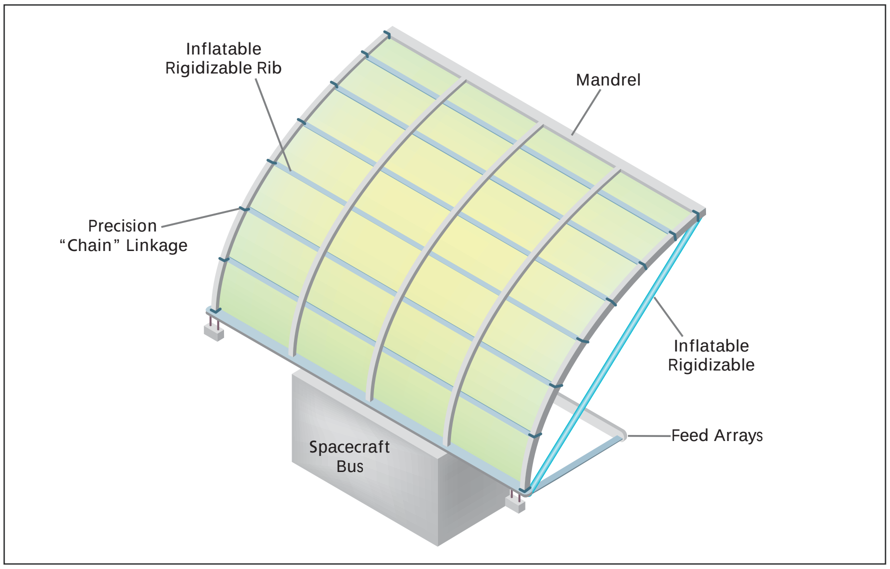


The configuration of the radar antenna features a **Chain-Link Support Structure** that is space-deployable.

vehicle stowage volume. The Ku and Ka band feed arrays are needed to achieve the required cross-track beam scanning. To demonstrate the inflatable cylindrical reflector with two linear polarizations (V and H), and two beam directions (0° and 30°), each frequency band has four individual microstrip array designs. The Ku-band array has a total of 166×2 elements and the Ka-band has 166×4 elements with both bands having element spacing about 0.65 λ_0.

The cylindrical reflector with offset linear array feeds reduces the complexity from "N×N" transmit/receive (T/R) modules of a conventional planar-phased array to just "N" T/R modules. The antenna uses T/R modules with electronic phase-shifters for beam steering. The offset reflector does not provide poor cross-polarization like a double-curved offset reflector would, and it allows the wide scan angle in one plane required by the mission. Also, the cylindrical reflector with two linear array feeds provides dual-frequency performance with a single, shared aperture. The aperture comprises a reflective surface with a focal length of 1.89 m and is made from aluminized Kapton film. The reflective surface is of uniform thickness in the range of a few thousandths of an inch and is attached to the chain-link support structure via an adjustable suspension system. The film aperture rolls up, together with the chain-link structure, for launch and can be deployed in space by the deployment of the chain-link structure.

This work was done by Yahya Rahmat-Samii of UCLA; John Lin of ILC Dover, Inc.; and John Huang, Eastwood Im, Michael Lou, Bernardo Lopez, and Stephen Durden of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-40470

Wide-Band Radar for Measuring Thickness of Sea Ice

This instrument could contribute to understanding of climate change.

NASA's Jet Propulsion Laboratory, Pasadena, California

A wide-band penetrating radar system for measuring the thickness of sea ice is under development. The need for this or a similar system arises as follows: Spatial and temporal variations in the thickness of sea ice are important indicators of heat fluxes between the ocean and atmosphere and, hence, are important indicators of climate change in polar regions. A remote-sensing system that could directly measure the thickness of sea ice over a wide thickness range from aboard an aircraft or satellite would be of great scientific value. Obtaining thickness measurements over a wide region at weekly or monthly time intervals would contribute significantly to understanding of changes in the spatial distribution and of the mass balance of sea ice.

A prototype of the system was designed on the basis of computational simulations directed toward understanding what signal frequencies are needed to satisfy partly competing requirements to detect both bottom and top ice surfaces, obtain adequate penetration despite high attenuation in the lossy sea-ice medium, and obtain adequate resolution, all over a wide thickness range. The prototype of the system is of the frequency-modulation, continuous-wave (FM-CW) type. At a given time, the prototype functions in either of two frequency-band/operational-mode combinations that correspond to two thickness ranges: a lower-frequency (50 to 250 MHz) mode for measuring thickness greater than about 1 m, and a higher-frequency (300 to 1,300 MHz) mode for measuring thickness less than about 1 m. The bandwidth in the higher-frequency (lesser-thickness) mode is adequate for a thickness resolution of 15 cm; the bandwidth in the lower-frequency (greater-thickness) mode is adequate for a thickness resolution of 75 cm. Although a thickness resolution of no more than 25 cm is desired for scientific purposes, the 75-cm resolution was deemed acceptable for the purpose of demonstrating feasibility.

The prototype was constructed as a modified version of a 500-to-2,000-MHz FM-CW radar system developed previously for mapping near-surface internal layers of the Greenland ice sheet. The prototype included two sets of antennas: one for each frequency-band/mode. For Arctic and Antarctic field tests, the prototype was mounted on a sled that was towed across the ice. The Arctic field test was performed in the lower-frequency mode on ice ranging in thickness from 1 to 4 m. In the analysis of the results of the Arctic field test, a comparison of the radar-determined ice thicknesses with actual ice thicknesses yielded an overall mean difference of 14 cm and standard deviation of 30 cm. The Antarctic field test was performed in the higher-frequency mode; analysis of the results led to the conclusion that this mode is useful for measuring thicknesses between 0.5 and 1 m.

