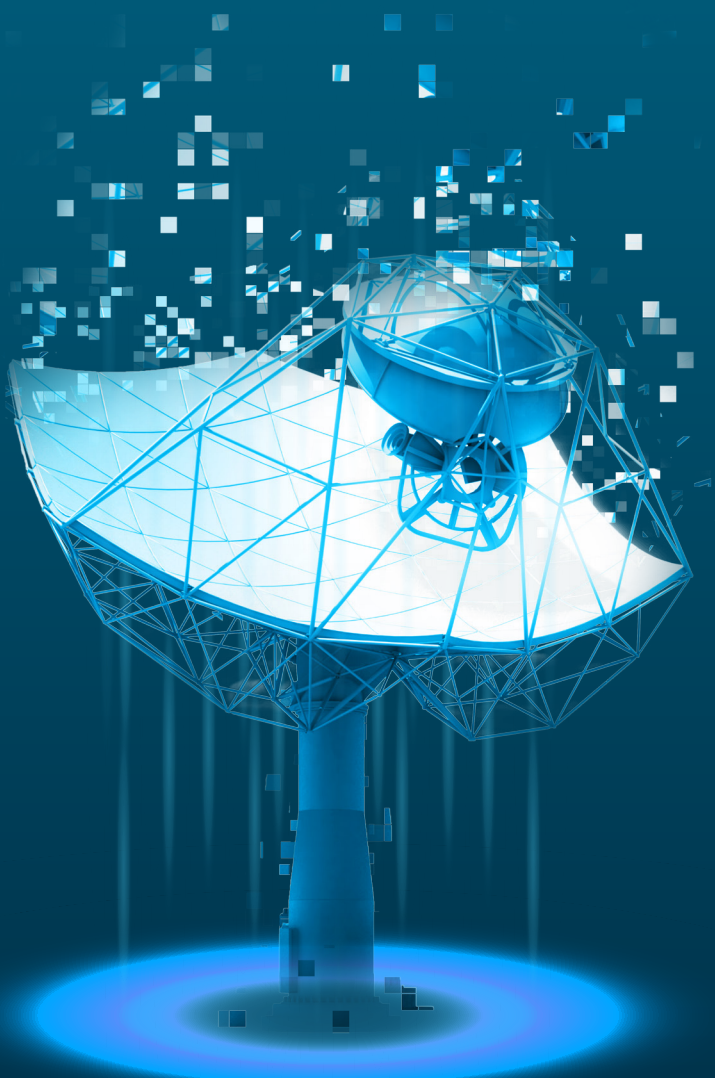


CONTACT

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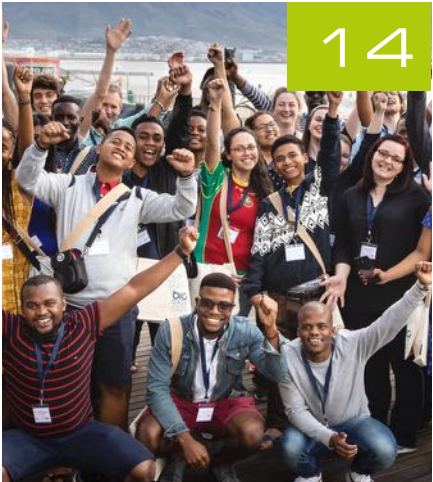
**FINAL SKA ENGINEERING DESIGN
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LET'S TALK ABOUT... BLACK HOLES

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FRIENDS AND COLLEAGUES,

I write having just returned from Shanghai where, as reported in this issue, we have just finished a highly successful week discussing the SKA system design, the plans for commissioning of SKA1 and for the long-term operations. There were opportunities to discuss the model for the SKA Regional Centres and our plans for a long-term Observatory Development Programme. The meeting was superbly hosted by our colleagues at the SKA China Office and the Shanghai Astronomical Observatory, part of the Chinese Academy of Sciences.

In the previous week, several of the SKAO team attended the 31st meeting of the SKA Board and the 10th meeting of the SKA Observatory's Council Preparatory Task Force in Nice, France, kindly hosted by colleagues at the Observatoire de Cote d'Azur. If interested, you can read a summary of the Board meeting in the [Notes from the Chair](#).

The distinguished panel we have gathered to conduct the SKA1 System Critical Design Review will meet in person at SKA HQ next week, 9th – 13th December. Over the past few weeks, the panel have been working hard, diving deep into the system design, studying the estimated costs of construction, and reviewing the programmatic materials. This review marks the culmination of six years of detailed design work from hundreds of engineers and scientists around the world and in the office and all should be

commended for their tremendous effort. The agenda for the meeting has been set and we anticipate a thorough but fair grilling on the details of the system design.

I am grateful to all of the panel members for the time they have committed to this process. As in many other projects, they do so without charge to the organisation. Our whole community benefits enormously from the professionalism and dedication of such people.

The ratification process of the SKA Observatory Convention that is paving our journey towards becoming an Inter-Governmental Organisation has also seen some significant recent progress, notably in [South Africa](#) and [Australia](#). I remain optimistic that the mid-2020 target that we set for our new organisation to enter into force can be met.

As we approach the end of the year, the staff at SKA Organisation and in many of our partner institutes around the world are preparing to take a break. I would like to take this opportunity to wish them and their families a Merry Christmas and a Happy New Year.

I hope you enjoy Contact #2.

Prof. Philip Diamond, SKA Director-General



Credit: SARAO

SARAO HOSTS SKA AFRICAN PARTNERS

BY SARAO COMMUNICATIONS

Ministers & senior officials from the SKA African partner countries recently visited the South African SKA site in the Karoo.

As well as touring the KAT-7 and MeerKAT telescopes, officials saw the Karoo Array Processor Building, where SKA-Mid's future Central Signal Processor will be housed.

The visit followed the partner countries' annual meeting which was held in the South African capital Pretoria and hosted by South Africa's Department of Science and Innovation. Participants also included officials from the Northern Cape Provincial Government and high-level representatives of the eight SKA African partner countries: Kenya, Madagascar, Zambia, Ghana, Botswana, Namibia, Mozambique and Mauritius.

The meeting, which brings together science and innovation ministers and senior officials, aims to provide political and strategic leadership on matters

relating to the SKA and the African Very Long Baseline Interferometry Network (AVN) projects, as well as other relevant radio astronomy initiatives. This year's meeting focused on advances in radio astronomy programmes and the combined effort to grow astronomy on the continent.

"We are excited about the Northern Cape being able to contribute to the socio-economic development of this country, and the South African Radio Astronomy Observatory's (SARAO) efforts to grow human capital in radio astronomy," said Northern Cape Premier Dr Zamani Saul, who was on his first visit to the site. Since 2006, SARAO has provided around 1,000 student bursaries, and about 130 of the recipients have been from SKA African partner countries.

Last year's meeting was held in Cape Town,

while in 2017 it took place in Accra, Ghana, to coincide with the launch of the Kuntunse Radio Telescope at the Ghana Radio Astronomy Observatory. Ghana was the first SKA/AVN African partner country to complete the conversion of a redundant communications antenna into a functioning radio telescope, capable of operating as part of a global Very Long Baseline Interferometry (VLBI) network.

[The official communique from the meeting is available here.](#)



ITALY HOSTS SKA DATA CHALLENGE WORKSHOP

BY MARCELLA MASSARDI, INAF

As September turned to October, the Italian city of Bologna welcomed 70 astronomers and engineers for the three-day SKA Data Challenges Workshop.

It was an opportunity for participants to get to grips with the fundamentals of SKA data: transfer, analysis, archiving, and data access. These factors are important to build a common mentality and the proper terminology to address the SKA's data challenges.

PhD students and young researchers were particularly encouraged to attend, and many also contributed with short presentations on their SKA-related activities. Among the topics discussed were the design of a European SKA Regional Centre (SRC) and science with SKA pathfinders and precursors.

In 2018, the first [SKAO Science Data Challenge](#) was issued to the global community to experience

some of the issues associated with the SKA-like data handling. During the Bologna workshop, its results were displayed for the first time at a conference by SKAO Project Scientist Dr. Anna Bonaldi, together with the plans for the future challenges.

The workshop idea was born within the framework of the Horizon 2020 AENEAS project activities, and was organised by the Italian node of the European ALMA Regional Centre, with the endorsement of the Italian SKA Board and INAF-Radioastronomy Division (UTGII).

As well as being a great opportunity to debate and agree definitions for terms that are becoming common but not often elaborated on in astronomy, like "big data", "interoperability", and "open science", there was also a chance to understand the origin of the SKA data size and analyse its effects on user activities. SRCs will play a crucial role in this as the user interface providing access to the archive, and in growing the community.



Credit: Italian Alma Regional Centre

"The archive is traditionally perceived as a mere repository of PI observations. New telescopes – not only radio ones – already deliver huge datasets with a huge potential of re-usability and interoperability," said Vincenzo Galluzzi, who presented examples and recommendations for archive user interfaces in astronomy.

