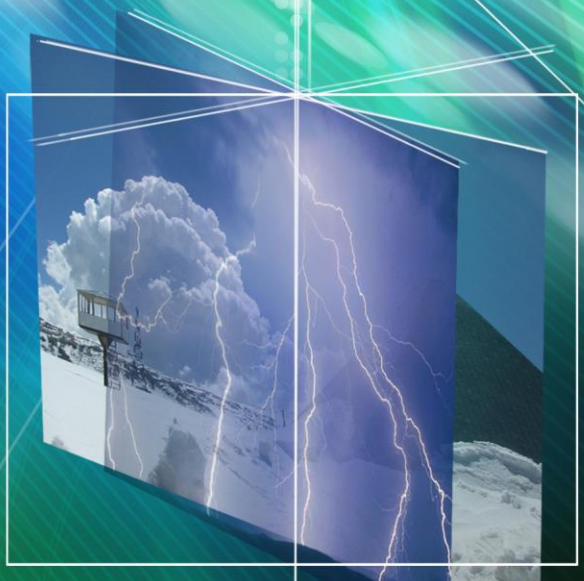
A. ALIKHANYAN
National Laboratory

DEVELOPMENT STRATEGIC PLAN FOR A. ALIKHANYAN NATIONAL LABORATORY (YEREVAN PHYSICS INSTITUTE)



Yerevan 2012

The development 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 ArtemAlikhanian 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.

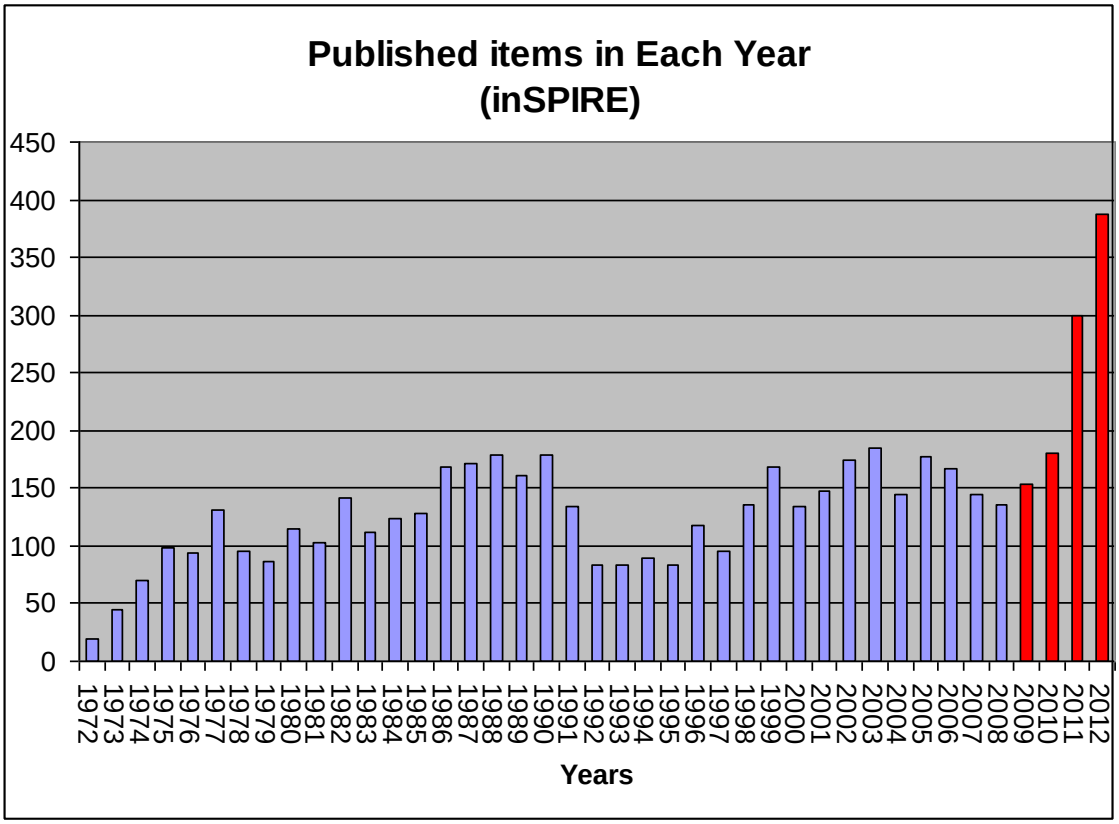
The theoretical department assure major achievements in the following areas: B-meson physics, QCD and Related Phenomenology, Neutrino physics, Quantum Field Theory, String/M-theory, Integrable Models, Statistical physics, Condensed Matter and Quantum Information. These results are internationally recognized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

