

Sensors Unlimited, Inc.

White Paper:

Imaging in the shortwave infrared spectrum helps track and detect lasers on the battlefield



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Imaging in the Shortwave Infrared (SWIR) Spectrum Helps Track and Detect Lasers on the Battlefield

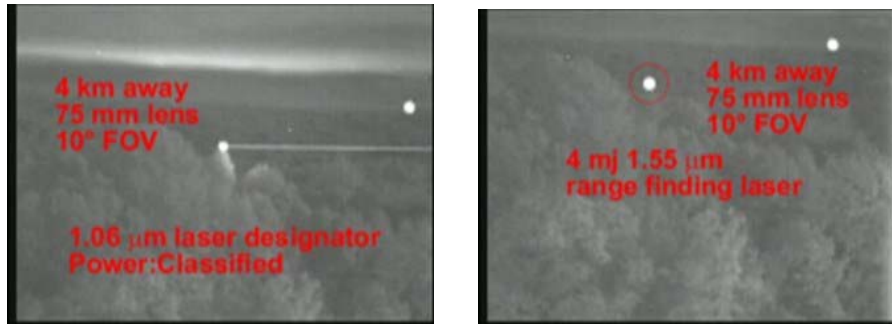
As warfare becomes more asymmetric, civilians and other non-combatants become a larger percentage of the casualties, along with unintended property damage. The military, of course, hopes to avoid these types of casualties and destruction. With advancing technologies that enable more precision from their weapons, they also need better pointing and targeting capabilities, while remaining covert. Improved targeting technologies that allow detection and identification at longer standoff distances from the designators are also needed. For instance, lasers are excellent at precision pointing but it is important that others be able to covertly image the scene as well.

To address these targeting challenges the military has deployed lasers which allow them to not only designate the target where munitions should hit but to use these same lasers to measure the distance to the target, illuminate the surrounding area, or point out to others something of interest. Visualizing where the lasers are pointing, tracking moving targets, and minimizing collateral damage requires imaging systems that see the active lasers used in the field. Room temperature indium gallium arsenide (InGaAs) cameras give users this capability in daytime and nighttime scenarios.

1060 Nanometer Lasers on the Battlefield

Although there are several different lasers currently used on the battlefield, most laser guided munitions are guided by lasers with a wavelength of 1.06 μm , or 1060 nanometers. The 1060 laser is a very powerful laser and is ideal for long distance targeting and designating. The limiting factor is not the laser but is instead the end-user's ability accurately to see the target and the objects around the target. Most of the systems currently deployed to image the 1060 laser are indium antimonide (InSb) based systems, where the InSb material is thinned down to the 1000 nanometer laser wavelength. This is far below InSb systems' peak sensitivity range of 3000 to 5000 nanometers, which is typically used for its main application as a mid-wave IR thermal detector.

These InSb cameras do image the 1060 nm (or 1.06 μm) laser, and they can provide situational awareness around the laser spot because of the laser's thermal emissivity. However, InSb-based systems need a large cooler that can bring the system down to 77k. Their sensitivity, too, is not ideal, registering at less than twenty percent quantum efficiency. Meaning, the InSb systems are big and require lots of power.



Figures 1a and 1b. Imagery taken with an SUI SWIR InGaAs camera of (a) a 1060 nm laser from 4km away and (b) a 1550 nm laser from the same distance.

Comparatively, InGaAs-based systems are much more sensitive and operate at room temperature. An InGaAs detector array has a quantum efficiency of greater than seventy percent and doesn't require a cooling system to regulate its temperature – making it smaller and much less power hungry. With a much smaller component, the user can have a much lighter system, and therefore more mobility on the battlefield. This added benefit ultimately enables imaging laser spots at a greater standoff distance from a variety of battlefield locations (see Figures 1a and 1b).

IR Cameras Image Covert 1550 nm Lasers

As mentioned before, lasers are not only used to guide munitions to their target; lasers can provide the soldier with information on the targeted object and the surrounding area. Specifically, lasers can determine the range to the target. Appropriately deemed "laser range finding," this application employs a different laser – one that registers at approximately 1550 nanometers (or, 1.5 μm). This laser is considered to be eye safe since the energy generated by this laser does not focus on the eye's retina and is not strong enough to blind someone hit by it. An added bonus of the 1550 laser is that it is covert to the human eye and night vision goggles, unlike the 1060 laser which is within the imaging range of night vision goggles (see Figure 2). Meaning, when using a 1550 laser to designate an object, the target is unaware they are being marked. The downside is that, without an imaging device that can see this laser, the war fighter has trouble knowing if he is correctly aimed at the target. Because InGaAs cameras are very sensitive to the eye-safe lasers, they are being deployed to ensure that the targeting system is still aligned correctly, even if the system has been knocked around on the battlefield.

