EXPERIMENTAL PARTICLE PHYSICS

Preamble

The role of the JINR Road Map in particle physics is to:

- ensure scientific excellence of JINR;
- maximize the scientific output and value for money from past and current investments;
- support and develop existing facilities and infrastructure, wherever it is scientifically productive and cost effective;

Particle physics is one of four major research direction of JINR. Particle physics program is carried out in four JINR laboratories: VBLHEP, DLNP, BLTP and LIT. The research is performed in the following main directions:

- **physics of new states of nuclear matter;**
- **nucleon structure and its spin origin;**
- **non-perturbative QCD;**
- **physics of rare processes and tests of fundamental symmetries;**
- **Standard Model and beyond physics at hadron and lepton colliders;**
- **neutrino physics.**

The research is carried out in JINR and its member states as well as in large world particle physics centers.

Research at JINR and JINR member state facilities

JINR Nuclotron-M and NICA/MPD.

The NICA/MPD is the new flagship JINR project in the field of relativistic nuclear physics. The main goal of this project is the experimental study of hot and dense strongly interacting QCD matter at the new Nuclotron based Ion Collider fAcility (NICA). This goal is proposed to be reached by:

1. development of the existing accelerator facility (1^{st} stage of the NICA/MPD accelerator program: Nuclotron-M subproject) as a basis for generation of intense beams over atomic mass range from protons to uranium and light polarized ions with the energy up to 6 Gev/n;
2. design and construction of heavy ion collider with maximum collision energy of $\sqrt{s_{NN}} = 9$ GeV and averaged luminosity 10^{27} $cm^{-2}\cdot s^{-1}$ (for U^{92+}) ;
3. design and construction of the Multipurpose Detector (MPD) and the detector for the 2^{nd} interaction point oriented on the spin physics problems.

The new JINR facility will allow to study in-medium properties of hadrons and nuclear matter equation of state, including a search for possible signatures of de-confinement and/or chiral symmetry restoration, phase transitions, mixed phase and QCD critical endpoint in the region of the collider energy $\sqrt{s_{NN}} = 3 - 9$ GeV. The project design presumes the continuation of some of the fixed target experiments. Especially important are the experiments with polarized deuteron and proton beams and polarized targets providing valuable information on the spin effects in few-nucleon systems and on the structure of nuclei at short distances.

These experiments give also information which expands the world nucleon-nucleon data base to multi-GeV region. With an upgraded Nuclotron-M and the collider creation JINR becomes one of the leading world centers in the field of relativistic nuclear physics and non-perturbative QCD.

U-70 IHEP Protvino. JINR physicists participate in two experiments at U70 accelerator – OKA and TERMALIZATION. The experiment OKA is focused on investigations of the properties of charged kaons (particularly, direct CP-violation, T-violation and anomalous interactions) using the separated kaon beam. The experiment TERMALIZATION is focused on the investigation of high multiplicity events (in particular, to search for multiboson phenomena) in hadron-hadron and hadron-nucleus collisions. It has been proposed by JINR physicists and its first stage is being carried out.

The results obtained with JINR participation in E391a experiment at KEK on the decay of a neutral kaon to a pion and neutrino-antineutrino pair allowed one to consider the continuation of this research at a higher level of precision giving access to a new physics. As a result of this feasibility study the project KLOD has been prepared which anticipates measurements at U-70 accelerator of IHEP. The project is competitive provided the detector and data taking parameters will be achieved. Otherwise, similar project with JINR participation could be realized at JPARC facility in Japan. The future strategy depends on possible agreement between members of KLOD collaboration on the time lines and resources of this project.

Research and Development. Experimental particle physics, by its nature, requires the application of the latest technologies to particle detectors and their electronic interfaces. A sustained and strategically directed program of R&D is essential in order to achieve the demanding performances required. Significant parameters are speed, granularity, and energy resolution and radiation hardness. It is essential to be able to support a program of R&D as well as to be able to respond rapidly to requests to support small experimental undertakings and minor experiment upgrades.

It is desirable to carry out a long-term R&D aimed toward future high-energy accelerators within our program. It is also important to continue the development of particle detectors. In particular ILC and super-LHC related R&D is required. These investments are crucial to the long-range future of our field.

