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DESY-CANDLE: A German-Armenian Cooperation in Science

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Armenia was in Soviet times a distinguished location for major research institutions in the area of physics. The Yerevan Physics Institute (YerPhI), founded 1943, built and runs until today two measurement stations for cosmic radiation at the slopes of mount Aragats, where also the astrophysical observatory Byurakan, founded 1946, is situated. Moreover the electron accelerator ARUS (the type is named synchrotron) was built under leadership of academician A.I. Alikhanian and started operation in 1967. Only a few years earlier was a quite similar machine built at the Deutsches-Elektronen Synchrotron – DESY in Hamburg. The similarity of the facilities and the associated problems and challenges led to first contacts between DESY[1] and YerPhI and a first cooperation. Based on a for and with DESY newly developed production procedure a ceramic vacuum chamber was built in western Europe and brought to Armenia (where it is still in operation). Despite a difficult political situation scientist could work together already at that times and could thus contribute to understanding and stability. In the following years, however, no more cooperation projects were conducted, probably due to the further degradation of the political situation.

Only in 1980's contacts to YerPhI were reactivated on the occasion of a visit by Volker Soergel (Head of the DESY directorate from 1981 to 1993). In the following several cooperation agreements were signed which led to contributions of YerPhI to experiments and accelerator facilities at DESY, as well as to mutual visits and guest scientist coming to Hamburg for work. Also Vasili Tsakanov, director of the CANDLE institute[2], came to Hamburg for the first time in 1988 by invitation of Soergel.

The facilities described in the beginning were at the time of construction outstanding and led to numerous, internationally acknowledged discoveries and contribution of Armenian scientists.

On the demise of the Soviet Union and the regained independence followed years of economic recession and isolation, accompanied by a strong reduction of experimental activities in Armenia. This was partially balanced by a stronger involvement of Armenian scientists in experimental activities outside the country (at DESY but e.g. also at CERN and others) and continuing emigration of scientists and engineers. Project planned or

[1] http://www.desy.de/
[2] http://www.candle.am/

under construction (construction of a large experimental station ANI on Aragats and of the test accelerator LUE) before the demise could not or only in parts be completed and operated. However, the high level of education and the strong interest in natural science are still reflected today - especially in the field of accelerator and high energy physics - in an over proportional high share of Armenian scientist at external institutes as DESY and CERN. Cooperation projects in which Armenian institutes contribute e.g. components for an experiment or theoretical work form an important possibility for Armenian scientists to stay in their homeland but still participate actively in international developments and gain financial support. This kind of participation is within the internationally organized major research area quite usual, also scientists working at DESY take part on experiments which are not located at DESY. The difference is in the provisions with financial and material expenses of the home institute. A sufficient provision is, however, mandatory for educating young academics, do development work and get access to external funds.

The strong orientation towards basic research of the Armenian physics, with an in parts already 1989 outworn scientific infrastructure and the correspondent structures in the academics required, after the independence, a fundamental realignment, in order to cope with the potential and the requirements of an independent state. In view of different viewpoints and interests a necessarily difficult and lengthy process, which led among others to the foundation of the independent CANDLE institute in 2001 and, after evaluation by an international committee, to the restructuring of the YerPhI in form of a national institute (AANL – A. Alikhanyan National Laboratory).

The foundation of the CANDLE institute went along with the proposal to build a so-called synchrotron radiation source in Armenia. To assess the value of this proposal it is necessary to know, that accelerators have developed into a universal tools for science, medicine and industry. Synchrotron radiation sources take thereby a distinguished position. Typically build in form of rings with a diameter of ~30 m and more, which are devoted to the generation and usage of synchrotron radiation. In principle synchrotron radiation is just X-ray radiation, but in comparison to the radiation of a tube, some million times more intense and – similar as laser light - directed. The applications of the radiation reach from investigations of biological molecules, paleontological objects, electronic elements or geological probes over application in material science up to the screening of archeological artifacts or complete art works[3].

[3] Even a rough presentation of the manifold applications would bust the frame of this article. A collection of interesting material is found on the following website: http://www.lightsources.org/

Worldwide about 50 facilities[4] are in operation today, often in form of open user facilities, to which every scientist can submit proposals for experiments and apply for measurement time. In many cases more than 1000 external scientists use a synchrotron radiation source per year. The facilities concentrate in Asia, Europe and the USA, but are also found in Canada, Brazil and Australia. Considerations for building further sources in Mexico and Africa are being discussed. Under the umbrella of UNESCO a source is under construction in Jordan and also Iran is working on the design of a source since 2010. No source exists in a large circle around the Caucasus.

In view of the scientific background in Armenia with expertise for the construction and operation of accelerators and the necessity to realign science stronger toward applied science and a broader area of topics the proposal for the construction a synchrotron radiation source is appealing. It should be explicitly mentioned that such a source has relevance beyond the region where it is build and can thus contribute to the development of the whole area.

Despite a very good technical proposal[5], as well as very positive evaluations by international expert committees and large support by national and international bodies[6] could the facility however, owing to the large investment cost (> 50 Mio Euro) and follow-up costs for operation and maintenance, not be realized.

Work at CANDLE concentrated hence increasingly on theoretical works concerning projects e.g. at DESY or the Swiss Paul-Scherrer Institute (PSI). Thus in 2010, with support of external consultants, the decision was taken to build in a first step a small laser driven linear accelerator at CANDLE and to open it for experimental usage.

The facility was constructed with support of DESY and the PSI and inaugurated in July 2014. To this end in-kind contributions of DESY and PSI were combined with in-house developments - partially built by local industry - and modern buy-components. Due to the efficient and clever assignment of financial resources, the facility could even be complemented by a two-photon microscope and a micro-fabrication experimental stations.

Design and construction were accompanied by an international advisory committee and met all international standards with respect to technology, safety as well as procurement procedures. After first beam tests the State Committee of Science of Armenia launched a ‘Call for Proposals’ with a reply of 14 requests of which five were elected with participation of external reviewers for the experimental period 2015[7] - and meanwhile conducted. For

[4] http://www.lightsources.org/regions
[5] http://candle.am/design_report/
[6] http://candle.am/candle/
[7] http://candle.am/2015-experimental-program-at-areal-facility/

2016 already 20 experiments are planned[8], whereupon for the first time two groups from Georgia applied successfully for measurement time.

The experiments cover such diverse fields as biology, material and radiation science, as well as detector and accelerator development. They are conducted by groups from various institutes and universities[9], so that the cooperation between academic institutions in Armenia is stimulated and the technological competence of the institutes is strengthened. Especially pleasing is the strong participation of young scientists and students, who work independently and who gain perspectives for education, over regional exchange and long term employment.

AREAL accelerator. During opening ceremony 22 July 2014.

The dynamic and positive development shall be picked-up and the facility shall be extended in the next years. The aim, after increasing the beam energy, is to install a so-called free-electron laser, which works in a particularly interesting frequency range (THz). This will open up new experimental possibilities which will allow Armenian scientists to work at the forefront of research. This requires of course continued funding and a broad support by national institutions, and extended cooperation with international partners.

[8] http://candle.am/experimental-program-at-areal-and-delta-2016/
[9] http://candle.am/areal-applications-in-life-and-materials-sciences/

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Prof. Dr. Vasili Tsakanov studied physics at Rostov-on-Don State University. After a 2 years guest stay at Technische Universität Darmstadt and DESY he headed since 1998 the beam physics division at YerPhI and was from 2002 on technical director, and from 2005 on director, of the CANDLE institute.