A. ALIKHANYAN
National Laboratory

2012 ANNUAL REPORT AND DEVELOPMENT PLAN FOR A. ALIKHANYAN NATIONAL LABORATORY (YEREVAN PHYSICS INSTITUTE)

YEREVAN 2013

CONTENT

Status Report, Artem Alikhanyan National Lab (AANL)March 2013

2012 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.*

In 2012 AANL continued to struggle against 3 major crises critically affecting its operation:

- Age crisis – lack of the young generation of scientists to substitute retired personnel;
- Funding crisis – fast declining of the international funding eligible for purchasing of the new equipment;
- Accelerator crisis - difficulties in reoperation of the electron – synchrotron ARUS.

To understand possible ways of resolving mentioned drawbacks in 2012 scientific council (SC) on unprecedented 10 summits accomplish a review of all scientific directions. Leaders of departments and senior scientists submitted updates of the division`s scientific activity, relevance of the research topics, achievements, contribution to international collaborations, conditions of the technical inventory, challenges, grants received, organized conferences, publications, staff qualification and staff age range. All presentations are available at YerPhI site. Further discussions resulted in the adopting of the development strategy of YerPhI and all scientific council member support following resolution:

- Accept the document "Scientific/technological development strategic plan for A.Alikhanyan National laboratory (Yerevan Physics Institute)" (see attachment 1).
- The Chair and secretary of SC will be responsible for the preparation of the detailed expanded version of development plan (Physical volume) and will present it to the SC for approval.

- Suggest to YerPhI director and to the Board of trustees to promote development of the main scientific directions and provide finance support for the encouragement of the best scientists, for business trips, and for the improvement of working conditions.

In 2012 AANL continued implementing the InComEx's (International Committee of Experts) recommendations concern development of the nuclear physics program and nuclear medicine. Sufficient progress has been achieved in test production of medical Tc99 isotope with electron beams; the design of more effective modes of the same isotope production with proton beams is prepared. 5 nuclear physics projects were prepared and submitted to for thematic funding to be started in 2013. 2 projects were prepared for turning old synchrotron to the stretcher for linear accelerator for investigations of clusters in low mass nuclei. Projects were delivered to the foundation chairmen for the expertize performing. Progress has been made in improving work conditions of young scientists and master students. All of them were provided with modern computers, offices were repaired. In all departments of AANL now are working master students from Yerevan state university and Yerevan technical university. The programs of supporting conference and school participation and was also successfully continued. Young scientists who published in 2012 scientific papers in the high rank journals were awarded by appropriate payments.

In 2012 the AANL strengthened its scientific activity in traditional scientific directions. Number of publications in peer reviewed journals and participation in international forums increased significantly. Groups of AANL scientists actively participated in intermediate and high energy physics experiments abroad (JLAB, DESY, CERN-LHC and others), exploring the nucleon structures, electromagnetic interactions of the nucleon, quark-hadron duality, short range nucleon-nucleon correlations, quark hadronization in nuclear medium, physics beyond standard model, quark-gluon plasma, and many other topics, as well as constructing experimental hardware and develop the software for data acquisition and analysis. Armenian physicists participate in experiments on Higgs boson search at CERN – the most important discovery in particle physics of last decades. The ongoing experiments on high altitude research stations on slopes of Mt. Aragats culminate in 2012 in 3 papers published in the journal of American physical society – Phys. Rev. D, establishing a new physical phenomena originated in thunderstorm atmosphere – Thunderstorm ground enhancements – large fluxes of electrons, gamma rays and neutrons from thunderclouds detected by networks of particle detectors located on the earth's surface.

AANL scientists publish approximately 20% of scientific publications of Armenia. Most of publications appear in high impact factor journals; high quality of research in national lab is proved by citations ~60% of overall citations to papers published by scientists from Armenia belong to AANL. Institute seminars were took place regularly, 10 PhD theses were defended.

In fall 2012 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 was formed and send to the chairman of the AANL board (see attachment 2)

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 84 people (43 scientific , including 4 Doctors and 30 PhDs 22 engineers and technicians,13 graduate students (bachelor and master) and 6 PhD students; total fund for salaries in 2012 – M116,336 dram, mean salary – K91,235 dram.

During 2012 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). In 2012 LHC operates in a regime of protons collision with total energy $\sqrt{s}$ = 8.0 TeV. ATLAS, ALICE and CMS groups continued the works in ongoing LHC physics program (shifts, data taking and analysis). 4th July 2012 in a joint ATLAS and CMS seminar at CERN researchers of these experiments at the Large Hadron Collider (LHC) presented their preliminary results on the search for the standard model (SM) Higgs boson and concentrated its efforts on two channels: Higgs decays to either two photons or to four leptons. Both channels show a statistically significant excess at about the same place: a mass of around 125-126 GeV. ATLAS and CMS YerPhI groups have participated in the dis covery of new particle, which may be the so-called Higgs boson. ATLAS group participated in the development and optimization of multijet balance technique adopting for the 2012 LHC dataset.CMS group actively contributed both for calibration of absolute jet energy scale in CMS experiment using $W \rightarrow q\bar{q}$ decay at $\sqrt{s}$ = 7 TeV (PhD-thesis was defended) and for analysis of experimental data in process of Vector Boson Fusion (VBF) Higgs production, where the Higgs boson decays into a $b\bar{b}$-pair. For calibration of CASTOR calorimeter using HF (Hadron Forward) CMS-group analyzed data of pp-collision at $\sqrt{s}$ = 900 GeV and 7 TeV with mesons (η,φ, J/ψ,..) decaying into di-gamma and di-electron pairs. On the Monte-Carlo level was shown that di-electron events in CASTOR can be used for calibration task with TOTEM data availability. Corresponding trigger configuration and rates are studying for upcoming pPb runs-2013 (with TOTEM). For estimations of gluons contribution in the Pomeron was used the process of $b\bar{b}$-pairs production via Double Pomeron Exchange (DPE) of protons. The contribution of valent partons is estimated about 61%. ALICE group in collaboration with the groups from IPNL (Lyon, France) and INFN/Cagliari University (Cagliari, Italy) have continued analysis of the low-mass region (from threshold to 2.0

GeV) for dimuon pairs produced in *pp*, *pPb* and *PbPb* collisions and development and upgrade of the GRID infrastructure of ALICE.
The DESY groups continued the data analysis based on the data accumulated by HERMES and H1 Collaborations: GPDs related physics including DVCS and exclusive vector mesons (like ,φ and ω mesons) and study of hadronization phenomena in electroproduction on different nuclear targets (PhD-thesis was defended), and participation in Jets analysis aimed to precise alpha_s extraction and PDF for gluon and see-quarks determination.Group also participated in methodical works with the Time of Flight (TOF) system and Monte Carlo simulations for a new OLYMPUS experiment at DESY on DORIS accelerator. The OLYMPUS experiment successfully finished the data taking on DORIS accelerator at DESY provided huge amount of data in e+/e- elastic scattering on hydrogen target to check very essential problem with possible contribution of two photon exchange in e+p/e-p ratio which can explain existing puzzle with the electric to magnetic form-factors ratio as a function of Q2. The challenging limit on total uncertainties to be less than 1% requires a lot of efforts during this and next years for detailed physics analysis and estimation of all sources of systematic as well to estimate possible radioactive corrections. The Yerevan group being responsible for Time of Flight detectors which are the main trigger detectors at OLYMPUS were actively involved in all aspects of TOF calibration, developed a special fitting procedure to determine the TDC meantime offsets, run stability for ADC pedestals and gains. The member of Yerevan group provided 50 shifts during the data taking.

The Jlab-groups actively contributed both for ongoing experiments in three halls for study of the structure of hadrons, their production and electromagnetic interaction properties with high energy electrons and photons and for preparation of new experiments and new experimental equipment for 12 GeV upgrade of CEBAF. Hall A –group participated in measurement of the electric form factor of the neutron G_E^n at $Q^2 = 1.3,\ 1.7,\ 2.4\ ,\ 3.4$ $(GeV/c)^2$ (PhD-thesis was defended) and in APEX-experiment for search of new vector boson A′ decaying to e+e−, connected with “dark matter”. Hall B –group participated in study of A-dependence of the scaling effect (the ratio of inclusive electron scattering cross sections for heavier nuclei and deuterium) in the region $x_B>1$ and $Q^2>1.5$ GeV^2 and in study of nucleon modification in the deuteron. Photoproduction of $a_0(980)$ and $f_0(980)$ scalar mesons with CLAS have been studied. Hall-C YerPhI group has valuable contribution to the physics program, as well as after CEBAF 12 GeV upgrade. Group participated in Q_{weak} experiment for search new physics via measurement of the proton weak charge. It is presented new proposal “Measurement of the ratio $R = \sigma_L/\sigma_T$ in Semi-Inclusive Deep-Inelastic Scattering”. On the basis of the experiment “Measurements of the Proton Electromagnetic Form Factor Ratio From Elastic Scattering at $Q^2 = 2.5,\ 5.2,\ 6.7,8.5$ (GeV/c^2) “ PhD-thesis was defended.

