Meet the International SKA Forum 2010 Team!
SKA Phase 1 defined!
LOFAR - World’s largest eye nears completion!
Peering through the Milky Way towards the Big Bang

Netherlands Institute for Radio Astronomy
Welcome to the summer edition 2010 of the ASTRON News. At the time of writing this, only two thoughts are on our minds: the International SKA Forum 2010 (ISKAF2010) and the inauguration of the LOFAR telescope. It is in the middle of this tumultuous preparation time that you find a special edition of the ASTRON News before you! We are also very happy to announce the breaking news that the funding of the entire Apertif upgrade of the Westerbork telescope is now secured! In this issue you can read all about this and about the opening of the new LOFAR telescope, ISKAF2010 and the activities we plan for the week.

As usual, we also present exciting scientific results. Marijke Haverkorn reports on the detection of the B-mode, which carries information about gravitational waves in the first fraction of a second after the Big Bang. Jean-Mathias Griessmeijer reports on his ground-based study of Saturn’s lightning.

The EMBRACE-team reports on the progress of the first full-scale prototype of an SKA phased array station, which achieved an impressive result during the Christmas break. Building upon the results of EMBRACE, the Aperture Array Verification Programme (AAVP) seeks to push the Aperture Array technology to the next stage of development from SKA Design Study to SKA Pathfinder. In this light, the programme got quite a push forward in Portugal by President Mr. Cavaco Silva. Read more about this in this newsletter!

Enjoy!

Femke Boekhorst, Raffaella Morganti and Mike Garrett
This is a very special edition of ASTRON News! Around the time when this edition appears in print, two very important events for ASTRON and our partners will be upon us – in particular, the International SKA Forum 2010 (ISKAF2010) and the inauguration of LOFAR! We are extremely happy to welcome so many visitors to the Netherlands and to Drenthe, and we hope everyone enjoys their stay with us. ISKAF2010 seeks to bring everyone involved in the Square Kilometre Array (SKA) together – one of the goals is to report on the recent EC sponsored COST-SKA workshop that focused on the non-scientific benefits of large-scale infrastructures for society.

The CISS (Connect Industry Science & Society) workshop, also being held during ISKAF2010, hopes to build on the success of the COST initiative. Not unrelated to this, the theme of ISKAF2010 is SKA Beyond Astronomy. We have some fantastic speakers lined up and we hope that this will further contribute to the case for the SKA. I should also not forget to thank all of our sponsors, in particular the European Commission that is supporting ISKAF2010 via a significant award from the FP7 Infrastructures Coordination and support actions instrument.

The International SKA Forum 2010 comes at an auspicious time for the SKA project. Over the last few months the project has made significant progress, culminating in the definition of both a scientific vision and technical concept for SKA Phase 1. This is a huge step forward for the project, and provides focus for everyone involved – not only the scientists and engineers, but also industry and the various government funding agencies. There is a general feeling from all quarters that the project has reached the point of no return, and that June 2010 will be a defining moment for the future direction of the project. We shall see!

LOFAR – seeing the Universe in a new light
LOFAR opens up a new window on the Universe, seeing the Universe quite literally in a new light! The telescope is already producing some stunning new views of the Cosmos - surveying the low-frequency radio sky with unprecedented resolution and sensitivity. The formal opening of LOFAR is an important milestone for ASTRON, and the various national and international partners that have contributed so much to the project. The telescope is now almost fully deployed, only a few of the remote stations remain to be rolled-out, the main sticking point being the negotiation of land rights in a few cases. Currently, 25 LOFAR stations have been verified and are now producing valid astronomical data. By the end of the year, this process will be complete and we expect all 36 Dutch and eight international stations to be up and running.
Meanwhile, the first scientific results from LOFAR are beginning to flow, and these together with new results from the other new and upgraded radio telescopes will be reported at the ISKAF2010 Astronomy Meeting – A New Golden Age for Radio Astronomy.

WSRT – the best is yet to come!
I’m told the excitement that is currently gripping ASTRON as we move from one success to another with LOFAR, is reminiscent of the old days when the first images appeared from the Westerbork Synthesis Radio Telescope (WSRT) in the early 1970s. This year also happens to be the 40th anniversary of the WSRT, and I for one, like to think of the telescope as being “in its prime”. However, the truth is that for Westerbork the best days may be yet to come!

In particular, the APERTIF focal plane array project has made fantastic progress recently and offers the potential to transform the WSRT into a fantastic survey instrument with a field of view that is 30 times larger than the current system. The success of the APERTIF system means that we are also enjoying a fruitful and very productive two-way collaboration with our colleagues in Australia (ASKAP), Germany (Effelsberg) and India (GMRT), all of whom are anxious to get their hands on one or more of the new APERTIF front-end systems. Funding for WSRT operations extends at least until 2016 and we received the great news that our recent APROPOS proposal (submitted to NWO-G) is successful - this requests the funding for the correlator, pipeline and archive system that is needed to fully exploit the APERTIF system. Our plans are to make the data publicly available from day 1, with no proprietary period involved except for possible data quality checks.

Aperture Array developments
There is more good news to report – the Aperture Array Verification Programme (AAVP) is now underway, building upon the results of LOFAR and EMBRACE, seeking to push the AA technology to the next stage of development from SKA Design Study to SKA Pathfinder. Arnold van Ardenne is coordinating an international team of engineers and scientists many of whom were involved in the highly successful FP6 SKADS project. The idea is that the technol-
logy developed at this stage, can be constructed, ready for the larger SKA demonstrator that is now planned as part of Phase 1 (see the article by Richard Schilizzi for more details).

**Attracting top-talent to ASTRON**

Finally, it’s a pleasure to report that both the Astronomy Group and the Radio Observatory have been extremely successful in attracting yet more top astronomical talent to ASTRON. In the last couple of months several young post-docs have joined us including Roberto Pizzo, Alicia Berciano, Rebecca McFadden, Vibor Jelic and Panos Lampropoulos. Michael Wise has also been appointed to a staff position within the Astronomy Group, although his move from the Radio Observatory will not happen until September. In addition to these developments, Marianna Ivashina has been awarded a VINNMER – *Marie Curie International Qualification Fellowship* in order to establish an international collaboration between Centres of Excellence in research and innovation between Chalmers University of Technology (Sweden) and ASTRON (the Netherlands). The proposed research project will address several important questions of the system modeling and calibration of phased array feed technology. The project runs for three years, beginning from January 2010. During the period of 2011-2012, Marianna will reside in Sweden but will retain her affiliation with ASTRON and will be a frequent visitor. Last but not least, Marijke Haverkorn was recently awarded an NWO-VIDI 800k Euro award which will permit her to build up a small group of post-docs and PhD students, in order to investigate the magnetic field of our own and other galaxies using the LOFAR telescope. This outstanding success is a good example of how much ASTRON has changed over the last few years. This combination of excellence in both Astronomy and Technical Research was also very much in evidence at the SKA2010 meeting in Manchester. I’m a great believer that success breeds success, and as part of that ethos Marijke’s VIDI programme nicely complements our recent “dynamiseering” award from NWO – in particular, we are in the process of appointing five new post-docs and together with the main Universities in the Netherlands, we hope to jointly fund ten PhD students in the fields of Astronomy and Technical Research over the next four years. It’s an investment in the future, but as projects like LOFAR begin to generate a veritable avalanche of data, and as the SKA newly emerges as an attainable goal, it’s one that we believe is worth making.

