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Opening a World of Discovery

With involvement from institutes across more than a dozen countries, and capability that will exceed that of the internet, the Square Kilometre Array will be a groundbreaking project that skips a generation in the development of radio telescopes.

Images by ID Photo

The Square Kilometre Array (SKA) project is a global radio telescope initiative that will be built in Western Australia and South Africa. Operating over a wide range of frequencies, the SKA will have a collecting area of approximately one square kilometre and will require greater network capacity than the entire current global internet and exceed the processing capacity of the fastest supercomputers in the world today by a factor of 100.

Professor Brian Boyle, Australian SKA Director, is passionate about this project and what it could mean for the future of scientific knowledge and discovery. "It's going to address many of the key contemporary questions of physics and astronomy. What is the nature of dark matter and dark energy that comprises 96 per cent of our universe? How did the universe evolve from chaos to the very organised universe that we see today? And perhaps answering one of the most challenging questions in history: what and where are the conditions for life elsewhere in the universe?

"Such a telescope will increase our ability to pick up signals from a volume of the cosmos up to a million times larger than previous telescopes. We will be able to pick up the equivalent of leakage from airport radars from planets orbiting stars out to 50 light-years from Earth. Quite frankly, probably the greatest scientific discovery that it will make is one that we can't even contemplate right now. Most major pieces of scientific kit end up answering questions that were not even considered when they were first built."

The other major impact the SKA may have on society is in the area of technological breakthroughs. "In its first full day of operation the SKA will generate five million million million bytes of information. That is more information than is contained in all the words spoken by humanity–ever. The opportunities for science and industry innovation, especially in the fields of data transport and data analysis, are tremendous.

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important, particularly if you are trying to promote a program like this. A key part of implementing the project is building strong partnerships; between the scientists who dream these dreams and the engineers who make them happen, industry who commercialise it and the politicians who take the credit [laughs]. I think it's a wonderful combination."

While partnerships have been instrumental in bringing the SKA together, it is also a challenge to coordinate, especially since it's an internationally funded project. "The sheer scale and ambition of the SKA project means that it can't all be done by one organisation, or even one country. Designing and building a scientific instrument this big has to be a global undertaking. Through the SKA, we are bringing countries together through their institutions and industries, but also through their governments who are able to fund these kinds of mega-science projects in a coherent way."

Already, collaboration has facilitated numerous technological innovations for the SKA. "The CSIRO have developed an innovative new radio camera. In ›

radio astronomy we're used to using the astronomy equivalent of 1-pixel cameras; focusing on just one little area of the sky at a time. The problem with this is that it takes a long time to map the sky and to keep an eye on large areas of sky. So CSIRO developed a new hi-tech solution called the phased array feed, which allows us to view a much larger area of the sky—about 100 times larger in effect. This will speed up large-scale censuses of the universe."

Other organisations are bringing innovation to the manufacturing arm of the project. "There is a yacht-building company, Innovation Composites, in Nowra, which is actually building the shielding for the phased array camera that sits at the top of the telescope. The hi-tech phased array feed cameras are full of electronics, which generate lots of radio signals—the last thing you need when you're trying to listen to the faintest whispers of the radio universe.

"The lightest, cheapest and most effective way of shielding these cameras from radio interference is to use materials manufactured in a process invented by Innovation Composites. They are now in the business of building yacht hulls and radio-frequency interference shielding for radio telescopes. Australia does this kind of innovative design and manufacturing really well, and I think it's a strength which we bring to the international project."

Considering the scale of this project, Brian notes the importance of power reduction and power management. "With the amount of computing power that the project needs, one of the biggest challenges is to maintain the computers at optimal operating temperatures. Of course, the lion's share of the power budget can't go on cooling computers, so we are actually looking at new ways of cooling computer buildings through heat-exchange systems with the ground or groundwater."

A groundwater heat-exchange system developed by the CSIRO is already in operation at the Pawsey supercomputing centre in Perth, which will also house SKA's supercomputer in Australia.

To perform the power generation and power storage, the SKA is looking at solar photovoltaic and solar thermal devices among other options. "That's an area where we've been actively involved with overseas organisations; for example, the Fraunhofer Institute for Solar Energy Systems in Germany." The sorts of power solutions that the team is trying to devise for the SKA are equally applicable to remote communities and remote industries as well. "Building an energy system for a project of this scale, particularly one that may be off-grid and large scale, is the sort of thing that would be easily transferable to remote Australian industries such as mining, or remote towns and settlements. So there are significant benefits in that area as well."

The SKA is a landmark project that will completely change the world of science and technology for generations to come. "If I could predict exactly what the SKA will be able to do, then we would not be aiming high enough; we really are on a journey into the unknown. In the next couple of years, both of the Australian precursor telescopes will be fully operational and will be generating headline science for Australia and around the world. I feel proud of having played a small role in initialising these programs and shepherding through some of the stages, but hats off to the likes of CSIRO, Curtin University, and the companies that have been involved; they've been just fantastic. High-precision electronics manufacturing companies like Puzzle Precision have seen a major increase in their business and capability through their involvement in the ASKAP [Australian Square Kilometre Array Pathfinder] telescope with CSIRO.

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"The plan is that by 2017 we'll have assembled the partnership that will be going out to industry to procure the various elements of the world's largest and most ambitious piece of scientific infrastructure. By then we'll be talking to all the Australian companies involved and working out not only what they are going to get in terms of contracts, but what they are going to be developing in terms of their own skills and capability to make them competitive in a broader marketplace.

"We should all feel a sense of great pride in what has been achieved already here in Australia with the SKA precursor telescopes. The SKA itself should remain iconic and inspirational for generations to come, reminding us all of how central science and technology are to the wellbeing and prosperity of our society." ◦