САМАРСКИЙ УНИВЕРСИТЕТ
SAMARA UNIVERSITY

Межпланетные миссии наноспутников

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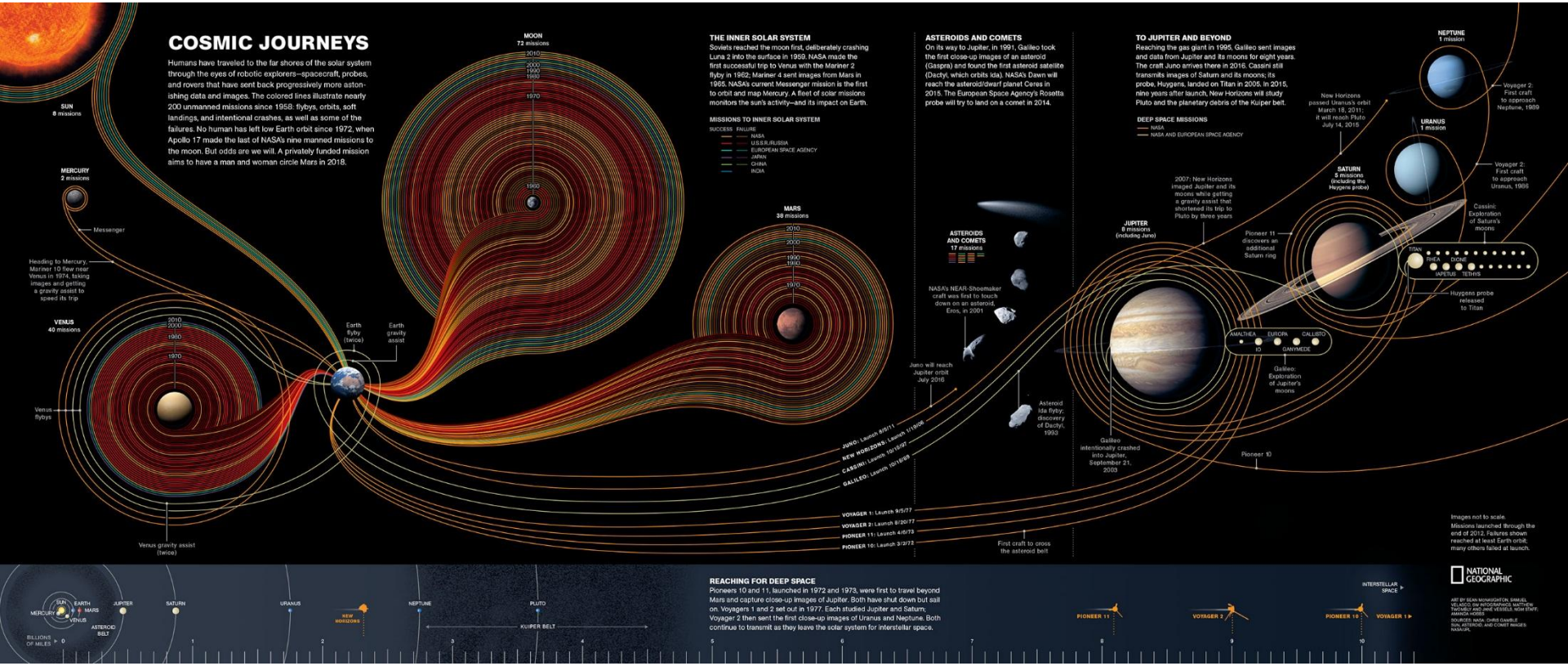
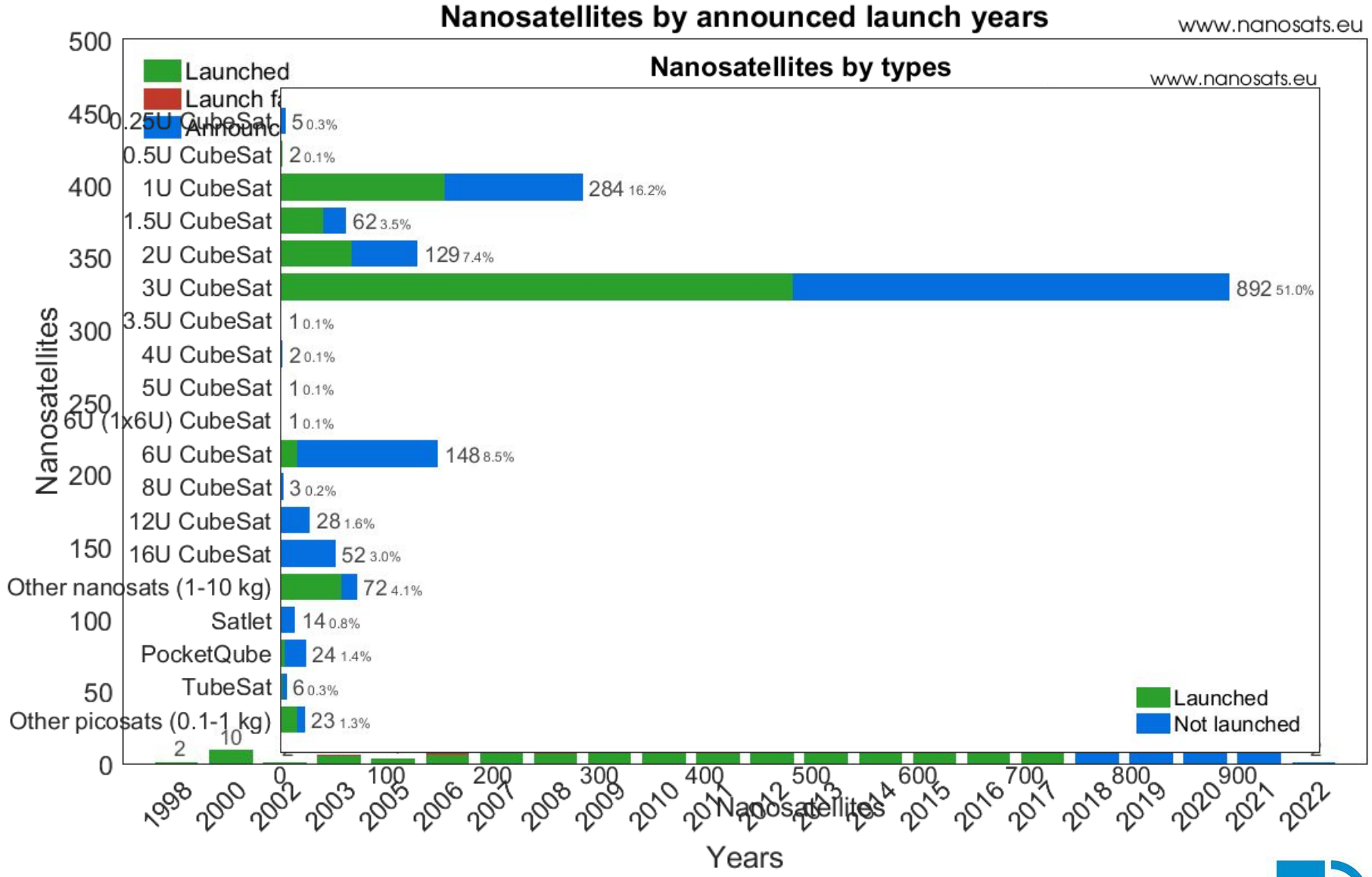
ВВЕДЕНИЕ


