



# METAMORPHOSIS

A Mobile Testing Facility

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## A Mobile Testing Facility

Winner of



## SME Instrument Phase I





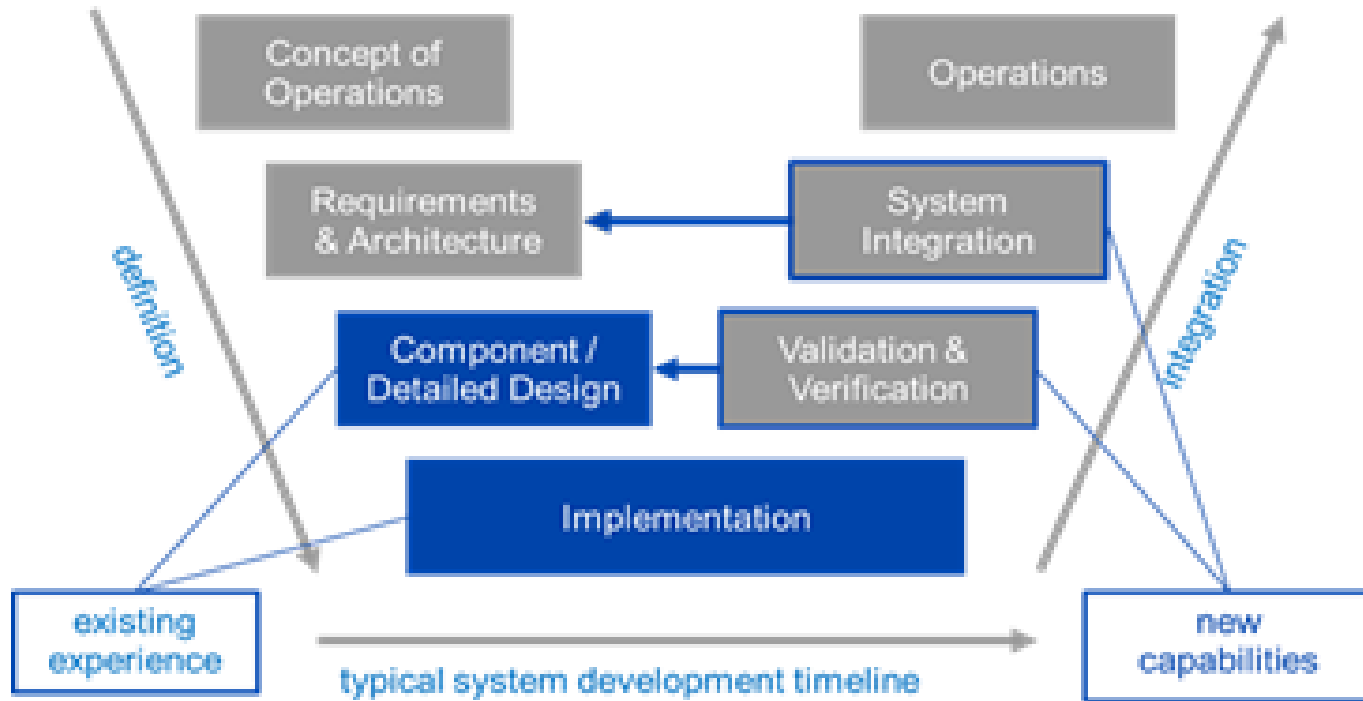
# If you are:

- Hi-Tech start-up with brilliant ideas for space
- Space Equipment Engineering Team wishing to start your own space production
- Small - Medium Equipment Supplier with a desire to enter the space market
- Experienced Space Equipment Supplier, temporary lacking testing capabilities to validate and verify all systems you want to develop or
- University Team, aiming to have space-ready graduates with real-life system design and testing experience ...

...then this is Your Key to Open Space

# Why you need environmental tests?

- To develop an innovation from idea to a space-ready market product, all phases of project development are substantial



As soon as the idea transits from paper to the laboratory, the question demands an answer - **will it work in the outer space?**

To answer that the new product needs to be validated and verified in space – like environment simulation facility after every step of development

**No tests = no product future = only idea**

# Why you need environmental tests?

To sell products, two conditions apply:

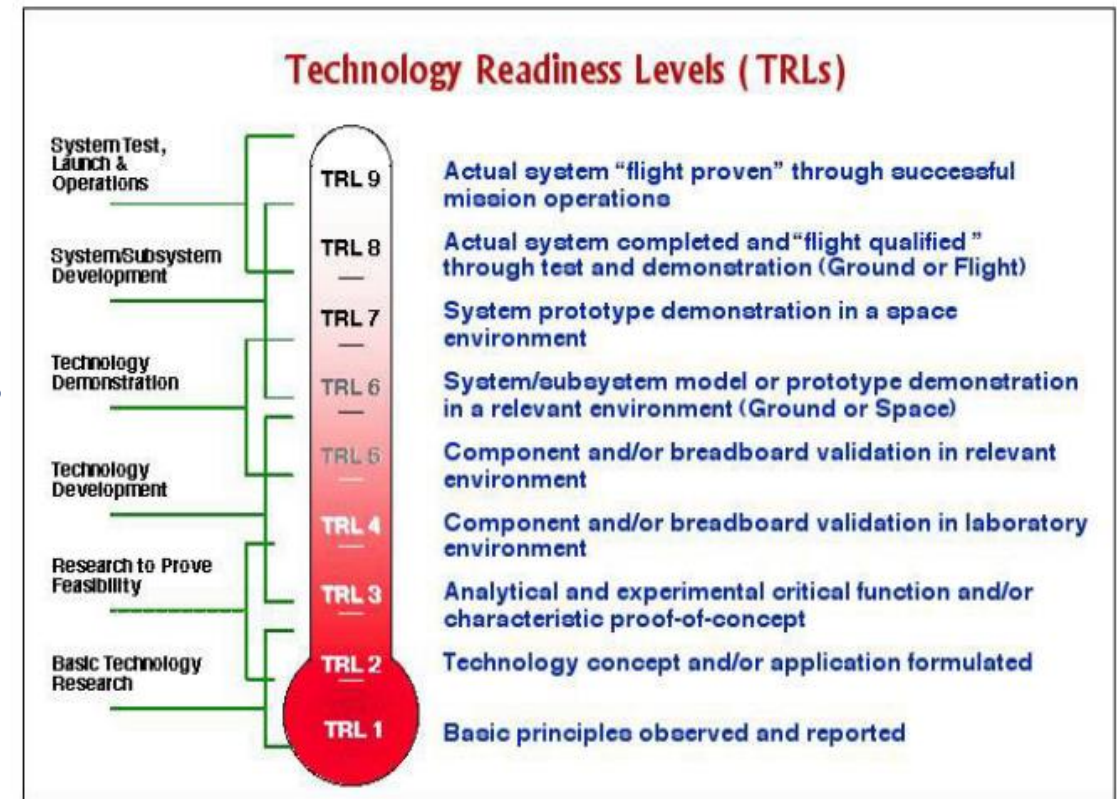
First – nobody buys a “raw” product or a card-board model

Second – the higher Technology Readiness Level (TRL) a product development is in, the easier it is to sell it.

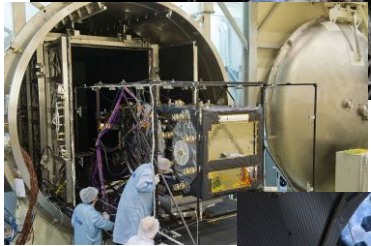
The only way from TRL 3 up to TRL 9 is through environmental testing.

That means – **Space Simulation**

Figure 3.1-1 Technology Readiness Levels – Thermometer Diagram



# Why you need environmental tests?



Up until now there were only 2 ways to get to space environment simulation testing:

- Spend several millions EUR and develop your own space simulating facility
- Wait for several years and spend hundred thousand EUR for business trips and payments to use public or private testing facility

Now there is a **new** opportunity:  
**METAMORPHOSIS**

- A mobile space simulator facility with a service team that comes to your factory or laboratory, and the testing will cost half or even less the price charged by the stationary testing facilities

