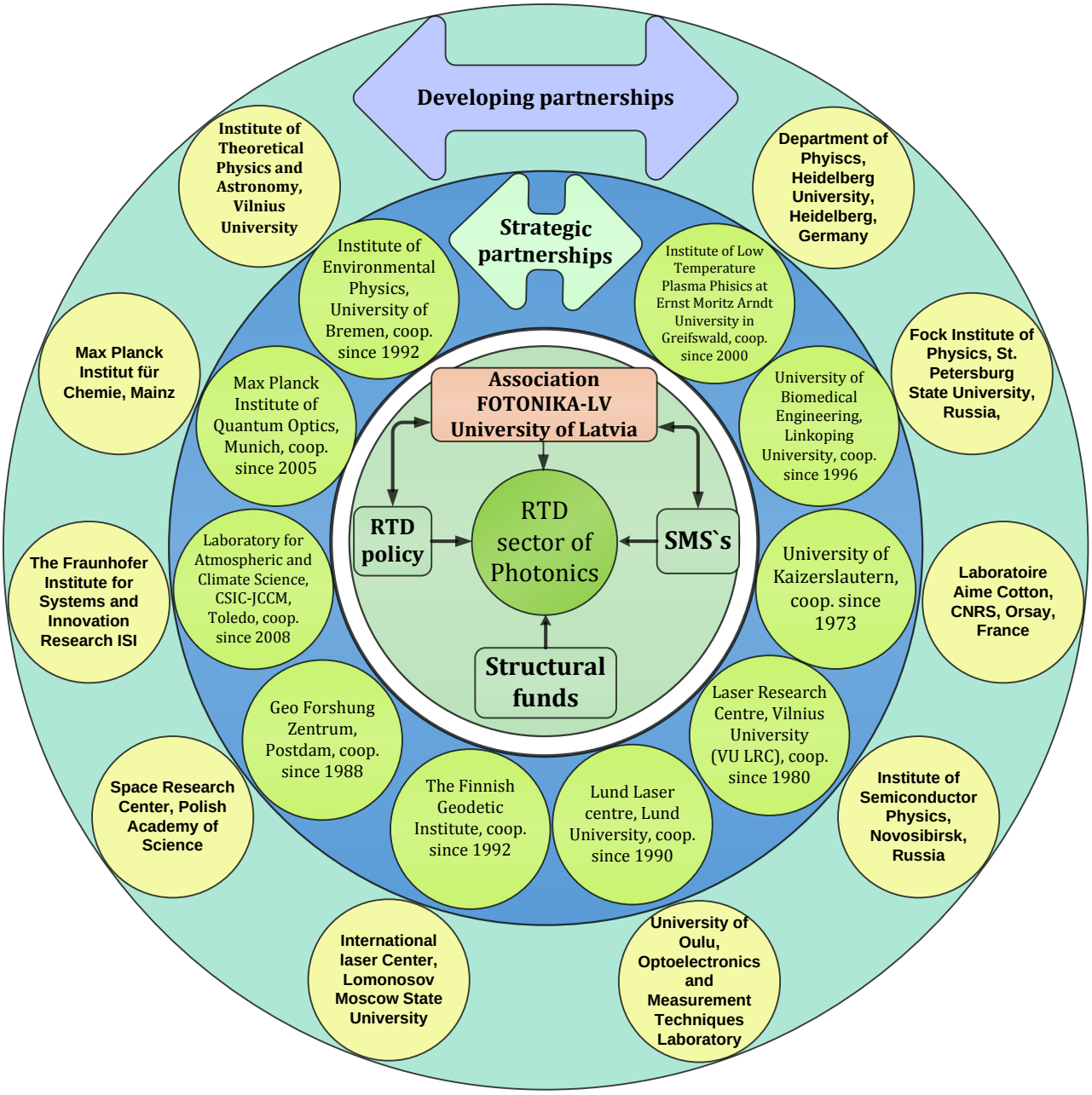
Mission of FOTONIKA-LV

The Association FOTONIKA–LV at the University of Latvia has been created to take a challenge to lead the photonics sector in the country and has a clear vision of its mission to nurture and develop sustained and growing research activities in photonics domain for Latvia and European Research Area.



The mission, presence and networking of FOTONIKA-LV in Latvia, in European Research Area and beyond.