Prof. Mike Garrett
General Director, ASTRON.
Phased array feeds (PAFs) placed in the focus of a radio dish offer a number of important advantages over single-pixel receiver systems. The main reason to consider PAFs is, of course, the large increase of the field of view of the telescope that is achieved. This feature is the main motivation for Apertif, now fully funded, which will turn the WSRT into an effective survey radio telescope. Another advantage is that the instrument characteristics can be tuned to the aim of a particular observation, for example, by optimising the polarization response. Recent work using DIGESTIF, the APERTIF prototype PAF installed in one of the WSRT dishes, has shown that there is another reason for using a PAF in a radio telescope. One instrument feature plaguing many radio telescopes currently in operation is standing waves. They occur because a certain amount of radiation is reflected back into the dish by the feed and feedbox and, for the right (or wrong?) frequency, this creates a resonance in the dish. For the WSRT, as it is currently in use, the effects due to standing waves are known as the infamous 17-MHz ripple. The resonances cause periodic changes in the illumination of the dish. These, in turn, cause the shape and extent of the primary beam, as well as the spillover, to change periodically with frequency. This strongly affects instrument performance, in particular for off-axis sources. Figure 1 shows the spectrum, taken from a WSRT observation, of a source located about 20 arcmin N of the pointing centre where the spectrum is normalised with respect to the spectrum of a source at the field centre. The spectrum shows strong modulations spaced by about 17 MHz in frequency. Moreover, the amplitude of the modulations strongly depends on polarization, implying that the standing waves also induce strong instrumental polarization. Needless to say that the presence of such modulations very much complicate the calibration of the data because instrument models have to take this strong frequency modulations into account.

An important recent result obtained with DIGESTIF is that we have been able to demonstrate that the effects due to standing waves are basically absent in a radio dish equipped with a PAF. This is due to the very low level of reflection by the PAF: the amount of radiation reflected back into the dish by the PAF is 30 dB less compared to the current WSRT horn.
waves with APERTIF phased array feeds

system. Therefore, the resonances due to back-reflection are much weaker. This means that standing waves are absent already at the level of the individual elements of the PAF and that the result is unrelated to the beam optimisation that can be done with PAFs.

Figure 2 illustrates the absence of standing waves in DIGESTIF. This figure shows the illumination and illumination efficiency of a WSRT dish with the standard single-horn WSRT frontend and of the WSRT dish with DIGESTIF. The plot at the bottom of PAF has a smooth frequency behaviour, indicating that no effects due to standing waves are present. The top part of the figure shows the illumination pattern of the dish. It is clear that the illumination of the PAF is much better than that of the horn system.

The absence of standing waves has major implications for the calibration and analysis of the datacubes that will be obtained with APERTIF (or, for that matter, any other telescope equipped with PAFs). The instrument models to be used in the calibration of APERTIF data can assume smooth frequency behaviour over the entire field of view. This greatly simplifies the calibration of APERTIF.

Figure 2 shows the well-know fact that the illumination efficiency of a PAF system is higher than that of a single-horn system. But the plot also shows that the illumination efficiency of the single-horn system has a periodic dependence on frequency due to standing waves. In contrast, the dish with a
Hunting for new radio millisecond pulsars, with Fermi as our guide

by Jason Hessels (ASTRON) on behalf of an international team

An international team of astronomers is using the world’s largest radio telescopes to hunt for rare and elusive millisecond pulsars. Luckily, we have an excellent map to guide us: the impressive new catalogue of gamma-ray sources produced by NASA’s Fermi Gamma-ray Space Telescope. Many of these gamma-ray sources were suspected to be associated with energetic radio pulsars, and to the great excitement of many an observer and theorist this hypothesis has proven to be very much true.

Whereas in the last 30 years only 60 millisecond pulsars have been identified in the disk of our Galaxy, 18 new millisecond pulsars have been found in just the last 6 months by using telescopes such as the GBT, Parkes, and Effelsberg to target the sources of high-energy gamma-rays recently found by Fermi. This sudden jump in the known population of these rare stars increases the chances of using an ensemble of millisecond pulsars as the lever arms of an immense gravitational wave detector.

Millisecond pulsars are also especially interesting because they are the result of an exotic stellar evolution process and, in some cases, can strongly constrain the equation of state of neutron stars.

Millisecond pulsars, as their name implies, are pulsars that spin with rotational periods of only a few milliseconds – as fast as a kitchen blender. They are by far the fastest-spinning stars known and are formed when a neutron star is “spun-up” by the transfer of angular momentum from a companion star. Their weak pulsations are detectable at radio wavelengths, and in some cases they are also visible in high-energy gamma-rays.

Finding millisecond pulsars has always been computationally demanding, partly because their extreme properties require very precise measurements, but also simply because we don’t know where to look for them a priori. The Fermi catalogue of gamma-ray sources has hel-

Figure 1 (Credit: Jason Hessels): The 5 new millisecond pulsars found by our team, 4 of which were found using ASTRON’s “DROP” computer cluster. The average pulse profiles (the sum of many thousands of individual pulses) are shown at the top and repeated twice for clarity. The greyscale shows the signal strength as a function of the observing time and rotational phase of the star.
ASTRON is specifically involved in a pilot survey of 50 faint gamma-ray sources using the 100-m Green Bank Telescope, the world’s largest steerable radio dish. This survey was initiated by Mallory Roberts (Eureka Scientific/Naval Research Lab). Starting from my early days as a graduate student, I have worked with Mallory on searches for radio pulsars coincident with gamma-ray sources. In fact, the first pulsar I ever discovered was part of a similar project with Mallory. Since then, we have searched many of the unidentified gamma-ray sources found by the earlier EGRET gamma-ray instrument, with occasional success but often also with a good measure of frustration. This latest survey however has been tremendously successful. So far, our team has discovered 5 of the new millisecond pulsars mentioned above, of which 4 were found right here at ASTRON using the “DROP” (Data Reduction of Pulsars) computer cluster to perform the required heavy calculations in parallel.

This sudden sharp increase in the number of known millisecond pulsars is exciting news for pulsar astronomers like us who want to use them as a means to directly detect gravitational waves. By measuring their rate of pulsation, millisecond pulsars can be used as precise clocks, whose long-term stability is comparable to that of man-made atomic clocks. With a sizable array of known millisecond pulsars spread over the sky, we are attempting to measure correlated timing changes among these clocks in order to make the first ever direct detection of the gravitational wave background of the Universe - an important consequence of Einstein’s theory of General Relativity. Some of the new millisecond pulsars that are being found may be excellent clocks to help in this effort. ASTRON astronomers are part of the European Pulsar Timing Array (EPTA), which is one of several international teams working towards this lofty goal.

