

THE FLUIDS AND COMBUSTION FACILITY: ENABLING THE EXPLORATION OF SPACE

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ABSTRACT

The Fluids and Combustion Facility (FCF) is an International Space Station facility designed to support physical and biological research as well as technology experiments in space. The FCF consists of two racks called the Combustion Integrated Rack (CIR) and the Fluids Integrated Rack (FIR). The capabilities of the CIR and the FIR and plans for their utilization will support the President's vision for space exploration. The CIR will accommodate physical research and technology experiments that address needs in the areas of spacecraft fire prevention, detection and suppression, incineration of solid wastes, and power generation. Initial experiments will provide data to support design decisions for exploration spacecraft. The CIR provides a large sealed chamber in a near-weightless environment. The chamber supports many simulated atmospheres including lunar or Martian environments. The FIR will accommodate experiments that address needs for advanced life support, power, propulsion, and spacecraft thermal control systems. The FIR can also serve as a platform for experiments that address human health and performance, medical technologies, and biological sciences. The FIR provides a large volume for payload hardware, reconfigurable diagnostics, customizable software, active rack-level vibration isolation, and data acquisition and management in a nearly uniform temperature environment.

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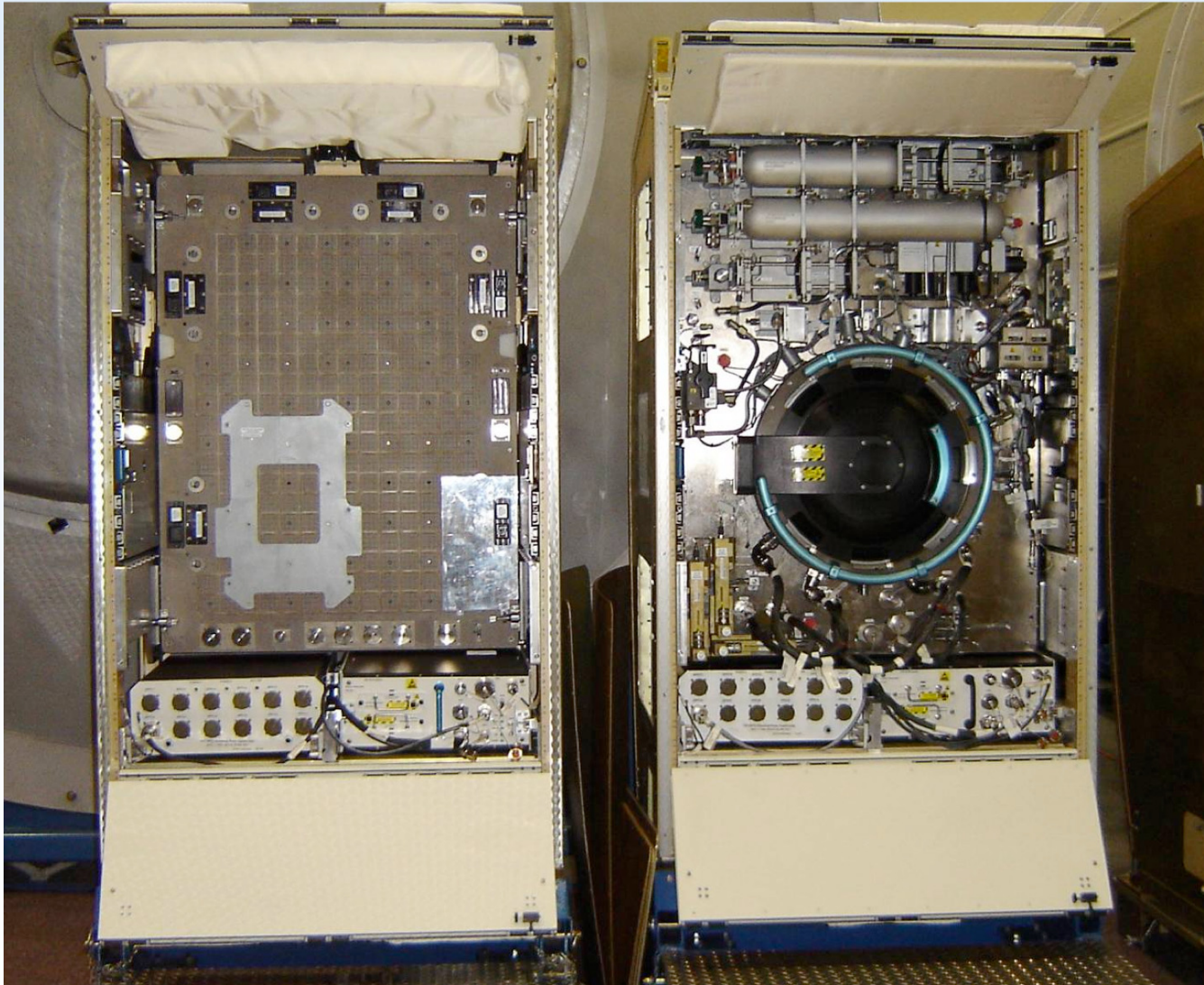
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INTRODUCTION

