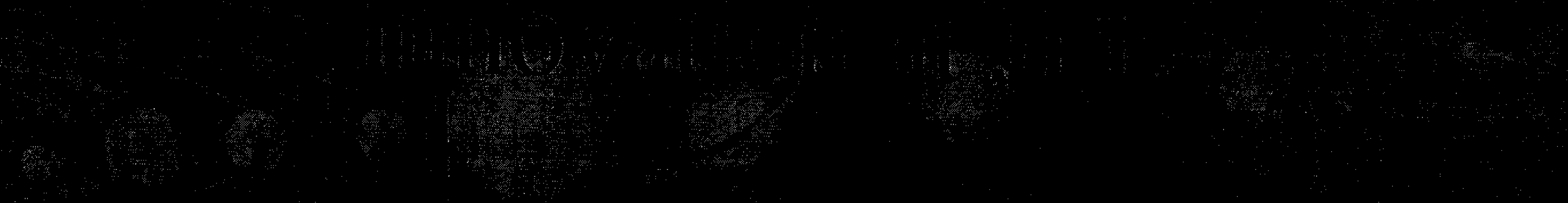
NASA



Engineering and Science Directorate

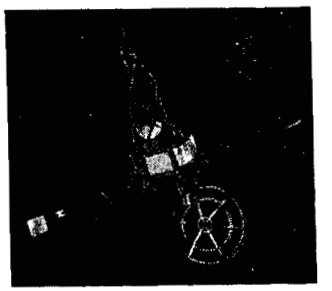
JPL Historical Highlights

First rocket experiments conducted with oversight from Caltech's Theodore von Karman in the late 1930s

Developed jet-assisted takeoff rockets for the Army in World War II

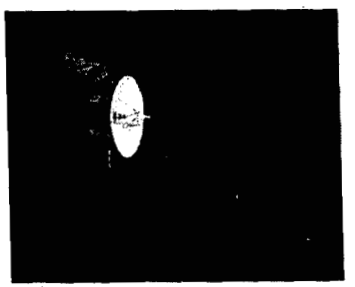
Developed Corporal and Sergeant missiles in the 1950s

Developed the first U.S. satellite, Explorer 1, in 1958

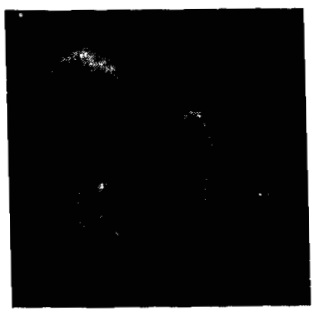


Built and flew the world's first successful interplanetary satellite, Mariner 2, 1962

Lunar missions were precursors to Apollo



Mariners, Viking, Voyager, Galileo, Cassini and other missions have explored the solar system

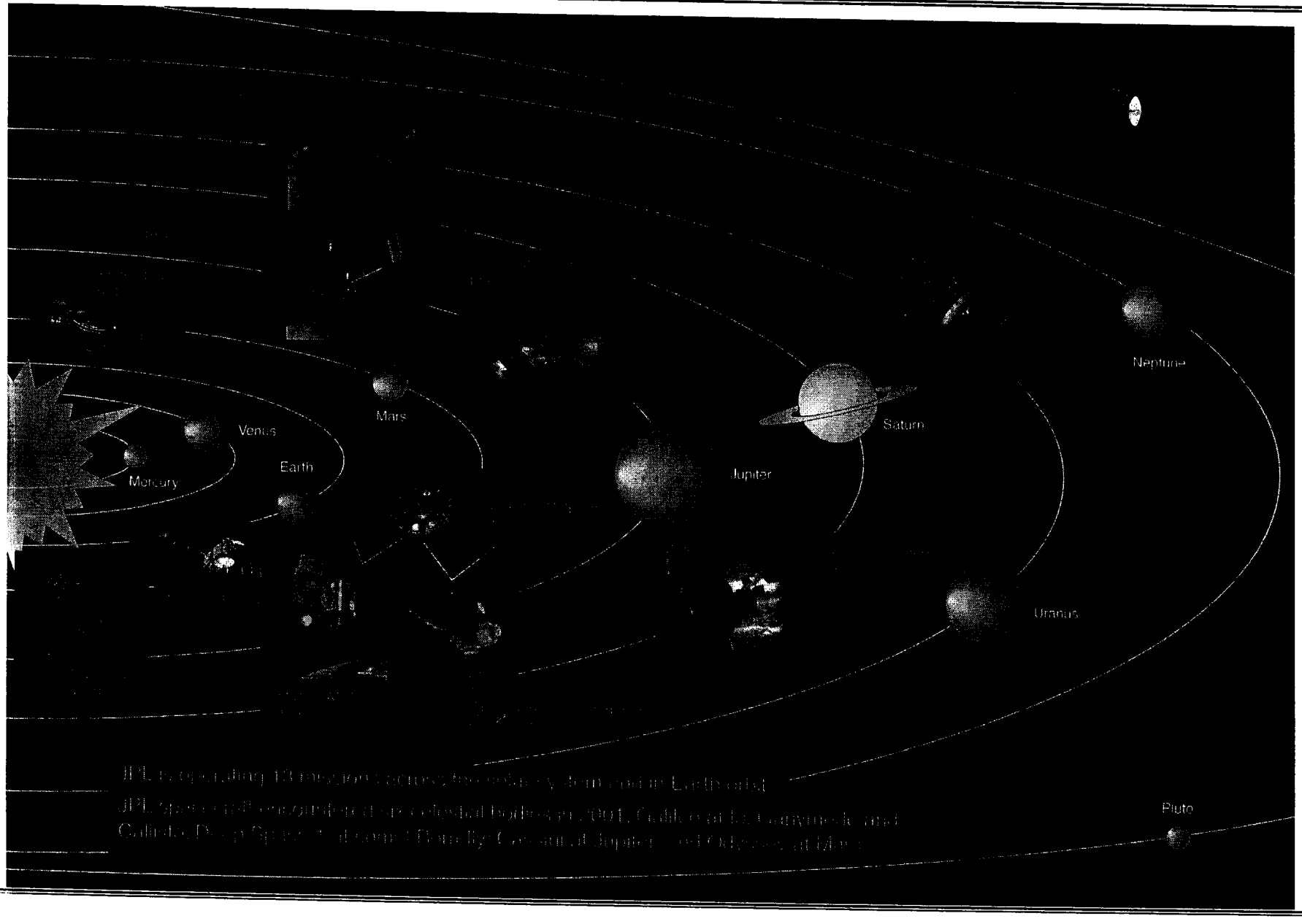


Wide-Field Planetary Camera on Hubble Space Telescope enabled full operation of the telescope

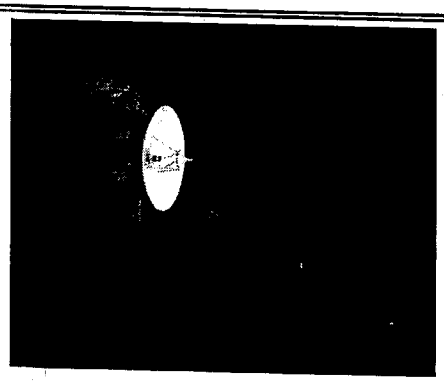
Mars Pathfinder and Sojourner explored Mars' surface in 1997