Yerevan groups is participating in the development and construction of the experimental apparatus for 12 GeV upgrade: Hall A- for SBS (Supper BigBite Spectrometer) , HCal simulations and prototype tests, HRS Calorimeter calibration, Focal Plane Polarimeter upgrade;

Hall B- Design and construction of a pre-shower calorimeter for CLAS12, Slow Control;

Hall C- Design and construction of SHMS spectrometer (assembly, testing, calibration). Group of fission and fragmentation continued investigation and test of RF phototube and low-pressure MWPC. Gamma Ray Astrophysics Group, member of HESS (High Energy Stereoscopic System) collaboration,

participated in data analysis and studies of the mathematical methods for gamma-images extraction and primary particle energy reconstruction at sub-50-100 GeV energy region and started in CTA collaboration.

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.

The possible development of experimental nuclear and particle physics program at ANSL might be also based on the accelerators (electron linac and synchrotron) with new non-acceleration stretcher mode (electron energy 50-75 MeV). It is proposed to develop the experimental method and begin the study of cluster structures of excited states of the light nuclei (He, Li, Be) in three body photodisintegration processes. For this task as first is calculated by Monte Carlo method the process of photodisintegration $\gamma + {}^{7}\mathrm{Li} \rightarrow {}^{6}\mathrm{He}^{*} + \mathrm{p}$ at energy $E_{\gamma} = 75$ MeV with subsequent decay of ${}^{6}\mathrm{He}^{*}$ to t+t.

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 74 employees: 19 scientific, including 1 Doctor and 18 Candidates of Science, 22 engineers and technicians, 3 graduate students (bachelor and magister) and 2 PhD students, 26 technical and support personnel; total fund for salaries in 2012 – M94,045 dram, mean salary – K95,838 dram.

The main work performed by CRD includes a series of experiments proving existence of huge particle fluxes from the thunderclouds and discovering the enigmatic physical process accelerating electrons to unexpected high energies. A large variety of experimental facilities and computational methods were used to reveal these enigmatic processes escaping from reliable observation and explanation near 100 years. The studies are of primary interest from fundamental physics point of view, since the lightning initiation mechanisms, which are closely related to the research, are not understood till

now. The findings may also have applied importance, helping to create an alert service forewarning on dangerous consequences of the strong thunderstorms.

Rapidly expanding field of energetic particle and radiation physics in terrestrial atmosphere, namely, High-Energy Atmospheric Physics, impacts traditional atmospheric electricity and lightning physics, study of cosmic-ray extensive air showers, discharge physics, space physics, plasma physics, and aviation safety. One of the most exciting manifestations of the new field is so called Thunderstorm Ground Enhancement (TGE): abrupt enhancements of surface particle detector count rates correlated with thunderstorm activity. Facilities of the Aragats Space Environment Center (ASEC) observe charged and neutral fluxes of secondary cosmic rays by the variety of particle detectors located in Yerevan and on slopes of Mount Aragats at altitudes 1000, 2000 and 3200 m. ASEC detectors measure particle fluxes with different energy thresholds as well as Extensive Air Shower (EAS) initiated by primary proton or stripped nuclei with energies greater than 50–100 TeV and Extensive Cloud Showers (ECS) initiated by the electron-gamma ray avalanches in the thunderstorm atmosphere. The majority of TGE events have amplitude less than 10 %. These small TGEs and analogical TGEs reported by other groups consist mostly of gamma rays and can be explained by the modification of the energy spectra of charged particles in the electric field of thunderclouds. Due to asymmetry of positive-to-negative flux of secondary cosmic rays in the terrestrial atmosphere, peaks and dips can arise in time series of count rates of surface particle detectors. These effects have been theoretically analyzed by L. Dorman and detected on Mount Norikura and in Baksan, Russia. Measurements at ASEC and simulations with GEANT4 package confirm additional flux of gamma rays up to 1000% in the energy range 2-10 MeV and up to 5% in the energy range up to 100 MeV. Simultaneously dips in the muon flux at energies above 200 MeV were obtained by GEANT4 simulations and detected by ASEC detectors.

Few very large enhancements can be explained only by invoking the Runaway Breakdown (RB) process, also referred as Relativistic Runaway Electron avalanche (RREA). Ambient population of secondary cosmic ray electrons in the electric fields with strength greater than critical value unleash the electron-gamma ray avalanches and total number of particles on the exit from cloud can be multiplied by several orders of magnitude. Proceeding from the measurements of the charged and neutral fluxes as well as from the energy deposit of particles in thick scintillators we recover the energy spectra of TGE electrons and gamma rays for the 2 largest TGE events. Installed at Aragats field meters and lightning detectors allow correlating the measured particle fluxes with near-surface electric field disturbances and with occurrences of lightning of different types.

The indispensable condition of TGE initiation is the creation of the lower dipole accelerating electrons downward. The temporarily emerging Lower positive charge region (LPCR) is smaller than the mid-level negative and upper positive layers of the main upper thundercloud dipole. Therefore TGE phenomena is local and its duration coincide with duration of the existence of LCPR, at Aragats usually ~10 minutes.

a) The main findings of the research are the following:

The main results obtained on Aragats consist in the pioneering works on observation and explanation of the new physical phenomenon; namely, Thunderstorm ground enhancements (TGEs) manifest themselves by at least 6 physical effects:

- Large fluxes of the electrons and gamma rays, exceeding the background of ambient population of secondary cosmic rays up to 10 times;
- Neutron fluxes, originated by photonuclear reactions of gamma rays with atmospheric nuclei;
- Microsecond bursts of the electrons, so called, Extensive cloud showers (ECS), the electron-photon cascades initiated in the strong atmospheric electrical fields by "runaway" electrons.
- Depletion of the high energy muon flux;
- Origination in the base of the thundercloud of the Lower positively charged regions (LPCR), afterwards the embedding "lower dipole" accelerates electrons downward;
- Depletion of the cloud-ground lightning occurrences and enhancement of the intracloud lightning occurrences.

Origin of TGE is a radiating region in the bottom of the cloud coincided with LPCR, which forms a lower dipole with the main negative charge region in the middle of the cloud. Intensive electrical field between these layers accelerates electrons downward and give birth to 2 processes:

- Relativistic runaway electron avalanches (RB/RREA) process sustaining electron and gamma ray fluxes up to 10 times above cosmic ray;
- Modification of CR energy spectra (MOS) process, which is responsible for the gamma ray and electron flux enhancements and depletion of high-energy muon flux.

Electrical fields in thunderclouds effectively transfers field energy to electrons; electrons generate gamma rays and gamma rates by photonuclear reactions born neutrons detected on earth's surface; RREA can generate particle bursts with duration less than 50 microseconds; overall duration of TGE is ~ 10 minutes; during 10 minutes large amount of short bursts occurs. Largest TGE events allows to estimate energy spectra: energy spectra of electrons and low energy gamma rays are exponential; energy spectra of gamma rays above 10 MeV are described by power law in overall agreement with GEANT4 simulation; TGEs usually occurred on negative near surface electrical field varied from -10 to -30 kV/m; During TGEs the fraction of IC- lightning occurrences is strictly increased, CG- lightnings are suppressed; observed behavior of lightning occurrences supports emergence of the LCPR and, consequently, lower dipole. The upper dipole accelerates electrons upward to the space where electrons, positrons and gamma rays are detected by space born gamma ray observatories.

The results of research on Aragats are very important for high-energy atmospheric physics, geophysics, atmospheric physics and climatology. The new approaches and methodologies developed in the framework of presented work will allow Armenian physicists to research and maybe solve 300 hundred year problem of lightning initiations. We plan to enlarge particle detector network, develop new type of particle detectors, enlarge network of electrical and geomagnetic field meters, as well as use new methodologies for measuring electrical field inside thundercloud.

Ongoing climate change can lead to significant increase of lightning occurrences mostly in globe dry regions. Monitoring lightning strikes by worldwide networks of antennas and by space born monitors, planned in coming decade at International Space Station will help to establish the forewarning services on disastrous weather conditions greatly enlarged recently. The increasing rate of lightnings and simultaneous increase of their height can alert on the upcoming huge thunderstorm with possible flooding. The established collaboration with Armenian meteorology service and anti-hailing service will help to create advanced forewarning facilities and methodologies.

Experiment Gamma in 2012 enlarged the network of particle detectors by 60 new ones located just below the center of surface array. That will improve significantly the possibilities to detect showers initiated by the primary gamma rays.

2.3. Theoretical Physics

Theoretical Physics Division consists from 47 employees: 40 scientific, including 17 Doctors and 20 Candidates of Science, 1 technician, 3 graduate students (bachelor and magister) and 3 PhD students; total fund for salaries in 2012 – M83,586 dram, mean salary – K145,545 dram.

The dominant directions of investigation during 2012 in the Department were high energy phenomenology, quantum field theory, statistical physics and integrable models, condensed matter physics. The Department published more than 50 articles in international journals, employees of the Department participated in more than 10 international conferences and workshops, and one PhD theses was defended.

