

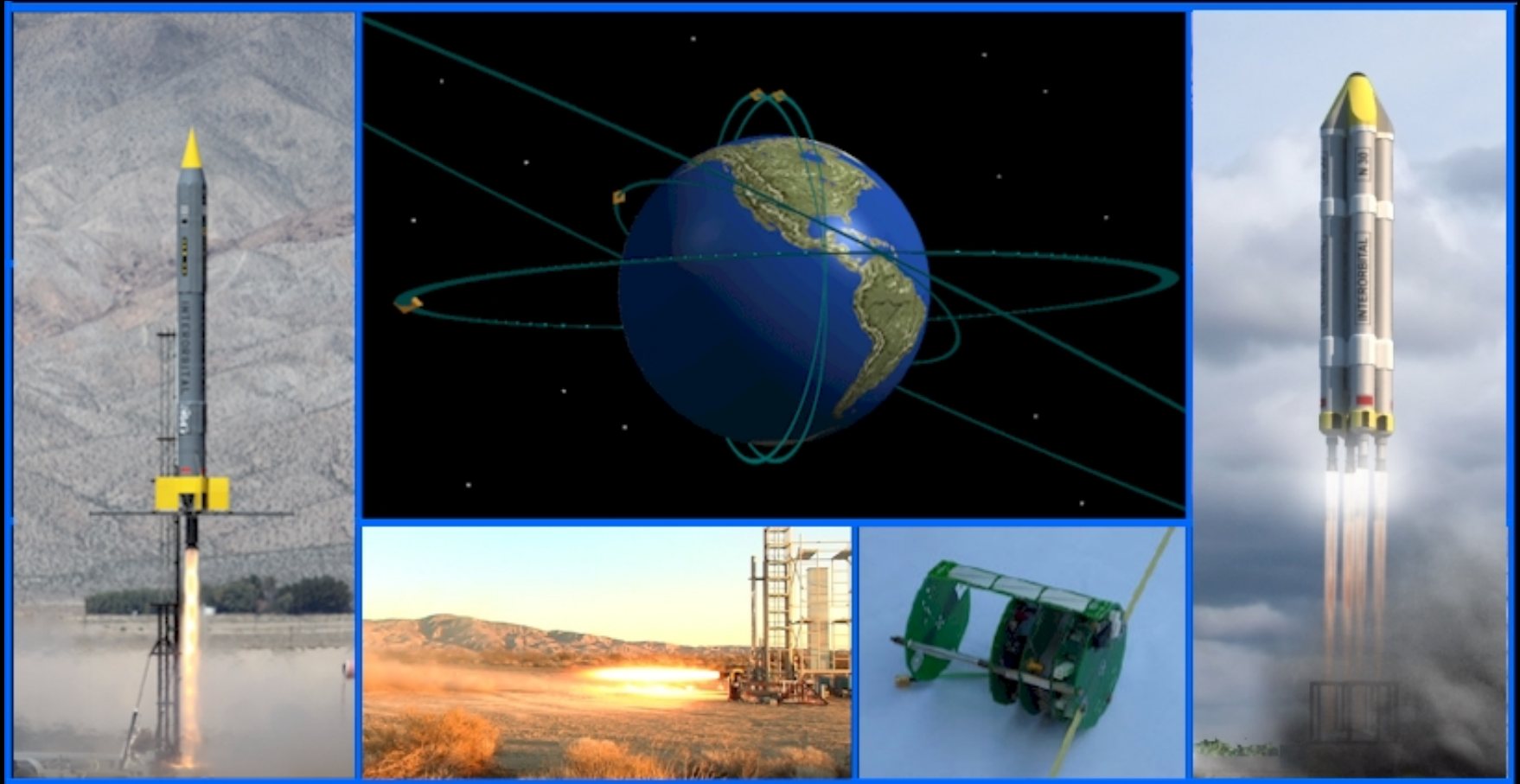


Interorbital Systems
www.interorbital.com

NEPTUNE 5: Interorbital Systems' Dedicated Small-Satellite Launcher

Cal Poly San Luis Obispo CubeSat Workshop, April 22-24, 2015

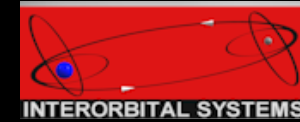
Presenter: Randa Milliron, CEO/CoFounder, Interorbital Systems



