**Course Venue:** Wright Brothers Institute, TecEdge Einstein Room, 5000 Springfield Street, Dayton OH 45431. Course dates are March 12-14, 2019 including a scripted USAF museum tour.

**Overview:** Any Scientist/Engineer/Technician working with low observable ground, air, or naval systems, or any Defense engineer looking for a broad exposure and understanding of low observable technology. This would be especially valuable to newer DOD government/contractors working on low observable projects.

**Course Background:** ARA's Berriehill Research Division redeveloped legacy Low Observable Course materials through the Ohio State University DMAP program. The purpose of this ARA subcontract was to recreate professional short courses for the Ohio Defense Market. The revised 2019 Short Course has the following characteristics:

1. There are no classified materials presented in this short course version. All materials are Unclassified-Distribution D.
2. References to open literature sources were to be made wherever possible.
3. A new section was specifically developed based on available open-source literature through the USAF Museum for the final lab day of the course.

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**LO Short Course Preliminary Syllabus**

Some preliminary instructor assignments may change based on work and travel schedules. Bold numbers refer to course note chapter numbers.

### DAY 1 (UNCLASSIFIED) – MARCH 12

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<tr>
<th>Time</th>
<th>Activity</th>
<th>Instructor</th>
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<td>0700</td>
<td>On-Site Check-In</td>
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<tr>
<td>0800-0815</td>
<td>Introduction and Welcome</td>
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<tr>
<td>0815-0830</td>
<td>(1) Course Administration</td>
<td>Dr. Kent, Course Organizer</td>
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<tr>
<td>0830-0930</td>
<td>(2) Basic Concepts in Low Observable Technology</td>
<td>Dr. Kent</td>
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<tr>
<td>0930-0945</td>
<td>(3) Breaking the Kill Chain Video</td>
<td>Dr. Kent</td>
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<tr>
<td>0945-1005</td>
<td>BREAK</td>
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<tr>
<td>1005-1055</td>
<td>(4) EM and Radar Fundamentals</td>
<td>Dr. Kent</td>
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<tr>
<td>1055-1145</td>
<td>(5) RCS Basic Concepts</td>
<td>Dr. Kent</td>
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<tr>
<td>1145-1300</td>
<td>LUNCH</td>
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<td>1300-1340</td>
<td>(6) RCS Scattering Mechanisms</td>
<td>H. Chizever</td>
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<td>1340-1410</td>
<td>(7) RCS of Simple Shapes</td>
<td>H. Chizever</td>
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<tr>
<td>1410-1430</td>
<td>BREAK</td>
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<tr>
<td>1430-1530</td>
<td>(9) Radar Absorbing Material Overview</td>
<td>Dr. P. Munk</td>
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<td>1530-1615</td>
<td>(16) RAM Material Measurement Techniques</td>
<td>Dr. Munk</td>
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<td>1615-1630</td>
<td>Closing Admin Remarks</td>
<td>Dr. Kent</td>
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<td>1630</td>
<td>ADJOURN Day 1</td>
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DAY 2 (UNCLASSIFIED) - 13 MARCH 2019

0730-0800 Arrive/Coffee
0800-0900 (10) IR Signatures Dr. Randy Jost
0900-0945 (11) Visual Signatures Dr. Randy Jost
0945-1010 BREAK
1010-1110 (12) Acoustic Signatures Dr. Randy Jost
1110-1145 (13) General IR/EO Measurement Methods Dr. Randy Jost
1145-1300 LUNCH
1300-1415 (14) General RCS Measurement Technology Dr. Kent
1415-1435 Break
1435-1515 (15) RCS Diagnostic Aids and Compliance Mr. Chizever
1515-1535 BREAK
1535-1635 (8) RCS Prediction Overview Dr. Tri Van
1635-1640 Closing Remarks Day 2 Dr. Kent
1640 ADJOURN Day 2

DAY 3 (UNCLASSIFIED) 14 MARCH 2019

0730-0800 Arrive/Coffee
0800-0900 (17) RCS Integration I Dr. Kent
0900-0920 BREAK
0920-1020 (18) RCS Integration II Dr. Kent
1020-1045 BREAK
1045-1200 (19) LO History – Design in Practice Dr. Kent
1200-1300 Lunch on own, meet at AF Museum (Optional)
1300-1500 Scripted Aircraft Visits (AF MUSEUM)
  • B-70 Supersonic Bomber
  • Tacit Blue
  • B-2 Spirit Bomber
  • F-117
  • F/A-22 Raptor Fighter
1500 ADJOURN
Short Course Speaker Biographies

