Activities of Space Debris Mitigation and Protection in China

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Outline

§1 Introduction

§2 Space Debris Environment situation and Its Risks

§3 Space Debris Mitigation in China

§4 Space Debris Protection in China

§5 Conclusions

China Academy of Space Technology (CAST)

Founded in February 20, 1968 ;
The first president: *Chien Hsuch-Sen (*Qian Xuesen)
: A world Known Space Pioneer
The largest base for space technology research & space products in China.
The most powerful backbone strength for China's space endeavor.

- **It's main fields & mission:**
- **Development and manufacturing of spacecraft, external exchange and cooperation in space technology, satellite applications, etc.. Also, participates in formulating the state space technology development plans, studies the technological approaches to exploration, exploitation and utilization of the outer space, develops a variety of spacecraft and ground application equipments, according to user's requirements, and provides corresponding services.**

Qian Xuesen

China Academy of Space Technology (CAST)

Almost all the milestones of China spaceflight:

- April 24, 1970 : Chinese first artificial Earth satellite - *DFH-1*
- October 2003: manned spacecraft - *Shenzhou-5*
- October 24, 2007: Chinese first lunar detector - *Chang'E-1*
- September 25, 2008: the first Extravehicular activity - *Shenzhou-7*
- October 1，2010，the second lunar detector - *Chang'E-2*
- September 29, 2011: China's first space lab module - Tiangong-1

- Beijing Institute of Spacecraft Environment Engineering (BISEE)
- The Spacecraft Environment Engineering department of CAST.

Shenzhou Spaceship series

神舟

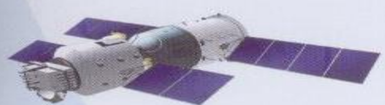
Shenzhou(Divine Vessel) manned spaceship series is the first kind of manned spacecraft self-developed by China. To date seven spaceships have been built, of which Shenzhou-1, -2, -3 and -4 are spaceships without crew and Shenzhou-5,-6,-7 are manned spaceships.

The spaceship is composed of orbital module, returnable module, propulsion module and an additional segment. The orbital module is the place where astronauts live and carry out experiments. The returnable module is the spaceship control center, where the astronauts stay during taking-off, returning and landing. The propulsion module supplies spacecraft with energy and power for operating in orbit and returning to the Earth. The additional segment is currently used to fix space scientific and technological equipment and as an installation place for rendezvous and docking mechanism in later.

The total length of spaceship is about 9m, its largest diameter 2.8m and orbital mass less than 8800kg.

The Shenzhou spaceship series has the capability of continuous operation remaining in orbit. After the returnable module returns, the orbital module remaining in orbit can continuously, as a satellite, carry out space applications and scientific experiments under the control of ground station.

舟－1无人飞船
enzhou-1 spaceship without crew



神舟－2无人飞船
Shenzhou-2 spaceship without crew

神舟－3无人飞船
Shenzhou-3 spaceship without crew

神舟－4无人飞船
Shenzhou-4 spaceship without crew

神舟－5 载人飞船
Shenzhou-5 manned spaceship

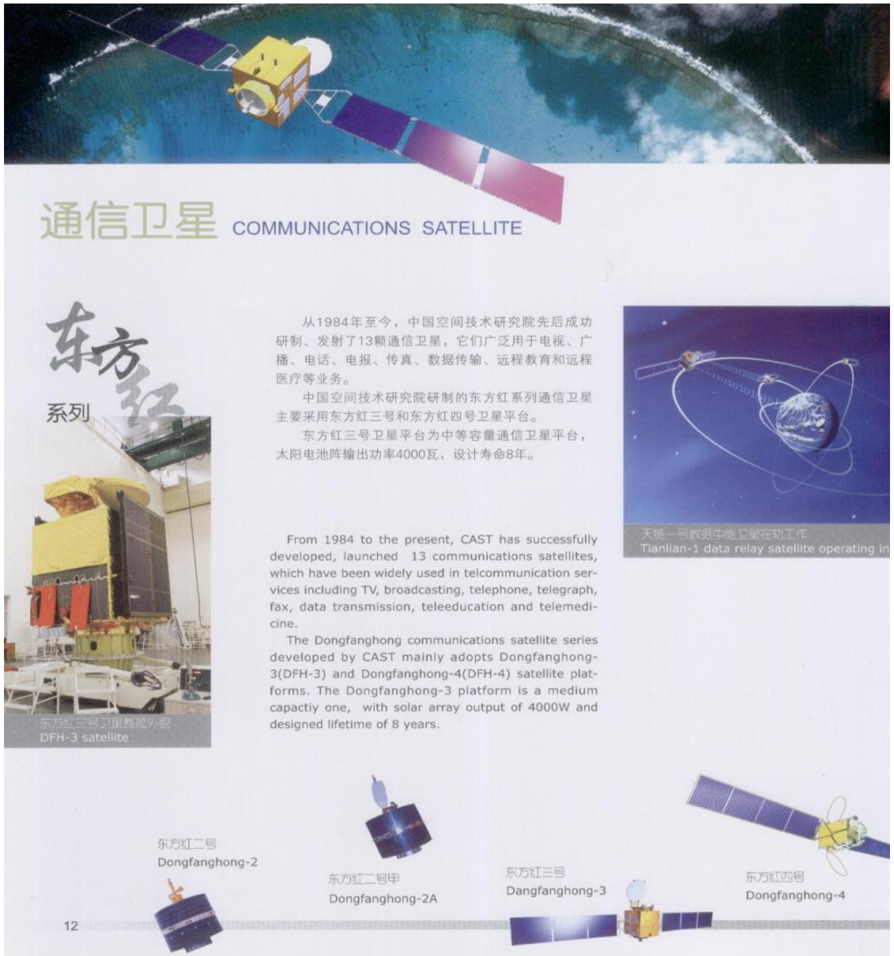
神舟－6 载人飞船
Shenzhou-6 manned spaceship

神舟－7 载人飞船
Shenzhou-7 manned spaceship

September 25, 2008: the first Extravehicular activity – *Shenzhou-7*

October 2003: manned spacecraft – *Shenzhou-5*

Communications satellites--Dongfanghong series



通信卫星 COMMUNICATIONS SATELLITE

东方红系列

从1984年至今，中国空间技术研究院先后成功研制、发射了13颗通信卫星，它们广泛用于电视、广播、电话、电报、传真、数据传输、远程教育和远程医疗等业务。

中国空间技术研究院研制的东方红系列通信卫星主要采用东方红三号和东方红四号卫星平台。

东方红三号卫星平台为中等容量通信卫星平台，太阳电池阵输出功率4000瓦，设计寿命8年。

From 1984 to the present, CAST has successfully developed, launched 13 communications satellites, which have been widely used in telecommunication services including TV, broadcasting, telephone, telegraph, fax, data transmission, teleeducation and telemedicine.

The Dongfanghong communications satellite series developed by CAST mainly adopts Dongfanghong-3(DFH-3) and Dongfanghong-4(DFH-4) satellite platforms. The Dongfanghong-3 platform is a medium capactiy one, with solar array output of 4000W and designed lifetime of 8 years.