- The Fluids and Combustion Facility (FCF) is an International Space Station U. S. Laboratory facility
- The FCF supports physical and biological sciences research as well as technology experiments that will support the Vision for Space Exploration
- The FCF consists of two racks: the Fluids Integrated Rack (FIR) and the Combustion Integrated Rack (CIR)

FIR AND CIR



RACK PHILOSOPHIES

- The racks use common hardware
 - Reduces design, development, and life cycle costs
 - Increases crew efficiency by using common procedures
 - Allows for common sparing on orbit, thereby reducing consumption of ISS resources such as up-mass and on-orbit stowage
- Each rack provides much of the equipment needed by sub-rack payloads
- Each rack is modular and reconfigurable for use by different sub-rack payloads
- The racks are designed to operate primarily without crew involvement using telescience
 - Commands to and data from the on-orbit racks are transmitted and received by the Glenn Research Center Telescience Support Center

COMMON RACK COMPONENTS

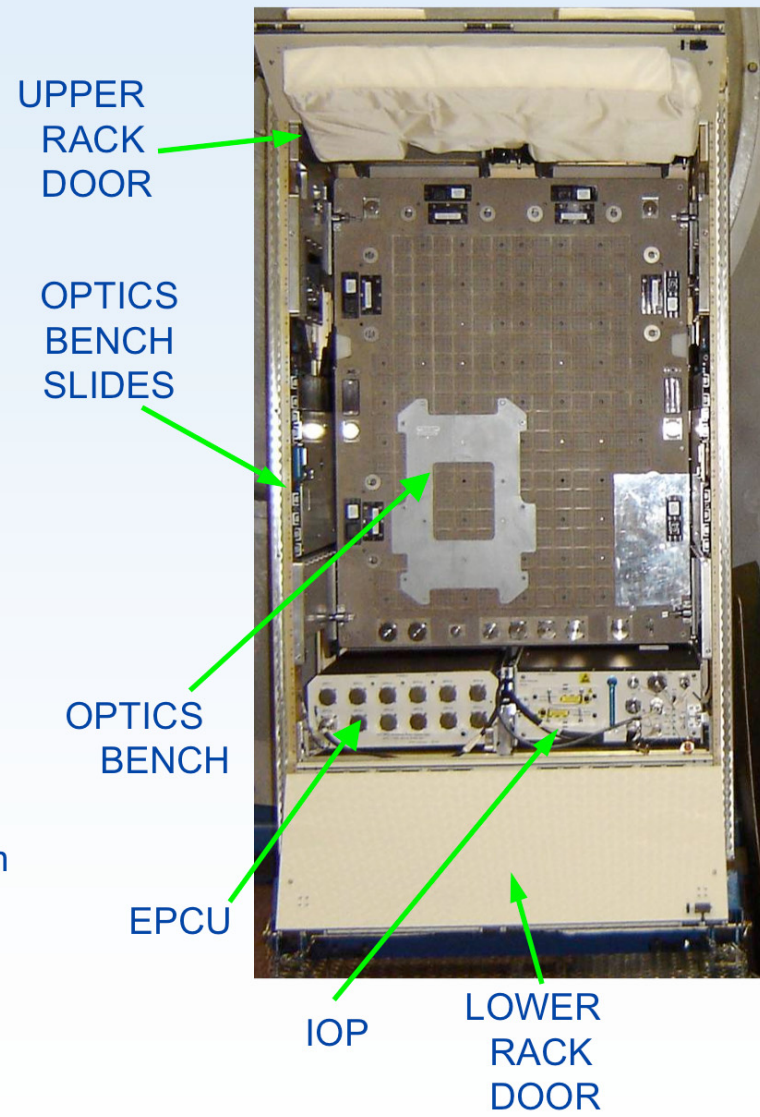
- International Standard Payload Rack
 - Supporting and mounting elements
 - Slides provide attachment for an optics bench
 - Bifold doors isolate the racks from the U. S. Laboratory environment
- Electrical Power System
 - Electrical Power Conversion Unit provides power conditioning for rack and sub-rack subsystems
 - 28 VDC and 120 VDC
- Environmental Control Subsystems
 - Water Thermal Control System
 - Air Thermal Control Unit
 - Fire Detection and Suppression System
 - Gas Interface Subsystem
 - Provides access to ISS gaseous nitrogen and vacuum systems

