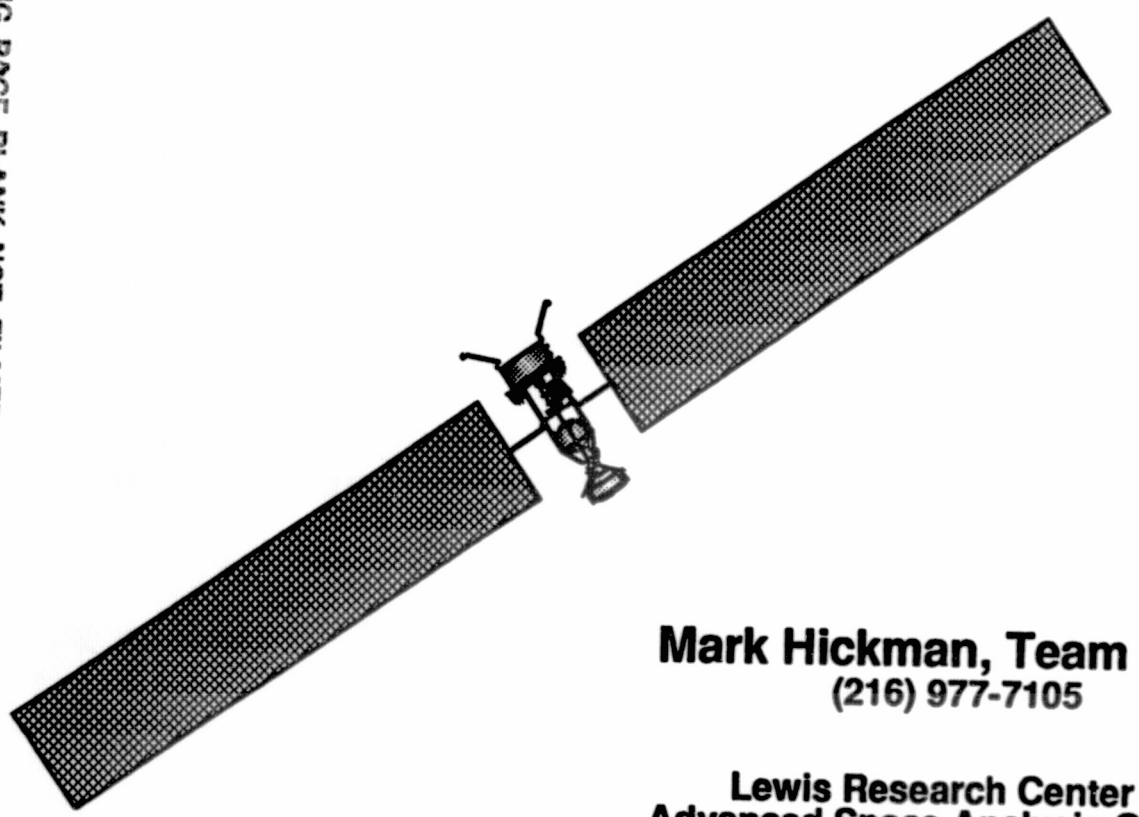
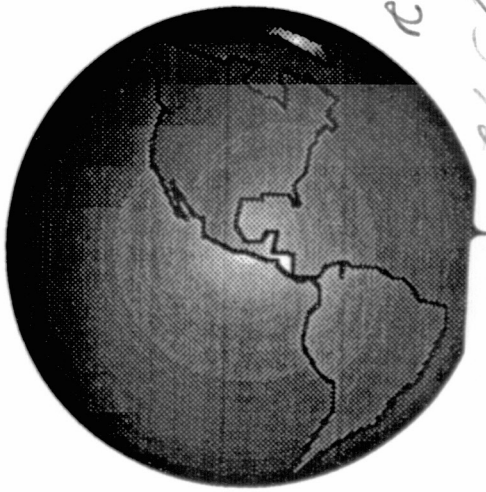
Transfer Orbit Plasma Interaction Experiment (TROPIX)





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TROPIX Science Mission Description

- Map the charged particles in Earth's magnetosphere from LEO to GEO at high inclinations
- Measure plasma current collection and resulting shifts in vehicle electrical potential from LEO to GEO across range of orbital inclinations
- Study spacecraft interaction with plasma environment using SEP thrusters as plasma contactors
- Measure array degradation over mission duration
- Evaluate the potential of various microelectronics, spacecraft components, and instruments for future space missions
- Demonstrate SEP technology applied to a flight vehicle

