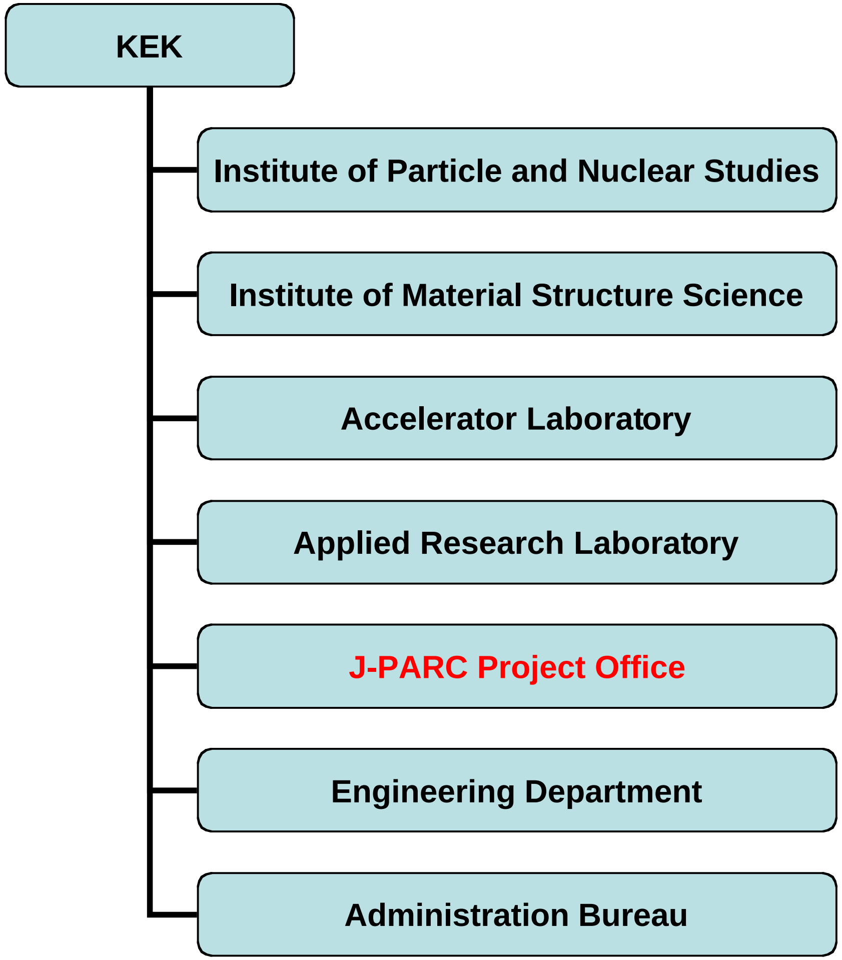
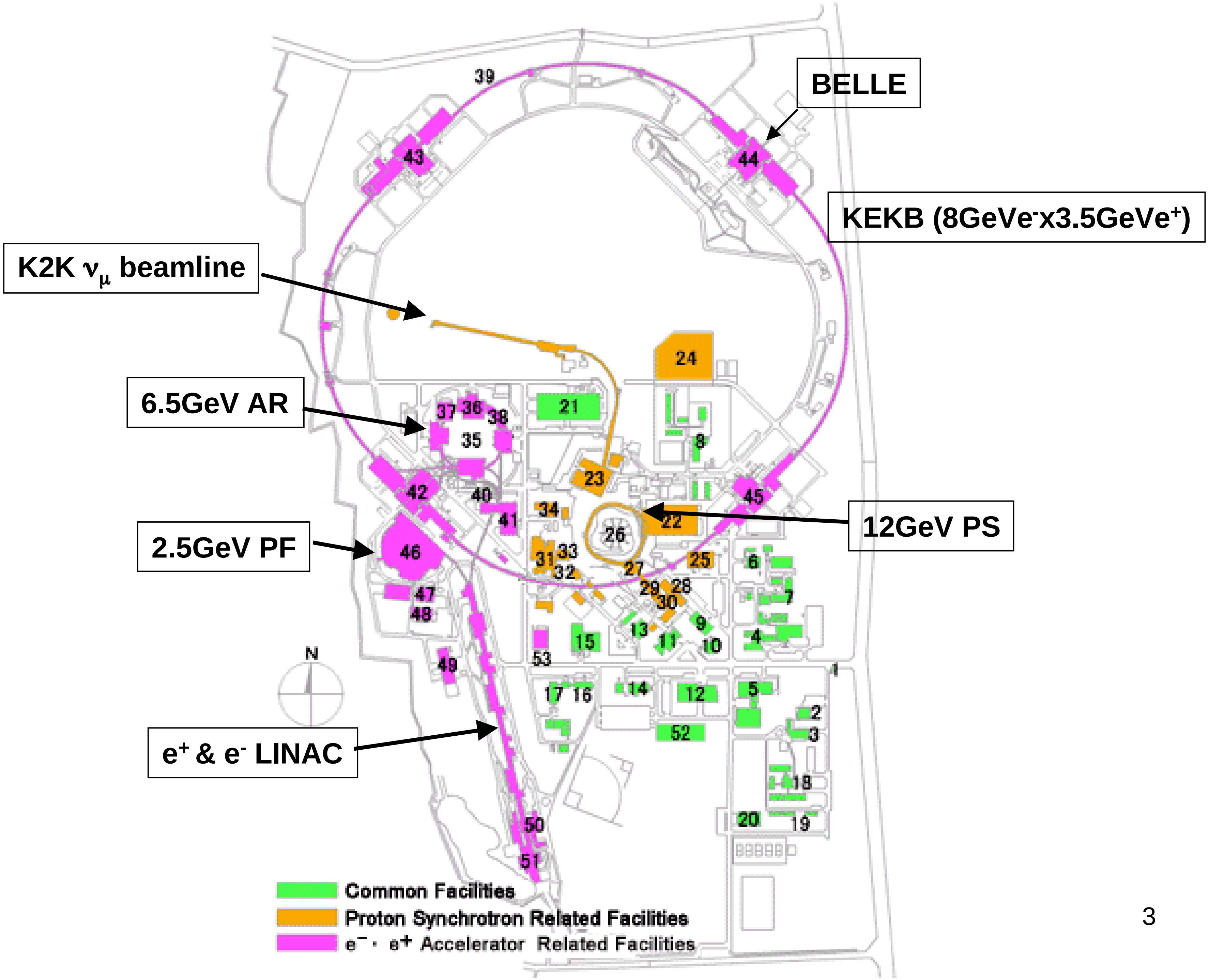
Views from KEK

