Microgravity Science Research
International Announcement of Opportunity 2000

Standard Companion Document

Issued by the International Microgravity Strategic Planning Group

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Introduction

This supplement is a companion to research solicitations released by agency members of the International Microgravity Strategic Planning Group: Agenzia Spaziale Italiana (ASI – Italy), Canadian Space Agency (CSA - Canada), Centre National d'Ètudes Spatiales (CNES - France), Deutsches Zentrum für Luft und Raumfahrt (DLR - Germany), the European Space Agency (ESA - Europe), National Aeronautics and Space Administration, (NASA - United States), and the National Space Development Agency of Japan (NASDA - Japan). The various sections of this supplement provide a common basis for proposal preparation and submission by any eligible scientist, regardless of the country of origin.

The purpose of the International Announcement of Opportunity (IAO) is to obtain the highest quality research through international solicitation and scientific peer review of research proposals, to increase the effective use of the International Space Station (ISS) through international cooperation and utilization of the ISS facilities, and to avoid duplication of projects by fostering international collaboration.

The research solicitations coordinated by this document aim to optimize the use of facilities available for microgravity research on the International Space Station. The equipment offered through the coordinated announcements during the period spanning Station assembly and the first years beyond assembly complete (approximately 2002-2006) is listed in Section 3. This AO is principally a solicitation for research on the ISS. However, if space shuttle opportunities becomes available during this period, participating agencies may carry out some of the selected experiments on these missions.

This document provides a common basis for proposal preparation and submission. Each participating agency will release an announcement of opportunity (AO) which will accompany this document and will include the unique requirements of the agency.

Interested persons who do not have a copy of the announcement of opportunity should contact one of the following persons for more information:

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The deadline for submitting a proposal for the IAO to any of the participating agencies is January 12, 2001.
A non-committing letter of intent should be submitted to the same participating agency by November 17, 2000. This letter of intent should provide a preliminary abstract of the project and a list of the potential participants.

1.0 International Microgravity Research Proposal Evaluation Process

This section describes the evaluation and selection processes that will be used for funding proposals submitted to any agency participating in the IAO in reply to the coordinated 2000 flight research solicitation.

Each research proposal must be a complete response to the appropriate individual space agency's official solicitation. In that solicitation, an agency may define a number of critical constraints that proposals must satisfy to be considered for selection. For example, an agency may fund no work in certain discipline areas, or no work without a flight component. Proposals to these agencies to carry out work that will not be funded by them will be returned to the proposer immediately following submission. For this reason, proposers are advised to communicate with their agency officials prior to submission if there is any doubt of the acceptability of a proposal by the agency in question. **Any request for supplementary support from an agency by a project, or by co-investigators or team members on a project(see section 4.6), other than the primary agency from which overall project sponsorship is being sought, must include a proposal meeting the requirements of the agency from which the support is being requested.**

The overall review process for each proposal will include the following factors:

- Microgravity relevance
- Scientific merit
- Preliminary technical assessment
- Relevance to the programs of the soliciting agencies
- Cost

Clear microgravity relevance will be a requirement for the selection. Apart from microgravity relevance, the most important criterion in the evaluation is the scientific merit, followed by flight feasibility, relevance to agency programs, and cost. Compliant proposals will undergo a three-tiered review process to assess these factors.

1.1 Microgravity Relevance and Science Merit Review

The first review tier will be a peer-review assessment of the microgravity relevance and the science merit by scientific experts. In general, proposals will be reviewed by a panel of experts drawn from the international scientific community. All panels will utilize the same factors in their evaluation and all panel meetings will be conducted using the same review guidelines. The merit review panel will assign a score or recommend no further consideration of the proposal, based upon its scientific merit.

The score assigned by this panel will not be affected by the cost of the proposed work or reflect the programmatic relevance of the proposed work to the sponsoring agency. However, the panel will be asked to include, in their critique of each proposal, any comments they may have concerning the budget.

The peer-review will consist of two categories, i.e., microgravity relevance and scientific merit.

Microgravity Relevance

Does the proposed project require the microgravity condition? Does the experiment need long duration microgravity to obtain unique scientific information not accessible by other means?

The following criteria in order of priority will be used in determining the merit score:

Significance: Does this study address an important problem? If the aims of the application are achieved, how will scientific knowledge or technology be advanced? What will be the effect of these studies on the concepts, methods, or products that drive this field?

Approach: Are the theoretical framework, experimental design, data analysis and interpretation methods adequately developed, well integrated, and appropriate to the aims of the project? Is the proposed approach likely to yield the desired results? Does the applicant acknowledge potential problem areas?

Innovation: Does the project employ novel concepts, approaches, or methods? Are the aims original and innovative? Does the project challenge existing paradigms or develop new methodologies or technologies?

Personnel: Are the scientific personnel appropriately trained and well suited to carry out this work? Is the evidence of the personnel's productivity satisfactory? Are the functions and responsibilities of the team members adequately described and appropriate? Does the project employ useful collaborative arrangements?

Environment: Does the institutional environment, in which the work will be performed, contribute to the probability of success?

1.2 Preliminary Technical Assessment

The second tier involves a technical assessment, or engineering review, that will evaluate the feasibility of implementation of the proposed work on the research facilities offered in this IAO. This review will be conducted by a qualified international team of engineers representing the research facilities. A detailed experiment description, necessary for this evaluation, should be clearly and succinctly included in the proposal. Because of the limited resources available for use of the experimental facilities, experiment requirement for volume, mass, power, etc will be an important aspect in the technical assessment. It is important to note that during the early utilization phase, resource constraints will favor selection of proposals with simple requirements and procedures. Of particular concern regarding the evaluation of the feasibility of a proposal is the identification of the risk factors that could impact the implementation of an otherwise meritorious proposal. Therefore, the feasibility of implementing the proposal and associated risks will be evaluated using the following technical criteria:

Functional Requirements: Will the available flight hardware and related ground support resources meet the functional requirements of the experiment? How much experiment-unique equipment will be required, and can it be developed in time for the projected flight opportunities?

Space Platform Resource Requirements: To what extent will this experiment consume the launch vehicle capacity and flight platform resources (such as crew time and electrical power) that are projected to be available? Are sufficient resources available? Does this experiment require such a large amount of the available resources that it will preclude conduct of other experiments? Can the experiment be carried out within a reasonable period of time?

Safety: Are there elements of the proposed activities and hardware that pose concerns for the health and safety of personnel and/or the environment?

1.3 Evaluation of Programmatic Relevance and Cost

The third tier of review will consider two factors: programmatic relevance and cost. This review will be conducted independently by program scientists and managers from each soliciting agency for proposals submitted to their specific solicitation. Programmatic relevance will include an evaluation of how the proposed work may help achieve agency goals. Evaluation of cost will be performed for proposals by the agencies from which funds are requested including the development and support for the flight experiment. This evaluation includes consideration of the realism and the reasonableness of the cost of the proposed research, and the relationship of the overall cost to available funds.