We’re going to continue searching for millisecond pulsars that are coincident with Fermi gamma-ray sources, and will likely soon employ Westerbork and PuMall in this effort as well. We expect that many exciting discoveries still lie ahead.
A Nobel Prize was awarded for the discovery that a faint glow that was emitted only a few hundred thousand years after the Big Bang was still detectable. This is the Cosmic Microwave Background (CMB) radiation. The observation of tiny fluctuations in this Big Bang afterglow which carried information about the young Universe resulted in another Nobel Prize in 2006. Recently, it has been observed that the CMB radiation is partially linearly polarized, as predicted. The next big challenge in this field is trying to measure a particular mode of polarization, called the B-mode, which carries information about gravitational waves in the first fraction of a second after the Big Bang.

Needless to say that observational cosmologists are eagerly trying to detect the B-mode, most easily done around 100 GHz, i.e. using sub-mm telescopes at the south pole, hanging from balloons or in satellites. Current upper limits for the B-mode are around 1 μK, but theory predicts that the signal might be orders of magnitude smaller than that. The weakness of the signal is not the only challenge; even if the signal would be theoretically visible, the observed radiation is completely dominated by the emission from foreground sources such as synchrotron or dust radiation in our own Milky Way.

The strongest polarized foreground at lower frequencies is synchrotron emission, which can be estimated by measuring it at much lower radio frequencies. Combine this with an estimate to which level this foreground can be subtracted, and we can determine down to which level we expect the CMB B-mode to be detectable. This exercise is important for future missions that will try to measure the CMB polarization B-mode; if the foregrounds can only be corrected for to a certain level, it does not make sense to invest in instruments that are much more sensitive than that.

One of the main questions is: which part of the sky to look for the CMB polarization signal? Obviously the CMB background is everywhere, so the point is to find a large region in the sky with minimum foreground contamination. A team was started by observational cosmologist Ettore Carretti to examine foreground levels as a function of Galactic latitude, i.e. angular distance from the Milky Way plane. As these measurements would also lead to interesting investigations of the Milky Way itself, ASTRON researcher Marijke Haverkorn was recruited to add the Galactic science component to the project.

The team measured the polarized emission on the sky in a 5-degree wide strip from the Milky Way plane down to the Southern Galactic pole in the Parkes Galactic Meridian Survey (PGMS), observed with the Parkes 64 m single-dish telescope in a frequency band from 2.2 to 2.4 GHz. Figure 1 shows the linearly polarized intensity in this strip, which shows maps centered at Galactic longitude 254 degrees, and the white lines and numbers represent the Galactic latitude. The left-most map, closest to the Galactic plane, ranges in intensity up to 35 mK, the two high-latitude maps show intensities from 0 to 10 mK.

Close to the Galactic plane, the polarized intensity shows small-scale structure, most notably the black, narrow ‘depolarization canals’. Higher up, away from the Galactic plane, the fluctuations in polarization are weaker and on larger scales, but are still clearly visible all the way to the Galactic pole. This seems to imply a pronounced boundary between the Galactic plane and the gaseous halo, at a Galactic latitude of about -20 degrees. Power spectra showing the scales of the fluctuations in Galactic polarization confirm a sharp change in the properties at -20 degrees.

For regions closer to the Galactic pole, at Galactic latitudes lower than -40 degrees, the
The APERTIF project, which aims to increase the survey speed of the Westerbork Telescope by a factor 30 by installing Phased Array Feeds, successfully passed the Preliminary Design Review (PDR). A panel consisting of Albert-Jan Boonstra (chair, ASTRON), Ger de Bruyn (ASTRON), Aaron Chippendale (CSIRO, Australia), Jason Hessels (ASTRON), Lister Staveley-Smith (UWA, Australia) and Bruce Veidt (NRC-DRAO, Canada) reviewed the project progress to make sure that the current baseline design optimally covers the science case and is technically feasible. The APERTIF team produced an extensive set of documentation for the review that included the science requirements, the system requirements, the system architectural design and the design of the subsystems.

The panel considered APERTIF a perfect science project, with a good link between astronomers and engineers, and also with links to other front-line FPA work in the world. Also, the good synergy between APERTIF and LOFAR was acknowledged. Various valuable suggestions were made by the panel to further improve the science case and the proposed design. The panel concluded that the APERTIF science case is broad, and justifies upgrading the WSRT with focal plane arrays in L-band. To the best of their knowledge, all major risks had been identified and they concluded that, with APERTIF, ASTRON is at the international forefront with respect to developing FPA technology for radio telescopes.

Obviously ASTRON, and in particular the APERTIF team, is very happy to pass this important milestone with such excellent comments. APERTIF now continues with the detailed design phase, aiming for rollout in 2012.

Properties of the polarized Galactic foreground turn out to be remarkably uniform. Power spectra of this emission are constructed and scaled up to their expected intensities at the higher frequencies where the CMB polarization will be measured. The results are shown in Figure 2, which shows theoretical power spectra of the polarized CMB B-mode (dashed lines) as a function of scale in terms of multipole l, which is the inverse of the angular fluctuation scale of the signal. The dotted lines denote earlier foreground estimates, based on averages over the entire high-latitude sky (WMAP) or small patches of sky (BOOM, DRAO, BaR). The PGMS results, given by the solid line, show significantly lower Galactic foreground limits. Therefore, the PGMS results prove for the first time that there are large (50-degree long) regions in the sky which allow much deeper CMB B-mode observations than the all-sky average at high latitudes. This conclusion may have ramifications for the designs of future B-mode detection missions; if foreground synchrotron emission can be cleaned to lower intensities than expected, the optimal frequency for B-mode detection might shift, as may the optimal detector technology.


Figure 2
The SKADS Wide field Science and Technology Conference

Arnold van Ardenne (ASTRON)
Some 100+ astronomers and engineers from across Europe, the United States of America, South Africa, Australia, Canada and the Russian Federation, shared their collective wisdom at a three-day conference in the beautiful location of Château de Limelette, in Belgium. Admittedly, most participants came from Europe which was not surprising giving that SKADS birthplace was European and that the programme has received significant funding through the EC-FP6 programme. Some attendees already knew Limelette as it was the location of an inspiring SKADS kick-off meeting four years earlier, albeit with only half the number of participants. It was good to see how much younger the crowd was after four years of collaboration in the project! After studying wide-field science and technologies with aperture arrays with an average effort of 80 person years per year, SKADS now drew to a close and this was the chance to see how far we all had come. Here, it is only possible to mention a few important areas where progress was made: a full cycle of simulated skies (S-cubed) through the astrodata pipeline using MeqTrees, beam pattern simulations, electromagnetic and circuit modeling of a full aperture array, a cos-
ting tool, demonstrators like EMBRACE/2-PAD and BEST, and a first go at data processing and computing vs. the required power. In summary, SKADS proved the attractiveness as well as the technical and scientific feasibility of using dense arrays for the SKA.

In a remarkable spirit of collaboration between contributors and editors, the SKADS Conference book became available four months after the conference finished, in time for the SKA2010 workshop in Manchester and was even available on the SKADS webpage after only three months! In the meantime, the SKADS vision of an SKA design also became available as a SKADS white paper (see also www.skads-eu.org).

Now that SKADS is turning off (not yet for the administration though!), some sadness always comes when departing from such an excellent crowd of co-workers. However, the astronomically verified capability of Aperture Arrays still needs to be proven. This will be done in the follow-up programme called the Aperture Array Verification Programme, which has just had its kick-off meeting.

