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Summary of Project «CREATION OF INTERACTIVE DATA BANK FOR EXPERIMENTS CARRIED OUT AT BASIC PLANTS OF LHE, JINR» (Project «FIBR»)

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1. General thesis of the project [13]

The existing DB's (data banks) are no other than libraries of published information. Nobody could yet construct a modern base with open interactive access to experimental data in view of large difficulties in creation of detailed description of experimental information and unified data representation. In consequence of most experiments, the only part of information is selected from the remained "row" data and described (processed) in the case of need. Clients of data bank will get a chance to process initial data in accordance with their requirements.

The purpose of this project is the constructing of the bank of experimental data obtained at various physical plants to ensure the access to these data for the physicists both from JINR and from other scientific centers. Within the project, it is planned to create and check out a general format of data from various experiments, to compose base sets of queries for each type of data and to compose an extended set of queries for several types of data simultaneously. The problem consist in that it is necessary to optimize the number of versions of contained data and complexity of data queries. It needs to take into account the queries to DB have to contain a data retrieval as well as some processing of data using intrinsic programs.

The present project is based on the unique experimental data obtained at plants of LHE, JINR, and original methods used by physicists groups for processing these data.

These data are the good basic material both for independent investigation and for checking up on theoretical predictions, simulation of new experiments and applied investigations. The data were used and continue to be used by scientists from all Member States of JINR and also from collaborations GEM, IN2P3, SACLE, COSY a.o.

The realization of the present project does make sure the possibility of direct access to unique data from work places of any re-

moteness. It is necessary for user the only availability of WWW–browser at his computer to work with BANK.

In present time, the realization of such access has grown possible as it has appeared a sufficient technical basis in the form of the computer nets connecting scientific centers, developed basis facilities of information exchange, and also the facilities of data processing for concrete physical experiments have attained the sufficient level of progress.

Later on, it is proposed to use methodical elaborations obtained in result of fulfillment of the project to fill up the bank by data of the experiments, including electronic one. During carrying out of main task of project – creation in interactive data BANK, some other problems will be solved, for example:

— determination of general format for various data types,

— the problem of optimization of access rate, complexity of queries and capacity of information,

— the problem of compact data holding, using new methods of data compression.

2. Physical and methodical basis of the project

2.1. Physical basis and brief description of data given by physical groups to place into BANK

The necessity of constructing such data bank is first at all due to requirements presented by modern theory of particle physics. If there is more or less satisfactory theory (QCD at small distances) in the region of small distances (large momentum transfers), but there is no satisfactory theory in the region of large distances. The principal questions are here concerned with the mechanism of quarks confinement and the mechanism of hadronization. Data inserted into BANK allow one to study just these problems because they contain mainly information about the so-called "soft" processes in nucleon–nucleon, nucleon–nuclei and nuclei–nuclei interactions. They will be necessary, of course, also in the analysis

of high-energy collisions where secondary particles interact also between themselves at large distances. It is necessary especially for taking into account a production of various sorts of resonance effects.

The accumulated data are necessary also in the analysis and designing of experiments of nuclei–nuclei scattering to select collective effects from effects of nucleon–nucleon interactions. It is hard here to overrate their significance, because no model calculations can substitute the experimental data.

Evidently, original data concerning total nuclei destruction, deuteron–nuclei interaction at low energies ($\approx$ 1 GeV/nucleon), spectra of secondary pion and neutrons will be useful for applied investigations.

The data obtained in exposures of bubble and streamer chambers of LHE, JINR have no analogies in the word due to the conditions of obtaining (4π–geometry; energies from 1 to 40 GeV; neutron, deuteron and nuclei beams). The physical groups have an experimental information of 27 types of data containing approximately 5,500,000 processed tracks.

- Neutron–proton interactions at energies 0.6–5 GeV obtained in an exposure of 1m hydrogen bubble chamber of LHE, JINR by the monochromatic beams. [1–3]

  The present information has a number of principally important qualities:
  — high accuracy of measurements of particle parameters;
  — 4π–geometry;
  — selected exclusive channels of reactions;
  — absence of combinatorial background;
  — large statistics of data and possibility of its increasing;
  — possibility of using the data for an analysis of nuclear interactions by realistic simulation of experiments that employ nuclear beams and targets.

- Nuclei–proton experiments using 1m Hydrogen bubble chamber of LHE, JINR. [12]

  For 30 years there was accumulated experimental information obtained in the beams of nuclei of deuterium, ^3He, ^4He, oxygen and in the beam of vectorially–polarized deuterons. The results are unique due to obtaining on the pure proton target in condition of 4π–geometry.

