



All About The C

Go TAIKO

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刘洋
Yang Liwei

**Living in the
Heavenly
Palace**

Editor's Note

The Shenzhou 9 manned space mission will have been the most noticeable event of this year. The launch took place in June as expected. The unexpected thing about it was its launch date, which was exactly the same day that Valentina Tereshkova, the first female space traveller ... page 2

Quarterly Report

April - June 2012



Launch Events
 From 30 April to 29 May, China created another record in its history in making five space launches within 30 days. The five launches involved three launch sites, four types of launch vehicles and seven satellites ... page 3

On The Spot

Navigating to Guangzhou - The 2012 Meeting Place for the Navigation World

Impressions from the 3rd China Satellite Navigation Conference - CSNC 2012
 For the third time in a row, the China Satellite Navigation Conference attracted not only Chinese navigation experts, government officials, business ... page 21

Soviet-Chinese Symposium of the British Interplanetary Society

The British Interplanetary Society (BIS), a British organisation for space flight enthusiasts, has for many years been hosting an annual Soviet Symposium, an event dedicated to various aspects ... page 24

Gallery

Shenzhou 9 Mission

... page 29



Living in the Heavenly Palace

The long anticipated historic Shenzhou 9 mission has concluded successfully. It was the most complicated manned mission ever flown in Chinese human space history. Simply looking at the following records reveals ... page 7

Feature

Finding a Female Taikonaut

In 2004, soon after Yang Liwei completed China's first manned spaceflight, sections of the Chinese media began to ask when a Chinese woman would be sent into space, to emulate Yang's feat. The topic was first aired officially by Gu Xulian, President of the All-China Women's Federation, and the general tenor of the 'official' response suggested approval of the idea, at least in principle ... page 13

Commentary

China's First is Asia's Fourth and the Earth's 56th

Here she is: beaming with her special I-am-never-getting-tired smile on her face and launching in a mission which in one sense was already accomplished before it began: Overnight the military Major Liu Yang became China's latest charming ambassador and attracted a global media attention which overshadowed the technical significance of the manual docking mission Shenzhou 9 - Tiangong 1... page 19

Database

Chinese Space Launch History - Part 5
 The most detailed Chinese launch record ... page 26

Shenzhou Missions
 Mission data of Shenzhou's manned and unmanned flights from 1999 to 2012 ... page 28



Editor's Note

The Shenzhou 9 manned space mission will have been the most noticeable event of this year. The launch took place in June as expected. The unexpected thing about it was its launch date, which was exactly the same day that Valentina Tereshkova, the first female space traveller in the world, flew into history 49 years ago. Whether it was carefully selected or not, it was very iconic. This was just because Shenzhou 9 carried China's first female taikonaut, Liu Yang, into space. As in previous cases, Chinese media again produced extensive and comprehensive reports about this mission. And this time they were especially enthusiastic about Liu Yang. This turned out to be good for us (Go-Taikonauts!). The media provided us with a large amount of information, making it easy to write about this historic space flight.

However, sending a female taikonaut into space was not the main objective of this mission. The more important tasks for the Shenzhou 9 crew were to complete the first automatic docking with Tiangong 1 with a crew on-board the Shenzhou spacecraft; to enter the small space station to live for a longer duration; and to make a manually controlled docking with the Tiangong 1 space laboratory. Only with these objectives achieved, could China claim that it had mastered all of the necessary technologies for human space flight in low Earth orbit. It's much more important than a taikonaut's gender. And yes, China has done it.

Here you know why we put Liu Yang's portrait on the cover but gave to the cover story the title "Living in the Heavenly Palace". The cover story is a comprehensive report focusing on the mission, covering all the important events. Besides, we have another two articles about the mission in this issue. The first, an article by Tony Quine from the UK that tells the story of how a small group of people in different places of the world tried to track the names of the Chinese female taikonauts on internet in an effort that lasted for more than 7 years. The second, a commentary by Jacqueline Myrrhe who provides her insights on female taikonauts from a woman's point of view.

While Liu Yang and life under zero-gravity inside Tiangong 1 caught the attention of the media and the public all over the world, two important events related to Chinese space development, attracted scientists, engineers, businessmen and enthusiasts from many different countries. The first was the 3rd China Satellite Navigation Conference held in Guangzhou in mid-May. With the motto "Beidou (COMPASS) Going to Application", it has become one of the largest satellite navigation conferences in the world, indicating the growing influence of the Beidou system. On this occasion 2,500 people participated in the event. In contrast, those who attended the second event, the Soviet-Chinese Symposium of the British Interplanetary Society, were from an exclusive small group, mostly experts and researchers on these topics for many years. We have reports about these two events in this issue.

It has been one year since Go Taikonauts! was first published as an electronic magazine. We have received quite a lot of positive feedback. Many thanks! We will keep up our work and will try to make it better - step-by-step in a thought-through and steady process.

Chen Lan



Imprint

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The Go Taikonauts! Team

William Carey - Dave Chen Qing - Chen Lan - Jacqueline Myrrhe

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Contact us at: info@go-taikonauts.com

Web site: www.go-taikonauts.com

Chinese Space Quarterly Report

April - June 2012

by Chen Lan

Launch Event

From 30 April to 29 May, China created another record in its history in making five space launches within 30 days. The five launches involved three launch sites, four types of launch vehicles and seven satellites in the fields of navigation, communication and Earth observation for civil and military use:

- On 30 April at 04:30, from the Xichang Satellite Launch Centre, a Long March 3B/E (CZ-3B/E) sent the Beidou M3 and M4 (MEO) navigation satellites into the pre-set orbit. It was the first dual-sat launch by the CZ-3B. A 10.8 m long new type of faring was used for the first time to deploy the two satellites one by one.
- On 6 May 15:10, a CZ-2D rocket lifted off from the Jiuquan Satellite Launch Centre, carrying the Tianhui 1B mapping satellite. The satellite was put into a sun-synchronous orbit successfully.
- On 10 May at 15:06, the Yaogan 14 and the Tiantuo 1 nanosats were launched on top of a CZ-4B from Taiyuan. Tiantuo 1 is a 9.3 kg single-board nanosat measuring 425 x 410 x 80 mm. It has an AIS (Automatic Identification System) payload, optical imager and space environment detectors. It was developed by the National Defense Science and Technology University that became the fifth Chinese university capable of developing satellites after Tsinghua University, Harbin Institute of Technology (HIT), Zhejiang University and Nanjing University of Aeronautics and Astronautics.
- On 26 May at 23:56, a CZ-3B blasted off from the Xichang Satellite Launch Centre, putting the Zhongxing-2A (Chinasat-2A) military comsat into GTO. It is believed to be the successor of the Zhongxing-20 and 20A satellites, launched in 2003 and 2010.
- On 29 May at 15:31, a CZ-4C launched another Yaogan series Earth observation satellite, the YG-15, into orbit.

The last launch in the second quarter was the long awaited Shenzhou 9 manned launch. It happened at 18:37:24 on 16 June; the 49th anniversary of the flight of the world's first female space traveller, Valentina Tereshkova. The CZ-2F Y9 rocket completed its job perfectly, sending the three-crew spacecraft into an orbit with an error of only 19 m compared to the theoretical altitude.

During the first half of 2012, China made 10 space launches, ranking it number one in terms of number of space launches. Both Russia and the U.S. achieved 9 launches during the same period.

Launch Vehicle

On 31 May, the booster separation test of the Long March 5 launcher was completed successfully in Tianjin. The test article of the booster has a length of more than 20 m and weighs more than 10 tonnes. It was separated within one second, but it took Chinese engineers and workers 16 months to prepare it for the test, including building a 40 m high test tower.

Meanwhile, at another location in the Tianjin New Generation Launch Vehicle Industrial Base, the 93 m high vibration test tower was topped out. This tower has become the highest such facility in Asia and will be ready for use in September. Earlier, in April, the 5 m diameter Long March 5 first stage hydrogen tank passed an X-ray examination, and the second stage hydrogen tank was transported to Beijing for a static load test in cryogenic conditions.

The Long March 5 development has entered its critical phase. The above progress paved the way for its maiden flight in 2014-2015.

A report from CASC entitled "Social Responsibility Report on 2011" revealed two launcher designators in an illustration. The first, the Long March 11, is a small launcher, even smaller than the CZ-6 currently in development. While the second, the Long March 9 (CZ-9) is a super-heavy launch vehicle with an estimated height of more than 80 m, a core stage with an estimated diameter of 8 m and four strap-on boosters with an estimated diameter of 3.35 m. There have been many indications previously that China is performing a trade-off study on using liquid-fuelled boosters or segmental solid boosters for its super launcher. The illustration showed that the solid booster design had probably been dropped. This new revelation is consistent with earlier reports that China has planned a super-heavy launcher with LEO payload capacity of 130 tonnes and launch mass of 3,000 tonnes. However, the new designator does not mean the Chinese government has approved its funding. It is still in an early study phase within CASC.

Engine

In early June, the YF-100 engine finally received acceptance by the State Administration of Science, Technology and Industry for National Defence (formally COSTIND). The project achieved government approval and funding in 2000, and has since accumulated more than 32,000 seconds of test firing time. Before that, the two engine configurations designed for CZ-6 and CZ-7 completed a successful manufacture-processing verification test firing in March and May respectively. The first YF-120 for CZ-6 was delivered in April. The successful conclusion of the YF-100 development was a very important milestone in the Chinese space programme. It marks the end of reliance on toxic and polluting liquid rocket fuel.

The expander cycle YF-75D cryogenic engine also made progress during the second quarter, when it completed the first simulated high-altitude thermal test and the long duration re-ignition test in April and May respectively. The YF-75D is to be used on the second stage of the Long March 5.

Around beginning of June, a new type of plasma ignitor was successfully test fired. It was developed by Institute 11 of the Academy of Aerospace Propulsion Technology (6th Academy of CASC), paving the way for its use in future rocket engines.

One particularly interesting development concerns the engine to be used on the future super-heavy launcher. On 20 June, CASC completed a review on the proposal of a new engine for the mega launcher. The engine was designed by the 6th Academy of CASC (AAPT – Academy of Aerospace Propulsion Technology). To prepare the review, AAPT built a wooden mock-up that took them six months. The wooden engine consumed 20 cubic metres of wood. When it was finally assembled, many experts were shocked by its size, a report stated.

Satellites

During the second quarter, five Chinese satellites completed in-orbit testing and were put into service:

- The Ziyuan 1C (ZY-1C) resource satellite, launched on 22 December 2011, was delivered to the customer, the Ministry of Land and Resources of China, on 14 April. ZY-1C is China's first wide-strip, high-resolution civil Earth remote sensing satellite. Xi'an Satellite Tracking Centre, China Centre for Resources Satellite Data and Application and China Academy of Sciences are responsible for the satellite's operation.
- China's first civil mapping satellite, Ziyuan 3, completed in-orbit testing in April. From 11 to 15 April, a series of satellite laser ranging (SLR) testing was made from four satellite observation stations located in Fangshan near Beijing, Chuangchun, Kashi and San Juan in Argentina. Ziyuan 3 was launched on 9 January 2012.
- In May, another Chinese satellite, the FY-2F geostationary weather satellite, completed in-orbit testing and was put into service. FY-2F was the first of the FY-2 block 3 satellites. During a review held on 17 May, experts confirmed that its scanning radiometer had provided images with much better quality than those by the block 2 satellites.
- On 14 May, Apstar announced that Thales Alenia Space built Apstar 7 comsat started service the same day. It was launched by a CZ-3B on 31 May. After completion of in-orbit testing, the satellite had been moved to a 76.5°E orbit.
- Shiyang 4 (SY-4) has also completed in-orbit testing and was delivered to the customer. Also delivered was the first satellite computer fully made in China with a domestically built space CPU. The computer was developed by the Institute 513 of CAST.

A couple of other already-operational satellites celebrated their anniversary of smooth operation in space. The FY-1D sun-synchronous weather satellite has been in good condition and has provided its service for 10 years, since 5 May 2002. The Haiyang 1B ocean satellite has performed well for 5 years of operation, up to 11 April. These two anniversaries indicate that China has mastered satellite manufacturing technology, and is able to support practical satellite applications.

We also see progress on the development of new satellites and their payloads. The new generation geostationary meteorological satellite, the FY-4, started prototype development. An engineering model of the atmospheric composition detection system, developed by Anhui Institute of Optics and Fine Mechanics (AIOFM), Chinese Academy of Sciences (CAS), completed the acceptance testing organised by SAST. In mid May, the Qian Xuesen Youth Space Academy announced the

plan for the CAS-2 (China Amateur Satellite 2) satellite, which incorporates a dual-sat design and is the successor of the XW-1 amateur satellite launched in 2009, unofficially called XW-2.

