The Pioneering Biological Experiment On Moon

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Content

1. Background of program √
2. Program design
3. Research and development process
4. On-orbit operation summary
5. Impact and significance

Background of program

In order to stimulate the public to explore the enthusiasm and innovation potential of the universe, **the National Defense Science and Technology Bureau, the Ministry of Education, the Chinese Academy of Sciences, the China Association for Science and Technology, and the Central Committee of the Communist Youth League hosted a lunar exploration payload creative design collection campaign with the theme of "Inspiring enthusiasm for exploration and encouraging public innovation" in 2015 .**

A total of 257 entire from all over the country were received . After the primary selection, the initial evaluation of the expert group, the public online voting, the publicity, and the final evaluation of the expert group, the lunar micro-ecological bio-experiment payload was the winner.

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Challenge and Key technology

1. Must meet the change-4 probe:Weight:≤3kg, size ：≤ 200mm*180mm ,only Two control command signals：release water and take pic.

2复杂力学环境下的生物固定技术The biological immobilization technology in complex mechanics. And 2 months keep on Launching site and 1 month during fly to moon,The biology organism can not grow and can not Rotten

3.月面自然条件下的导光技术The light-guiding technology under lunar natural environment, thick dust.

4.月表高真空、宽温差条件下的密封技术The sealing technology under environment of high vacuum， and 1 bar inside

5.小尺度、高湿度、宽温差条件下的自主温控技术The independent temperature control technology under the conditions of small scale, high humidity and wide temperature range. range -180-+120℃.

6.高湿度条件下相机防雾成像技术The Anti-fog imaging technology for cameras under high humidity conditions.100%

Objective of playload

1）探索在月球表面低重力、强辐射、自然光照条件下动植物的生长发育状况和光合作用效果；

To explore the growth and development of photosynthesis and photosynthesis effects on the lunar surface under low gravity, strong radiation and natural light;

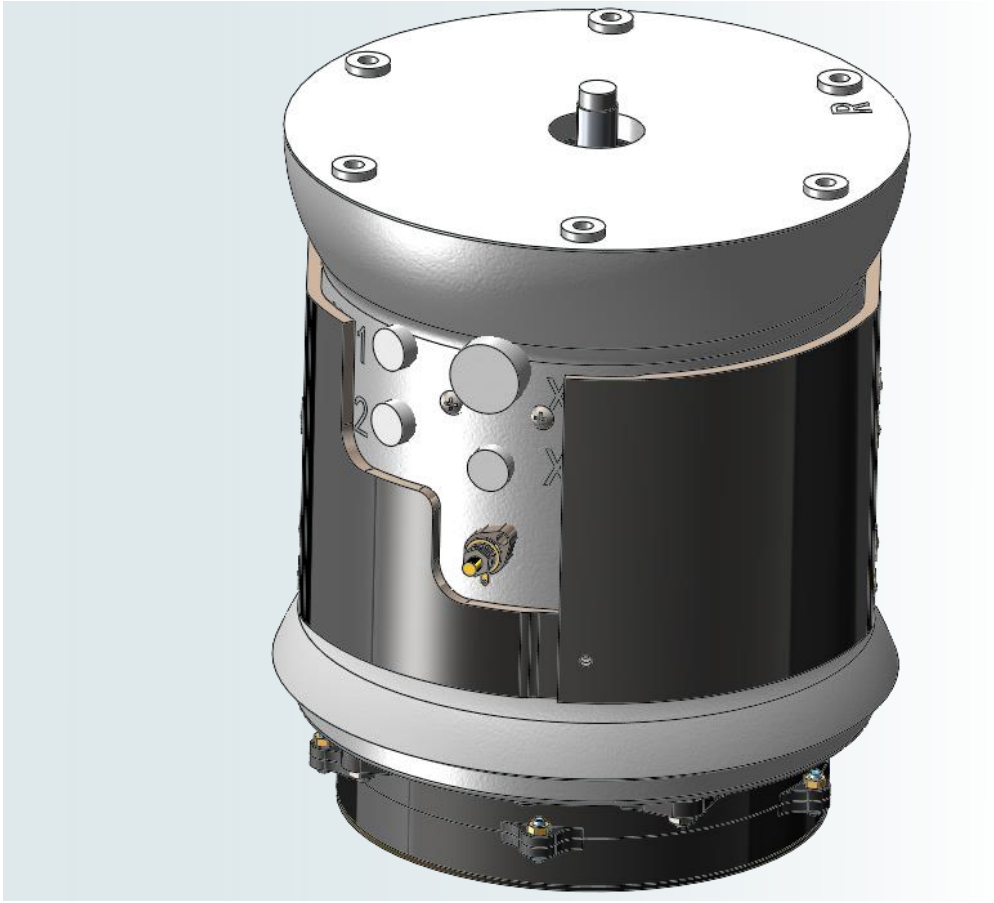
2）通过生物科普试验载荷的实施，推动生物学知识的普及，加深普通民众对生物学原理的了解；

To promote the popularization of biological knowledge through the biological experiment payload, and deepen the understanding of the general public on biological principles;

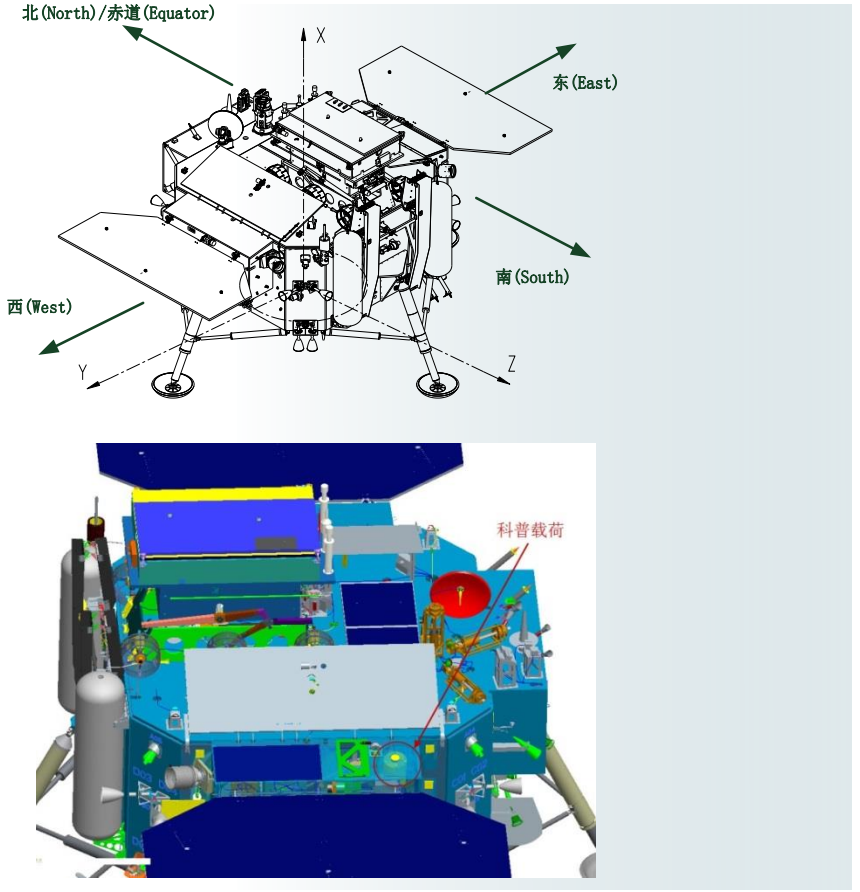
3）宣传我国探月工程成果，激发人们对宇宙探索和科学研究的兴趣，提高人们的环境保护意识。

To publicize the results of China's lunar exploration project, stimulate people's interest in the exploration of the universe and scientific research, and raise people's awareness of environmental protection.

