International Development Team

IDT WG2 Activities

Benno List, DESY

ILC Europe Meeting

23.3.2022

Snowmass Paper

arXiv:2203.07622

Quantity	Symbol	Unit	Initial	$\mathcal{L}$ Upgrade	Z pole		Upgrades	
Centre of mass energy	$\sqrt{s}$	GeV	250	250	91.2	500	250	1000
Luminosity	$\mathcal{L}$	$10^{34}\mathrm{cm}^{-2}\mathrm{s}^{-1}$	1.35	2.7	0.21/0.41	1.8/3.6	5.4	5.1
Polarization for e^-/e^+	$P_-(P_+)$	%	80(30)	80(30)	80(30)	80(30)	80(30)	80(20)
Repetition frequency	f_{rep}	Hz	5	5	3.7	5	10	4
Bunches per pulse	n_{bunch}	1	1312	2625	1312/2625	1312/2625	2625	2450
Bunch population	N_{e}	10^{10}	2	2	2	2	2	1.74
Linac bunch interval	Δt_{b}	ns	554	366	554/366	554/366	366	366
Beam current in pulse	I_{pulse}	mA	5.8	8.8	5.8/8.8	5.8/8.8	8.8	7.6
Beam pulse duration	t_{pulse}	μs	727	961	727/961	727/961	961	897
Average beam power	P_{ave}	MW	5.3	10.5	1.42/2.84*)	10.5/21	21	27.2
RMS bunch length	σ_{z}^*	mm	0.3	0.3	0.41	0.3	0.3	0.225
Norm. hor. emitt. at IP	$\gamma\epsilon_{\mathrm{x}}$	μm	5	5	5	5	5	5
Norm. vert. emitt. at IP	$\gamma\epsilon_{\mathrm{y}}$	nm	35	35	35	35	35	30
RMS hor. beam size at IP	σ_{x}^*	nm	516	516	1120	474	516	335
RMS vert. beam size at IP	σ_{y}^*	nm	7.7	7.7	14.6	5.9	7.7	2.7
Luminosity in top 1 %	$\mathcal{L}_{0.01}/\mathcal{L}$		73 %	73 %	99 %	58.3 %	73 %	44.5 %
Beamstrahlung energy loss	δ_{BS}		2.6 %	2.6 %	0.16 %	4.5 %	2.6 %	10.5 %
Site AC power	P_{site}	MW	111	138	94/115	173/215	198	300
Site length	L_{site}	km	20.5	20.5	20.5	31	31	40

Table 4.1: Summary table of the ILC accelerator parameters in the initial 250 GeV staged configuration and possible upgrades. A 500 GeV machine could also be operated at 250 GeV with 10 Hz repetition rate, bringing the maximum luminosity to $5.4 \cdot 10^{34}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$ [26]. *): For operation at the Z-pole additional beam power of 1.94/3.88 MW is necessary for positron production.

ILC Advisory Panel Results

1. The panel recognizes the academic significance of particle physics and the importance of the research activities, including that of a Higgs factory, and understands the value of international collaborative research. However, the panel found that it is still premature to proceed into the ILC Pre-lab phase, which is coupled with an expression of interest to host the ILC by Japan as desired by the research community proposing the project.