The most important (10) results of division during 2012 were in area of phenomenology, quantum field theory, integrable models and statistical physics.

More detailed description of achievements:

- **Phenomenology:**

For the first time proposed formulae for computing the phase space integrals of $1\to3$ and $1\to4$ processes with massive particles in final states. As an application of these formulae we study the final state mass effects in some interesting phenomenological cases, giving fully integrated analytic results for the corresponding phase spaces.

Another important theoretical investigation in the area of the B and K -meson physics in the Standard Model and beyond during 2012 is: Important QCD corrections to the observables in B and K meson processes. More detailed for the first time $O(\alpha_s)$ corrections to the double differential decay width for the process $B \to X_s \gamma\gamma$ originating from diagrams involving the electromagnetic dipole operator O_7 are calculated analytically. The results are important for analysis and testing the Standard Model and its extensions.

We declare that members of department obtained the important achievements in the area of resonance physics connected with the experimental studies at the JLab 12 GeV upgrade. In the paper with 26 world leading authors in the field, including S.Brodsky, V.Braun, and others was presented detailed description of the physics that can be addressed through Nastructure studies in exclusive meson electro production. Moreover, important review of the recent progress in the investigation of the electro excitation of nucleon resonances, both in experiment and in theory also was published during 2012.

- **Field theory and integrable models**

In the series of articles [5] constructed Baxter operators for the homogeneous closed XXX spin chain with the quantum space carrying infinite or finite dimensional representations. This results obtained in a systematic and very transparent approach where the cases of finite and infinite dimensional representations are treated in analogy. Simple relations between the Baxter operators of both cases are obtained. The authors proof not only the relations between the operators but present also their explicit forms and expressions for their action on polynomials representing the quantum states.

In the very elegant article for the first time, the closed simple integral representation through Vogel's universal parameters is found both for perturbative and nonperturbative parts of free energy of Chern-Simons theory on S3. This proves the universality of Chern-Simons partition function. For classical groups partition function manifestly satisfy $N \to -N$ duality, in apparent contradiction with previously used ones. This result is very important as a successful application of the strong mathematical relations to the gauge theory model.

It is worth to mention another exiting paper, where a system of O(N)-matrix difference equations is solved by means of the off-shell version of the nested algebraic Bethe ansatz. The proof of the main theorem is presented in detail. In particular, the cancellation of all “unwanted terms” is shown explicitly. This work performed by scientists recognized as a leading researchers in this area of mathematical physics.

The last interesting result in this area is a new electrically charged black brane solutions in a consistent truncation of the N=4, D=5 Romans' gauged supergravity which contains gravity, SU(2) and U(1) gauge fields, and a dilaton possessing a nontrivial potential approaching a constant negative value at infinity (AdS space). The international group of authors find that the U(1) x U(1) solutions become unstable to forming non-Abelian hair.

- **Statistical physics and integrable models**

Group of authors studied (analytically) finite-size corrections in the dense polymer model on the strip by perturbing the critical Hamiltonian with irrelevant operators belonging to the tower of the identity. They generalize the perturbation expansion to include Jordan cells, and examine the finite-size corrections. Though the corrections themselves are not universal, the ratios are universal and correctly reproduced by the conformal perturbative approach, to first order.

Another important result is analysis of the entangled diamond chain with Ising and anisotropic Heisenberg (Ising-XXZ) coupling. Two interstitial particles are coupled through Heisenberg coupling or simply two-qubit Heisenberg, which could be responsible for the emergence of entanglement. They are able to get the thermal average of two-qubit operator, called the reduced two-qubit density operator. The thermal entanglement (concurrence) is constructed for different values of anisotropic Heisenberg parameter, magnetic field and temperature.

2.4.Accelerator Physics and Techniques

Accelerating Physics Division on the basis of 4 scientific groups and 2 operating and maintenance groups consists from 38 employees: 11 scientists, including 3 Doctors and 6 Candidates of Science, 12 engineers and technicians, 3 graduate students (bachelor and master) and 12 support personnel; total fund for salaries in 2012 – M48,197 dram, mean salary – K84,095 dram.

The Accelerator Physics and techniques Division provides linear accelerator (ARUS injector) operation for the test production of the medical isotopes. The microtron group continues the 25-MeV device assembling and maintenance of the 5 MeV microtron. In collaboration with DESY the Logbook software was installed and adopted, as well as, the equipment for the remote control of accelerator operation. A new program of beam diagnostic tools development was started.

2.5. Applied Physics

Applied Physics Department on the basis of 4 scientific and 1 engineering groups consists from 22 employees:12 scientists, including 4 Doctors and 7 PhDs, 7 engineers and technicians, 2 graduate students (bachelor and magister) and 1 PhD student; total fund for salaries in 2012 – M32,095 dram, mean salary – K108,818 dram.

Research of the radiation defect formation in condensed materials

Single crystals of yttrium aluminum garnet $Y_3Al_5O_{12}$ (YAG) are famous due to their excellent mechanical, optical and chemical properties. YAG crystals and ceramics are widely used as hosts for doping with different rare-earth ions, which makes it possible to use them in rather different applications like laser crystals, fast scintillators, phosphors in LEDs, dosimeters for ionizing radiation and etc.

Absorption, emission and excitation spectra of 50 MeV electron beam irradiated and as-grown YAG single crystals were studied and compared in the 10-300 K temperature range using time-resolved luminescence spectroscopy, UV/VUV/XUV excitation by synchrotron radiation and cathodoluminescence. The emission spectra consisted of intrinsic (excitonic) and defect related non-elementary bands in the VIS/UV range. It was shown that fast electrons create stable F and F^+ color centers with characteristic emission and absorption bands in the visible/UV range.

Investigation of materials and devices in extreme physical conditions

Silicon single crystal conductivity was studied in-situ in the course of 8 MeV electron irradiation. It was shown that the specific conductivity of silicon samples measured in the course of irradiation was much higher than that after irradiation. The higher value of conductivity at in-situ irradiation was due to ionization mechanisms (Auger or other irradiation induced process) that resulted in the formation of non-equilibrium carriers (hole-electron pairs).

It was shown by the performed measurements that in the case of electron irradiation at room temperature, specific resistance (ρ) of p- and n- Si type samples changed at different rates depending on the radiation dose. Besides, in p- Si samples the strong increase of ρ (compared to the n- Si ones) was observed at significantly higher irradiation doses, i.e. the p-Si type samples were more stable to irradiation.

It was revealed that in n-Si type samples the change of conductivity varied significantly depending on the irradiation dose and temperature.

The experiments were carried out in vacuum chamber simulating near Earth space conditions. The results may be used in the silicon-based electronic elements intended for space and accelerator applications, as well as to develop less expensive radiation stable detectors.

Investigation of high-temperature superconductors

The stages of penetration of the static magnetic field into ceramic high-temperature superconductors (HTS) based on bismuth-doped iron (Bi-Pb-Sr-Ca-Cu-Fe-O) were eexperimentally detected and studied. The effect of transport current on resistive and superconducting properties of bismuth samples with various substituent impurities were also investigated. It turned out that the results depended on several factors such as temperature of the measured samples, their bulk density, synthesis and heat treatment regimes as well as external magnetic fields. Some heat treatment regimes were found, when resistive properties showed rather high sensitivity to the transport current. Here, depending on the sample composition or measurement temperature, both increase (positive magneto resistance) and decrease (negative magneto resistance) of its resistance was observed with the transport current rise. Besides, it was found that after a certain holding period the quenched bismuth and yttrium samples revealed some changes in the superconducting transition temperature and normal resistance (so called "aging phenomenon"). The occurrence of positive or negative magneto resistance depending on

various factors is related to the formation and destruction of weak superconducting links and, therefore, to the up to now unknown mechanism of superconductivity.

The above results are of both fundamental and practical importance. For example, finding the substances sensitive to the transport currents passing through them, will allow developing the supersensitive magnetic field detectors. And the study of aging effects should promote the obtaining of HTSC samples with time-stable characteristic parameters. This is especially necessary to prevent unwanted aging effects, when they are used as high-power current limiters and may heat up considerably upon passage of high currents causing.

Production of the biosensors for environmental monitoring

It was shown, that soil pollution in Nubarashen burial ground by toxic chemicals has led to considerable decrease of microbial community population (approximately by two orders of magnitude) in the soil.

From the soil samples of Nubarashen burial ground, some strains of microorganisms with extremely high tolerance (stability) to high (within the limit of their water solubility: about 200 mg %) concentration of insecticide actara were isolated to investigate the possibility of biodegradation by microorganisms via their serial fermentation in the liquid media. The work is aimed at the development of biosensors. It was shown that short-time (less than one minute) UV treatment of water suspension of the investigated bacteria strain has resulted in the increase of the quantity of colony forming units (CFU) of microorganisms after inoculation on agar plate with a nutrient medium.

