A.ALIKHANYAN
National Laboratory

ANNUAL REPORT 2014

Artem Alikhanyan National Lab (AANL)

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2014 STATUS REPORT

A. Alikhanyan National Laboratory (AANL)

(Yerevan Physics Institute, YerPhI)

1. INTRODUCTION

Vision: *A. Alikhanyan national lab has distinctive expertise and insights relating tohigh-energy physics and astrophysics, nuclear physics, scientific instrumentations and multivariate data analyses, as well as in education. National lab should serve for the positive influence and impact to national values through research, education and innovation programs. National lab provides opportunities for intellectual, personal and professional growth. Learning and working at national lab will foster high professionalism, quick, well-rounded minds, well equipped to succeed in our fast-changing world.*

Mission: *Perform world-class research in Armenia, participate in world-biggest scientific collaborations, and offer scientific instruments and services for Armenian nuclear medicine, industries and cultural studies. Establish high standards of education in master and PhD courses; demonstrate that science and education can really provide development of Armenia.*

AANL continuing implementing the InComEx's (International Committee of Experts) recommendations[1] and is focusing the scientific efforts on defined priorities. In 2014 the AANL strengthened its scientific activity in traditional scientific directions and increased activity in nuclear physics. The National committee of science approved four projects in nuclear physics using 18-MeV proton beam of new IBA cyclotron, to be installed on former premises of YerPhI in 2015:

1. Development of the medical 99mTc isotope direct production methods with C18 cyclotron proton beam – A. Avetisyan
2. Investigation of the Proton-Induced Reactions Excitation Functions on Tungsten Using the Cyclotron C18 – I. Kerobyan
3. The formation of neutron flux by proton beam of cyclotron C18 for nuclear reactions investigations – R. Avagyan
4. Decay particles spectrometer – H. Vardanyan

AANL scientists plan as well to collaborate with new opening diagnostic center in preparation of new medical isotopes.

The program of the innovation projects continued in 2014 with lidar based device for the remote electric field estimation in thunderclouds and scintillation detector system for the carbon dating in low background solar mine. A new scintillation detector was designed for registering of low energy electrons from thunderclouds on the high altitude station Aragats. Installation of this detector along with gamma ray spectrometer will allow disentangling mixed electron –gamma ray fluxes of thunderstorm ground enhancements. A robotic machine was designed and fabricated by young scientists and engineers in the isotope research department for transportation of radioactive materials. New device for the fluorescence analysis of organic materials was designed and fabricated in the applied physics department. Experimental physics and accelerator divisions in 2014 were preparing synchrotron for the operation in the new mode. The power

supplies and vacuum checking devices for synchrotron machine were repaired, vacuum pumps were repaired and pumping performed. However these works do prepare synchrotron for the operation. The main drawbacks were physical condition of the 50-year old machine and leakage of water resulted in corrosion of significant parts of synchrotron. The absence of yang engineers and technicians in accelerator department did not allow expecting repairs and modernization in future. Fall the year A.Chilingarian asks DESY directorate gather a meeting to find out possible DESY support. Dr. Jensen tell that in principle it is possible to keep electrons in ring for ~5000 rounds. However for it a computer controlled power supplies with feedback are needed. 10 years ago DESY donate this equipment to accelerator department, however nothing was done. Dr. Fleisher was ready to donate another power supplies, however he strongly advised not to put any money and any efforts to this old machine. Performed repairs will be used for the conservation of synchrotron, now underway.

A novel equipment for the elemental analysis the ARL QUANT'X Energy-Dispersive X-Ray Fluorescence Spectrometer from Thermo Electron Corporation (USA) installed in 2014 was used for analysis of superconductors, archeology materials, concentration of metals from the underground resources of Armenia and others (see attachment 7).

An automatic weather station was installed in the new monitoring site established nearby Sevan lake. The monitoring of the particle fluxes nearby Sevan lake do not demonstrate any of thunderstorm ground enhancements (TGE) proving unique position of Aragats research station where TGEs are copiously registered each Spring and Autumn.

Number of publications in peer reviewed journals and participation in international forums continue to be high; fruitful collaborations with world-largest high energy physics centers strengthened, cooperation agreements were renewed with a number of Russian institutions. New seminar for young scientists and students actively operates; institute employees presented twenty-one talks and invited lecturers see attachment 5.

Program to support and motivate young scientists was successfully continued; it helped to mitigate aging profile of the AANL. The age structure of institute has improved with employing in 2001-2013 40 master students from Yerevan universities. Some of them enters PhD program in institute, different departments of institute hired some of students. Unfortunately due to overall decay of high education in Armenia number of students in 2013-2014 diminished, we have problems to attract new talents for work in our collaborations in CERN, DESY and Jlab. Number of PhD students and PhD defenses also were less in 2014 comparing with previous years. Master courses start operation in national lab in 2014. Programs were prepared and lectures started to educate students in the field of the experimental high-energy physics and astrophysics. As well we held summer school for students in 2014. Students attend lectures and labs of national center as well as the Aragats research station. New classes equipped with modern electronics and particle detectors started to operate in education center of national lab.

About 400 registered VOIP users are connected to internal network by IP soft phone and Ip phones.

Directorate of AANL establishes special regulation for hiring new employees by competition and examination. 2 young scientists and 5 engineers were employed in 2014 according to this procedure. Major changes and painful optimization of the age structure was performed in fall 2014 according to adopted strategic development plan. 30 scientists with age above 30 were

fired; however they can return to office for time not exceeding 6 months on requests of heads of divisions. Repairing the AANL campus's infrastructures and high altitude research stations was continued. The international conference center in Nor Amberd was innovatively repaired and now meets stringent international standards for holding workshops and small-scale symposiums.

The infrastructure of 5-th floor of main building, where theory department resided was completely repaired. In 2014 the TEPA-2014 workshops were successfully held (see attachment 7). AANL scientists won 20 state and international grants (see attachment 3).

2. SUMMARY OF THE SCIENTIFIC ACTIVITIES OF AANL DEPARTMENTS

2.1. Experimental Physics

In the reporting period, the research groups of the division have been taking part in the high-energy physics experiments carried out at such international research centers as CERN-LHC, DESY-OLYMPUS, HESS and JLAB-Hall A, B, C, D. The ATLAS group continued the processing of the data from 8-TeV proton-proton collisions; in particular, they calibrated the energy of hadron jets by the multi-jet-balance and measured their inclusive cross-section. The group's postgraduate student has made a report at the XXII Deep Inelastic Scattering and Related Subjects Conference on the measurement of the jet cross-sections entitled "Measurement of the jet production cross-section at 7 TeV". At the Compact Muon Solenoid (CMS) Experiment, the National Laboratory's group has made their contribution in the Higgs Boson's discovery through the fermionic decay of H-> {BBbar, ττbar}. The group has also taken part in the calibration of the CASTOR (Centauro And Strange Object Research) calorimeter located at the front of the CMS detector, using the experimental data from *pp*-collisions - (η, ρ, ω, φ) mesons which decay into $\gamma\gamma$ and e^+e^- pairs. The 2013 data on the *p+Pb* ($\sqrt{s}$ *= 2.76 TeV)* experiment, using TOTEM telescope, has been processed for the energy calibration of CASTOR calorimeter. The CMS group have taken their part in the investigation of the proton gluon distribution function (PDF) in the low-*x* region, using the standard HERA PDF functions *f(x)*. The processing of the data on the muon pair production in the invariant mass range of $M<1.5$ *GeV* at 8 GeV *pp*-collisions is under way in the ALICE Experiment at CERN. The functionality of Grid System of ALICE Experiment has been improved as well as the "File Access Monitoring Service" (FAMoS) software updated.

In 2014, the JLAB Hall A, B, C and D groups continued to take part in the acquisition and interpretation of the data of CEBAF's 6 GeV experiments. These groups have also taken part in the 12-GeV experiments as well as in the designing of the new equipment. In particular, they took part in the assembling of the high-threshold Cherenkov counter for CLAS 12, in the testing of the preshower counter of SHMS magnetic spectrometer and neutral particle spectrometer (NPS); they also took part in creating of graphic tools and software for low- and high-voltage power supply units of CEAN and WIENER.

With the purpose of measuring the *e+p/e-p* elastic scattering cross-section ratio, the DESY research group has taken part in the processing of the data from the OLYMPUS Experiment on DORIS accelerator.

The investigation of astrophysical sources with the help of imaging atmospheric Cherenkov telescopes of HESS collaboration is under way as well.

Within the framework of a program for search for rare channels of fission of heavy nuclei, there have been developed a number of techniques, such as a technique for the measurement of the resolution of germanium detectors and efficiency of registration of gamma rays.

There have been conducted computations concerning the low-energy nuclear reactions induced by the proton beam of C18/18 cyclotron. The possibility of generation of neutron beams has been considered. The nuclear reactions initiated by the medium-energy deuteron beam of LHEP JINR nuclotron have been investigated.

2.2. Cosmic Ray Physics (CRD)

2014 research activities were concentrated on the new emerging scientific field of High-energy physics in atmosphere where CRD is one of world leaders.High-energy processes in the magneto- sphere and atmosphere such as Thunderstorm ground enhancements (TGEs), terrestrial gamma ray flashes (TGFs), and transient luminous events (TLEs) trigger various dynamic processes in the Earth's environments and have broad astrophysical relevance. The problem of how lightning is initiated inside thunderclouds is not only one of the biggest unsolved problems in lightning physics; it is also probably one of the biggest mysteries in the atmospheric sciences. The relationship between thundercloud electrification, lightning activity, wideband radio emission and particle fluxes have not been yet unambiguously established. One of most intriguing opportunities opening by observation of the high-energy processes in the atmosphereis their relation to lightning initiation. Investigations of the accelerated structures in the geospace plasmas can as well shed light on particle acceleration to much higher energy in the similar structures of space plasmas in the most distant objects in the universe.

Particle detectors, field meters, lightning detectors and weather station located on the slopes of Mt. Aragats in Armenia provide 50 msec, 1-second and 1-minute time series 24/7 whole year. TGE comprises fluxes of the electrons, gamma rays and neutrons detected by the particle detectors located on Earth's surface. Simultaneous measurements of the gamma ray differential energy spectra, electric field disturbances, and meteorological conditions provided by experimental facilities located at Mt. Aragats in Armenia allows to establish the model of particle acceleration and propagation in thunderstorm atmosphere. We perform detailed comparisons of measured and modeled thunderstorm ground enhancements (TGEs). The power law shape of the gamma ray differential energy spectra tends to soften with increasing electric field strength. When the intracloud electric field reaches the Relativistic Runaway Electron Avalanches (RREA) initiation threshold the TGE intensity exponentially grows and an exponential fitis suitable for the spectra interpolation at energies 7–20MeV; at higher energies the power law fit describes the spectrum rather well. The TGE patterns zoomed in hierarchy of time series scales incorporating electric field changes, lightning occurrences, Extensive Air Shower (EAS) detection and optical monitoring of the skies allows to draw definite physical inference on long-standing problems of the atmospheric discharges.The high frequency detector, installed in September 2014 at Aragats allows to record the waveform of HF radio emission with temporal resolution of 5ns, repetition rate of 1 Hz, and data capture length of 5 ms. The radio measurements are compared with the time series of the near-surface electric field disturbances and with the time series of occurrences of lightning. Proceeding from the simultaneous measurements of the lightning occurrences, slow and fast electric field disturbances, particle flux enhancements and its abrupt terminations we formulate a lightning origination model supported by the simultaneous measurements of the lightning occurrences, slow and fast electric field disturbances and particle flux enhancements and terminations.

CRD scientists publish 5 papers in referred journals, organize annual TEPA (Thunderstorms and elementary particle acceleration) symposium in Nor Amberd and present talks on largest international forums, including American geophysical union (AGU) fall meeting (invited talk).

2.3. Theoretical Physics

Theory Division consists of several small groups, working on different problems of modern theoretical physics. Currently we have 17 doctors of science, 21 Ph.D. and 4 students.

The activities of the members cover a large area from mathematical and theoretical high-energy physics to the condensed matter theory, statistical physics, quantum mechanics and thermodynamics.

The main directions of investigations in 2014 were:

Theoretical high-energy physics: phenomenology, quantum field theory and integrable models. These traditional for Department directions continue to bring new achievements and results. One can declare that in this area we certainly have Scientific School with several high-qualified experts and ability to teach and prepare new master and PhD students who successfully defend their Theses and obtain positions at the Division or get postdoctoral positions at universities worldwide.

During 2014 Department published 30 articles in international journals. The members of Division participated in more than 15 conferences and international workshops.

One can single out three important events happened during 2014 in Department:

- The member of department (R. Poghossian) gave invited lecture course for master students at the Second University of Rome (Tor Vergata).
- Another important achievement not only of Theory Division, but also for Institute is the fact that in Review of Particle Properties for 2014, published in Chin. Phys. C38 (2014), whole subsection "Electroproduction" (pages 1388-1389) in section "Baryons" is based on the review paper of I. Aznauryan on electroexcitation of nucleon resonances obtained till 2014.
- Head of department (R. Manvelyan) successfully organized international workshop:

"Frontiers in field and string theory"
International Workshop, September 22-26, 2014, Yerevan, with participation of the many recognized experts in area of string/field theory from Europe and USA.