COMMON RACK COMPONENTS (cont.)

- Avionic Subsystems
 - Input/Output Processor
 - Image Processing and Storage Units (IPSUs)
 - Common IPSU: IEEE 1394 and high speed digital interfaces
 - Common IPSU-A (Analog): IEEE 1394 FireWire and analog frame grabber Interfaces
- Diagnostic Control Modules
- Station Support Computer
- Space Acceleration Measurement System
 - Triaxial sensor head measures the microgravity environment
- Software
 - Flight
 - Ground

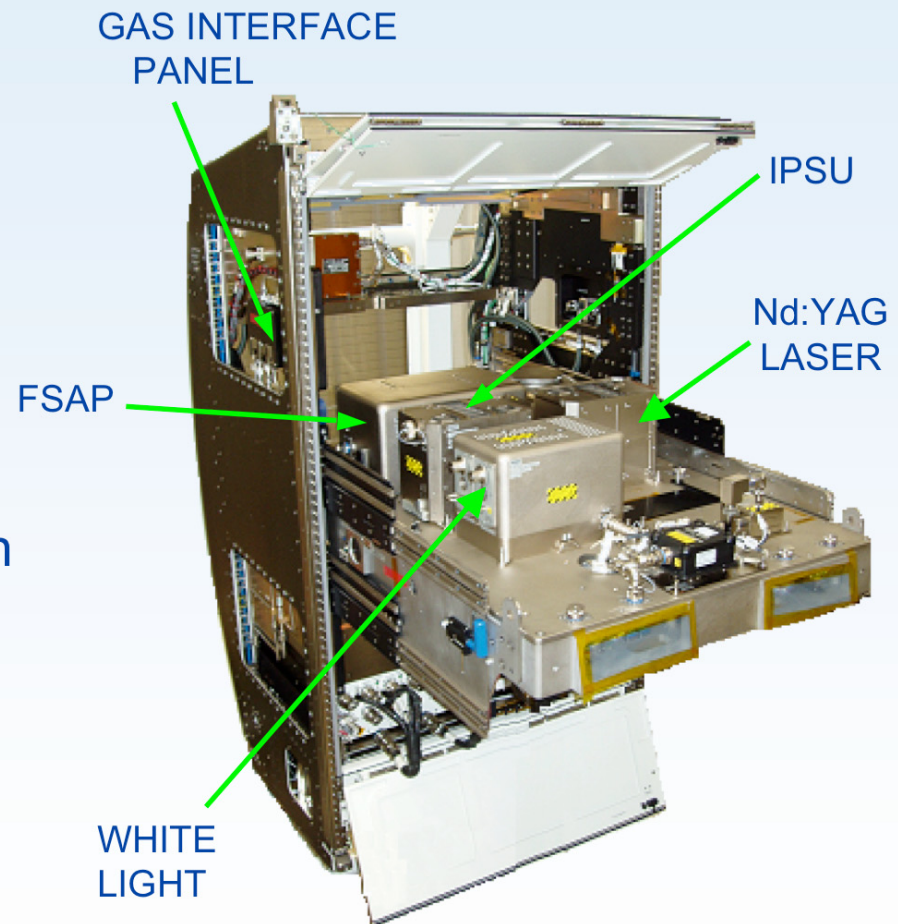
FIR COMPONENTS AND CAPABILITIES

- Common Rack Components
 - ISPR and Doors
 - Environmental Control Systems
 - 3 kW water (Medium Temperature Loop)
 - 1300 W air (provided at 20°C to 30°C)
 - Electrical Power Systems
 - Nominal 672 W/ 1600W max at 28 V DC
 - 1450 W at 120 V DC
 - Avionics (IOP, IPSUs, SSC)
 - SAMS
- Active Rack Isolation System
- Optics Bench and Slides
 - Volume ~ 0.5 m³ (1100 mm x 895 mm x 495 mm)
 - Mass ~ 300 kg



FIR WITH OPTICS BENCH ROTATED

- Video
 - Analog Color Camera
 - C-IPSU-A
 - IEEE 1394 Firewire
 - Analog Video
 - Illumination
 - White Light Package
 - 532 nm Nd:YAG Laser
- Control and Data Acquisition
 - Fluids Science Avionics Package (FSAP)
 - 540 GB of storage



LIGHT MICROSCOPY MODULE

- Mounts on the front of the optics bench
- Remotely controllable, automated, on-orbit microscope subrack facility
- Video microscope to observe microscopic phenomena and dynamic interactions
- Interferometer to make thin-film measurements with nanometer resolution
- Confocal microscope to provide enhanced three-dimensional visualization of structures is a potential capability

