# Installation for the investigation of multiparticle nuclear disintegrations

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A hybrid gas–liquid chamber was constructed for the study of multiprong disintegrations of nuclei on pure targets in the proton beam of the synchrocyclotron constructed and started at the Leningrad Institute of Nuclear Physics. The gas target is sensitive to radiation. The chamber is located in a solenoid magnet with a field up to 1.6 T.

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The investigation of the interaction of nucleons and nuclei with nuclei is of considerable scientific interest, since it yields information on the structure of the nucleus and on the nature of nuclear forces. Investigations of this type are of definite scientific and practical interest in connection with the construction of shields for new strong-current accelerators, the development of the study of radiation-enduring materials, for cosmic dosimetry, etc.

Individual channels of such interactions were investigated by the counter method, but the number of channels along which the interaction products are registered is limited by the operating speed of the electronic circuits, and also by the intensities of modern accelerators.

The most complete information on many-particle disintegrations of nuclei is provided by the nuclear emulsion method. It was this method that yielded information on disintegration of the nuclei contained in the emulsion under the influence of fast particles, and on the spectra, composition, and angular correlations of the interaction products.[1] The timeliness of research of this type has stimulated the development of experimental methods that ensure highly complete and accurate information.[2]

A bubble chamber with a gas target sensitive to radiation is intended for the registration of ionizing products of many-particle nuclear disintegrations. This

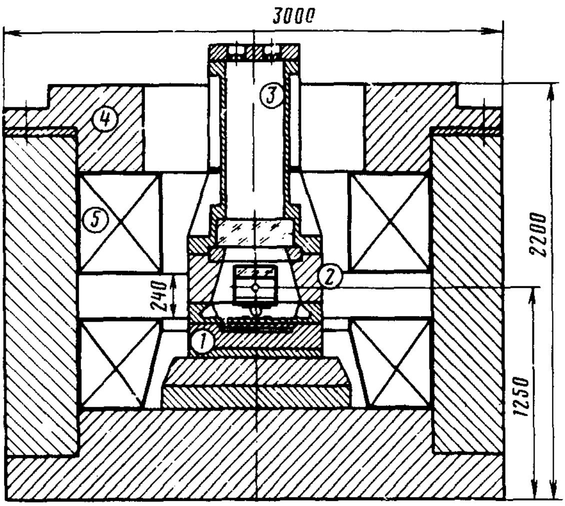



FIG. 1. Hybrid gas-liquid chamber in an MS-12 solenoid magnet: 1—base of chamber with expansion device, 2—Housing of working volume of chamber. This volume contains channels with lamps that illuminate the volume of the bubble chamber. 3—Counterpressure cap, carrying the photography unit on its upper cover, 4—Magnet yoke, 5—magnet coil.

feature of the instrument affords new possibilities for the study of disintegration of nuclei, since it makes it possible to carry out detailed investigations of the product of the interaction with definite target nuclei in a wide range of charges, masses, and energies. In the present experiment, the target used was $^{40}$Ar at a pressure 2.35 atm absolute, and the bubble chamber was filled with a mixture of the freons F13 and F13B1 (molar concentrations 30 and 70%, respectively).

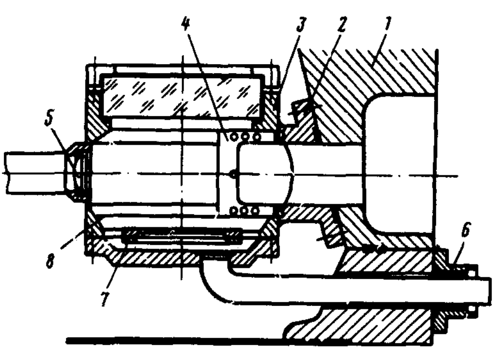
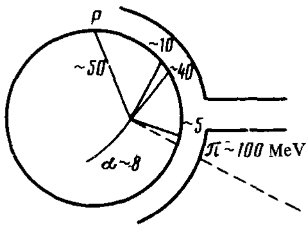



FIG. 2. Diagram of target chamber: 1—body of liquid chamber, 2—flange with gasket, 3—body of gas chamber, 4—frame to secure the lavsan window, 5—lavsan cover of tube, 6—seal of the expansion unit of the gas chamber, 7—diaphragm with rigid disk in the central part, 8—grid with velvet covering.



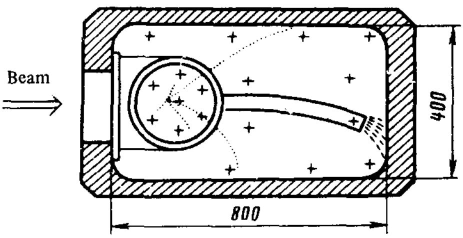




FIG. 3. Placement of the gas target in the volume of the liquid chamber. The top drawing shows the reconstruction of the disintegration of the $^{40}$Ar nucleus after the reduction of the event (the numbers denote the particle energies in MeV).

The chamber consists of three basic parts made of 1Kh18N10T stainless non-magnetic steel (Fig. 1). The first part is the base of the chamber, on which the expansion unit of the bubble chamber is placed. It consists of the expansion volume, covered with a grid on which a diaphragm is placed, and two principal expansion and recompression valves. The housing of the working volume of the bubble chamber is secured on the base. A hole with dimensions equal to those of the Wilson cloud chamber (180× 70 mm) is cut in the housing wall facing the beam. This window, which is covered with a 100 $\mu$ lavsan polyester film, is used to admit the particle beam and to illuminate the interior cavity of the target chamber. The target chamber itself (see Fig. 2) is a cylinder of 228 mm diameter and wall thickness 4 mm. A bulky oval flange is welded to the generatrix of the cylinder and is used to secure the chamber to the body of the bubble chamber. The beam passing through the bubble chamber proceeds then to a tube of 50 mm diameter. The small amount of matter inside the tube makes it possible to weaken by a factor of many times the background of the tracks of the scattered particles in the working liquid. The cavity of the tube is cut off from the volume of the target by a lavsan film. The body of the entire chamber is hermetically sealed and gasketed at an internal pressure up to 30 atmospheres by means of an upper flange, which serves as a frame for a glass plate 150 mm thick. A counterpressure cap is located on the flange and its cover has four windows for the photography and observation of the internal volume of the chamber. Also secured to the cover is a plate with photographic objectives and film-advancing mechanisms. The photography is by Russar-Plasmat T-2c lenses ($F=150$, $2\beta=60°$), which are corrected for minimal aberrations at a scale 0.136. The photography base was 240 mm. The actuating mechanisms of the apparatus and the synchronization of the operation of its units with the high-frequency system of the synchrotron were controlled by an electronic system operating on a prescribed program. It takes into account all the features of the formation and growth of the tracks in the gas and liquid media, the different requirements with respect to illumination of the tracks, etc. The system of magnetic lenses and collimators forms at the input to the chamber a beam of protons with energy 1 GeV and diameter of approximately 1 cm. The number of particles passing through the chamber is monitored by magnetically-shielded scintillation counters connected for coincidence. The signal from the coincidence circuit is fed to a scalar with a printout unit.

The stereophotographs were scanned with reprojecting devices. The selected steroframes were measured with PUOS microscopes with automatic data readouts. The particles were identified by analyzing the lengths and curvatures of their tracks in the gas and liquid of the chamber, the variation of the curvature with the length of the range, and the density of the tracks in the different media.

Figure 3 shows a schematic diagram of the horizontal section of the installation, and a typical reconstruction of the disintegration of the $^{40}Ar$.

The obtained information is presently being reduced.

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