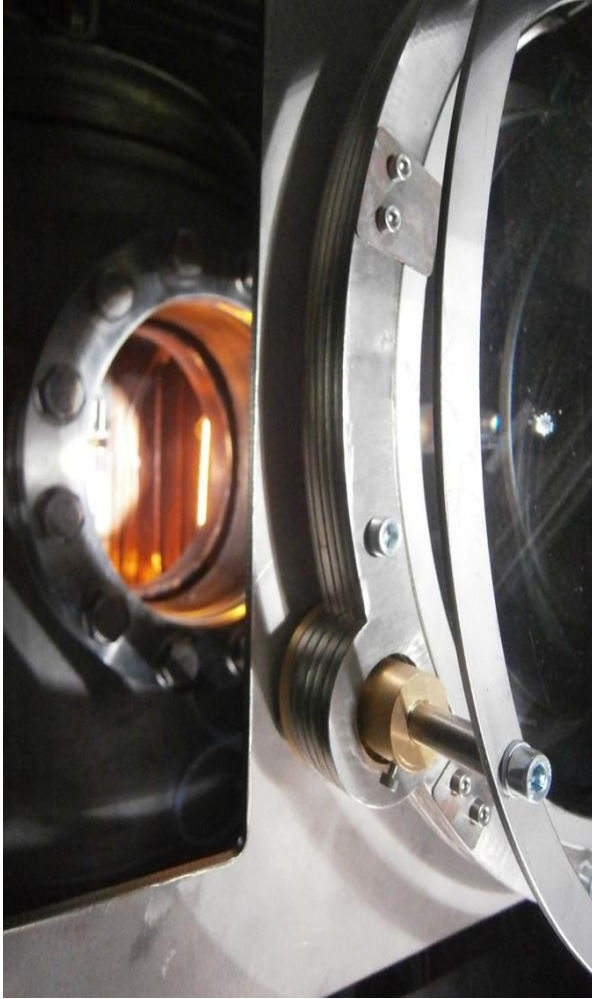
# Why you need environmental tests?

You need METAMORPHOSIS:

- To understand real outer space environments
- To validate and verify your equipment in space-like conditions according ECSS or NASA Standards requirements
- To have full space-like environment thermal-vacuum, electrical, pneumatic testing and leak detection in your laboratory or factory yard
- To use space simulator, which emulates all in-orbit conditions, including Sun radiation and Van-Allen belts (upon request)
- To have experienced space testing service team to prepare a testing program for your product (including confirming compliance with requirements of ECSS or NASA standards), run all the necessary tests and interpret test results according to the product validation and verification process



# What is METAMORPHOSIS



## Project advantages

- **Mobility** – a truck or trailer- mounted laboratory
- **Universality** – the testing facility will include a Clean-room for preparation of test specimens, a universal multi-functional space simulator and a control room for testing data collection and processing
- **Competence** – the equipment and the team will provide full-range validation and verification test service in accordance with ECSS or NASA space standards



# What is METAMORPHOSIS

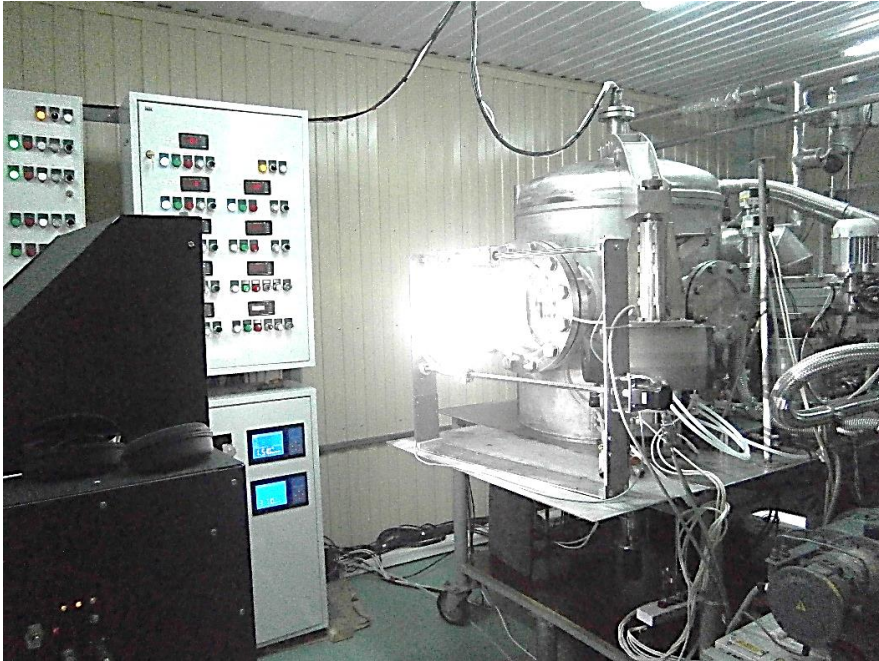


## Space conditions

**Variety** – can provide various modes of product design optimization, verification and testing:

- High fidelity space simulation on a predetermined specimen orbital position
- Thermal-vacuum testing of a specimen (thermostating, thermocycling, thermobalance)
- Pneumatic tests, helium leak detection and tightness control
- Electrical tests in different vacuum, radiation and thermal conditions
- Sun radiation and Van-Allen belts (upon request) simulation

