KEK International Working Group for the ILC

Fermilab PAC – January 15, 2020

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KEK
High Energy Accelerator Research Organization

Mandate of This Working Group

- Please discuss the ILC project especially on the following three points, and give a report by the end of September 2019.
  - Model of international cost-sharing for construction and operation
    - ✓ Study the 250 GeV ILC version of the construction cost based on the ILC-TDR cost estimate and propose a model for the construction describing: (a) items that are appropriate for the host responsibility, and (b) items that should be shared by all partners. Propose a model for sharing the operational and decommissioning cost.
  - Organization and governance of the ILC Laboratory
    - ✓ Propose an organizational and governance model of the ILC Laboratory as well as the ILC Pre-Lab.
  - International share of the remaining technical development
    - ✓ Present an R&D plan in the preparation phase to solve the technical issues pointed out in the MEXT's ILC Advisory Panel report and the SCJ report, including the possibility of international cooperation.

From introductory presentation by KEK DG at 1st working group meeting.

KEK
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Schedule of the Working Group

- **1st Meeting, May 17, 2019, in Granada (~4 hours)**
  Charge to the Working Group; Introduction to the ILC project and ILC-PIP; List of discussion points

- **2nd Meeting, June 2019, remote meeting (~3 hours)**
  Presentation concerning the discussion points from the preparatory group and further discussions

- **3rd Meeting, July 2019, KEK (1.5 days)**
  Presentation of a draft report by the preparatory group and further discussions

  Previous PAC presentation and presentation to LCB in July/August.

- **4th Meeting, August 2019, remote meeting (~3 hours)**
  Editing of the draft report taking into account the input from LCB members

- **5th Meeting, September 2019, KEK (1.5 days)**
  Finalizing the report

  Report transmitted to KEK 9/25, transmitted by KEK to MEXT 10/1.

Member List of
KEK International Working Group on the ILC Project

Members:

Klaus Desch (Bonn)
Andy Lankford (UC Irvine)
Kajari Mazumdar (TIFR)
Patricia McBride (FNAL)
Shinichiro Michizono (KEK)
Yasuhiro Okada (KEK) ****Chair*
Claude Vallée (Marseille)

Scientific Secretary:

Keisuke Fujii (KEK)

When (if?) the ILC moves forward, it will be a product of international negotiations among interested governments.

The WG's task, as I saw it:

To draft proposals for cost sharing and governance that define a space of possible solutions in which a final-agreed upon solution can be found.

To establish a departure point for MEXT discussions with other governments that is not a non-starter for any prospective partner.

Do not propose a unique solution.
Do not be overly prescriptive.

To encompass the outlook of each partner whose participation is essential to the success of the ILC.

Cost Sharing – General Principles

ILC is conceived as an international project

- **Implying construction, operation, & decommissioning costs to be shared**
- **This is not the same as projects at CERN or as LBNF/DUNE at Fermilab.**

Stakeholders

- **A Host State + non-host Member States**
- **All stakeholders should be committed beyond their deliverables to the success of the overall project.**

Sharing via contributions:

- **In-kind** – scientific, economic, and technological benefits
  - Built to ILC project specs. Responsibility for function, performance, and maintenance stays with contributor through the life of the ILC.
  - Value established by cost estimate of ILC at time of the intl. agreement.
- **Monetary** – to fund central budget
- **Labor**

Level and admixture of contributions should be driven by Member State's interests & capabilities and the resource requirements of the project.

- Contributions of all Member States to be determined via international discussion and agreement.
- "Standard sharing" is defined by agreed fraction of ILC construction.

Sharing of ILC Construction Cost

Breakdown of ILC accelerator complex:

1) **Civil engineering** (~22%)
2) **Conventional facilities** (~15%)
3) **Superconducting RF** (~35%)
4) **Accelerator components** (~28%)

- (Land acquisition and local infrastructure not included in project cost)
- (Detector(s) not included)

Fractions of ILC250 construction
Includes labor for (1) + (2)
Does not include:
Labor at ILC Lab or in Member States
Infrastructure & services outside ILC Lab

Civil engineering – a host state in-kind contribution

Conventional facilities (mostly (~75%) power and water facilities)**:**

- **Mostly host state in-kind contribution** (because tied to site and local regulations)
- **Some pieces could conceivably be provided as in-kind material contributions.**

SRF & accelerator components – generally suitable for in-kind contribution

- **A great deal of design coordination required. Complete subsystems preferred.**
- **SRF requires large numbers of cavities & cryomodules and are 25-30% of project cost. Multiple production centers (hub labs) expected.**
- **Match complexity/cost of deliverables to expertise/resources of contributor.**

