Technical Requirements of International Space Science and Scientific Payload Competition (ISSSP)

1. Overview of Space Station Environment

1.1 Micro-gravity Environment

The Space station can provide a long-term micro-gravity environment, with a micro-gravity level (residual micro vibration acceleration) of 10^{-3}-10^{-4}g. Under the condition of the environment, phenomena, caused by the ground gravity effect, such as buoyancy convection, gravity settling, liquid pressure gradient in fluid (gas, liquid, melt) will basically disappear, and some secondary effect overshadowed by the ground gravity effect will be highlighted, resulting in significant change in fluid form and physical (chemical) process. These will directly affect or change the flow and combustion mechanism, and also affect the processing and preparation of related materials (including biological materials). In addition, micro-gravity will also have a direct effect on the experimental conditions of some fundamental physics, under which experiments can be carried out with higher indexes and accuracy to satisfy the verification of important fundamental physics theories. The survival and evolution of all living organisms (including human beings) have always been realized under the environment of gravity, and the influence of micro-gravity on organisms and their various aspects is very significant. Therefore, micro-gravity environment is a unique and valuable resource for related scientific research.

1.2 Orbital Position

The Space station runs in the near-circular low earth orbit with an inclination of 41-42 degrees and at an orbital altitude of 340-450 kilometers, circling the earth in about 90 minutes. The space station assembly is earth-oriented with three-axis stabilization the orbit of the space station is completely out of the earth’s atmosphere and located in the F2 layer of the earth’s ionosphere, which is suitable for sky-survey space astronomical observation and special space-physical research. For earth observation, the orbit of the space station covers the area within the south and north latitude 42 degrees, where 90% of the earth's population inhabit. Compared with the solar synchronous orbit adopted by general earth remote sensing satellites, the intersection local time of the space station orbit is constantly changing, enabling observation in the same area under variable light conditions. Due to the low orbital altitude, the spatial resolution of the same earth-observing instrument is higher.

1.3 Radiation Environment

Radiation comes from galactic cosmic rays and solar cosmic rays (including solar proton events). The main components of cosmic rays are protons (about 90%), helium nuclei (about 9%), and electrons, various heavy ions, gamma rays, etc. (about 1%). Cosmic rays have a wide energy range and a power-law descent in their energy spectrum (the higher the energy, the lower the flow). Due to the effect of the earth's magnetic field, space station running in low earth orbit within the range of latitude ±43° will deflect low-energy charged particles to the polar region. Only higher-energy charged particles (above about 1GeV/n) can arrive, reducing the total radiation dose. When the space station passes through the lower part of the south Atlantic anomaly of the earth's inner radiation belt, the charged particles trapped by the radiation belt have a significant effect on the space station, but the total radiation dose is not high. Solar proton events are random and can increase radiation dose significantly in a short time. Due to the protective effect of the cabin structure, the radiation measurement in the cabin is 1-2 orders of magnitude lower than that outside the cabin, but high-energy particles can still penetrate the bulkhead. Space radiation environment has certain harm to space-crafts, astronauts and equipment, but the complex composition and energy spectrum form of cosmic rays cannot be simulated on the ground, which is a favorable condition for the research of radiation biology and a necessary condition for the research of high-energy astronomical observation and particle astrophysics.

1.4 Extreme Extravehicular Environment

Some experiments, including extreme heat and cold cycles, high vacuum, atomic oxygen erosion, solar ultraviolet radiation and cosmic high-energy radiation, etc. can be conducted in space station by using the extreme conditions outside the cabin. The performance of the materials, electronics, organisms and tissues outside the cabin will be significantly affected by the outer space environment. The particular environment (and its combination) is difficult to realize on the ground, which also illustrates the uniqueness of this experimental environment.

The Space station's unique environment, over 10 years' continuous operation, sky-ground round-trip transportation support and astronauts' participation provide necessary conditions for systematically carrying out research on space life science and biotechnology, space basic physics, micro-gravity fluid physics and combustion science, space materials science, as well as important astronomical observation, earth observation, space physics research and new technology test, etc.

2. Recommended environmental constraints for Payload

The experimental design of Space station not only needs to consider the impact of the experimental environment, but also is limited by the carrying capacity of the experimental platform. The team can refer to: 1) The Payload in the Intravehicular of the Space station. 2) For the extravehicular load of the Space station, the corresponding Space science experiments are designed for two experimental scenarios. Specific environmental constraints are as follows:

2.1 Environmental requirements in Intravehicular of the Space station

The air pressure in the pressured cabin of the space station is 81.3kPa-104.3kPa, the temperature is 19-26℃, the relative humidity is about 30-70%, the gas composition is close to the ground atmosphere, and the noise level in the working area is no more than 65dB. Independent Payload equipment can be placed in the Intravehicular to carry out space scientific research. When developing the design scheme of space science experiment, the team should consider the following constraints:

1) Weight: The total weight of single working payload or combined working payload group shall not exceed 10kg as far as possible.

2) Volume: The constraint conditions of payload volume vary with the installation position, and no special provisions are made here.

3) Power: The working power of payload shall be controlled within 20W as far as possible.

4) Full automation or semi automation capability: The experimental equipment

shall have full automation capability as far as possible, that is, the equipment can complete the experimental objectives without assistance or participation. If personnel assistance is necessary, the workload needs to be minimized.

5) Safety: The experimental equipment shall ensure that there is no liquid leakage and no release of any harmful gas.

2.2 Environmental requirements in Extravehicular of the Space station

Outside the pressured cabin of the space station, there are exposure experiment platforms, large payload hangpoints and extensive experiment platform hangpoints to support research in space astronomy, space physics and environment, earth science and applications, new aerospace technologies, and new space application technologies, etc. Payload equipment constraints are as follows:

1) Weight: The total weight of single working payload or combined working payload group shall not exceed 10kg as far as possible.

2) Volume: The constraint conditions of payload volume vary with the installation position, and no special provisions are made here.

3) Power: The working power of payload shall be controlled within 30W as far as possible.

4) Full automation capability: The experimental equipment shall have full automation capability as far as possible, that is, the equipment can complete the experimental objectives without assistance or participation.

5) Adaptability of Space environment: The load equipment shall have the ability to operate under the extreme environment of space (to be explained).