Introduction to China Human Space Program

Prof. Gongling SUN

MELiSSA Conference 2020 Nov. 3, 2020

Road Map of Human Space Program in China

Manned Spaceship

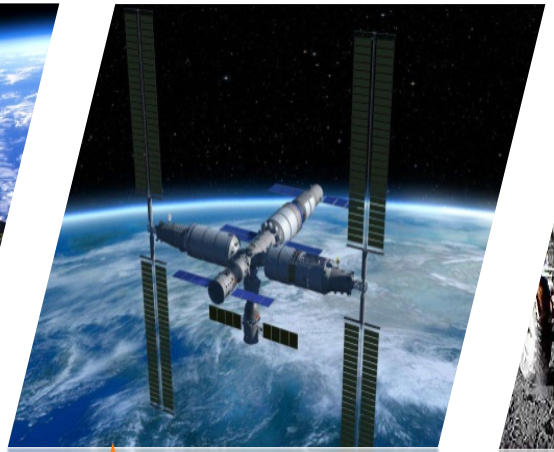
01

- 1992-2005

EVA, RDV and Docking, Spacelab

02

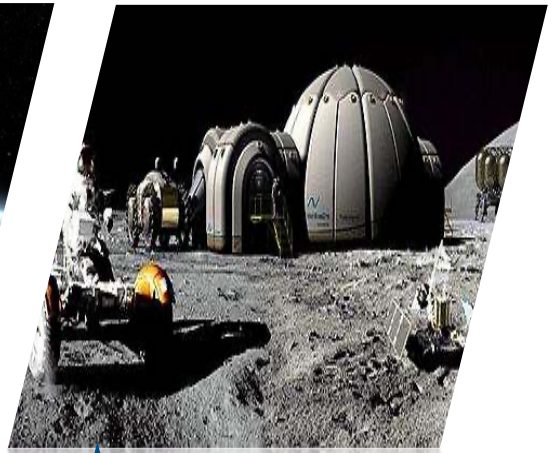
- 2005-2018



Space Station

03

- 2010-2035



Human Lunar Exploration…

04

- to be Continued

Names and Abbreviation

Spacecrafts

Shenzhou (SZ, *divine ship*) : manned spaceship

Tiangong (TG, *palace in heaven*): spacelab

Tianzhou (TZ, *vessel in heaven*): cargo spaceship

Launch vehicles:

Long March(LM): Chinese launch vehicle series, also called Chang Zheng (CZ)

LM-2F: launch vehicle for manned spaceship and spacelab

LM-7 : launch vehicle for cargo spaceship

LM-5 : heavy launch for space station, etc.

Hangtianyuan (*taikonaut, personnel in space)*: Astronaut

Phase 1

Objective is to launch a manned spacecraft, set up primarily integrated experimental manned spacecraft engineering, and carry out space application experiments with 6 flights.

- ✓ Four unmanned missions:
  - *Shenzhou-1* *1999.11.20*
  - *Shenzhou-2* *2001.01.10*
  - *Shenzhou-3* *2002.03.25*
  - *Shenzhou-4* *2002.12.30*
- ✓ Two Manned missions:
  - *Shenzhou-5 (1 astronaut, 1-day flight) on 2003.10.15*
  - *Shenzhou-6 (2 astronauts, 3-day flight on 2005.10.12*

Long March 2F

Phase 2: EVA, RDV and Spacelab

Objective is to 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 with 8 flights.

1. EVA mission: SZ-7 (3 astronauts, 7-day flight)
2. RDV mission: Tiangong (TG)-1 with SZ-8, SZ-9 and SZ-10
3. Spacelab mission:

