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— Philip Diamond, Director-General, SKA

# SKA: Shooting for the stars with AI

The intergovernmental Square Kilometre Array (SKA) Observatory will be in charge of building and operating the largest and most powerful radio telescope ever created. With a collection area that will cover more than 1 million square meters and the first prototype elements recently rolled out in Western Australia and South Africa, the potential for answers about the universe and its origins will increase by orders of magnitude, with artificial intelligence likely to occupy a key role.

By Samuel Luke Winfield, Linda Xu

## What can we learn?

Since the first radio signals were detected from space by Karl Jansky in the 1930s, astronomers have used radio waves emitted from a range of celestial bodies and objects to explore our universe. These waves are invisible to the eye, but can be picked up and converted into images by radio telescopes at distances of billions of light years away. Radio astronomy has led us to some amazing astronomical

discoveries such as pulsars, exoplanets, and the cosmic microwave background.

SKA is set to take this to a new level. Stretching over dusty, flat plains across South Africa and Western Australia, SKA combines a host of different antenna technologies to map the sky hundreds of times faster than today's best radio astronomy facilities.

"In the SKA, the sun truly never sets", says SKA



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Director-General Philip Diamond. With 13 member countries forming the cornerstone of the SKA and around 100 organizations across about 20 countries participating in project design and development, Diamond believes ambitious projects like this can only happen when governments, engineers, scientists, and business come together with a common goal.

The reasons behind the SKA could hardly be more profound, “The motivation for building the SKA is to do science, to understand things like the origin of the universe, the origin of stars and galaxies, the nature of gravity,” says Diamond. Already, radio astronomy has changed scientists understanding of physics, challenging even Einstein’s seminal theory of relativity.

Diamond says that the SKA is often referred to as a “time machine.” When complete, SKA telescopes will be able to look further back in time than ever before, “We will be able to use radio telescopes to study hydrogen, the most common element in the universe, all the way back to the big bang,” he says. “We will be looking back in time to those first moments of the universe, and then watching the universe evolve, understanding how those first stars formed, how the first galaxies formed, and why the universe looks like it does today.”

There’s still so much about the universe that’s a mystery, even to astronomers. According to Diamond, this is “somewhat embarrassing to us astronomers, because we really only have a grasp and understanding of about 4 or 5 percent of the constituents of the universe.” And this exploration of the unknown is a major driving force behind the project. One example is a phenomenon known as fast radio bursts, “There are these bursts going off all over the sky all the time, which are a millisecond or two in length,” explains Diamond. “It’s very powerful. We have no idea what’s causing them, but a telescope like SKA will see thousands of these. It will be able to locate them wherever they are, and will be able to figure out what they are.”