Interorbital Systems

www.interorbital.com

ABOUT INTERORBITAL SYSTEMS



Founded in 1995 by Roderick and Randa Milliron

Location: Mojave Air and Space Port , Mojave, California

R&D and manufacturing facilities

Two rocket engine test sites

Launch locations land/sea worldwide



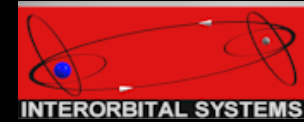
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PROTOTYPING & TESTING



LAUNCH & TEST FACILITIES



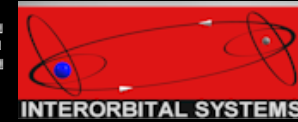
Low-Altitude Flight Test Area: FAR / MTA



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CANISTER OCEAN LAUNCH: MOBILE SELF-CONTAINED SPACE PORT



Ocean Launch Flexibility Advantages



Allows the customer to set the launch schedule

Safer for manned launches

Allows rocket to be positioned for any orbit

Doesn't set a limit on the size of a launch vehicle

Requires only a minimum of launch support hardware

Rapid-response; no waiting in a spaceport line

The most cost-effective launch option

New Launch Staging Area: Port of Los Angeles!



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COMMON PROPULSION MODULE



The CPM is the basic building-block of the N-Series modular orbital launchers

Bi-propellant storable, high-density, hypergolic liquid rocket system

Blowdown propellant feed

CPMs clustered together in multiples to meet mission requirements for both small and large payloads

Stand-alone sounding rocket SR145:145-kg to 310km

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ROCKET ENGINE AND THRUSTER MANUFACTURING



Storable-Propellant Liquid Rocket Engine Technology

Test of rocket thruster engine and CPM controller at Mojave Spaceport

IOS is first in the US to use high-density nitric acid, furfuryl alcohol, and turpentine as propellants of choice

Substitutes for expensive, toxic hypergols like hydrazine and nitrogen tetroxide



All rocket engines designed and built by Interorbital in the USA!

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GPRE 7.5KNTA CPM MAIN ENGINE TEST



ISP 245 seconds (sea level); Density specific impulse 323 seconds (sea level); Vacuum ISP = 305 sec

Blowdown propellant feed; hypergolic propellants; no ignition system or turbopumps required

State-of-the-art, all-composite combustion chamber and nozzle

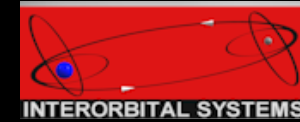
Replaceable ablative chamber cartridge yields plug-and-play engine reusability

Designed for rapid mass production

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CPM TEST VEHICLE PRE-FLIGHT PREPARATIONS AND LAUNCH



Specifications

Length: 30.0 ft (9.1 m)

Diameter: 2.1 ft (0.64 m)

Weight Loaded: 1,200 lbs (544 kg)

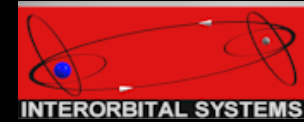
Engine Thrust (SL): 7,500 lbs (33,360 n)