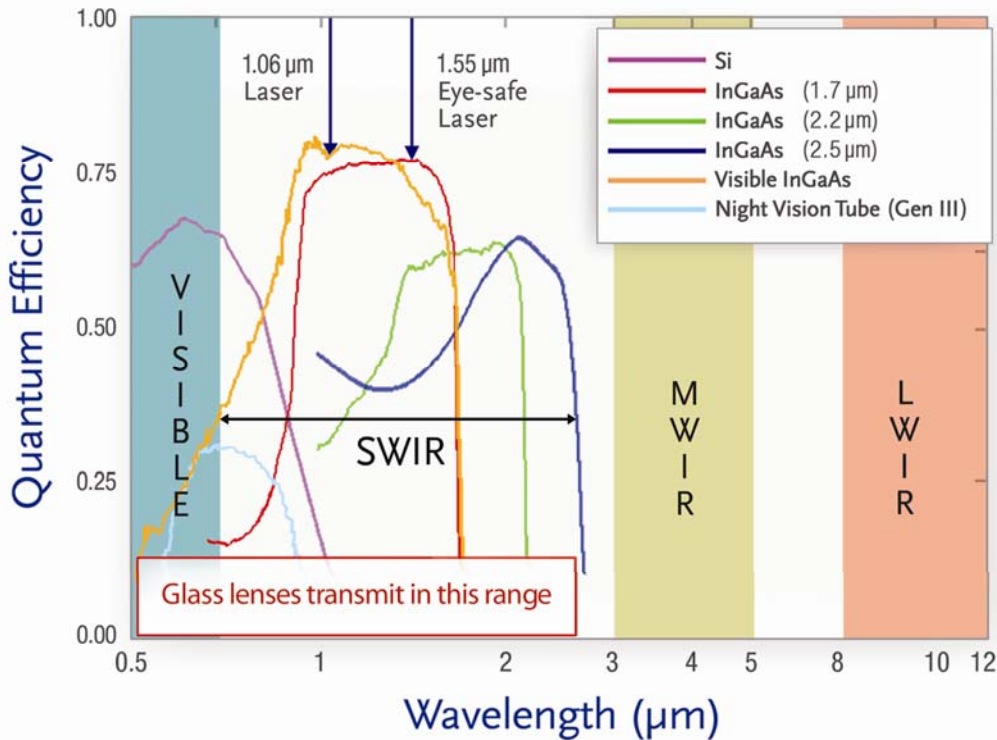


Figure 2. The quantum efficiency chart illustrates the response curves for silicon, InGaAs, visible-InGaAs, and night vision tube detectors in the visible and shortwave infrared wavelengths. Key laser wavelengths are also noted.

850 Nanometer Lasers

The most commonly used laser on the battlefield is the one attached to the war fighter's rifle; this laser typically is around 850 nm (or, 0.85 μm). It is used by soldiers to identify and target objects to one another, along with accurately aiming their weapons while wearing night vision goggles. Like the 1060 nm laser, this laser is invisible to humans, but visible to the goggles. An additional similarity is that the rifle lasers are not eye-safe. Unfortunately, they are detectable using other detector technologies, both new and old.

The biggest issue with this laser is that while the soldier needs the best NVGs to image at longer distances and at lower light levels, the laser is visible to older and cheaper NVGs. Meaning, the enemy can easily detect the lasers with old and inexpensive night vision goggle technology. As a solution to this problem, InGaAs imagers are being used because they are backward-compatible, as they image the older 1060 and 850 nm lasers and the newer eye-safe lasers used by next generation systems.

Next Generation Systems

In the future, lasers will not only determine how far off the target is, i.e. laser range finders, but they will be able to allow the war fighter to see through obscurants such as mist, haze, and dust at far off distances. This long standoff distance allows the war fighter to identify targets from a safer distance and under any light conditions.

The most recently developed systems are using 1550 nm lasers in order to protect soldiers in the field and because they are covert to NVGs, which unfortunately has been acquired by enemies. These next generation systems are using InGaAs detector arrays to save on weight, power, and size. Combined with the high sensitivity, these future systems offer better performance with safer conditions for the end user and innocent bystanders.



Figure 3. The SUI SWIR KTX camera for imaging lasers in daytime and nighttime scenarios.

For example, the new SU-KTX Camera from Sensors Unlimited, Inc. features high sensitivity in the 900 to 1700 nm wavelength range and can be deployed for a number of covert and low-light-level imaging operations, including laser detection (see Figure 3). With wide dynamic range imaging in partial starlight to direct sun illumination, the SWIR imager can be easily integrated into UAVs, unmanned ground vehicles, handheld or other robotic devices.

[Contact Sensors Unlimited, Inc.](#) for more information on shortwave infrared cameras for laser tracking and detection applications.