Vol.4 No.1

KEK News

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High Energy Accelerator Research Organization

International Collaborations at KEK

KEK Director-General
Hirotaka Sugawara

ICFA (International Committee for Future Accelerator) was founded during the 1970s and had set a guide line for projects in high energy physics field. It says that all proposals must be judged solely by its scientific merit and feasibility, and no laboratory should put any bias on it due to nationality, race, gender and so forth.

We, at KEK, respect this rule and are trying to be a laboratory fully open to the international community not only in high energy physics, but in all fields of research we are related to. We are also actively participating in projects at other laboratories in the world. Among them are projects in the USA under the Agreement on Japan-US Scientific Cooperation, and collaborations at CERN and SLAC.

While these international collaborations are going alright, we feel the necessity to make KEK more open to the world in terms of personnel. It is a vital importance to get talented people from all over the world to enrich and further activate researches in KEK, and keep close relationship with other part of the world. I feel we should try harder on this respect.

KEK staff members are Japanese public servants, but this does not pose much legal restriction. Linguistic problems exist like anywhere else, but can be overcome. Expecting that international collaborations will become of much larger scale, further internationalization of staff members will be very important. This will be an essential key factor if KEK aims to be a host institute of a huge international project in a future.

Japan-U.S. Cooperative Program in High Energy Physics

Start of the Program

High-energy-physics (HEP) research community in Japan had seen a considerable increase in its size by the time when KEK was established in 1971. Although the 8-GeV Proton Synchrotron approved as the main research facility at KEK was not as high in energy as originally hoped for, it nevertheless represented a revolutionary expansion of the domestic research base. Fierce competition soon ensued among research teams for the opportunity to conduct long-waited high-energy experiments. Even then, most of the experimental proposals were both large-scale and long-term. However, the research environment was not yet adequately equipped to accommodate many such experiments, and accelerator energy was not high enough for designing world-competitive HEP experiments. It was only natural that many groups began considering the possibility of participating in experiments at high-energy facilities overseas; some in Europe and others in the U.S. At the time, three U.S. laboratories (BNL in New York, FNAL in Illinois and SLAC in California) already had impressive accelerator facilities, offering attractive opportunities. Unfortunately, none of the interested teams in Japan had means of getting funded for their plans.

It then happened that, at a summit meeting of Japan and U.S. heads of state in 1978, the two countries pledged to cooperate in tackling the world's energy problems. In the same year, the International Conference on High Energy Physics was held in Tokyo, the first time in Asia in the conference's august history. Sizing the occasion, representative researchers of both sides appealed

Participants of the eleventh annual meeting of the Japan/U.S. Committee on High Energy Physics, held in May, 1989, at BNL lab. The committee is co-chaired by KEK and DOE representatives.

to the government to include HEP research in the cooperative program. By then, every major Japanese University groups had already been involved in some project planning, and the pressure was high enough that things moved forward quickly. In May 1979, the two governments signed an agreement to cooperate in "Research and Development in Energy and Related Fields", with HEP research included as one of the cooperative areas. The Japan-U.S. Cooperative Program in the Field of High Energy Physics was thus initiated in November 1979, under the terms of the Implementation Agreement between the Japanese Ministry of Education (Monbusho) and the U.S. Department of Energy. Research program for each year has been coordinated by the Joint Committee which has been held in Japan and the U.S alternately.

The First Stage

In executing the program, some inconveniences existed such as a mismatch of the fiscal year periods and a different practice of imposing overhead on the spending. In addition, the funding level for traveling, though significant, was not enough to fully support year-long visits of many Japanese researchers that was required by the very nature of typical high-energy-physics projects. Also, constant presence of at least one faculty member at each lab was required by law to take care of the local accounting. Despite these problems, the joint experiments set out smoothly owing largely to help from the U.S. labs, and yielded important physics results mainly from studies of particles containing the charm quark, and those including the strange quark, and interactions of the neutrino. It was also during this stage that the modern nuclear-emulsion technology was successfully developed for studies of short-lived particles and the experimental program with bubble chambers completed its historic mission.

