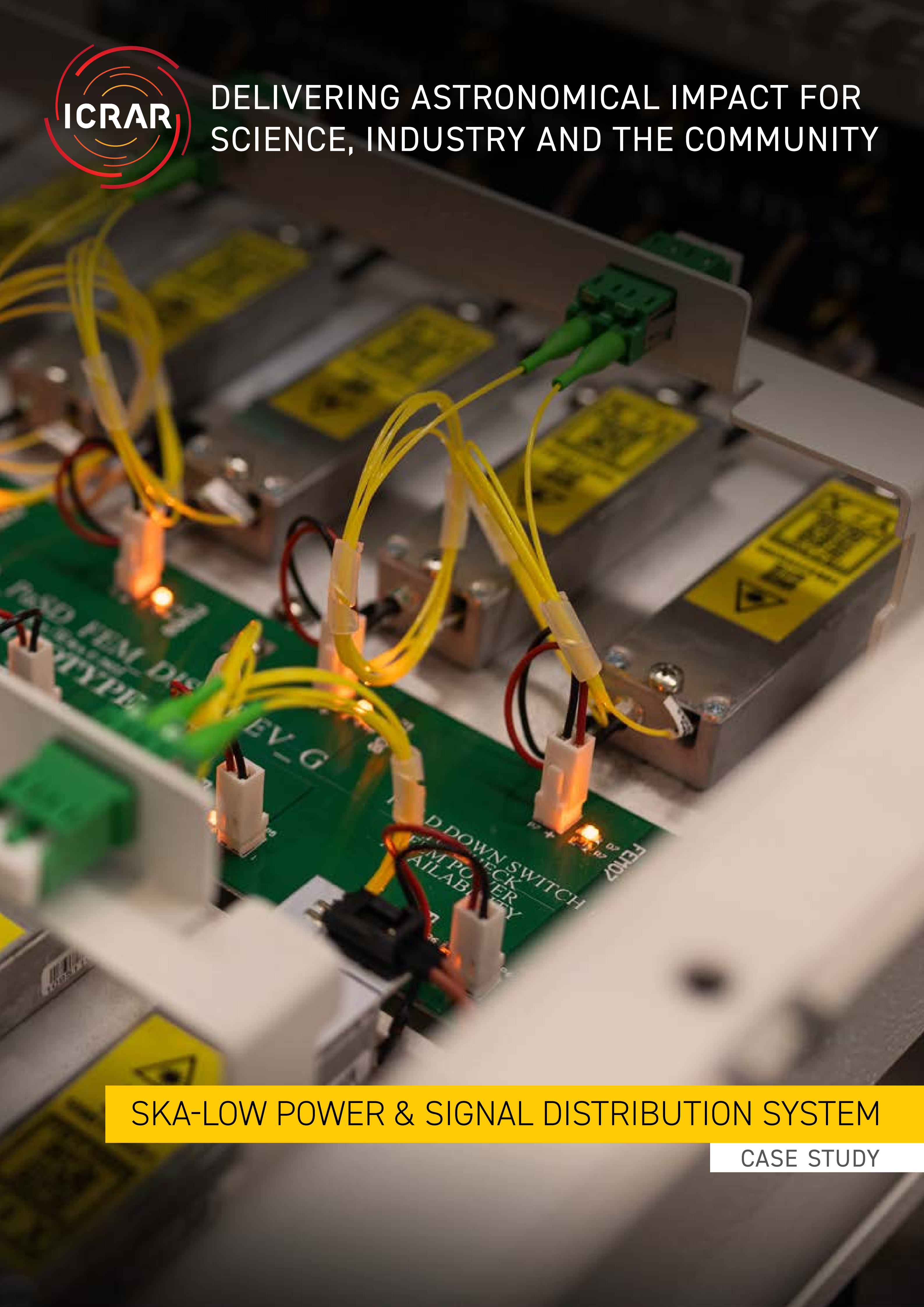
