Conf Paper / IN-16

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Sp ce 2000

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Risk Reduction
for the Next Generations

♦ In Space Investment Area Overview	Les Johnson
♦ Hall Propulsion Technology	Robert Jankovsky
♦ Ion Propulsion Technology	John Brophy Mike Patterson
♦ Fission Propulsion: SAFE	Mike Houts
♦ Cryogenic Fluid Management Technologies	David Plachta
♦ Solar Thermal Propulsion Technologies	Steve Tucker
♦ Momentum Transfer Tether Technology	Kirk Sorensen
♦ Electrodynamic Tether Coatings for ProSEDS	Jason Vaughn
♦ AeroAssist Technologies	Richard Powell
♦ Solar Sail Technology	Humphrey Price
♦ Mini Magnetospheric Plasma Propulsion (M2P2)	Dennis Gallagher

In-Space Agenda

SP CE 2000

RANSPORTATION

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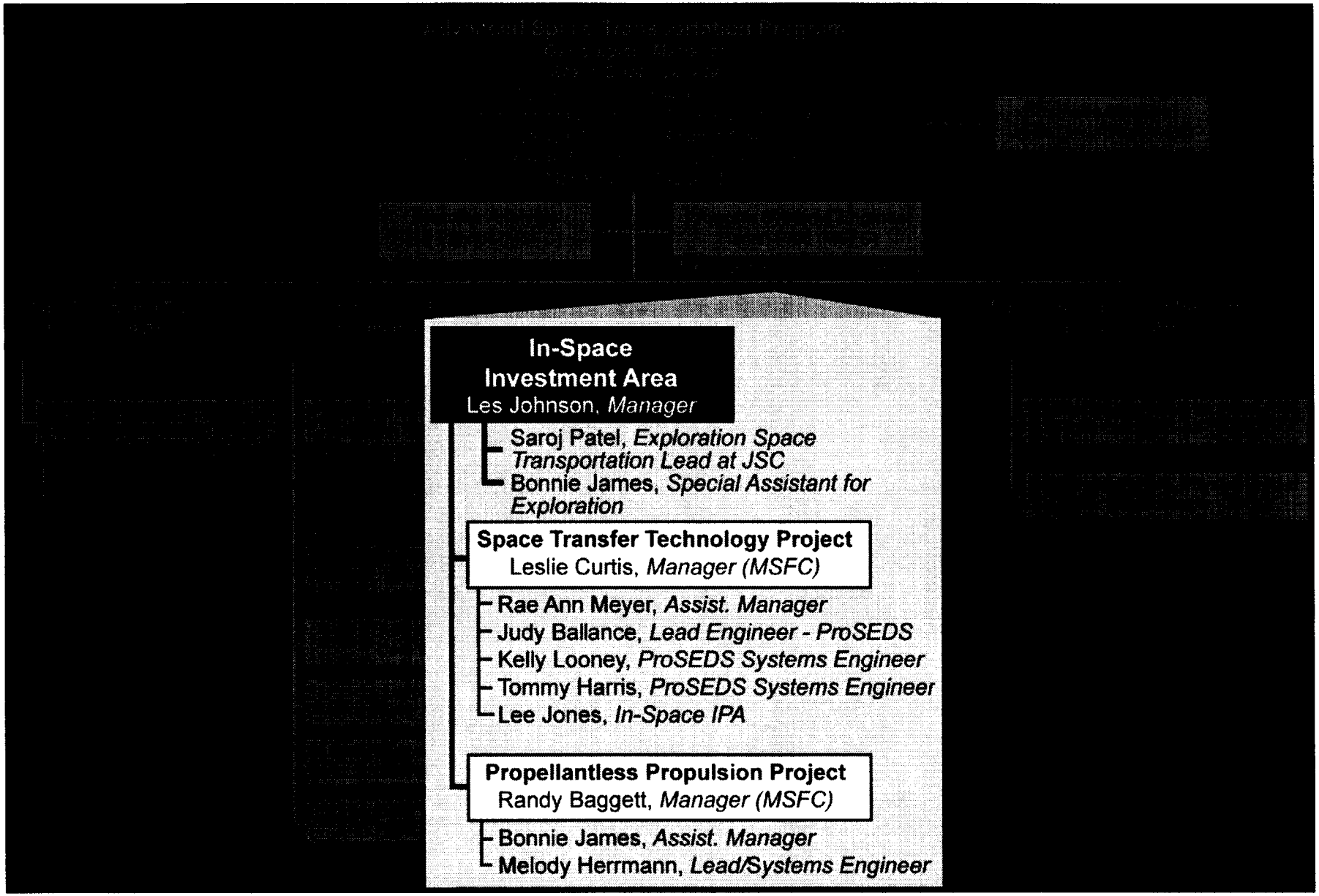
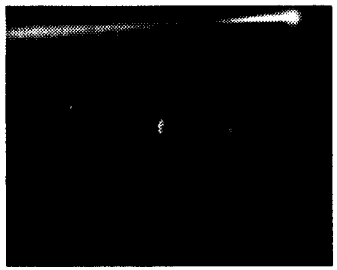
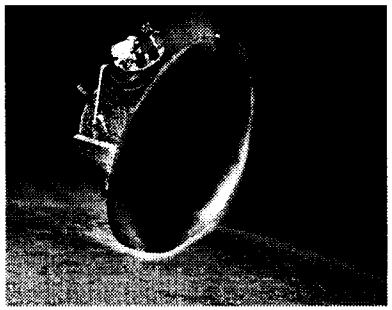
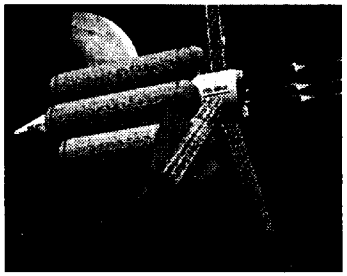


