“Technical Preparation” of dumps

Input for ILC-IDT from the WG2-DR/BDS/Dump subgroup

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Accelerator activities at ILC Pre-lab phase

Technical preparations /performance & cost R&D [shared across regions]

- SRF performance R&D, quality testing of a large number of cavities (~100), fabrication and shipping of cryomodules from North America and Europe (for validating shipping)
- Positron source final design and verification
- Nanobeams (ATF3 and related): Interaction region: beam focus, control; and Damping ring: fast kicker, feedback
- Beam dump: system design, beam window, cooling water circulation
- Other technical developments considered performance critical

Technical preparation

Final technical design and documentation [central project office in Japan and possibly regional project offices]

- Engineering design and documentation, WBS
- Cost confirmation/estimates, tender and purchase preparation, transport planning, mass-production planning and QA plans, schedule follow up and construction schedule preparation
- Site planning including environmental studies, CE, safety and infrastructure (see below for details)
- Review office
- Resource follow up and planning (including human resources)

Engineering Design Report (EDR)

Preparation and planning of deliverables [distributed across regions, liaising with the central project office and/or its satellites]

- Prototyping and qualification in local industries and laboratories, from SRF production lines to individual WBS items
- Local infrastructure development including preparation for the construction phase (including Hub.Lab)
- Financial follow up, planning and strategies for these activities

Planning and preparation of Hub lab.

Civil engineering, local infrastructure and site [host country assisted by selected partners]

- Engineering design including cost confirmation/estimate
- Environmental impact assessment and land access
- Specification update of the underground areas including the experimental hall
- Specification update for the surface building for technical scientific and administrative needs

Civil engineering

Documents for the “Technical Preparation”

- Listing the ***remaining topics which should be done in the ILC preparatory phase***.
- Fill the ***template*** in Nov. and Dec.
- Complete the draft in the IDT-WG2 DR/BDS/Dump meeting on 12/22.
- Draft will be discussed in the IDT-EB meeting on 12/25.
- Documents will be used for the budget requests of each partner. (Feb. 2021~)

WG2 Charges

- C1: Technical preparation (remaining topics) at Pre-lab
- C2: Preparation for mass production at Pre-lab
  - It is out of the scope for beam dump … max 9 units for 60kW tune-up dump
- C3: Possible schedule at Pre-lab
- C4: International sharing candidates of these activities

Template of “Technical Preparation”: example of SCRF mass-production

Technical Preparation [Title] nd cryomodule production

Outline : SCJ and MEXTs' ILC Advisory Panel had technical concerns about maintaining cavity quality during mass production and cryomodule assembly. This plan is proposed to demonstrate prototype manufacturing using new cost-effective production methods on the scale of 1% of the full production, corresponding to about 100 cavities in the main preparatory phase. Half of the cavities will be produced in Japan and th countries. The performance of the cavities will be evaluated to conf patibility will be checked. Other components, such as couplers a to improve (in terms of) their performances; they will also be ma be evaluated. Overall testing after assembling these parts into a cryomodule will be the final step of evaluating the performance as an accelerator component. The US and Europe have accumulated significant experiences in cavity production and in formulation of countermeasures against performance degradation after cryomodule assembly. It is anticipated that Germany and the US will work on cost reduction of the cavity fabrication process, and on reproducibility and high yield of cavity performance at the design gradient, while France could play a leading role in automation of cryomodule assembly.

[Outline]

Goals of the technical preparation:

Parameters	Unit	Design
Baseline: Cavity gradient, E, at Q		31.5 (±20%) at Q ≥1E10, 35 at Q ≥0.8 E10
Cost-Reduction R&D goal: E and		35 at Q ≥ 2E10, 38.5 at Q ≥ 1.6E10
Cavity production yiel		90

[Goals]

Items:

- total ~ 100 nine-cell cavities will be produced with international collaboration.
- 9-cell Cavity production by cos
- RF performance, success yield g-compatible fabrication conditions, with an expected statistics (for exar stics, with fixed fabrication conditions in each region), and enabling to s regulation”.
- Ancillaries production (power coupler, tuner, HOM antenna, etc.)
- Cryomodule (CM) production (Prototype, Type A, Type B)

[Items]

Expected cost:

Issue	*Tasks*	*Human Resources (FTE)*
Mass production	*Perform*	

(not including corresponding cost of human resources)

[Expected cost]

Candidates:

DESY, CEA-S FNAL, LLAB

[Candidate of cooperation]

Appendix

(Current status)

[Appendix (current status)]

The beam commissioni arch 2019 at KEK's Superconducting RF Te as 280 MeV, and the average accelerating gr exceeding the ILC specification of 31.5 MV/m. DESY and FNAL have also demonstrated cryomodule operation satisfying the requirements of the ILC.