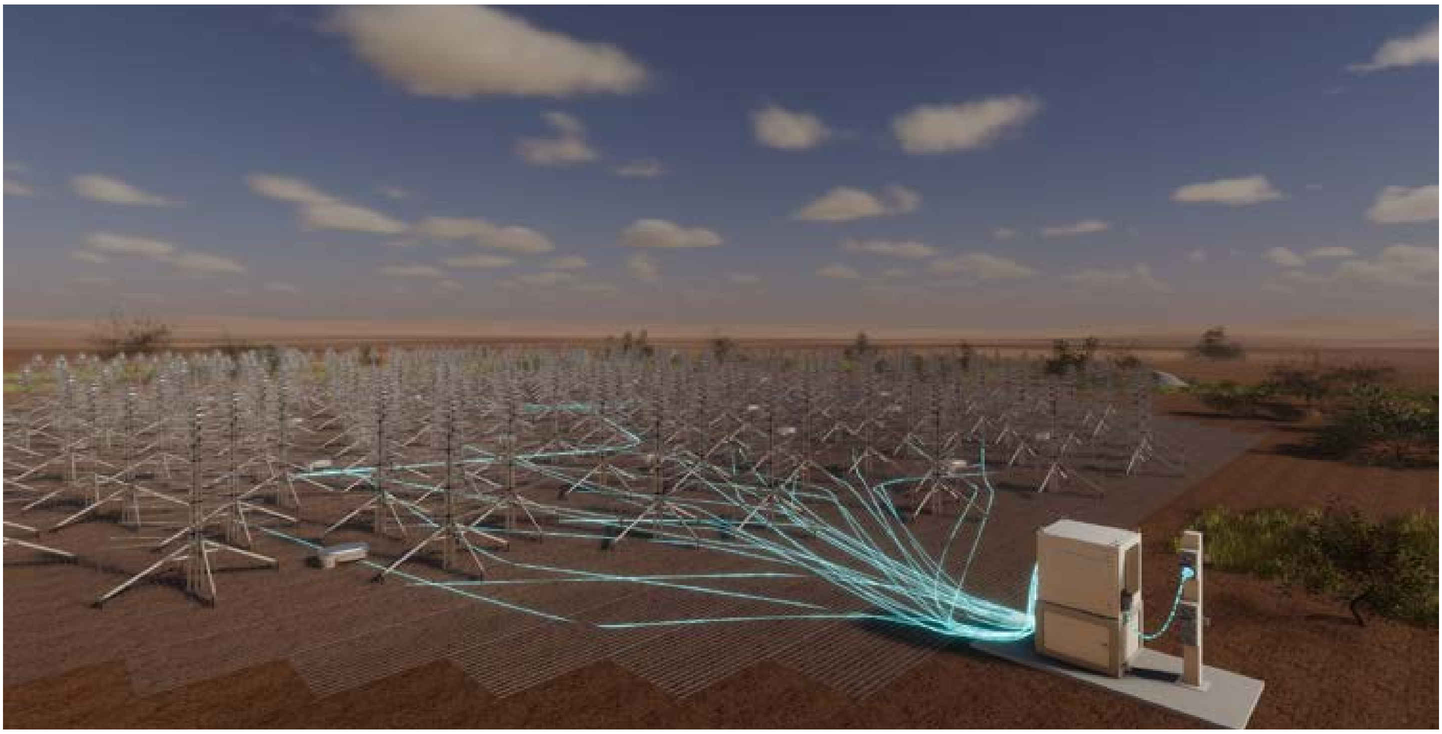