Sharing of Person-Power Contributions to Construction

a) **Assembly, test, and integration of accelerator components** (~50%)
   - **A portion provided as part of in-kind contributions**
     Work in Member States, transport to ILC, integration at ILC
     ILC Lab can also employ some persons working at ILC on behalf of Member
     (Note: A significant fraction of personnel at ILC Lab are expected to work on long-term assignment from Member States, and count as labor contribution)
   - **A portion directly employed at ILC Lab**
     A strong scientific and technical staff directly employed by the ILC Lab is desired if sufficient funding via the central budget can be secured from member state contributions.
   - **The proportions of resident staff on long-term assignment and directly employed should be worked out by the international negotiations.**

b) **Management of civil engineering and conventional facilities** (~5%)
   - **Provided by the Host State as a labor contribution**

c) **Directorate, project management, and administration** (~20%)
   - **Directorate should be employed by ILC Lab**, to ensure independence of management from national interests
   - **Project management & most admin staff foreseen to be ILC Lab staff.**
   - **These roles paid from the central budget**

d) **Installation of ILC accelerator components on site** (~25%)
   - **Experts to ensure quality provided as part of in-kind contributions**
   - **Non-expert labor from ILC Lab provided by Host State**, with possibility of non-host Member State labor contributions.

ILC Lab Central Budget during Construction

The central budget is crucial for timely completion of ILC construction.

A. Salaries of person-power directly employed by ILC Lab

Standard sharing

Included in ILC250 cost estimate

B. Salaries of installation person-power

Contribution of Host State larger than standard sharing

Included in ILC250 cost estimate

A. Central contingency

- **Not quite like contingency in U.S. projects**
- **In-kind contributions include any contingency needed (off-budget)**
- **Purpose:**
  - **Unforeseen cost increases in activities covered by central budget**
  - **Cost increases arising from proj. mgmt. decisions** (e.g. design changes)
  - **Not for cost overrun of in-kind contributions**
  - **Exceptional use to keep project on track**
- **Experience from past projects shows that contingency is critically important.**
- **Size of central contingency should be determined at the time of the international agreement.** A figure of 10% could be used until then.
  - Surplus of central contingency at ILC completion should be returned to Member States or transferred to central contingency budget for operations.

Sharing of ILC Detector Construction and Operation

- **Cost separate from accelerator construction** (as is traditional)

- **Detector collaborations expected to fund detector costs**
  - **Cost sharing to be agreed upon by collaboration**
  - **Level of contribution to construction by each participating partner is driven by partner's interests, technical capability, and resources.**
  - Cost sharing can be different during operations phase (e.g. #Ph.D.'s)

- **Role of ILC Laboratory**
  - **Responsible for success of the experimental program**
  - **Not foreseen to take on a major role in construction of detector components.**
  - **Provide experimental areas and all related services**
  - **Provide support for assembly and installation**

- **Boundaries between responsibilities of ILC Lab and detector collaborations should be clearly defined in the ILC cost estimate.**

Function of the ILC International City

- **Purpose: to attract an international community**
- **Host state and local government expected to provide a living environment that is welcoming to the international community, such as:**
  - **Sufficient & affordable residences for long- and short-term stays**
  - **Language support in everyday life**
  - **Educational and medical aspects**
  - **Facilitation of locating job opportunities for family members**
- **Not a project cost**

Sharing of Operational Cost

Operation cost breakdown:

- **Utilities,** e.g. electricity and water
- **Person-power for accelerator operations**
- **Person-power for management & administration and operating costs**
- **Accelerator maintenance and repair**

Operational costs should be shared among Member States incl. Host State. The way in which costs are shared should be agreed before construction. The way could be related to capital contributions to construction.

Ways to share operation costs:

- **Contribution to maintenance of in-kind components**
- **Contribution of labor for operation and management**
- **Cash contribution**
- In-kind contributions and labor contributions should be encouraged to minimize the need for cash contributions.
  - However, some level of cash contribution will be necessary, particularly because of the significant utility costs.

