[Tentative Translation]

ILC Advisory Panel Report on ILC Organization and Management

July 28, 2017
International Linear Collider (ILC) Advisory Panel

Contents

Introduction

The International Linear Collider Advisory Panel (ILC-AP) published two reports: *Summary of the International Linear Collider(ILC) Advisory Panel's Discussions to Date* in July 2015; and *Report on Measures to Secure and Develop Human Resources for the International Linear Collider* in July 2016. These reports cover ILC-AP discussions since the first meeting in May 2015 and three working groups created by the ILC-AP: the elementary particle physics and nuclear physics working group, the technical design report (TDR) validation working group, and the human resource securing and developing verification working group initiated at the first meeting convened in May 2014.

In response to a September 2013 Science Council of Japan observation regarding the ILC project, an expert working group was set up in February 2017 to investigate options for the domestic organizational structure for researchers and the administrative organization needed to run the project. Six meetings were held between March and June 2017. This report summarizes the results of working group and ILC-AP discussions through July 2017.

This latest working group reviews the organizational and managerial aspects of the international institution which researchers plan to establish for the ILC project as well as surrounding infrastructure and environment. It also studies what would be a suitable domestic organizational structure should the collider be built in Japan.

1. Researcher community reports to working group

1-1. Organization and management of an international laboratory

The Linear Collider Board (LCB), an international organization set up to promote linear collider projects such as the ILC (Appendix 1), published the following report on the organizational structure and management of an international laboratory for the ILC project:

1) Revised ILC Project Implementation Planning (PIP) Revision C (July 2015, LCB)

This PIP is supplemented by the following two documents, which cover preparatory work to do before the start of the project:

2) Project Design Guideline toward ILC (PDG) (Sept. 2012, ILCSC*)

*ILCSC, the International Linear Collider Steering Committee (LCB's predecessor)

3) KEK-ILC Action Plan (Jan. 2016, KEK*)

*High Energy Accelerator Research Organization

The overall schedule of the ILC project, the organizational structure, and management at each stage of the project assumed in the above reports are as follows:

Overall schedule

1) A *pre-laboratory organization (pre-lab)* will be established based on agreements with the approval of the respective governments among participating institutions to finalize engineering design and segregate duties among participating entities for the first four years. This pre-lab is then to be succeeded by 2) the *ILC Laboratory*, a treaty organization responsible for the some nine years of construction.* After this, 3) an *international collaboration group* will run experiments for two decades or more.

*The PIP specifies an eight-year construction period, but Global Design Effort's technical design report (TDR) assumes nine years, including tunnel boring and adjustments, followed by a one-year commissioning period for the accelerator. Gathering of experimental data would begin in the 11th year.

1-1-1. Pre-lab

- The PDG looks at five different models (M1 to M5) of organizational and managerial structures for the ILC preparatory organization from the perspectives of legal basis, employment pattern, and procurement. While many details still need to be sorted out, the PDG recommends starting with M4, a model based on agreements among participating institutions, then to transition to M3 or M5, a multi-national research institution based on an international treaty.

M1: A treaty-based organization. The employment and procurement are financed by in-cash contributions from participating entities (CERN* type)

*CERN: European Organization for Nuclear Research

M2: A limited liability company financed by a combination of in-cash and in-kind* contributions (European XFEL† type).

*in-kind: including labor

† XFEL: X-ray Free Electron Laser

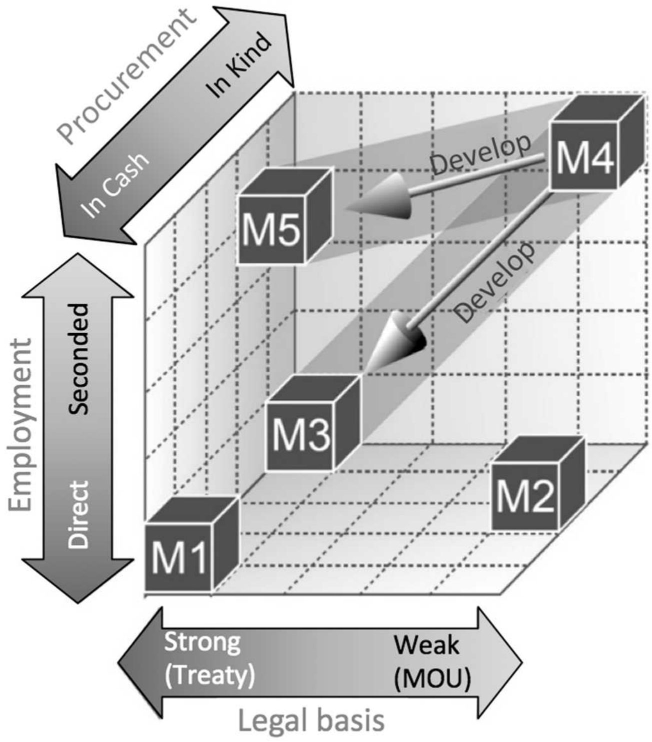
M3: A treaty-based organization. Materials are supplied in-kind and core organizational staff are employed by a common fund (ITER* type).

*ITER: International Thermonuclear Experimental Reactor

M4: An organization based on agreements concluded among participating institutions, which supply materials in-kind and second human resources, as in multi-national research institutions.

M5: A treaty-based organization evolved from M4 with a strong legal basis.

Figure: Conceptual view of the ILC organization transition



Source: PDG

- In the event Japan hosts the ILC, the KEK-ILC Action Plan recommends establishing a pre-lab based on agreements among participating institutions, with headquarters located at the KEK, then finalizing design and segregating duties among participating entities within four years.

- The KEK-ILC Action Plan estimates the number of personnel on the pre-lab to be about 200, of which 20% to 40% are expected to come from overseas institutions. The pre-lab will have to provide training for the employees to build up their capacity for project management, quality control, performance evaluation as well as the technology verification necessary for mass-production of superconducting cavities.

1-1-2. ILC Laboratory

- The PIP assumes the following regarding the organization and management of the ILC Laboratory (composed of about 1,100 members*):

  *The required number of personnel during the ILC's construction period is estimated in the TDR, and the average is 1,100 per year.

[Legal basis]

- The following terms are to be stipulated in an international treaty:
  - exemption from VAT, import tariffs, and similar privileges;
  - the rights and obligations of the host state;
  - decommissioning procedures and responsibilities.
- The treaty prohibits withdrawal of member states for 10 years, assuming nine years of construction and 20 years of operation, and requires two years notice of withdrawal beginning the 11th year.

