Terrestrial Planet Finder Mission

TPF

Terrestrial Planet Finder Coronagraph

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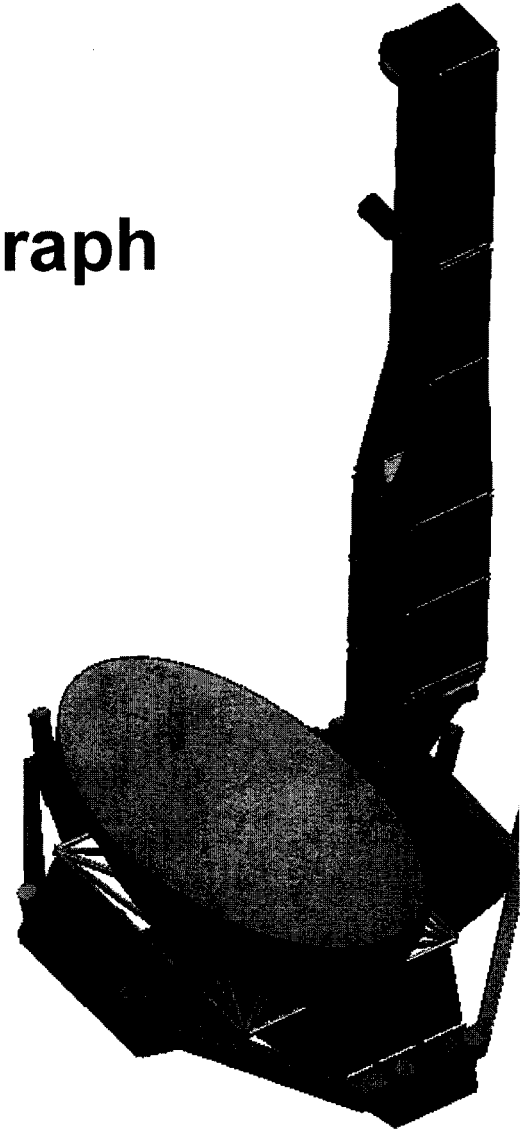
Jet Propulsion Laboratory, California Institute of Technology



A NASA Origins Mission

Earth- Finding Missions

PRIMARY SCIENCE OBJECTIVE
Detect and characterize Earth-like planets

METHOD

- Survey stars near Earth
- Detect planets orbiting the stars as points of lights
- Determine whether planets possess an atmosphere using low resolution Spectroscopy
- Analyze the spectrum for biomarkers of life

ADDITIONAL SCIENCE

- Study giant planets
- Study planetary atmospheres
- Image other celestial objects
- Study star and planet formation
- Study the formation and evolution of galaxies
- Observe galaxies with black holes
- Observe the center of our galaxy

ESA Darwin

Search nearby stars for terrestrial planets (MWIR)

ORIGINS

Keck Interferometer
Searching for planets in other solar systems

Space Interferometry Mission
Taking the measure of the universe

Terrestrial Planet Finder
Origins of stars, planets, and life

Michelson Science Center
Providing expertise in optical interferometry

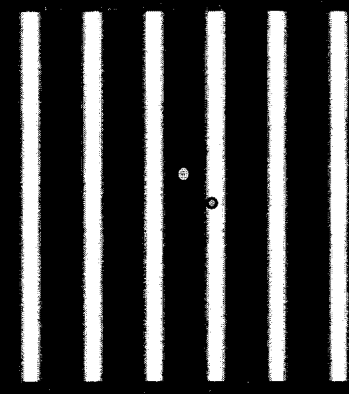
Kepler
A search for habitable planets

LBTI
An instrument for ground-based planet searches

TPF-I
(MWIR Interferometer)
Formation Flying
or
Structurally Connected

TPF Science Working Group

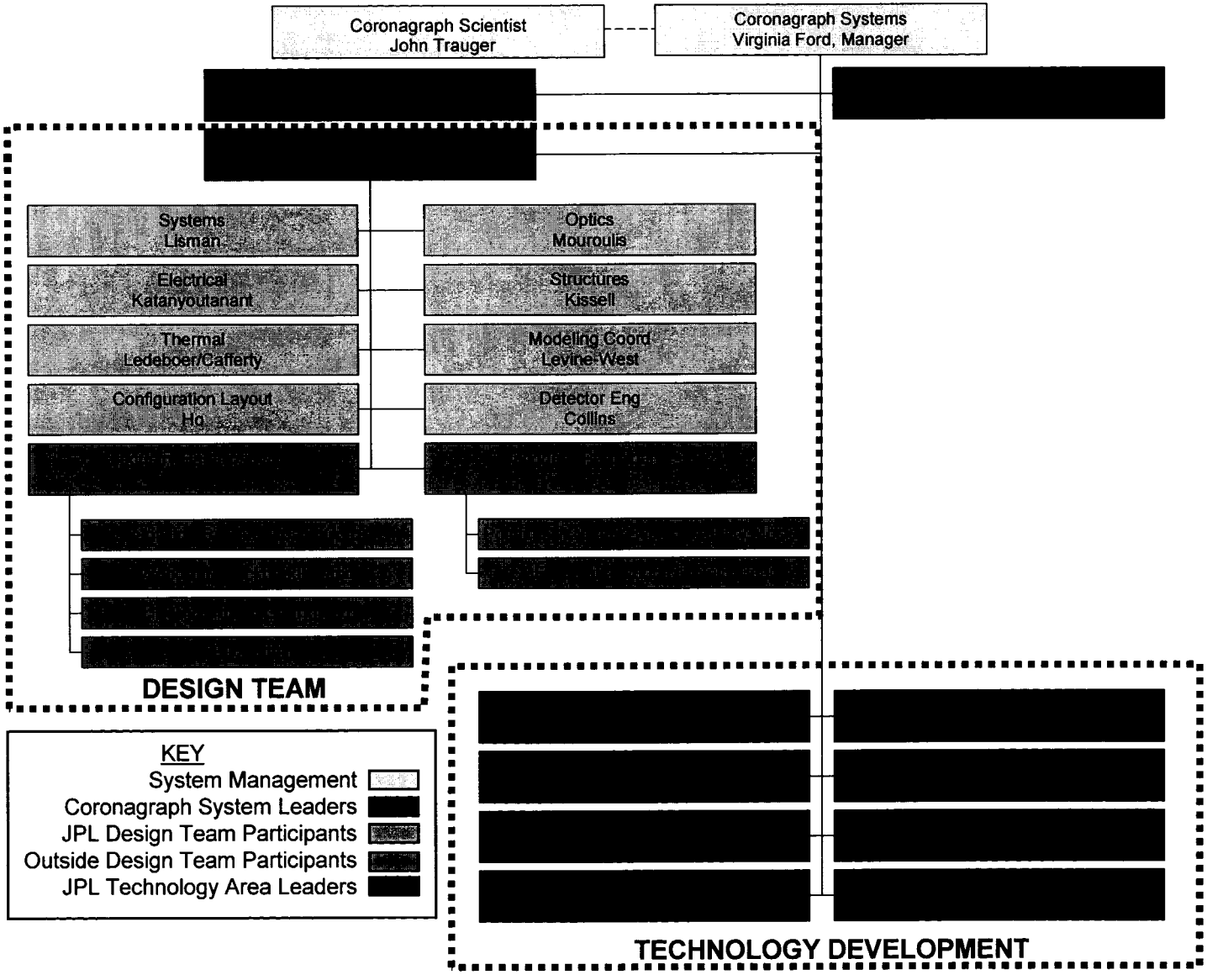
TPF-C
(Visible Coronagraph)