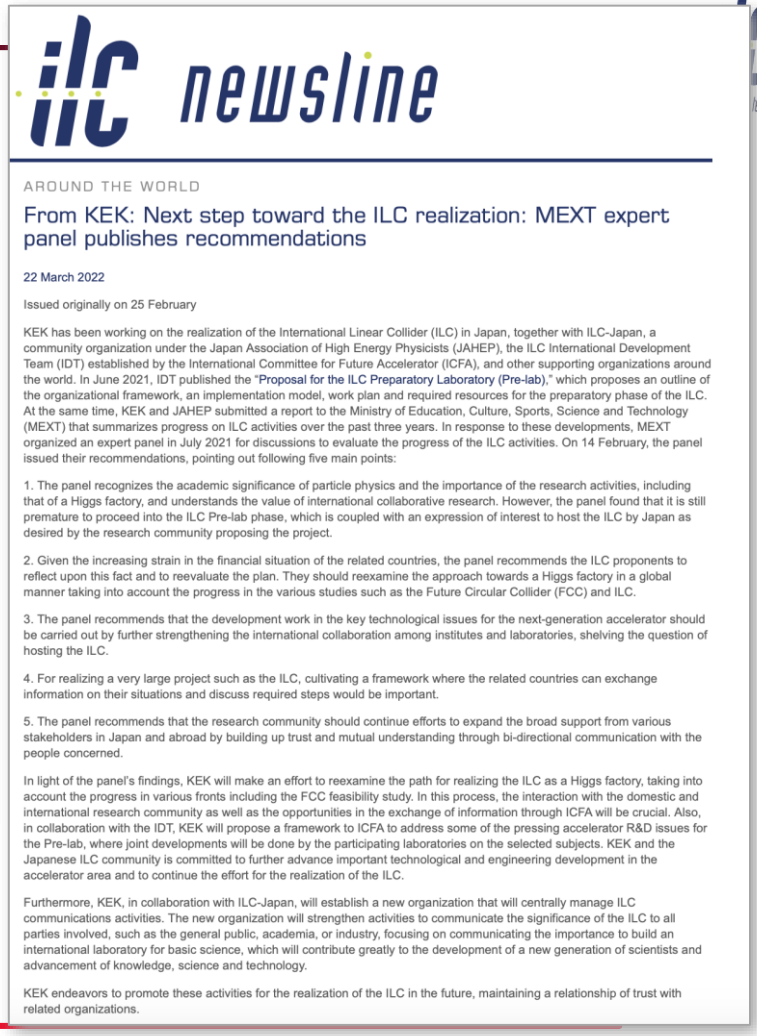
2. Given the increasing strain in the financial situation of the related countries, the panel recommends the ILC proponents to reflect upon this fact and to reevaluate the plan. They should reexamine the approach towards a Higgs factory in a global manner taking into account the progress in the various studies such as the Future Circular Collider (FCC) and ILC.

3. The panel recommends that the development work in the key technological issues for the next-generation accelerator should be carried out by further strengthening the international collaboration among institutes and laboratories, shelving the question of hosting the ILC.

4. For realizing a very large project such as the ILC, cultivating a framework where the related countries can exchange information on their situations and discuss required steps would be important.

5. The panel recommends that the research community should continue efforts to expand the broad support from various stakeholders in Japan and abroad by building up trust and mutual understanding through bi-directional communication with the people concerned.

In light of the panel's findings, KEK will make an effort to reexamine the path for realizing the ILC as a Higgs factory, taking into account the progress in various fronts including the FCC feasibility study. In this process, the interaction with the domestic and international research community as well as the opportunities in the exchange of information through ICFA will be crucial. Also, in collaboration with the IDT, KEK will propose a framework to ICFA to address some of the pressing accelerator R&D issues for the Pre-lab, where joint developments will be done by the participating laboratories on the selected subjects. KEK and the Japanese ILC community is committed to further advance important technological and engineering development in the accelerator area and to continue the effort for the realization of the ILC.



ilc newsline

AROUND THE WORLD

From KEK: Next step toward the ILC realization: MEXT expert panel publishes recommendations

22 March 2022

Issued originally on 25 February

KEK has been working on the realization of the International Linear Collider (ILC) in Japan, together with ILC-Japan, a community organization under the Japan Association of High Energy Physicists (JAHEP), the ILC International Development Team (IDT) established by the International Committee for Future Accelerator (ICFA), and other supporting organizations around the world. In June 2021, IDT published the "Proposal for the ILC Preparatory Laboratory (Pre-lab)," which proposes an outline of the organizational framework, an implementation model, work plan and required resources for the preparatory phase of the ILC. At the same time, KEK and JAHEP submitted a report to the Ministry of Education, Culture, Sports, Science and Technology (MEXT) that summarizes progress on ILC activities over the past three years. In response to these developments, MEXT organized an expert panel in July 2021 for discussions to evaluate the progress of the ILC activities. On 14 February, the panel issued their recommendations, pointing out following five main points:

1. The panel recognizes the academic significance of particle physics and the importance of the research activities, including that of a Higgs factory, and understands the value of international collaborative research. However, the panel found that it is still premature to proceed into the ILC Pre-lab phase, which is coupled with an expression of interest to host the ILC by Japan as desired by the research community proposing the project.