**Dr. Brian M. Kent**, lead instructor, currently serves ARA as chief scientist and S&T lead for electromagnetics (EM), radio frequency (RF), and sensing systems. He received his MS and PhD in electrical Engineering from The Ohio State University, and his BSEE from Michigan State University. Outside ARA, Dr. Kent continues to serve as Adjunct Professor of Electrical Engineering with Michigan State University’s Department of Electrical Engineering. Dr. Kent’s technical work in ARA includes the design impacts of High Power Microwave Devices, instrumentation of static and dynamic radar cross section and antenna measurement ranges, and the passive EMI emanations from commercial instrumentation.

Dr. Kent is a Fellow of the Institute of Electrical and Electronics Engineering (IEEE) and is a former IEEE Distinguished Lecturer for the Antenna and Propagation Society. He is also a Fellow of the Antenna Measurement Techniques Association and of the Air Force Research Laboratory. He also was a 2009 Federal Civil Service Meritorious Presidential Rank Awardee. Previously, Dr. Brian M. Kent, was a member of the scientific and professional cadre of senior executives, as the Chief Technology Officer, Air Force Research Laboratory, Wright-Patterson Air Force Base, Ohio. He served as AFRL’s principle scientific/technical advisor and primary authority for the technical content of the Science and Technology Portfolio. Dr. Kent is an internationally recognized scientific expert in signature technology, and provided authoritarian counsel and advice to AFRL management and the professional staff as well as to other government organizations. He collaborated on numerous interdisciplinary research problems that encompass multiple AFRL directorates, customers from other DoD components, as well as the manned space program managed by NASA. He also served as a member of the Shuttle Columbia Accident Investigation technical staff. His technical specialties include EM scattering & material property measurements, radar, antenna, and radar cross section measurements, radar performance evaluation, RF/EO sensing technologies, passive/active electronic warfare, and co-serves as an adjunct professor (Michigan State University). He is an active IEEE fellow and APS Distinguished Lecturer, an Antenna Measurement Techniques Association Fellow, and an Air Force Research Laboratory fellow.

**Mr. Hirsch Chizever** is the senior technical advisor in the RF Materials and Measurements Group at BerrieHill Research Division. Hirsch received his MS in Electrical Engineering at the University of Dayton, and BS in Electrical Engineering from the University of Evansville. Hirsch hopes to complete his Ph.D at the Air Force Institute of Technology in 2019. Hirsch is a 30-year veteran of radar cross section, antenna, and material measurements. He oversees the development and operation of BerrieHill Research Division of AR’s own RF measurement facilities and various on-site RF measurement support contracts. Previously, Hirsch worked for Mission Research Corporation where he participated in the design, construction, and verification of the Air Force radar signature measurement facility at Wright-Patterson Air Force Base. After acceptance testing, he served as manager of the facility and directed all facets of its operation. This facility is still the premier indoor compact range for the USAF, and maintains leading-edge capabilities not found in any other measurement range of its kind. Hirsch also developed a unique antenna system for law enforcement vehicles for the Department of Justice and participated in numerous RF signature exploitation programs. Hirsch is an active member of the adjunct faculty at Wright State University, where he teaches RF Measurement Techniques, Linear Systems Theory, and Electromagnetics, and was tasked with writing the chapter on “Indoor Antenna Measurements” for the McGraw-Hill Antenna Engineering Handbook, 5th Edition. He is a member of the Institute of Electrical and Electronic Engineers and the American Radio Relay League.
Dr. Tri Van is the Computational Sciences Group Leader in BerrieHill Division. Tri received his PhD in Mathematics from the University of Florida, MS in Mathematics from the State University of New York – Stony Brook, and his BA in Mathematics from New College of Florida. He has knowledge and experience in a wide range of analytical and numerical methods, working with engineers and scientists to solve challenging real-world problems. At BerrieHill Research Division of ARA, he has been involved directly with research and code development to perform large-scale computations on high performance supercomputers at the DoD Supercomputing Resource Center (DSRC), analyzing the installed performance of antennas on Air Force system platforms. He has been leading the long-standing project on computational electromagnetics (CEM) research and development for Northrop Grumman since 2008 to present. His computational team was twice awarded the prestigious Northrop Grumman’s World Class Team Supplier Awards in 2011 and 2015 for outstanding performance and service in advancing Northrop Grumman’s computational and modeling capabilities. He is also the principal investigator of the five-year Computational Research and Engineering Acquisition Tools and Environments (CREATE) RF project for AFRL, testing and improving the performance of the state-of-the-art CEM SENTRi code as a computational engineering design tool for acquisition programs.

