Vol.3 No.1

KEK News

Applied Research Laboratory

Radiation Science Center
Computing Research Center
Cryogenics Science Center
Mechanical Engineering Center

High Energy Accelerator Research Organization

Radiation Science Center

The Radiation Science Center conducts various tasks related to the radiation and chemical safety in KEK. There are tasks concerning radiation workers, radioactive materials, measurement and control of radiation levels, and analysis and disposition of chemical substances. KEK operates various accelerators of which the energy and intensity are the highest in Japan and new method to estimate or to measure various quantities related to radiation and chemical safety are required to assure our safety control level to the supervisory offices of the government. In the Radiation Science Center, 15 staffs (10 scientists and 5 technicians) are engaged in the radiation-safety work and 3 staffs (2 scientists and 1 technician) are working for chemical safety with other contracted helpers.

Developments of various detectors and Improvement of EGS4

The Self-TOF detector is developed to measure high-energy neutrons in an energy range of 100 MeV to 1 GeV. It consists of a radiator composed of 20 thin plastic-scintillation counters, a start counter and a stop counter (segmented into nine plastic-scintillation counters). The neutron energy is measured by the time-of-flight of protons produced in the radiator.

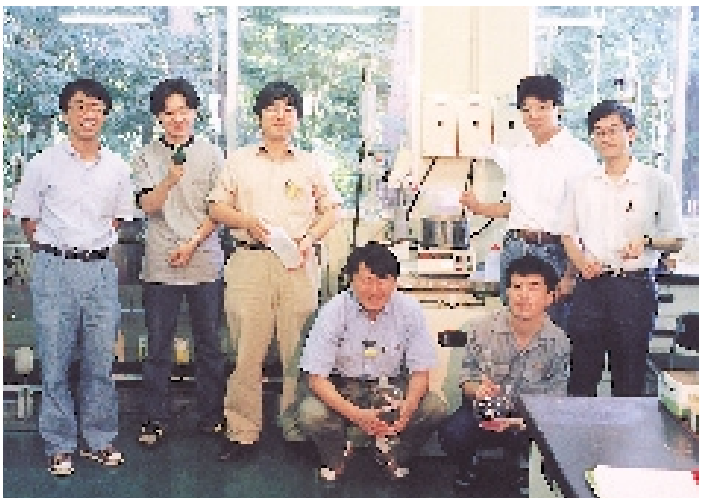
The penetration of neutrons that has energy over 100 MeV in a shielding was measured for the first time. We are developing a beam-loss-location monitor using quartz fiber tube filled with liquid scintillator. The location where a beam particle hit a beam pipe when it came off from orbit is measured by the arrival time difference of light signals to each end of the fiber where PMT is attached. The liquid scintillator can be used in high-radiation areas of accelerator tunnels and the quartz provide light path for a long distance.

The resonance-ionization method is now applied to measure trace amount of elements or ultra-low-level radioactive materials. The precise simulation of electrons and gamma-ray transport in matter requires taking into account the interaction between a low-energy photon and bound electrons. For this simulation, the EGS4 code is widely used. The interaction between bound electrons in L and higher orbits with a low-energy photon, the Doppler effect of orbital electrons and polarization of photons were newly included to the EGS4 code. The X-ray produced in the Photon Factory have been measured by a solid state detector and compared with the calculation. The agreement between experimental results and the calculation using EGS4 was remarkable.

Radiation activation of various materials, radiation damage, and chemical analysis

The estimation of radioactive material production in material is important. Various reaction cross sections for high-energy neutrons and protons have long been measured. The data are useful for the design of the accelerator facilities. The new beam line for the neutrino experiment requires the estimation of the soil activation around the decay volume of the neutrino beam line. The related experiments and estimation using a calculation code were carried out. The principle and the policy for the management of soil activation were newly established using our results.

Radiation damage on various materials can be studied by measuring life-time of positronium. A new device was developed which generates a pulsed positron beam with very high efficiency from positrons emitted from a ^{22}Na source by applying a specially generated high voltage. The device is now used for analysis of various targets.



A novel method of separation and concentration using unique features of surfactant assembly at the sillica-water interface has been developed. The surfactant assemblies were applied for separation and concentration of trace metals as chemical compound of hydrophobic chelates.

The author of this article, Professor ***Tokushi Shibata*** is the head of the Radiation Science Center and the radiation supervisor in KEK since 1997.

