Introduction for CF Work in Mountain Regions

GDE Asian Regional Team
KEK
A. Enomoto

Overview

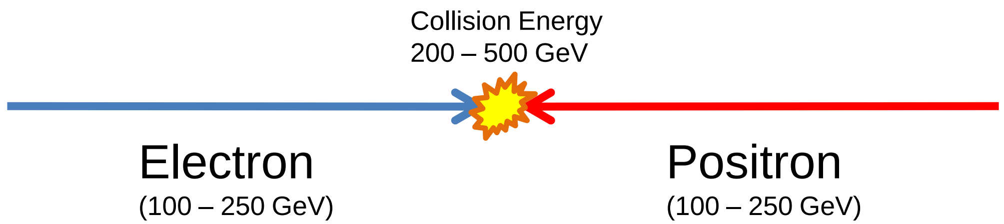
- Introduction
- ILC Design and Cost Containment for Conventional Facilities
- Asian Site Features
- TDP2 Design Concepts

Introduction

WHAT IS ILC?

International Linear Collider (ILC)

- Experiment Overview -

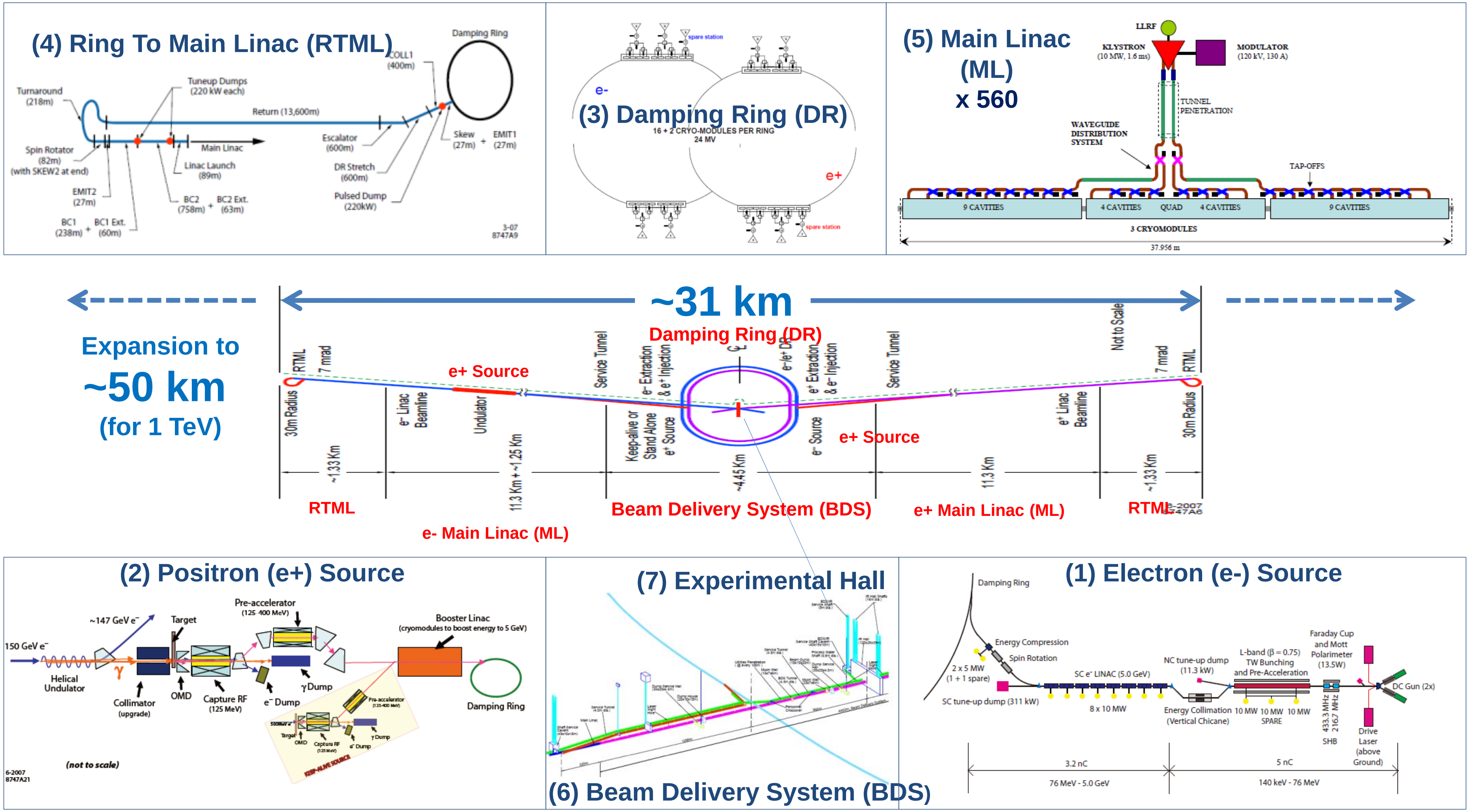


- a continuous center-of-mass energy range between 200 GeV and 500 GeV;
- a peak luminosity of $\sim 2 \times 10\ 34\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$, and an availability (75%) consistent with producing 500 fb^{-1} in the first four years of operation[2] ;
- $>$ 80% electron polarization at the Interaction Point (IP);
- an energy stability and precision of $\leq 0.1\%$;
- an option for $\sim$60% positron polarization;
- options for e^--e^- and γ-γ collisions.

In addition, the machine must be upgradeable to a center-of-mass energy of 1 TeV.

ILC ‘Area System’

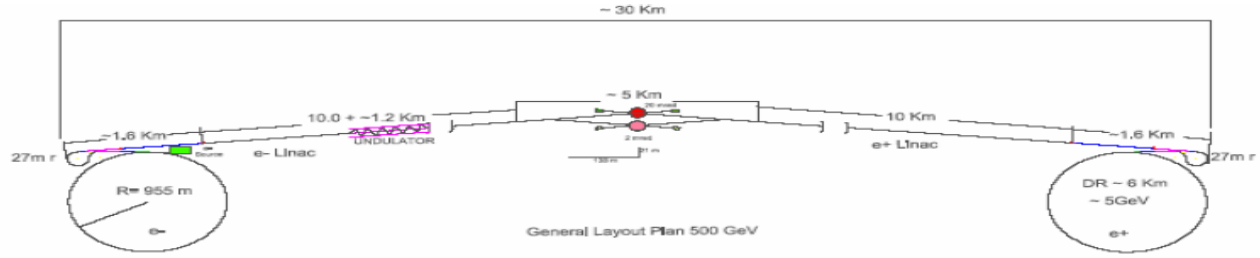
- Superconducting Electron/Positron Linear Accelerators-