2. Given the increasing strain in the financial situation of the related countries, the panel recommends the ILC proponents to reflect upon this fact and to reevaluate the plan. They should reexamine the approach towards a Higgs factory in a global manner taking into account the progress in the various studies such as the Future Circular Collider (FCC) and ILC.

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Furthermore, KEK, in collaboration with ILC-Japan, will establish a new organization that will centrally manage ILC communications activities. The new organization will strengthen activities to communicate the significance of the ILC to all parties involved, such as the general public, academia, or industry, focusing on communicating the importance to build an international laboratory for basic science, which will contribute greatly to the development of a new generation of scientists and advancement of knowledge, science and technology.

KEK endeavors to promote these activities for the realization of the ILC in the future, maintaining a relationship of trust with related organizations.

https://newsline.linearcollider.org/2022/03/22/from-kek-next-step-toward-the-ilc-realization-mext-expert-panel-publishes-recommendations/

ILC Expert Panel – ILC Newsline

ilc newsline

DIRECTOR'S CORNER

ILC expert panel review: hosting is not the problem, says Shoji Asai

Shoji Asai | 22 March 2022

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Many in the high energy physics community might know that Japan's ILC Advisory Panel which examines the ILC project for the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT), released its recommendation on 14 February. Following that, KEK issued a statement about what steps they will take in response to the recommendation.

I would like to point out that the Japanese language is rather ambiguous, and various contexts are said only between the lines. I hear that many of you thought it was bad news when you read the English translation of the text. Here, I would like to clarify the meaning of the recommendation. It was not "totally negative", rather, it makes the project move one step ahead.

One of the issues that caused misunderstanding is this expression in the recommendation: "*shelving the question of hosting the ILC*" (as translated in KEK's statement). Some interpreted this statement to mean that Japan is no longer interested in hosting the ILC, but that is not the case. It does not mean that Japan has given up wanting to host the ILC.

The Proposal for the ILC Preparatory Laboratory (Pre-lab) was published by the ILC International Development Team (IDT) in August 2021, and it was submitted to Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT). It stated "Some indication that the Japanese government is moving towards expressing its interest in hosting the ILC in Japan as an international project will be necessary". What IDT asked for was "some indication", not an official statement to host the ILC or an interest to do so. Yet it is a very delicate and difficult issue for Japan to address. Actually, this has become an obstacle for the fair discussion on the international cost sharing to start, a chicken-and-egg problem. In order for the discussion on international cost-sharing to begin effectively, it is vital to prepare an environment where each partner can be on an equal footing. For this reason, they recommend setting aside the site issue for now, to move the discussion on cost-sharing forward, removing the constraining condition. This is actually a positive move.

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It truly is crucial to move the discussion on cost sharing forward for the realisation of the ILC. In the recommendations, the expert panel pointed out that the outlook on such discussion stays uncertain, and it is important to foster an environment where government officials from each country can discuss this subject frankly and constructively. Since 2019, several rounds of discussions have been held, but they did not produce the anticipated results, as pointed out in the recommendations. I believe the reason for this is the lack of an environment which enables discussions among governments, in addition to the chicken-and-egg problem mentioned above. Needless to say, the ILC is an enormous project which will have a very large cost. I'm afraid that the discussion of cost sharing of this magnitude cannot proceed unless a considerable relationship of mutual trust has been established among the governments.

