YUZHNOYE

design office

GENERAL PRESENTATION OF YUZHNOYE SDO ACTIVITIES IN ROCKET SPACE DOMAIN

YUZHNOYE

Yuzhnoye State Design Office named after M.K.Yangel was founded in 1954 to initiate development of strategic-purpose missile-weapon complexes.

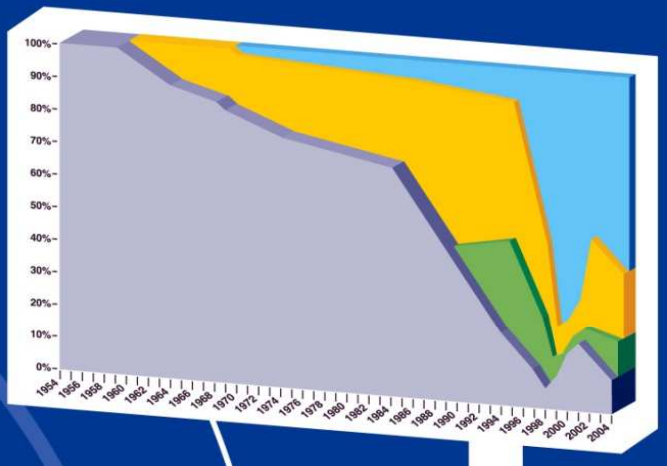
60 years of collaboration with SE PA Yuzhny Machine-Building Plant, academic, science and research, manufacturing enterprises of former Soviet Union resulted in the development and production of four generations of strategic missiles, represented by 13 modifications which formed the basis of strategic missile forces. The world-class launch vehicles were also produced (Kosmos, Interkosmos, Cyclone-2, Cyclone-3, Zenit-2, Zenit-3SL, Zenit-2SLБ, Zenit-3SLБ, Zenit-3SLBF, Dnepr).

YUZHNOYE

Trends of Development

Space Systems

Launch Services



Materials and Technology Development

Analytival and Design Efforts

Space Launch Systems

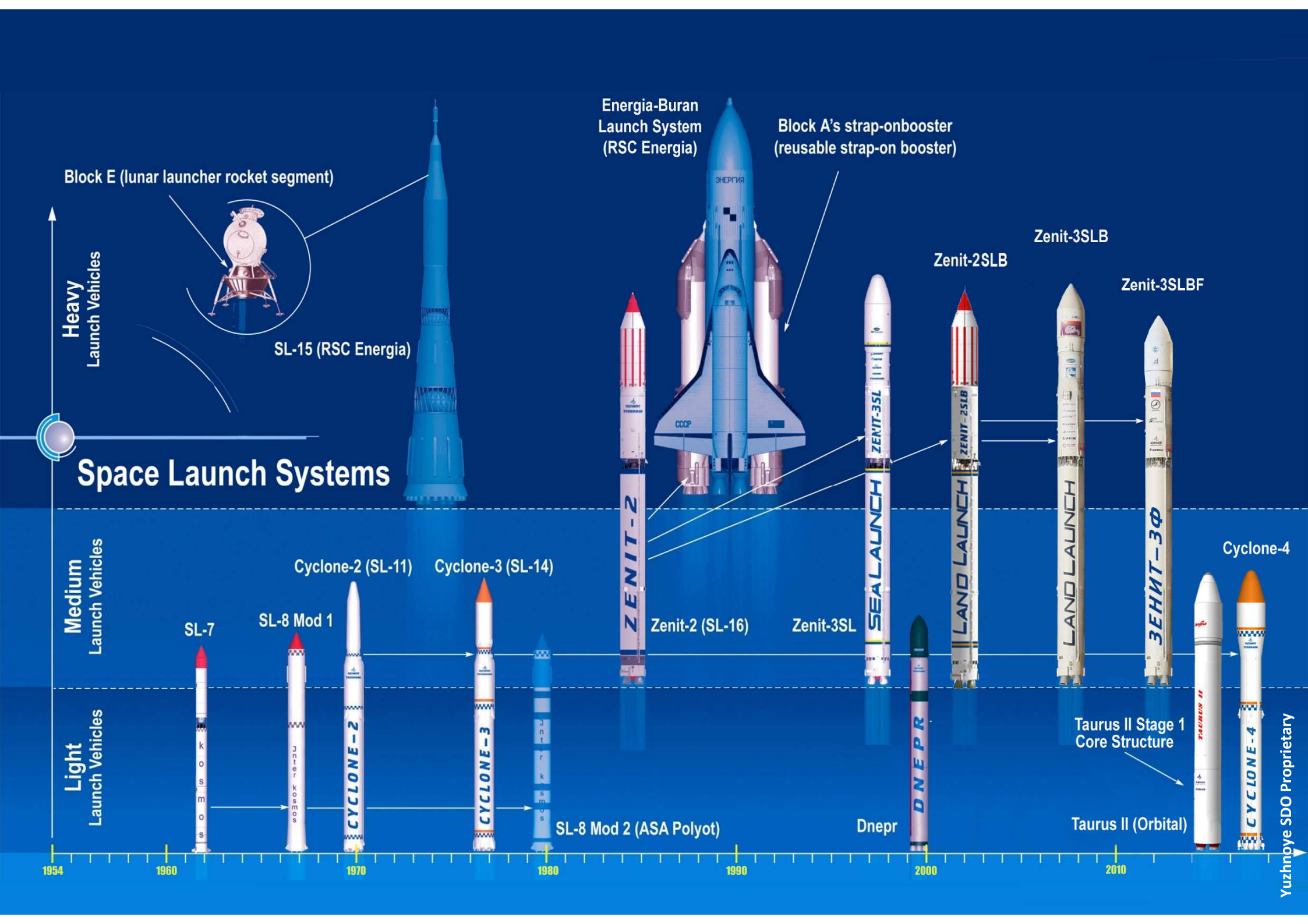
Testing

National Economic Complexes

Missile Complexes

YUZHNOYE

EXISTING AND PROSPECTIVE LAUNCH VEHICLES


Space Launch Systems
Heavy
Launch Vehicles
Medium
Launch Vehicles
Light
Launch Vehicles
Block E (lunar launcher rocket segment)
SL-15 (RSC Energia)
Energia-Buran
Launch System
(RSC Energia)
Block A's strap-onbooster
(reusable strap-on booster)
Zenit-2SLB
Zenit-3SLB
Zenit-3SLBF
Cyclone-4
Cyclone-2 (SL-11)
Cyclone-3 (SL-14)
SL-7
SL-8 Mod 1
Zenit-2 (SL-16)
Zenit-3SL
SL-8 Mod 2 (ASA Polyot)
Dnepr
Taurus II Stage 1
Core Structure
Taurus II (Orbital)
1954
1960
1970
1980
1990
2000
2010
Yuzhnoye SDO Proprietary

ZENIT LAUNCH VEHICLES FAMILY

11К77 Base LV (Zenit-2)

Zenit-3SL ILV

Zenit-3SLБ ILV

Zenit-2SLБ ILV

Zenit-3SLБФ ILV

On the basis of the developed Zenit LV in 1985, Yuzhnoye SDO has developed the modern ILV family successfully launching spacecraft within the framework of commercial and governmental programs from Baikonur launch site and sea-based platform in the Pacific Ocean.
The total number of Zenit ILV launches is 80.

YUZHNOYE

SEA LAUNCH

PROFILE: Sea Launch is the world's only ocean-based launch services company that provides commercial satellite customers with the most direct and cost-efficient route to geosynchronous transfer orbit. From its equatorial launch site, the robust Zenit-3SL launch vehicle can lift a heavier spacecraft mass or place a payload into a higher perigee, enabling satellite operators to attain a longer satellite service capability.

YEAR OF ESTABLISHMENT: 1995

HEADQUARTERS: Long Beach, USA

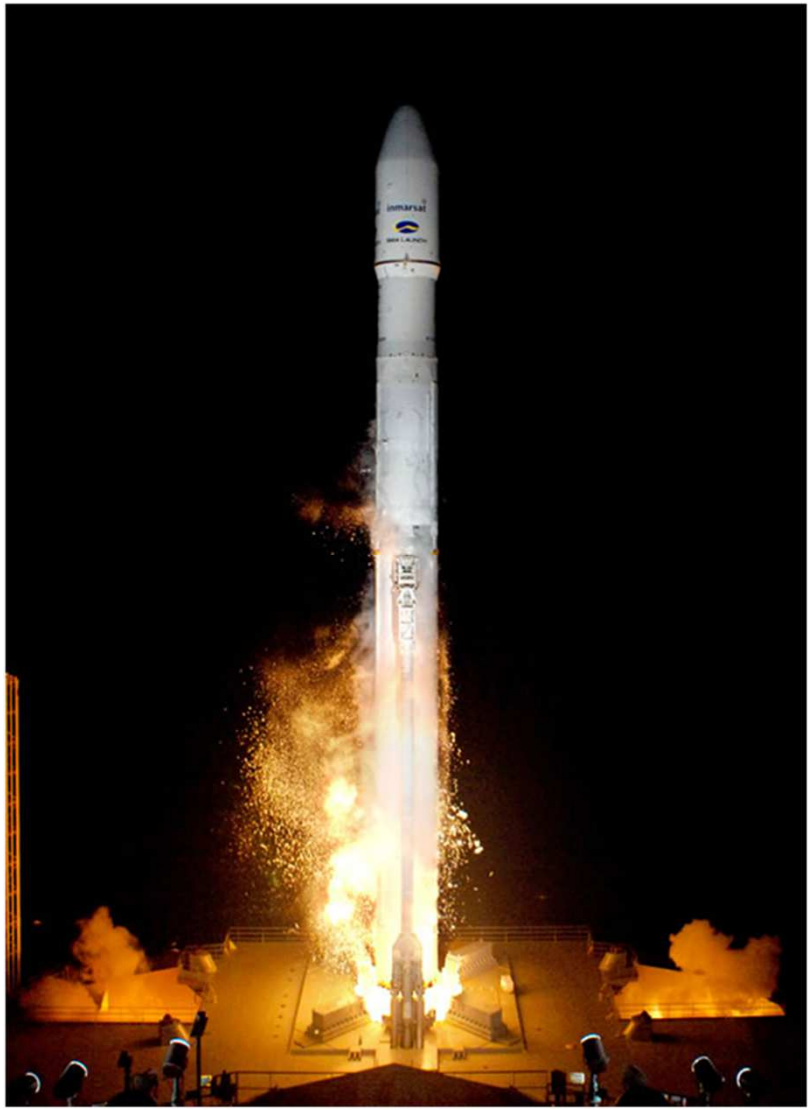
DEMO LAUNCH: March, 1999

FIRST COMMERCIAL LAUNCH: October 9, 1999

ZENIT-3SL

Zenit-3SL is operated under Sea Launch Program and launched from Odyssey floating platform in the equatorial area of the Pacific Ocean.

