Opportunities and needs for collaboration in Adriatic and Mediterranean region in the field of space research

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Full member of IAA

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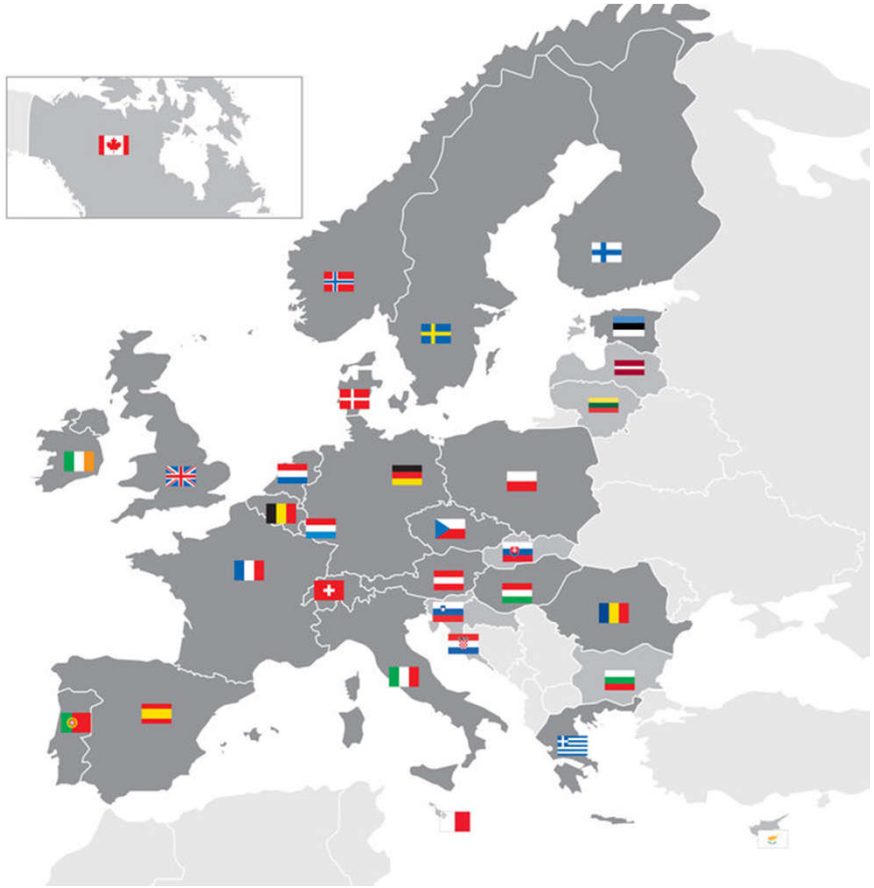
1. Present state in the organisation of space activities in Europe

ESA has 22 Member States.
The national bodies responsible for space in these countries sit on ESA's governing Council:

Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, **Greece**, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland and the United Kingdom.

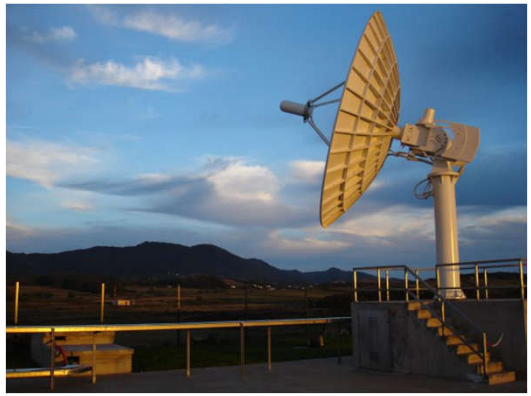
Slovenia is an Associate Member. Seven other EU states have Cooperation Agreements with ESA: Bulgaria, Croatia, Cyprus, Latvia, Malta, Lithuania, and Slovakia.
Israel (2011) and Canada (2000) also signed Cooperation Agreements and sits on the ESA Council.



(Courtesy of ESA)

2. Short overview of space activities in Mediterranean area

Portugal



St Maria trecking station (5m antena) - Azores island
(Credit: ESA)

Portugal Space is an *agency* to be primarily considered as an instrument of the Portuguese government, in close articulation with the Regional Government of the Azores, to implement the national strategy 'Portugal Space 2030'. The main present goal is to manage and promote the *Azores International Satellite Launch Program.*

2. Short overview of space activities in Mediterranean area

Spain

Sounding rocket INTA 300B

Lume 1
CubeSat 2U
(Universidade De Vigo)
launched 27.12.2018

CAPRICORNIO orbital launcher (suspended 1998)

