High Intensity Proton Accelerator Project

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From JFY2001 a new accelerator project to provide high-intensity proton beams proceeded into a construction phase. This project is conducted under a cooperation of two institutions, KEK and JAERI. The accelerator complex will provide 1 MW proton beams at 3 GeV and 0.75 MW beams at 50 GeV. The project will be completed within six years. In this article, a brief overview and possible nuclear/particle physics studies are described.

I. INTRODUCTION

The high intensity proton accelerator project is a new accelerator project jointly conducted by KEK (High Energy Accelerator Research Organization) and JAERI (Japan Atomic Energy Research Institute). The aim of the project is to construct a world-class hadron accelerator complex, whose beam power, 1 MW for the 3 GeV synchrotron and 0.75 MW for the 50 GeV synchrotron, is the highest in the world (see Fig. 1). The accelerator complex consists of:

- 400 MeV proton linac (normal conducting) to inject beams to the 3 GeV synchrotron.
- A superconducting linac to accelerate protons from 400 MeV to 600 MeV. The 600 MeV proton beams will be used for R&D towards nuclear transmutation.
- 25 Hz 3GeV proton synchrotron with 1 MW power. This will be used primarily for materials and life sciences with neutrons and muons.

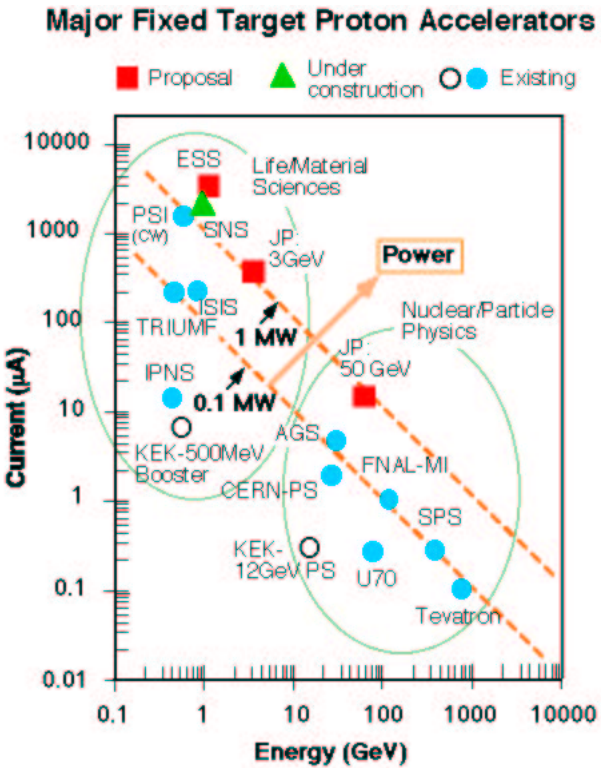

FIG. 1: Proton accelerators in the world.

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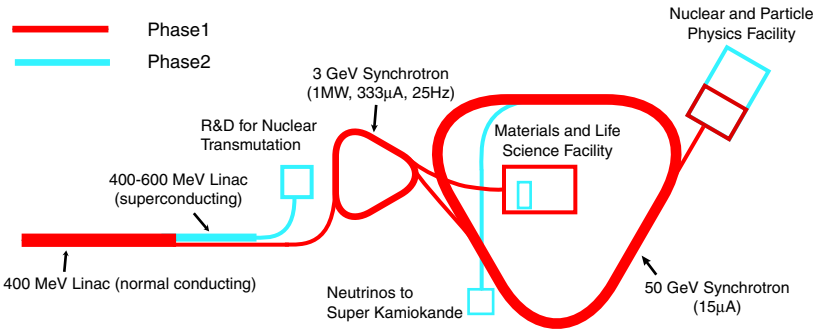

FIG. 2: Layout of the High Intensity Proton Accelerator Project at the Tokai campus of JAERI. Indicated by "Phase1" is a budgetary approved portion of the project.

- 50 GeV synchrotron with 0.75 MW power. The slow-extracted beams will be used to produce kaons and other secondary particles, while the fast-extracted beams will be used to produce neutrino beams to Super-Kamiokande.

The usage of various secondary particle beams (neutrons, mesons, antiprotons, etc.) that are produced in proton-nucleus reactions, together with daughter particles of the secondary beams such as muons and neutrinos, is the prime purpose of the project. With these secondary and successive decay particles, three major scientific goals will be pursued: a) nuclear and particle physics, b) materials and life sciences, and c) R&D for nuclear transmutation. The accelerator complex will be constructed at the Tokai campus of JAERI, about 70 km north-east of KEK. The total cost of the project is about 189 billion yen. From JFY2001 (April 2001 – March 2002), Phase 1 of the project (134 billion yen) is approved. The construction period is 6 years. The configuration of the accelerator complex is illustrated in Fig. 2.

II. SCIENCES AT THE HIGH INTENSITY PROTON ACCELERATOR PROJECT

Figure 3 is a summary of the sciences to be conducted at the project from nuclear and particle physics to materials and life sciences.

Materials and life sciences will be studied with neutrons and muons from 3 GeV proton beams. The neutron carries two unique features. One is that the neutron does not have any electric charges and it has a mass which is close to the proton mass. Thus, neutrons are scattered by atomic nuclei, in particular, by light-mass nuclei. This feature is unique if one compares neutrons with synchrotron-radiated X-rays, which are scattered by electrons and thus observe atoms with large atomic numbers. The other one is that the neutron carries a magnetic moment. With these features, neutron beams are unique and indispensable tools for materials and life sciences. The features of muons, its mass between an electron and a proton and its magnetic moment, are also important to investigate these sciences.

