



Issue 1

# GO TAIKONAUTS!

All About The Chinese Space Programme

龙腾太空

August 2011



**Chinese Spacesuit  
Endeavors in 50 Years**



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Go Taikonauts! is back! Never heard of it? It doesn't matter. After you read through this electronic magazine, you will know what it is all about ... page 2

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January - March 2011



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### Launch Vehicle

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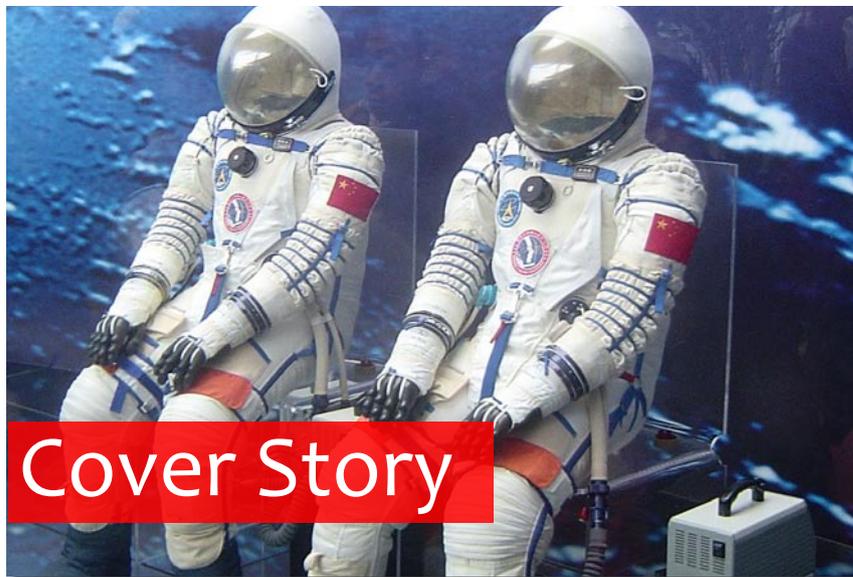
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It sounds big and moreover it even sounds like a privilege: The German Aerospace Agency DLR announced on the 11 May 2011, that the first non-Chinese experiment on a Shenzhou mission is going to be a German experiment. Dr. Markus Braun, German Project Manager for the German-Chinese space ... page 15

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## Editor's Note

Go Taikonauts! is back! Never heard about it? It doesn't matter. After you read through this electronic magazine, you will know what it is all about. It is exactly the meaning of the words we put on the logo – it is "All about the Chinese Space Programme". Thirteen years ago, it was only a web site. Now, it's an e-Magazine on iPad, and soon on other existing and future mobile devices.

The primary objective of this magazine is the same as its predecessor – to help people outside China, to know and understand more about the Chinese space programme. In fact, the Chinese space programme is not as closed and mysterious as many people think, though it is not as transparent as the space programmes in other countries, such as Europe or the United States. There is a significant amount of information in the Chinese media, especially on the internet, and only a very small fraction of this is being translated into English. We hope that our efforts will eliminate misunderstandings about China, in particular amongst the western space community, and assist the establishment of cooperation between China and other countries.

In the first issue, we present readers with an in-depth article about the Chinese space suit. To many people's surprise, China has been developing space suit technologies for almost half a century. The Chinese space suit is not just a simple copy of the Russian suit. There is a long history behind it. China's first space station prototype, the Tiangong 1, is scheduled to be launched in August and will be docked with the un-manned Shenzhou 8 vehicle in October. To coincide with this "Big Event", we have prepared two relevant articles in this first issue: one about the uncertain military nature of Tiangong 1, and the other about the German SIMBOX experiment on Shenzhou 8 – the first non-Chinese experiment ever flown on a Shenzhou mission.

We will follow the tradition of the old web site to keep our information unique, precise and professional. Remember, all our articles are original. Stay tuned!

(Chen Lan)

## Imprint

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## Chinese Space Quarterly Report

January - March 2011

### Launch Event

There were no launch activities in Q1 2011.

### Launch Vehicle

The Long March 5 (CZ-5) is the most important launch vehicle development programme in China after its initiation in late 2006. In Q1 2011, the programme progressed steadily:

- The Aluminum Corporation of China manufactured a large 5.2m diameter forged aluminum ring for the first time in China. It will be used in the CZ-5 rocket body.
- In Tianjin Rocket Industrial Park, the steel structure of the static separation test building was completed in February, and will be put into service in May. The Park was established for Long March 5 manufacture, assembly and testing. It is reportedly the world's largest park of its kind. 20 of 22 buildings in the Park had been completed by February 2011. The assembly and test building and the vibration test tower are under construction. All facilities are expected to be finished by the end of 2011. There will then be 800-1000 people working there.
- Xinhua reported in January that a special purpose quay for Long March 5 equipment, the Qinlan New Quay, in Wenchang, Hainan Island, was near completion. The quay has a length of 196.25m and was expected to be finished in May 2011.
- The new electromagnetic compatibility test chamber in CALT started construction in February. It will meet the requirement of Long March 5 development. The project was initiated in 2004 and approved in October 2009.



- On March 18, the first static tank article, the 5m diameter hydrogen tank of the second stage, successfully passed hydraulic testing, paving the way for follow-up testing.

In early March, during the China's National Congress's annual session, a top official in CALT revealed that China is undertaking pre-studies of a heavy launch vehicle with a LEO capacity of 130 tons. It is mainly intended for manned lunar landings and deep space exploration. The studies started early 2011 and the project is expected to be approved during the twelfth five-year plan (2011-2015).

Also in early March, the CZ-2F rocket prepared for the Shenzhou 8 launch entered the assembly phase. In late March, the second test facility of the CZ-3A series was put into service in Xichang, which enables parallel testing of two launch vehicles to meet the requirement of a high frequency launch rate later in 2011.

### Engine

In Q1 2011, there was a series of successful liquid engine testing making a good start to the year:

- On January 20, the propulsion system of the Chang'e 3 lander made a successful whole-system hot-fire test in the Institute 101 in Beijing. It was developed by the Institute 801, Shanghai.
- On January 28, the YF-115 engine made a simulated high-altitude test firing.
- From January 3 to 26, a new type of engine developed by the Institute 11, completed 5 long-duration tests. It continued to make another 4 tests during the period from March 3 to 15. All these tests pave the way for a demonstration experiment.
- In Q1, the ATR combined engine developed by the Institute 11 made its first successful test firing.
- In early February, China's first methane / liquid oxygen engine made its first test firing successfully. The 60-ton thrust methane engine was developed by the Institute 11, Beijing, based on the existing LH<sub>2</sub>/LOX engine.
- On March 1, the variable thruster propulsion system made its first whole-system hot-firing. This system was also developed by the Institute 11, Beijing.

There was also progress in larger solid-motor development. In parallel to the 130-ton heavy launch vehicle studies, studies on large solid boosters started in early 2011. These studies are undertaken by the 4th Academy of CASC. The academy has test-fired a 120-ton motor in March 2009, and a 1-m diameter segmental solid-motor in April 2010. A 2-m diameter, three segment demonstrator will be tested in the near future.

*Note: The Institute 11, Beijing, formerly belonged to CALT, and is the developer of the YF-73, 75, 77 LH<sub>2</sub>/LOX engines. The Institute 101, Beijing, formerly belonged to CALT, and is in charge of LH<sub>2</sub>/LOX engine testing. The Institute 801, Shanghai, formerly belonged to SAST, and is the developer of the Shenzhou propulsion system. The Institute 11, Xi'an, belonging to the 6th*

Academy of CASC, is the developer of most of China's liquid engines, including the new generation YF-100. In 2008, all above institutes were merged into the 6th Academy of CASC, or China Academy of Aerospace Liquid Propulsion Technology.

## Satellites

On January 4, Thales Alenia Space announced that it has signed in December 2010, a contract with the French space agency CNES (Centre National d'Etudes Spatiales), to produce the Surface Waves Investigation and Monitoring (SWIM) instrument. This wave-scatterometer spectrometer was chosen within the scope of a joint French-Chinese programme to develop an Earth observation satellite, the "China France Oceanography Satellite" (CFOSAT), built jointly by CNES and the China National Space Administration (CNSA).

In early January, China's own Haiyang 2 ocean satellite completed the ground calibration test for its microwave radiometer. At the same time, on January 10, the new calibration parameter of the FY-3A polar meteorological satellite passed a review, after a series of in-orbit and ground calibration tests in 2010. In early January, the China Meteorological Administration reviewed and passed the orbital position plan for the FY-2-07, the first of the FY-2 block 3 satellites. Later in the same month, in a coordinating meeting for the Civil Space Programs, it reviewed progress of the ground system upgrading for the FY-2 block 3. The upgrading includes a new 18.5m antenna in Beijing. The new ground system will be completed in November 2011.

In late February, SAST held a FY-4 working meeting in Shanghai. FY-4 is China's next generation geostationary weather satellite based on the SAST 5000 bus. The FY-4 optical satellite weighs 3200kg and the radar satellite weighs 5300kg. In 2010, it completed a series of tests on the satellite and the payloads. In 2011, it will complete the electrical model, the design and manufacture of a ground engineering model and the feasibility study of the ground system.

Regarding communication satellites, the Sinosat 5 comsat completed integration of the French built payload and the Chinese built DFH-4 bus. It is the largest comsat China has ever built, with 46 transponders onboard and a projected 15 year working life. At the same time, another DFH-4 based comsat, the PakSat-1R, also went smoothly. Both satellites are currently undergoing testing and will be ready for launch later in 2011.

## Manned Space Flight

The beginning of the year 2011 marks start of a major national fundamental research programme on manned space flight. The programme consists of a series of studies on the influence of long-term space flight on human beings. The researches will be performed during 2011-2015 by eight major Chinese research organizations, including the Astronaut

Center of China (ACC, formerly the Space Medical Engineering Institute, or Institute 507). This programme will build a foundation for China's permanent space station planned for 2020.

