ANNUAL REPORT

Artem Alikhanyan National Lab (AANL)

2013

ALIKHANYAN
National Laboratory

CONTENT

Status Report, Artem Alikhanyan National Lab (AANL) 2013

2013 STATUS REPORT

A. Alikhanyan National Laboratory (AANL)

(Yerevan Physics Institute, YerPhI**)**

1. INTRODUCTION

Vision: *A. Alikhanyan 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.*

AANL continuing implementing the InComEx's (International Committee of Experts) recommendations[1] and is focusing the scientific efforts on defined priorities. In 2013 the AANL strengthened its scientific activity in traditional scientific directions and increased activity in nuclear physics. Significant progress was achieved in preparation of production of Tc isotope for SPECT scanners with 18-MeV proton beam of new IBA cyclotron, to be installed on former premises of YerPhI in autumn 2014. AANL scientists plan to collaborate with new opening diagnostic center and prepare a proposal of services that AANL can provide to the center.

The AANL physicists are preparing research projects for nuclear physics experiments with 18 MeV proton beams, one of projects get state thematic funding another projects will be submitted for RA competitive funding in May 2014.

The program of the innovation projects continued in 2013 with significant progress in lidar based device for the remote electric field estimation in thunderclouds and new ionization detectors for the carbon dating in low background solar mine. A new CsI crystal based spectrometer was designed and 2 units were fabricated now under operation at Nor-Amberd and Aragats research stations. Significant lowering of the energy threshold of new spectrometer (down to few hundreds of KeV) allows registering new mods of the thunderstorm ground

[1] The InComEx's recommendations were endorsed by the Government of the Republic of Armenia, as a roadmap for transforming the AANL into a modern and competitive national science laboratory

enhancements, a new high-energy phenomenon in terrestrial atmosphere discovered by YerPhI physicists.

In 2013 a novel device for the elemental analysis the ARL QUANT'X Energy-Dispersive X-Ray Fluorescence Spectrometer from Thermo Electron Corporation (USA) was installed in AANL. It is designed for inorganic elemental analysis from Na to U with sensitivity of10-100ppm. A new lab was organized to deliver appropriate services to Armenian industry and archeological sciences.

New monitoring site was established on the shore of lake Sevan. Particle detectors and electric field meter are continuously measuring changing geophysical parameters and sending it to Yerevan headquarters of cosmic ray division. In 2014 we plan to install automatic weather station at Sevan monitoring site.

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 signed with CERN LHC experiments. New seminar for young scientists and students actively operates; institute employees presented twenty-five 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 2013 comparing with previous years. We hope that master courses to be established in national lab fall 2014 will help to educate students in the field of high-energy physics and astrophysics. New classes equipped with modern electronics and particle detectors are now under construction in education center of national lab. Seminar rooms in Experimental physics, Cosmic ray and Theory divisions were repaired and refurbished. Continued works on the modernization of the institute networking and computing center. Additional 30 workstations were added to the network. Butch Cluster System powered by 4 x Graphic card Nvidia GTX Titan 'Supercomputer GPU' 2,688 CUDA cores with 6GB of GDDR5 memory. Computer Installed Eduroam authentication server provides secure, world-wide roaming access service for the international research and education community. Eduroam allows to obtain Internet connectivity across Europe by simply opening laptop in the universities and research lab. Installed **Voice Over IP Phone Service** with full PBX integration

allows to institute employees to connect internal and extended phone networks. About 300 registered VOIP users are connected to internal network by IP soft phone and Ip phones.

New design gets the WEB site of YerPhI. Periodically are published news on research, press releases and "pictures of the day". We publish most important papers of YerPhI employees; plan to publish as well bibliometric information of YerPhI scientists.

In July the directorate of AANL on special meeting invited all master students for listening their reports and gave them the recommendation on further work in AANL. In 2013 national management lab pay much more attention to track **staff check** in times and working hour to know what national lab **staff** is working on and how effective. However major changes and painful optimization of the age structure is planned in Summer 2014 according to adopted strategic development plan. Repairing the AANL campus's infrastructures and high altitude research stations was continued. Equipment for teleconferencing and new projectors was installed. Internet bandwidth accessible to the scientist was significantly upgraded. The international conference center in Nor Amberd was innovatively repaired and now meets stringent international standards for holding workshops and small-scale symposiums. In 2013 the CERN RDCMS and TEPA-2013 workshops were successfully held (see attachment 7). In 2013 AANL`s scientists won the RA Presidential Award for physics, (see attachment 7). Also AANL scientists won 20 state and international grants (see attachment 3).

2. SUMMARY OF THE SCIENTIFIC ACTIVITIES OF AANL DEPARTMENTS

2.1. Experimental Physics

Experimental Physics Division on the basis of 8 scientific groups consists from 76 people (including 4 Doctors and 25 PhDs, 40 engineers and technicians, 4 master students and 3 PhD students; total fund for salaries in 2013 – M87.8 dram, mean salary – K115.5 dram.

During 2013 year groups of scientists actively participated in high energy physics experiments on accelerators abroad (CERN-LHC, DESY-HERMES, H1, OLYMPUS, JLAB-Hall A,B,C). ATLAS, ALICE and CMS groups continued the works in ongoing LHC physics program (repairing old and preparing new facilities for LHC, data analysis).

The DESY groups continued the data analysis based on the data accumulated by HERMES and H1 Collaborations and finished to data taking OLYMPUS experiment.

The Jlab-groups actively contributed both to data analysis and to preparing new experimental facilities for updated accelerator.

According to the decision of the Government of Armenia, from the Belgian

company IBA will be purchased and located on the territory of Alikhanyan National Science Laboratory, Yerevan Physics Institute, Cyclotron CYCLONE C18. It is suggested the experimental program on the C-18 cyclotron which will be useful for a better understanding of the nuclear structure and the mechanisms of the cosmic nucleosynthesis, as well as for testing and improvement of various theoretical models on the low-energy nuclear reactions.

In Yerevan were investigated possibilities and prepared projects on nuclear physics experiments based on the ARUS synchrotron with new non-acceleration stretcher mode and with 18-MeV proton beam from IBA-18/18 cyclotron.

2.2. Cosmic Ray Physics (CRD)

Cosmic Ray Division on the basis of 6 scientific groups, 2 mountain stations and 1 technical team, consists from 62 employees: 1 Doctor of sciences 20 PhDs, 26 engineers and technicians, 2 master students and 1 PhD students, 13 support personnel; total funds for salaries in 2013 – M63.86 dram, mean salary – K103 dram.

CRD in 2013 published several key papers establishing comprehensive model of the new high-energy phenomena in atmosphere, namely – Thunderstorm ground enhancements. New experimental facilities measuring secondary cosmic ray particle flux on research station in Nor Amberd and Aragats as well on new established monitoring center on Sevan lakeshore were launched and put in the uninterruptable operation. International symposium TEPA-2013 was hold in repaired and refurbished Nor Amberd international conference center; TEPA-2014 symposium planned in September 2014.

2.3. Theoretical Physics

Theoretical Physics Division consists from 45 employees: including 16 Doctors and 19 PhDs, 1 technician, 3 graduate students (bachelor and magister) and 3 PhD students and 4 master students and 1 technician; total fund for salaries in 2013 – M77.31 dram, mean salary – K171.8 dram.

The main directions of investigation during 2013 in the Department were high energy phenomenology, quantum field theory, statistical physics and integrable models, condensed matter physics. The Department published about 50 articles in international journals, employees of the Department participated in more than 10 international conferences and workshops, and one PhD theses was defended.

2.4. Accelerator Physics and Techniques

Accelerating Physics Division on the basis of 4 scientific groups and 2

maintenance groups consists from 37 employees: including 3 Doctors and 5 Candidates of Science, 16 engineers and technicians, 1 master student and 15 support personnel; total fund for salaries in 2013 – M43.84 dram, mean salary – K109.6 dram.

The Accelerator Physics and techniques Division prepares linear accelerator (ARUS injector) operation for the new experiments in acoustic-physics .The microtron group continues attempts to repair the 25-MeV microtron.

2.5. Applied Physics

Applied Physics Department on the basis of 4 scientific and 1 engineering groups consists from 22 employees: 5 Doctors and 7 PhDs, 6 engineers and technicians, 2 master and 1 PhD student; total fund for salaries in 2013 – M23.41 dram, mean salary – K106.4 dram.

The main lines of research in 2013 continued Research of the radiation defect formation in condensed materials, Investigation of materials and devices in extreme physical conditions, accelerator diagnostics and instrumentation based on the vibrating wire technology

2.6. Isotope Investigation and Production

Isotope Investigation and Production *Department* on the basis of 3 scientific and 1 engineering groups consists from 23 employees: including 5 PhDs, 13 engineers and technicians, 4 master and 1 PhD students; total fund for salaries in 2013 – M23.76 dram, mean salary – K103.3 dram.

During 2013 were performed preparatory works for starting isotope and research on cyclotron IBA-18/18.

2.7 Center for Cosmology and Astrophysics

Cosmology and Astrophysics Centre consists from 6 employees including 1 Doctors and 5 PhDs; total fund for salaries in 2013 – M7.134 dram, mean salary – K118,9 dram.

Main lines of research include participation in the LARES (LAser Relativity Satellite, Italian Space Agency, European Space Agency, NASA) experiment and study of theoretical cosmological models vs the observational maps on Cosmic Microwave Background radiation recently available from Planck collaboration.

2.8 Computer center

During 2013 following upgrades and modernizations were performed:

1. GEANT4 HERMES software with all required libraries was installed and operated.
2. GRID systems were upgraded from EMI 2 to EMI 3. Including all underlying software, services libraries necessary for the ALICE and ATLAS groups.
3. Asterisk Telephony System for AANL internal and eexternal lines (with dahdi ax4g and ax800p cards. Internal phone connectivity was established with mplementation of IVR and full integration with AANL PBS.
4. The mail system security was improved including checks for spam, phishing and other type of known attack (added rate limit for ssl authenticated users, etc.).
5. Monitoring Systems based on cacti, nagios with alarm and mail notification were prepared and installed .
6. Linux System servers , Kernels, Services, etc were periodically upgraded.

3. IMPROVING THE AGE STRUCTURE OF THE AANL

The administrative structure of AANL after intense hiring of master students in 2011-2013 was significantlyimproved. In 2013 as a transitional year ~50 scientists and engineers with age above 70 years were kept in the AANL staff. Total number of employees above 70 years is now 46; below 35 years – 95. 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 = 95/46 = 2.06. Before major modernizations this number was below 1. However among group leaders there are only 6 persons below 40 (4 from CRD, 2 from accelerator department). Overall number of employees decreases from 2009 to 2013 by 83 persons: 499 in 2009, 416 – in 2013. In July 2014 the major changes of both senior and young staff is planned according to the real contribution and qualification.