In means of important publications, we can mention four most important results:

1) Investigation of the Quantum Chromodynamics corrections to the double differential decay of B-mesons producing two photons and massive strange quarks (H. Asatryan [1]),
2) Exact calculation of partition function in Chern-Simons theory using new universality properties of classical and exceptional Lie groups (R. Mkrtchyan) ,
3) Second order in coupling constant corrections to the Zamolodchikov's famous analysis of the renormalization group trajectory for minimal conformal field theory models. (R. Poghossian)

Description of the Quantum Chromodynamics strings as an effective string whose action describes long-range stringy fluctuations. (A. Sedrakyan)

It is worth to mention that appearance of such a type of high-level publications in international journals and in collaboration with the recognized experts was possible only because of existence of the above-mentioned scientific school and laborious work of two-three generations of theorists of our Department.

2.4. Applied Physics

Investigation of solid state materials with application of high-energy particle irradiation and accelerated particle beam diagnostics.

In Applied R&D Division investigations in following directions are performed

- Radiation effects in solid state materials
- Luminescence spectroscopy of wide-gap materials
- Investigation of active biological environments
- Electrophysical and magnetic properties of dielectric materials
- Development of methods for accelerated ion beam diagnostics

The long-time relaxation (LR) and residual conductivity in n-type gallium phosphide (GaP) crystals irradiated by 4,10 and 50 MeV electrons were studied. A manifold increase in photosensitivity and quenching of residual conductivity were found as a result of irradiation.

The role of interstitial atoms and divacancies, electrically passive oxygen and impurity atoms in formation of radiation defects, in particular, clusters of point defects, as well as their influence on electrical and optical properties of silicon crystals are shown.

It was shown that the studied electron irradiated films deposited on n-Si had electron conductivity (across the film surface), with charge carriers mobility of over 2400 $cm^2/V•s$ and specific electrical resistance less than 10^{-3} Ω•cm.

Radiation effects on wide-gap single crystals are spectroscopically investigated for pure and rare-earth doped materials (garnets, corundum) from the point of view of defect creation under extreme conditions (e-beam and neutron irradiation, low temperature, high vacuum).

Development of a new type of vibrating wire monitor (VWM), which has two mechanically coupled wires (vibrating and target), was presented. The new monitor has a much larger aperture size than the previous model of the VWM, and thus allows us to measure transverse beam halos more effectively. A prototype of such a large aperture VWM with a target wire length of 60 mm was designed, manufactured, and bench-tested. Initial beam measurements have been performed at the Fermilab High Intensity Neutrino Source facility, and key results are presented.

With application of chemilumine scence methods investigations on influence of X-Ray (150-200keV) and ultraviolet irradiation on biological model systems had been performed. It is shown that in X-Ray and UV irradiated systems creates intense overoxidation of thin film structure lipids.

Development of “Luminescence analysis universal setup” had been performed, which will allow to investigate the effects of irradiation on biological active environments.

Works are performed on new experimental setup according to project to perform experiments on ion beam in Cyclotron C-18MeV. Currently personnel of Applied R&D Division is working on development of measurement chamber and in near future it will be ready for In-situ investigation of electro-physical properties of single crystal and thin film dielectric and semiconductor materials as well as active biological environments under various intensities

Number of papers during 2014 - 7 papers in rated journals and 10 presentations on International conferences.

2.5. Isotope Investigation and Production

^{99m}Tc is the most widely used isotope in nuclear medicine today. Presently, Armenia gets this isotope from abroad providing 6-8 days of patients' scanning. The delivery frequency is 1-2 generators ^{99}Mo/^{99m}Tc every 1–1.5 months.

Last decade many scientific centers are working hard to find alternative technologies of Mo/Tc production, in particular using charged particles accelerators. Various accelerator-based schemes for ^{99}Mo production and direct production of ^{99m}Tc are being studied [1,3-8]. For proton beam energies close to 25 MeV ^{99m}Tc can be produced directly via the reaction ^{100}Mo(p,2n)^{99m}Tc.

In general the focus is on the direct production of ^{99m}Tc from proton bombardment of enriched molybdenum and although other accelerator based technologies are feasible. Usable quantities of ^{99m}Tc can be produced by the ^{100}Mo(p,2n)^{99m}Tc reaction which has a peak in the cross-section at 15-16 MeV, well within the reach of many commercial medical cyclotrons. With 150 μA on target using 19 MeV protons for 6 hours, up to 9 Ci (333 GBq) of ^{99m}Tc can be produced 2 to 3 times per day, which is enough to supply a large metropolitan area. Higher yields can be reached with higher energy cyclotrons and/or with a more intense beam current.

Armenia purchased a C18 cyclotron and now is in the process of its commissioning.There are plans for research and applied tasks execution using proton beam of that cyclotron in particular ^{99m}Tc direct production technology development and trial production.

For that task one of the problems is preparation of metallic Mo tablets with enough high mechanical strength and enough high thermal conductivity.

1. To prepare a target tablet from metallic Molybdenum powder with enough high mechanical strength and thermal conductivity a new method was suggested by which a natural molybdenum powder has been pressed with ~40000N force, then its surface has been burn out by use of focused solid-state laser beam. The technology development is completed; an article has been prepared for print.
2. After Mo irradiation and produced ^{99m}Tc extraction the solution with Mo should be recovered till metallic powder state for multiple irradiations. For that a technology of Mo recovery has been created by which on the first step the Mo dissolved in a base is recovering to MoS_3. The R&D of the technology of this step is completed, the layout has been mounted and tested with positive results.
3. To transport the irradiated target with high level of activity the remote control robot has been designed and constructed. It could capture the capsule and/or target disc from container and put it into "hot" cell for technetium extraction. Due to high level of activity it is impossible to do by hand. The above mentioned robot is completely ready to use.

Number of papers during 2014 - 3 papers in rated journals and 1 presentations on International conferences.

2.6. Center for Cosmology and Astrophysics

Studies have been performed by means of the PLANCK satellite. It was shown (Astronomy & Astrophysics, 566, A135, 2014) that the Cold Spot, a non-Gaussian region in cosmic microwave background sky, reveales properties typical for the voids in the large scale matter distribution. Then it becomes the biggest known structure in the Universe. This conclusion was discussed in cosmological web portals and soon after, the same conclusion (Cold Spot-supervoid) has been reached by the study of the galaxy large scale surveys (I.Szapudi et al, arXiv:1405.1566).

PLANCK's data enabled us to detect (Astronomy and Astrophysics (Letters) 565, L3, 2014)the halo of M31 in microwaves, after preliminary study with WMAP satellite. The results reveal for the first time the size and rotation of the halo. Also, a tiny signal is detected possibly due to the regular motion of M31. This study performed with Italian and Swiss colleagues was included in the Highlights of the journal Astronomy & Astrophysics (impact factor = 5.084).

The studies with LAGEOS and LARES satellites have been continued on the high precision tests of General Relativity. Particularly, the Yarkovski-Rubincam effect was detected using the data by LAGEOS 1 and 2 satellites. It is the first detection of this effect distorting the satellite trajectories for artificial satellties.(Phys. Scripta, 89, 084006, 2014; in : Frontiers in Relativistic Celestial Mechanics, Walter de Gruyter GmbH Publ., Berlin, p.158, 2014).

Lectures have been given within the series Frontiers of Modern Physics, where along with theoretical problems advanced numerical methods used in various physical problems have been presented: pdf files of the lectures are available here: http://cosmo.yerphi.am/cosmology-lectures/. Talks have been given at several conferences.

2.7 Computer center

During the reported period the following tasks were performed by AANL IT Department:

- technical support of network equipment, servers and user workstations.
- Upgrade of the Fiber Optic segments of AANL Local area Network.
- technical support of VOIP phone service with the full PBX integration. Now we have 400 registered telephone users.
- GRID upgrade from EMI-2 to EMI-3 stage. Include of all underlying software, services libraries, etc. with consideration and requirements of ALICE and ATLAS groups. Upgrade of all Grid worker nodes OS , Kernels.
- Mail server: upgrade spam control and virus scanning software update
- Update ROOT, GEANT4, CERN libraries, specific HERMES/OLYMPUS software.
- Support of the Eduroam authentication service in YerPhI and worldwide.
- Change of the old switches to the new manageable Laer2 switches in TH division.
- Additional 20 workstations were added to network.

3. IMPROVING THE AGE STRUCTURE OF THE AANL

The administrative structure of AANL after intense hiring of master students in 2011-2013 was significantly improved. In 2014 as a transitional year ~31 scientists and engineers with age above 70 years were dismissed from the AANL staff. Total number of employees above 70 years is now 17; below 35 years – 79. See, age distribution in Figure 1 and Table 1. The employee age based Key performance indicators (KPI, see attachment 2) equals K = N <35 / N>70 = 79/17 = 4.64 .

Before major modernizations this number was below 1. However among group leaders there are only 4 persons below 40 (4 from CRD). Overall number of employees decreases from 2009 to 2014 by 132 persons: 499 in 2009, 416 – in 2013, 367 - 2014.

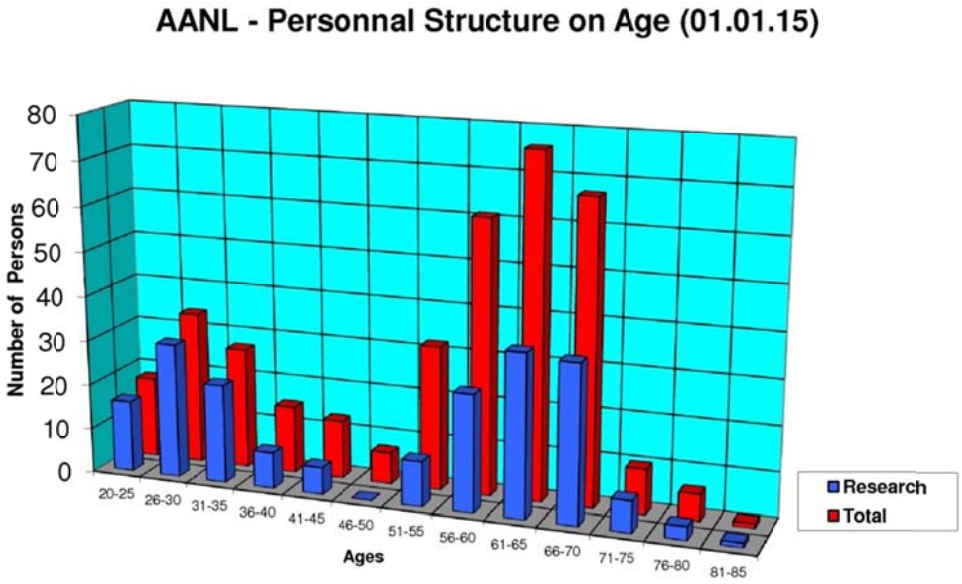

Figure 1. AGE distribution of the AANL employees

№ n/n	Division (department, service)	Breakdown on age												TOTAL (person)
		till 35 years	36-40 years	41-45 years	46-50 years	51-55 years	56-60 years	61-65 years	66-70 years	71-75 years	76-80 years	81-85 years	over 86 years	
1	Directorate	0	0	0	0	1	1	0	5	0	0	0	0	7
2	Administration	6	0	2	0	4	4	3	4	0	1	0	0	24
3	Experimental Physics Divizion	24	1	1	0	1	10	13	11	5	1	1	0	68
4	Theoretical Physics Divizion	13	2	2	0	6	8	7	3	1	1	0	0	43
5	Cosmic Ray Division	10	6	3	1	1	6	11	12	0	1	0	0	51
6	Accelerating Physics Divizion	4	1	0	0	2	3	5	9	1	0	0	0	25
7	Applied Physics Department	4	0	0	0	0	3	8	4	0	1	0	0	20
8	Isotope Research and Production Department	6	0	0	0	1	2	4	4	0	0	0	0	17
9	Cosmology and Astrophysics Centre	4	0	0	0	0	1	0	0	0	0	0	0	5
10	Computer Center	5	0	0	0	1	1	1	0	0	0	0	0	8
11	Industrial and household services	1	3	5	3	11	14	15	8	3	1	0	0	64
12	Security guard	2	2	0	3	4	8	9	7	0	0	0	0	35
	IN TOTAL:	79	15	13	7	32	61	76	67	10	6	1	0	367

Table 1. Breakdown on age as it is on 1.04 2015

4. AANL PUBLICATIONS AND CITATIONS

Government administrators need reliable and comprehensive bibliometrics to measure and promote unique strengths of scientific and educational institutions, understand opportunities for improvement and collaboration, as well as monitor their progress.