Computing Research Center

The Computing Research Center has been operating a large-scale computer and network system for various research activities at KEK. Photo below shows some of our staff members working for system management and user support. Two ladies on the left end are visiting researchers from the Computer Center of IHEP at Beijing.

COMPUTING

We are responsible on most computer systems such as Central system, KEKB system, Nuclear Research system, Photon Factory system and Super-computer system. The systems installed in the Computing Building are illustrated in the diagram on opposite page. The Central computer system is shared by several working groups. Major use of the system is for data analysis by a number of experimental groups at 12 GeV Proton Synchrotron. The KEKB system is dedicated to the data analysis of the BELLE experiment at the KEK B-Factory Project. Large amount of data will be stored and analyzed in the coming several years to study CP violation in the nature. A Fujitsu VPP500/80 is the Super-computer system with a power of 128 GFlops. The system comprises 80 vector processor elements. The research programs utilizing the system include a lattice gauge calculation on QCD, a simulation of nuclear physics and of astrophysics.

NETWORKING

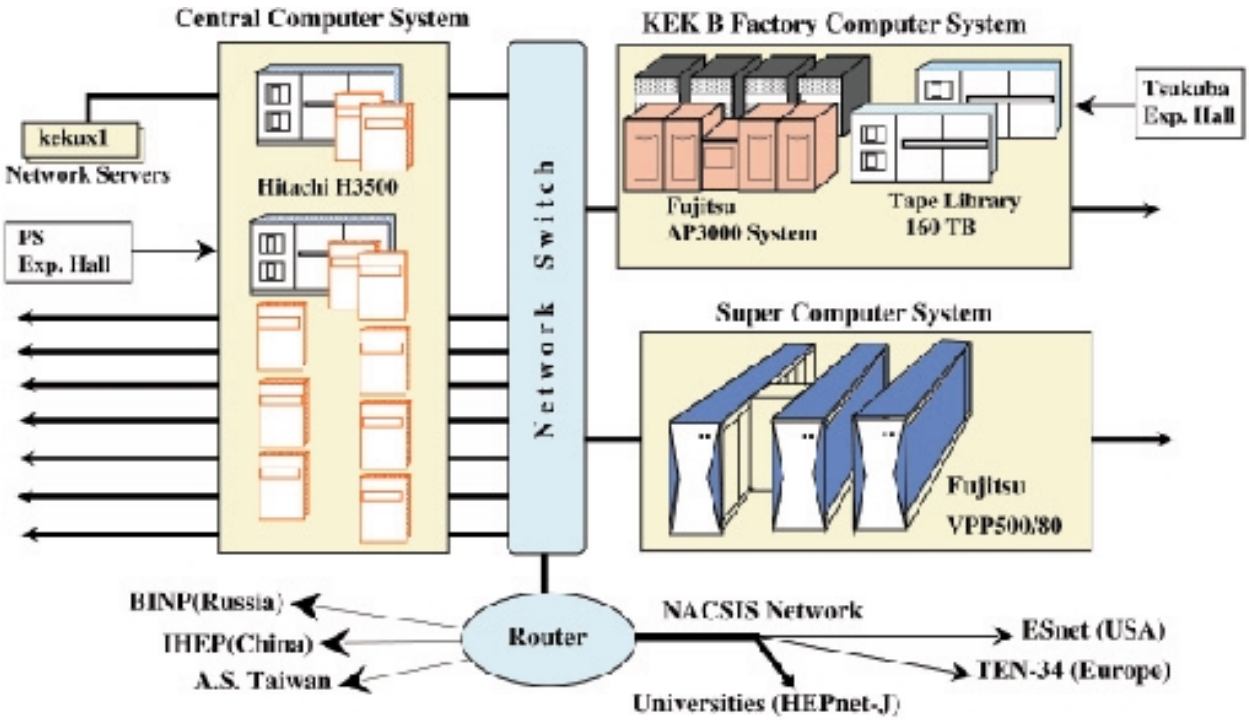
The operation and management of the network is one of the major missions of this Center. The world-wide network connection to universities and laboratories has been grown to be huge in recent years. Traditionally, world-wide member institutes of HEP community collaborate to keep the network connection run smoothly. They operated the HEPnet using the dedicated leased line or bandwidth. Currently, KEK is connected to Japanese universities, to US and Europe as well as to

Russia, China and Taiwan. The network is also an infrastructure for more general communications such as electronic mails and video conferencing all of which are supported by this Center.

