China Academy of Space Technology

China's New Generation of Recoverable Satellite

—An Advanced Platform for Space Environment Utilization

Beijing Institute of Spacecraft System Engineering, CAST

6th Nov. 2017

Questions

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Why do we persist in recoverable satellite?

What are the differences from the ISS or other platforms?

Which kind of payload does platform support?

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CAST's Reentry Spacecraft

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- China Academy of Space Technology(CAST) is a core member of CASC.
- All reentry spacecraft launched in China were designed by CAST.

25 recoverable satellites, 11 manned spaceships , 1 lunar reentry capsule.

1975.11.5
First Recoverable Satellite

2003.10.15
First Manned spaceship

2014.10.24
First Lunar Reentry Capsule

2016.4.18
First Experiment Recoverable Satellite

2016.6.26
Next Generation spaceship

CAST's Recoverable Spacecraft

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By 2016, we had launched 25 recoverable satellites.
They can be classified into 4 generations by scale and task.

FSW-1
Height:~3m
Weight:~2000kg

1975~1992

FSW-2
Height:~4m
Weight:~3000kg

1993~1996

FSW-3
Height:~5m
Weight:~3500kg

2003~2005

FSW-4
Height:~5m
Weight:~3500kg

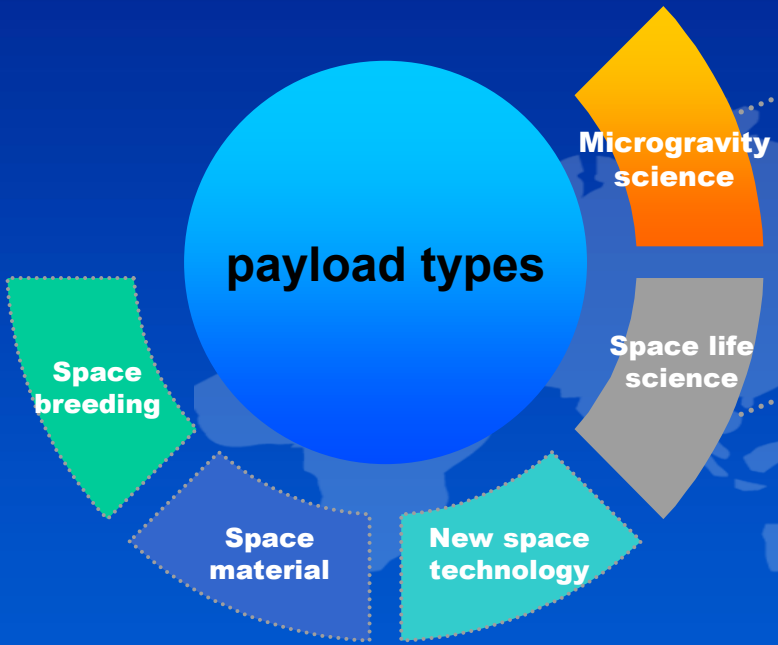
2006~2016

Generation 5
Height:~5m
Weight:~3500kg

Now & Future

Space Science Experiments on the Recoverable Satellites

The FSW1~3 (first 23) satellites, while conducting the main task of earth observation, had carried out 17 batches of space science experiments in the form of piggyback payload. The FSW 4 (24th and 25th) satellites were built to operate space science experiment.



Accounting for 28% of the all experiments

including microgravity combustion, microgravity fluid physics

Accounting for 23% of the all experiments

including space radiation effects, space biological effects, biological effects of microgravity

Space Science Experiments on SJ-10 (2016)