Zenit-3SL LV presents an optimal solution in terms of power characteristics, reliability, accuracy and cost of SC injection, which has been reached owing to utilization of developed systems and optimal planning of production process, transportation technology, prelaunch preparation and launch.



TECHNICAL CHARACTERISTICS

Maximum lift-off mass, t	473
Payload mass injected into the GSO transfer orbit, t:	6,1
Propellant mass, t	425
Engines thrust during LV start, tf	740
Maximum acceleration during injection, g	4,0
Propellants	liquid oxygen/kerosene
Full length, m	59,6

LAND LAUNCH

Zenit-2 SLB and Zenit-3 SLB are designed for launching under the LAND LAUNCH program from launch site at Baikonur

DNEPR

DISTINCTIVE FEATURES

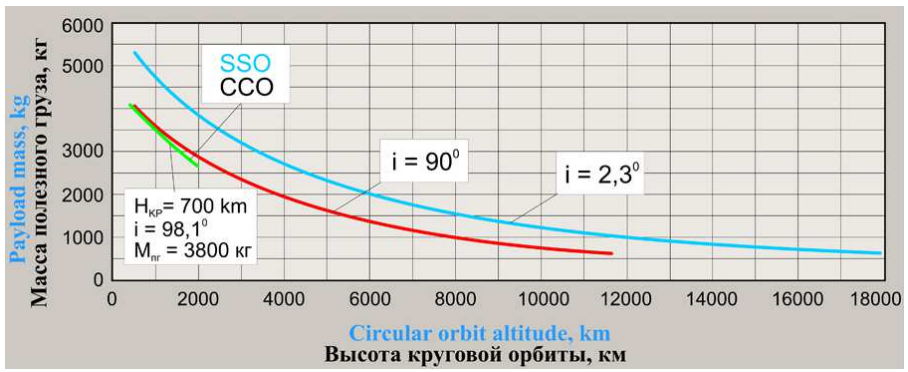
- Deployment of satellites of 300…3500 kg into circular orbits with the heights of 300…900 km
- High accuracy of deployment
- Low cost
- High reliability
- Flexibility

CYCLONE-4 LAUNCH VEHICLE

Cyclone-4 LV and Ground Complex are being developed by the Ukrainian companies jointly with the Brazilian companies to launch LV from Alcantara launch site (Brazil).

Currently, LV and its components ground development testing is to be completed, ground support equipment is being manufactured. The first set of ground support equipment has been delivered to Alcantara launch site.

The System main buildings and ground infrastructure are successfully being constructed.

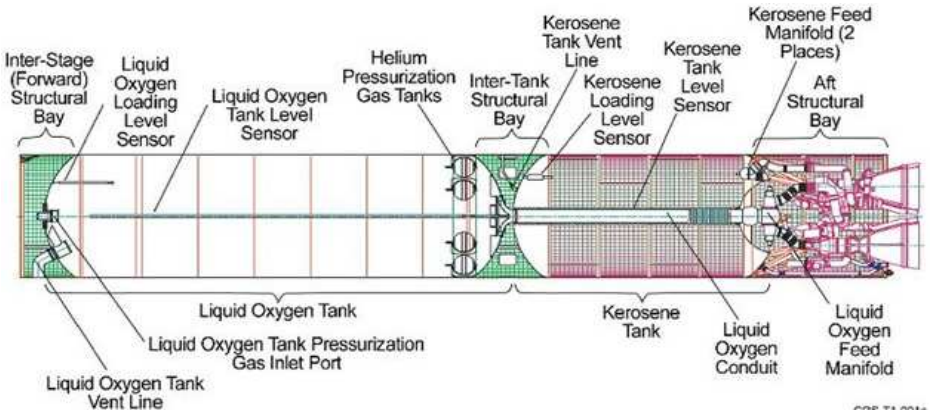


LAUNCH VEHICLES

ANTARES (TAURUS-II)

This project is being developed by Orbital Sciences Corporation (USA) under the Contract between NASA for resupply vehicles launching to ISS.
Yuzhnoye SDO is the developer, SE PA Yuzhmash is the manufacturer of LV First Stage Core Structure and a number of ground support equipment systems.

Research-production Enterprise "Hartron-arkos" Ltd is the developer and manufacturer of Control System of LV First Stage Core Structure.
Four sets of the first stage have already been manufactured and delivered to the Customer in USA under the project.
The maiden launch of Antares LV was implemented on April 21, 2013 from MARS launch site (Wallops Island).



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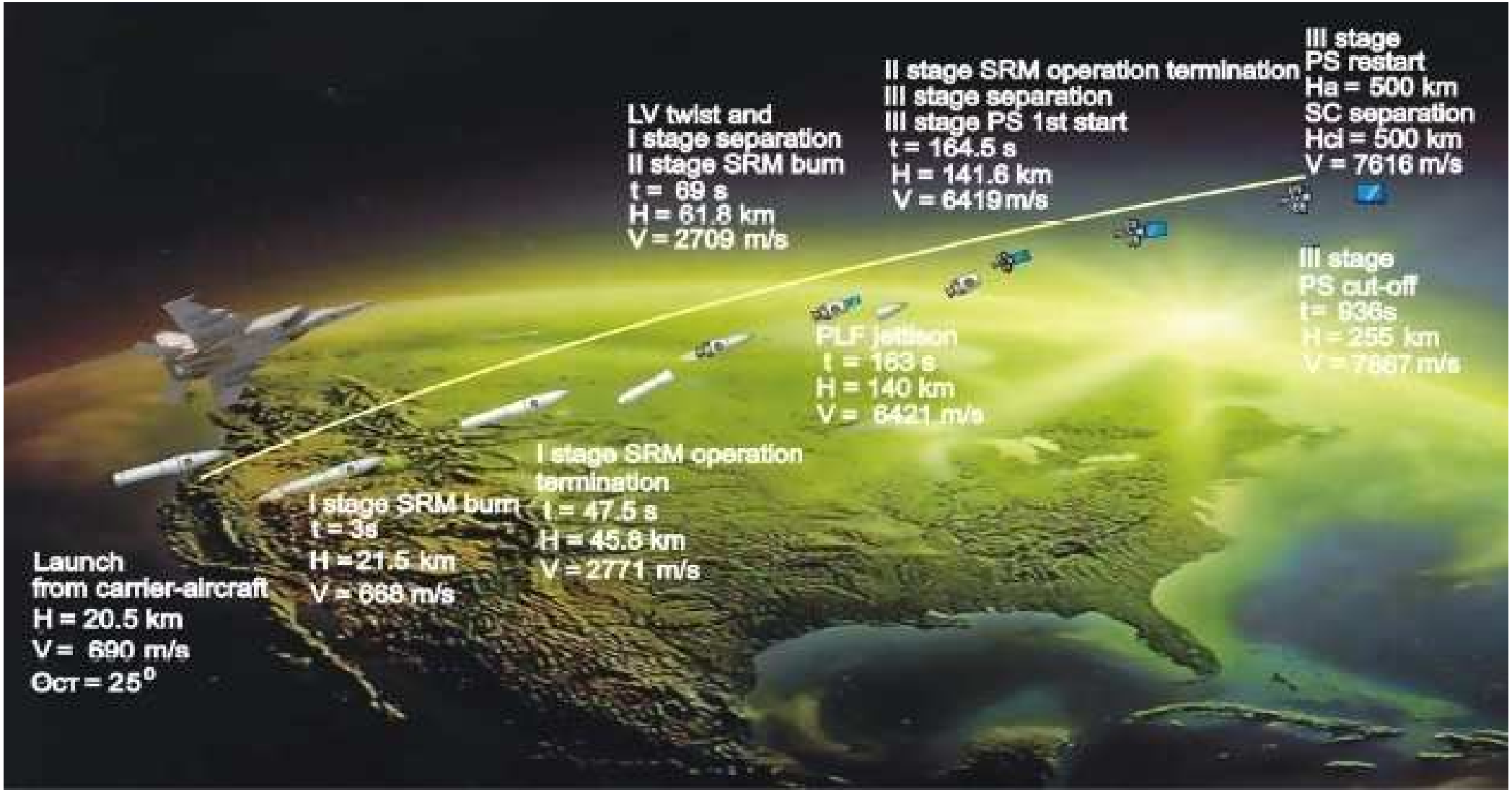
MICROSPACE-2

The Purpose of Microspace-2 Project is to use supersonic aircraft as carrier-aircraft of Space Transportation System for microsatellites injection.



