Institute of Aviation
Warsaw, Poland, since 1926

# Development of Green Rocket Propulsion in Poland

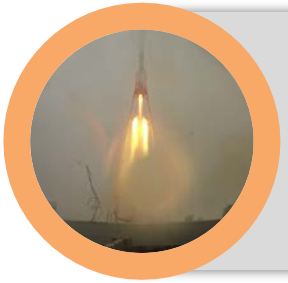
**COMMITTEE ON THE PEACEFUL USES OF OUTER SPACE**
**SIXTY-FIRST SESSION**
**Vienna, 26th June 2018**

CST
Center of Space Technologies

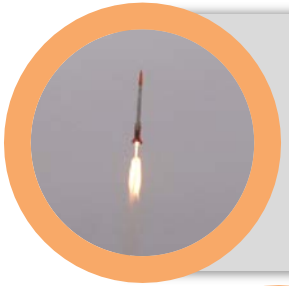
Adam Okninski, Leszek Loroch, Piotr Wolański

# PRESENTATION PLAN

**INTRODUCTION**
- INSTITUTE OF AVIATION
- HERITAGE
- DEVELOPMENT STRATEGY



**PROJECTS**
- EUROPEAN PROGRAMMES
- PRESENT ACTIVITIES
- KEY TECHNICAL DOMAINS



**TECHNOLOGIES**
- SPACE PROPULSION
- SUBORBITAL ROCKETS
- LAUNCH VEHICLES

**SUMMARY**
- FACILITIES
- HUMAN RESOURCES
- CONCLUSIONS

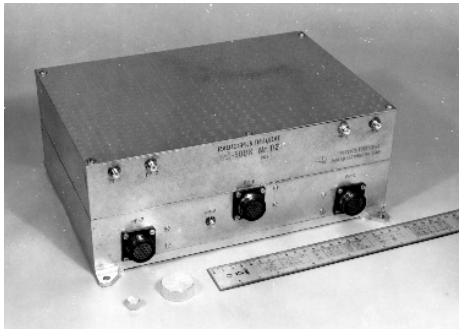
# SPACE TECHNOLOGIES AT INSTITUTE OF AVIATION

- Dedicated Space Technologies Center
- Over **50 year of space technology projects** (90 years in Aerospace)
- Research, development, **comercialisation**

- **Rocket and spacecraft technologies, avionics, remote sensing**
- Significant work in numerous European Programmes
  (EC FP7, EC H2020, EDA, ESA PECS, ESA PLIIS, ESA GSP, ESA TRP, ESA GSTP)

# HERITAGE

- ”Meteor” Program - launching small payloads to over 100 km
- Concept of developing a Polish micro-launch-vehicle
- Satellite flight hardware



# DEVELOPMENT OF SPACE PROPULSION TECHNOLOGIES

- since 2004 – work on **conceptual small launch vehicle design**
- since 2012 – development and comercialisation of the technology of producing **highly concentrated (up to 99.99%) Hydrogen Peroxide** – an effective green propellant (Institute of Aviation - Jakusz)
- development of rocket **monopropellant thrusters** using Hydrogen Peroxide
- development of **hybrid rocket motors** using Hydrogen Peroxide
- development of **solid rocket motors**
- development of **liquid rocket engines** using Hydrogen Peroxide
- Development of **sounding rockets**

# PRESENT DEVELOPMENT STRATEGY

## 5 KEY TECHNOLOGY DOMAINS:

- 1N Green Monopropellant Thruster
- 500 N Green Liquid Apogee Engine (bipropellant)
- Solid Rocket Motor for deorbit
- Suborbital Rockets
- Upper Stage /Lander Engine

**SPACECRAFT PROPULSION**

**SPACE TRANSPORTATION**

# External projects in Space Propulsion

**9 out of 11 ESA projects in Chemical Propulsion in Poland are undertaken by Institute of Aviation with its partners**

esa
European Space Agency

## Active in programmes of the European Comission

European Commission

SEVENTH FRAMEWORK PROGRAMME

HORIZON 2020

## Present in the three largest national* projects related to rocket propulsion

* Projects financed by the National Centre of Research and Development and aid national security and defence activities

The National Centre for Research and Development

research for future

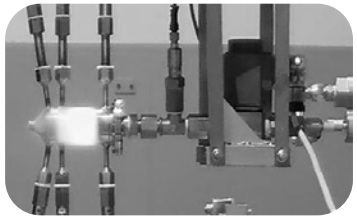
# ULTRA-PURE HYDROGEN PEROXIDE IN HTP CLASS