A. ALIKHANYAN NATIONAL LABORATORY

Employee's Ages Distribution (01.04.2013)

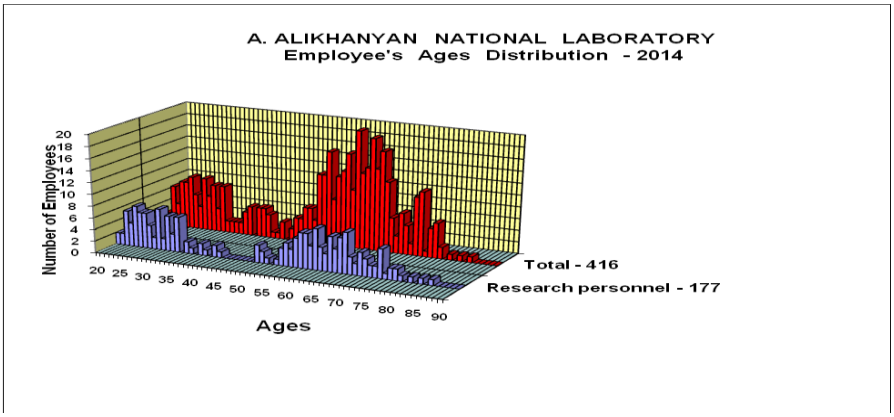


Figure 1. ***AGE distribution of the AANL employees***

Table 1 Breakdown on age as it is on 1.04 2014

PERSONAL STRUCTURE OF AANL ON AGE

(as of 30.06.2014)

№ п/п	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	1	4	0	0	0	0	7
2	Administration (+ 3 advisers)	5	0	3	0	4	4	3	3	2	0	0	0	24
3	Experimental Physics Division	26	1	1	1	2	13	10	11	9	1	1	0	76
4	Theoretical Physics Division	14	2	2	2	5	9	5	3	2	1	0	0	45
5	Cosmic Ray Division	15	5	3	1	2	7	12	9	7	2	0	0	63
6	Accelerating Physics Division	6	0	0	0	3	2	7	9	4	6	1	0	38
7	Applied Physics Department	8	0	0	1	1	2	7	1	1	1	0	0	22
8	Isotope Research and Production Department	8	0	0	1	2	2	7	1	0	0	0	0	21
9	Cosmology and Astrophysics Centre	5	0	0	0	0	1	0	0	0	0	0	0	6
10	Computer Center	4	0	0	0	1	2	0	0	0	0	0	0	7
11	Industrial and household services	2	3	6	3	17	11	16	4	6	2	0	0	70
12	Security guard	2	2	1	3	4	8	10	4	1	0	0	0	35
	IN TOTAL:	95	13	16	12	42	62	78	49	32	13	2	0	414

4. AANL PUBLICATIONS AND CITATIONS

In 2013 YerPhI scientists continue actively participate in high-energy physics and astrophysics experiments in Armenia and abroad. YerPhI theoreticians continue to publish papers in variety of topics of their interest. Cosmic Ray physicists publish a series of papers on the new discovered on Aragats TGE (Thunderstorm Ground enhancements) phenomena – high-energy processes in thunderstorm atmospheres. The number of articles published by YerPhI's researchers in 1972-2013 according to inSPIRE database is presented in Fig. 2. The diagram of citations to papers published by YerPhI scientists is posted in Fig. 3. The overall growth of both this internationally recognized key indicators during last years is apparent. The revolutionary research made on Large Hadron Collider (LHC) of CERN in the last 2 years improves YerPhI results. 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 and in preparation of data analysis. All this years there were very few publications concerning CERN activity. 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.

According to Thomson-Reuters (Web of Knowledge) database in 2006-2013 the total number of papers published by YerPhI's researchers in ISI indexed scientific journals is 1537 with total number of citations to these papers – 31,771. Corresponding numbers for the all-Armenian publications and citations are 5555 and 44738. About 15% of 1537 papers authored by YerPhI scientists were published in journals with impact factors greater than 6. Furthermore, YerPhI scientists published 9 papers in Science and 3 papers in Nature that also is international recognized criteria for high rank research of insrtitution..

YerPhI scientists have leading positions in Armenia by these 2 main indexes enumerating scientific product of institutions. Near 8-fold advantage of YerPhI in number of citations upon nearest institution is explained by high qualification of YErPhI scientists that lead to publishing in journals in very high impact factor.

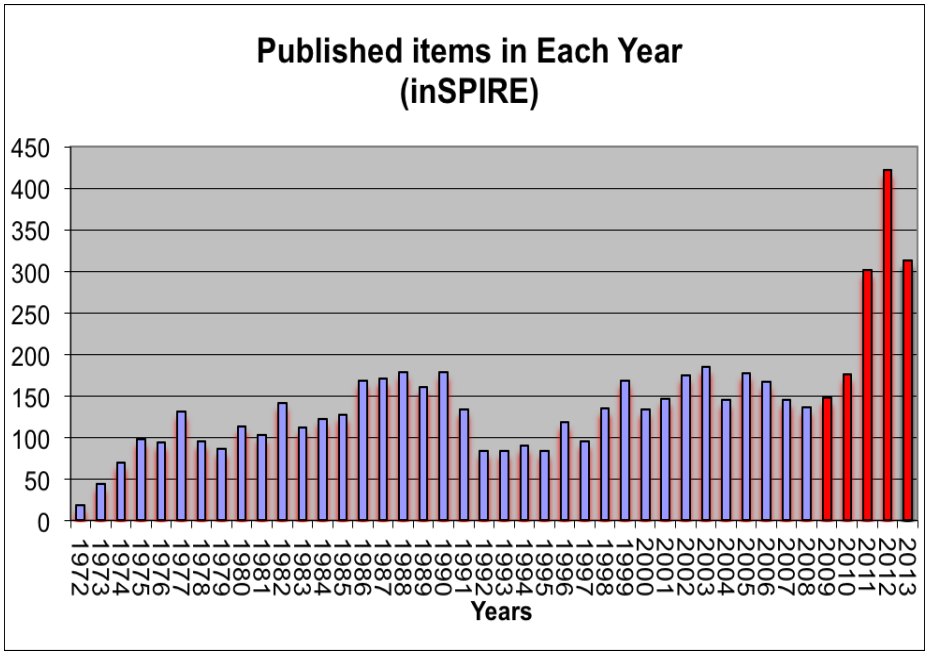


Figure 2 . *Distribution of the published papers in peer review journals, inSpire 8.05.2014*

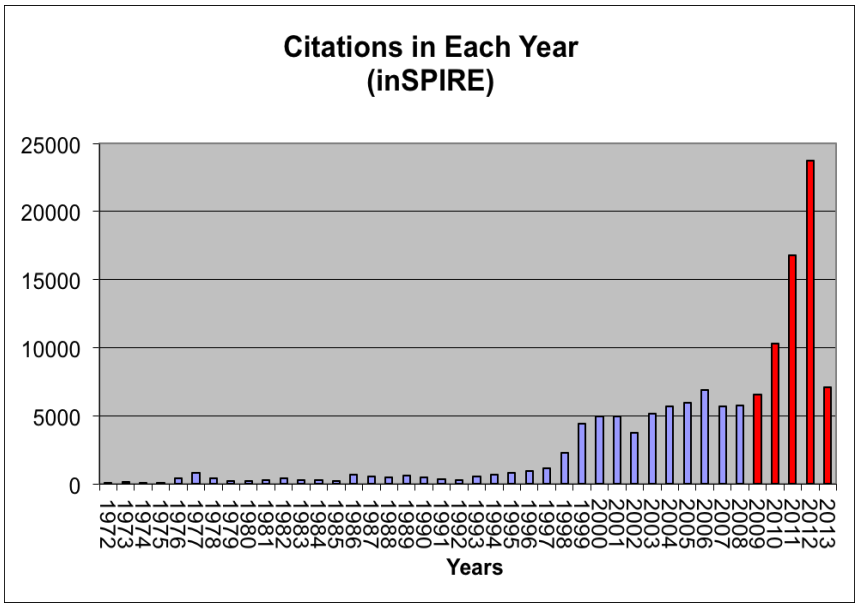


Figure 3 . Number of citations to the national lab employee`s papers*, inspire 8.05.2014*

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

In 2013 AANL Scientific Council held 4 meetings. In 2013 AANL`s Professional Council # 024 listed and approved 4 PhD theses and 1 doctor of science thesis, the titles of which are presented in the attachment 4.

In 2013 AANL`s seminars were very active, see the list in attachment 5.

Among 122 business trips made by AANL employees in 2013 44 were to CERN/DESY/JLab according to program of mutual research, 29 – participation in conferences, summer schools, 37 – according individual invitations.

New agreements for the joint research were signed in 2013 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	2013 (MLN. DRAMS) 1$=409.03 DRAM)	2012 * (MLN. DRAMS) 1$=401.72 DRAM)	2011 * (MLN. DRAMS) 1$=370.32 DRAM
RA funding Salary	704.0 M1721.1$ 463.3 M1,132.7$	710.4 M1,768.4$	660.6 M1,783.9$
Additional salary	33,812.0 K82.66$		
RA communal	58,150.0 K142.17$		
RA Scientific conf.	5,488.0 K13.42$	-	-
RA Project funding	41,807.8 K102.2$	41,659.8 K103.7$	39,787 K107.4$
International projects	19657.7 K48.06$	3,039.0 K7.6$	
DESY (salary)	38,530.0 K94.2$	27,782.0 K69.2$	44,151.0 K119.2$
JLab (Internet)	-	5,694.2 K14.2$	3,568.0 K9,6$
CNCP	-	3,260.0 K8.1$	3,240.0 K8,7$
ISTC overhead	24,460.8 K59.8$	25,848.0 K64.3$	5,305.0 K14.3$
YErPhI Services	14,165.9 K34.63$	988.0 K2.5$	15,2570.0 K41.2$
Rent of space	30,865.0 K75.46$	33,402.0 K83.1$	27,342.0 K73.8$
Sales	8,441.6 K20.64$	18,255.0 K45.4$	1,434.0 K3,9$
Other	11,089.3 K27.11$	5,660.0 K14.1$	20,117.0 K54.3$

Total from RA	**855.6 M2,091.8$**	**752.1 M1,872.2$**	**700,4 M1,891.3$**
Own profits	**134,852.6 K329.7$**	**123,928.2 K308.5$**	**120,414.0 K325,2$**
State + own	**990.4 M2,421.3$**	**876.0 M2,180.7$**	**820,8 M2,216.5$**