Manned Space Flight

During 16 to 29 June, the long anticipated Shenzhou 9 manned mission was performed successfully, made history and marked the dawning of China's space station era. It was the longest Chinese manned space mission to date, lasting 13 days, and a first time space station occupation of 10 days. It also included China's first female taikonaut Liu Yang and the first return-to-flight taikonaut Jing Haipeng. Shenzhou 9 was launched at 18:37:24 on 16 June. After two days of orbital manoeuvres and chasing, it made a successful automatic docking with Tiangong 1 at 14:07, 18 June. Three hours later, Jing Haipeng, Liu Wang and Liu Yang entered the Tiangong 1 space laboratory and started a totally new experience inside Tiangong 1. On 24 June, the three crewmembers returned to Shenzhou 9 and departed their temporary home, moving to the 400 m parking point location, and then performed the first manual docking accomplished by Liu Wang at 12:48. Successful completion of the manual docking and the occupation of Tiangong 1 has proven that China has fully mastered all the technologies required for manned space flight in LEO. During their 10-day occupation of Tiangong 1, the crew acquired a lot of useful experience not achieved in previous manned Shenzhou missions. On 28 June, Jing Haipeng closed the Tiangong 1 hatch and then Shenzhou 9 undocked from the space lab for the last time, and one day later, at 10:03 Beijing Time, the capsule landed safely in Siziwangqi, Inner Mongolia. Although the capsule experienced an unexpected roll caused by wind during the landing, all three taikonauts were in good condition and egressed the capsule by themselves one hour later.

During the Shenzhou 9 mission, the two Tianlian data relay satellites were put into operational service for the first time. With the Tianlians, the three Yuanwang tracking ships and a number of tracking stations inside and outside of China, Shenzhou 9 tracking coverage was increased to 70 % of the orbit. The newly-launched Tiantuo 1 smallsat, provided AIS (Automatic Identification System) service to the rescue ships that would play an important role in the case of an emergency.

After seven years of hard work, CAST finally secured the project of the space robotic arm on the future space station. It started a concept study in 2005. In 2007, a proof-of-concept prototype was completed in CAST, and in 2008 the system was tested and adjusted. In 2009 CAST completed the design of the engineering model, and in 2011 it passed a design review. As the CAST design has significant advantages, for example, it is self-relocatable which allows it to "walk" on the exterior of the station, it finally won out over all its competitors.

Lunar and Deep Space Exploration

Chang'e 3 development continued to make progress. The payload sub-system of the Chang'e 3 prototype passed a quality review in the National Space Science Centre (NSSC). On 14 June, another review of the flight model of the Chang'e 3 landing-gear was completed. The gear was developed by the Institute of Solid State Physics, Chinese Academy of Sciences

(CAS). Earlier, in April, CAST and the Hong Kong Polytechnic University (PolyU) signed an agreement for the PolyU to further support China's lunar exploration programme. Having already developed the Camera Pointing System for Chang'e 3, it will be involved in the development of the prototype of the Surface Sampling and Packing System used in future Chang'e missions. Previously, PolyU has provided the sampling tool for the UK's Beagle 2 Mars lander and Russia's Phobos-Grunt lander.

On 17 April, the rear framework of the 65 m diameter antenna of the new radio telescope in Shanghai was successfully hoisted to its installation position. On 13 May, its sub-reflector was also raised into position. Once completed at the end of the year, it will become the largest radio telescope in Asia and will support the Chang'3 mission planned for 2013.

On 14 June, CAS academician, Chief Scientist of China's lunar exploration programme, Ouyang Ziyuan, revealed in a presentation during the CAS annual meeting, that the Chang'e 2 probe had left the Sun-Earth L2 point on 15 April and was flying to a Near Earth Object (NEO) - the asteroid 4179, Toutatis. The peanut-shaped Toutatis has a size of about 4.6 x 4.6 km and will make its closest approach to the Earth at about 7 million kilometres on 12 December 2012. Chang'e 2 is planned to make a flyby of the asteroid in early January. The decision for this surprise change of plan is probably based on the good condition of the spacecraft and sufficient remaining fuel in its tank.

Research and Development

On 14 May, the JF12 hypersonic shock-wave wind-tunnel completed its acceptance review in Beijing. The JF12 has a length of 255 m, a nozzle diameter of 1.5-2.5 m, and an experiment section diameter of 3.5 m. It is able to generate hypersonic flight conditions at an altitude of 25-40 km with maximum speed of Mach 9 and maximum temperature of 3,000°C. The JF12 is capable of providing valid experimental time for 100 ms that is reportedly the world number one. Its development cost was about 46 million RMB.

We also witnessed the formation of four new organisations in April and May focused on space technology R&D. The first is the State Key Laboratory of Laser Propulsion and Application, based in the PLA Armament College. It is equipped with an advanced laser propelled demonstration launch system and a full-system laser propulsion research platform. The State Key Laboratory in Fundamental and Applied Studies of Aerospace Medicine that is to support the human space programme, completed construction and started operation in April. Another State Key Laboratory, the State Key Laboratory of Space Dynamics was established in Xi'an on 4 May. It is supported by the Xi'an Satellite Tracking and Control Centre. On the same day, the Aerospace Broadband Network Technology Synergy and Creativity Laboratory was created in Beijing. It was jointly founded by Beijing Space Information Transportation and Relay Technology Centre and Tsinghua University, and will support future manned space flight with high quality communications.

International Cooperation

China is also expanding its space R&D to other countries. The

"Scotsman" reported on 1 May that the Chinese government is to fund a new laboratory at a Scottish university to develop technologies for space stations and spacecraft docking. The landmark agreement between the University of Strathclyde and the CALT is the first time the Chinese organisation has established a partnership with a university outside China.

On 10 April, CAST welcomed a VIP guest, the Turkish Prime Minister Recep Tayyip Erdoğan. The Prime Minister visited the CAST display hall, the thermal vacuum chamber and satellite assembly hall. Erdoğan said that Turkey and China had started cooperation in the field of space and hoped to expand it in future. According to an earlier report, China will launch the Turkey's Gokturk 2 satellite using a Long March launcher.

On 7 June, China and Pakistan signed a 2012-2020 space cooperation outline between the China National Space Administration and the Pakistan Space and Upper Atmosphere Research Commission. Chinese President Hu Jintao and his visiting Pakistani counterpart Asif Ali Zardari witnessed the signing.

China and Kazakhstan signed an agreement on the joint management of two geostationary satellites at the orbital slot of 86.5°E. The satellites involved are Kazsat-2 comsat and China's FY-2D polar weather satellite. China has cooperative management at 140°E for the Beidou 1A, MTSAT and Express-AM3, with Japan and Russia.

During the 9th international LISA Symposium, held 21 – 25 May in Paris, the international LISA (Laser Interferometer Space Antenna, a space-based gravitational wave detector) community analysed the new situation. For the first time, a large Chinese delegation participated in the LISA Symposium and announced their scientific interest in a close collaboration on a gravitational wave mission. The Chinese Academy of Sciences and the Chinese Space Agency are developing their own plans for a gravitational wave detector in space.

On 6 June, Cheng Jingye, China's Permanent Representative to the United Nations and other International Organisations in Vienna said that China is willing to cooperate with other countries and to provide the opportunities for more countries, particularly the developing countries, to participate in the construction of the Chinese Space Station and scientific research. He made the remarks on the 55th session of the Committee on the Peaceful Uses of Outer Space (COPUOS) at the United Nations Office in Vienna.

Commercial Space

Sri Lanka is set to launch its first communication satellite by 2015, following an agreement with the China Great Wall Industry Corporation (CGWIC) for the design, manufacturing and launching of the satellite. SupremeSAT, a local company said it has reached an agreement with the Sri Lankan board of investment to the tune of 20 million U.S. dollars for the project.

On 15 May, the Ministry of Post and Telecommunications of Laos signed a contract with the CGWIC to launch a communication satellite by 2015, to mark the 40th anniversary of the founding of the Lao People's Democratic Republic. CGWIC then

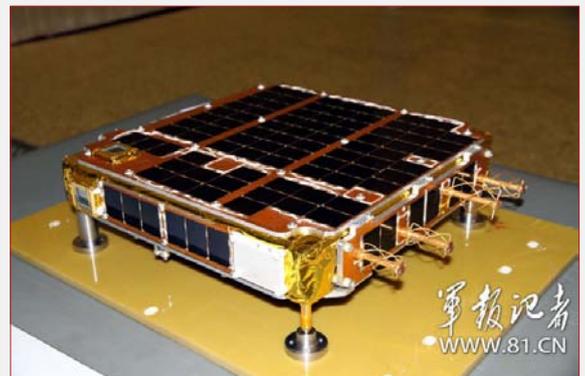


signed sub-contracts on 16 May with the China Satellite Launch & Control General, CALT, CAST and other related contractors. In mid June, the Lao Minister of Post and Telecommunication visited CASC during his official trip to China.

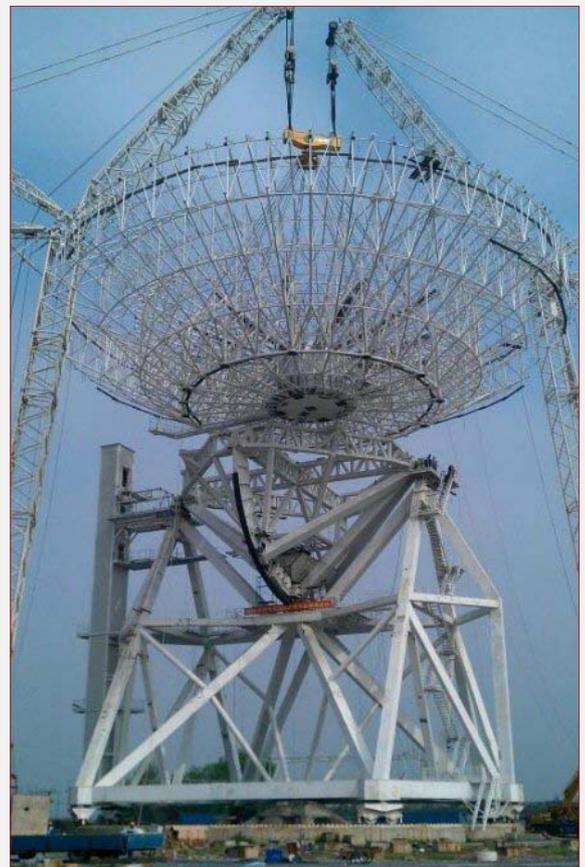
In June, China Investment Corp., the world's fifth-largest sovereign fund, agreed to buy a 7 per cent stake in the satellite company Eutelsat Communications SA from Spain's Abertis Infraestructuras SA. China Investment will pay the Barcelona-based Abertis 385.2 million Euros for 15.4 million shares of the Paris-based Eutelsat, Abertis said in a statement. Earlier in April, the U.S. State Department blocked an attempt by China to buy a fully functional European satellite imaging constellation, the RapidEye system operated by a German venture, because the spacecraft contained U.S. technology.



left:
The vibration test tower in Tianjin (construction photo and artist's impression). (Chinese internet photo)



right:
The Tiantuo 1 nanosat. (credit: www.81.cn)



right:
The 65 m telescope under construction. (Chinese internet photo)



left:
The JF12 hypersonic shock-wave wind tunnel. (Chinese internet photo)

Living in the Heavenly Palace

by Chen Lan



The long anticipated historic Shenzhou 9 mission has concluded successfully. It was the most complicated manned mission ever flown in Chinese human space history. Simply looking at the following records reveals its significance:

- The longest duration Chinese manned space mission - 13 days.
- The first Chinese space station occupation - 10 days.
- The first manual docking between two Chinese spacecraft and the first crew-controlled Shenzhou in-orbit operation.
- The first female taikonaut and the youngest taikonaut - Liu Yang.
- The first taikonaut return to space - Jing Haipeng.

It has been nearly four years since China's last manned flight, the Shenzhou 7 spacewalk mission. In these four years, the Chinese manned space programme made a series of breakthroughs that has brought China into the space station era. Shenzhou 9 was only China's fourth manned space flight, but it has already been largely comparable to the U.S. and former Soviet Union's first space station missions, Skylab 2 and Soyuz 11 respectively, showing again the wisdom and vision of China's strategy on the manned space programme - it's low-cost, slow-pace - but with steady and substantial progress. CMSEO spokeswoman Wu Ping announced after completion of the mission that China has spent about 39 billion RMB (approximately USD 7 billion) in the last 20 years on the manned programme.

Pink Taikonaut

It is worth noting that the Shenzhou 9 launch date, 16 June, is exactly the 49th anniversary of Valentina Tereshkova's historic

Vostok 6 flight. The world's first woman space traveller and China's first woman taikonaut flew into space on the same date! Furthermore, Shenzhou 9's second launch window was scheduled for 18 June, the 29th anniversary of the launch of the first American woman, Sally Ride. Is this a coincidence? No one knows. But in any case, it was very iconic. China earned another "world third" title for sending a woman into space. It is, in fact, not essential for this mission but it does have great value for public relations. The female taikonaut has been a hot topic for many years and it became a media mania short before launch.

Months before the launch, Chinese sources revealed that there were two females in training for the Shenzhou 9 mission. China selected two women into the second taikonaut group two years ago. Their names were revealed by a signed philatelic cover appearing on the internet last year. (see also the article by Tony Quine in this issue) As there were more and more official and unofficial reports pointing to a woman among the Shenzhou 9 crew, Wang Yaping and Liu Yang, the only female taikonauts in training, appeared in Chinese media more and more frequently. It was not until 9 June that official confirmation was given that a woman would be part of the Shenzhou 9 crew. Two days later, two photos appeared in Chinese media. One picture showed six taikonauts including two women who were apparently the prime and the backup crews. Another photo showed one crew planting trees. Chinese netizens immediately identified five of them: Jing Haipeng, Liu Wang and Liu Yang in one crew and Nie Haisheng and Wang Yaping in another crew. On the same day, the Beijing-based Global Times confirmed that the unidentified taikonaut was Zhang Xiaoguang. Though Chinese media almost confirmed that Jing Haipeng, Liu Wang and Liu Yang would be on-board Shenzhou 9, the official announcement of the crew names came as late as the afternoon of 14 June during a news conference, just one day before the launch. Later that day, the prime crew met the media in Jiuquan. Liu Yang, the 33 year-old PLA Major, received world celebrity status overnight.

