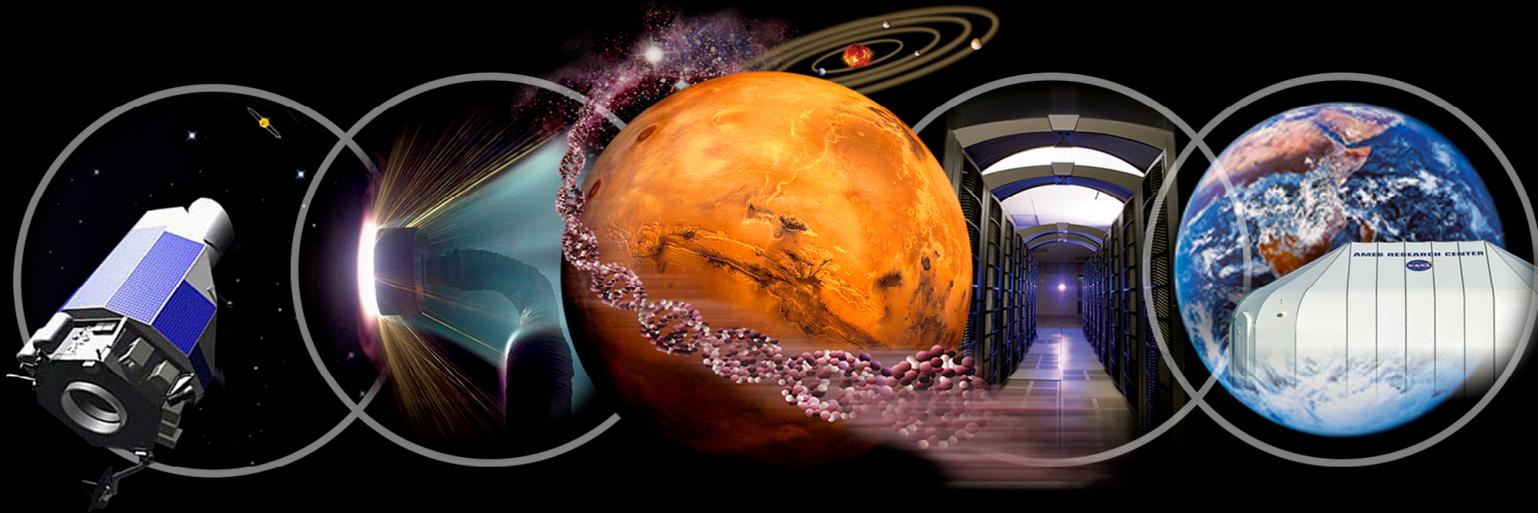


Discovery ➡ Innovation ➡ Solutions



# Entry Probe Workshop

G. Scott Hubbard  
NASA Ames Center Director

August 23 , 2004



Visibility ➡ Excellence ➡ Impact





***The NASA Vision***

**To extend life to there,  
To find life beyond.**

***The NASA Mission***

**To understand and protect our home planet  
To explore the universe and search for life  
To inspire the next generation of explorers  
...as only NASA can**

# The Vision for Space Exploration

- **Implement** sustained & affordable human/robotic program to explore the solar system and beyond
- **Extend** human presence across the solar system, starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations
- **Develop** the innovative technologies, knowledge, and infrastructures both to explore and to support decisions about the destinations for human exploration
- **Promote** international and commercial participation in exploration to further U.S. scientific, security, and economic interests.