Shuttle Radar Topography Mission (SRTM) global topographic map

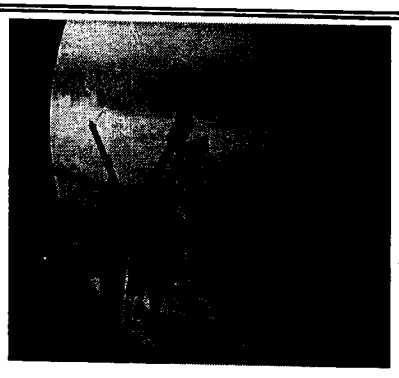
JPL Operating Missions



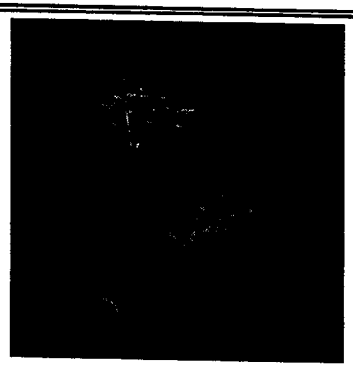
JPL Operating Missions



Voyagers 1 & 2



Galileo



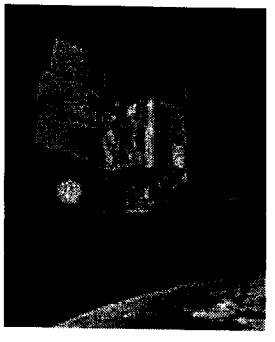
Ulysses

Topex/Poseidon

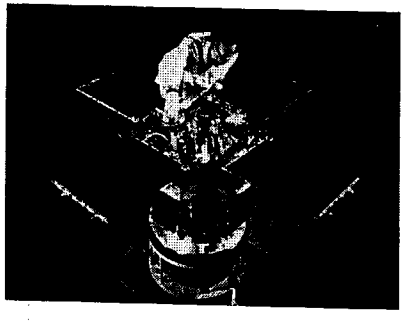
Mars Global Surveyor

Cassini

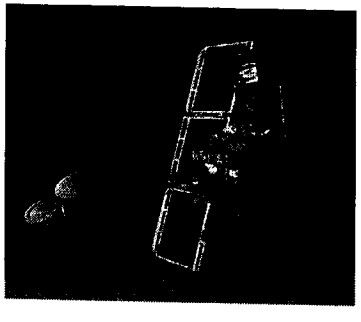
Stardust



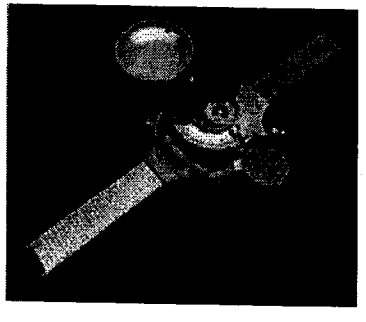
Quikscat



ACRIMSAT



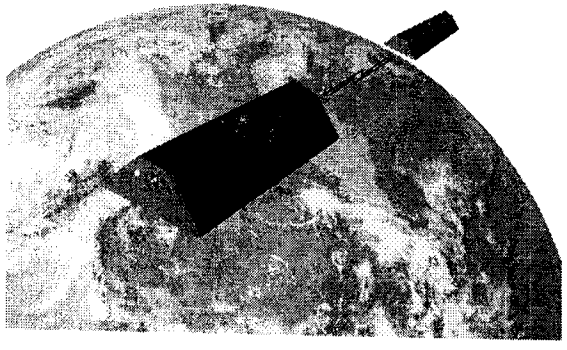
Mars Odyssey



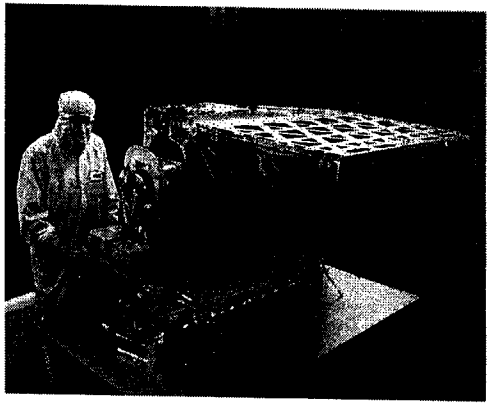
Genesis

Jason

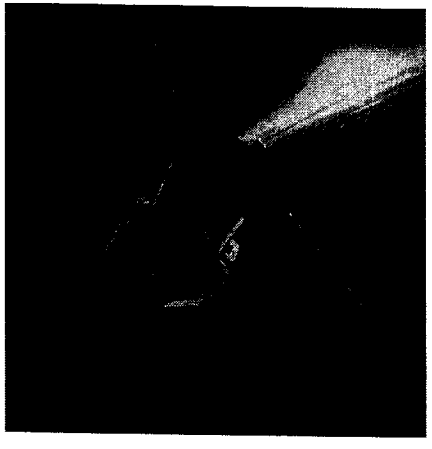
Near-Term Launches



GRACE: March 2002

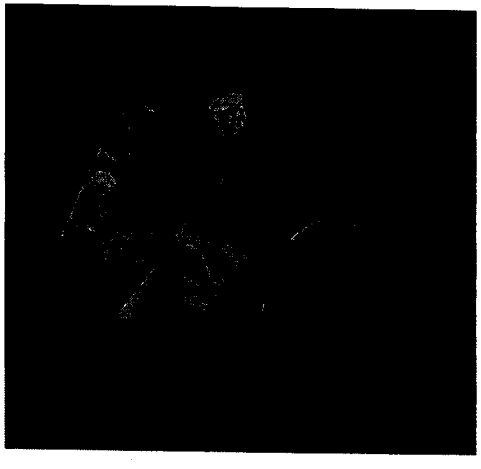


AIRS: April 2002



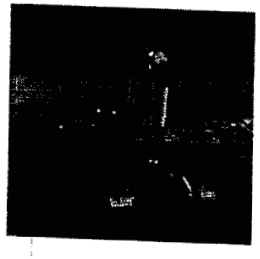
Galex: July 2002

SIRTF: Dec 2002/Jan 2003



Seawinds: November 2002

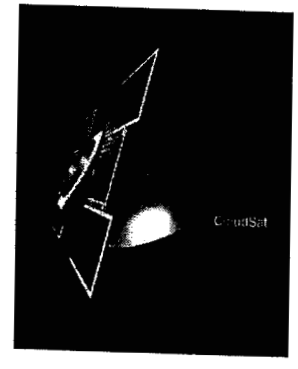
JPL Missions in Development



MER: 5-6/2003 (JPL)

Mars French Orbiter: 2007 (CNES, JPL)

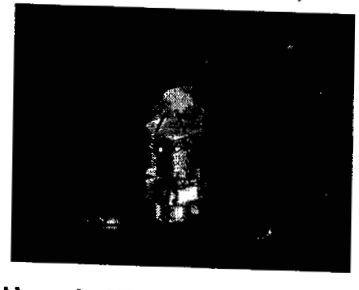
Starlight: 2006 (JPL, Ball)



Cloudsat: 2003 (CSU, Ball, JPL)

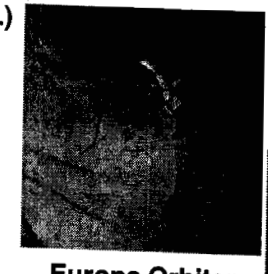
Deep Impact: 2004 (U/MD, Ball, JPL)

Marconi Mars Telecom: 2007 (ASI, JPL)

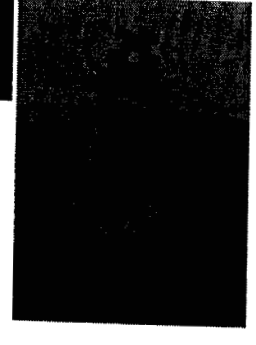


Herschel/Planck: 2006 (ESA, JPL)

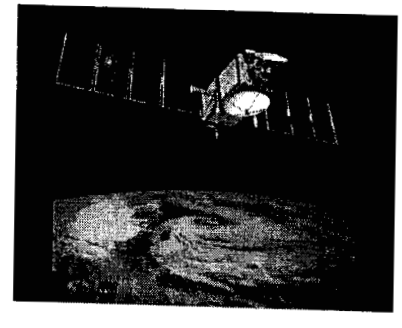
Mars Recon Orbiter: 2005 (LMA, JPL)



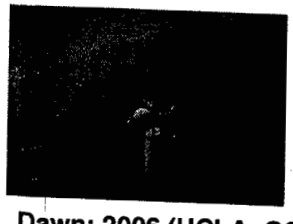
Europa Orbiter: 2008 (JPL)



Mars Smart Lander: 2009 (JPL, TBD)



Jason II: 2006 (JPL, CNES)

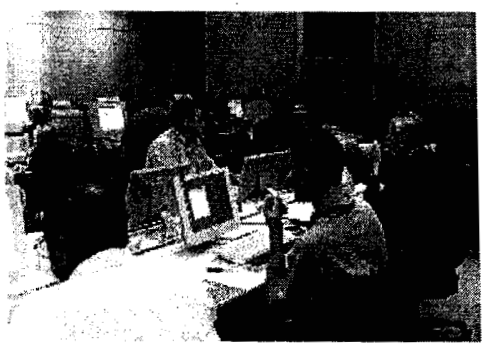


Dawn: 2006 (UCLA, OSC., JPL)

SIM: 2009 (JPL, TRW, LMA)

Technology and Engineering

JPL is a world leader in key areas critical to deep space exploration

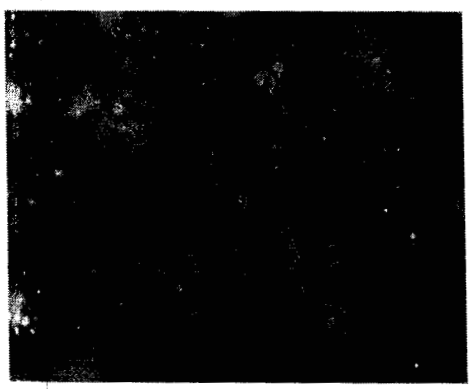


End-to-end system engineering and project management

Autonomous mobility

Deep space communications

Deep space navigation and highly stable clocks



Extreme precision formation flying for science and rendezvous

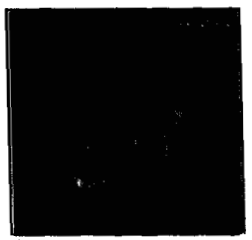
High precision spaceborne systems in optical to sub-millimeter, including interferometry

Active sensors for mapping and positioning (SAR, altimeters, GPS)

NASA's Origins Program

Are we alone? Where do we come from?

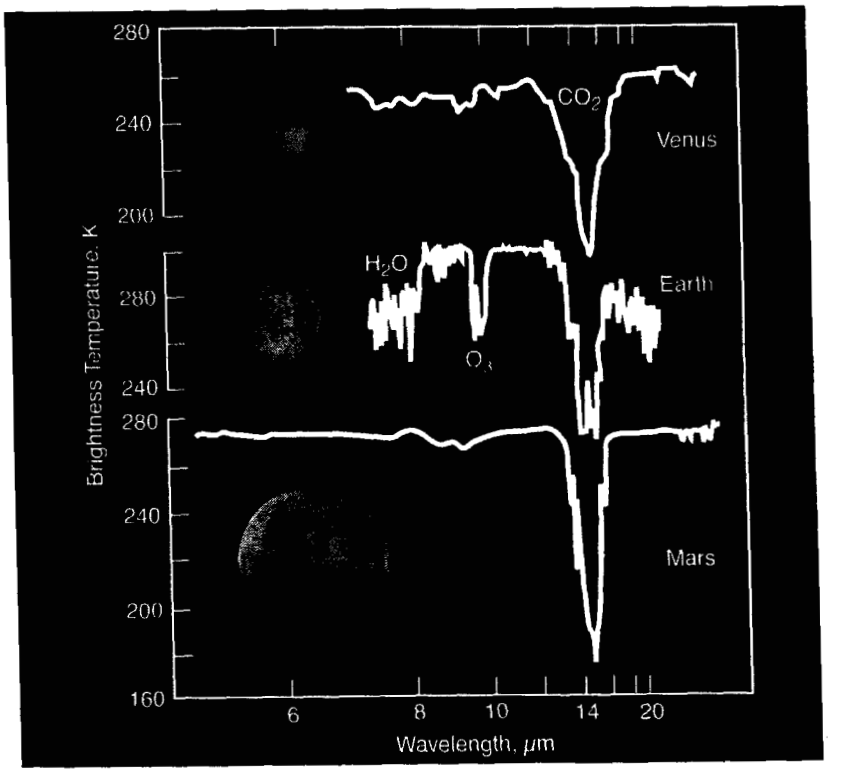
HST and NGST will study formation of stars and planets



SIRTF will find disks associated with planets

Starlight will demonstrate separated spacecraft interferometry

SIM will find earth-sized planets around nearby stars



Eventually, TPF will detect and study habitable planets (and life?) around nearby stars

