A cosmic vision for world science

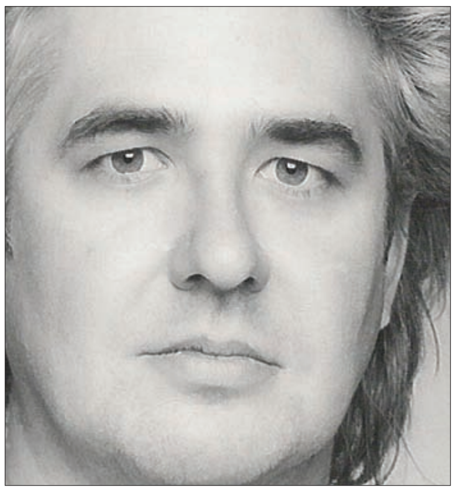
James Pinfold considers how relatively low-cost experiments to study ultra-high-energy cosmic rays could bring developing countries into frontier research

Many developed countries face the challenge of encouraging more young people to take up science to ensure future innovation to benefit society. However, there is a related and equally important challenge – to promote a scientific infrastructure to aid the academic and career ambitions of members of under-represented and economically disadvantaged groups, as well as scientists from developing countries, to increase their participation in scientific and technical fields worldwide.

Severe constraints on resources, which are a common feature in developing countries, mean that research there does not usually consist of designing and making equipment for a new experiment at the forefront of the field. In many schools, colleges and universities laboratories either do not exist or are poorly equipped. Consequently, the brain drain of bright young scientists from developing to developed countries seems to be the norm, and further intellectually impoverishes the developing world. Collaborative programmes between scientists from developed and developing countries are urgently needed.

The Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste has set an international example by providing both a forum and practical support for collaboration in theoretical physics between developing and developed countries. It has also supported indigenous physics programmes in developing countries. Importantly, the director of ICTP, Katepalli Sreenivasan, plans to include experimental physics in the programme. CERN has also taken a significant step to foster a relationship with physicists from developing countries that does not require large cash contributions to CERN, but instead encourages the production of detector components at the home laboratories (*CERN Courier* July/August 2003, p26). This lets physicists from developing countries participate in frontier research.

The Pierre Auger Collaboration is involved in Vietnam in developing experimental work to



understand the universe at the highest energies. The Vietnam Auger Training Laboratory (VATLY) at the Institute for Nuclear Science and Techniques in Hanoi was inaugurated as a training ground for future experimentalists in astroparticle physics and related areas, and an exact replica of the water Cherenkov detector used in the Pierre Auger Observatory has been installed at VATLY. More recently, the atmospheric muon spectrum was measured in Vietnam for the first time. The phenomenology of neutrino oscillation is also being studied at this laboratory. Indeed, a Vietnamese community for experimental particle physics is developing well – in 2001 a group from the Institute of Physics in Ho Chi Minh City joined the D0 collaboration at Fermilab.

In many areas of research, leading-edge science is expensive and there are few support networks for disadvantaged groups. However, cost-effective projects to investigate the nature of ultra-high-energy cosmic rays (UHECR) are already being developed for high schools and could provide an ideal vehicle for such an effort (p19). These projects demonstrate the basic elements of research and technology, with modern detectors, fast electronics, GPS timing, computerized data acquisition and data analysis. Perhaps just as importantly, they also teach social skills such as collaborative effort, organization, long-term planning and teamwork.

Efforts to bring the developing world into such projects have already begun. For example, the collaboration behind the Mixed Apparatus for Radar Investigation of Cosmic-rays of High Ionization project has established contact with the Maseno University in Kisumu, Kenya, the University of Zambia in Lusaka and the University of Rio de Janeiro in Brazil, to investigate the hypothesis that some forms of lightning are induced by cosmic rays. The collaboration is also working with Rio de Janeiro to deploy detectors that register UHECR showers and meteors in high-school-based receivers.