Nuclear Power System

Communications

Materials Processing and Storage

Preparation

Habitats and Greenhouses  
With Life Support and  
Food Production

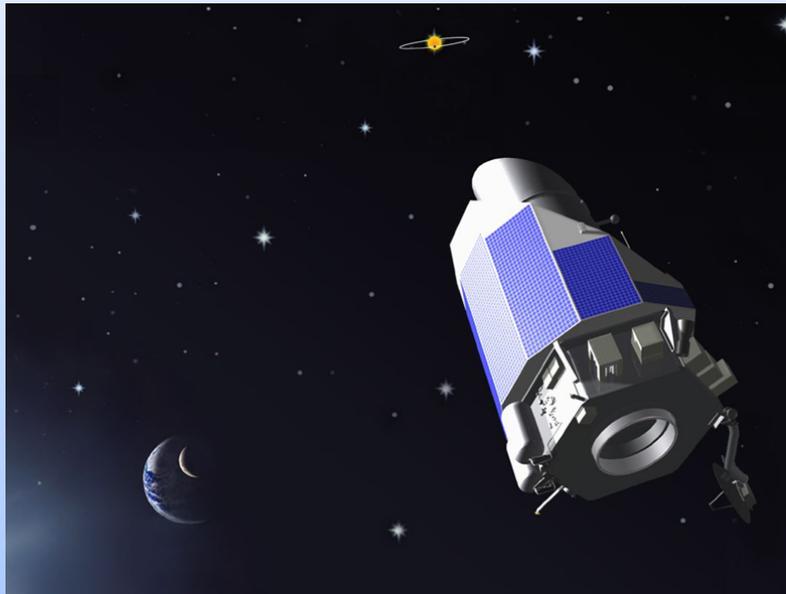
Multi-Purpose  
Pressurized Rovers  
for Transporting  
Cargo and Crew



# To explore the universe and search for life: Probes in Context

To fully understand the potential for life elsewhere in the universe, we must first understand the origins and evolution of our own solar system planets.

Probes are needed for full the comparative planetology that will help us understand the data from extra solar planet studies.



## Kepler: The Search for Habitable Planets

A Discovery class mission on track to launch in '07. Kepler will survey ~ 100,000 stars to detect planets, including terrestrial planets, and determine if they are in the habitable zone



