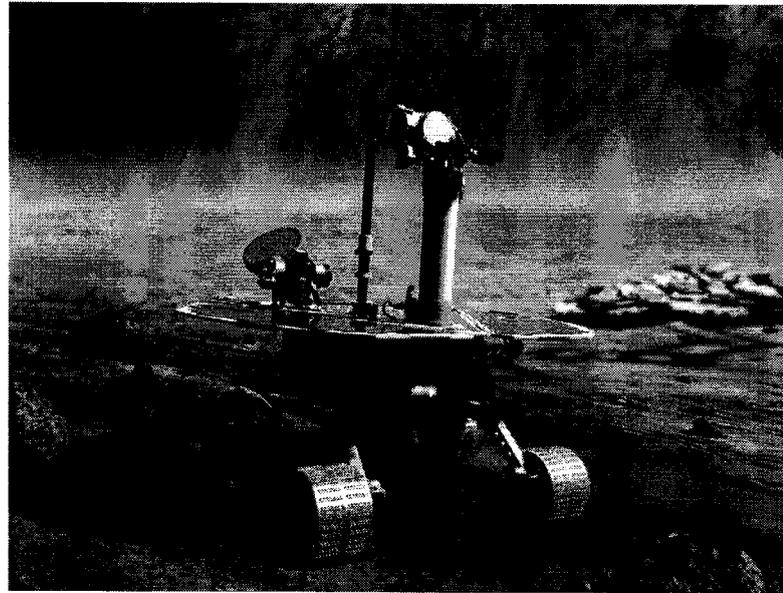




**JPL**

## Optomechanical Design of Ten Modular Cameras for the Mars Exploration Rovers



Virginia Ford, Paul Karlmann, Ed Hagerott, Larry Scherr

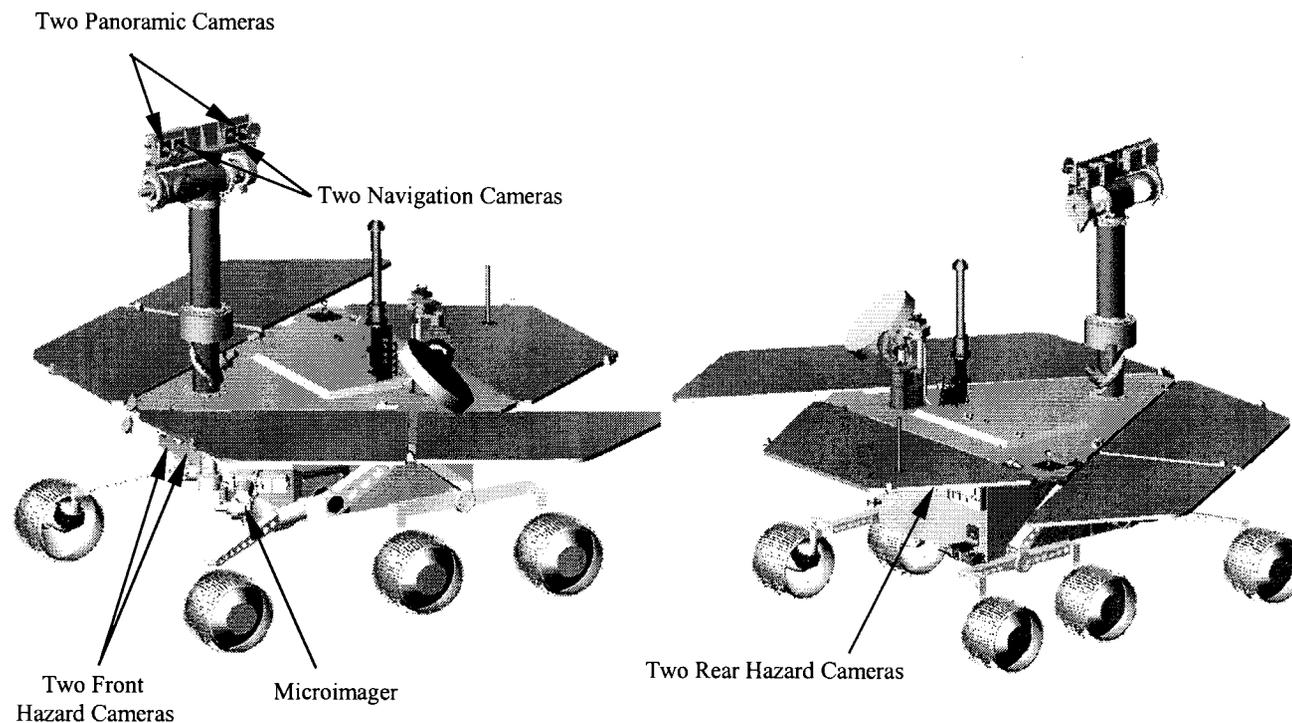
Jet Propulsion Laboratory, California Institute of Technology



# BACKGROUND



- Ten cameras for each lander and rover:
  - Science cameras: two Panoramic Cameras, one Microimager
  - Engineering cameras: four Hazard Cameras, two Navigation Cameras, on Lander Descent Camera

