

National Aeronautics and
Space Administration



Space Nuclear Propulsion 101

30 August 2024

Dragoncon – Space Track – Nuclear Power on the Moon and Beyond

Space Technology Mission Directorate

Space Nuclear Propulsion Project

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NASA Space Nuclear Propulsion (SNP)

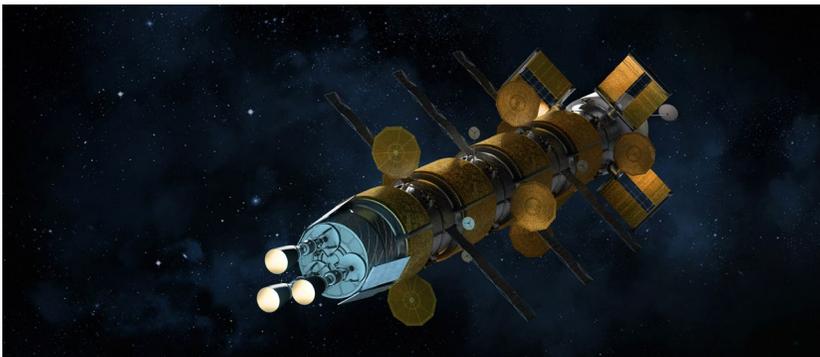


Overview

Vision

Robust and enduring access to destinations throughout the solar system

Space Nuclear Propulsion is an enabling capability



Nuclear Thermal Propulsion (NTP)

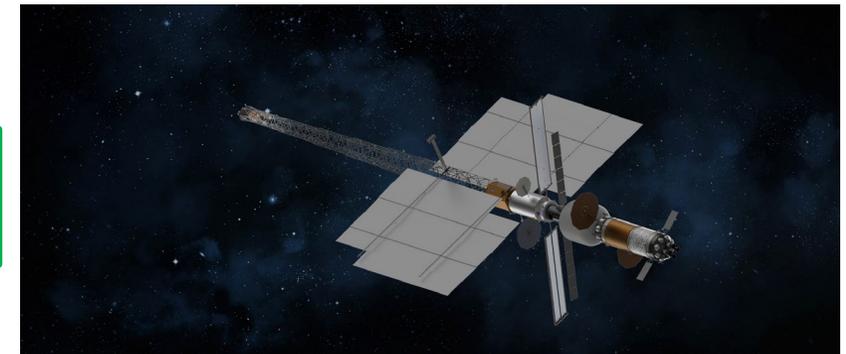


Thrusting 4-8 times for thirty minutes for a Mars mission

Nuclear Electric Propulsion (NEP)



Thrusting $\geq 20,000$ hours for a Mars mission



Why Nuclear Propulsion?

Floor performance is 2X current chemical systems



Crewed Interplanetary Missions

- Reduced transit times and exposure to space hazards (space radiation, microgravity, prolonged confinement)
- Increased robustness: larger launch windows, more abort and contingency opportunities

Next-Generation Science Missions

- Maximize payload, enable more science at the destination
- Increased power capability to enabling more science
- Reduced mission times – achieve objectives sooner



Space Nuclear Propulsion Mission Spaces

Orbital Transfers, Loitering, and Maneuvering

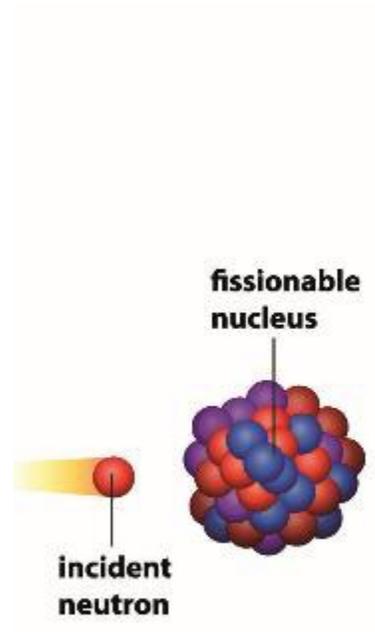
Cis-Lunar Maneuvering and Transportation

