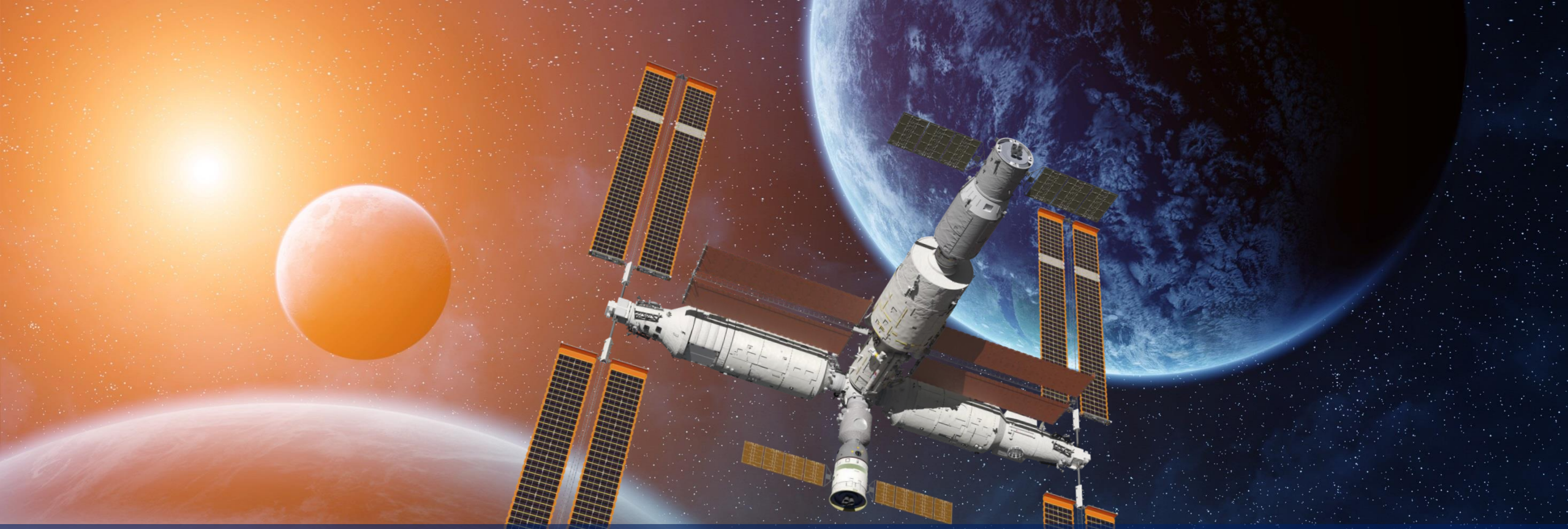
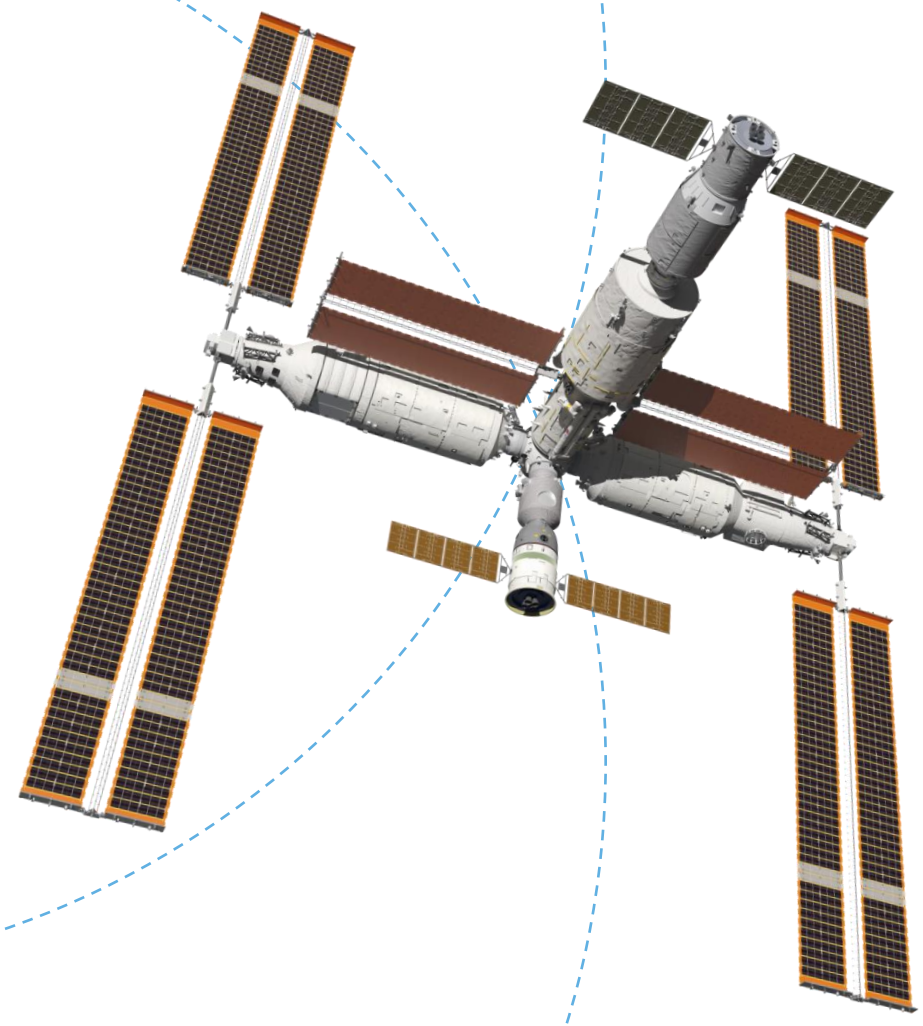


Progress and International Cooperation China Manned Space Program

Lu Yaofeng / Deputy Director
Integrated Planning Division
China Manned Space Agency (CMSA)

2021-8



1 Program overview

2 Construction progress of China Space Station (CSS)

3 International Cooperation

4 Conclusion

Program overview

The Three-step Strategy

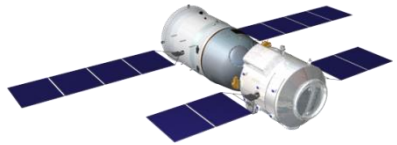
The First Step： launch a manned spaceship, set up primarily integrated experimental manned spacecraft engineering, and carry out space application experiments.

