

50 Years of the Space Age

Jonathan McDowell

Decade 1: 1957-1967

The Pioneering Decade

- Sputnik and the early years
- Yuri Gagarin
- The race to the Moon
- Early research and military satellites



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"All the News That's Fit to Print" **The New York Times** LATE CITY EDITION
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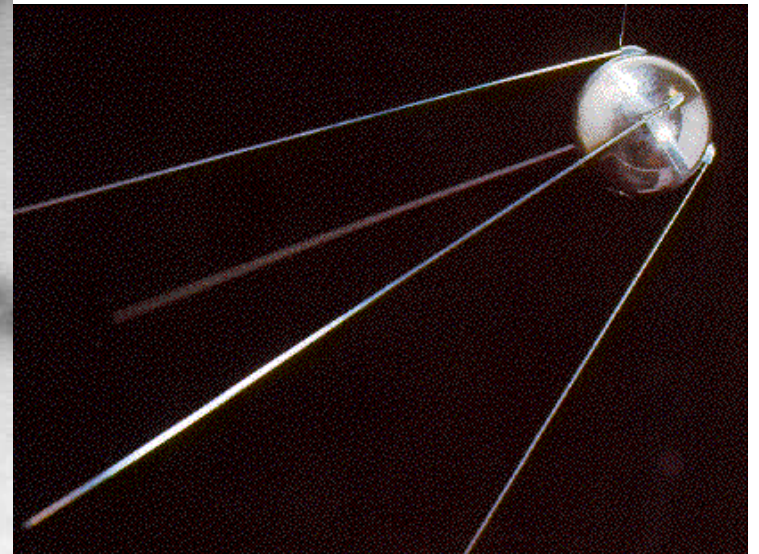
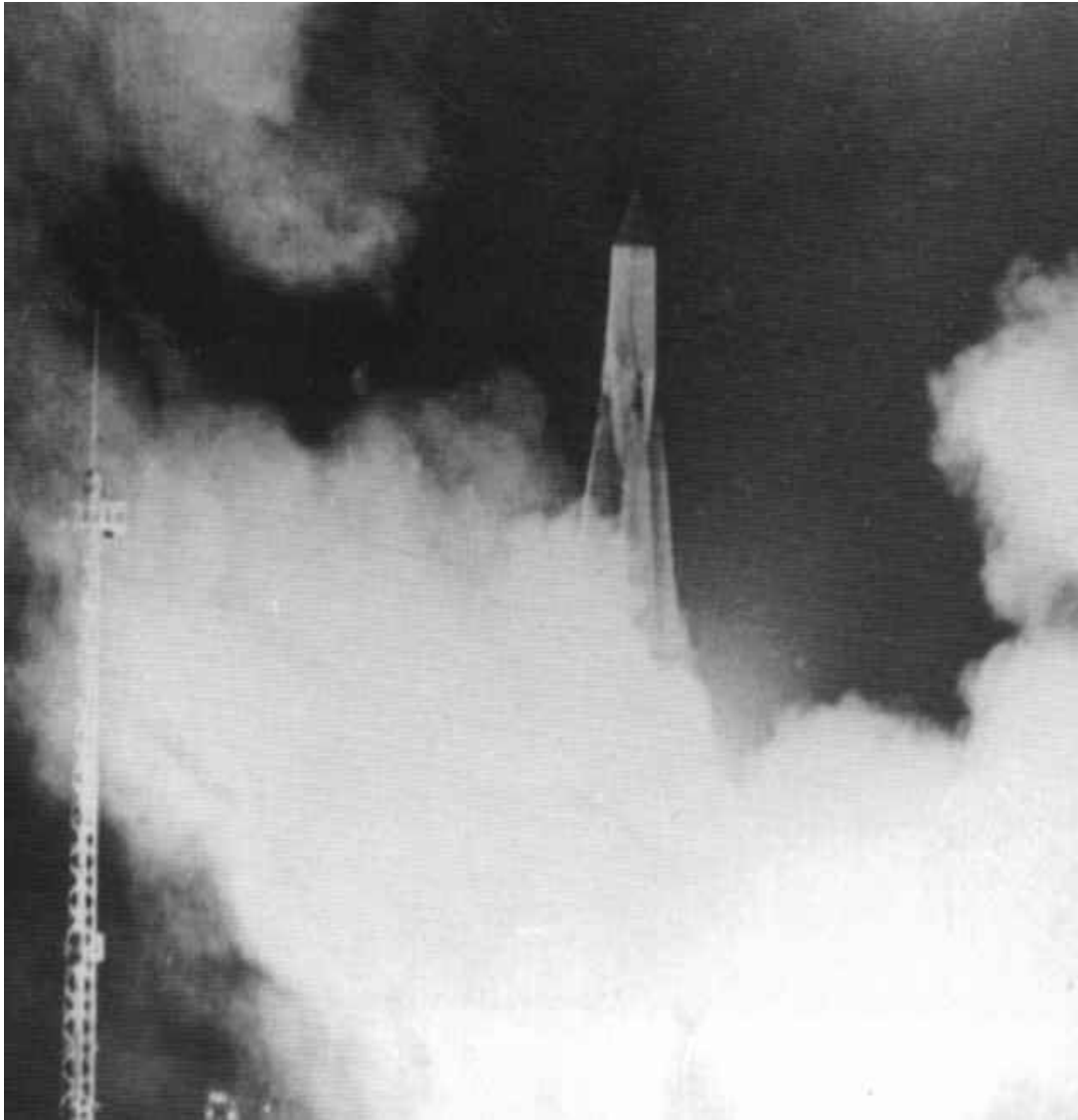
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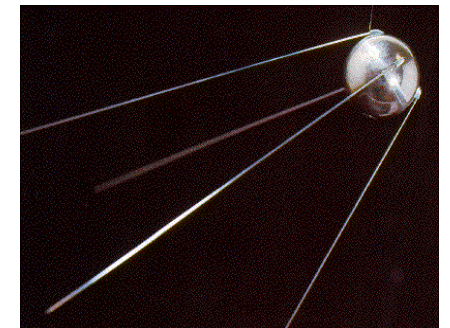
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October 1957: Sputnik

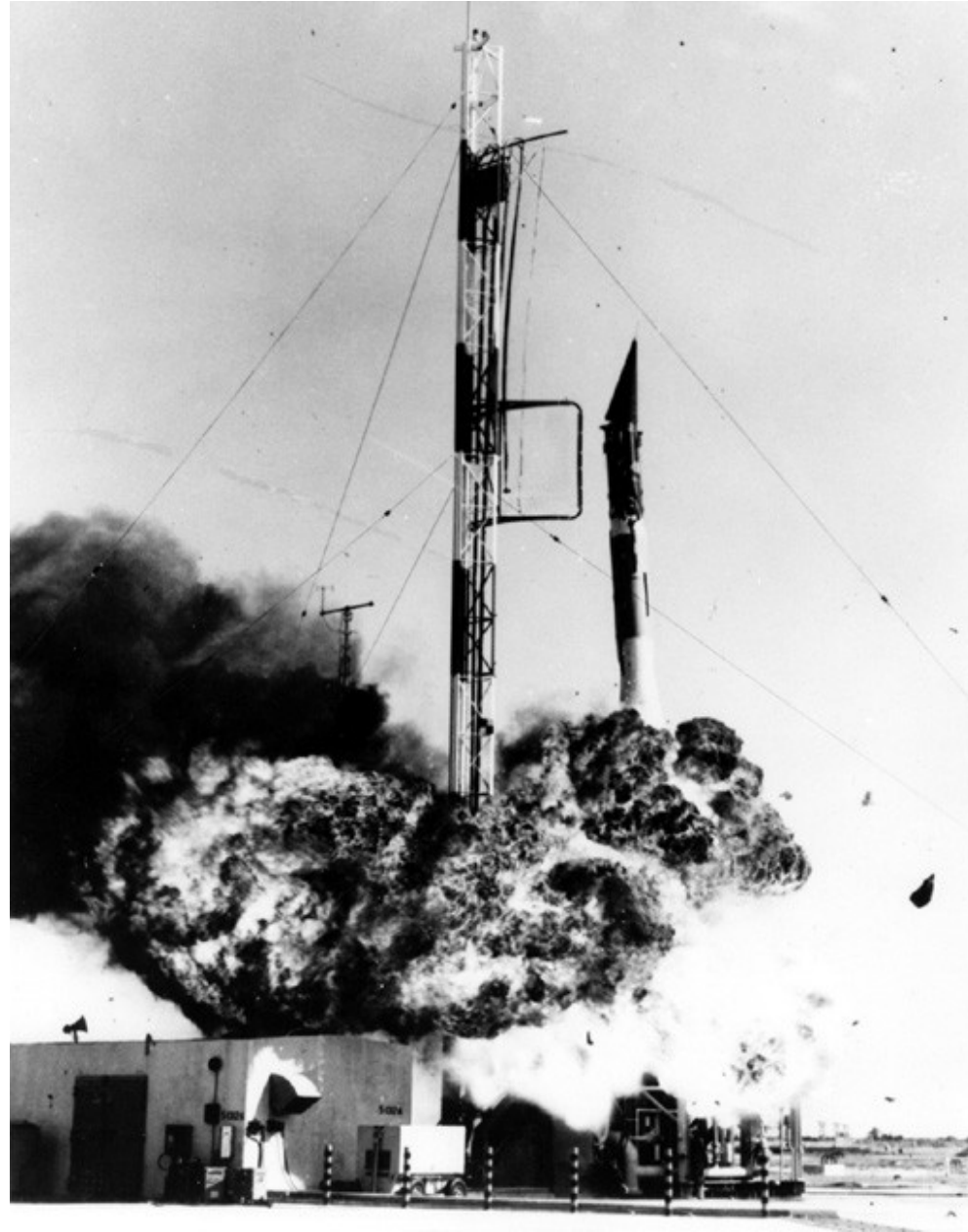


The first orbital launch

- Korolev (OKB-1) R-7 missile, product 8K71
- May 1957 launch failure, Aug 1957 first ICBM
- Plan to uprate engines: the 8A91 rocket for orbital launches, slipped to 1958 (Sputnik 3), related to 8K74 operational ICBM
- Quick and dirty version to preempt Vanguard: the 8K71PS, minimal mods to prototype ICBM version
- PS-1 (Oct 1957) “Simplest satellite”
- PS-2 (Nov 1957) carried dog Laika



NRL's Vanguard – Dec 1957



ABMA/JPL

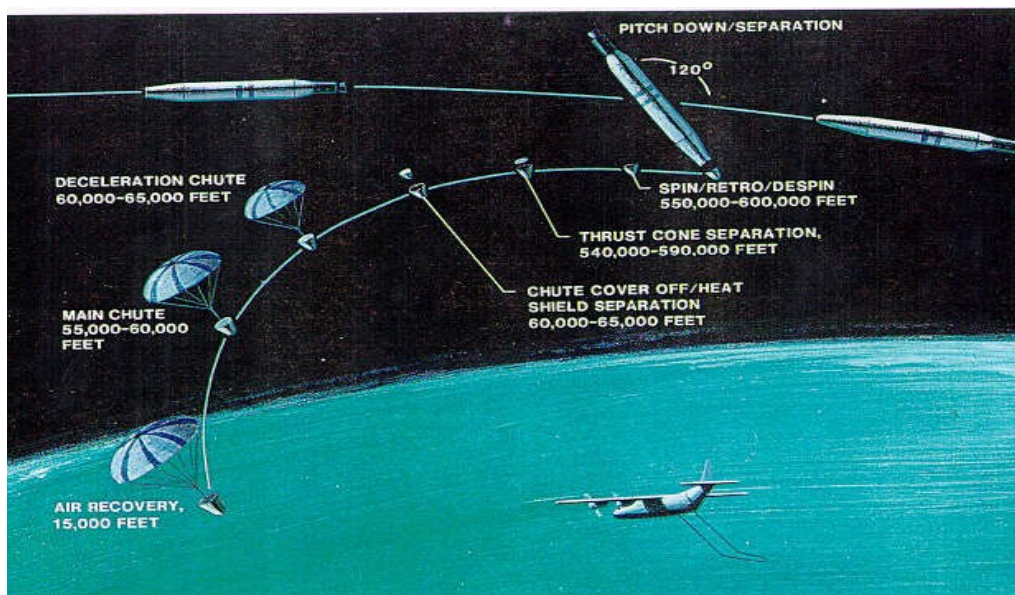
Explorer

- First US satellite – Feb 1 1958 (GMT)
- Werner von Braun's stretched V-2 with spinning upper stages from JPL and tiny 4 kg payload
- Redstone reached apogee, spinning stages fired horizontally to get orbital velocity

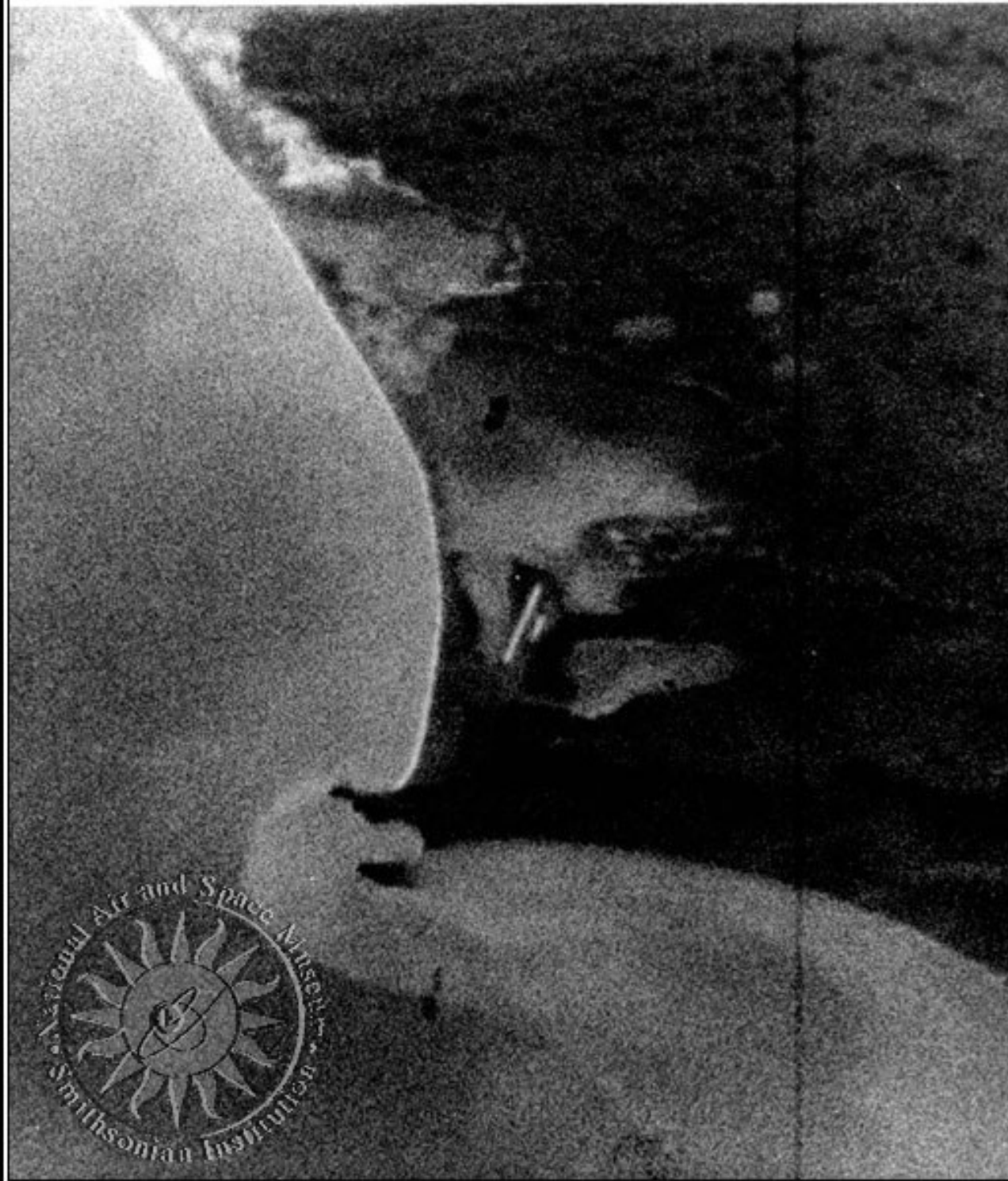


CORONA/Discoverer

- First polar orbiter (D-1, Feb 59 (?))
- First recoverable satellite (D-13, Aug 1960)
- First spy satellite images (D-14, Sep 1960)
- CIA's CORONA orbited Earth taking pictures, wound film onto reel in little capsule, ejected it – small rocket made it drop down over Pacific Ocean – caught in midair