Interferometer

Coronagraph

TPF Coronagraph Organization



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Technology Demonstration Mirror

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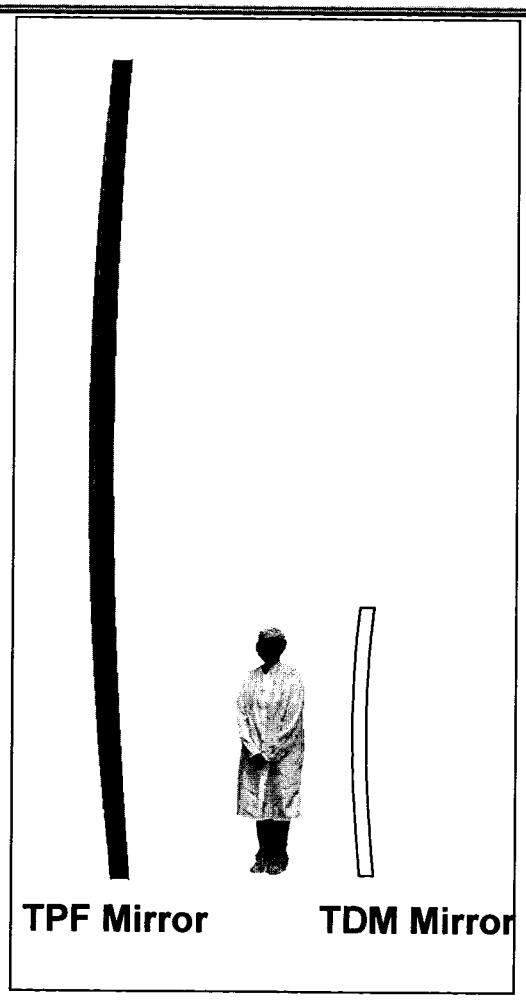

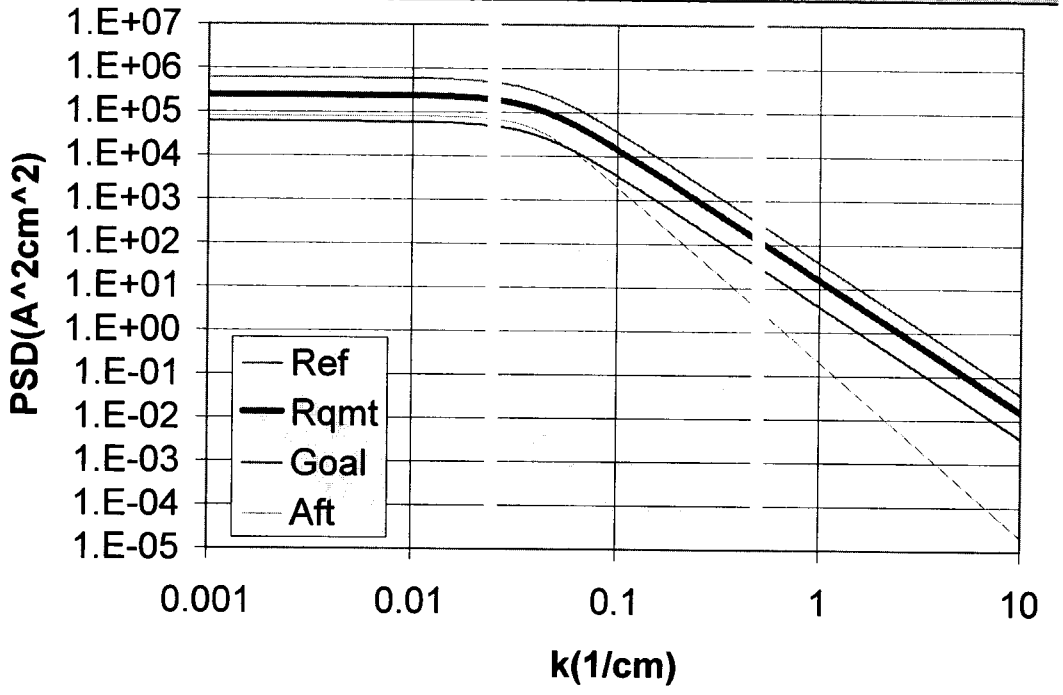

- TPF primary mirror features
  - -ellipse: 6-10 m major axis x 3.5-4.5m minor axis
  - -Off-axis paraboloid
  - -Surface accuracy specified based on spatial frequency

