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Report of KEK International Working Group on the ILC Project
(Technical Preparation plan)

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TCMB meeting

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Charge of the report

- *Model of international cost-sharing for construction and operation*
- *Organization and governance of the ILC Laboratory*
- ***International share of the remaining technical preparation***
  - *Present a technical preparation plan in the preparatory 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.

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- ***Technical issues, pointed out by SCJ and MEXT's ILC Advisory Panel***
- ***Technical preparation plan in preparation phase***
- ***Possible international cooperation .***

- ***The detail of each accelerator components***
- ***Present R&D status***

4.1 Technical preparation plan in preparatory phase (General)

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- The technical preparation plan assumes that most of the preparatory tasks will be performed through international collaboration. For tasks related to civil engineering, environmental conservation and safety, KEK will lead the efforts to address them through industry-academia collaboration.

- KEK released the KEK-ILC Action Plan in 2016. It was updated for ILC250 in 2018. The Action Plan lists the tasks that should be performed during the preparatory phase, such as the accelerator, conventional facilities, common technical support, and management and governance. It also includes a plan for international collaborations.

- The 2018 E-JADE Report "The European ILC Preparation Plan" [EIPP] complements the KEK ILC action plan and provides an overview of European expertise and possible contributions to the ILC preparatory phase.

- The US-Japan R&D collaboration for the cost reduction and the performance improvement of SCRF is started from 2017. The research program will be continued to the preparatory phase.

- The technical preparation during the preparatory phase will be reviewed by the machine advisory committee in the Pre-Lab.

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4.2 Technical preparation pointed out by the MEXT's ILC Advisory Panel and SCJ

- *The technical concerns pointed out by MEXT's ILC Advisory Panel and the Science Council of Japan (SCJ) had been discussed in the updated KEK-ILC Action Plan. These concerns are expected to be resolved during the preparatory phase.*

- *European expertise relevant for ILC accelerator construction were summarized in the EIPP and the input to the European Strategy for Particle Physics Update from the European ILC community [EILC]. The candidate of the international cooperation of European countries and CERN were listed based on these reports.*

- *The ILC accelerator collaboration with the United States were assumed based on the on-going R&D program at the US-Japan R&D collaboration, and recent and past ILC and other accelerator activities at the United States.*

The International Linear Collider : A European Perspective

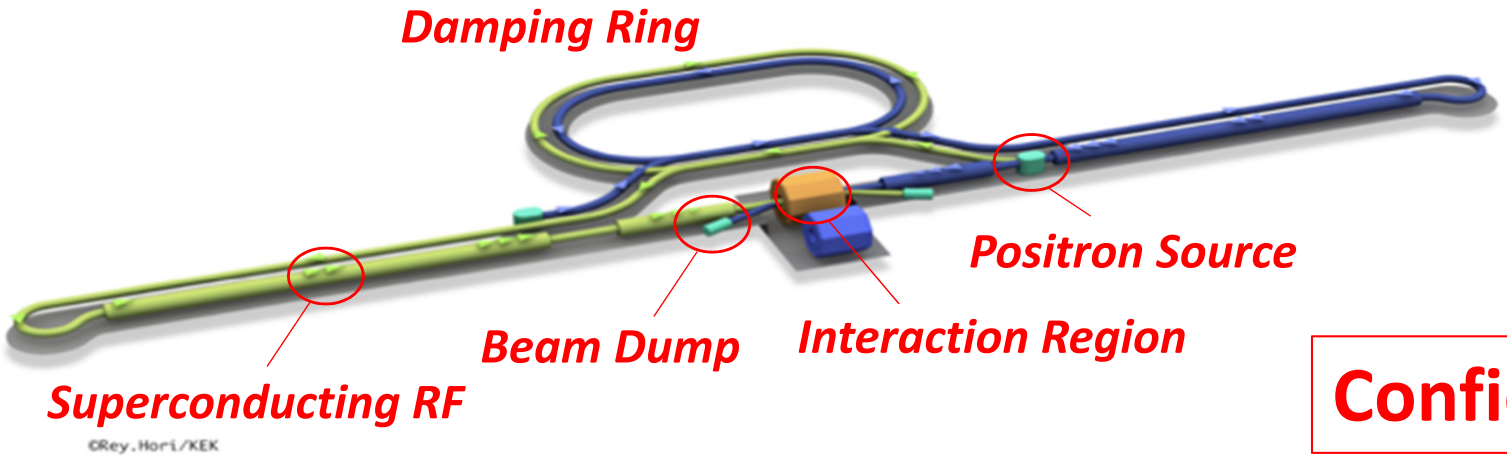
European contribution

European experience of ILC accelerator development was summarized in "The International Linear Collider : A European Perspective" The possible European contributions were from this report.