1.4 Development of Selection Recommendation

The results of these three levels of review will be used to prepare a selection recommendation developed by each of the soliciting agencies. This recommendation will be based on:

the numerical score for merit from the peer review panel,
the results of the technical assessment,
the programmatic relevance and an estimated cost.

At a coordination meeting, each agency involved in supporting a proposal will present its tentative selection plan and identify proposed funding of scientists and utilization of resources described in the IAO. The participating agencies of the IAO will establish a coordinated recommendation of selection based on a preliminary allocation of shared resources in order to optimize the science return and resource utilization. Participating agencies retain the authority for proposal selection and funding decisions for IAO proposals that have been submitted to them. The agency sponsoring an investigator retains responsibility for the management of the scope, duration and performance of the investigation.

It may be more efficient or effective to form international teams of researchers addressing overlapping questions or requiring similar, limited resources, than to have individuals competing for the same samples or flight apparatus. Experience has clearly shown that such teams are best formed before submission of proposals, rather than later in the flight experiment development process.

Applicants should be aware that selection for flight is a multi-step process. Following the evaluation of flight proposals, investigators will be informed that their experiment has been selected for definition phase support. During the definition phase, the agency(ies) with responsibility for the project will interact with the investigators in order to confirm that the proposed experiment can actually be implemented. At the end of this phase, projects may be committed to flight development. Selected flight experiments will be reviewed periodically and may be deselected based upon the policy of each agency.

2.0 Flight Opportunities Available for Microgravity Research

Proposals for space flight experiments for the time period spanning Station assembly and the first years beyond assembly complete (approximately 2002-2006) may be submitted. All proposals must address one or more of the research programs and emphases defined in the sponsoring agency(ies) research solicitation.

It is expected that the majority of experiments selected will be performed on the International Space Station (ISS). A small number of opportunities may exist for experiments that do not require ISS resources and can be accommodated in the Space Shuttle.

The investigator should allow for flexibility in selecting the best hardware to be used to accomplish the experiment goals. Reference sources for information on specific hardware items are listed in Section 3.

Research opportunities will be available during the construction phase of the ISS. Experiments with few or simple requirements have the greatest potential for selection during this time frame.

Research selected for the period following the completion of the ISS will have more extensive resources available. After assembly complete, the ISS laboratories will be more extensively outfitted for research. Capabilities will be introduced over several years. Research facilities and apparatus, for which proposals are solicited, are listed in Section 3.

3.0 Flight Research Capabilities

Information on all the facilities and experiment unique equipment offered through this announcement is available at: http://www.science.sp-agency.ca/K3-IMSPG(Eng).htm. The following is a summary of facilities and equipment planned for ISS utilization and offered through this announcement.

Some facility descriptions on the internet include a form that allows for the assessment of the suitability of this facility for performing the proposed experiment. When provided, a completed copy of this form will be used in the technical evaluation of your proposal.

ASI Research Apparatus

GLAD G-Level Analysis Drawer

The presence of the unavoidable residual-g on the ISS, which depends on the distance from the center of mass of the platform (gravity gradient and centrifugal acceleration), and on other external forces (e.g the aerodynamic drag and the solar pressure) may have a large impact on microgravity experiment sensitivity, resulting in undesired effects able to spoil completely the results.
GLAD is a Multi-user Italian Facility conceived to study the effects of the experiment orientation with respect to residual-g on board the ISS. It allows to evaluate the effects of the residual-g vector on simple microgravity study cases and to establish if highly accurate numerical models can be utilised to predict the acceleration effects on future experiments on the ISS. The facility is conceived as a rotating support, oriented at a given angle wrt the residual-g vector, on which dedicated experiment containers can be hosted. It is designed as a standard 8PU Drawer to be allocated into the U.S EXPRESS Drawer Rack as well as in the European one and can accommodate different Test Containers (TC). The exchangeable test containers are stored into a passive 4PU Drawer. A detailed description of the facility is available at: http://www.marscenter.it/asi/glad/html.

CNES Research Apparatus

DECLIC material sciences and fluid physics facility

DECLIC is dedicated to the physics of transparent media in general and to model material sciences and near-critical and supercritical research in particular. It is accommodated into two lockers of an express rack structure (2 x 32 Kg), its electrical power is 200 W, the video transmission for telescience works at 1 kHz, telemetry 4Mbps and telecommand 1 kbps. The crew time needed per experiment is 15 minutes in average. The experiments are performed into dedicated experimental containers 400 x 200 x 200 (mm) (average weight 15 Kg) that are inserted into the facility. The available optical diagnoses are: direct observation (∅ light beam = 12 mm spatial resolution = 10 µm), microscopy (∅ observation = 1mm, spatial resolution = 1 µm), grid observation (∅ observation = 1 mm, spatial resolution =10 µm), immersed microscopy (∅ observation = 1 mm, spatial resolution =5 µm, light transmission measurement (accuracy 1%) small angle scattering (13° angular resolution 2 m. radian), interferometry (∅ observation = 12 mm, spatial resolution =25 µm), phase shift interferometry (∅ observation = 12 mm, spatial resolution =1 µm); pressure measurements, from 0 to 500 bars DC to 10 kHz. Thermal diagnoses performances depend on experiments. For example the set point temperature stability for near –critical fluids studies, is ± 30 µK from 25 C to 70 C, and it is ± 31 mK from 300 C to 600 C; for directional solidification studies it is ± 0.1 K from –20 C to 150 C.

CSA Research Apparatus

ATEN furnace for the ISS

ATEN (the Advanced Thermal ENvironment) is a furnace designed to meet a wide range of scientific requirements. It will allow investigators to do fundamental studies (diffusion, Ostwald ripening, particle migration) as well as improving material processing techniques to grow semi-conductors, ceramics, and glasses of better quality. ATEN will be the size of a Standard Middeck Locker (MDL) and will be mounted on the Microgravity Vibration Isolation Mount Base Unit (MIMBU) that will be used to isolate ATEN from any vibrations, which would affect the experiment. The facility will contain one furnace core, a rapid cooling block and a sample cartridge system with an automated loading system to reduce handling by the crew. ATEN will be able to process samples up to 10 mm in diameter and 80 mm in length. The furnace will operate in isothermal mode at temperatures varying from 100ºC to 1300ºC and in temperature gradient mode with a gradient varying from 5ºC/cm to 50ºC/cm. The facility will also provide melt zone mode. The facility will allow the temperature to be regulated to a precision of ±0.25 % at high temperature and controlled to a precision of ±1ºC. ATEN will be remotely controlled from the ground or directly from space. Ground units will be made available to scientists for ground base experiments and mission preparation.

