

HRP Research Operations and Integration (ROI) ISS Facilities Overview

REVISED APRIL 2021

PUBLIC RELEASE APPROVED
NF-1676 20210013701



Current and Planned Flight Facilities*

- **Hardware Systems**

- Actiwatch Plus
- Cerebral Cochlear Fluid Pressure Analyzer (CCFP)
- Distortion Product Otoacoustic Emissions Device (DPOAE)
- ECG Patch
- Electroretinograph (ERG)
- Falcon Goggles
- Gas Delivery System (GDS)
- Holter Monitor 2
- Human Research Facilities 1 and 2 (HRF 1 & 2)
- HRF Centrifuge
- HRF Payload Drawer
- HRF Portable Computers
- Light Meter
- Pneumatometer (PTM)

- Space Linear Acceleration Mass Measurement Device (SLAMMD)
- Ultrasound 2
- Vortex Mixer

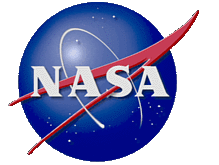
- **Consumable Hardware**

- HRF Supply Kits (Purple and Green)
- Blood Collection
- Saliva Collection
- Urine Collection
- Fecal Sample Collection
- Microbial Sample Collection

- **Software**

- Cognition

*Capabilities listed in the following slides as "currently available" are available and certified for ISS use, but may not necessarily be onboard the ISS at a given point in time depending on resupply and maintenance requirements



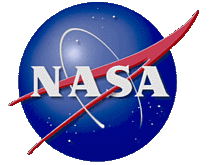
Actiwatch Plus

Currently available

- Waterproof sleep-wake monitor worn on the wrist
- Measures motion and ambient lighting
 - 3-axis accelerometer for motion
 - Integrated RGB and white light sensor for ambient lighting
 - Crew event marker recording with a button press
- Can be used to analyze circadian rhythms, sleep-wake patterns and activity
- Useful for the investigation of sleep quality, sleep onset, hyperactivity and other daily routines
- Modified commercial-off-the-shelf (COTS) system consisting of the Actiwatch Plus, Actiwatch Plus Kit, Actiwatch Plus USB Cable, USB Hub, and Actiware Software (v. 6.0.9 or later).



Cerebral Cochlear Fluid Pressure Analyzer (CCFP)



Currently available

- Indirectly measures Intracranial Pressure (ICP) by measuring Tympanic Membrane Displacement (TMD) under various stimuli
 - Can also perform Tympanometry
- Sensors for CCFP analysis are in the CCFP Headset and will interface with crewmember's ear canal via tubing with an ear tip
- Two other components work with the headset:
 - The Pulse Oximeter is placed on the finger to measure Pulse and O₂ saturation
 - The Cannula interfaces with the nostrils to monitor respiration



Distortion Product Otoacoustic Emissions (DPOAE)



Currently available

- The DPOAE is a commercial off the shelf unit called Otoport Advance, produced by Otodynamics Audiology Systems
- Used to take Otoacoustic Emissions (OAE) measurements
- Handheld device with an ear probe fitted with a speaker and microphone
- Measures cochlear response pairs of f1 and f2 frequencies used in turn to acquire emissions from areas along the cochlea
- These measurements allow the first signs of deafness to be detected
- Earmuffs used in conjunction with the DPOAE to isolate ISS noise during measurements



Earmuffs

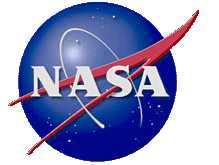


ECG Patch

Estimated Availability: NET April 2022

- The ECG Patch uses the Cardea SOLO™ ECG System to provide ambulatory ECG monitoring over several consecutive days.
- Available Features/Accessories:
 - Supports up to 8 days data collection per single-use patch (may be limited by patch adherence)
 - On-orbit data download with option to perform data analysis and generate a PDF report.
 - Atrial Rhythms (pauses, premature atrial contractions, supraventricular tachycardia, atrial fibrillation, tachycardia, bradycardia)
 - Ventricular Rhythms (premature ventricular contractions, couplets, triplets, ventricular tachycardia, bigeminy, trigeminy)
 - Reported 98.7% PPV for Atrial Fibrillation and Atrial Flutter (may vary with subject application and patch adherence in microgravity)