	SCRF	HLRF	Sources	Damping Rings	Instru-mentation	Beam Dynamics	Beam Delivery System	Cryogenics
CERN		C,O	O	G,C,O	C,G	C,G	C,G	O
France	X,E,G		G		A,G	G	C,G	
Germany	X,G	X	G	G	X	G		X,O
Italy	X,E,G			G				
Poland	X,E		O		E,O			X,E,O
Russia	X		G					
Spain	X,E				A		C,G	
Sweden	E						G	
Switzerland					X,C			
UK	E		G	G	A,C,G	C,G,A	C,G,A	

TABLE III. European expertise relevant for ILC accelerator construction, based on experience in the recent past. This is based on two major construction projects, the E-XFEL (X) and the ESS (E), several more R&D oriented efforts namely the GDE/LCC (G), ATF-2 (A), CLIC (C) and experience in other accelerator projects (O)

List of the technical issues pointed out in the MEXT's ILC Advisory Panel report and the SCJ report



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Component	Issue
SCRF	Mass production : New production method (cost reduction) and the yields
	Cryomodule transport
Positron Source	Rotating target
	Magnetic focusing system
	Photon dump (*)
Damping Ring	Fast kicker
	Feedback
Interaction Point	Beam focus/position control
Beam Dump	Beam window
	Cooling water circulation / Safety system

(*) Photon damp was not pointed out by SCJ and MEXT's ILC advisory panel .

Appendix D

Technical Issues pointed out in the report by SCJ and MEXT's ILC Advisory Panel

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Table E.1: Technical issues pointed out in the report by the Science Council of Japan (Original in Japanese: http://www.scj.go.jp/ja/info/kohyo/pdf/kohyo-24-k273.pdf)

R&D Issues
[SCRF] The design reference value for the SCRF acceleration gradient of 35 MV/m is based on the technical level that is currently achievable. It will be necessary to achieve this reliably and with a good yield; further performance improvement is also desired.
[SCRF] It is foreseen that the bulk of the SCRF cavities will be provided through in-kind contribution from the participating countries. An important issue will be the quality assurance that maintains the compatibility among them.
[Positron Source] In the preparation phase, it is planned that the prototype of the rotating target will be made and the magnetic focusing system immediately after the positron source will be developed. The technology selection is to be made by the second year of the preparation phase. The strategy should be clarified, taking into account the R&D cost.
[Interaction Region] The technology for the control and feedback system related to the beam focusing and position control needs be established. The acceptable level of microtremor in the interaction region needs to be quantified.
[Beam Dump] The soundness monitoring of the window material, the concrete design for a remote-controlled replacement/exchange system, and the detail of the reaction between a high energy beam and water need to be adequately studied during the preparation phase.

Table E.2: Summary of the ILC Advisory Panel's Discussions to Date after Revision http://www.mext.go.jp/component/b_menu/shingi/toushin/__icsFiles/afieldfile/2018/09/20/1409220_2_1.pdf

Page #	**R&D Issues**
5, 13, 32	[Damping Ring] There still remain issues on several subsystems, such as beam dump, positron source, electron source, beam control, and the injection/extraction of the damping ring.
32	[Beam Dump] The whole beam dump system should be developed in the preparatory phase. The required technologies include durability of the window, where continuous high-power beam pass through, and its maintainability and resistance to earthquakes.
32,33	[Positron Source] The helical undulator scheme is adopted as the positron source. It contains some technologies under development such as the cooling of the target irradiated by the gamma rays from the undulator and the replacement method of the activated target.

