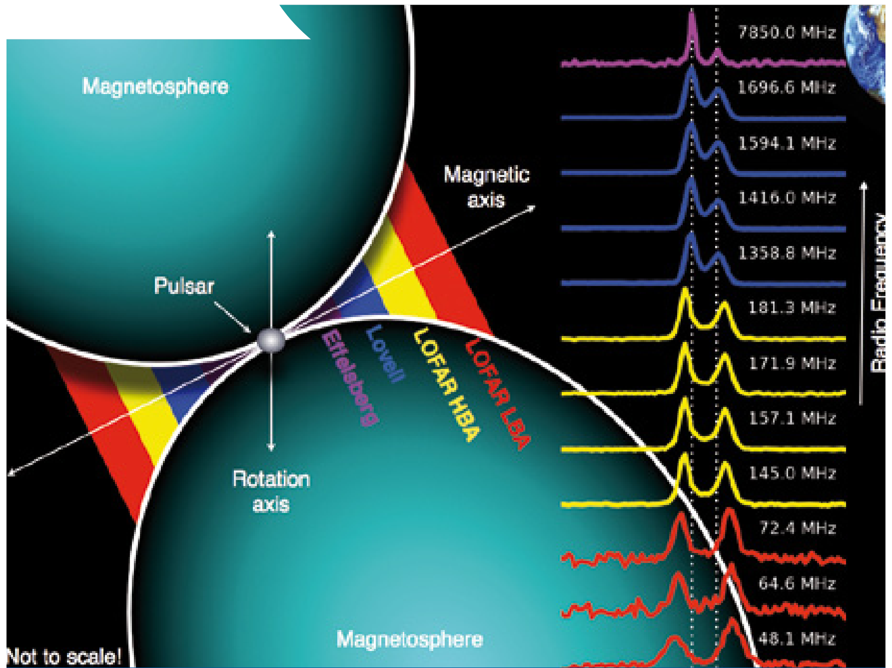
The LOFAR-EoR key science project will use the LOFAR telescope to detect the redshifted 21cm line of neutral hydrogen coming from the Epoch of Reionization (EoR). The EoR is a pivotal period in the history of the Universe during which the all-pervasive hydrogen gas was transformed from a neutral to an ionized state. It holds the key to structure formation and evolution, but also represents a missing piece of the puzzle in our current knowledge of the Universe. One of the major astrophysical challenges of the EoR experiments is the extraction of the EoR signal from the prominent Galactic and extragalactic foregrounds. Currently, there is no prevailing consensus on the most effective foreground removal method. In 2012 however, the LOFAR-EoR team (including ASTRON scientists Jelic, Labropoulos, Brentjens & de Bruyn) showed that the independent component analysis algorithm successfully removes the foregrounds (paper: Chapman et al. 2012, MNRAS 423, 2518).



Successful removal of the foreground emission in the EoR project.

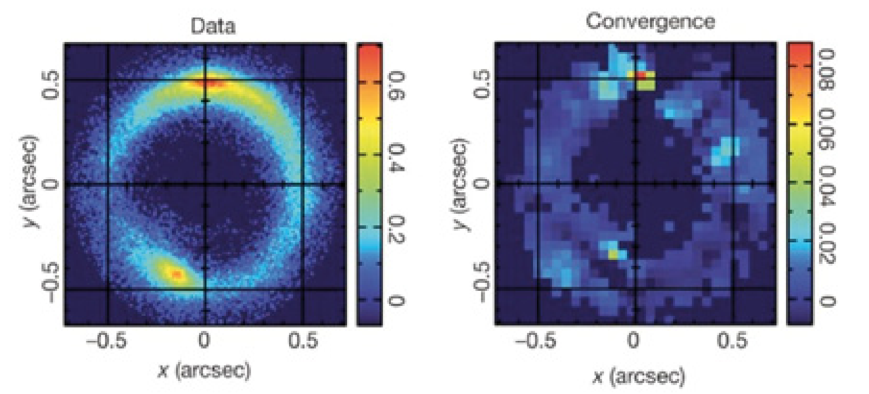
LOFAR observations illuminate pulsar profile variations

The second LOFAR pulsar paper, 'Wide-band simultaneous observations of pulsars: disentangling dispersion measure and profile variations' appeared in A&A in 2012. A team including researchers Hessels, Kondratiev and van Leeuwen reported the results of simultaneous observations of four pulsars using LOFAR, the Lovell and the Effelsberg telescopes at observing frequencies between 48 MHz and 8 GHz. In general, pulse profiles from radio pulsars are seen to get broader at lower observing frequencies. This can be explained by low frequency radio emission coming from higher up in the pulsar magnetosphere. In the standard model, radio emission is produced along dipolar magnetic field lines emanating from the magnetic poles, leading to a broadening of the average pulse profile as the field lines move further apart higher in the magnetosphere. This model also predicts that pulses from lower down in the magnetosphere (at high frequencies) should take a longer time to reach us than the pulses from higher in the magnetosphere (at low frequencies), as they have further to travel. By carefully timing when the pulses at different frequencies arrived at Earth it was possible to show that, for all four of the pulsars we observed, their radio emission is confined to a remarkably narrow range of heights above the neutron star surface. In the case of PSR B1133+16 (pulse profiles shown in the image below), this range is less than 110 km. →



Pulse profiles from PSR B1133+16, with color-coded emission heights.

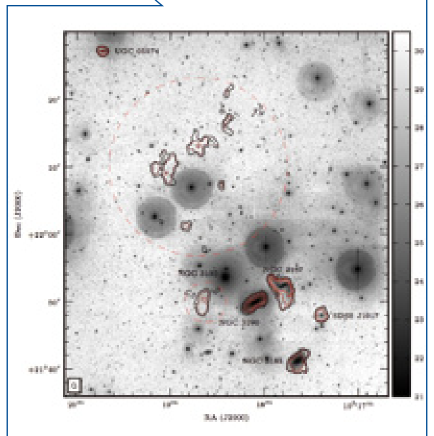
The pulse broadening which we observe cannot be explained by the curvature of a dipolar field in this narrow range of emission heights, suggesting that something may be wrong with our current model of pulsars. Further work needs to be done to reconcile these observations with theory. LOFAR will be vital for such studies since it probes the highest altitudes of the radio emission region (paper: Hassall et al., 2012, A&A 543, 66).



The infrared Einstein ring from the gravitational lens B1938+666. Data on the left, model output on the right.

Neutral hydrogen and Early-type galaxies

The Atlas3D project consists of a multi-wavelength study of a volume-limited sample of 260 nearby early-type galaxies, supported by semi-analytic models and N-body simulations. The team included Serra, Oosterloo and Morganti from ASTRON. In 2012, this team produced four new papers. The ASTRON researchers published the WSRT HI survey of galaxies in the sample. The main results of this paper are the high HI detection rate of early-type galaxies outside clusters (~40 percent); the high fraction of galaxies with very large HI discs and rings (half of the HI detections) and the correlation between a central HI detection and signatures of ongoing star formation. These results highlight that the family of early-type galaxies, often thought of as very regular (to the point of having sometimes been called boring) and homogeneous, is in fact composed of very diverse and heterogeneous systems which are still evolving under the major influence of the environment around them (paper: Serra et al. 2012, MNRAS 422, 1835).


In Atlas3D, compact group HCG 44 a giant HI tail was discovered.

Another highlight of 2012 is the publication of a Nature paper demonstrating that galaxies stellar initial mass function (IMF) is not universal but depends strongly on their star formation history. This work employs a unique combination of dynamical modelling based on optical integral-field spectroscopy and stellar populations analysis. It demonstrates that the IMF depends on the way galaxies formed their stars (e.g. in an intense and short burst as opposed to an extended period of moderate star formation). Different star-formation histories correspond to different physical conditions in which stars formed, and our result demonstrates that these conditions affect the relative number of stars of different mass (paper: Cappellari et al. 2012, Nature 484, 485).

Gravitational lensing: testing galaxy formation models on the smallest scales

The SHARP collaboration, which includes ASTRON astronomer McKean, studies the mass properties of gravitational lens galaxies. The main aim is to test galaxy formation models by measuring the mass function of low mass substructure in dark matter haloes. The first target of the survey is B1938+666, which shows an almost complete infrared Einstein ring of a radio-loud AGN at redshift 2.059 that is gravitationally lensed by a massive elliptical galaxy at redshift 0.881. Through Keck, a small perturbation in the surface brightness distribution of the ring emission was found. This perturbation can be explained by the presence of a 1.9 x 108 Msol substructure in the lensing halo. Note that the mass of the substructure is similar to that of the Sagittarius dwarf companion of our own Milky Way. Combining this result with the detection of a distant dwarf galaxy in another lens galaxy, the SHARP team were able to place the first constraints on the slope of the substructure mass function beyond our Local Group, finding a slope of -1.1 +/- 0.6. This is just consistent with the expectations from galaxy formation models with cold dark matter (paper: Vegetti et al 2012, Nature 481, 341).

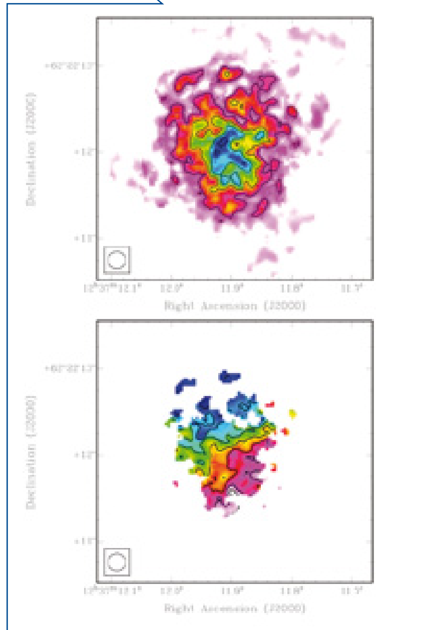
Evidence for a clumpy, rotating gas disk in a submillimeter galaxy at z=4

As part of an international team, ASTRON scientist de Blok investigated the dynamics of the CO(2-1) emission in the z=4.05 submillimeter galaxy GN20. These high resolution data allow us to image the molecular gas at 1.3 kpc resolution just 1.6 Gyr after the Big Bang. The data reveal a clumpy, extended gas reservoir, 14 ± 4 kpc in diameter, in unprecedented detail. A dynamical analysis shows that the data are consistent with a rotating disk of total dynamical mass 5.4 ± 2.4 1011 solar masses. →

We identify five distinct kpc–sized gas clumps in the disk of GN20 with masses a few percent of the total gas mass. Their volume densities are in the order of local giant molecular clouds (~100 cm−3), consistent with expectations for kpc–sized clumps in a high–pressure environment. A multiwavelength comparison demonstrates that the molecular gas is concentrated in a region of the galaxy that is entirely obscured in the rest–frame UV/optical (paper: Hodge et al. 2012, ApJ 760, 11).

Search for cold gas; the nature and evolution of 21-cm absorbers

While it is well established that absorbing gas is seen in the spectra of distant quasars, the exact nature and the underlying physical processes driving this gas is still a matter of debate. A systematic survey of 21-cm absorption in a sample of absorbers towards radio loud quasars allows us to measure the fraction of cold gas associated with these absorbers and investigate the physical conditions in the interstellar medium of distant galaxies. A paper led by Gupta (ASTRON) reported four new detections of 21-cm absorption from a systematic search of 21-cm absorption in a sample



CO maps of GN20.

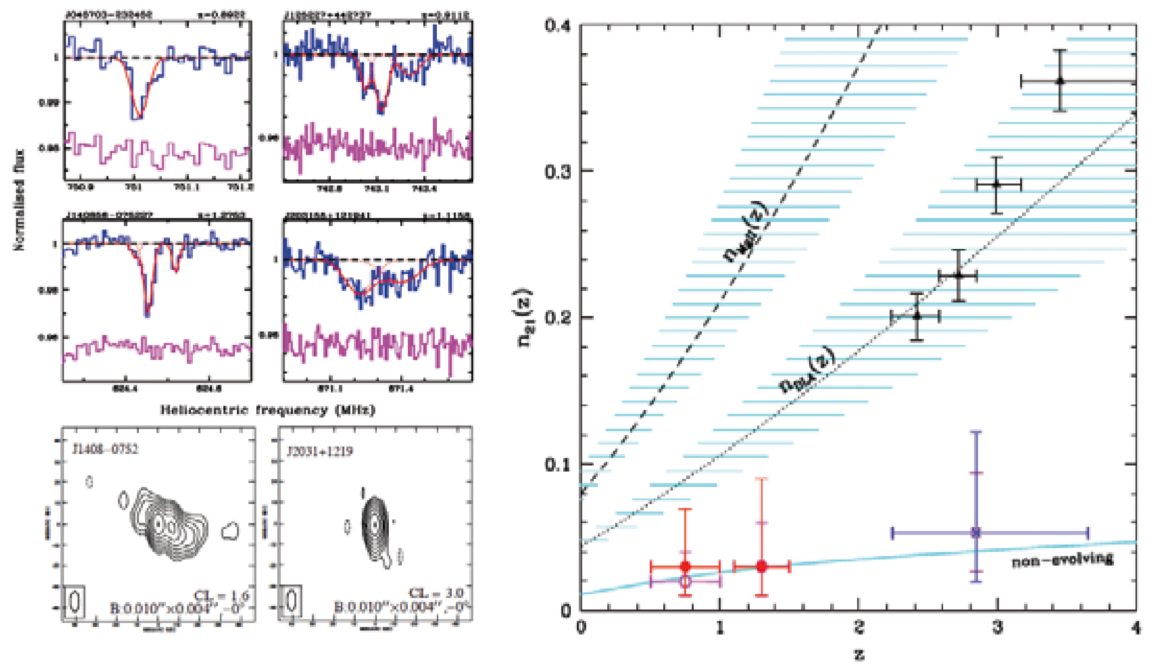
of MgII absorbers at 0.5 < z < 1.5. The observed detections can be understood if the absorbing gas is 'patchy' with a typical correlation length of ~30-100 pc.

VLBI observation of a probable AGN in a dwarf starburst galaxy

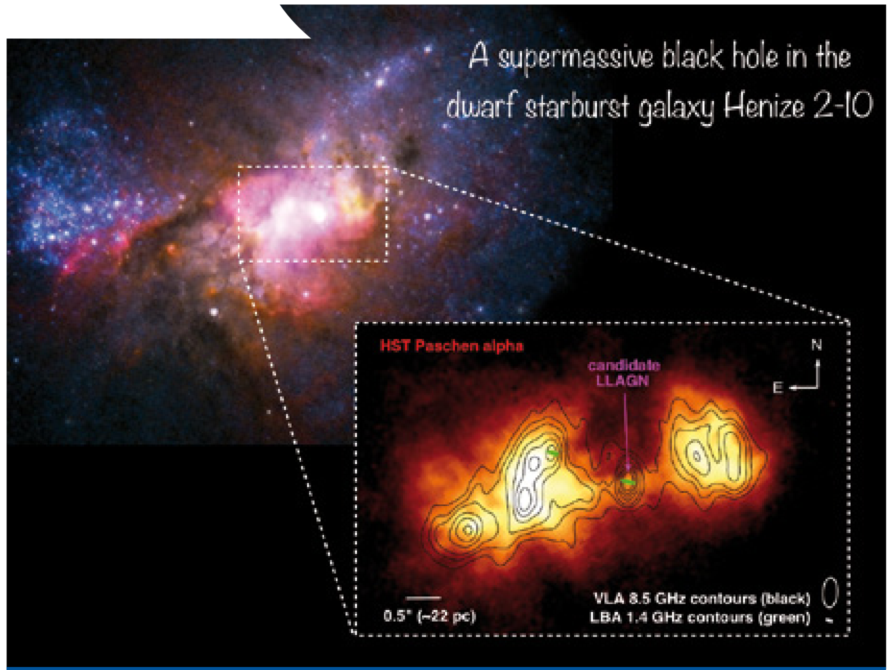
Amy Reines and ASTRON scientist Adam Deller used the Long Baseline Array in Australia to observe the AGN candidate in the dwarf starburst galaxy Henize 2-10. This AGN candidate, identified by a radio and hard x-ray source with very little associated optical emission, was found to be compact at the pc scale, strengthening the case for the AGN interpretation. With an inferred black hole mass of around 1 million solar masses and at a distance of 9 Mpc, the AGN in He2-10 offers a rare chance for 'close-up' study of a relatively light supermassive black hole, similar to those thought to exist in the early Universe (paper: Reines & Deller, 2012, ApJ 750L, 24).

Exploring the radio bimodality of QSOs

Quasi-Stellar Objects (QSOs) are often classified into two broad categories; radio-loud and radio-quiet, but the underlying distribution of radio luminosities has long been debated in the literature. There are two opposing views; the first is that the distribution is bimodal with approximately 5-10% of QSOs being radio-loud, and the second is that there is a broad, continuous distribution with no clear dividing line between radio-loud and radio-quiet QSOs. →



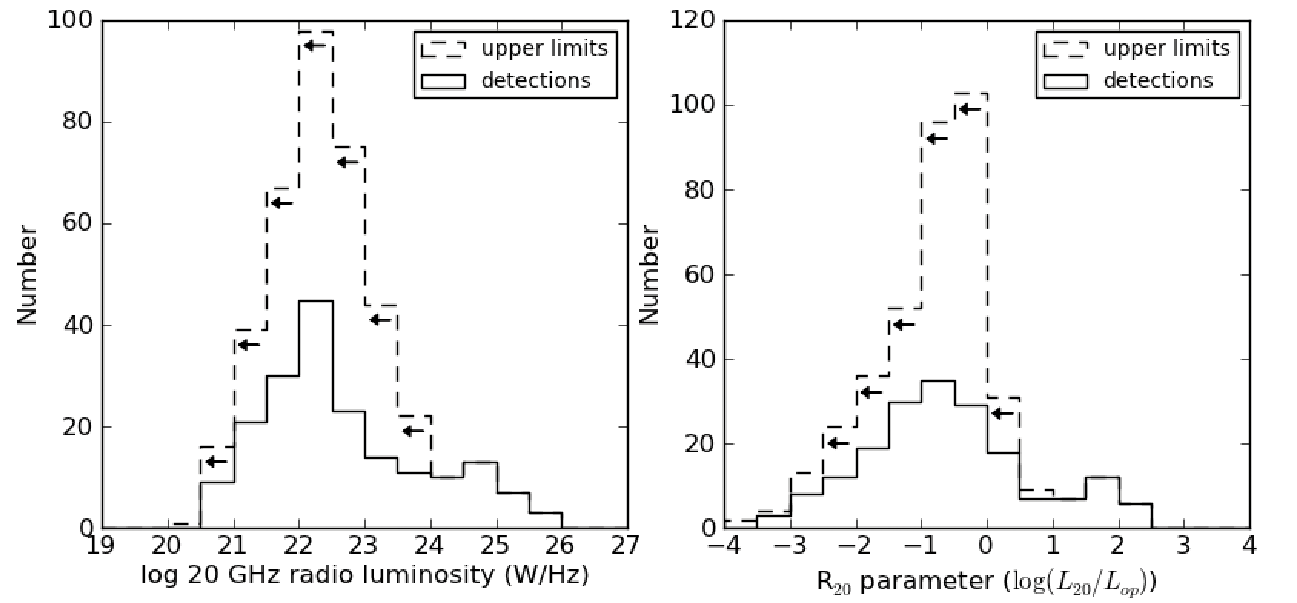
Left: spectra of 21-cm absorption detections. Right: Number of absorbers versus redshift.



