EXTENDED SCOPE OF APLICATION OF INDUSTRIAL ELV ACCELERATOR

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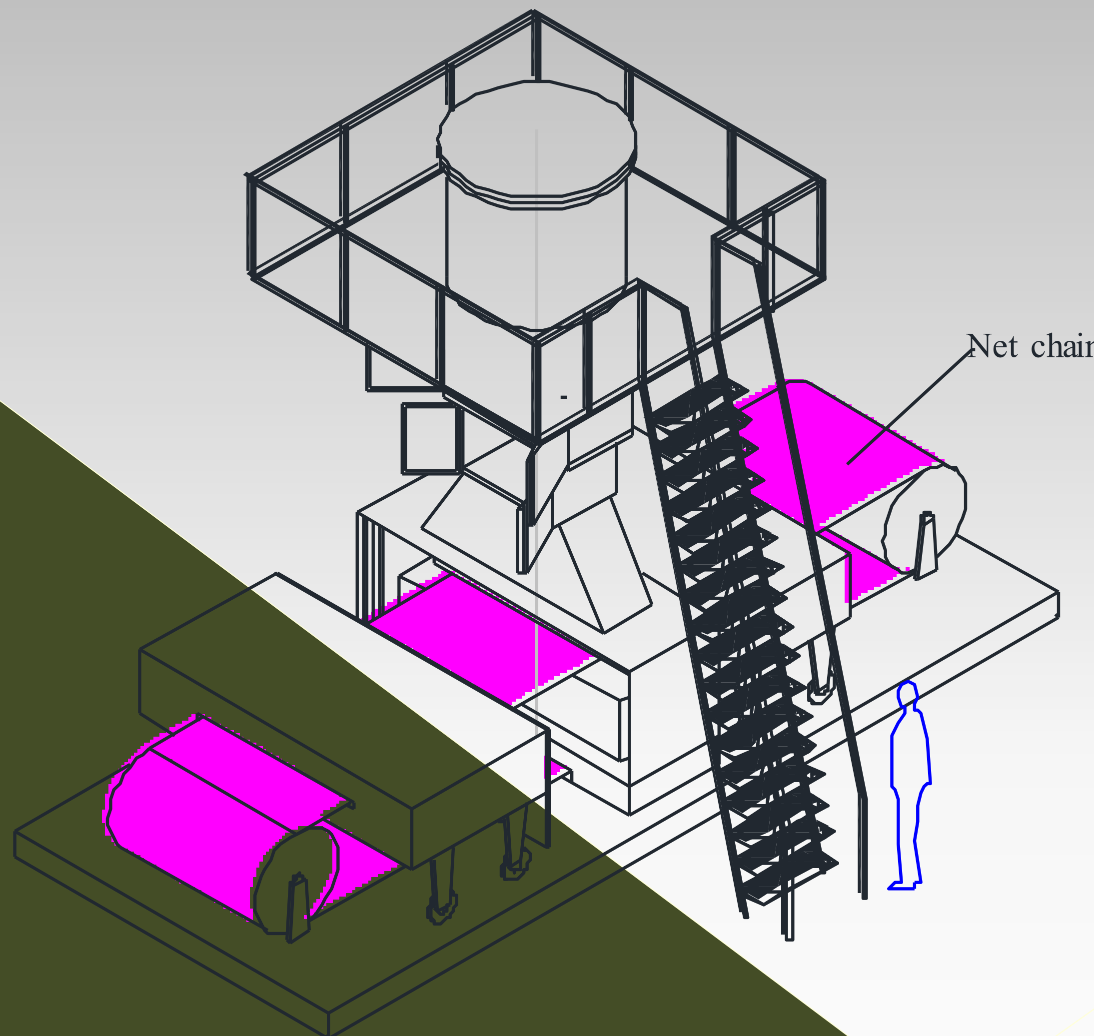
ELV accelerators of Budker Institute of Nuclear Physics of the Siberian Branch of Russian Academy of Sciences are well known in the world. They are operating from Germany in West to Indonesia and Malaysia in East. The ELV accelerators series has the range of accelerated electrons energy from 0.3 to 2.5 MeV, maximum beam power for separate machines from 20 to 100 kW

The special accelerator was designed and manufactured for ecological and research purposes with a beam power 400 kW.