The mission of A.Alikhanyan national laboratory as it was declared in its strategic plan is to perform world-class research in Armenia in the field of high-energy particle physics and astrophysics, in theoretical physics and material science. To achieve these goals scientists of the national laboratory perform sophisticated experiments on own experimental facilities and participate in world's biggest scientific collaborations. In the future will be offered scientific means and services for Armenian nuclear medicine, industries and cultural studies. Established high standards of education in PhD program that are offered by national laboratory scientists demonstrate that science and education can really promote development in Armenia. In the presented paper we perform numerical analysis of the current progress based on internationally accepted Key performance indicators. Comparisons of national laboratory and other largest Armenian institutions were based on the Thompson Reuters database.

A I. Alikhanian National Science Laboratory (Yerevan Physics Institute) in recent years has significantly enhanced its status as a leader in the science of Armenia.

Number of articles published in peer review journals by YerPhI annually is the more 35% of the country's overall published articles and what is more essential according Thomson Reuters prestigious journal over 76% of citations of Armenia's scientific results goes to YerPhI. The institute for its international recognition of its scientific potential and the scope and quality of work occupies a special place in the unique research infrastructure of the organization that proposes ways to develop science and science-based technologies in various fields of modern physics.

According to the international standards, the journals classified by the Thomson Reuters (Web of Science) should be used both for counting publications and citations. In Table 1 we put the all-Armenia and YerPhI citations and publications from 2008 till 2014 years.

Table 1. Comparison of all-Armenia and YerPhI bibliometrics results

Year	2008		2009		2010		2011		2012		2013		2014	
	Publ.	Cit.	Publ.	Cit.	Publ.	Cit.	Publ.	Cit.	Publ.	Cit.	Publ.	Cit.	Publ.	Cit.
Armenia	**670**	**3000**	**610**	**4200**	**700**	**4800**	**750**	**7000**	**910**	**11100**	**810**	**12900**	**630**	**10500**
YerPhI	**124**	**1900**	**126**	**2800**	**160**	**3000**	**230**	**4700**	**325**	**8400**	**290**	**9800**	**230**	**7500**
%	**19%**	**63%**	**21%**	**67%**	**23%**	**63%**	**31%**	**67%**	**36%**	**76%**	**36%**	**76%**	**35%**	**71%**

We can see from the Table 1 that in recent years, the growth rates of Armenia is mainly due to Yerevan Physics Institute scientists' impressive results. In these years, to enhance the

effectiveness of the YerPhI scientists was implemented, recruitment of young personnel, scientific infrastructure improvements, expansion of international collaborations.

YerPhI has continued basic research in theoretical and experimental elementary particle, nuclear and cosmic ray physics, applied research. Cosmic Ray Division scientists started 3 new scientific topics, namely solar-terrestrial relations, Space weather and high energy phenomena in atmosphere where become one of world leaders. Developed world-wide network is continuously measuring important geophysical parameters; appropriate forewarnings and alerts are issued for the space storms and dangerous thunderstorms.

YerPhI scientists continue actively participate in high-energy physics and astrophysics experiments in Armenia and abroad. Yerevan Physics Institute is active member of 3 LHC collaborations: ATLAS, CMS and ALICE. During last 20 years groups of our scientists actively participate in construction of experimental facilities. After starting LHC program in 2011 large harvest of the experimental results and related publications culminated in Nobel prize in 2013 awarding the enormously efforts of LHC scientists. Armenia should be proud that most important discovery of last decades in particle physics was co-authored by YerPhI scientists.

Table 2 below shows the results of the 2012-2014 Armenia's largest scientific institutions indicators according to Thomson Reuters' Web of Science database. The last column for of the Table 2 shows the summary h-index, which enumerates overall results of the scientific research of a institution. Over the past 20 years, our scientists have published more than 3700 publications.

Table 2. Bibliometrics results of the largest Armenian scientific institutions

h/h	Scientific Organizations	2012		2013		2014		h-index
		Publ	cit	publ	cit	publ	cit	
1.	Yerevan Physics Institute	325	8400	290	9800	230	7700	85
2.	Yerevan State University	210	1240	220	1340	165	1250	31
3.	Ashtarak- Institute for Physical Research Institute for Radiophysics and electronics	52	230	47	320	39	275	18
4.	Byurakan Observatory	30	120	16	125	19	139	13
5.	Yerevan State Medical University	31	120	24	190	27	210	12
6.	Institute for Molecular Biology	17	115	19	113	8	95	12
7.	Russian-Armenian (Slavonic) University	23	72	16	86	16	90	11
8.	Molecular Structure Research Center	7	55	11	57	8	53	11
9.	Institute of Biochemistry	17	80	22	79	8	60	9
10.	National Engineering University of Armenia	16	72	10	71	12	62	9
11.	Institute of Applied Problems of Physics	17	65	18	108	12	90	9
12.	Institute of Chemical Physics Named After A. Nalbandyan	8	32	7	44	6	60	9
13.	American University of Armenia	12	33	2	32	10	34	8
14.	Institute of Fine Organic Chemistry	15	33	21	19	17	28	4
15.	CANDLE	1	13	1	14	2	12	4

The total number publications published by Armenian scientific organizations in 2014 (Thomson Reuters, Web of Science) and the number of citations to these publications is shown in the following diagrams:

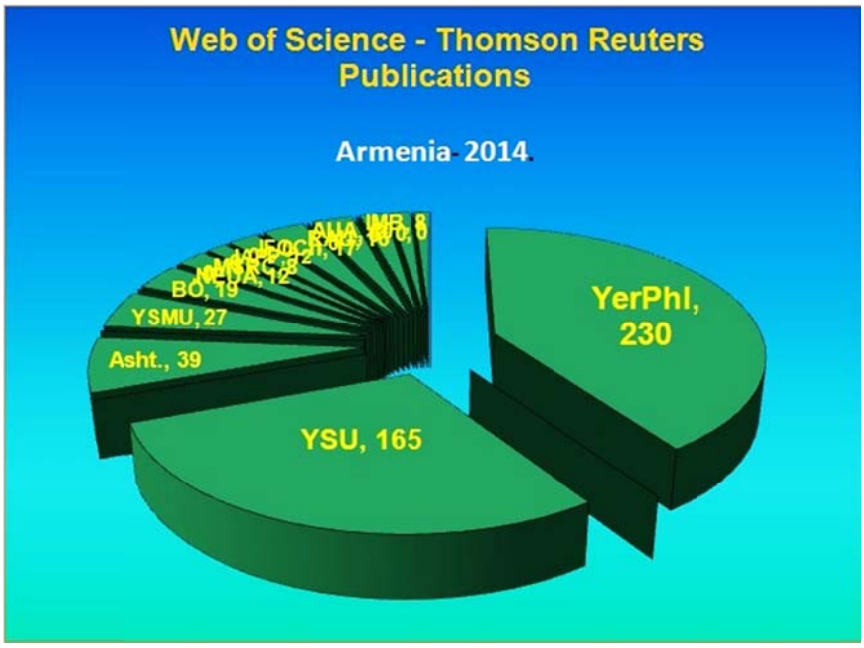

Figure 1. Comparison of the Armenian largest scientific institution publications

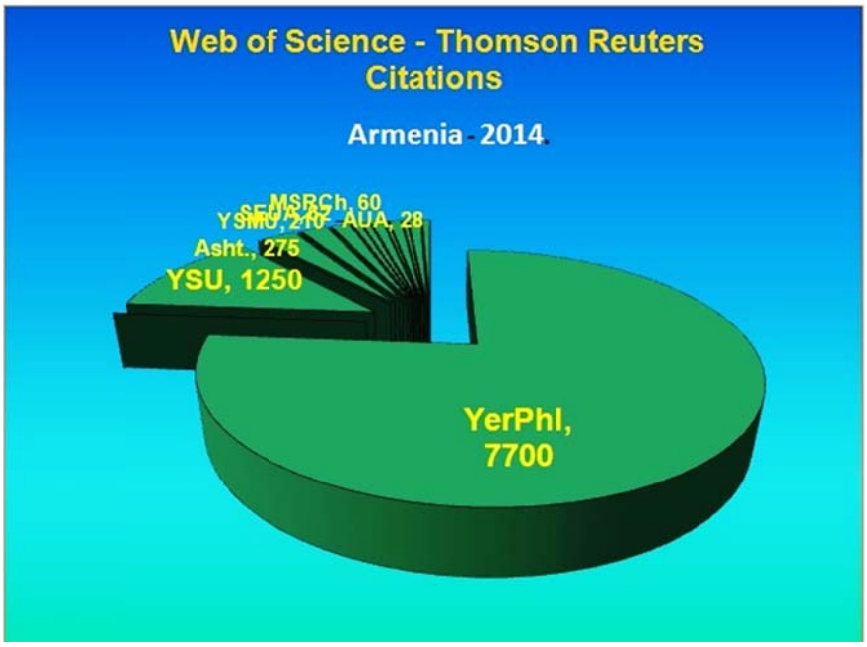

Figure 2. Comparison of the citations to Armenian largest scientific institution publications

Data was obtained from the http://apps.webofknowledge.com database as it was on December, 2014 for 13 largest Armenian scientific institutions.

5. AANL SCIENTIFIC COUNCIL MEETINGS, SEMINARS, PHD DEFENDS, BUSINESS TRIPS, AGREEMENTS

In 2014 AANL Scientific Council held 4 meetings. In 2014 AANL`s Professional Council # 024 listed and approved 4 PhD theses, the titles of which are presented in the attachment 4. YerPhI employees that are absolute minimal number authored only 2 PhD theses. Although all efforts for educating young scientists and students the situation is more and more dangerous putting on question the future of institute.

In 2014 AANL`s seminars were very active, see the list in attachment 5.

Among 130 business trips made by AANL employees in 2014: 41 were to CERN/DESY/JLab according to program of mutual research, 22 – participation in conferences and summer schools.

New agreements for the joint research were signed in 2014 with a number of international and Armenian institutions, see the list in attachment 6.

6. AANL BUDGETARY ISSUES

Table 2. National lab income from state, own profits and international grants

YERPHI INCOME **ԵՐՖԻԻ ԵԿԱՄՈՒՏՆԵՐ**	**2014** **(MLN. DRAMS)** **1$=415.65 DRAM)**	**2013** **(MLN. DRAMS)** **1$=409.03 DRAM)**
Base funding	**752.0** **M1809.2$**	**808.3** **M1976.2$**
RA Scientific conf.	-	5,488.0 K13.42$
RA Project funding	73,317.6 K176.4$	41,807.8 K102.2$
DESY (salary)	31,687.4 K76.2$	38,530.0 K94.2$
ISTC overhead	-	24,460.8 K59.8$
Rent of space	29,710.6 K71.5$	30,865.0 K75.46$
Sales	94,497.2 K227.3$	12,402.0 K30.32$
Other	23,067.0 K55.5$	20,639.5 K50.46$
Total from RA	**825.3** **M1,985.6$**	**855.6** **M2,091.8$**
Own profits	**178,963.0** **K430.6$**	**134,852.6** **K329.7$**
State + own	**1,004.3** **M2,416.1$**	**990.4** **M2,421.3$**

Table 3. National lab expenditures

YERPHI EXPENDITURES	**2014** **1$=415.65 DR**	**2013** **1$=409.03 DR**
Salary	632714.8 K1522.23$ (62.0%)	590653.4 K1444.03$ (66.0%)
Electricity	65659.0 K157.97$ (6.4%)	43471.0 K106.28$ (4.9%)
Gas	18271.2 K43.96$ (1.8%)	12487.0 K30.53$ (1.4%)
Phone	3594.0 K8.65$ (0.3%)	2629.0 K6.43$ (0.3%)
Water	13087.0 K31.48$ (1.3%)	9386.0 K22.95$ (1.0%)
Internet	3692.0 K8.9$ (0.4%)	4620.0 K11.3$ (0.5%)
Taxes	21972.6 K52.86$ (2.1%)	21117.0 K51.63$ (2.4%)
Business Travel	40083.0 K96.43$ (3.9%)	44119.6 K107.86$ (4.9%)

Fuel	13805.8 K33.21$ (1.3%)	9800.0 K23.96$ (1.1%)
Materials & equipment	144525.2 K347.7$ (14.1%)	84242.0 K205.95$ (9.4%)
Capital & current repairs	19587.5 K47.12$ (1.9%)	26868.0 K65.68$ (3.0%)
Fees	20000.0 K48.1$ (1.9%)	15962.0 K39.0$ (1.8%)
Scientific conf.	-	5488.0 K13.4$ (0.6%)
Other services and expenses	29079.3 K69.96$ (2.8%)	24106.0 K58.9$ (2.7%)
Total	**1026.071**	**894.949**

The remainder on 01.01.14 was M133,025.0 AMD, on 01.01.15– M111,267.0 drams

The AANL budget is more or less stabilized in last 3 years. Huge losses due to finishing of international grants support (mostly ISTC and CNCP) were compensated by the RA funding.