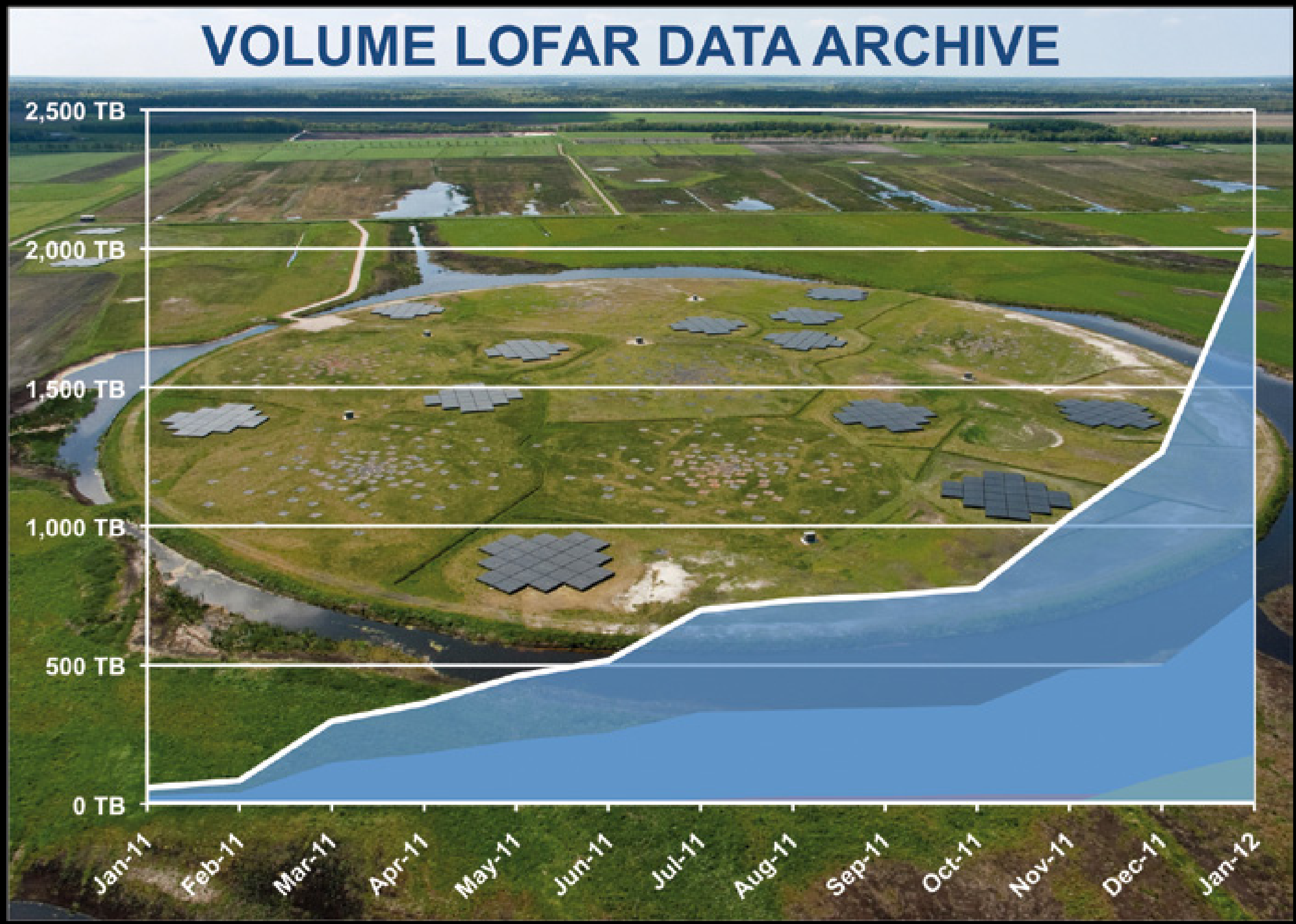
A multiwavelength view of the dwarf starburst galaxy He2-10 and its probable AGN component.

Resolving this issue can provide insight into the physics associated with forming radio jets. A bimodal distribution suggests that there are two intrinsically different classes of QSOs, only one of which is able to become a strong radio source, while a continuous distribution suggests that all QSOs have low-luminosity radio sources which become stronger during episodes of unusually high activity.

ASTRON astronomer Elizabeth Mahony and collaborators have obtained 20 GHz observations using the Australia Telescope Compact Array (ATCA) for a large sample of QSOs to investigate whether the luminosity distribution is bimodal. High frequency observations ensure that we pick up the central core component of the QSO and hence see the most recent activity. At lower frequencies the observed emission is often dominated by large-scale radio lobes, which could be relics of past activity integrated over large timescales, thereby confusing our results. The resulting distributions shown here confirm that neither the radio luminosity distribution nor the distribution in radio-loudness (the ratio of the radio to optical luminosities termed the 'R' parameter) are bimodal (paper: Mahony et al., 2012, ApJ 754, 12).



The radio-luminosity (left) and radio-loudness (right) QSO distributions.



Scientists estimate that in full production the LOFAR telescope will produce over five petabytes (the equivalent of roughly two hundred thousand DVD's) of data each year to be stored in the Long Term Archive (LTA). The LTA takes care of the long-term storage, distribution, and further analysis of LOFAR data by astronomers world wide. Even while LOFAR operations are still in a preliminary phase, the LOFAR LTA already entered the Petabyte era in 2011. At the beginning of 2012, the volume of LOFAR data stored in the LTA passed the two petabyte mark and there are currently almost 100,000 unique files stored in the LTA. The volume of LOFAR data has now outgrown the volume of ATLAS data on Big Grid managed 'permanent' storage (i.e. tape).

Radio Observatory

Operations with the Westerbork Synthesis Radio Telescope

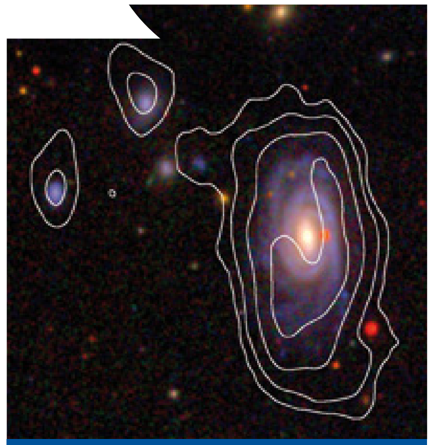
With an operations model aimed at the minimal staff effort compatible with reasonable output, the Westerbork Synthesis Radio Telescope (WSRT) nevertheless kept its net science efficiency at nearly 70%. Maintenance over the year took about four FTE, divided over about a dozen Radio Observatory staff (mechanical, electronics, cryogenic, software, and network engineers, with specialist support from one of the systems engineers). Sadly, our cryogenics engineer, Jan Stolt, passed away in October; his tasks were divided amongst two experienced engineers of the ASTRON R&D department. The three operators continued their regular weekly duty roster, rotating primary WSRT, primary LOFAR, and backup responsibilities. One support scientist was in charge of WSRT scheduling, assistance to the PC, and data inspection.

Planned maintenance on the WSRT took one day a week, with repairs in the lab continuing on other days. Corrective maintenance was needed for only four mechanical problems in the year. However, the incidence of electronic and related problems is slowly rising. Especially the analogue part of the backend is showing its age with nearly 45 units requiring repairs last year. Four ADC units had to be replaced, and five DZB units required repairs. There were 16 MFFE receiver exchanges due to failed cryogenic parts; five MFFE feed revolvers developed problems. The MFFE communications and control system had six problems. There were three ICT related problems (failing hardware, one software problem).

On four occasions lightning strikes caused damage to the WSRT, twice in the position tracking system. On one occasion the weather monitoring station was damaged. In early September, a 70 minutes power outage at the WSRT caused significant damage and disruption to the system. Although the cryogenic system in only one MFFE failed, several subsystems in the backend failed when powered up. All in all, it took roughly one week to bring the whole WSRT back on line.

Preparations continued for the installation of Apertif. Ducts were placed to carry the fibers from radio telescopes 0 to B to the service building. Concrete pads to carry the containers housing the beamformers were placed in late 2012. Plans were developed for required extensive maintenance on the telescope's mechanical structure, the drive mechanics, and the drive electronics, in conjunction with the installation of Apertif.

Science Highlights with the Westerbork telescope



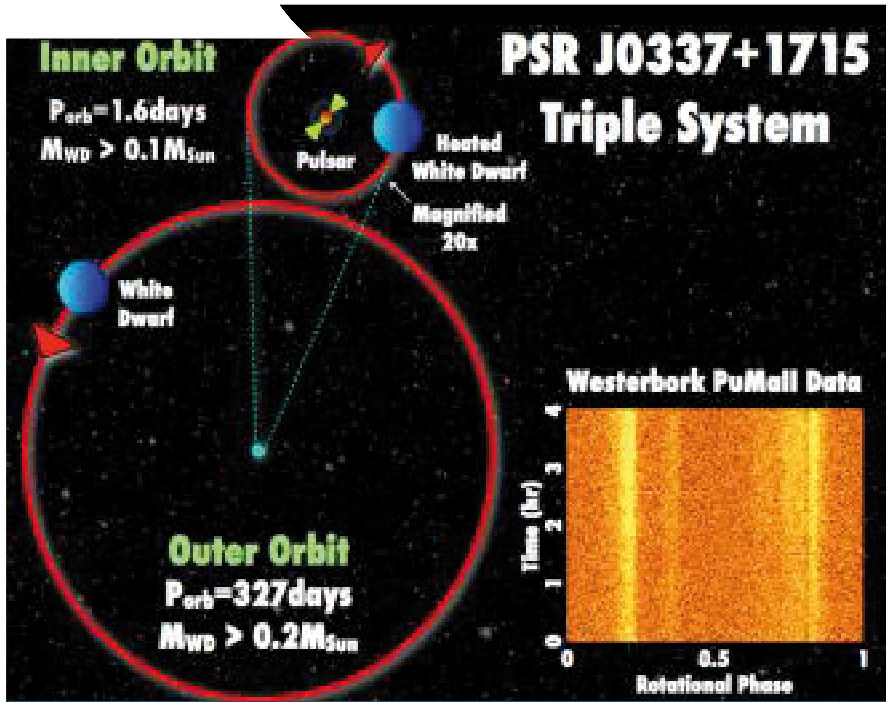
An SDSS colour-composite of the Bluedisk galaxy J110759+352747 overlaid with neutral-hydrogen contours. The galaxy was found to contain 17 billion solar masses of neutral gas and is apparently interacting with several gas-rich companion galaxies.

The WSRT Bluedisk HI project

The Bluedisk project (Kauffmann et al.) is a large WSRT HI survey of 50 galaxies, selected on their optical and ultraviolet properties. Half of the sample galaxies, with unusually blue outer disks have an excess HI component, while the other half form a control sample. A typical image is shown in the figure on the top right. The Bluedisk team has concluded that their results do not conform to a scenario in which new gas has been brought in by mergers, but are possibly more with cooling from a surrounding quasi-static halo of warm/hot gas.

PSR J0337+1715: A Pulsar in a Compact, Hierarchical Triple System

In early 2012, the WSRT rapidly provided a precise localization of the newly discovered pulsar PSR J0337+1715, which was critical for phase-connecting the timing data of this unique system in a compact, hierarchical triple system (see figure below). →



An artist's view of the triple system PSRJ0337+1715. Credits: J. Hessels, ASTRON.

Using the PuMaII pulsar backend, the WSRT provided over 600 hrs of short near-daily observations in 2012 –a monumental data set that is crucial to unambiguously count the number of pulsar rotations between observing sessions, and is a vital piece in a multi-telescope observing programme to map the variations of the inner orbit with time, and with the ultimate goal to make unique tests of gravitational theories (Ransom et al. 2013, in prep.).

LOFAR Hardware Improvements

After the major HBA repair effort in 2011, the number of defective HBAs at any given time remained fairly constant at the 1-2% level, thanks to the use of new parts with improved shielding against high moisture levels and measures to obtain dryer conditions in and around the HBA tiles.

All eight international stations were visited by Radio Observatory engineers for annual maintenance. Repair work was done in cooperation with local personnel.

In the autumn of 2012, the so-called SyncOptic boards, that distribute a common clock signal to the receivers in a station in a phase-locked loop, were installed on all Dutch stations; the international stations will follow next year. This has significantly improved the forward gain and stability of the station beams. Furthermore, within the LOFAR core, all of the stations were connected through these boards to one single clock, which has resulted in the ability to form coherent Core Tied Array beams, with a dramatic improvement in sensitivity for pulsar and other point-source observations.

Testing was conducted on a LOFAR core station with upgraded Transient Buffer Board memory to hold 5.2 seconds of data (up from 1.3 seconds) at full bandwidth. Memory boards for these upgrades were then ordered for all Dutch stations and five of the international stations.

LOFAR software development and commissioning

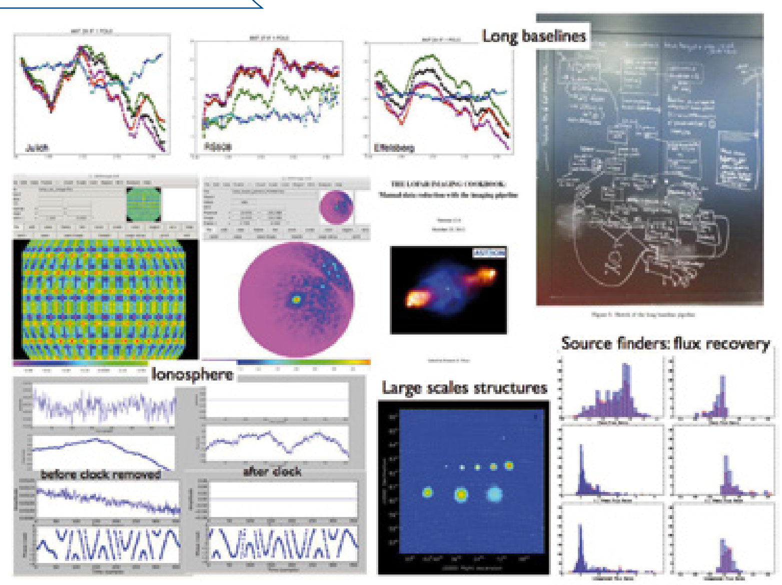
LOFAR software development and commissioning continued as a joint effort of Radio Observatory and R&D staff, under the supervision of the LCCG, with significant contributions from others in the wider LOFAR community.

During so-called 'Busy Thursdays', bi-weekly one day commissioning workshops, an average of 20 commissioners, participating in person or remotely from all over Europe, discuss calibration issues, present recent results and plan tests on new features of the software; activities are illustrated in the figure. Commissioners are asked to work on specific issues, write missing parts of code when needed, test and certify newly implemented features in the software, experiment with new calibration algorithms, document with written reports all the tests (available in the wiki) and contribute to write and update the LOFAR imaging cookbook.

In addition, the Technical Advisory Group (TAG) continued bi-weekly meetings. The TAG maintained the overall set of top commissioning priorities, reviewed and approved commissioning proposals in pursuit of those priorities, discussed LOFAR calibration issues in detail, and coordinated the activities of KSP commissioners through the bi-weekly LOFAR Status Meeting (LSM). Members of the TAG also served in 2012 as a technical review panel to evaluate the feasibility of all submitted Cycle 0 observing proposals.

A number of significant development goals were reached in 2012. By far the most important was the rollout of the first version of the full operational observing system to support the start of regular Cycle 0 science operations. It constitutes a minimal base functionality including a core set of observing modes, initial versions of both the imaging and pulsar processing pipelines, and preliminary archiving capabilities.

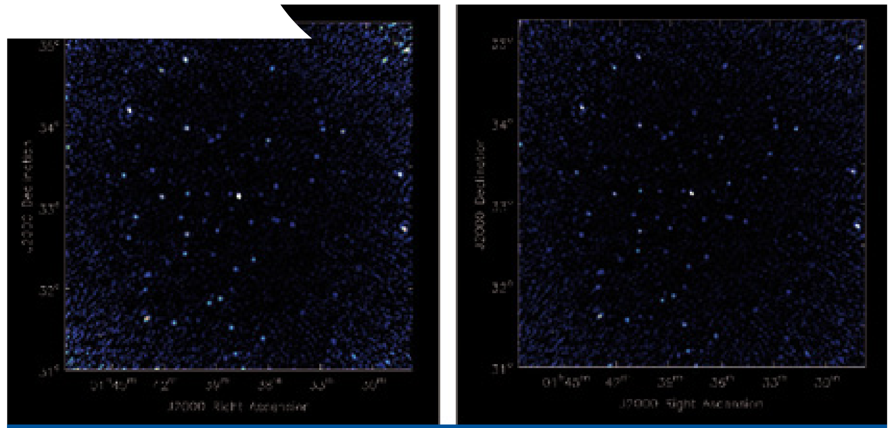
In addition to the core functionality of the Version 1.0 system, a number of enhancements were deployed during the second half of 2012. The most important enhancement was the 8-bit observing mode; the default LOFAR data sampling rate is 16 bits. The 8-bit mode, doubling the usable LOFAR bandwidth from 48 MHz to 96 MHz, was designated a crucial capability for the EoR KSP programme and given the highest development priority. It has come into wide use for Cycle 0 observing programmes. →



Set of sample images and plots produced by commissioners during the Busy Thursday commissioning days. These Busy Thursdays are organized by the Radio Observatory department and occur bi-weekly with a rotating group of 10-20 active commissioners joining either by Videocon or in person.

The figure on page 28 shows an early, deep image of the NCP field taken in 8-bit mode late in 2012.