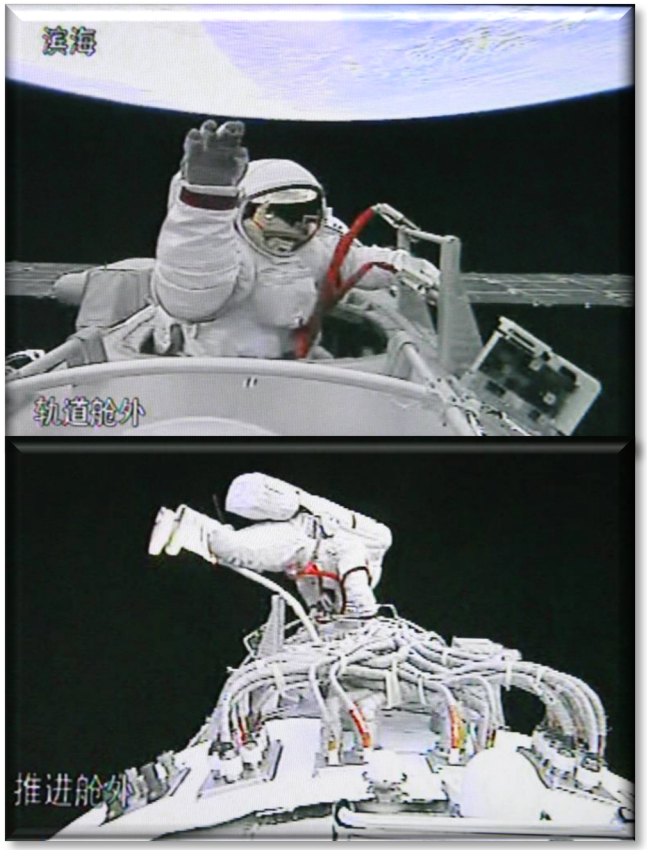
   Tiangong-2 Spacelab

   LM-7 maiden flight with Tianzhou(TZ)-1;

   SZ-11

Key Milestones in Phase 2

1. SZ-7 was launched on Sept.25, 2008 for EVA mission. It was the 3rd human space mission with 3 astronauts for the first extra-vehicular activity (EVA) marked the commencement of the second phase.
2. The mission lasted three day, and it made Chinese space program the third to have conducted an EVA.



Key Milestones in the Second Step

Missions for RDV, docking and Spacelab:

1. Launch of Tiangong (TG)-1 Spacelab and SZ-8 (unmanned) in Sept. 2011
2. First RDV and docking (automatic) of TG-1 (target) with SZ-8 in Sept. 2011
3. Second RDV and docking of SZ-9 with TG-1 in June 2012
4. Third RDV and docking of SZ-10 with TG-1 in June 2013
5. Maiden flight of LM-7 rocket in June 2016
6. Launch of Tiangong-2 Spacelab in September 2016
7. Launch of Shenzhou-11 manned spacecraft in October 2016
8. Launch of Tianzhou-1 cargo spacecraft in April 2017

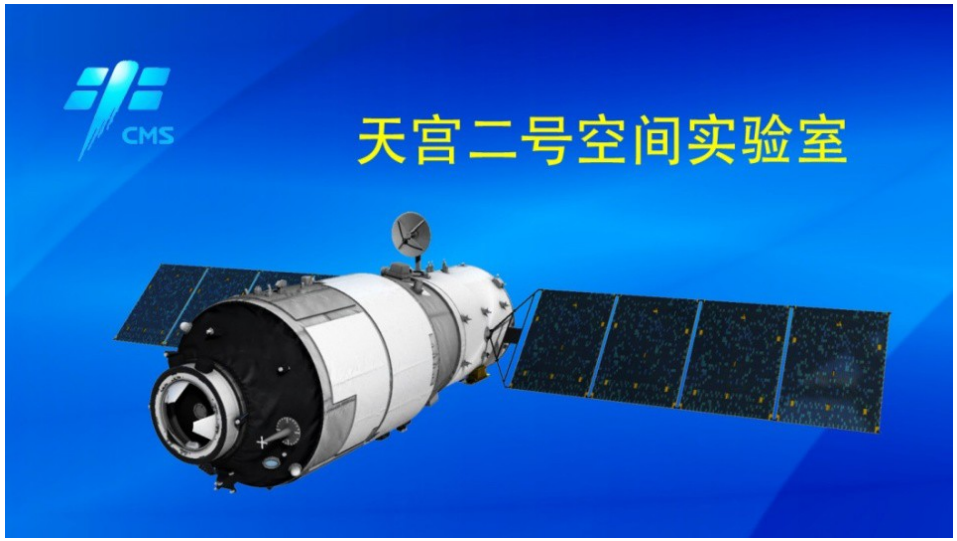
Spacelabs

Objectives of Spacelab：

1. Verify key technologies for:
   - ✓ cargo transportation;
   - ✓ accommodation for mid-term stays of astronauts;
   - ✓ on-orbit propellant re-supply;
   - ✓ ground-based mission long-term support.
2. Carry out space experiments and applications;
3. Accumulate experience for space station construction and operation.