Other developments in Q1 2011 were all related to the Tiangong 1/Shenzhou 8 rendezvous and docking mission planned for late 2011. In early March, the Chinese News Agency reported that the Tiangong 1 docking target vehicle has completed all subsystem testing, interface testing and simulated flight-tests. The mechanical and thermal testing was to be followed. The Shenzhou 8 spacecraft was planned to have the electrical testing in mid-March. Meanwhile, scientific payload development and taikonaut training went smoothly. It was indicated that two female taikonauts were involved in the training.

In CAST, the main contractor of the two vehicles, four teams were formed on March 11 to prepare for the launch. They are the Tiangong 1 Team, the Shenzhou 8 Team, the Rendezvous and Docking Team and the Recovery Team. On March 30, after completion of the integrated testing, the Shenzhou 8 vehicle was transferred and made ready for mechanical testing. At the same time, the Tiangong 1 was transferred to the KM-6 thermal vacuum chamber for a critical space environment testing covering rendezvous and docking operations. After the thermal vacuum chamber testing, Tiangong 1 was to start reliability growth testing in the coming months.

## Lunar and Deep Space Exploration

Chinese media reported in early January that China is building a deep space tracking network including three tracking stations. Two new large antennas in Kashi Station, Xinjiang, and Jiamusi Station, Heilongjiang, were under construction. These two antennas have diameters of 35m and 64m respectively, and will be completed in 2012. The third large antenna in South America capable of S, X and Ka band telemetry and data receiving capability will be completed in 2016. The deep space tracking network will provide support for the planned Chang'e 3 and 4 missions and future Mars exploration.

The Chang'e 3 probe is China's most important deep space project under development. It is to be launched towards the Moon, with a lander and a rover in 2013. Chang'e 3 progresses in Q1 2011:

- On January 20, the propulsion system of the Chang'e 3 lander underwent a successful whole-system hot test firing in the Institute 101, Beijing, paving the way for the lander development.
- In early March, an official of the Chinese lunar program revealed that Chang'e 3's rover development is going smoothly, with engineering model development having started. He also denied a rumour that the rover was to be developed by Tsinghua University, confirming that it is still being developed by Chinese space industry.

- In March, the annual working meeting of the Chang'e 3 project was held in CAST. The targets set for 2011 were to complete the engineering model, and to start the flight model development by end of the year.

In early March, experts from CAST informed Chinese media that China's independent Mars exploration program was recently initiated. They hoped that it would obtain the government's approval by the end of the year, and to be launched in 2013. At the same time, a model of China's new Mars probe, including an orbiter and a lander, was displayed in an exhibition in Beijing.

### Miscellaneous

On January 8, a news video clip broadcast by Shanxi TV Station revealed an interesting message that the mysterious Shenlong spaceplane recently performed a successful sub-orbital flight. The message was from simple text on a display board in an exhibition, in which the vehicle was called "trans-atmospheric vehicle". Shanxi TV also showed a small picture of the vehicle in testing. However, unconfirmed rumours on Internet indicated that the flight was not fully successful, and that the spaceplane had crash-landed somewhere outside China.



On January 25, a nationwide programme for a Tiangong 1 student experiment was initiated in Nanjing. The programme was open to Chinese primary schools, middle schools and high middle schools. At end of March, it was announced that 5 experiments were finally selected. There were 2,956 proposals from 113 schools in 16 provinces. The winning proposals were recommended to be launched within Tiangong 1 in late 2011.

Hainan Daily reported in March that 1,418 fishing boats in the

province had installed the Beidou navigation and communication terminal. The Hainan government initiated the plan to equip 6,000 fishing boats with Beidou terminals within 3 years, in order to provide the fishermen with a means of navigation and communication on the ocean.

In February, the Shanghai Aerospace Museum, located in Minhang District, started construction. 36 exhibits formerly belonging to the Display Hall of SAST, including a CZ-4B and a CZ-2D, were transferred to the museum authority. The museum is expected to be completed in 2012.

On January 19, the China-U.S. Joint Statement was issued by China and the United States in Washington. According to the Joint Statement, China and the United States agreed to take specific actions to deepen dialogue and exchanges in the field of space. The United States invited a Chinese delegation to visit NASA headquarters and other appropriate NASA facilities in 2011, to reciprocate for the productive visit of the U.S. NASA Administrator to China in 2010. The two sides agreed to continue discussions on opportunities for practical future cooperation in the space arena, based on principles of transparency, reciprocity, and mutual benefit.

In February, a delegation led by Dr. Maurice Borgeaud from ESA visited the National Space Science Center of CAS. In March, delegations from Venezuela, Myanmar (Burma) and Bolivia visited CASC. In early February, Yuan Jiajun, the CASC vice general-manager, visited Myanmar and reportedly made progress on a communication satellite project.

(Chen Lan)

- CASC: China Aerospace Science and Technology Corporation
- CALT: China Academy of Launch Vehicle Technology
- CAST: China Academy of Space Technology
- SAST: Shanghai Academy of Spaceflight Technology

## Chinese Space Suit: Endeavours in 50 Years

### Building the Foundation

The Sputnik Moment was a great propelling force to the U.S. space programme. And so it was with China. In May 1958, China started planning its first space programme. Three months later, China's first satellite programme, Project 581, was kicked-off. In September, the Biological Space Research Group was formed to study space biological science and related technologies with the dream of establishing China's own manned space flight in the future. This was nearly three years before Gagarin's historic space flight in 1961.

The Biological Research Group was supported by various organizations. The Institute of Working Physiology, or the 3rd Institute, of the Chinese Military Academy of Medical Science, was one of those organizations. Its studies were focused on life support systems. It was a totally new area for China. Fortunately, China had a good relationship with the Soviet Union that time, as Khrushchev needed China's support after he took up the top position of the Soviet leadership. In 1963, Jia Siguang from the 3rd Institute, who was a graduate from a Soviet University, was sent to Moscow to seek help. He visited the Institute of Aviation and Space Medicine (IAKM) that was a major research organization of the Soviet Union on physiological effects in aviation and space flight, and was involved in the development of life support systems, as well as military pressure suits. He was warmly welcomed, and gained a fundamental knowledge of what kind of suit is required at high altitude and what facilities are necessary to develop such a suit. At last, through IAKM, he managed to purchase two Mig-21 high-altitude compensation suits built by the Zvezda Design Bureau (now the Research & Development Production Enterprise Zvezda, or NPP Zevzda in Russian). The suits were supposed to be one model of the VKK-4 series suit. This was very fortunate, considering that the Sino-Soviet relationship was getting worse at that time, and the Mig-21 equipment was still one of top secrets of the Soviet Union.

Soon after his visit, China shot down some spy planes from Taiwan over Chinese territory. They were RB-57Ds and U-2s. The pressure suits found in the wreckage were almost intact, and it provided the engineers in the 3rd Institute a good opportunity to test and compare the four suits, two from the Soviet Union and two from the U.S. They gathered a large amount of useful data. Based on these data, the 3rd Institute started to develop its own suit that was supposed to be used in the Chinese J-8 fighter. The suit was called the "6002 high-altitude compensation suit".

The design of the 6002 suit had both the advantages of the Mig-21 suit and the U-2 suit. It had successfully passed manned testing in a low-pressure chamber at a simulated altitude of 24,000 meters. Its performance was near that of the MC-3 suit used on the U-2. Before the Cultural Revolution

broke out in 1966, it was almost finished. Unfortunately, the Air Force did not select the 6002 suit for the J-8 programme. Instead, their choice was a copy of the Mig-21 suit, as they were concerned about the reliability of an unproven product.

The 6002 suit was the first independently developed high-altitude compensation suit in China. When the 3rd Institute was developing the suit, they also dreamt of a space suit. In fact, in early 1967, the Institute was named the Aeronautical and Cosmos Medical Institute, which clearly showed China's will for a manned space programme. The 6002 suit was never used, but the knowledge gained was not wasted. The 3rd Institute learned a lot from its development and it provided a solid foundation for the future manned space programme – at the time, this looked very close, while it actually took several decades to come true.

### Shuguang: The First Attempt

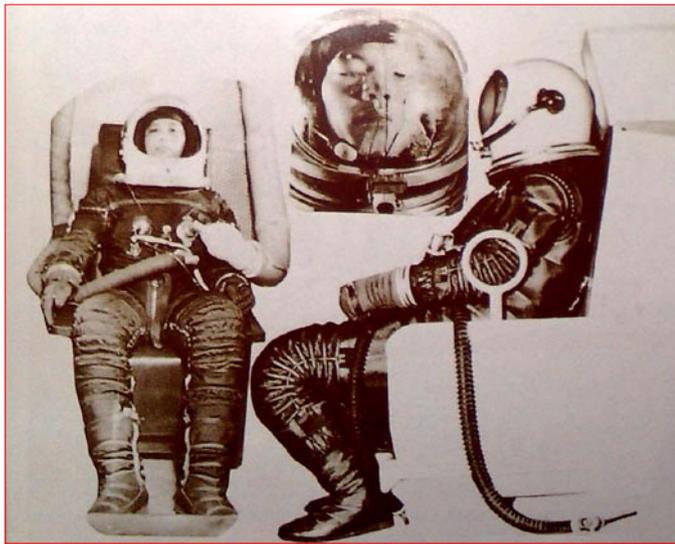


In October 1965, the manned space programme was discussed for the first time at a high-level planning meeting. In January 1966, an initial plan for China's first manned space flight was planned that envisioned the first flight during 1973-1975 by skipping the biological satellite. In early 1967, preliminary studies for the manned spacecraft started. February 1968 could be considered the official kicking-off of China's first manned space programme that was named as Shuguang (meaning "dawn" in Chinese). In that month, the 5th Academy (now CAST, the China Academy of Space Technology) was formed to undertake development of the first satellite and the first manned spacecraft. Two months later, to support the programme, the 3rd Institute was merged with two other organizations from CAS (the China Academy

of Sciences) and the China Academy of Medical Sciences. The new organization was named Institute 507 and was under the 5th Academy. The Institute 507 was to be responsible for development of life support systems and astronaut selection, and training in the Shuguang manned space programme. In June 1968, the new institute started development of the Shuguang space suit.