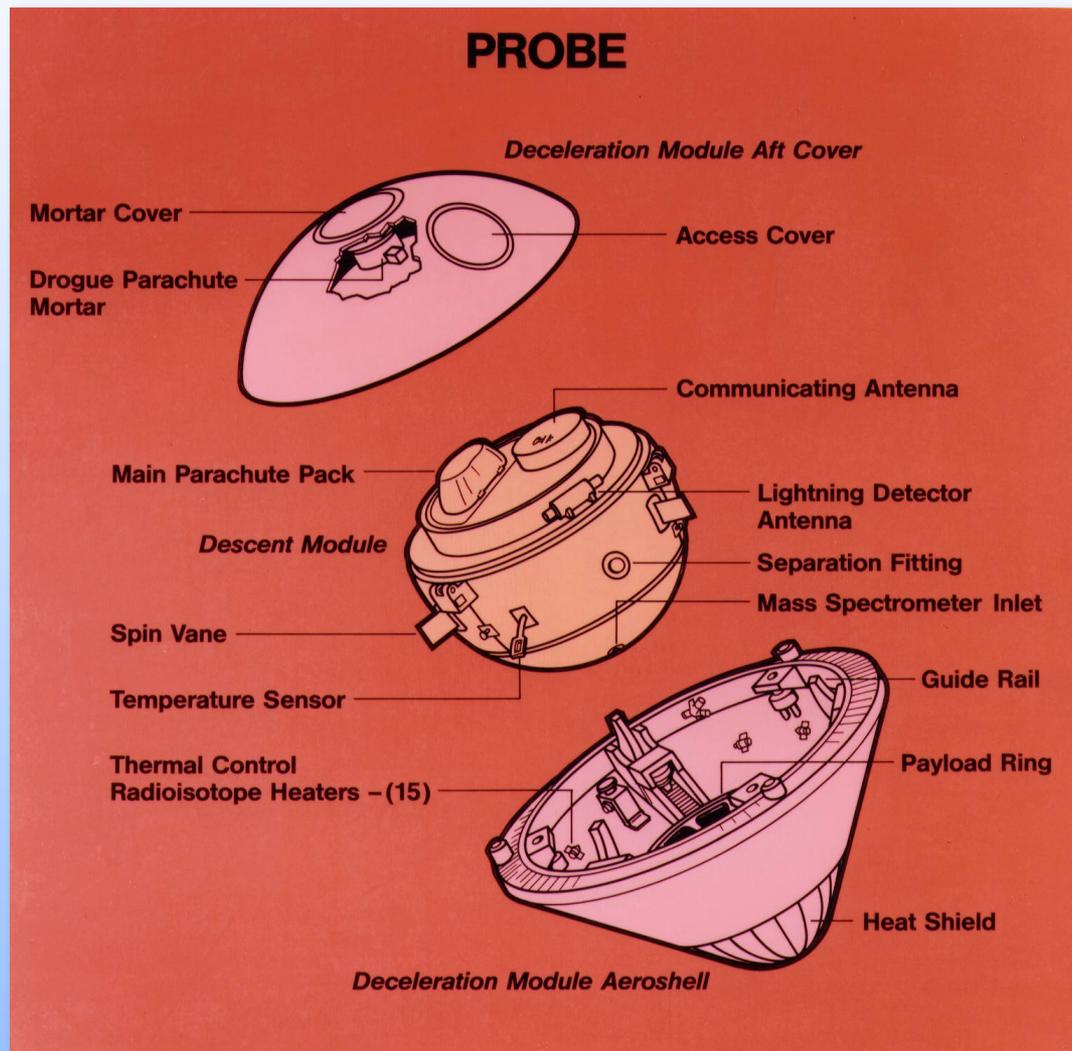
## Terrestrial Planet Finder

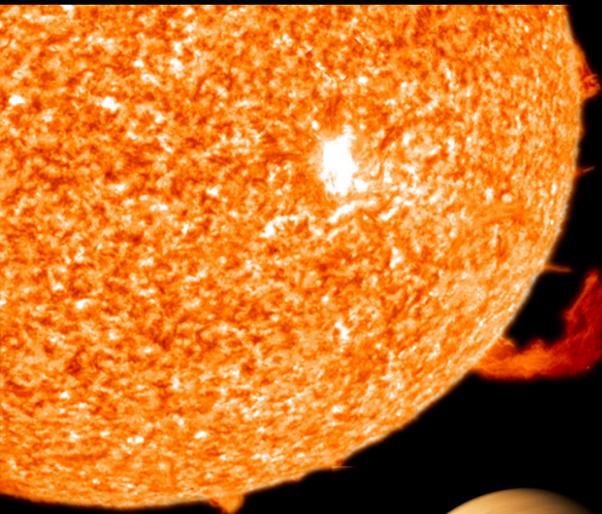
Two missions planned to launch within the next 10 to 15 years. Observing extra-solar planets in both visible and infrared light will greatly enhance understanding of whether a planet ever could or actually does harbor life.



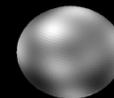
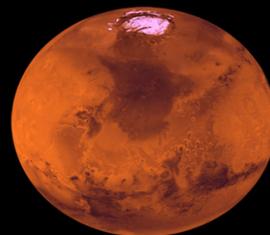
# What is a probe?

## Galileo Probe

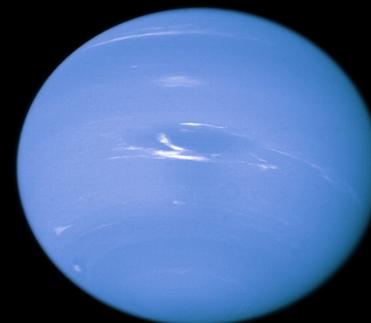




probes



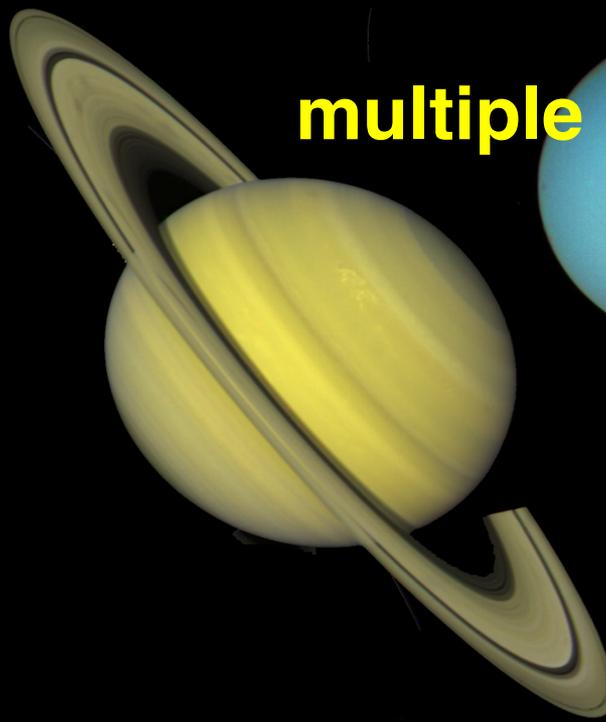
to



Multiple



multiple



worlds





# NASA Ames Research Center-founded 1939

**Basic Science (Earth-Life-Space): Astrobiology- the study of life in the universe**

## Major Projects

- **Stratospheric Observatory For Infrared Astronomy**
- **Kepler Mission-Search for Habitable Planets**
- **Space Station Biological Research Project**