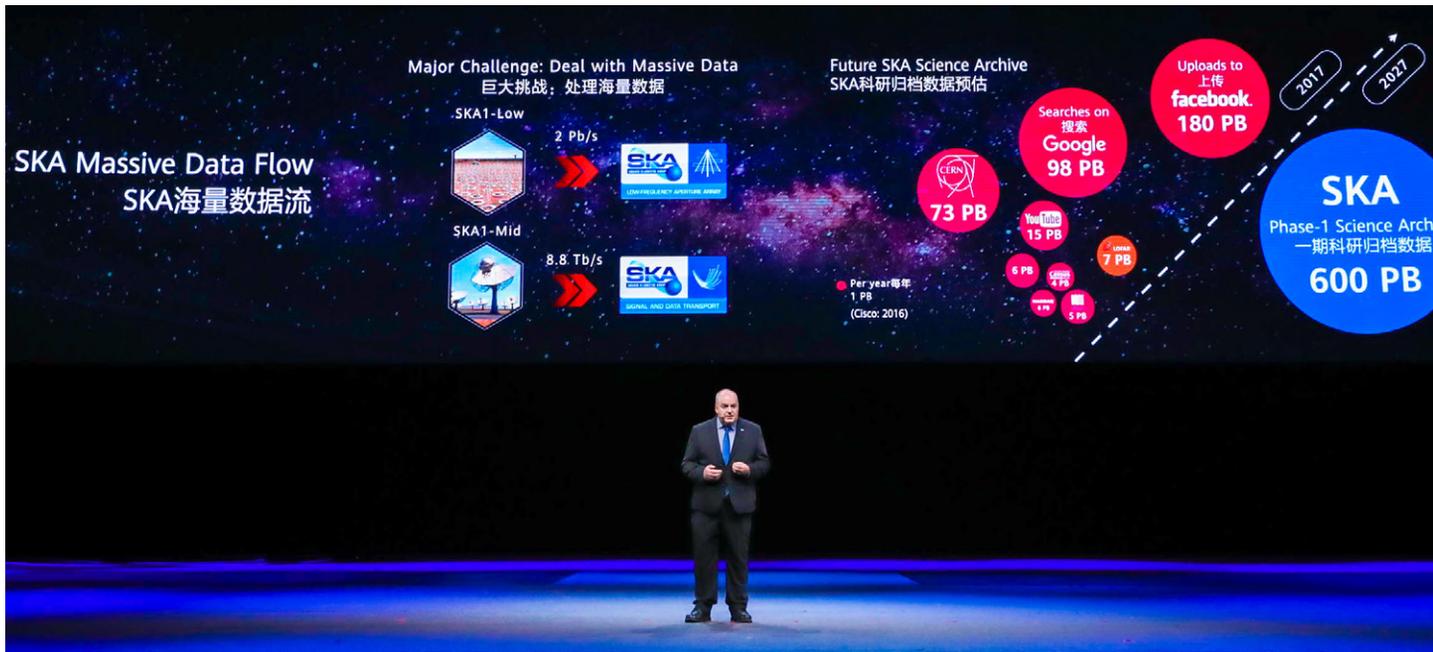
## The source of technological innovation

Radio astronomy, the field of astronomy that detects radio emissions to look deep into the universe, may seem like a very distant concept. In fact, many people may never have even heard of radio astronomy, other than in movies like *Contact*. In fact, radio astronomy is much closer to home than we might imagine. “It’s not well known,” says Diamond. “But radio astronomers developed the Wi-Fi that we all use every day.” Wi-Fi was in fact invented by radio astronomers in Australia trying to process signals

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coming from black holes. This is just one example of how each of us directly benefits from the contributions of radio astronomy on a daily basis.

Radio astronomy is also vital in telecommunications, global positioning satellites, and medical imaging techniques. Diamond also believes much potential exists for radio astronomy to contribute to data visualization, artificial intelligence, and machine learning.

## Massive datasets call for AI

A project on the scale of the SKA will no doubt face huge technical challenges. To avoid signals being polluted by radio waves from cities and other built-up areas, arrays must be constructed in remote, inaccessible regions. This poses the first challenge: supplying power to the hardware. “We have to have very power-efficient hardware. So that’s one challenge,” states Diamond.

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The SKA is not only physically enormous: The data to be processed will be immense. SKA will explore the universe in unprecedented detail, doing so hundreds of times faster than any current facility. Its central computer alone will have the processing power of about 100 million PCs. “The raw data generated by the telescopes was about six times the entire data that flows around the Internet.” explains Diamond.

The data flows will be on the scale of petabits, or a million billion bits, per second — more than the global Internet rate today. About 600 PB of data will be archived during phase 1 of the project, dwarfing that of Internet giants Facebook and Google. Processing such data is no walk in the park, and that’s where Huawei comes in with its supercomputing and AI capabilities. “With our colleagues at Shanghai Astronomical Observatory, Huawei has developed the first of what we call the SKA regional centers,” says Diamond. “So this is a prototype, a high-performance computing system, utilizing AI techniques to process data for astronomers far more rapidly than we’ve been able to do before.” Diamond believes that AI is crucial to quickly process such huge amounts of data, and that only with SKA regional centers and partners such as Huawei is it possible to “extract the science from the SKA”.