Deep Space Exploration and Science

Mars Cargo and Crew Transit

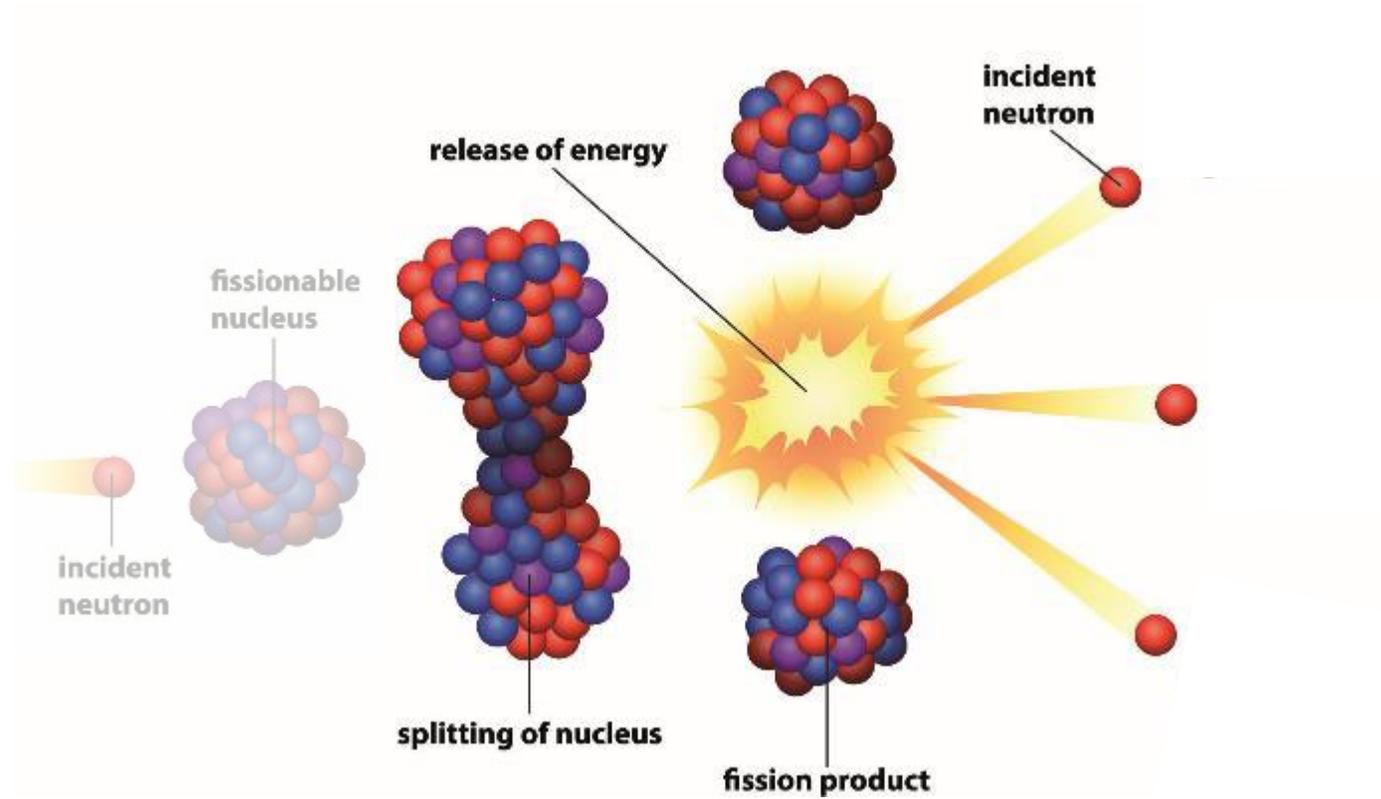


