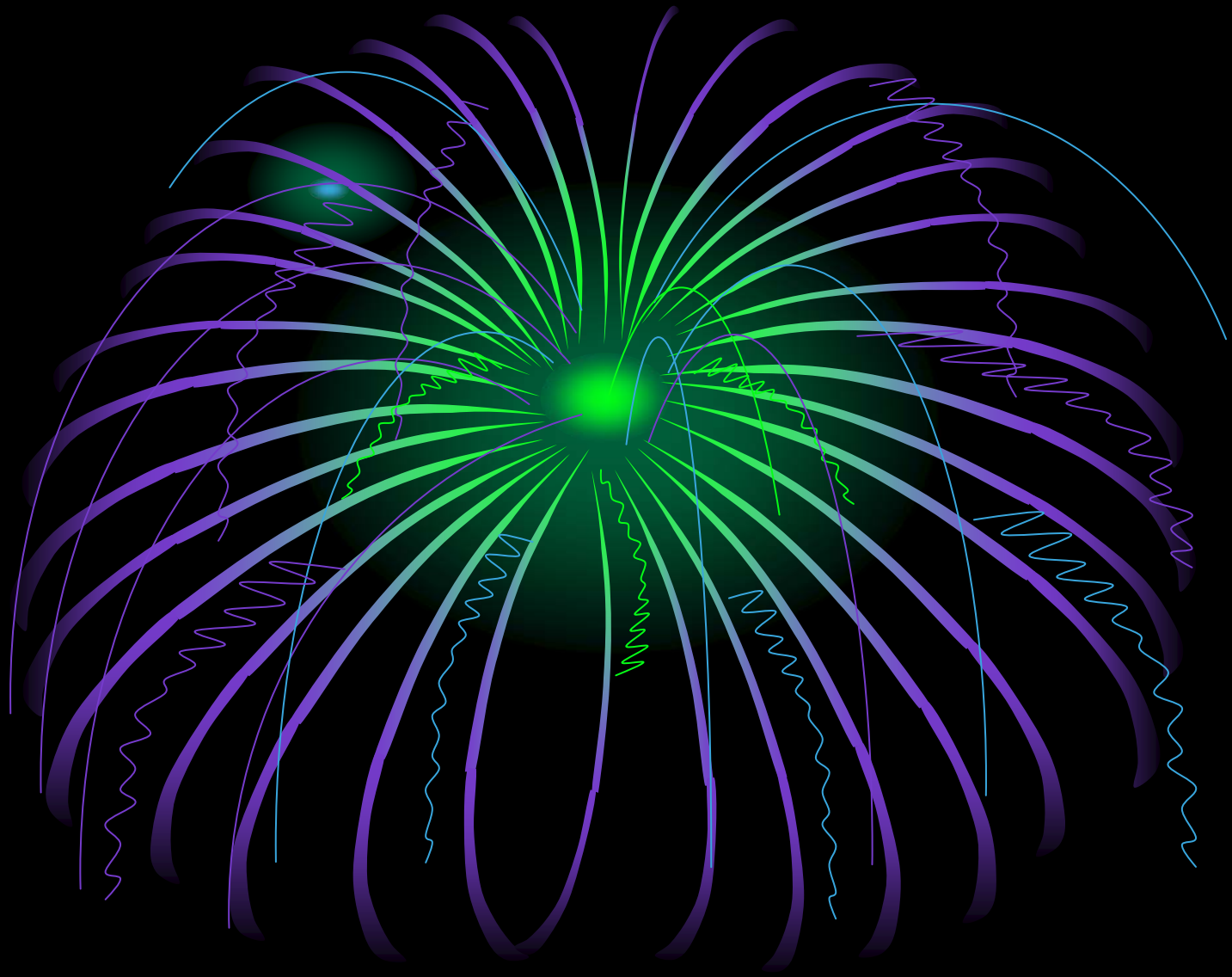


China's Space Programme

- **Significant achievements as a developing country in space launches and programs, despite HRD, financial and S&T problems**

- **Satellite launches (with 97 put in orbit by 2007)**

- **Manned spacecraft (six launched by 2005)**

- **Lunar probe efforts (to be launched by late 2007)**

- **Develop and launch space shuttle by 2020**

- **satellite and spaceship recovery technologies, space engineering system with development of nearly a dozen Long March series of launch platforms, multiple-satellite launching and networking, synchronous positioning, high-energy, low-temperature fuel, compatibility with other international systems, monitoring**

- **fourth combat front** 第四　争

European Space Agency photo of the Great Wall

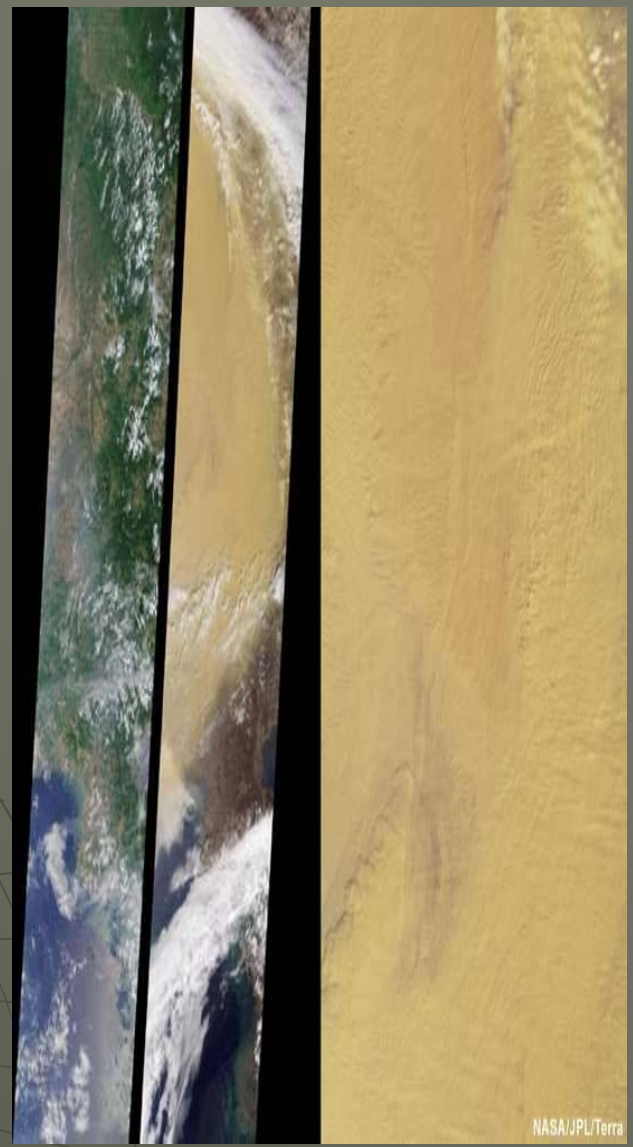
Space Policy

1. Maintaining and serving the country's overall development strategy, and meeting the needs of the state and reflecting its will. China considers the development of its space industry as a strategic way to enhance its economic, scientific, technological and national defense strength….

2. Upholding independence and self-reliance policy, making innovations independently and realizing leapfrogging development.

3. Maintaining comprehensive, coordinated and sustainable development, and bringing into full play the functions of space science and technology in promoting and sustaining the country's science and technology sector, as well as economic and social development. [and]

4. Adhering to the policy of opening up to the outside world, and actively engaging in international space exchanges and cooperation."



Three Terra images - dust storm over China

Space Program

- 12 year S&T programme launched in 1958
- "two [atomic & hydrogen] bombs, one satellites"
- In March 1986 the "863"Plan identified space programme (along with five other technologies)
- 1992 spacecraft launch programme was initiated
- June 1997 further enhancement of the space technology programmes
- 9th Five Year Plan focus was on improving the success rate of the rockets, enhancing its payload capacity, shifting from satellite testing to application with the objective of making these for commercial usage subsequently
- 10th Five Year Plan China identified three key areas of space programme as priority lists: "a new type of carrier rockets", "broadband high-speed information network", and "key integrated circuit"
- 11th Five Year Plan improving the independent innovative capability, expanding the scale of the space industry, expanding international exchanges and cooperation and strengthening Chinese competitive capabilities

- **Retrievable remote-sensing satellites, communications and broadcasting satellites, meteorological satellites, and scientific exploratory and experimental satellites**

- **30 satellites and several spacecraft during the 2001-2005 period covering 15 different categories**

- **Serialisation of Earth resources, navigation positioning, and oceanic satellites**

- **11th & 12th Five Year Plans: 50 small satellites weighing less than one tonne**

April 24, 1970 DFH-1
15-day mission

- **Launch Sites at Jiuquan, Xichang and Taiyuan with plans for the fourth in Hainandao**
- **Most of the earlier launches at Jiuquan**
- **Most of launches for foreign companies from Xichang**
- **New Launch pad constructions in the offing**

