Technical Goals in TD Phase

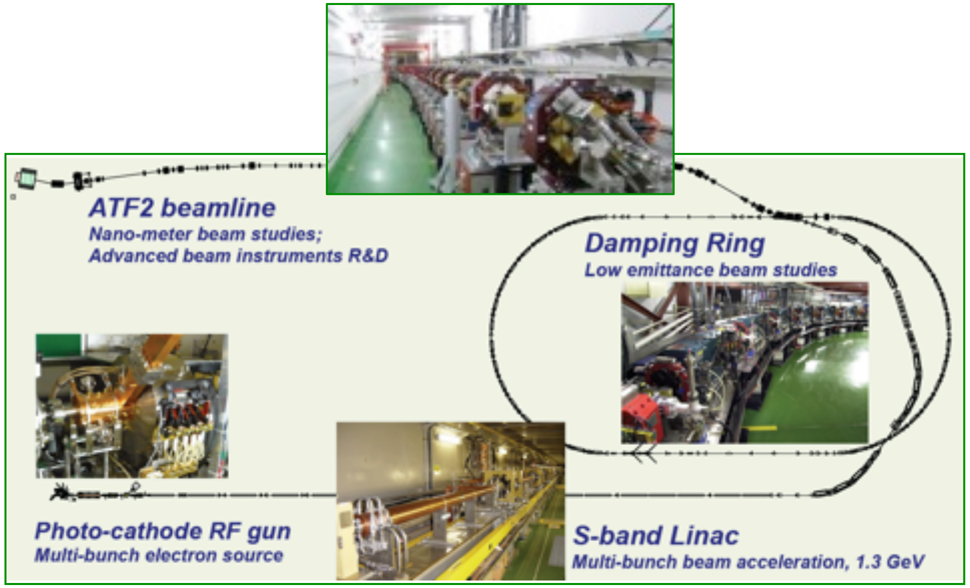
技術設計段階での技術開発・ハイライト

- **SCRF Technology (超伝導・ ビーム加速技術)**
  - Cavity: High Gradient R&D:
    - 35 MV/m with 50% yield by 2010 , and 90% by 2012 (TDR)
    - Manufacturing with cost effective design
  - Cryomodule performance including HLRF, and LLRF
  - Beam Acceleration
    - 9 mA: FLASH
    - 1 ms: STF2 - Quantum Beam
- **Nano-beam handling （ナノビーム技術）**
  - ILC-like beam acceleration
    - Ultra-low beam emittance: Cesr-TA, ATF
    - Ultra-small beam size at Final Focusing: ATF2

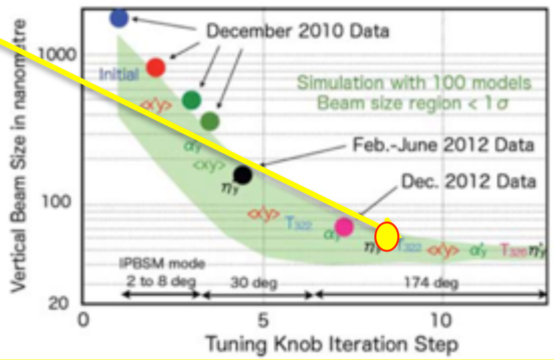
ATF2 Progress by 2013
2013年までの進展

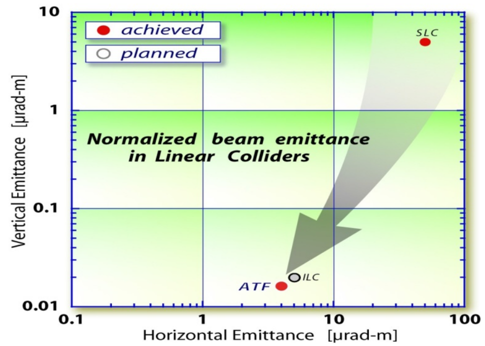
Ultra-small beam

- Low emittance : KEK-ATF
  - **4 pm achieved**
  - (ILC target value, in 2004).
- Small vertical beam size : KEK ATF2
  - **Goal = 37 nm,**
    - 160 nm (spring, 2012)
    - 65 nm (April, 2013) at low beam current



$$\mathcal{L} = f_{rep}\frac{n_b N^2}{4\pi\sigma_x^*\sigma_y^*} \times H_D$$





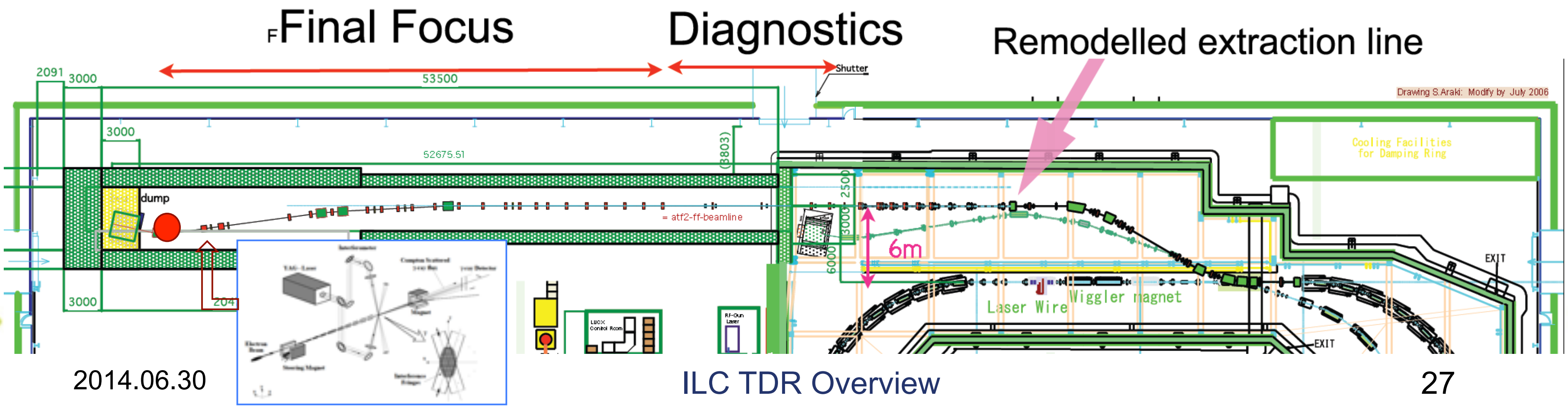
ナノビームによるルミノシティ向上：KEK-ATFが国際協力の中心的役割

KEK-ATF2: BDS Test Facility for ILC

ILC 最終収束モデル化・ナノビーム技術検証

- **Modeling of ILC BDS**
  - Same Optics: ILCと同じ光学
  - Int’l Collab. (国際協力）
- **~25 Lab. , > 100 Collaborators**