## Technology for Science and Exploration

- **Information Technology (Autonomy, Human Factors, High-End Computing)**
- **Nanotechnology**
- **Bio-Info-Nano Fusion**
- **Thermal Protection Systems**

## Aviation and Aeronautics

- **Air Traffic Management and Control**

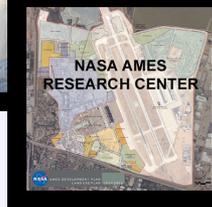
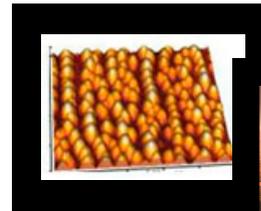
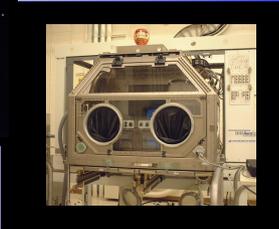
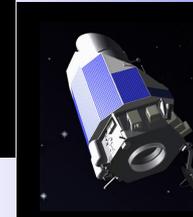
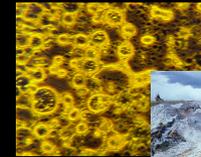
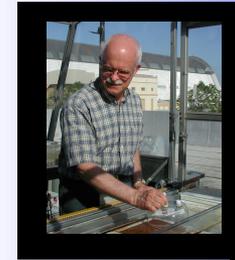
## Education

**3919 Employees**

- **(1471 Civil Service/2448 Contractor and Other)**

**\$775+ M Annual Budget**

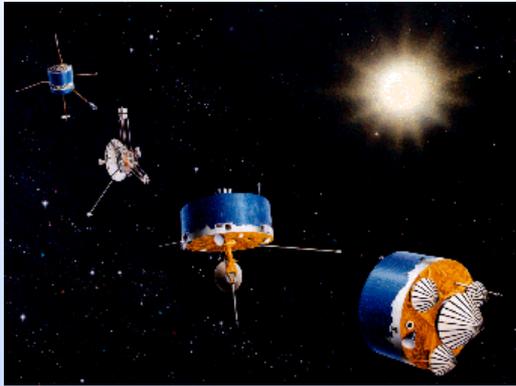
Discovery ➡ Innovation ➡ Solutions



**Exploration Center**



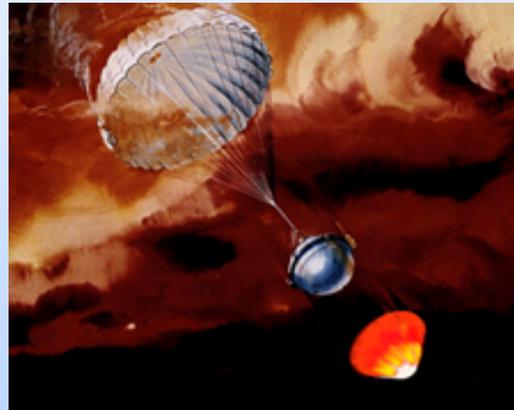
# Past & Present: Successful Probes and Fly-by's