Dr. Randy Jost (Consultant) received the BSEE, MSEE, and PhD. EE from the University of Missouri-Columbia. He served as an officer in the USAF, and completed assignment in the Signature Technology Office (Air Force Research Laboratory) and On-Site Test Manager of the National RCS Test Facility (RATSCAT), Holloman AFB, NM. Dr. Jost later worked for the University of Utah’s Space Dynamics Laboratory, where he was involved in the development and implementation of electromagnetic range and materials characterization activities for more than 25 years, both in the RF and optical area. He has developed calibration and measurement procedures to accurately and verifiably measure the signatures of components, subsystems and platforms for aerospace systems. He has also been active in the development of analysis and prediction codes for the modeling and simulation of aerospace systems. Additionally, he has been active in developing codes for the modeling and simulation of the propagation of electromagnetic waves for such applications as optics, radar and wireless communications. He is also a staff engineer at Ball Aerospace where he executed EMC design and testing of aerospace systems. Provide in-house training for electromagnetic compatibility design and testing. Provide company-wide support in EMC/EMI technologies. Also provide support in electromagnetics-related technologies in other divisions of Ball Aerospace.

Dr. Peter Munk received his BS, MS, and PhD in electrical engineering at The Ohio State University. Dr. Munk has more than 25 years of experience in electromagnetics, antenna and frequency selective surface (FSS) design. Dr. Munk is currently jointly employed at ARA as a principal engineer for a government laboratory that specializes in measuring the electrical properties of materials for use in the defense industry. Specific duties involve developing new and improved inverse algorithms and measurement techniques to determine the properties of these materials including their constitutive parameters, sheet and surface impedance values as well as their conductivity. Prior to this, Dr. Munk served as a member of the BRC Antenna and Radome division where his interests resided in high power microwave (HPM) FSS solutions. While employed at BRC, and prior to that at Mission Research Corporation (MRC), he performed detailed design and analysis on several projects involving Frequency Selective Surfaces (FSS) and array antennas. These designs include broadband Active Electronic Scanned Arrays, bandpass and bandstop FSS radomes, and circuit analog absorbers. While employed in the Electromagnetic Observables Sector at MRC Dr. Munk worked on several DoD-related programs involving detailed computational analysis of embedded antenna/radome structures. Prior to joining Mission Research Corporation, Dr. Munk was part of the research staff at the MIT Lincoln Laboratory. His duties included investigating methods of establishing a direct downlink between Defense Support Program (DSP) geostationary satellites and NAVY AEGIS cruisers, and performing an analysis of the Raytheon/TI Systems UHF Electronically Steered Array (UESA). Also while at Lincoln Labs, Dr. Munk developed a concept for an array capable of maintaining superior circular polarization over a large scan sector which was patented in February of 2002.
Registration and Tuition Information

Course Tuition: $1,900.00 per student. Payments must be made by credit card ONLY.

Course Registration Instructions:

• Go to www.ara.com/products/fundamentals-low-observable-technologies-short-course
• Download the Registration PDF and course Syllabus from the page.
• Press the Add to Cart button in the sidebar of the page.
• Complete the checkout process. You will receive an email that your order has been received.
• Email your completed Registration PDF to LOCourse@ara.com.
• Once final processing is complete, you will receive an email that your order is finalized and your credit card has been processed.
• Note: If you are registering multiple individuals for the course each attendee will need to return a filled out Registration PDF.

Course Cancellation and Refund Policy:

Full tuition refunds will be issued if cancelled before March 5, 2019. Within seven days, the course registration can be transferred with written permission of the student’s employer to another participant at no cost as long as the new student is a government/contractor and U.S. citizen. There will be no cash refunds within seven days.

To receive a refund, you must email your request to LOCourse@ara.com. You must provide your online order number in order for the refund to be issued. A refund will be sent to the credit card used to make the purchase. ARA will reply to your refund request email when the refund is issued. It may take 7-10 business days before the credit appears on your card. You will need to contact your credit card company if the credit has not appeared after this time.

In the unlikely event the course does not enroll a minimum of 20 students, ARA reserves the right to cancel or reschedule the offering, and ALL students will be afforded full refunds.