


BECOMING A MULTIPLANET SPECIES



SPACEX



“You want to wake up in the morning and think the future is going to be great - and that's what being a spacefaring civilization is all about. It's about believing in the future and thinking that the future will be better than the past. And I can't think of anything more exciting than going out there and being among the stars.”

Elon Musk, CEO and Lead Designer, SpaceX

**PROGRESS**

# DEEP CRYO LIQUID OXYGEN TANK TESTING

Pressure tested to 2.3 atmospheres

Carbon fiber matrix

Volume 1000m<sup>3</sup>

Holds 1200 tons of liquid oxygen



# ENGINE TESTING

Over 1200 seconds of firing across 42 main engine tests

Longest test 100 seconds; 40 seconds typical for Mars landing

Test engine operates at up to 200 atmospheres



# PERFECTING PROPULSIVE LANDING

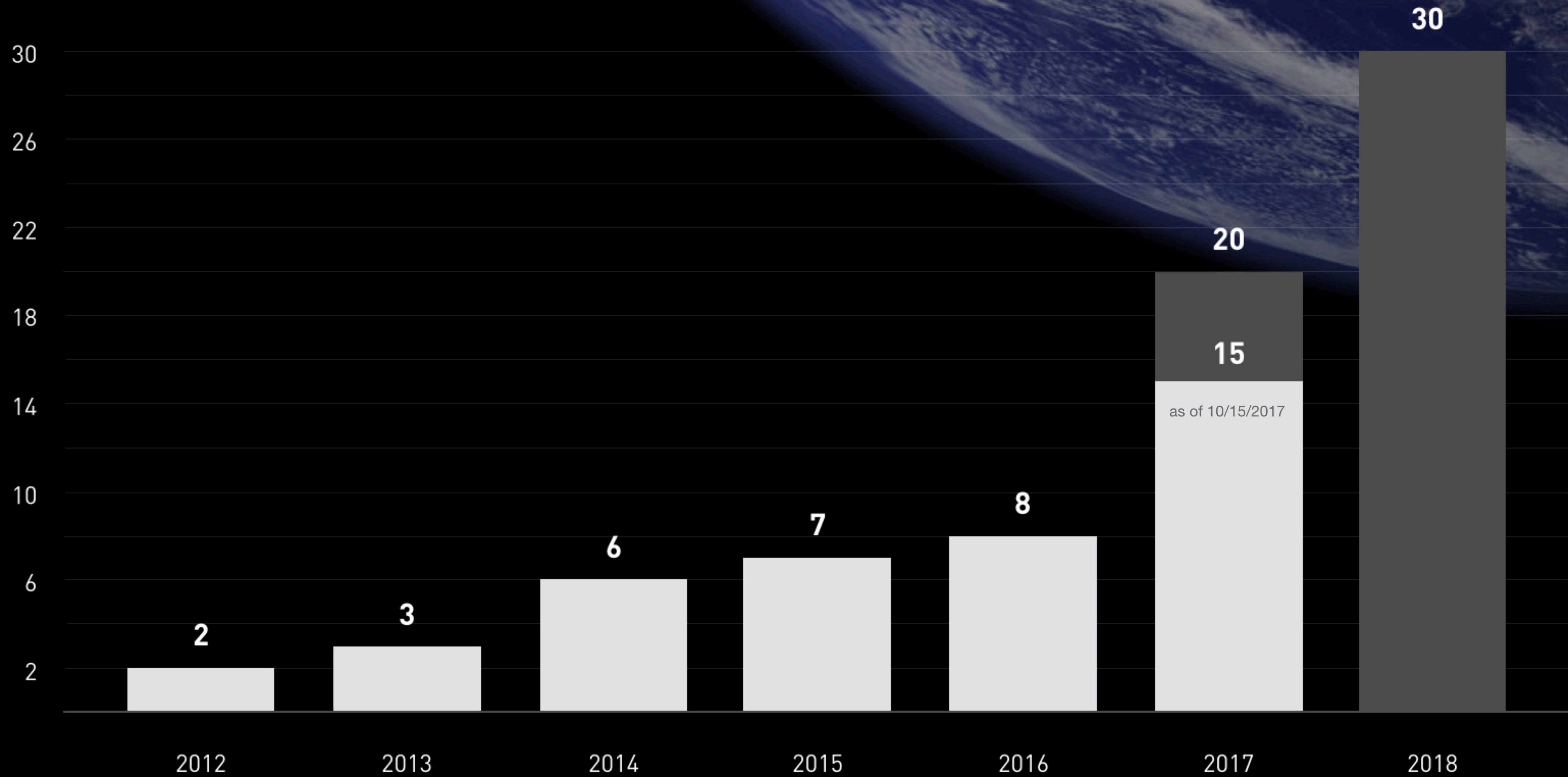
18 successful Falcon 9 landings as of  
10/15/2017

Very high reliability demonstrated with  
single engine landings

Precision landing will allow for return to  
launch mount, no landing legs needed



# LAUNCH RATE



# DRAGON UPDATES

Demonstrated automated rendezvous and docking to space station with Dragon 1

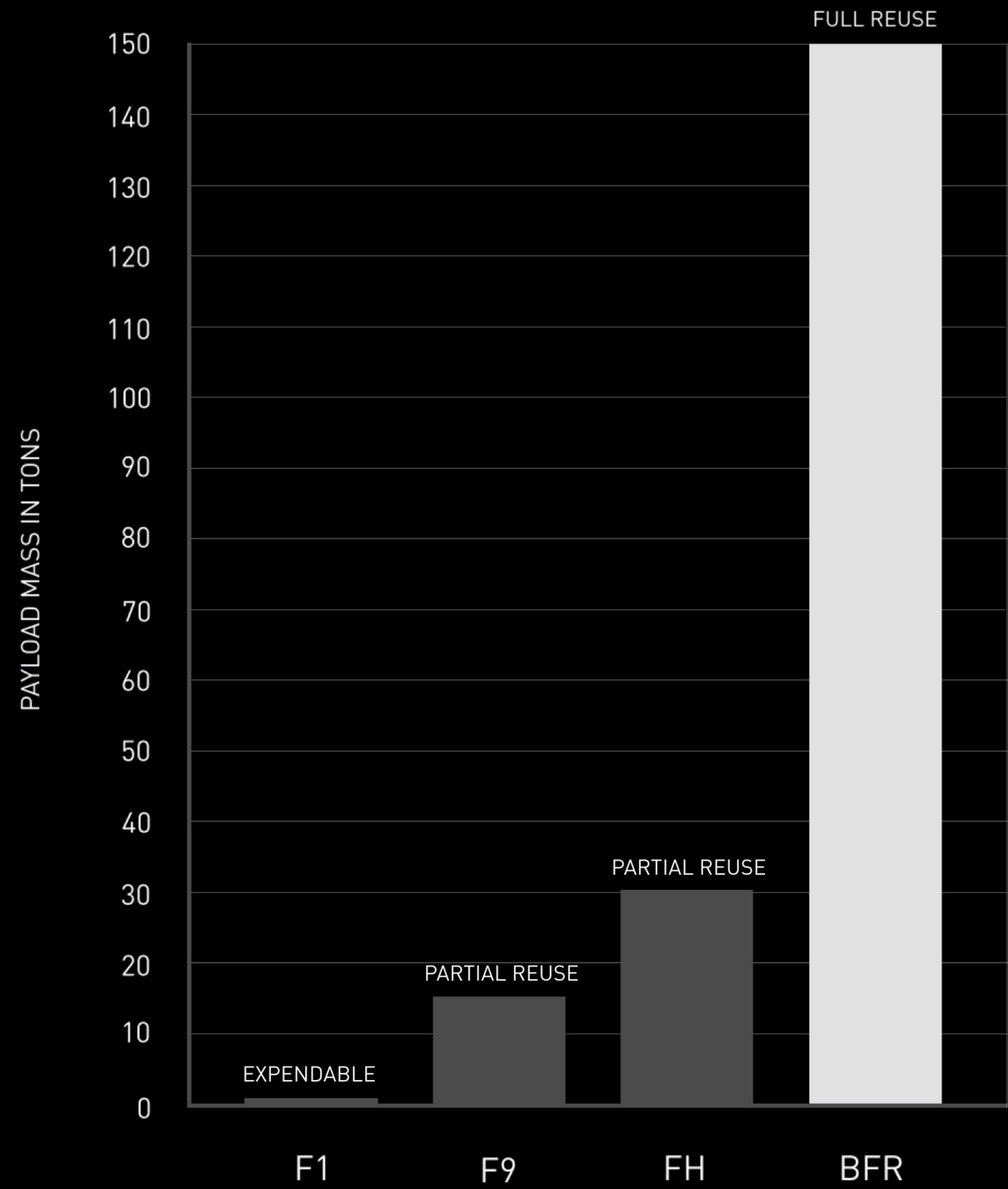
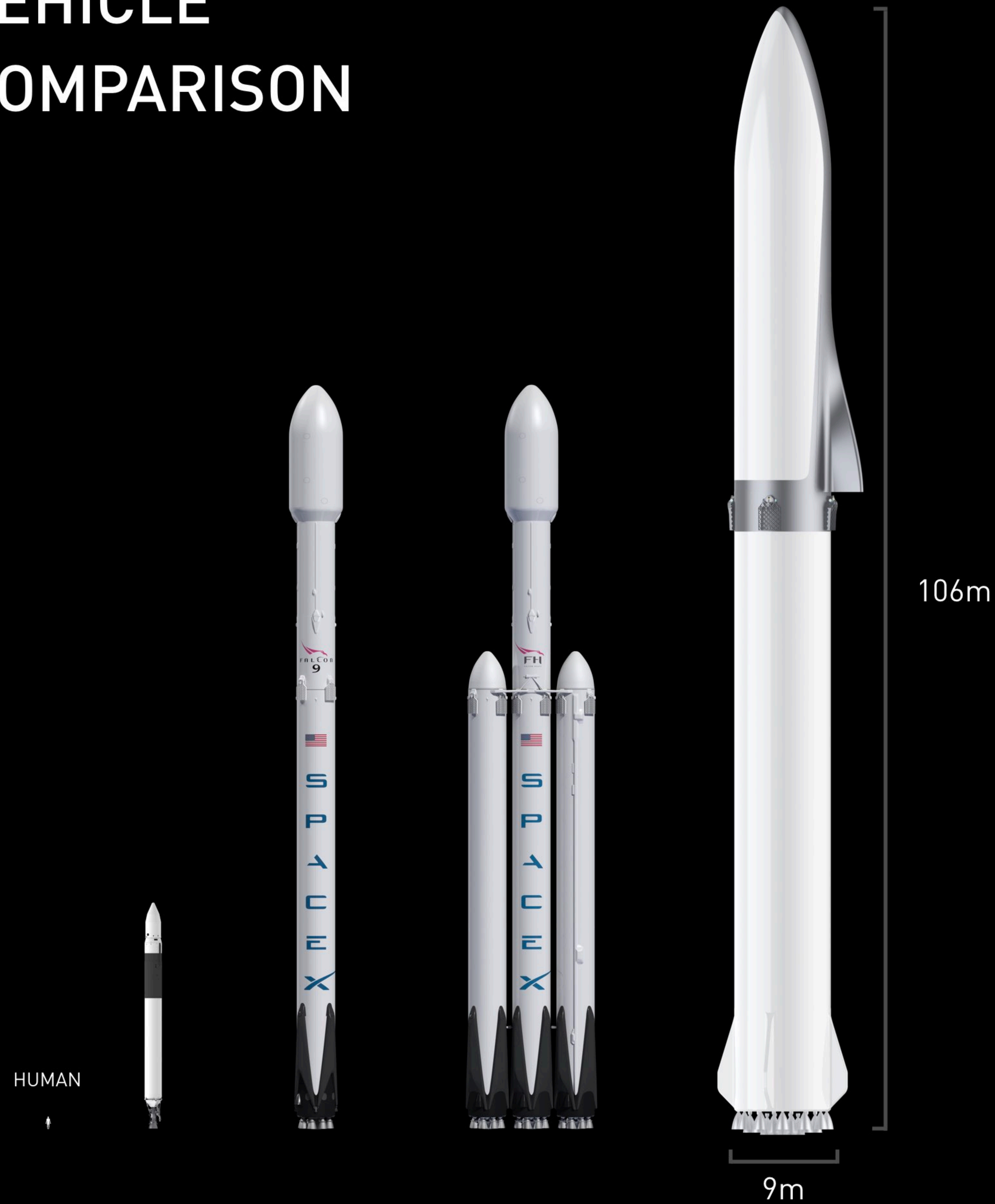
Dragon 2 will dock directly, not needing use of Canadarm