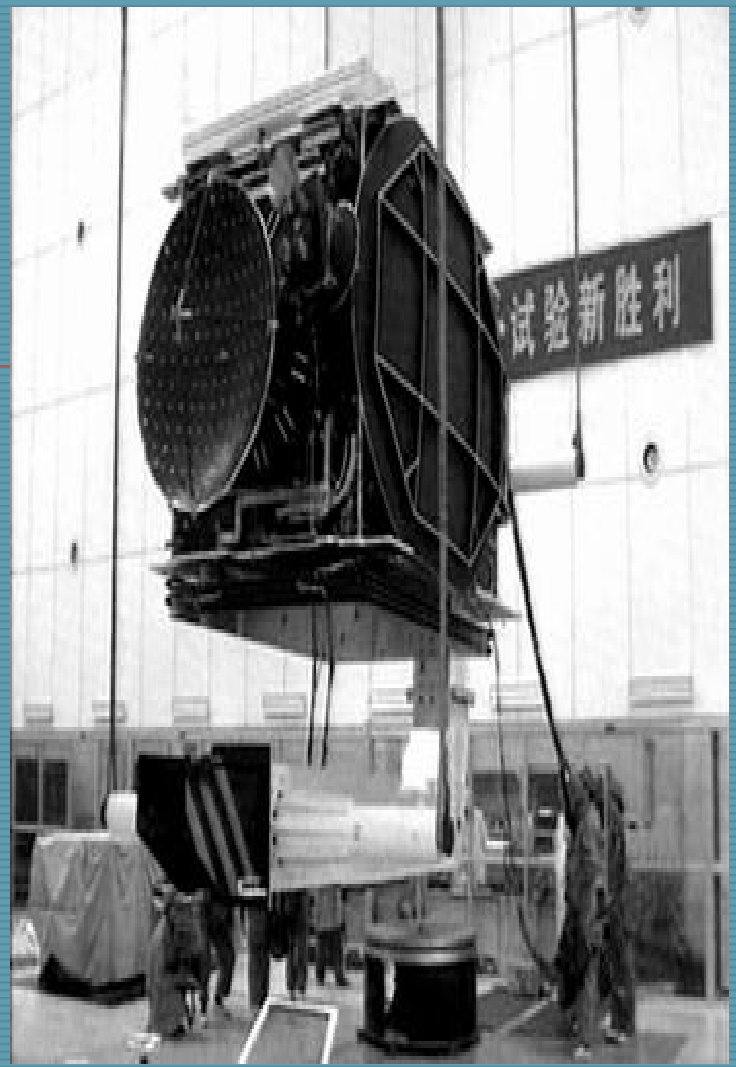
The Long March 2F launch pad at Jiuquan Satellite Launch Center

•Expansion of the current C band system from 500 MHz to 800 MHz;

• Introduce systems operating on Ku, Ka UHF, L, S, and X bands;

•Development of multi-time user time-sharing facilities of 60-120 MB per second capacity together with a satellite communication system of 100 MB per second performance;

•Changing from the current system of accommodating only voice and data signals to that of a very small aperture terminals for handling signals for not only voice and data but also graphics, characters and TV broadcasts; developing systems for inter-communication between two or more satellite systems, automated systems, improving safety and security measures



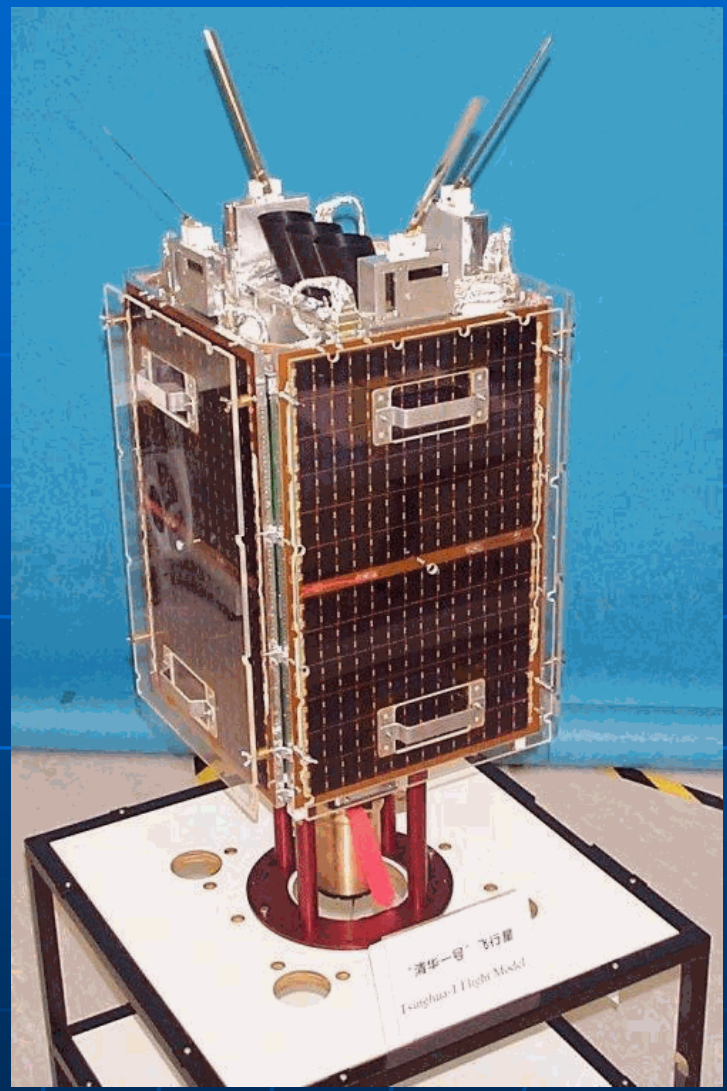
尚　于研制　段的鑫　二号　星。如今的它极可能成　太空垃圾 Sinosat 2 not working- Nov 06

- The China Space Aviation Industrial Group, developed “Space Qinghua No. 1” mini-satellite

- small satellites for the benefits of transforming aspects of reconnaissance, telecom, command, decision-making, logistics, and weapons systems in the modern warfare

- 2002 Chinese *Sinosat* 1 satellite broadcasts were jammed reportedly by the Falun Gong activists in Taiwan

- Piggyback satellites



Qinghua 1 Minisat

Beidou

- Two satellites launched in October and December 2000; 3rd in May 2003; February and April 2007 launch of two more satellites

- For transportation, meteorology, petroleum production, forest fire prevention, disaster forecast, telecommunications and public security sectors

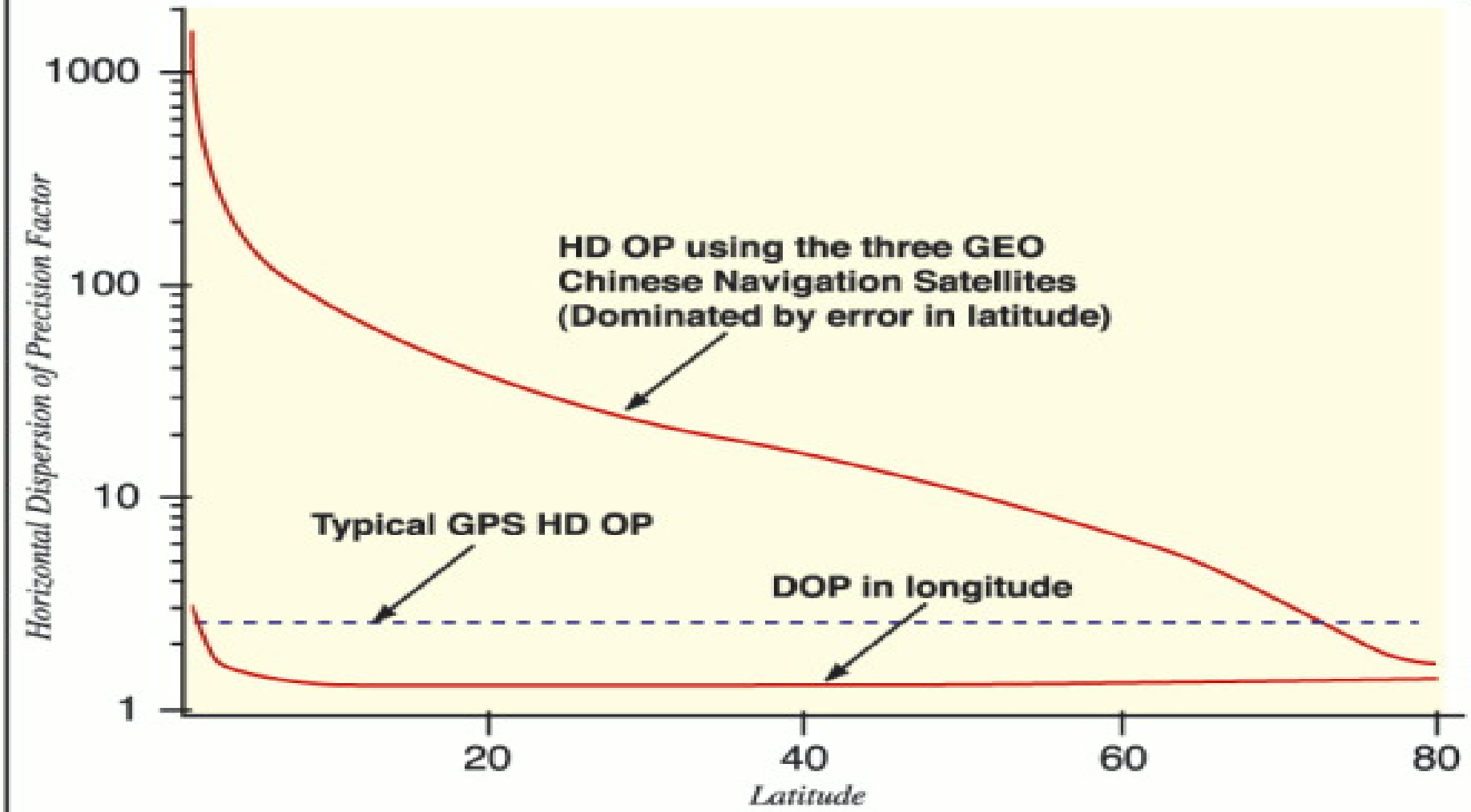
- positioning of *Beidou* series of satellites over West Asia during the 2003 Iraq war