- **Goal:**
  FF Beam Size: 37 nm
  - (ILC で5.9 nm に相当）



KEK-ATF2: BDS Test Facility for ILC

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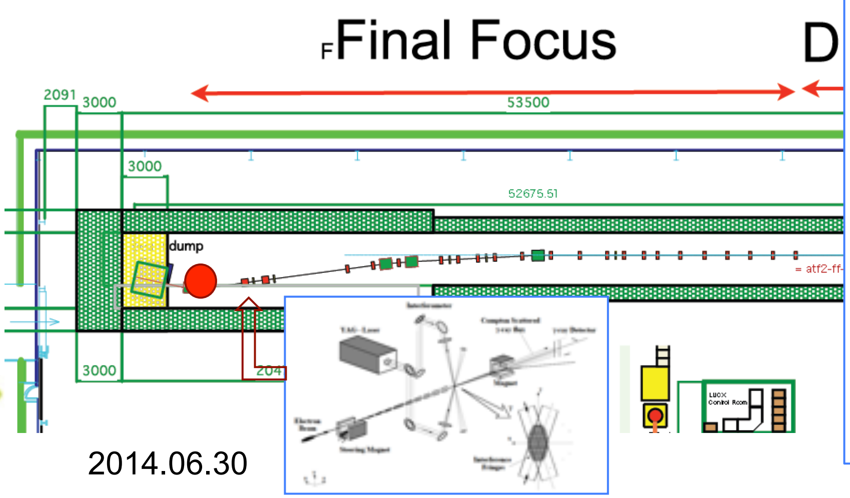
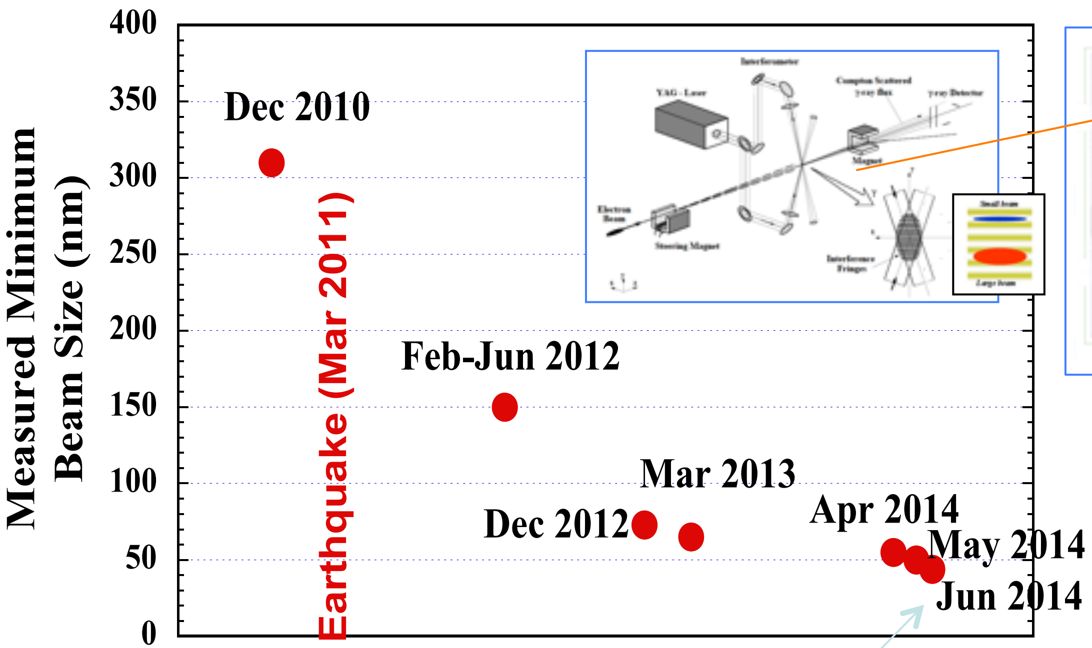
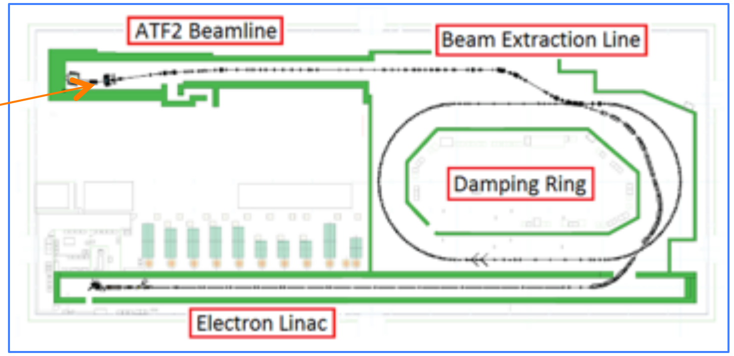


Parameter	ILC	ATF2
Beam Energy [GeV]	250	1.3
Energy Spread (e+/e-) [%]	0.07/0.12	0.06~0.08
Final quad – IP distance (L^*) (SiD/ILD detector) [m]	3.5/4.5	1.0
Vertical beta function at IP (β^*_y) [mm]	0.48	0.1
Vertical emittance [pm]	0.07	12
Vertical beam size at IP (s^*_y) [nm]	5.9	37
L^*/β^*_y (~natural vertical chromaticity, SiD/ILD detector)	7300/9400	10000

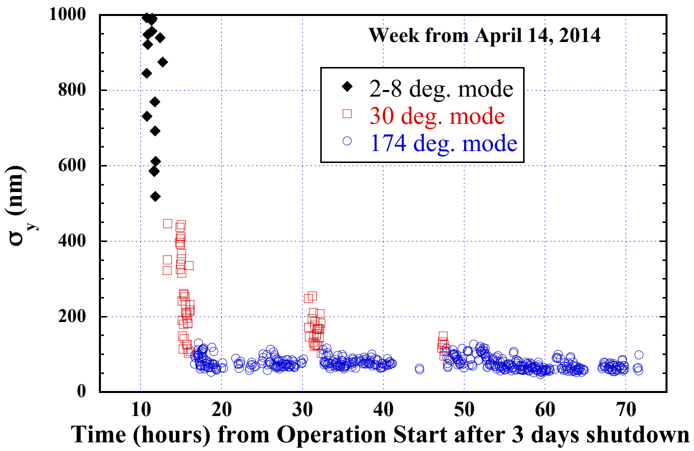
Progress in measured min. beam size at ATF2