Current R&D activity at JINR is concentrated on the topics important for the realization of the 1st stage of the NICA/MPD project (Nuclotron-M subproject), creation of the MultiPurpose Detector MPD and the heavy ion collider. Particularly, the design of the MPD calorimeter is based on the technique of scintillating calorimeters with Multipixel Avalanche Photo-Diodes – novel photo-detector developed at JINR in the framework of innovation activities.

While research on accelerators and detectors is critical to progress in the field, it also has broader benefits for society. Medical technology routinely uses particles and particle detectors to see inside patients and diagnose their ailments. Particle beams themselves can effectively treat certain types of cancer.

Computing. A well developed, corresponding to the nowadays requirements, telecommunication, networking, and computing infrastructure of the Institute is a sine qua non condition for the successful international collaboration of JINR, especially in the field of high-energy particle physics and relativistic nuclear physics.

Even after the huge data reduction achieved by the hierarchical data filtering of the multi-level event triggers, the LHC experiments will produce many Petabytes of data per year. This is a direct result of the high interaction rate, the complexity of the interactions to be studied and the requirement for high precision measurements of particles produced in the interactions. Extraction of physics from the LHC will have to be a truly global activity. The data analysis will require massive distributed CPU power with huge data storage facilities networked together through high bandwidth links, as well as new mathematical methods for extracting insightful information from the experimental data. Close collaboration with CERN, European and US GRID programs are central, both to avoid duplication and to speed dissemination of new ideas. The need for further investment in hardware, up to and beyond the start of the LHC should therefore be anticipated in this area. The home made implementations of open software, together with their quality assessment through specific validation procedures, are cornerstones of an activity devoted to the minimization of the financial effort. This is particularly important for successful participation of JINR in future large scale projects at FAIR complex, Super-LHC, International Linear Collider (ILC), etc.

Current JINR participation in world particle physics centers

JINR particle physics program is carried out in the largest world particle centers: BNL, CERN, DESY, GSI, Fermilab, Gran Sasso, KEK, IHEP Beijing.

Running Experiments

FERMILAB. The Tevatron proton-antiproton 2 TeV collider at FNAL is presently at the energy frontier in a number of key studies, including the search for a relatively light Higgs and searches for physics beyond the Standard Model. JINR physicists participate in the experiments CDF and D0 and, particularly, play a leading role in the top quark mass measurement. These experiments extend the mass range over which predictions from theories such as Standard Model or supersymmetry can be explored, up until the LHC at 14 TeV takes over the energy.

BNL. Physics of heavy ion interactions is dominated by experiments at RHIC collider in BNL. The collisions of gold ions at the Brookhaven accelerator are producing a new extremely dense form of matter, quite possibly the postulated quark-gluon plasma, which existed a few microseconds after the Big Bang. This matter possesses unexpectedly high collective flows and thus appears to be rather a liquid with an extremely low viscosity than a gas of free quarks and gluons. There are a lot of other spectacular results, particularly coming from the collisions of unique beams of high energy polarized protons. JINR physicists are involved in Phenix and STAR experiments. To remain competitive with future LHC experiments, the RHIC luminosity upgrade is foreseen in near future. There are also plans to build up the electron-nucleus collider eRHIC.

CERN. After LEP shutdown in 2000, only very restricted number of experiments is running at the PS and SPS accelerator. JINR physicists play very strong role in all major four experiments: COMPASS, DIRAC, NA61 and NA62. Particularly, the idea of pionium lifetime measurement in DIRAC experiment comes from JINR. The best world measurement of direct CP violation in K^0 decays has been performed in NA48/1 and NA48/2 experiments at CERN. Currently the experiment NA62 aims to set the best possible limit on a similar effect with charged kaons and will measure very rare kaon decays. The COMPASS is one of the major CERN experiments at SPS for the period of time between the end of LEP and the start-up of LHC. Participation of JINR in COMPASS experiment is a continuation of a long and traditional interest of Dubna particle physicists to nucleon spin physics. To complete the picture of the nucleon spin structure, there are plans to study Drell-Yan processes and deeply virtual Compton scattering. The purpose of NA61 experiment is the study of hadron production in hadron-nucleus and nucleus-nucleus collisions at the CERN SPS. This project together with HADES (GSI) and planned by STAR in 2010 energy scan run at RHIC are the first experiments aimed on the study of in-medium properties of hadrons and nuclear matter equation of state, including a search for possible signatures of de-confinement and/or chiral symmetry restoration phase transitions, mixed phase and QCD critical endpoint.