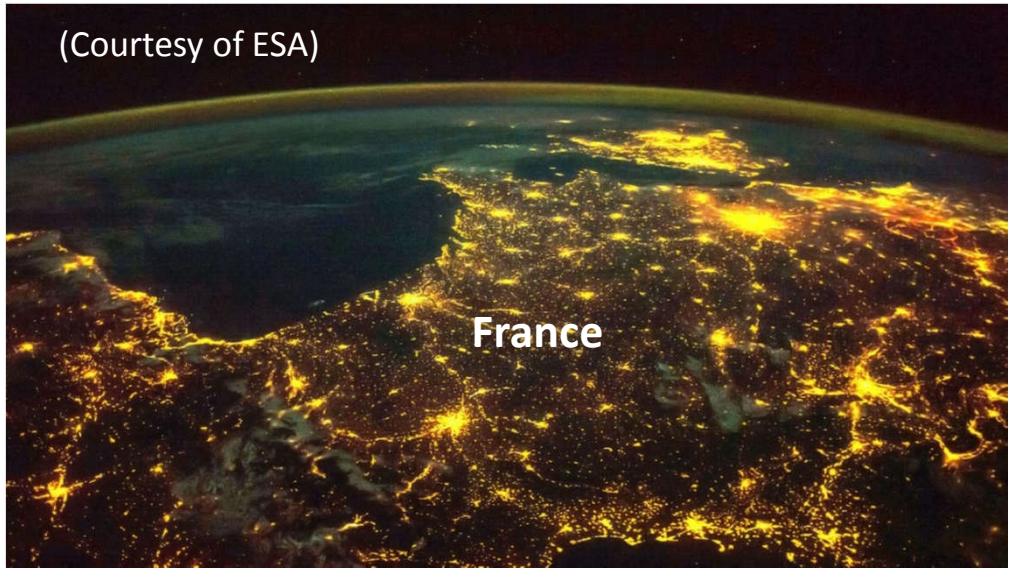
PAZ – EO and reconainaissance satellite launched 22.02.2018

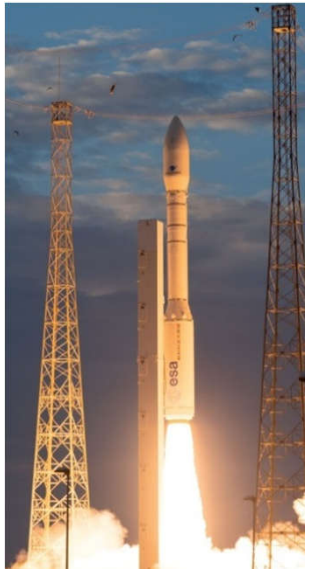
Amazonas 4a – Hispasat 74W-1 [Star2]

Madrid Deep Space Communication Complex operated by INTA (*Credit: Hector Blanco de Frutos)*

2. Short overview of space activities in Mediterranean area

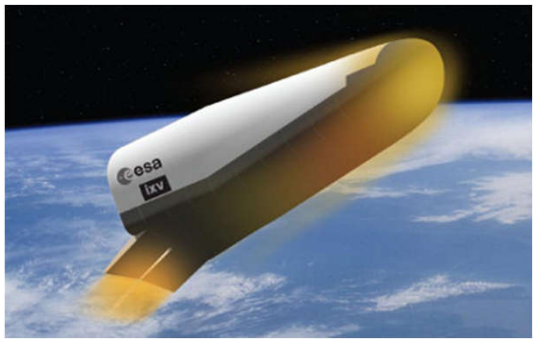
France





Vega launch

Athena-Fidus is a **F**rench-**I**talian tele-communication **d**ual **u**se **s**atellite (2014)



Intermediate e**X**perimental **V**ehicle (IXV)

ARIANE 6.2 and 6.4 (ESA)

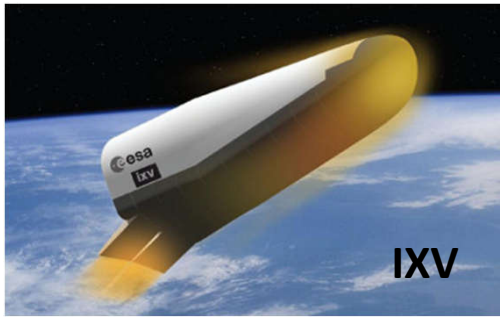
2. Short overview of space activities in Mediterranean area

Italy

Paolo Angelo Nespoli is an Italian astronaut and engineer. Flights:

- Space Shuttle Discovery STS-120 (2007)
- Soyuz TMA-20 spacecraft (2010)

VEGA – C launcher

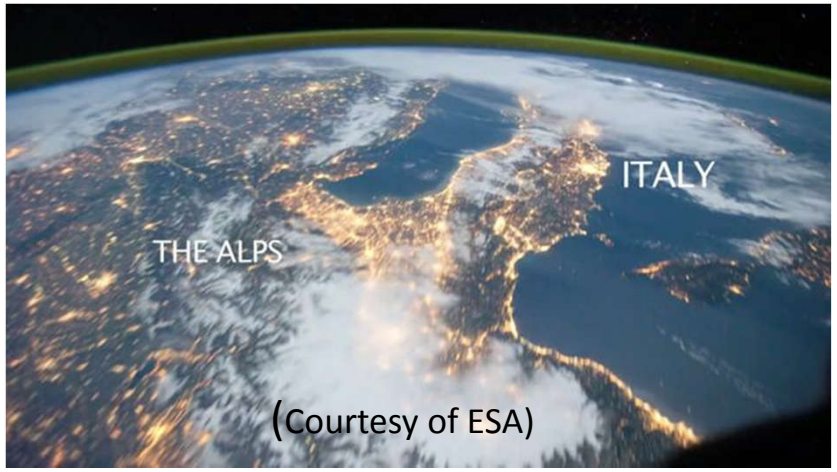


Intermediate eXperimental Vehicle

ISS module Harmony, itself built in Italy on contract (Credit: NASA)

2. Short overview of space activities in Mediterranean area

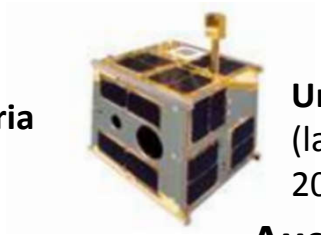
Austria



The Federal Ministry for Transport, Innovation and Technology (BMVIT) of Austria, is the responsible governmental department and policy maker.