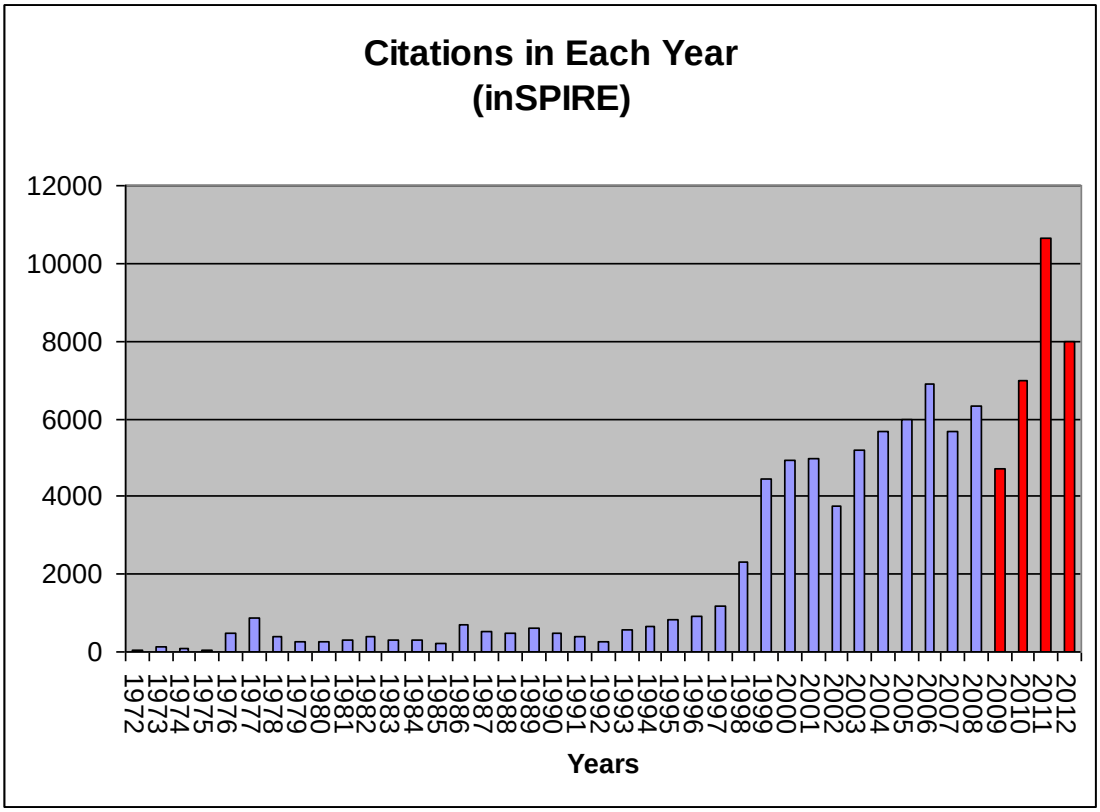
In the mid-1980s in YerPhI was developed the concept of stereoscopic approach in Very High Energy gamma-ray astronomy using multiple Imaging Atmospheric Cherenkov Telescopes (IACT). This concept was materialized in the very successful

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).

Below are the Key Performance Indicators (KPI) characterizing the efficiency of research conducted by national lab: number of publications in the peer reviewed journals and citations of these publications. The sizable enlargement of both parameters during last years is apparent. National lab scientists publish appr. 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 – more than 60% of overall citations to papers published by scientists from Armenia belongs to national lab (see Figures below).





