Ministry of Education of Republic of Belarus, Belarusian State University, Minsk, Belarus

Aerospace Education in the Republic of Belarus

S.V. Ablameyko, V.V. Ponariadov, V.A. Saetchnikov, A.I. Zhuk

United Nations/Belarus International Workshop on Space Technology Applications for Socio-Economic Benefits
11-15 November, Minsk
Belarusian State University - the leading educational center in Belarus, founded in October 30, 1921
BSU today

- 20 faculties and educational institutes
- lyceum
- college
- 3 scientific-experimental stations
- 3 museums
- 4 scientific-research institutes
- 115 scientific-research laboratories
- 25 scientific centers
- 10 unitary enterprises
BSU today

University staff: 
7398 (8680) staff members, including:
- 2477 lecturers
- 1900 researchers and research engineers

Lecturers:
- 6 academicians of the National Academy of Science of Belarus
- 7 corresponding member of the National Academy of Science of Belarus
- 291 doctors of science
- 1350 candidates of science
## BSU in international ranking systems

<table>
<thead>
<tr>
<th>BSU in international ranking systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Webometrics</td>
</tr>
<tr>
<td>QS</td>
</tr>
<tr>
<td>Scimago</td>
</tr>
<tr>
<td>University Ranking by Academic Performance (URAP)</td>
</tr>
<tr>
<td>4 international Colleges &amp; Universities (4icu)</td>
</tr>
</tbody>
</table>
BSU dynamics in «Webometrics»

Динамика рейтинга БГУ по данным "Webometrics Ranking of World Universities"
BSU in QS World University Rankings

<table>
<thead>
<tr>
<th>QS</th>
<th>Place</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>500–550</td>
</tr>
<tr>
<td>2012</td>
<td>500–550</td>
</tr>
</tbody>
</table>

In 2012 BSU remained among 550 best universities of the world, and among universities of CIS countries moved from 10 to 9 place.
According to Webometrics BSU takes 5 place among universities of CIS countries.

Ahead of us only:

• Lomonosov Moscow State University
• Saint Petersburg State University
• Tomsk State University
• National Technical University of Ukraine “Kyiv Polytechnic institute”

In all ranking systems BSU is among 10 best universities of CIS countries.
<table>
<thead>
<tr>
<th>Faculties and Educational Institutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Mechanics and Mathematics</td>
</tr>
<tr>
<td>• Applied Mathematics and Computer Science</td>
</tr>
<tr>
<td>• Radiophysics and Computer Technologies</td>
</tr>
<tr>
<td>• Physics</td>
</tr>
<tr>
<td>• Chemistry</td>
</tr>
<tr>
<td>• Biology</td>
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<tr>
<td>• Geography</td>
</tr>
<tr>
<td>• Economics</td>
</tr>
<tr>
<td>• Military</td>
</tr>
<tr>
<td>• History</td>
</tr>
<tr>
<td>• Philosophy and Social Science</td>
</tr>
<tr>
<td>• Law</td>
</tr>
<tr>
<td>• International Relations</td>
</tr>
<tr>
<td>• Pre-University Education</td>
</tr>
<tr>
<td>• Journalism</td>
</tr>
<tr>
<td>• Philology</td>
</tr>
<tr>
<td>• Liberal Arts</td>
</tr>
<tr>
<td>• Business and Management of Technologies</td>
</tr>
<tr>
<td>• Management and Social Technologies</td>
</tr>
<tr>
<td>• Theology</td>
</tr>
</tbody>
</table>
International students

![Bar chart showing international student numbers from 2008 to 2012.

- 2008: 1426
- 2009: 1716
- 2010: 1892
- 2011: 2036
- 2012: 2320

The chart indicates a steady increase in the number of international students over the years.]
In 2012/2013 academic year:

2 320 international students from 53 countries of the world.

Among them:

China – 900,
Russia – 239,
Turkmenistan – 702,
Turkey – 58,
Vietnam – 51,
Azerbaijan – 40.
# International Contacts

**More than 300 partner bilateral agreements:**
- CIS
- Europe
- Asia
- Africa
- North and South America

**Membership in international associations:**
- Eurasian University Association
- European University Association
- Baltic University
- International Association of Teachers of Russian language as a Foreign Language
- CEI University Network
- CIRCEOS
- IAESTE
- ICRANet

**International centers at the university:**
- EU Informational Center
- Council of Europe InfoPoint
- Center for UN study
- Confucius Institute
Academic mobility

More than 1000 staff members are sent abroad for study and research visits per annum.