TROPIX Builds On Previous Investigations

- **CRRES (Combined Release and Radiation Effects Satellite)**
  - Joint program of MSFC and DOD/Air Force Space Test Program designed to understand problems of highly sensitive electronics and sensors in hostile radiation environment
  - Collected data on dynamics, structure, and chemistry of near-earthspace environment, and studied the survivability of electronics
  - Atlas/Centaur launch, July 25, 1990
  - Elliptical GTO: 400 km by 35,800 km
- **PASP+ (Photovoltaic Array for Space Power plus diagnostics)**
  - Pegasus launch, May 1993
  - Elliptical orbit: 190 nm (352 km) by 1050 nm (1945 km) at 70° inclination
- **SAMPIE (Solar Array Module Plasma Interaction Experiment)**
  - Investigate the arcing and current collection behavior of materials and geometries likely to be exposed to the LEO plasma on high voltage space power systems in order to minimize adverse environmental interactions
  - To be flown aboard Shuttle, January 1994

TROPIX Will Augment Previous Missions

- TROPIX will provide a clearer understanding of the effects induced by energetic particles and solar radiation
  - Damage caused to satellite electronics
  - Degradation to solar arrays
  - Hazards to people in space
- TROPIX altitudes and inclinations are unmeasured
- Mission length of approximately 1 year sufficient to take time dependent data
- Spacecraft power over 3 kWe
  - Enhances current collection measurements
  - Conditions more applicable to real future spacecraft than at lower power

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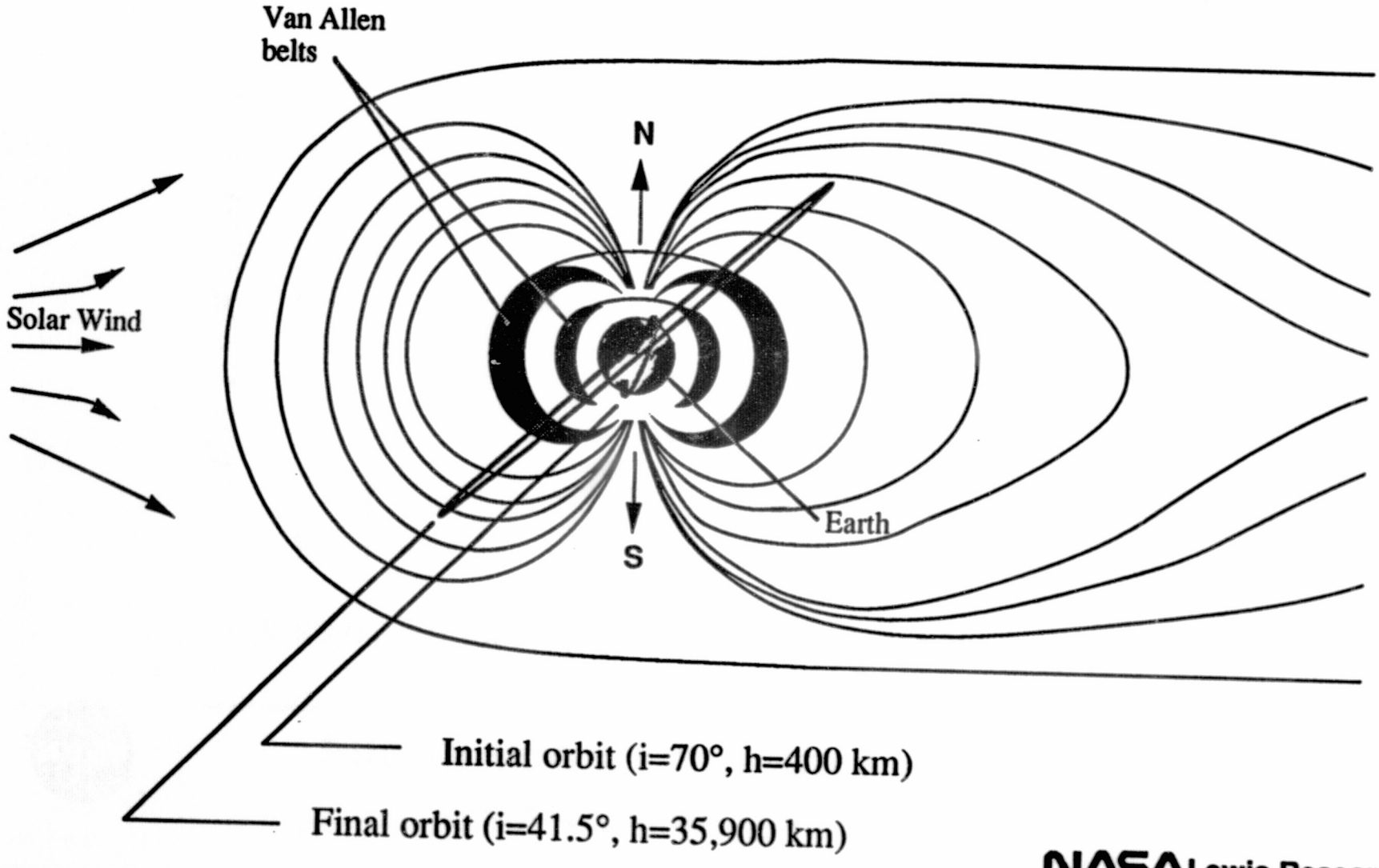
Initial and Final TROPIX Orbits Within Earth's Magnetosphere



