Welcome and Innovation at JPL

Presentation to
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JPL: From Caltech students testing rockets to exploring the planets in our lifetime
End-to-end capabilities needed to implement missions

- Project Formulation - Team X
- Scientific Research
- Real Time Operations
- Mission Design
- Environmental Test
- Integration and Test
- Spacecraft Development
- Mars Rovers
- Large Structures - SRTM
- Ion Engines
- Scientific Research
MER and MSL
Entry-Decent-Landing
EPOXI: A New Mission for Deep Impact

Launched
Jan 12, 2005

Tempel-1 Encounter
July 4, 2005

Hartley-2 Flyby
November 4, 2010
Dawn’s Exploration of New Worlds in the Main Asteroid Belt

- A mission to orbit both Vesta and Ceres would be impossible without ion propulsion.
  - Dawn will be the first spacecraft ever to orbit two solar system targets.
- Even a mission only to Vesta would be unaffordable for the Discovery Program without ion propulsion.
A Step-Wise NEO Campaign

Provide new data from range of NEO types, understand surface and structure to correlate with remote observations

Detailed Characterization of Target, Target Surface and Hazards for human mission

Demonstrate crew system capabilities for long duration

Acquire Asteroid Samples

2014
Orbit 2-6 NEOs
Surface Interaction

2018
Land on NEO
Surface Analysis

2025
Crewed Mission
Sample Return
Active Optics for Space Telescopes

- AHMs are active mirrors made by replication for high optical quality, low cost, and rapid fabrication.

  - Nanolaminate multilayer metal foil, made by sputter deposition, provides reflecting surface.
  - SiC Substrate, made by molding and firing process.
  - Actuator with Mounting Tabs.
  - Actuator integration.
  - Completed Active Hybrid Mirror (AHM).

- Ground testbeds using large Active Optics demonstrate diffraction-limited imaging.
  - WF Before Control: WFE = 6,100 nm (RMS)
  - WF After Control: WFE = 42 nm (RMS)

- Active optics technologies...
  - Reduce mission risk by correcting virtually any optical error after launch.
  - Accelerate production by relaxing fabrication and alignment tolerances.
  - Compress costly I&T phase.
  - Enable large deployed apertures for future large telescope missions.

- Nanometer-precision laser metrology for control of segmented mirrors.
Advanced spectrometer designs are enabled by curved multi-blaze e-beam grating.

In 1989, the proposed HIRIS Imaging Spectrometer was 970 Kg, 879 W and the size of small car.

Today, the HyspIRI Earth Decadal Survey instrument is 55 Kg and 41 W, compact and provides a superior science measurement.
Panchromatic Fourier Transform Spectrometer (PanFTS)

- PanFTS is an innovative new instrument concept for atmospheric remote sensing
- PanFTS has wide spectral sensitivity for simultaneous observations of reflected sunlight and thermal emission enabling measurement of numerous atmospheric composition species such as
  - Pollutants: $O_3$, NO$_2$, NH$_3$, SO$_2$, HCHO, CH$_3$OH, CO
  - Greenhouse Gases: CO$_2$, CH$_4$, N$_2$O, O$_3$, H$_2$O
  - Transport Tracers: HDO, N$_2$O, O$_2$, O$_4$
- From geostationary orbit PanFTS can make hourly measurements to capture rapidly changing atmospheric chemistry over all of North and South America

PanFTS has the measurement capabilities of several satellite instruments combined

![Earth Spectrum](image)

- Radiance, photons/(s·cm$^2$·sr·cm$^{-1}$) vs Wavelength (µm)

- Airborne, satellite, and in-situ observations from various missions

- AIRS, TES, IASI, GOSAT, OMI, SCIAMACHY
High Performance Gigapixel Focal Plane Arrays

High Performance Detectors: JPL-invented delta doping technology enables world record sensitivity and stability in UV-Vis-NIR.

High Capacity MBE: JPL-unique facility at Microdevices Laboratory allows batch processing/delta doping of Silicon imager wafers up to 8 inches in diameter.

Gigapixel focal plane arrays: JPL investments in advanced FPA technologies such as MBE, unique coatings, curved FPAs, packaging, and testing are pushing the frontiers of imaging and spectroscopy for NASA missions and reimbursable customers.

Partnerships: Caltech, ASU, LBNL, e2v, etc.
Conventional SAR
- LIMITED SWATH
- One pulse in swath at a time

SweepSAR
- ULTRAWIDE SWATH
- Track multiple pulses in swath
The power received by the 70m DSN antenna from Voyager is so small that if it were to be accumulated for 10 trillion years it could power a refrigerator light bulb for one second!

Orbiting Mars relays enabled a 5X increase in science

- Each MER returned 15 Gb in the first 3 months using relays – 5X as much as Pathfinder
- Nearly all data from Mars’ surface comes via relays today

Overall return increased 10X over the last decade: from 100’s of Kbps to 6 Mbps at Mars, for example

The technology is already in hand for the next 10X

- Ka-band, advanced coding, arraying of ground antennas
Access to Caltech research facilities
  - Keck Observatory
  - Palomar Observatory
  - Owens Valley Radio Observatory
  - Cornell Caltech Atacama Telescope
  - Beckman Institute
  - Kavli Nanoscience Institute

Caltech - JPL Joint Appointments
  - Appointments of Caltech faculty to JPL: 4
  - JPL appointments at Caltech: 74

Caltech’s emphasis on excellence pervades JPL’s research

World-class researchers are attracted to JPL because of affiliation with Caltech

Caltech brings intellectual depth to JPL research topics
  - Planetary science
  - Radar studies of solid Earth
  - Gravitation wave studies
  - Atmospheric chemistry
  - Cosmic Microwave Background research
JPL Early Career Hires
FY 05 through fiscal month-end June 27, 2010 (Q3 FY’10)

Early Career Hires (ECHs)

- FY '05: 119
- FY '06: 81
- FY '07: 166
- FY '08: 181
- FY '09: 90
- FYTD FY '10: 69

Total Projected=109
FY '05 Through FYTD FY '10 Total=746 (Projected)
**Eyes on the Earth**
Tracking NASA spacecraft, their data and positions in Earth orbit.

**Summer Student JPL Internships**
> 450 Students

**Imagine Mars Project:**
> 10,000 Participants so far

**Mars Student Imaging Project**
at Arizona State University:
> 15,000 Students so far

**Reading Writing and Rings**
(Reading Skills through Exploring Saturn)
> 3000 Teachers trained

**High Impact**
- **Solar System Ambassadors:**
  500 Nationwide

- **Museum Alliance, now for all of NASA:**
  400 Institutions

- **Night Sky Network:**
  > 350 Amateur Astronomy Clubs