UKRAINIAN
SCIENTIFIC RESEARCH AND TECHNOLOGICAL EXPERIMENTS PROPOSED FOR THE INTERNATIONAL SPACE STATION

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I. BRIEF OVERWIEW OF THE ISS PROJECT: INTERNATIONAL AND UKRAINIAN PARTICIPATION

Space exploration for various purposes ranging from purely commercial systems of telecommunication and television up to research platforms in the orbits of Earth and other planets of the Solar System is a powerful stimulus for a faster advance of science and technology in the XXI century.

The most ambitious scientific and technological project bursting into a new era of space exploration is the International Space Station (ISS). The ISS will be a multidisciplinary and multinational world-class laboratory for advanced technologies and pioneering research and will create new venues allowing scientists to gain more profound knowledge for the benefit of humanity.

I.1. BRIEF OVERVIEW OF THE ISS PROJECT

Being the initiative of the United States in 1980s, the construction of the ISS became the international project due to Canada, the European states (the ESA members — Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom), Japan, Russia, and Brazil joining the project.

The first agreements were signed between NASA and Canadian Space Agency, and ESA in 1988 and between NASA and NASDA (Japan) in 1989. Under these agreements, the «Columbus», one of the main station modules-laboratories forming the ISS heart as well as separate «free fliers» is the ESA's contribution. Japan produces a sophisticated module. Canada develops a mobile service «hand-manipulator». Using special modules, Italy will deliver experimental equipment, materials, and provision supply to the ISS.

Since 1988 the ISS project was more than once revised and suspended, mainly because of its expences. In 1995, when the President of the USA, W. Clinton assured NASA that the US would provide the required annual funding, the ISS project started becoming a reality. The prospect of the successful ISS assembly and further maintenance was essentially improved, when Russia joined the ISS community. The partnership with Russia envisaged utilization of the main orbital station components, which had been earlier planned for the OSS «Mir-2», as well as of its own research station segment. In January 1998, a mutual agreement between all the space partners was signed and the ISS design and Assembly Sequence was approved.

According to this sequence, the assembly of the main ISS components (Russian service module, the first of the American power modules, multi-purpose logistics module), as well as the delivery of two components of the Mobile Servicing System (MSS, Canadian «hand-manipulator») and of various segments of the truss structure has been planned to be completed by the end of 2001. The MSS having a 110-ton payload capability, is a key component of the ISS, which will service the construction elements attached to the station, releasing and capturing satellites, supporting astronauts during EVA sessions. The Assembly Sequence envisages further attachment of other American power modules, Japanese experimental module and three Russian research modules. The «Columbus» ESA laboratory and American habitation module were planned to be attached in 2004, at which point, a full crew of astronauts up to seven persons could work at the ISS between three and six months.

The ISS Assembly is presented on the fourth page of cover of this issue. The principal features of the ISS Assembly, which were planned in 1998, were as follows (http://spaceflight.nasa.gov/station):