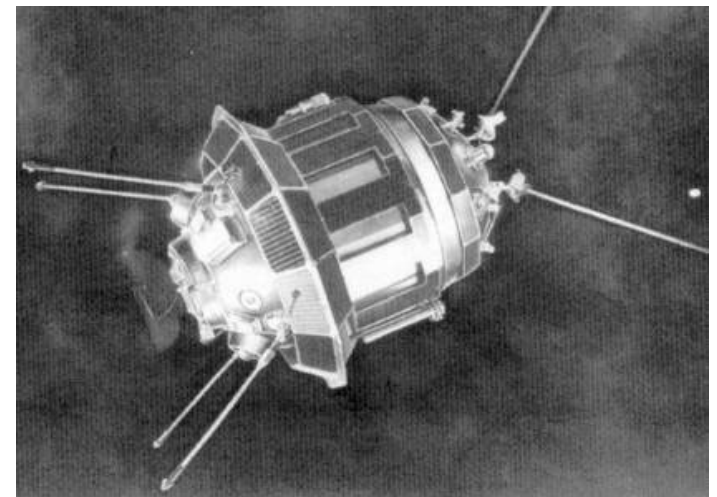


Soviet Airfield (first image), 18 August 1960



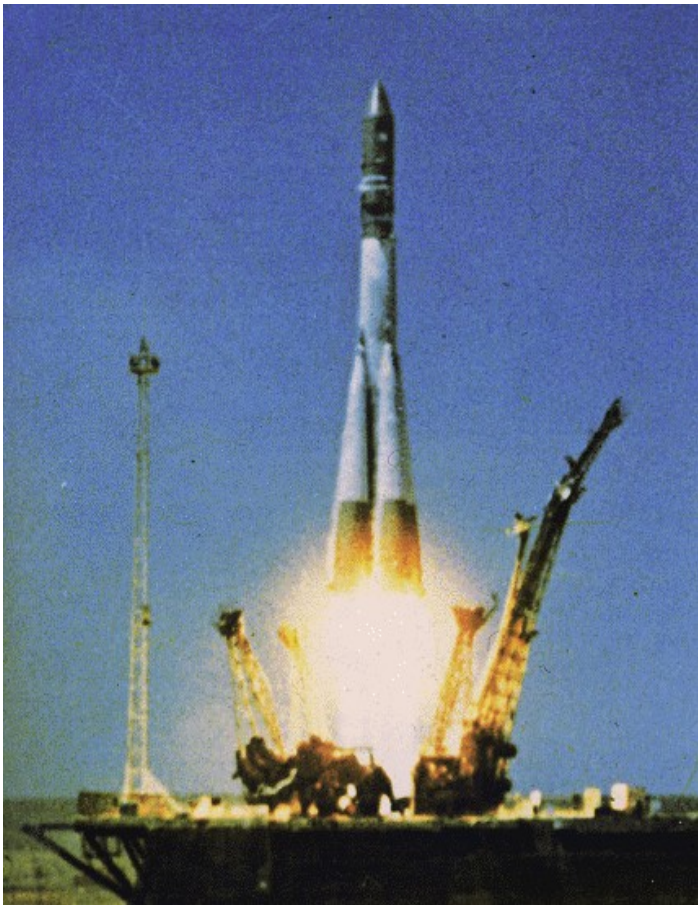
The Luna program

- Silence from USSR from May 1958 to Jan 1959 – what's going on?
- Jan 1959 – First announced Moon probe. Misses Moon and becomes first artificial planet around the Sun
- Used “8K72”, Sputnik rocket with an upper stage
- Sep 1959 Luna-2 becomes first probe to hit the Moon
- Scatters pennants with Lenin's face over Lunar surface
- Oct 1959, Luna 3 photos of lunar far side



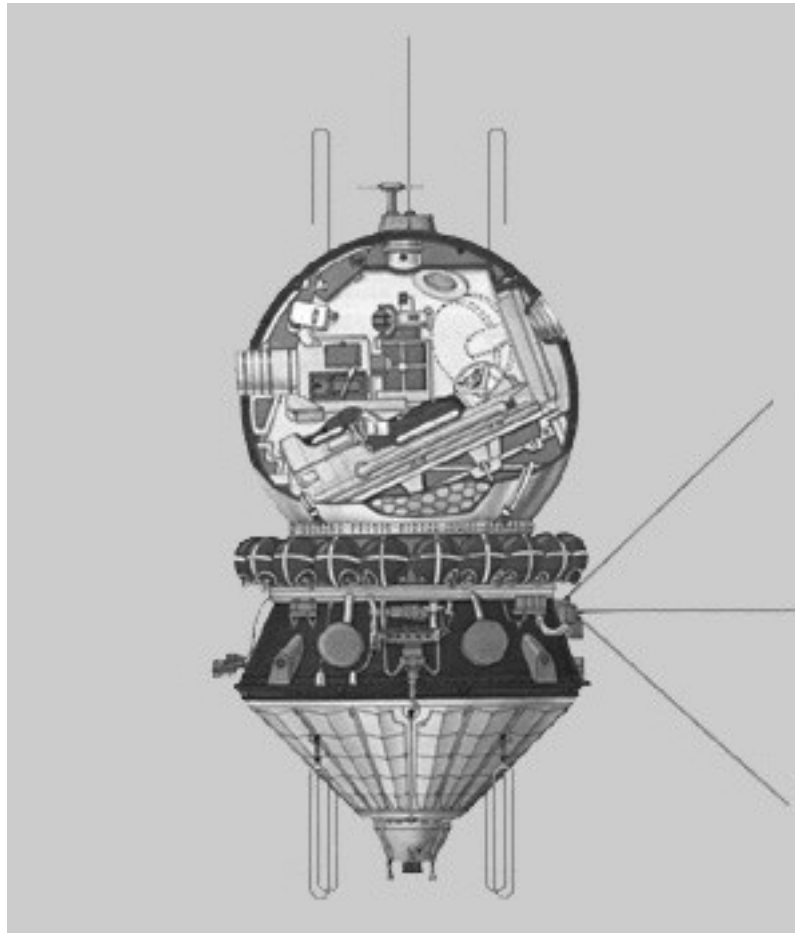
Vostok

- Apr 12, 1961: Yuriy Gagarin becomes the first astronaut aboard “Vostok 3KA No. 3”

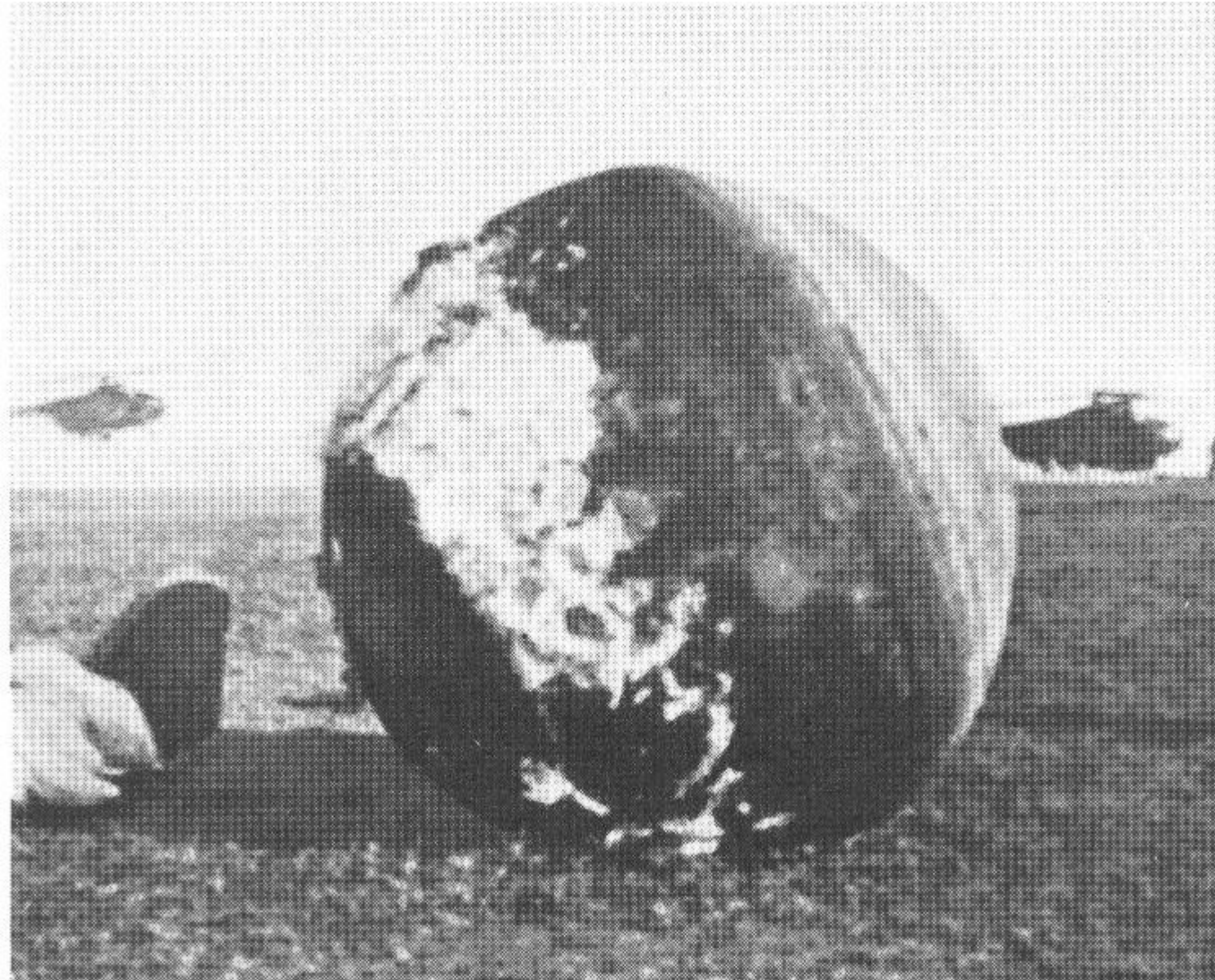


Vostok in orbit

- Spherical cabin
- Double-cone instrument module with liquid retrorocket



Vostok landing



“In this decade...”

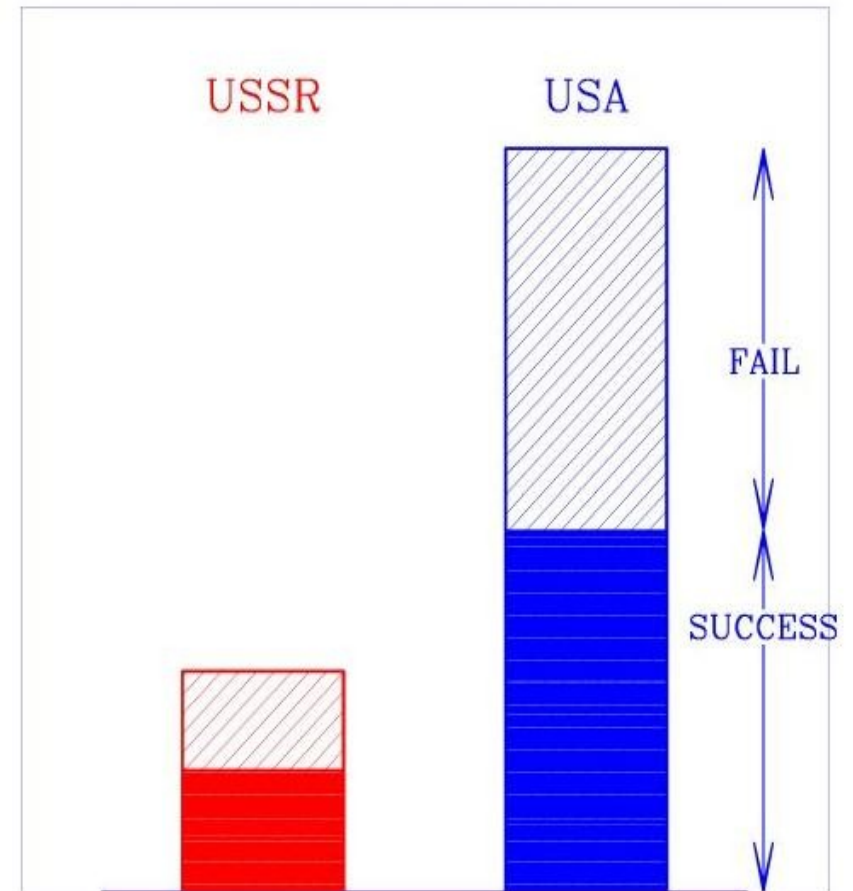
- May 25, 1961: JFK starts the Moon race.



Who was winning? Oct 1957- May 1961

- Total orbital attempts 109
- USSR attempts 14 out of 25 successful (+1 failed in parking orbit) which is 56 percent (or 60 percent)
- US attempts 41 of 84 successful, or 49 percent
- Marginal case: USSR Apr 1960 moon launch counted, had 200000 km apogee, better than Pioneer 1 and 3
- If these probes are excluded rates are 52 percent to 46 percent
- Within root-n Poisson standard deviation, both countries had 50 percent success rate
- Note the small number of early USSR launches despite large number of “firsts”