**The Pioneer 6-11 and Pioneer Venus Program 1965-2003 :**

**A series of projects considered models of science driven, cost effective missions.**

**Pioneer Venus multi-probe**



**Galileo Probe 1995 (entry):**

**Entered Jovian atmosphere to return first data ever of the interior of Jupiter**



**Huygens probe**

**Will descend through the atmosphere of Saturn's largest moon, Titan on January 15, 2005.**

**The result of effective international collaboration**

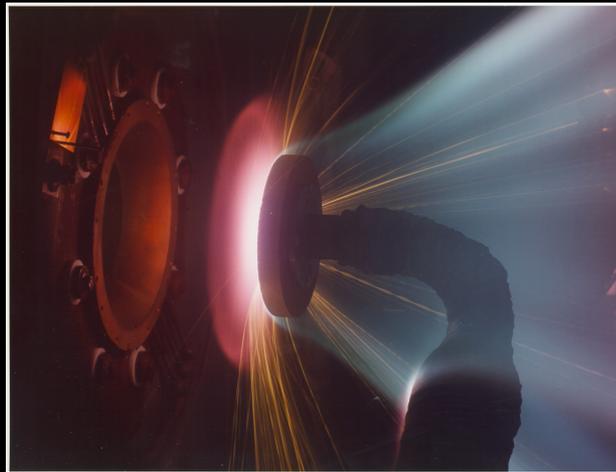


# Thermal Protection Materials and Arc-Jet Facility

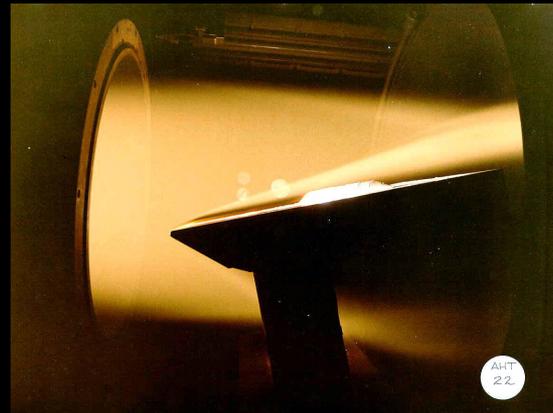
Testing and materials for Mars Pathfinder and  
Mars Exploration Rovers  
Support for Shuttle, and future human vehicles



PICA: A posttest sample of Phenolic  
Impregnated Carbon Ablator or PICA,  
used in the thermal protection system  
of the Stardust mission



Ablative TPS Testing



Panel Test in the AHF



Lost tile test for  
Shuttle Orbiter



# Mars Exploration Rovers-Spirit & Opportunity

## Ames' Contributions

Science discovery  
3 Co-Investigators from Ames

David Des Marais

Natalie Cabrol

Michael Sims

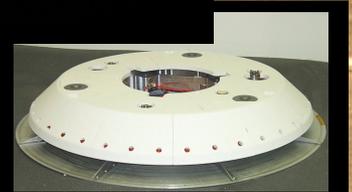
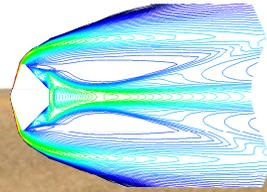
Technology & Major Facilities Enabled the Mission

Thermal Protection Systems  
and Arc Jet Testing

Wind tunnel parachute testing

Mission systems software tools

Human Factors/Mars Time



TPS system validation

MER  
Parachute  
Testing in 80  
by 120 foot  
Wind Tunnel



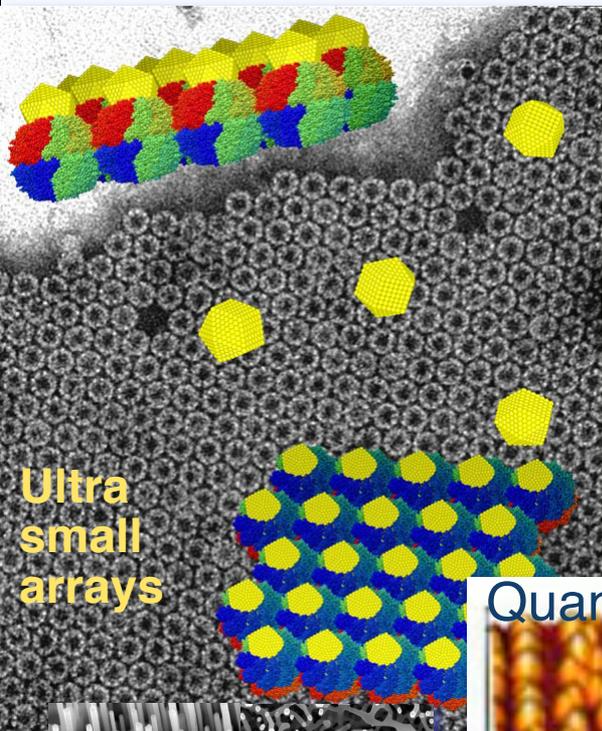
Science &  
Engineering  
Collaboration  
Tools