TG-2

1. Total length: 10.4 m;
2. Max. 3.35-meter diameter;
3. Width with solar arrays: 8.4 m;
4. Lifetime: ≥ 2 years;
5. Supply for 3 crew of 60-days stay;
6. Support propellant refueling.



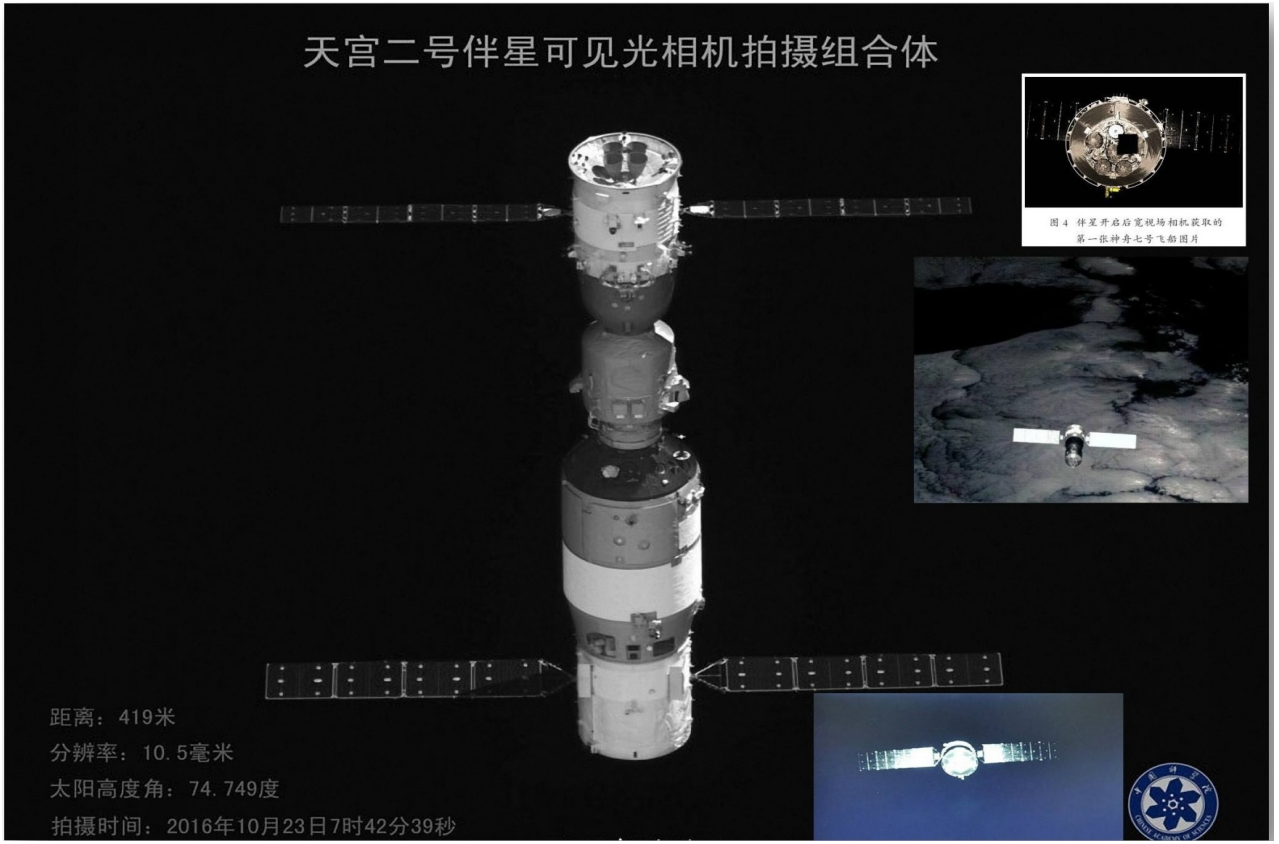
Launched by LM-2F on 15 September 2016 Beijing time, TG-2 was the first spacelab in China with basic physics, space astronomical observation, space life science, space materials science etc. including 2 European payloads: POLAR (CMSA-ESA), CADIO space(CMSA-CNES)

