



Integrity ★ Service ★ Excellence

Energy, Power and Propulsion Sciences

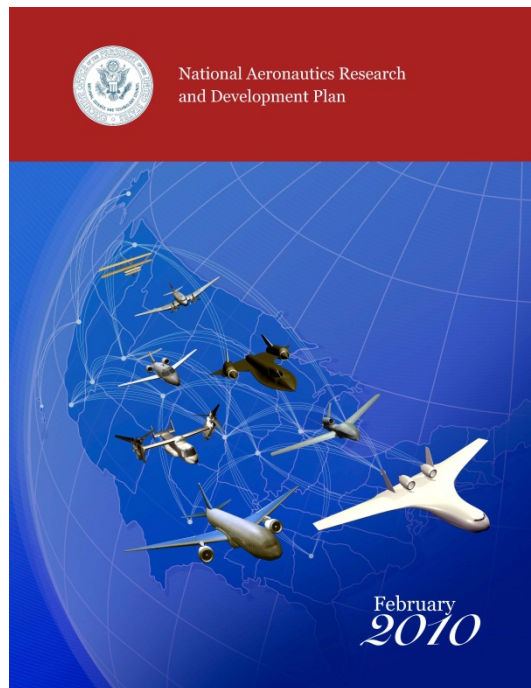
8 March 2013

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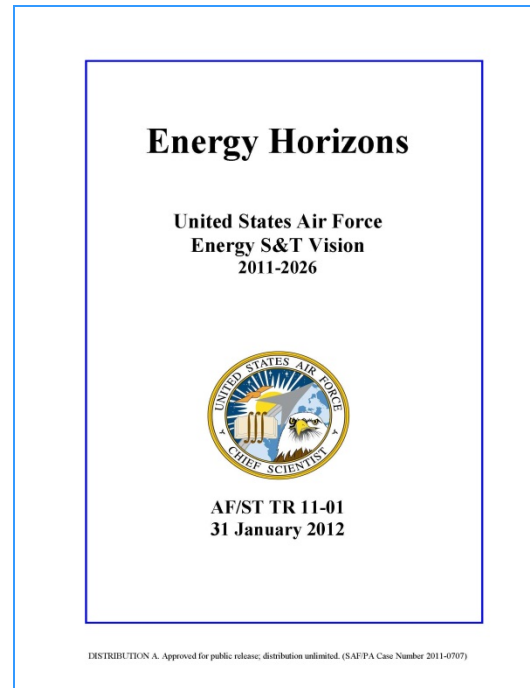
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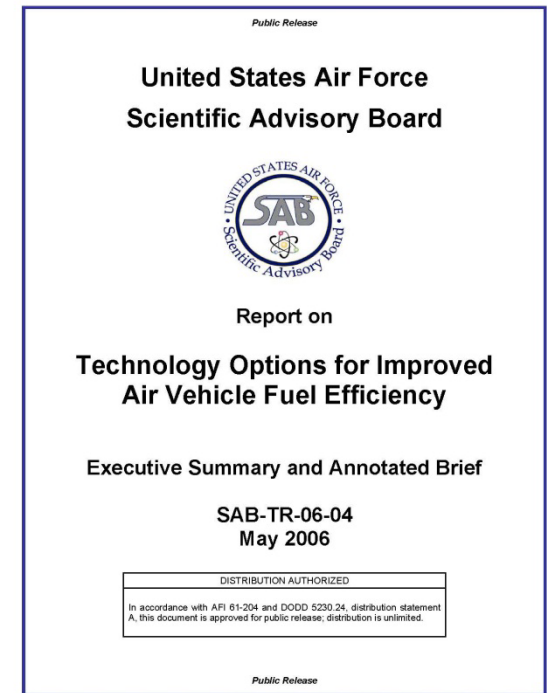
An Energy-Driven Environment



“Assuring Energy Availability and Efficiency Is Central to the Growth of the Aeronautics Enterprise ...”



“Energy is essential to all Air Force (AF) missions. ... a vector to increase energy supply, reduce demand, and change our culture ...”



“... there are increasing pressures ...to simultaneously conserve fuel as well as seek new sources of energy ...”



