Office of Biology and Physical Research

Space Life Sciences

Ground Facilities Information Package

2000

A Companion Document
to
NASA Solicitations
in
Space Life Sciences

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Table of Contents

Introduction

This supplement is a companion to research solicitations released in 2000 by the National Aeronautics and Space Administration (NASA). The various sections of this supplement provide a common basis for proposal preparation and submission by any eligible scientist.

Interested persons who do not have a copy of the appropriate research solicitation should contact:

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Proposers submitting responses to this solicitation should be aware that the proposal submission deadline for 2000 is **January 19, 2001**.

Special Ground Research Facilities

This document provides descriptions of special research facilities currently available for use by the scientific community. These facilities are available to investigators for ground research at sites specified in the description. **Applicants must contact the person(s) identified at the end of each facility's description for additional scientific and technical information.** Applicants are cautioned that the cost of using these facilities, where applicable, and the cost of traveling to and from the facilities must be included in any proposal requiring them. Facility use costs **must** be negotiated and approved by the listed contact person **prior** to proposal submission.

Table 1. Cross-Reference Table

Biocomputation Facilities		
Facility Name	**Location**	**Page**
Center for Bioinformatics	Ames Research Center	8

1.0 Research Facilities

1.1 The Vestibular Research Facility (VRF)

The Vestibular Research Facility (VRF) at the NASA Ames Research Center (ARC) provides unique, state-of-the-art equipment for ground-based studies of the effects of precise low-noise angular and linear accelerations on biological subjects. The VRF houses the following:

- Multi-Axis Centrifuge
- 30 ft Human-Rated Sled
- Programmable Linear Sled

VRF hardware enables the study of responses to smooth, linear motion or to combinations of linear and angular motion over the frequency range of natural head movement. Specific space-related and non-space-related science questions may be addressed. The facility permits electrophysiological study of how complex linear or rotational accelerations are transduced during centrifugation, encoded by biological sensors, and processed by the brain. Interactions between linear and angular motion, as well as visual and proprioceptive inputs (peripheral, central, and motor) may be examined in any physiological system using electro-physiological, reflex, and behavioral methods. Sensorimotor interactions under complex linear and angular acceleration conditions may be studied systematically.

Information on the VRF is also available on-line at http://lifesci.arc.nasa.gov/cgbr/cgbr.html

1.1.1 The VRF Multi-Axis Centrifuge

The VRF Multi-Axis Centrifuge allows an investigator to apply up to 2 g linear (centrifugal) acceleration to a gimbaled Specimen Test Container (STC) whose center is at a 1.0 m radius from the centrifuge's axis of rotation. Gimbal motors allow an experimenter to apply DC to 5 Hz angular motions (up to 500º/sec velocity and 500º/sec^2 acceleration) to the STC and its 54-pound payload during centrifugation. Fifteen electrically isolated slip-ring assemblies allow the recording of multiple channels of electrophysiological data continuously during centrifugation. This centrifuge accommodates small primates and rodents or smaller animal or plant specimens.

For further information, contact Tianna Shaw at NASA/Ames Research Center (Telephone: 650-604-6496).

1.1.2 The VRF 30ft Linear Sled

The VRF 30 ft Linear Sled uses air bearings to produce noise-free linear acceleration for studies of human perception of linear acceleration that do not confound vestibular cues with somatosensory ones. It also enables other physiological studies of humans and other species. The long track enables lower stimulus frequencies (periodic motion from 0.25 Hz to 5.0 Hz at 0.5 g peak), and noise-free periods of constant linear velocity (trapezoidal profiles with acceleration and deceleration of 1.0 g, and 100 cm/sec constant velocities). It consists of an experimental platform floating on air bearings on a granite surface. A gimbaled chair is mounted on the platform to accommodate human subjects or a specimen container for non-human subjects. Solid support is provided by a 30 ft long block of granite. The 30 ft linear sled can accommodate humans, small primates, rodents, or other biological specimens.

