Report on ILC status

Shin MICHIZONO
International Development Team (IDT) WG2/ KEK

- *IDT-WG2 for ILC Pre-Lab*
  - *Accelerator activities at ILC Pre-Lab phase*
  - *Technical preparation*
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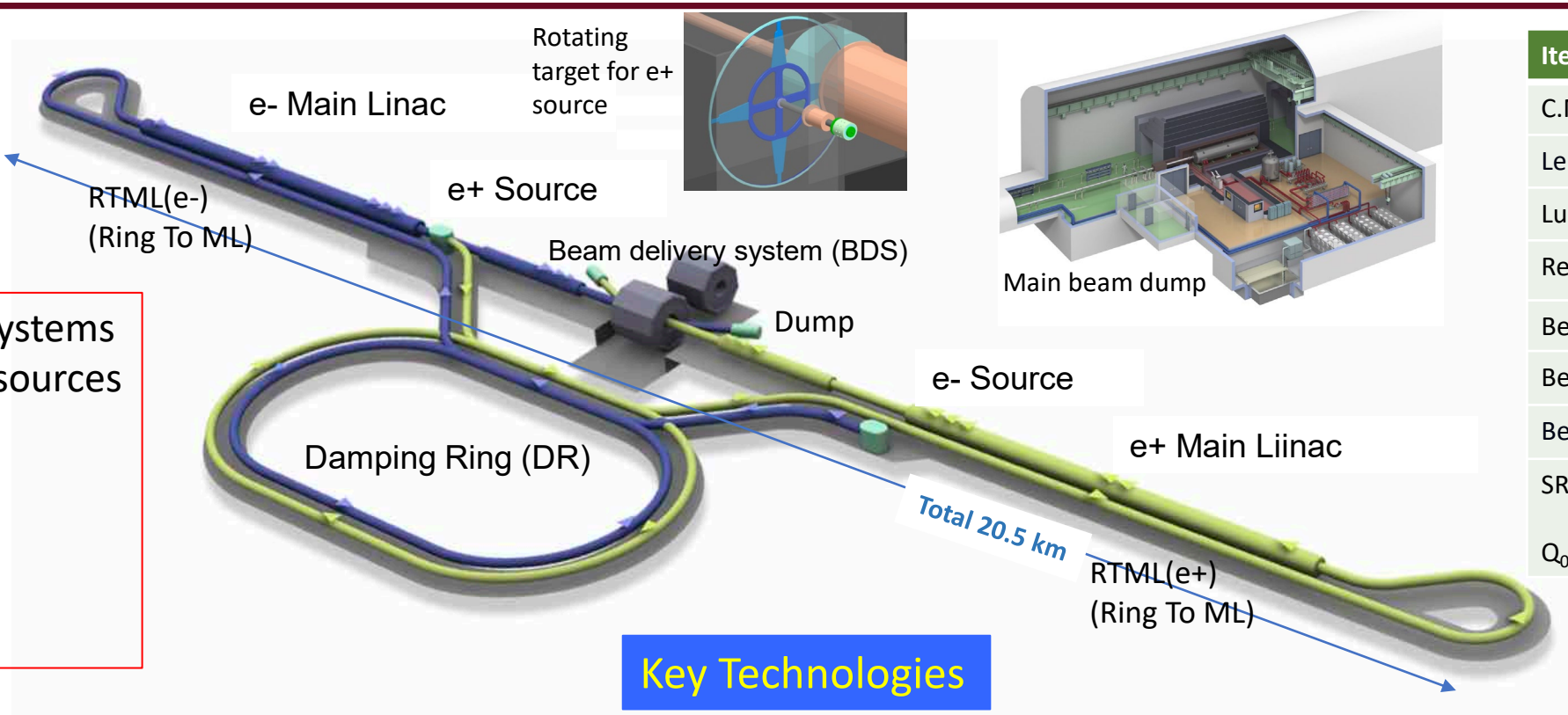
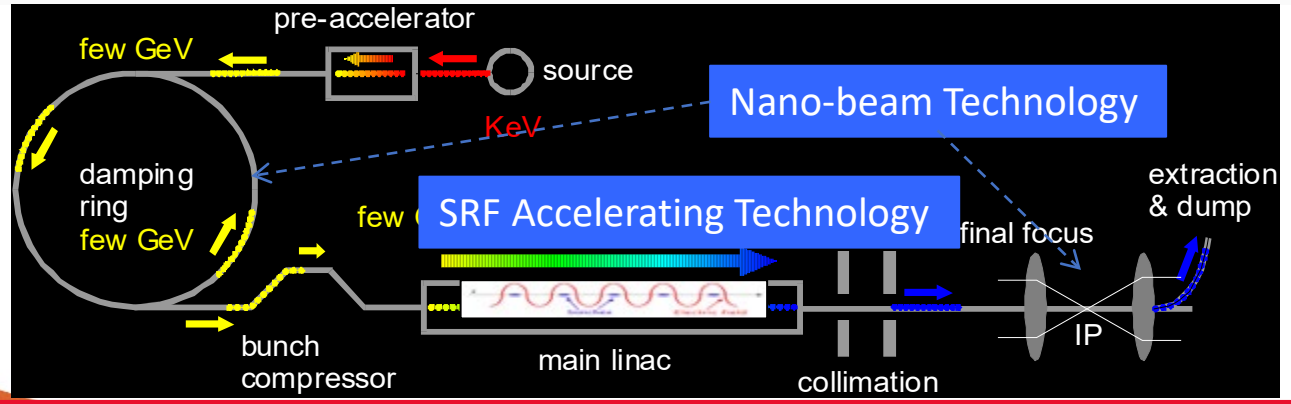
ILC250 accelerator facility