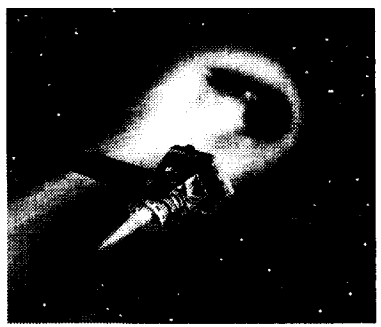
ASTP Organization







- **Achieve within 15 years a factor of 10 reduction in the cost of Earth orbital transportation and a factor of 2 to 3 reduction in propulsion system mass and travel time required for planetary missions. Within 25 years enable bold new missions to the edge of the solar system and beyond by reducing travel times by 1 to 2 orders of magnitude.**



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In-Space Transportation Goals

- High percentage of projected launches to Low-earth Orbit (LEO) will require upper stages.
  - More than 70% go to Geosynchronous Orbit (GEO) or higher.
- Under current total mission cost caps, more ambitious science missions require improvements in propulsion technologies.
  - DS-1 enabled by NSTAR solar electric ion propulsion.
  - Future planned missions require 2 to 3 times more Delta V.
  - Rendezvous and return missions will require similar investments in chemical propulsion systems and aerocapture technologies.
- Per current studies, human exploration missions to Mars, in-space transportation costs are projected to be higher than earth-to-orbit costs.
  - Affordable in-space transportation is enabling for human exploration missions (lighter weight systems, shorter trip time).
  - In-situ propellants offer significant potential to reduce mission costs.
- New opportunities to explore beyond the outer planets will require unparalleled technology advancement and invention.




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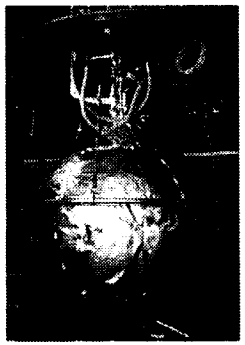
In-Space Investment Rationale

Electric Propulsion

Advance EP systems to reduce mass & cost of orbital transfer and to enable interplanetary missions

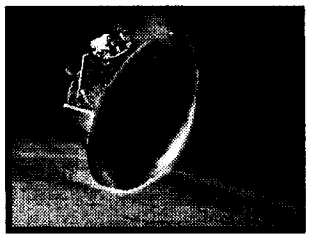
Sails

Solar and magnetic sails to enable exciting new mission concepts and by reducing mass and overall trip time for interplanetary missions.



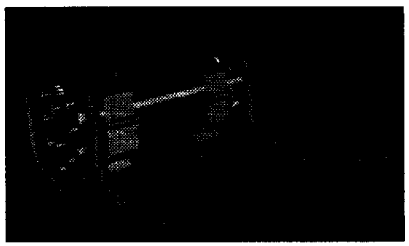
Cryogenic Fluid Management

Advance CFM systems to enable long term storage of cryogens in space



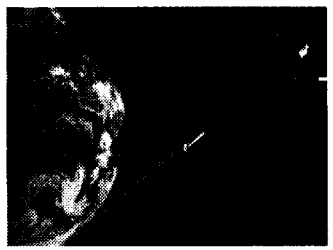
Aeroassist

Utilize aerocapture and aeroassist transportation systems to significantly reduce mass -- by using planetary environments for orbit capture and deceleration



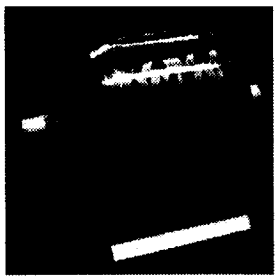
Fission

Develop fission technology to enable rapid, affordable access to any point in the solar system



Tethers

Develop reusable electrodynamic and momentum transfer tethers to reduce transportation system mass and cost



Light Weight Components

Develop light weight components to reduce the dry mass of spacecraft propulsion systems

