ExoPlanet Exploration Program

# NASA Research Announcement: Technology Development for Exoplanet Missions (TDEM)

## Infrastructure: Introduction

July 8, 2009

Peter R. Lawson

Jet Propulsion Laboratory
California Institute of Technology

# JPL Infrastructure Support

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## Available Facilities

The following two presentations will provide an overview of the facilities, resources, and infrastructure that are available to support your proposal.

It is a non-exclusive list.

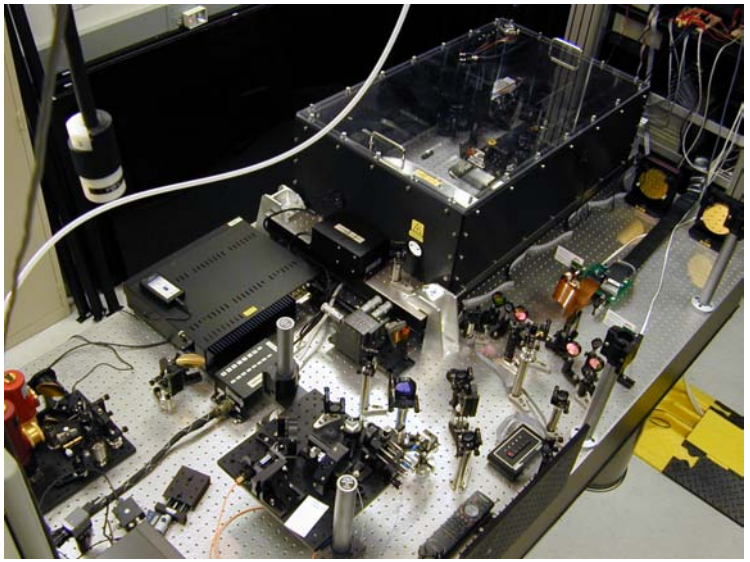
## How does one cost the use of JPL facilities?

Some base-funding of JPL infrastructure is anticipated in FY2010.

However, if you wish to use JPL infrastructure, you must cost the associated labor as part of a proposal.

Each facility/resource is different.

The actual cost for a proposal for the use of infrastructure may eventually be adjusted as part of the award to make best use of facilities and work-force, as viewed across all awards.



## Point of contact

Phone the point-of-contact for the facility of interest to obtain costing guidelines:

| | |
|---|---|
| Marie Levine | (818) 354-9196 |
| Peter Lawson | (818) 354-0747 |

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## Interferometry Infrastructure

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# Adaptive Nuller

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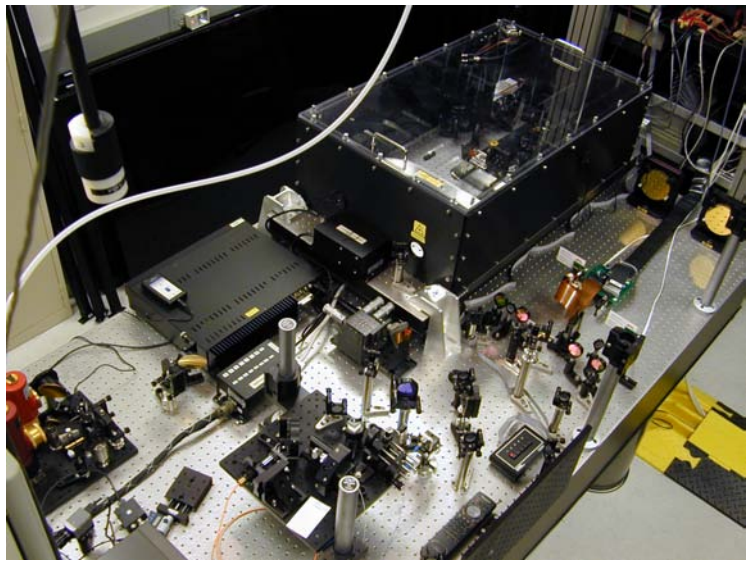
## Two-beam mid-infrared nulling interferometer

