Project: FOTONIKA-LV

Unlocking and Boosting Research Potential for Photonics in Latvia - Towards Effective Integration in the European Research Area

Grant agreement no: 285912

Final report on upgrading, development or acquisition of research equipment in 10 tasks of WP3

WP3 - Upgrading, Development or Acquisition of Research Equipment

Deliverable Number: D3.8.

Public

Version 1.0

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Section 0 Change Control

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1.0	01.01.2015.	Edgars Smalins
0.2	15.01.2015.	Edgars Smalins
1.0	28.02.2014.	Arnolds Ubelis

Change History

Version 0.1 – Structure / Table of Content

Version 0.2 – Draft of the Deliverable

Version 1.0 final release

Release Approval

Name	Role	Date
Edgars Smalins	WP Leader	
Sandra Smalina	Quality Manager	
Arnolds Ubelis	Project Manager	

Table of Contents

1. Introduction

This WP3 was designed to answer the needs for upgrade of the existing research infrastructure via replacement of outdated equipment, purchase of new components and modules, and developing new apparatus' replacing the old ones. Such upgraded infrastructure will ensure that the human potential gained via recruitment or repatriation of researchers through WP2 has been placed in the *state-of- the-art* environment enabling them to efficiently perform research. Furthermore, condition of the infrastructure is also an important precondition for the achievement of full mutual benefit from cooperation with partnership organizations and secondments organized in WP1.
During project 4 procurement procedures for equipment and 3 procurement procedures for IT equipment purchases were organized.

2. Upgrading, development or acquisition of research equipment

2.1. Task Task 3.1. Equipment to develop lab made working model device for Night-Time Cartography of Atmosphere by Exposing Satellite Instruments with a White Light Beam

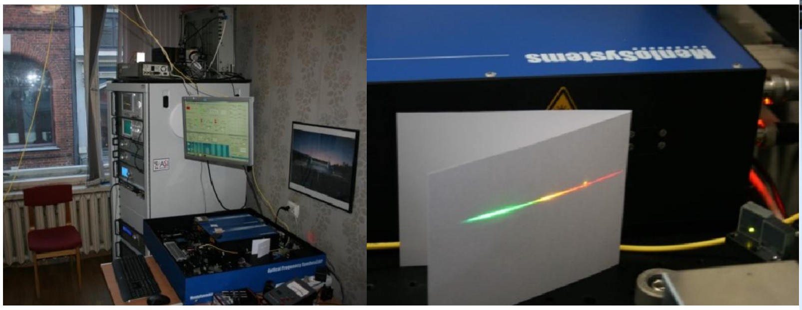
Leading scientist	Dr. Māris Ābele
Laboratory Upgraded	Institute of Astronomy, Association FOTONIKA-LV, University of Latvia
Equipment Purchased	There are purchased following equipment" 1) Optical lens kit.
Amount spent	5965.3EUR
Justification for the purchase of equipment	This equipment was planned to purchase in the project to fulfill the tasks of lead scientists Māris Ābele. Optical lens kit for Schmidt telescope optical channel was purchased. This improvement will allow of a small part of curved focal plane image carry out of tube where it will be perceived with the CCD. Two that channels increase the effectiveness of observations with telescope more than 30 time

Picture 1. Optical lens kit for Schmidt telescope optic channel

2.2. Task 3.2. Development of satellite laser ranging systems towards application of Femtosecond lasers and Frequency Combs

Leading scientist	Janis Alnis
Laboratory Upgraded	Institute of Atomic Physics and Spectroscopy Association FOTONIKA-LV, University of Latvia
Equipment Purchased	There are purchased following equipment" 1. Laser stabilization resonator; 2. Femtosecond optical frequency comb 3. 780 nm laser system 4. HZ laser system 5. Radio frequency sintesator. 6. GPS support frequency generator.
Amount spent	333500 EUR
Justification for the purchase of equipment	This equipment was planned to purchase in the project to fulfill the tasks of lead scientists Janis Alnis, recruited in WP2.
Scientific results	An application is received for a PhD student position. Outcome 2 publications submitted to Latv. J. Phys.: 1. K.Bluss, A.Atvars, I.Brice, J.Alnis Broadband Zerodur FP rezonator for laser stabilization below 1 kHz linewidth with <100 Hz/s drift and reduced sensitivity to vibrations. 2. E. Nitisss, K. Bluss, J. Alnis Numerical 2D and 3D simulations of a spherical Fabry-Perot resonator for application as a reference cavity for laser frequency stabilization. 3. D. A. Cooke, P. Crivelli, A. Antognini, S. Friedreich, K. Kirch, A. Rubbia, B. Brown , J. Alnis, T. W. Haensch **Observation of positronium annihilation in the 2S state.**

Femtosecond laser system is used for optical frequency standards, remote sensing and laser ranging. It is emitting a rainbow of colors in the range 500...1000 nm. Frequency comb has applicability in bio-optics research, for example skin fluorescence after illumination with fs pulses, and could be used for cancer diagnostics.



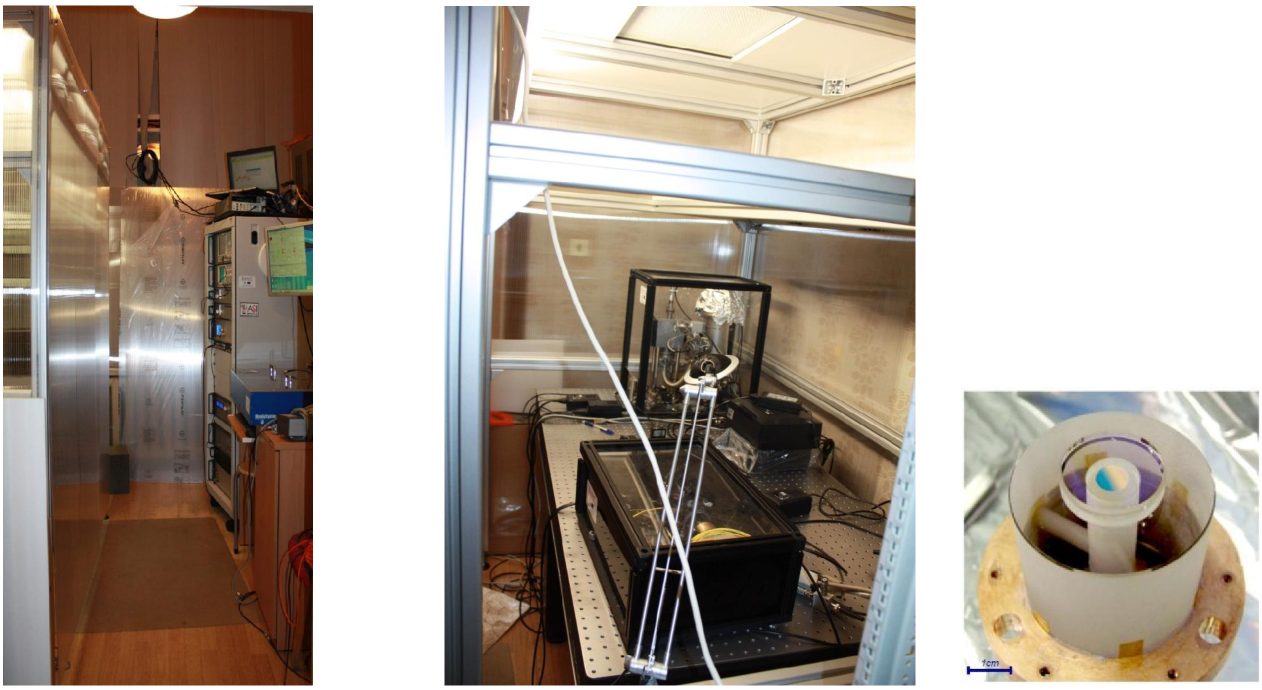
Picture 2. Femtosecond laser system

Temperature-stabilized Fabry-Perot resonator inside a vacuum chamber is used as an optical frequency standard to narrow spectral line width of lasers to ca 1 kHz in the range of 650-1100 nm. It's short term stability is a better compared to frequency comb and is be used for precision measurements of atomic (Rb) or molecular (Iodine) optical transition frequencies.

Picture 3. Temperature-stabilized Fabry-Perot resonator inside a vacuum chamber

Femtosecond optical frequency comb metrology laboratory on the 2nd floor of Institute of Atomphysics and Spectroscopy.