Playload mounting position



Structural sketch



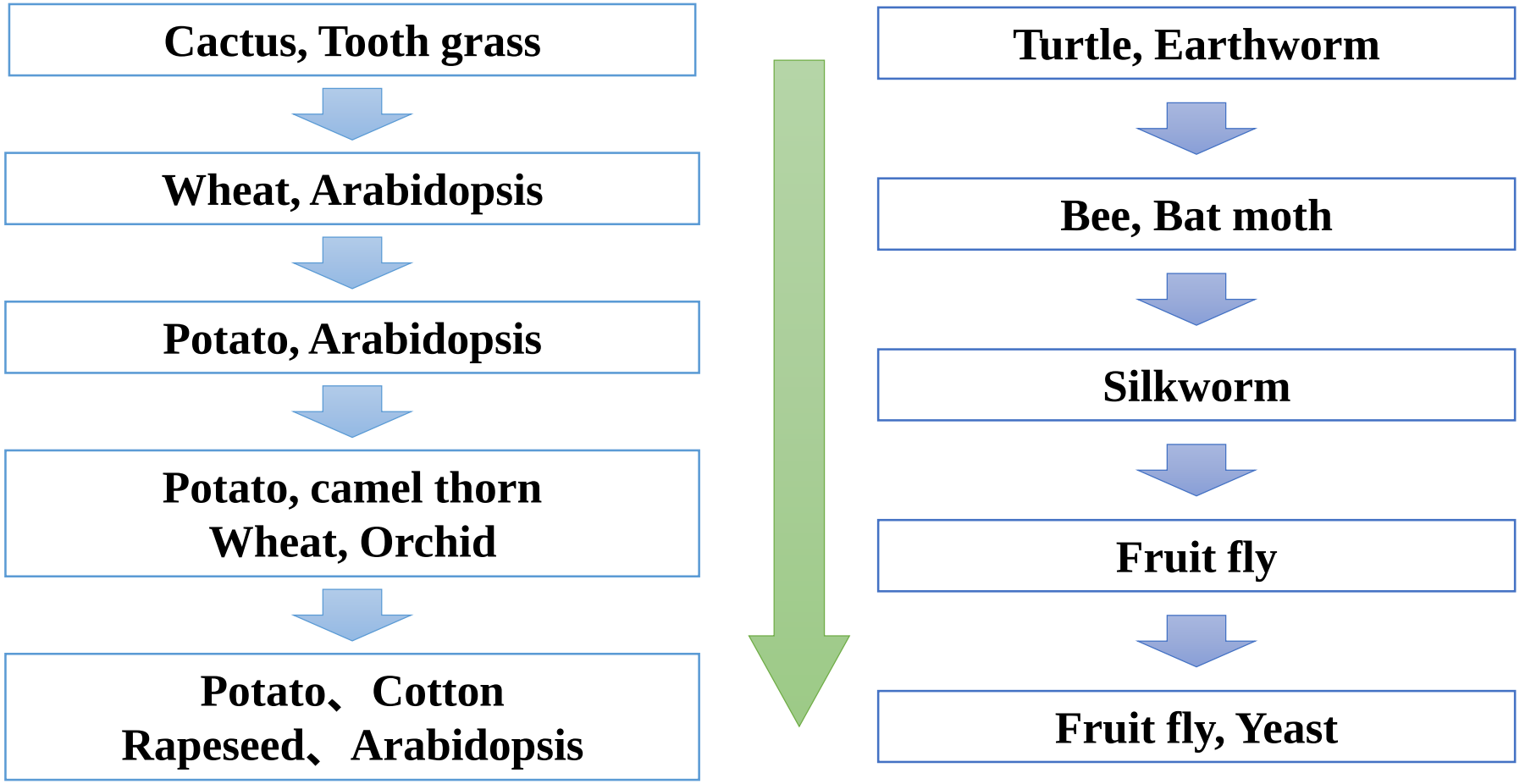
The position

Technical Indicators target

items	indicators
weight	2.608kg
full size	Φ173(±0.5) mm×198.3 (±0.5) mm
Light guide pipe	10mm±0.1mm
Spatial size of biological activity	Φ128.6×72 mm
power dissipation;	15W
Data volume	每24小时65 Mb
Data transmission rate	256B/s
Leakage rate	$<1.9\times10^{-5}$ Pa·m^3/s

The screening of organism

Hundreds of organism



Final selected species

Potato

- ✓ The fourth largest crop in the world.
- ✓ Chinese stapled strategy food.
- ✓ Future space food.

Rapeseed

- ✓ Important oil crop.
- ✓ Beautiful scenery after flowering.
- ✓ Fast seed germination.

Cotton

- ✓ Important fabric crops.
- ✓ Large seedlings, good display.

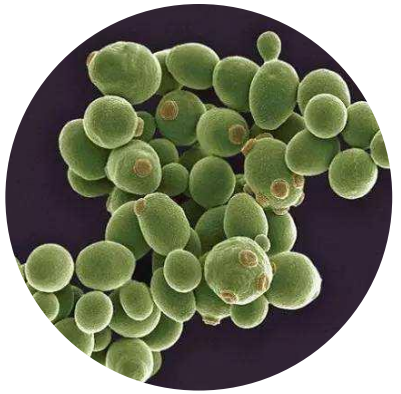
Final selected species

Arabidopsis

Flowering around 12 days for the ultimate goal.

Fruit fly

Model animal with short life cycle.

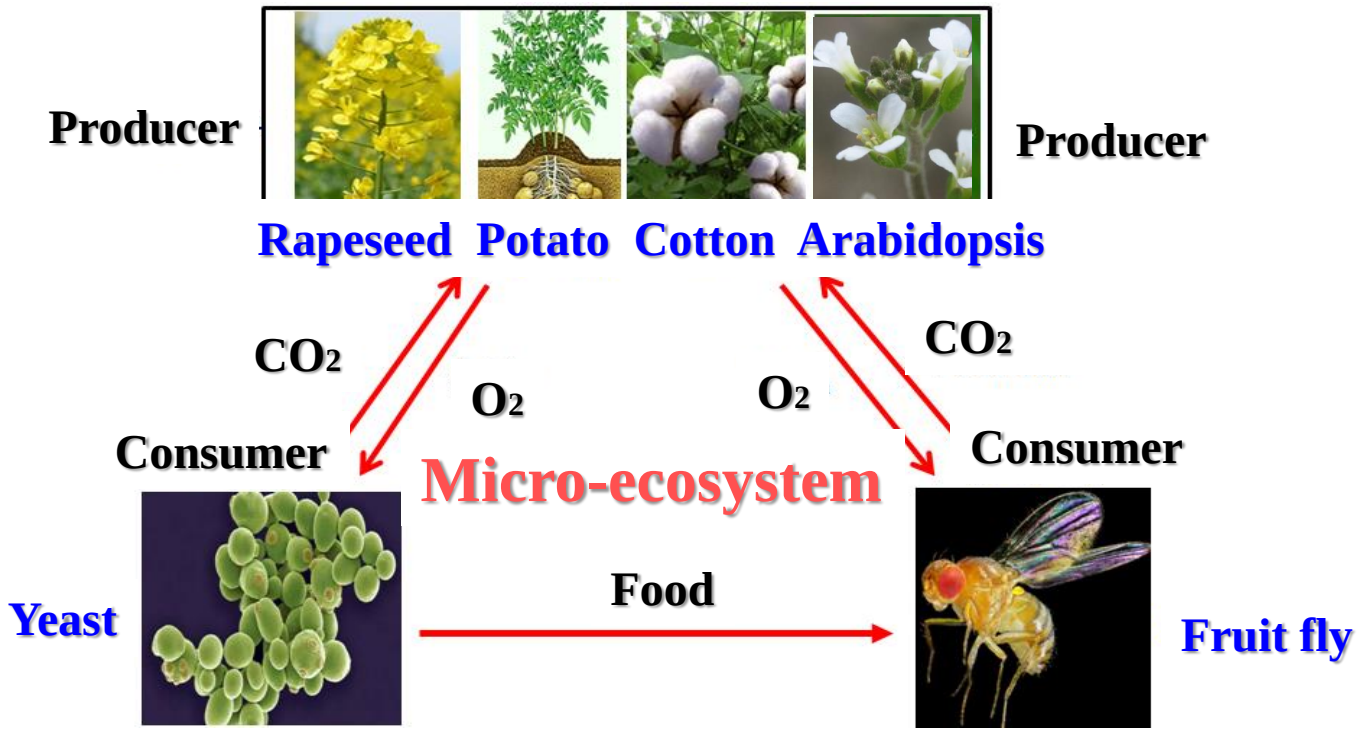


Yeast

Important engineering microorganism.

Fruit fly food.

Relationship between selected species



The photosynthesis of the seeds in the lunar environment and the photosynthesis of plants were verified by observing the whole process of seed germination, seedling growth and flowering of plants under low gravity and strong radiation conditions, or hatching of eggs, larval growth and development, and smashing. Inspire people's awareness of eco-environment.

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Research and development process

(Jan. 2016- Oct. 2018)

Jan. 2016 to Aug. 2016, preliminary program design of payload.

Sept. 2016 to Dec. 2016, detailed design of each subsystem.

Jan. to Oct. 2017, comprehensive program design of payload.

Aug. 2017, participate the lander EMC test.

Oct. 2017 to Apr. 2018, Development of payload identification components.

May to July 2018, the identification test (including mechanical test, thermal environment test, leakage test), complete the development of the product.