Area systems
e-/e+ sources
DR
RTML
ML
BDS
Dump

Item	Parameters
C.M. Energy	250 GeV
Length	20km
Luminosity	1.35 x10^{34} $cm^{-2}s^{-1}$
Repetition	5 Hz
Beam Pulse Period	0.73 ms
Beam Current	5.8 mA (in pulse)
Beam size (y) at FF	**7.7** nm@250GeV
SRF Cavity G.	**31.5** MV/m (**35** MV/m)
Q_0	Q_0 = 1x10^{10}

Key Technologies



8,000 SRF cavities will be used.

International Development Team (IDT)

IDT-WG2 organization

IDT EB

IDT WG2
Shin Michizono (Chair)
Benno List (Deputy)

Smooth transition to the ILC Pre-Lab

ML&SRF

Yasuchika Yamamoto	***KEK***
Sergey Belomestnykh	FNAL
Nuria Catalan	CERN
Enrico Cenni	CEA
Dimitri Delikaris	CERN
Luis Garcia Tabares	CIEMAT
Rongli Geng	ORNL
Hitoshi Hayano	KEK
Bob Laxdal	Triumf
Matthias Liepe	Cornell
Peter McIntosh	STFC
Laura Monaco	INFN Milano
Olivier Napoly	CEA
Sam Posen	FNAL
Robert Rimmer	JLAB
Marc C. Ross	SLAC
Kensei Umemori	KEK
Hans Weise	DESY
Akira Yamamoto	KEK

DR/BDS/Dump

Toshiyuki Okugi	***KEK***
Karsten Buesser	DESY
Philip Burrows	U. Oxford
Angeles Faus-Golfe	LAL
Andrea Latina	CERN
Kiyoshi Kubo	KEK
Jenny List	DESY
Thomas Markiewicz	SLAC
Brett Parker	BNL
Ivan Podadera	CIEMAT
David L. Rubin	Cornell
Nikolay Solyak	FNAL
Nobuhiro Terunuma	KEK
Glen White	SLAC
Kaoru Yokoya	KEK
Mikhail Zobov	INFN LNF

Dump

Nobuhiro Terunuma	***KEK***
Toshiyuki Okugi	KEK

Sources

Kaoru Yokoya	***KEK***
Jim Clarke	STFC
Steffen Doebert	CERN
Joe Grames	JLAB
Hitoshi Hayano	KEK
Masao Kuriki	U. Hiroshima
Benno List	DESY
Jenny List	DESY
Gudrid Moortgat-Pick	U. Hamburg
Sabine Riemann	DESY
Peter Sievers	CERN -retired