Accelerator diagnostics and instrumentation based on the vibrating wire technology

A Vibrating Wire Scanner consisting of two mechanically coupled wires was developed. In this scanner one wire remains vibrating and serves as a measurement instrument for the strain of the second wire exposed to the beam. One of the advantages of the proposed monitor is that its aperture is equal to the length of the exposed wire and can be made as long as necessary. This wire is completely free and can even be made of a dielectric material. The use of materials with extraordinarily high thermo conductivity leads to decrease of the monitor response time, which is very desirable in some cases.

A prototype of such a Large Aperture monitor with 60 mm long exposed wire was developed and manufactured (LA_VWM). Laboratory tests of LA_VWM with 60 mm long detecting wire were done. The thermal characteristics of LA_VWM were estimated analytically; response times of LA_VWM were investigated by the irradiation of the monitor detecting wire by laser beam, and DC current modeled the characteristics of LA_WM depending on the detecting wire temperature changes.

Based on the vibrating wire technology monitor, a proposal for neutron beam diagnostics was prepared.

Another proposal based on the use of Diffusive Radiation as Accelerator beam diagnostic tool was prepared. Such a diagnostics can be especially useful for the observation of storage rings beam halo.

A series of laboratory furnaces with different properties was developed and manufactured within the frame of CNCP/ISTC Project.

2.6. Isotope Investigation and Production

Isotope Investigation and Production *Department* on the basis of 3 scientific and 1 engineering groups consists from 21 employees: 6 scientists , including 4 PhDs, 7 engineers and technicians, 7 graduate students (bachelor and magister) and 1 PhD student; total fund for salaries in 2012 – M28,910 dram, mean salary – K95,421 dram.

During 2012 within the framework of ISTC A-1444 project titled "Development of medicine intended isotopes production methods on the basis of electron accelerator facility of Yerevan Physics Institute" (manager – Dr. Albert AVETISYAN, foreign collaborator – Dr. Thomas RUTH, TRIUMF, CANADA) in the National Laboratory after A. Alikhanyan AANL (Yerevan Physics Institute - YerPhI) a positive results have been achieved. The production of two types of isotopes namely ^{99m}Tc and ^{123}I has been investigated to develop the methods of production on the base of the YerPhI linear electron accelerator facility. The technology and commercial aspects of this activity have been developed under CNCP (Close Nuclear Cities Partnership) project, which allow purchasing of part of specific equipment and covering licensing costs. The dedicated building has been prepared to host the isotopes production department; reparation and furnishing are completed. The beam intensity of linear electron accelerator has been increased for a factor more than 2 achieving 10 mkA due to new high emission cathode purchasing, modifying, adjusting and tuning for existing electron gun.

The performed in 2012 trial production proves possibility of nonstop providing of ^{99m}Tc. The only disadvantage is that the primary cost of isotope producing using electron accelerator irradiation is higher than that from Mo/Tc generators. That's because of low beam intensity and therefore long duration of irradiation.

The results of this activity have been reported in 2009 and 2011 on International Conferences of Nuclear and Radiation Physics (Almata, Kazakhstan). Two articles have been published in the Armenian Physics Journal of National Academy of Science. One article is under preparation for Journal of Nuclear Medicine and Biology.

The most important and expensive part of listed equipment is a system for ^{99m}Tc extraction from irradiated MoO_3 target (see above). For ^{99m}Tc that is a centrifuge extractor with MEK solvent technology is successfully working many years in Moscow and St. Petersburg covering more than 1/3 of Moscow demand and full demand of St. Petersburg. The complete automatic equipment commissioned by Moscow "Federal center of nuclear medicine projects design and development" of FMBA of Russia factory was installed in a "hot" cell and commissioned.

For radioizotopical and radiology purity of produced isotopes a new high purity Ge/Li detector (producer – ORTEC) has been purchased, commissioned and calibrated. The model is GEM15p4-70 coaxial type. The very high energy resolution allows its use in a large area of low energy nuclear physics, environment ecological monitoring, isotopes production etc. Very few such a detectors are used in Armenia for the moment.

For chemical impurities test a spectrophotometer Shimadzu UVmini-1240 has been purchased to control the quality of the isotope and to determine the presence of undesirable impurities.

A new way of ^{99m}Tc production has been investigated namely direct production avoiding parental ^{99}Mo stage. The technology of such a process is under very high attention around the world due to many reasons. For this a new project has been prepared for research during next 2 years. The aim of this project is create and develop the technology of ^{99m}Tc direct production under C18 proton beam using $[^{100}Mo]O_3$ target material.

The suggested methods and trial production allow transfer whole experience and technology to an option of isotopes production using proton beam of C18 cyclotron which will be commissioned during 2013 on the territory of AANL-YerPhI. Estimated values of activity on that cyclotron are as a minimum an order of magnitude higher than that from LUE50. It could cover whole demand of Armenian clinics for homemade ^{99m}Tc isotope.

2.7 Center for Cosmology and Astrophysics

Cosmology and Astrophysics Centre consists from 6 employees: 6 scientists, including 1 Doctors and 4 Candidates of Science; total fund for salaries in 2012 – M8,309 dram, mean salary – K104,500 dram.

1. Participation in the LARES (LAser Relativity Satellite, Italian Space Agency, European Space Agency, NASA; Gurzadyan - member of science team) satellite mission project, to test the predictions of the General Relativity, the Lense-Thirring effect with unprecedented precision of several percent.
2. Study of theoretical cosmological models vs the observational data on Cosmic Microwave Background radiation large scale universe, galaxies, dark matter, baryon acoustic oscillations.
3. Development, modeling, numerical experiments on advanced methods based on theory of dynamical systems, for nonlinear astrophysical problems.

The cosmic microwave background data of Wilkinson Microwave Anisotropy Probe's 7-year observations have been used to detect a galactic dark halo for the first time (M31 galaxy), in the joint study with Italian and Swiss collaborators. Modeling and advanced numerical methods have been operated for composite cosmological signals. Further results of the obtained new limit for the light speed anisotropy and the Lorentz invariance violation based on the measurements at GRAAL facility of European Synchrotron Research Facility (Grenoble) have been released. The first results on the LARES satellite launched in February 2012 have been released (Eur. Phys. J. Plus 127 (2012) 133).

A PhD thesis has been defended supervised by Gurzadyan: Daniele Vetrugno "Astrophysical applications of Kolmogorov's parameter", Universita di Salento, Italy. Gurzadyan was a keynote speaker at "9th Swiss Biennial on science, technics + aesthetics on **"**The large, the small and the human mind", Lucerne, 2012.

2.8 New facilities of the Computer center

YerPhI Batch Cluster System is High-Performance Computing Resource, which allows processing parallel and serial jobs submitted locally at YerPhI. The Primary work node of cluster is Dell Super Mini Server 7047GR-TRF 32 CPU and 512 GPU NVIDIA GeForce Professional Graphics Processors. During next upgrade we will add extra 4 NVIDIA Tesla Computing Processor modules.

Super Server 7047GR-TRF hardware specification

Barebone: Supermicro SuperServer 7047GR-TRF - 4U/Tower GPU Server - 1620W Redundant Processor: 2 x 8 x 2 - Core Intel Xeon Processor E5-2665 2.40GHz 20MB Cache (115W) Memory: 8 x 16GB PC3-10600 1333MHz DDR3 ECC Registered DIMM Hard Drive: 2.0TB SATA 7200RPM - 3.5" - Western Digital RE4WD2003FYYS Video Card: PNY NVIDIA GeForce GTX 580 2GB GDDR5 (2xDVI, 1xHDMI, 1xDP) Network Card: QLogic QLE7340 40Gbps InfiniBand Host Channel Adapter (1x QSFP)Peripherals: Microsoft Wired Desktop 400 Keyboard and Mouse (USB)

The YerPhI Batch Cluster System provides following hardware and software resources

- up to 60 cpu cores for interactive and batch processing
- up to 512 GPU cores NVIDIA GeForce GTX 580 processors
- Primary work node: Super Server 7047GR-TRF
- Worker Nodes: AMD Opteron 2,5GH 2x CPU ,RAM 4GB HDD 80GB
- 20 TB NFS mounted Storage Disk Space
- Group specific software and storage
- Submit and control jobs from Linux Command Line Interface
- Fair share load distribution and quota handling
- Runs "Rocks" Cluster Solution based on Sun Grid Engine (SGE).

Current Status of the Grid site

AM-04-YERPHI Tier-3 site registered us a full operational site in Armenian national grid infrastructure and in European Grid Initiative. ArmGrid is connected to the international research network GEANT2 through a 6 Mbps bandwidth.