Perfected heat shield technology to withstand extremely high reentry temperatures





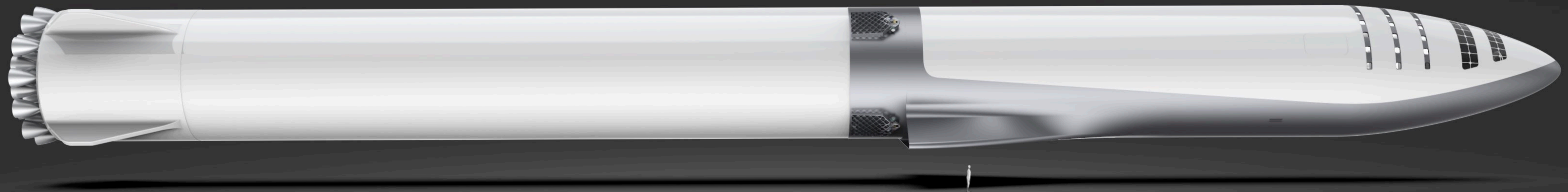
# VEHICLE COMPARISON



# BFR OVERVIEW

By creating a single system that can service a variety of needs, we can redirect resources from Falcon 9, Falcon Heavy and Dragon to this system—which is fundamental in making BFR affordable.

[WATCH ANIMATION](#)



Vehicle Length: 106 m

Booster Length: 58 m

Booster Thrust: 52,700 kN

# BFR



Ship Length 48 m  
Body Diameter 9 m

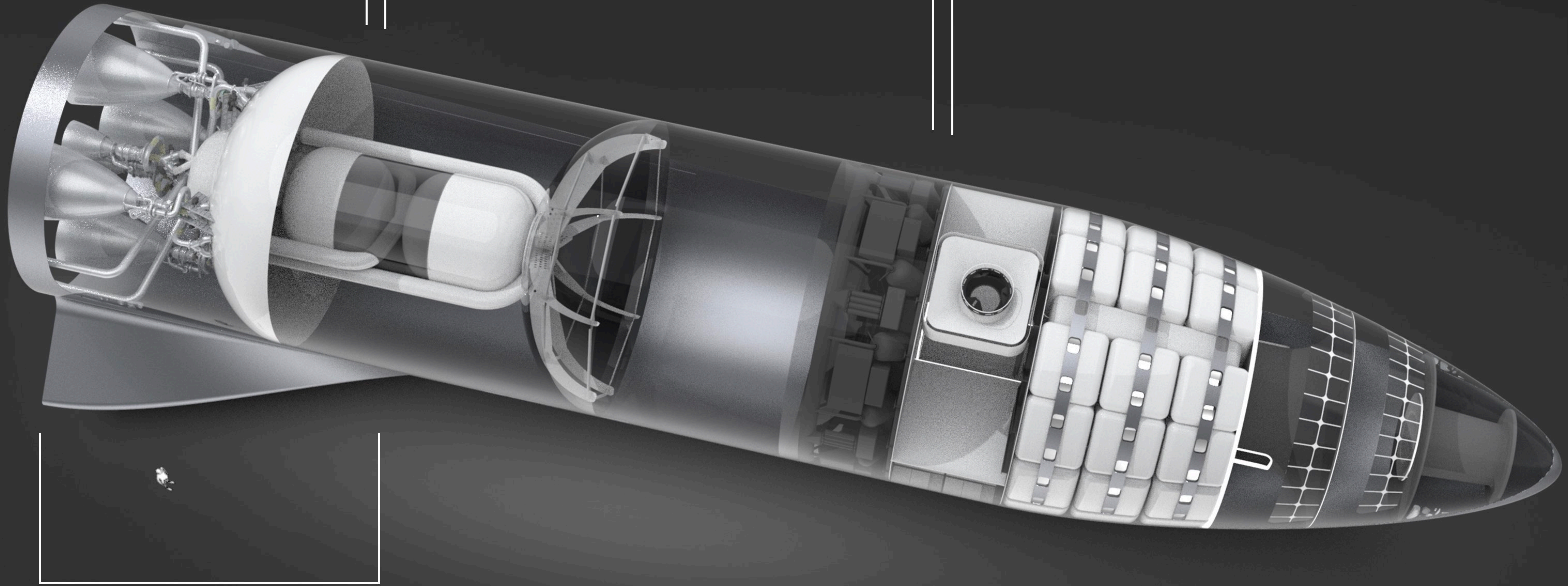
Ship Dry Mass 85 t  
Propellant Mass 1,100 t

Max Ascent Payload 150t  
Typical Return Payload 50 t

**ENGINES**

**PROPELLANT TANKS**

**PAYLOAD**



**DELTA WING**



**PRESSURIZED VOLUME 825 m<sup>3</sup>**

Greater than an A380 main deck

**MARS TRANSIT CONFIGURATION**

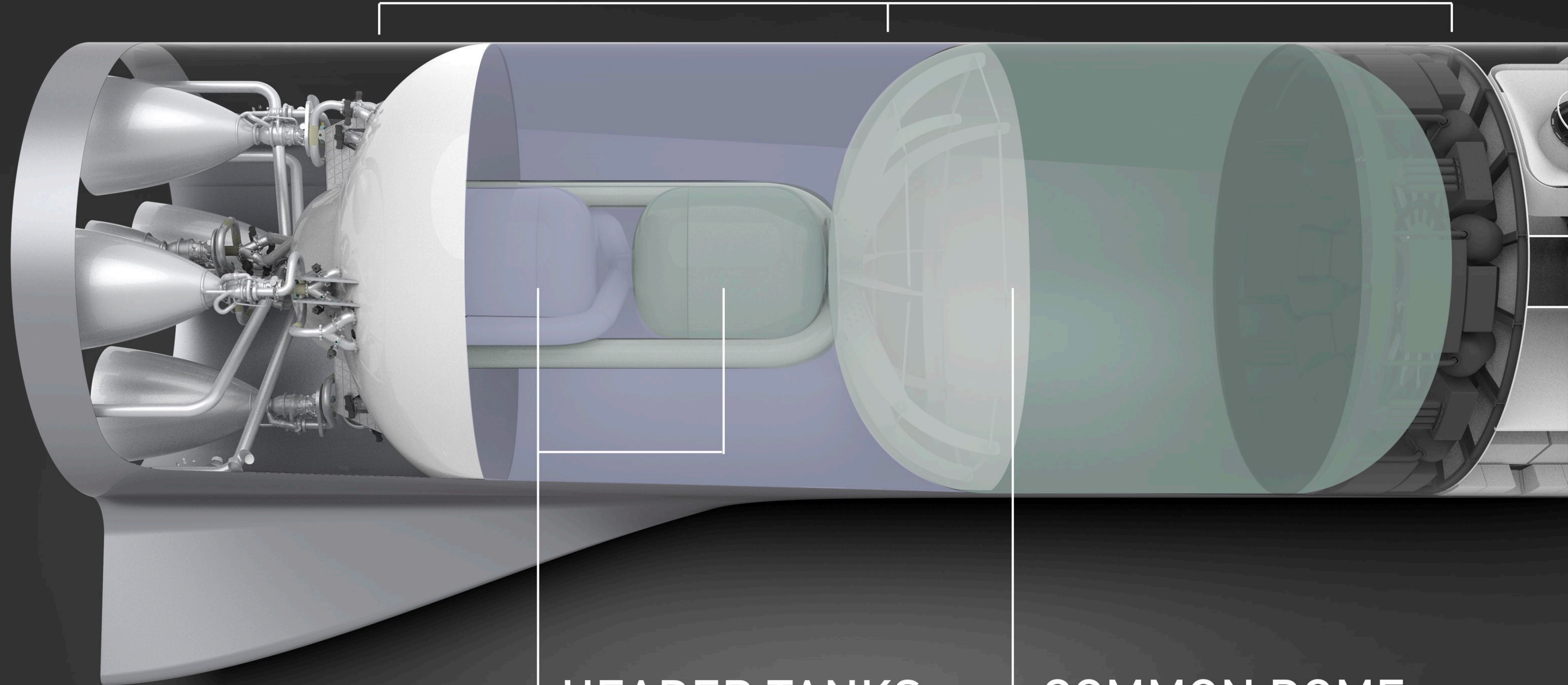
40 cabins and large common areas  
Central storage, galley and solar storm shelter

## FUEL TANK

Holds 240 tons of  $\text{CH}_4$

## OXYGEN TANK

Holds 860 tons of liquid  $\text{O}_2$



## HEADER TANKS

Hold landing propellant during transit

## COMMON DOME

Separates  $\text{CH}_4$  and  $\text{O}_2$

## RAPTOR ENGINES

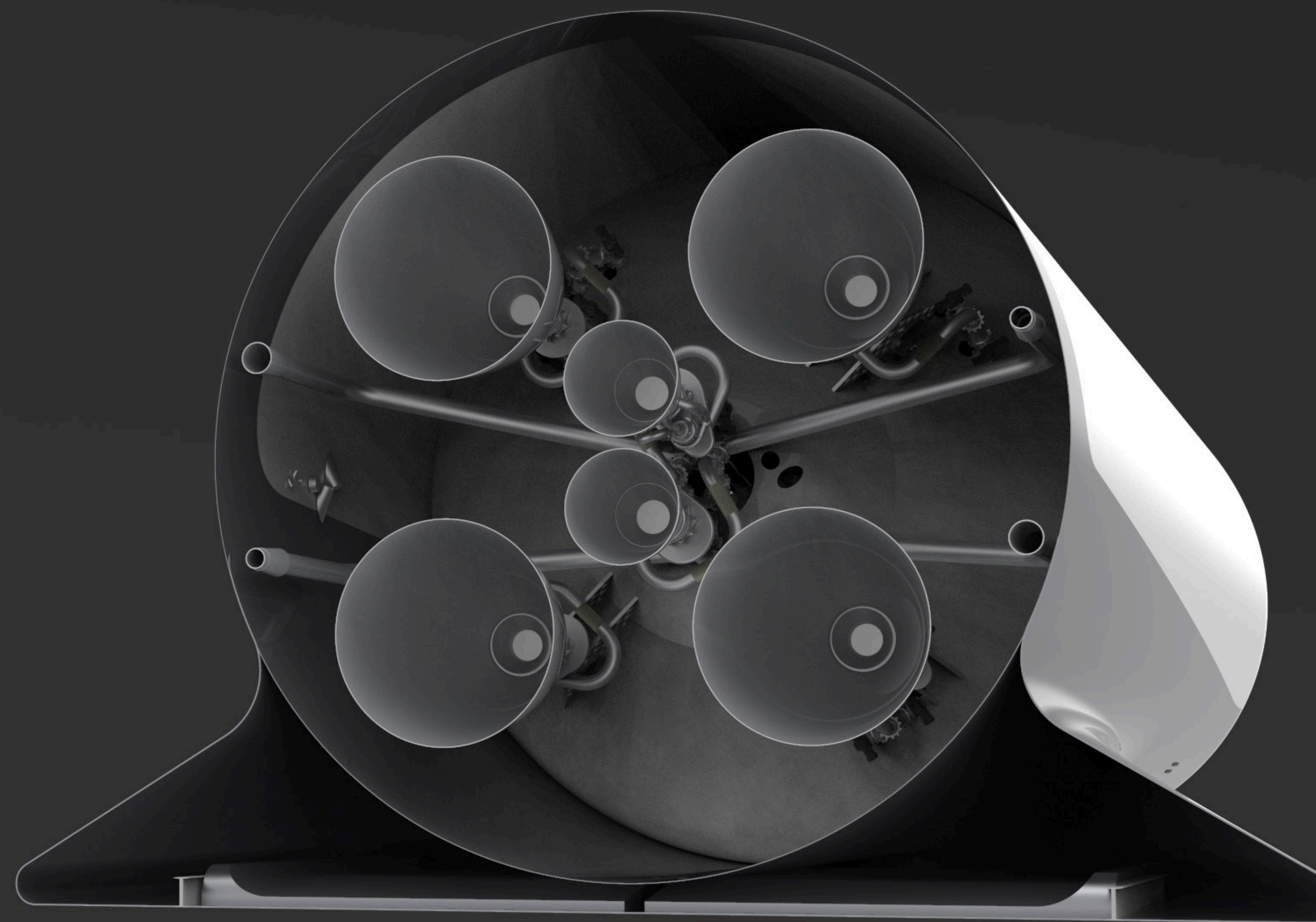
Chamber pressure 250 bar  
Throttle 20% to 100% thrust