R&D PROJECTS

The Center is also active in research on various aspects of computing. Major subjects of R&D at the Center are related to large-size data storage and analysis as well as to simulation on physics processes and detector systems. Currently, a study on object-oriented approach for data analysis is underway not only in the application software but also in the system software. The center has been contributing to the world-wide development of the GEANT4, a detector simulation program tool kits based on the object oriented programming technology.

The GRACE system, a program package for automatic amplitude calculations on Feynman diagram, has been extended to treat SUSY Standard Model in collaboration with Computational Physics Group of IPNS of KEK.



The author of this article, Professor ***Yoshiyuki Watase***, is the head of Computing Research Center since 1991.

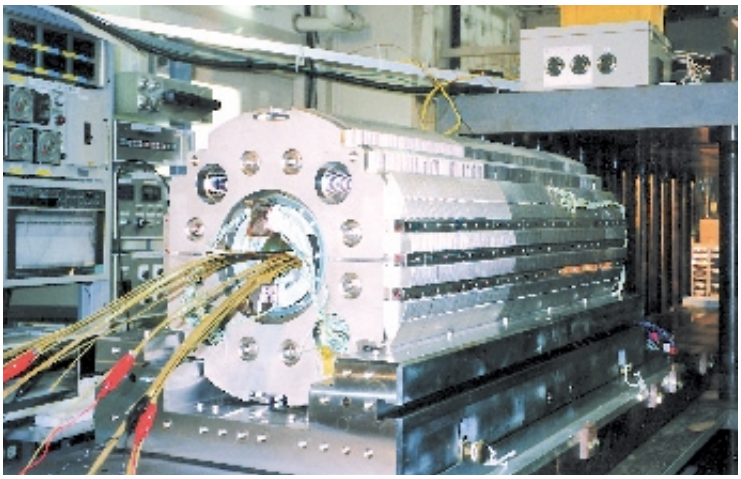
Cryogenics Science Center

Supply of Liquid Helium

The temperature of liquid helium is -269 ℃ (4.2 K) at which all other matters, even hydrogen gas, is frozen. The properties of materials change at low temperatures. Then, liquid helium is an important coolant used for investigating material properties at low temperatures. The Center which is constituted of 12 people supplies a large amount of liquid helium, more than 100,000 ℓ in FY1998, to various researches with a capacity of 300 ℓ /hr. Since helium is a valuable resource, evaporated helium gas is recycled. Another liquefier (170 ℓ /hr capacity) has been operated exclusively for the tests of Large Hadron Collider (LHC) magnet in a collaborative work with CERN.

R&D of LHC superconducting magnet

A cooperative program to develop strong focusing superconducting quadrupole magnets for LHC has been running between KEK and CERN since 1995 as a main frame of activities of the Center. The magnets are for making accelerated beams focus into a very small size.



Superconducting magnets of over 9 tesla field strength using Nb-Ti cables should be cooled with superfluid helium at 1.9 K.

The 1m long model magnets have been successfully developed and have shown satisfactory performances to stand for the severe operation conditions. Now the R&D are in a stage of the construction of the prototype magnets which are 6.3 m long.

Second 1-m model magnet for CERN/LHC

It is important to know the heat conduction in superfluid helium to remove beam-induced heat in these magnets. Superfluid helium below 2.17 K has no viscosity and goes through every tiny micro channel, and then it has excellent cooling performances. The study of the heat transfer characteristics has been carried out for applying its excellent properties to the LHC magnets.

Superconducting magnets for particle detectors

R&D of superconducting solenoids for particle detectors have been carried out in a joint work with the Inst. of Particle and Nuclear Studies of KEK. High strength aluminum-stabilized

