

2nd meeting of SRF subgroup in IDT/WG2

- ✓ New members of SRF subgroup
- ✓ Mission and schedule (again)
- ✓ Discussions
- ✓ Programs of SRF session in AWLC2020
- ✓ Others (if any)

Attendees: A. Yamamoto, A. Lankford, S. Michizono, H. Hayano, M. Ross, O. Napoly, D. Delikaris, N. C. Lasheras, B. List, S. Posen, R. Rimmer, R. Geng, M. Liepe, Kirk

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

IDT-WG2 organization

Bi-weekly meeting: Sep.22, Oct. 6, ...

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

Charges of Sub-groups

- Discuss 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

<i>Yasuchika Yamamoto</i>	KEK
Dimitri Delikaris	CERN
Hitoshi Hayano	KEK
Olivier Napoly	CEA
Marc C. Ross	SLAC
Akira Yamamoto	KEK
Sam Posen	FNAL
Nuria Catalan	CERN
Robert Rimmer	JLAB
Rongli Geng	JLAB
M. Liepe	Cornell

DR/BDS/Dump

<i>Toshiyuki Okugi</i>	KEK
Philip Burrows	U. Oxford
David L. Rubin	Cornell
Nikolay Solyak	FANL
Nobuhiro Terunuma	KEK
Kaoru Yokoya	KEK
Jenny List	DESY
Thomas Markiewicz	SLAC
Luis Garcia Tabares	CIEMAT

Sources

<i>Kaoru Yokoya</i>	KEK
Hitoshi Hayano	KEK
Masao Kuriki	U. Hiroshima
Benno List	DESY
Gudrid Moortgat-Pick	U. Hamburg
Joe Grames	JLAB

Civil engineering

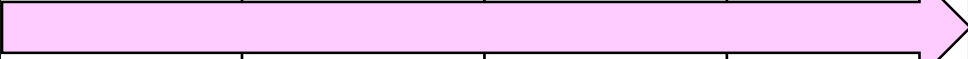



<i>Nobuhiro Terunuma</i>	KEK
John Andrew Osborne	CERN
Tomoyuki Sanuki	U. Tohoku

Technical preparation etc. will be discussed in bi-weekly sub-group meeting.

Mission of SRF subgroup in IDT/WG2

- ◆ List work items in ILC preparation period
 - ◆ Plug-compatibility of design to be re-confirmed/re-established
 - ◆ Mass production
 - ◆ Global CM transfer
 - ◆ Any other?
- ◆ List technical concerns (if any)
 - ◆ Although E-XFEL has been successfully constructed and operated (and LCLS-II also in progress), are there any concerns for ILC to be constructed in Japan?
 - ◆ High pressure gas (HPG) regulation to be globally handled
 - ◆ In Japan, IFMIF (@Rokkasho) requested CM construction to EU (satisfied with HPG regulation)
 - ◆ Contents specialized in Japan?
- ◆ List human resources/budget/schedule for each work item and in each region/lab.
 - ◆ Necessary to discuss how to share each work item for each region/lab.

Pre-Lab schedule (translated into table)

	Technical preparation period (Fiscal year)							
Items	1		2		3		4	
Cost down R&D								
Cost estimation based on TDR								
Review				Internal	External			
Engineering design report	Writing				Draft		Publish	
Prototyping of critical items								
Preparation for mass-production line								
Global CM transfer		fabrication	CM assembly/Cold test		Global CM transfer/Cold test in Japan			

We have to fit the SRF schedule to this overall schedule!

Schedule of SRF subgroup meeting in IDT/WG2

Meeting #	Date	Contents
1	29/Sep/2020	introduction, member list, schedule/work items in technical preparation, discussions
2	13/Oct/2020	New member, discussions on how many cavities/CMs to be produced, AWLC2020
	19~22/Oct/2020	AWLC2020 on virtual
3	27/Oct/2020	
4	10/Nov/2020	
5	24/Nov/2020	
6	8/Dec/2020	
7	22/Dec/2020	Draft of sharing work items in technical preparation period
?	12/Jan/2021?	
	Feb/2021	First draft of budget request in each region/lab., Submission to WG1/EB
		Preparation for MOU between/among laboratories
	Jun~Jul/2021	Submission of budget request to MEXT, in case of Japan

Technical preparation of SRF (only 4 years!)