With a similar design objective to China's first satellite whose mass exceeded the sum of all other countries' first satellites, Shuguang first had the ambitious design to carry five people into orbit - but very soon it was recognized that this was completely unrealistic. Qian Xuesen, father of the Chinese space programme and the most important advocator of manned space flight in China, proposed to make a two-person and a three-person crew design first, then selecting one of these designs for later implementation. In early 1969, a consensus was reached to develop a Gemini-like capsule-type spacecraft carrying a two-person crew. It would be launched in 1973, by an enhanced version of the DF-5 missile from which the CZ-2 launch vehicle was derived.

There was a debate on the cabin pressure to be used for Shuguang. Some insisted on following the U.S. path, using



pure oxygen and a low pressure of one-third of an atmosphere to reduce the structural mass and to simplify the design. While others thought the Soviet one-atmosphere pressure was better and safer. The final decision was interesting: the Shuguang cabin pressure was decided to have a half atmosphere pressure (around 50kpa) with the oxygen density increased to 42%. It was said to have both the advantages of the Soviet and U.S. design. Once overall design and cabin parameters were decided, the space suit requirement was also fixed.. The suit pressure was set at 30.65kpa to match the half atmosphere cabin pressure. The Shuguang space suit was designed as a suit for intra-vehicular activity (or IVA) to protect the crew during launch, orbital flight and landing in an ejection seat.

The space suit development was mainly based on the experience gained in the development of the 6002 suit. But there are too many differences between a high-altitude suit that is used for fighter aircraft and a space suit that is to be used in orbit. Chinese engineers had no international communications at all during this time, with the West viewing China as an "enemy", and the Sino-Soviet relationship at its lowest ebb, including a military conflict at the China-Soviet border in 1969. These engineers could only find astronaut photographs in the media, so they studied Gemini and Apollo suits and started to design a Chinese one.



Unfortunately, there is very little information about the Shuguang suit that has been revealed even after more than four decades. Most of Shuguang technical materials and test articles were likely lost or are still classified. Although available information is very limited, one can still find a few details of the suit from the various interviews and articles of the former Institute 507 engineers. It was a one-piece suit with detachable gloves and a helmet, with its own circulation system to control the internal temperature and humidity.

As a space suit is very different from a fighter aircraft suit, there were a lot of difficulties. The engineers recruited several experienced tailors to make the major part of the suit. The helmet and the gloves were developed by separate teams. To test the suit in a space environment, they built a low-pressure chamber to simulate explosive pressure loss. Up to the programme's cancellation, two Shuguang suits were built and tested. The suit can withstand a shock pressure of 6000kg/m<sup>2</sup> when being ejected. It was tested a total of five times by human testers in the low-pressure chamber.

China released some photos during the late 1970s showing testers wearing an orange colour "space suit". It is believed that this suit was not the original Shuguang suit. Most likely, it was an improved and simplified version for low-pressure testing instead of a flight-ready suit.



The Shuguang Programme entered full-scale development when the Chinese leader Mao Zedong stated his support



in April 1971. It was given the codename "Project 714". Just when the programme achieved this boost and was sped up, it encountered a sudden stop. Lin Biao, Mao's legal successor, died in a plane crash in Mongolia after he decided to betray Mao and escape to the Soviet Union. The programme was stopped simply because the PLA Air Force, being controlled by Lin's followers including his son, was deeply involved in the Shuguang Programme. There was never a formal announcement at this time of a termination or suspension of the programme, but with key personal leaving and the funding ceased, its fate became uncertain immediately. It was the start of a long and difficult period for Institute 507. No one told them how to proceed with the projects that were related to the manned space programme. They decided to continue to do their best on these projects, and fortunately received support from Qian Xuesen, who was very influential in the Chinese space programme. With Qian's help, the Institute avoided closure, but the development process was

slowed down significantly.

In April 1972, a decision was taken for the planned manned launch to be delayed to 1978. In early 1974, the 5th Academy (CAST) was separated from the military, and Institute 507 became a unit directly under COSTIND (Commission of Science, Technology and Industry for National Defense). Its name was changed to the Space Medical Engineering Institute, but most people still refer to its old name - Institute 507. The efforts to develop a space suit continued until the official decision to cancel the Shuguang Programme in August 1978, the same year of the planned manned launch. At that time, the space suit was almost completed. It was tested and achieved its design objectives. But the Institute were again facing the possibility of closure. They argued that China must keep its only manned space flight research organisation, preserve research capabilities and the research results of the last decade for future manned space programmes. They again received support from Qian Xuesen. Finally they survived. They released about two thirds of their staff but retained key and experienced engineers and workers, and continued working on projects for military and civil applications. However, this was not the last crisis, for in 1985, a funding shortage forced them to consider yet again closure of the Institute. The visit of U.S. President Ronald Reagan to China raised their hopes. Reagan offered an opportunity for a Chinese payload specialist to fly on a Space Shuttle mission. But just when they started to prepare for this mission, the Shuttle Challenger accident happened and the joint mission was cancelled immediately. It was Programme 863 (863 representing the programme that was initiated in March, 1986) that finally saved the Institute 507.

## Shenzhou: Designed in Russia, Made in China

Programme 863 was China's first high-tech development programme and was a response to other countries' similar programmes such as the US Star Wars project, Japan's Fifth Generation Computer programme and Europe's Eureka programme. Space technology is one of six areas within Project 863. Manned space flight was considered from the beginning when Programme 863 was initiated. However, the debate on "space plane vs. capsule" took around six years to resolve. During these six years, Institute 507 received a small number of pre-study projects on life support systems, which guaranteed its survival and progression - albeit at a slow pace. One notable achievement of the Institute in this period was China's first biological space experiment in 1990. In this flight, three guinea pigs lived in space for 5½ days in a Fanhui Shi Weixing (FSW) capsule, meaning literally "recoverable satellite" in Chinese.



In January 1992, the Chinese manned space programme kicked off again. This time with the objective to launch a manned vehicle into orbit before 2002. The development of a space suit, life support system, space food, medical monitoring and support systems, as well as taikonaut selection and



training, etc., were given to Institute 507 – which immediately began work. They formed the teams and recalled some retired staff, with Mr. Chen Jingshan being made responsible for the space suit development. To reduce the development risks involved, the agreed approach was to seek Russia's assistance, and at the same time to

develop China's own space suit. In April, 1992, a delegation from Institute 507 visited NPP Zvezda of Russia and agreed a deal to purchase a Sokol space suit. It was only several months after the Soviet Union's collapse and everything was in a state of uncertainty, including NPP Zvezda itself and their staff. The Russians requested only 50,000 US dollars for a copy of the Sokol suit, but stipulated cash payment! Although the Chinese felt that this was quite a good deal, they only had 20,000 dollars to hand, and as the opportunity would be lost any time, they went immediately to the Chinese Embassy for help. Unfortunately the Embassy had no ready cash either, but somehow managed to raise the 30,000 dollars from their living expenses. With cash in hand, the deal was executed very smoothly and quickly.

Following return of the Sokol suit to Beijing, testing started immediately, with a disassembly and detailed studying of the suit. They found that the Sokol had many advantages over the Shuguang suit. For example, Sokol did not have its own circulation unit for maintaining temperature and humidity, but instead, pumped external air to the upper part of the suit to maintain a high partial-pressure of oxygen near the head area. Such a design is simple and reliable. Compared to the Shuguang suit, Sokol's helmet and glove interface were simpler and easier to use. However, it was the experience of the Shuguang suit development that helped them to fully understand the Sokol design.

The Shenzhou suit is a so-called IVA (Intra-vehicular Activity) space suit. It consists of a one-piece pressure suit, helmet, gloves and communication headset, together with a ventilation and emergency oxygen supply system. The suit is operated in three modes. In the "standby mode", the visor is open and the crew breathes in the in-cabin air. In the "working-ready mode", the visor is closed but the suit is still open to the in-cabin air. In this case, only the ventilation works to maintain the temperature and humidity inside the suit. In the emergency case of an accidental depressurization of

the spacecraft, the suit switches to the "working mode" and the emergency oxygen supply system is able to pump pressurized oxygen at a rate of 21 liters per minute to maintain pressure inside the suit at 39kpa for three hours, and another 3 three hours at 28kpa. The total working time is 6 hours. The Shenzhou IVA suit weighs 14.5kg and costs RMB 50-100 thousand.

The Shenzhou suit looks almost identical to the Sokol suit and is thought of by many as being a simple copy of the Sokol suit. In fact, Institute 507 engineers made several "improvements" intentionally to avoid making an exact copy, as they knew that the Russians would quickly recognize this. One improvement is a new design of the constraint component at the ankle position, with another being the improved chest shield. Also, the materials used and the manufacturing processes are all Chinese.

Nevertheless, although they kept most of the Sokol design unchanged, and also had hands-on Shuguang suit experience many years ago, they met with many technical difficulties. But with support from various experts and contractors and a relatively long schedule, they eventually qualified and delivered the suit before the Shenzhou 1 test flight in 1999.

On October 15, 2003, Yang Liwei made the first Chinese manned space flight. In his historical 21 hour 23 minute flight, he never took off his suit which worked nominally from launch to landing.