## 2 SEA-LEVEL ENGINES

Exit Diameter 1.3 m  
Thrust (SL) 1,700 kN  
Isp (SL) 330 s  
Isp (Vac) 356 s

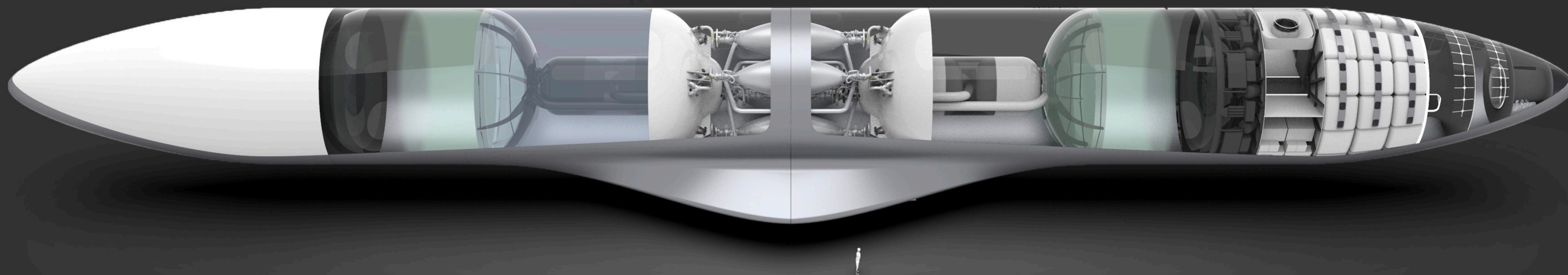
## 4 VACUUM ENGINES

Exit Diameter 2.4 m  
Thrust 1,900 kN  
Isp 375 s



# REFILLING

Propellant settled by milli-g acceleration using control thrusters

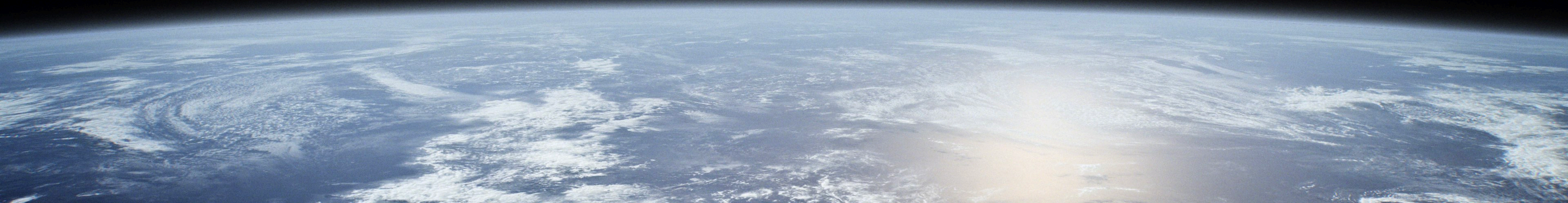
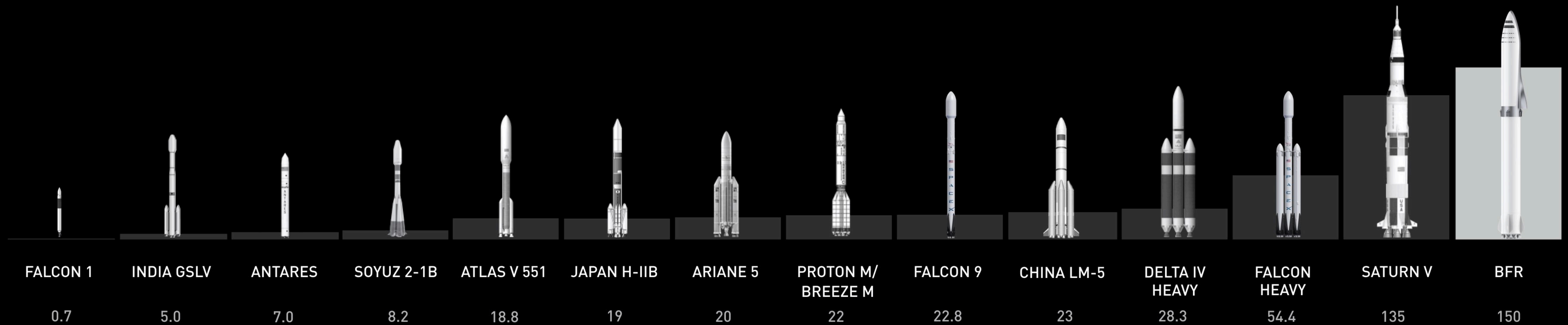




# ROCKET CAPABILITY

PAYLOAD TO LOW EARTH ORBIT IN TONS

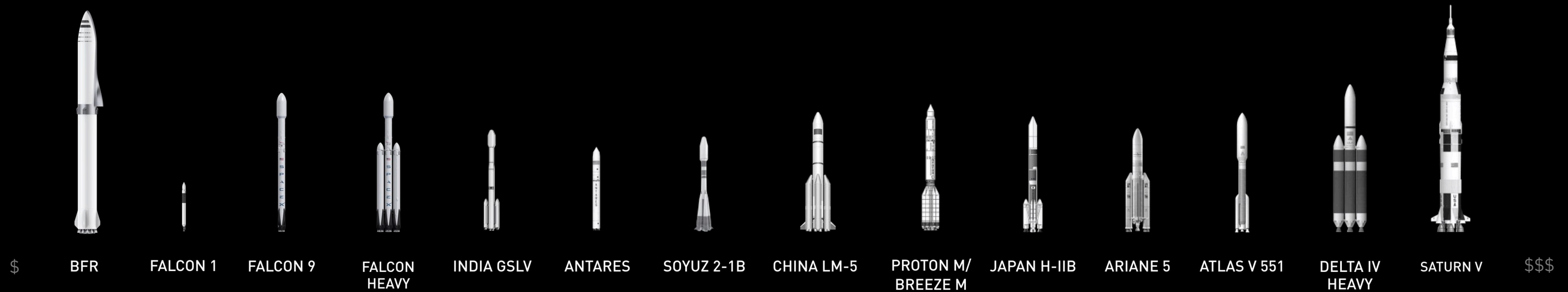
BFR has larger payload capacity than a Saturn V, while being fully reusable



# LAUNCH COST

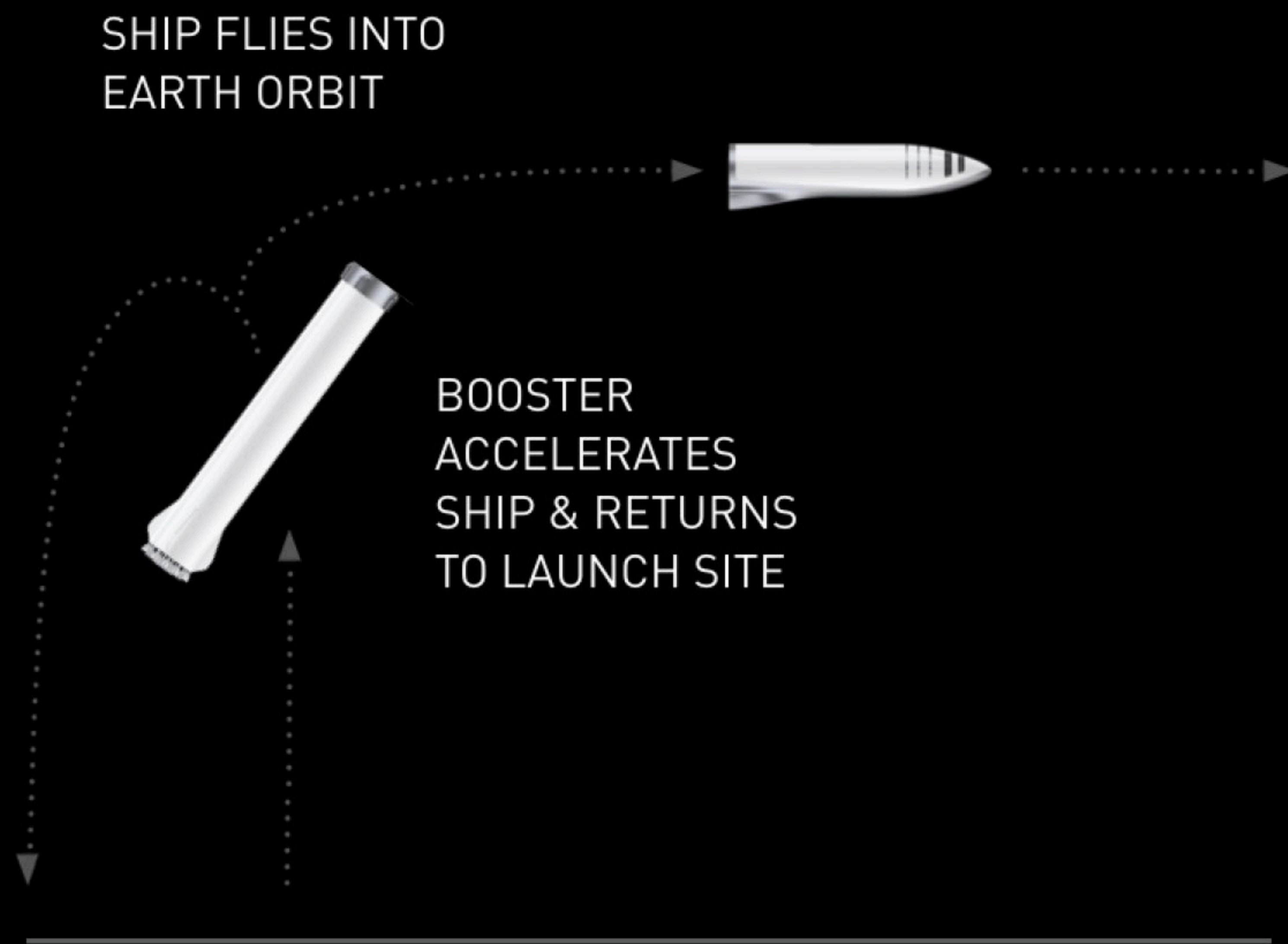
MARGINAL COST PER LAUNCH ACCOUNTING FOR REUSABILITY