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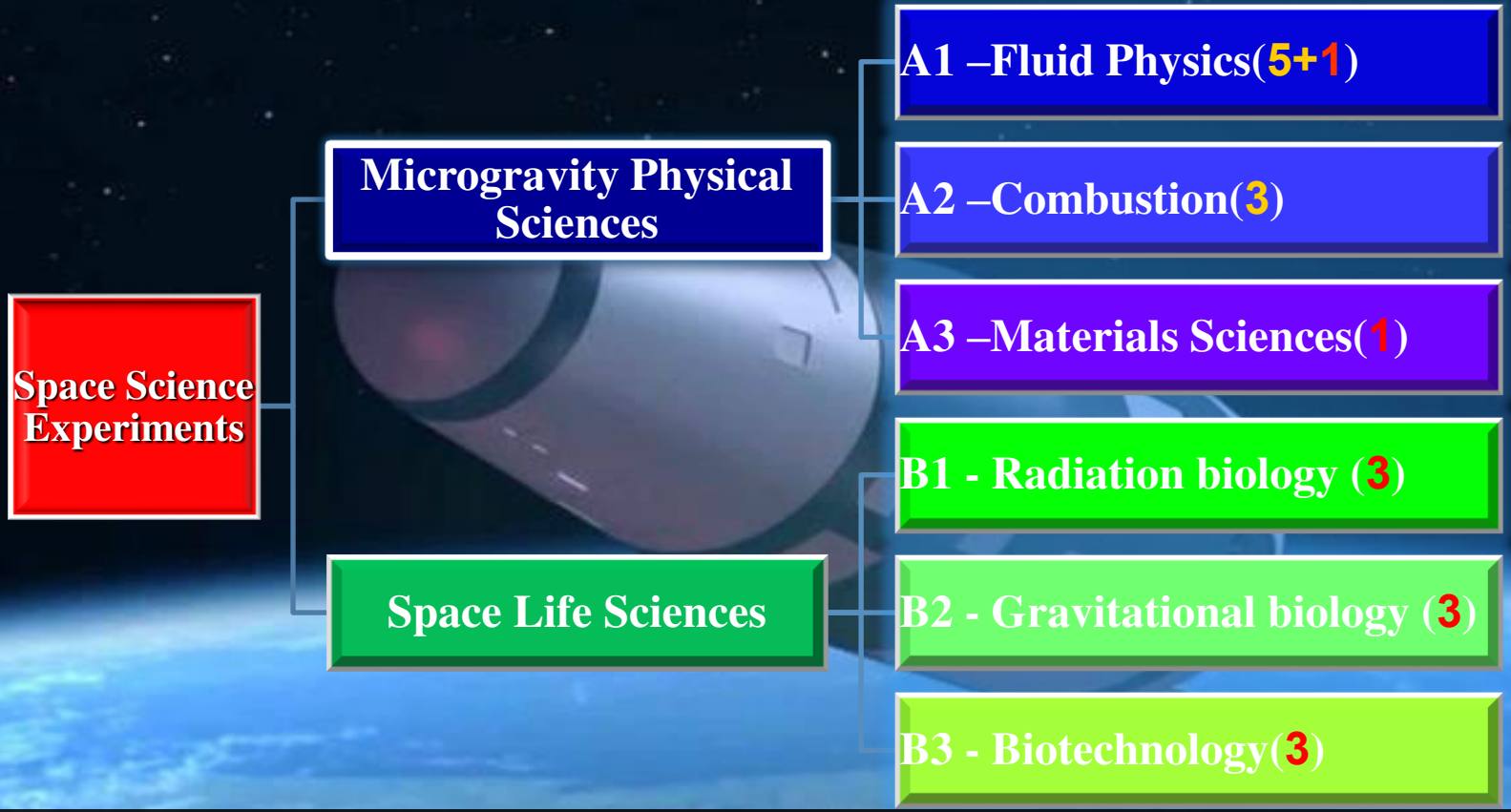
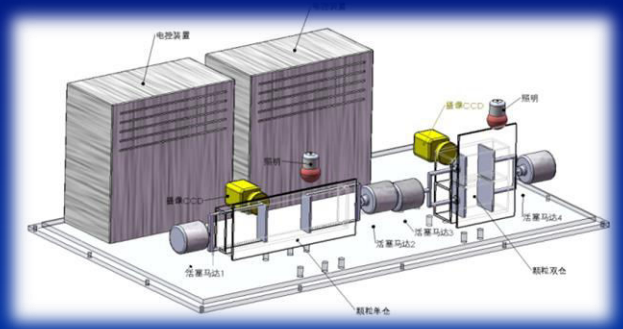
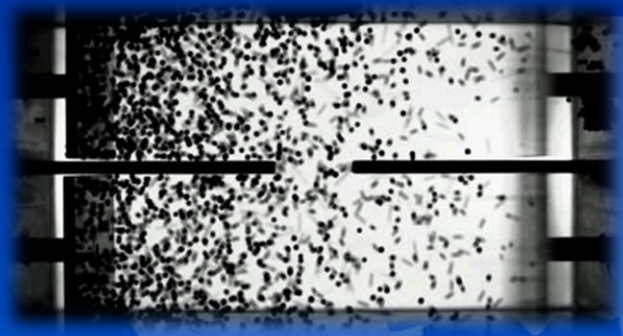