Civil engineering

Nobuhiro Terunuma	***KEK***
John Andrew Osborne	CERN
Tomoyuki Sanuki	U. Tohoku

CRAB

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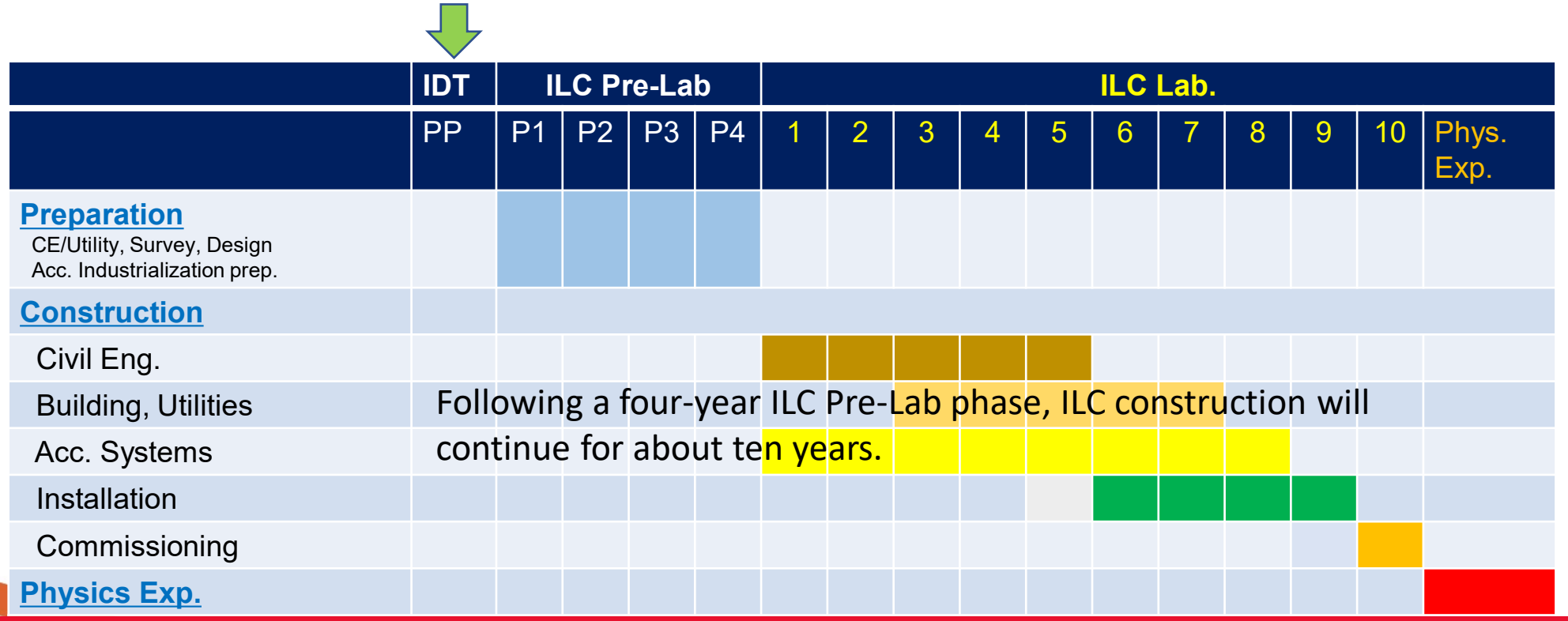
Accelerator activities at ILC Pre-lab phase

- *Technical preparations (Solve the technical concerns by international cooperation)*
- *Final technical design and documentation (Engineering Design Report, Cost confirmation)*
- *Preparation and planning of mass production*
- *Civil engineering, local infrastructure and site*

Planning technical preparation was our first work at IDT-WG2

+ develop human resources necessary for ILC construction



ILC Pre-Lab timeline (accelerator)

Accelerator related timeline during Pre-Lab phase (Technical preparation and final documentation)

Year	Technical Preparation (focusing on SRF and e+ Source)	Final Documentation
1	- Extend SRF cavity cost-reduction R&D - Start a pre-series SRF cavities production in cooperation with industry - Continue e+ source survey and internal review	- Work on TDR-based cost-estimate confirmation to be started by an international team centered at the Pre-lab
2	- Complete SRF cost-reduction R&D with success yield statistics - Extend the preparation to assemble the cavities with cryomodule (CM) - Review e+ source scheme	- Conduct internal Program Advisory Panel on the progress in technical and cost-confirmation issues
3	- Demonstrate "Cryomodule Global transfer", with HPGS (high pressure gas safety) legal-process, shipment - Establish e+ source scheme down-select, and prototyping of critical items (such as e+ target)	- Complete the cost-estimate confirmation - Conduct internal and external Cost-confirmation Reviews and complete scrutiny of costs and risks -Complete the draft of Engineering Design Report (EDR).
4	- Evaluate CM performance after CM shipment and demonstrate the QA, and establish SRF Hub Lab. functioning - Progress prototyping of critical items (such as e+ target)	- Publish the EDR, including report on resolving the technical issues encountered - Start to prepare for each large bid, with specification documents and drawings - Add the EDR addendum, if necessary for the documentation to be completed