***- 2011 and 2012: Budget revenues are not separated**

Table 3. National lab expenditures

YERPHI EXPENDITURES	**2013 1$=409.03 DR**	**2012 1$=401.72 DR**	**2011 1$=370.32 DR**
Salary	600957.7 M1469.23$ (67.15%)	577665.0 M1438.0$ (64.4%)	495,870.0 M1,339.0$ (63.7)
Electricity	43471.0 K106.28$ (4.9%)	41346.0 K102.9$ (4.6%)	42,109 K113.7$ (5.4%)
Gas	12487.0 K30.53$ (1.4%)	16889.0 K42.0$ (1.9%)	8,793.0 K23.7$ (1.1%)
Phone	2629.0 K6.43$ (0.3%)	2684.0 K6.7$ (0.3%)	2,723.0 K7.4$ (0.35%)
Water	9386.0 K22.95$ (1.0%)	12706.0 K31.6$ (1.4%)	6,526.0 K17.6$ (0.84%)
Internet	4620.0 K11.3$ (0.5%)	6299.0 K15.7$ (0.7%)	3,576.0 K9.7$ (0.46%)
Taxes	21117.0 K51.63$ (2.4%)	16622.0 K41.4$ (1.8%)	13,194.0 K35.6$ (1.7%)
Business Travel Գործուղում	44119.6 K107.86$ (4.9%)	43946.0 K109.4$ (4.9%)	32,603.0 K88.0$ (4.2%)
Fuel	9800.0 K23.96$ (1.1%)	8051.0 K20.0$ (0.9%)	8,650.0 K23.4$ (1.1%)
Materials & equipment	142392.0 K348.12$ (15.9%)	85416.0 K212.6$ (9.5%)	89,773.0 K242.4$ (11.5%)
Capital & current repairs	26,868.0 K65.68$ (3.0%)	40,678.0 K101.3$ (4.5%)	33,915.0 K91.6$ (4.4%)
Fees	15962.0 K39.0$ (1.8%)	20000.0 K49.8$ (2.2%)	22,800.0 K61.6$ (2.9%)
Scientific conf.	5488.0 K13.4$ (0.6%)	-	-

Other	24106.0 K58.9$ (2.7%)	24075.0 K59.9$ (2.7%)	17,221.0 K46.5$ (2.2%)
Total	**894.949** **M2188.0$**	**896.377** **M2231.3$**	**777,753** **M2100.2$**

The remainder on 01.01.13 was M37,574 AMD, on 01.01.14 – M64,574.7 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, phone connections and other is significantly improved in 2013.

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 ^{99m}Tc 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-pressurevessels 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.

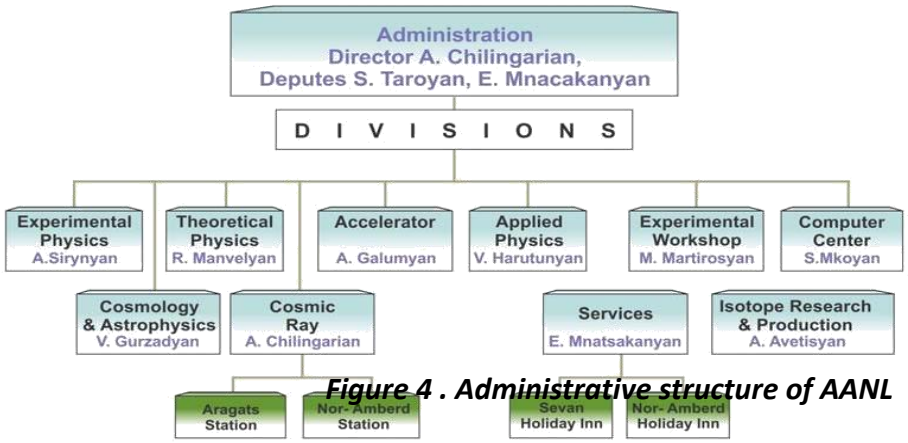


Figure 4 . Administrative structure of AANL

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
   - ✓ researc her
   - ✓ 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.

5. Provide access to national lab information, Internet recourses, high productivity computing, scientific publications, and libraries of applied programs, printers, and telephones.
6. Establish small business innovation research (SBIR) and small business technology transfer competitive funding.
7. Provide secure storage of the isotopes and radioactive materials according to MAGATE standards.
8. 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

2013 թ. Ա. Ալիխանյանի անվան Ազգային Գիտական Լաբորատորիայում գործող դրամաշնորհների ցուցակ

Հ /Հ	Թեմայի համարը	Ֆինանսավորող կազմակերպություն	Ղեկավարի անուն, ազգանուն, հայրանուն	Թեմայի անվանումը	Կատարման ժամկետը
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 ՄՍՄՄ -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
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	Չիլինգարյան	Ամպրոպային	2013-2015

		գիտատեխնիկական գործունեության պայմանագրային ֆինանսավորման թեմա	Աշոտ Աղասու	Վերգետնյա Աճերի հետազոտությունները տարրական մասնիկների դետեկտորների , Էլեկտրական եւ գեոմագնիսական դաշտի եւ օպտիկական գրանցիչների օգնությամբ	
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
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".	2013-2015

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	Քվանտային սպինային համակարգերի խճճվածությունը, մագնիսական հատկությունները, վիճակագրական գումարի զրոները և Լյապունովի ցուցիչները)	2013-2014
15.	295302, SPIDER	Marie Curie Actions, FP7-PEOPLE-2012-IRSES,	Իզմաիլյան 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	Մանվելյան Ռուբեն Պ.	Infinite-Dimensional Symmetries, Gauge/String Theories and Dualities	2012-2015
18.	CNRS IE-017	**ՀՀԿԳՆ ԳՊԿ – ԳՀԱԿ (France)**	Անանիկյան Ներսես Ս.	Classical and Quantum Chaos (CLASSQUANT)	2012-2013
19.	CNRS IE-028	**ՀՀ ԿԳՆ ԳՊԿ – ԳՀԱԿ (France)**	Մարտիրոսով Ռոմեն Մ.	Study of fine structure of the primary cosmic ray energy spectrum with the GAMMA experiment at Mt. Aragats	2012-2013
20.	12GE-012	**ՀՀ ԿԳՆ ԳՊԿ – BMBF (Germany)**	Ռեյմերս Արթուր	ՎԵԲ Տեխնոլոգիաների վրա հիմնված տիեզերական եղանակի դիտման համակարգ	2012-2013

ATTACHMENT 4. List of The Theses Defended in AANL (2013).

N	Name	Academic degree	Title of PhD and supervisor's name
1	**Kiarkosyan Zara Alexanderi**	**Ph.D**	**" The Resolution of evolution models with the methods of statistical methods" Supervisor: Doctor of Science Sahakyan D. B. (AANL)**

2	**Dallakyan Ruben Koyai**	**Ph.D**	**"The Study of photo-nuclear reactions under electron beam with a maximum energy of 40 MeV of linear electron accelerator" YerPhI** **Supervisor: Doctor of Science Avagyan R. O. (AANL)**
3	**Karapetyan Tigran Tatuli**	**Ph.D**	**"Research of solar and thunderstorm modulation effects posed on the secondary cosmic ray fluxes"** **Supervisor: Doctor of Science Chilingaryan A.A.(AANL)**
4	**Sargsyan Seda**	**Ph.D**	**"The general theory of relativity and generalizations inspections by the satellite data and Kolmogorov analysis"** **Supervisor: Doctor of Science Gurzadyan V. G.**

ATTACHMENT 5. List of AANL Seminars 2013

1. *15.10.2013 Thomas RUTH (TRIUMF,CANADA),* World Medical Isotope Crisis: How did this happen and where are we now?
2. *27.09.2013 Sergey Gevorkyan,* Pions photoproduction in the nucleus Coulomb field (Primakoff effect)
3. 20.09.2013 *Misak Sargsian, (Florida International University)*, Nuclear Forces at Short Distances and the Dynamics of Superdense Matter
4. *5.09.2013* Razmik Mirzoyan, Max-Planck-Institute for Physics, Munich, Germany "Recent Highlights of MAGIC"
5. *29.08.2013* Eduard Aleksanyan, YerPHI "Luminescence spectroscopy of wide-gap solids"
6. 02.08.2013 *Yves Gallant (Laboratoire Univers et Particules de Montpellier, France)*, Results from gamma-ray astronomy and implications for Galactic cosmic rays
7. *30.07.2013* Christopher Fasano, Professor and Chair Department of Physics Monmouth College "New detector for Thunderstorm Ground Enhancement (TGE) detection in American Midwest"
8. *30.07.2013* , Sergey Minasyan, YerPhI "Gravitational lensing as a major tool to study the dark Universe"
9. 31.07.2013 *A. Khodjamirian*, Hadronic effects in semileptonic and radiative B decays
10. *24.07.2013* A.Beglarian Karlsruhe Institute of Technology "National Instruments products in the KATRIN experiment"
11. *17.07.2013* Davit Karakhanyan, YerPhI (This seminar was postponed) "Quantum computers"

12. *11.07.2013* Davit Karakhanyan, YerPhI "Cosmology, Dark Matter and Dark Energy"

13. *1.07.2013* Suren A. Chilingaryan, Karsruhe Institute of Technology "UFO project"

14. *25.06*.2013 Harutyun Khachatryan, YerPHI "The dark side of the Universe; dark matter and dark energy"

15. *18.06.2013* Gegham Yegorian, YerPHI "Cosmic Microwave Background radiation: window to early Universe"

16. *31.05.2013* Hayk Hakobyan, Jefferson Lab, Valparaiso university. "Characterization of Novel Hamamatsu Multi Pixel Photon Counter Array erson Lab, Hall D"

17. *30.05.2013* Christian Spiering, DESY, Ice cube "Neutrino Astronomy: a new window to the Universe"

18. *15.05*.2013 Levon Pogosian, Simon Fraser University, Canada "Our universe: facts and speculations"

19. *A. Gasparyan,* A Novel High Precision Measurement of the Proton Charge Radius 81

20. *25.04.2013 Авакян (ВНЦ ГОИ имени С.И. ВАВИЛОВА),* Энергетика современных климатических изменений

21. *25.04*.2013 Sergey Avakian, Pulkovo Observatory, RAS "The role of the activity of the sun in the Global Warming"

22. *15.02.2013 Hrachya Marukyan,* Exclusive reactions at HERMES

23. *08.02.2013 K.A.Ispirian,* Gamma Ray Cherenkov–Transition Radiation

24. *17.01.2013 V.G. Gurzadyan et al.,* Book Presentation "Low Dimensional Physics and Gauge Principles" Matinyan Festschrift

25. *11.01.2013 D. Saakian,* The three different phases in the dynamics of chemical reaction networks and cancer

ATTACHMENT 6. List of Scientific Institutions with whom YerPhI Has Signed Agreements or MOU on 2013

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. 13Armenian metheorological center of ministry of Emergency.
14. Lund university – MAX Lab accelerator center.

ATTACHMENT 7. Press Releases of AANL of 2013

1. The Scientific Committee on Solar Terrestrial Physics (SCOSTEP)

Last year Armenia is has became a member of Scientific Committee on Solar Terrestrial Physics (SCOSTEP) and by the decision of Prof. Samvel Harutyunyan, the chair of State science committee, Prof. Ashot Chilingarian, Director of Yerevan physics institute, has been nominated as the Armenia National representative to the SCOSTEP General Council.