ICRAR

DELIVERING ASTRONOMICAL IMPACT FOR SCIENCE, INDUSTRY AND THE COMMUNITY

SKA-LOW POWER & SIGNAL DISTRIBUTION SYSTEM

CASE STUDY



Cover Image of electronics inside a SMART box. Credit: ICRAR.

Top Left The Field Node Distribution Hub (FNDH, lower right of image) distributes power and fibre connections to the 24 SMART Boxes deployed in each SKA-Low Station. Artist's impression by Scott Bell. Credit: ICRAR-Curtin.

Top Right 24 white, printer sized—SMART Boxes located within each SKA-Low Station. Each box provides power to and receives the signals from up to 12 antennas. Artist's impression by Scott Bell. Credit: ICRAR-Curtin.

Bottom Right Detailed image of electronics inside a SMART box. Credit: ICRAR.

SKA-LOW POWER AND SIGNAL DISTRIBUTION SYSTEM

When ICRAR's engineering team completed the prototype power and distribution system for the SKA Observatory's (SKAO's) low frequency telescope in Australia, it faced a big test.

The system had to be very radio-quiet to avoid obscuring faint signals from the distant Universe. And the requirement set by the SKAO was unprecedented.

The target was so strict that a mobile phone on the surface of the Moon would need to impact the telescope antennas more than the power and distribution system positioned among them.

"We were confident we had done a good job but we weren't so optimistic as to think we'd met the requirement," says ICRAR engineering and operations program lead Tom Booler. "Nothing in the world had ever met this requirement."

The team flew to South Africa to test the system in one of the few facilities in the world sensitive enough to measure electromagnetic emissions at such low levels. The test performed very well, ensuring the project got off to a good start.

"When they commenced the testing, they had to ask us, 'is your system switched on?'," says ICRAR engineer Dave Emrich, one of the lead designers. "Because they couldn't detect a thing."

It was a fantastic result for the team. "Honestly, I don't think we expected it to go that well," Booler says.

"We knew we'd done a good job, but the SKAO's requirement was orders of magnitude more demanding than what's typically found in industry. It was a great outcome for the team, and a big sigh of relief for the SKA Project."

HIGH-TECH, LOW COST

The power and signal distribution system is an essential part of the SKA-Low telescope, currently under construction in Western Australia's Murchison region. It will provide electrical power to the telescope's 131,072 antennas and collects the signals they receive from the sky for processing.

The components are housed in thousands of 'SMART' boxes, each about the size of a home printer. One box can power and collect signals from up to 12 antennas.

Booler says the SMART boxes were designed to sit beneath the antennas and be as invisible as possible to them. "Even though the electronics are radio-quiet, it's still a metal box that can reflect radio signals," he says. "So we tried to keep as low a profile as possible within the station."

Booler says electronics that produce less radio emissions are used in other industries. "It's

reasonably well understood—the techniques are known and there are inherently quiet components available," he says. "They pay a lot of attention to it in safety-critical and high-cost applications like aircraft and satellites."

But such radio-quiet components can be very, very expensive. That's fine for aerospace projects with massive budgets and small numbers, but not for the SKA telescopes. One of the big challenges for ICRAR's engineers was to achieve a suitable design for a fraction of the usual cost.

"In a lot of domains, when you're engineering for radio-quiet, you're engineering equipment where you're going to use one, two or five of something." Booler says.

"For the SKA-Low telescope, one of the defining characteristics is an extended, massively parallel analogue signal architecture, resulting in high part counts. You can't afford for every SMART box to contain tens of thousands of dollars' worth of electronics."

UNDER THE MURCHISON SUN

Another challenge was keeping the lasers—required to transmit the antenna signals several kilometres to processing nodes—at a stable operating temperature, in a harsh environment where the mercury can soar above 50°C.

"That was a big challenge, because all electronics in the box obviously generate heat," Booler says. "Not to mention the fact that they're sitting out in the baking sun in the Murchison."

The team contained all the active electronics in a separate sub-enclosure that's thermally isolated from the enclosure that contains the lasers. The lasers are also directly mounted onto large heat sinks, which suck heat from the module and release it into the surrounding environment.

Having built 24 prototype boxes, ICRAR has now handed over the design to Perth company AVI, who will manufacture thousands of SMART boxes needed for the SKA-Low telescope.

The company won the contract to build the power and distribution system—the biggest contract in Australia for SKA construction, outside infrastructure and software—in a competitive tender process.

Booler says he's pleased the SMART boxes will be built in Western Australia. "It's a promising indication of Australia's sovereign capability in the space industry, and one that could be leveraged into the future," he says.

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We acknowledge the Wajarri Yamaji as Traditional Owners and native title holders of Inyarrimanha Ilgari Bundara, the CSIRO Murchison Radio-astronomy Observatory, where the SKA-Low telescope is being built.

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