The other part that lead to misunderstanding is the statement "*taking into account the progress in the various studies such as the Future Circular Collider (FCC) and ILC*". Some interpret this line as the recommendation to choose between the ILC and the FCC. It is NOT. There is a clear understanding of the timing difference between the two projects. As I mentioned above, a considerable relationship of mutual trust among the governments is needed to be established to move the discussion on cost-sharing forward. To that end, it is important for the governments to discuss how to advance various large-scale projects globally. In order for the governments to move such discussions forward, we, the researchers ourselves, need to reexamine the medium- to long-term plans for future global particle physics projects, and broaden the understanding on the importance of building the ILC in that global context.

Who will take the initiative in these international discussions is another important point. Since the IDT is an organisation whose mission is to realise the Pre-lab for the ILC to be established in Japan, the Pre-lab proposal stipulated that Japan should take the initiative. We still hope to realise the ILC in Japan, so if possible, we would like Japan to take the initiative. What we researchers can do is to create an environment that makes it easier for Japan to take the initiative. How do we realise fruitful cost sharing negotiations? This is not an issue just for Japan, and I would like to see researchers from relevant countries build relationships with their own governments. I'm hoping that researchers around the world will work with their own funding agency.

It's unfortunate that we couldn't move on to the Pre-lab right away. On the other hand, I would like to emphasise that the panel understands the need for prototype development and engineering demonstration. We believe that the ILC is mature in technology and is ready to move to the Pre-lab phase. In order to prove that the ILC is a feasible project realised by international collaboration, it is important to show the actual components. The recommendation suggested moving high-priority parts of the work packages forward. Once the budget for this activity is approved, we can gain credibility that we can build the actual components, prove that the technology is mature, and the scientists from around the world can work together. And those efforts should be carried out by international cooperation, with each government bearing cost and responsibility. By doing so, we can demonstrate that it is possible to realise the ILC.

Here, I would like to remind you once again that the ILC is an enormous project. Regarding this recommendation, it is easy to react by saying "*ILC is dead*" or criticising "*Japan is not interested*". However, this is not a project that can be talked about in such a simple manner. You need to double down. In the "new normal" with the COVID-19 pandemic, the research environment and the international environment and the situation of national finance are changing dramatically. There is no doubt that the stature of fundamental science is weaker than in the second half of the twentieth century because of the diversity of scientific research. I also think there has been an increase in mistrust of science because of a variety of accidents and disasters. Under such circumstances, it is necessary for stakeholders around the world to calm down and think about how to proceed with the ILC.

ILC | JAPAN

SHOJI ASAI

Shoji Asai (University of Tokyo) is the Spokesperson of ILC-Japan.