Needless to say that this will be done in close cooperation with the SKA Science and Engineering Committee, the SKA Programme Development Office, and of course, with our collaborators in ESKAC and beyond.

Hope to meet you all in AAVP!
Summer 2010 sees the LOFAR roll-out back in full swing. The LOFAR core area in Exloo is now complete and by the end of the year we expect almost all the remote stations to be complete. A handful of stations may be delayed, due to the complex process of arranging land rights. By the end of the summer we also expect all the international stations to be up and running.

The progress we have made in the last few years has been in the words of our Scientific Advisory Committee "amazing" - there have been some challenges, including the weather and other delays associated with the bird breeding season but in the end we have prevailed. ASTRON staff have been in the vanguard of the construction process but none of this would have been possible without the support of our contractors and regional partners - many thanks to all involved, As the images presented here show, it has been a remarkable job!
The radio signature of Saturn lightning was first detected during the Voyager 1 fly-by in November 1980. These impulsive radio bursts were observed in the frequency range between 1 and 40 MHz, and are now known to be caused by lightning activity in an atmospheric cloud, which is approximately co-rotating with the planet. Additional measurements and continuous monitoring only became possible in 2004, when the Cassini spacecraft approached Saturn. When Cassini detected the first lightning signal, it still was at a distance of more than 20 million km (350 Saturn radii) from Saturn, while for the same instrument, terrestrial lightning became undetectable at a distance of 80000 km (14 Earth radii). Thus, Saturn’s lightning has a flux density more than 104 times higher than terrestrial lightning!

Considering that the Cassini spacecraft “only” has three antennae that are 10 m in length, one may wonder whether a large radio telescope on Earth could possibly detect the same signal. With Saturn at a distance of 1.4 billion km, we would need ~5000 times the effective area of the Cassini instrument (which is of the order of 10 m²). Thus, a low-frequency radio telescope with an effective area of the order of 100000 m² is required! Luckily, there is a telescope with such a rather impressive size: The giant Ukrainian radio telescope UTR-2 at Kharkov. Also, another telescope is ready to join the ranks: LOFAR.

Indeed, since 2006, Saturn lightning has been observed at UTR-2 (Ukraine) over the whole spectral range of the newly installed broadband receiver (10-30 MHz), yielding complementary information to those obtained by Cassini. We are able to detect planetary lightning over a distance of 1.4 billion km!

During an observing campaign (12/2007-01/2008), we recorded over 2500 lightning flashes, which allows a comparison to the data recorded by Cassini. Figure 1 shows a comparison of the numbers of Saturn lightning flashes detected by UTR-2 (upper histogram) and the normalized number of Saturn lightning flashes detected by Cassini (lower histogram, displayed downwards) for early December 2007. One can see that the period of Saturn lightning episodes as detected by Cassini is close to Saturn’s rotation period (approx. 10.6 h). Because of the Earth’s rotation, only every second Saturn lightning episode can be seen by UTR-2.
The pattern, consisting of white and gray areas in Figure 1, indicates the geometrical visibility of the Saturn lightning source as seen from the respective observatory. White colour means that the Saturn lightning source is within the visible horizon of the observer, while gray areas indicate when the Saturn lightning storm is beyond the geometric horizon. The patterns are slightly different for UTR-2 and Cassini because they observe Saturn from a different angle.

Figure 2 shows the distribution of the duration of Saturn lightning events. It can be seen that typical durations range from 20-200 ms. We find an exponential distribution with a time constant (the “e-folding time”) which is consistent with the measurements by Voyager and Cassini. Note that the observations were taken with a time resolution of 20 ms, so that timescales smaller than this are not resolved.

There are still many things that we’d like to understand: Why is Saturn lightning so rare and intense, how fast are the lightning bolts when compared to Earth lightning, and what can we deduce about the atmospheric dynamics and physics?

Unfortunately, Saturn lightning emission is relatively rare: unlike on Earth, the interval between two lightning storms can be over one year. Unfavorable conditions have prevented further observations in 2008 and 2009. However, in February 2010, Saturn woke up again, and we were able to take data with Cassini (at 2-16 MHz), UTR-2 (at 10-30 MHz), and with the Westerbork Synthesis Radio Telescope (at 130-156 MHz). The Westerbork observation will allow us to test how far the emission extends in frequency - up to now observations have never been attempted in that frequency range. In the coming weeks, we will try to add the LOFAR-observations, which will be an extremely powerful tool in the further understanding of Saturn lightning. On the long-term, we will also use LOFAR to observe Uranus and Neptune where lightning was briefly observed during the Voyager fly-bys... exciting times are awaiting us!

Figure 1. Saturn lightning detected by UTR-2 (upper part) and Cassini (lower part) for early December 2007.
The period lightning episodes as detected by Cassini is close to Saturn’s rotation period (approx. 10.6 h). White and gray areas: Geometrical visibility of the Saturn lightning for UTR-2 and Cassini. White area: Saturn lightning is within the visible horizon of the observer. Gray area: Saturn lightning storm is beyond the geometric horizon.

Figure 2. Duration of Saturn lightning. Statistical distribution of the duration of Saturn lightning events. Solid line: Exponential fit.
There’s a real buzz in the SKA world at the moment! So what’s happening? The big news is that the science case and baseline technical concept for the first part of the SKA (Phase 1) have been defined. The headline science themes for Phase 1 are neutral hydrogen from the Epoch of Re-ionisation to the present day, General Relativity and Gravitational Waves using pulsars, and transients and new phenomena. These are a subset of the Key Science Projects for the full SKA. The baseline design has two elements, a sparse low frequency aperture array and a 250 dish array with single pixel feeds operating at frequencies up to 3 GHz.

With Phase 1 defined, work on the system design is in full swing, led by the SKA Program Development Office (SPDO) and six “lead institutes” around the world, including ASTRON. The system design will be completed by the end of 2012. In addition,
the characterization of the two candidate sites for the SKA, Australia + New Zealand and Southern Africa, is also making good progress with very sensitive measurements of RFI about to start simultaneously at both sites using identical equipment. In addition, detailed array configurations for both sites are in the final stages of definition for use in evaluating the science performance and for costing the infrastructure required for the SKA.

Meanwhile, the funding agencies and governments represented in the Agencies SKA Group are actively involved in defining policy issues for the SKA, including such topics as governance, procurement and industry interaction, and funding. Two particular issues are in focus at the moment: the funding and governance of the “pre-construction period” from 2012 to 2015, and the site evaluation and selection process due to be completed by early 2012.

And two major meetings have just been held, both successful beyond their expectations. The first in sunny Manchester where 250 astronomers, engineers, industry representatives and funding agency officials gathered for SKA2010, to present the latest results from SKA pathfinder and precursor instruments, and to discuss engineering design issues and their impact on the science. The second meeting was in glorious Rome organised by the (European) Committee on Science and Technology (COST). Over 100 government, industry and science representatives met to consider the economic and social benefits of large research infrastructures using the SKA as an example. Particular issues were ICT, remote ‘green’ energy supply, global science-industry-government linkages driven by the SKA, and the potential role of the SKA in science education and awareness, and boosting the Science, Engineering and Technical work force.

By the time this newsletter appears, the International SKA Forum 2010 will be underway in Assen – we’re looking forward to a memorable event!
Meet the International SKA Forum 2010 Team!

