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Special Research Facilities

for

Space Life Sciences

Life Sciences Division
NASA Headquarters
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SPECIAL RESEARCH FACILITIES
for
SPACE LIFE SCIENCES

This document provides detailed descriptions of the special research facilities listed in Appendix C of the two NASA Research Announcements (NRAs) released on February 20, 1996: Research Opportunities in Space Life Sciences (NRA 96-OLMSA-01A), and Advanced Life Support and Environmental Technologies for Human Exploration and Development of Space (NRA 96-OLMSA-01B). These facilities are available to investigators for ground research at one of the NASA Field Centers or at other sites. Potential applicants should contact the person identified at the end of each facility description for additional technical information. The cost of using these facilities should be included in any proposal requiring them; such costs should be approved in advance by the contact person listed here.

This document will be revised as new information on facilities becomes available. Paper copies of this document may be obtained by contacting Information Dynamics, Inc. at (202) 488-5157.

AMES RESEARCH CENTER

1. The Vestibular Research Facility (VRF)

The Vestibular Research Facility (VRF) at Ames Research Center provides unique, state-of-the-art equipment for ground-based studies of vestibular function. It also includes support laboratories and office areas. The VRF houses the following:

- Ground-based multi-axis centrifuge,
- 12- Foot linear spring sled,
- 30- Foot Sled, and
- Portable linear sled.

The 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 the study of how complex linear and/or rotational accelerations are transduced, encoded by the vestibular system, and processed by the brain. Interactions between linear and angular vestibular stimuli, and visual and proprioceptive inputs (peripheral, central and motor) may be examined using electro-physiological, reflex and behavioral methods. Sensorimotor interactions under complex linear and angular acceleration conditions may be studied systematically.

The VRF ground-based centrifuge was designed to provide Each Specimen Test Container payload with accelerations from rotations about two axes simultaneously - the main spin axis and one other high performance axis. If the main spin is not utilized, rotation could occur about a maximum of four axes - both inner and outer high performance axes of both Specimen Test Containers. Currently only one Specimen Test Container is used to perform experiments; however, the opposite container performs a mirror rotation for dynamic balance. The ground-based centrifuge can accommodate small primates, rodents, and chicks.

The VRF 12-Foot linear spring sled features a highly advanced air bearing system for linear acceleration. It consists of an experimental platform kept 80 millionths of an inch above the test bed. A gimbaled Specimen Test Container is mounted on the platform. Solid support is provided by a 12 foot long block of granite.

The VRF 30-Foot linear sled also features a highly advanced air bearing system for linear acceleration. It consists of an experimental platform kept 80 millionths of an inch above the test bed. A gimbaled chair is mounted on the platform to accommodate human subjects or the 12 foot specimen container to accommodate non-human subjects. Solid support is provided by a 30 foot long block of granite. The 30-foot linear sled can accommodate humans, small primates, rodents, and small chicks.

The Portable Linear Sled (PLS) was developed to utilize air-bearing and new linear motor technology with low vibration at the low end to study the vestibular system in remote locations. It can operate in either the horizontal or vertical positions and has been used in Russia for pre- and postflight vestibular studies. The PLS can accommodate small primates.

For further information, contact Dr. David Tomko at Ames Research Center, telephone: (415) 604-5723.

2. Human Rated Hypergravity Facilities

Ames Research Center has a suite of hypergravity facilities capable of supporting studies using human subjects and often other species as well. These facilities include a:

- 20-G Centrifuge,
- Human-Carrying Rotation Device (HCRD), and
- Human Powered Centrifuge.