For further information, contact Tianna Shawat NASA/Ames Research Center. Telephone: 650-604-6496

1.1.3 Programmable Linear Sled (PLS)

The Programmable Linear Sled (PLS) uses air-bearings and linear motor technology to study vestibular system responses in small primates, rodents, or smaller animal specimens. This device allows studies of electrophysiological, reflex, or behavioral responses during precisely controlled linear oscillations (1.0 Hz to 5.0 Hz, $\pm$1 g peak acceleration) parallel or perpendicular to Earth gravity (i.e., horizontally or vertically). The PLS supports short-term studies of biological responses to linear acceleration.

For further information, contact Tianna Shaw at NASA/Ames Research Center (Telephone: 650-604-6496).

1.2 Human-Rated Hypergravity Facilities

The NASA Ames Research Center has two hypergravity facilities that enable psychophysical and physiological research on humans and other species. They are:

- the 20-g Human-Rated Centrifuge and
- the Human Powered Centrifuge.

Information on the Human-Rated Hypergravity Facilities is also available on-line at http://lifesci.arc.nasa.gov/cgbr/cgbr.html

1.2.1 The 20 g Human-Rated Centrifuge

The 20 g Human-Rated Centrifuge, NASA's only centrifuge currently human-rated (to 12.5 g), enables delivery of accelerations with onset rates of 1 g/sec to 12 g and 0.5 g/sec from 12 g to 20 g. It is frequently used to simulate Space Shuttle launch and landing profiles for a variety of payloads. The centrifuge has three enclosed cabs, each with a 16,000 g-pound payload capacity. One cab, at a 29-ft radius, contains a modified jet fighter seat in which a human volunteer sits during psychophysical or physiological tests. A second cab, located at the other end of the rotating arm, can be configured for rodents or other animals, plant species, or cell cultures. A third cab, located near the center of the centrifuge rotation can also be adapted to experimental requirements. This cab can be used as an on-center control for angular acceleration. Hypergravity exposures of minutes to hours are possible.

For further information, contact Tianna Shaw at NASA/Ames Research Center (telephone: 650-604-6496).

1.2.2 The Human Powered Centrifuge

The Human Powered Centrifuge is a 6.25-ft radius centrifuge. A stationary bicycle beside the centrifuge or a recumbent bicycle onboard provides power for rotation of from minutes to hours, allowing human-generated gravitational forces for a payload of up to 500 pounds, without or with exercise, respectively. This centrifuge can also be driven by a motor. Human subjects have been found to be capable of generating up to 5 g's of acceleration comfortably, reaching maximum rotation speeds of 50 rpm. Electronic equipment for monitoring physiological parameters, such as cardiovascular function, temperature oxygen consumption, and other basic data, may be mounted onboard. Instrumentation-quality slip rings are available to transfer signals off-board for real-time monitoring.

For further information, contact Tianna Shaw at NASA/Ames Research Center (telephone: 650-604-6496).

1.3 Parabolic Flights: The KC-135 "Zero-G" Aircraft

This aircraft, a specially modified version of a Boeing 707, can generate 20- to 30-second periods of microgravity and various levels and periods of hypergravity. This platform can be used to test and validate experimental equipment and new devices to ensure that they will operate properly in varying gravitational fields. Furthermore, since multiple parabolas can be flown, it is also possible to conduct actual experimental studies.

For further information, contact Todd Schlegel, M.D. at the NASA Johnson Space Center (telephone: 281-483-9643).