Design Progress from 2005 to 2009

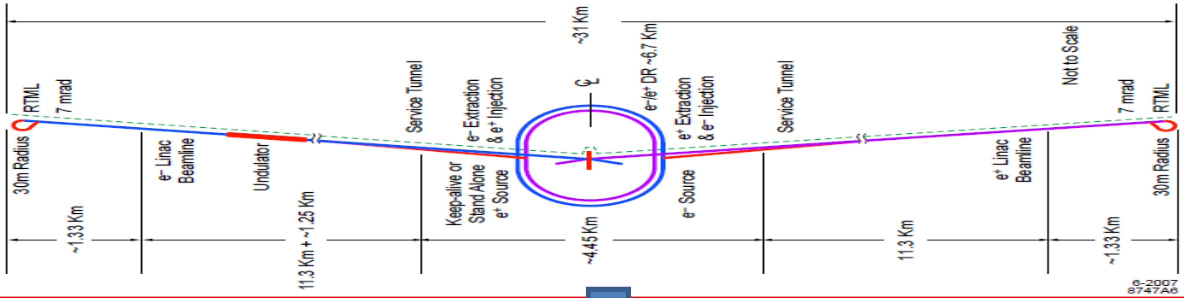
Reference Design Report (RDR) published in 2007.

Re-baselining for cost containment undergoing.



Baseline Configuration Document

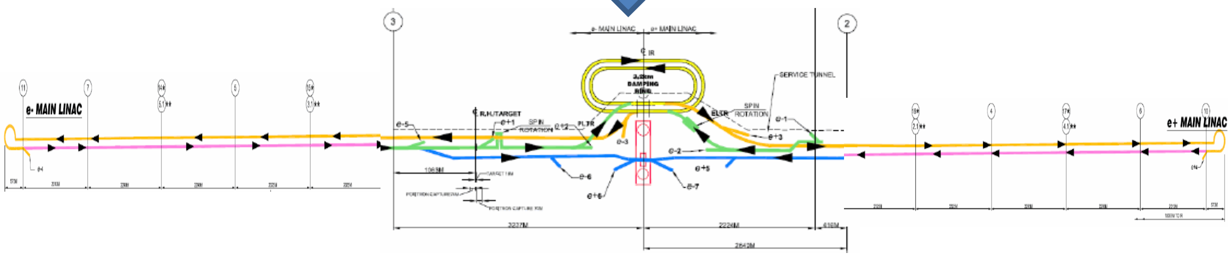
BCD (2005)



Reference Design Report

RDR (2007)

Current Baseline



Strawman Baseline for Technical Design Phase2 (2010-2012)

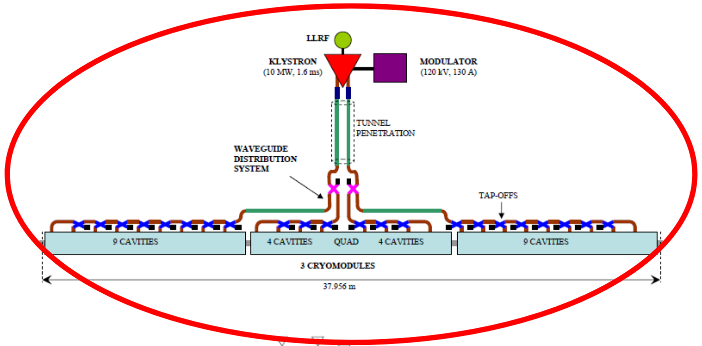
SB2009

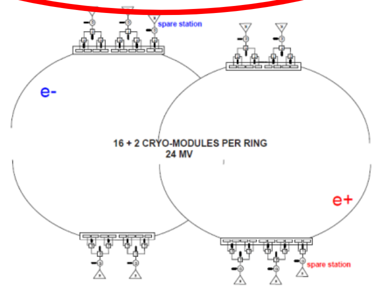
Re-baselining

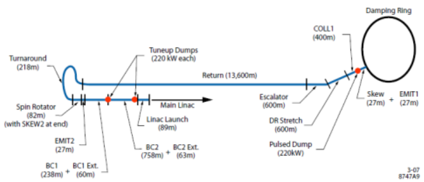
Boundary conditions and guidelines for design works

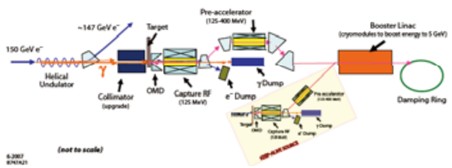
ILC DESIGN & COST CONTAINMENT

Construction Cost Profile









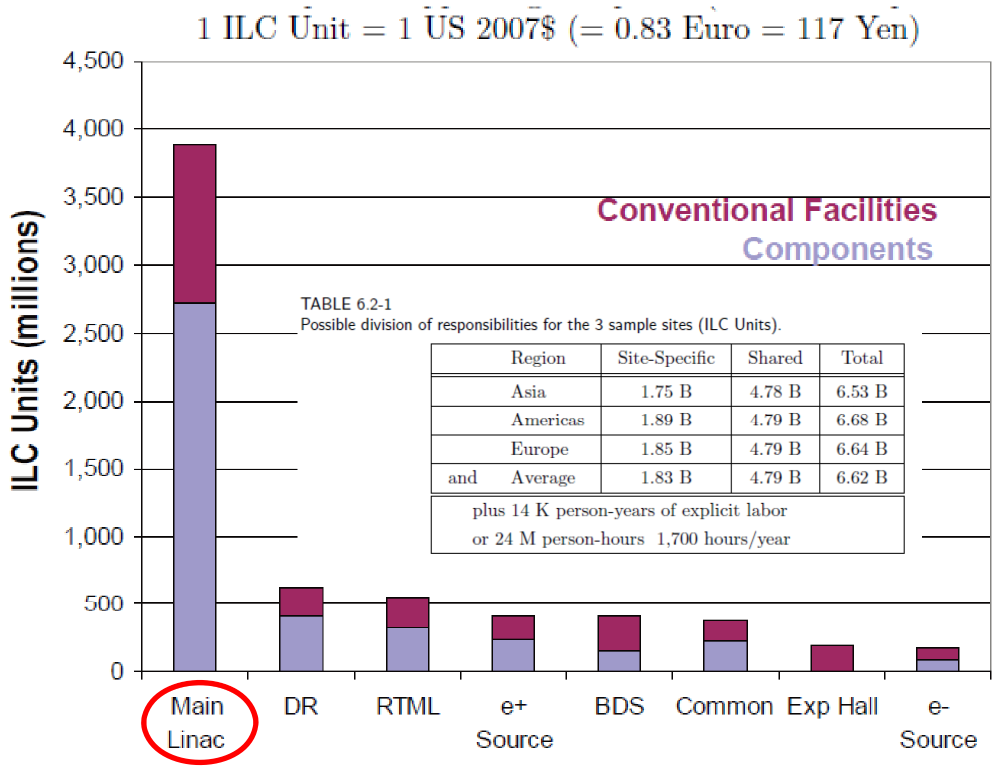
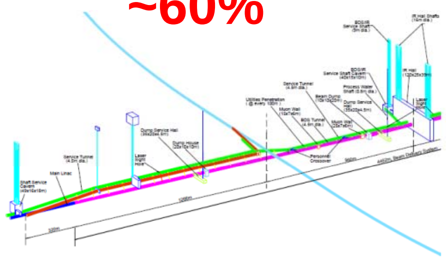
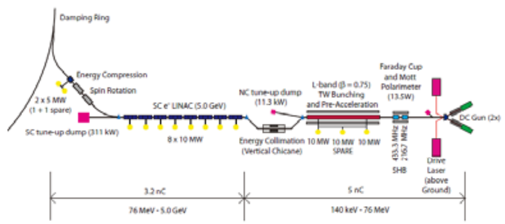