[Top management]

- The ILC Laboratory Council, the ultimate decision-making body composed of two official delegates from each member state, decides by a simple majority vote except for financial agenda items, which are decided by a qualified majority vote depending on financial contribution. Council delegates must be of sufficient standing in their respective governments to facilitate prompt decisions.
- The council appoints the director-general after a full and open search and delegates to him/her significant authority and responsibility for the management of the ILC Laboratory.
- The ILC Laboratory Directorate, selected by the council, executes financial and administrative affairs under the director-general.

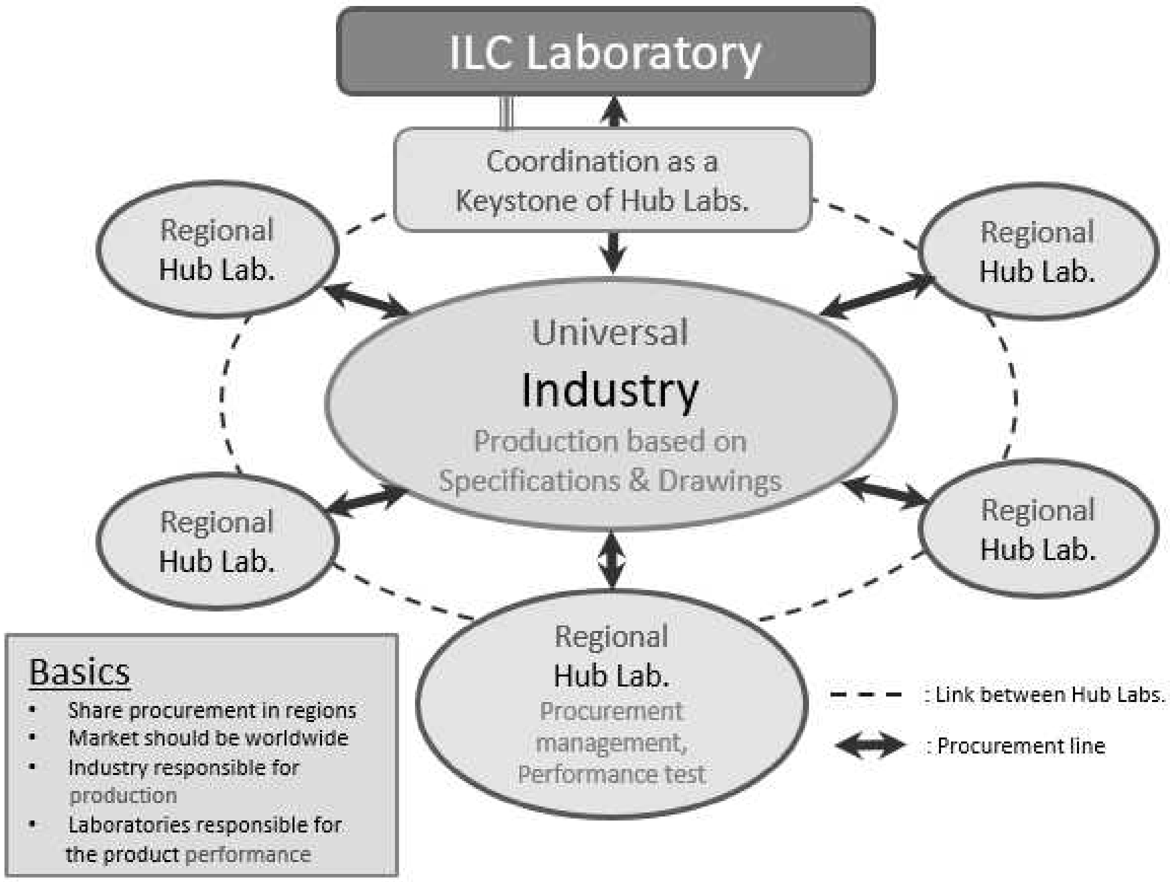
[Project management]

- The ILC Laboratory Central Project Team is responsible for the accelerator's design, one that is compatible with the selected construction site, and specifications for equipment contributed in-kind by participating countries.
- Participating countries are responsible for cost containment and the delivery on schedule of its in-kind contributions.

[Management of accelerator construction]

- A hub laboratory in each region coordinates the construction of the accelerator and its components, divided among international partners as per their in-kind contributions, based on contracts with corporations selected through a bidding process.
- Contractors are responsible for the product on a build-to-print basis, based on the specifications and fabrication drawings indicated in the contract. The product must pass an international standard inspection at delivery.
- The hub laboratory, or a consortium of collaborating institutes, guarantees the performance of the product by conducting a comprehensive test of the electric field gradient, the cavity's resonance characteristics, and other prominent product features.
- The hub laboratory can produce prototypes and verify technology. It is expected to mitigate risk for vendors by transferring technology and data after establishing a manufacturing process.
- The ILC Laboratory serves as a central hub connecting hub laboratories and supervises the entire supply chain.

Figure: International procurement of ILC components



Source: PIP

[Cost sharing]

- The host state is basically responsible for land acquisition, civil construction works including the tunnel, and infrastructure development. Member states make in-kind contributions for the accelerator and detectors.
- A contingency (about 10% of the total project cost) is required to deal with unforeseen events, and a common fund is required to pay for some items such as the experimental hall, which cannot be shared through in-kind contributions. The ILC Laboratory requests member states to provide in-cash contributions and manages them.
- In addition to the costs listed above, assuming that the host state will also wish to have a share not smaller than other major contributing states in the provision of technologically advanced items such as superconducting radio frequency technology, a total host state contribution of approximately 50% seems likely.
- As for operational costs, three possible scenarios and their combinations are under study as a model of cost sharing:
  - i) in proportion to the capital contributions of the partners;
  - ii) in proportion to the capital contributions of the partners excluding the civil construction, land purchase costs, and infrastructure development;
  - iii) in proportion to the number of PhD experimental scientists employed by each country and taking apart in the activities of the ILC Laboratory.