- Introduction
- Basic strategy
- Project priority (FY2003)
- Organization/management

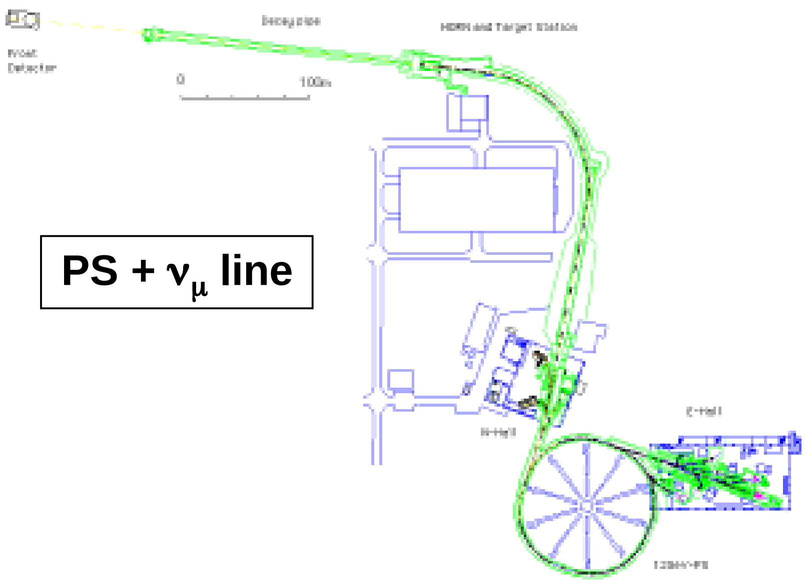
  - Appendix 1
  - Appendix 2

Organization (till the end of FY 2003)

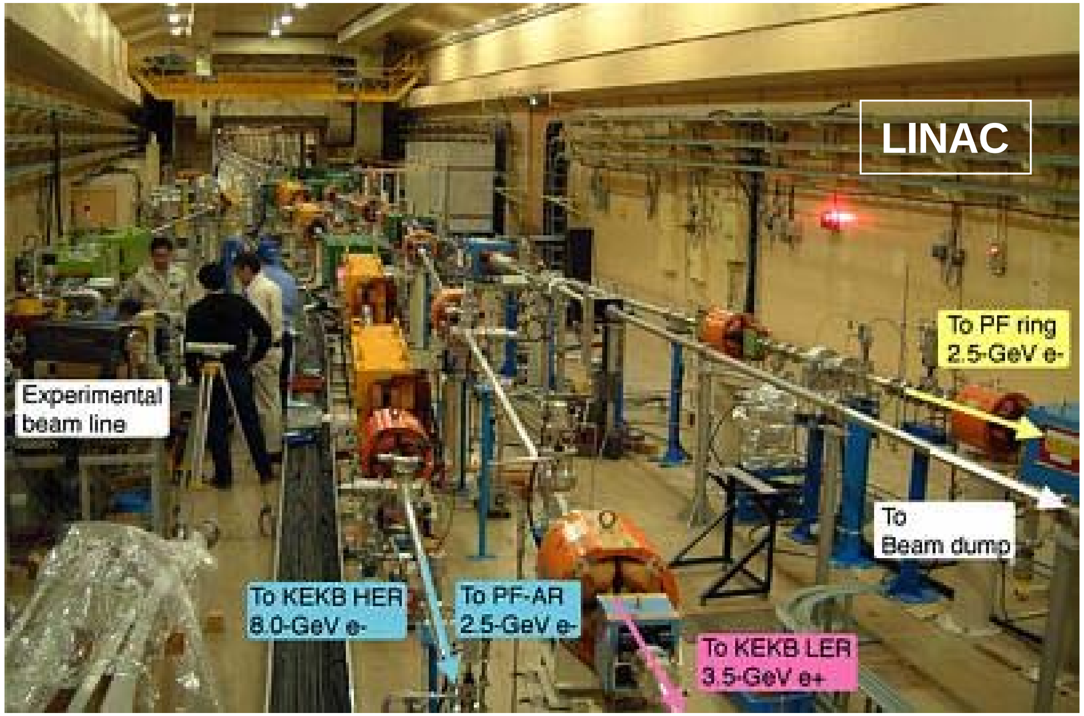



BELLE
KEKB (8GeV e- x 3.5GeV e+)
K2K ν_μ beamline
6.5GeV AR
12GeV PS
2.5GeV PF
e+ & e- LINAC
N
Common Facilities
Proton Synchrotron Related Facilities
e− · e+ Accelerator Related Facilities