Superconducting RF (SCRF)

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Technical Preparation of SCRF

Technical concern pointed out by SCJ and MEXT's advisory panel

- ✓ *Mass production : New production method (cost reduction) and the yields*
- ✓ *Common design ⇐Already done by S1 grobal*
- ✓ *Cryomodule transport.*

Technical preparation at preparation phase

- ✓ ***International collaboration***
  - *Performance test of cost reduction and mass production preparation*
  - *Automation by robotics*
  - *Transport of the cryomodules produced by the different regions*

R&D status of SCRF (Appendix)

- ✓ *Cost reduction R&D (US-Japan R&D collaboration)*
- ✓ *Cryomodules with cavities, manufactured in three different regions (Asia, Europe, and US), were assembled and tested at KEK.*
- ✓ *The land transport has been already performed in Europe and in the US.*

Issue	***Tasks***	***Cooperation candidates***
Mass production	*Performance / mass production technology*	*Germany, France, USA*
Cryomodule transport	*Performance assurance after transport*	*Germany, France, USA*

Positron source

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Technical Preparation of Positron Source

Technical concern pointed out by SCJ and MEXT's advisory panel

- ✓ *Rotation targets*
- ✓ *Magnetic focusing devices*
- ✓ *Target replace/exchange system*

Technical preparation at preparation phase

- ✓ ***International Collaboration***
  - System design of rotation targets / magnetic focusing devices / beam window
  - System design of photon dump (not pointed out by SCJ etc.)
- ✓ ***Domestic industry-academia joint efforts, lead by KEK***
  - Reliability of the equipment
  - System design of the remote handling for exchanging the rotating target

Issue	***tasks***	***Cooperation candidates***
Rotating target	*System design / Exchanging target*	*CERN, Germany, France, USA, domestic industry-academia efforts*
Magnetic focusing system	*System design*	*Germany, France, Russia, USA*
Photon dump	*System design*	*CERN, Germany, USA*

Positron source - continued

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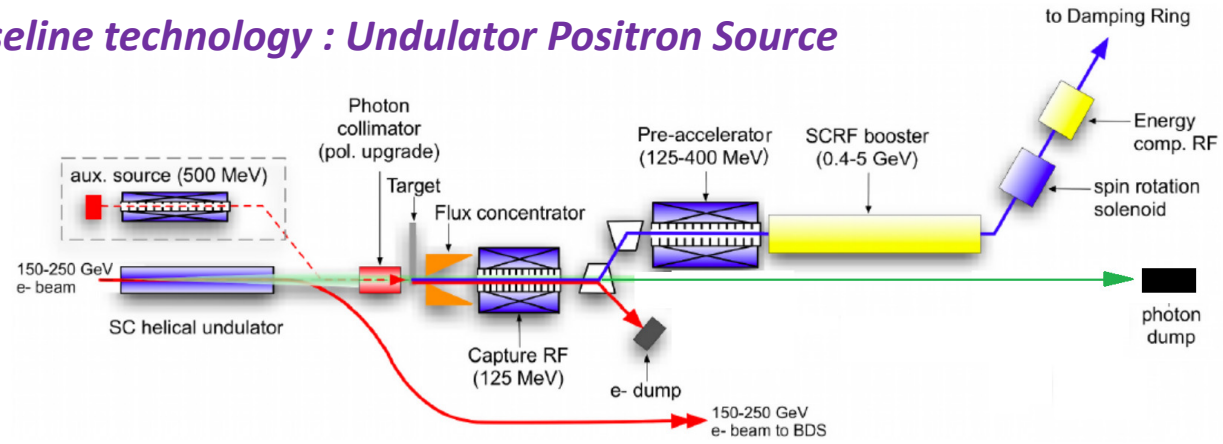
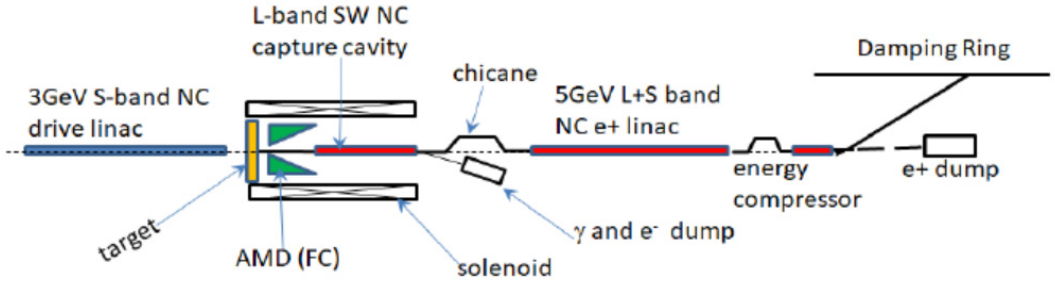
R&D status of Positron Source (Appendix)