Date	Flight	Launch Vehicle	Element(s)
Nov 20, 1998	1A/R	Russian Proton	Zarya Control Module (Functional Cargo Block — FCB)
Dec 4, 1998	2A	US Orbiter	STS-88 Unity Node (1 Stowage Rack); Pressurized Mating Adapters attached to Unity
May 27, 1999	2A.1	US Orbiter	STS-96 Spacehab — Logistics Flight
Nov 1999	1R	Russian Proton	Zvezda Service Module
Jan 22, 2000	2A.2	US Orbiter	STS-101 Spacehab — Logistics Flight
Feb 2000	3A	US Orbiter	STS-92 Integrated Truss Structure (ITS) Z1; Pressurized Mating Adapter — 3; Ku-band Communications System; Control Moment Gyros (CMGs)
Mar 2000	2R	Russian Soyuz	Expedition 1 Crew
Mar 2000	4A	US Orbiter	STS-97 Integrated Truss Structure P6; Photovoltaic Module; Radiators
Apr 2000	5A	US Orbiter	STS-98 Destiny Laboratory Module
Jun 2000	5A.1	US Orbiter	STS-102 Logistics and Resupply; Lab Outfitting Leonardo Multi-Purpose Logistics Module (MPLM) carries equipment racks
July 2000	6A	US Orbiter	STS-100 Rafaello Multi-Purpose Logistics Module (MPLM) (Lab outfitting); Ultra High Frequency (UHF) antenna; Space Station Remote Manipulating System (SSRMS)
Aug 2000	7A	US Orbiter	STS-104 Joint Airlock; High Pressure Gas Assembly
Sep 2000	4R	Russian Soyuz	Docking Compartment 1 (DC-1); Strela Boom
Nov 2000	7A.1	US Orbiter	STS-105 Donatello Multi-Purpose Logistics Module (MPLM)
Jan 2001	UF-1	US Orbiter	STS-106 Multi-Purpose Logistics Module (MPLM); Photovoltaic Module batteries; Spares Pallet (spares warehouse)
Mar 2001	8A	US Orbiter	STS-108 Central Truss Segment (ITS S0); Mobile Transporter (MT)
May 2001	UF-2	US Orbiter	STS-109 Multi-Purpose Logistics Module (MPLM) with payload racks; Mobile Base System (MBS)
July 2001	9A	US Orbiter	STS-111 First right-side truss segment (ITS S1) with radiators; Crew & Equipment Translation Aid (CETA) Cart A
Aug 2001	11A	US Orbiter	STS-112 First left-side truss segment (ITS P1); Crew & Equipment Translation Aid (CETA) Cart B
Nov 2001	9A.1	US Orbiter	STS-114 Russian provided Science Power Platform (SPP) with four solar arrays
Jan 2002	12A	US Orbiter	STS-115 Second left-side truss segment (ITS P3/P4); Solar array and batteries
Mar 2002	12A.1	US Orbiter	STS-117 Third left-side truss segment (ITS P5); Multi-Purpose Logistics Module (MPLM)
May 2002	13A	US Orbiter	STS-118 Second right-side truss segment (ITS S3/S4); Solar array set and batteries (Photovoltaic Module)
June 2002	3R	Russian Proton	Universal Docking Module (UDM)
July 2002	5R	Russian Soyuz	Docking Compartment 2 (DC2)
July 2002	10A	US Orbiter	STS-120 US Node 2
Aug 2002	10A.1	US Orbiter	STS-121 Propulsion Module
Oct 2002	1J/A	US Orbiter	STS-123 Japanese Experiment Module Experiment Logistics Module (JEM ELM PS) Science Power Platform (SSP) solar arrays with truss
Jan 2003	1J	US Orbiter	STS-124 Kibo Japanese Experiment Module (JEM) Japanese Remote Manipulator System (JEM RMS)
Feb 2003	UF-3	US Orbiter	STS-125 Multi-Purpose Logistics Module (MPLM) Express Pallet
May 2003	UF-4	US Orbiter	STS-127 Express Pallet Spacelab Pallet carrying «Canada Hand» (Special Purpose Dexterous Manipulator)
June 2003	2J/A	US Orbiter	STS-128 Japanese Experiment Module Exposed Facility (JEM EF) Solar Array Batteries
July 2003	9R	Russian Proton	Docking and Stowage Module (DSM)
Aug 2003	14A	US Orbiter	STS-130 Cupola; Science Power Platform (SPP) Solar Arrays Zvezda Micrometeroid and Orbital Debris (MMOD) Shields
Sep 2003	UF-5	US Orbiter	STS-131 Multi-Purpose Logistics Module (MPLM); Express Pallet
Jan 2004	20A	US Orbiter	STS-133 US Node 3
Feb 2004	1E	US Orbiter	STS-134 European Laboratory — Columbus Attached Pressurized Module (APM)
Mar 2004	8R	Russian Soyuz	Research Module 1
Mar 2004	17A	US Orbiter	STS-135 Multi-Purpose Logistics Module (MPLM); Destiny racks
May 2004	18A	US Orbiter	STS-136 Crew Return Vehicle (CRV)
June 2004	19A	US Orbiter	STS-137 Multi-Purpose Logistics Module (MPLM)
July 2004	15A	US Orbiter	STS-138 Solar Arrays and Batteries (Photovoltaic Module S6)
Aug 2004	10R	Russian Soyuz	Research Module 2
Aug 2004	UF-7	US Orbiter	STS-139 Centrifuge Accommodation Module (CAM)
Sep 2004	UF-6	US Orbiter	STS-140 Multi-Purpose Logistics Module (MPLM); Batteries
Nov 2004	16A	US Orbiter	STS-141 Habitation Module

Notes: Additional Progress, Soyuz, H-II Transfer Vehicle and Automated Transfer Vehicle flights for crew transport, logistics and resupply are not listed.

During 1998 — 2004, 45 missions of the US Shuttle and Russian Soyuz and Progress vehicles are scheduled to assemble more than 100 elements of the ISS construction. The ISS assembly will require about 1700 hours of «space roads» that is many more, than has been flown during the whole time of manned space exploration. The plan is to complete the primary ISS assembly in the orbit of 350 km and after that to move the station up into the working orbits of 410—450 km. This phase will mean that the 15-years period of active lifetime of the ISS can be started. The ISS will have the length of 79.9 m and width of 108.6 m, the total mass of about 460 tons and internal volume of 1217 m^3. The station will make one revolution around the Earth with the velocity of 28 000 km per year, and its flight trajectory will enable 85 % of the Earth's surface to be observed. The total cost of the ISS project is about $95.6 billion.