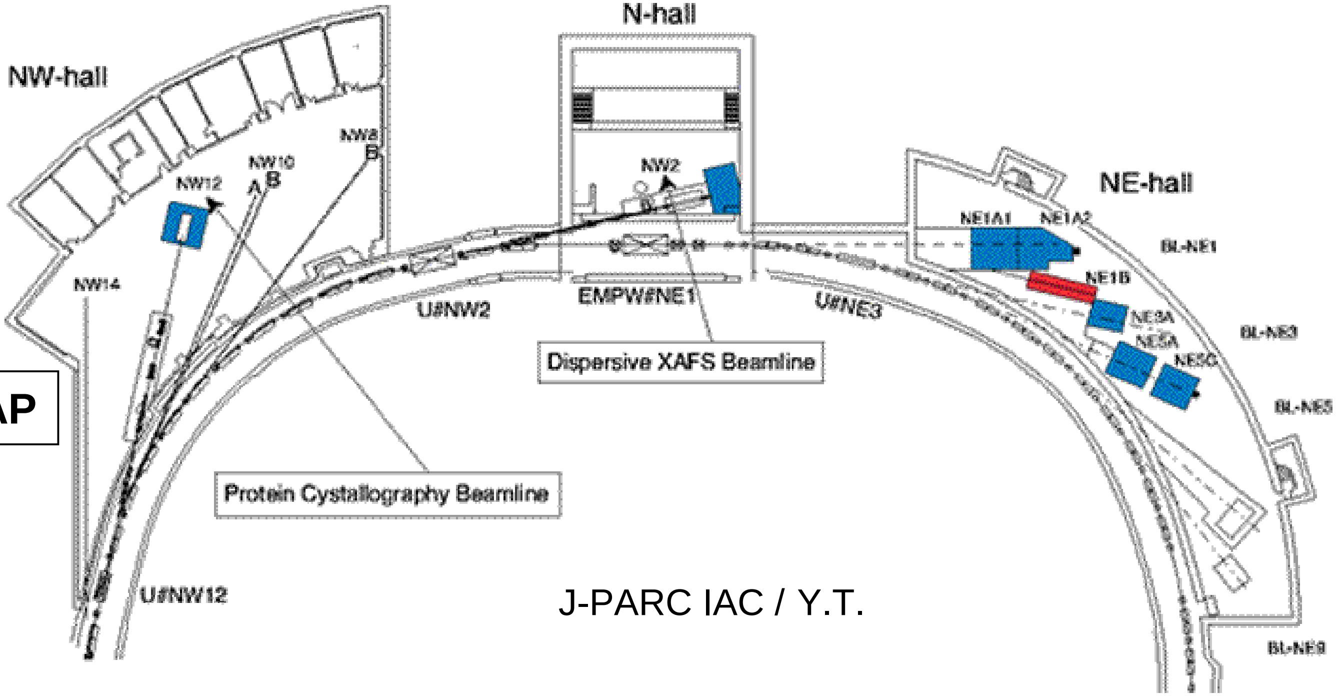
PS + ν_μ line



LINAC



6.5 GeV AP



- J-PARC is, to KEK, a new accelerator added to the existing accelerator complex
- Yet J-PARC is a joint project of JAERI and KEK, and KEK wishes to take advantage of the close cooperation with JAERI

Basic strategy

- Institute of Particle and Nuclear Studies at KEK will make a full use of the 50 GeV PS for particle / nuclear experiments
- The neutron group at Institute of Material Structure Science will closely cooperate with the JAERI counterpart for 3GeV spallation neutron source
- Yet the KEK neutron group will make a healthy competition with JAERI
- KEK will be responsible for the low-energy muon facility

- Credits of experimental results obtained by KEK personnel should be given to KEK
- KEK keeps the principle of “Joint university use”;
  - University people, domestic or international, are allowed to submit proposals to use neutron/muon beam lines, or to do particle/nuclear experiments
  - Proposals from industry are also encouraged
  - KEK supports domestic travel expenses and a part of experimental apparatus for approved proposals

Project priority　(FY2004)

- 1st Priority for KEK's FY2004 budget proposal for J-PARC will be the neutrino oscillation experiment
- Reason:
  - The JHEPC (Japanese high energy physics committee) recommends so [appendix 1]
  - Recommendation from the Research Plan Committee of Institute for Particle and Nuclear Studies, KEK [appendix 2]
  - Priority set within KEK, repeatedly stated by the KEK-DG
- KEK appreciates IAC's continuous support for the neutrino oscillation experiment

[2] Request for the early construction of the neutrino beam line at JHF (J-PARC)
(High Energy News vol.21, no. 3, Oct.2002 p88)

June 25, 2002
Japan High Energy Physics Committee

The constructions of JHF (J-PARC) is in the second year and a little more than four years left before the start of experiments.

The future of JHF (J-PARC) and other accelerator plans depend on whether JHF (J-PARC) can successfully produce physics results that can be recognized internationally at the earliest possible time after the commissioning. The early realization of neutrino experiment is indispensable.

With limited financial resources, it is necessary to set priorities based on physics evaluation that can be recognized internationally. The LOI for the JHF neutrino experiment was submitted to Dr. Nagamiya, Director of JHF (J-PARC) in 2000. The contents were reported at the workshop, which was held January 2000 (High Energy News vol.18, No.5, p135). The committee concluded 'The JHF neutrino is the experiment that is feasible in early stage of the JHF project and has enough potential to compete internationally.' Also, the international advisory committee, held in April 2002, reported that the neutrino experiment should have first priority among the JHF projects.

In addition, the recent results on solar neutrinos reported by SNO, Super-Kamiokande, and other radio-chemical experiments show that the mixing angle in solar neutrinos is rather large. The other mixing angle, which is measured in muon-neutrino disappearance in atmospheric neutrinos, has been shown to be large and confirmed in K2K experiment.

The measurement of the third mixing angle, which is one of the main goal of the first stage of JHF neutrino experiment, become more important and urgent

High Energy Physics Committee requests the project office of JHF (J-PARC) to make every effort toward the early realization of the JHF neutrino experiment.