2014年の進展（目標達成まで、あと一歩！）

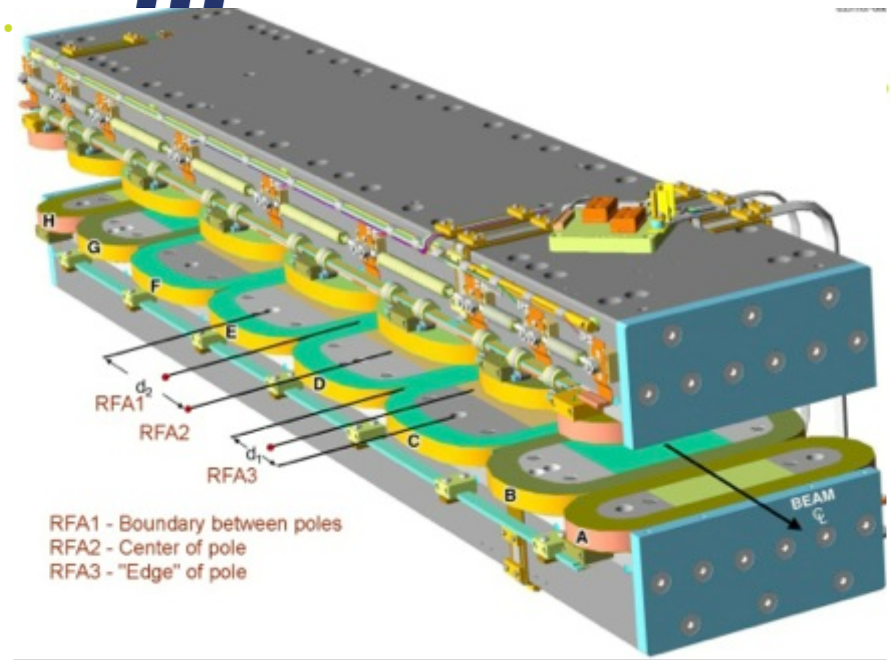


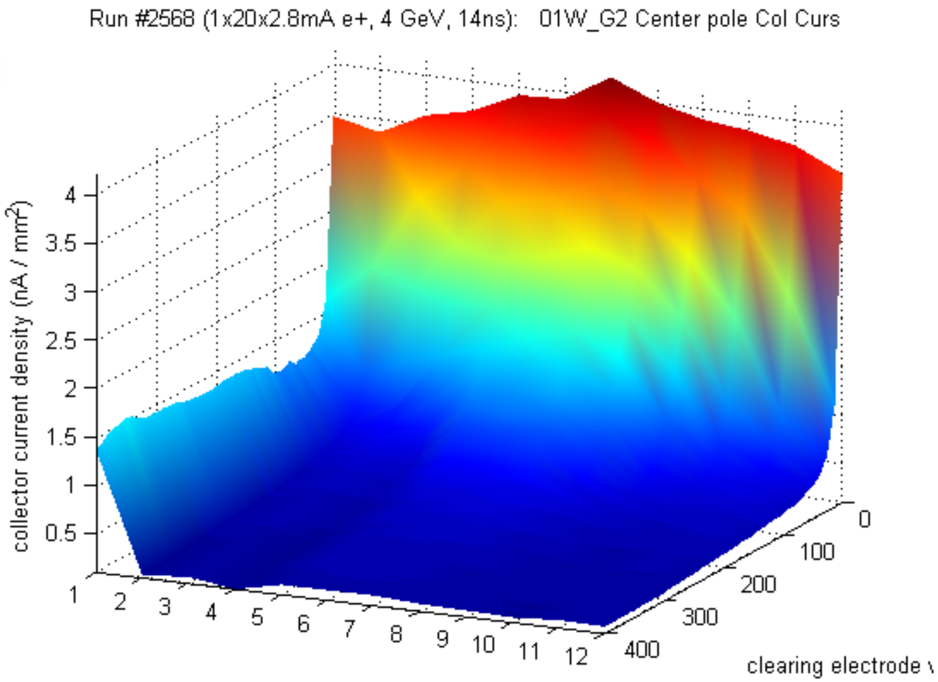


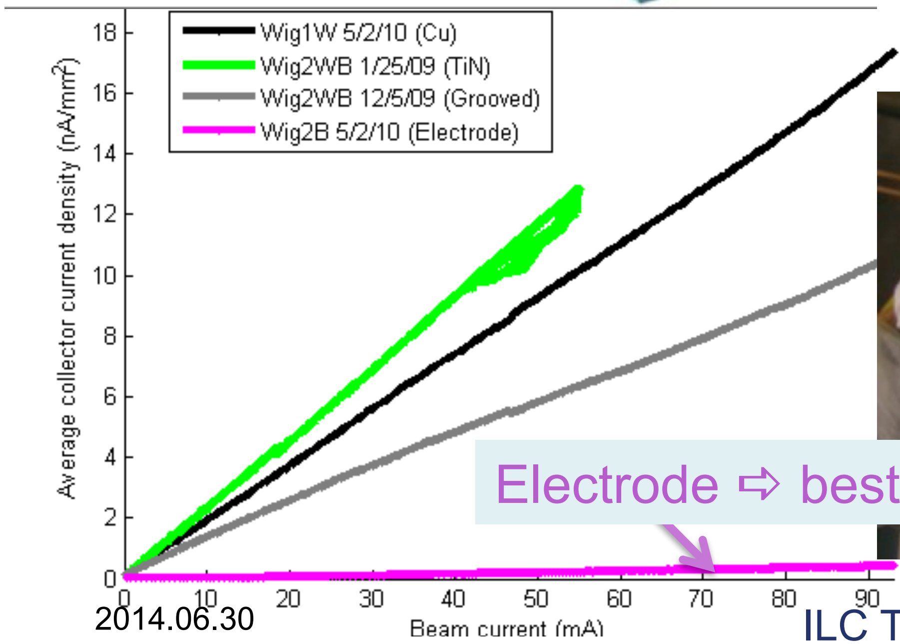
Beam Size 44 nm observed,
(Goal : 37 nm)



CesrTA - Wiggler Observations







Baseline Mitigation Plan

EC Working Group Baseline Mitigation Recommendation				
	Drift*	Dipole	Wiggler	Quadrupole*
Baseline Mitigation I	**TiN Coating**	**Grooves with TiN coating**	**Clearing Electrodes**	**TiN Coating**
Baseline Mitigation II	**Solenoid Windings**	**Antechamber**	**Antechamber**	
Alternate Mitigation	**NEG Coating**	**TiN Coating**	**Grooves with TiN Coating**	**Clearing Electrodes or Grooves**