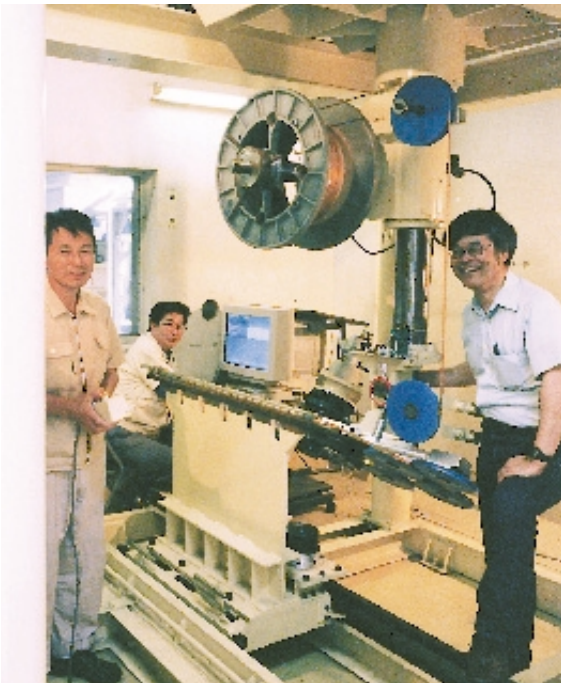
superconductor is a key technology to develop very thin super-conducting solenoids. It can be realized with “micro-alloying” to very pure-aluminum of 99.999 % combined with “cold work” without loss of electric conductivity required for a stabilizer. The strength of the developed micro-alloy aluminum is four times higher than pure aluminum. A superconductor stabilized with the high strength aluminum is applied to the ATLAS central solenoid being developed at KEK.

R&D of a high-field magnet beyond 10 tesla

For future accelerators, it is important to develop superconducting magnets over 10 tesla using advanced superconducting materials. A collaborative design study of 11 tesla dipole magnet with Nb_3Sn has been carried out in collaboration with Fermilab and LBL of USA. Construction of dipole magnet with optimized design has started at Fermilab. In parallel, winding and other necessary tests for the construction have been carried out at KEK. The 5-axis automatic winding machine for high field magnets is developed for winding the superconducting coils.

Detection of gravitational waves

Detection of gravitational waves is one of the most concerned researches for fundamental physics. Laser interferometric gravitational wave (GW) detectors are being developed and constructed in Japan, the United States and Europe. To improve the sensitivity of the GW detector, a cryogenic sapphire mirror has been developed by collaboration with the Inst. for Cosmic Ray Research, U. of Tokyo. Basic idea of the mirror has been confirmed effectively by experiments and a positive result of very high Q-value. We are confident that the sensitivity of the cryogenic GW detector will be improved by one order of magnefude.

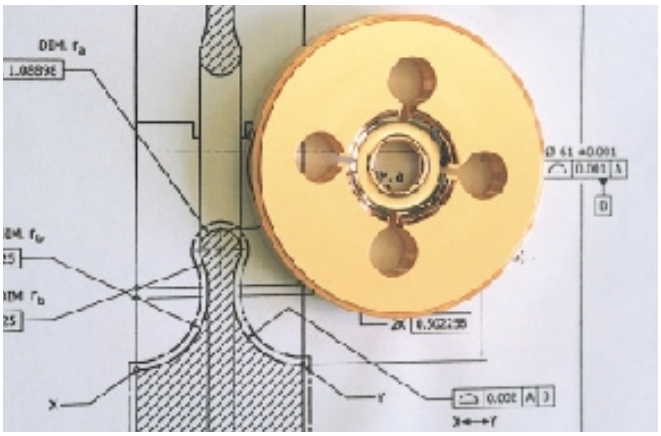


Automated winding machine

The author of this article is Professor ***Takakazu Shintomi*** who has been the head of the Cryogenics Science Center since 1995.

Mechanical Engineering Center

In the quiet precision machining room, one can hear slight hissing sound of air bearing of an ultra-precision lathe, swish sound of cutting oil mist, monotonous plopping sound of air regulator and air conditioner fan that keeps the room temperature at exactly 20℃. A 61 mm diameter copper disk is cramped with the vacuum chuck located at the top of the work spindle, spitting out a thin copper string shaved off by a diamond-cutting tool. These are the X-band accelerator structure disks that were designed and developed by KEK and SLAC collaboration. Machining accuracy on the inner side of the disk is within ±1μm and the surface roughness is under 0.05 μm. (picture left)



There are three main functions of the Mechanical Engineering Center (MEC); service workshop, R&D supporting and own research on the mechanical engineering field.

The service workshop

MEC has a responsibility of manufacturing parts and sometimes assembled machines for the researchers' demand, if outside manufacturers can not provide them because of either technical difficulty or of required delivery time. The staffs of MEC design, fabricate, assemble, install and adjust them quickly. They have installed about one hundred machine tools in their machine shop factories.