-TDM features

- -Circular, 1.8m CA, F no. 2.11
- -Off-axis paraboloid

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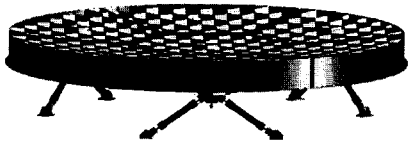
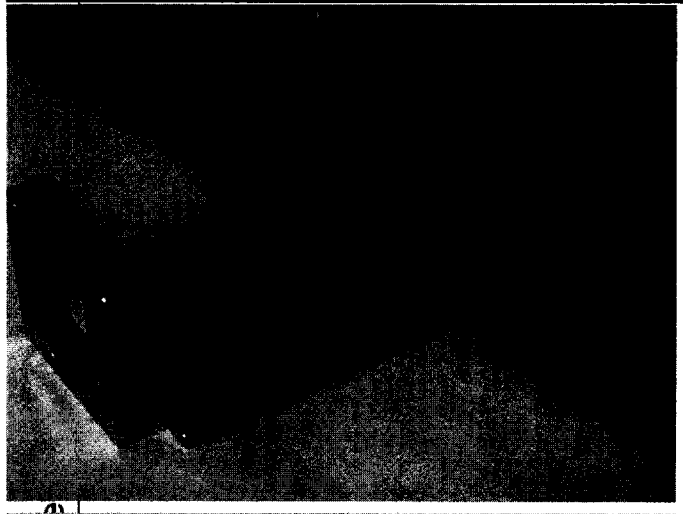
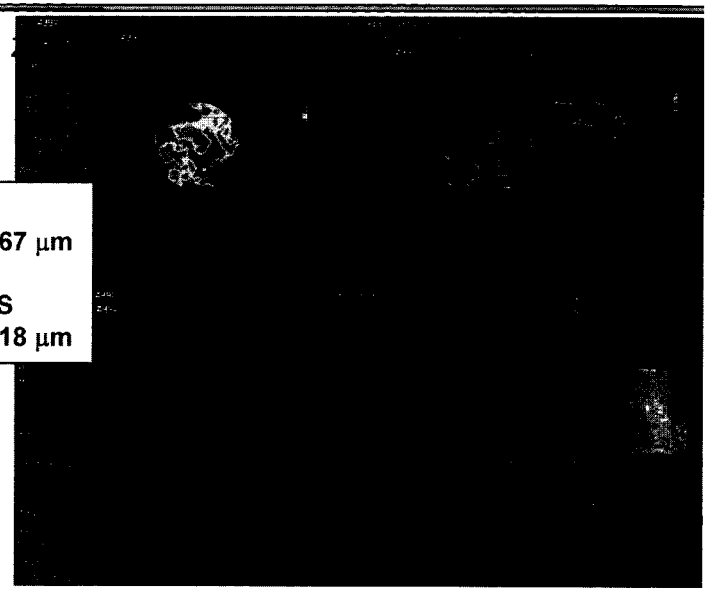
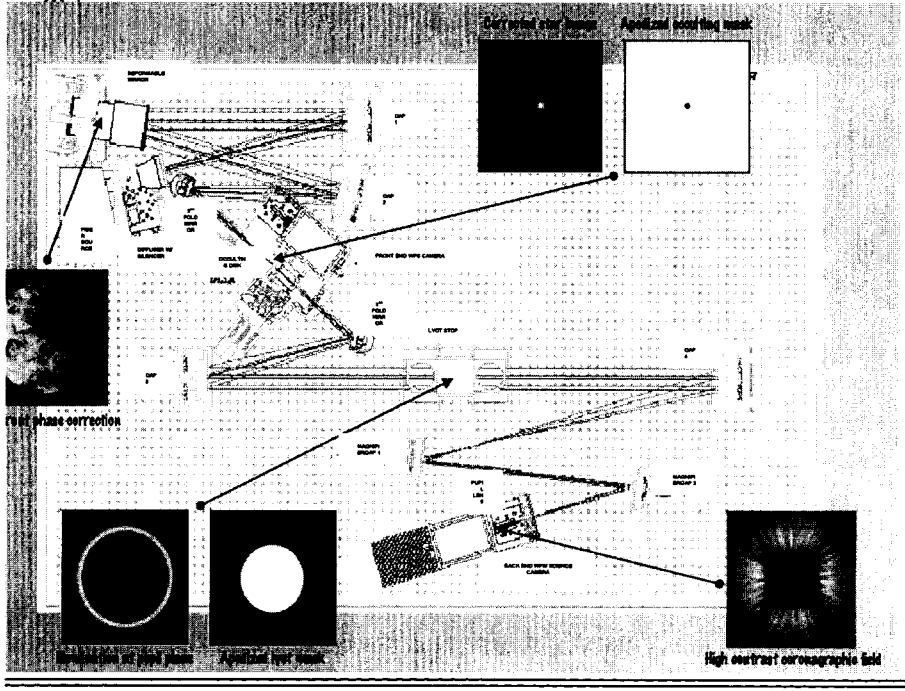