The Second Step： make technology breakthroughs in extravehicular activities (EVA) as well as space rendezvous and docking of manned spaceships and spacecrafts, launch a space lab, and provide a solution for space application of a certain scale with man-tending on a short-term basis.

The Third Step： establish a space station, and provide a solution for space application of larger scale with man-tending on a long-term basis.

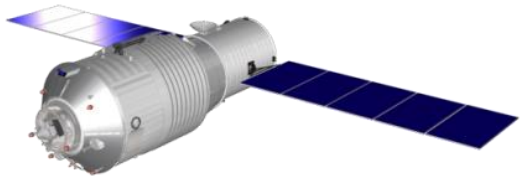
The 1st step:

- manned spaceships
- basic space technologies in Earth-orbit crew transportation.



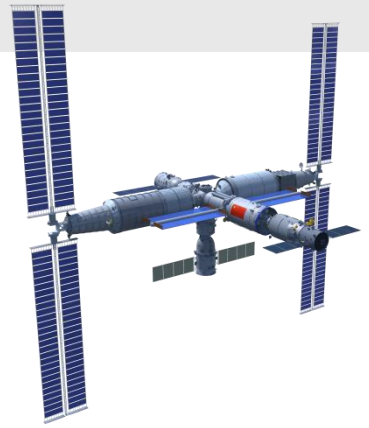
The 2nd step:

- Space Labs
- Technologies in EVA, R&D, and accommodation of short-term man-tended utilization on a modest scale



The 3rd step

- China Space Station
- Long-term man-tended utilization on a large scale



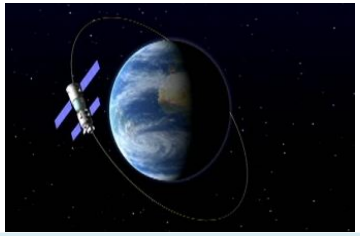
Program overview / Overview of the first step

From 1992 to 2005, four unmanned flight missions and two manned space missions
Breakthrough in the earth-to-orbit manned transportation system
Successfully completed the first step of CMSP.

Unmanned spaceflight missions

Shenzhou-1
20 Nov 1999

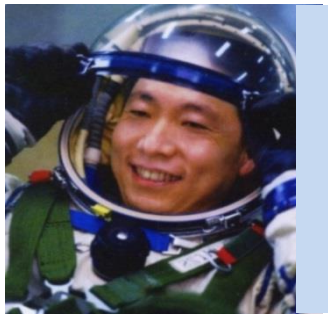
Shenzhou-2
10 Jan 2001



Shenzhou-3
25 Mar 2002

Shenzhou-4
30 Dec 2002

Manned spaceflight missions



Shenzhou-5, 2003
1st manned spaceflight

Shenzhou-6, 2005
multiple-crew, multiple-day

Program overview / Overview of the second step

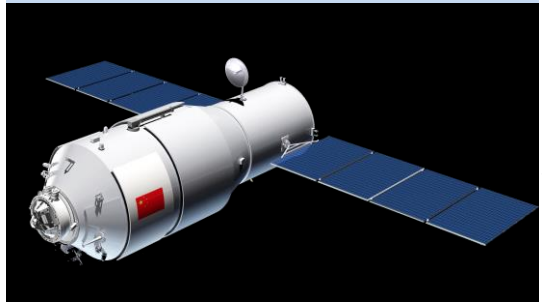
From 2005 to 2007, China’ s first EVA, Rendezvous & Docking

Material supply, propellant refueling, a series of space science experiments and technology demonstrations with man-tending on medium and long-term basis

TG-1 and TG-2 missions successfully accomplished all assignments, bringing off a completeness of the second step of CMSP.

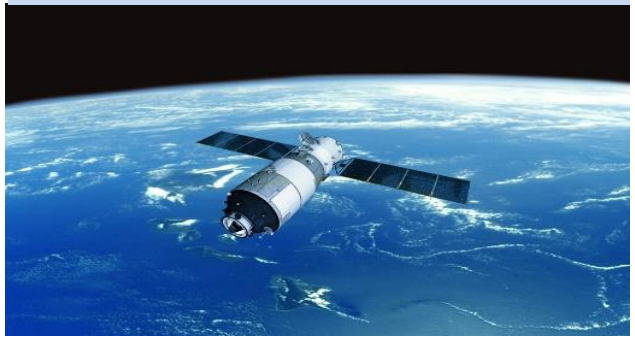
2008, Shenzhou-7, 1st Extravehicular Activity (EVA)