东方红三号卫星整星外貌
DFH-3 satellite

天链一号数据中继卫星在轨工作
Tianlian-1 data relay satellite operating in

东方红二号
Dongfanghong-2

东方红二号甲
Dongfanghong-2A

东方红三号
Dangfanghong-3

东方红四号
Dongfanghong-4

东方红四号卫星平台是中国空间技术研究院研制的新一代大型通信卫星平台，具有大容量、长寿命的特点。平台可用于建造大容量通信广播、视频/音频直播、跟踪与数据中继和区域移动通信等卫星。

平台由推进舱、服务舱和太阳翼构成，承载有效载荷能力595千克，太阳翼输出功率10500瓦，设计寿命15年。

DFH-4 satellite platform developed by CAST is a new generation platform for large communications satellites with high capacity and long lifetime. It can be used to build high-capacity communications and broadcasting, video/audio direct broadcasting, tracking and data relay, regional mobile communications satellites, etc.

The platform consists of propulsion module, service module and solar arrays, with payload-bearing capacity of 595kg, solar array output of 10500W, and designed lifetime of 15 years.

东四平台卫星力学试验
Static test of satellite of Dongfanghong-4 platform

东四平台卫星分系统测试
Subsystem test of satellite of Dongfanghong-4 platform

Returnable Satellites

返回式卫星 RETURNABLE SATELLITE

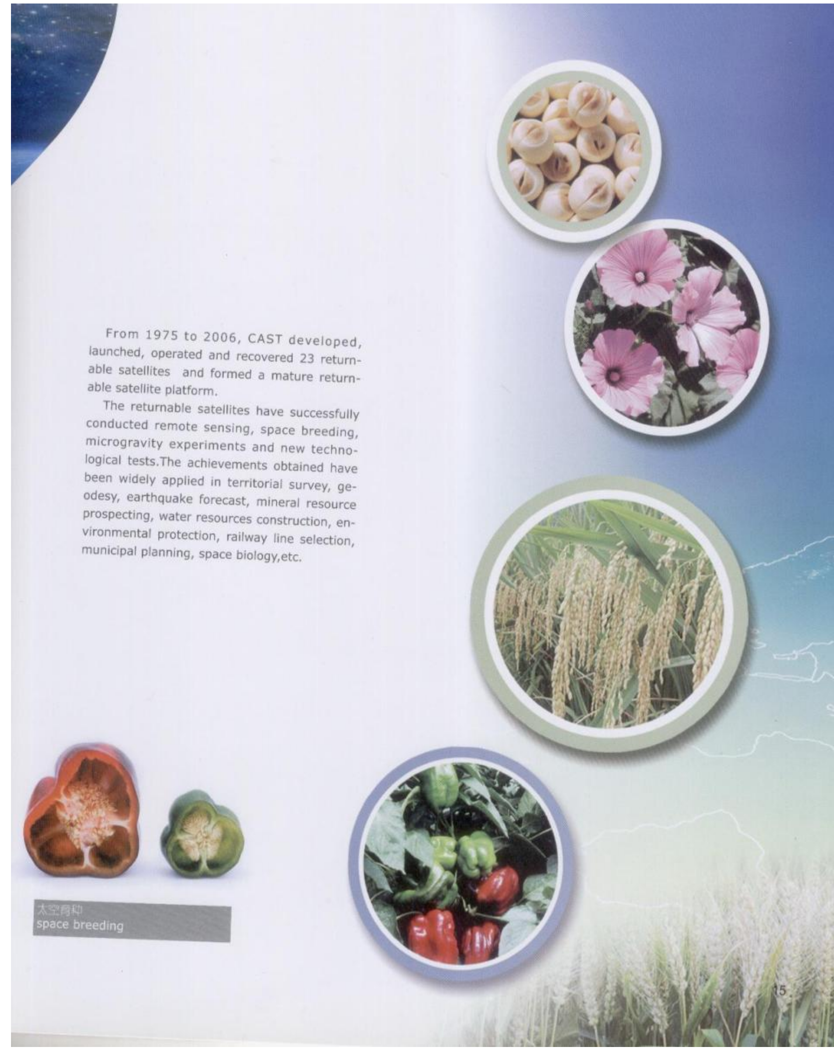
1975—2006年，中国空间技术研究院先后研制、发射、运行和回收了23颗返回式卫星，形成了成熟的返回式卫星公用平台。

利用返回式卫星成功进行了遥感、太空育种、微重力实验和新技术试验，其成果广泛应用于国土普查、大地测量、地震预报、矿产资源勘探、水利建设、环境保护、铁路选线、城市规划及空间生物等方面。

返回式卫星发射前吊装
hoisting assembly of returnable satellite before launch

电磁兼容性试验
electromagnetic compatibility test

返回式卫星回收现场
recovered returnable satellite on site



From 1975 to 2006, CAST developed, launched, operated and recovered 23 returnable satellites and formed a mature returnable satellite platform.

The returnable satellites have successfully conducted remote sensing, space breeding, microgravity experiments and new technological tests.The achievements obtained have been widely applied in territorial survey, geodesy, earthquake forecast, mineral resource prospecting, water resources construction, environmental protection, railway line selection, municipal planning, space biology,etc.

太空育种
space breeding

Navigation Satellites—Beidou Navigation System

导航卫星 NAVIGATION SATELLITE

BDENS

中国空间技术研究院已连续成功发射运行了4颗北斗导航试验卫星，这些卫星同地面应用系统构成了中国北斗导航试验系统。

北斗导航试验系统是全天候、全天时提供卫星导航信息服务的区域导航系统，可为公路交通、铁路运输、海上作业及特种服务等领域提供导航服务。

2007年4月，首颗北斗导航卫星成功发射，标志着我国自行研制的北斗导航系统进入了新的发展建设阶段。

中国北斗导航卫星系统
Beidou Navigation Satellite System

北斗导航试验卫星定位示意图
BDENS positioning sketch diagram

CAST has successfully launched and operated four Beidou(Compass) experimental navigation satellites (BDENS) in succession, which have composed, together with ground application system, the Chinese Beidou Experimental Navigation System.

The developed Beidou Experimental Navigation System, as a regional navigation system, can provide satellite navigation information in all weather and all time. The system mainly provides navigation service for highway communication, railway transportation, on-the-sea operation, and special services.

In April of 2007, CAST has successfully launched the first Beidou navigation satellite, which marks the Beidou Navigation System self-developed by China has entered a new development stage.

北斗导航试验卫星太阳帆板展开试验
BDENS solar array deployment test

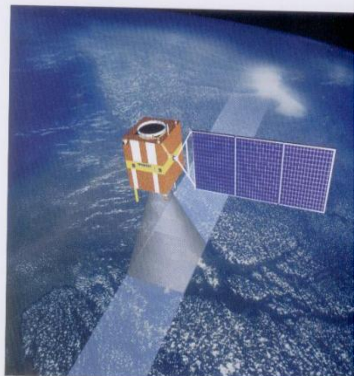
Earth Observation Satellites—Resources Satellites

对地观测卫星 EARTH OBSERVATION SATELLITES

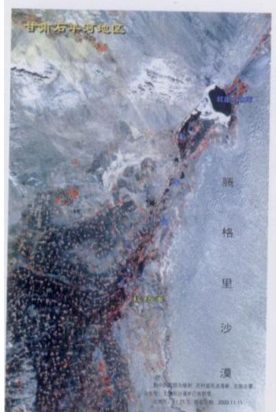
资源卫星
Resources Satellite

中国空间技术研究院成功研制了系列资源卫星、系列气象卫星和系列海洋卫星等对地观测卫星以及一批新型高性能卫星有效载荷。

CAST has successfully developed several series of earth observation satellites, including Ziyuan series of earth resource satellites, Fengyun series of meteorological satellites and Haiyang series of oceanic satellites, as well as a lot of new satellite payloads with high performance.