In 1998-2000, six flights have already occurred to assemble the ISS in orbit.

The first station component, the Zarya control module, was launched by a Russian Proton rocket in November 20, 1998. The Russian Zarya (Functional Cargo Block) built by Khrunichev SRPSC under a subcontract to the Boeing Co. for NASA is the US-owned component of the station. This module is designed to provide propulsion, control system, orientation and electrical power for the ISS's first months in orbit. Its docking ports allow attachment of Soyuz manned spacecraft and unmanned Progress spacecraft. The Zarya module has an operational lifetime of at least 15 years, and later, as envisaged by the station's sequence, it will be used as the ISS passageway, docking port and external fuel tank. Two weeks after Zarya rendezvous, in December 4, the first US pressurised module Unity-1 was to be launched and attached to the Zarya module (STS-88 mission). The Unity-1 connecting module is providing six attachment ports to join all the future US modules. In June, 1999 the third ISS mission, the Space Shuttle Discovery rendezvous (STS-96), was completed to perform the necessary testing of equipment and to connect power and data transmission cables to the Zarya — Unity-1 system, as well as to inhabit the ISS.

Afterwards several changes in the Assembly Sequence mentioned above have happened, because of the nine-months delay of the launch of the Russian Zvezda component.

In May 19, 2000, the STS-101 was launched with the seven-member crew. It was a re-scheduled Space Shuttle flight for correction of orbital changes of the ISS, which occurred because of Zvezda delay, and for performance of maintenance tasks. The third major station component, the Russian Zvezda, was docked with the ISS in July 26, 2000 (the fifth flight). This component is the Service Module, the crew's living quarters. It is the first fully Russian station contribution and the core of the Russian station segment. The Service Module enhances and replaces many functions of the Zarya block. It provides functioning of a life support system, navigation, communication and propulsion, as well as of other facilities for the early stage of the ISS. In Sept 8, 2000, the international crew visited the ISS to deliver supplies and outfit the Service Module as well as to complete engineering operations, which are necessary for preparing the station for long-duration habitation. In Oct 11, 2000, STS-92 delivered Integrated Truss Structure, Pressurrized Mating Adapters-3, Communication System and four Control Moment Gyros.

In October 31, 2000 the first long-term Expedition was launched from the Baikonur Cosmodrome to the ISS on Soyuz space vehicle. The crew consists of W. Shepard (USA), Yu. Gidzenko, S. Krikalev (Russia). The astronauts, who are to spend about four months in space, will have to make the station habitable. After installation of all equipment associated with the Electron Oxygen Generation System and testing on-board computers and communication facilities, the crew will start doing the numerous scientific experiments. For the first month and a half the cosmonauts' activity will be monitored by the Russian Flight Control Center and then the NASA Houston Center will control it.

The ISS Assembly Sequence at the current date (on Nov 7, 2000) is the following (for information updated see http://hq.nasa.gov/office and http://spaceflight.nasa.gov/station):

Date	Flight	Launch Vehicle	Element(s)
Nov 20, 1998	1A/R	Russian Proton	Zarya Control Module (Functional Cargo Block — FCB)
Dec 4, 1998	2A	US Orbiter	STS-88 Unity Node (1 Stowage Rack); 2 Pressurized Mating Adapters attached to Unity
May 27, 1999	2A.1	US Orbiter	STS-96 Spacehab — Logistics Flight
May 19, 2000	2A.2a	US Orbiter	STS-101 Spacehab — Maintenance Flight
Jul 12, 2000	1R	Russian Proton	Zvezda Service Module
Sept 8, 2000	2A.2a	US Orbiter	STS-106 Spacehab — Logistics Flight

