

## On KEK B-Factory

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There are two principles which the management of a research institute like KEK must respect when dealing with such big project as B-Factory. One is the scientific merit of the project and the other is the organizational consideration which includes financial, human, technical and historical elements. Ideally, the two principles are to be fully taken into account. But, in many cases, one or the other is only partially fulfilled due to unavoidable circumstances. The lack of flexibility to respond to all possible situations is more dangerous and may lead to a disaster as in the case of SSC. I will describe the process which lead to the successful construction, operation and physics presentations of KEK B-Factory following faithfully the official records.

Subject Index: 151, 152, 155

### §1. Prologue

The global environment of the late 1980's and the early 1990's in the field of high energy physics can be characterized by the US push of SSC and the European effort of SSC counterpart LHC. Already in 1985, Japanese High Energy Committee chaired by Yorikiyo Nagashima decided that the Japanese high energy community will participate in SSC (and/or LHC) experiment. It also recommended that, domestically, the JLC should be considered as the top priority. In fact, the US government approached the Japanese government at the highest level and asked Japan to get involved in the SSC project in a major way.\*) It promoted heated discussions in many sectors of scientific, bureaucratic, political and industrial communities. Negotiation was started and KEK was heavily involved in it. Inside KEK, the TRISTAN project was going smoothly both technologically and also physics wise. But the attitude of the general public and that of the government were a different matter. The top quark, which was one of the major scientific goals of TRISTAN, turned out to be out of reach within the TRISTAN energy. The justification of the project was under serious attack because of this unlucky situation. Also, historically, nuclear physics project had been postponed due to the TRISTAN and the sentiment was mounting among the nuclear physics community that it should be their turn to get funding for their project now that the TRISTAN project was over. Synchrotron radiation community was also waiting for the TRISTAN project to be ending. The

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\*) At much later time, Prime Minister Miyazawa told me directly that he was surprised that the US President George H.W. Bush asked him to get involved in SSC because, to him, SSC looked like a kind of US version of "Ko kyo jigyo" (budget for the public works). Nevertheless, he asked Wataru Mori of "Kagaku Gijutsu Kaigi" (Council for the Science and Technology Policy) and Jiro Kondo of "Gakujutsu Kaigi" (Science Council of Japan) to discuss the matter. He thought that he would accept Bush's offer if the Japanese researchers were interested in it.

so called third generation facility which has the emittance of one order of magnitude smaller than that of KEK Photon Factory was already becoming a realistic project both in the US and in Europe. It was clear that something had to be done. Joint Kamiokande project of KEK-ICRR-Physics Department of Todai turned out to be extremely fruitful although the initial objective of finding the proton decay was not realized. The next generation of water Cerenkov detector-SuperKamiokande was being contemplated. I became the Director General of KEK in April 1989 under such an environment.

## §2. First proposal of B-Factory—wrong idea

There were several options for KEK to choose as its direction. One of the most persuasive was to transform the TRISTAN into the synchrotron radiation facility and KEK should work towards the realization of Japan Hadron Facility (JHF) which was basically a nuclear physics project. In this scenario, the Japanese high energy physics community was supposed to participate in SSC and/or LHC without major domestic project. Not many high energy physicists agreed on this scenario. They claimed that the domestic high energy physics project should exist even though the participation in some oversea projects might also be important. The first written version of the proposal (Fig. 1) towards this direction was made in 1988, one year before I became the Director General of KEK, although the proposal in the form of Letter of Intent to the TRISTAN Advisory Committee was started back in 1985. The idea was to use the TRISTAN Accumulator Ring for the B-factory. Unfortunately, its luminosity goal was too low and it was not an asymmetric collider either. The scientific capability was rather low. This meant that my first principle of considering the scientific merit of the project was not quite fulfilled. Nevertheless, this was an attractive idea from the second principle of looking at it from the organizational view point. Namely, the project might not interfere with the scenario of transforming the TRISTAN into a radiation facility. Director Tetsuji Nishikawa asked the Tristan Program Advisory Committee (TPAC) to assess this proposal in fiscal 1988. The committee members were Satoshi Ozaki (chairperson), Shuji Orito, Toshio Kitagaki, Roy Schwitters, Hirotaka Sugawara, Paul Soding, Kasuke Takahashi, Tadao Fujii and Yoshio Yamaguchi. The committee's decision was the following:

*The TPAC recommends that a decision on the proposal for study of B-Physics at the AR (Accumulator Ring) be deferred. The committee was impressed by the prospects for studying B-physics as described in this proposal and wishes to commend the proponents for the realistic case that was presented. However, the committee is concerned, given the existing competition in this field, the long lead-time necessary to complete the new detector and AR modification, and the significant laboratory resources required, that the scope of this effort seems marginal. The committee wishes to note that B-physics may become a major part of KEK's scientific program after TRISTAN effort matures. Accordingly, it encourages the laboratory to work with the present proponents and others to study accelerator and detector issues that could lead to a world-competitive program in B-physics.*

As this recommendation shows, the proposal was not thought to be acceptable



KEK Internal 88- 1  
May 1988  
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PROPOSAL FOR  
STUDY OF B PHYSICS  
BY  
A DETECTOR WITH PARTICLE IDENTIFICATION  
AND HIGH RESOLUTION CALORIMETRY  
AT TRISTAN ACCUMULATION RING

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Fig. 1. A cover page of KEK Internal 88-1, May 1988.

from physics point of view. We discussed this proposal extensively within the committee and also outside of it with the members of the group who made the proposal. But the conclusion of the committee was unanimously negative to it and recommended that a new group should be formed to seriously consider other options of B-factory. This committee was the last one under Director Nishikawa and the new committee was formed in 1989 with some of the new members appointed by myself.

### §3. Small ring version of B-factory

The experience of the study of  $c$ -quark taught us that, while the proton machine may be advantageous as a discovery machine, the electron machine is absolutely necessary for the detailed studies. It was, therefore, clear at that time for any high energy physicist that we need B-factory based on the electron collider for the purpose of the detailed study of  $b$ -quark including the  $CP$  violation. The same thing is still true at the present time for the top quark. In 1989, when I became the Director of KEK, a task force to study the issues related to B-factory was formed, follow-

ing the recommendation of the Tristan Program Advisory Committee of 1988. The task force was lead by Fumihiko Takasaki and it had no connection to the previous proposal. AR Ring version was abandoned completely because of its scientific weakness. This was my decision as the Director of KEK, but it was a decision supported unanimously by the Tristan Program Advisory Committee as the record shows.\*) The newly formed Tristan Program Advisory Committee oversaw the activities of the task force. Members of the committee included Seigi Iwata, Satoshi Ozaki, Shuji Orito, Yoshitaka Kimura, Makoto Kobayashi, Gunter Wolf, Richard Taylor, Tadao Fujii and Sakue Yamada. The B-factory considered at this stage was, in a way, an ideal one with a new tunnel inside the TRISTAN Ring. The circumference of the new ring was 1415 m with asymmetric energy of 3.5 GeV  $e^+$  and 8.0 GeV  $e^-$  and the target luminosity was over  $10^{34}$ . The report of the 1990 Tristan Program Advisory Committee on the B-factory task force was the following:

*2) The committee was impressed with the significant progress which has been made in the past year by the B-physics Task Force. The committee believes that a B-factory at KEK will provide an important facility for the progress of high energy physics, and recommends a conceptual design report to be generated within next 10 months. Because of the importance of CP violation in the B-meson system, the committee feels that the specifications of any such machine built at KEK should call for luminosities  $3 \times 10^{33} \text{cm}^{-2} \text{sec}^{-1}$  or more to be achieved shortly after the turn on of the machine, and suggests that efforts be made to avoid design features which would limit the luminosity to less than  $10^{34}$ . Since it is the average luminosity which determines the amount of data which is produced, the machine design should stress reliability and ease of operation along with high peak luminosity.*