- ❑ Mass production satisfied with the ILC spec.
 - ❑ 9-cell cavity production by cost effective method (to be discussed true number)
 - ❑ Production to be demonstrated during the Preparation Phase (Japan: 50 cavities, Others: 50 cavities)
 - ❑ RF performance, and success yield to be evaluated, under plug-compatible fabrication conditions
 - ❑ Surface treatment to be discussed (see next slide)
 - ❑ Ancillaries production (power coupler, tuner, HOM antenna, etc.)
 - ❑ Cryomodule (CM) production (Prototype, Type A, Type B)
- ❑ Global CM transfer
 - ❑ After surface (sea/marine) transportation, CM test to be done to confirm legal process in high-pressure code and RF performance in Japan (maybe in others)
 - ❑ After CM test, CM may return to home country

In case of Japan;

- ❑ Construction of hub-laboratory for mass production
- ❑ Demonstration of beam acceleration satisfied with ILC spec.

Any other items?

Remarks:

- Necessary cost should be considered **based on TDR**.
- Another important point is that new technology (fabrication/surface treatment) is **reliable**.

How many cavities are produced for mass production?

Discussion item

We can refer Volume 3 Part 1 in TDR.

At that time, **16** 9-cell cavities (out of > 50 cavities, **recognized as identical in fabrication and surface process**) were used to evaluate cavity performance.

In the preparation phase, **at least ~ 20 or much more cavities are necessary** to evaluate recent surface treatment method including fabrication method much advanced since TDR.

Not only surface treatment method but also what type of Nb material/fabrication method is used has to be discussed.

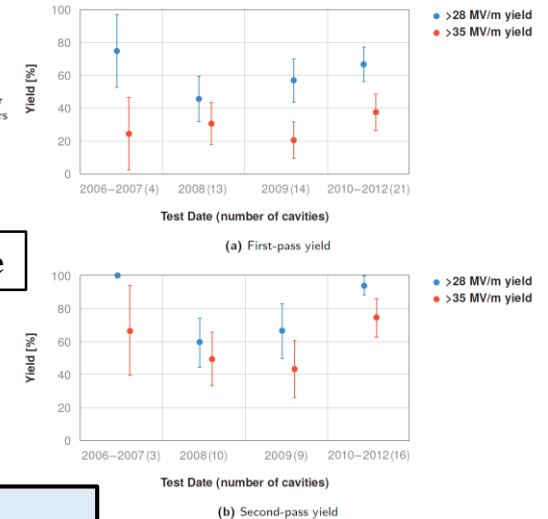
Table 2.6
Processing and handling of high-purity niobium cavities

Treatment method in TDR

Light BCP etching (10 μm)
Heavy EP (100-120 μm)
Post-heavy-EP cleaning
Vacuum-furnace outgassing (800 $^{\circ}\text{C}$ for 2 h)
RF tuning by no-touch bead-pull
Light EP (25 μm)
Post-light-EP cleaning
First HPR 3 passes (~ 6 h)
First clean room assembly
Final HPR 3 passes (~ 6 h)
Final clean-room assembly
Leak checking
In-situ baking at 120 $^{\circ}\text{C}$ for 48 h

History of cavity performance

Figure 2.19
Cavity yield for two gradient thresholds as a function of years, based on the global ILC cavity database updated as of October 2012 [67, 68]. Numbers in parentheses refer to cavity sample size. The cavities received standard treatment and were provided by established vendors.



Helium tank/tuner are not necessary for this evaluation

When we evaluate success yield of cavity performance, each region/lab. has to select one method of fabrication and surface process. But, we don't need world-unified method of fabrication and surface process.

# of cavities	Japan (/Asia)	Americas	E.U.
w/o helium tank/tuner	20	20	20
w/ helium tank/tuner			

How many cryomodules are produced for mass production?

ILC needs two types of cryomodules; Type A and Type B.

Any laboratory has never produced same types of CM as ILC.