Inside the Class 6 clean room box is 1 Hz FP resonator and 980 nm external cavity diode laser. Cylindrical shape FP resonator needed for laser stabilization is made from ultra low expansion glass and has high reflection mirrors on both ends.



Picture 4. Femtosecond optical frequency comb metrology laboratory

Numerical 2D and 3D simulations of a spherical Fabry-Perot resonator for application as a reference cavity for laser frequency stabilization

One office room at the 5th floor of ASI was renovated in September-December 2014 and turned into laser optics laboratory. In the pictures below you see it during the renovation.

Picture 5. Renovation in laboratory.

Optical table was placed in the room, electronics rack and 980 nm laser system. We aim to design and test novel laser stabilization scheme using this laser.

The 780 nm laser was used to run laboratory exercise on saturated absorption spectroscopy in rubidium atoms for Bachelor program students. The picture was taken in the ASI hall on the ground floor in December 2014.

Picture 6. Laboratory Team.

GPS receiver *Connor-Winfried* CW742-ND was set up It shows much less scatter than the *TeximNavstar GNS701* receiver used formally.

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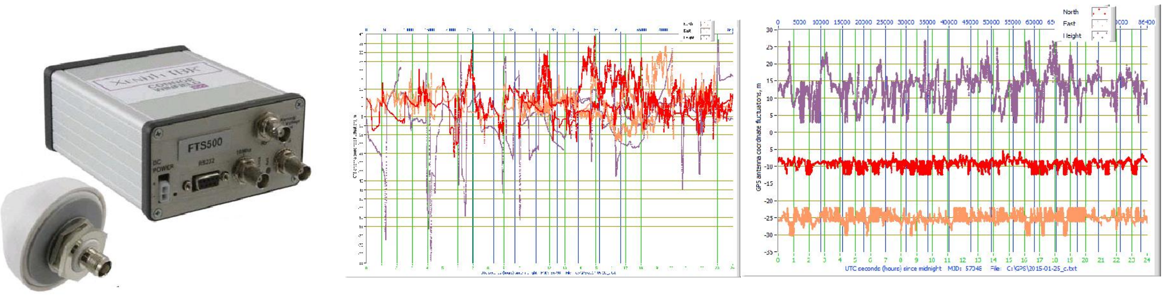
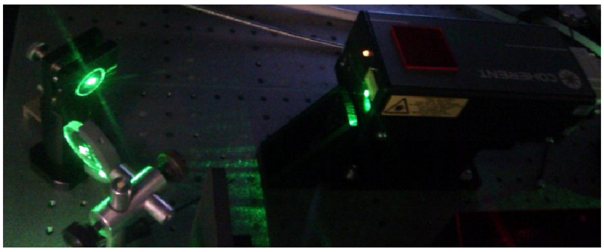
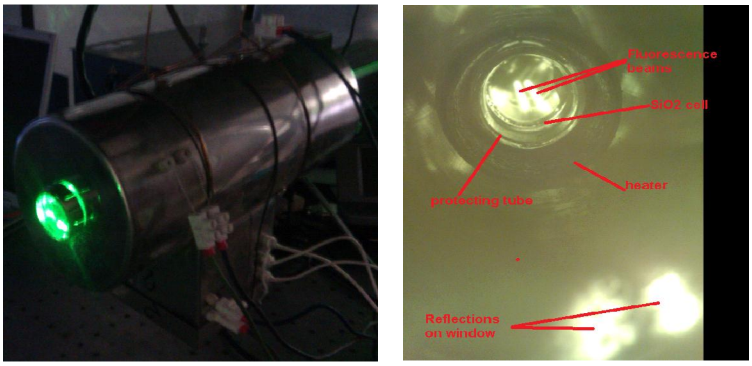


Picture 7. GPS data scatter during one day. Left: old receiver. Right: new receiver.

Laser spectroscopy of Tellurium molecular vapor

Uses Verdi laser and TiSa laser situated at Riga Laser centre.





Picture 8. Research on tellurium is done for collaboration with ETH Zurich as an optical reference for positronium spectroscopy experiment.

Outcome from 3 weeks secondment to ETH Zurich in 2013 is a manuscript:

D. A. Cooke, P. Crivelli, A. Antognini, S. Friedreich, K. Kirch, A. Rubbia, B. Brown , J. Alnis, T. W. Haensch

Observation of positronium annihilation in the 2S state

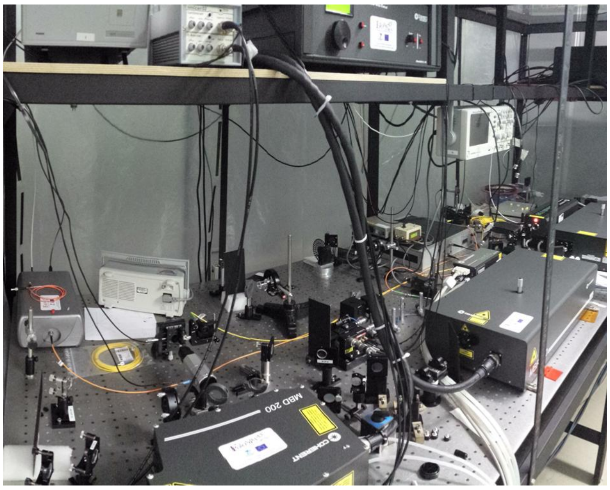
2.3. Task 3.3 Upgrade of laser equipment of the Molecular Beam Laboratory of the repatriated researcher Dr.A.Ekers

Lead scientist	Dr. Aigars Ekers
Laboratory Upgraded	Molecular Beam Laboratory of the Laser Centre Institute of Atomic Physics and Spectroscopy Association FOTONIKA-LV, University of Latvia
Equipment Purchased	The key components of the purchased tunable single frequency laser system with frequency doubling included **1)** Coherent Verdi - G18 CW, Single-Frequency *(532 nm)* Laser Properties: solid state single frequency cw radiation source at 532 nm with power up to 18 W, low noise level and built-in cooling contour; **2)** Coherent MBR -110 Ring Laser Properties: actively stabilised single frequency laser with monolith ring resonator, tuning range700-1100 nm, experimentally tested single-frequency peak power of 6 W and 18 W pump power; **3)** Coherent MBD - 200 Frequency doubler Properties: frequency doubling of laser radiation compatible with the MBR-110 output, with experimentally tested frequency conversion efficiencies of up to 15%; **4)** Supplementary optics and devices Properties: the supplement included options for laser wavelength measurement, mode structure monitoring, beam shaping and fibre coupling optics and controllers; a full set of optics for MBR -110 laser and optics and crystal sets for MBD-200 frequency doubler covering the entire lasing range of Ti:Sa crystal. 5) Thermocouple data acquisition modules (2 pcs.); Key properties: • 8 thermocouple inputs; • Compatible with type K thermocouples; • Connection to a computer: USB 2.0; 6) Thermocouples (10 pcs.); Key properties: • Type K thermocouples; • Work temperature 0 – 800°C; • Sheathed with 304L stainless steel; • Ungrounded junction; 7) Miniature spectrometer; Key properties: • Measurement range: 200 – 1100 nm; • Optical resolution: 2.0 nm; • Connection to a computer: USB 2.0; • Fiber optic connector: SMA 905; 8) Microchannel plate Time-Of-Flight detector. Key properties: • MCP effective diameter 27mm; • Two stage V-stack (Chevron) detector; • Minimal gain: 1×10^6 Operating vacuum condition: 1.3×10^{-4}Pa.
Amount spent	1st period 316 930 EUR 2nd period 11543,40 EUR
Justification for the purchase of equipment	1) Resolution of laser dressed states in the Autler-Townes spectra upon laser coupling of hyperfine level systems require a high stability of laser frequency and large Rabi frequencies of the respective quantum transitions. The laser system upgrade undertaken within this task included replacement of an outdated system of Ar+ ion laser