We have numerically controlled machines, such as 5-axis milling machine, ultra-precision lathes as well as conventional machine tools. To fulfill the requirement of the scientists, various types of special machines are also used here: electric cutting machine, water-jet cutting machine to machine aluminum, tungsten, styrofoam, stainless steel, aerogel; welding machines using gas, electricity, LASER and electron beam for making joints between all sorts of materials. Some machining tools were developed here to accommodate special requests; ultra precision mirror cutting and polishing machine to make an aspherical surface mirror for the hard X ray radiation. We fabricated the five-cell super-conducting cavity designed by a collaborated work of ARL of KEK and JAERI.

The R&D supporting

We collaborate with researchers on development works for special apparatuses with new ideas and concepts on mechanical designing and fabrication technology. We have ten CAD workstations for anything from FEM analysis to general drawing. Here are some examples. We developed and

produced a special high precision machine to bore 33,440 holes for the end plate of the BELLE central drift chamber. We participated in the BELLE Silicon Vertex Detector (SVD) team and produced the SVD mechanical design that fulfils all the difficult requirements in rigidity, precision, etc. We also developed a gluing process involving automatic robot mechanism for the Si-ladder and fabricated the SDV.

Own research projects

Since producing the X-band accelerator disks required sub-micron ultra-precision machining, we have been accumulating technical data to be used for the next challenging projects. Some studies are on tool life for mass production in the future, the accuracy and stability of the bonding process of disks, the cleaning process before bonding and some measurement technologies. They are still studying the fabrication of high precision mirror. They also study about the process technology of the super-conducting cavity made of the Nb-Cu clad material to decrease the manufacturing cost while keeping its electric performance.

MEC members are 3 scientists, 16 engineers and a secretary

The author of this article, Professor ***Nobuteru Hitomi***, has been the head of Mechanical Engineering Center since 1997. He worked in automobile industries as a research engineer before he came to KEK.

The KEK-PS Beam Channel Group

The KEK-PS beam channel group is responsible for design, construction, operation, maintenance and upgrading of all the primary and secondary beam lines of the KEK 12GeV Proton Synchrotron. During the last several years, the group devoted themselves to the new neutrino beam facility to send neutrinos to the Super-Kamiokande located 250 km away. (See KEK News, June 1998.)

One of the primary proton beam lines was extended some 300 m with approx. 90 magnets placed in the beam line. It was remarkable that the whole work was handled by this group of only 5 engineers and 4 physicists.

Front row (left to right)
Y.Suzuki, Y.Kato,
Y.Yamanoi,M.Minakawa, E.Kusano
Rear row (left to right)
M.Takasaki, K.H.Tanaka,
M.Ieiri, H.Noumi

Yoshihiro Suzuki has more than 25 years of experience. He took care of DC power supplies for magnets, pulsed power supplies for the magnetic horns, and their remote control system. Yoji Kato is responsible for all the radiation shields of the whole beam channels as well as on the interlock system for the radiation safety. Yutaka Yamanoi is in charge of beam monitors, magnets, and many other devices (target driver etc). He is now concentrating on the magnetic horns. Michifumi Minakawa is working on electrostatic beam separators, cabling of beam monitors and power supplies. He is an expert on the finite-element analysis program, ANSYS. Erina Kusano is the newest member. She has been working on magnets and beam profile monitors.

Those five engineers work with physicists of the group: Kazuhiro Tanaka, Masaharu Ieiri and Hiroyuki Noumi who are in charge of the beam-channel design, beam monitors and beam tuning. The beam channel group is conducted by Minoru Takasaki.

(K.Tanaka)

Hirotaka Sugawara Received the Medal with Purple Ribbon

On April 29, Hirotaka Sugawara, the KEK Director General, was awarded the Medal with Purple Ribbon from the Japanese Government for his outstanding contributions to theoretical physics. Sugawara's interest in physics has been very broad. His ambitious paper "A field theory of currents" (1968) opened the door to the algebraic formulation of field theories. The Sugawara construction of the energy-momentum tensor is now the indispensable tool in formulation of string theories. He formulated extended model of elementary particles with T.Eguchi. He created a zero-parameter model of the nuclear potential with F. von Hippel. The paper "CP violation in six-quark model" with S. Pakvasa pointed out the importance of the paper by Kobayashi and Maskawa.