## Feitian: Defining Chinese Elements

In early 2004, China decided to fly the Shenzhou 7 spacecraft and to make the first Chinese space-walk, or EVA (extra-vehicular activity). It was actually a major change in China's manned programme. According to the original plan made in 1992, China's manned space programme had three steps identified. The first step was to send a human into space. The second step to complete a rendezvous and docking, and perform an EVA and launch a mini man-tended space station. The last step was to build a Mir-class modular space station and perform a long-duration space flight. In step two, the EVA was supposed to follow the rendezvous and docking mission. However, in 2004, China found that the docking mechanism development was behind schedule and the docking mission would not be feasible until around 2010. This situation was unacceptable concerning public relations, and the international image of China if no manned space flight would occur in the 5 years following the planned Shenzhou 6 mission in 2005. The only solution was to move the EVA mission ahead of the rendezvous and docking mission.

However, the EVA mission required an EVA suit. The original plan requested its readiness by 2010. In 2004, full-scale development of China's own EVA suit had not yet started, and as a result, it was decided to introduce the Russian Orlan EVA suit. Again, a delegation went to Russia and visited NPP

Zvezda. In fact, during the 1990s, Russia once agreed to sell an Orlan suit with the complete life support system in the backpack for 700,000 US dollars. But the superior department controlling Institute 507 insisted on paying half of the requested amount in a barter transaction, which was very common between Russia and China at that time. The Russians immediately turned down the deal. In 2004, the Russians raised the price to 800,000 US dollars, and only provided a sample model of the life support system. China had no choice but to accept this offer, and under this deal, China purchased three Orlan-M flight-suits, two ground training suits and 4 water pool training suits, together with four cabin-interface systems. For the flight and ground training suits, the power and communication systems were developed by China.

However, this was not what Institute 507 wanted to see. They started a campaign to lobby for a completely Chinese EVA suit. The reason was very political – China’s first space-walk must be seen to use a Chinese EVA suit - this was reasonable. In July 2004, the programme planner agreed to develop a Chinese EVA suit for the Shenzhou 7 mission. The mission date was also postponed from the originally planned 2007 to 2008 to guarantee the success of using a Chinese-developed suit. As the schedule was very tight, using a Russian suit for the EVA was retained as a backup plan.

In similarity to the IVA suit, the Russia Orlan-M suit became the baseline design. But this time the Chinese engineers decided to make it with obvious differences – both inside and outside. As one designer recalled in a book, they were always so embarrassed when people mocked them that the Chinese space suit so closely resembled the Russian suit. In July 2006, the suit was named by President Hu Jintao as “Feitian”, which means “flying in space” in Chinese.

Similar to the Orlan-M, the Feitian suit is a single-piece suit consisting of a solid torso, flexible arms and attachable helmet and gloves. It has a rear hatch entry, and the backpack is on the hatch cover. The Feitian EVA suit weighs 120kg, has a reliability factor of 0.997 and costs approximately RMB 30 million. It is equipped with an independent life support system and communication systems. An electrical umbilical tether was used to provide power, telemetry and communication links. It also supports wireless communication.

As the designers had hoped, the differences between the Orlan-M and the Feitian suits are obvious and involved in a number of components and subsystems:

- A purely Chinese-designed communication, telemetry and data management systems that are completely digital.
- The use of an Organic Light Emitting Diode (OLED) display on the electrical control panel at the top right part of the chest.
- A different appearance and layout of the electrical con-

trol panel and the gas-liquid controller at the bottom left part of the chest.

- A larger visor size and a wider view-angle.
- Different designs of the water collector, water distributor and connectors on the liquid-cooled undergarment.
- The wireless communication system between the suit



and the spacecraft uses Code Division Multiple Access (CDMA) technology, unlike the Orlan-M that uses High Frequency (HF).

- Working time is limited to 4-5 hours, in comparison with Orlan-M’s working time of 8 hours.

The EVA suit is more complicated than the IVA suit, but although the schedule for the former was much tighter than the latter, it was the experience gained from the IVA suit development that helped faster progress. Advances in China’s overall manufacturing capabilities in recent years also contributed to this fast progress. Some serious problems did occur during testing, however. On one occasion, the hatch cover opened suddenly during a low-pressure chamber test and on another occasion the visor exploded, slightly injuring a worker. All these issues were identified as manufacturing process problems instead of design flaws. The most difficult-to-build component was the torso shell, that was constructed from irregularly-shaped aluminum alloy plate having a thickness of 1.5mm. In early 2006, the development of the torso shell (by an unnamed contractor) had to be terminated, and the project was transferred to Factory 211 of CALT (the China Academy of Launch Vehicles). Factory 211 is equipped with advanced manufacturing facilities, such as various numerical control machines, and this decision was validated when three torso shells were delivered in February 2008, and passed qualification in August 2008.

In March 2008, the suit was delivered to CAST for system integration and testing. But many in the programme were still not confident in the suit. As a result, the Orlan-M suit was always tested and prepared in parallel with the Feitian suit. In April to June 2008, the Feitian suit passed a series of crew-suit-spacecraft matching tests in the low-pressure chamber. It was not until this moment that the Feitian suit was selected to be the one the first Chinese space-walker would wear.

On September 25, 2008, the Shenzhou 7 spacecraft was launched. Two days later, Zhai Zhigang became the first Chinese to walk in space. The 19½ minute EVA was completed nominally and the Feitian suit had made its debut in front of

TV audiences all over the world. More than one year later in January 2010, the Shenzhou 7 orbital module decayed and burned-up in the atmosphere with the Feitian suit inside. Another one of the only two completed Feitian suits was later displayed in various exhibitions all over China following the Shenzhou 7 mission.

In 2005, the Space Medical Engineering Institute was re-named to Astronaut Center of China (ACC).

## Future Evolution

After the Shenzhou 7 mission, China is focusing on rendezvous and docking testing. The Tiangong 1 space laboratory prototype (China officially refer to it as the “docking target spacecraft”) will be launched in late 2011 and followed by Shenzhou 8,9 and 10 sequentially in 2011 and 2012. For these missions, no EVA is planned. China then plans to launch the Tiangong 2 and 3 space laboratories and the permanent modular space station, to allow the crews to carry-out longer-duration stays. A manned lunar-landing has also been mentioned by some media and space scientists, but this is too far in the future. Currently, there is no urgent requirement to develop a new space suit, and there is also no official indication that any new space suits are in development.

Considering this situation however, it is very interesting to note a new model of an EVA suit called Feitian II appearing on Internet. The alleged Feitian II suit appears very similar to the US Constellation EVA suit (the US Constellation programme is now formally cancelled). Feitian II features a larger hard torso shell, indicating higher pressure (i.e. more than 1/3 atmosphere). If this is true, it would be one of the most advanced space suits in the world. However, it has been revealed that this suit is only a film-prop, but considering that this film was supported by major Chinese space organizations, and that it has many “correct” technical details, it is still interesting to speculate if it is based on a real prototype or a test article planned for the future? Time will tell!

**(Chen Lan)**

*Please go to the Gallery for more photos. This article is also to be published in the September issue of “Raumfahrt Concret” magazine in German language.*



## Is the Chinese Manned Space Programme a Military Programme?

China recently disclosed more details of its manned space plan. Tiangong 1, a small man-tended space station, is one of the hot topics in China now. It also received some attention in the western media. Craig Covault's article "China readies military space station" published on space flightNow was one example. It is interesting that the article concluded that Tiangong 1 will be a military station. Of course, it's not unusual that the Chinese manned space programme is often described as a military programme in the west. It seems quite reasonable, because:

- The Chinese manned space programme is run by the People's Liberation Army (PLA).
- Chinese taikonauts are military pilots.
- Previous Shenzhou spacecraft allegedly carried military payloads.
- Many Chinese experts claim that the manned space programme has important military applications.

However, it conflicts with China's official statements. What's the truth?

### How did China initiate the manned programme?

Looking back through Chinese space history, you will find that the military was not the advocate of a manned space programme at any time. So far, there is no evidence indicating the military wanted such a programme. It was the science community and the space industry that were continuously lobbying the government. Since 1986, the Ministry of Aerospace (part of it is now China Space Science and Technology Corporation, or CASC) had been very active in pushing the manned programme and performed a lot of fundamental work within the framework of Project 863, China's national high-tech programme. In September 21, 1992, the decision was made during a special Political Bureau meeting and the programme received approval from the government. It is worth noting that according to various reports based on declassified documents, including President and Party General Secretary Jiang Zeming's speech during that meeting, the objectives of the manned programme were set to have political, economic, scientific and technical, and military benefits, in which the military was last. A programme with only minor military usage cannot be called a military programme.

There are often reports in the Chinese media quoting "space experts" as saying the Chinese manned space programme has significant military value and important military applications. But there are no space officials or scientists directly in charge of the programme making similar claims. By spending a little more time on these reports, you will find that most of these "experts" are not familiar with the manned space programme. Some of them are scholars in colleges.

The others are military analysts expert in non-space fields, scientists/engineers involved in related periphery projects,



or retired officials or scientists/engineers. These reports, usually written by non-professional journalists, sometimes contain amplified or distorted facts. How can these reports represent the truth?

That is why the Chinese government always claims that the manned programme is for peaceful use.