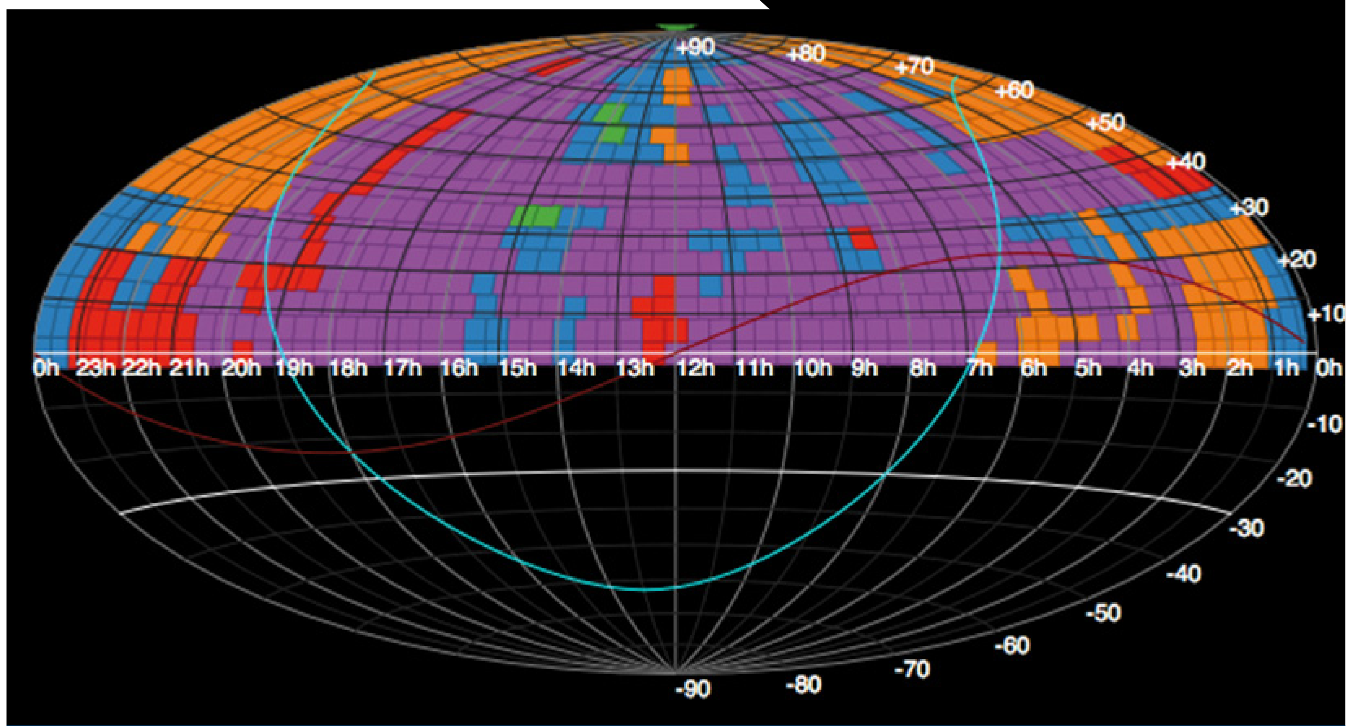
Furthermore, an 'HBA Inner' observing mode was developed, to allow selection of only the innermost 24 HBA tiles in a LOFAR remote station, which reduces calibrations issues due to inhomogeneous HBA station beams. Updates to the beam model in the standard imaging pipeline were rolled out, and initial work on integrating the GSM database and source finding into the pipeline began. Performance improvements to the gridding and w-projection components of the AWimager codebase were achieved, yielding better image quality and an order of magnitude increase in execution speed (see figure on top). Finally, enhancements to the NDPPP pre-processing code to support post-correlation baseline addition were implemented as a first component of a tailored processing pipeline to support long-baseline imaging.


Images of the field surrounding M51 using the old version of the AWimager (left) and the new version (right) with improved performance. The new implementation of the w-projection algorithm yields less image artifacts, especially far off-axis, and with an order of magnitude increase in execution time.

The MSSS project

Multi-frequency Snapshot Sky Survey (MSSS) observations began in the LBA band late in 2011 and have been the focus of a concerted development and analysis campaign for 2012, as illustrated in the status diagram below.

The on-going MSSS effort has involved significant manpower contributions from both the Astronomy Group and Radio Observatory at ASTRON, as well as a steady stream of KSP-contributed commissioners. Over the course of 2012, between 4-8 members of the various KSP teams travelled to ASTRON on a weekly basis to take part in the MSSS commissioning effort. MSSS is a crucial driver and testing ground for the imaging pipeline development, as well as delivering one of LOFAR's most important initial science products: a shallow all-sky survey.



Summary of the observing status of the low frequency part of the LOFAR MSSS all-sky survey discussed in the text. Orange indicates fields that are not yet observed. All other colors indicated observed fields in various states of processing. At the time of writing, 80% of the low frequency part of MSSS has been observed, and the high frequency part (expected to complete by Fall 2013) has already begun.

Early image of the NCP field using the 96 MHz, 8-bit observing mode taken late in 2012. The image covers a field-of-view of 30 deg x 30 deg and achieved a noise level of 0.1 mJy. Subsequent deep images of this field have yielded even higher dynamic range. Image credits: S. Yatawatta (ASTRON).

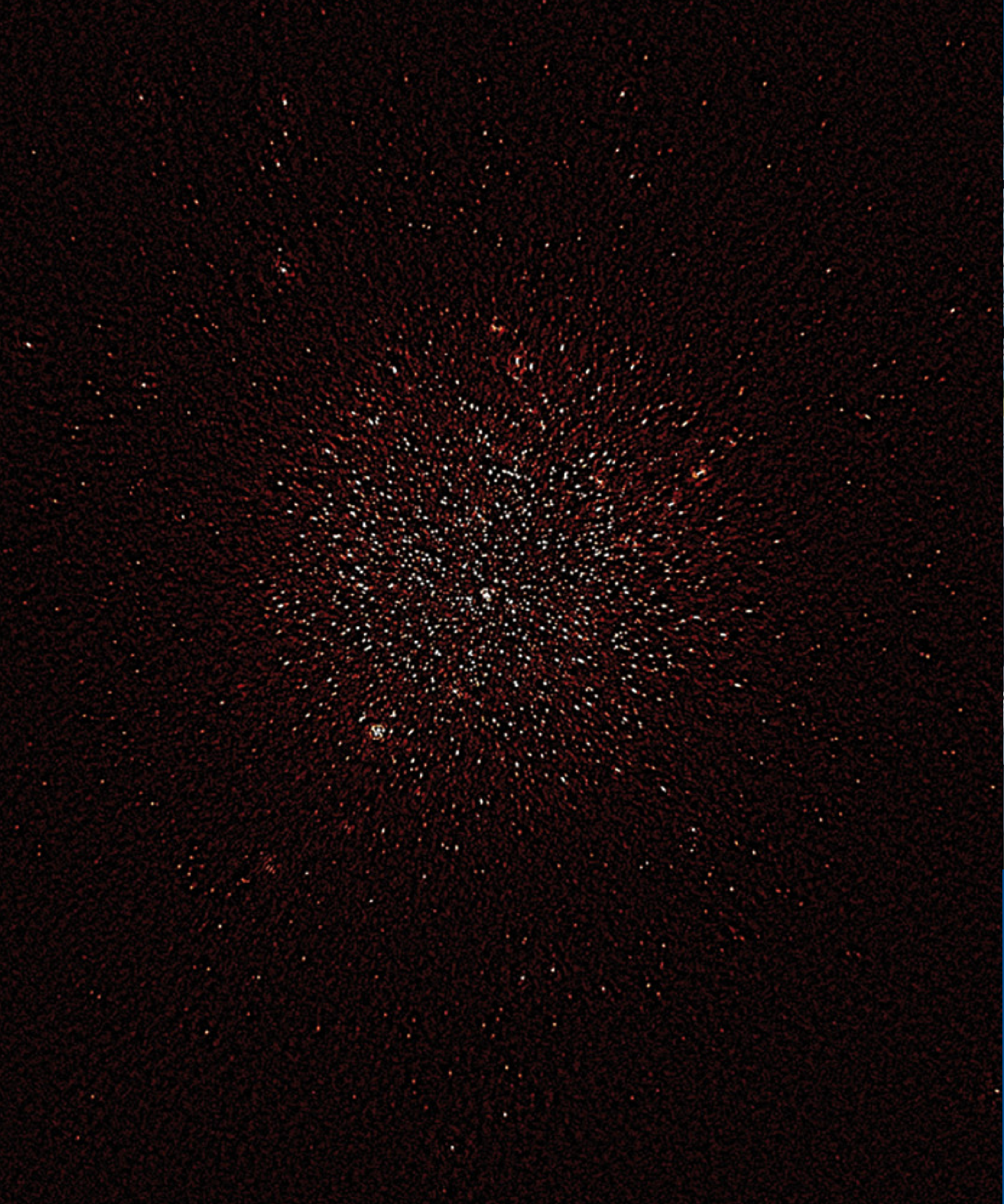


Photo: In September 2012, a group of people from the Radboud University Nijmegen, Aachen and ASTRON performed a three-day measurement campaign with LOFAR core-stations using a highly advanced toy, an octocopter (see images), to study effects of timing and element pattern in more detail. Read more about this measurement on the ASTRON/JIVE Daily Image http://www.astron.nl/dailyimage/main.php?date=20121009 and check out http://www.youtube.com/watch?v=9zqu_RQ1ZNQ&feature=youtu.be.

R&D Laboratory

Big Bang meets Big Data: the DOME project

The DOME project, a public-private R&D partnership between IBM and ASTRON officially started on February 1st 2012. The project, focusing on signal processing challenges for the Square Kilometre Array (SKA), is realized with financial support from the Dutch Ministry of Economics, Agriculture and Innovation (EL&I) and the province of Drenthe. The partners, ASTRON and the IBM Zurich Research Laboratories (ZRL), started the project with a kick-off workshop in Dwingeloo, Drenthe.

The DOME researchers are working at the newly established ASTRON & IBM Center for Exascale Technology in Dwingeloo. At the centre, the researchers are investigating enabling technologies for the SKA in the context of the following research themes:

- Green Computing: addressing technologies to radically reduce the power needed to do computationally intensive work on extremely large amounts of data,
- Nano-photonics: addressing technologies that are necessary to drastically reduce the power needed for data transport over longer distances and inside computing machines,
- Data & Streaming: addressing technologies to process data on-the-fly and store data at a high efficiency for later use.

#ASTRONtweets

e-ScienceTalk @e_scitalk 2 Apr
*'Exascale radio astronomy collaboration between Netherlands **ASTRON** and **#IBM** for Square Kilometre Array #ska'*

NoordNieuws @noordnieuws 2 Apr
*'**ASTRON** gaat samenwerken met **IBM**'*
rtvnoord.nl/?p=108841

KurzweilAINews @KurzweilAINews 2 Apr
*'**ASTRON** and **IBM** to explore origins of the universe: **IBM** and **ASTRON**, the Netherlands Institute for Radio Astronomy...'*
bit.ly/HA0ZR7

ASTRON - Mike Garret @ASTRON_LOFAR 3 Apr
*'I think this is a first for **ASTRON** - we have made Fox News'*
tinyurl.com/c8gsovj

IBM to study myseries of Big Bang with world's biggest telescope
Planet Earth's next big science project is a telescope so massive it wil span a continent, and generate on its own as much data as the entire internet carries on a regular day. But what do yo do...
Fox News @FoxNews

The official opening of the Exascale Center and project-start, for which all stakeholders were invited, took place on October 17th. The official opening act, connecting a glass fibre from a sensor array to a prototype microserver, was performed by Chris Buijink, Secretary General of the Ministry EL&I. This act symbolized the connection between the different elements of the DOME project, as well as between fundamental research (as in antenna technology) and practical applications (new computer platforms).

To make sure investments also find their way into society, ASTRON and IBM have set up a DOME Users Platform for industry, small and medium sized businesses, universities, and knowledge institutes. In this way partners can work together with IBM and ASTRON scientists, participate in the project, and contribute to the project goals. In June, the kick off of the Users Platform took place at a networking meeting of Sensor Universe in Assen.

ASTRON-IBM Center for Exascale Technology openings act by Chris Buijink (Ministry of EL&I).

A new clock system for the LOFAR core

In order to improve the LOFAR clock stability (jitter on the 1 PPS signal), R&D have developed a new clock-board: the SyncOptics board. In the original configuration, a rubidium clock and GPS-based synchronization were employed. The improved system makes use of a central clock at the network Concentrator Node in Buinen (near Exloo), in combination with an optical distribution of the signal along the LOFAR fibre optic cable infrastructure. By using optical transmitters (lasers) at unoccupied →

#ASTRONtweets

IBMResearch @IBMResearch 11 Mar
*'YOU can work on the ultimate #BigData project with **@IBM** and @ASTRON #DOME'*
t.co/31a7VCnX6K

Chris Buijink @chrisbuijink 17 Oct
*'Dome: a great partnership between astron.nl, **#IBM**, #Drenthe & #ELenl: it stretches the sky as the limit in science & enterprise'*

Astronomy Tweets @starsmaven 18 Dec
*'Big Bang Meets Big Data: South Africa Joins **ASTRON** and **IBM** to Build the Foundation for a New Era Computing'*
yhoo.it/YRb6WP

wavelengths, in combination with wavelength multiplexing, it was not necessary to lay new fibres for this upgrade. Experiments in October 2012 confirmed that the board indeed solves the stability problems.

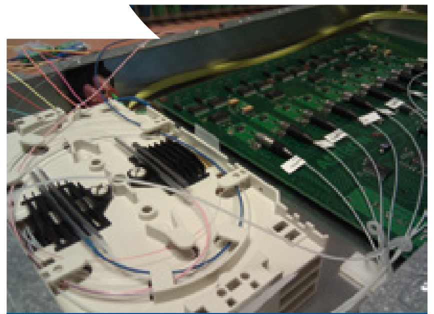
UniBoard Liquid Cooling

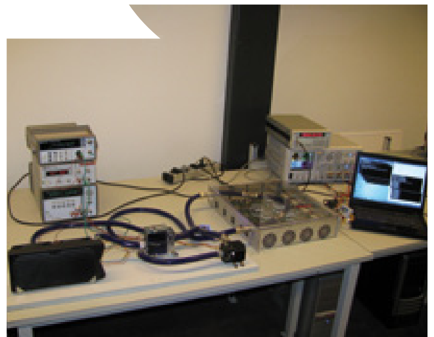
ASTRON and JIVE have taken first steps towards applying liquid cooling to UniBoards. The image shows the set-up of an experiment in which heat sinks of two FPGA chips are replaced by liquid cooling blocks. A special liquid is pumped trough the blocks to remove heat from the FPGAs. The heated liquid is then cooled down in the air-vented radiator (bottom left in the image).

Even when the system is running at half speed (fans in the radiator at half speed and water flow at half speed) the selected FPGAs are cooler than the other ones: 41°C instead of 57°C. The goal of liquid cooling is to increase power efficiency. Normally, forced-air cooling is used: an air-flow passes the FPGAs, thus transporting heat from the FPGAs in a subrack to the cabinet, where another set of fans or an airco is used to remove the heat from the cabinet. With liquid cooling, the heat exchange can be done from the FPGA to the outside of the cabinet directly, thus reducing the number of fans. Above all, we expect higher cooling capacity will be needed for future FPGA boards. With liquid cooling the aim is to both increase cooling capacity as well as power efficiency. This technology will be further developed for use in the UniBoard2, a new-generation UniBoard.

AARTFAAC Correlation Record

The AARTFAAC project, which stands for Amsterdam-ASTRON Radio Transients Facility and Analysis Centre, is a collaboration between ASTRON and the University of Amsterdam (UvA) that aims to continuously image the entire northern sky at 1-sec time resolution, and thus find the brightest and rarest types of transients and figure out what they might be.

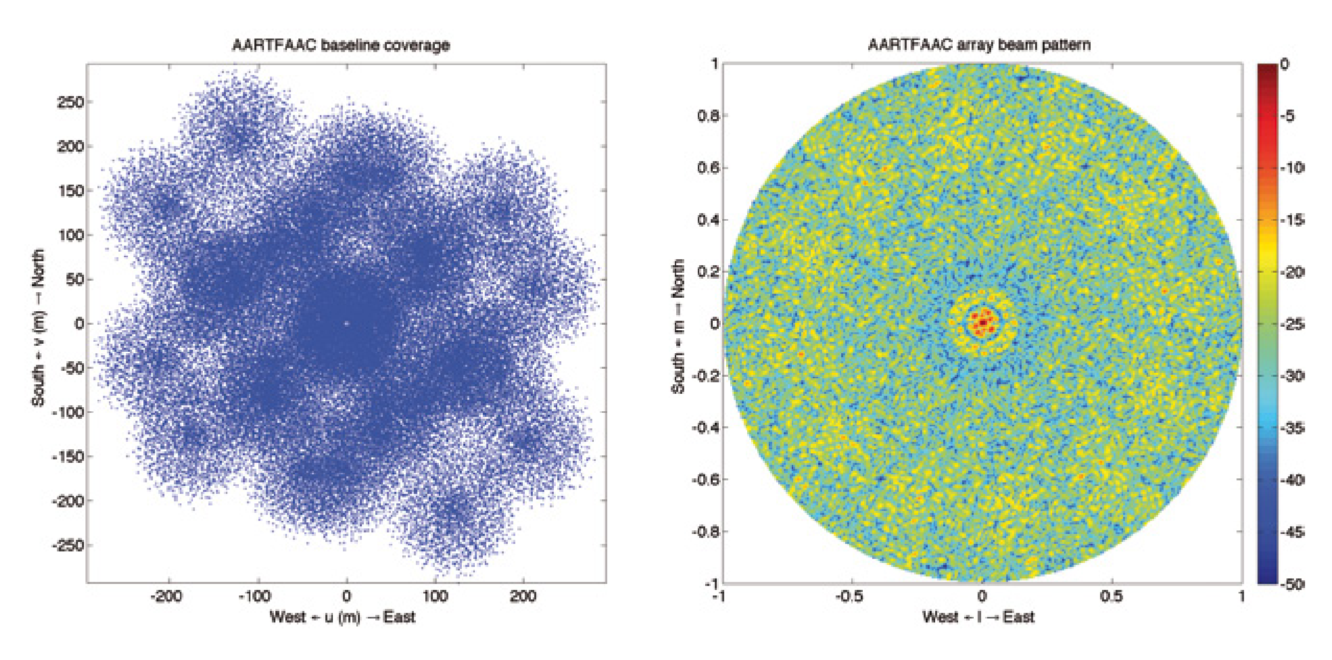

Clock board with lasers, splice trays, and the optical multiplexers in a transmitter box.


Set-up demonstrating liquid cooling of a UniBoard processing board.