TABLE 6.2-1
Possible division of responsibilities for the 3 sample sites (ILC Units).

Region	Site-Specific	Shared	Total
Asia	1.75 B	4.78 B	6.53 B
Americas	1.89 B	4.79 B	6.68 B
Europe	1.85 B	4.79 B	6.64 B
and Average	1.83 B	4.79 B	6.62 B
plus 14 K person-years of explicit labor or 24 M person-hours 1,700 hours/year			

~60%

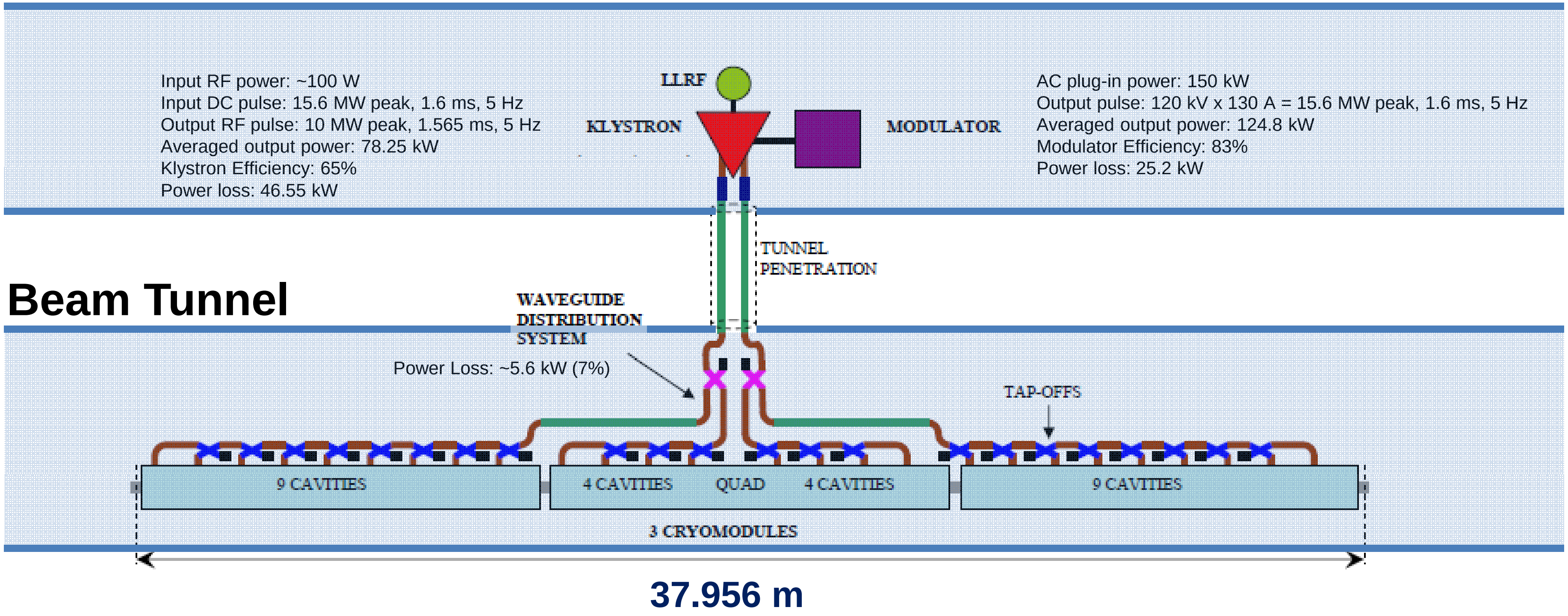




Main Linac (ML) RF Unit in RDR

- **Twin-tunnel** accelerator configuration -

Service Tunnel



e- ML	282 RF units	Field gradient:	31.5 MV/m
e+ ML	278 RF units	Energy gain per RF unit :	**850 MeV**
Total	**560 RF units**	(with 22% tuning overhead)	

11:00-11:30 Hitoshi Hayano, Cryomodule Requirements

RDR(2007) to TDR(2012)