- Experiments using 2m propane bubble chamber of LHE, JINR.[5–8]

  A large number of experiments were carried out using propane bubble chamber of LHE, JINR irradiated by beams of particles at various energies (in some experiments a solid target was placed into the chamber). An experimental information concerning the interactions of π–measons, protons and nuclei of deuterons, ^3He, ^4He, and ^{12}C with the nuclei of hydrogen, carbon and tantalum was obtained under condition of 4π–geometry and particles identification within wide range of momenta.

- Experiments registering γ–quanta in propane bubble chamber of LHE, JINR. [4]

  The information is obtained in the exposure of 2m propane bubble chamber by deuterons at the momentum of 1.25 GeV per nucleon. The characteristics of propane bubble chamber have allowed one to determine with a good accuracy the momentum of γ–quantum, escape angles of secondary particles, and to register all charged particles practically without losses due to 4π–geometry.

- Experiments using the streamer chamber GIBS of LHE, JINR. [9–11]

  The qualitative advantage of the data obtained by means of streamer chamber is a possibility of investigating characteris-

tics of all charged particles produced in charge exchange reactions. These data give a chance to select necessary channels of reaction and essentially make easier the choice of possible theoretical description of process $^3H \to {}^3He$.

A peculiarity of information concerning central interactions is that the only negative pions and V^0–particles were measured. The presence of a trigger at the streamer chamber has allowed one to realize such strict criterion of centralicity to which there corresponded only little (approx. 10^{-4}) part of inelastic nuclei–nuclei interactions.

- Experiments at "Ludmila" plant

  During approximately 20 years it was carried out a large number of experiments at 2m hydrogen bubble chamber (HBC) "Ludmila" of JINR in $\bar{p}, D, \bar{D}$–beams. The results are unique since they are obtained by means of pure proton target under condition of 4π–geometry. The technical innovation was placing into the chamber of the internal track-sensitive target, constructed specially to study the DD and $\bar{D}D$ reactions. In some experiments, the solid target (Pb) has been placed into the chamber.

2.2. Methodical basis of the project

Creation of modern data bases with open external automatized access is the task put forward to specialists in various branches of knowledge. The modern data base must not simply give a part of contents of "data storehouse" but carry out some analysis of it. And besides, a process of query composition has to be simple and convenient.

The tendency to unify modes of queries to world data bases (SQL — the language supported and understood by overwhelming majority of DBMS is pretending to be the united language of queries) gives a confidence that users of project will compose queries in the form usual for them.

of query set of 1 level and a part of queries of 2 level, defining of tables for allocation into DMB and access limiters.

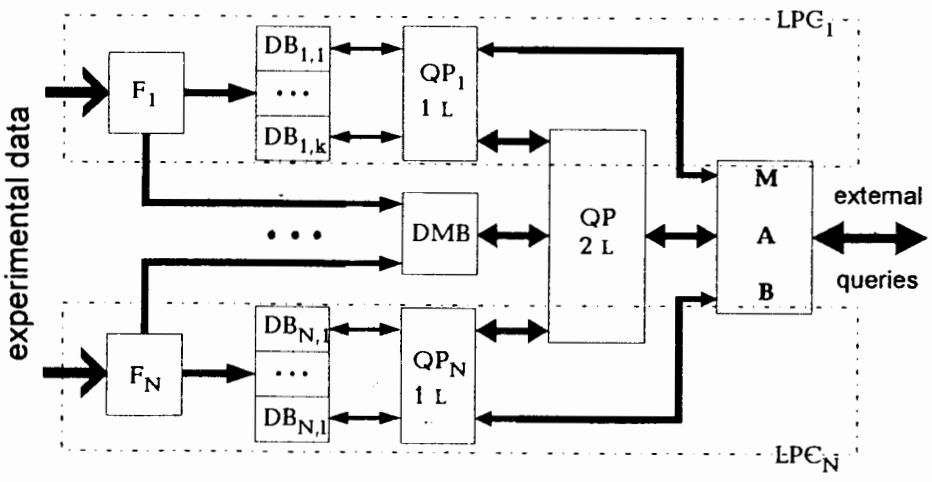

Fig.1. Logical structure of PLANT

- F_i formalizates i type of data;
- $DB_{i,j}$ contains data group selected by unique attribute;
- QP_i 1 L contains and executes basic query set for $DB_{i,j}$;
- DMB contains specifications and tables that are asserted in the block simultaneously with entering data into DB;
- QP 2 L process queries to more than one DB_i distributing them and integrated answers;
- LPC_i — logical chain of processing
- MAB — management and external access block

3.3. Technical structure and parameters of PLANT

Constructively, PLANT consists of server ALPHA-2000/5/250 with two auxiliary PC (server complex), where DBMS (ORACLE-7) is set and BANK is actually placed, and some PC-clients (client complex), where formalization of concrete data is fulfilled and basis query sets for DB are composed. All computers

of plant are integrated in local areas network with one entry into external network.