AANL scientists are making efforts to win scientific grants (RA thematic funding and "best" scientists awards). Own profits of AANL are only ~15% of RA funding however there is tendency of rise. There is also tendency to allocate lager portion of funds to employee salaries in promised attempt to enlarge mean salary and make it close to mean salary in RA. Apparent growth of mean month salary was achieved reaching ~110,600 dram. Along with enlarging of mean salary the fraction of funds spent for equipment and materials also rose reaching 16% of budget. Communal expenses also are stabilized on the level of 8%. Simultaneously the quality of water supply, Internet speed, and phone connections and other is significantly improved in 2014.

ATTACHMENT 1. Recommendations of scientific council

According to identified key components of overall strategy of National Lab. the Scientific Council recommends the following main areas of activities for coming 10 years:

The participation in experiments at CERN and JLAB, in existent and planned Atmospheric Cherenkov Telescope networks (HESS, MAGIC, CTA).

Participate in the data preservation and analysis activity using data bases from high energy physics (DESY, CERN, Jlab) and astrophysics (PLANCK, LARES, FERMI, LOMONOSOV) experiments.

Investigations at the cosmic ray research stations of National Lab. Research on theory of elementary particles.

Investigate possibilities and perform nuclear physics experiments on modernized electron synchrotron ARUS and on Cyclon-18 cyclotron.

Provide high-tech services to different branches of Armenian science and industry.

The brief description of overall activities of the National Lab for the coming 10 years is the following:

Experimental Physics on Accelerators Abroad

- Physics beyond standard model, structure of matter, three dimensional picture of the nucleon, quark-gluon plasma, electric and magnetic form factors, nucleon-nucleon short range correlations, hadronization in nuclei, Drell Yan processes, etc.
- For achieving these goals research groups from national lab will continue participation in high-energy physics experiments on accelerators abroad: CERN LHC (ATLAS, CMS, ALICE, COMPASS – hardware upgrade, data analyses, continuation of experiments in 2015).
- DESY (HERMES, H1, OLYMPUS, - data analysis in DESY, 2013, after 2014 – participate in data preservation stage, mostly in national lab).
- JLAB (Halls A,B,C,D -hardware upgrade, data analysis, development of physics projects for CEBAF 12 GeV machine to be commissioned in 2015) .
- JINR (BECQUEREL – emulsion microscopic treatment, NICA – spin physics).
- Participation in joint programs in nuclear physics with Notre-Dame University, USA;
- MAX-lab, Lund, Sweden, participation in the nuclear physics experimental program, detector development;
- MAMI, Mainz, Germany, detector development, experiment proposals; Nuclear Physics
- Proton-nucleus interactions, photo-fission, cluster structure of excited light nuclei, stellar nucleo-synthesis, isotope production and research, etc. For achieving these goals research groups from national lab will explore possibilities to modernize electron synchrotron ARUS (launch 75 MeV acceleration mode on the accelerator injector and use 216 m long synchrotron ring as stretcher as well as design and introduce the automatized beam parameters control), and will prepare and perform nuclear physics experiments on the IBA Cyclon 18/18 cyclotron, to be launched in the end of 2013.
- Accelerator Techniques and Research

- Modernizing the electron synchrotron to provide beams for the low energy nuclear physics experiments. The LINAC 75 MeV electron beam of duration 0.7 μsec will be stretched up to 3-5 msec.
- Automated testing and control of all accelerator subsystems including the electron beam parameters will support operation of the ARUS in new regime.
- Launching of the Microtron MT-25. Research of new methods of electron acceleration with junction of electron and laser beams.
- Developing of the nonlinear Raman spectroscopy diagnostic methods. Experimental research of interaction of the laser beams with the electron beam in the homogeneous magnetic fields.
- Accelerator diagnostics and instrumentation based on the vibrating wire technology: transversal profiling and diagnostics of charged and neutral particles and hard photon beams.

Theoretical Physics

- Heavy Quark and Flavor Physics
- Spin in QCD and Related Hadron Phenomenology Neutrino Physics
- Physics Beyond the Standard Model
- Higher spin interacting quantum field theory, AdS/CFT and and dualities in gauge theories
- Investigations in low dimensional physics (d=1,2,3,4): Applications to non-critical strings and condensed matter physics
- Quantum and Classical Phase Transitions in Spin Systems Statistical physics of disordered systems
- Quantum Information Theory
- Integrability in d=4 super Yang Mills theories
- Powerful coherent radiation sources and new effective methods of acceleration Cosmology studies including general relativity theory.
- Electrodynamics of complex form cavities and waveguides, the electromagnetic field interaction with relativistic electron bunches.

Cosmic Ray Physics

- Research of fine structure of all particle energy spectrum in energy region above the first knee.
- Registration of the Extensive air showers initiated by primary gamma rays.
- Investigation of the solar-terrestrial connections and solar accelerators by the networks of particle detectors located in Armenia (ASEC network in Aragats, Nor Amberd, Yerevan) and worldwide (SEVAN network, Armenia, Croatia, Bulgaria, Slovakia and India).
- Research of Thunderstorm Ground Enhancements and atmospheric electricity by the networks of particle detectors with low threshold, electrical and geomagnetic field meters, and lightning detectors.
- Search of rare processes in underground laboratory of Avan salt mine.
- Participate in the HESS and MAGIC collaboration, and started CTA collaboration.

Material Physics

- Investigation of the materials and devices in extreme physical conditions; in-situ study of the crystal modification induced by electron and ultraviolet irradiations in the temperature range 120 to 450K and high vacuum; radiation stimulation of materials by protons (18 MeV Cyclotron).
- Research of the radiation defect formation in condensed materials, research of the mechanisms of electron excitation in doped crystals.

Nuclear Medicine

- Production of the 99mTc isotope with 18 MeV proton beam from C18/18 cyclotron.
- Investigation of the production possibilities of the medicine intended isotopes such as Cobalt-57, Copper-64, Gallium-67, Gallium-68, Indium-111, Indium-114m and others.

Services

- Development of the technologies for the processing of highly active radionuclides with the use of natural Armenian minerals (zeolite, clinoptilolite, basalt) for the Armenian nuclear power plant.
- Development of physical methods for the express analysis of organic and inorganic materials, dating of archaeological evidences and objects of cultural heritage.
- Element/isotope diagnostic bench on the basis of EMAL-2A energy-mass-analyzer.
- Comprehensive monitoring and prediction of potentially dangerous atmospheric and extra-atmospheric processes; global climate change research.
- Monitoring of the cosmic ray variations for obtaining information on Space Weather conditions and alerting on upcoming radiation storms.
- Development of techniques ensuring precise welding of materials used in particle accelerator technologies.

High Productivity Calculations and Data Analysis

- Launch high productivity cluster; support GRID system.
- Support data preservation activity.
- Support storage and access to databases with information from high energy physics, cosmology and astrophysics experiments, as well as from ASEC and SEVAN networks of particle detectors.
- Create “Knowledge Center” for analysis of huge amount of data collected at different
- HEP centers, Plank observatory, as well the data on cosmic rays.
- Create and maintain advance tools for data storage, multidimensional complex statistical analysis and physical inference.

Scientific Instrumentation

- Construction of silicon strip detectors with readout electronics for low energy nuclear physics experiments.
- Construction of the variety of calorimeters, Cherenkov detectors and neutron detectors for experiments at CEBAF 12 GeV machine.
- Fabricate and test RF phototube, low-pressure MWPC. Fabricate and test of radio frequency photomultiplier tubes, RF PMTs, RF timing detectors of secondary electrons, detectors based on low-pressure MWPCs.
- Fabrication of the radiation detectors and electronic devices (thermoresistors, heat sinks) on the basis of diamond and diamond for high temperature applications.
- Fabricate CsI based low threshold particle spectrometers.
- Fabricate hybrid particle detectors for the Space Weather monitoring.

Technological/Business Applications

- Production of the biomedical instruments for investigation of the effects of ionization radiation.
- Production of the biosensors for environmental monitoring.
- Production of chitin/chitosan systems, synthesis and research of their new modification.
- Technological lasers applications. Industrial furnaces production.
- Solar energy based electrical/heating systems.
- High-pressure vessels repair/attestation.
- Liquid gases production.
- Development and creation of high spatial resolution X-ray image detectors for the medical diagnostic systems.

ATTACHMENT 2 . Strategic Plan for A.Alikhanyan National Laboratory (Yerevan Physics Institute)

Executive summary

The Strategic Plan of the A.Alikhanyan National Laboratory aimed at the declaring the mission of the national lab, developing of increased laboratory capacity; requiring policy adoption and strategic planning and implementation of activities appropriate for Armenia.

The development of laboratory capacity within Armenia is a long-term endeavor, which requires the support of the government and industry, as well as in- country stakeholders, multilateral agencies, donors, the private and public sectors, communities, and others.

Vision: A. Alikanyan national lab has distinctive expertise and insights relating to high-energy physics and astrophysics, nuclear physics, scientific instrumentations and multivariate data analyses, as well as in education. National lab should serve for the positive influence and impact to national values through research, education and innovation programs. National lab provides opportunities for intellectual, personal and professional growth. Learning and working at national lab will foster high professionalism, quick, well-rounded minds, well equipped to succeed in our fast-changing world.

Mission: Perform world-class research in Armenia, participate in world-biggest scientific collaborations, and offer scientific instruments and services for Armenian nuclear medicine, industries and cultural studies. Establish high standards of education in master and PhD courses; demonstrate that science and education can really provide development of Armenia.

The key components of overall strategy:

- Focus on high impact research that advances knowledge and its application, and in which national lab has major achievements having international recognition and leadership.
- Inject a spirit of enterprise into education and research, and develop impactful between education and research, within a dynamic “no-walls” environment.
- Develop advanced services for the Armenia industry, environmental monitoring and preserving cultural heritage.
- Develop advanced technological processes and high productivity computation facilities for Armenian science and industry.
- Nurture committed alumni to be key members of the lab community, who will actively support national lab towards its Vision and Mission.
- Adopt and adapt best practice governance and management, for optimal administration, management of resources, staff and student services.

Brief summary of the scientific activities

Brothers Abraham Alikhanov and **Artem Alikhanyan** founded in 1943 Yerevan Physics Institute (YerPhI) as a branch of the Yerevan State University. Later high-altitude Cosmic Ray stations were founded on the slopes of Mount Aragats. Among the key results of YerPhI in the early years were the discovery of protons and neutrons in cosmic rays, and the establishment of

the first evidence of existence of the particles with masses between that of muons and protons. The high altitude research stations have remained the main research base of the Cosmic Ray Division (CRD) of YerPhI until now. Among the CRD achievements there were: discovery of sharp knee in light components of primary cosmic rays, detection of the highest energy protons accelerated on the Sun, and the creation of the Aragats Space environmental Center in 2000 for studies of the solar-terrestrial connection, where CRD becomes one of the world's leaders.

The 6 GeV electron synchrotron was accomplished in 1967. During 1970-1991 synchrotron was operated with energies up to 4,5 GeV and in Experimental Physics Division were obtained significant results, including: hadronic properties of photons in π- meson photo-production on nuclei; structures of nucleon resonances in multi-polarization experiments, structure and characteristics of nuclear matter, important properties of X-ray transition radiation and channeling in monocrystals. Thanks to these achievements physicists from Yerevan Physics Institute started from 1985 are successfully participating in the large international collaborations.

Traditional topic of YerPhI is the development of new particle detectors. Wide spark chambers and transition radiation detectors are examples of the experimental techniques developed and implemented in YerPhI. During the last years groups of scientists from Yerevan Physics Institute have actively participated in intermediate and high energy physics experiments abroad (JLAB, DESY, CERN-LHC, MAX-lab, MAMI), exploring the meson and nucleon structures, electromagnetic interactions of the nucleon, quark-hadron duality, short range nucleon-nucleon correlations, quark hadronization in nuclear medium, physics beyond standard model, Higgs boson searches, quark-gluon plasma, fission and fragmentation of nuclei and hypernuclei and many other topics, as well as constructing experimental hardware and develop the software for data acquisition and analysis.

The theoretical department assure major achievements in the following areas: B-meson physics, QCD and Related Phenomenology, Neutrino physics, Quantum Field Theory, String/M-theory, Integrable Models, Statistical physics, Condensed Matter and Quantum Information. These results are internationally recognized and highly cited.

In the mid-1980s in YerPhI was developed the concept of stereoscopic approach in Very High Energy gamma-ray astronomy using multiple Imaging Atmospheric Cherenkov Telescopes (IACT). This concept was materialized in the very successful IACT system (HEGRA). After first success, Armenian physicists successfully participate in operation of the IACT systems on the Canary Islands (MAGIC) and in Namibia (H.E.S.S.).

In the course of many years, the Applied Physics Department of YerPhI successfully investigates electron-energy structure of new wide-band laser materials using synchrotron radiation in various spectral regions. The investigations were carried in DESY and will be continued in MaxLab- II (Sweden).

Organization structure and human recourses management

1) Lab board appoints director of national lab and chair of the board signs contract with director for 5 years.

2) Director of the national lab appointed 2 deputies, chief accountant, scientific secretary and five assistants of director (human recourses management, security, economics, office management, international connections) and sign contract with them.