This event was intended as the first of a series that will take place around Europe. All presentations can be found here: https://zenodo.org/communities/skadatachallengesws_i/

ADASS CONFERENCE DRAWS HUNDREDS TO THE NETHERLANDS

BY YAN GRANGE, ASTRON

The Astronomical Data Analysis Software and Systems (ADASS) conference is the place to be for astronomers, software engineers, and data specialists to discuss software and algorithms used in all aspects of astronomy.

The 29th edition of this annual conference was organised in Groningen, the Netherlands, from 6th to 10th October 2019. Many radio astronomers were among the more than 350 attendees, who represented 23 countries on six continents. The organisation is grateful to have had the SKA Organisation as one of its sponsors.

The talks, posters and tutorials were grouped under 11 themes, several of which were very relevant to the SKA community, including a session on the delivery of accessible and science-ready radio data, and one on telescope operations and scheduling.

Before ADASS kicked off, a hackathon – sprint like events in which computer programmers and experts involved in software development collaborate on software projects – took place involving top-tier local high-school students, with the

winning team attending part of the event and receiving an award on stage. The week ended with a tour of the LOFAR and WSRT/APERTIF telescopes for more than 100 conference participants, giving them the chance to learn more about radio astronomy instrumentation.

The programme and slides are available here: <https://www.adass2019.nl>.



Group photo taken on a visit to the Westerbork Synthesis Radio Telescope
Credit: Jelle de Plaa



WEST AUSTRALIAN ASTRONOMY FESTIVAL WINS COVETED SCIENCE AWARD

BY ICRAR

An astronomy festival that attracts more than 4,000 visitors a year has won a celebrated award for science outreach.

Astrofest is the largest astronomy festival in Australia and one of the biggest science events in Perth.

In August, the festival was jointly awarded the Chevron Science Engagement Initiative of the Year at the WA Premier's Science Awards for a decade using space and the night sky to inspire West Australians.

Astrofest is coordinated by the International Centre for Radio Astronomy Research (ICRAR) on behalf of Astronomy WA, and every astronomy organisation in Perth takes part.

Each year, thousands of people attend the festival to view the night sky through giant telescopes, hear local researchers and science communicators talk about astronomy, and learn more about the SKA.

ICRAR Astronomy Ambassador and Astronomy WA Co-Chair Kirsten Gottschalk said she was

delighted that the hard work of so many individuals and organisations has been recognised with a Premier's Science Award.

"Astrofest is only possible because of the collaborative efforts of an amazing group of amateur astronomers, researchers and astronomy outreach providers all working together," she said.

"Every year we love sharing Western Australia's incredible night sky and the state's role in the SKA with thousands of people."

The event was launched in 2009 by Curtin University, Scitech, the Astronomical Group of WA, the Perth Observatory and ICRAR and is now also supported by CSIRO.

Astrofest 2020 will be held on February 29. Visit astronomywa.net.au for more details.

Series of photos taken at Astrofest and the Premier's Science award. Credit: ICRAR



NEW UPGRADE FOR SKA-LOW GEMINI BOARD

BY ASTRON

In early October an upgraded version of the Gemini computer board, called Gemini-XH, was assembled at Neways in Leeuwarden, The Netherlands.

Developed by Australian CSIRO, the Auckland University of Technology (AUT) in New Zealand and ASTRON in the Netherlands, Gemini-XH is a processing board intended for SKA-Low's Central Signal Processor, to be located in Australia.

The intricate work required more than 1000 parts ranging from 1mm up to 5mm to be placed on a 340 x 144mm 18-layer printed circuit board.

"It was like carrying out a medical procedure working with clearly predefined steps," says Gijs Schoonderbeek, ASTRON Instrument Engineer. "The biggest challenge was placing the field programmable gate array (FPGA), a highly efficient type of processor that enables Gemini to deal with huge data streams.

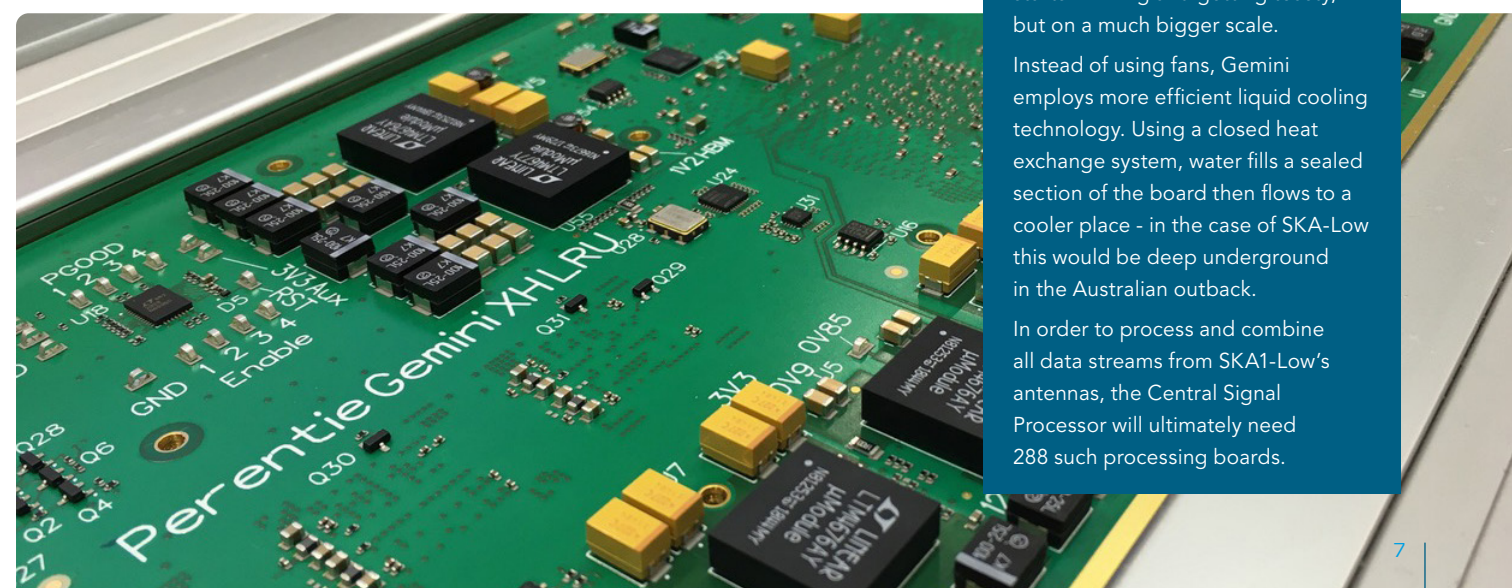
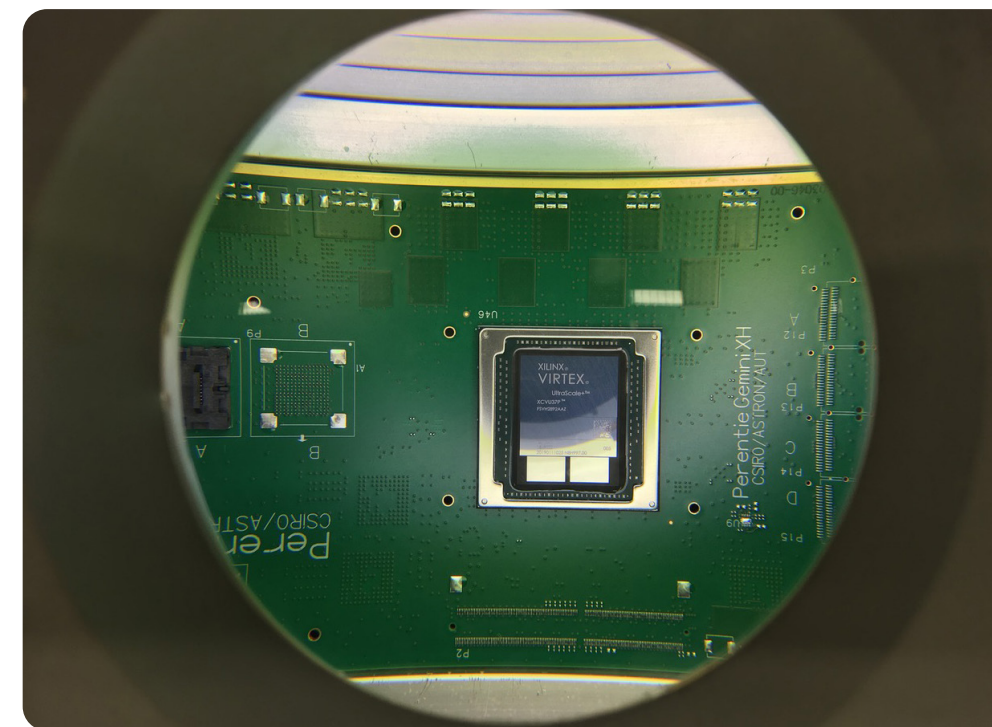
"It's a 55 x 55 mm component with 2892 solder balls. Most electronic assembly machines simply aren't capable of dealing with components of that size – this is highly specialised work."

The assembly was verified using an X-ray scan to ensure that all connections are reliable.