4 Recommended Grand Plan for the JHF Programs

Based on our basic guidelines, and the review and recommendations on each physics program, we recommend the following grand plan for the 50GeV PS at JHF. Figure 1 shows the timeline of the plan.

1. Build the neutrino beam line as soon as possible, and push the neutrino oscillation program with the highest priority.
2. In order to support wide variety of nuclear physics and high energy physics experiments, start strangeness nuclear physics and rare K decay (e.g. continuation of E391a experiment at JHF) experiments from Phase 1, as they are expected to produce steady results.
3. The muon program must be developed to get physics output in Phase 2. It should start identifying and studying technological problems and test the feasibility (phase A study).

For Phase 2, the B-line/C-line and the extension of the counter hall should be constructed as originally planned, as these are required for running K decay, strangeness nuclear physics, and hadron physics experiments.

4. While continuing the above programs, run series of hadron physics experiments in the latter half of Phase 1 and Phase 2.
5. Depending on the plans made for foreign *anti-p* projects, start the *anti-p* experiments from Phase 2.

All these programs should be reviewed at proper stages and this overall plan should be revised if necessary. In particular, we recommend to give a higher priority to the muon program if its phase A studies give promising results. These recommendations are made mainly based on the physics importance. Technical reviews should be planned in the future, in order to closely examine feasibility of each experiment once LOIs or proposal are submitted. We will also have to take into account the actual accelerator performance.

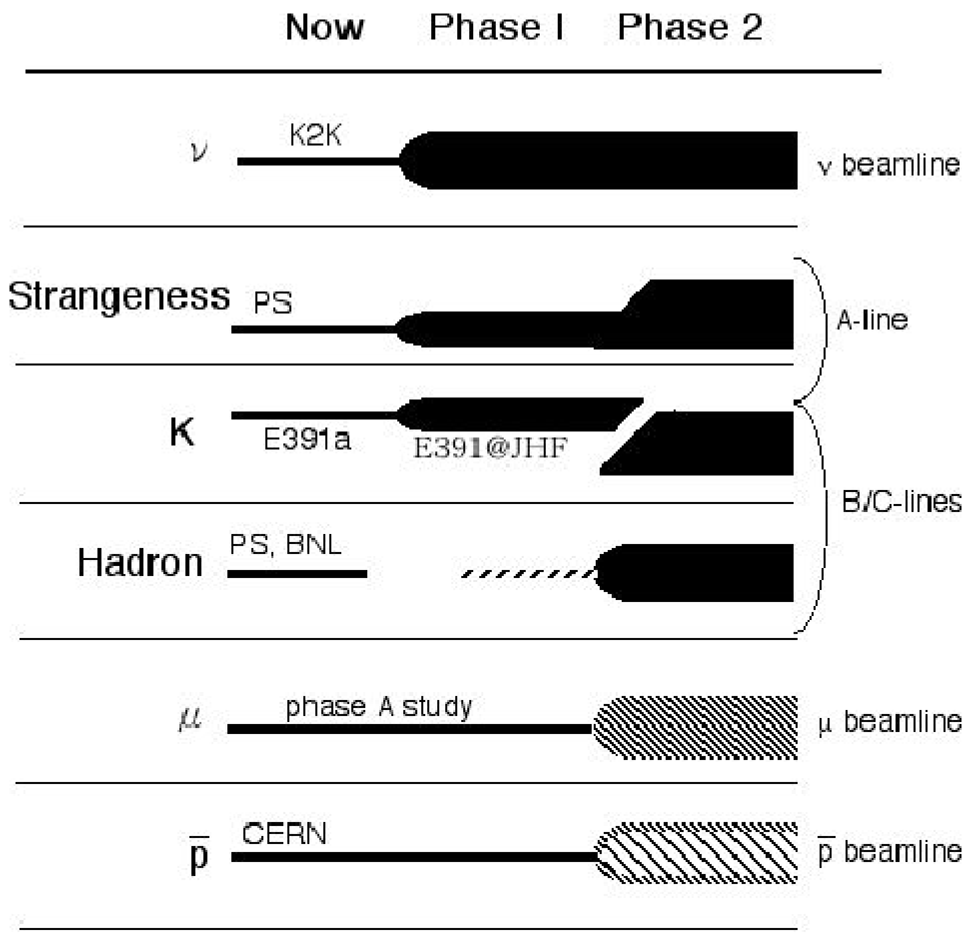
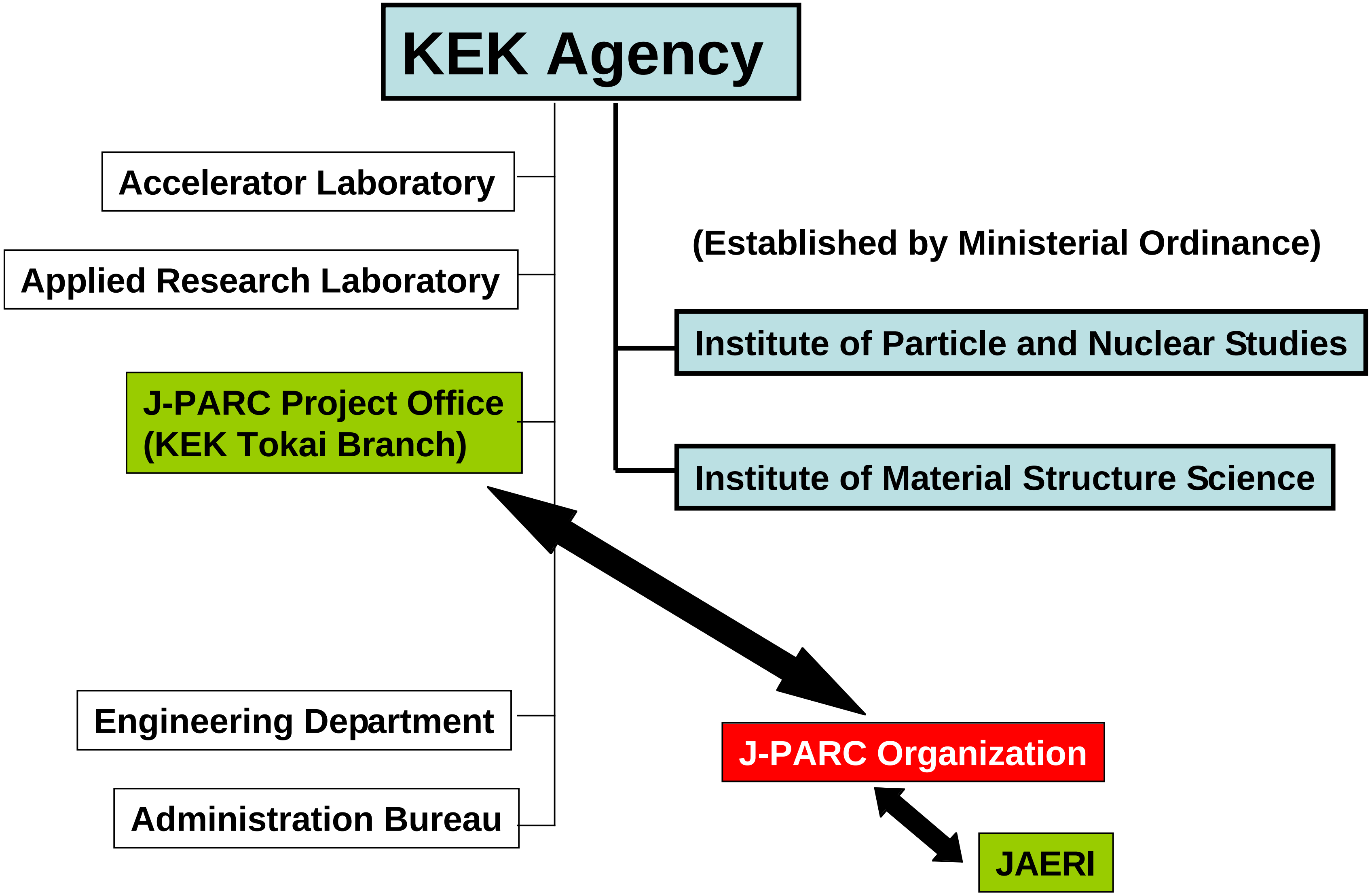