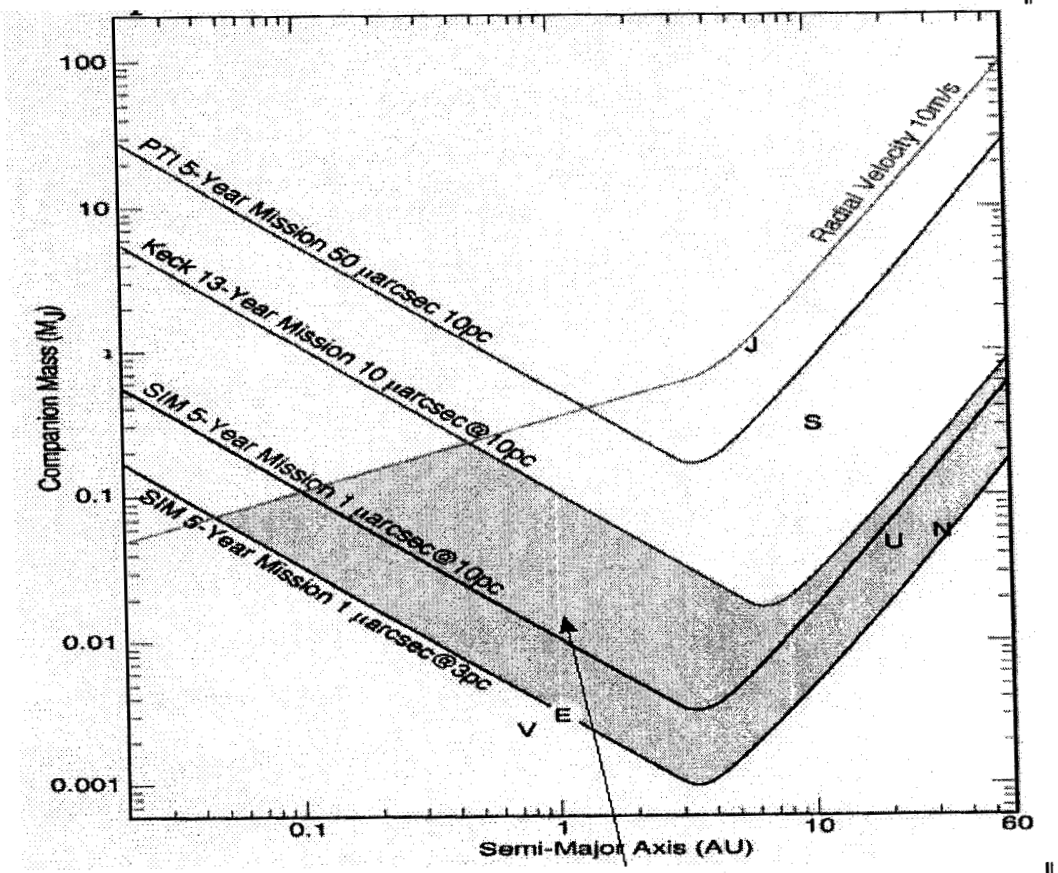
Knowledge and Ignorance of Extrasolar Planets

- **What we know**
  - Giant-Planet occurrence is high: ~7%
  - Mass distribution extends below Saturn mass
  - Eccentric orbits are common: scattering?
  - Several multiple systems of giant planets are known

- **What we *don't* know**
  - Existence of terrestrial planets
  - Planetary system architecture
    - Coplanarity of orbits, eccentricities
  - Mass distribution
    - Only astrometry measures the mass of a planet unambiguously
  - Low-mass planets in 'habitable zone' ?

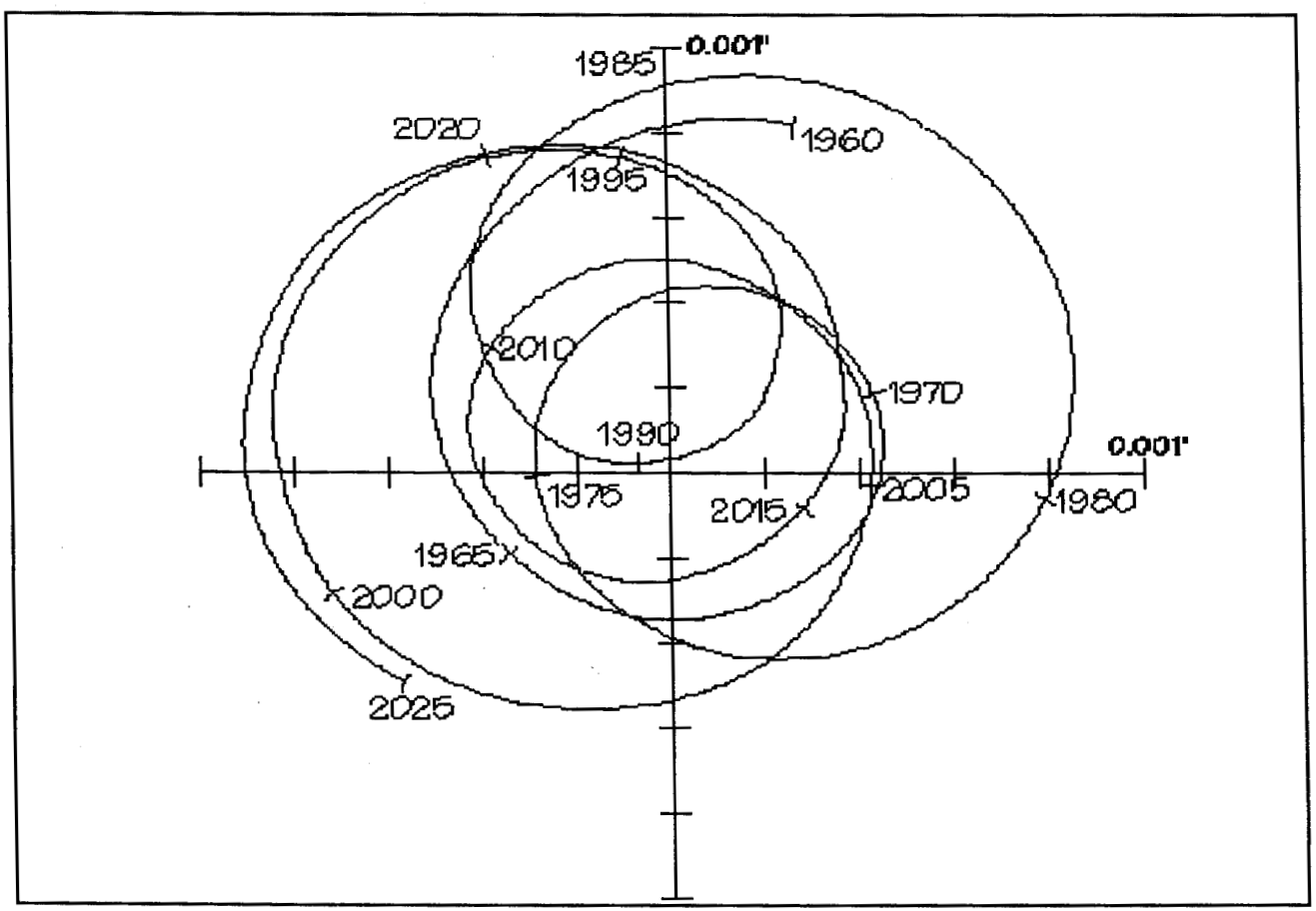
Astrometric Planet Detection

- SIM will search for ~3 Earth mass planets in the habitable zone around ~250 stars within 10 parsecs
- SIM will survey ~2000 stars within 20 parsecs to find planetary systems like our own (Jovian planets in Jovian orbits). SIM will place our solar system and its planets in the context of planetary systems in this part of the galaxy
- SIM will study the birth of planetary systems around young stars to understand how planetary systems evolve



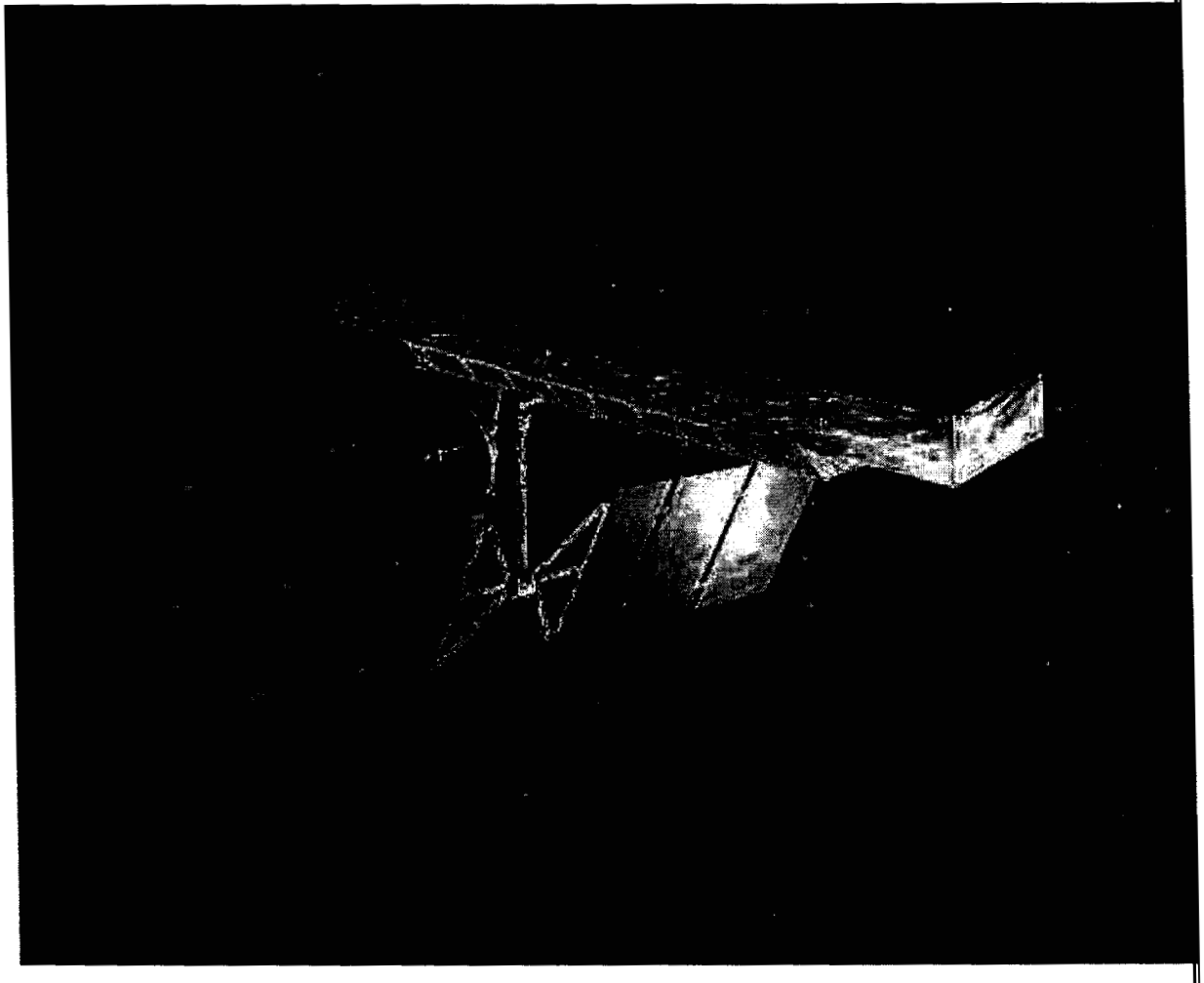
Astrometric Planet Detection

- Planetary systems inducing only low radial velocities (<1m/s) in their central star and therefore, not possible to detect from the ground can be detected through the astrometric displacement of the parent star.



