H-SPACE 2017

3rd INTERNATIONAL CONFERENCE
ON RESEARCH, TECHNOLOGY AND EDUCATION OF SPACE

Proceedings of
3rd International Conference on Research, Technology and Education of Space

February 9-10, 2017, Budapest, Hungary
at Budapest University of Technology and Economics

Organized by
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Budapest University of Technology and Economics
and
Hungarian Astronautical Society

Editors
László Bacsárdi and Kálmán Kovács

MANT 2017

Conference proceedings

H-SPACE 2017

3rd International Conference on Research, Technology and Education of Space
February 9-10, 2017, Budapest, Hungary
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WELCOME

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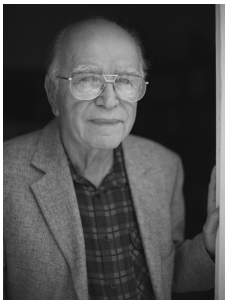

''Please, don't forget that in 2017 there will be an important anniversary: on the 4th of October we should commemorate the sixtieth return of the day when the first man made celestial body started to orbit the Earth. It was the birthday of such important disciplines as space exploration, space research, and space applications for the benefit of mankind. In the past sixty years Sputnik-1, was followed by thousands of different artificial satellites of the Earth, including the giant International Space Station, hundreds of astronauts from different countries, dozens of space probes exploring closely all planets, and many satellites, dwarf planets, asteroids, and comets. Twelve astronauts carried out short visits to the surface of the Moon. The functioning of artificial satellites have revolutionized such important tasks as telecommunication, remote sensing of the Earth, meteorology, navigation and many others. Orbiting telescopes discovered billions of unknown objects in deep space. These were the most important results of the first 6 decades of the space age. Let's remember these achievements in the current year and also the motivated people – most of them are already not alive – who started to build rockets and satellites more than 60 years ago!''

Fruzsina Tari

Head of the Hungarian Space Office
Ministry of National Development

„Dear participants of the H-Space 2017 Conference organized in Budapest.
Now, we can talk about a tradition that was fund by Federated Innovation and Knowledge Centre (EIT), within the Faculty of Electrical Engineering and Informatics at the Budapest University of Technology and Economics (BME) and the Hungarian Astronautical Society and supported by the Hungarian Space Office. The organizers invite the space community each year in February to Budapest to exchange exciting topics.

This year's topic, the "Integrated space systems, missions and concepts" will bring us to the future. Now, not only current mission elements but both the complexity of missions and new ideas can be discussed. Beside the space technology, space applications can also inspire the participants and the audience.

As Hungary is engaged to support both technology and application and wish to develop new service infrastructures, I consider personally that such a conference is rather well addressed in Hungary. Last year, we started to support the development of the so called CROSS space infrastructure that will provide data on cosmic radiation. This is a new approach internationally to measure this important indicator of space weather and serve with key information the community to design space missions in a more efficient way.

In this spirit, I wish you all a successful meeting in Budapest also in the name of the Hungarian Space Office."

WELCOME from the Organizing Committee

What an amazing year we had in the field of space activities since the H-SPACE 2016 conference! NASA's Juno spacecraft started orbiting Jupiter, the first mission of the ESA ExoMars programme reached Mars, and for Hungary, 2016 was the year of our ESA full membership.

We are happy to welcome you at the 3rd International Conference on Research, Technology and Education of Space. The event is organized by the BME Space Forum operated by the Federated Innovation and Knowledge Centre (EIT) of the Faculty of Electrical Engineering and Informatics at the Budapest University of Technology and Economics (BME) – in cooperation with the Hungarian Astronautical Society.

The organization of the conference comes at a time of growing opportunities arising from ESA recently granting full membership to Hungary and the need for a joint presentation of space activities pursued at BME. The selection of the date of the event pays tribute to the successful deployment to orbit and mission of the first Hungarian satellite, Masat-1.

The main topic of this year's conference is "Integrated space systems, missions and concepts". Naturally, our leading topic continues to be the roles of small satellites in space research and smart services, which covers applications and services from Earth Observation to future Smart City solutions. The agenda of the conference addresses scientific, technological and educational issues of space research and space activities. The conference is open for both local and international professionals and provides an opportunity to showcase Hungarian scientific, technological, educational and outreach activities, related to space.

The Organizing Committee has internationally recognized members: Prof. József Ádám, Dr. Tibor Bálint, Prof. László Pap, Prof. Gábor Stépán and Dr. Fruzsina Tari. We are grateful for their contributions to the success of the conference.

We appreciate the support of our sponsors, since their contribution makes the offer of free-of-charge participation possible.

On the first day of the conference, we will welcome Prof. Amnon Ginati, ESA's Senior Advisor to the Directorate of Telecommunications and Integrated Applications.

The conference will have three main sections: Science and Technology I, Science and Technology II and Education and Outreach (English and Hungarian). This will be the first year that we organize a poster session with a number of great presentations.

The best lectures (oral or poster) will receive the option of publication in a journal, thus the conference contributes to the scientific progress of the researchers as a publication opportunity.

After the conference, a special educational and scientific event will be held named as SpacePaprika Workshop. The workshop is organized by the Space Generation Advisory Council (SGAC), the Budapest University of Technology and Economics (BME), the Hungarian Astronautical Society (MANT), and the Scientific Association for Infocommunications (HTE). During the workshop, a new Hungarian scientific experiment which could be placed onboard of the ISS will be discussed.

We hope you will enjoy your time in Budapest and the H-SPACE conference will help learning about new scientific and technological results and strengthen your network.

Kálmán Kovács
chair
Director of EIT BME

László Bacsárdi
co-chair
Secretary Genaral of MANT

3rdInternational Conference on Research, Technology and Education of Space

February 9-10, 2017
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Address: Magyar tudósok krt. 2., Budapest, H-1117, Hungary

Conference Program

February 9, Thursday

14:00–14.20 Opening

János Józsa, Rector of Budapest University of Techology and Economics (BME)
Fruzsina Tari, Hungarian Space Office, Ministry of National Development
Amnon Ginati, Directorate of Telecommunications and Integrated Applications, ESA
László Pap, National Council for Telecommunications and Information Technology of Hungary
János Solymosi, President of Hungarian Astronautical Society

14:20–15:20 Section of Science and Technology I/A

Keynote talk:
Space Eco-System Investment: Shaping the Future of the Space Economy
Amnon Ginati, ESA's Senior Advisor to the Directorate of Telecommunications and Integrated Applications

Philae's landing and autonomous operation control on a comet – challenges, achievements and lessons learnt
András Balázs, Wigner Research Centre for Physics of Hungarian Academy of Sciences (HAS)

Introducing E-GNSS navigation in the Hungarian Airspace: the BEYOND experience and the relevance of GNSS monitoring and vulnerab
Rita Markovits-Somogyi, HungaroControl Zrt.

15:20–16:15 Poster session with coffe break

Analyzing energy efficiency of sensor networks deployed on the surface of a Solar System Body
Roland Béres, Department of Networked Systems and Services, BME

Analyzing the Quantum Efficiency in Satellite-based Quantum Key Distribution Network
András Kiss, Institute of Informatics and Economics, University of Sopron

Comparative analysis of tropospheric delay models using reference data derived from ray tracing
Ildikó Juni, Department of Geodesy and Surveying, BME

Follow-up psychological status monitoring of the crew members of Concordia research station at Antarctica based on speech
Gábor Kiss, Department of Telecommunications and Media Informatics, BME

HABIT – instrument on ExoMars rover to detect microscopic liquid water
Ákos Kereszturi, Research Centre for Astronomy and Earth Sciences, HAS

Simulated Mars Rover Model Competition - More than a decade as a research area
Pál Gábor Vizi, Wigner Research Centre for Phyiscs, HAS

16:15-18:00 Section of Science and Technology I/B

Invited talk: Performing chemistry in space, industrial and academic aspects: challenges and recent progress
Ferenc Darvas, ThalesNano Inc.