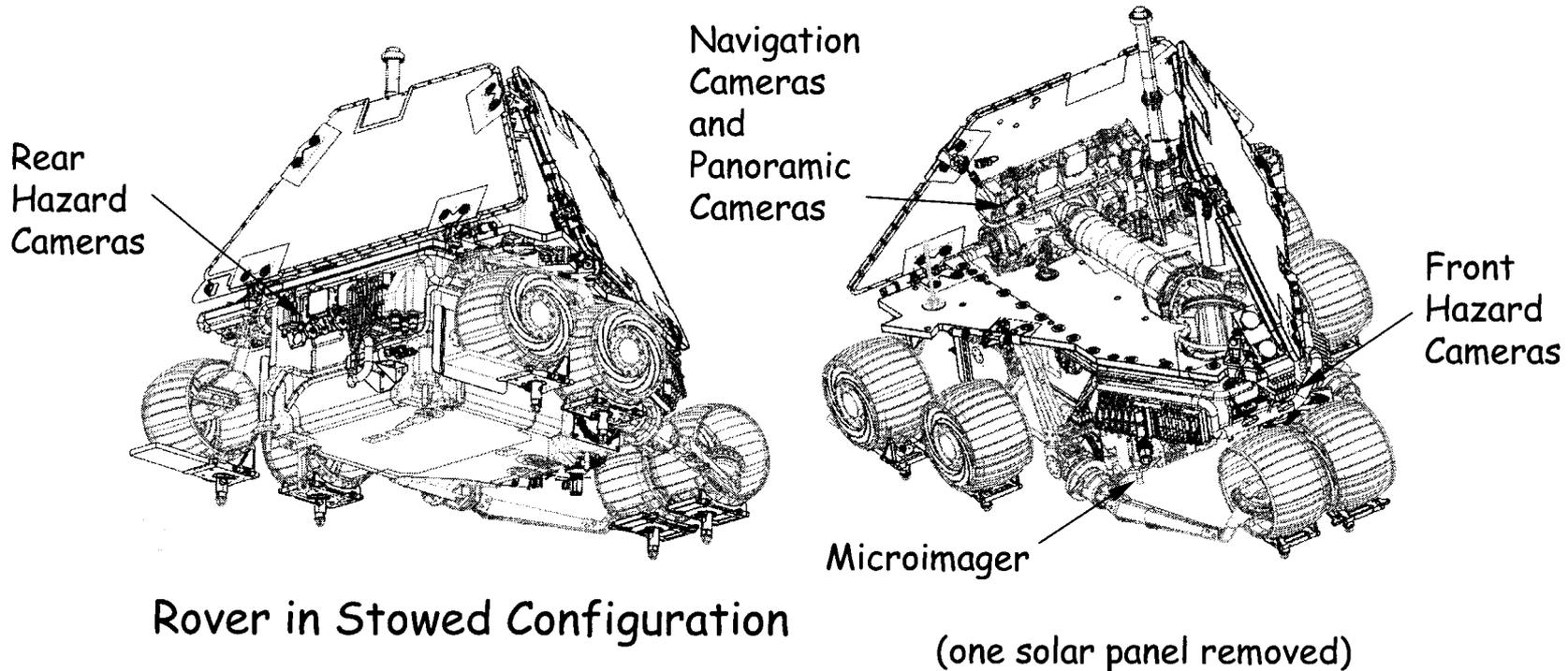




# BACKGROUND (CONT)

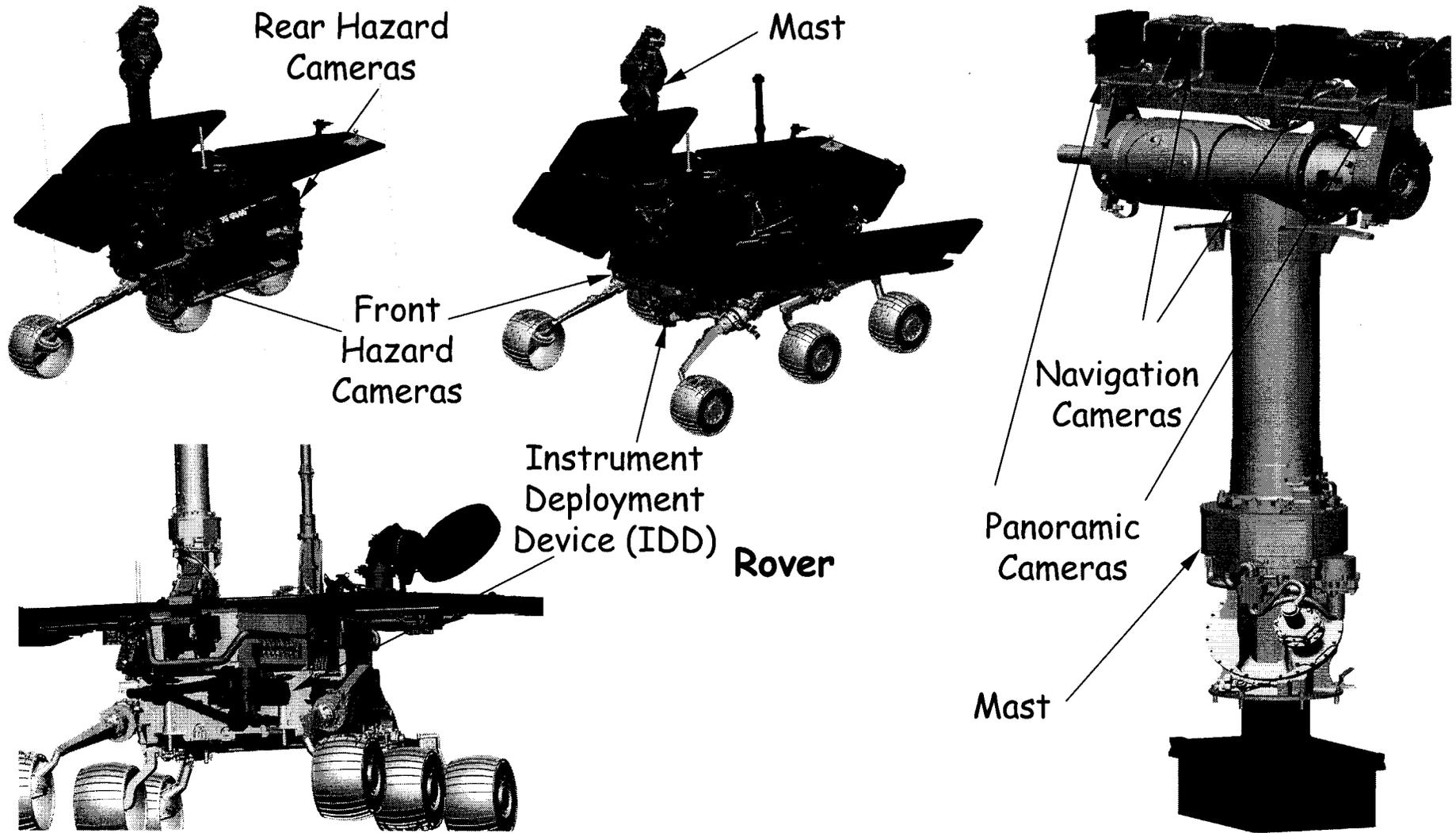


- Design drivers:
  - Volume constraints (and mass)
  - Thermal requirements
  - Versatility requirements