Results from this collaboration can already be seen. Huawei and the Shanghai Astronomical Observatory are already applying machine learning techniques to astronomy problems, such as pulsar searches and radio galaxy detection, using data generated by SKA precursor telescopes.

### China for SKA

China, as a founding SKA member, is preparing to build a regional data center and is currently developing reflector antennas. Due to its extreme sensitivity, a wide field of view, ultra-fast survey speed, and super-high resolution, SKA will generate a vast amount of observational data, says An Tao, head of the SKA group at the Shanghai Astronomical Observatory (SHAO). The transportation, storage, reading, writing, computing, management, archiving, and release of the SKA data will pose big challenges to the technologies in the field of information and computing, explains An.

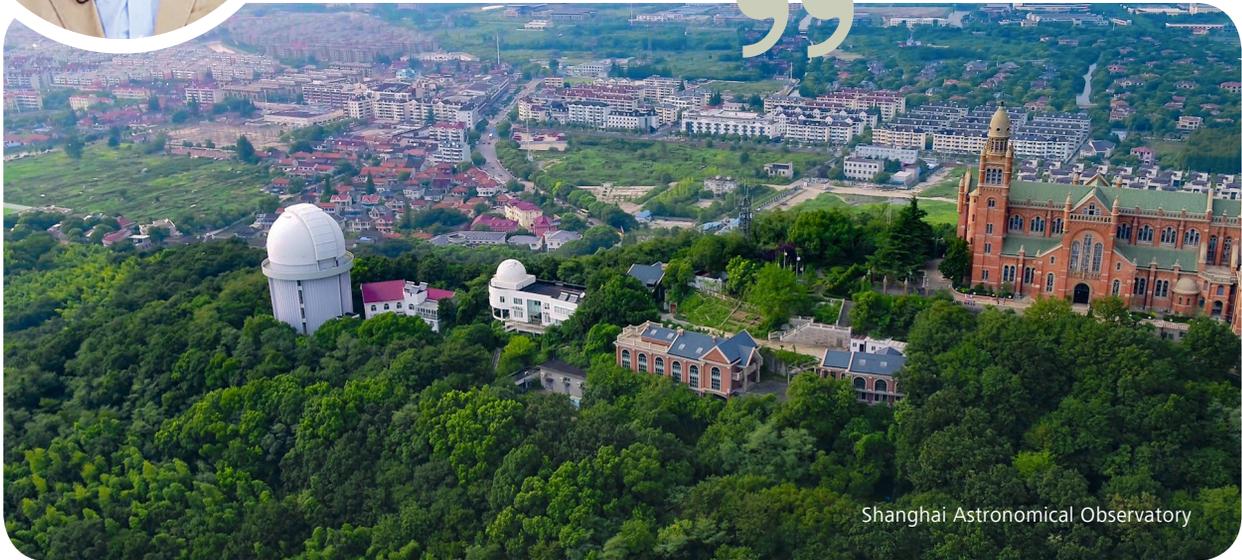
China’s SKA science team will work with the information, communication and computer industry to tackle the challenges of the SKA big data, which he says “will bring major scientific discoveries and help promote China’s economy.”

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Shanghai Astronomical Observatory

“When you build an enormous radio telescope, the aim is to gather as much information as possible, and that means a lot of data,” adds Diamond. The Shanghai hub, which is “leading the way”, he says, in developing data processing solutions, is working with Huawei to use AI to process the data.

## Collaboration is key

Diamond emphasizes that a project of this magnitude requires partnerships with not just governments and universities – industry partners are also invaluable. “We have very bright people in university departments who can solve some of those problems,” Diamond says. “But many of them

require industry, the innovation that comes from industry, the techniques being developed to enable us to put the systems, the solutions together, which will sit out in the desert and then in our supercomputing centers to enable us to process these volumes of data. So we work intimately with industry.”

It remains uncertain what new technologies will be born from the SKA project. What is certain is that such an ambitious project will require collaboration between not just governments and universities, but also the industry partners that drive the development of the latest technologies, with AI set to be one of the major stars of the show. [WINWIN](#)