Uses a deformable mirror to adjust amplitude and phase across 12 channels in the 8-12 micron band

Demonstrated the deepest broadband mid-infrared nulls

Point of contact: Peter Lawson



***"Broadband phase and intensity compensation with a deformable mirror for an interferometric nuller," R. D. Peters, O. P. Lay and M. Jeganathan, Applied Optics 47, 3920-3926 (2008).***

**TPF-I Milestone #1** completed, July 2007

- Demonstrated 0.09% intensity compensation and 4.4 nm phase compensation

**TPF-I Milestone #3** completed, February 2009

- Demonstrated $1.0\times10^{-5}$ mean null depth with a 34% bandwidth in three 6-hour experiments.

# Formation Control Testbed

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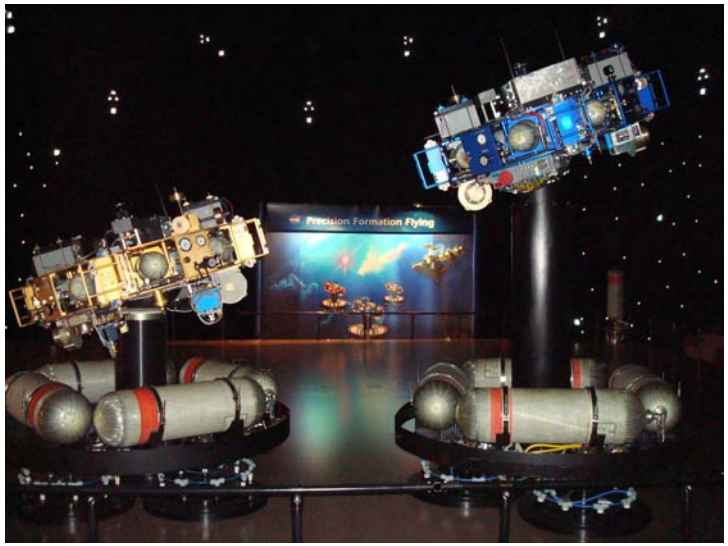
**Robotic testbed for guidance, navigation and control demonstrations**

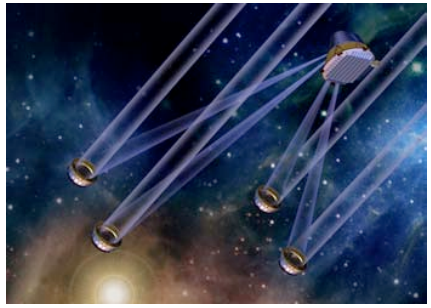
6-degree of freedom (DOF) motion of 2 robots
Frictionless flat floor and attitude
Flight-like hardware & software environment
Planned addition of a third robot in 2010.

Point of contact: Peter Lawson



***"TPF-I Technology Milestone #2 Report: Formation Control Performance Demonstration,"***
***D. P. Scharf and P. R. Lawson, JPL Publication 08-11***
***(Jet Propulsion Laboratory, January 2008)***

***http://planetquest.jpl.nasa.gov/TPF-I/TPFI_M2_ReportV3.pdf***



**TPF-I Milestone #2** completed January 2008

Guidance navigation and control algorithms for a formation of two telescopes were demonstrated with traceability to flight in a ground-based robotic testbed. (16 January 2008)

# Planet Detection Testbed

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## Four-beam mid-infrared nulling interferometer

Emulates the system complexity of a beam-combiner of a TPF/Darwin mission.

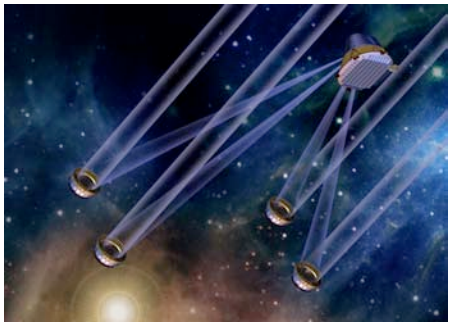
Now successfully demonstrating rotation, chopping, and averaging.