- Compass system of navigation: 35 satellites (with five geostationary and 30 medium earth orbit satellites) serving Chinese and unspecified neighbouring countries customers by 2008

- positioning accuracy within 10 meters, velocity accuracy with 0.2 meter per second and timing accuracy within 50 nanoseconds

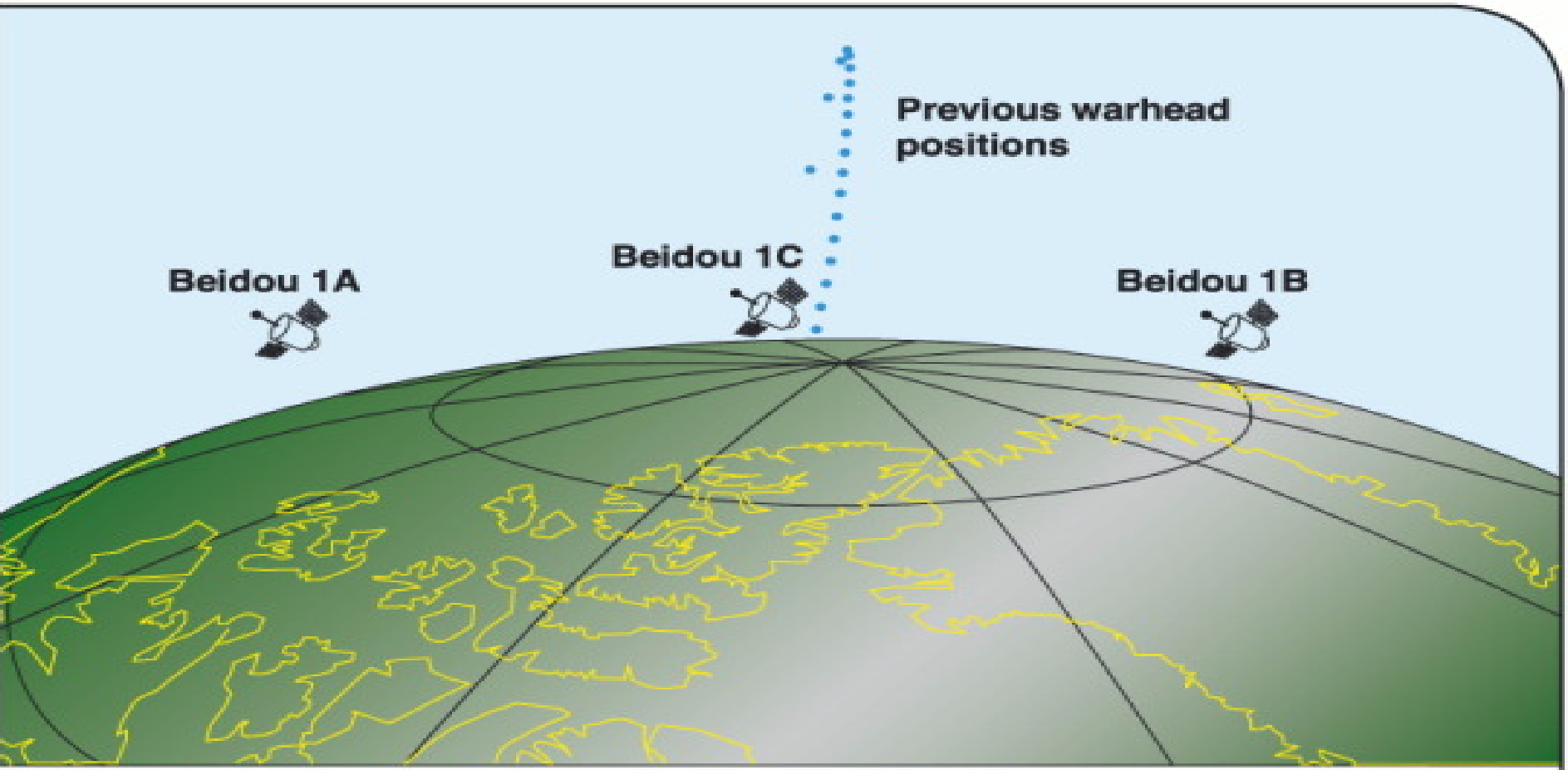
- purchasing rubidium and hydrogen maser atomic clocks in Europe

2nd Beidou launch



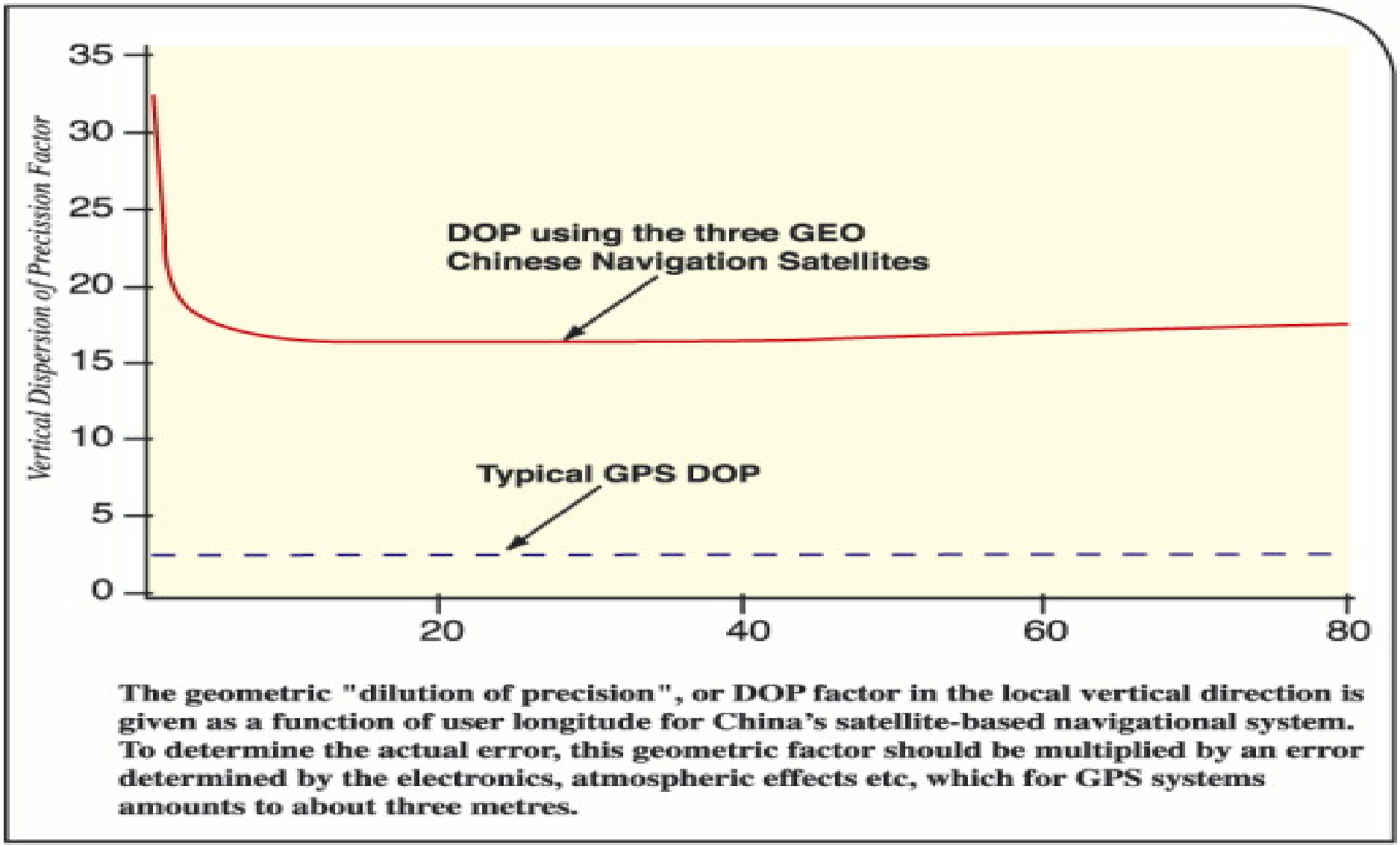
The geometric factor associated with navigational satellite accuracy (known as HDOP, for Horizontal Dilution of Precision) is shown here as a function a user latitude for the Chinese navigational satellite system. To determine the actual error, this geometric factor should be multiplied by an error determined by the electronics, atmospheric effects etc, which for GPS systems amounts to about three metres.

