Sunjammer
Solar Sail
Demonstration

June 7, 2012
L’Garde Inc
Tustin CA
Sunjammer Name

Sunjammer is a story by the late Sir Arthur C. Clarke that detailed a race of solar sail yachts.

The coining of the term “solar sailing” is attributed to this story.

Sir Clarke’s estate has granted permission for L’Garde/NASA to use the name for this mission.

Dear Mr Barnes

Georgia is away at the moment, but on her behalf I am pleased to be able to let you know that we may grant you non-exclusive permission to use ‘Sunjammer’ as the name of your NASA mission.

Please would you keep Georgia informed of what happens next? I would also be grateful if you could send updates to the Arthur C Clarke Foundation in the US informed, especially its Vice Chair, Professor Joseph Pelton, who has worked on space transport systems for decades. His address is joepelton@verizon.net

Thanks and best wishes

Marigold

Marigold Atkey
Assistant to Anthony Goff and Andrew Gordon

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One of the great challenges NASA faces incorporating advanced technologies into future missions is bridging the gap between technology development and initial mission infusion.

Demonstration is Critical Component!!
L’Garde Solar Sail Heritage

Key In-Space Propulsion (ISP) Sail Personnel Involved in TDM Project

Design Features
- High Density Packagability
- Controlled Linear Deployment
- Structural Scalability
- Propellantless Operation
- Meets Current Needs
- Meets Future Desires

Design Heritage
- Cold Rigidization Boom Technology
- Distributed Load Design
- Aluminized Sun Side
- High Emissivity Eclipse Surface
- Beam Tip Vane Control
- Spreader System Design

83 m² ISP L’Garde Solar Sail 2004
318 m² ISP L’Garde Solar Sail 2005
170 m² JAXA Ikaros 2010
1200 m² L’Garde Sunjammer Launch 2014
Sunjammer

**Description:** Small Sat Sailcraft extending a 1200m² Solar Sail on a 1 year mission

Technology Readiness Level (TRL)
TRL 5 to TRL 9

**Launch Mass:** 112 kg / **Spacecraft Volume:** 1m³

**Benefits:**
The end goal is the deployment, flight, and navigation of a mission capable solar sail to demonstrably prove the efficacy of solar sails. With this mission, L’Garde will advance the technology of solar photon propulsion.

**Life Cycle Cost (LCC)**

<table>
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<th>Updated LCC Requirement (2011.1.26)</th>
<th>FY12</th>
<th>FY13</th>
<th>FY14</th>
<th>FY15</th>
<th>FY16</th>
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<tr>
<td>Mission Costs</td>
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<td>Launch Costs</td>
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<td><strong>Project Estimated LCC in $M</strong></td>
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<td></td>
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**Key FY12CR Activities:**
- Finalize Contract
- Project Formulation
- Restart of the solar sail fabrication capability
- Establish mission requirements
- Develop preliminary design

**Key Milestones:**

<table>
<thead>
<tr>
<th>Tests ØB</th>
<th>Reviews</th>
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<tbody>
<tr>
<td>Test Short Tubes – 1/2012</td>
<td>SRR – 1/2012</td>
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<tr>
<td>Test Sail Coupons – 1/2012</td>
<td>PDR – 9/2012</td>
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<td>Test Vane Mechanism – 4/2012</td>
<td>CDR - 9/2013</td>
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<td></td>
<td>FRR - 9/2014</td>
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<td>Launch- as early as 10/2014</td>
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Mission Overview

Demonstrated Objectives

1. Demonstrate segmented deployment of a solar sail
2. Demonstrate attitude control plus passive stability and trim using beam-tip vanes.
3. Execute a navigation sequence with mission-capable accuracy.
4. Fly to and Possibly Maintain Position at L1 and/or Pole Sitter Positions
Conceptual Design (1/3)

Sailcraft

Carrier
Conceptual Design (2/3)

- Hydrazine Tank
- Canister Doors
- Stowed Boom
- Stowed Spreaders
- N2 Tanks
- Separation Band
- RCS Thrusters
Conceptual Design (3/3)

Sunjammer
Before
Carrier
Jettison

~1200m²
Sail Area

Camera
Boom

Directional
Antenna

Control
Vanels
Importance of Infusion

Demonstration is Not Enough – TDM Programs Need Infusion Into Other Agencies and Commercial Entities

**To NASA**

- Without a credible path to infusion, the TDM program might be another unfulfilled research program.
- Successful infusion of the technology will demonstrate the technology development capabilities of the TDM, OCT, and NASA as a whole.

**To L’Garde**

- As a commercial entity L’Garde is committed to infusing technology.
- *Our business model is committed to successful infusion.*
- L’Garde is an ideal partner to help demonstrate the infusion ideals promoted by TDM.

**To Partners**

- With a successful infusion effort all participants benefit. There are applications ready to incorporate these technologies but, demonstration and infusion are needed.

**To Country**

- For taxpayers, successful infusion will mean a significant ROI on tax dollars already invested.
# Infusion Opportunities

## NASA
- **Heliophysics**: Near Term
- **Communication**: Mid Term
- **ADR/ODR**: Long Term

## NOAA
- **Storm Warning**: Near Term
- **Communication**: Mid Term

## DOD
- **STP**: Near Term
- **Communication**: Mid Term
- **ADR/ODR**: Long Term

## SSHI
- **Celestis Payloads**: Near Term
- **Advertising Rights**: Mid Term
SSHI Solar Sail Heritage

- SSHI – 30 years in commercial space
- Solar Sail Missions
  - Team Encounter: >$6m invested, NASA Space Act Agreement (SAA), NOAA data purchase = significant solar sail technology advance
  - NOAA: 5 studies to date; Sentinel Satellite commercial space weather missions; >$2m
- Other commercial missions: South Pole communications; Lunar communications; entertainment missions

Mission Benefits

- Opportunity to fund costs, extended mission ops, even an insurance policy for a second mission
- Augment public outreach and education, and support
- Validate commercial business model for future missions

NASA TDM Mission

- SSHI selected for secondary payloads (Celestis, Inc.) and public outreach augmentation via commercial rights (sponsorship, internet)
- SSHI commitment: $250k - $1m cash and $100k website development
- Currently considering augmenting commitment – seeking to expand cash contribution

Implementation

- Seeking SAA. NASA must approve: Requires non interference with primary mission objectives; Must be appropriate sponsor partners
- Ample precedents: Most notable - Lego to Jupiter
Program Status

Reviews
- TAG
- TIM1
- SRR/MD
- KDP-B
- PPBE
- TIM2
- TIM3
- TIM4
- PDR
- KDP-C

Docs
- Project Plan
- SRR/MDR
- ODAR
- PPBE
  - PDR

Design
- Requirements Def.
- Mission Design
- Cycle 1
  - Cycle 2
  - Cycle 3
Sunjammer

Demonstration Objectives:
• Fly a Mission Capable Sail
• Minimize Mission Cost
• Draw From Heritage
• Demonstrate Risk Tolerance

Rapid Demonstration:
Flight Ready in Three Years

✓ Sunjammer Has a Tremendous Legacy Foundation
✓ Sunjammer Will Enable Critical Science Missions
✓ Sunjammer Will Help Commercialize NASA Technology

-Final Demonstration-