Tech's Compact RCS Range Offers Unique Capabilities

An important task in present-day military planning is to make equipment and weapons as "invisible" as possible to enemy radar. In the field of stealth technology, GTRI is a leader in radar cross section (RCS) research, or "low observables," as it is often called.

Tech's Compact Range

One of the most useful tools in this effort is the compact range in the basement of the Baker Building. Dr. Richard C. Johnson of GTRI invented the indoor compact range for antenna measurements more than 20 years ago and was awarded a patent in 1967. Since then, GTRI's compact range facilities have been continuously improved with the addition of microwave absorber and modern electronic equipment.

Over the past two to three years, the Electronics and Computer Systems Laboratory (ECSL) has developed the compact range for high-resolution radar cross section (RCS) measurements. ECSL researchers Gene Weaver, Brian Shirley, and Chuck Ryan have developed a fully automated broad-band 2-18 GHz system that can operate in both continuous and pulsed modes. The data processing employs Fourier transform signal processing to obtain a downward resolution of approximately 0.3 inch.

The compact range is used to test and evaluate items from scale models of fighter planes to single components of military hardware at full scale. By using the Fourier transform processing, the signature of small components mounted on larger objects, such as test bodies, can be isolated and evaluated. The range uses a 12" by 16" section of an offset-fed paraboloidal reflector to produce a plane wave in an approximate 4" by 6" test zone. The reflector is located in a radio wave absorbing anechoic chamber to minimize reflections from anywhere except the item being tested.

The researchers have just built and installed a new low-RCS wing-shaped model tower that can support targets up to 250 pounds. The GTRI-designed tower head can rotate a model horizontally 360 degrees. A dual synchro system in the tower head provides angular resolution of 0.09 degree.

Computer Controls

All of the positioning, transmitting and receiving equipment is connected, by digital data links, to a "Data Logger" computer system implemented by Weaver and Shirley, with computer hardware design by Jeff Hopper. This unique system is programmed to control and perform the RCS measurements automatically. Unique software features include automatic system calibration, adjustable data averaging, automatic status checking, and operator alert if data are erroneous.

The software error checking and control is so complete that most measurements can be performed unattended. Generally, such measurements require that the radio frequency source be tuned and the receiver relocked 1,601 times per measurement, and operators are needed to manipulate the test devices.

Three Operational Modes

The measurement system can be configured for operation in three modes. The continuous-wave (CW) mode is a 2-18 GHz, stepped frequency amplitude and phase measurement. A pulsed, single-frequency mode can be used to determine RCS as a function of azimuth angle when the target does not have an extremely low RCS.

The third mode uses a "chopped CW" system to perform measurements over the entire 2-18 GHz band, thus combining the advantages of both continuous and pulsed modes. "We use switches to reduce the coupling between the transmitting and receiving arms," Ryan says.

"This produces a larger dynamic range that enables us to look at much lower RCS targets." This system currently is being tested and evaluated.

Unique Resource

"Our compact range is unique not in its hardware, but in its automation and Fourier transform processing," Weaver says. "We can accomplish complex measurements in hours that took weeks or months.

EDL Studies Economic Activity Related to Japan

by Lincoln Bates, EDL

Against the backstop of U.S.-Japan lodging over trade, the Economic Development Laboratory has produced two studies offering guidance to Georgia developers and industries wishing to do business with Japan.

According to research economist Tom Majors, the studies permit determination of the suitability of attracting Japanese manufacturing investment or of exporting goods to Japan.

"Japan's Ministry of International Trade and Industry expects the country's investment in U.S. manufacturing to grow 14.2% annually until the year 2000," says Majors, noting that Japan's huge trade surplus, possible U.S. protectionist trade policies, appreciation of the yen, and a lower corporate tax rate have been incentives to Japanese investment.

Georgia, with its Atlanta transport hub, leads the Southeast in total Japanese investments and in the number of Japanese manufacturing plants. The state received $190 million in Japanese investments in 1986 alone and is well-positioned to attract still more, according to EDL's research.

"The study," notes Majors, "should prove useful to county developers trying to decide if Japanese investment is desirable for their areas." The other study addresses exports to Japan, looking at what that country currently imports and at what present trade negotiations might affect. For Georgia, says Majors, certain high-tech gear and scientific medical instruments may be worthwhile export items. He adds that agricultural products offer considerable promise because of Georgia's extensive resources and because there's a good chance tariffs will drop in this area.