Gran Sasso. Over the last decade the remarkable success of the Standard Model in explaining experimental results, despite its theoretical deficiencies, has brought to the fore the desire for well-founded experimental evidence for Beyond the Standard Model phenomena. Observation of neutrino oscillations requires neutrinos to have mass and implies lepton flavor non-conservation. Neither of these effects is included in the Standard Model as presently formulated. JINR particle physicists play an active role in Sun neutrino experiment Borexino and accelerator CNGS Opera experiment. In JINR, there is planned the systematic investigation of neutrino-nucleon interactions, required to perform high accuracy analysis of the data.

In-Build Experiments

CERN. The future of particle physics is dominated by the LHC at CERN. Experiments at this machine will be able to access the energy above the characteristic electro-weak symmetry breaking scale of 246 GeV that sets the mass scale of all the known fundamental particles. JINR physicists participate in the general purpose experiments, ATLAS and CMS, which are designed to make excellent measurements of the many possible (known and unknown) products of collisions at the unprecedented centre-of-mass energy of 14 TeV. Thus the experiments should be able to solve the problem of mass through the discovery either of the Higgs particle (or particles) or of whatever other mechanism might be responsible for breaking the symmetries involved in mass generation. Physics program of LHC experiments is, however, much more complex and it contains precision physics of CP violation, SUSY particles searches, extra dimensions and unexpected new phenomena. The searches for new physics will be supported by extensive analytic calculations and numerical simulations performed in JINR, with a special emphasis on angular asymmetries. Commitments to ATLAS and CMS dominate the current JINR particle physics budget with installation of the experiments and the start of data taking expected in 2008.

The LHC also provides a unique opportunity by the collision of heavy ions at unprecedented energy densities, allowing the LHC experiments to investigate the properties of a new phase of matter, the quark-gluon plasma, which may have already been glimpsed by CERN and RHIC experiments. Besides ATLAS and CMS, JINR physicists participate in ALICE experiment dedicated to a detailed study of the new collective phenomena.

IHEP Beijing. In 2008 the new BEPC-2 e+e- collider with the detector BES-3 will start operation at Beijing. The JINR group in this experiment is planning to conduct the research on charm-quark spectroscopy and tau-lepton physics. It is important that several physics topics in the program of this experiment were initiated by JINR physicists and this experiment will connect past experience gained at LEP with future physics at ILC for which accelerator and detector R&D is going on at JINR.

Future projects

FAIR complex. The proposed project FAIR (Facility for Antiproton and Ion Research) is an international accelerator facility of the next generation. It builds on the experience and technological developments already made at the existing GSI facility. The existing GSI accelerators serve as injector for the new facility. The double-ring synchrotron will provide ion beams of unprecedented intensities as well as of considerably increased energy. Thereby intense beams of secondary beams - unstable nuclei or antiprotons - can be produced. Moreover, in connection with the double ring synchrotron, an efficient parallel operation of up to four scientific programs can be realized at a time. The substantial participation of JINR in both accelerator and detector (CBM and PANDA) activities at FAIR is determined to a large extent by the financial support from Germany within its associated membership in JINR as well as by the planned large scale financial participation of Russia in this project. Based on the technological achievements in the production of fast cycling superconducting magnets of the Nuclotron type, the prototypes of the SIS 100 magnets are at present under construction at JINR. The JINR team also participates in the solution of the problems of beam heating and cooling at the internal target. The main JINR activity within the CBM (heavy ion collisions) collaboration is the production of the transition radiation detectors and the construction of the superconducting dipole magnet. The JINR efforts within the PANDA (non-perturbative QCD) collaboration are concentrated on the production of the magnet yoke, the quartz radiators and the full muon detector system.