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.

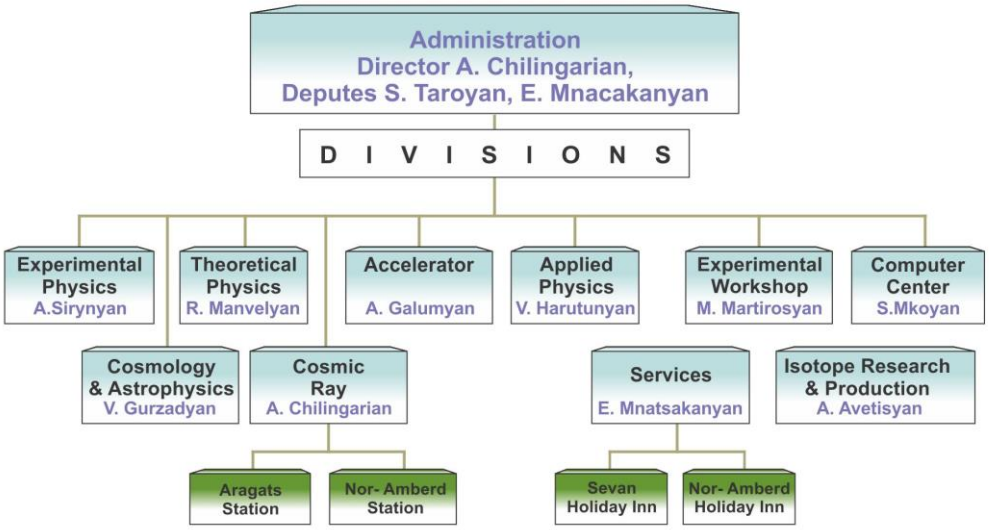
- Fabrication of the radiation detectors and electronic devices (thermoresistors, heat sinks) on the basis of diamond and diamond for high temperature applications.
- Fabricate CsI based low threshold particle spectrometers.
- Fabricate hybrid particle detectors for the Space Weather monitoring.

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.

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 5 director assistants (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.



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.
5. The age limit of 65 years is stated for the heads of departments and groups; in exceptional cases (up to 2013 in the transitional period) until the age of 70. The limiting age for other national lab employees is 65 years, for doctors of science and academicians – 70.
6. National lab adopted following list of scientific positions.
   --intern
   --researcher
   senior researcher
   leading researcher
   Scientific /Academic (Technical) 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 up to 80 year (no more than 5 persons in each department).

5. 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
   - Reports on the international conferences, invited talks
   - Organized conferences
   - Title and date of last thesis, place of defense
   - Total list of publication
   - List of managed grants.

6. 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).
7. Director reserves the right to appoint his advisors, mostly doctor of science, academicians.
8. The business trips of national lab employees to foreign countries are organized according special regulation; duration of business travel should not exceed 6 months.
9. The hours of workweek are fixed to 48. Automatic system is calculating the working hours according to which the actual salary is assigned.
10. 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 additionally to 24 days without payment.
11. 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).

2. 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 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.

3. 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.

4. Organize international expertise of the projects submitted for funding, form commissions and project accepting committees; provide recommendations for republican funding bodies for selected projects.
5. 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.

6. Provide access to national lab information, Internet recourses, high productivity computing, scientific publications, libraries of applied programs, printers, and telephones.
7. Establish small business innovation research (SBIR) and small business technology transfer competitive funding.
8. Provide secure storage of the isotopes and radioactive materials according to MAGATE standards.
9. 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 sum of the impact factors of the journals.
- Number of citations made to publications of national lab employees made in the assessed year.
- The share of the papers devoted to the main national lab directions (high energy physics and astrophysics, nuclear physics) of the whole publications.
- Number of master and PhD students, defends of PhD theses.
- The ratio of the numbers of employees below 35 years old to number of employees above 65 years old.
- The percent of the funds spent to the new equipment and materials relative to total budget.
- The percent of funds spent to business travel relative to total budget.
- The percent of funds spent to repairs relative to total budget.
- Total income from high technological services.
- Number of new agreements with Armenian and international organizations.