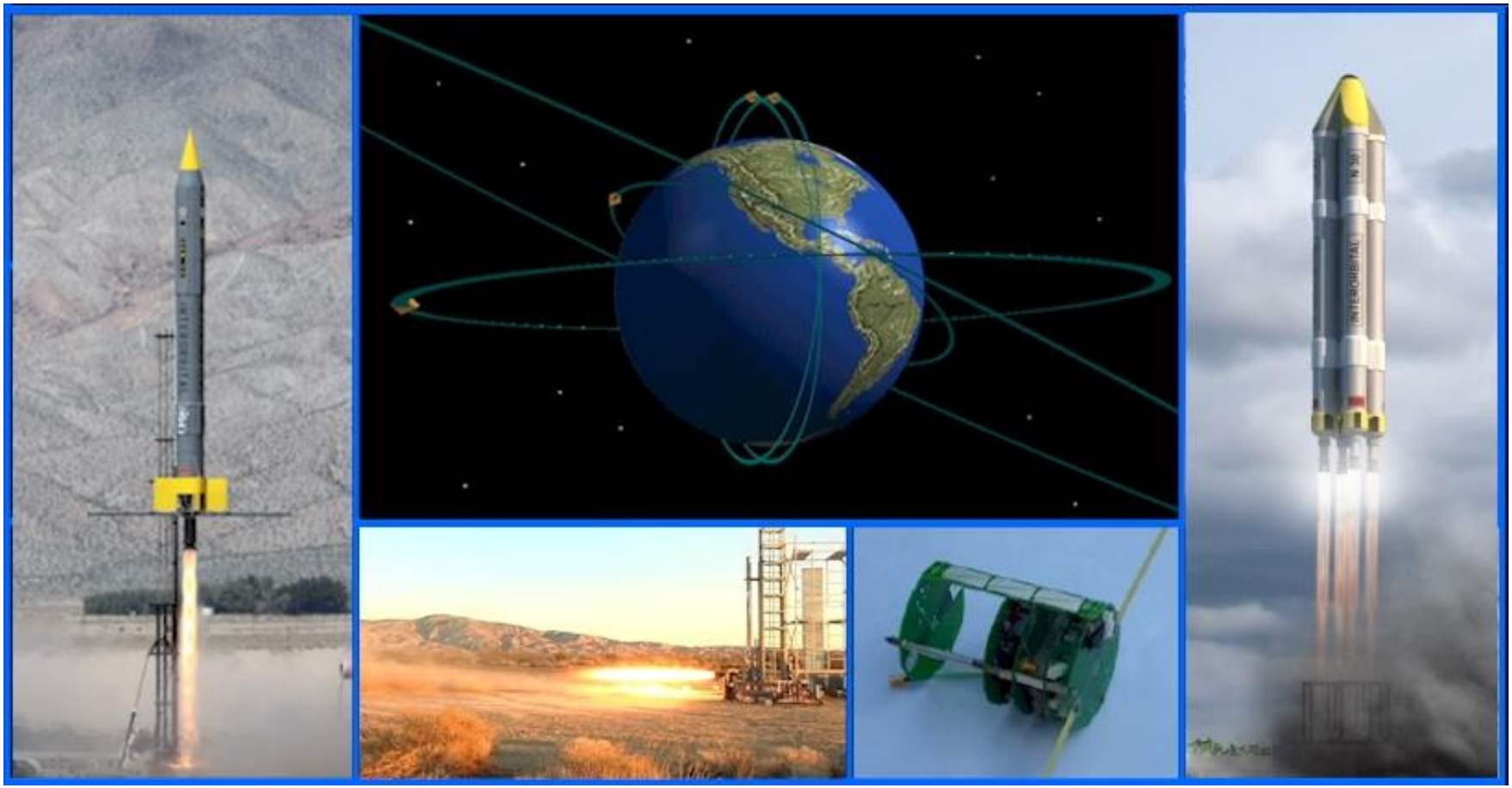
INTERORBITAL SYSTEMS: Launch Services to LEO, LUNA, and Beyond