COSMIC JOURNEYS
Humans have traveled to the far shores of the solar system through the eyes of robotic explorers—spacecraft, probes, and rovers that have sent back progressively more astonishing data and images. The colored lines illustrate nearly 200 unmanned missions since 1958: flybys, orbits, soft landings, and intentional crashes, as well as some of the failures. No human has left low Earth orbit since 1972, when Apollo 17 made the last of NASA's nine manned missions to the moon. But odds are we will. A privately funded mission aims to have a man and woman circle Mars in 2018.
SUN
8 missions
MERCURY
2 missions
Messenger
Heading to Mercury, Mariner 10 flew near Venus in 1974, taking images and getting a gravity assist to speed its trip
VENUS
40 missions
Venus flybys
Venus gravity assist (twice)
Earth flyby (twice)
Earth gravity assist
MOON
72 missions
MARS
38 missions
THE INNER SOLAR SYSTEM
Soviets reached the moon first, deliberately crashing Luna 2 into the surface in 1959. NASA made the first successful trip to Venus with the Mariner 2 flyby in 1962; Mariner 4 sent images from Mars in 1965. NASA's current Messenger mission is the first to orbit and map Mercury. A fleet of solar missions monitors the sun's activity—and its impact on Earth.
MISSIONS TO INNER SOLAR SYSTEM
SUCCESS FAILURE
NASA
U.S.S.R./RUSSIA
EUROPEAN SPACE AGENCY
JAPAN
CHINA
INDIA
ASTEROIDS AND COMETS
On its way to Jupiter, in 1991, Galileo took the first close-up images of an asteroid (Gaspra) and found the first asteroid satellite (Dactyl, which orbits Ida). NASA's Dawn will reach the asteroid/dwarf planet Ceres in 2015. The European Space Agency's Rosetta probe will try to land on a comet in 2014.
ASTEROIDS AND COMETS
17 missions
NASA's NEAR-Shoemaker craft was first to touch down on an asteroid, Eros, in 2001
Juno will reach Jupiter orbit July 2016
Asteroid Ida flyby; discovery of Dactyl, 1993
First craft to cross the asteroid belt
TO JUPITER AND BEYOND
Reaching the gas giant in 1995, Galileo sent images and data from Jupiter and its moons for eight years. The craft Juno arrives there in 2016. Cassini still transmits images of Saturn and its moons; its probe, Huygens, landed on Titan in 2005. In 2015, nine years after launch, New Horizons will study Pluto and the planetary debris of the Kuiper belt.
DEEP SPACE MISSIONS
NASA
NASA AND EUROPEAN SPACE AGENCY
JUPITER
8 missions (including Juno)
2007: New Horizons imaged Jupiter and its moons while getting a gravity assist that shortened its trip to Pluto by three years
Pioneer 11 discovers an additional Saturn ring
Galileo intentionally crashed into Jupiter, September 21, 2003
Pioneer 10
Galileo: Exploration of Jupiter's moons
AMALTHEA
IO
EUROPA
GANYMEDE
CALLISTO
SATURN
5 missions (including the Huygens probe)
New Horizons passed Uranus's orbit March 18, 2011; it will reach Pluto July 14, 2015
Cassini: Exploration of Saturn's moons
TITAN
RHEA
DIONE
IAPETUS
TETHYS
Huygens probe released to Titan
URANUS
1 mission
Voyager 2: First craft to approach Uranus, 1986
NEPTUNE
1 mission
Voyager 2: First craft to approach Neptune, 1989
JUNO: Launch 8/5/11
NEW HORIZONS: Launch 1/19/06
CASSINI: Launch 10/15/97
GALILEO: Launch 10/18/89
VOYAGER 1: Launch 9/5/77
VOYAGER 2: Launch 8/20/77
PIONEER 11: Launch 4/6/73
PIONEER 10: Launch 3/2/72
Images not to scale.
Missions launched through the end of 2012. Failures shown reached at least Earth orbit; many others failed at launch.
NATIONAL GEOGRAPHIC
ART BY SEAN MCNAUGHTON, SAMUEL VELASCO, DAV INFOGRAPHICS, MATTHEW TWOMBLY, AND JANE VERSELA, NGM STAFF; MAPS BY MAPQUEST
SOURCES: NASA, CHRIS GAMBLE (SUN, ASTEROID, AND COMET IMAGES NASA/JPL)
SUN
MERCURY
EARTH
MARS
VENUS
ASTEROID BELT
JUPITER
SATURN
URANUS
NEPTUNE
PLUTO
NEW HORIZONS
KUIPER BELT
BILLIONS OF MILES
0
1
2
3
4
5
6
7
8
9
10
PIONEER 11
VOYAGER 2
PIONEER 10
VOYAGER 1
INTERSTELLAR SPACE
REACHING FOR DEEP SPACE
Pioneers 10 and 11, launched in 1972 and 1973, were first to travel beyond Mars and capture close-up images of Jupiter. Both have shut down but sail on. Voyagers 1 and 2 set out in 1977. Each studied Jupiter and Saturn; Voyager 2 then sent the first close-up images of Uranus and Neptune. Both continue to transmit as they leave the solar system for interstellar space.