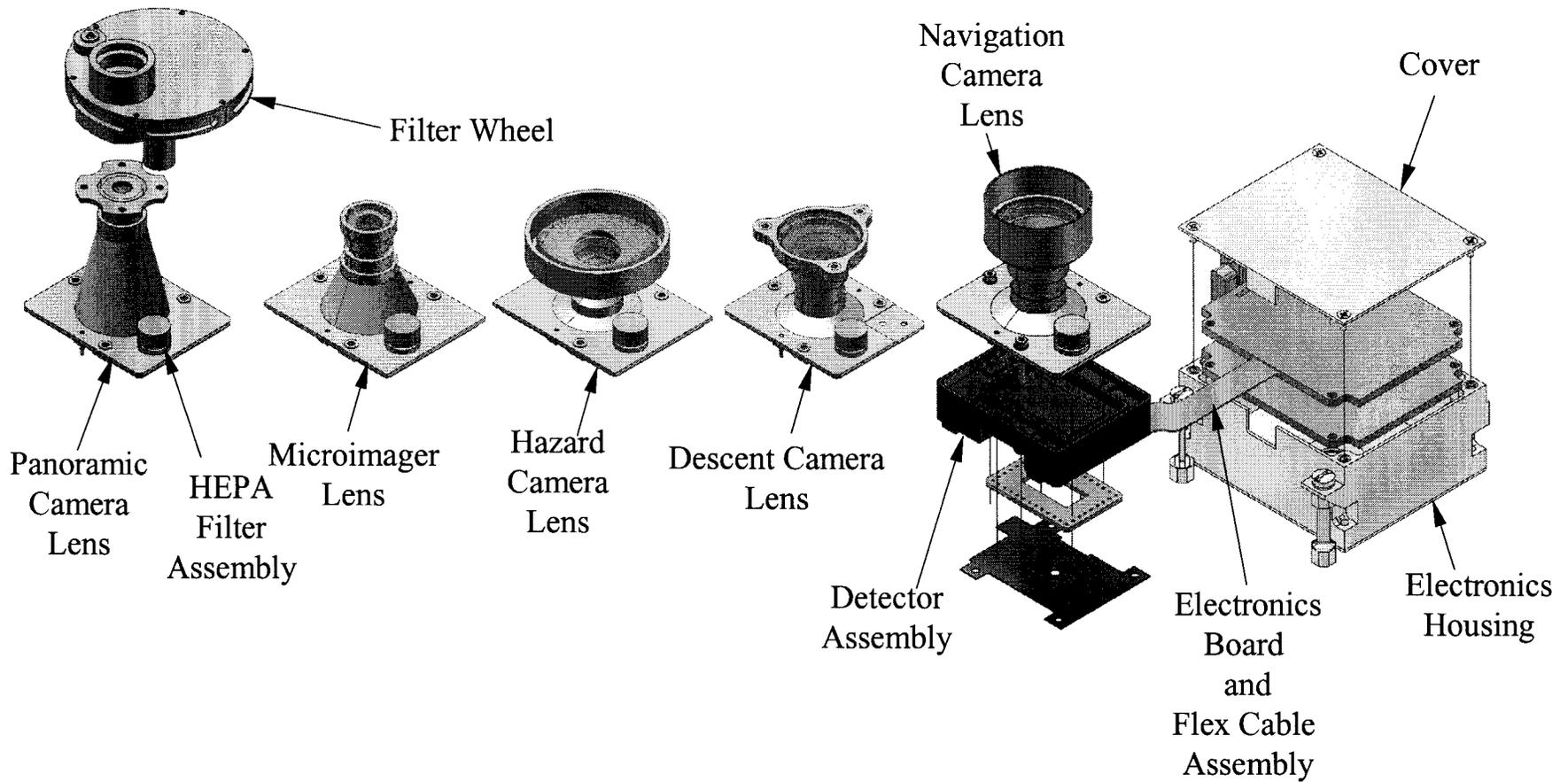


**JPL**



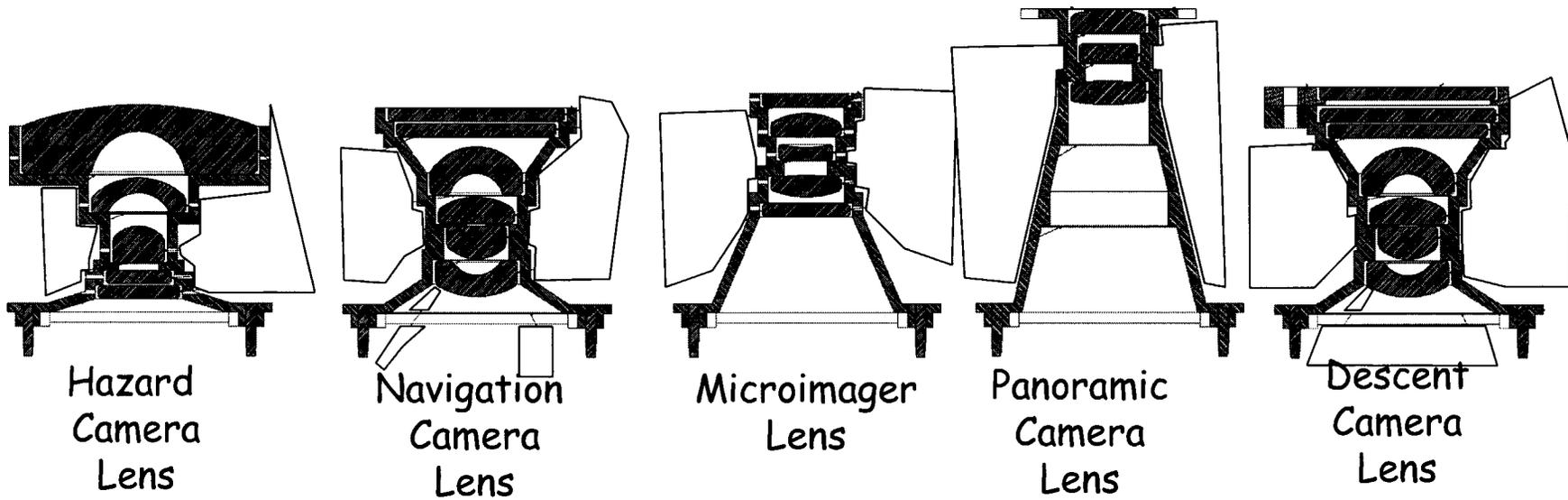


# Camera Parts



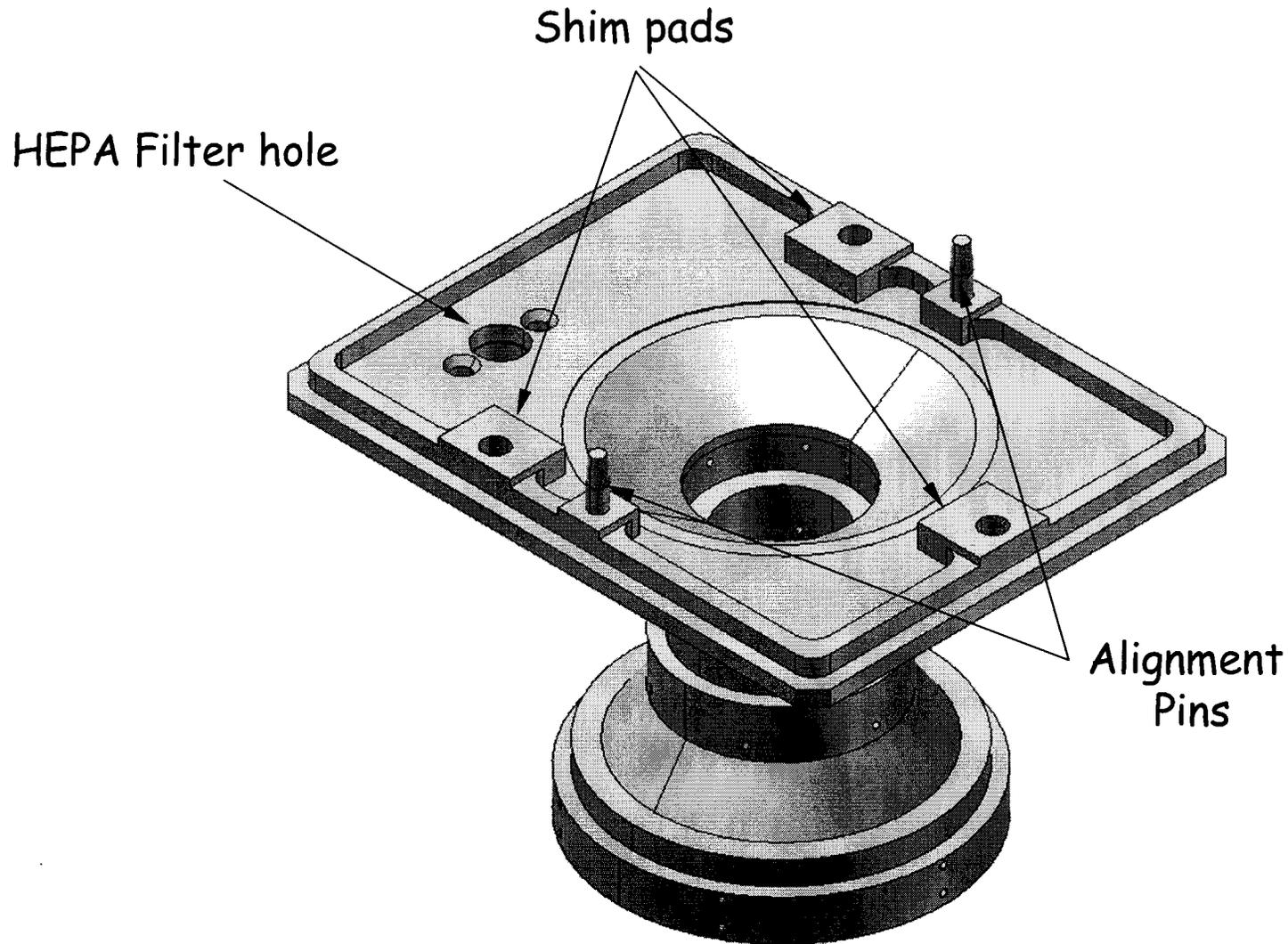


# Lens Designs



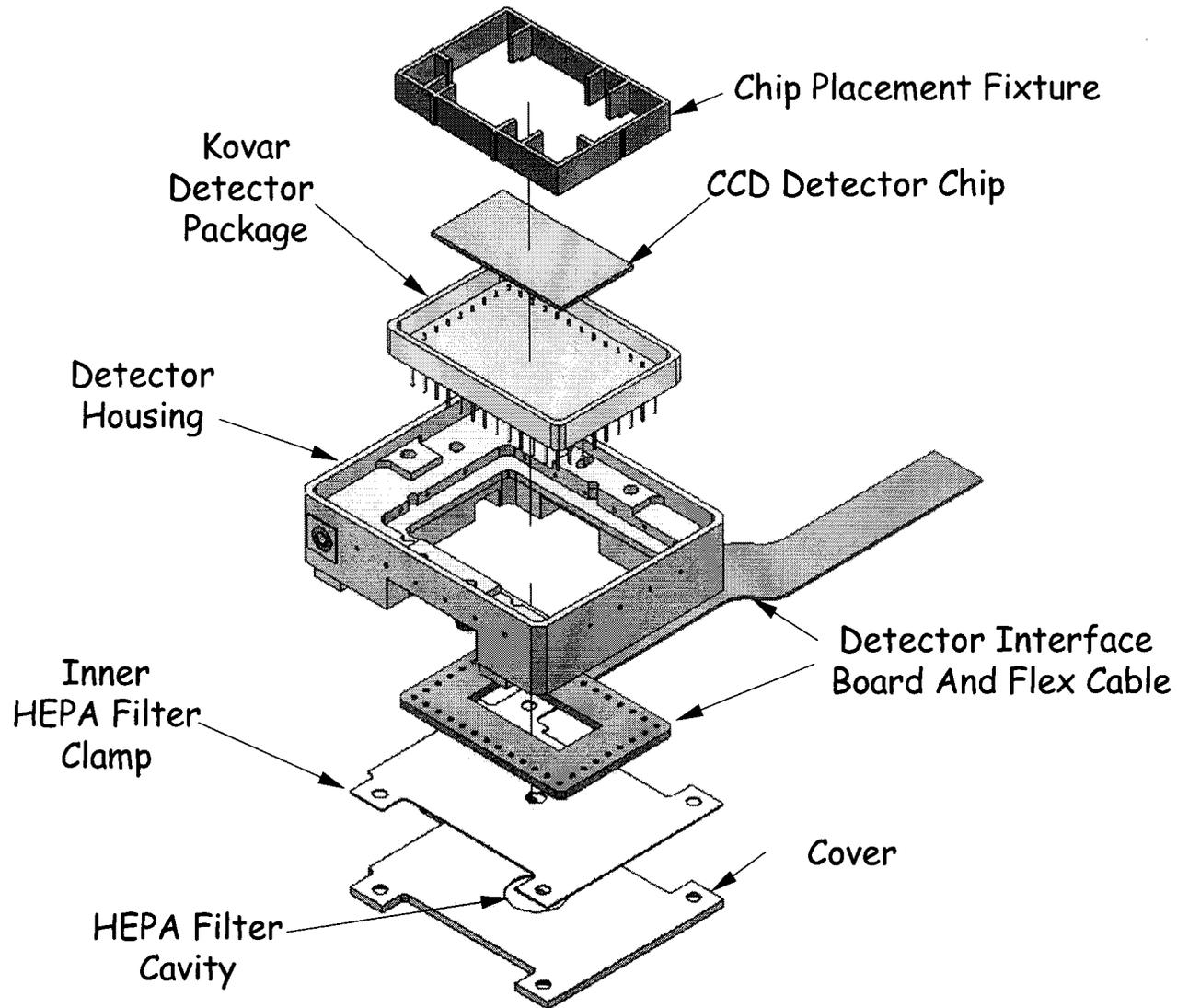


