Active Project (2014 - 2017)

AFTA-WFIRST Coronagraph Technology (ACT) Development Project

Game Changing Development Program | Space Technology Mission Directorate (STMD)

ANTICIPATED BENEFITS

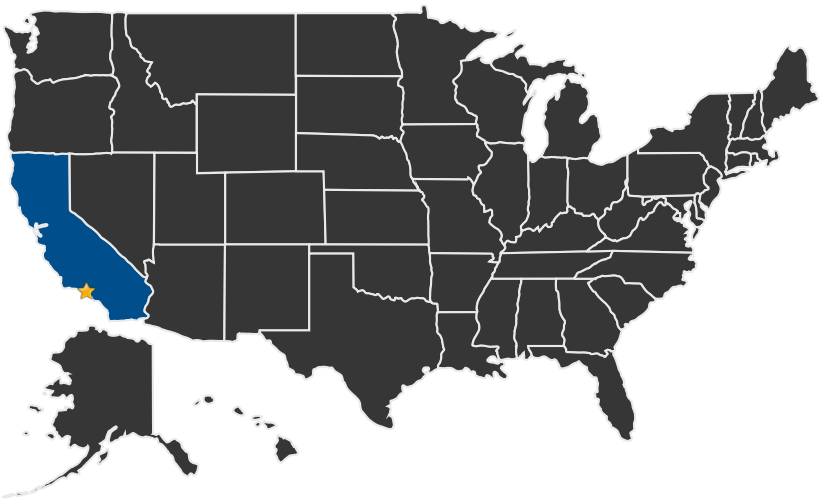
To NASA funded missions:

WFIRST/AFTA mission study Any future astrophysics mission with scope that includes direct imaging of exoplanets, such as ATLAST/UVOIR studies

DETAILED DESCRIPTION

Direct imaging of exoplanets allows their spectral characterization, revealing their atmospheric composition and, potentially, signs of life

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Jet Propulsion Laboratory

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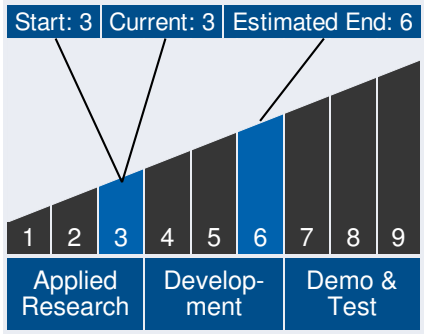
Technology Maturity



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Other Organizations Performing Work:

- California Institute of Technology
- Northrop Grumman
- Princeton University
- Space Telescope Insititute
- University of Arizona
- Xinetics, Inc. (Devens, MA)

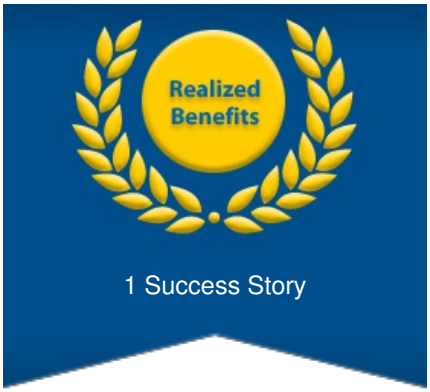
LATEST SUCCESS STORY

Deformable Mirror Infusion

PROJECT LIBRARY

Success Stories

- Deformable Mirror Infusion
  - (http://techport.nasa.gov:80/file/16853)



Management Team

Program Executive:
- Lanetra Tate

Program Manager:
- Mary Wusk

Project Manager:
- Feng Zhao

Principal Investigator:
- Denise Podolski

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Technology Areas

Primary Technology Area:
Science Instruments, Observatories, and Sensor Systems (TA 8)
- Remote Sensing Instruments and Sensors (TA 8.1)
  - Detectors and Focal Planes (TA 8.1.1)
    - Visible/Near-Infrared Focal Plane Array (TA 8.1.1.1)
    - Visible/Near-Infrared Focal Plane Array (TA 8.1.1.1)

Secondary Technology Area:
Science Instruments, Observatories, and Sensor Systems (TA 8)
- Remote Sensing Instruments and Sensors (TA 8.1)
  - Detectors and Focal Planes (TA 8.1.1)
    - Large Format Visible/Near Infrared Photon Counting Detector Array (TA 8.1.1.6)

Continued on following page.