	pumped Coherent CR-699-21 dye laser by a new generation tunable Ti:Sa solid-state pumped laser system with frequency doubling option, which has far superior characteristics in terms of stability and power of output radiation. The upgrade package included also a laser wavemeter allowing a continuous and accurate monitoring of laser wavelength, a Fabri-Perot interferometer for laser mode structure monitoring, and an accurate adjustable single-mode polarization-maintaining fibre coupler system that enables efficient delivery of laser radiation to the experiment. The laser wavelength and mode structure monitoring, as well as accurate laser radiation delivery and polarization control enable a substantially higher accuracy experiments than what was possible with the old system. Of particular importance is the possibility to achieve substantially higher Rabi frequencies. In addition, the new laser system is substantially more energy- and resource- efficient, consuming by more than an order of magnitude less electrical power than the old system, thus complying with environment-friendliness policy of the laboratory. Supersonic molecular beam machine is the central experimental device at the Molecular Beam Laboratory. Its flawless operation is essential in obtaining valid experimental data. The supersonic molecular beam machine produces a high velocity collimated beam of geometrically cooled sodium atoms and molecules. During an experiment, beam source is heated up to 400 - 750°C to produce the necessary concentrations of unbound Na atoms and Na_2 molecules. Continuous temperature monitoring of all parts in thermal contact with the beam and its source is necessary to control formation of the beam, to avoid burning of heating elements and condensation of sodium vapor on surfaces in dangerous quantities. Temperature sensors must be suitable for working in the extremely chemically aggressive environment of vaporized sodium and its chemical compounds. The temperature monitoring system upgrade (thermocouples and thermocouple data acquisition modules) replaces dysfunctional components of the old temperature monitoring system, and enables continuous monitoring and logging of temperature measurements throughout the molecular beam machine. Low-noise detection of weak optical fluorescence signals is best carried out using photoelectron multiplier (PM) detectors. While this technique allows detection of extremely weak signals over wide range of wavelengths, the data obtained carry no information about spectral properties of the original signal. In the case of complex Autler-Townes spectra involving spectrally partially resolved hyperfine structure, PM detector signals and spectral composition of fluorescence radiation carry complementary information about energetic structure and populations of atomic/ molecular ground and excited states. The miniature spectrometer obtained within this task allows acquisition of such fluorescence radiation spectra thus enabling more detailed analysis of complex quantum systems. 2) Strength of fluorescence signal from excited states carries information about relative population of the respective states. Knowledge about population of the excited states is crucial in developing new techniques for coherent population switching and laser-enhanced chemical reactions. Experimental observation of fluorescence signals can become a challenging task in case of metastable and highly excited states due to their long lifetimes. Relative population of highly excited Rydberg states is more conveniently studied using methods of ionization spectroscopy. The microchannel plate Time-Of-Flight detector obtained within this task allows detection of positively charged ions enabling precise analysis of Rydberg state populations.
Progress toward task	1) The laser system including optical components and fibre couplers have been installed in the laboratory, fundamental Ti:Sa laser radiation of up to 6W in single

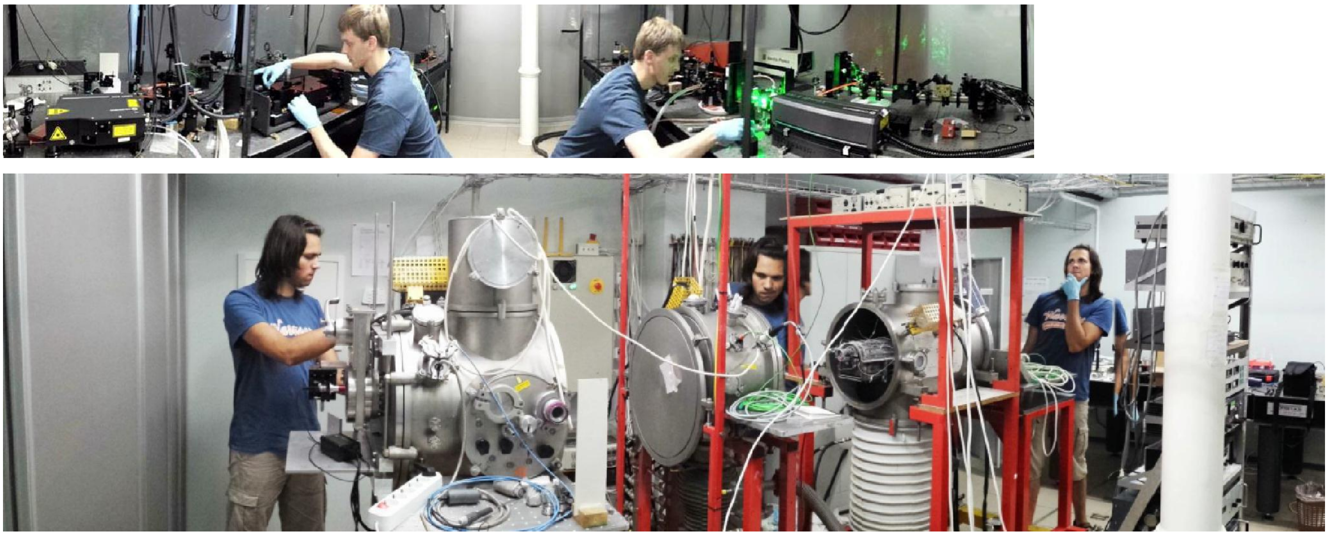
implementation	frequency and second harmonic radiation of op to 500mW are available for experiments. Some minor technical problems related to replacement of not well suited optical diode isolating the Ti:Sa laser from back reflections from the frequency doubler optics and from the fibre coupler, as well as incompatibility of the supplied beam collimator with the output beam size are being solved with the supplier. Currently, a new experiment is being set up for observation of dark state formation upon strong coupling of hyperfine levels inthe Na 3p and 3d states of Na at 819 nm. 2) Thermocouple data acquisition modules, thermocouples and miniature spectrometer have been installed in the laboratory. The Time-Of-Flight detector is kept in a protective packaging while Rydberg atom ionization stage and ion decelerating and focusing optics are being built, and will be installed on the molecular beam machine as soon as current measurements of residual Doppler profiles in two-photon excitation and experiments on dark state formation upon strong coupling of hyperfine levels in the Na 3p and 3d states of Na at 819 nm are finished.
Scientific results	1) The first test experiments with strong coupling between the 3 s and 3p states of Na and probing between 3p and 7d states have revealed oscillatory structures in the 7d excitation spectra. The theoretical analysis revealed that, given the available single frequency laser power of several watts at the 819 nm with the new laser system corresponding to coupling of 3p and 3d states, the coupling scheme with probe on 2s-3p and laser-dressing on 3p-3d should enable there solution of laser dressed states formed upon coupling of individual hyperfine sublevels. Such experiment is being set up with the new laser system. 2) Theoretical analysis revealed that shape of supersonic beam collimating aperture has significant influence on Doppler broadening of absorption spectral lines. The upgraded temperature monitoring system and spectrometer are being used in ongoing experimental verification of the theory on residual Doppler profile formation.

Laser system upgrade provides wider range of laser frequencies and higher laser output power. An essential improvement is that the new laser systems enable the achievement of higher Rabi frequencies in experiments, which in turn ensures the right experimental conditions for the achievement of well-resolved interference fringes.

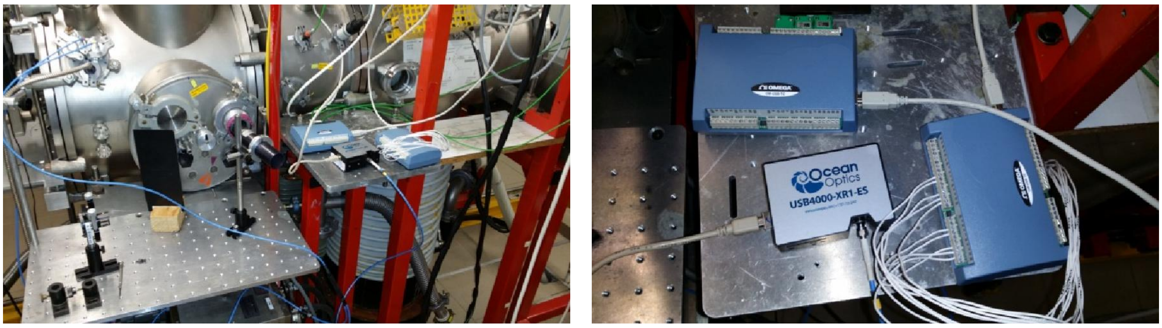


Picture 9. Laser system upgrade provides wider range of laser frequencies and higher laser output power

The acquired laser sources have been set up on an optical table, and both the fundamental Ti:Sa laser frequency and the doubled frequency are available for experiment. Notable, 6W single mode output power of Ti:Sa laser has achieved at 819 nm at 18 W pump power at 532 nm. The fibre coupling stages have been installed, enabling a transmission of 40% of laser power via optical fibres to the experimental setup.