SZ-11 / TG-2 Mission

Launched on Sept. 15, 2016

2 astronauts

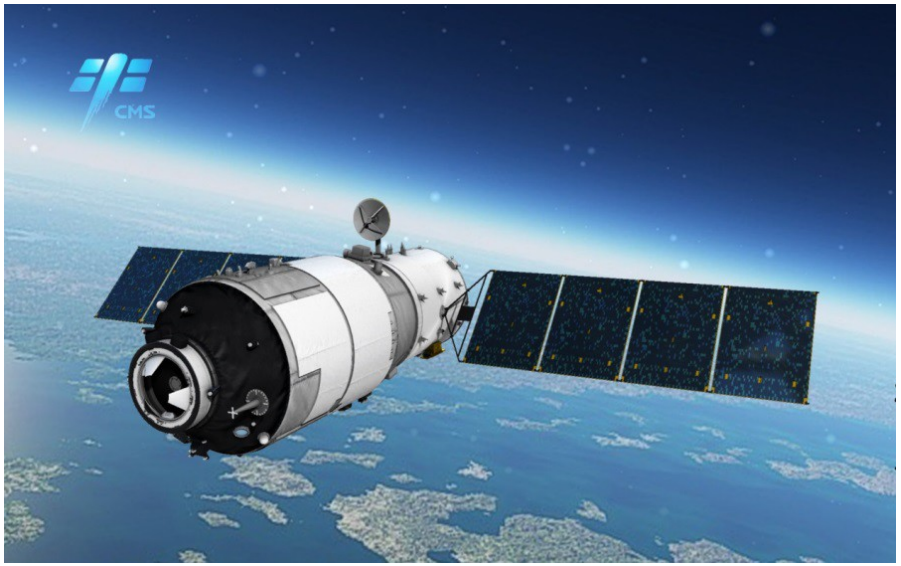
33 days in orbit



Tianzhou (TZ)-1 flight mission

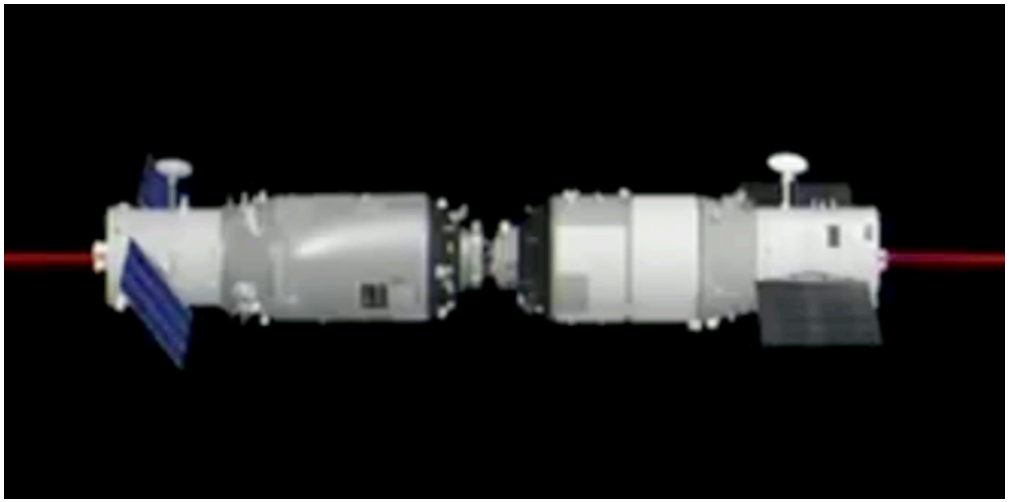
Launched on April 20, 2017 and docked with TG-2 within 2 days.