Sharing of the Decommissioning Cost

Seen as a responsibility of the ILC Lab and Member States

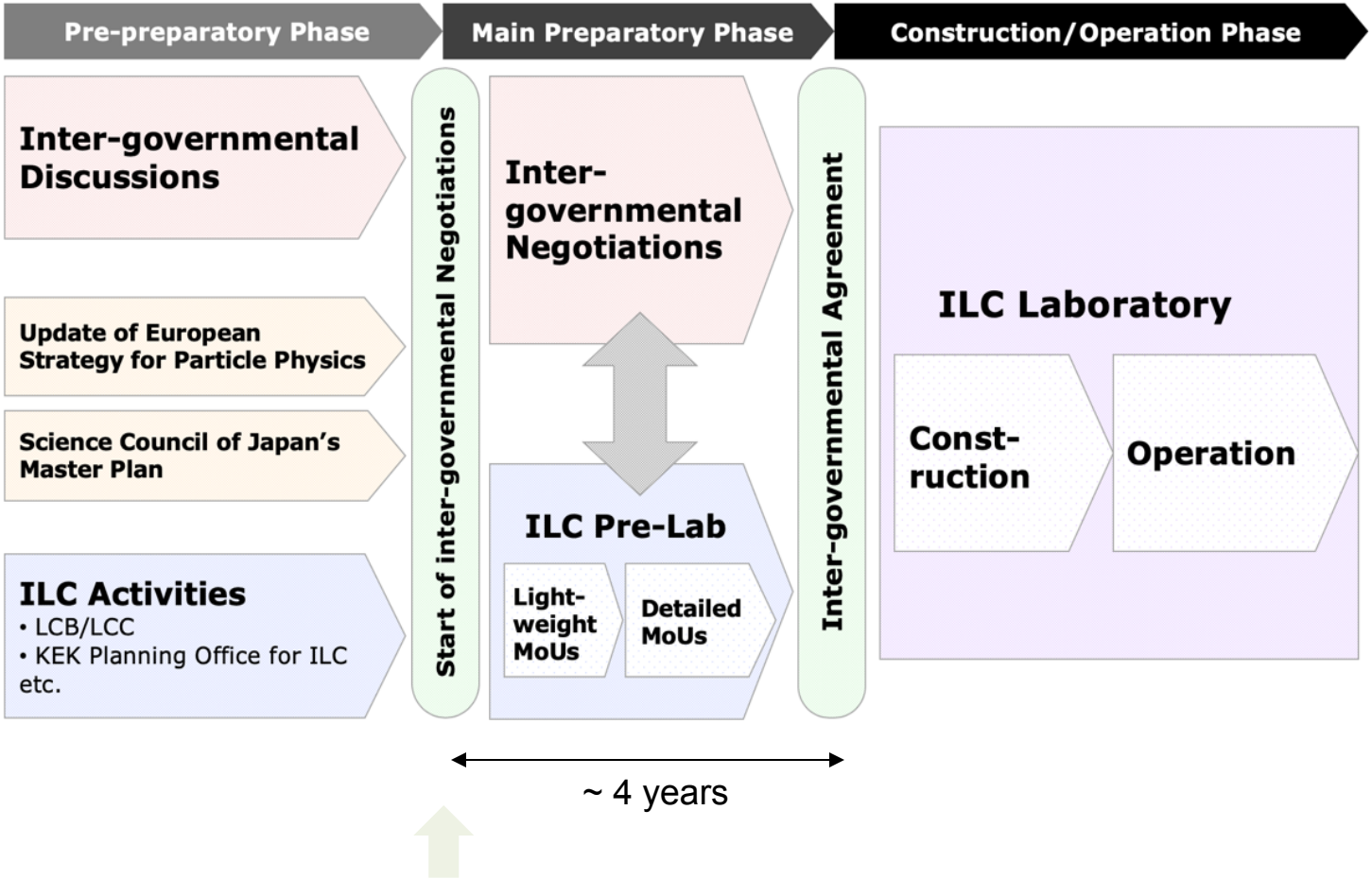
Consists of dismantling, but not long-distance shipping

Cost estimated to equal ~2 yr of operational costs.

A possible model for sharing - to extend operational cost by ~2 yr

The decommissioning of in-kind contributions should be undertaken primarily by the contributors.

Flowchart towards the realization of the ILC



ILC Pre-Lab Overview

Pre-Lab = laboratory for the preparatory phase
Preparatory phase to be triggered by Japanese government expressing its intent to host the ILC (as part of the critical decision process).

"The creation of the Pre-Lab will be based upon a mutual understanding of the Pre-Lab mandate and organizational structure by participating laboratories with the consent of their respective governmental authorities."
This understanding is to be developed during the pre-preparatory phase.

- **Partnership among member laboratories**
- **Hosted by KEK, as national lab of host state**
- "Participating partners" are either the member laboratories or their funding agencies, whichever is appropriate to the different countries or regions.