1-1-3. International collaboration group

- In the PIP, two detectors designed for the ILC, ILD (International Large Detector) and SiD (Silicon Detector), are being advanced by two international teams. Each design team is expected to evolve into an experimental collaboration when the ILC project is approved.
- The ILC Laboratory will operate the mechanism to evaluate submitted proposals and to oversee the progress of approved experiments. It is a common practice of the existing accelerator laboratories to organize relevant committees for this purpose, such as a Program Advisory Committee (PAC).
- Participation in the collaboration will be open to the entire world community, as for existing collaboration, such as those for LHC. Physicists from countries that do not participate in the construction of the accelerator may join experiments.
- ILC detector collaboration will be self-organizing and governing. The financial support of each collaboration should be sought, in principle, by the participating members of the collaboration from individual funding agencies. It is not expected that the ILC Laboratory will make direct contributions to the detector components except for supply infrastructure that is common to both detectors and also staff to help with assembly and integration work.

1-2. Living environment and social infrastructure

The general requirements for living environment and social infrastructure around the ILC site, independent of the actual site, is discussed in the following report and in the PIP.

- Report on the Siting of the ILC Project (Siting Report) (Feb. 2014, KEK, Nomura Research Institute and Fukuyama Consultants)

An outline of the surrounding environment assumed in these two documents is described below.

1-2-1. Demographics

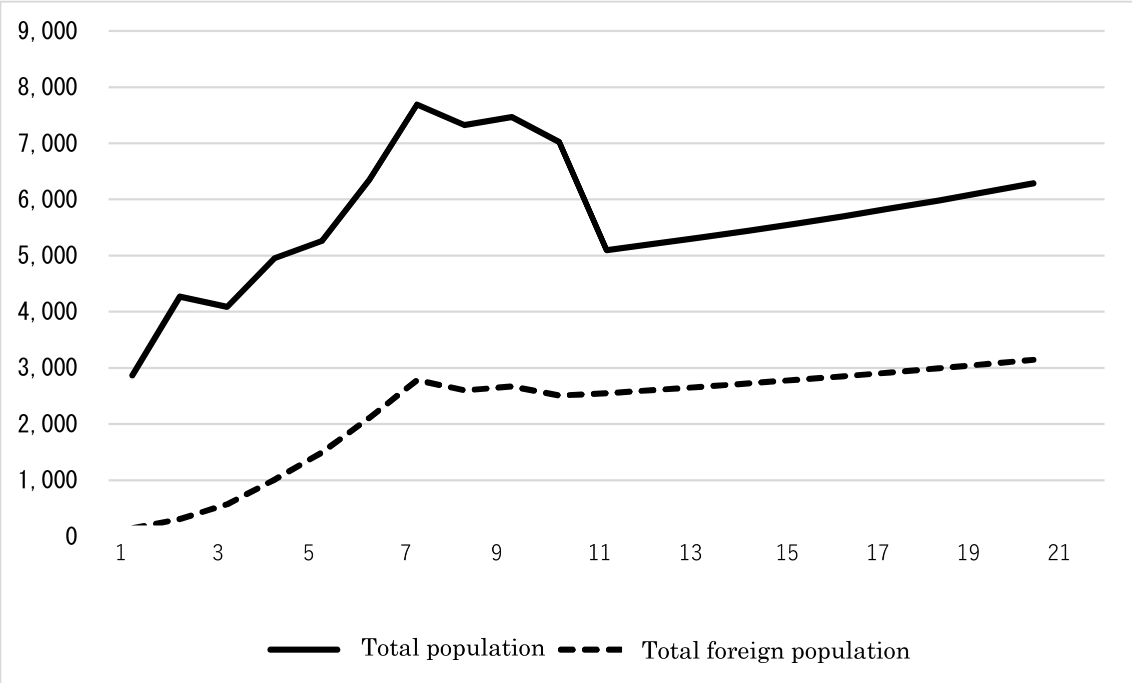
- The PIP assumes a total population of researchers, laboratory employees and their families of about 10,000, the size of a small town.
- The Siting Report estimates for different points along the timeline the ILC population living near the site -- including researchers, engineers, office staff, construction workers, maintenance staff, and their families, assuming Japan hosts the ILC Laboratory, as in the table below.

Table: Estimated population around the ILC site

	Construction period		Operation period	
	1st year	7th year	11th year	20th year
Researchers, engineers and office staff	100	2,481	2,200	2,751
Construction workers and maintenance staff	2,610	2,658	360	360
Associated family members	156	2,552	2,536	3,176
Total (of whom foreigners account for)	2,866 (143)	7,691 (2,781)	5,096 (2,548)	6,287 (3,143)

Source: Siting Report

Figure: Population changes related to the ILC project around the ILC site



Source: Siting Report

1-2-2. Living environment and social infrastructure

- The PIP summarizes the requirements for living environment and social infrastructure as below.

  [Living environment]

  - Conventional utilities and services need to be available to the researcher community, such as job opportunities, basic amenities, housing, and recreation facilities.
  - It is also indispensable to establish a high-grade multi-lingual kindergarten and elementary schools for the children of ILC Laboratory staff.
  - For short-term visitors, immigration procedures should be simple, such as multi-entry visas, and on-site lodging, hotel and guest houses will be needed.
  - Basic security and health care infrastructure, such as fire and disaster prevention, emergency medical service, and hospitals, should be secured.

  [Social infrastructure]

  - Very high-bandwidth network connections to every country/institution participating in the ILC project is needed.
  - Conventional support utilities (electrical power, industrial cooling water supplies, sanitary and waste disposal systems, and fuel resources such as oil and natural gas) should be available.
  - Access routes, roads, and rail, capable of bearing loads as heavy as 70 metric tons should be available from a port to the site.

- The Siting Report lists the requirements for living environment (housing, childcare, education, medical care, health insurance, livelihood support, finance, transportation, shopping, food, culture, recreation, visas, residence status, and employment) and the requirements for social infrastructure (wide-area transportation, information networks, and supply processing infrastructure), should Japan host the ILC (Appendix 2).
- Morioka City used the Siting Report to study the construction costs for the central campus and housing for the researchers and their families, as shown in the table below.

Table: Additional costs that go into ILC construction

	Construction Cost (billion JPY)	Remarks
ILC Central Campus Construction	60.2	Spending on the ILC Central Campus site (high-rise architecture: 31.7ha, not including the site cost) Spending on the building of facilities on the ILC Central Campus (including research administration, experiment facilities, on-site dormitory, service facilities; total floor area: 120,000m^2)
Housing for Researchers (off campus)	65.2	Spending on the building of 1,917 homes off campus
Total	125.4	

Source: Report on the Influence of the ILC Project (Influence Report)
(Mar. 2015, Nomura Research Institute and Fukuyama Consultants)

Notes;

- This estimate does not presume any particular location in Japan
- The cost of ILC Central Campus construction (60.2 billion JPY) overlaps partially with the initial cost estimate for the Central Campus construction described in the TDR. Thus this is not necessarily required in *addition* to the ILC construction cost.
- The estimated cost of housing for researchers (65.2 billion JPY) assumes all required off-campus housing is newly constructed.

