САМАРСКИЙ УНИВЕРСИТЕТ
SAMARA UNIVERSITY

Innovation education programs in space technologies of Samara University

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1. BSS&T Education programs in Samara University

Main feature of educational process: Education through research like effective way for capacity building in space science and technique

Bachelor training program (four years)

Direction: «Rocket systems and cosmonautics»

Program: «Small-size spacecraft and nanosatellites» (rus)

Master training program (two years)

Direction : «Rocket systems and cosmonautics»

Program : «Advanced space technologies and experiments in space» (rus/eng)

Master training program (two years)

Direction: «Applied Mathematics and Physics»

Program: «Space information systems and nanosatellites. Navigation and remote sensing» (rus)

Master training program (two years)

«Advanced space technologies and experiments in space»

	COURSES	Credits
1	Orbital Mechanics	4
2	Nanosatellite attitude dynamics	4
3	Space Navigation	4
4	Control in Space	5
5	Space Physics	5
6	Modular design of nanosatellite	5
7	Onboard Electronic Systems	5
8	Software development for microprocessors	5
9	Computer technologies for nanosatellite design and construction	4
10	Mathematical simulation with use MatLab	4
11	Numerical methods applied to problems of orbital mechanics (for mission analysis)	4
12	Nanosatellite Testing Technologies	4
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2. DSR SU infrastructure for support of education and space research

Center of Nanosatellite Technologies (design and manufacturing of electronic systems):

- Laboratories of digital design of the nanosatellite and its onboard systems
- Laboratory of onboard systems manufacturing and assembly of nanosatellites

Center of Nanosatellites Testing

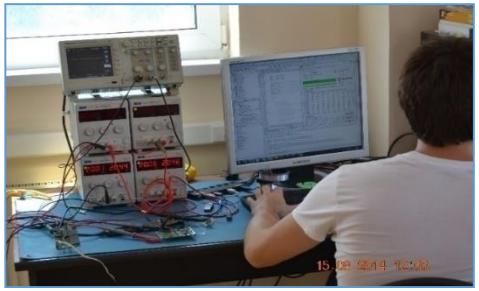
Flight Operating Center

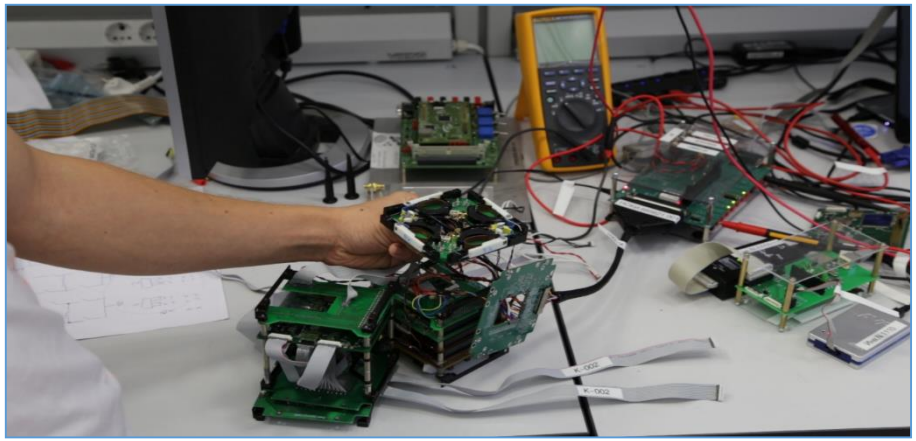
Science Laboratory "Basic and Applied Space Research Using Nanosatellites" (financial support by Ministry of Science and High Education of Russia)

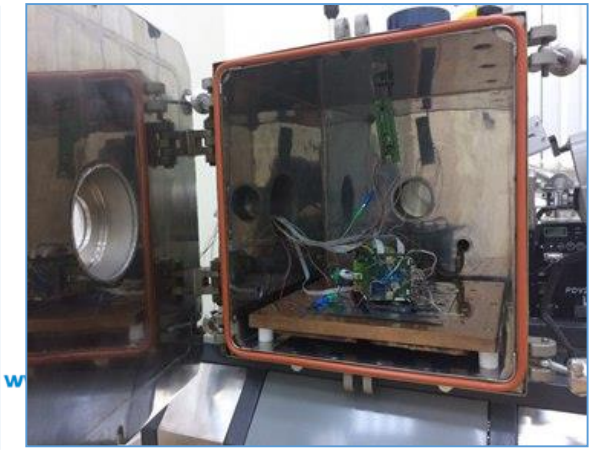
Partners: Institute of Space Research of RAS, Lebedev Physical Institute of RAS, Institute of Applied Physics of RAS, Keldysh Institute of Applied Mathematics of RAS