Several modifications have been conceived for implementation in further development toward an improved practical system:

- The system would function in a single frequency-band / mode (100 to 1,200 MHz) that would afford a resolution of about 15 cm.
- There would be a single antenna system that would be optimized for the entire 100-to-1,000-MHz frequency band.
- To enable ice-thickness surveys over larger areas, the system would be made capable of operating aboard a low-flying aircraft that could be either piloted or robotic.
- Data-processing techniques to deconvolve the system response have been developed on the basis of impulse-response measurements over a calm ocean. Implementation of these techniques in the system would enable correction for imperfections of the system and would thereby increase the effective sensitivity of the system.

This work was done by Prasad Gogineni and Pannir Kanagaratnam of the University of Kansas and Benjamin M. Holt of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). **NPO-45565**

Vertical Isolation for Photodiodes in CMOS Imagers

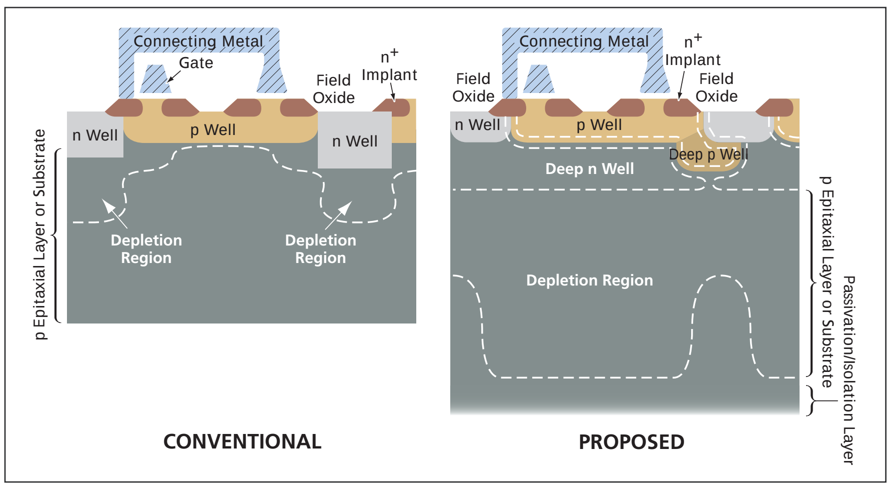
Diffusion cross-talk would be reduced substantially.

NASA's Jet Propulsion Laboratory, Pasadena, California

In a proposed improvement in complementary metal oxide / semiconductor (CMOS) image detectors, two additional implants in each pixel would effect vertical isolation between the metal oxide / semiconductor field-effect transistors (MOSFETs) and the photodiode of the pixel. This improvement is expected to enable separate optimization of the designs of the photodiode and the MOSFETs so as to optimize their performances independently of each other. The purpose to be served by enabling this separate optimization is to eliminate or vastly reduce diffusion cross-talk, thereby increasing sensitivity, effective spatial resolution, and color fidelity while reducing noise.

Ideally, the spatial resolution of an imager should be limited by the geometric pixel size. However, in most practical image detectors, resolutions are limited, not by geometric pixel sizes, but by cross-talk. (As used here, "cross-talk" denotes the response of a pixel to light focused on an adjacent pixel.) Cross-talk degrades spatial resolution of an imager, reduces overall sensitivity, compromises color fidelity, and leads to additional noise in the image after color correction. Diffusion cross-talk occurs where photogenerated charge carriers can move to neighboring charge-accumulation sites — in particular, where junction diodes in adjacent pixels have insufficient depletion widths.

The left side of the figure presents a schematic cross section of a typical conventional CMOS imager pixel containing a junction diode connected to the source of a reset MOSFET. The junction diode is formed between the n well and the p epitaxial layer (or p substrate). The n well is connected to the source of the reset MOSFET through an n^+ implant. The reset MOSFET and an associate source-follower MOSFET are n-type and are placed inside a p well. For reasons too complex to present in this article, the depletion width is too small to prevent lateral diffusion of photo-induced charge carriers in the undepleted (field-free) epitaxial region. In the absence of a guiding electric field, photoelectrons generated in the epitaxial layer substrate diffuse omnidirectionally between pixels, thereby causing cross-talk.



The **Proposed CMOS Imager Pixel** device structure would be similar to the conventional one but would include deep p and n wells.

The maximum supply potential in a CMOS process is between 3 and 5 V. When potential drops are taken into account, the reverse bias across the diode is between 2 and 3 V. At these reverse biases, the p-n junction depletion width is too small to prevent diffusion cross-talk, especially for longer wavelength light, In principle, the depletion width could be increased significantly by applying a large reverse bias (e.g., 50 V) to the p epitaxial layer or substrate. However, because of (1) the electrical connection between the p well and the p epitaxial layer or substrate and (2) a requirement to keep at the most between 3 and 5 V across the CMOS devices, it is not possible to apply such a large reverse bias in this device structure. This prompts the proposed improvement in device structure.

A CMOS imager pixel as proposed, depicted on the right side of the figure, would include a deep n well and a deep p well in addition to the conventional n and p wells. The photodiode would be formed by the deep n well and the p epitaxial layer or substrate. The anode end (n end) of the diode would be connected to the n^+ source