ASTRON and NWO are pleased to host the International SKA Forum 2010 or ISKAF 2010 for short. After Perth, Australia (2008) and Cape Town, South Africa (2009), the third international forum is being held in the Northern part of the Netherlands, centred around the city of Assen. This is the first time the forum has been held in Europe, bringing together scientists, engineers, politicians, educators and industrial partners that are interested in the SKA, the international radio telescope for the 21st century.

Like every large event, a lot of effort has gone into organizing a memorable week of activities. ISKAF 2010 kicks-off on the 9th of June with a large science meeting - “A New Golden Age for Radio Astronomy”. Around 150 scientists from all over the world are expected to participate with ASTRON’s Raffaella Morganti acting as the SOC chairperson. We are expecting to see some exciting results from the SKA pathfinder and precursor telescopes to be presented, including LOFAR.

One of the highlights of ISKAF 2010 will be the ceremony around the LOFAR inauguration on Saturday June 12th. For this exciting and unique event all ISKAF2010 participants are invited, and both Michiel van Haarlem and Peter Benemma have been busy making sure that everyone will enjoy the party!

On Monday June 14th science funding agencies from around the globe will meet to discuss how they will accommodate the SKA (Agencies SKA Group). Patricia Vogel of NWO has been looking after the logistics for this very important group of people.

On the same day industrial partners will join in a workshop to discuss the opportunities of the SKA, not only for science and industry but also for society as a whole in the Connect Industry Science and Society Workshop (CISS). This is being organised by Henk Koopmans, Director of Sensor Universe.

The venue for all of the above meetings will be the luxury resort “Hof van Saksen” located south of the city of Assen. Also on the 14th June, there will be an ISKAF2010 dinner in Groningen. All participants of the various events are invited to attend this dinner – it should be a lot of fun!
The absolute climax of the week will be the International SKA Forum on June 15th at the TT-hall in Assen where high level politicians, top scientists, major industries, policy makers and candidate sites for the SKA will meet at ‘SKA Beyond Astronomy’. Marco de Vos is responsible for the Forum events aided by Arnold van Ardenne who is looking after the associated exhibition.

Last but not least, Andre van Es is the ISKAF2010 project manager who has the heavy task of keeping the rest of the team in order. He is ably supported by the ASTRON secretariat, Femke Boekhorst (ASTRON’s outreach officer) and the Groningen Congress Bureau.

My name is Roberto Francesco Pizzo and I recently joined the User Support group of ASTRON. I am not new in The Netherlands; I arrived here in July 2005, when I started my Ph.D. at the Kapteyn Institute of the University of Groningen under the supervision of Professor A. G. de Bruyn. Originally, I come from Modena, a very nice city located in the north of Italy. After Classical Studies at the high school, I decided to enlarge my knowledge by getting into science and I joined the Astronomy department of the University of Bologna. There I studied for four years before getting my master degree with a thesis on the spectral and (de)polarization properties of giant radio galaxies in sparse environments.

During the last four years, my main scientific interests focused on the properties of low-redshift galaxy clusters in the radio domain. Some clusters of galaxies show diffuse and extended steep-spectrum radio sources, which have been named halos and relics, depending on their location, morphology, and polarization properties. My Ph.D. project focused on the analysis of Abell 2255 and Coma, both known as galaxy clusters hosting important examples of such sources. By observing these targets with the WSRT at several frequencies between 150 MHz and 1.4 GHz, I proved that low-frequency radio data have the potential to reveal many still unknown properties of galaxy clusters and that RM-synthesis is a powerful tool that we can use to unveil their 3-dimensional geometry. The data allowed also a detailed study of the numerous tailed radio galaxies belonging to A2255 and of the Galactic foreground, which dominates the polarized signal detected in the field of this cluster at 350 MHz.

Through this project I have acquired considerable experience in handling low-frequency radio data, which is now an important tool for my current job.

Due to its extraordinary capabilities, LOFAR will play a major role in such investigations. I am currently a member of the cluster group of the LOFAR Survey KSP and of the Cosmic Magnetism KSP, both very active in designing the pioneering LOFAR observations. In this early time of the development of LOFAR, spending many hours in the control room is undoubtedly very exciting!

When not at work, I enjoy my free time in my apartment in Groningen, together with my cat Luna. Many friends come over and enjoy my Italian dinners, made of tasty bruschetta, pasta, pizza, and nice desserts. Movies, music, and travelling are my biggest hobbies, together with looking at a beautiful clear sky at night time!
A supernova faster than the others:
SN 2007gr produces a mildly-relativistic outflow

Zsolt Paragi (JIVE)

Massive stars end their life in a brilliant flash, outshining billions of neighbouring stars for a short time. In supernovae the outer layers of the star are expelled at a velocity of about 3 percent of the speed of light. In comparison, gamma-ray bursts (GRB’s), the most luminous explosions in the Universe, produce well collimated highly relativistic outflows (jets) pointing right towards us. A sub-group of GRBs has been thought to be related to the death of massive stars. But is there a real link in between these two phenomena: can ordinary supernovae produce jets (albeit less powerful) as well?

Supernova 2007gr was discovered in the bright spiral galaxy NGC 1058 on 27 August 2007. Optical observations firmly classified it as a Type Ic stripped-envelope core-collapse supernova. These stars show no Hydrogen lines in their spectra because they lost their H-rich envelope due to either interaction with a companion or because of their strong stellar winds. These are also the most massive stars that likely form a black hole when they explode. At the time of discovery, SN 2007gr was less than five days old. It appeared as a normal Type Ic SN with no peculiarly high luminosity and no sign of an extremely large outflow speed seen in the optical spectrum. However it was the closest of its kind, located at “only” 10.3 million parsecs away from us.

The Very Large Array detected radio emission in the source at the level of 600 microJy at 8.4 GHz on 17 August 2007. Although it was rather faint, JIVE and ASTRON scientists, in collaboration with astronomers in the UK, US, Canada, South Africa and Australia decided to carry out very long baseline interferometry observations with the European VLBI Network (Figure 1). Thanks to the regular e-VLBI observing opportunities this could be organised quickly, and the results were very promising (see ASTRON News, December 2007): SN 2007gr was detected at 5 GHz at the 400 microJy level, positionally consistent with the VLA measurements. However, at that time the real significance of this detection was not known yet.

The team organised follow-up observations with the EVN and the Green Bank Telescope on 5-6 November 2007. SN 2007gr was just barely detected with a peak brightness of 60 microJy/beam, and at a slight offset in position compared to the earlier VLBI measurement (Figure 2). The synthesis array data from Westerbork however showed that the source had a total flux density of 260 microJy during the observations. This puzzle had to be resolved. Careful analysis showed that amplitude and phase errors in the VLBI data could not be responsible for this discrepancy. Later analysis of archival VLA data showed that the WSRT measurements were correct, SN 2007gr had a total flux density of 250 microJy 13 days after the second VLBI observations.

