

# *China's Human Spaceflight Program: Achievements and Prospects*

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## **The Newest Member of the EVA Club**



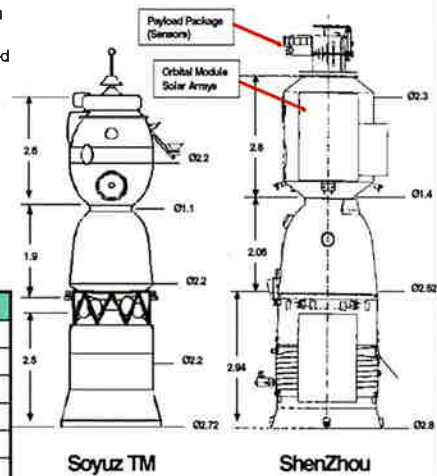
## Milestones in Space Capability

	China	Russia	United States
<b>Satellite Launch</b>	1970	1957	1958
<b>Human Launch</b>	2003	1961	1962
<b>2-man crew</b>	2005	N/A	1965
<b>3-man crew</b>	2008	1964	1968
<b>Space walk/EVA</b>	2008 (14 min.)	1965 (24 min.)	1965 (20 min.)
<b>Space Laboratory</b>	?	1971 (Salyut 1)	1973 (Skylab)
<b>Circum-lunar flight</b>	?	?	1968 (Apollo 8)

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## Orion-Shenzhou-Soyuz Comparison

- Shenzhou is an upgraded version of the proven design of the Russian Soyuz vehicle
  - Shenzhou is ~95+% indigenously developed and produced
  - Shenzhou is 13% larger than Soyuz
  - Modifications to landing, abort, and reentry systems
- Future Shenzhou missions influenced by or will utilize evolved Russian designs & products
  - Space suits (EVA)
  - KURS & APAS (rendezvous and docking system)
- Implication: Shenzhou likely compatible with ISS**



	Soyuz	Shenzhou	Orion
<b>Total Mass - kg</b>	6,800-7,500	7,840	~16,800
<b>Length - m</b>	7.48	9.25	~10.00
<b>Diameter - m</b>	2.72	2.80	~5.00
<b>Service Module Mass - kg</b>	2,600-2,950	3,000	~8,300
<b>Propellant Mass - kg</b>	900	1,000	~3,600
<b>Service Module Length - m</b>	2.5	2.94	~6.00
<b>Crew Module Mass - kg</b>	4,200-4,300	4,760	~8,500
<b>Crew Module Length - m</b>	4.50	4.86	~3.60

Shenzhou: 13% Larger

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## Preliminary NASA-CNSA Discussions



- **NASA Administrator Sean O'Keefe meets with CNSA delegation in December 2004**
  - Sun Laiyan, Administrator of China National Space Administrator
  - Space applications, Earth science and space science
- **NASA Administrator Mike Griffin Visits China in September 2006**
  - Discussion of regular exchanges
- **NASA team visits CNSA in July 2008**
  - Formation of two working groups on Earth and space science
- **Dependent on the broader U.S.-China relationship**
  - Missile sanctions on Great Wall Industry lifted by Treasury in 2008

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## Chinese Human Spaceflight Capabilities

- **Steady progress on an updated "Von Braun Paradigm"**
  - Shenzou 8 and 9 to demonstrate rendezvous/docking in 2010
  - Shenzou 10 to be a small space lab
  - Humans to the Moon?
- **China's first lunar mission (Chang'e 1) launched October 2007**
  - Second vehicle to be launched in 2009
  - Some European communications cross-support via international standard protocols
- **During the Shenzou 7 mission there were 3 Chinese, 2 Russians, and 1 American in space.**
  - Following established technical paths, e.g., use of water tank training, hand holds, and a Russian Orlan suit as part of their first EVA
  - China increasingly has the capability to execute major space operations at the time and place of their own choosing.
  - Chinese capabilities are becoming clearer, but their strategic intent has not
    - Will China develop a human lunar lander?
    - Will China give CZ-5 priority over CZ-2 evolution?
    - And/or focus on unmanned systems for disaster monitoring, navigation, etc. ?
- **China endorses the "Global Exploration Strategy" but missile proliferation and export control issues remain problematic**