Challenges & Opportunities



The Air Force Consumes 60% of the fuel used by the DoD

80% of which is aviation fuel

- 2006 SAB Study

Aerial Refueling Costs are estimated at \$35-40/gallon.

- Congressional Research Service Report R42558



Addressing system level challenges requires contributions from many disciplines and emphasized multidisciplinary integration

The objective of the Energy, Power and Propulsion Sciences Department is to lead the discovery, refinement and transition of innovative science that *provides the foundation for revolutionary new capabilities enabling energy efficiency and security*



The RTE Team



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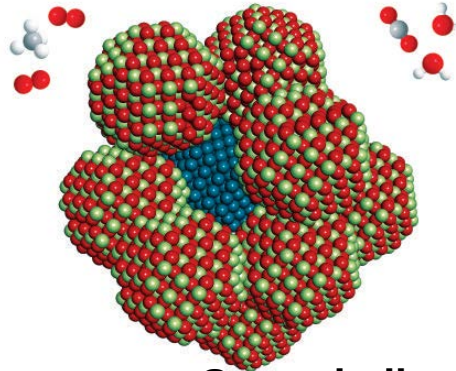


RTE Scientific Emphasis

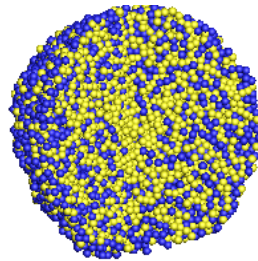


Energy Extraction and Storage:

- Storage in chemical structures
- Nanoenergetics
- Fuel Characterization
- Microbial-generated
- Energy Recycling

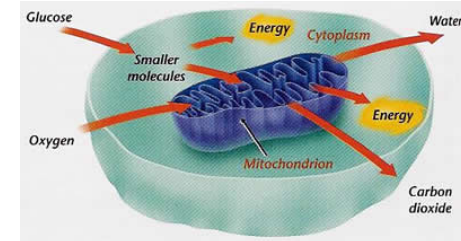


**Core-shell
nanocatalyst**



**Nanoenergetic
Particles**

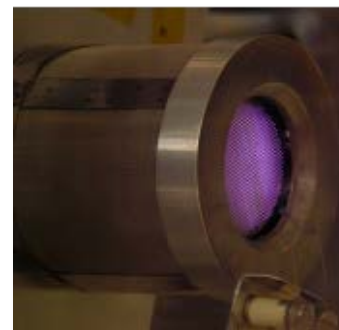
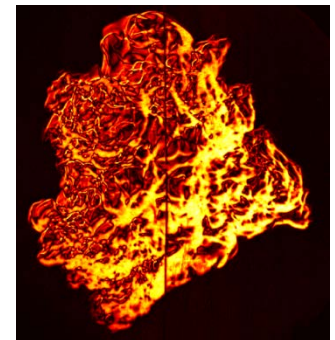
Photoelectric Stimulation of Mitochondrial Metabolism



Energy Conversion and Utilization:

- Energy transfer mechanisms
- Flame dynamics and properties
- Combustion chemistry
- Plasma dynamics
- Aerothermodynamics
- Alternative Conversion

