

Purpose of this visit and outline of the ILC project

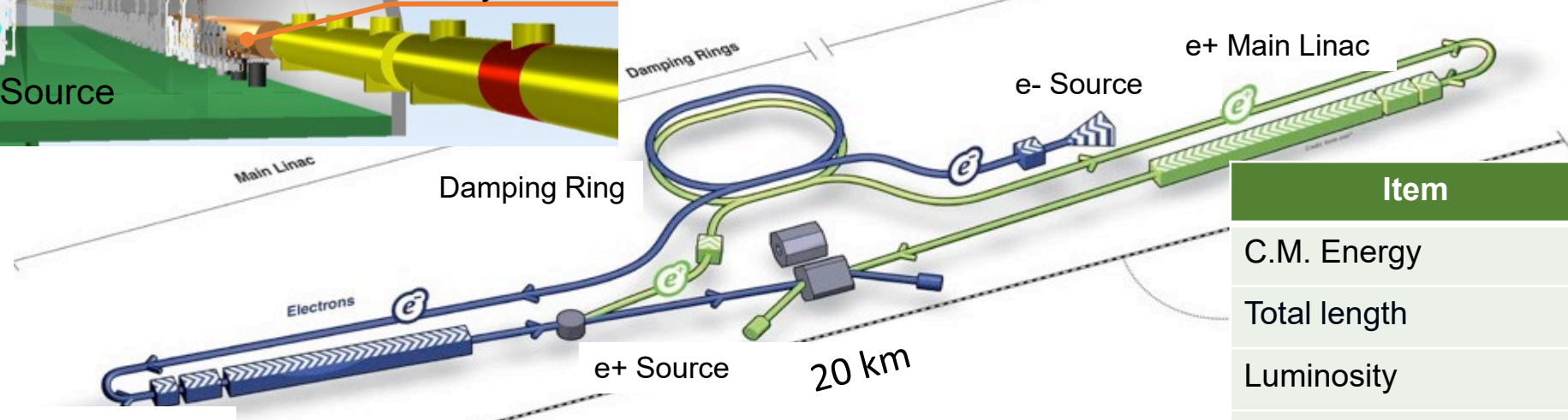
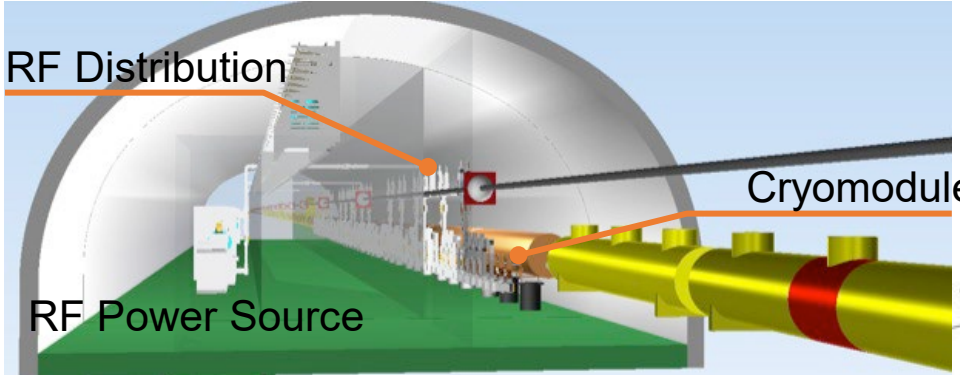
Yasuhiro Okada (KEK)

October 11, 2023

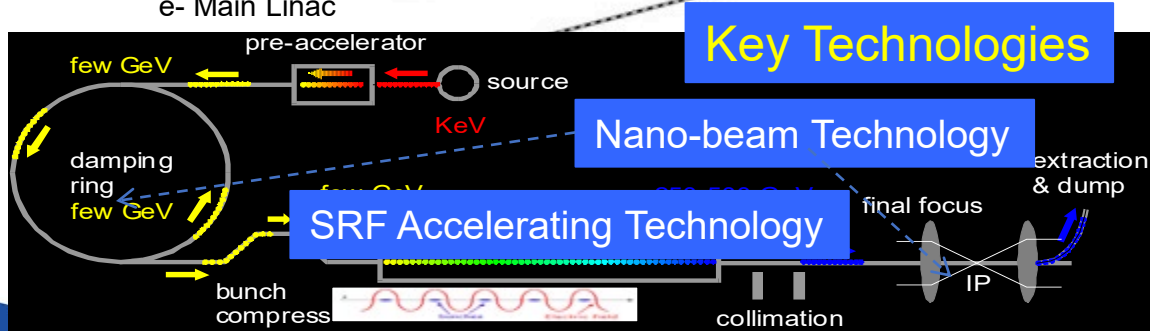
Japan/IDT delegation visit to Cornell University

International Linear Collider

ILC has been proposed by the international HEP community as a global project. Its design has been conducted by the initiative of ICFA.