# What is METAMORPHOSIS



## Simulating facility composition

Main systems of the testing facility:

- Vacuum chamber
- Sun simulator
- Earth heat flow simulator
- Cryogenic system
- Vacuum system
- Van-Allen Belts simulating system
- Mass-spectrometry residual gas analyze and helium leak detection system
- Control and measurement system
- Supply system

# What is METAMORPHOSIS



## Vacuum chamber

- Position – horizontal
- Dimensions - diameter  $\approx 2000$  mm, length  $\approx 3500$  mm
- Access - top lid (removable or tilt-up)
- Specimen operational place - approximately  $1500 \times 1500 \times 1500$  mm
- Specimen support - fixed platform or rotary table with high precision specimen positioning system for orbit position simulation
- Vacuum chamber are thermal insulated – the inside temperature may fluctuate from  $-200^{\circ}\text{C}$  to  $+200^{\circ}\text{C}$ , but the chamber body will be nearly room temperature



# What is METAMORPHOSIS



## Sun Simulator

- Wide spectrum exoatmospheric solar radiation simulation with intensive ultraviolet and deep infrared bands
- Solar beam form factor – circle, rectangle or polygon
- Beam reference plane  $\approx 1500 \times 1500$  mm
- Spectrum type – close to AM0
- Flow density non-uniformity in reference plane  $< 10\%$
- Flow density non-uniformity in test volume  $< 15\%$
- Maximum flow density - up to 2 SC ( $3200 \text{ W/m}^2$ ) with 500 W regulation stages and 20% in-stage adjustment

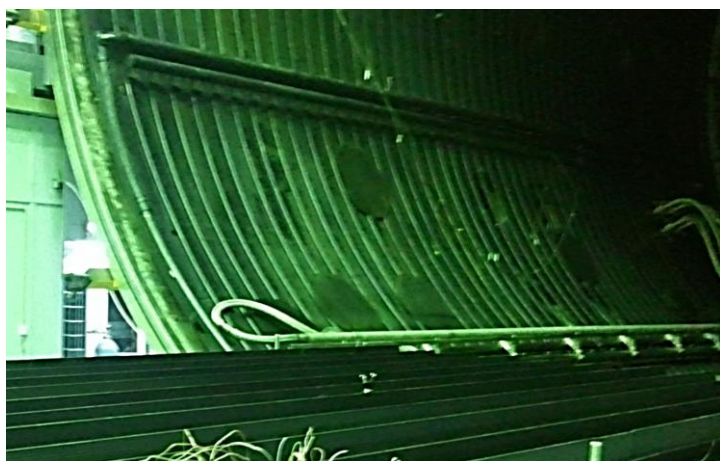
# What is METAMORPHOSIS



## Earth heat flow simulator

- Simulate Earth IR-radiation ( $850 \text{ W/m}^2$ ) or IR part of Solar light, or for specimen heating and outgasing
- IR emitting system - sources on the base of IR-lamps with shrouds (black body) and IR-lasers
- IR Lasers simulate local overheating and interference of other satellite systems
- Quantity of IR lamps power control channels – 50
- IR power in each channel - lamp - 0-1500W, semiconductor laser (regulated, up. req.) – 0-5 W,  $\text{CO}_2$  laser (regulated, upon request) – up to 100 W
- The specimen maximum temperature - up to  $+300^\circ\text{C}$

# What is METAMORPHOSIS



## Cryogenic system

- Coolant – Liquid Nitrogen
- Shrouds temperature – 78 - 93 K
- Shrouds material – copper
- Shrouds surface – about 20 m<sup>2</sup>
- Shrouds absorption in IR band  $\geq 0,9$
- Shroud surface temperature non-uniformity – less 15%
- Shrouds have heating system to speed up chamber opening possibility
- LN system cooling power - up to 100 kW
- System build-up LN storage tank capacity – 18 m<sup>3</sup>
- LN Filling system