Picture 11. Laser system upgrade provides wider range of laser frequencies and higher laser output power



Picture 12. Miniature spectrometer and thermocouple data acquisition modules

Miniature spectrometer and thermocouple data acquisition modules are installed in the laboratory and are being used as a part of the supersonic molecular beam machine.

Picture 13. Thermocouples

Termocouples must withstand working in a highly corrosive environment, which significantly reduces their working lifetime. A few replacement thermocouples are always kept in the laboratory.

Picture 14. Microchannel plate Time-Of-Flight detector

Microchannel plate Time-Of-Flight detector is kept sealed in protective packaging to avoid air damage to the detector.

2.4. Task 3.4. Upgrade of UV and vacuum UV, spectroscopy instrumentation, and linked quartz & glass blowing workshop and technology laboratory and development of far UV laser spectroscopy.

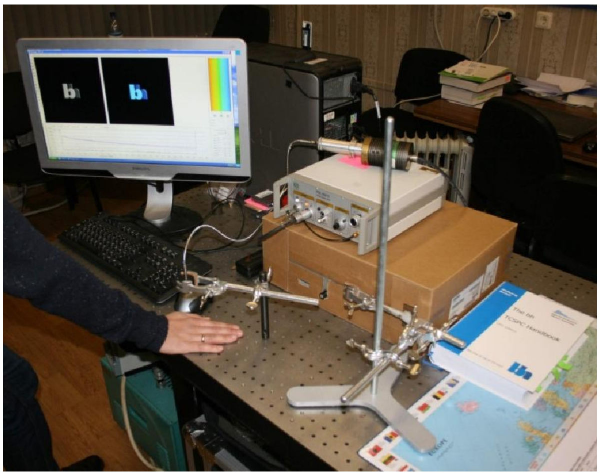
Lead scientist	Dr. A.Ubelis, Uldis Gross
Laboratory Upgraded	Institute of Atomic Physics and Spectroscopy, Latvian University
Equipment Purchased	There are purchased Parts for a vacuum spectrometer Mc Person 234/302 1. 8302-0190-0, Grating Holder 3gab. 2. 355-107853-1, 1200 G/mm concave corrected grating 1 gab. 3. 355-107855-1, 600 G/mm concave corrected grating 1 gab. 4. 355-107856-1, 300 G/mm concave corrected grating 1 gab.
Amount spent	7248, EUR
Justification for the purchase of equipment	Spectrometer can record spectra in the range from 37nm -151nm at the same time, which allows performing complex and effective research of UV sources and respective radio frequency excitement generators.
Progress toward task implementation	Procurement procedure is finished and supply of equipment is expected in September
Scientific results	UV radiation source and radio frequency excitement generator research.

2.5. Task 3.5. Upgrade of biophotonics research facilities.

Lead scientist	Dr. Janis Spigulis; Edgars Kviesis-Kipge
Laboratory Upgraded	Institute of Atomic Physics and Spectroscopy, Biophotonics Laboratory, Association FOTONIKA LV, Latvian University
Equipment Purchased	MSO4054B - Mixed signal oscillograph
Amount spent	9541,09 Ls (13575,748 EUR) [0.702804]
Justification for the purchase of equipment	Mixed signal oscillograph was purchased to facilitate the electronics product development and testing.
Progress toward task implementation	Oscillograph is actively used for the development of electronic devices.
Scientific results	Oscillograph is a measurement device that is used in electronics product development. With oscillograph scientific research have not been performed.

Lead scientist	Dr. J.Spigulis ; Inesa Ferulova
Equipment Purchased	TCSPC (Time-correlated single photon counting) set-up: Photon counting detector, PMC-100-4; Detector's controller DCC-100; Data processing system, SPC-150; Three pico-second lasers: LDH-D-C-405, LDH-D-C-470, LDH-D-C-510; Lasers controller: PDL 800-D.
Amount spent	70866 EUR
Justification for the purchase of equipment	For skin's autofluorescence lifetime measurement. Lasers and lasers controller is one system. With this three wavelengths we worked before, measured autofluorescence photo bleaching. Photon counting detector, Detector's controller, Data processing system, SPC-150 is one system for photon counting and time-correlating; with the minimum requirements for lifetime imaging.
Progress toward task implementation	Participation in two conferences (DOC 2013; BPR-2013) , Proc. paper in SPIE. Investigate the skin autofluorescence lifetimes before and after low power cw laser pre-irradiation.
Scientific results	Participation in conference BPR-2013, Proc. paper in SPIE
Equipment Purchased	TCSPC (Time-correlated single photon counting) set-up: Photon counting detector, PMC-100-4; Detector's controller DCC-100; Data processing system, SPC-150; Three pico-second lasers: LDH-D-C-405, LDH-D-C-470, LDH-D-C-510; Lasers controller: PDL 800-D.

Picture 15. Tektronix Oscilloscope is an important tool in the electronics lab of Prof. Spigulis for develping of microcontroller circuits.



Picture 16. Single photon detection setup consisting of laser emitting picosecond pulses and fast photomultiplier detector with time interval counter card.

Picture 17. Scanner.

Equipment necessary for skin's autofluorescence lifetime measurement. Lasers and lasers controller is one system. With this three wavelengths we worked before, measured autofluorescence photo bleaching Photon counting detector, Detector's controller, Data processing system, SPC-150 is one system for photon counting and time-correlating; with the minimum requirements for lifetime imaging. The result of measurements was present in several conferences and published in Journal of Biomedical Optics and in Quantum Electronics.

2.6. Task 3.6. Advanced upgrade of research equipment for Fundamental Geodynamical observatory

Lead scientist	Kalvis Salmins
Laboratory Upgraded	Institute of Astronomy, Fundamental Geodynamical observatory
Equipment Purchased	• GNSS (GPS+GLONASS+GALILEO) receiver Leica GR25 with calibrated AR25 antenna • Heidenhain angular encoders for SLR system telescope Moving control • Optical elements (lenses, mirrors, 532nm laser line interference filters) for the SLR telescope visual tracking/receiver channel combined unit • 532nm 4.5mW laser diodes for SLR system alignment and testing • Two 25m single mode Thorlabs 460HP fiberoptic cables with custom adapters to fit in the existing SLR system's internal calibration optical path • Calibrated Tektronix DC power supplies PWS2185, PWS2721, PWS4205 • Digital multimeter Tektronix DMM4050 • Leica Disto D5 rangefinder with digital pointer • Frequency counter Pendelum CNT-91 with high accuracy time base • Picoscope USB oscilloscope and signal generator • Jewell Instruments digital tiltmeter D701 • Thorlabs PM100D laser power meter with measurement heads • Auxiliary Spectracom SecureSync reference time and frequency source with OXCO oscillator and 10MHz frequency distribution amplifiers DA36 with fiberoptic cable connections • Vaisala PTU301 pressure, temperature and humidity sensor • Mintron night vision camera and 2.4Ghz wireless transmitter/receiver components • MoonGlow All sky cameras • Computer workstations for data processing and hardware control, notebooks for use for SLR system testing and for the portable USB oscilloscope, to check and configure measurement equipment, Synology NAS for centralized data storage and distribution with SLR station
Amount spent	105500 EUR
Justification for the purchase of equipment	Leica GR25 with calibrated antenna AR25: to upgrade SLR station's existing receiver antenna with state of the art geodetic receiver with support for all major GNSS satellite systems (GPS/Navstar, Galileo and Glonass, optional BeiDou when available), high frequency (up to 50Hz) data recording option, multiple data streaming options. Riga 1884 is the EUREF class "A" station and IGS base station. Upgrade will improve station performance and will fulfill the international GNSS network requirements; will allow to participate in upcoming projects like planned Grace-FO satellite mission in 2017. Vaisala pressure, humidity and temperatu sensor is used for environmental control at telescope building and also as an independent pressure measurement control for observatory meteosttaion serving SLR and GNSS measurements Measurement equipment: digital multimeters, USB oscilloscope, frequency counters, are used for the SLR station equipment performance monitoring and testing, particularly to check the existing time and reference frequency setup