Due to full reusability, BFR provides lowest marginal cost per launch, despite vastly higher capacity than existing vehicles



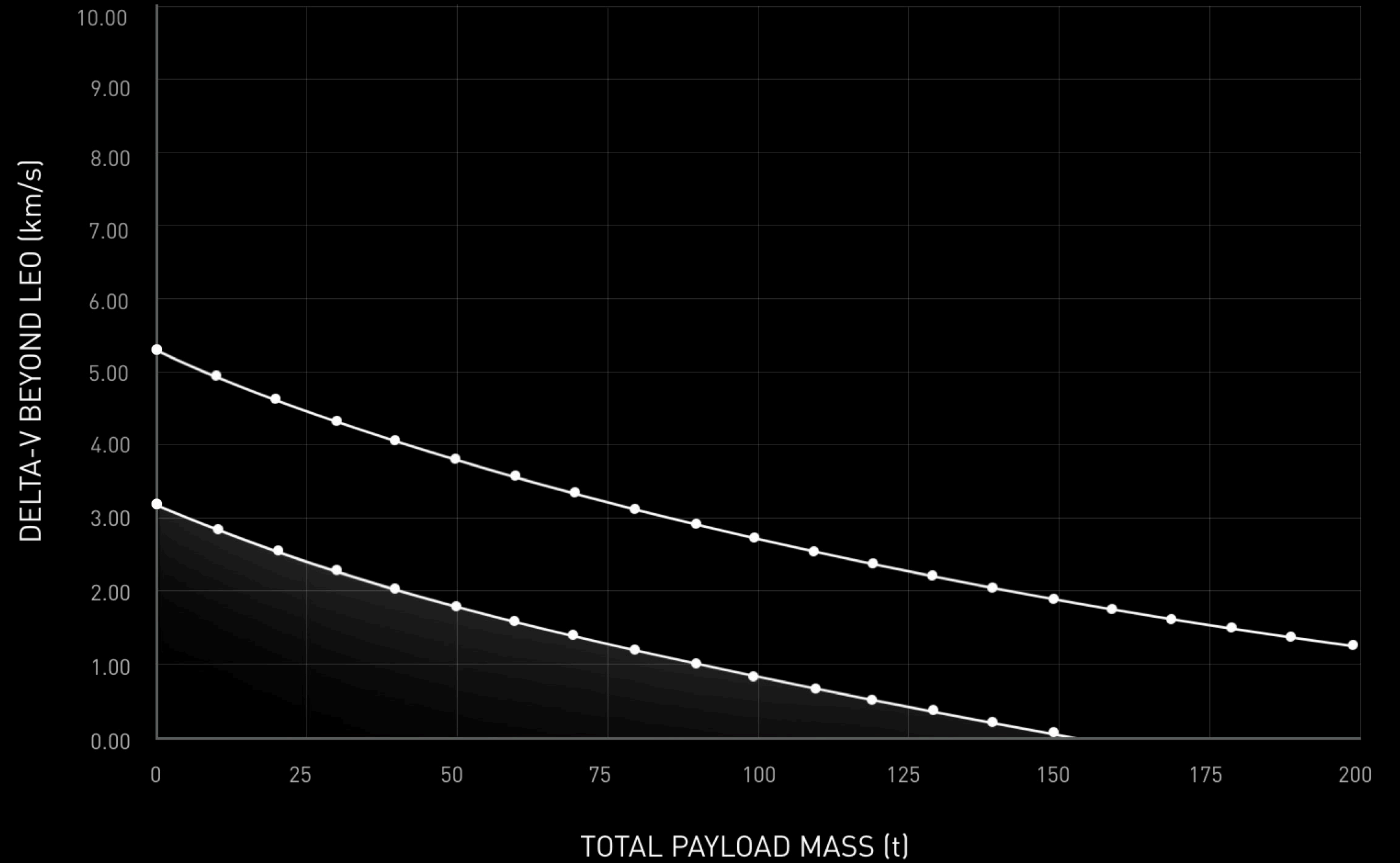
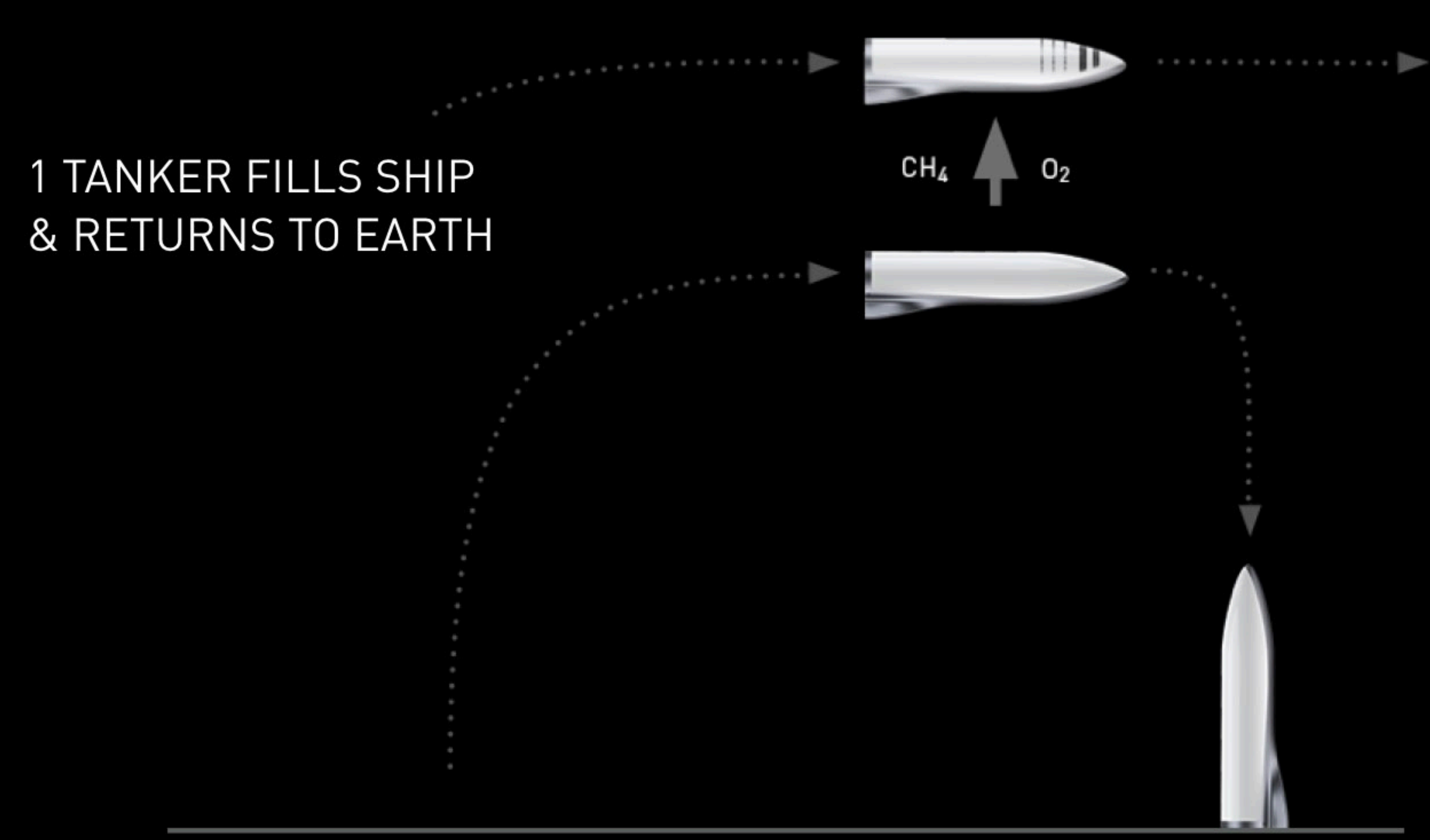
# VALUE OF REFILLING

