Innovative Concepts and Special Focus Projects

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Innovative Concepts and Special Focus Projects

- ***Description*:**
  - This Research Area solicits innovative concepts and special-focus projects that can provide game-changing solutions to increase the performance and reduce the cost of the future BMDS.
  - This year, this Research Area emphasizes technologies that are particularly well suited to university involvement and encompasses all STTR topics.

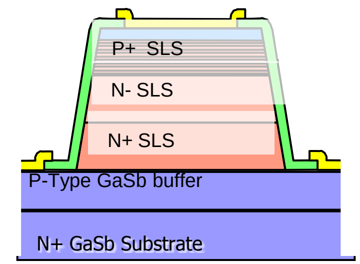
Topic Overview

High Performance IR FPAs with Advanced Quantum Structures

Objective

- Develop next-generation high-performance IR FPAs by exploring advanced quantum structures and utilizing innovations in nano-engineering. May include investigation and demonstration of the type-II strained-layer superlattice FPAs based on III-V materials.

Technology Areas of Interest



- Novel detector architecture and structure design
- Optimization of various combinations of interface elements
- Reduced in growth defects & alternate growth approaches
- Precision control of a large space of growth parameters
- Improving surface quality, reduced defects and doping control of substrates
- Correlate substrate crystal orientation and superlattice material growth quality

Key Performance

- Substrate: X-ray rocking curve FWHM 20 arc sec, Roughness ~2 angstrom
- Diode Quantum Efficiency >60%, dark current < 1uamp/cm2

Phase I Goal

- Feasibility study and preliminary design. Breadboard-level experiments or computer modeling should be carried out. Critical testing unit design parameters and testing scenarios should be defined for the testing under mission-relevant environment task.

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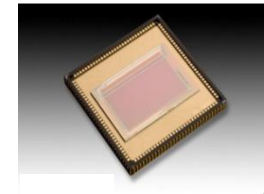
Topic Overview
Advanced Readout Integrated Circuits (ROIC)



Objective

- Develop advanced, smart read out integrated circuitry (ROIC) that can be operated robustly in ballistic missile defense environments. & mitigate adverse radiation effects from high-energy particles and lasers.

Technology Areas of Interest

- Digitization either on the column or the pixel is desired while reducing the power
- On FPA image processing such as spatial filtering, background noise subtraction, change detection, multiple-band spectral data manipulation
- Improving charge injection efficiency & offering flexibility for FPA polarities
- Advanced features e.g., super framing, programmable spatial resolution, pixel level change detection, high speed imaging of multiple targets, on-ROIC A-D converter
- Mitigation of adverse effects caused by high-energy particle and laser radiation

Key Performance

- ROIC formats:1024 x 1024, 1280x720 or larger, pixel pitch from 8 μm to 20 μm
- Well capacity up to 50 million electrons, read noise less than 200 electrons, dynamic range 14 bits, full frame rate 200 Hz, power consumption less than 200 mW

Phase I Goal

- Single unit cell design. Prepare and deliver feasibility study. Small format array demonstration is strongly encouraged.

Topic Overview

Next Generation Inertial Sensing Technologies

Objective

- Develop revolutionary inertial sensing concepts for next generation precision pointing and guidance applications for MDA. Both linear accelerometers and angular rate sensors are of interest.

Technology Areas of Interest

- No specific technology approach is favored. Interest in development of both linear accelerometers and angular rate sensors.
- Emphasis is on measurement performance and compact packaging.

Key Performance

- Linear Accelerometer Goals
  - Noise floor, DC-1000 Hz < 100 nano-g. Scale Factor stability < 10 ppm
- Angular Rate Sensors
  - Bias stability < 0.0005 deg/hr. ARW < 0.00005 deg/rt-hr. Scale Factor stability < 5ppm.
- Approach must be able to meet stated space qualification requirements

Phase I Goal

- Theoretical proof of concept through Modeling, Simulation and Analysis (MS&A) of basic physics and known error sources must be demonstrated
- Conceptual design of sensor and electronics
- Proof of concept hardware development (can be sub-scale) and experimental model validation is highly desirable.