July to Sept. 2018, payload acceptance test (including mechanical test, thermal environment test, leak test)

Research and development process

Structural optimization	**17 times**
Processing prototype	**6 times**
Reports	**more than 150**
Reported	**nearly 100 times**

Completed 35 engineering verification tests

Completed 200 biological experiments

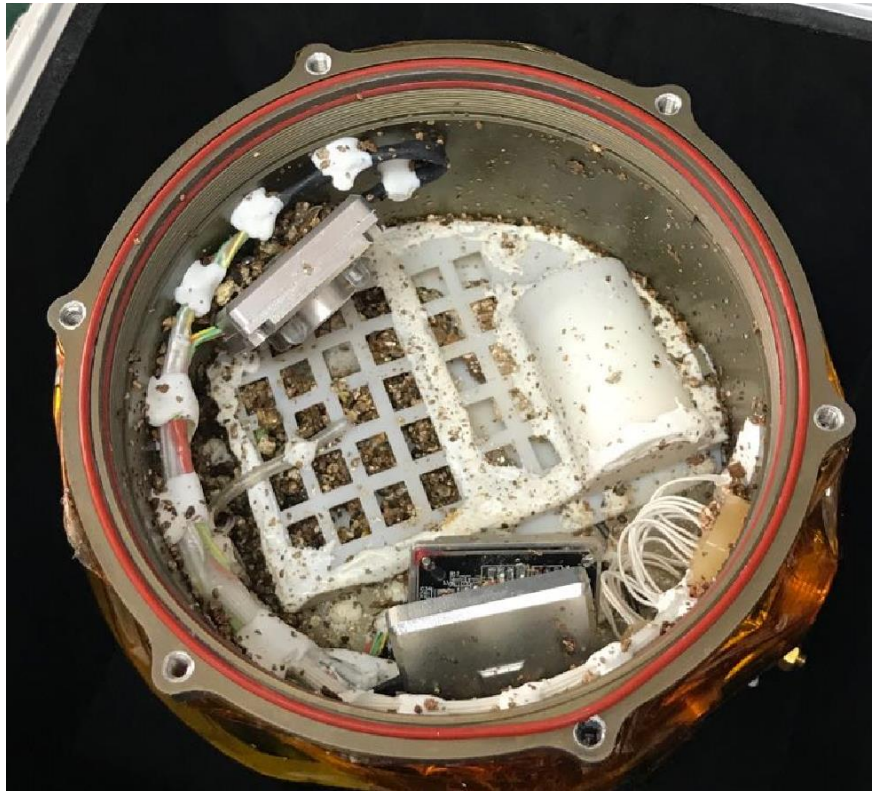
Visited more than 50 enterprises and institutions in 15 provinces and cities

Experienced 4 times of reset process

Research and development process

On-orbit risks

- The early release of water with scattered soil, the air leaks
- The water might not be released
- The light pipe might be blocked by the moon dust
- The camera might not work
- The data might not be transmitted, and so on.



Team

General Counsel – Academician Zhihua Zhong

Vice President of Chinese Academy of Engineering

Provide guidance on the scientific direction, technical guidance and resource coordination for main issues.

Team

Commander in Chief –Hanlong Liu

Vice President of Chongqing University

Coordinate the resources to promote the development of program, and ensure the reliability and safety of the development process.

Team

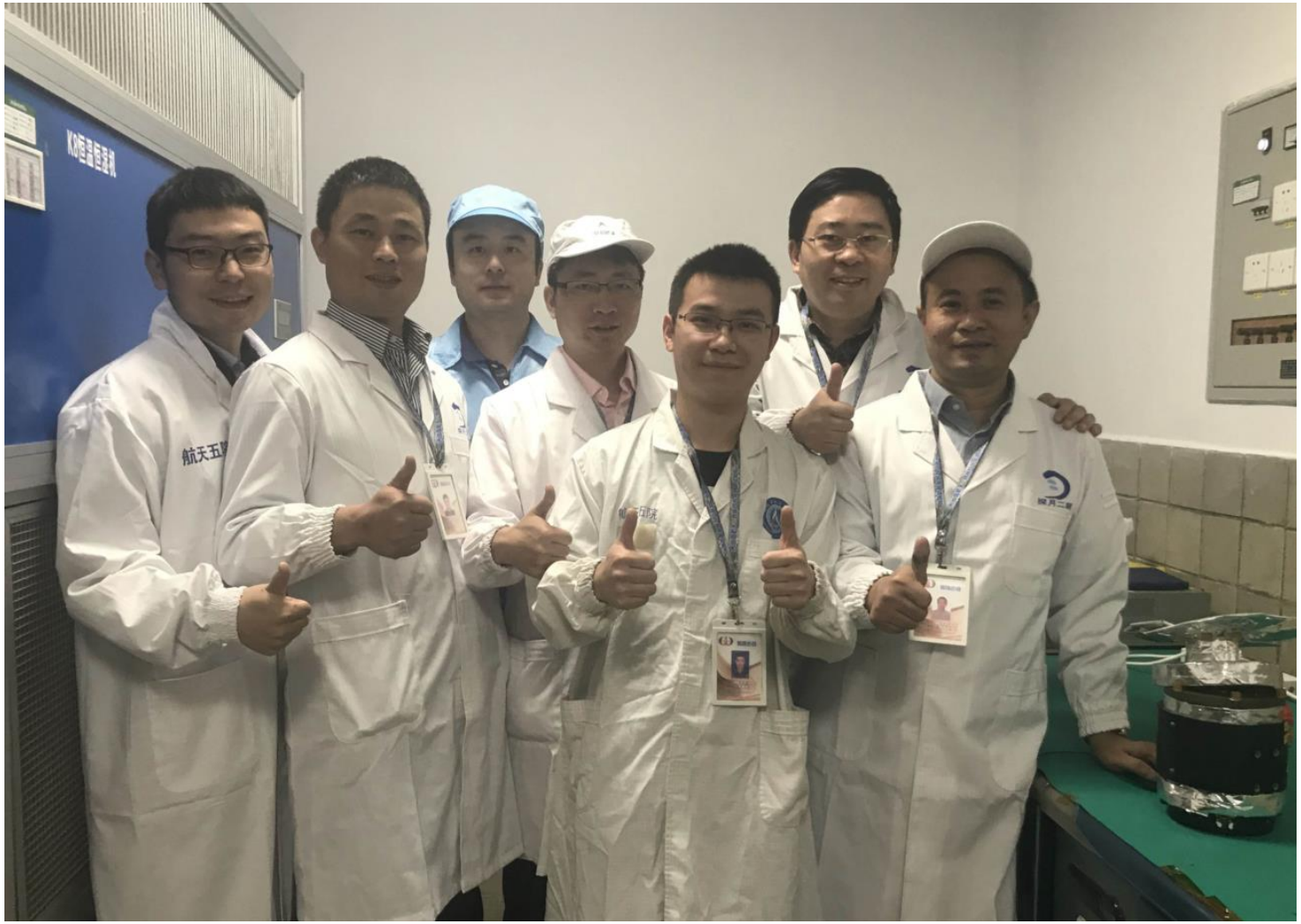
Designer in Chief ——Gengxin Xie

xiegengxin@vip.sina.com, skype ID:xiegengxin

Deputy Director of Center of Space Exploration, Ministry of Education, Dean of the National Defense Science and Technology Research Institute of Chongqing University.

In charge of the overall design, research and development process, and key technology development.

Team



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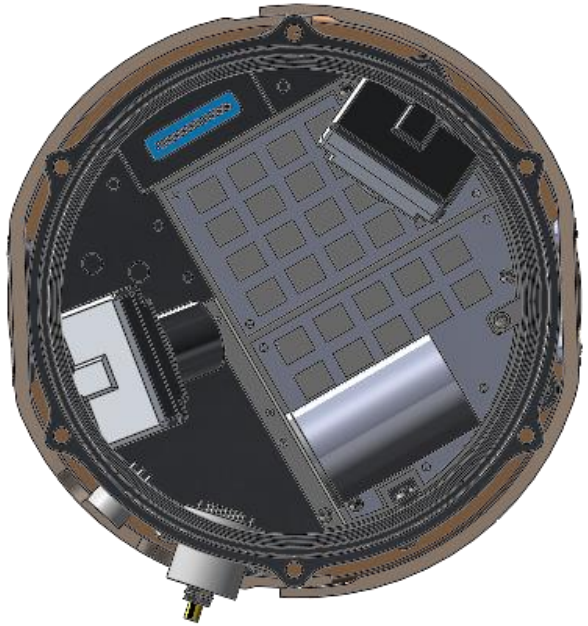
On-orbit operation summary

The payload was turned on at 23:18:40 on January 3, 2019, 12.88 hours after the landing of the lander. On May 9, 2019, 11:48:50, it was powered off. The pressure inside is 1.04 bar on Jun.3 and 0.82bar on May.5,2019

So far, the accumulated working time was 1300 hours, a total of 127 shots with 632 photos were received, of which:

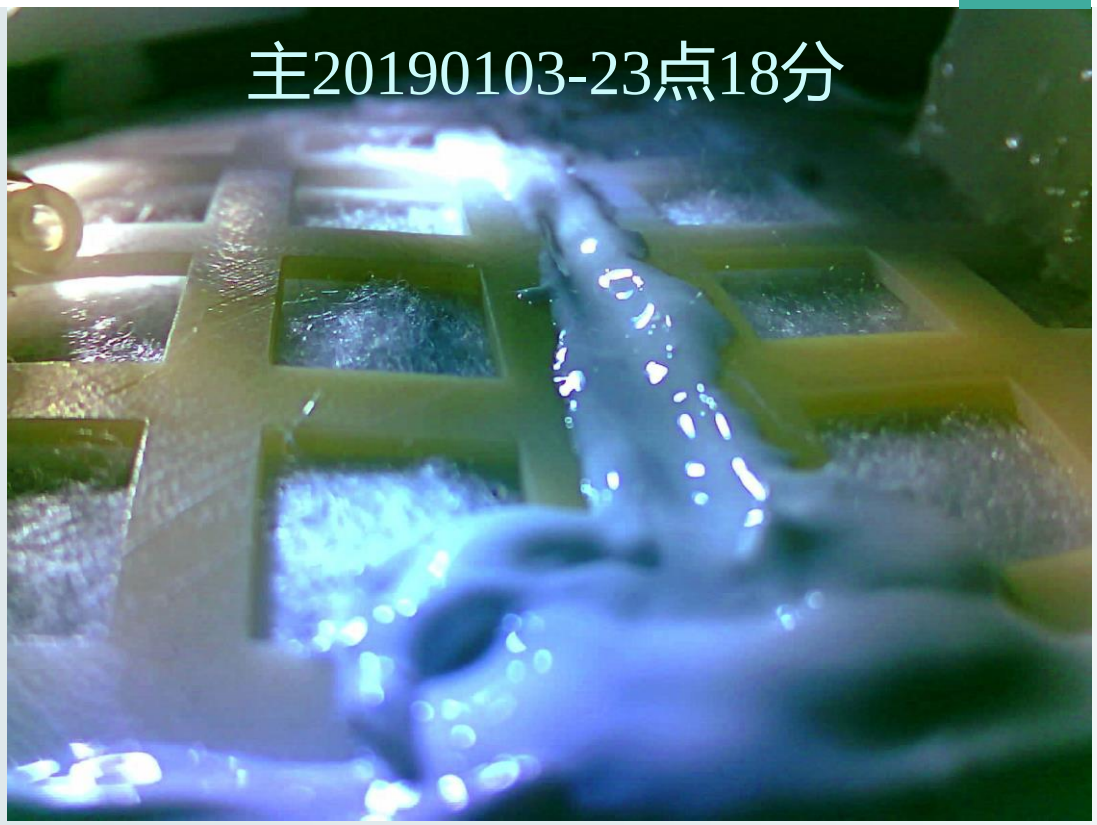
- The main camera took 69 shots and 343 photos
- The spare camera took 58 shots and 289 photos



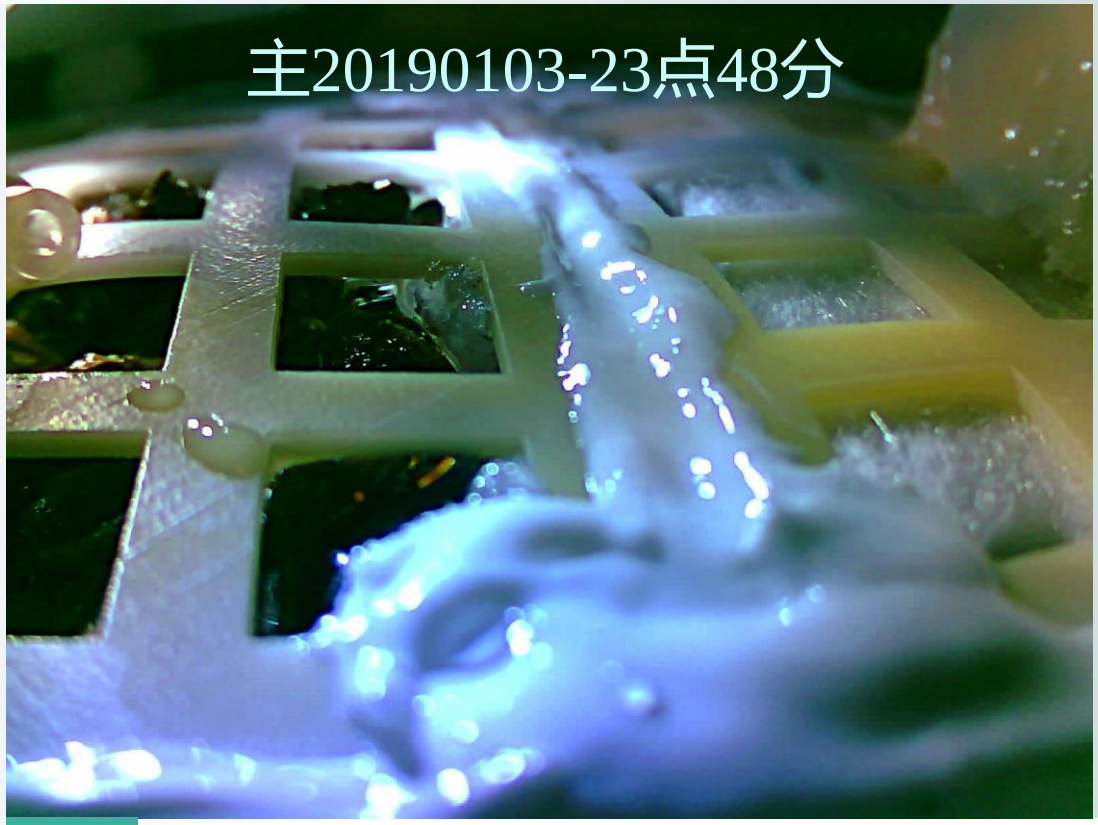
Temperature variation inside load

date	t-℃	
1月4日	31.6~32.5	
1月5日	32.5~36.5	
1月6日	36.5~35.0	
1月7日	35.0~33.0	
1月8日	33.0~28.1	
1月9日	28.1~22.9	
1月10日	22.9~18.2	
1月11日	16.7~25.2	
1月12日	16.7~25.2	

主20190103-23点18分



主20190103-23点48分



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Solve the Key technologies

1. The biological immobilization technology in complex mechanics.

2. The light-guiding technology under lunar natural environment.

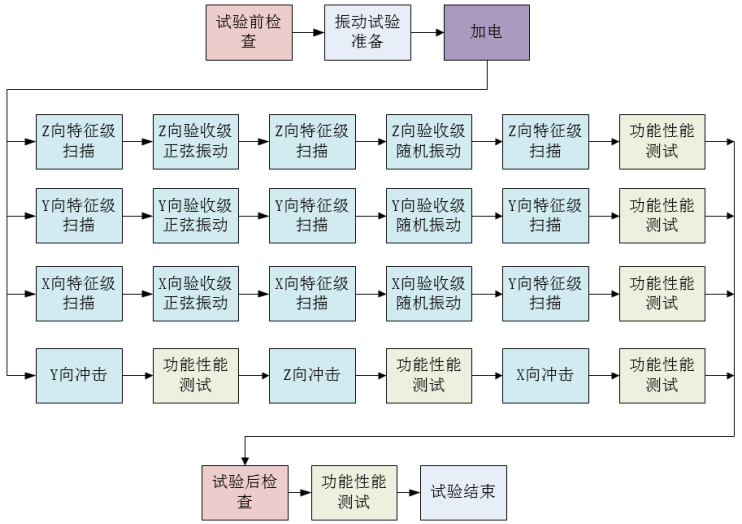
3. The sealing technology under environment of high vacuum and wide temperature range.

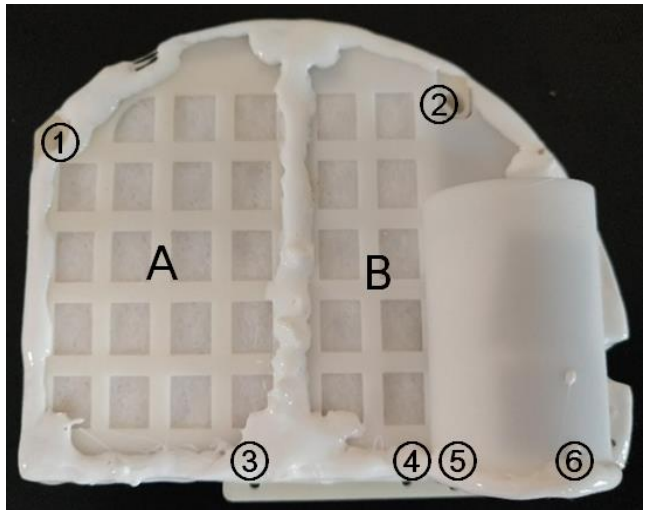
4. The independent temperature control technology under the conditions of small scale, high humidity and wide temperature range.