Center of nanosatellite testing

Thermal vacuum chamber, vibration test bed, equipment for testing systems of orientation and stabilization, Sun simulation, equipment for calibration of MEMS inertial sensors, equipment for determination of inertia moments tensor and position of mass center for nanosatellites)







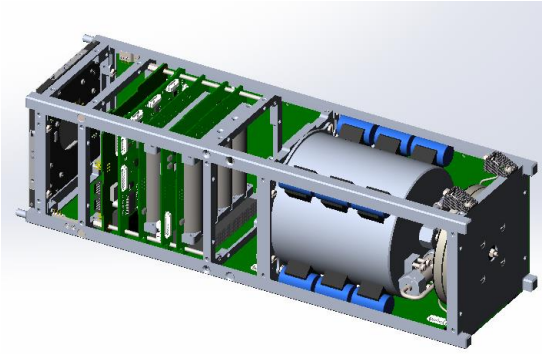
3. Nanosatellite platform SamSat (CubeSat 3U)

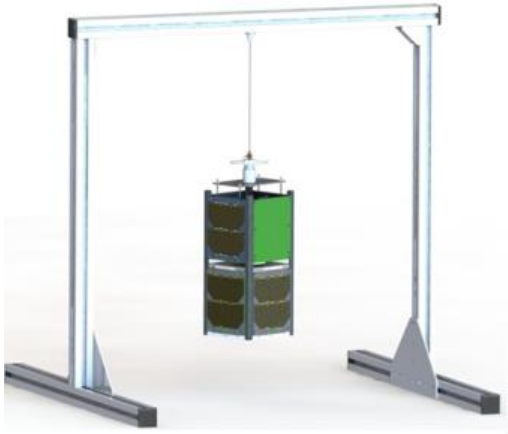
The full set of life systems by own design

(EPS, ADCS, Solar panel, OBC, TRX, battery array)

Additional systems:

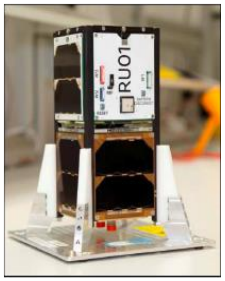
- thermo-electric engine for maneuvering,
- navigating receiver,
- special equipment for functional testing of nanosatellites

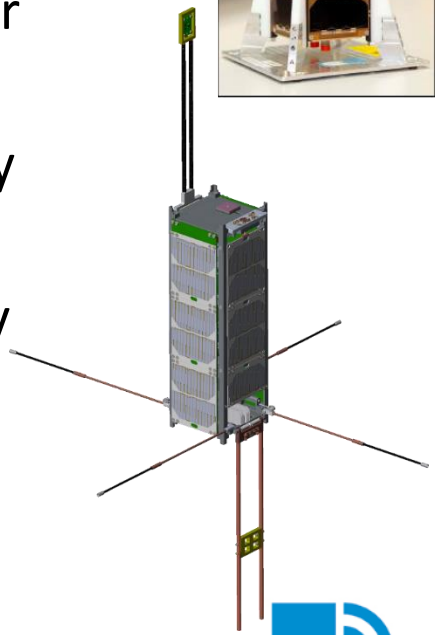




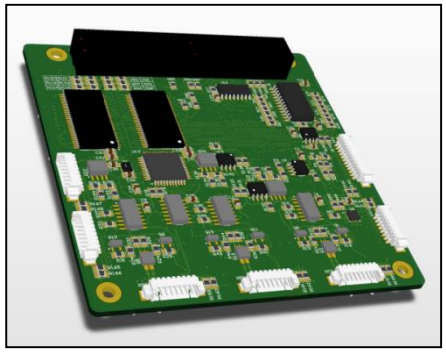
4. Experience in the field of space research