INTERPLANETARY SMALL SATELLITE CONFERENCE May 7-8, 2018 Cal Tech, Pasadena, CA

Presented by Randa Milliron, CEO/CoFounder



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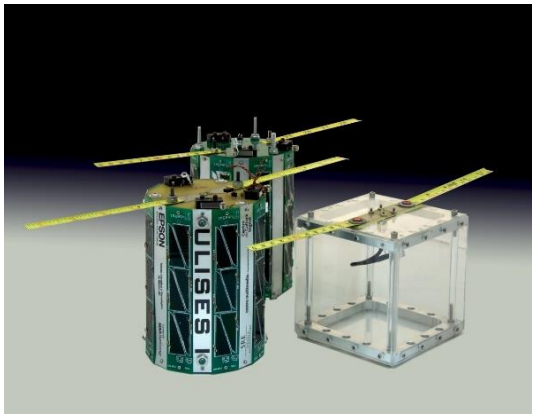
Rocket/Satellite R&D at IOS Mojave Air and Space Port Lab



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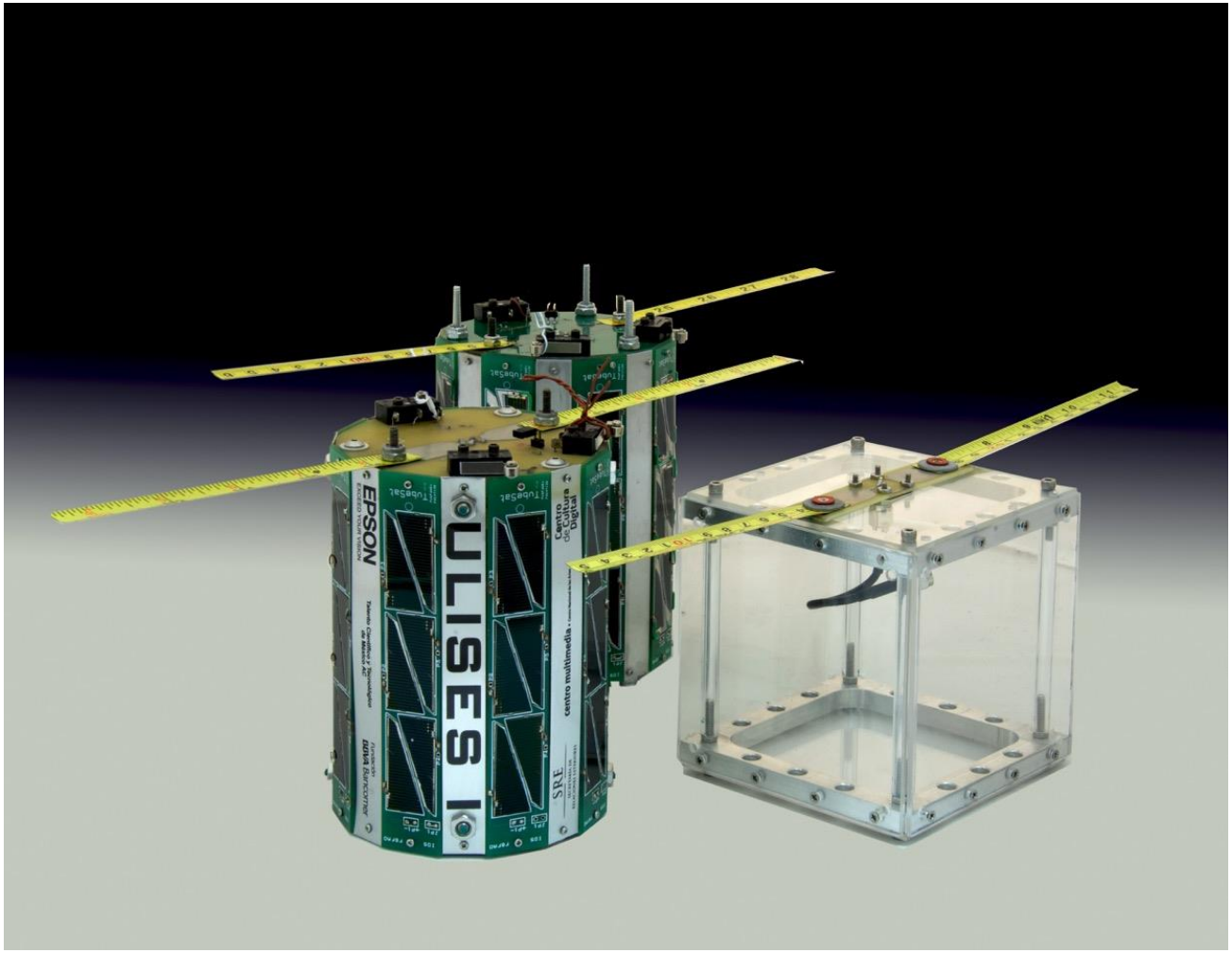
IOS TubeSats and CubeSat Personal Satellite Kits: in use in 25 Countries as the Center of STEM Curricula