3) National lab adopted two-level internal organizational structure, consisting of departments where relevant scientific and technical groups operate.

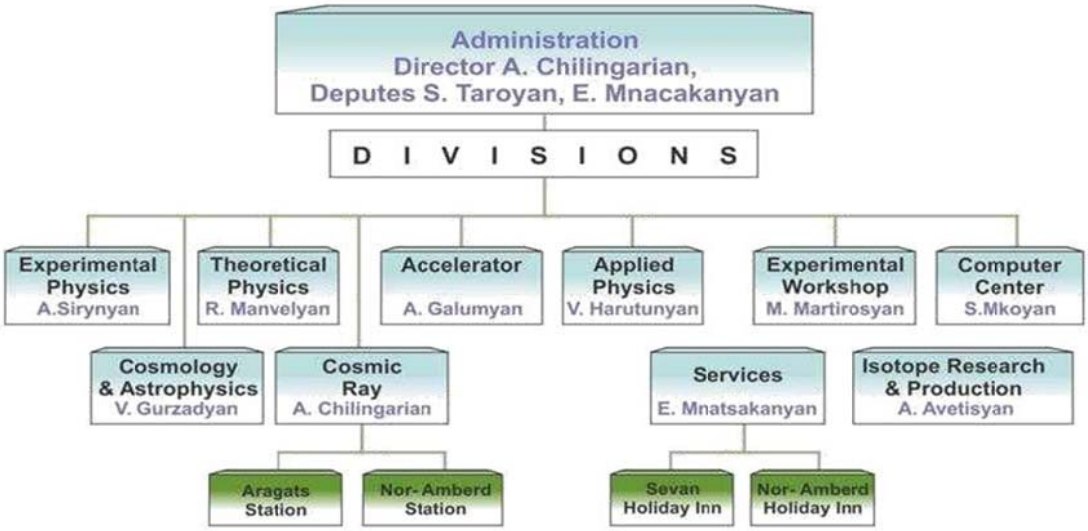

Figure 4 . Administrative structure of AANL

4) The appointment to the position of the heads of departments should be realized for up to 5 years period and they should sign contracts with national lab director. The contract with heads of groups is realized for up to 3 years.

5) The age limit of 65 years is stated for the heads of departments and groups; in exceptional cases (started from 2014 no contracts will be signed with older candidates to group or department leader positions) until the age of 70. The limiting age for other national lab employees is 65 years, for doctors of science–

70. The age limit for consultants/advisers is 85 for academicians and 75 for doctors of science.

6) National lab adopted following list of scientific positions.

- ✓ intern
- ✓ researcher
- ✓ senior researcher
- ✓ leading researcher
- ✓ Scientific /Consultant-Advisor Notification:

a. Intern position is assigned to the young professionals currently engaged in higher Educational system (master courses) and those who are doing their PhD in national lab.

b. Intern-researcher position («Postdoc» status) is assigned by competition to young scientists, having PhD degree; prior to postdoc competition the competition for opening postdoc position should be hold in the national lab departments.

c. Lab's director in accordance with the recommendations of the Scientific Advisory Committee decides distribute the intern-researcher positions among lab departments.

d. Researcher, senior and leading researcher positions are assigned by depending on the overall score based on several criteria (H-index, leadership, work with students, etc.).

e. To the scientific /technical/consultant position are appointed scientists and engineers with age above 65 years old (no more than 5 persons in each department).

7) Special commission appointed by lab's director makes the attestation of the national lab employees periodically. Each employee should present to commission following documents:

- Filled standard attestation form
- List of publications with abstracts during last 5 years Best 3 publications (according to author's opinion) List of graduate students
- List of reports on the international conferences, invited talks List of organized conferences
- Title and date of last thesis, place of defense
- Total list of publication
- List of managed grants.

8) In exceptional cases department leaders can employ personnel for the period up to 6 months for work of strategic importance (not more than 2 employees).
9) Director reserves the right to appoint his advisors, doctor of science, academicians.
10) The business trips of national lab employees to foreign countries are organized according special regulation; duration of business travel should not exceed 6 months.
11) The hours of workweek are fixed to 40. Automatic system is calculating the working hours according to which the actual salary is assigned.
12) According to the national *regulations* administration provides 24-day vacation to all employees; vacation may be provided in two parts; in exceptional cases vacation can be given additional vacation without payment.
13) National lab affords all measures to increase the professional skills of young scientists (send them to summer schools and conferences, invite professor for lecturing, organize summer schools in Armenia) and to provide proper working conditions (repair office, seminar rooms, provide modern computers).

Administration obligations, economical and property management issues

1. Provide full and timely logistical support for the implementation of the linear functions of the National Lab, such as:
2. Ensure efficient utilization of the office spaces, carrying out necessary maintenance and repairing activities
3. Purchase modern equipment for high precision measurements.
4. Install modern security equipment for the offices and experimental laboratories.
5. Organize the efficient provision of irrigation water for the whole territory of the National
6. Lab to guarantee the green and clean environment.
7. Select an operator, through a competitive tender, for establishing restaurants and cafes on the lab's premises.
8. Optimize and manage the vehicles' park, giving priority for smaller number of cars but with appropriate power and environmentally friendly engines.
9. Optimize the workshops and provide it with modern tool kits and technological equipment.
10. Organization of workshops and conferences (logistics).
11. Develop and implement non-current assets (immobile property) management strategy:
12. Establish criteria for selecting the buildings requiring capital restoration and build up a renovation and restoration long-term master plan.
13. Ensure energetic efficiency of the buildings.
14. Establish procedures for providing the premises for short-time (up to 1 year) lease to the third parties.

2. Provide assistance to CRD employees in preparing grant applications and develop a sustainable fundraising strategy:

    - Provide timely information to the staff about relevant funding opportunity announcements.
    - Negotiate with Republican agencies to open funding possibilities for the researchers.
    - Reduce dependency on a single income stream; improve chances to operate independently.
    - Create a sustainable funding base and build up reserves to safeguard financial future.

3. Organize international expertise of the projects submitted for funding, form commissions and project accepting committees; provide recommendations for republican funding bodies for selected projects.

4. Implement the financial management of the National Lab:

    - Prepare annual budget. Discuss with national board the priorities, and due to the board decision decide ongoing expenditure, which must be met from ongoing income streams, and reserves.
    - Provide accounting and material resources "house-keeping" according to the best corporative standards.
    - Each year prepare comprehensive report for the annual audit.

4. Provide access to national lab information, Internet recourses, high productivity computing, scientific publications, and libraries of applied programs, printers, and telephones.

5. Establish small business innovation research (SBIR) and small business technology transfer competitive funding.

6. Provide secure storage of the isotopes and radioactive materials according to MAGATE standards.

7. Providing touristic and recreation services

Key performance indicators (KPI) for organizational performance evaluation

The national lab is guided by a sharp programmatic vision, by a strategic plan formed by this vision, and by a constant striving for managerial excellence and effectiveness in implementing the plan. A systematic program to refine work processes is underway with the aim of achieving the greatest programmatic output for a given funding level. Management has renewed their efforts to continuously strengthen a culture of high performance that extends to all areas of work, and underscores the importance of safe operation as a core institutional value.

Among the major KPIs to be used to evaluate the national lab performance are:

- ✓ Number of publications in the peer reviewed journals each year and the sum of the impact factors of the journals.
- ✓ Number of citations made to publications of national lab employees made in the assessed year.
- ✓ Number of master and PhD students, defends of PhD theses.
- ✓ The ratio of the numbers of employees under 35 years old to number of employees above 70 years old.
- ✓ The percent of the funds spent to the new equipment and materials relative to the total budget.
- ✓ The percent of funds spent on business travel relative to the total budget. The percent of funds spent for repairs relative to the total budget.
- ✓ Total income from high technology services.
- ✓ Number of new agreements with Armenian and international organizations.

ATTACHMENT 3. International Grants

2015 թ. Ա. Ալիխանյանի անվան Ազգային Գիտական Լաբորատորիայում գործող դրամաշնորհների ցուցակ

Հ/Հ	Թեմայի համարը	Ֆինանսավորող կազմակերպություն	Ղեկավարի անուն, ազգանուն, հայրանուն	Թեմայի անվանումը	Կատարման ժամկետ
1	13-1C023	ՀՀ ԳՊԿ գիտական եւ գիտատեխնիկական գործունեության պայմանագրային ֆինանսավորման թեմա	Ազնաուրյան Իննա Գեւորգի	Սպինային հետազոտությունները ՔԽԴ-ի շրջանակներում Jlab-ի տվյալներից մինչեւ LHC Ֆենոմենոլոգիա	2013-2015
2	13-1C137	ՀՀ ԳՊԿ գիտական եւ գիտատեխնիկական գործունեության պայմանագրային ֆինանսավորման թեմա	Անանիկյան Ներսես Սիրեկանի	Ցածր չափանի եւ ռեկուրսիվ սպինային ցանցերի մագնիսական հարթակները քվանտային խճճվածությունը եւ դինամիկ համակարգերի մեխանիզմը	2013-2015
3	13-1C153	ՀՀ ԳՊԿ գիտական եւ գիտատեխնիկական գործունեության պայմանագրային ֆինանսավորման թեմա	Ասատրյան Հրաչյա Մանվելի	ՔՔԴ Ուղղումները B մեզոնների հազվագյուտ տրոհումների համար ստանդարտ Մոդելում եւ ՄՍՍՄ -ում	2013-2015
4	13-1C245	ՀՀ ԳՊԿ գիտական եւ գիտատեխնիկական գործունեության պայմանագրային ֆինանսավորման թեմա	Գուլքանյան Հրանտ Ռուբենի	Ծանր Միջուկների ճեղքման հազվադեպ կանալների որոնումը	2013-2015

Հ/Հ	Թեմայի համարը	Ֆինանսավորող կազմակերպություն	Ղեկավարի անուն, ազգանուն, հայրանուն	Թեմայի անվանումը	Կատարման ժամկետ
5	13-1C080	ՀՀ ԳՊԿ գիտական եւ գիտատեխնիկական գործունեության պայմանագրային ֆինանսավորման թեմա	Իզմաիլյան Նիկոլայ Շահենի	Ընդհանրությունը և վերջավոր չափի հետեւվանքները վիճակագրական մեխանիկայի երկչափ մոդելներում	2013-2015
6	13-1C232	ՀՀ ԳՊԿ գիտական եւ գիտատեխնիկական գործունեության պայմանագրային ֆինանսավորման թեմա	Մանվելյան Ռուբեն Պետրոսի	Բարձր Սպինների փոխազդեցություն եւ ունիվերսալություն տրամաչափային / լարային տեսություններում	2013-2015
7	13-1C275	ՀՀ ԳՊԿ գիտական եւ գիտատեխնիկական գործունեության պայմանագրային ֆինանսավորման թեմա	Չիլինգարյան Աշոտ Աղասու	Ամպրոպային Վերգետնյա Աճերի հետազոտությունները տարրական մասնիկների դետեկտորների , Էլեկտրական եւ գեոմագնիսական դաշտի եւ օպտիկական գրանցիչների օգնությամբ	2013-2015
8	13-1C278	ՀՀ ԳՊԿ գիտական եւ գիտատեխնիկական գործունեության պայմանագրային ֆինանսավորման թեմա	Պողոսյան Ռուբիկ Հրաչիկի	N=2 Սուպերսիմետրիկ Յանգ - Միլսի Տեսություն կապը երկչափ կոնֆորմ դաշտի տեսության եւ ինտեգրվող մոդելների հետ	2013-2015

Հ/Հ	Թեմայի համարը	Ֆինանսավորող կազմակերպություն	Ղեկավարի անուն, ազգանուն, հայրանուն	Թեմայի անվանումը	Կատարման ժամկետ
9	13-1C001	ՀՀ ԳՊԿ գիտական եւ գիտատեխնիկական գործունեության պայմանագրային ֆինանսավորման թեմա	Սահակյան Վարդան Հայաստանի	Գերբարձր Էներգիաների գամմա ճառագայթների աստղաֆիզիկա ՊՄՃԴ - ների օգնությամբ	2013-2015
10	13-1C132	ՀՀ ԳՊԿ գիտական եւ գիտատեխնիկական գործունեության պայմանագրային ֆինանսավորման թեմա	Սեդրակյան Արա Գրիգորի	Եռաչափ և երկչափ ինտեգրվող մոդելներ. Քվանտային հաշվարկներ ու Կիտաեւի մոդել	2013-2015
11		ՀՀ ԳՊԿ Նյութատեխնիկական բազայի արդիականացման համար գիտական սարքավորումների և ենթառուցվածքի ձեռքբերման դրամաշնորհ	ՀՀ ԿԳՆ «Ա. Ալիխանյանի անվան ազգային գիտական լաբորատորիայի (ԵրՖԻ) հիմնադրամ		
12	612707, DIONICOS	Marie Curie Actions, FP7-PEOPLE-2013-IRSES	Անանիկյան Ներսես Ս.	Dynamics of and in Complex Systems	2013-2017
13	13RF-022	Հայ-ռուսական հիմնարար գիտական հետազոտությունների համատեղ նախագծերի «ՀՀ ԿԳՆ ԳՊԿ-ՀՀՌՀ - 2013»	Պողոսյան Ռուբիկ Հ.	"Itegrable Models in Quantum Field Theory and Moduli Spaces of Instantons". Քվանտային սպինային	2013-2015

Հ/Հ	Թեմայի համարը	Ֆինանսավորող կազմակերպություն	Ղեկավարի անուն, ազգանուն, հայրանուն	Թեմայի անվանումը	Կատարման ժամկետ
14	YSSP-13-02	The National Foundation of Science and Advanced Technologies (NFSAT), YSSP and CRDF Global Young Scientists Support Program (YSSP-13) 2013	Հովհաննիսյան Վահան	համակարգերի խճճվածությունը, մագնիսական հատկությունները, վիճակագրական գումարի զրոները և Լյապունովի ցուցիչները)	2013-2014
15	295302, SPIDER	Marie Curie Actions, FP7-PEOPLE-2012-IRSES,	Իշմաիլյան Նիկոլայ Շ.	Statistical Physics in Diverse Realizations, within the 7th European Community Framework	2012-2016
16		VOLKSWAGEN FOUNDATION	Ասատրյան Հրաչյա Մ.	The B mesons' Inclusive Rare Decays and Oscillations	2012-2015
17		VOLKSWAGEN FOUNDATION	Մանվելբան Ռուբեն Պ.	Infinite-Dimensional Symmetries, Gauge/String Theories and Dualities	2012-2015

ATTACHMENT 4. List of The Theses Defended in AANL (2014).