ВВЕДЕНИЕ

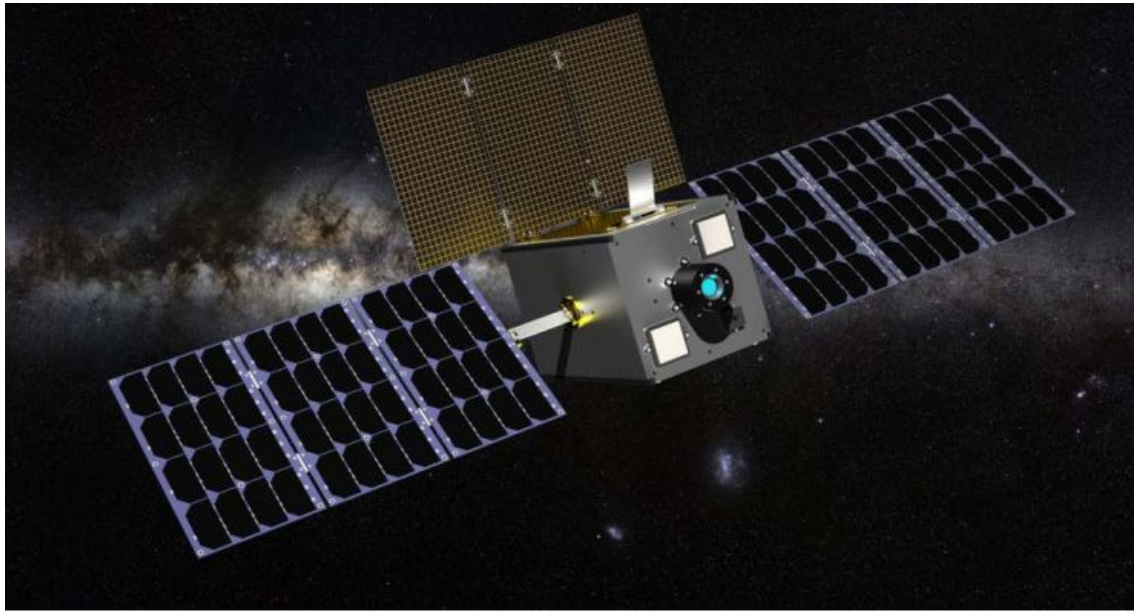

Nanosatellites by announced launch years
www.nanosats.eu
Nanosatellites by types
www.nanosats.eu
Launched
Launch f
Announc
0.25U CubeSat 5 0.3%
0.5U CubeSat 2 0.1%
1U CubeSat 284 16.2%
1.5U CubeSat 62 3.5%
2U CubeSat 129 7.4%
3U CubeSat 892 51.0%
3.5U CubeSat 1 0.1%
4U CubeSat 2 0.1%
5U CubeSat 1 0.1%
6U (1x6U) CubeSat 1 0.1%
6U CubeSat 148 8.5%
8U CubeSat 3 0.2%
12U CubeSat 28 1.6%
16U CubeSat 52 3.0%
Other nanosats (1-10 kg) 72 4.1%
Satlet 14 0.8%
PocketQube 24 1.4%
TubeSat 6 0.3%
Other picosats (0.1-1 kg) 23 1.3%
Launched
Not launched
Nanosatellites
Years

КОСМИЧЕСКИЕ АППАРАТЫ

M-ARGO
BIRDY
INSPIRE-A
(INSPIRE-B)

M-ARGO - СВОДКА

M-ARGO(Miniaturized Asteroid Remote Geophysical Observer)
Запуск: 2021 год
Агентство: ESA
Бюджет: 25 млн евро
Форм-фактор: 12U



M-ARGO - МИССИЯ

Возможные миссии:

1) Непосредственное исследование астероида
2) Наблюдение солнечной активности в L5