PURPOSE AND ESSENCE OF THE PROJECT

PURPOSE OF THE PROJECT:

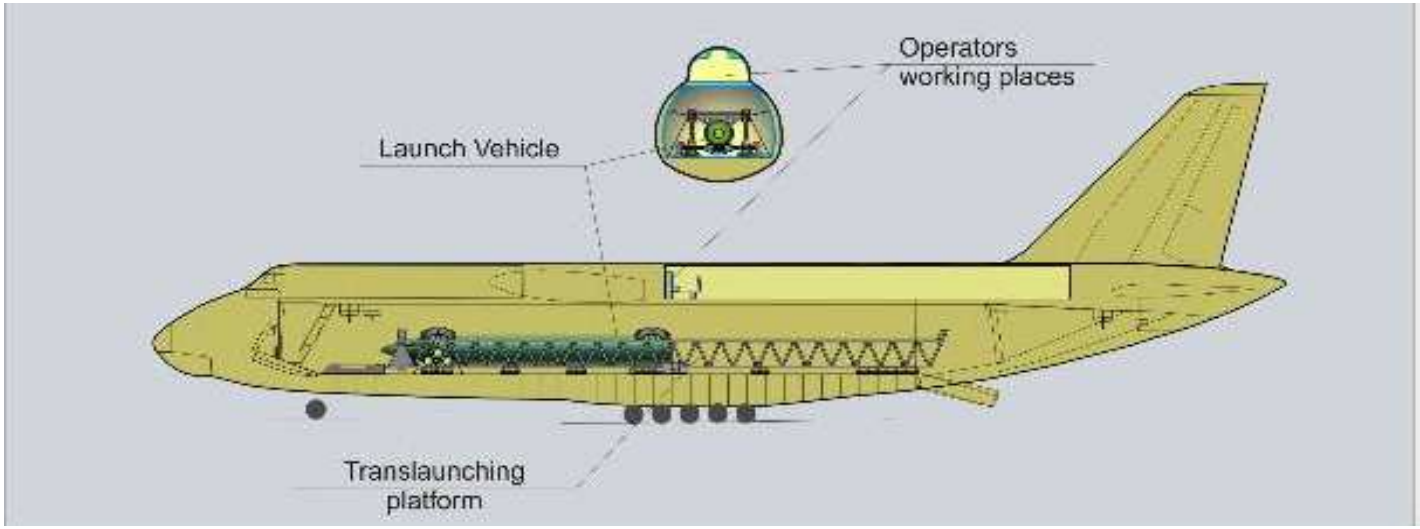
The purpose of Space Clipper Project is ensuring of access to space that would not depend on geographical position of a country and would provide dedicated launch for growing number of spacecraft

ESSENCE OF THE PROJECT:

Utilization of heavy cargo aircraft which serves for dropping two/three-stage launch vehicle weighing 36-70 tons.

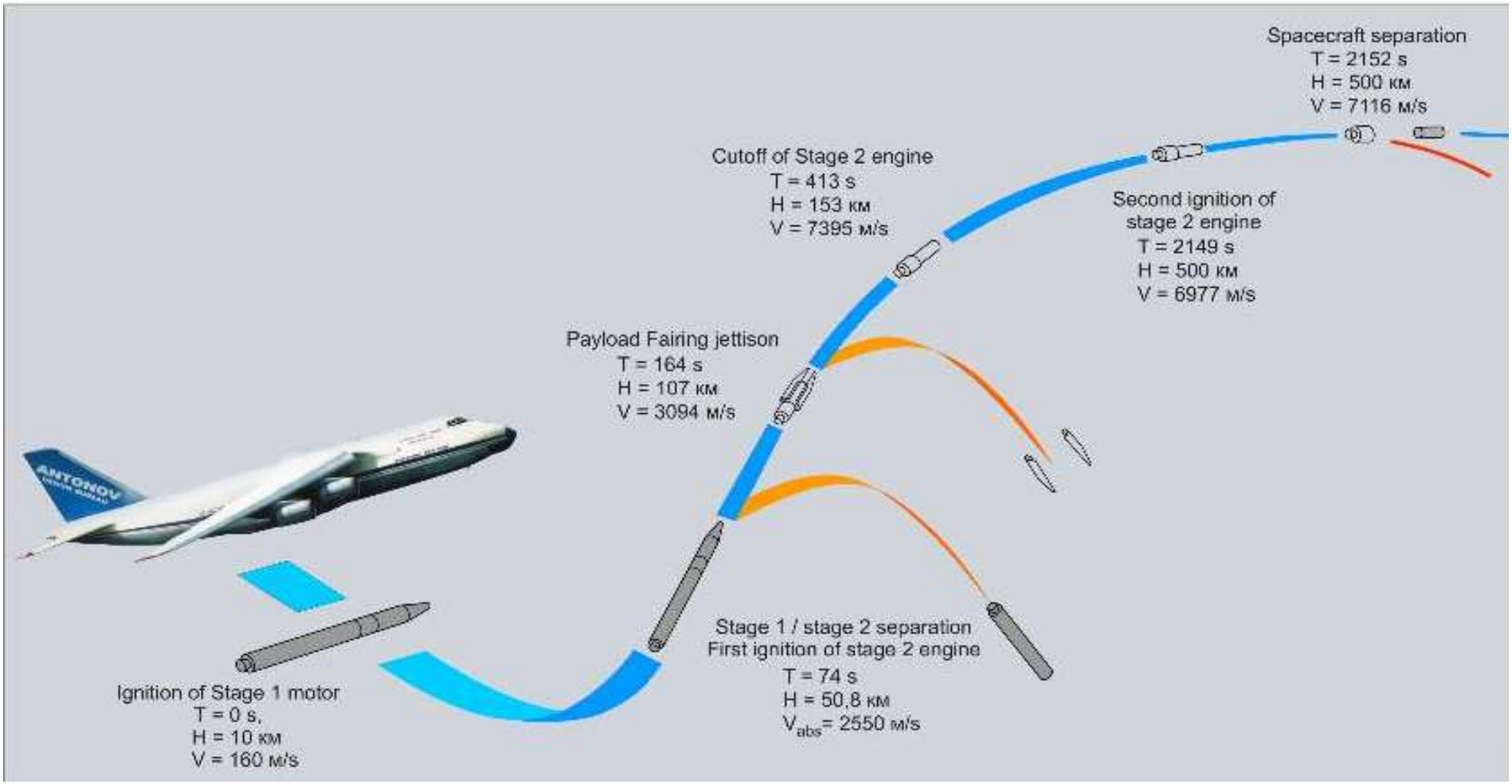
Aerospace Rocket Complex Space Clipper consists of:

- aviation complex (modified An-124-100 Ruslan aircraft, ground-support equipment);
- space rocket complex (two/three-stage launch vehicle, on-board launch complex, technical base)

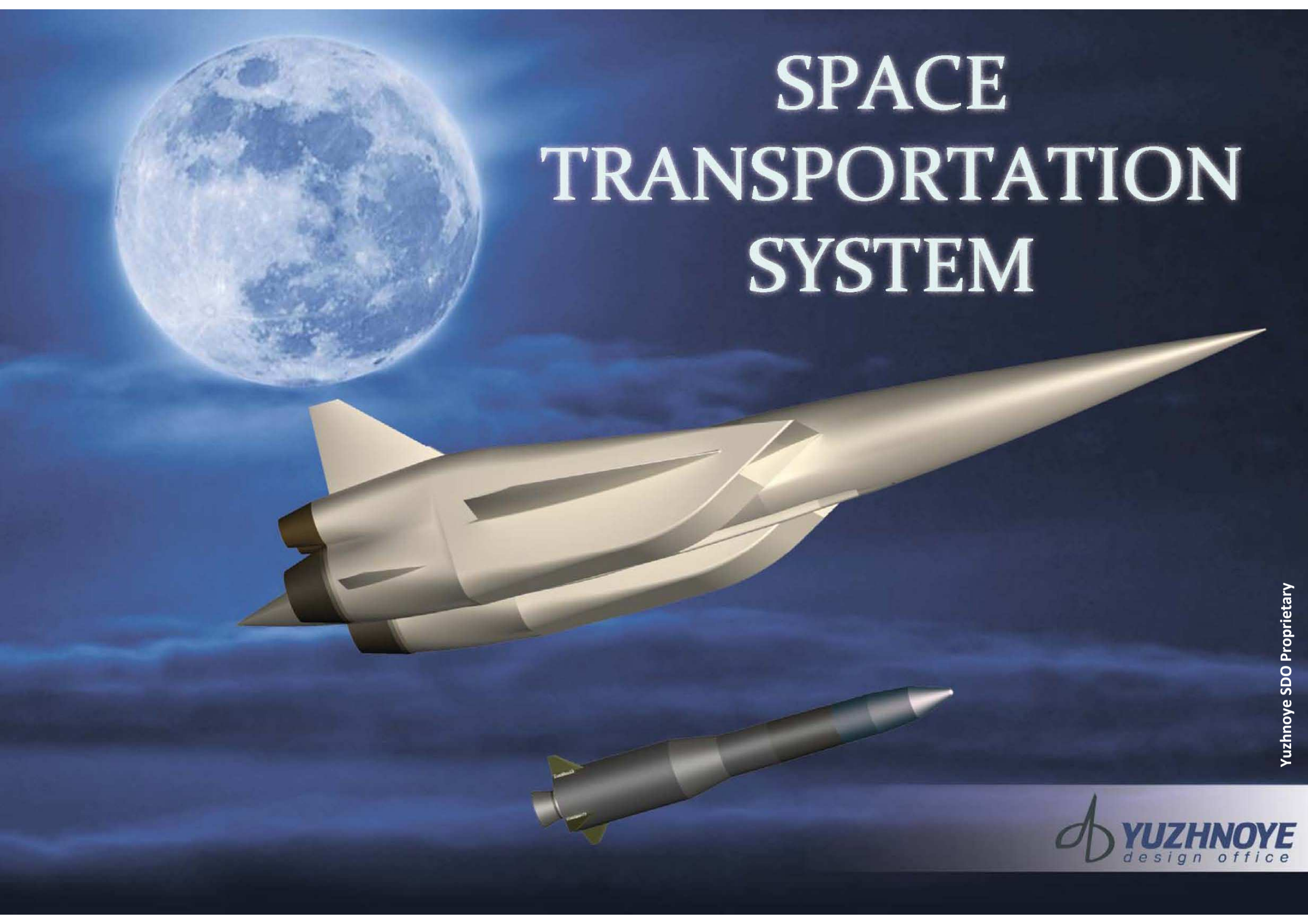


SPACE CLIPPER

ROCKET FLIGHT PROFILE



SPACE TRANSPORTATION SYSTEM



YUZHNOYE
design office

SPACE TRANSPORTATION SYSTEM APPLICATION

- launching scientific and civil application microsatellites (mass not less than 100 kg)

STS Components

- reusable high-altitude hypersonic unmanned aerial vehicle
- expendable three-stage integrated launch vehicle