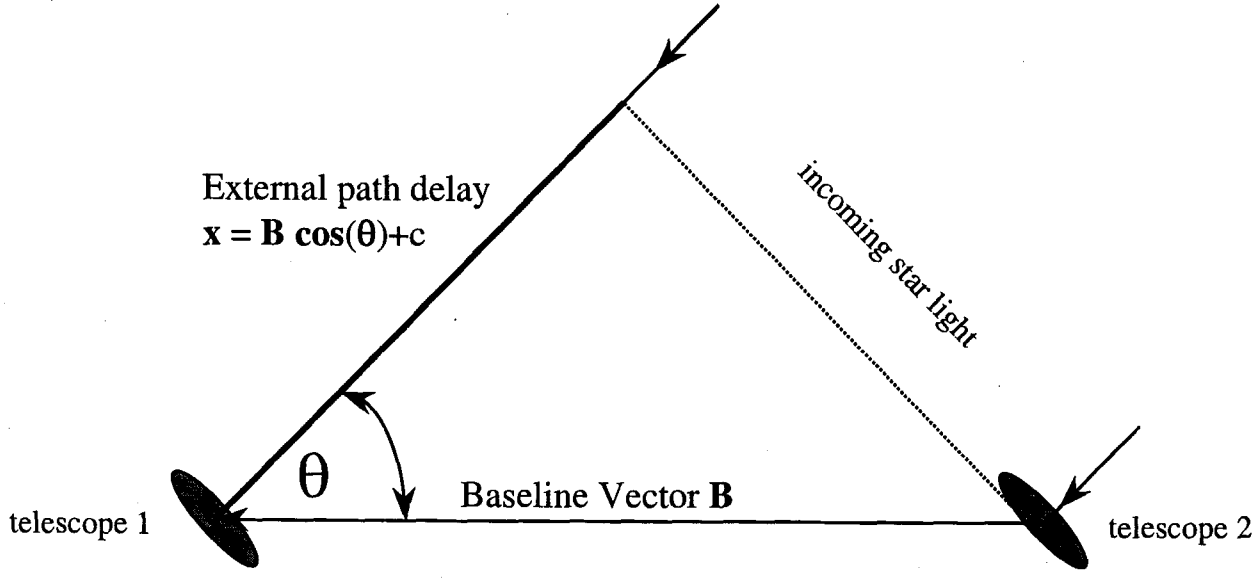
Space Interferometry Mission

- 3 Michelson Stellar Interferometers
- 10 meter baseline
- Visible wavelength
- Launch Vehicle: Space Shuttle or EELV
- Earth-trailing solar orbit
- 5 year mission life with 10 year goal
- SIM is a JPL, Caltech, Lockheed Martin, TRW, and The SIM Science Team partnership



Star-Baseline Geometry

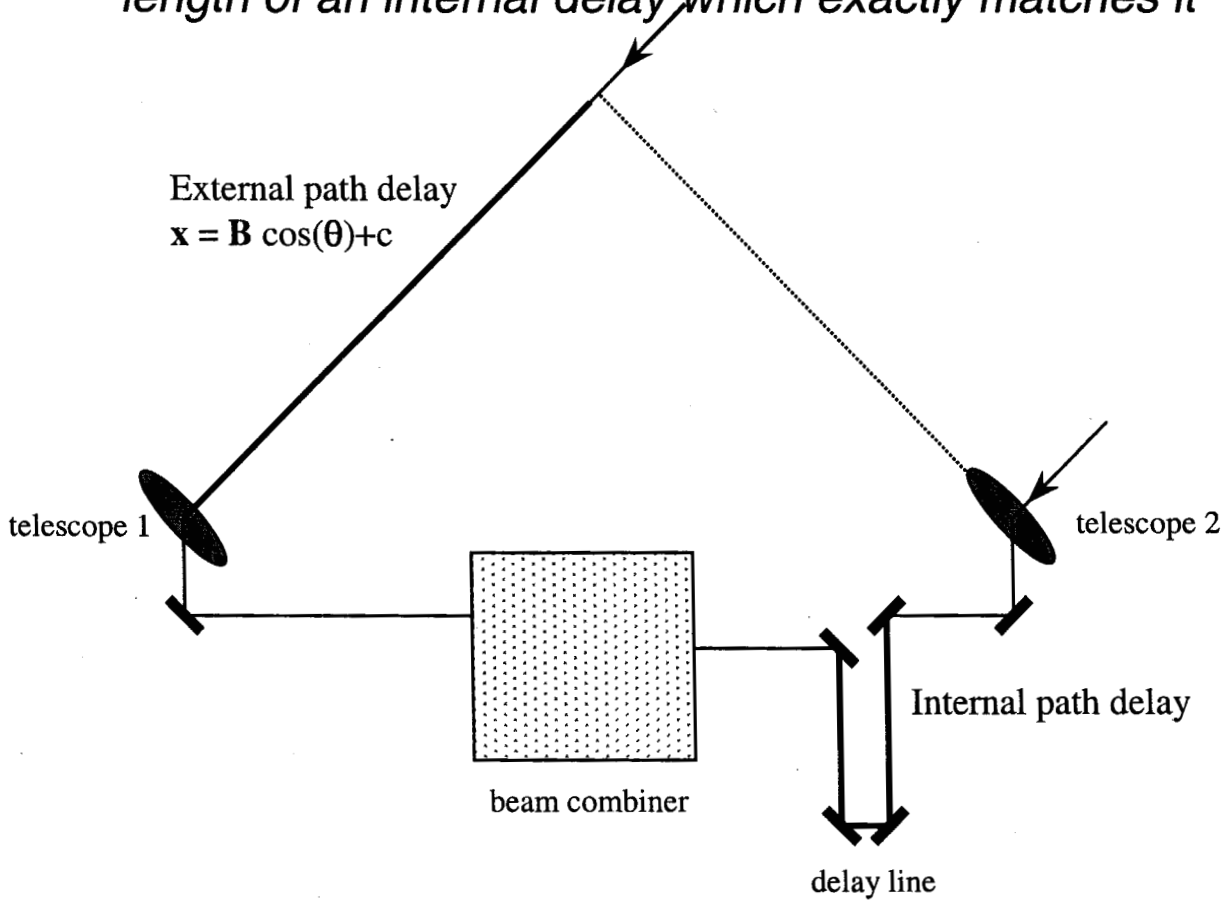
*The angle between the star and baseline creates an external path delay **x***



*If we know **B**, and can determine **x**, we can solve for the star position θ*

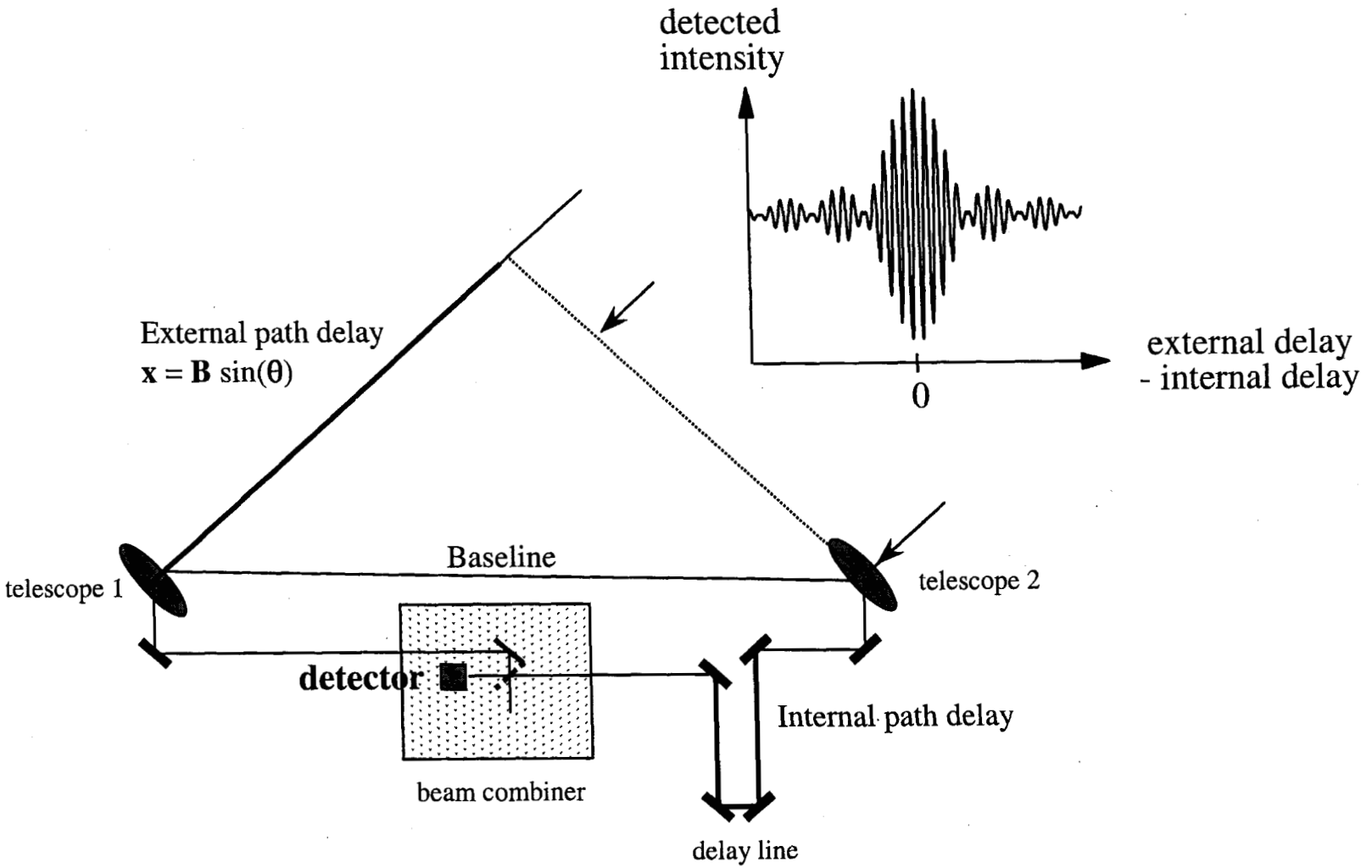
Determining the External Delay

We determine the external delay by measuring the length of an internal delay which exactly matches it