*The Association FOTONIKA-LV at the University of Latvia (LU, FOTONIKA-LV[1]) has been created to combine the intellectual capacity of three strong research institutes at the University of Latvia (*LU ASI, LU AI, and LU GGI*)[2]. FOTONIKA-LV has currently brought together multidisciplinary R&D task force - up to 100 well trained people including: 4 Professors, 28 experienced scientists (Dr), 7 specially trained technicians in the areas of electronics, optics, and materials, and 34 doctoral candidates and MSc level students.*

[1] *LU FOTONIKA-LV – acronymos designed from Latvian name of the Association*

[2] *LU ASI, LU AI, LU GGI – acronyms designed from Latvian names of the institutes - Institute of Atomic Physics and Spectroscopy – www.asi.lv, Institute of Astronomy – www.astr.**lu**.lv/, Institute of Geodesy and Geoinformatics – www.ggi.lu.lv at the University of Latvia*

State-of-the-art

Motto: **"*Photons do the job*"**

Photonics is the science and technology of generating, controlling, and detecting photons. On the landscape of science, photonics is adjacent to quantum optics and optoelectronics. The relevance and significance of photonics has been precisely summarised by the **Former Parliamentary Under Secretary of State for Science and Innovation** in the UK, Lord Sainsbury of Turville, who said on 13 July 2006 in the context of UK Photonics Strategy:[3]

"…the impact of photonics in the 21st century will be as significant as electronics was in the 20th, or steam in the 19th…"

Photonics today is a trans-disciplinary science and technology that studies and exploits emission, transmission, deflection, amplification and detection of light by optical components, a range of photonics based instruments, lasers, convential and novel light sources, fiber optics, electro-optical instrumentation and sophisticated nano-photonic systems. Photonics *(as described in monographies and textbooks, Salex.[4])* enables a range of optical technologies, spectroscopy, laser technology and laser based techniques, holography, material processing, remote sensing, metrology (e.g. time and frequency measurements, laser ranging), material processing, biological and chemical sensing, medical diagnostics, medical therapy, and other applications.

The ambitions of FOTONIKA-LV are based on long-term history and relevant expertise of research and technology development in photonics domain in Riga and Latvia [5] and existing links to photonics related industry, including a number of companies *(Z-Light, Ltd, ISP Latvia, Ltd., Holograma, Ltd., Difraks, Ltd., Dardedze Holografija, Ltd., HEE Photonic Labs, Ltd., ST-STEEL, Ltd. etc.)*. Accent on EU level partnerships, innovation, knowledge and technology transfer to industry is not only in line with the urgent needs of development of RTD in Latvia; they also align with the context of European Research Area and are coherent with the Vision of Innovative Union 2020.

The University of Latvia and the three institutes comprise the Association FOTONIKA-LV are located in downtown of Riga. Historically Riga was a significant member and trading partner in the Hanseatic League of cities *http://wapedia.mobi/en/Hanseatic_League*. During the last couple of centuries Riga boasted the reputation being a city of advanced technology. At the beginning of the 20th century, when the Industrial Revolution was in full steam, Riga ranked high among the technologically advanced European cities with its factories producing trains, cars, planes, radios, and bicycles, and its ship-building and textile industries – industries that produced the welth reflected in Art Nouveau (Jugendstil) which was the dominant style of architecture during the early20th century in Riga[6].

Riga's virtue and reputation were almost completely obliterated in the aftermath of lasting Soviet occupation starting from WW II; but in spite of hard conditions during the following Soviet era intellectual environment in Riga and nation's wisdom favoured recovery of industry in Latvia to be assumed one of the forefront positions in Soviet technology, supplying trains, ships, minibuses, radios, electronics, optical equipment, pharmacy products and textile to the large Soviet markets. With the subsequent rapid decomposition of the Soviet Union in 1990, much of Latvia's industry collapsed, especially the knowledge-based sectors, as scientists and technicians became unemployed and many left the country seeking work elsewhere. Despite these exceedingly unfavourable developments, the scientific community in Riga has managed not only to maintain its potential but also to further develop through opportunities opened by the fall of the iron curtain and integration of Latvia into European scientific community.