资源一号卫星在轨工作
Ziyuan-1 satellite operating in orbit



资源一号卫星拍摄的甘肃石羊河地区合成图像
Composite image of Shiyanghe region, Gansu Province, taken by Ziyuan-1 satellite

资源一号卫星拍摄的高分辨率图像
High resolution image taken by Ziyuan-1 satellite

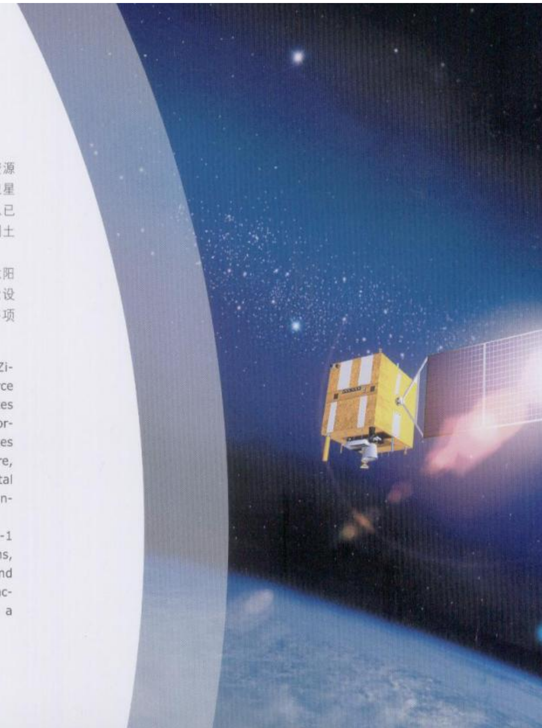
资源一号卫星拍摄的北京市镶嵌影像图
Mosaic image of Beijing city taken by Ziyuan-1 satellite

中国空间技术研究院已研制、发射了三颗资源一号和三颗中国资源二号卫星。中国资源二号卫星实现了三星组网运行。资源卫星获取的遥感信息已广泛应用于农业、林业、水利、海洋、环保、国土资源、城市规划和灾害监测等领域。

成功开发的资源一号和中国资源二号卫星太阳同步轨道对地观测卫星公用平台，采用公用舱设计，可根据任务需求搭载多种遥感设备，完成多项飞行任务。

CAST has developed and launched three Ziyuan-1(ZY-1) and three Ziyuan-2 earth resource satellites, of which the three Ziyuan-2 satellites have formed a network.The remote sensing information obtained by the earth resource satellites has been widely used in the fields of agriculture, forestry, water resources, ocean, environmental protection, territorial resources, municipal planning and disaster monitoring.

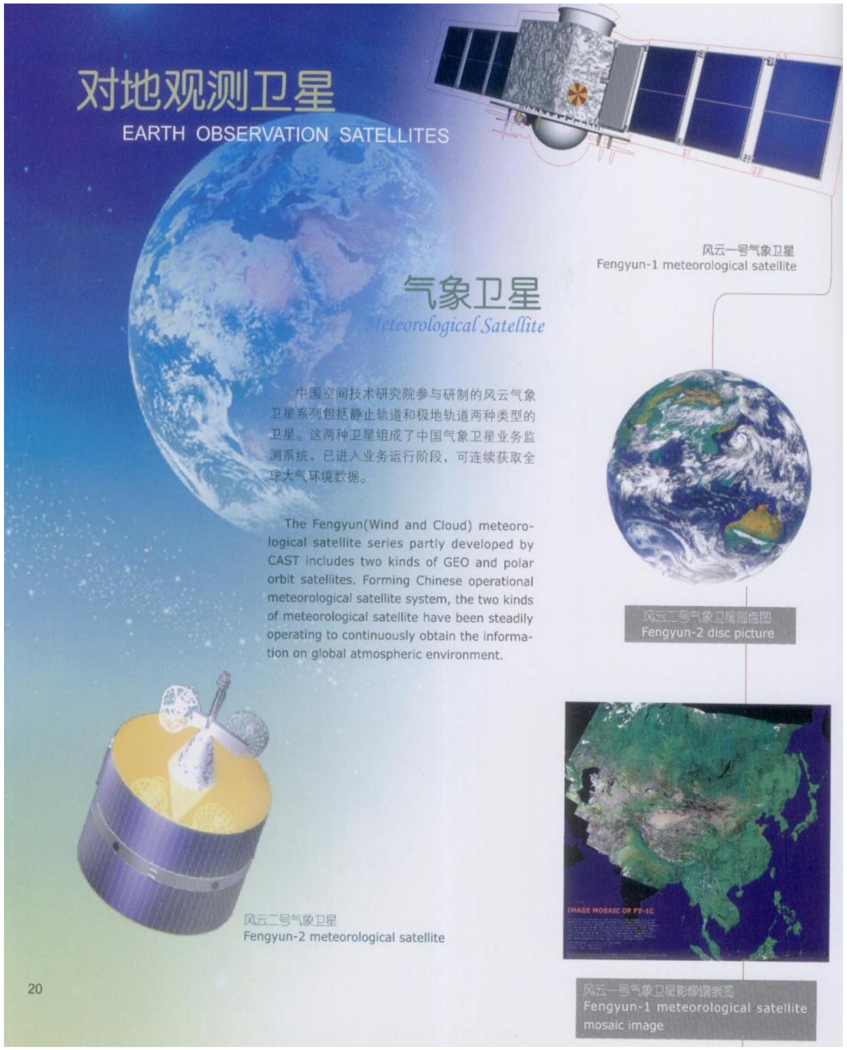
CAST has successfully developed Ziyuan-1 and -2 sun synchronous orbit satellite platforms, which adopt bus (common module) design and can carry various remote sensing equipments according to mission requirements to complete a variety of flight missions.



中国资源二号卫星发射准备
Ziyuan-2 satellite preparing for launching

中国资源二号卫星三星组网
three Ziyuan-2 satellites form a network

Earth Observation Satellites—Meteorological Satellites
Ocean Satellites



对地观测卫星
EARTH OBSERVATION SATELLITES

风云一号气象卫星
Fengyun-1 meteorological satellite

气象卫星
Meteorological Satellite

中国空间技术研究院参与研制的风云气象卫星系列包括静止轨道和极地轨道两种类型的卫星。这两种卫星组成了中国气象卫星业务监测系统，已进入业务运行阶段，可连续获取全球大气环境数据。

The Fengyun(Wind and Cloud) meteorological satellite series partly developed by CAST includes two kinds of GEO and polar orbit satellites. Forming Chinese operational meteorological satellite system, the two kinds of meteorological satellite have been steadily operating to continuously obtain the information on global atmospheric environment.

风云二号气象卫星圆盘图
Fengyun-2 disc picture

IMAGE MOSAIC OF FY-1C

风云二号气象卫星
Fengyun-2 meteorological satellite

风云一号气象卫星影像镶嵌图
Fengyun-1 meteorological satellite mosaic image

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海洋卫星
Ocean Satellite

海洋一号卫星测试
Haiyang-1 satellite in testing

中国空间技术研究院研制、发射了2颗海洋水色探测卫星——海洋一号卫星。

海洋一号卫星主要用于海洋水色、水温环境要素探测，服务于海洋生物资源开发利用、河口港湾的建设与治理、海洋污染与防治、海岸带资源环境调查与开发及全球变化研究等领域。

CAST has developed and launched two Haiyang(Ocean)-1 ocean water color detection satellites.

Haiyang-1 satellite is mainly used for the inspection of ocean water color and water temperature to provide the services for the fields of development and application of marine biological resource, construction and management of port and harbor, monitoring and prevention of ocean pollution, investigation and development of ocean-belt resource as well as the study of global environment change, etc.