MIMBU Microgravity-vibration Isolation Mount Base Unit

The MIMBU is a research support facility, housed in a double middeck locker in an EXPRESS rack, for experimental payloads on the size of an ISS middeck locker. It provides g-jitter isolation, as well as, controlled g-inputs into the experiments for their study. It is counter balanced for experiments needing large g-inputs during the microgravity period of the ISS. MIMBU will be visited by many types of experimental facilities. It provides common services such as power, data collection and analysis, as well as, control of the experiment if required. These services reduce duplication within the experimental facilities, making them lighter, smaller and cheaper. Direct feed-through from the experiment facility to the EXPRESS rack, bypassing MIMBU is also possible. MIMBU offers an enclosure which will limit heat losses from the payload to the cabin and protect the payload which is attached to Stator (non-isolated region) and removable for large facilities on flotor. Open for use by ISS partner's facilities. To be housed permanently on the ISS.

DLR Research Apparatus

FMF Float Zone Furnace
The Float Zone Furnace with Rotating Magnetic Field (FMF) represents a heater insert for the Materials Science Laboratory (MSL) of the ISS. It is dedicated to crystal growth experiments and can create a floating zone with a maximum temperature of 1500°C. The heater design sustains the formation of adjacent gradients in the range of 5-25 K/cm (for Si).

FMF consists of 7 heating zones whose temperature can be individually adjusted and controlled. By using optical fiber sensors for temperature control the temperature stability is better than ±0.02 K. Due to the implementation of graphite diffusors the azimuthal temperature distribution for each zone is better than 1°C. The height of the molten zone will be visualized during processing. The flow field in the molten zone can be influenced by applying a rotating magnetic field (5-400 Hz) with a maximum induction of 5 mT. The furnace is mounted on a very stable, low-noise drive unit which allows for a pulling length of 120 mm with a rate adjustable from 0.8 mm/d up to 10 mm/min. Cartridge rotation is possible.

The cartridge design relies on the utilization of transparent ampoules (quartz or sapphire). The facility allows for processing samples up to a diameter of 20 mm. FMF supports a high-vacuum processing environment and a 200 mbar Ar atmosphere.

FMF is currently designed/breadboarded by DLR and planned as its facility contribution for a NASA selected flight experiment to be performed in the MSL (ESA) as part of the MSRR-1 (NASA) in the US Lab. The availability is planned for 2003.

IMPF Plasma Facility

The International Microgravity Plasma Facility (IMPF) introduces a new concept for plasma research in space. Its purpose is to provide flexible and diversified possibilities for fundamental research as well as applications. The design is modular, with the "support equipment" able to service a number of "research platforms", which can be exchanged. The main research area is "complex plasmas" (multicomponent plasmas containing ions, electrons, charged microparticles and neutral gas), with the emphasis on measurements at the kinetic level on such topics as strong coupling phenomena, liquid and crystalline plasmas, phase transitions, interfaces and surface phenomena, waves, shocks and global modes, homogeneous, inhomogeneous and anisotropic systems, transition to turbulence etc. In the more applied studies, topics such as particle growth, coagulation, disagglomeration and surface treatment of microparticles - amongst others - are envisaged.

The predecessor of IMPF is the Plasma Crystal Experiment (PKE) facility developed by DLR. PKE will be operational on the Russian Service Module in late 2000 for one year exploitation as a cooperative effort with RSC Energia and ROSAVIAKOSMOS.

After completion of a feasibility study on IMPF DLR is currently funding the predevelopment of critical subcomponents. The facility is designed for accommodation onboard the ISS in different station modules. ESA is planning an accommodation study of IMPF for its own facilities.

The IMPF flight hardware development is under consideration as a common effort by several parties beginning in 2002/2003.

ADL Advanced Disc Laser System

The Advanced Disk Laser (ADL) is a modular, pulsed, all solid state laser system which combines high laser output energies of several tenths of millijoules with high repetition rates in the kilohertz range. In combination with an intensified high speed camera system spatially and temporally resolved diagnostics of combustion processes and of flow dynamics can be performed. The system supplies spectrally narrowed radiation in the near infrared (NIR), visible (VIS) and ultraviolet (UV) spectral region.

To enable the application in different spectral regions the tunable NIR radiation of the laser source is converted by harmonics generation in nonlinear optical crystals. The laser system is applied for planar laser induced fluorescence (PLIF) measurements of combustion relevant species as e.g. OH, NO, O_2, CHO or HCHO. Additionally established laser diagnostic techniques as Raman-, Mie- and Rayleigh-scattering, laser induced incandescence (Lll) or particle imaging velocimetry (PIV) become available. Besides species and velocity fields also temperature distributions can be detected.

The robust laser system is designed for research in the Combustion Integrated Rack (NASA) but also for experiments in drop towers and parabolic airplane flights. Because of the modular design the laser system performance can be adapted to special experimental requirements.

The disc laser as the core element of the new diagnostic system is under development by DLR. The complete module is planned to be available for the ISS in 2005.

Advanced TITUS

Advanced TITUS is a new, modular multi-user facility designed for a wide spectrum of materials science experiments (solidification dynamics, crystal growth, thermophysical properties, etc.). Its concept and design are based on the experiences from the predecessor TITUS on board MIR since 1995.

The main features are plain technical interfaces to the ISS, in the first configuration 9 individually controlled heater segments with a maximum heater temperature of 1500 °C, and a dedicated laptop for process control, data storage, re-programming of process parameters, and telemetry link. A 3-axis acceleration measurement of the µg environment is provided throughout operation.

The facility is sub-divided into a furnace and an electronic module. The furnace module can be located conveniently within the ISS and oriented with respect to the vector of residual gravity to minimize its influence. Heater assembly, sample cartridge, cartridge fixation and feeding unit are insulated against µg disturbances. The modular concept allows for exchangeable subunits for various diagnostic techniques and heater inserts.

Advanced TITUS is planned as a DLR development for the Russian research modules of the ISS. So far DLR has developed a technological model for laboratory experiments.

ESA Research Apparatus

MSL Materials Sciences Laboratory

The MSL aims to support priority areas of microgravity research: solidification physics, the measurement of thermophysical properties of materials and crystal growth. ESA's MSL furnace facility will be located in NASA's Materials Science Research Rack in the US Laboratory Module of the ISS. The MSL-Electro Magnetic Levitator is developed cooperatively with DLR and will be located in ESA's Columbus laboratory.

LGF Low Gradient Furnace insert
This will be the first European furnace insert in the MSL and is developed to support research in the field of Bridgman crystal growth. The LGF consists of two heated cavities separated by an insulating, "adiabatic" zone. It is intended to provide restricted but well-controlled gradients between two stable temperature plateaux. Crystal growth is performed by translating the furnace over a stationary sample; thermomechanical stresses in the grown crystal are minimised by maintaining the solidified part of the sample in the heated cavity throughout processing. Alternatively, the insert can be used for thermodiffusion experiments by keeping the furnace stationary and using only the gradient capability. Isothermal experiments can also be carried out with suitable sample/cartridge configurations.