Planned upgrade for instability noise studies.

Point of contact: Peter Lawson

***"Exoplanet Interferometer Technology Milestone #4 Whitepaper: Planet Detection Demonstration," S. R. Martin, A. J. Booth, O. P. Lay, and P. R. Lawson," (Jet Propulsion Laboratory, May 2008)***

***http://planetquest.jpl.nasa.gov/TPF-I/tpf_currentStatus.cfm***



**TPF-I Milestone #4** in progress, June/July 2009

- Demonstrate array rotation, chopping, and averaging
- Detect planet signal at a contrast of ≤ $10^{-6}$ relative to the star
- Show residual starlight suppression from phase chopping and rotation ≥ 100.

# APEP: Visible Nulling

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## Vacuum facility supported

- Optical layout as shown on the right
- Includes DM, pupil and science cameras
- Leverages technology development from TPF-I, Gemini Planet Imager, and SIM

## 16-Bit DM Electronics for Vacuum

- Minimizes feed-throughs into vacuum tank
- Designed for Boston Micromachines segmented DM
- Conductively cooled electronics and chassis

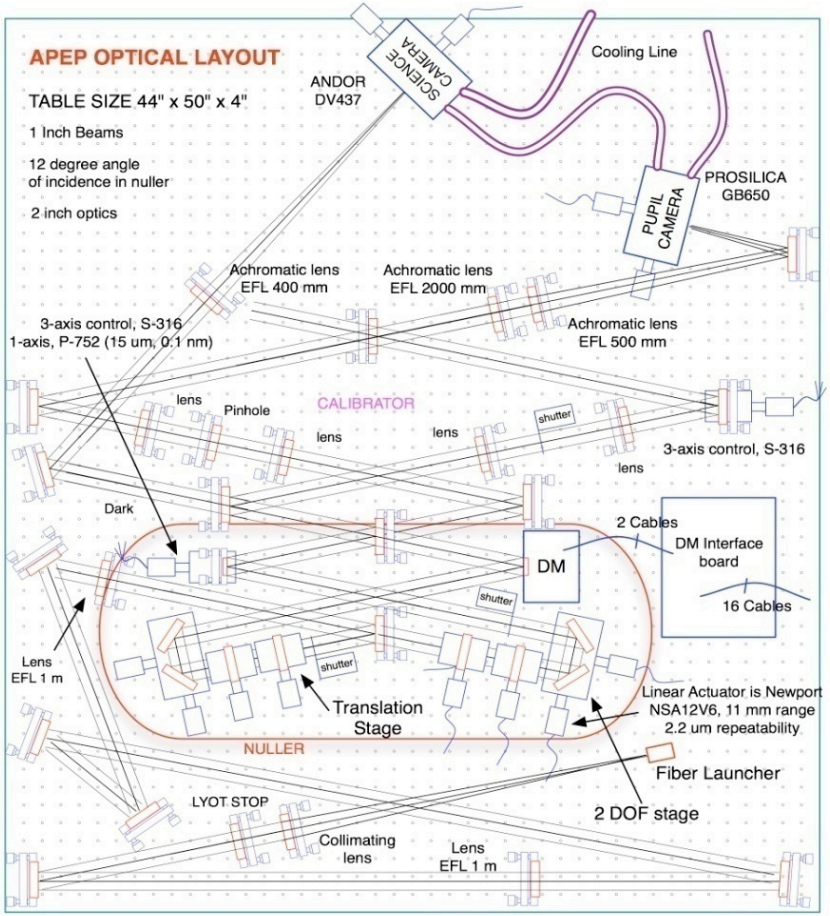
## Coherent Fiber Bundle and Lens Array

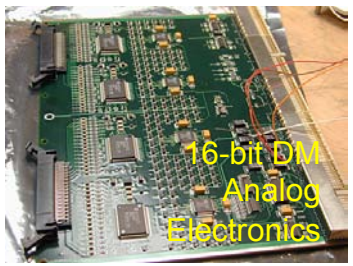
- Prototype of 217 fibers, with map of fiber positions
- Vitrum to produce custom lens-array, based on map
- Fiber bundle now complete, lenset array being designed