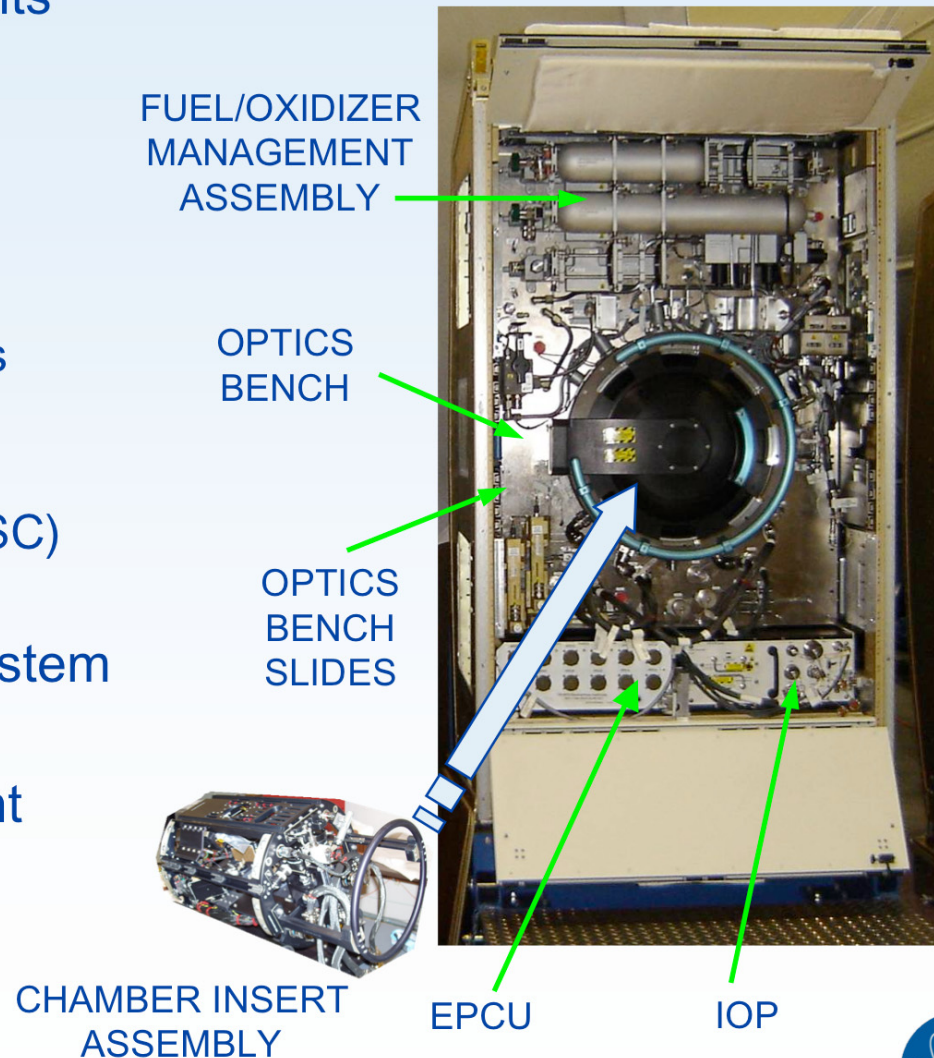


FLUIDS RESEARCH UTILIZATION

- Accommodates Exploration Systems investigations:
 - Advanced life support (i.e., air revitalization, water reclamation), power, propulsion and spacecraft thermal control
 - Boiling/condensation heat transfer, liquid vapor interface control, and multiphase flow
 - Human health and performance, medical technologies and biosciences
- Largest contiguous volume for experimental hardware of any ISS facility
- Easily reconfigurable diagnostics