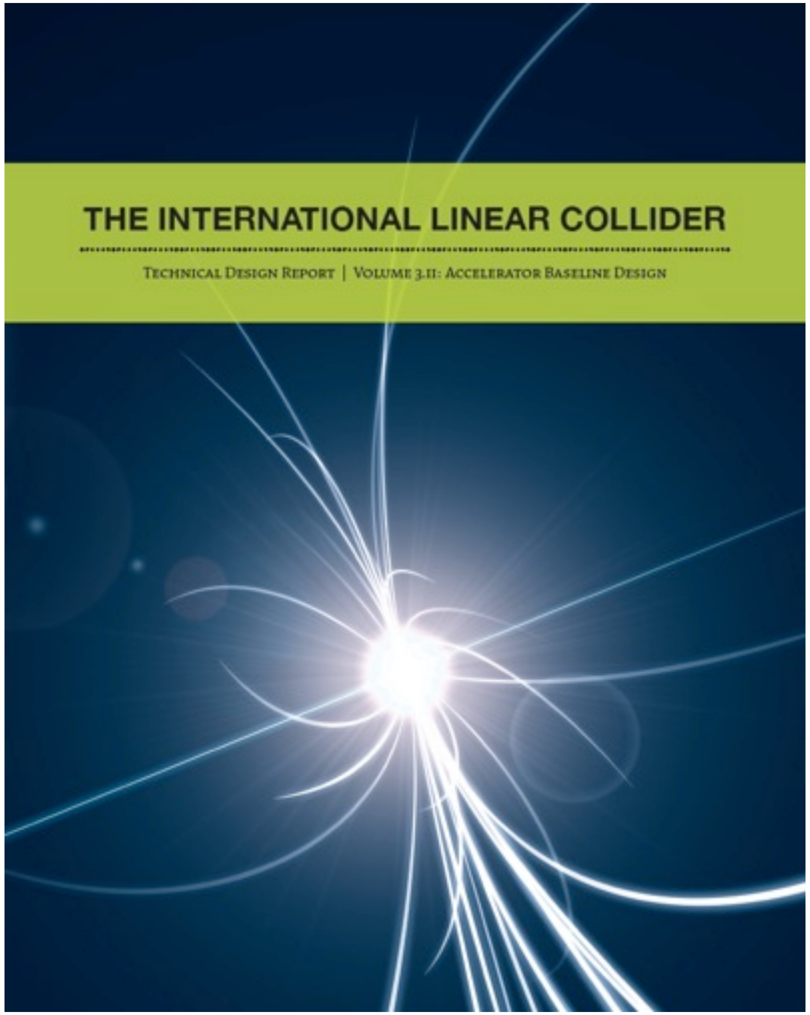
*Drift and Quadrupole chambers in arc and wiggler regions will incorporate antechambers

- Preliminary CESRTA results and simulations suggest the presence of *sub-threshold emittance growth*
  - Further investigation required
  - May require reduction in acceptable cloud density ⇨ reduction in safety margin
- An aggressive mitigation plan is required to obtain optimum performance from the 3.2km positron damping ring and to pursue the high current option

Outline

- Introduction
- Accelerator R&D
- Accelerator Baseline Design,
- Detectors
- Energy Staging
- Schedule
- Summary

