University of Illinois at Chicago, Electrical and Computer Engineering Department
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Characterization of Space Shuttle Ascent Debris Based on Radar Scattering and Ballistic Properties – Evolution of the NASA Debris Radar (NDR) System

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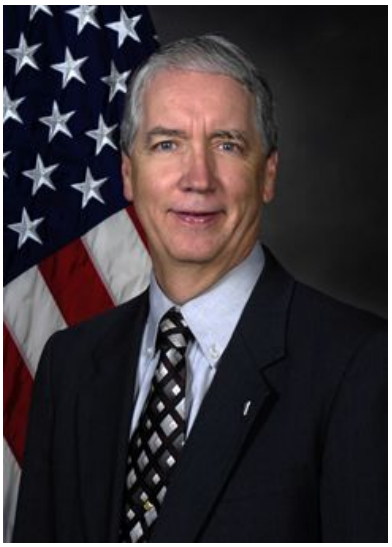
Abstract: This is a presentation that introduces the NASA Debris Radar (NDR) system developed to characterize debris liberated by the space shuttle (and any follow-on rocket system) during its ascent into space. Radar technology is well suited for characterizing shuttle ascent debris, and is especially valuable during night launches when optical sensors are severely degraded. The shuttle debris mission presents challenging radar requirements in terms of target detection and tracking, minimum detectable radar cross-section (RCS), calibration accuracy, power profile management, and operational readiness. After setting the stage with background of the Columbia accident, I initially describe the NDR system consists of stationary C-band radar located at Kennedy Space Center (KSC) and two X-band radars deployed to sea during shuttle missions. To better understand the signature of the shuttle stack, Xpatch calculations were generated at C and X band to predict the radar signature as a function of launch time. These calculations agreed very well with measured data later collected. Various sizes, shapes, and types of shuttle debris materials were characterized using static and dynamic radar measurements and ballistic coefficient calculations. The second part discusses the NASA Debris Radar (NDR) successes, which led to a new challenge of processing and analyzing the large amount of radar data collected by the NDR systems and extracting information useful to the NASA debris community. Analysis tools and software codes were developed to visualize the shuttle metric data in real-time, visualize metric and signature data during post-mission analysis, automatically detect and characterize debris tracks in signature data, determine ballistic numbers for detected debris objects, and assess material type, size, release location and threat to the orbiter based on radar scattering and ballistic properties of the debris. Future applications for space situational awareness and space-lift applications will also be discussed.

BIOGRAPHY



Dr. Brian M. Kent is an adjunct Professor at Michigan State University, and recently retired as the Chief Scientist, Sensors Directorate, Air Force Research Laboratory, Wright-Patterson Air Force Base, Ohio after serving for 37 years as a USAF Civilian. He is currently a part time engineering consultant supporting government, academic, and industrial partners related to the aerospace industry.
During his tenure as Chief Scientist, he served as the directorate's principal scientific and technical adviser and primary authority for the technical content of the science and technology portfolio. He identified research gaps and analyzed advancements in a broad variety of scientific fields to advise on their impact on laboratory programs and objectives. He served as an internationally recognized scientific expert, 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.

Dr. Kent joined the Air Force Avionics Laboratory in 1976 as cooperative engineering student through Michigan State University. He began his career performing research in avionics, digital flight displays and radar signature measurements. Through a career broadening engineering assignment with the Directorate of Engineering, Aeronautical Systems Division, he modeled a number of foreign threat missile systems and performed offensive and defensive electronic combat systems assessments. He received a National Science Foundation Fellowship in 1979, working at both the Air Force Wright Aeronautical Laboratories and the Ohio State University Electroscience Laboratory until the completion of his doctorate. Dr. Kent spent two years in the Passive Observables Branch of the Avionics Laboratory, later transferring to the AFWAL Signature Technology Office. From 1985 to 1992, Dr. Kent was involved with classified research efforts, managed through the Air Force Wright Laboratory, now the AFRL. During his tenure with AFRL and its predecessor organizations, Dr. Kent held a variety of positions. He has made pioneering and lasting contributions to the areas of signature measurement technology, and successfully established international standards for performing radar signature testing.

Dr Kent became an adjunct professor in 1998 at Michigan State University, and has served the department on the Visiting Curriculum Committee, ABET accreditation, ECE Chair Search Committee, Deans Search Committee, and Dean’s Advisory Committee. He has also participated in reforming the Senior Design Project classes, and has served for many years as a judge at the Spring and Fall Engineering “design day”.

Dr. Kent has authored and co-authored more than 85 archival articles and technical reports and has written key sections of classified textbooks and design manuals. He has delivered more than 200 lectures, and developed a special DOD Low Observables Short Course that has been taught to more than 2,000 scientists and engineers since its inception in 1989. Dr. Kent has provided technical advice and counsel to a wide range of federal agencies, including the Department of Transportation, the Department of Justice and NASA's Space Shuttle Program. He is also an international technical adviser for the DOD and has provided basic research guidance to leading academic institutions.