M-ARGO

Форм-фактор	12U
Полезная нагрузка	1U
Управление движением	Ионный двигатель(2.8 кг Xe); 3 маховика; 8 двигателей РСУ
Энергетическая установка	Li-ion батареи, 6U фиксированная солнечная батарея, две развёртываемых батарей 6U*3
Терморегуляция	Радиатор и нагревательные элементы

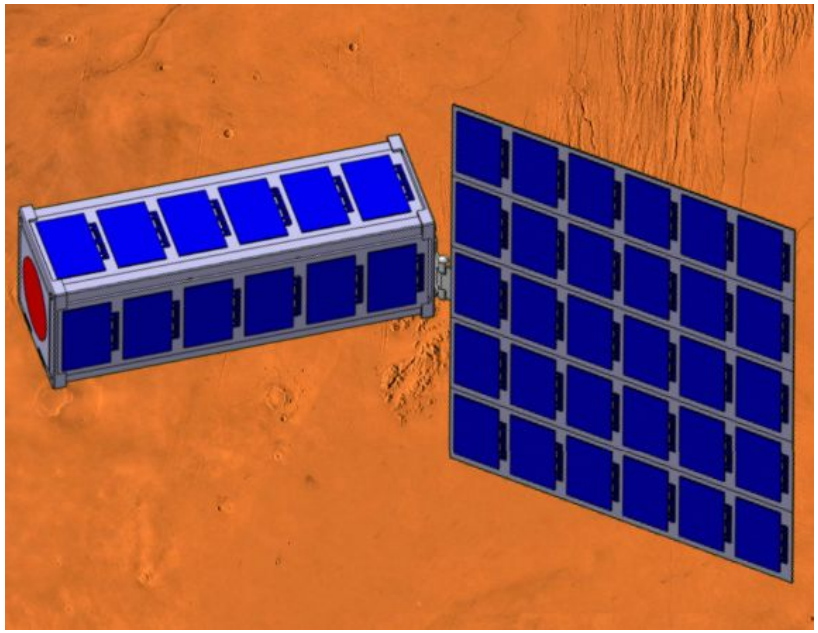
M-ARGO - АСТЕРОИДЫ

Анализ потенциальных целей для миссии

Designation	a [AU]	r_a [AU]	r_p [AU]	e	i [°]	H	ΔV [km/s]	m_P [kg]
2012 UV136	1.008	1.148	0.868	0.14	2.21	25.5	3.17	2.2
2014 EK24	1.006	1.077	0.935	0.07	**4.81**	23.3	3.92	2.50
1996 XB27	1.189	1.258	1.120	0.06	2.47	21.7	3.62	2.32
YORP	1.006	1.238	0.775	0.23	1.60	22.7	6.74	4.10
2013 BS45	0.992	1.075	0.909	0.08	0.77	25.9	1.88	1.31
2016 FU12	1.003	1.170	0.836	0.17	2.06	26.9	2.7	1.88
2011 MD	1.056	1.095	1.017	0.04	2.45	28.0	3.19	2.17