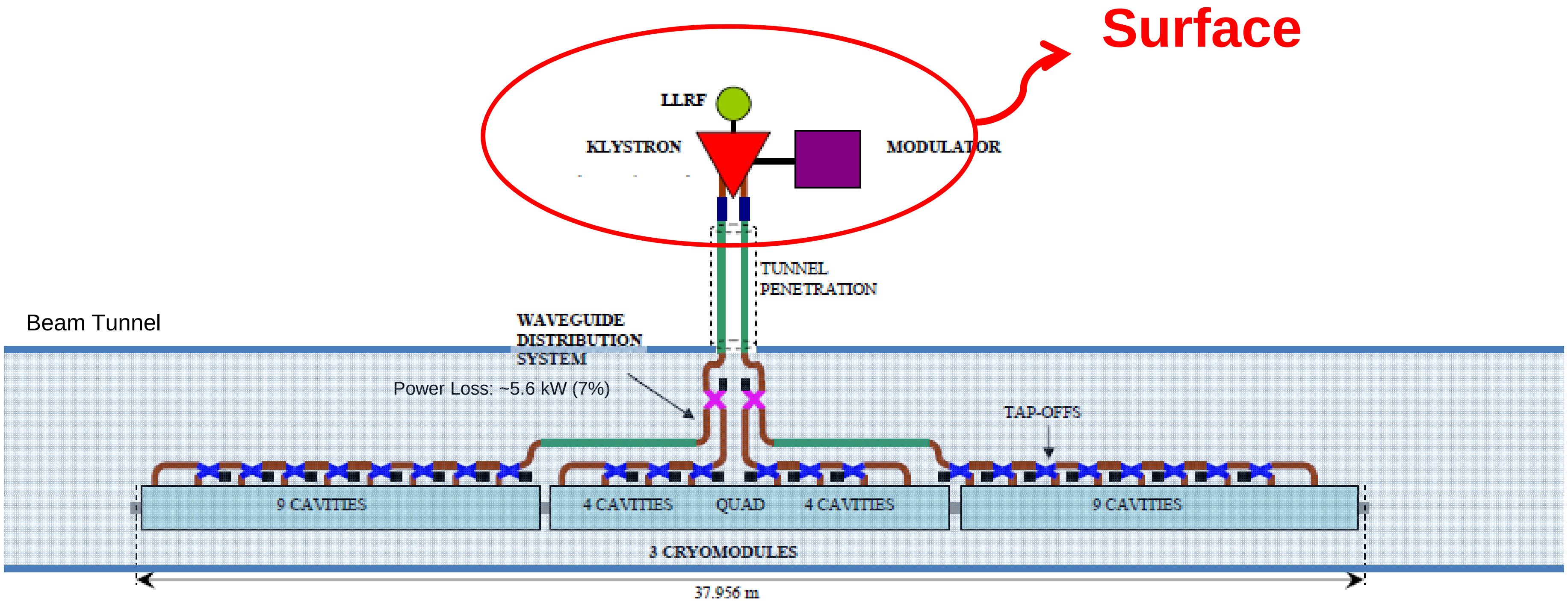
- Cost Containment -

- RDR: 6.62 BILCU (4.80 Shared + 1.82 Site Specific) + 14.1 kPerson
- SB2009: 7 working assumptions with ~13% cost reduction
- One of the most cost-effective assumptions is:

2. **A single-tunnel solution for the Main Linacs and RTML, with two possible variants for the High-Level RF (HLRF):**
   - Klystron cluster scheme (KCS);
   - Distributed RF Source scheme (DRFS).

ML Single-Tunnel Configuration

- Klystron Cluster System (KCS)-



e- ML	282 RF units
e+ ML	278 RF units
Total	560 RF units

Field gradient	31.5 MV/m
Energy gain per RF unit	850 MeV

(with 22% tuning overhead)

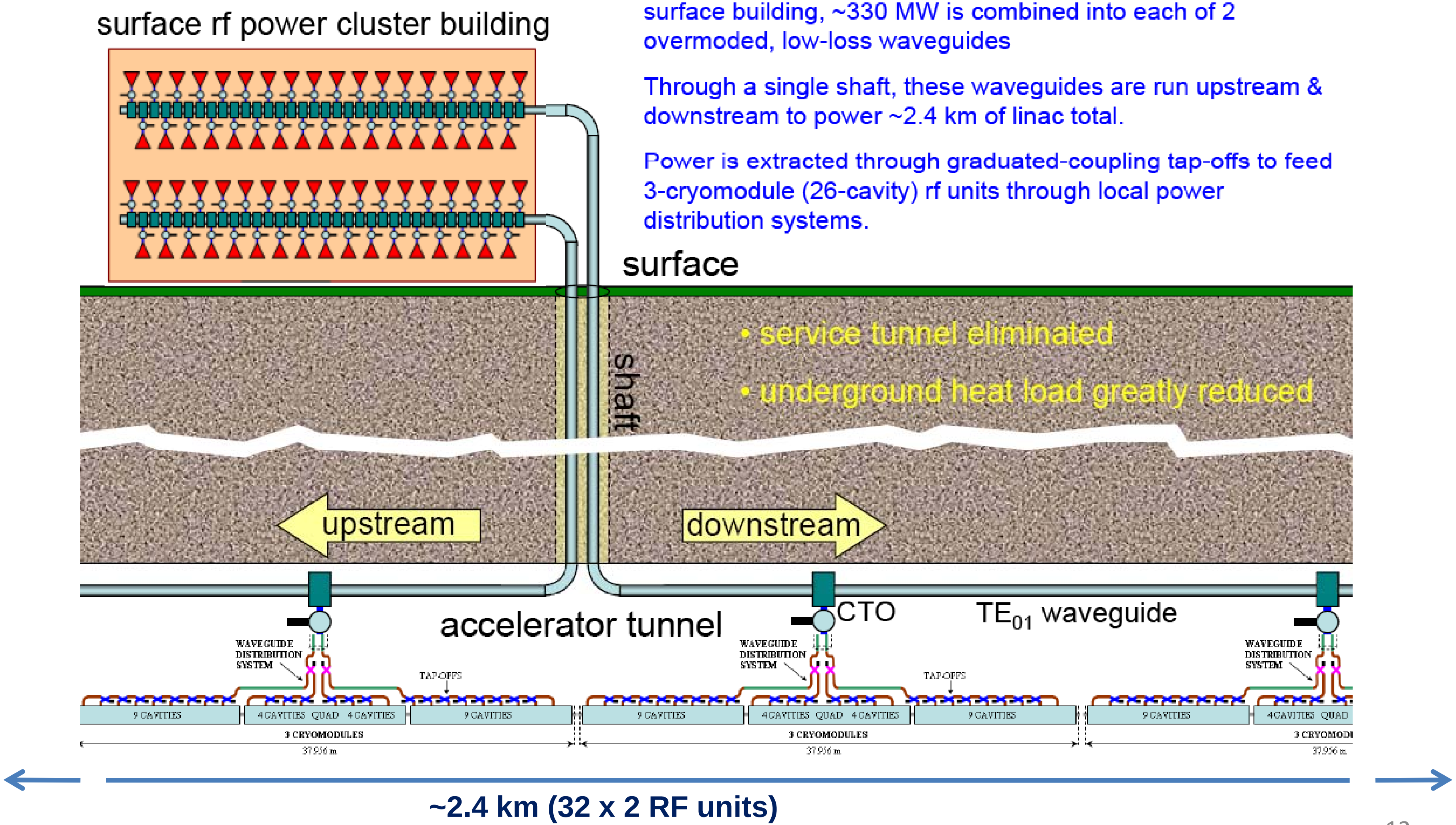
ML RF Units

- Klystron Cluster System (KCS) -

From 2 groups of ~35 klystrons & modulators clustered in a surface building, ~330 MW is combined into each of 2 overmoded, low-loss waveguides