Computational resources of AM-04-YERPHI Tier-3 Grid site are as follows:

- Model: Dell PE1950 III Additional Quad-Core Xeon
- CPU: 6 nodes x 2 cpus per node X 4 cors per cpus= 48 cors
- HDD:160 GB
- RAM: 8 GB
- Storage Capacity 50TB
- Site Core Services MAUI/Torque PBS and SRM v1, v2

3. IMPROVING THE AGE STRUCTURE OF THE AANL

The administrative structure of AANL after significant modification in 2011 was not changed in 2012; see Fig.4 in the attachment 2. In 2012 as a transitional year 90 scientists and engineers with age above 65 years were kept in the AANL staff. Total number of employees above 70 years is now 35; below 35 years – 96. 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 = 96/35 = 2.74**. 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 71 persons: 499 in 2009, 428 – in 2013.

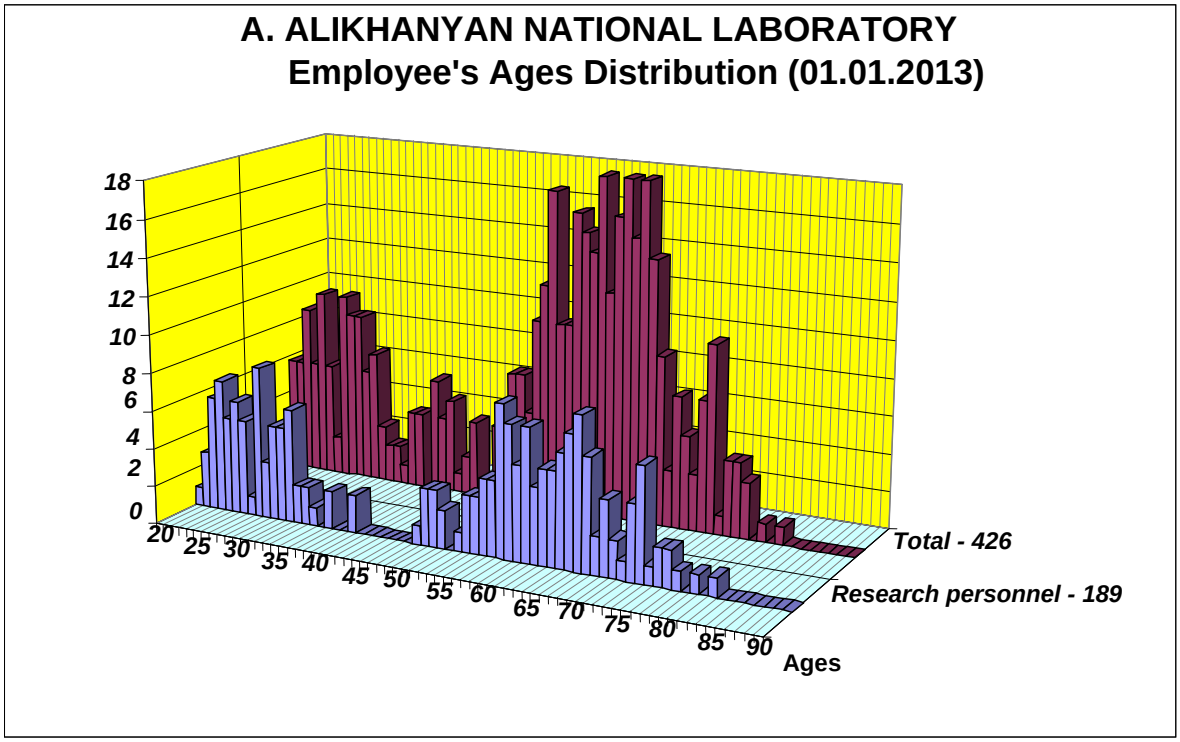

Figure 1. AGE distribution of the AANL employee

Table 1
Age structure of AANL employees (as of 01.03.2013)

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	
0	***0***	***0***	***0***	***1***	***2***	***2***	***3***	***0***	***0***	***0***	***0***	**8**
6	***1***	***5***	***0***	***4***	***6***	***1***	***3***	***2***	***2***	***1***	***0***	**31**
26	***2***	***0***	***1***	***8***	***16***	***13***	***10***	***7***	***1***	***0***	***0***	**84**
14	***2***	***0***	***5***	***5***	***7***	***6***	***6***	***1***	***1***	***0***	***0***	**47**
17	***4***	***2***	***1***	***2***	***6***	***15***	***6***	***8***	***1***	***0***	***0***	**62**
8	***0***	***0***	***1***	***3***	***2***	***9***	***8***	***3***	***4***	***0***	***0***	**38**
4	***1***	***0***	***0***	***0***	***7***	***3***	***6***	***0***	***1***	***0***	***0***	**22**
8	***0***	***0***	***1***	***1***	***3***	***7***	***1***	***0***	***0***	***0***	***0***	**21**
5	***0***	***0***	***0***	***0***	***1***	***0***	***0***	***0***	***0***	***0***	***0***	**6**
4	***0***	***0***	***0***	***2***	***1***	***0***	***0***	***0***	***0***	***0***	***0***	**7**
2	***3***	***6***	***6***	***17***	***8***	***16***	***5***	***4***	***2***	***0***	***0***	**69**
1	***2***	***3***	***1***	***8***	***6***	***10***	***3***	***1***	***0***	***0***	***0***	**35**
95	**15**	**16**	**16**	**51**	**65**	**82**	**51**	**26**	**12**	**1**	**0**	**430**

4. AANL PUBLICATIONS AND CITATIONS

AANL scientists continue to actively participate in high-energy physics and astrophysics experiments in Armenia and abroad. AANL theoreticians continue to publish papers in variety of topics of their interest. In 2012 the total number of publications significantly enlarges exceeding 400 (last year 250, the **KPI enhancement is 60%).** *About 20% of all scientific publications in Armenia come from AANL, and what is more impressing ~60% of the citations to all-Armenian scientific papers is made to AANL publications*. This numbers were obtained from Thompson Reuters database, thanks to national science committee signing agreement with this world most confident intellectual property-monitoring agency. This proves that AANL physicists remain essential members of the world high-energy physics community; and, unfortunately, that a vast part of Armenian scientific publications is not well known to world.