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[3] *PHOTONICS: A UK STRATEGY FOR SUCCESS www.berr.gov.uk/files/file39193.pdf. www.dti.gov.uk/.../ukphotonicsstrategy*

[4] *B.E.A.Saleh, M.C.Teich. Fundamentals of Photonics. Second edition Willey-Interscience, 2007, 1173 pages.*

[5] *History of Science in Latvia, http://www.li.lv/index.php?Itemid=1107&id=30&option=com_content&task=view*

[6] *Art Nouveau in Riga www.li.lv/index.php?option=com_content, www.jugendstils.riga.lv,*

The early seeds of photonics in Latvia can be traced back to late 1930's, when the smallest photo-camera of that time was invented and manufactured at the VEF factory in Riga[7]. The tradition of optics was maintained throughout the 20th century, resulting in optical systems for space applications and fibre optics[8,9] among several other technologies.

Today the domain of photonics in Latvia is substantially driven by the three mentioned above institutes forming the Association FOTONIKA-LV. Until recently these three have evolved separately as centres of science in their own each having a strong component of photonics research - which has facilitated their consolidation around a common goal to become the leading Baltic research centre in the fields of fundamental and applied photonics, ranging in scales from aerospace applications to atmosphere and biosphere research, to imaging, biomedical optics, cardio-vascular monitoring and to micrometer and nanometer scale research.

Astronomy and optical technologies have been known in Riga for centuries but basic research on nano scale in started with sesibilized fluorescence studies of energy transfer in atomic collisions early 1960's in the downing of laser era. Currently, in the association FOTONIKA-LV are 9 strong internationally recognised research departments and labs which represent a multi-disciplinary spectrum of research including cutting edge photonics problems demanding usage or using light from VUV to infrared wavelengths. Simultaneously, it's worth mentioning that sometimes situations emerge needing cross scale approach, like atmospheric photochemistry, remote sensing, optical atomic clocks and laser cams (*femtosecend lasers*) for measurements in space etc.

In terms of the academic manpower-building man- and woman researchers of the the FOTONIKA-LV team can claim to have trained a large number of highly qualified young scientists, for example an Marie-Curie Fellow, Dr. A. Ekers in FP5 project with the 2003 Max-Planck Prize holder Prof. K. Bergmann at the University of Kaiserslautern and the the individual Marie-Curie Fellow Dr. J. Alnis in FP7[10] who is working with the 2005 Physics Nobel Prize winner Prof. T. Hänsch in Garching[11]. Worth to mention also Dr.Hab.Phys Uldis Berzins since 1990 get research training in Chalmers University of Technology in Gothenborg and worked very productively together with Prof.Sune Svanberg at the Lund University. He becomes the youngest Dr.Hab. degree holder in Physics in Latvia when he defended his doctoral thesis. Now for almost 10 years he is leading researcher in Swedisch high-tech company Micronic Laser Systems AB (*http://www.micronic.se*). These three and a total of 15 other scientists who were trained by FOTONIKA-LV emigrated driven by their scientific curiosity and better opportunities provided by leading West European countries. Contacts are not lost and the challenge is to bring them back and to reverse a "brain drain" into a "brain gain".

Therefore, another important issue is the linkage of photonics research to industry in human capital supply and applied research in total counting more than 100 highly qualified specialists for Latvia during the 5 decades.

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[7] *The roots of high-quality optics manufacturing go back to the pre-WWII time, when the MINOX mini-camera (http://en.wikipedia.org/wiki/Minox) was invented in Latvia and produced at the VEF factory in Riga in late thirties;*

[8] *Riga Optics Factory has been manufacturing precision optical components and devices for industry and space applications up to 1990-ies, including a series of satellite laser ranging telescopes, some of them still in operation in Latvia and a number of other countires (e.g., Finland)*

[9] *United Nations paper A/AC.105/857, 18 November 2005, V.05-90111 (E) 301105 011005 *0590111*, Committee on the Peaceful Uses of Outer Space: International cooperation in the peaceful uses of outer space-activities of Member States Note by the Secretariat,*
http://www.oosa.unvienna.org/pdf/reports/ac105/AC105_857E.pdf

[10] *Precision Laser Spectroscopy of the 1S-2S Optical Clock Transition in Atomic Hydrogen, Hydrogen 1S - 2S,Nr. 41173, FP6-EIF, Dr.Janis Alnis.*

[11] *The Nobel Prize in Physics 2005: Roy J. Glauber, John L. Hall, Theodor W. Hänsch*
http://nobelprize.org/nobel_prizes/physics/laureates/2005/

Expertise and **Capacity**

A **T**he three research institutes forming the association FOTONIKA-LV grew out of a number of research and technology developments in Riga during the 20th century, and their combined expertise includes 50-60 years of R&D experience in optics and photonics related disciplines, including:

