

## StarShade Readiness Working Group (SSWG) - Charter

1/14/2016

### A. Background

The search for Earth-like planets orbiting other stars and their subsequent characterization for evidence of life will require the ability to directly image exoplanets. NASA's Astrophysics Division (APD) within the Science Mission Directorate (SMD) intends on having two direct-imaging techniques sufficiently matured for possible recommendation by the 2020 Decadal Survey Committee. The starshade concept is one of two high-contrast imaging technology architectures that will be studied. The Astrophysics Division chartered and recently completed two probe-scale mission concept studies<sup>1</sup> to explore what compelling exoplanet direct-imaging science could be performed within a ~\$1B lifecycle cost. The Science and Technology Definition Team (STDT) for the Exoplanet Starshade (Exo-S) delivered two concepts for external occulter missions using a ~30m deployable starshade flying in formation with an imaging telescope, and the STDT for the Exoplanet Coronagraph (Exo-C) delivered a concept for an internal occulter mission

A starshade technology plan to achieve TRL 5 was delivered by the Exo-S STDT and is being updated by the Exoplanet Exploration Program (ExEP) with community input for submission to APD in CY16 for planning and funding purposes. The plan to advance from TRL5 to a flight mission has not yet been fully developed nor vetted. It is widely assumed that some form of subscale starshade flight demonstration would be required before NASA implemented a starshade as a core element of a large mission involving exoplanet imaging and characterization. The Starshade Rendezvous science mission concept, one of the two architectures delivered by the Exo-S STDT, would be another example of one such prior demonstration. Therefore, **a technical concept and risk reduction plan for the technology validation of starshades from TRL5 to TRL 6/7 is required to prioritize technology investments that enable starshade science flight missions to be considered in the 2020 Decadal Survey.**

For operational purposes this working group will assume the *Starshade Rendezvous* mission concept, one of the two architectures delivered by the Exo-S STDT, as a point of reference to motivate the performance requirements for technology readiness. The Starshade Rendezvous concept study assumed that a 34-meter starshade is flown in formation with WFIRST, as an example, or any large telescope in an L2 orbit. Although the Starshade Rendezvous mission concept documented by the STDT is in fact a range of mission options, the one case studied and documented in detail is considered to be reasonably sufficient to initially motivate performance

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<sup>1</sup> <http://exep.jpl.nasa.gov/stdt/>

requirements and technology drivers for the class of missions that may be considered at the time of the next Decadal Survey, until such time as updates are delivered by the large mission study team recently chartered by the Astrophysics Division.

## **B. Deliverables**

The Exoplanet Exploration Program Office (ExEPO) is directed by the NASA Astrophysics Divisions to:

1. Develop and deliver to the NASA Astrophysics Director by July 2016 a recommendation for a plan to validate starshade technology (to TRL 6/7) that is both necessary and sufficient prior to building and flying a Starshade Rendezvous science mission. The recommendation will best satisfy the architecture and technical goals for the Starshade Rendezvous option studied by the Exo-S STDT, the NASA definitions for technology readiness prior to project formulation and project implementation, and programmatic criteria including risk, schedule, and cost.

## **C. Participation**

The APD is committed receiving a recommendation produced through active and open engagement with the community. The following groups will participate in the study:

1. A **Working Group** consisting of engineers and scientists who are representative of the breadth of starshade technology, including representatives from government and academia.
2. A **Steering Committee** (a subset of the Working Group) responsible ensuring adequate community representation and for assisting the chairpersons in setting agendas and evaluating progress.
3. **Subject Matter Experts (SMEs)** as needed and approved by the Steering Committee
4. An independent **Technical Advisory Committee (TAC)** approved by the APD to provide technical assessment of the recommendation.

D. **Structure of the Work:** The process leading to a recommendation to APD is illustrated in Figure 1 and the attached schedule.

- Kickoff with Steering Group (December 2015)
- [1] The Exo-S-ES STDT will deliver the science and technology goals of a possible WFIRST Starshade Rendezvous mission concept to provide the framework for the validation recommendation.
- [2] The ExEPO Chief Technologists Team will deliver the TRL 5,6,7 success criteria tailored to starshade mission technologies.
- [3] Advocates will propose technical validation concepts and approximate implementation plans
- [4] The Working Group will, as a whole, analyze figures of merit (both technical and programmatic) relative to the TRL criteria
- [5] The ExEPO Chief Technologist Team will deliver an assessment of the degree to which the proposed validation concepts against the TRL 5,6,7 success criteria, considering completeness and risk
- [6] The Technology Management Team will deliver an assessment of the cost, schedule and viability of the plans to implement the concepts
- [7] The TAC will provide an independent analysis of the proposed validation to meet the TRL criteria
- [8] By July 2016 the co-chairs will deliver a joint recommendation to the Astrophysics Division Director [9]

The SSWG is expected to consist of approximately two face-to-face workshops of 1-2 days duration and supporting biweekly telecons that enable virtual participation by all participants. The Space Technology Mission Directorate will be briefed periodically on the progress of the working group.