SCOSTEP, an interdisciplinary body of the International Council for Science (ICSU) is international organization organizing and conducting solar-terrestrial research programs worldwide. The current program is the Climate and Weather of the Sun-Earth System (CAWSES), which is established in 2004. The main functions of CAWSES are coordinating international activities in observations, modeling and applications crucial to achieving a better understanding Earth's space environment and impacts onlife and society. The CAWSES program involves scientists from over 30 countries, with regional offices in Brazil, France, Germany, Japan, India and Taiwan. Armenia has been very active in the Solar terrestrial physics research with lots of young researches active and making their presence known with excellent publications. Armenian scientists have also been contributing enormously to the physics of the Sun-Earth system by creating observing facilities and data analysis tools, so the president of SCOSTEP Nat Gopalswamy invites Armenia to become official part of the SCOSTEP community.

What is SCOSTEP?

The Scientific Committee on Solar Terrestrial Physics (SCOSTEP) is an interdisciplinary body of the International Council for Science (ICSU). SCOSTEP promotes ICSU's mission to strengthen international science for the benefit of society. SCOSTEP runs international interdisciplinary scientific programs and promotes solar-terrestrial physics research by providing the necessary scientific framework for international collaboration and dissemination of the derived scientific

knowledge in collaboration with other ICSU bodies. SCOSTEP seeks opportunities for interaction with national and international programs involving solar terrestrial physics elements to ultimately gain a full understanding of how the variability of the Sun affects the human society.

What does SCOSTEP do?

SCOSTEP has three main activities that address the needs of the solar terrestrial physics community worldwide: (1) Scientific programs, (2) Capacity building and outreach, (3) International Scientific Meetings. SCOSTEP has been running scientific programs for the past 40 years that are timely and relevant to the human society. The current scientific program is the Climate and Weather of the Sun-Earth System (CAWSES) which addresses how Earth is affected by the long-term and short-term changes on the Sun. Under capacity building, SCOSTEP disseminates knowledge gained from solar terrestrial research to the public and students using comic books, SCOSTEP Newsletter, and other media. SCOSTEP has partnered with other international bodies such as the International Space Weather initiative to train university students to become next generation scientists. SCOSTEP conducts timely international symposia in various parts of the world, including the quadrennial solar terrestrial physics symposia since 1966.

How is SCOSTEP governed?

SCOSTEP is governed by a General Council and the Bureau. The Bureau is constituted by the President, Vice-President, Scientific Secretary (ex-officio), and members from ICSU unions and interdisciplinary bodies: Committee on Space Research (COSPAR), the International Astronomical Union (IAU), the International Union of Radio Sciences (URSI), the Internationals Association of Geomagnetism and Aeronomy (IAGA), the International Union of Pure and Applied Physics (IUPAP), the International Association of Meteorology and Atmospheric Sciences (IAMAS), and Scientific Committee on Antarctic Research (SCAR). The General council consists of national representatives from 36 member nations, 55 scientific discipline representatives, and experts appointed to run scientific programs.

How does SCOSTEP cooperate with international bodies?

SCOSTEP is a permanent observer at the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS). SCOSTEP will provide input to the COPUOS Scientific and Technical Subcommittee on the Long-term Sustainability of Outer Space Activities related to Space Weather. The scientific programs run by SCOSTEP are in cooperation with the seven ICSU international unions. SCOSTEP jointly undertakes capacity building schools and workshops in cooperation with the International Space Weather Initiative (ISWI) and the United Nations Office of Outer Space Affairs (UNOOSA).

How can my country benefit from SCOSTEP?

Your country will have a say in the policy and functioning of SCOSTEP because your country will be represented in the SCOSTEP General Council by your the National Adherent Representative. The National Adherent Representative serves as a close liaison between SCOSTEP and the respective Adherents. The National Adherent Representatives also provide valuable advice in establishing the SCOSTEP scientific programs and as members of the General Council (GC) the Adherents participate in the governing and decision making of SCOSTEP. According the

SCOSTEP Constitution the GC: 1) Reviews the scientific, financial and administrative activities of SCOSTEP and, if necessary, refers matters to the Bureau for further consideration; 2) Participates in the election of SCOSTEP's president (every four years); 3) Determines the scale of annual subscriptions for Adherents, and 4) Considers and acts on the admission of Adherents. Scientists from your country involved in Sun-Earth connection studies can connect with the rest of the community. SCOSTEP can help organize international symposia, space science schools, and capacity building activities in your country.

How does a country become a SCOSTEP member?

A responsible scientific body can write to the President of SCOSTEP seeking membership. The application will be presented to the SCOSTEP General Council (GC) which considers and acts on the admission of new member nations. In most countries the Academy of Sciences administers SCOSTEP affairs including selecting the National Adherent Representative from the STP community to the SCOSTEP General Council (GC) and sending annual dues to the SCOSTEP secretariat. SCOSTEP has a graduated scale of annual subscription, ranging from $500/year to $25,000/year (details are available from this office or on-line at the SCOSTEP website http://www.yorku.ca/scostep/). Voting rights among Adherents on SCOSTEP financial matters are proportionate to the annual subscription given by each country. On scientific matters and all other business, the voting rights are equal.

2. New students join CRD

Several students from Yerevan State University who have been conducting their thesis work at the Cosmic Ray Division of the Yerevan Physics Institute have entered a new milestone in their career preparation.

Hripsime Mkrtchyan and Hasmik Rostomyan successfully finished their Master in Physics courses at the Yerevan State University. Hripsime's Master's theses was titled "The Electrical structure of Thunderclouds and Initiation of the Thunderstorm Ground Enhancements (TGEs)", and Hasmik's was "The Maximal Energy of Solar Acceleretors: Evidence from Space and Earth's Surface Measurements". Now they have applied for a job at the Cosmic Ray Division (CRD) of Yerevan Physics Insitute and will prepare for the Thunderstorms and Elementary Particle Acceleration (TEPA 2013) international conference to be hold in Nor-Amberd, Armenia, Septemper 9-13. They will also prepare for the YerPhI PhD program entrance examinations in November. Hripsime and Hasmik were the recipients of the Kirakos Vaporciyan Scholarship for CRD students at Yerevan State University this year. Congratulations to Hripsime and Hasmik for their recent accomplishments and we wish them well in the coming years.

Figure 1.From left to right: Hripsime Mkrtchyan and Hasmik Rostomyan: recent Master's Degree recipients from YSU in Cosmic Ray Physics.

Hayk Avagyan, graduated from the Mathematics Department of the Yerevan State University and started to work at the CRD. His main topics of interest at the CRD will be the development of new algorithms for data analysis and the analysis and correlation of the Aragats Space Environmental Center data and other astroparticle physics experiments.

Figure 2. Hayk Avagyan: recent graduate from YSU and now working at the CRD

On 1st of June Patrick Fasano, an undergraduate at the University of Notre Dame in South Bend, Indiana, USA, starts his internship at the Cosmic Ray Division (CRD) of Yerevan Physics Institute. With the support of the Nanovic Institute for European Studies at the University of Notre Dame, Patrick will work 10-weeks at the Cosmic Ray Division, assisting with upgrades and improvements to the Division's data storage and processing software, as well as learning about data analysis of Thunderstorm Ground Enhancements, a new discovered high energy phenomena in the terrestrial atmosphere. He will also work with CRD graduate students to make improvements to ADAS (Advanced data analysis system) file servers to support archived file formats for reducing storage space.

Figure 3. Patrich Fasano: 2013 Summer Intern at CRD from the University of Notre Dame at CRD's Nor Ambert research station.

Thirteen of the CRD's young scientists and staff received a performance based bonus from the Harutyun and Nadya Vaporciyan Family for their outstanding work and the resolve to continue their excellence in Armenia. "I have their picture on my mirror, and I look at them every day and I am so proud", says Harutyun Vaporciyan when he speaks of these talented young people.

All in all, we are satisfied with the progress of our students and our young and seasoned scientists who mentor our students", says Prof. Ashot Chilingarian, the director of Yerevan Physics Institute and the head of its Cosmic Ray Division. We are also very grateful to the Vaporciyan family for supporting our young scientists and students with scholarships and prizes.

Figure 4. The Harutyun and Nadya Vaporciyan bonus recipients: Front row left to right - Tigran Karapetyan , Hasmik Rostomyan, Narine Khachatryan, Mari Gasparyan , Bagrat Mailyan, Anoush Hakopyan , Artur Reymers; Back row left ot right - Karen Arakelyan , Ara Babayan, Levon Vanyan, Hayk Avagyan, Pavel Solakhyan, Hripsime Mkrtchyan

3. CRD scientists win Armenia President award

The Armenian Presidency hosted at 29 May the Presidential Awards Ceremony for 2012.President Serzh Sargsyan and member of "Robert Boghossian and Sons" foundation Albert Poghosyan handed out the awards, along with enclosed certificates and monetary bonuses. SerzhSargsyan congratulated the awardees and wished them every success. Under the presidential decree on "Awarding persons for outstanding contribution to the cause of international recognition of the Armenian Genocide," award for 2012 was given to 22 scientists, painters, actors and musicians.

Among then were Cosmic Ray Division scientists:

Figure 1: The Armenia President residence: from left to rigth: Bagrat Mayilyan, Levon Vanyan, Gagik Hovsepyan, Ashot Chilingarian, Nichola Bostanjyan before the ceremony of awardeing in the field of physics for a series of research papers referred to as "High-energy phenomena in thunderous atmosphere". the discoveries of armenian scientists were published in 5 papers, follow the link *http://crd.yerphi.am/thunders_and_parts/crd_journal*

Figure 2: Bagrat Mayilyan with RA president Serzh Sargsyan and Albert Poghosyan

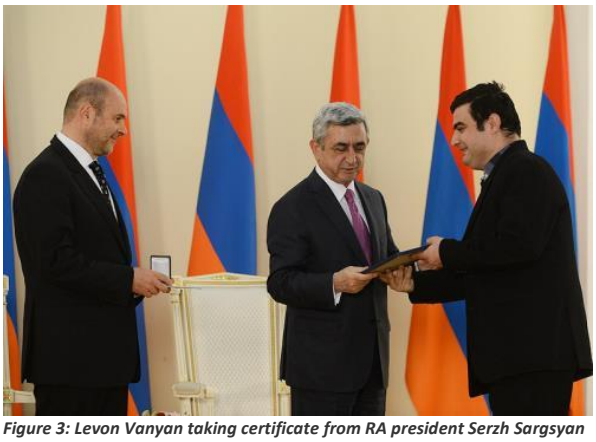


Figure 3: Levon Vanyan taking certificate from RA president Serzh Sargsyan

The RA Presidential Award is an annual award, which was established by the January 19, 2001 decree of the President of Armenia. It is awarded for a

- breakthrough discovery or significant contribution to the area of natural sciences,
- breakthrough discovery or significant contribution to the area of technical sciences and information technologies,
- significant contribution to the arts,
- breakthrough discovery or significant contribution to the area of medical science,
- breakthrough discovery or significant contribution to the area of physics,
- significant contribution to the literature,
- significant contribution to the area of humanitarian sciences.