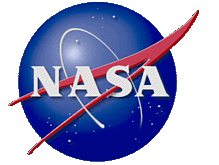


Electroretinograph (ERG)

Estimated Availability: NET August 2021

- The ERG system is a measurement device based on the Diagnosys E³ System that supports a variety of visual electrophysiology modalities.
 - The ERG is deployed and powered from an HRF Payload Drawer, with test protocols and databases managed from an HRF PC.
- Available Accessories:
 - Monocular Pattern Stimulator (Envoy™ OLED Monitor)
 - Monocular Flash Stimulator (ColorBurst Ganzfeld Stimulator)
 - Chin Rest
- The following modalities have been certified for operations:
 - Photopic Negative Response (PhNR)
 - Pattern ERG (PERG)





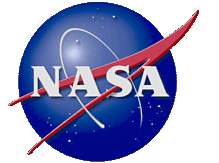
Electroretinograph (ERG): Accessories

Estimated Availability: NET August 2021

ERG Accessories Kit

- **Envoy Handheld Assy (1)**
- **Colorburst (1)**
- **ERG Power Cable (1)**
- **ERG USB Cable (1)**
- **ERG Amplifier (1)**
- **ERG Extension Leads (2)**
- **Eye Electrode (Ziploc of 25)**
 - **DTL Plus Electrodes**
- **ERG Forehead Electrodes (Ziploc of 10)**
- **ERG Skin Prep Pad (Ziploc of 30)**
- **Wetting Eye Drops (2 Ziplocs of 30 ea)**
- **16.2 x 10.1 x 6.5 inches, 10.32 lbs**





Falcon Goggles

Estimated Availability: NET August 2021

- The Falcon Goggles, based on the Neuralign DX Falcon™, provide a system for capturing detailed high-speed video of the eyes to collect precise data on ocular alignment and assess vestibular function.
- Available Features/Accessories:
 - Supports 100 Hz and 250 Hz video oculography (VOG)
 - Supports interpupillary distance (IPD) range of 50 to 75mm Blackout cover with built-in fixation light
 - Built-in calibration laser for manual calibration.
 - Goniometer for testing range of motion.
 - ISS Cabin Video cameras and USB3.0 cables for high-speed data transfer (provided by ISS Program)
 - Neuralign VEST™ Software for system operations and data analysis/export, and I-Portal® for digital eye tracking.



Gas Delivery System (GDS)

Currently available

- The Gas Delivery System consists of 1.3L pressurized gas cylinders (GDS Tanks) provided as single-tank soft-stowed assemblies.
 - The PFS Gas Cylinder is a single-tank protective container that can be used within different modules of the ISS.
- The GDS Tanks can be filled with a variety of gas mixtures tailored to experiment requirements. Examples include Breathing and Calibration mixtures used to support ESA's Portable Pulmonary Function System (PPFS) and Medical Operations Max CEVIS periodic fitness evaluations.
 - PPFS Breathing Gas: O₂ (40%); R-22 (1%); SF₆ (1%); N₂ (58%)
 - PPFS Calibration Gas: O₂ (15%); CO₂ (5%); N₂ (80%)





Holter Monitor 2

Currently available

- Ambulatory ECG which accurately and non-invasively measures the electrical activity of the heart for up to 24 hrs on a single AA battery charge.
- A snap-lead cable connects to electrode pads that have been applied to the torso
- The LCD displays subject information, instructions, messages, date, and time of day
- Three pushbuttons are used to navigate through the LCD screen