SQF Solidification and Quenching Furnace insert
This is the second European furnace insert. The SQF consists of a hot cavity separated from a water-cooled cooling zone by an insulating "adiabatic" zone. It is primarily intended for metallurgical solidification research under steep temperature gradients, with the possibility of quenching the solidifying interface at the end of processing (by quick displacement of the cooling zone). Directional solidification is achieved by translating the furnace over a stationary experiment cartridge. High gradients are established by coupling the cartridge to the cooling zone with a liquid metal contact. The furnace is re-configurable to different sample diameters and gradients by exchange of the components providing the adiabatic zone.

MSL-EML Material Science Laboratory - Electro-Magnetic Levitator
The Materials Science Laboratory – Electro-Magnetic Levitator (MSL-EML) is an ISS experiment platform for investigations on solidification phenomena and for the measurements of thermophysical properties in metallic and possibly semiconductors melts. The samples can be containerlessly processed in ultra-high vacuum or high-purity gas

atmospheres and at temperatures ranging from about 400 °C to 2400 °C. This is important for reactive sample materials, the properties of which are sensitive to contamination. Solidification speeds can be measured from different undercoolings by inducing heterogeneous nucleation and observing the pyrometer signal with time resolutions up to 1 µsec. Thermophysical properties can be measured in stable and undercooled melts over wide temperature ranges. These properties include surface tension, viscosity, heat capacity, melting enthalpy, electrical conductivity, thermal expansion and volume increase with melting. The MSL-EML capitalises on the experience acquired on Spacelab flights with the TEMPUS facility, during which most of these capabilities were demonstrated. For the ISS a modular design concept is adopted which encompasses exchangeable experiment inserts where all these capabilities are maintained, with enhanced accuracy and over longer term operation. These experiment inserts accommodate 15 individual samples and will serve as sealed transport container as well as in-orbit processing chamber. They can be adapted to specific user requirements and could potentially accommodate new diagnostics and stimuli. The MSL-EML is a cooperative ESA/DLR development and will be hosted in the COLUMBUS laboratory. Its availability is planned for 2004.

FSL Fluid Science Laboratory

The FSL is a multi-user research facility dedicated to investigations in fluid physics under microgravity conditions. It can be operated in a fully automatic or semi-automatic mode on the station by the flight crew or remotely controlled from ground in the so called tele-science mode. The design concept of the FSL facility is based on user requirements as well as the Space Station utilisation requirements and constraints. This essentially resulted in a highly modular concept allowing for continuous upgrades of the system capabilities throughout its operational life-time. The central element to the FSL is the Facility Core Element comprising the Central Experiment Module with the dedicated Experiment Container (EC) and the Optical Diagnostics Module which carries the equipment for optical diagnostics, related control electronics and accommodates Front Mounted Cameras (e.g. High Speed, High Resolution, Infrared). Different types of interferometric measurements can be performed, including Electronic Speckle Pattern Interferometry, Differential Interferometry and Holographic Interferometry. In addition a Schlieren observation mode is available. The implementation of a Microgravity Vibration Isolation System and of digital holography are considered.

FSL Experiment Container for investigations on Aqueous Foams

A modular Experiment Container (EC) devoted to investigations on Aqueous Foams in the Fluid Science Laboratory (FSL) is studied. It will address both liquid drainage in foams and foam bubble stability.

In this EC, columns of foams will be produced with high liquid fraction and the propagation of a liquid front generated by forced flow or capillary forces will be accurately measured. The liquid distribution in the foam will be analysed by a novel method. Other experiments will focus on the physico-chemical understanding of the mechanisms that affect foam film rupture. The fluid motions in the liquid films between foam bubbles and the motions at the liquid-gas interfaces will be quantitatively investigated.

In addition to the liquid front analysis method implemented in the EC, the various optical diagnostic tools of the FSL will be employed.

FSL Experiment Container for investigations on Emulsions

Complementary to the facility addressing this topic above, this modular experiment container for the FSL will enable investigations on drop/drop interactions and diluted emulsions as well as investigations on concentrated or opaque emulsions and on phase inversion.

The EC will allow using the optical diagnostic tools of the FSL to study drop/drop interactions, droplet size evolutions, droplet motions, as well as their aggregation and coalescence in diluted, transparent emulsions. Specifically for diluted emulsions droplet-freezing temperatures will be studied by cooling emulsions in specific steps and monitoring the number and the sizes of droplets freezing at each step. Analogously also a stepwise heating of frozen emulsions while monitoring the number and sizes of melting droplets will be possible.

Furthermore, the EC will allow experiments that aim at analysing phase inversion mechanisms in emulsions using Differential Scanning Calorimetry (DSC) and Conductometry. During cooling and heating emulsions, the DSC method will serve to analyse heat flow rates in the emulsions in comparison to a reference sample.

Since the conductivity of specific emulsions depends on their droplet size distribution, Conductometry allows experts to investigate the transition from the dispersed to the matrix phase. A dedicated experiment container will therefore represent a Micro-Calorimeter being useful for general investigations on phase transition phenomena, with a high potential to serve as a multi-user facility.

FSL Experiment Container for investigations on Convection and Interfacial Mass Exchange

This dedicated FSL EC will allow studying mass transfer processes through interfaces and their coupling with surface-tension driven flows and instabilities that affect mass and energy transfer. The interfaces the facility will be primarily addressing will be those of evaporating pure liquids and evaporating multicomponent liquids.

Studies on the coupling between evaporation and convection are relevant for heat-pipe grooves and thin-film evaporators. The first set of experiments that are planned to be integrated in this modular EC will evaporate fluid volumes while fluid surface deformation and local temperatures will be measured and effects of Marangoni convection studied.

The facility will allow an automatic and telescience mode.

FSL Experiment Container for investigations on Fluid Motions in Spherical Gaps

This FSL EC will be devoted to study in microgravity fluids between rotating spherical gaps. The facility consists basically of a sphere that is surrounded by a sphere shell that forms an equilibrium gap with the sphere. The modular EC offers a set up in which the inner and out sphere are either rotating with the same or different velocities. Various gap sizes will be offered as well as various rotation speeds. Additionally the inner and out sphere are independently temperature controlled making temperature gradients over the gap possible. A high voltage at the level of about 0.5 kV allows simulations of fluid motions under concentric forces, such as geophysical fluid motions.

Facility for investigations on Interactions in Cosmic and Atmospheric Particle Systems

The objective is to investigate the various interaction processes of small solid and liquid particles with an ambient gaseous atmosphere, with electromagnetic radiation, and with other particles in their vicinity. The fundamental mechanisms to be addressed are important for understanding a large number of physical phenomena such as the light-scattering properties of particulate media and the aggregation of dust particle, aerosols, the interaction of particles with growing ice crystals. This research relates to the formation of planetary systems, the surface properties of low-gravity Solar System objects, such as comets and asteroids, the behaviour of airborne aerosols and their effect on clouds, rain formation, dust storms, and climate. Composition, albedo, size distribution will be derived from light scattering measurements.

The facility is considered for the European Drawer Rack. ESA will investigate the feasibility of combining it with the Microgravity Plasma Facility studied by DLR.