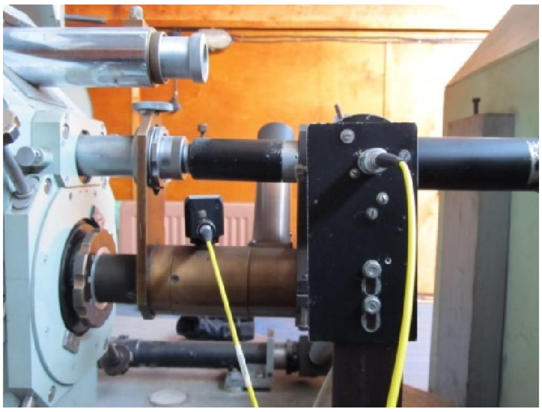
	involving connections between buildings, PMT and receiver electronics testing, measuring receiver channel performance and system tuning Auxiliary SecureSync OXCO frequency and time source serves as slave clock for main time sources (GPS steered Rb) and supplies additional frequnces (1Mhz, 5Mhz) for other SLR system subsystems like drive control. New frequency distribution amplifiers allows to use also fiberoptics cable in place of coaxiaal to transfer 10Mhz reference frequency between buldings minimizing risk of ground loops. Distance meter with digital point finder and tilt measureing capability is required to remeasure optical passes within SLR telescope, determine SLR external calibration target distances and measure horizon masks for GNSS antenna and SLR system. Single mode fiberoptics cable: replaced existing internal calibration multimode fiber cable with unknown properties. 532nm laser diodes are used in telescope system alignment control and testing. Optical elements: lenses, mirrors, laser line filters are for the new, combined visual tracking/receiver channel unit currently under construction. New unit will allow to install additional detectors for different targets e.g. SPAD detectors for space debris and also will allow to use CCD cameras for visual tracking. New unit is intended to replace old image intensifier for visual tracking.r Angular encoders are installed on SLR telescope movement axis and will be incorporated in the new telescope control system which will provide higher telescope positioning accuracy then previous system utilising step counting. Tiltmeter: to control telescope monument stability over time; to monitor telescope vertical axis orientation changes and mechanical accuracy of internal mechanical components and to directly measure certain telescope mount model parameters independently from the star observations. Night camera with accessories and all sky cameras: to give station operator a wide angle viewon TV monitor of tracking path on sky: cloudiness, approaching planes and also overall sky overview. All sky cameras are intended for permannet use to collect cloudiness statistics. DC power supplies: to replace old units, some of them more than 25 years old, with new calibrated sources e.g. PMT, laser, SLR start diode circuit and also for laboratory use.
Progress toward task implementation	Purchased equipment allowed to restore existing SLR system functionality and now it’s possible to take steps to participate in upcoming projects like space debris tracking. Next steps: telescope mount model improvement, SLR telescope receiver path performance improvement and to develop new telescope control system.
Scientific results	The most important result is restoring SLR system functionality and several its subsytems were improved. Redesigned SLR system calibration - calibration RMS now is about 7ps instead of 14ps, also it’s now more stable. Fully upgraded time and frequency system now features GPS steered Rb oscillators and OXCO slave clocks connected with fiberoptic and coaxial cables. Timing system clocks were evaluated and compared with primary cesium time standards at GFZ Potsdam, Germany and results are published: E.Hoffman et. al., “Modernization and Characterization of the Riga SLR Timing System”, 19th International Workshop on Laser Ranging, Annapolis, US (2014). Redesigned telescope alignment instrumentation using stable 532nm laser diodes. Construction of new combined visual tracking/receiver channel unit is

	currently under way. New unit will allow to use additional detectors like SPAD will use CCD for tracking.

Geodynamical observatory

Picture 18. SLR (Satellite Laser Ranging) station test and measurement equipment: Frequency counter and analyzer Pendelum CNT-91

Picture 19. Heidenhain angular encoders for SLR telescope mount control

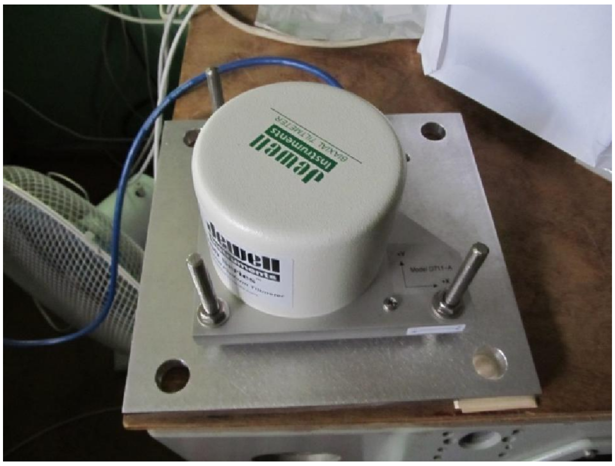


Picture 20. Single mode optical fiber cable for SLR system calibration

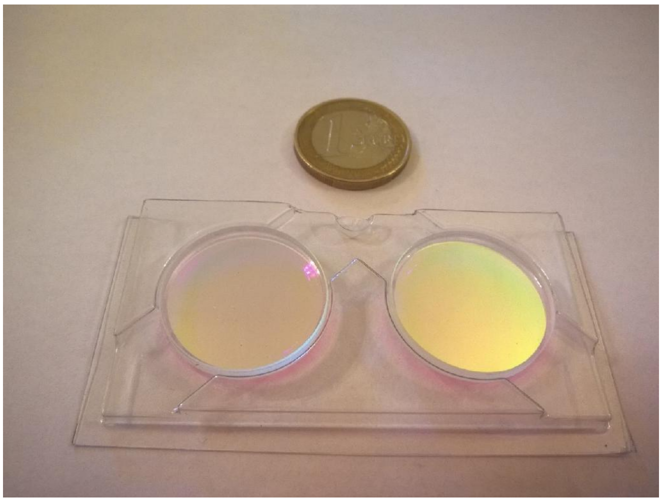
Picture 21. High stability Tektronix/Keithley DC power supply for Hammamatsu PMT photon detector installed at SLR system

Picture 22. Calibrated Leica AR25 GNSS receiver antenna about to be installed at IGS/EUREF site Riga

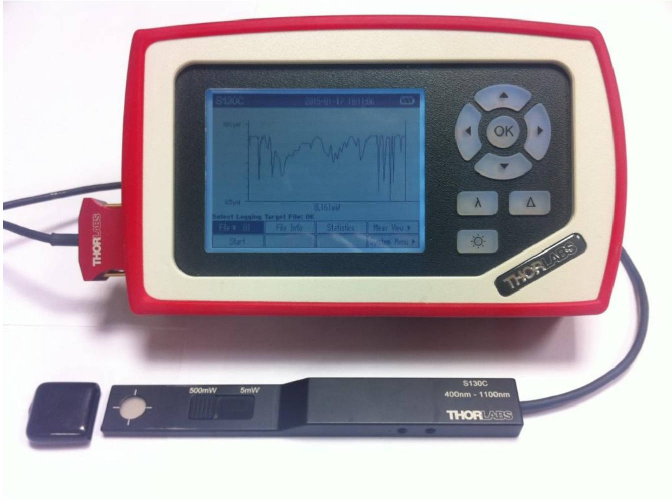
Picture 23. Geodetic GNSS receiver Leica GR25 capable of tracking all major GNSS systems: GPS, Glonass, Galileo, Beidou installed at Geodynamical station Riga



Picture 24. Jewell Instruments tiltmeter D711, mesaurement accuracy 1 microradian, for monitor laser ranging telescope vertical axis orientation and mount stability

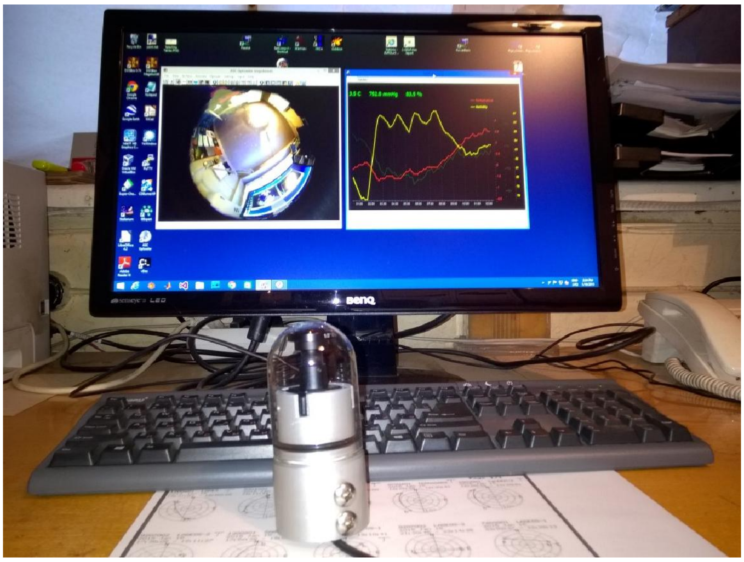


Picture 23. Laser line mirrors for the SLR telescope LS-105 receiver/visual tracking unit