	Name	Academic degree	Title of PhD and supervisor's name
1	**Saghatelyan Armen Aharoni**	**Ph.D**	"ACTION-ANGLE VARIABLES IN CONFORMAL MECHANICS" **Supervisor: Doctor of Science Nersisyan A. P. (AANL)**
2	**Gabrielyan Levon Arami**	**Ph.D**	**"Experimental studies on the establishment of free electron lasers in the terahertz range radiation" YerPhI Supervisor: Doctor of Science Petrosyan M. L. (AANL)**
3	**Tamaryan Levon Sayat Novayi**	**Ph.D**	"Geometric Measure of Entanglement and Schmidt Decomposition of Multipartite Systems" **Supervisor: Doctor of Science Gevorgyan L. A (AANL)**
4	**Grigoryan Armen Hranti**	**Ph.D**	**"Resonance Study of singlemode accelerating structure with slow runaway wave" Supervisor: Doctor of Science Tsaknov V. M.**

ATTACHMENT 5. List of AANL Seminars 2014

1. An Introduction to the Ising Model, by Vahan Hovhannisyan
2. Cosmic microwave background radiation and Planck-2015 by Gegham Yegoryan
3. Numerical methods in cosmology III: data mining techniques by Harutyun Khachatryan
4. Testing random number generator with multidimensional Chi-square by Narek Martirosyan
5. Some aspects of neutrino physics by Valeri Pogosov
6. Neutron-induced Reactions Investigations in the Neutrons Energy Range of up to 16 MeV by Roza Avetisyan
7. 3-dimensional uniform response: a new design of light collection for scintillation detectors by Varlen Grabski
8. Final state interaction in kaon decays by Sergey Gevorkyan.
9. Asset exchange models, the origin of Pareto's Law, and the origin of oligarchy by Bruce Boghosian
10. Information Theoretic Tools for Social Media by Aram Glastyan
11. An elementary introduction to Bayesian statistics by Armen Allahverdyan
12. On the origin of the thunderstorm ground enhancement (TGE) by Vanyan Levon
13. Numerical methods in cosmology III: Correlation functions and fractals by Emil Poghosian
14. An Introduction to Lie Algebras by Zhirayr Avetisyan
15. Numerical methods in cosmology, II: Wavelets by Emil Poghosyan
16. Normed Division Algebras and Hopf Maps by Vahagn Eghikyan
17. Faraday Rotation in a Disordered Medium by Zhyrair Gevorkian
18. Numerical methods in cosmology by Harutyun Khachatryan
19. Квантовый диффузионный подход к описанию ядерных реакций захвата. Вазген Саргсян
20. Neutrino oscillations and future Lang Baseline experiments by Ara Ionnisian
21. Database search: the simplest example of quantum speed-up by Armen Allahverdyan

ATTACHMENT 6. List of Scientific Institutions with whom YerPhI Has Signed Agreements or MOU on 2014

1. Thomas Jefferson National Accelerator Facility
2. Deutsches Elektronen-Synchrotron (DESY)
3. The European Organization for Nuclear Research (CERN)
4. Stanford Linear Accelerator Center (SLAC)
5. Notre Dame University
6. Cherenkov Telescope Array Consortium (CTA)
7. Institute for Structure and Nuclear Astrophysics (University of Notre Dame, USA)
8. *Warsaw* University of Technology
9. Heidelberg Ion-Beam Therapy Center (HIT)
10. Объединенный Институт Ядерных Исследований (ОИЯИ, Дубна)
11. Московский Инженерно-Физический Институт (МИФИ, Москва)
12. Armenian Anti-hailing center of ministry of Emergency.
13. 13 Armenian meteorological center of ministry of Emergency.
14. Lund university – MAX Lab accelerator center.

ATTACHMENT 7. Press Releases of AANL of 2014

1. Aragats Sky Monitor Detected Russian Topol/SS-25 Rocket in Our Sky

On May 20, 2014 Russian Strategic Rocket Forces carried out a successful launch of a Topol/SS-25 rocket that was used to test "new combat payload for future intercontinental ballistic missile." The rocket was launched at 21:08 Moscow Standard Time (17:08 Universal Coordinated Time - UTC) from the Kapustin Yar test site toward the Sary Shagan test site in Kazakhstan.

In Figs. 1-3 one can see the bright images in the sky at 17:12-17:13 CUT detected by Aragats Sky monitor. We idebtify this images as an evidence of Topol launch. The Aragats sky monitor is located at Aragats high-altitude research station of the Yerevan Physics Institute and is used for investigation of high-energy phenomena in terrestrial atmosphere. Namely, recording thunderclouds simultaneously with registration by other station facilities huge fluxes of high energy particles.

The Aragats Sky Monitor gives you a live video view of the entire sky, day or night, rain or shine. The All Sky Cam is always on, always providing live full color video. You can see:

- Sun, Moon, planets, stars, aurora, Milky Way & zodiacal light.
- Clouds, their type and moving directions, precipitation, lightning, rainbows.

Aragats camera images available from the WEB link:

- http://crd.yerphi.am/Aragats_Sky_Monitoring

Fig1. The object in the sky recorded by Aragats Monitor/Russian strategic rocket Topol/SS-25/

Fig.2. The process of the motion of Topol/SS-25

Fig. 3. The trace left by Topol/SS-25

2. The department of Nuclear Science and Engineering of Massachusetts Institute of Technology (MIT) has made an offer of an Assistant Professor position to Areg Danagoulian.

The department of Nuclear Science and Engineering of Massachusetts Institute of Technology (MIT) has made an offer of an Assistant Professor position to Areg Danagoulian. Dr. Danagoulian will take up his position in September of this year.

Dr. Danagoulian specializes in the field of nuclear security. This is a broad field, which encompasses such areas as nuclear non-proliferation, nuclear forensics, technologies for verification of arms reduction treaties, safeguards of nuclear spent/fresh fuel, as well as cargo security and nuclear detection. Aregs main interests include development of zero knowledge detectors for treaty verification purposes, and monochromatic tunable particle sources for cargo interrogation.

Areg has studied at the Yerevan's #1 physics-mathematics high school named after academician Shahinian. After his graduation in 1993, his family moved to the US. Areg pursued his undergraduate studies in physics at MIT, and received Bachelor of Sciences degree in 1999. This could make him Armenia's first citizen who graduated from MIT. Next he pursued his Ph.D. work in experimental nuclear physics at the University of Illinois at Urbana-Champaign (UIUC). His thesis work was titled "Measurements of Compton scattering on the proton at 2 - 6 GeV." In 2006 Areg accepted a postdoctoral position at Los Alamos National Laboratory, where he performed experiments for the Lab's stockpile stewardship program, studied cold neutron physics, and worked on nuclear security programs.

Since joining Passport Systems Inc. (Boston, MA) in 2009 as a senior scientist, Areg has lead the development of neutron detection applications, which are currently being fielded as part of a cargo inspection system. He has lead the development of the Prompt Neutrons from Photofission (PNPF) system, which uses prompt neutrons from photofission to rapidly detect various actinides (such as uranium and plutonium) hidden in the container. PNPF is capable of detecting 4kg of uranium hidden in dense cargoes in seconds, with 95% probability of detection and 5% false alarm rate.

Areg's parents, Dr. Samuel Danagoulian and Dr. Svetlana Aroutiounian, are former scientific staff members of Yerevan Physics Institute.

We wish the best of luck to our compatriot in his new position.

3. CRD is hosting a student from Worcester Polytechnic Institute

In Summer 2014 the Cosmic Ray Division of Yerevan Physics Institute (YerPhI) is hosting Harrison Vaporciyan a student fromWorcester Polytechnic Institute (Massachusetts, USA), where he is studying robotics engineering. Harrison has arrived in Yerevan on June 6-th and starts his internship at CRD by visiting Aragats Research Station.

During the summer season on Aragats (3200 m above sea level) where road is opened from snow the employees of cosmic ray division repaired the network of particle detectors used for research of the violent solar events and Thunderstorms and install new detecting systems designed fabricated in YerPhI. In 2014 the systems of stacked scintillators and NaI spectrometers will be installed outdoor to research fluxes lowest energy electrons and gamma rays possibly originated from decay of short leaving isotopes brought by clouds on Aragats mountain. As well Harrison will participate in installing automotive system of optical monitoring of high-energy outbursts from thunderclouds to open space above Ararat valley – an enigmatic process now in the center of interest of physicists of all countries. He is staying in Yerevan till the 11 of August and we hope that his internship at our division will useful for his future work and he will be able to put some of his knowledge of robotics into optical monitoring system.

Figure 1. Harrison Vaporciyan (left) and data transfer and analysis group leader Artur Reimers installing new particle detectors at Aragats Research Station

4. Felix Aharonian won the prestigious Viktor Hambardzumian International Prize

The Viktor Hambardzumian International Prize 2014 has been awarded to former employee of Yerevan Physics Institute Felix Aharonian. Felix Aharonian (Dublin Institute for Advanced Studies, Ireland and the Max Planck Institute for Nuclear Physics, Heidelberg, Germany) was awarded for his "outstanding contribution to high-energy astrophysics and physics of cosmic accelerators and for playing a leading role in development of stereoscopic Cherenkov telescopes system. "

He shared this prize with Igor Karachentsev (Special Astrophysical Observatory, Russia) and Brent Tull (Institute for Astronomy, University of Hawaii USA).

Viktor Hambardzumian International Prize was established by the president of RA in 2009, and currently is one of the most important prizes in astronomy, astrophysics and related sciences. It is given to the outstanding scientists of any nationality who have a significant contribution to astrophysics.

In his letter to A.Chilingarian Felix Aharonian stressed that Yerevan Physics Institute played a key role in this success.

We congratulate Felix Aharonian and wish him more achievements in the coming years.

5. Summer School at Artem Alikhanyan National Laboratory

A Summer School named "High-energy physics and Astrophysics (from measurements to models and theories)" was carried out at *September 9-12 in research and teaching laboratories of Artem Alikhanyan National Laboratory – Yerevan Physics Institute (YerPhI).* 10 lecturers introduce students in hottest topics of modern theoretic and experimental physics. 9 students from Yerevan state university, 2 students from Yerevan technical university and 3 students from YerPhI participate in the summer school.

During laboratory works students assemble systems of particle detectors; measure elemental composition of artifacts; become acquainted with modern JPU servers and GRID system and calculate proportion of generated medical isotopes.

The practical orientation of summer school emphasis that physics is experimental discipline and the route from measurements to models and theories proofs to be very effective in last and present centuries instrumenting the powerful infrastructures of our civilization and explaining micro and macro cosmos. A.Alikhanyan national lab provides to student modern experimental facilities encouraging them to be a part of scientific endeavor.

Mission of the National lab includes as one of most important segments anticipates establishment of the high standards of education in Master in science and PhD programs for demonstrating that science and education can really provide development of Armenia. National lab is starting Master courses in 2014 for physics students. The formal aim of the MSc in Physics is: "To provide a high quality education in Physics which prepares students for research in an academic environment, national research laboratories and industry."