海洋一号卫星应用图
Haiyang-1 satellite applications scheme

海洋一号卫星遥感图
Haiyang-1 satellite remote sensing image

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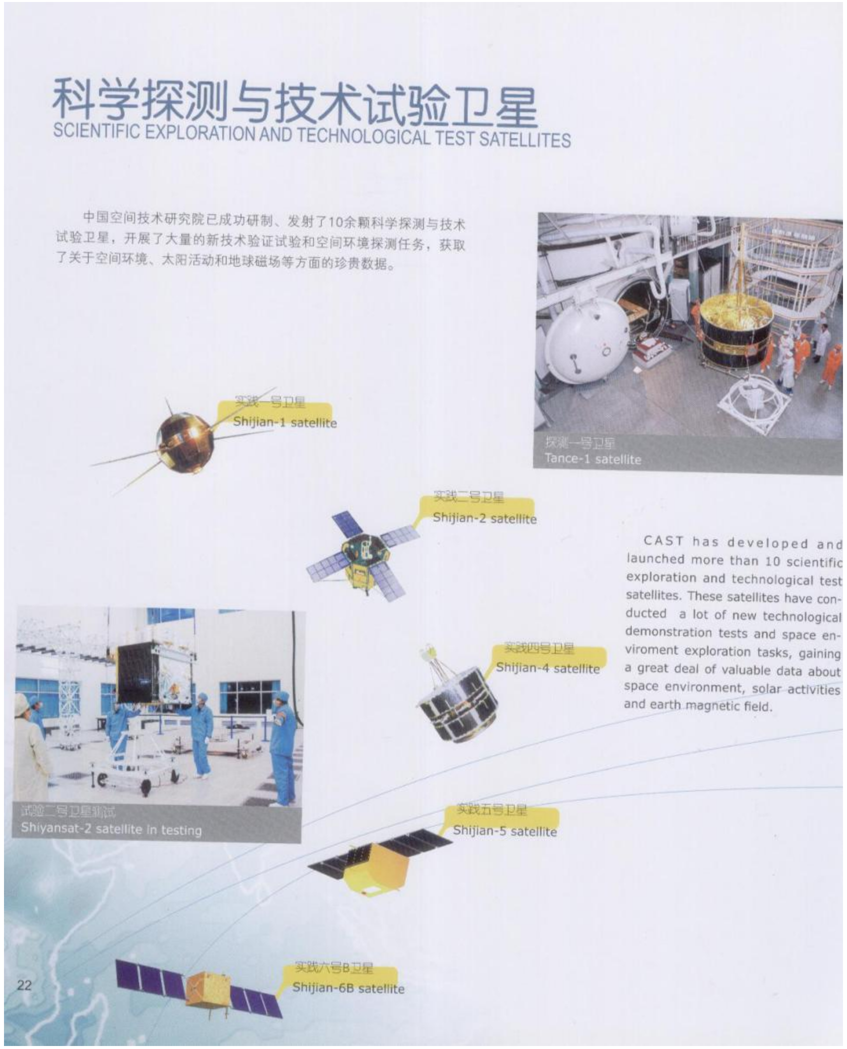
Scientific Exploration and Technological Test Satellites

Small Satellites series



科学探测与技术试验卫星
SCIENTIFIC EXPLORATION AND TECHNOLOGICAL TEST SATELLITES

中国空间技术研究院已成功研制、发射了10余颗科学探测与技术试验卫星，开展了大量的新技术验证试验和空间环境探测任务，获取了关于空间环境、太阳活动和地球磁场等方面的珍贵数据。

CAST has developed and launched more than 10 scientific exploration and technological test satellites. These satellites have conducted a lot of new technological demonstration tests and space environment exploration tasks, gaining a great deal of valuable data about space environment, solar activities and earth magnetic field.

探测一号卫星
Tance-1 satellite

实践一号卫星
Shijian-1 satellite

实践二号卫星
Shijian-2 satellite

实践四号卫星
Shijian-4 satellite

试验二号卫星测试
Shiyansat-2 satellite in testing

实践五号卫星
Shijian-5 satellite

实践六号B卫星
Shijian-6B satellite

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小卫星 SMALL SATELLITE

中国空间技术研究院自20世纪90年代，按照成本低、研制周期短的要求，开展了小卫星研制，成功研制、发射了包括海洋一号海洋探测卫星在内的多颗小卫星。2008年成功发射了环境与减灾小卫星环境A星和B星。

小卫星主要使用CAST1000、CAST2000和CAST3000小卫星公用平台，平台设计中采用了模块化和一体化设计思想，具备高度的扩展能力和较广的适应性，可用于空间科学、遥感、通信和新技术验证等广阔领域。

In the 1990s, CAST began to develop small satellites in a low-cost and short-term way and has successfully developed and launched several small satellites including Haiyang(Ocean)-1 ocean exploration satellite. Two satellites for environment monitoring and disaster relief Huanjing-A and -B were launched in 2008 successfully.

The small satellites of CAST are mainly based on CAST1000, CAST 2000 and CAST3000 small satellite common platforms, which adopt modular and integrated design ideas and have so high expandability and wide adaptability that they can be used in wide fields of space science, remote sensing, communication, technological demonstration, etc.

Fengniao-1 microsatellite

小卫星测试
Small satellite in test

Huanjing-A,-B satellites in test

小卫星编队飞行
Small satellite formation flight

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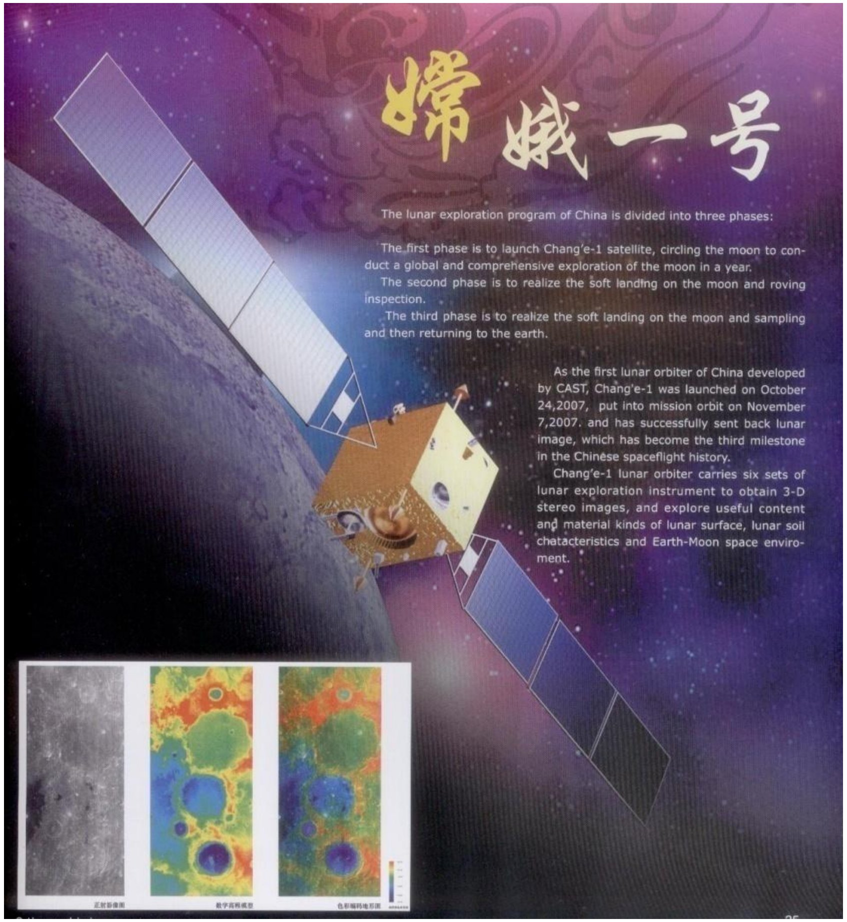
Deep Space Exploration