Liu Yang was born on 10 October 1978 in Zhengzhou, a central Chinese city. In 1997, she graduated from the Zhengzhou 11th Middle School. She achieved quite a good score in the national college entrance examination and had a chance to enter good local universities. But Liu Yang's choice was the PLA Air Force Changchun Flight College. Following a few rounds of screening, she became one of the "7th generation" female pilots in the Air Force. After four years of study in the flight college, Liu Yang started her 11-year flight career in the PLAAF. She performed very well there and accumulated 1,680 flight hours. On one occasion, her plane collided with a flock of pigeons and one engine was damaged. Similar to other female PLAAF pilots, Liu Yang was a transport plane pilot, and her Y-7 had only two turboprop engines. However, she kept calm and managed to land the plane safely, showing her excellent psychological qualities. Liu Yang told reporters that she had never thought to be a taikonaut when in the Air Force. But opportunity often arrives unexpectedly. When China made the decision to recruit the second taikonaut group and started selection in early 2010, the 7th generation female pilots became the only candidates, as their flight experience was the most suitable for the taikonaut



requirements. Through three rounds of screening, the number of candidates was reduced to 15, 6 and finally, 2 - Liu Yang and Wang Yaping in March 2010. In March 2012, luck fell on Liu Yang when she was selected to be one of the Shenzhou 9 prime crew.



The first crew picture released by the official media. (credit: Xinhua)



One of the first Liu Yang photos on the internet. It was taken during her pilot career. (Chinese internet photo)



Liu Yang and her husband. (credit: Xinhua)



Liu Yang in her middle school years. (Chinese internet video)

Chinese media has revealed plenty of details about Liu Yang's family, her school life as well as her military career. On the internet, there are Liu Yang's family photos, her primary school, middle school and senior middle school's graduation pictures, and even her 100 day-old baby photo. A video of Liu Yang in an English class in her middle school became very hot on Chinese video sites days before her historic flight. Journalists flocked to her family, her relatives and friends, and her schools. And also, some interesting things happened in Zhengzhou, her hometown, for example, its hospital proudly claimed that 33 years ago, Liu Yang was born there. Two hundred kilometres away from Zhengzhou, in a remote small village where Liu Yang's father was born, but Liu Yang visited only once in her life, the local government organised a grand celebration and set up a commemorative plaque. In contrast, when Yang Liwei became the first Chinese citizen flying in space, his personal life, his family and hometown never attracted so much media attention. Is this an advantage of female taikonauts?

China explained the reason for the choice of crew composition. Considering that Shenzhou 9 would be the most complicated Chinese manned space mission ever to fly, an experienced taikonaut would reduce risks significantly. This is the Shenzhou 9 commander Jing Haipeng who flew in Shenzhou 7 four years ago. A woman would not only be good for prestige and attracting public attention, but also be psychologically helpful during the relatively longer stay in space. It would also provide a chance to perform space medical study on women. Liu Yang's role was to take care of the on-board medical experiments. Liu Wang was assigned as the manual docking operator. He has waited for 14 years for this mission but he is still luckier than some of his taikonaut colleagues who may never fly after 14 years of training.

To support female taikonauts in space, there were some technical changes or enhancement of the spacecraft and the spacesuit. Liu Yang's space suit is specially modified to fit her size with consideration of female characteristic, for example, personal hygiene. The toilet was equipped with an additional adapter for females. Also, a temporary enclosed space was created on Tiangong 1 and Shenzhou 9 to protect female privacy.

Welcome to the Heavenly Palace

At 18:37:24 on 16 June, an all-white Long March 2F rocket, with the Shenzhou 9 spacecraft on top, blasted off from the Jiuquan Satellite Launch Centre into a clear sky. It was launched exactly at the so-called zero launch window that does not allow even one second of delay. Relaxed expression on the faces of the people in the control room showed this was another textbook launch. Manned launches have seemingly become routine for Chinese engineers. As a routine too, CCTV broadcast the launch live. Ground and on-board cameras captured all the key events in the launch phase – from escape tower jettison, booster separation, first stage separation, fairing jettison, spacecraft separation, to solar panel deployment and Tianlian TDRS antenna deployment. As seen from the live video, when gravity suddenly disappeared, Liu Yang couldn't help playing around with the pen connected to her flight handbook and seemed amazed by its magic.

This is the third launch of an improved Long March 2F and its first

manned flight. With the newly added iterative guidance system, Shenzhou 9 reached an unprecedented orbit insertion accuracy – only 19 m off the planned orbital altitude. The Shenzhou 9 mission has also better communication coverage than previous manned missions. The two Tianlian data relay satellites were formally put into service for the first time and provided coverage of 70 %.

To prepare the Shenzhou 9 docking, Tiangong 1 lowered its orbital altitude to 343 km in early June. After 4 manoeuvres (5 manoeuvres were planned) on 16 and 17 June, Shenzhou 9 reached the same orbit of Tiangong 1 and started the journey to chase Tiangong 1 from behind. Shenzhou 9's automatic rendezvous and docking procedure was almost identical to that of Shenzhou 8 last year. (see also "Go Taikonauts!" issue no. 3) We observed the same parking points at 52 km, 5 km, 400 m, 140 mm and 30 m. We saw three kinds of proximity measurement system working at different distances – the microwave radar, the laser radar and CCD sensors during the final stage. But there were also some differences:

- There were three people on-board Shenzhou 9. They can oversee the automatic rendezvous and docking while in the re-entry module. It was an opportunity for the crew to feel a "real docking" before the planned manual docking a few days later with the real space environment, real data on the displays, and real images from the docking camera. It was also the first time for hundreds of millions of TV viewers to see the white cross target taken by the docking camera during live TV broadcasting.
- The manual docking system was, for the first time, powered on. The crew was prepared for a manual docking during the final stage or for a retraction in case of an emergency if the automatic system failed, though manual docking had never been tested before. Compared to Shenzhou 8, more than 50 emergency modes were designed and implemented.
- For the first time, final approach and docking was done under sunlight. Three door hatches (one between the orbital module and the re-entry module of Shenzhou 9, one at the front of the orbital module, and one on Tiangong 1) were to be opened immediately after a successful docking.

Shenzhou 9 arrived at the 52 km parking point at 11:47, 18 June Beijing Time. It took a little more than two hours for the spacecraft to get to the 30 m parking point. Docking occurred at 14:07 when the two 8-tonne class spacecraft made contact at a speed of 0.2 m/s. Everything looked smooth and perfect and the two spacecraft established a firm connection at 14:14. For the TV audience, it was almost a replay of the two Shenzhou 8 dockings of about seven and half months earlier. However, a successful docking was only a prelude to this historic event. The most exciting moment came three hours later.

After docking, the crew started a series of busy work activities to prepare for entering the Tiangong laboratory. They powered off the manual docking system and opened the hatch to the orbital module. In the orbital module, they took off their space suits and donned a blue working suit. One important step was to pressurise the docking tunnel and balance the air pressure between the connecting modules. This took quite a long time. At 16:05, Jing Haipeng opened the hatch at the front of the orbital module and entered the tunnel inside the docking mechanism. Liu Wang,

floated behind Jing, filming the event using a handheld video camera. The video was transmitted back to Earth in real-time. Through a small window at the centre of the Tiangong 1 hatch, we saw the interior of Tiangong from Liu Wang's handheld camera. While from a Tiangong 1 camera pointing to the hatch, we saw Jing Haipeng moving about behind the small window. It was interesting that both scenes were shown side-by-side on CCTV.



Liu Yang played with her pen just after orbit insertion. (credit: CCTV)



Jing Haipeng opening the Tiangong 1 hatch, taken by Liu Wang using a handheld video camera. Note the central window of the hatch. (credit: CCTV)



Tiangong 1 hatch opened and Jing Haipeng floated in. (credit: CCTV)



The first group photo of the crew in Tiangong 1. (credit: CCTV)

At 17:06, Jing Haipeng finally opened the hatch of Tiangong 1 and floated into Tiangong 1. He looked very happy but was obviously not yet adapted to the larger space in Tiangong. There was a burst of laughter from the control room when he lost his balance momentarily at one point. One minute later, Liu Wang became the second visitor to Tiangong 1. Their first task in Tiangong 1 was to switch Tiangong 1 from auto-flight mode to operational mode, and power on equipment for communication and on-board system checkout. At the same time, Liu Yang was in the re-entry capsule. Their second task was collecting air samples for analysis. It has to be noted that none of the crew wore masks or protective eye-glasses for ingress, showing a high level of confidence on Tiangong's Chinese life support system. It was reported that ground control monitors more than 7,000 parameters of Tiangong 1, 900 of which are transmitted to the ground on a daily basis. In contrast, when the ISS crew entered the Dragon capsule for the first time, they wore masks in case of toxic air composition or free-floating particles in the capsule.

Liu Yang entered Tiangong 1 at 17:27. Shortly after, there was a nice photo-opportunity facing the live transmission camera. The three smiling crew members waved their hands with excitement. This marked China as being the third country in the world to have a space station capable of human occupation. This picture is destined to be an historic scene and to be remembered for many years.

After the crew wrapped the hatch door with a cloth bag and installed a hose between the Tiangong 1 and Shenzhou 9 orbital module for ventilation, the station was almost ready for living in.

Driving Shenzhou for Another Space Kiss

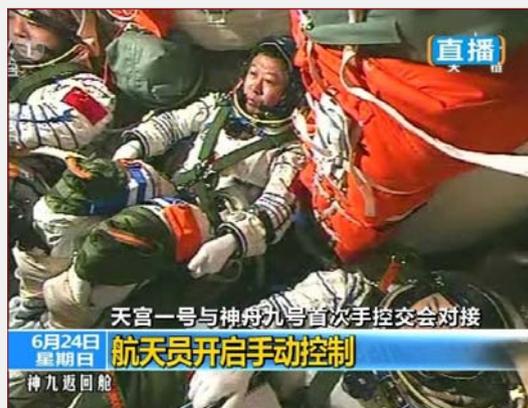
After 6 days in Tiangong 1, the Shenzhou 9 crew ushered in another important moment – to test manual docking in space. Only with a successful manual docking, could China say it has fully mastered rendezvous and docking space technologies. It was planned as the most important and challenging task in the Shenzhou 9 mission. The manual docking day was set for 24 June.

Maybe it was again a coincidence. China planned another technological challenge on the same day – a manned deep-sea submersible named Jiaolong (Flood Dragon) to dive below 7,000 m in an area of the Mariana Trench in the western Pacific Ocean. At 9:07, the three-seat vehicle touched the seabed 7,020 m in depth on its fourth dive since arriving in the area earlier this month. Immediately after reporting the successful touch-down, the crew delivered a message from the seabed to space: “We, the three aquanauts, Ye Chong, Yang Bo, Liu Kaizhou wish the three taikonauts Jing Haipeng, Liu Wang, Liu Yang, a smooth docking with Tiangong 1.”

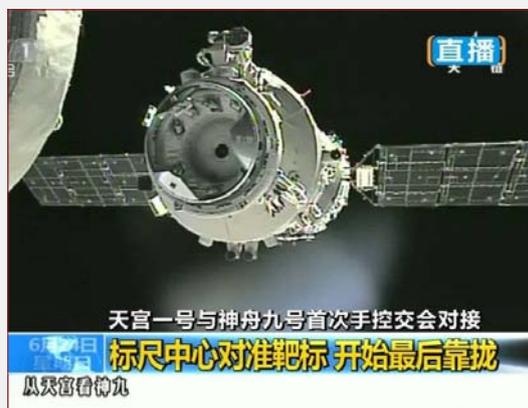
Two hours later at 11:08, Shenzhou 9 separated from Tiangong 1. It was retracted to the 400 m parking point and approached again to the 140 m point, all of which was performed automatically. This time, and for the first time in a docking, Shenzhou 9 flew ahead of Tiangong 1. At 12:38, the spacecraft switched to the manual control mode. Liu Wang tested the manual control handles and confirmed they worked normally. At 12:42, Shenzhou 9 started moving again, controlled by Liu

Wang. This was the first time for China to have a piloted space flight in its true sense. Liu Wang became China's first space driver. On the control panel, there were real-time parameters of the spacecraft and the video taken by the docking camera at the orbital module. The camera points to the docking aiming target – a white standoff cross on the front of Tiangong 1. If the cross exactly aligns with marks at its base plate, the two spacecraft then have the correct relative position and angle for a docking. We have seen a similar device on ISS modules for Shuttle and Soyuz docking. Liu Wang controlled the spacecraft using two handles at the sides of his seat. The left handle controls the spacecraft's movement along three axes including acceleration, deceleration, horizontal and vertical translation. While the right handle is for attitude control, that is pitch, yaw and roll.