Payload: 2 CubeSats and 2 TubeSats

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CPM TEST VEHICLE LIFT-OFF

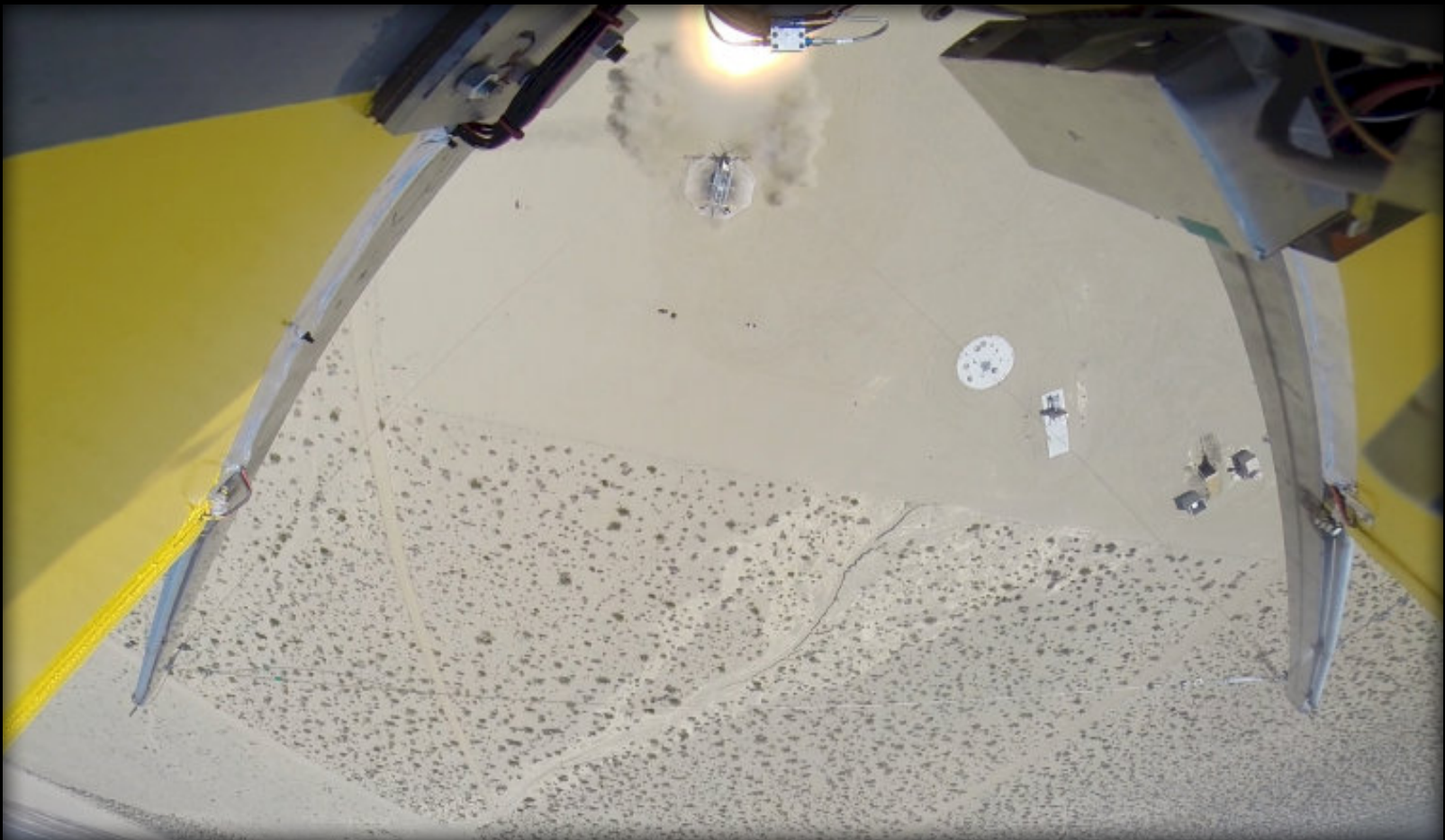


CPM TV reached Mach 1.5 in under 5 seconds. Recovered rocket and all four payloads, intact and still functioning.

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CPM TEST VEHICLE LAUNCH: ROCKET TV



CPM TV LAUNCH: NEPTUNE-SERIES COMMERCIAL LAUNCH SERVICES GO OPERATIONAL!