**HTP Production Technology**

European Patent Office

- Concentrations of $H_2O_2$ even up to 99.99%
- Compliant with MIL-PRF-16005F
- Simple, safe and reliable
- Proven within comercial applications

**Green Propulsion**



European Commission

esa European Space Agency

The National Centre for Research and Development

# ROCKET AND SPACECRAFT PROPULSION

Polish developments

## LIQUID ROCKET ENGINES AND THRUSTERS

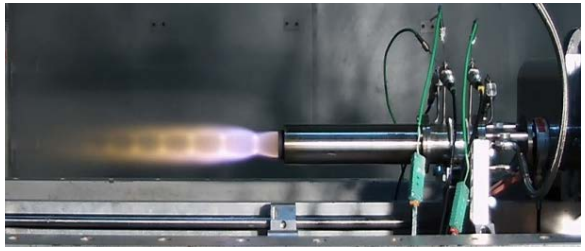
esa European Space Agency

TECHNOLOGY OF HYDROGEN PEROXIDE HAS BEEN DEVELOPED AND COMERCIALISED BY INSTITUTE OF AVIATION

S/C APPLICATION (1-500 N)

ROCKETS (>5000 N)

## HYBRID ROCKET MOTORS



European Commission

research for future

## SOLID ROCKET MOTORS

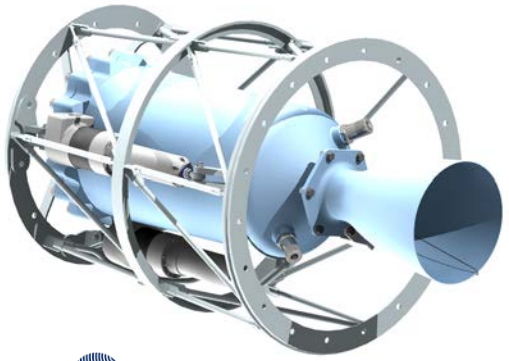
REACH COMPLIANCE

THRUSTS UP TO **50 000 N**

The National Centre for Research and Development

* Projects financed by the National Centre of Research and Development and aid national security and defence activities

# DEORBITATION SYSTEM DEVELOPMENT

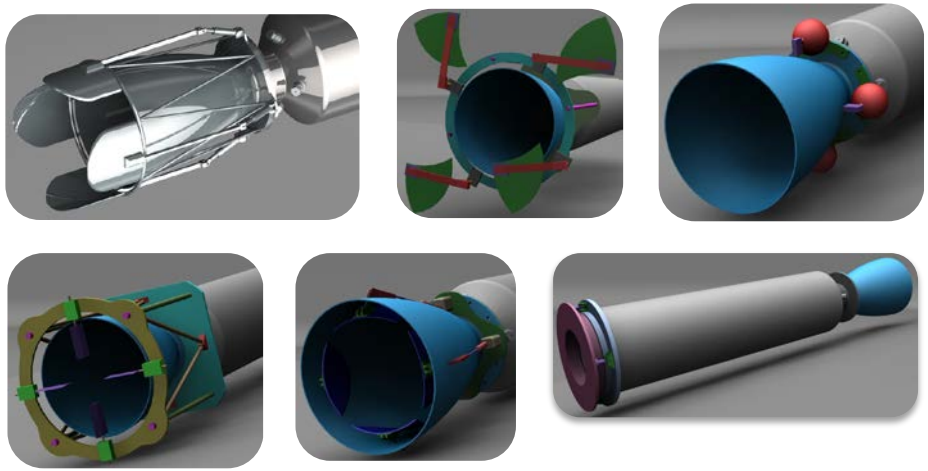


AIRBUS DEFENCE & SPACE
ThalesAlenia Space
OHB SYSTEM

COOPERTION WITH LSI (FINAL USERS!)

instituteofaviation warsaw, since 1926
esa European Space Agency
esa European Space Agency
esa European Space Agency