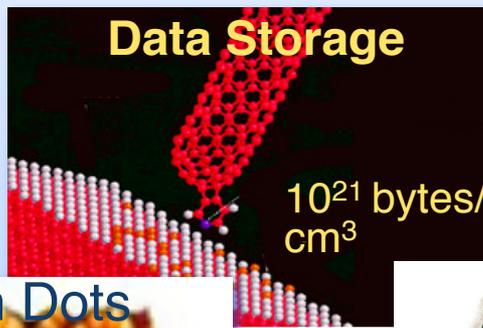


# Bio/Info/Nanotechnology

**“NASA Ames - One of the largest single nanotechnology research centers in the world.”\***

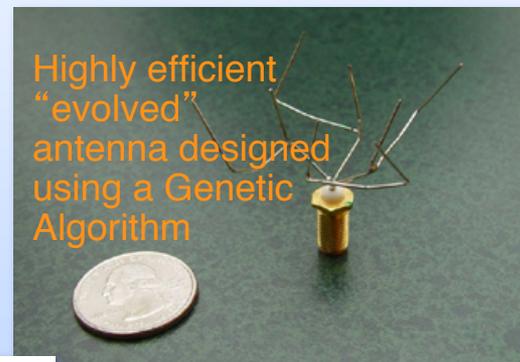


Ultra small arrays

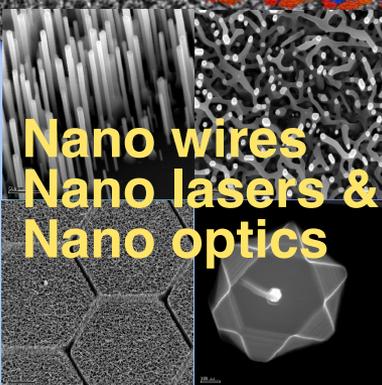


Data Storage

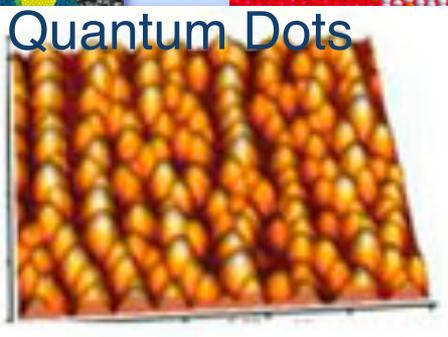
$10^{21}$  bytes/  
 $\text{cm}^3$



Highly efficient “evolved” antenna designed using a Genetic Algorithm



Nano wires  
Nano lasers &  
Nano optics



Quantum Dots



Gecko Feet Adhesive



100-1000 spatulae/  
seta  
( $10^8 - 10^9$  per gecko)

\* January 20, 2004 "Nanoscience and Nanotechnology: Opportunities and Challenges in California" report prepared by the California Council on Science and Technology for the state legislature.



# Technology for Exploration

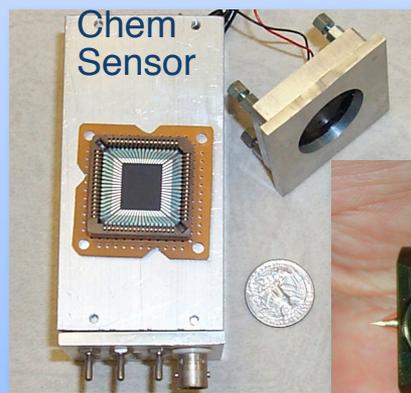
## Applications in nanotechnology

*Established World Class base for future revolutionary capabilities*

- Next Generation thermal, radiation, & impact protective systems
- Highly efficient life support systems
- Extremely sensitive & selective life detection sensors

### Developed:

- Carbon nanotube (CNT) based Chemical sensor
- X-ray tube for soil analysis instrument to fly on Mars-09 mission
- Probe for atomic force microscope to analyze Martian dust
- Nanotube-copper composite for advanced thermal control in space

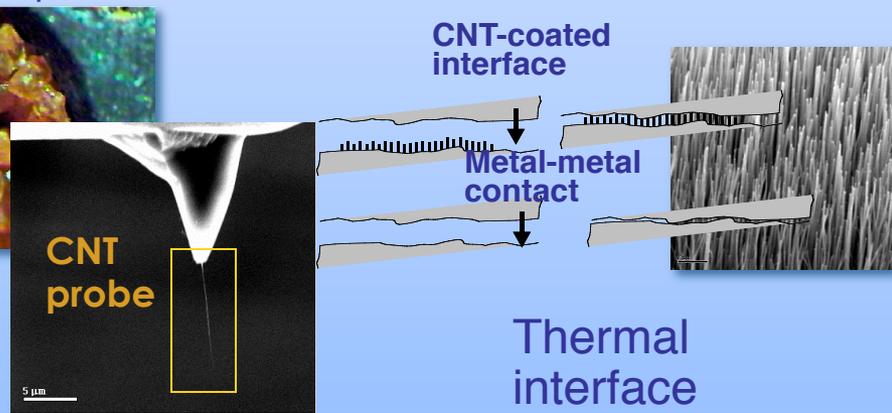
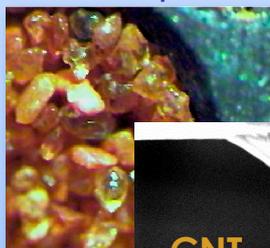


Chem Sensor



X-ray tube

CNT tips on Atomic Force Microscopes...