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project
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EXPLORE
MÍDIA


mucsat
A SPACE ART PROJECT


FIU

Launch Manifest: 146 Satellites

CUBESATS: UC Irvine, UCISAT1; NASA Independent Verification and Validation (IV&V) Facility, FPT University, Vietnam, F-1 CubeSat: Nanyang Technological University, Singapore VELOX-P; Google Lunar X PRIZE (GLXP) Team PLAN B (Canada);GLXP Team EuroLuna, Romit 1, Denmark; King Abdullah University, Saudi Arabia (KAUST); The Golden iPod: Earth to Sky, spaceweather.com, Bishop, CA; Pakistan's I CUBE-1 Series, Islamabad Institute of Science and Technology; Boreal Space, Wayfinder III; Rufs the Space Lion, Sweden; Solarem (UK); Ars Technica /Ars Orbital; Dave Cote, Vancouver; SatRevolution, Poland; MITRE Corporation

TUBESATS: Morehead State University (Kentucky Space); InterAmerican University of Puerto Rico; Project Calliope; University of Sydney (2) *i-INSPIRE (initial-INtegrated SPectrograph, Imager & Radiation Explorer)*; Aslan Academy,LA; Universidad de Puerto Rico/Marcelino Canino Middle School; GLXP Team SYNERGY MOON Space-Qualifying Comms; NASA CubeQuest Team MILES / Fluid & Reason Software; Naval Postgraduate School; Defense Science and Technology Lab (DSTL) United Kingdom; Austrian Arts Group mur.at with MURSAT: Earth-as-Art Project; United States Military Academy at West Point; Universidad de Chile, Santiago; AKQA Advertising, SF; Brazilian Space Institute/ Ubatuba Middle School, Sao Paulo, Brazil; Mexican Space Collective, ULISES I; TriVector Services (Huntsville) TRACsat; La Despensa, Advertising; Mountain View/Los Altos School District; NASA (IV&V) Facility; Institute of Advanced Media Arts and Sciences, Japan; University of Sao Paulo, David Lawrence K-8 School, North Miami; RADG, Ohio; OMNI LABS, Brazil; Noise Figure Research; Ute Mountain Ute/Colorado State University Extension 4H; Shasta College, California; KEN KATO, Japan; Ryerson University, Toronto; DOCTOR WHO TARDIS in Orbit; Spacebooth, Belgium; Raytown Quality Schools, MO; College of Staten Island; University Nova de Lisboa; National University of Singapore, RSPL; Manhattan Satellite Lab; NYCSAT-1; RMC s.r.o.; *Popular SK*, Slovakia; Penn State University, Wilkes-Barre; Universidad Autónoma de Zacatecas, Mexico; UNAM, Mexico; Technical University of Moldova; Harmony School of Excellence, Austin; Base 11/ West LA College; MEDO, South Africa; IBM (Partial List)

NEPTUNE Rocket Series Common Propulsion Module (CPM)

CPM 1.0: Basic Building-Block of World's Most Affordable Dedicated Small-Sat Launcher

GPRE 7.5KNTA Rocket Engine Static Test

ISP = 245 Sec (sea level); Density ISP = 323 Sec (sea level); Vacuum ISP = 305 Sec

Pressure Fed; Green Hypergolic Propellants; No Ignition System or Pumps Required;

State-of-the-Art All-Composite Combustion Chamber and Nozzle; Designed for Rapid Mass Production