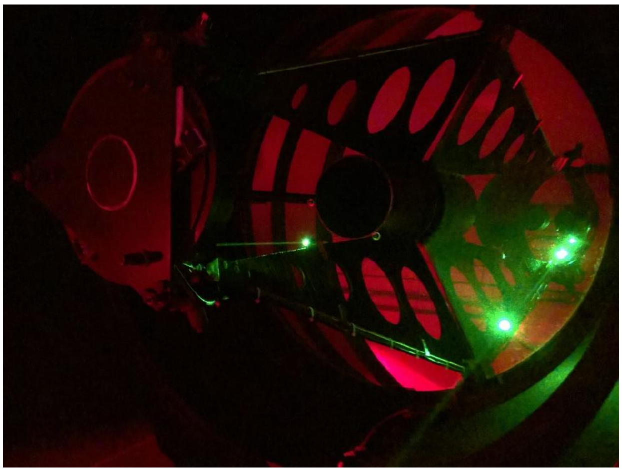
Picture 24. Laser power meter for SLR system LS-105

Picture 25. Vaisala PTU301 pressure, temperature and humidity sensor before installation at SLR telescope building

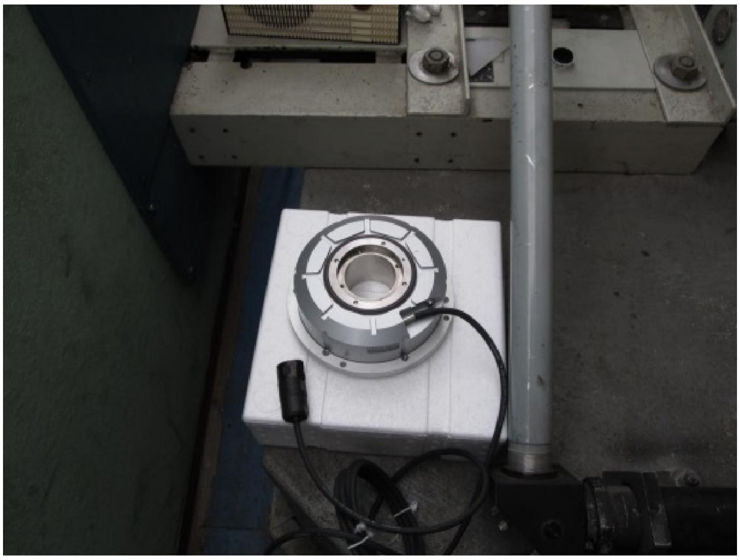


Picture 26. MoonGlow AllSky camera testing

Picture 27. SecureSync auxiliary time and frequency source with OXCO together with CNT-91 counter at telescope building while testing PMT and Constant Fraction Discriminator Tennelec 456 setup



Picture 28. CPS532 laser diode during receiver channel performance evaluation



Picture 29. Encoder for telescope azimuth axis before installing within telescope

Picture 30. Installing calibrated GNSS antenna at SLR station Riga

Picture 31. Optical components for the SLR system visual tracking/receiver channel unit

2.7. Task 3.7. Advanced upgrade of largest Baltic wide field Schmidt system telescope.

Lead scientist	Dr. Ilgmars Eglitis
Laboratory Upgraded	Institute of Astronomy, upgrade wide field Schmidt system telescope
Equipment Purchased	Flatbed scanner complex: flatbed scanner scan format 300x400 mm, resolution at least 2400 dpi, optical density up to 3.8 D; connectivity USB 2.0; supported environment, WindowsXP; with computer: dual-core processor; CPU over 2 GHz; RAM 2048 MB; CD-ROM, DVD-RW; 4 USB canals; at least 300 GB HDD; 21-inch LCD monitor;
Amount spent	2269EUR, excl. 21% VAT
Justification for the purchase of equipment	Flatbed scanner complex needed to digitalize a wide field Baldone Schmidt telescope astronomical plate archive, which obtained 1966-2005 time period. The uniqueness of plate archive is regular observations almost 40- year long period toward constellation of Swan and anticenter of Galaxy directions. Digitization will give a high volume database which will allow to explore the brightness variability of stars of different spectral types in long time span, to measure the intrinsic speed of stars, to discover new asteroids and comets.
Progress toward task implementation	The digitalization process was begun.
Scientific results	1000 astronomical plates from Schmidt telescope archive are digitalized till the July 2013.

Picture 32. CCD 2184 x 1472 pixels, Size of pixel 6,7 x 6,7 µ

Pictures 33. Scanner for astronomical plates 25x25cm

■ Will be acquired 98% of the unexploited scientific information;
■ be obtained photometric data changes (in B, V, R systems) in selected fields for almost over a period of 40 years of stars in different evolutionary stages;
■ The data will be used in stellar astrophysics, the interstellar medium and small bodies of the solar

system studies;

- To be included in the international Virtual Observatory Alliance;
- A large set of several PhD study of star formation process.

Picture. 34. For visitors in Baldone Observatory the projector was used to presenting photonics sector developments

The two 55 cm twin telescope dome coating with composite materials was performed. Telescope pavilions were mounted white beam telescope for nighttime the atmospheric properties and the determination of cosmic debris.

Picture 35. Baldone Schmidt Telescope reconstruction.

2.8. Task 3.8. Zenith Refractometer

Lead scientist	Dr. M.Cakule , Dr. J.Balodis
Laboratory Upgraded	Laboratory Institute of Geodesy and Geoinformatics
Equipment Purchased	* Laptop computer DELL Latitude E5520 15,6" 1366x768/i3-2310M/2GB/DVD-RW/BT/ 802.11n/ Windows 7 Professional * Solid Edge University Perpetual license with technical support (Insight XT/Ms Share Point App) up to 31.08.2015. * CCD matrix: Santa Barbara Instrument Group, model: STT-8300M * GNSS receiver: Hemisphere GPS, model: A325 with interface cable * Multifunctional printer HP Photosmart 6510 e-All-in-One; * Set of components for optical coude * high resolution tiltmeter HRTM * Data acquisition board RT-DAC/PCI * Rotary actuators Aerotech AGR-100 * Linear actuators M-229 * Rotary encoders Heidenhain RON-275
Amount spent	***19920 EUR***
Justification for the purchase of equipment	According to concept of zenith refractor: • Equipment for mobile computerized large volume data flow registration in field conditions is necessary. The purchased laptop computer will be used for this purpose. It will serve also for mechanical component design and associated calculations using Solid Edge software package and for device control and data acquisition software compiling • SBIG CCD matrix will be used for star field image acquisition, necessary to calculate accurate instrument orientation, relative to coordinate system, defined by reference stars. • Hemisphere GPS A325 will be used to determine an accurate instrument position in geocentric coordinate system and time of star imaging events. • Accurate actuators and encoders will be used for instrument positioning control. Mount and a number of mechanical, optical and electronic components will be used for instrument assembly, imaging support, power supply, data flow support and control functions.
Progress toward task implementation	- Software package for event timing and geocentric coordinate data acquisition using Hemisphere GPS A324 is developed and tested; - Tests of optical system are performed; - Software packages for reference star catalog download, formatting, data extraction, astrometric apparent position calculations are developed; - Instrument control software package development is in progress. - Work drawings of mechanical components are prepared. The progress in design and assembling of the instrument is limited by availability of personnel funding and of mechanical component manufacturing possibilities.
Scientific results	Instrument is under construction, some subsystem tests are performed. Scientific results are expected when instrument will be fully functional.

Picture 36. Laptop computer DELL Latitude E5220.

Laptop will be used with SolidEdge package for mechanical component design purposes and as device control computer.

CAD software package SolidEdge (academic licence) - will be used for learning of mechanical component design and load analysis

Picture 37. GNSS receiver Hemisphere GPS A325

GNSS compact high accuracy GNSS time and coordinate receiver, integrated with antenna. It will be used for site geocentric coordinate and time acquisition and event timing (gps.jpg).

Picture 38. CCD camera SBIG STT-8300M

8Mp resolution monochrome CCD camera, will be used for acquisition of star field images needed for determination of instrument orientation relative to geocentric reference frame.

Picture 39. Set of components for optical coude (flat mirrors and mirror holders).