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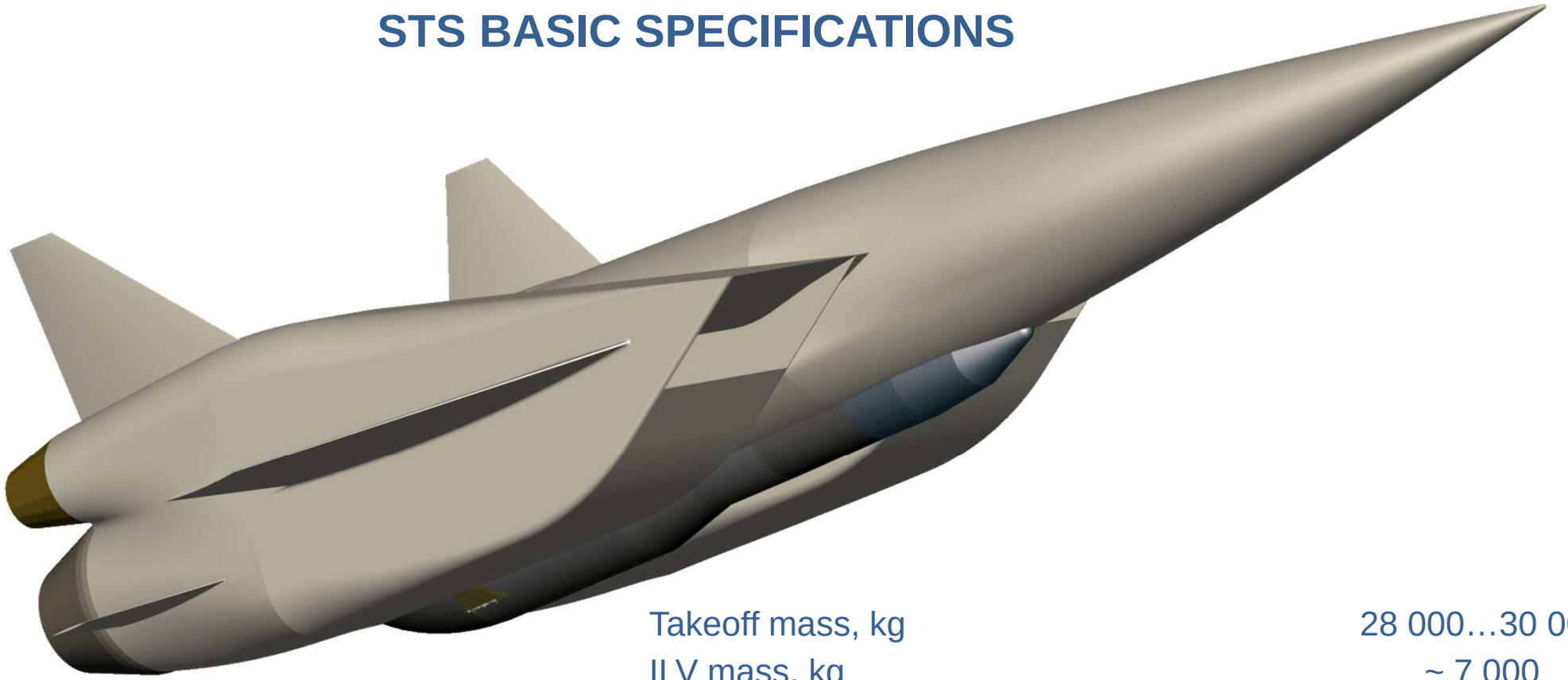
SPACE TRANSPORTATION SYSTEM

STS BASIC SPECIFICATIONS



Takeoff mass, kg	28 000…30 000
ILV mass, kg	~ 7 000
Payload capability, kg	not less than 100
Sun-synchronous orbit height, km	500
UAV wing loading, kg/m^2	500…600
Speed at ILV separation, Mach	4…6
Altitude at ILV separation, km	25…30
Flight path slope, deg	40…50

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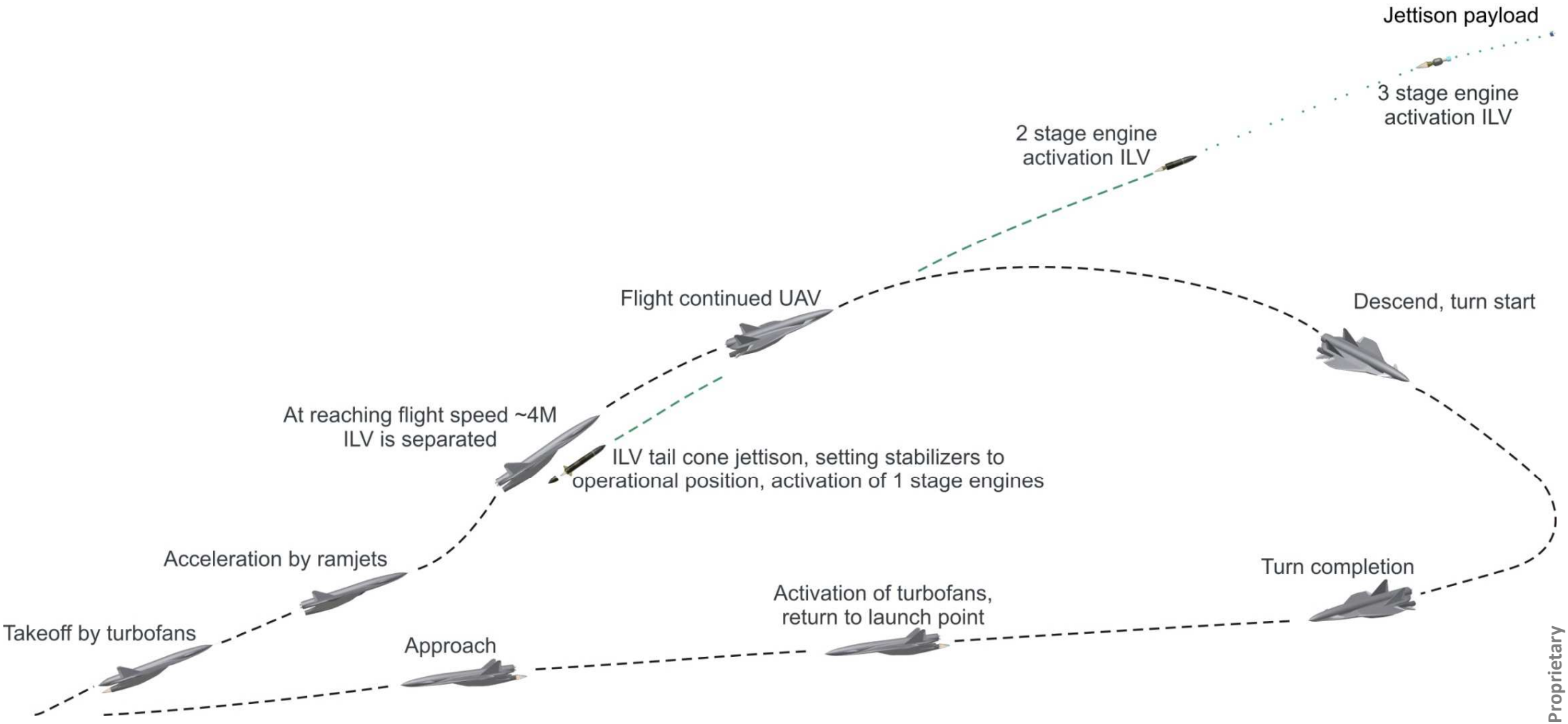
SPACE TRANSPORTATION SYSTEM

STS FLIGHT PROFILE



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ROCKET ENGINES

YUZHNOYE

RD-860

RD-8

AUOS-Z spacecraft
gas jet propulsion system

Okean-0
spacecraft thruster

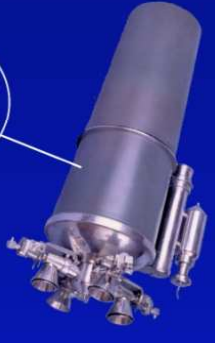
Sich-2 spacecraft
ammonia thruster

- 11 types of main liquid-propellant engines with thrust level from 500 kg to 48,000 kg
- 6 types of liquid-propellant control rocket engines with thrust level from 5,000 kg to 29,000 kg
- 16 types of liquid, gas jet and electrical jet spacecraft propulsion systems with thrust level from 0.005 kg to 10 kg
- 7 types of main solid-propellant rocket motors with thrust level from 150,000 kg to 300,000 kg
- more than 100 types of special purpose solid-propellant rocket motors, pressure accumulators and gas generators
- 8 types of electric power units to provide hydraulic power to steering systems

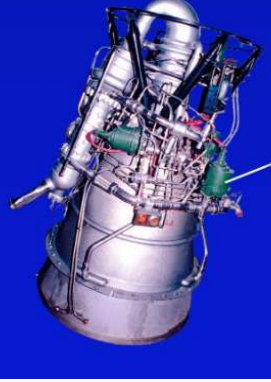
were developed

15D339

15D171



Rocket Engines



RD-862

RD-861G

15D305

15D284

15U78

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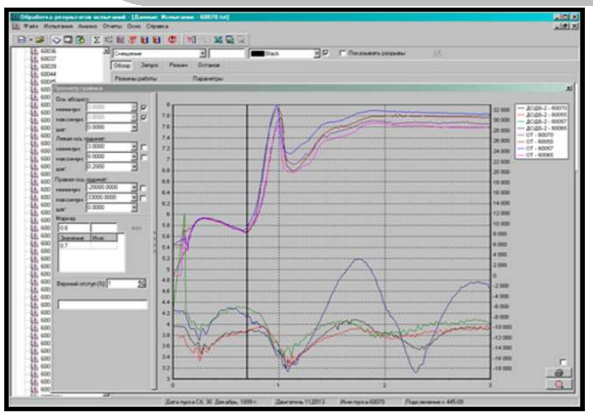
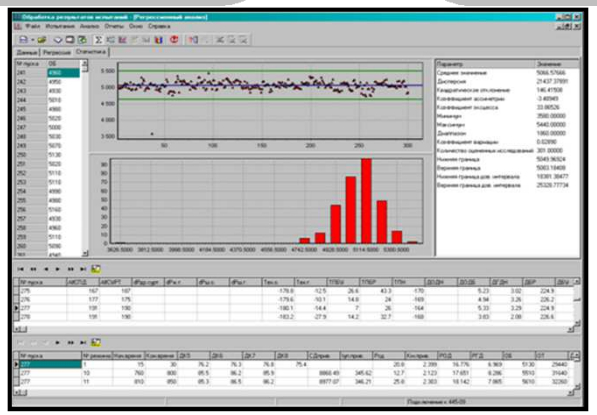
ROCKET ENGINES