It was decided that the RA Presidential Award in each area is to consist of a certificate with the inscription and prize money (equivalent of 10,000USD

4. TEPA 2013 workshop was devoted to the presentation and discussion of recent observations and simulations of the high-energy phenomena in the earth's atmosphere.

The **Thunderstorms and Elementary Particle Acceleration (TEPA-2013)** conference was hold from September 9 through 13, 2013 in the Nor Amberd international conference centre of Yerevan Physics Institute (YerPhI) in Armenia.

Studying of the High-energy Phenomena in the atmosphere is important for several reasons:

- *It provides unique information about particle acceleration and multiplication in the lower and upper atmosphere during thunderstorms;*
- *Generation and propagation of huge fluxes of electrons, positrons, gammas and neutrons is an important part of fundamental processes in the atmosphere responsible for the formation of terrestrial climate;*
- *Electromagnetic emissions connected with thunderstorms trigger various dynamic processes in the Earth's magnetosphere, causing global geo-effects and changing electrodynamics properties of the ionosphere;*
- *The large fluences of energetic electrons, photons and neutrons produced by runaway electron avalanches can potentially be a danger to aircraft crew, passengers and onboard electronic systems.*

The Cosmic Ray Division (CRD) of YerPhI and Skobeltsyn Institute of Nuclear Physics (SINP) of Moscow State University organized the workshop. YerPhI and the Armenian State Science Committee sponsored it. 30 scientists and students from USA, Germany, Norway, Russia and Armenia attend the workshop. The presentations were focused on the following issues:

- **Research of the Thunderstorm ground enhancements (TGEs)**
- **Research of the Terrestrial gamma-ray flashes (TGFs)**
- **Atmospheric High-energy phenomena observations by space-born facilities**
- **Instrumentation**

The discussions on the most intriguing problems of new emerging topic of high-energy physics in atmosphere covers:

- **TGEs and TGFs - what we can learn by comparisons of both?**

Thunderstorm Ground Enhancements (TGEs) originated from the lower dipole between the main negatively charged layer in the middle of thundercloud and emerging Lower positive charge region (LPCR) in the bottom of thundercloud. Lower dipole is accelerated electrons from the ambient population of the secondary cosmic rays (CR) downward. The electric field effectively transfers energy to electrons MOdifying their energy Spectra (MOS process) and enlarging their time of live and consequently the probability to radiate gamma rays. As thunderclouds on mountain altitudes usually are very close to earth's surface measured electron and gamma ray fluxes enhance for several percent in energy range up to 100 MeV. If the electric field strength exceed the critical value the Relativistic Runaway Avalanches (RREA) may be unleashes enlarging the electron and gamma rays flux several times. RREA avalanches, called Extensive cloud showers (ECS) are systematically different from the Extensive air showers (EASs) originated from the galactic or high-energy solar cosmic rays incident on earth's atmosphere.

Very low location of thunderclouds at Aragats allows direct observation of the RREA avalanches and "switching on" rather rare RREA mechanism. The simulation of the TGEs with GEANT4 code applying rather plausible electric field and thundercloud parameters (strength ~ 1.8 km, elongation ~ 1 km, height above earth's surface 50-200 m) using as seeds electrons from ambient population of CR successfully reproduces observed on Aragats TGE events including electron, gamma ray and

neutron fluxes.

Terrestrial Gamma flashes (TGFs) are originated from electrons accelerated by the upper dipole between the main negative and main positive layer on the top of the thundercloud. Gamma ray emitted by accelerated upward electrons propagate in the space (possibly generating electron-positron pairs) and reach gamma ray spectrometers on orbiting several hundred kilometers above earth's surface gamma ray observatories primarily intended to detect gamma bursts and other energetic processes in the Universe. Modified triggers of gamma ray events allow copious detection of the TGFs mostly from the equatorial thunderstorms. However, distant location of the fast moving particle detectors leads to several difficulties in the development of the TGF model:

- Required number of seed electrons greatly exceeds the available electrons of secondary CRs; proposed mechanism of "cold runaway" – acceleration of electrons by the strong electric fields in front of lightning leaders still is not observed;
- Due to scarcity of detected particles only cumulative energy spectra from all detected events are available for analysis and comparisons with simulations; it smears information about particular events, which, as we know from the TGE observation, may be very different.
-

Direct measurements of the intense particle fluxes on the earth's surface may be used for tuning the parameters of TGF models. The spatial and energetic characteristic of the ECSs, measured energy spectra of the TGE gamma rays and electrons may be used for checking characteristics of the particle fluxes obtained by the TGF simulations.

- **Particle fluxes and atmospheric discharges - any causal relation?**

Observed relation of lightning occurrences detected during TGFs and TGEs do not support assumptions on their causal relations. Most likely TGFs and TGEs constitute alternative type of the intracloud discharges: IC+ - corresponds to TGF and IC- - to TGEs. During TGEs the cloud-to-ground (CG-) lightning flashes are highly suppressed. It is interesting to investigate short bipolar pulses (pulse trains) during TGEs before CG lightning flashes. Possibly they manifested the creation of the LPCR.

- **Data bases of TGEs and TGFs are they available for community? Presentation how to access the data bases of Cosmic ray division;**

NASA maintains TGF data correspondent to different hierarchy of triggers. On-line data on particle fluxes, electrical and geomagnetic fields, lightning occurrences and meteorological information enters MSQL data bases of Aragats Space Environmental Center (ASEC). These multiple one-minute and one-second time series contain information on hundreds of TGEs. On-line data and 10 year data archives are in free access with possibility of multivariate visualization and statistical analysis. However, additional instruction should be prepared and user-friendly TGE selection procedures should be added to make data available to community.

- **Transient energetic events in in the Earth' s atmosphere (TGF, TGE, TLE, particle precipitation…) can they all be explained in one theoretical framework?**

The precipitation of electrons from radiation belts can trigger energetic processes in the atmosphere. Precipitation can be triggered by the huge electromagnetic pulses emitted during thunderstorms.

The participants of workshop agree that the research of the high-energy phenomena in thunderclouds is entering intensive development stage. New satellite and balloon missions are prepared exclusively for detection of optical, radio and gamma ray emissions from the thunderclouds. Research groups from new countries worldwide are installing on earth surface particle detectors for TGE detection. New models aimed to explain TGF and TGE events are currently developed and tested. Vast amount of experimental evidence on TGE, TGF and TLE is available for tuning the models and for the crosschecks.

During workshop also lecture on frontiers of the very high-energy gamma-ray astronomy was presented.

Besides scientific program participants visit Aragats research station of YerPhI located on 3200 m altitude in 18 km from the Nor Amberd. Excursion program include the 8-th century Amberd footrest, the museum of ancient manuscripts in Yerevan, cafedral in Echmiadzin and several archeological excavations nearby Aragats mountain.

The slides of presentations and videos of discussions are available from conference site.

Figure 4 Aragats station, near Vishap stone erected in vicinity of Kare lake. The highest north peak of Aragats (4070 m) is seen in background to the right.

Figure 5 Workshop official picture on the entrance of Nor Amberd conference center

5. Armenian physicists continue research of high-energy phenomena in atmosphere

Interdisciplinary workshop (HILITE 2013 , Torino, Italy 30 Sep – 1 Oct 2013) was meant to intensify the exchange of information between the astroparticle physics community and the geophysics community, on the phenomenology of the high-energy atmospheric phenomena.

HILITE 2013 focused on the long standing issue of the possible correlation between cosmic rays and atmospheric electricity, as well as the new explored phenomena of TGFs(Terrestrial gamma flashes) and TGEs Thunderstorm Ground Enhancements).

Dr. Levon Vanyan from Cosmic Ray Division group of Yerevan Physics Institute presents 2 invited talks on workshop:

Cosmic rays and gamma ray emissions during thunderstorms and *Neutron emission in TGEs.*

Figure 1.Levon Vanyan presenting results on atmospheric electron and gamma ray energy spectra

New exciting results from Aragats were published recently in high impact factor journals:

1. A.Chilingarian, T. Karapetan, LMelkumyan, **Statistical analysis of the Thunderstorm Ground Enhancements(TGEs) detected on Mt. Aragats**. J. Adv. Space Res. 52, 1178 (2013).
2. A. Chilingarian, Mailyan B., Vanyan L., **Observation of Thunderstorm Ground Enhancements with intense fluxes of high-energy electrons,**Astropart. Phys., 48, 1 (2013).
3. A. Chilingarian, G. Hovsepyan, and L. Kozliner, **Thunderstorm ground enhancements: Gamma ray differential energy spectra,** Physical Review D 88, 073001 (2013)

For October-November – the season of the second peak of the thunderstorm activity on Aragats (the first peak is April – May) Armenia physicists are preparing new particle detectors and lightning sensors to measure particle fluxes from the thunderstorm and get new insight in enigma of atmospheric electricity. It is expected to join the global lightning registration device; currently the necessary equipment are being tested.

The construction of atmospheric research laboratory in the extremely important and interesting climatic region – Sevan lake is underway.

Young scientists of Cosmic Ray Division (Mailyan Bagrat, Vanyan Levon) started a joint project with Laboratory of Physics and Chemistry of the Environment and Space, University of Orleans, France (Sebastien Celestin) to compare their models of radiation propagation in thunderstorm atmosphere.

6. Professors Walter Kutschera and Thomas Ruth visit national lab and deliver seminars for young scientists and students.

Professor emeritus of Physics at the University of Vienna Walter Kutschera visited Yerevan Physics Institute. He established the Vienna Environmental Research Accelerator (VERA), a universal facility for Accelerator MassSpectrometry (AMS), based on a 3-MV Pelletron tandem accelerator. VERA is operating since 1996, providing exploration of our world by means of the “isotope language” utilizing both long-lived radioisotopes (cosmogenic and anthropogenic) and stable isotopes. This research is performed with AMS utilizing the long-lived radioisotopes ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, and others. Isotope analysis for numerous problems arise in archaeology, art, atmospheric science, biomedicine, environmental physics and many other fields helps to develop explanatory models of sophisticated social, environmental, forensic medical and other systems.Recently, his research

focused on (1) Search for superheavy elements in nature with AMS, (2) Efforts to solve the puzzle of dating the Minoan Eruption of Santorin, (3) ^{14}C bomb peak dating of human DNA, (4) Measuring stable Pt isotopes in pre-solar nanodiamonds, (5) Developing radiometric dating of ancient ice with the $^{26}Al/^{10}Be$ chronometer.