The analysis of demands for accelerators (a market for accelerators) was made in 2011. As a result, the in-demand accelerators are distributed evenly for maximum energy from 1 MeV up to 2.5 MeV. Concerning the beam power – all queries on the boosters had 100 kW beam power. In accordance with the results of the analysis of ELV family was supplemented by accelerators with the maximum current up to 100 mA in the range 0.5-1.0 MeV, with max. current 80 mA in the range of 0.8-1.2 MeV, max. current 67 mA - in the range of 1.0-1.5 MeV. For the range of energy 1.0-2.5 MeV max. current is the same as previous - 50 mA.

Analysis of last years' activity concludes the increasing requests of low-voltage machines (range 0.3-0.7 MeV). In all these settings, it was the wish of the local radiation protection. It should be noted that the increasing interest in low-voltage accelerators is caused by the mobile accelerators, among others. This mobile accelerator was developed together with our South Korea partner EB-TECH Co Ltd.

- The main purpose of this machine is to demonstrate the advantages of electron beam technology for environmental purposes. As a result of the carried out research the Institute offers a series of accelerators in the local protection of overlapping energy range of 0.25-0.7 MeV. The value of the maximum current depends on the design of the extraction devices (length of foil windows, one window, two windows) and can reach up to 150 mA.

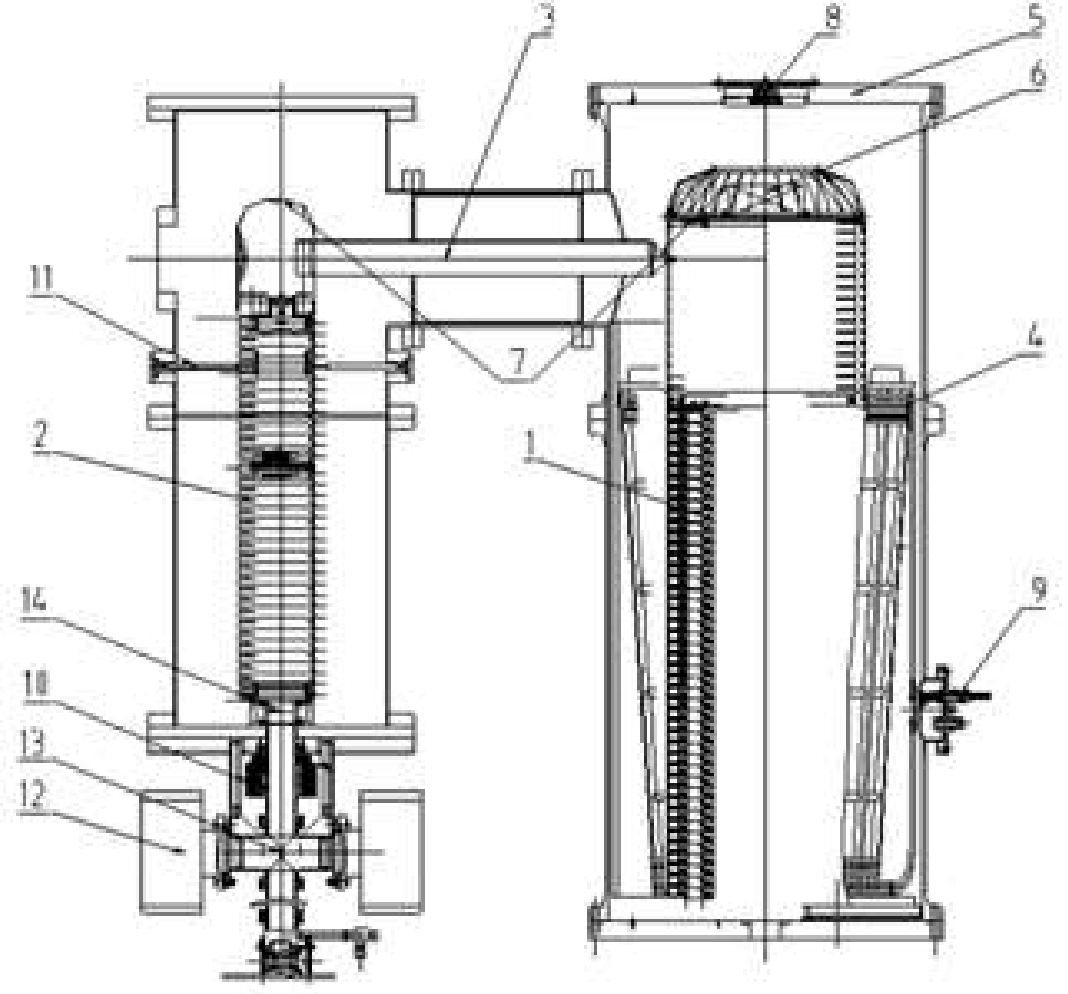


- The accelerator for rubber industry 0.3 MeV*100 mA

- The new concept enables to upgrade old ELV accelerators and accelerators produced by other manufacturers. Picture shows the accelerator which was manufactured by Efremov Electrophysical Institute (Russia) in 1970 and modernized by BINP in 2012. The scanning system of accelerator was upgraded.

Electron-beam tomography imaging method is promising for studying rapid processes such as a multiphase flow, and gives good spatial resolution of one millimeter or better. But in many cases, these flows occur in vessels with thicker walls or interior metal. Therefore, electron beams with a high energy electrons must be sufficiently hard X-rays. Furthermore, this technology is very flexible, i.e. by scanning the electron beam can be adapted to a complex object shapes, and can be expanded to multi-slice and three-dimensional visualization.

Common design of tomography accelerator

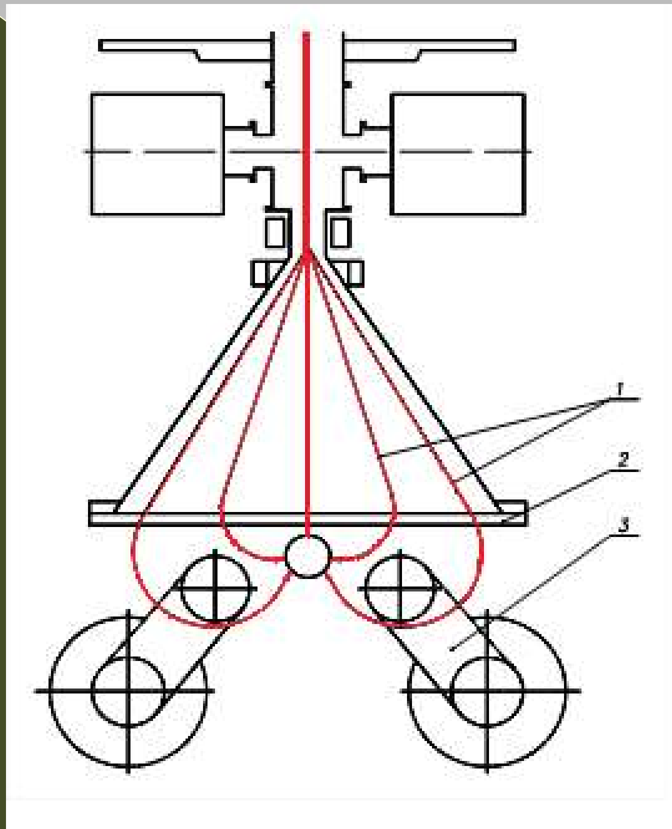


1 - column rectifying sections; 2 - accelerating tube; 3 - gas feeder; 4 - the primary winding; 5 - the case of the pressure vessel; 6 -block injector control; 7, high voltage electrodes; 8 - the optical elements of the beam current control system; 9 entries of the primary winding; 10 - lens; 11 - supports to support tube; 12 - ion pump vacuum system; 13 - docking port of the vacuum system; 14 - bellows for fixing the accelerating tube.