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Technical issues pointed out by MEXT and SCJ

- The MEXT advisory panel and Science council of Japan pointed out some remaining technical issues that need to be resolved during the ILC preparation period.

  http://www.mext.go.jp/component/b_menu/shingi/toushin/__icsFiles/afieldfile/2018/09/20/1409220_2_1.pdf
  http://www.scj.go.jp/ja/info/kohyo/pdf/kohyo-24-k273-en.pdf

- These are discussed at international working group (KEK,2019) and summarized in the report.

  "Recommendations on ILC Project Implementation" https://www.kek.jp/en/newsroom/2019/10/02/1000/

Component	Issue	Summary of tasks	Candidates for collaboration
SRF 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

ILC Pre-Lab

Real cavity and cryomodule production

ML&SRF

- WP-1 Cavity production
- WP-2 Cryomodule transfer
- WP-3 Crab cavity

Sources

Electron source

- WP-4 Electron source

Positron sources

Undulator scheme

- WP-5 Undulator
- WP-6 Rotating target
- WP-7 Magnetic focusing

E-driven scheme

- WP-8 Rotating target
- WP-9 Magnetic focusing
- WP-10 Capture cavity
- WP-11 Target replacement

DR

- WP-12 System design
- WP-13 Collective effect
- WP-14 Injection/extraction

BDS

- WP-15 Final focus
- WP-16 Final doublet

Dump

- WP-17 Main dump
- WP-18 Photon dump

Technical Preparation Document (TPD) was summarized by IDT-WG2.

18 WPs were proposed.
Total ~60 MILCU ~360 FTE-yr
+ infrastructure (cavity/CM evaluation etc.) at each region

Please visit Accelerator plenary session

Technical preparation document (TPD)

- Technical preparation during ILC Pre-lab phase is based on the in-kind contribution.
  (budget request, implementation, and documentation of the results)

- The technical preparation document (TPD: main text and appendix) itself is made for the world-wide WP coordination and for supporting each regional budget request.
  - This document also can be used to show the global collaboration effort during ILC Pre-lab.
  - Further region- or laboratory-dependent estimates will be necessary for the regional budget request (since the accounting system and FTE conversion will be different).
  - The TPD main text will be revised following the TPD review and uploaded to ILC web page.
  - Appendix (including cost, FTE, and candidate laboratories) will not be on the public web. (only used for the ILC Pre-lab discussion)

- The discussion about WPs (sharing, preparation for budget request (including re-estimate based on TPD)) will start in each region based on this document.

Technical Preparation Document (TPD) review (remote)

TPD review was organized by IDT-EB.

Mandate of the review:

1. Does the list of work identified by WG2 cover all the technical issues for the accelerator that need to be addressed before starting ILC construction?
2. Do the work package descriptions adequately define the scope of the work?
3. Are there any work packages that could be performed or could continue after the start of construction?
4. Is the estimation of the cost and required human resources adequate for the participating laboratories to prepare their funding requests?

Review Committee members

Camille Ginsburg (JLab, USA)
Michael Harrison (BNL, USA)
Erk Jensen (CERN, Switzerland)
Deepa Angal Kalinin (ASTeC, UK)
Heung-Sik Kang (Pohang Accelerator Laboratory, Korea)
Eugene B. Levichev (BINP, Russia)
Tor Raubenheimer (SLAC, USA), Chair
Naruhiko Sakamoto (RIKEN, Japan)
Nick Walker (DESY, Germany)IDT-WG2

IDT-WG2 would like to thank the review committee.

The TPD main text will be revised following the TPD review and uploaded to ILC web page.