# Lens Interface with Detector Assy



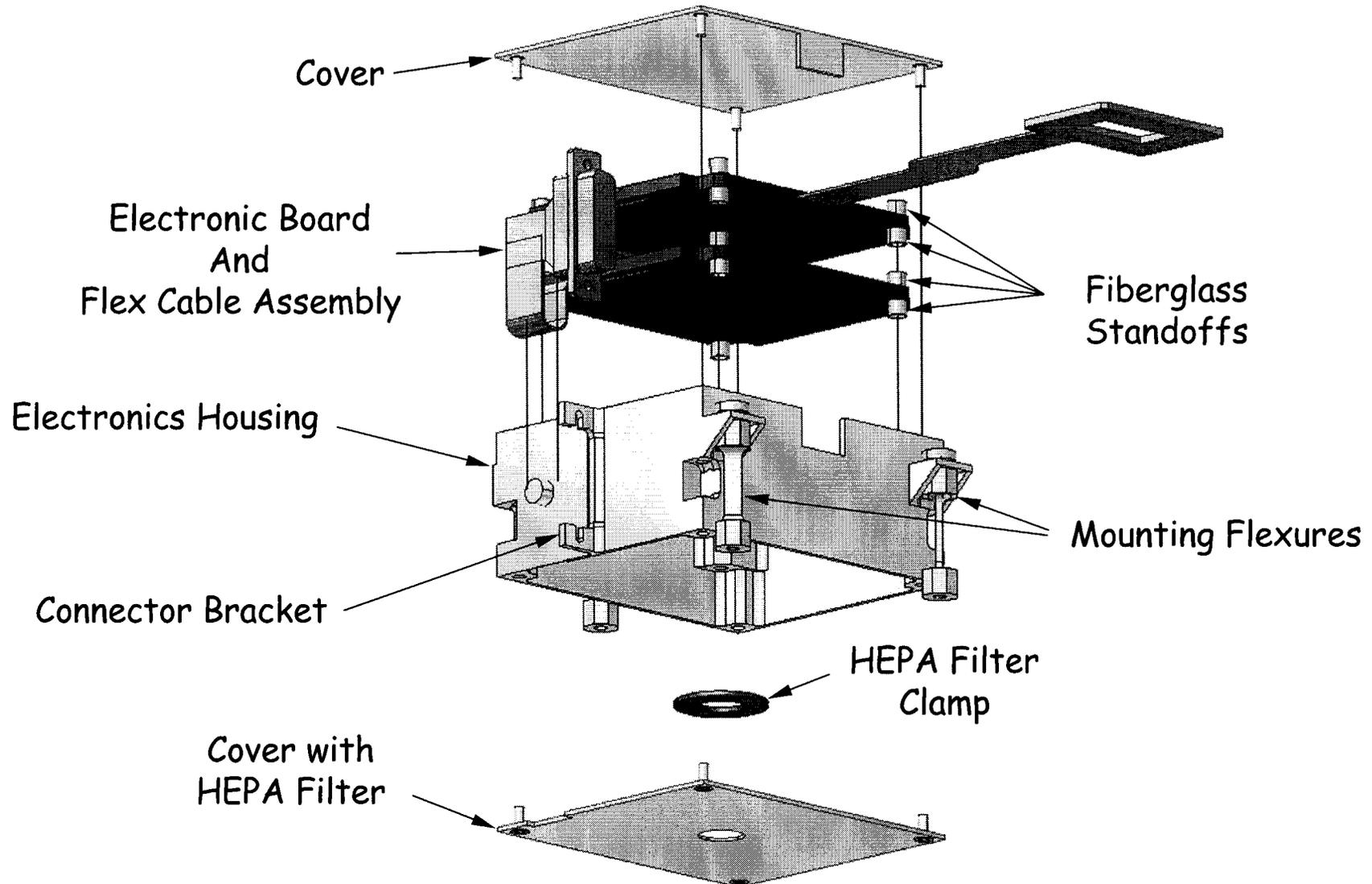


# Detector Assembly



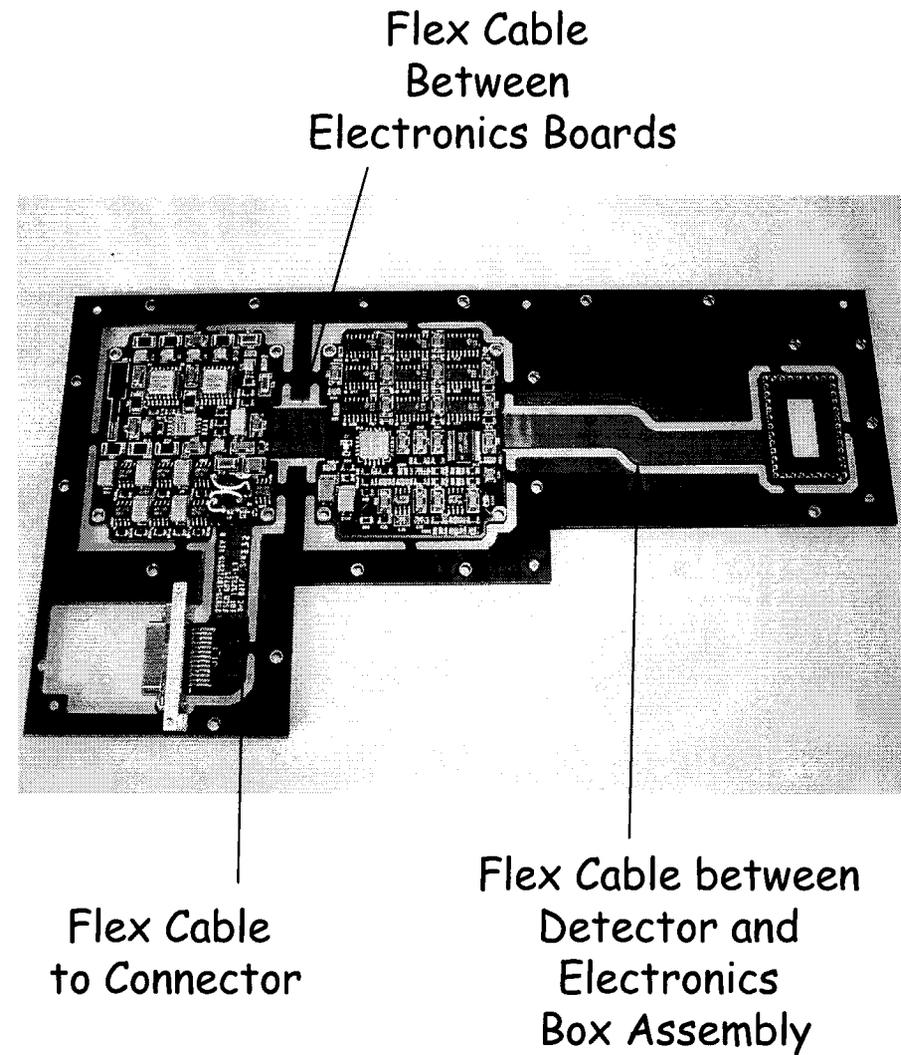
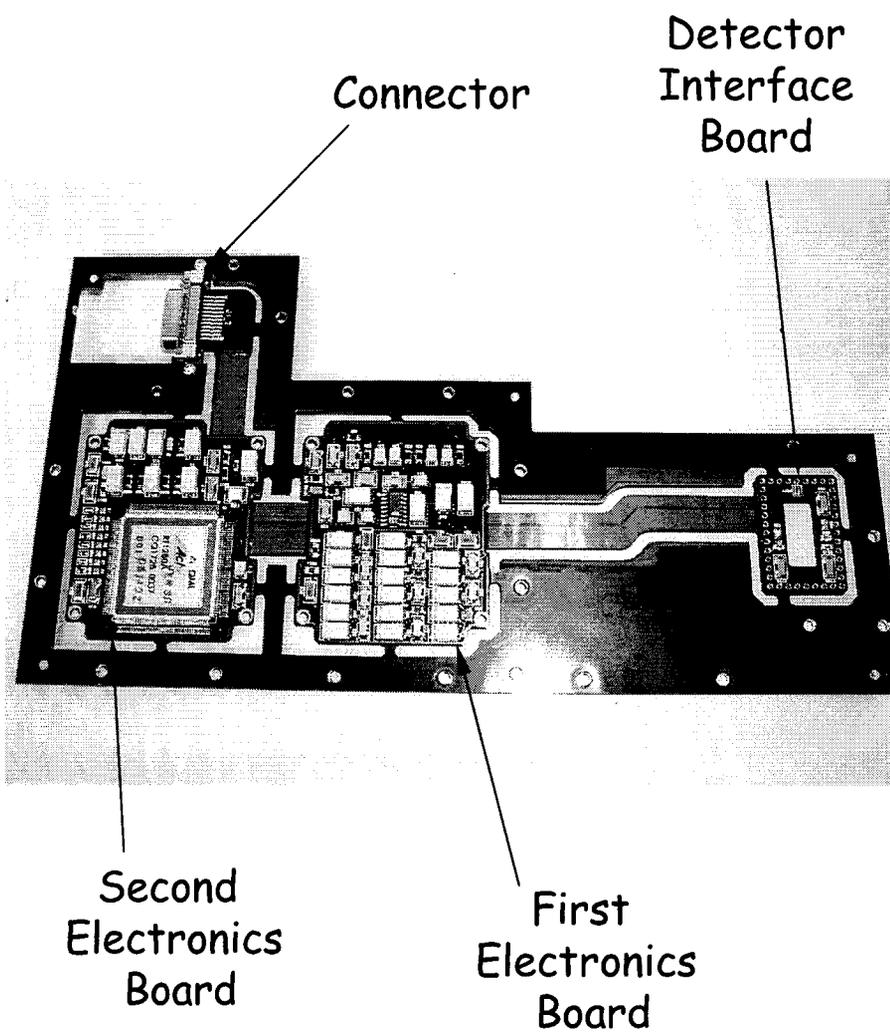