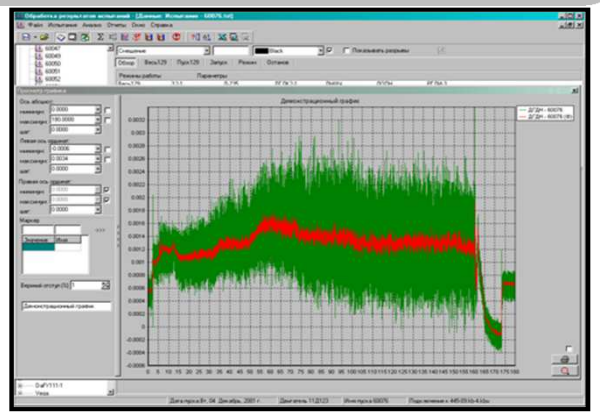
The achieved level of reliability

For Liquid Rocket Engines no less than 0,992-0,999

For Solid propellant Rocket Motors 0,995-0,999







ROCKET ENGINES

HIGH RELIABILITY OF ENGINES IS ENSURED BY PRACTICALLY CLOSED PRODUCTION CYCLE

Design

Manufacturing

Testing

Serial production

Propulsion Design Office Yuzhnoye SDO

Engines manufacturing SE PO YMZ

Testing base SE PO YMZ and Yuzhnoye SDO

Engines manufacturing SE PO YMZ

Specialists training

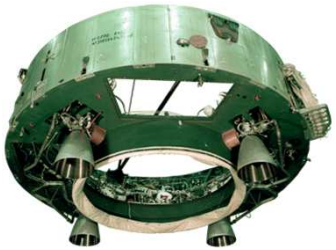
DNU (Dn-sk)

KAI (Kharkov)

Design support

LIQUID PROPELLANT ROCKET ENGINES

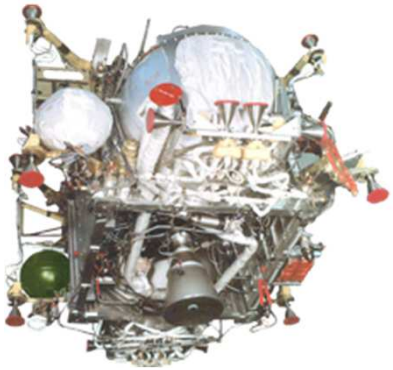
Over more than 55 years Ukraine has gathered large experience in the development of different types of LREs with storable and cryogenic propellants (17 engines of 35 developed were serially produced and installed on launch vehicles). The necessary testing and production base is established.



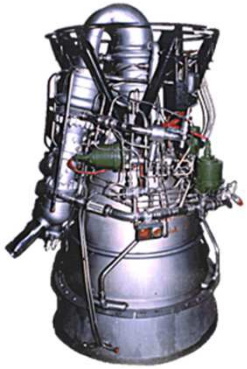
Steering engines for
1st and 2nd LV stages (RD8)

Multimode engines for
space tugs (RD869)

Lunar Landing Module liquid
rocket engines RD858 and RD859



Space tug propulsion
systems (RD866)



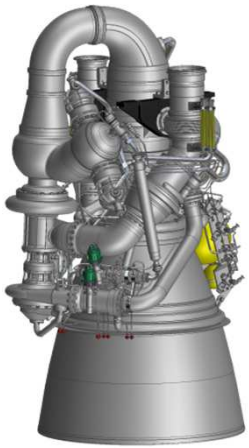
Rocket engines with gas-dynamic thrust
vector regulation (RD862)

Upper-stage rocket engines
with multiple restarts (RD861)

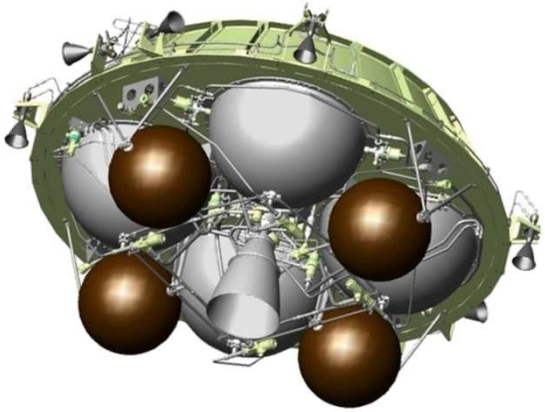
DEVELOPMENT OF NEW ROCKET ENGINES

VG143 (Vega)

RD809M



RD801



DU-802 (Krechet)

RD861K

RD809K

RD810

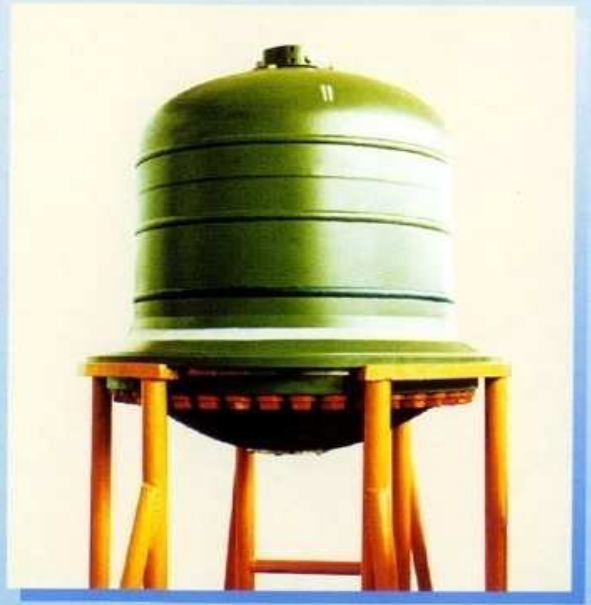
YUZHNOYE SOLID PROPELLANT ROCKET ENGINES

11 Main and 77 Auxiliary Solid Propellant Rocket Motors have been developed

SOLID PROPELLANT ROCKET ENGINES

Large Solid Sustainer Engines
КРУПНОГАБАРИТНЫЕ МАРШЕВЫЕ РДТТ

Special Purpose Engines
ДВИГАТЕЛИ СПЕЦИАЛЬНОГО НАЗНАЧЕНИЯ



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LAUNCH VEHICLES STRUCTURE COMPONENTS

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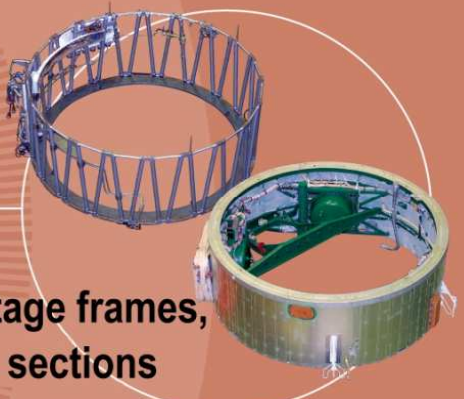
Rocket Components