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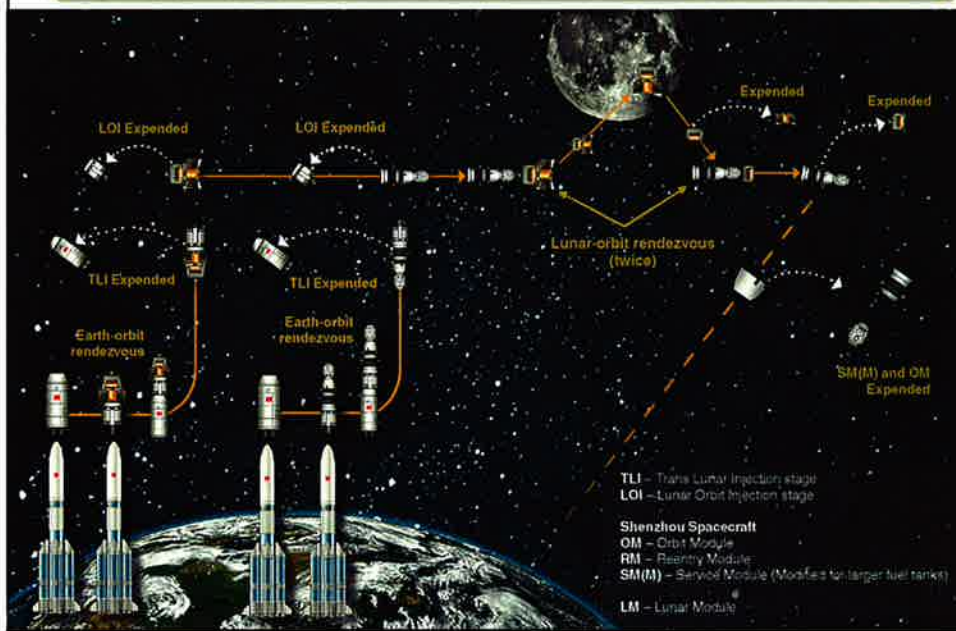
## Chinese Long March 5 (LM5)

- **Long March Family History**
  - Derived from Chinese ballistic-missile technology
  - Long March 1 first launched April 1970
  - Overall reliability (as of 25 Sep 2008)
    - 102 successful launches out of 109 attempts
    - No failures since 1996
- **LM5 – 5th generation Chinese booster**
  - Program announced February 2001
    - Designed for heavy geosynchronous communications satellites
  - Projected to launch in the 2014 timeframe following many slips
  - Several different variants for varying payload capacities
  - **New capabilities**
    - 25 mT (55,000 lbs) into low earth orbit
    - 14 metric tons (31,000 lbs) into a geosynchronous transfer orbit
    - Maximum fairing size 5.2 meters
    - Non-toxic liquid propellants (hydrogen/oxygen and kerosene/oxygen)
  - **New Facilities**
    - Ground breaking on new production plant reported October 2007
    - New launch site announced for Hainan Island (19.6 degrees N)



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## NASA concept of notional Chinese Lunar Landing CONOPS (4 Launches, LM5)



## Recent View of CZ-5 Chief Designer

- **2008 Paper "Research on the Technical Approach of Manned Lunar Mission" (in Chinese)**
  - Long Lehao, Chinese Academy of Launch Vehicle Technology and Rong Yi, Beijing Institute of Space System Engineering
  - "Four approaches are analyzed...and show circumlunar orbital rendezvous and docking can bring Chinese landing on the Moon...before 2030."
- **Direct Ascent:** vehicle development difficult but can be a backup plan
- **EOR (Earth Orbit Rendezvous):** uses the Long March vehicle family but transfer stage docking problems are a challenge. New engine and orbit transfer stage would be needed.
- **LOR (Lunar Orbit Rendezvous):** most **realizable and practical** approach. The carrying capacity for new CZ-5 should be at least 10t. Three astronauts. Assembly in Lunar orbit.
  - First launch: Lunar Module - 15t, including descent stage (10t) and ascent stage (5t).
  - Second launch: Re-entry Module: 10t, including fuel 5t.
  - Third Launch: Service Module: 5t, including instruments, etc.
- **Three CZ-5 launch vehicles:** using a 5.0 m diameter core stage and four 3.35 diameter strap-on boosters (double LOX/kerosene engine)
  - Comparable to Delta IV Heavy, GSLV Mk.III, Atlas V, Ariane 5, Angara A5, Proton, and Falcon 9.
- **EOR+LOR:** realizable but may suffer from a low reliability due to multiple launching (4~6 times) and docking (2~5 times) events

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## Critical Skills for Lunar Exploration

	U. S.	Russia	China	Europe	Japan	India
Extended Human Space Flight	D	D	D/P	P	P	
Rendezvous	D	D	P	D	D	
Docking	D	D	P	D	D	
Extra-vehicular Activity	D	D	P			
Navigation to the Moon	D	D	D	D	D	P
Telemetry/Control at the Moon	D	D	D	D	D	P
Multiple Launch Sites	D	D	D		D	

