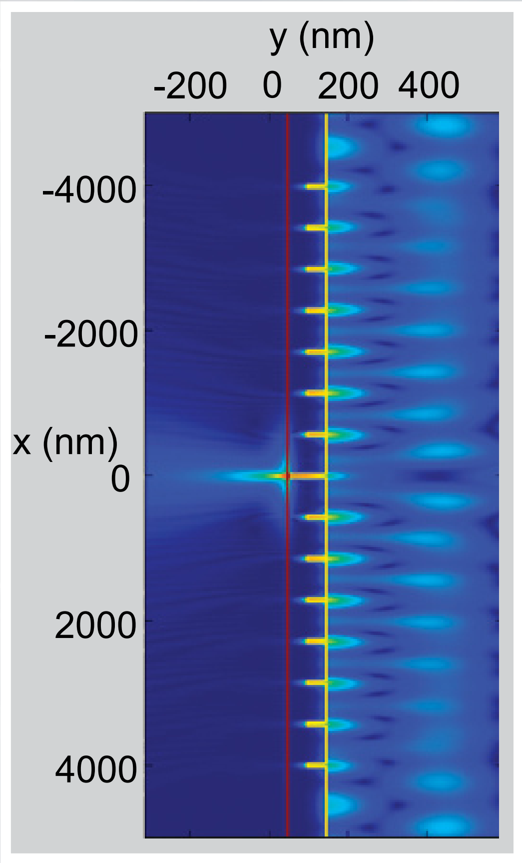
# Photon-Plasmon-Electron Conversion Enables A New Class of Imaging Cameras

***Accomplishment:*** The world's smallest array of imaging pixels was conceived and created. A device was built and tested to demonstrate this new imaging approach.




***Impact:*** High resolution, multi-spectral and polarimetric imaging systems are essential for intelligence, surveillance and reconnaissance missions. The present accomplishment demonstrates a new imaging approach that offers these capabilities at significantly reduced volume, weight and cost relative to conventional systems. This provides mission enhancement for conventional aircraft, and may give an enabling new capability for platforms with limited payloads, such as unmanned air vehicles.

***Motivation and Approach:*** The size, weight and cost of imaging cameras are important considerations for conventional air vehicles, and are enabling considerations for platforms with significant restrictions on payload weight and volume such as unmanned air vehicles (UAVs). The size, weight and cost of imaging systems increase dramatically with the size of the imaging chip. High-resolution cameras require more pixels, increasing the detector size. The imager pixel size is currently limited by the physics of light diffraction to 2.0 microns for visible light, thus limiting the potential to reduce the size of imaging cameras. Improved target identification and the ability to distinguish between manmade and natural features requires simultaneous signal collection from more than one wavelength of light (multi-spectral imaging) or from polarized signals (polarimetric imaging), also significantly increasing the imager system size. These capabilities are currently difficult to incorporate into unmanned air vehicles due to size and weight restrictions.

The present accomplishment conceived and demonstrated a new detector imaging approach that converts photons from an incoming optical signal into surface plasmon waves (as sound waves are produced by oscillating densities of air molecules, plasmons are quantized oscillations of the electron gas in a metal). The plasmon waves are formed in a metal film that is typically less than 100 nanometers thick bonded to a semiconductor base, and they are collected by a slit in the metal film, where their energy is focused to produce electron/hole pairs in the semiconductor that give a measurable electrical signal. The plasmon has a wavelength shorter than that of the incoming light, and so the diffraction-limited minimum pixel size is also reduced. This phenomenon was exploited here to demonstrate an imager with a pixel size of 1.3 microns. Different polarization signals may be produced from the same imaging chip by fabricating different slit orientations, and multi-spectral signals can be produced by fabricating an imaging chip with several different slit sizes. This accomplishment provides a decrease in detector size of at least 50% relative to existing technology at equivalent resolution.

***Team:*** This research was conducted by Dr. Ravi Verma and Dr. Joe Lee (Tanner Research), and by Prof. Mark Brongersma and Justin White (Stanford University). The research was funded by the Air Force Office of Scientific Research (Dr. Gernot Pomrenke, Program Manager).