The project uses 288 individual LOFAR LBA dipoles on the superterp, to detect transients in the radio sky. With 288 dipoles, no less than 41,328 baselines can be formed, yielding an incredible instantaneous (u, v)-coverage as shown in the left part of the top figure on page 32, made at the end of January 2012. The right part of this figure shows the corresponding array beam pattern with a color scale in dB. In this example, over three hours of data from 288 antennas (576 dipoles) was captured. Even though only five 195-kHz subbands (59.7 - 60.6 MHz) were observed, this already resulted in 27 TB of data. As the LOFAR correlator could not handle more than 64 station inputs, the data was moved to the DAS-4 computer cluster in Dwingeloo, using a 10 Gb/s Ethernet connection. With a number of quick 'hacks' the researchers were able to run the LOFAR correlator on the system. Using 21 machines, correlating the data took less than 9 hours. At 64 channels per subband, this resulted in 619 billion correlations. We think that correlating 288 dual-polarized antennas broke the world record. By chance, the LOFAR all-sky transient detection facility detected its first transient in this first observation: a solar burst!

APERTIF Polarization Calibration

Magnetic fields are present in all different types of astronomical objects; studying these require polarimetric observations. The Westerbork Synthesis Radio Telescope (WSRT) has proven to be an excellent instrument for this type of observations. In the coming years, the WSRT will be upgraded with APERTIF Phased Array Feeds (PAFs). Due to the very different nature of the APERTIF feed system, its polarimetric calibration required a novel approach. To verify the new approach, the Rotation Measure (RM) of BL Lac was measured in March. Due to its large RM, the observed polarization angle varies strongly over frequency. →

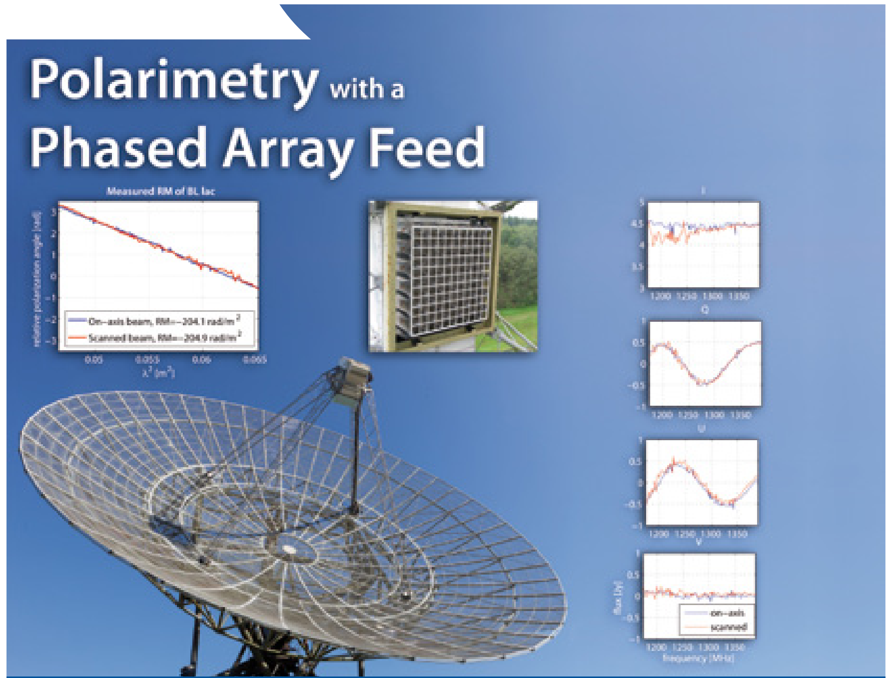


(u, v)-coverage for 288 dipoles on the LOFAR superterp (left), and corresponding array beam pattern (right).

Such measurement is very challenging since it requires a polarimetrically calibrated and stable interferometer system. Five measurements were combined to span the frequency range from 1190 to 1390 MHz. The observations were performed twice: on March 14, BL Lac was observed through an on-axis PAF beam. On March 22, BL Lac was observed through a 1 degree scanned beam, i.e. twice the half-power beamwidth of the standard WSRT!

The image displays the observed Stokes parameters. The flux scale was not calibrated accurately, resulting in variations of Stokes I. The observed polarization angle has been derived from Stokes Q and U and plotted as function of lambda squared. Using a linear least-squares fit, an RM of -204.1 rad/m2 was found for the on-axis measurement and -204.9 rad/m2 for the 1 degree scanned beam. These results agree very well with a measurement by Ger de Bruyn using the entire Westerbork telescope. He measured an RM of -205.1 rad/m2 on April 1,2012. The slight differences can be explained by variations of the source and ionospheric conditions.

This convincingly demonstrated that the APERTIF prototype can be polarimetrically calibrated and, most importantly, that there are no major issues to perform polarimetric measurements with APERTIF phased array feeds.

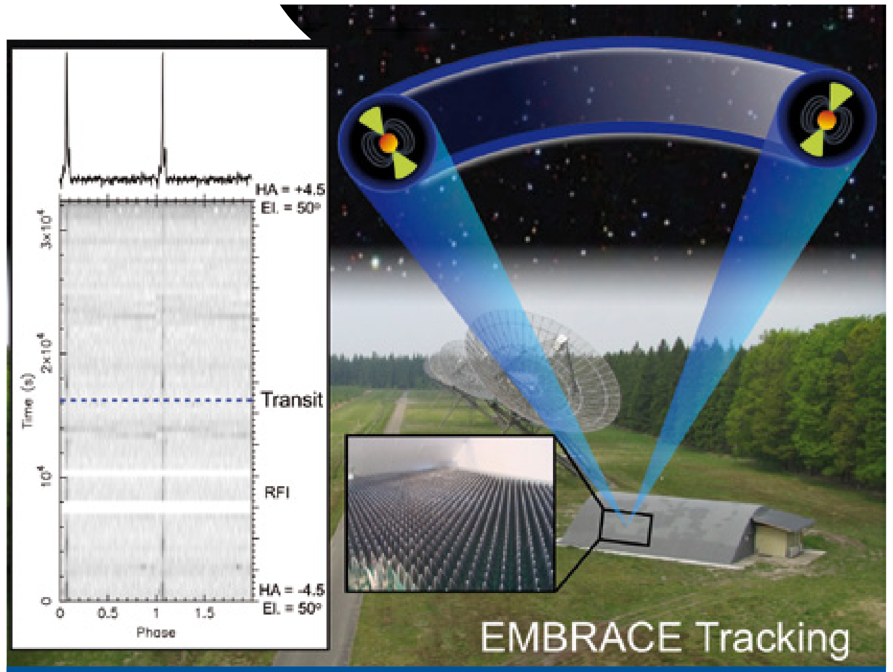


APERTIF test results showing Rotation Measure estimates (left inset), and measured Stokes parameters (four insets on the right).

EMBRACE tracking and stability tests

Being a 'new kid on the block', aperture array systems still have to demonstrate their technological merit when it comes to astronomical observations. Even something seemingly simple like pointing/tracking requires → proper verification when the beam is synthesized from many stationary elements.

To demonstrate EMBRACE's multi-hour stability and tracking capabilities, in April 2012, ASTRON researchers observed the pulsar B0329+54 for nine hours (from an elevation of 50 degrees, through transit, and then back down to 50 degrees elevation). The array was calibrated only once before the start of the observation, using GPS satellites to determine the phase calibration coefficients necessary to phase the array into a single beam on the sky.



EMBRACE stability test, showing nine hours of tracking pulsar B0329+54.

As can be seen in the image, the pulsar was visible throughout the 9-hour observation, though the signal strength varied on on time scales of typically 15-30 minutes. It is quite possible that this variation is simply due to scintillation of the source in the small 12-MHz band we recorded. In any case, this 9-hour observation is a major step forward compared with previous attempts to track a source continuously over multiple hours.

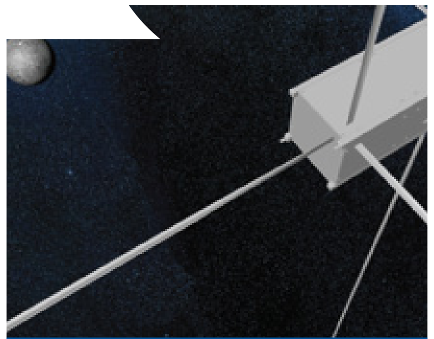
The successful tracking of such a weak astronomical signal places high demands on the re-pointing precision of the beam and the dynamical behavior of the EMBRACE array at the WSRT. Such observations demonstrate the usefulness of aperture array technologies for radio astronomy, which will be important for the Square Kilometre Array (SKA).

Conferences and exhibitions in 2012

Besides conducting busy projects such as the ones listed above, staff of the R&D department were also involved in showing ASTRON technologies to the astronomical and engineering community, and of course to the general public. The R&D department participated in a number of workshops, conferences, and open days, some of which are depicted here.

OLFAR at the IAC

From 1 to 5 October 2012, ASTRON and partners had a booth at the International Astronautical Congress (IAC) to promote various research projects, including Orbiting Low Frequency Antennas for Radio Astronomy (OLFAR). The OLFAR project is a feasibility study for a low-frequency radio telescope in space, consisting of a swarm of scalable and autonomous 'nano' satellites. These will be spread over a virtual sphere with a diameter of 100 km, emulating a large all-sky radio telescope. As the Earth's ionosphere is opaque at low radio frequencies (f<10 MHz), OLFAR needs to be space based. The figure below on the left shows an artist impression of one of the OLFAR satellites in orbit around the Moon.



Impression of one of the OLFAR space based satellites in orbit around the moon.

ASTRON at the Hannover Messe

In April 2012, the top sector High Tech Systems and Materials (HTSM) presented itself with the Holland High Tech House at the Hannover Messe, the largest industrial trade fair in the world, in Hannover, Germany. ASTRON participated in the Holland House showing amongst others LOFAR telescope technology, water-cooled UniBoards, and a photonic smart-antenna demonstrator. The picture to the left shows the VIP-meeting at the Holland High Tech House. Mr. Bertholt Leeftink, Director General of Industries and Innovation of the Ministry of Economic Affairs, is making a statement to Mrs Ineke Dezentje-Hamming, Director General of FME (entrepreneur organization for the technological industry). →

The VIP-meeting at the Holland High Tech House at the Hannover Messe in 2012.

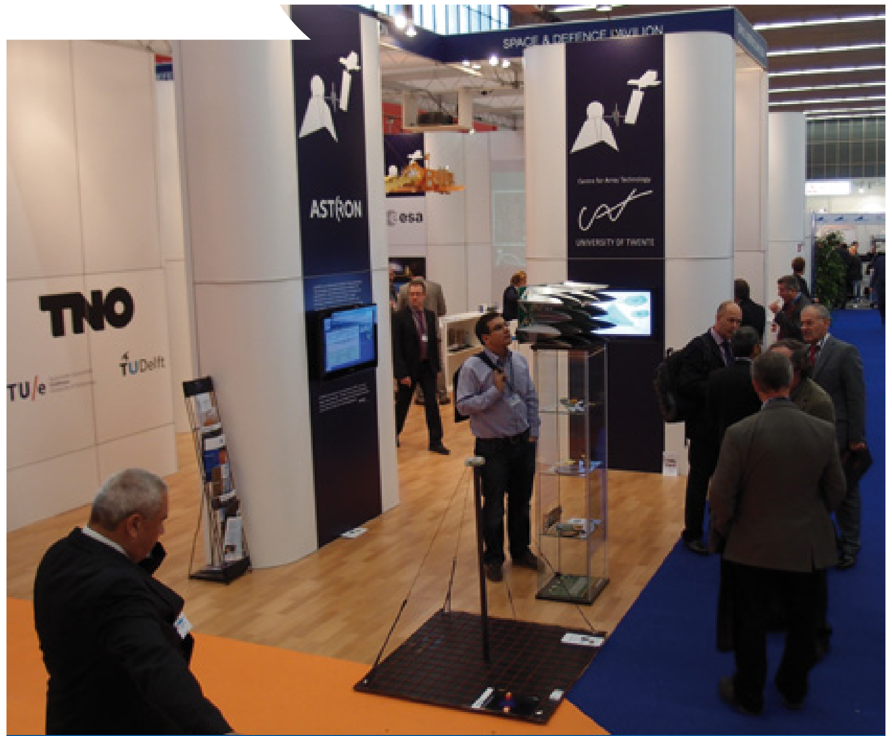
He is outlining the open communication in Dutch industries. Director General General Hans de Groene of NWO, the Netherlands Organisation for Scientific Research, emphasized with his presence (left of the far table) that the Advanced Instrumentation Programmes of the NWO institutes firmly contribute to the Dutch High Tech Systems and Materials programme.

DOME at CeBIT

The ASTRON-IBM DOME project was presented at CeBIT 2013 in Hannover, Germany, as part of the Big-Data focus area of the IBM booth; the DOME theme was 'Big Bang Meets Big Data'. The CeBIT was opened by Dr. Angela Merkel, Chancellor of the Federal Republic of Germany. The picture at the top of the page shows the Chancellor at the IBM Booth talking to the IBM Germany General Manager Martina Koederitz. The inset lower-left shows some of the goodies presented at the DOME booth: a dense aperture array antenna, a 3-D stacked chip, a phase-change memory chip, a low power ADC chip so small a magnifier is needed to see it, a very thin photonic link replacing a wire stack the size of a small tree trunk. Also a printed circuit board for a micro-server was on display, produced by a manufacturer in Drenthe. The SKA signal processing challenges are impressive; the items on display showed we are on a route towards affordable low-power computing and signal processing as is required for the SKA.

IEEE European Microwave Week

The annual IEEE European Microwave Week made Amsterdam RAI its home location for the 2012 edition. The microwave week combines three European conferences of importance for ASTRON: the Microwave Integrated Circuits conference, the Microwave conference, and the RADAR conference. On various levels, ASTRON contributed to the success of the week: as a secretary of the organization committee, with contributions to workshops, publications, and with an ASTRON presence at the exhibition.



The ASTRON booth at the European Microwave Week 2012.

At a good spot in the Space & Defense Pavilion, achievements such as LOFAR, the EMBRACE antennas and Uniboard were presented. The booth was shared with ESA, TNO, and Dutch technical universities.

NOVA Optical/ Infrared Instrumentation Group

These are exciting times at the NOVA optical infrared instrumentation group. A lot of progress has been made on a suite of interesting projects. These projects can be in an entirely different phase: from a first idea, the development of the concept, design, hardware realization, all the way up to commissioning at the telescope. Below you can find a short summary of the projects and activities in 2012.

Funding for the European Extremely Large Telescope is not complete yet. We have to wait for the Brazilian parliament to approve ESO membership. This allows us to develop prototypes for some essential components in collaboration with several Dutch high tech companies: an immersed grating for the METIS high resolution spectrograph, a cryogenic chopper that allows accurate observation of objects that are fainter than the sky background and vibration free cooling techniques. Also the possibilities and implications for micro-arcsecond astrometry using MICADO have been investigated. EAGLE and OPTIMOS-EVE have merged into a new multi object instrument called MOSAIC. Extremely fast converging adaptive optics algorithms are developed for EPICS and tested on a GPU based clusters.

NOVA is working on several Multi Object Spectrographs projects: WEAVE, 4MOST and MOONS. In all these projects NOVA is responsible for the design of the spectrograph.

WEAVE is an optical multi object spectrograph for the ING William Herschel Telescope on La Palma. Its location on the Northern hemisphere is ideal for LOFAR and APERTIF follow up. 4MOST is an optical all sky survey instrument for the VISTA telescope on Paranal. The spectrograph is very similar to WEAVE. The combination of WEAVE and 4MOST allow for GAIA follow up on both hemispheres. MOONS is a near infrared expansion or replacement of the VLT Flames-Giraffe multi object spectrograph. In 2012, documents were prepared for review early in 2013: the concept review for 4MOST and MOONS and the preliminary design review for WEAVE.

MATISSE is the mid infrared interferometer for the ESO VLTI, combining the light of all four Very Large Telescopes at the same time, creating six baselines and micro-arcsecond angular accuracy. NOVA is responsible for the MATISSE Cryogenic Optics, MPIA (Heidelberg) for the Cryostats, MPIfR (Bonn) for the detectors and data reduction and OCA (Nice) for the warm optics, integration and overall management. The MATISSE Cold Optics is a challenging design with many optical components and mechanisms for observation modes and alignment, all with extreme stability and accuracy requirements situated in a vacuum cryogenic environment. The final design review is successfully passed in 2012. A lot of hardware is being manufactured and procured. In September 2012, a dummy cold optics box has been delivered to MPIA for cryogenic tests. This dummy cold optics box contains the thermal mass and external interfaces of the cold optics box, however without optics or mechanisms. Just as last year, MATISSE is the most important project in 2012 in terms of staff effort.