...may go to Mars

# Award Winning\* NASA Research Park

*“NASA Research Park partnerships permit NASA to achieve a high return on its investment dollar”*

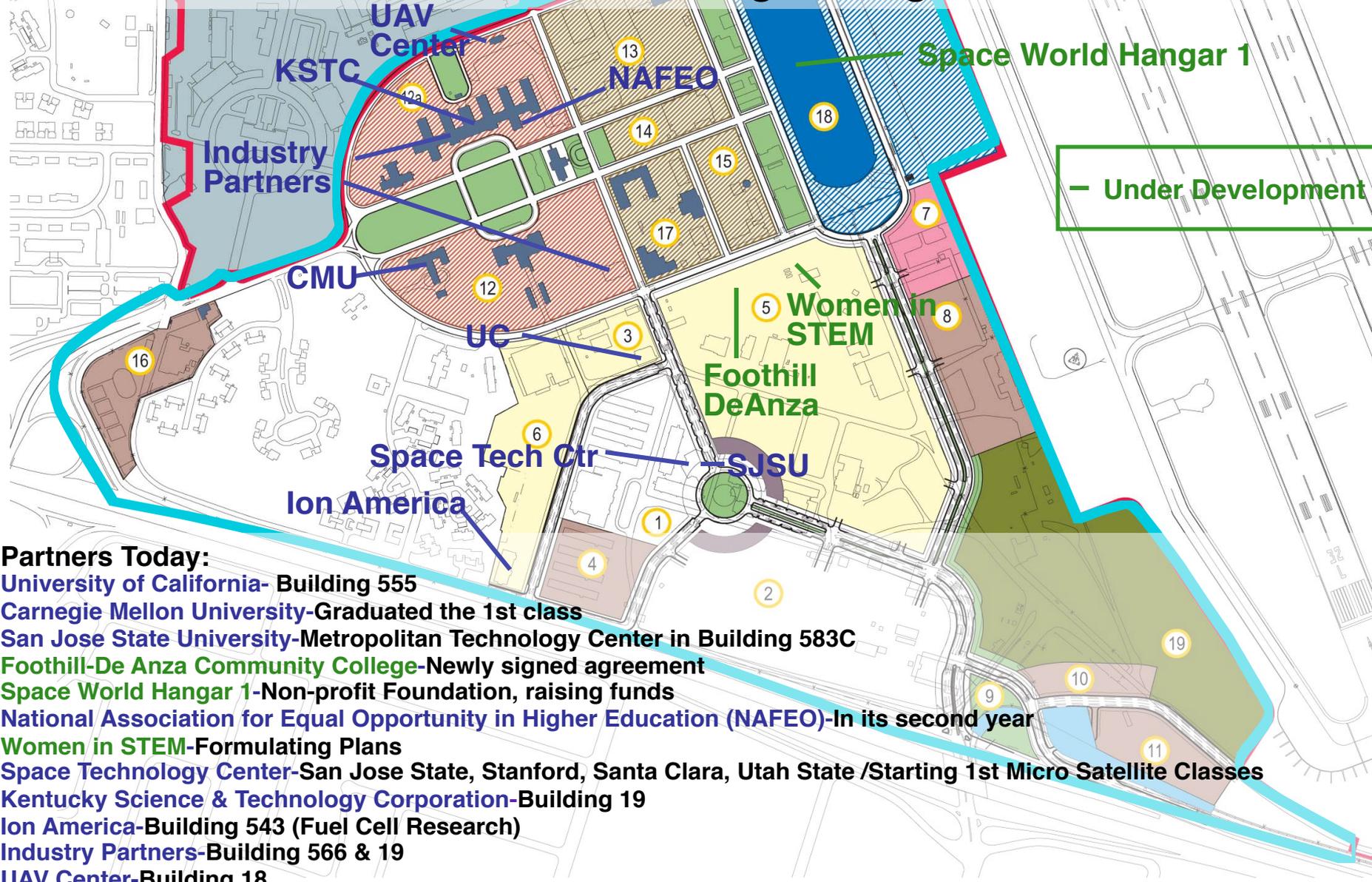
*-National Research Council review of NRP*

