Traditional rad-hard space computers are very expensive and typically have long lead times. These computers are either based on traditional rad-hard processors, which have extremely low computational performance, or triple modular redundant (TMR) FPGA arrays, which suffer from power and complexity issues. Even more frustrating is that the TMR arrays of FPGAs require a fixed, external rad-hard voting element, thereby causing them to lose much of their reconfiguration capability and in some cases significant speed reduction.

The benefits of COTS high-performance signal processing include significant increase in onboard science data processing, enabling orders of magnitude reduction in required communication bandwidth for science data return, orders of magnitude improvement in onboard mission planning and critical decision making, and the ability to rapidly respond to changing mission environments, thus enabling opportunistic science and orders of magnitude reduction in the cost of mission operations through reduction of required staff. Additional benefits of COTS-based, high-performance signal processing include the ability to leverage considerable commercial and academic investments in advanced computing tools, techniques, and infra structure, and the familiarity of the science and IT community with these computing environments.

This work was done by David Czajkowski of Space Micro, Inc. for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16078-1

Sub-Shot Noise Power Source for Microelectronics

Potential applications include microelectronics, sensors, and time/frequency standards.

NASA's Jet Propulsion Laboratory, Pasadena, California

Low-current, high-impedance microelectronic devices can be affected by electric current shot noise more than they are affected by Nyquist noise, even at room temperature. An approach to implementing a sub-shot noise current source for powering such devices is based on direct conversion of amplitude-squeezed light to photocurrent.

The phenomenon of optical squeezing allows for the optical measurements below the fundamental shot noise limit, which would be impossible in the domain of classical optics. This becomes possible by affecting the statistical properties of photons in an optical mode, which can be considered as a case of information encoding. Once encoded, the information describing the photon (or any other elementary excitations) statistics can be also transmitted. In fact, it is such information transduction from optics to an electronics circuit, via photoelectric effect, that has allowed the observation of the optical squeezing. It is very difficult, if not technically impossible, to directly measure the statistical distribution of optical photons except at extremely low light level. The photoelectric current, on the other hand, can be easily analyzed using RF spectrum analyzers. Once it was observed that the photocurrent noise generated by a tested light source in question is below the shot noise limit (e.g. produced by a coherent light beam), it was concluded that the light source in question possess the property of amplitude squeezing.

The main novelty of this technology is to turn this well-known information transduction approach around. Instead of studying the statistical property of an optical mode by measuring the photoelectron statistics, an amplitude-squeezed light source and a high-efficiency linear photodiode are used to generate photocurrent with sub-Poissonian electron statistics.

By powering microelectronic devices with this current source, their performance can be improved, especially their noise parameters. Therefore, a room-temperature sub-shot noise current source can be built that will be beneficial for a very broad range of low-power, low-noise electronic instruments and applications, both cryogenic and room-temperature. Taking advantage of recent demonstrations of the squeezed light sources based on optical micro-disks, this sub-shot noise current source can be made compatible with the size/power requirements specific of the electronic devices it will support.

This work was done by Dmitry V. Strekalov, Nan Yu, and Kamjou Mansour of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47949