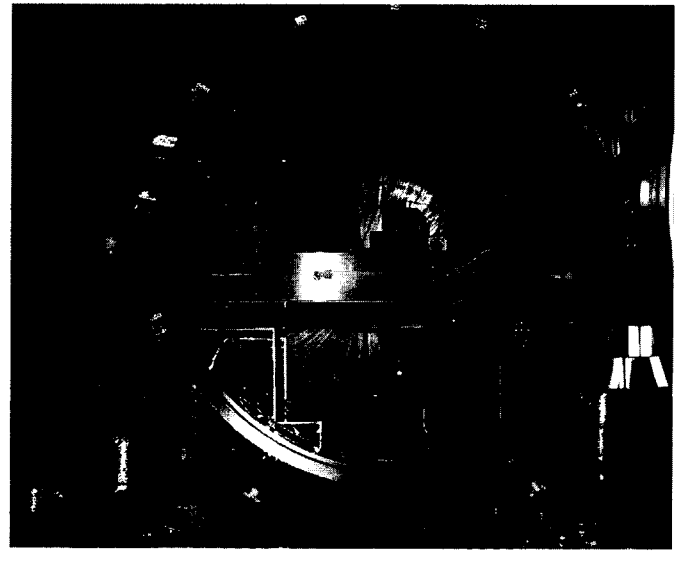
High Contrast Imaging Testbed



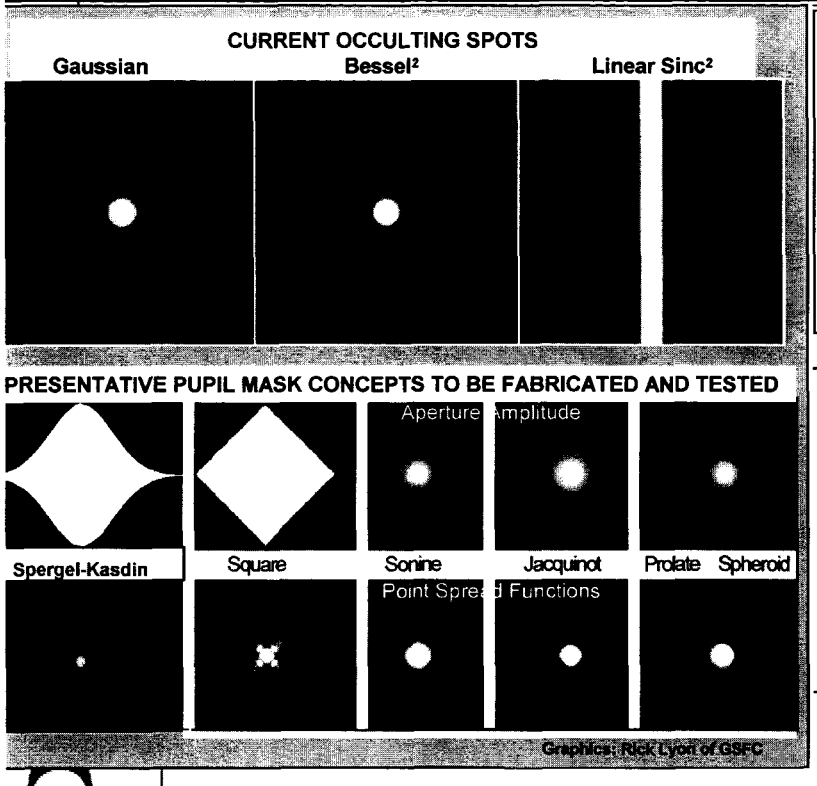
- Guest Testing of Coronagraph Concepts
- Wavefront stability - Angstroms
- Stable Vacuum Environment – μKelvin temperature stability, vibration isolated
- Flexible layout for trying alternate concepts Goal: Contrast = 10^{-10} at Q=1, 0.2 = DI/I

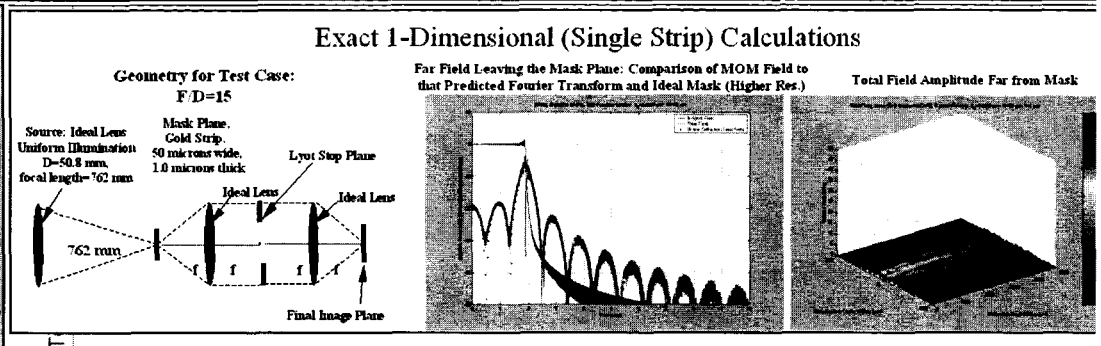


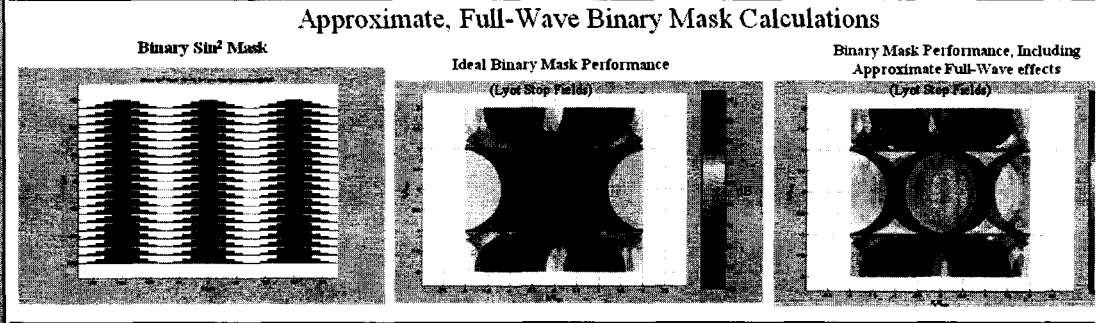




Masks and Stops







- **Activities:**
  - **Theoretical performance predictions and comparisons**
  - **Modeling – including substrate interactions, diffraction effects, tolerances**
  - **Fabrication of devices**
    - **Successful HEBS glass devices**
    - **Other methods tried with limited success so far**