At KEK's Cavity Fabrication Facility (CFF), single-cell, 3-cell, and 9-cell cavities have been fabricated in collaboration with some local companies since 2012. CFF is equipped with an electron beam welding (EBW) machine, a chemical polishing (CP) system, and a mechanical pressing machine. Cavity fabrication conforming to Japanese high-pressure gas regulations is in progress.

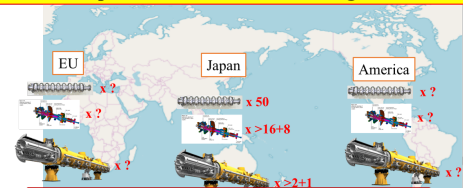
Concerning cryomodules, cavities and other components manufactured in three different regions (Asia, Europe, and Americas) with a common interface design have been brought together and assembled into a cryomodule at the KEK Superconducting Test Facility (STF), and the cryomodule's performance has been tested and successfully demonstrated with the common interface design for the ILC.

Since 2017, the US and Japan have been collaborating on cost reduction. There are two ways to reduce/save the cost of cavities. One is cost reduction of the niobium material. Another is to improve cavity performance, enabling to reduce the required number of cavities. Research on improvement of cavity performance by new surface treatment such as “nitrogen-infusion” is underway worldwide.

Technology for mass production for the ILC is ready, as demonstrated by successful construction of an accelerator with a few hundred cavities housed in a few tens of cryomodules for the European XFEL and for a similar accelerator currently under construction for LCLS-II in the US. In both cases, after cryomodule assembly, modules were transported on the ground and installed in the tunnel with no major issues caused by the transportation. However, marine/ship transport of cryomodules between two different regions across a sea, and the performance test after transport are yet to be carried out. This will be done as a part of crucial technical preparation in the main preparatory phase.

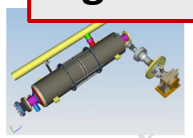
(Add some figures to explain visually)

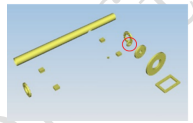
Before mass production starts, tuner design should be fixed!!



[Supplemental Figures and tables]

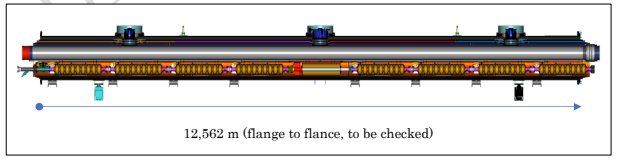
W CM, etc.?





Item	Variation	TDR Baseline
Cavity shape	TESLA / LL	TESLA
Length		Fixed
Beam pipe flange		Fixed
Suspension pitch		Fixed
Tuner	Blade/ Slide-Jack	Blade
Coupler flange (cold end)	40 or 60	40 mm
Coupler pitch		Fixed
He –in-line joint		Fixed

L=1,247 m



“Technical Preparation” for dumps, *drafts will be prepared by KEK*

- **Main Dump (17 MW)**
  - Design and prototyping of window sealing and remote exchange
  - Robustness test of window (pressure, beam??)
  - Engineering design water flow system
  - Design for countermeasure of failures
- **Photon dump (300kW)**
  - System design for operation and maintenance

Dump	Max. Power	Num	Examples (design)	
Tune-up	60 kW	9	LCLS-II (120kW)	If rastering → 250kW
Tune-up ML	400 kW	2	XFEL (300kW)	
Undulator photon	**300 kW**	**1**	**-none-**	**Conceptual designs (graphite at 2km, water)**
Main dump	**17 MW (1TeV)**	**2**	**SLAC (2.2MW), JLAB (1MW)**	**Water dump; 0.75, 0.9MW operated**
Undulator 5+5Hz	8 MW	1	*Same as main dump*	*Same as main dump*

Please send me your comments and suggestions!

Thank you.

C1: Technical preparation (remaining topics) at Pre-lab

- Specific designs what we need to proceed
  - **300 kW photon dump**
  - **17 MW main dump**
    - Water flow system (include vortex flow in dump vessel)
    - Window sealing and remote exchange (30cm in diam., 10 atm activated water)
    - Countermeasure for failure; e.g., window, water system,…
  - **Civil and utility design under the condition of candidate site**
- Robustness test of window for 17 MW main dump
  - Prototyping of window and its attachment
  - Beam test of window material if possible

Slide of the previous WG2 meeting, 10/13/2020

C3: Possible schedule at Pre-lab

- **A convincing main dump design with maintenance and failure scenarios should be prepared in early Pre-lab phase.**
- SCJ and MEXT panel show concerns about the safety on the main beam dump. Radioactive product is a concern by people especially in candidate site.
- The main dump window needs to be studied well, but the concern about it is not like a showstopper, but an engineering issue.
- **Prototyping of the window system** is expected in Pre-lab phase, for a better maintenance design.