PAYLOADS

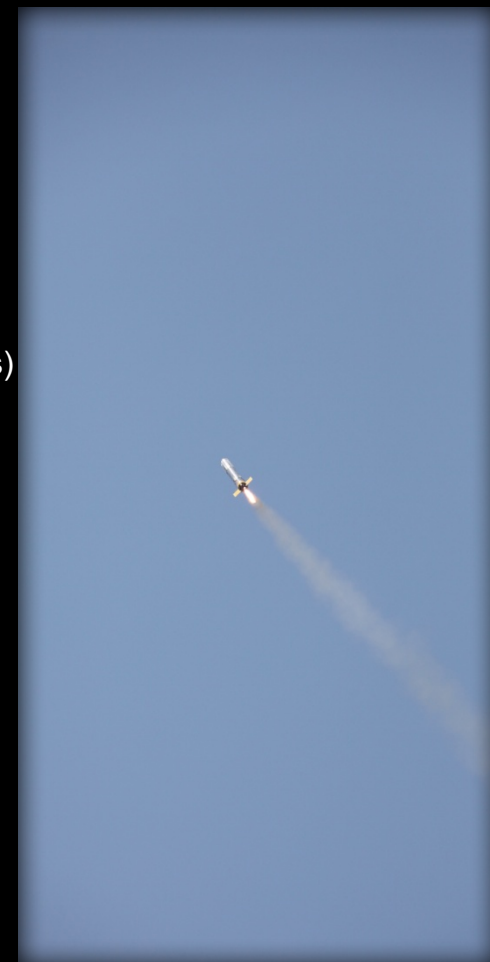
National Cheng Kung University (Taiwan) 2U CubeSat
M2M2SKY/Boreal Space (Brazil/California) 1U CubeSat
Google Lunar XPRIZE Team SYNERGY MOON (California/International) Payload
John Frusicante's (Red Hot Chili Peppers) album ENCLOSURE (The Record Collection, Malibu; Loducca Ad Agency, Brazil---Golden Lion Award Winner at Cannes)

PRIMARY CPM HARDWARE TESTED

Propulsion System in flight;
Cable Launch Device (CLD) and Pyrotechnic Staging System (PSS);
Telemetry
Health and Recovery System
Wireless-Encrypted CPM Controller

CURRENT LAUNCH MANIFEST

90+ TubeSat and CubeSat payloads from 15+ countries
First four orbital launches sold-out
SYNERGY MOON manifested for 2016 GLXP Lunar Mission
Booking now for Lunar Sample Return/Surface Missions and Lunar Tourism



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FIVE CPMs + KICK STAGE = N5 NEPTUNE 5 ORBITAL ROCKET