With unnoticeable movement of his hands on the handles, Liu Wang was completely absorbed as the 8 tonne vehicle slowly approached Tiangong 1 at a speed of 0.4 m/s. The manual docking skipped the 30 m parking point. From the docking camera, Tiangong 1 got larger and larger, and the white cross was clearly visible, but the movement of Shenzhou 9 was slowed-down slightly. Everything went well. Contact and capture happened at 12:48. The docking precision was even better than all previous automatic dockings. The three taikonauts held their hands and raised them high in celebration. Though this was an exciting moment and the peak of the mission, they kept calm. Liu Wang's heartbeat was only 90 beats per second at contact time. Liu Wang fully realised his piloting capabilities, as he had told reporters before the launch that he was 100 % confident of completing the docking task successfully. For this short 10 minute duration, prior to the mission, he had practised more than 1,500 manual dockings on the ground simulator.



Liu Wang operating the Shenzhou 9 during the first manual docking. (credit: CCTV)



Shenzhou 9 in final approach to Tiangong 1, piloted by Liu Wang. (credit: CCTV)

Two views taken from SZ-9 and TG-1 just seconds before soft contact in the manual docking. (credit: CCTV)



Crew re-entered Tiangong 1. At the same time, the Jiaolong submersible returned to her mother ship. (credit: CCTV)



At 14:55, telemetry data confirmed that a hard connection was established normally and the first ever manual docking had been completed successfully. It took the crew about three hours to open the three hatch doors and re-enter Tiangong 1, their home. It seemed that all the taikonauts were now more at ease with the familiar environment of Tiangong 1. Just when Liu Wang reopened the Tiangong 1 hatch and returned to the mother spacecraft, in the Pacific Ocean, the Jiaolong submersible returned to her mother ship. CCTV covered the two events simultaneously. It was so iconic to observe these two scenes shown side-by-side on TV. This reminded us of Chairman Mao's famous poem: "Up in the high sky we can pluck the Moon; Down in the oceans we can catch the turtles". It is still not the end of the story, however, just a few days later Chinese scientists announced a plan to build a permanent deep-sea research station. There will also be a permanent Chinese space station in the high sky around 2020. It is well worth waiting for other future simultaneous ventures in space and deep-sea.

First Tiangong Expedition

If the manual docking was a risky adventure for the three space travellers, their daily life inside the Tiangong 1 was easier and simpler but full of amazement. The first thing they faced was to adapt to the weightless environment. Compared to the elegance and ease we often see from the ISS crews, the Shenzhou 9 crew's movement in Tiangong 1 looked clumsy and awkward, especially during the first few days. This may be partially caused by the design of the soft support handles that appeared unable to provide stable support, although it is safer. The same design philosophy can also be seen from the large area of soft covers

and curtains. This makes Tiangong 1 look neat and comfortable, and distinguishable from ISS and Mir. Tiangong 1 has an external diameter of 3.35 m, more than one metre less than that of the ISS and Mir modules. But from the video, it looked large, much more spacious than any manned space capsule. It is more like a real space station.

Of course, Tiangong 1 is a real space station, though the smallest. It is not only because Tiangong 1 is larger than most manned capsules, and has living facilities like sleeping compartments and exercise bicycles, but also because it has a lot of essential station equipment and facilities a capsule does not have. It has micrometeoroid shield, six control moment gyroscopes (CMGs), an improved environment control and life support system (ECLSS) with experimental water vapour separation facility and water electrolysis, a more comprehensive spacecraft health monitoring system, and the capability to take over control of the visiting vehicle for altitude, power, communication, data management and in-cabin environment. As a result, many systems on the visiting vehicle can be shut down when docked with Tiangong 1.

The Shenzhou 9 crew spent 13 days in space, more than the total of the previous three missions. The 10-day Tiangong 1 occupation has also become the first Chinese space station endurance record. In this longest Chinese manned space flight, there were many important or interesting events worth reporting:

- Once the Shenzhou 9 crew became Tiangong 1 residents, they started a new life in space with many differences to living in the Shenzhou spacecraft. As the youngest and most active member of the crew, Liu Yang tried to make a somersault in space. At first, it seemed to fail, but it got better and better over time. On 20 June, with the help from Jing, Liu Yang tried the exercise bicycle on Tiangong 1. In contrast, it seemed very easy. On 26 June, in her second night shift, Liu Yang practised Taiji (or T'ai Chi), a type of Chinese martial art. Though her movements looked a little strange, it was the first in space history and a first in thousands of years in the history of Chinese martial art.
- On 19 June, at 15:46, ground control sent the first electronic mail to Tiangong 1. Liu Yang received the e-mail. It was the first time a taikonaut received an e-mail in space. On 25 June, 16:43, Liu Yang sent back the first text message from space through the e-mail system.
- On 19 June, at 18:50, the first two-way video call test was successfully done. From this moment on the crew members were able to see video images from the ground; it made them all happy and excited.
- Just after the successful two-way video call testing, all the crew had a chance to talk to their family members. The conversation was in private so we could only see video but without sound. There is also a "private communication room" at ground control prepared for the taikonaut's family members. We don't know what they were talking about, but from the TV screen, when talking to her husband, Liu Yang behaved like a little girl, cute and lovely. Liu Wang played a harmonica to his wife and daughter.
- On the last day before undocking, the crew completed all work at 21:00. It then became their happy hour. They posed for photographs and enjoyed floating leisurely. Liu Yang practiced her Taiji and somersault again. Before she went



Good Morning!
(credit: CCTV)



Liu Yang in private communication with her husband.
(credit: CCTV)



Liu Yang practicing Taiji in Tiangong 1.
(credit: CCTV)



Liu Yang riding the exercise bike.
(credit: CCTV)

to sleep, Liu Yang left a Chinese knot in Tiangong 1 that she had made during her stay, for the next visiting crew.

On 27 June, at 14:42, the Tiangong 1 - Shenzhou 9 combination turned 180 degrees under control of the ground, in preparation for the undocking on the next day. At 6:37 on 28 June, the three taikonauts left the Tiangong 1 one by one. Jing Haipeng was the final one. He saluted solemnly to the camera and then closed the hatch, leaving the heavenly palace empty again. At 9:22, undocking was done smoothly by the crew in manual control mode. It was reported that China planned to do another rendezvous test after Shenzhou 9 retracted to the 5 km parking point. It would re-approach Tiangong 1 until it arrived at the 140 m parking point, but there were no further reports to confirm if this was actually done as planned or not.

29 June 2012, Shenzhou 9 started its journey home. Around 9:15, the orbital module separated. About 5 minutes later retrofiring occurred, followed at 9:38 by propulsion module separation. Then the Shenzhou 9 capsule plunged into the atmosphere, followed by the propulsion module that was broken into several pieces, resulting in a number of bright streaks in the morning sky. Around 9:50, the main chute was deployed with a big bang. China dispatched seven rescue helicopters. The camera on the helicopter captured and transmitted live video from the site. Thanks to the automatic tracking and stabilisation system on the camera, we saw zoomed images of the Shenzhou capsule landing for the first time. The capsule finally landed at 10:03. Just after the landing rockets fired, the capsule made a roll. The capsule was lying on its side, but highly inclined, with the hatch very close to the ground. It was obviously caused by strong wind that also made the landing 16 km off target, much more than any manned Shenzhou landing in the past. Fortunately, all taikonauts were in good condition. About one hour later, the three taikonauts egressed the capsule one by one, smiling happily. The 10-days spent living in space seemed to have no impact on their capability to quickly adapt to normal gravity.

Tiangong 1 raised its orbit shortly after Shenzhou 9's undocking and switched back to autonomous flight mode. The next guest it is to welcome will be the Shenzhou 10 crew at the end of 2012 or by early 2013. It was revealed that Tiangong 1 has enough fuel to run much longer than its designed two year working life. He Yu, Chief Commander (a Chinese title roughly equivalent to manager) of the spacecraft sub-system of the manned programme, said it is very likely that Tiangong 1 will still be in operation when Tiangong 2 is launched into space. It seems the clock is turned back to the 1980s when Salyut stations launched one after another, and a Soyuz visited two stations in one mission. Now, it's the turn of China!

Please, go to the gallery for more photos.

Finding a Female Taikonaut

by Tony Quine



Liu Yang - China's Valentina Tereshkova. (credit: Xinhua)

In 2004, soon after Yang Liwei completed China's first manned spaceflight, sections of the Chinese media began to ask when a Chinese woman would be sent into space, to emulate Yang's feat. The topic was first aired officially by Gu Xulian, President of the All-China Women's Federation, and the general tenor of the 'official' response suggested approval of the idea, at least in principle. However, no concrete timetable or firm commitment was provided.

The suggestion prompted curiosity in this author, and also the late Rex Hall, and caused us both to speculate how and when this might happen, and what options the Chinese would have to find suitable candidates.

It is also worth mentioning at this early stage, that although the Chinese authorities have been very candid and open about some aspects of their manned space programme, they have maintained a cloak of secrecy around their taikonauts. The 14 male taikonauts, selected from among PLAAF fighter pilots in 1998 have never been officially named. Although their names were published in a German magazine in early 2003, the Chinese authorities have only released their names, photographs and biographies when assigned to a Shenzhou flight, as either prime or back-up crew. The only exceptions to this have been the two pathfinder candidates, Wu Jie and Li Qinglong who undertook training in Russia in 1996/7. Therefore, Rex and I guessed (correctly, as the following eight years have shown) that any female candidates would be subject to a similar level of mystery and secrecy.

Nevertheless, Rex and I decided to gather whatever information was in the public domain to try and anticipate how and when, the Chinese would progress matters, and if possible to identify the candidates. With 700 million women in China, this may have seemed to be an absurd ambition, but read on...

At that time (2004/5), observers of the Chinese manned programme had very little indication of the planned rate of future flights, or its general pace. Certainly the Chinese were talking about longer flights, multi-crew flights, EVA and docking, but there was no clear timeframe associated with these ambitions.

However, it was clear that for the foreseeable future, Shenzhou's capability would be advancing and evolving, and would thus remain largely a test flight programme. This encouraged us to think that flights for Chinese engineers, doctors and researchers, would be some way in the future, and that only experienced military pilots would be sent into space on Shenzhou missions during the following several years.

If there were to be female taikonauts, then it was most likely that they would be drawn from the ranks of military pilots too. We also surmised that the PLA leadership would wish the honour of being the first Chinese woman in space, to fall upon one of their own officers, and not, for example, on a design bureau engineer or a doctor. Therefore, the first step in researching the identities of potential female taikonauts was to gather information on the role of female pilots in the PLAAF.

In fact, this proved to be relatively easy. There was a great deal of coverage in both English and Chinese language websites (aided by the capability of on-line translation engines) of the exploits of women pilots, from the earliest days of the PLAAF in 1949, through to contemporary (2004) reports of current serving pilots. What became clear, quite rapidly, was that during this whole period of over 50 years, China had only recruited and trained around 300 women as Air Force pilots.

Furthermore, they had a curious system of recruiting them in batches of 30-40 every 8 years - a pattern rigidly followed since 1949. Each batch was assigned the collective title of 'generation'. So the '1st generation' dated from 1949; the '2nd generation' from 1957; and so on, until the '7th generation' were recruited in 1997. In each recruitment process, candidates were selected directly from school, and so were all more or less the same age. The 6th and 7th 'generations' were also the first where the members had been given a degree level education as part of their training, which meant they had actually graduated and been assigned to operational duties in 1993 and 2001 respectively.

The duties of the female pilots were also mentioned, and illustrated, and it was widely reported that none had ever been trained for combat roles, or to fly fast jets (some did fly jet transports) and that they were deployed to fly transport and cargo aircraft only; a situation that endured from 1949 to 2004.

In 2004 there were apparently only one or two women still active from the first four 'generations' (1973 and earlier), and most of those who featured in media reports were from the 6th (1989) and 7th (1997) 'generations'. Presumably, because female pilots were still something of a rarity, they did appear quite frequently in media reports on their activities, in both mainstream media websites and the PLA's own publicity machine.