How Fission Works



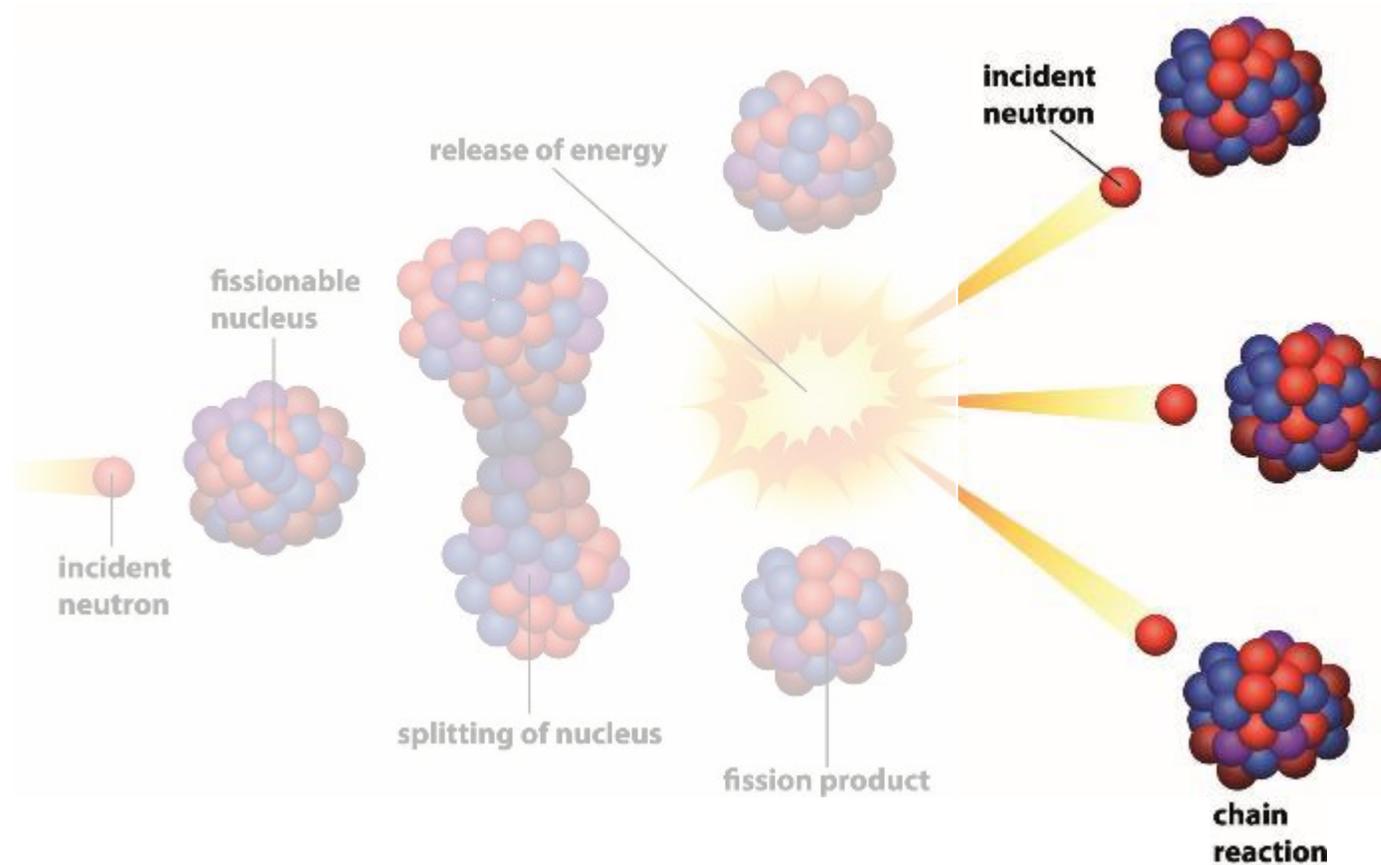
Two fundamental ingredients:
neutron and an atom