Orbital Launch Score Oct 1957–May 1961

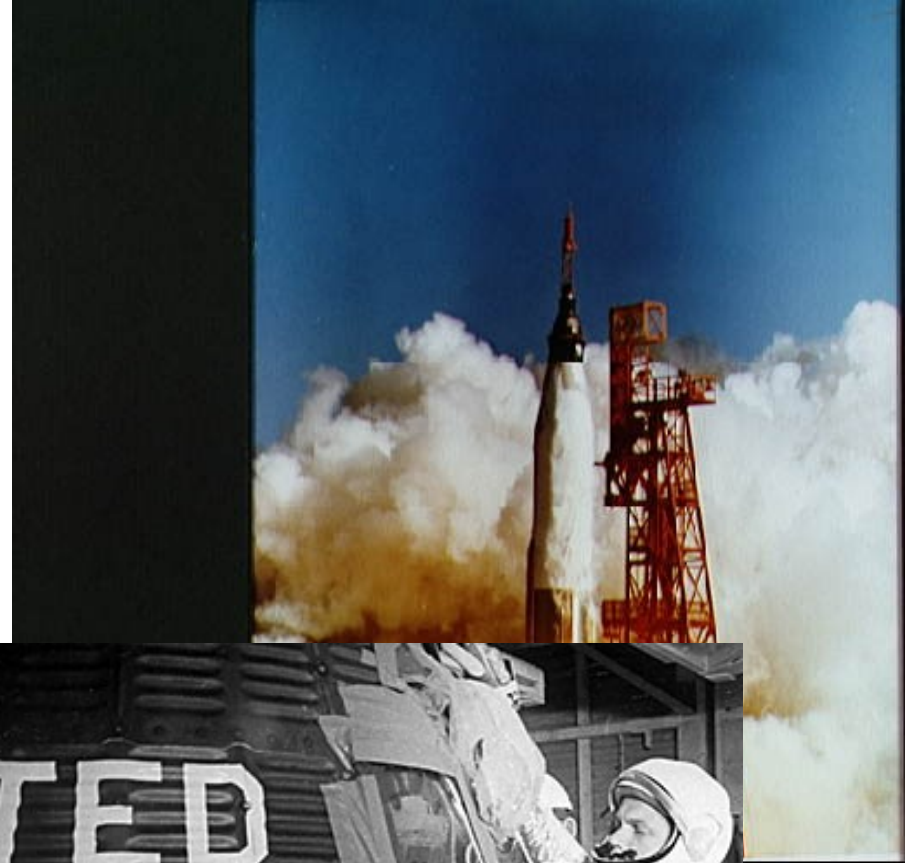


New horizons 1962

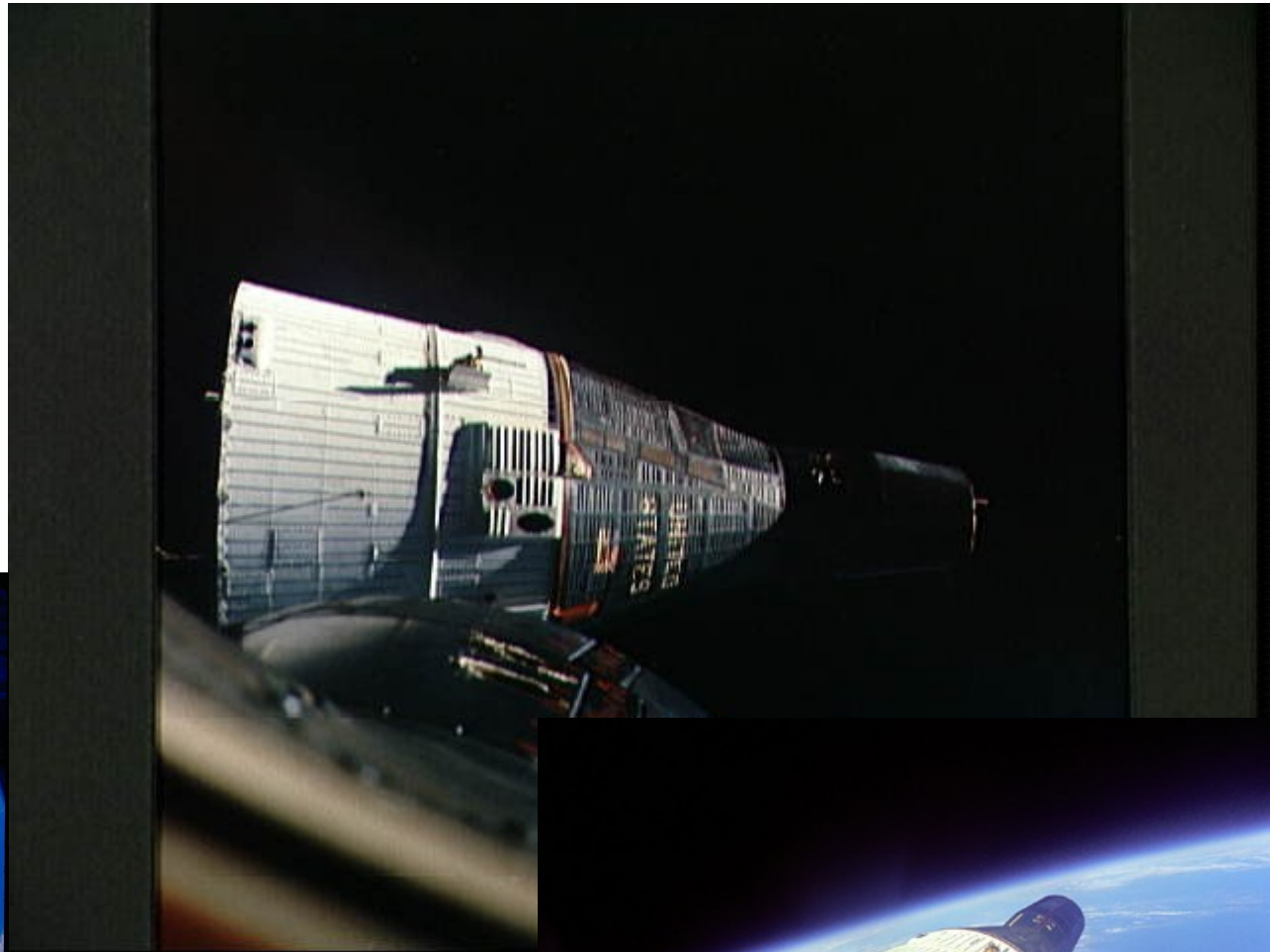
- Ariel (UK owned, UK-built instruments, US-built satellite)
- Alouette (Canadian built and owned, US launched)
- The satellite age begins to reach beyond the superpowers



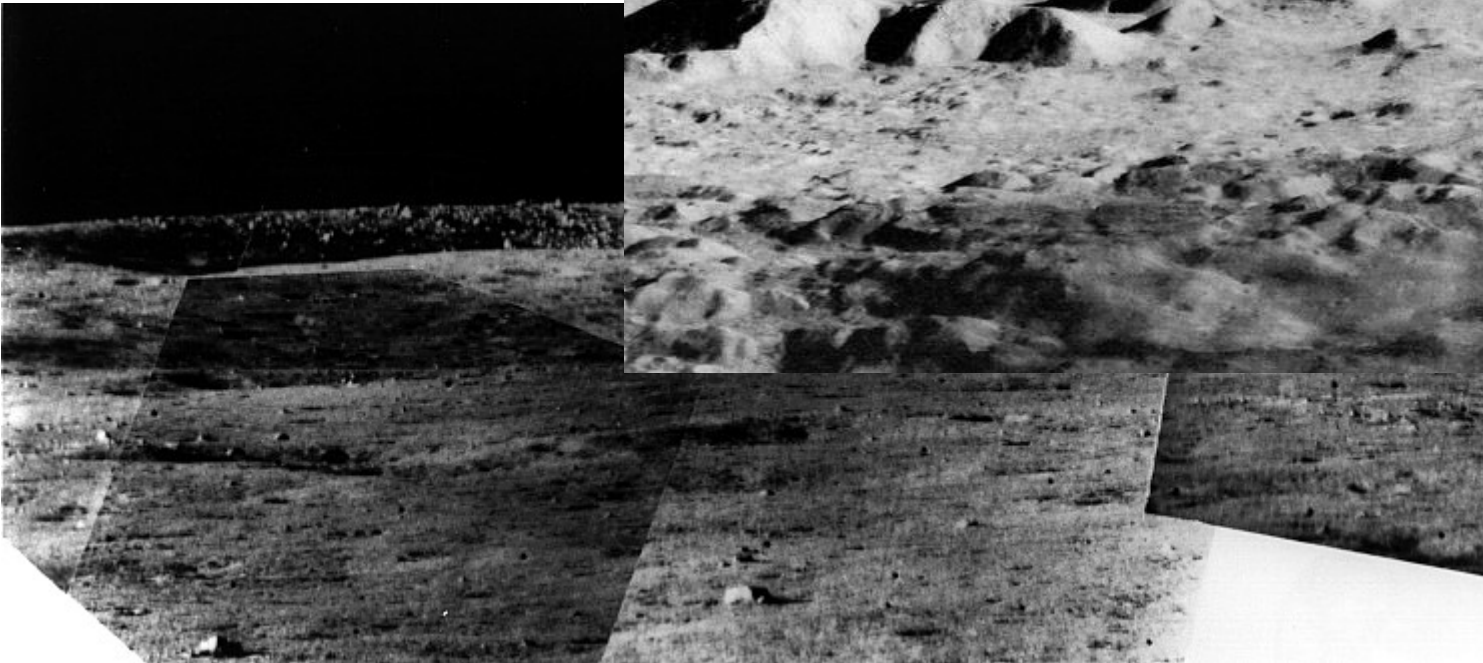
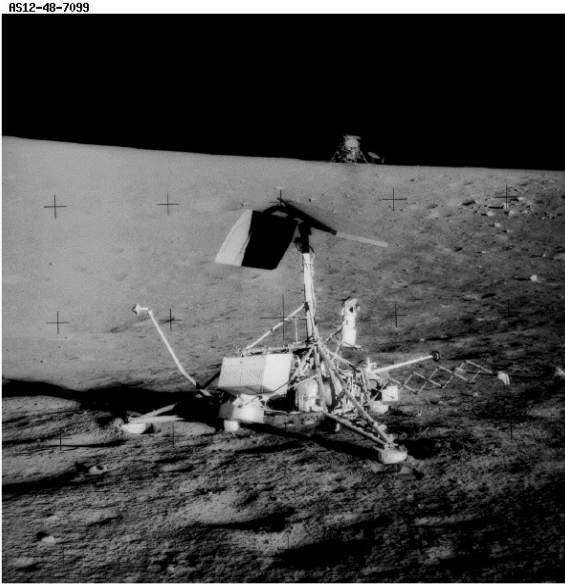
1961: Alan Shepard suborbital flight
1962: John Glenn orbits Earth in Mercury



1965-66: Gemini rendezvous and docking



Surveyor and Lunar Orbiter survey the Moon - 1966-68

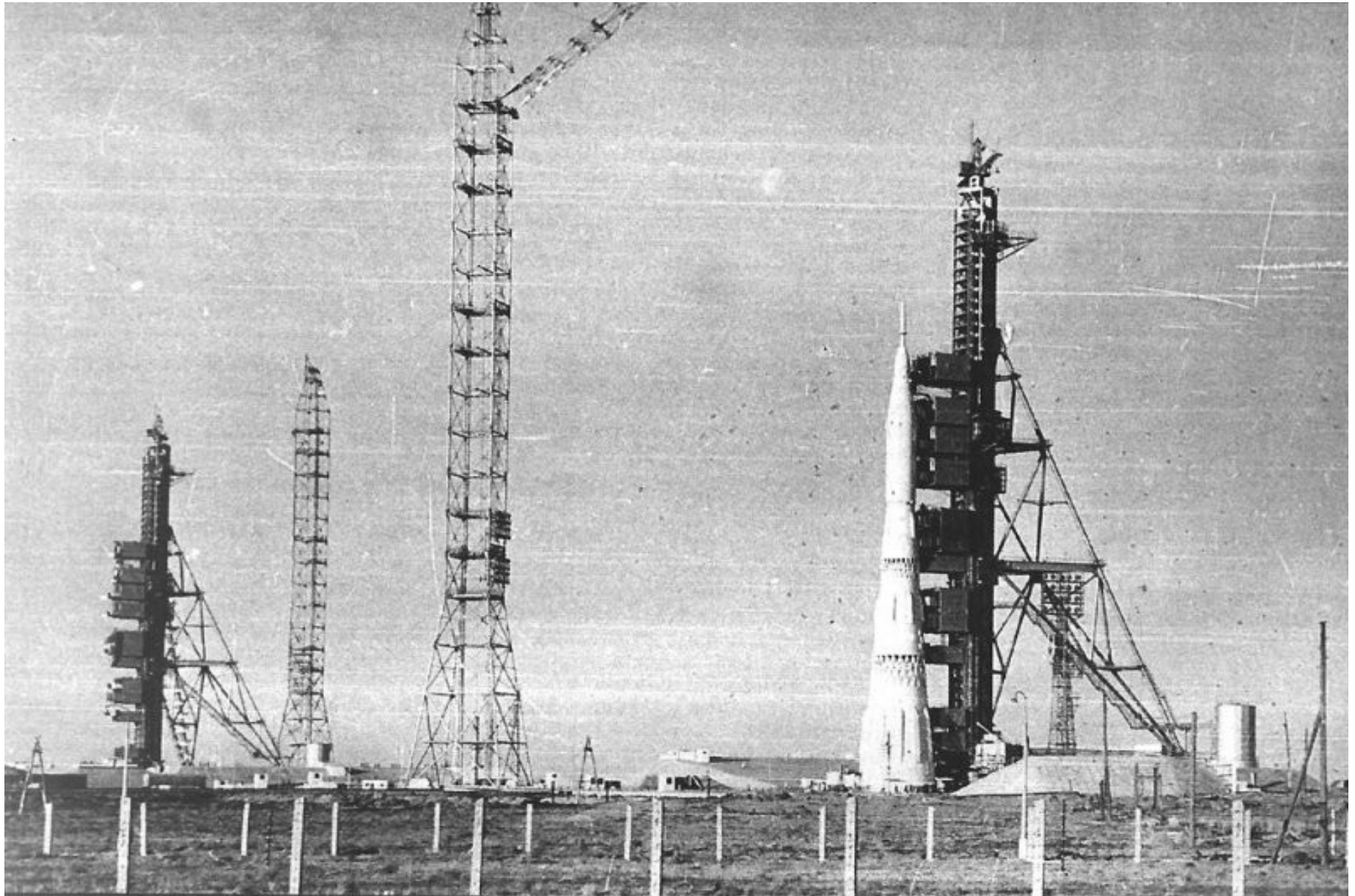


Decade 2: 1967-1977

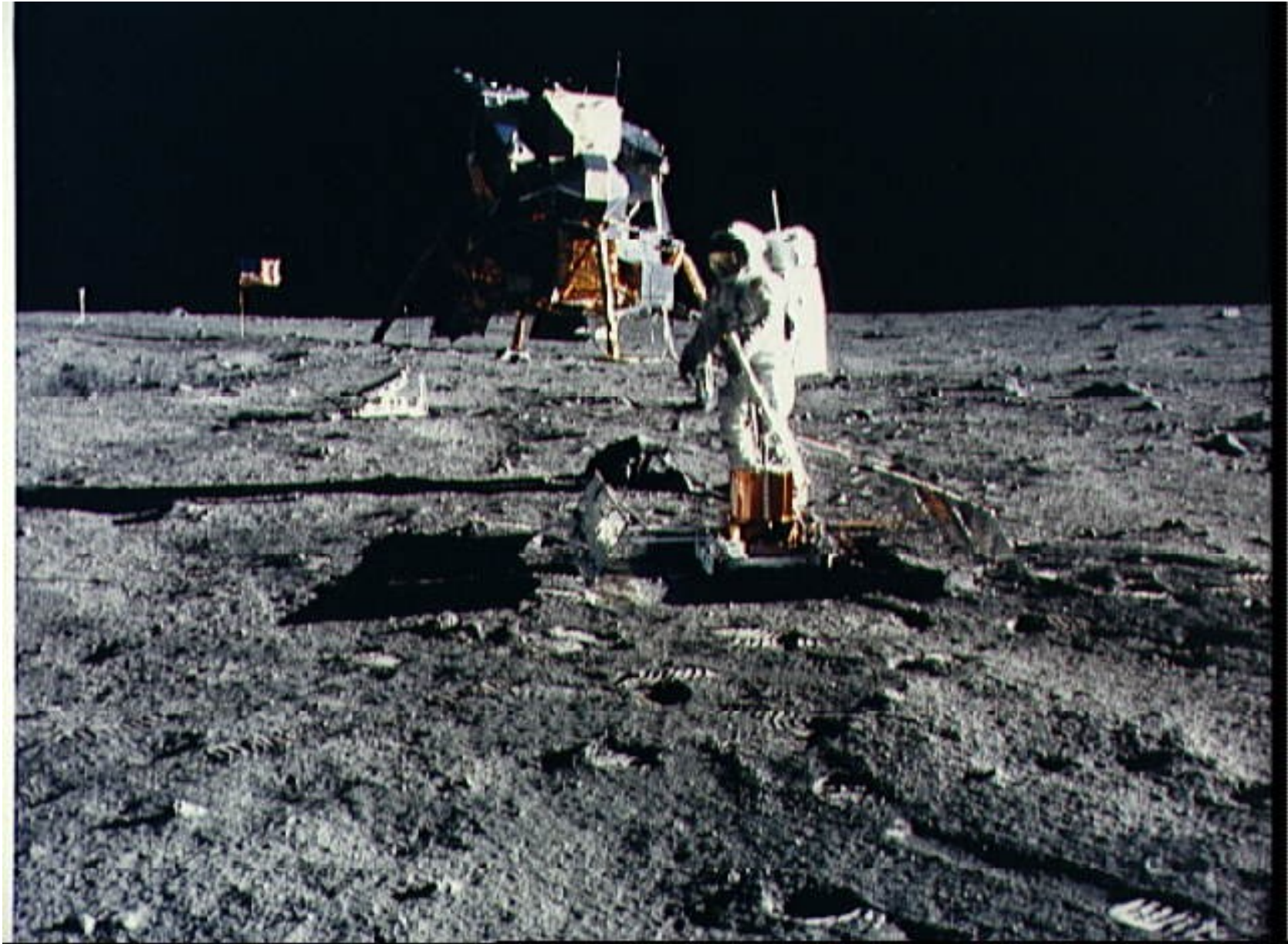
Triumph of Apollo; first applications

- Apollo explores the Moon
- Viking explores Mars
- First commercial communications satellites
- Spy satellites allow SALT treaties
- Beginnings of space astronomy (Uhuru)
- France, Japan, China enter the game