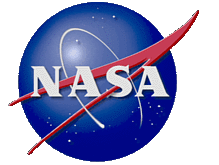




Human Research Facilities 1 and 2 (HRF-1, 2/HRF Rack 1, 2)

Currently available

- Consists of items mounted in a rack [based on the EXPedite the PROcessing of Experiments to Space Station (EXPRESS) rack design] as well as equipment kept in stowage and brought out as needed
- The HRF drawers provide power, command and data handling, cooling air and water, pressurized gas, and vacuum to experiments
- The racks have front-panel access ports for the laptop, vacuum system, deployed payloads, and nitrogen delivery system
- The International Space Station (ISS) moderate temperature cooling loop is extended into the HRF to keep the rack at ambient temperature
- Payloads in HRF Racks can operate independently of each other regardless of their cooling and power needs and the flight schedule.
- Each payload can use up to 500W of power and the sum of all payloads can use up to 2000 W of power. The HRF power converter delivers 120V of direct current (DC) power from the utility outlet panel to the rack and converts it to 28 Vdc for distribution to the payloads
- The racks are connected to the ISS video services and Ethernet, which allow the ISS and ground operations crews to control payloads. Payload computer and video operations can be conducted from the ground or on the space station.

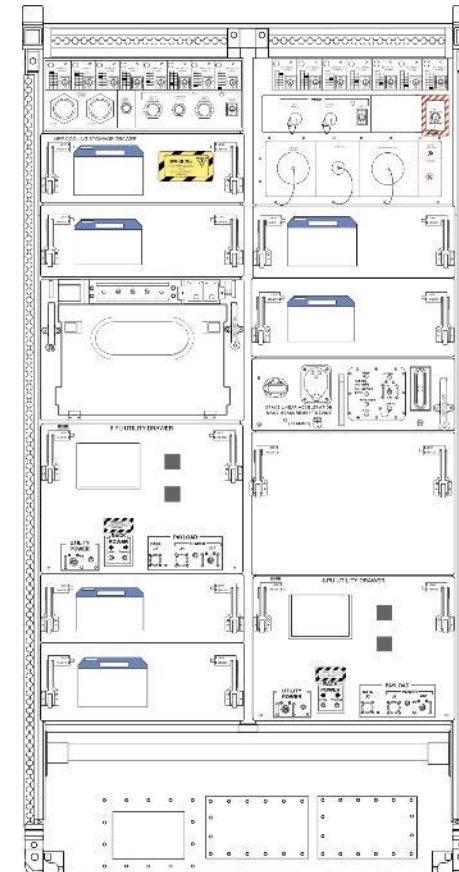


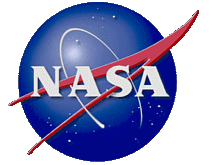
Human Research Facility 1 (HRF-1/HRF Rack 1)

Currently available

- The hardware housed in HRF-1 Includes:
 - Portable computer (HRF PC), which is used to install and execute software that supports the experiments. It is used to control equipment; to collect and store data, crew notes, and equipment notes; and to provide uplink and downlink capabilities.
 - One HRF Payload Drawer with an integrated HRF Centrifuge
 - One Cooling Stowage Drawer (CSD) to provide increased air flow over the heat exchanges in the Rack when needed to increase removal of heat generated by other payloads, in addition to providing stowage for equipment.
 - Two HRF 8PU Utility Drawer provides stowage for consumables with added radio-frequency identification (RFID) that automates inventory of the tagged contents without crew intervention.
 - Space Linear Acceleration Mass Measurement Device (SLAMMD)
 - When deployed, the Ultrasound 2 may be connected to the front of HRF-1 for power and to allow real-time downlink of scan head video.