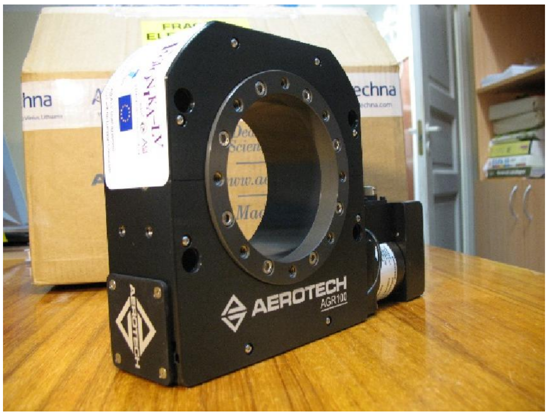
It will be used for directing of light beam through rotating mount.

Picture 40. High resolution tiltmeter HRTM.

It Will be used for accurate determination of gravity field direction.

Picture 41. Data acquisition board RT-DAC/PCI.

It will be used for computer control of actuators and data acquisition.



Picture 42. Rotary actuators Aerotech AGR-100.

It will be used for accurate rotary positioning of mount.

Picture 43 Linear actuators M-229.

It will be used for computerised levelling of mount.

Picture 44. Rotary encoders Heidenhain RON-275.

It will be used for accurate determination of angular position of mount

2.9. Task 3.9. - Upgrade of low pressure plasma research facilities

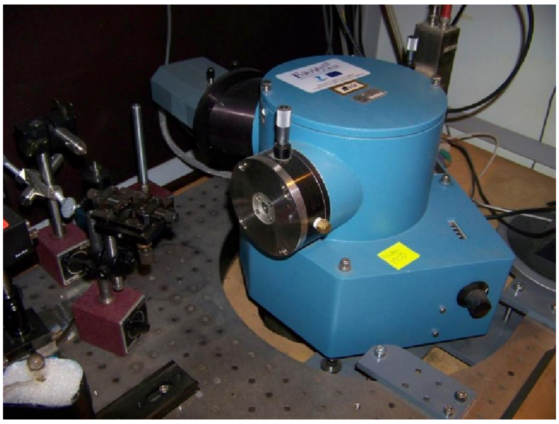
Upgrade of Low pressure plasma research facility, which were planned during project planning stage were perform form money attracted from State investment Programme. Money available for this task was transferred to the work package 3.10.

2.10 Task 3.10. Advanced upgrade of electron-beam and resistive evaporation of dielectric, semiconductor and metal multilayer achromatic optical coating installation - VU-2M for interference mirrors and filters etc. (250-1100 nm) with simultaneous photometric layer testing –

Lead scientist	Dr. Arnolds Ubelis, Electronic Ing. Janis Blahins
Laboratory Upgraded	Institute of Atomic Physics and Spectroscopy, Labor.of Atomic Phys&Photochem on behalf of new erectable Laboratory of Vacuum Coatings
Equipment Purchased	Bought: 1) Ventilator 4000 m3/h 2) Air conditioners 3 pcs 3) Stainless steel (3 separate cases) 4) Welding electrodes 5) Floor constructive 6) Antidust paints and antidust floor installing
Amount spent	1) 1332,27 LVL (Energostar) 2) 2707,33 EUR (Instarom) 3) 1612,78+1461,07 LVL (Steeltech) 4) 85,40+169,79 LVL (Rumba-V) 5) 493,23 LVL (Baumachinen) 6) 3631,10 EUR (Hagmans)
Justification for the purchase of equipment	1) For general air inlet to cleanroom where the sputtering laboratory will have processing machinery, calculated in accordance to standard for cleanrooms HVAC systems. Seller was chosen cheapest of those having high enough quality and good exploitation costs 2) Bought according to calculated heat flux from instruments to the dust-free cleanroom to maintain minimum working conditions to personnel (under 27 C), taking in consideration heat balance from air ventilators. Modell was choose with known very good lifespan expectancy, with air nanoparticle electrostatic filtering and anti-humidity functions, and bought in the shop abroad where prices was lower than for less advanced models at Riga. 3) Steel was bought for specific cleanroom environment HVAC, filtering box constructing, ventilation piping needs, for needs of most clean part of cleanroom on-wall ventilator channel mounting and for new large sized astronomical mirror aluminization apparatus vacuum chamber constructing. The seller was chosen as cheapest having the needed assortment. 4) To weld vacuum chaber and mentioned above stainless steel constructions. Seller was used geographically nearest to us who has relatively low price. 5) For cover the technical communication channels (electricity, canalisation, cooling water) with strong, cleanable and easily openable plastic covers, allowing 250 kg/m2. The seller was chosen only at region having such covers. 6) For to insulate a most cleanest part of cleanrooms walls and ceiling with specially designed and qualified for that need antidust paint and paint

	cleanroom floor with industrial quality antidust qualified plastic covering, and paint all floors for other clean zone laboratory space with less expensive industrial floor permitting to save them well clean. The seller was chosen only in region having quality warranties and good qualification proofs.
Progress toward task implementation	Bought: 1) Ventilator 4000 m3/h, bought, installed for 90%. 2) Air conditioners 3 pcs, bought, installation in progress. 3) Stainless steel, first stocks are already installed, last stock is in progress. 4) Welding electrodes, used for 80%, will be need for buy more 5) Floor constructive, 95% installed 6) Antidust paints and antidust floor installing stopped due plan changes about cleanroom configuration - there stand up idea to widen clean zone, destroy some inner walls, and therefore until now floor is not made ready for painting. Expecting that will be done in September or latest November. Planed at future: 1) Vacuum turbopump with driver module. Specifications are made, but previous concourse returned empty. This time we shall give a few seller name to concourse administrators. 2) Cryopump with few cold heads and helium compressor. Specifications are about be made with a term at 01.09.2013. 3) Tangent ventilators. All trials to buy them from local producer at Germany ended with policy "we are not selling less than million". As soon as we shall find other concurrent the concourse will be opened. 4) HEPA filter sections. Seller is known but forbidden by University regulations. As soon as local laws will be suspended for our case, them will be bought. Laws forbid e-bay and most of EU producers if they havent undergone long mediator chains, what is unacceptable by viewpoint of price-economy. Dust pollution control measures. Specifications and models are about clear, will be formulated at autumn concourse end-term 01.09.2013.
Scientific results	Results will be gained at point when all equipment will be laid to work. Today we had tiny test deposition what was used as student (bacalaure) graduation work experimental part results. At future is planed to process few astronomical mirrors as soon is possible and many at future, is planed to have optical equipment small series producing by demand, is planned to install the negative ion research apparatus GRIBAM at hall next to cleanroom, the crystal growing owe with zone cleaning regime, and use the semi-clean zone for ion implantation instrument constructing and adjusting whilst it stays at us. Later implanter place will be occupied with special laser or precision frequency comb instrument. Cleanroom will be permanently occupied with three deposition devices and sample cleaning equipment.

Picture 45. Ventilator for sputtering clean room



Picture 46. Interference Grid for optical coating installation - VU-2M

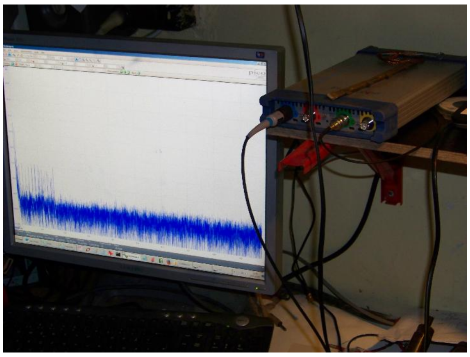
Picture 47. Air conditioner for sputtering clean room

During 2nd period following equipment is purchases:

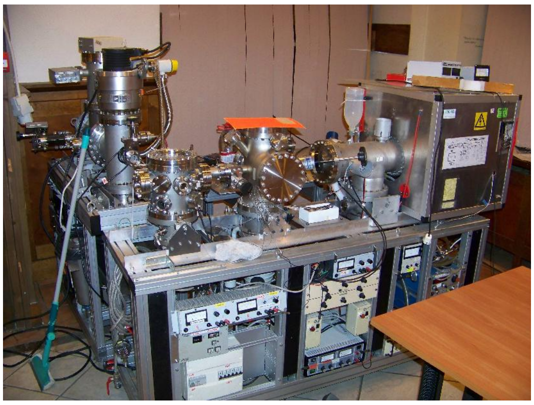
Leading scientist	Dr. Arnolds Ubelis, Electronic Ing. Janis Blahins
Laboratory Upgraded	Institute of Atomic Physics and Spectroscopy Association FOTONIKA-LV, University of Latvia
Equipment Purchased	There are purchased following equipment for Cleanroom: 1) Vacuum pumps 2) HEPA/ULPA particulate filter cells 3) Recirculation tangentventilators 4) PM measurers 5) Sputtered layer thickness meter 6) Construction metals (sheets, profiles, pipes) 7) Glass walls and installation 8) Door security system
Justification for the purchase of equipment	At the ground floor of LU-ASI existed unused slam-place of over 100 m2 what allowed to make all building-jobs to create there a cleanroom with vacuum sputtering device (690 mm chamber) allowing to make thin interference layers as conductive as insulator (glass over glass like). That allows for custom produce of any interference mirror/filter and even semiconductor device or sensor element, so economizing huge procurement expenses, as well as realizes most of imaginable projects for high-tech photonics scientific or R&D projects. More over, the new scientific ideas demands still non-existing devices with what to begin experimentation and here in ASI sputtering center will be possible to anyone working in photonics research, place the order for producing the unique test sample or test instrument. This deposition device had uncleverly made vacuum part not allowing avoiding the oil-vapor pollution, therefore old 13 000 m3/s oil vacuum pump was substituted with new 3x2500=7500 m3/s modern turbo pumps with oil-less prepumps (actually it was reused to large astronomical mirrors metallization chamber where pollution is not a problem). That was expensive purchase, however we got those hardly under price, the investment have to pay back a few years as only economic bills for electricity. Surplus apparatus becomes much nearer to ideal for processing Nano scale applications what are so sensitive about pollution. The PM measurers are demand for high class cleanrooms, and they allows to realize the full time monitoring as well the problem-place detecting. Those are two because one is rough for pre-clean room, and another is only for ultrapure environment. If there sputtering happens about Nano scale, the dust-free environment is essential, therefore in certain compartment of ground floor was designed high class cleanroom, where the sputter device had been placed. To organize a dust-purified air inlet there was purchased corresponding class HEPA and ULPA filter cells, the walls had undergone a lining with profiled double AISI-304L sheets, used for double aim - as securing the epoxidized walls dust transpiration/abrasion/erosion, as organizing recirculating air flow between purchased cross flow fans at ceiling over the filters and inlet at floor. Such design allows to economy as running costs, as installation costs. All the air-pipes were custom made by those sheets too. To process the exact layers, the exact layer thickness meter is the first must to be. Therefore was bought the very modern (based on phase controlled quartz

	sensor in contrast the frequency controlled), yet not extra expensive model. Some heavy weight schwellers was bought to re-organize our Czochralsky crystal growing heater stand to CNC driven stepper motor, larger active walk, and less vibration habit. Previously the stand`s main “bone” was too azure thus we used H profile to construct it much more stable. That allow to serve our Photonics sector enterprises as well the researchers of material-sciences or device-designers about custom grown crystalline of custom composition and custom size. Surplus that is most basic raw material source for sputtering apparatus. By the way, other sputtering centers in Balticum has over occupied by jobs working into 3 shifts, thus they never are willing to spend a time for unique “one-exemplary” projects by demand of new inventor of something. To secure the cleanroom against non-qualified stepping in - thus pollution, there was obtained the RF driven door security card system, what was extended to few other LU-ASI maindoors too, so allowing in the future to minimize the watchmen number and running-expenses for Fotonika-LV center existence.
Progress toward task implementation	Vacuum pumps are waiting for floor will be painted/dried and initial cleanness regime will be gained into cleanroom before installation. Before that it is damaging even unpack pumps. The warranty includes the help of supplier at spring time to adjust them to the system. Steel is already spent, HEPA filters are mounting into prefilter box, but not into cleanroom yet, where beforhand must be gained pre-clean status like for the vacuum pumps. Ventilation pipes are installed, both prefilter boxes are ready, dust-proof glass walls was installed. RFID door control system was installed, however it activation is still on the tray due the fire-inspectorate demanded to make a slight changes to the system what supplier not wants to fulfill without of additional price, thus we are disputing about these two to get a permission to switch on.
Scientific results	DireThe Fotonika-LV Sputtering Center and it consistent - cleanroom gives a try to first high class cleanroom in Baltics, permitting to design a Nano scale material sciences experiments, allows to fabricate experimental samples of sensors or devices for R&D designers in the Photonics field for very attractive price or some occasions even dotted. Thus the innovations in the Photonics field will have a much easier way toward markets.

Picture 48. HEPA Filtrs for cleanroom



Picture 49. Picoscope USB osciloskope.



Picture 50. Vacummeter (on the right on top)

Picture 51. Vacuum pump.

Picture 52. PM meter.

Leading scientist	Dr. Arnolds Ubelis, Electronic Ing. Janis Blahins Janis Blahins
Laboratory Upgraded	Institute of Atomic Physics and Spectroscopy Association FOTONIKA-LV, University of Latvia
Equipment Purchased	There are purchased following equipment 1) Vacuum chamber
Amount spent	25800 Eur
Justification for the purchase of equipment	Chamber was custom-made for to solve a problem of eldening the astronomical mirrors at several Latvia astronomer installations and shortage of renovation capabilities. Until now they had to had forward mirror once a teen years far abroad, where transportation was expensive, risky for damages and processing even more expensive, yet with poor quality. Having equipment at the local place gives a serious price-cut and transparent responsibility of layer quality. Additionally, metallization equipment gives a chance to begin some activities for custom-producing and offering LU Astronomy institute`s portfolio of projects on new type of scientific instruments, like fleksible SLR, like Zenith telescope, like White-light complex etc. Two people of Fotonika-LV was undergone certain hands-on training of using similar device for 1200 mm mirrors at Crimea Observatory just before the war there begun.
Progress toward task implementation	Chamber shell is received at 30.01.2015 and stored at appropriate facility, where soon will be organized the Fotonika-LV heavy duty technical center (trans-institutional mechanical workshop). The vacuum pump to attach the chamber will be used one we have, what was not enough qualified for demanding deeds, yet is satisfactory for mirror processing. Until the end of project there will be crafted the adapter neck between new chamber and pump and connected the custom -made mirror positioning motor as well the adapted metal-evaporator power supply.
Scientific results	Scientific results will follow after each concrete mirror installation on the concrete aimed specific science project about astronomy and will benefit for decades long future, making accessible projects what was previously non-accessible.

Picture 53. Vacuum chamber

Leading scientist	Janis Blahins
Laboratory Upgraded	Institute of Atomic Physics and Spectroscopy Association FOTONIKA-LV, University of Latvia
Equipment Purchased	There are purchased following equipment 1) Turning bench (max diameter 720 mm) 2) Grinding bench (max diameter 1350 mm) 3) Bandsaw bench (max diameter 400 mm) 4) Stand drill bench (max offset 700 mm, cone No.3)
Amount spent	1) 16 235 Eur
Justification for the purchase of equipment	In the early ninteens University had a malpractice to destroy all non-science instruments. Mechanical workshops was claimed “non-scientific; everything for science must be bought in the procurement”. Later turned out that most of scientific projects cannot avoid metalworks before experiments, and in most cases there are no factories ready for one custom device/detail or the price is skyscraping. Such situation is common for all LU institutes now, thus this is on-going effort to call back the good universal mechanical workshop for all Fotonika-LV members, having relative independence of LU caprices. If there is no workshop, there is no way for science, except pure theoretical disciplines.
Progress toward task implementation	Equipment at 30.01.2015. was loaded at Astronomy institute belonging watched premises at Baldone rural territory 30 minute driving off the Riga, because there is no space limitations as well the electrical input limitations. The plan is to connect and get ready all machinery before the early spring. In the future plans is to alter that machines installing the digital position readers, stepper motors and CNC software (we have a previous experience about that in smaller scale).
Scientific results	None direct. Huge indirect. All the results must be derivate outcomes of new scientific apparatuses what will be there processed, when scientists will have projects and some financing for it. Existence of such workshop allows to strong economy procurement prices as well as allows to produce details in sizes what are very hard somewhere else at Latvia.

Picture 54. Tools, Work tables.

3. Conclusions

All purchases of Equipment are made according planning made in beginning of project. Purchased equipment allows strengthen capacity of Association Fotonika LV and support scientists are recruited in a project. It will allow making scientific research at a much higher scientific level using upgraded equipment.