Austria participates in ESA programmes for Earth observation (EO), telecommunications, technology development, scientific instruments and exploration, launchers, satellite navigation and space situational awareness.

TUGSAT-1 / BRITE-Austria (launched 2013)



UniBRITE (launched 2013)

PEGASUS, an EO spacecraft (launched in 2017)

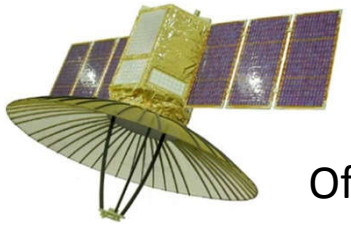
OPS-SAT (2019) in orbit test bed

Austrian Nano Satellites

2. Short overview of space activities in Mediterranean area

Israel

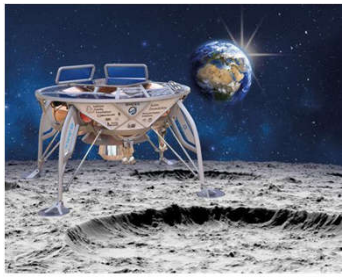
Shavit-1 launch



Ofeq 8/ 10

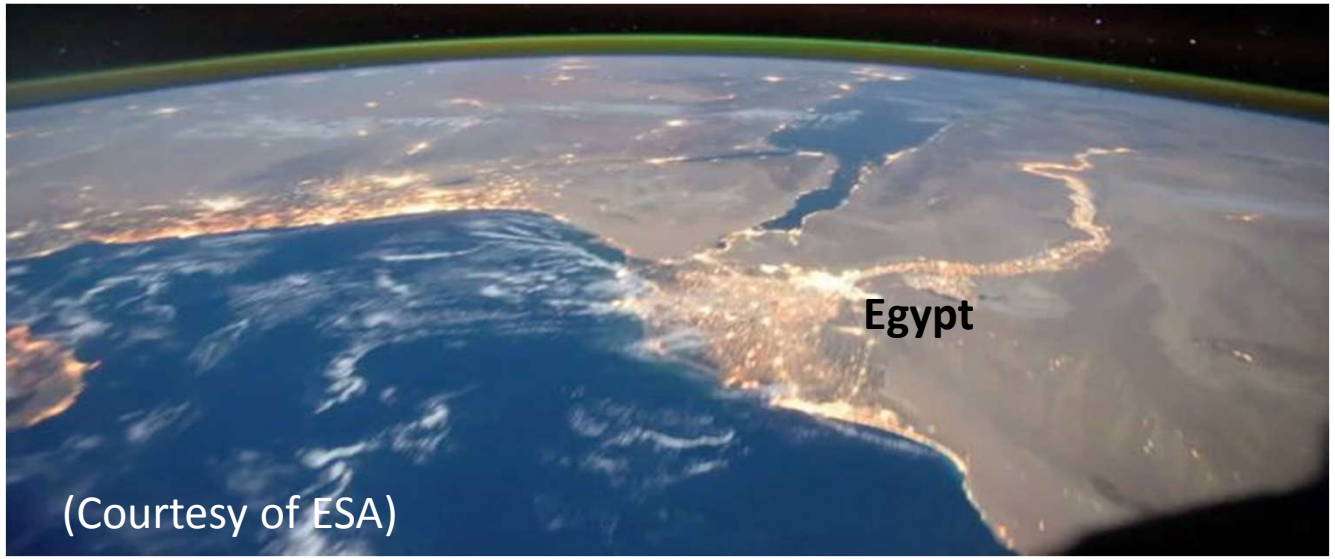
Military **Ofeq 11** satellite was successfully launched on 13.09.2016 from Palmachim Air Base using the upgraded Shavit launcher

The "Beresheet" Moon lander (*with courtesy of SpaceIL and IAI*)



2. Short overview of space activities in Mediterranean area

„Al Zafer“ IBCM rocket Egypt



ALCOMSAT 1-1 (Algeria)

3. Balkan affairs in space exploration

Croatia

Croatian Astronautical and Rocket Federation

AMPHINICY TECHNOLOGIES

interval d.o.o.