D = Demonstrated

P =Planned

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## Human Space Flight Symbolism



- U.S. and Soviet space race of the 1960s was symbolic of the Cold War competition for international influence
- Chinese space achievements are also highly symbolic, but more subtle than Cold War competition
  - Internal source of nationalist pride
  - Prestige for the Chinese Communist Party
  - Support to Party objectives for economic, scientific, and “social” development
  - Support to foreign policy objectives with respect to resource-rich developing countries

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## Benchmark: US Space-lift Requirements to Moon



**260,000 lbs (120 mT)  
In Low Earth Orbit**

### **Apollo (1970)**

- 3 Astronauts (2 to Surface)
- 8-12 Day Mission
- Single Launch (Saturn V Booster)

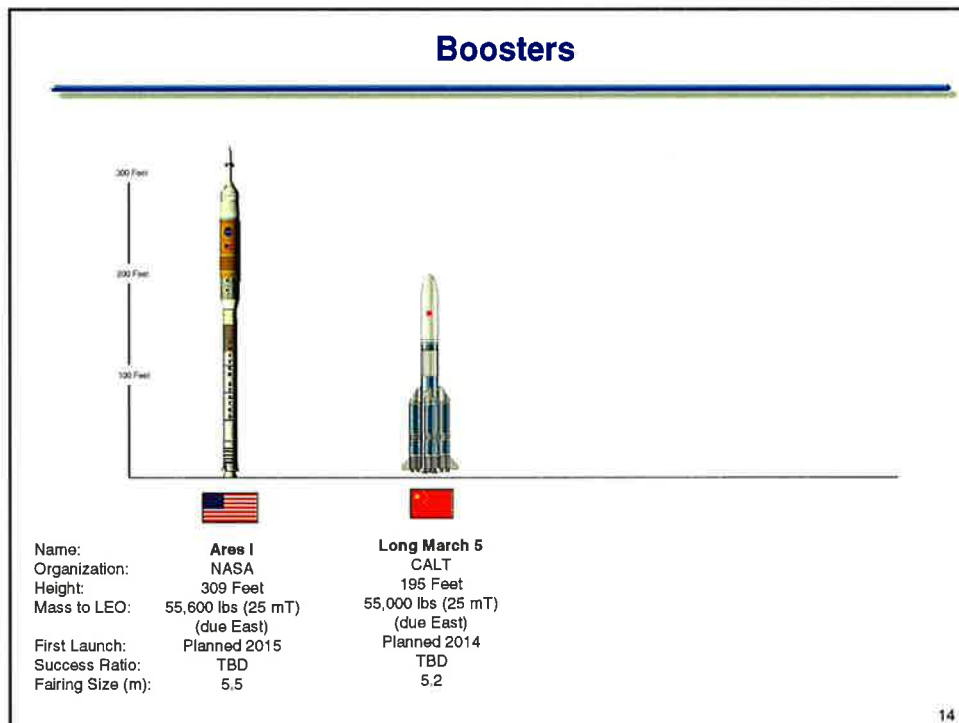
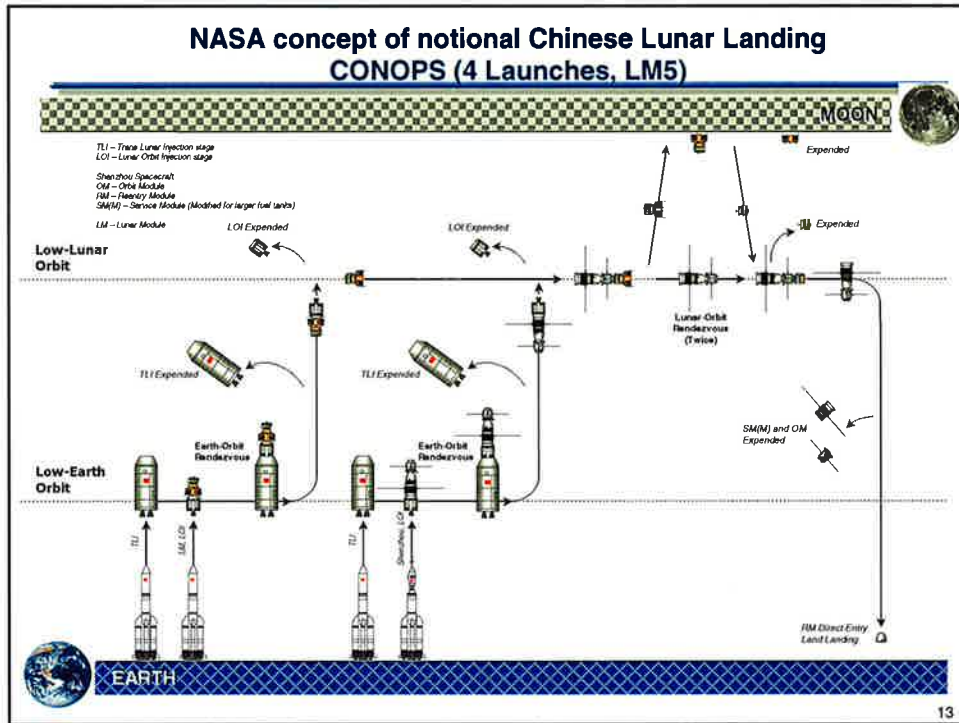