The Alphasat Scientific Experiment: Propagation Measurements and Statistics in the Ka/Q Band
Bernard Adjei-Frimpong, Department of Broadband Infocommunications and Electromagnetic Theory, BME

Developing a VLF transmiter for LEO satellites: Probing of Plasmasphere and RADiaton Belts - the POPRAD proposal
János Lichtenberger, Department of Geophysics and Space Sciences, Eötvös Loránd University

SATCOM developments for ESA
János Solymosi, BHE Bonn Hungary

An analysis of entanglened-based solutions on Earth-satellite channel
Ákos Korsós, Department of Networked Systems and Services, BME

Plasmaspheric density measurements based on guided VLF wave propagation
János Lichtenberger, Department of Geophysics and Space Sciences, Eötvös Loránd University

* * * * *

February 10, Friday

9:00–9:30 Opening of the second day

Gyula Barta-Eke, Chancellor of BME
László Jakab, Dean of Faculty of Electrical Engineering and Informatics, BME
Marissa Michelini, President of the International Research Group on Physics Teaching
László Bacsárdi, Secretary General of Hungarian Astronautical Society

9:30–10:35 Section of Science and Technology II/A

Long talk: Novel materials for aerospace hardware
Pál Bárczy, Admatis Kft.

Hexavalent Chromium free Coatings for Space Metallic Hardwares
Kalaivanan Thirupathi, University of Miskolc and Matmod Limited

Reusable Launch Vehicle-Concept of Minimizing Space Transportation Cost
Nadeem Alam, Department of Aeronautical Engineering, Babu Banarasi Das National Institute of Technology and Management

10:35–11:00 Coffee break

11:00–12:15 Section of Science and Technology II/B, **Education/Outreach I/A** *(in English)*

High speed integrated space streaming swarms as mission concepts
Pál Gábor Vizi, Wigner Research Centre for Phyiscs, HAS

Probing and Analyzing Triple Asteroid System
Hari Shankar R L, Team DeSpaceInvaders

RadMag development for the RADCUBE mission
Balázs Zábori, Centre for Energy Research, HAS

Optical spectroscopy for high school and university students
Daniele Buongiorno, URDF - Università degli Studi di Udine

Space Education in Nigeria, Why there's more to be done
Chucks Okoroafor, Federal University of Technology, Owerri

12:15–13:00 Lunch break

13:00–15:15 Section of Science and Technology II/C,
Education/Outreach I/B *(in Hungarian)*
Invited talk: How Space is Shaping our World
Lluc Diaz, Technology Transfer Office, ESA

Inspiring space enthusiast students and young professionals
István Arnócz, Space Generation Advisory Council

Space research and mini-satellites in secondary high school
Mária Pető, Székely Mikó High School, St. Goerge

About Space Weather in High Schools
Annamária Komáromi, Eötvös Loránd University

Funding opportunities of the EUROPLANET 2020
Melinda Dósa, Wigner Research Centre for Phyiscs, HAS

„Csillagszekér" Planetarium in education - experiences
Attila Szing, Stratolab Kft.

ESERO HUNGARY, the Hungarian Education Office of ESA
László Veress, Orion Space Generation Foundation

15:05-15:15 Closing remarks
Kálmán Kovács, Director of Federated Innovation and Knowledge Centre, BME

15:30-19:00 SpacePaprika Workshop
Students and Young Professionals Workshop (Invitation only, in Hungarian)

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KEYNOTE

Space Eco-System Investment: Shaping the Future of the Space Economy

Amnon Ginati
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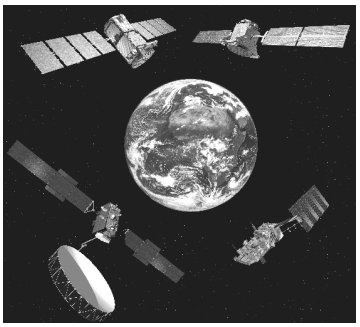
Senior Advisor
Directorate of Telecommunications & Integrated Applications (D/TIA)
European Space Agency



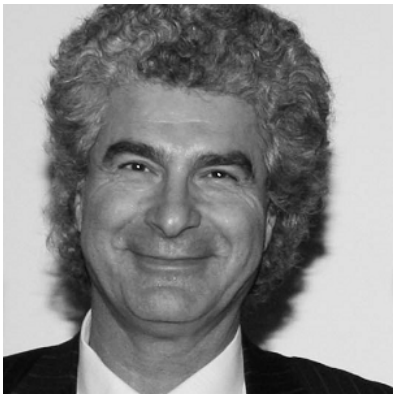
The increasing complexity of modern society, the globalisation of the economy, the increasing pressure on natural resources, the degradation of the environment and maintaining the security of citizens are significant challenges facing governments and political decision-makers. To meet these challenges, timely access to high quality and reliable information and communication channels is of strategic importance to European governments, citizens and companies. Individual space technologies (Earth observation, satellite navigation, satellite telecommunications, and human spaceflight technologies), alone or in combination with terrestrial systems, play a major and sometimes unique role in providing solutions.

The potential of satellite-based systems is under-utilised. The new ESA ARTES programme approach is able to embrace a wide range of new applications. It starts from a set of user/customer's needs rather than a particular technology solution. It develops sustainable application or services, it combines all relevant, existing space and terrestrial assets, necessary to build the right response; in short: ESA ARTES, "One Stop Shop" integrated applications and services. The current estimate of the potential market involve satellite-based services is around 50 times greater than the cost associated with the development of the satellite infrastructure.

The benefits to society are numerous. To name a few, integrated services are of importance to disaster assessment and management, all forms of transport including those on the open seas and safety policies; also to health services (particularly early-warning and epidemiology intelligence). Encompassing de facto the idea of "Space for Daily Life".

The commercial successful and diverse applications facilitate novel and innovative solutions that previously were unimaginable. This clear commercial success already attracted a rainbow of various investors. The presentation will describe the background, the methodology and the results how the investment in space eco-system helps to shape the future of space economy.

Short Biography



Prof Ginati was one of the initiators and the programme manager of the TUBSAT (Technical University Berlin SATellites) programme. He joined OHB-System, Germany in 1990 in a newly created position as Head of Satellite Department with the objective to develop new satellites and launchers programmes. He concluded these challenging and successful 10 years as a Director of Advanced Systems, Satellites & Probes in the company.
In 2000 he joined the European Space Agency (ESA) as Head of the Earth Observation Future Programmes Department, preparing the EOEP (Earth Observation Envelope Programme), Meteorology and Copernicus (GMES) Programmes.
Thereafter he was special adviser to ESA Director General, Head of the Inter Directorate Taskforce, responsible for the initiation of the Integrated Applications Promotion (IAP) programme. Until February 2016 he was Head of the Integrated & Telecommunications Related Applications Department initiating also user/app driven programmes (e.g. SAT-AIS, RPAS, etc) in partnership with EMSA.
Prof. Ginati established a new culture of leveraging private and institutional investment in ESA space programmes. He is currently Senior Advisor for the Directorate of Telecommunications and Integrated Applications.

Performing Chemistry in Space, Industrial and Academic Aspects: Challenges and Recent Progress

Ferenc Darvas*, Dorottya Milánkovich
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ThalesNano, Hungary

After a short introduction of the topics (Why chemistry in the space? How flow chemistry may help in overcoming issues from microgravity?), the presentation will focus on the recent practical and scientific developments of the SpaceFlow Consortium, first of all by summarizing the results of the Hungarian participants of the otherwise more than 30 membered consortium in five continents.

Concepts and results of two NASA-inspired projects dealing with nanoformulation of active ingredients and catalyst optimization are summarized together with progress of developing flow chemistry reactors for utilization under microgravity environment. As recognition to the high importance of the field, the largest global chemical society, ACS with members over 150,000 is organizing the world-first scientific symposium on space chemistry with substantial contributions from the management and scientific contributors of the SpaceFlow project (including its Hungarian members), as it will be reviewed. The lecture is dealing with a detailed analysis of the scientific perspective of space chemistry surveying also recent interest for monetarization from US investment communities.