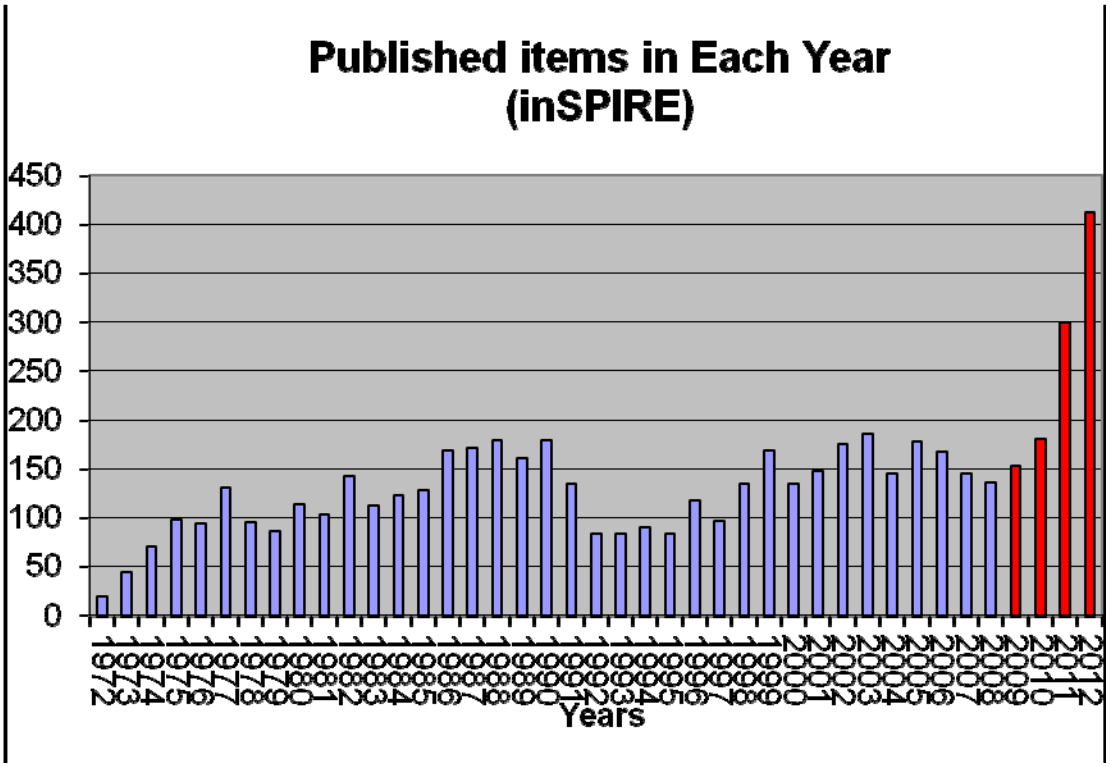

Figure 2. Distribution of the published papers in peer review journals

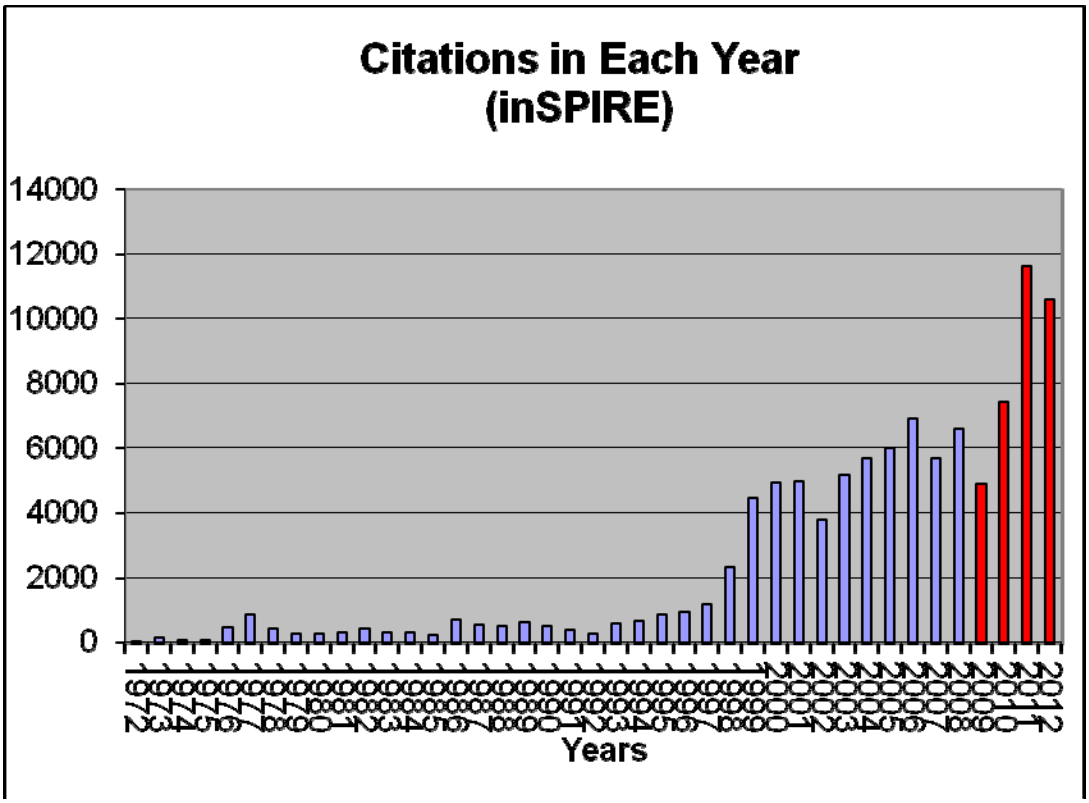

Figure 3. Number of citations to the national lab employee`s papers

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

In 2012 the scientific-technical conference of AANL elected the scientific council by secret ballot and scientific council again by secret ballot elected its chairman, secretary and deputy chairman, see details in the attachment 3. AANL Scientific Council held 12 meetings in 2012.

In 2012 AANL`s Professional Council # 024 listed and approved 10 PhD theses, the titles of which are presented in the attachment 4. In 2012 AANL`s seminars were very active, see the list in attachment 5.

Among 129 business trips made by AANL employees in 2012 55 were to CERN/DESY/Jlab according to program of mutual research, 28 – participation in conferences, 46 – according individual invitations. 18 young scientists were supported by AANL for participation in schools, conferences and CERN, Jlab and DESY activities.

New agreements for the joint research were signed in 2012 with a number of international and Armenian institutions, see the list in attachment 6.

6. AANL BUDGETARY ISSUES

Table 2. Income in 2009 -2012 from state, own profits and international grants

AANL INCOME ԵՐՑԻԻ ԵԿԱՄՈՒՏՆԵՐ	2012 (MLN. AMD) 1$=401.72 AMD)	2011 (MLN. AMD) 1$=370.32 AMD	2010 (MLN. AMD) 1$=373.4 AMD	2009 (MLN. AMD) 1$=377 AMD
Base funding **Բազայից ֆինանսավ.**	**710.4** **M1,768.4$**	**660.6** **M1,783.9$**	**319,7** **K856.2$**	**283,2** **K752$**
Project funding Թեմատիկ ֆինանսավ.	41,659.8 K103.7$	39,787 K107.4$	96,54 K258,5$	93,1 K247$
International support; US diaspora, Slovakiaetc…		5,137.0 K13,9$	70,563.6 K189$	17,007 K45,1$
DESY (salary)	27,782.0 K69.2$	44,151.0 K119.2$	30,129.5 K80.7$	31,402 K83,3$
JLab (Internet)	5,694.2 K14.2$	3,568.0 K9,6$	3,871.0 K10.4	5,160 K13,7$
Agreements: Yertsyan H., Mkoyan S.	3,039.0 K7.6$			
INTAS, FP7, CRDF, other…				34,436 K91,3$
ISTC overhead	25,848.0 K64.3$	5,305.0 K14.3$		7,833 K20,8$
Scientific conferences support				3,783 K10$
Agreement Applied radiation processing Harutyunyan Kh.,	988.0 K2.5$	10,120.0 K27,3$	4,232 K11,3$	8,256 K22$
Rent of space	33,402.0 K83.1$	27,342.0 K73.8$	24,266 K65$	27,679 K73,6$
Sales	18,255.0 K45.4$	1,434.0 K3,9$	4,239 K11.4$	4,144 K11$
Other	5,660.0 K14.1$	20,117.0 K54.3$		19,190 K50.1$
Total from state	**752.1** **M1,872.2$**	**700,4** **M1,891.3$**	**416,24** **M1,15**	**376,3** **$1M**
Own profits	**123,928.2**	**120,414.0**	**137,3**	**155**

	K308.5$	K325,2$	K368$	K411$/
State + own	876.0 M2,180.7$	820,8 M2,216.5$	553,54 M1,518$	532 M1,411$
ISTC +CNCP	3,260.0 K8.1$	3,240.0 K8,7$	K820	K816
State+ own+ ISTC	M2,188.8$	M2,225.2$	M2,330$	M2,227$

Table 3 .Expenditures in 2009 - 2012

YERPHI EXPENDITURES ԵՐՑԻԻ ԾԱԽՍԵՐ	2012 1$=401.72 AMD	2011 1$=370.3AMD	2010(MLN. AMD) 1$=373.4 AMD	2009(MLN. AMD) 1$=377 AMD
Salary Աշխատավարձ	577665.0 K1438.0$ (64.4%)	495,870.0 K1,339.0$ (63.7)	354,094.0 (62.9%)	357 (67.2%)
Electricity Էլեկտրաէներգիա	41346.0 K102.9$ (4.6%)	42,109 K113.7$ (5.4%)	34,389.4 (6.1%)	32,720 (6.16%)
Gas Գազ	16889.0 K42.0$ (1.9%)	8,793.0 K23.7$ (1.1%)	3,665.4 (0.65%)	2,884 (0.53%) 60,950m^3
Phone Հեռախոս	2684.0 K6.7$ (0.3%)	2,723.0 K7.4$ (0.35%)	2,443 (0.43%)	2,493 (0.46%)
Water Ջուր	12706.0 K31.6$ (1.4%)	6,526.0 K17.6$ (0.84%)	4,992.3 (0.89%)	5,874 (1.08%) 39.913m^3
Internet Ինտերնետ	6299.0 K15.7$ (0.7%)	3,576.0 K9.7$ (0.46%)	3,433 (0.61%)	4,000 (0.74%)
Taxes Հարկեր	16622.0 K41.4$ (1.8%)	13,194.0 K35.6$ (1.7%)	22,638 (4%)	21,000 (3.96%)
Business Travel Գործուղում	43946.0 K109.4$ (4.9%)	32,603.0 K88.0$ (4.2%)	52,792 (9.4%)	16,540 (3.11%)

Fuel Վառելիք	8051.0 K20.0$ (0.9%)	8,650.0 K23.4$ (1.1%)	7,763.3 (1.4%)	7,970 (1.37%)
Materials & equipment Նյութեր և սարքավորում.	85416.0 K212.6$ (9.5%)	89,773.0 K242.4$ (11.5%)	26,779 (4.8%)	38,503 (7.25%)
Repairs Վերանորոգում	40678.0 K101.3$ (4.5%)	33,915.0 K91.6$ (4.4%)	34,828 (6.2%)	37,2 (7.02%)
CERN participation fee Անդամավճար	20000.0 K49.8$ (2.2%)	22,800.0 K61.6$ (2.9%)		
Other expenditures Այլ ծառայութ. և ծախսեր	24075.0 K59.9$ (2.7%)	17,221.0 K46.5$ (2.2%)		
Total **Ընդամենը**	**896.377** **M2,231.3$**	**777,753** **M2,100.2$**	**563,258** **M1,508.5**	**530,8** **M1,41$**

The remainder on 01.01.12 was M57,951 AMD, on 01.01.13 - M37,574,000 drams

As we can see from the Tables 2 and 3 the expenditures in 2012 were larger than income from all sources in 2012. The surplus remainder on the accounts of AANL on 01.01.12 covered the difference.