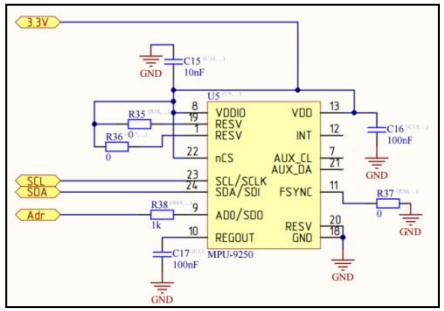
- Microsatellites PION for study density of high atmosphere (1989-1992, 6 sats)
- SV “Foton-12” (1999), study of microgravitational environment inside of SV (in collaboration with ESA)
- SV “Foton-M2” (2005), study short-term variations of atmosphere density (using navigating receiver)
- SV “Foton-M3” (2007) , navigation support of YES2 tether experiment (in collaboration with ESA)
- Nanosatellite SamSat-218D (2016), testing of technology of aerodynamically stabilization of nanosatellites
- Nanosatellite SamSat-QB50 , testing technology of study ionosphere by aerodynamically stabilized nanosatellites
- Nanosatellite SamSat-ION (2022), study of ionosphere

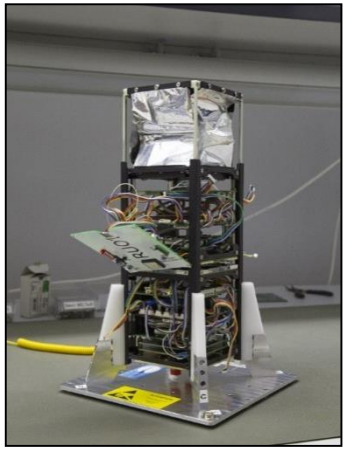


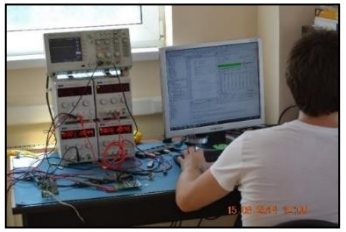


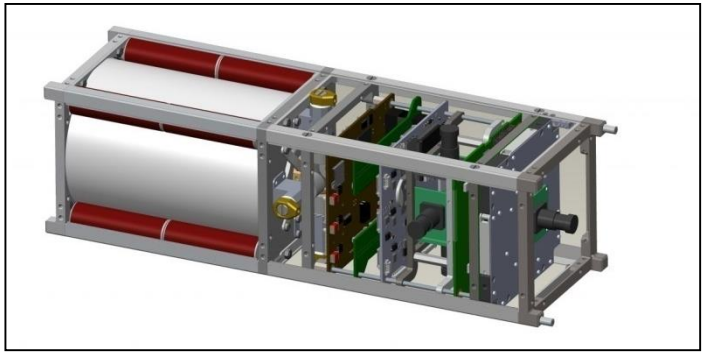
Nanosatellites at Samara University

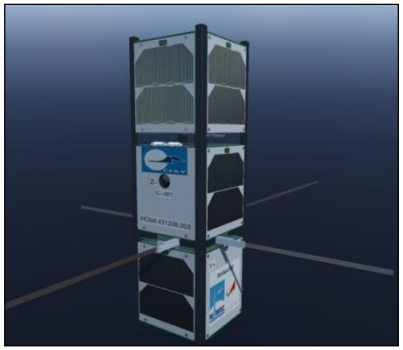


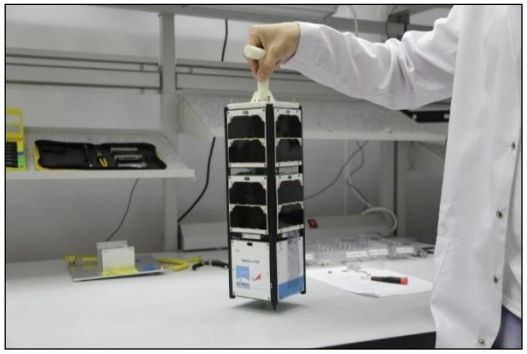












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5. Collaboration with Emerging Countries

Regional Centre for Space Science and Technology Education for Western Asia (RCSSTEWA)

•Regional Centre for Space Science and Technology Education in Asia and the Pacific (RCSSTEAP - China)

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•The Arthur C Clarke Institute for Modern Technologies (ACCIMT), Sri Lanka

•The Regional Centre for Space Science and Technology Education for Latin America and the Caribbean, Mexico

•The National Commission on Space Activities of Argentina (CONAE)

•The African Regional Centre for Space Science and Technology Education in English, Nigeria

Short-term educational trainings for emerging countries

Types of short-term educational programs:

1. At an inviting organization
duration 1 - 2 weeks

2. At Samara University
duration from 2 weeks to 2 month

3. Distant courses
duration about 20 hours

The main topics of lectures and practical classes:

- design of space technologies;
- space mission analysis;
- basics of space navigation and control;
- software for design;
- basics of microcontroller programming.

