MILESTONES OF HEP DIVISION HISTORY

This compilation is issued on occasion of the 25th Anniversary of the Petersburg Nuclear Physics Institute. It includes short reviews of principal research activities at the High Energy Physics Division of PNPI.

The HEPD history, along with the whole PNPI history, started within the precincts of the Leningrad Physical-Technical Institute long before the official birthday of PNPI. In the middle of 50s, there were two small laboratories at LPTI whose activities were directed towards the experimental research with particle accelerators. Those were the Cyclotron laboratory headed by D.G.Alkhazov and the Roentgen and gamma rays laboratory headed by A.P.Komar. The experimental basis of the laboratories was modest – a small cyclotron for acceleration of heavy ions with the energy up to 3 MeV per nucleon and a 100 MeV electron synchrotron. Around these facilities, there was a group of young physicists eager to work on the problems of nuclear and high energy physics arising at that time. This small community was actively replenished with new members, mostly graduates from the Nuclear Physics Faculty of the Leningrad Polytechnic Institute, also headed by A.P.Komar. Both the leaders and the students were unexperienced in investigations in the nuclear physics field, had poor technical equipment, and, in addition, were isolated from the world community. To some extent, this was compensated by enthusiasm and youth of the community. On the other hand, the conditions turned out to be favourable for development of self-dependency and inventiveness of the young physicists and engineers since it was necessary to invent practically everything – from physical apparatus to power supplies, amplifiers, amplitude analyzers etc. And not only to invent, but to produce everything themselves. At that time, the important collaboration with electronics engineers began. The electronics group led by S.N.Nikolaev was created in the laboratory of A.P.Komar.

The next stage was the decision to organize at Gatchina a branch-institute of the LPTI, specially oriented on nuclear physics, and the decision to construct there a proton synchrocyclotron (SC) with the record for this type of accelerators energy of 1000 MeV. The SC project was worked out at the Efremov Institute with participation of D.G.Alkhazov, D.M.Kaminker, N.K.Abrossimov, and other LPTI engineers. The SC construction started in 1959. At the end of 1967 the trial start of the accelerator took place, and full the exploitation began from April of 1970.

In order to organize the research work at the SC, the High Energy Physics Laboratory was created in 1963 on the basis of the Roentgen and gamma rays laboratory (the first 15 members of this laboratory were officially transferred to HEPL on July 10, 1963). A.P.Komar has become the first leader of HEPL, he directed the laboratory until 1971. The following groups were formed at HEPL: the group of Mesons and mesoatoms (the group leader S.P.Kruglov), the group of Nuclear structure (A.A.Vorobyov), the group of Spectroscopy of deep spallation nuclei (E.Ye.Berlovich), the group of Meso-nuclear reactions (M.V.Stabnikov), and the group of Direct nuclear interactions (B.A.Bochagov). From that time, the preparations for the experiments at the synchrocyclotron began. Various equipment was elaborated: magnetic spectrometers, scintillation hodoscopes, a mass-separator, a hydrogen bubble chamber, a heavy-liquid diffusion chamber, a polarized proton target.

It should be mentioned that the SC proved to be a very useful accelerator, especially for nuclear studies. The 1000 MeV energy of the protons was optimal for the nuclear structure studies (the ideal region for applying the Glauber–Sitenko theory for quantitative description of the nuclear reactions). The small energy spread of the beam (0.3 MeV), the good duty factor

(30%), the high enough intensity (1μA) make this accelerator valuable even in the up-to-date nuclear studies. For example, the program of production and investigation of the nuclei far from the nuclear stability region (IRIS project), which already has given many important results, still has very interesting continuations, especially in the study of neutron-rich nuclei.

The elementary particle physics has the feature of saturation with appearance of new accelerators of higher energy or of higher intensity. Of course, our SC is not an exclusion from this principle. Though, during these years many important results were obtained, especially in the field of the pion-proton and proton-proton interactions. A series of experiments on muon catalyzed nuclear fusion reactions was successfully carried out in the muon channel of the SC. The muon beam is also effectively used for studies of magnetic properties of various materials with the muon spin-rotation method.

The 1000 MeV proton beam also proved to be effective for neuro-surgical operations. The proton therapeutics method worked out at PNPI jointly with CRIRR [1] is being successfully used already for 25 years treating the most complicated brain diseases. About 1000 patients had been treated during this period.

The accelerator utilization efficiency is characterized by the amount of the beam time for experiments. Annually (excluding three last years) this figure was about 6000 hours, while the amount of the requests was always much bigger. Besides the PNPI staff, physicists from many other institutes of our country participated in the SC experiments, as well as scientists from USA, France, Germany, Denmark, Sweden.

From the very beginning of the HEPL activity, we were guided by two main principles: maximum use of our own accelerator and active collaboration with other nuclear centres. Such combination of the "outside" and the "inside" programs proved to be quite effective. Participation in the "outside" program keeps the laboratory constantly at the front line of the fundamental research. On the other hand, the "inside" program, interesting by itself, nourishes the "outside" one. Just in the SC experiments, the qualified specialists were grown up and the experimental methods were developed, which later formed the basis of our participation in the international experiments.

The starting point of the international collaboration was in 1967, when the bilateral collaboration agreement between LPTI and the Niels Bohr Institute (Denmark) was signed and the first joint experiments (α-spectroscopy) were carried out. Then a similar agreement was signed with CERN in 1967. In 1973 an intensive program on nuclear structure studies was started in collaboration with the Saclay laboratory (France). The first joint experiments were accomplished at Gatchina and continued later at Saclay after construction of the SATURN accelerator there.

A decisive step on our way to the world's high energy physics community were WA9 and NA8 experiments carried out at CERN in 1978–1981. These experiments studied small angle scattering of hadrons with the recoil director IKAR worked out at HEPD.

After the successful experiments at CERN, the geography and the scale of our international collaborations permanently widened. At present, HEPD participates in 16 international projects carrying out in the leading world scientific centres: CERN, FNAL (USA), PSI (Switzerland), BNL (USA), DESY (Germany), Darmstadt (Germany), Jülich (Germany), Saclay (France). And as a rule, our participation means a serious contribution both to creation of the experimental setups and to the ideology of the experiments. Sometimes this contribution

[1] Central Research Institute of Roentgenology and Radiology of the Ministry of Public Health

was a decisive one as in the studies of hyperon rare decays at FNAL (E715 and E761 experiments), in the studies of the muon catalyzed nuclear fusion at PSI, or in the studies of exotic nuclei scattering in Darmstadt.

Now we are entering the era of "industrial" physics, when the cost of an experiment at colliders goes to hundreds millions of dollars. Effective participation in such experiments is possible only if one has a powerful technology basis able to produce big amounts of the experimental equipment. Fortunately, such a base has been created at HEPL during the years of its activity, and now we are trying to enforce it further. This enabled us to participate actively in many collider experiments: L3 (CERN), PHENIX (BNL), D0 (FNAL), ATLAS (CERN), CMS (CERN), ALICE (CERN), LHC-B (CERN). Thus the conditions are created for further full-value activity of HEPD.

The High Energy Physics Division nowadays is a mature community of about 500 employees. Among them there are 180 scientific workers (14 doctors and 79 candidates of sciences), 184 engineers.

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