- observational astronomy, such as observations of asteroids and Near Earth Objects (NEOs), spectroscopy of galactic carbon stars, research on late evolution stars (MS, S type);
- satellite laser ranging (SLR), including design of software and hardware components for SLR;
- design of precision optical systems with apertures up to 35 cm for astronomy, laser ranging, remote sensing and other applications, including novel equipment for light emission and sensitive detection;
- Earth geodesy;
- remote sensing;
- theory of atomic processes in high-power laser fields and experimental laser spectroscopy;
- atomic, molecular and optical physics;
- photochemistry, UV and VUV spectroscopy, development of novel sources of atomic spectra from VUV to infrared;
- atmospheric photochemistry and development of optical techniques of atmospheric remote sensing;
- plasma physics, plasma spectroscopy, light sources and applications;
- bio photonics for cardiovascular monitoring, skin diagnostics, and biomedical optics;
- optoelectronics, in particular UV fibre optics;
- Quartz, glass and vacuum technologies.

B Scientists of FOTONIKA-LV have established long-term strategic partnerships and twinning with a number of research institutes which are leading various fields of photonics in Europe and worldwide.

A) Each of the three institutes of FOTONIKA-LV can demonstrate an already existing track-record of excellence:

- The Institute of Atomic Physics and Spectroscopy of the University of Latvia (*LU ASI*) has already been individually approved as a Centre of Excellence having a contract for the project proposal to the call QoL/Growth/EESD-2001-INTEGR Support for the integration of .newly associated states in the European research area ***"Centre of Excellence in Nanosciences and Applications" (****FP5 contract G1MA-CT-2002-04063, years 2003-2005*). In FP6 the Institute was a partner in the Networks of Excellence project "*ACCENT - Atmospheric Composition Change: a European Network, Contract No. 505337".* The Institute is well recognised in the European Research Area as a welcome and strong partner in the Framework Programme proposals, having on its account successful participation in six FP5, five FP6 projects. The latest confirmation of excellence comes from two FP7 projects: *FP7-INFRASTRUCTURES-2008-1*, "T*he Integrated Initiative of European Laser Research Infrastructures LASERLAB-EUROPE Contr 28334"; FP7-ENV-2010, "Global Mercury Observation GMOS 265113.* The international dimension of the Institute is sustained by various bilateral projects with partners outside the EU (in USA*, Taiwan, South Africa, Russia, Ukraina etc.*).
- The Institute of Astronomy of the University of Latvia (*LU AI*) is well known internationally for its activities in classical astronomy and satellite laser ranging technologies. It has a long history of cooperation with partners in the EU and beyond; it is now also becoming involved

also with European Space Agency[12], in particular, with the European Student Moon Orbited project. The Astrophysical Observatory of LU AI has a considerable collection (*of 22 000*) of wide-angle celestial pictures starting from the year 1967 and containing unique information used today for the identification of distant astronomical objects, like novas in Andromeda Galaxy. During the last three years it discovered twenty-eight asteroids, including one NEO type and one Centurion class Trans Neptunian Object, showing its capacity for observation of small and faint objects. The infrastructure of the Institute of Astronomy includes complex observational instruments which form the basis for a potentially new approach in Near Earth Object observation – combing laser ranging with optical observation. Geodynamic station of the Institute of Astronomy is running a satellite laser ranging (*SLR*) system and a permanent GPS station. SLR station is a member of the International Laser Ranging Service (*ILRS*) and Eurolas, permanent GPS station (*RIGA_12302M002*) is a member of the International GPS service (*IGS*) and EUREF permanent GPS network EPN. SLR station, ILRS code name 1884 Riga, is capable to make day and night observations and measure distances to the satellites in the range from 400 to 28,000 km with single shot accuracy around few cm, depending from the range and satellite signature. The high accuracy SLR and GPS observations made by the Astronomical observatory serves as the basis of the Latvian coordinate system LKS-92 and ties it to the ITRF 2005 and EUREF international reference frames. The research is centered on SLR related activities: design and testing new equipment, data analysis, algorithms and software for the tracking objects in the vicinity of the Earth.