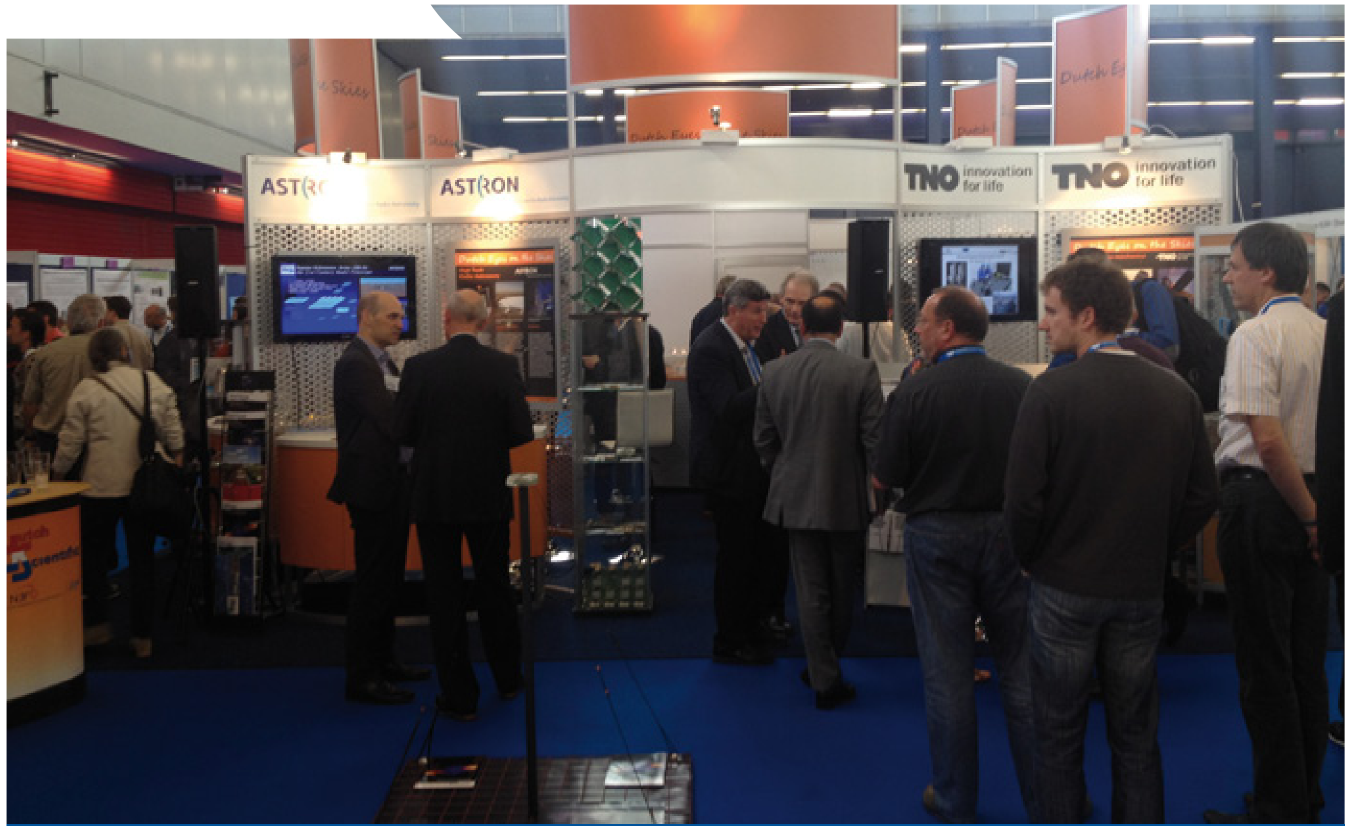
ZIMPOL is a high contrast imaging polarimeter for the SPHERE instrument on the ESO VLT, being developed by ETH (Zürich) and NOVA. ZIMPOL operates in the visual range and is based on a differential comparison of the two polarization images at 1kHz using a Ferro-electric Liquid Crystal. Both polarization directions are measured on the same pixel, allowing to reach a star to planet contrast ratio of 10-7. In ZIMPOL, planets are revealed, because their reflected light is polarized, while starlight is not polarized. In 2012, Sphere-ZIMPOL has been tested thoroughly at the Grenoble test facility. The late delivery of the deformable mirror caused some delay, but this time is used to increase reliability of the instrument. Some final test campaigns are planned for 2013 and first light on the VLT in Chile is expected before the end of 2013.

On May 9th 2012, the European MIRI consortium and ESA officially delivered the Mid InfraRed Instrument (MIRI) to NASA in a special gathering in London. NASA will integrate MIRI in the James Webb Space Telescope (JWST). Progress on the telescope is as planned and the project is on schedule for launch in 2018.

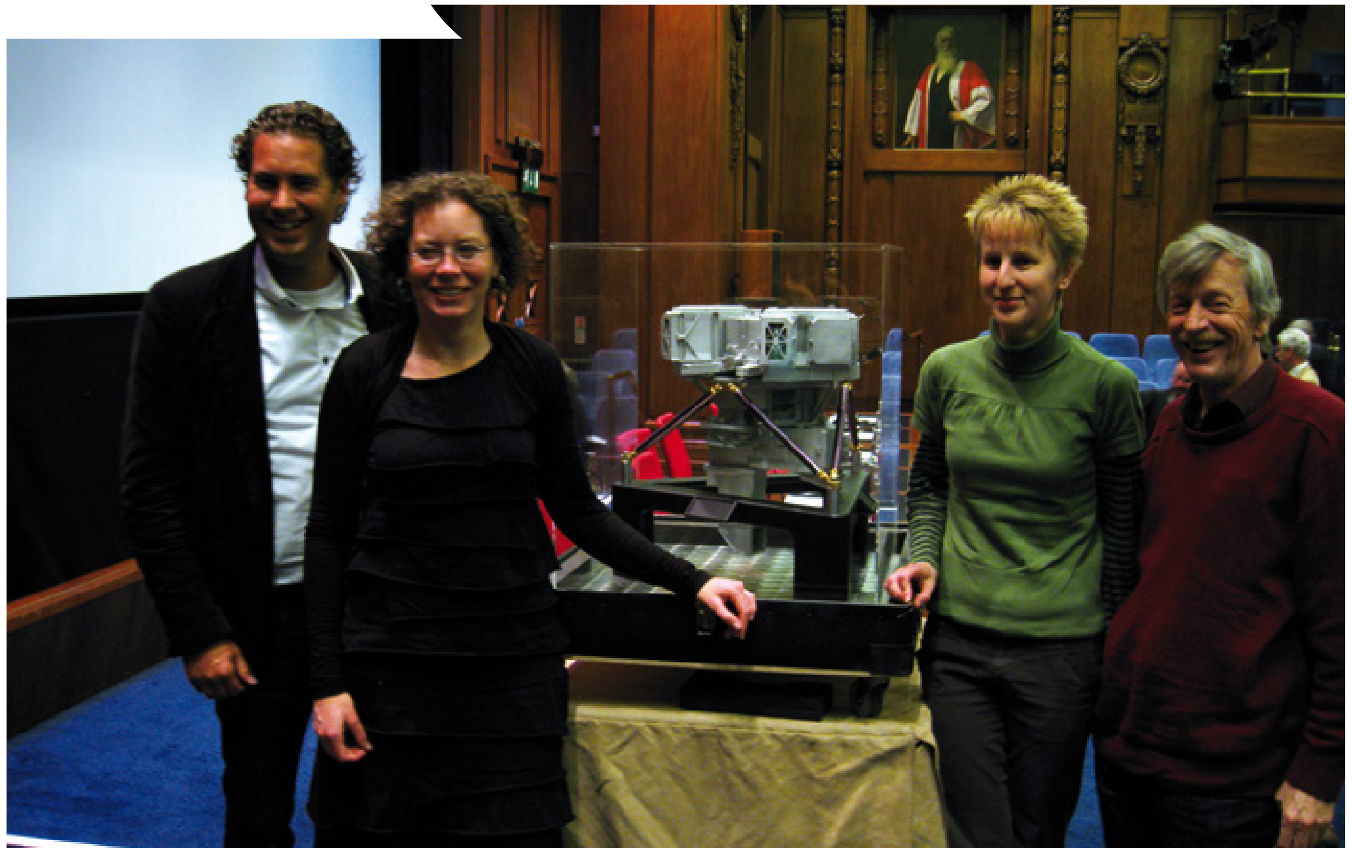
Other highlights in 2012 were the SPIE Astronomical Telescopes and Instrumentation Conference in the RAI Amsterdam, drawing over 2300 participants for a long week of presentations, posters, meetings and excursions to e.g. the LOFAR telescope, ASTRON and ESTEC. Dutch knowledge institutes and several companies presented themselves in a highly visible Holland pavilion at the exhibition.

Furthermore we should not forget to mention the iSpex team winning the 100.000 Euro Academic Year Prize for the best translation of scientific research to a broad audience. The team created a simple but clever extension piece for the (camera of the) iPhone, which allows people to measure the concentration of particles in the atmosphere.

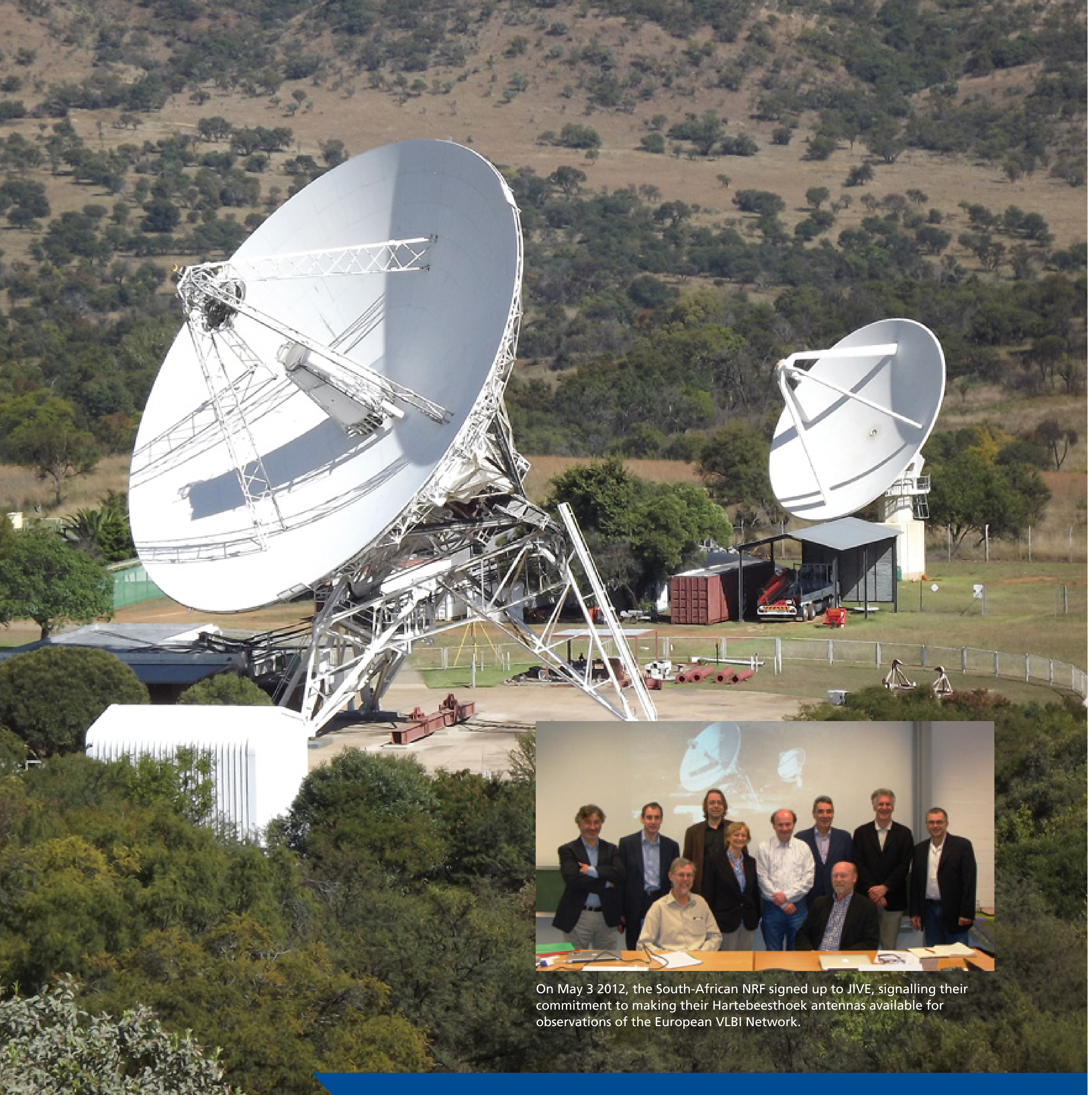
A complete dummy of the MATISSE Cold Optics Box was created as a verification model for the thermal properties.In the picture you see the gold colored backbone of about 70 kg, cut from a solid block of aluminum of 600 kg. It has been the largest part ever milled on ASTRON's big milling machine. In September 2012, the thermal dummy COB was shipped to MPIA Heidelberg, exactly on schedule. Credits: NOVA optical infrared group at ASTRON.



ASTRON was one of the institutes that exhibited in the 'Dutch Eyes on the Skies' pavilion in the Amsterdam RAI, in early July 2012. The Dutch pavilion was among the highlights of the largest-ever SPIE Astronomical Telescopes and Instrumentation exhibition. It showcased several Dutch knowledge institutes, including ASTRON and NOVA. Credits: NOVA optical infrared group at ASTRON.



Some NOVA team members posing near a scale model of MIRI at the Institute of Engineering and Technology in London during the official transfer of MIRI from the MIRI consortium and ESA to NASA. Credit: NOVA optical infrared group at ASTRON.



On May 3 2012, the South-African NRF signed up to JIVE, signalling their commitment to making their Hartebeesthoek antennas available for observations of the European VLBI Network.

Joint Institute for VLBI in Europe

JIVE, the Joint Institute for VLBI in Europe, faced an international review in March 2012 in preparation for a new funding agreement between its partners. In parallel, discussions concerning whether JIVE should transform into an ERIC (European Research Infrastructure Consortium, a legal entity with an EC basis) continued. A panel of recognized international experts visited JIVE and evaluated the operations, research and development programme (Figure 1), as well as the scientific potential of the European VLBI Network (EVN) and JIVE. In its report the panel expressed great confidence in JIVE and its plans for the future. This result was followed up by a decision of the international partners to sign a two-year extension of the JIVE contributions agreement, recognising this period as a transition to the ERIC establishment.

Figure 1. Demonstration of the UniBoard prototype during the review of JIVE on March 5, 2012.

Very relevant in this process was the positive decision by the South-African NRF to become a member of JIVE in May 2012. The Hartebeesthoek telescope has been a long-standing member of the EVN. However, with the construction of the MeerKAT and the ambition to start an African VLBI Network, this formal partnership could be the starting point for building up important new VLBI capabilities during the years that the SKA is being constructed, and even during its operation.

The review was held after serious construction work had started in Dwingeloo. Several JIVE staff members moved to temporary offices in the spring, and during the summer there were considerable further disturbances as the old building was prepared for integration with the new wing. JIVE offices were ready just before Christmas, and the last days of 2012 were used for moving staff into the new wing.

In 2012, the EVN users continued to enjoy an increasing number of VLBI capabilities offered by the EVN infrastructure and the JIVE correlators. Notably the EVN software correlator at JIVE (SFXC) matured significantly to the point that it was doing almost all correlation at the end of the year, in addition to the special wide field, pulsar gating and spectral line modes. A notable event showcasing the effort of the JIVE and EVN teams was the 11th EVN symposium. In a great setting the EVN users demonstrated the breadth of modern VLBI science, particularly showing the latest scientific progress with e-VLBI and software correlation.

The R&D programme at JIVE depends largely on external funding. Efforts on the UniBoard were extended in 2012 within the new RadioNet3 project. JIVE's user software efforts, as well as the vital Trans National Access funds used to implement user support for VLBI in Europe, are also supported by RadioNet3.

The e-VLBI development effort, sponsored by the EC through the NEXPReS project, has been focusing on methods to implement the best of both worlds; e-VLBI data streaming in real-time, as well as transparent caching if the data is needed (again) in a later stage. In this project the consortium members are also pioneering methods to allocate connectivity bandwidth on demand. The progress of the project was rated excellent by the EC's review panel in September 2012.

In pushing the scientific application of VLBI, again significant progress was made in facilitating VLBI observations of spacecraft. Among the experiments carried out were the successful measurements of the drag forces on the Venus Express when skimming the →

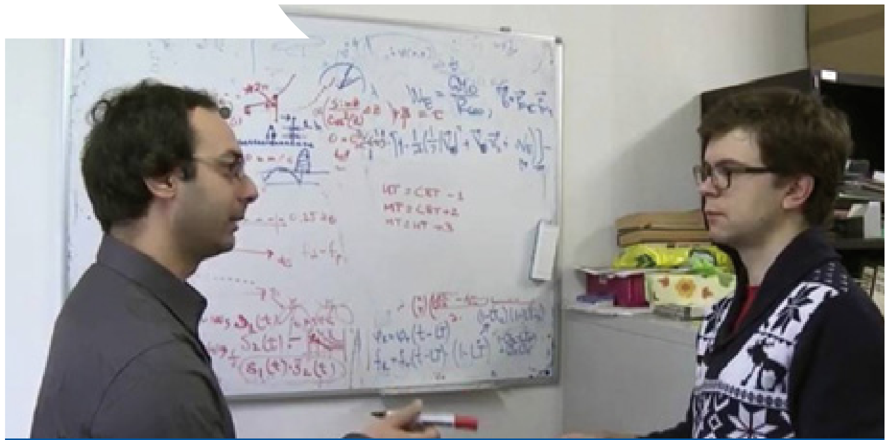


Figure 2. JIVE's Giuseppe Cimo' and Dmitry Duev discussing details of the Space application programme; still from the JIVE movie available at *http://www.jive.nl/jive-movie*.

Venus upper atmosphere. Major efforts also went into preparing the science case for various future missions, such as the Marco-Polo-R and JUICE. Actual measurements were made of the RadioAstron orbiting radio telescope, eventually attempting to refine its state vector and getting fringes on space baselines with these results.

From all the science results that JIVE staff obtained, in collaboration with other EVN users, we highlight the measurement of methanol maser magnetic fields (Fig. 3). Probing the close environment of high-mass proto-stars the team is researching the relation between magnetic fields and outflows, attempting to decide on the scenario for high-mass star formation.

This programme too benefits from the new capabilities that the SFXC correlator offers, as it provides very accurate polarization products at very high spectral resolution and it was a result obtained by one of the summer students (Luis Henry Quiroga-Nunez).

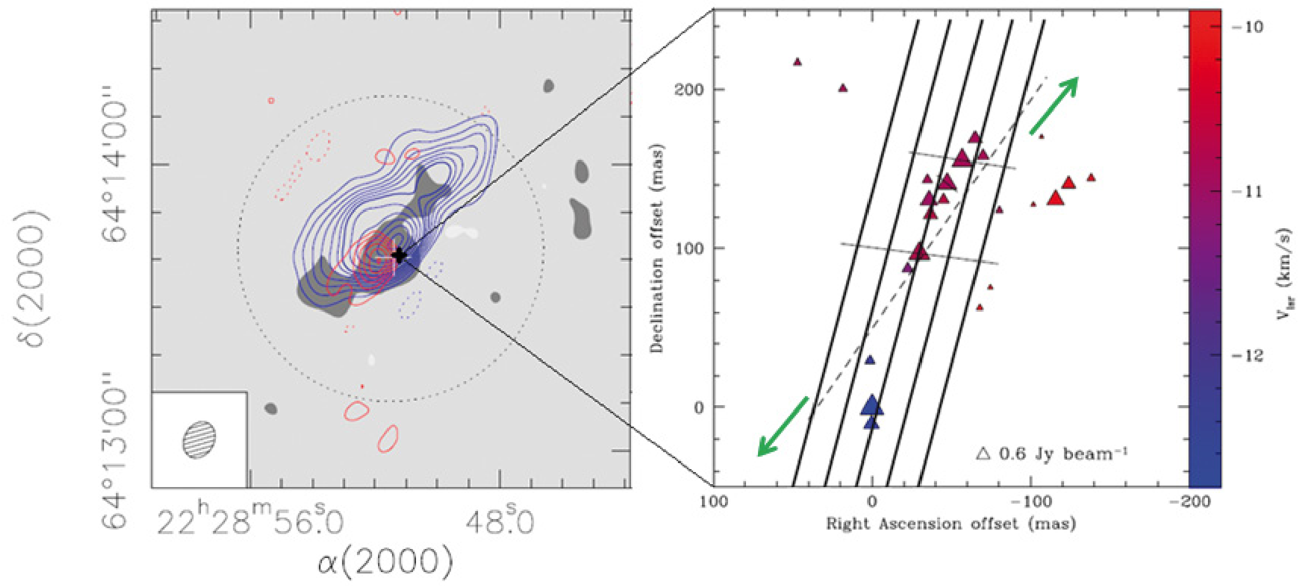


Figure 3. EVN observations of maser polarization in the massive star-forming region IRAS22272+6358A. Left: CO blue-shifted and red-shifted CO emission overlaid on the 2.7 mm continuum emission (from Beltran et al. 2006, A&A, 457, 865). Right: Distribution of 6.7 GHz methanol masers detected around IRAS22272+6358A. The linear polarization vectors are over-plotted. The thick line is the projection on the plane of the sky of the magnetic field. Surcis et al., submitted.

