University helps map the universe

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The University of Manchester is developing high-speed data crunching technology that will be crucial to the success of one of the greatest scientific projects of the 21st century.

The £1.1 billion (Euro 1.5bn) Square Kilometre Array (SKA) radio telescope will be around 200 times bigger and 100,000 times more powerful than the famous landmark Lovell radio telescope at Jodrell Bank.

This visionary global project will allow astronomers to collect information over one million square metres – the equivalent of around 200 football pitches.

It will give astronomers the ability to probe the early Universe, test Einstein's theory of relativity, learn more about mysterious dark matter and energy – and even search for signs of alien life.

The University is leading the UK's involvement in the SKA's development through a Euro 38m European design study known as SKADS.

Engineers are working on a sophisticated all-digital system to process the information gathered by the giant telescope and turn the torrents of data into a detailed map of the sky.

Researchers in the schools of Physics and Astronomy and Electrical and Electronic Engineering are working on the technology for an 'aperture

array', which will be composed of tens of thousands of small antenna fixed to the ground. The completed SKA will consist of around 250 aperture arrays.

Time delays will be used to match up the signals received by each antenna and turn them into a single large 'beam' – digitally reproducing what currently happens when the Lovell dish is pointed in a specific direction.

By adding up the signals in different ways, the proposed aperture array will allow many 'beams' to be created at the same time.

So unlike the big Lovell dish, which can only physically point in one direction at once, the SKA will be able to 'point' in many different directions at the same time and cover a huge area of the sky.

This new approach will allow many astronomers to look at the sky in different directions at the same time – adding to the effectiveness of the telescope and the financial investment.

The Microelectronics and Nanostructures research group in The School of Electrical and Electronic Engineering, led by Professor Mo Missous, is designing and fabricating receiver components and ultra high-speed analogue-to-digital converters using special semiconductor technology developed internally.

The Microwave and Communication Systems group, led by Professor Tony Brown, is developing the very high performance antenna elements and array layout required for the system to work successfully.

In developing the proposed all-digital system, engineers face a huge challenge in developing a system that can simultaneously handle data gathered by around 128,000 receivers – two receivers in each of 64,000

elements.

To assist with the project, a Joint Study Agreement has been signed between the University of Manchester and IBM – a partnership that will give the University access to the most advanced real-time processing systems available.

Engineers are currently working with researchers based at IBM's Thomas J Watson Research Center in the United States to design the advanced processing systems required for the SKA.

They will look across the range of IBM's high-speed multi-core processing technologies for the solution that is best suited to their needs.

Dr Andrew Faulkner of the University's Jodrell Bank Observatory, who is Project Engineer for SKADS, said: "We are looking at processing an enormous amount of data at astonishing speeds and then stitching it all together to make an system of unprecedented capability."

Prof Peter Wilkinson from The School of Physics and Astronomy and UK SKADS programme leader added: "The SKA is designed to be a discovery instrument. There will be a huge harvest of fundamental science from locating enormous numbers of distant galaxies using the faint radio emission from hydrogen gas. But this new telescope will be so big and will be able to operate in so many different ways that it's bound to find things we haven't anticipated. This is why the prospect of the SKA is so exciting."

"IBM Research's participation in the SKA project is very exciting and the challenge of designing its data processing systems will bring a whole range of new ideas to our multi-core research," said David Cohn, director, Business Informatics, IBM Research.

Professor John Perkins, Vice President and Dean of the Faculty of Engineering and Physical Science (EPS) at The University of Manchester, said: “The SKA looks set to become one of the great scientific projects of the 21st century and this latest exciting collaboration with IBM can only strengthen our relationship.”

Source: University of Manchester