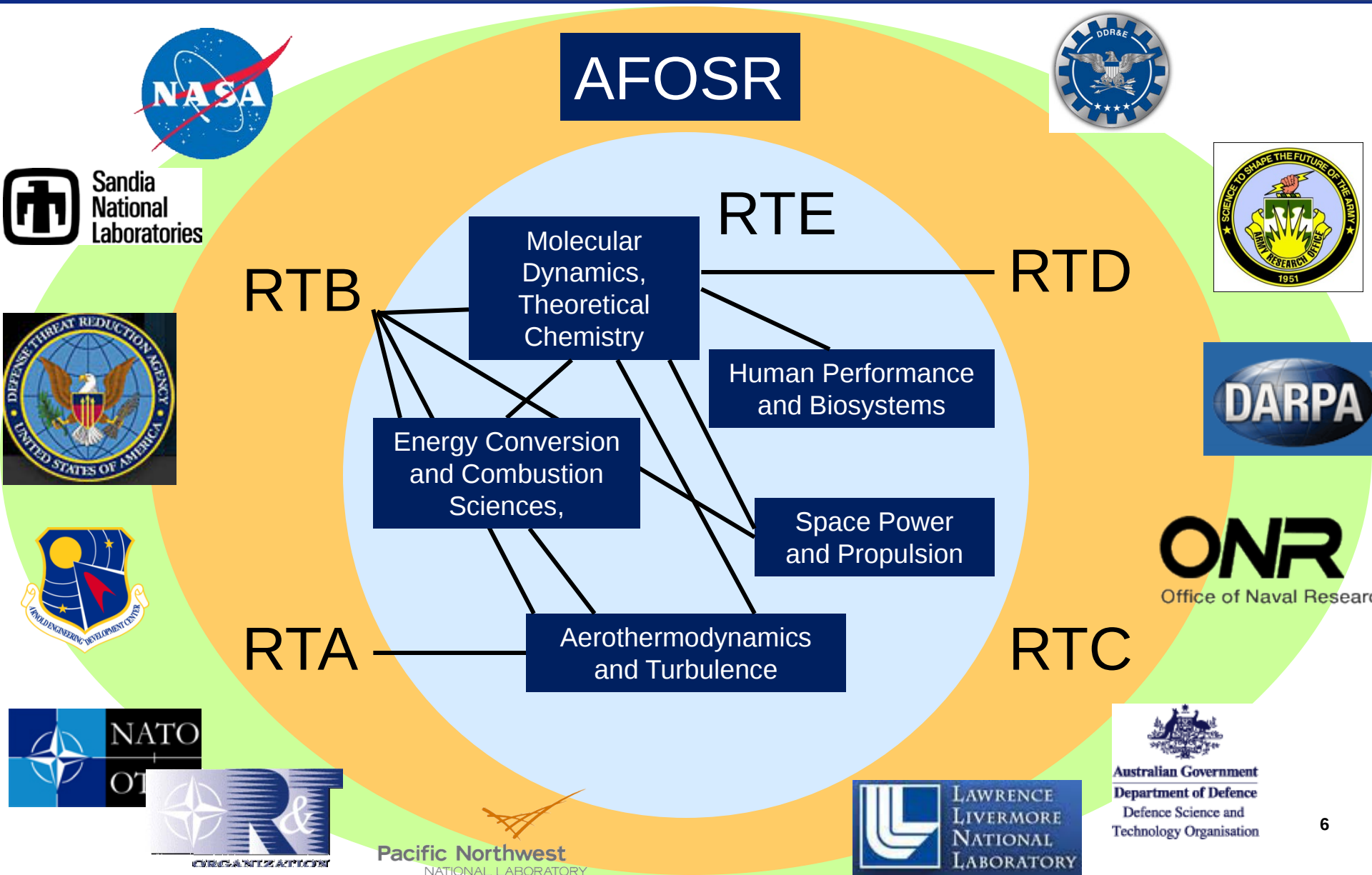
Turbulent Flame Dynamics



**Micro-scale
plasma source**



Strong Emphasis Multi-Portfolio Collaboration





Foundations of Energy Transfer in Multi-Physics Flow Phenomena



Establish the multidisciplinary scientific foundation for innovative approaches to *inherent* flow control

- Identify fundamental processes
- Exploit energy transfer in shaping macroscopic flow behavior