OS WINDOWS-NT is chosen as operating system.

ORACLE-7 is chosen as DBMS for server.

Both BANK and systems of access to it for external users must be disposed in server complex. For this purpose, it is necessary to realize WWW-server and Proxy-server and to integrate all components into united system.

The necessity of PC-clients is due to that the data of physical groups are placed in various storage media, including magnetic tapes of ES format and their remaking requires to complete PC by various peripheral equipment and to employ an exploited software written mainly in DOS FORTRAN. Composition of SQL-queries and final data formatting will be fulfilled by means of software based on WINDOWS. It is possible to satisfy these various requirements to hard- and software using PC-clients. PC, which is necessary to maintain documentation and to fulfil management functions, has a specific set of peripherals.

4. Experimental set-up

To begin the processing of physical data and the forming of BANK, it is necessary to assemble PLANT in a minimum working configuration, including:

— server + 2 PC (server group);

— PC-clients with assembled peripherals and software;

— network equipment.

The following enhancement of PLANT is fulfilled together with accumulation of data in BANK and growth of number of users.

At present, the experimental data are stored in various media which makes inconveniences for data processing and does not guarantee against data losses on failure of media or spoiling of readers. Therefore the first stage of data preparation in working group will be a collection of data from various media and data allocation in CD in convenient format.

At the same time, each working group will analyze experimental data to determine the next:

* number of sorts for data that must be prepared to store into DB;
* restriction tables and descriptions that are necessary for users;
* structure of basis set of SQL-queries;
* data format, co-ordinated with other working groups.

As soon as working groups will determine the number of data sorts, co-ordinate data format and process preliminary ≈30% of available data, the filling of DB and forming and check out of SQL–queries will begin. DB's will fill up and basis set of SQL–queries will expand while increasing the quantity of processed data.

With accumulation of sufficient set of 1-level queries, the forming of 2-level queries will begin for each DB_i.

After filling (partial) of DB, one can debug the method of access to DB by means of WWW–interface, that is the pioneer work in the field of physical data bases. On this stage it is necessary to get the co-ordination of hard– and software capabilities to guarantee the stable operation of system taking into account the further filling of BANK.

In the division of BANK documentation (DBD), it is necessary to contain both data description and accompanying information: description of experiments and plants, results already obtained at these plants (or references to papers allocated in another DB's). This division also has to guarantee copyrights of experimenters by means of contacts with users and to ensure agreements with them. For successful beginning of BANK function, it is necessary that DBD division would be ready by a moment of opening of access for first users.

The maintenance of BANK consists of:

— filling up of DB;
— creation of new bases and update of available one in case of need;
— filling up and update of SQL–query sets;
— control of access;

— support of contacts with users;
— realization of non-standard queries according to direct agreements with users;
— modernization of hard– and software.

The maintenance of BANK is considered to begin since the moment of opening of data access for outside users and to last during the whole period of PLANT function. Preparation for maintenance begins since the beginning of project and consists of the training of personnel that will support the maintenance. With this purpose it is planned to attract specialists from the working group of project.

5. Tables of experimental data

Neutron–proton interactions at energies 0.6–5 GeV obtained in an exposure of 1m Hydrogen bubble chamber of LHE, JINR by the monochromatic beams

Reactions	Number of events at beam momenta (GeV/c)		
	3.85	4.42	5.2
$np \to pp\pi^+\pi^-\pi^-$	509	1183	12631
$np \to pp\pi^+\pi^-\pi^-\pi^0$	103	445	6933
$np \to np\pi^+\pi^+\pi^-\pi^-$	144	713	10215
no fit	206	694	9149
Total	962	3035	38928

Reactions	Number of events at beam momenta (GeV/c)						
	1.25	1.32	1.43	1.72	2.21	3.84	5.2
$np \to pp\pi^-$	3229	5460	4211	4196	5093	1819	8107
$np \to pp\pi^-\pi^0$	—	—	4	141	1161	1369	9369
$np \to np\pi^+\pi^-$	—	—	24	687	6595	6018	35585
no fit	499	1119	778	1290	2523	3472	29809
Total	3728	6579	5017	6314	15372	12678	82870

Nuclei–proton experiments using 1m Hydrogen bubble chamber of LHE, JINR

Interactions	Beam momenta, A GeV/c	Number of events
^{3}He$\rightarrow p$	4.5	40000
^{4}He$\rightarrow p$	2.15	40000
^{4}He$\rightarrow p$	3.4	40000
^{16}O$\rightarrow p$	3.1	20000
$D \rightarrow p$	1.67	200000
Total		214000

