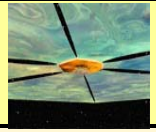
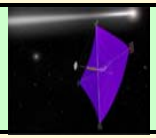
# FY01 Focus Areas

- **Prioritize investments to achieve Agency goals**
  - In-Space propulsion, nuclear power/propulsion and radiation mitigation
- **Improve understanding of the Earth's Neighborhood**
  - Refine concepts and science needs
- **Improve definition of the robotic/human partnership in space**
  - Capture the state-of-the-art for future robotics
  - Quantify and compare robotic/human performance in projected operations
  - Increase understanding of critical Bioastronautics issues
- **Advance Technology for Human/Robotic Exploration and Development of Space (THREADS)**
  - Discover innovative concepts and technology
  - Show progress in key technology areas
- **Expand leveraging activities**
  - Active investments from; NIAC, RASC, SBIR, SSP
  - DoD - opportunities through Technology Area Review and Assessment (TARA), Advanced Concept Technology Demonstrations (ACTD), etc.
  - Education; Steckler Trust

# Prioritized In-Space Propulsion Technologies

## Process

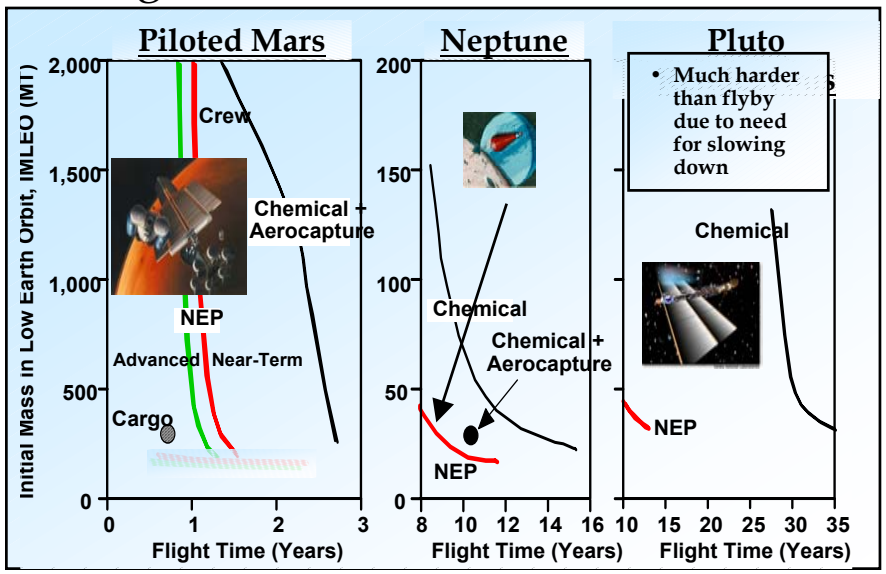
- Requirements/Goals Established by NASA Enterprises
- Technology options identified
- Systems concepts developed
- Systems Concepts Compared
- Technologies Prioritized

| In-Space Propulsion Technology | High Priority | Medium Priority | Low Priority | High Payoff/ High Risk |
|---|---|---|---|---|
| Advanced Chemical | |  | | |
| Aerocapture |  | | | |
| Solar Electric Propulsion (SEP |  | | | |
| Nuclear Electric Propulsion (NEP |  | | | |
| Solar Sails |  | |  | |
| Solar Thermal | |  | | |
| Nuclear Thermal Propulsion (Bimodal) | |  | | |
| Plasma Sails | | | |  |
| Momentum Exchange Tethers (MXER) | | | |  |

- Code S Priority
- Code M Priority
- Code M and S

# Nuclear Power and Propulsion

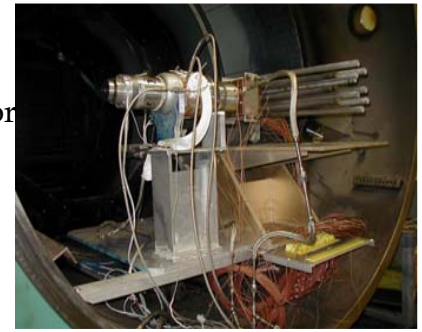
- NEP identified as high-priority in space propulsion technology for human and robotic exploration
  - Enables very high delta-V missions
  - Offers abundant power at destination
- Evolutionary approach to fission propulsion proposed (3 phases)
  - 10-500 kW NEP and surface
  - Up to 10 MW NEP, solid-core NTR
  - Up to 100 MW NEP
- Enables non-Keplerian orbits that can avoid hazardous regions (e.g. ring particles)
- Enables complex, long duration missions



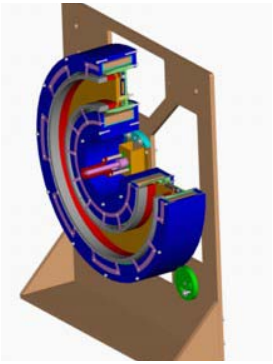
# Nuclear Power and Propulsion

- Refurbished 2 kWe Brayton testbed and began high power Brayton system design studies with industry
- Conducted Heat Pipe reactor-to-Stirling power conversion integrated test
- Conducted Stirling engine-to-Hall thruster integrated test
- Fabricated and tested plasma injector for compact toroid high power plasma thruster
- Completed design and initial fabrication stages of 50kWe Hall thruster
- Conducted mission/trajectory design and analysis for high and low thrust nuclear propulsion systems
- Prepared conceptual designs of NEP and NEP/NTR vehicles for human and robotic science missions