How Fission Works



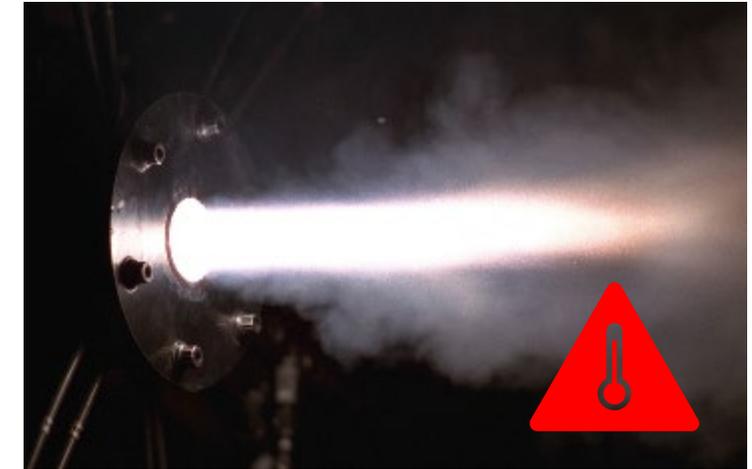
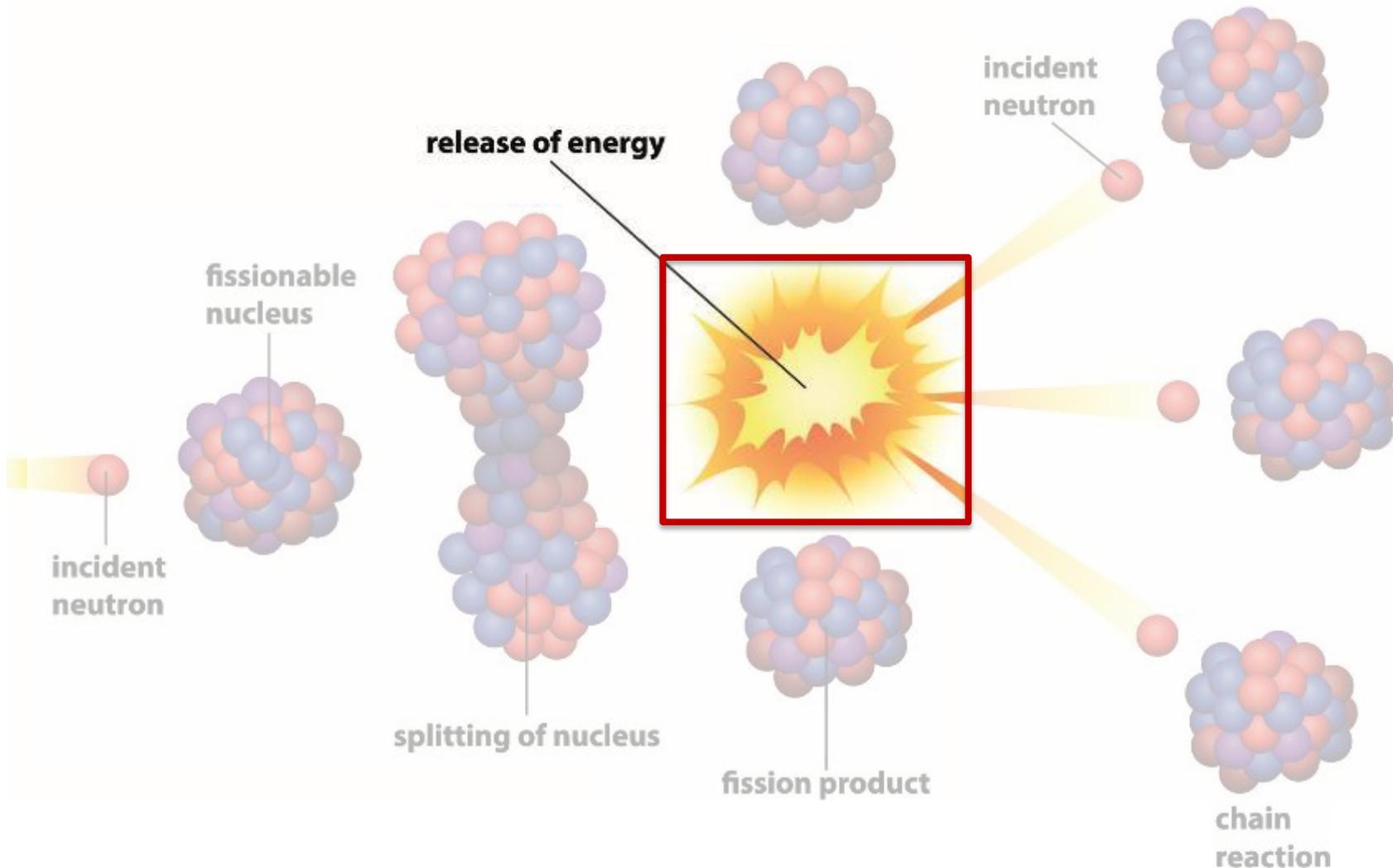
Decomposition of the unstable new nucleus results in the release of energy, fission products, and subatomic particles

How Fission Works



New neutrons produced from fission keep the process going as a chain reaction, making energy generation continuous