Super-LHC. It is expected that the mechanism which leads to the fundamental particle masses will be resolved by the beginning of the next decade. However, to study rare decay modes of the Higgs, measure couplings to ≤10% precision or to make a first attempt to access the Higgs self-couplings requires the additional statistics achievable at the Super-LHC. In addition, the LHC could access Supersymmetry, which if established provides a quantitatively consistent account of the Dark Matter densities required by astrophysical measurements. Here, the increased luminosity of a Super-LHC can extend the mass reach by as much as a further 500 GeV. Many ideas involving TeV scale quantum gravity phenomena in the context of `large' extra dimensions also predict spectacular signatures which could be seen at the LHC but may require the additional energy reach achieved with the higher luminosity of the Super-LHC. R&D for the Super-LHC upgrade has already started.

International Linear Collider (ILC). While the LHC/Super-LHC, due to the inherent broad range of constituent quark/gluon collision energy scales, is perfect to search for new particles with masses up to the TeV scale, the precise measurements needed for a detailed understanding of new phenomena will require an accelerator with a known, adjustable, centre-of-mass energy. This can be achieved with an electron-positron collider, which is complementary in its physics reach to a proton collider (which still retains advantages in mass reach for certain channels). The international particle physics community is agreed that the ability of an electron-positron collider to select precisely the energy of the interaction at the fundamental fermion level and also to provide polarized beams, is required both to complement the LHC program and to extend very significantly the window of opportunity for high precision measurements and additional new discoveries. Work has been proceeding world-wide for many years into the design of a linear electron-positron collider. JINR actively participates in both accelerator and detector activities within the ILC project. Particularly, Dubna is officially considered as one of the possible ILC hosting place. In past JINR physicists and engineers contributed essentially to the detectors construction and data analysis of e+e- collisions at LEP in CERN. The natural continuation of this effort is an involvement in the R&D for detectors and preparation of the ILC physics program.

Future Neutrino Experiments. In the neutrino sector measurements are now available for the solar and atmospheric mixing parameters (the two mass differences squared and the two large mixing angles θ_{12} and θ_{23}) as well as for the sign of the solar mass difference squared. Consequently the focus of attention moves to measuring $\sin^2\theta_{13}$. The most advanced projects for that are Daya Bay reactor and T2K accelerator experiments. There are very good prerequisites for JINR involvement in these experiments. In particular, at Daya Bay the contribution to the detector instrumentation is based on the JINR member states facilities. For T2K an important input to the experiment will be from data analysis conducted by JINR group at NA61 experiment.

Oscillations between the neutrino flavors gives rise to the probability of CP violation in the lepton sector, characterized by the phase δ, and this may well provide the elusive key to the matter-antimatter asymmetry. Measurements of δ are difficult and at present the only possibility is to use the intense, highly collimated beam with tuneable energy and small spread provided by a neutrino factory. Even there the strength of observable CP violating effects depends upon the size of the parameter $\sin^2\theta_{13}$ and so this needs to be known to specify the performance requirements (the stored muon energy, the baselines and detector masses, and muon intensities) for the design of the neutrino factory.

The absolute neutrino mass scale and neutrino‘s Majorana or Dirac origin could be revealed in neutrinoless double beta decay. The decay rate is proportional to a linear combination of the three neutrino masses if they have a Majorana component and thus measurements give information on the absolute neutrino mass scale. In principle, such experiment could reach sensitivities of 0.05-0.01eV, although the precise limit achieved will be subject to nuclear uncertainties. Nevertheless the observation of neutrinoless double beta decay would be very significant, confirming that neutrinos were Majorana particles. This has far-reaching implications for physics beyond the Standard Model.

JINR nuclear physicists participate in various projects of non accelerator neutrino experiment. The effort has started to join one of future generation neutrino experiment.

Main topics in contemporary particle physics

A general feature of high-energy physics research is its truly global nature, characterized by large facilities built in different countries and shared by the international community. Therefore a plan for the JINR particle physics program has to be formulated in an international context.