Propellant refueling, scientific experiments and technical tests, autonomic fast RDV and other series of expansion test



- ✓ 2 modules: pressurized module + propellent module;
- ✓ Length: 10.6m and max diameter: 3.35m;
- ✓ Width with solar arrays' deployment : 14.9m;
- ✓ Total mass: 13 tons with 6 tons of payload.

Spacelab TG-2/Cargo Ship TZ-1



1. The combination of Tianzhou-1 and the Tiangong-2 flight in June 2017; later two spacecraft kept their flight in orbit independently;
2. During this period, space science experiments and technical tests will be carried out and as appropriate to carry out fly around, autonomic fast rendezvous and other series of expansion tests.

Summery of spacelab mission

1. Astronaut mid-term on orbit staying guarantee technology;
2. A complete and effective astronaut selection and training system;
3. The earth-to-orbit transportation systems for both crew and cargo supply;
4. Technology demonstration and evaluation of rendezvous and docking;
5. The capacity for cargo transport and propellent refuel laid the foundation for the supply for the space station operation.
6. The success of operating the first space laboratory accumulated for us human mid-term space flight life supports and guarantee, experience of implementation of large-scale space science and application.

Launcher development: LM-7

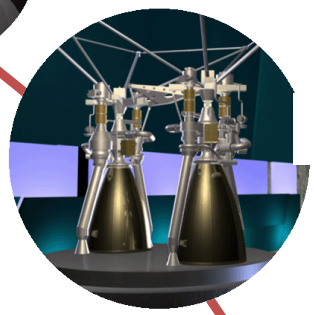
The maiden launch of the Long March-7 (LM-7) rocket with inauguration of the newly built launch site in Hainan on 25 June 2016.

- ✓ Medium launch vehicle;
- ✓ Two stages and four boosters;
- ✓ Engines with kerosene and LOX;
- ✓ Height: 53.1 meters;
- ✓ Liftoff mass: 597 tons;
- ✓ Launch capacity: 13.5 tons / LEO;
- ✓ Cargo supply of Chinese space station.

Launcher development: LM-5 and LM-5B

The maiden flight of the Long March-5 (LM-5) in November 2016 and launch of LM-5B in May 2020, respectively.

120t LOX-kerosene engine

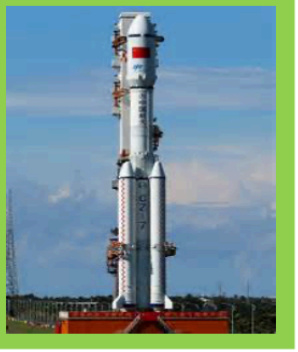


50t LOX/LH engine

LM-5

- Non-toxic, pollution-free, high reliability
- 25t (LEO), 14t (GTO)
- First flight expected in 2016

- **Cargo transportation**
  - Pressurized, semi-pressurized, unpressurized
  - Transport airtight cargo, large extravehicular payloads, experiment platform
  - To be launched by CZ-7
  - At China Wenchang Space Launch Site



- **Crew transportation**
  - Shenzhou (SZ) Spaceship
  - CZ-2F launch vehicle
  - Crew members: 3
  - Crew rotation: up to 6 months
  - Launch site: Jiuquan

- **Station modules**
  - To be launched by the CZ-5B
  - At China Wenchang Space Launch Site.
  - Complete construction in 2022

Phase 3

The phase 3 is to deploy a space station and provide a solution for space application of larger scale with human-tending on a long-term basis by the end of 2022.