2011, TG-1 Space Lab

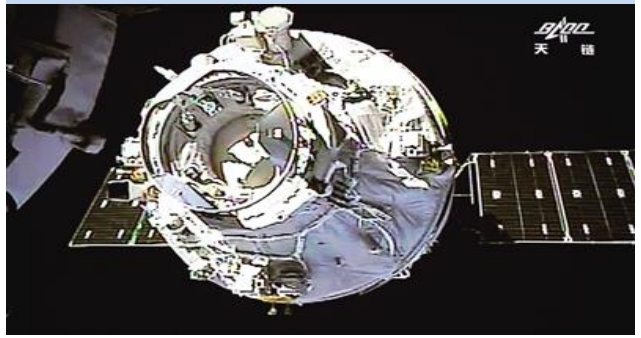


SZ-8、SZ-9、SZ-10 docking with TG-1

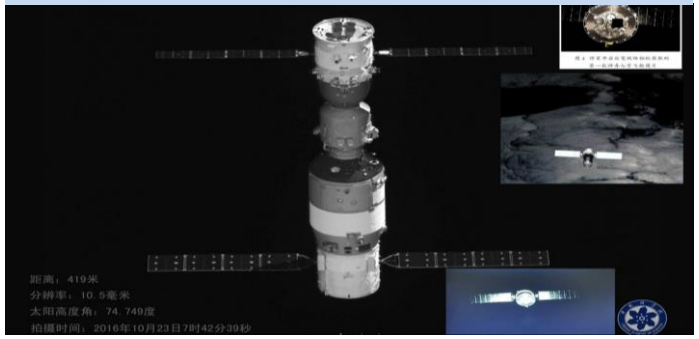
2016, TG-2 Space Lab



2017 , TZ-1 cargo ship



2016, SZ-11 docking with TG-2



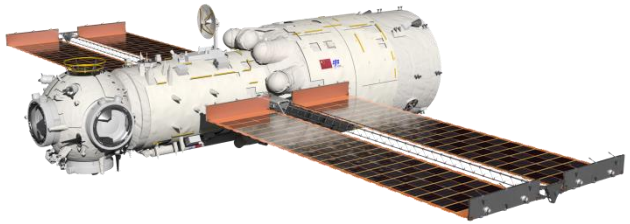
Construction progress of China Space Station (CSS)

/ Introduction of CSS construction

Establishing a space station, and providing a solution for space application of larger scale with man-tending on a long-term basis, is the goal of the third step which was inaugurated.

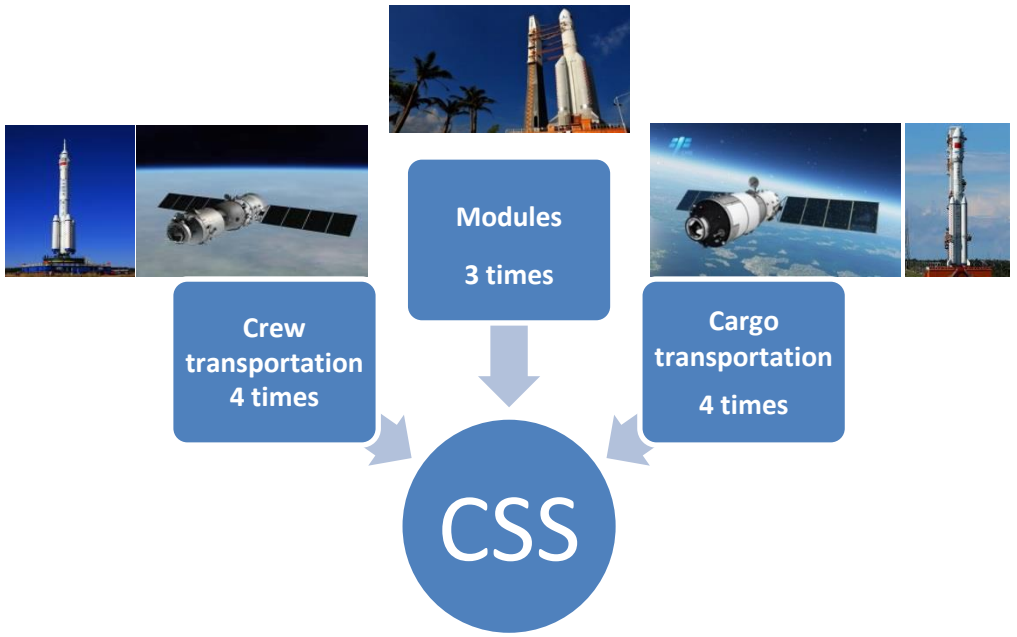
Maiden Flight of Long March 5B

Marked the beginning of the 3rd step of China Manned Space Program



The core module

Assembly of CSS



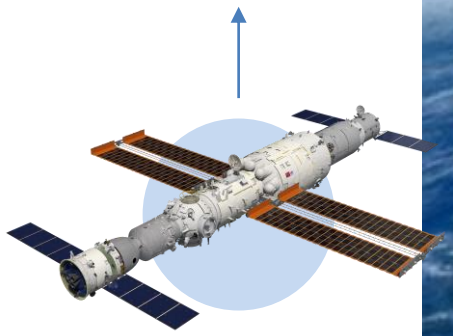
Includes 11 fights will be completed around 2022