Sugawara spends most of his time as the Director General of KEK. On weekend, he enjoys studying theoretical physics as a Sunday physicist. Recently, he is interested in cosmology in the superstring theory, especially in the model without stable vacuum. This idea might be originated from Zen Buddhism. He is also studying the algebraic formulation of the relation between the eleven dimensional theory and string theories. He received the Nishina Memorial Prize by his work on "Lee-Sugawara relation" in 1971. He was also awarded the Toray Science and Technology Prize for his outstanding contribution to algebraic formulations of field theories in 1996.

Born in 1938 as a son of a Zen Buddhist, Sugawara's interest in science, especially in chemistry, was aroused when he was in high school. As he grew up, he was fascinated by theoretical physics. When he was still a graduate student at the U. of Tokyo, he derived a relation for non-leptonic hyperon decay amplitudes, called "Lee-Sugawara relation". He received Ph.D. from U. of Tokyo in 1966. After spending several years each at Cornell, U.C.Berkley, U. of Chicago and Tokyo U. of Education, he became an associate professor of the INS at the U. of Tokyo in 1970. In 1974, he came to Tsukuba as a professor of KEK. He has been the Director General of KEK since 1989.

(K.Higashijima)

The Enjoyment of Summer

by Henry Mittwer

Summer is best in the evening
on a moonlit night ...
Even if it is dark without moon, it is lovely
when the fireflies dart all over,
or even one or two fly by here and there
with cool lights.
It is also wonderful when it rains.

This is one of my favorite stanzas from the famous Makura no Soshi, “Pillow Book”, written by Sei Shonagon, a court lady who was active in the capital city, Kyoto, during the elegant Heian period (794 -1192).

Anyone who has visited Kyoto in the summer knows how hot and humid this time of year is here. Many a night, it seems unbearable to sleep without air-conditioning the room. But for one who, like Shakespeare suggests, “finds tongues in trees, books in the running brooks, sermons in stones, and good in everything,” finds that the wind and rain and thunder, the flowers and the forest, the singing birds and even the stinging insects comfort the fragile heart and save the soul from adversities.

I have on my bookshelf another musty old book which may not be too useful in this science-oriented day. Called Tsurezuregusa, translated into English as “Harvest of Leisure”, it is by Yoshida Kenko (1282-1350), who writes that “a house should be built to be comfortable in summer.” What he means is that it is not so difficult to cope with the cold of winter; one can put on extra clothing. But when one builds a house, one should consider the direction in which the breeze tends to blow in the summer, and design the rooms so that the breeze can flow through them.

Here is a haiku poem by Matsuo Basho (1644-94):

Mountain and garden –
they move and enter
the summer room

Though perhaps prosaic, it shows that the traditional Japanese house is made to open up to the outside world in the summer; there is no barrier – not even insect screens or glass panes.

Just like we change our clothing to suit the weather, so the Japanese house changes from a winter outfit to cooler summer wear. At the beginning of summer, sparsely woven, thin bamboo shades are hung under the overhanging southern eaves, to soften the glaring summer sun. The sliding panels of thick, double-layered paper that divide the rooms are exchanged with loosely fitted reed panels which let the air flow freely through the rooms, and a fine rattan carpet is spread

over the thick tatami floor matts, to insulate the heat that tends to get trapped in the tatami.

By using the bamboo shades, the room darkens to simulate something like a cool cave-like interior. The rattan carpet over the floor provides tactile coolness. Sprinkling water in the garden quenches the dry earth and thirsty greenery and refreshes the atmosphere.

Among other things that symbolize summer in Japan, There are windchimes, goldfish, shaved ice, watermelon, and herbal insect-repellent incense, the metal or glass windchime swayed by the slightest breeze brings auditory coolness in its high-pitched tinkle. The plump goldfish swimming lazily but gracefully in a fancy glass bowl offer a visual sensation of coolness. A crystal-like bowl of shaved ice topped with lemon or lime flavoring, or a bit of cold and juicy watermelon, gives chilling gustatory satisfaction. The insect-repellent incense pleases the olfactory nerves by adding its special fragrance to the summer atmosphere. The Japanese discovered such wonderful props that appeal to the various senses, to create the illusion of coolness in the summer, and this ingenuity has been both artistic and poetic.

But alas, with the advent of the mechanical age and the Westernization of Japan, the artistic and poetic ingenuity once seen in the Japanese house has become a thing of the past. Those devices once used to created the illusion of coolness in the summer have lost their purpose. Above all, the people – traditionally so nature-conscious – have lost their poetic response to nature.