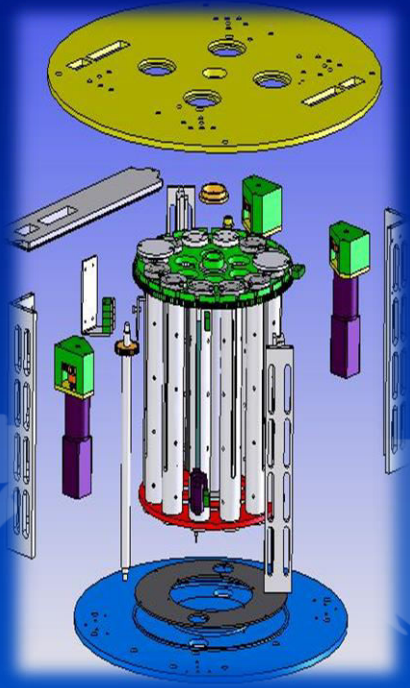
8 experiments aboard the orbit capsule + 11 aboard the recoverable capsule

Microgravity Physical Sciences Projects on SJ-10(2016)





Phase separation and dynamic clustering in Granular gas



Multi-function furnace & Materials research

Space Life Sciences Projects on SJ-10(2016)

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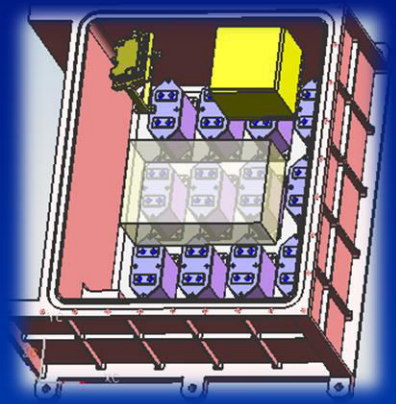
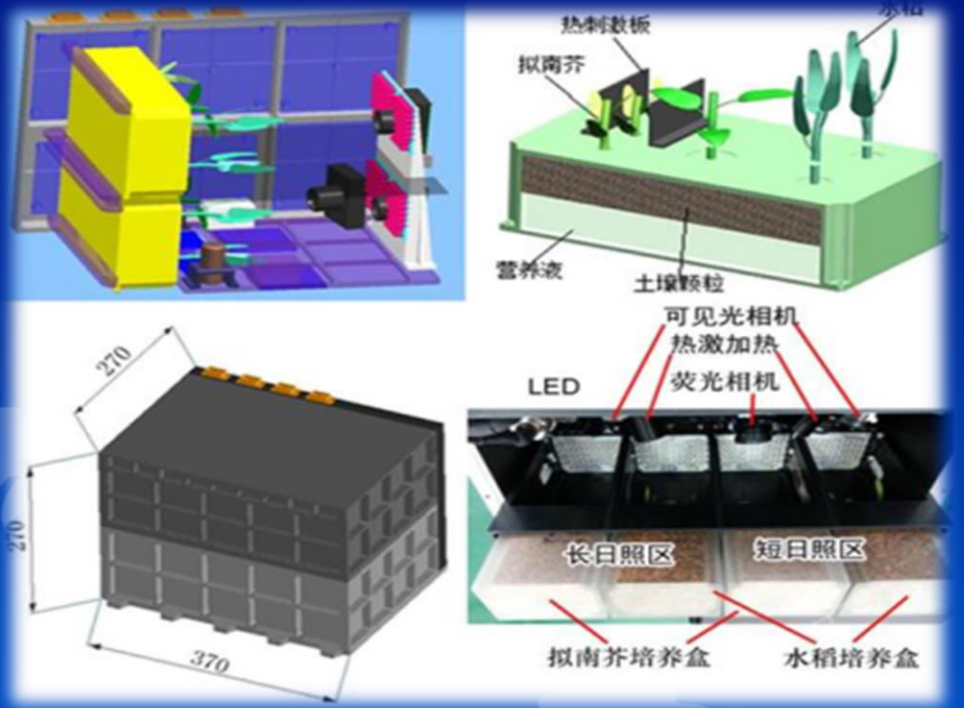