# What is METAMORPHOSIS



## Vacuum system

- Dry (oil-free) vacuum system
- High vacuum
- High pumping speed
- Fore vacuum pumps: high speed screw pumps with Roots boosters
- High vacuum pumps: turbomolecular pumps and cryogenic pumps (for high gas load)
- Nominal pressure -  $1 \cdot 10^{-6}$  mbar
- Pumping time to  $10^{-4}$  mbar < 120 min
- Maximum pumping speed – up to 20 000 l/s

# What is METAMORPHOSIS

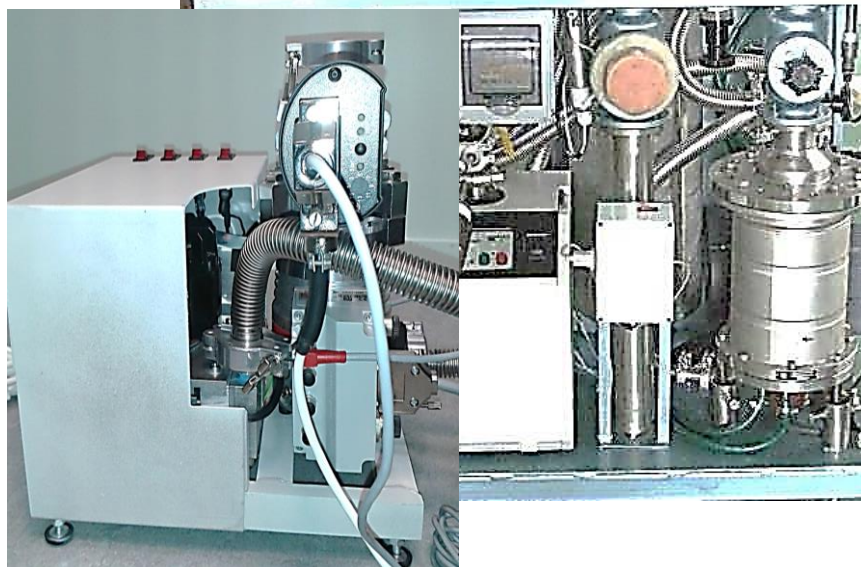
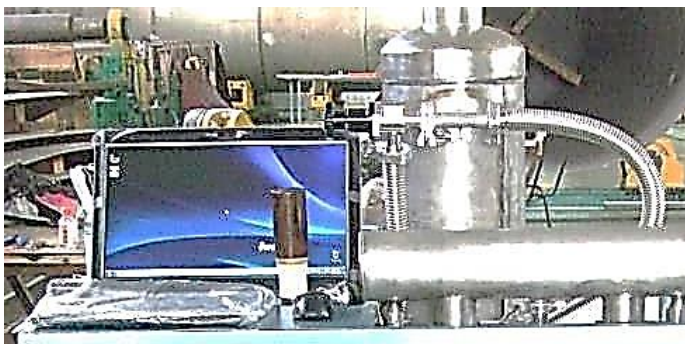


## Van-Allen Belts simulating system (on request)

- Electron source - electron beam or disperse  $\beta$ -rays source
- Ion source including  $\alpha$ -particles generation option
- Plasma source
- Electron energy – up to 50 keV
- Plasma/ions density –  $10^4 - 10^{12}$  pcs/sm<sup>3</sup>
- Plasma/ions source gases – nitrogen, helium, on request – oxygen, hydrogen
- Charge-discharge measurement system