Professor Kutchera lectures on " Physical methods in mass spectroscopy and their application in material science" were addressed to young researchers and students of and were best advertisement of new exciting topic to be started in national lab.
Another very important topic assigned to national lab by Armenian government is nuclear medicine. Professor Thomas Ruth is a nuclear chemist by training with more than four decades of experience. He is an expert in isotope production, extraction, and purification; radiochemical synthesis and formulation; and molecular imaging using PET-based compounds. He oversaw operation of the TRIUMF medical-isotope cyclotron for routine production of clinical research isotopes for the Pacific Parkinson's Research Centre and the BC Cancer Agency. He has also pioneered the design and implementation of target technologies.
Professor Ruth delivers lectures:
"World Medical Isotope Crisis: How did this happen and where are we now?"
"Production of radionuclides for science and medicine with a low energy cyclotron."
These topics are very important for researchers and students of new organized in national lab department of isotope research and production.
The head of department Dr. A.Avetisyan just returned from Second Research Coordination Meeting on"Accelerator-Based Alternatives to Production of 99Mo/99mTc", Legnaro (Padova, Italy).
The talk was devoted to "Accelerator based isotopes production technology development in Armenia".
The development of commercially feasible accelerator based production of medical isotopes in nearest future will be possible by use of proton cyclotron C18 (producer – IBA, Belgium) to be installed nearby national lab in fall of 2013. The main task of that cyclotron is short life isotopes production such as ^{18}F for PET. In addition the 18 MeV protons will be used to investigate accelerator-based schemes for the direct production of ^{99m}Tc using proton beams.
Professors Ruth and Kutschera met chair of the board of trustees of the laboratory Dr. NersesYeritsyan. The director of A. Alikhanyan National Laboratory, professor Ashot Chilingaryan introduced them to research performed on Mount Aragats at high altitude cosmic ray research stations; it was specially mentioned that detected neutron production during thunderstorms can introduce a bias in Carbon dating used worldwide.
Professor Kutschera discussed possible modernization of the mass spectrometer EMAL 2 presently in the accelerator diagnostics and fluorescence spectrometry groups. A. Alikhanyan National Laboratory had won the State Science Committee grant and will purchase the Thermo Scientific ARL QUANT'X Energy-Dispersive X-ray Fluorescence spectrometer for material science research and for support of archeological expeditions in Armenia.
Also professors Kutschera and Ruth visited the low background laboratory located in Yerevan Salt Mine. Armenian scientists are preparing methodology for implementing Carbon dating techniques in this lab. The lower background in salt mine will allow

Carbon dating with advanced ionization detectors are now under preparation in the lab.

Professors Walter Kutschera and Thomas Ruth in Yerevan Physics Institute

7. Alikhanian national laboratory employees Tigran Karapetyan and Seda Sargsyan defended the PhD theses in November, 2013

On 11th of November in 2013 A. Alikhanyan National Laboratory employees T. Karapetyan from Cosmic Ray Division and Seda Sargsyan from the Theoretical Physics Division defended their PhD theses. The aspirants' scientific advisers were professors Ashot Chilingaryan and Vahagn Gurzadian respectively.

From 2012 up to this day 15 PhD students have defended their PhD theses from our laboratory. This shows that A. Alikhanian National Laboratory continues preparing highly qualified specialists in the field of high energy physics and astrophysics. Furthermore, very soon the laboratory is going to open a Master Degree department, which is a strategic route for Armenia.

National laboratory also continues to host scientists from abroad, and one of them is professor K. Y. Georgieva from Space Research and Technologies Institute, who stayed in Armenia for a about a month and with whom the laboratory orginezed a seminar, which was titled "What do we expect from the Sun during the next decades". She also kindely agreed to be Tigran Karapetian's opponent.

Fig 1. Tigran Karapetyan

Fig 2. Seda Sargsyan

8. 10th European Space Weather Week

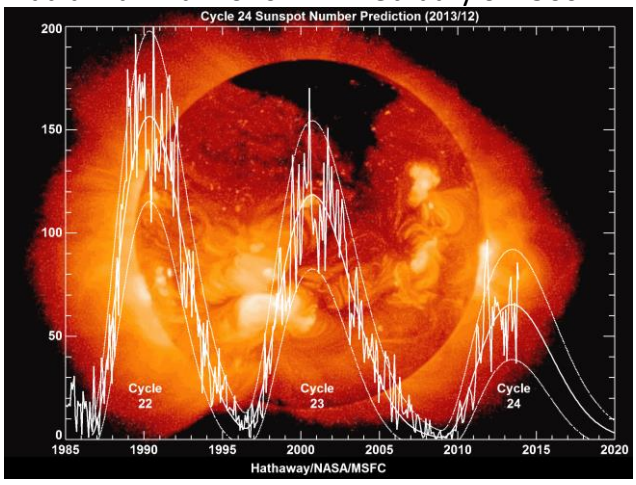
More than 350 scientists, engineers and satelliteoperators gather in Antwerp during the tenth edition of the *European Space Weather Week* (ESWW, November 18-22). During this international congress, causes of solar storms, the strategic

organization of the networks of measuring devices, as well as the necessity of the continuous space weather monitoring were discussed. For the first time A.Chilingarian and K.Kudela organize new plenary session – "|Use of ground-based cosmic ray detectors for space weather monitoring and forecasting" (see details inhttp://www.stce.be/esww10/sessions/13cosmicraydetectors.php).Invited speakers present currently operated networks:

- the network of neutron monitors providing data to Neutron monitor data base (NMDB, (http://www.nmdb.eu/)
- the Global Muon Detector Network (GMDN) developed and coordinated by Shinshu University
- the mid-latitude Space Environmental Viewing and Analysis Network (SEVAN) of hybrid particle detectors developed by the Cosmic ray division of the Yerevan Physics institute

The session provides possibility for the discussion of fundamental problems of particle propagation in the interplanetary space, their interaction with the atmosphere;it fosters better understanding of the capabilities of cosmic rays detectors for space weather monitoring and forecasting purposes.

However, the scientific discipline of Space weather is facing unexpected challenges.The observed number of the sunspots (a measure of solar activity) of Solar activity Cycle 24 is only ~65 that makes current cycle the smallest sunspot cycle since Cycle 14 which had a maximum of 64.2 in February of 1906.



Applied research, like Space Weather, can be useful only if it is tightly connected with fundamental research, having objective to advance basic knowledge on the Sun and its influence on the solar system. Making emphasis only on the alerts based on GLEs is counterproductive not only because last 7 years we had only one small GLE, making no harm, but also because concentrating on technical problems we do not progress in understanding the underlying physical mechanisms. Large Solar data centers, like Solar influences data analysis center (SIDC,Belgium)have research as primary goal, that, of course, do not harm their excellent operational space weather services (http://sidc.oma.be/aboutSIDC/). Therefore, I recommend to the members of NMDB collaboration to spend much more efforts on basic research proceeding from the Neutron monitor data. Solar physics, High-energy cosmic ray physics, high-energy phenomena in atmosphere (see for instance Chilingarian et al., 2012 and Tsuchiya et al., 2012)arethe topics where data from neutron monitors can bring new exciting knowledge.

References

- ✓ A.Chilingarian, N. Bostanjyan, and L. Vanyan, Neutron bursts associated with thunderstorms, Physical review D 85, 085017, (2012).
- ✓ H. Tsuchiya, K. Hibino, K. Kawata, et al., Observation of thundercloud-related gamma rays and neutrons in Tibet, Phys. Rev. D 85, 092006, (2012).

9. Knowledge Discovery and Data Mining in High-Energy Physics, Astrophysics and Geophysics

R&D activity resulted in designs, articles, software products and machines, and last but not the least – in databases. Databases from thousands of projects form gigantic interconnected information networks containing knowledge acquired by the current human generation, however mostly hidden from community and decision makers.

Rapidly growing field of Knowledge Discovery and Data Mining in combination with the widely accepted by HEP community new open data access approach on stage of data preservation represents an urgent need of society for new techniques and tools that can interconnect databases and transform discrepant data from multiple sources into useful knowledge and science. As to the latest expert estimations only 30-40% of the results based on data collected at biggest world accelerator centers are realized in published papers.

Developing knowledge acquiring and analysis technologies becoming also one of the major topics of A.Alikhanyan national lab (Yerevan Physics Institute – YerPhI):

- Combining results from CERN COMPAS experiment, Jefferson lab (US) and DESY HERA experiments maybe it will be possible to make major discoveries in nuclear matter structure; data analysis from all mentioned experiments are currently made by YerPhI groups.
- With excellent astrophysical surveys such as Planck, Fermi, RHESSI and others, providing open access to databases of archival material a special scientific focus should be made on the new long expected cosmological paradigm that will finally explain both macro and microphysics.
- The geophysical network operated in Armenia is unique by the climatic zones included (high mountains and large mountain lakes) and by measuring facilities (advanced particle detectors, field meters, lightning detectors and meteorological stations). Data can be used for global prognosis, forewarning on upcoming space and weather storms and many other applications.

For promoting network solutions for mentioned 3 problems only CPU power and memory is not enough, although YerPhI computer center last years after a long delay start modernization of its servers. The most important recourse we need and badly lacking is experts in knowledge management and networking.

YerPhI director A.Chilingarian during his recent visit to several European centers met with former YerPhI software experts to discuss their possible participation in domestic and joint European projects.

In DESY (Hamburg)former YerPhI PhD student Dr. Zaven Akopov will lead the knowledge management in the new world-largest European facility XFEL. In Karlsruhe Institute of technology (KIT) a meeting was held with Dr. Gevorg Poghosyan, head ofsimulation laboratory for elementary- and astro- particle physics of Steinbuch Center for computing and researcher of the same ~~center~~ institute working in Large Scale Data Management and Analysis project, former YerPhI employee, Arsen Hayrapetyan, and Dr. Suren Chilingaryan – Data Processing Expert at Institute of data processing and electronics.

The participants confirmed their willingness to contribute to the possible extentto the future coordination activities in preparing research projects and software development.

The latest development of web technologies makes it possible to create sophisticated web applications providing fast visualization, client-side data analysis exploiting massive parallelism of modern GPUs using WebCL technology and 3D imaging with WebGL.

Ongoing joint German-Armenian research project named *"Web-based Data Analysis Platform for Space Weather Observations"* aimed to develop a web based platform to facilitate collaborative analysis of the multidimensional data and provide a range of data analysis tools for the physical inference in the multivariate, multi-instrument environments with varying instrument settings captured in a wide range of formats. The developed methodology will serve to link a multitude of space and geophysical observations into an integrated system that provides analysis tools and services to fully utilize the scientific potential of current and future space weather/geophysical observations.

Started in 2013 project will give opportunity to facilitate collaborative effort of Armenian scientists in solving one of the most challenging projects of 21-th century.