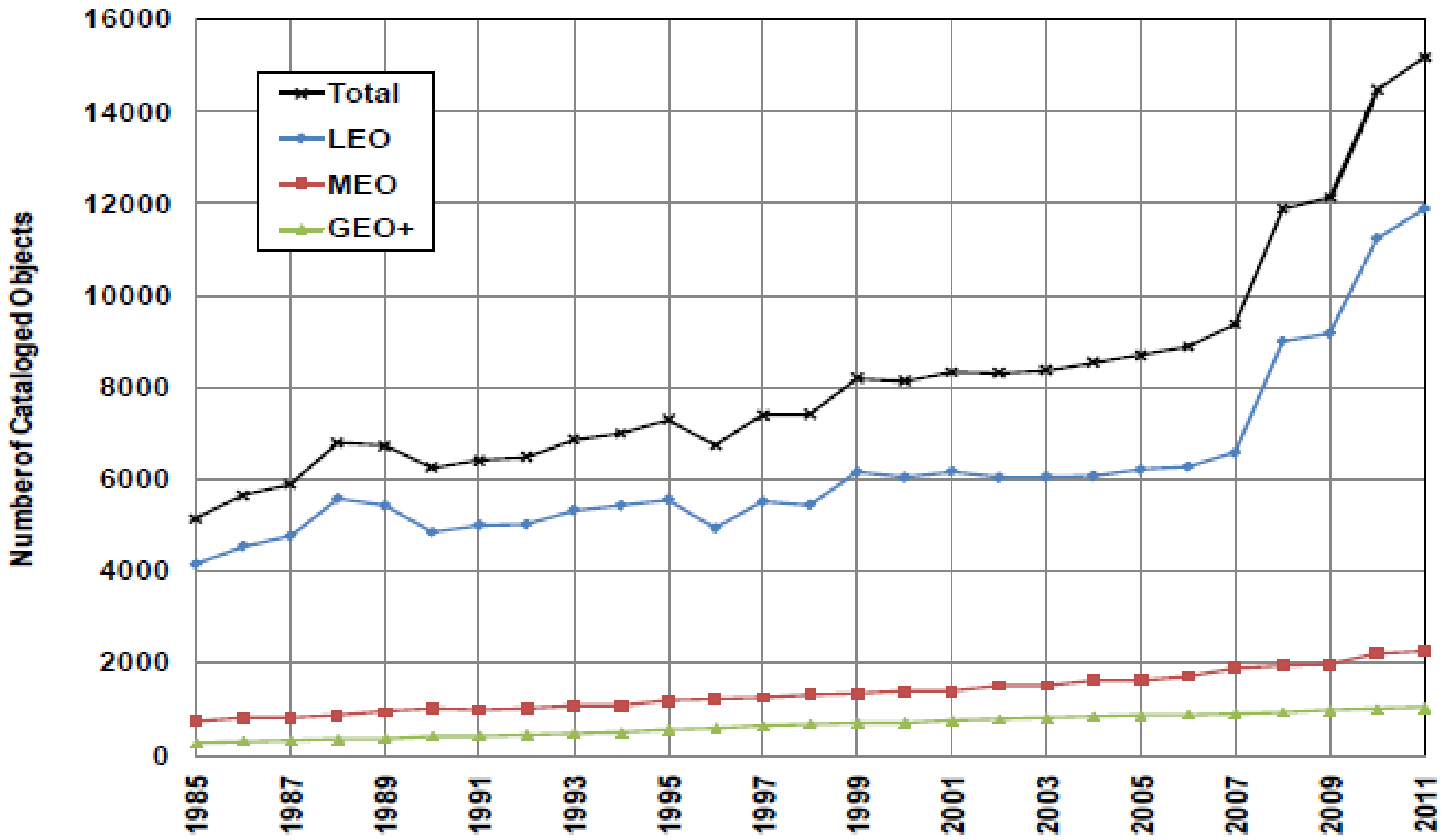
- **October 24, 2007: Chinese first lunar detector – *Chang'E-1***
- **October 1，2010，the second lunar detector *Chang'E-2***
- ***Near future: Mars Exploration***

§ 1

Space Debris Environment and Its Risks

Growth of the Cataloged Satellite Population

The number of cataloged objects in Earth orbit by orbit type, as assessed by the U.S. Space Surveillance System.



Graphic compiled from publicly available orbital data at www.space-track.org

Growth of the Cataloged Satellite Population

SATELLITE BOX SCORE
(as of 06 July 2011, cataloged by the U.S. SPACE SURVEILLANCE NETWORK)

Country/ Organization	Payloads	Rocket Bodies & Debris	Total
CHINA	105	3518	3623
CIS	1408	4667	6075
ESA	39	44	83
FRANCE	49	435	484
INDIA	44	130	174
JAPAN	114	69	183
USA	1144	3723	4867
OTHER	493	112	605
TOTAL	**3396**	**12698**	**16094**

Satellite Reentries in 2010

- **The U.S. Space Surveillance Network recorded 382 reentries during 2010.**
  - 369 uncontrolled reentries
  - 13 controlled reentries
- **The uncontrolled reentries accounted for a total mass of ~60 metric tons from 22 payloads and 27 rocket bodies.**
- **No accounts of personal injury or significant property damage were reported.**
- **The overall rate of uncontrolled reentries is expected to increase during the next several years due to the approach of solar maximum; however, the vast majority of these reentries will represent small debris which do not pose hazards to people and property on Earth.**

Orbital Debris Collision Avoidance

During 2010 NASA robotic satellites conducted 7 collision avoidance maneuvers.

Spacecraft	Maneuver Date	Object Avoided
Terra	22 January	Iridium 33 debris
Cloudsat	17/18 August	Unidentified debris
Landsat 5	24 August	Cosmos 2251 debris
Cloudsat	11 October	Zenit rocket body debris
Cloudsat	13 October	Cosmos 2251 debris
Aura	22 November	Cosmos 2251 debris
Landsat 7	21 December	USA 26 debris

October 6, 2009, China remote sensing satellite Yaogan-3 conducted collision avoidance maneuver. This is the first time maneuver for China satellites.

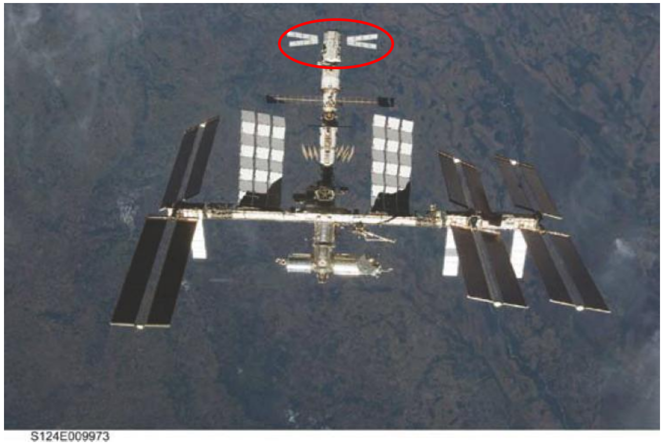
ISS Collision Avoidance Maneuver

From October 26, 1999 to June 28, 2011, 13 times collision avoidance maneuver conducted by ISS .