1969 - Soviet Moon Rocket



1969 - Apollo on the Moon



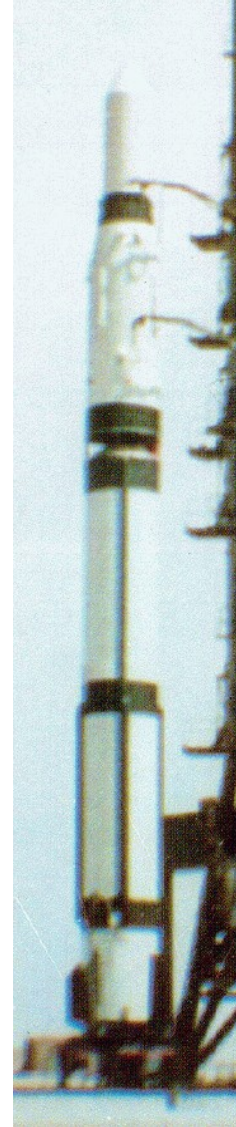
More players in the launch game



France - 1965



Japan - 1970

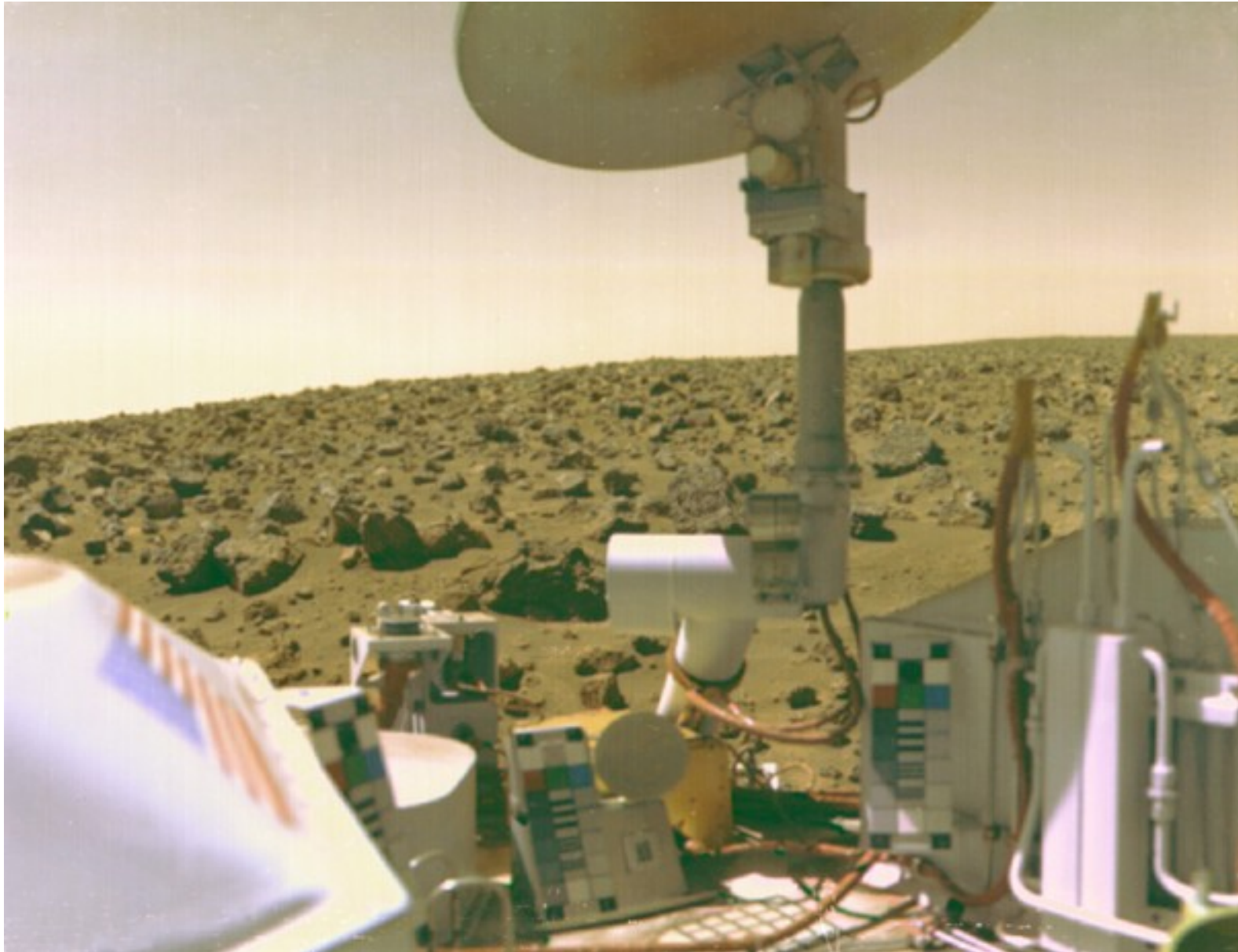


China - 1970



UK - 1971

1976 - Viking on Mars

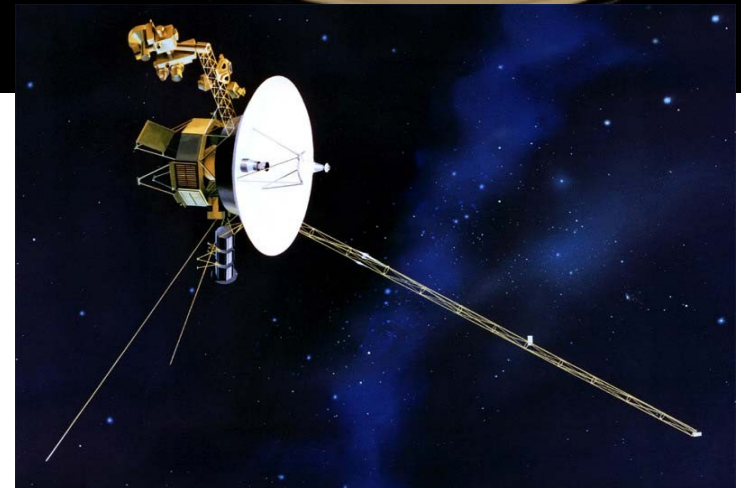
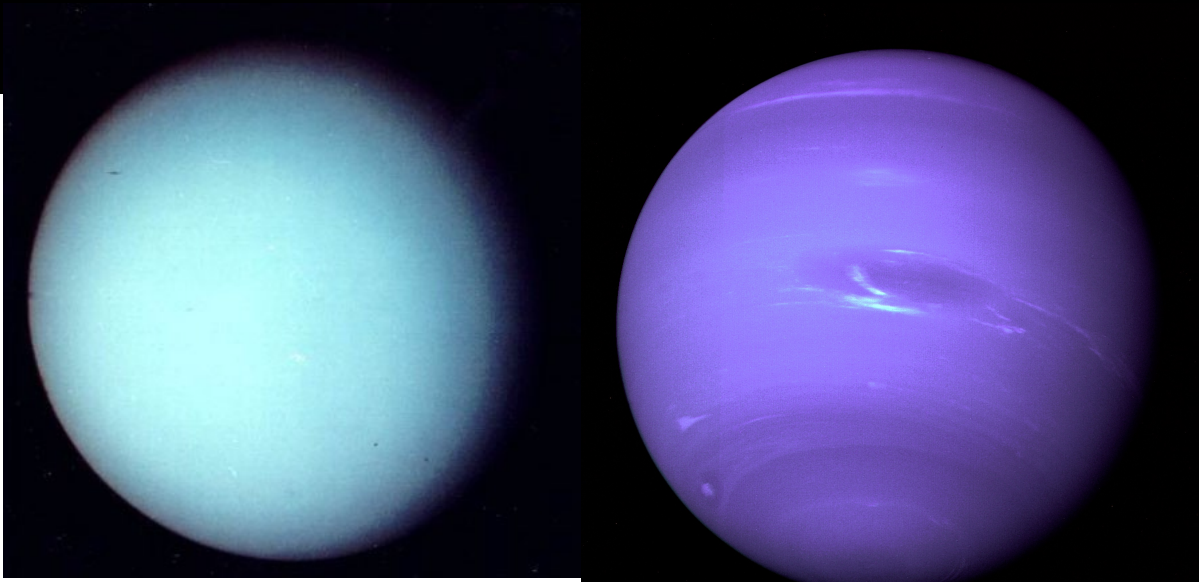
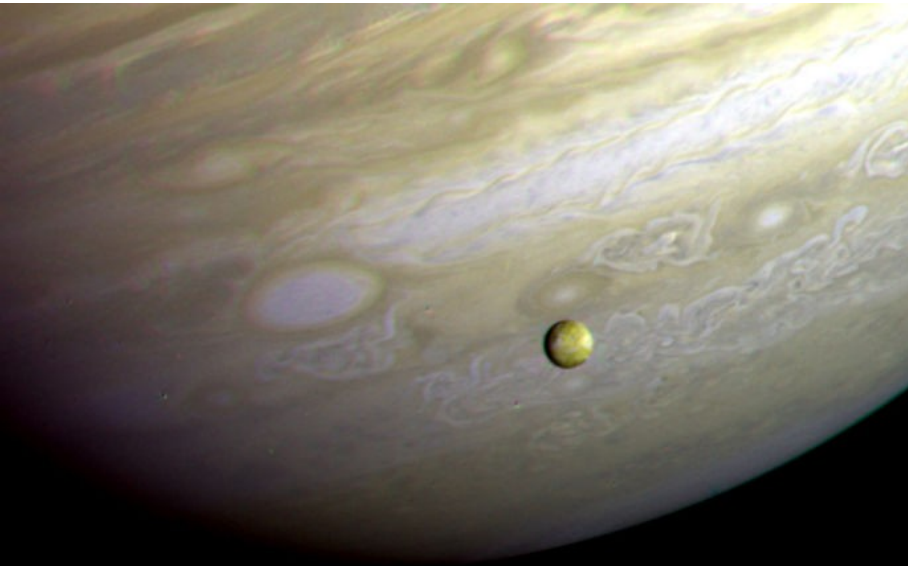


Decade 3: 1977-1987

The Exploration Decade

- Voyager explores the solar system
- Salyut-6,7 pioneer long duration spaceflight
- The Shuttle flies – and then the Challenger accident shuts it down
- First GPS satellites fly
- Giotto at Halley's comet

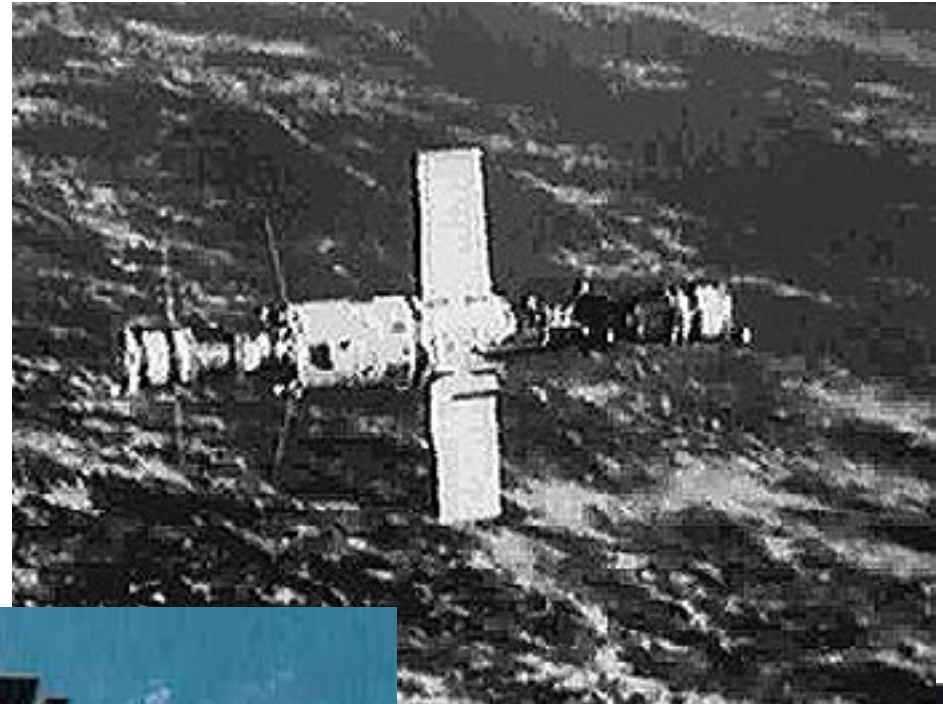
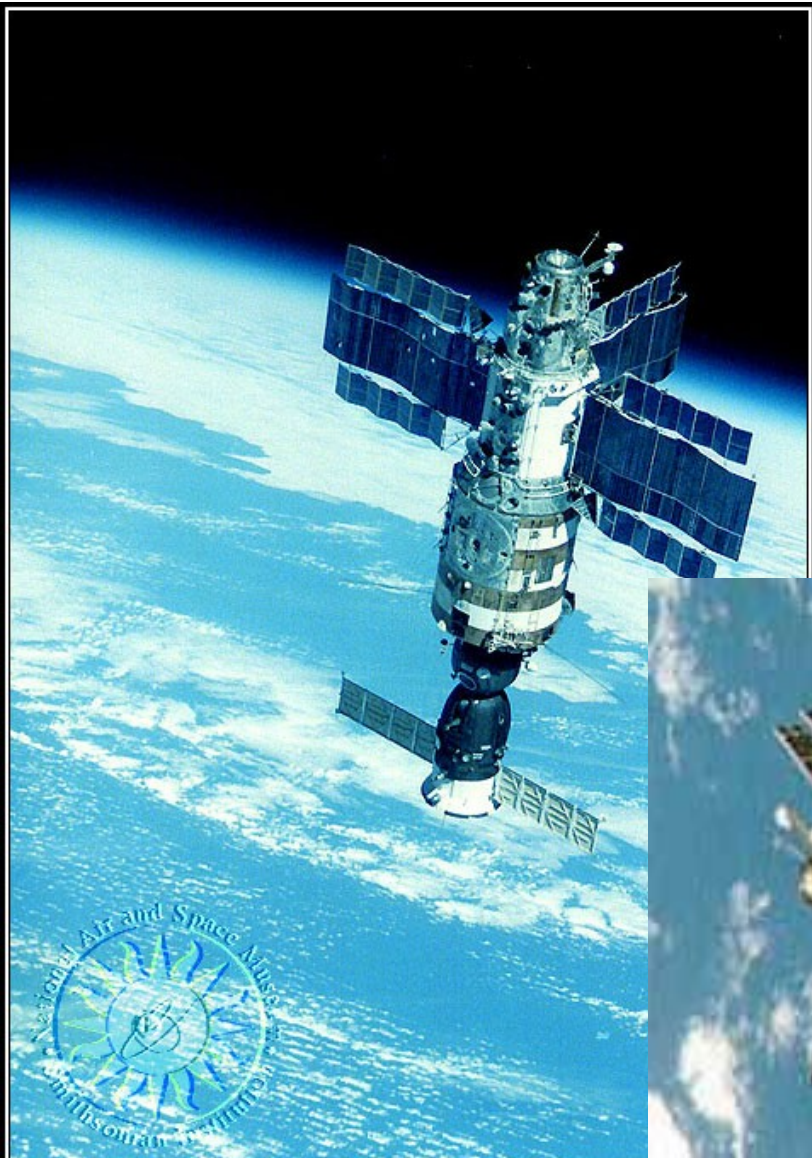
Voyager missions



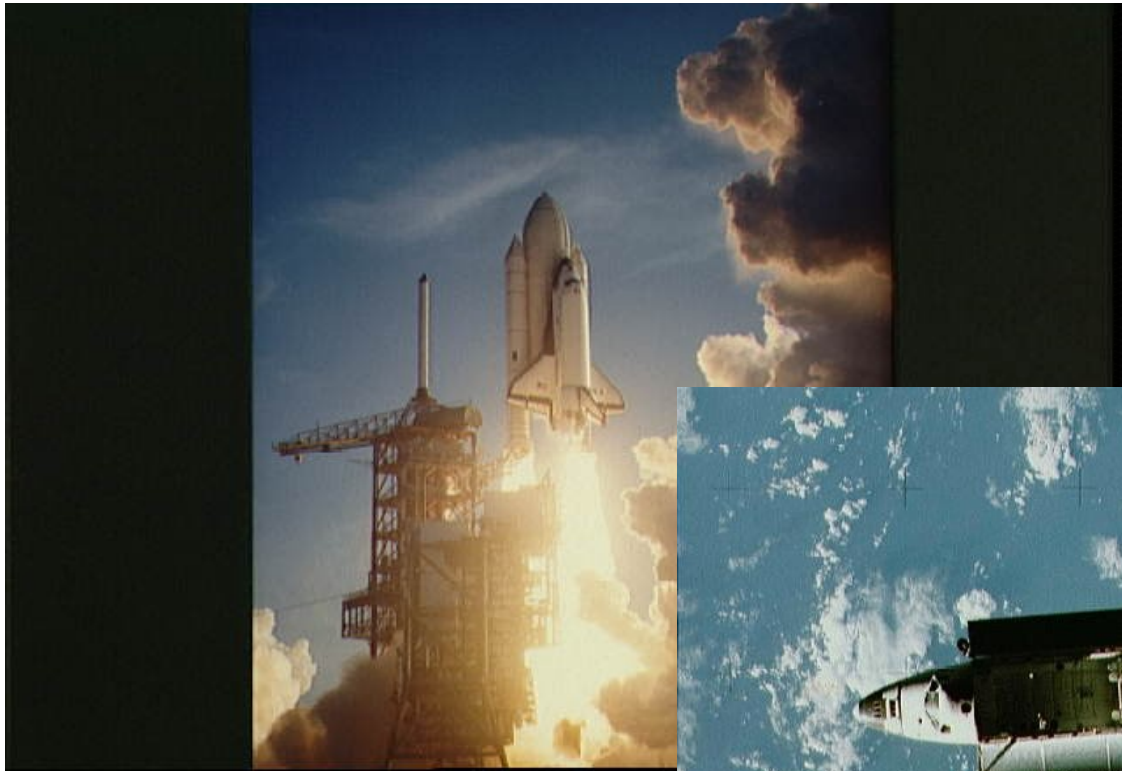
Long duration spaceflight on Salyut 6 and 7