Silkworm embryo development and mutation



Photoperiod-controlling flowering of plants

Advantages of Recoverable Satellite

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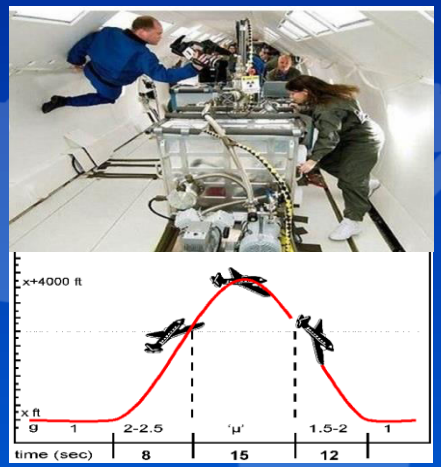
Why do we need the recoverable satellite for the space science research?

It can provide better service of microgravity, radiation, vacuum, duration, which are the most important elements for space science research.

Drop Tower	Parabolic Flight	Space Station	Satellite
			
$10^{-3}g_0$ ~$10^{-6}g_0$ Seconds	$10^{-3}g_0$ ~$10^{-6}g_0$ Seconds ~ Minutes	$10^{-3}g_0$ ~$10^{-6}g_0$ Days ~ Years	$10^{-4}g_0$ ~$10^{-7}g_0$ Days ~ Years

Advantages of Recoverable Satellite

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Better microgravity

Without astronauts activities and solar wings, NGRS' quasi-steady acceleration is up to ~$10^{-7}g_0$.

More available

NGRS offers shuttle service, with the capacity of 1000kg/year.

Less constrained

As a commercial platform, NGRS has less matters to coordinate with other systems.

More flexible

Launch and flight sequences are planned based on the experiments.

The New Generation Recoverable Satellite

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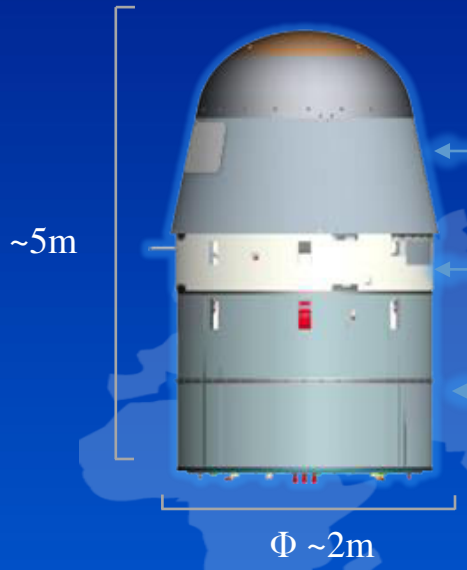
Short-term Type

Long-term Type



Recoverable Module
To be used for 15 times

Retro Module

Propulsion & Power Module

Total weight ： 3500kg

The New Generation Recoverable Satellite

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Orbit	Circular orbit, altitude: 340km, inclination angle: 43°	
Flight Duration	10~20d for recoverable module 1 year for Propulsion & Power Module	
Capacity For Payload	400W, 500kg, recoverable	400W, 600kg, recoverable 400W, 300kg, unrecoverable
Power Supply	$Li/SOCl_2$ Battery Lithium-thionyl chloride	Solar Array & Li^+ Battery