23-Feb	First day	Charges	Andy Lankford
		Overview	Shin Michizono
		Exec. Session	
24-Feb	e+	Positron overview	Kaoru Yokoya
	e-Driven	WP-8~10	Masao KURIKI
		WP-11	Masao KURIKI
	DR/BDS/Dump	DR/BDS/Dump overview	Toshiyuki Okugi
		WP-17,18	Nobuhiro Terunuma
		Discussion and Exec. Session	
26-Feb	SRF	ML/SRF overview	Yasuchika Yamamoto
		WP1	Sergey Belomestnykh
		WP2	Yasuchika Yamamoto
		WP3	Peter Mcintosh
		Discussion and Exec. Session	
3-Mar	e-	WP-4 (incl. electron overview)	Joe Grames
	Undulator	WP-5~7	Gudrid Moortgat-Pick
	DR	WP-12-14	Toshiyuki Okugi
	BDS	WP-15	Angeles Faus-Golfe
		WP-16	Brett Parker
		Discussion and Exec. Session	
4-Mar	Last day	Discussion	
		Exec. Session	
12- Mar	Debriefing	Debriefing	

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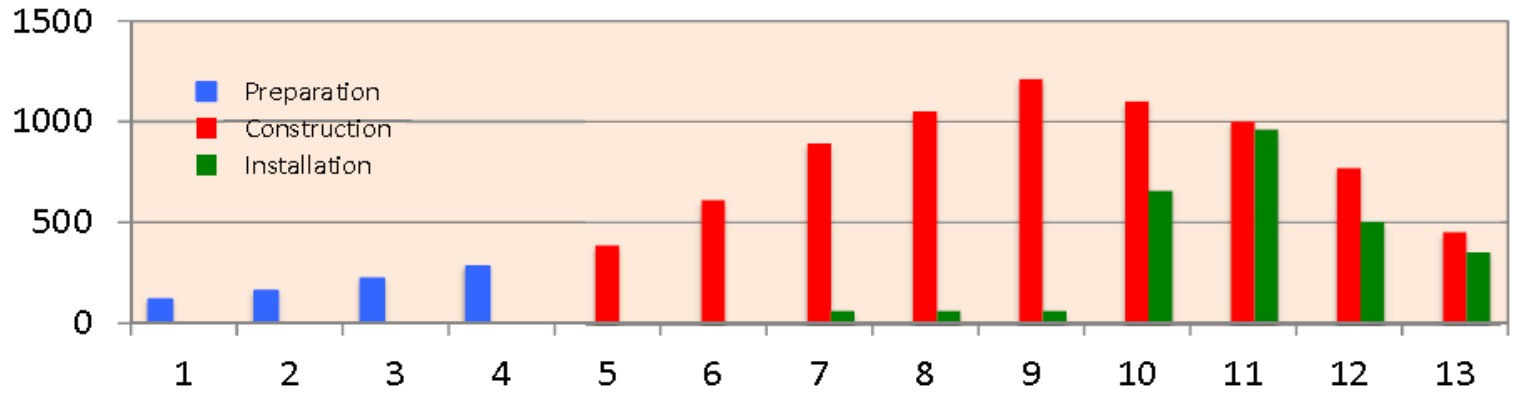
Human Resource Development

unit: person

Stage	Preparation				Construction									Total
	1	2	3	4	1	2	3	4	5	6	7	8	9	
Prep.	118	161	222	282										
Acc.	82	115	163	211			TDR, ILC-500 Ann. average: ~ 1,100 persons							
Except Civil, common														
Constr.	Acc. total 571 FTE-yr				410	922	1208	1350	1589	1480	1374	1106	679	10,118
Install.							80	80	80	768	1140	683	522	3,353
Total					410	922	1288	1430	1669	2248	2514	1789	1201	13,471
ILC-250							ILC-250: Ann. average: ~ 830 persons							
Constr.					385	610	890	1050	1210	1100	1000	770	450	7,465
Install.							60	60	60	655	960	500	350	2,645
Total					385	610	950	1110	1270	1755	1960	1270	800	10,110



https://www.kek.jp/en/newsroom/KEK-ILC_ActionPlan_Addendum-EN%20%281%29.pdf

Technical preparation requires ~360 FTE-yr (+regional infrastructure)

EDR requires ~60 FTE-yr

The scientists/engineers working at ILC Pre-Lab will play the central role during the ILC construction.