Gemini-XH is equipped with a Xilinx Ultrascale+ VU37P FPGA. This is the first Xilinx FPGA with high bandwidth

memory (HBM), making it more efficient for the task at hand. With this upgrade of the Gemini board, the design of the hardware platform for the CSP-LOW Correlator Beamformer (CBF) is ready for production.

Both Images: The Gemini board is a collaboration between ASTRON in the Netherlands, Australia's CSIRO and the Auckland University of Technology (AUT) in New Zealand. Credit: ASTRON



DID YOU KNOW?

The SKA's two Central Signal Processors (one for each telescope) are the first computing stop for signals after being collected by the antennas.

SKA1-Low's 131,000 antennas will create huge amounts of data that will need to be processed - and that means a lot of heat. Think of how your laptop sometimes starts whirring and getting toasty, but on a much bigger scale.

Instead of using fans, Gemini employs more efficient liquid cooling technology. Using a closed heat exchange system, water fills a sealed section of the board then flows to a cooler place - in the case of SKA-Low this would be deep underground in the Australian outback.

In order to process and combine all data streams from SKA1-Low's antennas, the Central Signal Processor will ultimately need 288 such processing boards.

FRANCE INAUGURATES SKA-LOW PATHFINDER

BY THE NENUFAR TEAM

On 3rd October, Observatoire de Paris, Orléans University and CNRS officially inaugurated NenuFAR, a French SKA Pathfinder, located at the radio astronomy station in Nançay, France.

NenuFAR, or “New Extension in Nançay Upgrading LOFAR”, observes in the 10–85 MHz range (thus overlapping slightly with the SKA-Low telescope in Australia), and will be one of the most sensitive instruments at these frequencies.

NenuFAR aims to detect and study radio emissions from exoplanets, the Cosmic Dawn as well as pulsars. With NenuFAR, astronomers will also observe the radio emission from eruptive or magnetised stars, galaxies and clusters of galaxies, spectral lines in the interstellar medium,

planetary lightning, radio bursts from Jupiter’s magnetosphere, the Sun, and various transient sources.

Once complete it will be composed of 96 mini-stations of 19 antennas each. More than half of the stations are already in operation. Most are located within a core of 400m diameter, while six additional stations will be located at distances of up to 3km for imaging purposes.

The antennas are connected in parallel to several receivers so that the instrument can operate in three separate modes while contributing simultaneously as a giant station of the international LOFAR array.

Early Science observations have already begun and will last until the end of

2021. Fifteen Key Programmes and Pilot Programmes make up the observations, representing about 140 scientists from the European community, half of them French. Once this Early Science phase is completed, NenuFAR will be open to the international community.

NenuFAR not only holds the promise of new and exciting scientific results, but is also a valuable tool to prepare the French community to future observing programmes on the SKA. For more information visit <https://nenufar.obs-nancay.fr/>



All images courtesy of CNRS

VIRTUAL REALITY APP SHOWCASES SKA SITE AND MULTI-WAVELENGTH NIGHT SKY

BY ICRAR

An app that allows users to explore Australia’s remote SKA site and view the Milky Way in different wavelengths has launched on the Apple and Google Play stores.



The GLEAMscope VR app shows the Milky Way as seen from the Western Australia’s Murchison region, in wavelengths ranging from gamma ray to X-ray, visible light, far-infrared, microwave and radio waves.

The app features the Murchison Radio-astronomy Observatory (MRO) site, including the recently deployed SKALA 4.1 antennas.

The radio observations on GLEAMscope originate from the GaLactic and Extragalactic All-sky MWA (GLEAM) survey on the Murchison Widefield Array (MWA), an SKA precursor telescope.

The survey has a resolution of two arcminutes (about the same as the human eye) and searches the sky for radio waves between 72 and 231MHz.

“We’re showing off what the SKA will look like and giving people an on-the-ground

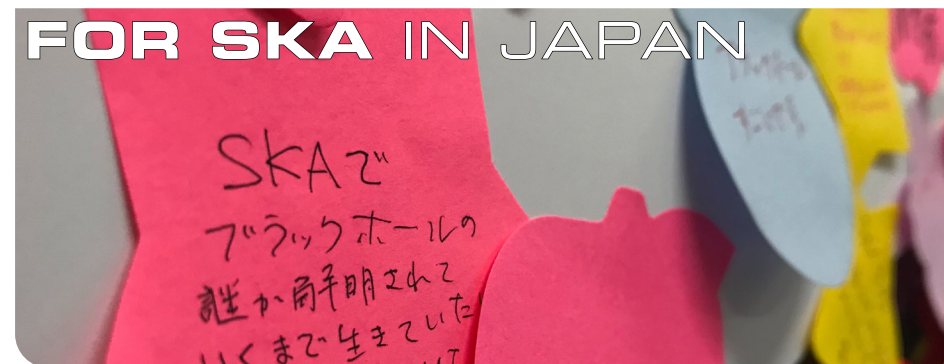
feeling of being there at the MRO,” said astrophysicist Dr Natasha Hurley-Walker of the International Centre for Radio Astronomy Research (ICRAR).

“This virtual version is set in the outback at night time, showing the visible Universe as well as the sky at other wavelengths. Users can switch between the wavelengths, see interesting objects and then query those objects and find out more about them with explanatory audio contributed by real radio astronomers.”

GLEAMscope VR recently added an Italian language option, and is available for both Android and Apple devices.

The app is available for download from the Google Play store and the Apple store, and a web-based version is available at gleamoscope.icrar.org

MESSAGES OF SUPPORT FOR SKA IN JAPAN



BY JAPAN SKA CONSORTIUM

On 26th October the National Astronomical Observatory of Japan (NAOJ) hosted its annual Open House Day at its headquarters in Mitaka, Tokyo.

About 4,000 members of the public took part in the event, learning about NAOJ’s diverse projects and activities during the day, including the Subaru and ALMA telescopes and the TMT project.

The large number of visitors who dropped by the Mizusawa VLBI Observatory stand saw an impressive range of materials, including SKA

posters, the 2015 SKA Science Book, and Japanese-language SKA leaflets.

Already, more than 200 astronomers across the country have joined the Japan SKA consortium. The SKA1 Study Group, which sits under NAOJ’s Mizusawa VLBI Observatory, is tasked with developing a concrete plan for their contribution to SKA1 construction, in order to provide

access to the Japanese astronomy community, including the Japan SKA consortium. Volunteers from the group collected messages of support from visitors on small post-it notes that now line the walls at the NAOJ office!



LET'S TALK ABOUT... BLACK HOLES

Credit: Event Horizon Telescope Collaboration

BY CASSANDRA CAVALLARO (SKAO)

In April black holes hit the headlines when the [Event Horizon Telescope Collaboration](#) released the first ever image of one of these enigmatic objects*, captured using a technique called VLBI.

Black holes have often appeared as plot devices in sci-fi movies – not always plausibly, more on that later – but there's still much we don't know about them. Or as ICRAR PhD student Pikky Atri puts it: "Black holes seem to be where our physics laws break."

Let's begin with what we do know.

Firstly, they're not all alike. There are small, stellar-mass black holes between 5 and 20 times the mass of our own Sun, formed when a massive star dies and its core collapses inward. There are dozens of these that we know about in our own galaxy, and there could be many more lurking which we cannot yet see. Then there are the supermassive black holes, which lie at the centre of galaxies and can be up to a billion times the mass of the Sun.

"Supermassive black holes govern galaxy birth and evolution through interactions with their host galaxies, so they play a very important role in

shaping the Universe," says Prof. Tao An of Shanghai Astronomical Observatory, co-chair of the SKA's VLBI science working group. "In fact, supermassive black holes and their host galaxies co-evolve – they grow together."

What they all have in common is a gravitational pull so strong that nothing can escape – not even light. If galaxies are close enough, this same force also causes them to collide and merge, expanding the galaxies and the black holes within them. "This happens frequently but the timescale is very long, maybe even 10 billion years," adds Tao. "We call these cosmic timescales!"

So how do we study something we cannot see? Most black holes exist quietly, and we only observe them when matter is consumed. As a star falls in, its outer layers gradually slip away creating an accretion disk, with "outbursts" which we can study using

WHAT'S VLBI?

Very Long Baseline Interferometry (VLBI) uses telescopes separated by long distances - or baselines - to observe the same object at the same time. When the data is all combined, it's like using one huge telescope. For the EHT, with telescopes spread across four continents, this virtual telescope was the size of the Earth.

X-ray telescopes. In the radio bands, we can see jets that spew out from the sphere surrounding the black hole. These jets are so powerful that they can travel beyond their galaxy!

"This inflow-outflow system gives energy to the galaxy," explains Pikky, who's studying the birth of stellar-mass black holes. "Interestingly,

*Sort of. What we see is the event horizon, the point of no return for anything unlucky enough to be near a black hole.

while massive black holes only vary over hundreds or thousands of years, with tiny black holes the star is much closer, so matter falls in much more quickly. That means within days or months they'll show some variation which can be studied."

