Verus Research Introduction to the Crocker Nuclear Laboratory

XL Scientific dba

Verus Research

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Wheaton Byers (Tony)
Chief Executive Officer
505-244-8501
A new research and development (R&D) company focused on providing top-tier engineering services in the federal R&D space (established - April 2014)

Our focused strengths and academic connections, combined with our size, make us an agile and responsive R&D company

Locations in Albuquerque, Colorado Springs, San Francisco, Greenville SC

At our 4 ½ year anniversary:
- 2 offices, 2 lab spaces, >70 employees in 5 states
- 8k sq. ft. office space, 9k sq. ft. lab space
- Over 30 active programs, 15 current subcontracts
- ~$16M current annual run rate
- DCAA approved accounting system & provisional billing rates
- DCMA approved property system
- DoD TS facility clearances. Setup to process & store up to Secret.
VERUS RESEARCH VISION

Our Vision is to \textit{forge} a scientific research and development environment built around creatively solving our customer’s most difficult technical problems.

We promote a culture that \textit{creates opportunities} for the individual, benefits for the community, and strength and stability for the enterprise.

We seek to maximize the mutual \textit{joy} in developing technical solutions that meet tomorrow’s needs.
Program Objectives
• Develop verification methods for spacecraft with autonomy
• Implement a spacecraft benchmark with autonomous behavior that requires verification to catch instabilities
• Test existing verification tools and develop new tools to verify performance of benchmark

Key Results
• Successfully developed a benchmark with non-obvious instabilities
• Caught said instabilities using a variety of developed methods
• Created a verification process using a combination of statistical, optimization-based, and formal methods
Program Objectives

- Verify safety of proposed trajectories and enable real-time path corrections/re-planning to ensure safe unmanned vehicle operations
- Offline trajectory safety assessment incorporating trajectory predictions under various conditions
- Real-time monitoring for safety violations with auto-corrections to ensure safety is always enforced
- Goal is increasingly permissive flight with guarantees of safety

Key Results

- Generated a crash projection tool with visualization that is fast and encompasses all possible landing sites without relying on simulation
Program Objectives

• Develop novel miniaturized antennas for UWB HPM radiation

• Support radiation of UWB NLTL source from BAE Systems

Key Results

• Conceived and developed a novel “Ferengi family-of-antennas” topologies to allow antenna miniaturization to approach Chu-Harrington limit for HPM applications

• Developed evolutionary Particle-Swarm-Optimization (PSO) techniques for antenna design methodology to meet user requirements

• Fabricated and demonstrated a low dispersion (<1.2ns), UWB (>188% BW), up to 10MW, antenna prototype for HPEW and HPRF applications.

• Patent Pending
Program Objectives

- Design mm-wave (~100GHz) near field arrays and spatial light modulators for mm-wave compressive sampling imaging systems

Key Results

- Designed and developed components that comprise a compressive imaging spatial light modulator for remote detection of person-borne Improvised Explosive Devices and/or Baggage Screening
- In Progress
Program Objectives

- Investigate and demonstrate the use of HPM mm-wave energy for power beaming applications
- Re-engineer, modify and optimize the existing Active Denial System (ADS System 0) to support power beaming research

Key Results

- Engineered and Adapted the existing Active Denial System (ADS-0) to support power beaming research through the W-band Optics for Matching Beams with Astigmatism and Tilt (WOMBAT)
- Utilized high fidelity modeling and simulation analysis to design and fabricate mm-wave optics to match astigmatic and tilted beams from the ADS-0 Gyrotron source and into a heat exchanger with >99% efficiency
- Supported AFRL in experimental design and setup to demonstrate the feasibility of mm-wave power beaming
**Program Objectives**

- Develop UnderWater Acoustic (UWA) Low-Probability of Intercept/Detection (LPI/LPD) modem for covert communications

**Key Results**

- Demonstrated the use of coherent chaotic waveforms for LPI/LPD UWA communications
- Demonstrated the technical feasibility of transmitting and receiving digital information across a UWA channel using LPI/LPD chaotic waveforms
- Developed and demonstrated a UWA cognitive modem and a UWA signal interceptor modem
- Developed a modeling and simulation engagement tool for predicting the covertness of LPI/LPD UWA comm links (to include platform trajectories, Tx/Rx modem characteristics, LPI/LPD modulation schemes, beamforming sonar capabilities, SNR/SNJ and SINAD estimation and tracking)
Design, development and test of operational systems and sub-systems for tactical employment

Active Contracts: 11  
Active Ceiling: $20.9M

Key Capabilities
- This portfolio examines state-of-the-art solutions to transition technology to the warfighter
- Active contracts span HPM system development and test – from enabling subsystems and system integration to empirical effects testing and data archival
- Efforts include both innovative design and effective prototype development

Active Efforts
- HPM Source Design and Development
- Efficient hardware development for frequency agility
- HPM effects standardization and web-base database
- Full system design and development for rapid prototyping
Program Objectives

- Develop prototype triggered sealed switch for integration with HPM pulsed power system
- Demonstrate required performance characteristics
- Qualify for 5-10 year storage life:
  - Via analysis
  - Via Highly Accelerated Life Testing
- Integrate with HPM System for Air Force specified platform

Key Results

- Self-break sealed switch prototype demonstrated
- Preliminary designs for triggered design
Program Objectives
- Develop a real-time electric field detection capability to assess HPM weapon system surface-to-air performance at range (far field)
- System should be portable and report HPM beam width over a large area (100’ x 100’)
- Detection capability from 500MHz to 4GHz

Key Results
- Designed hardened detection box that lights a bright LED with a color based on the incident HPM field strength (8 distinct levels)
- Three axis detection capable of measuring V/H polarization
- Diode detection capability demonstrated above 5GHz
- Brass-board design demonstrated with surrogate HPM source
- Operational for over a week with existing battery power design
Program Objectives

• Develop a network of HPM sensor nodes to record field strength and communicate data wirelessly.
• Flexible mobile detection capability for outdoor testing. Diagnostics for open air developmental, static, and operational testing.
• Enhanced data acquisition and distribution over wide area.

Key Results

• Baseline design development underway with selection of an 8-channel (4Gs/sec each) FPGA
• RF detection of wideband and narrowband signal
• Battery operated throughout the test day
• Wireless communication of test data back to base station
• Thermal analysis shows viability for desert environments
• Baseline GUI developed to streamline outdoor test operations
Nuclear Effects and Systems-Level Multidisciplinary Engineering to Deliver Confidence and Capabilities

**Key Capabilities**
- Nuclear Effects Modeling, Simulation, Assessment, and Testing
- Nuclear Survivability Test Capability Development
- System-level Analysis, Design, Integration, Test

**Active Efforts**
- Dense Plasma Focus - Fission Pulsed Neutron Test Capability Development
- Nuclear Survivability Test Facility Modernization
- Multidisciplinary Science and Technology Assessment
- Space Radiation Assessment Tool Development
**Program Objectives**

- Develop processes and tools that reduce the time needed to perform radiation transport modeling on complex National Aeronautics and Space Administration (NASA) Computer Aided Design (CAD) models.

**Key Results**

- Developed CRIT, a parsing tool that inputs CAD models and creates extensible markup language (XML) input for processing through the On-Line Tool for the Assessment of Radiation in Space (OLTARIS) to perform transport modeling.
- Successful demonstration of CRIT led to a Phase II SBIR award to continue development efforts.

**Customer:** NASA  
**POC:** Dr. Robert Singleterry  
**PoP:** 06/10/16 - 12/09/16  
**Funding:** $125K
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