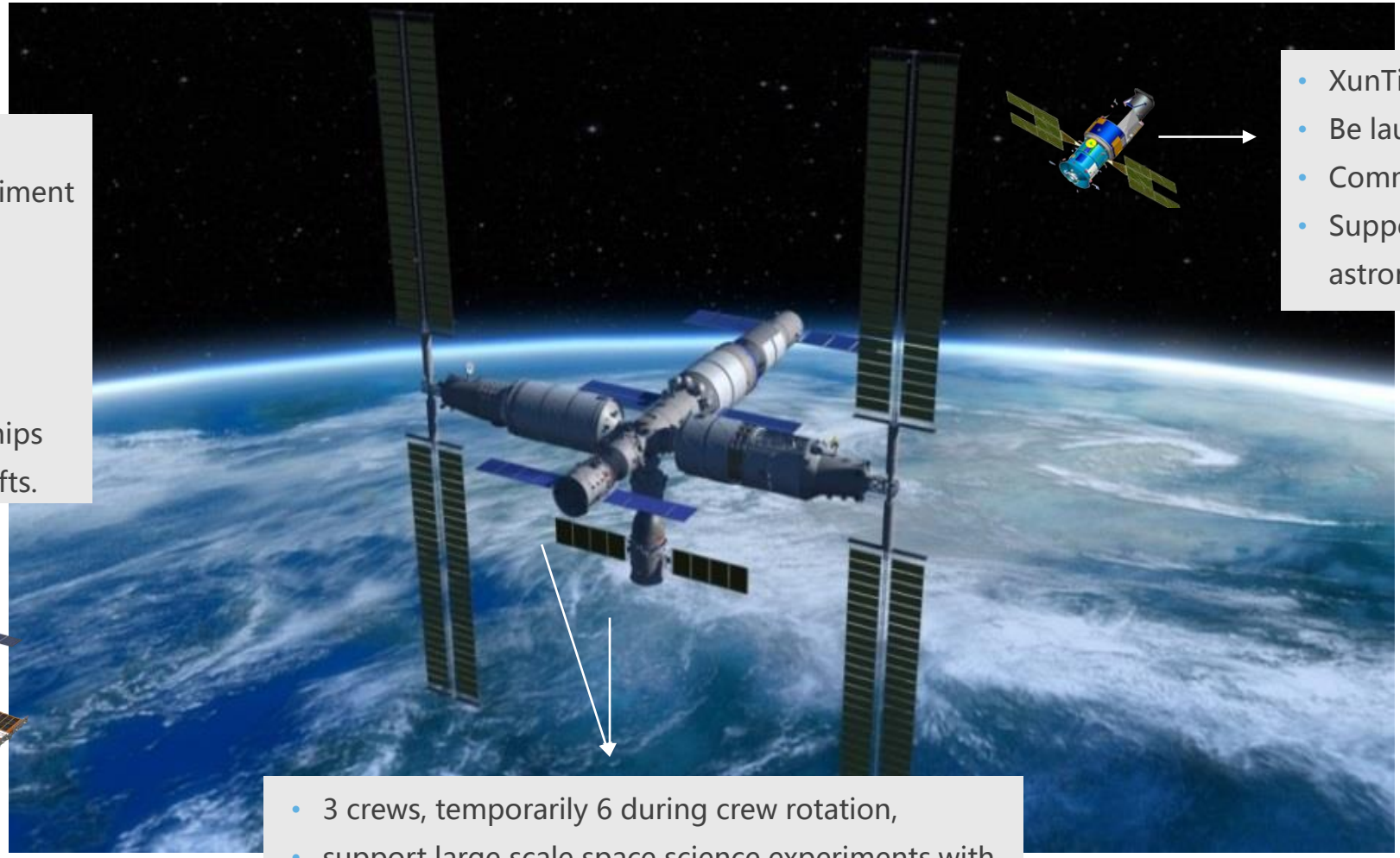
Construction progress of China Space Station (CSS)

China Manned Space Agency (CMSA)

/ Introduction of CSS construction

- lifespan over 10 years
- 1 core module and 2 experiment modules
- ＞90 tons
- T-shape configuration
- Supporting the docking of manned and cargo spaceships and other visiting spacecrafts.





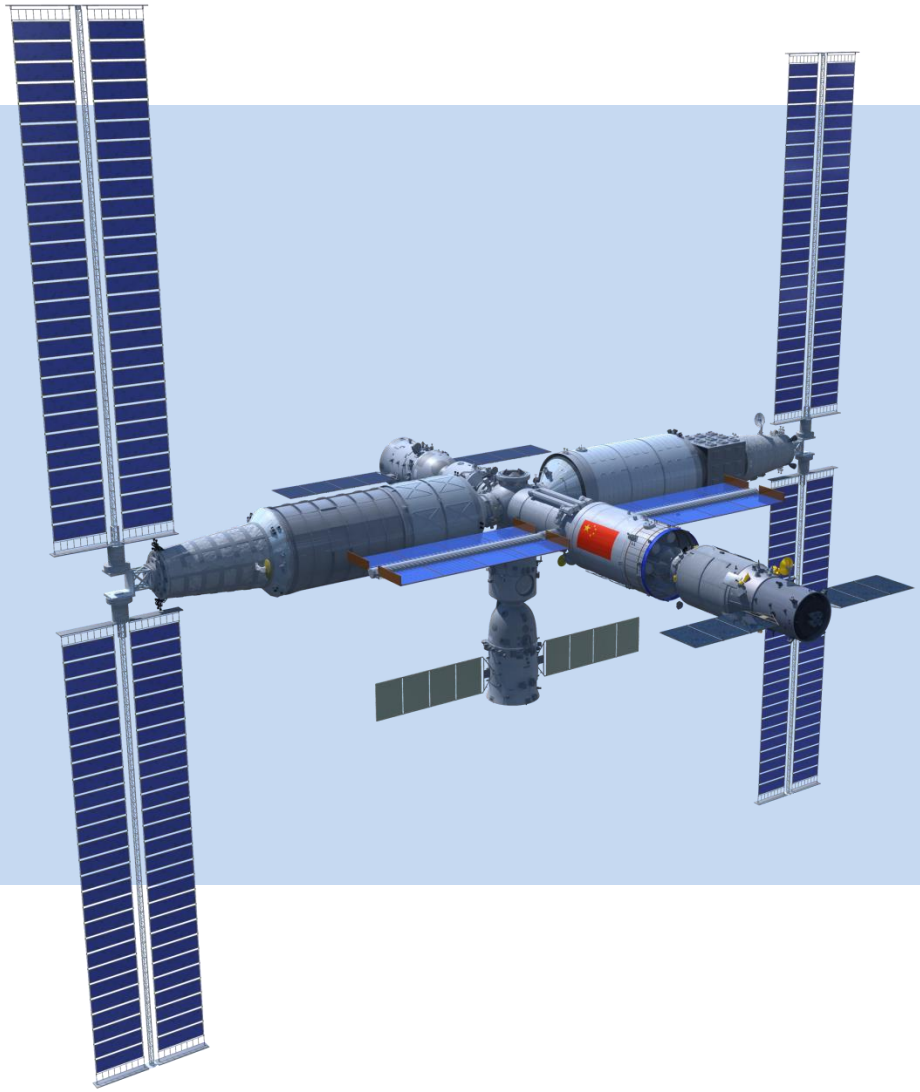
- XunTian optical telescope
- Be launched separately
- Common orbit flight with CSS
- Supporting research in space astronomy and related fields.