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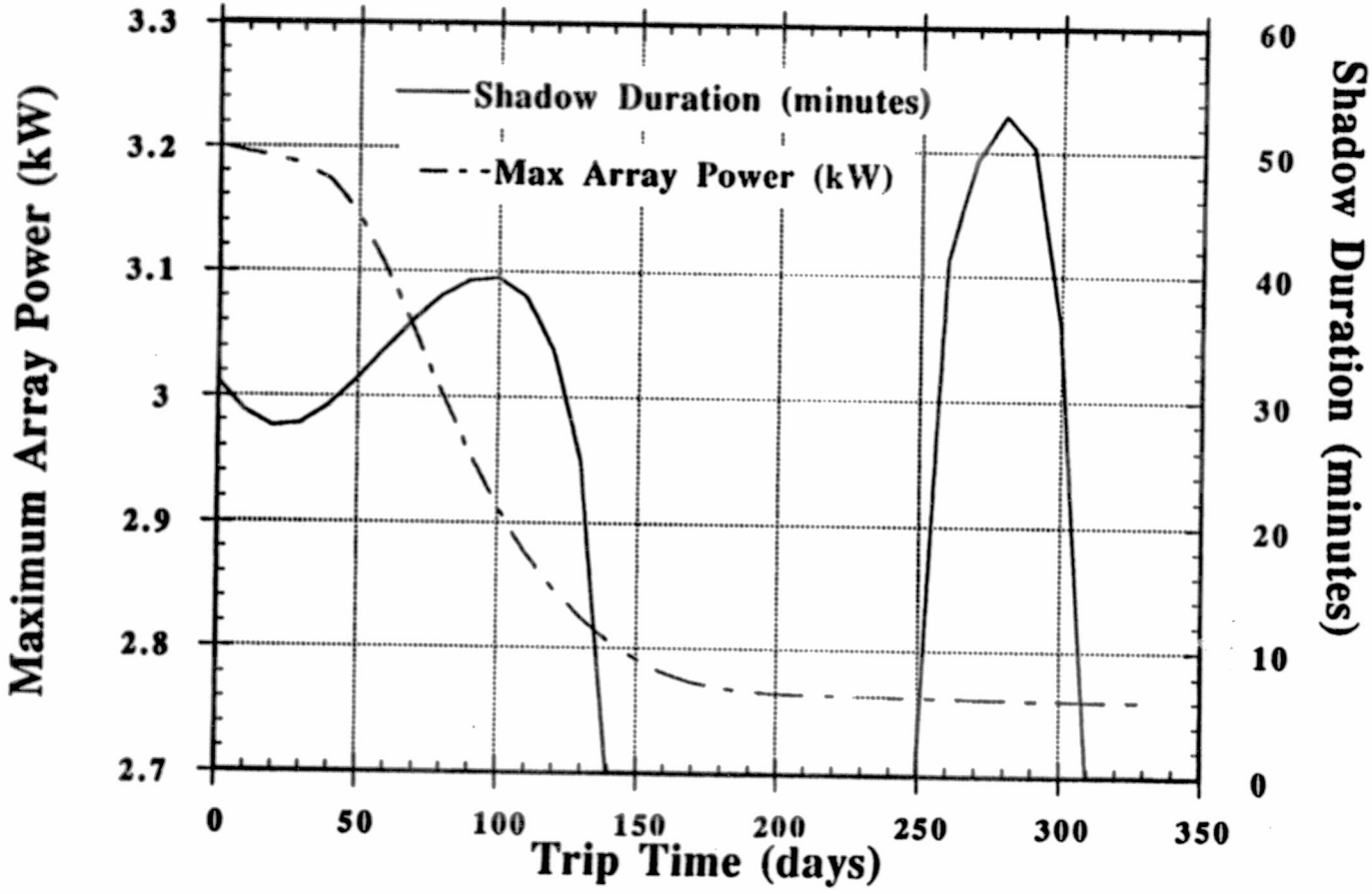
Solar Array Degradation and Shadow Duration vs. Trip Time