- Customizable software, including capability to uplink modifications from the ground
- Data downlink, removable hard drives, and on board data processing

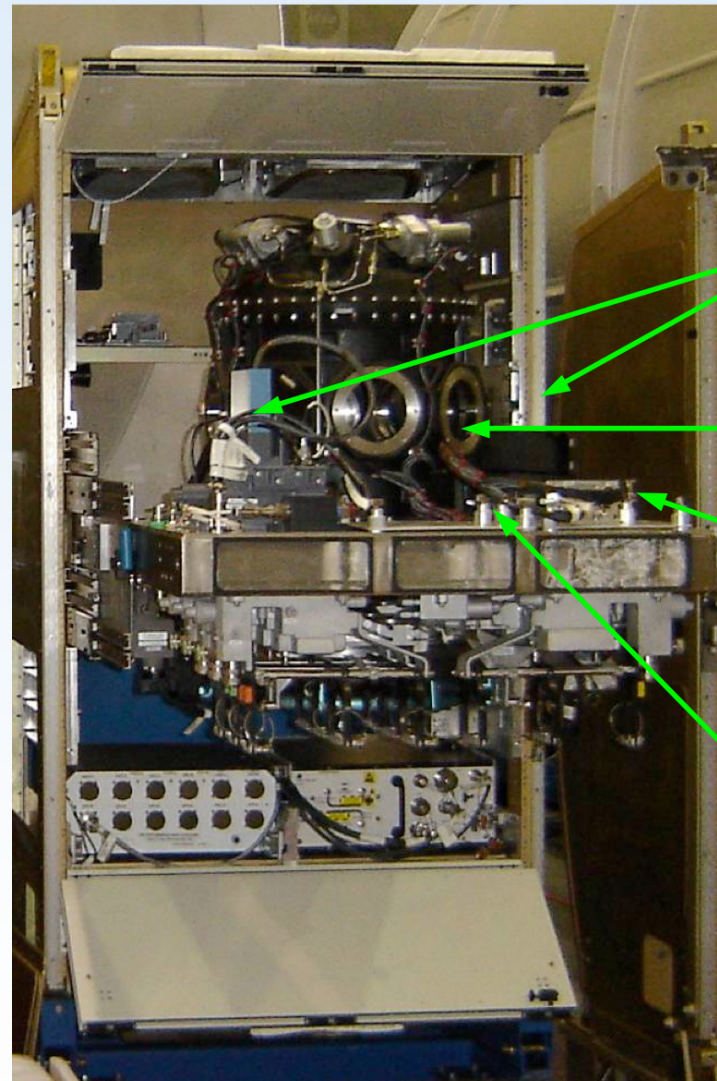
CIR COMPONENTS AND CAPABILITIES

- Common Rack Components
 - ISPR and Doors
 - Environmental Control Systems
 - 3 kW water
 - 1650 W air
 - Electrical Power Systems
 - 2 kW max at 28 V DC
 - 1450 W at 120 V DC
 - Avionics (IOP, IPSUs, SSC)
 - SAMS
- Passive Rack Isolation System
- Optics Bench and Slides
- Fuel/Oxidizer Management Assembly
 - Gas Distribution
 - Exhaust Vent