The Second Stage

The first stage of cooperation had played an important role in building up mutual understanding and trusts among physicists of both sides. The next stage, from the late 80's and through the 90's, turned out to be very productive. The research program was focussed on 1) new particle search at the highest available energies, 2) high precision studies of particle decays, 3) R&D on next-generation accelerators / particle-detectors, and 4) high-energy heavy-ion collision experiments.

The highest-energy accelerator is the one at FNAL, known as the Tevatron collider, where protons and antiprotons of the energies 900 GeV each are smashed head on. Here a large group of physicists including a Japanese

CDF detector at FNAL in the final stage of construction (1986). It has been a leading figure in HEP research, and its upgrade is near completion to be ready for the second-stage experiment from March, 2001.

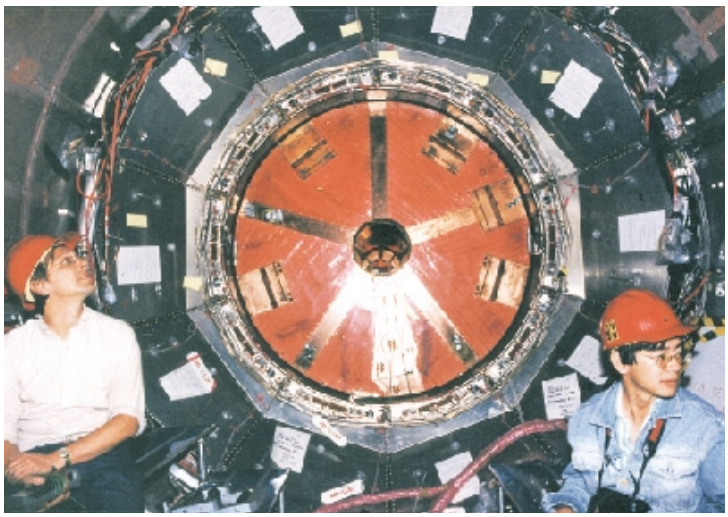
team had spent the first 8 years building a gigantic device (called the CDF) that can record particle reactions in the world's highest-energy environment. The experiment started from 1987 and produced many important findings; the biggest achievement was the discovery of the top quark. The CDF experiment has been the most important element, a flagship experiment of the Cooperative Program, and is expected to be so with considerably upgraded accelerator and detector.

Microscopic world of elementary particles can also be studied through careful observations of how unstable particles decay in various ways. Japanese teams actively participated in experiments at the proton accelerators of BNL and FNAL that provide secondary K-meson beams of high intensities. A variety of important results came out from their first-round runs. Also a unique study of Z-boson decays was carried out at SLAC using a spin-polarized electron beam in collision with a positron beam.

A fairly large Japanese team has been deeply involved in construction of a device called the PHENIX detector at BNL, aiming to search for a new transient state of matter that could be created in a microscopically hot environment when heavy nuclei collide head on at relativistic energies. Recently the first collision of such composite particles was observed at the new accelerator just completed at BNL. Another active component of the second-stage program was accelerator / detector R&D. Some of the achievements in this area have already been successfully applied to recently-started projects and many of them are essential to promoting the JLC project, an energy frontier research program with an electron-positron linear collider.

Toward the Third Stage

The Cooperative Program covers an entire field of HEP research with a significant level of funding support, and allows full participation of senior graduate students. Since its start in 1979, it has very effectively supported research activities of many university groups. So far, around 700 scientific papers were published with over 110 Japanese researchers receiving their doctoral degrees from work on the Program. Such scientific achievement and the cultivation of many young scientists in an international environment have been highly evaluated by the third-party reviews.



Central part of the SLD detector, before installation of the central drift chamber (around 1987). Half a million events of Z-boson decays were recorded at the SLAC electron-positron collider (SLC).