Slide of the previous WG2 meeting, 10/13/2020

C4: International sharing candidates of Pre-lab activities

- **Possible collaboration on the engineering design of dump system**
  - SLAC, JLAB … experience of the 1MW water dump
  - CERN, DESY … High power dumps
  - Spain … ESS Target (5MW), IFMIF dump (1MW)

- **Study of the window material**
  - Industry/supplier
  - possibly with RaDIATE collaboration for the high-power targets

Slide of the previous WG2 meeting, 10/13/2020

Activity on ILC main dump

- Until the TDR, overseas researchers contributed and summarized the base design.
- After the TDR, especially in recent years, KEK has resumed the dump study to fulfill the responsibility for radiation safety by host country.
  - Member: staff of ILC accelerator and Radiation Safety
  - Studying the radiation safety over the ILC
  - Visited the dump sections at CERN, SLAC and JLAB
  - Now we start the design work with companies for the sub-system
    - Water flow system
    - Window system (sealing and remote exchange)
    - Civil and utility design under the condition of candidate site
- Willing to re-organize the international team

Slide of the previous WG2 meeting, 10/13/2020

IDT-WG2 organization

Bi-weekly *Tuesday* meeting: Sep.22, Oct. 6, 20,…

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

https://agenda.linearcollider.org/category/256/

Charges of Sub-groups

- Discuss and coordinate the topics for
  - technical preparation (remaining topics) at Pre-lab
  - preparation for mass production at Pre-lab
  - possible schedule at Pre-lab
  - international sharing candidates of these activities
- Report to the IDT-WG2

All members belong to some sub-group(s).

SRF

Bi-weekly Tuesday Oct.13,27,…

Yasuchika Yamamoto	***KEK***
Nuria Catalan	CERN
Dimitri Delikaris	CERN
Rongli Geng	JLAB
Hitoshi Hayano	KEK
Bob Laxdal	Triumf
Matthias Liepe	Cornell
Peter McIntosh	STFC
Olivier Napoly	CEA
Sam Posen	FNAL
Robert Rimmer	JLAB
Marc C. Ross	SLAC
Akira Yamamoto	KEK

DR/BDS/Dump

Bi-weekly Tuesday Oct.13,27,…

Toshiyuki Okugi	***KEK***
Karsten Buesser	DESY
Philip Burrows	U. Oxford
Angeles Faus-Golfe	LAL
Jenny List	DESY
Thomas Markiewicz	SLAC
Brett Parker	BNL
David L. Rubin	Cornell
Nikolay Solyak	FANL
Luis Garcia Tabares	CIEMAT
Nobuhiro Terunuma	KEK
Glen White	SLAC
Kaoru Yokoya	KEK

Sources

Bi-weekly Monday Oct.12,26,..

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

Civil engineering

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

Note: Summer to Winter time transition will be specially considered at next sub-group meeting.

1pm (->2pm) UTC (6am US Pacific, 8am US Central, 2pm U.K., 3pm Geneva, 10pm (->11pm) Japan)

Assumed Pre-lab timeline

For Engineering design

1st year: Work on TDR-based cost-estimate confirmation, started by an international team centered on the Pre-lab.
2nd year: Complete the cost-estimate confirmation, and an internal review in the latter half of the 2nd year.
The review also reports on the progress of technical issues during the preparation period.
3rd year: Conduct an external review and completed scrutiny of costs and risks.
Complete the draft of Engineering Design Report (EDR).
4th year: Publish EDR (in first half yr), report progress on technical issues,and prepare each large bid.

For technical preparation (example of SCRF and positron)

1st year: Extend SCRF cost reduction R&D, Start a pre-series SCRF cavities production preparing for industrialization
Continue positron survey
2nd year: Complete SCRF cost-reduction R&D, and extend the work to assemble the cavities with cryomodule (CM),
Select positron scheme
3rd year: Demonstrate "Global CM transfer, aiming at HPG legal-process, shipment, and SRF QA test after transport
Mature Lab. planning and preparation
Prototyping of critical items (such as positron target)
4th year: Evaluate CM performance based on CM shipment, and prepare for Hub Lab. functioning
Progress prototyping of critical items (such as positron target)