**350,000 lbs (160 mT)  
In Low Earth Orbit**

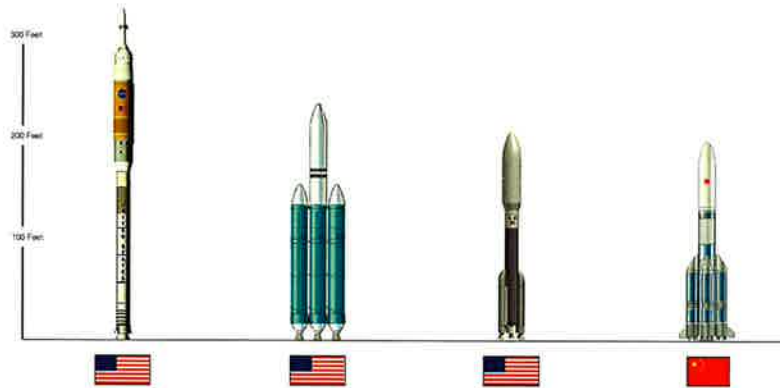
### **Constellation (2025)**

- 4 Astronauts (4 to Surface)
- 14 Day Mission
- '1.5' Launches (Ares I and Ares V)

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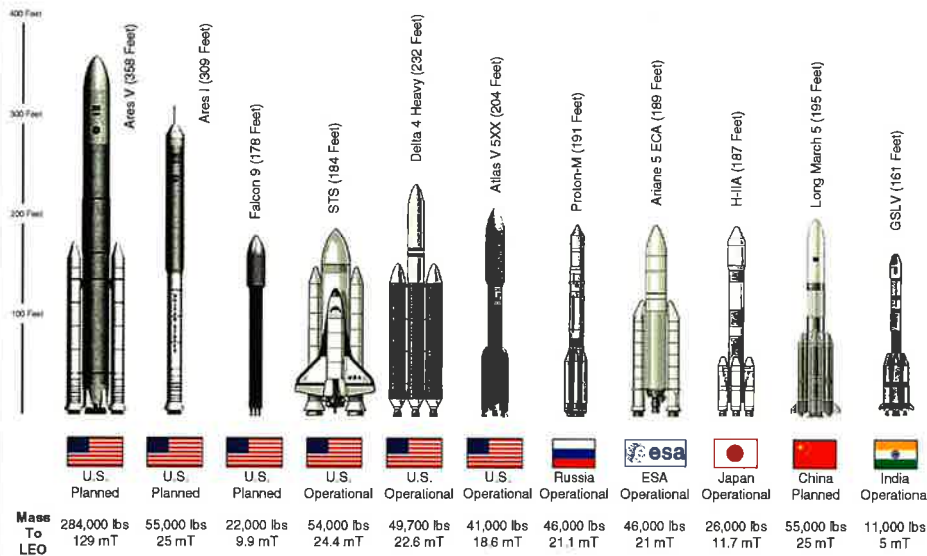
## Boosters



Name:	Ares I	Delta IV Heavy	Atlas V Medium	Long March 5
Organization:	NASA	Air Force EELV (Boeing)	Air Force EELV (Lockheed)	CALT
Height:	309 Feet	232 Feet	204 Feet	195 Feet
Mass to LEO:	55,600 lbs (25 mT) (due East)	49,700 lbs (22.6 mT) (due East)	41,000 lbs (18.6 mT) (due East)	55,000 lbs (25 mT) (due East)
First Launch:	Planned 2015	2004	2002	Planned 2014
Success Ratio:	TBD	2/2*	12/12*	TBD
Fairing Size (m):	5.5	5.0	5.0	5.2

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## Global Capability Benchmark: Large Boosters (Enabling Space-lift Capability for Exploration)



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