Figure 1. The e-EVN at the time of the SN 2007gr observations in 2007. The data rate was limited to 256 Mbps at each of the telescopes. Since then, most of the EVN stations have been connected to the EVN MarkIV Correlator at JIVE at a data rate of about 1 Gbps, allowing rapid feedback measurements at very high sensitivities.
The best explanation is that the supernova expanded significantly within a few months, and some of its radio flux density was resolved out at the highest resolution. In that case the true expansion speed had to exceed half of the speed of light. It seems some of the supernovae can indeed produce collimated, at least mildly relativistic outflows, similarly to the more powerful gamma-ray bursts! There are important implications for the diversity of H-stripped core-collapse supernovae: while the total energy of these SNe is nearly constant, it appears that their relativistic energy content varies dramatically. It is likely that most Type Ic supernovae have very modest energy in relativistic material (and do not produce a GRB), which explains why only a small fraction of them are detected in the radio.

This result appeared in the 28 January 2010 issue of Nature. The real-time e-VLBI capability of the EVN and the Westerbork Synthesis Array Telescope in the Netherlands played an important role in this discovery. This publication highlighted the achievements in the recently concluded EXPReS project that introduced e-VLBI as an operational facility in the EVN.

The full team included: Zsolt Paragi (JIVE), Greg Taylor (Univ. New Mexico), Chryssa Kouveliotou (NASA/MSFC), Jonathan Granot (Univ. Hertfordshire), Enrico Ramirez-Ruiz (Univ. California), Michael Bietenholz (Hartebeesthoek Radio Observatory; York University), Alexander J. van der Horst (NASA/MSFC), Yuri Pidopryhora (JIVE), Huib J. van Langevelde (JIVE; Leiden Obs.), Michael A. Garrett (ASTRON; Leiden Obs.; Swinburne University), Arpad Szomoru (JIVE), Megan Argo (Curtin University), Stephen Bourke (JIVE), Bohdan Paczynski (deceased).

**Figure 2.** The initial e-VLBI detection of SN 2007gr in colours, with the second epoch VLBI map overlayed in contours. A significant fraction of the total flux density was resolved out at the second epoch, requiring a true expansion speed exceeding 0.5c.
METIS – Mid-infrared ELT Imager and Spectrograph

Ramon Navarro (NOVA Optical / IR Group at ASTRON)

METIS is one of the instruments studied in parallel with the phase B design of the European Extremely Large Telescope, the E-ELT. It is one of the eight instrument studies, issued by ESO, to study in more detail the feasibility, the interface and the discovery potential of both the telescope and instruments. METIS is the only E-ELT (phase A) instrument to cover the thermal/mid-infrared wavelength range from 3 – 14 µm.

The study is performed in a consortium of the Netherlands, Germany, France, the United Kingdom, and Belgium. Within the consortium, there is a long history of collaboration in mid-IR projects: JWST-MIRI, VISIR, MIDI, TIMMIZ, NAOS/CONICA, MICHELLE, HERSCHEL-PACS, ISO-SWS, and SPITZER-IRS. Bernhard Brandl from the University of Leiden is the PI of METIS.

The METIS science team developed and analysed the science case, based on discovery potential, the performance expectation of METIS at the E-ELT and the expected interaction with other major facilities like ALMA and JWST. From the twelve most important cases as shown in table 1, five cases were put forward as the primary science drivers (defining the instrument baseline specification).

As both the science cases and the instrument baseline design developed, the instrument and its top level requirements took shape. METIS consists of:

1. A diffraction limited imager at L/M, and N band with an approximately 18”×18” wide FOV. The imager also includes the following observing modes:
   - coronagraphy at L and N-band
   - low-resolution (900 < R < 5000) long slit spectroscopy at L/M and N band
   - polarimetry at N-band.

2. An IFU fed, high resolution spectrograph at L/M (2.9 – 5.3µm) band. The IFU field of view will be about 0.4”×1.5”, and the spectral resolution will be R ~ 100,000.

Mid-IR observations from the ground have to cope with a high thermal background (orders of magnitude more than the science target) from the emission from the telescope and the atmosphere. Special measures are taken to enable METIS to handle the high background:

1. Diffraction limited optics, to focus the science target on a smaller spot and thereby effectively reducing the background from the atmosphere and the telescope

2. Internal instrument chopping mirror, E-ELT does not provide the traditional solution with a chopping telescope mirror

3. Internal rapid switching flat fielding, to calibrate the detector pixel gain as good as possible


5. Cryogenic environment to reduce the instrument background well below the telescope and atmosphere contributions.

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Due to the large aperture of the telescope and the need to operate at the diffraction limit with a very stable field requires, compared to the current technology, a high order Adaptive Optics (AO) system even for the mid-IR wavelength domain.
The wavefront sensing of METIS is based on two systems:
1. From day one, an internal WFS, which is optimized for the highest Strehl numbers quasi-on-axis (self-referencing targets), will be used.
2. To provide full sky coverage a laser guide star (LGS) system (LTAO/ATLAS) should become available within a couple of years after first light.

For the wavefront correction, the adaptive mirrors of the E-ELT (M4/M5) provide sufficient resolution to meet METIS requirements.

Figure 1 gives an overview of the optical concept of METIS. The optical system uses all-reflective optics (with the exception of the spectral filters and dichroic beam splitters) to simplify testing and integration and to minimize chromatic aberrations.

It consists of a fore-optical module, that splits the signal towards the wavefront sensor and the science instruments; provides the input for the calibration units, the METIS chopping mirror, cold stop and the image derotator.

A selection mirror selects between an imager and a high resolution spectrometer. The L/M band and N band imager modules are very similar and contain a reimaging system with filter and grism wheels, pupil imaging optics, and a single detector each. The optical system is based on Three Mirror Anastigmats, which allow a very compact size and excellent performance over the entire field of view.

The high resolution L/M-band integral field spectrometer is composed of an image slicing integral field unit and an Echelle spectrometer. Order selection is accomplished by pre-dispersion with a ZnSe prism, optimizing its throughput.

The study not only showed that the discovery potential of METIS is high, but that METIS is well feasible within a time frame that fits with the telescope development schedule even when ESO decides to select METIS as one of the first light instruments. There are a few parts and components that will be critical, but using the time between the finishing of the phase-A studies and the start of the next phase, most of the issues can be worked out.
High school girls take over ASTRON and JIVE!

Femke Boekhorst (ASTRON)

On Thursday 22 April, ASTRON and JIVE welcomed 30 high school girls from three schools in the North of the Netherlands during Girlsday 2010. On this day, astronomers and engineers of ASTRON and JIVE introduced the girls to their daily routine and exciting workshops. They had the chance to do interesting experiments and talk to the female astronomers and engineers about their work and everyday lives.

The girls learned about how antennas and other instruments for telescopes are built and how a telescope as big as Europe can be simulated. They also chatted with telescope operators in other European countries such as Sweden, Italy and Poland. Besides this they built their own radio receiver.