Black holes and the SKA

Black holes will be key for the SKA to test one of the best known theories of physics, Einstein's general theory of relativity, which predicts the effects of curved space time. It will use black holes and pulsars to test this in the most extreme environments (you can read more on that here: <https://www.skatelescope.org/challenging-einstein/>).

The SKA's sensitivity will also allow us to detect more of the "quiet" black holes that have very weak emissions, and adding VLBI would create higher resolution images, which should give us a clearer view of the supermassive black hole at the centre of the Milky Way.

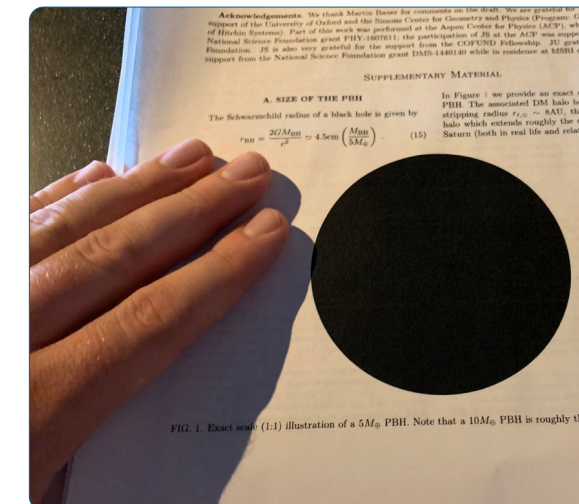
It could also answer a key mystery dating back to the epoch of reionisation – the first light in the Universe.

Until this year we could only imagine what black holes really look like. This 1979 simulation by French astronomer Dr. Jean-Pierre Luminet of CNRS, was the first depiction of a black hole, and bears a striking resemblance to the EHT image. Credit: Dr. Jean-Pierre Luminet/CNRS Phototheque

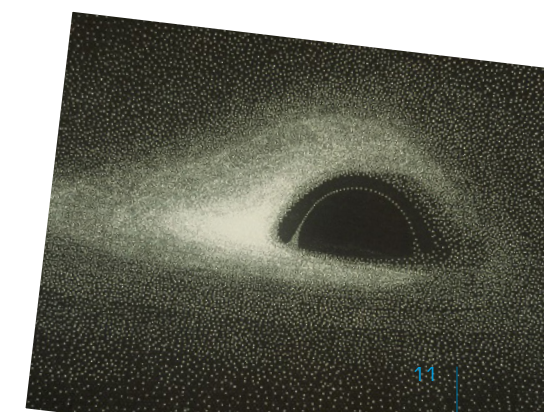
"At this point supermassive black holes already existed, and they grew very rapidly, over the course of several million years," says Tao. "This challenges current theories of how they form, and how they got enough material to grow in such a burst when the Universe was so young. The SKA has the potential to detect those very early supermassive black holes to answer that question."

What about the depiction of black holes on the silver screen? Would an Interstellar-style voyage into a black hole be possible? Pikky points out that the gravity involved would result in a rather slow and painful death.

"The term is 'spaghettification' because you get slowly stretched, becoming longer and longer, and we don't know how that process ends," she says. "Another theory is there might be multiple dimensions within the black hole that we're not aware of yet. After all, once we thought space had three dimensions, but now we understand that time makes it four dimensional, so maybe there are more."



Black holes come in all sizes. This science paper shows a 1:1 scale example of a black hole with the mass of the Earth, which is roughly the size of a ten-pin bowling ball. Credit: Paper by Jakub Scholtz and James Unwin; Photo: Jared Head



MEERKAT REVEALS GALACTIC BUBBLES

This stunning radio image was obtained by South Africa's MeerKAT telescope, the first result to come from observations using the full 64-dish array. It shows bubble-like structures which tower hundreds of light years above and below the centre of our Milky Way, caused by a phenomenally energetic burst that erupted near the galaxy's supermassive black hole a few million years ago.

It's the work of an international team of astronomers, led by institutions in South Africa, the UK and the United States, whose findings were detailed in a [Nature paper](#) published in September. Operated by the South African Radio Astronomy Observatory (SARAO), MeerKAT is currently the world's most powerful radio telescope of its kind and one of two SKA precursor instruments in South Africa.

"These enormous bubbles have until now been hidden by the glare of extremely bright radio emission from the centre of the galaxy," says SARAO Chief Scientist Fernando Camilo, a co-author on the paper. "Teasing out the bubbles from the background noise was a technical tour de force, only made possible by MeerKAT's unique characteristics and ideal location." That location is deep in the Karoo region, which is also high and dry enough to minimise atmospheric disruptions to faint astronomical signals.

Amazingly, this result came as a surprise to the team, who had to keep their excitement under wraps for months while they worked on the paper.

"MeerKAT was designed to be the best in the world at doing some experiments, but investigating the complex Galactic Centre wasn't one of those," Fernando says. "We all know that great scientific instruments over time make unexpected major discoveries. Still, we were genuinely surprised that these bubbles popped out of the first batch of images the telescope ever made, in preparation for its inauguration!"

"Personally, what gives me the most pleasure is to share the joy and credit of this discovery with our South African colleagues who made this wonderful telescope a reality."

MeerKAT is redefining what we expect from radio astronomy images, showing us the Universe in exquisite detail. It's also a taste of what will be possible once MeerKAT's dishes are ultimately incorporated into the SKA, after MeerKAT has completed its science programme. MeerKAT's 64 dishes will then represent about one third of the total array of SKA dishes.

*Image credit: SARAO/Oxford/NRAO.
Adapted from results published in Heywood et al. 2019.*



Credit: SARAO

Twenty-five young science and engineering students took part in the 2019 Big Data Africa School, hosted by the South African Radio Astronomy Observatory (SARAO) in Cape Town from 6th to 16th October.

The aim was to teach the students important techniques when working with large data sets, which they can then apply to their own postgraduate research. They were given access to real-life astronomy, healthcare and sustainable agriculture data sets, which they were asked to use to solve real-life problems. Working in teams, under the guidance of local and international big data experts, the students then presented their solutions to their peers.

"The fact that this 3rd Big Data Africa School has brought together students from the eight SKA African partner countries, from different fields, is a testimony that astronomy can contribute to the broader societal needs of the continent," said Takalani Nemaungani, Director of Multiwavelength Astronomy in the Department of Science and Innovation. "I am grateful that our partnership with the UK through the Newton Fund and the DARA initiative, is equipping a new

The school was followed by a two-day industry session giving students exposure to data science careers, from leading experts from a variety of industries such as higher education, cloud and data services, supercomputing, research and radio astronomy.

BY FIONA DAVENPORT & MATHIEU ISIDRO (SKAO)

With the SKA membership spanning five continents, Diversity & Inclusion is an obvious value for the project.

The SKA treaty preamble – written by governments – even goes as far as highlighting how members of the SKA Observatory are “committed to an organisation where diversity and equality are promoted and respected.”

With visibility comes responsibility. So in order to become a role model on issues of Equity, Diversity & Inclusion (EDI) in astronomy, SKAO has been busy updating its practices, first implementing a Code of Ethics and Code of Conduct, appointing Ethical Champions, reinforcing its EDI Committee, working on its recruitment strategy, and more, as well as taking part in EDI sessions at major conferences to learn from other organisations.

Within that context, Fiona Davenport, Head of HR and chair of SKAO's EDI Steering Committee, and Mathieu Isidro, Deputy Communications

Manager & Ethical Champion, represented SKAO at the first IAU Symposium dedicated to EDI in astronomy in Tokyo in November.

It was a busy week, which involved giving a presentation on EDI policies at SKAO, presenting a poster of how SKAO outreach initiatives supports EDI, running a workshop on how recruitment can improve diversity, as well as being part of a panel discussion on diversity in research environments. Many fruitful discussions also took place with researchers and representatives from other major organisations including ESO, ESA, TMT, CSIRO and others.

Together with other participants, SKAO is now helping to develop a roadmap to action for the field in the form of an IAU resolution, to be passed at the next IAU General Assembly in Busan in 2021. So stay tuned!