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Topic Overview
Innovative Hardware Technologies for Electromagnetic Attack Rejection in BMD Radars

Objective

- Identify, develop, and demonstrate novel or innovative advances in electromagnetic attack protection hardware technologies that will support existing BMDS X-band, S-band, and other radar systems as well as communication and GPS systems.
- The focus of this research is to develop and demonstrate hardware technologies that provide protection and/or mitigation of the radar from high power microwave (HPM) and ultra wide band (UWB) attacks and with minimal insertion loss. It must be compact enough to fit within a 3″ diameter and 24″ long enclosure and be capable of G hardening for the anticipated missions.

Technology Areas of Interest

- Limiters with minimal insertion loss, fast turn on, and high power handling capability.
- Limiters based on new materials.

Key Performance

- High power handling capability (> 10 kW/cm^2).
- Fast turn on time (1 ns).
- Wide bandwidth about center frequencies of 3 and 10 GHz.

Phase I Goal

- Conduct proof-of-principle tests.
- Demonstrate that limiter has the potential for providing protection against high powers and minimum insertion loss.
- Identify possible issues associated with manufacturing the limiters.

Topic Overview
Advanced EO/IR Sensor Components

Objective

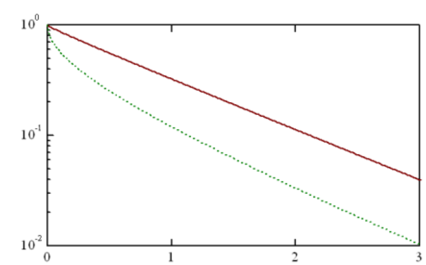
- Develop IR detector materials and architecture, readout electronic circuits, signal processing algorithms, radiation hardening for all components, cryogenic coolers, and sensor optics.

Technology Areas of Interest

- Identification of carrier lifetime limiting defects in superlattice material
- Modeling/calculations of underlying physics that controls superlattice lifetimes
- Reduction of defect occurrence through new growth technologies or procedures
- Techniques to reveal the defect types, e.g., point defects, interfaces, and dislocations
- Epitaxial growth of antimonide superlattice on GaAs substrate
- Ideas for planar detector structure applicable to antimonide superlattice materials
- Suppression of various noise sources with detector architectures

Key Performance

- Minority carrier lifetimes ~1μs, Spectral crosstalk <10%
- Quantum Efficiency >75%, Dark current <50% of LWIR Rule 07



Phase I Goal

- Preliminary experimental study or analytical study showing the feasibility of proposed ideas. The small business and the research institution need to demonstrate coherent and mutually supporting goals and plans

Topic Overview
Fast Algorithms for Generating Hardbody Thermal Histories

Objective

- Develop an innovative thermal solver capability to operate at real-time rates to support in-the-loop operation.

Areas of Interest

- A creative simulation solution is needed to accurately model in real-time the changing thermal characteristics and evolving nature of responsive threats and other associated objects.
- Historically, tools for providing high fidelity thermal histories of hardbodies such the Optical Signatures Code (OSC) have been operated in an off-line manner, i.e. they have run as stand-alone programs generating databases that are later used in larger scale simulations.
- These simulations are being developed to integrate the various potential sensors, space platforms, and weapons to examine complete system effectiveness.

Key Performance

- Generate hardbody thermal solutions to support closed-loop real-time system simulations that are currently being developed by MDA.
- Generate complex hardbody thermal solutions, with multiple disparate material layers with unique material/optical properties.

Phase I Goals

- Provide an assessment of potential thermal modeling solutions for suitability for real time operation. Approaches for code development should be clearly laid out, along with anticipated hardware requirements.
- Develop a detailed verification and validation plan to show how the codes accuracy will satisfy the requirements in a similar manner that the legacy code bases have fulfilled during their operational history.

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Topic Overview

Modeling of Lithium-Ion Cell Performance

Objective

- Develop, from first principles, advanced mathematical models of lithium-ion cell & battery performance.

Technologies of Interest

- Predictive models for new chemistries to optimize performance/life balance
- Models coupled to real cell/battery cycling to enable accelerated life "testing" to aid in mission design & battery performance improvement

Key Performance goals

- Understanding of the thermo/electro/structural process that occur at cell anodes & cathodes to correlate performance at nominal Depths of Discharge (DoD)/Discharges Rates, to that at higher levels

Phase I Goals

- Design & develop representative software supported by data from appropriate lithium-ion cell hardware
- Functionally test the software against other actual cell performance data

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