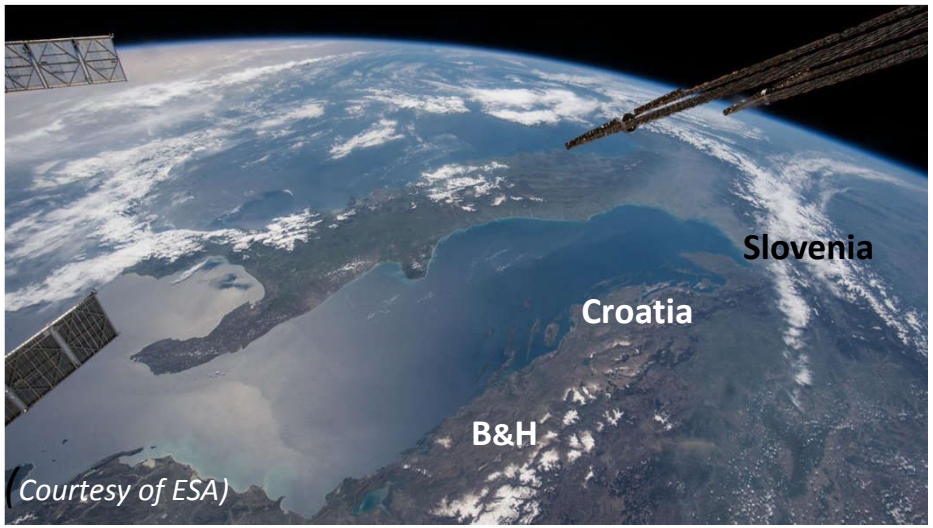
ATIR d.o.o.

IJEX Seit 1927.

ULTINORM

HSTec HIGH SPEED TECHNIQUE

INSTITUT ZA FIZIKU



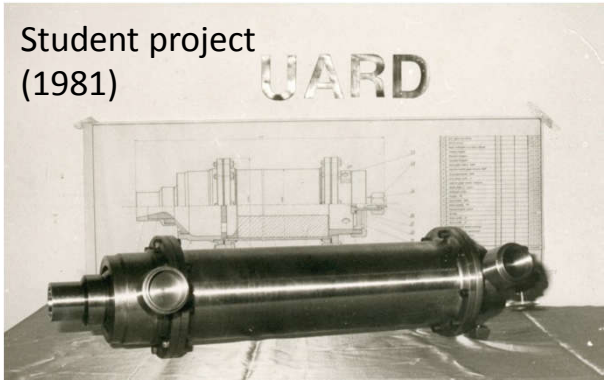
3. Balkan affairs in space exploration

Bosnia and Hercegovina

Airplane G-4 (serial 23005) in 1984 produced in company SOKO, Mostar Republic Bosnia and Hercegovina

The M-87 Orkan is an Yugoslavian (former) self-propelled multiple rocket launcher, produced in B&H

Sounding rocket "Dorado"
- student UARD project (1976)

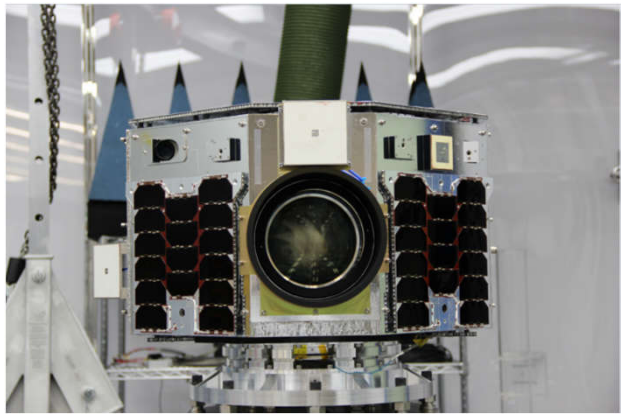


Hybrid rocket engine (propellant HNO_3/Araldit B) – UARD Sarajevo

3. Balkan affairs in space exploration

Slovenia

The Slovenian Centre of Excellence for Space Sciences and Technologies (SPACE-SI)



NEMO-HD microsatellite for Earth Monitoring and Observation (collaboration with the SFL at the University of Toronto

Two ground stations to provide real-time communication with satellite

Institute ***SPACELINK*** Trbovlje (students start-up)

THE FIRST SLOVENIAN SPACE PROGRAM

Rocket STELA -1
(altitude 10 km)

Hybrid rocket engine SL-18
(Credit: Institute SPACELINK, Trbovlje)

3. Balkan affairs in space exploration

Romania

Dumitru-Dorin Prunariu and A. Popov, Soyuz 40, 14 May 1981.