COMING UP...
(NON-EXHAUSTIVE LIST)

AAAS ANNUAL MEETING

<https://meetings.aaas.org/>

13 – 16 February 2020 | Seattle, USA

PUBLIC COMMUNICATION OF SCIENCE AND TECHNOLOGY (PCST)

<https://www.pcst.co/conferences>

26 – 28 May 2020 | Aberdeen, UK

SPIE ASTRONOMICAL TELESCOPES AND INSTRUMENTATION

<https://spie.org/conferences-and-exhibitions/astronomical-telescopes-and-instrumentation?SSO=1>

14 - 19 June 2020 | Yokohama, Japan

**EUROPEAN ASTRONOMICAL SOCIETY
ANNUAL MEETING (FORMERLY EWASS)**

<https://eas.unige.ch/EAS2020/>

29 June – 3 July 2020 | Leiden, the Netherlands

EUROSCIENCE OPEN FORUM (ESOF)

<https://www.esof.eu/en/>

5 – 9 July 2020 | Trieste, Italy

BLUEDOT FESTIVAL

<https://www.discoverthebluedot.com/home>

23 – 26 July 2020 | Jodrell Bank, UK

43RD COSPAR SCIENTIFIC ASSEMBLY

<https://www.cospar2020.org/>

15-22 August 2020 | Sydney, Australia

COMMUNICATING ASTRONOMY WITH THE PUBLIC (CAP)

<https://www.communicatingastronomy.org/cap2020/>

21 – 25 September 2020 | Sydney, Australia

INTERNATIONAL CONFERENCE ON RESEARCH INFRASTRUCTURES (ICRI)

<https://ri-vis.eu/events/international-conference-on-research-infrastructures-icri-2020/>

30 September – 2 October 2020
Ottawa, Canada

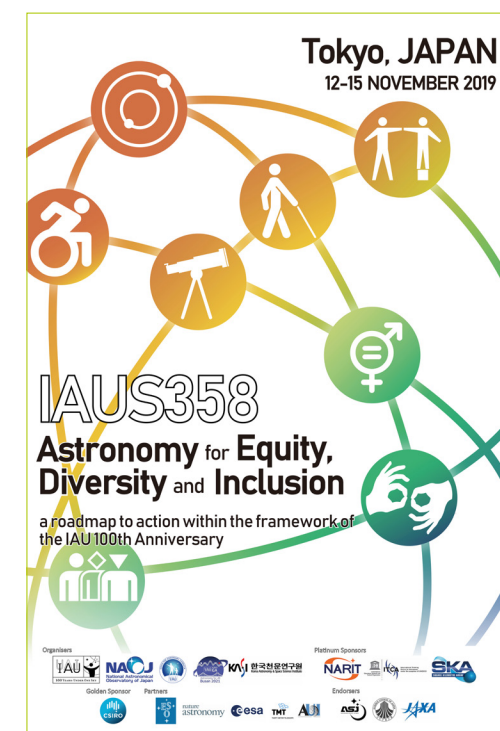


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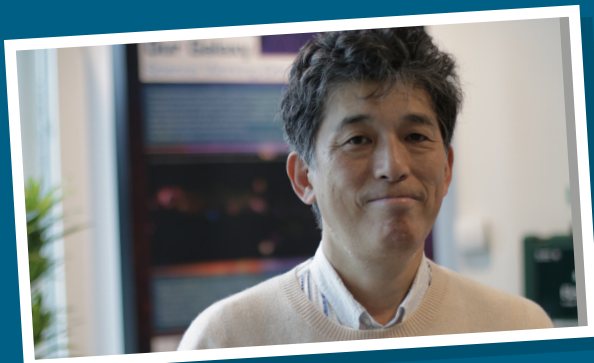
Takalani Nemaungani, Department
of Science and Innovation



2 MINUTES WITH...

PROF. TOSHIHIRO HANDA
KAGOSHIMA
UNIVERSITY, JAPAN

Toshihiro recently visited SKA HQ with graduate students Yushi Hirata and Takeru Murase. He took a moment to tell us about Japanese interest in the SKA.



What do you work on at Kagoshima University?

My main research field is on the interstellar medium. I'm mainly interested in the process that leads to star formation.

What brings you to SKA HQ?

We took the opportunity to visit SKA HQ after attending a conference named "From Gas to Stars", held in York. While here, each of my students gave a presentation on mapping observations of the molecular cores in ammonia lines, which is key to address how gas gathers to form stars.

How have you found visiting the HQ?

I last came here three years ago, when the office was much smaller – now it has expanded, like the Universe! Although I will be retired when the SKA is completed, my students will be some of those using it, so it's good for them to experience the international collaboration behind a world-class telescope project.

What kind of interest is there in the SKA among the Japanese science community?

In Japan we have the SKA pathfinder VERA, which operates at higher frequencies than the SKA. My hope is that Japan can help install a further receiver on the SKA dishes to increase the bandwidth above 15 GHz. This would allow us to better understand star-forming activity. We also have many astrophysicists interested in the early Universe and magnetism.

Do you think we could see Japan joining the SKA?

The National Astronomical Observatory of Japan is currently focused on building TMT, The Thirty Meter Telescope, in Hawaii, so there has been some hesitation in joining SKA. Our community is campaigning to show that SKA will be very important in the next decade, and we will continue our scientific appeal in the hope that Japan will eventually join the SKAO partnership.

HQ STAFF GET BAKING FOR CHARITY

Every year, millions of people in the UK gather in workplaces and community groups for what's billed as the World's Biggest Coffee Morning, a cake-filled fundraising drive in aid of Macmillan Cancer Support.

In October, SKA HQ's very international staff once again baked up a storm in support of the event, offering up cakes, muffins, pies, pastries and more specialities from around the world. Macmillan provides emotional, physical and financial support to cancer patients and their families, and relies on donations for 98% of its funding. So far this year it has raised more than £20m through coffee morning donations.

"Our cake buffet was a joy for the eye, but behind it is everybody's commitment to supporting a great cause. That's what makes our Macmillan Coffee Morning a very special event," says HQ receptionist Daniela Franchini, who organised this year's event as part of the SKA HQ Recreation Committee. "Together we raised £800 which is a fantastic sum, even more than last year. It was great to see colleagues coming together in aid of a cause which is close to many of our hearts."

The coffee morning is one of a number of charitable events which are becoming fixtures in the HQ. The next will be in December when staff will be invited to join in with Save the Children's Christmas Jumper Day by wearing their finest festive attire to work!



SETTING THE WORLD'S EYE ON THE SKY WITH THE SKA

BY CRISTINA GARCIA-MIRO (JIVE), ZSOLT PARAGI (JIVE), ANTONIO CHRYSOSTOMOU (SKAO), GINA MAFFEY (JIVE)

Back in October, SKA HQ played host to a major scientific workshop, which explored how the SKA can be integrated with existing Very Long Baseline Interferometry (VLBI) networks across the world.

"SKA will have a VLBI capability" – with this strong statement, Prof. Phil Diamond, SKA Director-General began the SKA-VLBI Key Science Projects and Operations workshop* to explore VLBI in the SKA context. By remotely combining the data from radio telescopes observing the same source at the same time, VLBI offers the highest possible imaging resolution in astronomy. In light of this, ensuring that the future SKA Observatory is VLBI-enabled is a priority for the SKA Organisation.

"The black hole image unveiled by the EHT collaboration this year demonstrated the potential and power of a global VLBI effort," said Antonio Chrysostomou, SKAO Head of Science Operations. "The size of the SKA will have a significant impact on the science that we can do with this technique. This is an exciting prospect."

During the course of the week, 65 scientists from 18 different countries came together to share their enthusiasm for the scientific possibilities that VLBI brings. Sessions at the workshop were organised to focus on SKA high priority science objectives – providing snapshots of current research on wide ranging topics such as Active Galactic Nuclei (AGN), Fast Radio Bursts (FRBs), stellar birth and evolution, exoplanets, and the prospect for the inclusion of African telescopes in SKA-VLBI.

A common theme across the talks was the need for very high sensitivity in VLBI observations. To tackle this challenge, SKA telescopes will need to be included in existing VLBI arrays – which in turn, will present interesting technical hurdles in the coming years.

During the workshop, four working groups sought to practically address some of the highlighted challenges and the subsequent discussions were extremely fruitful. Participants grappled with how to realise the ambitious science objectives, but a highlight was the realisation that it may be possible to achieve extremely precise astrometric observations with SKA-VLBI – down to 1 micro-arcsecond!

The workshop was led by the Joint Institute for VLBI ERIC (JIVE). As the central organisation in the European VLBI Network (EVN), JIVE offers both technical and scientific support to the VLBI community across the globe. Former Director of both JIVE and the SKA, Richard Schilizzi, closed the workshop with a reminder of the inspiring legacy of collaboration across the community that SKA-VLBI can build on.

One of the SKA's catchphrases is "the future of radio-astronomy has already begun". At the end of the workshop, one thing was clear: SKA-VLBI can play a significant role in defining that future.

*We wish to acknowledge support from Horizon 2020, the EU's Research and Innovation programme, through JUMPING JIVE and the SKA VLBI Working Group as well as complementary support from RadioNet. Our thanks to the SKA Organisation for making this event possible.

DID YOU KNOW?

One arcsecond equates to about 2km on the Moon's surface. A micro-arcsecond is 1 million times smaller than this, around 2mm. That means that using VLBI, we would be able to resolve and see a strand of spaghetti on the Moon!



Team members walking across the site on the heritage survey. Credit: CSIRO

OBSERVING WAJARRI YAMAJI HERITAGE

BY ANNABELLE YOUNG (CSIRO)

Australia's national science agency, CSIRO, operates the Murchison Radio-astronomy Observatory (MRO) in the remote Murchison Shire of Western Australia, about 800 km north of Perth.

One of the newest astronomy observatory sites in the world, the MRO already hosts the ASKAP, MWA and EDGES radio telescopes and boasts cutting-edge infrastructure and technologies that are paving the way for the SKA-Low telescope. But the heart and soul of the site is the sun-scorched red earth and its Indigenous cultural heritage which belongs to the Wajarri Yamaji, its traditional custodians.

