IDT-WG2 report

KEK / IDT-WG2

Shin MICHIZONO (KEK)

- ITN meeting after LCWS2024 (July 12, 8AM-10AM)
- LC vision session at LCWS2024
- Next IDT-WG2

ITN meeting just after LCWS 2024 (12th July)

- ITN meeting after LCWS2024 (12th July, 8AM-10AM (in JST), hybrid)

- the **second meeting** (following the last ITN information meeting at CERN in October 2023)

Indico is ready and I will inform you by mailing list. (registration is necessary)

Preliminary program

Start	End	Talks	Contents	Speaker
8:00	8:05	Welcome		Tetsuyuki Muramatsu
8:05	8:13	ITN general		Shin MICHIZONO
8:13	8:21	SRF Asia	WPP1-2	Kirk YAMAMOTO
8:21	8:29	SRF Europe	WPP1-2	Enrico Cenni
8:29	8:37	Sources Undulator/Target	WPP6/7	Gudrid Moortgat-Pick
8:37	8:45	Sources e-Driven	WPP8-11	Yoshinori Enomoto
8:45	8:53	Nanobeam inj./ext.	WPP14	Phil Burrows
8:53	9:01	Nanobeam ATF	WPP-15	Angeles Faus-Golfe
9:01	9:09	Nanobeam Dump	WPP-17	Nobuhiro Terunuma
9:09	9:29	ITN organization		Tatsuya NAKADA
9:29	10:00	Discussion		

LC Vision session at LCWS2024

	Fukutake Hall 14:30 - 14:45	*Ito Hall, Ito International Research Center* 14:30 - 14:45
	CEPC: accelerator developments *yuhui li* *Fukutake Hall* 14:45 - 15:00	**Opportunities and Experimental Challenges at the Higgs-...** *Junping Tian*
15:00	**FCCee: accelerator developments** *Frank Zimmermann* *Fukutake Hall* 15:00 - 15:15	**Highlights from LHC detector upgrades** *Gustaaf Brooijmans* *Ito Hall, Ito International Research Center* 15:00 - 15:15
	Energy Upgrades of a linear Higgs factory *Emilio Nanni* *Fukutake Hall* 15:15 - 15:30	**Highlights from detectors for EIC** *Taku Gunji* *Ito Hall, Ito International Research Center* 15:15 - 15:30
	coffee *Foyer, Ito International Research Center* 15:30 - 16:00	
16:00	**Plenary: Open discussion sesson - Global Vision for a Linear Collider facility** *Jenny List, Steinar Stapnes* *Ito Hall, Ito International Research Center* 16:00 - 17:30	
17:00		
18:00	**Posters: Posters and Reception**	

Preliminary topics with 5 min. presentation

- Stages and physics goals from 91 GeV to 800-1000 GeV
- ILC at CERN (250 GeV) vs. FCC-ee
- **ILC realization of full program**
- CLIC/C3 realization of full program as upgrade of ILC250
- RELIC upgrade of ILC250 and physics need for higher luminosity
- Realizations of the full program with plasma wakefield upgrade of ILC250
- Community aspects & beyond-collider program

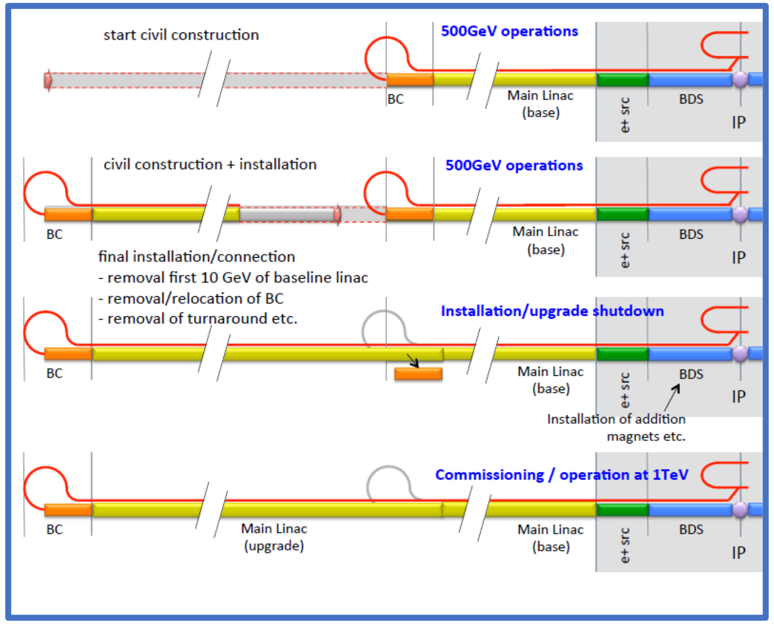
  Implications for exploring the 10 TeV parton energy scale