Serbia

Serbian Office for Space Sciences Research and Development

Serbian Case for Space

SPACE GENERATION ADVISORY COUNCIL

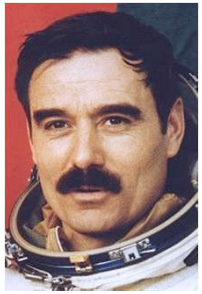
Montenegro

TARA Aerospace and Defence Products AD Montenegro

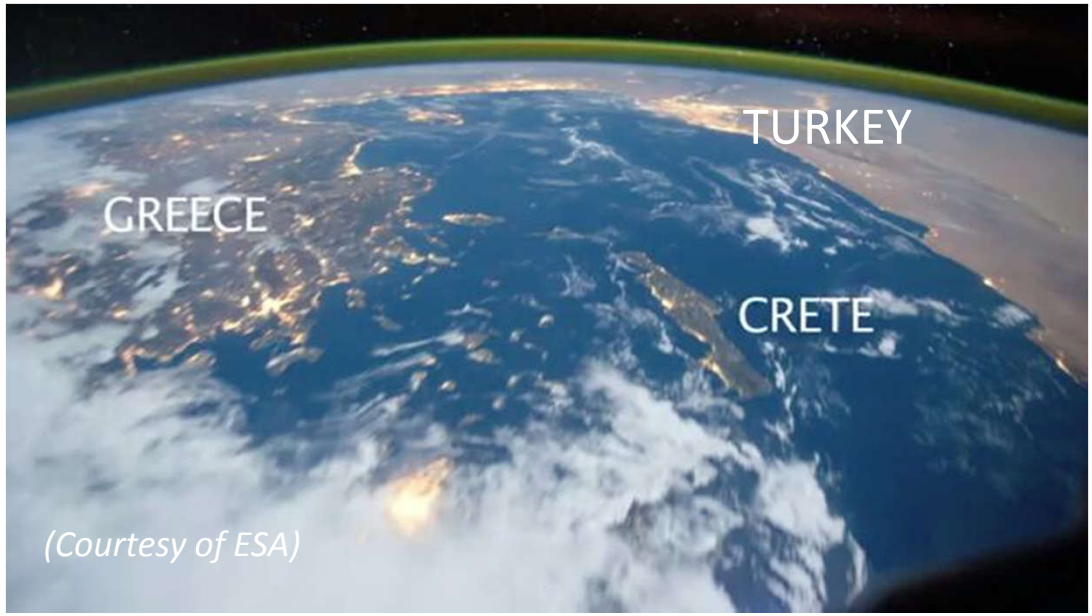
Bulgaria

Bulgarian Aerospace Agency (BASA) is a non-profit organization with government participation (established 1993).

Satellites – "Bulgaria 1300" and "Meteor-Priroda 2-4" (launched in 1981) ,Cosmonaut Georgi Ivanov (1979)



3. Balkan affairs in space exploration



GREECE

Greek/ Hellenic Space Agency (GSA) is private, non-profit organization that promotes scientific and techno-logical breakthroughs to be benefited by all Greek citizens.

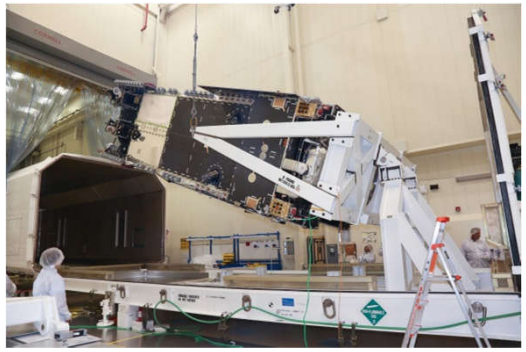
Space Hellas

HELLAS SAT

OHB HELLAS

Hellenic Technology of Robotics (HTR)

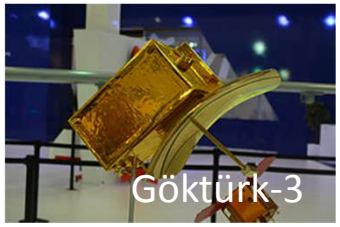
LOGIKON ABS



HellasSat 4/SaudiGeoSat-1 is a communication satellite

TURKEY

TURKISH AEROSPACE



"Göktürk-1" EO satellite launched on 5th Dezember 2016.
"Göktürk-2" satellite launched 2012 (Ministry of Nat. Defense)
"Göktürk-3" SAR EO satellite (Ministry of National Defense)
Manufacturer: Turkish AI, ASELSAN, TÜBİTAK UZAY (planed 2019)

4. Balkan and Mediterranean cooperation

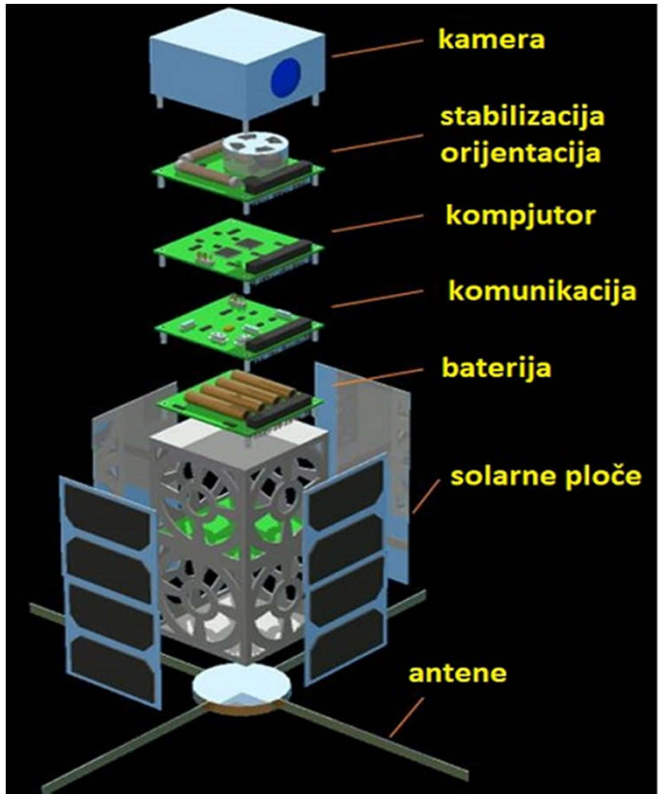
Forms and principles of cooperation:

- Joint projects with maximum synergy
- Joint appearance at forums and international organizations concerned with space exploration
- Partial or complete commercialization of space exploration to reduce the scope of national budgets
- Collaborative education of youth, students and young professionals to enhance motivation and competence in space technology and research
- Balkan countries should pool their human resources so that they can participate in larger programs offered by ESA, the EU, China and other leading countries in space exploration.