Figure 1: The timeline of the overall plan of JHF programs. The muon program in Phase 2 depends on the result of phase A study. The *anti-p* science program depends on the plan of foreign competing projects.

New Organization in FY2004



Organization/management

- Discussion is still under way on the Organization / management issues of J-PARC after commissioning
  - KEK task force for organizational issue
  - Joint task force for organizational issue
- It must fulfill the basic strategy of KEK
  - KEK prefers J-PARC not being a new, autonomous institute independent of JAERI and KEK
  - Man power at KEK, especially the accelerator group, should not be divided in two independent groups
- The accelerator complex must be operated through a single hierarchy
- Also a single group must be responsible for the radiation safety

Appendix-1: workshop and recommendations from JHEPC

Developments – Past

The neutrino program has been one of the main motivations of building a high intensity proton synchrotron since the JHF project was first proposed in 1995. The possible neutrino experiments were first discussed in 1996 at INS symposium. The JHF project was proposed as the joint project of KEK and JAERI in 1998. The construction of the accelerator was formally approved in 2000 and the construction started in 2001.

Due to rapid progress of neutrino physics in the world, it became necessary to re-evaluate the physics goals for the next generation neutrino oscillation experiment. The JHF neutrino experiment-working group was formed in 1999 to formulate our strategy. The results of the studies were reported at JHF-workshop, promoted by Japan High Energy Physics Committee (JHEPC)*.

The workshop was held on January 7, 2000, in order to review high-energy physics programs at JHF (J-PARC) by Japanese high-energy physicist community and the neutrino project received strong endorsement [1]. The Expression of Interest was submitted to the director JHF project in January 2000. The first LOI was published in 2001.

In 2002, two international workshops were held. The attendants include physicists from Canada, France, Italy, Korea, Russia, Spain, UK and US, and an international working group has been formed. JHEPC requested the project office of JHF (J-PARC) to make every effort toward the early realization of the JHF neutrino experiment [2].

[1] An extraction from the conclusion of JHF workshop

(High Energy News vol.18, no. 5, Feb. 2000 p135)

The studies reported at the workshop show that the neutrino experiment at JHF has high feasibility from the beginning of JHF. The studies also showed the concrete physics goal and strong competitiveness.

[2] Request for the early construction of the neutrino beam line at JHF (J-PARC)
(High Energy News vol.21, no. 3, Oct.2002 p88)

June 25, 2002
Japan High Energy Physics Committee

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The future of JHF (J-PARC) and other accelerator plans depend on whether JHF (J-PARC) can successfully produce physics results that can be recognized internationally at the earliest possible time after the commissioning. The early realization of neutrino experiment is indispensable.

With limited financial resources, it is necessary to set priorities based on physics evaluation that can be recognized internationally. The LOI for the JHF neutrino experiment was submitted to Dr. Nagamiya, Director of JHF (J-PARC) in 2000. The contents were reported at the workshop, which was held January 2000 (High Energy News vol.18, No.5, p135). The committee concluded 'The JHF neutrino is the experiment that is feasible in early stage of the JHF project and has enough potential to compete internationally.' Also, the international advisory committee, held in April 2002, reported that the neutrino experiment should have first priority among the JHF projects.