# What is METAMORPHOSIS

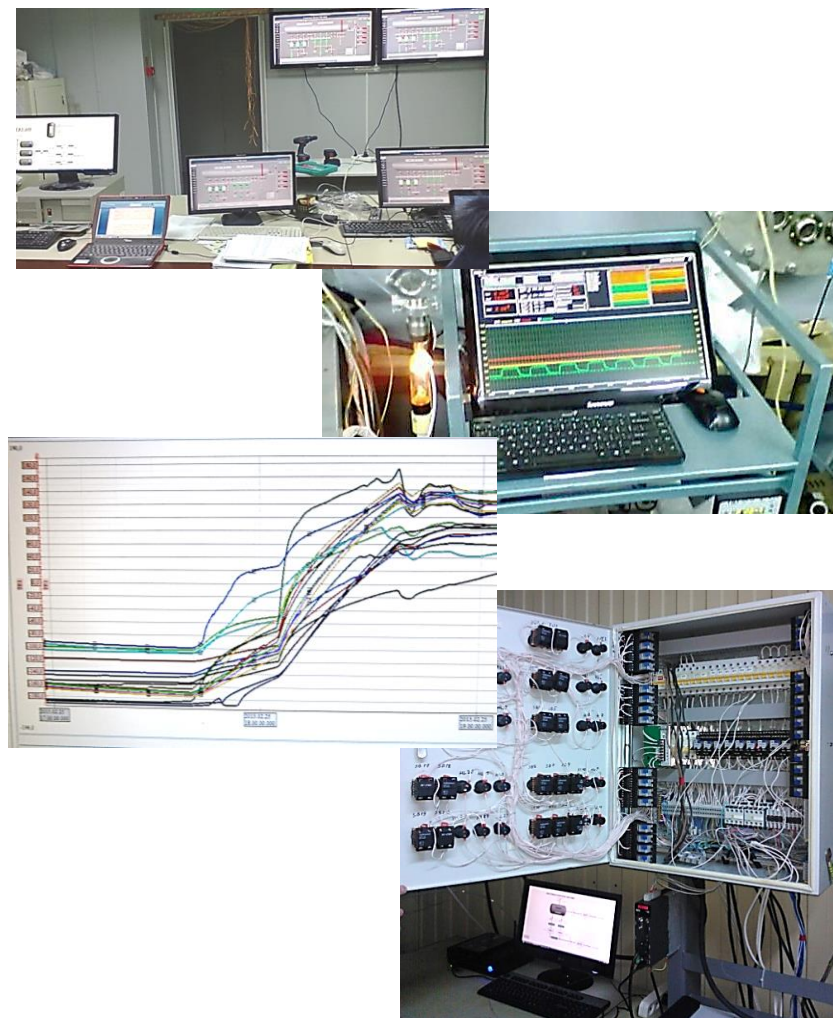


## Mass-spectrometry residual gas analysis and helium leak-detection system

- Residual gas mass detection range – up to 200 amu (up to 2000 amu - on request)
- Mass-analyzer type - quadrupole
- Leak detection probe gas - helium
- Leak detection method – helium mass-spectrometry
- Leak detection sensitivity – up to  $10^{-5}$  l·mTorr/s
- Leak calibration system installed
- On request – cryogenic probe gas accumulation system, increasing leak detection sensitivity up to 100 times