Historical dispersion of precision factor (Source: Janes)

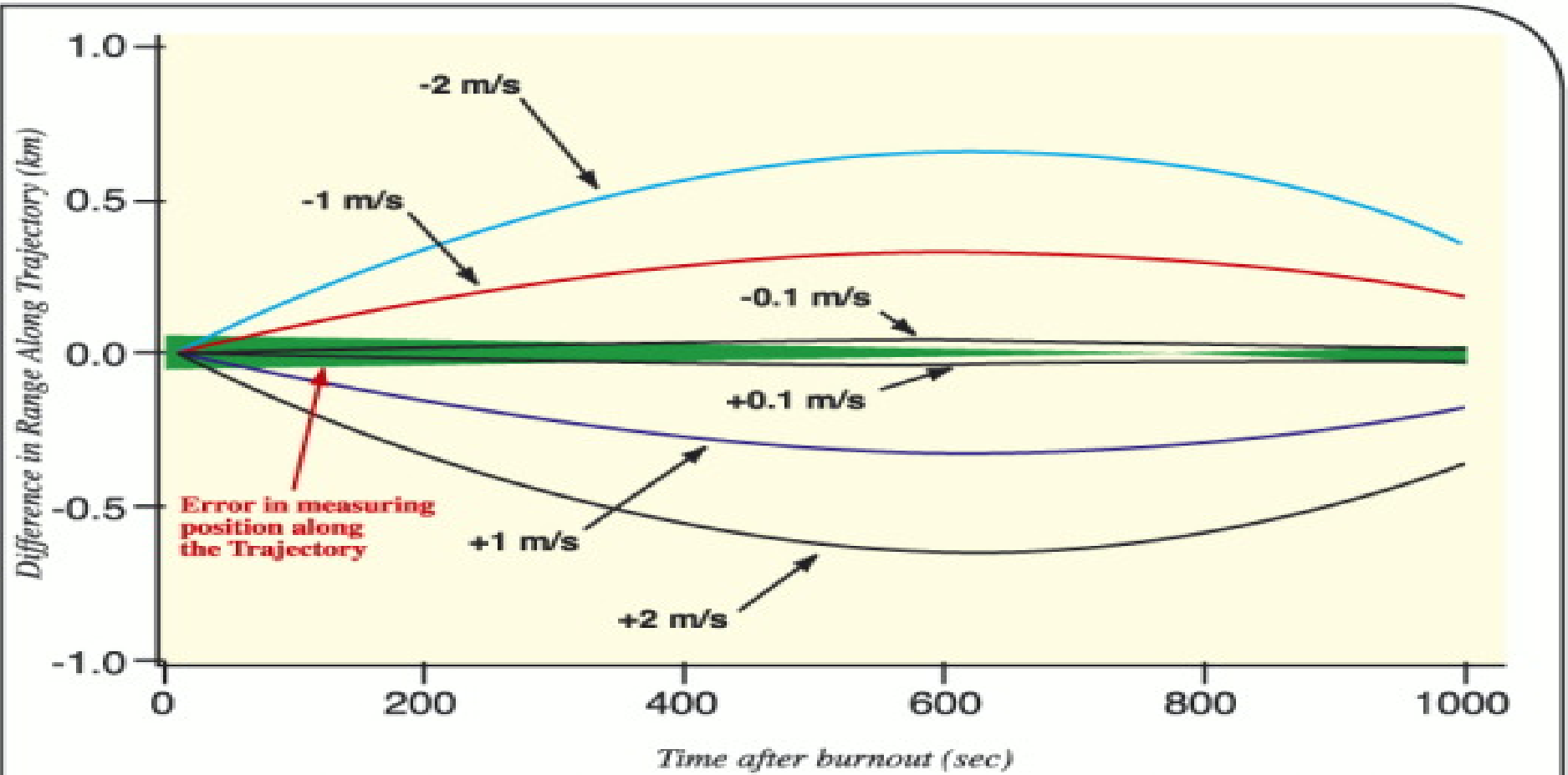


A warhead, launched from China and on route to Washington, D.C., remains in contact with all three Chinese navigation satellites (Beidou 1A, Beidou 1B, and Beidou 1C) for most of its trajectory. This image shows the view looking back from the warhead about 27 minutes after liftoff and moments before Beidou 1C disappears behind the curve of the Earth. At this time the warhead is somewhere over Canada; the outline of Greenland is visible to the right.

Warhead launch (Source: Janes)



Vertical dispersion of precision factor (Source: Janes)



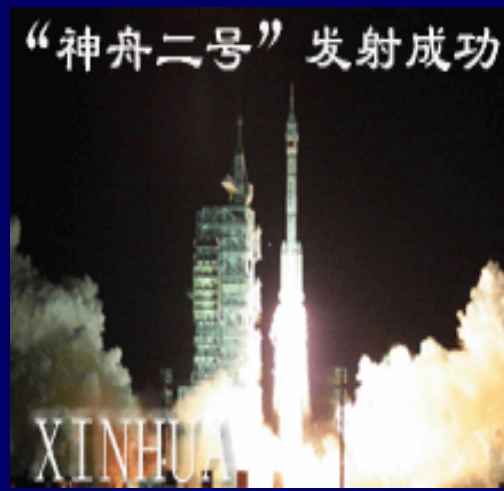
Changing the velocity of a Chinese warhead along its polar trajectory by very slight amounts (on the order of a metre per second out of over 7000 metres per second total speed) produces measurably different trajectories. This graph shows the differences in range as a function of time after burnout for trajectories differing by these small amounts. These differences get significantly greater than the errors associated with measuring the warhead's position using China's navigational satellites, which is shown in green.

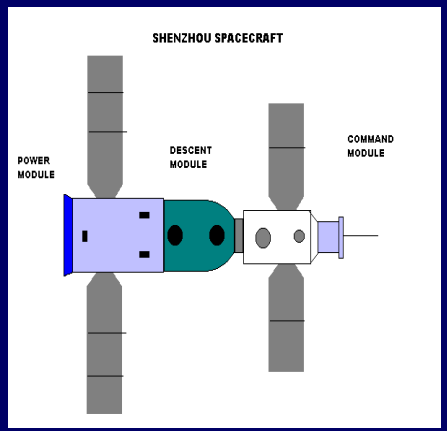
Difference in range along trajectory (km) (Source: Janes)

Spacecraft Program

Shenzhou 1999

1. heavy-duty carrier rockets that can launch the payload of about 10 tonnes into the space;
2. space recovery technology [by late 1990s, China recovered 17]
3. unmanned space ship is produced in preparation for manufacturing a manned space ship
4. breakthroughs in space technologies- solar energy batteries, primary gamma-ray burst observation apparatus, training of personnel at Kakarin Astronauts Preparation Center in Russia





Shenzhou

Shenzhou

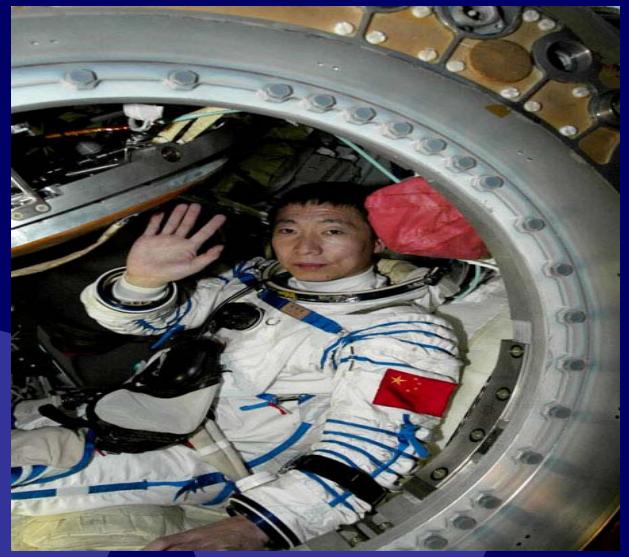
China spent about Yuan 18 billion ($2.2billion) for the manned space programme from 1992 to 2003. This accounts to Yuan 1.6 billion ($200million) in average annual spending on the programme