Using ELV accelerators for the industrial tomography tasks associated with the need to fulfill a number of requirements on the parameters of the injected beam such as:

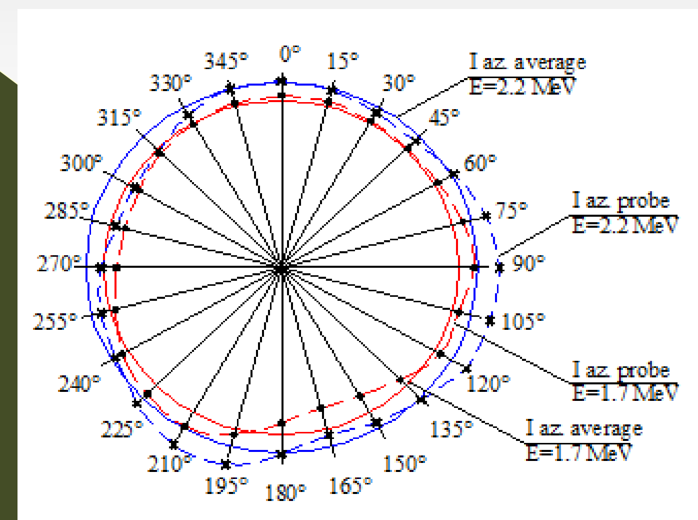
- instability of energy on level E = 1,0 MeV ≤ ± 5%;
- instability of current on the level I= 100 mA ≤ ± 2%.

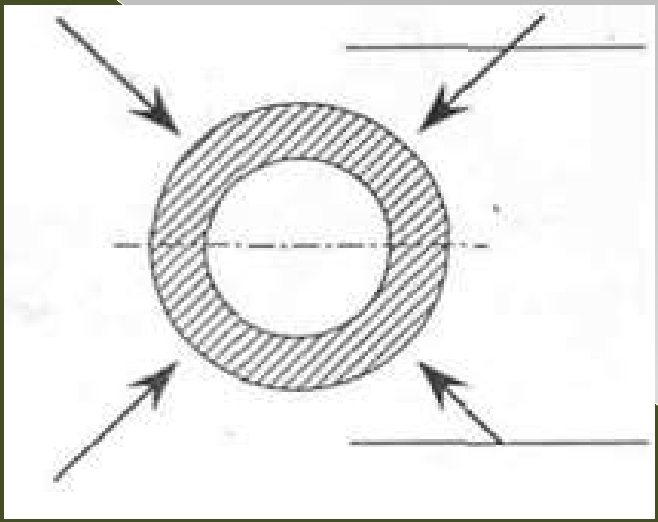
To conform to these requirements and to take to account specific requirements of design, ELV4-based accelerator has been developed. In fact, the parameters of the pulsations of energy and beam current were improved by 2-3 times compared to the standard accelerator ELV4. At the moment the accelerator for tomography has been assembled and passes up tests.



The circular irradiation system is used to irradiate the insulation of large diameter (up to 50 mm) power cables and heat shrinking thin wall pipes. The use of this system allows one to get rid of the shadows produced by metallic wire strands and perform azimuthally uniform irradiation of the insulation in one pass of the cable under the beam. The trajectories are indicated of electrons 1 that pass through the accelerator extraction window 2 and enter the field of electromagnets 3 with pole pieces designed to curve the trajectories of electrons

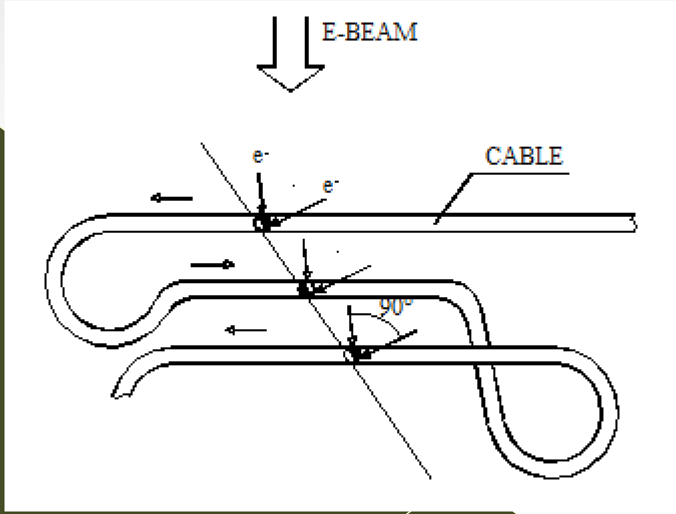
This system ensures that the dose uniformity over the cable azimuth is no worse than 15% at a beam utilization efficiency of 50%. The systems work efficiently at an electron energy in excess of 1.2 MeV.