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ILC Environment Assessment Advisory Board

Please visit CFS parallel session

- **Established under the ILC Planning Office of KEK** in Sep.2019.
- Members (3) are experts of the environmental assessment.
- Five meetings were held in addition to the tour of the Kitakami site and KEK.
- The discussion was summarized in Dec.2020 and **the report was released in Feb.2021.**

"Strategic Environmental Assessment of the ILC Project - Summary of the Discussion", ILC Environmental Assessment Advisory Board
https://www2.kek.jp/ilc/ja/contents/docs/Strategic_Environmental_Assessment_of_the_ILC_Project_Summary_of_the_Discussion_r.pdf

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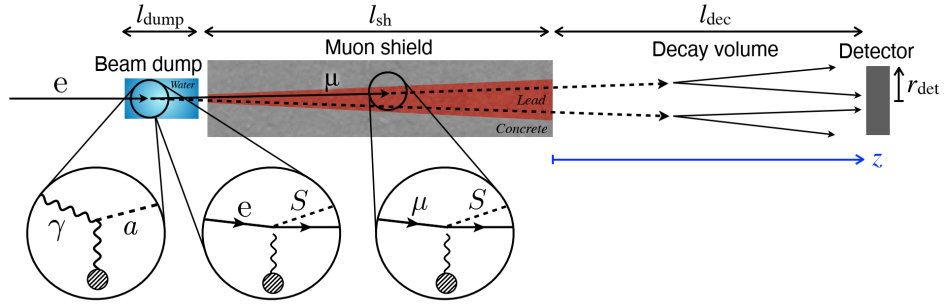
Use of ILC Beam for Fixed Target Experiment

There are many possible experiments using the ILC beam other than the colliding experiment

- Experiments using the main dump
  - ✓ Observe particles created in the main beam dump
  - ✓ Dark photon, dark lepton, ALP (axion-like particle), Higgs-portal particles, ……
  - ✓ Positron main dump
    - Positron annihilation with atomic electrons
  - ✓ Parasitic with the main collision experiment



- Experiments using Extracted beam
  - ✓ Extract the strong ILC beam somewhere for e.g., strong QED experiment
    - This is perhaps difficult (the beam is too strong to ontercept)
  - ✓ Or, create and extract a weak beam
    - Low bunch intensity but many (>> 1312) bunches
    - Ideally, CW
    - Missing energy experiment to search for dark photons
    - Lots of accelerator issues such as beam creation, to avoid damping in DR, control of very weak beam, etc.

By Kaoru Yokoya on Tuesday 10PM (Europe)
"N1: Dark Sector, Fixed-Target and Beam Dump Experiments"

- Far detector
  - ✓ Long-lived particles may be produced at the IP
  - ✓ They may be detected by a detector behind 50-200m shield (natural rocks)
  - ✓ Need to construct a cavern (near the main beamline, or along the access tunnel)

We would be happy to discuss the further possibilities of the ILC accelerator.

Application of ILC

– Quest of Diversified ILC –

ILC will be a unique and very powerful accelerator complex, once it is built. It has not only the high power energetic electron beam but also powerful positron and photon beams. In addition to these beams, large cryogenic plants are furnished together with various utility facilities in a site. This precious facility should be widely shared among the world.

Tunnels or extra spaces have to be incorporated from the beginning. Raise the attention of researchers who are not interested, and dig up discussions to sublimate attractively.

Three workshops have been held in Japan to seek the possibilities:

2017 Nov.

2018 Jul.

2018 Nov.

This WORKSHOP:

New Research and Opportunities Track

N1: Dark Sector, Fixed-Target and Beam Dump Experiments

N2: New Technologies & Ideas for Collider Detectors

N3: Beams for Accelerator and Detector R&D and Irradiation

on Monday 10PM (Europe)

We would be happy to discuss the further possibilities of the ILC accelerator.

Summary

- *ILC250 accelerator is 20 km long e-/e+ collider for the Higgs factory.*
- *Key technologies at the ILC are superconducting rf (SRF) and nano-beam.*
  - *Nano-beam technology has been demonstrated at ATF hosted by KEK*
  - *SRF technology has been widely adopted at XFELs such as European XFEL.*
- *We assume 4-year preparation and 9-year construction.(now we are at pre-preparation phase (IDT))*
- *Preparation phase activities are*
  - *Technical preparation*
  - *Final engineering design*
  - *Planning and preparation of Hub lab.*
  - *Civil engineering*
  - *Human resources for ILC construction …*
- *Technical preparation document is summarized by IDT-WG2 and IDT-EB organized its review.*
- *Report on "Strategic Environmental Assessment of the ILC Project" is now available.*
- *We would be happy to discuss further possibilities of the ILC accelerator.*

Thank you for your attention