Item	Parameters
C.M. Energy	250GeV
Total length	20km
Luminosity	$1.8 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$
Repetition rate	5 Hz
Beam pulse period	0.73 ms
Beam current	5.8 mA (in pulse)
Beam size (y) at FF	7.7 nm
SRF cavity gradient and Q_0	31.5 MV/m $Q_0 = 1 \times 10^{10}$



Some history of ILC

- By early 2000's, it became a consensus among the world HEP community that an e^+e^- linear collider with the CM energy of about 500 GeV should be the next collider beyond the LHC.
- ICFA chose the cold technology for LC as a global project and set up a global team (GDE) for design and coordination of R&D for the ILC. The TDR of the ILC was published in 2003.
- KEK and Japanese HEP community proposed Japanese Government to host ILC in Japan in 2013. The promotion activities have been carried out with the cooperation of the Diet Members' Caucus and the industrial sector, but no remarkable progress was made. So the framework for promotion was changed in 2021 and the project was restarted under a new structure in Japan.
- In 2020, ICFA organized the International Development Team (IDT) to pave a way towards the preparatory phase of the ILC. The proposal of the PreLab was, unfortunately, not approved by Japanese Government. The IDT proposed to form ILC Technology Network (ITN) and International Expert Panel (IEP) to perform some of the PreLab functions on its behalf.



Since the discovery of the Higgs particle,

- The high-energy physics community in Japan proposed to realize the ILC hosted in Japan as a global project in 2012 after the discovery of the Higgs particle. This was welcomed by the HEP communities across the world.
- MEXT in Japan set up an ILC expert panel and started a series of investigations.
- Meanwhile, the baseline of the ILC was changed to 250 GEV CM energy (a Higgs factory) keeping technical energy extendibility to a 1 TeV energy region in 2017 after LHC Run 2 results.

Emerging from recent strategic studies

European Strategy for Particle Physics (2020)
Snowmass study(2022)

- A Higgs factory is the highest priority next collider.

ILC, CLIC, FCC-ee, CEPC, C3, etc.

- A Higgs factory is not the end of the story. We need a plan of a path toward higher energy scales.

LC to higher energies at a later stage
Circular Colliders: ee-> pp
Developments of muon colliders

Proposal Name	c.m. energy [TeV]	Luminosity/IP $10^{34} \text{ cm}^{-2} \text{ s}^{-1}$	Yrs. pre project R&D	Yrs. to 1st physics	Constr. cost [2021 B\$]	Electr. power [MW]
FCC-ee ^(1,2)	0.24	7.7 (28.9)	0-2	13-18	12-18	290
CEPC ^(1,2)	0.24	8.3 (16.6)	0-2	13-18	12-18	340
ILC ⁽³⁾ -0.25	0.25	2.7	0-2	<12	7-12	140
CLIC ⁽³⁾ -0.38	0.38	2.3	0-2	13-18	7-12	110
C ³ ⁽³⁾	0.25	1.3	3-5	13-18	7-12	150
HELEN ⁽³⁾	0.25	1.4	5-10	13-18	7-12	110
CLIC-3	3	5.9	3-5	19-24	18-30	~ 550
$\mu\mu$ Collider ⁽¹⁾ -3	3	2.3 (4.6)	>10	19-24	7-12	~230
FNAL $\mu\mu$ ⁽¹⁾	6-10	20 (40)	>10	19-24	12-18	~300
FCC-hh ⁽¹⁾	100	30 (60)	>10	>25	30-50	~560
SPPC	125	13 (26)	>10	>25	30-80	~400