President Hu Jintao met PLA Air Force's 7th generation female pilots in 2005. Liu Yang is the third from left. (Chinese internet photo)



Cao Yanyan

Liu Yang



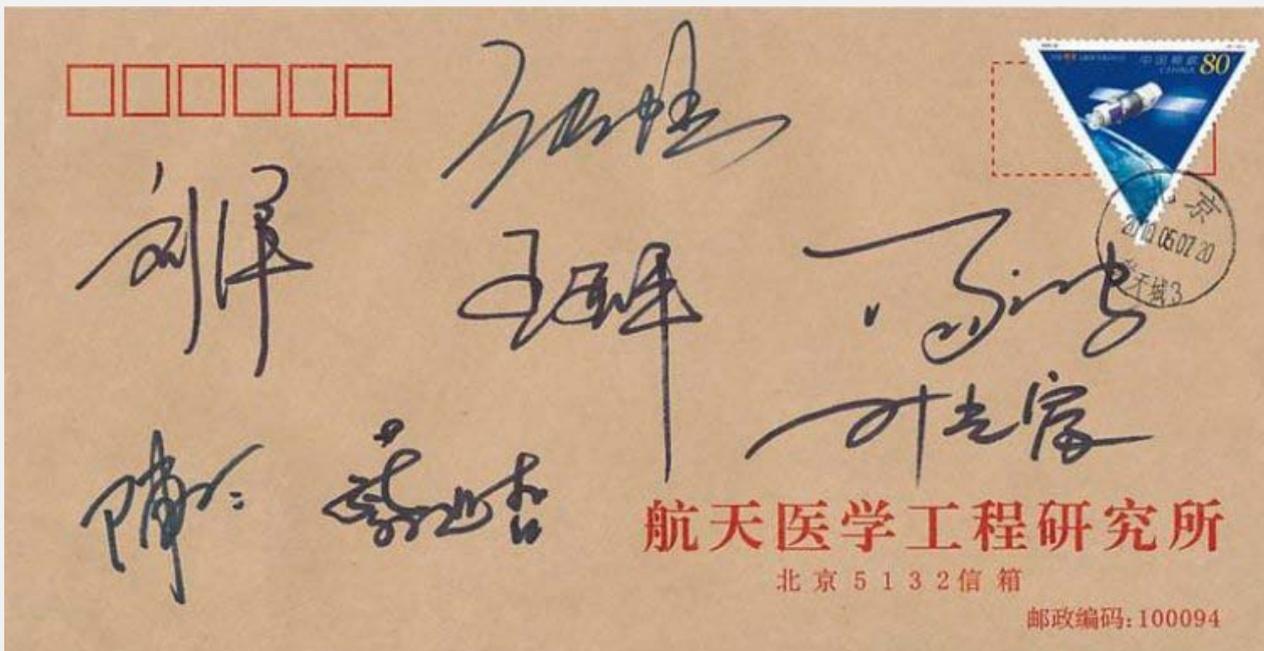
Yang Guang

Wang Yaping

Outstanding members in the 7th generation female pilots. (Chinese internet photo)



left: The female fighter pilots from the 8th generation pilots. (Chinese internet photo)



The cover revealing the names of the 2nd taikonaut group. (internet photo)

航天医学工程研究所

北京 5132 信箱

邮政编码: 100094

Whilst we had no idea when the Chinese might begin to select a female taikonaut group, Rex and I formed the view that when they did so, they would be fishing in these fairly small groups of female pilots of the 6th and 7th generations. Therefore, we began to make notes of their names and back stories; where and when were they born; where and what they flew; any unusual assignment they had completed; were they married, etc.

I should emphasise that all this information was in the public domain and freely published, in either English or Chinese. However, it did take a little time and effort to cross-reference and merge different fragments of information into as cohesive a picture as was possible for each name.

So, during 2005, we began to record the names of such young women as Li Lingchao, Cao Yanyan, Wang Yaping, Yang Guang, Liu Yang and fifteen or so others. In fact, these final four were all profiled on a PLAAF website in 2005, as being the outstanding members of the '7th generation' and were fully operational transport pilots and co-pilots. At this time, these four were aged between 24 and 26 and, they seemed to be possible future taikonaut recruits. There might even be opportunity to train them to fly jets in the interim, if that was a rigid qualification for the future taikonaut programme. Altogether, over the next few years, Rex and I would identify twenty-one women who had graduated from that 7th recruitment group to active flying roles.

During this time, Rex Hall and I, speculated that the Chinese might want to showcase their manned space programme during the 2008 Olympic Games, and that a Chinese man and woman orbiting in a Shenzhou capsule, taking a remote part in the opening or closing ceremony, would be a spectacular achievement. However, this thought turned out to be well wide of the mark, and in fact the Chinese authorities then seemed to cool on the idea of even selecting female taikonauts, and even began to report that they didn't have female pilots with appropriate experience or credentials. The hopes of the 6th and 7th generations appeared to be fading, as the next 'generation', the 8th, came into the picture.

It was already apparent from the 8 year sequence of selection dates that a new group of female pilot cadets was due to be selected in 2005, and throughout that year there were frequent references to that process in the Chinese media. Apparently 200,000 students, in the age range 17 to 19 were eligible for consideration. Interestingly, from the outset, the PLAAF authorities mentioned that some of this group would be given the opportunity to train as fighter pilots – the first Chinese women to be considered for this type of training. It was also said that they would be eligible to be considered for taikonaut training, although as they would not graduate from Aviation College until 2009, this was clearly planning for the distant future.

Nevertheless, with this future opportunity, one of the cadets, 17-year-old Tao Jiali from Sichuan Province was brought to Beijing to meet NASA astronaut Mae Jemison who was on a goodwill visit, and the pair appeared together on Chinese Television in the summer of 2005.

The 2005 group were christened the 8th 'generation', and there were said to consist of 37 members, although later reports referred only to 35, suggesting that two may have dropped out.

It was reported that they would receive 2.5 years of theoretical study at one of the PLAAF's aviation colleges, culminating in the award of a Bachelor's Degree, and then 1.5 years of basic pilot training before they graduated in 2009.

During the period 2006 to 2008, there were occasional references and photographs of this group in the Chinese media, but on the whole they disappeared from view. However, whenever the matter of female taikonauts was mentioned, the media tended to refer back to this group as the likely source of candidates.

Rex and I were rather sceptical as to whether this was a realistic outcome. By 2009, these girl pilots would still only be aged 21 to 23, and have limited flying experience. Against this, could be weighed the possibility that the Chinese authorities had identified an opportunity to recruit exceptional pilots at a very young age, specifically for spaceflight training, by-passing the conventional route of gaining experience as an operational aircraft pilot.

In April 2009, the PLAAF proudly released group and individual photographs, names and profiles of sixteen of the 8th 'generation' who had graduated as China's first female fighter pilots. It is assumed that the other twenty or so cadets graduated into more traditional (for Chinese women) flying roles. It was also announced that the team would make a flypast in their jet trainers at the 60th Anniversary of the Communist Revolution celebrations on the 1st October. Preparations for this event were widely reported during the summer of 2009 and frequently featured 22-year-old Lt. He Xiaoli who had been chosen to lead the team through this event. This media coverage still perpetuated the earlier message that this group would soon provide China's first female taikonauts. Indeed, interviews with them often raised the topic and, it is apparent from their responses that they expected to be part of the selection process when it came, and that one of their group would indeed be China's first woman in space.

In fact, often repeated rumours and speculation about the selection of a second taikonaut group were gaining momentum in early 2009. Even Yang Liwei confirmed that he was involved in the process, and by the summer it was confirmed that dozens of PLAAF pilots, both men and women, were being evaluated.

In September 2009, the position crystallised further with the announcement that 45 pilots, 30 men and 15 women had been short-listed, and that 5 men and 2 women would eventually be chosen. The process had started in May 2009, and had considered male fighter pilots and female transport pilots aged between 25 and 35, with a minimum of 800 hours flying time in their logs. It was instantly apparent that the 8th generation were not in this picture at all, and that all of the 15 women must have come from the 7th generation. It was also evident that they must have short-listed 15 candidates from just 21 women who were eligible.

At this point, attention switched back to the 7th generation and the database of information that we had been steadily accumulating since 2005. In fact, during the intervening 3 or 4 years, aside from basic personal data, much had appeared in the Chinese media. For example, five of the female pilots Cao Yanyan, Song Xuefei, Chen Yu, Chen Jinlan, and Wang Yaping, had been involved in relief work following a disastrous

earthquake in Sichuan province in 2009. Wang Yaping had flown special cloud-seeding flights during the Beijing Olympics. Both Wang Yaping and Liu Yang had been profiled in a book about 60 years of Chinese pilots in 2009.

Immediately we began to check through the 21 names; two eliminated themselves; Yan Fang and Wang Hui, took part in the same 60th Anniversary displays as the 8th generation, and specifically said that participation had been possible as they were not taking part in the taikonaut selection process. Effectively, the pool was down to 19, from whom 15 had been taken to the final stage.

The small size of the initial selection pool, a maximum of 21, raises an interesting question. Were the women pilots all invited to take part in the selection process? Did they have to apply? Was it a mandatory obligation to participate? Although no doubt disciplined military officers and competent pilots, their background was in routine transport and cargo flying; not an environment which would generally cultivate adventurous risk takers. The women pilots were all in their late twenties or early thirties; had stable careers; most were married; some had young children. It seems likely that some of the 21 (or even their families) might have felt the risks of spaceflight unacceptable or daunting, and would not have wished to take part. That is a question to which we will never know the answer.

Around this time, I pooled my information with Igor Lissov, noted writer for the Russian magazine *Novosti Kosmonavtiki*, who it transpired had been doing the same research exercise as Rex and I, and who had built up an identical list of names. When Rex died in 2010, Igor became my main partner in continuing the work.

The next milestone was reached in March 2010 when it was announced that the final 5 men and 2 women who would form the second taikonaut group had been selected. Whilst they were not named, General Zhang Jianqi, who was a former deputy commander of the taikonaut group, did give some tantalising clues. Five of the fifteen women candidates, Cao Yanyan, Xing Lei, Wang Yaping, Liu Lu, and Sun Jing, all came from Shandong Province which indicated there was a strong chance that one of them would be in the final two. Local Shandong media also added two more names to the list, Wang Ying and Song Xuefei. The media coverage surrounding the 'Shandong seven', also mentioned that the successful candidates had to be married and have given birth naturally. This appeared to eliminate at least two of the seven, and raised the question of when this criteria had been added to the selection process. If the successful candidates had to be married, why were any unmarried women in the 15? This author has surmised that the Chinese selectors had a preference for married women, but with a very small overall pool had to keep their options open until they knew they had enough suitable married women.

Two months later, the seven new taikonauts reported for duty and once again, General Zhang spoke to the media. Again, he gave some helpful information; both women were 'from the North' and the seven taikonauts included pilots who 'had taken part in the Sichuan earthquake relief'. It was very unlikely this was a reference to any of the male fighter pilots as this was not their type of work, and so almost certainly related to the one or

both of the women.

At this point, it was possible to cross-reference all this information and tentatively conclude that Wang Yaping met all of the various criteria mentioned by General Zhang. It also enabled several other names of women who were not 'from the North' to be eliminated.

So, how could I be sure Wang Yaping was one of those selected? The opportunity presented itself later in 2010, when a friend who was attending the Association of Space Explorers Congress in Kuala Lumpur and was familiar with my research, was able to ask members of the Chinese delegation. Whilst they were very careful not to give the game away, their surprise at being confronted with exactly the right name was evident, and their initial uncertainty of how to respond was enough to confirm that Wang Yaping was one of the two.

A few weeks later I published her name, photograph and some biographical information on the www.NASASpaceflight.com and www.CollectSpace.com websites, following which Wang's name was widely reported in the Western media, although very few Chinese language sources picked up the information. The search for the second name continued but was fairly fruitless, save for eliminating several more women (Li Lingchao, Tan Hongmei and Wang Si) who appeared in the Chinese media undertaking more cloud-seeding, this time for the 2011 Asian Games.

However, in September 2011 Wang Yaping's name did appear in the Chinese media during the coverage of the Tiangong 1 launch. Although the information was 'unofficial' and relied upon recycling old photographs and personal background details, it did say that she was one of China's two female taikonauts and that she was slated to fly on the Shenzhou 10 mission to Tiangong 1. However, there was no sign of the second name being released.

There were still 7 or 8 possible names on my list, when the final breakthrough came in December 2011. Whilst searching Google! under Wang Yaping's name, I found a philatelic cover being offered for sale on a European collectors website, which bore her signature together with six others. It rapidly transpired that these were the signatures of the seven members of the second taikonaut group. The cover was dated 7th May 2010; the date they reported for duty, and included Liu Yang, a name I had first seen in 2005 when with Wang Yaping and two others, she had been profiled on the PLAAF's own website. The search was over!

So the two who had been selected in March 2010, were:

- Captain Wang Yaping. Born 27th January 1980, in Yantai District, Shandong Province.
- Major Liu Yang. Born 6th October 1978, Zhengzhou, Henan Province.

In many ways this concluded the search which Rex and I had started over seven years before, but naturally I, and also Igor Lissov, who had helped validate the philatelic cover, continued to take a keen interest in how the plans for either Liu or Wang to actually make it into space might evolve.

Following the successful unmanned docking of Tiangong 1 and Shenzhou 8 in November 2011, the Chinese authorities began to release more details of their plans for further flights to Tiangong 1 in 2012 and 2013. Whilst they were initially a little reticent about whether Shenzhou 9 would carry a crew or be a further unmanned test flight, and whether any crews for Shenzhou 9 or 10 would be 2 or 3 taikonauts, they did report that a training group of nine taikonauts, seven men and two women had been formed.

Although the indigenous Chinese media, and some International media, interpreted this as a suggestion that two women might fly a mission together, this author, and other observers surmised that the nine probably formed three crews, each of three people. There would be one all male crew, and two mixed crews. This would provide prime, back-up and support crews for two three-person missions.

Meanwhile, Liu Yang's name had begun to appear in the Chinese media too, and mild speculation on forums and blogs began to take place on whether she or Wang Yaping would be China's first woman in space.

In February China confirmed that Shenzhou 9 would be a manned flight; it would launch between June and August; would carry a crew of three and would dock with Tiangong where it would remain for 10 days. No information on the crew was given, although TV images of taikonauts training in Shenzhou simulators showed a rear view of someone who could, from their build and hair-style, have been one of the women.

However, within a few weeks Qi Faren, former Chief Designer of Shenzhou, disclosed that the two women in the training group were in contention for a seat on the Shenzhou 9 flight, although with typical reserve, he said that a final decision would depend on their training, and flight readiness reviews occurring just before the launch. However, this was a clear indication of China's plans, if everything went well over the following weeks.