March 30, 2011, 10一15cm， probability

June 28, 2011， probability of collision on the order of 1 in 360, with a miss distance of 725 m. insufficient time was available to prepare for and to conduct a collision avoidance maneuver. As a precaution, on 28 June the six members of the ISS crew retreated to the two attendant Soyuz transport ships to be ready to undock and return to Earth should a collision occur. In the end, the debris passed the ISS without further incident, and the crew returned to their normal duties.

astronauts



International Space Station

Satellite Fragmentations in 2010

- **Six satellite fragmentations were detected by the U.S. Space Surveillance Network during 2010.**

- **Fortunately, none of the events have been assessed as contributing large numbers of long-lived debris to the near-Earth environment.**

- **The causes of four of the events have yet to be determined.**

Common Name	International Designator	Fragmentation Date	Perigee	Apogee	Cataloged / Assessed Debris	Cause
Yaogan 1	2006-015A	4 February	625 km	630 km	8 / 8	Unknown
Briz-M Tank	2009-042C	21 June	90 km	1490 km	89 / 400^{+}	Aerodynamic
Briz-M Stage	2008-011B	13 October	645 km	26565 km	9 / 30^{+}	Propellants
CZ-3C Third Stage	2010-057B	1 November	160 km	35780 km	1 / 50^{+}	Unknown
NOAA 11	1988-089A	24 November	835 km	850 km	2 / 2	Unknown
H-2A Debris	2007-005E	23 December	430 km	440 km	3 / 6	Unknown

Status of Cosmos 2251 and Iridium 33 Debris

The accidental collision of the Cosmos 2251 and Iridium 33 spacecraft in the 2009 remain the worst known debris generation events in the Earth orbit.

	Cataloged Debris	Cataloged Debris in Orbit 1 Jan 2011
Cosmos 2251	1347	1273 (94%)
Iridium 33	528	492 (93%)

A simulated evolution of the 5-mm-to-1-cm Cosmos 2251 debris between 2009 and 2019

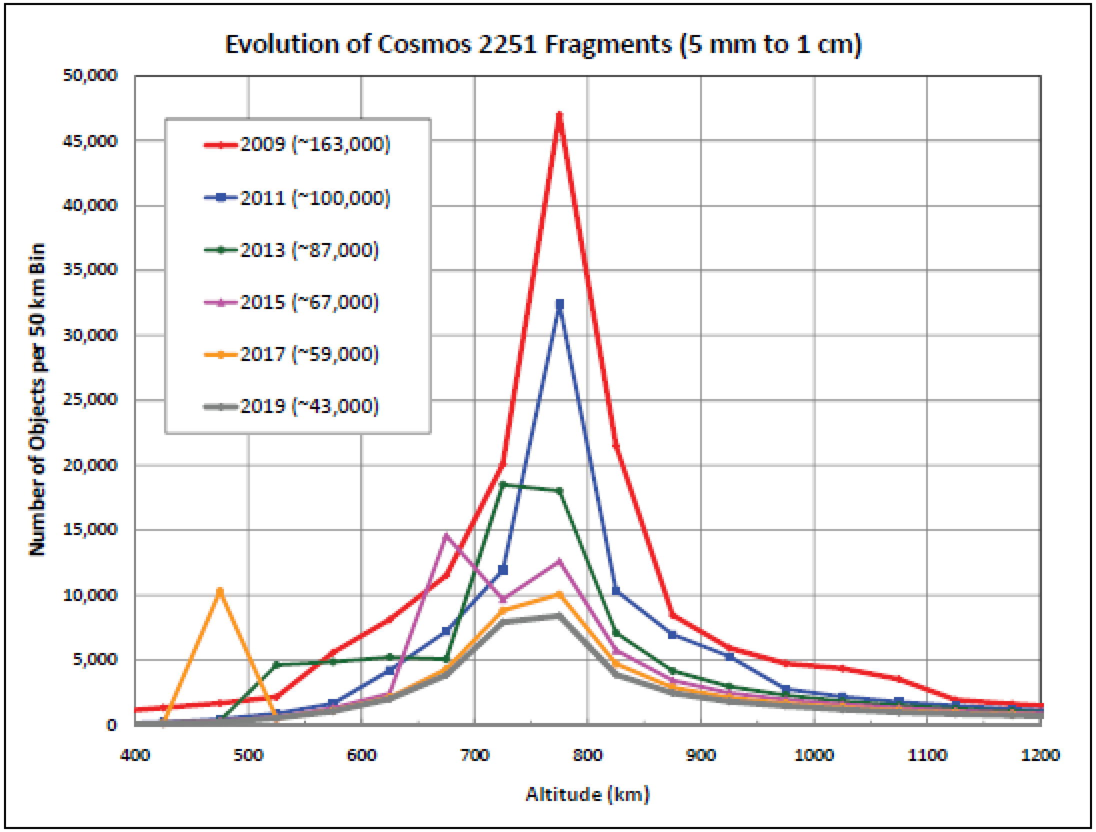
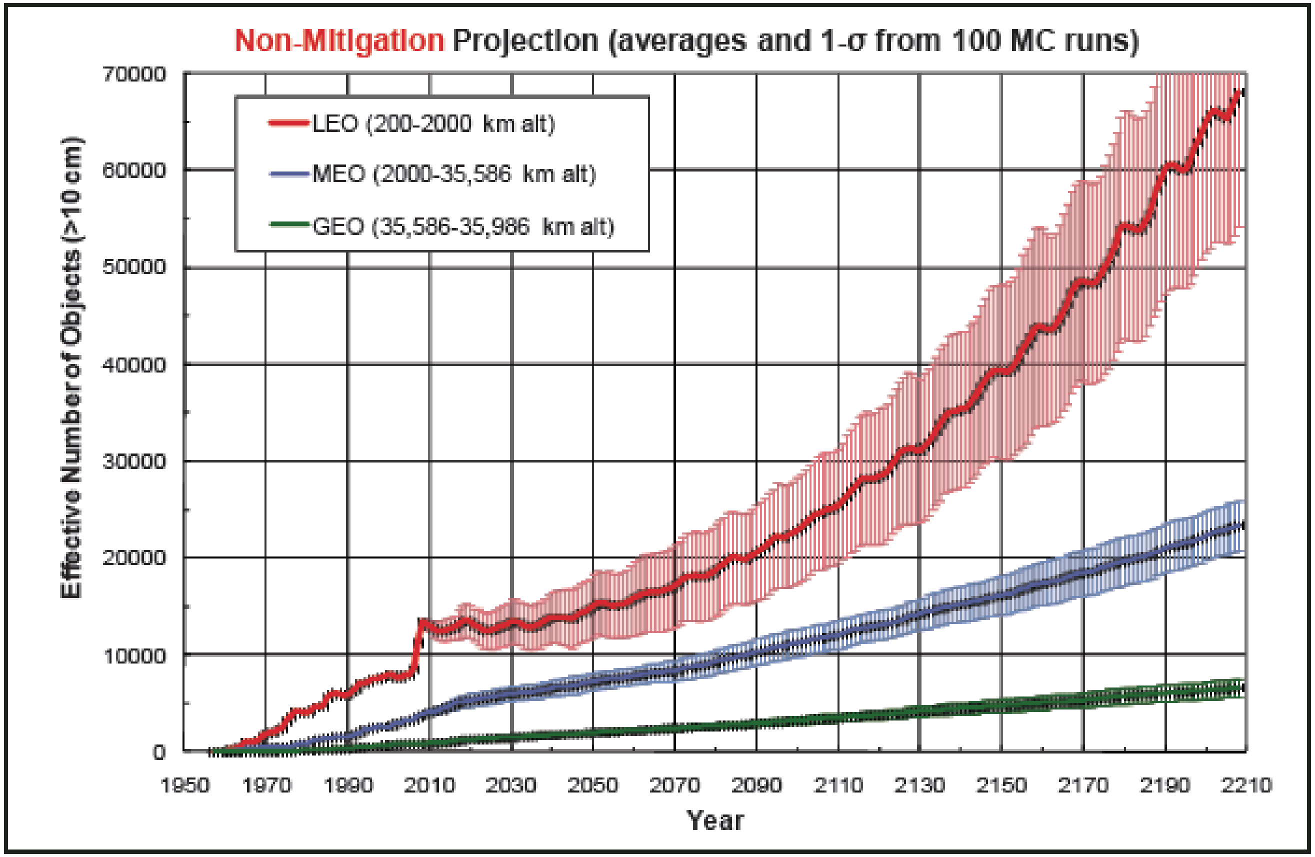