- Mission Trajectory Optimized for Science Requirements



Potential Customers

- **Applied Science**
  - **NASA & DOD** — SEP has application to highly maneuverable observation satellites
  - **Mid and high orbit spacecraft designers** — environmental interactions impact spacecraft and platform design
  - **Solar cell designers and array manufacturers** — measurements of different solar cell types as they degrade through the Van Allen radiation belts may lead to improved design
- **Theoretical Science**
  - **Plasma physicists** — characterization of plasma field at altitudes and inclinations not previously measured
  - **Geophysicists** — real time data on magnetospheric field line vibration and charged particle population

TROPIX Vehicle
To Use Solar Electric Propulsion (SEP)

- Maneuverability of SEP vehicle to different orbital planes enables large variation in data collection location
- Chemical mission designed to approximate SEP mission requires over 4 times initial mass in LEO
- Ion thrusters act as plasma contactors enhancing environmental interaction study
- Arrays
  - Act as solar cell degradation experiment
  - Large electrical power capacity for payload satisfies high power requirements
- Power availability allow mission operation design flexibility
- Slow transit time of electric propulsion permits many months of data collection
- Evolvable to other near earth, and possibly, lunar missions

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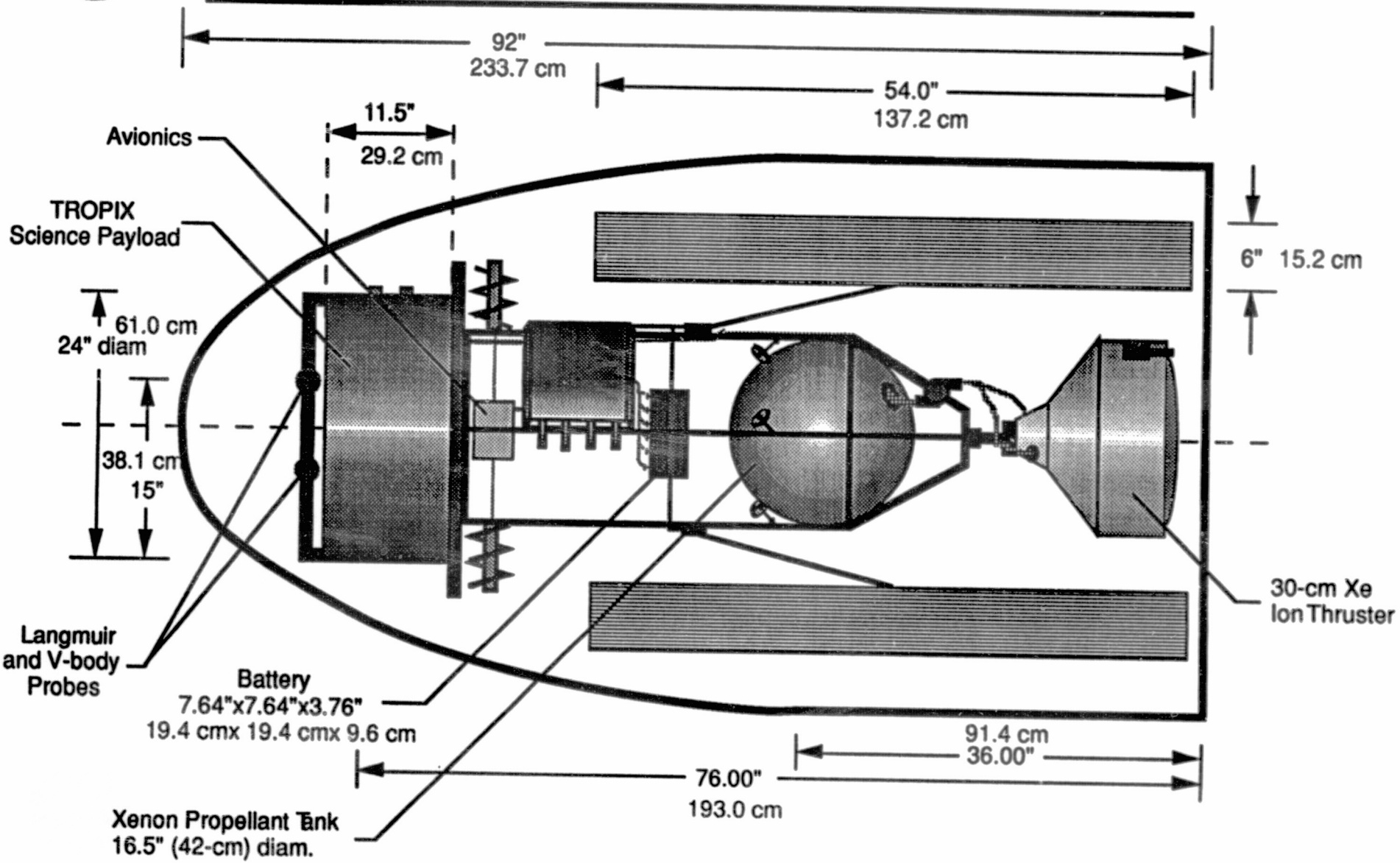
TROPIX Instrumentation