Would-be exporters also can find advice on where and how to invest in the potential of their products for sale to Japanese markets.

Both studies involved extensive examination of trade statistics and balance-of-payments figures as well as discussions with local Japanese manufacturers and site decision-makers, Georgia economic developers, and officials of state and federal trade agencies and the Japanese External Trade Office.

"These studies won't create investments or exports," observes Majors, "but they will serve as a guide to the game." And that game is an increasingly potent and important one.
ECSL Staffers to Coordinate International IEEE Symposium

Several staff members of the Electronics and Computers Systems Laboratory are busy organizing and producing the 19th IEEE International Symposium on Electromagnetic Compatibility. Hugh Denny is the general chairman, John Daher is technical program chairman, and Ernest Donaldson is the treasurer and finance chairman; all are in the Electromagnetic Compatibility Division. Jim Toler (Biomedical Research Division) is in charge of local arrangements. Other laboratory staff members are likely to be involved in various other symposium activities as well. The symposium will be held at the Radisson Hotel Atlanta (formerly the Downtown Marriott) on August 24-27, 1987. During the three days, 17 technical sessions plus two workshops will provide attendees with the opportunity to select from approximately 100 technical presentations. Technical papers will address modeling and testing of conductors and radiated electromagnetic emissions, shielding evaluations, cable and connector performance, electromagnetic pulse, electromagnetic discharge, and lightning.

More than 100 companies are expected to exhibit instruments, testing facilities, and components associated with the assessment and control of unwanted electromagnetic energy. The expected 1,000 attendees will also have the opportunity to see local attractions and participate in an old-fashioned Georgia hoedown. The audience is expected to be truly international in scope, with numerous visitors from Europe, Asia, and South America.

It Seems to Me . . .

What is the single best idea you've found to help you do your job effectively?

Answer that question in 50 words or less and you may find yourself in print in the November issue of the CONNECTOR! We'll print or summarize the best answers.

Send your answer, along with your name and job/service group designation, to GTRI Connect, GTRI, 2225 ERB. If we get a sufficient shower of interest, we may make this a regular reader feedback column.

Happy Anniversary!

At the faculty/staff honors luncheon June 2, Jerry L. Eaves (RAIL) and Gerald K. Webb (RCO) received Gold-T pins for 25 years of service to Georgia Tech.

Software Review

by Pat Mathiasmeier, CRSI

CRSI is now operating a Training Facility at the Cobb County Research Facility (CCRl). Five computers are set up in the CRSI terminal room, and CRSI instructors regularly conduct classes for GTRI personnel at CCRF. Several courses have been added to the Training Facility curriculum this year.

C Programming Language

An introduction to programming in the C language. Originally developed for systems programming in the UNIX operating system environment, C provides performance approaching that of assembly language, as well as the portability and productivity features of a higher order language. Topics covered include structure, syntax, data types and structures, operators and expressions, control flow, functions, arrays and pointers, compilers, and support products. Prerequisites: Programming experience.

Organizing Your Hard Disk

Designed to make working with a hard disk easier, faster, and more efficient. Topics covered include tree structured directories, the promod and path command, autexec.bat and config.sys files, DOS shell programs, creating menu systems with PATCH commands, setting up RAM disks, using backup and restore, and disk optimizers. Prerequisites: Beginning DOS.

Rdbase System V

Introduces the concept of database management and typical applications. Topics covered include an introduction to the theory of databases, file structure and field types, database creation and use, the use of data entry and the retrieval of information from the database. Students also learn sorting and indexing commands, program language codes, as well as commands in the formatting of output with the development of reports. Finally, accessing information by communicating with other programs is discussed. Prerequisites: Beginning DOS.

IBM PC Communication

Covers the basics of communicating with the IBM PC and looks at these popular communications packages. Some of the functions covered for each of the three packages are establishing a connection, originating and answering calls, uploading and downloading files, and capturing data. Also covered are mainframe-to-PC transfers using Kermit and mainframe-to-mainframe transfers. Prerequisites: Beginning DOS.

See "Software," page 3
GTRI Says Good-bye to Three Retirees

Dick Johnson
Dr. Richard C. Johnson retired March 31 after 31 years of distinguished service to GTRI. A principal research engineer in the Office of the Director since 1979, he played a large role in the growth of electronics activity at GTRI.

