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returns with  
37,000 runners

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# CHINA DAILY

香港版  
HONG KONG

MONDAY, February 13, 2023

中國日報

[www.chinadailyhk.com](http://www.chinadailyhk.com) HK \$10

## CHINA

## Spacecraft controllers aim for the heights

Like many office workers, Hu Guolin and his colleagues deal with figures, charts and graphics on their computer screens.

However, the information in front of Hu's team comes from Earth's orbit or even places hundreds of millions of kilometers away.

From the first day of its existence, people working at the Beijing Aerospace Control Center — like Hu, some of the smartest minds in China — have been tasked with applying their talent and expertise to realize the nation's ambitions in orbit, ranging from building a permanent space station to operating rovers on extraterrestrial bodies.

Established in 1996 to serve the nation's manned space program, the center has played an indispensable role in all crewed space activities. It is also the country's top body responsible for controlling and tracking deep-space missions.

During the past two years, mission controllers at the center, which is located inside the strictly guarded Beijing Aerospace Control Center in a northwestern suburb of the capital, have often appeared on television monitoring spacecraft operations, calculating trajectories, uploading commands and conversing with astronauts.

The controllers in aquamarine uniforms with the "China Space" logo on the back, were attentive, energetic and sharp-eyed on TV.

Behind that glamorous appearance, though, the work of these men and women is demanding, challenging and painstaking.

The nonstop flow of information related to trajectories and positions pours into the windowless control halls 24 hours a day from orbiting spacecraft and telemetry stations across the country, as well as tracking ships on the oceans.

The controllers monitor the data with rapt attention, make quick decisions on the measures to take in the event of alarms about in-orbit malfunctions or emergencies, and produce specific plans for the next step of each mission.

"The controllers on the Tiangong space station program work 12-hour shifts that start at 8 am or 8 pm. Their job requires them to be utterly focused on information that changes in a matter of minutes or even seconds. Actually, they spend much longer than 12 hours every day because they need to attend briefings before and after their shifts, and also often need to participate in workshops on mission details," Hu, head of the controllers in charge of long-term spacecraft operations, said during a recent media tour at the center.

The Tiangong space station was completed at the end of last year, after 12 launch missions.

As one of the largest space-based assets ever deployed in Earth's orbit, the station currently consists of the core command module, the Tianwen and Mengtian lab modules, the Shenzhou XV crew spacecraft, and the Tianzhou 5 cargo ship.

So far, four groups of astronauts have lived and worked inside the facility. The current crew — the three

Experts at a center in Beijing oversee operations of crews and missions, ensuring that nation's program continues to build upon recent successes. **Zhao Lei** reports.



**Top:** Members of the ground crew celebrate the successful launch of Shenzhou XI in 2016. **Above:** Photos of the lander (left) and the Yutu 2 rover from the Chang'e 4 robotic mission on the surface of the moon, taken by each other. PHOTOS PROVIDED TO CHINA DAILY



Hu Guolin, head of controllers in charge of long-term spacecraft operations, at the Beijing Aerospace Control Center.

members of the Shenzhou XV mission — arrived in November. The astronauts are scheduled to live on the station until May, when the crew of Shenzhou XVI will take over.

#### Busy days

On a typical day shift in the space station operations team, the controllers start work by contacting and communicating with the astronauts inside Tiangong. A designated con-

troller talks with the crew members about the arrangements for the day and notes their needs.

Meanwhile, those in charge of the tracking apparatus relay the daily tasks to tracking stations and ships, and ensure that they are able to do their jobs. The controllers also need to amend arrangements for tracking stations and ships and relay satellites whenever any of the assets are not functioning properly, Hu said.

"Some controllers are responsible for uploading commands. They prepare orders for the spacecraft based on what the mission planners want the vehicles to do, then send the signals to the spacecraft in accordance with predetermined schedules," he said. "For instance, when the astronauts want to sleep, we will upload an order to the station's alarm system to shut down the voice alarms."

The chief controller said that there are many unpredictable factors when it comes to operating large orbiting infrastructure such as a space station in near-Earth space, which is already crammed with satellites and debris.

"It is not unusual that we have to

move our space station higher or lower than its normal altitude to avoid incoming hazardous debris — and that is never easy," he said.

"Adjusting a spacecraft's position is not as simple as just typing some codes and sending them out, as some people may imagine. It requires systemic considerations: you must decide which tracking station or ship will upload the commands and monitor the spacecraft during the process; you need to pick another station or ship as backup; you also need to take a host of factors into account, including the orbital adjustment's impact on the space station's condition, like its power generation and the operation of internal equipment."

He added that the controllers must have clear, sharp minds and be quick and decisive to figure out solutions to potential risks.

"Not long ago, an alarm warned that the barometric pressure inside the Tiangong station was falling rapidly; if that were really happening, the situation would be highly dangerous for our mission crew. So, we immediately collected and ana-

lyzed all the readings and concluded that it was a false alarm caused by minor sensor errors," he said.

#### Ultimate goal

To further improve their efficiency and capabilities, the controllers continue to study and use cutting-edge technologies such as cloud computing and artificial intelligence, according to Hu.

"I am sure that AI technology has great potential in spacecraft control — for example, in the assignment of personnel duties and orbital positioning," he said.

He added that all the efforts have one ultimate goal, which is to guarantee the astronauts' safety and the long-term, smooth operation of the space station.

"Our task is to make the astronauts feel safe and comfortable, and let them know that they have our full support and that of the entire nation; so they can do their jobs in a happy mood," he said. He noted that he and his colleagues often meet the astronauts in person, sometimes formally and sometimes informally.