Date	Flight	Launch Vehicle	Element(s)
Oct 11, 2000	3A	US Orbiter	STS-92 Integrated Truss Structure (ITS) Z1; Pressurized Mating Adapter — 3; Ku-band Communications System; 4 Control Moment Gyros (CMGs)
Oct 31, 2000	2R	Russian Soyuz	Expedition 1 Crew
Nov 30, 2000	4A	US Orbiter	STS-97 Integrated Truss Structure P6; Photovoltaic Module; Radiators
Jan 18, 2001	5A	US Orbiter	STS-98 Destiny Laboratory Module
Feb 15, 2001	5A.1	US Orbiter	STS-102 Logistics and Resupply; Lab Outfitting Leonardo Multi-Purpose Logistics Module (MPLM) carries equipment racks
March 2001	4R	Russian Soyuz	Docking Compartment 1 (DC-1); Strela Boom
April 19, 2001	6A	US Orbiter	STS-100 Rafaello Multi-Purpose Logistics Module (MPLM) (Lab outfitting); Ultra High Frequency (UHF) antenna; Space Station Remote Manipulating System (SSRMS)
May 17, 2001	7A	US Orbiter	STS-104 Joint Airlock; High Pressure Gas Assembly
June 21, 2001	7A.1	US Orbiter	STS-105 Donatello Multi-Purpose Logistics Module (MPLM)
Oct 4, 2001	UF-1	US Orbiter	STS-106 Multi-Purpose Logistics Module (MPLM); Photovoltaic Module batteries; Spares Pallet (spares warehouse)
Jan 2002	8A	US Orbiter	STS-108 Central Truss Segment (ITS S0); Mobile Transporter (MT)
Feb 2002	UF-2	US Orbiter	STS-109 Multi-Purpose Logistics Module (MPLM) with payload racks; Mobile Base System (MBS)
May 2002	9A	US Orbiter	STS-111 First right-side truss segment (ITS S1) with radiators; Crew & Equipment Translation Aid (CETA) Cart A
June 2002	ULF1	US Orbiter	Utilization and logistics Flight
Oct 2002	11A	US Orbiter	STS-112 First left-side truss segment (ITS P1); Crew & Equipment Translation Aid (CETA) Cart B
Oct 2002	9A.1	US Orbiter	STS-114 Russian provided Science Power Platform (SPP) with four solar arrays
Dec 2002	12A	US Orbiter	STS-115 Second left-side truss segment (ITS P3/P4); Solar array and batteries
Feb 2003	12A.1	US Orbiter	STS-117 Third left-side truss segment (ITS P5); Multi-Purpose Logistics Module (MPLM)
April 2003	13A	US Orbiter	STS-118 Second right-side truss segment (ITS S3/S4); Solar array set and batteries (Photovoltaic Module)
June 2003	13A.1	US Orbiter	Logistics and Supplies
Aug 2003	3R	Russian Proton	Universal Docking Module (UDM)
Aug 2003	5R	Russian Soyuz	Docking Compartment 2 (DC2)
Oct 2003	UF-4	US Orbiter	STS-127 Express Pallet Spacelab Pallet carrying «Canada Hand» (Special Purpose Dexterous Manipulator)
Nov 2003	10A	US Orbiter	STS-120 US Node 2
Feb 2004	1J/A	US Orbiter	STS-123 Japanese Experiment Module Experiment Logistics Module (JEM ELM PS) Science Power Platform (SSP) solar arrays with truss
April 2004	ATV		European Automated Transfer Vehicle
May 2004	1J	US Orbiter	STS-124 Kibo Japanese Experiment Module (JEM) Japanese Remote Manipulator System (JEM RMS)
June 2004	10A.1	US Orbiter	STS-121 Propulsion Module
Sept 2004	UF-3	US Orbiter	STS-125 Multi-Purpose Logistics Module (MPLM) Express Pallet
Oct 2004	1E	US Orbiter	STS-134 European Laboratory — Columbus Module
June 2005	2J/A	US Orbiter	STS-128 Japanese Experiment Module Exposed Facility (JEM EF) Solar Array Batteries; Cupola
Feb 2005	UF-5	US Orbiter	STS-131 Multi-Purpose Logistics Module (MPLM); Express Pallet
TBD	9R	Russian Proton	Docking and Stowage Module (DSM)
May 2005	14A	US Orbiter	STS-130 Science Power Platform (SPP) Solar Arrays; Zvezda Micrometeroid and Orbital Debris (MMOD) Shields
June 2005	UF-6	US Orbiter	STS-140 Multi-Purpose Logistics Module (MPLM); Batteries
July 2005	20A	US Orbiter	STS-133 US Node 3
Aug 2005	8R	Russian Soyuz	Research Module 1
Sept 2005	16A	US Orbiter	STS-141 Habitation Module
Oct 2005	17A	US Orbiter	STS-135 Multi-Purpose Logistics Module (MPLM); Destiny racks
Dec 2005	18A	US Orbiter	STS-136 Crew Return Vehicle (CRV)
Jan 2006	19A	US Orbiter	STS-137 Multi-Purpose Logistics Module (MPLM)
March 2006	15A	US Orbiter	STS-138 Solar Arrays and Batteries (Photovoltaic Module S6)
March 2006	10R	Russian Soyuz	Research Module 2
April 2006	UF-7	US Orbiter	STS-139 Centrifuge Accommodation Module (CAM)

Notes: Additional Progress, Soyuz, H-II Transfer Vehicle and Automated Transfer Vehicle flights for crew transport, logistics and resupply are not listed.