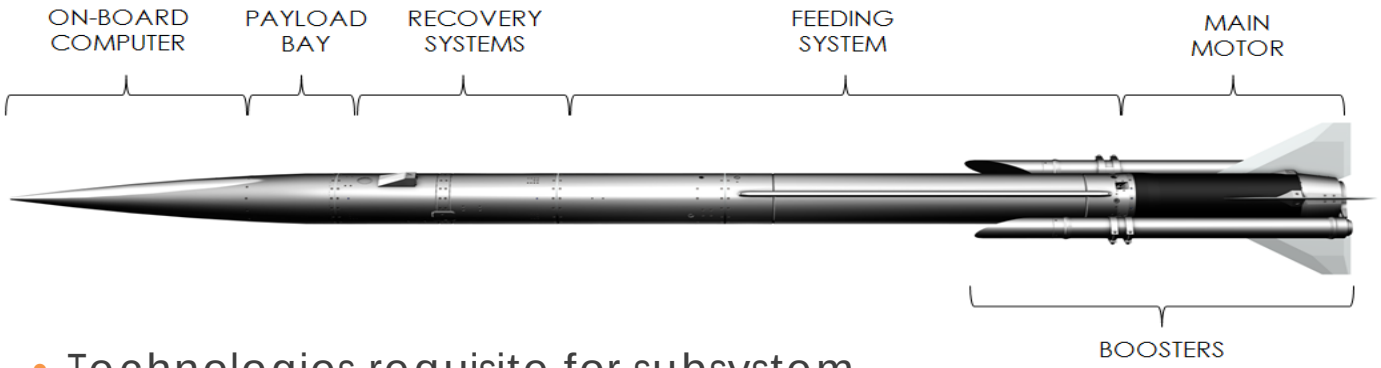
| | | | |
|---|---|---|---|
| Initial internal work at IoA | CleanSat - technology assessment and concurrent engineering in support of LEO platform evolutions | Pre-qualification of Aluminum-free Solid Propellant (ASPro) | Motor development |



**Institute of Aviation** is **one of the first entities** working on chemical propulsion for space debris removal

# SUBORBITAL ROCKETS

**Development of the ILR-33 ”Amber” demonstrator**



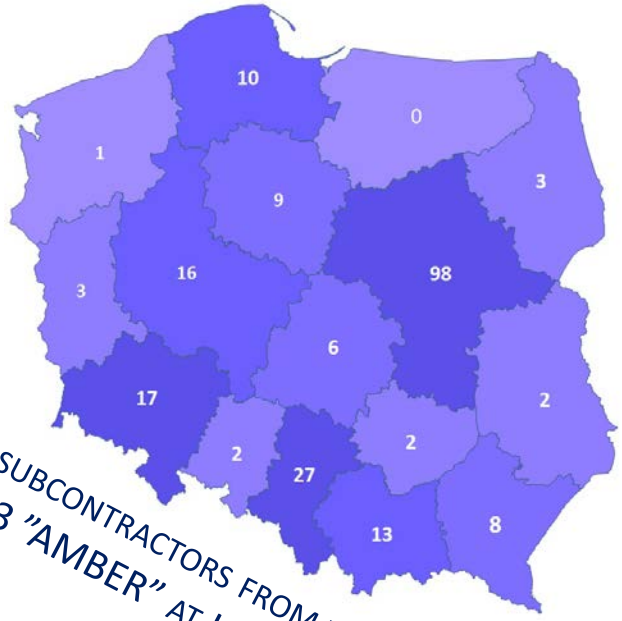

- Technologies requisite for subsystem development of spacecraft and rockets
- Possiblity of microgravity experimentation
- Increase of Polish competences in the field of Space Transportation