Dr. Gevorg Poghosyan, Arsen Hayrapetyan and Suren Chilingaryan at Steinbuch Center for computing of Karlsruhe Institute of Technology, December 6, 2013

10. National lab physicists launch High Energy Atmospheric Research station on the shore of Sevan lake!

Last week Arakelyan Karen, Reymers Artur, Hanikyanc Gena, Daryan Ara and Rushanyan Geim visited YePhI summer hotel on Sevan lake to launch long awaiting High Energy Atmospheric Research (HEAR) station. Special thanks to staff of

the Sevan summer hotel staff leading by Hamayak Dganikyan for repairing of HEAR building!

HEAR is equipped with modern elementary particle detection system measuring cosmic ray electrons, muons and gamma rays. The electric mill is monitoring the electric field above the lake and lightning detector – the occurrences and distance to lightning flashes. All together the research complex is ideally suited for research of high-energy phenomena in atmosphere, including Thunderstorm ground enhancements (TGEs) discovered at Aragats, relativistic runaway electron avalanches and enigmatic particle bursts correlated with lightning. The unique location of station near large high-mountain lake is extremely favorable for discovering new high-energy phenomena in terrestrial atmosphere, ionosphere and magnetosphere.

HEAR along with 3 other YerPhI research stations will provide early warnings on upcoming severe storms, when thunderclouds appear ~1000 km from Armenian borders. Station will operate 24 hours/12 months and will send the data and forewarnings to Yerevan CRD headquarters and to mirror sites in Europe and USA.

Figure 6 HEAR monitors: STAND1 and NaI particle detectors are measuring 1-minute time series (in the right); electronics and control equipment send data on-line each minute to Yerevan CRD headquarters (on the table).

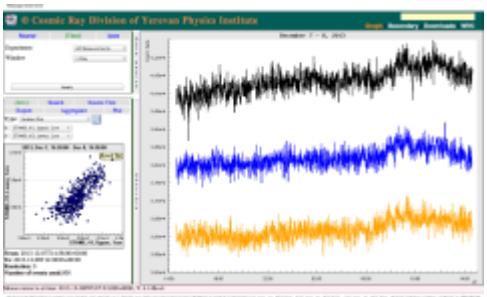


Figure 7 Time series of charged particle fluxes measured by the layered STAND1 detector; when large enhancement of count rate occurred data from 3 scintillators will be used for recovering integral energy spectrum of TGE events.

Figure 8. HEAR building with electric mill and antenna of lightning detector on the roof; from left to right: Khanikyanc Gena, Dganikyan Hamayak, Daryan Ara, Arakelyan Karen and Rushanyan Geim

Figure 9. Shore of Sevan lake near YerPhI summer hotel; note clouds in the air – potential source of particle fluxes!

11. Armenian-German collaboration at DESY (Deutsches Elektronen-Synchrotron, Hamburg)

DESY is one of the world's leading accelerator centers. Researchers use the large-scale facilities at DESY to explore the microcosm in all its variety – from the interactions of tiny elementary particles and the behavior of new types of nanomaterials to biomolecular processes that are essential to life. That makes DESY not only a magnet for more than 3000 guest researchers from over 40 countries every year, but also a coveted partner for national and international cooperation.

For more than 20 years groups from Yerevan Physics Institute actively participated in construction and operation of the HERMES and H1experiments on the HERA accelerator.Their studies have concentrated on the spin structure of the nucleon and hadronization phenomena including nuclear attenuation effects, having as very ambitious goal revealingthe three-dimensional picture of the nucleon structure –one of the most enigmatic problems of the structure of matter.

After closing HERA accelerator in 2007 the Yerevan groups have been extensively involved in the ongoing data analysis, being responsible for many important publications. On the longer term(after 2014) the Yerevan group will continue the local activities at YerPhI with the analysis of the HERMES data providing further new physical results and papers.

In 2010 Armenian physicists took part in the last high-energy physics experiment at DESY named OLYMPUS, which has completed at the end of 2012. Now physicists are concentrated on the analysis of the electric and magnetic features of the nucleon and hope to obtain fundamental results in the near future.

Some of the key physical equipment of the finished OLYMPUS experiment was donated to the Yerevan Physics Institute and will be used for new accelerator and cosmic ray experiments in Armenia. DESY took care of packing and sending expenses; 2 tons of particle detectors and electronics expected to arrive to Armenia in January 2014.

HERA physicists can now continue research using the computer center of Yerevan Physics Institute (A.Alikhanyan National Lab) which has in recent years been substantially modernized significantly enlarging the CPU power and data storage, to host Terabyte data archives from HERA and other large particle physics and astrophysics experiments.

DESY continues the experimental particle physics program, being deeply involved in the LHC experiments ATLAS and CMS as well as Belle II at SuperKEKb. The local activities are strengthened as intense X-ray light producer, opening completely new windows onto the universe. The world's sharpest X-ray beam shines now at DESY. At the X-ray light source PETRA III, scientists generated a beam with a diameter of barely 5 nanometres – this is ten thousand times thinner than a human hair.
Participating in the new DESY activities would be the best training on world's largest machine. It would not only prepare the scientific community for using intense light beams in Armenia, but also help to continue the long-standing, fruitful collaboration of Armenian and German scientists.

The **leader of the Yerevan group at DESY Akopov Norair (left) and the deputy spokesman of the DESY Olympus group, Uwe Schneekloth, are examining the OLYMPUS experiment beam monitoring system at DORIS accelerator rings.**

12. National lab to start Master courses

Mission of the National lab includes as one of most important segments anticipates establishment of the high standards of education in Master in science[1] and PhD programs for demonstrating that science and education can really provide development of Armenia. In the end of November the Minister of education and science issued a license allowing organizing master courses 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 or industry."

Yerevan physics Institute research covers a comprehensive range of topics in theoretical and experimental fields offering variety of topics for the postgraduate research program. The courses will prepare students for PhD level research or a career in an industrial or national research laboratory environment. The 2-year full-time programme consists of lecture courses and a major project work on the premises of National lab or on the world largest experimental facilities abroad. Lecture activities are followed by a supervised project in a specialist area, drawn from the research activity carried out within the Yerevan Physics Institute.

National lab is planning to start Master courses in coming year after approving the lectures and research projects lists and finishing the major repairs and equipping lecture halls in 3 main departments – Theoretical physics, Experimental physics and Cosmic Ray physics.

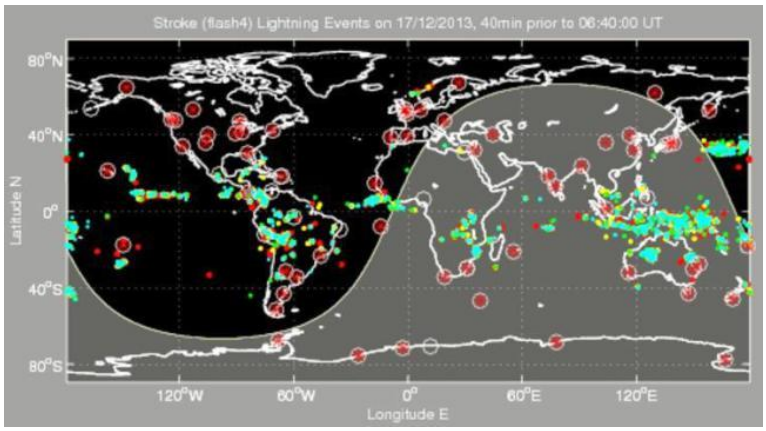
[1]the Master in Science (MSc) or Magister is a postgraduate degree of two years duration that involves writing and defending a thesis based on a research project which represents the culmination of the material learned.

13. CRD joins World Wide Lightning Location Network (wwlln.net)

The ground- based World Wide Lightning Location Network (WWLLN, managed by Department of Earth and Space Sciences, University of Washington, Seattle, Washington, USA) detects very low frequency (VLF) radio waves emitted by lightning. It is most sensitive to cloud-to-ground (CG) flashes since they radiate strongest in the VLF range.

A global lightning detection system has a variety of applications in the scientific, commercial, and governmental sectors. Scientifically, it could provide a better understanding of the global electric circuit and provide better understanding of the physics of atmospheric discharges. Its seasonal and yearly averaged data could be used as an indicator of global climate change as well as in estimating the direct impacts on the local regional environments, including agriculture sector. Global lightning data could be used in the commercial sector and in the governmental sector (e.g.,tracking of severe storms and forecasting of hail).

Continuing its policy of joining and creating international measurement network CRD in fall of 2013 joins the WWLLN installing measuring equipment in Yerevan. In the Figure below one can see symbolic image of the Armenian node of WWLLN between Caspian and Black seas. By red, green and yellow dots the lightning occurrences are denoted; in winter lightnings occur mostly in equatorial region and Sought hemisphere.



Each lightning stroke location requires the time of group arrival from at least 5 WWLLN sensors. The geographical arrangement of the sensors is important. Enhancing the accuracy of lightning detection requires more stations especially in the "empty" regions. The Armenian station is very important. To the East and North of Armenian station there is no other nodes thousands of kilometers along. To the Sought and West the only station is in Tel-Aviv. Therefore Armenian node will participate in lightning detection in areas covering tens of thousands square kilometers bringing new information to WWLLN.

The research of high-energy phenomena in atmosphere conducted by CRD at slopes of Aragats mountain and near Sevan lake will also highly profit from WWLLN information. Comparing the WWLLN data on lightning location and type with information from Armenian local lightning detection network will help to calibrate Armenian network and check its time precision.

14. Bring your projects to life with 3D printers of National lab workshop!

3D printing is a process of making a three-dimensional solid object of virtually any shape from a digital model. 3D printing is achieved using an additive process, where successive layers of material are laid down in different shapes. 3D printing is also considered distinct from traditional machining techniques, which mostly rely on the removal of material by methods such as cutting or drilling.

The 3D printing technology is used for both prototyping and distributed manufacturing with applications in architecture, construction, industrial design and many other fields.

Yerevan Physics institute by its workshop of 3D printers started a pilot project of investigation possibilities of rapid prototyping for the innovation projects currently performed in the institute.

Following 3D printers are available in YerPhI:

- Replicator 2
- CubifyCubeX
- VellemanK8200

Figure 1. Software engineer Pavel Solakhyan is tuning 3D printer

15. X-ray Elemental Analysis Capabilities opened at A.Alikhanyan National lab

A modern X-Ray Fluorescence Spectrometer has been installed at A.Alikhanyan National laboratory (Yerevan Physics Institute). The ARLQUANT'X Energy-Dispersive X-Ray Fluorescence Spectrometer from Thermo Electron Corporation (USA) is a state-of-the-art instrument designed for elemental analysis from Na to U with sensitivity of 10-100 ppm (parts per million).It is a modern device for fast, non-destructive high-performance, multi-element analysis in all types of materials, including solids, powders, and liquids. Numerous applications of X-Ray Fluorescence Spectrometry involve the environmental monitoring, chemicals, mining, archeology, food, electronics, and metal industries.