- The Institute of Geodesy and Geoinformatics of the University of Latvia *(LU GGI*) despite its short history already has significant international involvements. The small size modern satellite laser ranging system (SLR) and it's control software has been developed at the Institute recently. SLR will be used for the regular observations of low Earth orbiters (LAGEOS, GOCE, GRACE, ERS2, ENVISAT, CRYOSAT, etc.) within the framework of ILRS. The test observations have proved the results of high quality. In order to improve the Latvian geoid model quality and accuracy the Institute is taking part in an ESA performed GOCE mission[13]. The high precision geoid model is essential for the normal height determination when the Global Navigation Satellite Systems (*GNSS*) positioning methods are used. Application of GNSS in geodesy discovers a powerful tool for the verification and validation of the height values of geodetic levelling benchmarks established historically long time ago. Within the European framework of ground based GNSS European positioning augmentation system ***EUPOS***® the local ***EUPOS***®-Riga continuously operating geodetic reference system has been developed by the Institute and "Rigas GeoMetrs" land surveying company. The system consists of 5 GNSS base station network located within the framework of Riga city. The GNSS observation RTCM corrections produced by the ***EUPOS***®-Riga system can be used for high precision position determination in various navigation and land surveying applications.

C FOTONIKA-LV has strong involvement in activities at the Baltic Sea Regional level:

- LU ASI is a member of the network *BALTICNET-PlasmaTEC* (*www.balticnet-plasmatec.org*) since April 2007. BalticNet-PlasmaTec is a borderless network focused on technology and market oriented cooperation between science and economy in the field of the plasma technology;
- LU AI is a Forum member of FP6 ERA-NET network *ASTRONET..* It is also involved in a twinning cooperation with the institute of Theoretical Physics and Astronomy of Vilnius University, Lithuania in the field of research on small bodies of Solar system, and cooperates with the Finnish Geodetic Institute on upgrading of SLR technologies and with Geo Forschungs Zentrum Potsdam in SLR related research;

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[12] *The Institute and other two from FOTONIKA-LV is trying for years to convince the Government to sign assotiation agreement with ESA refering to significant space research capacity in Latvia.*

[13] http://ilrs.gsfc.nasa.gov/satellite_missions/list_of_satellites/goce_general.html

- The LU GGI has skilled personnel developing the geographic information system 2D and 3D data bases for Riga city and for al of Latvia and Baltic Sea coastline which is important for the monitoring of environmental and global changes;

D FOTONIKA-LV has long-term experience and potential for implementing its mission of teaching photonics-related subjects *(existing courses on optics, photonics, laser physics, biomedical optics, medical waveguides, plasma light sources, remote sensing of atmosphere, etc.)*; the existing scientific infrastructure ensures hands-on scientific training in modern optics and photonics for MSc and PhD students;

E FOTONIKA-LV is acting as a national consulting agent for private and public sectors in the fields of optics, optoelectronics, UV and VUV spectroscopy, sophisticated atomic spectra sources, quartz, glass and vacuum technologies, and bio photonics;

F Research groups within FOTONIKA-LV have various direct links with emerging industry of photonics products in Latvia – fibre-optic cables and assemblies (*Z-Light, Ltd,* www.z-light.lv), optical crystals and components (*ISP Optics Latvia, Ltd*, holography products (*Holograma, Ltd., Difraks, Ltd., Dardedze Holografija, Ltd.*), design of optics instrument *(HEE Photonic Labs Ltd, www.heephotonics.eu; ST-STEEL, Ltd*) and others;

G FOTONIKA-LV has strong links with leading photonics-related international societies and associations. In the years 1994-2007 LU ASI was running the office of Baltic Chapter of SPIE – International Society for Optical Engineering (*www.spie.org*) the global coordinator of photonics events. International Commission for Optics (ICO) of the Optical Society of America (*OSA*) is also represented in Latvia by offices under the auspice LU ASI. Many FOTONIKA-LV scientists hold individual SPIE, OSA, EOS (*European Optical Society*), IAU - International Astronomical Union, EAS - European Astronomical Society, Eiro-Asian Astronomical Society and Astronomical Society of the Pacific memberships. Two laboratories of the Association are involved in the activities of European platform PHOTONICS 21[14];

H And finally the location of LU AI and GGI in central building of University of Latvia in downtown of Riga and LU ASI building in walking distance in the heart of Old Riga is advantage which could be used in various promotional activities of photonics in Riga and Latvia. LU ASI is located on a busy walking street and its ground floor premises and windows are already being used to promote awareness of FOTONIKA-LV and *public access* ***Riga Photonics Centre*** is planned to be developed.

[14] *Technology platform Photonics 21* - www.photonics21.org