During April and May 2012, the Chinese authorities gave regular updates on the process of approving and shipping the various hardware components to the Jiaquan Launch Centre. On 10th May, following the arrival of the Long March booster by rail, the author predicted, via online forums, that the launch was likely to take place on, or very close to 16th June. This estimate was based on the fact that the boosters for both Tiangong 1 and Shenzhou 8 had arrived 38 days before the planned launch.

By late May Chinese reports began to confirm that the launch would take place in 'mid-June', but information on the crew was scarce with nothing official being mentioned about individual crew members. Reports that a woman was likely to take part in Shenzhou 9 continued to flow, and a number of Chinese bloggers began to publish information, and to encourage speculation on the possible identity of China's first woman in space. This produced very little meaningful new information, but it did begin to generate a steady stream of comment, suggesting that Major Liu Yang had already been selected to be the first Chinese woman in space. Some contributors claimed connections with her family, or to have served with her husband in the PLAAF. After many months in which Wang Yaping had been promoted regularly for the honour, this increase in Liu Yang's profile began

to redress the balance.

Although the Chinese system is that two crews are prepared for each flight, and they train in parallel, the flight crew are only named a day before the launch. Until that point both crews are said to have an equal chance, although in practice it seems likely that there must be a 'preferred candidate' team. But, who was in the 'preferred team'?

On 9th June, the Chinese media reported that the Long March rocket and Shenzhou 9 assembly had been relocated to the launch pad. That same day it was also announced that the six crew members making up the prime and back-up crews had flown to Jiuquan. It was clear that a launch attempt was imminent, and would take place in no more than five to seven days.

On 11th June, three photographs were released showing the six taikonauts at a flag-raising and tree-planting ceremony. For the first time, Wang Yaping and Liu Yang were seen in their taikonaut roles, although the photographs were released without any official indication as to who the six people were. Both Wang and Liu looked fit, slim and confident, and had their hair cut short, probably for practical purposes.

Two of the male taikonauts shown were veterans of previous flights, Nie Haisheng and Jing Haipeng, whilst the other two were unfamiliar faces, but later identified as Liu Yang and Zhang Xiaoguang. The photos also clearly indicated that the six were arranged into two crews:

- Jing Haipeng, Liu Yang and Liu Wang
- Nie Haisheng, Zhang Xiaoguang, Wang Yaping

With typical drama, the Chinese authorities did not reveal which crew was planned to make the flight, nor did they release any more images or official information over the next several days. It was however, confirmed that the launch was planned for 16th June. Media coverage did begin to suggest that Jing Haipeng's crew would be chosen, with some observers citing their direct involvement in the tree-planting as being a decisive clue.

Finally, on the morning of 15th June, the Chinese authorities confirmed that the Jing, Liu, Liu crew were to be sent into space to conduct the Shenzhou 9/Tiangong 1 docking mission. Curiously, the back-up crew were not formally named, and no photographs or other details about them were released.

However, an avalanche of personal information, interviews and training videos were released providing a massive amount of information about Liu Yang, propelling her from the obscurity of a low profile military career to a media celebrity and national heroine, overnight.

For her part, Major Liu Yang now 33 years old, turned out to be an inspired choice. The rather serious, even sombre, looking young woman, who had first been seen in a photo in 2005, had become not only a talented, tough and brave military pilot, but an attractive and energetic woman, and quickly captured the affections of the Chinese media and public.

Just 24 hours before she would be strapped aboard Shenzhou 9,



she showed no apprehension at either her new public profile or the looming launch, but spoke of 'Limitless pride, at the confidence put in me by the motherland, and the people, for giving me this chance to represent China's millions of women by going into space.'

It also became apparent that whilst being an Air Force pilot had been a prerequisite to enter the taikonaut training programme, Liu Yang would not be involved in flying Shenzhou 9 during the active phases of the flight, but was assigned as 'Mission Specialist' with responsibility for research and experiments, once onboard Tiangong 1.

Despite her very short period of training, Major Liu gave the impression of being well prepared, both technically and psychologically for her assignment. On the prospect of riding the Long March rocket, she confidently declared, 'I feel no fear, just growing anticipation and excitement.'

Over eight years had passed since Gu Xulian first suggested the flight of a Chinese woman into space, when, on the afternoon of 16th June 2012, Major Liu Yang prepared for the most important flight of her career. Wearing her white pressure suit, carrying her portable ventilator and waving jauntily at the cameras, Major Liu Yang, and her two colleagues departed for the launch pad a little under three hours before launch.

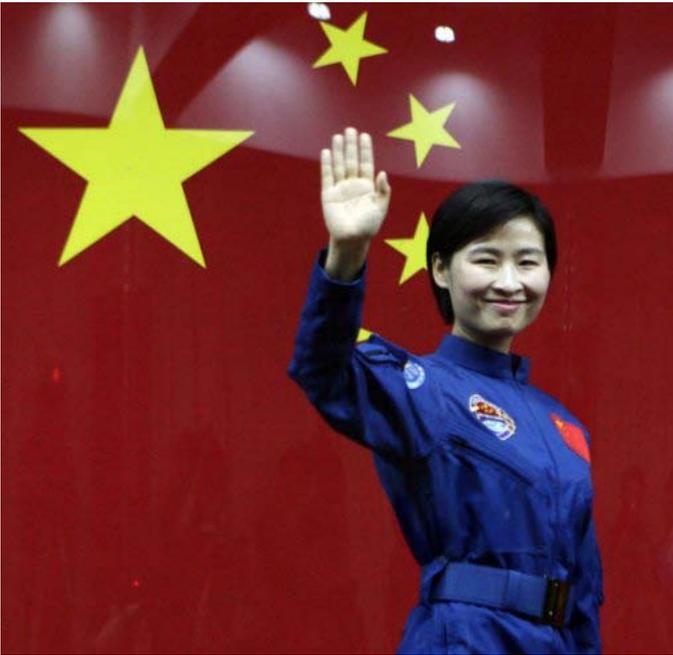
Precisely on time at 18.37 p.m. Beijing Time, Shenzhou 9 launched, and less than ten minutes later, after a text book ascent, Major Liu Yang became the first Chinese woman to orbit the Earth; China had found her first female taikonaut!

The full account of Major Liu Yang's role in the Shenzhou 9 mission is featured elsewhere in this issue of Go Taikonauts!

In concluding this account of the seven-year search to find China's first woman in space, the author would like to acknowledge the help and support of Bert Vis, Gareth Parry, and especially, the late Rex Hall, for constant encouragement.

China's First is Asia's Fourth and the Earth's 56th

by Jacqueline Myrrhe



Here she is: beaming with her special I-am-never-getting-tired smile on her face and launching in a mission which in one sense was already accomplished before it began: Overnight the military Major Liu Yang became China's latest charming ambassador and attracted a global media attention which overshadowed the technical significance of the manual docking mission Shenzhou 9 – Tiangong 1.

Liu Yang is following big footsteps and this is not only because she is a tiny lady. Launched on the 49th anniversary of Valentina Tereshkova's epoch-making flight into the cosmos, Liu Yang went down in Chinese space history as the first Chinese woman to make it into space. On the 16 June 2012 she also, and foremost, became the 56th woman who ever orbited our home planet Earth. However, depending on the counting rule, she is just the fourth or even merely the sixth Asian woman flown into space.

The first Asian woman in space was Japanese astronaut Chiaki Mukai who flew in 1994 on-board of Space Shuttle Columbia mission, STS-65. She was followed in 1997 by India-born NASA astronaut Chawla Kalpana and Iran-born US-citizen Anousheh Ansari in 2006.

The second actual Asian woman was Yi Soyeon from South Korea who flew in 2008 with Soyuz TMA-12 to the ISS. Throughout the history of human space flight, usually the first representative of a nation has been a man. Yi Soyeon, after British Helen Sharman, became the second woman in the world who represented her country for the first time in space, and being a female citizen. Two years later, JAXA astronaut Naoko Yamazaki made her way to space on-board of Space Shuttle Discovery STS-131 in a flight to the International Space Station.

But Liu Yang holds other remarkable records and firsts which give her a privileged position in the small female world of "manned" space flight. Just an incidental remark: substituting "manned" with "human" does not help much, it still is about "man", namely "hu-man". Even the word "wo-man" inherited the dominating male part. On the contrary, the Chinese symbols for "male" and "female" or "ying" and "yang" are more distinguishable and originated independently.

China is only the third country in the world to send a woman into space on its own vehicle. In 1983, almost exactly 20 years after Tereshkova, NASA launched Sally Ride, its first woman. Since then women of nations other than the US or the Soviet Union have had to hitch a ride with one of the two major space powers.

Considering that the first Soviet space station, Salyut 1 as well as the US-American Apollo programme or the Skylab missions were closed for women, the Chinese are not doing too badly. They included a female taikonaut already in only their fourth manned mission, which was also the first mission to a space station, the Tiangong 1 module. The Soviet Union put Valentina Tereshkova on their sixth national manned mission, but they needed until Salyut 7 to allow women to access to their space



From left to right: Valentina Tereshkova; Sally Ride; Helen Sharman; Chiaki Mukai (credit: Valentina Tereshkova-TASS, NASA, Helen Sharman-Roscosmos, NASA)

station assets. In total, only three Soviet-Russian women made it into space – a fact not really honourable for such a major space-faring nation. Compared with the situation in the US, the early years of US-American space exploration were a no-go-zone for women. The US never made it possible for women to live and work on its indigenous space station. Although, one cannot deny that the flight of Sally Ride really paved the way for the biggest female astronaut corps in the world, and the magic phrase “equal opportunity” enabled a multitude of US-American women to go to work in space. Since the mid-1980’s, the Space Shuttle missions witnessed regular flights of mixed crews. To date, 44 out of 56 female space-travellers belong to the NASA astronaut corps. It was fantastic to see Eileen Collins becoming the first female Space Shuttle pilot in 1995. She was the right stuff for sitting at the controls of a Space Shuttle. Her STS-63 mission, which involved a rendezvous between the shuttle Discovery and the Russian space station Mir, included a Mir fly-around in preparation for the first docking mission with STS-71 later on. Only four years later Colonel Collins made it for the first female commander of an U.S. spacecraft with Space Shuttle Columbia, mission STS-93, launched in July 1999. It is absolute accurate, to claim that she was the world’s first female space craft commander. When in October 2000, Colonel Pamela Melroy flew the Space Shuttle Discovery STS-92 mission, within the space community all around the globe the hope for an all-female Space Shuttle crew was entertained for a brief moment in time. With Collins as a female commander, Melroy as a female pilot, and several female mission specialists possible, NASA would have been more than capable of composing an all-female crew. While all-male crews are considered perfectly normal, the opportunity for an all-female NASA crew never materialised.

Will China now jump on this chance for another remarkable first? Will the Chinese Astronaut Training Centre decide to train enough female taikonauts to assemble an all-female crew for flying to its future Chinese Space Station – CSS? Although she has temporarily disappeared from the limelight, we should not forget about Wang Yaping, Liu Yang’s back-up. Wang Yaping is immediately available for a next manned space mission, Shenzhou 10.

In an interview with “China Daily”, Pamela Melroy shared her delight about a Chinese woman joining her as a colleague. She pointed to China’s requirement for taikonauts to be trained as military pilots. She said this ensures Liu Yang, being a military like herself, will be of a special breed. “I feel a special kinship with her, because there are so few women pilots in space.” Melroy added: “In this field, you have to learn to work together with different people because your lives depend on it. When you become a pilot you cannot allow yourself to be distracted;

you have to continue to maintain control of the aircraft in all situations. It requires a certain personality type and mental toughness, so I am 100 per cent sure that Liu Yang will handle herself well, based on her military flying background.” After she was asked how the return to Earth after a space mission feels, she explained: “Life will never be the same,” she said. “It’s such a unique and rare opportunity, and what happens is that people feel that they have a piece of space through you, so for the rest of your life, it will be a big part of your identity.”

This is along the same lines as the statement by Wu Ping, Spokeswoman for China’s Manned Space Programme and Deputy Director of CMSEO. She confirmed before Liu Yang’s historic flight: “Generally speaking, female astronauts have better durability, psychological stability and ability to deal with loneliness.” She stressed that Liu’s mission into space also promoted “the social influence of the manned space programme.”

And Chen Shanguang, Director of the Chinese Astronaut Research and Training Center, pointed out during a press conference after the return of the Shenzhou 9 trio: “Sending a woman into space reflects the increasing status and greater role played by our female compatriots in society.” But he did not want to reveal detailed crew planning for the next missions: “A specific plan for selecting crew members for the Shenzhou 10 mission will be established after the research is completed.”

NASA astronaut, Mae Jemison, who became the first Afro-American woman in space in 1992 toured China in 2005. During her visit she met with young Chinese women in space flight training. She admitted that she was impressed with what she saw in China. “China has tremendous talent and resources, but if you don’t bring all your best players in, you are not going to have the best opportunities to understand how things can be better, and how to make stuff happen more effectively. Including female astronauts on a Chinese launch is a very conscious and important decision.” For China, leaving out women would be cutting the potential for progress in half, Jemison concluded.

Before her launch on-board of Shenzhou 9 Liu Yang expressed how proud she is: “I feel honoured to fly to space, on behalf of many hundred million Chinese women.”

