Linear electron accelerator LUE-75 of the AANL

In the foreground is the building of LUE-75

Linear electron accelerator LUE-75 of the Department of Experimental Physics of the A.Alikhanyan National Science Laboratory (Yerevan Physics Institute) is the only operating electron accelerator in Armenia in the energy range up to 75 MeV. In neighboring countries, there are currently no charged particle accelerators with energies of this range.

The linear accelerator LUE-75 served as an injector for the Yerevan Synchrotron ARUS (Armenian Accelerator), at one time the largest electron accelerator in the Soviet Union with an energy of 6 GeV, designed and built in 1960-1966 on the initiative and under the leadership of outstanding scientist A.I. Alikhanyan, whose name is associated with the formation and development of the physics of the atomic nucleus, cosmic rays, elementary particles and accelerator physics in Armenia. Famous physicists Yu.F. Orlov, S.K. Esin, E.G. Komar and others participated in the creation of the synchrotron.

The experiments were carried out on the accelerator by prominent Armenian physicists G.M. Gharibyan, G.A. Vardapetyan, G.A. Gurzadyan, A.Ts. Amatuni, R.O. Avakyan, A.R. Mkrtchyan, A.M. Sirunyan and others, who made a significant contribution to physical science. Over the years, many famous scientists from around the world have worked here. Experiments to study the deep structure of matter were carried out at the ARUS accelerator complex. The results of these studies have received worldwide recognition.

In 2008, the operation of the synchrotron was suspended due to economic difficulties. In connection with the increased interest in problems of low-energy nuclear physics, a complex was created on the basis of the linear electron accelerator LUE-75, which includes the linear accelerator itself and the beam transport path with

parallel transfer, located in the synchrotron hall. This linear accelerator complex continued to operate in an autonomous mode to solve urgent problems in the field of low-energy nuclear physics.

Hall of linear accelerator LUE-75

Beam transport path with parallel transfer

It successfully carried out scientific experiments on the study of electro-photonuclear phenomena, the interaction of an electron beam with single crystals, the development of a technique for obtaining ^{99m}Tc radioisotopes for medical diagnostics using an electron accelerator, etc.

Some parameters of LUE-75

Number of accelerating *sections*	*4*
Field frequency, GHz	*2.7973*
Number of RF blocks, klystrons	*3*
RF power per unit, MW	*20*
Repetition rate, Hz	*50*
Beam energy, MeV	*15 –75*
Average beam intensity without collimation, μA	*10*
Bunch duration, ps	*36*
Energy spread at the injector outlet, %	*2*
Pulse duration, μs	*0,5 – 1,0*
Vacuum, Torr	10^{-6}

In recent years, a large amount of renovation scientific and technical work has been carried out aimed at expanding the capabilities of a linear accelerator and increasing its reliability. In particular, thanks to the work on the restoration of an additional accelerating station, the electron energy was brought up to 75 MeV, which made it possible to study photonuclear processes in reactions with a higher energy threshold, announced in the topics of the research groups of Yerevan State University, Department of Experimental Physics of the AANL, BUT (Czech).

Employees of the AANL and Yerevan State University at the control panel of LUE-75

Discussion of the experiment with Czech colleagues

The creation of a transportation path provided a sharp decrease in the level of both the radiation background and the effect of electrical pickups and radio interference on measuring equipment, which is essential when conducting precision scientific experiments in applied and fundamental work. Work was carried out to strengthen the special rotary parallel transfer magnets and tract elements located in the synchrotron hall.

The beam intensity can be varied over a wide range from tens of electrons per second to several μA of the average beam current in the energy range up to 75 MeV.

Also, a technique was developed for obtaining primary electron beams of extremely low intensity 10-20 e–/s (10^{-17} - 10^{-18}) A. Such beams were used in 2015-2019 during joint research with JINR (Dubna,

Russia) on the calibration of the calorimeter prototype for the Mu2e experiment (FNAL, USA). Studies of the matrix of CsI crystals with test beams in the energy range of 15–75 MeV with a step of 5 MeV supplemented the results obtained with the participation of the JINR group in Frascati (Italy) for the range of 80–120 MeV. These works demonstrated the possibilities of the linear accelerator complex to serve also as a bench for calibration of detectors of elementary particles.

Photo for memory with colleagues from Dubna

JINR staff in the hall of the ARUS accelerator

Current work at the accelerator

At present, the accelerator is in working condition and provides electron beams for problems of low energy nuclear physics and scientific and methodological research. The accelerator can also serve for educational purposes. It is planned to modernize the accelerator with the introduction of modern vacuum technology, power electronics and measurement base, as well as replenishment with new qualified specialists, which will improve the parameters of the linear accelerator complex, increase the quality of the beam, and hence the demand for LUE-75 for precision experiments. This will expand the range of topical research problems solved at the accelerator.

The accelerator complex, once a brand of Armenia, has become an almost obligatory place of visit for participants in various international and republican conferences that take place periodically in Armenia. Numerous excursions are often organized for high school students and university students, which helps them in choosing their future specialty. Such events are of great educational and cognitive importance for the formation of a correct understanding of science in general and physics in particular.

9th grade students on a field trip

Schoolchildren from Artsakh on a tour of the accelerator complex

Joint photo at the ARUS synchrotron with colleagues from the European Space Agency, August 2022

See more:

- ✓ http://epd.yerphi.am/History.htm
- ✓ http://epd.yerphi.am/LUE-75.htm
- ✓ https://en.wikipedia.org/wiki/Yerevan_Physics_Institute