But the committee also adds that *it was very impressed by a rapid development of JLC studies and it recommends that the study of B-factory which is regarded as the continuation of TRISTAN Project should not interfere with it.* I was attending all the advisory committees of KEK including the Tristan Program Advisory Committee. In the committees, we talked about all sorts of projects such as JLC, B-Factory, Japan Hadron Project, Fourth Generation Light Source etc., etc., but my thought was always centered around how I could bring all these to the government and persuade them to fund the project. In the early 1990's, I was not even able to mention to the government officials that we have a new project after TRISTAN. All they wanted to hear was when KEK would shut down the TRISTAN. This attitude is understandable to some extent because they themselves were targeted for funding a large sum of money to TRISTAN which failed to find a top quark. The committee to discuss the issues of Japan Hadron Facility was a joint committee of KEK and the Institute of Nuclear Study (INS) of University of Tokyo and it had been started by the Director Tetsuji Nishikawa of KEK and the Director Yoshimitsu Yamazaki of INS. The sentiments of the nuclear physics community, the neutron community and

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\*) Dr. Sanda was among the members of the group who made the AR-ring version of the B-factory as is shown in Fig. 1. He publicly made a statement which sounds as if I was opposed to B-factory in general. The fact is, I was not able to accept the wrong idea of his group which is neither asymmetric nor sufficient in the luminosity. The first asymmetric B-factory proposal came from the task force lead by Takasaki.

the muon community were such that the project should be started as soon as possible with perhaps accompanied by the reorganization of KEK and INS. Scientifically the project was a sound one and could be regarded as important as B-physics, depending on who makes the judgment. What was not clear to me was whether KEK was ready for this at that stage as an organization. INS was long ready for the project because its facilities were already too obsolete for doing modern nuclear physics or any other scientific research. The idea of transforming the TRISTAN into the fourth generation light source was also an interesting one and pushed especially by Ando of Photon Factory. It is partly because of this project that I was not able to dismiss the small ring version of B-factory although it was rather expensive, and I could hardly see the way to get its approval from the government. 1991 Tristan Program Advisory Committee recommendation for B-factory goes as follows:

*The committee heard several reports on the third stage of the TRISTAN Project. Extensive studies during the past year have demonstrated the feasibility of constructing a B-factory at KEK. Various options have been identified which will achieve the level of luminosity required for a productive physics program which includes studies of CP violation in the B system. The Laboratory should select the most favourable option for the facility based on practical considerations which will become more evident as the options are developed further. The committee believes that the Laboratory should proceed with the construction of B-factory at TRISTAN as quickly as possible. The expected impact of the physics results and growing international interest in constructing similar accelerators elsewhere lead the committee to recommend the earliest possible completion of the project. The conceptual design of a detector to be used at the B-Factory was presented. The initial studies are well advanced and promise to be well suited to the physics potential of the B-factory. RD work is proceeding in several areas. Further optimization seems to be advisable in the areas of vertex detection, kaon identification, and solid angle coverage. Masking is critical issue and further studies seem desirable so that stray electron induced background will not overload the detectors.*

The same committee also recommended strongly that *KEK should construct Accelerator Test Facility for the linear collider as quickly as possible.* 1992 recommendation is similar but is stronger in its wording, saying that the early construction of B-factory is crucial for KEK. I was certainly aware of the importance of moving fast but I needed to persuade nuclear physics community, neutron community and above all the government. Nuclear physics community was gradually showing its understanding. In particular, INS director Yamazaki agreed that the B-factory should be constructed before going to JHF (current J-PARC). This generous understanding was indispensable for KEK to decide its policy on its direction. I was also able to slowly open up a constructive dialogue with the government officials on the future of KEK. Strangely enough, this was made possible through our collaborative negotiation with the US on SSC. The question was whether it is a sound policy in the field of high energy physics of Japan to participate in SSC and maintain no project domestically. Mr. Zen-ichi Hasegawa, who was, at the time, the Director General of International Bureau of Monbusho repeatedly asked me whether we want to maintain some domestic facility. My answer was invariably positive and I explained the