There is the saying in China that, ‘women hold up half the sky’. Whether this is just a nice quotation or an ambition for the future, will become obvious soon. Witnessing the sudden neglect for manned space flight in the West, no-one should complain if the return to the Moon will become a Chinese endeavour – a female Chinese endeavour or even better: an international female affair.



left:
Yi Soyeon
(credit: Yi Soyeon-ROSCOSMOS)

right:
Naoko Yamazaki
(credit: NASA)



left:
Kalpana Chawla
(credit: NASA)

right:
Anousheh Ansari
(credit: Anousheh Ansari-ROSCOSMOS)

Navigating to Guangzhou - The 2012 Meeting Place for the Navigation World

Impressions from the 3rd China Satellite Navigation Conference - CSNC 2012

by Jacqueline Myrrhe

For the third time in a row, the China Satellite Navigation Conference attracted not only Chinese navigation experts, government officials, business executives, but also navigation professionals from the U.S., Russia, Japan, and Europe, to meet in China. With over 2,500 participants, the CSNC has grown into one of the largest scientific Global Navigation Satellite System conferences in the world. The conference took place from 15 to 19 May 2012 at the Poly World Trade Center, Exhibition Hall 6, in Guangzhou – China’s third largest city. With almost 12 million inhabitants Guangzhou is China’s biggest city in the South of the country. This year’s conference was held under the motto “BeiDou (COMPASS) Going to Application”.

As in previous years, the CSNC conference was conceived as an open platform aiming at the promotion of academic development of theory and methodology in the fields of Global Navigation Satellite Systems (GNSS); the enhancement of technical innovation for the acceleration in the construction of satellite navigation systems and their applications; and is focussed on the expansion of the national and international cooperation among universities, research institutions and industry.

Frequently, this official event is an opportunity for the Chinese government to announce news about its indigenous navigation system Compass/BeiDou2. And indeed, several presentations gave an insight into the impressive developments, the current status and recent results of the Chinese BeiDou/Compass system. The gathering is jointly sponsored by the China Satellite Navigation Office, the National Space Administration, the Department of High and New Technology Development and Industrialisation, the Ministry of Science and Technology, the P.R.C State Administration of Science, Technology and Industry for National Defence, and others.



View into the main conference room. (credit: Dr. Jens Wickert)

The chair of the scientific committee, largely consisting of the Chinese who-is-who in satellite navigation, was Sun Jiadong. Sun is not only the Chief Designer of Compass/BeiDou2, but he became famous in 1967 as the Chinese “Father of Satellites”. The distinguished engineer designed China’s first satellite and since then has been a leader in China’s space efforts.

This year’s conference comprised nine sessions covering a wide range of GNSS topics:

- **Session 1:** BeiDou/GNSS Navigation Application.
- **Session 2:** Satellite Navigation Signal System, Compatibility & Interoperability.
- **Session 3:** Precise Orbit Determination and Positioning.
- **Session 4:** Atomic Clock Technique and Time-Frequency System.
- **Session 5:** Satellite Navigation Augmentation and Integrity Monitoring.
- **Session 6:** BeiDou/GNSS Test and Evaluation Technology.
- **Session 7:** BeiDou/GNSS User Terminal Technology.
- **Session 8:** Satellite Navigation Model and Method.
- **Session 9:** Integrated Navigation and New Methods.

A remarkably large and impressive exhibition of the various companies from Chinese GNSS industry accompanied this international navigation event.

Keynote From a Dutch Expert

The Dutch scientist Peter Teunissen gave the invited keynote presentation on the topic “Some Challenging GNSS Research Topics on Estimation, Validation and Positioning”. Peter J. G. Teunissen is a Professor and Head of the Department of Earth Observation and Space Systems at Delft University of Technology, The Netherlands, and a member of the Royal Netherlands Academy of Sciences. His secondary employment is as Professor of Geodesy and Earth Observation at the Curtin University in Australia. Furthermore, he is a Federation Fellow of the Australian Research Council (ARC), and Positioning Science Director of the Cooperative Research Centre for Spatial Information (CRC-SI). In addition to this, he was awarded an Honorary Professorship of Wuhan University and of Tongji University. His current research focus is on modelling next-generation GNSS for high-accuracy relative navigation and attitude determination in space and air. As the inventor of the LAMBDA method and with more than 25 years of GNSS research experience, his address to the participants of the conference was an extremely accomplished and highly appreciated opening to the week long programme. Professor Teunissen reflects: “I have a long standing cooperation with Chinese institutes and Chinese researchers. Therefore I know of the importance of this conference and consequently I was glad to participate and thereby strengthening the ties. Second, with my presentation and its topic I wanted to generate more

interest, in particular among the many bright young Chinese researchers, in some of the more theoretical, still open research problems that need to be solved.”

US Presence and Presentation

Next to Teunissen, the participation of the U.S. government official, David Turner of the Department of State is worth mentioning. He delivered a presentation about GPS during CSNC 2012, which provided an overview of U.S. space-based PNT (Positioning, Navigation and Timing) policy, status of GPS and GPS augmentations, future plans and international cooperation activities. The presentation concluded that the current performance of GPS is better than it has ever been, and that it will continue to improve. David Turner also stressed that the current US policy encourages the worldwide use of civil GPS and its augmentations, and that the US is committed to international cooperation in pursuit of systems compatible and interoperable with GPS.

German Participation

The Chinese organisers of the Guangzhou navigation conference put a significant effort into the international orientation of the programme and composition of presenters. Five of the nine sessions involved one or two foreign co-chairs. In particular the GFZ German Research Centre for Geosciences, a member of the “Helmholtz-Association of German Research Centres” had a strong presence during the event. Physicist and expert for Earth Observation, Dr. Jens Wickert of GFZ co-chaired Session 8 “Satellite Navigation Model and Method”, and Dr. Maorong Ge of GFZ co-chaired Session 3 “Precise Orbit Determination and Positioning”. Both these German-based scientists, together with a third colleague of GFZ in Potsdam, Dr. Zhiguo Deng, contributed with four presentations to the success of the conference. Dr. Jens Wickert was invited for an overview presentation on recent activities and results of his GPS/Galileo-Earth Observation section at GFZ.



Prof. Teunissen is giving his keynote speech. (credit: www.beidou.gov.cn)

His colleague Dr. Ge spoke about “Real-Time Global Precise Point Positioning Service And Its Regional Augmentation: Recent Progress And Preliminary Compass Results”, and also about the topic “What is achievable with the current Compass constellation?” while Dr. Deng presented “Medium-scale Travelling Ionospheric Disturbances (MSTID) modelling using dense GPS network”.

Decades of Chinese-German Cooperation

Traditionally, there exists a long-term cooperation between China and Germany in the area of geodesy.

The German geo-scientific research centre in Potsdam, south-west of the German capital Berlin, is looking back at a year-long cooperation with Chinese partners in the field of geodesy and satellite navigation. Straight from the moment of the foundation of the GFZ in January 1992, the former Director for Geodesy and Earth Observation of GFZ, Prof. Reigber, realised the strategic importance of scientific cooperation with Chinese colleagues. Prof. Reigber maintained several personal contacts with experts in China, among them a particularly good relationship with Professor Jingnan Liu of the Chinese Academy of Science who is also a Professor at Wuhan University. Since more than 20 years now, the Potsdam research institute is cooperating with Wuhan University, and the Shanghai Astronomical Observatory. The continuous scientific exchange is accompanied by visiting scientists in each other’s institutions.

In general, there are three main topics of the bilateral work. One focus of interest is on the development of specific scientific software for processing and evaluation of navigation satellite data. Another emphasis is on the geo-physical application of GNSS data for early warning systems, climate research, and probing the atmosphere. The third topic is the validation of orbital data for the Chinese navigation system Beidou/Compass.

The overall assessment of the Sino-German cooperation is positive and includes mutual benefits for both sides. In recognition of these trail-blazing efforts for the promotion of



During a conference break a satisfied trio joined together for a photo. From the left: Prof. Shuanggen Jin (SHAO), Dr. Jens Wickert (GFZ), Prof. Kefei Zhang (RMIT Melbourne) (credit: Dr. Jens Wickert)

scientific exchange between Germany and China, Professor Reigber became an Honorary Professor at Wuhan University, the academic home of his colleague Professor Liu. Professor Jingnan Liu is also an Executive Chairman of the Scientific Committee of the 3rd CSNC. Therefore, it seems to be obvious that scientists from the Potsdam GFZ play a visible role in the CSNC 2012.

A few days after his return from China, Dr. Jens Wickert confirmed that the conference was well-organised and that he was very happy about the outcome of the event. "The conference went very well. We could find many opportunities for the consolidation of existing contacts but could also start the initiation of new projects. We could manifest our efforts for the joint development of GNSS analysis software for processing of real time data, which will involve also in the future visiting scientists at the GFZ in Potsdam. Among the newly initiated projects is the application for the set-up of a joint working group consisting of scientists from the GFZ German Research Centre for Geosciences at Potsdam and the Shanghai Astronomical Observatory of the Chinese Academy of Science. The working group would look into the utilisation of GNSS signals for climate research and early disaster warning systems. We are expecting the final decision on the project this autumn."

Proceedings

The proceedings of the 3rd China Satellite Navigation Conference are already published and available from Springer Verlag: <http://www.springer.com/engineering/mechanical+engineering/book/978-3-642-29174-6>.

The book presents selected research papers from the CSNC 2012 conference. These papers discuss the technologies and applications of the Global Navigation Satellite System GNSS, and especially the latest progress made in the Chinese BeiDou system. They are divided into 9 topics to match the corresponding sessions at CSNC 2012, which broadly covered key topics in GNSS. Readers can learn about the BeiDou system and keep abreast of the latest advances in GNSS techniques and applications.

Next year, the CSNC 2013 will be held in Wuhan, China.

This article was compiled with valuable inputs provided by Prof. Teunissen and Dr. Wickert.

Soviet-Chinese Symposium of the British Interplanetary Society

by Dr. William Carey and Jacqueline Myrrhe

The British Interplanetary Society (BIS), a British organisation for space flight enthusiasts, has for many years been hosting an annual Soviet Symposium, an event dedicated to various aspects of space activities during the Soviet era. This year however, saw for the first time a joint Soviet-Chinese Symposium, to reflect the recent growing emergence and influence of Chinese space activities.

Founded in 1933, the Society has been and is “devoted to initiating, promoting and disseminating new concepts and technical information about space flight and astronautics through meetings, symposia, publications, visits and exhibitions” as the interested individual can read on the BIS website (www.bis-space.com).

Beginning during the time of the Cold War, the members of the BIS took a courageous step: they initiated a channel for the publication of information, news and analysis on the Soviet space programme, since first-hand information was otherwise hard to find in the English publishing world. Although, over time Soviet data became easier to access, a new space-faring nation has recently emerged having the same type of characteristic – information in English was extremely hard to find – China. Coupled with the reduction of space activities by the United States, in terms of the cancellation of the Space Shuttle programme, there is a global community currently showing a high interest in the Chinese space programme.

On 9 June 2012, at the premises of the BIS in Vauxhall on the South bank of the river Thames in London, the 2012 Soviet-Chinese Symposium took place between 9:30 in the morning and 16:30 in the afternoon. The organisers, led by Bert Vis and Dave Shayler, composed a packed programme of highly interesting presentations.

Three out of eleven lectures were dedicated to the Chinese space programme. These three presentations were certainly worth the visit to London, although the information from the lectures on the Russian space projects was also highly interesting. Before we focus on the lectures on the Chinese space activities however, we would like to highlight just two of the presentations on the Russian space programme, since they were particularly original and professionally presented respectively.

George Spiteri gave with his lively talk “Following the Soviet/Russian Manned Space Programme Over Short Wave Radio”, an amazing insight into his long-term efforts in listening to Radio Moscow on short-wave, to get some first-hand information on the Soviet space programme. Since his teenage years he has not only been a space fan, but also an enthusiastic short-wave radio listener. He described how he learned to interpret the news given by the radio newscaster, and also to understand that no news is not necessarily good news. Later, he could also identify and receive other Eastern European radio stations or even stations in the Near East. He had some recordings with him of announcements by Radio Moscow that are now more than 30 years old.

The second remarkable lecture in the Russian part of the programme was given by Bart Hendrickx on “The NK-33 Engine: End of a 40-year Countdown”. Bart Hendrickx traced the development and use of this highly specialised engine from its beginning to how it appears today. His Russian language skills allowed him to read original documents and information so that he could follow all the events and milestones of the intended use of the engine. Professionally, he put all pieces of the puzzle together and gave a full picture of the technical capabilities of the engine in parallel with background information on the fact that, despite its convincing performance, it never made it into a rocket. But this could change now, and hopefully, Bart Hendrickx



All speakers and part of the audience of the BIS symposium. (photo: William Carey)

can present the status on this during next year's Soviet-Chinese Symposium.

Let's turn now to the three presentations given on the Chinese space activities which were:

- "Chinese Space Science - Progress and Prospects" by Brian Harvey
- "China's Third Five-Year Space Plan" by Pat Norris
- "Finding a Female Taikonaut - Space Sleuthing in the 21st Century" by Tony Quine.

Brian Harvey, a long-time observer of Chinese space activities and well-known book author on the Chinese space programme in the UK and Ireland, gave a brilliant and comprehensive overview on the scientific efforts within the Chinese space programme. He did not miss any space project, starting with Shi Jian 1,2,3 etc., and ending with the latest Chang'e Moon missions to outline the corresponding science involved.