China Space Station (CSS)

CSS Configuration:

The basic configuration

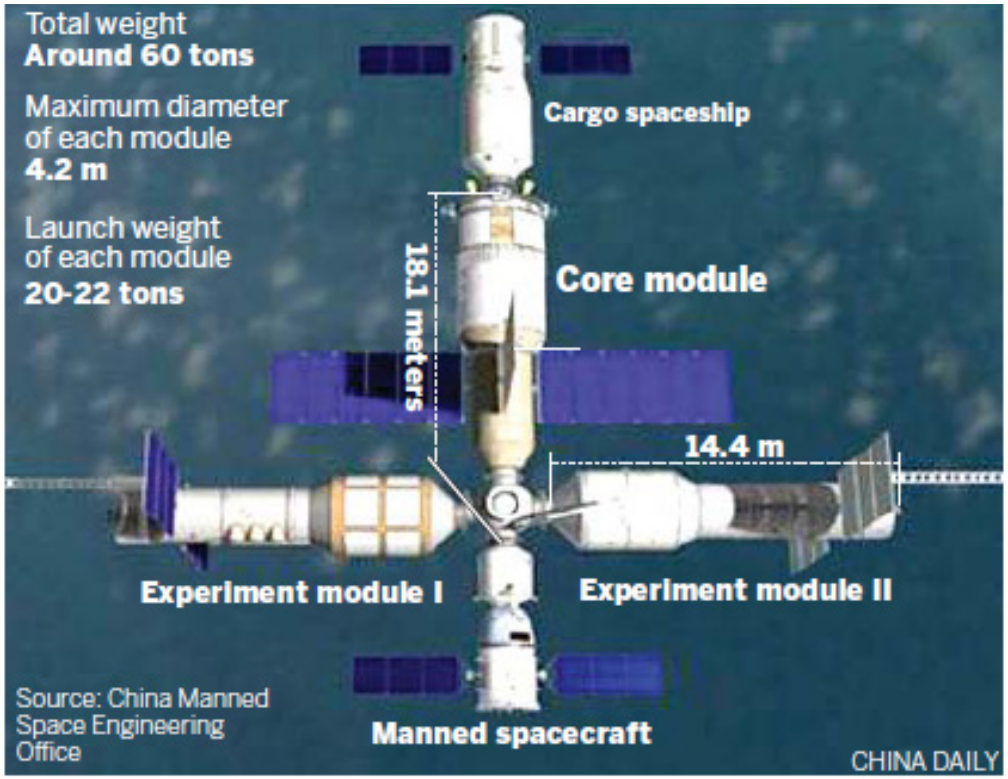
- Core Module (CM)
- Experiment Module I (EM I)
- Experiment Module II (EM II)

Inclination: 41° ~ 43°

Altitude: 340~450 km

Lifetime: >=10 years

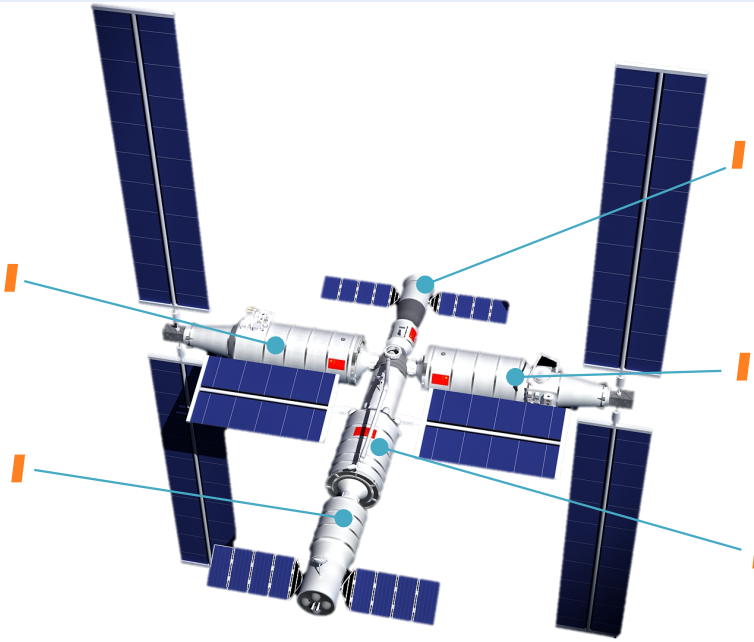
Crew members: 3 for daily work
6 for rotation



Expansion Capability:

Upon future requirements for utilization and international cooperation, newly built modules could be added to the Station.