Payload adapters

Fuel tanks

Pyrotechnic devices

Fairings



Interstage frames, dry sections

High pressure bottles

Electromechanical actuators

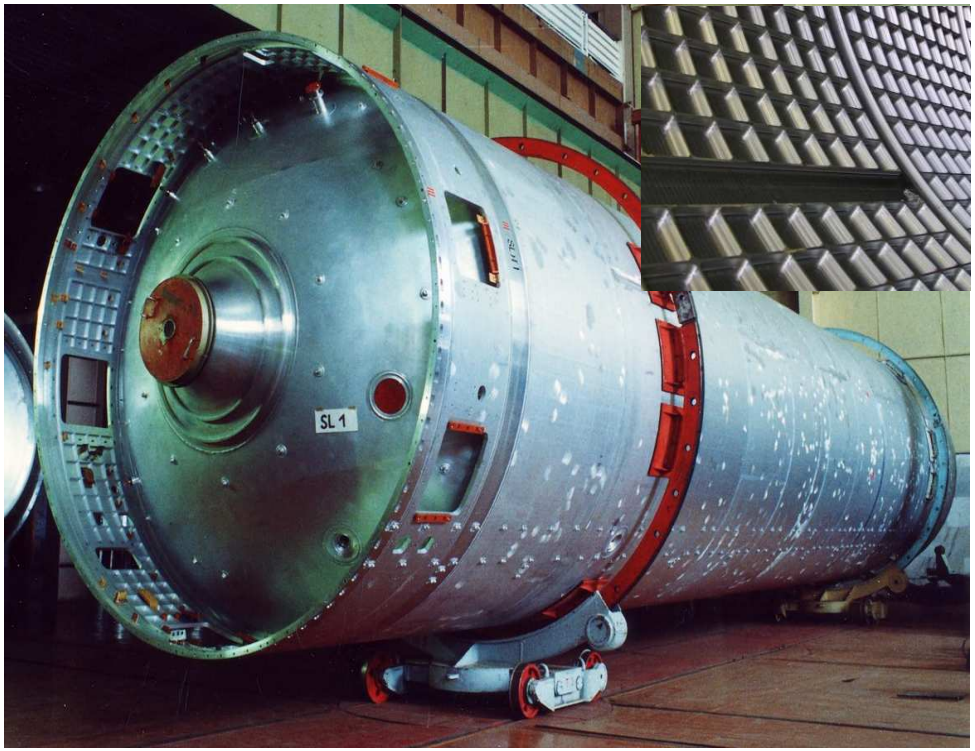
Electrohydraulical actuators

Pneumatic-hydraulic units

Sensors

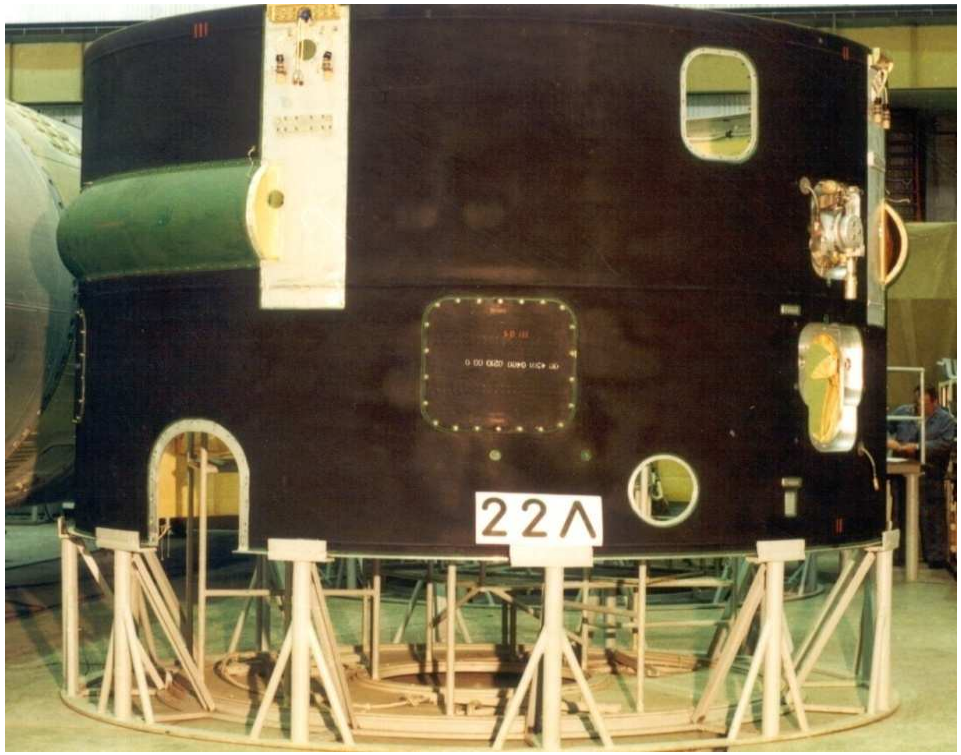
LAUNCH VEHICLES STRUCTURE COMPONENTS

Oxidizer Tank (Liquid Oxygen)



It is manufactured from aluminum alloy and has waffle structure.

Aft Bay



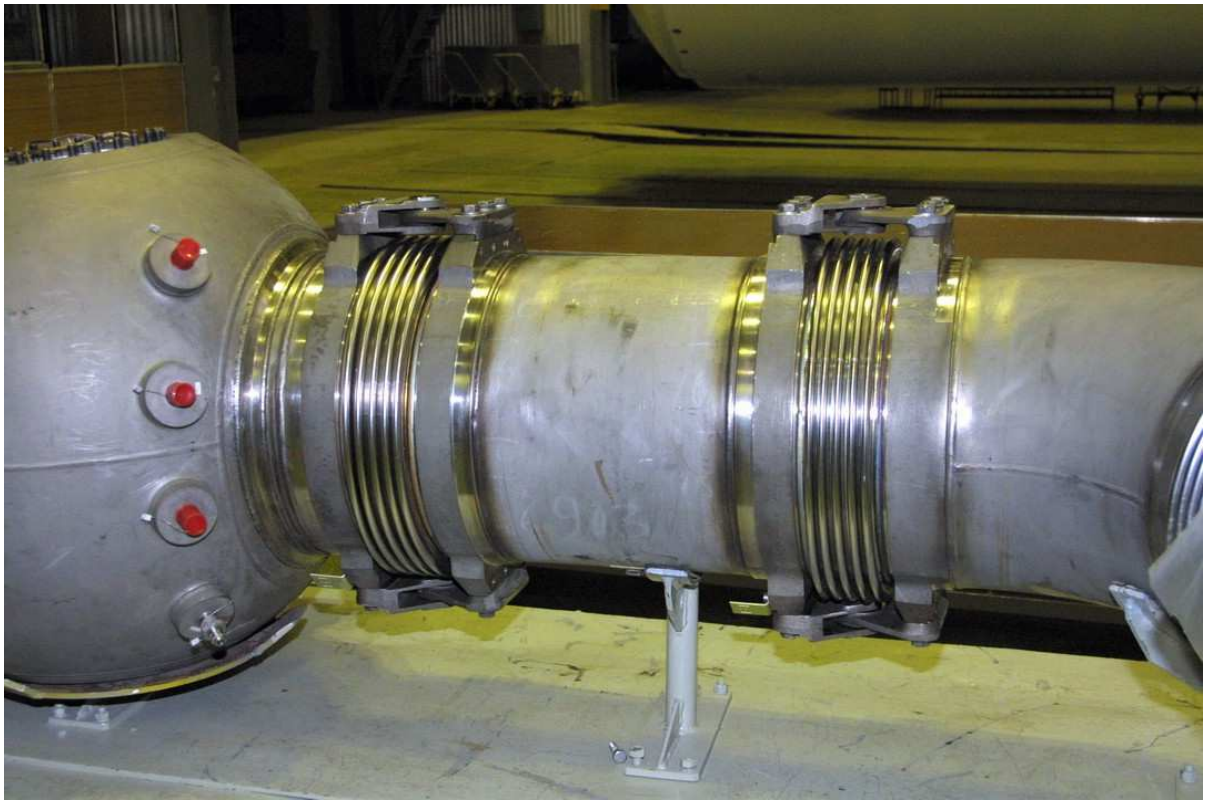
It is manufactured from aluminum alloy and covered by high-efficient heat-protection material

LAUNCH VEHICLES STRUCTURE COMPONENTS

Inter-stage frame

It is manufactured from high-strength steel capable of operating at cryogenic temperatures

Bellow



It is installed on pipelines with diameter of up to 400 mm

LAUNCH VEHICLES STRUCTURE COMPONENTS

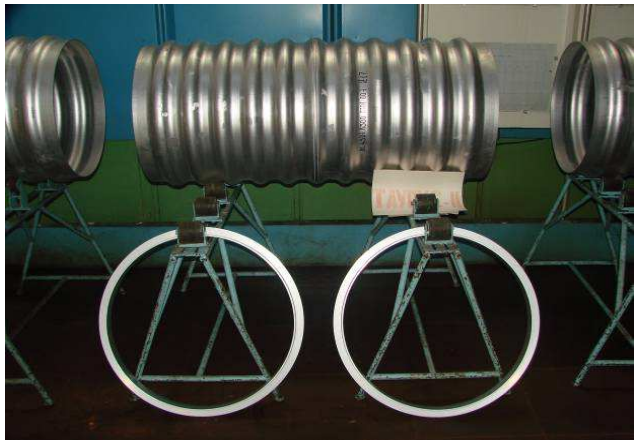
Oxidizer Tank Bottom Dome

Intertank Bay

Tank Shells

Bulkhead for Fuel Tank Bottom Dome

Fuel Tank Upper Dome



Fuel Tank Tunnel Pipeline (for Oxidizer Feedline)

LAUNCH VEHICLES STRUCTURE COMPONENTS

Oxidizer Tank Final Pressurization Valves

Fuel Tank Safety Valves

PCCS Elements

FMS Sensors

Helium Bottles Components

Stainless Elements of PHS Pipeline

LAUNCH VEHICLES STRUCTURE COMPONENTS

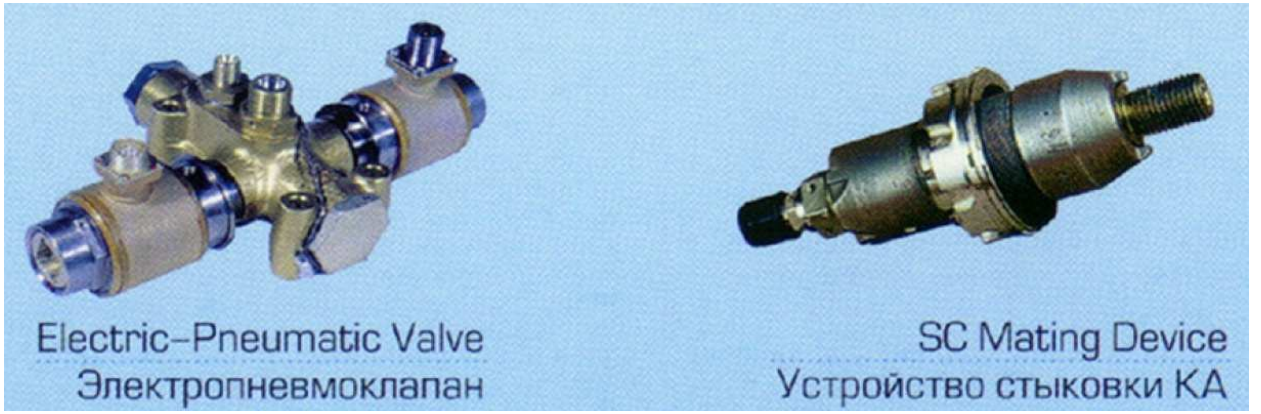
Payload Fairing

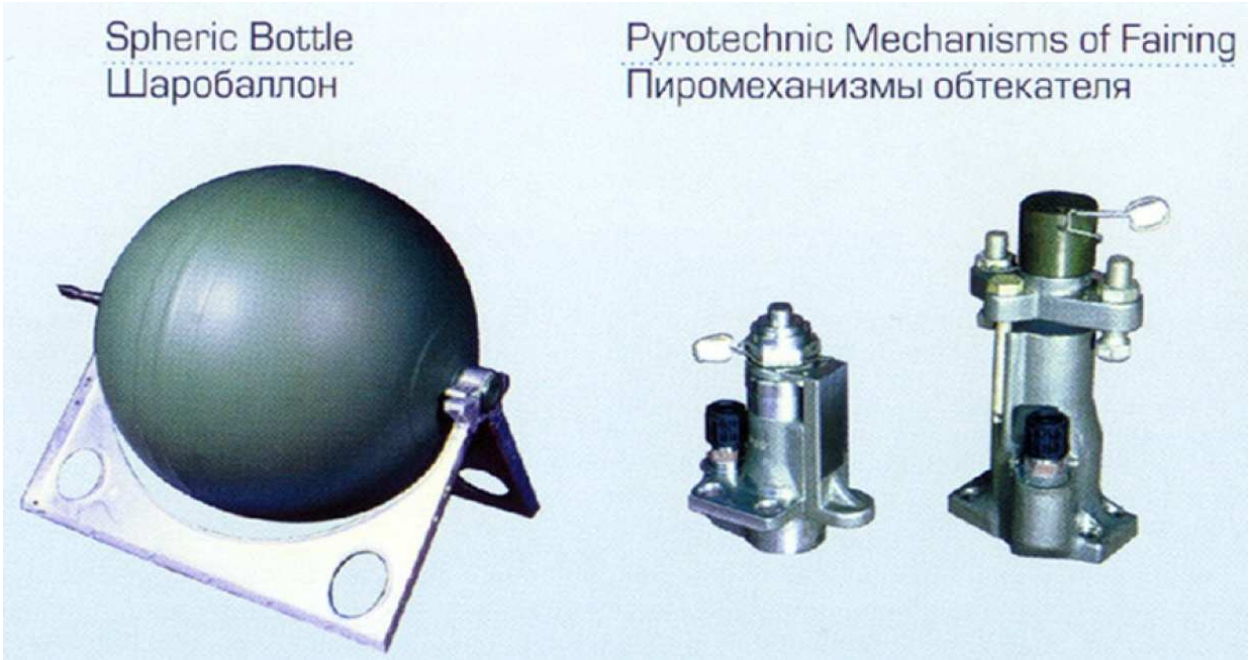
It is manufactured from high-strength aluminum alloy