### Who runs the Manned Space Programme?

It is first necessary to look at the organizational structure of the Chinese space programme and its history. From the beginning, the Chinese military was responsible for the space programme. This was natural as there were no civil programmes at all in the 1960s and early 1970s. When the space programme expanded with civil programmes such as communication satellite and weather satellite programmes, they were also led by the military sector. At that time, a military department called COSTIND (Commission of Science, Technology and Industry for National Defense) was responsible for the space programme as well as other defense programmes. In 1998 most of the responsibilities of COSTIND moved to the PLA's newly-formed General Armaments Department (GAD). The COSTIND was reorganized to carry out overall management of the space industry and to run civil space programmes. Later, the China National Space Administration (CNSA) was founded as an organization under COSTIND to oversee international cooperation. In 2008, COSTIND itself became a department within the Ministry of Industry and Information Technology and lost most of its military color. Most of China's civil space programmes started in recent years are under COSTIND/CNSA, for example, the Chinese Lunar Exploration Program (CLEP), the Haiyang (Ocean) satellite programme, the Huanjing (environment)

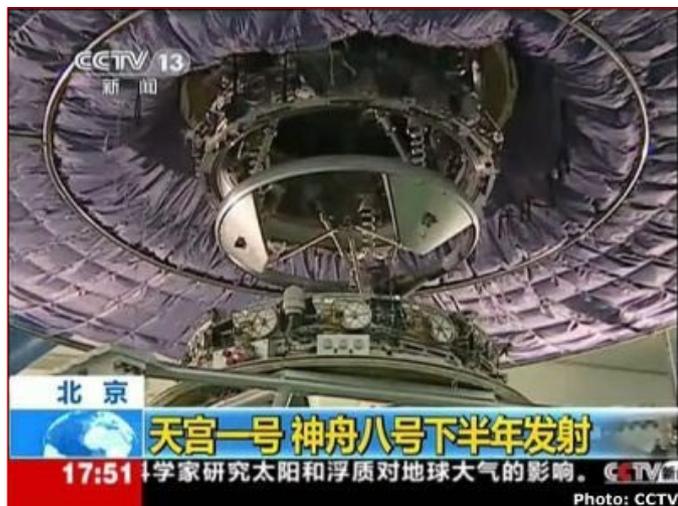
satellite programme, etc.

As early as the late 1980s, COSTIND was given the responsibility to lead the feasibility study of the manned programme, and to run the programme after its approval. In 1998 the manned space programme was moved to the GAD, instead of staying in COSTIND. Under such an organizational structure, if judged by western mindset, the manned programme is definitely a military programme. But in China, things are quite different. Like the space programme before 1998, and similar cases in aeronautic and nuclear industries (civil planes and nuclear power stations), the military also runs many civil programmes. Today the PLA still operates all space launch sites and tracking and control facilities for civil and commercial launches. In 1998 the PLA departments were busy building new ground facilities and training taikonauts. It was a wise decision to move the manned programme to GAD along with most COSTIND programmes. A smooth transition was very important to guarantee success of the maiden flight of the CZ-2F launcher and the Shenzhou spacecraft, which was already one year behind schedule. The manned space programme's military framework had its historic origin and practical needs.

It is true that the military is running the manned programme, but it does not naturally mean the programme itself is military.

### How does the Military run the Manned Space Programme?

Nearly 50 years after establishment of China's space programme, the military today still plays the most important role in it. All civil space programmes are still heavily dependent on the military. There is an efficient cooperative system between the civil and military departments. Take the Fengyun weather satellite for example, China Meteorological Administration (CMA) does the funding, planning and require-



ment definition, CASC develops the satellite and provides the launch vehicle as the contractor, COSTIND organizes and

coordinates the development, and the military (GAD) takes responsibility of launch and tracking operation. Once the satellite is delivered, the CMA receives data using its own ground stations, but routine orbital control and management is still done by control centers belonging to the GAD. So are the Chinese commercial satellite programmes. The military is experienced handling civil programs. The system works so well that there was no reason to change it for the manned programme.

As stated previously, the military's role does not mean a military programme, even the manned programme has more military involvement than other civil space programmes. In fact, the taikonauts all are military pilots. This is not unusual because they are obviously most suitable to pilot or control the spacecraft. Early astronauts and cosmonauts all were military pilots. Many astronauts flying the civilian Space Shuttle today are also military personnel. A slight difference with NASA is that the Chinese military is directly in charge of taikonaut training and mission operation. The taikonauts officially belong to the PLA Taikonaut Squadron. It is a natural result that the programme is directly run by the GAD. Like other cases of the military's involvement in civil programmes, the taikonauts' military status cannot prove that the whole programme is military, just like you cannot say that the Shuttle programme is military, though it involves military astronauts and even specific DoD missions.

On the contrary, there is evidence indicating the manned programme is different from other military programmes, if we take a look at its funding and the way the GAD runs it. The Chinese Manned Space Engineering Office (CMSEO), a special department within GAD, takes full responsibility of the manned programme from planning, budgeting and spending, overall management, until mission operation. And the manned space budget was specially allocated to the CMSEO and probably not within the national defense budget. There is no hard evidence to support that China's manned space programme is for a military purpose. Instead, there are more clues pointing to a civil programme.

### How about these military payloads?

Shortly after the Shenzhou 1 mission in 1999, western observers noticed a "mystery payload" at the top of the orbital module. Speculation was that it was a type of military payload. During the Shenzhou 5 and 6 missions, the large cameras in the orbital module were said to be military reconnaissance equipment. As China has ignored this equipment in its official reports, it seems reasonable to conclude that they are military payloads. This may be true. Unfortunately, many western analysts concluded that the Shenzhou missions mainly served military purposes and China's manned space programme is an important part of its military build-up. Most recently, some western observers claimed that the Tiangong 1 small station was a MOL or Almaz counterpart.

However, studies based on Chinese materials provide an opposite conclusion. According to various records, the Center

that China has to focus on economic development instead of military build-up. Undoubtedly, China will not repeat the mistakes of the Soviets.

(Chen Lan)

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for Space Science and Applied Research (CSSAR), Chinese Academy of Sciences (CAS), is responsible for planning, designing, development and operation of the Shenzhou application subsystem, one of seven subsystems of the Shenzhou manned system (the other six are the launch vehicle, spacecraft, launch site, landing zone, tracking and control, and taikonaut). CSSAR is the only subsystem contractor without a military heritage. CSSAR has also published a large number of research papers on experiments during various Shenzhou missions. It is possible that military applications are considered in the design phase at some level, but hard to believe the whole application system was designed for military use. Similarly, Tiangong 1's application subsystem is also designed and developed by CSSAR. So the possibility of a Chinese military station is quite low.

Of course, there may be various military or dual-use payloads in past Shenzhou spacecraft. And Tiangong 1 will very likely carry out military related experiment, too. This is also a normal practice in Soviet and U.S. manned space history. The manned system is cost inefficient for operational military tasks, but could be used as a test-bed for military experiments. Combined scientific, engineering, commercial and military usage is a way to offset high development and operations costs of the manned system.

We can conclude that the Chinese manned space programme is mainly for civil purposes, no different to that of U.S. and Russia today, though there are sometimes limited, experimental military payloads.

Just as Chinese decision-makers have studied other aspects of the Russian and American space programmes, they have carefully studied the U.S and Soviet plans to deploy military spacecraft in space, both of which were finally abandoned. They must have realized that a manned military system is not a good idea. Most importantly, so far China is still on the right track with Deng Xiaoping's warning almost 20 years ago

## Is Germany Europe's trail-blazer to China?

It sounds big and moreover it even sounds like a privilege: The German Aerospace Agency DLR announced on the 11 May 2011, that the first non-Chinese experiment on a Shenzhou mission is going to be a German experiment. Dr. Markus Braun, German Project Manager for the German-Chinese space project dubbed SIMBOX, goes into more detail: "It is a pilot project in many respects: with SIMBOX not only the first non-Chinese experiment is launching on a Shenzhou satellite, but it is also the first German-Chinese project within the Chinese manned space flight programme." Dr. Braun, together with his DLR colleagues and their Chinese counterparts from the China Manned Space Engineering Office (CMSEO), successfully concluded a dry-run of the SIMBOX flight- and engineering models in April and May in Beijing. Only after all parameters were met, and the simulation of the experiment completed without any difficulties, the international team gave the go-ahead for the integration of the approximately one-tenth of a cubic metre sized incubator into the Shenzhou 8 rocket.

Dr. Braun explains: "In August, the SIMBOX facility will be transported to the Jiuquan launch site in Inner Mongolia, and the launch is set for end of October."

After docking with the earlier-launched Tiangong-1 space laboratory, the SIMBOX incubator will be switched on automatically. Neither the Shenzhou 8 spacecraft, nor the Tiangong laboratory will be manned until the end of the year, and therefore no active human interference would be possible. After 20 days of operation it is foreseen that Shenzhou 8 would undock and re-enter the atmosphere. As soon as the capsule would be located after landing, the Chinese rescue team can get hold of the SIMBOX and transport it to Beijing for further investigation.

Dr. Markus Braun is already looking forward to this period of the flight: "We are very confident, that the mission will become a success. The cooperation works very well and there is an atmosphere of mutual trust. With this cooperation, DLR is opening a unique opportunity for microgravity research in the areas of biology and human physiology for German scientists. DLR is contributing the SIMBOX incubator and is financing the entire experiment-specific hardware. The Chinese are responsible for the flight opportunity and mission operation. Only a few years ago, such a project would have been unthinkable. The working relationship is determined by respect for each other and a very good personal, pleasant, and constructive atmosphere. Of course, there are big cultural differences and differences in engineering and safety approaches, in test procedures and how to run a project. Misunderstandings are unavoidable and sometimes discussions and decision-making can become lengthy and complicated. However, there is a strong will on both sides to make the first joint experiment on Shenzhou a success,

and therefore we could always find a solution acceptable for all sides."

In this light, it was a wise decision by the Germans to share the experiment facility with the Chinese colleagues. SIMBOX comprises in total 17 different biological and physiological experiments. Out of the 17 test locations, 10 are occupied with Chinese experiments, 6 with German and one slot is filled with a joint experiment. Dr. Braun specifies the research subjects: "We are experimenting with a number of organisms, among them are nematodes, micro-algae, bacteria, sprouts and several human cell cultures (neural and immune cells). The objectives are to find out which effects gravity and microgravity have on the human immune system and nervous system, but also on the growth, development, and behaviour of microbes, plants and living organisms."

The SIMBOX hardware was built for DLR by EADS Astrium in Friedrichshafen – a space company with one of the longest traditions in the construction of space hardware. The engineers in Friedrichshafen can gain from their experience in the design and development of space incubators such as the European Modular Cultivation System - EMCS, currently flying on the International Space Station.