Training's themes:

Introduction to nanosatellite technologies»(duration 30 hours)

Basics of nanosatellite technologies (duration 60 hours)

Advanced nanosatellite technologies

(duration 120 hours)

Trainings are illustrated with examples of Samara University nanosatellite projects

Programs, proposed for implementation on the basis of the regional centers, affiliated to UN

Program of a week training

«Introduction to nanosatellite technologies»

(duration 30 hours)

Program of lectures and practical classes

Topic	Hours
Introduction to space technologies and nanosatellite missions	2
Basics of space flight mechanics and navigation	6
Introduction to nanosatellite design	10
Introduction to space radio engineering	8
Introduction to software for nanosatellite design	4

Programs, proposed for implementation on the basis of the regional centers, affiliated to UN

Program of a two weeks training
«Basics of nanosatellite technologies»
(duration 60 hours)

Program of lectures and practical classes

Topic	Hours
Introduction to space technologies and nanosatellite missions	4
Basics of space flight mechanics and navigation	10
Basics of nanosatellite design	12
Basics of space radio engineering	10
Basic principles of work with software for nanosatellite design	6
Basics of attitude determination and control	**8**
Basics of microcontroller programming	**10**

Programs, proposed for implementation on the basis of the regional centers, affiliated to UN

Program of a month training **«Advanced nanosatellite technologies»**
(duration 120 hours)

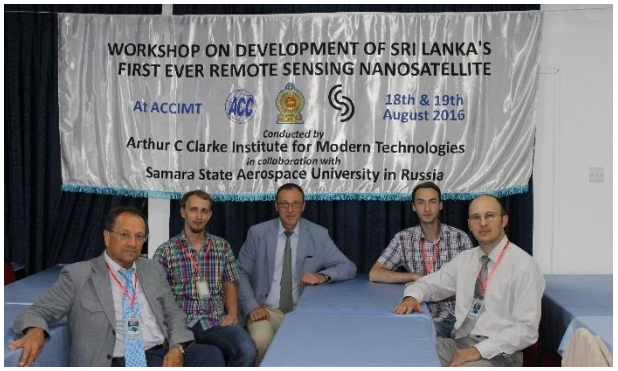
Program of lectures and practical classes

Topic	Hours
Advanced space technologies and nanosatellite missions	6
Space flight mechanics and navigation	14
Nanosatellite design	12
Basics of space radio engineering	16
Work with software for nanosatellite design	24
Basics of attitude determination and control	8
Basics of microcontroller programming	22
Nanosatellite deployers	**2**
Basics of nanosatellite relative motion	**8**
Ground station and other facilities	**4**
Testing of nanosatellites	**4**

Examples of specialized trainings in the field of nanosatellite design

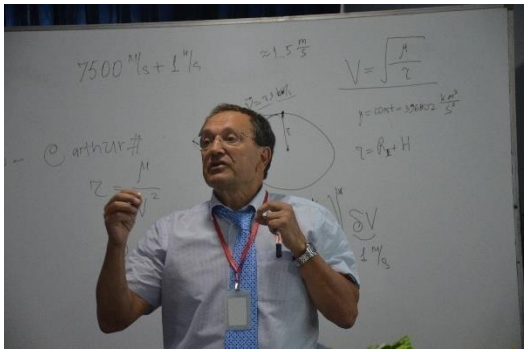
18 and 19 August 2016

***workshop** on development of the first Sri Lanka remote sensing nanosatellite at Arthur C Clarke Institute for Modern Technologies (Sri Lanka)*



from 20 till 23 August 2016

*at Arthur C Clarke Institute for Modern Technologies (Sri Lanka) was **short-term training** «Introduction to nanosatellite design»*



Examples of specialized trainings in the field of nanosatellite design

Training at Monterrey Institute of Technology and Higher Education (Mexico)
«Basics of nanosatellite design» (duration 30 hours)
November-December 2017

The training includes introductions to the next topics:

- nanosatellite design;
- space flight mechanics and navigation;
- space radio engineering;
- attitude control;
- software for nanosatellite design.