High pressure gas regulation of Japan should be also satisfied for ILC.

As first step, each region produces **one prototype CM** (not necessary for conforming high pressure gas regulation).

Type B is preferred, as it includes systems of SC-Q magnet/cold BPM. Prototype CM is produced and tested in each region.

As second step, each region produces **at least one CM conforming high pressure gas regulation of Japan**.

That CM (Type B is preferred) is produced and tested in each region. If possible, Type A can be also produced.

As final step, each region carries out **global CM transfer to Japan**. CM produced in second step is available.

Discussion item

Table 3.1

Summary of key numbers for the SCRF Main Linacs for 500 GeV centre-of-mass-energy operation. Where parameters for positron and electron linacs differ, the electron parameters are given in parenthesis.

<i>Cavity (nine-cell TESLA elliptical shape)</i>		
Average accelerating gradient	31.5	MV/m
Quality factor Q_0	10^{10}	
Effective length	1.038	m
R/Q	1036	Ω
Accepted operational gradient spread	$\pm 20\%$	
<i>Cryomodule</i>		
Total slot length	12.652	m
Type A	9 cavities	
Type B	8 cavities	1 SC quad package
<i>ML unit (half FODO cell)</i>		
(Type A - Type B - Type A)	282 (285)	units
<i>Total component counts</i>		
Cryomodule Type A	564 (570)	
Cryomodule Type B	282 (285)	
Nine-cell cavities	7332 (7410)	
SC quadrupole package	282 (285)	
Total linac length – flat top.	11027 (11141)	m
Total linac length – mountain top.	11072 (11188)	m
Effective average accelerating gradient	21.3	MV/m
<i>RF requirements (for average gradient)</i>		
Beam current	5.8	mA
beam (peak) power per cavity	190	kW
Matched loaded Q (Q_L)	5.4×10^6	
Cavity fill time	924	μ s
Beam pulse length	727	μ s
Total RF pulse length	1650	μ s
RF-beam power efficiency	44%	

# of cavities/couplers/CMs	Japan (/Asia)	Americas	E.U.
Cavity	16 + spare	16 + spare	16 + spare
Power coupler	16 + spare	16 + spare	16 + spare
Cryomodule	2	2	2

Questions/Discussions/Comments (memorandum) @2nd meeting

Translation by Kirk

- CM production
 - Existing CM or New CM?
 - In Japan, before production, we have to discuss with KHK (authority of high pressure gas in Japan)
 - During production, inspection by KHK is necessary
- CM transfer
 - Shipping/High pressure gas regulation can be separated
 - Also rechecking cavity performance after shipping
- No cavity vendor in U.S., but same process as LCLS-II can be used
- How many cavities are produced? 20 at minimum. It depends on budget.
- Fabrication (incl. Nb material)/surface treatment to be discussed
- In TDR, second pass was available. How many times in surface treatment is available? It also depends on cost, and to be discussed.
 - Reliability
 - Cost-effectiveness
- Same method of fabrication and surface treatment as technical preparation period has to be used in construction of ILC
- Global CM transfer among Japan/U.S./EU to be discussed (Japan → U.S./EU?)
 - For fair international collaboration
- There are strict rules in high pressure gas regulation of Japan
 - It may take longer time to solve this
- How many prototypes do we need?
 - No prototype CM in LCLS-II → The construction started immediately (some of existing cavities are used)
 - Three prototype CMs in E-XFEL (PX FEL series)

Program of SRF session in AWLC2020

Date: 20~22/Oct

Conveners: Marc Wenskat (Univ. Hamburg), Sam Posen (FNAL), Kirk Yamamoto (KEK)

- All presenters were finally assigned
- Sam hosts the SRF session by using FNAL zoom as primary host
- Kirk has a KEK zoom account as back-up host