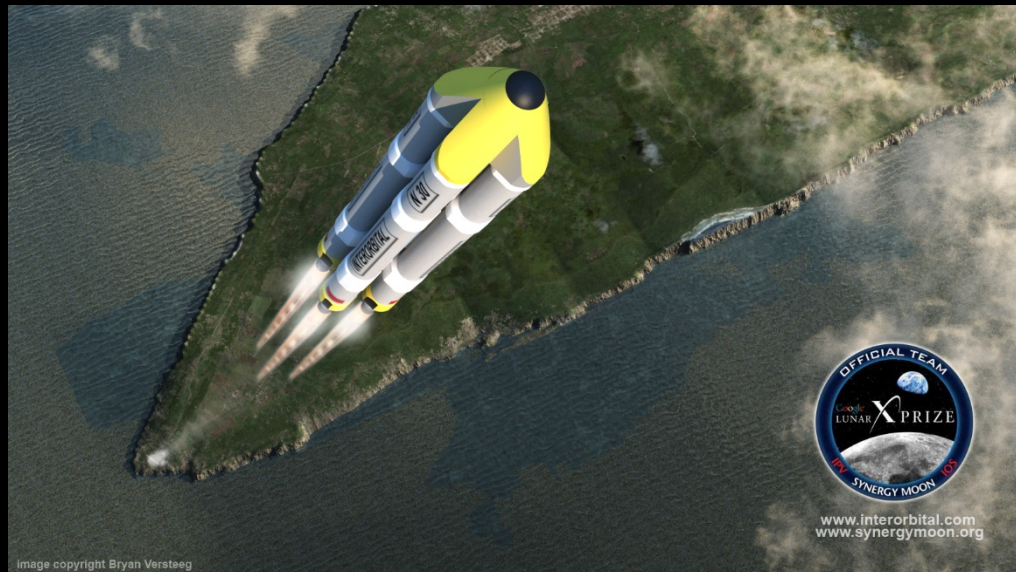
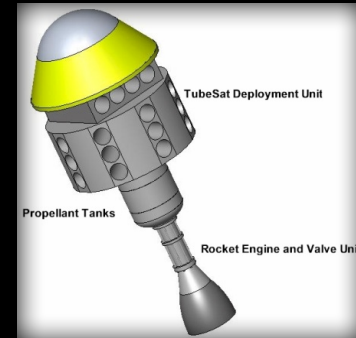
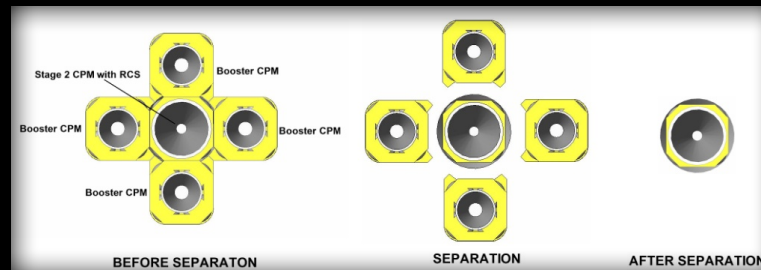
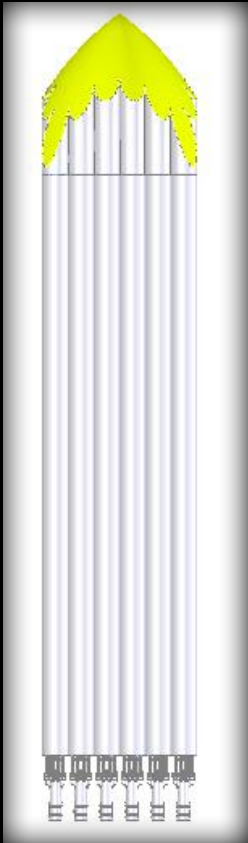


Image copyright Bryan Versteeg

N36 MEDIUM-LIFT ROCKET



Manned Orbital and Lunar Missions

36 Common Propulsion Modules (CPMs)

36 Ablatively-Cooled Liquid Rocket Engines

Four Stages (Lunar Transfer Vehicle = Stage 4)