# ILR-33 "AMBER" – PROJECT IMPORTANCE

## KEY MILESTONE ACHIEVEMENT

**First rocket in the world using HTP with concentration above 95% (even +98% !!!)**

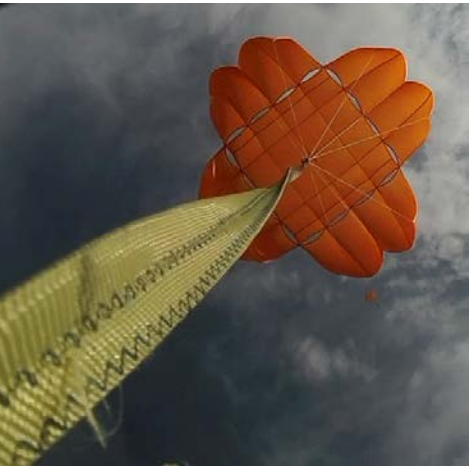
## CREATING SUPPLY CHAINS

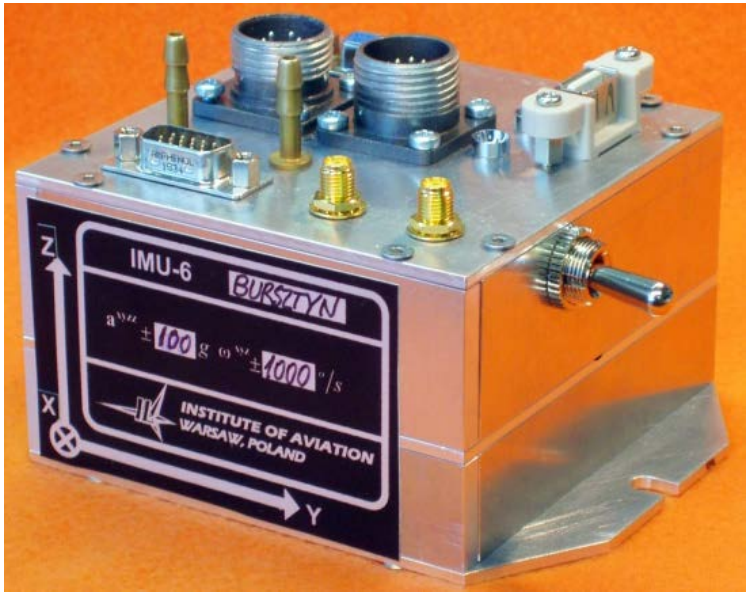



BASED ON SUBCONTRACTORS FROM THE DEVELOPMENT OF ILR-33 "AMBER" AT INSTITUTE OF AVIATION

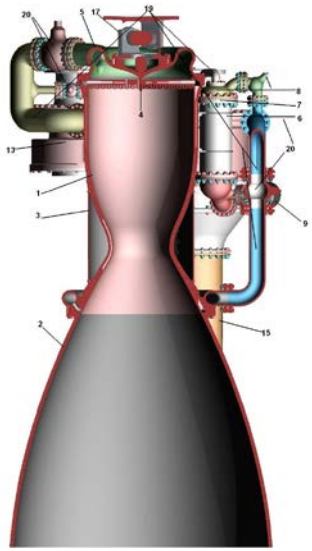
# RECOVERY AND ELECTRONIC SYSTEMS FOR ROCKETS

- **Parachute systems**
- **Control systems and electronics**
- **Pyrotechnical devices**
- **Verification: in-flight tests of rockets, drop tests, wind tunnel testing**





# SMALL LAUNCH VEHICLES



**Small Launcher development plans**

**Targeting satellites up to 200 kg of mass**

**National security**

## OPPORTUNITY FOR POLAND

### Space Sector

POLSKA AGENCJA KOSMICZNA

creo TECH Instruments S.A.

GPS HERTZ SYSTEMS

Astronika space solutions here & now

JAKUSZ SpaceTech

### Defence Sector

PGZ

MESKO

HSW STALOWA WOLA

PITRADWAR

ZPS Gamrat Sp. z o.o.

### R&D Sector

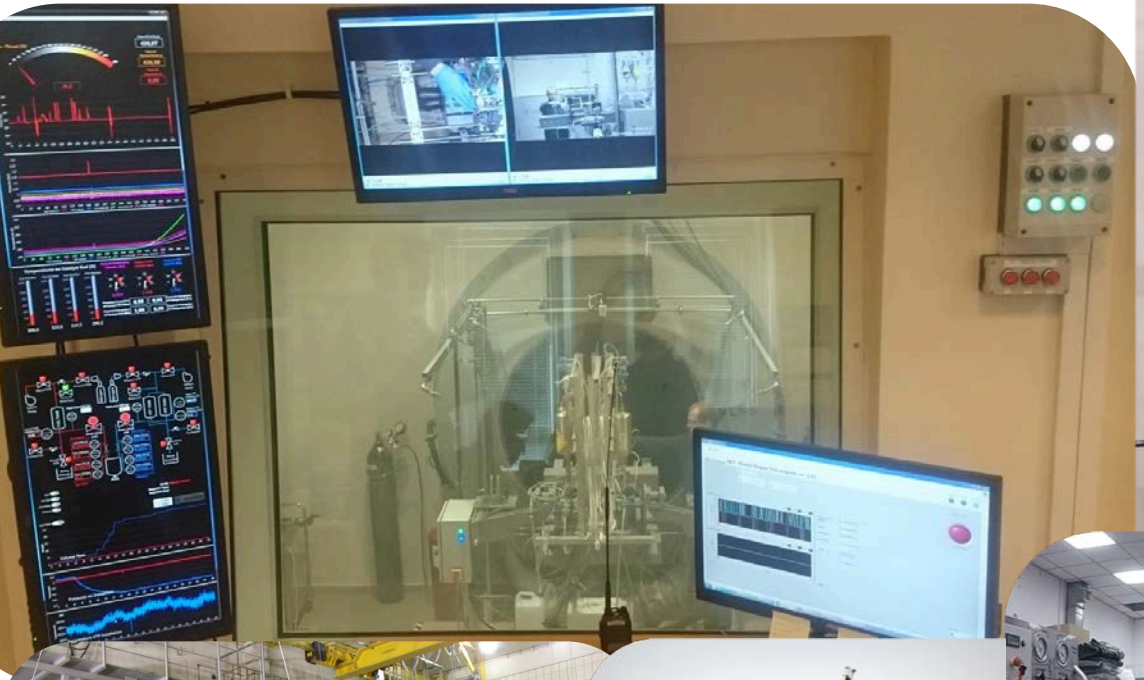
Politechnika Wrocławska

CBK PAN

research for future

# FACILITIES

**"NI Engineering Impact Award" - 1st place in Europe**




# HUMAN RESOURCES

**POTENTIAL**


*30 people working within rocket technology, with the majority being below 30 years old*