5. The Anti-fog imaging technology for cameras under high humidity conditions.

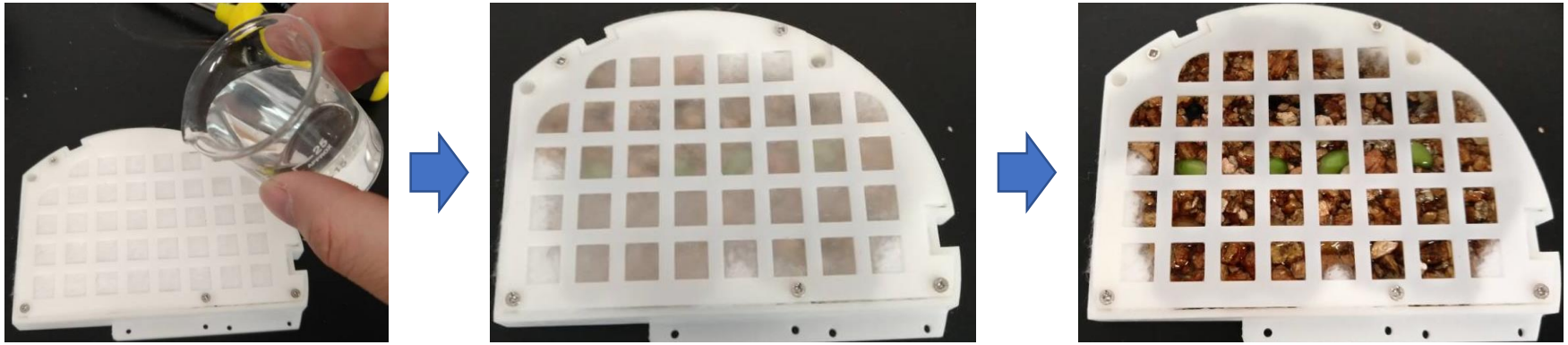
Key technologies

1. The biological immobilization technology in complex mechanics.and control the grow of organisms.





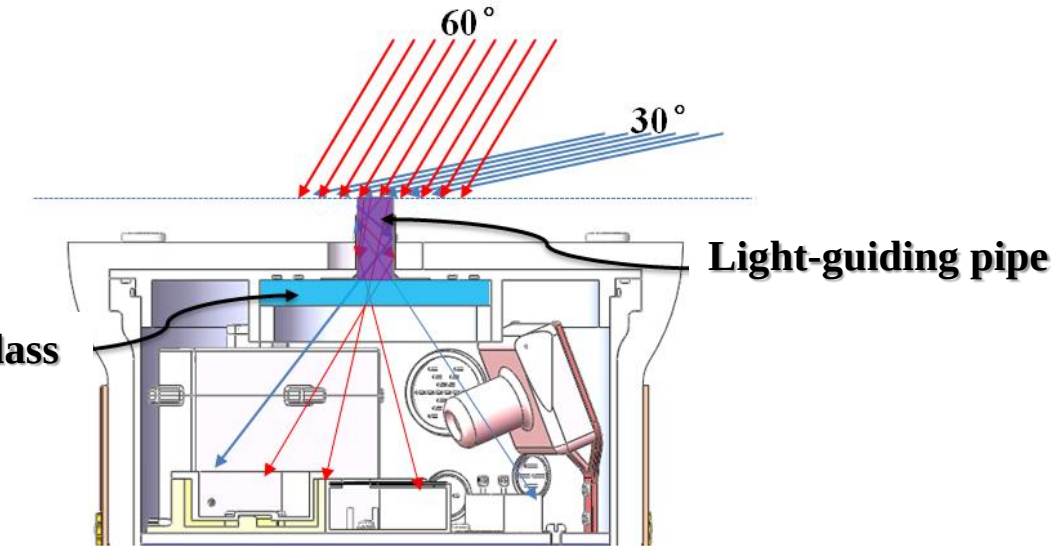
Watering **1 sec after watering** **20 secs after watering**



Key technologies

2 . The light-guiding technology under lunar natural environment.

Two end face seal rings were installed between the light guide glass and the cover plate to reduce leakage of internal gas while ensuring light introduction.

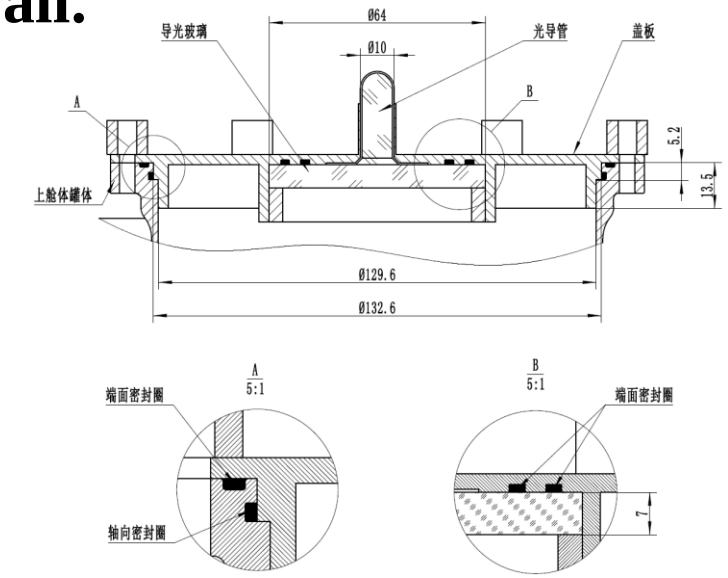


Microstructure of light-pipe

Key technologies

3. The sealing technology under environment of high vacuum and wide temperature range

The payload was a sealed container, with a total of 7 leak points, two of which are located between the casing, the cover plate and the light guide glass, and the other five are caused by the connectors passing through the wall.

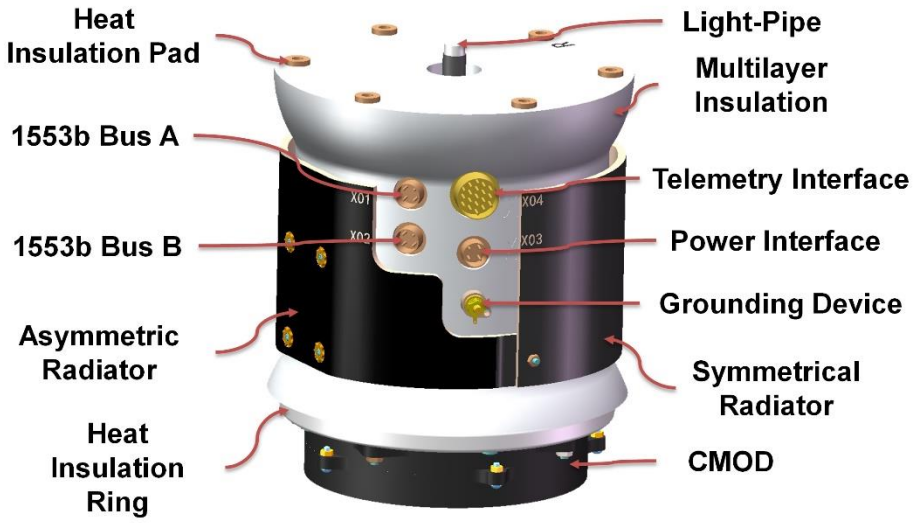


The sealing ring and gasket are specially developed with G302 material and can withstand temperatures from -100 ℃ to +250 ℃.

Key technologies

4. The independent temperature control technology under the conditions of small scale, high humidity and wide temperature range.

The payload heat interface consists of a heat insulator, a heat sink, a multi-layer, an insulation ring and a control module casing.