The JINR particle physics program outlined in the Road Map is focused on current world wide priorities in particle physics. The key scientific themes for particle physics research in the coming years are:

- **the origin of mass;**
- **the properties of neutrinos;**
- **the properties of the strong interaction including properties of nuclear matter;**
- **the origin of the matter-antimatter asymmetry in the universe;**
- **the unification of particles and forces including gravity;**

1. The origin of mass.

It is expected that the mechanism which leads to the fundamental particle masses will be resolved by the beginning of the next decade. However, to study rare decay modes of the Higgs, measure couplings to ≤10% precision or to make a first attempt to access the Higgs self-couplings requires the additional statistics achievable at the Super-LHC. In addition, the LHC could access Supersymmetry, which if established provides a quantitatively consistent account of the Dark Matter densities required by astrophysical measurements. Here, the increased luminosity of a Super-LHC can extend the mass reach by as much as a further 500 GeV.

JINR physicists participate actively in ATLAS and CMS projects. They are involved in the construction and completion of key parts of the detectors – tracker, calorimeters and muon spectrometer. Major physics topics – Higgs search, top quark physics, SUSY and others – will be investigated by JINR physicists using an experience of JINR groups working currently at CDF and D0 experiments.

The Road Map for JINR in this topic is from CDF and D0 experiments in Fermilab to ATLAS and CMS in CERN with future perspectives of high luminosity LHC and ILC.

2. The properties of neutrino.

Discovery of neutrino oscillations attracted a lot of effort in neutrino physics in past years. This has resulted in tremendous progress in understanding of the oscillation phenomena. The measurements are now available for the solar and atmospheric mixing parameters as well as for the sign of the solar mass difference squared. The accuracy of these will be further improved in the next few years. Consequently the focus of attention moves to measuring and to solve the problem of Dirac or Majorana origin of the neutrino. Oscillations between the neutrino flavors also gives rise to the probability of CP violation in the lepton sector, characterized by the phase δ, and this may well provide the elusive key to the matter-antimatter asymmetry. Measurements of δ are difficult and perhaps the only possibility is to use the intense, highly collimated beam with tuneable energy and small spread provided by a neutrino factory. Advances in the neutrino sector may come, as they have in the past, from experiments using natural sources. SNO, SuperKamiokande, KamLAND and Borexino will provide results in the next few years that may point toward a next generation of non-accelerator experiments.

Neutrino physics program has a long tradition in JINR being established by B. Pontecorvo and it is also carried out within JINR nuclear physics research. JINR particle physicists participate in appearance oscillation experiment OPERA in Gran Sasso and in Borexino experiment. At the same time JINR physicists actively work on the preparation of future neutrino experiments.

At present the neutrino physics program in JINR concentrates on an accelerator based appearance oscillation experiment. Road map in this subject is to complete the existing JINR program by participation in one of future experiments to measure $\sin^2 e_{13}$.

3. The properties of strong interaction including new states of nuclear matter.

This topic is the most interesting for JINR because the new flagship NICA/MPD project will make it possible to perform competitive research in this field directly at JINR. The topic comprises two major subtopics, namely:

Phase transitions in nuclear matter. Together with NICA/MPD program, in JINR this subtopic is covered by participation in world leading experiments PHENIX and STAR at BNL, NA61 and ALICE at CERN, HADES and FAIR program in GSI**.**

Nucleon spin structure, non-perturbative QCD, hadron spectroscopy, nucleon structure itself. This activity in JINR is currently jointly covered by experiments at NUCLOTRON in JINR (study of spin effects in few-nucleon systems, hyper-nuclei, nucleon-nucleon interaction at intermediate energy), TERMALIZATION experiment at U-70, H1 experiment in DESY, COMPASS and DIRAC experiments at CERN. Future is with the BES-3 experiment at BEPC-2 e+e- collider, the experiments at NUCLOTRON-M, the spin program of NICA accelerator complex, and with the FAIR program in GSI. Proton structure and bottom-quark spectroscopy is now also being studied in CDF and D0 and will be continued in ATLAS and CMS experiments.

4. **The origin of the matter-antimatter asymmetry in the universe.**

Measurements of CP violation are now imposing significant constraints on the description of CP violation within the Standard Model. Since it is generally thought that the origin of the matter-antimatter asymmetry in the Universe requires physics beyond the Standard Model, the investigation of CP violation is now entering an era of searching for new physics corrections to the Standard Model picture. Currently there is a very strong participation of JINR in NA48/2 experiment at CERN. Future plans are with the experiments OKA and KLOD in IHEP, the experiment NA62 at CERN and B-meson physics at ATLAS and CMS.