**\*2003 GSA Award for Best Use of Federal Property**



# NASA Research Park

## Innovative Collaboration in Science, Engineering & Education



### Partners Today:

- University of California- Building 555
- Carnegie Mellon University-Graduated the 1st class
- San Jose State University-Metropolitan Technology Center in Building 583C
- Foothill-De Anza Community College-Newly signed agreement
- Space World Hangar 1-Non-profit Foundation, raising funds
- National Association for Equal Opportunity in Higher Education (NAFEO)-In its second year
- Women in STEM-Formulating Plans
- Space Technology Center-San Jose State, Stanford, Santa Clara, Utah State /Starting 1st Micro Satellite Classes
- Kentucky Science & Technology Corporation-Building 19
- Ion America-Building 543 (Fuel Cell Research)
- Industry Partners-Building 566 & 19
- UAV Center-Building 18

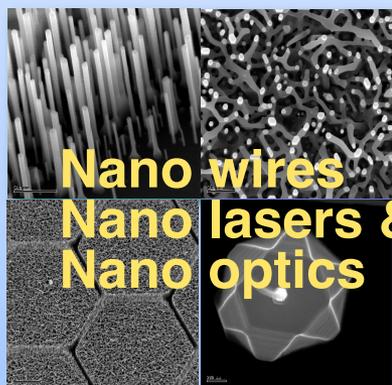


# Where we need to go

- Broader Collaborations
- Growing infrastructure
- Multiple micro/nano probes
- Longer lived surface probes
- Integrated new technologies



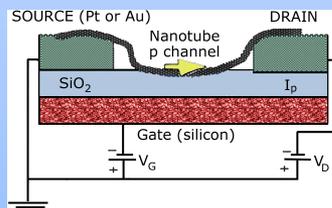
Pascal: a multi micro probe concept for Martian weather stations



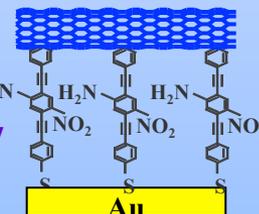
Nano wires  
Nano lasers &  
Nano optics

Nano materials: advanced nano materials may offer solutions to surviving high pressure, high temperature environments

Carbon Nanotube Transistors



Molecular Electronic Memory Array

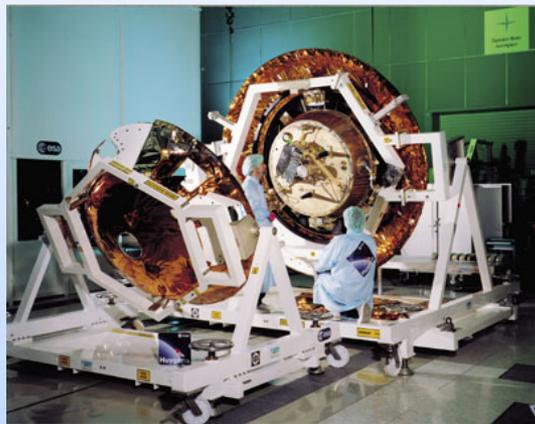


Nano instruments: ultra small, ultra light instruments will make it all possible



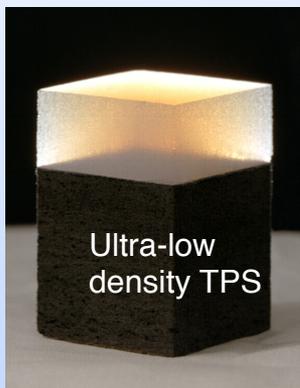
# The Future: Pico Probes

new materials,  
&  
nanotechnologies



Today: Huygens probe:  
> **318 kg**

+



Ultra-low  
density TPS

Next Generation  
of Light Weight  
Ceramic  
Ablators (LCA)

=

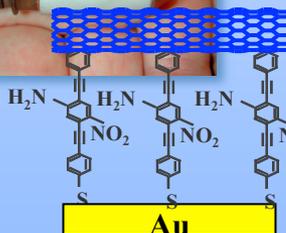


Scale of future “pico”  
probes

< **1kg**



Ultra-small  
instruments



Nano-  
electronics