About 240 students take part in conferences and seminars abroad annually.

About 150 incoming and 180 outgoing exchange students per year.

30% of outgoing exchanges students carry out long term study visits (more than 6 months).

Top 7 countries outgoing exchange students:
1. Russia
2. Germany
3. Poland
4. China
5. Czech
6. Italy
7. France

Top 7 countries incoming exchange students:
1. Germany
2. Poland
3. Finland
4. Ukraine
5. Czech
6. China
7. Lithuania
Academic mobility

Programs of academic mobility in the BSU

1. ERASMUS-MUNDUS. Annually over 50 BSU staff and students conduct their studies and research in European universities. 8-10 European students come to BSU each year in the framework of the Program.

2. DAAD. Every year approx. 15-20 students and researches are being selected for scholarships to study in Germany.

3. IAESTE. Since 2002 more than 30 BSU students took part in the program.

4. VISEGRAD FUND. 10-15 BSU students and graduates receive funding to study in HIEs in Czech Republic, Poland, Hungary and Slovakia.

BSU students and staff participate in many other programs of study and research abroad, such as Fulbright, GFPS, Copernicus, Visby as well as national scholarship programs of different counties.
International projects

There are more than 40 international projects implemented funded by INTAS, FP7, ISTC, NATO, CEI, CERN, VISBY, SIDA, UNO, UCPD, FPB-Belarus, different EU funding instruments and etc.

Since 1994 the BSU has participated in 12 Tempus projects

Approximate amount of personal grants BSU teaching stuff and researchers receive is about 200000 Euro per year
Participation of BSU in USSR, Russia and international space programs

Mir project (USSR)

Venera project (USSR)

Buran-Energia project (USSR)

International Space Station
Space Remote Sensing Systems, 1988 (Mir)

- Since 1985 BSU has been developing optical methods and equipment for Earth remote sensing. As a result different space remote sensing systems have been designed.
- BSU specialists have participated in many international projects: FIFE-89 (USA), Curecs - 86, - 88, -91. They have developed scientific equipment for aircraft laboratories.

Board video-photometric system
«VFS-3M», 2000 - 2002 (ISS)

- Designed to an automatical remote registration of optical emission at atmosphere.

- Able to register Red Sprites and Blue Jets.

Photospectral system «ФСС», 2000 – today (ISS)

Designed to research reflected emission spectrum from underlying terrain and to obtain visible photographic image on board ISS -1 - ISS -24 (experiment «Storm»).
ФОТОСПЕКТРАЛЬНАЯ СИСТЕМА ФСС
(создана НИИФП им. А.Н.Севченко БГУ по контракту с РКК «Энергия»)

предназначена для проведения измерений спектров отраженного излучения подстилающих поверхностей в диапазоне дли волн от 350 до 1050 нм и фотоизображений в видимом диапазоне дли волн на Российском сегменте Международной космической станции в космическом эксперименте «Ураган-МКС» (экспериментальная отработка наземно-космической системы мониторинга и прогноза развития природных и техногенных катастроф)

В июле, августе ОАО РКК «Энергия» были проведены летно-космические испытания ФСС. Целью этих испытаний была проверка работоспособности ФСС и отработка различных режимов съемки космонавтом в рамках космического эксперимента «Ураган».

В июле 2010 г. система ФСС была доставлена грузовым кораблем «Прогресс-М-06М» на борт РС МКС.

С борта РС МКС космонавтами А.А. Скворцовым и Ф.Н. Юрчиным в ходе первых включений научной аппаратуры ФСС получены первые результаты съемок земной поверхности. На основании полученных результатов проведен анализ работы аппаратуры ФСС в различных режимах.

14 июля 2010 г. был проведен трехуровневый подспутниковый эксперимент по съемкам объекта «Кольцевая структура» (обвалованное песчаным кольцом озеро в Гомельской области, РБ).
БЛОК ВНЕШНИХ ДАТЧИКОВ БВД научной аппаратуры "Фотон-Гамма"

Транспортным кораблем «Прогресс» БВД в октябре 2010 г. доставлен на борт РС МКС.