5. Possible development of space activities in Croatia

AAA proposal for a Croatian space program:

- telecommunications
- navigation
- Earth observation (EO)
- space science and research
- investigation under space conditions
- space transport
- space stations
- technology for space systems



The PERUN project began in early 2018 when it was agreed to create two satellites that would primarily play the role of integrating the education, science and technology sectors linked closely to space technology and science.

5. Possible development of space activities in Croatia

Chemical Propulsion

Green Propellants:

- Hydrogen peroxide (>87%wt)
- ADN - Ammonium Di-Nitramid
- Monopropellant LPM-103S (ADN, Methanol, Ammonia, Water)

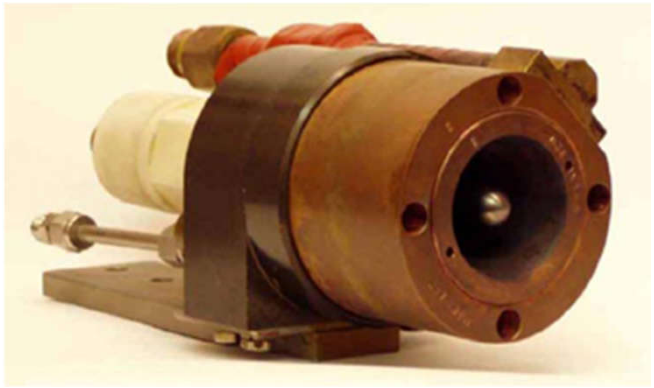
Rocket engines for ADN- based monopropellant

Sounding rocket and technology demonstrator VIHOR with chemical hybrid propulsion based on H2O2/HTPB propellants

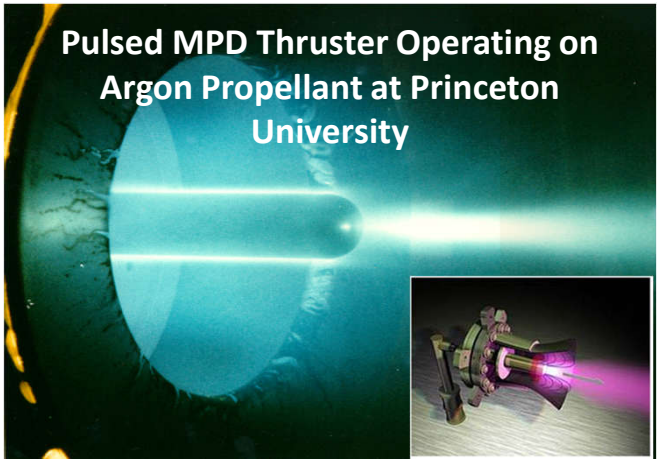
Predesign of a sounding rocket upper stage with Hybrid Rocket Propulsion Group (HRPG)
Credit: German Aerospace Center (DLR), Institute of Aerodynamicss and Flow Technology, Braunschweig

5. Possible development of space activities in Croatia

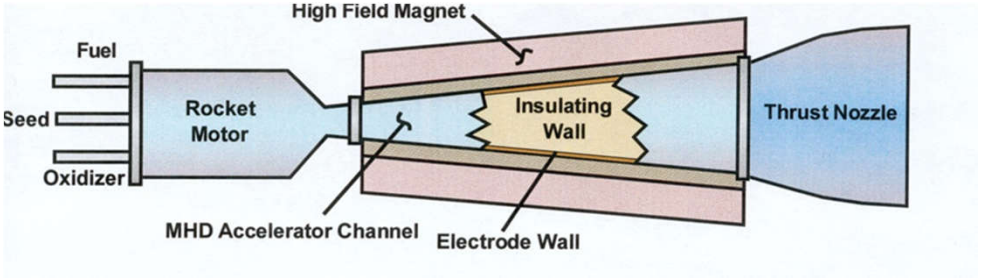
Electric Propulsion



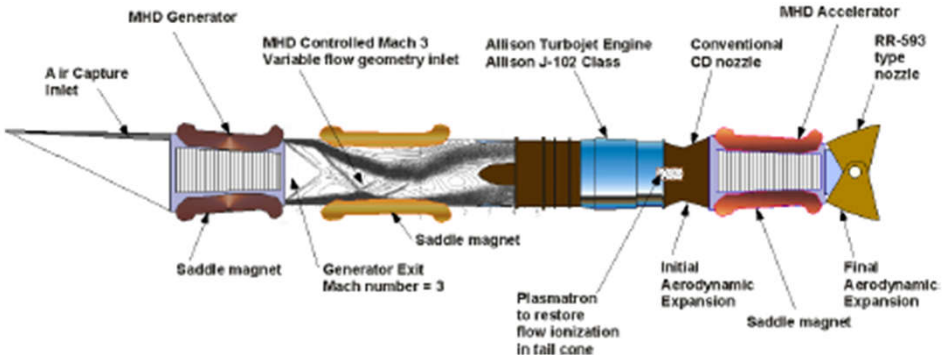
200-kilowatt MPD thruster (*Credit: NASA*)