Gimbaled Steering

Modular Construction



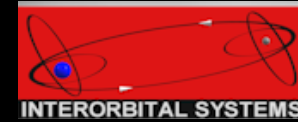
1 Metric Ton to LEO: NEPTUNE 36

250 kg (550 lbs) to Lunar Surface

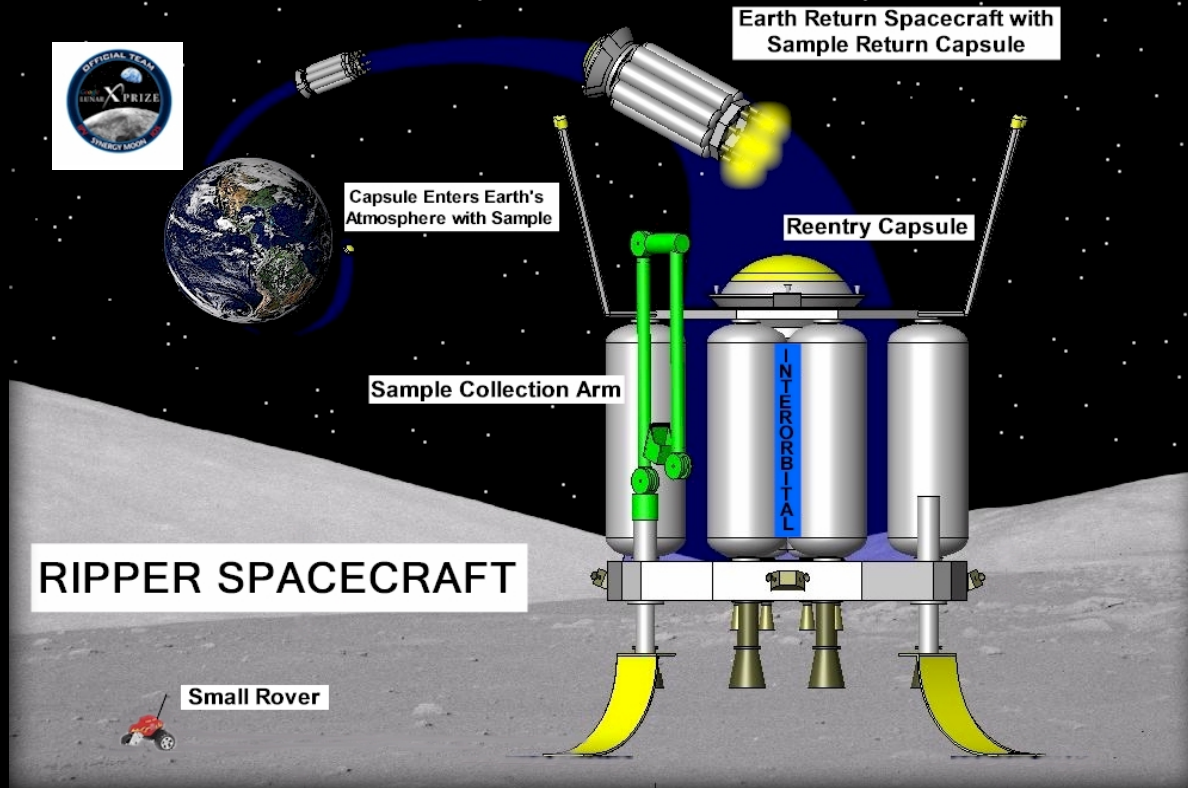
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LUNAR LANDING SYSTEM for GLXP TEAM *SYNERGY MOON*



IOS LUNAR SAMPLE RETURN MISSION



PRE-SALE OF LUNAR MATERIAL TO COLLECTORS AND RESEARCHERS

HARDWARE DEVELOPMENT & LAUNCH SERVICES



MODULAR ORBITAL and LUNAR LAUNCH VEHICLES (N-SERIES)

NEPTUNE 5 (N5) : PicoSatellite Launch Vehicle

NEPTUNE 36 (N36): Medium-Lift Launch Vehicle

ORBITAL SPACECRAFT

Small to medium satellites (LEO)

Reentry Capsule Spacecraft (manned and unmanned)

Robotic Orbital Supply System (ROSS)

LUNAR SPACECRAFT

Lunar / interplanetary rocket landing system

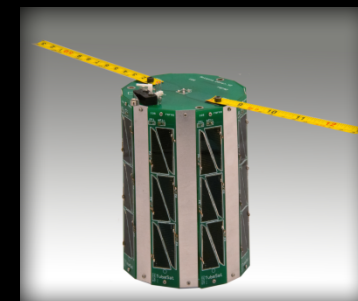
Robotic InterPlanetary Prospector Excavator Retriever (RIPPER)

SATELLITE KITS AND LAUNCH SALES

TubeSat Kit (Developed at Interorbital)