The other day, a sultry summer afternoon, I went to town on a little errand. A small, antiquated shaved-ice banner hanging out at a modern coffee shop attracted me, and, wiping the perspiration from my brow and neck, I walked in through the automated glass door and ordered a bowl of lemon flavored shaved ice. By the time the pantaloon-attired waitress brought the anticipated shaved ice, my perspiration had dried and my body was cold. I put one spoonful of the yellow-colored ice in my mouth, and that was enough. The efficient room cooler had lowered my physical temperature, but it also ruined my enjoyment of the hot summer afternoon.

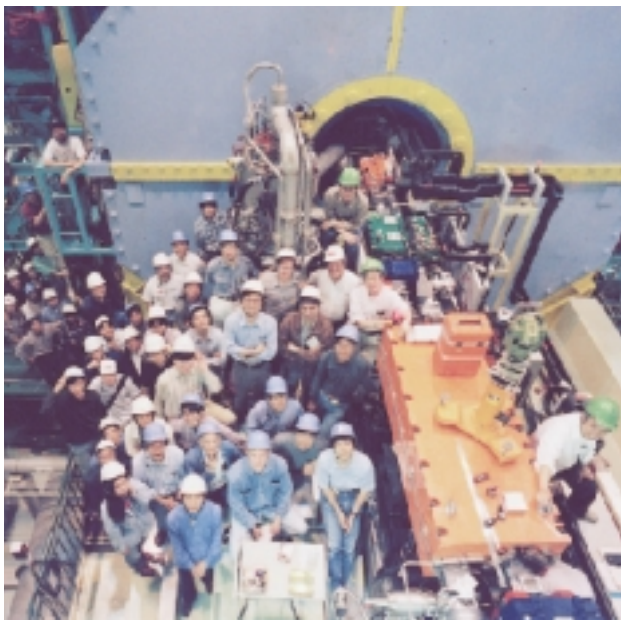
Mr. Mittwer (80) is a Zen priest of Tenryuji Temple, Kyoto. He is active as a lecturer, painter, ceramist and writer. When he visited KEK not long ago, I had the pleasure of guiding him on a tour through experiment areas. (Editor)

April 29

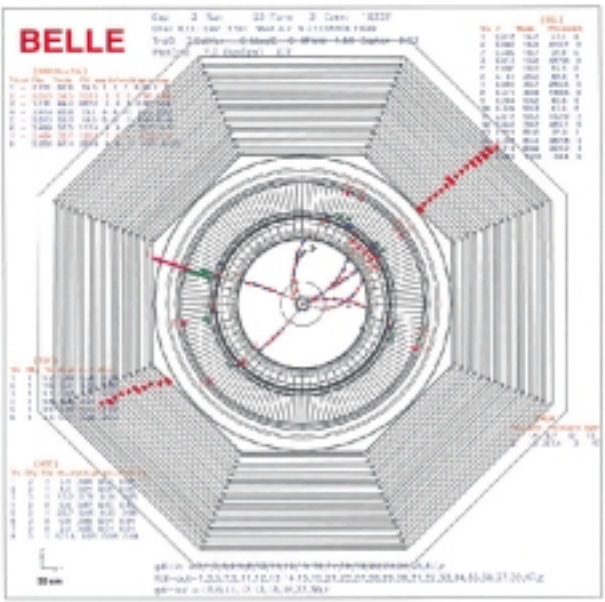
KEK DG, Hirotaka Sugawara received a "Medal with Purple Ribbon" from Japanese Government.

June 1

BELLE found the first event they have been looking for on June 1. They started to take data on May 31 after years of preparation. Details are found in http://bsunsrv1.kek.jp/



BELLE detector in KEKB beam line



BELLE first di-muon event with M(μμ)=3.1GeV

June 3 and 4

The Twenty-First Meeting of Japan/US Committee for Cooperation in High Energy Physics was held at KEK. The meeting was co-chaired by S. Yamada of KEK and S. P. Rosen of US DOE.