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Modeling Efforts

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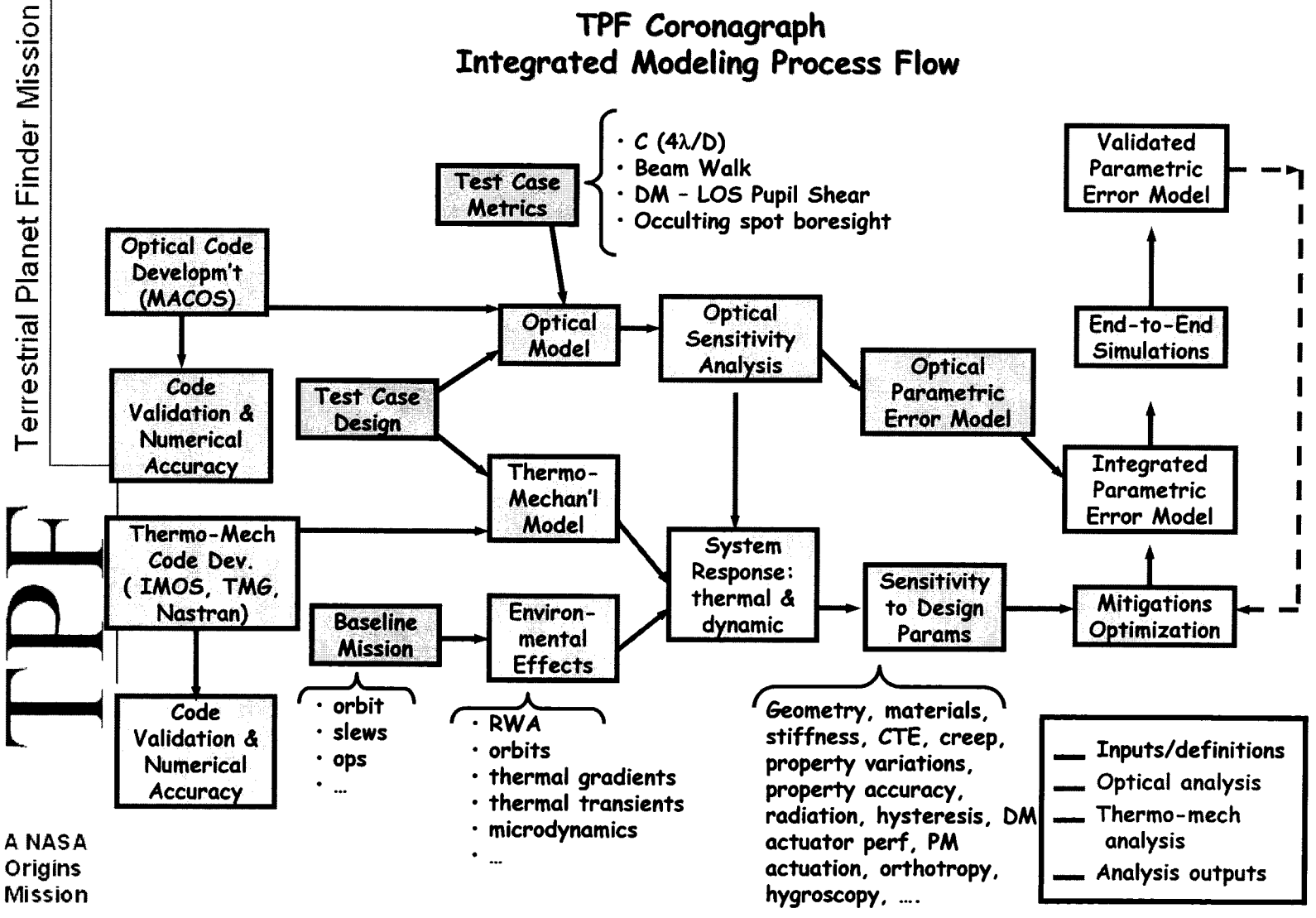

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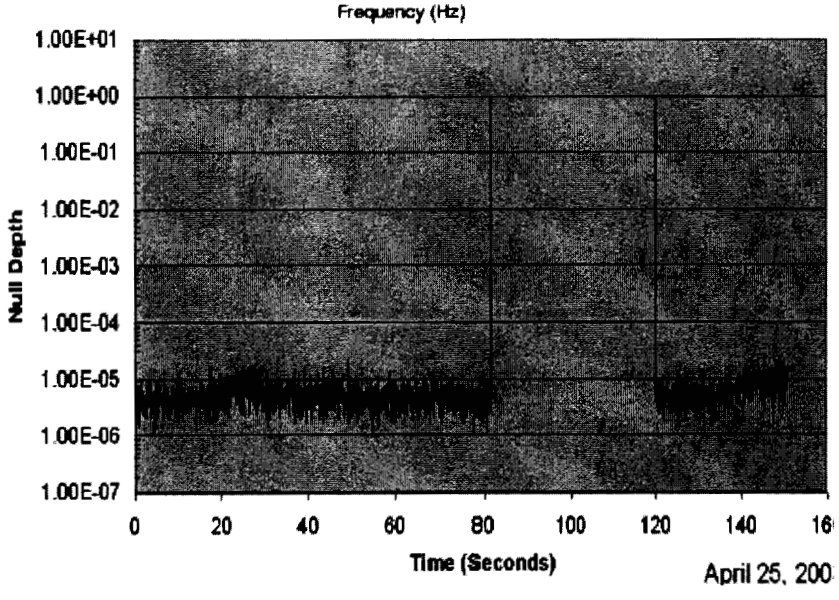
- Multiple modeling efforts
- Validation by comparison t HCIT performance and to each other
- Full end-to-end performance model is goa – for flight hardware design
- Code development to ensure accuracy anc efficiency