Optical delay lines are used to vary the internal delay

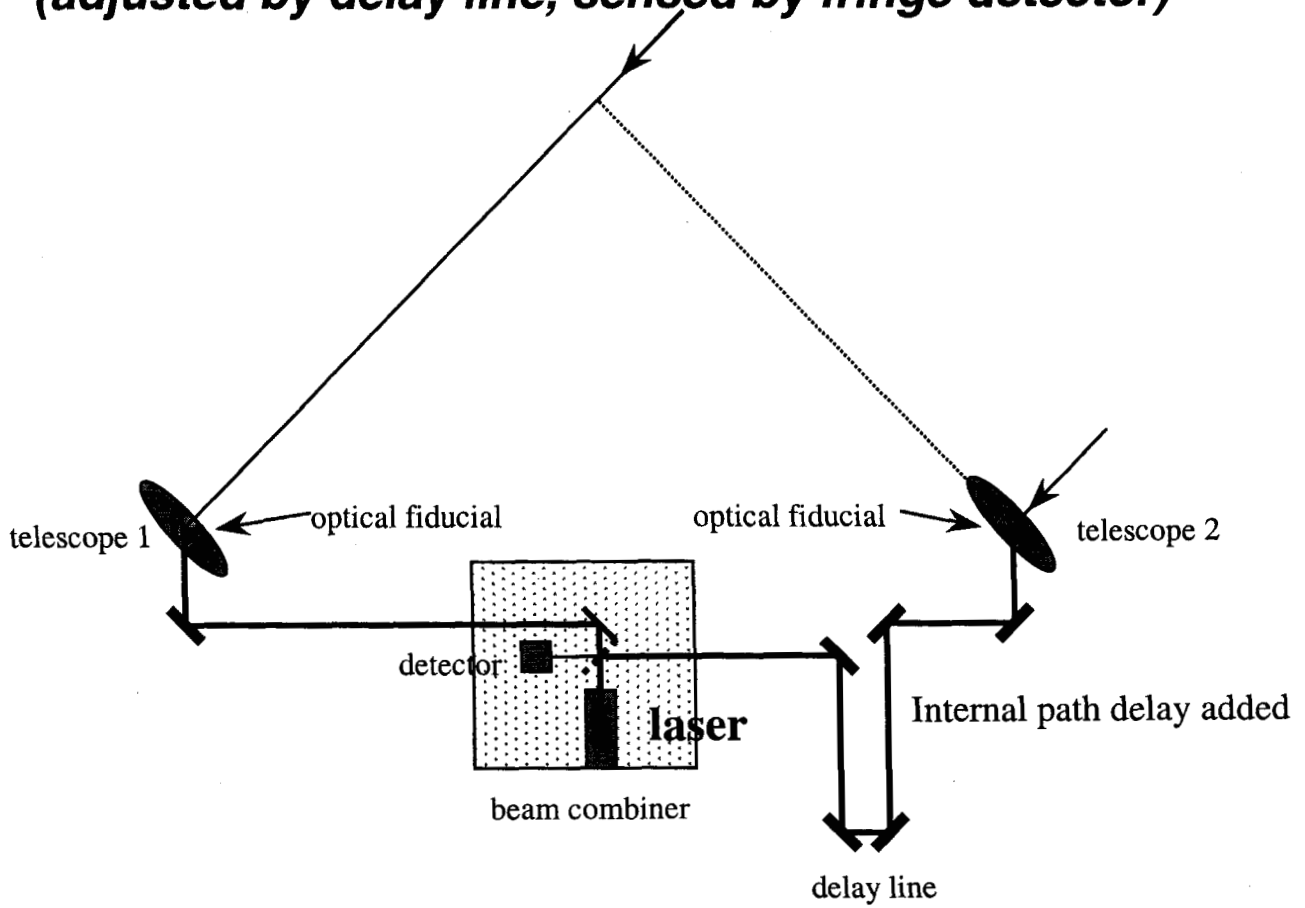
Fringe Position as a Measure of Pathlength Equality



The peak of the interference pattern occurs when the internal path delay equals the external path delay

Internal Metrology

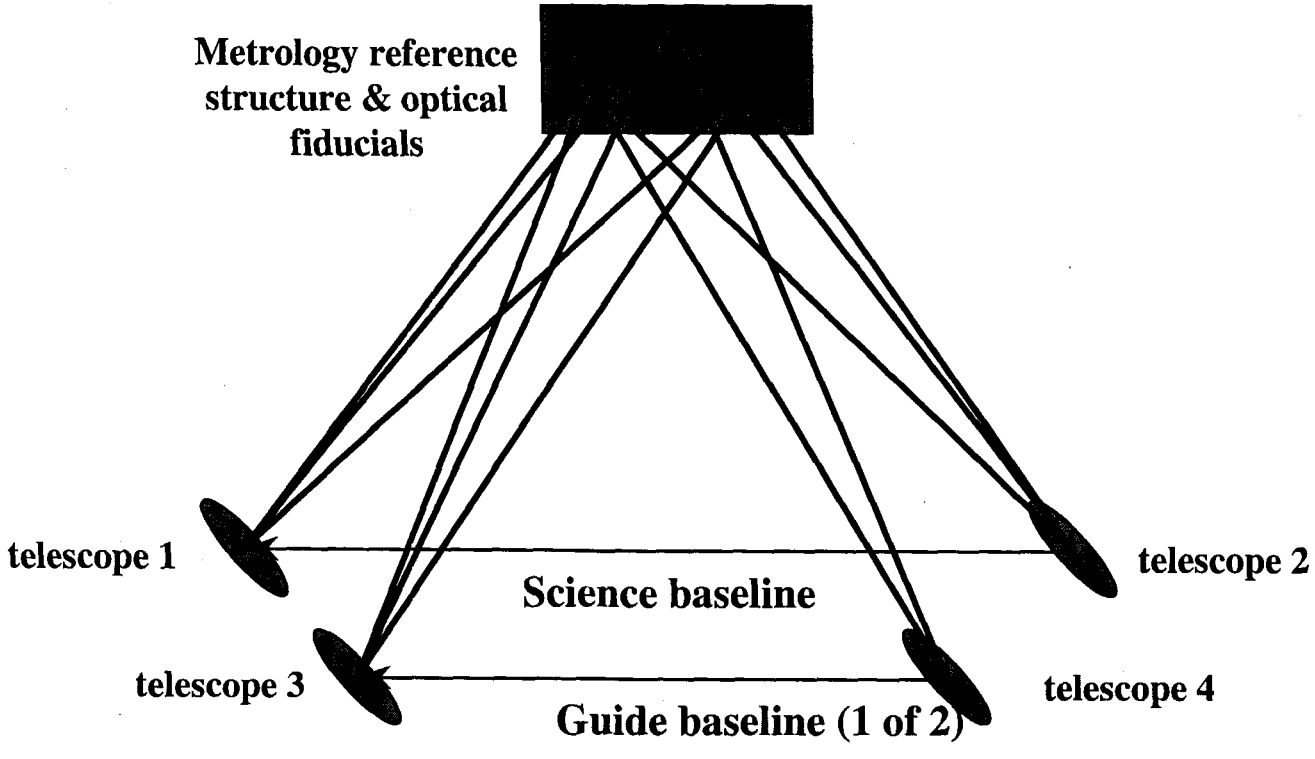
Laser gauge measures internal delay
(adjusted by delay line, sensed by fringe detector)



Laser path retraces starlight path from combiner to telescopes

Relationship Between Baselines

Measure baseline B using laser triangulation



The Guide baseline attitude information is used to stabilize the science interferometer

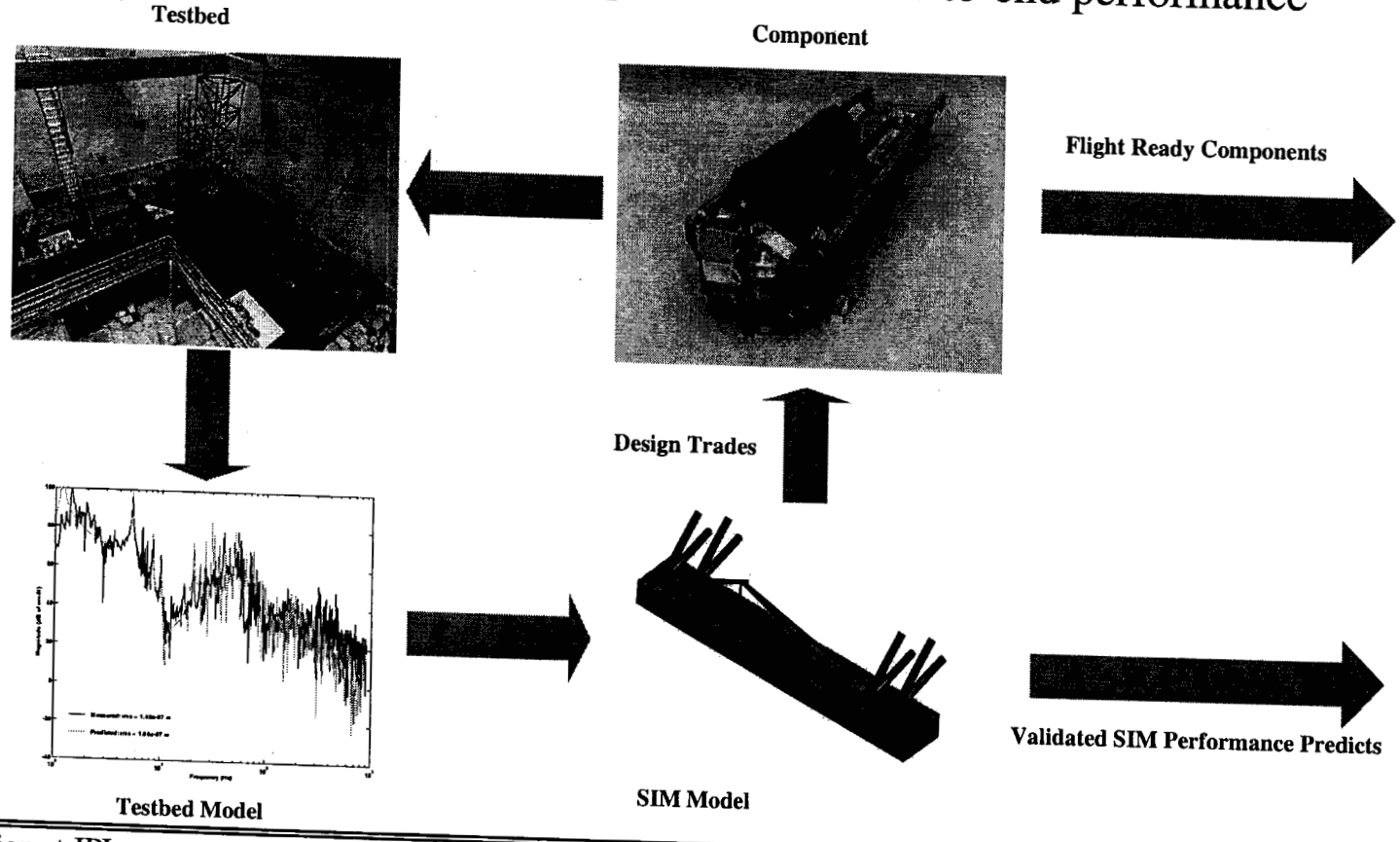
SIM is Enabled by New Technology

- Knowledge of positions of optical elements to 25 Picometers (100 pm = diameter of a hydrogen atom)
  - Picometer laser metrology
  - Picometer starlight fringe position measurement

- Nanometer control of optical path difference to 10 Nanometers (75,000 nm = thickness of a human hair)
  - Nano-g vibration isolation
  - Nanometer/nanoradian active optics
  - Micron stability of structures