MHD - Magneto-Hydro-Dynamic (in cooperation)



Principle of operation of the rocket motor extended with MHD* channel to increase thrust (profit 30-50%)



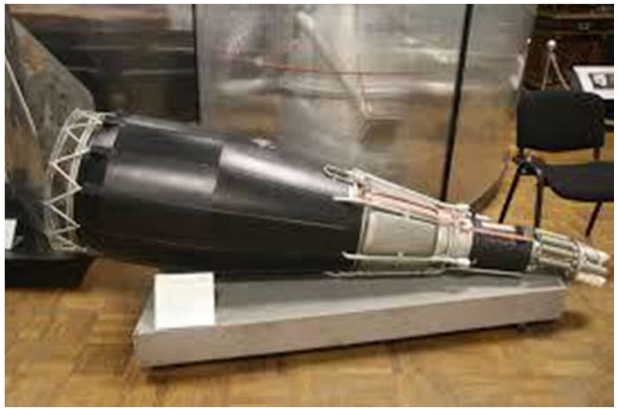
General arrangement of MHD controled turbojet für high speed propulsion (Credit: Theresa N. Benyo, NASA/TM 2010-216734)

5. Possible development of space activities in Croatia

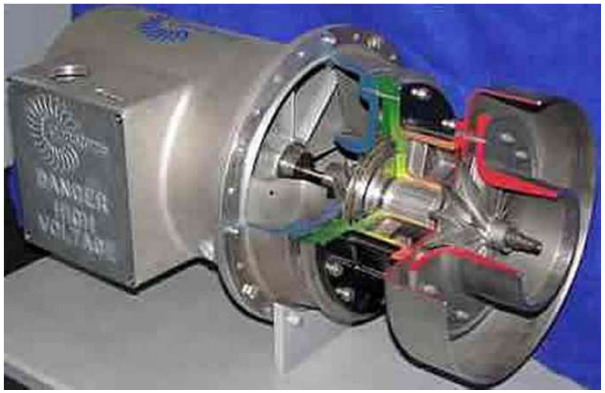
Energy sources for electric and hybrid rocket propulsion - **Succeeded or Promising**

Thermoelectric

Thermionic

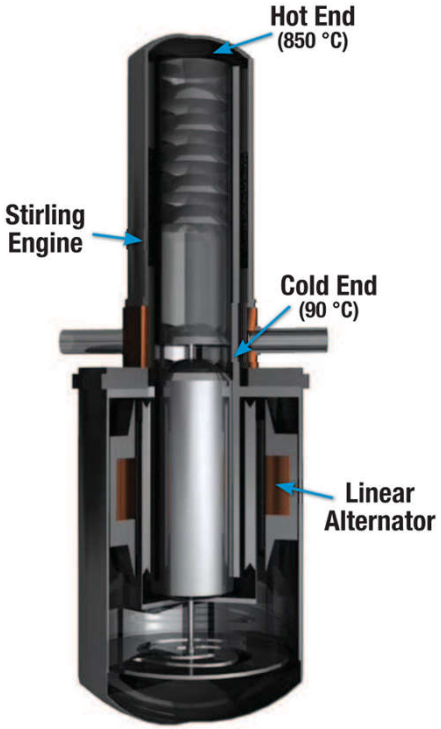


Brayton cycle



High Power Dual Brayton Test Rig at NASA Glenn Research Center (GRC)

Stirling cycle



Advanced Stirling Convertor model

Credit: NASA)

Thank you for your attention !

Attachment

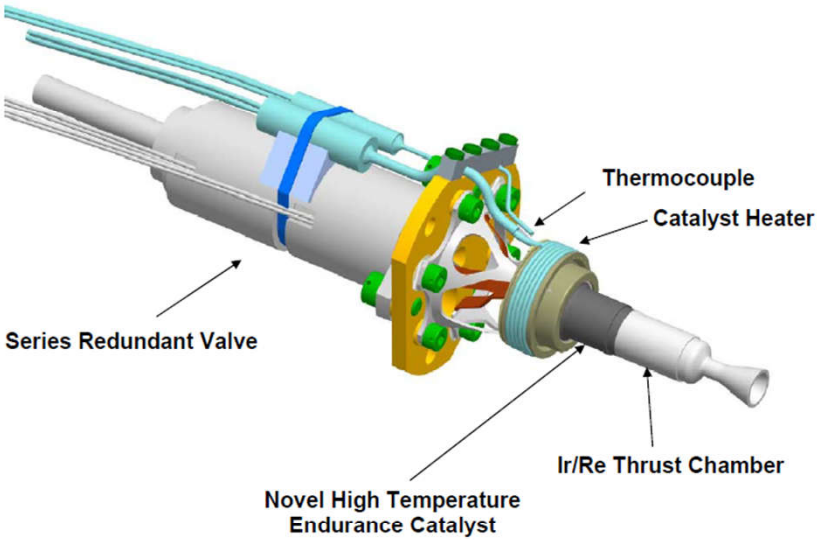
Sounding rocket and technology demonstrator VIHOR

Payload 350 kg
Rocket length 15 m
Diameter 0.80/ 0.56 m
Total mass (GLOW) 3050 kg