[For more information click here](#)



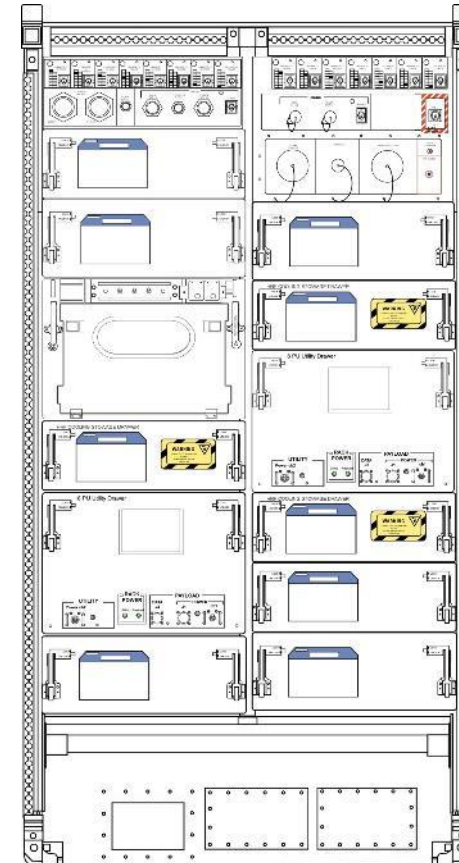


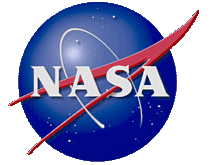
Human Research Facility 2 (HRF-2/HRF Rack 2)

Currently available

- The hardware housed in HRF-2 includes:
 - Portable computer (HRF PC), which is used to install and execute software that supports the experiments. It is used to control equipment; to collect and store data, crew notes, and equipment notes; and to provide uplink and downlink capabilities.
 - One HRF Payload Drawer with an integrated HRF Centrifuge
 - Three Cooling Stowage Drawers (CSD) can provide increased air flow over the heat exchanges in the Rack when needed to increase removal of heat generated by other payloads, in addition to providing stowage for equipment.
 - Two HRF 8PU Utility Drawers provide stowage for consumables with added radio-frequency identification (RFID) that automates inventory of the tagged contents without crew intervention.
 - When deployed, the Ultrasound 2 may be connected to the front of HRF-2 for power and to allow real-time downlink of scan head video.

[For more information click here](#)





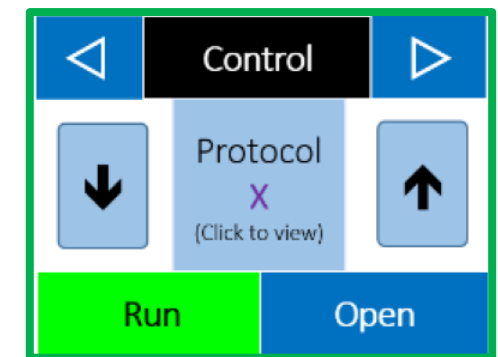
HRF Centrifuge

Currently available

- HRF Centrifuge
 - Swing-bucket centrifuge used to separate biological substances of varying densities by spinning at a high rate
 - Rotor can hold 6 tube carriers
 - Speed can be selected from 1000 to 4300 rpm for 1 to 99 minute durations with braking from 0-9
 - A total of 10 operational protocols can be pre-programmed and saved
 - Telemetry available to monitor spin parameters and status. Software on HRF PCs allows the system to be monitored, configured, and controlled from the ground.



HRF Centrifuge



Pre-programmed protocol

HRF Centrifuge Accessories

Currently available

- HRF Centrifuge Tube Carrier
 - Two 12-mm to 13-mm outer diameter (OD) centrifuge tubes and two 15-mm to 16-mm OD centrifuge tubes
 - 24 tubes total with 6 carriers installed
- HRF Centrifuge Tube Carrier, 50 mL
 - One 50-mL sample tube per carrier
 - 6 tubes total with 6 carriers installed
- Blood Tube Carrier
 - Modified HRF Centrifuge Tube Carrier with 15-mm to 16-mm OD slots replaced with one of two Vial Adapters for small sample tubes and with a tube carrier cap for added containment.
 - Vial Adapter (yellow cap) can house and provide secondary containment for a single 1.5-2 mL tube (max 13-mm OD) with negligible reduction in spin radius for higher maximum relative centrifugal force (RCF)
 - Vial Adapter (purple) can support a single 1.5 to 2-mL sample container with simpler loading and unloading, but with a significantly shorter radius and lower maximum RCF