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In-Space Transportation Technology Elements

Electric Propulsion

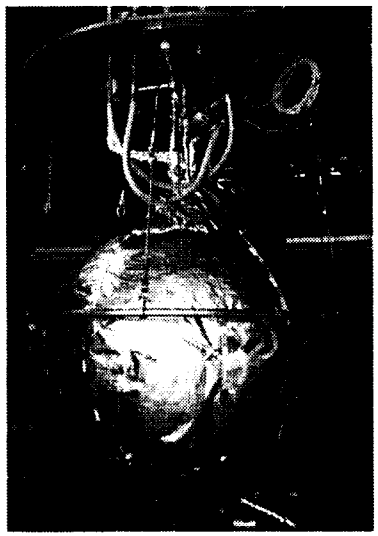
Advance EP systems to reduce mass & cost of orbital transfer and Enable interplanetary missions

- GRC – Hall, Ion, MPD, PIT technologies
- JPL – MPD (lithium), DS-1 tests, ion optics
- JSC – VASIMR Technologies
- MSFC- PIT (switch and ckt design)

Fission

Develop Fission Technology to enable rapid, Affordable access to any point in the solar system

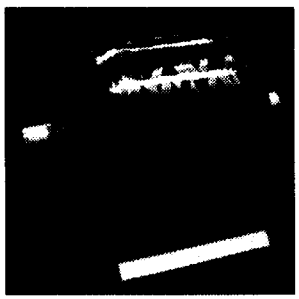
- GRC – Energy Conversion, Fuels, LANTR
- JSC – Two phase systems and technologies
- KSC – Operational and range requirements
- MSFC – Fuels, SAFE, System studies, non nuclear testing



Cryogenic Fluid Management

Advance CFM systems to enable long term Storage of cryogens in space

- ARC- Cryocooler & Refrigerator development, insulation
- GRC- Subscale/Component test, analytical modeling
- JPL - technology requirements
- JSC - In-situ propellant production
- KSC - GSE, quick-disconnects, insulation
- MSFC- System/Large scale test, analytical modeling



Light Weight Components

Develop light weight components to reduce the dry mass of spacecraft propulsion systems

- Center Roles are still being established

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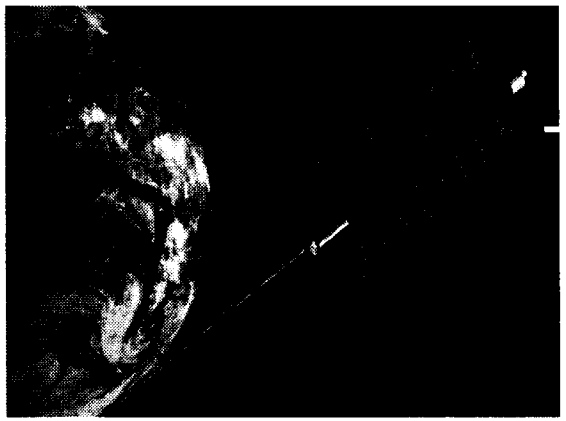
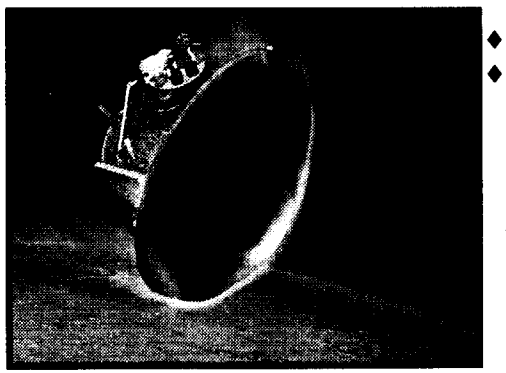
Space Transfer Technology Project Elements

- Sails
  - Solar
  - Magnetic
- Center Roles:
  - JPL: TWG lead; system design; GN&C; Mechanical systems; Large structures; I&T
  - LaRC: materials & Lt. weight structures; mechanical system
  - MSFC: Prop. Physics;M2P2; mt'l & light weight structures
  - JSC: Large Structure environ.





- Aeroassist
- Center Roles:
  - LaRC: TWG Lead; system design/performance; Aero/ Aerothermal analysis; structures; GN&C simulations
  - ARC,JSC,JPL,LaRC,MSFC: Vehicle design/system analysis
  - ARC: TPS; TPS Aerothermal sensors; Aerothermal analysis
  - JSC: GN&C; deceleration systems; Adv.. TPS materials
  - MSFC: Environmental models

- Tethers
  - Electrodynamics
  - Momentum Transfer Tethers
- Center Roles:
  - MSFC: TWG Lead; system design/performance; integrated test; tether survivability; deployer; GN&C; deployment test facilities; orbital tracking & collision avoidance
  - JSC: orbital tracking & collision avoidance

Propellantless Propulsion Technology Project Elements