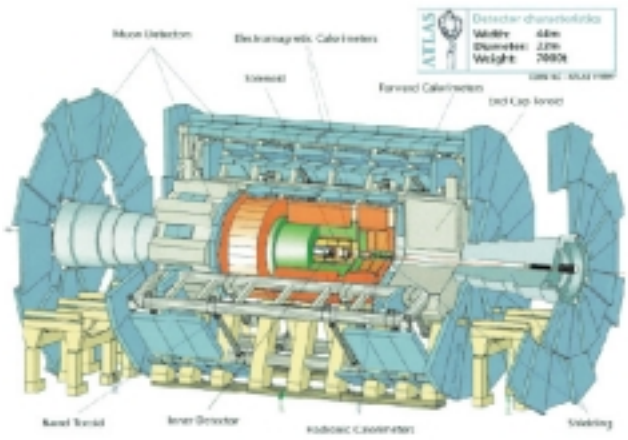
High-energy accelerators have been the central means of addressing key issues of physics of elementary particles and will, no doubt, continue to play a principal role. On the other hand, there are some of the important issues in this

field that can be better addressed through different styles of experiments including especially those called non-accelerator experiments. The Japan-U.S. Committee has agreed, in its annual meeting held in June 2000, to pay attention to such new development, and to give supports to a cosmic gamma-ray experiment and an R&D for solar-neutrino detection.

PHENIX detector under construction at BNL. In a test run performed in June, 2000, it succeeded to record multiparticle production events from collisions of high-energy gold nuclei.

The author of this article, professor ***Seigi IWATA***, is the deputy director of IPNS as well as the Japanese-side supervisor of whole US-Japan cooperation program since 1994.

ATLAS experiment at CERN



ATLAS detector

What exactly have happened at the Big Bang can be explored by studying the physics laws of the quarks, leptons (of which everything from the universe to a cabbage is made) and forces between them. The frontier of such physics will be advanced by the most powerful accelerator, the LHC (Large Hadron Collider) starting in year 2005 in Geneva, Switzerland.

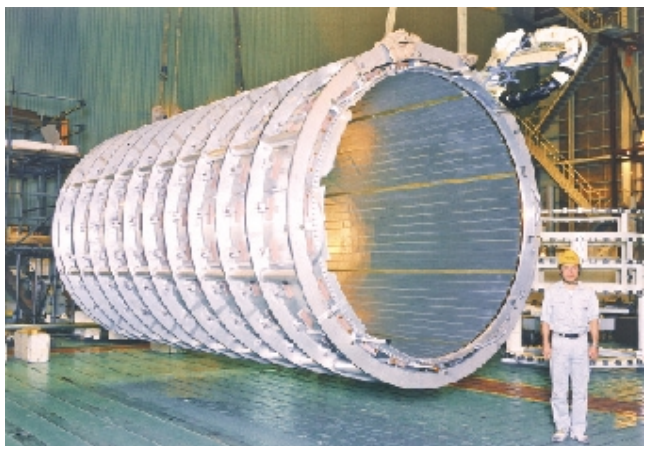
Protons collide head-on with extremely high energy, equivalent to recreate the energy state of the first milliseconds after the Big Bang. In 1935, Professor Yukawa predicted that a force between particles is generated by an exchange of a particle. Indeed, the strong force, holding quarks together in proton, the electromagnetic force, and the weak force, that causes the beta decays and radio-activity, are all caused by exchanging gluons, photons, and W or Z bosons, respectively.

Now, we know all these forces are beautifully described in what we call "The Standard Model", the basic theory of 6 quarks, 6 leptons and 3 forces. Yet, there are so many mysteries left:

- why are the W and Z bosons so heavy (100 times of proton mass) ?
- what is the origin of masses of quarks and leptons?
- why are there 6 quarks, 6 leptons and 3 forces (excluding gravity) ?
- why and to where had the antimatter disappeared from our universe?