Reuse Design of NGRS

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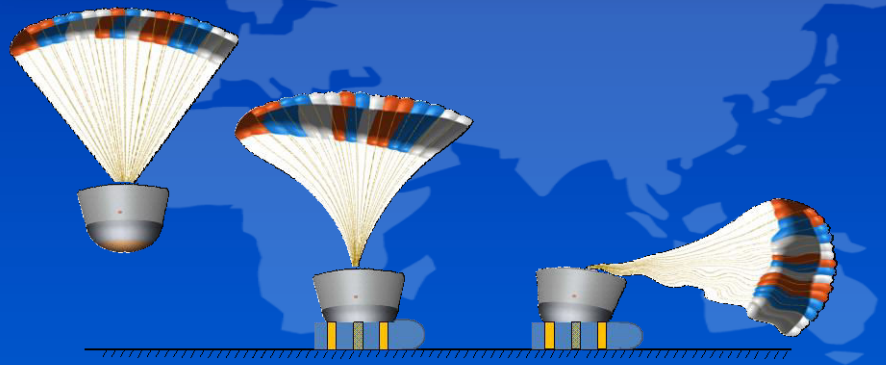
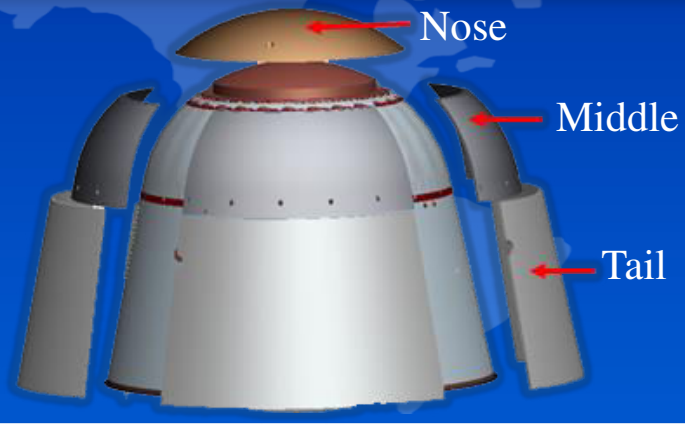
Low Impact

- The recoverable module is equipped with an airbag as a cushion while landing. The impact could be limited to 10g.
- airbag volume:10m^3.



Reuse Design

- The recoverable module including structures, equipment and cables can be reused for 15 times.
- The thermal protective shield(TPS) will be replaced after each flight.



Services for Payloads

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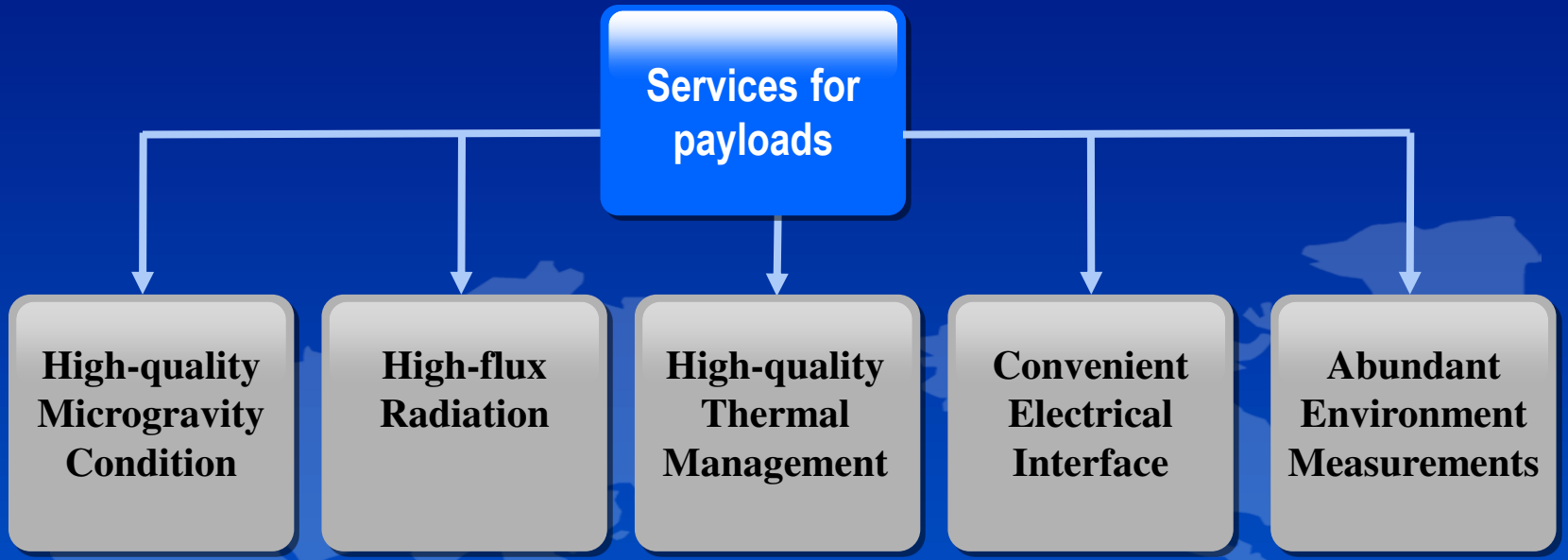