Dr. Johnson headed the Radar Branch from 1963 to 1968, was chief of the Electronics Division (equivalent to a laboratory) from 1968 to 1972, and manager of the Systems and Techniques Development Branch from 1972 to 1975. The last named position was equivalent to GTRI associate director today. He currently is an associate director of GTRI from 1975 to 1979, and a member of the OOD senior staff from 1979 to his retirement.

An internationally respected scientist, Dr. Johnson is a fellow of the Institute of Electrical and Electronics Engineers. He was president of the IEEE Antennas and Propagation Society in 1980, and distinguished lecturer in 1978-1979. He has some 76 major reports and publications to his credit, including coauthorship of the Antenna Engineering Handbook (1984). His basic compact antenna range design was patented in 1967.

Dr. Johnson’s contributions in microwave theory and components include development of design techniques for linear waveguide tubes, microwave ring switches, and dual-polarized transducers. In the area of microwave antennas, he formulated methods for designing several types of geodesic lenses, developed techniques for reducing wide-angle sidelobes in radar antennas, and developed compact ranges.

Dr. Johnson received his BS and MS degrees in physics and his PhD from Georgia Tech. Although he is officially retired, you'll still see him around the campus. He is available "hourly-as-needed" to help with antenna problems as always.

Clark Butterworth
J. Clark Butterworth, head of the Radar Technology Branch of the Radar and Instrumentation Lab, is retiring June 30. He came to EES/GTRI as a technician in 1951 after graduating from Southern Technical Institute, and has held the title of senior research technologist since 1951. Butterworth's recent interests are in the fields of millimeter and submillimeter wave transmitter techniques, high-voltage power supplies, high-voltage pulse techniques, radar systems and measurements methods. He is the author of 33 major reports and publications.

Among his research accomplishments at GTRI were design and development of pulse modulators for millimeter wave extended interaction oscillators, development of the solid-state dual modulator for high-power magnetrons, and design and development of a 0.9 GHz solid-state radar transponder.

Lillian Johnson
Lab personnel who deal with travel expense statements are like having been missing accounting assistant Lillian R. Johnson for several months. She moved from the GTRI Accounting and Budget Department.

Johnson Spencer, an aide to Georgia Tech in 1960 to work in the office of the Vice President for Business and Finance, and transferred to EES/GTRI in 1971 for a busy keeping machine operator. She was promoted to accounting assistant in 1980.

Range (from page 1)
would have taken years by the old, time-honored methods.

The range is used not only to test devices developed at GTRI, but to perform testing for government agencies and private companies.

In the past two years, 80% of our work has been for smaller companies that can’t afford our own custom ranges.

Weaver points out, “We get a lot of small contracts—the longest

has been for two months—but the volume has been enough to make us self-sufficient. These contracts, in turn, have allowed us to maintain and upgrade our facilities, software and techniques, to stay technically current and to support many of GTRI’s larger contracts.”

Ryan emphasizes that the range, built up gradually by small investments over the years, would take $5- to $8-million to duplicate today. Thus it is an invaluable resource for both antenna and RCS measurements at Georgia Tech.

Software (from page 2)
General Markup Language
Access the powerful printing capabilities of the IBM 6670 and 3814 laser printers through a PROFS or CMACH account. The General Markup Language is a text process-

ing program that allows the user to "mark" text with tags that create tables of contents and indexes, draw boxes, lists, headers, footnotes, and figures. Prerequisites: None.

Library On-Line Catalog
Students learn to retrieve bibliographic information describing holdings of the Price Gilbert Library catalog database. Any record available in the microfiche catalog is available on-line. Topics covered include system logon, and search, print, and message commands. Prerequisites: None.

PROFESSIONAL ACTIVITIES

ECONOMIC DEVELOPMENT LAB
General Clifford attended a conference in Washington (DC) June 8-9 entitled "Using Technology to Compete: Strategies to Assist the Small/Medium-Sized Manufacturer" and participated in a panel discussion on Elements of an Effective Technology Assistance Policy for Small Manufacturers.

Art Brown chaired a workshop on "Developing New Infrastructure" at a southern regional seminar. The Higher Education-Economic Development Connection: Making the Partnership Work, April 27-28 in Orlando (FL).