The ISS will provide a marked improvement in the level of international cooperation and in understanding the potential of space science and technology for solving the common problems of human civilization. As it is pointed out by NASA, «the ISS will afford scientists, engineers, and entrepreneurs an unprecedented platform on which to perform complex, long-duration, and replicable experiments in the unique environment of space. The ISS will maximize its particular assets: prolonged exposure to microgravity and the presence of human experiments in the research process» (*The International Space Station. The NASA Research Plan, an Overview, 1998*). The modern high technologies, such as telescience, will enable virtual access to the remote station laboratories to be realized. The ISS program envisages the following science and technology directions: biomedical research; medical care in space; advanced human support technology; biotechnology; combustion science; fluid physics; fundamental physics; materials science; gravitational biology and ecology; Earth sciences; space science; commercial product development. Several hundred thousand people at space agencies and various companies, as well as at scientific institutions of the whole world are involved in the ISS, contributing to the success of this project. Without doubt, this permanent station will also provide experience for further space exploration, in particular, the preparation of the Martian manned mission in 2015-2020. «When the Solar System is being conquered, the human beings will have new dimensions» (K. Tsiolkovskij).

I.2. UKRAINE'S PARTICIPATION IN THE ISS. STATUS OF THE UKRAINIAN RESEARCH MODULE

Ukraine's policy in the area of peaceful exploration of space is aimed at preservation and strengthening of the scientific schools and scientific-engineering potential of the space industry. Being one of the constellation of space-faring countries of the world, Ukraine is interested in the ISS project to conduct the national experiments onboard the ISS and to take part in international utilization of the space station.

Main objectives of Ukraine's participation in the ISS are the following:

- consolidate Ukraine's position of excellence in international scientific exploration of space;
- encourage development of space technology for progress of society;
- provide opportunities for Ukrainian scientists and engineers to participate in the national and international space missions;
- strengthen USA-Ukraine and Russia-Ukraine partnership in space exploration.

To meet these objectives the National Space Agency of Ukraine (NSAU) has included the Ukrainian Research Module (URM) project into the National Space Program for 1998-2002.

Status of the Ukrainian Research Module of the ISS

- URM should be the Space Station Element defined in Art. 3 of a Memorandum of Understanding between NASA and Russian Space Agency (RSA) as the Research Module incorporated into the Russian Segment;
- according to the Minutes of NSAU — RSA negotiations, the URM consists of the following main components:

— scientific and technological payload and specialized downlink for data transmission;

— basic complex for payload support (shared with the Russian Segment);

— set of maintenance equipment (shared with the Russian segment).

It is presumed that the Ukrainian Research Program to be implemented onboard the URM, will be harmonized with the ISS planning process and will benefit from performance of international experiments.