Other Technology areas

- Visible Nulling Coronagraph



- Contracts:
  - University solicitations
    - Technology Topics
  - Industry solicitations
    - TDM
    - Deformable mirror development
    - Telescope Front End Study – RFP due out Wednesday
    - Technology topics – due out by end of August

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Strawman Design relation to Schematic

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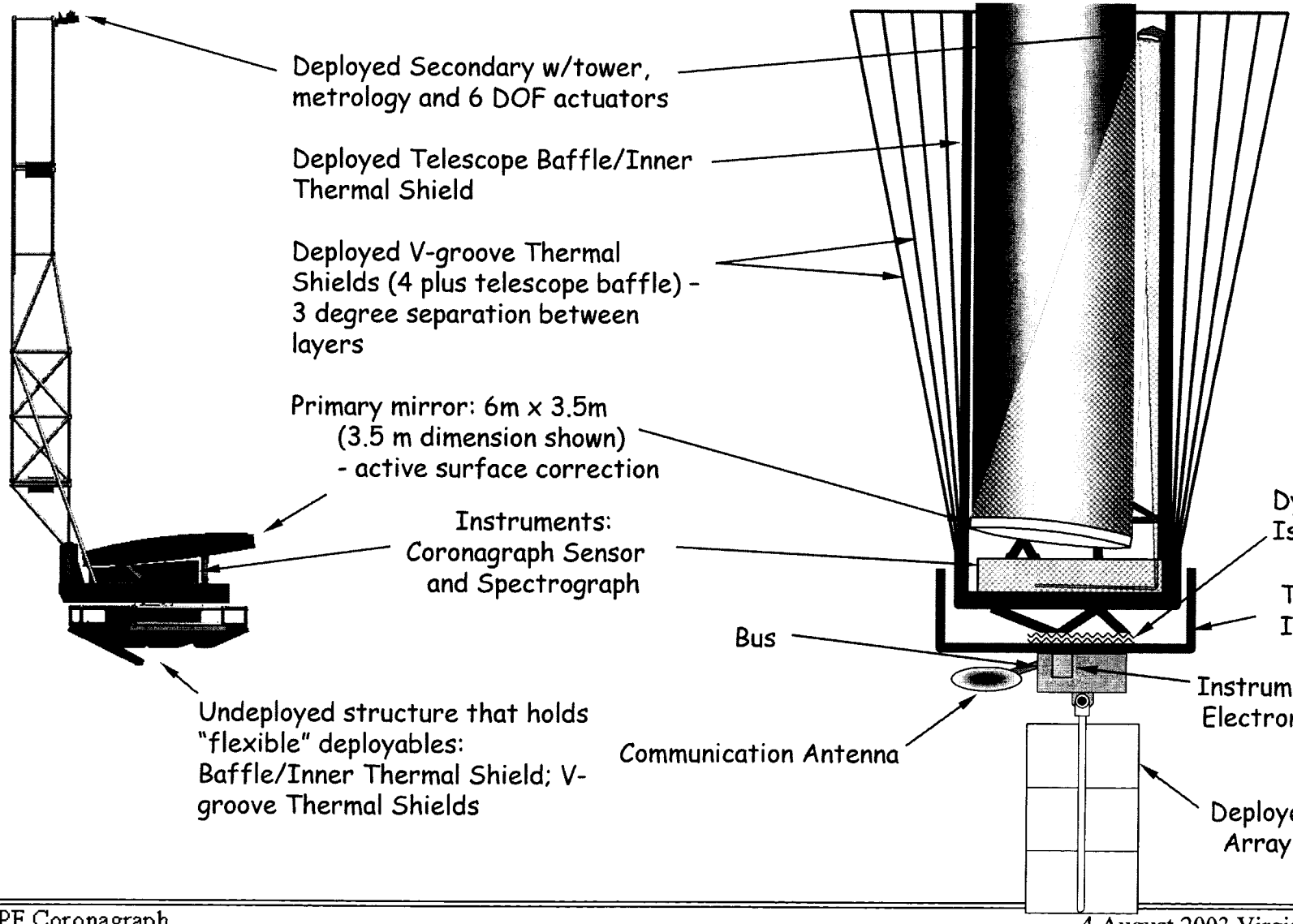