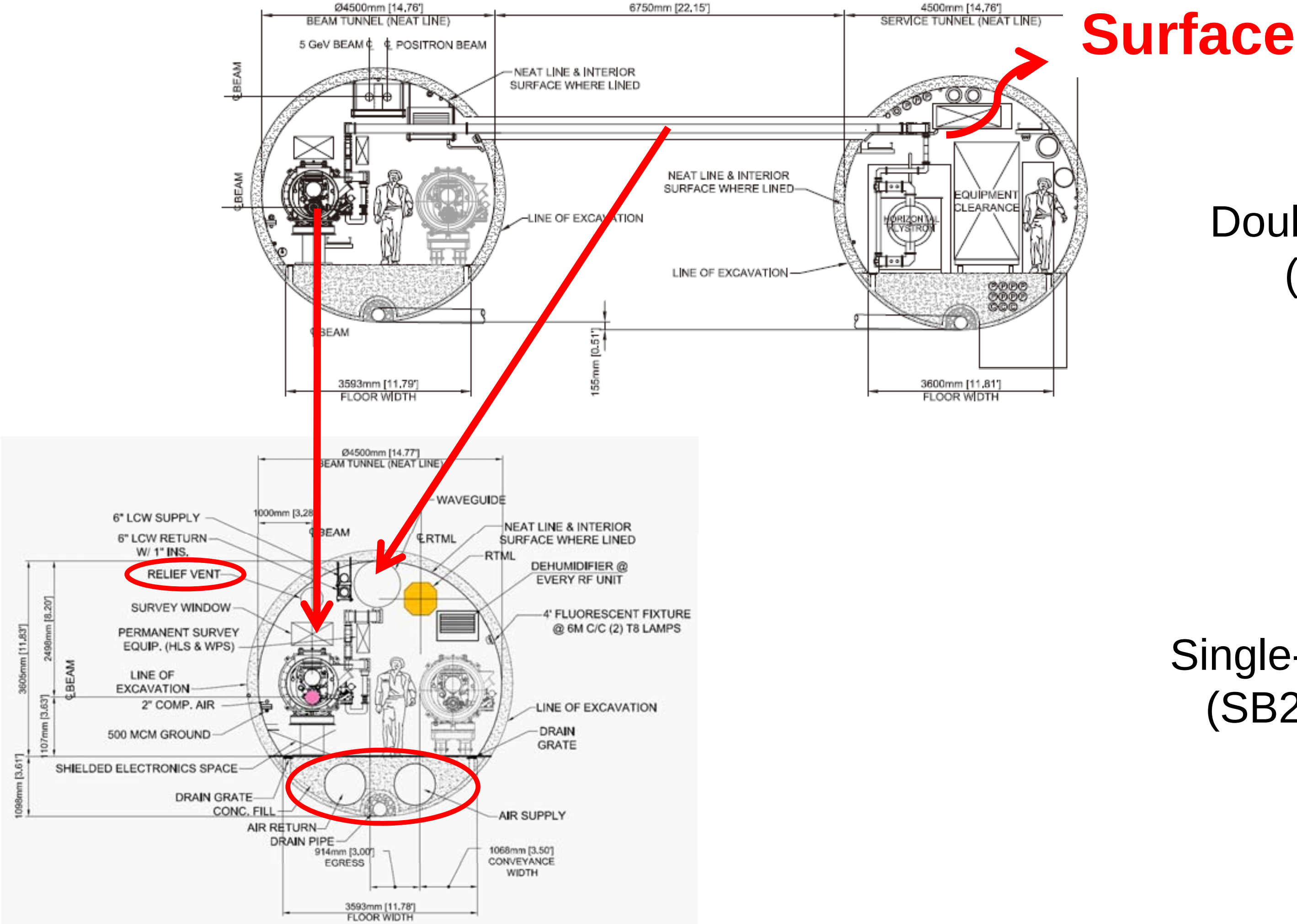
Through a single shaft, these waveguides are run upstream & downstream to power ~2.4 km of linac total.

Power is extracted through graduated-coupling tap-offs to feed 3-cryomodule (26-cavity) rf units through local power distribution systems.



ML Civil Engineering

- Klystron Cluster System (KCS) -

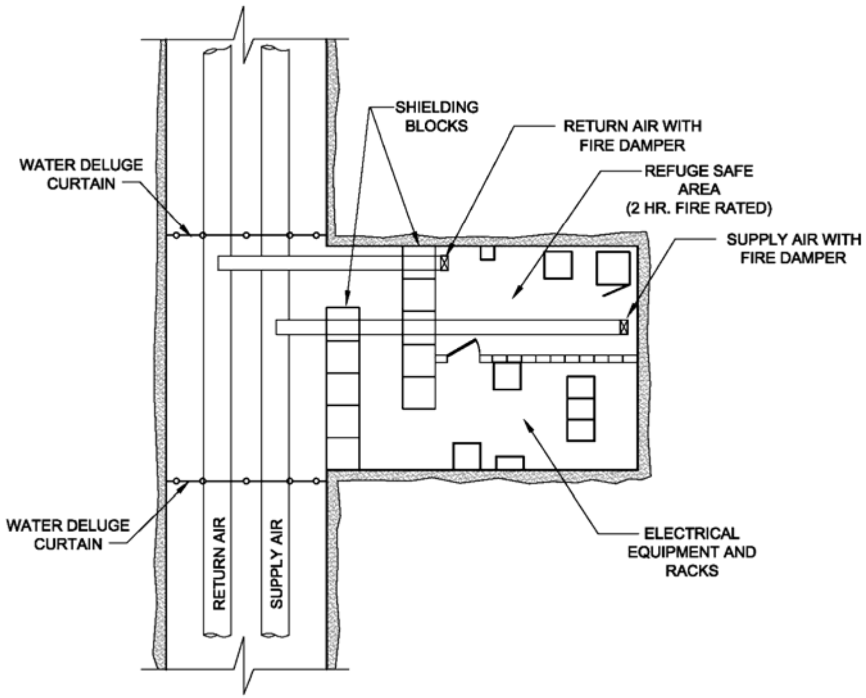


Double-tunnel (RDR)