Services for Payloads

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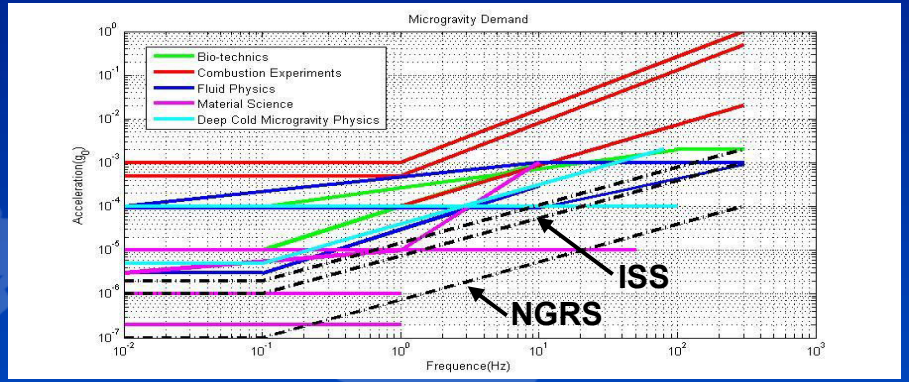
Microgravity | High-flux Radiation | Thermal Management | Electrical Interface | Environment Measurement

Our Goals:

- Quasi-steady Acceleration: ~ $10^{-7}g_0$
- Oscillatory & Transient Acceleration: $10^{-4}g_0$ ~$10^{-5}g_0$