Flight altitude …… 250 km (apogej)
Flight time above 100 km > 360 s
Maximum acceleration < 13 g
Drop point of booster stage ~ 1500 m
Drop point of payload < 50 km

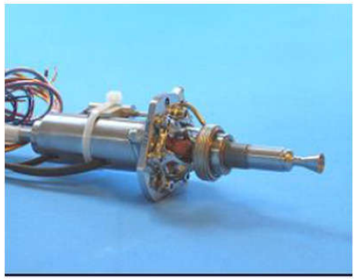
Attachment

EM Thruster Design



EURENCO GROUPE SNPE

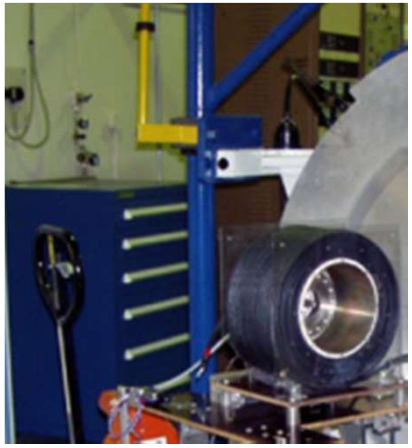
ECAPS Swedish Space Corporation Group



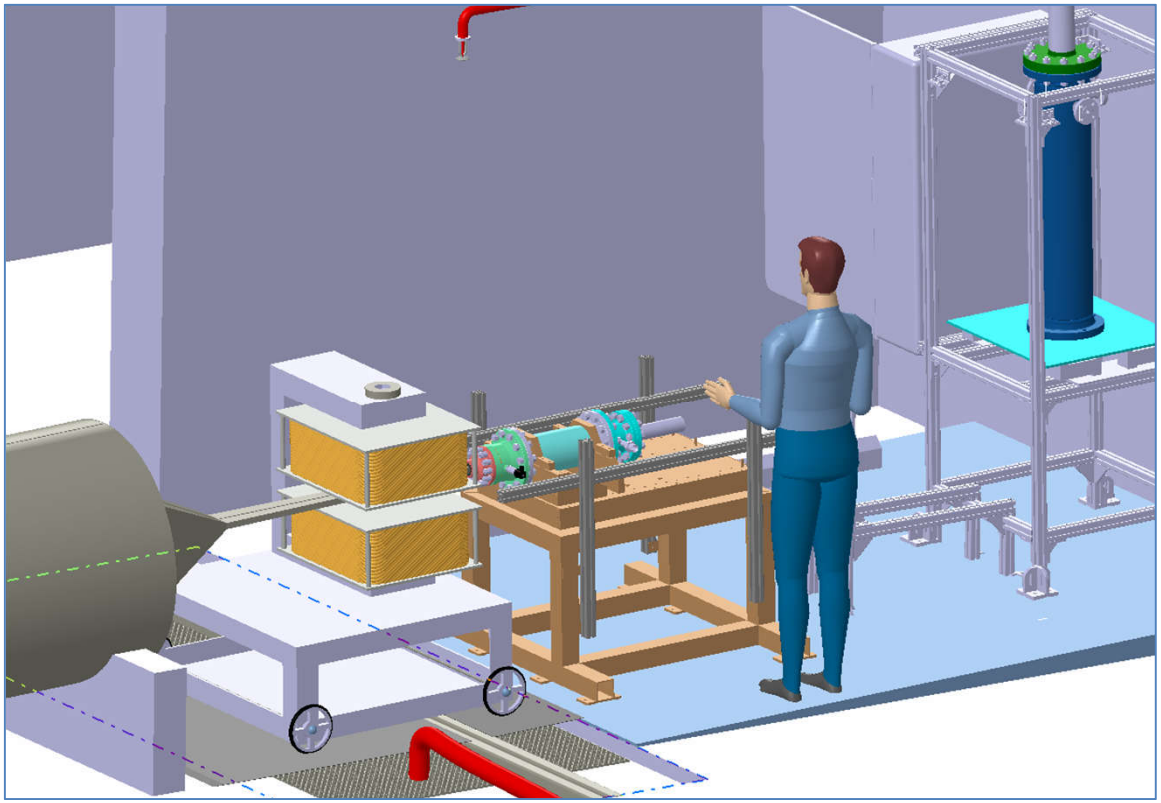
1 N HPGP Rocket Engine Characteristics	
Propellant	LMP-103S
Inlet Pressure Range	5.5 - 22 bar
Thrust Range	0.27 - 1 N
Isp *vacuum*	2010 – 2300 Ns/kg (205 - 235 sec)
Density Impulse	2850 Ns/L
Minimum Impulse Bit	0.01 – 0.05 Ns
Overall Length	176 mm
Mass	0.34 kg
Demonstrated Life	
Total Impulse	50 kNs
Pulses	60 000
Propellant Throughput	25 kg
Accumulated Firing Time	24 hours
Longest Continues Firing	1.5 hours
Status	
Ready for flight on PRISMA 2009 TRL 7	

Attachment

MPD with nozzle
(Credit: NASA)



Baseline applied-field MPD thruster *(Credit: NASA)*



MHD Test Arrangement - Hybrid rocket motor as plasma generator for MHD stage (magnet field strength 4 T).
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