- 3 crews, temporarily 6 during crew rotation,
- support large scale space science experiments with man-tending on a long-term basis.

Construction progress of China Space Station (CSS)

China Manned Space Agency (CMSA)

/ Introduction of CSS construction



More complicated and technically challenging

A large number of core technologies:

long-term manned flight

in-orbit assembly and construction

material supply in bulk

space robotic manipulator and extravehicular operation

research an development of large module

new generation launch vehicle

……

Construction progress of China Space Station (CSS)

China Manned Space Agency (CMSA)

/ Mission of Tianhe Core module

April 29th 11:23 a.m. (Beijing Time)，by Long March-5B/Y2 launch vehicle

- ✓ Function tests on rendezvous and docking, astronaut space stationing and robotic manipulator
- ✓ In-orbit performance checks of space application equipment

Core module was functioning and operating in good condition, well prepared for the follow-up missions

Tianhe Core Module

Equipped with :

Robotic manipulator

regenerative environmental control and life support system

container-free material science rack

medical sample analysis and high microgravity science experimental system

human system research rack

……

The successful launch marks the on-orbit construction of CSS in full swing, laying a solid foundation for subsequent key technology demonstration and smooth assembly and construction of CSS.

Construction progress of China Space Station (CSS)

China Manned Space Agency (CMSA)

/ Mission of Tianzhou-2 Cargo spaceship

May 29th 20:55 (Beijing Time), hosted on Long March-7, at Wenchang Launch Center

May 30th 5:01 (Beijing Time), in about 8 hours, docking to Tianhe Core Module in autonomous rapid rendezvous and docking mode

Propellant refueling and space application equipment testing was carried out according to the schedule

Tianzhou-2 Cargo spaceship

Carrying capacity of 6.9 tons, carrying ratio > 50%

The materials uploaded includes :

- Astronauts' living materials
- China’ s self-developed new generation of "Feitian" EVA suits
- Platform equipment
- Application payloads and propellants

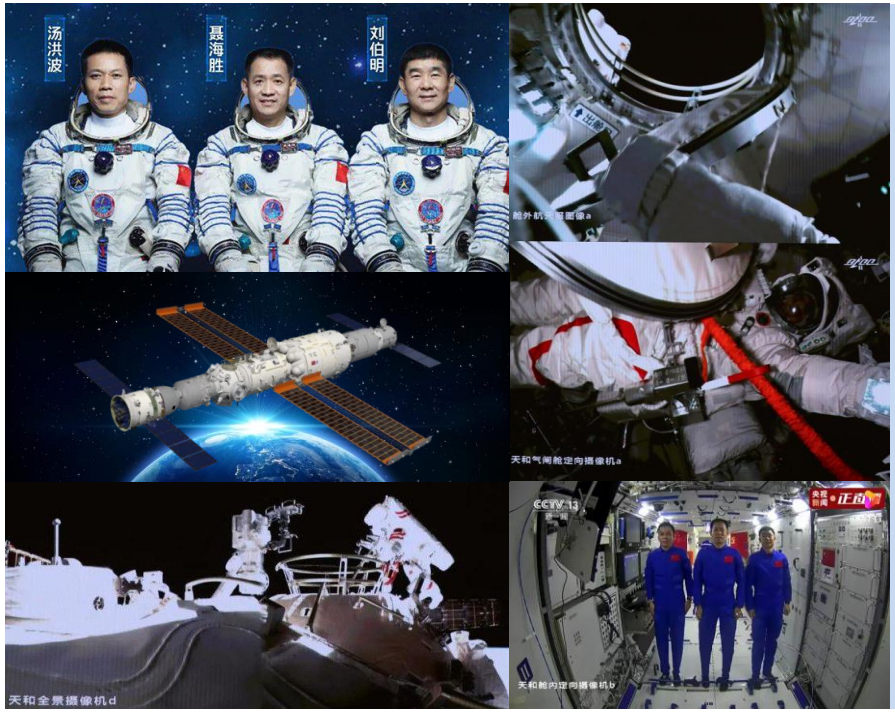
The first application flight of the cargo transportation system composed of Tianzhou Cargo spaceship and Long March-7 launch vehicle

Construction progress of China Space Station (CSS)

China Manned Space Agency (CMSA)

/ Mission of Shenzhou-XII Manned Spaceflight

June 17th 9:22 a.m. (Beijing Time), by Long March-2F Y12 carrier rocket, from Jiuquan Satellite Launch Center
3 crew astronauts: ending Nie Haisheng, Liu Boming and Tang Hongbo
About 6.5 hours later, the spaceship successfully completed autonomous rapid rendezvous and docking to Tianhe Core Module, forming a complex with the orbiting Tianzhou-2 Cargo spaceship



The crew of Shenzhou XII spaceship,would stay in-orbit for 3 months

Conduct:

Daily management of the complex

EVA and operations

Space science experiments and technical demonstrations

Crew health care.