SINGLE LAUNCH CAPABILITY FROM EARTH ORBIT



# VALUE OF REFILLING

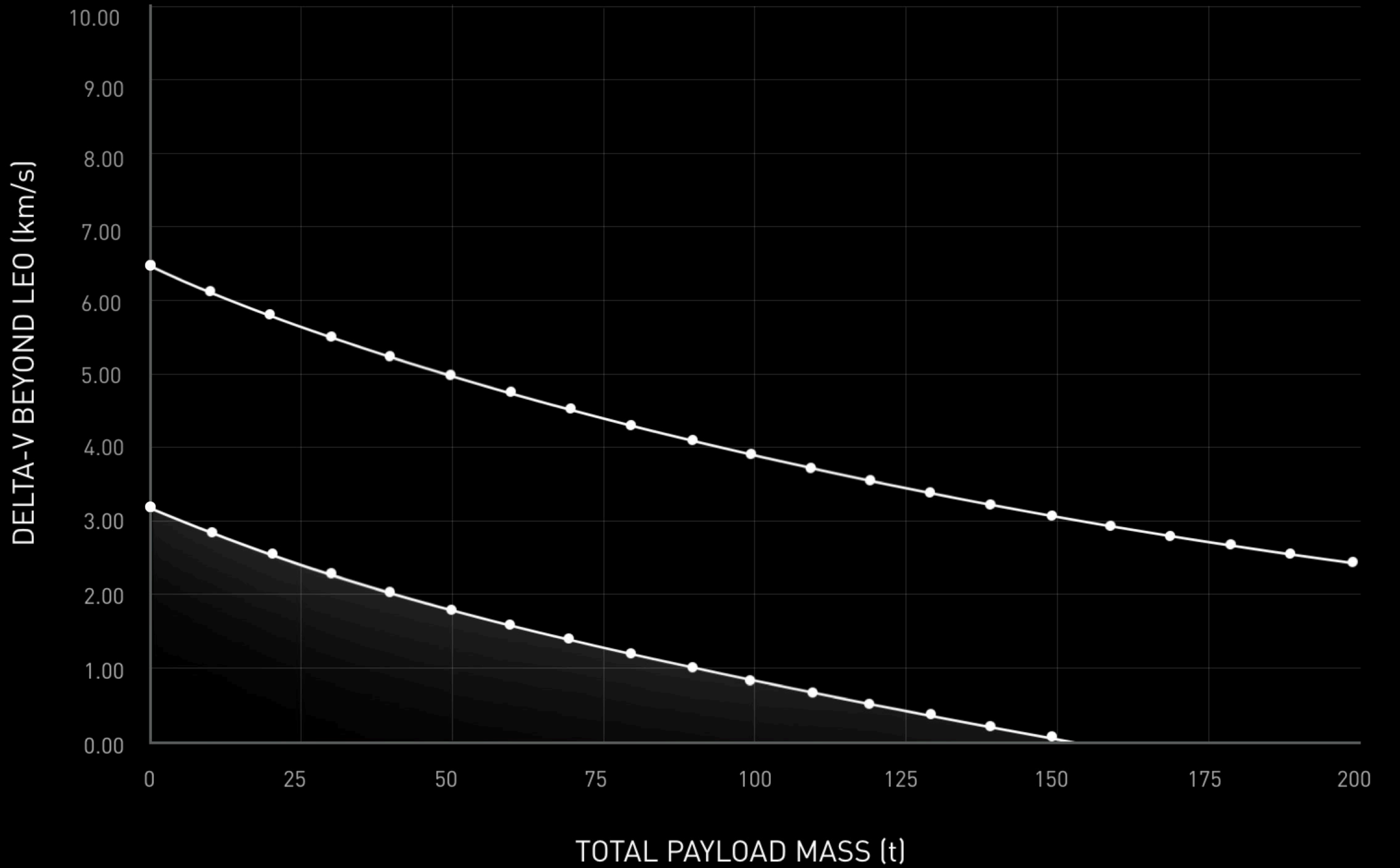
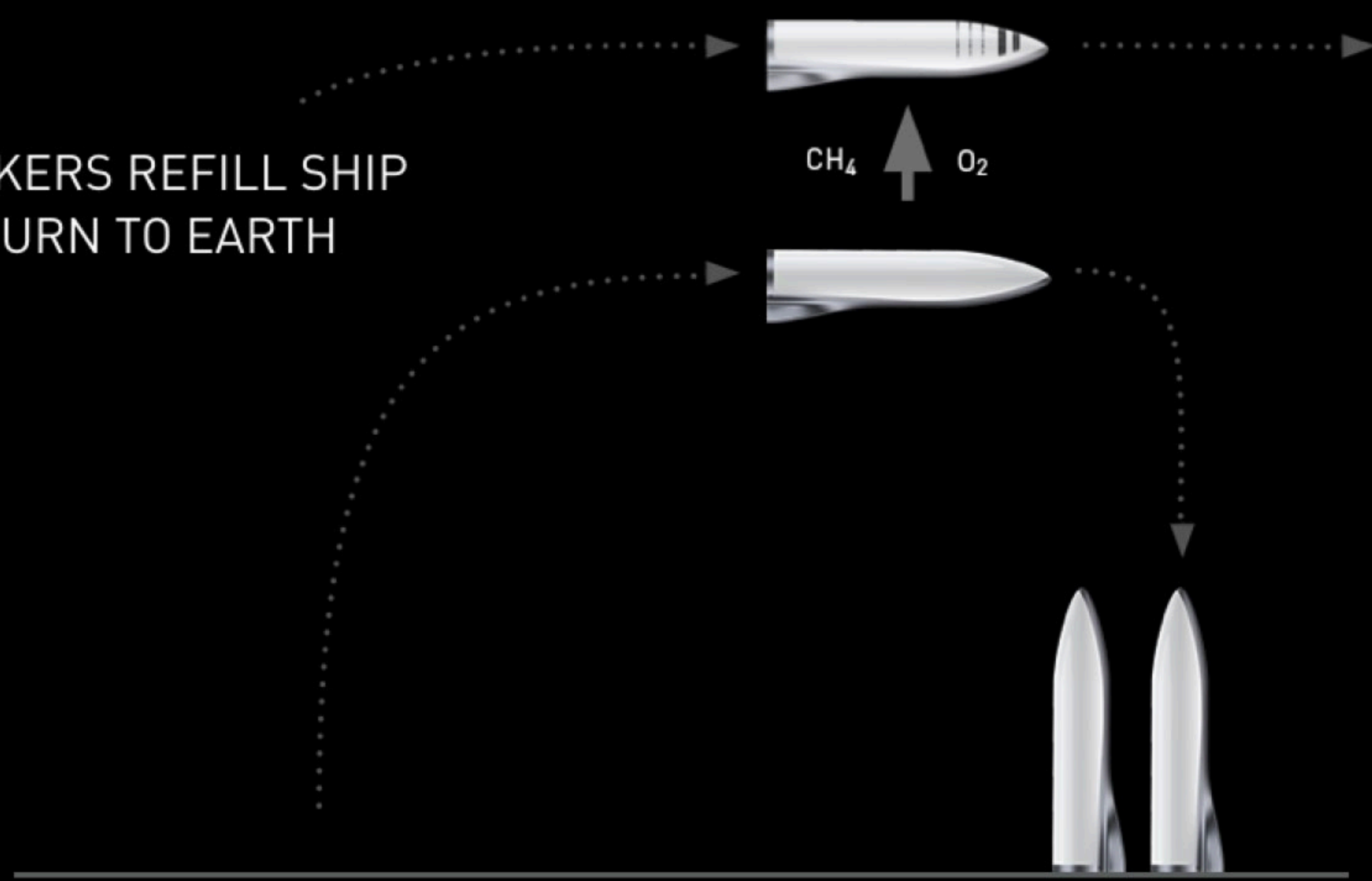
ONE TANKER



# VALUE OF REFILLING

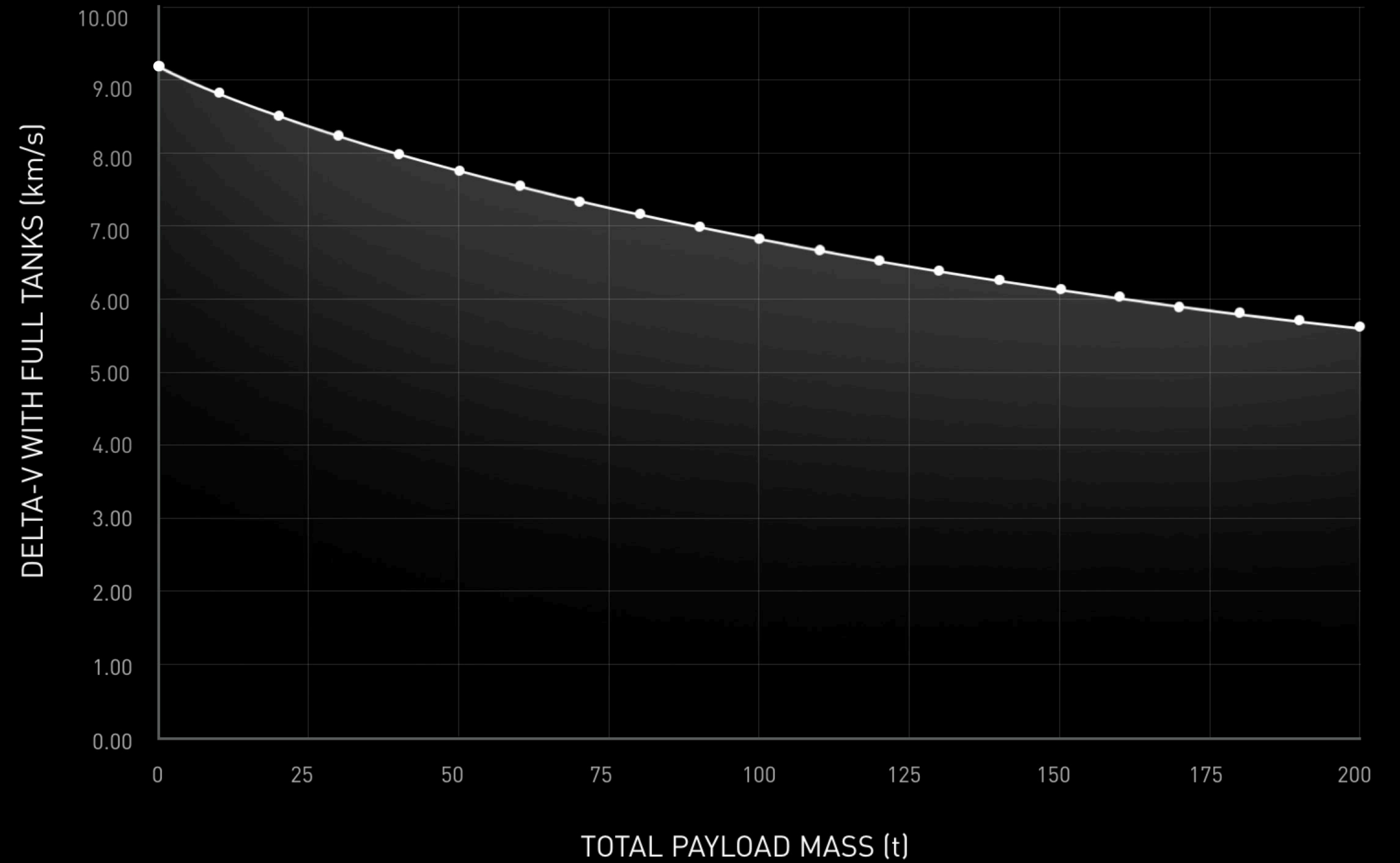
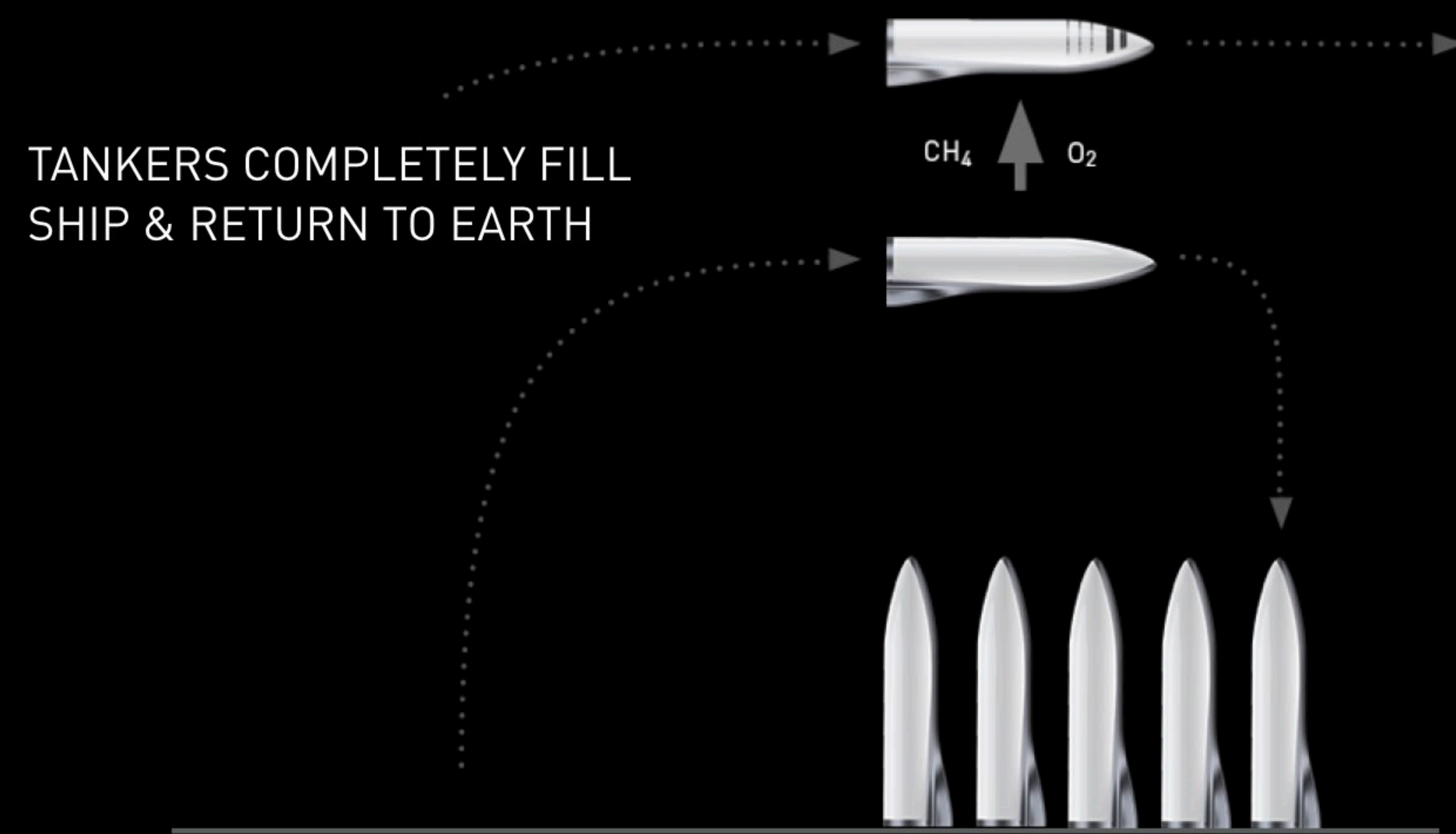
TWO TANKERS