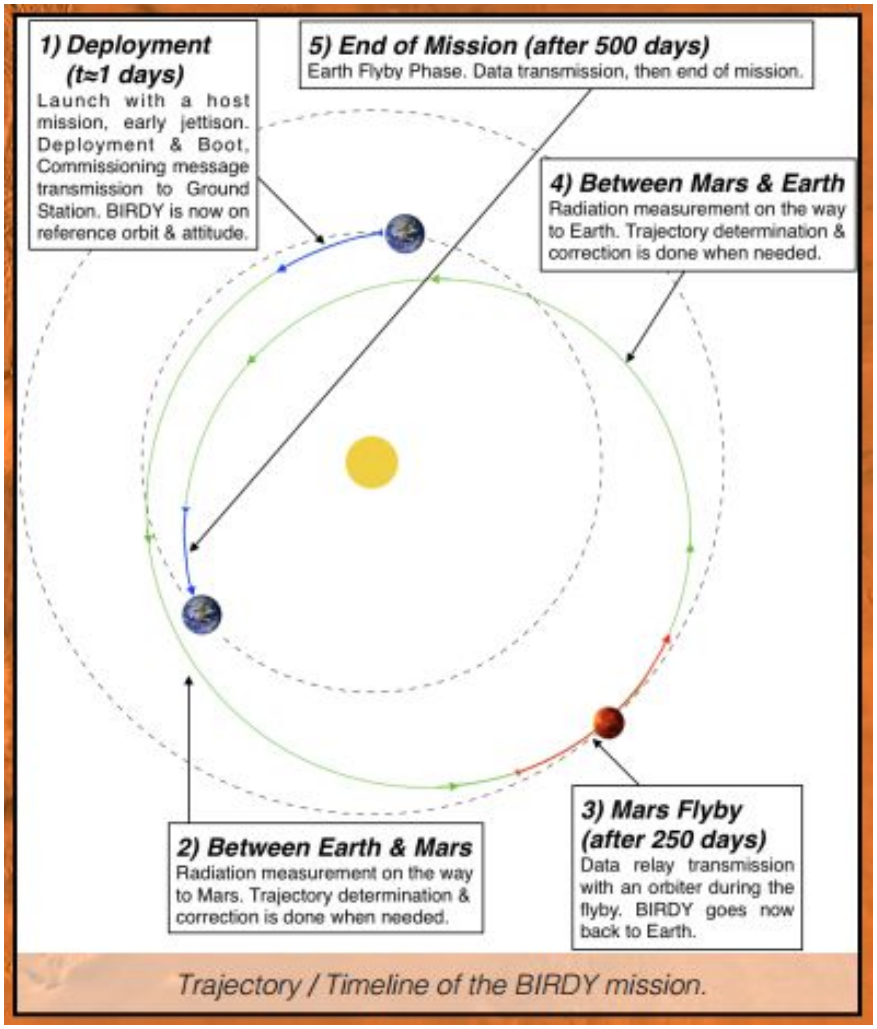
BIRDY

BIRDY – Bleeping Interplanetary Radiation Determination Yo-yo
Форм-фактор: 3U
Год: 2020
National Cheng Kung University(Тайвань)



BIRDY - МИССИЯ

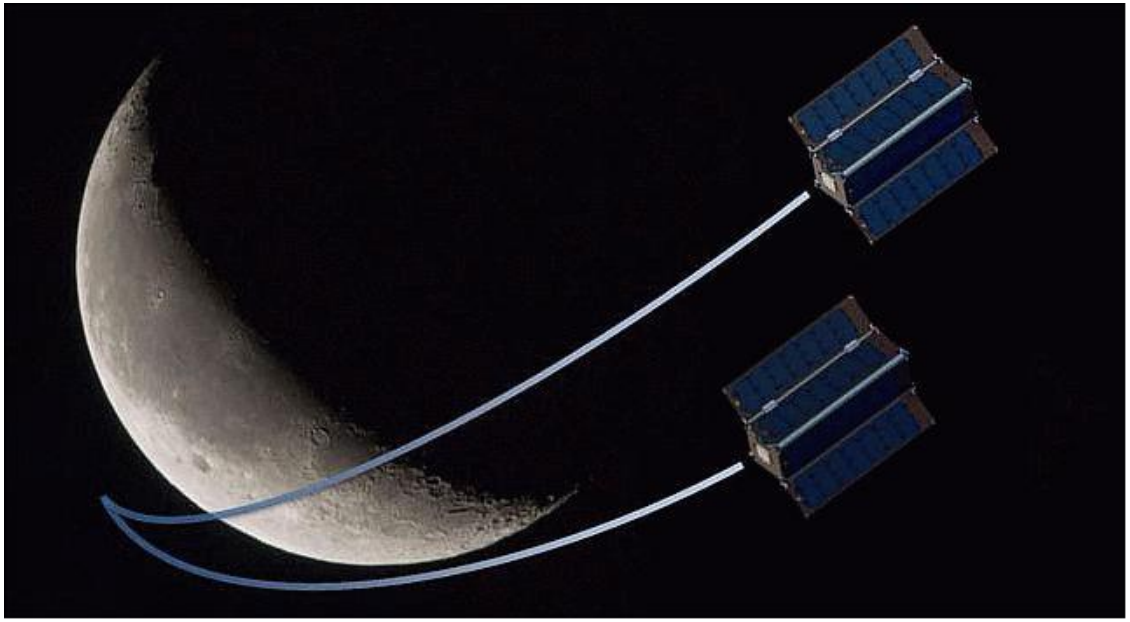
Миссия BIRDY:
1) Изучение радиационной обстановки и фиксирование высокоэнергетических частиц в космическом пространстве между Марсом и Землёй
2) Создание автономной системы навигации, которая будет поддерживать курс КА