Yuan 1.6 billion (about $200 million) in annual average expenditure for the 11-year-old programme since 1992

cost of building Shenzhou VI was reportedly about Yuan 900 million

•Shenzhou Yagi antenna for PHOTOINT

•Shenzhou 5 has implications for the proposed BMD system in East Asia as well



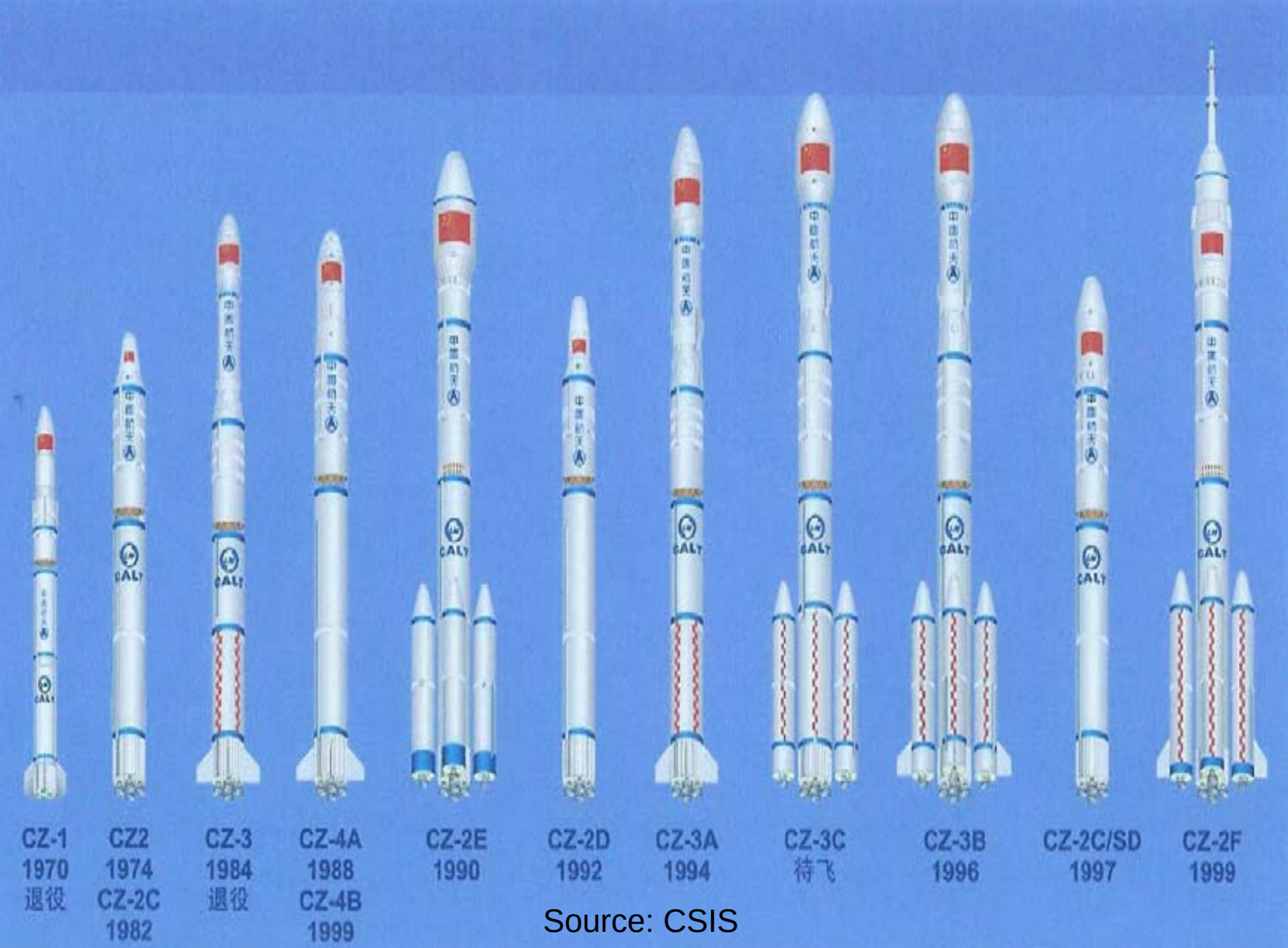
Yang Liwei

Fei Junlong & Nie Haisheng

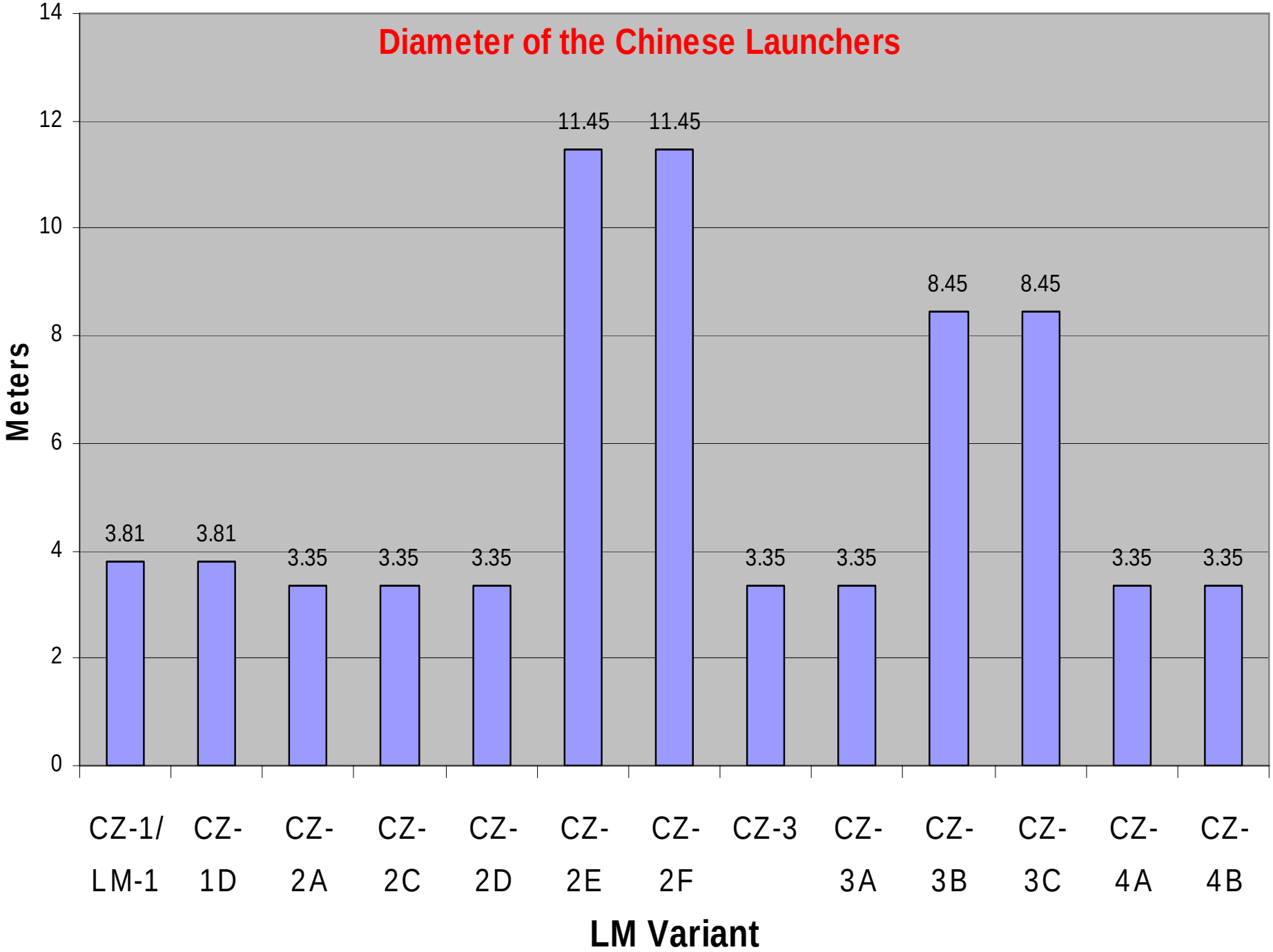
The four missions of the lunar probe are:

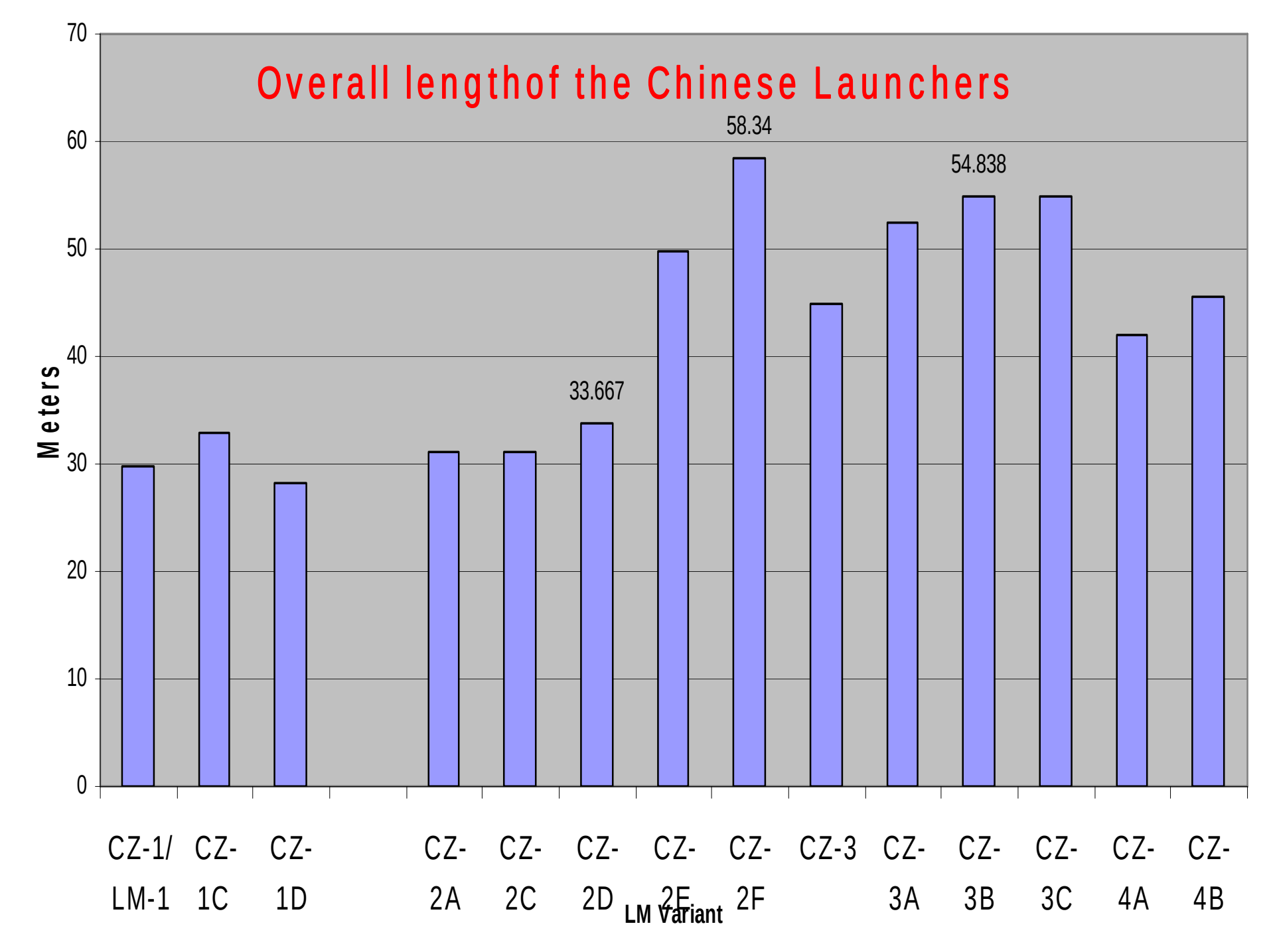
1. **collecting three-dimensional moon images,**
2. **exploring lunar soil,**
3. **analyzing chemical elements on the Moon's surface and**
4. **investigating the space environment between the earth and the moon**

An artist's interpretation of China's Chang'e 1 lunar orbiter

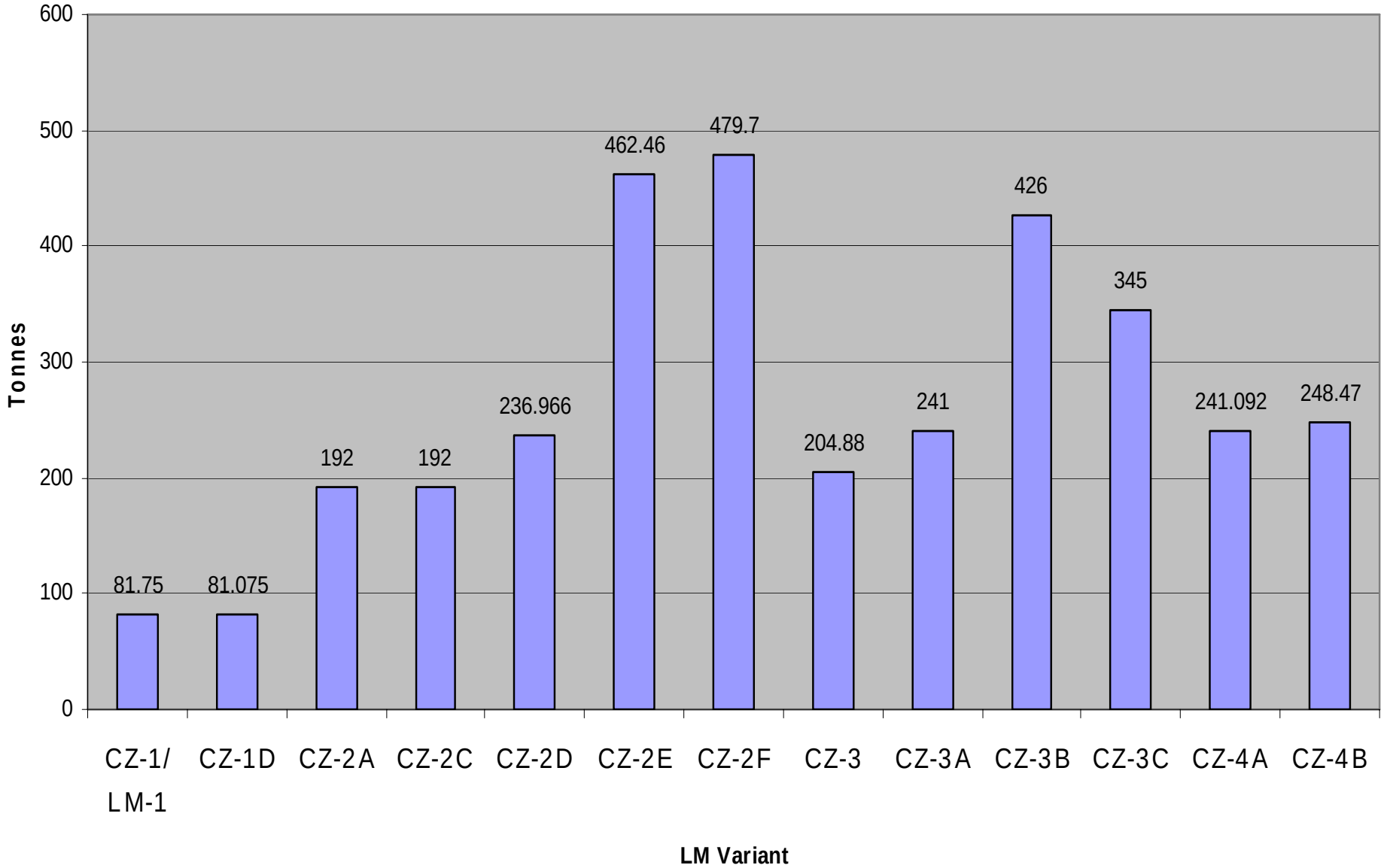

CZ-1
1970
退役
CZ2
1974
CZ-2C
1982
CZ-3
1984
退役
CZ-4A
1988
CZ-4B
1999
CZ-2E
1990
CZ-2D
1992
CZ-3A
1994
CZ-3C
待飞
CZ-3B
1996
CZ-2C/SD
1997
CZ-2F
1999

Source: CSIS


Diameter of the Chinese Launchers
Meters
0
2
4
6
8
10
12
14
3.81
3.81
3.35
3.35
3.35
11.45
11.45
3.35
3.35
8.45
8.45
3.35
3.35
CZ-1/ LM-1
CZ-1D
CZ-2A
CZ-2C
CZ-2D
CZ-2E
CZ-2F
CZ-3
CZ-3A
CZ-3B
CZ-3C
CZ-4A
CZ-4B
LM Variant


Overall lengthof the Chinese Launchers
Meters
70
60
50
40
30
20
10
0
58.34
54.838
33.667
CZ-1/ LM-1
CZ-1C
CZ-1D
CZ-2A
CZ-2C
CZ-2D
CZ-2E
CZ-2F
CZ-3
CZ-3A
CZ-3B
CZ-3C
CZ-4A
CZ-4B
LM Variant

Launch mass


600
500
400
300
200
100
0
Tonnes
81.75
81.075
192
192
236.966
462.46
479.7
204.88
241
426
345
241.092
248.47
CZ-1/ LM-1
CZ-1D
CZ-2A
CZ-2C
CZ-2D
CZ-2E
CZ-2F
CZ-3
CZ-3A
CZ-3B
CZ-3C
CZ-4A
CZ-4B
LM Variant

- LM 2 variants launched 27 times

- more success rate from October 1996: launch success rate has reached 92 percent

- initial propellant for the LM rockets, nitric acid was replaced with nitric tetra oxide

- for the three-stage LM-3 liquid oxygen cryogenic upper stages and in 1984 succeeded in this effort

- China purchased three RD-120 class engines from Russia although the latter refused to part with RD-170/171 class engines

Launch Failures

- About 9 launch failures till the 1990s, excluding wrong orbital placements
- dummy AUSSAT could not be placed in the orbit in 1990 (but Pakistan's Badr-1 was successful in a different launch but failed after a month)
- Long March 2E in January 1995: Rocket exploded after launch- 6 killed and 23 injured
- Long March 3B in February 1996 carrying Intelsat 708 satellite – inertial guidance system malfunctioned- 6 killed 57 injured
- Loran & Hughes accused of transferring satellite guidance technologies to China

Space Launches

- KT-series of launch vehicles

- design capacity ranging from 1.2 tons to 25 tons when moving in lower orbits, or 1.8 tons and 14 tons in higher orbits

New model launch vehicles at Zhuhai04

International cooperation with Australia, Brazil, Canada, Chile, France, Germany, Italy, Japan, Kazakhstan, Pakistan, Russia, South Korea, and Sweden.