2. Reviews of international research body's organization and management

Sections 2, 3 and 4 review the organizational structure and management of an international laboratory, its living environment and social infrastructure described in the previous section. They also review and summarize the implementation structure for hosting such an international laboratory in Japan in the event that the ILC is hosted in Japan.

2-1. Organization and management of pre-lab

- In the KEK-ILC Action Plan, it is assumed that the headquarters of the pre-lab is located at KEK, in the event Japan hosts the ILC. It should be noted that the timing and range of relocating resources from KEK's on-going research program to the pre-lab must be carefully determined based on discussions not only with the relevant research groups but also with the international research community. The relocation should not negatively affect on-going research programs at KEK.
- The KEK-ILC Action Plan assumes that the pre-lab consists of 200 accelerator experts, and therefore a significant number of accelerator researchers who must be newly trained. These personnel should be employed according to a well-organized plan. It is effective to train them at accelerator facilities in operation, such as the SuperKEKB (electron-positron circular collider operated by the KEK) and J-PARC (Japan Proton Accelerator Research Complex, run jointly by KEK and JAEA – Japan Atomic Energy Agency), in order to take advantage of the experience of researchers at these facilities.
- Industrial partners responsible for production also need to convene engineers and technical staff with professional knowledge and skill. They could be temporarily relocated to the pre-lab and collaborate with the researchers there for training. This would provide useful methods to supplement the human resources of the pre-lab.
- Administrative functions of the pre-lab should be reinforced to satisfy of requirements of the international organizations, in terms of, for example, multi-lingual readiness, public relations, intellectual property management, export-import operations, and technology transfer.

2-2. Organization and management of the ILC Laboratory

2-2-1. Legal basis

- It makes sense that the PIP recommends establishing and running an international treaty organization as the ILC Laboratory because the ILC is a facility that requires a long-term commitment from multi-national partners, particularly in terms of funding.
- A framework for negotiating the authority sharing among states in accordance with their responsibilities will be necessary since each country will contribute a share to the large facility and enormous assets of the ILC. A treaty-based framework will facilitate this process.
- An international treaty organization, in which participating entities are responsible for the execution of the terms of a strongly binding agreement, also deters them from withdrawing midway, leading hopefully to sustainable operation.
- On the other hand, reaching consensus on an international treaty organization may require protracted negotiations.
- An alternative international agreement other than a treaty should be devised in order to avoid an impasse that might be brought about by a participating entity due to domestic constraints. A legally binding instrument would still be effective in avoiding possible conflicts.

- The United Nations University is an example of an international treaty organization that could work should Japan host the ILC. Articles in its agreement (*Agreement regarding the Headquarters of the United Nations University*) stipulate, for example, tax exemptions, privileges for the officers and staff members, making it a useful reference for an ILC agreement.
- Another useful reference is found in the ITER Agreement (*Agreement on the Establishment of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project*) concerning the process and responsibility of participants up through to the end of the project as stipulated in the PIP.

2-2-2. Top management (executive board) and project management

- The PIP assumes the ILC Laboratory is to be established as a new international organization. Thus, full-time employees should be recruited to facilitate prompt decision-making and operations.
- Staff members capable of working in an international organization should be newly recruited. Difficulty relating to starting up a new research institute is recognized as one of the reasons why the Superconducting Super Collider (SSC) in the US failed. The lessons from the SSC project suggest to consider reducing the risk of project failure by its structure, for example, restructuring an existing institute.
- The top management (executive board) assumed in the PIP is reasonable which reflects experience gained in international research organizations in different research fields such as the ITER in addition to high-energy physics laboratories like CERN. Assigning internationally recognized researchers with high management skills as top managers (executive board) will be important to secure effective management.
- Project management as described in the PIP entails the central project team that serves as an engine to lead the project by, for example, managing the resources both in-cash and in-kind contributed by participating entities. The team should be reinforced by inviting high-profile talent with sufficient experience organizing production; controlling quality and reliability; and distributing the budget, as well as managing research project(s).
- In establishing an international organization, its organizational structure and personnel appointments are two sides of the same coin. In the event that Japan hosts the ILC, a domestic leadership training program should be laid out in order to enhance Japan's presence as the host state, in addition to securing experienced international management resources.*

  * Refer to *Report on Measure to Secure and Develop Human Resources for the International Linear Collider* published in July 2016 by ILC-AP.
- A good lesson on human capital development can be learned from the Atacama Large Millimeter/Submillimeter Array(ALMA). The presence of Japan has been appreciated in the ALMA thanks to Japan's commitment in every aspect of the project, including

budget, personnel, security, public relations and labor management; taking risks even in difficult situations.

2-2-3. Accelerator manufacturing framework and cost sharing

- If equipment fabrication is shared among participating entities in accordance with their in-kind contributions, as assumed in the PIP, local industry could receive contracts according that country's fractional contribution. Contingency risks could thus be spread among participating entities.
- Despite the above advantage, in-kind contributions risk schedule delays and cost overruns due to the complexity of production management when considering the budget and progress in each country/region and the interfaces among components provided by other countries.
- Consequently, there remains a risk that the sharing of responsibility is not clearly defined, because overall specifications are being decided primarily by the ILC Laboratory, while the cost and delivery of in-kind contributions are being decided by each hub laboratory.
- In fact, a serious conflict broke out between the ITER Organization and participating institutes in 7 members (the European Union, Japan, the US, Russia, China, Korea, and India), concerning inter-apparatus interfaces and process control together with various other managerial issues. This conflict led to further delay and a cost overrun.
- Even when a hub laboratory cannot solve a problem alone, the project schedule should be maintained within the budget by having the ILC Laboratory coordinate among the hub laboratories, and by having the hub laboratories manufacture at its discretion within the range of its delegated authority. For this to work out well, clarifying the rules to modify specifications and the authority of the ILC Laboratory and each individual hub laboratory will be essential.
- The PIP proposes that both the contingency and the common fund should be provided by in-cash contribution. Lessons learned from other international projects listed below include the importance of setting the right size of contingency fund to deal with various unforeseen circumstances even for problems related to in-kind contributions.