All Rocket Engines Designed and Built in the U.S. by Interorbital Systems

GPRE 0.75KNTA Upper-Stage Rocket Engine Static Test

First test firing of Interorbital's NEPTUNE series launch vehicle's liquid upper-stage rocket engine (GPRE 0.75KNTA) with a sea-level thrust of 750 pounds and a sea-level specific impulse of 245 seconds, or a thrust of 1,000 pounds and a specific impulse of 300 seconds in a vacuum (with expansion nozzle). The ablatively-cooled rocket engine is powered by the hypergolic combination of White Fuming Nitric Acid (WFNA) and Turpentine/ Furfuryl Alcohol. Interorbital's N1 launch vehicle employs two GPRE 0.75KNTA engines for its second stage and a single GPRE 0.75KNTA engine for its third stage.

CPM 1.0 Test Launch as Stand-Alone Sounding Rocket, N3 Second-Stage, and N1 Booster, with 4 Small-Sats on Board

IOS Composite Team with Freshly-Wrapped Carbon Filament–Wound Upper-Stage Tank

CPM 2.0: Four-Tank Enhanced Performance Upgrade, next to previously flown CPM 1.0

CPM 2.0/N1 GTV: Four-Tank Sounding Rocket and NEPTUNE Modular Rocket Series Basic Core Component

The CPM 2.0 is the core construction unit of all NEPTUNE launchers and also serves as a stand-alone, space-altitude capable Sounding Rocket. The current build will become an SR 145: Suborbital Rocket with a 145kg lift and 310km apogee capability and also the N1 Guidance Test Vehicle(N1 GTV), testing the NEPTUNE 1 orbital launcher's new guidance and control system in flight. It is scheduled to be used as a guidance system test vehicle in Q3/4, 2018, by Interorbital as a precursor to the company's first orbital launch. Bundled in flight configurations from 1 to 9 modules, these identical CPMs become Interorbital's NEPTUNE Modular Rocket Series of orbital and interplanetary launchers: N1; N3; N5; N7, N8, and N9. These rocket variants can be configured to meet any mission requirement for completely mobile rapid-response, low-cost launch-on-demand from land or sea.

Sub-Orbital, Orbital, and Lunar Launches: 2018-2021

UPCOMING LAUNCHES

Test-launch of NEPTUNE upper-stage engine on NEUTRINO Sounding Rocket
11 PAYLOADS on Low-Altitude Suborbital Guidance System Test Flight II, 2018.

INTERORBITAL ANNOUNCES LEO, LUNAR, AND INTERPLANETARY MISSIONS

2019 Q1: First NEPTUNE dedicated small-sat orbital launch SOLD OUT
First Four NEPTUNE Orbital launches through 2019; booking into 2022

2019: Project LUNAR BULLET—Lunar Direct. Lunar Impactor. A collaboration between Ed Belbruno's Orbital Design and Interorbital Systems. RANGER-style MOON impact mission. Excess payload space available: 0.5 kg (soft-landing). As the rocket nears Luna, and before the Lunar Bullet impacts the Moon, the secondary payload will be ejected and will soft-land on the Lunar surface using a retro rocket and airbags. 0.5kg excess payload allowance available at $500K

2019: Lunar Sample Return Mission

2020/21: VENUS Atmospheric Mission; Continuing Moon Missions

2021/22 Begin Construction of Lunar Research Station/Hotel/Utilities, Lunar South Pole

Images, right: NEPTUNE 3 (N3) Sat Launcher; NEPTUNE 8 LUNA

N8 LUNA: Ocean-Launched Moon Rocket

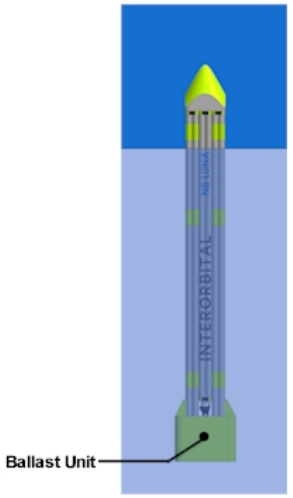
NEPTUNE 8 LUNA (N8 LUNA)

The Interorbital Systems' N8 Luna is a member of the modular NEPTUNE System Launch Vehicle Series. It is assembled from eight (8) IOS Common Propulsion Modules (CPMs). Each Common Propulsion Module is made up of a pressure-fed ablatively-cooled liquid rocket engine and valve unit; an aluminum and carbon-composite tank system; a CPM controller; and a carbon-composite fairing section. The CPMs can be bundled in arrays of 3 or more units for orbital and deep-space operations. The launch vehicles can be customized to meet any mission scenario or requirement—from LEO to LUNA and Beyond.