1977: 96 days 1978: 140 days 1979: 175 days 1980: 185 days

1982: 211 days 1984: 237 days



1981-86 - First Shuttle Flights

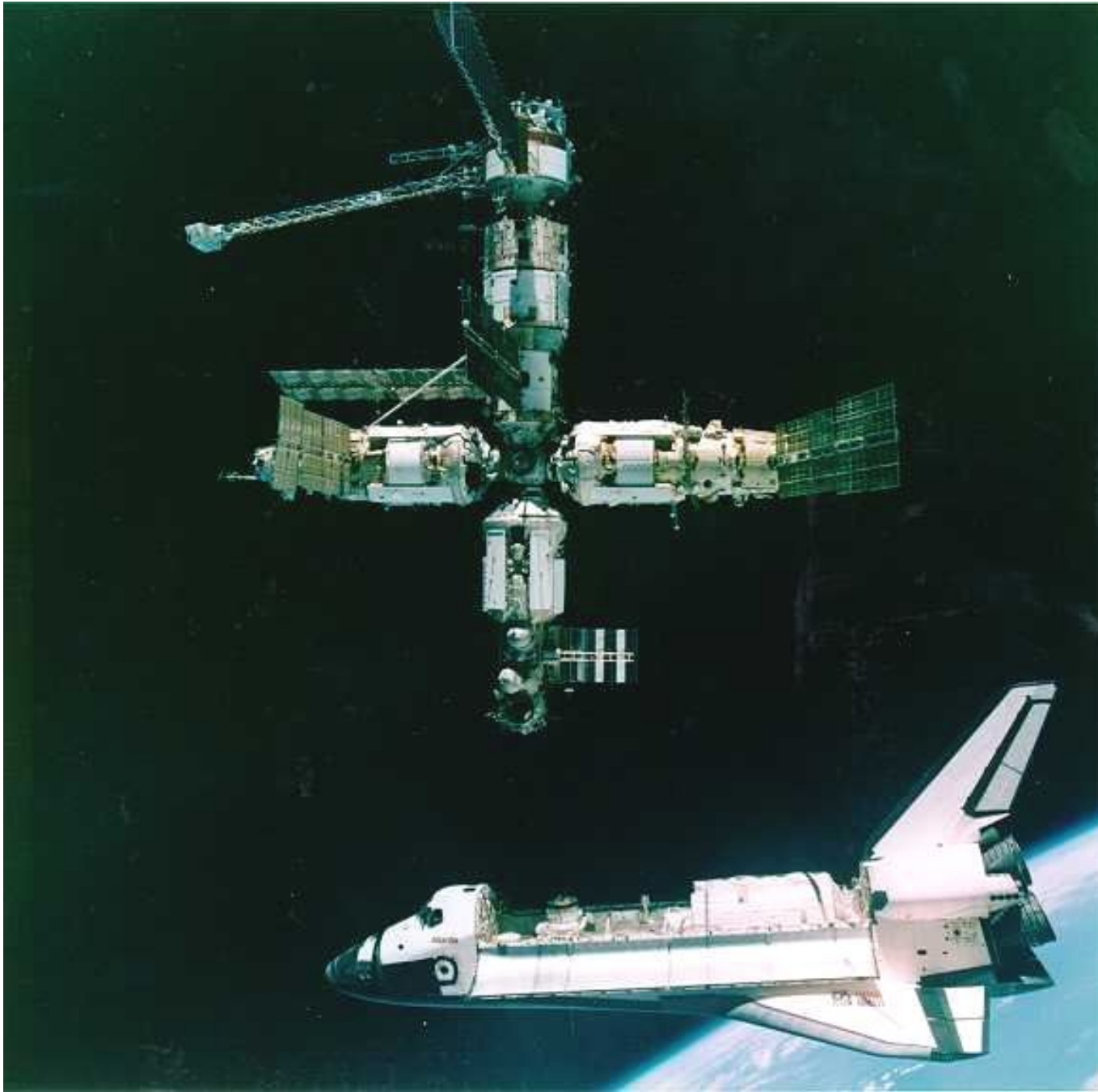


Decade 4: 1987-1997

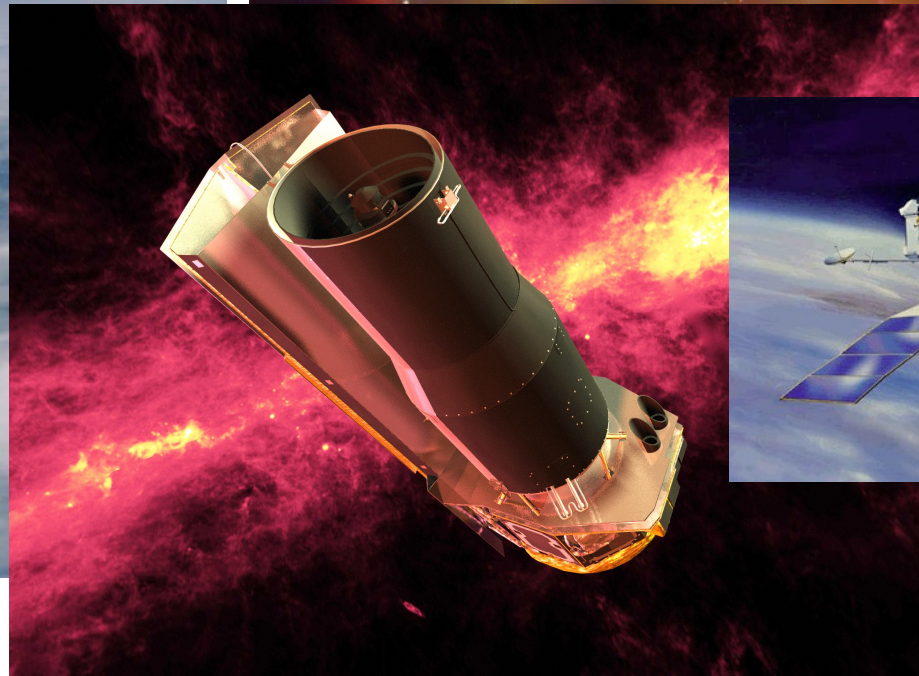
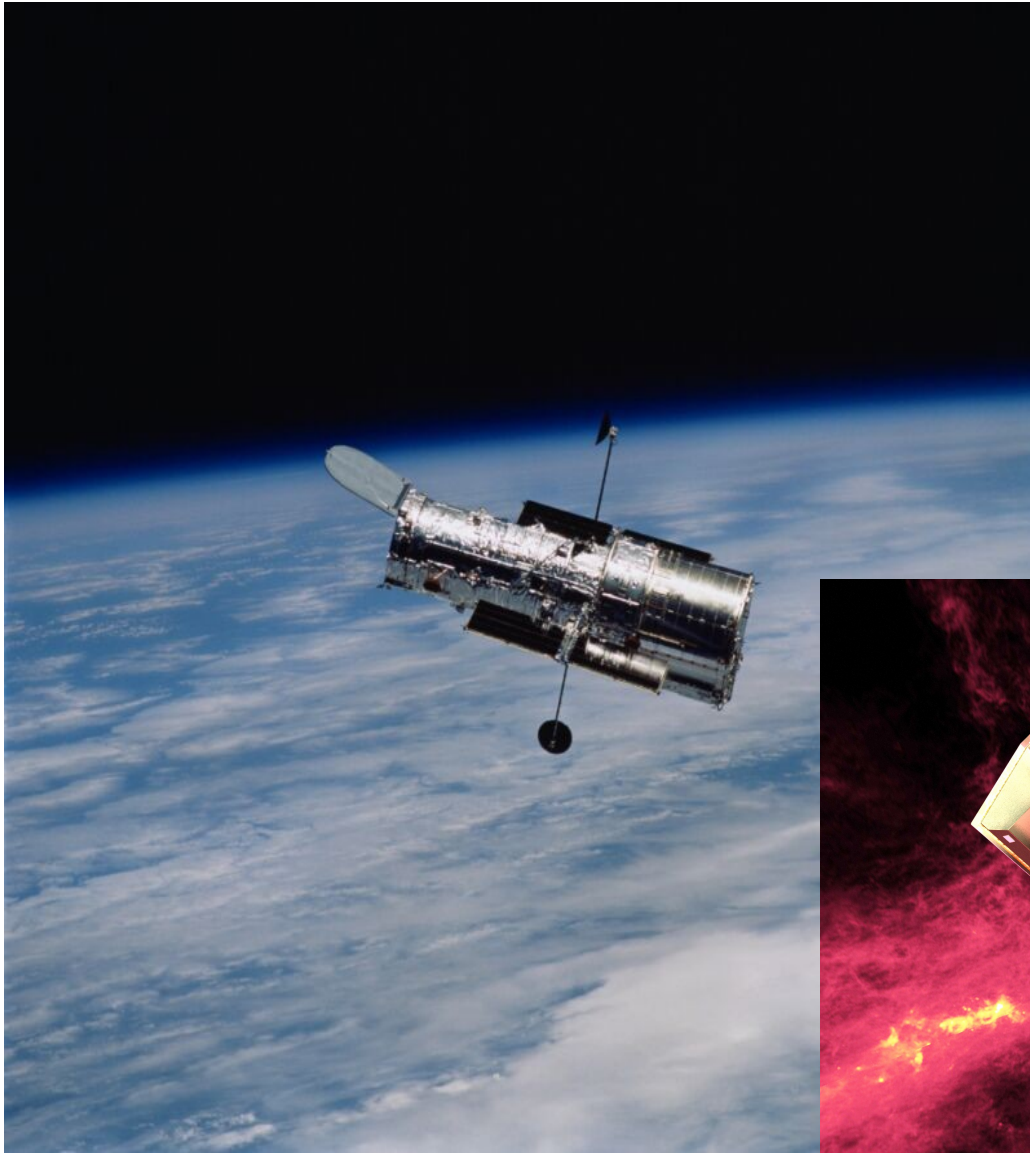
Space taken for granted

- Shuttle returns to flight
- Mir station occupied for a decade
- Great age of space astronomy begins
- Planetary exploration slows down (but Galileo at Jupiter, Magellan at Venus)
- Commercial comm satellites proliferate
- Space tethers

1990s: Mir and Shuttle



Great Observatories



Geostationary communications satellites launched 1997

31 sats: USA, Japan, Russia, China, Thailand, Indonesia, Argentina, India, Phillipines, Sweden, Norway, Luxembourg, INTELSAT, INMARSAT, EUTELSAT

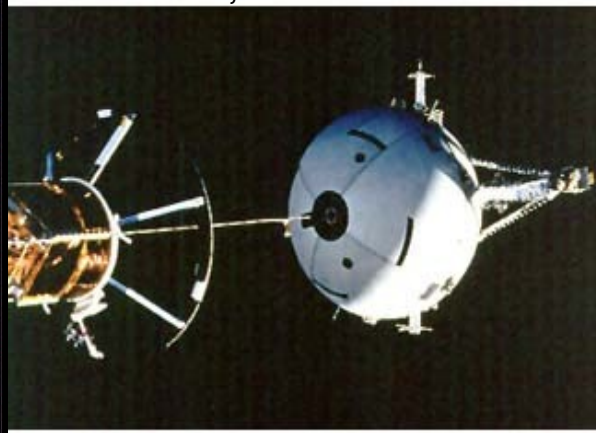
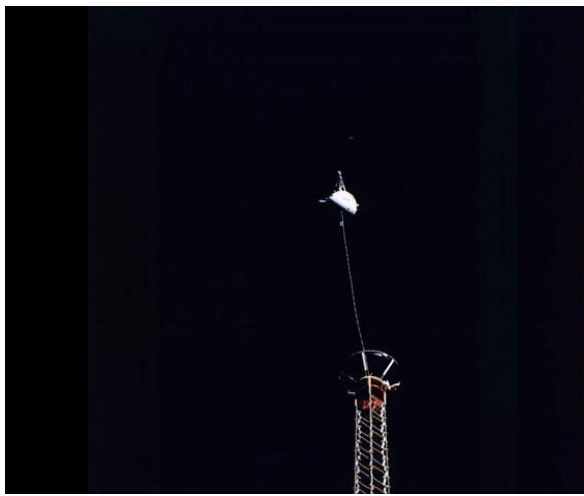


Space tethers

SEDS-1, 1994 (19 km long)



TSS-1R, 1996



7 March 1996 1017 UTC

© Copyright 1996 Kym Thalassoudis

Decade 5: 1997-2007

Space programs revitalized

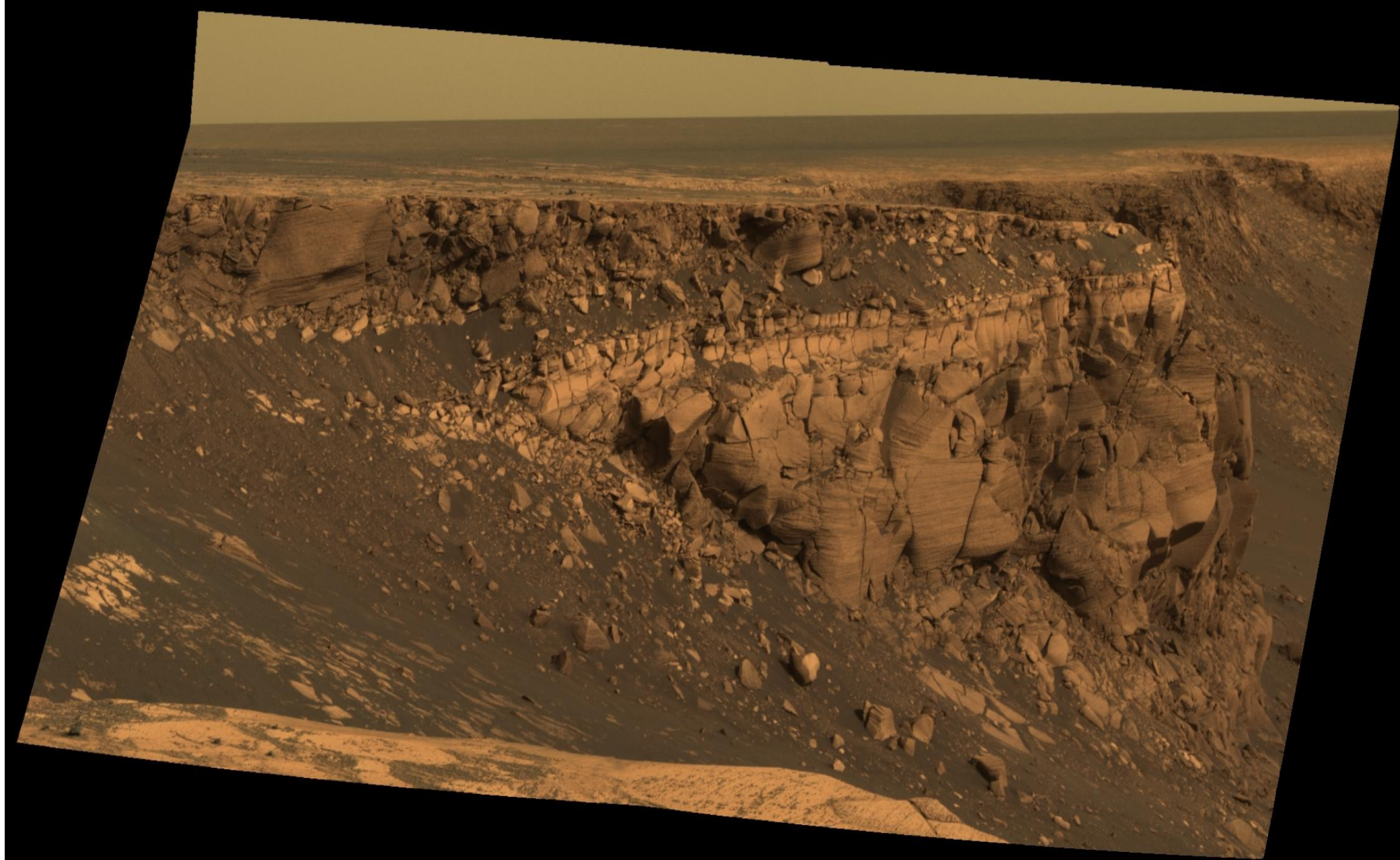
- International Space Station assembled
- Planetary probes resurgent: Mars rovers, Cassini, asteroid and comet missions
- Ion drive in use
- Space tourism begins
- GPS is everywhere