First two can be solved by introducing "Higgs Field". Then, a particle called "Higgs" must exist. The LHC project would discover this Higgs particle. We believe that the LHC can provide the key to solve these mysteries. Discovery of the particle or other alternatives, together with detailed studies of it, would make a revolutionary advance in mankind's understanding on the basic matters and forces.

The LHC project was proposed in 1984. The CERN member countries formally approved the project in December 1994. In May 1995, Japan decided to cooperate with CERN in the LHC accelerator construction.

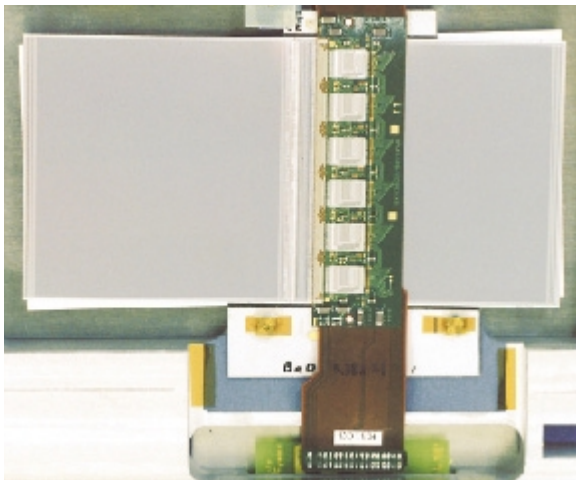


ATLAS Central Solenoid

By 1997, the LHC project effectively became the unique world-wide project, accepting cooperation from Japan, USA, Canada, Russia, India and others in addition to the CERN member countries. Two experiments, ATLAS and CMS, are now under detector construction aiming at discovery of the Higgs particles.

TGC construction at KEK

The ATLAS collaboration is formed by people of 150 institutions from 35 countries (and CERN) including Japanese physicists from KEK and 14 universities. About twenty people are directly involved in the ATLAS detector construction: Superconducting solenoid led by Akira YAMAMOTO and Yoshikuni DOI, Endcap muon chambers led by Hiroyuki IWASAKI and Shuji TANAKA, Trigger electronics system led by Osamu SASAKI, Silicon microstrip detectors led by Yoshinobu UNNO and Susumu TERADA, TDC (time-to-digital conversion) VLSI led by Yasuo ARAI, Computing software led by Katsuya AMAKO, Data acquisition led by Yoshiji YASU, Physics studies led by Junichi KANZAKI and Shigeru ODAKA.



ATLAS Silicon strip detector module

These research efforts are going well along with very close collaboration with people from other Japanese universities. All participating people are anticipating the exciting moment of LHC and ATLAS commissioning in 2005, hopefully followed by a discovery of the Higgs particles. We very welcome your enthusiastic participation.

The author of this article, Professor ***Takahiko KONDO***, is the co-leader of the ATLAS-Japan group.

Collaboration with DESY (German Electron Synchrotron Lab)

The HERA at DESY in Hamburg, Germany is the first electron-proton collider in the world. It collides a proton beam of 920 GeV with an electron or positron beam of 27.6 GeV. The e-p collision can be regarded as an extreme extension of what electron microscopes do; one probes the target with 'light' emitted from the electron enabling to look at the size as short as one thousandth of a proton radius. At such scale, one sees quarks and gluons in the proton, and their dynamical behavior. If the quarks are not the ultimate elementary particle, one would perhaps see their substructure - subquarks.

KEK has been participating in one of the two HERA collider experiments, ZEUS, with Tokyo Metropolitan and other Japanese Universities since its beginning. It consists of 450 physicists from 12 countries. Japan shares responsibility for its first-level trigger, uranium-scintillator calorimeter, hadron-electron separator and recently in forward-plug calorimeter and microvertex detector which is to be installed next year.

Carrying out a long-run experiment abroad requires creative thinking to solve many problems. One must deal with occasional hardware problems in DESY even when one is back to Japan, with remote diagnostics over the network. Video conferencing is extensively used in analysis team across several countries. We also have to deal with difference in fiscal-year period between Europe and Japan especially on budgeting.