HRF Centrifuge Tube Carrier



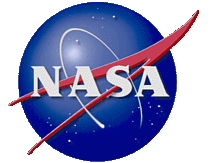
HRF Centrifuge Tube Carrier, 50 mL



Blood Tube Carrier
Vial Adapter (yellow cap)



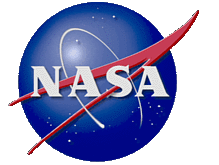
Blood Tube Carrier
Vial Adapter (purple)



HRF Centrifuge Certified Use

Currently available

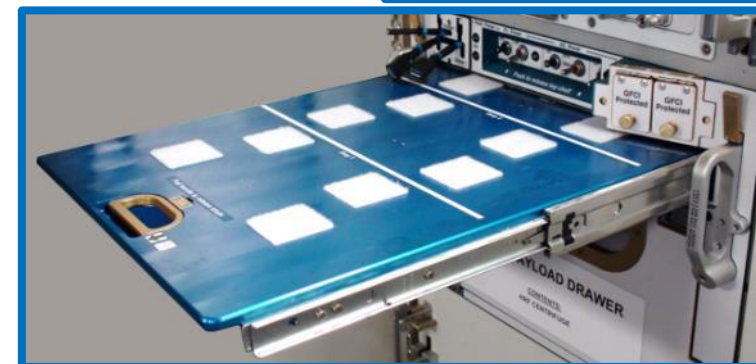
- The HRF Centrifuge was originally certified to spin astronaut blood. Neither the centrifuge nor the tube carriers provide any level of safety containment.
- Any use other than astronaut blood must be coordinated with the Payload Safety Review Panel and ROI.
- Any samples containing items rated as toxic or with a biological safety level (BSL) of 1 or higher should plan on providing their own primary and secondary containment.
- ROI reserves the right to approve or disapprove any use of the HRF Centrifuge



HRF Payload Drawer

Currently available

- HRF Payload Drawer Capabilities
 - Payloads internal to drawer:
 - **Power:** 120V AC, 28V DC
 - **Data:** RS-422, Ethernet, USB (over Ethernet)
 - **Mounting Interface:** Sliding tray w/ fasteners
 - Payloads external to drawer:
 - **Power:** USB Type A (two), USB Type C, 120V AC
 - **Data:** USB Type A (over Ethernet) to HRF PC 2
 - **Mounting Interface:** Deployable shelf w/ Velcro



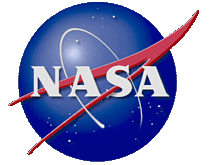


HRF Portable Computers

Currently available

- There are two HRF PCs currently on-orbit
- HRF PC1 and PC2: HP Z-Book 15 G2 Mobile Workstation - Windows 10
- In addition to the software interfacing with the HRF rack hardware, HRF experiment-specific software may be used when necessary





Light Meter

Currently available

- Portable handheld spectrometer with stylus and distance guide designed to measure different light sources (e.g., LED, fluorescent, natural light) and provide data feedback via a USB connection.



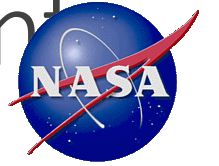
Pneumatonometer (PTM)

Estimated Availability: NET August 2021

- The PTM is a device based on the Reichert Model 30™ Pneumatonometer for measuring intraocular pressure (IOP) in either manual or pulse mode, and tonometry.
 - Only manual mode measurements are certified for operations.
- The PTM is deployed and powered from an HRF Payload Drawer, with data streamed to an HRF PC for storage and downlink.
- Supports IOP range of 5-80 mmHg
 - Characterization testing has been performed to ~40 mmHg
- Required consumables for flight data collection include probe tips and eye drops.