June 4

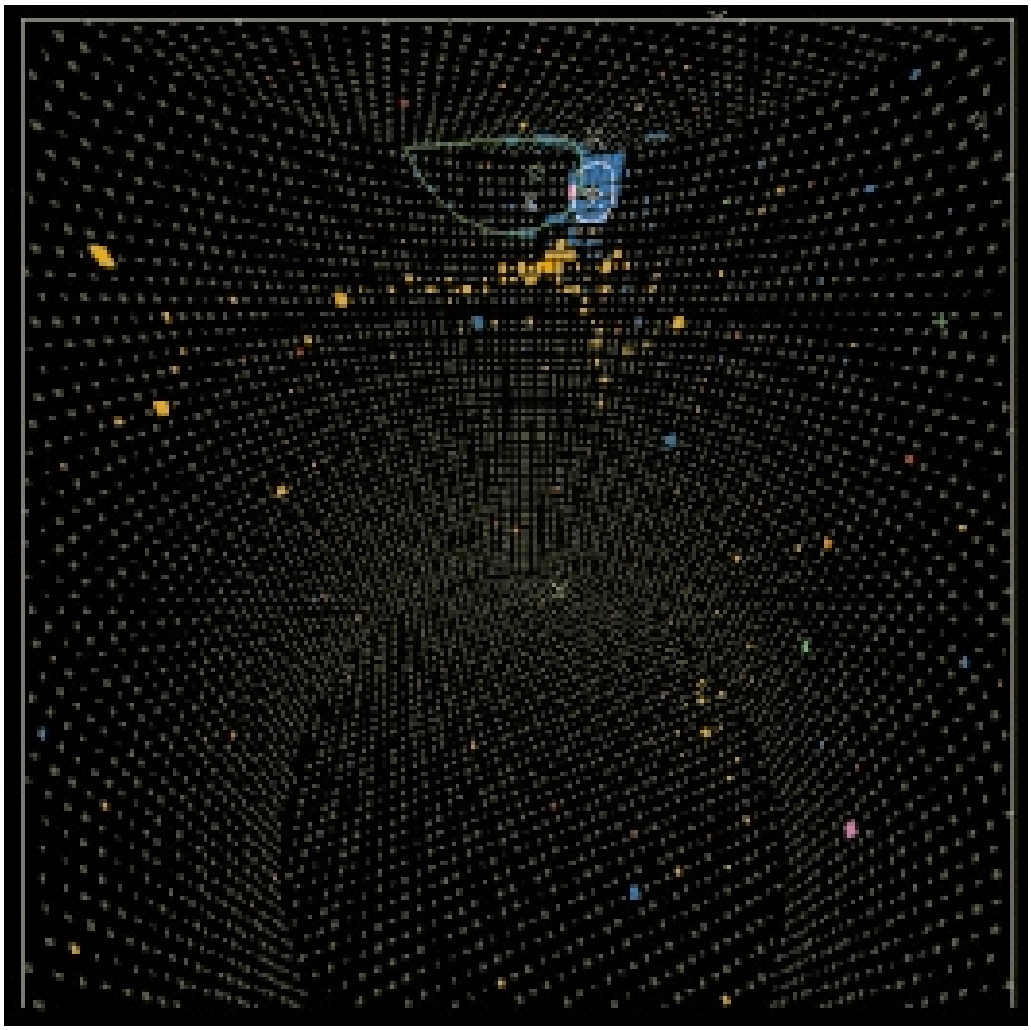
Akira Yamamoto of KEK received the Honorary Ph.D. from Uppsala University of Sweden for his contribution to superconducting magnet technology.

July 22-July30

International Science School was held with high school students from 10 countries as well as students from Japanese high schools.

June 19

Long-baseline Neutrino Experiment, K2K, observed the first event at Super-Kamiokande site located 250 km from KEK. The group has been observing events in the Near-Detector located in KEK, but this observation assured that the neutrino beam from KEK is properly directed to the Far-detector in Kamioka as designed. Details are found in http://neutrino.kek.jp/



First Super-Kamiokande event as seen from a far away corner. Spot size corresponds to observed charge.

Picture on front cover
Drill bits are quite beautiful to look at. They show another asymmetry in universe.

Pictures on back cover
Thomas Edison used bamboo filament from Kyoto, Japan (lower picture) for his first mass-produced light bulbs (1880 - 1893). The lamp here is a real one of around1880. (Courtesy of Mr. Saburo Tatemoto)

ISSN 1343-3547

KEK News Vol.3, No.1 September 1999

Published by High Energy Accelerator Research Organization
1-1 Oho, Tsukuba, Ibaraki, 305-0801 Japan
telephone +81-298-64-1171, telefax +81-298-64-5195
Printing and cover design : Matsueda Printing Inc.
2438 Tenmancho, Mitsukaido, Ibaraki, 303-0034 Japan
Editor : Tokio K. OHSKA
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