Development of cooperation with Sri Lanka

It is discussing cooperation in area of consultation and assistance in the design of the first nanosatellite of ACCIMT (Sri Lanka).

Examples of specialized trainings in the field of nanosatellite design

Training «Basics of nanosatellite design»
(duration 120 hours)
03 –28 April 2017

Training was at Space Research Department of Samara University.

<u>The training included topics</u>:

- Introduction to space technologies and low-orbital nanosatellite missions,
- Nanosatellite design,
- Basics of software for design,
- Basics of space navigation;
- System analysis of space missions;
- Excursions to the aerospace museums of Samara.

The concept of a dual educational program Samara University and UPC in the field of space engineering (under discussion)

The master's program meets the demand from the developing countries of Latin America and the rapidly developing market for education in the field of space technology, which would combine the best practices of the world's leading universities.

The program is based on the wide experience of Samara University and UPC of providing educational services in this area, combines and strengthens the capabilities of their educational programs.

Based on the results of the training, students have the opportunity to receive a UPC diploma and a Samara University state diploma in space engineering, or only a UPC diploma and a certificate of study during one semester at Samara University.

Students have the opportunity to choose disciplines from the list (Table 1) to form a wide range of competencies in space technologies and an individual educational trajectory.

The master's program is a two-year program with the following distribution of stages:

1-st semester (the first study year, September-February) - training at Samara University under the dual master's program.

Semester	Subject	ECTS	
1	Decision theory and system analysis (compulsory)	3	Samara University
	Academic Russian (compulsory)	2	
	Master's research (compulsory)	3	
	Technologies for nanosatellite design and construction	5	
	Mathematical simulation with use MatLab	4	
	Numerical methods applied to problems of orbital mechanics	4	
	Orbital Mechanics	4	
	Space Navigation	5	

2-nd and 3-rd semesters (the first study year, February-June and the second study year, September-February) - training at UPC on the existing master's program lasting 1 year with the defense of the master's thesis and the issuance of a UPC master's diploma

2	**Aerospace R&D&I (compulsory)**	**5**	**UPC**
	Atmospheric Physics	5	
	Modern Control Systems	5	
	Unmanned Aerial Vehicles	5	
	Global Navigation Satellite System (GNSS) Data Processing	5	
	Astrodynamics **OR** Architecture of Nano and	5	

2-nd and 3-rd semesters (the first study year, February-June and the second study year, September-February) - training at UPC on the existing master's program lasting 1 year with the defense of the master's thesis and the issuance of a UPC master's diploma

3	**Aerospace Seminars (compulsory)**	**5**	**U P C**
	Space Systems Engineering (compulsory)	5	
	Aerospace Materials **OR** Analog and Digital Signal Processing in Aerospace Applications **OR** Computational Engineering **OR** Space Exploration **OR** Test and Instrumentation Systems in Aerospace Applications **OR** Aircraft Trajectory Management **OR** Astrodynamics **OR** Architecture of Nano and Picosatellites	5	
	Master thesis (compulsory)	15	

- 4-th semester (the second study year, February-June) - training at Samara University with the defense of the master's thesis and the issuance of master's degree Russian Federation state diploma.
- Education in semester 4 depends on the student's capabilities:
- – if the students, after defending their master's thesis at UPC and receiving a master's degree from UPC, want to continue study and to receive state-recognized diploma from Samara University, they come back to Samara and study during the 4th semester;
- – if students after receiving a master's degree from UPC do not plan to receive a second diploma, then they complete their studies after the 3rd semester and do not return to Samara (if necessary, Samara University can issue a certificate of the 1-st semester completion at Samara University). In this case, students who completed their studies after the 3rd semester and received a UPC diploma have an advantage over those who simply received education in a one-year program. The advantage is in the first semester they receive additional knowledge, skills and abilities at Samara University, and they can return to Samara University to complete their studies (in case if the dual master's program is available).

4-th semester (the second study year, February-June) - training at Samara University with the defense of the master's thesis and the issuance of master's degree Russian Federation state diploma.

4	**Project Management and Innovative Entrepreneurship (compulsory)**	**2**	**Samara University**
	Psychology of team building and creative communication (compulsory)	2	
	Internship (Master's research)	20	
	Master thesis	6	

Thank you for attention

United Nations/Russian Federation Workshop (2017)