Table I. Comparison of parameters between New/Old B-factory project.

|                                  | Plan with a new tunnel | Diversion of the TRISTAN tunnel |
|----------------------------------|------------------------|---------------------------------|
| 1. Shape of the ring             |                        |                                 |
| Circumference                    | 1,415 m                | 3,016 m                         |
| Straight sections                | 480 m                  | 924 m                           |
| Arc sections                     | 935 m                  | 2,092 m                         |
| 2. Magnet Systems (Arc sections) |                        |                                 |
| Dipole magnets                   |                        |                                 |
| 3.5 GeV                          | 0.54 m $\times$ 168    | 0.42 m $\times$ 224             |
| 8.0 GeV                          | 3.8 m $\times$ 168     | 2.6 m $\times$ 224              |
| Quadruple magnets                |                        |                                 |
| 3.5 GeV                          | 168                    | 224                             |
| 8.0 GeV                          | 168                    | 224                             |
| 3. Vacuum Systems                |                        |                                 |
| Length of vacuum duct            | 1,415 m $\times$ 2     | 3,016 m $\times$ 2              |
| # of ion pumps                   | 280                    | 600                             |
| 4. RF Systems                    |                        |                                 |
| Cavities                         | (new)                  | (new)                           |
| 3.5 GeV                          | 40                     | 40                              |
| 8.0 GeV                          | 90                     | 90                              |
| Krystrons                        | (relocation)+(new)     | (addition)                      |

project of B-factory to him. He understood our request and it eventually became the official policy of Monbusho. This happened in 1993 as I will explain later. As for the participation in SSC, Monbusho decided that it will support the participation of experimentalists in SSC. And, considering the interest shown by industrial sector in contributing to the construction of SSC, it was decided that MITI (Ministry of International Trade and Industry, present METI) should be in charge of that part. Under such circumstances it became possible for KEK to make a budget proposal of B-factory at least as a trial in 1992.

Looking back, it was a peculiar mixture of B-factory project and the light source project reflecting the indecisiveness of the KEK management (or rather myself) at this time (Tables I and II). It includes the B-factory of two options, one with a small ring of 1415 m circumference and the one with the TRISTAN Ring. It also included the utilization of TRISTAN Ring for the light source. The purpose of the former is: (1) Study of breakdown of the basic symmetry, (2) Study of weak forces on the quarks, (3) Study of new technology and its spin-off. For the latter, we listed: (1) Study of the structure and the property of the mesoscopic quantum crystal, (2) Transformation of protein molecular structure using the stroboscopic-photo technique, (3) X-ray holography. The total cost of the former was estimated to be 430 oku yen<sup>\*)</sup> and the latter was 200 oku yen. There was a fatal deficiency in this budget proposal. Our emphasis was on the small ring version of B-factory. We, therefore, did not study in detail whether the second option for the B-factory which utilizes the TRISTAN Ring can be compatible with its utilization as the light source. Furthermore, the total cost was too high. I did not expect that this would be

<sup>\*)</sup> 1 oku yen = 0.1 billion yen.

Table II. Annual plan of the TRISTAN III (B-factory, MR-PF) in million JPY.

