Research Highlights

THE AUSTRALIAN NATIONAL UNIVERSITY

Quantum Supercomputer is a Step Closer

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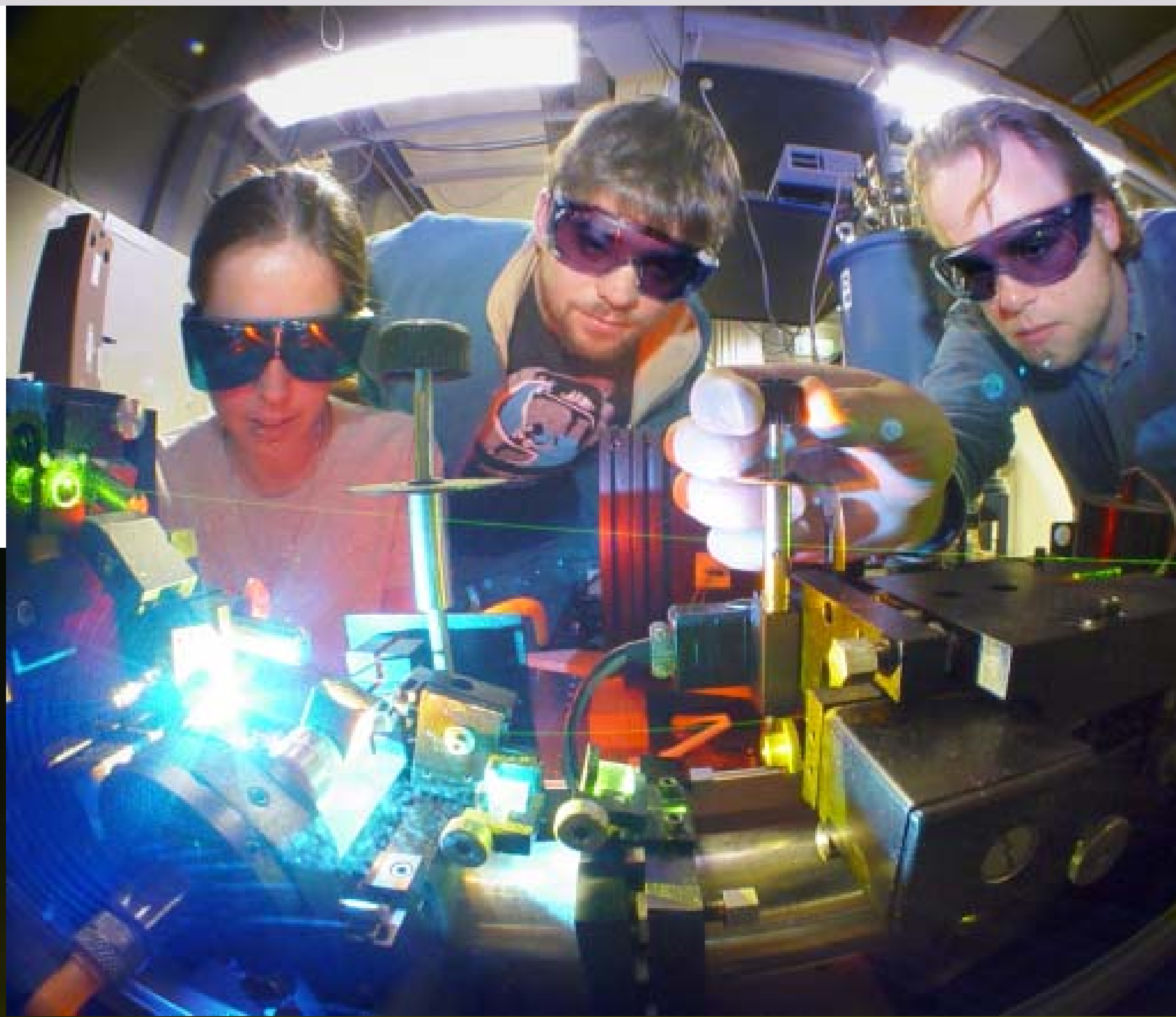
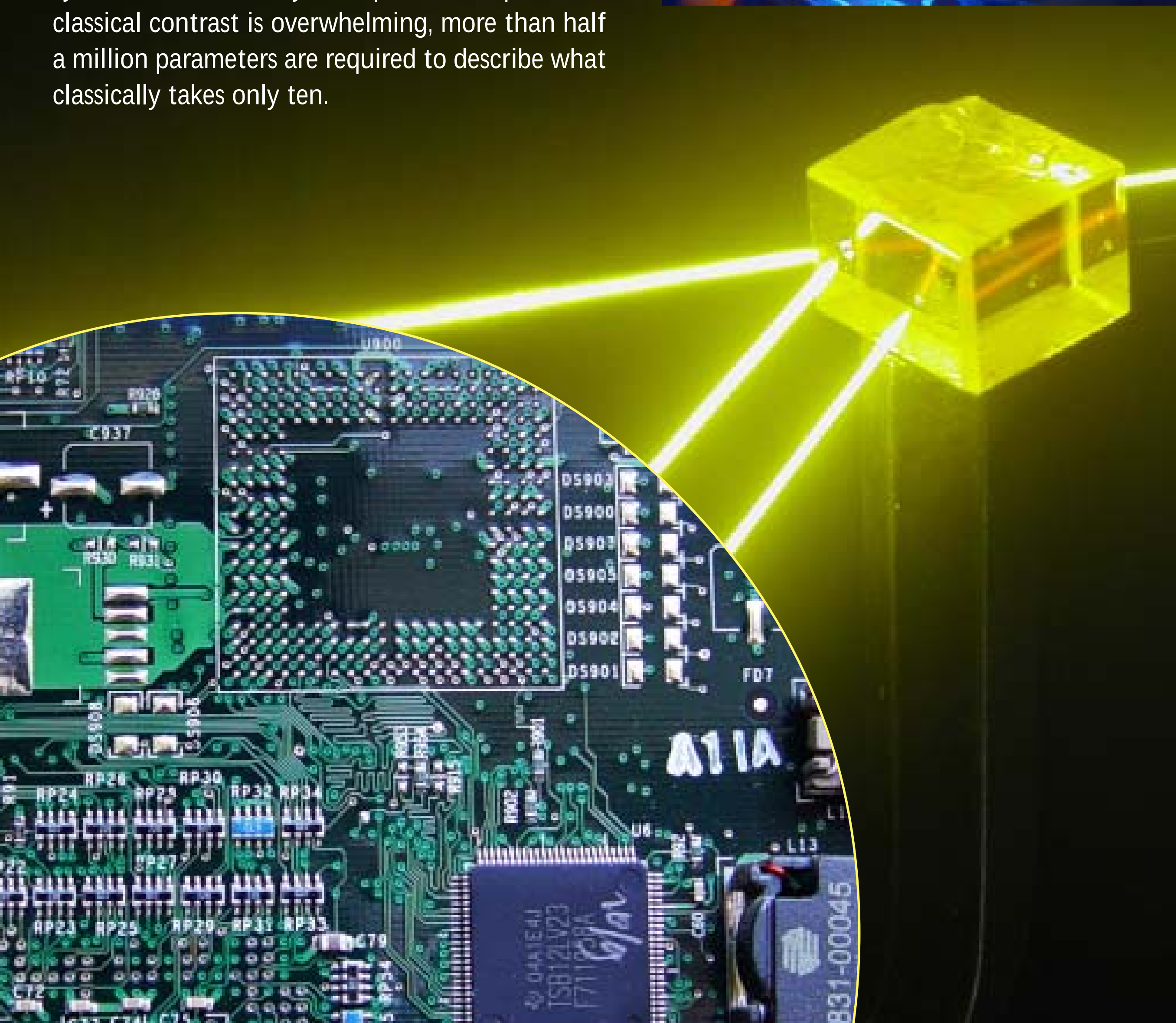
As the computer industry continues increasing the density of transistors on silicon chips a scale will be reached where quantum mechanical effects will introduce fundamental randomness into the chip's logic operations. This scale represents the ultimate limit for classical computing technology. These quantum effects whilst presenting a barrier, also provide a way forward. Quantum computing attempts to control and exploit quantum effects not as a means to cram more bits into silicon, but to support a new kind of computation with qualitatively different algorithms based on quantum principles.



The potentially awesome power of quantum computing is due to the numerous parameters needed to define the state of a quantum system. In a classical computer, a single 1 or 0 describes the state of a bit. In a quantum computer, each qubit has both an amplitude and phase term but in addition to this, information also resides in coherent superpositions of these states. In this way, the number of parameters rapidly increases with the number of qubits in the system. A two-qubit system has eight parameters, where equivalent classical systems have two. By ten qubits the quantum/classical contrast is overwhelming, more than half a million parameters are required to describe what classically takes only ten.



Despite the tantalizing advantages of quantum computers, there are many difficulties in realizing one. The coherence time of the quantum states has to exist for a useful computation period and data corruption through uncontrolled interactions with the outside world has to be avoided. ANU scientists are overcoming these difficulties by developing quantum technologies based on the nuclear spins associated with optically active centers in solids. The centres chosen have inherently long coherence times and the low temperatures and all optical addressing minimise interference.

This novel ANU quantum architecture was recently used to demonstrate the world's first two-qubit quantum logic operations based on solid-state impurity sites.

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