# Electronics Assembly





# Electronics Boards and Flex Cable Assembly JPL



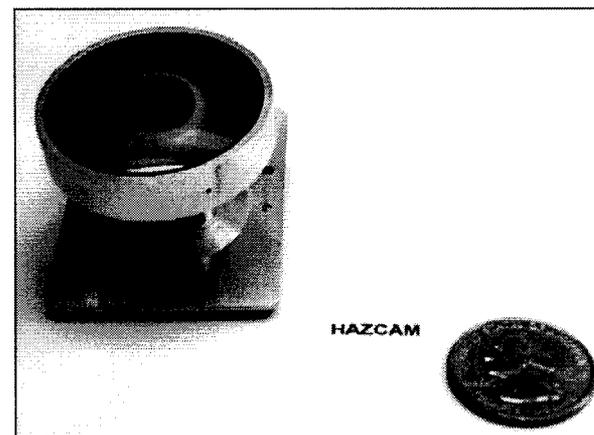
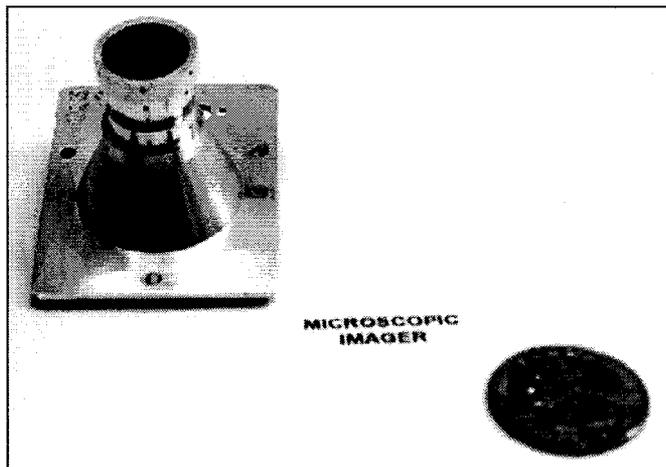
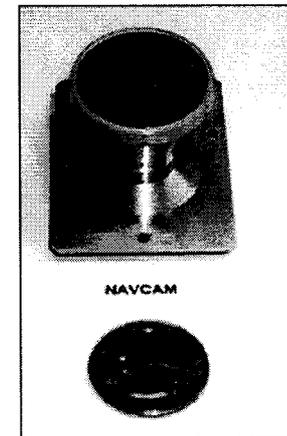
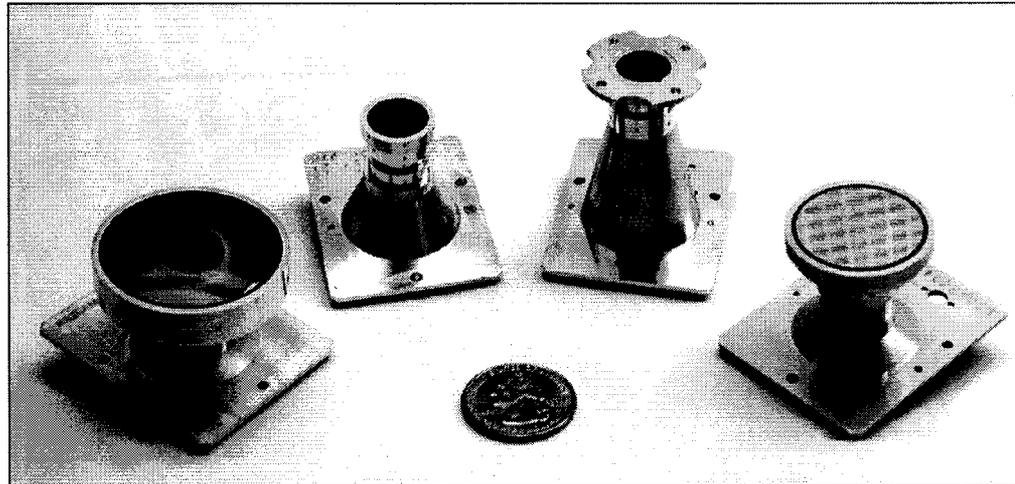
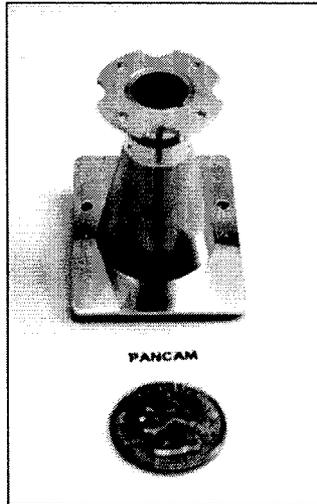