Facility for investigations in Plasma Physics

This facility will back a scientific programme to study the physics of plasmas in the strong-coupled regime (where electrostatic forces between particles are much greater than any thermal effects). Condensed plasma states (liquid and crystalline) can be achieved by using ionised colloidal particles. This facility will serve investigations in fundamental new physics, and related applications. Technical studies have already been initiated by DLR and synergy with the development of the Facility for investigations on Interactions in Cosmic and Atmospheric Particle Systems will be exploited.

PCDF Protein Crystallisation Diagnostics Facility

The PCDF will be installed in the European Drawer Rack (EDR) in ESA's Columbus Laboratory. This new instrument focuses on understanding the nucleation and crystallisation processes and the influence of gravity thereon. It will enable the monitoring of these processes over long periods in microgravity using advanced diagnostics instruments (light scattering, high resolution video and phase shift interferometry). In turn, each individual reactor is provided with temperature and solution composition control to enable the scientists to control the process. PCDF basically consists of two drawer units, a process unit, including the process chamber with the crystallisation reactors and an electronics unit accommodating the main controls and support systems for the performance of experiments.

Facility for investigations on Metallic Foams

A facility for investigating metallic foams is studied for either the European Drawer Rack (EDR) or alternatively, the Materials Sciences Laboratory (MSL) as a low temperature furnace insert. The facility will consist of a furnace that allows processing of metal powders above their melting temperature. The maximum achievable temperature will be at least 700 deg.C. The facility will encompass a system for controlling the injection of bubbles in the molten material. In the case of a drawer accommodation, a cartridge exchange mechanism will be used which enables the consecutive processing of up to 6 different cartridges. The experiment scenario includes holding the foamed material molten over various durations, followed by a controlled directional solidification process, including the possibility of varying the solidification rate. Magnetic and electric fields will serve as tools to control the bubble distribution during the period over which the foamed material remains molten. Diagnostic tools will enable investigators to monitor the foaming process and investigate bubble stability and coarsening. This includes tools to analyse the structure of non-transparent materials in the liquid and the solid state.

Drawer facility for investigations on Magnetic Fluids
This self-standing drawer-type facility will be accommodated in the European Drawer Rack (EDR).
Cylindrical probes of magnetic fluids, the temperature of which can be controlled in the range of 10 to 50 deg.C will be exposed to axial and azimuthal magnetic fields of controlled strength. The diagnostic tools will enable the scientists to monitor the interactions between magnetic particle, the spatial distribution of these particles, the temperature distribution in the ferro-fluid and the thermomagnetic convection flows as a function of the experimental conditions. The facility will be designed to allow for both automatic and telescience operation mode.

Drawer facility for Diffusion and Soret Coefficient (DSC) Measurements in Crude Oils
This self-standing drawer-type facility will be accommodated in the European Drawer Rack (EDR).
The DSC facility is dedicated to measurements the diffusion coefficients of binary and ternary liquid mixtures, primarily crude oils. Each diffusion cell will first be activated under isothermal conditions to allow for interdiffusion measurements, then under various thermal gradients for thermodiffusion investigations. The sample pressures will be adaptable to realistic oil reservoir conditions ranging up to about 350 bars. The analysis of the samples is planned to be performed onboard the ISS. The facility design will allow for both telescience and automatic control mode.

Drawer facility for investigations on Emulsions (single drop or bubble)
This self-standing drawer-type facility will be accommodated in the European Drawer Rack (EDR).
This EDR facility will employ the oscillating bubble or drop technique. Gas bubbles or liquid drops are formed in another fluid, a gas or a liquid in a temperature controlled environment. Both single and double interfaces can be established to enable investigations of thin films. The bubbles, drops and thin films are then submitted to oscillations with controlled shape. The concentration of surfactant can be changed between runs. The exchange of liquids and surfactants is envisaged. Optical diagnostic tools provide for the analysis of the bubble, drop or film shape as well as of the motions in the films and at interfaces. Accurate dynamic measurement of the pressure in the bubble or drop enable investigations of surfactant effects. The facility design will allow for both telescience and automatic control mode.

Insert for NASA's Combustion Integrated Rack for investigations on the Combustion Properties of Partially Premixed Spray Systems (CPS)

ESA is studying the development of an insert for NASA's Combustion Integrated Rack primarily aiming at investigations of the vaporisation and autoignition behaviour of droplets and droplet arrays. The experiment chamber will be capable of providing controllable environmental conditions, including high pressure and temperature. Droplet ignition will be investigated in a premixed atmosphere that provides a mixture ratio below the relevant flammability limits. Investigations on the vaporisation behaviour at sub- and supercritical conditions will require an inert gas atmosphere. Another objective with this facility is to study the dependency of NO generation in combusted droplet clouds under atmospheric and increased pressure conditions on premixing and fuel vapour concentration in the gas phase. Diagnostics to investigate effects originating from slip-velocities between droplets and gas are also considered.

NASA Research Apparatus

QMI Quench Module Insert
The Quench Module Insert provides for unique rapid quenching of the solidification interface. This insert is a Bridgman type furnace with an actively cooled cold zone and gas quenching capability. The maximum temperature accommodated is 1400°C and helium is used as the quench medium. Gradients of up to 100°C/cm are required. An experiment-specific electronic package for resistance measurement is included. The MI envelope is 22 cm in diameter and up to 62 cm long depending on the translation stroke. The furnace is planned to operate in a partial pressure gas environment. Key processing operations include sample melting and rapid quenching of the solidification interface.

DMI Diffusion Module Insert
The Diffusion Module Insert provides both precision isothermality in the heated zones and axial gradient between the zones to accommodate diffusion studies using the shear cell method. The DMI is a Bridgman type furnace insert designed for processing temperatures up to 1600°C with good isothermality and controllability. The isothermal zone length is approximately 10 cm. An adiabatic zone is used between the heated zones to achieve the desired axial gradient of up to 100°C/cm. Furnace translation capability is also provided. Both Fickian and Soret diffusion experiment can be carried out using a shear cell in which the diffusion process is allowed to occur inside the capillary tubes and the experiment is terminated by the shearing of the cell. The MI envelope is 22 cm diameter and up to 62 cm long depending on the translation stroke. The Diffusion Module Insert will nominally operate in a vacuum environment

SDLE/TPP Self-Diffusion in Liquid Elements/Thermophysical Properties Experiment Module
This experiment module is envisioned as a self contained, semi automatic, sealed, and multiple temperature apparatus. All furnace components, samples, sample exchange

mechanism, electronics/microprocessors are within or on the sealed experiment container. The SDLE experiment container is divided into a processing volume and a non-processing volume. The experiment container will provide for either a vacuum or an inert gas environment surrounding the measurement cell. The Experiment Module diffusion sample cartridge container will be designed to be changed out on-orbit to accommodate multiple runs of up to 5-10 samples each. Processing temperatures up to 1400°C can be achieved.