[CERN]
This institute, operated by in-cash contribution from member states, is able to take prompt action against risk and to reduce cost by implementing a centralized budget. Making available a long-range budget outlook enables the levelling out of budgetary changes during construction and coping with unforeseen circumstances.

[ITER]
In 2015, a reserve fund, under the control of the director-general, was created to cope with design changes and unforeseen equipment procurement. This fund enabled a

more streamlined management and timely budget allocation, for example, to control inter-equipment interfaces.

[ALMA]
The lack of contingency in the Japanese budget is seen as a problem. The contingency should be included in the budget plan and should be used at the discretion of management.

2-2-4. International cost sharing

- The PIP assumes the host state's financial contribution* to ILC construction and management to be no greater than approximately 50%, with the remainder to be shared among the member states. The operational budget of the accelerator is also to be shared among participating entities; several cost sharing methods are being discussed. As an international organization financially supported by the participating entities, a balanced management system is indispensable to avoid excessively centralized power accruing to the host state and to guarantee an appropriate degree of authority for each member state.
  * Not including the costs to improve living environment and social infrastructure
- International cost sharing differs for different projects. Examples presented at the organization and management working group meetings are shown below.

[ITER]
The host "premium" increased during the course of bidding for the site. Later negotiations, however, readjusted the contribution to 45.46% for the host and 9.09% each for the remaining partners (Japan, the US, Russia, China, Korea, and India), securing democratic decision making and preventing the host from securing a controlling majority.

[CERN]
European countries established it in 1957 in response to the rapid expansion of a scientific project and to the perceived need to compete with the US and the Soviet Union. The financial contribution of a member state was originally based on its GDP while the system of sharing* over the past three years is based on its Net National Income (NNI).

* Top three countries in financial contribution (2015) were: Germany (20.5%); France – the host country (15.1%); and the UK (14.3%). Switzerland, another host country contributed 3.9%.

[ALMA]
While started with the assumption that the total cost would be divided equally among Japan, North America, and ESO (European Southern Observatory), during the course

of project approval and budget negotiations in each country, the final fractional contribution resulted in 25% from Japan and 37.5% each from North America and ESO.

- International cost sharing will be negotiated among participating governments. Agreement will be reached only after the project is approved by a science council or its equivalent in each country and progress towards securing the budget in each country, made by each government.
- Considering the possibility that the ILC Laboratory hosted by Japan may be regarded as an Asian international research center complementary to CERN in Europe, the project should be open to Asian partners that could join and cooperate with proper financial contributions.

2-3. Organization and management of detector construction and international experiments

- Two experiments, the ILD and the SiD as assumed in the PIP, allow scientific cross-checks, but the costs of building detectors and the experimental hall will rise. The need for two experiments should be carefully investigated.
- As in the case of previous experiments at accelerator facilities, an experiment at the ILC should be open to any institutions in any country/region. Democratic administration should be secured through a management body of an appropriate size comprised of elected members with limited terms. A high-level decision-making body should oversee the executive management.
- Some may argue that cost-effective participation with less contribution is possible. In the event that Japan hosts the ILC, it will be important to demonstrate clearly the rationale, appropriateness and merits of hosting the ILC.
- Strategic management of the ILC experiment is required to ensure that each country has a balanced share of responsibility for detector construction; of group management that requires significant budget and human resources; and of responsibility for data analysis that is more attractive academically.

3. Reviews of living environment and social infrastructure

3-1. Demographics

- The PIP assumes a total population of researchers, laboratory employees, and their families of about 10,000, the size of a small town. The Siting Report estimates an ILC-related population around the site of 7,700 in the construction peak 7th year; 5,100 in the 11th year after the start of operations; and 6,300 in the 20th year.
- However, the above estimates should be reexamined for the following reasons. Firstly, the population around the site may diminish after the construction period as collaborators are able to carry out data analysis at their home institutions thanks to high-speed internet connection achieved with currently available technology.

- Secondly, it should be noted that CERN, on which the above estimation is based, is located in the vicinity of Geneva, an international city.

3-2. Requirements for living environment and social infrastructure

- With the above caveats, the population estimated in the PIP and the Siting Report should be readjusted for designing the living environment and social infrastructure around the ILC site based on more realistic data for the case that Japan hosts the ILC.
- Requirements for living environment and social infrastructure include housing, childcare, education, medical care, life support, finance, transportation, shopping, food, culture, recreation, visa, residence status, job opportunity for family members, and participation in community activities. Support from local governments around the ILC site will be indispensable to provide public facilities and services to satisfy some parts of the requirements.
- Development of local infrastructure is a significant investment, and the cost sharing should be sorted out between the ILC Laboratory and relevant organizations such as the central/local governments, with the possibility of cost sharing between the host state and member states.
- Unlike the case of ITER, in which the cost of local infrastructure was covered primarily by the host state* as a result of international competition in project invitation, a more balanced sharing would be better for the ILC for which there is no such international competition.

  * Responsibility of the host state, France, is defined in the ITER Agreement Annex. Within this framework local governments agree to share the cost for ITER infrastructure development with 467 million euro over 10 years.
- As Japan suffers from frequent natural disasters such as earthquakes, safety will be essential for the ILC to coexist with local governments. It will be important to build a good relationship with local governments, considering the fact that the ILC Laboratory will handle radioactivity.

4. Study of a plan to set up an international research institute in Japan

4-1. Participation of Japanese universities in ILC experiments collaboration

- Make good use of the experience gained in the management of the Belle II experiment, which is currently under way as a joint international project hosted by Japan.
- It is difficult for a research group at a university to make a visible contribution to a huge international accelerator experiment. Devise a strategy to strengthen the presence of Japanese universities if the ILC Laboratory is hosted by Japan.
- Invest available resources in a focused manner, by establishing a national consortium for the detector development and data analysis. This scheme will be effective in increasing the presence of Japanese universities. It will also encourage talented foreign

scientists working at the ILC Laboratory to visit and collaborate with university teams, thereby helping domestic universities internationalize.

- Establish a training course on special topics, such as accelerators, cutting-edge semiconductor detector technology, electronics, and computing, with the cooperation between the ILC Laboratory and universities. The courses would be for young researchers who will be able to work in an international environment.
- Provide a training opportunity for technical and office staff to improve multilingual communication skills and their ability to provide technical and administrative support to researchers.