ILC TDR: Vol. 3-II Acc. Baseline Design
Vol. 3–II. 加速器基本設計

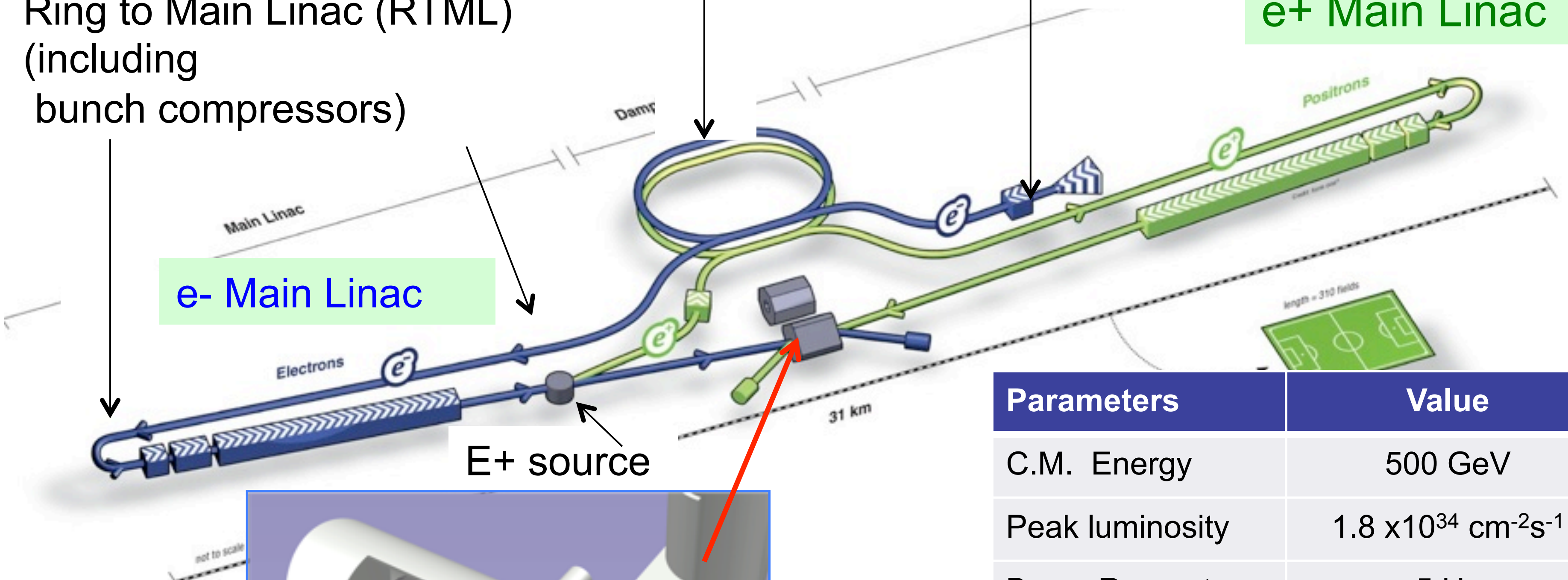


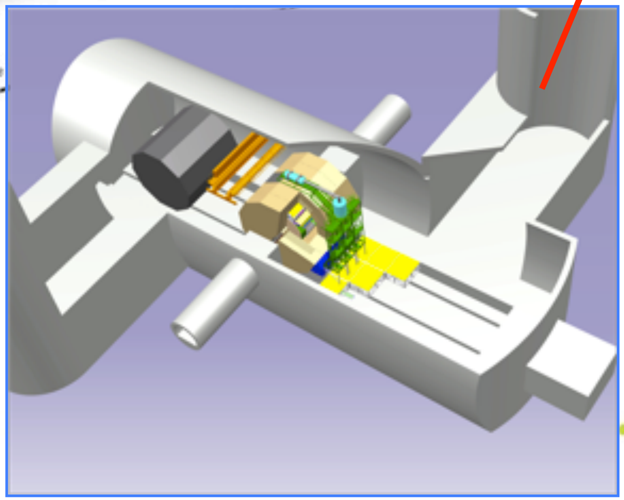
1. Introduction
2. General Parameters, Layout, System Overview → (山本)
3. Main Linac and SCRF Technology → (早野、道園)
4. Electron Source
5. Positron Source
6. Damping Rings (DR) → (横谷)
7. Ring to Main Linac (RTML)
8. Beam Delivery Sys. (BDS) & Machine Detect. Int. (MDI)
9. Global Accelerator Control Systems
10. Availability, Commisssioning, and Operations
11. Conventional Facilities and Siting (CFS) → (榎本、宮原)
12. Possible upgrade and staging options
13. Project Implementation Planing → (山本)
14. Construction schedule
15. ILC TDR Value Estimate → (設楽)

A. Evolution of the ILC design in the TD Phase

- Detectors: → (藤井)

ILC TDR Layout





ILC Scheme | © www.form-one.de

Parameters	Value
C.M. Energy	500 GeV
Peak luminosity	1.8 x10^{34} $cm^{-2}s^{-1}$
Beam Rep. rate	5 Hz
Pulse duration	0.73 ms
Average current	5.8 mA (in pulse)
E gradient in SCRF acc. cavity	31.5 MV/m +/-20% Q_0 = 1E10

ILC Published Parameters

Centre-of-mass dependent:

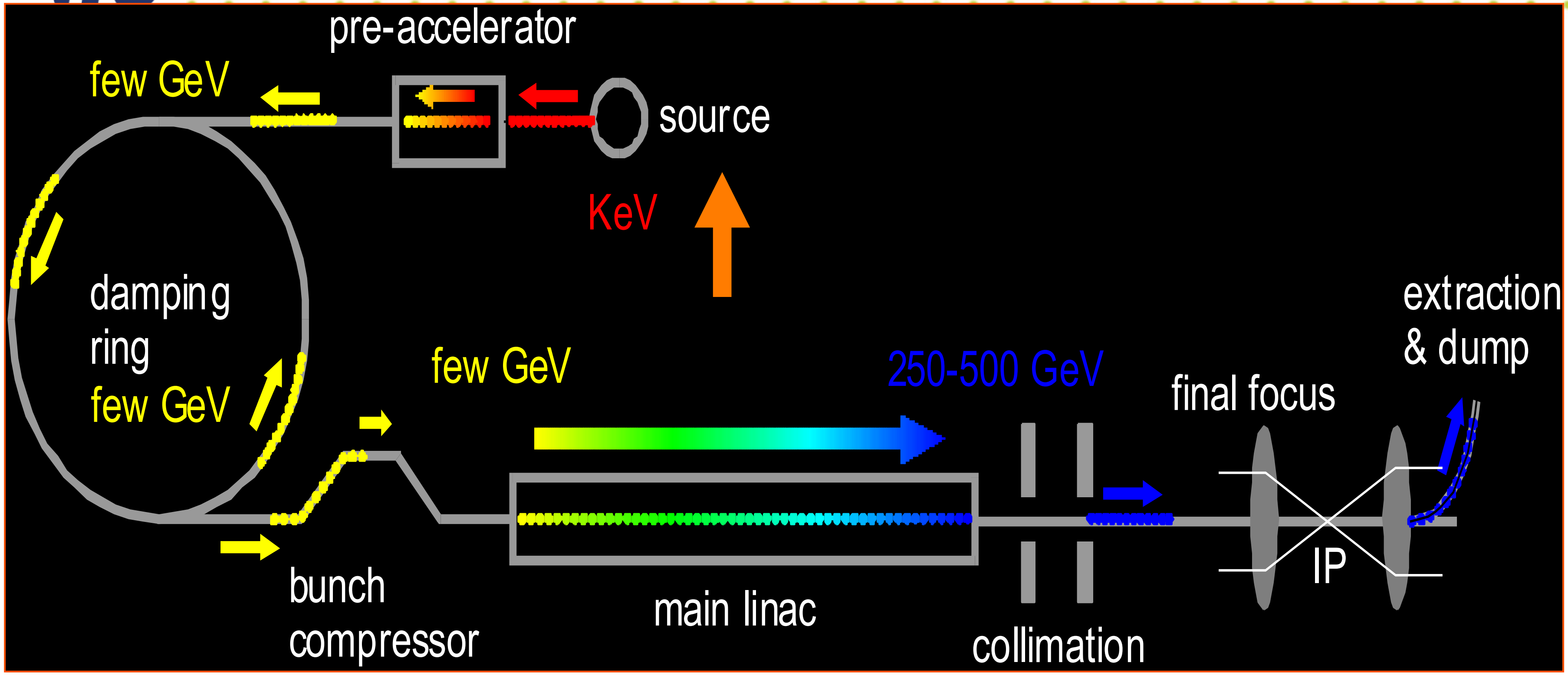
Focus of design (and cost!) effort

Centre-of-mass energy	GeV	200	230	250	350	500
Electron RMS energy spread	%	0.21	0.19	0.19	0.16	0.12
Positron RMS energy spread	%	0.19	0.16	0.15	0.10	0.07
IP horizontal beta function	mm	16	16	12	15	11
IP vertical beta function	mm	0.48	0.48	0.48	0.48	0.48
IP RMS horizontal beam size	nm	904	843	700	662	474
IP RMS veritcal beam size	nm	9.3	8.6	8.3	7.0	5.9
Vertical disruption parameter		20.4	20.4	23.5	21.1	24.6
Enhancement factor		1.83	1.83	1.91	1.84	1.95
Geometric luminosity	$\times 10^{34}$ $cm^{-2}s^{-1}$	0.25	0.29	0.36	0.45	0.75
Luminosity	**$\times 10^{34}$ $cm^{-2}s^{-1}$**	**0.50**	**0.59**	**0.75**	**0.93**	**1.8**
% luminosity in top 1% ΔE/E		92%	90%	84%	79%	63%
Average energy loss		1%	1%	1%	2%	4%
Pairs / BX	$\times 10^{3}$	41	50	70	89	139
Total pair energy / BX	TeV	24	34	51	108	344

