Solar Electric Propulsion Benefits for NASA and On-Orbit Satellite Servicing

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Overview

- Current developments in technology that could meet NASA, DOD and commercial mission objectives
- Applications of Solar Electric Propulsion (SEP) vehicle development for NASA priorities
- Opportunities to meet Commercial Servicing needs as spin-offs from NASA's SEP vehicle

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Electric Propulsion

NEXT is Nearing TRL6 Validation

- Critical tests have been completed, or are imminent, on high fidelity hardware

	Thruster 	PPU 	PMS 	Gimbal 
Functional & Performance Testing	Complete	Complete	Complete	Complete
Qual-Level Vibration Test	Complete	FY2010	Complete	Complete
Qual-Level Thermal/ Vacuum Test	Complete	FY2010	Complete	Not in project scope

- Single-String Integration Test and Multi-String System Integration Testing (90% complete)
- Thruster Life Test: In progress & continuing through FY2013
- PM wear test: Complete

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Electric Propulsion

NEXT Transition-to-Flight Planning

- Complete Phase 2 of Technology Development
  - FY10: EM PPU testing complete, Project Close-out Review
- Phase 3: First-User Risk Reduction
  - FY11-13: Continue thruster long duration testing and associated life validation tasks
  - FY11-13: PPU risk reduction development activities
    - Address desired design and analysis updates identified in technology development
- Continue comprehensive independent thruster testing at Aerospace Corporation
  - Testing has begun with Aerojet-fabricated Prototype Model thruster

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Fast Access Spacecraft Testbed

FAST Overview

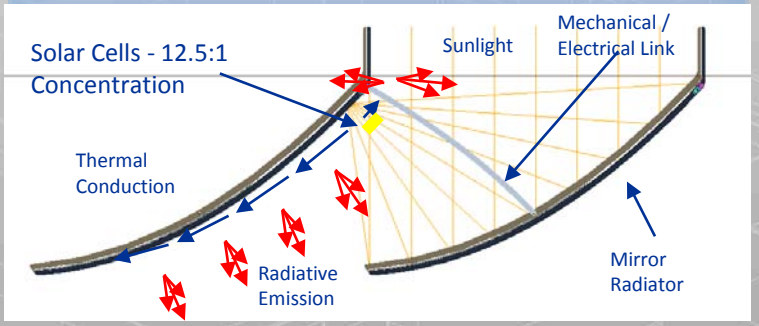
Fabricate a high power and light weight solar electric array that can support a wide range of space applications, and ground test it in a relevant space environment

GOALS

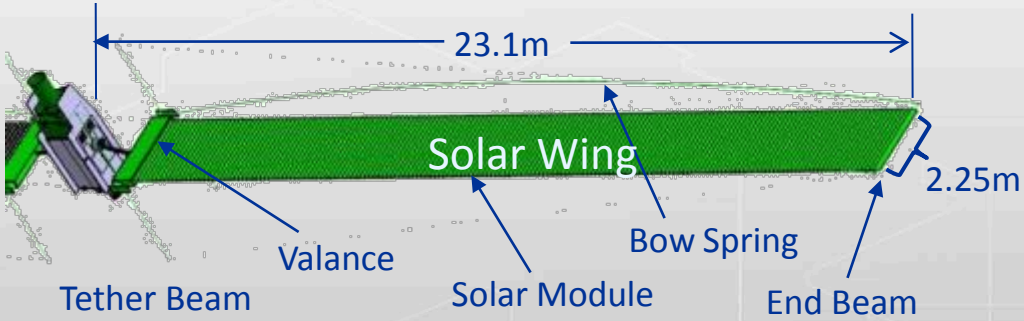
>20 kWe electrical power

>130 W/kg specific power

Scaleable to 80 to 1,000 kWe



MCA Solar Performance Characteristics



- ✓ Demo design mature, CDR in Aug 09
- Multifunctional Concentrator Assembly (MCA)
  - 171 MCA's make up solar array wing
  - Wing tension enables precise pointing
  - Concentration of 12.5:1 reduces acreage ~92%

- ✓ Power generation of 29.3 kWe
  - *Beginning of life power in LEO*
- ✓ Specific power of 136 W/Kg
  - 216 kg for entire power system, except batteries