High school girls and staff from ASTRON, JIVE and the NOVA Optical/ Infrared group had a group picture taken to conclude their Girlsday 2012.

Outreach and education

Compilation of the different visitors at ASTRON in 2012.

Visitors

In 2012, we continued the long tradition of our very successful summer student programme. This year the programme also brought a number of enthusiastic young scientists: Patricia Carroll from the University of Washington (Seattle, USA) working at the project MSSS survey with the LOFAR telescope to understand the multi-frequency properties of the sources and supervised by George Heald; Andreas Johansson from the Univ. Gothenburg working at detecting the IGM-ISM interface in galaxies using the Westerbork telescope and supervised by Jozsa Gyula and Tom Oosterloo; Saavidra Perera from the Imperial College, London, working at the properties of faint sources in the LOFAR-EoR observing windows under the supervision of Panos Labropoulos and Vibor Jelic; Janez Kos, from the University of Ljubljana, looking for Ammonia in Galaxy Cluster Cores and Optical Line Emitting Gas in Brightest Cluster Galaxies supervised by Raymond Oonk.

We have also continued to support the visit of female colleagues as part of the Helena Kluyver female visitor programme. This year we have enjoyed the visit of Preeti Kharb (Rochester Institute of Technology) working on the analysis of multi-epoch space VLBI data of the extreme IDV quasar J1819+38, and Simona Vegetti (Massachusetts Institute of Technology) working on the Strong Lensing at High Angular Resolution Program (SHARP) with the goal of searching for low mass substructure in cosmological distant galaxies.

#ASTRONtweets

Megan @AstroMeg 15 Jan
*'Calling astro undergrads! Fancy spending the **summer** in the Netherlands? Apply to the **ASTRON**/JIVE **summer** programme'*
astron.nl/about-astron/press-public/news/sign-astronjive-summer-student-programme-2013/sign-astronjive-summer

Outreach activities

Renovation of the old Dwingeloo Telescope

On Tuesday 5 June 2012, the skyline of the National Park Dwingelderveld changed drastically. On that day at 14.00 hrs, the 25-meter dish of the Dwingeloo Radio Telescope was lifted off its tower and placed on a special construction next to it, so that it could be restored. The dish, which weighs over 30,000 kilo's, has not been out of place since its construction in 1956. Without restoration, the risk of the structure collapsing was too big and it would have to be taken down. After the dish of the telescope was removed, all steel parts were sandblasted and repainted. On Monday 19 November, the dish was placed back on its tower.

The restoration of the Dwingeloo Radio Telescope is made possible by grants from the National Heritage Board of the Ministry of Education, Culture and Science, the province of Drenthe, the municipality of Westerveld and contributions of the VSB, SNS REAAL FUND, Rabobank Southwest Drenthe, ASTRON and the Netherlands Organization for Scientific Research (NWO). The restoration is expected to be completed by mid-2013. More information about the telescope can be found on *http://www.astron.nl/node/516* and on *www.camras.nl*.

The dish of the Dwingeloo Telescope came off its tower for restoration. The Dwingeloo Radio Telescope was, at the time of its opening in 1956 by Queen Juliana, the largest radio telescope in the world. Until the '90's of the last century, the telescope has served as a scientific instrument. Astronomers mapped our galaxy with the Dwingeloo Radio Telescope. In 1998, the 25-meter dish, was placed in the so-called storm position and since then, has no longer been used for scientific purposes. The Dwingeloo Radio Telescope is a protected monument since 2009 because of its history and (international) scientific significance. With the establishment of the CAMRAS foundation in 2007 (www.camras.nl), the radio telescope has been given a new purpose for amateurs and education.

#ASTRONtweets

ASTRON - Mike Garret @ASTRON_LOFAR 4 Jun
*'Preparations being made for the dish being lifted off **Dwingeloo telescope**'*

Ingenieur @de_ingenieur 6 Jun
*'Opknapbeurt voor **#telescoop #Dwingeloo** - achterstallig onderhoud aan schotel en draagconstructie #erfgoed #astronomie'*
deingenieur.nl/nl/nieuws/18845/opknapbeurt-voor-telescoop-dwingeloo.html

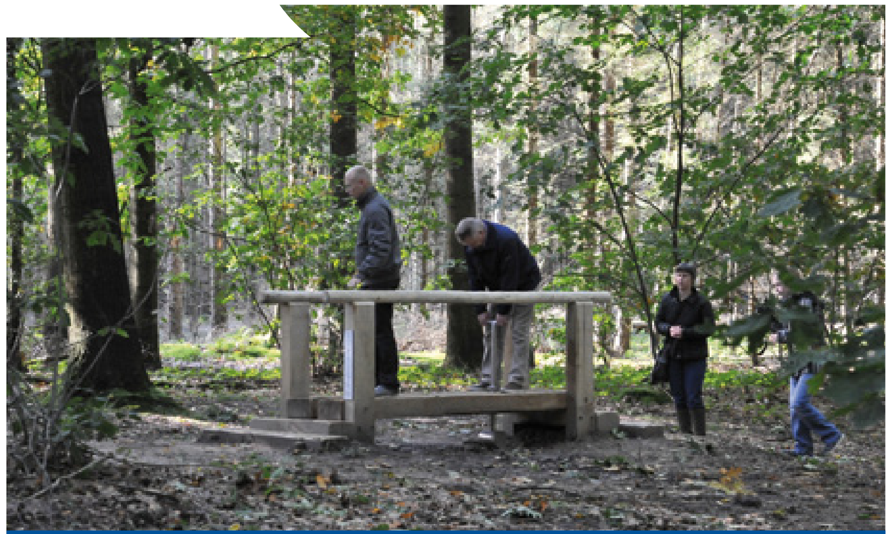
Academic Transfer Tweets @starsmaven 7 Dec
*'This is also Science, In The Netherlands MT @hfalcke: The refurbished 25 m **telescope** in the snow in **Dwingeloo**'*
pic.twitter.com/VflRjtVw #FB

Re-opening of the Milky Way path

On Sunday 7 October 2012, over four hundred people visited the Milky Way path near ASTRON's Westerbork telescope. In the months before, the path, which houses a scale model of our solar system, was renewed. During the Dutch Weekend of Science (6 and 7 October), ASTRON, Universe Awareness, the remembrance centre for Camp Westerbork (which lies next to the telescope) →

The Dwingeloo telescope in the snow.

The photo shows one of the whisper dishes on the Milky Way path. Whisper at the whisper dishes and 100 meters further your friend can hear exactly what you said!



Kids and adults can experience gravity on the weights activity on the Milky Way path.

One of the ASTRON astronomers helped kids (and adults!) make their own pulsar during the LOFAR open day in May 2012.

and the State forest organisation re-opened the path and organised a number of activities on and around the Milky Way path and the Westerbork telescope. The activities were mainly aimed at kids, as October is also kids' month in the Netherlands.

A couple hundred kids showed up with their parents and looked at the stars and planets in the mobile planetarium, blew up chocolate marshmallows (and ate them), looked at the sun through the solar telescope and moved one of the Westerbork dishes by themselves.

On the Milky Way path they also made their own star, painted the Earth as they thought it would look like from the sky and juggled with planets to put them in the right order.

Open day at the LOFAR telescope

In May 2012, over 800 people visited the LOFAR telescope during ASTRON's open day. The day was organized in the context of the socalled EU 'Kijkdagen' (EU Open days), an initiative of the Northern Netherlands Provinces (SNN). On these open days, organizations in the Netherlands that received funding from the European Union (EU) can open their doors to the public.

ASTRON invited visitors to come and see LOFAR, the largest radio telescope in the world. Here they could perform an observation with the telescope, get a tour at the telescope in the field, travel through the universe in the mobile planetarium and learn about an even larger telescope than LOFAR, the Square Kilometre Array. The Square Kilometre Array (SKA) will be the world's largest and most sensitive radio telescope with a total collecting area of approximately one square kilometre. The SKA will be built in Southern Africa and in Australia. It is a global enterprise bringing together eleven countries from the five continents. ASTRON is one of the major players in this project. In the Netherlands, ASTRON has set up the SKA Northern Netherlands (SKA-NN) project to, in cooperation with industry, strengthen its position in the race to build the SKA. During the LOFAR open day, visitors could learn everything about the SKA-NN project. You can find more information about the EU open days on http://www.europaomdehoek.nl/.

#ASTRONtweets

Sze-leung Cheung @cheungszeleung — 14 May
'*#PTTU Over 800 visitors on **open day** @ ASTRON'S **LOFAR** telescope: ASTRON: Over 800 people visited the **LOFAR** telescope*'
bit.ly/JwgjwH

evert thomas @muskedier — 5 Oct
'*Zondag activiteiten voor kinderen in kader Oktobermaand Kennismaand langs **Melkwegpad** boswachterij Hooghalen*'

f westra van holthe @fwvh — 7 Oct
'*Lekker weer voor een wandeling over het vernieuwde **melkwegpad** bij de #radiotelescoop #Westerbork*'
astron.nl/about-astron/press-public/news/ontdek-ons-eigen-zonnestelsel/ontdek-ons-eigen-zonnestelsel

Assen Nieuws @_Assen — 5 Sep
'*Veel activiteit op Melkwegpad: Op zondag 7 oktober organiseert ASTRON, het Nederlands instituut voor radioastronomie, allerlei activiteiten op het Melkwegpad bij Hooghalen.*'

Press releases

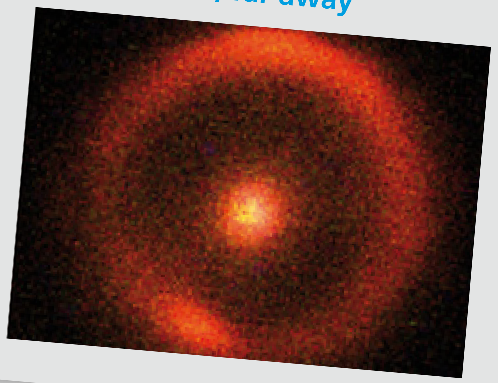
10 January 2012
A Boost for European Radio Astronomy

26 January 2012
Dwingeloo telescope live monument

16 January 2012
International LOFAR radio telescope kicks off all-sky survey

21 March 2012
First RadioAstron interference fringe at 220,000 km baseline

19 January 2012
Astronomers find dark matter galaxy far, far away



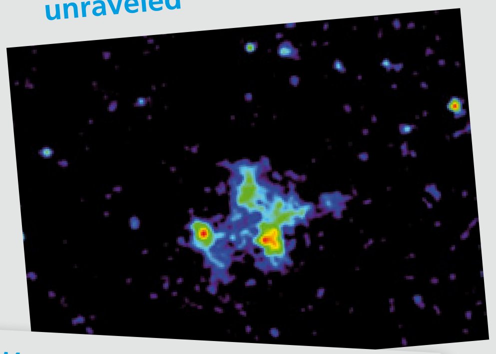
1 April 2012
ASTRON & IBM collaborate to explore origins of Universe

10 April 2012
ASTRON & Staatsbosbeheer signal start of building project

27 April
Restoration Dwingeloo Radio Telescope kicks off

19 April 2012
Girls on their way to new astronomical discoveries

23 May 2012
Colliding galaxy cluster unraveled



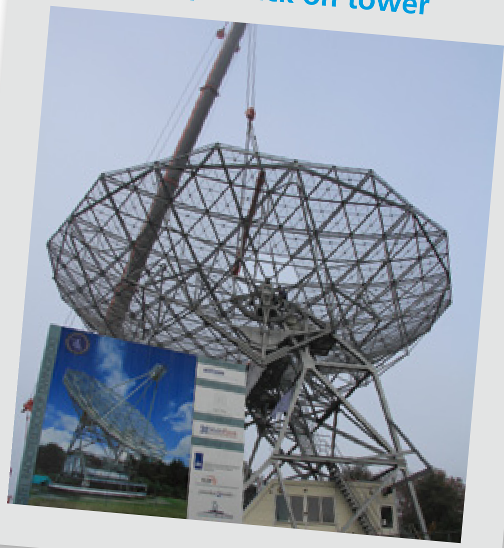
8 May 2012
Be an astronomer for one day at ASTRON

26 April
Under 'dark halo' old galaxies have many more stars

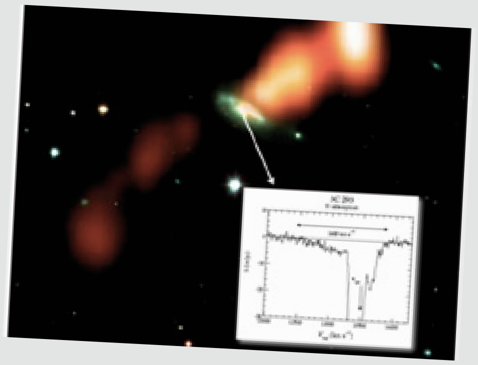
29 May 2012
Dish Dwingeloo Telescope temporarily dismantled

5 September
Sunday 7 October: astronomy on the Milky Way path

16 November 2012
Dish Dwingeloo radio telescope back on tower

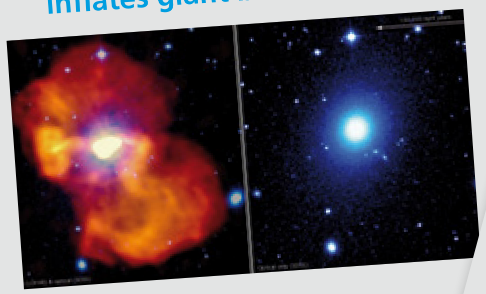


17 October 2012
European Advanced Grant for ASTRON astronomer

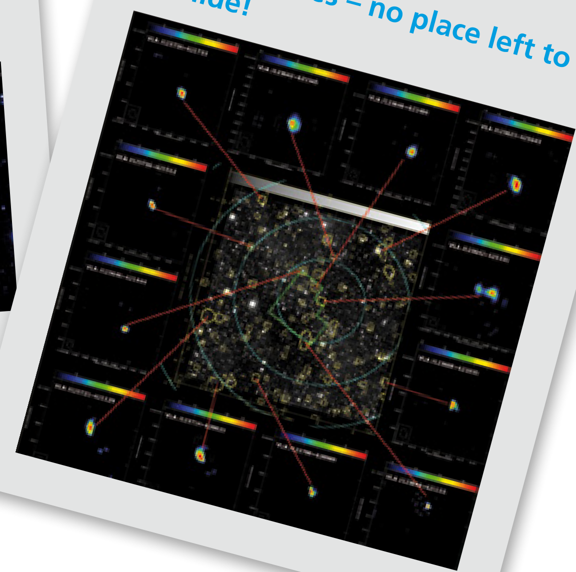


12 December 2012
ASTRON engineer promoted on system design LOFAR telescope

29 October 2012
Supermassive black hole inflates giant bubble



20 December 2012
Black holes – no place left to hide!



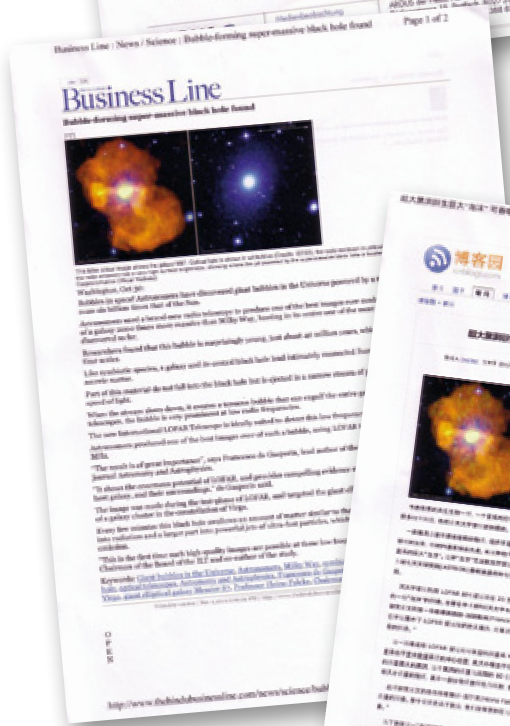

Zwart gat blaast gigantische bel


DOME-inating Research
Scientists look forward to looking back at the Big Bang


ASTRONOMIE.NL
ERC-grant voor Raffaella Morganti


IN BEELD
Werelds grootste radiotelescoop


Tages-Anzeiger
Voller Datendrang
Das SKA-Teleskop


Business Line


'Paddenstoelen' schieten schotel uit

Major group visits 2012

As every year, many people visited ASTRON in 2012. Below you can find an overview of some of these groups.

January

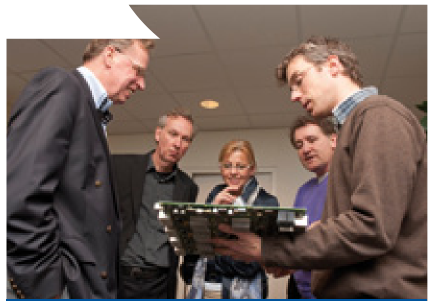
12 January 2012
Students from the Esdalcollege, Borger (near the LOFAR telescope).

18 January 2012
Students from the Kandinsky school, Nijmegen.

February

3 February 2012
Anniversary symposium of CAMRAS (the foundation that manages the Dwingeloo telescope).

21 February 2012
VNO-NCW Noord (entrepreneur organization in the northern Netherlands, interest group for 12,000 companies).



Instrument engineer Gijs Schoonderbeek shows visitors of VNO-NCW Noord the Uniboard, compact hardware that can process as much as 120 GB of (telescope) data per second.

22 February 2012
Mayor of Westerveld and members of Dutch and European parlement.

23 February 2012
Students from primary school 'de Kloostertuin', Assen.

Students from primary school 'de Kloostertuin', Assen, visited ASTRON.

Maart

March 2012
Students electrical engineering and mechanical engineering from Windesheim, Zwolle.

