Suborbital Flight Testing of a Deployable Reflector

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Deployable Structures

"A deployable structure is an assembly of prefabricated members or elements that can be transformed from a closed compact or folded configuration to a predetermined expanded form of a complete stable structure capable of supporting loads."

Deployable Structures, Analysis and Design, C.J. Gantes



Deployable Reflectors

- Began with ground operations, then necessary for space
- Most radially compact only: not for CubeSats!
- Project: Design 1-meter reflector to deploy from CubeSat
 - Focus on kinematics of stowage
 - Avoid furlable designs: mesh, inflatable







Pictures from: "Shape Memory Materials" K. Otsuka & "Overview of Deployable Stuctures" T. Murphy

Design Concept Overview

Surface: Segmented carbon-fiber parabolic shellStowage: Gores wrapped around central hubDeployment: Simple, autonomous





Spiral Gore Pattern

- Avoid twisting deformation
- Optimize packing volume

Design Concept



- Interlocking 'Pantograph' perimeter
- Elastic folding is simpler than joints and mechanisms
- No complex joints, complicated pieces, or interference

Reflector Deployment

Model Deployment









Test Reflector Deployment



Suborbital Flight Test

- Purpose: Test deployment kinematics and structural dynamics of a deployable reflector
- Necessity: Complicated dynamics cannot be studied in 1-g



Experiment Setup



Meets mass, dimensional and power requirements

Data Collection and Analysis

- Quantitative: stereophotogrammetry for estimation of the three-dimensional coordinates of a large number of points on the reflector
- Qualitative: video footage



Conclusions

- Novel deployable reflector design with interlocking wrapping gores has been invented
- Microgravity environment is required for studying deployment and dynamics of a new reflector design
- Suborbital flight provides the necessary time frame to characterize the deployment kinematics, vibration modes, and damping

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