- **Technical preparation work is to be carried out by member laboratories.**
  - **The Pre-Lab plays a leading role in coordination.**
- **Activities specific to Host State**, i.e. field work at ILC site, **led by host lab.**
  - Host lab, KEK, to provide office space for personnel employed by Pre-Lab

Getting Pre-Lab Started

A two-stage MoU approach:

1. **Lightweight MoUs**
   - **Signed by KEK and participating partners**
   - **Expression of interest to participate in the main preparatory phase**

2. **Detailed MoU**
   - **After funding is assured to participating partner**
   - **Signed by KEK and partner**
   - **Includes:**
     - **Commitment of budget**
     - **Agreement on specific tasks to be undertaken and schedule**

Membership should be dynamic.
New members are to be added as they become ready and sign MoUs

Pre-Lab Mandate

1. **To coordinate international efforts on technical preparations**
2. **To provide necessary information to assist inter-governmental negotiations.**

Overview of remaining necessary technical preparations to be shared and conducted by the member laboratories.

- **Preparation for mass production of ILC components**
- **Engineering design**, including civil engineering tasks.
  - Reviewed by a machine advisory committee
  - Resolve open issues of the ILC configuration, considering risk and cost.
    - e.g. SCRF cavity specs (after performance R&D); positron source
- **Review machine-detector interface requirements & timeline**
- **Initiate preparations for the experimental program and foster technical development of detector concepts.**
- **Play a leading role in outreach and communication.**

Pre-Lab Organization

- **Governance Board**

  No longer includes a Resource Review Board

  Ultimate decision-making authority

  Composed of representatives of the 'participating partners'
  - A minimum level of contribution to accelerator design may be required.
  - Reps to be of high enough standing that they can make timely decisions.

  Should delegate the management of Pre-Lab activities to the Director

- **Director**

  Advised by appropriate external committees

  Assisted by the Directorate, manages the Pre-Lab activities

  Should have sufficient delegated authority for decisive action without continual referral back to the Governance Board.

  Appointed by the Governance Board after a search

  During selection, an interim director should be appointed by host lab.

- **Directorate**

  Advised by appropriate external committees

  Composed of associate directors each responsible for a major activity, e.g.:

  Project management

  Accelerator design

  Civil engineering, and environmental impact assessment,

  Physics and detector coordination

  Nominated by Director and approved by the Governance Board

- **Member Laboratories**

  Under direction of Director & Directorate, execute the Pre-Lab activities

  According to the plans detailed in the MoUs

  Member labs or their funding agencies represented in Governance Board

Funding for Pre-Lab Activities

a) Central budget

- **Salaries of top mgmt., admin. staff, and a minimal # of PM experts**
- **Initially seeded by Host State as part of preparatory budget**
  - Sharing may be negotiated at a later stage if possible

b) Budget available to individual member labs for Pre-Lab activities

- **Funding for completing technical preps and design responsibilities**
- **Division of tasks and schedule to be outlined in the detailed MoUs**

c) Budget allocated by the Host State for site-specific preparations

- E.g. environmental impact assessment and civil engineering
- **Expected from host state as part of preparatory budget**

Project Management

A dedicated project mgmt. team is critical for successful ILC construction.

- Should start early during main preparatory phase.
- **Support technical preparations and engineering design**
- **Define PM procedures and tools for construction phase**

Should incorporate expertise from outside the scientific community

Including public and private sectors

Preparation for Mass Production & Towards Hub Laboratories

- **Expected to begin during main preparatory phase**
- **Technical preparation plan includes manufacturing ~1% of cavities & cryomodules.**

- **Member labs who have or will have capabilities and expertise for producing large quantities of accelerator components are to start coordinating the personnel and facilities needed for mass production.**
  - These production centers are precursors to full-scale hub laboratories during the construction phase.

Regional Design Offices

- **An optional organization**
- **To play a central coordinating role in combining regional efforts towards preparation and construction**
  - Suggested in *The European ILC Preparation Plan*
  - **Can coordinate some of the regional bidding and contracts**
  - **Can centralize regional efforts for the engineering design**
- These regional design offices could be precursors to regional project offices during the construction phase.

Interplay between Pre-Lab and Inter-governmental Negotiations

The success of the inter-governmental agreement critically depends on the close interaction of the prospective Member States with the laboratories participating in the Pre-Lab. The Director of the Pre-Lab should play a leading role in facilitating the inter-governmental negotiations and in providing all necessary information.