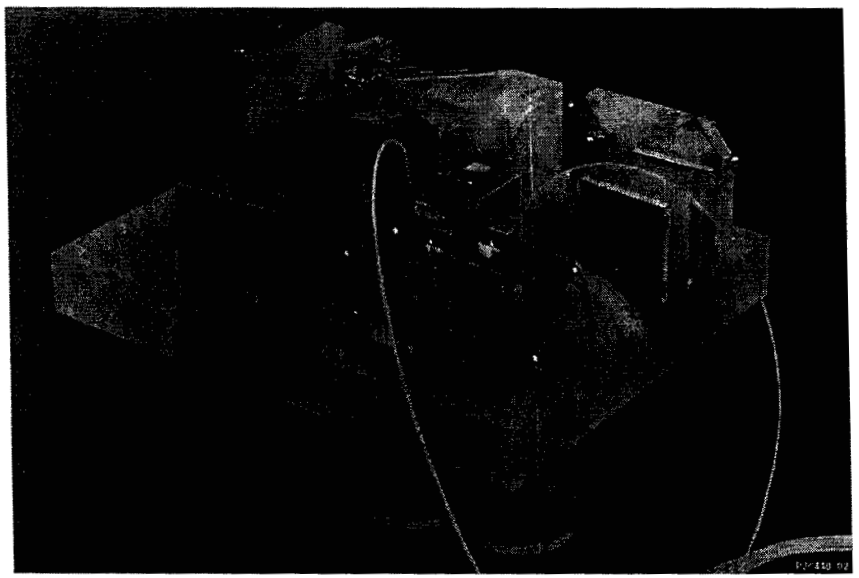
Approach to Technology Development

- Prototyping of technology component hardware and software
- Extensive use of ground testbeds to verify that the components play together at the system level
- Modeling, anchored by testbeds, predicts SIM end-to-end performance

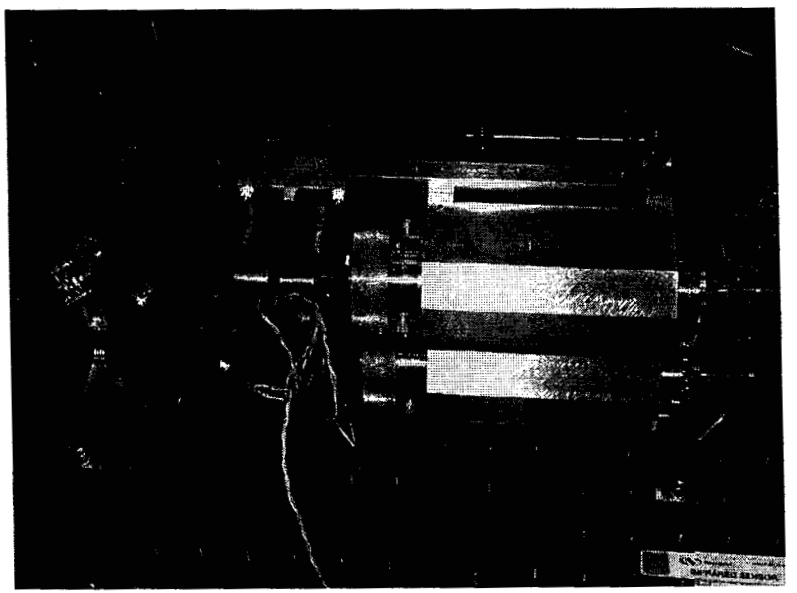


Metrology Beam Launcher Performance

- SIM uses two beam launchers designs
  - External Metrology launcher has achieved 60 pm gauge performance to date
  - Internal Metrology launcher has achieved 100 pm gauge performance to date



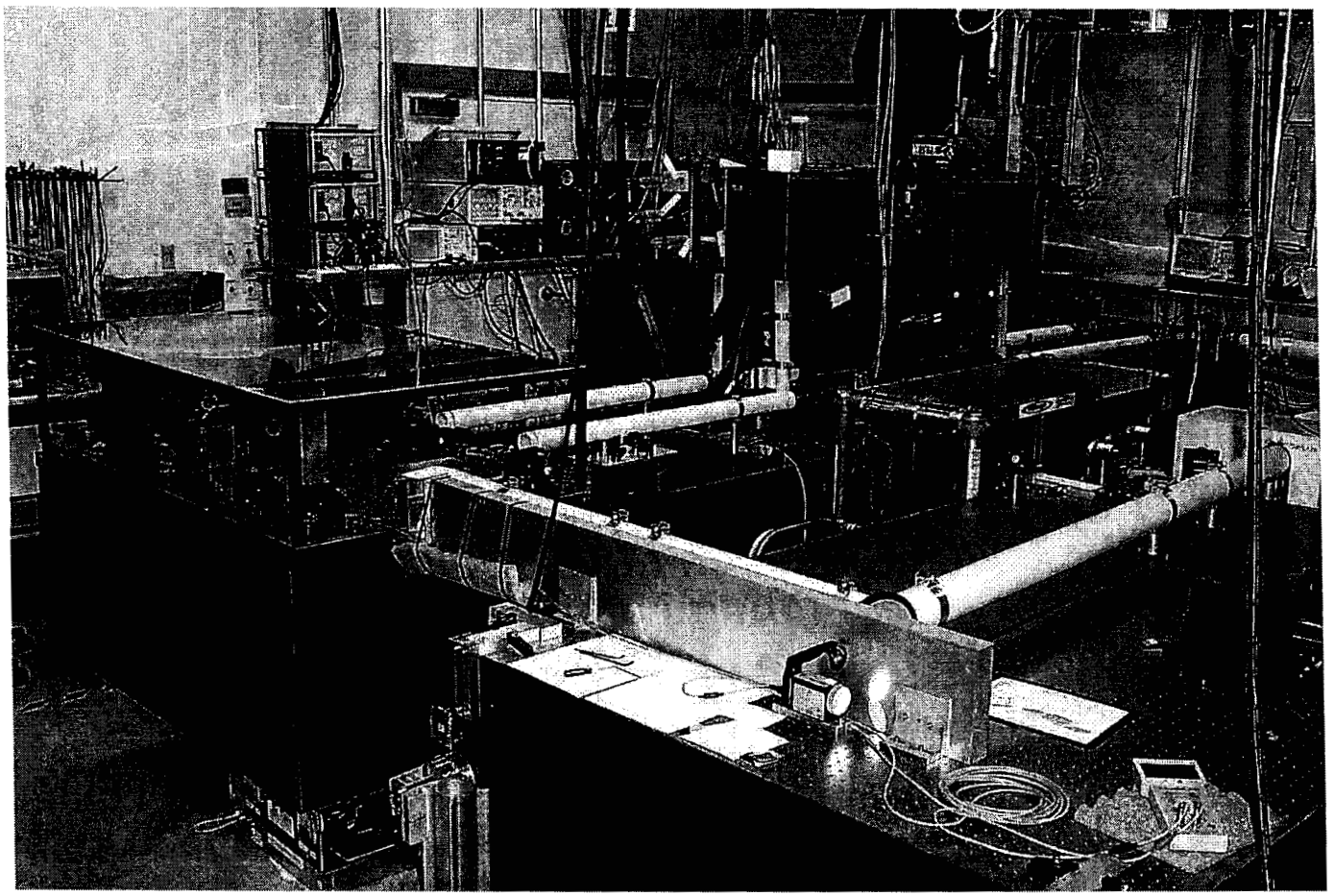
Launcher for External Metrology



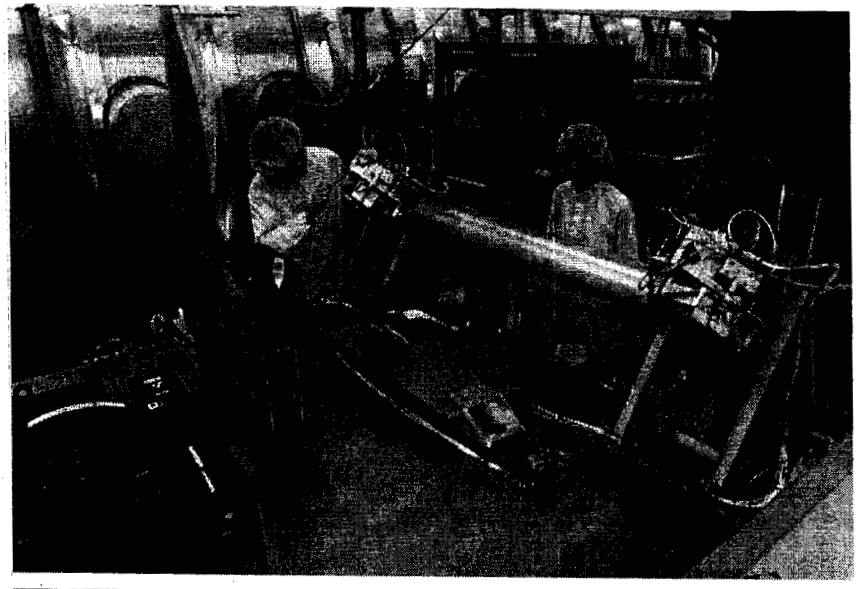
launcher for Internal Metrology

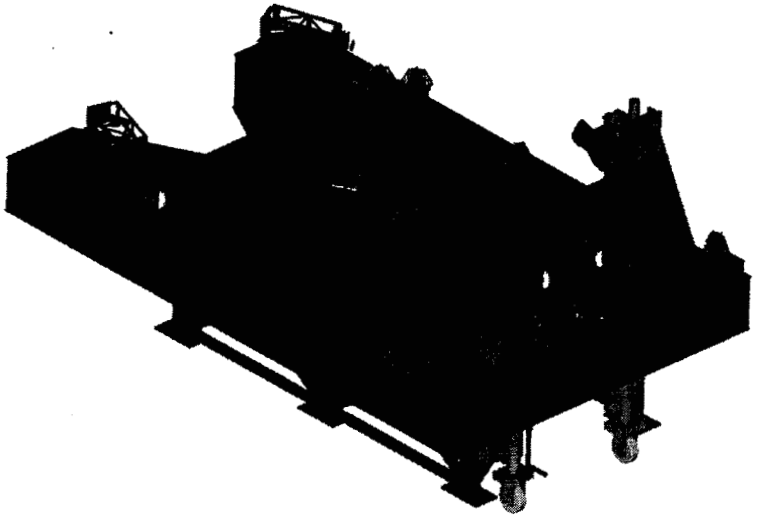
Nanometer real-time control Performance

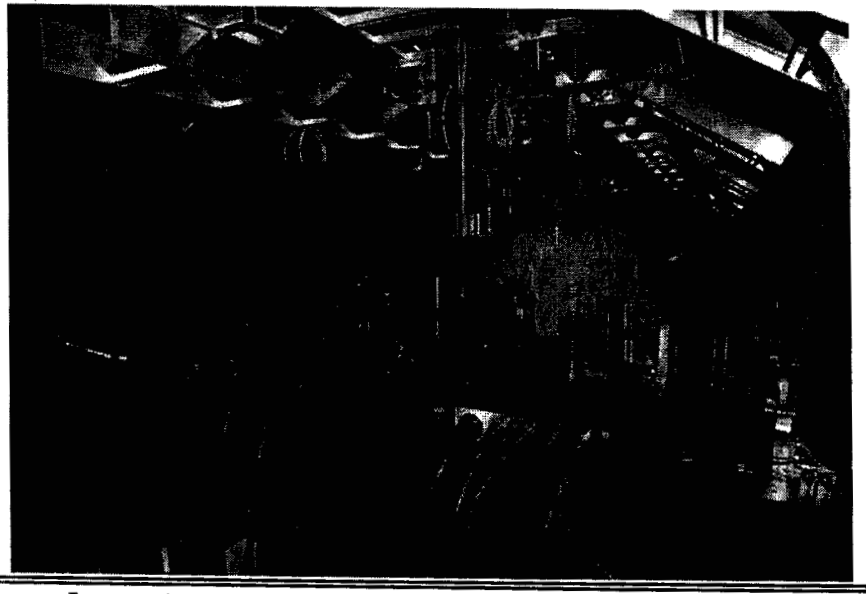
- Demonstration on System Test Bed 3 (STB-3) shows ability to use bright guide star tracking to stabilize dim science star fringe by better than 60 dB