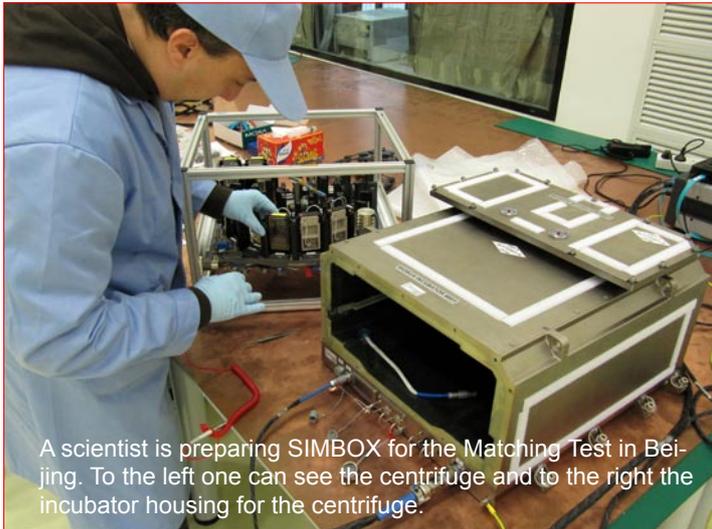
Project Manager Dr. Braun appreciates the Astrium product a lot: "The experiment units are just as big as cigarette boxes. It was a master performance by Astrium GmbH, a branch of EADS, to integrate the sample chambers, fixing liquids, electronic control units, LEDs, and pumps within the smallest space and to let the experiments run automatically. For sure, one or other of the scientists might have been disappointed that we did not have more experiment units available, or better conditions for the experiments, but 17 highly diverse experiments in one batch can only work if compromises are made. Maybe some of the scientists were hoping for a little German miracle that would make it possible to conduct even better experiments within the tiniest space."

When talking about long traditions, one has to remember that there is a long record of German-Chinese space cooperation existing. This fact remains almost unnoticed since the strong and dynamic German integration into the European Space Agency or NASA activities seems to dominate the general perception. Probably the COSIMA 1 protein crystallisation experiment was the first German experiment on a Chinese space mission. It was launched on the Fanhui Shi Weixing 1 (FSW-1) recoverable satellite in 1988, also from the Jiuquan space centre. "Joint German-Chinese research activities already exist since more than 20 years." confirms Dr. Braun.

"Among those are experiments for protein crystallisation, drop tower experiments and joint parabolic flight experi-

ments. Since 1996, a regular German-Chinese workshop on microgravity research is taking place – the last time in May 2009 in Shanghai. The strong mutual interest in joint research is reflected in the high number of 100 to 120 workshop participants. In 2008, the DLR management responsible for space, signed a human space flight cooperation agreement with the Chinese Manned Space Engineering Office – CMSEO. In the same year, a project agreement for the flight of the German incubator SIMBOX with 17 biological experiments was

at DLR is giving the big picture for the future: “The cooperation agreement between DLR and CMSEO confirmed the will of both sides for future collaboration. The main interest of the German management is on the promotion of microgravity research for the preparation of future space missions, but in particular on the improved understanding of fundamental biological, chemical and physical processes leading to applications for us humans here on Earth. Considering this, the Shenzhou satellites are a suitable platform for German scientists. Apart from that, China is busy constructing its own space station, which would open-up further research opportunities for German scientists. On this level I can see a big potential for future scientific cooperation. The increasing opening-up of China is a good way leading towards a joint, international, and peaceful cooperation in space.”



A scientist is preparing SIMBOX for the Matching Test in Beijing. To the left one can see the centrifuge and to the right the incubator housing for the centrifuge.

Looking back at the first half year of 2011, there is a certain dynamic in the developments to observe.

signed.” What sounds so easy was not always like that. Dr. Braun would welcome more transparency on the Chinese management level and would consider deeper insight into the structures and decision making processes of his Chinese partners as helpful. When Dr. Braun is asked about moments of stagnation or disappointment, he refers to the working level. “We could not tolerate stagnation at any moment of time. All hardware development and the test campaigns were done under high time pressure, since the preparation phase for such a complex mission was kept pretty short. In particular, the German scientists showed on the one side much patience and on the other side a high motivation: as soon as hardware components were ready, they had to be scientifically tested within a very tight time-frame because the technical tests were waiting in Beijing.” Dr. Markus Braun also recalls surprising developments: “Very often we were surprised that after hours of tough negotiations and endless discussions we finally made it and mastered apparent hopeless situations or were able to circumnavigate them skilfully. For me personally, again and again, it is surprising to see that, after hefty debates during the day, we can slap each other on our backs and celebrate together. This mutual respect and the very good personal relationship with our Chinese cooperation partners surely contributed to the very successful running of the project so far.”

On 4 and 5 April 2011, a Chinese delegation headed by the Director of CMSEO, Wang Wenbao, together with Yang Liwei, Deputy Director and first taikonaut, visited DLR in Bonn. The delegation met with Christoph Hohage, Director of Space Management. Both sides exchanged their views on further cooperation in the field of human space flight. Wang Wenbao and Christoph Hohage briefly introduced the current situation with respect to human space flight in China and Germany, and jointly reviewed the progress made of their cooperation project SIMBOX since the Cooperation Framework Agreement between CMSEO and DLR was signed in December 2008. To further strengthen cooperation and exchanges, both sides agreed that a joint working group should be set-up based on the original Framework Agreement, so as to promote continuous cooperation. During the talks, the two sides also had an extensive and in-depth exchange on further cooperation in the construction and operation of China’s space station. Both sides stressed that the SIMBOX project on the upcoming Shenzhou 8 mission, was the starting point of cooperation, and that in the future, China and Germany would have a broad cooperation in the field of space station construction technology and space science experiments.

This first project in the domain of human space flight has a big significance.

The Chinese delegation left Germany for France to visit ESA Head Quarters in Paris. The Chinese officials had friendly talks with Jean-Jacques Dordain, Director General of ESA. Jean-Jacques Dordain welcomed the CMSEO delegation and spoke about the main progress made since last year in the field of human space flight, while Chinese Director Wang Wenbao presented China’s current human space missions and the construction plan on the future space station. During the meeting, the two sides engaged in an in-depth discussion on potential exchanges and cooperation for human space flight.

Dr. Peter Preu, Department Head for Microgravity Research

It was not clear how much room the Chinese Premier Wen Jiabao gave to talks about scientific and technological coop-



eration during his recent visit in Berlin on 27 and 28 June, although he came with the biggest delegation in the history of Sino-German relations. The focus was clearly on economic interest. The fact of his visit shows the importance of growing ties between Germany and China. Germany has always been the promoter for human space flight in Europe. Unfortunately, Europe has never achieved autonomous manned access to space. Maybe the closer move to China is underlined by a strategic thinking in two directions. Germany is looking for opportunities for human space flight after 2020 – the current end-of-lifetime of the International Space Station. On the other hand, Germany, indeed, could be crucial in supporting China's participation in the ISS – an option so far heavily opposed by the USA. But things are starting to change slowly.

**(Jacqueline Myrrhe)**



Team photo of the scientists and engineers involved in the Matching Test in Beijing.

## On the Way to Mars

### China participates in a milestone project in Mankind's space history

It should not come as a big surprise that the Russians are currently leading a ground-based Mars flight simulation study lasting for 520 days.

Already during the times of the Soviet Union, the Russians focused on the continuous build-up of psychological experience for long-term manned space missions. Scientists of the Institute of Biomedical Problems (IBMP - established in 1963 in Moscow), soon recognised the importance of simulation studies to learn from them, and prepare for real missions. It is remarkable that in the late 1960's, at a time when actual Soviet space missions lasted just days, the first simulation study at IBMP already lasted for a whole year.

The most recently completed Russian simulation study lasted 240 days, and was conducted in the period from February 1999 through March 2000. This experiment named, SFINCSS-99 (Simulation of Flight of International Crew on Space Station), served to prepare for the International Space Station programme, with its characteristic of international crews in long-term stays on the human outpost in low Earth orbit.

Immediately after this project, the Russians began planning for the ultimate ambition: a ground-based simulation of a manned space flight to the planet Mars. The Russians wanted to aim for nothing less than a full-duration Mars flight, comprising of 250 days for the flight to the Red Planet, 30 days for surface operations and 240 days for the flight back to Earth.

When in May 2007 the Russians were ready with their crew selection and almost about to start the experiment, at the last moment the European Space Agency – ESA - decided to jump onto the virtual rocket launching towards Mars. Russia delayed the simulation study to give the European partners time for the selection of their own participants. In the meantime, two test studies were carried out. In November 2007, a 14-day facility test with Russian crew members only, and in the second quarter of 2009 a 105-day pre-cursor study with four Russian and two European crew members.

But a real surprise emerged when during the press conference on 18 May 2010, the final crew members for the Mars500 simulation were announced. It was expected that four Russians and two Europeans would be presented, but instead three Russians, two Europeans and one Chinese were selected.

Wang Yue, by that time 27-years old, is an employee of the China Astronaut Research and Training Centre in Beijing. It is reported that he belonged to the second group of the preliminary Chinese astronaut selection, and may have been considered for crew training for the Shenzhou 7 mission. On

3 June 2010 he, together with his five international Mars flight crew members, entered the ground test facility at the IBMP premises in Moscow. The entrance door closed behind the six young “Marsonauts”, it was sealed, and in front of them stretched 520 days inside their new home - a habitat of four interconnecting modules with a total volume of 550 cubic metres, which translates into a ground surface area of 200 square metres.