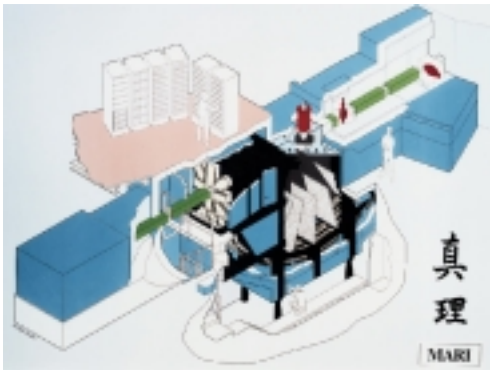
The life at DESY is very international and fun. The International Office in DESY makes life much easier for people from abroad. Starting from September 2000, HERA will undergo a major upgrade to increase the luminosity (the rate of particle collisions) by a factor of five. We look forward to the new data-taking of upgraded HERA from 2001, which gives us substantial increase in the physics potential.

The author of this article, Dr. ***Masahiro KUZE***, has been participating in ZEUS since 1990 and is coordinating its physics group for the searches for physics beyond the Standard Model.

United Kingdom - Japan Collaboration on Neutron Scattering

Neutron scattering is one of the most powerful methods to investigate atomic structure and dynamics of materials. It covers fields such as high-temperature superconductivity, magnetism, polymer science, material science, glass science, battery science, bio-science and so forth. KEK pioneered a pulsed neutron scattering technology since 1980's. It utilizes an accelerator-driven neutron source instead of a nuclear reactor. This technology gave an influence to the world and more intense pulsed neutron facilities have been built since then. Rutherford Appleton Laboratory in UK (RAL) is one of them. RAL established a facility, ISIS, in 1985, which has 50 times more intense pulsed neutrons. Our collaboration started for the mutual benefit and built a neutron chopper instrument, MARI in ISIS in 1990 which is an instrument for inelastic neutron scattering to investigate dynamics in materials. MARI produced quite outstanding results on studying dynamics of non-crystalline materials, hydrogenous materials, quantum-magnetic systems, high-Tc materials etc. Utilizing MARI, we verified that the pulsed neutron scattering method with chopper instrument is extremely suitable for investigating excitation from materials.

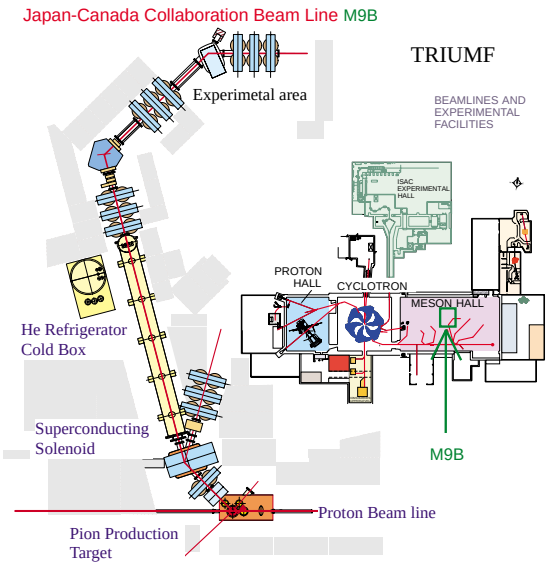
UK-Japan collaboration was extended to the second phase and built a new instrument, MAPS, which is a specifically designed chopper instrument for studying dynamics in single crystals. We are expecting to be able to obtain significant results on MAPS for understanding the mechanism of the high-Tc superconductivity, which has never clarified since the discovery in 1986. We send more than 20 physicists each year from KEK and universities to perform experiments in collaboration with researchers not only from UK but also from other countries.



The author of this article, Professor ***Masatoshi ARAI***, has been the leader of the project since 1999.