NEPTUNE System Launch Vehicles are designed to lift-off from the ocean using a method called "floating launch." Each rocket is waterproof and will float. A ballast unit, attached to the rocket's aft end, stabilizes the rocket and allows it to float eighty-percent submerged prior to launch. At lift-off, the rocket engines ignite underwater. After the ballast unit is jetisoned, the NEPTUNE Launch Vehicle rises out of the ocean and begins its programmed space mission.

N8 LUNA will launch Interorbital Systems' Google Lunar X-Prize Payload. The IOS Lunar Lander (IOSLL) is designed to soft-land on the Moon using a single Minerva I solid rocket motor decelerator and an airbag system.

Pre-Launch: Submerged



Performance

Payload (LEO):	500 pounds (226.8 kg)
Payload (Lunar Orbit):	100 pounds (45.4 kg)
Payload (Lunar Soft Landing):	30 pounds (13.6 kg)

Structure

Number of Stages:	4
Type of Staging:	Parallel and Tandem
Length:	60 feet
Width:	6 X 6 feet
Dry Weight:	8,043 pounds
GLOW:	76,500 pounds

Stage-1 Data

Number of CPMs:	6
Thrust:	6 X 20,000 = 120,000 pounds
Propellants:	White Fuming Nitric Acid/Turpentine
Ignition:	Hypergolic

Stage-2 Data

Number of CPMs:	2
Thrust:	2 X 11,000 = 22,000 pounds
Propellants:	White Fuming Nitric Acid/Turpentine
Ignition:	Hypergolic

Stage-3 Data

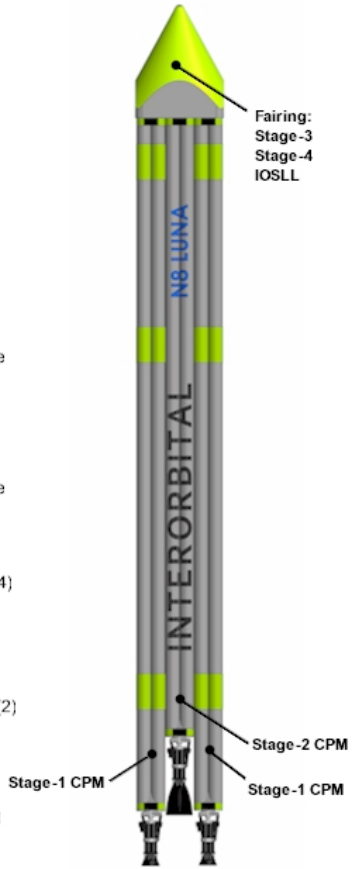
Solid Motors:	IOS Minerva II Solid Rocket Motors (4)
Thrust:	4 X 2,000 = 8,000 pounds
Propellants:	HTPB/AP/Al

Stage-4 Data

Solid Motors:	IOS Minerva II Solid Rocket Motors (2)
Thrust:	2 X 2,000 = 4,000 pounds
Propellants:	HTPB/AP/Al

IOSLL Data

Solid Motors:	IOS Minerva I Solid Rocket Motor (1)
Thrust:	1 X 1,5000 = 1,500 pounds
Propellants:	HTPB/AP/Al



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LUNAR BULLET Impactor Mission
+ Soft-Landing Mini-Payload