1.4 Non-Human Hypergravity Facilities

The NASA Ames Research Center has a suite of hypergravity facilities capable of supporting studies using non-human subjects and human and/or non-human tissues in addition to those listed above. These facilities include:

- Chronic Hyper-Gravity Exposure (24ft Diameter) Centrifuge
- International Space Station Test-Bed (8ft Diameter) Centrifuge

- Low Vibration Rotational Device

Information on the Non-Human Hypergravity Facilities is also available on-line at http://lifesci.arc.nasa.gov/cgbr/cgbr.html

1.4.1 The Chronic Hyper-Gravity Exposure (24-ft Diameter) Centrifuge

The Chronic Hyper-Gravity Exposure (24-ft Diameter) Centrifuge is designed to create hypergravity conditions up to 4.15 g for small animal (such as rats, guinea pigs, rabbits, or primates) and plant research. The centrifuge has 10 radial arms and carries up to 20 large, opaque, ventilated enclosures for holding animals and equipment. These enclosures can be located at different radii (variable from 4 ft to 12 ft at 6-inch intervals) to produce gravitational forces of up to four times Earth gravity on the floor of the enclosure. Three additional, smaller enclosures are available near the axis of rotation of the centrifuge, and eight stationary enclosures are available within the centrifuge rotunda to provide appropriate rotation and vivarium controls. Slip rings provide in-cage TV monitoring and instrumentation capability. Hypergravity exposures are chronic (from days to months) with two half-hour stops per week for feeding and change of bedding.

For further information, contact Tianna Shaw at NASA/Ames Research Center (telephone: 650-604-6496).

1.4.2 The International Space Station Test-Bed (8ft Diameter) Centrifuge

The International Space Station Test-Bed (8' Diameter) Centrifuge is being configured to enable experiments in all habitats that will be used in the International Space Station. Experiments may be performed on plants or animals (e.g., rodents, small aquatics, insects, or cell cultures).

For further information, contact Tianna Shaw at NASA/Ames Research Center (telephone: 650-604-6496).

1.5.3 The Low Vibration Rotational Device (LVRD)

The Low Vibration Rotational Device (LVRD) is a single-arm centrifuge with a 10-ft radius. It has a swing frame that can be positioned at various distances from the hub. Hypergravity levels up to 6 g can be provided. Hydrostatic bearings provide for precise angular accelerations ($0.1°/sec^2$) with a rise time of 0.1 sec and minimal vibration. Instrumentation-quality slip rings are available for off-board monitoring of experiment data.

The LVRD may be configured with an onboard CO_2 incubator to study the effect of short- or long-duration hypergravity exposure on cultured cells. This configuration is referred to as the Hypergravity Facility for Cell Culture (HyFaCC). Temperature, % CO_2, relative humidity, and g level data are transferred off-board through the slip ring assembly. The HyFaCC accommodates cell culture dishes of any type, but sealed vessels with vented caps are recommended for sterility. Additional equipment such as peristaltic pumps or automated cell culture devices may be accommodated. Studies up to 3-weeks duration may be run on the centrifuge. Long-duration studies will require stopping the centrifuge every 2 to 3 days for media replenishment unless a system to automatically replenish media is provided.

For further information, contact Tianna Shaw at NASA/Ames Research Center (telephone: 650-604-6496).

1.5 Bed Rest Research Facility (Human Research Facility)

The NASA Ames Research Center Bed Rest Research Facility is a 4100 ft^2 facility used to conduct studies of physiological responses of humans exposed to the bed-rest simulation that produces many of the physiological changes seen in space flight. Human subjects may be maintained comfortably for prolonged periods in either supine or 6° head-down bed-rest. During and following the bed-rest exposure, experimenters may conduct physiological studies of a variety of disciplines (e.g., endocrine, metabolic, and cardiovascular adaptations, musculoskeletal changes, exercise effectiveness, etc.).

Up to 12 subjects can live comfortably in this non-hospital environment for weeks or months, with all living requirements provided. The facility contains separate but readily accessible subject-living and test-administrative

areas. It provides a controlled environment (temperature, light intensity, and photoperiod) and is suitable for research on ambulatory or bed-rested subjects. A horizontal shower is used for test subjects who must remain supine. Two bedrooms are sound-proof and have adjoining bathrooms, making them ideal for either isolation or group interaction studies. A dumbwaiter is used to transport biological specimens (e.g., blood and urine samples) to a clinical laboratory on the floor above for processing. Biomedical data can be transmitted by hard wire from the subject's bed to a central data station for monitoring and recording. All meals are prepared in an integral modern kitchen, so that experiment dietary requirements may be strictly controlled. A dietician is responsible for planning and preparing all meals. Ambulatory subjects eat and relax in a central lounge/recreation/dining area.