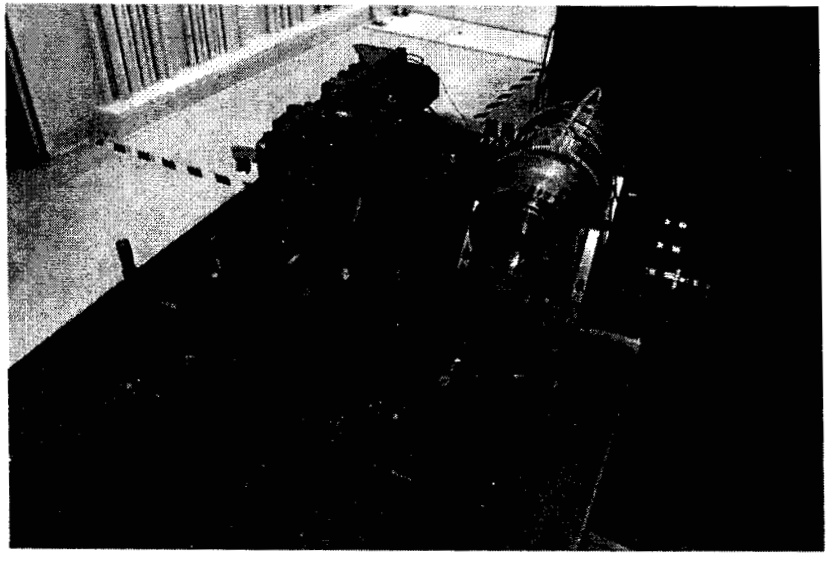


Instrument-Level Demonstration of Picometer Knowledge

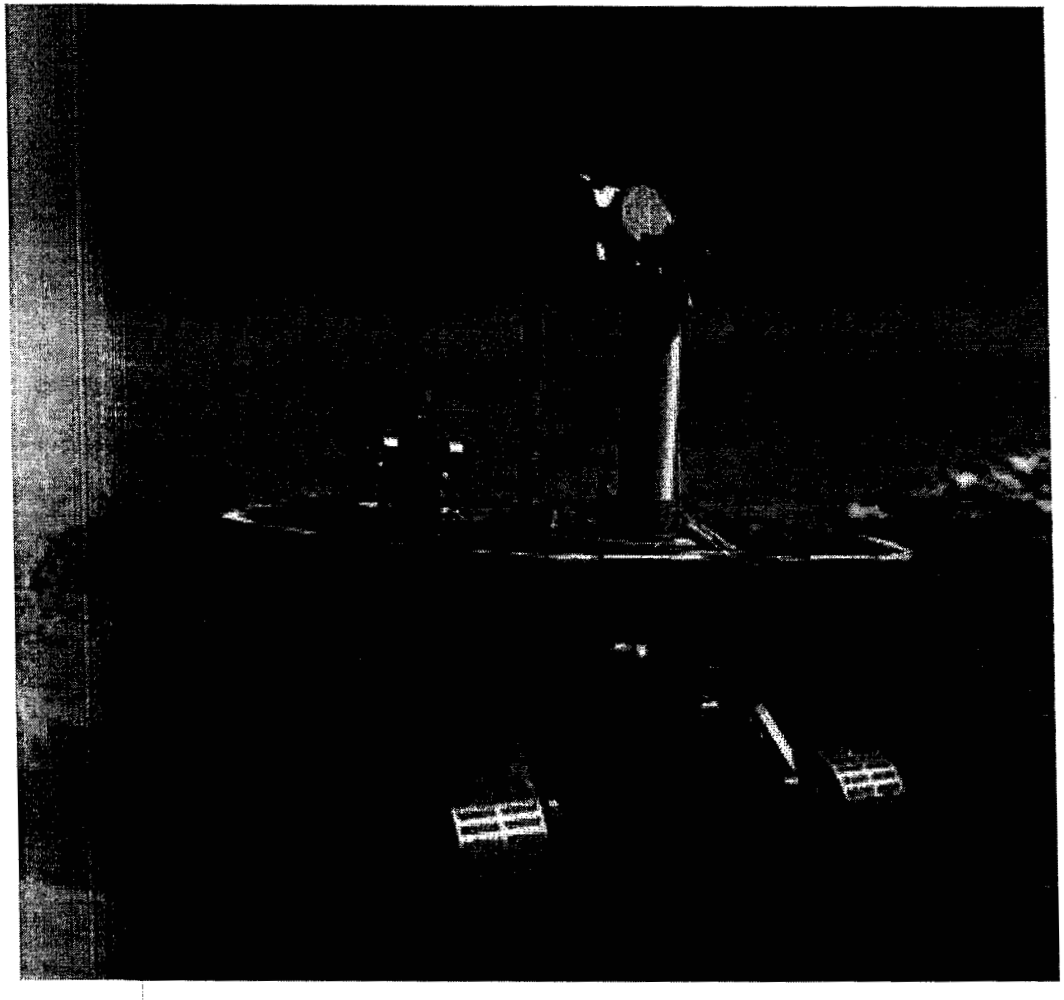






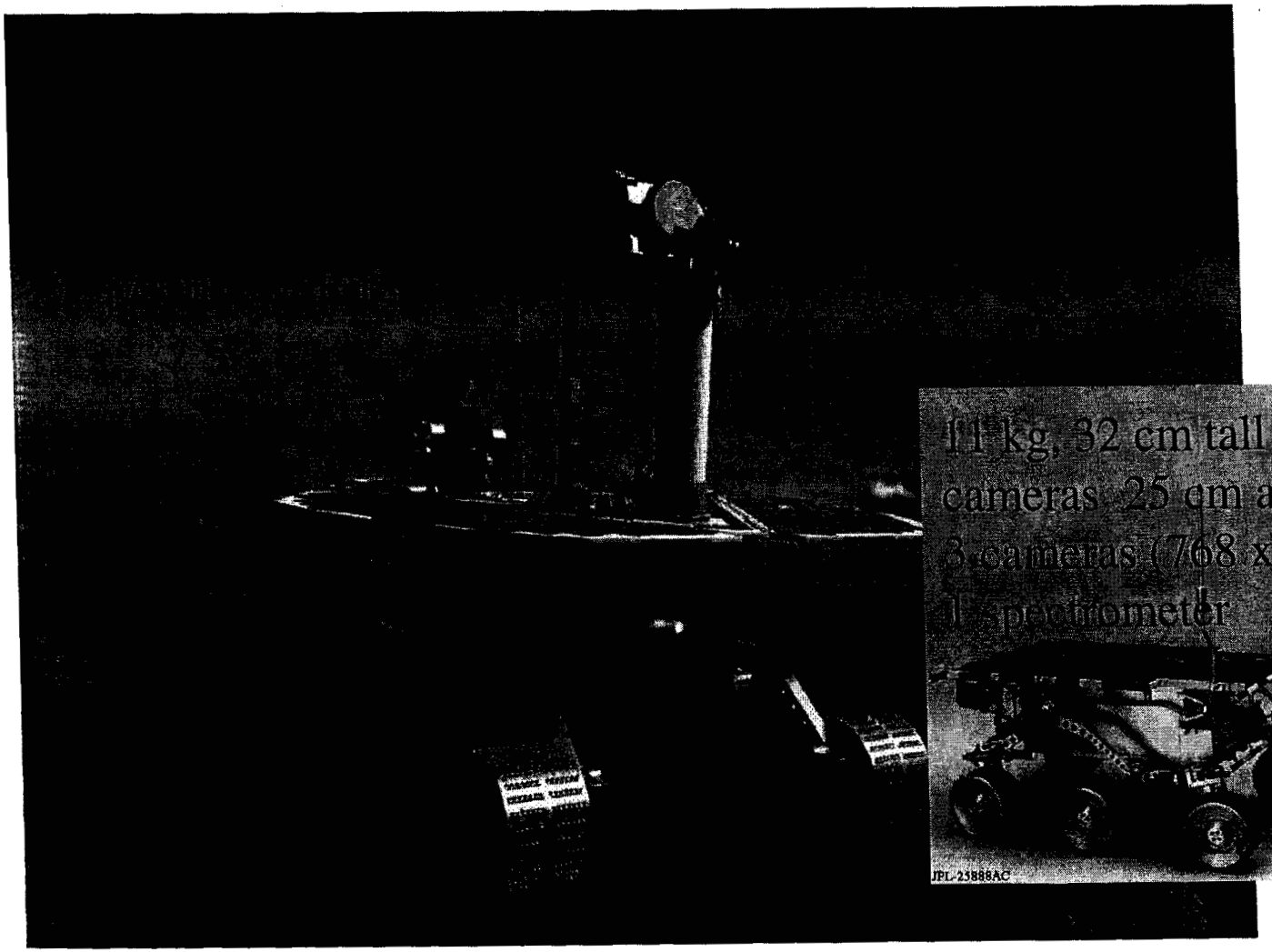


Mars Exploration Rover



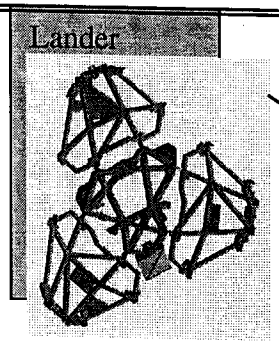
- Two rovers to be launched in May and July 2003.
- Arrive January 4 and January 25, 2004, at two scientifically distinct sites.
- Move 100 meters per day, with a traverse capability of >1km.
- Instruments: camera, spectrometers, microscopic imager, rock abrasion tool.
- Instruments perform remote sensing and in-situ science.
- Search for past water.