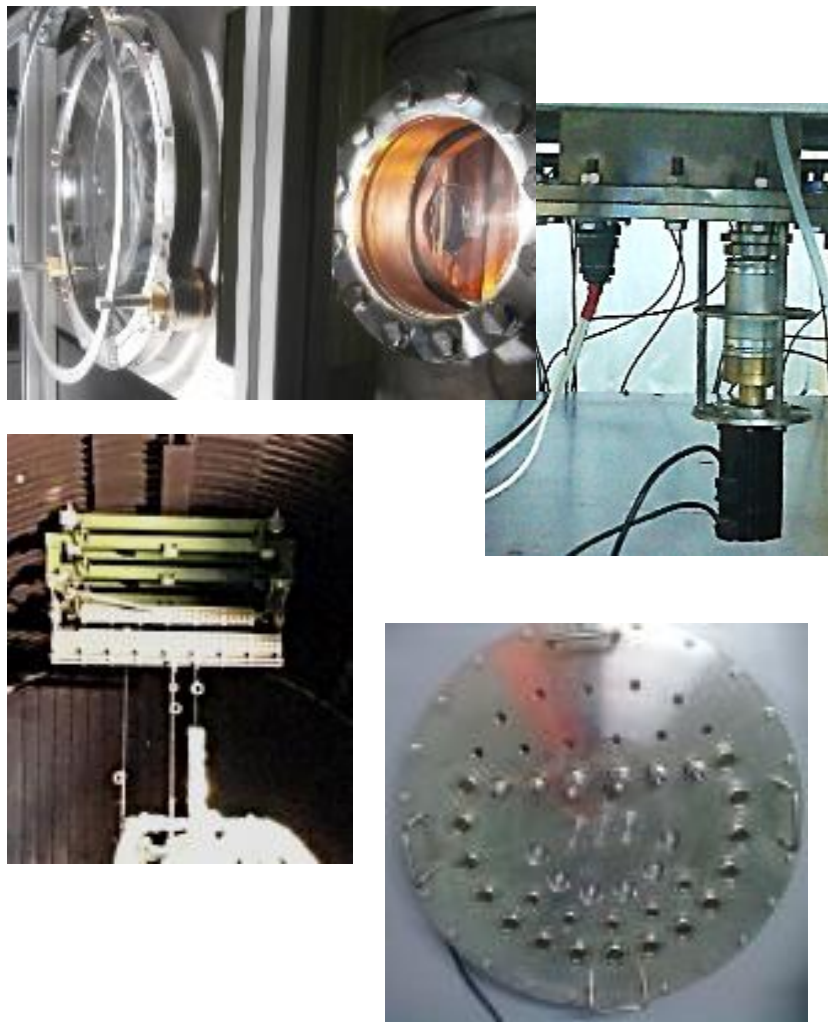
# What is METAMORPHOSIS



## Control and measurement system

- Data collection, analyze, indication and facility systems control
- Semi-automatic operation of Vacuum system, Cryogenic system, Sun simulator, Heat flow simulator
- Indication of specimen temperature distribution, pressure, light flow etc.
- Time synchronization of all measurements and operations
- Long and short term data archive
- Data fast analyze, facts synchronization finding

# What is METAMORPHOSIS



## Supply system

- Different optical viewports, DC, AC, RF electrical and pneumo/hidro feedthroughs
- 1-3 axis specimen positioning system for high fidelity orbit simulation (on request)
- Gravity compensation system (on request)
- Vacuum chamber inner lighting LED system and TV-control system
- Autonomous or stationary electricity, compressed air and liquid nitrogen consumption
- Autonomous equipment cooling system
- Clean room filtered air pressure and climate control

# When will METAMORPHOSIS service be available

- At this point our aim is to provide an excellent market research to win Horizon 2020 SME Instrument Phase two.
- We hope to start production of the first facility by spring, summer 2018, and begin its testing (together with final assembling and equipment mounting) in spring-summer 2019

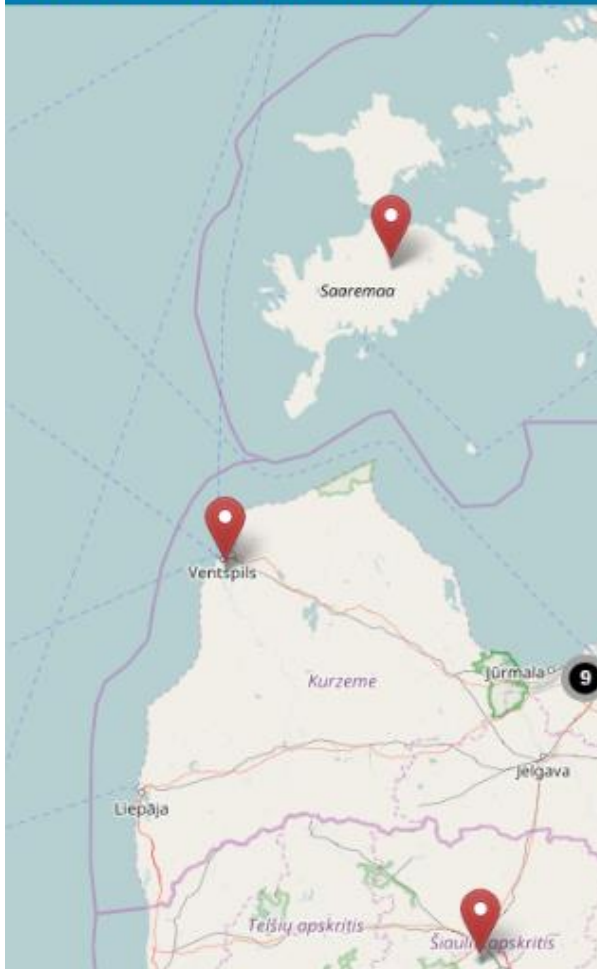
«Can it happen sooner?»

- That depends on your reply to our survey.
- If we create an excellent business plan, we will not wait for H2020 SME Instrument Phase 2 results, but invite private investors, who are watching our project very closely