The 20-G Centrifuge is NASA's only centrifuge currently rated safe for humans. It's three enclosed cabs make it unique among all U.S. centrifuges. One cab contains a modified jet fighter ejection seat in which a human volunteer sits during tests. A second cab, at the other end of the rotating arm, can be configured to meet an investigator's needs. The third cab, located in the center of the centrifuge can also be adapted to the investigator's needs. This cab allows investigators to study variable gravity gradients and can also be used as an on-center control for angular acceleration. A person lying in this cab with the head at the center of rotation experiences different gravity forces on different segments of the body (gravity gradient). The force varies with the distance from the center of rotation. The 20-g Centrifuge can be used to evaluate flight hardware and flight experiment payloads and to test the effects of hypergravity on humans and other animals. The 20-g Centrifuge can also be configured to accommodate rodent and primate subjects.

The HCRD has a 6.5 foot radius and one cab. The cab can be positioned at variable distances from the hub (0 to 6 feet), producing variable gravity levels up to 4.5 G. Hydrostatic bearings provide for precise angular accelerations (0.1 deg/sec^2) with a rise time of 0.1 sec. Designed primarily for humans, the HCRD can also support research on rodents, primates, and plants.

The Human Powered Centrifuge was developed as a research tool to provide gravitational forces without exercise or with exercise using only human effort. Currently configured with a pedal mechanism, a variety of exercise methods (stair stepper, rowing, etc.) can be incorporated into the drive system.

For further information, contact Barbara Corbin at Ames Research Center, telephone: (415) 604-3145.

3. Non-Human Hypergravity Facilities

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:

- 24-Foot Diameter Centrifuge,
- 8-Foot Diameter Centrifuge, and
- Hypergravity Facility for Cell Culture (HyFaCC).

The 24-foot Diameter Centrifuge is designed to create hypergravitational conditions for small animal and plant research. The centrifuge has 10 radial arms and holds up to a total of 20 large, opaque, ventilated enclosures for holding animals and equipment. These enclosures can be located at different radii 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 non-hypergravity controls. Onboard water and food dispensing systems permit continuous studies. Slip rings provide in-cage TV monitoring and instrumentation capability. The 24-foot diameter centrifuge can accommodate rodents, guinea pigs, rabbits, primates, and plants.

The 8-foot centrifuge was primarily designed for rodent studies, but can be modified to accommodate other specimens such as small primates. The centrifuge has 10 radial arms, each capable of holding one animal enclosure. The rodent enclosure, similar to that on the 24-foot centrifuge, can accommodate up to two vivarium cages. In addition, special enclosures have been developed to allow centrifugation studies with snakes. These tubular enclosures replace the gimbaled animal enclosures and run parallel with each radial arm. The center of the tube is fixed at a 4 foot radius.

The Hypergravity Facility for Cell Culture (HyFaCC) is a single arm centrifuge with a 9-foot radius and one Forma Steri-CuH HEPA Filtered Infrared CO_2 incubator. The incubator can be positioned at variable distances from the hub (0 to 9 feet), producing variable gravity levels up to 6 g. The HyFaCC was designed to provide the unique opportunity to study the effects of short and long duration hypergravity exposure on cultured cells.

For further information, contact Barbara Corbin at Ames Research Center, telephone: (415) 604-3145.

4. The Biocomputation Center

The Biocomputation Center at NASA Ames Research Center is dedicated to computer-based three-dimensional (3-D) visualization of cells, tissues and organs, to mathematically-based modeling, and to 3-D simulations of the functioning of living systems from the subcellular and molecular to the organismal level. The emphasis is on teams of broadly based, inter-disciplinary investigators and on a union between computational, theoretical and experimental research. Main facilities include a Zeiss 902 Transmission Electron Microscope and approximately 1,000 sq. ft. of open laboratory subdivided into eight workstation areas.

For further information, contact Dr. Muriel Ross at Ames Research Center, telephone: (415) 604-5757.

JOHNSON SPACE CENTER

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 insure 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 Johnson Space Center, telephone: (713) 483-9643.

BRANDEIS UNIVERSITY

Slow Rotation Test Facility. The slow rotation test facility was developed at Brandeis University to aid in the study of human behavioral and physiological responses to both predictable and aberrant force vectors generated by a rotating environment. The forces experienced under these conditions are very similar to those encountered in space vehicles that rotate to create artificial gravity.