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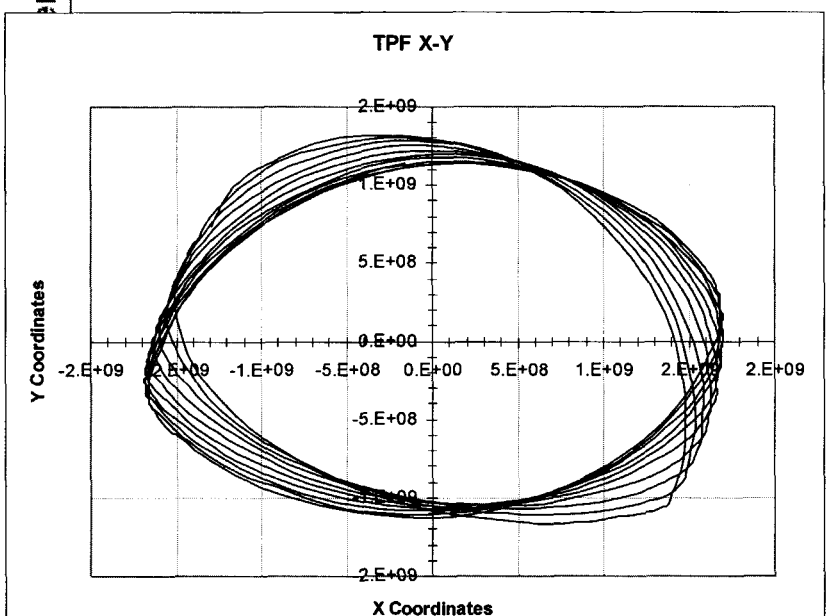
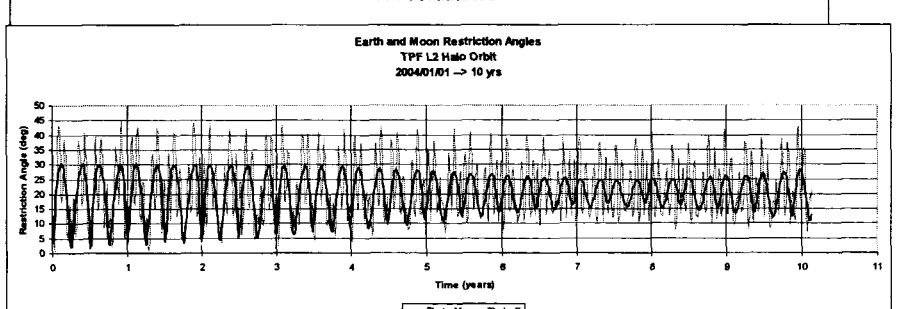
Design Team parameters

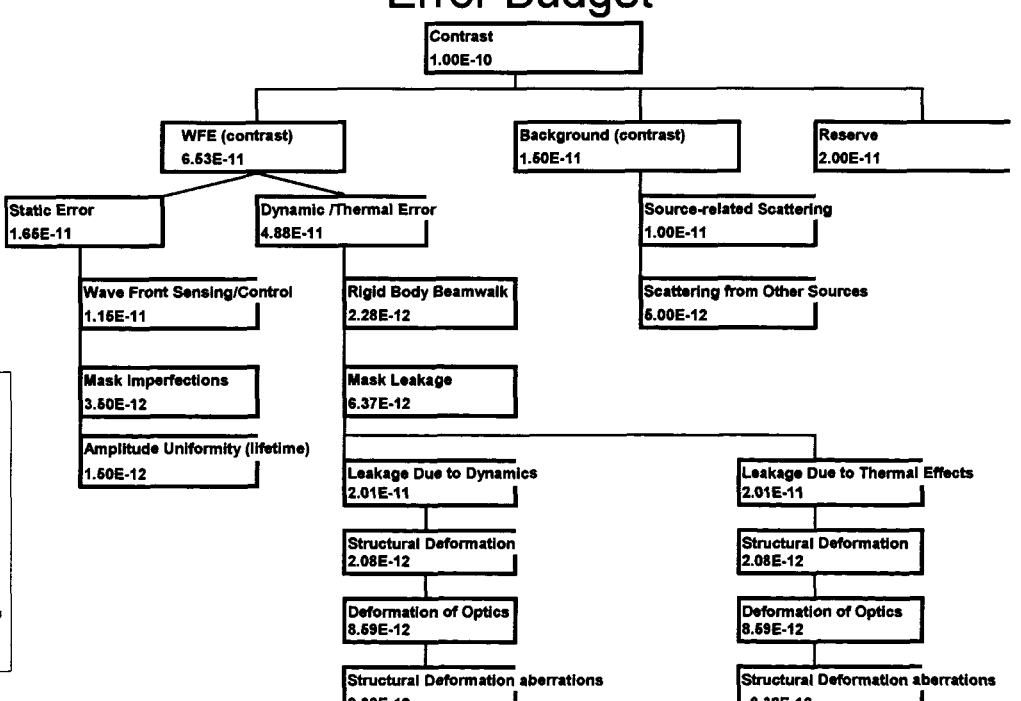




Science Requirements

Key Parameter	Full TPF	Minimum TPF
Number of Stars Visited	150	30
Spectral Range	0.3 to 1.1 μm	0.5 – 1.0 μm
Angular Resolution at $\lambda = 0.5$ μm	10 mas	30 mas
Inner Working Distance	30 mas	63 mas
Outer Working Distance	2000 mas	1000 mas
Contrast	10^{-10}	10^{-10}
Stability timescale	4 sec	10 sec