On June 4, John Nemeth spoke at the Governor’s Conference on the Environment on community right-to-know regarding hazardous materials in the workplace and potential exposure to the public.

Ed Valentine made presentations on EDL’s newly developed thermally enhanced sludge dewatering process at the spring meeting of the Georgia Poultry Federation and the Southern Eastern Processors Workshop in Atlanta last month.

Marlyn Black presented a paper, coauthored by Charlene Bayer and Linda Hackney, titled “An Office Building IAQ Problem,” at a recent

ASHRAE Indoor Air Symposium in Washington (DC). Both Black and Bayer made indoor air quality presentations at the U.S. Department of Interior annual safety meeting in Atlanta.

The entire Asbestos Group traveled to Seattle for the week of May 11 to give the "Supervision of Asbestos Abatement Programs" course to 80 people.

ELECTRONICS & COMPUTER SYSTEMS LAB

At the SPIE Technical Symposium Southeast in Orlando May 22, Eric Bamberger gave a paper on "Millimeter Wave Communications: Air-to-Air Applications," and Jeff Hooper presented a paper on "Infrared Image Acquisition and Analysis System Using Optical Disk Storage.

Norberto Ezquerro gave a poster session on "A Method for 3D Display of Artificial Bracing Structure Associated on Myocardial Perfusion Distribution".

June 3 at the Society of Nuclear Medicine conference in Toronto.

ENERGY & MATERIALS SCIENCES LAB
Kellie Storr gave two presentations at the Fossil Energy Materials Program Conference.

John Handley gave a lecture on "Radome and Antenna Analysis" at the Antennas and Propagation Society Los Angeles Chapter Meeting May 12.

Jon Gooch’s work on fish oil applications was published in the February issue of Chemical Marketing Reporter and American Paint & Coatings Technology, the April issue of Modern Paint & Coatings, and the May Industrial Finishing.

RADAR & INSTRUMENTATION LAB
Presenting papers at the SPIE Technical Symposium Southeast in Orlando May 22 were: Bill Holm, "Dual-Mode IR/MMW Sensor Scene Registration"; Neal Alexander, "94 GHz Search and Track Radar"; and Gene Martini, "Baloon Lofterd Sphere as a Range Dependent Calibrated Target for Millimeter Wave Radar.

This month, Joe Bradley received his Ph.D. from Georgia Tech. SYSTEMS & TECHNIQUES LAB
Jeffrey Sitterle presented two papers at the International Geoscience and Remote Sensing Symposium at the University of Michigan, Ann Arbor May 18-21: "On the Temporal Power Spectrum of the Intensities and Angle-of-Arrival Fluctuations of a Ground-Station Observation of an Atmospherically Corrupted Signal at the Focal Plane of an Antenna." Coauthors were Dr. Frank Merat and Dr. Paul Clapsy of Case Western Reserve University.

SYSTEMS ENGINEERING LAB
The Ninth Annual Electronic Warfare Program Review was held at the Cobb County Facility May 12-14 with 84 DoD personnel from 19 installations in attendance. Presenters from SEL, STIL, RAL, EML, and ECCL made 40 presentations.

Dennis Folds received his PhD in psychology from Georgia Tech in June. His dissertation, which received a commendation for excellence, is entitled "The Organization and Time-Sharing in Dual-Task Performance.

Phil West was a coauthor of a paper, "Approximate Nonlinear Filtering for Piecewise Linear Systems," presented by Professor A. H. Hadlock at the NEATO AGARD Symposium on Guidance and Control, Athens, Greece, in May.
QUESTIONS, ANYONE?

by Charles McCullough, HRD

You’ve heard of I-9 by now, haven’t you? No, it’s not a karate move invented by yourundo, nor a new EDL research project on mutant dogs. I-9 is a remarkably simple form that must be filled out by employers. But behind this little form is aggressive new federal legislation that affects us all, the whole country: the Immigration Reform and Control Act. Here are answers to the questions most often asked about this new legislation.

Q: What is the Immigration Reform and Control Act supposed to accomplish?

A: The whole intent is to curb the employment of illegal aliens. Note the emphasis on illegal! The Immigration Reform and Control Act (all right, let’s get ahead and call it IRA) is not intended to keep employers from hiring aliens, just the illegal variety.

