Intelligence Advanced Research Project Activity (IARPA) Proposers’ Day

Space debris Identification and Tracking (SINTRA)

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Plasma Phenomenology

*Space Debris Detection Studies*

John Petillo, Leidos Center for Electromagnetic Science

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Leidos Innovation Center (LInC) Mission:
To research, develop, and transition innovative
technologies and solutions for customers and the Leidos enterprise

- The Center for Electromagnetic Science
  - Physics / plasma physics / fusion
  - EM Simulation - semi-analytic to 1st principles
  - Computational plasma & RF physics
  - Electromagnetics / Vacuum electronics

- First-principles physics code development
  - EM/ES PIC code
  - Material emission physics model development
  - Ionization/charge exchange
  - Molecular dynamics (direct Coulomb interactions)

- Core R&D areas: Signal detection/processing
  - Air & Space ISR
  - Electronic warfare / CBRN sensing
  - Advanced analytics and machine learning

- Some Applications
  - Plasma physics
  - Particle accelerators
  - High-Power microwave sources
  - Adaptive radar countermeasures
  - Space payloads

Gridded Electron Gun
Ion Thruster
Electrons
Multi-charge state ions
Neutrals
Charge exchange
Image charges
Plasma sheath

RF Amplifier
High-power
Wide-bandwidth
Charged particles interacting
with electromagnetic fields

Physics Code Development
Molecular Dynamics
Electro- / Magneto-statics
RF/Electromagnetic PIC

Ka-band CC-TWT

Molecular Dynamics
Multi-species / charged particle
Electro- / Magneto-static optics
Image charges

5 Generations Secondaries
First Principles Codes:
Simulate conditions leading to enhanced cross section
- Phenomena: solitons, plasma waves/disturbances

- MICHELLE-eBEAM (Leidos)
  - Direct Coulomb interactions
  - Molecular Dynamics
  - Dielectric interactions/charging
  - Emission physics

- MICHELLE (Leidos)
  - Electrostatic Particle-in-Cell (SS / TD ES-PIC)
  - Plasma/Acoustic Waves
  - Emission, ionization, charge exchange
  - Dielectric interactions/charging

- ICEPIC (AFRL) & NEPTUNE (NRL)
  - Electromagnetic Particle-in-Cell (EM-PIC)
  - RF effects
  - RF interacting with partially ionized plasmas

Wide simulation capabilities and simulation model development experience for plasma phenomenology
Application of Relevant Capabilities

- Particle Physics / Plasma Phenomenology:
  - First principles modeling of the parameter space covering small scale space debris in the ionosphere enables…
  - Understanding of the conditions debris will present
  - Intuition development of the phenomenology
    - Under what conditions would solitons develop?
    - Research alternative phenomenologies that may lead to detection

- RF Engineering and Detection
  - Understanding fields levels, signals, and signal levels
  - Understanding the effectiveness of radar sensing
  - Design/Develop of detection platform solution