16 февраля 2011 г. российские космонавты Дмитрий Кондратьев и Олег Скрипочка во время выхода в открытый космос установили БВД на внешней поверхности модуля «Звезда» российского сегмента Международной космической станции.
Spectrophotometric system «SPS», 2007- today (ISS)

- Developed as part of «Cosmos-SG» program.
- Designed to hydroxyl and monatomic oxygen emission detection and registration on board ISS.
Spectrometers and spectroradiometers (today)

MS-10

Spectroradiometers series MC (radiation brightness and rapid analysis of radiation, scattering, transmission, absorption and luminescence characteristics of various objects)

MS-08

Spectroradiometer PSR-02 (spectral density of energy brightness and the polarization characteristics of radiation)

MS-09

Spectrometer PVS-02 (the emission, reflection and absorption spectra)

MS-12

MS-10

Spectroradiometers series MC (radiation brightness and rapid analysis of radiation, scattering, transmission, absorption and luminescence characteristics of various objects)
Aircraft Control System (today)

Aircraft videospectral system «VSS-2»
(Designed to forest remote control)

Aircraft emergency situation control system
Compact spectrometers

- Voltage - 5 V.
- Power < 0.2 W - detector based on a CCD matrix
- Power < 10 W - detector based on InGaAs.

<table>
<thead>
<tr>
<th>Compact spectrometer</th>
<th>Multi Element detector based on InGaAs photodiode array</th>
</tr>
</thead>
<tbody>
<tr>
<td>S10420-1006</td>
<td></td>
</tr>
<tr>
<td>Vacuum UV spectrometer</td>
<td>IR spectrometer</td>
</tr>
<tr>
<td>Spectral range of the detector based on CCD - 160 nm – 320 nm.</td>
<td>Spectral range of detector based on InGaAs photodiode array - 1.3 – 2.8 µm.</td>
</tr>
<tr>
<td>Spectral resolution - 0.08 nm/pixel</td>
<td>Spectral resolution - 3 nm/pixel</td>
</tr>
</tbody>
</table>

Spectrometer equipped with a mirror, lens and fiber optic lighting system entrance slit. The LVDS interface used to connect to Control and Data Acquisition System.
Control and Data Acquisition System

The system is designed to control the actuators optoelectronic and mechanical systems, collecting and gathering data from various sensors, including multielement photodetectors.

- Processor Size - 60 mm x 44 mm with 240-pin; Expansion Module Size - 100 mm x 64 mm with 240-pin;
- Voltage – 3V; Power – 3.5 W;
- 32-bit Processor ARM9 c MMU @ 200 MHz;
- SDRAM Memory 16MB – 256MB;
- NAND Flash Memory 32MB – 256MB;
- 4 serial RS232 interface;
- USB interface, compatible with USB2.0;
- 10/100Mb Ethernet interface;
- I²C interface, 100KHz and 400KHz;
- SPI interface; JTAG interface; External Memory Interface – 4GB;
- 2-channel DMA; LVDS interface Expansion Module;
2004 – National project: **Development of the national remote sensing system (NRSS)** including satellites, ground station infrastructure and national bank of remote sensing data for state and commercial users.

Educational segment of NRSS was provided by BSU.

2008 – **National space program** which consists of 12 subprograms including **educational program**:

Some aims of the educational program:

- Development of student space research including development of university satellites and using experimental data from its for education.
- Modernization of the education system (new and updated educational trade, branched).
- International cooperation.
- Разработка и реализация международных молодежных проектов по реализации научно-образовательных космических экспериментов.
- Development of Internet and distant education technologies.

To coordinate these activities Aerospace educational center has been organized.
REMOTE SENSING

- Development Ground station equipments
- Development new methods and software
- Receiving and processing of remote sensing data

BSU AEROSPACE EDUCATIONAL CENTER

- Educational and methodical support for the Universities
- Development Aerospace courses
- Aerospace training courses
- Development and launching microsatellite
- Development new scientific experiments
- Development new scientific equipments
- Experimental data and telemetry processing and analyzing

UNIVERSITY MICROSATELLITE
Aerospace Education in BSU

2008 г. – BSU aerospace educational center was founded.

2009 – new educational branch “Satellite information systems and technologies” was opened.

2010 – new educational trade “Aerospace radio electronics and information systems and technologies” with branches:
  • “Global navigation and telecommunication systems”.
  • “Radio electronics systems for data transmission and data processing”.
  • “Onboard and ground information systems”.
Национальная программа по использованию космического пространства в мирных целях
Подпрограмма: Кадровое обеспечение космической деятельности в Республике Беларусь

Цель подпрограммы:
- Создание системы профессионального аэрокосмического образования.
- Формирование кадрового потенциала аэрокосмической отрасли.