Girlsday is a European initiative to make young girls enthusiastic about technology and ICT, and takes place annually on the fourth Thursday in April. On Girlsday, girls can see that working in science and technology is fun and exciting. It can also help them in their choice of profiles in high school or in their choice for further studies and a career in science and technology. It was the third time ASTRON and JIVE organised a Girlsday.
ASTRON researchers demonstrate 10 K room-temperature LNA

Bert Woestenburg, Roel Witvers (both ASTRON)

Technical scientists and engineers recently beat performance records for room-temperature Low-Noise Amplifiers. The detection of weak astronomical signals requires extremely sensitive amplifiers right after the antenna. These so-called Low-Noise Amplifiers (LNAs) used to be cooled to extremely low temperatures (below -250 °C) with large and expensive refrigerators to reduce the noise signals generated by the electronics themselves. For the next generation of radio-telescopes like LOFAR and the SKA, this approach is no longer feasible. The Aperture Array approach, advocated by ASTRON and its European partners, makes use of large numbers of inexpensive antennas. These antennas cannot be cooled individually and require new approaches in un-cooled LNA designs. The technology for these devices is studied world-wide. Through innovative designs and careful measurements ASTRON demonstrated that noise signals can be brought down to 10 K in room temperature LNAs.

A new approach on simultaneous power and noise matching to a (non standard) 150 Ohm antenna source impedance, in combination with a low noise 70 nm GaAs semiconductor process, paved the way for a new generation of Low Noise Amplifiers, resulting in these exciting low noise temperatures for room temperature amplifiers.

ASTRON LNA expert Bert Woestenburg says, “Although there are still numerous challenges before we can use this result in the SKA, we made a major step by demonstrating that the low noise levels can indeed be reached.” Accurate and well-controlled measurement processes are essential in proving the claim of the ASTRON team. “It is far from trivial to actually verify the performance of these highly accurate chips. We have been investing a lot of effort in creating test set-ups and measurement protocols to make these claims substantial rather than best guesses”, continued Woestenburg.

Research at ASTRON has been carried out as part of the SKA Design Study (SKADS), a project in the Sixth Framework programme of the EC. After successful completion of SKADS in 2009, research is now being continued as part of the European Aperture Array Verification Programme. The research is done jointly with ASTRON’s APERTIF project which will turn the WSRT into an SKA Pathfinder.
**Steady progress with EMBRACE**

Stefan Wijnholds, Dion Kant, Erik van der Wal, Mark Ruiter and Pieter Benthem (all ASTRON)

The Electronic Multi-beam Radio Astronomy Concept (EMBRACE) is the first full-scale prototype of an SKA phased array station. It is a single polarization demonstrator operating between 500 and 1500 MHz, and is designed by ASTRON and its international partners, the Observatoire de Paris, MPIfR and INAF-IRA. In the previous newsletter, we reported on the first solar fringes found using ten tiles located at the WSRT site, which confirmed that the system temperature of the tiles in bore sight is close to 100 K. At that time, the measurements were hampered by strong inter-modulation. This has now been resolved and the tiles are being modified accordingly before they are installed at either the Westerbork site or the Nancay site. The roll-out of these stations continues steadily, while further system tests are performed.

An impressive result was achieved during the Christmas break. Nine modified tiles were used to scan the sky at 1475 MHz, observing Afristar, which is a geostationary satellite positioned at 21 degrees East. Using a clever signal processing scheme, we were able to obtain the maximum achievable signal-to-noise ratio per tile for each direction, without calibrating the array itself. Since Afristar is the single dominant radio source at this frequency, this reveals the average tile beam pattern for a 3x3-array of uncalibrated tiles (see Figure 1). This image shows Afristar close to the southeastern horizon, the grating response of the system in the North and the side lobe pattern.

Based on our knowledge of the arrangement of the 72 active antennas on each tile and the operation of the 3-bit analog beamformer, we can make a prediction of the tile beam pattern shown in the right panel of Figure 1. Comparing the two images shows that even the regular grid of small speckles can be accurately predicted. This confirms our understanding of the system and demonstrates that the deviations of the individual tiles, even when they are uncalibrated, are small, otherwise these speckles would have averaged out. The resemblance improves even further if the production tolerances of the analog beamformer components are taken into account. This is an important step in the validation of the analog tile beamformer and shows that EMBRACE is ready for further array level system validation.

As a first step, we successfully demonstrated all-sky mapping with a 3x3-array at 1475 MHz. The resulting 40 dB dynamic range image of Afristar is shown in Figure 2. The resolution has improved considerably compared to the single tile results shown in Figure 1. For this experiment, the tiles were scanning the sky on an (l,m)-grid with 0.02 resolution correlating their signals in a 195 kHz subband over 1 s integration using a LOFAR station backend. The pointing on Afristar was used to calibrate the delay and gain differences between the tiles while the autocorrelation powers were equalized for each pointing. The image resolution was increased to 0.004 by producing 5x5-pixel sub-images around each pointing direction, based on the covariance matrix. The image shown in Figure 2 is therefore a mosaic of sub-images.

Although we are still busy understanding all of the intricacies of the EMBRACE system, these results demonstrate that the control software has reached sufficient maturity for us to start conducting real experiments with EMBRACE. With the roll-out of the two stations in Westerbork and Nancay progressing steadily, we look forward to presenting the first multi-beam multi-modal astronomical observation with an aperture array at these frequencies in the next issue, so stay tuned!
VINNMER award for ASTRON researcher

Marianna Ivashina has received a VINNMER award – A Marie Curie International Qualification Fellowship for establishing an international collaboration between Centres of Excellence in research and innovation, namely, Chalmers University of Technology (Sweden) and ASTRON (The Netherlands). The proposed research project will address several important questions about the system modeling and calibration of future radio telescopes, which employ the phased array feed technology. These questions are of joint interest to Chalmers and ASTRON, and are crucial for an optimal design of such systems for the SKA. This project will also open up new areas of joint research, in particular on the various innovative wide-band single pixel feeds being developed at Chalmers. For ASTRON, it is of strategic importance to stay connected with such developments. This project is expected to contribute to the understanding of the proper and well-founded performance tradeoffs between the SKA antenna concepts – Phased Array Feeds and Small Dishes with Single Pixel Feeds. The project will run for 3 years, and started in January 2010. During the period of 2011-2012, Marianna will reside in Sweden and will pay multiple visits to ASTRON.

OPTIMOS-EVE

Ramon Navarro (NOVA Optical / IR Group at ASTRON)

With the large collecting area of the 42 m primary mirror and its novel five mirror design, the E-ELT will reveal a revolutionary view of the Universe enabling the study of extra-solar planets, of stellar populations in external galaxies, and of faint distant galaxies tracing the early history of the Universe. The final review of the OPTIMOS-EVE phase A study, March 31, concluded the period of study for instrumentation on the European Extremely Large Telescope (E-ELT).

The OPTIMOS-EVE consortium consists of partners from France, the Netherlands, UK, Denmark and Italy. It builds on the expertise of the FLAMES/GIRAFFE (optical fibre-fed multi-object spectrograph on the ESO Very Large Telescope), VLT/X-shooter (wide-band optical-to near-infrared spectrograph) and Subaru/FMOS (fibre-fed near-infrared spectrograph) consortia.

OPTIMOS-EVE is one of the few E-ELT instruments under study that will explore the visible to near-infrared wavelength region. It has been designed for the E-ELT Nasmyth focus and provides low-, medium-, and high-resolution spectroscopy (R~5,000 – 30,000) from the ultraviolet to the near-infrared for multi-object studies of sources nearby and at cosmological distances. OPTIMOS-EVE operates in seeing limited mode and GLAO mode, producing scientific results when the E-ELT has not yet reached its full performance and in the 30% of the nights when the atmosphere turbulence is too bad to operate AO. The fibre positioner provides the opportunity to observe over 200 single targets within the 10 arcmin field of view, or to combine the fibres into medium- or large-sized IFUs.