Advantages of the ILC project

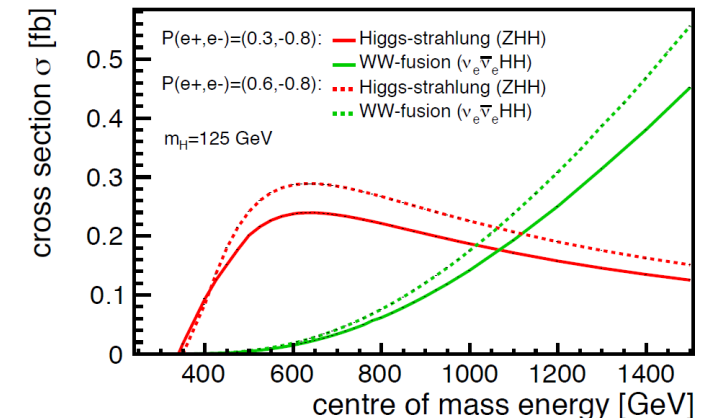
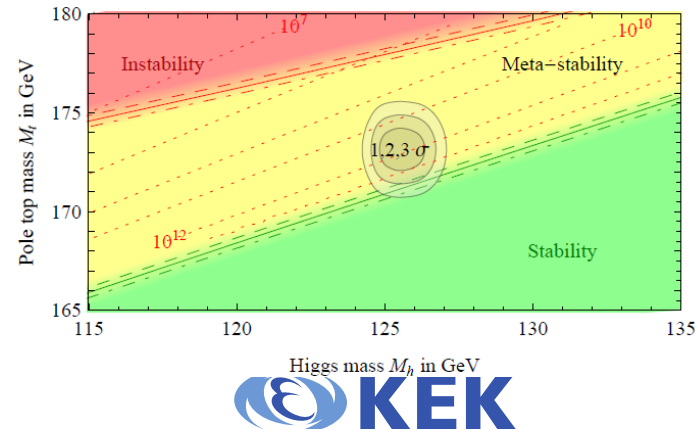
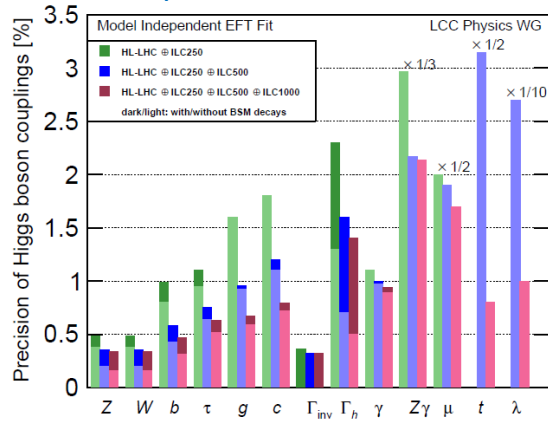
- Accelerator technology is mature. Experience of European X-FEL, LCLS-II
- Reliable cost estimation and modest energy consumption
=> **Early realization**
- A path to higher energy upgrades can be decided and implemented step by step based on scientific outcomes of early-stage experiments.
=> **Flexibility in accordance with future science developments and a long total life-time**



Installed cryomodules in the European XFEL

- Note that even in the minimum case, we expect important physics results in each step (top-pair, ttH, double Higgs production, ...)