CubeSat Kit

Custom Satellites



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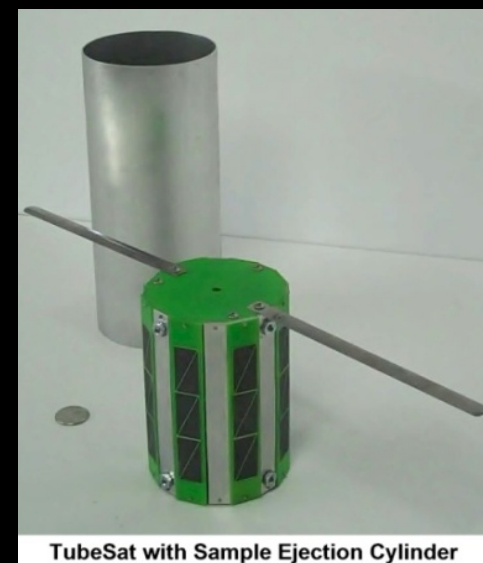
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PERSONAL SATELLITE KITS



KIT FEATURES:

- PCB Gerber Files
- Spectrolab TASC solar cells
- Antennas
- A Li-ion battery pack (3.7 V 5200 mAh)
- Microcomputer (NetMedia BasicX-24 or Arduino Mini)
- Transceiver (Radiometrix)
- Fasteners
- Complete instructions and assembly guide
- \$8,000 Academic Price: Kit & Launch



TubeSat with Sample Ejection Cylinder



SATELLITE LAUNCH MANIFEST

100th Payload Booked!



CUBESATS

UC Irvine, UCISAT1

FPT University, Vietnam, F-1 CubeSat

Nanyang Technological University, Singapore VELOX-P CubeSat

Google Lunar X PRIZE (GLXP) Team PLAN B (Canada)

GLXP Team EuroLuna, Romit 1 (2-Unit CubeSat from Denmark)

NASA Independent Verification and Validation (IV&V) Facility, 1CubeSat

King Abdullah University, Saudi Arabia (KAUST)2 CubeSats;1TubeSat

The Golden iPod: Voyager revisited; Earth to Sky,spaceweather.com, Bishop, CA STEM Program

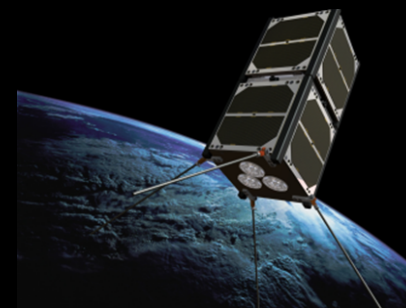
Pakistan's I CUBE-1 Islamabad Institute of Science and Technology

Boreal Space, California / M2M2Sky, Brazil; Wayfinder I

Rufs the Space Lion, Sweden

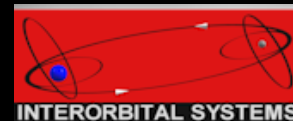
Base 11/ West Los Angeles College (2)

Denmark's GLXP Team Euroluna: Romit 1 2U (2-Unit) CubeSat >>



SATELLITE LAUNCH MANIFEST

100th Payload Booked!