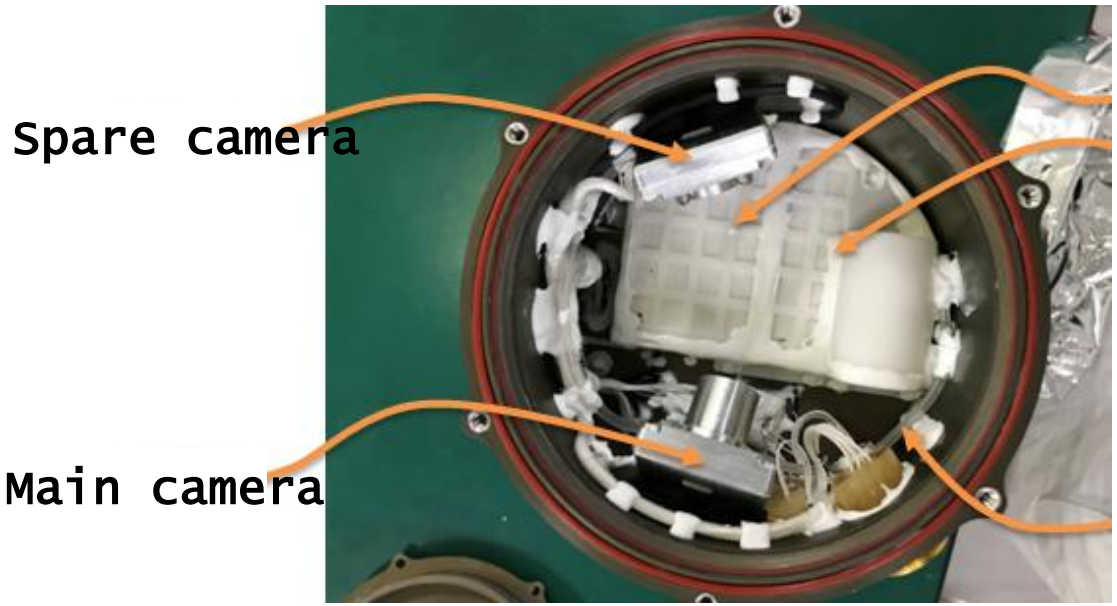


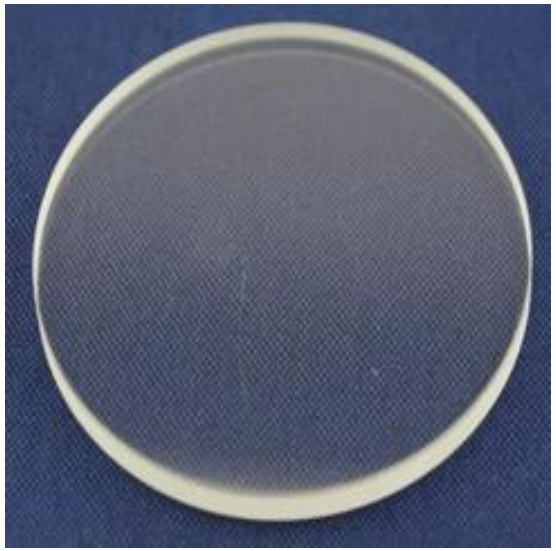
The insulation pad and the insulation ring are processed by polyimide YS20 material, and the control module casing is processed by 7075-T6 aluminum alloy, and the outer surface is blackened.

Key technologies

5. The Anti-fog imaging technology for cameras under high humidity conditions.

The device prevents the mist from adhering on the glass window through the main body sealing and optical window coating (hydrophilic active agent). The anti-fog effect was tested by the damp heat test, and the result showed that the coating can effectively avoid fogging of the glass window. Temperature range: 0-35 ° C, humidity >95% RH。





High purity coated glass window

Impact and significance

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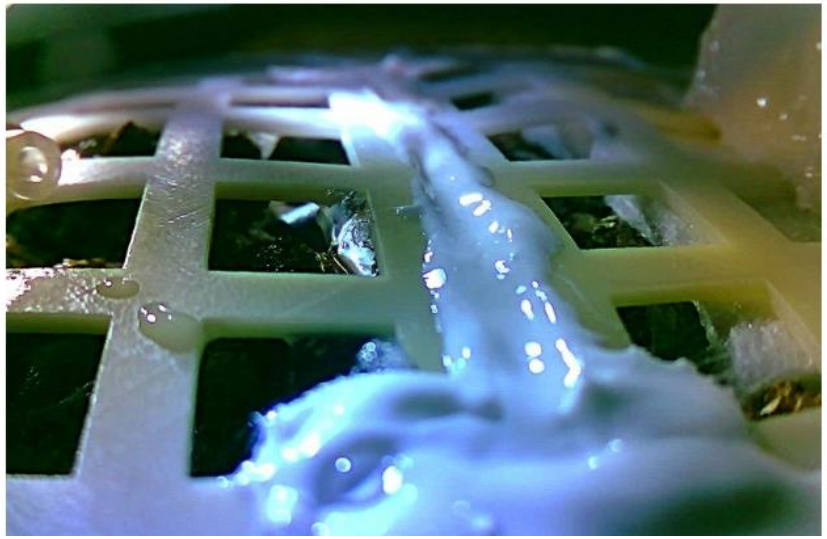
NEWS · 15 JANUARY 2019

Plant sprouts on the Moon for first time ever

China's Chang'e-4 lander has sent back pictures of a cotton seed sprouting in a miniature biosphere experiment on the craft.

Davide Castelvecchi & Mićo Tatalović



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How to build a Moon base

China set to launch first-ever spacecraft to the far side of the Moon

Exoplanet hunters rethink search for alien life

SUBJECTS

Plant sciences Space physics

Impact and significance

Credit: Wang Quanchao/Xinhua via Zuma

China's Chang'e-4 mission has become the first ever to grow plants on the Moon. The lander sent back images of a cotton seed sprouting in a mini-biosphere experiment, a feat announced on 15 January.

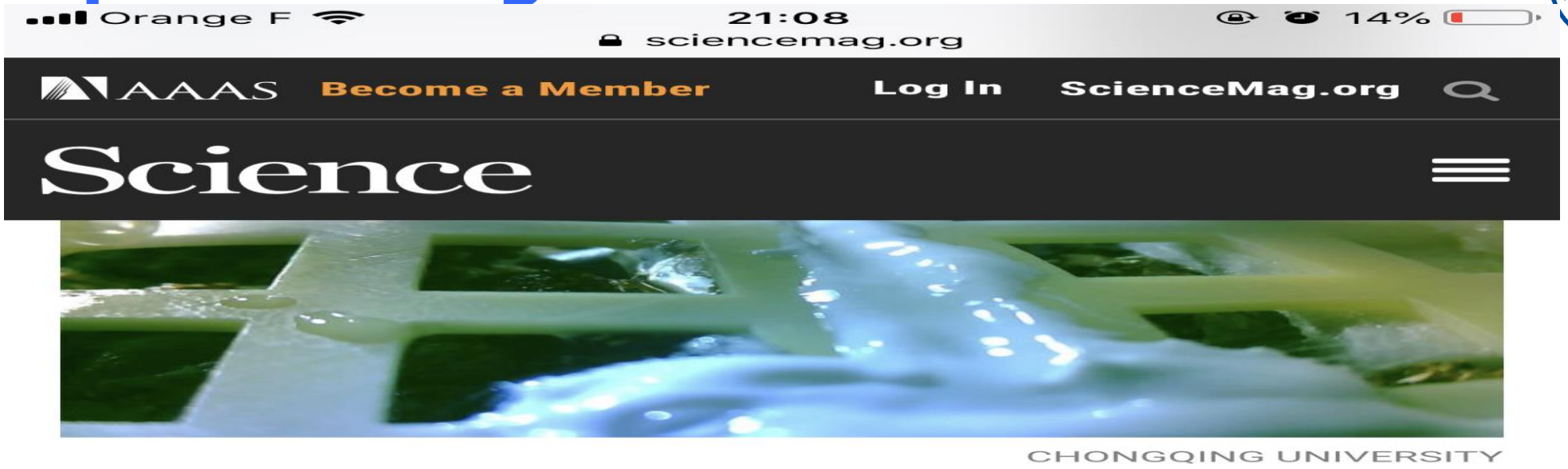
The pioneering experiment is one of several being carried out by Chang'e-4, a mission that is quickly racking up lunar firsts. On 3 January, it became first craft to make a soft landing on the far side of the Moon.