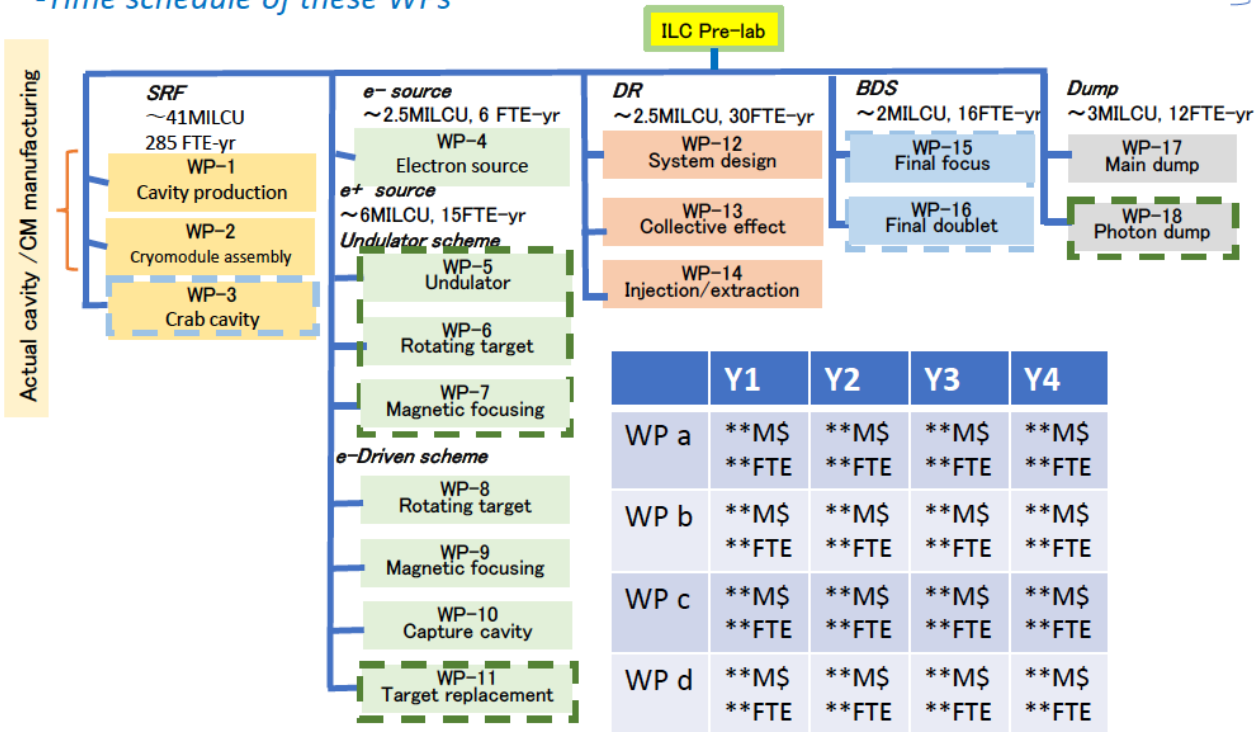
https://newsline.linearcollider.org/2022/03/22/ilc-expert-panel-review-hosting-is-not-the-problem-says-shoji-asai/

Prioritizing work packages

Prioritizing the essential and time-consuming work packages
-How much we need for these "essential" WPs? ("full" or "partial" WP?)
-Time schedule of these WPs

example: not 40 cav. /region but ~20 cav./region (in WP1)

Each group's (SRF, DR/BDS/Dump, Sources) steering panel discuss the prioritization.



	Y1	Y2	Y3	Y4
WP a	**M$ **FTE	**M$ **FTE	**M$ **FTE	**M$ **FTE
WP b	**M$ **FTE	**M$ **FTE	**M$ **FTE	**M$ **FTE
WP c	**M$ **FTE	**M$ **FTE	**M$ **FTE	**M$ **FTE
WP d	**M$ **FTE	**M$ **FTE	**M$ **FTE	**M$ **FTE