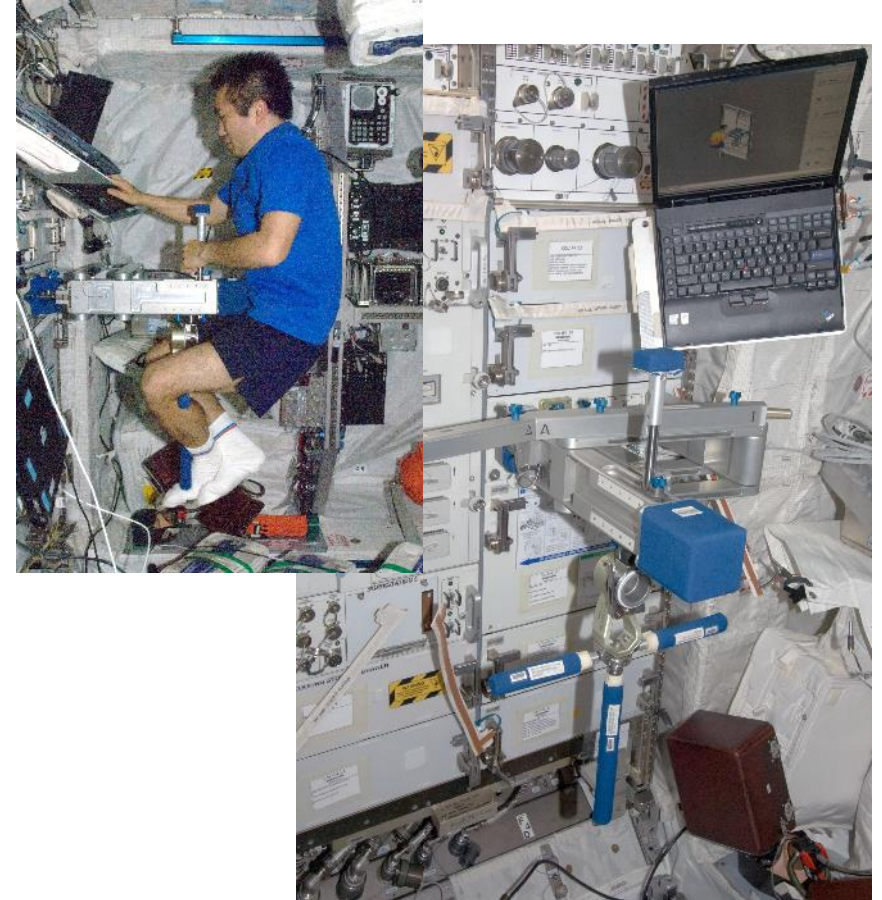
Space Linear Acceleration Mass Measurement Device (SLAMMD)



Currently available

- Follows Newton's Second Law of Motion by having two springs generate a known force against a crewmember mounted on an extension arm, the resulting acceleration being used to calculate the subject's mass
- Accurate to 0.5 pounds over a range from 90 pounds to 240 pounds
- Intended to provide an accurate means of determining the on-orbit mass of humans between the 5th percentile Japanese female and the 95th percentile American male