China might just have grown the first plant ever on the moon

By Ben Westcott and Yong Xiong, CNN

Updated 1435 GMT (2235 HKT) January 15, 2019

Impact and significance



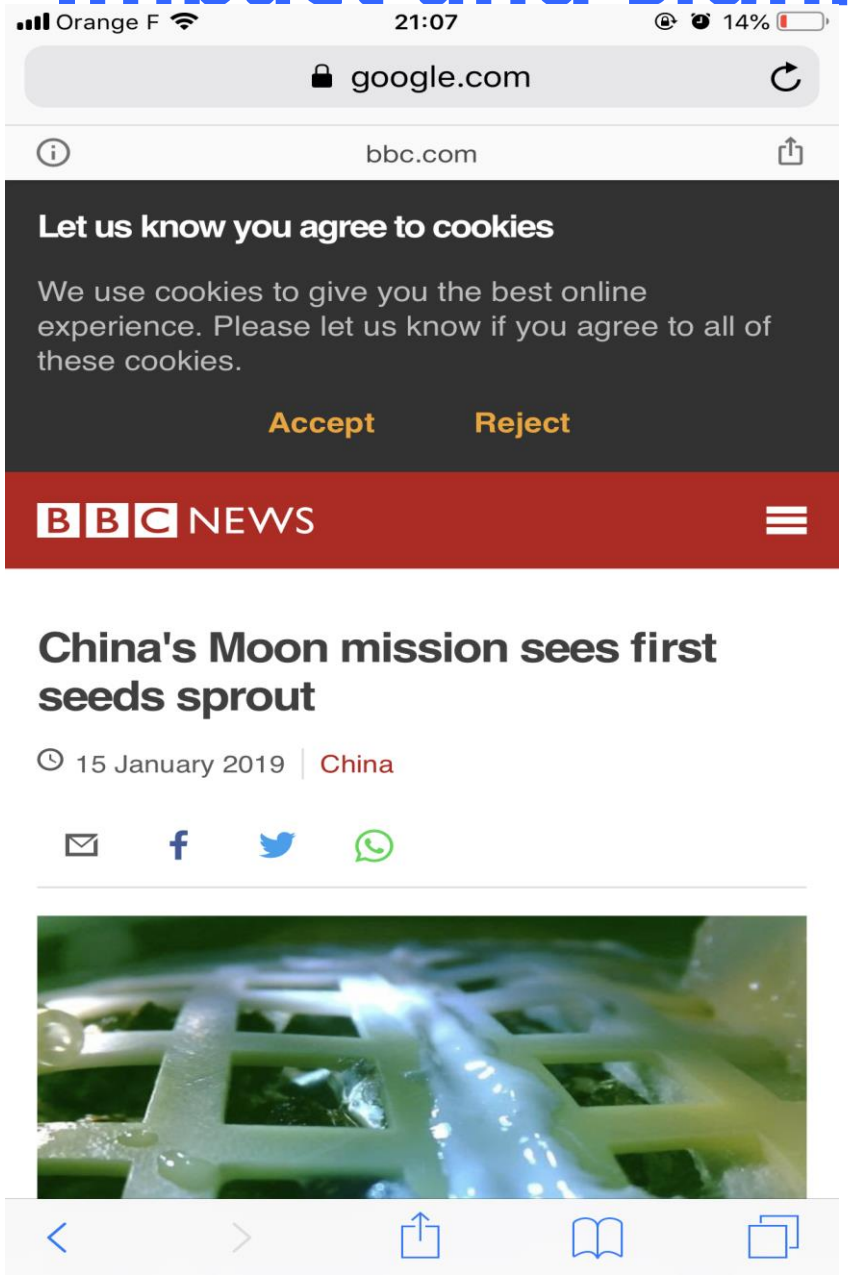
CHONGQING UNIVERSITY

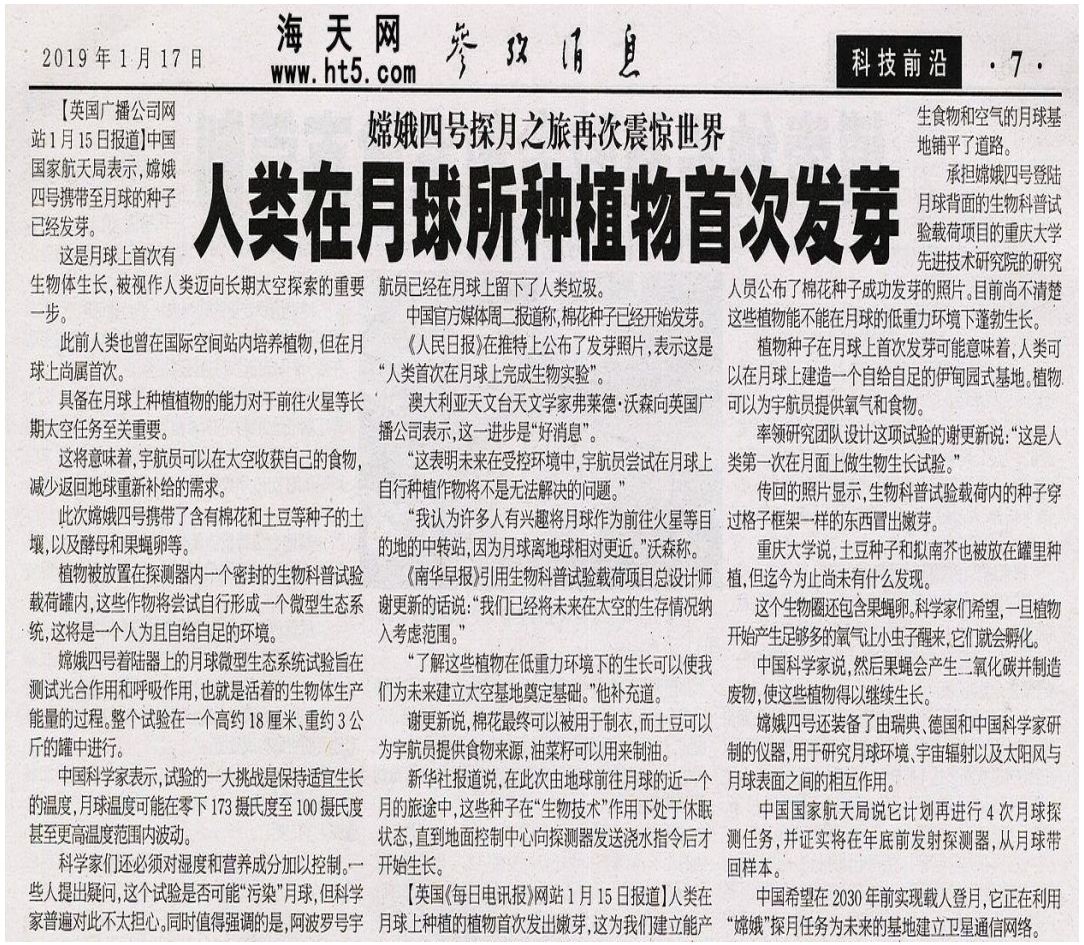
China sprouts cotton plants on the moon

By **Alex Fox** | Jan. 15, 2019 , 5:05 PM

In a first for humankind, **plants are growing on the surface of the moon**, the *South China Morning Post* reports. Cotton, rapeseed, and potato seedlings have all sprouted inside a canister aboard China's Chang'e-4 lunar lander, now parked on the far side of the moon. Yeast, fruit flies, and rock cress were also sent aboard Chang'e-4 as part of an experiment to investigate growth in low-gravity environments. The mission's architects say the experiments could help lay a foundation for one day establishing a lunar base.

Impact and significance





海天网 www.ht5.com 2019年1月17日 科技前沿 ·7·

嫦娥四号探月之旅再次震惊世界

人类在月球所种植物首次发芽

【英国广播公司网站1月15日报道】中国国家航天局表示，嫦娥四号携带至月球的种子已经发芽。

这是月球上首次有生物体生长，被视作人类迈向长期太空探索的重要一步。

此前人类也曾在国际空间站内培养植物，但在月球上尚属首次。

具备在月球上种植植物的能力对于前往火星等长期太空任务至关重要。

这将意味着，宇航员可以在太空收获自己的食物，减少返回地球重新补给的需求。

此次嫦娥四号携带了含有棉花和土豆等种子的土壤，以及酵母和果蝇卵等。

植物被放置在探测器内一个密封的生物科普试验载荷罐内，这些作物将尝试自行形成一个微型生态系统，这将是一个人为且自给自足的环境。

嫦娥四号着陆器上的月球微型生态系统试验旨在测试光合作用和呼吸作用，也就是活着的生物体生产能量的过程。整个试验在一个高约18厘米、重约3公斤的罐中进行。

中国科学家表示，试验的一大挑战是保持适宜生长的温度，月球温度可能在零下173摄氏度至100摄氏度甚至更高温度范围内波动。

科学家们还必须对湿度和营养成分加以控制。一些人提出疑问，这个试验是否可能"污染"月球，但科学家普遍对此不太担心。同时值得强调的是，阿波罗号宇航员已经在月球上留下了人类垃圾。

中国官方媒体周二报道称，棉花种子已经开始发芽。

《人民日报》在推特上公布了发芽照片，表示这是"人类首次在月球上完成生物实验"。

澳大利亚天文台天文学家弗莱德·沃森向英国广播公司表示，这一进步是"好消息"。

"这表明未来在受控环境中，宇航员尝试在月球上自行种植作物将不是无法解决的问题。"

"我认为许多人有兴趣将月球作为前往火星等目的地的中转站，因为月球离地球相对更近。"沃森称。

《南华早报》引用生物科普试验载荷项目总设计师谢更新的话说："我们已经将未来在太空的生存情况纳入考虑范围。"

"了解这些植物在低重力环境下的生长可以使我们为未来建立太空基地奠定基础。"他补充道。

谢更新说，棉花最终可以被用于制衣，而土豆可以为宇航员提供食物来源，油菜籽可以用来制油。

新华社报道说，在此次由地球前往月球的近一个月的旅途中，这些种子在"生物技术"作用下处于休眠状态，直到地面控制中心向探测器发送浇水指令后才开始生长。

【英国《每日电讯报》网站1月15日报道】人类在月球上种植的植物首次发出嫩芽，这为我们建立能产生食物和空气的月球基地铺平了道路。

承担嫦娥四号登陆月球背面的生物科普试验载荷项目的重庆大学先进技术研究院的研究人员公布了棉花种子成功发芽的照片。目前尚不清楚这些植物能不能在月球的低重力环境下蓬勃生长。