On July 4th and August 20th, two EVA were conducted, successfully completed various extravehicular tasks as scheduled.

The first manned flight in CSS phase, CSS welcomed the first crew of space visitors.

International Cooperation / Overall International Cooperation

Principles:

Peaceful use of outer space
Equality and mutual benefit
Joint development

UN Member States

Human SpaceTechnology Initiative (HSTI)

UNITED NATIONS Office for Outer Space Affairs

Cooperation areas:

- Collaborative development of devices, components, subsystems, modules
- Space science experiments onboard Station
- Astronaut selection / training / flight
- Application of human space technology

ROSCOSMOS
esa
agenzia spaziale italiana
DLR
cnes CENTRE NATIONAL D'ÉTUDES SPATIALES
SUPARCO

International Cooperation / Overview of cooperation with UNOOSA

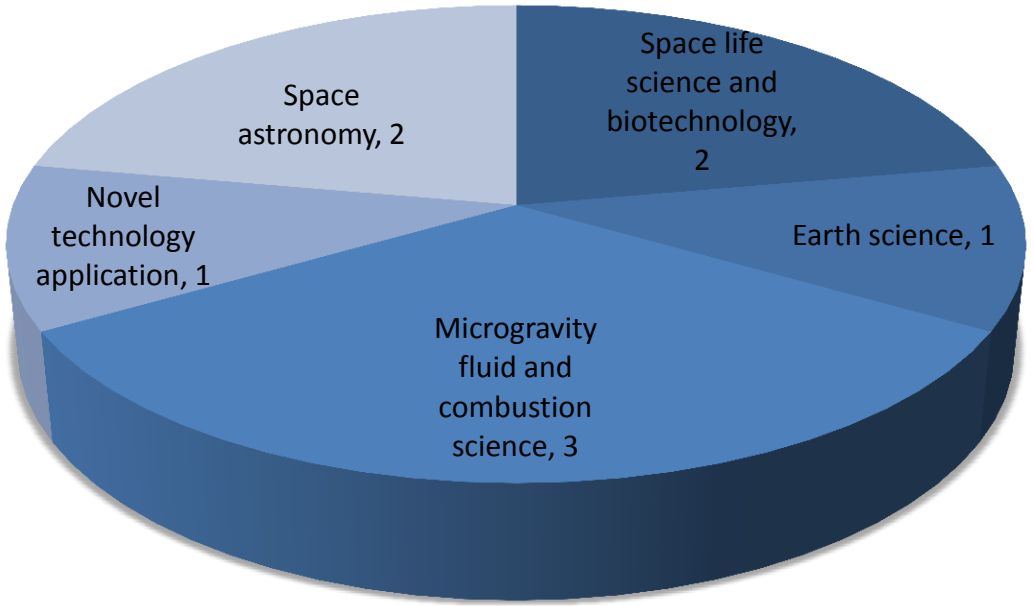
China Manned Space Agency (CMSA)

List of selected space science experiment projects for the 1st cycle concerning UN/China cooperation on the utilization of China Space Station
联合国\中国围绕中国空间站应用开展空间科学实验第一批入选项目清单

No. 序号	Project Title 项目名称	Name of Organization 申请单位	Country of Organization 申请国家	Research Area 研究领域
1	POLAR-2: Gamma-ray burst polarimetry on the CSS POLAR-2: 中国空间站上的伽玛暴偏振探测仪	1. University of Geneva 2. National Centre for Nuclear Research (NCBJ) 3. Max Planck Institute for Extraterrestrial Physics 4. Institute of High Energy Physics, Chinese Academy of Sciences 1.日内瓦大学（瑞士） 2.国家核研究中心（波兰） 3.麦克斯普朗克外层空间物理研究所（德国） 4.中国科学院高能物理研究所（中国）	1. Switzerland 瑞士 2. Poland 波兰 3. Germany 德国 4. China 中国	Astronomy in Space 空间天文学
2	Spectroscopic investigation of nebular gas 星云气体的光谱研究	1. Indian Institute of Astrophysics 2. Institute of Astronomy of the Russian Academy of Sciences (INASAN) 1.印度天体物理研究所（印度） 2.俄罗斯科学院天文研究所（俄罗斯）	1. India 印度 2. Russia 俄罗斯	Astronomy in Space 空间天文学
3	Behavior of partially miscible fluids in microgravity 部分混相流体在微重力下的行为研究	1. Indian Institute of Technology (BHU) 2. University of Brussels 1.印度理工学院（印度） 2.比利时布鲁塞尔自由大学（比利时）	1. India 印度 2. Belgium 比利时	Microgravity Fluid Physics and Combustion 微重力流体物理与燃烧
4	BARIDI SANA - High performance Micro 2-Phase cooling system for space applications 高性能微两相冷却系统的空间应用	1. Sapienza University of Rome 2. Machakos University 3. In Quattro s.r.l., Italy 1.意大利罗马萨皮恩扎大学 2.肯尼亚马查科斯大学 3.意大利 In Quattro s.r.l.公司	1. Italy 意大利 2. Kenya 肯尼亚	Microgravity Fluid Physics and Combustion 微重力流体物理与燃烧
5	Mid infrared platform for Earth observations 中红外地面观测平台	1. National Institute of Astrophysics Optics and Electronics (INAOE) 2. Benemérita Universidad Autónoma de Puebla (BUAP) 1.墨西哥国家天体物理光学电子研究所(墨西哥) 2.普埃布拉自治大学(墨西哥)	Mexico 墨西哥	Earth science in space 地球科学
6	Flame instabilities affected by vortices and acoustic waves (FIAVAW) 受涡流和声波影响的火焰不稳定性研究	1. Tsinghua University 2. The University of Tokyo 1.清华大学 2.东京大学	1. China 中国 2. Japan 日本	Microgravity Fluid Physics and Combustion 微重力流体物理与燃烧
7	Development of multi-junction GaAs solar cells for space applications 用于空间应用的多结 GaAs 太阳能电池的开发	1. National Center for Nanotechnology and Advanced Materials 2. King Abdulaziz city for Science and Technology (KACST) 1.国家纳米技术和先进材料中心(沙特) 2.阿卜杜勒阿齐兹国王科学和技术城(沙特)	Saudi Arabia 沙特	Space Utilization Technology 应用新技术
8	Tumors in space: Signatures of early mutational events due to space-flight conditions on 3D organoid cultures derived from intra-individual healthy and tumor tissue 太空肿瘤：来自个体内健康和肿瘤组织的 3D 类器官培养物由于空间条件导致的早期突变特征研究	1. Norwegian University of Science and Technology 2. International Space University (ISU) 3. Vrije University Amsterdam 4. Belgium Nuclear Research Centre 1.挪威科技大学（挪威） 2.国际空间大学（法国） 3.阿姆斯特丹自由大学(荷兰) 4.比利时核研究中心（比利时）	1. Norway 挪威 2. France 法国 3.The Netherlands 荷兰 4. Belgium 比利时	Space Life Sciences and Biotechnology 空间生命科学与生物技术
9	Effect of microgravity on the growth and biofilm production of disease-causing bacteria 微重力对致病菌生长和生物膜产生的影响	1. The Mars Society – Peru Chapter 2. The Mars Society - Spain Chapter 1.火星学会秘鲁分会（秘鲁） 2.火星学会西班牙分会（西班牙）	1. Peru 秘鲁 2. Spain 西班牙	Space Life Sciences and Biotechnology 空间生命科学与生物技术