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High Energy Physics Committee requests the project office of JHF (J-PARC) to make every effort toward the early realization of the JHF neutrino experiment.

Appendix: Japan High Energy Physics Committee (JHEPC)

The JHEPC was formed in April 4, 1968 based on Japan Association of High Energy Physicist (JAHEP), in order to represent the intent of high-energy physicists, to make recommendations and to express their opinions.

The members of JAHEP elect the JHEPC committee every two years. The JAHEP consists of high-energy physicists who have been working in this field for more than two years, where the high-energy physics is the experimental research mainly based on high-energy accelerator and detector technologies. The JAHEP also include physicists of high-energy accelerators and detector developments.

Appendix: Recommendations from the Research Plan Committee of Institute for Particle and Nuclear Physics, KEK

H. Enyo (RIKEN), Y. Okada (KEK), Y. Kamiya (KEK), S. Kim (Tsukuba), S. Kurokawa (KEK), K. Kondo (KEK), H. Sakurai (Tokyo), T. Takahashi (ISAS), H. Tamura (Tohoku), M. Nakahata (Tokyo), T. Nakaya (Kyoto), M. Nojiri (Kyoto), M. Hazumi (KEK), T. Hatsuda (Tokyo), K. Hikasa (Tohoku), K. Fujii (KEK, Secretary), H. Miyatake (KEK), T. Yamanaka (Osaka, Chair), and K. Yoshimura (KEK)

September 23, 2002

Introduction

The charge of Research Plan Committee of the Institute of Particle and Nuclear Studies (IPNS) is defined 1 as follows. ”Upon request of the director of IPNS, the committee (1) investigates long range physics research programs and related projects, and (2) examines the progress and outcome of current research activities and makes recommendations for improvements.” Among various future projects of IPNS we decided to investigate the most urgent issue. How should IPNS conduct experiments at the 50GeV proton synchrotron (hereafter abbreviated as the 50GeV PS) at JHF? We had meetings that totaled 10 days in the period of October 2001 to September 2002. We first invited 19 experts in various fields of particle and nuclear physics to give reviews on the current status and future prospect of their field. We then discussed from various aspects on how to select and carry out experiments at the JHF 50 GeV PS, in light of their physics importance. Here we report our view and unanimous conclusions.

1 Grand View of Particle and Nuclear Physics, and JHF

The goal of particle and nuclear physics is to understand the ultramicroscopic world, *i.e.*, the most fundamental level of Nature. In the second half of the 20th century this field made a rapid progress as a result of rapid advances in accelerator capabilities. Discoveries and measurements of new elementary particles have uncovered the fundamental interactions and their symmetries. Together with studies on hadronic and nuclear structures, we have obtained a unified picture of the basic structure of matter and the history of the universe founded on quantum theory and relativity.

In spite of such major efforts to understand Nature, a multitude of challenging questions remain. Some of them are deeply connected to the basis of our very existence: the mass generation mechanism of fundamental particles, the origin of fundamental interactions, matter-antimatter asymmetry, the hierarchy problem between weak force and gravity, and the source of spacetime structure. It has also became clear that multi-particle systems have a variety of quantum phenomena: new forms of nuclear matter appear under extreme conditions, as do exotic nuclear structures of hypernuclei and nuclei far from stability. These questions stimulate more than ever the intellectual curiosity of humanity. As we enter the 21st century, we are about to step into a new stage to challenge these unsolved problems.

The most direct means to look into the ultramicroscopic world is through energy frontier experiments with high energy accelerators. While Tevatron is now at the frontier, the LHC (under construction) and linear colliders (being planned) will push this energy frontier back and lead us to deeper understanding of Nature. However, raising energy is not the only way to do this. Even at a relatively low energy, one can still study physics at high energy scale by searching for rare phenomena with large data sets from intense beams. Neutrino oscillation and *B* factory experiments good examples. In fact, such luminosity or intensity frontier experiments are the only means to access physics at energy scales beyond the reach of the highest energy colliders.

For elucidation of matter phases under extreme conditions and new phenomena in quantum manybody systems it is important to have ystematic studies that vary parameters such as temperature, baryon density, strangeness, spin, and isospin. The same duality exists on the microscopic nuclear scale. For instance, the experiments for producing quark-gluon plasma with high energy heavy ion collisions at RHIC or LHC aim at investigating phase transitions of nuclear matter at high temperature. These are energy frontier experiments in the field of nuclear physics. On the other hand, nuclear physics experiments utilizing strangeness or hadrons as a probe, and experiments producing unstable nuclei by RI beams, can study various nuclei and nuclear matter phases that appear in neutron stars and supernovae. These are intensity frontier experiments in nuclear physics. As shown above, high intensity accelerators are needed for a wide range of particle and nuclear physics. The proton synchrotron at JHF will deliver the world's highest intensity (0.75 MW) beam, with 3£1014 50GeV protons every 3.4 s. This machine will make an important contribution to the world-wide physics community by offering a unique facility that opens a new high intensity frontier of particle and nuclear physics.

In particle physics, the JHF will contribute to neutrino oscillation physics, precision CP violation studies, and searches for flavor violation. In nuclear physics, the JHF can study multi-body system of quarks and gluons by using strangeness and hadrons as probes. In addition, mass production of antiprotons will open up a new era of antiproton science. The JHF will have many research programs that are expected to produce high quality results. These programs will complement other domestic and international energy frontier experiments and together will accelerate the progress of particle and nuclear physics in this country.

We should also stress that the JHF will also serve as a base to grow new generation of talented particle and nuclear physicists.

