



# RAN Science & Technology, LLC

Opening new frontiers in scientific innovation

RAN seeks to engage in dynamic, collaborative partnerships focused on transformational research and innovation that can be applied to a range of markets and opportunities. In the past, this has included cutting-edge research, product development, and small systems integration in cooperation with high-tech businesses (large and small), investment banks, and the State and Federal Governments. We operate within the framework of the International Trade in Arms Regulations.

Academic researchers, businesses, investors, and others interested in collaborating with RAN to open new frontiers in scientific innovation and product development should contact RAN's Chief Scientist, Dr. Russell Kurtz.

The following are some of RAN's areas of active research.

## Photorefractivity

RAN scientists have performed ground breaking research in this important area of non-linear optics. Our work has extended the bandwidth of photorefractive amplification by several orders of magnitude, and the range of photorefractive detection devices by a factor of 200. We have developed devices for optical amplification (30x amplification with 29.5x increase in signal-to-noise), long-range vibrometry and vibroacoustic target recognition.

### Sample Applications

- Extracting signals from noisy backgrounds
- Remote structural health monitoring
- Real-time monitoring of aircraft surfaces

## Holography

Our expertise in holography extends from surface techniques through thick holographic systems (which relate to photorefractivity), including such diverse holographic materials as silver halide, photopolymer, dichromated gelatin, and photoplastic. We have worked in both static and dynamic arenas, and have developed holographic optical elements (HOEs) that improve display depth-of-field, change the background color, and act as complex lens systems.

### Sample Applications

- Wide field of view optical antennas
- Optical camouflage

## Alternative Energy

Our clean energy expertise extends from geothermal electricity and wind power to solar thermal energy. Our most recent work has been in solar energy, where we have developed efficient HOE-based solar concentrators, multilayer nanotechnology-based photovoltaic cells, and photoelectrochemical (PEC) generation of hydrogen for energy storage.

### Sample Applications

- Material optimization
- Direct generation of H<sub>2</sub>

## Laser Systems

RAN has developed a number of laser systems for both defense and commercial purposes. While a large portion of our development has concentrated on solid-state lasers (crystalline, glass, fiber, and semiconductor), we also have significant experience in gas and chemical lasers. We have developed efficient methods of combining individual lasers into a more powerful array, greatly reducing the cost per watt compared to single-emitter lasers. Some of our unique laser cavity and system designs can increase the efficiency of solid-state lasers by more than a factor of three.

### Sample Applications

- Long-range detection, designation, and countermeasures
- High precision cutting and welding
- Clear communication in difficult environments

## Metrology Systems

Combining our expertise in lasers, interferometry and analysis, we have developed metrology systems that can be used in such diverse areas as machine vision, assembly automation, and nondestructive evaluation (NDE). Using shearography as the NDE technology, RAN scientists have developed two innovative methods of applying metrology to NDE: Bulge thermal stress (BTS), in which the shearographic stress is applied by a thermal source (usually a laser), and directed acoustic shearography (DAS), in which the stress is acoustic.

### Sample Applications

- Nondestructive evaluation
- Automatic measurement and scanning
- Assembly automation and control
- Machine vision

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## RAN Science & Technology, LLC

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# RAN Science & Technology, LLC, Contracts

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These contracts were completed successfully by RAN Science & Technology, LLC, and its scientists.

## Optical Assembly Control (OAC)

Contact: Jennifer Brown  
Phone: (937) 904-4746

Completion: 6/22/2010

To address the Air Force need for automated, affordable, accurate, dimensional control of aircraft outer mold line (OML) structures, RAN Science & Technology, LLC, developed a preliminary OAC system.

The OAC was designed to ensure precise metrology of assembly units, such as frame and skins, including both metal and composite parts, and compare these measurements of the “as-built” structure to the “as-designed” native CAD file. This information could then be used to define and locate shims and project the information on the assembly, resulting in highly accurate assembly guidance. The OAC was designed to store the measurements and calculations in a shared database that is compatible with open database and statistical process control formats.

## Phase Conjugate Micromotion Detection-Based Interferometric Vibrometer (PIV)

Contact: Richard Richmond  
Phone: (937) 255-9614

Completion: 7/15/2008

The Air Force is tasked with monitoring satellites in orbit whether for identification or health monitoring. To achieve this, we developed the PIV, based on our innovative Phase Conjugate Micromotion Detection (PCMD) technology. Through the combination of interferometry, nonlinear optics, and Fourier transform spectroscopy, the PIV acted as an ultra-long-range vibrometer, capable of recognizing the vibroacoustic (sonar-like) signatures of orbiting spacecraft and identifying small changes in these signatures that indicate problems with satellites or on-board equipment. The phase conjugate portion of the measurement system reduced the effects of propagation through the atmosphere, while the use of photorefractivity resulted in an optical amplifier with SNR improvement nearing 20 dB. Although the PIV was specifically designed to study satellites at distances <300 km, theoretical studies indicate that distances of 1000 km are achievable with only slight reduction in sensitivity.

## Phased Array Subsurface Corrosion Acoustic Locator (PASCAL)

Contact: Dennis Keene  
Phone: (478) 327-4133

Completion: 12/23/2009

To meet the Air Force requirement for an automated nondestructive evaluation technology that enables location of corrosion as small as 0.05 inch diameter, occurring within a sheet that may be up to 0.300 inch thick and composed of layers of dissimilar metals, composites, and sealant, we developed a preliminary PASCAL device.

Using our unique Directed Acoustic Shearography (DAS) technology, RAN demonstrated the PASCAL capability of detecting damage as small as 1/32 (0.03) inch diameter and depth. The PASCAL is designed to be scanned in angle and position, enabling location of the corrosion spot to an accuracy of  $\pm 0.1$  inch along the surface of the sheet and  $\pm 0.05$  inch in depth. Size, weight, and power requirements will enable the PASCAL to be carried on a scanning platform such as the Boeing MAUS V.

## Enhanced Laser-Induced Target Spectroscopy (ELITS)

Contact: Randy Yates  
Northrup Grumman Corp.

Completion: 11/19/2007

As a subcontract to Northrup Grumman Corporation, we studied long-range detection of improvised explosive devices (IEDs). This combined our laser-based photoacoustic technology and long-range laser-induced breakdown spectroscopy (LIBS) with Northrop's aircraft (particularly UAVs), fabrication capabilities, and beam direction devices. Using purely physics-based analysis, we determined the requirements and limitations of LIBS and photoacoustic detection, and developed models of ELITS systems for use in a range of scenarios. The models included generation of size, weight, power requirements, and cost, and directed Northrop in their ongoing development of IED detection.

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