Quasi-steady Acceleration <0.1Hz

Oscillatory & Transient Acceleration 0.1Hz~300Hz

Services for Payloads

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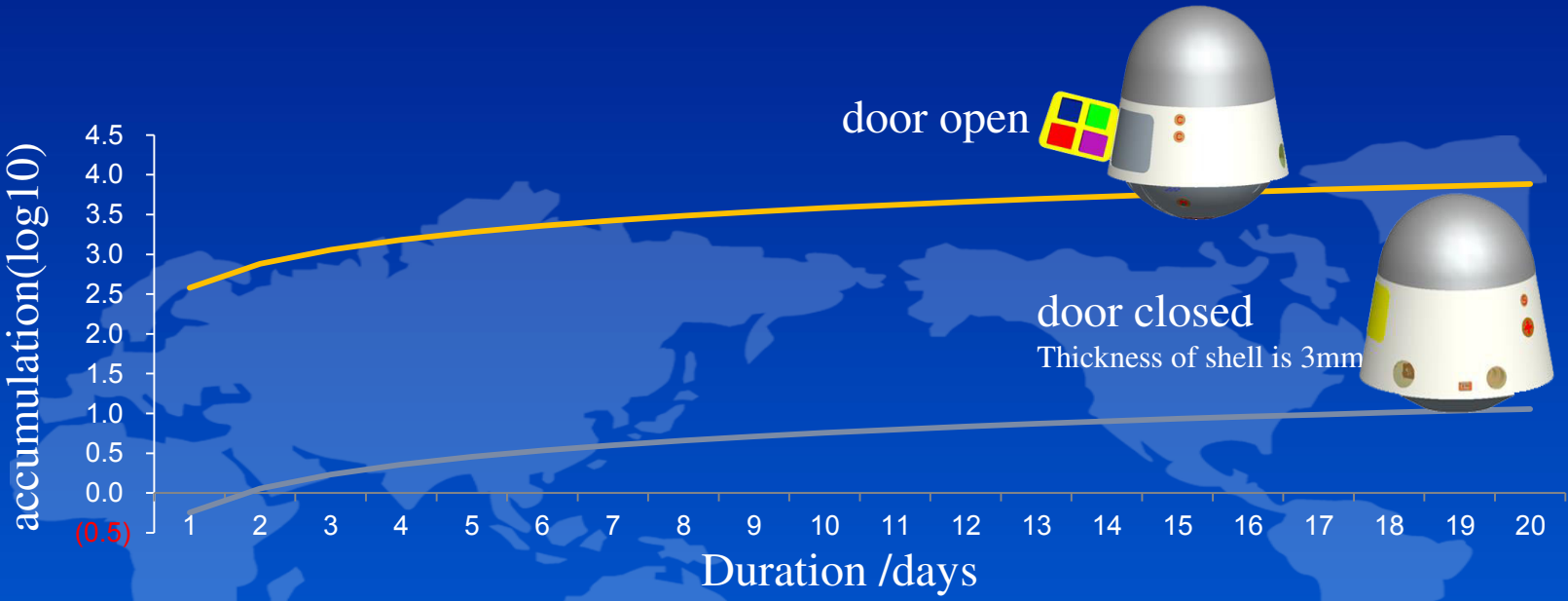
Microgravity | High-flux Radiation | Thermal Management | Electrical Interface | Environment Measurement



Services for Payloads

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Microgravity | High-flux Radiation | Thermal Management | Electrical Interface | Environment Measurement

NGRS is equipped with a single phase liquid loop system, so it may satisfy the demands for thermal control of payload, especially life science payload.

- **Heat dissipation capacity: 600W**
- **Temperature range: 4℃~30℃**
- **Control accuracy:±2℃**
- **Control stability: ±0.5℃/h**

Services for Payloads

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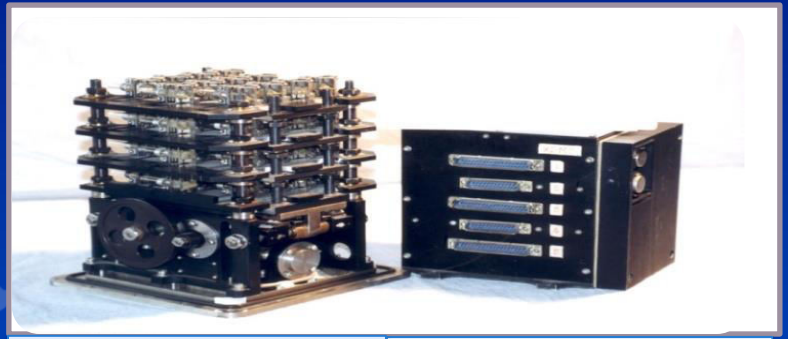
Microgravity | High-flux Radiation | Thermal Management | Electrical Interface | Environment Measurement

All the payloads are managed by Payloads Management Unit(PMU).

PMU offers various communication interfaces.

Both science date and engineering date from payloads can be transmitted to platform, then to ground data centers.



Power	TM\TC
DC: +28V	RS485
Data & TM\TC	Data
WIFI Ethernet	RS422\LVDS

Services for Payloads

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Microgravity | High-flux Radiation | Thermal Management | Electrical Interface | Environment Measurement

- **Microgravity**

  Quasi-steady Acceleration： frequency: 10^{-4}Hz~0.1Hz, rang: $\pm10^{-4}g_0$, resolution: $10^{-9}g_0$

  micro-vibration: frequency: 0.1Hz～300Hz, rang: $\pm10^{-2}g_0$, resolution : $10^{-6}g_0$

- **Dynamic environment**

  vibration, noise, shock during the launch and EDL phases.