ILC Baseline and the Upgrades

Quantity	Symbol	Unit	Initial	$\mathcal{L}$ Upgrade	Z pole	E / $\mathcal{L}$ 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
Accelerating gradient	G	MV/m	31.5	31.5	31.5	31.5	31.5	45
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	$\gamma\epsilon_x$	μm	5	5	5	5	5	5
Norm. vert. emitt. at IP	$\gamma\epsilon_y$	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

Energy upgrades:

- 500GeV (**31.5 MV/m Q_0=1** x 10^{10})
  - 1TeV (**45 MV/m Q_0=2** x 10^{10}, 300 MW)
  - more SCRF, tunnel extension

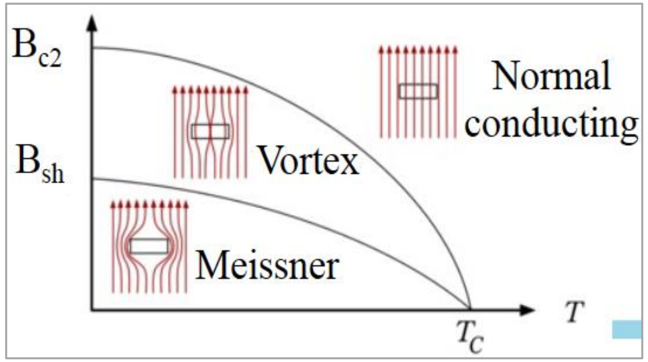


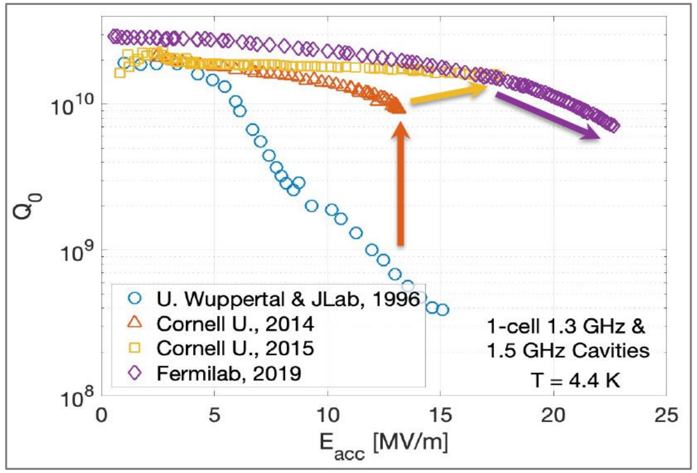
Further energy upgrades can be realized by
- Nb_3Sn cavity (>80MV/m)
- Nb Traveling Wave (TW) structures (>70MV/m)

Nb_3Sn / multilayer cavity for the future upgrade

Nb_3Sn

Courtesy, S. Posen





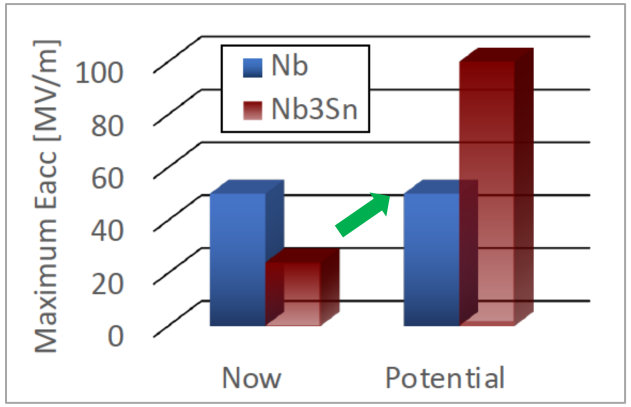
Nb_3Sn Potential in high-G future

SRF cavity

- B_{sh} = practical limit for SRF
  - $Bs_{sh\text{-}Nb}$: 210 mT
  - $Bs_{sh\text{-}Nb3Sn}$: 430mT