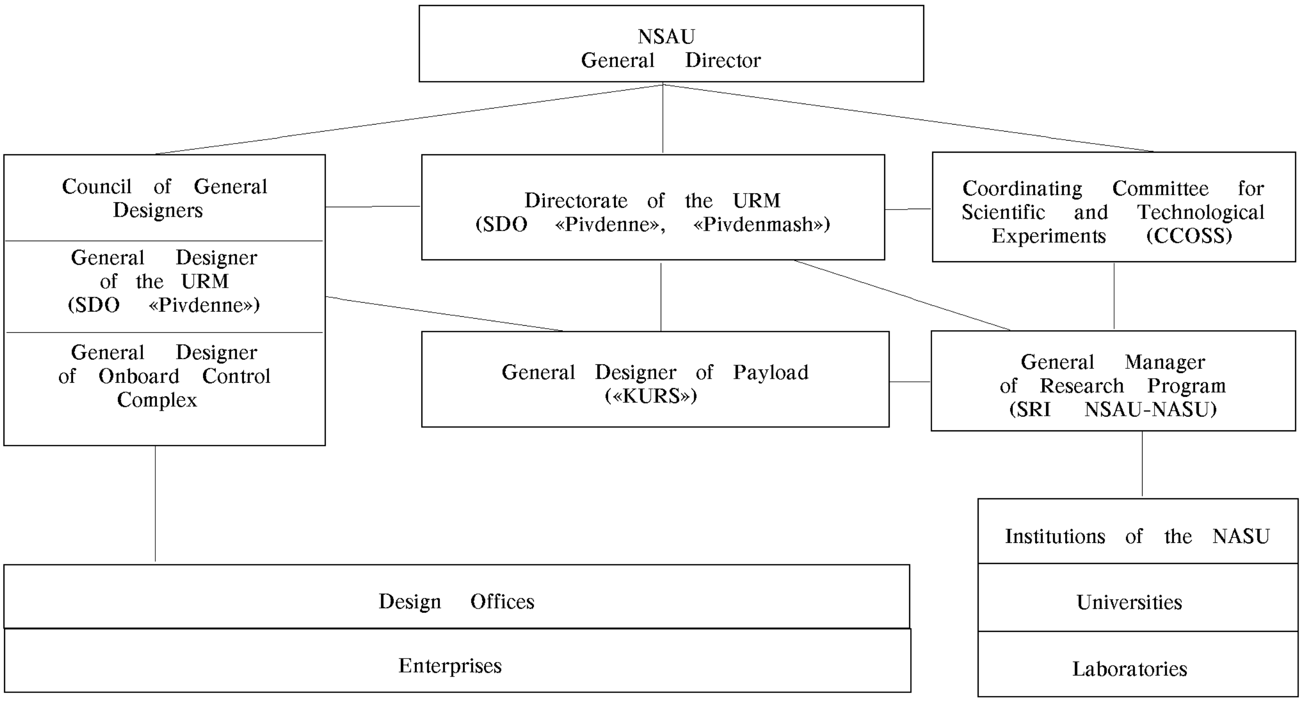

Fig. 1. Management Structure for Development and Construction of the URM

I.3. MANAGEMENT STRUCTURE OF UKRAINE'S PARTICIPATION IN THE ISS

Provisional **Management Structure** for development and construction of the URM includes the following Parties (see also Figure 1):

— Directorate of NSAU;

— Coordinating Committee for Scientific Research and Technological Experiments onboard the OSS;

— Directorate of the URM Program;

— Council of General Designers.

NSAU is responsible for general management of thee URM Program, for its financial and legal support, as well as for participation in the international planning process.

Directorate of the URM Program integrates the scientific and engineering proposals for development and construction of the URM.

Council of General Designers is responsible for design of the URM and for the flight planning.

General Designer of the URM is responsible for integration of scientific instrumentation, planning and development of scientific instrumentation.

General Manager of the URM Program is responsible for management of the URM Program.

To select scientific and technological experiments to be performed onboard the URM, a special coordinating committee was formed in October, 1997 by the National Academy of Sciences of Ukraine (NASU) and NSAU, namely the **Coordinating Committee for scientific research and technological experiments onboard the Orbital Space Stations (CCOSS)**.

I.4. COORDINATING COMMITTEE FOR SCIENTIFIC RESEARCH AND TECHNOLOGICAL EXPERIMENTS ONBOARD THE ORBITAL SPACE STATIONS (CCOSS)

Main tasks:

— define a general strategy for Ukraine's participation in the ISS;

— distribute an announcement of opportunity for identifying the scientific and technological experiments to be performed onboard the URM;

— make an examination (peer review) of proposals received from scientific and engineering communities;

— select a set of experiments to be included into Instrument Definition and Development Program;

— work out the Ukrainian Program of Scientific Research and Technological Experiments proposed for the ISS;

CCOSS consists of Chairman, Vice-Chairman, Chairmen of Scientific Sections, Scientific Secretary, Members of Committee (see also Figure 2).

Members of the CCOSS:

Borys E. Paton	President of the NASU Director of the E. O. Paton Electric Welding Institute *Chairman*
Yaroslav S. Yatskiv	Director of the Main Astronomical Observatory, NASU *Vice-Chairman*
Elizaveta L. Kordyum	Deputy-Director of the Institute of Botany, NASU
Vsevolod M. Kuntsevich	Director of the Space Research Institute, NSAU-NASU
Leonid N. Litvinenko	Director of the Institute of Radio Astronomy, NASU
Volodymyr V. Nemoshkalenko	Director of the Institute for Metal Physics, NASU
Volodymyr F. Prisnyakov	Principal Research Scientist, Institute of Geotechnical Mechanics of the NASU *(Member of CCOSS up to 1999)*
Victor V. Pilipenko	Director of the Institute for Technical Mechanics, NSAU-NASU
Victor I. Trefilov	Director of the Institute for Materials Science Problems, NASU
Volodymyr J. Dranovsky	Chief of DO-3, the Yangel State Design Office «Pivdenne» *(Member of CCOSS from 1999)*
Oleg P. Fedorov	Chief of Division for Scientific Space Program, NSAU
Sergij N. Sedykh	Administration Secretary, Presidium of NASU