## Control System Based on RTC

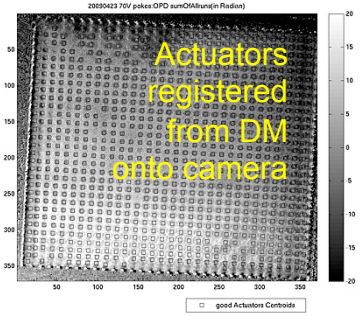
- Initially using a continuous face-sheet DM
- Real-time phase retrieval now being tested

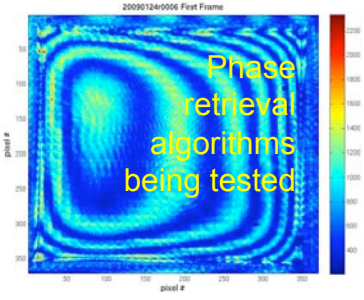
Point of contact: Peter Lawson







# Interferometer Modeling

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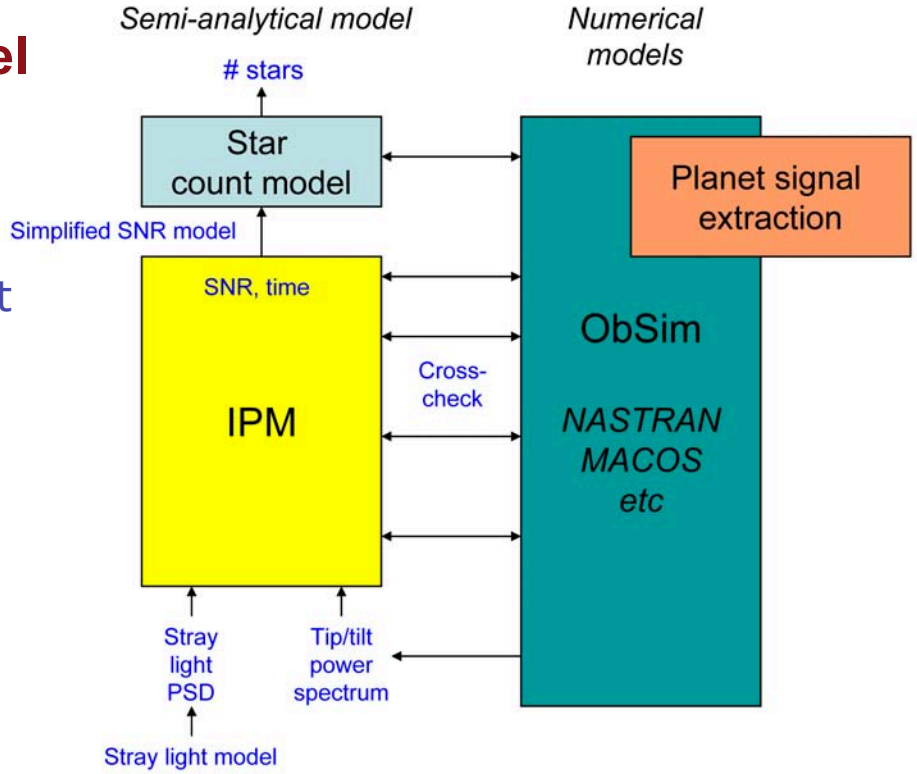
## Interferometer Performance Model & Observatory Simulation

- Predicts the science return of a mid-infrared interferometer
- Includes system noise model consistent with the interferometer error budget
- Instability noise removed by spectral filtering
- Consistent with European models in support of the Darwin mission concept

Point of contact: Peter Lawson




***"Earth-like planets: Science performance predictions for future nulling interferometry missions," D. Defrere, O. Lay, R. den Hartog, and O. Absil, Proc. SPIE 7013, 701321 (2008)***

***http://planetquest.jpl.nasa.gov/TPF-I/performanceModels.cfm***

# Exoplanet Program Point of Contact

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