NEP
End-to-End
Demonstrator



50 kW
Hall thruster



Ion
thruster

# Attacking the Radiation Challenge

* NEXT funded Activities

Exploration Location/ Duration

LEO+
500-1000
Days

LEO
180 Days

**ADVANCED APPROACHES**

Fast Transit
Personnel Screening
Active Shielding*
Pharmaceuticals
Integ. Design of Passive Shields*
Materials*
Tissue Testing/Modeling

As Low As Reasonably Achievable

**3% lifetime limit**

**CURRENT MITIGATION**

Safe Havens
Career/Mission Time Constraints
Dosimetry
Historical Data/Modeling
Earth's Magnetic Field

**Risk/Uncertainty**

# NEXT Radiation Research

**Recommendations for effective dose limits (Sv*) for 3% excess cancer fatality for 10 year careers**

| | Female | | Male | |
|---|---|---|---|---|
| Age | 1990 | 2000 | 1990 | 2000 |
| 25 | 1.0 | 0.4 | 1.5 | 0.7 |
| 35 | 1.8 | 0.6 | 2.5 | 1.0 |
| 45 | 2.5 | 0.9 | 3.2 | 1.5 |
| 55 | 3.0 | 1.7 | 4.0 | 3.0 |

| Age at First Mission | No. of 180-day LEO missions** | |
|---|---|---|
| | Female | Male |
| 25 | 0 | 1 |
| 35 | 1 | 1 |
| 45 | 1 | 2 |
| 55 | 2 | 3 |

## Considerations

- Costs of training
- Costs of crew replacement
- Career corps vs one-mission astronauts

* 1 SV = 100 REM. 1 REM = measure of effective biological damage as determined by absorbed dose x quality factor

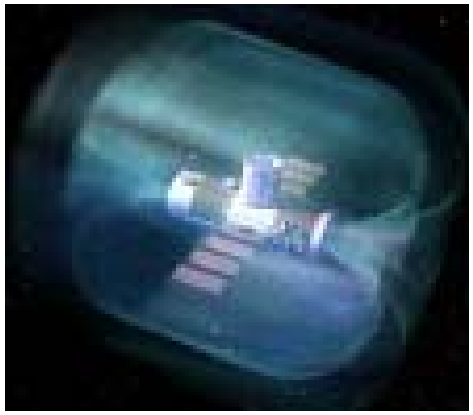
** Administrative limits: 1% risk excess cancer risk; 0.2 Sv/mission; no uncertainty assumed.

Report Available - Space Radiation Cancer Risk Projections

# Shielding Materials

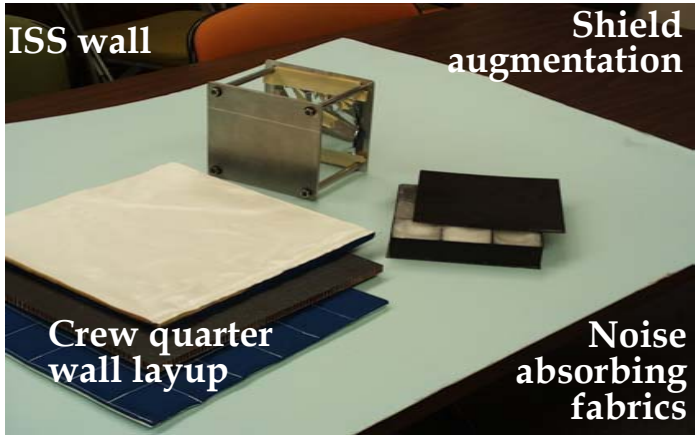
## Multidiscipline Networked Immersive 3D Simulation and Optimization

## Mini Magnetospheric Plasma Propulsion



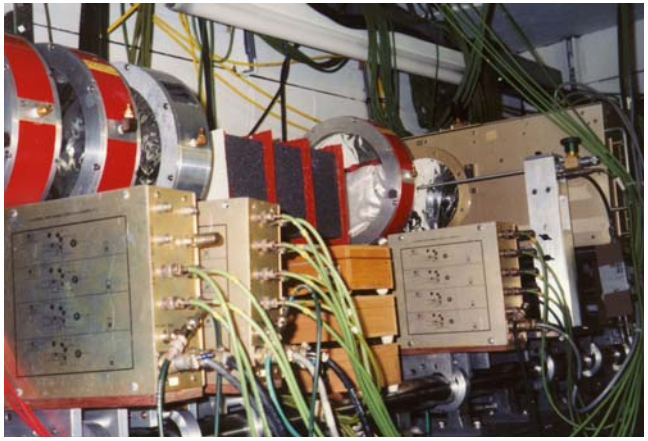
## Brookhaven National Lab (BNL)


## Polyethylene Augmentation for ISS




## Radiation Absorbing Materials

## Habitat and EVA Garment Material Testing



Reports Available - "Optimization of Multifunctional Material for Radiation Protection" and numerous papers