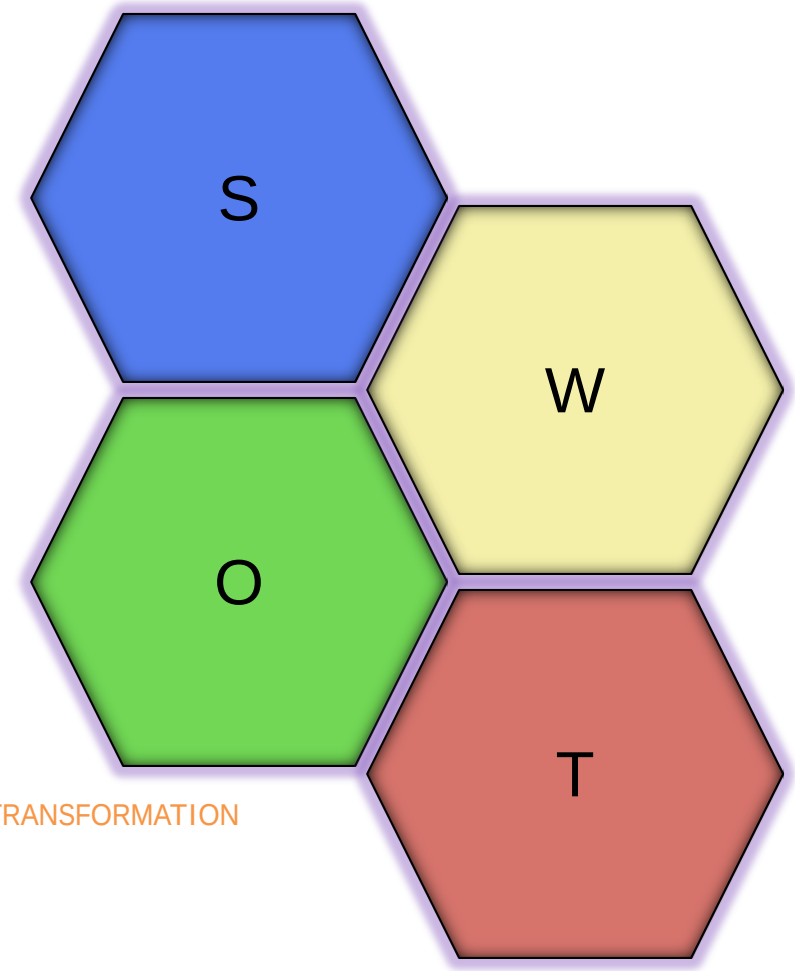
*9 with experience working abroad*

*3 people with experience from ESA*

# SWOT – activities in Space Propulsiona and Control

## STRENGTHS

- HUMAN RESOURCES
- GREEN PROPELLANTS
- PROPULSION FACILITIES
- GOOD EXPERIENCE IN COOPERATION WITH ESA
- HIGH PURCHASING POWER




## WEAKNESSES

- ORBITAL FLIGHT HARDWARE
- LOW TRLS
- LIMITED EXPERIENCE IN LARGE SPACE PROJECTS

## OPPORTUNITIES

- NEW FIELDS (CLEAN SPACE ETC.)
- SPACE 4.0 – ONGOING MARKET TRANSFORMATION
- SPECIAL MEASURES PROGRAMME

## THREATS

- BUDGETARY LIMITS
- NATIONAL FOCUS ON OTHER DOMAINS

esa
European Space Agency
10 projects

European Commission
3 projects

The National Centre for Research and Development
3 projects

# SUMMARY

- Institute of Aviation develops technologies with **high potential** for use in international systems
- Focus is given to **green propulsion** and **deorbitation** due to expected directions of market growth - niches for comercialisation
- Since 10 years over 15 projects in the field of **Space Propulsion** and **Space Transporation** have been carried out within ESA, EC and NCBiR
- Institute of Avtiaton is seeking for opportunities to **work with global partners**