For detail,
http://doi.org/10.5281/ zenodo.4742018

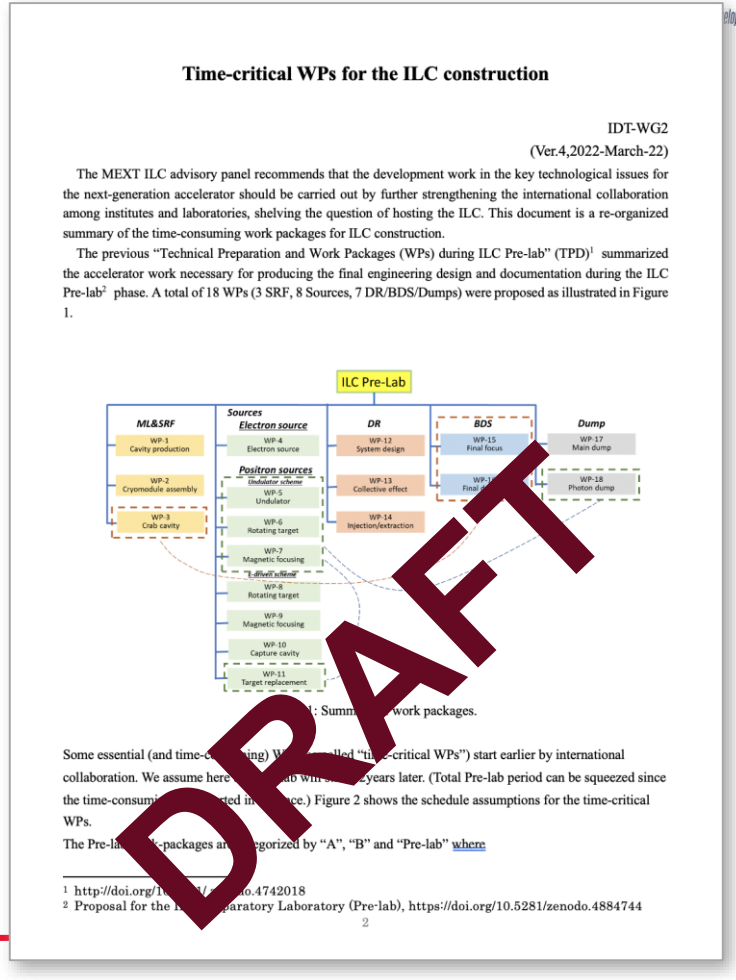
1

Report: Time-Critical WPs

- ILC Prelab will not start immediately
- Assume 2 year period before PreLab
- Prioritize work, reduce costs to minimum and keep current activities running
- Aim for MoUs between partner institutes to fund activities
- -> Identify “time critical WPs” and formulate R&D plan

	P1	P2	P3	P4	
Pre-lab proposal	Pre-lab ~4 years				Construction ~10 year
	Y1	Y2	Y3/P1?	Y4/P2?	
Time-critical WPs	~4 years				
			Pre-lab 3~4 years		Construction ~10 year

Figure 2: Assumed schedule of the time-critical WPs



Time-critical WPs for the ILC construction

IDT-WG2

(Ver.4,2022-March-22)

The MEXT ILC advisory panel recommends that the development work in the key technological issues for the next-generation accelerator should be carried out by further strengthening the international collaboration among institutes and laboratories, shelving the question of hosting the ILC. This document is a re-organized summary of the time-consuming work packages for ILC construction.

The previous “Technical Preparation and Work Packages (WPs) during ILC Pre-lab” (TPD)[1] summarized the accelerator work necessary for producing the final engineering design and documentation during the ILC Pre-lab[2] phase. A total of 18 WPs (3 SRF, 8 Sources, 7 DR/BDS/Dumps) were proposed as illustrated in Figure 1.

l: Summ work packages.

Some essential (and time-c ing) W lled “ti -critical WPs”) start earlier by international collaboration. We assume here ab wh years later. (Total Pre-lab period can be squeezed since the time-consumi ied in ce.) Figure 2 shows the schedule assumptions for the time-critical WPs.

The Pre-la -packages ar egorized by “A”, “B” and “Pre-lab” where

[1] http://doi.org/1 /z o.4742018

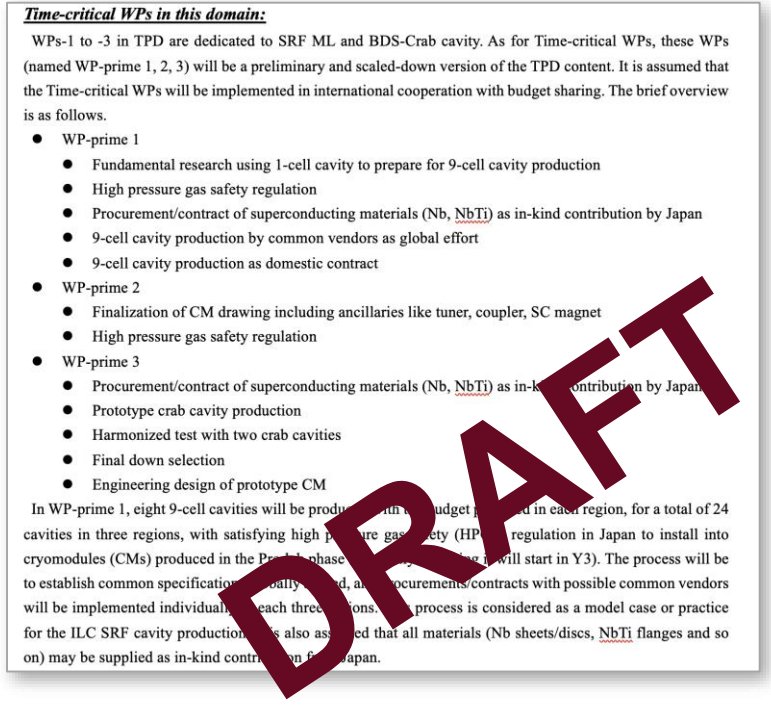
[2] Proposal for the I paratory Laboratory (Pre-lab), https://doi.org/10.5281/zenodo.4884744