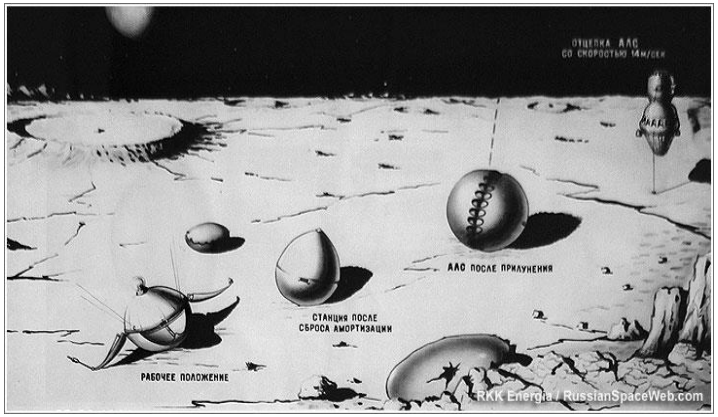
N3 Launcher

---Commercial Moon Impact Mission

---Lunar Soft-Landing System

---Payload mass max of 0.5 kg

---0.5kg Payload Allowance: $500,000



Luna 9-Type Thruster/Airbag Landing

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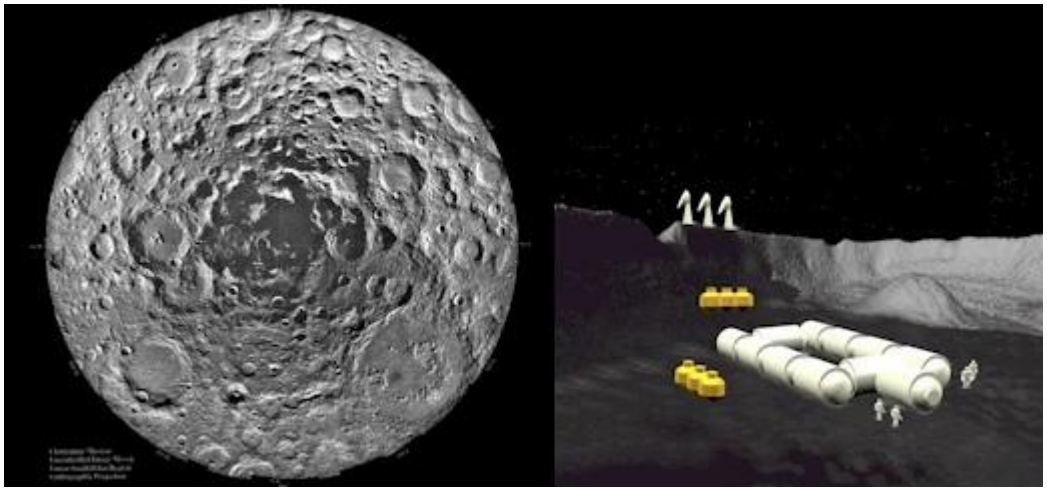
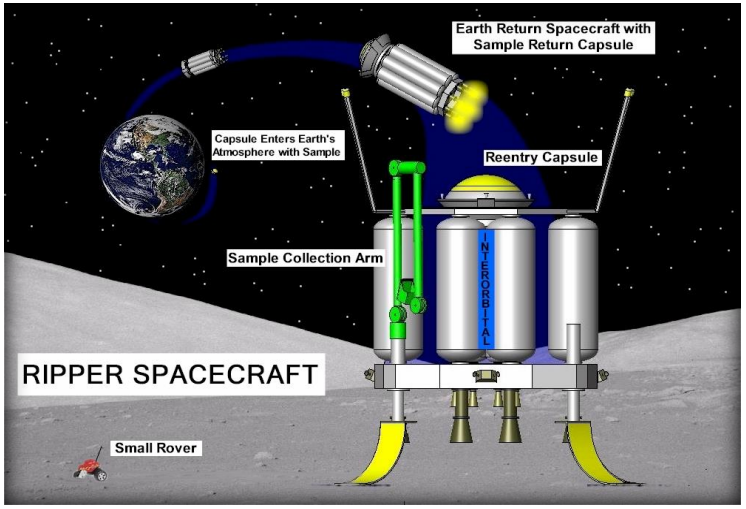
Moon Colonization Missions and Precursor Launches



Interorbital Systems and Trans Lunar Research Joint Effort

Lunar Corporate Research Station/Tourism Destination, at the Moon's South Pole, Shackleton Crater

Lead-up Missions:
---Lunar Bullet Impact Mission
---Lunar Sample-Return Mission
---Base Components-Cargo Missions
---First Mission with Crew
---Utilities Infrastructure Build-up
---Start-up Phase: 2019-2021--Onward



Lunar Hopper Landing in Shackleton Crater

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