The Wajarri Yamaji, or Wajarri people, hold native title rights over the MRO and their ancestral ties to the land date back tens of thousands of years. Evidence of ancient customs etched into the landscape reveal a sustained traditional life. Connection to country, culture and heritage continue to be an important part of everyday life for many Wajarri people.

Knowledge of the land, of sacred sites and cultural areas, has been passed from generation to generation through ceremonies and traditional practices. Elders describe open grass plains as a dominant feature of their youth in the Murchison. In some areas, particularly close to creeks and rivers, evidence of past habitation can be prolific but less so in areas that

were more likely travel routes.

CSIRO has joined a team of Wajarri people to conduct heritage 'walkovers' to identify areas of visible heritage and areas that embody heritage value across the SKA1-Low telescope site prior to SKA construction and operations. Led by Wajarri Elders, the team also includes archaeologists and an anthropologist, with support from the Australian Government's SKA Office.

The MRO covers an area of 3,450 sq km (or 345,000 hectares), and the SKA1-Low telescope will be spread over 65 km west to east and north to south. The team will survey a small part of this large area, a total area of about 600 hectares, mainly tracing the thin lines of SKA1-Low's spiral arm design. In concentrated areas, such as the proposed telescope core, the team is categorising artefacts into levels of significance.

Step by step, the team is walking the land, observing artefacts and establishing where heritage is located and site boundaries.



Members of the Heritage walkover team: From left Len Merry, Jimba Merry, Frank Merry, Kane Whitby, Daniel Puletama (Archaeologist), Quentin Simpson, Robert Ryan, Geoffrey Mongoo (front), Darry Hawkins (back), Jeremy Egan, Anthony Dann, Ted Ryan, Philip Haydock (Anthropologist), Dana Anaru (Assistant Archaeologist). Credit: CSIRO

- The Wajarri heritage walkovers commenced in 2018
- About 70% of the proposed locations for SKA1-Low have been covered
- The walkovers are due to be completed by mid-2020
- In total the team will survey an area of about 600 hectares

The heritage walkover process is assisting the SKA1-Low project team to understand where there are areas that are of heritage value and, with these sites recorded, to ensure that heritage is given the highest level of consideration.

There are many different types of artefacts, and Wajarri rock art and

carvings are known to exist in parts of the Murchison. CSIRO's SKA Infrastructure team member, Kerry Ardern, says that over time he's come to understand how a seemingly inhospitable environment was able to sustain inhabitants that lived with the land rather than on the land, a rich culture and traditional way of life that flourished for thousands of years.

"The dominance of mulga bushes and low hills gives the impression that the land is flat but over time the subtle changes in elevation and characteristics of the country become more evident. Changes in the light during the day and changes in air clarity can allow features previously unseen to stand out, some close and some far away," Kerry said.

Kerry has participated in all the walks and with the guidance of Wajarri Elders has seen quarries where stone was sourced to make essential tools for everyday life - arrow tips, scraping and cutting tools and seed grinding tools and grinding sites. The artefacts being observed may have been discarded or even dropped accidentally but either way, he understands the local Wajarri people believe artefacts are where they are for a reason. It's important that visitors to the Observatory respect Wajarri culture and beliefs and leave things where they are, as observed.

The Wajarri heritage walkovers commenced in 2018 and about 70% of the proposed locations for SKA1-Low have been covered. One of the greatest challenges for the walkover team has been the weather, from high temperatures in the summer to storms with heavy rains but they are on track to complete by mid-2020, ahead of the start of SKA1 construction.



COMMON PURPOSE & MOMENTUM FOR SKA TEAMS IN SHANGHAI

BY MATHIEU ISIDRO (SKAO), AN TAO (SHAO) & YANG JIE (SKA CHINA OFFICE)

At the end of November, some 250 engineers and scientists from around the globe gathered in the city of Shanghai, China for a momentous occasion: after six years of hard work, the sixth and final all-hands meeting on SKA engineering design was held, shortly before the full SKA system review is due to take place.

This time, however, the meeting was about more than engineering. As the design phase of this massive international project finally wraps up, engineers, scientists, policy-makers and other experts are looking at what comes next: procurement, commissioning, operations and more were all on the agenda.

Science “warm-up” talks took place every morning to highlight important areas of research of relevance for the SKA. As Mia Walker, the Murchison Widefield Array (MWA) Project Officer who gave the first such talk, put it: “It is good to focus back on our science goals and what we hope to achieve with the SKA,” to contextualise the engineering work taking place.

Indeed Tim Stevenson, Head of Mission Assurance at SKAO, invited participants at the end of the meeting to look forward to the day when their engineering work will result in in ground-breaking science results obtained with the telescope.

“We can feel a real sense of common purpose in the SKA community,”

he added to the assembled participants. “There is tremendous momentum, and we can now smell the first whiff of success.”

Common purpose was also a theme in the Ministry of Science and Technology (MOST) Vice-Minister Huang Wei’s opening address at the conference. “China has always attached high

importance to the SKA project,” he said. The country “joins hands with all other member countries to promote the establishment of the intergovernmental organisation, and takes an active part in the design, research and development of the project by contributing Chinese technology and proposals.”

On the sidelines of the event, senior SKAO officials took the opportunity to hold a bilateral meeting with the Vice-Minister. “The Vice-Minister has confirmed China’s strong long-term support for the project,” indicated SKA Director-General Prof. Philip Diamond upon concluding the bilateral. “We can expect Chinese ratification of the SKA Observatory Convention sometime in the first half of 2020 as well as their continued role in leading the SKA dish work and in various science working groups and engineering teams.”

A sign of the SKA’s growing visibility and the importance of this particular milestone, 17 local and international media covered the meeting, including Science; Xinhua, the official Chinese press agency; China Daily, the country’s official English newspaper with an [...] average

THE CONTEXT

Nine international consortia, representing hundreds of institutions and engineers in some 20 countries, have been wrapping up their work designing the SKA’s various elements this year ahead of the SKA’s system review at SKA HQ in December, which will look at the project as a whole, making sure the various pieces of the puzzle fit and work together as one as intended.

Find out more here:
cdr.skatelescope.org



“

WE CAN FEEL A REAL SENSE OF COMMON PURPOSE IN THE SKA COMMUNITY. THERE’S TREMENDOUS MOMENTUM, AND WE CAN NOW SMELL THE FIRST WHIFF OF SUCCESS.

”

Dr. Tim Stevenson, Head of Mission Assurance



[...] readership of 300,000 for printed copies and 5.5m for online articles; and CGTN, the Chinese state broadcaster's international channel, which broadcasts to some 130 countries. Altogether, media coverage of the 2019 SKA Shanghai meeting is expected to have reached some 50 million readers and viewers inside and outside China.

You can [watch the CGTN report here](#).

After Manchester, UK in 2013, Fremantle, Australia in 2014, Penticton, Canada in 2015, Stellenbosch, South Africa in 2016 and Rotterdam, the Netherlands in 2017, this sixth and final SKA engineering meeting in Shanghai

was an opportunity for all to reflect on the enormous progress made over the past few years to design a uniquely complex machine, but also to open a new chapter in the history of this 25-year project.

"This final engineering design meeting is a new starting point for the construction work of SKA," concluded Wang Qi'an, Director-General of SKA China Office of the Chinese Ministry of Science and Technology (MOST).

The SKA Shanghai meeting was hosted by SKAO and MOST and organised by the SKA China

Office and Shanghai Astronomical Observatory (SHAO). We wish to thank everyone across SKAO, SKA China Office, SHAO and the many other partners who made the event possible.



All Images Credit: SKA Organisation



Summit, Oak Ridge National Laboratory's 200 petaflop supercomputer. Credit: Oak Ridge National Laboratory

SKA DATA PIPELINES TESTED ON WORLD'S FASTEST SUPERCOMPUTER

BY ICRAR

Data scientists from Australia, the United States and China have simulated the complete data flow from phase 1 of the SKA-Low array to end users.

The researchers used the world's most powerful scientific supercomputer – Summit – to successfully run the specialised SKA pipeline with data rates of 400 gigabytes a second.

Summit is located at the US Department of Energy's Oak Ridge National Laboratory in Tennessee.

The amount of data was equivalent to more than 1600 hours of standard definition YouTube videos every second, and represents an almost full-scale simulation SKA1-Low. It is the first time radio astronomy data has been processed on this scale.

The advanced prototyping of the

SKA data pipeline is part of a direct collaboration of ICRAR, CSIRO and Shanghai Astronomical Observatory (SHAO) with SKAO.

The Summit test run involved researchers from ICRAR, Oak Ridge National Laboratory and SHAO.

To test the data pipeline, the team first generated mock observational data on Summit using OSKAR2, a simulator developed at the Oxford e-Research Centre. The simulator factored in a cosmological model of the Epoch of Reionisation, foreground objects and the array configuration of SKA-Low to generate data as it will come from the telescope.