His carefully-prepared slides not only covered all projects, but also outlined the red (silk!) thread of the growing development of China's space ambitions. He did not forget the cooperation projects with ESA, and he also highlighted Chinese ambitions for planetary missions - information which is hard to get in English. A big surprise was his presentation of a Chinese exploration roadmap for the Moon and Mars, surely something what has not been presented in this way before. Considering with hindsight that it might have been almost impossible to pack this wealth of information into a 30-minute presentation, it was another surprise that Brian succeeded - well prepared and thought through.

The second presentation that strongly captured the attention of the audience, was Tony Quine's explanation of his and his friends almost decade-long efforts to find and identify the female candidates among the corps of Chinese taikonauts, and the enormous dedication in the search for the identity of the first women supposed to be flown on a Chinese space mission. When listening to his talk it became obvious how much time, dedication, analytical capabilities and overall knowledge was required to get some incisive conclusions on the subject. Against all odds, Tony came up with reliable and accurate results and made a truly significant break-through at the end of last year, when he found a philatelic cover containing the signatures of two female pilots of the People Liberation's Army. Tony was so kind to write down all his findings and contributed to this issue of "GoTaikonauts!" with an article on his search for China's Valentina.

Both of the above-mentioned presentations on China contained a clear assessment of the available facts and concluded with a clear message. The central message of the presentation by Pat Norris on "China's Third Five-Year Space Plan" was not so well defined. Although the incremental milestones of the Chinese space programme were highlighted, a greater detail on some aspects of the background information was lacking. Pat is an acknowledged and well-respected expert in the area of military space and spy satellites, but a relative newcomer to the study of the Chinese space programme. This was particularly highlighted by a somewhat biased statistical analysis for the number of launches in 2011, which was aimed at supporting the

thesis that the Chinese space programme is lacking in scientific objectives – only 19% of launches having scientific objectives, the rest being military. The correct figure should have been stated as 32%, and would be even higher if dual-use launches, such as for the Beidou satellites were taken into account.

Despite morning coffee, lunch break and afternoon tea, the whole programme was very much on time. All of the speakers were highly-disciplined in sticking to their allotted times - unusual for such an event of this type. Also unusual was the very noticeable absence of women. Since the Chinese have known since antiquity that women are "carrying half of the sky", maybe this could become an inspiration for the BIS to try and attract more females interested in space to their meetings.

We would also like to thank the BIS for allowing us to give a short introduction to the "Go-Taikonauts!" iPad App and website following the break for lunch. On asking how many of the audience had heard of Chen Lan or the old "Go-Taikonauts!" website that he started around 14 years ago, it was pleasantly surprising to note that around half of those present (approx. 10-15) had.

For the full programme of the symposium, please, check-out the link:

<http://www.bis-space.com/2012/02/27/3853/chinesesoviet-symposium>



Brian Harvey



Tony Quine



Pat Norris

(all photos: William Carey)

Chinese Space Launch History (Part V: 2011 – Present)

#1	#2	Date	Time (UTC)	ID	Model	LV S/N	Launch Site	Launch Pad	Payload		Orbit				Remark
									Name	Weight	Type	Perigee	Apo-gee	Inclina-tion	
147	137	4/9/2011	20:47:04	11013	CZ-3A	Y19	Xichang	3	Beidou-2 IGSO-3		IGSO				
148	138	6/20/2011	16:13:00	11026	CZ-3B/E	Y20	Xichang	2	ZX-10		GTO				
149	139	7/6/2011	4:28:03	11030	CZ-2C	Y25	Jiuquan		SJ-11 03		LEO				
150	140	7/11/2011	15:41:04	11032	CZ-3C		Xichang	2	TL-1 02		GTO				
151	141	7/26/2011	21:44:28	11038	CZ-3A	Y17	Xichang	3	Beidou-2 IGSO-4		IGSO				
152	142	7/29/2011	7:42:04	11039	CZ-2C	Y24	Jiuquan	603	SJ-11 02		LEO	689.3	704.7	98.1	Orbit data from US observation network, TLS
153	143	8/11/2011	16:15:04	11042	CZ-3B/E	Y19	Xichang	2	PakSat-1R	5120	GTO	204	41,985	24.8	
154	144	8/15/2011	22:57:19	11043	CZ-4B	Y14	Taiyuan	New	HY-2	1575	LEO	904.8	915.8	99.4	
155	145	8/18/2011	9:28:00	11F02	CZ-2C	Y26	Jiuquan	603	SJ-11 04		LEO				First time using 3.8 m faring; launch failure.
156	146	9/18/2011	16:33:04	11047	CZ-3B/E	Y16	Xichang	2	ZX-1A / FH-2		GTO	192	35,807	26.9	
157	147	9/29/2011	13:16:03	11053	CZ-2F/T1		Jiuquan	921	TG-1	8506	LEO	200	346.9	42.75	
158	148	10/7/2011	8:21:04	11057	CZ-3B/E	Y18	Xichang	2	Eutelsat W3C	5400	GTO	206	35,973	26.1	
159	149	10/31/2011	21:58:07	11063	CZ-2F	Y8	Jiuquan	921	SZ-8	8082	LEO	200	239.8	42.8	
160	150	11/9/2011	3:21:05	11066	CZ-4B	Y21	Taiyuan	New	YG-12		LEO				
									Tianxun-1		LEO	491	484	97.41	Orbit data from USSTRATCOM
161	151	11/20/2011	0:15:04	11068	CZ-2D	Y19	Jiuquan	603	SY-4			768.2	800.7	98.4	
									CX-1 03			784.5	802.5	98.5	
162	152	11/29/2011	18:50:04	11072	CZ-2C	Y20	Taiyuan	New	YG-13		LEO/SSO				
163	153	12/1/2011	21:07:04	11073	CZ-3A	Y23	Xichang	3	Beidou-2 IGSO-5		IGSO				



#1	#2	Date	Time (UTC)	ID	Model	LV S/N	Launch Site	Launch Pad	Payload		Orbit				Remark
									Name	Weight	Type	Perigee	Apo-gee	Inclination	
164	154	12/19/2011	16:41:04	11077	CZ-3B/E	Y21	Xichang	2	NigComSat-1R	5100	GTO				
165	155	12/22/2011	3:26:14	11079	CZ-4B	Y15	Taiyuan	New	ZY-1/ CBERS-02C	2100	LEO	762	770	98.55	Orbit data from USSTRATCOM
166	156	1/9/2012	11:17:10	12001	CZ-4B	Y26	Taiyuan		ZY-3	2650	LEO	494	503	97.5	
									Vesselsat-2	28	LEO	488	502	97.5	
167	157	1/13/2012	0:56:04	12002	CZ-3A	Y22	Xichang	3	FY-2F (07)		GTO	211	36,139	24.4	
168	158	2/25/2012	0:12:04	12008	CZ-3C	Y6	Xichang		Beidou-2 G5		GTO	202.7	36,011.8	20.54	NORAD Data
169	159	3/31/2012	10:27:04	12013	CZ-3B/E	Y22	Xichang	2	Apstar-7	5250	GTO	209	50,419	27.4	Orbit data from Xinhua. For the weight three different figures found: 5,250; 5,251 and 5,254 kg.
170	160	4/29/2012	20:50:04	12018	CZ-3B/E1	Y14	Xichang	2	Beidou-2 M3 Beidou-2 M4		MEO	243.4	21,575	55.02	NORAD data
171	161	5/6/2012	7:10:05	12020	CZ-2D		Jiuquan	603	TH-1 02		LEO	492.8	503.6	97.36	USSTRATCOM
172	162	5/10/2012	7:06:04	12021	CZ-4B	Y12	Taiyuan	New	YG-14		LEO	470	474	97.4	USSTRATCOM, 3.8 m fairing
									Tiantuo-1	9.3	LEO				
173	163	5/26/2012	15:56:04	12028	CZ-3B/E	Y17	Xichang	2	ZX-2A		GTO	207	35,787	27.09	Orbit data from USSTRATCOM
174	164	5/29/2012	7:31:05	12029	CZ-4B	Y10	Taiyuan	New	YG-15		LEO	1202	1207	100.12	Orbit data from USSTRATCOM
175	165	6/16/2012	10:37:25	12032	CZ-2F	Y9	Jiuquan	921	SZ-9		LEO	200	330.2	42.8	
176	166	7/25/2012	15:43:04	12040	CZ-3C	Y9	Xichang	2	TL-1 03		GTO	214	42,495	18.11	Orbit data from NORAD

Note:

- #1 and #2 are flight numbers of all launches and launches per vehicle family (CZ, FB, KT) respectively.
- Last digits in CZ-3B/E designators are unofficial and refers to "Enhanced version".

Sources:

- CGWIC website: <http://cn.cgwic.com/LaunchServices/LaunchRecord/LongMarch.html>
- Chinese Internet forum: <http://www.9ifly.cn/thread-407-1-1.html> (author: heito, darklighter, liis, zhaoyublg)
- Jonathan McDowell, History of Space Flight, <http://www.planet4589.org/space/book/index.html>
- Wikipedia, <http://zh.wikipedia.org/wiki/中国运载火箭发射列表>



Shenzhou Missions

No.	ID	Launch date/time (BJT)	Landing date/time (BJT)	Crew	Launch mass (kg)	Flight duration	No. of orbits	Landing location/ deviation	Orbital Module re-entry	Main payloads	Remarks
SZ-1	1999-061	11/20/1999 6:30:7	11/21/1999 3:41	/	7,755	21h 11m	14	12 km	12/01/1999	An unknown 3-pod package in front of the orbital module.	First unmanned test. No life support system. Orbital module not operational.
SZ-2	2001-001	01/10/2001 1:00:03	1/16/2001 19:22:00	/		6d 18h 22m	108		8/24/2001	An unknown 3-pod package in front of the orbital module.	Hard landing due to main chute failure. The first working orbital module with solar panel deployed.
SZ-3	2002-014	03/25/2002 22:15:00	4/01/2002 16:51	/		6d 18h 51m	108		11/12/2002	Medium-resolution imaging spectrometer; Cloud detector; Dummy taikonaut.	First vehicle in manned status. All systems were activated.
SZ-4	2002-061	12/30/2002 0:40:00	1/05/2003 19:16:00	/	7,794	6d 18h 36m	108		9/09/2003	Multi-mode microwave radiometer; Two dummy taikonauts.	Final unmanned test.
SZ-5	2003-045	10/15/2003 9:00:00	10/16/2003 6:23	Yang Liwei	7,840	21h 23m	14	111.483°E 42.10°N 4.8 km	5/30/2004	Two optical cameras, reportedly with 0.6 m resolution.	First manned flight. Crew stayed in the re-entry capsule.
SZ-6	2005-040	10/12/2005 9:00:00	10/17/2005 4:32	Fei Junlong, Nie Haisheng	8,079	4d 19h 32m	77	1 km	4/01/2008	One optical camera	First multi-person crew mission and first time crew in orbital module.
SZ-7	2008-047	9/25/2008 21:10:05	9/28/2008 17:37	Zhai Zhigang, Liu Boming, Jing Haipeng		2d 20h 27m	45	111.345°E 42.296°N	1/04/2010	A 40 kg sub-satellite, BX-1, got released from SZ-7.	First EVA mission. Orbital module converted to airlock and no independent flight.
SZ-8	2011-063	11/01/2011 5:58:10	11/17/2011 19:32:30	/	8,082	16d 13h 34m	262	111.298°E 42.239°N	4/02/2012	Two dummy taikonauts.	Unmanned docking mission. First standard "ferry" vehicle.
SZ-9	2012-032	6/16/2012 18:37:24	6/29/2012 10:03:00	Jing Haipeng, Liu Wang, Liu Yang (f)		12d 15h 26m	200	111.295°E 42.267°N 16 km	in orbit		First manned docking and station visiting mission. First female and first re-flown taikonaut.

Gallery Shenzhou 9 Mission



The Shenzhou 9 crew in training inside the ground simulator of Tiangong 1. (credit: Xinhua)



The Shenzhou 9 spacecraft being lifted into the KM-6 thermal vacuum chamber for testing. (credit: Xinhua)



The CZ-2F launch vehicle rolled out on 10 June 2012. Thousands of people witnessed the event. (credit: China.com)



Jing Haipeng, Liu Wang and Liu Yang walking out of the bus upon arrival at the launch pad. (credit: Xinhua)



The CZ-2F Y9 rocket, with Shenzhou 9 on top, lifted-off at 18:37:24, on 16 June 2012 from the Jiuquan Satellite Launch Centre. (credit: Xinhua)



The CZ-2F soared up in the clear sky. Nozzles and flames of the 8 engines are clearly visible in this picture. (credit: Xinhua)



Just after the first manned docking with Tiangong 1, people in the control room took pictures of this historic moment using their own digital cameras or mobile phones. (credit: Xinhua)



On 29 June 2012, the Shenzhou 9 re-entry module safely returned to Earth in Siziwangqi, Inner Mongolia. This picture shows that the main parachute was fully-deployed. (credit: Xinhua)



Landing rocket firing and touch-down. Due to strong winds, the capsule did a roll before the parachute was cut. (credit: Xinhua)



Shenzhou 9 capsule lying on its side, but highly-inclined, with the hatch very close to the ground. (credit: Xinhua)



A view of the whole landing site. Compared to a Soyuz landing, the Chinese dispatch more people and vehicles. (credit: Xinhua)



The crew sit in chairs after egress, successfully concluding the 13-day-long first Chinese space station visiting mission. (credit: Xinhua)