



**Intelligence Advanced Research Project Activity (IARPA)
Proposers' Day**

Space debris Identification and Tracking (SINTRA)

Wednesday, August 10, 2022

Plasma Phenomenology

Space Debris Detection Studies

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PR Approval: 22-leidos-0805-24704



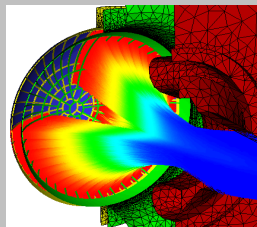
Leidos Innovation Center (LInC) Mission:

To research, develop, and transition innovative

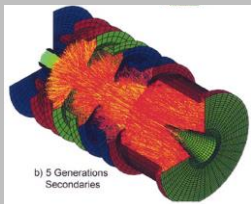
technologies and solutions for customers and the Leidos enterprise



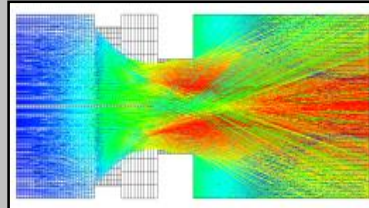
- ▶ The Center for Electromagnetic Science
 - Physics / plasma physics / fusion
 - EM Simulation - semi-analytic to 1st principles
 - Computational plasma & RF physics
 - Electromagnetics / Vacuum electronics
- ▶ First-principles physics code development
 - EM/ES PIC code
 - Material emission physics 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



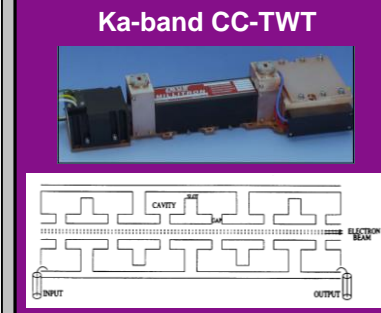
Gridded Electron Gun



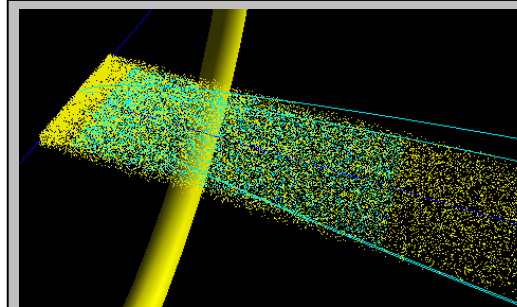
5 Generations Secondaries



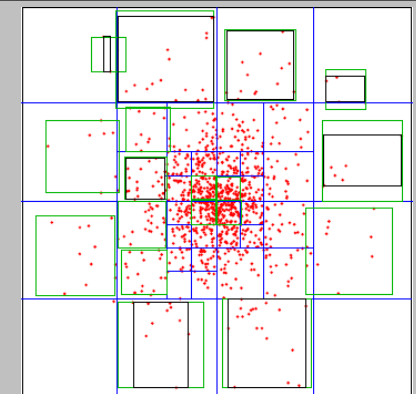
Ion Thruster
Electrons
Multi-charge state ions
Neutrals
Charge exchange
Image charges
Plasma sheath



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



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



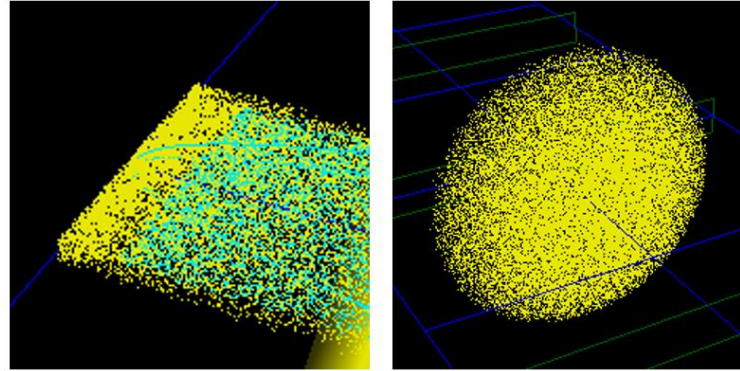
Physics Code Development
Molecular Dynamics
Electro- / Magneto-statics
RF/Electromagnetic PIC

First Principles Codes:

Simulate conditions leading to enhanced cross section
- Phenomena: solitons, plasma waves/disturbances

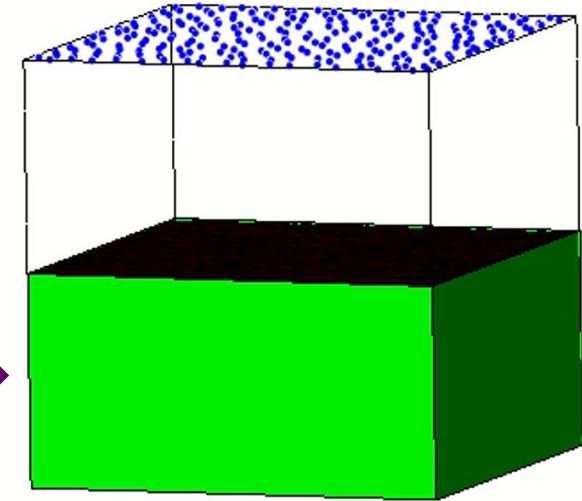
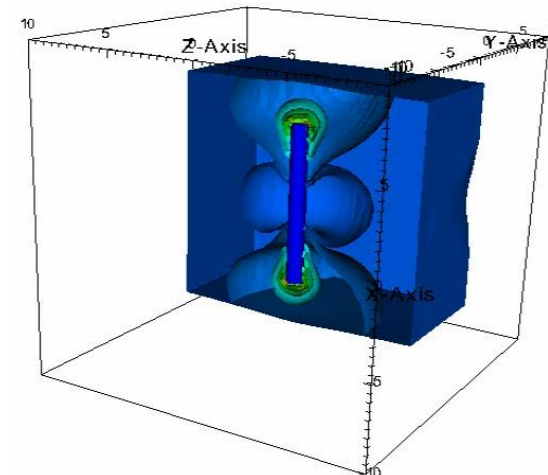
▶ MICHELLE-eBEAM (Leidos)

- 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