http://ilc-edmsdirect.desy.de/ilc-edmsdirect/item.jsp?edmsid=D00000000925325

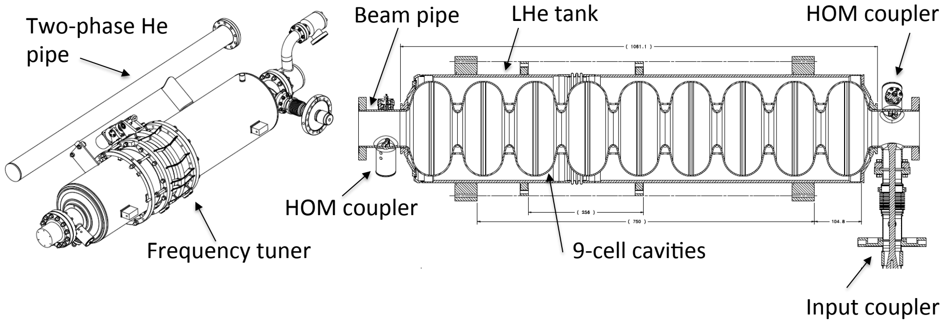
→ To be reported by H. Hayano, S. Michizono

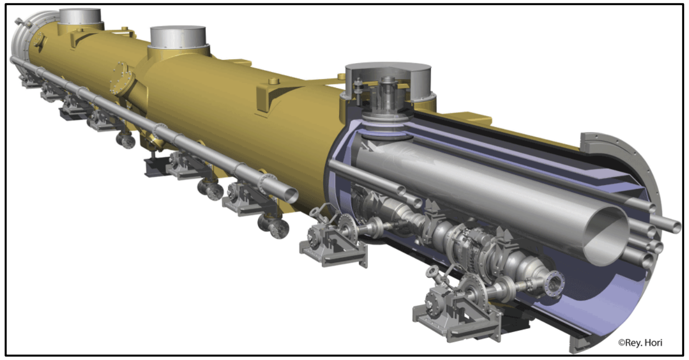
ILC Accelerator: Sub-Systems

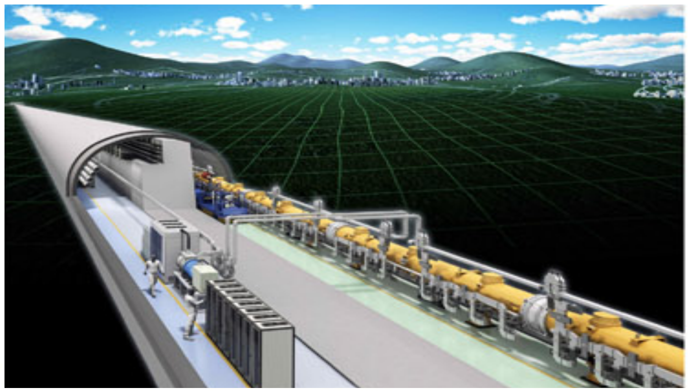


- Electron and Positron Sources (e-, e+) : 電子・ 陽電子源
- Damping Ring (DR): 減衰リング
- Ring to ML beam transport (RTML) ：ビームトランスポート
- Main Linac (ML) ：主線形加速器 (超伝導加速技術)
- Beam Delivery System（BDS ）：ビーム伝達・ 最終収束システム)

SCRF Linac Technology
超伝導・線形加速器技術







1.3 GHz Nb 9-cellCavities	16,024
Cryomodules	1,855
SC quadrupole pkg	673
10 MW MB Klystrons & modulators	436 /(471 *)

* site dependent

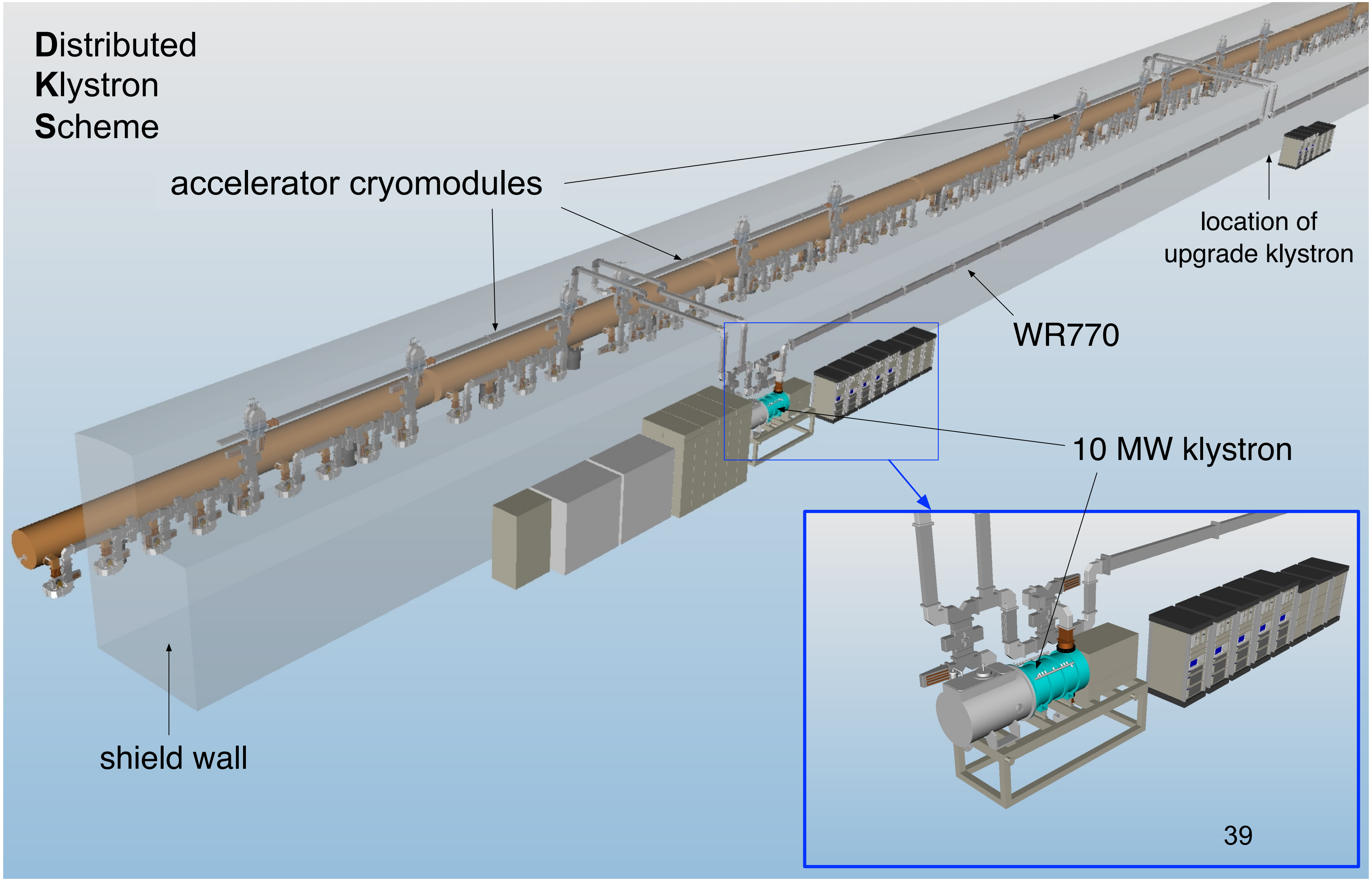
Approximately 20 years of R&D worldwide
→ Mature technology