|   | Amount | 1992   | 1993   | 1994   | 1995   | 1996   | 1997   | 1998   | 1999   | 2000   |
|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| TRISTAN III                             |        |        |        |        |        |        |        |        |        |        |
| Special allocation for large facilities | 47,300 | —      | 1,000  | 5,200  | 14,200 | 12,700 | 4,900  | 3,600  | 3,500  | 2,200  |
| B-factory                               | 33,300 | —      | 700    | 2,300  | 12,700 | 12,700 | 4,900  |        |        |        |
| MR-PF(1st phase)                        | 4,700  | —      | 300    | 2,900  | 1,500  |        |        |        |        |        |
| MR-PF(2nd phase)                        | 9,300  | —      |        |        |        |        |        | 3,600  | 3,500  | 2,200  |
| Facility expenses                       | 15,700 |        |        | 2,600  | 5,100  | 2,800  | 12,00  |        | 1,600  | 2,400  |
| B-factory                               | 9,700  |        |        | 1,800  | 3,900  | 2,800  | 1,200  |        |        |        |
| MR-PF                                   | 6,000  |        |        | 800    | 1,200  |        |        |        | 1,600  | 2,400  |
| Budget for construction                 |        |        |        |        |        |        |        |        |        |        |
| B-factory                               | 43,000 |        | 700    | 4,100  | 16,600 | 15,500 | 6,100  |        |        |        |
| MR-PF                                   | 20,000 |        | 300    | 3,700  | 2,700  |        |        | 3,600  | 5,100  | 4,600  |
| Budget for operations                   |        | 14,260 | 14,260 | 12,500 | 13,000 | 4,300  | 10,000 | 14,000 | 14,500 | 15,000 |
| The TRISTAN II experiments              |        | 14,260 | 14,260 | 12,500 | 12,500 |        |        |        |        |        |
| The TRISTAN III experiments             |        |        |        |        | 500    | 4,300  | 10,000 | 14,000 | 14,500 | 15,000 |
| MR-PF                                   |        |        |        |        | 500    | 2,500  | 3,000  | 3,500  | 4,000  | 4,500  |
| B-factory                               |        |        |        |        |        | 1,800  | 7,000  | 10,500 | 10,500 | 10,500 |

approved by the government. In a way, this budget proposal was to investigate the government reaction to it. After lengthy negotiations with the government officials, they finally agreed to consider some option of B-factory seriously, which meant that the project would be among the agenda of the Science Committee of Monbusho (Gakujutsu Shingikai). In those days we had a subcommittee of Gakujutsu Shingikai called “Kasokuki Bukai” (Subcommittee for the Accelerator Based Science) and the main committee usually approved the report from the subcommittee without serious discussions.

It was very important, therefore, to have a statement on the B-factory in the report of the subcommittee. Fortunately, the chairperson of the subcommittee at that time was the former director of KEK Tetsuji Nishikawa and the secretarial role was played by Ken Kikuchi who just retired from the deputy directorship of KEK. Among the members of the committee were Akito Arima and Hiroyasu Ejiri from the nuclear physics community, Seturo Ebashi and Haruo Kuroda from the synchrotron radiation community and Yasuo Endo from the neutron community. I was representing the high energy physics community in addition to Nishikawa and Kikuchi. Other members included medical doctors, economists, engineers, media people etc. Outside of the committee, I was talking to many people in the nuclear physics community, the neutron community and the synchrotron community. Fortunately, the construction of the Japanese third generation facility of the light source, Spring 8, had been started in 1991 by the Science and Technology Agency. The interest of the majority of the users of the light source shifted from our TRISTAN Light source to Spring 8. Prime promoter of the former, Ando of the Photon Factory agreed that he will perform the fourth generation experiment using the TRISTAN Ring for limited time of one year and then gives it back to high energy physics community to construct B-factory. As I mentioned before, the nuclear physics community, the

neutron community and the muon community generously agreed that KEK needs some facility of high energy physics. In return we agreed that the discussion on the Japan Hadron Facility will be continued in the joint INS and KEK committee. The report of the “Kasokuki Bukai” to the main committee was made in 1993 and it perfectly reflected this situation. The final section of the report goes as follows (translated from Japanese by the author):