21 March 2012
High school students from Leiden and university astronomy students from the university of Leiden.

21 March 2012
Students post-college education for heritage and space, college from Utrecht, visited the Dwingeloo telescope.

April

19 April 2012
Physics students from the University of Hasselt, Belgium.

26 April 2012
Girlsday at ASTRON, JIVE and the NOVA Optical/ Infrared group.

27 April 2012
Students from the Hanze Institute of Technology, Assen.

May

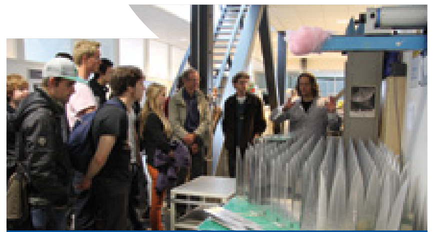
31 May 2012
High school students from the Celeanum, Zwolle.

June

22 June 2012
Member of European parliament Thijs Berman.

Member of European parliament Thijs Berman (3rd person from the left) visited ASTRON.

25 June 2012
Students from the Leiden instrument making school (LIS).



Students from the Leiden instrument making school (LIS) during a tour at ASTRON. Marco Drost is explaining them about the so-called EMBRACE-antennas (on the right).

28 Jun 2012
EU-network northern Netherlands.

Some members of the EU-network of the northern Netherlands, with representatives of different economical institutes, city councils, provinces and higher education, during a tour at the ASTRON headquarters.

July

3 July 2012
Participants of the SPIE Astronomy conference in Amsterdam.

4 July 2012
SKA NL Industry meeting.

19 July 2012
Euro commissioner Hahn + delegation.

EU commissioner Hahn (5th person from the left) during his tour at ASTRON.

19 July 2012
Primary school students from the Stork school, Dwingeloo.

September

20 Sep 2012
Francesco Azzarello, Italian ambassador.

Italian ambassador Francesco Azzarello in the control room (second from the right) during his tour at ASTRON.

October

5 Oct 2012
Students for the NOVA Fall school.

31 Oct 2012
Students from the college in Utrecht.

November

19 Nov 2012
Trade organisation from Dwingeloo.

22 Nov 2012
High school students from the Technasium of the Roelof van Echten school, Hoogeveen.

23 Nov 2012
City council of Westerveld/ Project IJsseldelta.

December

19 Dec 2012
High school students Kandinsky school, Nijmegen.

Appendix 1: financial summary

Financial report 2012

The financial report of 2012 compared with 2011

	2012 Budget	2012 Actual	2012 Difference	2011 Actual
REVENUES				
Government Grants-Ministry of Education, Culture & Science	12.474.800	11.849.877	624.923	11.190.309
Subsidies / Contributions	5.887.265	5.988.853	-101.588	18.013.218
Release to provision	0	10.348	-10.348	412.370
Other Income	412.000	440.044	-28.044	487.381
Cash management	50.000	32.675	17.325	114.992
Subtotal	*18.824.065*	*18.321.797*	*502.268*	*30.218.270*
Results Subsidiaries				
Subsidiary ATH	0	14.045	-14.045	10.954
Subtotal	*0*	*14.045*	*-14.045*	*10.954*
Special Income				
Special Income	0	480.332	-480.332	217.006
Subtotal	*0*	*480.332*	*-480.332*	*217.006*
Total Income	**18.824.065**	**18.816.174**	**7.891**	**30.446.230**
EXPENDITURES				
	16.397.606	15.161.801	-1.235.805	14.826.316
Grants / Expenditures	pm	-7.889.528	-7.889.528	-7.281.282
Operations	1.400.000	12.123.396	10.723.396	22.896.109
Allocation to Projects	*17.797.606*	*19.395.669*	*1.598.063*	*30.441.143*
Projectcosts				
Subtotal				
	0	0	0	0
Results Subsidiaries	*0*	*0*	*0*	*0*
Subsidiary ATH				
Subtotal				
	0	234.397	234.397	40.930
Other Expenditures	*0*	*234.397*	*234.397*	*40.930*
Other Expenditures				
Subtotal	**17.797.606**	**19.630.066**	**1.832.460**	**30.482.073**
Total Expenditures				
	1.026.459	**-813.892**	**1.840.351**	**-35.843**

Appendix 2: personnel highlights

The year 2012 was very busy for the Human Resources department at ASTRON. The Netherlands Organisation for Scientific Research (NWO) started two projects to renew, improve and refocus on several HR instruments such as competences and performance & development. ASTRON participated in both projects. The execution of these new instruments will follow in 2013 and we hope to reap the benefits from this in 2013 and onwards. Recruiting new personnel for several positions (both new and replacement positions) covered the better part of 2012.

As part of the project 'Talent to the top' within NWO, NWO has provided ASTRON with funds to offer two talented female scientists positions at ASTRON to develop themselves. ASTRON has started the recruitment and we hope to fill both positions in 2013.

Absenteeism

In 2012, the absenteeism percentage was 2,9%. This is slightly higher compared to 2011 (2,8%), but still lower compared to 2010 (3,6%) and 2009 (3,7%).

Building project

One of the big projects with a major impact on ASTRON staff in 2012, was the start of the building process. The building project entails the building of a new wing, renovations of wing '1980' and upgrading several aspects of wing '1996'. We kicked off the project with building a new wing (called building '2012').

The area at the ASTRON building made ready to start building the new wing alongside building '1980'.

Chairman of the ASTRON board Prof. Gaemers and ASTRON General Director Mike Garrett gave the official go ahead to start building, on April 11, 2012.

The building process had a lot of impact since many people needed to move to temporary offices to create enough room to build. ASTRON stayed fully operational while the building project was in progress so it was important to collaborate with the builders and keep each other informed about any nuisances (noise and so on) that occurred throughout the process.

The new wing of the ASTRON building during the building process.

At the end of 2012, the new wing was ready to be used. The remaining parts of the project will most likely be finished by the end of 2013.

Building '2012' completed.

Number of employees at ASTRON in 2012

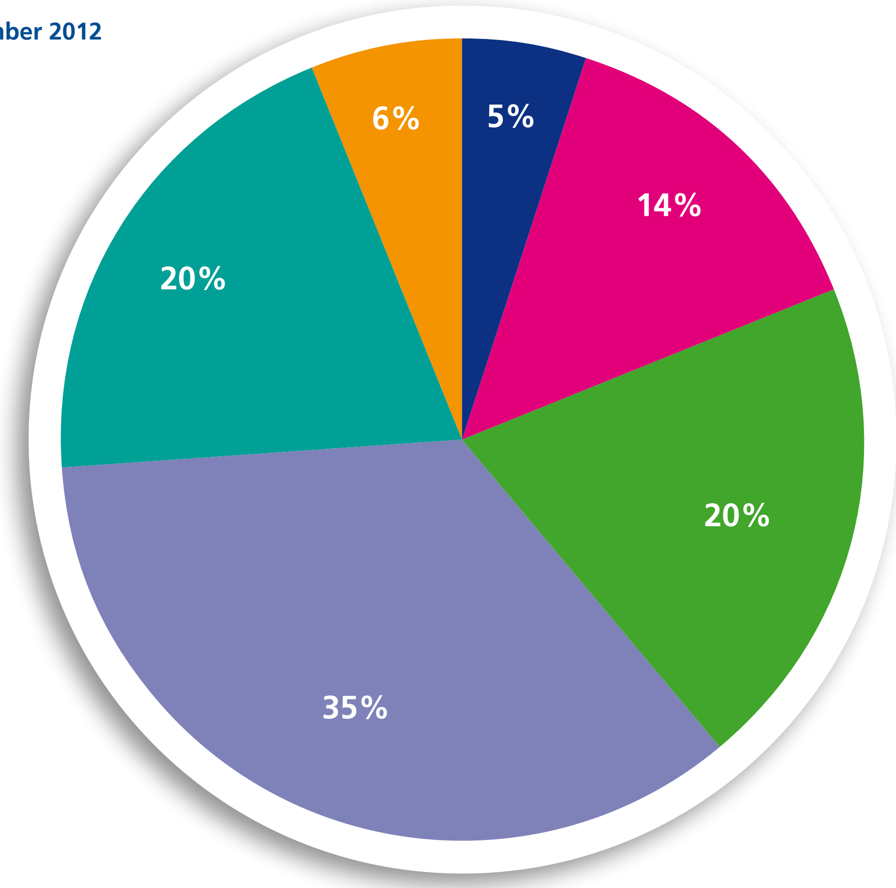
Department	Number of people
Management and Staff	8
Astronomy Group	22
Radio Observatory	32
Research & Development	55
General affairs	31
NOVA*	10
Total	158

*NOVA, the Dutch research school for astronomy, is a separate entity but all personnel of the NOVA/ Infrared group is employed by ASTRON (NWO).

Departments at ASTRON per 31 December 2012

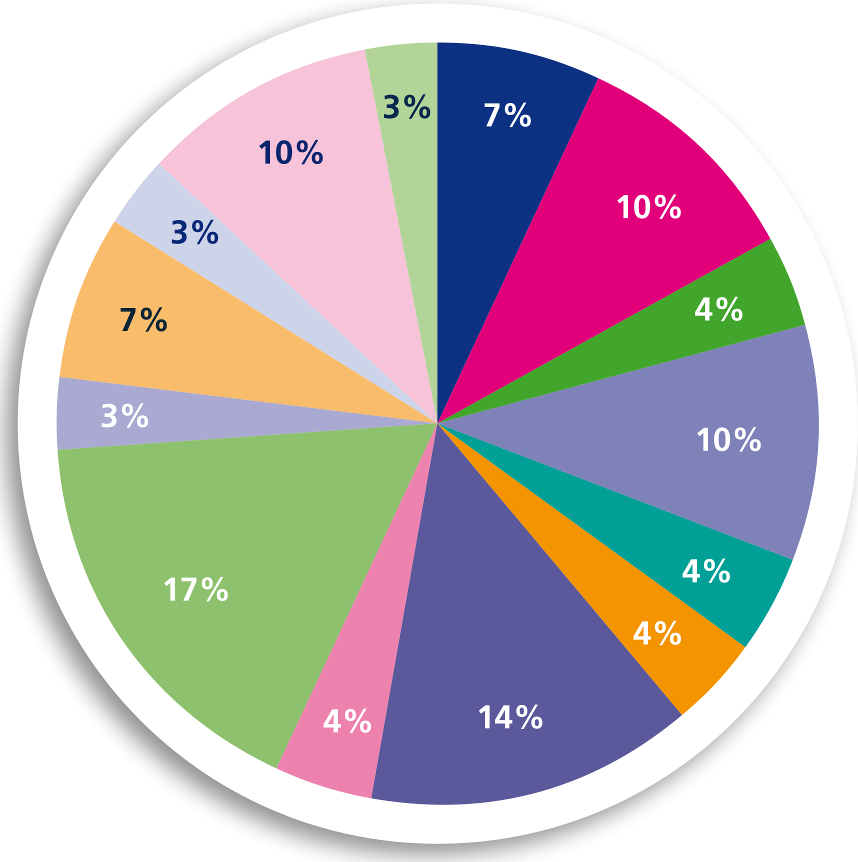
- Management and Staff
- Astronomy Group
- Radio Observatory
- Research & Development
- General Affairs
- NOVA*

**NOVA, the Dutch research school for astronomy, is a separate entity but all personnel of the NOVA/ Infrared group is employed by ASTRON (NWO).*



Non-Dutch nationalities at ASTRON per 31 December 2012.

- Australian
- British
- Canadian
- German
- Greek
- Hungarian
- Indian
- Iranian
- Italian
- Russian
- Spanish
- Sri Lanka
- American
- South Africa



Appendix 3: WSRT and LOFAR proposals in 2012

Table of proposals submitted to the WSRT in 2012 and accepted by the WSRT Programme Committee; rejected proposals are not shown.

Project-ID	Name of Project	Name of PI
Semester	**12A**	
R12A/001	Cyg X-3 in outburst: from gamma-ray to radio wavelengths	Tudose
R12A/002	The large-scale diffuse radio emission in A781	Pizzo
R12A/004	The Nature of Hoag's Object	Finkelman
R12A/005	The Large European Array for Pulsars	Janssen
R12A/006	Cold accretion in massive elliptical galaxies	Bemmel
R12A/007	High-magnetic field neutron star X-ray binaries during outburst	Migliari
R12A/008	Mapping the HI in galaxies with actively star-forming outer disks	Kauffmann
R12A/009	Characterisation of a sample of "Voorwerpjes" with the WSRT	Argo
R12A/010	Studying the profile variation of PSR J1022+1001	Liu
R12A/011	Studying the HI content of two subregions in the Ursa Major cluster	Wolfinger
R12A/012	WSRT High-Resolution Observations of Newly Detected, Nearby Spiral Galaxy	McIntyre
S12A/002	Cas-A Radio Recombination Lines: A Spectral Atlas	Oonk
S12A/003	PSR J2129-04: studying the eclipse properties of a rare type of millisecond pulsar binary system	Hessels
S12A/004	PSR J0337+17: Characterization of a Possible Pulsar Triple Star System	Hessels
S12A/005	Revisiting the Intra-Hour-Variable Quasar J1819+3845	Bruyn
S12A/006	The variable Faraday structure of BLLac	Bruyn
Semester	**12B**	
R12B/005	Following up study of the profile variation of PSR J1022+1001	Liu
R12B/008	Magnetization of the Universe with starbursting dwarf galaxies	Chyzy
R12B/009	Multi-frequency simultaneous observations of nulling phenomena in PSR B2111+46	Gajjar
R12B/010	Unraveling the Physics of Gamma-Ray Burst Blast Waves	Horst
R12B/011	A HI SKA Pathfinder pilot survey in the ZOA: A previously unexplored rich cluster and its immediate surroundings in the Perseus-Pisces Chain	Kraan-Korteweg
R12B/012	The last throes of star formation in blue early-type galaxies	Wong
R12B/013	A Daily WSRT Timing Campaign of a Pulsar in a Triple Star System	Hessels
R12B/014	Cyg X-3 in outburst: from gamma-ray to radio wavelengths	Tudose
R12B/015	RadioAstron Space VLBI survey of AGN at the highest angular resolutions	Kovalev
R12B/016	High-magnetic field neutron star X-ray binaries during outburst	Migliari
R12B/017	The European Pulsar Timing Array	Janssen
R12B/018	Shock and Awe: Do cluster collisions change the history of cluster galaxies?	Rottgering
R12B/019	The WSRT Coma Survey	Serra
R12B/020	The Large European Array for Pulsars	Janssen
R12B/021	Revisiting the Intra-Hour-Variable Quasar J1819+3845	Bruyn
R12B/022	A WSRT continuum legacy survey: Galactic foregrounds towards LOFAR-EoR windows	Jelic
S12B/001	A search for radio relics in the Musket Ball Cluster	Van Weeren
S12B/002	Space-ground maser observations of hydroxyl masers in W75N	Alakoz
S12B/003	Is TYC 4051-1277-1 a new gamma-ray binary?	Marcote
S12B/004	PSR J2339−0533: Characterizing the eclipses of a new pulsar "redback" system	Hessels
S12B/005	Timing the Crab pulsar during a large scattering event	Janssen

Tables of LOFAR Proposals in 2012

Proposal code	PI	Title
1	E. Orru'	Observation of the Double-Double B1835+62
2	M. Iacobelli	Observation of the Double-Double B1835+62
3	A. Horneffer	Polarised pulsars as calibrators
4	A. G. de Bruyn	Deep field observing
5	F. de Gasperin	Virgo A, HBA and LBA
6	J. Swinbank	Transients: Monitoring Bell#1 (PSR B0329) and SS433
7	D. Rafferty	Hydra A
8	G. Heald	Measure the station beam shape with a pointing offset grid
9	O. Wucknitz	Commissioning observations of the Crab and possibly other bright pulsars for amplitude calibration
10	A. Horneffer	Transfer of Cal solutions on 3C295 and M51
11	O Wucknitz	Long baseline observations of calibrator sources (e.g. 3C48, 3C147, 3C196, 3C295)
12	J. Hessels	Rotation measures of pulsars
13	R. Fallows	Sun and Interplanetary space observastions during solar flares
14	C. Tasse	Re-observing Bootes
15	R. Morganti	Calibration approach for LBA data
16	A. G. de Bruyn	High-accuracy ionospheric RM determinations
17	L. Birzan	Commissioning data of Hercules A
18	R. Fallows	Interplanetary Scintillation commissioning proposal
19	J. McKean	Cyg A
20	O. Wucknitz	Very long baseline observations with LOFAR and LWA
21	R. Oonk	Tied array observations of RRL
22	C. Vocks	Observations of the Sun crossing Taurus A (throughout 15-30 June)
23	A. Stroe	A-team removal in extended sources
24	C. Vocks	Solar imaging with external calibrators
25	G. Heald	Galactic center
26	O. Wucknitz	B0218+357
27	A. Deller	Bright calibrators in HBA
28	D. Mulcahy	NGC891 and PSR J0218
29	C. Tasse	3C295 field
30	H. Vedantham	Commissioning Test of LOFAR Long Baselines on a "random" field

Table 1: LOFAR Commissioning projects approved and observed in 2012.