International Space Station



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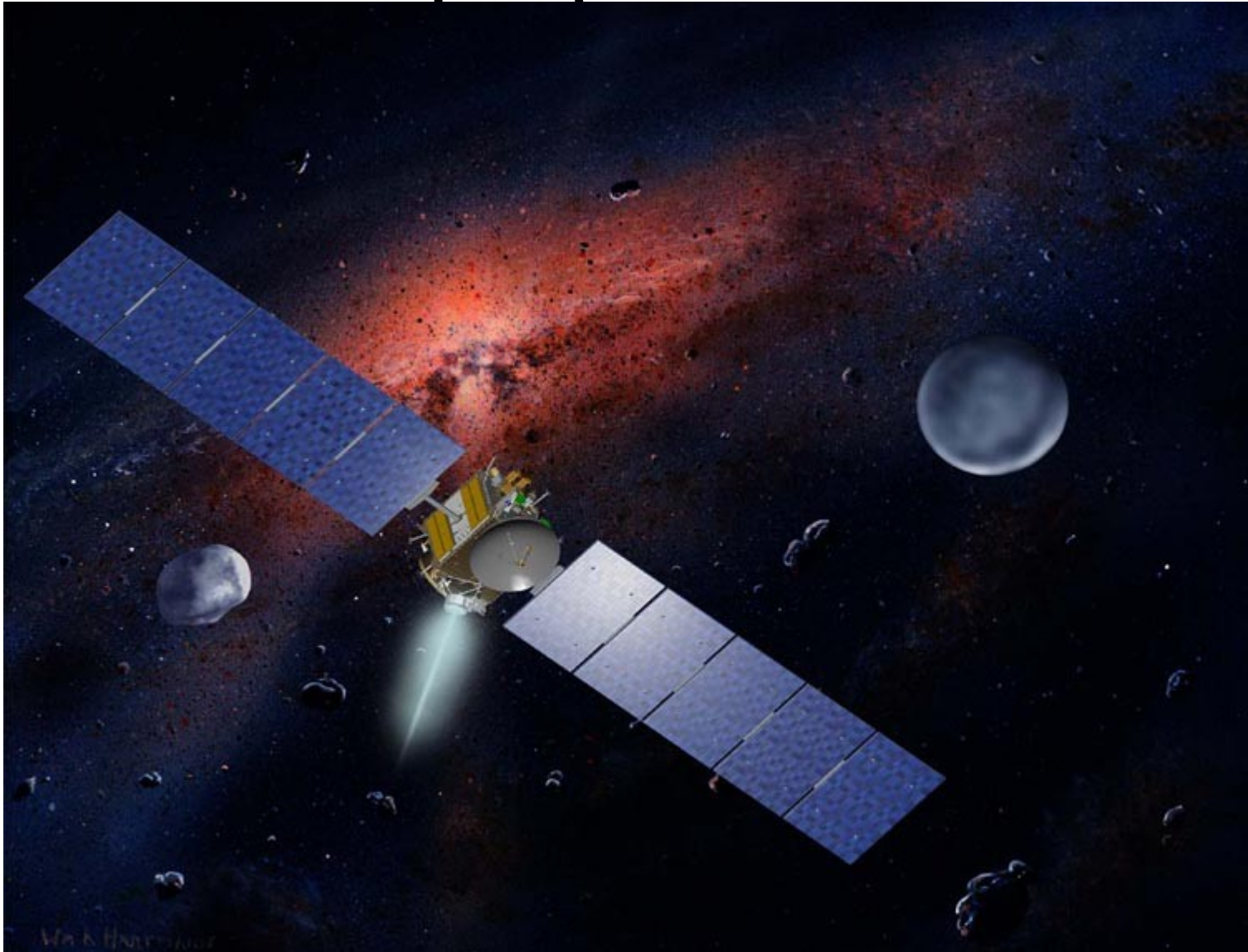
Inside a Martian crater



Deep Impact on Tempel-1, 2005

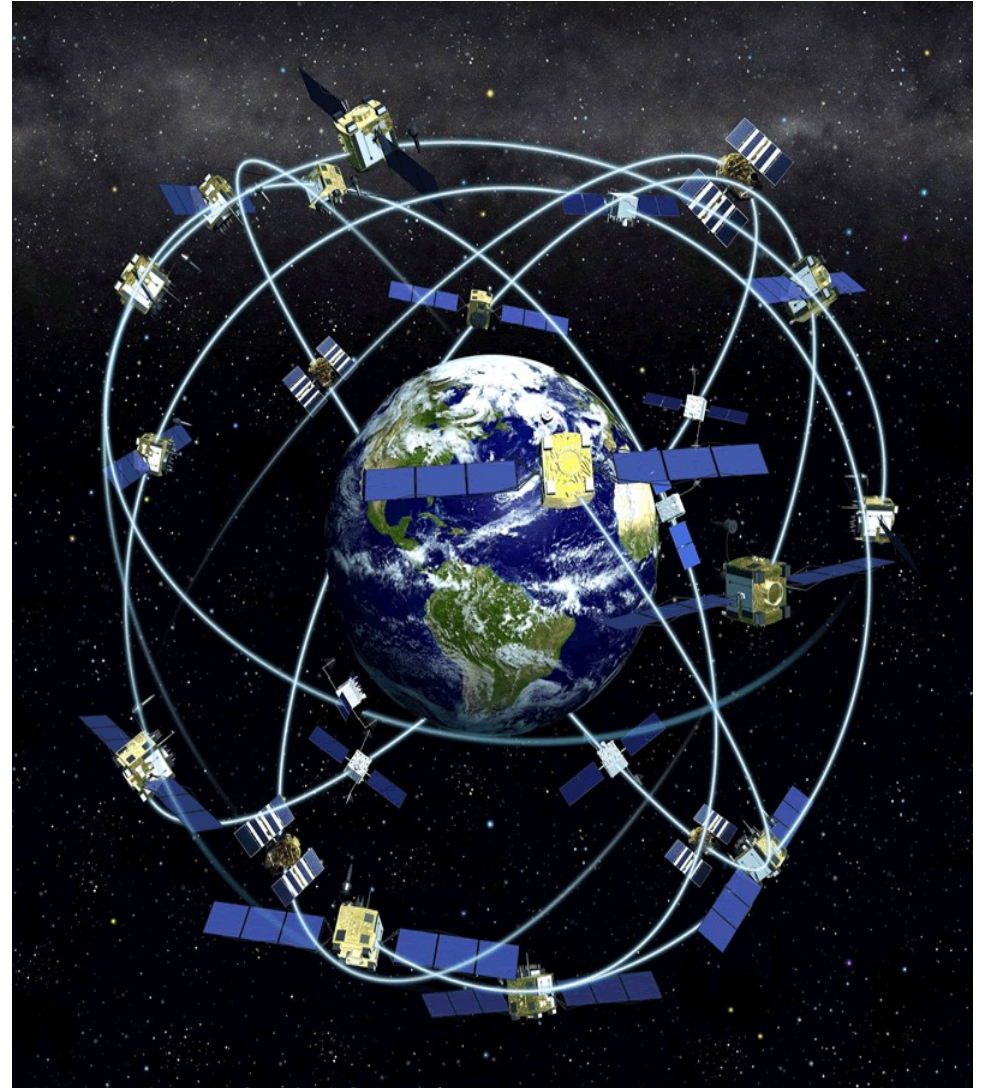


Ion propulsion



Dawn probe, launched last month toward asteroid Vesta

GPS



Onward and Upward...

- The Next 50 years: on to 2057
 - Space Tourism
 - Space Debris – Disaster in the Making
 - Inner Solar System Infrastructure
 - Outer Solar System: Europa and Titan
 - Back to the Moon (and on to Mars?)

2004 - Spaceship One



Photo by Bill Deaver

Station Tourists



Dennis Tito (US, finance) 2001

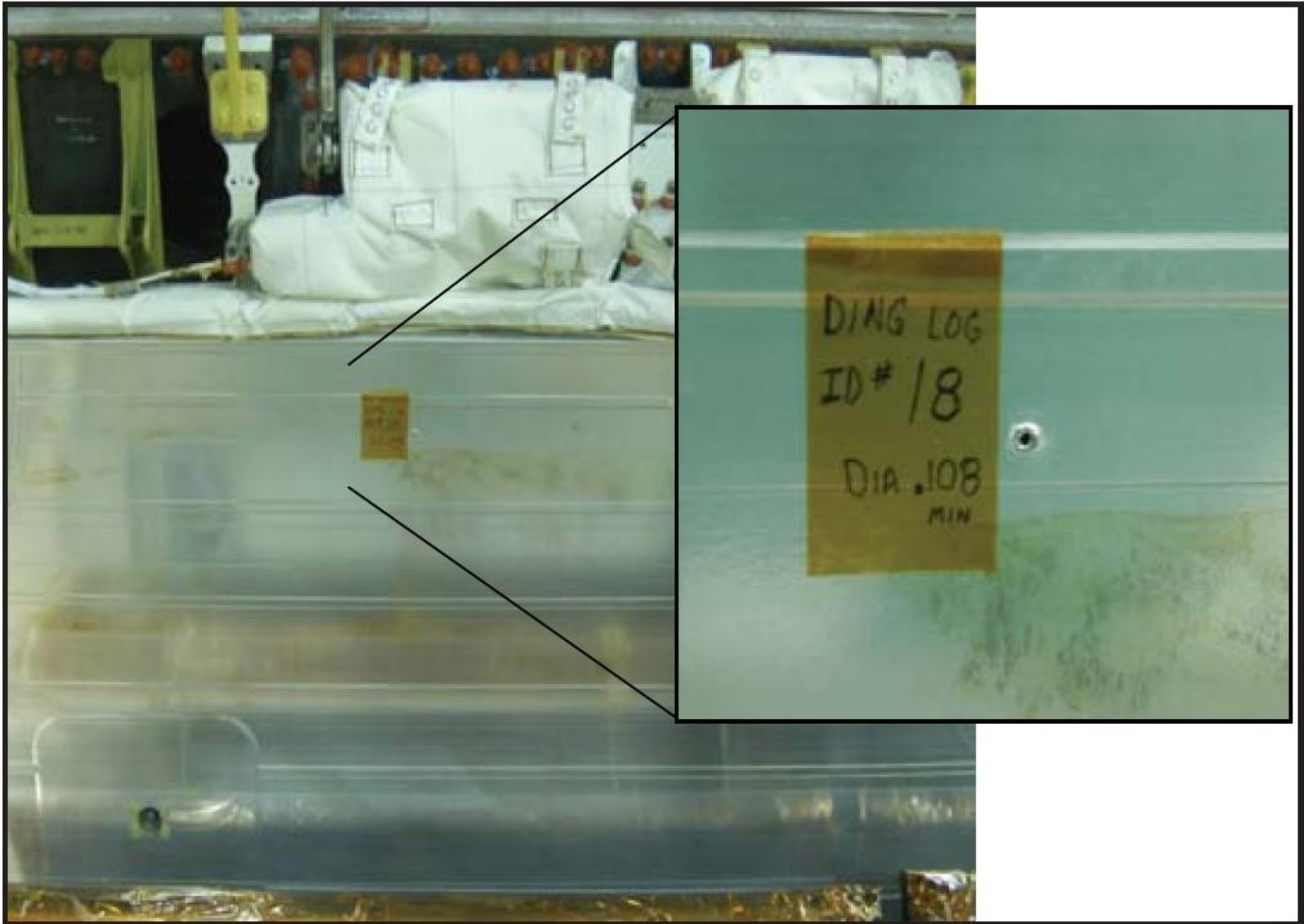
Mark Shuttleworth (S Africa, Ubuntu Linux) 2002

Greg Olsen (US, IR sensors) 2005

Anousheh Ansari (US, telecoms) 2006

Charles Simonyi (US, Microsoft) 2007

Debris hit on Shuttle



Space debris from collisions



Figure 2. Cloud of debris greater than 10 cm in size after 10 minutes.



Figure 3. Debris cloud after 10 days.



Figure 4. Debris cloud after 6 months.

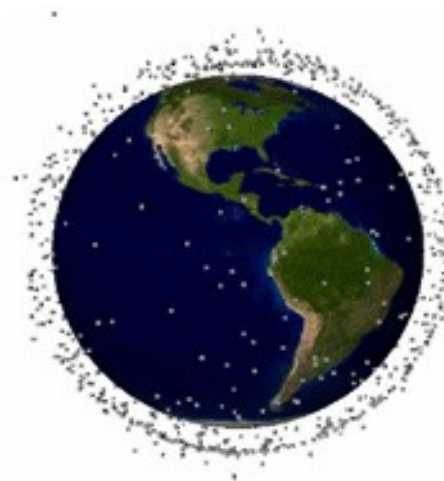


Figure 5. Debris cloud after 3 years.

Debris versus time

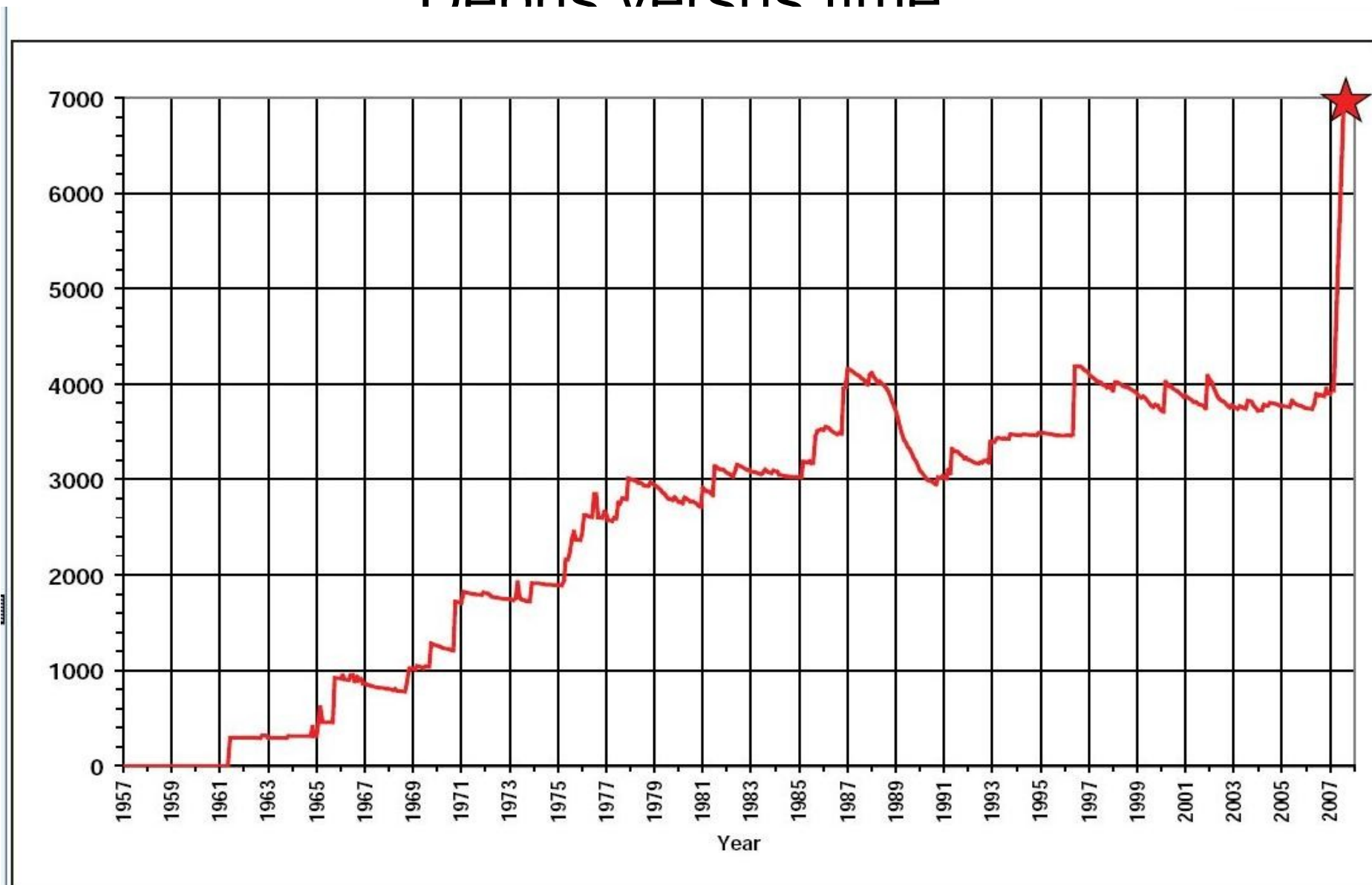
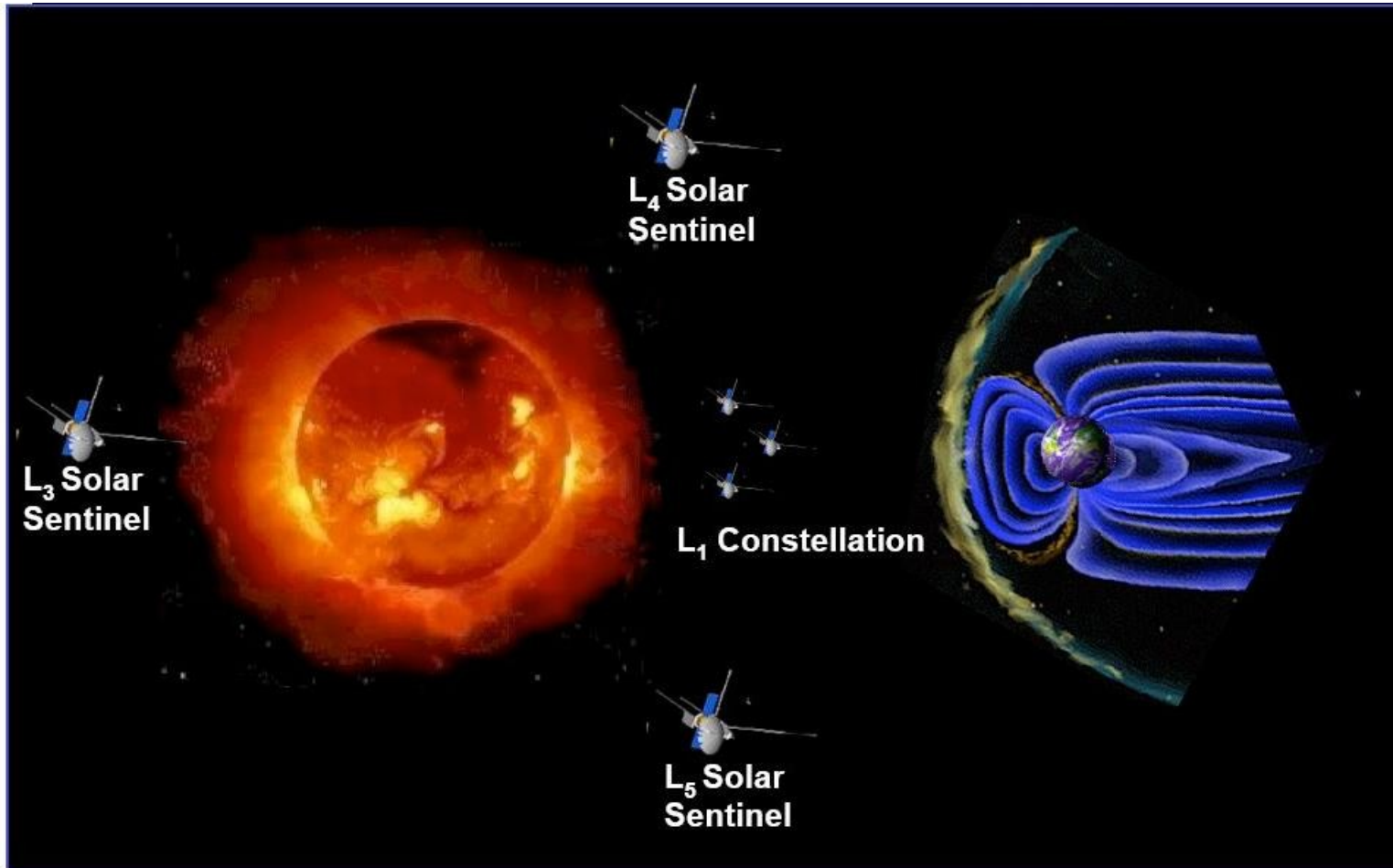