2 TANKERS REFILL SHIP  
& RETURN TO EARTH



# VALUE OF REFILLING

FULL TANKS





# BFR CAPABILITIES

# SATELLITES

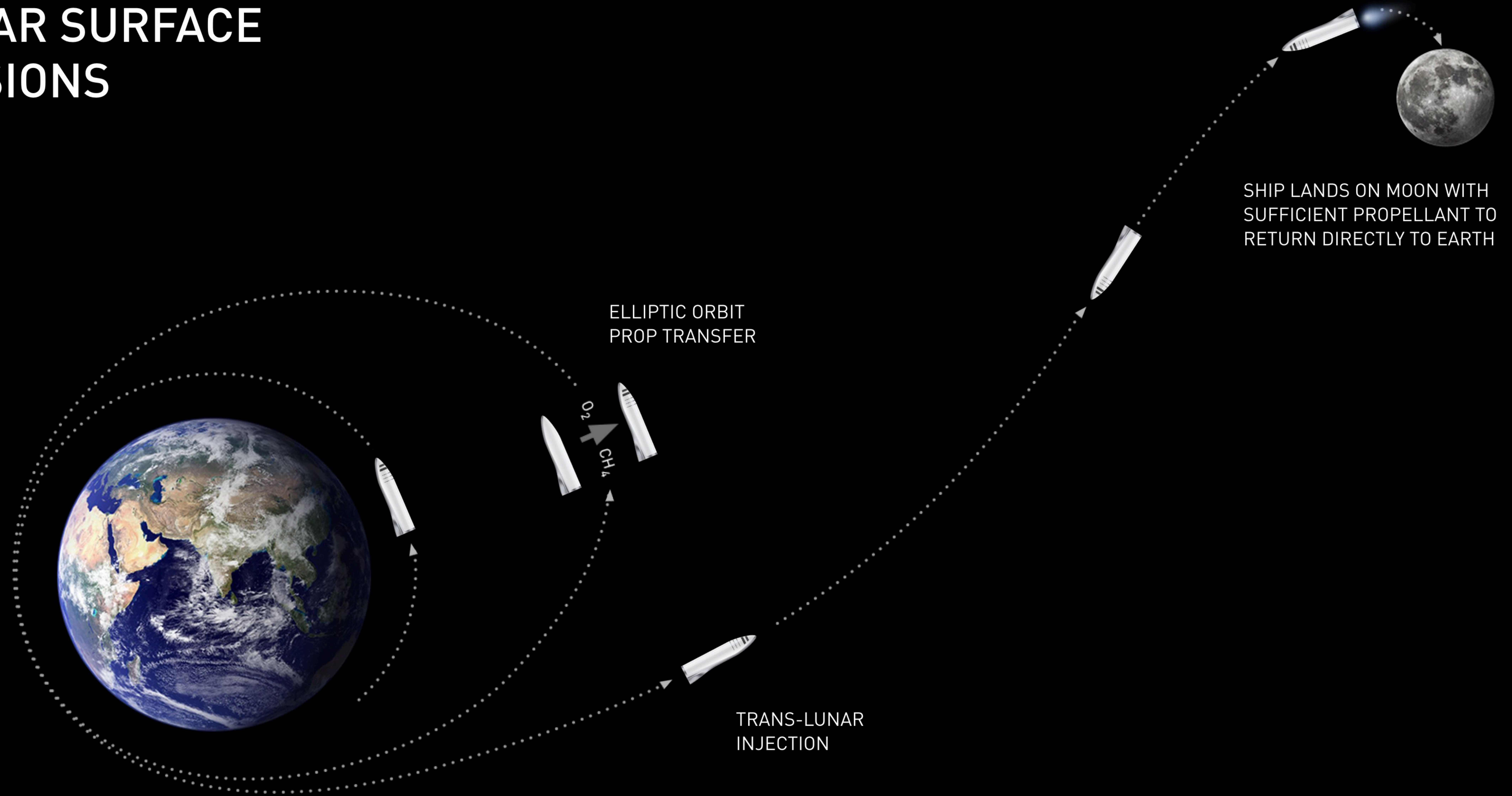




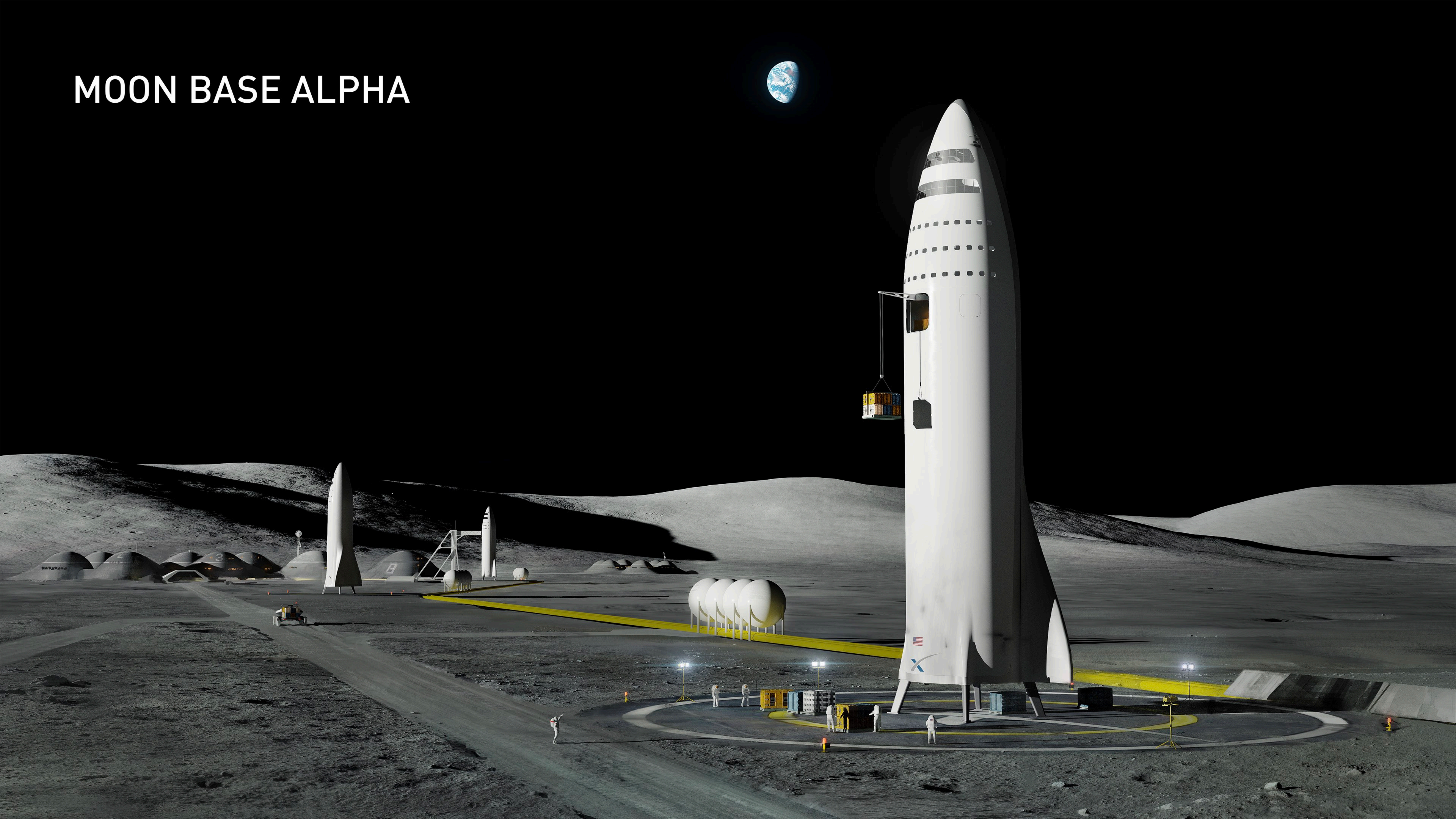
# INTERNATIONAL SPACE STATION



# LUNAR SURFACE MISSIONS



# MOON BASE ALPHA



# MISSIONS TO MARS

# MARS TRANSPORTATION ARCHITECTURE

1. BOOSTER ACCELERATES SHIP/TANKER & RETURNS TO LAUNCH SITE

2. SHIP FLIES INTO EARTH ORBIT

3. TANKERS REFILL SHIP & RETURN TO EARTH

6. SHIP PERFORMS MARS ASCENT & DIRECT RETURN TO EARTH

4. REFILLED SHIP TRAVELS TO MARS

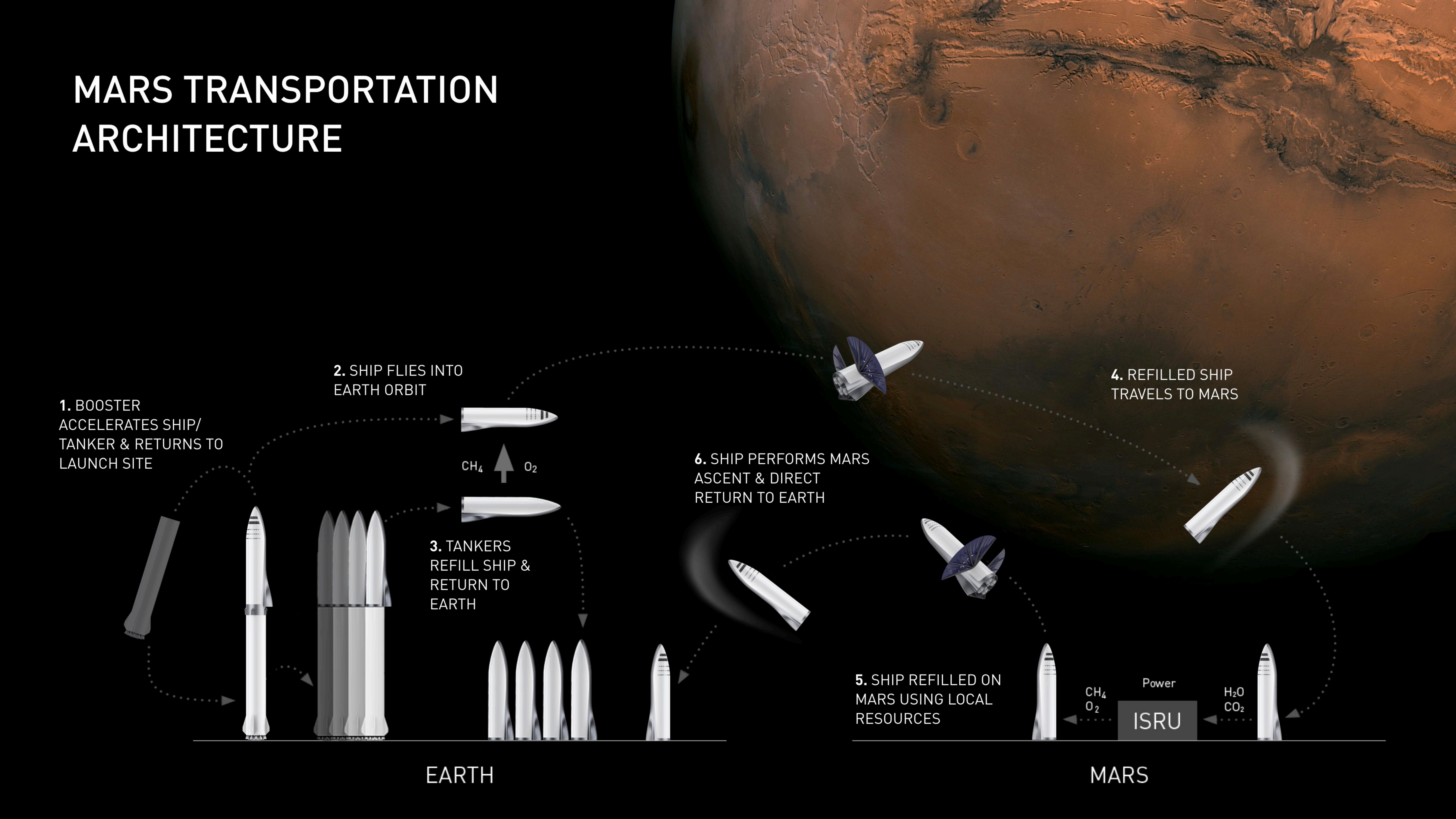
5. SHIP REFILLED ON MARS USING LOCAL RESOURCES