Wang Yue

Each crew member has a personal cabin of 9 square metres. The food is rationed as well as the water and energy supply. The six men have to organise their daily routine, the conduction of the experiments and most importantly, their inter-human relationships. The scientists want to know how the confined environment and the extreme long-stay, affect the psychology and physiology of the crew. Apart from weightlessness and radiation, all other parameters of a real human mission may be tested. Just like during a real interplanetary mission, the voice communication between spacecraft and mission control experiences a delay of up to 20 min per direction. That alone drives the crew to get on with most of the problems on their own – no matter whether it would be an emergency situation, stress or even disputes among the crew members.

According to interviews published by the IBMP on 3 June 2011, the first anniversary of the beginning of the experiment, the mood inside the habitat is really good; the crew is getting on very well; they even consider each other as friends. The only problem Wang Yue admitted to is the daily intake of Western food. Even after one year, his stomach is still not used to European food packages. Fortunately, the Korea Food Research Institute provided some astronaut food supplies. But Wang Yue still looks forward to having national food after the conclusion of the simulation. He also admitted that the whole exercise is not as easy as he thought it would be initially. Despite that, he has no intention of giving up prematurely, and performs calligraphy during his leisure

time to help him relax.

The Chinese would-be astronaut even became assigned to the 3-person-crew landing on Mars – the highlight of the



Wang Yue practicing calligraphy.

Photo: IMBP

mission, as confirmed by all six space travellers. Wang Yue, Russian Alexandr Smoleevskiy and Italian Diego Urbina separated from the other three crew members on 12 February this year, entered another module, the so called EU50, and “landed” on Mars. The three took turns in conducting a total of three EVAs on the “Martian surface”, which was an extra module prepared solely for that purpose. Wang Yue joined Alexandr for a Martian walk on 18 February 2011.

Without doubt the Mars landing was the central focus of the mission, but China also contributed some very special experiments, which run during the full course of the mission. One of these Chinese experiments deals with the syndrome differentiation of Traditional Chinese Medicine during long-term stay in a closed environment; another one with the effects of the environmental factors during the simulation study on circadian rhythm and oxidative stress; and a third one explores the influence of long-term confined and multi-cultural environments on non-verbal communication.

Since the Mars500 study is the first cooperation project between IBMP and the China Astronaut Research and Training Centre, many high-ranking experts and officials from the People’s Republic of China paid a visit to the Moscow institute.

In June, delegations lead by the Head of Political Administration of General Armament Department of Chinese People’s Liberation Army, Deputy Director of Chinese Human space flight Programme, General-Colonel Chi Wanchun, and another by the Director of China’s Manned Space Engineering Office, Wang Wenbao and his Deputy, the first Chinese taikonaut Yang Liwei, visited IBMP. The space officials had a tour

through the facilities and communicated with the Mars500 crew via video messages.

Currently, the Russians together with their partners are preparing for the return of the six crew members to Earth. The arrival is set for 5 November 2011. By that time Wang Yue celebrated his birthday once on his way to Mars and once on his way back.

## The crew

### Commander

Alexey Sergeevich Sitev, 38 years old (Russia)

### Crew Doctor

Sukhrob Rustamovich Kamolov, 37 years old (Russia)

### Researcher

Alexandr Egorovich Smoleevskiy, 32 years old (Russia)

### Flight Engineer

Romain Charles, 31 years old (France)

### Researcher

Diego Urbina, 27 years old (Italy/Columbia)

### Researcher

Wang Yue, 27 years old (China)  
(age as of June 2010)

## Main Mission Milestones

03 June 2010 - Take off for Mars

01 February 2011 - Arrival at Mars

12 to 23 February 2011 - Mars Surface operations – 3 EVAs

02 March 2011 - Departure from Mars

13 October 2011 - Entering into spiral orbit towards Earth

05 November 2011 - Landing on Earth



Wang Yue, Russian Alexandr Smoleevskiy and Italian Diego Urbina showing flag on Mars.

Photo: ESA

## Interview with Wang Yue

given to Go Taikonauts! via e-mail in May 2011

**Congratulations to you and your crewmates for the big-big success so far! Looking at the ESA website with the regular diaries and published photos, it seems that the mood is still very good and the team spirit is high. Can you confirm this?**

Thank you for your care. We all live and work smooth inside. Well, if I say anything is perfect, I guess no person believes. Just like the wave has its regular fluctuation, our individual mood changes sometimes. But I could confirm our team atmosphere and spirit is good. I am sure about this.

**You are not only a member of the Mars500 crew, but you were also assigned to all of the challenging parts of the mission: descent to the Mars surface, Mars surface operations and additionally a period of bed rest. How did you cope with these demanding jobs? Did you have a moment when you wanted to give up?**

Yes, and I am not the only one who are proud to have the chance to do the Mars job. It was teamwork that helped me to achieve these uneasy things. I felt tired, felt bored, sometimes even depressed, but I never had the feeling to give up. I think I can represent my crew to assure this point.

**How did it feel to be on Mars?**

Amazing! Excellent! Even though it was just a simulation, I was excited to participate in this landing.

**What were, from your perspective, the most exciting phases of the mission?**

It must be the Mars landing days.

**What were, from your perspective, the most difficult parts during the mission? What helped you through difficult times?**

The whole experiment is totally difficult. I think, for me, the most difficult phase should be the first month when we finished the landing and returned from EU50 (the landing module). The climax was over, the strongest feeling past. I felt a bit at a loss. Time, time can cure everything. I just remind myself, everything will pass.

**We understand that you have to give a lot of blood for the experiments and medical analyses. Is there still some blood left in your body?**

Sure, enough for my survival.

**We also saw photos showing you teaching your crew mates Chinese. Can we expect now that all crew members will**

**speak Chinese fluently after your return to Earth?**

Aaaaa.... Please, we are just doing the amusement. Foreign language learning is a good way for our spare time. English, Russian and also Chinese are all good foreign languages respectively. But I am not a professional teacher, though my students are clever. But I think you can expect we speak not bad English when we are outside.

**Looking back to the time before the start of the mission and thinking about your expectations when you applied for participation in this simulation study – were your expectations realistic? Which expectations did not turn out during the course of the mission? What surprised you pleasantly?**

I don't know. It is really a huge question for me. Before we began the mission, I set up several aims for myself, which worked to improve my abilities. Till now, I think I have learned a lot from this mission, from my crew, from IMBP, etc. But I am not sure I make all my expectations come true. I think, I still have a lot of things to learn, Oh, I can confirm one thing now, I lost my weight successfully!

**Was there a moment when you were particularly proud of your crew members?**

In EU50, when we three finished the work in the daytime, we got the phone from our other three guys in our neighbourhood, and when we returned from EU50, our six got together again... I felt so proud of our team!

**In the meanwhile you are on your way back to Earth. Once you are back you will be a hero – not only in China. How difficult is it to be patient and work through the last part of your journey?**

Hero is a much too big praise for us. We just do a job, a research, in a strange and special place. Yes, really strange. And yes, we need a lot of patience to work through the last long-term part. It is really, really not an easy thing. But I think we will get it.

**Would you volunteer for a real mission to Mars or do you have enough now?**

Sure! I adore to see the real space, real stars, real Mars.

**Where do you want to see China in 20 years from now with respect to astronautics? Maybe on Mars?**

20 years is too long... who knows. But I should confess I hope so.

(Jacqueline Myrrhe)

*Hi-res photos of Wang Yue in the Mars500 experiment will be published in the Gallery of the later issue.*

## Chinese Space Launch History (Part I: 1970 – 1989)

#1	#2	Date	Time (UTC)	Intl ID	Model	Rocket S/N	Launch Site	Launch Pad	Payload Name	Weight	Orbit Perigee	Apogee	Inclination	Remark
1	1	04/24/1970	13:35	70034	CZ-1		Jiuquan	5020	DFH-1	173	439	2384	68.5	
2	2	03/03/1971	12:04	71018	CZ-1		Jiuquan	5020	SJ-1	221	266	1826	69.6	
3	1	09/18/1973	12:12	73F07	FB-1		Jiuquan	138	CK-1-1	1138				launch failure, 2nd stage vernier thruster failure
4	2	07/12/1974	13:55	74F05	FB-1		Jiuquan	138	CK-1-2	1108				launch failure, 2nd stage engine lost thrust
5	3	11/05/1974	9:40	74F07	CZ-2	Y1	Jiuquan	138	FSW-0-0	1790				launch failure, lost data from pitch rate gyroscope
6	3	07/26/1975	13:30	75070	FB-1		Jiuquan	138	CK-1-3	1107	187	474	69.027	
7	4	11/26/1975	3:30	75111	CZ-2	Y2	Jiuquan	138	FSW-0-1	1790	177	479	63	return to earth after 3 days
8	4	12/16/1975	9:21	75119	FB-1		Jiuquan	138	CK-1-4	1108	184	387	68.991	
9	5	08/30/1976	11:45	76087	FB-1		Jiuquan	138	CK-1-5	1108	191	2145	69.166	
10	6	11/10/1976	9:05	76F03	FB-1		Jiuquan	138	CK-1-6	1208				launch failure, 2nd stage vernier thruster failure
11	5	12/07/1976	3:38	76117	CZ-2	Y3	Jiuquan	138	FSW-0-2	1812	159	489	59.4	return to earth after 3 days