Figure 1. The total number of known fragmentation debris in Earth orbit increased by about 75% during the first quarter of 2007.

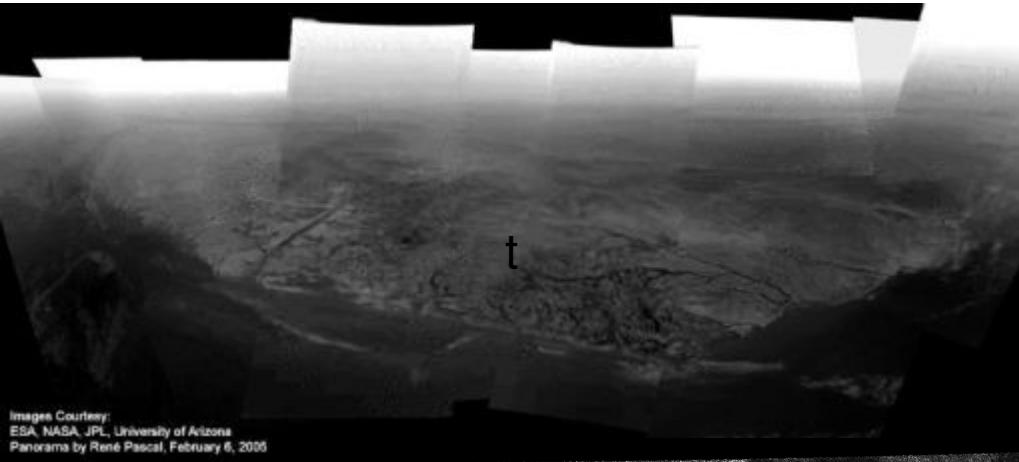
Inner solar system



Inner solar system in 2057 will be 'home territory' like Low Earth Orbit in 2007... communications relays, navigation, space 'weather' networks

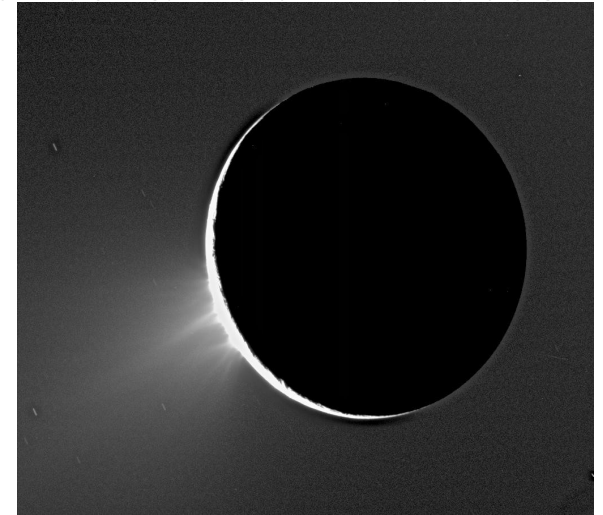
Source: GSFC Sentinels proposal

The Outer System

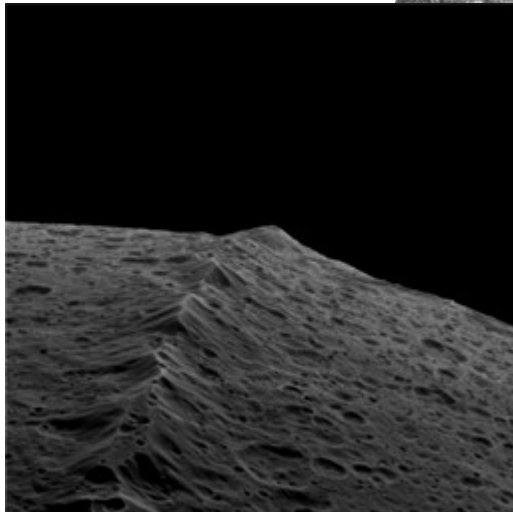
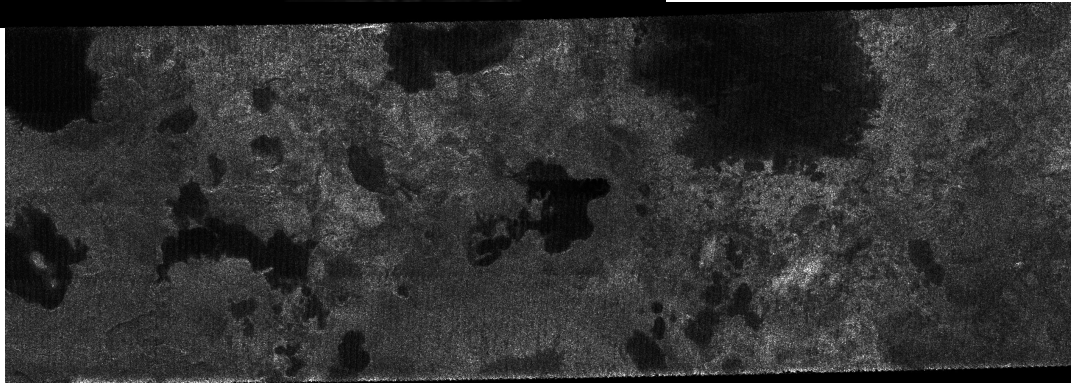


Images Courtesy:
ESA, NASA, JPL, University of Arizona
Panorama by René Pascal, February 6, 2006

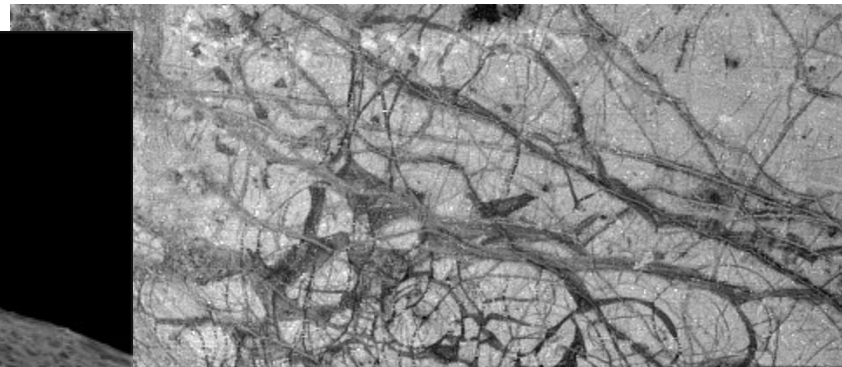
The Fountains of Enceladus



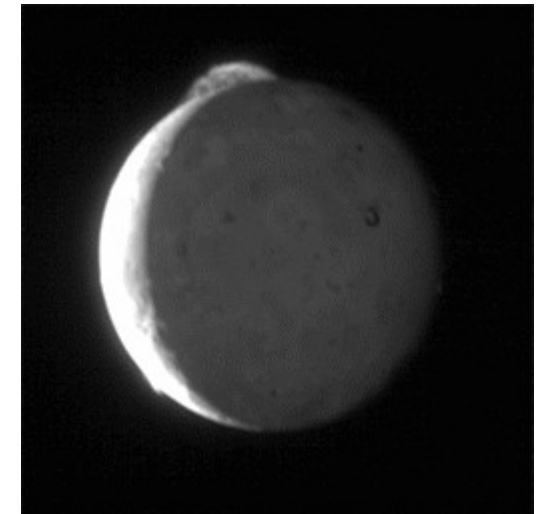
The Lakes of Titan



The Iapetus Equatorial Ridge



The Ice Ocean on Europa



Tvashtar volcano on Io

Source: NASA, ESA via Emily Lakdawalla

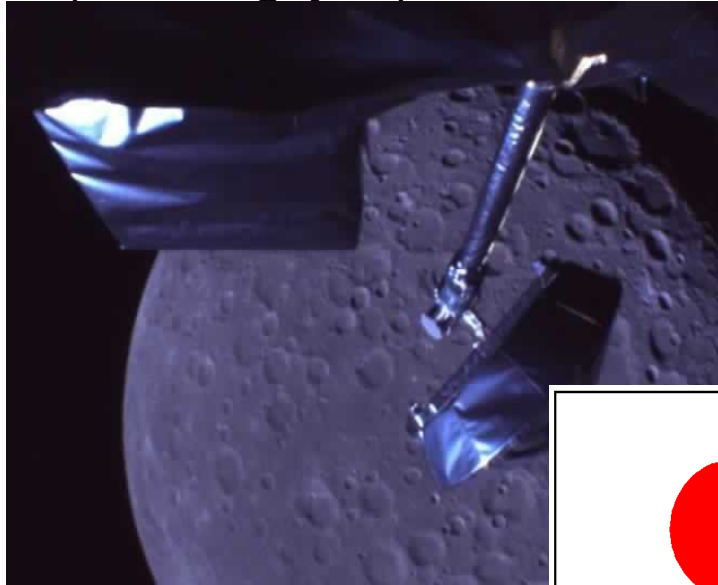
Closeup: lakeshore on Titan



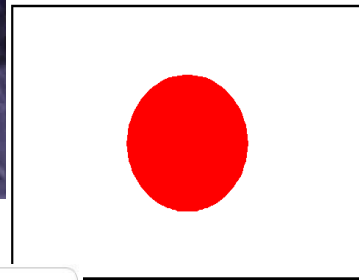
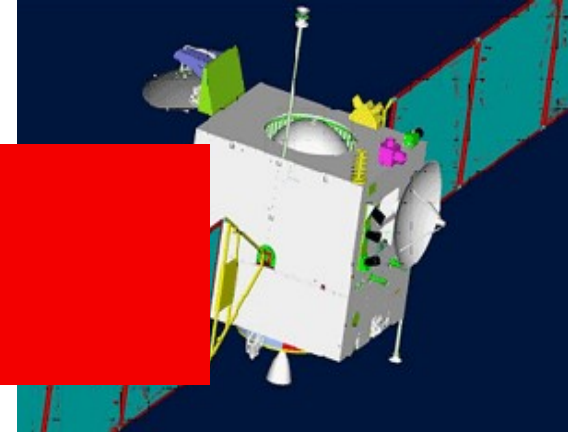
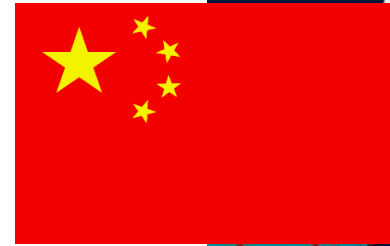
Images Courtesy:
ESA, NASA, JPL, University of Arizona
Panorama by René Pascal, February 6, 2006

Back to the Moon – International Robotic Exploration

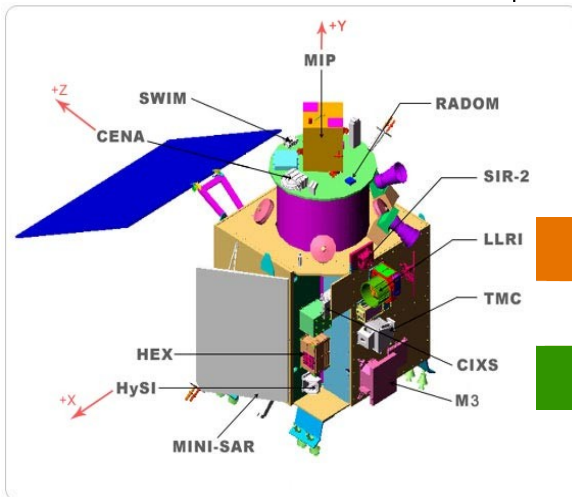
Japan's Kaguya spacecraft reached the Moon two weeks ago



China's Chang'e-1 is due for launch Oct 26



Europe's SMART-1 (2003-2006) ->
<- India's Chandrayaan-1 (2008)



Back to the Moon with astronauts?



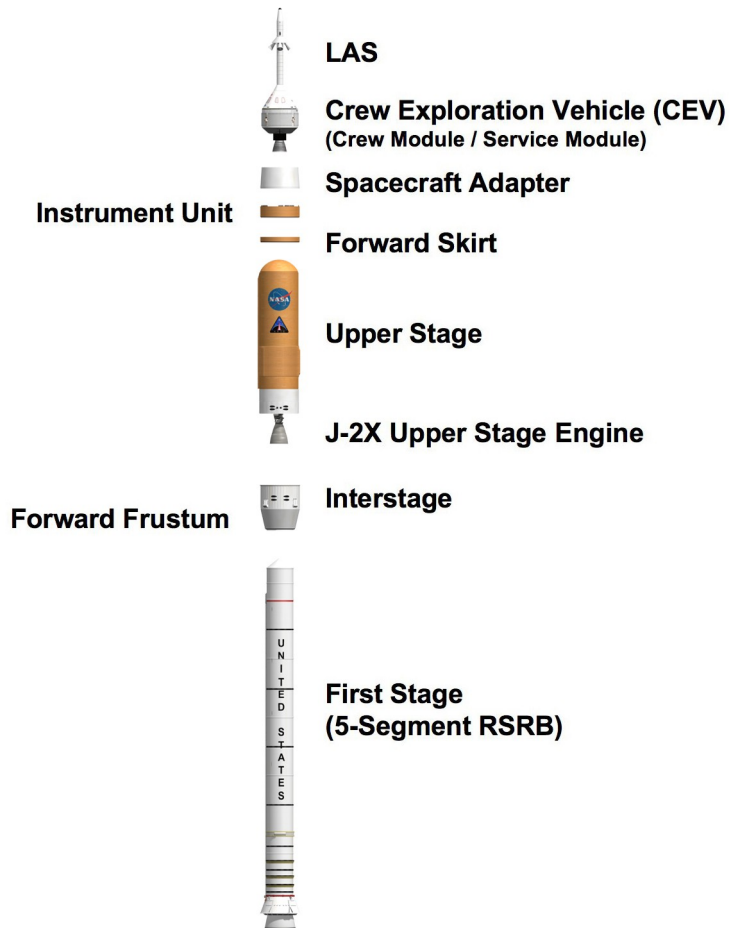
December 14, 1972: the last US astronauts leave the Moon

(Apollo 17 lunar module ascent stage leaves Taurus-Littrow with Gene Cernan and Jack Schmitt)

Constellation Program

Ares I – the Crew Launch Vehicle – first full launch 2013?