From Table 2 it is apparent that most dangerous consequences of the decay of international funding happened in 2011 was overcome. Missing 820,000$ from international foundations were compensated by the Armenian government with significantly enhancing the base funding. The rise of the Key performance indicators achieved in 2011 was sustained in 2012:

a. The percent of the funds spent to the new equipment and materials relative to the total budget was rather large – 9.5%; among key equipment purchased is modern gamma spectrometer for experiments on 18 MeV proton beam of IBA cyclotron and a new modern servers.
b. The percent of funds spent on business travel relative to the total budget was 4.9%.
c. The percent of funds spent for repairs relative to the total budget was 4.5%.

The most critical repairs of building roofs were the first priority. We repaired the roof of building 22c (BESM6 building) where we plan to organize international conference center, building of applied physics department, small hotel building in Nor Amberd. The total funds spent for repairs in 2012 reach K200$ - 6 time more comparing with previous years. The funds spent on equipment purchases also grew 3 times. Crucial purchases of computer and office equipment were done in 2011-2012, see report of computer center

above. Also were purchased 20 personal computers for young scientists and students, networking equipment and other.

7. APPLIED/TECHNOLOGICAL ACHIEVEMENTS

The competition of innovation projects hold in 2012 gives some positive results: The project: "Development of diamond electronic components, their investigation and use at the Armenian nuclear power plant", performed by Applied physics department, V.Harutunyan, ended with the product tested and accepted by the end user. The project is aimed at the development of radiation resistant, non-degrading elements of passive and active electronics with high thermal conductivity (thermoresistors, heatsinks) on the basis of high-purity diamond ceramics for operation at temperatures up to 700 K. As a result of the complex physical research aimed at the development of operating components of diamond electronics and their application in special extreme conditions at the Armenian nuclear power plant, the following objectives were achieved:

- A new manufacturing technology was developed for some electronic elements using diamond ceramics, which allowed significant simplification of their production process, reduction of costs in comparison with the commonly used single-crystal diamonds. The elements developed (heat sinks, thermoresistors, capacitors) are characterized by high resistant to gamma, neutron, and beta radiation, mechanical stresses, high temperature (400^{o}C) and chemical attack, which chemical effects that allows significant expansion of the scope of their application, as well as greater reliability and stability.

- The most important characteristics of initial diamond micro-powders (absorption, dielectric losses) necessary to obtain the ceramics of required quality, were experimentally determined.

- An opportunity for the development and manufacture of radiation and humidity sensors for the use in controlled zones was shown. Test report with the opinion of the Armenian NPP Chief Engineer is available.

Another innovation project "Establishing the network of the lightning detectors and field meters for thunderstorm and hailing alerting", performed in CRD, A.Chilingarian, also culminates in 2 agreements with Armenian emergency ministry institutions, namely, with department of active influence on meteorological processes and Hydro-meteorological nation service.

The network of electrical mills and lightning detectors were installed in 3 locations on slopes of Mt. Aragats and in Yerevan. The on-line wireless modems and appropriate networking infrastructures provide on-line transfer of information to CRD databases. Special visualizing codes are developed to present the alerts and warning in the most appropriate for end user shape. The special pages in the CRD site display on-line information on upcoming lightnings, frequency of lightning types and other necessary

information. Please, follow the link http://crd.yerphi to watch the lightning and other alerts and warnings.

On 15th October the Laser technological complex with laser power of 1000 W has put into operation. The complex was funded by British Nuclear Nonproliferation program (CNCP). In laboratory infrastructure a special industrial area was set up, where it is possible to explore the whole facilities of the complex: to design and fabricate products with sophisticated counters, laser cutting, welding, surfacing, etc. The complex consists of:

- Modern digital control software system (analog FANUK-0)
- Three-axis table with the transportation system of the laser beam and the optical head for cutting
- CO2 laser source power of 1300 W and 2000 W
- Power supply cabinet
- Laser mount system
- Optical head for cutting / welding
- Non-contact tracking system along the axis of "Z"

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-pressure vessels repair/attestation.
- Liquid gases production.
- Development and creation of high spatial resolution X-ray image detectors for the medical diagnostic systems.

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

Executive summary

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

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

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

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

development of Armenia.

The key components of overall strategy:

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

Brief summary of the scientific activities

Brothers Abraham Alikhanov and **Artem Alikhanyan** founded in 1943 Yerevan Physics Institute (YerPhI) as a branch of the Yerevan State University. Later high-altitude Cosmic Ray stations were founded on the slopes of Mount Aragats. Among the key results of YerPhI in the early years were the discovery of protons and neutrons in cosmic rays, and the establishment of the first evidence of existence of the particles with masses between that of muons and protons. The high altitude research stations have remained the main research base of the Cosmic Ray Division (CRD) of YerPhI until now. Among the CRD achievements there were: discovery of sharp knee in light components of primary cosmic rays, detection of the highest energy protons accelerated on the Sun, and the creation of the Aragats Space environmental Center in 2000 for studies of the solar-terrestrial connection, where CRD becomes one of the world's leaders.

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

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

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

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

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

Organization structure and human recourses management

1) Lab board appoints director of national lab and chair of the board signs contract with director for 5 years.
2) Director of the national lab appointed 2 deputies, chief accountant, scientific secretary and five assistants of director (human recourses management, security, economics, office management, international connections) and sign contract with them.
3) National lab adopted two-level internal organizational structure, consisting of departments where relevant scientific and technical groups operate.

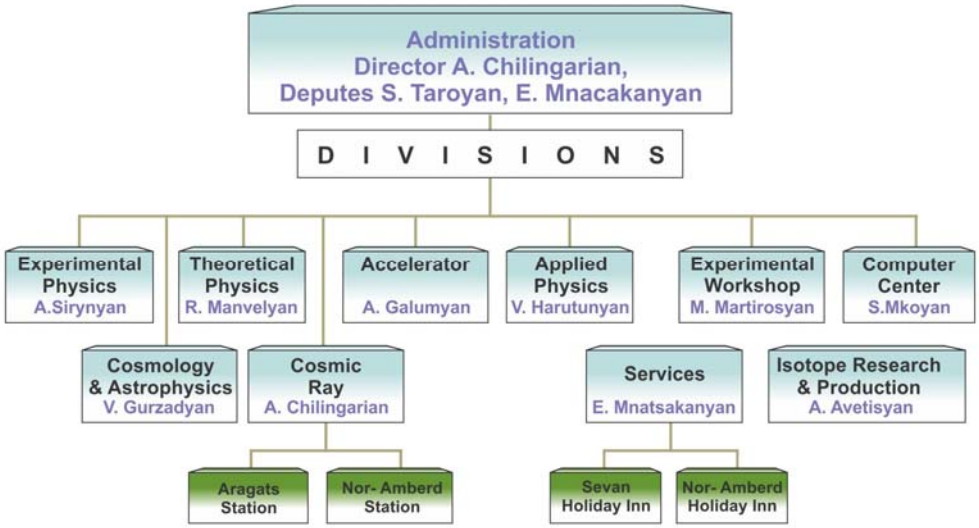

Figure 4 . Administrative structure of AANL

4) The appointment to the position of the heads of departments should be realized for up to 5 years period and they should sign contracts with national lab director. The contract with heads of groups is realized for up to 3 years.
5) The age limit of 65 years is stated for the heads of departments and groups; in exceptional cases (started from 2014 no contracts will be signed with older candidates to group or department leader positions) until the age of 70. The limiting age for other national lab employees is 65 years, for doctors of science– 70. The age limit for consultants/advisers is 85 for academicians and 75 for doctors of science.
6) National lab adopted following list of scientific positions.
   --intern
   --researcher
   --senior researcher
   --leading researcher
   --Scientific /Consultant-Advisor
   Notification:
   a. Intern position is assigned to the young professionals currently engaged in higher Educational system (master courses) and those who are doing their PhD in national lab.
   b. Intern-researcher position («Postdoc» status) is assigned by competition to young scientists, having PhD degree; prior to postdoc competition the competition for opening postdoc position should be hold in the national lab departments.
   c. Lab's director in accordance with the recommendations of the Scientific Advisory Committee decides distribute the intern-researcher positions among lab departments.
   d. Researcher, senior and leading researcher positions are assigned by depending on the overall score based on several criteria (H-index, leadership, work with students, etc.).

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

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

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

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

Administration obligations, economical and property management issues

1. Provide full and timely logistical support for the implementation of the linear functions of the National Lab, such as:

- Ensure efficient utilization of the office spaces, carrying out necessary maintenance and repairing activities
- Repair and equip the seminar and meeting rooms, providing the facilities for teleconferences, and other relevant multimedia possibilities.

- Purchase modern equipment for high precision measurements.
- Install modern security equipment for the offices and experimental laboratories.
- Organize the efficient provision of irrigation water for the whole territory of the National Lab to guarantee the green and clean environment.
- Select an operator, through a competitive tender, for establishing restaurants and cafes on the lab's premises.
- Optimize and manage the vehicles' park, giving priority for smaller number of cars but with appropriate power and environmentally friendly engines.
- Optimize the workshops and provide it with modern tool kits and technological equipment.
- Organization of workshops and conferences (logistics).