Single-tunnel (SB2009)

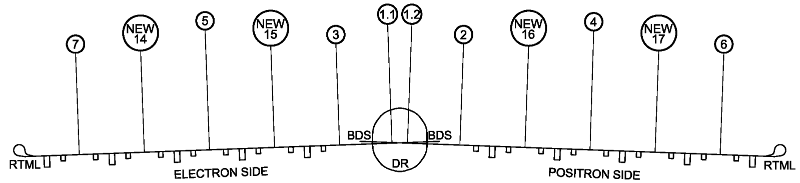
ML Single-Tunnel Life Safety

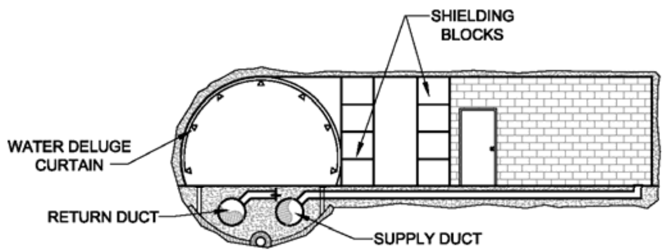
- Americas Region-

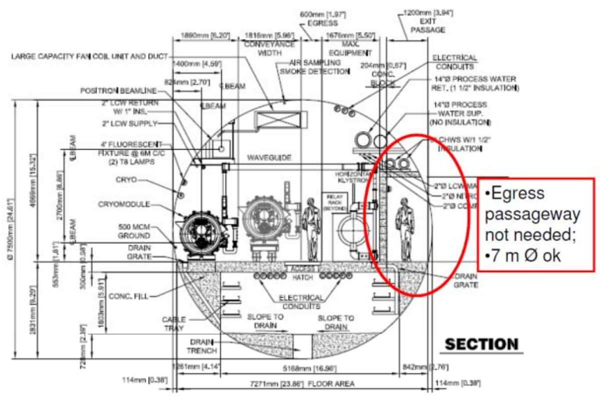


NFPA 520-2005 (Subterranean Spaces)

Prescribes 2 paths of travel to an exit or refuge area. The travel distance to be less than 610 meters.