Keywords:
Space Chemistry, flow chemistry, SpaceFlow Project, American Chemical Society, Flow Chemistry Society, NASA, hydroponic culture, CO2 reconversion, hydrogen technology

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* corresponding author

Short Biography

Dr. Darvas acquired his degrees in medical chemistry, then in computer sciences, furthermore PhD for the use of artificial intelligence in drug design. Dr. Darvas is a serial inventor and entrepreneur, including inventions in process intensification through developing both combinatorial approaches and continuous-flow procedures. He was a pioneer in the field of molecular modeling (QSAR) and the use of chemometrics. He conceived the first industrialized solution-phase combinatorial synthesis technology (CMT), and initiated and co-developed H-Cube®, the #1 selling flow reactor in the world. For the development of H-Cube®, ThalesNano received a prestigious 100's award of the R&D Magazine, and the Innovation award in Hungary, amongst many others.

Dr. Darvas, as president of the Flow Chemistry Society in Switzerland, initiated the SpaceFlow Project, for bringing chemical experimentations and production to the space, together with 30 prestigious academic and industrial partners from 5 continents in 2014.

He is the founder and president of Darholding, Inc., one of the largest upstream technology networks in the CEE region. Exports to over 70 countries, affiliates/firms/spinoffs in USA, UK, IR, with a track record since 1983. The network was listed among the 500 largest firms in Hungary (2011). Invested and founded/co-founded high-tech corporations in the UK, like Thalesnano UK, Nuformix, Nanoform, ComZat, this latter for space chemistry.

He is serving as associate professor at Florida International University, Miami, after teaching at the University of Florida (Gainesville), in Austria, Spain and in Hungary, at altogether 8 universities.

How Space is Shaping our World

Lluc Diaz
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Technology Transfer Program Office, European Space Agency

The impact of Space in our life is increasing day after day. Hardware, software, telecommunications capacity, earth observation images and positioning systems, they are all assets that enable and incredible amount of products and applications that make our life better on Earth. The role of the Technology Transfer and Business Incubation Office of ESA is to facilitate the access to all theses assets and technologies to entrepreneurs, start-ups and established companies.

Short Biography

Lluc Diaz is currently coordinating the Technology Transfer Network of ESA and he is based in ESTEC (Netherlands) and Chair of the Innovation and Technology Transfer Group of the EIROforum organization. Lluc holds a degree in Telecommunications from the UPC (Polytechnic University of Catalonia), where he specialised in Business and Telecommunications Policy. He also studied an Intellectual Property Strategy Program at Harvard Business School.

He started his career in the private sector working as Project Manager at Abertis Telecom (Spain). After this experience in the telecommunications sector, Lluc started working in Technology Transfer in Knowledge Innovation Market Barcelona (KIM). In KIM, after a short period as Project Manager he took the position of Corporate Development Directo. During 6 years he was responsible for the growth of the KIM model at a national and international level, with presence in the U.S., Europe, Asia and Latin America. His responsibilities in the management of several of the group subsidiaries have given him valuable experiences in innovation and management of the value chain of technology transfer, ranging from the evaluation and enhancement of knowledge, commercialization of intellectual property, public and private financing of projects and business creation and entrepreneurship, to business growth.

Lluc was Member of the Board at KIM Uruguay (Montevideo) between 2011 and 2014 and was Managing Director of Technology Reserve in Spain before joining ESA.

Section of Science and Technology

The Alphasat Scientific Experiment: Propagation Measurements and Statistics in the Ka/Q Band

Bernard Adjei-Frimpong*, László Csurgai-Horváth
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The increasing demand for bandwidth in radio communication in both terrestrial and satellite domain is becoming a serious challenge. This demand can be met by moving the communication channels to a higher frequency band. The Ku band is already exhausting its capacity, and the higher Q band is fast becoming the preferred choice for satellite communication. Hence for both research and commercial purposes it is important to effectively explore the Q band. This high frequency band is subject to attenuation, depolarization and signal scintillation due to different atmospheric effects.

In 2013, the European Space Agency (ESA) launched the Alphasat communication satellite which also include four technological experiments. One of them is the Aldo Paraboni payload, supported by ESA in the framework of the ARTES 8 Telecom program and the Italian Space Agency (ASI). The Alphasat scientific experiment is transmitting coherent beacon signals at Ka-band (19.701 GHz) and Q-band (39.402 GHz). The Q band beacon covers the whole of Europe while the Ka-band beacon coverage additionally includes North Africa. This satellite supports Europe-wide experiments which investigate the atmospheric propagation effects occurring in the higher frequencies.

In view of this, BME-HVT has developed a ground station to help answer the basic questions that may arise when exploring the Ka/Q band. The station receives signal from the satellite to characterize the satellite-Earth propagation channel in the Ka/Q band. The beacon receiver station is operating since 2014, collecting signal power data, and additionally records relevant meteorological data as well.

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* corresponding author

This paper gives an overview of the design and the components of the receiver station at BME-HVT. It reports on the experimental activities which have been carried out so far and describes the planned long term measurements, where the measured propagation statistics will be related to meteorological data from the weather station. The received data is then analysed and the first and second order attenuation statistics are compared with appropriate ITU-R models. We provide yearly and annual time series as well to demonstrate the attenuation events mainly induced by rain.

Keywords:
Atmospheric propagation, Ka-band, Q-band, attenuation statistics, Alphasat

Reusable Launch Vehicle-Concept of Minimizing Space Transportation Cost

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The cost for accessing space exploration and space utilization is very high since the technologies have been developing day by day. We need to minimize the cost of space exploration and space utilization. Till now we are using non reusable launch vehicle to send payloads into the space which takes more cost. This paper give a idea to launch a Reusable Launch Vehicle (RLV) to send payloads to the space. RLV is a series of technology demonstration missions that have been considered as a first step towards realizing a Two Stage To Orbit (TSTO) fully re-usable vehicle. These technologies will be developed in phases through a series of experimental flights. The first in the series of experimental flights is the hypersonic flight experiment (HEX) followed by the landing experiment (LEX), return flight experiment (REX) and scramjet propulsion experiment (SPEX). If the mission success the cost of accessing space exploration and space utilization could be minimized.

Keywords:
Reusable Launch Vehicle, RLV, Minimizing Space Transportation Cost

Philae's landing and autonomous operation control on a comet – challenges, achievements and lessons learnt

A. Balázs*[1], A. Baksa[2], H. Bitterlich[3], I. Hernyes[1], O. Küchemann[5], Z. Pálos[1], J. Rustenbach[3], W. Schmidt[4], P. Spányi[1], J. Sulyán[2], S. Szalai[2], K. Szegő[1], P. Vizi[1], L. Várhalmi[1]

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The Rosetta-Philae mission was a cornerstone project of the European Space Agency (ESA). It was of Europe-wide significance in terms of technological and research organisation, and of worldwide significance in scientific and public outreach terms. Several short-term close observations have delivered valuable scientific data about other comets in recent years, typically via one-shot, high-speed fly-bys. The Rosetta-Philae mission was unique in many aspects, however, and has provided much more knowledge about comets than previous missions. After a ten-year journey across the Solar System and many complicated manoeuvres, the Rosetta spacecraft carrying the Philae lander and scientific mini-laboratory smoothly approached a small celestial body, comet CG/67P. Furthermore, the Rosetta spacecraft executed additional fine manoeuvres to fly a multitude of low and high altitude orbits around the comet, mapping its shape and surface in detail never seen before, and has continued to observe it for more than two years. The ballistic delivery of the Philae lander onto the surface of the comet 500 million km away from Earth was also a remarkable success. The Philae lander had also the complexity of a spacecraft; in addition to traditional and some Philae specific subsystems it was equipped with numerous scientific instruments that provided a wealth of new knowledge, including spectacular close-up images of

* corresponding author

the comet's surface. The success of the project was the result of dedicated teamwork of engineers, scientists and mission operators. The introductory section of this paper gives a brief overview of the objectives and highlights of the Rosetta-Philae mission. The Philae lander had to be designed for a high level of reliability. In the second half of the paper the major hardware and software design aspects, including the conceptual design and implementation of the central on-board computer (CDMS) of the Philae lander are outlined. The focus is on the implementation of fault tolerance, autonomous operation and operational flexibility by means of specific linked data structures and code execution mechanisms, an object oriented scheme for mission control and sequencing.