The mock observations were then captured and ingested into a specialised pipeline for reduction. The data was averaged down to a size 36 times smaller, before being processed to produce image cubes for analysis by astronomers.

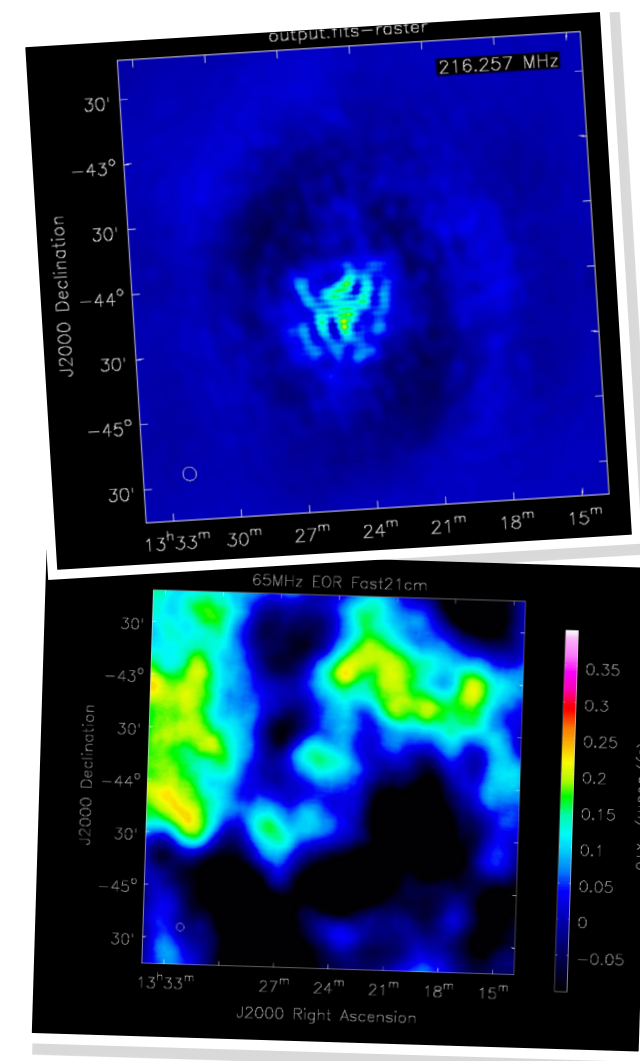
Finally, the image cubes were sent from the US to Australia, simulating the complete data flow from the telescope to the end-users.

The researchers used the Data Activated Flow Graph Engine (DALiuGE) execution framework written by ICRAR to distribute the simulators to each of the 27,648 graphics processing units that make up Summit.

They also employed the Adaptable IO System (ADIOS), developed at Oak Ridge National Laboratory, to resolve a bottleneck caused by trying to process so much data at the same time.

It marks the first time algorithms designed for processing observations from today's radio telescopes and have been applied to data on this scale.

The supercomputer has a peak performance of 200,000 trillion calculations per second.



Above. The recovered simulated EOR signal (generated from the 21cm Fast simulation, Mesinger et al. 2010) at 65 and 212MHz, from visibilities generated on Summit and imaged with the Yandasoft package cimager. Credit: ICRAR, CSIRO and SHAO

SUMMIT-RUN IN NUMBERS

Parameter	Value
Computer Nodes	4561
Node Hours	15000
GPUs	27360
Simulation Time Steps	24000
Frequency Range	46-221 MHz
Antenna Baselines	130816
Visibility Generation Rate	250 GB/s
Simulated Visibilities	2.6 Petabyte
Data Product Volume	112 Terabyte

THIS EXPERIMENT REFLECTS THE STATE-OF-THE-ART FOR RUNNING RADIO-ASTRONOMY SIMULATIONS AND DATA PROCESSING WORKFLOWS AT SCALES APPROACHING WHAT WILL BE NEEDED FOR THE FIRST DEPLOYMENT OF THE SKA. WHILE THERE ARE STILL MANY QUESTIONS AND CHALLENGES THAT WE HAVE TO ADDRESS IN ORDER TO DELIVER A SUCCESSFUL DATA PROCESSING SOLUTION FOR THE NEAR-TERM, THIS EXPERIMENT HAS PROVIDED VALUABLE INSIGHT INTO WHAT IS CURRENTLY FEASIBLE AND HELPS GUIDE US IN DEVELOPING OUR ROADMAP FOR THE FUTURE.

NICK REES, SKAO HEAD OF COMPUTING AND SOFTWARE

SHAO AND HUAWEI JOIN FORCES ON SRC PROTOTYPE

BY CASSANDRA CAVALLARO (SKAO)

Around the world, conversations are under way between SKA partners and technology giants to explore the best ways to tackle the SKA telescopes' enormous data flows.

"SKA is a science-driven project but also a big data challenge that cannot be handled by astronomers alone," says Prof. Tao An of Shanghai Astronomical Observatory (SHAO), which has collaborated with Huawei Company on the first SKA Regional Centre (SRC) prototype.

Recently completed, this high performance computing (HPC) centre is specifically designed to handle the complex demands of SKA data. SRC work is already taking place across the SKA partnership.

As a subset of a full SRC, the Chinese prototype has a capability of around 200 Teraflops* at peak performance. "That's roughly the same as 1,000 laptops, and very advanced ones!" says Prof. An, who is leading the work in China.

The prototype combines three types of architectures, using cutting-edge hardware including the INTEL X86 CPU and Nvidia GPU Tesla and Huawei ARM architectures. That's necessary because the diversity of the SKA's science projects generate vastly different requirements in terms of computing, memory, network and storage, some requiring several orders of magnitude more processing time than others. Prof. An adds: "Most HPC's don't have to pivot between such different data, so SRCs will need to be highly

customised to the SKA's needs."

That's where Huawei came in, helping with the design, deployment and integration of the SRC prototype. The focus was on exploring ways that artificial intelligence (AI) can improve efficiency, and innovating methods for SKA research.

With more than 200,000 galaxies in the southern hemisphere sky, analysing them is no mean feat. SHAO and Huawei Cloud together developed a new AI model, and used data from current studies to locate and classify radio galaxies.

SKA REGIONAL CENTRES (SRCs)

The SRCs will be a distributed network of supercomputing centres. As the access point to SKA science products for astronomers, they will be where data becomes knowledge.

Connected to the SKA host countries Australia and South Africa via intercontinental networks, they will receive, process and store around 600 PB annually, creating an ever-growing archive of SKA data. To store that much at home, you would need more than a million 500GB laptops – every single year!

"Huawei Cloud provided the Ascend cluster service which has world-class AI computing power," says Hongyu Sang, Huawei Cloud AI Marketing Director. "Using this cluster and the new AI model, the time for data processing and analysis can be shortened from 169 days [using

manual analysis and current computer systems], to just 10 seconds." That includes a boost in the mean Average Precision (mAP) of the AI model over existing methods, putting it at 81%.

SHAO and Huawei Cloud have also launched a new study on pulsar detection, using existing pulsar data to train a new AI model to analyse whether a signal is from a pulsar or not.

"Considering that we get more than 1 million signals in total, detecting one pulsar signal among them is very tough," says Hongyu Sang. "Both the precision and recall of the AI model can reach 98% - that's 2% higher than the previous research. In this field, even 1% improvement is very difficult and crucial."

The Chinese prototype is already helping astronomers to understand the SKA data challenge, and test SKA software algorithms and data pipelines – the steps needed to turn raw astronomical data collected by the antennas into useful science data output. It's also recently deployed software to enable data processing for the Australian Square Kilometre Array Pathfinder (ASKAP) and Murchison Widefield Array (MWA) precursor telescopes in Australia.

"This Huawei collaboration is a good example of how the SKA will be developed in the future - we do need other communities' involvement and support, including cutting-edge industry partners," says Prof. An. "The Chinese SRC prototype is also the collective wisdom of the whole SKA community, and such international collaboration will form the basis of science support to the SKA's globally distributed users."

** Flops are a measure of computing speed; one teraflop equates to a trillion floating point operations per second.*

NEWS FROM AROUND THE WEB

IFL SCIENCE

[Spectacular new image of the center of the Milky Way reveals remnants of ancient supernovas](#) – The Murchison Widefield Array (MWA) is teaching us a lot more about the disk of our galaxy, including the discovery of 27 remnants of ancient supernovas.

ITU NEWS

[Radio astronomy, Spectrum Management and WRC-19 \(pg. 81\)](#) – NRAO Spectrum Manager Harvey Liszt explains why the careful management of the radio spectrum is so important for the success of radio astronomy in the modern era.

NEW SCIENTIST

[Weird repeating signals from deep space may be created by starquakes](#) – Repeating fast radio bursts might be caused by "starquakes", according to researchers studying an FRB which was first observed by the Australian SKA Pathfinder (ASKAP).

RADIO FRANCE INTERNATIONALE

[Giant radio telescope array prepares to begin construction in Australia and South Africa](#) – SKA officials and partners meet at a final engineering meeting in Shanghai, China, to present designs for the telescopes' dishes and antennas – setting the stage for construction to begin.