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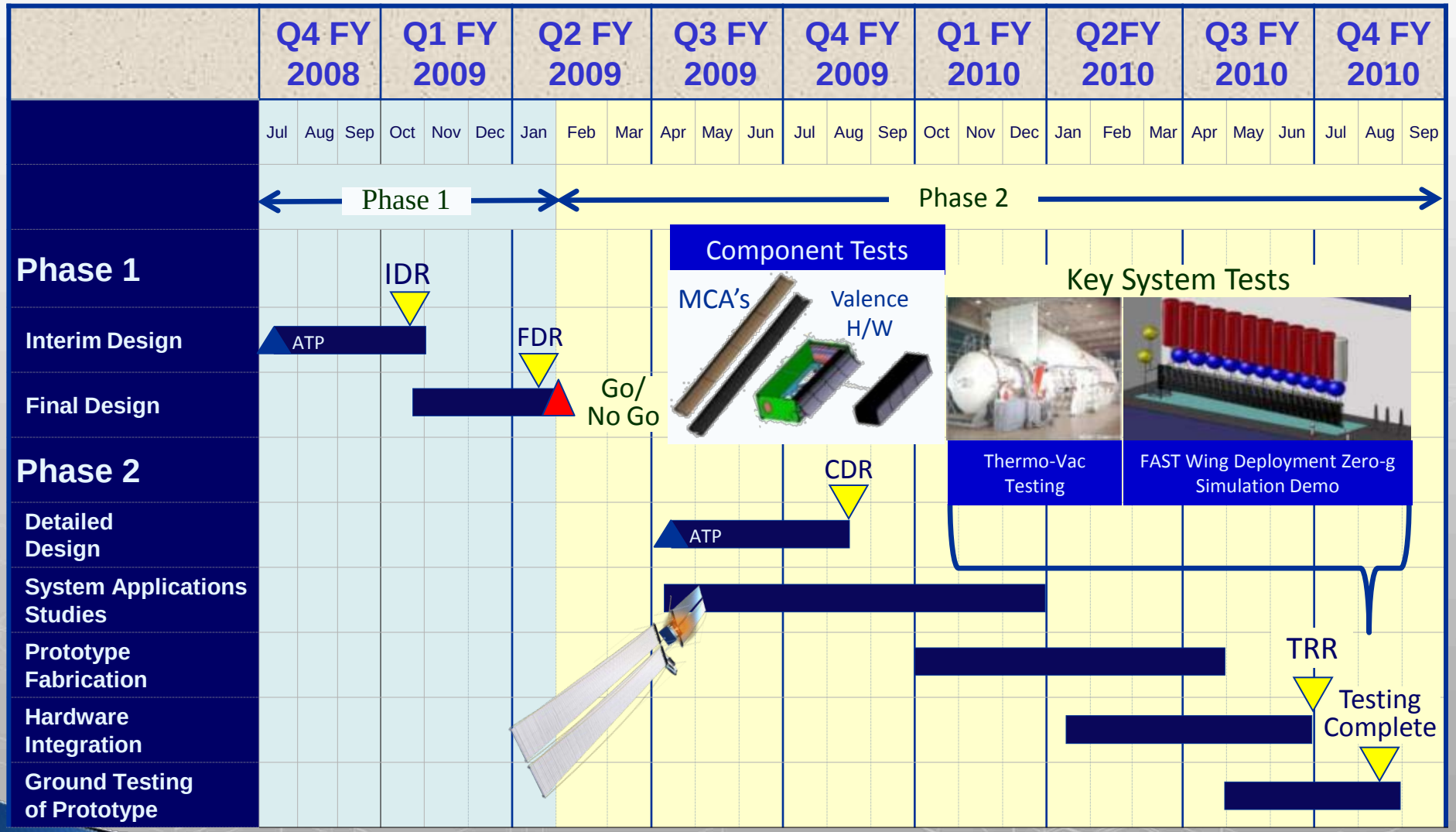
DARPA FAST Schedule & Testing



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Current Phase II FAST Effort

- **Goal is to develop and perform ground demonstrations of a 30 kW High Power Generation System. When combined with a state-of-the-art electric propulsion system (e.g., NEXT), it will form the technological basis for a lightweight, high power, highly mobile spacecraft platform**

- **Offers the potential for high specific impulse missions which downsize the size of the launch vehicle required or significantly increases the payload mass to high-energy orbits**

- **FAST Integrated Power Demo (IPD) – Objectives**
  - Demonstrate the FAST concentrator solar array (@ NASA GRC).
  - Measure solar array performance in a simulated space environment, including effects of thermal vacuum, solar illumination, and spacecraft electrical loads.

- **Overall Approach**
  - Use subsystem and component level tests to validate thermal, optical, structural and contamination models.
  - Demonstrate system level performance in an illuminated thermal vacuum test (at NASA Glenn Research Center).
  - Use the test results to generate power predictions for each mission environment.

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NASA Space Science Missions Enabled by SEP Stage or Standalone Bus

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NASA Exploration Mission Applicability

- **Near-term Exploration Missions – Particularly for Flexible Path Architectures**
  - Spacecraft for in-space transfer of cargo and robotic systems to planetary orbits and Near Earth Asteroids (NEAs)
  - Return of cargo, samples and other elements to Earth

- **High-Performance Crewed Missions**
  - Advanced high power thruster and power technologies
  - Variable specific impulse and operation at high specific powers
  - Large reduction in travel times for piloted vehicles and extension of human exploration sphere to Asteroid Belt and beyond

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Orbital Servicing Capabilities