The Philae operations were partitioned into four major mission phases: Cruise, Separation-Descent-Landing, First Comet Science Sequences and Long Terms Science operations. The requirements for controlling descent, touchdown and follow-on operations of a robotic lander to be operated under harsh environmental conditions on a comet nucleus were extremely challenging. Finally, by addressing technical and scientific achievements and also some design and operational flaws a summary of "lessons learnt" is also provided.

Keywords:
critical embedded systems, fault tolerance, object oriented model for mission sequencing, operational flexibility

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Novel materials for aerospace hardware

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New age in field of space materials. With understanding the rules of atomic arrangments in solids the gate is now opened to develop new materials on base of computer modelling. This is an outstanding possibility to create new stable materials resisting elevated radiation environment used in future deep space missions. The project with title: Innovative Coarsening-resistant Alloys with enhanced Radiation tolerance and Ultra-fine grained Structure for aerospace application — (ICARUS) was selected in frame of HORIZON2020, FET-Open: Novel Ideas for Radically New Technologies, RIA. Among the 11 collaborating institution Miskolc University works on the fundamental modelling and research while ADMATIS Ltd has the task the long term aerospace application. The presentation gives an overview about the extreme challenges of the project.

Keywords:
nanocrystal, thermodynamical stability, long term property, radiation resistance

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Analyzing energy efficiency of sensor networks deployed on the surface of a Solar System Body

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Following the exploration of Moon, the next step could be the exploration of Mars, since many man-made devices already sent measurement results from our closest planet. There is an interesting tendency that the private funding space researches are becoming more and more substantial next to state sponsored space programs. In the process of mapping a distant planet, cost efficiency is high priority since the available resources are limited. A cost efficient method is using sensor networks to explore, which can be done on a lower budget compared to "single-probe" missions [1].

Human intervention is often not possible due to the great distances. Therefore, the usage of sensor networks can partly be a solution to the arising problems, since losing connection with the home base on Earth does hinder the measurements [2]. Another advantage is that the failure of a device does not put the mission at jeopardy [3].

In our work, we assumed such a sensor network, which we examined from different point of view. Real Martian topographical data was used to create a Digital Elevation Model on which we studied different sensor movement algorithms. We analyzed the communication between sensors from the energy-efficiency aspect and we established an energy model to estimate the resource consumption of the sensors.

A simulation program has been developed to examine our sensor network. In this simulation, we compared the efficiency of the algorithms and we investigated how the energy level of the sensors affect the time required to cover the measurement area.

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Keywords:
space exploration, sensors, energy efficiency

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Comparative analysis of tropospheric delay models using reference data derived from ray tracing

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Electromagnetic signals broadcast by GNSS satellites suffer considerable delays while travelling through the atmosphere. Apart from the ionosphere, the troposphere also has a significant effect on the propagation. The delay caused can be separated into two different parts: the effect of gases in hydrostatic equilibrium and the effect of water vapour and condensed water present in the troposphere. According to this distinction, we can talk about tropospheric hydrostatic and wet delay. The amount of these delays depend on the meteorological parameters of the troposphere (temperature, air pressure, relative water vapour pressure etc.), but also on the elevation angle, under which the satellites can be observed. As the elevation angle decreases, the path of propagation becomes longer and therefore the signals suffer larger delays.

There are numerous models for calculating the tropospheric delays, however, these models deviate quite significantly from each other, either in the meteorological parameters used during the calculation or whether they take into account the periodic perturbation of said parameters. Moreover, even when using merely one model, we can differentiate between so called blind mode, which means using the models own dataset, or site mode, where we can determine the values of the meteorological parameters using in situ measurements in the field.

In order to carry out the comparative analysis of the models', we needed to possess some kind of reference data. To create this dataset for our study, we employed a ray tracing algorithm coupled with meteorological data from numerical weather models at a number of different elevation angles. Using this data, we could calculate statistical parameters to substantiate the accuracy of each model.

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In the study, we analysed various models in use, such as the RTCA MOPS tropospheric delay model, ESA's model created to be used in the GALILEO system, the GPT2 and the GPT2w, which were developed at the Vienna University of Technology.

In our poster presentation, we exhibit our results and the possible future uses of the data for the integrity analysis of the delay models.

Keywords:
GNSS, troposphere, ESA, RTCA MOPS, GPT2, GPT2w, blind mode, site mode, delay, hydrostatic delay, wet delay, numerical weather models, meteorology, ray tracing

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HABIT – instrument on ExoMars rover to detect microscopic liquid water

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There is an ongoing debate on the possible existence of microscopic liquid water on Mars today. Based on the current general dryness, bulk microscopic liquid water is not expected on Mars, however there are two possibilities for the emergence of liquid at microscopic scale. One possibility is connected to the low temperature salty brines, and the conditions required for this exist based on the observations of Curiosity rover [1]. Another possibility is the low temperature water ice in physical contact with mineral surfaces, were so called interfacial liquid water might be present [2]. For the confirmation of the first possibility the HABIT instrument was made at the Lulea University of Technology with the lead of Javier Martin Torres, where the author and its Hungarian institute is a collaborating-investigator.

The HABIT instrument will be located on the landing platform of the ESA-IKI ExoMars 2018 mission. The instruments installed on this platform will stay as a static station at the landing site, provide context imaging of the site and monitor climatic and atmospheric changes for at least one Martian year. The HABIT is an acronym for the "Habitability, Brine Irradiation and Temperature" name and it aims the complex analysis of the current habitability related parameters of the Martian surface regarding the available liquid water, temperature and UV radiation. Beside these aims, it also tests in-situ resource utilization (ISRU) method to gain liquid water on Mars for future manned missions.

HABIT has two main units: 1. BOTTLE (Brine Observation Transition to Liquid Experiment) that consists 6 bottles of 9 cm^3 volume covered with HEPA filter. Inside the bottles salts (magnesium, sodium and calcium perchlorates, and sodium chloride) were put there on the Earth which have physical contact with the Martian atmosphere and trap the water vapour from there. Under proper conditions it produces deliquescence (e.g. emerge of microscopic liquid on the surface of these salts crystals), that could be identified by the change of the conductivity, recorded by three

sensors at different depth in the small vessels filled with salts. The process could produce 5 millilitre/day liquid, altogether possibly up to 50 litre liquid might be recirculated by these bottles from the atmosphere in a Martian year. 2. ENVPACK (Environmental Package) is to monitor UV radiation, surface and atmospheric temperature in three directions (using the heritage from REMS instrument onboard Curiosity rover).

The aim of the HABIT instrument besides to better constrain the potential habitability is the monitoring of regolith-atmosphere volatile exchange, the dust settling from the atmosphere, atmospheric convection, ozone concentration and demonstrating how ISRU technology could extract H_2O from the Martian atmosphere. The Hungarian contribution is the modelling based forecast of ideal periods for the deliquescence, correlation of meteorological data with brine formation, correlation of HABIT based results with the drill based material analysis of the ExoMars rover (supported by COOP-NN-116927, NKFIH fund), and provide infrared spectroscopic reference data of hydration of certain salts.

Keywords:
planetary missions, Mars, ExoMars rover, HABIT instrument, astrobiology.

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Analyzing the Quantum Efficiency in Satellite-based Quantum Key Distribution Network

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In the last years, there were several proofs about the feasibility of the satellite-based quantum communications [1]. Nowadays, the satellite-based quantum communication is getting closer to be applied in our everyday life [2]. A typical case of space-based quantum data transmission is basically composed of a satellite, a ground station (or optionally another satellite). The receiver object needs to have a detector to detect and measure the signal [3]. All of the analyzed quantum key distribution (QKD) protocols, including BB82, B92, S09, Gisin take into account the efficiency of the detector to determine the Quantum Bit Error Rate (QBER) of the protocol. That means one of the most important performance property is the quantum efficiency in a quantum-based satellite network. In this paper, our primary goal is to analyze and evaluate the influences of the quantum efficiency of the detector.