#1	#2	Date	Time (UTC)	Intl ID	Model	Rocket S/N	Launch Site	Launch Pad	Payload Name	Weight	Orbit Perigee	Apogee	Inclination	Remark
12	6	01/26/1978	5:00	78011	CZ-2	Y4	Jiuquan	138	FSW-0-3	1810	167	509	57	return to earth after 3 days
13	7	07/27/1979	21:28	79F02	FB-1		Jiuquan	138	SJ 2 SJ-2A SJ-2B	250 480 30				launch failure, 2nd stage vernier thruster failure
14	8	09/19/1981	21:28	81093	FB-1		Jiuquan	138	SJ 2 SJ-2A SJ-2B	250 480 30	231.4	1610.4	59.44	
15	7	09/09/1982	7:19	82090	CZ-2C	Y1	Jiuquan	138	FSW-0-4	1783	177	410	63	return to earth after 5 days
16	8	08/19/1983	6:00	83086	CZ-2C	Y2	Jiuquan	138	FSW-0-5	1842	175	410	63.3	return to earth after 5 days
17	9	01/29/1984	12:25	84008	CZ-3	Y1	Xichang	3	DFH-2-0	910	400	31.1		launch failure, cryogenic 3rd stage lost thrust after restart.
18	10	04/08/1984	11:20	84035	CZ-3	Y2	Xichang	3	DFH-2-1	910	400	36111	31.1	
19	11	09/12/1984	5:43	84098	CZ-2C	Y3	Jiuquan	138	FSW-0-6	1809	178	414	68	return to earth after 5 days
20	12	10/21/1985	5:04	85096	CZ-2C	Y4	Jiuquan	138	FSW-0-7	1809	175	409	63	return to earth after 5 days
21	13	02/01/1986	12:37	86010	CZ-3	Y3	Xichang	3	DFH-2-2	917	400	36127	31.1	
22	14	10/06/1986	5:40	86076	CZ-2C	Y5	Jiuquan	138	FSW-0-8	1800	176	402	63	return to earth after 5 days

#1	#2	Date	Time (UTC)	Intl ID	Model	Rocket S/N	Launch Site	Launch Pad	Payload Name	Weight	Orbit Perigee	Apogee	Inclination	Remark
23	15	08/05/1987	6:37	87067	CZ-2C	Y6	Jiuquan	138	FSW-0-9	1819	175	400	69.96	return to earth after 5 days. The first Western Piggyback payload, microgravity Test Instruments from Matra Marconi
24	16	09/09/1987	7:15	87075	CZ-2C	Y7	Jiuquan	138	FSW-1-1	2076	208	323	63	return to earth after 8 days
25	17	03/07/1988	12:41	88014	CZ-3	Y4	Xichang	3	DFH-2-3	1024	200	36116	31.1	
26	18	08/05/1988	7:28	88067	CZ-2C	Y8	Jiuquan	138	FSW-1-12	2129	208	313	63.92	return to earth after 8 days. Piggyback payload, from German Space Agency DFVLR and private company Intospace
27	19	09/06/1988	20:30	88080	CZ-4A	Y1	Taiyuan	Old	FY-1A	757	833	918	99.1	
28	20	12/22/1988	12:40	88111	CZ-3	Y5	Xichang	3	DFH-2-4	1024	200	36151	31.1	

**Note:**

- #1 and #2 are flight numbers of all space launches and launches per vehicle family (CZ,FB,KT) respectively.
- Two CZ-1 suborbital launch tests carried out on Nov 16, 1969 and Jan 30, 1970 and all FB-1 suborbital launches are not included.

**Sources:**

- CGWIC website: <http://cn.cgwic.com/LaunchServices/LaunchRecord/LongMarch.html>
- Chinese Internet forum: <http://www.gifly.cn/thread-407-1-1.html> (author: heito, darklighter, liss, 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>

## Chinese Launch Sites

### (Part 1 - Jiuquan Satellite Launch Center)

#### Brief History

China began to build the Jiuquan launch site as a missile test site in 1958 and completed the first phase construction in 1960. In the same year, China successfully conducted its first surface-to-surface missile test. China's first satellite DFH-1 was launched on April 24, 1970 from the site, which was later on named Jiuquan Satellite Launch Center. A railway connecting Jiuquan City, an airport and a small town called East Wind Space City were established to support the launch operations. In 1994 to 1997, at south of the existing site, new launch pads and new facilities was built as a part of the Project 921, the manned space program. The two sites were later renamed as the North Launch Center and the South Launch Center. The North Center has been abandoned since 1996 and was listed as a protected historical site in 2006.

#### Facilities

##### The North Launch Center (abandoned):

- Launch Pad 5020, mixed use for satellite launches and missile tests
- Launch Pad 138 for low orbit satellite launches
- Launch Service Tower, movable and used for vertical tests, for both Pad 5020 and 138
- Control Center (underground)

##### The South Launch Center:

- Launch Pad 921 for manned launches
- Launch Pad 603 for low orbit satellite missions
- Vertical Assembly Building (VAB, Project 9001)
- Test and Launch Control Building (Project 9008)

##### Other Facilities:

- Optical Station (Zone 1)
- Telemetry Station
- A dedicated branch railway line connecting JSLC with the national Lanzhou-Urumqi Railway
- Dingxin Airport, 75km south of JSLC, having a 4100 m x 80 m runway
- Shenzhou Landing Site (Secondary Landing Site)

#### Milestones

- Nov 5, 1960 China's first surface-to-surface missile was successfully tested from JSLC
- Oct 27, 1966 China's first nuclear missile was launched from JSLC
- Apr 24, 1970 China's first satellite DFH-1 was launched from JSLC
- Nov 26, 1975 China's first recoverable satellite was launched from JSLC
- May 18, 1980 China's first test ICBM was launched from JSLC
- Aug 5, 1987 China's first piggyback payload from Matra Marconi was launched from JSLC
- Oct 15, 2003 China first manned spacecraft Shenzhou 5 was launched from JSLC

#### Launch Pad Statistics

Pad No.	Location	Construction Date	First Launch	Last Launch	Launch Stats (by LV model)	Launch Stats (by orbit type)	Fuel type	Remarks
5020	41°18'22"N 100°18'47"E	Sep, 1965	Dec 26, 1966	May 21, 1980	CZ-1: 2	LEO: 2	UDMH /N <sub>2</sub> O <sub>4</sub>	
138	41°18'32"N 100°19'00"E	Unknown	Sep 10, 1971	Oct 20, 1996	FB-1: 8 CZ-2: 4 CZ-2C: 11 CZ-2D: 3 Total: 26	LEO: 26	UDMH / N <sub>2</sub> O <sub>4</sub>	
921	40°57'29"N 100°17'30"E	Jul, 1994	Nov 19, 1999	In use	CZ-2F: 7	LEO: 7	UDMH / N <sub>2</sub> O <sub>4</sub>	Support manned launch
603	40°57'38"N 100°17'54"E	Unknown	Nov 3, 2003	In use	CZ-2D: 11 CZ-2C: 5 CZ-4C: 1 Total: 17	LEO: 13 SSO: 4	UDMH / N <sub>2</sub> O <sub>4</sub>	First concrete tower in the world
					Total : 52			

**Note:** launch statistics are up to end of Jul 2011

##### Sources:

1. 百度百科, <http://baike.baidu.com/view/25207.htm>
2. 互动百科, <http://www.hudong.com/wiki/%E9%85%92%E6%B3%89%E5%8D%AB%E6%98%9F%E5%8F%91%E5%B0%84%E4%B8%AD%E5%BF%83>
3. CGWIC, <http://www.cgwic.com>



## Gallery

### The Chinese Space Suits



This photo was taken in November 2003 in an exhibition in Shanghai. The photo shows the IVA suit used by Yang Liwei in his historic Shenzhou 5 flight lasting 21 hours 23 minutes. Yang Liwei never took off the suit during the whole duration of the flight. (Photo: Chen Lan)



This photo was taken in April 2006 in an exhibition in Shanghai. The photo shows the IVA suits used by Nie Haisheng and Fei Junlong in the 5-day Shenzhou 6 mission. The two taikonauts removed their suits once they entered orbit. (Photo: Chen Lan)



This photo was taken in July 2009 in an exhibition in Shanghai. The photo shows the IVA suit used by Zhai Zhigang in the Shenzhou 7 mission. (Photo: Jacqueline Myrrhe)



This photo shows exterior details of the Shenzhou IVA suit used by Yang Liwei in the historic Shenzhou 5 mission in 2003. (Photo: Chen Lan)



This photo shows exterior details of the Shenzhou IVA suit used by Nie Haisheng in the Shenzhou 6 mission in 2005. (Photo: Chen Lan)



This photo shows the Chinese Feitian EVA suit. It has many similarities with the Russian Orlan-M suit, but there are also many obvious differences between the two suits that may be seen from this front view. (Internet photo)



This photo was taken in July 2009 in an exhibition in Shanghai. The suit in this photo is not the flight-suit used in the Shenzhou 7 mission. Instead, it is the second flight-ready Feitian EVA suit used as the backup. (Photo: Jacqueline Myrrhe)



This photo shows equipment mounted at the chest part of the suit. Note the electrical control panel at the far upper part and the gas-liquid controller at the near lower part. (Photo: Jacqueline Myrrhe)



This photo shows the backpack of the Feitian suit. Similar to the Russian Orlan-M, the Feitian suit is a one-piece EVA suit with hatch at back. The backpack is on the hatch cover. (Photo: Jacqueline Myrrhe)



This photo shows the gloves of the Feitian suit in which taikonaut Zhai Zhigang made the historic spacewalk during the Shenzhou 7 mission. It was detached from the flight-suit before re-entry and brought back to the Earth by the crew. The flight suit was left in the orbital module and destroyed during re-entry in 2009. (Photo: Jacqueline Myrrhe)



This photo shows the Feitian suit and the Russian Orlan-M suit side-by-side. The Orlan-M suit was used as the backup of the Feitian suit in the Shenzhou 7 mission. In this mission, taikonaut Zhai Zhigang made a 16-minute spacewalk, while Liu Boming only partially emerged from the spacecraft, wearing the Orlan-M suit. (Internet photo)



This photo shows the Feitian suit and the Russian Orlan-M suit in a low-pressure chamber test in early 2008. The Orlan-M suit was used as the backup of the Feitian suit in the Shenzhou 7 mission. In this mission, taikonaut Zhai Zhigang made a 16-minute space walk, while Liu Boming only partially emerged from the spacecraft wearing the Orlan-M suit. (Internet photo)