The slow rotation test device is 22 feet in diameter and has a net weight in excess of seven tons. It is driven by a linear induction motor drive designed specifically for this application which has the capability of developing a constant torque of 2,350 ft. lbs. The drive can produce a gravitoinertial force in excess of 4g within the room for a 6,000 lb. payload. By means of preprogrammed velocity profiles the motor drive system can accurately control the rate of speed of the device in either direction over the entire 0 to 35 RPM speed range in increments as small as 1 degree per second squared to ten degrees per second squared increments can be achieved; constant velocity can be maintained to within =/- .001%. Over the entire speed range z-axis vibration has been measured at <.001g. The room can also sinusoidally oscillate over a wide range of frequencies.

The control system for this device consists of a time-shared micro-processor that also monitors 280 discrete room safety parameters per second while providing this information to control room personnel. The slow rotation room can accommodate a wide variety of test devices with on board power for devices requiring either 110 VAC, single phase or 220 VAC, three phase.

For further information, contact Dr. James Lackner at Brandeis University, telephone: (617) 736-2033.

GROUND-BASED 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 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 1 GeV/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.

The AGS machine is a US Department of Energy (DOE) facility that is funded by the DOE for research in high energy particle and nuclear physics. Since not all the beam available is actually used for this purpose, 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-foot 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 AAALAC-accredited animal facilities, subject to standard use charges, are available in the Medical Department. Brookhaven also has on-site housing accommodation for users (dormitory and apartment style units); a cafeteria, an automobile service station; travel and post offices. Scientific personnel are available to assist users.

A first experimental run, using 100 hours of beam time delivered to experimenters over a 2 week period, was completed successfully in 1995. The next run, of similar duration, has been scheduled for the Fall of 1996. Beams with energies as low as 1 GeV/nucleon have been extracted, with circular beam spots up to 16 cm

diameter, center to edge uniformity of 15%, and dose rates 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.

It is expected that similar arrangements, taking advantage of existing in-house expertise, will be negotiated with Loma Linda University Medical Center, in the framework of the MOA with that institution.

For further information contact the following:

Brookhaven National Laboratory

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MICROGRAVITY USER SUPPORT CENTER, KÖLN, GERMANY

The DLR Microgravity User Support Center (MUSC) is the German user support center for research under space conditions. The MUSC is equipped with laboratory infrastructure, simulation facilities, experiment control rooms, user rooms for science monitoring and data evaluation, a user information area with a microgravity library, and the information system ARIADNE. Further equipment and laboratories are located in the Institute of Aerospace Medicine. The Institute of Aerospace Medicine set up a unique infrastructure now offered for application in an international scope of space biology and human physiology research, offering support for ground-based research and small payloads in the scope of a

joint interagency research program for cell and molecular biology, systems biology, plant biology, botany, and zoology.

For 0-g simulations, hypergravity experiments, and extended ground-based research, the following infrastructure and facilities can be utilized for integrated investigations in the above mentioned fields of research:

- Fast rotating clinostats;
- Cuvette clinostats;
- STATEX hardware;
- BIOLABOR double rack (DARA hardware);
- Low Rotating Centrifuge Microscope (NiZeMi lab model);
- Cultivation chambers for Biorack containers Type I and NiZeMi;
- Different centrifuges including large centrifuge;
- Large-scale Magnetic Resonance device (imaging, microscopy and spectroscopy);
- Tilting microscope;
- Data and image processing capabilities;
- Computer-based fluorescence microscopy (Zeiss Attofluar); and
- Laboratories and sophisticated workshops also for electronics.

For further information, contact Dr. Marianne Schuber, Microgravity User Support Center - MUSC, German Aerospace Research Establishment (DLR), Institute for Aerospace Medicine, Linder Höhe 45, D-51147 Köln, Germany.
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