HGDS High Gradient Directional Solidification Furnace Experiment Module
The HGDS will be a directional solidification furnace supported by its own subsystems for operation. The module is designed to support studies involving crystal growth processes, segregation in alloys and interface pattern selection criteria. The furnace can accommodate processing temperatures up to 1600°C and includes a reconfigurable gradient zone length from 1 to 5 cm in order to be able to achieve an axial gradient of 50 to 150°C in the sample. The processing atmosphere can be either inert gas or vacuum. A precise translation drive is provided. Quench capability from either water or gas or phase change collet will be provided to achieve quench rates up to 100°C/sec in the sample. An automatic sample exchange capability (up to 20 samples) with provision for crew interaction is provided. Sample size up to 2 cm in diameter and 20 cm long can be accommodated. Higher gradient, accommodation of larger size samples, provision of an automatic sample exchange capability distinguishes this furnace module from the Quench Module Insert.

DSVT Directional Solidification and Vapor Transport Experiment Module
This Experiment Module provides capabilities for both directional solidification and vapor transport crystal growth processing. In addition, it will provide current pulse interface demarcation, very precise and extremely low translation rates, and in situ optical measurement features. The furnace can accommodate processing temperatures up to 1400°C and includes a reconfigurable gradient zone length from 1 to 5 cm. The processing atmosphere can be either inert gas or vacuum. A very precise and extremely low translation (0.028 to 0.058 µm/sec) drive is provided. An automatic sample exchange capability (up to 20 samples) with provision for crew interaction is also provided. The sample will be contained in ampoules housed in special cartridges to obtain a single level of containment. Sample size up to 2 cm in diameter and 20 cm long can be accommodated. Programmable current pulses up to 100 A are required. Video capability includes resolution comparable to NTSC TV at a frame rate of about 1 per second.

Suspension Research Apparatus
A couette cell is being developed to study the flow of bubbly suspensions. The couette device is 30 cm high, with an outer cylinder diameter of 30cm and gap-thickness of 3 cm. The outer cylinder is capable of rotating at variable speeds (up to 100 rpm), while the inner cylinder remains stationary. Bubbles are introduced into the couette cell at gap-averaged volume fractions ranging from 0.1 to 0.2. The bubble diameters vary from 2 to 3 mm and are uniform within 10% of the mean bubble radius. The instrumentation consists of hot wire probes to measure liquid velocity and the bubble collision rate, wall shear stress probes, and photography to visualize the flow cell.

LMM Light Microscopy Module

The LMM is currently under development for several colloid science investigations. The LMM will include a fully remotely-controlled, up-right microscope containing a video microscopy system that includes variable magnification optics, video camera, and color illumination sources. The system will be capable of resolving down to 0.5 micron structures within thin cell samples of approximately 100 microns thick. The LMM will also be employing light scattering techniques (Bragg, Dynamic Light Scattering, Static Light Scattering) to provide data on crystal growth and dynamics. The means for handling multiple samples will be included, to permit sample manipulation and change-out of test samples. The sample system will also contain a homogenizer to provide for a homogenous sample before the growth cycle begins. A confocal optics attachment may be included to improve resolution of the focal plane and to aid in the construction of 3-D imaging of the crystalline structures. The use of LASER Tweezers during real-time operations to manipulate and capture sample particles to affect crystal growth possibly may be included.

Granular Flow Apparatus

A shear cell is being developed to study an aspect of particle segregation important in reduced gravity. In this device, bumpy frictional boundaries in an oval channel will be used to control the energy of particle velocity fluctuations in the fully-developed flow in the straight sections. The device is approximately 34 inches long, 9.5 inches wide and 6.6 inches high. Cross section of the flow area is about 2.5 cm. by 4 cm. The outer boundary is stationary, while the inner boundary is capable of being driven at speeds up to at least 1 meter/second. Various material and size particles can be used. The instrumentation consists of temperature, tachometer and acceleration probes, as well as photography to visualize the flow at a window located along the straight section.

Pool Boiling Apparatus
An apparatus suitable for a variety of pool boiling investigations is being developed. It consists of a pool boiling chamber, with an envelope measuring 35 cm x 35 cm x 75 cm, several imaging cameras and light sources, a nitrogen fed pressure control system and bellows, a stirrer, a smooth silicon surface over a microheater, and cooling system. A computer controller is used to regulate the temperature of the boiling surface and the bulk fluid. The temperatures in the pool, as well as on the backside of the silicon wafer are measured using thermocouples. The variation of the temperature in different parts of the pool held to within ±0.2°C of the mean temperature. The system pressure above the liquid pool is measured with an accuracy of ±0.5 kPa. The hardware has a video imaging system that will operate at a frame rate of 10-50 fps. The addition of a holographic interferometer for temperature distribution measurements around the bubble is being contemplated.

Physics of Colloids in Space Apparatus
The PCSA apparatus is designed to study colloidal systems with light scattering diagnostics. The apparatus can study fractal phenomena, growth of super-lattice structures from binary (two-component) solutions of hard-sphere colloidal particles, and behavior of polymer-colloidal mixtures (e.g. depletion flocculation). It also has applications in studying a wide range of fundamental problems in colloid physics, physical chemistry, chemical physics, materials science, and biological fluids. The PCSA provides four basic diagnostic measurements. These include non-invasive dynamic light scattering (DLS), static light scattering (SLS), Bragg scattering, and rheological measurements. The light scattering measurements are provided by two Nd-Yag lasers (maximum incident power of 40 mW) and either avalanche photo diodes or digital cameras for scattered light detection/measurement.

MDCA Multi-user Droplet Combustion Apparatus
The MDCA design is strongly based upon the NASA Droplet Combustion Experiment design, with requirements influences of other droplet investigations being added to enable completion of multiple investigator-specific conditions. The MDCA deploys and ignites fuel droplets ranging from 1 mm to 5 mm. Multiple viewing angles (back lit and dark field) are supported. The droplets are freely deployed or deployed onto a fiber. The fiber tether method restrains the droplet from drifting, allowing higher resolution imaging, though with some loss of droplet uniformity. The MDCA is planned to conduct four current investigations as first user of the Combustion Integrated Rack (CIR) system.

FEANICS Flow Enclosure Accommodating Novel Investigations in Combustion of Solids
The FEANICS design is based on a series of thin and thick fuel solids combustion investigator requirements. The FEANICS apparatus accommodates both quiescent and flow conditions. Flows ranging from near quiescent to 200 mm/sec are provided. A carousel sample-changeout arrangement is implemented for thick fuel samples, minimizing CIR chamber openings. Thin fuels can be dispensed at the centerline of the chamber in a single sheet form or on a continuous roll. Depending on the fuel type, a

variety of diagnostic views are available including fuel surface and fuel edge views. The FEANICS apparatus is planned to be the second microgravity science system to use CIR.