China launched a Swedish scientific satellite, Freja, in 1992

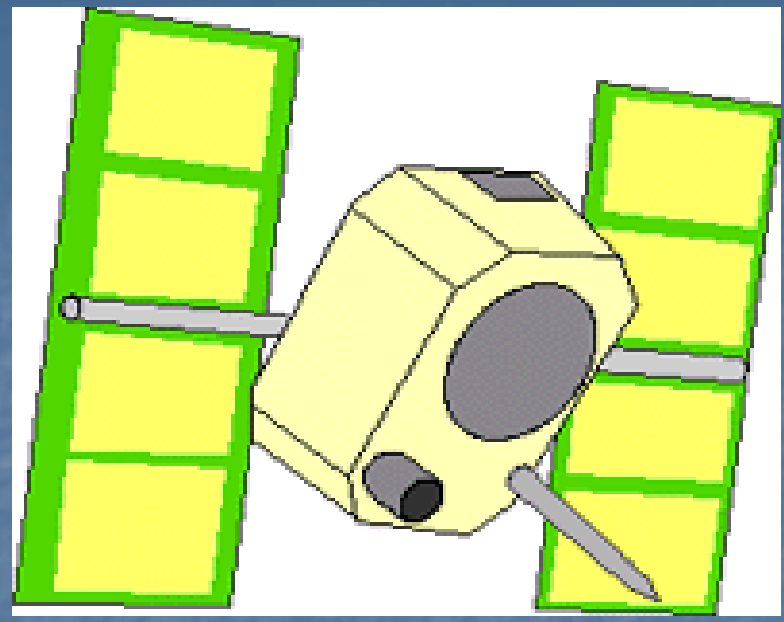
In 1994, China Aerospace Co. and Germany's Deutsche Aerospace (now DASA) formed a joint venture, EuraSpace, to build communications and remote sensing satellites; cooperating on a solar telescope

Arianespace for joint development of a launch system with China

1994 Sino-Russian cooperation agreement- areas of cooperation robotic missions to Mars and human spaceflight, Soyuz purchase, training Chinese specialists at Russia's cosmonaut training center in Star City

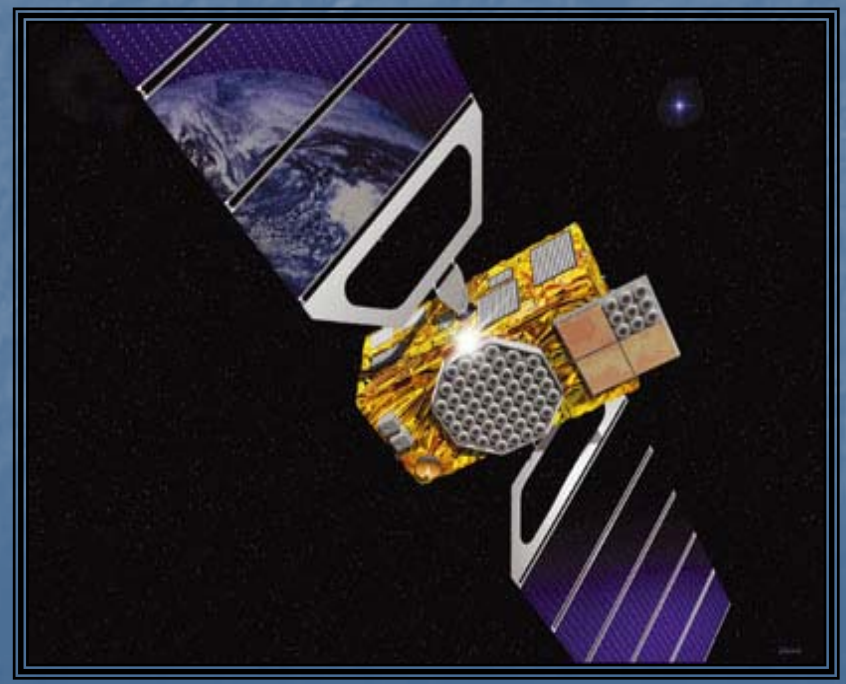
France's Aérospatiale builds Sinosat-1 for the Chinese-German company Eurospace July 1998

GPS/Glonass/Galileo



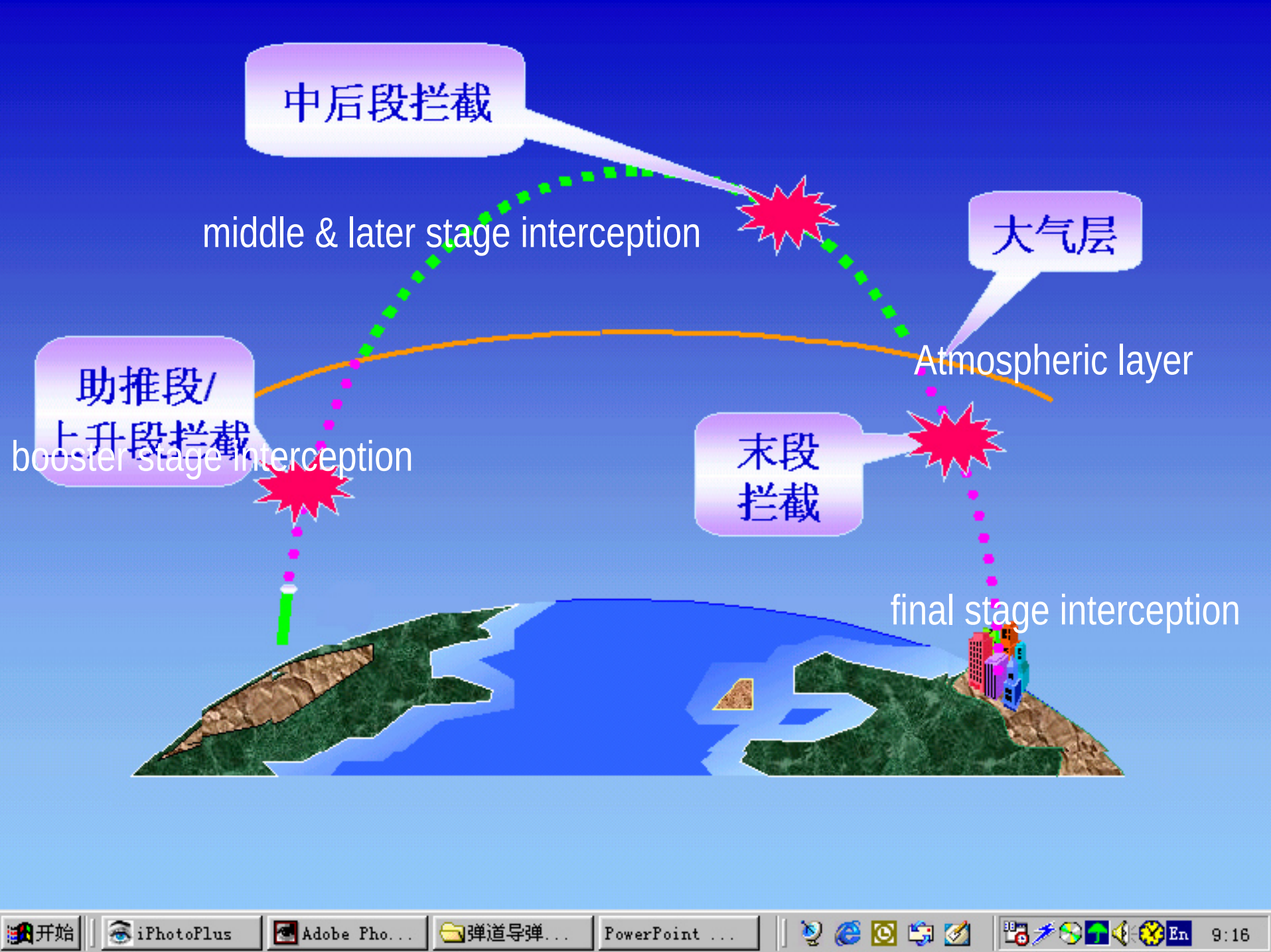
1989 launch service agreement with the US but launch failures and allegations about violation of launch service agreement and sanctions in 1993 (for selling missiles to Pakistan) led to denial of satellite export licenses.