Figure 1. Altitude distributions of the simulated 5-mm-to-1-cm Cosmos 2251 fragments between 2009 and 2019. The number of remaining in-orbit objects at each snapshot is indicated in parenthesis.

Orbital Debris Quarterly News, Volume 15, Issue 3,July 2011

the first accidental collision between Iridium 33 and Cosmos 2251, in February 2009 have significantly increased the number of 10 cm and larger objects in orbit, confirming the instability of the debris population in low Earth orbit, underlined the potential collision cascade effect, commonly known as the "Kessler Syndrome"



Orbital Debris Quarterly News, Volume 14, Issue 1 January 2010

§ 2

Activities of Space Debris Mitigation in China

Space launch activities in China 2010-now

Launch No.	Launch vehicle	Launched date	Spacecraft	Mission	Launched site	Result
148	CZ-3B	2011.10.07	W3C通信卫星	GTO	XSLC	OK
147	CZ-2F	2011.09.29	天宫一号空间站	LEO	JSLC	OK
146	CZ-3B	2011.09.19	中星1A	GTO	XSLC	OK
145	CZ-2C	2011.08.18	实践十一号04星	SSO	JSLC	failure
144	CZ-4B	2011.08.16	海洋二号	LEO	TSLC	OK
143	CZ-3B	2011.08.12	巴基斯坦通信卫星１Ｒ	GTO	XSLC	OK
142	CZ-2C	2011.07.29	实践十一号02星	SSO	JSLC	OK
141	CZ-3A	2011.07.27	北斗二号卫星	IGSO	XSLC	OK
140	CZ-3C	2011.07.11	天链一号02星	GEO	XSLC	OK
139	CZ-2C	2011.07.06	实践十一号卫星	SSO	JSLC	OK
138	CZ-3B	2011.06.21	鑫诺五号卫星	GTO	XSLC	OK
137	CZ-3A	2011.04.10	北斗二号卫星	IGSO	XSLC	OK

Launch No.	Launch vehicle	Launched date	Spacecraft	Mission	Launched site	Result
136	CZ-3A	2010.12.18	北斗二号卫星	IGSO	XSLC	OK
135	CZ-3A	2010.11.25	中星—20A卫星	GEO	XSLC	OK
134	CZ-4C	2010.11.05	风云三号卫星	SSO	TSLC	OK
133	CZ-3C	2010.11.01	北斗二号卫星	GTO	XSLC	OK
132	CZ-4B	2010.10.06	“实践六号“04组卫星	LEO	TSLC	OK
131	CZ-3C	2010.10.01	嫦娥二号月球探测器	GTO	XSLC	OK
130	CZ-2D	2010.09.22	遥感十一号卫星	LEO	JSLC	OK
129	CZ-3B	2010.09.05	鑫诺六号卫星	GTO	XSLC	OK
128	CZ-2D	2010.08.24	天绘一号卫星	LEO	JSLC	OK
127	CZ-4C	2010.08.10	遥感卫星十号	LEO	TSLC	OK
126	CZ-3A	2010.08.01	北斗二号卫星	IGSO	XSLC	OK
125	CZ-2D	2010.06.15	实践十二号卫星	LEO	JSLC	OK
124	CZ-3C	2010.06.02	北斗导航	GEO	XSLC	OK
123	CZ-4C	2010.03.05	遥感卫星九号	SSO	JSLC	OK
122	CZ-3C	2010.01.17	北斗二号卫星	GEO	XSLC	OK

China Space activities will be more and more active

- Launched 15 time in 2010.

- will launch 20 times by the end of 2011.

- According to China space plan, More than 20 spacecraft will be launched into the space every year in the coming 10 years.

- The space activities in China will increase of 50% every year in the future.

History of Space Debris Mitigation

- From 1957 until 1985 there was very few civilian concern about space debris and it was not an open subject.

- Following an Arianne launch to GTO there was complain about space debris from USA in 1986. a few scientist, awareness of the problem was made.

- 1991: First IAA Symposium on Space Debris at the International Astronautical Congress.

- 1991:The Inter-Agency Space Debris Coordination Committee founded.

- 1993:China National Space Administration (CNSA) joined IADC.

Key Events Towards China Space Debris Mitigation

- **1993: installation of Chinese National Space Debris Office and Chinese Space Debris Advisory Group of experts, coordination of space debris research activities in China.**
- **1999: formation of Chinese National expert committee of Space Debris research.**
- **2000:started special budget for Chinese Space Debris research.**
- **since 1999: always actively taking part in the IADC activities; Presented status report on space debris activities of China at IADC annual Meeting. already implementing practical steps on space debris mitigation on a voluntary basis within its own national mechanisms.**
- **2000: first Chinese Conference on Space Debris was held .The conference was opened and was held every two year. The one and only journal of space debris research in the world issued.**
- **2006: China National Industry Standard “Requirements on Space Debris Mitigation”） promulgated and came into force.**

And The one and only journal of space debris research in the world.

Chinese Conference on Space Debris

Mitigation in The Launch vehicle including:

- **Launch vehicle equipment passivation,**
- **Solid retro-rocket fairing and other operational debris controlling,**
- **the active de-orbit of orbital stages,**
- **the correlative standards,**
- **etc..**

Mitigation in Spacecraft including:

- **spacecraft passivation;**
- **spacecraft passive de-orbit ;**
- **Design and practice of lifetime 25 years limit of LEO space system,**
- **active removing of spacecraft and orbital stages that have reached the end of their mission operations in protected regions;**
- **Accurate measure and depletion technique of the residual propellants;**
- **Controlling techniques of discharging batteries, relieving pressure vessels, Self-destruct systems, terminated flywheels and momentum wheels during the disposal phase;**
- **Safety Assessment for Re-entry of space debris,**
- **the correlative standards,**
- **etc..**

Reseaeches of space debris mitigation technique in China

Key results of space debris mitigation research in China:

- **2006: China National Industry standards "Orbital Debris Mitigation Requirements（QJ3221-2005)） came into force.**

  All China flight projects are now required to provide debris assessments and end-of-mission planning as a normal part of the project development.

- **2010: The integrated system of space debris mitigation design of China.**

  To minimize or eliminate generation of debris in every steps of space activities, during planning, design, orbit operation, end of mission of spacecraft and launch vehicles.

  Also can be used for learning and training tool.