2 Basic Guidelines for the JHF 50GeV PS Programs

We recommend the following two basic guidelines for the JHF 50GeV PS to maximize the physics output from Phase 1 and Phase 2. 2.

1. High priority should be given to scientifically important and urgent programs which Japan can take leadership.
2. Research programs should be established to pursue wide variety of physics utilizing the characteristics of JHF. The timeline of these programs should be optimized to maximize the overall effciency.

3 Review and Recommendations for Each Program

Based on the basic guidelines described above, we have grouped experiments that had been considered into the following six programs for our reviews and discussions.

- Neutrino oscillation experiments (ν)
- Rare K decay experiments (K decay)
- High intensity muon physics (μ)
- Strangeness nuclear physics (Strangeness)
- Hadron physics (hadron)
- Antiproton science (*anti-p*)

Details of each program and its review are described in the full report (KEK Report 2002-11, only available in Japanese). Here we list the executive summary of our review and recommendations on each program.

Neutrino oscillation experiments

Japan has been leading the field of neutrino oscillation and recent observations have established the first signature of physics beyond the standard model. The mixing between generations in the neutrino sector was found to have a totally different structure from mixing in the quark sector. This suggest that an unknown physics mechanism is behind neutrino oscillation. Neutrino physics should be pursued further, since the overall structure of neutrino mixing is still unclear; e.g. $\nu_\mu \rightarrow \nu_e$ oscillation has not been observed yet. JHF can shoot neutrinos to Super Kamiokande with an intensity >100 times that of K2K. Not only will experiments with JHF measure the oscillation parameters accurately, they will have ultimately the potential to discover CP violation in the lepton sector. Considering the importance of this physics, its future potential, and the competing experiments in the world, this program should be given high priority and the construction of the beam line should be started as soon as possible.

Rare K decay experiments

CP violation due to Kobayashi-Maskawa mechanism has been established by the e'/e measurements at CERN and Fermilab and by the high luminosity B factories at KEK and SLAC. The next step is to search for CP violation caused by a physics beyond the standard model. These can be searched for with precise measurements of the branching ratios of $K_L \rightarrow \pi^0\nu\nu$ and $K^+ \rightarrow \pi^+\nu\nu$ and with a search for T-violation in $K^+ \rightarrow \pi^0\mu^+\nu\nu$. Although it is ideal to do all these experiments, the kaon community should choose one of them for the start up phase of JHF, considering the cost and manpower. The committee recommends the $K_L \rightarrow \pi^0\nu\nu$ experiment. The experiment has a potential to achieve the first observation of the decay by upgrading the current KEK PS E391a experiment for JHF Phase I, and further more could establish a base for a precise measurement of the branching ratio. Of course, before continuing on to Phase 2, the experimental plan must be reviewed for its feasibility.

High intensity muon physics

Supersymmetry is a promising model to solve the hierarchy problem. This model predicts new phenomena beyond the Standard Model such as the lepton number violating transition, $\mu \rightarrow e$. JHF can cover a wide range of predicted $\mu \rightarrow e$ transition rates by using high quality and high rate muon beams. The proposed plan uses ambitious technologies such as PRISM 3 to achieve an intensity 104 times larger than existing facilities. The R&D necessary for the $\mu \rightarrow e$ search should start immediately. These new technologies are not limited to the $\mu \rightarrow e$ experiment; they can be applied to high intensity muon facilities and such facilities can evolve into a neutrino factory and high energy frontier experiments. Consequently the high intensity muon physics program has strategic importance and can make international contributions to the future of the particle and nuclear physics.

Strangeness nuclear physics

Japan has been leading the study of nuclear forces involving strangeness by developing innovative experimental methods, and this has been acknowledged internationally. At JHF, high intensity secondary beams will allow further systematic studies of the structure of hypernuclei and hyperon–nucleon scattering. By describing the properties of nuclear matter with strangeness, these studies will lead to a better understanding of the nuclear forces. In addition they will offer important information required to build theoretical models for high density nuclear matter such as neutron stars. Since many of the proposed experiments are expected to produce new results quickly, they should be prioritized properly and run in series from the JHF start up time. The entire program should be further developed by introducing new detectors and secondary beamline(s).

Hadron phyiscs

Hadron physics experiments can open a unique field utilizing the high intensity beams from JHF. The main focus will be the study of structure functions of nucleons and nuclei, and the observation of non-perturbative QCD phenomena such as partial restoration of chiral symmetry in nuclei. These will be studied by observing lepton pairs produced by high intensity primary or secondary beams. The program covers wide variety of studies including some proposals from foreign countries. Therefore, multi-purpose beamline and detectors should be built and the program should be continued in a long time span. Heavy ion acceleration for producing high density nuclear matter could lead to a new physics frontier, but our competitiveness vis-a-vis that of GSI should be taken into account.

Antiproton science

One of the antiproton programs at CERN lead by a core Japanese group recently succeeded in mass-production of anti-hydrogen. This success marks a new era in the antiproton science. The high-intensity antiproton beam at JHF can contribute to a wide field of science, ranging from basic science to various applications: tests of CPT, measurement of neutron-matter distributions in unstable nuclei, medical applications, etc.. The decision to build an antiproton facility at JHF will very much depend on the future plans of similar facilities around the world. JHF can produce a low energy high intensity beam in *DC mode* and this feature should be a part of the plan for the JHF-*anti-p* program to be competitive.

The star rating of each program is shown in Table 1.