Among wide variety of sciences planned, nuclear and particle physics using the 50 GeV synchrotron is one of the major objectives. At the nuclear and particle physics facility, fixed target experiments using kaons, pions, etc. will be carried out. Since the intensity of the secondary beams such as kaons and pions will be the highest in the world, kaon rare decays and strangeness nuclear physics will be extensively studied. Physics using low momentum antiprotons, hadron spectroscopy, and hadron physics including mass shift of vector mesons, multifragmentation, and Drell-Yan measurements at large x region, will also be important issues.

There will be a dedicated neutrino facility with fast extraction, which produces neutrino beams traveling to the Super-Kamiokande detector about 300 km away. This facility will lead the world as a next generation neutrino facility, which aims even to measure the CP violation in the lepton sector.

III. STATUS AND SCHEDULE OF THE PROJECT

The present schedule of construction is shown in Fig. 4. The first beam of the 50 GeV synchrotron will be expected in the year 2007. We expect that construction of Phase 2 will start continuously after the Phase 1 construction.

KEK and JAERI have formed a joint team for construction, in which over 300 people from both institutions are involved. The nuclear and particle physics facility group, headed by Jun Imazato, is making serious efforts

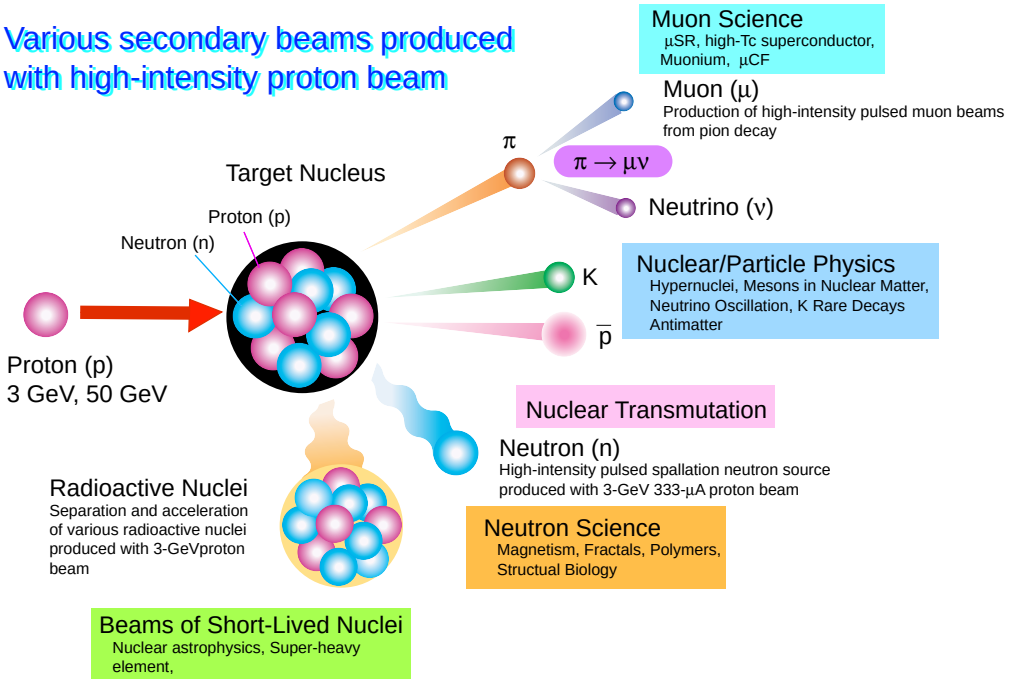

FIG. 3: Production of secondary beams and applications of these beams into a variety of sciences.

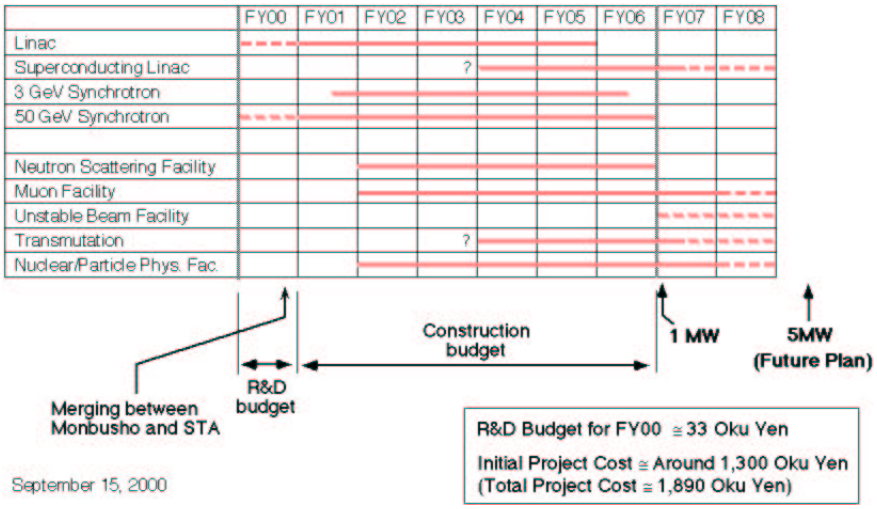

FIG. 4: Proposed schedule of the project.

with its four sub-groups (the general facility group, the hadron beam group, the target group, and the neutrino group) for design and R&D of the facility within the joint team. In addition, the international advisory committee and the users' consortium are being formed.

In order to reflect needs from the potential users to the design of the facilities, there will be a call for letters of intent on nuclear and particle physics experiments in the near future. Although research programs should, of course, be developed under long time discussions and efforts to polish up the programs should be employed continuously, expression of interest from the potential users with the research programs at this time is very much important for the construction team to fix the baseline design of the facilities. Physicists all over the world who are interested in the researches of nuclear and particle physics are urged to respond to the call.