2

DRAFT

SRF Work Packages

- WP 1' Cavities:
  - Reduce # of produced cavities: 40/region -> 8/region
  - Focus on R&D (demonstrate 35MV/m) and industrial readiness
  - R&D cavities (no helium tank), not for CM installation
- WP 2' Cryomodules:
  - No cryomodule prototypes anymore
  - Finalize cryomodule engineering design
- WP 3' Crab cavities:
  - Downselect 2 designs
  - Produce and test prototypes



Time-critical WPs in this domain:

WPs-1 to -3 in TPD are dedicated to SRF ML and BDS-Crab cavity. As for Time-critical WPs, these WPs (named WP-prime 1, 2, 3) will be a preliminary and scaled-down version of the TPD content. It is assumed that the Time-critical WPs will be implemented in international cooperation with budget sharing. The brief overview is as follows.

- WP-prime 1
  - Fundamental research using 1-cell cavity to prepare for 9-cell cavity production
  - High pressure gas safety regulation
  - Procurement/contract of superconducting materials (Nb, NbTi) as in-kind contribution by Japan
  - 9-cell cavity production by common vendors as global effort
  - 9-cell cavity production as domestic contract
- WP-prime 2
  - Finalization of CM drawing including ancillaries like tuner, coupler, SC magnet
  - High pressure gas safety regulation
- WP-prime 3
  - Procurement/contract of superconducting materials (Nb, NbTi) as in-k ontribution by Japa
  - Prototype crab cavity production
  - Harmonized test with two crab cavities
  - Final down selection
  - Engineering design of prototype CM

In WP-prime 1, eight 9-cell cavities will be produ udget p d in each region, for a total of 24 cavities in three regions, with satisfying high p re gas ety (HP regulation in Japan to install into cryomodules (CMs) produced in the Pr phase g i will start in Y3). The process will be to establish common specificatio bally d, a ocurements/contracts with possible common vendors will be implemented individual each thre ions. process is considered as a model case or practice for the ILC SRF cavity productio s also as ed that all materials (Nb sheets/discs, NbTi flanges and so on) may be supplied as in-kind contri on f apan.

DRAFT

Sources, BDS and Dumps

Sources

- WP4' Electron source
  Design work in y1-2, prototype in y3-4
- Undulator driven source:
  considered mature
  - WP7' prio A: plasma lens prototype
- Electron driven source:
  Continue design in y1-2, prototyping y3-4
  - WP 8' rotating target
  - WP 9' matching device
  - WP 10' capture cavity and linac
- WP 11' target maintenance:
  design and prototyping of critical components in years 1-2

Damping Rings

- WP 12' Damping Ring
  Continue optics studies, magnet design deferred
- WP 13 Collective effects: no priority items
- WP 14' kickers: study power supplies (B+)