Figure 1. Electronics lab; Gagik Hovsepyan demonstrates particle detectors and front-end electronics for measuring incident particle flux

Figure 2. Material science lab; Suren Sogomonyan explains operation of the XRF device for measuring of elemental composition

Figure 3. Visit to computer center; Sargis Mkoyan speak about new generation of JPU servers recently installed in YerPhI

6. Exploring Origin of the High-energy particle “beams” in Earth’s Atmosphere

Thunderstorms and Elementary Particle Acceleration;

Yerevan, Armenia, 22–26 September 2014

High-energy processes in the magnetosphere and atmosphere like TGEs (Thunderstorm ground enhancements), TGFs (Terrestrial gamma ray flashes) and TLEs (Transient luminous events) and recently discovered relativistic electron acceleration in the Earth’s outer radiation belt trigger various dynamic processes in the Earth’s environments and have broad astrophysical relevance. Investigation of the «accelerated» structures in the Geospace plasmas can shed light on particle acceleration to much higher energy by the similar structures of space plasmas in the most distant objects in the Universe. The Earth’s broad environment is a real laboratory for high-energy astrophysics.

To discuss these high-energy phenomena, the conference on Thunderstorms and Elementary Particle Acceleration was held at the Nor Amberd International Conference Center of the Yerevan Physics Institute (YerPhI) in Armenia. The Cosmic Ray Division of YerPhI and Skobeltsyn Institute of Nuclear Physics of Moscow State University organized the workshop; YerPhI and the European Geophysical union sponsored it. Thirty scientists and students from the United States, France, China, Israel, Russia, and Armenia attended.

Presentations focused on research on observations and models of the high-energy emissions in thunderclouds; on emerging charged structures in thunderclouds and estimation of its size; on radio frequency emission from atmospheric electrical discharges; on comparisons of different simulations of cascade developments in the atmospheric electric fields; on observations of broad band electromagnetic emissions by RELEC and CHIBIS-M space missions; on new methods of data analysis of registered TGFs and new planned space missions.

Discussions covered questions such as the following: are the TGEs and TGFs – symmetric processes? are Extensive cloud shower (ECSes) observed on microsecond scale in TGEs analog of the TGFs? are there causal relations between particle fluxes and lightnings ?

The workshop participants agreed that it would be useful to compare vast amount of experimental data on TGE energy spectra with the TGF observations and models. Research on high-energy phenomena in thunderclouds is becoming more and more multidisciplinary including measurements of secondary cosmic rays, radio emission from atmospheric discharges, optical monitoring of the thunderclouds and emissions from them, lightning detection and classification and meteorological monitoring. The multivariate visualization and correlation analysis of all measurements pose serious problems on searches in the data archives when data stream is pressing and new interesting events are appearing almost every new day. One of possible solutions to assist researchers in physical analysis is presented on symposia intellectual data exploration system developed by collaboration of Institute of electronics and Data Processing of Karlsruhe institute of technology (KIT) and Cosmic Ray Division (CRD) of Yerevan Physics Institute. A user-friendly interface interactively visualizes the multiple time-series and selects relevant parameters for different research objectives. In this way we try to fully utilize the new concept of “big” data when enormous amount of relevant observations culminates in “new” physics unprecedented fast and precise.

As usual on TEPA symposia organizers prepare lectures on selected topics of "hot" science. Students and researchers highly appreciate presentations of Ani Abrahamyan,

University of Notre Dame, Indiana, USA, The Frontiers of Nuclear Physics In the 21st Century; Robert Avagyan, Yerevan Physics Institute, Armenia, Accelerator Complex for Nuclear Physics Studies and Boron Neutron Capture Therapy; Felix Aharonian, Dublin Institute for Advanced Studies, Ireland and Max Planck Institute for Nuclear Physics, Heidelberg, Germany, Nature's most effective particle accelerators;

Kh. Meliksetyan, institute of Geology, National Academy of Armenia, Vulcanic activity in Armenia.

The presentation slides and discussion videos are available on the conference website,http://crd.yerphi.am/Conferences/tepa2014/home.

Figure 1 V.Bogomolov, S.Mkoyan, M.Panasuk and G.Garipov measuring cosmic ray flux at Aragats with precise gamma spectrometer from RELEC space mission (start of Armenian-Russian joint multivariate measurements project at Aragats)

Figure 2 M.Panasuk, V.Bogomolov, G.Khanikyanc, G.Garipov and S.Sogonyan at new establish radio-emission monitoring facility (Aragats high altitude research station).

Figure 3 Young scientists and students visiting Aragats station. Future collaborations are anticipated. (from left to right Vadim Vybornov and Pavel Minaev, Space Research Institute, Russia; David Sarria, the Research Institute in Astrophysics and Planetology, France; Alexander Infanger, University of California, Santa Cruz, USA; Dmitry Vavilov Space Research Institute, Russia,Hripsime Mkrtchyan, Yerevan Physics Institute; Zara Asaturyan, Yerevan Physics Institute; Bagrat Mailyan, Shandong University at Weihai, Tigran Karapetyan, Yerevan Physics Institute.

7. At Aragats research station of Yerevan Physics institute started observations of radio frequency emission from atmospheric electrical discharges

Our planet Earth is source of wideband electromagnetic radiation and, as was established recently, particle beams. To understand origin of these radiations, having enormous impact on climate and "global change" we need to measure as much as possible parameters of radiation and correlate them with thunderstorms and space storms. Cosmic ray division of the Yerevan Physics institute with its Aragats space environmental center launched a endeavor of installing in Armenia and worldwide networks of particle detectors, field meters, lightning detectors, now enlarged by monitoring of the radio emissions.

The high frequency (HF) detector, installed in September 2014 at Aragats and in Yerevan is a active outdoor whip antenna (MFJ-1024)thatcovers 50 KHz to 30 MHz frequency range, a digital oscilloscope (Picoscope 3206) with maximum sampling rate of 200MS/s, and an on-line PC. The apparatus allows to record the waveform of HF radio emission with temporal resolution of 5ns, repetition rate of 1 Hz, and data capture length of 5 ms. The radio measurements are compared with the time series of the near-surface electric field disturbances (measured with Boltek EFM-100 field mill), and with the time series of occurrences of lightning (detected with Boltek Storm Tracker Lightning Detector). Correlations between radio frequency detected events and data of the two Boltek devices are presented.

Figure 1. Suren Sogomonyan near new installed on Aragats fast electric field monitoring system. Measurement system involves flat plate antenna followed by a passive integrator, and a digital storage oscilloscope with 10 ns sampling interval.

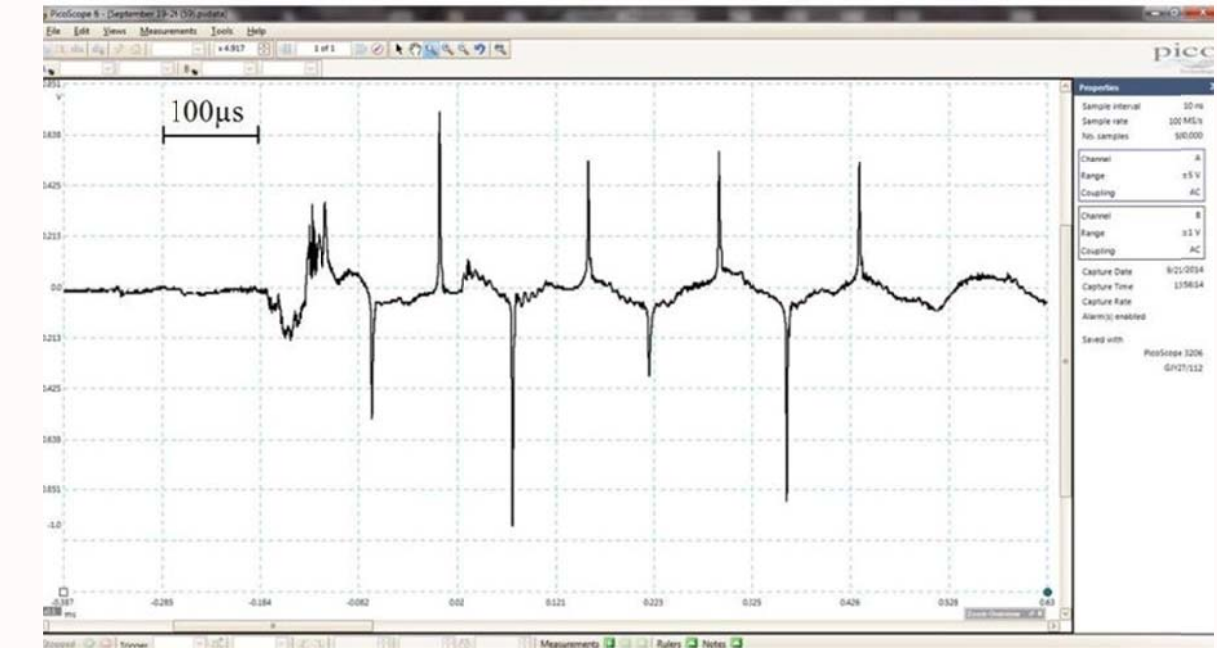

Figure 2. Thunderstorm at Aragats September 21, 2014; registered pattern of the waveform of wideband electric field disturbances.

ATTACHMENT 8. The Board of Trustees of AANL

1. **N. Yeritsyan –** Deputy president of Central Bank of RA (Executive board member)
2. **K. Harutyunyan –** Deputy minister of Science and Education (Board member)
3. **S. Harutyunyan** - Chairman of the State Committee on Science (Board member)
4. **A. Ghukasyan** – Chief executive officer of "Byblos Bank Armenia" CEO (Board member)
5. **A. Papoyan** - Director of Institute for Physical Research of the National Academy of Sciences of Armenia (Board member)
6. **Kh. Nerkararyan** – Professor at Faculty of radio physics of Yerevan Physics Institute (Board member)
7. **Z. Baghdasaryan** – The President and CEO of "Tahoe Associates", a private investment entity in USA (Board member)

ATTACHMENT 9. The Letter of Nerses Yeritsyan on Sponsorship

ՀԱՅԱՍՏԱՆԻ ՀԱՆՐԱՊԵՏՈՒԹՅՈՒՆ
Ա. Ի. ԱԼԻԽԱՆՅԱՆԻ ԱՆՎԱՆ ԱԶԳԱՅԻՆ ԳԻՏԱԿԱՆ ԼԱԲՈՐԱՏՈՐԻԱ (ԵՐԵՎԱՆԻ ՖԻԶԻԿԱՅԻ ԻՆՍՏԻՏՈՒՏ) ՀԻՄՆԱԴՐԱՄ

REPUBLIC OF ARMENIA
A. I. ALIKHANYAN NATIONAL SCIENCE LABORATORY (YEREVAN PHYSICS INSTITUTE) FOUNDATION

0036 Երևան, Ալիխանյան եղբայրների 2, հեռ.(37410) 341 500, ֆաքս(37410) 349 392 • 2 Br. Alikhanyan str., 0036 Yerevan, tel.(37410) 341 500, fax. (37410) 349 392

RESOLUTION

ON THE IMPLEMENTATION OF THE PROGRAM "SUPPORT THE ACTIVITY OF COSMIC RAY DIVISION" OF A. I. ALIKHANIAN NATIONAL SCIENCE LABORATORY (YEREVAN PHYSICS INSTITUTE) FOUNDATION IN ACCORDANCE WITH THE BENEFITS OF CHARITABLE PROGRAMS OF LEGISLATION OF RA.

On the basis of № M-884-A decree issued by the RA Government's Charity program coordination commission in September 14 2014, as well as on the Article 37, part 3 of the regulation of A. I. Alikhanian National Science Laboratory (Yerevan Physics Institute) Foundation (hereafter Foundation), the "Support the Activity of Cosmic Ray Division" project implemented by the Foundation and the Armenian Engineers and Scientists of America /AESA/ has been granted the status of charity program, which ensures:

1. The provision of facilities, goods and services within the charity program are exempt from value added tax /VAT/ (Value Added Tax Law of the Republic of Armenia, article 15, paragraph 28).
2. Goods imported into the customs territory of Republic of Armenia within the program are exempt from customs duty payment (Customs Code of the Republic of Armenia, article 104, paragraph 1, part jg) and customs fee (Customs Code of the Republic of Armenia, article 111, part A).
3. To apply other applicable benefits for the charitable programs in accordance with the law of the Republic of Armenia

***The Board of Trustees made a resolution*:**

On the basis of issued program /attached/ "Support the Activity of Cosmic Ray Division" by the Government of RA entrust to the director of Foundation A. Chilingarian:

1. To administrate "Support the Activities of Cosmic Ray Division" program.
2. To ensure the use of other benefits of charitable program in accordance with the tax and customs legislation of the Republic of Armenia and to exempt the allowances of employees from tax within the program.
3. To open a separate bank account in the territory of RA on which the funds within the framework of the program shall be transferred to.
4. To submit a report to the government of RA, to the Board of Trustees, and the Armenian Engineers and Scientists of America /AESA/ on the results of the program implementation quarterly.