SCRF Main Linac Parameters (500 GeV)

Characteristics	Parameter	Unit	Demonstrated
Average accelerating gradient	31.5 (±20%)	MV/m	DESY, FNAL, JLab, Cornell, KEK,
Cavity Q_0	10^{10}		
(Cavity qualification gradient	35 (±20%)	MV/m)	
Beam current	5.8	mA	DESY-FLASH, KEK-STF
Number of bunches per pulse	1312		
Charge per bunch	3.2	nC	
Bunch spacing	554	ns	
Beam pulse length	730	μs	DESY-FLASH, KEK-STF
RF pulse length (incl. fill time)	1.65	ms	DESY-FLASH, KEK-STF, FNAL-ASTA
Efficiency (RF→beam)	0.44		
Pulse repetition rate	5	Hz	
Peak beam power per cavity	190*	kW	* at 31.5 MV/m

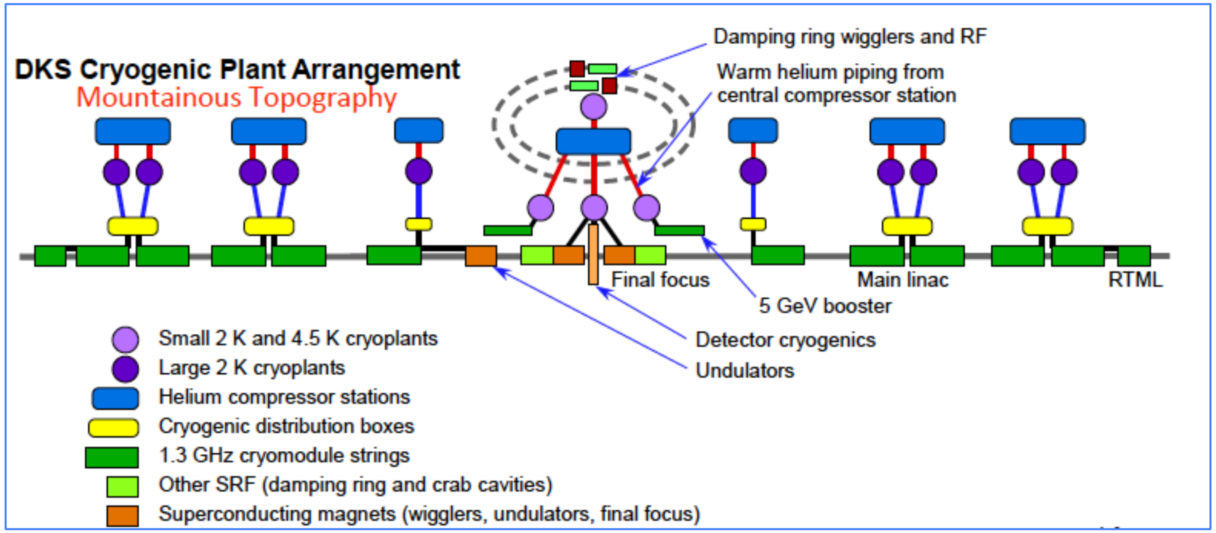
→ To be reported by S. Michizono

Site Specific Design in RF Power



ILC Cryogenic (TDR)