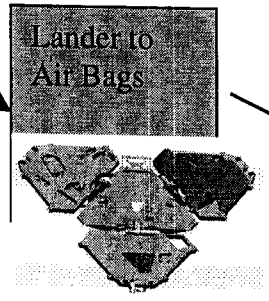
Comparison: MER Rover and Pathfinder Sojourner Rover

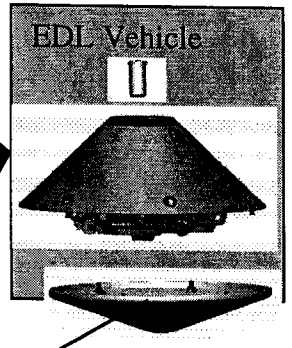


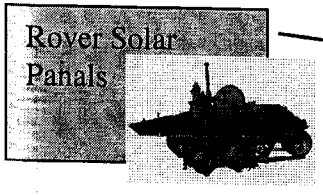
11 kg, 32 cm tall
cameras 25 cm above the ground
3 cameras (768 x 484)
1 spectrometer

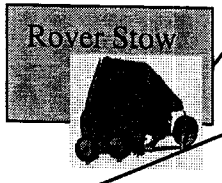
MER System Integration

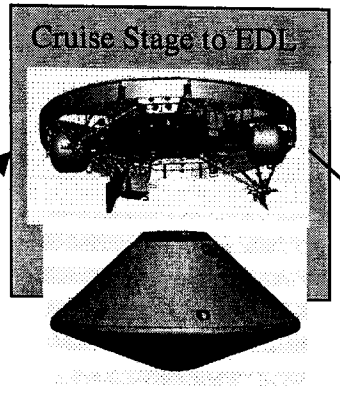


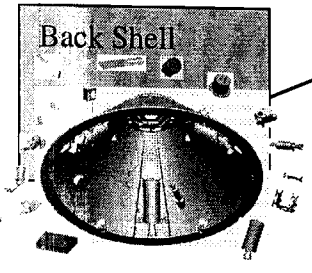


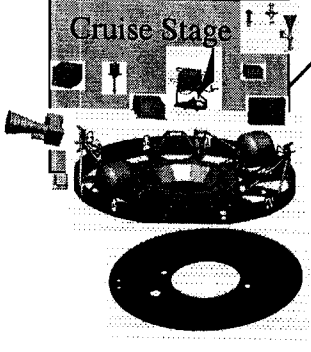


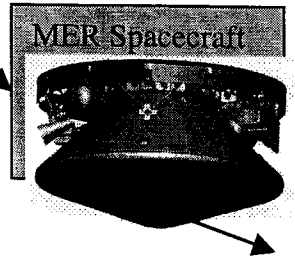


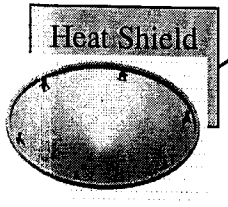






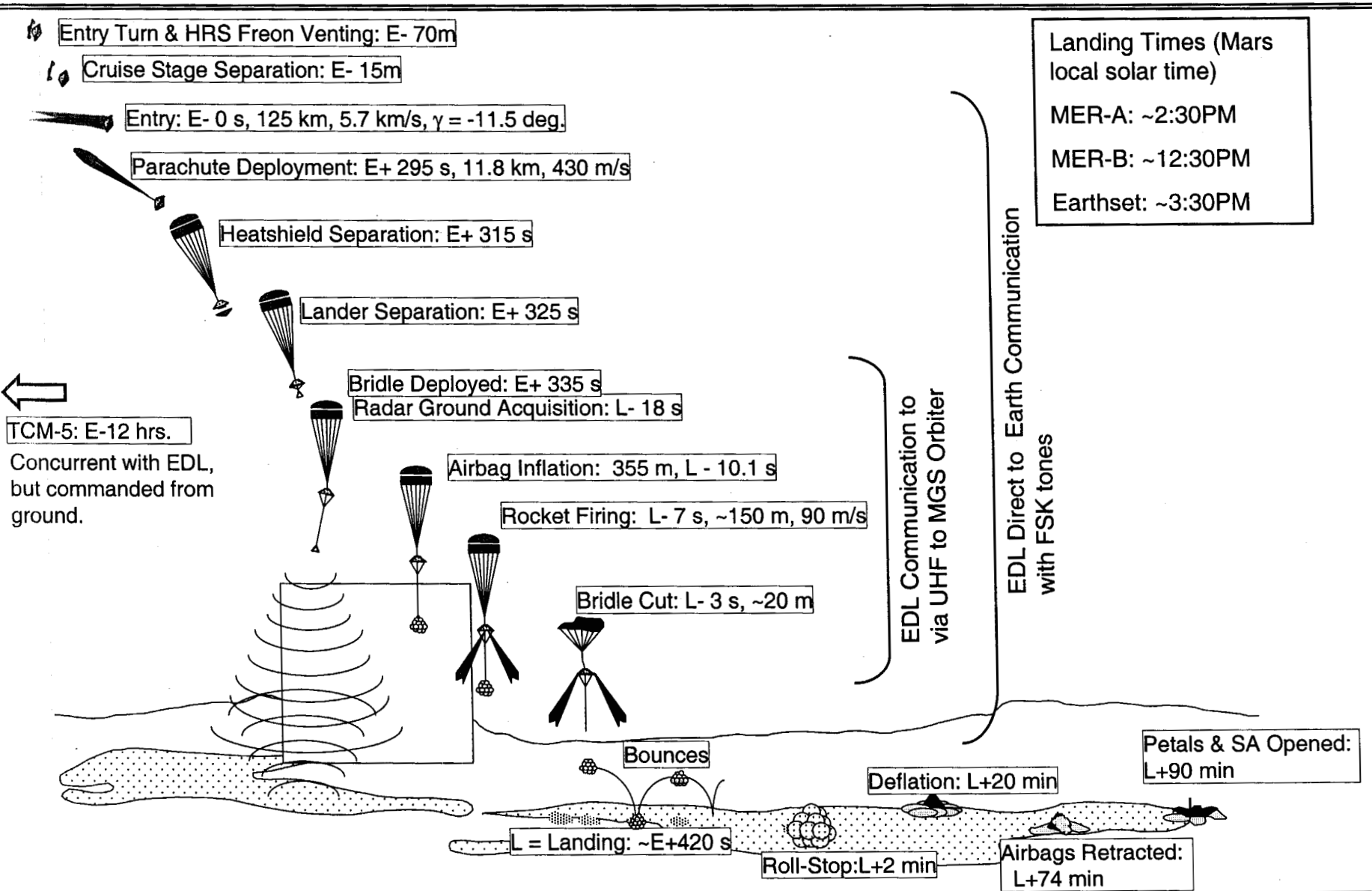






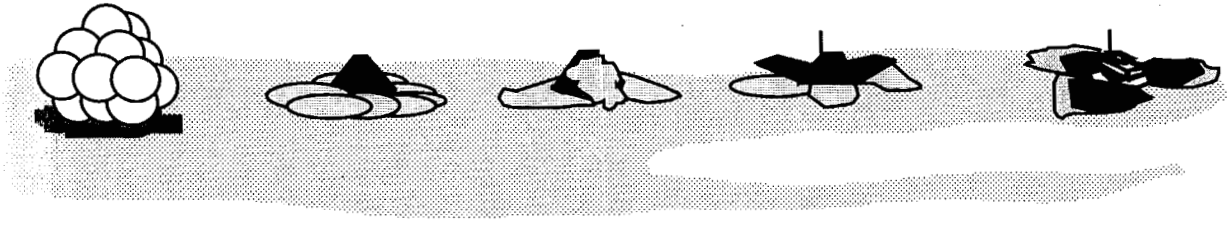
To System Environmental Test

Entry, Decent and Landing



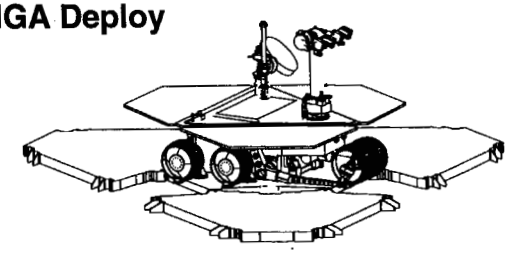
Impact to Egress Scenario

Airbag Retraction / Petal Deploy / Egress Aid Deploy



Sol 1

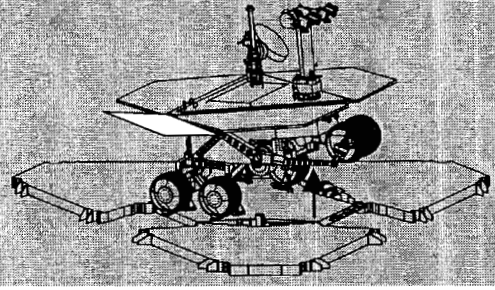
Solar Array Deploy
PMA Deploy & Imaging
HGA Deploy



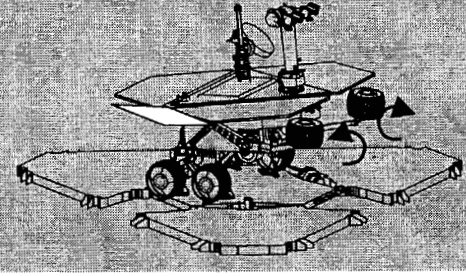
Sol 2-3

Petal / Airbag Adjustments
Pancam/Mini-TES

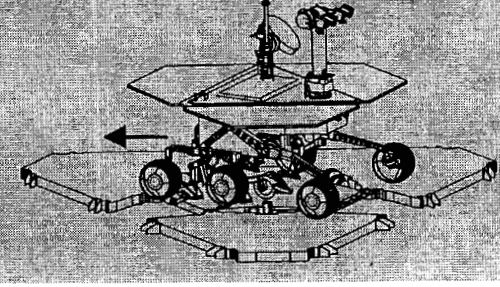
Lift Rover / Lock Rockers



Deploy Rockers



Lower Lift Mechanism & Deploy Bogies



Drive Petals to final Configuration

Release Middle Wheels & Fire 3rd Cable Cutter

Turn in Place

Drive Off Lander Deck

Sol 4

Future Direction in Planetary Science

- Focus shifting to surface and near-surface science exploration
  - Drives technology needs for mobility and in-situ science instruments
    - Rovers, aircraft, balloons, drills, melting probes, and submarines
    - Small, highly integrated in-situ science instruments with a focus on mineralogy and life-detection
- Significant increase in software development and information technology
  - Drives technology needs for breakthrough software development processes and validation, autonomous operation, intelligent, collaborative sensors