Previously, we developed the Quantum Satellite Communication Simulator software directly to execute simulation scenarios in satellite-based quantum communication applications [4]. It provides opportunity to execute evaluations in the following scenarios: calculation by constant parameters, sensitivity analysis, time driven communication, optimization and channel analysis. In the latest development phase we focused on the opportunities of the detailed examination of the detector properties and as a result we performed several simulations to analyze the efficiency of the detector. In summary, depending on the QKD protocol the efficiency of the detector is as important factor as the link transmittance or the mean photon number of the signal is.

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Keywords:
quantum communications, satellites communications, quantum efficiency

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Follow-up psychological status monitoring of the crew members of Concordia research station at Antarctica based on speech

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In this study an automatic prediction method is presented which can predict the severity of the depression of the examined person based on the speech signal.

Several researchers work and live at the Concordia research station, which is located in Antarctica. The aim of our project, titled the "Psychological Status Monitoring by Computerised Analysis of Language phenomena (COALA-Phonetics), is to monitor the psychological status of the researchers at the Concordia research station, especially to detect depression based on speech. Speech samples were collected from each crew member once a week. Two type of tasks were recorded: a short voice diary and reading out loud the standard phonetically balanced folk tale. Less frequent intervals, each crew member filled out a subjective psychological test.

In normal atmospheric conditions speech data were collected from depressed patients and healthy subjects as well, and this reference database was used to train the automatic prediction system. To measure the severity of depression Beck depression inventory II (BDI-II) [1] was used, and each sample were labeled with this value. Our earlier results proofed that automatic classification of depressed state can be carried out [2]. In this study we intended to create a method which can make an automatic prediction of the severity of depression based on speech signal.

Those acoustic-phonetic parameters were selected and measured which values correlate with the value of the BDI-II index based on the reference database, and thus which describe the severity of depression well. Support Vector Regression (SVR) method [3] was used for the automatic prediction method. The severity of

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depression of each record of each crew member of the Concordia research station was predicted using this automatic prediction method, and thus we got the severity of depression for each crew member over time as a function. The analysis of these time-depression functions were carried out and were compared with the results of the subjective psychological tests. We had two hypotheses: at the beginning, the predicted depression value for each crew member will be low (because at the start of the experiment they were healthy) and the highest predicted value will be measured around the middle of the winter at Antarctica.

Keywords:
depression, SVR, speech, follow-up status monitoring

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Plasmaspheric density measurements based on guided VLF wave propagation

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We outline the state of the art of using the detection of naturally occurring guided whistler waves for electron density measurements in the plasmasphere that surrounds the Earth. Subseqently we demonstrate a novel method of using specific VLF transmitter signals, also exhibiting guided propagation, to perform similar density measurements. In 2016 we carried out a satellite-based measurement campaign to demonstrate and calibrate this method, we summarize the results of this campaign. We also investigate the possibility of carrying out the same measurement and analysis at a future ground-based VLF receiver station, to ensure a more steady stream of data.

Keywords:
plasma, plasmasphere, electron density, VLF propagation

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An analysis of entanglened-based solutions on Earth-satellite channel

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The development of quantum computers effects several fields of the current information technology [1]. In digital communication, the data encryption and the distribution of keys used for the encryption rely on computationally secure cryptosystems, which means that cracking the encryption with current technology would take astronomical time. With the arrival of quantum computers, this security will not be enough, the current cryptosystems will be breakable in short time with existing quantum algorithms (e.g., Shor's algorithm).

Using quantum key distribution (QKD) [1], which is probably the most advanced practical branch of quantum communication, two communicating parties can establish a secret cryptographic key. Since the security is based on the fundamental properties of quantum mechanics, in principle information-theoretic security can be achieved. The secret key, established with QKD can be used to encrypt further classical communication to provide information-theoretically secure encryption and a mobile QKD network could deliver an unparalleled level of security to wireless users.

Although commercial applications of QKD technology are already available, currently direct QKD links on the ground cannot reach distances beyond a few hundred kilometers due to optical losses [2]. With quantum repeaters long-distance QKD networks may be feasible, but such devices are not ready for operational integration yet [3]. Alternatively, satellites could be used as relays to provide a global free-space QKD network [4].

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We started to analyze the properties of the Earth-satellite quantum communication by simulating a global, satellite based quantum key distribution network. We examined the current state-of-art of quantum key distribution and free-space quantum communications. We have proposed an entanglement-based QKD satellite network using mirrors to increase the coverage. For this network, we have calculated the maximum distance allowed between the satellites to minimize the atmospheric distortion of the transferred quantum states. Simulations were made to determine the rotation of the basis states which has to be corrected by the ground stations for the received photons.

The research was supported by the Hungarian Scientific Research Fund – OTKA PD-112529.

Keywords:
entanglement, quantum-based communications, satellite communications

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Developing a VLF transmitter for LEO satellites: Probing Of Plasmasphere and RADiation Belts

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Recent advances in the monitoring of the plasmasphere (e.g. the PLASMON FP7-Space project,http://plasmon.elte.hu, [1] makes the continuous monitoring of the plasma-sphere possible. But this monitoring capability totally depends on natural and sporadic phenomena, preventing systematic monitoring required for operational Space Weather models and forecasts. The limiting factor in the physics-based models of the radiation belts is not due to inadequacies of the model but rather due to the quality and availability of inputs and drivers.

To overcome of this bottleneck, we proposed a project to develop a VLF transmitter for polar orbiting LEO satellites for a) systematic probing of the plasmasphere by transmitting impulses in the range of 1-10kHz that are powerful enough to reach the other hemisphere propagating along the magnetic field lines; b) systematic probing of energetic electron populations by generating frequency steps in the range of 1-10kHz by pitch-angle scattering the counter-streaming electrons and precipitate them; c) systematic probing of the

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ionosphere using the impulses propagating downward that can be used to increase the accuracy of GNSS systems.

The proposal intends to complete the development with a successful launch of the instrument as payload on satellite(s). During the operation of such a satellite, the transmitted impulses is planned to received by the global, ground based Automatic Whistler Detector and Analyzer Network (AWDANet [2]) to obtain the electron densities along the propagation paths of the impulses. The precipitated energetic electrons are planned to be measured by the very same or by the SEM/MEPED instruments on polar orbiting satellites.

Keywords:
VLF transmitter, plasmapshere, radiation belts, LEO satellite, GNSS

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Introducing E-GNSS navigation in the Hungarian Airspace: the BEYOND experience and the relevance of GNSS monitoring and vulnerabilities

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The use of GNSS solutions and the satellite based augmentation system, EGNOS, the European Geostationary Navigation Overlay Service, can provide a cost-efficient alternative to instrument landing systems at airports. Until the year of 2016, the market uptake of E-GNSS navigation solutions in the Hungarian airspace was hindered by a lack of the relevant approach procedures. It was with the aim of filling this gap that the European H2020 framework of project, BEYOND, managed by the European GNSS Agency (GSA) and led by the European Satellites Service Provider (ESSP) was launched.

The overall project concept of BEYOND lies in developing capacity building in the field of multimodal applications, especially focused on aviation, and based on E-GNSS (EGNOS and Galileo) in different Eastern European and Euro-Mediterranean countries.

In aviation specifically the transfer of knowledge has been consolidated through a four stepped methodology (trainings, guided exercises, technical workshops, flight trials) applied within six key knowledge domains (Performance Based Navigation, Safety, Procedure Design, GNSS Monitoring and Ground Validation, Flight Validation and Future GNSS scenarios). With the help of this process, a PBN implementation plan has been developed; and having carried out the relevant cost benefit analyses, a regional airport, Debrecen, has been selected as the candidate of the procedure design and flight validations tasks. During spring 2016,

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LPV approaches were designed for Debrecen, which then were also flight validated in the summer.