4-2. Relationship between KEK and the ILC Laboratory

- In the event that Japan hosts the ILC, KEK is expected to conduct research programs in disciplines different from those at the ILC Laboratory. A model can be found in Europe, where particle physics research is integrated into CERN, while other national laboratories, such as DESY (Deutsches Electronen-Synchrotron) in Germany and PSI (Paul Scherrer Institute) in Switzerland, constructed accelerators for purposes different from the one at CERN, such as creating a light source that includes free electron lasers and a high-intensity proton accelerator.
- Even after the ILC is built in Japan, the national accelerator laboratory, namely KEK, needs to be maintained, taking maintenance and development of expertise and technology into account. Financial constraints, however will make it difficult to maintain the funding level as is, and the programs will be subjected to close scrutiny by the relevant communities.
- A strategy taken by DESY provides a good model for the future of KEK in the event Japan hosts the ILC. Among the accelerator laboratories in the world that shifted their research focus from particle physics to photon science, DESY maintains an active group of experimental particle physics researchers and plays a leading role in the high-energy physics programs at CERN and KEK, although photon science is DESY's current major research program.
- When DESY terminated its accelerator operations for high-energy physics at almost the same time as CERN began the operation of the LHC, many researchers at DESY joined the LHC experiments while keeping their affiliation to DESY. In a similar way, high energy physicists at KEK could join the ILC experiments while keeping their KEK positions.
- It is important for the ILC Laboratory to have a strong central team with clearly defined authority. KEK is expected to support early establishment of such a central team as the main laboratory for the hosting country.
- It will take time before the ILC central team can seize the initiative, particularly in technology. By assigning leaders capable of leading an international team, with the support of KEK on various issues, the leadership in accelerator construction will be gradually transferred to the central project team.

4-3. The future of high-energy physics in Japan

- At the building a new accelerator, the available knowledge and technology together with future progress will need to be considered. In Europe, the European Committee for Future Accelerators(ECFA), organized by the European particle physics researchers' community, led discussions on the type of accelerator, the available technology and an appropriate host institute. The host institute in each country submitted a proposal; then the science council in each country coordinated various disciplines; and finally the government decided go or no-go.
- The Japanese high energy physics community is currently conducting diverse research programs and has proposed a huge project, ILC, as a major future project. The community must establish a consensus on a future research strategy by limiting the number of projects to implement the ILC project.
- A model can be found again in Europe. European laboratories working on fusion science concentrate their efforts on the completion of ITER procurements, support the ITER project and related R&D for prototyping, following the roadmap laid out by EUROfusion,* a European consortium that coordinates fusion research in Europe.

  *A consortium composed of 30 research institutes and organizations from 26 countries in the EU, Switzerland, and Ukraine. EUROfusion manages European nuclear fusion research other than ITER procurement.

4-4. Industrial participation including Japanese corporations

4-4-1. Hub laboratories and industry

- The PIP assumes a promising model of production that entails mass production of superconducting cavities and cryo-modules at regional hub laboratories in a short period of time. This framework enables corporations to conduct R&D without capital investment. Access to the technical expertise benefits industry.
- Corporations without assembly facilities can justify new capital investment by noting that experience gained by the ILC project will lead to future spin-off business. A participating company, for example, is expected to have access to the assembly facilities to meet future demand.
- Application of superconducting cavity technology is important, although this is not so clear at present. Spin-offs and technology transfer should be promoted by collaborating with industry, just as CERN supports knowledge transfer by establishing a dedicated support group (CERN Knowledge Transfer Group).
- To reduce the costs of ILC construction, it will be important that hub laboratories provide technical support to the industry and that they share information among themselves. In the long history of the development of high-energy accelerators and superconductor technology, researchers at academic institutions and industrial engineers have shared their experience in joint R&D, even their experience of unsuccessful results. The top management of the ILC Laboratory should also make use of this collaborative practice.