Experiments registering γ–quanta in propane bubble chamber of LHE, JINR

Reactions	Beam momenta, A GeV/c	Number of events
$np \rightarrow np\pi^-(p_s)$	1.25	30000
$np \rightarrow nn\pi^-(p_s)$	1.25	30000
$np \rightarrow pn\pi^-(n_s)$	1.25	30000
$np \rightarrow pp\pi^0(n_s)$	1.25	30000
Total		12000

$(p_s), (n_s)$ — nucleon–spectator

Experiments at "Ludmila" plant

Interactions and kinds of DST	Beam momenta, A GeV/c	Number of events
$\bar{p}p$ — inclusive	22.4	78000
$\bar{p}p$ — V^0 and γ-quanta	22.4	8000
$\bar{p}p$ — exclusive	22.4	20000
DD — inclusive	12	27000
$\bar{D}D$ — inclusive	12	10000
$\bar{D}Pb$ — V^0 γ-quanta	12	2100
Total		145100

Experiments using 2m propane bubble chamber of LHE, JINR

Interactions	Beam momenta, GeV/c per nucleon	Number of events
$\pi^- \rightarrow C_3H_8$	40.0	33800
$p \rightarrow C_3H_8$	9.9	14209
$p \rightarrow C_3H_8$	4.2	14043
$d \rightarrow C_3H_8$	4.2	11372
$C \rightarrow C_3H_8$	4.2	37952
$^4He \rightarrow C_3H_8$	4.2	19363
$^4He \rightarrow C_3H_8$	5.1	994
$p \rightarrow Ta$	9.9	2363
$p \rightarrow Ta$	4.2	1517
$p \rightarrow Ta$	5.4	774
$d \rightarrow Ta$	4.2	1424
$C \rightarrow Ta$	4.2	2469
$^4He \rightarrow Ta$	4.2	1532
$^3He \rightarrow Ta$	4.2	775
Total		142587

Experiments using the streamer chamber GIBS of LHE, JINR

Reactions	Beam momenta, A GeV/c	Number of events
$^{12}C + Cu \rightarrow X$	4.5	1203
$^{16}O + Pb \rightarrow X$	4.5	732
$^{24}Mg + ^{24}Mg \rightarrow X$	4.5	4380
$^3He + Mg \rightarrow He + X$	3	2000
$^3He + C \rightarrow He + X$	2	1000
Total		19315

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Index	Title
E3-94-419	Proceedings of the II International Seminar on Neutron-Nucleus Interactions (ISINN-2) «Neutron Spectroscopy, Nuclear Structure, Related Topics». Dubna, 1994 (363 p. in English)
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D3,14-95-323	VII School on Neutron Physics. Lectures. Vol.1. Dubna, 1995 (356 p. in Russian and English)
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Аникина М.Х. и др. Д1-96-418

Краткое описание проекта «Создание интерактивного банка данных экспериментов, проведенных в ЛВЭ ОИЯИ» (Проект «ФИБР» — физический интерактивный банк реакций)

Предлагается проект создания интерактивного банка данных, полученных в течение 30 лет на установках ЛВЭ ОИЯИ с использованием камерных методик. Эти данные являются хорошим материалом как для самостоятельного изучения, так и для проверки теоретических предположений, моделирования новых экспериментов и практического применения.

Построение банка данных согласно предлагаемому проекту позволяет сохранить уникальные, зачастую не имеющие аналогов в мире данные по нуклон-нуклонным, нуклон-ядерным и ядро-ядерным взаимодействиям при энергиях от 1 до 40 ГэВ, полученные в условиях 4π-геометрии, и обеспечивает физикам из различных научных центров прямой и удобный доступ к этим данным по сети INTERNET с использованием WWW-интерфейса.

Работа выполнена в Лаборатории высоких энергий ОИЯИ.

Сообщение Объединенного института ядерных исследований. Дубна, 1996

Anikina M.Kh. et al. D1-96-418

Summary of Project «Creation of Interactive Data Bank for Experiments Carried out at Basic Plants of LHE, JINR» (Project «FIBR»)

The project is proposed for creation of interactive data bank obtained for 30 years on LHE JINR plants using chamber methods. These data are the good basic material both for independent investigation and for checking up of theoretical predictions, simulation of new experiments and applied investigation.

The creation of data bank in accordance with proposed project allows one to keep unique, often having no world analogies, data on nucleon-nucleon, nucleon-nuclei and nuclei-nuclei interactions at energies from 1 to 40 GeV, obtained under 4π-geometry condition, and ensures for physicists from various scientific centres the direct and comfortable access to these data by INTERNET using WWW-interface.

The investigation has been performed at the Laboratory of High Energies, JINR.

Communication of the Joint Institute for Nuclear Research. Dubna, 1996