Q: In as few words as possible, what does this Act do?

A: As few words as possible? You must be the one that keeps mailing in copies of this column marked, “Wordy! Wordy!” At any rate, the IRA charges employers with the responsibility of obtaining from each new employee proof of identity and proof of eligibility to work (meaning, the employee has to prove that he or she is not an illegal alien). Further, the Act imposes stiff criminal and civil penalties and/or industrial-strength fines for employers who are found to be in non-compliance.

Q: How do new employees prove their eligibility to work? And why

this business of “proof of identity”?

A: A new employee proves his or her eligibility to work by showing up with certain designated documents (originals only) that prove he or she is not an illegal alien. The new employee must provide proof of identity so that the employer knows that the documentation proving eligibility to work does, in fact, belong to that person. Your lab’s personnel coordinator, or your department manager, has a list of exactly what documents can be used.

Q: Who is included in the definition of “new employee”?

A: All employees with a hire date of 1 June 1987 or later must completely fill out an I-9 within the first three days of their employment. In addition, everyone is now in our employ and was hired on or after 7 November 1986 must complete an I-9 by the end of September of this year.

Q: What do new employees do with all this great proof they’re carrying around with them?

A: During the first three days of employment, all new employees (including student employees, including part-time employees . . . well, never mind, we went through this exercise in last month’s column) report to the office of an authorized deputy and fill out and sign an I-9 form. The I-9 form basically asks the employee, “Who are you? And what makes you eligible to work: citizenship or some type of legal alien status?” Then, the employee shows his or her original documents of proof of identity and work eligibility to the deputy, who verifies them. The deputy then completes the bottom portion of the form, certifying what documents were shown and attesting that they seem to be genuine. Photocopies of the forms of proof are then made, attached to the original I-9 form, and the whole packet is shipped off to some place of great safekeeping so that federal auditors can dig through them if they get the itch to do so.

Q: Is there an authorized deputy within GTR?

A: The Human Resources Department has an authorized deputy. New GTR employees employed on the main campus or at KRTF/GGCC must visit the offices in the Coliseum Annex Building within the first three days of their employment.

Q: What do new employees do when they’re hired at our Huntsville, Alabama, facility?

A: Details about how to handle new employees at our remote sites, including the field offices, will be decided in meetings to take place shortly after the deadline for this column. HRD will distribute more specific procedures through the Administrative Network as soon as the information is available.

Q: I leave next month for a year’s educational leave of absence. Will I still need to go through the I-9 ordeal upon my return?

A: In the first place, it’s not an ordeal. It’s five minutes of simplicity. If you were employed by us prior to 7 November 1986 and have remained in our employ continuously since then, you are “grandfathered” in, meaning GTR doesn’t have to obtain an I-9 from you. If you do go on a leave of absence for reasons of study, illness or pregnancy, you retain your grandfathered status. However, if your employment is terminated and you later return to our employ, you would, at that time, have to be I-9-ed by us.

PERSONNEL NEWS

OFFICE OF THE DIRECTOR

Janice Manders will become administrative assistant to Dr. Donald J. Grace, effective July 1. She is transferring from SEL, where she was administrative coordinator for Bob Zimmer.

RADAR & INSTRUMENTATION LAB

New Warning System

For several years, a flock of Canadian geese have spent their winters on the lake at the Cobb County facility. This year, two geese stayed to raise their family. (Photo by Anita Edwards)

EDL: Ben and Lynn Holt have a new daughter, Jessica Ragan, born May 18. Lou Brackett has entered Tech’s graduate program in management.

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EMSL: Congratulations to student assistant Doug Twiss for winning the Outstanding Senior award in materials engineering.

RAIL: Scott Bostler and Cheryl Doos were married June 6, and Ceci Edwards was married to Varten Hetrick on April 3. Judy and Powers Garmon welcomed their first child, Caroline, born April 1. Condescendences to Cecel Fettick on the recent death of her sister.

SEL: Patti McRae was married May 30 to Mitch Hoffman.

STL: Congratulations to Don Bodnar, whose son, David, graduated first in his class at North Cobb High School and will be entering Georgia Tech in the fall as a President’s Scholar.

SSD: Condescendences to Billy Boner and Jerry Brown, whose fathers recently died.

Radar & Instrumentation Lab.jpg

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