CH<sub>4</sub> ↑ O<sub>2</sub>

CH<sub>4</sub> O<sub>2</sub> Power H<sub>2</sub>O CO<sub>2</sub> ISRU

EARTH

MARS



# MARS ENTRY AND LANDING

Hyperbolic entry at up to 7.5 km/s

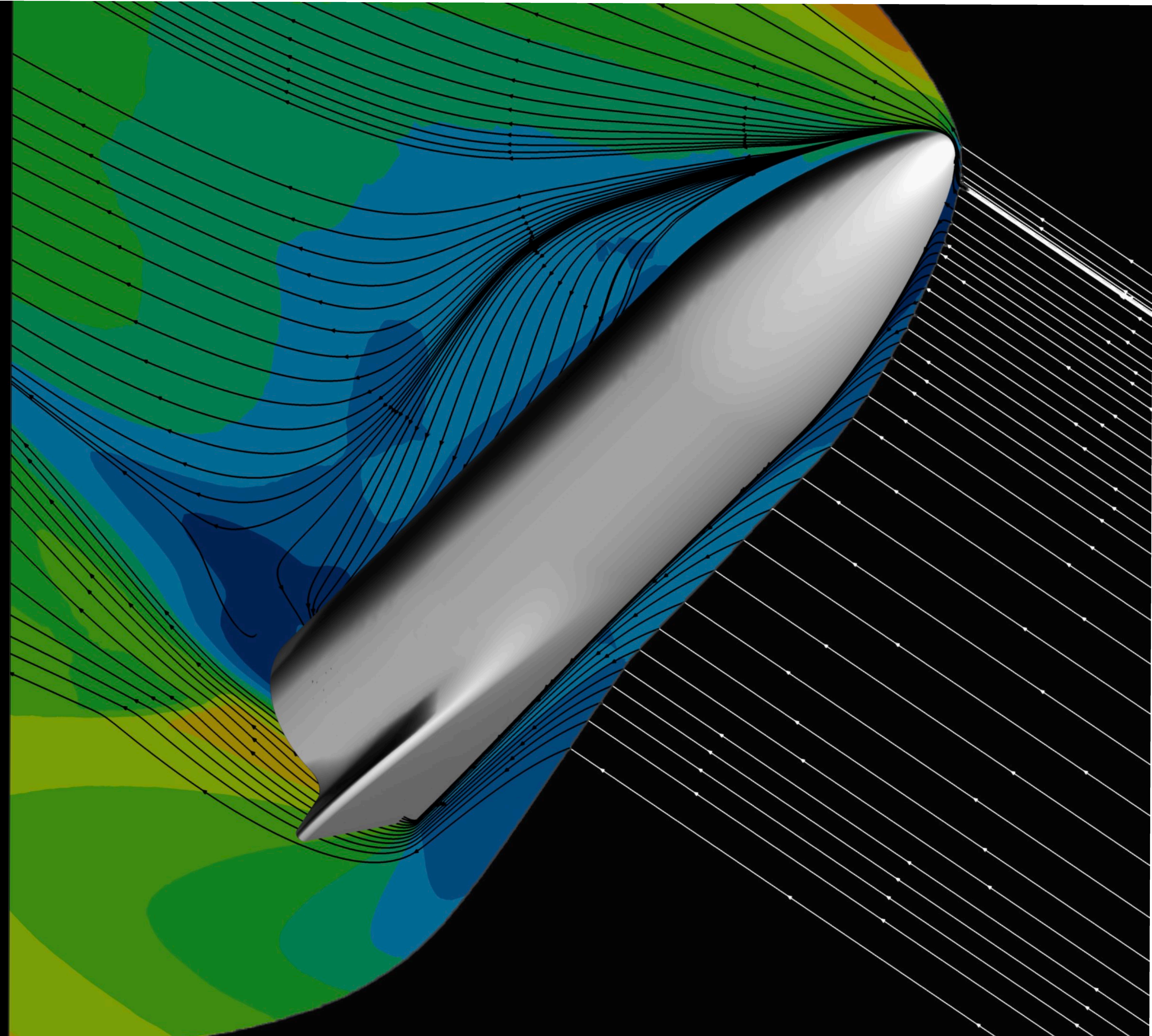
Leverages ablative heat shield materials  
developed for Dragon vehicles

Peak acceleration of 5 g's (Earth referenced)

Over 99% of energy removed aerodynamically

Supersonic retropropulsion for landing burn

[WATCH ANIMATION](#)



# INITIAL MARS MISSION GOALS



## 2022: CARGO MISSIONS

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Land at least 2 cargo ships on Mars

Confirm water resources and identify hazards

Place power, mining and life support infrastructure for future flights



## 2024: CARGO & CREW MISSIONS

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2 crew ships take first people to Mars