The ILC report to Snowmass 2022, arXiv:2203.07622



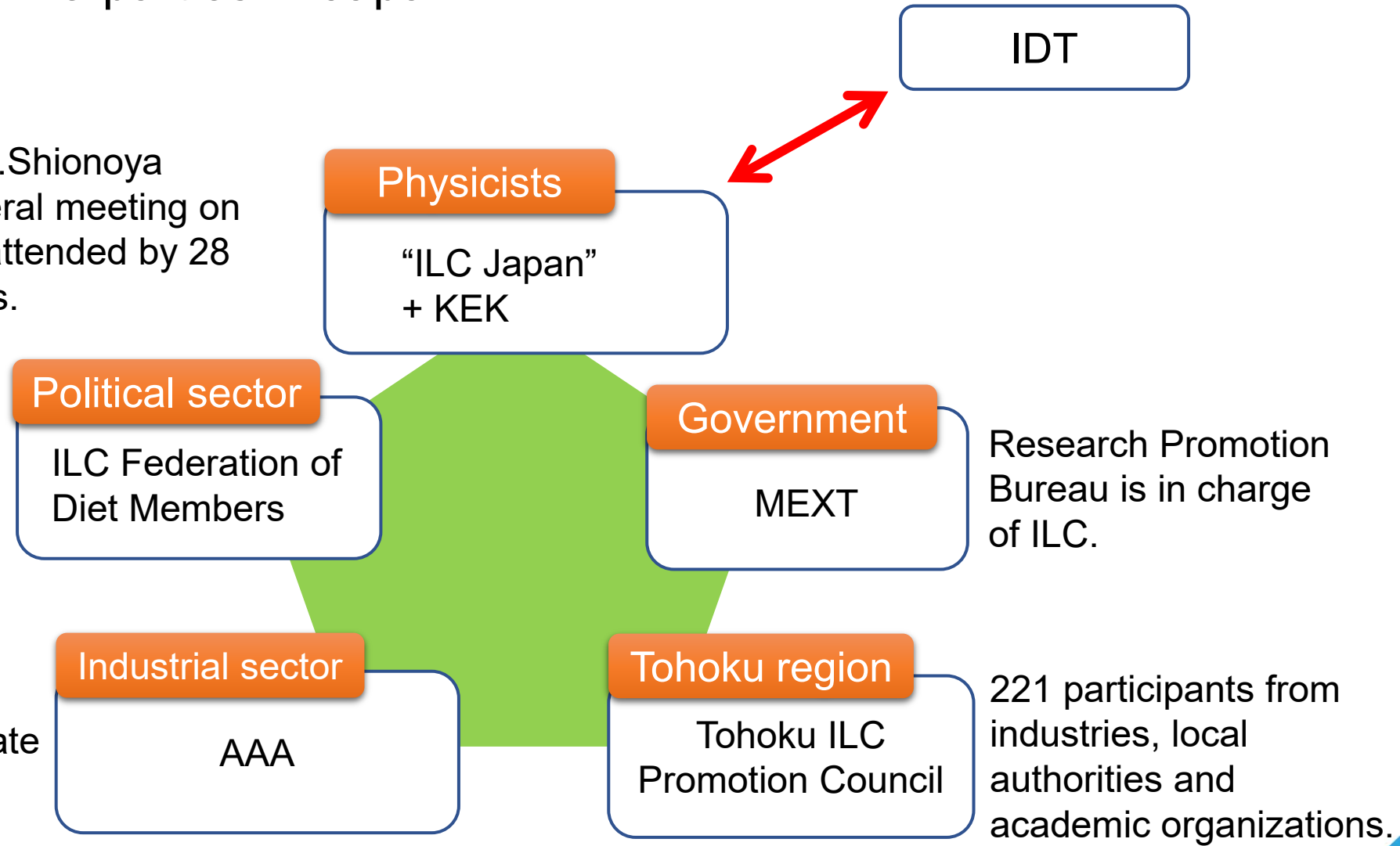
ILC Promotion by the Five-parties in Japan

President: Mr. Shionoya
The last general meeting on Apr. 27 was attended by 28 Diet members.