- ✓ Since 2016, we’ ve been working with UNOOSA to solicit cooperative projects from member states of UN with interest in CSS.
- ✓ After primary and final selection,PESC confirmed the final selection results.
- ✓ In June 2019, CMSA and OOSA jointly announced the result of the selected projects for the first cycle for space science experiments on CSS.

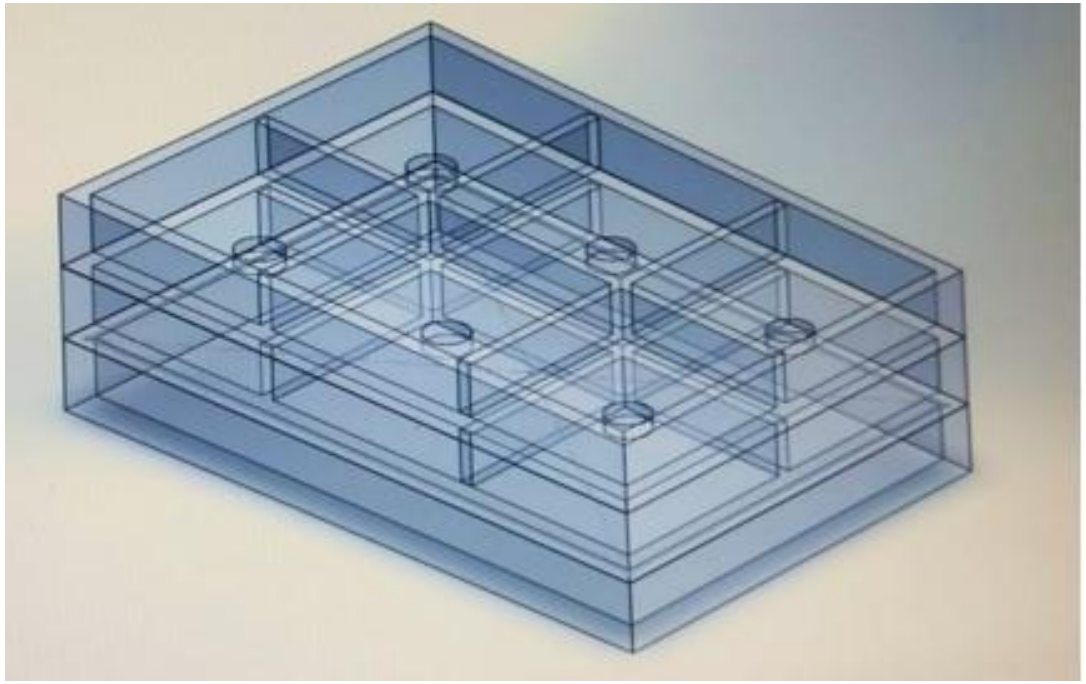
9 projects from 17 countries and 23 entities were selected, indicating a new stage of international cooperation of CSS.