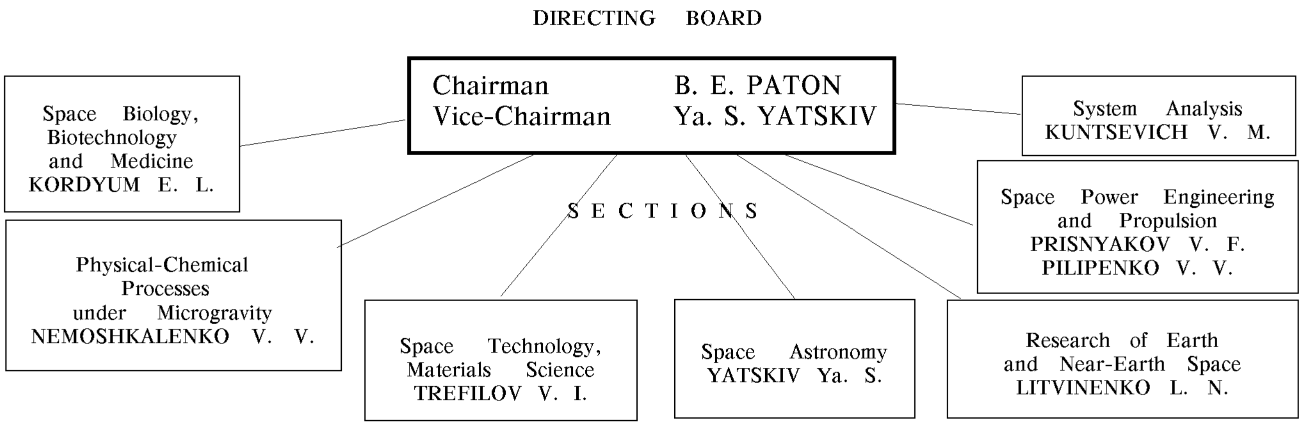

Fig. 2. Scientific Sections of the CCOSS

SCIENTIFIC SECTIONS of the CCOSS:

— **Space Technology and Materials Science** (creation of new types of materials; research of materials under microgravity; production of a limited number of samples of materials with unique properties; experiments on welding and soldering of materials in space);

— **Research of Earth and Near-Earth Space** (research of the ionosphere and lithosphere-ionosphere connection, as well as the Earth's surface);

— **Space Astronomy** (solar and Solar system physics; extragalactic astronomy);

— **Space Biology, Biotechnology and Medicine** (cell biology under microgravity; developmental biology (plants, animals) under microgravity and under the influence of altered gravity; functioning of the autotropic and heterotropic links of controlled ecological life-support systems of astronauts during a long-term flight; technology for production of biopreparations and biomaterials for fundamental sciences, medicine and agriculture);

— **Space Power Engineering and Propulsion** (development and improvement of space power systems); in 2000, this section was renamed as the «**Space Power Engineering and Analysis of Experiment Compatibility**»;

— **Physical-Chemical Processes under Microgravity** (research of the influence of gravity-driven phenomena on solidification and crystal growth of materials; processes of heat-mass transfer in liquids and gases; solidification of metals and alloys);

— **System Analysis** (optimal planning, removed control of experiments, system analysis).

I.5. ANNOUNCEMENT OF OPPORTUNITY FOR SCIENTIFIC RESEARCH AND TECHNOLOGICAL EXPERIMENTS ONBOARD THE UKRAINIAN RESEARCH MODULE (FIRST STAGE OF SELECTION)

In 1997 the CCOSS announced an All-Ukrainian competition of proposals from scientific and engineering teams for experiments onboard the URM of the ISS. The 266 proposals have been received from over 40 Ukrainian scientific and industrial organizations. Statistics of the proposals from scientific and engineering teams at the first stage of CCOSS's competition is presented in Table 1.

After examination by independent reviewers, CCOSS selected 70 proposals and recommended them to the NSAU for the First Stage of conducting the URM Program, the Assessment Study. These research teams received NSAU grants of about $1.3 million in 1998. The Assessment Study of the URM Program was completed at the beginning of 1999. Afterwards, in April, 1999, CCOSS summarized results of the projects completed by scientific and engineering teams to select the projects for the Feasibility Study.

Table 1. Statistics of the proposals for experiments onboard the ISS URM.

Section	Number of Proposals				
	Received	Positive Review	Negative Review	Others	Recommended for contract
Space Technology and Materials Science	75	42	13	20	10
Research of Earth and Near-Earth Space	44	28	15	1	10
Space Biology, Biotechnology, Medicine	70	25	22	23	15
Physical-Chemical Processes in Microgravity	17	5	8	4	5
Space Power Engineering and Propulsion	27	9	3	15	7
Space Astronomy	8	4	1	3	3
System Analysis	25	6	13	6	3
Total	266	119	75	72	53