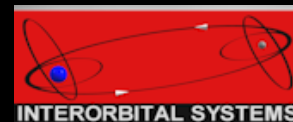


TUBESATS

Morehead State University (Kentucky Space) (TubeSat and 2 suborbital payloads)
InterAmerican University of Puerto Rico
University of Sydney (2) *i-INSPIRE (initial-INtegrated SPectrograph, Imager & Radiation Explorer)*
Aslan Academy (Private LA High School) STEM Program
Project Calliope (Space Music Project)
Universidad de Puerto Rico / Marcelino Canino Canino Middle School, STEM micro-meteoroid impact study
GLXP Team SYNERGY MOON Space-Qualifying Rover Team AUV's Comms
GLXP Team Part-Time Scientists / Fluid & Reason Software (2) (US/Germany)
Naval Postgraduate School (3); TubeSats as ad-hoc orbital communication nodes
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 (2)
Brazilian Space Institute/108 5th-7th Graders, Ubatuba, Sao Paulo, Brazil STEM Program
Mexican Satellite Project ULISES Sat from PLAY Festival's Arts/Soccer Opera from Space
TriVector Services (Huntsville) TRACsat – TriVector Radiation and Attitude Control Satellite
La Despensa (The Pantry) Advertising Agency/Iniciativas en Idiomas (Madrid, Spain)
AKQA Advertising, San Francisco
Universidad de Chile, Santiago
Galaxy Global, 1 TubeSat, donated to NASA Educational Program
NASA Independent Verification and Validation (IV&V) Facility (5)

SATELLITE LAUNCH MANIFEST

100th Payload Booked!



TUBESATS

Institute of Advanced Media Arts and Sciences/The Science Project, Inc., Japan (7)
University of Sao Paulo, Brazil (2)
David Lawrence K-8 School, North Miami, Florida
RADG, Ohio---Undisclosed Advertising Project
Jose Virgilio Braghetto Neto/OMNI LABS, Brazil
Ute Mountain Ute/Colorado State University Extension 4H
KEN KATO---Personal Satellite Project, Japan
Ryerson University, Toronto, Canada
DOCTOR WHO TARDIS in Orbit: Robert Doyle and Team
Emmanuel Lesser, Private Spacebooth, Belgium
University Nova de Lisboa, Portugal
National University of Singapore, RSPL (3)
Manhattan Satellite Lab; NYCSAT-1
RMC s.r.o.; *Popular SK*, Slovakia
Penn State University, Wilkes-Barre Campus
Universidad Autónoma de Autónoma de Zacatecas, Mexico (2)
MEDO, South Africa
NoiseFigure Research
Technical University of Moldova
Harmony School of Excellence, Austin

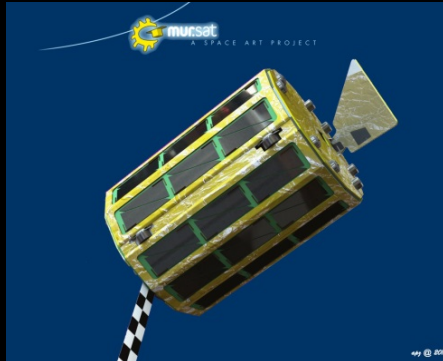


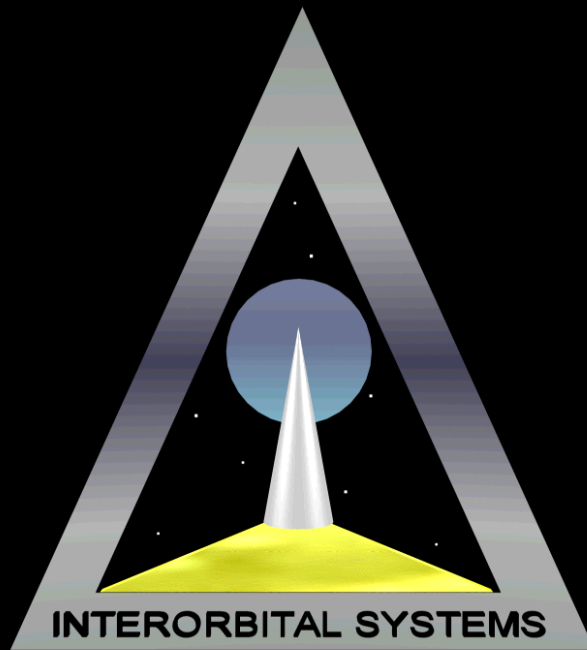
Mission Patch #1, 'Calliope over Africa'

Mission Patch #2, 'Calliope over the Americas'



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