New Modular Camera No Ordinary Joe

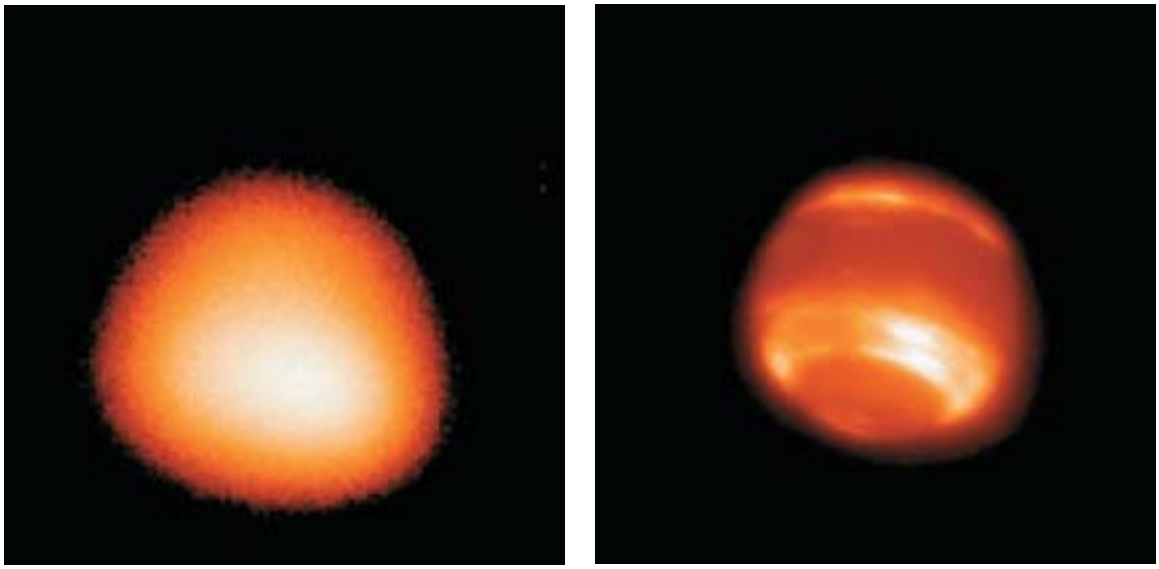
Although dubbed "Little Joe" for its small-format characteristics, a new wavefront sensor camera has proved that it is far from coming up short when paired with high-speed, low-noise applications. SciMeasure Analytical Systems, Inc., a provider of cameras and imaging accessories for use in biomedical research and industrial inspection and quality control, is the eye behind Little Joe's shutter, manufacturing and selling the modular, multi-purpose camera worldwide to advance fields such as astronomy, neurobiology, and cardiology.

In astronomy, Little Joe is used as a wave sensor to eliminate aberrations triggered by wavefront distortions that are known to plague this field with image degradation. Little Joe is also capable of correcting wavefront distortions in medical imaging applications—such as measuring distortions in the human eye—but its high frame rate, high quantum efficiency, and low readnoise properties are really what make the technology an elite member of its camera class. In turn, these properties allow Little Joe to visualize high speed phenomena by optimizing signal-to-noise ratio in light-limited conditions.

Little Joe was not always so little, though. Developed in cooperation with NASA's Jet Propulsion Laboratory under a **Small Business Innovation Research (SBIR)** contract, the wavefront sensor camera underwent radical changes from the time it was merely a concept to the time it was ready to be presented as a commercial charge coupled device (CCD) product. During Phase I of the SBIR contract, Atlanta, Georgia-based SciMeasure worked to adapt a design that would be cost effective, yet powerful in promising efficiency and low-noise operation (the signal generated from CCD cameras contains various noise components that can adversely affect performance). The Phase I camera, however, was essentially a rack of equipment that weighed several hundred pounds, generated roughly 600 watts of heat, and contained components that were imminently obsolete.

SciMeasure and the Jet Propulsion Laboratory were determined to make the camera design as independent as possible from the most critical components, which turned out to be the CCD itself and the analog-to-digital converters that digitize the analog signals from the CCD. Further camera design projects during Phase I led to considerable progress in versatility and modularity

SciMeasure Analytical Systems, Inc.'s "Little Joe" wavefront sensor camera is finding increasing application in astronomy and medicine.



These infrared images of Neptune were obtained by the Jet Propulsion Laboratory/Palomar Observatory Hale Telescope. By using an adaptive optics system that incorporates technology found in "Little Joe," the telescope was able to improve resolution and capture a sharper shot of the planet.

of the technology. The next objective for SciMeasure was to significantly reduce the mass, volume, and power requirements.

The developments that took place in Phase II of the NASA SBIR project translated into a camera that was 95 percent smaller, 92 percent lighter, and used 92.5 percent less power than its first-phase predecessor. Additionally, the camera was configured to run all available scientific CCDs, making it extremely versatile. To address special needs, the camera features an open architecture, allowing end-users to develop replacement or add-in modules.

NASA is using SciMeasure's Little Joe Wavefront Sensor Cameras to support the Jet Propulsion Laboratory/Palomar Observatory Adaptive Optics program, extending the abilities of the 200-inch Hale Telescope located at Palomar Mountain. The cameras have further been selected for the proposed California Extremely Large Telescope (CELT), a joint University of California and California Institute of Technology program aimed at building a 30-meter diameter telescope to generate high-resolution images at short wavelengths. The light-gathering segmented mirror for this terrestrial-based telescope would consist of approximately 1,000 individual mirrors. Future potential application of the cameras exist in the upcoming NASA interferometry explorations, including the 2009 Space Interferometry Mission, which will attempt to determine the positions and distances of stars several hundred times more accurately than any previous program.

South of the stars, the wavefront sensor cameras are finding increasing application at various biomedical and medical research institutions. In late 2001, SciMeasure delivered four commercial Little Joe cameras to RedShirtImaging,™ LLC, of Fairfield, Connecticut, for use in the company's low-light NeuroCCD®-SM neural- and CardioCCD™-SM cardio-imaging systems. Renowned researchers from Yale University all the way to Tokyo University in Japan are utilizing this high-speed, highly sensitive technology to capture the spread of membrane potential and changes in calcium concentration in animal tissue under study. Membrane potential is an important physiological parameter; propagating membrane potential waves is the method that nerve, muscle, and heart cells use to carry information from one end to the other. Calcium concentration is another important parameter because calcium controls many physiological functions, including muscle contraction and communication between nerve cells.

The technology has shown to be imperative for neuroscientists, who commonly perform studies that call for high-speed imaging of fluorescent dyes in the brain at rates of 1,000 to 5,000 frames per second. Cardiovascular scientists can also employ it to monitor abnormal conditions such as tachyarrhythmia. Synchronized operation of two cameras creates an extra functionality for those who would like to simultaneously record cardiac activity using two different dyes or from two different sides of the heart.

With the ability to detect any fast, low-light event with exceptional resolution, Little Joe has demonstrated that it is more than ready to measure up to the many promising commercial applications ahead.