5. **The unification of particles and forces including gravity.**

Many ideas involving TeV scale quantum gravity phenomena in the context of `large' extra dimensions also predict spectacular signatures which could be seen at the LHC but may require the additional energy reach achieved with the higher luminosity of the Super-LHC. Nevertheless, it is widely recognized that the LHC program alone cannot measure particle properties with the precision needed to extrapolate masses and coupling to the ultra-high energy scales required to discriminate between possible Grand Unified Theories, and through these explain the low energy hierarchy of masses and couplings. The Road Map for this subject is essentially CDF and D0 today, ATLAS and CMS in near future and ILC as a perspective.

Conclusions

….

- JINR program is carried both in JINR and member states as well as in the largest accelerator centers. The program covers the current particle physics priorities.
- The NUCLOTRON-M subproject allows for JINR active participation in worldwide particle physics researches and has to be a high priority in JINR particle physics program.
- In the projects realized outside Dubna JINR physicists play an important role, in some cases they initiated experiments and/or lead experiments or their parts.
- Long term future of JINR particle physics program is focused to NICA/MPD project as well as to High Luminosity LHC, FAIR project and ILC.
- The present JINR Road Map assumes the existing level of the budget. The scenarios outlined ensure that JINR can play an important but not the leading role in the long term future of the experimental particle physics.

.

Summary of projects: Many of the current or planned particle physics projects simultaneously address a number of the themes. It is natural, therefore, that the particle physics Road Map is defined in terms of ***projects*** rather than ***themes***. The following table links the various projects in the particle physics – current and in-build with JINR participation and future (with anticipated participation) program - with the above five scientific themes.

Theme		**Current projects**	**In-build projects**	**Future projects**
Origin of mass	***Higgs boson Top quark***	TEVATRON (CDF,D0)	LHC (ATLAS, CMS)	High Lumi LHC Linear Collider
Properties of neutrinos	***Neutrino oscillations***	CERN SPS (NA61) BOREXINO	CERN / GRAN SASSO (OPERA)	New generation neutrino experiments
Properties of the strong interaction	***Phase transitions in nuclear matter***	**NUCLOTRON-M (theme "Study of multiple production in 4π-geometry", FAZA)** RHIC(PHENIX, STAR) CERN SPS (NA61) GSI (HADES)	**NUCLOTRON-M theme "Study of multiple production in 4π-geometry", ()** **IHEP U-70 (TERMALIZATION)** LHC (ALICE)	**NICA(MPD)** FAIR (CBM)
	Nucleon (spin) structure	HERA (H1) CERN SPS (COMPASS) **NUCLOTRON-M (Ins/phe3, delta-sigma,strela, alpom)**	**NUCLOTRON-M** **(Ins/phe3, delta-sigma,strela, alpom)**	**NICA (spin program)**
	Non perturbative QCD	**NUCLOTRON-M (NIS/GIBS)** CERN PS (DIRAC) IKP JULICH (ANKE)	**NUCLOTRON-M** **(NIS/GIBS)**	FAIR (PANDA)
Origin of the matter-antimatter asymmetry in the universe	***K mesons CP and T violation, rare decays***	CERN SPS (NA48/2) KEK (NP04)	CERN SPS (NA62) **IHEP U-70 (OKA)**	High Lumi LHC
	B mesons CP violation	TEVATRON (CDF,D0)	LHC (ATLAS, CMS)	
Unification of particles and forces	***SUSY Compositeness Extra dimensions***	TEVATRON (CDF,D0)	LHC (ATLAS, CMS)	High Lumi LHC