The project also included GNSS Monitoring exercises, where the performance (accuracy, continuity, availability, integrity) parameters of EGNOS coverage were investigated. This issue is particularly interesting in Eastern Europe, within the boundary zone of available EGNOS corrections. The article presents how the data collected by permanent GNSS stations can be used to calculate SBAS corrections, and how these corrections enhance the efficiency of GNSS bases navigation. Apart from and inspired by the obligatory tasks within the project, the research team conducted extra investigations and measurements as well. Coverage parameters in the Debrecen area were investigated, and the vulnerability of the system was tested by interference monitoring. The paper presents the results of these investigations which do not only show that Debrecen is located in a well performing EGNOS area, but also highlight and measure the vulnerability that GPS jammers may pose to GNSS solutions. The authors also venture to examine the potentially achievable efficiency of the future Galileo solutions.

Keywords:
GNSS, EGNOS, Galileo, air navigation, procedure design, flight validation,

Probing and Analyzing Triple Asteroid System (PATAs)

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Asteroids are often considered primitive objects left relatively unchanged since the formation of the solar system. A unique source of information about the early solar system, the formation of the planets, and the connection between stars and our Sun, are meteorites and asteroids. The idea of exploiting the natural resources of asteroids dates back over a hundred years, but only now has the technology become available to make this idea a reality. To uncover more details about asteroids, we need to analyze the size, mineralogy, shape and geochemistry. Earlier few missions were send to asteroids to take images and to study its surface.

The data we got from those missions helped us to know few characteristics of asteroid but not to depth. To know more detail we need asteroid sample it can help to study in depth about formation of planets and it can reveal many unknown secrets. So, we targeted Triple Asteroid System Asteroid 2001 SN-263. We planned to perform Asteroid mission in two phase. Our first phase is to send an orbiter to Asteroids and to collect asteroid sample and return back to earth successfully. Second phase is kind of mining the asteroid and use it for future space exploration and it can help in built space habitat. This missions can help in deflecting impactor asteroids.

Keywords:
NEA, Orbiter, Human exploration

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Hexavalent Chromium Free Coatings for Satellite Metallic Hardware's

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Considering aviation and space sectors, aluminium alloys are the major manufacturing materials due to its excellent mechanical and physical properties. In general, satellite hardware's will be confined to controlled environment. However, it requires a highly protective anticorrosive treatment followed by a systematic coating scheme (Primers and paints). Hexavalent chromium based chromate conversion coating is the most traditional method for protecting surface of aluminium alloys from corrosion. Due to the toxic and carcinogenic nature of hex chrome it has been prohibited by various directives from European Union [1]. European Space Agency (ESA) itself faces stringent regulations from Registration, Evaluation, Authorisation and Restriction of Chemical substances (REACH) and the Restriction of Hazardous Substance Directive (RoHS) that have set a mid-2017 as sunset date for hex chrome hardware's.

So this research work will address an environmentally friendly, cost efficient and performance oriented trivalent chromate conversion coating. In addition to this, it also details an inevitable procedure to evaluate any coating technique under a set of predefined space qualification test series before its application. Since material in space will be exposed to various radiations, temperature variations and high vacuum [2].

The overall objective of this innovative work by Matmod Limited under supervision of ESA is to test trivalent chromate coating system that includes pre-treatments, pre-treatments with primer and topcoat over aluminium alloy form various series is suitable for replacing hexavalent chromium coating in space industrial application [3].

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Keywords:
Chromate Conversion Coating, Trivalent Chromium, Space Qualification and Acceptance Test.

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High speed integrated space streaming swarms as mission concepts

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Recent technologies allegedly promise fast speed space devices - probes - accelerated by a launch base until to some percent of the speed of light. Some new reports talk about big plans to reach really distant targets [1]. Several hard challenges are standing before those plans and let we try to show some of them.

Author's earlier works described the Nano, Pico Space Devices and Robots (NPSDR) and the fleet of Micro Sized Space-Motherships (MSSM) [2] which type or similar devices maybe can fulfil the requirements incidentally.

Let we show some trouble affecting a swarm and elements in case of high speed:
- How can we accelerating up to order of magnitude of speed of light?
- How can brake down the probes from the speed of light? Nohow. Is any solution to use them without decelerating (see below)?
- Relativistic communications – According to different rates of Doppler effects new telecommunication systems needed.
- Can we measure any characteristic at the target for example outgassing, magnetic fields and spectrums?
- Extreme radiation affects the devices etc…
Let we look some advantageous solutions if we assume that they are feasible.

In case of big abundances of elements of the swarm we can command a special part of the swarm to do a specific job inside a space interval. Let we divide the space into sectors near the target – a moon, planet or star. Particular space intervals demand definite activities. One classical probe is orbiting the target and makes measurements in circulating orbit. A high speed streaming swarm couldn't orbit the target, but we can command the part of them at just the target area to make the same measurements at the same position where classical probe made. Behaviour of the prepared elements of the flowing swarm are turning into the position dependent program branch and collecting the data. When the

element leaves the position turning the behavior to the next program branch, makes new measures and finally transmit all the collected data to a relay transmitter.

Conclusion: Special philosophy is necessary to choose the HW and SW plans depending on the abundant enough or restricted availability of resources. In case of smarter but more expensive elements measuring and transmitting can be turned really efficient. The redundancy is coming from the large amount of abundance. In case of a realistic streaming swarm mission a weighted distribution of tasks necessary to elaborate during developing and the whole fleet necessary to behave like one big organisation as one big integrated space system.

Keywords:
mission concept swarm fleet system

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Simulated Mars Rover Model Competition - More than a decade as a research area

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Competition is the base of the evolution. Possibilities are increasing in the field of space research and industry according to evolution of the industrial progression worldwide both in science and in the available technology. New demonstration and standardized methods can arise virtually from nothing, but the background of the new successful solutions is the several independent attempts. A serial of competition is a proper field and can speed up this process together with competitors from many educational centers and can proof the students and young experts in one time. Results can be realized as mission concepts in integrated space systems when solutions are emerging from serials of tasks during year by year of the contest.

The Competition of Applied Engineering Sciences, working name is Magyarok a Marson (Hungarians on Mars) is in process more than a decade. Founder of the contest is Attila Sipos. We presented our previous works (Sipos, Vizi 2009-2015) [1,2,3,4,5,6] at the 40th-47th LPSC and at several conferences in Hungary, e.g. at H-SPACE 2016 where we described shortly the ten years of the Competition [7].

Missions completed during years from the simple classical 'one device per mission to fulfill one task' to the 'high reliable swarm and fleet of micro robots to accomplish a complex job from different manufacturers' solutions.

Certifiable result of our research is: The reliability to fulfill a mission is considerable better when we deploying different manufacturers parallel for one task. This method is applicable during demonstration missions. The best results of a successful mission can be standardized for the future.

* corresponding author

Why don't we use immediately standardized methods? The answer is mainly come from the worldwide evolution when new reliable solutions sometime are already excellent to implement into space missions but the skills are emerging from work of recently educated engineers and researchers, because they can use and implement technology of nowadays bravely and successfully.

The task of the 2016 year was a blind remote and self-controlled contest to reach several places, to position a small target in different highs, to take a sensing/measuring process, to compete others by catching high score targets form each other. It was similar to a job to clean up a contaminated target field only from dangerous pieces of space debris repeatedly as the frame story described.

The tasks for the 2017 year will a blind remote and self controlled contest to deploy ball shaped, meteor like small robots, to reach several different high positions to make several tricks.

Keywords:
evolution competition space model engineering education

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SATCOM developments for ESA

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In this paper, the author describes the main results of two developments. The first is an S-band, cost effective, spectral and power efficient, fully configurable telemetry/data transmitter, which can be used in small-sat missions as off-the-shelf, satellite platform subsystem. The second is a wideband RF module which is part of the novel digital receivers used in ESA EDTE network.

In the frame of an ESA PECS project BHE developed the BUMT25, onboard, SDR-based, spectral and power efficient S-band Telemetry and Data Transmitter for future European Small Satellites. The project was successfully completed in December 2015. In order to provide the best possible link parameters, carefully selected combination of modulations, codings, power amplifications were chosen. As a result, the TM transmitter provides extremely clean and very compact output spectra. The BPSK, QPSK, OQPSK, SOQPSK, PCM/FM modulations and codings are realized by SDR technology, implemented in a single FPGA. The employed algorithms provide constant amplitude modulations with programmable data rates between 9.6 Kbit/s and 20 Mbit/s, amplified by an S-band, high PAE Class-F GaN amplifier without any spectral distortion. In the S-band satellite TM frequencies 80% power efficiency has been achieved. The output power is programmable up to 5W in four different power steps. In order to keep the Class-F amplifier in the optimum efficiency range at all times, adaptive drain supply voltage is used. The transmitter is connected to the OBC through Space Wire, MIL-1553 or CAN interface, in compliance with the ESA ECSS-E-ST-50C standard. The developed technology has been tested in space with excellent results, which will be introduced.