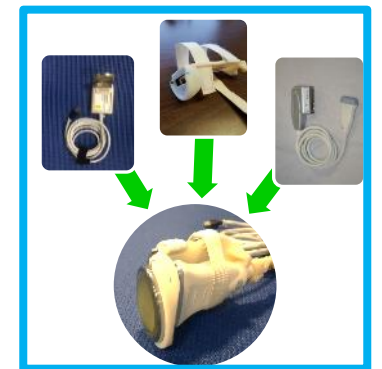
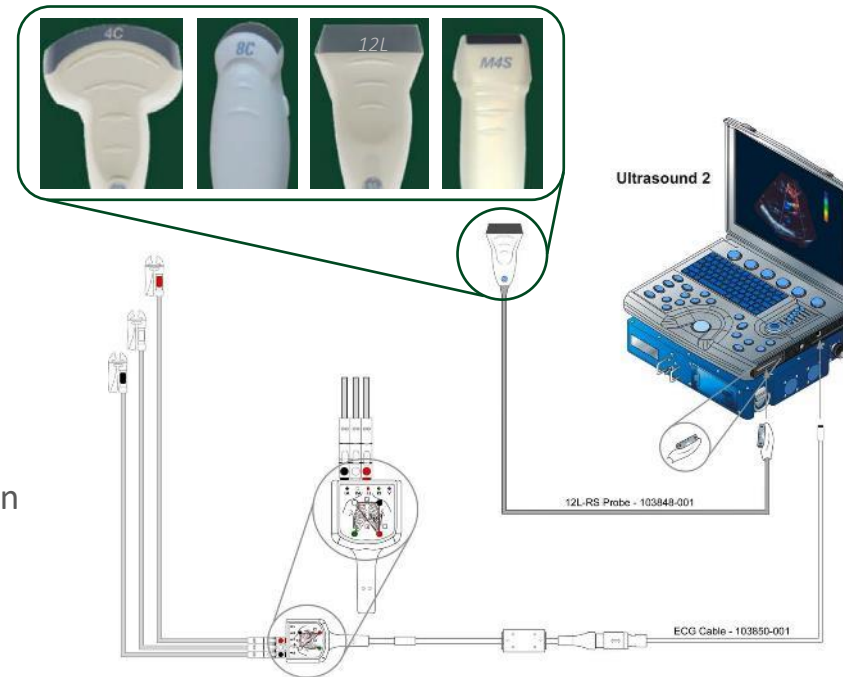
[For more information click here](#)



Ultrasound 2

Currently available

- Modified General Electric (GE) Medical Systems Vivid-q™ model
- Can be used for a variety of experiments for cardiac, muscle, vessel, and blood flow analysis
- Includes additional features that allow for panoramic image construction to estimate muscle volume changes, speckle tracking functions to analyze cardiac stress-strain, and dynamic morphology
- Available accessories:
 - GE phased, linear, and curved array probes available (M4S-RS, 12L-RS, 4C-RS, and 8C-RS)
 - Vein Press for non-invasive venous pressure measurement in conjunction with linear array imaging with integrated software display
 - Manometer for measuring differential pressure across two sample ports with integrated software display



Vein Press



Manometer

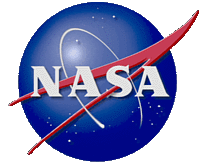
[For more information click here](#)

Vortex Mixer

Currently available

- The Vortex Mixer is a commercial off the shelf unit called N-20M Mini-Vortex, produced by Nissin Instruments
- Used to mix sample tubes in prep for sample storage or return
Powered via 4 AA batteries or 120 AC with power adapter (for ground support only)
- Operational modes: continuous or touch
- Mixer speed: 2600 rpm



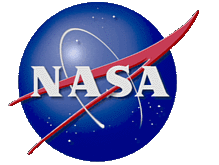


Consumables: HRF Supply Kit Purple

Currently available. Consumables inventory is based on active and upcoming experiment complements.

- Urine tube kits
- Blood tubes (vacutainers)
- Disposable gloves
- Blood collection belts
- Sharps containers
- Liner bags (biohazardous trash)





Consumables: HRF Supply Kit Green

Currently available. Consumables inventory is based on active and upcoming experiment complements.