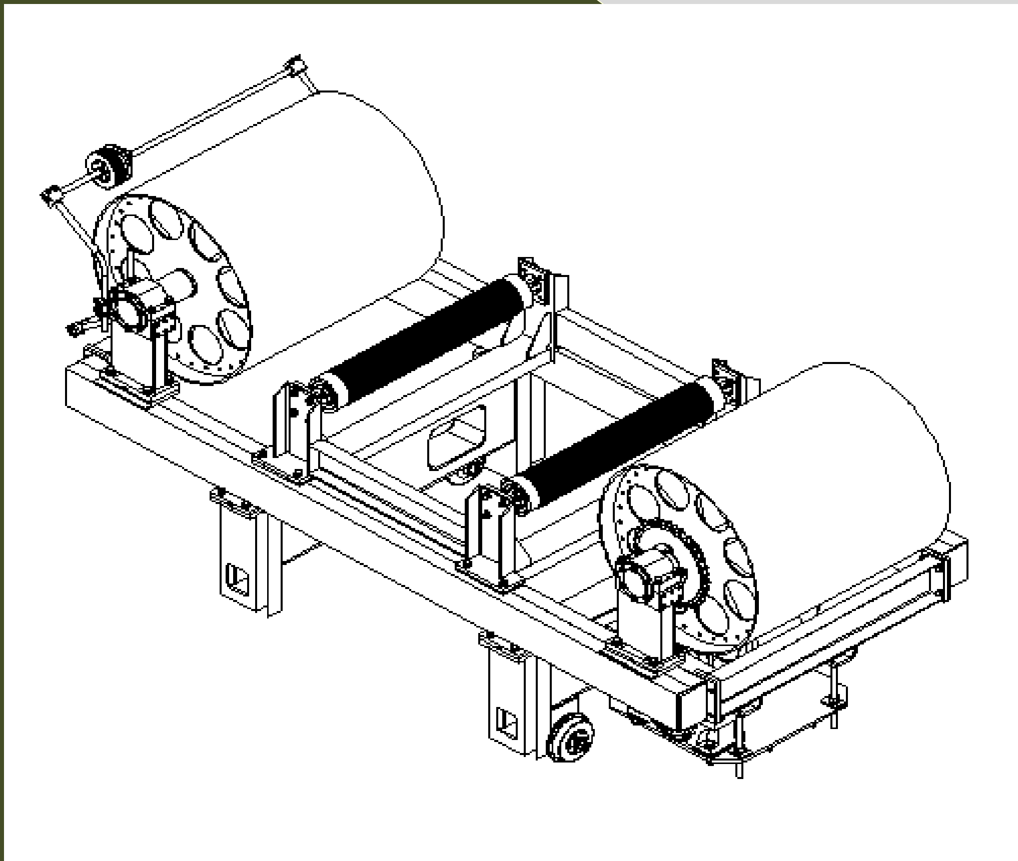


The four-way irradiation system that enhances the uniformity of irradiation of the cable insulation is now used most widely. The cable is laid out under the beam in such a way that the upper and lower surfaces of this cable are swapped over at each turn.

If the beam trajectories intersect at an angle of 90° and the surfaces are swapped as described above, four quadrants of the cable section get irradiated in two passes of this cable under the accelerator extraction window. It is rather important that the cable passes through the irradiation zone several times.



The main requirement imposed on the system conveying the cable through the irradiation zone consists in keeping the conveying speed proportional to the beam current. The proportionality factor (“specific speed”) depends on the irradiated material type and the accelerator parameters. A general service underbeam conveying system (UCS) was developed at the Institute in response to customer requests. The UCS produced by the Institute (Fig. 7) allows one to irradiate films,



cables, or pipes. The system may both be operated in an autonomous regime and controlled by the accelerator (or, conversely, control the accelerator). It has the following basic parameters:

the wire speed 20–250 m/min;

the electric motor power of 18 kW;

the diameter of irradiated cable products:

for rigid cables up to 15 mm;

for flexible cables up to **64** mm;

the irradiation zone width - 800 mm.

UBS can treat the cable 0.35mm diameter

Treatment of cable with 64 mm diameter

- ELV accelerators continuously adapted for use in a variety of processes of radiation in industry and can be used for research into and development of new techniques and materials by electron irradiation.

OUR ATTENTION