*The researchers of each field which utilizes an accelerator, high energy physics, nuclear physics, sciences utilizing synchrotron radiation facility and neutron science, have been making their own future project to advance their fields. The committee discussed all these projects and reached the following tentative recommendations. The experimental research in the field of high energy physics has been rapidly advanced by the establishment of KEK. It reached the top level of the world by the completion of the TRISTAN not only in the high energy physics experiment but in the technology of the accelerator and of the detector. It is necessary, as the top priority project in the field of accelerator related sciences, to engage in the project of TRISTAN 3 (B-factory) immediately, in order to maintain the level of high energy physics, to train the researchers in the field and to contribute to the world community of high energy physics. This project is to utilize the existing facility and to modify it and to perform the electron positron asymmetric collision in order to clarify the fundamental law of physics such as the CP-violation. Its goal is to expand the frontier of the precision measurement. We believe that it is the most excellent project compared to other similar projects of other countries. It will, therefore, make an important contribution to the field of high energy physics. There are various kinds of accelerators depending on the purpose of the research fields. The Committee discussed the other projects in fields of nuclear physics etc., considering the importance of making a consistent way of promoting these fields from a view point of long term strategy.*

1. *In the field of nuclear physics, neutron science and muon science, the Japan Hadron Project is being conceived with the INS of University of Tokyo as its main player. The project is to construct a proton accelerator to advance the wide area of interdisciplinary researches. The University of Tokyo is examining the possibility of forming a new research organization to push this project. This organizational system will serve to the utilization of many researchers for a long period of time and it will contribute to the international community of researchers. Considering the financial situation of the nation, it is, nevertheless, difficult to start this project right away. It is desirable to proceed step by step towards this project, by utilizing the existing KEK facility and by shifting gradually to the new system.*
2. *The light source covers wide range of fields from basic science to applied science. The users are spread all over the country and their number is increasing rapidly. It is getting difficult to satisfy all their demands with the existing facilities. It is, therefore, desired that the new light sources be arranged taking into account the local character of the facilities. The Committee understand that the construction of low energy, high brilliance machine is desired for the purpose of cutting edge research utilizing the vacuum ultra-violet and soft X-ray beams and on the other hand, the high energy, high brilliance machine is desired for the*

*research utilizing the X-rays. However, considering the financial situation of the country, it is difficult to construct these two machines in parallel. It is also difficult to utilize the TRISTAN Ring for the purpose of light source in parallel with the B-factory. It is necessary to contemplate the way these synchrotron radiation facilities should be built taking these situations into account.*

It was Ken Kikuchi who chose the wordings very carefully. But the message was clearly to recommend the construction of B-factory as the top priority. The discussion in the INS-KEK joint committee was continued and one of the main topics of the committee was the “New System” which is to be realized at much later time as the current “National Accelerator Organization”. One of the “Kasokuki Bukai” members, Kuroda pushed the low energy radiation facility strongly and it continued to be the issue until recently. Although every member of the committee knew that Spring 8 was being constructed and it was having huge influence on the discussions on the light sources, there was no mention of it in the report because the STA was still not to be mentioned in the Monbusho committee. The “local character” of the radiation facility was the word Kikuchi chose to mention it in a hidden way. Nothing was mentioned on the SSC participation in this concluding section but it was noted in the main part of the report that the US is asking Japan to join the project. The negotiation was going on and the in-kind contribution was more or less decided that it will go through MITI rather than Monbusho. In this connection, I must mention that it was very disturbing when I found that some rather influential American physicists blamed Japan for not cooperating in SSC and attributed the demise of SSC to this false fact.