LTMPF Low Temperature Microgravity Physics Facility

The LTMPF superfluid helium dewar maintains a base temperature pre-selected at between 1.6 K to 2.0 K for a period of approximately five months. The dewar insert (the instrument) is configured to accommodate two experiments. It consists of two sets of thermal-mechanical platforms called probes. Attached to each probe are the experiment unique cells and sensors. Both probes and experiment hardware occupy a cylindrical volume 19 cm in diameter and 70 cm long. The weight for both sets of experiment hardware attached to the probes (but excluding the probe mass) is 12 Kg or less. Electronics are built on a modular VME chassis with up to 42 slots for electronic boards. High-resolution temperature and pressure sensors have been developed based on Superconducting Quantum Interference Device magnetometers. These high-resolution thermometers have demonstrated sub-nano-Kelvin temperature resolution in past space experiments. Other instruments include resistance thermometers, precision heaters, capacitance bridges, precision clocks and frequency counters, gas handling systems, and optical access capability. An onboard flight computer controls all facility and instrument electronics, all ISS interfaces, command, telemetry, and data storage during on-orbit operations.

LCAP Laser Cooling and Atomic Physics Hardware

To support future flight experiments, a variety of technologies will be developed to enable space flight experiments involving Cs and Rb. A number of specific hardware packages are currently under development or are planned for development, including: Lasers - NASA is currently developing injection-locked laser systems capable of producing several hundred milliwatts of tunable, frequency stabilized light suitable for a typical Magneto-Optical Trap (MOT) or molasses experiment; Vacuum systems - Ultra-High Vacuum systems employing a combination of ion pump and getter technologies will be developed to provide vacuum capability below 10^{-10} torr; Cold atom sources - NASA is currently developing capabilities to collect atoms in a vapor cell molasses or magneto-optical trap (MOT), cool them to a temperature below 2 μK and then launch them with a moving molasses into an UHV region, such as is required for a Bose-Einstein Condensation experiment; Compact Magnetic traps - In addition to MOTs and optical molasses, NASA will also develop compact magnetic traps of the Ioffe-Pritchard type suitable for BEC experiments; Raman-cooling laser systems - a laser system suitable for driving Raman transitions in cesium is a planned future development for a Raman-cooling experiment or for an atom interferometer.

NASDA Research Apparatus

GHF Gradient Heating Furnace
The GHF is an experiment facility for investigating crystal growth and gaseous phase growth of semiconductors. The GHF is a multiuser furnace, consisting of the Material Processing Unit (MP), which directly operates the heating and cooling process of samples; the GHF Control Equipment (GHF-CE), which controls the overall operation of the GHF and communications with ISS; the Sample Cartridge Automatic Exchange Mechanism (SCAM), which can automatically exchange up to 15 samples cartridge; and the SCAM Control Equipment (SACM-CE). The MP has three independent heating zones that can provide various temperature profiles to the sample in accordance with the experiment requirements under vacuum conditions. In order to conserve crew resources on orbit, the sample cartridge is automatically exchanged by the Sample Cartridge Automatic Exchange Mechanism (SCAM). Ten channel thermocouples allow measurement of the sample temperature distribution.
Availability will be May 2005 after ISS assembly complete.

AFEX Advanced Furnace for microgravity Experiment with X-ray radiography
The AFEX can perform single-crystal growth experiments by the Floating Zone method. AFEX is a multiuser image furnace which has the capability of in-situ observation of semiconductor crystallization and Marangoni convection by using X-ray radiography. The AFEX has a gold-plated ellipsoidal mirror. The sample placed in one focus of the mirror is heated and melted by the radiation from a 1500W halogen lamp, placed in another focus. With ceramic heaters attached around the sample, instead of the halogen lamp, the AFEX can perform isothermal heating experiments and thermal gradient control experiments. X-ray radiography (two axes), a sample monitor camera, an infrared thermometer, and five channel thermocouples allow observation and measurement of the samples.
Availability will be May 2005 after ISS assembly complete.

FPEF Fluid Physics Experiment Facility
The FPEF is used to conduct fluid physics experiments in a moderate temperature environment. In the microgravity environment, Marangoni convection, which is driven by the difference of surface tension, affects the behavior of convection. The main purpose of this facility is to investigate the effects of the Marangoni convection on space experiments (such as semiconductor crystal growth in the Floating Zone Method). Observing the Marangoni convection is considered to be a prerequisite for future techniques such as controlling Marangoni convection and applying Marangoni convection to remove air bubbles in liquids.

The FPEF's observation capabilities include two/three dimensional flow field observations, surface temperature measurement, ultrasonic velocity profile measurement and surface-flow rate observation. Currently, Marangoni convection research with a liquid bridge is supposed as standard experiment, and suitable experiment units are being developed for that purpose. Bubble generation, heat transfer, liquid wettability, combustion and bubble behavior experiments are considered as feasible experiments using FPEF.
Availability will be May 2005 after ISS assembly complete.

SPCF Solution Protein Crystal Growth Facility
The SPCF can provide opportunities for fundamental study of crystal growth of various solutions and proteins in space. SPCF consists of two major units, the Solution Crystallization Observation Facility (SCOF) and the Protein Crystallization Research Facility (PCRF).
The SCOF has a cell cartridge for growing the crystal in solution. The temperature of crystal can be controlled. Moreover the SCOF provides the in-situ observation capability. The SCOF has several observation equipment, the two wavelength Mach-Zehnder interferometer microscope, the Michelson interferometer microscope and the light scattering measurement. They provide the capability to observe the crystallization morphology and the crystal surface and to measure the temperature of the liquid phase, the concentration distribution and the particle size.
The PCRF realize the protein crystal growth with real-time observation by CCD camera. Simultaneously, up to six protein crystal growth cartridge can be installed and can be selected with each arbitrary temperature profile. The sample cartridge could be designed to contain several cells. These two units can be operated independently as two separate facilities.
Availability will be May 2005 after ISS assembly complete.

4.0 International Application Forms and Instructions for Proposal Preparation

This section contains the general instructions for proposal preparation and the specific forms required by proposers responding to agency solicitations for flight experiments in the microgravity sciences IAO for 2000. The forms at the end of this section include the following:

Form A	Solicited IAO Application
Form B	Proposal Executive Summary
Form C	Signature Page
Form D	Biographical Sketch
Form E*	Other Support
Form F*	Detailed Budget, First Year
Form G*	Summary Budget Projection
Form H	Distribution List
Form I	Checklist for Proposers

*Refer to your agency's solicitation for any specific requirements.

<u>Instructions for Proposal Preparation</u>

The proposal must include the following material, in this order:

(1) Cover Page: Solicited Proposal Application (Form A)
(2) Proposal Executive Summary (Form B)
(3) Project Signature Page (Form C)
(4) Distribution List (Form H)
(5) Project Description
(6) Management Approach
(7) Letter of Assurance of Foreign Support (if applicable)*
(8) Biographical Sketch (Form D)
(9) Other Support (Form E)*
(10) Supporting Budgetary Information (if applicable)*
(11) Detailed Budget, 12 Month (Form F)*
(12) Summary Budget Projection (Form G)*
(13) Facilities and Equipment
(14) Any other information required by the sponsoring agency*
(15) Checklist for Proposers (Form I)
(16) Appendices, if any
(17) Computer diskette (3.5 inch, Macintosh or PC format) containing an electronic copy of the principal investigator/team coordinator's name, address, telephone and fax numbers, e-mail address, and the complete project title and executive summary as provided on Form B.