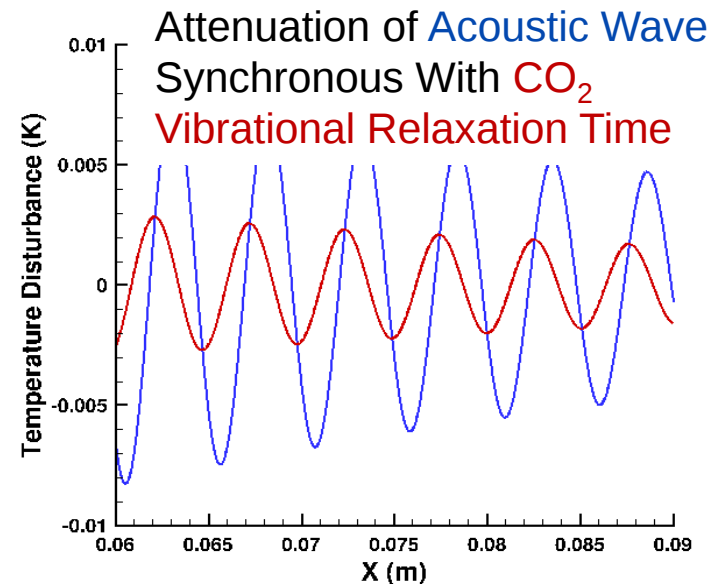
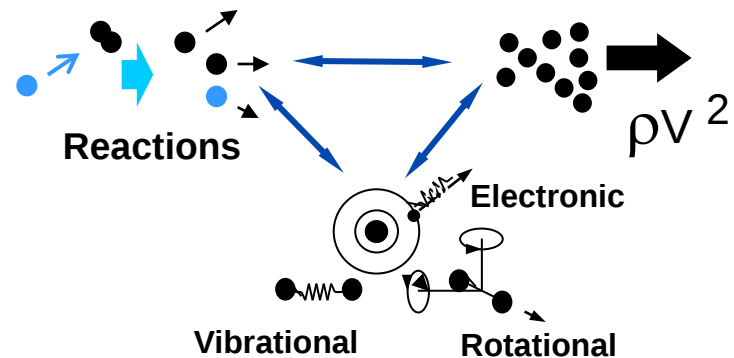
Bridging Multiple Portfolios

- Aerothermodynamics and Turbulence
- Energy Conversion and Combustion Sciences
- Molecular Dynamics and Theoretical Chemistry
- Flow Interactions and Control
- Plasma and Electroenergetic Physics

RTE

RTA

RTB



BRI Process has driven exchange of PIs across portfolios



Interactions within AFOSR Via BRIs

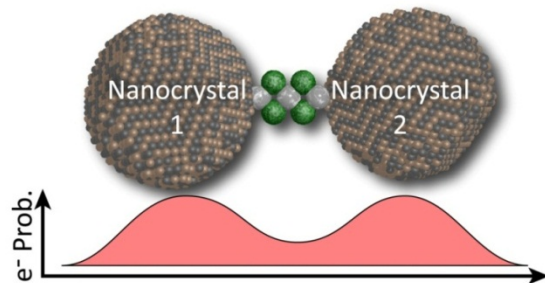


Nanoscale Building Blocks for Novel Materials

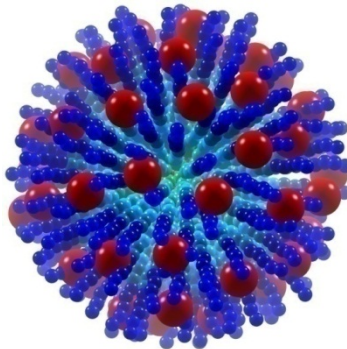
Berman with RTD (De Long)

Use nanoscale structures as building blocks to make novel materials with new properties for energy manipulation

Chemical linkers



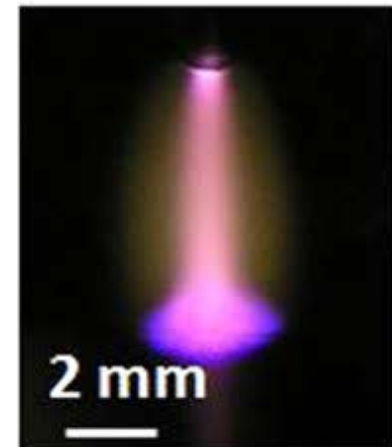
Bio-based linkers



Plasma-Surface Interactions

Berman with RTB (Luginsland)

Plasma-surface interactions for enabling novel and energy-efficient means of protecting or creating materials





National Hypersonic Science Centers



Joint AFOSR-NASA Fundamental Aeronautics Sponsored
National Hypersonic Science Centers Extend Collaboration
Initiated Under the Foundational Research Plan

Total of \$30M in invested over 5 years

More than 20 Universities Supported via Centers



**NHSC: Hypersonic
Laminar-Turbulent
Transition, Texas
A&M**



**NHSC: Hypersonic
Materials and
Structures, Teledyne
Scientific and
Imaging**



**NHSC: Center for
Hypersonic
Combined Cycle
Flow Physics,
Uva**





The RTE Team



- Relevant, game-changing Science addressing energy *extraction, storage, conversion and utilization*
- Strong emphasis on partnerships and collaborations