#### §4. Real machine

One of the reasons that it took such a long time for “Kasokuki Bukai” to come up with this clear recommendation was the SuperKamiokande Project. Jiro Arafune became the Director of ICRR back in 1987 and he was determined to reform this institute and he pushed the SuperKamiokande project as the central project of ICRR. The question was whether we should discuss this in “Kasokuki Bukai” since it was regarded as a project of high energy physics and KEK was closely working with ICRR. The cost was rather high and the worry was the compatibility of this project with the B-factory. Fortunately, “Uchu Bukai” chaired by Minoru Oda decided to make this proposal their agenda. Under the leadership of Jiro Arafune and Yoji Totsuka, this project was approved by the government in 1991. Arafune succeeded in reforming the ICRR and it became one of the most productive research laboratories in this field. The collaboration of KEK and ICRR continued and it became even more fruitful when we started the long base line neutrino experiment in 1999. KEK continued to submit the budget request for 1993 with the combined small ring version of B-factory and the Light Source utilizing the TRISTAN Ring. But it became very clear that the cost of this version was too high. It also became evident that the installment of both the light source and the B-factory in the TRISTAN Ring was not feasible. These facts were the bottom line of the recommendation of “Kasokuki Bukai”. Finally, we modified our budget proposal in 1994 and B-factory became



Fig. 2. Toast to the approval of the B-Factory Project (KEKB). KEK Annual report 1993, p. 36.

the only machine to be installed in the TRISTAN Ring. The financing of the one year period of light source experiment in the TRISTAN Ring was taken care by the KEK operation budget. After rather intensive negotiations and the joint Monbusho-KEK effort to get support from lawmakers, the government approved our proposal towards the end of 1993. It was a great step forward for KEK and for the Japanese high energy physics community. It was also a personal joy for me because this was my first major accomplishment as the director of KEK (Fig. 2). The budget included 20 oku yen for fiscal 1994, 76 for 1995, 116 for 1996, 74 for 1997 and 92 for 1998. The operation money was still to be negotiated. There were some opinions among the experts that the TRISTAN Ring might be too long for the B-factory but the study showed that it is not so. It turned out at the later stage that the long circumference actually had some advantages. In March 22, 1994 the first Tristan Program Advisory Committee after the approval of the B-Factory was held and it showed the satisfaction that the various studies and some new ideas on the machine were presented to the committee. In particular the members praised the new type of non-superconducting cavity for the positron ring called ARES cavity which was invented by Tatsuya Kageyama and Yoshinari Yamazaki to avoid a rather strong multi-bunch instability of this very high intensity machine. They also recommended that the committee should be expanded to include accelerator experts to assess the B-factory. The notable character of KEK B-Factory, compared to SLAC one, among other things, is that it tries to solve various kinds of instabilities using both the hardware and the software technique. The latter seems to depend rather heavily on the software technique. In the mean time the Belle experimental group was formed with spokespersons Fumihiko Takasaki, Steve Olsen and Shiro Suzuki later to be replaced by Masanori Yamauchi, Tom Browder and Hiroaki Aihara. They submitted the LOI to the Committee and it was accepted immediately with many

technical suggestions and recommendations. The accelerator construction group was also formed under the leadership of Shin-ichi Kurokawa. The construction of the B-Factory ended in 1998 and, after some period of commissioning of the machine and the detector, serious data taking was started in 1999. About at the same time, our long baseline neutrino experiment was also started. KEK became the world center of high energy physics with these two important experiments.