In 2016 BHE developed the BLLC14 wide band RF module to be used in the EDTE digital receiver made by Celestia. These novel receivers are installed at the ESA Deep Space ground stations. As first test of the system, Sentinel-1 images were received by the EDTE ground stations through an EDRS satellite. Today the system is in daily use in EDRS and ExoMars 2016 projects.

Keywords: SATCOM, TT&C, Ground Stations, Onboard Communication

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RadMag development for the RADCUBE mission

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The research on space weather and its effects will be more and more important in the near future, as a continuous increase in human presence is in progress in the Near-Earth region and the technology dependency of the human civilization has become higher than ever mainly in the fields of energy and telecommunication systems. To study space weather and to protect our technology, as a first step, it is necessary to develop and establish an advanced monitoring system to provide scientific data about the cosmic ray intensity and the status of the magnetosphere in order to gain the possibility for a reliable forecast database.

Thus development of a new cosmic ray instrument package got under way at the Centre for Energy Research, Hungarian Academy of Sciences based on silicon detector technology, called RadMag. By having a compact design realized following CubeSat standards, the monitoring of the cosmic radiation and magnetic field environment will be possible with sufficient statistics in the Near-Earth region on-board a fleet of CubeSats. Additionally the RadMag instrument to be developed can provide a low-cost alternative for supporting radiation damage estimations commercially for future satellite missions as well [1].

The major goal of the mission and the instrument development is to fulfil needs of the European Space Agency (ESA) SSA (Space Situational Awareness) programme space weather product in order to provide long term (up to three years) service capability.

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The RadMag development and the RADCUBE mission are almost at the end of the mission objectives and preliminary requirements definition stage and soon they will be moved into the implementation phase with the preliminary design definition and with some breadboard testing activities in order to verify the instrument functionalities. Additionally, a high level of effort is given to provide a boom system for the satellite in order to maximize the scientific output of the magnetic field measurements, as changes in the geomagnetic field play a key role in space weather processes. The present paper provides a short overview about the development status of the RadMag instrument package for the RADCUBE mission and a quick overview about the status of the RADCUBE mission itself.

The RADCUBE mission and the RadMag development are realised in the frame of the ESA GSTP (General Support Technology Programme) 6.3 programme.

Keywords:
space weather, cosmic rays, CubeSat, RadMag, RADCUBE

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Section of Education and Outreach

Inspiring space enthusiast students and young professionals

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Nowadays people's lifestyle has accelerated and it is not an easy task to inspire the students and young professionals, compete with distractions from the internet and make extra courses. Fortunately, space and space research is still a mysterious topic for the public. It provides wild range of new and exciting knowledge for curious minds. In addition, hopefully, the space industry is developing gradually and it will continue in the next years and decades, therefore, it will need qualified experts and engineers. The UN-established Space Generation Advisory Council (SGAC) provides opportunity for university students and young professionals between age of 18 and 35 years to expand their knowledge of international space policy issues and space research, build relationships and think creatively about the future [1]. SGAC Hungary in collaboration with the Hungarian Astronautical Society would like to foster Hungarian youth to take part in the process and share the knowledge and experience with the enthusiast young generation. In Hungary, they organize several events during the year for their audience. The goal of these programs is to develop and maintain a platform for the young generation in our country and give them the chance to learn more about space research and economy. Here they can connect with space experts and entities, share ideas and get involved in the national and international space sector. Based on our four years of experience, lessons learned will be discussed in our presentation.

Keywords:
space generation, outreach, dissemination, students and young professionals

References:
Website of SGAC: http://www.spacegeneration.org

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Optical spectroscopy for high school and university students

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Optical spectroscopy is one of the fundamental analysis techniques used in physics research, in particular in astrophysics. The analysis of the spectral features is the only way to derive information about elemental composition, temperatures, distances and relative motions of stars and galaxies, since light is the fundamental carrier of astronomical information. Not surprisingly, the nature of light, its interactions with matter and optical spectroscopy are the central topics common to introductory astronomy courses [1]. Several studies [1, 2] show that introductory astronomy college students have a general understanding about the utility of optical spectra, but they show a variety of misconceptions in their interpretation, in particular as concern the nature and causes of emission and absorption line spectra.

From a general point of view, optical spectroscopy allows to obtain information about micro and macro-world, it makes use of the energy conservation principle in order to describe atomic systems in terms of energy states and transitions and it represents a conceptual bridge between classical and modern physics. Its importance on disciplinary, cultural and social plans is universally recognized, but there a lack in didactical tradition dealing with this specific topic.

On the basis of a limited, but significant, literature concerning secondary-school and university students' ways of interpreting atomic spectra [3, 4, 5] we designed a study in wich interpretative issues concerning the analysis of simple atomic spectra are submitted to a group of secondary school students and a group of university students during a lab activity. Tutorials and post-tests were used in order to monitor students' reasonings concerning the interpretation of spectra and the role of the various elements in the experimental setup.

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* corresponding author

Here we report some results concerning students' reasonings and interpretative models, that could help the design of educational activities related to space, astronomy and astrophysics.

Keywords:
optical spectroscopy, education

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Inclusiveness - Europlanet program for supporting Eastern European space research

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The Europlanet 2020 Research Infrastructure project to integrate and support planetary science activities across Europe was launched in 2015 and will last at least until August 2019. The main objective of the project is to bring together European solar system research groups and institutions and counter the fragmentation that still exists in the European planetary science community. Among others, open access databases are being established, grants are given to visit laboratories and institutions. The program has 33 beneficiary institutions including Wigner Research Centre and two partner institutions: Thales Alenia and Eurospace.

It is also an objective to integrate scientists from countries that are underrepresented in European research – Hungary belonging to them. These countries are called Inclusiveness States. A new Information and Integration Centre is established with the aim to help the management of Inclusiveness states and groups and inform them of all the possibilities offered by Europlanet. The Centre aims to work multilateraly and asks all inclusiveness institutions to help with experience and ideas concerning integration. Available funds and other possibilities will be presented.

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About Space Weather in High Schools

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Besides earth weather, the relatively new concept of space weather [1] is increasingly discussed in 21st century schools. This is expected, because it has been proven that space weather influences our everyday life. For example, space weather can affect the electronic systems on satellites or on any spacecraft, thus, indirectly, our activities, as well, because information provided by these satellites are getting connected with a growing portion of our life.

Therefore, besides physical knowledge about satellites, secondary teaching of physics should include the clarification of space weather concepts. We need to discuss with students the exact meaning of space weather, what factors form a possibly adverse space weather. We need to show the difference between solar storm and space storm. Of course, first we need to introduce students to the various solar activities. Today, due to technical development, the penetration of space research, the amount of space weather related information increases by leaps and bounds which need to be presented at some level in high school physics classes. The topic is perfect to apply the method of the so-called research-based teaching [2], because students can obtain information from a very wide range of various space research and astronomy portals. Research topics may include the investigation of the lesser-known impacts of adverse space weather, including the manipulation impact on the migration of migratory birds or even the influence on the corrosion protection of pipe networks.

Students should get to know the websites of the largest space weather warning centres, where space weather can be tracked real-time. They should also learn about spacecraft used to monitor space weather today. We can find charts at the sites of space weather warning centres that are perfect for student analysis. By a deeper teaching of this topic, students can acquire a more intense "space awareness", by way of which interest towards space research can be aroused, as on account of its significance in our century it is very important that space researc is attractive for the youth.