# Who we are and why we do this

## Horizon 2020 SME Instrument data hub



### CRYOGENIC AND VACUUM SYSTEMS

<http://www.cvsys.eu>

**Project:** On Request Mobile Testing Facility "Metamorphosis"

**Project Acronym:** Metamorphosis

**Project type:** Phase 1

Before launch all satellite components must experience space-like temperatures and thermal vacuum testing, that is a significant factor contributing to the success of the space program. Lot of local Eastern Europe companies has potential to develop components for space industry, but has difficulties to realize it due to lack of cheap and close to home located space qualification test possibility. Space tests difficulty harm the European small space technology enterprise development and hinder all European space industry progress and development. To solve this problem we offer disruptive innovation - to create transportable space simulating system on the automotive base. That system will be able come to client and make all required tests in cooperation with research team. New designed space simulator provides complex testing of space technology: thermal vacuum tests simultaneous with imitation of effects of solar radiation and the Earth's radiation, and the impact of the Van Allen belts, all influences together. Such comprehensive test simulator currently is not available on the market. Any other space simulator cannot provide the entire set of proposed tests. CVS team specialists has long term experience in space simulator development, up to now has built 14 space simulators, different volume, from small one to very high volume (from 0.07 m3 to 5000 m3) has necessary expertise to build a innovative space simulator with improved features and reasonable price, than can be used as fixed or also transportable complex space simulating test system.

**Topic:** Engaging SMEs in space research and development

**Total budget:** 71.429 €

**EU Contribution:** 50.000 €

**Call ID:** H2020-SMEINST-1-2016-2017

**Participants:**

- CRYOGENIC AND VACUUM SYSTEMS (Coordinator) - Latvia

We are private limited liability company established by a group of engineers in July 2014. At CVS we make custom cryogenic and vacuum systems, our capability covers all the aspects of the project life cycle:

- Fundamental and applied research
- System design and engineering
- Original Equipment Manufacturing
- Testing and verification
- Maintenance and after-market support

# Where and How will be build METAMORPHOSIS, what resources we have

## Our Partners:

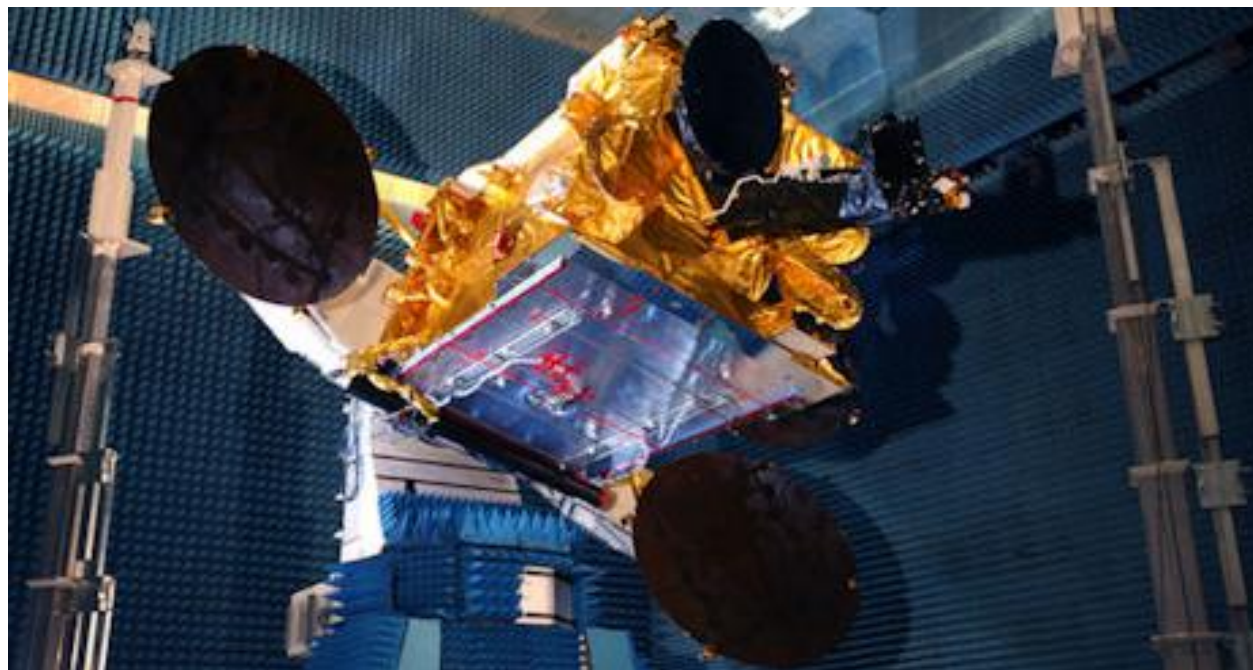
- scientific partner Institute of Aeronautics of RTU FTME
- design and production partners and suppliers will be:



... and the list is open for best suggestions!

# Be Space-Ready!

Help us to provide METAMORPHOSIS for you



Thank you for attention and cooperation!