Research in electromagnetics ranges from the highly theoretical to the very applied. Efforts include atmospheric science, antennas & microwaves, fiber optic communications, numerical methods/simulation, material characterization, time-domain measurements, random media, focused waves, propagation, remote sensing, and photonics. Photonics encompasses acousto-optics, image processing, holography, fiber optic processes, and fiber-optic sensors and devices.

**UWB Propagation & Applications**

The Time Domain Laboratory (TDL) is collaborating with communications researchers in ultra wideband (UWB) propagation studies and applications. UWB communication systems utilize very short pulses occupying a bandwidth ranging from 3.1 to 10.6 GHz for direct transmission of information signals. Projects have included a comprehensive UWB indoor propagation measurement in two campus buildings. The data collected in this campaign are used to develop channel models for indoor UWB communication systems. Researchers also studied the simulation of indoor UWB propagation using ultra wideband ray tracing techniques in conjunction with time-domain analyses of transmitting and receiving antennas. Other efforts include ultra wideband material and device characterization and instrumentation.

**Radio Astronomy**

In 2003, a new research program was started investigating issues in radio astronomy applications. Work includes interference mitigation for radio astronomy and remote sensing, high dynamic range, very-wideband FPGA-based digital receivers, and design of large antenna arrays for radio astronomical imaging and transient detection.

**Remote Detection of Buried Mines**

The ElectroMagnetic Interactions Laboratory (EMIL) has devised a technique for remotely detecting buried mines and mapping their locations using a standoff radar method. Working under an NSF Small Grant for Exploratory Research, EMIL is investigating the trade-offs, capabilities, and limitations of this unique method.

Unusual and beautiful, noctilucent clouds glow in the northern twilight sky and may be an indication of global climate change. ECE’s Wayne Scales is studying these clouds and their relationship to strong radar echoes that often accompany them. (Photo by Pekka Parvinen)
World's smallest high temp pressure sensor

The world’s smallest known high temperature pressure sensor is a mere 125 microns in diameter and can function at temperatures as high as 700° C. Currently available sensors are limited to use in temperatures as high as 500° C.

Developed by Yizheng Zhu, a Ph.D. student in the Center for Photonics Technology (CPT), the sensor is fabricated directly on the tip of a fiber by micromachining and thermal fusion, giving it the same thickness as the optical fiber.

The sensor has minimal cross-sensitivity to temperature, resulting in a simplified sensor system with a wide temperature range. Its small size and low mass give the sensor an extremely high resonant frequency, resulting in a flat response over a very wide range of frequencies.

Sensitivity can be adjusted for different applications, with a pressure range as low as a few psi or as large as 10,000 psi. The sensor is another step toward CPT’s goal of developing pressure sensors that can operate above 1000° C.

Optical scanning cryptography:

T.-C. Poon is developing an on-the-fly optical encryption system for secure wireless transmission. The proposed technology could use standard laser scanners to encrypt documents and images and automatically transmit the data securely. Without the right decryption key, a receiver would see only digital noise.

Turn off your cell phones, please – ECE researchers, with colleagues at George Washington University, are developing a system to detect and identify cell phones, pagers and other emitters in a building or area. The Range Limited Antenna (RLA) system can detect emitters within a specified area, obtain detailed information, such as frequency, range, and angle, and locate and track the emitter. “Identifying and tracking emitters is important in high security buildings and in hospitals and other places that use highly sensitive equipment,” said Amir Zaghloul, the Virginia Tech lead on the project. The system uses two patch antenna arrays mounted on an elevated platform, with an adjustable angle for detection at varied floor heights.