The instrument top-level requirements were derived from the analysis of five key science cases provided by the Science Team. This led to a requirements matrix and the study of various designs, each with a different score on the scientific performance, the technical and operational feasibility, and the volume-, weight-, cost- and risk-budget. Six different designs for the positioner and six different designs for the spectrograph have been studied, resulting in the adopted Phase A design.
The OPTIMOS-EVE instrument consists of three main sub-systems:
1. a pick-and-place positioner
2. fibre bundles for various spectral resolutions and integral field units
3. two highly efficient VIS-NIR spectrographs with VPH gratings

The fibre positioner is based on a pick-and-place design with magnetic fibre ends. It contains four focal plates mounted on a carousel that can be rotated. One focal plate is used for active observations on sky, while two robots are reconfiguring another focal plate in order to minimize reconfiguration times and allowing continuous observation with the E-ELT.

A group of seven fibres form a Mono-Object with a field of view of 0.9″. Micro lenses re-image the telescope pupil onto the fibre core, creating a very efficient light injection into the fibres. At the output side, the bare fibres are aligned to form the spectrograph entrance slit. Smaller micro-lenses and smaller fibre diameters are used to create a narrower slit and thereby increasing the spectral resolution, however more fibres are needed to cover the same aperture on sky and therefore the multiplex is lower in high resolution. The Integral Field Unit modes have 0.3″ spatial sampling on sky and operate in Low Resolution (LR) only.

Two identical copies of the spectrograph are required to meet the number of fibres that need to be accommodated. At the end of the fibre a dichroic splits the light into two different arms: one covering the visual regime (0.37 – 0.93 µm) and one covering the near-infrared regime (0.93 – 1.7 µm). The efficiency is very high thanks to the use of VPH gratings working in 1st order. The Spectrographs have fast cameras composed of seven lenses and a very large field of view (12k x 12k pixels on the detector). The spectrographs are located in a thermally controlled cold chamber to observe the infrared spectrum undisturbed.

OPTIMOS-EVE is a workhorse instrument because of its versatility. In combination with the large multiplex and the photon collecting power of the E-ELT the instrument is extremely productive. There is an excellent synergy between OPTIMOS-EVE, the James Webb Space Telescope (JWST) (possibly also EUCLID), GAIA and the Atacama Large Millimetre Array (ALMA), as they observe the same targets and many studies will highly benefit from the combined observations of OPTIMOS-EVE to JWST and ALMA.

The phase A study has clearly shown that OPTIMOS-EVE is a very attractive instrument that will produce breakthrough discoveries in numerous scientific areas. From its concept and design, it is a robust instrument, and it can be developed, manufactured and integrated using existing technologies. The interfaces between OPTIMOS-EVE and the telescope are straightforward and the project schedule agrees well with the E-ELT roadmap. Considering all of the above, we conclude that OPTIMOS-EVE is an ideal first generation instrument for the E-ELT!

The next steps in the process are the selection of first generation instrumentation for the E-ELT and the approval for construction of the telescope.
With all the excitement surrounding the rollout of the LOFAR station hardware, one could have easily missed an equally important rollout that has been underway since the beginning of the year. Starting in January, staff from the Radio Observatory and ASTRON R&D division have begun field-testing the operational control software for LOFAR. This system allows LOFAR scientists and operators to configure, execute, and process observations from start to finish including ingest of the resulting scientific data products into the Long Term Archive (LTA). Configuration interfaces for various observing modes, creation and propagation of metadata through the system, and interfaces to actually initiate and control the science pipelines are all under active development. Borrowing a page from the scientific commissioning efforts, the Radio Observatory has organized a series of focused “busy weeks” to get this new control system up and running. These busy weeks are being held monthly and will continue throughout the commissioning phase.

As with their KSP-driven counterparts, the Observatory’s operational busy weeks serve several functions. First they provide an opportunity to test and debug the software systems, but just as importantly they allow both operators and support scientists to gain experience actually using that system. The ultimate goal is to produce a system where the full data flow of a LOFAR observation from proposal to archived scientific data product can be supported. With this goal in mind, these busy weeks are striving to emulate the actual operational LOFAR data-taking process as much as possible even while the full system functionality is still being deployed. These “dress rehearsals” over the coming months will be an important part of preparing for the sustained operations required to execute the MSSS over the summer and the full science operations that follow.
The Aperture Array Verification Programme (AAVP) received an incredible push forward by the Portugal President Mr. Cavaco Silva while he paid a visit to Moura (125 km west of Lisboa) on 12 March 2010. A main part of the President's visit was the opening of a new building for the company Logica, which focuses on innovation, developments, qualification and testing in the area of sustainable energy. The intended reference site of the AAVP is developed through Logica, and through that connects Moura to the SKA.

The ASTRON EMBRACE team had a very short time to respond to the request from Domingos Barbosa, part of the Portuguese SKA leadership, to deliver and demonstrate four working tiles in preparation for the Presidential visit. Located at Logica's premises, these tiles were presented to the President to illustrate the advanced technology that will be located at the site. This worked out beautifully thanks to Jan Geralt bij de Vaate, Dion Kant, Pieter Benthem and Nico Ebbendorf as the tiles arrived the day before the event! Judging from the picture, Domingos succeeded in catching the President's interest under the watchful eye of Andrew Faulkner, the AAVP system engineer. Not seen in the picture is that the tiles were remotely controlled from Dwingeloo, thanks to Erik van der Wal, while Arnold van Ardenne happily enjoyed a lunch offered by the Municipality in honour of the Presidential couple.

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The Aperture Array Verification Programme takes off in Portugal

Arnold van Ardenne (ASTRON)

ERC Advanced Grant for astronomer Ralph Wijers

Prof. dr. Ralph Wijers, astronomer of the Astronomical Institute ‘Anton Pannekoek’ of the University of Amsterdam (UvA), has received an Advanced Grant of the European Research Council (ERC). The ERC is an institute that finances groundbreaking research within the European Union. Wijers, also a member of the Science Advisory Committee of ASTRON, receives 3.5 million Euro, of which 1 million is intended for equipment.

Ralph Wijers is researching radio explosions in the Universe, using the new telescope of ASTRON: LOFAR. These explosions are often a signal of so-called black holes and other extreme objects. He examines what kind of objects show these energetic explosions and how they work. For his research he is extending the LOFAR telescope with a 24/7 all-sky monitor in cooperation with ASTRON to find these rare explosions and figure out how they work. In this way, Wijers seeks answers to some big, fundamental questions of physics: how does a black hole originate? How strong can a magnetic field be? Where does cosmic radiation come from?

The ERC Advanced Grant is a prestigious European research grant for individual researchers. The grant is part of the European Seventh Frame Programme (FP7), a funding programme for 2007-2013. The ERC Advanced Grant is awarded to excellent individual researchers for groundbreaking research. Besides research ideas, the track record of the researchers and the research settings are also evaluated.

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

Our mission is to make discoveries in radio astronomy happen, via the development of novel and innovative technologies, the operation of world-class radio astronomy facilities, and the pursuit of fundamental astronomical research.

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