- High-ΔV capability tugs and servicing spacecraft
  - Key element for propellant resupply and servicing operations in non-LEO orbits
- Enables multiple orbit transfers between LEO to GEO and reusability
  - Launch to LEO on ELV
  - Transfer to GEO using Electric Propulsion
  - Service up to two dozen clients
  - Periodically return to LEO to rendezvous & grapple with new payload launched on ELV
  - Execute new mission with refreshed payload, tool kit, propellant & electric thrusters
- Could also perform repositioning/removal of satellites and assets

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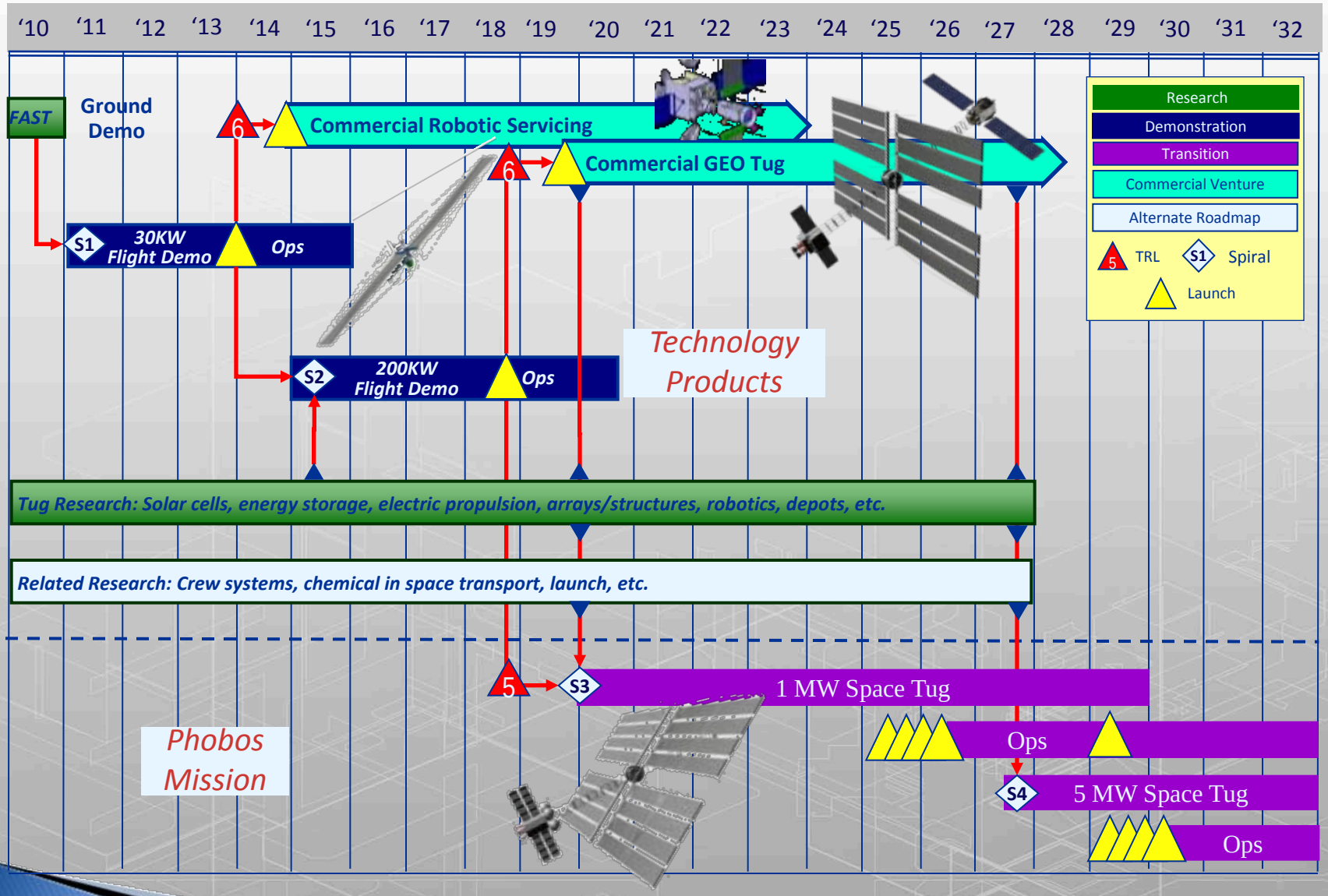
Notional Space-tug Technology Roadmap



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Summary

- Advancing FAST and NEXT into a design for an SEP stage quickly integrates emerging complementary technologies into an operational spacecraft
- The SEP system and stage enable low cost/low risk opportunities for multiple DOD, NASA and commercial payloads
  - The bus will be designed to interface with either the NEXT or high power Hall thrusters, enabling earth orbital missions as well as deep space science missions
- SEP Stage enables cost effective missions within Earth orbit, Cis-lunar, NEOs, and deep space robotic science missions
- SEP Stage enables robotic missions to be launched on smaller, lower cost launch vehicles to reduce launch costs
- Builds a new national capability that will dramatically enhance the competitiveness of existing U.S. launchers by minimizing the requirement for on-orbit propellant

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