Japan-Canada Collaboration Program at TRIUMF

All the activities of Japanese Meson (Muon) Science Researches have historically been initiated long time ago, namely in 1974, by the small experimental team called Tokyo group at TRIUMF situated inside the campus of the University of British Columbia in the city of Vancouver, Canada. Successful developments of muon condensed-matter studies have triggered a construction of the present muon experimental facility at KEK in 1978.

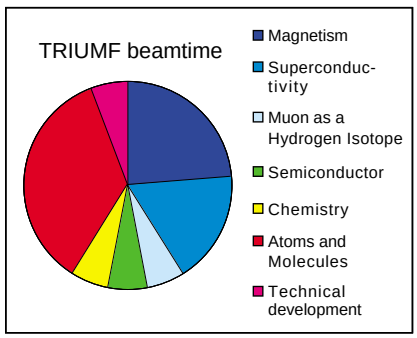


Complimentary to pulsed muon experiments at KEK-MSL, experimental program with continuous muons is still actively in progress at TRIUMF mainly by using decay μ^+/μ^- beam from the Japan-Canada superconducting muon channel built during the period of 1986-1988.

Several μSR studies probing microscopic magnetic properties of condensed matter, in particular, heavy Fermion system, strongly correlated electron systems including colossal-magnet-resistance perovskite oxides, etc have been conducted.

Additionally, some experiments related to particle / nuclear / atomic physics have also been conducted, in particular, muon catalyzed fusion in ortho-para controlled solid-D_2.

The allocated beam-time in each field of muon science for the KEK group (graph) demonstrates vivid activities of the collaboration program.



TRIUMF beam time allocated for the KEK

The author of this article, professor ***Kanetada NAGAMINE***, has been the director of Meson Science Laboratory since 1997.

Where the traditional Japanese art meets high energy physics

Mr. Bungo YOSHIDA playing Kumagai Naozane

Origin of the Bunraku, the Japanese puppet theatre, goes back several hundred years. It is a combination of a story-telling music, and puppets which made the Bunraku one of the most popular entertainment of the 17th century. When a great singer, Gidayu TAKEMOTO (1651-1714) and one of the most famous playwright, Monzaemon CHIKAMATSU (1653-1724), started a collaboration, Bunraku reached its peak of fame. CHIKAMATSU wrote 103 plays, many of his scenarios found way to Kabuki and even to movies of modern days.

CHIKAMASTU is called as “the Japanese Shakespeare” due to his dominating influence in Japanese theatrical plays. Between 1729 and 1749, lots of improvements, such as opening and closing eye lids, moving eyeballs, were incorporated to the puppets. By 1736, three manipulators started to work together for each puppet to provide more sophisticated movement. Movement of eyebrows and ears followed. One would think that an audience would see manipulators and not puppets on stage since there are many more manipulators and humans are significantly larger than the puppets. When you are dragged into the magic world of Bunraku, you are amazed to realize that you do not notice the manipulators and watch the puppets as the live actors / actresses on the stage. These puppets are actually quite heavy, ranging between 3kg to 13kg (some weighs 20kg) and the main player has to support the weight for over half an hour while providing sophisticated puppet movements.

Most Japanese have an image of traditional Japanese artists as very exclusive, stubborn, extremely conservative people, who would lead life along with very old customs which in turn have kept the arts in original form. Most of them keep the art within their family so that it would be very difficult to join the group if you are not related to the family. However, Bunraku is, as I learnt recently, one of the exceptions. Any talented person can join in Bunraku company.

I had never expected a link between them and our world. When we contacted two famous puppet players, Mr. Bungo YOSHIDA (the 5th) and Mr. Minotaro YOSHIDA, to plan a show at the ICHEP2000 as an evening program, we were surprised to find links between the artists and high energy physics. NHK TV (Japanese national broadcasting station) produced seven 90 minutes series on Einstein introducing his life and work (April-December, 1991). The program was presented by an Einstein puppet manipulated by Mr. Bungo YOSHIDA (the 5th) and his company. The puppet made the series more interesting than just showing old films and literatures. The puppet (and Mr. Bungo YOSHIDA) even traveled to Israel and had a show in Jerusalem.