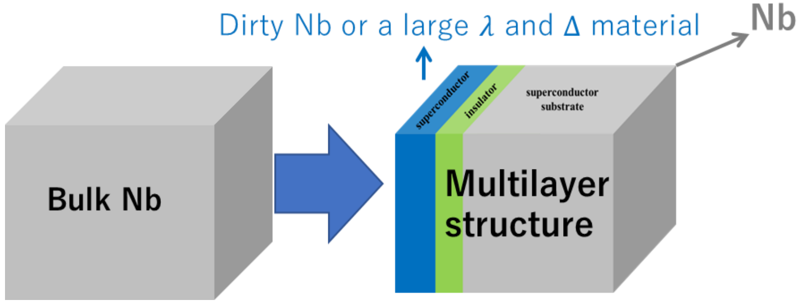
x2

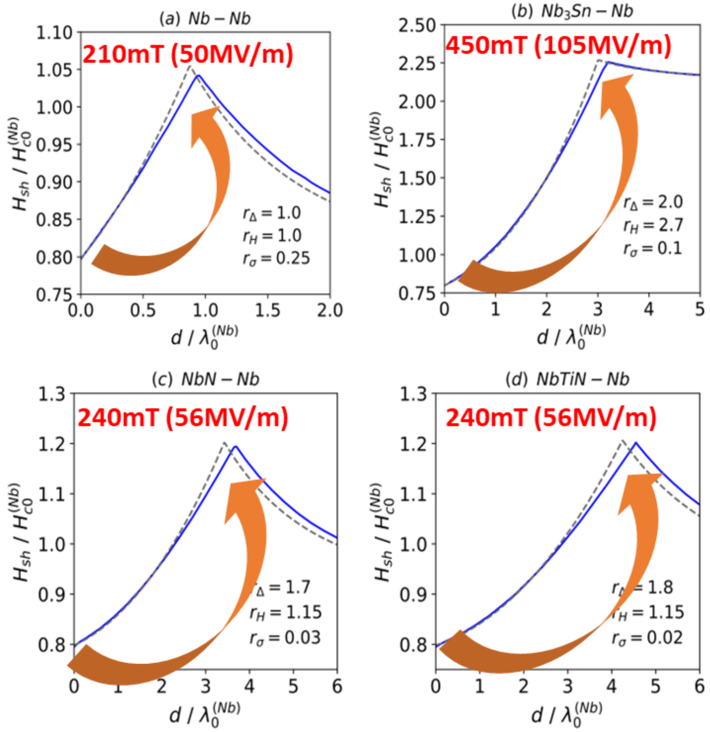
>80 MV/m in future



Nb_3Sn progress at Fermilab.
S. Posen et al., SUST, 34, 02507 (2021)

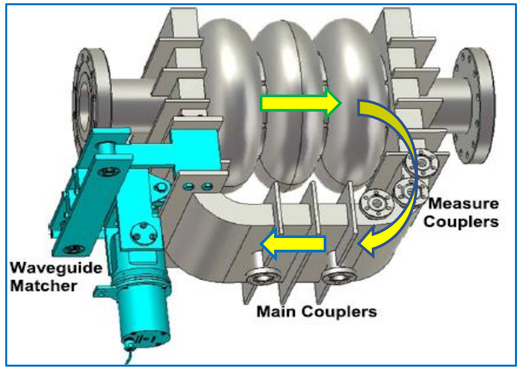
multilayer





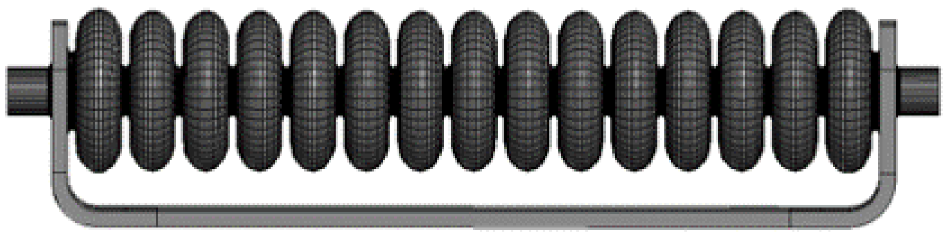
A new concept for SRF proposed for ILC-3TeV and Helen: Traveling Wave (TW) SRF cavity, compared with Standing Wave

Courtesy: H. Padamsee et al., for ILC-3TeV
S. Belomestnykh et al., for HELEN



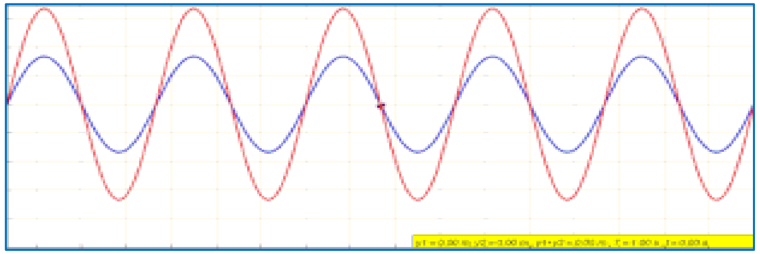
Prototype TW structure under test

SW: TESLA cavity (ILC baseline)