Table 2. LIST OF PROJECTS TO BE REALIZED AT THE 2ND STAGE OF THE URM PROGRAM

Title of Project (Name of Section)	Project Summary	Project Manager and Principal Institute
1. PENTA - COMPLEX (Materials Science, Microgravity Science)	Effect of microgravity on liquid helium boiling and of space factors on the processes of friction and wear of materials, etc.	BONDARENKO S. I., POKHYL Yu. A. B. I. Verkin Institute for Low Temperature Physics and Engineering, NASU
2. MATERIAL (Space Technology, Materials Science)	Experiments on production of new unique materials in space and development of special welding equipment, etc.	PATON B. E. E. O. Paton Electric Welding Institute, NASU TREFILOV V. I. I. N. Frantsevich Institute for Materials Science Problems, NASU
3. DEGRADATION (Space Technology, Materials Science)	Degradation of metals and alloys under the effect of space factors	TREFILOV V. I. I. N. Frantsevich Institute for Materials Science Problems, NASU
4. DIAGNOSTICS (Space Technology, Materials Science)	Methods and equipment for control of defectiveness and stressed state of constructions used in space	LOBANOV L. M. E. O. Paton Electric Welding Institute, NASU
5. INFRAMON (Research of Earth and Near-Earth Space)	Research of the Earth's upper atmosphere by optical and mm-waves techniques.	MOROZHENKO O. V. Main Astronomical Observatory, NASU
6. ENVIRONMENT (Research of Earth and Near-Earth Space)	Research of plasma and gas environments of large space constructions	BASS V. P. Institute of Technical Mechanics, NASU- NSAU
7. SPACE (Research of Earth and Near-Earth Space)	Research of the Earth's ionosphere	YAMPOLSKI Yu. M. Institute of Radio Astronomy, NASU
8. SURFACE (Research of Earth and Near-Earth Space)	Remote sensing of the surface and oceans of Earth	LYAL'KO V. I. Institute of Geological Sciences, Centre of Aerospace Research of Earth, NASU
9. CONTEST (Space Astronomy)	Solar-oriented research	YATSKIV Ya. S. Main Astronomical Observatory, NASU
10. GREENHOUSE (Space Biology)	Creation of Greenhouse and research of plants growth under microgravity	KORDYUM V. A., KORDYUM E. L. M. G. Kholodny Institute of Botany, NASU
11. BIOLABORATORY (Space Biology, Biotechnology)	Biological experiments onboard the URM	KORDYUM E. L. M. G. Kholodny Institute of Botany, NASU
12. ZOOMODULE (Space Biology, Medicine)	Effect of space factors on functioning and aging of living organisms	FROL'KIS V. V. M. G. Kholodny Institute of Botany, NASU
13. BIOMEDCONTROL (Space Biology, Medicine)	Medical monitoring of astronauts and biological control in situ of the URM	KORKUSHKO O. V. M. G. Kholodny Institute of Botany, NASU
14. MORPHOS (Physical-Chemical processes under Microgravity)	Processes of solidification of materials and composites under microgravity	NEMOSHKALENKO V. V. G. V. Kordyumov Institute of Metal Physics, NASU
15. SYSTEM (System Analysis)	Development of a system for planning the experiments onboard the URM	KUNTSEVICH V. M. Space Research Institute, NASU-NSAU

I.6. ANNOUNCEMENT OF OPPORTUNITY FOR SCIENTIFIC RESEARCH AND TECHNOLOGICAL EXPERIMENTS ONBOARD THE UKRAINIAN RESEARCH MODULE (SECOND STAGE OF SELECTION)

Taking into account the recommendations of peer review of Reports by Project Managers, as well as the opinions of the Section Chairmen, CCOSS decided to recommend 15 Integrated Projects to NSAU for conducting the Feasibility Study under the URM Program. CCOSS identified 10 Institutes of the NAS of Ukraine, which will be Managers of these Integrated Projects. Some information on these Integrated Projects is given in Table 2.

In October 20-21, 1999 during the Russian-Ukrainian workshop on the current status of the Russian-Ukrainian co-operation in space science and industry, the representatives of the NASU, Russian AS, NSAU, and Rosaviakosmos discussed the project of an agreement between NSAU and Rosaviakosmos related to the URM. The Parties agreed the necessity of a joint discussion on the planned Ukrainian and Russian experiments to eliminate their duplication and to consider the technical compatibility of the experiments.

In October 8, 1999 the Government of Ukraine and the Government of the USA signed a Memorandum of Understanding on co-operation in the field of space research, and the US-Ukrainian Agreement on protection of technologies related to the Ukrainian carrier-rockets, rocket systems and technical data for the Sea Launch project, which are indicative of the high level of bilateral strategic partnership in this priority field. The signing of these agreements provided a new impetus to development of the space industry of Ukraine through implementation of joint research projects in co-operation with the US aerospace companies, in particular, under the ISS program. Legal protection of the Ukrainian rocket technology, technological equipment and technical documentation related to the Sea Launch project is also envisaged, as well as creation of a favourable investment climate for further development of space research. In 2000 NASA selected the projects, which will be conducted during 2001 within the framework of a Memorandum of Understanding, from those recommended by NSAU and CCOSS. Most of the projects are in field of space biology and materials science under microgravity, and part of them are in field of telemedicine and telecommunications. It should be also noted that in 2000 Ukraine became a regular member of the International Working Group on Space Biology, which is responsible for scientific program of the ISS in this field of research.

In the next Chapters we will provide a short description of the projects of scientific research and technological experiments recommended by CCOSS for implementation onboard the ISS.