- **Radiation**

  Radiation dose in and out of the capsule through the flight.

- **Temperature**

  Temperature of payload and surrounding equipment.

- **Pressure**

  Pressure in the capsule through the flight.

Cooperation with NGRS

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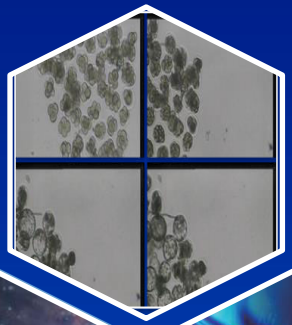
Various kinds of payloads are welcome.

Microgravity science

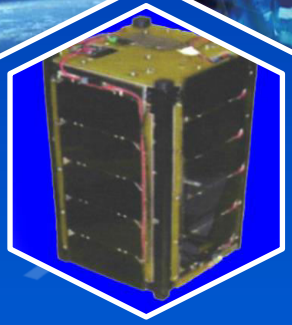


Life science

Space material

Space pharmacy

New tech demonstration



Education & Others

Cooperation with NGRS

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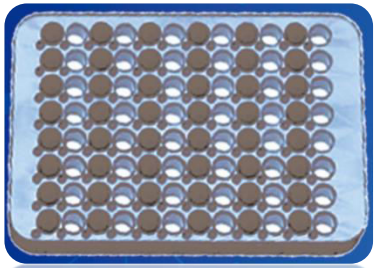
Realization of your ideas for space

We can design equipment to realize your ideas!
We also provide the training for equipment development and space technology

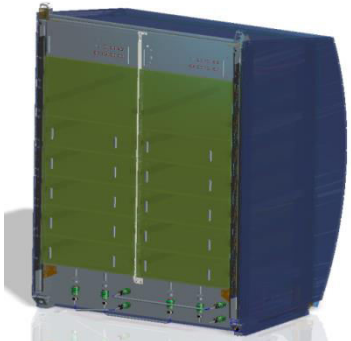
Users provide equipment

ampoule furnace

Space material

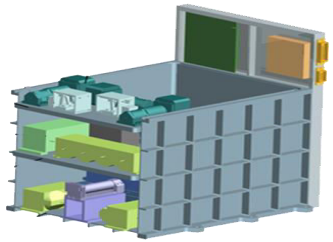


micro plate



Multi-function sealed capsule for special payloads

Life science



Users' equipment

Any types

Mission Phases for Payloads

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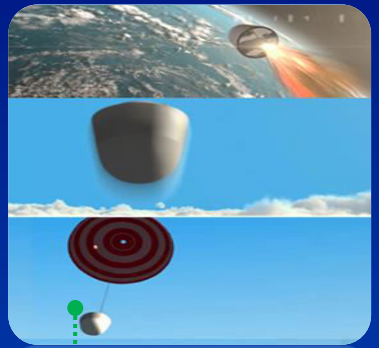
AIT in Beijing

Launch



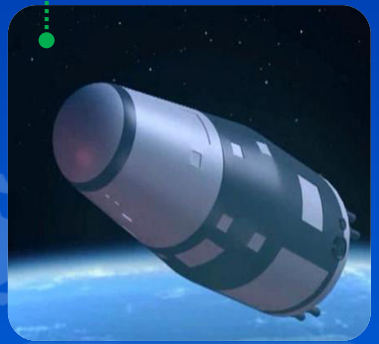
Reentry

Return samples

Manufacture & Delivery

AIT at launch site

Experiment on orbit



Uninstall equipment

Plan and Progress of NGRS

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First Flight	Flight Plan	Object
To be scheduled late 2018 or early 2019	15 missions are planed during 2018~2025	To establish a commercial and sustainable path for the space utilization.

Current Phase: Phase C currently , Phase D (System AIT) will start late this year.

Piggyback chances: It's still available for the first flight by the end of this year.

Cost: As a commercial satellite, the cost will be in the affordable and reasonable range.

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Thanks for your attention!

LET'S WORK TOGETHER

CREATING A BETTER FUTURE

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