- **Science instruments based on SAMPIE, CRRES, and PASP+**
  - **V-body probe:** measure the potential of spacecraft relative to the surrounding plasma environment
  - **Langmuir probe:** measure plasma density and temperature
  - **Particle detectors:** characterize total plasma environment local to the vehicle to understand thruster efflux interactions with the plasma environment
  - **Four dosimeters:** determine the high energy electron and proton dose rates through the radiation belts
  - **Electrometers:** read the electric currents of test samples
  - **Test samples**
    - **Indium Phosphide solar cells without cover slides**
    - **"Plasma-proof" array test section**
    - **Array test section with overhanging coverslides**
- **Gallium arsenide arrays used as degradation test sample**
- **Xenon ion thrusters as plasma contactors**

TROPIX Spacecraft
Stowed Within Pegasus XL Fairing



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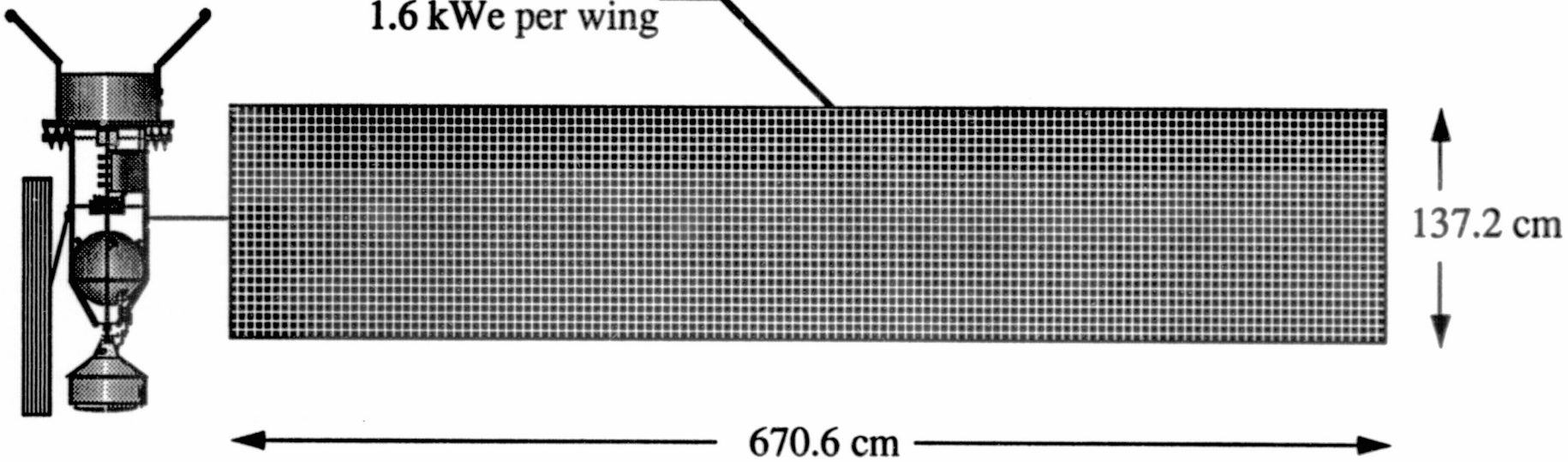
TROPIX With One Wing Deployed



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Next Steps

- Complete Team/Form Collaborations
- Characterize TROPIX experiment hardware interfaces and requirements
- Prepare for Phase A
  - Complete preliminary trades and analyses
  - Complete preliminary program plan
- Refine TROPIX concept
  - Determine and design components
  - Complete packaging scheme
- Prepare for Concept Design Review