Основные направления выполнения подпрограммы:
- Развитие студенческой науки по космическим исследованиям, в том числе создание университетских малых космических аппаратов.
- Разработка и реализация международных молодежных проектов по реализации научно-образовательных космических экспериментов.
- Развитие образовательной деятельности посредством интернет – технологий на основе использования экспериментальных данных о космических объектах и информационных космических технологий.
- Создание (возможно в структуре Национального космического агентства) научно-методического центра аэрокосмического образования, обучающего:
  - координацию деятельности организаций, занимающихся вопросами космической деятельности, и взаимодействие с отраслевыми и тематическими организациями по вопросам подготовки, переподготовки и повышения квалификации кадров по направлению исследований и использования космического пространства.
  - согласование предложений по открытию новых специальностей и квалификаций и внесению изменений в Общегосударственный классификатор Республики Беларусь ОКРБ 011-2001 «Специальности и квалификации».

Программа Союзного Государства «Космос НТ»

Цель программы:
- Создание технических и научно-методических центров для обеспечения системы обучения (в том числе и дистанционного), а также подготовки высококвалифицированных специалистов и производственных кадров по современным космическим технологиям в интересах объединения научно-технического и информационного пространств России и Беларуси.

Основные направления выполнения программы:
- Создание инфраструктуры Научно-методического Центра аэрокосмического образования БГУ и Центра космических технологий и образования МГУ.
- Совершенствование и унификация правового, информационного и научно-методического обеспечения системы подготовки кадров по современным космическим
Ground station

- Command and Telemetry
- Science Mission Data (137, 415 MHz)
- Science Mission Data (1.2 GHz)
- Science Mission Data (1.7 GHz)
- Science Mission Data (8.2 GHz)

Ground station for university satellite control and radio-band data reception (based on radio station Kenwood TM-D710A)

Ground station for university satellite control and radio-band data reception (based on radio station ICOM ID)

Ground station for L-band data reception from university and remote sensing satellites

Ground station for X-band data reception from university and remote sensing satellites

Control of acquisition and data recording to a PC hard disc

Preliminary processing of science mission data, telemetry, remote sensing data

Fund of science mission data, telemetry, space images

Secondary thematic processing of science mission data, telemetry, remote sensing data

Thematic End-product
<table>
<thead>
<tr>
<th>Satellite</th>
<th>Frequency, MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>HO-68</td>
<td>435.7900</td>
</tr>
<tr>
<td>ITUpSAT1</td>
<td>437.3250</td>
</tr>
<tr>
<td>PRISM</td>
<td>437.2500</td>
</tr>
<tr>
<td>KKS-1</td>
<td>437.3850</td>
</tr>
<tr>
<td>CO-66</td>
<td>437.4850</td>
</tr>
<tr>
<td>CO-55</td>
<td>436.8375</td>
</tr>
<tr>
<td>CO-65</td>
<td>437.2750</td>
</tr>
<tr>
<td>CO-58</td>
<td>437.4650</td>
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<tr>
<td>CO-57</td>
<td>436.8475</td>
</tr>
<tr>
<td>RS-22</td>
<td>435.3520</td>
</tr>
<tr>
<td>VO-52</td>
<td>145.8600</td>
</tr>
</tbody>
</table>

**Radio amateur range**
L-band range for remote sensing satellites
Ground station for L-band data reception from university and remote sensing satellites (processing data)

Control of acquisition

Decoding information

AVHRR image from NOAA-19

Visualisation and preliminary processing

FengYun-1D image, CHRPT format
Lecture courses for “Satellite information systems and technologies”

- Small sized satellites;
- Global navigation satellite system;
- Statistical theory of radiotechnical systems of remote sensing, radar and navigation;
- Communications satellites;
- Image processing and remote sensing;
- Databases;
- The object-oriented approach and programming;
- Optical and radar-based observations;
- Spacecraft system design;
- Electronics in space;
- Space Technique and instrumentation.
The methodical materials is being developed on small spacecrafts and space navigation
Remote sensing data processing

Starobinsk deposit of potash salts and predictive model.
Course “Small satellites” (Lectures)

Lectures presented on the origins of spacecraft flight dynamics and control; spacecraft system; spacecraft and mission design; spacecraft system engineering; propulsion systems.

- Control System (Active Pixel Sensor)
- Satellite Dynamics
- Power System Design
- Space Environment
- Control System (GNSS/GPS Receiver)

- Power System Design
  - Generation
    - Solar Array
    - Primary Battery
    - RTG (Radioisotope Thermoelectric Generator)
  - Management
    - Secondary Rechargeable Battery
    - Power Control Regulation Switching
Course “Small satellites” (Practice)

The purpose of the lab exercises is to introduce the students to the methods of the measurements, to the modern conception of near-Earth space structure and the physical processes and phenomena occurred in it. It's also intended to the teaching of the basic methods of experimental data processing and analyzing.