There are two options for NASA to use the energy from fission once it's produced

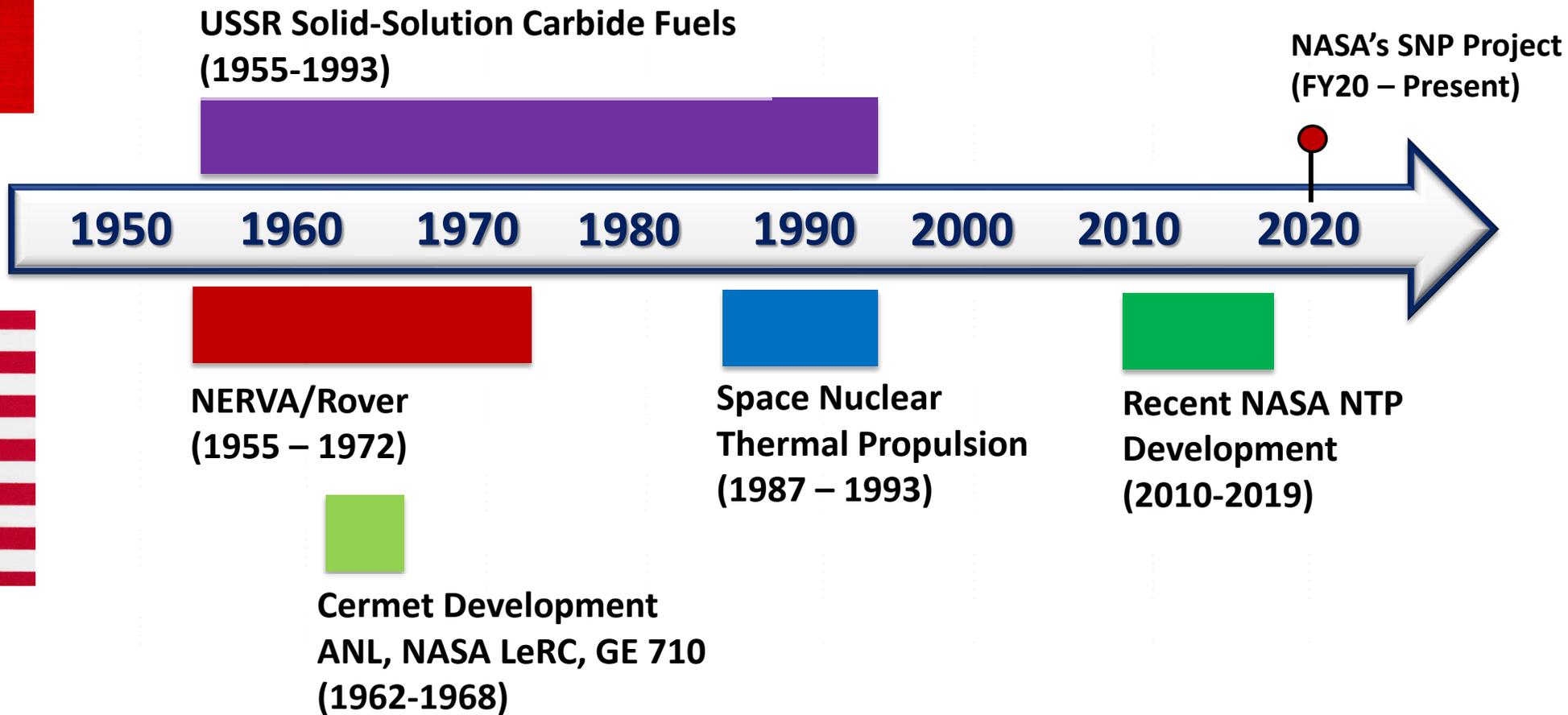


Use Energy to Heat a Propellant

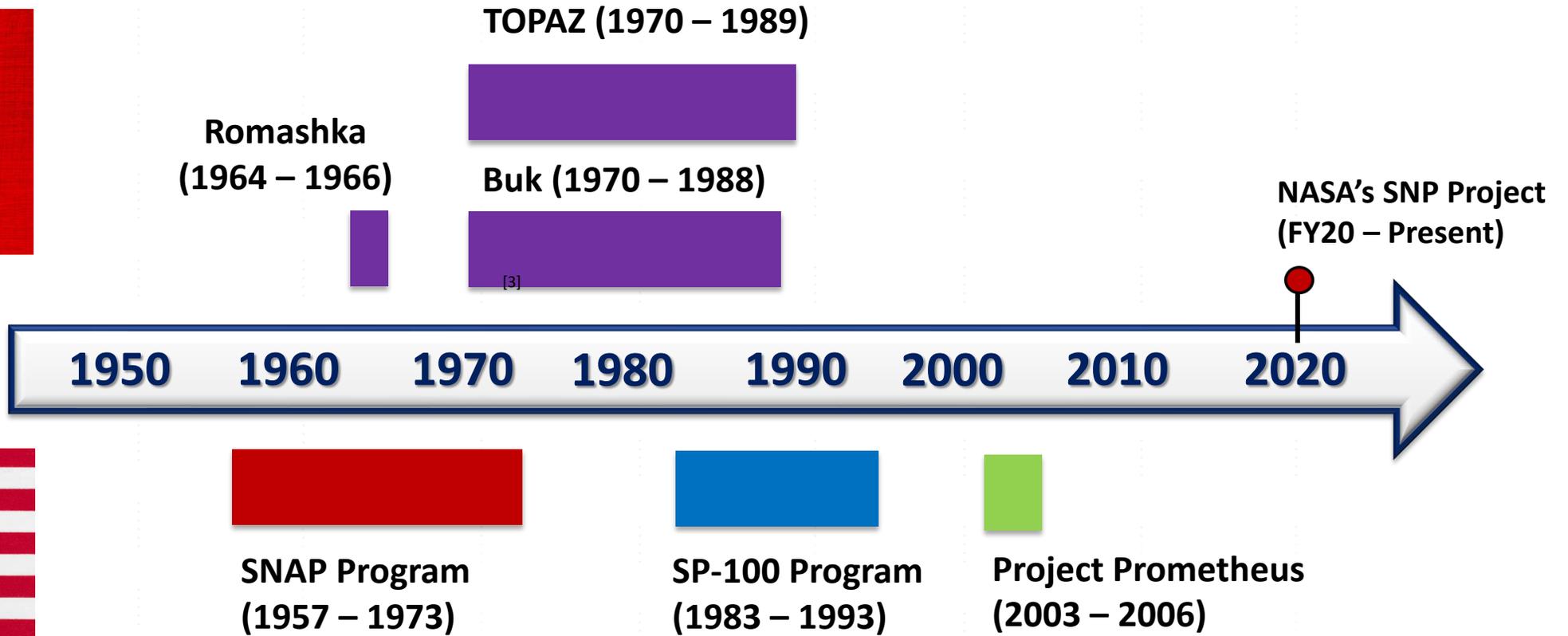