Adjoining test areas contain a variety of physiological and exercise test equipment. In addition to medical monitoring equipment, the facility provides a lower-body negative pressure device, upright and supine bicycle ergometers, an upright treadmill, isokinetic exercise devices, and a tilt table to test orthostatic tolerance. Investigators can also bring additional experiment-specific equipment. For provocative testing of bed-rest de-conditioned subjects using hypergravity or vestibular testing, near-by human-rated facilities at ARC may be used.

For further information, contact Tianna Shaw at NASA/Ames Research Center (telephone: 650-604-6496).

1.6 Ground-Based Radiation Accelerator Facilities

NASA has signed Memoranda of Agreement (MOA) with two ground-based laboratories where energetic beams of protons and high-energy heavy ions are available; in particular, proton beams at the **Loma Linda University Medical Center** (protons with energies between 70 MeV and 250 MeV) and the Alternating Gradient Synchrotron (AGS) at **Brookhaven National Laboratory** (beams of iron and other heavy nuclei, with energies as low as 600 MeV/nucleon, up to 10 GeV/nucleon). Delivery of beam time at the Brookhaven facility has been directly funded by a contract between NASA and Brookhaven, and similar arrangements are intended for use of the beam time at Loma Linda University Medical Center.

1.6.1 Brookhaven National Laboratory

The AGS machine is a U.S. Department of Energy (DOE) facility that is funded by the DOE primarily for research in high energy particle and nuclear physics. Brookhaven is allowed by DOE to provide additional AGS beam time to other scientific users of the machine, as long as operating funds are provided by the sponsor of such proposed work. Use of the Brookhaven facilities requires a separate proposal, which is reviewed by a laboratory-appointed panel and is scheduled in accordance with available beam time and other laboratory resources. Once experiments are approved, they are required to satisfy the normal process of preparation for running at the AGS, which includes familiarization with AGS rules and policies (safety being the paramount consideration among these), and registration with the laboratory as a guest scientist.

User facilities have been developed at Brookhaven for radiation biology research, including cell cultures and small animals. These include the shielding cave containing the beam, the biological experiment station, and laboratory space and animal facilities in the Brookhaven Medical Department. A 10-ft long optical bench for sample exposures is available in the cave, as well as beam handling, sample changing, and dosimetry instrumentation. The biological experiment station contains one area for cell culture equipped with a laminar flow hood and incubator, one short-term animal holding facility, and one area for physics/run-control use. In addition, laboratory space and access to animal facilities accredited by the Association for Assessment and Accreditation of Laboratory Animal Care are available in the Medical Department, subject to standard use charges. Brookhaven also has on-site housing accommodation for users (dormitory and apartment-style units).

Iron (^{56}Fe) beams at 600 MeV/nucleon and at 1 GeV/nucleon, as well as ^{28}Si and ^{79}Au, have been used for experiments to date; investigators who need to use other beams or energies should contact the Brookhaven liaison scientists listed below. Normally, circular beam spots are provided, with diameters up to 10 cm, and center-to-edge uniformity between 10% and 20% (depending on dose rate -- high dose rate beams are less uniform than low-dose rate beams). Dose rates have been measured up to 11 Gy/min. Investigators currently funded by the NASA program participate in research using these beams, and coordination of beam use with these investigators and institutions is actively encouraged. In particular, a physics and dosimetry group is available for investigators requiring their assistance.

For further information regarding Brookhaven National Laboratory, contact Dr. Marcelo Vazquez (e-mail: vazquez@bnl.gov), Dr. Betsy Sutherland (e-mail: betsy@image.bio.bnl.gov), or Dr. Phil Pile (e-mail: pile@bnldag.ags.bnl.gov). The address is Brookhaven National Laboratory, PO Box 5000, Upton, NY 11973-5000. Information about this facility is also available at: http://bnlstb.bio.bnl.gov/biodocs/nasa/nasa_ags.htmlx.