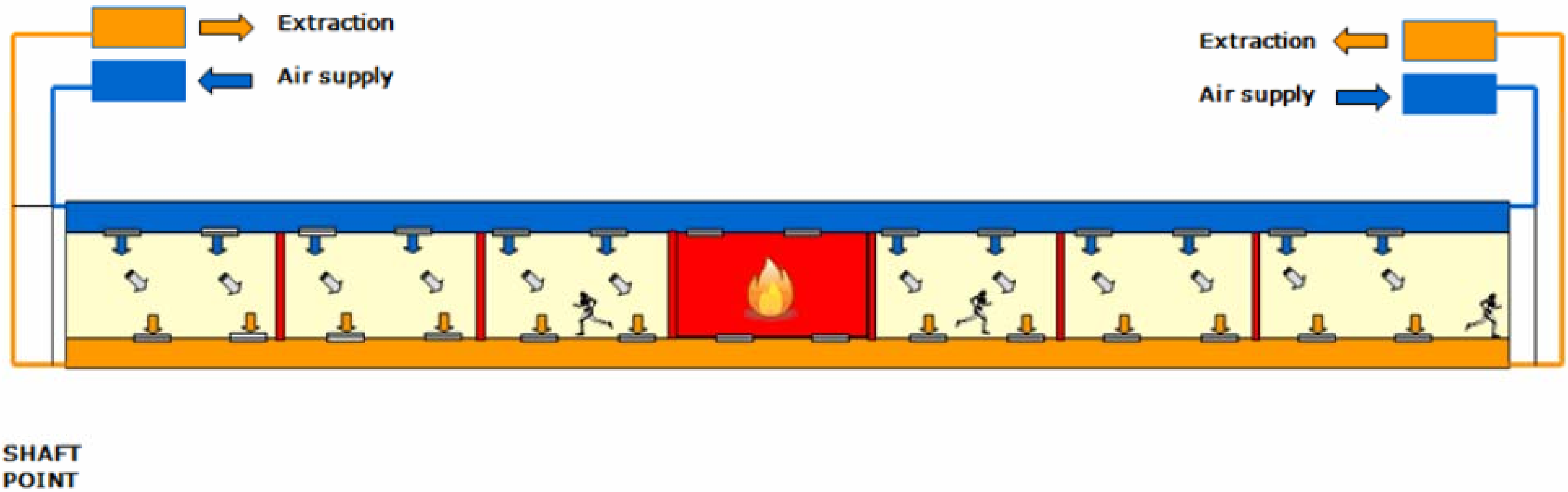






ML Single-Tunnel Life Safety

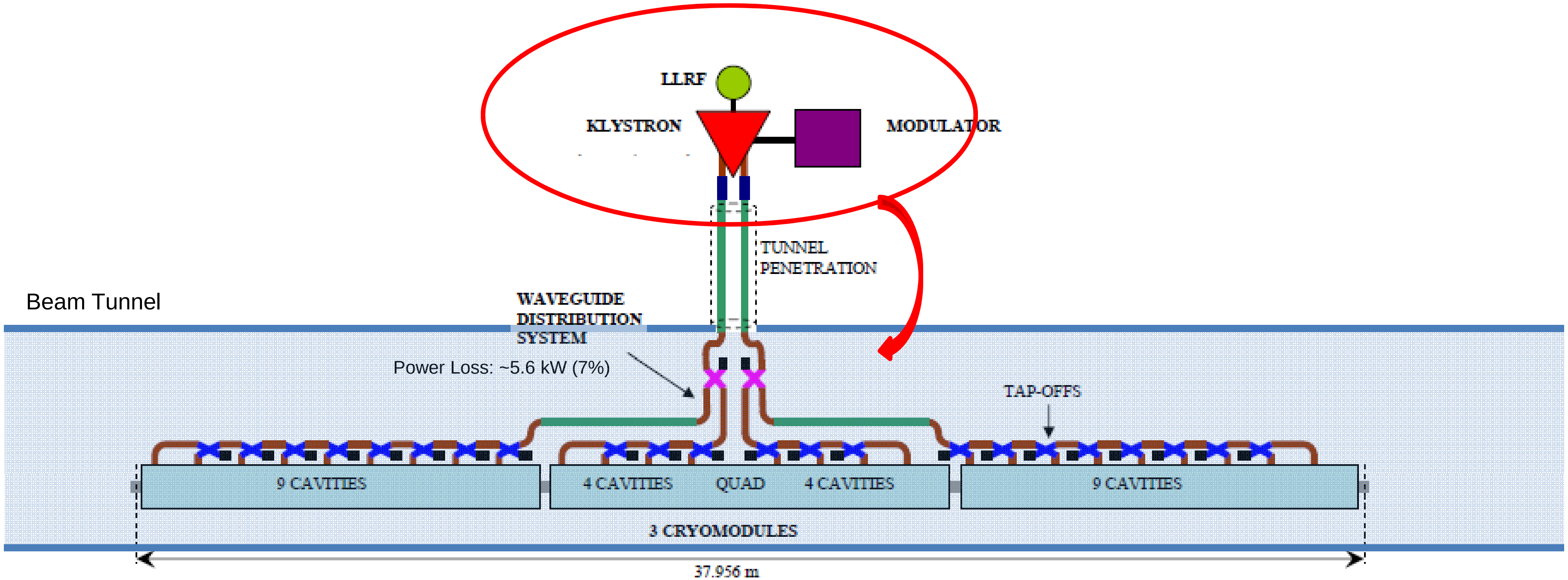
- European Region-



- Control of the pressure from both ends of a sector.
- Control of the pressure (overpressure or underpressure in each area).
- Fire detection per sector compatible to fire fighting via water mist.

ML Single-Tunnel Configuration

- Distribute RF System (DRFS) -

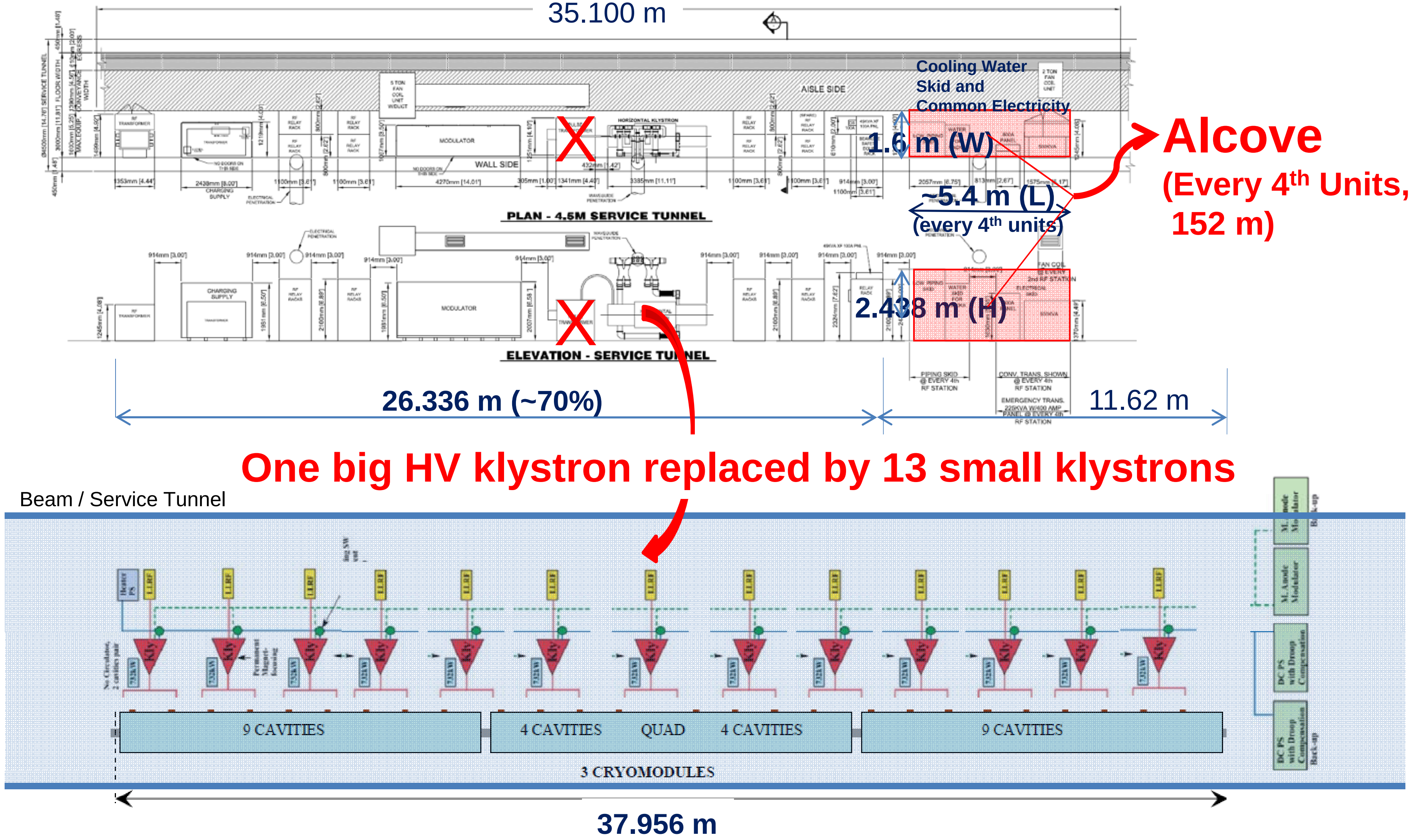


e- ML	282 RF units
e+ ML	278 RF units
Total	560 RF units

Field gradient	31.5 MV/m
Energy gain per RF unit	850 MeV
(with 22% tuning overhead)	