- **2010: Safety Assessment for Re-entry of space Debris of China.**

- **At the end of 2010, 19 items relevant standards of space debris mitigation have been finished to research and compile, and these documents are under to be approved.**

Orbital Debris Mitigation Standards in China

1. China National Industry standard QJ3221-2005 Orbital Debris Mitigation Requirements (came into force in 2006)
2. KJSP-T-1-01 Rules of Spacecraft Passivation Desgin (under approved)
3. KJSP-T-1-02 Requirements of GEO Spacecraft Treatment and Implement after Task (under approved)
4. KJSP-T-1-03 Requirements of LEO Spacecraft Treatment and Implement after Task (under approved)
5. KJSP-T-1-04 Control Requirements and Desgin Rules for Operational Debris of Spacecraft (under approved)
6. KJSP-T-1-05 Residual Propellant Measuring and Estimating of Spacecraft (under approved)
7. KJSP-T-1-06 Procedure Requirements and Risk Assessment of Reentry of Spacecraft (under approved)
8. KJSP-M-1-01 Management Requirements for Orbital Debris Mitigation of Spacecraft (under approved)

QJ3221-2005 Orbital Debris Mitigation Requirements (promulgated and came into force in 2006)


QJ

中华人民共和国航天行业标准

FL 1905 QJ 3221—2005

空间碎片减缓要求

Requirements for space debris mitigation

2005-04-11 发布 2005-07-01 实施

国防科学技术工业委员会 发布

中国空间技术研究院
China Academy of Space Technology(CAST)
中国航天

Engineering Practice of space debris mitigation in China

Mitigation operations of the launch vehicle :

- Up to now , Chinese Long-March(CZ) series rocket have launched 27 times, brought more than 27 satellites into the scheduled Orbital。Most of the launch vehicle took measures relevant to Debris Mitigation.

- CZ-4B/C launched 4 times in 2010 and brought 7 satellites into the scheduled Orbital, all the orbital stage of rockets completed the passivation operation, depleted thoroughly all the residual propellant after the separated of the satellite and the rocket, to eliminate the potential breakup on the orbit.

- CZ-2D launched 3 times in 2010 and actively took the de-orbit disposal after the successfully separated of the satellite and the rocket.

Mitigation operations of the satellites :

In order to protect the geosynchronous region, 3 China Xinnuo-2 GEO satellites actively took the de-orbit disposal at the end of mission successively.

§ 3

Space Debris Protection in China

Hypervelocity Impact Testing Facilities in China

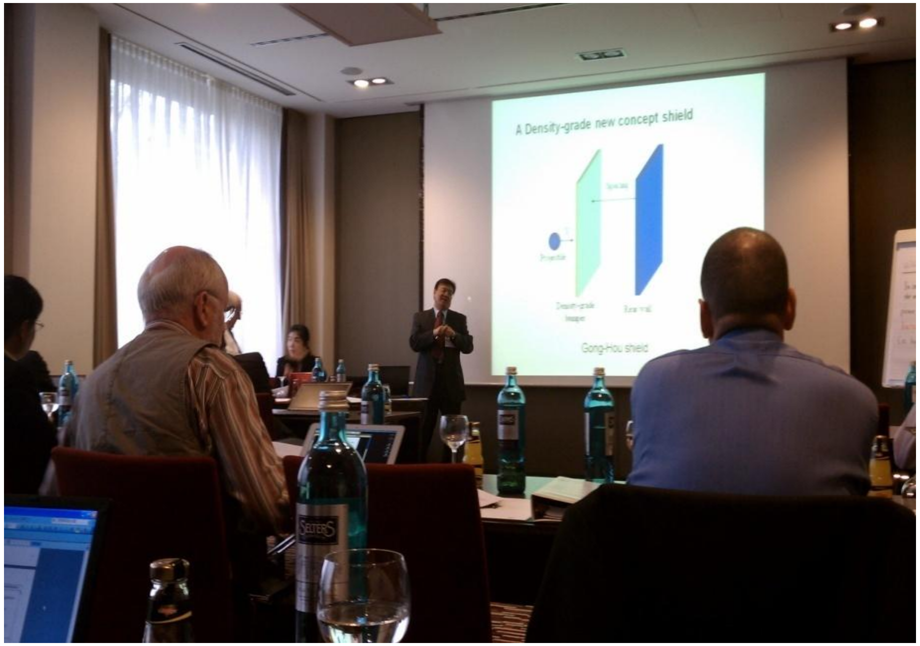
Hypervelocity Impact Testing Facilities in China Academy of Space Technology.

The whole family of space debris hypervelocity impact research in BISEE, CAST

Hypervelocity Impact Testing Facilities in Haerbing Institute of Technology

Hypervelocity Impact Testing Facilities in China Academy of Engineering physics

Hypervelocity Impact Testing Facility Cross Calibration between CNSA and NASA



Dr. Zizheng Gong and Dr. Eric L. Christiansen from NASA-JSC addressed the Hypervelocity Impact Testing facility cross calibration results at the 29th IADC Meeting.

Impact Risk Assessment Codes

BUMPER: NASA, JAXA
ESABASE/DEBRIS: ESA
COLLO, BUFFER, PSC: ROSCOSMOS
MDPANTO: DLR
SHIELD: BNSC
MODAOST: CAST

Table 1 **Calibration results for the cube**

		BUMPER	ESAB./ Debris	MDPANTO	COLLO	SHIELD	MODAOST
NASA 2000	d > 0.1 mm	2.131E+01	n.a.	2.139E+01			2.143E+01
	d > 1.0 cm	2.876E-06	n.a.	2.872E-06			2.873E-06
	p > 1.0 mm	3.528E-01	n.a.	3.360E-01			3.368E-01
	single	1.714E+00	n.a.	1.642E+00			1.639E+00
	double	2.373E-05	n.a.	2.257E-05			2.303E-05
Meteoroid	d > 0.1 mm	2.221E+01	2.12E+01	2.164E+01			2.164E+01
	d > 1.0 cm	1.398E-06	1.30E-06	1.360E-06			1.362E-06
	p > 1.0 mm	1.013E-01	8.30E-02	9.064E-02			8.812E-02
	single	6.804E-01	6.00E-01	6.204E-01			6.018E-01
	double	1.354E-05	1.20E-05	1.142E-05			1.142E-05

Engineering Application of Space Debris Protection design in China

- **Conducted the space debris impact risk assessment and designed the appropriate protection shield for China's first space lab module Tiangong-1.**

§ 4

Conclusions

Conclusion -1

- The number of debris larger than 10 cm would continue to increase significantly due to collisions between existing resident space objects, even if no new satellites were launched.

- The orbital debris environment is instability and unsustainable.

- Space security is fragile.

Conclusion -2

- **China has been making unremitting effort to protect space environment and is already implementing practical steps on space debris mitigation on a voluntary basis within its own national mechanisms taking into account the UN Space Debris Mitigation Guidelines and IADC Space Debris Mitigation Guidelines, and had made contributions in the field.**

- **The China National industry Standard «Orbital Debris Mitigation Requirements » came into force. The requirements of the Standard were harmonized with the UN Space Debris Mitigation Guidelines and IADC Space Debris Mitigation Guidelines.**

- **China has been always actively taking part in IADC and other relative international organizations and activities, vigorously promoting space debris mitigation.**

Conclusion -3

- **Preserving the space environment for the responsible, peaceful, and safe use , is the one and only choice for the international communities.**

- **Mitigation and active remove on-orbit debris (Active Debris Remove, ADR) are wise approach of keeping long-term sustainability of space activities.**

- **New discipline and possibly new international mechanisms are required to ensure decrease the likelihood of technical barrier, friction and conflict.**

Thank you for your attention