The interplay between the Pre-Lab and inter-governmental negotiations is expected to be bi-directional. The Pre-Lab will assist the inter-governmental negotiations by providing technical information. At the same time, certain technical decisions in the Pre-Lab activities may require guidance from the inter-governmental negotiations; these include decisions on the open issues related to the engineering design, as discussed in Sec. 3.2.2.

Various topics requiring technical input are expected to be raised during the inter-governmental negotiations, such as, but not limited to, costing, organization, and project management. It is recommended to form an appropriate organizational structure within the Pre-Lab in order to address these topics. This could be achieved, for example, by forming a dedicated working group on each of these topics. The planning for the topics to be addressed by the Pre-Lab should begin as soon as possible in the pre-preparatory phase.

The Director of the Pre-Lab should be the official point of contact connecting the Pre-Lab and the inter-governmental negotiations. The proposed working groups should report to the Director. The Director will be responsible for communicating the findings and conclusions of the Pre-Lab as technical input to the inter-governmental negotiations.

ILC Laboratory Overview

A fully international laboratory

Legal Basis:

International Treaty Organization would be the preference,
but may not be suitable for all member states (e.g. U.S.)
Explore alternative forms of international agreement

Important considerations:

- **Stability of the project (long-term budgetary commitments)**
- **Rights and obligations of the Host State and non-host Member States**
- **Exemption of import duties and taxes**
- **Managing intellectual property**
- **Labor standards of host state**
- **Rules of financial**, including the possibility of bank loans
- **Decommissioning procedures and responsibilities**

Governance & Organization Structure

- Governance model inspired by CERN's
- **Governed by Council**
  - **Ultimate decision making authority**
  - **Composed of delegates of member states**
    - **Delegates with sufficient standing to make decisions on their own authority without frequent reference back to their governments.**
  - **A number of dedicated subsidiary committees advise Council**,
    - e.g. on financial matters and scientific policy.
  - "Being a new organization, the ILC Laboratory may initially benefit from an independent advisory committee of external management experts familiar with large scientific research infrastructures."
- **Managed by Director-General (DG) & Directorate**
  - **DG is Chief Executive Officer of ILC Laboratory.**
  - **DG should have significant delegated authority from the Council, allowing decisions without continual referral back to the Council.**

Roles & Responsibilities by the DG & Council

Action	Director-General	Council
Selection of Director-General	--	Elects
ILC organizational structure	Defines	Approves
Composition of Directorate	Nominates	Approves
ILC project planning	Proposes	Approves
Operational plan	Defines	Approves
Annual budget	Proposes	Approves
Typical other actions	Responsible for direction & execution; Reports to Council	Oversight responsibility

Council Representation & Voting Structure

Representation and voting structure will depend on the organization and governance model determined by inter-governmental negotiations.

An example:

- **Representation**
  - **Each Member State represented by 2 official delegates**
    - **1 from high-energy physics**
    - and a maximum of 2 advisors
    - **A minimum level of contribution may be established for a Member State to be represented in Council.**

- **Voting**
  - **Most Council decisions require a simple majority of Member States.**
  - **Financial questions could be decided by qualified majority voting determined by a majority of financial contributions plus a majority of individual Member States.**
    - To give Host State an appropriate voice on financial issues
  - **In general, requiring unanimity should be the exception rather than the rule.**

Laboratory & Project Management - 1

Director-General

- **Elected by Council for a renewable fixed term**
- **As scientific leader of the ILC Lab, the DG will:**
  - **Propose to Council the organizational structure of the lab**
    - including its advisory bodies
  - **Nominate members of Directorate & other top mgmt. members**
    - for Council endorsement
  - **Direct ILC construction and operation**
  - **Report regularly to Council**

Laboratory & Project Management - 2

Directorate

- **Under the direction of the DG, the Directorate will:**
  - **Steer ILC construction and operation**
  - **Direct laboratory divisions in that task**

- **Structure**
  - **Defined by the DG and approved by the Council.**
  - **Should reflect critical facets of laboratory activity**
    - E.g. civil engineering and conventional facilities, accelerator, and research program

- **Composition**
  - **Should reflect the expertise & experience required in all aspects,**
    - Including project mgmt., engineering and technology, and administration.