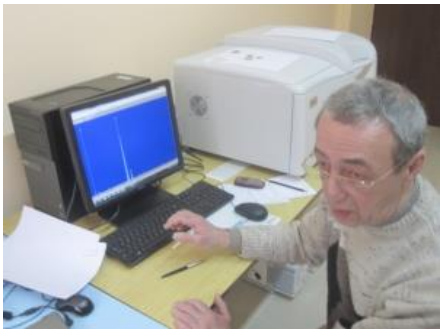


Figure 1. Senior scientist Sogomonyan Suren testing new spectrometer

The YerPhI experts now are preparing methodologies for different applications of the spectrometer. The device will serve to Armenian scientific community and different industries.

Funds for purchasing of X-Ray Fluorescence Spectrometer were provided by State Science committee as special infrastructure grant.

Figure 2 Director of the Scientific and Research Institute of Historical and Cultural Heritage HakobSimonyan and Thermo Techno Corporation engineer Boris Kupcov discussing new spectrometer possibilities in archeometry

Figure 3 The first archaeological item processed by spectrometer; 500 BC

16. Cosmic Ray Division (CRD) Young Researchers

Make International Impact

Three of the researchers from Cosmic Ray Division of Yerevan Physics Institute, Levon Vanyan, Tigran Karapetyan and Hripsime Mkrtchyan will participate in international meetingspresenting and discussing CRD research results.

From 27th of April through 02 of May, in Vienna, Austria,LevonVanyanwill participate inthe *European Geosciences Union (EGU) General Assembly*. AGU brings together scientists from all over the world to one forumto discuss new developments in all disciplines of the Earth, planetary and space sciences.Levon's presentation is titled "The Origin of Thunderstorm Ground Enhancements (TGEs): Energy Spectra Analysis".

Tigran Karapetyan will travel to Sozopol, Bulgaria to take part in the *Solar Influences on the Magnetosphere, Ionosphere and Atmosphere* conference to be held from May 26 to 30.Tigran will present a report on the significant enhancement ofcosmic ray fluxes in our galaxy due to the enormous weakening of solar activity since 2006. This enhancement poses additional hazard to the satellite electronics.

Thunderstorm Effects on the Atmosphere-Ionosphere System (TEA-IS) summer school in Lyon, France, will start on June 23 and last until the 27th. The goal of the TEA-IS Summer School is to train to scientists, particularly young scientists, interested in better understand the role of thunderstorms in the atmosphere-ionosphere-magnetosphere system. The students will also have an opportunity to report on their own work in the field. CRD's PhD student Hripsime Mkrtchyan will report on lightning detection networks operated in Armenia and their relation to Thunderstorm ground enhancements (TGE). TGEs are high-energy phenomenon in the atmosphere first discovered and characterized by Armenian physicists of the CRD. Recently a node of the *Worldwide Lightning Location Network (WWLLN)* was established in Yerevan to further explore this phenomenon.

All 3 of the young CRD scientists have received financial support from the conference organizers to assure their attendance, confirming the international appreciation for the work done at CRD in Armenia.

For its part in enhancing the cooperation between international scientist in this exciting new field, CRD in partnership with Skobeltsyn Institute of Nuclear Physics of Moscow State University, has established the series of symposiums called *Thunderstorms and Elementary Particle Acceleration (TEPA).* The first one in the series was held in Armenia in 2010 with the expectation of a biannual event rotating between participating countries. The second one was held in Moscow in 2012. The participants then decided that given the rapid knowledge gain in this field the TEPA conference series should become an annual event. TEPA 2013 was held in Armenia and TEPA 2014 is scheduled for September 22-26,2014 again in Armenia at CRD's Nor Amberd ***International Conference Centre of the Yerevan Physics Institute.*** Scientists from USA, Europe and Russia will gather to discuss the most intriguing problems of high-energy physics in the atmosphere and on possible directions for the advancement in research and collaborative studies. TEPA 2014 has received financial support from the European Geosciences Union to assist young scientists to participate this important symposium.

Figure 1. From left to right: Tigran Karapetyan, Hripsime Mkrtchyan, Levon Vanyan

17. Alikhanian National Laboratory (YerPhI) website has a new interface

With a new interface website of Alikhanian National Laboratory (YerPhI) went live http://www.yerphi.am/. New website offers quick and easy access to essential information on YerPhI activity and breaking scientific news worldwide.

The website boasts a modern design and is divided into several sections, each section providing detailed information on the organization's functioning. Website includes sites of all 5 national lab divisions (http://www.yerphi.am/index.php/yerphi-divisions-menuitem), press releases (http://www.yerphi.am/index.php/yerphi-news-menuitem/press-release), which offers the user to learn about our latest activity, spectacular scientific discoveries, information on scientific publications and citations to papers of YerPhI scientists (http://www.yerphi.am/index.php/bibliometrics/46-bibliometrics), articles in press about Armenian science and about YerPhI (http://www.yerphi.am/index.php/yerphi-news-menuitem/press-about-us) and many others. Recently we add 2 new sections: Armenian Geophysics Network (http://www.yerphi.am/index.php/aragats) which offers the user weather forecast, solar radiation, pressure, humidity and sky monitoring from Aragats, Nor Amberd and Yerevan; and Master Courses page

(http://www.yerphi.am/index.php/young-scientists-and-students/master-courses) which is dedicated to upcoming master program at Alikhanian National Laboratory. As the national lab has already official blog and official pages on all social media, we created social media icons to make the user to find our pages more easily.

Figure1. The interface of YerPhI website at www.yerphi.am

Figure 2. The Armenian Geophysics Network's Page

18. The node of Space Environmental Viewing and Analysis Network (SEVAN) from March 20 2014 operates at Lomnickystit

Space Environmental Viewing and Analysis Network (SEVAN), is a worldwide network of identical particle detectors located at middle and low latitudes aimed to improve fundamental research of space weather conditions and to provide short- and long-term forecasts of the dangerous consequences of space storms. SEVAN detected changing fluxes of different species of secondary cosmic rays at different altitudes and latitudes, thus turning particle detector network into a powerful integrated device used to explore solar modulation effects. Till to now the SEVAN modules are installed at Aragats Space Environmental Centre in Armenia (3 units at altitudes 800, 2000 and 3200 m a.s.l.), Bulgaria (Moussala), Croatia and India (New-Delhi Univ.) and now started operation at LomnitskySchtit (Institute of Experimental Physics of Slovak Academy of Sciences, Kosice, Slovakia).

SEVAN network provides following advantages upon existing detector networks measuring single species of secondary Cosmic rays:

- Cheap and simple operation;
- Probe different populations of primary cosmic rays with rigidities from 7 GV up to 20-30 GV;
- Reconstruct Solar Cosmic Ray spectra and determine position of the spectral "knees";
- Classify Ground level Enhancements in "neutron" or "proton" initiated events;
- Estimate and analyze correlation matrices among different fluxes;

- Significantly enlarge the reliability of Space Weather alerts due to detection of 3 particle fluxes instead of only one in existing neutron monitor and muon telescope world-wide networks.

Recently SEVAN detectors were used for research of new high-energy phenomena originated in terrestrial atmosphere – Thunderstorm Ground Enhancements (TGEs).

The characteristics of SEVAN operated at LomnickyStit are excellent see pictures 1-3.

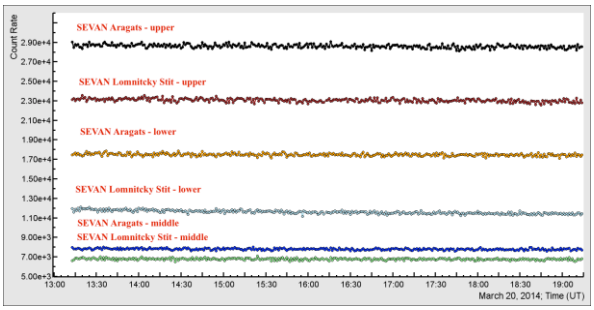


Figure 10 Mean count rates of SEVAN scintillators located at Aragats and LomnickyStit

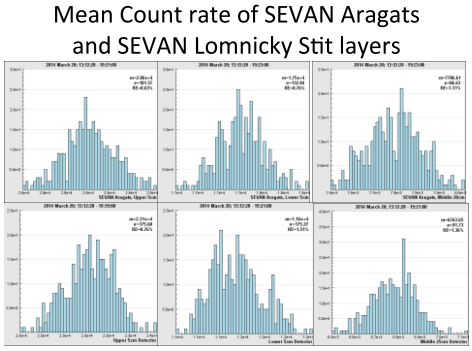


Figure 11 Histograms of count rates of SEVAN modules located at Aragats and LomnickyStit

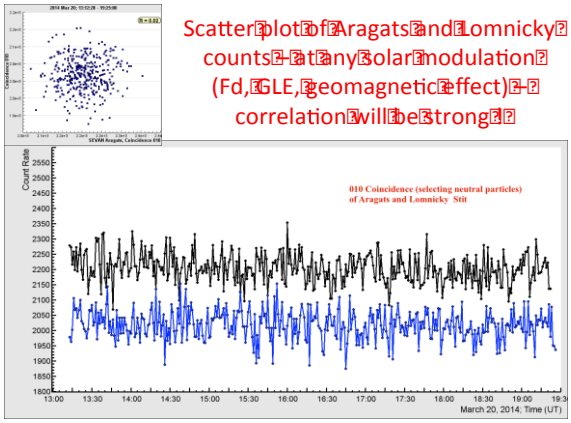


Figure 12 Time series of 010 combination (mostly neutrons) of SEVANs at Aragats and LomnickyStit

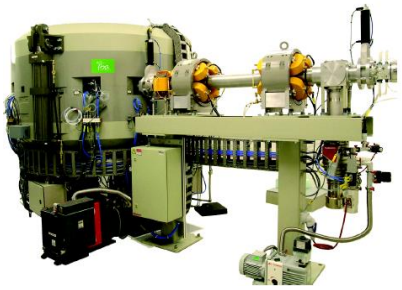
19. The International Atomic Energy Agency (IAEA) supports producing of medical isotopes in Alikhanyan national lab (Yerevan Physics Institute)

IAEA supports the project "**Technetium 99m Production Using Proton Beam from C18 Cyclotron".** The Contracting department is Isotope research and production division of Yerevan Physics Institute (YerPhI). The isotope research and production program will use the 18 MeV proton beam of the medical accelerator IBAC18 to be installed on premises of YerPhI in the end of year.

^{99m}Tc is the most widely used isotope in nuclear medicine today with over than 30 million diagnostic medical imaging scans every year around the world.

According to the Scientific Center of Radiation Medicine and Burns Armenian Ministry of Health, the need in Armenia of the isotope Tc-99m is 5,000 doses per year. However, currently this isotope is received from abroad in amounts enough only for diagnostic of about 1000 patients a year. Thus there is an urgent need in Armenia for a non-stop supply of the isotope 99mTc.

The goal of above mentioned propgram is to develop the technology of ^{99m}Tc direct production at YerPhI, covering the demand of Armenian clinics.



C18/18 IBA cyclotron used for producing medical isotopes