Beam Delivery System BDS

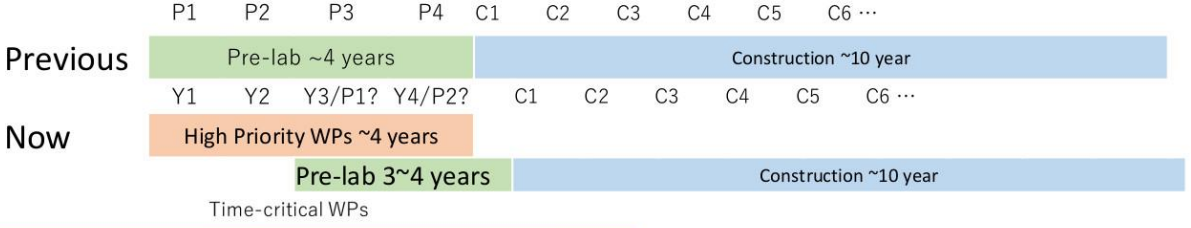
- WP 15' BDS system design
  Continue design work and tests at ATF, concerning wakefields, high-order aberrations and beam tuning
- WP16' Final doublet
  Produce and test QD0 prototype

Beam Dumps

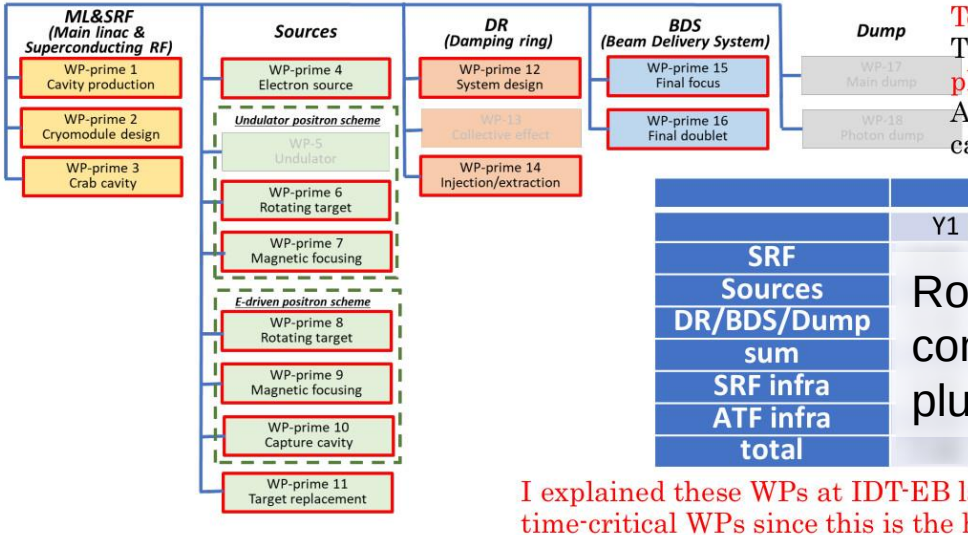
- WP 17' Main dump:
  Continue design, concentrate on high-risk items (water vortex flow, window)
- WP 18 Photon dump: no priority items

Time critical WPs

*Assumption:*Some essential (and time-consuming) WPs starts by international collaboration.
We assume here that Pre-lab will start ~2years later. (but total pre-lab period can be squeezed since the time-consuming WPs started in advance (except civil engineering survey).)



Time-critical WPs



Total ~13M$ 110FTE-yr. (In Pre-lab proposal, total ~60M$,360 FTE-yr.)
The pre-lab proposal only included a four-year total, but the annual plan is also summarized here.
Although the number of WPs has not been significantly reduced, we carefully selected the contents to be implemented and work on them.

	Global material cost (M$)					Global human resources (FTE-yr)				
	Y1	Y2	Y3	Y4	sum	Y1	Y2	Y3	Y4	sum
SRF										
Sources										
DR/BDS/Dump										
sum										
SRF infra										
ATF infra										
total										

Roughly 1/5 material and 1/3 person power compared to original plan,
plus costs for infrastructure (STF and ATF)

I explained these WPs at IDT-EB last week. EB members suggested to include "dump" into the time-critical WPs since this is the hot topics at MEXT ILC advisory panel.