* - Refer to your agency's solicitation for any specific requirements.

Proposals must be written in English. The Project Description Section is limited to 20 pages. Any pages in this section beyond 20 will not be reviewed. The name of the Principal Investigator should appear in the upper right hand corner of each page of the proposal, except on the Forms in this Document where special places are provided for this information. Note that the proposal <u>must</u> specify the period of performance for the work described; periods of performance may be for any duration up to three (3) years but should be suitable for the project proposed.

4.1 Cover Page: Solicited IAO Application (Form A)

All of the information requested on Form A must be provided. The cover page should contain the project title, name and address of the submitting institution, the name, address and telephone number of the principal investigator/team coordinator, and the names and institutions of any co-investigators/team member. Proposers should refer to agency specific solicitations for instructions regarding additional information which should be included on the cover page(s).

4.2 Proposal Executive Summary (Form B)

The information requested on this form is essential to the review of the proposal. It determines how the application will be evaluated and which agency manager(s) will receive the final review materials for possible inclusion in one of the research programs of the agency.

4.3 Proposal Signature Page (Form C)

By signing this page, the primary participants in the research activities being proposed indicate their commitment to the proposed project. Other signatures may be required, on other forms, by the various agencies participating in the IAO. See the solicitation released by the agency to which you are responding to confirm that you are meeting their requirements.

4.4 Biographical Sketch (Form D)

A short biographical sketch of the Principal Investigator that includes his or her current position title and educational background, a list of principal publications, and a description of any exceptional qualifications must be included. Use Form D to describe the research and professional experience of each professional staff member. Concluding with present position, list, in chronological order, previous employment, experience, and honors. Include present membership on any government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. Do not exceed two pages. Omit personal information which does not merit consideration in evaluation of the proposal. Provide similar biographical information on other senior professional personnel who will be directly associated with the project. Provide the names and titles of any other scientists and technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants, together with information as to their level of academic attainment. Any special industry-university cooperative arrangements should be described.

4.5 Project Description

The length of the Project Description section of the proposal should not exceed 20 pages using regular (12 point) type, using 8 ½" x 11" or A4 size paper. Any pages beyond 20 will not be reviewed. The proposal should contain sufficient detail to enable a reviewer to make informed judgments about the overall merit of the proposed research. The proposal should identify specific aims of the project, and demonstrate that the investigators will be able to accomplish their stated objectives with the resources requested and with their own resources. The proposal should indicate clearly the relationship between the proposed work and the research emphases defined in the agency specific solicitations. The proposal should describe the position of the proposed research in the context of the current research in the field.

4.6 Management Approach

Scientists active in the same research field may consider it beneficial to adopt a coordinated or collaborative approach to the definition, preparation and execution of space experiments. This approach is of clear relevance if the experiments require for example the development of a modular insert for one of the facilities proposed for utilisation in this IAO. In this case, the team can submit a proposal encompassing the joint definition, specification and utilisation of a dedicated insert for e.g. multiparametric investigations. Such an approach may result in a higher yield of scientific results and, thereby, an optimised scientific return on the investment made in the development and flight on ISS of any insert.

Each team member who contributes to the project must then have clearly identified in the proposal his tasks and responsibilities in reaching the global objectives set by the team. All team members must sign the signature page. The funding each team member requests from his sponsoring agency for performing the tasks he is responsible for must be clearly defined in the proposal, using the specific form of this particular agency.

A single team coordinator must be agreed by the team members. He is responsible for submitting the proposal to the IAO through the participating agency that represents him. He becomes the contact point to the whole team with the responsibility of coordinating the activities of and inputs needed from the team related to the project.

Alternatively, proposals must specify a single principal investigator who is responsible for carrying out the proposed project and coordinating the work of other personnel involved in the project. In proposals that designate several senior professionals as key participants in the research project, the management approach section should define the roles and responsibilities of each participant, and note the proportion of each individual's time to be devoted to the proposed research activity. The proposal must clearly and unambiguously state whether these key personnel have reviewed the proposal and endorsed their participation.

4.7 Facilities and Equipment

Describe the available facilities and major items of equipment specially adapted or suited to the proposed project, and any additional major equipment that will be required. Identify any government-owned facilities, industrial plant equipment, or special tooling that are proposed for use on the project. The need for items that can be typically used for research and non-research purposes should be explained.

4.8 Other Support (Form E)

This form describes the other research support currently active or pending decisions, for the principal investigator/team coordinator and other senior project scientific participants. It should be clear that the work described in the submitted proposal is new and not being supported by other sources, and that the senior scientific participants are available for their proposed time commitments. Not all participating agencies can ask for this information. Refer to your agency's solicitation to determine what information should be provided.

4.9 Detailed Budget, First Year (Form F)

4.10 Summary Budget Projection (Form G)

Not all participating agencies can ask for the information requested on these forms. Refer to your agency's solicitation to determine what information should be provided.

Direct Costs - Please detail, explain, and substantiate other significant cost categories as described below:

a) Subcontracts: Describe the work to be contracted, estimated amount, recipient (if known), and the reason for subcontracting.
b) Consultants: Identify consultants to be used, why they are necessary, the time they will spend on the project, and the rates of pay
c) Equipment: List separately. Explain the need for items costing more than $5,000. Describe basis for estimated cost. Any equipment purchase requested to be made as a direct charge under this award must include the equipment description, how it will be used in the conduct of the basic research proposed, and why it cannot be purchased with indirect funds.
d) Supplies: Provide general categories of needed supplies, the method of acquisition, and estimated cost.

e) Travel: Describe the purpose of the proposed travel in relation to the grant and provide the basis of estimate, including information on destination and number of travelers where known.
f) Other: Enter the total of direct costs not covered by a) through e). Attach an itemized list explaining the need for each item and the basis for the estimate.

Indirect Costs - Indirect costs should be explained to an extent that will allow the agencies to understand the basis for the estimate.

4.11 Distribution List Form (H)

This form indicates which agencies are being requested to support parts of the project, and therefore are receiving copies of the proposal. Every agency from which support is being requested must receive the proposal, and the proposal each agency receives must meet its requirements.

4.12 Checklist for Proposers (Form I)

One copy of a completed version of this checklist should be attached to the transmittal letter.

4.13 Appendices

Some facility descriptions on the internet include a form that allows for the assessment of the suitability of this facility for performing the proposed experiment. When provided, a completed copy of this form will be used in the technical evaluation of your proposal.

4.14 Computer Diskette

A diskette (3.5 inch, Macintosh or PC format) should contain an electronic copy, Rich Text Format, of the Principal Investigator/Team coordinator's name, address, telephone and fax numbers, e-mail address, and the complete Project Title and Executive Summary as provided on Form B.