### §5. Relation with SLAC

When Carlo Rubbia visited KEK around 1993 to promote CERN-KEK collaboration on LHC, he asked me in private, ‘Are you seriously trying to compete with SLAC? Do you know that they have the world’s best group of accelerator scientists?’ I just smiled back in a Japanese way and said nothing. Well, I knew that SLAC people helped us a great deal in constructing our TRISTAN machine. They were, in a sense, our teacher. The best way to be a good student is to surpass the teacher. We were determined to be a good student. More importantly, the two principles of scientific and organizational considerations both supported this decision to go with the B-factory. The competition is just a mechanism to promote the vigorous activities. Burt Richter, the Director General of SLAC at the time had a different view. He knew, being an accelerator expert himself, that KEK has an excellent group of accelerator scientists. He mentioned to me often such names as Yoshitaka Kimura, Kaoru Yokoya, Katsunobu Oide, Tsumoru Shintake etc., etc.. He did not know that we also had such excellent young accelerator physicists as Haruyo Koiso. Burt Richter told me that we were going to have a “neck and neck” competition in B-factory. It turned out to be quite true. But there was one more truth. That is, we enjoyed the competition and the most of us understood that the competition is good for the good performance and it is good only for that reason. In fact the KEK-SLAC relation was more of collaboration rather than of competition. Especially the accelerator scientists were frankly exchanging the information and were discussing the common problems and the common achievements. The only bad memory I have, in connection with our relation to SLAC, is an article in “Nature”. The article, written by some writer of the journal, insisted that the KEK B-Factory is inferior to that of SLAC and quoted some SLAC scientists. I sent my letter of objection but the “Nature” did refuse to take any responsibility. Other than a few such scattered incidents, I believe we maintained an excellent relationship with SLAC. The good relationship continued after Jonathan Dorfan became the Director General of SLAC succeeding Burt Richter. The collaboration covered not just B-factory but more intensely the linear collider R/D, synchrotron light sources etc. For example, when we started the construction of our long base line neutrino beam line to send neutrino from KEK to Kamioka, Burt Richter offered us their spare magnets. The magnets sent to us at that time are still in KEK, sitting somewhere in the neutrino beam line.

## §6. Epilogue

As stated repeatedly, the policy of the laboratory like KEK should be decided based on the scientific and the organizational considerations. Sometimes it could happen that one or the other must be sacrificed due to an unavoidable circumstance. A good example is given by the creation of KEK itself. Japanese high energy physicists of the 1960's had an ambitious plan of constructing the 40 GeV proton accelerator which is to become the world highest energy proton accelerator at that time. But the situation did not allow them to do so. Governmental offer of 12 GeV machine was far from enough to do the world-class experiment. But the community, with the leadership of Shigeki Suwa and Tetsuji Nishikawa accepted the offer. They decided that the creation of KEK is more important than anything else. The decision was the right one. KEK was created and it accumulated human, technical and material resources gradually and it became much easier for the community to make a large project proposal, such as Photon Factory, TRISTAN, B-Factory, J-PARC and so forth. A typical example of the failed case is SSC. It was the policy failure which lead to its demise. One cannot blame the surrounding environment for its termination. The project's own policy failure to adjust to the change of the environment is to blame. SSC should have sacrificed its too ambitious physics goal and should have reduced the energy in order to match the cost requirement. Still, the energy could have been higher than the LHC. On the other hand, LHC went through partly because it was pushed by the existing powerful organization-CERN unlike the case of SSC, which had to be started from scratch. Even CERN required a global support for its LHC to be approved. We must learn a lesson from these cases to start a linear collider project. In this case also, it is getting clear that we have to start from a scratch as in SSC. Then, creating an international laboratory is itself a big project. We need to minimize the cost even sacrificing the physics goal. In an extreme case, we should be ready to create an international laboratory with only an R/D financing. The human, technical and material resources will be gradually accumulated and it will be much easier to make a serious linear collider proposal from this laboratory. The way to realize this is to transform the current GDE<sup>\*)</sup> organization into an international laboratory with contributions from the interested countries. Some country should take the leadership and the site of ILC will most likely to go to this country. In case it is indispensable to have some physics output from the first machine of this laboratory, I would think that such a precursor to ILC as the photon-photon collider should be seriously considered. On the other hand, the competition between the Belle group and the Babar group is still going on. The former wants to upgrade the KEKB and the latter wants to build a brand new Super B-factory in Italy. Hopefully, they both will get the funding. But the situation is a little different from that in the 1990's. We will be seeing a challenge from the LHCb soon. It is a part of human nature that people stop fighting each other when they find a new common enemy or a new common rival. Italian idea of

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<sup>\*)</sup> GDE (Global Design Effort) is an international organization whose mission is to produce a design for the ILC.

finite crossing angle with relatively large bunch length is a charming one. Maybe there is a possibility that the two groups get together around this kind of machine, wherever it is going to be built, to meet the new challenge from the LHCb.

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