Proposal code	PI	Title
LRA12A002	G. Mann	Solar Observations with LOFAR
LRA12A003	H. Rottgering	LOFAR Surveys: Opening up a New Window on the Universe
LRA12A004	R. Fender	The LOFAR Transients Key Science Project
LRA12A005	J. Hoerandel	Cosmic Ray KSP Reserved Access Proposal
LRA12A006	G. de Bruyn	Studying the Epoch of Reionization and Cosmic Dawn on the Universe
LRA12A007	M. Bisi	Observations of Interplanetary Scintillation (IPS) with LOFAR
LRA12A008	R. Beck	The LOFAR Magnetism Key Science Project (MKSP)

Table 2: The seven Reserved Access Proposals leading up to LOFAR Cycle 0

Proposal code	PI	Title
LC0_002	Olaf Wucknitz	Location and motion of sources of Jupiter's magnetospheric/auroral decameter emissions
LC0_003	Rob Fender	Wide field searches for image-plane radio transients
LC0_004	Neal Jackson	Gravitational lenses at low frequencies
LC0_005	Regis Courtin	A determination of the abundance of water in Saturn's deep atmosphere with LOFAR
LC0_006	Imke de Pater	LOFAR Observations of Jupiter's Synchrotron Radiation
LC0_007	Philippe Zarka	Exoplanet radio search and characterization
LC0_008	Ben Stappers	LOFAR studies of pulsars, fast transients and the interstellar medium
LC0_009	George Miley	Particle acceleration and cold gas in high-redshift radio sources - long baseline and recombination line studies
LC0_010**	Aris Karastergiou	ARTEMIS on LOFAR: real-time searches for fast transients with international LOFAR stations
LC0_011	Joris Verbiest	Pulsar timing with LOFAR
LC0_012	Raffaella Morganti	Using LOFAR for detailed studies of AGN, and AGN physics
LC0_013	Rachel Osten	Stellar Radio Astronomy with LOFAR
LC0_014**	Maciej Serylak	Studying pulsars and the interstellar medium using International LOFAR stations
LC0_015	Philip Best	A deep and wide extragalactic survey at low frequencies: AGN evolution, star formation, and cosmology
LC0_016	Ewan OSullivan	Stephan's Quintet: the role of shocks in the formation of the hot intragroup medium
LC0_016	Ewan OSullivan	Stephan's Quintet: the role of shocks in the formation of the hot intragroup medium
LC0_017	Joseph Lazio	A Search for radio emissions from HD 80606b near planetary periastron
LC0_019	A G de Bruyn	Studying the Epoch of Reionization and cosmic dawn of the Universe
LC0_020	David Jones	Determining the origin and (magnetic) substructure of the Fermi bubbles
LC0_022	Scott Ransom	LOFAR timing of pulsars and rotating radio transients discovered in GBT 350-MHz surveys
LC0_024	Leonid Gurvits	Atomic hydrogen at z>5
LC0_025	Anna Scaife	Low Frequency Investigation of the Super-CLASS Super-cluster
LC0_026	John Conway	Imaging compact SNR, Supernova and AGN emission in M82 and M81
LC0_027	Gottfried Mann	Solar activity studies with LOFAR
LC0_028	Raymond Oonk	LOFAR Galactic Radio Recombination Line Survey (LG-RRLS)
LC0_029	Jean-Pierre Macquart	The polarization footprint of a nearby anomalously turbulent scattering screen
LC0_030	Gottfried Mann	LOFAR studies of the evolution of coronal mass ejections in the heliosphere
LC0_031	Brian McNamara	AGN outburst in MS0735.6+7421
LC0_032	Glenn White	LOFAR Survey of High Mass star forming regions in Galactic plane
LC0_034	Jason Hessels	LOTAAS: The LOFAR Tied-Array All-Sky Survey for Pulsars and Fast Transients
LC0_035	Joeri van Leeuwen	Targeted searches for pulsars and fast transients
LC0_037	Marcus Brueggen	Exploitation of LOFAR surveys to study galaxy clusters
LC0_038*	Stijn Buitink	Cosmic ray detection using LORA triggers
LC0_039	James Miller-Jones	Variable jet sources in the LOFAR band
LC0_040	James Cordes	Using Diffractive Interstellar Scintillations (DISS) to Resolve Pulsar magnetospheres and the issue of potential DC emission
LC0_041	Stijn Buitink	Imaging of the Moon
LC0_042	Natalia Lewandowska	Multi-frequency observations of giant radio pulse emission from pulsars
LC0_043	Rainer Beck	LOFAR Survey of nearby galaxies
LC0_044**	Jana Koehler	Studying large-scale polarization properties of the Milky Way ISM at low frequencies

Table 3: The Regular Proposals that were approved for LOFAR Cycle 0
* project run in piggybacking mode ** projects requesting stand alone use of a few international stations

Appendix 4: board, committees and staff in 2012

Board members
Prof. K. Gaemers *(Chair of the Board)*
Prof. dr. J.T.M. de Hosson
Prof. dr. J.C.M. van Eijndhoven
Prof. dr. ir. J.A.M. Bleeker
Drs. S.B. Swierstra
Drs. J.P. Rijsdijk

Members of the Science Advisory Committee
Prof. dr. J.H. van Gorkom, *Columbia University*
Dr. D.R. DeBoer, *CSIRO-ATNF*
Dr. L.V.E. Koopmans, *Kapteyn Institute*
Dr. J. Ulvestad, *NRAO*
Prof. dr. J.L. Jonas, *Rhodes University*
Prof. dr. H.J.A. Röttgering, *Radio Observatory Leiden*
Dr. J. Vink, *University Utrecht*
Prof. dr. R.A.M.J. Wijers, *University of Amsterdam*

Members of the WSRT Program Committee
Prof. P. Biermann
Dr. D. Gabuzda
Dr. J. Kaastra
Dr. U. Klein
Prof. dr. M. Kramer
Dr. T. Oosterloo
Dr. I. Prandoni
Prof. dr. T. van der Hulst
Prof. dr. G. Woan

Directorate
Michael Garrett, *Scientific director/ Director General*
Marco de Vos, *Managing director/Deputy Director General*

Staff functions
Diana van Dijk, *Management assistant*
Truus van den Brink-Havinga, *Office manager*
Michiel van Haarlem, *Interim Director General SKA Organisation*
Arnold van Ardenne, *Coordinator ASTRON SKA Program Office*
Femke Boekhorst, *PR & Communications officer*
Ina Lenten-Streutker, *Secretary*
Marja Carnal – v.d. Spek, *Secretary*
André van Es, *Project manager European projects*
Arno Gregoor, *Employee general affairs*

Human Resources and Internal Communications
Diana Verweij, *Head HR&IC*
Carin Lubbers, *HR assistant*
Erika Timmerman, *HR officer*
Marianne Wielink-Strating, *HR assistant Finance, Planning & Control*
Janneke Wubs-Komdeur, *Head FP&C*
Ingrid Arling, *Assistant FP&C*
Emmy Boerma, *Project controller*
Anne Doek, *Assistant FP&C*
Bertine Kok-Winters, *Financial administrative assistant*
Anno Koster, *Purchasing administrative assistant*
Karin Spijkerman-Hogenkamp, *Project controller*

ICT support
Roelof Boesenkool, *Head of ICT*
Marc Luichjes, *System and network support*
Merijn Martens, *ICT assistant*
Jan Slagter, *System and network support*
Klaas Stuurwold, *Senior officer ICT*
Henk Vosmeijer, *Application and system administrator*

Facilities
Anne Veendijk, *Head of Facilities*
Alex Benjamins, *Technical support*
Henk Bokhorst, *Security*
Roelie Kremers, *Telephone operator/ receptionist*
Derk Kuipers, *Building and terrain*
Arjen Meijer, *Technical support*
Fritz Möller, *Facilities coordinator*
Miranda Vos, *Telephone operator/ receptionist*
Albert Wieringh, *Security*

Astronomy Group
Raffaella Morganti, *Head of Astronomy*
Monique Ankone, *Coordinator education and diversity**
Megan Argo, *Research assistant*
Ilse van Bemmel, *PostDoc*
Alicia Berciano Alba, *PostDoc*
Erwin de Blok, *Senior staff astronomer**
Ger de Bruyn, *Senior astronomer*
Adam Deller, *Junior scientist*
Liesbet Elpenhof, *Secretary*
Neeraj Gupta, *PostDoc*
George Heald, *Junior scientist*
Jason Hessels, *Staff astronomer*
Vlad Kondratiev, *Pulsar PostDoc*
Joeri van Leeuwen, *Staff astronomer*
Elizabeth Mahoney, *Research assistant**
John McKean, *PostDoc*
Raymond Oonk, *PostDoc*
Tom Oosterloo, *Senior scientist*
Maura Pilia, *PostDoc*
Paolo Serra, *PostDoc*
Mike Sipior, *Astronomical software support coordinator*
Marjan Tibbe, *Office manager*
Javier Moldón Vara, *PostDoc**
Michael Wise, *Associate scientist*

Research and Development
Albert-Jan Boonstra, *Head of R&D a.i.*
Alexander van Amesfoort, *HPC software engineer*
Michel Arts, *Antenna Researcher*
Laurens Bakker, *RF System engineer*
Pieter Benthem, *Instrument engineer*
Mark Bentum, *Senior scientist DESP*
Saswata Bhaumik, *RF/ Microwave instrument engineer**
Jan Geralt Bij de Vaate, *Senior Project Manager*
Patricia Breman, *Office manager*
Raymond van den Brink, *Instrument engineer Mechanics*
Chris Broekema, *HPC Researcher*
Wim van Cappellen, *Head Antenna Group*
Arthur Coolen, *Software Design engineer*
Renate van Dalen-Bremer, *Secretary*
Sieds Damstra, *Design engineer*
Ger van Diepen, *Software System engineer*
Marco Drost, *Instrument engineer mechanics*
Albert van Duin, *Support engineer*
Nico Ebbendorf, *Head of Technical support*
Benedetta Fiorelli, *Antenna Design Engineer*
Marchel Gerbers, *Reliability engineer*
André Gunst, *System engineer*
Ronald Halfwerk, *Technology Transfer Officer*
Hiddo Hanenburg, *Instrument engineer mechanics*
Jan Idserda, *Head Mechanics Workshop*
Dion Kant, *Head System design & integration*
Koos Kegel, *Senior RF engineer*
Eric Kooistra, *System engineer DESP*
Anne Koster, *Project support engineer*
Sjouke Kuindersma, *Support engineer Mechanics*
Marcel Loose, *Software System engineer*
Peter Maat, *System researcher Photonics*
Maaike Mevius, *Researcher**
Jürgen Morawietz, *RF Instrument engineer*
Eim Mulder, *Support engineer*
Jan Nijboer, *Project support engineer*
Ronald Nijboer, *Head of Computing*
Jan Noordam, *Senior software engineer*
Ruud Overeem, *Instrument engineer software*
Arash Owrang, *PHD researcher*
Vishambhar Nath Pandey, *Researcher*
Harm-Jan Pepping, *Design engineer DESP*
Johan Pragt, *Head of Mechanics*
Raj Thilak Rajan, *Digital signal processing engineer*
John Romein, *System researcher Software*
Mark Ruiter, *RF Instrument engineer*
Gijs Schoonderbeek, *Instrument engineer DESP*
David Smith, *PostDoc OLFAR**
Niels Tromp, *Instrument engineer Mechanics*
Lars Venema, *Senior researcher*
Klaas Visser, *RF Instrument engineer*
Erik van der Wal, *RF Instrument engineer*
Stefan Wijnholds, *Researcher*
Ronald de Wild, *Instrument engineer DESP*
Roel Witvers, *RF Instrument engineer*
Bert Woestenburg, *Head of RF & low noise systems*
Sarod Yatawatta, *Researcher Software*
Sjouke Zwier, *Design engineer DESP*

Radio Observatory
René Vermeulen, *Director Radio Observatory*
Michiel Brentjens, *Researcher Science support*
Pieter Donker, *ICT/Software engineer*
Liesbet Elpenhof, *Secretary*
Richard Fallows, *Support scientist**
Wilfred Frieswijk, *Support scientist*
Yan Grange, *Scientific Programmer**
Teun Grit, *ICT/Software engineer*
Peter Gruppen, *Support engineer electronics*
Hanno Holties, *System engineer*
Alwin de Jong, *ICT/Software engineer*
Gyula Józsa, *Support scientist*
Wouter Klijn, *Software engineer*
Geert Kuper, *Operator*
Hans van der Marel, *System engineer*
Henri Meulman, *Hardware engineer*
Rob Millenaar, *System engineer (SKA Project Office)*
Jan David Mol, *ICT/Sofware engineer*
Harm Munk, *Head of Technical Operations*
Menno Norden, *System engineer*
Emanuela Orrù, *Support scientist**
Roberto Pizzo, *Head of Science Support a.i.*
Antonis Polatidis, *Observatory Astronomer*
Jan-Pieter de Reijer, *Hardware engineer*
Adriaan Renting, *ICT/Software engineer*
Arno Schoenmakers, *ICT/Software engineer*
Jurjen Sluman, *Operator*
Roy Smits, *Support scientist*
Harm-Jan Stiepel, *Hardware engineer*
Yuan Tang, *Operator*
Marjan Tibbe, *Office manager*
Carmen Toribio, *Support scientist**
Nico Vermaas, *ICT/Software engineer*

NOVA Optical/IR Instrumentation Group
Ramon Navarro Y Koren, *Groupleader*
Tibor Agócs, *Instrument engineer*
Felix Bettonvil, *System engineer*
Eddy Elswijk, *Hardware engineer*
Menno de Haan, *Support engineer*
Rik ter Horst, *Instrument engineer*
Jan Kragt, *Design engineer*
Gabby Kroes, *Instrument engineer*
Ronald Roelfsema, *System engineer*
Menno Schuil, *Support engineer*

*New employee in 2012

Appendix 5: publications

Astronomy Group and Radio Observatory

Astronomical publications in refereed journals 2012

1. Xu Han, **Tao An**, Jun-Yi Wang, Ji-Ming Lin, Ming-Jie Xie, Hai-Guang Xu, Xiao-Yu Hong, Sandor Frey: *Confirming the 115.5-day periodicity in the X-ray light curve of ULX NGC 5408 X-1*, 2012, Research in Astronomy and Astrophysics, 12, 1597-1602
2. Marc Klein Wolt, Amin Aminaei, Philippe Zarka, Jan-Rutger Schrader, Albert-Jan Boonstra, **Heino Falcke**: *Radio astronomy with the European Lunar Lander: Opening up the last unexplored frequency regime*, 2012, Planetary and Space Science, 74, 167-178
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5. Yogesh Chandola, **Neeraj Gupta**, D. J. Saikia: *Associated 21-cm absorption towards the cores of radio galaxies*, 2012, Monthly Notices of the Royal Astronomical Society, , 464
6. E. C. Elson, **W. J. G. de Blok**, R. C. Kraan-Korteweg: *H i synthesis observations of the blue compact dwarf NGC 1705*, 2012, Monthly Notices of the Royal Astronomical Society, , 435
7. Yogesh Chandola, **Neeraj Gupta**, D. J. Saikia: *Associated 21-cm absorption towards the cores of radio galaxies*, 2012, Monthly Notices of the Royal Astronomical Society, , 429
8. I. H. Whittam, J. M. Riley, D. A. Green, M. J. Jarvis, I. Prandoni, G. Guglielmino, **R. Morganti**, H. J. A. Röttgering, **M. A. Garrett**: *The faint source population at 15.7 GHz - I. The radio properties*, 2012, Monthly Notices of the Royal Astronomical Society, , 422
9. Davor Krajnovic, Katherine Alatalo, Leo Blitz, Maxime Bois, Frédéric Bournaud, Martin Bureau, Michele Cappellari, Roger L. Davies, Timothy A. Davis, P. T. de Zeeuw, Pierre-Alain Duc, Eric Emsellem, Sadegh Khochfar, Harald Kuntschner, Richard M. McDermid, **Raffaella Morganti**, Thorsten Naab, **Tom Oosterloo**, Marc Sarzi, Nicholas Scott, **Paolo Serra**, Anne-Marie Weijmans, Lisa M. Young: *The ATLAS3D project - XVII. Linking photometric and kinematic signatures of stellar discs in early-type galaxies*, 2012, Monthly Notices of the Royal Astronomical Society, , 278
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11. C. N. Tadhunter, C. Ramos Almeida, **R. Morganti**, J. Holt, M. Rose, D. Dicken, K. Inskip: *PKS 0347+05: a radio-loud/radio-quiet double active galactic nucleus system triggered in a major galaxy merger*, 2012, Monthly Notices of the Royal Astronomical Society, 427, 1603-1613
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13. P. Abreu, ..[135 authors collapsed].., **H. Falcke** and [372 authors collapsed] : *A Search for Point Sources of EeV Neutrons*, 2012, The Astrophysical Journal, 760, 148
14. E. Aliu, ..[88 authors collapsed].., **V. Kondratiev**: *Search for a Correlation between Very-high-energy Gamma Rays and Giant Radio Pulses in the Crab Pulsar*, 2012, The Astrophysical Journal, 760, 136
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26. A. Bonafede, M. Brüggen, **R. van Weeren**, F. Vazza, G. Giovannini, H. Ebeling, A. C. Edge, M. Hoeft, U. Klein: *Discovery of radio haloes and double relics in distant MACS galaxy clusters: clues to the efficiency of particle acceleration*, 2012, Monthly Notices of the Royal Astronomical Society, 426, 40-56
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32. **R. J. van Weeren**, A. Bonafede, H. Ebeling, A. C. Edge, M. Brüggen, G. Giovannini, M. Hoeft, H. J. A. Röttgering: *Diffuse radio emission in MACS J1752.0+4440*, 2012, Monthly Notices of the Royal Astronomical Society, 425, L36-L40
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Appendix 6: abbreviations

A&A
Astronomy & Astrophysics
AA
Aperture Array
AAS
American Astronomical Society
AAVP
Aperture Array Verification Programme
AG
Astronomy Group
AGN
Active Galactic Nuclei
APERTIF
APERture Tiles In Focus, a focal plane array upgrade project for the WSRT
ASTRON
Netherlands Institute for Radio Astronomy
ATH
ASTROTEC Holding Company
DAS-4
The Distributed ASCI Supercomputer 4
EC
European Commission
E-ELT
European Extremely Large Telescope
EMBRACE
European Multi-Beam Radio Astronomy Concept - a dense aperture array demonstrator
EoR
Epoch of Reionisation
ESA
European Space Agency
ESTEC
European Space Research and Technology Centre
EVN
European VLBI Network
FPGA
Field Programmable Gate Array
FTE
Full Time Equivalent; the effort expended by one full time employee
GPU
Graphical Processing Unit
GRB
Gamma-ray bursts
HI
Neutral Hydrogen
IAC
International Astronautical Congress
IAU
International Astronomical Union
ICT
Information and Communication Technology
IEEE
Institute of Electrical and Electronics Engineers
ILT
International LOFAR Telescope
IR
InfraRed
ISM
Interstellar Matter
JIVE
Joint Institute for VLBI in Europe
LNA
Low-noise amplifier
LOFAR
Low Frequency Array
METIS
MFFE
Multi-Frequency Front-End
MHz
Megahertz
MIRI
Infrared camera and spectrometer for the James Webb Space Telescope
MNRAS
Monthly Notices of the Royal Astronomical Society
NEXPRES
Novel EXplorations Pushing Robust e-VLBI Services
NL
The Netherlands
NOVA
Netherlands Research School for Astronomy (collaboration of five Dutch universities)
NWO
Netherlands Organisation for Scientific Research
PAF
Phased Array Feed
PhD
Doctor of Philosophy
PSR
Pulsar
R&D
Research and Development
RF
Radio Frequency
RFI
Radio Frequency Interference
SAC
Science Advisory Committee
SKA
Square Kilometre Array
SNN
Joint Collaboration Northern Netherlands
SPHERE
Spectro-Polarimetric High-contrast Exoplanet Research
SPIE
International society for optics and photonics
URSI
International Union of Radio Science
VLBA
Very Long Baseline Array
VLBI
Very Long Baseline Interferometry
VLT
Very Large Telescope
VLTI
VLT Interferometer
WHT
William Herschel Telescope
WSRT
Westerbork Synthesis Radio Telescope

Colofon

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