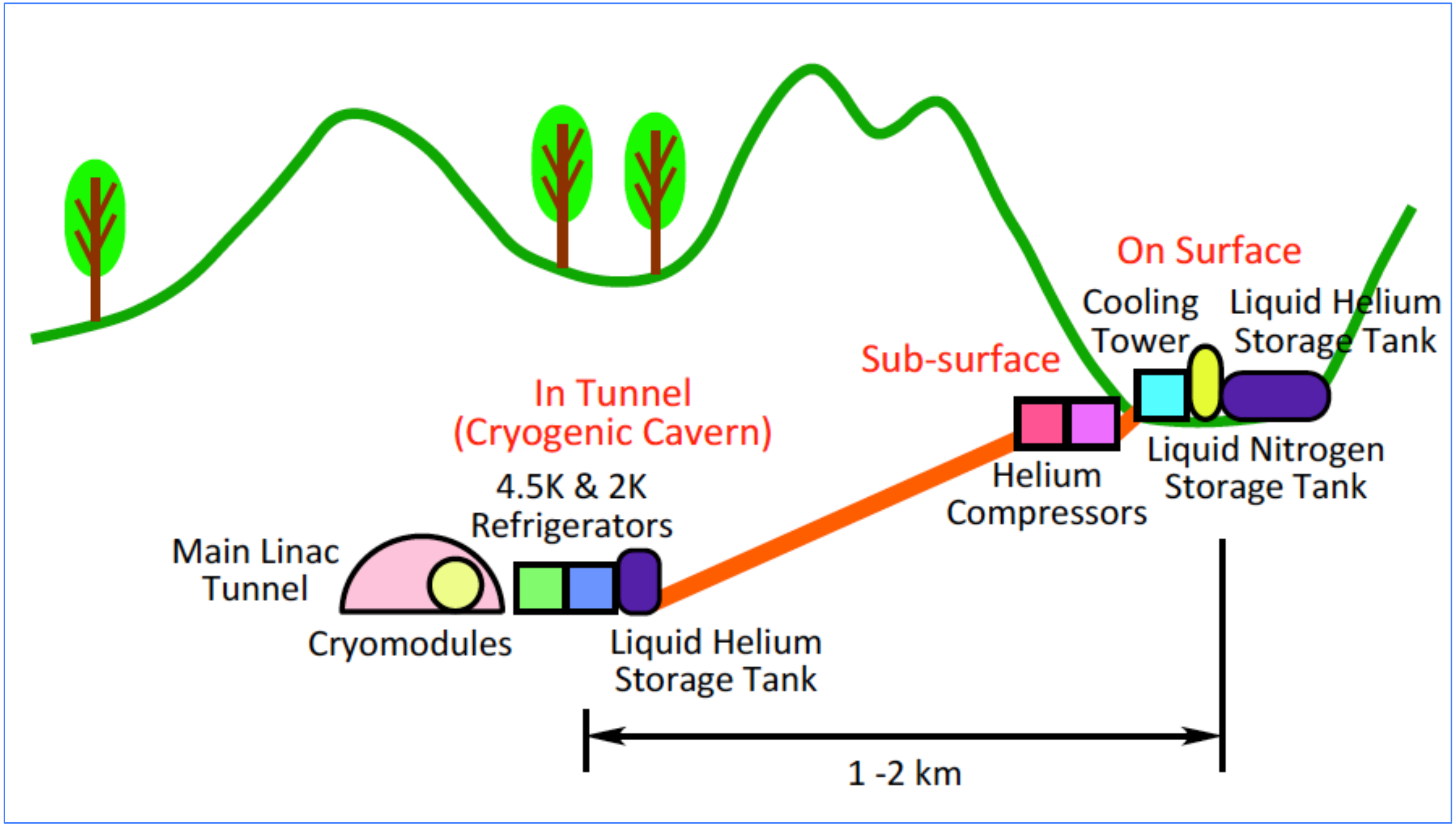
ILC 冷却システム



		40–80 K	5–8 K	2 K
Predicted module static heat load	(W/module)	75.04	10.82	1.32
Predicted module dynamic heat load	(W/module)	58.80	5.05	9.79
Number of cryomodules per cryogenic unit		156 / 189	156 / 189	156 / 189
Non-module heat load per cryo unit	(kW)	0.7 / 1.1	0.14 / 0.22	0.14 / 0.22
Total predicted heat per cryogenic unit	(kW)	21.58 / 26.40	2.61 / 3.22	1.87 / 2.32
Efficiency (fraction Carnot)		0.28	0.24	0.22
Efficiency in Watts/Watt	(W/W)	16.45	197.94	702.98
Overall net cryogenic capacity multiplier		1.54	1.54	1.54
Heat load per cryogenic unit including multiplier	(kW)	33.23 / 40.65	4.03 / 4.96	2.88 / 3.57
Installed power	(kW)	547/669	797/981	2028 / 2511
Installed 4.5 K equiv	(kW)	2.50 / 3.05	3.64 / 4.48	9.26 / 11.47
Percent of total power at each level		0.16	0.24	0.60
Total operating power for one cryo unit based on predicted heat (MW)			2.63 / 3.24	
Total installed power for one cryo unit (MW)			3.37 / 4.16	
Total installed 4.5 K equivalent power for one cryo unit (kW)			15.40 / 19.01	

flat / mountain topographies

ILC Cryogenics Layout (After TDR)

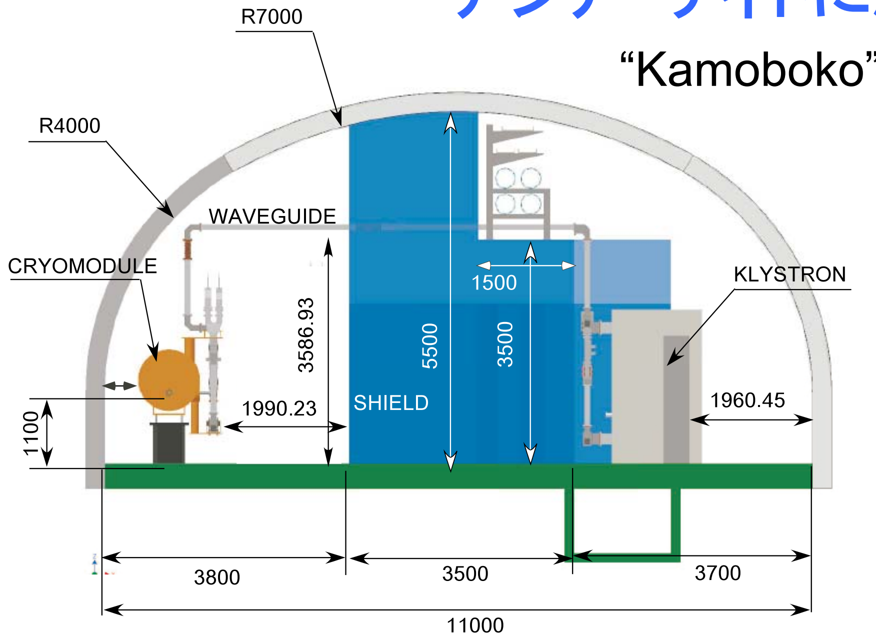


→ To be reported by A. Emonoto, M. Miyahara

Site Specific Design in CFS

アジア・サイトに沿った土木・建築設計

"Kamoboko" tunnel



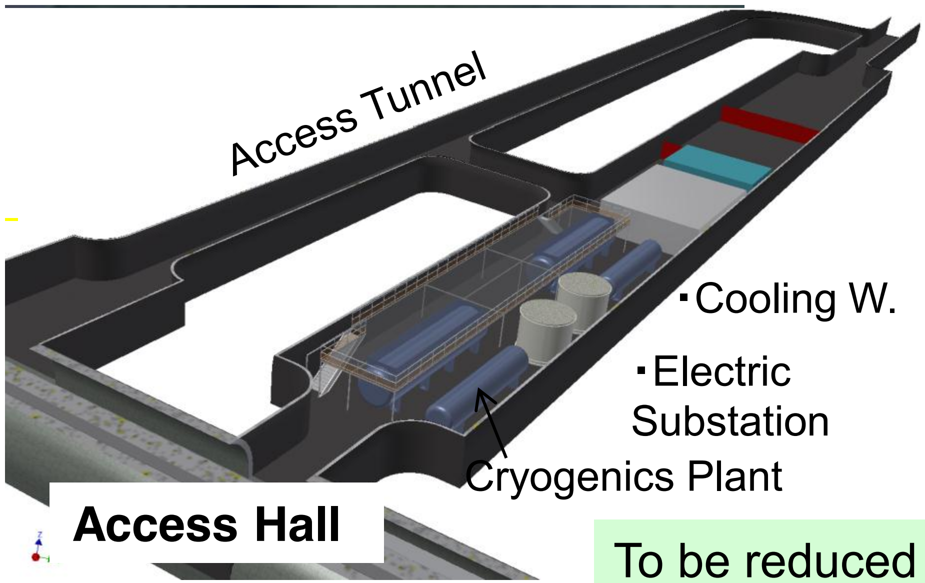
Reduced surface presence.

Horizontal access

Most infrastructure underground.

"Mountainous" Topography site-dependent design

→ To be reported by A. Enomoto, M. Miyahara



To be reduced