These are just two examples of the diverse topics related to the "cosmic connection" between research and education in both the developed and developing world. These include not only the astrophysics and particle physics of cosmic rays, but also topics in biology (e.g. the effects of natural radiation), mathematics, computer science and programming, chemistry, and environmental and Earth sciences (e.g studying the chemistry of ozone and how that could affect the transmission of cosmic rays).

The educational paradigm created by the networks of cosmic-ray arrays in high schools is one that can be employed in many areas. In geophysics, for example, one could use distributed arrays of seismometers to study geological activity over a large area. A specific example is the project BAMBI, which promotes the construction of an amateur array of radio telescopes distributed over a large area to study the radio sky at 4 GHz and search for signs of extraterrestrial intelligence. Such large-area, national and international school-based detector networks could aid and encompass other efforts throughout the world including developing countries, where it could provide entry to the global scientific community.

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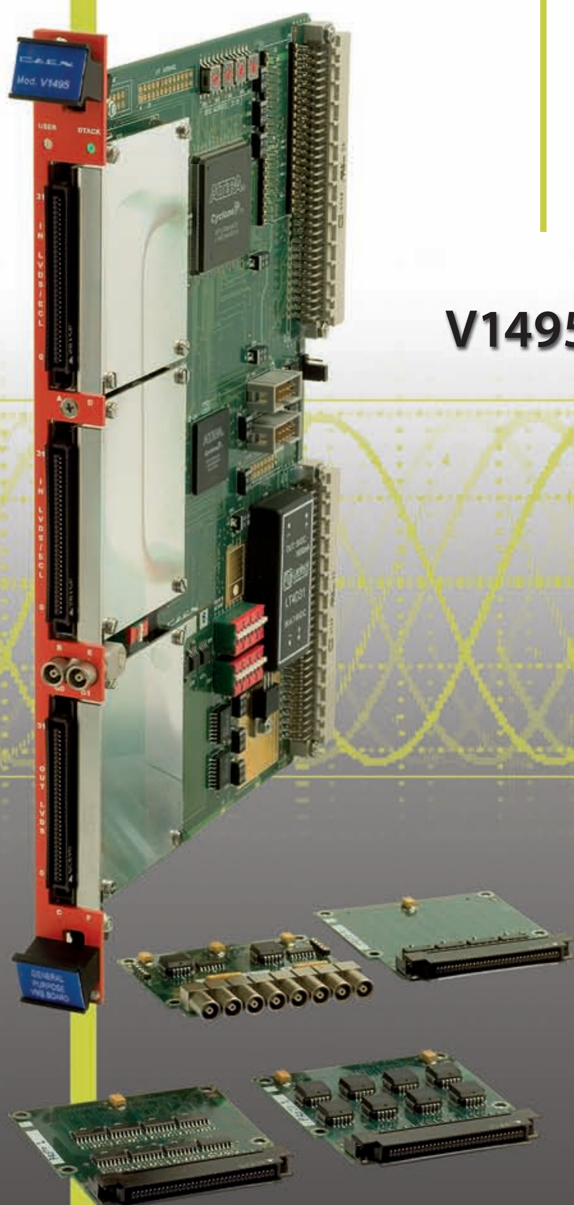
Overview

The V1495 is a fully programmable General Purpose VME board, suited to a variety of different applications. The heart of the board is a large FPGA (ALTERA® Cyclone), whose firmware can be directly customized by the user for his specific application.

The V1495 has a modular architecture: a mother-board with 98 I/O channels (64 inputs LVDS/ECL/PECL, 32 outputs LVDS, 2 I/O NIM/TTL) can be either used alone or expanded with 1, 2 or 3 additional piggy-back, choosing any combinations of the 4 available types:

- A395A: 32 LVDS/ECL/PECL input channels
- A395B: 32 LVDS output channels
- A395C: 32 ECL output channels
- A395D: 8 NIM/TTL input/output channels



V1495 General Purpose VME board

Highlights

- User programmable FPGA
- Up to 194 I/O channels
- LVDS / ECL / PECL / TTL / NIM signals
- 200 MHz min. bandwidth
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