Progress of the first cycle of cooperation projects

Effect of Microgravity on the Growth and Biofilm Production of Disease-causing Bacteria

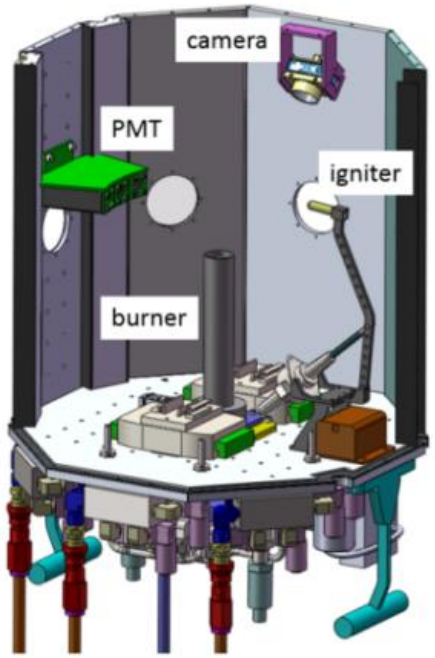
- Jointly applied by Peruvian Branch and Spanish Branch of The Mars Society
- Designed in-orbit experiment duration: 48-72 hours
- The review of experimental scheme and design are expected to be finished in 2021
- Planned to be implemented onboard CSS in the second half of 2022

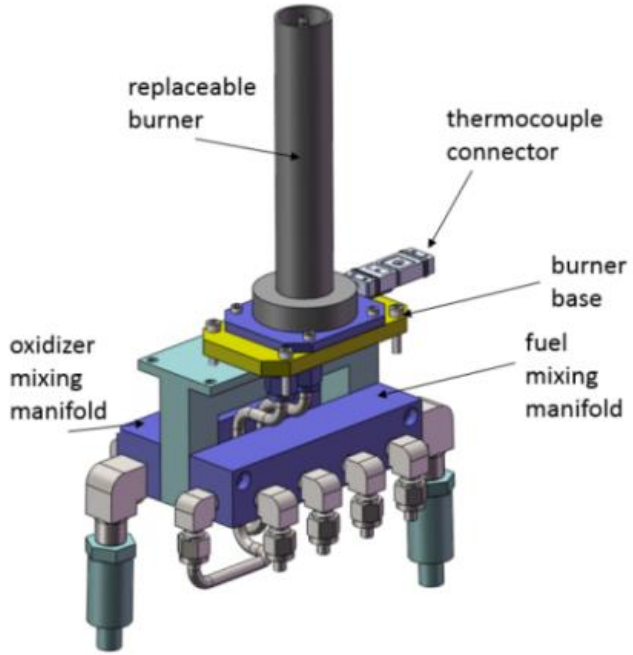


Progress of the first cycle of cooperation projects

Flame Instabilities Affected by Vortices and Acoustic Waves

- Jointly applied by Chinese and Japanese scientists
- Designed to have a 13-month in-orbit experimental research
- The Chinese technical support team has been helping the scientific team for the clarification of the technical indicators, in-orbit experimental resources and research schemes
- The experimental schemes and design review will be completed recently

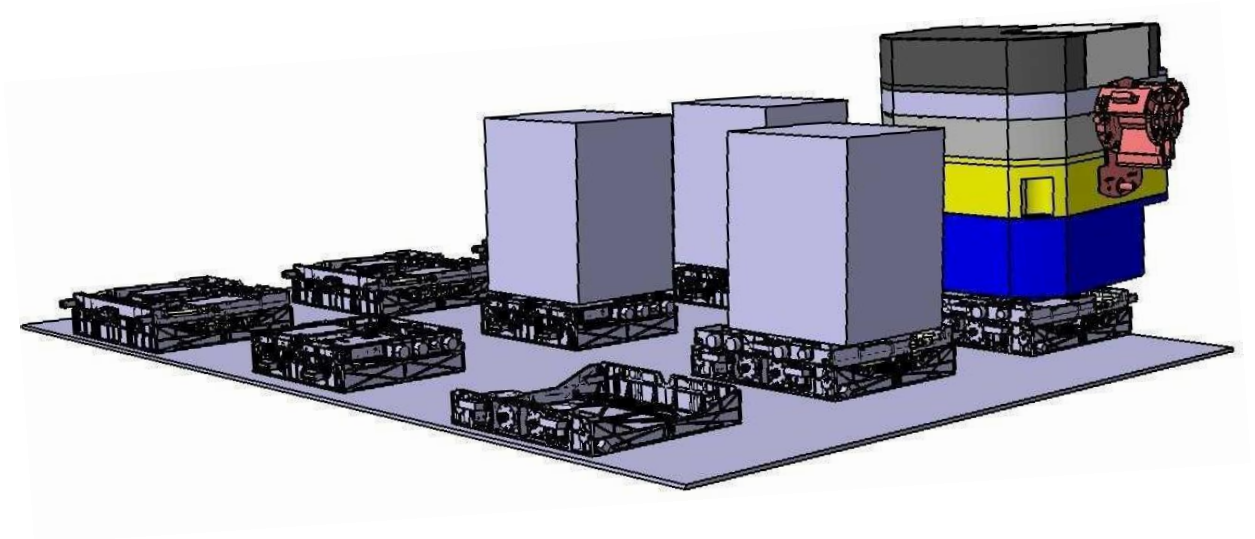




Progress of the first cycle of cooperation projects

POLAR-2. Polarization detection of gamma-ray bursts in CSS

- ✓ Onboard Tiangong-2 space lab, Chinese and European scientists cooperated on the polarization detection of γ-ray burst and completed high-precision polarization detection of the instantaneous radiation.
- "POLAR-2", is γ-ray burst polarization detection onboard CSS
- Jointly applied by Scientists form Switzerland, China, Germany and Poland
- γ-ray burst related to gravitational waves is likely to be detected within the 2-year in-orbit experimental research
- Relevant interface information and upload scheme was defined
- The program scheme design, key technology research and review on scheme and design are expected to be completed this year.



Conclusion

CMSA are working closely with OOSA for further expansion of our cooperation.

- space science and application
- joint flight of Chinese and foreign astronauts
- transformation of technological achievements

We expect to make CSS a great platform for international cooperation, and involve more countries and regions committed to the peaceful use of outer space to be part of the manned space cause.

Thank you

2021-8