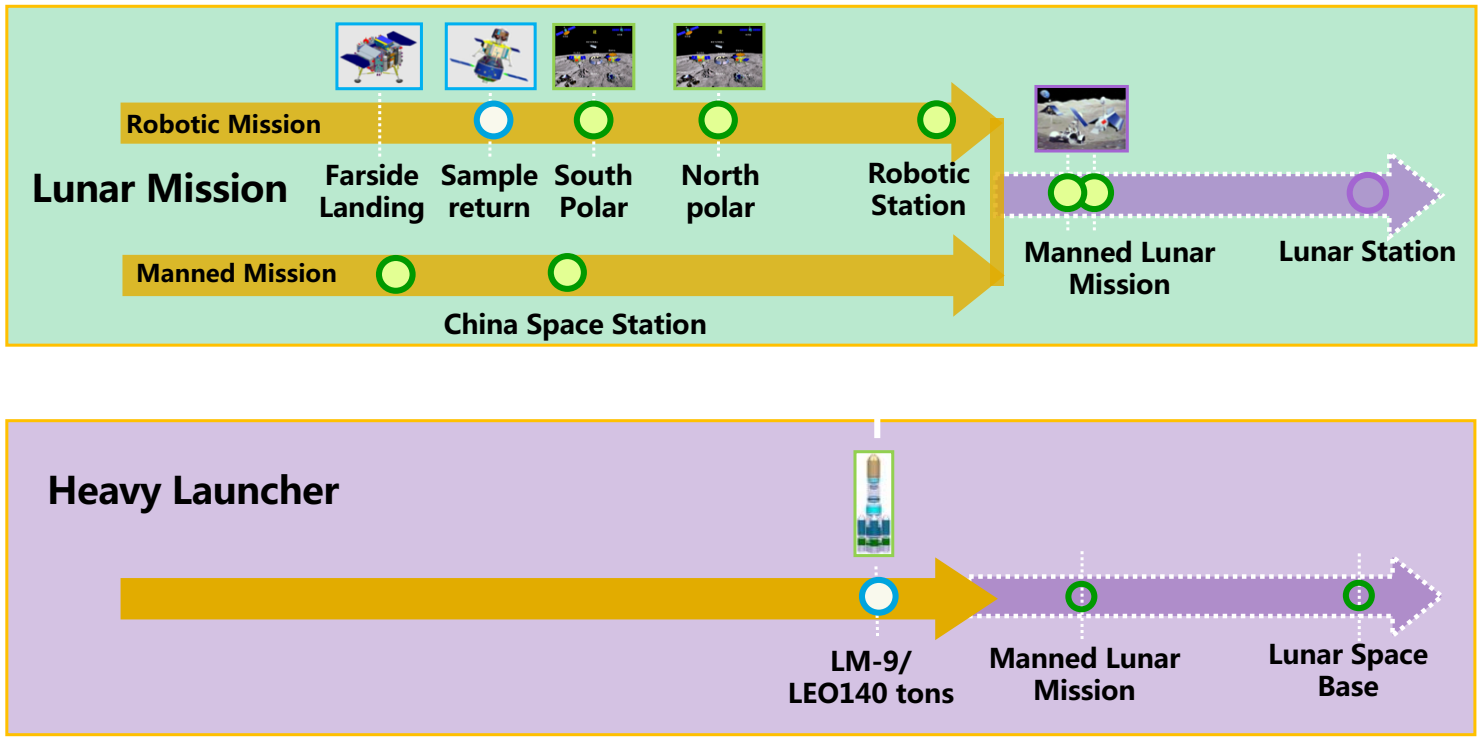
CSS Facts and Figures

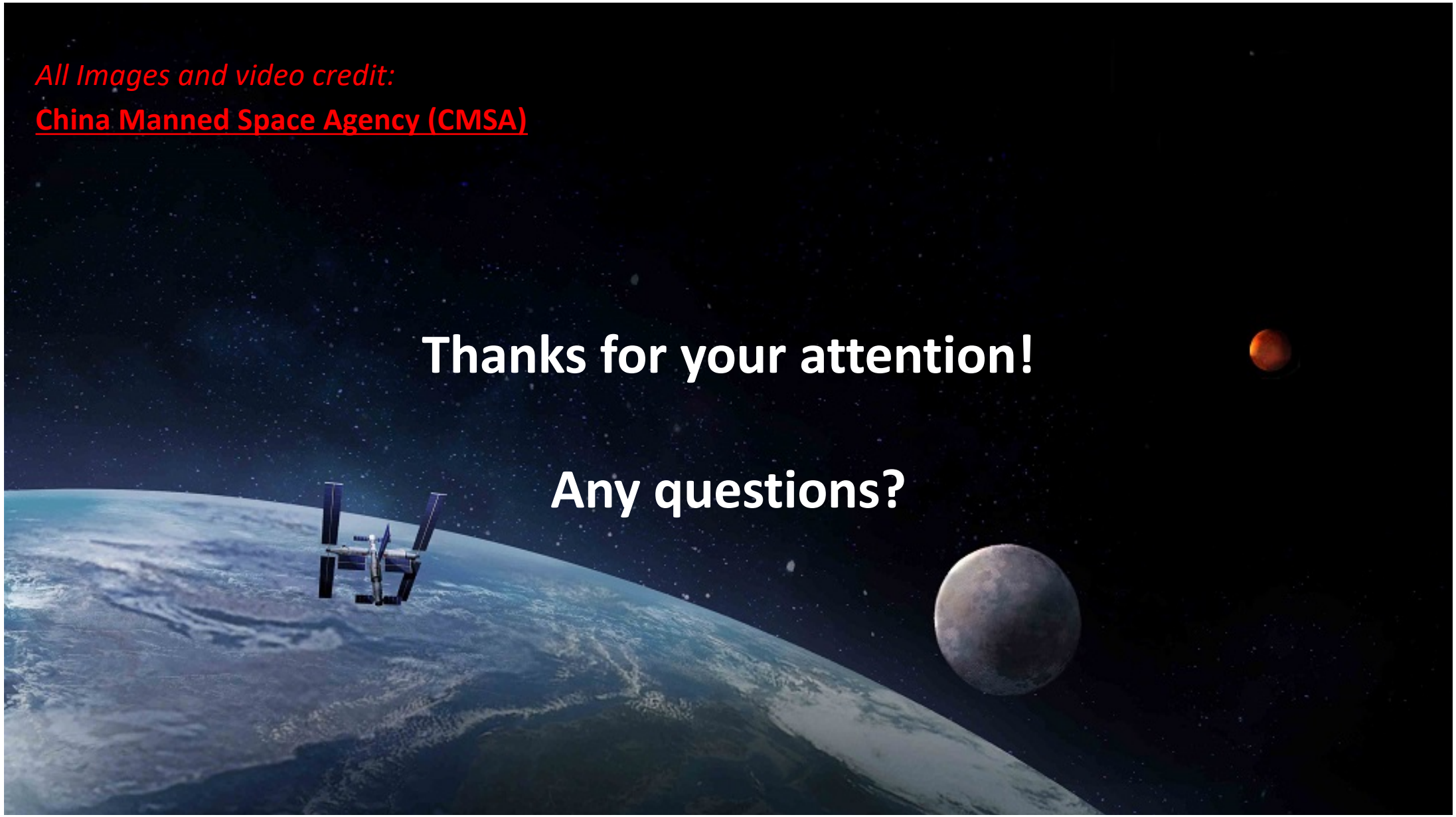


Altitude	**350-450km**
Lifetime	>10 years
Microgravity	10^{-3} - 10^{-5} g
Payloads support	17 tons , 12kW
Crew on board	3
Cargo ship	6 t to orbit

Experiment Rack	**26, placed in pressurized cabin**
Payload adaptor	67, placed on exposed platform
In-orbit storage capacity	1000 Tbits
In-orbit Computing rate	10 Tflops

Looking to the Future ……




All Images and video credit:
China Manned Space Agency (CMSA)
Thanks for your attention!
Any questions?