CIR WITH OPTICS BENCH ROTATED

- Combustion Chamber
- Diagnostics
 - Illumination Package
 - High Bit Depth Multispectral Imaging Package
 - Low Light Level Ultraviolet Imaging Package
 - PI-provided diagnostics
 - Color Camera
 - Mid-IR Imaging
- FOMA Control Unit and PI Avionics Box mount on the back side
- Crew can reconfigure as required for each experiment



DIAGNOSTICS
AND IPSU
LOCATIONS

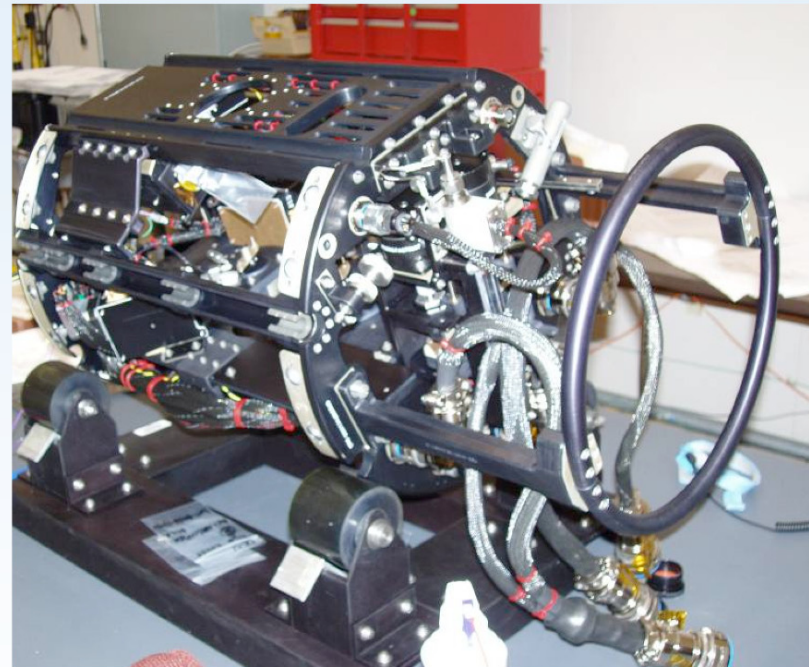
COMBUSTION
CHAMBER

FOMA
CONTROL
UNIT
LOCATION

PI AVIONICS
BOX
LOCATION

CHAMBER INSERT ASSEMBLY

- Interfaces to the chamber on a set of guide rails
- Contains internal components such as a burner, nozzle, or sample holder, ignitor, flow tunnel, and diagnostic sensors
- Electrical, vacuum, gas, and venting resources connect through an interface resource ring near the front of the chamber



COMBUSTION RESEARCH UTILIZATION

- Accommodates Exploration Systems investigations:
 - Fire safety (i.e., fire protection, detection and suppression)
 - Incineration of solid wastes, power generation, flame spread, and material synthesis
 - Serves as a test bed to mature systems and concepts to high technology readiness levels for exploration missions
- Large environmental chamber for the simulation of the space environment or Lunar, Mars, or planetary surface environments
- Easily reconfigurable diagnostics
- Customizable software, including capability to uplink modifications from the ground
- Data downlink, removable hard drives, and on board data processing

DEVELOPMENT STATUS

- NASA Glenn Research Center in Cleveland, Ohio is developing the FCF under a prime contract with ZIN Technologies, Inc.
- The overall system is in the process of being tested at the rack level
- Upon completion of testing, the racks will be shipped to NASA Kennedy Space Center for further testing in the Payload Test and Checkout System
- The racks will be launched in a Multi-Purpose Logistics Module
- The current schedule shows launch of FCF in 2007

ACKNOWLEDGEMENTS

- NASA Headquarters Exploration Systems Mission Directorate
 - Human Systems Research and Technology Division
- ZIN Technologies, Inc.