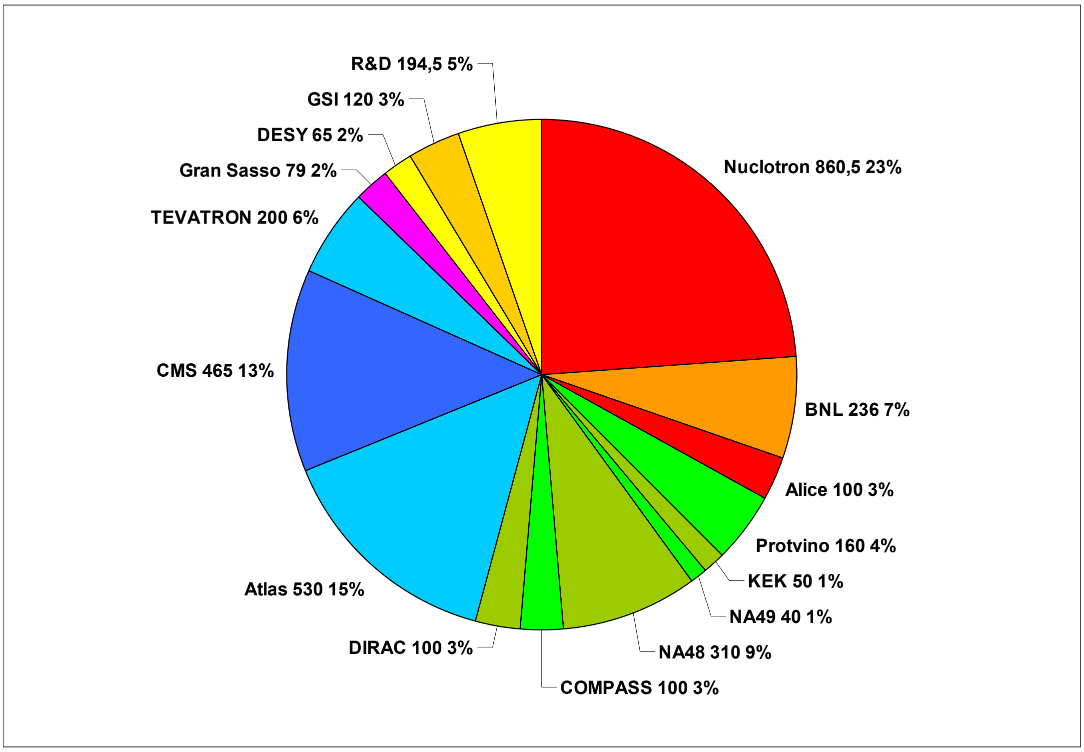
Theme		Current projects	In-build projects	Future projects
No. projects				

JINR ROAD MAP IN EXPERIMENTAL PARTICLE PHYSICS Draft 2 of 4 November 2005)

		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
NUCLOTRON	Delta, Marusia, LNS, NIS, PHe3, Pikaso			Data Taking									
U-70	OKA, TERMALIZATION			Data Taking									
CERN PS	DIRAC	Upgrad	Data taking										
KEK	NP04	Data proc.											
CERN SPS	NA48/2, NA48/3	Data proc.		NA48/3									
	COMPASS	Upgrade		Data Taking									
DESY	HERMES	Data taking											
	H1	Data taking											
IKP Julich	ANKE	Data taking											
FAIR	CBM, PANDA, PAX	R&D			Construction				Data taking				►►
GSI	HADES	Data taking											
CERN SPS	NA 49	Data proc.											
RHIC	PHENIX, STAR		Data taking				RHIC II						
LHC	ALICE	Construction					Data taking						
High Lumi LHC	ATLAS, CMS, ALICE					R&D					Upgrad	Data ta	►►
LHC	ATLAS, CMS	Construction				Data taking							
TEVATRON	CDF, D0		Data Taking										
Linear Collider	Physics and detector		R&D					Construction				Data ta	►►
CERN PS	HARP	Data proc.											
GRAN SASSO	OPERA	Constr.		Data taking									
	BOREXINO		Data taking										
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	

Neutrino physics
Standard Model and beyond
Np QCD, nucleon structure, rare processes
Nuclear matter

Current distribution of JINR particle physics budget



R&D 194,5 5%
GSI 120 3%
DESY 65 2%
Gran Sasso 79 2%
TEVATRON 200 6%
Nuclotron 860,5 23%
CMS 465 13%
BNL 236 7%
Alice 100 3%
Protvino 160 4%
KEK 50 1%
Atlas 530 15%
NA49 40 1%
DIRAC 100 3%
NA48 310 9%
COMPASS 100 3%