Date	Slot #	#	Time	Presenter Date	Presenter local time	Presenter	e-mail address	Affiliation	Talk time [min]	Presentation	Status	Preliminary title
20/Oct	1	1	7:00		16:00	Nick Walker	nicholas.walker@desy.de	DESY	15	remote	confirmed	Operational Experience with the European XFEL
	2	2	7:15		9:15	M. Checchin	checchin@fnal.gov	FNAL	15	remote	confirmed	LCLS-II HE
	3	3	7:30		9:30	G. Wu	genfa@fnal.gov	FNAL	15	remote	confirmed	PIP-II
	4	4	7:45		16:45	M. Wenskat	marc.wenskat@desy.de	Univ. Hamburg	15	remote	confirmed	optical inspections during cavity fabrication
21/Oct	1	5	7:00		23:00	T. Dohmae	dohmae@post.kek.jp	KEK	15	remote	confirmed	Current status report in KEK/CFF (early time expected)
	2	6	7:15		23:15	T. Saeki	tsaeki@post.kek.jp	KEK	15	remote	confirmed	Nb material: Nb disk directly sliced from forged ingot
	3	7	7:30		9:30	Y. Pischalnikov	pischaln@fnal.gov	FNAL	15	remote	confirmed	tuner review and some suggestion for improvement
	4	8	7:45		16:45	D. Kostin	denis.kostin@desy.de	DESY	15	remote	confirmed	Experience with the XFEL RF Couplers
	5	9	8:00		17:00	S. Berry	stephane.berry@cea.fr	IRFU/CEA	15	remote	confirmed	CEA last development about cleaning robots in clean room
	6	10	8:15		11:15	R.-L. Geng	geng@jlab.org	J-LAB	15	remote	confirmed	low surface field (LSF) 9-cell cavity, which has achieved 50 MV/m in some but not all cells
	7	11	8:30		11:30	Kellen McGee	mcgee@frib.msu.edu	M.S.U.	15	remote	confirmed	on-going effort to maximize performance on 644MHz cavities for the possible FRIB upgrade
	8	12	8:45		11:45	Sang Hoon Kim	kims@frib.msu.edu	M.S.U.	15	remote	confirmed	Lesson learned from FRIB low-beta cryomodules and development of new medium-beta cavity and subsystems for FRIB energy upgrade
22/Oct	1	13	7:00		23:00	R. Katayama	ryo.katayama@kek.jp	KEK	15	remote	confirmed	High-Q/High-G R&D of SRF cavities by applying 2-step baking at KEK
	2	14	7:15		22:15	J. Zhai	zhaijy@ihep.ac.cn	IHEP	15	remote	confirmed	High Q high gradient cavity R&D in IHEP
	3	15	7:30		23:30	A. Yamamoto	akira.yamamoto@kek.jp	KEK	15	remote	confirmed	An R&D proposed for ILC ML-CM SCM sustainable under the dark-current energy absorption
	4	16	7:45		10:45	R. Porter	rdp98@cornell.edu	CORNELL	15	remote	confirmed	Nb3Sn
	5	17	8:00		17:00	Igor Syratcev	Igor.Syratcev@cern.ch	CERN	15	remote	confirmed	Efficiency frontiers for the high power klystrons
	6	18	8:15		11:15	A. Palczewski	ari@jlab.org	J-LAB	15	remote	confirmed	A novel approach to flux expulsion analysis without the need of a single cell cavity
	7	19	8:30		8:30	S. Gessner	sgess@slac.stanford.edu	SLAC	15	remote	confirmed	Advanced Accelerator Upgrade Paths for the ILC
	8	20	8:45	23/Oct	0:45	Kirk Yamamoto	yasuchika.yamamoto@kek.jp	KEK	15	remote	confirmed	Introduction to the activities of the IDT/WG2 SRF subgroup

References

- KEK homepage
 - <https://www2.kek.jp/ilc/en/>
- Technical Design Report
 - <https://ilchome.web.cern.ch/publications/ilc-technical-design-report>
 - <https://www2.kek.jp/ilc/en/docs/>
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- The International Linear Collider – A Global Project
 - Submitted to European Particle Physics Strategy Update, 2020.
 - <https://indico.cern.ch/event/765096/contributions/3295702/>
- ILC Action Plan
 - <https://www.kek.jp/ja/newsroom/2016/01/06/1400/>
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- Recommendations on ILC Project Implementation
 - https://www.kek.jp/ja/newsroom/attic/20191001_%20ILC%20Project.pdf