New imaging detectors could take snapshots from deep space

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Snapshots from space may someday confirm the presence of lakes and oceans on Europa—one of Jupiter's moons—and on other planetary bodies. Imaging detectors that capture information from every wavelength in the electromagnetic spectrum could detect the presence of liquid methane or hydrocarbons, the stew that just might sustain microbial life forms.

An imaging detector under development by a team of scientists from Rochester Institute of Technology and University of Rochester promises to revolutionize future NASA planetary missions with technology that could withstand the harsh radiation environments in space. The team won $592,000 from the NASA Planetary Instrument Definition and Development Program to design, build and test a detector that should be resilient against radiation damage. The lightweight device will be smaller and consume less power than technology currently in use. The novel readout circuitry design will give the device a radiation tolerance not possible in standard optical detectors.

“All these benefits will lead to lower mission costs and greater scientific productivity,” says Donald Figer, director of the Rochester Imaging Detector Laboratory at RIT and lead scientist on the project. “But, ultimately, radiation immunity is the focus.”

Figer's team includes Zeljko Ignjatovic from UR, Zoran Ninkov from RIT, Melissa McGrath from NASA Marshall Space Flight Center, and Shouleh Nikzad from NASA Jet Propulsion Laboratory.

“Our detector captures images directly in the digital domain at the pixel level rendering subsequent signal transmission less susceptible to cosmic radiation environment,” says Ignjatovic, assistant professor of electrical and computer engineering.

The new detector is based on a technology created by Ignjatovic and his colleagues at UR in which each pixel reads and converts its signal from analog to digital immediately upon capture. Standard optical detectors lack this capability. Instead, signals must travel along a line of sensors to reach a readout circuit. This wastes energy and leaves the signal vulnerable to radiation damage that degrades the circuit over time.

“Radiation tolerant detectors are a critical need for NASA in the continued exploration of the solar system,” says McGrath, chief scientist in the Science and Mission Systems Office at NASA Marshall Space Flight Center.

“In space astronomy and planetary missions, detectors are frequently the critical pacing item,” adds Stefi Baum, director of the Chester F. Carlson Center for Imaging Science at RIT. “By developing detectors with greatly reduced noise properties and greatly enhanced tolerance to radiation damage—the chief lifetime limiter of detectors in space—the collaboration should dramatically improve the reach in sensitivity and lifetime of the missions to explore and understand the nature of the planets with which we share our solar system.”

Testing the overall system will determine how the sensors hold up in cryogenic environments where the detector is cooled to very low temperatures, imitating conditions in space. The device will be tested at RIT in the Rochester Imaging Detector Laboratory, a new facility established to develop detector technologies for next-generation ground-based and space telescopes.

The new imaging detector under development will boast a dynamic range and greater short wavelength sensitivity. Figer believes the detector could become a key technology for future planetary missions in the most severe radiation environments. The detector technology could figure heavily in missions under consideration for NASA's Discovery, Mars Exploration and New Frontiers programs.

The detector might someday be used to capture hyperspectral imaging from a platform orbiting the outer planets or their satellites. Cameras looking down on Europa could take a picture of every wavelength at every pixel.

"We could use that information to figure out if there are lakes of water on Europa or hydrocarbons on Titan," Figer says. "We can figure out the composition of a surface without having to land on it, which we might want to do 10 years later. Then we would know where to land."

Source: Rochester Institute of Technology