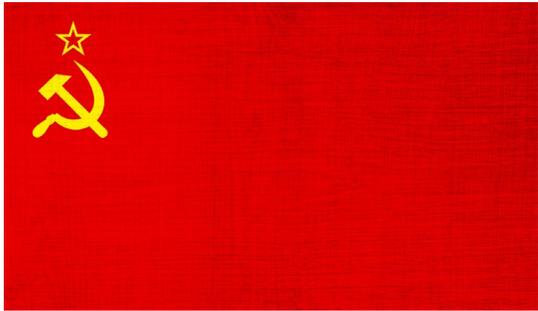


Convert Energy into Electricity

Historic NTP Programs



Historic NEP Programs



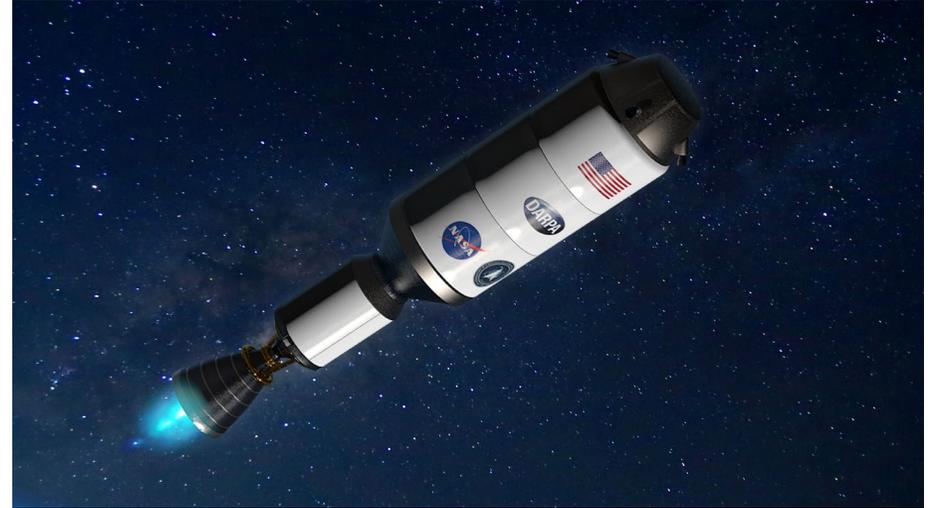
Current Development to Support NTP Systems