# An Array of Completed Lenses



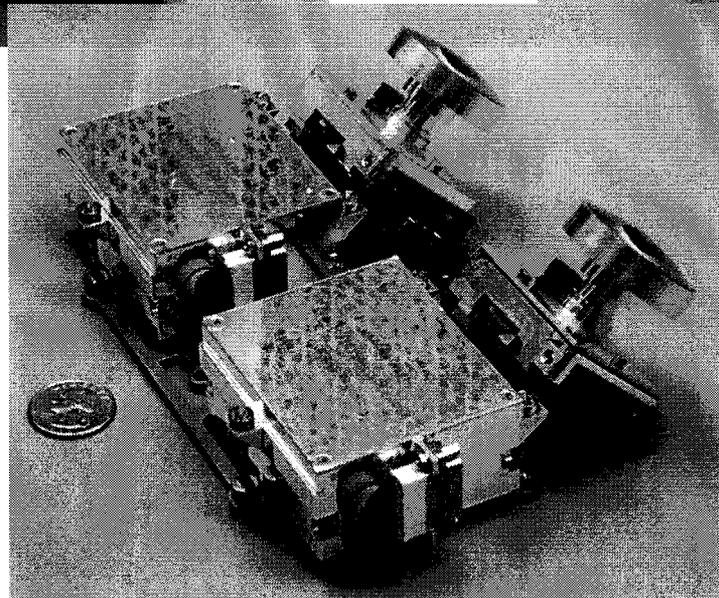
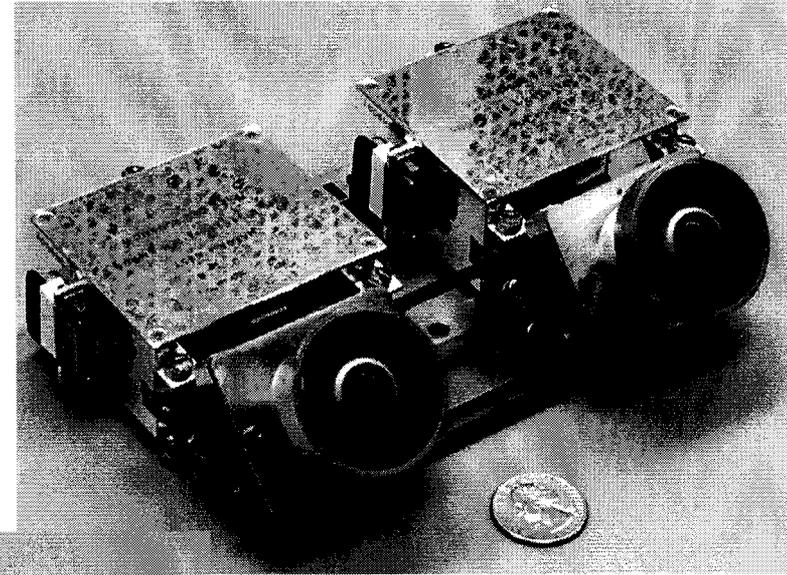
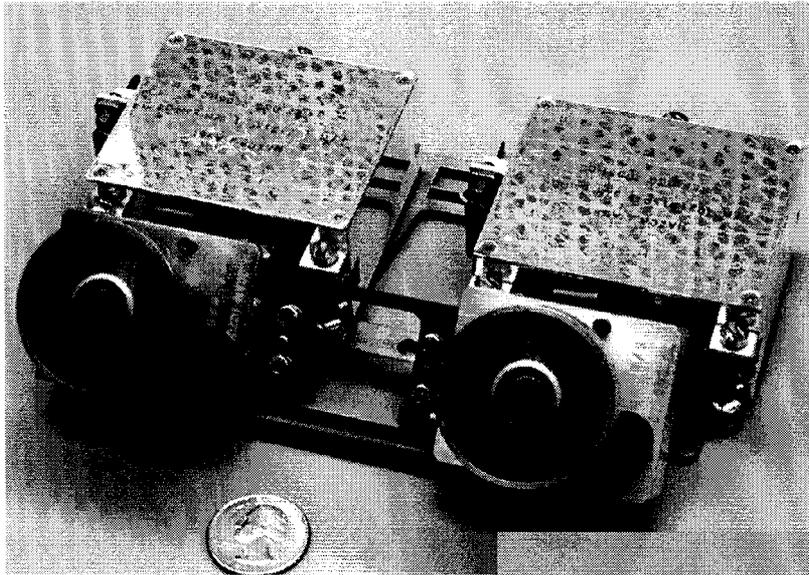


# Rover Lenses



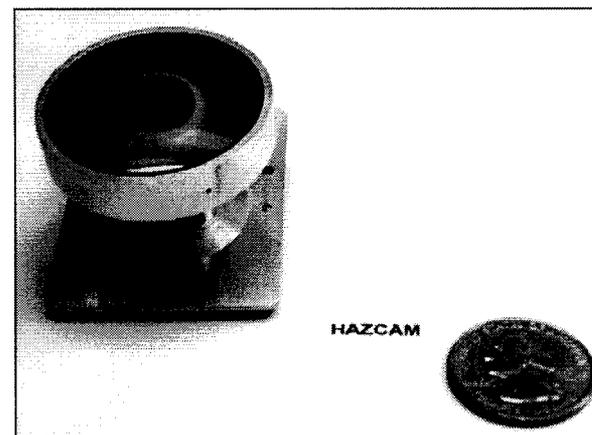
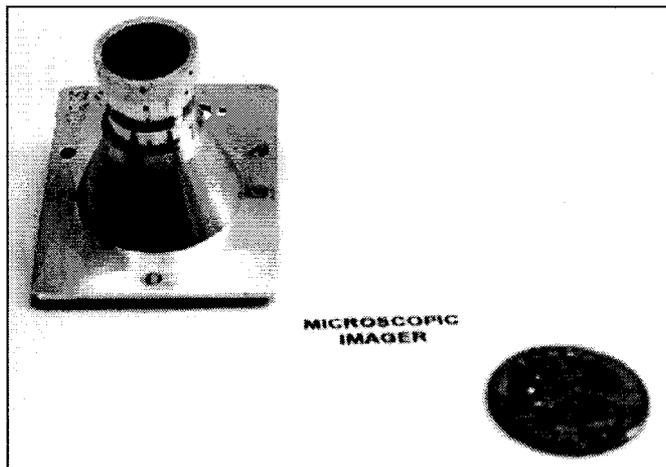
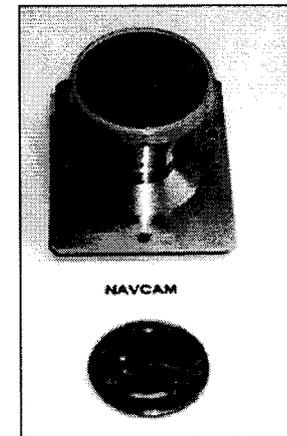
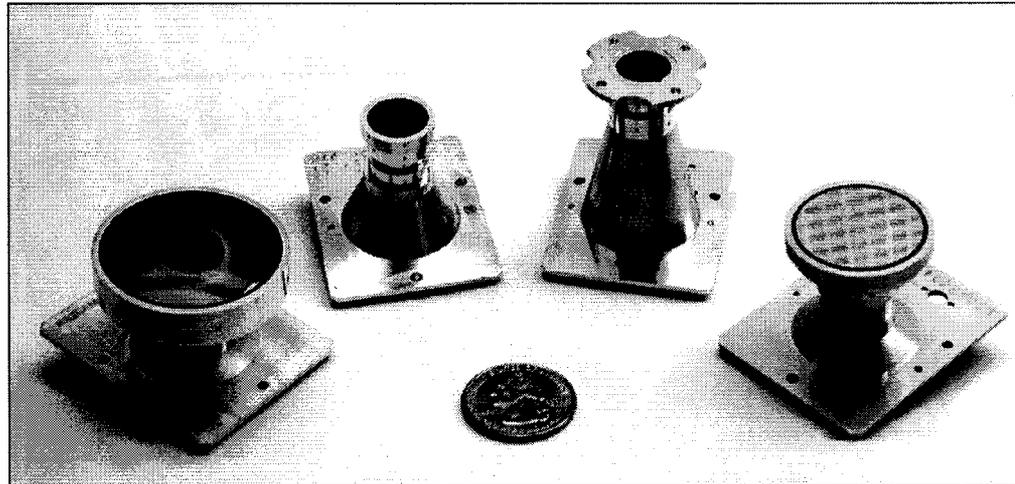
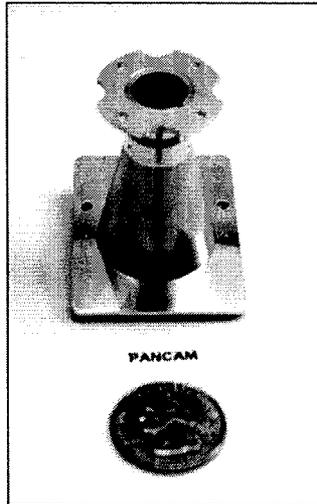