- **Members will be nominated by the DG and endorsed by the Council for the term of the DG.**

Laboratory & Project Management - 3

Project Management

- **During ILC construction, the laboratory organization must have a well-defined project management and a well-defined project organization,** to be defined by the DG.
- **Given the size, technical complexity, and international nature of ILC construction, a dedicated project management team will be critical for success.**
- **Directed by DG and by (or within) the Directorate**
- **Responsible for ILC construction**
  - **Including cost and schedule**
  - **Including civil engineering, conventional facilities, accelerator**
- **Composition, in addition to scientists & engineers, should include expertise in working with:**
  - **Public sector**
  - **Private sector**
  - **International projects and organizations**
  - **Legal matters**
  - This expertise could come from outside the scientific community, if needed.
- **Project organization and management should make provision for appropriate coordination and interfacing of global in-kind member state contributions.**

Laboratory & Project Management - 4

Some observations:

Directly employing scientific staff at the ILC Lab will be important

- **for the scientific atmosphere or the ILC Lab,**
- **to attract scientists to spend time at the Lab, and**
- **to motivate the technical and administrative staff.**

The technical and management expertise and experience in large scientific projects and their construction that is resident in the leading laboratories of the Member States should be provided to advise the project and to address unforeseen issues when they arise.

For instance, a wealth of know-how and expertise from manufacture of cryomodules and construction of light source facilities exists in the prospective Member States.

The management practices used for large science projects are relatively well-established and will be followed for the ILC.

Interface between ILC Lab & Experiments

The ILC Lab should:

- **Develop a successful scientific program in collaboration with the worldwide scientific community**
- **Define the process to be used to select experiments**
- **Supply the necessary infrastructure and services for experiments**
- **Propose a scheme to decide the precise running program after consultation with the scientific community.**

Expectations of detector collaborations:

- **Self-organizing and governing**
- **Open to participation of the entire community**

It is suggested that the collaborations be mandated to designate individuals in their management structure who are responsible for:

- **Financial matters**
- **Matters of safety of personnel and equipment**

and that these individuals should be staff members of ILC Lab during their tenure in these roles.

Technical Preparation Plan – An overview only

- MEXT's ILC Advisory Panel & Science Council of Japan each identified some technical concerns.
- An updated KEK-ILC Action Plan lists the tasks for the preparatory phase
  - Includes tasks addressing concerns identified by MEXT's ILC Advisory Panel & Science Council of Japan
  - Includes possibilities for international collaboration (and cost sharing)
    Principal partners: France, Germany, U.S., CERN, Italy, Russia, UK
- The tasks addressing concerns are:
  - SRF cavities: mass production – performance statistics & technology
  - Cryomodules: transport
  - Positron source design: rotating target; magnetic focusing; photon dump
  - Damping ring: fast kicker; feedback
  - Interaction point: stability of beam focus and position control
  - Beam dump: beam window; cooling water recirculation

Accelerator-related technical preparation tasks and possible partners for international collaboration as envisioned by KEK

Component	Issue	Summary of tasks	Candidates for collaboration
SCRF Cavity	Mass production incl. automation	Performance statistics, mass production technology	France, Germany, US
	Cryomodule transport	Performance assurance after transport	France, Germany, US
Positron Source	Rotating target	Exchanging target, system design	CERN, France, Germany, US + industry-academia efforts
	Magnetic focusing system	System design	France, Germany, Russia, US
	Photon dump*	System design	CERN, Germany, US
Damping Ring	Fast kicker	Test of long-term stability, system design	CERN, Italy
	Feedback	Test at SuperKEKB	Italy
Interaction Region	Beam focus/position control	Test of long-term stability	CERN, UK
Beam Dump	Total system	System design	CERN, US
	Beam window, cooling water circulation	Durability, exchangeability, earthquake-resistance	CERN, US + industry-academia efforts

Conclusion

- International Working Group (WG) convened to provide a resource to KEK and MEXT in international discussions on:
    - Cost sharing
    - ILC Laboratory organization and governance
    - Technical preparation plan, including sharing
- WG discussions build upon the GDE's Project Implementation Plan.

Summary

- Cost sharing based principally on in-kind contributions
- Organization and governance of ILC Laboratory inspired by CERN model
- Some focus on organization of Pre-Lab during preparatory phase
- Technical preparation plan exists in KEK-ILC Action Plan
  Involves international collaboration

- Report was drafted in close consultation with MEXT.
- Feedback was received from LCB/ICFA and from DOE.

- WG report was completed in September.
  Submitted Oct. 1, 2019 as recommendations from KEK to MEXT.
- Report used by BMBF-MEXT discussion group.
  Expected to be used in similar meetings with other nations.
- Expected to provide a basis for planning of Pre-Lab by ICFA.