Mr. Minotaro YOSHIDA playing SAIZO

As for Mr. Minotaro YOSHIDA, I was surprised to learn that his brother-in-law is a Canadian physicist who is a member of a CERN experiment! It's a small world.

Both Mr. Bungo YOSHIDA (Born May 3, 1934) and Mr. Minotaro YOSHIDA (Born March 1, 1953) have been very active in preserving the traditional art. They not only appear on many TV programs on traditional arts, but go all over the world to show Bunraku. They both have been awarded many prizes through their work. (Their last names are both YOSHIDA which is one of the famous family names which Bunraku Puppet players use. Their real names are Teruo TAKAHASI and Toyomi MIYANAGA, respectively.)

National Bunraku Company has been actively performing around the world starting from 1962 USA/Canada trip. Since then, they have performed in Europe, Australia, Canada, China, Korea, and so forth. Recent performances were in France (1997) with total of 11,600 audiences and in Germany (1999) with total of 7,000 audiences.

April 3

To support visitors better, Users Office started on April 3. Four office members have been handling reservation and payment for dormitory, user registration etc., processing around 200 requests per day. You can reach the office at : phone +81-298-6135, 6136, fax +81-298-64-6137, e-mail users.office@post.kek.jp.

May 16-20

Asian Meeting on Experimental Physics and Industrial Control System (EPICS) was held in KEK with 49 participants among which 18 were from abroad.

June 7

New building (Building #4) was completed and opening ceremony was held on June 7. Most people from Tanashi Branch have moved to Tsukuba.

July 27-August 2

The 30th International Conference on High Energy Physics (ICHEP2000) was held in Osaka with over 1000 participants. Major topics were the violation on charge and parity symmetry in B meson system, neutrino mass measurement and the evidence of tau neutrino existence. Over 300 papers were presented and 28 plenary talks were given in the conference. For more detail, see http://ichep2000.hep.sci.osaka-u.ac.jp/

Video pictures of each presentation were provided for non-participants within a few hours after each talk. A public lecture, "Are we really made of quarks?", presented by J.I. Friedman on the 30th was attended by over 500 enthusiastic audiences.

August 8-12

Second International Workshop on EGS (Electron Gamma Shower) was held in KEK with over 100 participants. (13 from abroad)

September 15

Despite of rainy weather, over 2000 visitors came for the annual KEK Open House. They visited KEK facilities, listened to lectures and participated scientific programs.

September 23

4th KEK TRIATHLON competition was held in KEK site. It combined 1km of swimming, 26.4km of bicycling and 6.6km of running. All 39 participants survived the athletic torture.

Send in your KEK LOGO design

KEK is planning to renew its LOGO and inviting general public to participate in the design contest of the logo. Send your design before November 15, 2000.

For detail, check our home page at; http://www.kek.jp/
For any questions, call +81-298-64-5114 or e-mail to tochigi@mail.kek.jp

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Japanese Language teacher, Mrs. Maruyama, passed away

The teacher for the KEK Japanese Language Class, Mrs. Setsuko MARUYAMA, passed away on September 14th before starting next semester. She was loved and appreciated by many KEK visitors. She will be remembered.

Picture on front cover
It did not take long to get so many passports in front of me after I asked for it in KEK. This clearly shows that high energy physics is a world collaboration. Words representing "elementary particle", "accelerator", etc. were written by their own languages when they came in with their passports. (back cover)

Picture on back cover
Many red strings on the globe represent collaborations of some kind between KEK and other laboratories of the world. In Japanese folk tale, a couple who eventually get married were tied together by a red string of fate in their previous life. Someday, the world would be covered with such strings connecting everyone to everyone and the world would become one big family.

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Please send comments to : KEK International Affairs Division
1-1 Oho, Tsukuba, Ibaraki, 305-0801 Japan
telephone +81-298-64-5130, telefax +81-298-64-5195
e-mail Kazhira@mail.kek.jp