# Rear Hazard Camera Assembly



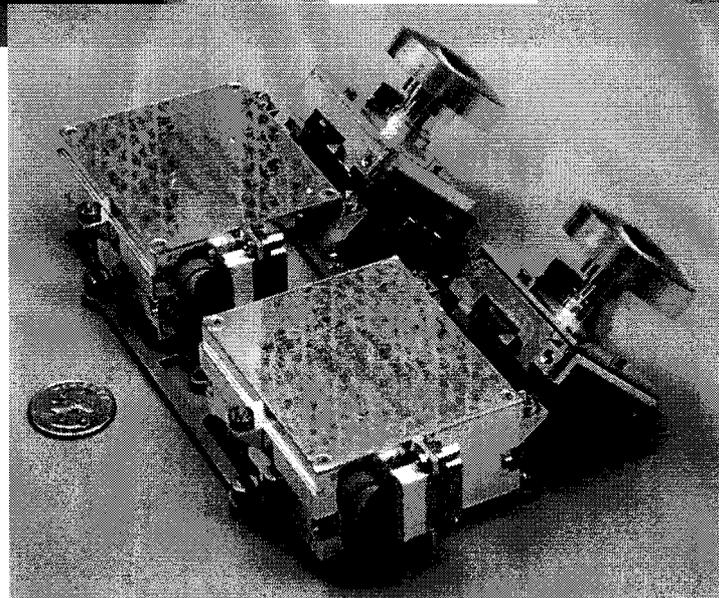
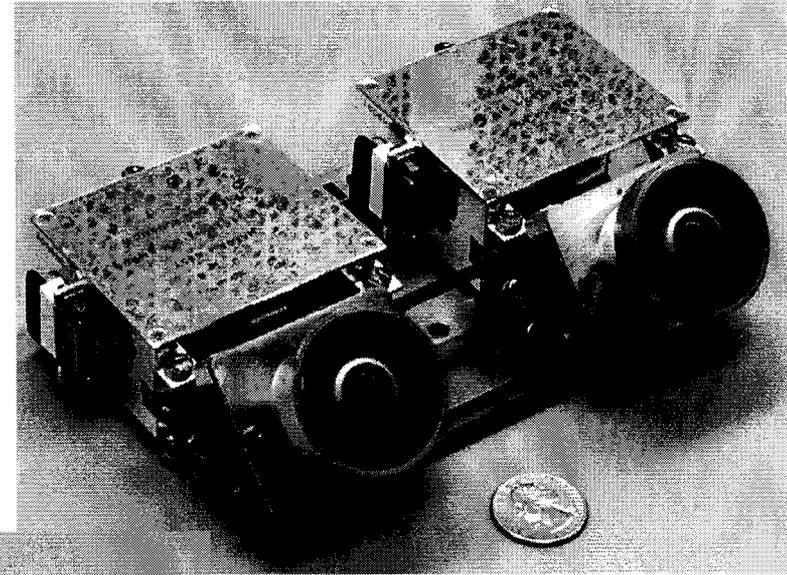
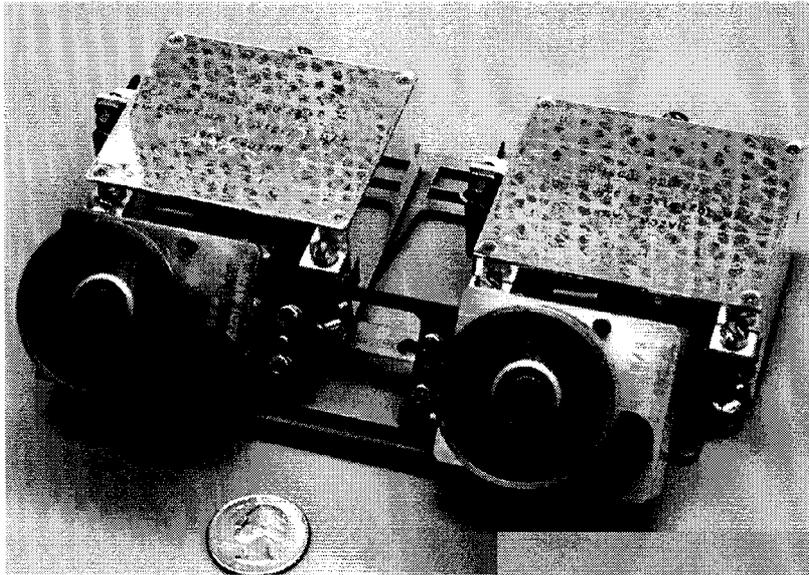


