

MRI-R² Acquisition of Enhanced Antenna Measurement Facilities for Emerging RF and Millimeter-Wave Application

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Project Summary

The state-of-the-art measurement facilities of the Antenna Research Laboratory (ARL) of the Center for Advanced Communication (CAC), Villanova University, coupled with the ARL's close collaborations with other well-equipped research laboratories of CAC, namely, the Radar Imaging Lab, Wireless Communication Lab and RFID lab, has created an educational and research environment that is unique in the tri-state area of Pennsylvania, Delaware and New Jersey, and has been instrumental of establishing strong partnership involving academia, industry, and government. Over the last decade, the research at ARL has been sponsored by a large number of companies and federal agencies, exceeding over \$10M, in grants and contracts. The research at ARL has encompassed diverse areas in applied electromagnetics, antennas metamaterials, aircraft scale model measurements, and through-wall imaging radar.

The existing facility, which is capable of fully automated antenna pattern, gain and Radar Cross Section (RCS) measurements from 2 to 40 GHz, is over ten years old and is rapidly becoming dated. It urgently needs to be upgraded and expanded if it is to continue to be a useful tool for academic research and training and remain a unique and comprehensive antenna measurement facility which only exists in a handful of US universities. Our goal is to enable measurements in both higher and lower frequency ranges. Towards this goal, the current MRI-R² proposal seeks to acquire a range of antenna measurement instruments to upgrade and expand the current 2-40GHz measurement capabilities of the ARL in two directions: 1) upgrading of the compact-range facility to include millimeter-waves antenna measurement system up to 110GHz, 2) adding of a near-field measurement system capable of accurate antenna gain and pattern tests at frequencies above 500MHz. These will vastly expand the capabilities of ARL from its present 2-40GHz range to 500MHz-110GHz and lead to 1) enhancing our ability to engage in both basic and applied research in emerging areas of communications, radar imaging, satellite navigation, wireless communication, and RFID systems, 2) establishing new opportunities for external research funding and sponsorship, 3) generating new means and projects for the involvement of undergraduates in research and training, 4) creating valuable graduate theses and dissertations.

We envision that the new instrumentations will, in particular, have immediate positive impact in the existing and future research projects dealing with scale-model measurements of antennas on large platforms, millimeter-wave antennas and arrays, Global Positioning System, wireless communications and RFID systems, and through-wall imaging and urban sensing. The new facility will foster and expand our existing federal, industrial and academic partnerships in these areas and other related technologies, and will enhance our ability to attract and conduct new sponsored research, utilizing the modern and upgraded facilities. Most important, it will allow the ARL to continue its unique role in the local and regional economy through its support and availability for use by many small companies whose business and technology focus evolves around smart, low cost and low-profile antennas. Through this mutual benefit, we can maintain a constant stream of revenues, supporting, along with indirect charges on research projects and overhead distributions, the lab maintenance cost and suitability requirements.

The new facility will also be invaluable in attracting new students to graduate studies in engineering, specifically, in electromagnetic, microwave, antennas and related fields, which traditionally suffer from low participation and limited student involvements. It will provide a distinctive opportunity to strengthen

education and training of undergraduate students in the vital technical areas of communications, navigation, and radar. To that end we plan to 1) integrate the use of new instrumentations in relevant graduate and undergraduate courses in electromagnetics and antennas, 2) provide research opportunities for undergraduate students by tapping into internally funded undergraduate research resources available at Villanova, 3) collaborate with the College of Engineering admission office to advertise and highlight the hands-on research training in antenna measurement techniques enabled by acquisition of the proposed instrumentations. 4. utilize the College's various outreach programs to show-case the new facilities in recruiting and broadening the participation of female and minority students, postdoctoral fellows and faculty in engineering research.