Trajectory / Timeline of the BIRDY mission.

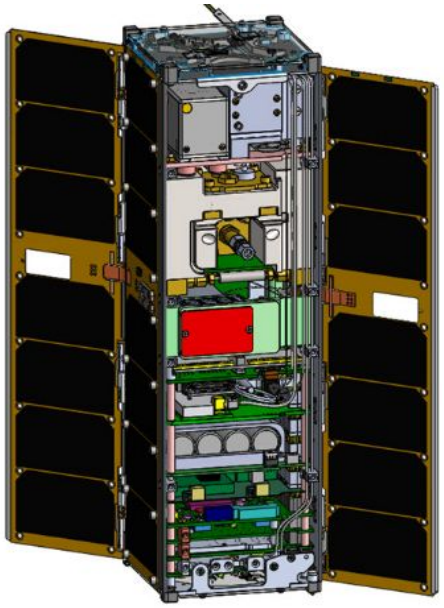
INSPIRE

INSPIRE - (Interplanetary Nano-Spacecraft Pathfinder in Relevant Environment)
Форм-фактор: 3U
Запуск: 2017
Организация: JPL



INSPIRE - ЗАДАЧИ

1) Показать возможность и протестировать ключевые моменты в управлении связки КА в дальнем космосе
2) Продемонстрировать возможность использования на таких аппаратах научной аппаратуры



Design Overview

CubeSat Overview:
Volume: 3U (10x10x30cm)
Mass: 4.0 kg
Power Generation:
3 Axis Stabilized: 20 W
Tumbling: 13 W
Data Rate: 62-256000 bps

Software:
Developed in-house (*protos*)

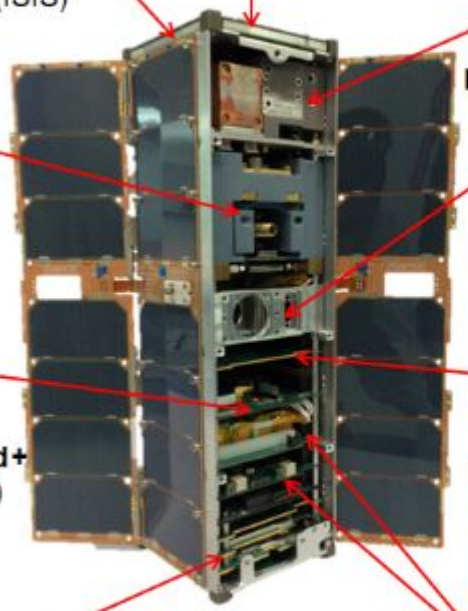
I&T:
In-house S/C I&T, external environmental testing, NASA CLI P-Pod/Launch Integration

Operations:
Primary: DSN
Secondary (Receive only): DSS-28 (GAVRT), & Secondary Stations, ex: Peach Mountain

Cold-Gas ACS (U. Texas)

C&DH + Watchdog Board + Lithium UHF (AstroDev)

Nav/Comm X-Band Radio (JPL)



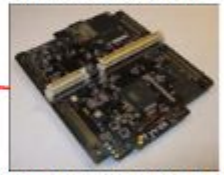
X-Band Patch Antennas (JPL) [two sets]

UHF Antenna (ISIS)

Deployable Solar Panels (Pumpkin) **Structure** (JPL)

Magnetometer (JPL)

Star Tracker (Blue Canyon)



Processing Board (CalPoly / Tyvak)

Electrical Power System + Battery Board (U. Michigan)

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