Error Budget



Strawman Design

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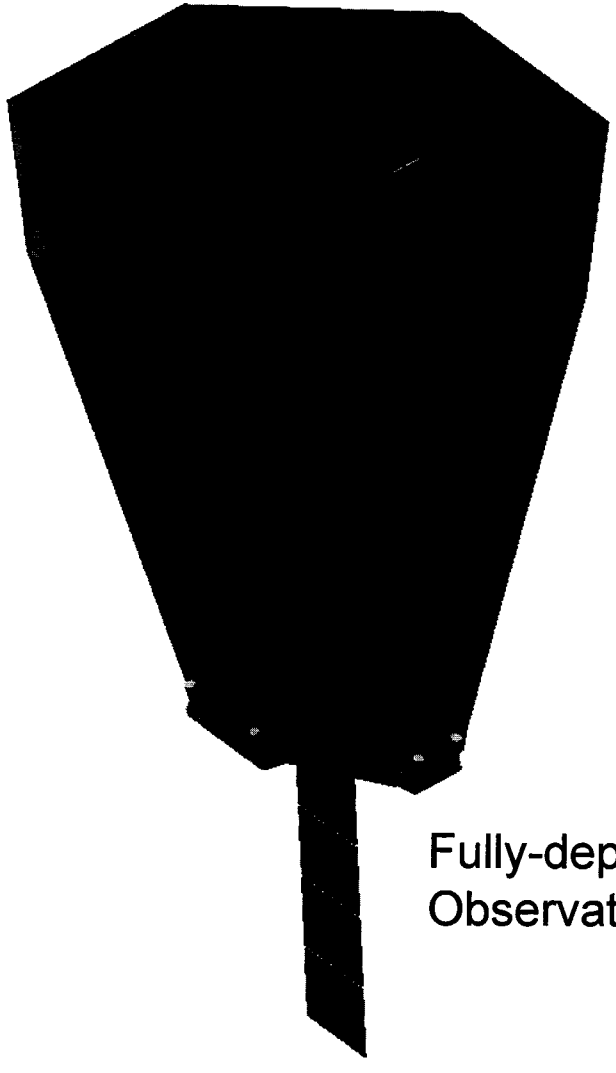
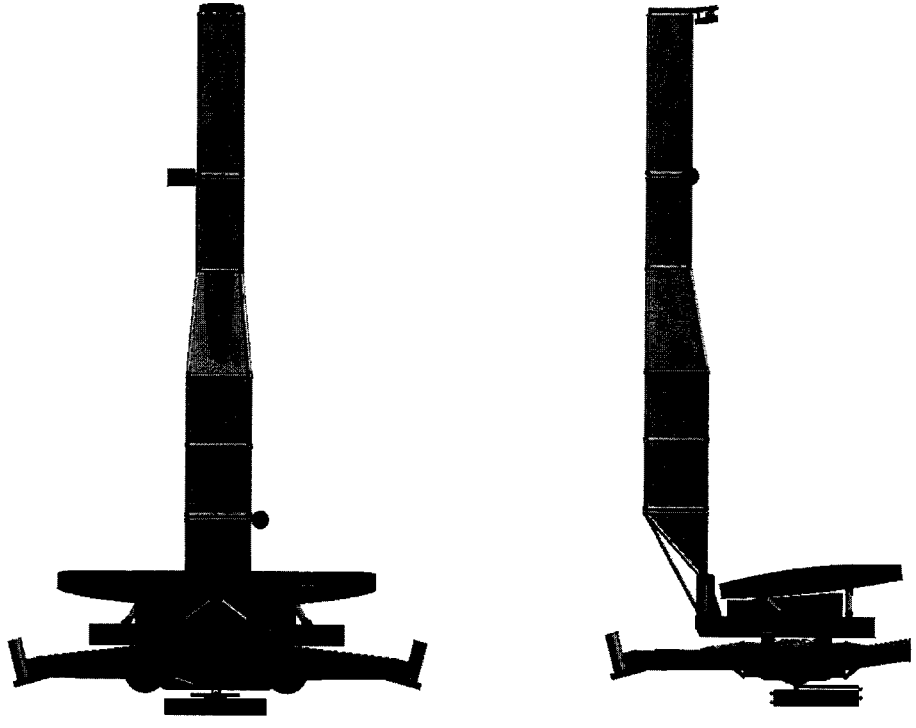


Fully-deployed Observatory



Deployed except for Thermal shields and light baffle

Stowing sequence in Delta IV Heavy

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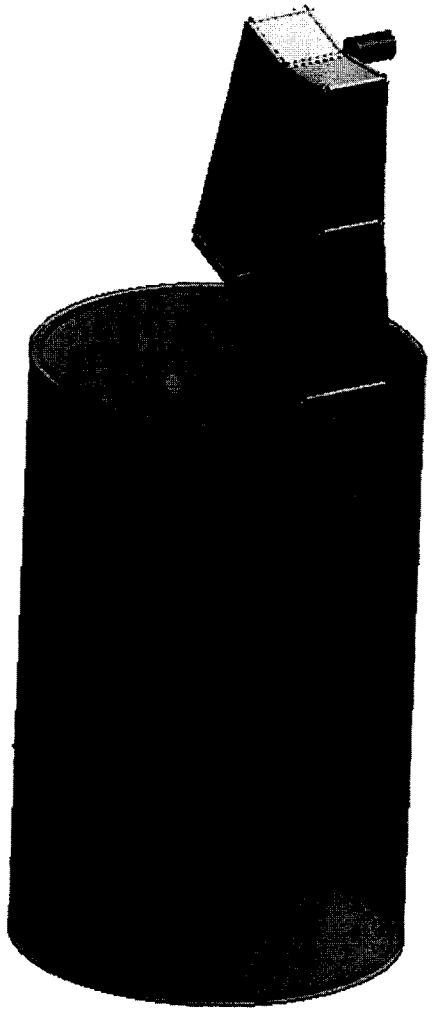
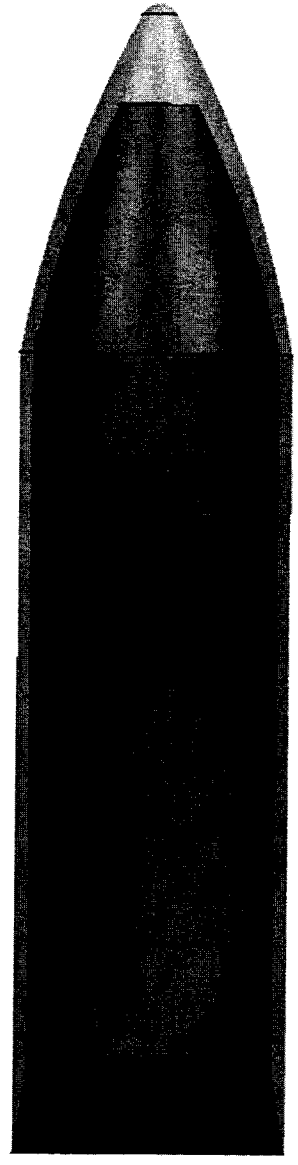
Folded



Installed in clam-shell support



In launch vehicle shroud