2 cargo ships bring more equipment and supplies

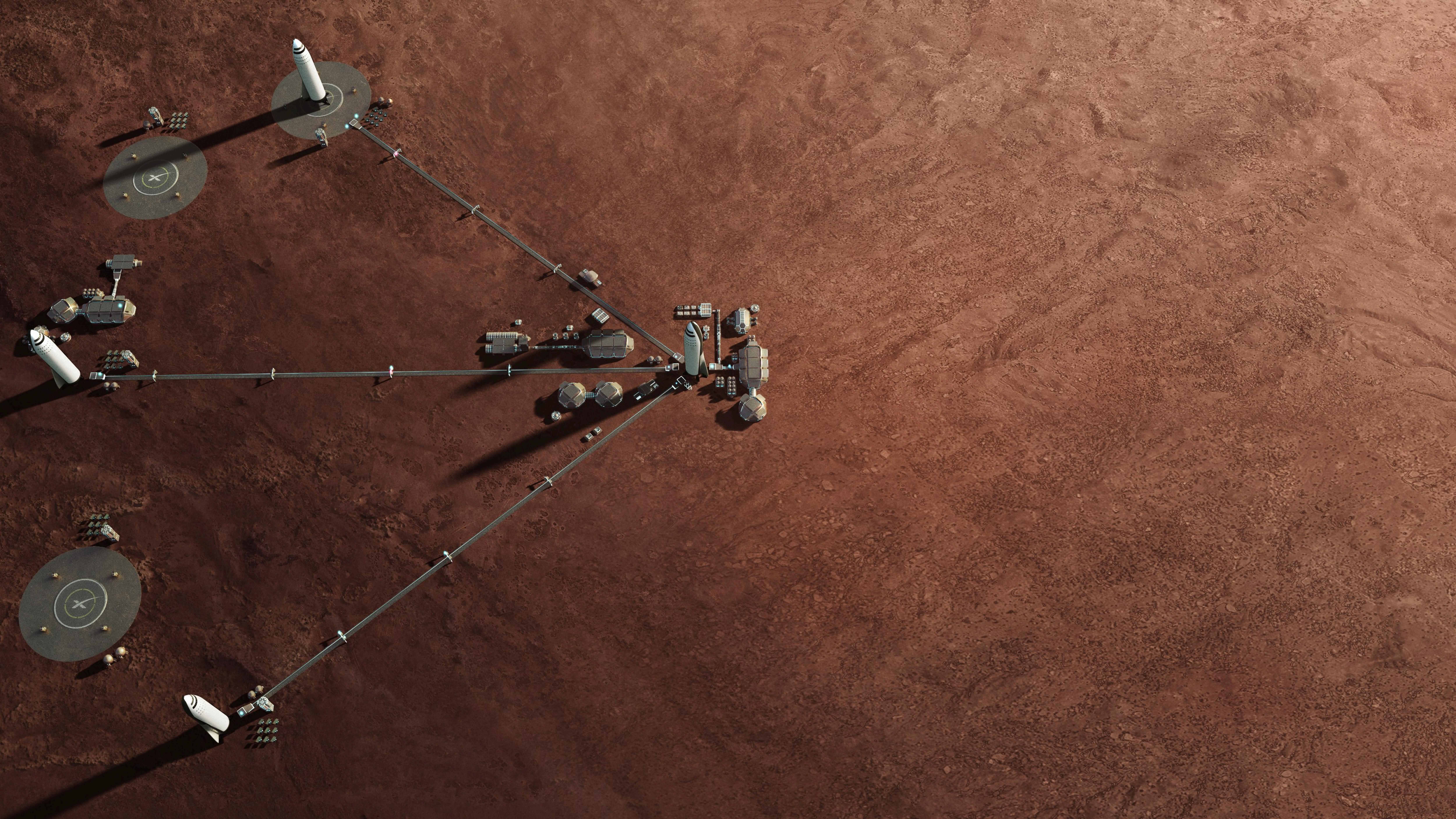
Set up propellant production plant

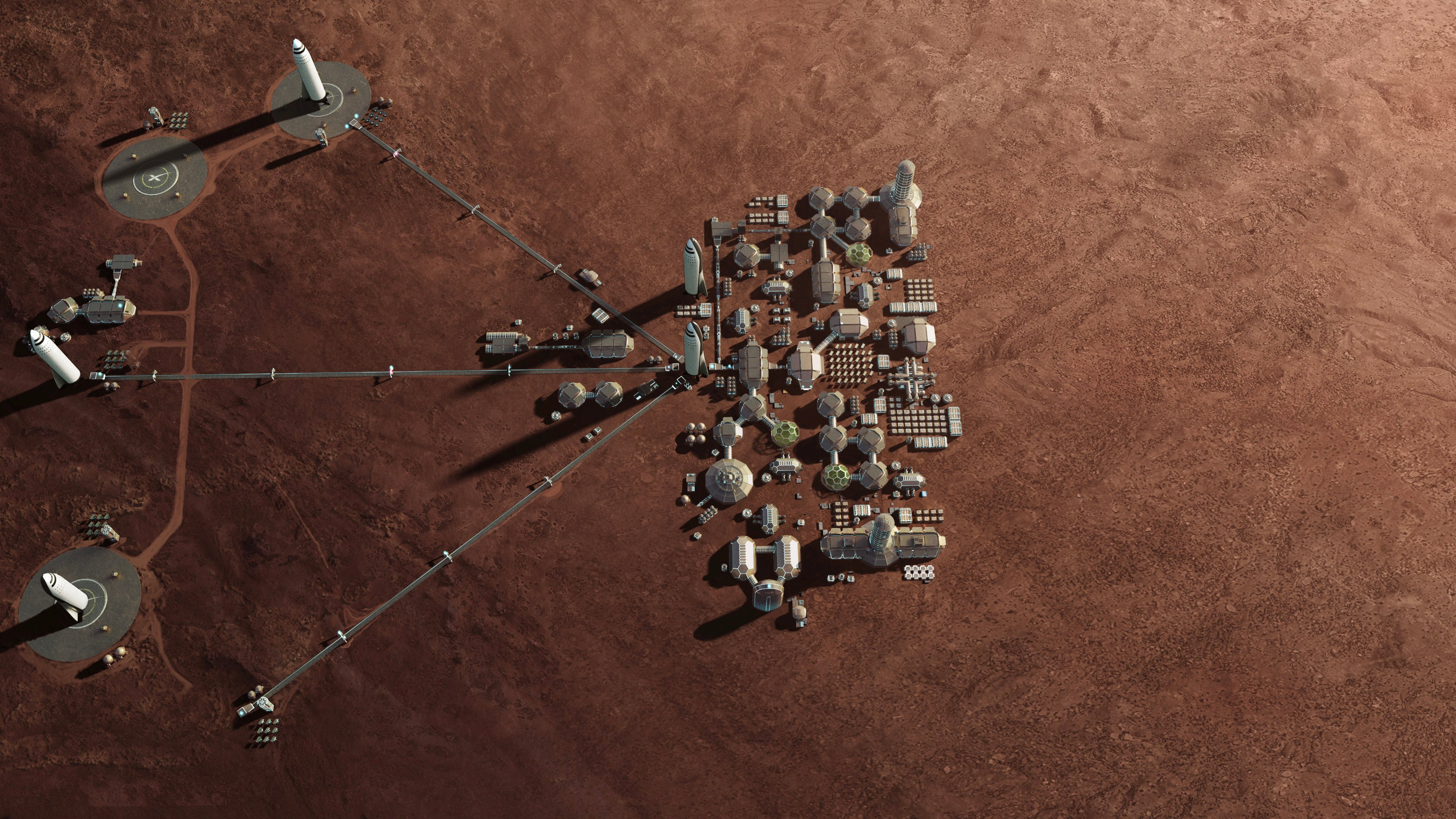
Build up base to prepare for expansion

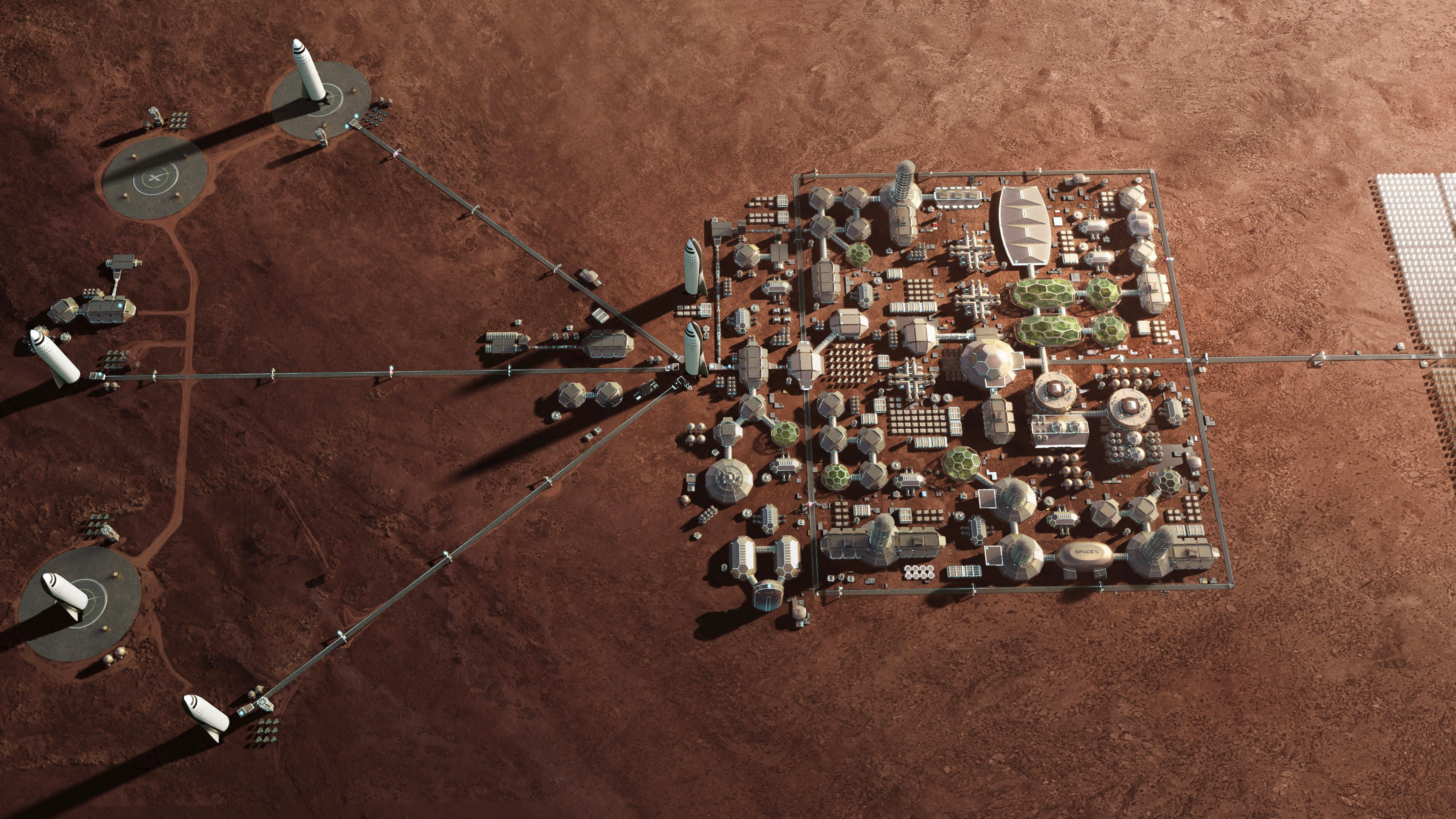


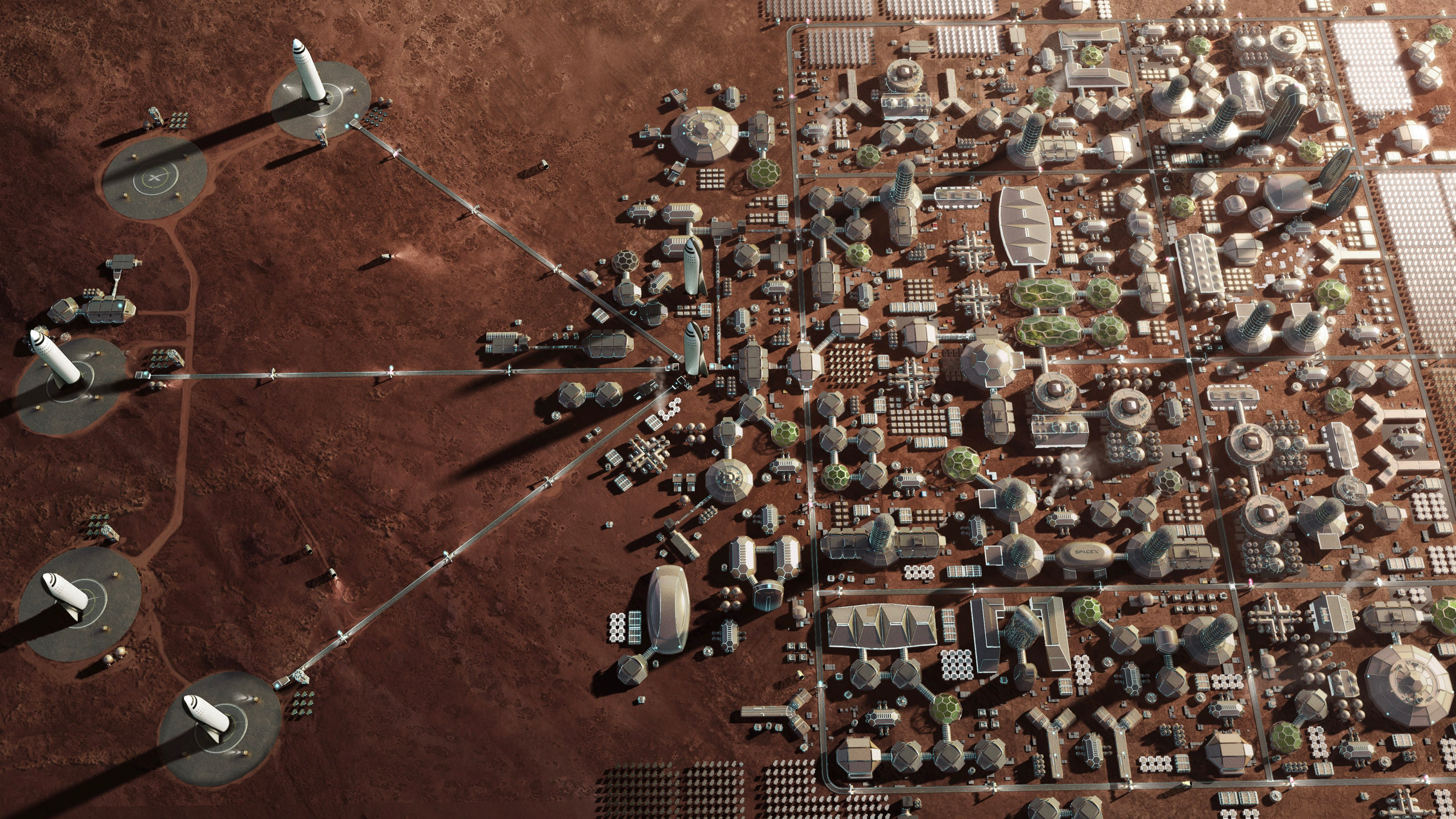
# BASE BUILDUP









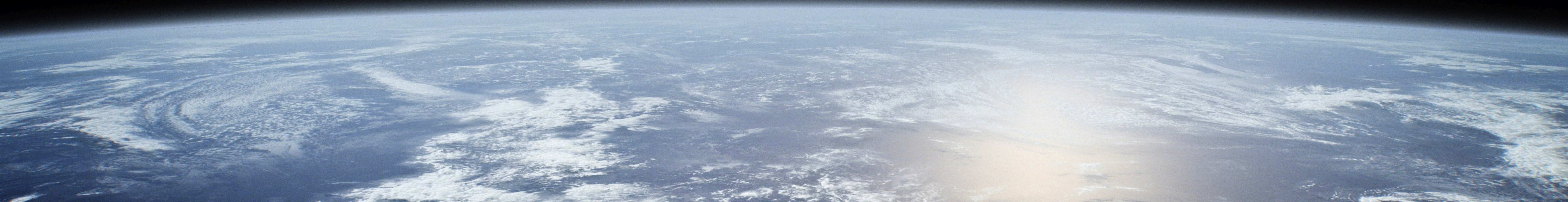




# EARTH TO EARTH TRANSPORTATION

BFR has the ability to support Earth to Earth transport, with most of what people consider to be long distance trips being completed in less than half an hour.

Consider how much time we currently spend traveling from one place to another. Now imagine most journeys taking less than 30 minutes, with access to anywhere in the world in an hour or less.



A rocket is shown ascending from the Earth's surface, viewed from space. The rocket is dark blue with a white nose cone and a white plume of smoke. The Earth's surface is visible in the background, showing a mix of green and brown colors. A white rectangular box is overlaid on the rocket, containing the text "WATCH EARTH TO EARTH FILM" in white capital letters.

WATCH EARTH TO EARTH FILM