- Saliva Session Packs
- Butterfly Needles
- Biocide Wipes
- Gauze
- Tape
- Band-Aids
- Sharpie
- Centrifuge Counterweight Tubes
- Tourniquet
- Echo Gel
- Dry Wipes
- Electrodes



Consumables: Blood Collection Kits

Consumables launched as needed to support science activities



Blood Tube Kit (open)



Large Blood Sample Kit



Blood Sample Kit



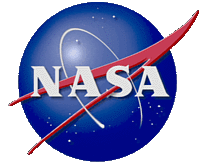
Insulated Blood Pouch



Consumables: Blood Collection Tubes

Consumables launched as needed to support science activities

Processing	Name	Fill Volume (ml)
Ambient	Blood 10ml EDTA	10
	Blood 10ml Heparin	8.5
	Blood 8.5ml ACD	8.5
	Blood 6ml EDTA	6
	Blood 6ml Heparin	6
	Blood Sodium Heparin	6
	Blood 6ml ACD	6
	Blood 4ml EDTA	4
Frozen or Ambient	Blood 4ml CPT	4
Frozen	Blood 7.5ml Serum	7.5
	Blood 7ml Heparin	4.5
	Blood 7ml EDTA	5
	Blood 7ml Serum	5



Consumables: Saliva Collection

Consumables launched as needed to support science activities

- Rolled or sublingual saliva collection – Saliva Session pack
 - Salivette bag - holds multiple salivettes
 - Salivette - roll-shaped synthetic saliva collector
 - Saliva bag - contains salivettes after sampling
- Dried Saliva Collection Booklet
 - 5 filter strips separated by wax paper with a tab



Saliva Session Pack



Salivette bag and Saliva Bag



Dried Saliva Collection Booklet

Consumables: Saliva Collection

Consumables launched as needed to support science activities

- Timed Saliva Session Pack
 - Supports timed sublingual saliva collection (< 3 minutes)
 - Provides containment of salivette to prevent contamination before and after sample collection.
 - Salivette may be transferred out of and returned to the container by subject without use of hands to prevent contamination.
 - Pre-delivery mass recorded to an accuracy of 0.01g to facilitate accurate measurement of sample mass following sample return.
 - Container supports ground centrifugation following frozen sample return without requiring removal of the salivette.



Consumables: Urine collection

Consumables launched as needed to support science activities



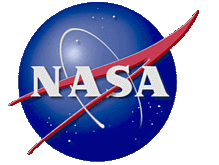
Urine collection device –
Male or female



Urine sample syringes



Urine containment bag



Consumables: Fecal Sample Collection

Consumables launched as needed to support science activities

- Fecal Swab – Used to collect and then store fecal samples in MELFI. Container includes 0.85% Saline buffer solution.
 - Provided in Fecal Session Packs with containment bags.



Fecal Swab collection hardware



Consumables: Fecal Sample Processing

Consumables launched as needed to support science activities

- Dry Fecal Tube – Used to collect samples for processing using DNA/RNA Shield Tubes as well as storage in MELFI.
 - Provided in Dry Fecal Session Packs with containment bags.
- DNA/RNA Shield Tubes – Used to process fecal samples using the Vortex Mixer prior to storage in MELFI. Provides additional protection and stability for nucleic acids in samples.
 - Provided in Fecal Processing Packs with containment bags.





Consumables: Microbial Sampling

Consumables launched as needed to support science activities

- Swab Kit – contains differently colored saline swabs for microbial collection of different body parts, for surface sample collection, and sweat sample collections



Swab Kit



Software: Cognition

Currently available (version 3)

- Software system that delivers brief, computerized neurocognitive tests
- Measures a wide range of cognitive functions
- Each administration (~20 mins) has a battery of 10 computerized tests, as shown in the figure to the right, and additional surveys that can be configured into sequences and assigned to subjects

NOTE: Use of Cognition software (apart from data sharing) requires additional funding and/or laboratory support agreements for data processing. Additional cognitive test batteries not part of the current software version will require additional funding to purchase through the software developer.