VICE

[Scientists Are Chasing an Ancient Signal That Could Explain the Modern Universe](#) – SKA-related telescopes are part of a global hunt to detect hydrogen from the early universe. Together with SKA, they're hoping to shed light on how the first stars & galaxies formed.

CHINA DAILY

[China lauded for vital role in radio telescope project](#) – China's key contributions to the SKA highlighted during meeting of scientists and engineers in Shanghai.

SKA JOBS

POSTDOCTORAL POSITION IN FAST RADIO BURST SCIENCE

This three-year post is a Postdoctoral research position in precision cosmology using fast radio bursts, based at SKA Global HQ in the UK, working with the SKA Science Team.

Deadline: 05/01/2020

[Apply here](#)

PARTNER INSTITUTE JOBS

ENGINEER – SUPPORTING SKA CHALLENGES – INRIA

Based in Lyon with SKA partners INRIA, the French national research institute for the digital sciences, this role will work on the high performance computing challenges of the SKA.

Deadline: 31/12/2019

[Apply here](#)

TRAINEESHIPS IN SCIENCE OPERATIONS WITH MASSIVE ARRAYS – ASTRON AND JIVE

This programme enables astronomers (post doc, PhD or graduate student level) to spend 12 weeks at the institute in Dwingeloo in the Netherlands. Under the supervision of Telescope Scientists, you will be exposed to the science operations of massive arrays.

Deadline: 15/01/2020

[Apply here](#)

PARTNER PUBLICATIONS

READ THE LATEST SKA-RELATED NEWS FROM SOME OF OUR INTERNATIONAL PARTNERS

RADIONET

[RADIONET NEWSLETTER – NOVEMBER 2019](#)



[SKA-FRANCE – BULLETIN – OCTOBER 2019](#)



[ONSAALA SPACE OBSERVATORY – NEWSLETTER – OCTOBER 2019](#)

SKA-LOW PROTOTYPE VIDEO

Check out the video below produced by our Australian colleagues in collaboration with INAF and SKAO showcasing the deployment of SKA-Low prototype antennas at the Murchison Radio Observatory (MRO) site in Western Australia.



[Click here to watch in your browser or to download.](#)



JONAS FLYGARE

The SKA's design phase has involved hundreds of engineers around the world, some with decades of experience, others at the start of careers. Jonas Flygare is a PhD student at Onsala Space Observatory in Sweden, which designed SKA-Mid's Band 1 receiver. He led work on a key component - the feed horn that transforms electromagnetic radio waves into a digital signal, which can then be amplified and transferred onwards for processing. Jonas spoke to us about his childhood fascination with robotics, the impact of inspirational lectures, and why he loves being part of Team SKA.

Let's start at the beginning – can you trace your interest in engineering back to childhood?

When I think about it, it probably all started with Lego and excavator toys. I remember being very entertained by the things I could build from the little Lego bricks, especially if I could add homemade parts to "improve" the model. I was really into the TV show "Robot Wars", where different

engineering teams built remote-

controlled robots which then fought each other. I would reconstruct these robots in small Lego versions, adding electrical engines to make them move and so on. I was fascinated by excavators at a young age too; the whole concept of a big "robotic" machine and how it worked sparked my interest in engineering.

Was there something specific that set you on this path?

One event in high school particularly inspired me. We were invited to Chalmers University of Technology (where I later did my B.Sc, M.Sc and currently am doing my Ph.D. via Onsala Space Observatory) for an amazing lecture by Rickard Jonsson, about Einstein's theory of gravity and cosmology. After that, combining engineering with physics seemed like a perfect fit for me. It's a bit corny but I was also growing up when the Star Wars movies were re-mastered from the original 70s' versions, and that fed my enthusiasm for space and technology.

What made you choose this type of engineering? Did you always dream of being involved in the space sector/telescope design?

Not exactly, but half-way through my masters studies I realised that I didn't want to continue down the theoretical physics track I was on. So I moved into more applied science and engineering courses, such as computational electromagnetics and antenna engineering.

I got an internship in the antenna group at the electrical engineering department, which led me more into my current field. It was another internship, this time at the Onsala Space Observatory, where I realised that engineering relating to space was what I wanted to do - I guess it was the Star Wars connection that came back in a way, that mix of technology and space.

How did you end up being involved with the SKA?

During the internship at Onsala I was introduced to the SKA by the former head of the electronics lab there, Miroslav Pantaleev, who gave me an opportunity right away to work on the feed design. I'll be forever grateful for that as it led me to where I am today.

You're now pursuing a PhD at Onsala – tell us about that.

My main fields of research are antenna feed design, receiver system characterisation and low-noise microwave circuits for radio telescopes. Particularly I work with wideband feed designs, like the low-frequency feed horn for the SKA Band 1. During my early time at Onsala, I began to really appreciate the fine engineering that goes into electromagnetic and microwave design, and the optimisation procedures you need to make it the best. I understood I was pretty good at what I was doing, and kept learning new things every day, so when the opportunity to do a Ph.D. came along, I decided it was the right move.

What does it mean for you to be involved in such a big project so early in your career?

The SKA is an enormous project – when I got involved it had already been planned for several decades, which makes you appreciate how much effort it takes to get the next level of radio astronomy up and running. Through the SKA I have gotten a wide range of skills, perspectives, and connections throughout the world. It means a lot to be a part of this. To have been in the team that made one of the first receiver designs for the SKA dishes is pretty special.

What's the most exciting thing about being part of Team SKA?

To provide technology for the next generation of astronomical discoveries. In a time with gravitational waves, black holes, exoplanets popping up everywhere, and fast-radio bursts, there are some fantastic discoveries to be made in the near future. It's pretty cool to figure out how the technology to do this should be designed.

It's also very exciting to work with such a diverse, international group of people. This gives you a really good network, but also so many lessons learned from different parts of the world. A diverse work environment like the SKA mirrors a diverse society, which is to the benefit of everyone if we are to progress.

As a young engineer, what advice would you give to students who may be considering a career in STEM?

This is not an easy thing to summarise, but the key is to be always curious and want to learn. Question why you are

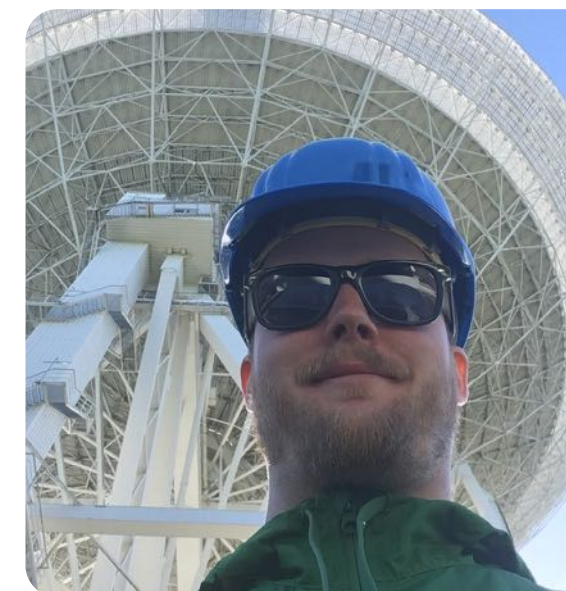
doing a certain project, and learn the motivation for it. Speak up when you don't understand something, in general this will save you lots of time and you are most likely not the only one in the room who wants to ask.

Trying to learn as many parts of a system as possible will make you not only more useful in different projects, but it'll help you see the full picture of how it all comes together at the end.

When you're not busy at Onsala or travelling all over the world for work, what do you like to do to unwind?

My favourite hobby currently is a sport called footvolley. It's like beach volleyball but you can't use your hands, and you play with a football over the net! In December this year we are organising and competing in the Swedish Footvolley Championship in Gothenburg, so I'm very excited about that!

I also enjoy surfing, an interest which grew during my time living in California during 2012-2013, where I had an internship at an R&D company working on thin-film transistor technology. There's something special about a smooth wave breaking at sunset on a California beach, and I take the opportunity to go out in the water whenever there is a chance.



| All images courtesy of Jonas Flygare

Team SKA

In each issue of Contact, we'll get to know one of the many talented people contributing to the SKA, hearing about their work, how they got here and their advice for the next generation.

[Hear more from them on our website.](#)



Contact – The SKA magazine

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We welcome your contributions to *Contact*!

Find out how to submit ideas [here](#).

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About the SKA

The Square Kilometre Array (SKA) Organisation leads an international effort to build the world's largest radio telescope. The SKA will be constructed in Australia and South Africa with a later expansion in both countries and into other African countries. Its global headquarters is located at Jodrell Bank in the UK.

The SKA will conduct transformational science and help to address fundamental gaps in our understanding of the Universe including the formation and evolution of galaxies, fundamental physics in extreme environments and the origins of life in the Universe.

Front cover: A snapshot of the key vision for the 2019 SKA Shanghai Meeting: Concluding Our Past, Realising Our Future. An SKA-Mid dish and SKA-Low antenna begin to materialise after years of design work, signalling the SKA's readiness for the construction era.

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