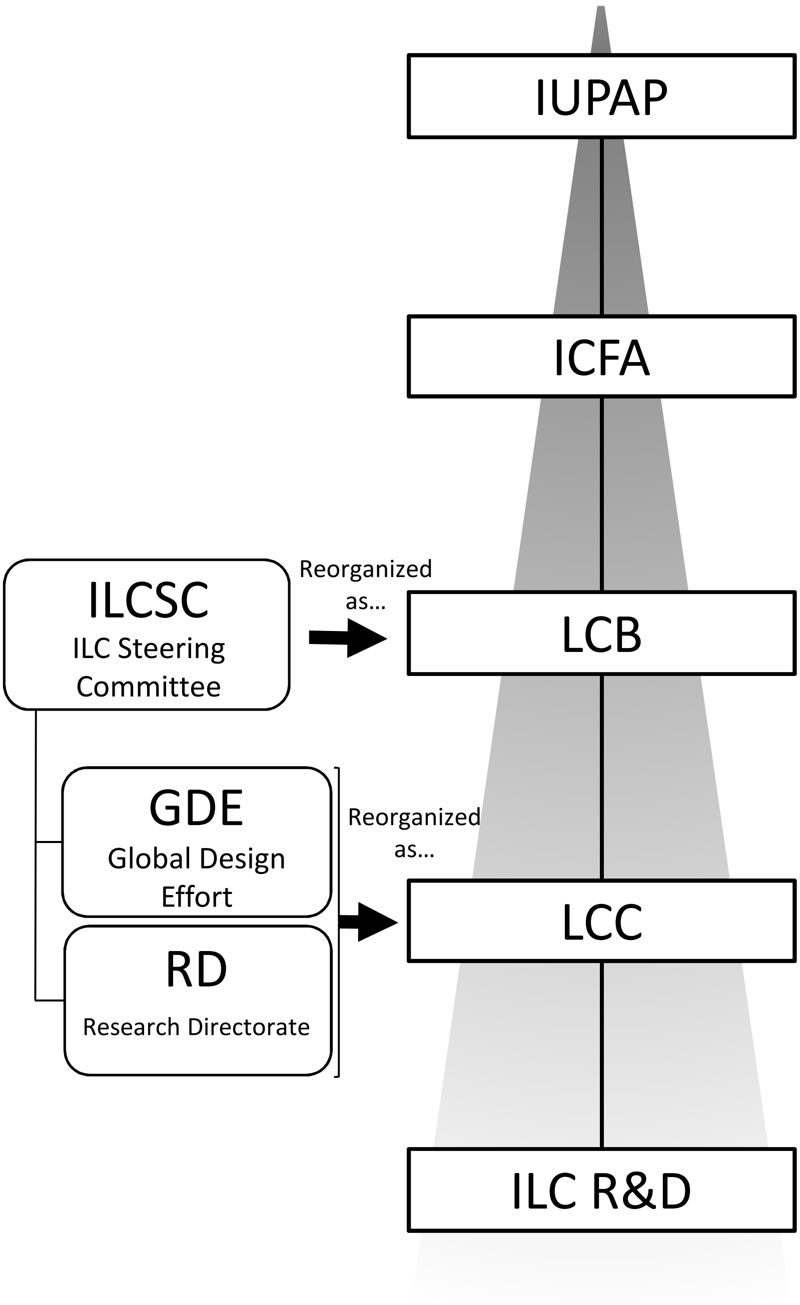
4-4-2. International tender

- Procurement for the ILC project is expected to comply with the WTO Agreement on Government Procurement. The contract therefore may not be won by a company that has already established a strong partnership with a hub laboratory. It is important to devise a procurement system and a procedure to quickly build up partnerships with contractors that have little experience in collaborating with a hub laboratory.
- In Japan and Europe, research institutes and industries often establish partnerships for the production of equipment, while in the US, it is usually manufactured in an in-house workshop. These differences in industrial culture should be respected as long as performance meets the specifications.
- A long and strong academia-industry partnership is one advantage to the Japanese way of manufacturing. Both parties should make an effort to maintain this good practice while ensuring compliance with international rules of procurement.

4-4-3. Lessons learned from previous accelerator projects

- It has been pointed out that the cancellation of the SSC originated from the alienation of the management of a production team in industry from the management of a design team at the institute. It is essential to establish a well-defined chain of command under the leadership of a scientist extraordinarily capable of management.
- A distinctive character common to most Japanese research institutions is a lack of engineer positions. Obviously a team comprised only of scientists will be unable to manage an international project as large as the ILC. Therefore, a strong management team should be established by inviting talent rich in experience on big international projects from both academia and industry.
- CERN, as a powerful central institute, has dealt with various problems arising at the LHC in cooperation with other world-leading institutes. The ILC project should learn from their experience.
- As the PIP was worked out only by scientists, some industrial angles are missing. Further study is needed to elaborate the plan of ILC management in cooperation with industry.

International Organizations of ILC Researchers



The International Union of Pure and Applied Physics
Federation of physics societies in different countries intended for advancement of physics and international cooperation

International Committee for Future Accelerators
Considers future accelerator projects as a sub-committee of IUPAP

Linear Collider Board
International board that promotes linear collider projects; Founded in 2013 through a reorganization of the ILCSC

Linear Collider Collaboration
International organization that promote multilateral discussion and technology development for linear collider projects

ILC Research and Development
Executes ILC R&D as part of LCC

Edited by MEXT based on information provided at the 1st working group meeting on the organization and management for ILC

Table: Desirable features in the living environments at / around the ILC lab, as noted by members of the research community.

Subject field	Desirable features / characteristics		Comments / Solution examples
Housing	Residential area	Suitability for daily lives and lifestyles of members / visitors from overseas	- Residential areas should be commutable within 30 – 40 minutes by private cars and/or public transportations <Ref: the reality of needs for foreign researchers in the similar research institute>
	Short-term housing (<90 days) stays	Fulfilment of typical expectations of members / visitors from overseas	- On-site or near-site housing (guesthouse, dormitory and hotel etc.) - Basic amenities (complete set of a bedroom with air conditioning, private shower and bathroom) at affordable fees.
		Assistance for reservation and stay	- User-friendly reservation system - Basic daily services (cleaning, meals etc.)
	Long-term housing (>90 days) stays	Fulfilment of typical expectations of members / visitors from overseas	- Off-site housing in the residential area for members / visitors with their families - On-site or near-site housing <On-campus residence is likely to be preferred before the members/visitors and their families familiarize themselves with life in Japan > - Reasonably spacious living and bedrooms, adequate bathrooms etc. - Furnished housing as an option
		Housing service	- Assistance for housing search and leases. <Posting of information for good properties. Assistance during lease negotiations etc.> - Elimination of restrictive practice in housing contract, if any, which causes difficulties for visitors/members from overseas. <Prepayment 6 months deposits, "Japanese-only" etc.>
Child care / Education	Multi-lingual childcare	Day-care services with multi-lingual, multi-cultural support	- New on-site or near-site day-care services. - Multi-lingual, multi-cultural assistance at existing day-care services in the vicinity - Childcare workers with multi-lingual capabilities >
	Multi-lingual education service	International schools	- New international schools <international curricula, multi-lingual classes> - Increased capacity for existing international schools - Possible financial aids for expenses < Financial aids from the laboratory and/or from the host nation/region >
		Multi-lingual support at existing schools	- Care and support at existing schools for students from overseas. <Multi-lingual teachers, multi-lingual support personnel, multi-lingual teaching materials >

Medical care/ health insurance	Medical care services	Multi-lingual and multi-cultural assistance at medical facilities	- Multi-lingual assistance at pharmacies <Translation of prescriptions descriptions, staff with multi-lingual communication capabilities> - Multi-lingual and multi-cultural support at hospitals and clinics <staff with multi-lingual communication capabilities>
		Multi-lingual and multi-cultural assistance in emergency medical care	- Multi-lingual support in emergency calls and emergency transport systems. - Multi-lingual support at emergency medical institutions.
		Assistance for medical care service users	- Interpreters who are specialized in medical issues with multi-lingual capabilities - Multi-lingual brochures for users of medical facilities
	Health insurance	Coverage of visitors / members from overseas	- Medical insurance for long-term and short-term visitors / members from overseas
General service	General service related to daily lives of visitors / members from overseas	Effective service system	- Offices dedicated to provide visitors / members with daily-life related services (e.g. international support office. Possibly, a specialized organization to support foreign life support)<To be set up within or near the lab possibly jointly with the host area> - Services on subjects such as: relocation, major purchases (e.g. automobiles), school attendance, visits to clinics or hospitals, administrative procedures, guidebooks on life in Japan, etc.
		Multi-lingual capabilities at municipal offices	- One-stop service desk at municipal offices for visitors / members from overseas - Attendance of support personnel with multi-lingual capabilities - Various information brochures prepared in multiple languages - Guidebooks in multiple languages on emergency/disaster management
Banking and credit services	Convenience and usability for visitors / members from overseas	Banking service	- Caching withdrawals using overseas credit cards at ATMs <ATMs with multi-lingual support for overseas credit cards, with possible off-hours support> - Assistance for account opening processes by lab members from overseas.
		Credit cards	- Improved procedure and processing speed for credit card acquisition by lab members from overseas <Speedier and less cumbersome processing >
Transportation	Easy-to-use transportation	Public transport services	- Commuting bus. On-campus bus service. On-demand bus service - Extension of public transportation routes or introduction of new ones, if needed, to incorporate stops at the institute and major residential areas - Accommodation of specific needs by lab members, including late night service and multi-lingual assistance