## Working Group Membership

- **Co-Chairs:**
  - Sara Seager MIT
  - Gary Blackwood NASA ExEP/ JPL
  
- **Steering Committee**
  - Nick Siegler NASA ExEP/ JPL – Chief Technologist
  - Karl Stapelfeldt NASA ExEP / JPL – Chief Scientist
  - Tupper Hyde NASA / GSFC
  - Remi Soummer STScI
  - Tom Greene NASA / ARC
  - Charlie Noecker NASA / JPL
  - Mark Melton NASA / GSFC WFIRST
  
- **Members (C = Confirmed)**  
(aim to reach to consensus, including Steering Committee)
  - Web Cash CU Exo-S STDT
  - Jeremy Kasdin PU Exo-S STDT
  - Maggie Turnbull Global Sci. Exo-S STDT
  - Stuart Shaklan NASA / JPL Exo-S STDT
  - Mark Thomson NASA / JPL Exo-S STDT
  - Doug Lisman NASA / JPL Exo-S STDT
  - Aki Roberge NASA / GSFC Exo-S STDT
  - Kerri Cahoy MIT
  - Bobby Braun Georgia Tech
  - Matt Greenhouse NASA / GSFC
  - Brent Knight NASA / MSFC
  - Denise Podolski NASA HQ / STMD
  - Steve Battel Battel Engineering
  - Keith Warfield NASA ExEP/ JPL – Chief Engineer
  - Lee Feinberg NASA / GSFC JWST
  - Goeff Andersen US Air Force Academy
  - Joe Pellicciotti NASA/ GSFC JWST
  
- **Subject Matter Experts and Guests:** (participate, but not as part of Members consensus group). Individuals will include those representing:
  - Analysts for Science and Technical figures of merit
  - NASA Astrophysics Division, Science Mission Directorate
  - NASA Science and Technology Mission Directorate
  - Industry
  - ExoTAC

- **Subject Matter Experts and Guests:** (tentative, C=confirmed)

Analysts for Science and Technical figures of merit:

- Dan Scharf NASA / JPL
- Robert Laskin NASA / JPL
- Peg Frerking NASA / JPL
- Simone D’Amico Stanford
- Neerav Shah NASA / GSFC
- Mark Clampin NASA / GSFC
- Bruce Macintosh Stanford

SMD representative

- Douglas Hudgins NASA APD

STMD representative

- Jeff Sheehy NASA HQ / STMD
- Keith Belvin NASA HQ / STMD

Industry

- Chip Barnes Ball Aerospace
- Alison Nordt Lockheed Martin
- Tom Kessler Boeing
- Kurt Klaus Boeing
- Steve Warwick Northrop
- Jon Arenberg Northrop

WFIRST:

- David Content NASA / GSFC – WFIRST

ExoTAC

- Alan Boss Carnegie Institution DTM
- Joe Pitman Exploration Sciences
- Lisa Poyneer LLNL
- Steve Ridgway NOAO
- Keith Patterson NASA / JPL

