Free Electron Lasers

A free electron laser (FEL) converts the kinetic energy of a relativistic electron beam into laser light by passing the electron beam through an array of alternating magnets called an undulator. Unlike most other types of lasers, the frequency of the emitted laser light from an FEL can be changed, allowing for wavelengths that are not available any other way. The tunability of an FEL opens new applications, including medical surgeries (see Figure 1), materials processing, advanced microchip manufacturing and nondestructive testing not possible with conventional lasers. In addition to being tunable, FELs can scale to much higher laser power than conventional lasers. A high power FEL based on a high current electron beam can be used for military purposes. The US Navy is currently leading the military development of a megawatt (MW) class FEL for use as a ship defense system (shown in Figure 2). Niowave is developing a 40 MeV, 500 mA superconducting accelerator that will drive a MW-class shipboard FEL, and recently dedicated a facility for testing our superconducting linacs as a part of the ongoing high power directed energy program with the Navy.

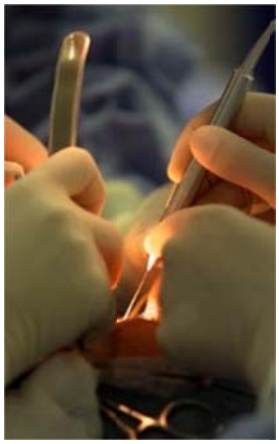

Figure 1. Eye surgery being performed with an FEL

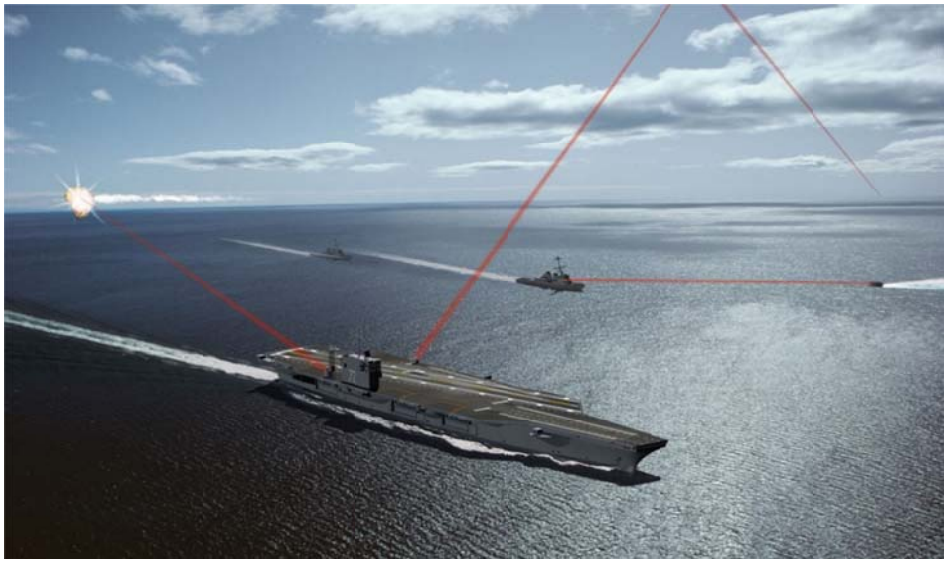

Figure 2. Depiction of the US Navy Free Electron Laser engaging multiple targets

In addition to the shipboard MW-class FEL, Niowave is also collaborating with the Naval Postgraduate School to demonstrate a high average power terahertz (THz) FEL. Currently available compact THz sources are limited to low power, and the high power THz source being developed by Niowave opens a number of homeland security, defense and commercial applications not currently available (see Figure 3).

Figure 3. Terahertz images can be used for homeland security purposes