- ✓ *Explanation of 2 schemes of ILC positron source*
- ✓ *Present R&D status of each component*

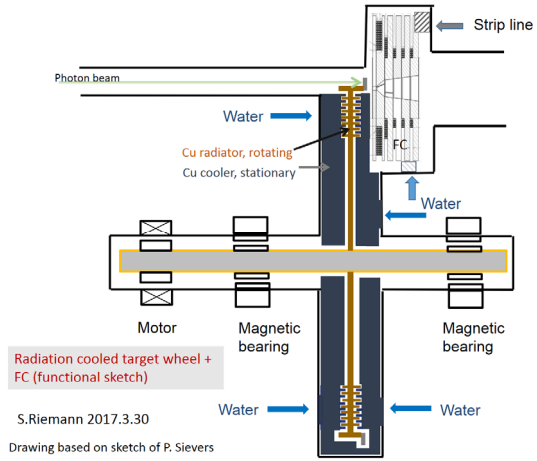
Baseline technology : Undulator Positron Source



Backup technology : Electron driven Positron Source



- ➢ *Rotating Target*
- ➢ *Magnetic focusing system*



Damping ring

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Technical Preparation of Damping Ring

Technical concern pointed out by SCJ and MEXT's advisory panel (MEXT's commissioned research/survey report)

- ✓ *long-term stability of the injection and extraction kicker systems*
- ✓ *high-resolution fast feedback system*

Technical preparation at preparation phase

- ✓ ***International collaboration***
  - *System design of injection / extraction systems*
  - *Long-term stability test of injection / extraction systems at ATF*
  - *Performance test / further development of feedback system*

R&D status of damping ring (Appendix)

- ✓ *Explanation of ILC injection / extraction systems*
- ✓ *Component test of ILC fast kicker was already performed.*
- ✓ *Fast feedback system was realized in many storage rings.*

Issue	***Summary of tasks***	***Cooperation candidates***
Fast kicker	*Test of long-term stability, system design*	*CERN, Italy*
Feedback	*Test at SuperKEKB*	*Italy*

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Final Focus System

Technical Preparation of Final Focus

Technical concern pointed out by SCJ and MEXT's advisory panel

- ✓ *long-term stability of IP beam size and IP beam position*

Technical preparation at preparation phase

- ✓ ***International collaboration***
  - Long-term stability test of IP beam size and position at ATF

R&D status of final focus system (Appendix)

- ✓ *Beam focusing at ATF2 to 41 nm*
- ✓ *ILC prototype feedback system has been verified to satisfy all ILC requirements.*

Issue	***Tasks***	***Cooperation candidates***
Beam focus/position control	*Test of long-term stability*	*CERN, UK*

Beam Dump

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Technical Preparation of Beam Dump

Technical concern pointed out by SCJ and MEXT's advisory panel

- ✓ *reliability and the stability of the window of the main beam dump*
- ✓ *reaction between the high energy beam and water*
- ✓ *Earthquake proof*

Technical preparation at preparation phase

- ✓ ***International collaboration***
  - *System design of monitoring of dump window.*
  - *System design to reduce the reaction effect between high energy beam and water.*
- ✓ ***Domestic industry-academia joint efforts, lead by KEK***
  - *System design of dump window replacement*
  - *System design for beam dump facilities ensuring the environmental and radiation safety.*
  - *System design of earthquake proof*

R&D status of Beam dump (Appendix)

- ✓ *Explanation of ILC beam dump design (2.2MW water dump)*
  - *Based on SLC 2.2MW water dump.*
  - *Beam dump is designed for 17 MW in order to withstand a future 1 TeV*

Issue	***Tasks***	***Cooperation candidates***
Beam window	*High pressure test / window replacement*	*CERN, USA, domestic industry-academia efforts*
Cooling water / Safety system	*System design*	*CERN, USA, domestic industry-academia efforts*