Keywords:
secondary teaching of physics, space weather, research-based teaching, space research

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Space education in Nigeria, why there is more to be done

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Space education in Nigeria is something that has been attempted by some individuals albeit wrongly. Some individuals have taken the technology which isn't so new anymore but is still being explored to institutions, secondary and primary schools around the country, it wasn't really accepted because of the mentality which makes people from this region not to accept new things especially abstract ones in this case because it is believed to come with problems of its own.

Even among adults in the Science, Technology and Engineering fields, so many are yet to be exposed to the relevance of space technology in their respective fields as even those who have heard about it don't know how to access digital information on the internet or aren't so good at accessing things they deem abstract or far-reached. The knowledge of space technology is one which is yet to sink into the minds of the populace especially those who should be deeply involved in its use and propagation. Students around the country who are the bedrock of the Nation's future development are so naive that they see satellite and space technology as something that is exclusive to America and Russia who they see use it in movies.

Some students even those in the universities would ask you questions like "Does Nigeria really own a satellite?" to which the best way to educate the likes of these would be a total education and for those who haven't passed the level, a compulsory inclusion into the curriculum would suffice. Even among those who have an idea about what space technology is all about and even need it, Director, Centre for Satellite Technology Development (CSTD), a division in NASRDA, Nigeria's Space Agency was reportedly quoted as saying in 2012 about the use of available space technology that "We have not been able to maximize them. Why? Because we need to work with the number of agencies, which are not still free to embrace our stretched hands. Even when we say look we can do this and that for you, they are not coming in fully; they're coming with a little bit of hesitations."(RadioNigeria,2016), He added that the Agency needed the support of every Nigerian to push forward, to

sell the knowledge of Space and Satellite technology and its application to primary and secondary schools, polytechnics and universities.

The words of the Director cited above shows clearly the perception people in general have about Space Technology and its use, they're very sceptical of its reliability and so do not patronise it, money invested into this fields do not return any yield due to low patronage. All these are just the problems of satellite technology, we are yet to encounter or even anticipate the challenges involved with having or sending astronauts into space, as if such news even comes to the hearing of the general public, they might even term it the handwork of witchcraft or sorcery due to poor understanding of its use and beneficial application into the daily life of the common man.

If interested international parties are involved with educating the masses by creating avenues where they're interacted with to educate them and have them ask questions that make them reject what they haven't experienced, it would go a long way in creating a safer environment for those whose field it is, as people tend to think of them as being jobless while wasting time proverbially beating around the bush instead of doing something which would produce immediate results like they're used to seeing. A system needs to be developed where education of all types, forms and nature is disseminated to people without their objecting to it with a view to them embracing it like it is done in other parts of the developed world. No one can ever over-emphasize the relevance of education on the perception of people towards new technology.

Keywords:
Education, Students

References:
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Space research and mini-satellites in secondary high school

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Space research, the universe and satellites are those fascinating questions for students which have no possible answers in the regular school curricula. Therefore, every opportunity to bring these topics into school activities and closer to students' interest is welcomed. Few years ago I found the European Cansat competition, which could be one solution for fulfilling this demand. Cansat is a mini-satellite that can be fit into a Coca-Cola soda can (330ml) and released from 1 km altitude.

This mini device is based on Arduino- microcontroller and performs certain scientific missions like: measuring the air pressure, temperature, humidity, dust pollution, radiation level, location, telemetry, etc. In the past few years my team have planned and designed devices which comply with all rules and standards of the CanSat competition and can perform special data analysis, by associating the data received with a 3D map, falling simulation and different dynamic and position measurements. During descend, the unit sends measuring data to the ground with the help of a radio transmitter and uploads the received information to a web server with a GPRS module. The collected data are analysed and processed by students and the results are presented at conferences or used at physics classes.

This competition and the preparation period are very useful for students as they offer a special opportunity to learn about sensors, microcontrollers, radio communication, space research missions, project management, and to develop technical skills and applications of the acquired theories.

Keywords:
cansat, satellite, Arduino, education

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„Csillagszekér" Planetarium in education - experiences

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Nowadays there is not much spoken about space science and astronomy within the scientific education. For the youth it seems that education of scientific objects like physics or anything else is just for itself. Learning and teaching is much easier, if we show interesting examples on how and where to use the newly gained knowledge. A portable planetarium is a good demonstration tool for this. It has more possibilities than a traditional analog planetarium by using digital projecting techniques. Since it is portable, it can be installed anywhere in schools or programs.

We are able to project everything in the doom, not only the starry night sky. It gives the possibility to have spectacular shows with live demonstrator which can be the part of physics education as an irregular lesson. It is also possible to show three-dimensional full-dome documentary films. Our planetarium lectures can be paired with telescope demonstration of the sky attractions or physical experiments so that the young people can experience the beauty of nature themselves. In my presentation I show our experience, how we can put the science back to the everyday life through the astronomy and space science and how to drag the attention of the youth.

Keywords:
education, documentary, planetarium, space science, astronomy

ESERO HUNGARY, space education office of ESA for Hungary

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The goal of ORION Space Generation Foundation is the raising of the interest of young generations for space exploration and the spreading of knowledge on space and sciences. To achieve this goal we set up the ESERO office for Hungary. But what is ESERO, anyway?

ESERO-s, ie. European Space Education Resource Offices are implementing the education program of the European Space Agency in the member states of ESA. By now 13 countries have set up their ESERO offices, so from 2017 ESERO Hungary will be the 14th of them. The aim of the program is to raise and increase the interest of students in space exploration on the first place and in STEM (Science, Technology, Engineering and Mathematics) subjects in general. The ESERO office provides a direct link between ESA and the education community (students and educators). Each ESERO office is manned by an expert team, well integrated into the local education system and networks, so we have to closely cooperate with the national curriculum, since our target group is 6-18 year-old students. Our approach is to present different scientific subjects to the students through the context of space.

The effective transfer this knowledge also requires the further training of teachers, where educators can learn European best practices and methodologies to increase the interest of student in STEM sciences. These European best practices will be adapted for the programs of ESERO Hungary, thus integrating the several years' experience of other ESERO offices.

In order to achieve the above objectives, ORION Space Generation Foundation cooperates with the Government of Hungary, the Hungarian Space Office, the Hungarian Astronautical Society (MANT), the European Space Agency and other relevant domestic and foreign professional organisations (Hungarian Institute for Educational Research and Development, National Association of Schools of Practice, New Generation Centre, etc.) Our intention is to implement multiannual complex programs, based on the assess-

ments and research of the initial conditions, which programs will consist of school and afterschool activities. We would like to involve a wide range of students and educators from the very beginning, from the joint elaboration of the teaching material to the organisation of diverse programs and activities.

Keywords:
Education, ESA, ESERO, STEM, SET

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SpacePaprika Workshop

The SpacePaprika workshop will be held on Friday afternoon, organized by the Hungarian Astronautical Society (MANT), the UN supported Space Generation Advisory Council (SGAC), Budapest University of Technology and Economics (BME) and the Scientific Association for Infocommunication (HTE).
In summer of 2016, the participants of the Space Academy organized by MANT and SGAC, created the idea of the next hungarian experiment to the ISS. The implementation is waiting for the young generation of space enthusiast students and experts between 18-35 year. During the workshop on February 10, we will start to shaping the experiment called SpacePaprika.
The registration for this event was opened for everybody beetween 18-35 year, up to 50 participants.

About the Space Generation Advisory Council (SGAC)

The SGAC is a global non-governmental and non-profit organization and network, which aims to represent university students and young space professionals to the United Nations, space agencies, industry and academia. SGAC was established as a recommendation from the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) held in Vienna in 1999. SGAC has Permanent Observer Status in the UN COPUOS and is regularly present at its annual meeting and its two subcommittee meetings. These presentations cover the outcomes of SGAC's annual conferences and projects throughout the year. This includes the reporting the recommendations and outcomes gathered at the annual Space Generation Congress (SGC) and the annual Space Generation Fusion Forum (SGFF), bringing together top young minds from around world to focus on key space topics

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H–SPACE 2018

The 1st International Conference on Research, Technology and Education of Space was the opening event of the conference series. It was held on February 13, 2015.
The 2nd International Conference on Research, Technology and Education of Space was held on February 25-26, 2016.
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