		Assistance for acquisition of private transportation measures (e.g. automobiles)	- Assistance for acquisition of driver's licenses by members from overseas <Areas of improvement include: driver's schools, driver's exams, license renewal, etc > - Assistance during purchasing of automobiles and related administrative procedures < Garage certificate, credit, insurance, emergency response, etc. > - On-site parking space at the lab - Carpool and ride sharing for visitors / members and their families
Shopping/food	Multi-lingual, multi-cultural services	Daily products sales service with multi-lingual, multi-cultural considerations	- Market stores in residential areas to offer multi-lingual, multi-cultural support < Multi-lingual displays, multi-cultural products > - On-site kiosks to offer multi-lingual, multi-cultural support
		Food service with multi-lingual, multi-cultural considerations	- Restaurants in residential areas to offer multi-lingual, multi-cultural services < Multi-lingual displays, multi-cultural products and cuisines> - Adequate considerations for customers with dietary restrictions
Culture / recreation	Accessibility to Japanese other cultural experiences	Japanese language and culture	- Japanese language courses and cultural courses for visitors / members from overseas < Programs jointly provided by the insititute and local communities> - Daily life related information that is available via institution web sites and/or SNS <Local community exchange programs, events, markets, garage sales, sport clubs etc.>
		Non-Japanese language and culture	- Accessibility to non-Japanese / overseas media (newspaper, magazine etc.) - Accessibility to facility for diverse religions and non-Japanese cultural activities - Internet connectivity <Fast processing of applications by new household >
	Accessibility to sporting and recreational facility	Provision of suitable facility services	- Accessibility to sporting facilities in residential area's neighborhood < Gyms, swimming pools, stadiums etc.> - Accessibility to recreational facilities in residential area's neighborhood < Gardens and parks for refreshment and amusement >
Visas	Assistance for visa application	Assistance for application of resident status, resident cards	- Assistance for application of resident status and registration for institute members and their families from overseas - Timely processing of applications for visa and resident status
Opportunities for jobs and social activities	Opportunities for jobs and social activities for spouses and family members from overseas	Social activities	- Opportunities to be offered to staff, their spouses and family members from overseas to participate in local social activities and events
		Employment	- Job opportunities for spouses and family members from overseas - Accessibility to information on job opportunities

Table: Desirable features in the social infrastructure at / around the ILC lab, as noted by members of the research community.

Subject field	Desirable features / characteristics		Comments / Solution examples
Transportation	Existence of a major international / domestic airport	Existence of a hub airport.	- Existence of a major hub airport on its own in the immediate neighborhood, or - Strong connectivity to a major hub airport
	Accessibility to an international / domestic airport	Public transportation measures to easily and quickly access an international / domestic airport	- Direct access to an airport by public transportation measures < Direct bus services to an airport or to train (shinkansen) stations which allow direct access to an airport >
	Existence of a major port facility	Existence of a major port facility suitable for handling international cargos	- Having an international container terminal, securing certain container international routes and flights - In addition to handling equipment for large-scale equipment, development large warehouses and CIQ systems
		Availability of ground access to a major port facility	- Availability of ground access routes for special vehicles to carry extremely large and heavy freight from a major port facility <New routes to prepare, if needed > - Availability of facility and routes for accepting and transporting international shipping containers to / from the ILC. < Capability to handle 45ft containers >
	Proximity to wide-area highway network	Availability of ground access routes to wide-area highway network and expressway interchanges	- Availability of ground access routes to wide-area highway network <new access routes, if needed, from the lab area> - Availability of ground access routes to expressway interchanges. <If needed, new routes to existing interchanges or new interchanges >
	Proximity to wide area railway network	Availability of public transportation means to railway stations	- Accessibility to wide-area public transportation systems < Public bus services to railway / Shinkansen stations, as found necessary depending on the demand and regional plans >
		Availability of railway hub associated with a wide-area transportation terminal function	- Availability of railway hub station associated with a wide-area transportation hub terminal function < Wide-area hub terminal with adequate multi-lingual support> - Availability of sufficient transportation capacity <Support commutes by local residents and the ILC users>

IT infrastructure	Broadband network connectivity	Broadband network connectivity within the lab area and with the global research communities	- Connection with academic information network(SINET4: Science Information NETwork)<Connection for SINET node(Connection base with network> - Tera-bit class core optical fiber network <Connected sites include: the ILC main campus, satellite campuses, international IX, international communication cable hubs>
		Introduction of international IX(internet Exchange)	- Introduction of International IX to become a node with direct links to the world Internet from the lab ※IX stands for "Internet eXchange", meaning a connection point on the Internet that interconnects networks including multiple ISPs. An international IX in Japan is a connecting point both domestic and overseas internet.
	Mobile connectivity	Introduction of mobile phone connectivity in accordance with international standard	- Introduction of GSM(Global System for Mobile Communications) area - Introduction of next-generation base station
Utility infrastructure	Electric power	Electric power to sustain ILC operation (> 200MW)	- Redundant power receiving facility to manage emergency (Substation (surface) and sub substations (underground)). - Connection with power grid <cooperation with the local electric company under agreement>
	Water	Supply of water and handling of waste water for ILC operation	- Use of drain water from the tunnel <Introduction of reservoir>
		Cooling water system of ILC facility	
		On-site water-related facilities	- Life water supply to be coordinated with municipalities - Waste water disposal to be handled at community plant with possible expansion
	Waste disposal	Excavated soil and stones during construction	- Availability of stockyards and crushing yards. Reuse of excavated soil and crushed stones. - Wastes during construction to be handled primarily at existing local disposal facilities.
		General waste from campus	- To be handled by existing local facilities < Planning required under coordination by municipalities>

Source: Siting Report