"We all work inside the Beijing Aerospace City compound. Our office building and some of our residences are close to the Astronaut Center of China, so we often run into the astronauts," Hu said.

"Sometimes, when we go jogging before or after work, we find some astronauts running beside us. We also take part in preflight workshops and ground simulations with them. There are discussions and debates between us, and even though the astronauts may not remember our names, we know that they trust us and that we are all striving for the same goal."

#### 'Loud and clear'

For Yuan Xudong, head of the center's communication engineers, his team's most important duty is to ensure that the astronauts and the ground control are always "online." He and his engineers are in charge of establishing and maintaining communications between the center and spacecraft.

"The more reliable our communications system is, the smoother the link between our controllers and the astronauts is," he said.

"It is our responsibility to make the voices of the astronauts and controllers loud and clear, and that they can be heard by all posts throughout the ground control network."

In addition to the routine work, Yuan's team now has a new task. The members are required to provide a video link between the astronauts and tens of millions of school students in China for the Tiangong Class science lectures.

Launched in December 2021, the Tiangong Class is China's first extraterrestrial lecture series. It aims to popularize space science and inspire young people to pursue their science and space dreams. Every flight crew since the Shenzhou XIII mission has delivered one or two lectures during their stay in orbit.

"I took part in the preparations for China's first space-based science lecture, hosted by the Shenzhou X mission crew in June 2013. Compared with that time, we now have more knowledge and experience in how to interact with our communication stations and better land- and space-based infrastructure," he said.

Each time a Tiangong Class lecture takes place, schools across the country arrange for their students to watch. Sometimes, the students are allowed to repeat the experiments shown in the lecture.

After one recent lecture, Yuan was invited by his son's classmates — all primary school students — to share some interesting stories behind the lecture and some information about spacecraft communications.

"I am always full of curiosity about the world and the universe. These lectures will plant the seed of science in the students, which will want to blossom and bear fruit," he said.

"Every time I realize that through our work, we can lead girls to experience the wonder and magic of outer space, I am filled with a sense of honor and mission."

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#### FIRST PERSON

## The work is addictive and always surprising

**Bao Shuo, 30, the first female chief controller at the Beijing Aerospace Control Center**

To me, the job of chief controller is challenging and exciting. It is all about exploration, and you will quickly become addicted and surprised as long as you can accept the challenges.

For example, during the Chang'e 5 robotic mission, we operated the probe in carrying out a number of sophisticated maneuvers that required great accuracy.

Under our guidance, the craft drilled and scooped up 1,731 grams of dust and brought the samples back to Earth.

They are being used for scientific



Bao Shuo (second from left), China's first female chief controller, is pictured as she directs a mission.

studies and public exhibitions. What is remarkable is that some of them have been kept inside a special storage facility in Shaoshan, Hunan province, the city where Chairman Mao Zedong was born.

This was our answer to the chairman's expectations that we, the Chinese people, should go to the moon to explore it.

After decades of "running and catching up," we have finally placed our national flag on the moon and shown the world the power of our science and technology. I am proud to have been part of the mission.

During the Tianwen 1 Mars mis-

sion, we all knew that failure was highly likely, because previous attempts by other nations had proved that it is very difficult to safely land a craft on the Red Planet.

So, when we saw that the probe was moving in accordance with pre-set programs, then green lights on the computer screen began to twinkle and all the maneuvers were completed based on our plans. It just felt, very cool and a little surreal. It was like we were flying an invisible kite and it had made it all the way to Mars.

Bao Shuo speaks with Zhao Lei.

## Large number of launches planned

By ZHAO LEI

China plans to carry out more than 70 launch missions this year, according to the nation's major space contractors.

China Aerospace Science and Technology Corp, the nation's dominant space enterprise, has more than 60 launch missions planned for this year, and it aims to deploy more than 200 spacecraft in orbit, according to the *Blue Book of China Aerospace Science and Technology Activities in 2022*, which was compiled and published by the company last month.

The document reviews China's space programs during the past year and briefly introduces CASC's plans for the next 12 months.

The planned spaceflights include two manned missions — Shenzhou XVI and XVII — and the Tianzhou 6 robotic cargo flight to the newly assembled Tiangong space station.

Three backup satellites for the Beidou Navigation Satellite System are scheduled to be launched to further strengthen the reliability of



A 2018 photo of the Earth and the moon taken by the mini-satellite Longjiang 2, which is deployed in lunar orbit with the Queqiao 2 relay satellite.

the network, currently China's largest civilian satellite system and one of four global navigation networks. The system has 45 satellites in active service at present.

In addition, the blue book says that CASC will place dozens of Earth-observation, weather, communications and experimental satellites to serve socioeconomic development.

In addition to the rocket launches, the company will continue with the research and development of the Tianwen 2 asteroid probe and the Chang'e 7 lunar probe, accord-

ing to the document. The Tianwen 2 mission is scheduled for launch in about 2026 to deploy a probe on an asteroid to collect and bring back soil samples.

The Chang'e 7 mission will land a sophisticated multipart spacecraft on the moon's South Pole some time around 2026 to search for trace elements, water, investigate the satellite's environment and weather, and survey its landform.

Another State-owned space contractor, China Aerospace Science and Industry Corp, is planning 10 spaceflights using its Kuizhou 1A and Kuizhou 11 solid-propellant rockets.

In addition to the State-owned actors, several private companies plan to launch many of their own rockets. However, project managers have said that the implementation of their schedules depends on the government's launch bases can spare service towers for them to use.

Last year, China conducted 64 rocket liftoffs, transporting 188 spacecraft into space, which were both national records.