E-SIGNED by John Gagosian  
on 2016-01-15 18:41:56 GMT

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*Douglas M. Hudgins*

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NASA Headquarters

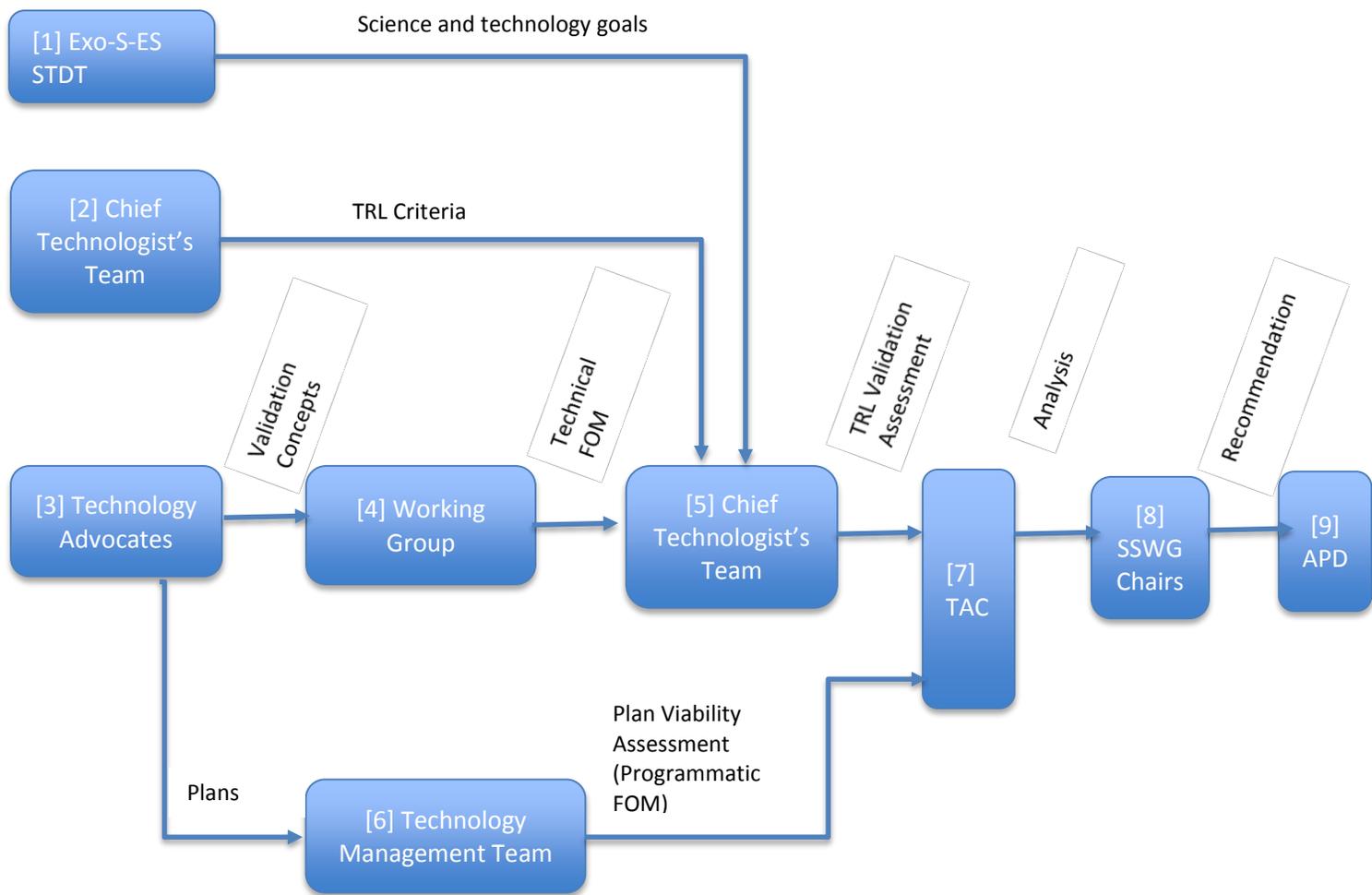


Figure 1: Work Flow

# SSWG Top Level Schedule

\* Tentative Dates

Rev. 1/12/2016

	FY16									
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	
<b>Events</b> Telecons Workshops		12/18 Kickoff	1/12 #1 2/11-12*	2/11		3/10 #2	4/7	5/5 #3 (optional)	6/2	6/30
<b>Community &amp; Customer Interface</b>				Briefing to STMD			Briefing to STMD			
<b>[1] STDT</b> Science & Tech. Goals			Concept Goals Delivered* 1/15							
<b>Advocates</b> [3] Validation Concepts Technology Plans TRL Assessments				Options		PFOM				
<b>[4] Working Group</b>						TFOM				
<b>ExEPO Chief Technologist</b> [2] TRL Definitions [5] TRL Assessment			TRL 5,6,7 Delivered*			Deliver Assessment				
<b>[6] Technology Manager</b> <b>[7] TAC</b> <b>ExEPO</b> [8] ExEPO Recs. to APD			SSWG Glossary PFOM: Programmatic Figure of Merit SFOM: Science Figure of Merit SSWG: Starshade Readiness Working Group STDT: Science & Technology Definition Team STMD: Space Technology Mission Directorate TAC: Technology Analysis Committee TFOM: Technical Figure of Merit TRL: Technology Readiness Level * Tentative Date				Deliver Analysis	Deliver Analysis	Deliver Validation Plan to HQ*	
▽ Milestone      ▼ Completed Milestone      ◻ Planned Activity										
										Scheduler: G. Luzwick