- Develop and implement non-current assets (immobile property) management strategy:
- Establish criteria for selecting the buildings requiring capital restoration and build up a renovation and restoration long-term master plan.
- Ensure energetic efficiency of the buildings.
- 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. Report of Scientific Council of AANL/05.2012-12.2012/

YerPhI scientific and technological community conference took place on March 16th, 2012. There were 76 delegates present out of 79. The agenda included the following topics:

1. Presenting information on current activities at YerPhI
2. Approving the Regulation of Scientific Council of YerPhI

3. Electing new members of Scientific Council

Members of the conference endorsed the activity of the SC for the period of 07.2008 - 07.2011. The overview of the work conducted at YerPhI has been presented by the director and was taken into consideration. Members of the conference discussed and approved the presented changes to the Regulations of the SC (YerPhI) as well as the subsequent changes to the Charter of YerPhI. The idea to establish trade union of YerPhI was supported by members of conference unanimously.

At this conference members of YerPhI Scientific Council (SC) were elected by secret ballot. The council`s members are listed below:

	Name	**Number of votes**
1	Hakobyan Hrachia	63
2	Sirunyan Albert	62
3	Margaryan Amur	60
4	Chilingaryan Ashot	58
5	Hambardzumyan Tatyana	58
6	Avetisyan Albert	55
7	Mkrtchyan Hamlet	54
8	Reymers Artur	54
9	Asatryan Hrachya	53
10	Vardapetryan Hamlet	53
11	Gazazyan Edmon	52
12	Garyaka Alexandr	51
13	Ananikyan Nerses	49
14	Manvelyan Ruben	49
15	Dashyan Natalya	48
16	Pogosyan Ruben	48
17	Avagyan Vardan	47
18	Sahakyan Vardan	45
19	Babudjyan Hrachia	44
20	Hovsepyan Gagik	44
21	Galumyan Arsen	44
22	Mamidjanyan Erik	44
23	Harutyunyan Vachagan	43
24	Petrosyan Marzik	42
25	Melikyan Gagik Representative of Ministry of Science and Education	-

During 2012 SC discussed the following subjects:

- During the first meeting Ashot Chilingaryan was voted into the chair of Scientific Council (there were 3 candidates: Chilingaryan A., Sirunyan A., Asatryan H.).

Voting results were as follows: for Chilingaryan A. – 16; Sirunyan A. -7 , Asatryan H.- 6.

- Topics discussed at YerPhI Board of trustees, which occurred on May 12th, were presented.
- The chair of SC presented the changes to YerPhI Charter, approved by government of RA.
- According to recommendations of the Board of trustees the preparation of YerPhI future development strategy was initiated. To resume the activity of every division it was decided to conduct a review of all the divisions in the course of 3 months. During the following 7 meetings of SC those reviews were presented. Leaders and head scientists of each division submitted updated of the division`s scientific activity, relevance of the research topics, achievements, contribution to international collaborations, conditions of the technical inventory, challenges, grants received, organized conferences, publications, staff and staff age range. All presentations are available at YerPhI site.
- Experimental physics division suggested carrying out an experiment using electron beam of 75 MeV. The accelerating ring is suggested to be used as a stretcher, where the target will be placed in order to generate gamma radiation. This gamma radiation will interact with light nuclei. The goal of experiment is to study clasterization effects in nuclei. According to the researchers from accelerator division the new operating regime of accelerator can be ensured. Funding required for the project is 10 million dram. The development of nuclear physics of low energy is the new strategy recommended by International Board of YerPhI.
- Summarizing received information the SC begun the discussion about development strategy of YerPhI. All suggested were placed onto YerPhI site. The main subjects under discussion were the future of synchrotron and practicability of suggested experiment which must be carried out using injector and accelerating ring. Shutting down YerPhI accelerator is an alternative approach.

ATTACHMENT 4 . List of The Theses Defended in AANL (2012).

N	Name	Academic degree	Title of PhD and supervisor's name
1	**Hovhannisyan Karen Vardani**	**Ph.D**	**" Fundamental quantum limits of cooling" Supervisor: Ph.D of Science Allahverdyan A (AANL)**
2	**Eghiazaryan Arsen Gagiki**	**Ph.D**	**"O(α_s) corrections of quantum chromodynamics for $B \to X_s\gamma\gamma$ decay " Supervisor: Doctor of Science Asatryan H. M. (AANL)**
3	**Hovhannisyan Armen Kolyayi**	**Ph.D**	**Investigation of Modulations Effects of secondary cosmic Rays and development of alert system for forecasting the upcoming radiation st orms Supervisor: Doctor of Science Chilingaryan A.A.(AANL)**
4	**Sahakyan Vahe Vardani**	**Ph.D**	**"The Study of X-ray Free Electron Laser with External Focusing" Supervisor: Doctor of Science Tsakanov V.M. (Stat. Univ.)**

5	**Tumasyan Armen Rafiki**	**Ph.D**	**"Energy calibration of the hadronic jets in the CMS (LHC) experiment using $W \to q\bar{q}$ decay in the pp-collisions at $\sqrt{s}$ = 7 TeV." Supervisor: Doctor of Science A.M. Sirunlyan (AANL)**
6	**Mktchyan Artur Hamleti**	**Ph.D**	**Measurements of the Proton Electromagnetic Form Factor Ratio from elastic $\vec{e} + p \to e' + \vec{p}'$ scattering at momentum transfer Q2 = 2.5, 5.2, 6.7 and 8.5 (GeV/c)2" Supervisor: Doctor of Science A.M. Sirunlyan (AANL)**
7	**Arakelyan Karen Vladimiri**	**Ph.D**	**" New electronics for Space Environmental Viewing and Analysis Network (SEVAN) and Aragats Space Environment Center" Supervisor: Doctor of Science Chilingaryan A.A.(AANL)**
8	**Asaturyan Arshak Razmiki**	**Ph.D**	**Investigation of the π+/π- ratios for proton and deuteron and Al/D ratios for π+ and π- mesons in Semi-Inclusive Electroproduction Reaction" Supervisor: Ph.D of Science Mkrtchyan H.G. (AANL)**
9	**Vanyan Levon Alfunsi**	**Ph.D**	**Model of Thunderstorm Ground Enhancements. Calculations of electron, gamma ray, and neutron fluxes from thunderclouds Supervisor: Doctor of Science Chilingaryan A.A.(AANL)**
10	**Karyan Gevorg Ararati**	**Ph.D**	**"A study of charged hadron multiplicities and the multidimensional nuclear attenuation effect at the HERMES experiment" Supervisor: Doctor of Science Akopov N.Z. (AANL)**

ATTACHMENT 5. List of AANL Seminars 2012

1) 21.12.2012 K.Oganesyan,Threshold conditions for Free Electron Laser without Inversion (FEL WI).Future XFELs.
2) 30.11.2012 М.И. Панасюк (НИИЯФ МГУ), Вклад СССР в 100-летнее исследование космических лучей и перспективы на будущее
3) 02.11.2012 H.Avakian (JLAB),, Studies of the Spin and Azimuthal Asymmetries in Electroproduction
4) 25.10.2012 Harald Fritzsch (Muenchen, Germany), Composite Weak Bosons at the LHC
5) 28.09.2012 Dima Shepelyansky (CNRS, Toulouse),Google matrix of social networks
6) 27.07.2012 Г. Хачатрян, Разработка биосенсоров для мониторинга окружающей среды
7) 28.06.2012 I. Kerobyan, A study of low-energy proton-nucleus interactions using the external beam of the CYCLONE-18

8) 21.06.2012 N. Akopov, Status of OLYMPUS experiment

9) 18.06.2012 D. Saakian, The Solution of multi-fractal models

10) 15.06.2012 V.G. Gurzadyan, Observations, Randomness and the Early Universe

11) 01.06.2012 Hartmut Gemmeke (Karlsruhe Institute of Technology), First Results from the KIT 3D Computer Tomography

12) 01.06.2012 Razmik Mirzoyan (Munich, Max Planck Inst), High-lights of the field: Pulsed gamma rays from the Crab pulsar and The Galactic source W51

13) 27.04.2012 Karo Ispirian, Petawatt Lasers, Laser Plasma Accelerators and Their Applications

14) 17.04.2012 Armen Kocharian (California State University, USA), Electronic spontaneous instabilities and magnetism in nanoclusters and nanomaterials

15) 23.03.2012 Amur Margaryan (AANL), Delayed Pion Spectroscopy of Hypernuclei

16) 18.01.2012 А.Н. Довбня (ХФТИ), Радиационные технологии и ускорители ХФТИ для народного хозяйства

17) 24.01.2012 Aram Kotzinian (AANL), Exploring nucleon spin in DIS electroproduction

ATTACHMENT 6. List of Scientific Institutions with whom YerPhI Has Signed Agreements or MOU on 2012

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.