TW: proposed for ILC-3TeV, Helen

>70 MV/m operation



← Red standing wave – High Peak Fields,

← Green (acc.) and Blue (Return) Waves are Travelling Waves Lower peak fields,

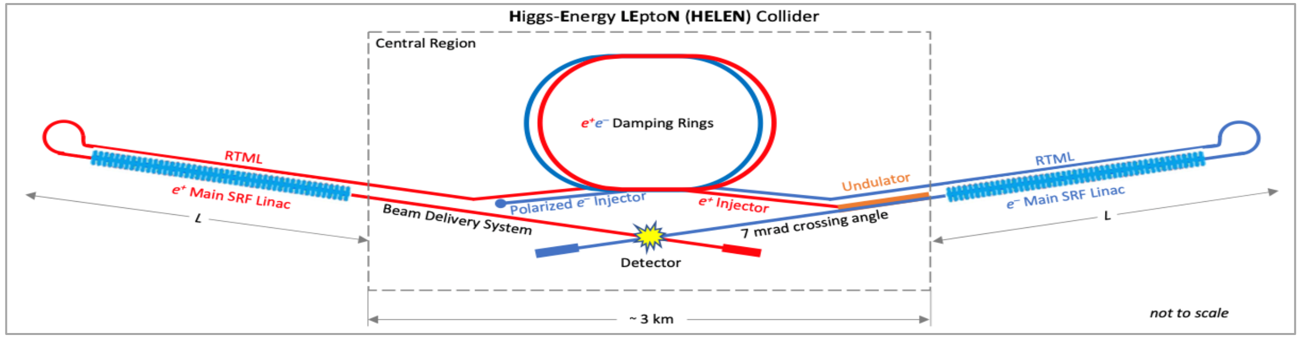
← **Guide blue** wave in a return wave-guide to avoid SW peak fields

– attached to both ends

HELEN: A LINEAR COLLIDER BASED ON ADVANCED SRF TECHNOLOGY*

S. Belomestnykh†,[1], P. C. Bhat, M. Checchin‡, A. Grassellino, M. Martinello‡, S. Nagaitsev[2], H. Padamsee[3], S. Posen, A. Romanenko, V. Shiltsev, A. Valishev, V. Yakovlev
Fermi National Accelerator Laboratory, Batavia, IL, USA
[1]also at Stony Brook University, Stony Brook, NY, USA
[2]also at University of Chicago, Chicago, IL, USA
[3]also at Cornell University, Ithaca, NY, USA

https://doi.org/10.48550/arXiv.2209.01074



Summary of future upgrade using SRF

	ECM[GeV]	Gradient [MV/m]	Length [km]	#of cavities	Additional material cost [MILCU*1]	Technology ready
TDR	250	31.5	20.5	~8,000	(~5,000 MILCU)	---
TDR	500	31.5	33.5	~16,000	+3,000 MILCU	---
TDR	1,000	45	44.5	~23,000	+3,000+7,100 MILCU	In 10 years
Nb3Sn/multilayer or TW	500	63	20.5	~8,000*2	?	In 20 years
NB3Sn/multilayer & TW	1,000	126*3	20.5	~8,000*4	?	In >20 years

*1 based on the ILC TDR and referring the ILC unit as of 2012.
*2 Requires RF source upgrade (x2) + Cryogenic upgrade (~x2)
*3 Surface discharge etc. can happen at such a high gradient operation
*4 Requires RF source upgrade (x4) + Cryogenic upgrade (~x4)

		500 GeV	TeV Upgrade			
		Baseline	Scenario A	Scenario B		Scenario C
				upgrade	base	
Energy range	GeV	15–250	15–500	15–275	275–500	15–500
Gradient	MV/m	31.5	31.5	45	31.5	45
Num. of cavities		7400	15 280	8190	7090	10 700
				total cavities: 15280		
Linac length	km	12	25	9.5	11.5	17.5
				total length: 21.0		

15.12.2.2 Summary of Value and Labour changes

The total Value changes associated with scenario A, B and C are 6,706, 5,489 and 7,082 MILCU, respectively. These increases correspond to 81%, 66%, and 86%, respectively, of the 500 GeV Value estimate for the baseline with luminosity upgrade. The total Labour changes associated with scenario A, B and C are 11,988, 9,416 and 14,256 thousand person-hrs, respectively. These increases correspond to 50%, 42%, and 59%, respectively, of the 500 GeV baseline Labour estimate with luminosity upgrade.

[19] This is not quite correct, since some of the baseline RTML Value and Labour is associated with the beamlines from the damping rings to the long 5 GeV transfer line. The RTML contribution to the 1 TeV upgrade is thus slightly overestimated.

296 ILC Technical Design Report: Volume 3, Part II

Next IDT-WG2 meeting : June 23, 2024 (4 weeks later)

(if nothing new, we will skip and move to summer vacation)