Technology Areas *(cont.)*

Additional Technology Areas:
Science Instruments, Observatories, and Sensor Systems (TA 8)
- Remote Sensing Instruments and Sensors (TA 8.1)
  - Detectors and Focal Planes (TA 8.1.1)
    - Large Format Visible/Near Infrared Photon Counting Detector Array (TA 8.1.1.6)

DETAILS FOR TECHNOLOGY 1

Technology Title

WFIRST / AFTA Coronagraph Technology Development

Technology Description

This technology is categorized as a hardware system for unmanned spaceflight

A number of technical challenges need to be overcome to achieve the desired starlight suppression in a space-borne observatory, with the leading challenge being the control of broadband (≥10%) starlight diffraction. The past TDEM efforts focused on unobscured pupil shape and produced excellent results demonstrated in a laboratory environment: http://exep/technology/. The AFTA telescope, however, has a central obscuration and six struts in the pupil. This pupil geometry provides additional challenges to starlight suppression due to diffraction from these complex structures. On the other hand, it also provides a useful opportunity to develop coronagraph technologies that can work with obscured pupils, since future space telescopes will likely also have pupil patterns such as obscurations and segment gaps.

The AFTA Coronagraph Working Group (ACWG) was formed soon after the release of the WFIRST-AFTA SDT report. ACWG consisted of representatives from the Exoplanet Program Office (ExEPO), AFTA Study Office (ASO) and Science Definition Team (SDT). The team worked between June and December of 2013 to comprehensively assess six candidate coronagraph architectures. During this

activity, the coronagraph architectures were evaluated according to their expected science return, technology maturity and likelihood of meeting the key program gates, as well as the ability to fit and perform within the spacecraft and telescope constraints.

NASA Science Mission Directorate (SMD), based on recommendation from ACWG and an independent Technology Assessment Committee (TAC), selected Occulting Mask Coronagraph (OMC) – a combination of Hybrid Lyot (HL) and Shaped Pupil (SP) coronagraphs in a single instrument – as the baseline for WFIRST/AFTA. The Phase-Induced Amplitude Apodization Complex Mask Coronagraph (PIAA-CMC) was selected as the backup architecture. The performance estimates from the recent SDT report indicate that OMC surpasses current best instruments by several orders of magnitude, even in the presence of un-optimized AFTA pupil. The estimated contrast allows direct imaging and spectroscopic characterization of gas giants in nearby star systems. The inner-working angle is about 0.1-0.2 arcsec, with target contrast below 10^{-9}. OMC design fits into the specified volume, mass and power envelope and has a relatively small increase in complexity compared to single SPC or HLC instrument configurations. Its advantages include risk mitigation during the technology development phase and in-flight, due to the trade-off between greater robustness to jitter provided by SPC and greater exoplanet science return promised by HLC: http://wfirst.gsfc.nasa.gov/news/2013/.

Capabilities Provided

- Ability to suppress light from a bright object (star) in order to directly observe light from nearby faint objects (up to a billion times fainter, located as little as 0.1 arcsec away from the star)

Potential Applications

- Direct imaging of exoplanets around nearby stars: Jupiter and Neptune sized, possibly super-Earths
- Spectroscopic characterization of exoplanets
- Technology demonstration for future exo-Earth discovery and characterization mission

Performance Metrics

Metric	Unit	Quantity
Imaging Bandpass	nm	430-1000
Inner Working Angle	mas	110-250

Continued on following page.

Performance Metrics *(cont.)*

Metric	Unit	Quantity
Outer Working Angle	arcsec	0.9 -2
Detection Limit	planet contrast	≤ 10^-9
Spectral Resolution	unit	70
IFS Spatial Sampling	mas	17