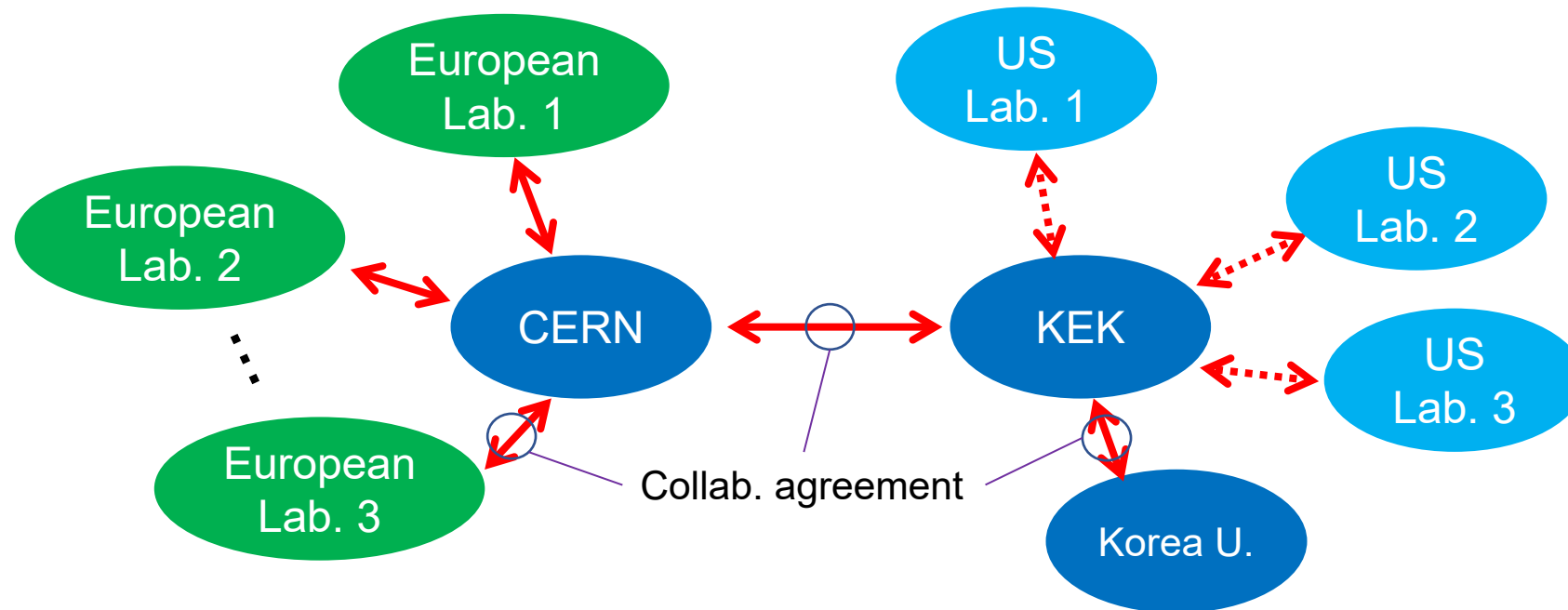
Federation members discussed with the MEXT Minister.

97 Japanese private industries are the members of AAA.



ILC Technology Network (ITN)

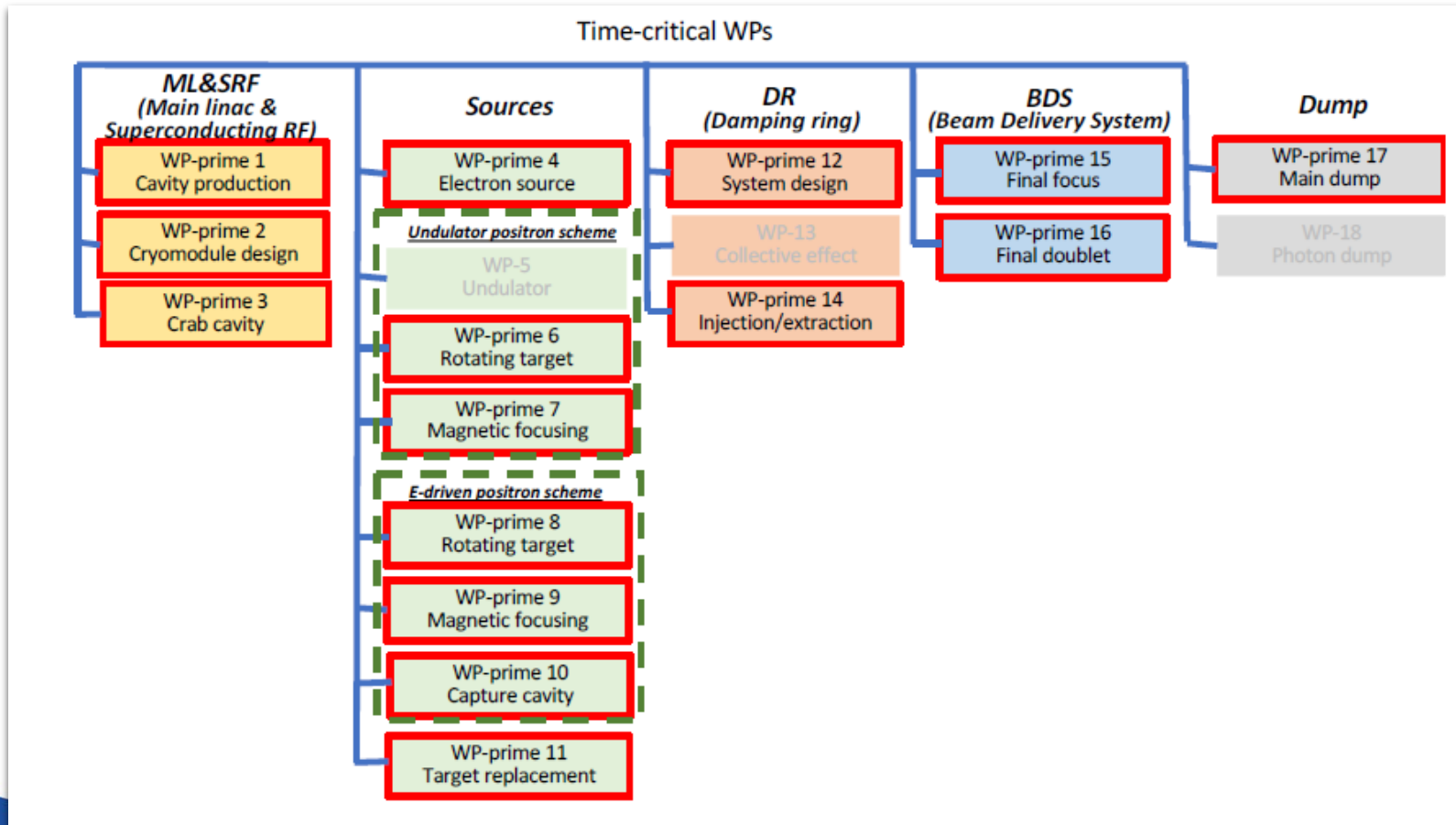
- ▣ The ITN is jointly initiated by KEK and IDT to execute high priority work packages identified by the IDT-WG2 from the ILC Pre-lab Proposal.
- ▣ ITN is an independent organization based on Arrangements between KEK and participating laboratories, and it takes full responsibility for the execution of those work packages.