Program	Importance of physics for the first stage of JHF	Urgency	Feasibility	Cost		# physicists	Comments
				Facility	Detectors		
ν	****	***	***	\\\	\\	MMM	
K decay	**	***	**	\ → \\	\ → \\	MM	1)
μ	++++ see 2)		*	\\\	\\	MM	3)
Strangeness	***	**	***	\ → \\	\ → \\	MMM	4)
Hadrons	**	*	**	\\	\	MM	
Anti-p	*	*	***	\\\	\	MM	5)

Table 1: Star ratings of the JHF programs
"Importance of physics for the first stage of JHF" includes the international competitiveness.
"Urgency" takes international competition into account.
"Feasibility" takes into account the amount of required R& D work.
"Facility" and "Detector" show rough costs estimated by the committee; \: <$10M, \\: $10 >>50M, \\\: $>50M (assuming $1M = 100M yen).
"#Physicists" shows the estimated number of physicists who will work on the program; MM:O(10), MMM:O(100).

1) The program is assumed to take two steps, and shown in a format: step 1 → step 2.
2) Since this program has a potential to lead to a new generation of particle and nuclear physics experiments, we rated the importance of starting R&D early.
3) It is too early to judge feasibility. This proposal should be reviewed after proving the basic idea and studying technological problems. The "Facility" includes the cost for the experimental hall.
4) The costs are shown in a format: Phase 1 → Phase 2. Phase 1 uses the existing detectors moved from KEK. Phase 2 assumes the upgrade / construction of beam line and detectors. The extension of K-Hall is also necessary for Phase 2.
5) The importance and the number of users will increase if GSI and CERN decide not to have *anti-p* programs.

4 Recommended Grand Plan for the JHF Programs

Based on our basic guidelines, and the review and recommendations on each physics program, we recommend the following grand plan for the 50GeV PS at JHF. Figure 1 shows the timeline of the plan.

1. Build the neutrino beam line as soon as possible, and push the neutrino oscillation program with the highest priority.
2. In order to support wide variety of nuclear physics and high energy physics experiments, start strangeness nuclear physics and rare K decay (e.g. continuation of E391a experiment at JHF) experiments from Phase 1, as they are expected to produce steady results.
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For Phase 2, the B-line/C-line and the extension of the counter hall should be constructed as originally planned, as these are required for running K decay, strangeness nuclear physics, and hadron physics experiments.

4. While continuing the above programs, run series of hadron physics experiments in the latter half of Phase 1 and Phase 2.
5. Depending on the plans made for foreign *anti-p* projects, start the *anti-p* experiments from Phase 2.

All these programs should be reviewed at proper stages and this overall plan should be revised if necessary. In particular, we recommend to give a higher priority to the muon program if its phase A studies give promising results. These recommendations are made mainly based on the physics importance. Technical reviews should be planned in the future, in order to closely examine feasibility of each experiment once LOIs or proposal are submitted. We will also have to take into account the actual accelerator performance.

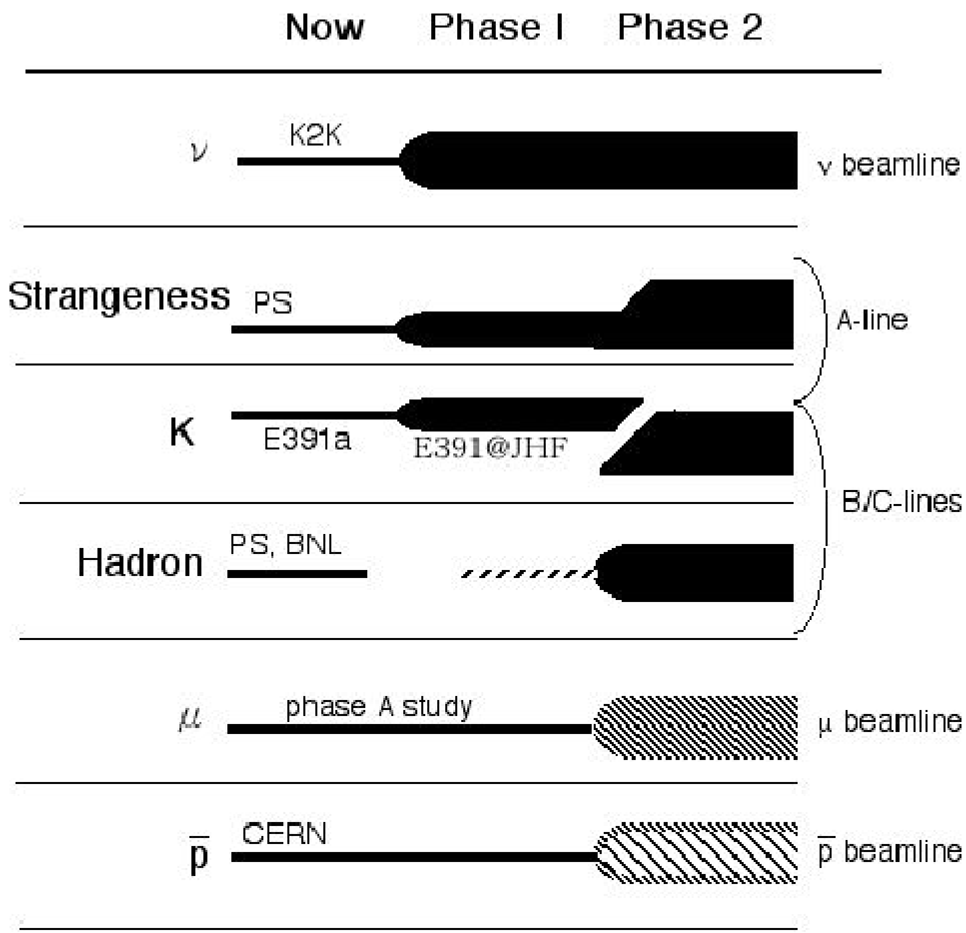

Figure 1: The timeline of the overall plan of JHF programs. The muon program in Phase 2 depends on the result of phase A study. The *anti-p* science program depends on the plan of foreign competing projects.