China-Brazil cooperation in space is designed to provide 20 meter resolution, which could be useful for both military and civilian purposes.



Euro 200 million in Galileo

Conflict or Cooperation with GPS/Galileo?


中后段拦截
middle & later stage interception
大气层
Atmospheric layer
助推段/
上升段拦截
booster stage interception
末段
拦截
final stage interception

- **Taiwan in the orbit (ROCSAT boosted in 1999)**

- **Violates the ABMT that ushered in global strategic stability during the Cold War [between the P/N-5]**

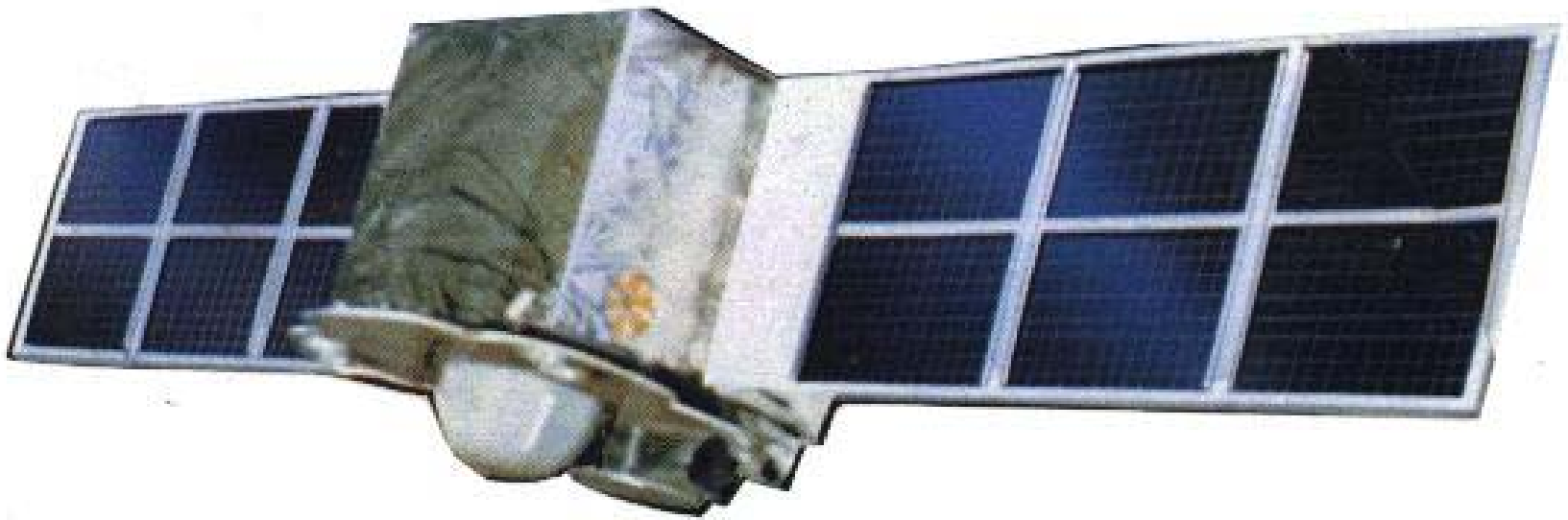
- **It Destabilizes the World Order and harm IR**

- **Undermines China's Strategic Deterrence & its retaliatory attack**

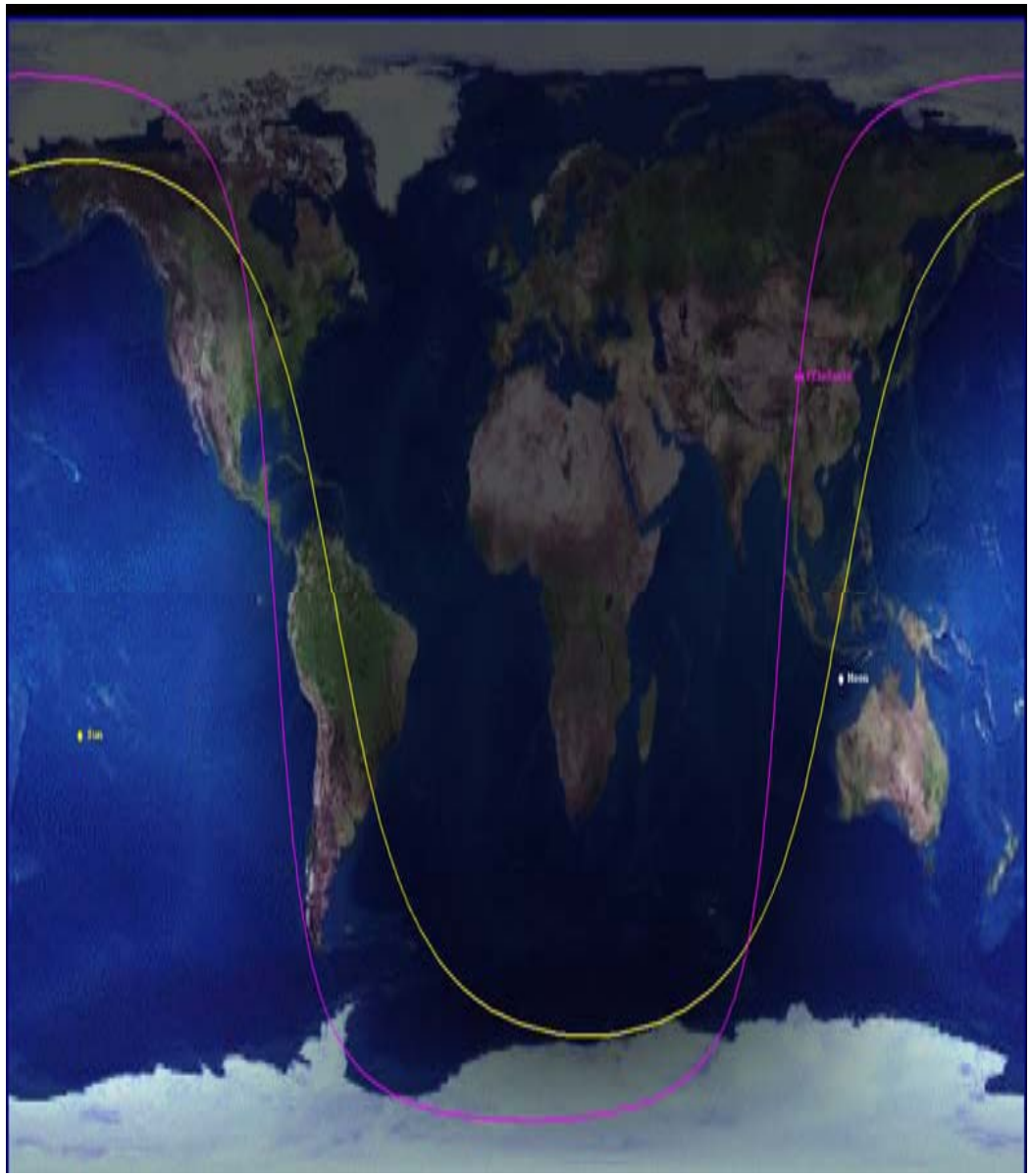
- **Leads to Arms Race in the Region**

- **US unilateral moves on BMD detrimental to non-proliferation efforts (NPT/FMCT/CTBT)**

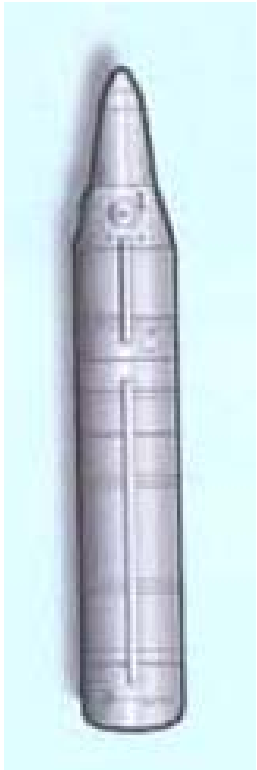
Mass: 880 kg
Orbital parameters: Apogee: 875 km
Inclination: 98.59o
At time of interception: Longitudinal speed: 7.42 km/s
Altitude: 856 km



The Target Satellite
Source: MIT



Fengyun-1C was placed in a sunsynchronous orbit



Total weight = 14,700 kg
Payload = 600 kg
Booster weight = 14,100 kg
Scaling by stage length:
1st stage: 10,389 kg
2nd stage: 3,710 kg
Solid grains burn from the inside out.
=> Burn time is independent of stage length: 36 s.
A sophisticated doublebase grain has a burn rate of 1.2 inch/sec.

DF-21:

Conclusion

- **Main drivers of China's Space Programme commercial and scientific advance & national defence in the form of its own navigational and positioning systems, opposing BMD and ASAT programmes**

- ***Selective* multilateral efforts at international space cooperation- China's efforts to gradually emerge as an Asian leader in the short to medium term and then expand at the global levels**

- **Dual-use nature of China's space programme with its emphasis on military applications**


Thank You