- Partnering with DARPA on the DRACO flight demonstration
- Reactor development (Government + 2 industry designs)

Developments include

- Fuel and other materials development and testing
- Engine development and integration
- Non-nuclear engine development
- Instrumentation and control
- Risk reduction
- Ground and flight test development
- Safety & Mission Assurance



DRACO concept

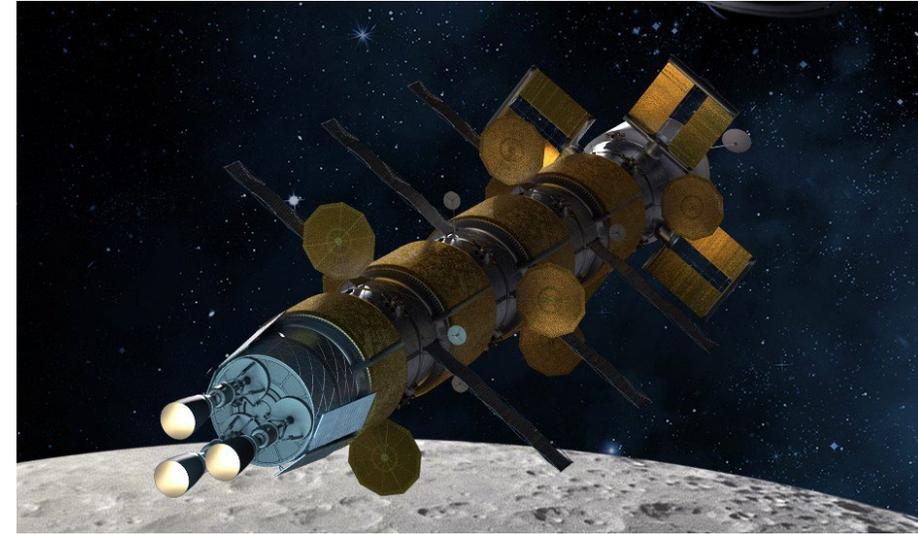


Fuel specimen testing

Space nuclear propulsion technologies meet NASA's advanced propulsion needs



- **Both NTP and NEP enable faster crewed trip times to Mars as well as faster and more capable science missions**
 - This is a huge advantage to reduce crew exposure to space hazards and to do more science!
- **NASA's Space Nuclear Propulsion Project is leading the nation**
 - Advancing space nuclear technologies by partnering NASA centers and resources with Department of Energy labs and Department of Defense projects
 - Performing the development and technology maturation needed to reliably use nuclear propulsion
 - Executing (with DARPA) the first in-space flight demonstration of an NTP system
 - Testing facilities within the government provide unique test environments for understanding reactor material performance under extreme nuclear conditions



NTP concept



NEP concept

Nuclear Safety is Key



- Nuclear fuel, prior to use, can be held in your hand with no adverse effects
- The U.S. has made nuclear reactor technologies incredibly safe over the last 50 years, leading to better safety metrics than even wind and hydroelectric power
- Chemical propulsion – like that used for Apollo, space shuttle, and Artemis – is expected to be used for launch
- Space reactor systems are inactive and produce NO radiation through launch since they don't begin operation until they reach a nuclear safe orbit
- Nuclear-powered spacecraft will be placed in orbits that have a decay lifetime which greatly exceeds the time required for any radioactivity to reduce to a safe limit



Artemis I launch

Learn more, and stay up to date with
everything Space Nuclear Propulsion



<https://go.nasa.gov/SNP>