Satellite Dynamics (satellite's orbit)  Calculation of the second zonal harmonics of the Earth's gravitational field
Precise positioning system of the Minsk region
Aerospace training courses, seminars, conferences

Professor BMSTU (Russia) Vlasov I.B. and members of seminar “Global navigation satellite system”

Creators University satellite Tatiana-2 (Russia) and members of seminar “Small satellites”

“Education and Space” (IV Belarusian Space Congress)
BSU University microsatellite (Project)

**Objectives** - BSU University microsatellite is intended for applied, scientific and educational issues as well as training students of BSU and other belarusian universities in control methods of spacecrafts and data processing out of space.

**Collaboration** - The project will be developed in cooperation with Universities and Research Institutes of Russia and International.

**Aim** - The main purpose of the experiment is study of interaction of the atmosphere, ionosphere and magnetosphere of the Earth by means of the orbital detectors.
BSU – SWSU educational nanosatellite

Problems

Research:
• Study the atmospere, ionosphere and magnetosphere of the Earth by orbital detectors.
• Material study under zero gravity and radiation.

Technological:
• Development and studying the technology of image transfer through channels of satellite communication.
• Development and studying orientation and stabilization systems of the nanosatellite.
• Development and studying radio engineering and optical methods for ballistic measurements of the nanosatellite.

Educational:
• Development of a new approach for education of students, training of technical and engineer staff in the field of space technologies.
• Development and carrying out international university space scientific experiments.
5.11.2012 in BGU competition was declared

On competition of the best project of space experiment 15 works were given also it is offered to the 23rd name of the university nanosatellite

15.11.2012-15.02.2013

Испытывает конкурс!
- На лучшее ИМЯ для университетского наноспутника
- На лучший проект космического эксперимента для университетского наноспутника
Open competition "Send your idea to the space"

Nomination - best project of space experiment
The 1st place – "Phase transitions under zero gravity and space radiation", the author the Krot Yury, the graduate student of the physics faculty.
The 2nd place – “Electromagnetic field pollution from a radio emission", author - Martinov Anton, the student of the 4th course of the faculty of radio physics and computer technologies.
The 3rd place – "An ionospheric harbinger" (research of ionospheric indignations during preparation of seismic events), author Reznikov Yury, the student of the 5th course of the faculty of radio physics and computer technologies.

Nomination – the best NAME for the university nanosatellite

BEKASS the author the Peter Lopuh, the head of the department of the general physical geography and hydrometeorology of geographical faculty.
May, 4 2012 the BGU lyceum team, under the leadership of students of faculty of radio physics and computer technologies started an educational picosatellite of own development "BelSat" on height of 2 km near the city of Kaluga (Grabtsevo's airfield) within the first CanSat championship in Russia. Through 213 seconds the satellite successfully landed on a parachute of own development. Descent all the time from the satellite the telemetry from various sensors, and also from the GPS receiver came to reception station which also is own development.

To the BelSat team the 2nd place among 17 teams was awarded, and also the cup on the nomination "For Development of the Best Scientific Task" is handed over.
The students participating in development
Nanosatellite model

Within performance of an academic year project by students of the 4th year of specialization "Satellite information systems and technologies" the training model of the nanosatellite had been developed. This model is applied for modeling of reliability and operability of onboard systems and separate modules.
The space vehicle simulator

- ARM920T 400/533 MHz
- 16 Kb cash
- tire speed 133 МГц
- NAND flash till 1Gb
- DDR SDRAM 256 Mb
- expected 4 Krad

Orbicom communication modem
CubSat nanosatellite exercise machine
Laboratory exercise machine of the CubeSat format

Orientation and stabilization system
Our Partners

Universities of Russian Federation: South-West State University, Kursk. Lomonosov Moscow State University, Bauman Moscow State Technical University, Siberian State Aerospace University (Krasnoyarsk), Samara State Aerospace University

Universities of Ukraine: Dnepropetrovsk National University, National Technical University of Ukraine (Kiev), National Aerospace University (Kharkov)

Universities of Kazakhstan: Karaganda State Technical University, Gumilyov Eurasian National University (Astana)

Universities of Europe: Technical University of Berlin (Germany), ECM-Office (Germany), Fontys University of Applied Sciences (Netherlands), Institute for Business and Management (Netherlands), Lessius University, Department of Industrial Sciences (Engineering) (Belgium), the Institute of Aeronautics and Astronautics (ILR) (Germany)
Thank you!