Dispenser

It is designed for installation of 12 spacecraft. It is manufactured from high-strength aluminum alloy and equipped with ventilation system and separation system

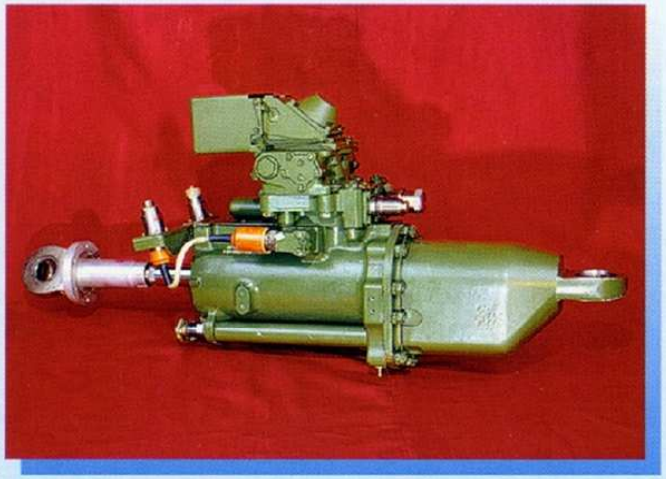
LAUNCH VEHICLES STRUCTURE COMPONENTS

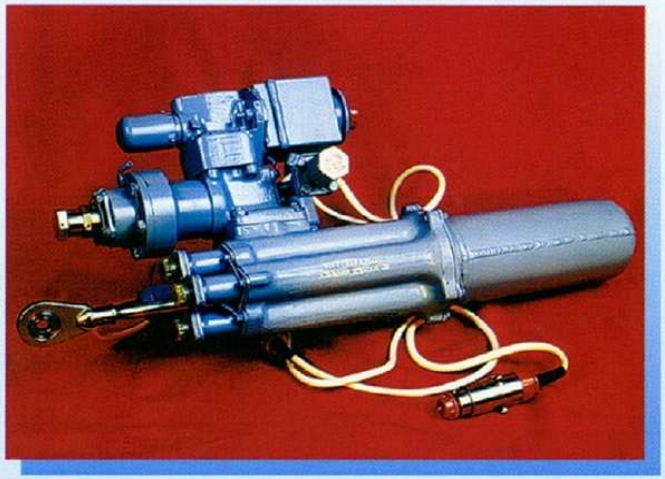




LAUNCH VEHICLES STRUCTURE COMPONENTS

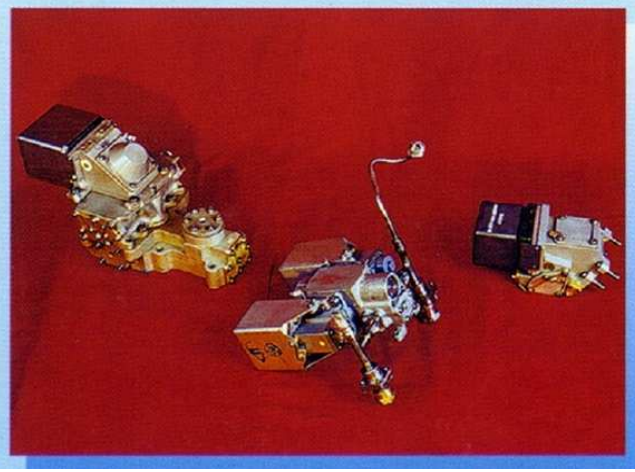
Electric–Hydraulic Actuators
ЭЛЕКТРОГИДРАВЛИЧЕСКИЕ ПРИВОДЫ





Electromechanical Actuators
ЭЛЕКТРОМЕХАНИЧЕСКИЕ ПРИВОДЫ

Hydraulic Power Amplifiers
ГИДРАВЛИЧЕСКИЕ УСИЛИТЕЛИ МОЩНОСТИ



Sensors of Different Purpose
ДАТЧИКИ РАЗЛИЧНОГО НАЗНАЧЕНИЯ

YUZHNOYE

PERSPECTIVE TECHNOLOGIES AND NEW MATERIALS

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Wind power generator blades and mine structures made of fiberglass plastic

Non-metallic composites

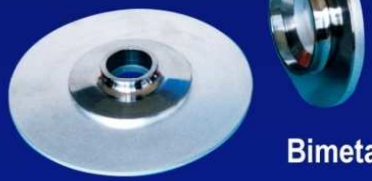
Metal Composites

are produsedby explosion welding

Multilayer composites

Heat exchangers

Plain bearings



Bimetallic adapters

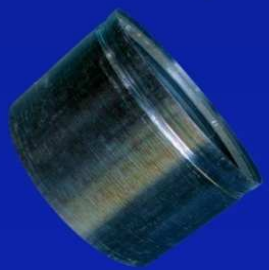
Advanced Materials and Technology

Solid rocket motor body of “cocoon” type

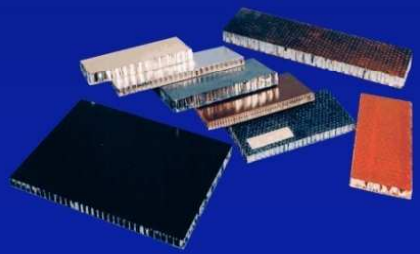
Nozzle inserts and bells made of carbon-carbon composite

Metal-Plastic Composites

Metal plastic bottles

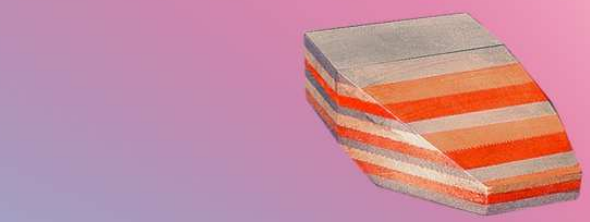


Launch vehicle aft sections and spacecraft trusses made of carbon fiber composite



3-layer honeycomb structures

COMPONENTS AND ELEMENTS OF STRUCTURES MADE OF MULTI-LAYER METAL-COMPOSITES



Steel-copper-brass composite

Steel-aluminum bimetallic adapters

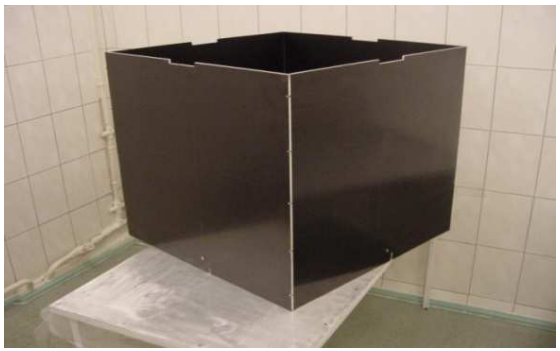
Steel-aluminum composite

Aluminum-copper composites

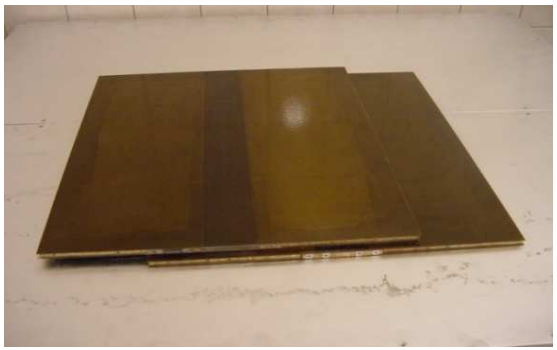
YUZHNOYE

HONEYCOMB STUCTURES

Element of a Fairing



Heat shields of spacecraft

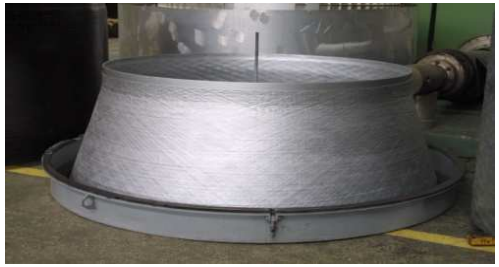


Bases for solar panels

Elements of heat insulation

UNITS MADE OF CARBON-CARBON MATERIALS

Liquid-propellant rocket engine with uncooled nozzle extenstion made of carbon-carbon