1.6.2 Loma Linda University

Loma Linda University operates a facility for therapy of cancer and other diseases using accelerated protons from a synchrotron, which is located within the medical center. Associated with the synchrotron are treatment rooms and all clinical services relevant to radiation therapy. Also associated with the synchrotron are an experimental area ("research room"), which can receive a proton beam, and an adjacent staging laboratory from which the accelerator can be operated and experiments may be configured prior to irradiation. Close to the accelerators is the new Chan Shun Pavilion, a wing of a research building whose first floor has been designated for a radiobiology research program with capabilities for modern cellular, molecular, and *in vivo* biology studies. Included in this structure is a laboratory dedicated for the use of visiting scientists whose research requires access to proton beams.

The basic beam line was designed to bring protons from 40 MeV to 250 MeV to the research room for experimental work while not interfering with patient treatments. The beam line will provide for flexible delivery of proton beams at doses, dose rates, energies, field sizes, and field uniformities that are adequate for many biology, physics, and materials science experiments. A Co-60 irradiator has been installed to provide gamma rays for control experiments.

For further information the Loma Linda University Medical Center, contact Dr. Gregory A. Nelson (e-mail: gnelson@lluci.llu.edu; telephone: 909-478-8366), Director, Radiobiology Program, Loma Linda University Cancer Institute, 11360 Mt. View Avenue, Hartford Bldg, Ste. B, Loma Linda, CA 92354. A description of the facilities at Loma Linda University Medical Center is available at: http://www.llu.edu/proton/patient/nasa1.html.

1.7 Space Human Factors Facilities

The Graphics Research and Analysis Facility (GRAF) and the Anthropometry and Biomechanics Facility (ABF) are managed by the Flight Crew Support Division at the Johnson Space Center.

1.7.1 Graphics Research and Analysis Facility

The Graphics Research and Analysis Facility has systems for computer modeling of humans and environments. It provides anthropometric, kinematic, and visibility analyses of humans working in 1g, 0g, or partial g. GRAF has access to strength and size databases and a physically-based system for computer modeling illumination for camera/eye vision with the ability to empirically collect luminance and illuminance data. It also has a large collection of models of the Shuttle, Spacelab, Spacehab, and ISS modules in which to perform this integrated analysis of humans working in space both EVA and IVA.

1.7.2 Anthropometry and Biomechanics Facility

The Anthropometry and Biomechanics Facility collects and analyzes strength, force, and motion data in the Weightless Environment Test Facility (WETF) and in the KC-135 0 g aircraft. Equipment includes Lido dynamometers, Ariel Motion Analysis Systems, and waterproofed and KC-135-qualified force plates. The ABF personnel are experienced in collecting data from suited subjects, as well as on the Precision Air Bearing Floor.

For further information, please contact Dr. Francis Mount at the Johnson Space Center (telephone: 281-483-3723).

1.8 Biocomputational Modeling Facilities

1.8.1 Center for Bioinformatics

The Ames Center for Bioinformatics is dedicated to the development and application of advanced visualization, computation and simulation technologies to support Life Science research. Equipment, software, and personnel capabilities allow support to the following four types of work:

1. 3-D Reconstruction (data from microscopic serial sections to multimedia medical scans)
2. Scientific Visualization and Modeling (diverse applications from structure and function of vestibular system, including genetic constructs, to astrobiology research)
3. Virtual Collaborative Environment Technologies (multicast collaborative interactions for scientific, educational, professional training, and medical applications)
4. Neurotechnology (from biological neuronal circuits and systems to chips, processors and computer architectures).

For further information, please contact Dr. Richard Boyle at NASA, Ames Research Center (telephone: 650-604-1099, email: rboyle@mail.arc.nasa.gov)