# Rover Lenses





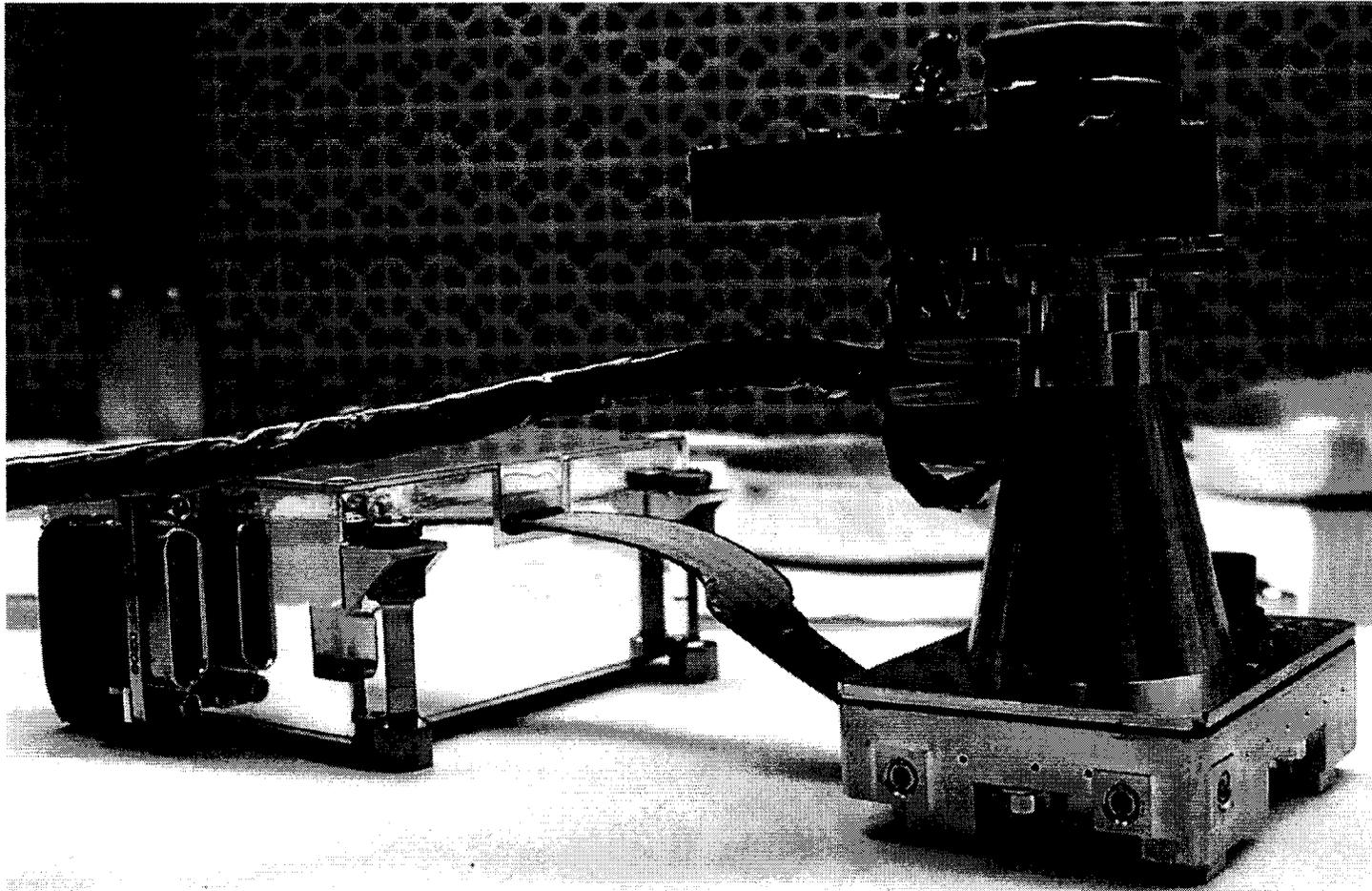
# Rear Hazard Camera Assembly





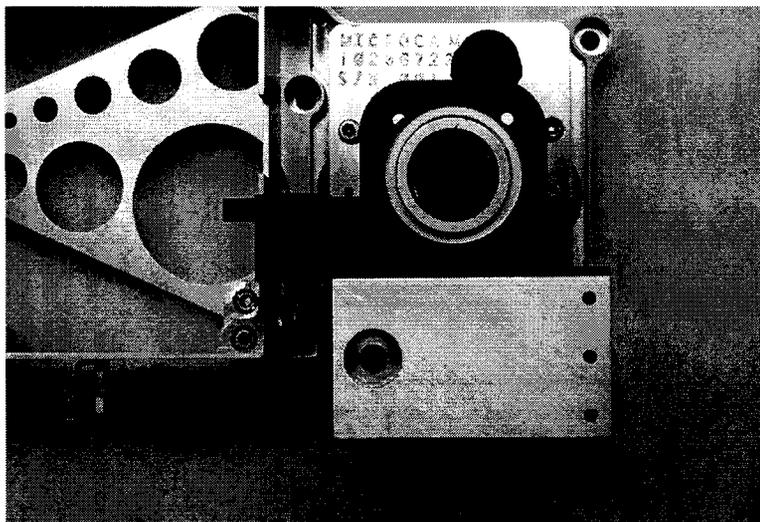
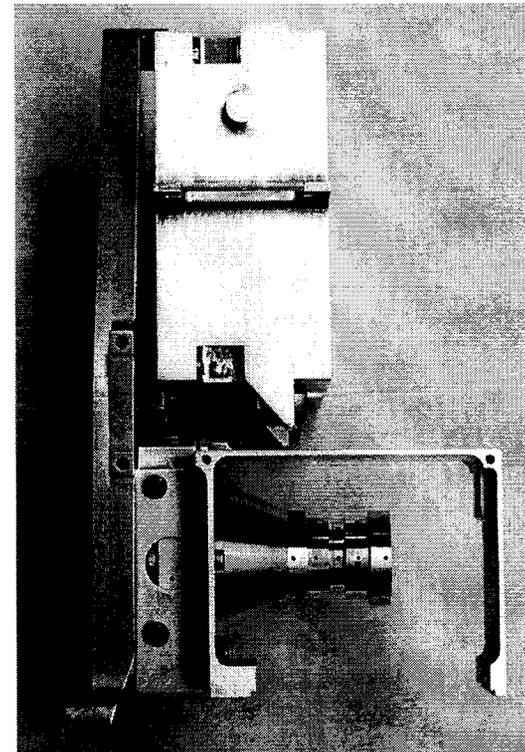
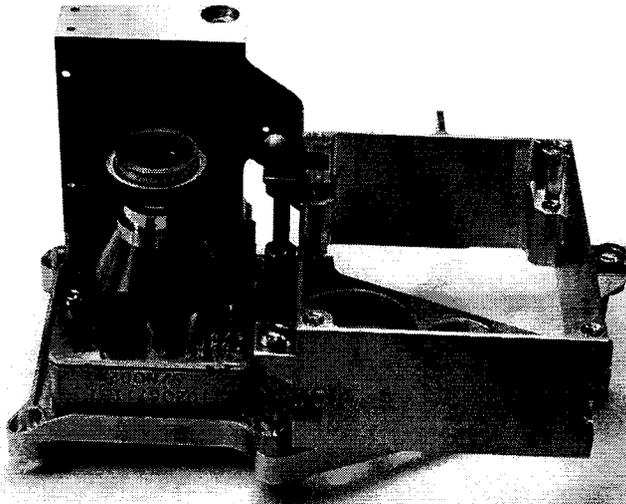
# Panoramic Camera

**JPL**



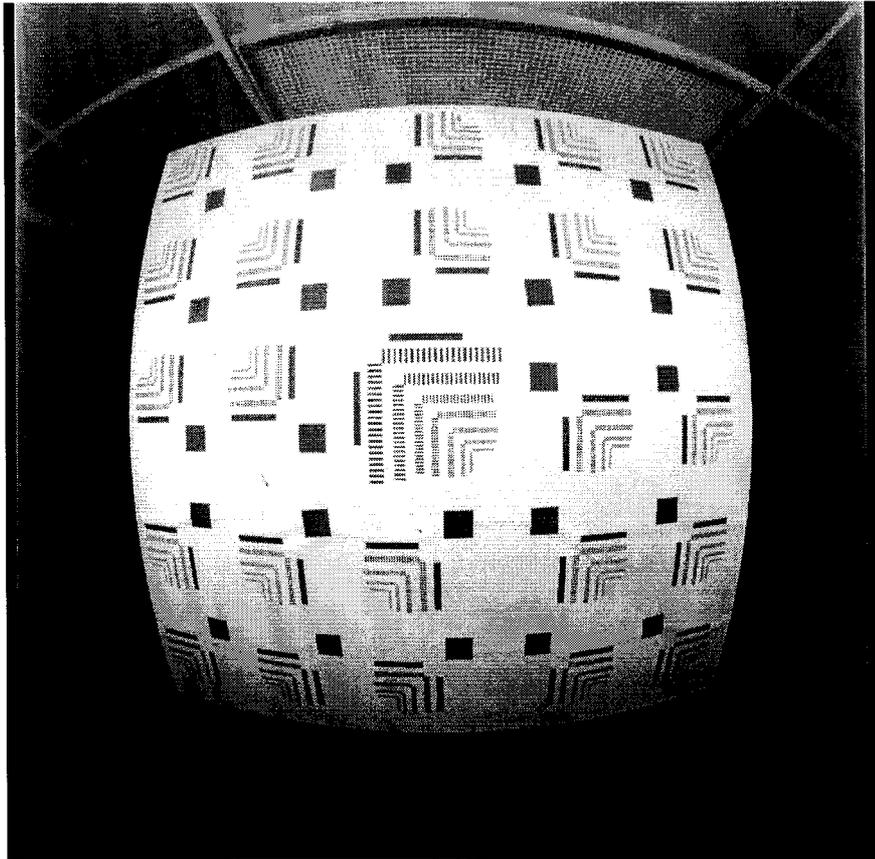


# Partially Assembled Microscopic Imager



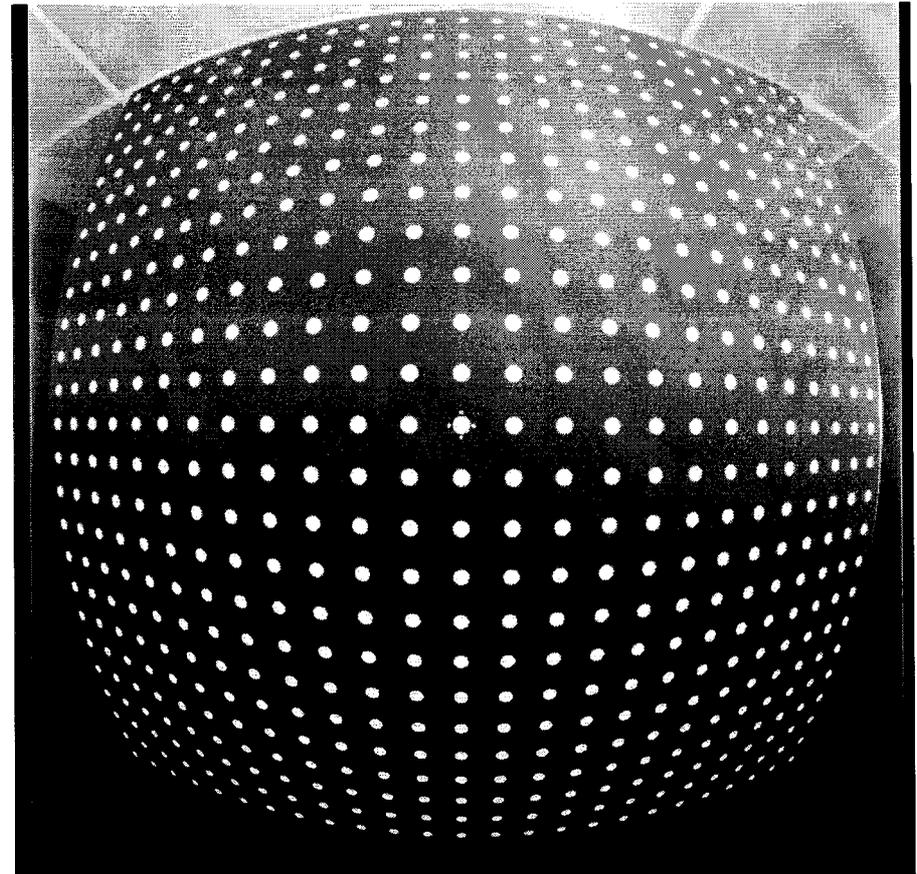


# Hazard Camera Test Images



**1m x 1m Focus Target**

**1m x1m Grid Target**





# STATUS



- **Testing**

- All camera types have been tested for image quality
  - No shim adjustment required on any lens
  - All target images have been falling on pixels as predicted
- Panoramic Camera has been through qualification vibration testing successfully
  - 3-axis random vibration
  - Landing load shock
  - Pyro shock
  - Rover-drilling-induced vibration

- **Lessons learned**

- Hazard Camera trouble with axial venting holes
- HEPA filters were transparent