Nozzle extension for Solid-propellant rocket engine

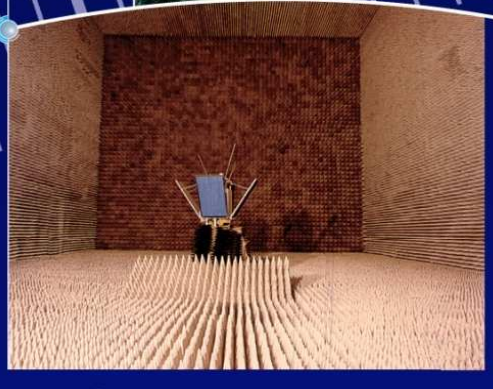
Elements of a nozzle unit

YUZHNOYE

Experimental and certification testing

Fire testing

Strength testing



Antenna systems

Functional testing

Full telemetry support for space rocket systems testing and nominal operation

YUZHNOYE

SATELLITES AND COMPONENTS

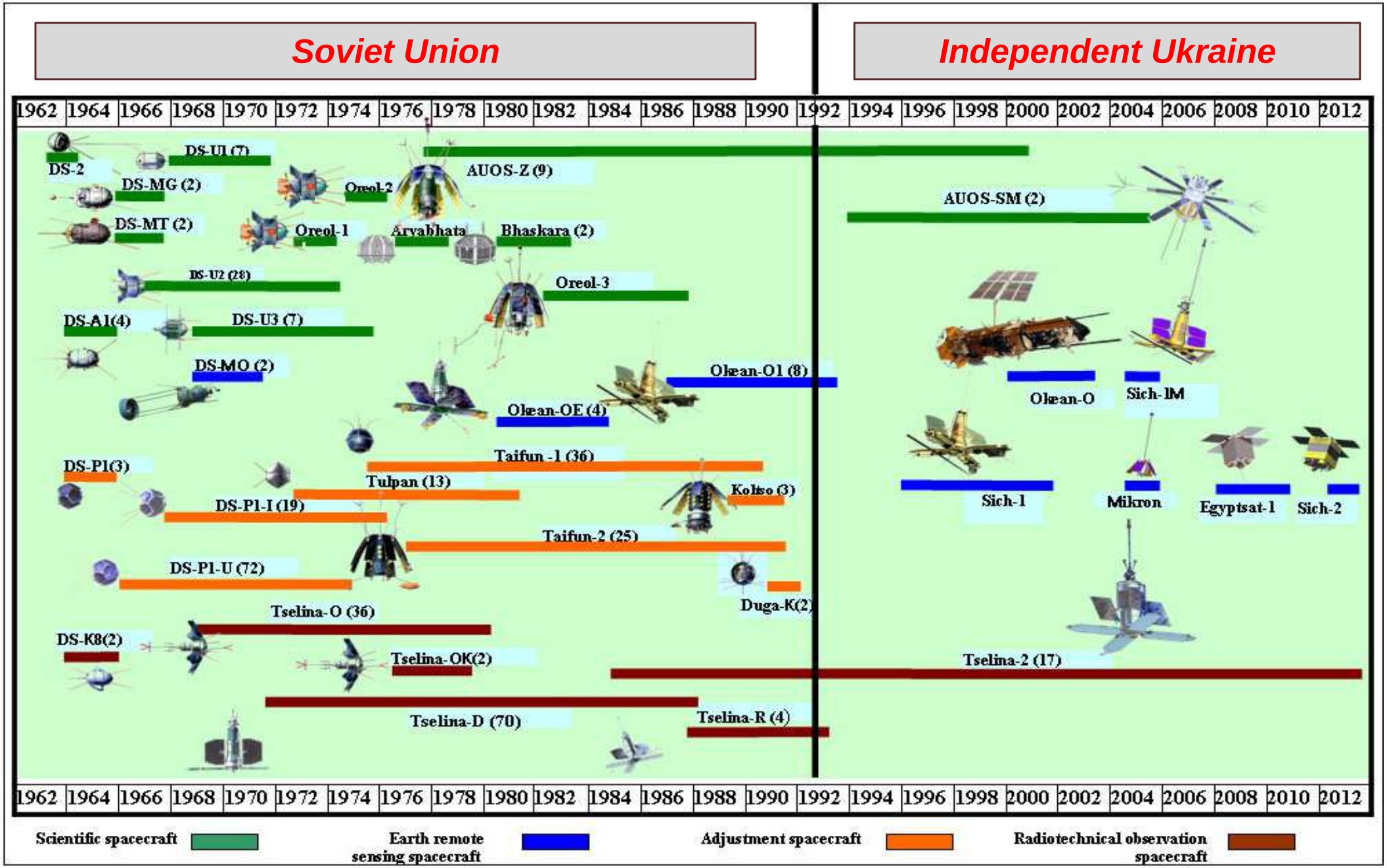
EXPERIENCE OF YUZHNOYE STATE DESIGN OFFICE IN DEVELOPMENT OF SATELLITES

Yuzhnoye SDO, which was founded in 1954, is the leading research and design enterprise of the space industry of Ukraine which is worldwide known for its activity in the sphere of man-made Earth satellites creation. Yuzhnoye SDO has a great experience in different purposes space systems and complexes development. The first satellite which was developed by Yuzhnoye SDO was launched on March 16, 1962 and since that time about 400 different purposes satellites were developed, manufactured and launched.

Satellites developed by Yuzhnoye State Design Office

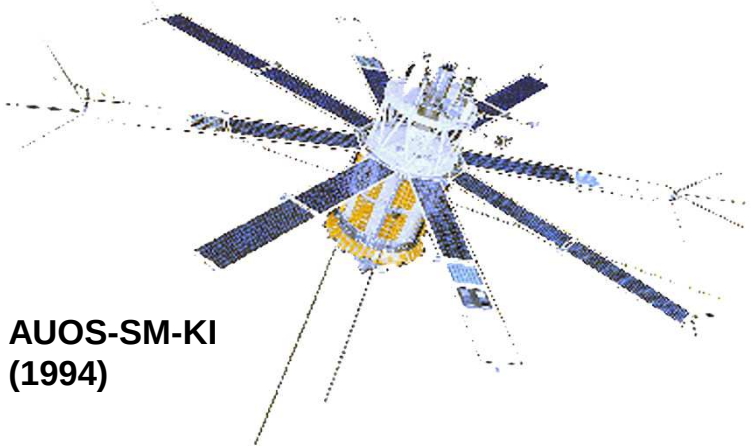
Name		Launch	Note
Kosmos 1	DS-2	1962	First satellite developed by Yuzhnoye SDO, First satellite of Kosmos series, 15 satellites were launched
Kosmos -93	DS -U2	1965	First satellite on the base of DS-U2 modification, 27 satellites were launched
Kosmos-166	DS-U3	1967	First satellite on the base of DS-U3 modification, 6 satellites were launched
Kosmos - 196	ДС-У1	1967	First satellite on the base of DS-U1 modification, 5 satellites were launched
Interkosmos-1	DS-U3-IK-1	1969	First satellite of Interkosmos series on the base of DS-U1,2,3 modifications, 14 satellites were launched
Interkosmos -15	AUOS-Z-T-IK	1976	First satellite – automatic multipurpose orbital station with orientation to the Earth, 10 satellites were launched
Kosmos- 1076	Okean-E №1	1979	First experimental Earth remote sensing satellite, 4 satellites were launched
Kosmos- 1766	Okean-O1 №1	1986	First satellite of Okean Earth remote sensing system, 6 satellites were launched
Koronas-I	AUOS-SM-KI	1994	First satellite - automatic multipurpose orbital station with orientation to the Sun, 2 satellites were launched
Sich-1	Okean-O1	1995	First satellite under jurisdiction of Ukraine
Okean-O	Okean-O	1999	First satellite of Okean Earth remote sensing system of new generation
Mikron	MS-1-TK	2004	First microsatellite on the base of innovative design-technological solutions
Egyptsat-1	MS-2	2007	First commercial satellite on the base of innovative design-technological solutions
Sich-2	MS-2-8	2011	Multipurpose satellite for optical-electronic observation of the Earth and ionosphere researches

EXPERIENCE OF YUZHNOYE SDO IN SATELLITES DEVELOPMENT



YUZHNOYE

SATELLITES DEVELOPED AND LAUNCHED IN 1994-2011

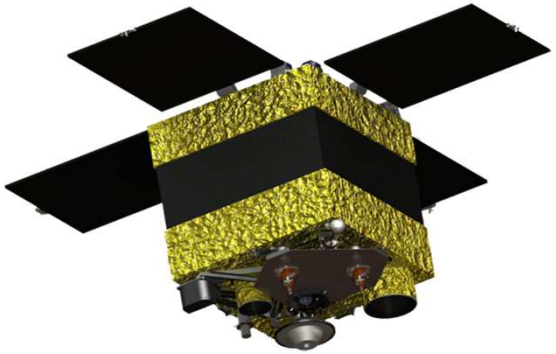


AUOS-SM-KI
(1994)

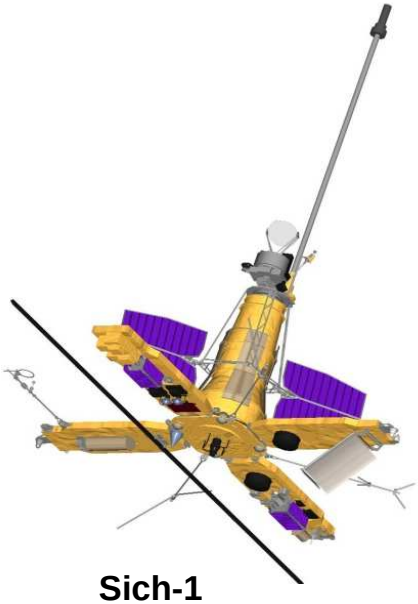
Mikron
(2004)

EgyptSat-1
(2007)

Okean-O
(1999)



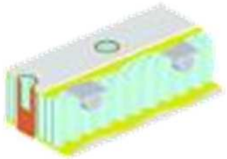
Sich-2
(2011)

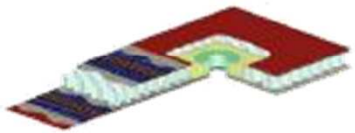


Sich-1
(1995)

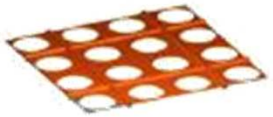
BASIC SATELLITE COMPONENTS

Satellite body panel with embedded heat pipes





Three-layer panel
with specific mass of 0.8 kg/m^2



Waffle panel
with specific mass of 0.6 kg/m^2

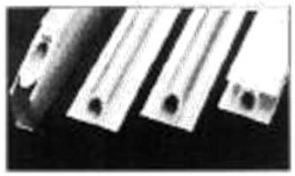
X- and S-band antennas

Thermostable trusses

Aluminum truss
of multisection heat pipe type

Truss made of carbon-reinforced plastic
(continuous winding, without fittings)

Heat pipes with constant
thermal resistance



Gravity gradient boom

Rotating mechanisms

Electric mechanism

Spring mechanism with speed regulator

Thrusters

Ammonia thruster
with working media heating

Electric thruster

Unique space structures

Structure for high-resolution (~1 m)
space telescope

Load-carrying structure
of phased array (15000x2300x300 mm)

Test equipment based on the principle of holographic interferometry

Holographic dilatometer

Defectoscopy complex for
three-layer structures

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