- based on Shuttle Solid Rocket Booster
- Carries Orion spaceship to orbit

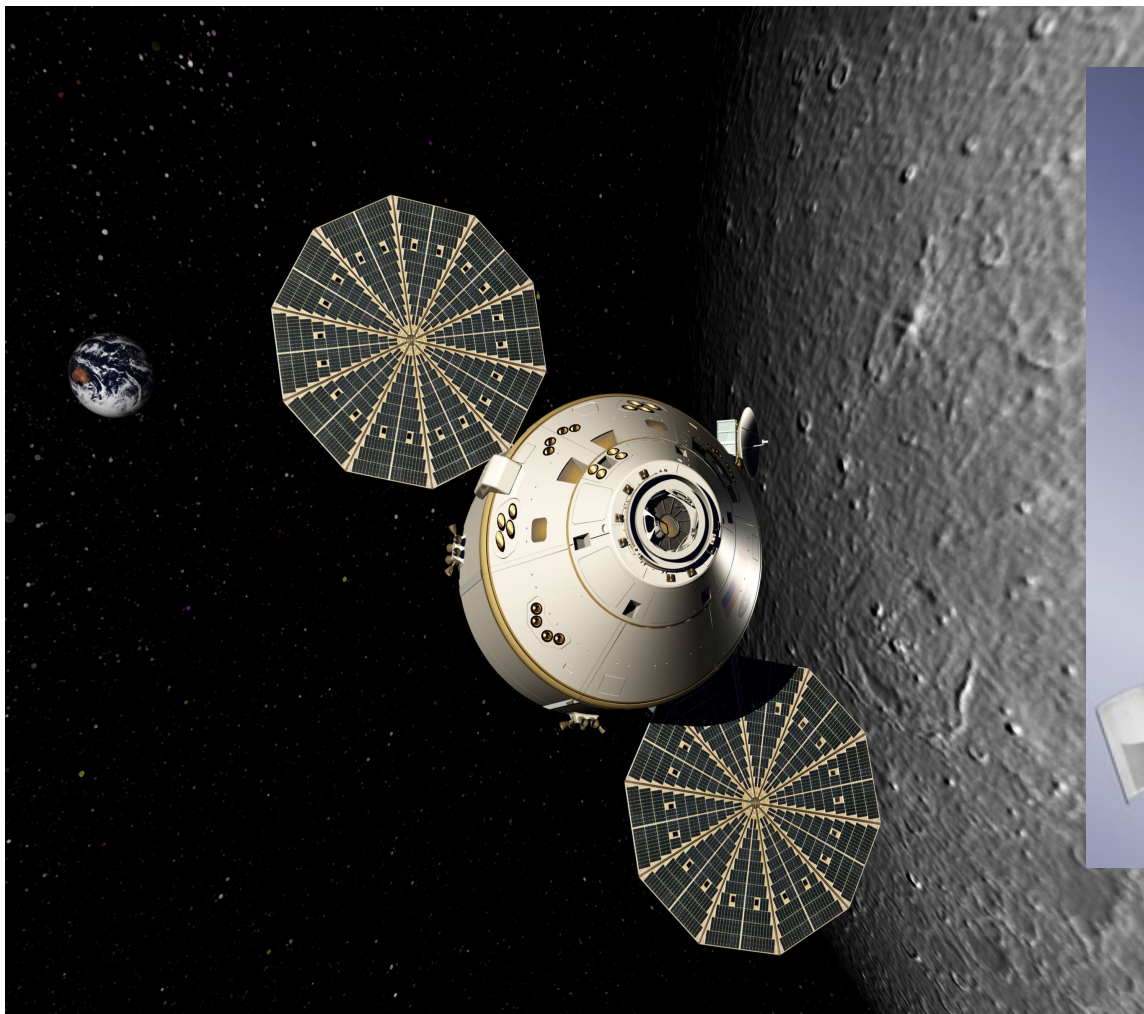


Constellation Program

Orion – the Crew Exploration Vehicle – first robotic test flight 2012?

- like a scaled up Apollo command and service module

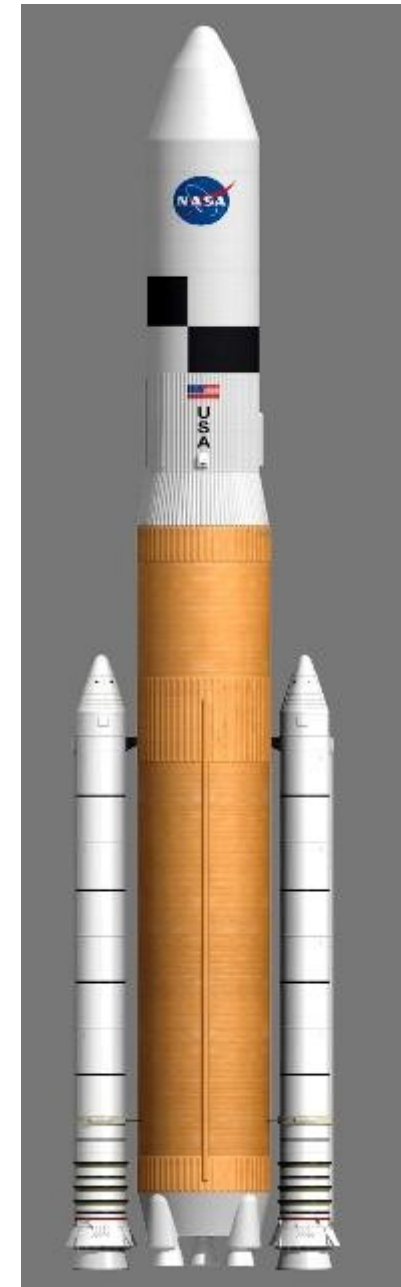
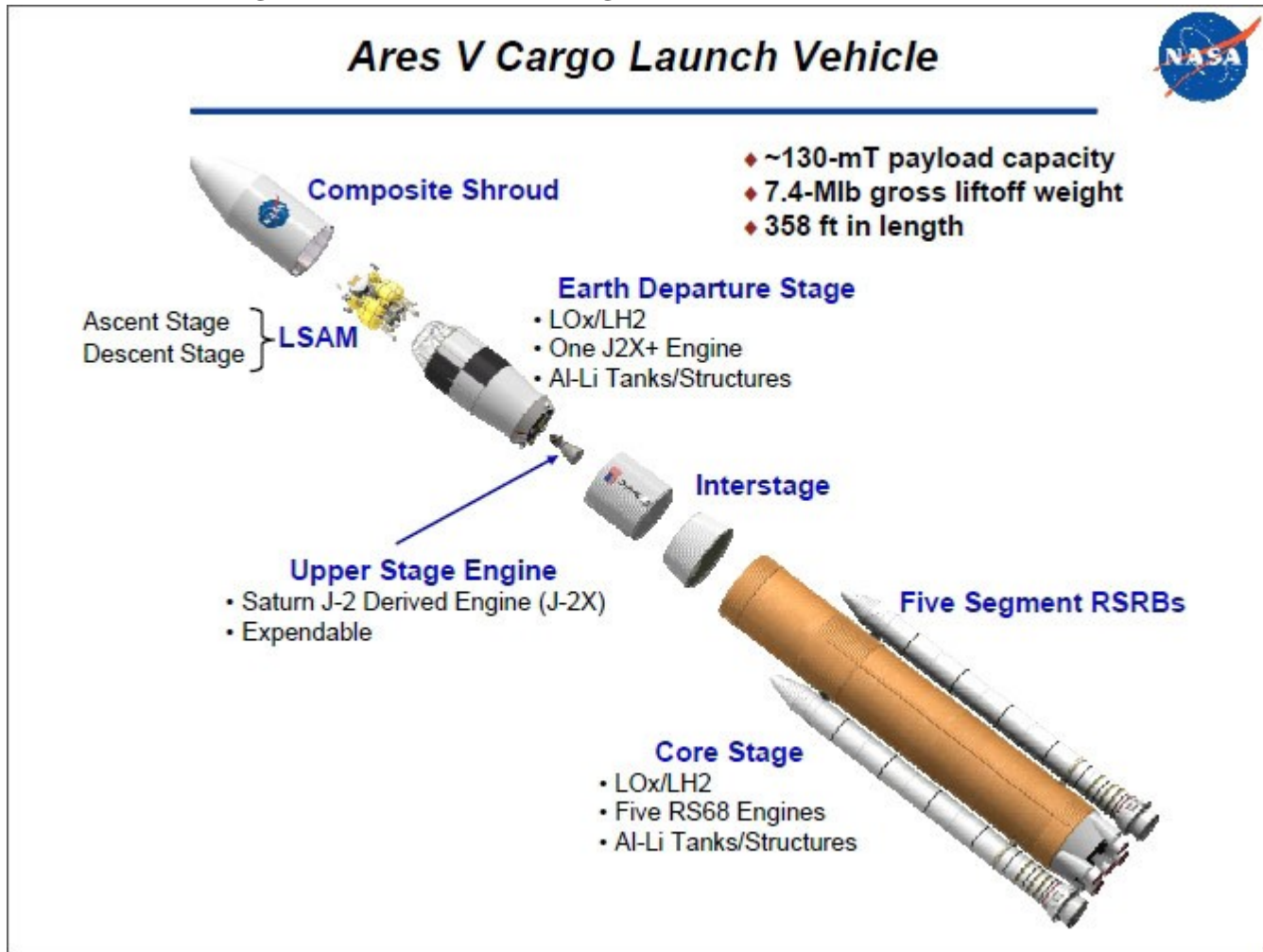
- will replace Shuttle as US way of getting astronauts to space



Constellation Program

Ares V – the heavy launch vehicle

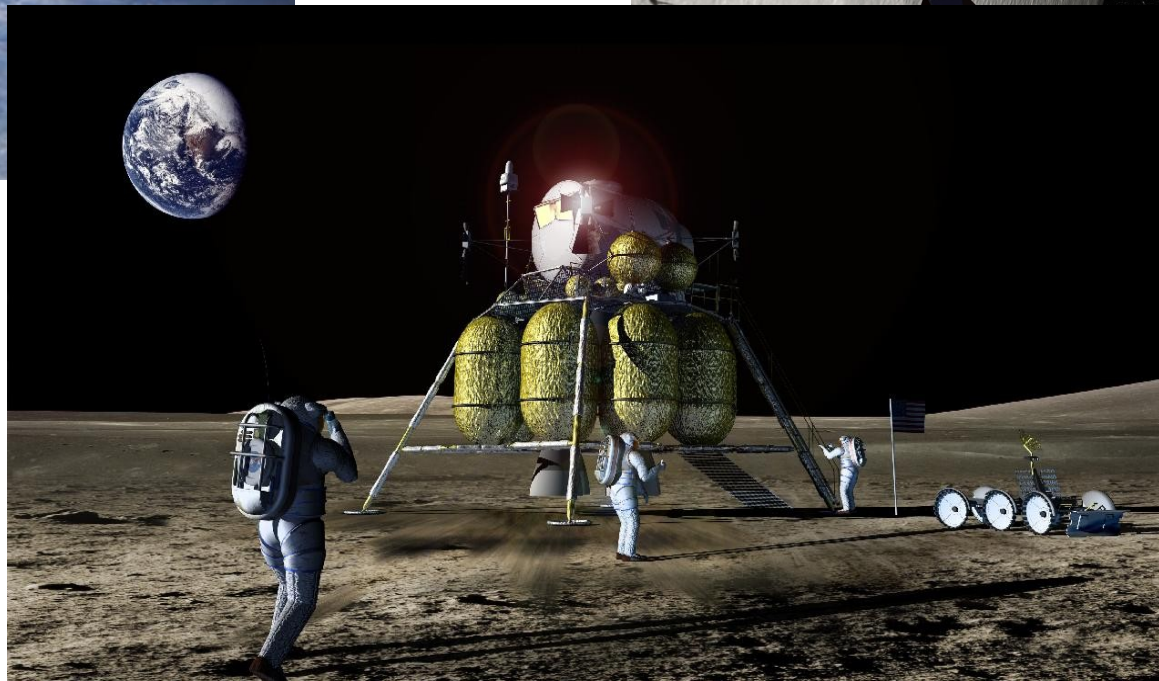
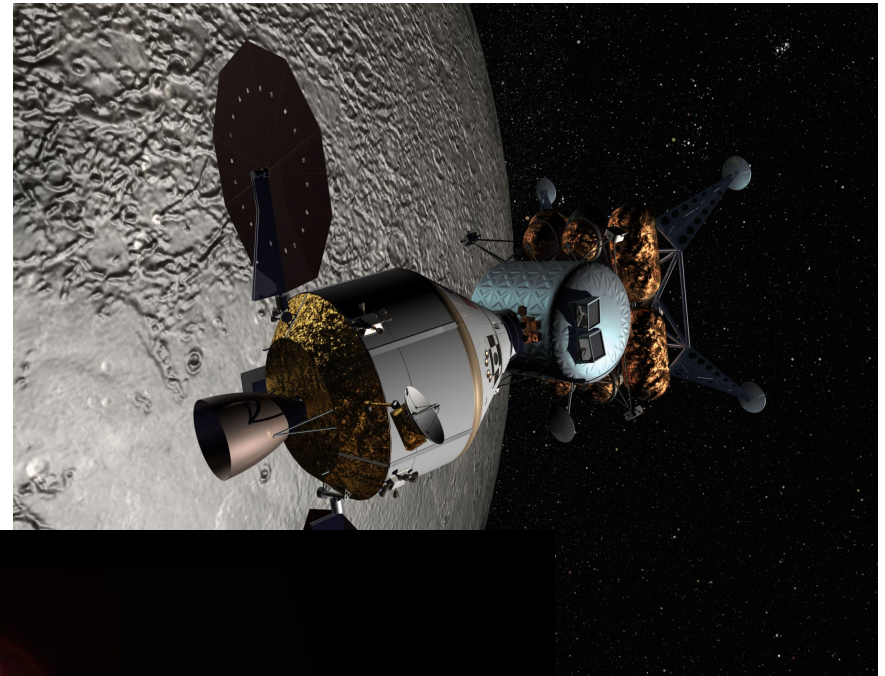
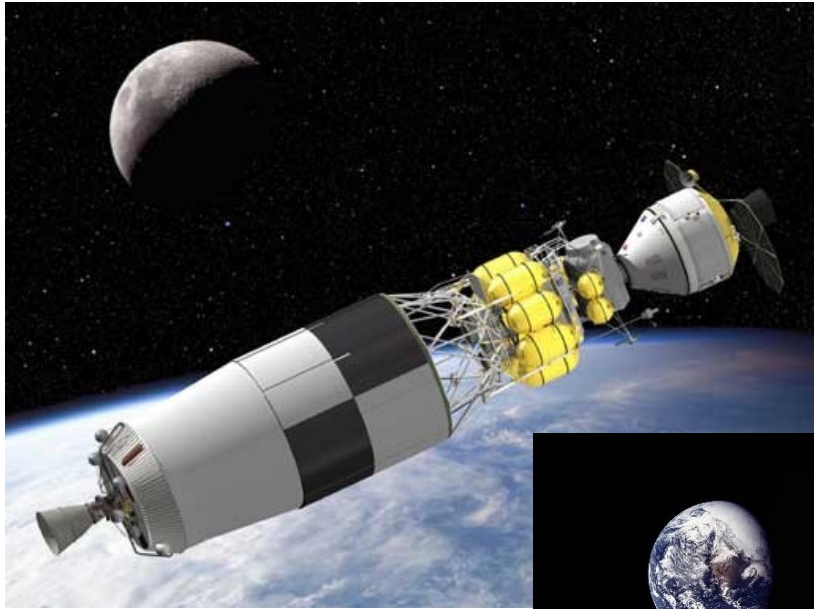
Test flight 2017 if funding allows



Constellation Program

LSAM – the lunar surface access module – astronauts back to the Moon

First flight 2019 if you are very optimistic...



Constellation Program: Lunar Outpost

After the first landings, a permanent base at the lunar south pole...



Constellation Program: On to Mars?

Maybe after 2050....but it won't be cheap.