3. This decision shall enter into the force upon its approval:

The chairman of Board of Trustees of the Foundation:

Nerses Yeritsyan

"2" December, 2014

Yerevan

ATTACHMENT 10. ALUMNI of AANL

1. Kocharian Armen Professor in Physics at California State University, Los Angeles

2. Tigran Hovhannisyan Technical leader at Telegate

3. Ashot Avetisyan Founder and CEO/CTO at MiaLinkup Inc.

ATTACHMENT 11. LIST of YerPhI PhD STUDENTS FROM 1971-2011

1971-2011

1971

1. Серов Валерий -0413 - Орлов Юрий
2. Сирунян Альберт – 0416 -Вартапетян Гамлет
3. Козлинер Лев -0416 -Асативни Тина
4. Акопов Норайр -0416 Авакян Роберт
5. Коваленко Владимир -0416 - Орлов Юрий
6. Коваль Леонид -0402 - Матинян Сергей
7. Никогосян Валерий - 0413 - Есин Сергей

1972

8. Одинцов Владимир -0416 - Будагов Юлиан
9. Бабаян Гектор -0416 – Ососков Г.А.
10. Есайбегян Сергей - 0402 -Матинян Сергей
11. Зазян Мери - 0416 - Мамиджанян Эрик
12. Григорян Ромен -0402 - Фрадкир Ефим

1973

13. Габриелян Рубен – 0416 - Безирганян П
14. Григорян Карен – 0416 - Тер- Микаелян Т. М
15. Элбакян Гарегин - 0416 - Вартапетян Гамлет
16. Пилипосян Сержик - 0416 -Вартапетян Гамлет
17. Ходжамирян Александр -0402 - Аматуни Андрей

1974

18. Асатрян Грачя -0402 – Матинян Сергей
19. Григорян Ара - 0402 – Аматуни Ардрей
20. Данагулян Самвел -0416 - Авакян Роберт
21. Саввиди Георгий- 0402 -Матинян Сергей
22. Седракян Ара - 0402 -Матинян Сергей

1975

23. Багдасарян Артем- 0402 -Матинян Сергей
24. Галумян Павлик - 0416 - Вартапетян Гамлет
25. Григорян Степан - 0402 -Матинян Сергей
26. Хачатрян Гагик - 0402 -Матинян Сергей

1976

27. Аракелян Валерий - 0402 -Чизмаджев Ю.А.
28. Арутунян Сурен - 0402 – Аматуни Ардрей
29. Гаспарян Ашот -0416 – Испирян Каро

1977

30. Басеян Айк - 0402 -Матинян Сергей

1978

31. Грабский Варлен- 0416 - Вартапетян Гамлет
32. Дашьян Наталья -0416 – Граменицкий И. М
33. Ананикян Нерсес - 0402 -Матинян Сергей

1979

34. Аматуни Цолак -0416 - Денисов Сергей
35. Карапетян Вардан - 0416 - Вартапетян Гамлет
36. Мартиросян Грачя – 0402 - Лебедев Андрей

1980

37. Казарян Акоп - 0416 - Вартапетян Гамлет
38. Прохоренко Евгений - 0402 -Матинян Серге

1981

39. Шахбазян Тигран - 0402 – Аматуни Ардрей
40. Кавалов Александр- 0402 -Матинян Сергей
41. Бадалян Арташес - 0416 - Мамиджанян Эрик

1982

42. Октанян Варужан- 0416 - Авакян Роберт
43. Хачатрян Витали - 0416 - Вартапетян Гамлет
44. Иоаннисян Ара - 0402 -Матинян Сергей
45. Оганисян Корун - 0402 – Аматуни Ардрей
46. Асатрян Размик- 0416 -Асативни Тина
47. Багдасарян Дереник- 0416 - Вартапетян Гамлет

1983

48. Галендухин Алексан - 0416 - Вартапетян Гамлет

1984

49. Мхитарян Карен- 0416 - Жданов Г.Б.
50. Саргсян Мисак- 0416 -Франкфурт Леонид
51. Гурджинян Вардан- 0416 - Авакян Роберт
52. Тыугу Армен - 0402 – Аматуни Ардрей
53. Саносян Хнланос - 0416 - Мамиджанян Эрик
54. Аланакян Рубен - 0402 -Матинян Сергей
55. Егорян Рубик- 0402 -Ансельм А.
56. Кочарян Арменак- 0402 -Матинян Сергей
57. Иванов Николай- 0402 – Аматуни Ардрей

1985

58. Манвелян Рубен- 0402 -Матинян Сергей
59. Оганесян Карапет-0402- Азнаурян Инна
60. Зурабян Левон - 0402 -Матинян Сергей
61. Погосян Рубик - 0402 -Матинян Сергей
62. Тамарян Саят-Нова -0402 – Шахбазян Всемайр
63. Айрапетян Аветик

1986

64. Караханян Давид -0402- Азнаурян Инна
65. Чатрчян Сергей - 0402 -Матинян Сергей
66. Лазиев Мкртыч-0402- Азнаурян Инна
67. Ахеян Арам- 0402 -Матинян Сергей
68. Кавалов Андрей- 0402 – Аматуни Ардрей
69. Аракелян Тигран -0402 – Шахбазян Всемайр
70. Вартапетян Армен- 0416 - Авакян Роберт
71. Буниятян Армен - 0416 - Вартапетян Гамлет
72. Авдалян Гоар - 0416 - Авакян Роберт

1987

73. Магакян Артур -0402- Ходжамирян Александр

74. Арутунов Артур - 0416 - Мамиджанян Эрик
75. Давоян Артур- 0416 - Авакян Роберт

1988

76. Сехпосян Нунэ – 0402- Тер-Исаакян Норайр
77. Шамамян Анаид -0402 – Геворгян Лекдр

1989

78. Амбарцумян Микаел -0402- Геворкян Сергей
79. Котельский Всеволод -0420 - Лазиев Эдуард
80. Шагинян Сурен- 0402 - Ян Ши
81. Цагоян Мартын- 0416 - Сирунян Альберт
82. Мартиросян Петрос- 0416 - Авакян Роберт

1990

83. Апян Армен – 0416 - - Авакян Роберт
84. Акопян Анжелика - 051316-ВТ - Акопов Норайр
85. Саакян Армен- 0416 – Мкртчян Гамлет
86. Шахназарян Армен- 0402 – Назарян Арсен
87. Манукян Галя- 051316-ВТ - Бабаян Гектор

1992

88. Бабаян Рубен 0402 – Азнаурян Инна

1993

89. Габриэлян Эмин-051316-ВТ - Нанасян Арам
90. Хорасанджян Армен-051316-ВТ - Нанасян Арам
91. Егиян Ованес- 0416 - Авакян Роберт
92. Захарян Арамаис -051316-ВТ - Чилингарян Ашот
93. Арутунян Амбарцум - 0420 - Лазиев Эдуард
94. Саркисян Гор- 0402 -
95. Егиян Гагик -0402 – Асатрян Грачя

1994

96. Григорян Арменак-051316-ВТ
97. Закарян Мартын-0420- Газазян Эдмон
98. Варданян Арарат-051316-ВТ - Чилингарян Ашот
99. Меликян Давид-0402- Гурзадян Ваагн
100. Мхитарян Вагаршак-0402- Саакян Давид

1995

101. Тотолян Рубен-051316-ВТ
102. Аллахвердян Армен-0402- Саакян Давид
103. Далакян Саркис - 0402 - Ананикян Нерсес

1996

104. Аракелян Седрак -0402- *Григорян Ромен*
105. Аветисян Эдуард - 0416 - Авакян Роберт
106. Агузумцян Гаяне - 0416- Демехина Нина
107. Ростомян Армине - 0416- Акопов Норайр
108. Дабагян Микаел -0416- Мкртчян Гамлет
109. Севинян Евгений -0416 -Чилингарян Ашот
110. Гавалян Гагик -0416- Егиян Ким
111. Авакян Аветис -0402- Седракян Ара

1997

112. 112. Меликян Арсен – 0402- Мкртчян Рубен
113. 113 Гулгазарян Рубен- 0402 - Ананикян Нерсес
114. Гамбурян Анна – 0416 – Элбакян Гарегин

1998

115. Асатрян Гайк – 0402 – Асатрян Грачя
116. Мирумян Мхитар – 0402 – Караханян Давид
117. Хачатрян Шагане - 0402 - Седракян Ара
118. Агаларян Арам -0416 - Геворкян Сергей
119. Ростомян Тигран -0416 – Маргарян Амур
120. Согоян Арутун -0416 - Чилингарян Ашот
121. Тваскис Владас - -0416 - Авакян Роберт

1999

122. Седракян Тигран -0402 – Погосян Рубик
123. Багдасарян Ованес -0416- Егиян Ким
124. Григорян Баграт -0420 – Цаканов Василий

2000

125. Саргсян Эдгар – 0416 - Авакян Роберт

2001

126. Акопов Завен - 0416- Авакян Роберт
127. Чилингарян Сурен - 0420 - Лазиев Эдуард
128. Оганисян Артем– 0402 – Асатрян Грачя
129. Азнаурян Оганес 0416- Егиян Ким
130. Мамян Ваге- 0416- Егиян Ким

2002

131. Погосян Ваагн – 0402 – Асатрян Грачя
132. Акопян Айк - 0416 - Сирунян Альберт

2003

133. Симонян Маргар - 0416 - Акопян Грачья
134. Мкртчян Гайк – 0402- Манвелян Рубен
135. Давтян Армен- 0420 - Лазиев Эдуард

2004

136. Кулогян Оганес -0402 –Гурзадян Ваагн
137. Ананикян Лев - 0402 – Иванов Николай
138. Овсепян Левон – 0416 - Авакян Роберт
139. Рейьерс Артур -0416 - Чилингарян Ашот
140. Ходжоян Мартин- 0420 - – Газазян Эдмон
141. Бабаян Вираб – 0407 – Добровольский Николай

2005

142. Саркисян Карен -- 0402 - Ананикян Нерсес
143. Алексанян Эдгар - 0420 - Лазиев Эдуард
144. Ханданян Ованес - 0416 – Тароян Саркис
145. Абрамян Сергей -0416 – Егиян Ким
146. Жамкочян Симон = 0416 – Маргарян Амур
147. Мкоян Карен -1304 – Акопов Норайр
148. Мовсисян Мгер – 1304 - Авакян Роберт
149. Гурджян Севада – 0416 - Авакян Роберт
150. Фаришян Григор – 0416 - Авакян Роберт

2006

151. Алексанян Эдуард – 0416 – Арутунян Вачаган
152. Овасапян Саркис – 1304 – Акопов Норайр
153. Игитян Айк -1302 – Маркаров Г. (ЕрПИ)
154. Габриэлян Айк – 0402 – Асатрян Грачя
155. Ованисян Ваан 0402 - - Ананикян Нерсес
156. Цаканян Андраник – 0413 – Лазиев Эдуард
157. Тарлоян Артур 0402 – Саарян (ЕГУ)
158. Геворкян Айк -0407 - 2008 перевод в ЕГУ

2007

159. Хачатрян Вардан – 0416 – Сирунян Альберт
160. Фарамузян Рафаэл -0416 - Авакян Роберт
161. Мовсисян Арам – 0416 –
162. Каграманян Тигран -0402- Гурзадян Ваагн
163. Киракосян Зара-0402- Саакян Давид
164. Петросян Ануш – 0416 – Элбакян Гарегин

2008

165. Мкртчян Карапет – 0402 – Манвелян Рубен
166. Маилян Баграт -0416 - Чилингарян Ашот
167. Карян Геворг - 0416 – Акопов Норайр

2009

168. Егиазарян Арсен– 0402 – Асатрян Грачя
169. Тумасян Армен -0416– Сирунян Альберт
170. Ованнисян Армен – 0416 - Чилингарян Ашот
171. Ванян Левон– 0416 - Чилингарян Ашот1
172. Карапетян Тигран – 0416 - Чилингарян Ашот

2010

173. Ованнисян Карен -0402= Аллахвердян Армен
174. Даллакян Рубен- 0416 - - Авакян Роберт

2011

175. Тамарян Левон - 0402 - Геворгян Лекдар

ՑՈՒՑԱԿ

01.01.15

Ա. Ի. Ալիխանյանի անվան ազգային գիտական լաբորատորիա

Ասպիրանտները

Առկա ուսուցում

Վարդանյան Գագիկ Հովաննեսի	2012-2015 -	01.04.16
Գյուրջինյան Արմեն Վարդանի	2013-2016	01.04.16
Հարությունյան Գևորգ Սուրենի	2013-2016	01.04.16
Բաբաջանյան Սանասար Գարնիկի	2014 – 2017	01.04.16
Մարտիրոսյան Նարեկ Հենրիկի	2014 – 2017	01.04.16
Էլբակյան Հայկ Վաչագանի	2014 – 2017	01.04.16

Հեռակա ուսուցում

Ղանդիլյան Երանուհի Սերգոի	2011-2015	01.04.16

Մկրտչյան Հռիփսիմե Վարդանի	2013-2017	01.04.16
Պողոսյան Արմեն Ռուբիկի	2012-2016	01.04.02
Պողոսյան Հասմիկ Ռուբիկի	2013-2017	01.04.02
Ապրեսյան Ելենա Անդրանիկի	2014-2018	01.04.02