植物种子在月球上首次发芽可能意味着，人类可以在月球上建造一个自给自足的伊甸园式基地。植物可以为宇航员提供氧气和食物。

率领研究团队设计这项试验的谢更新说："这是人类第一次在月面上做生物生长试验。"

传回的照片显示，生物科普试验载荷内的种子穿过格子框架一样的东西冒出嫩芽。

重庆大学说，土豆种子和拟南芥也被放在罐里种植，但迄今为止尚未有什么发现。

这个生物圈还包含果蝇卵，科学家们希望，一旦植物开始产生足够多的氧气让小虫子醒来，它们就会孵化。

中国科学家说，然后果蝇会产生二氧化碳并制造废物，使这些植物得以继续生长。

嫦娥四号还装备了由瑞典、德国和中国科学家研制的仪器，用于研究月球环境、宇宙辐射以及太阳风与月球表面之间的相互作用。

中国国家航天局说它计划再进行4次月球探测任务，并证实将在年底前发射探测器，从月球带回样本。

中国希望在2030年前实现载人登月，它正在利用"嫦娥"探月任务为未来的基地建立卫星通信网络。

British Broadcasting Corporation（BBC）

Impact and significance

Singapore Joint Morning Post

嫦娥四号完成人类首次月面生物实验

航天成就凸显中国治理模式优势

【新加坡《联合早报》网站 1 月 15 日报道】题:嫦娥四号完成人类首次月面生物实验

据中国媒体消息,今天,嫦娥四号上搭载的生物科普试验载荷发布了最新试验照片,照片显示试验搭载的棉花种子已经长出了嫩芽,这也标志着嫦娥四号完成了人类在月面进行的首次生物实验。

此次在月球上进行的生物科普试验选择了棉花、油菜、土豆、拟南芥、酵母和果蝇 6 种生物作为样本,将它们的种子和虫卵带到月球上进行培育。棉花的嫩芽长势良好,这是在经历月球低重力、强辐射、高温差等严峻环境考验后,在月球上长出的第一株植物嫩芽,实现了人类首次月面的生物生长培育实验。

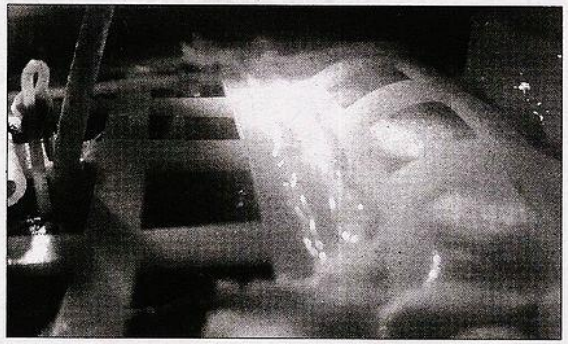
后续,这株成功培育出的植物嫩芽还将继续生长,有望成为月球上的第一片绿叶。

【香港《南华早报》网站 1 月 14 日报道】在成功登陆月球后,中国再次对向火星发射探测器产生了兴趣。

中国国家航天局的官员周一说,中国将在今年年底之前向月球发射可重返地球的探测器,在 2020 年前后向火星发射探测器。

中国国家航天局副局长吴艳华说,嫦娥四号成功在月球背面登陆标志着中国深空探测工程全面拉开序幕,同时欢迎对此项目感兴趣的外界人士加入进来。

吴艳华说,欢迎国际社会合作研制搭载在航天器上的设备,并欢迎国内外投资。



嫦娥四号上搭载的棉花种子已经长出了嫩芽(英国《卫报》网站)

据航天官员说,一颗卫星将于 2020 年左右被送入火星轨道,并且根据卫星收集的数据,一辆火星车将进行软着陆。

中国第一次尝试探测火星是在 2011 年,当时携带着中国"萤火一号"探测器的俄罗斯火箭未能离开地球轨道,最终在太平洋上空解体。

【法国《回声报》网站 1 月 13 日文章】题:太空,中国雄心的新边疆(作者 法国亚洲研究中心主任让-弗朗索瓦·迪·梅利奥 该中心特别项目部负责人露西·塞内沙尔-佩鲁奥)

2013 年嫦娥三号在月球软着陆,让中国成为第三个实现在月球上软着陆的大国。现在中国又成了第一个在月球背面登陆并传回图像的国家。嫦娥系列探测器今后的任务将是采集标本带回地球。

这并不是一个突发奇想的计划。如此成绩也彰显了中国想要成为一个特殊俱乐部成员的夙愿。从 1970 年 4 月 24 日发射第一颗卫星,到 2003 年 10 月 15 日首次将航天员送入太空,中国一直在通过宇宙探索行动谋求自己被承认为大国。

近些年中国有了新的考虑,其中包括"升级换代"。航天能力是中国打造经济转型的王牌,中国领导人希望在后世界经济危机时代,该国的经济增长不再依赖工业制成品的出口,而是转向国内消费和高技术产品。

在西方民主似乎日渐脆弱的背景下,中国的这种成长是一个有着极好治理模式的国家所具能力的最新体现。中国在航天事业上的成绩,可以看成是"中国特色道路"在科学领域的成功。

中国的科技创新很好地得到了五年规划的引领,而政府科研和国企的无所不能也避免了政治上的犹疑不决。

在被美国排斥在国际空间站项目之外的情况下,中国却将其未来的空间站面向国际联合项目敞开了大门。参与项目的国家主要是中国商用通信卫星的目标客户。此外,宏伟的太空探索计划也是中国展示高精尖技术的一扇橱窗。

Impact and significance

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Transcript

2019-01-13 19:48 GMT+8

Chang'e-4 Lunar Mission: First ever biological experiment on far side of Moon

Updated 2019-01-13 21:41 GMT+8

As we approach the 50th anniversary of man landing on the moon, a different group of living creatures has just arrived there. A team of scientists from Chongqing University has sent a

Impact and significance

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嫦娥四号生物科普试验载荷中的棉花种子发芽

2019-01-15 17:38 来源： 新华社 【字体：大 中 小】 打印

新华社重庆1月15日电（记者 谷训）1月15日，嫦娥四号生物科普试验载荷项目团队发布消息称，随嫦娥四号登陆月球背面的生物科普试验载荷中，棉花种子成功发芽。

由重庆大学牵头的嫦娥四号生物科普试验载荷内搭载了棉花、油菜、土豆、拟南芥、酵母和果蝇六种生物，均放置于密封的生物科普试验载荷罐内。生物科普试验载荷传回的照片显示，棉花成功发芽。据介绍，截至试验结束前，未从传回数据中观测到其它生物生长状况。

生物科普试验载荷罐由特殊的铝合金材料制成，直径173毫米，高198.3毫米，内部除了6种生物，还有18毫升水，和土壤、空气、热控以及两个记录生物生长状态的相机，总重量为2.608公斤。生物生长空间为1升左右。

生物科普试验载荷于嫦娥四号登陆月球第一天（1月3日）即加电开机，随后在地面控制中心发送放水指令后，植物种子和果蝇虫卵结束近3个月的休眠状态，进入生物月面生长发育模式。

Impact and significance

People's Net

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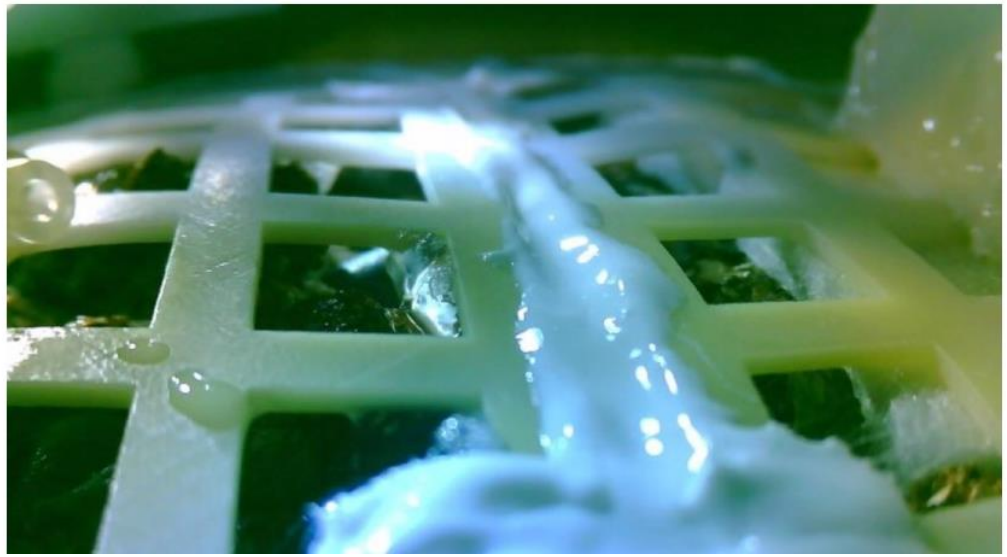
月球上长出了第一片绿叶！

2019年01月15日11:17 来源：人民网-重庆频道　分享到：



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