9.7 oku JPY is included in JFY2023 MEXT budget which was a twice of the budget in the previous year. A new R&D grant for accelerator technology developments was awarded to KEK. MEXT requested to MOF a more budget for JFY2024. These allow us to conduct the international collaboration for technology developments

Work packages at the ITN

- The IDT-WG2 has created a set of time-critical work packages to be implemented in the ITN by selecting 15 of the 18 work packages proposed in the Pre-lab and reducing their size.



WPP	1	Cavity production
WPP	2	CM design
WPP	3	Crab cavity
WPP	4	E- source
WPP	5	
WPP	6	Undulator target
WPP	7	Undulator focusing
WPP	8	E-driven target
WPP	9	E-driven focusing
WPP	10	E-driven capture
WPP	11	Target replacement
WPP	12	System design
WPP	13	
WPP	14	Injection/extraction
WPP	15	Final focus
WPP	16	Final doublet
WPP	17	Main dump
WPP	18	

ITN is being launched

- The first agreement on the ITN work was made between KEK and CERN in July 2023. CERN will act as a coordinating and facilitating hub for ITN in Europe.
- MOU between Korea Univ. and KEK was renewed with cooperation in R&D under ITN.
- KEK intend to conclude similar arrangements with other institutions and expand the ITN framework.

The ITN Information meeting will be held on October 16 and 17, 2023 at CERN in a hybrid mode.

The framework of the ITN is described by the document co-authored by KEK and IDT.

<https://linearcollider.org/wp-content/uploads/2023/09/IDT-EB-2023-001.pdf>



<https://www.kek.jp/en/topics-en/202307081205/>



ILC Development Facilities at KEK



ATF:

1. KEK hosts the nanobeam R&D at ATF, where the goal is to establish stable and reliable nano-beam operation.
2. Accelerator scientists from Europe and Korea joined the ATF experiments .



SRF:

1. 80 m long superconducting linac that can be used to test the SRF cavities with beam.

Remarks on the ILC timeline

A model for ILC project phases – the most optimistic case



Note: It assumes that obstacles like pandemics, international tensions and global economic turmoil will be timely resolved.

Purpose of this visit

- ❑ Communicate the recent progress of the ILC to the international community of the accelerator-based science at large and build a cooperative relationship for the realization of the ILC.
- ❑ KEK and the Japanese physics community are working closely with the IDT to establish “ILC Technology Network”, an international framework to complete the technical development for the ILC, and we would like to invite the Cornell scientists to join us at the ITN. We would like to talk about this with you, including the lab management, and hope that this will be an opportunity to start a discussion in the laboratory.