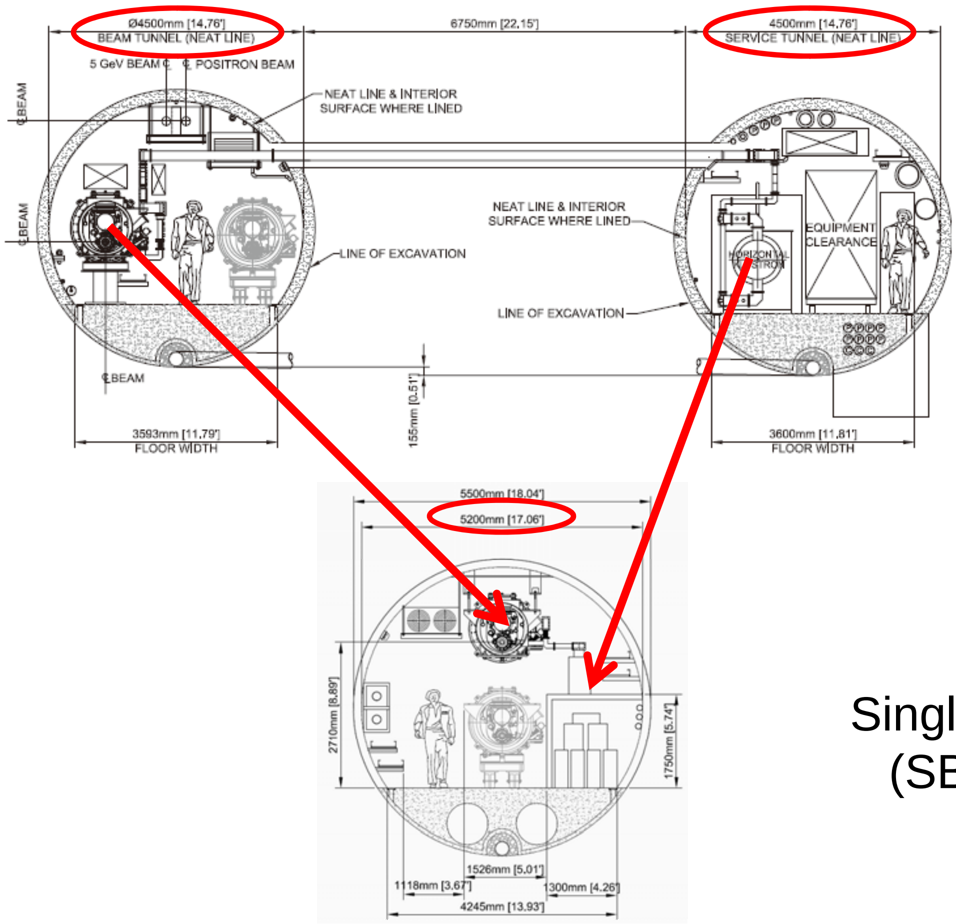
ML RF Unit

- Distributed RF System (DRFS) -



11:30-12:00 Shigeki Fukuda, HLRF Requirements

ML Civil Engineering
(DRFS)



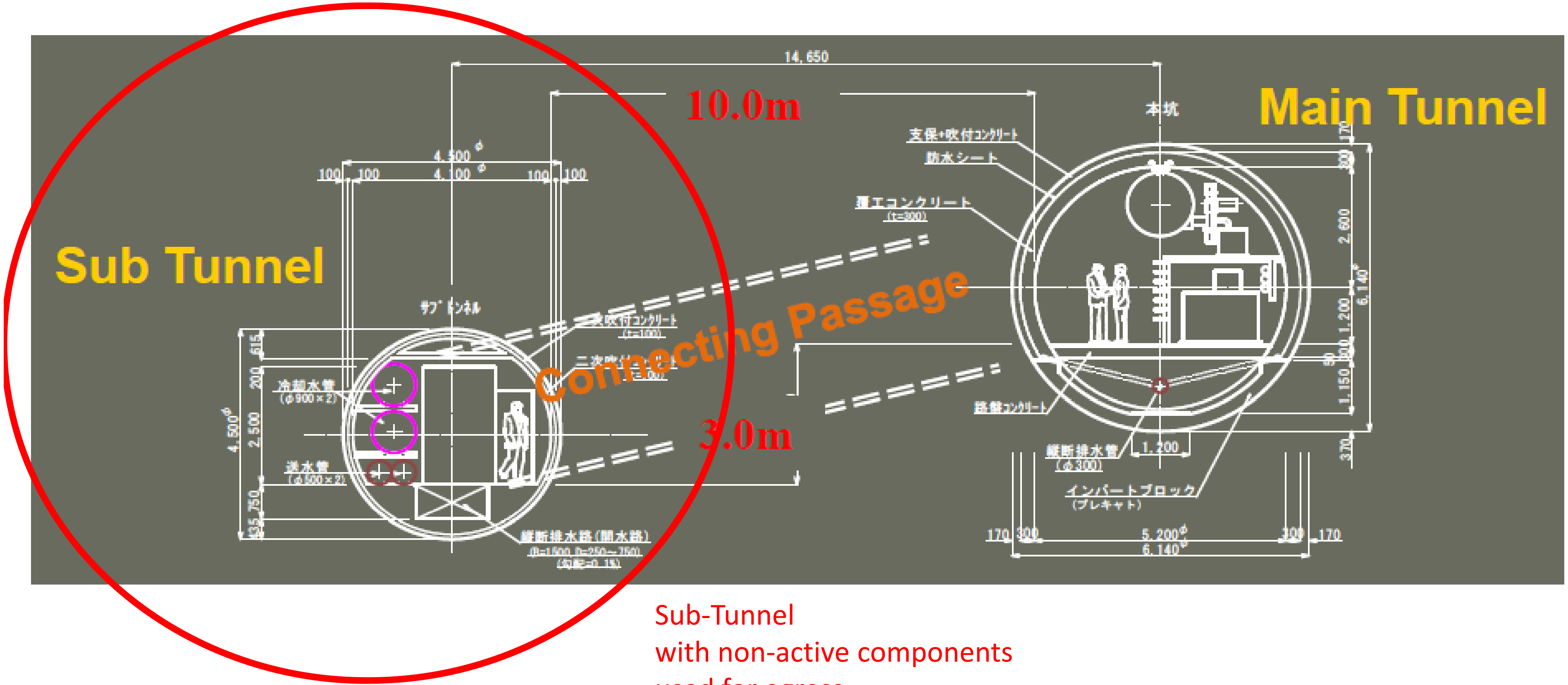
Double-tunnel
(RDR)

Single-tunnel
(SB2009)

11:30-12:00 Shigeki Fukuda, HLRF Requirements

ML Single-Tunnel Life Safety

- Asian Region-



Sub-Tunnel
with non-active components
used for egress,
access,
water utility,
geology survey in construction
etc.

13:30-15:30 Masanobu Miyahara,

Cryogenic System Configuration in RDR

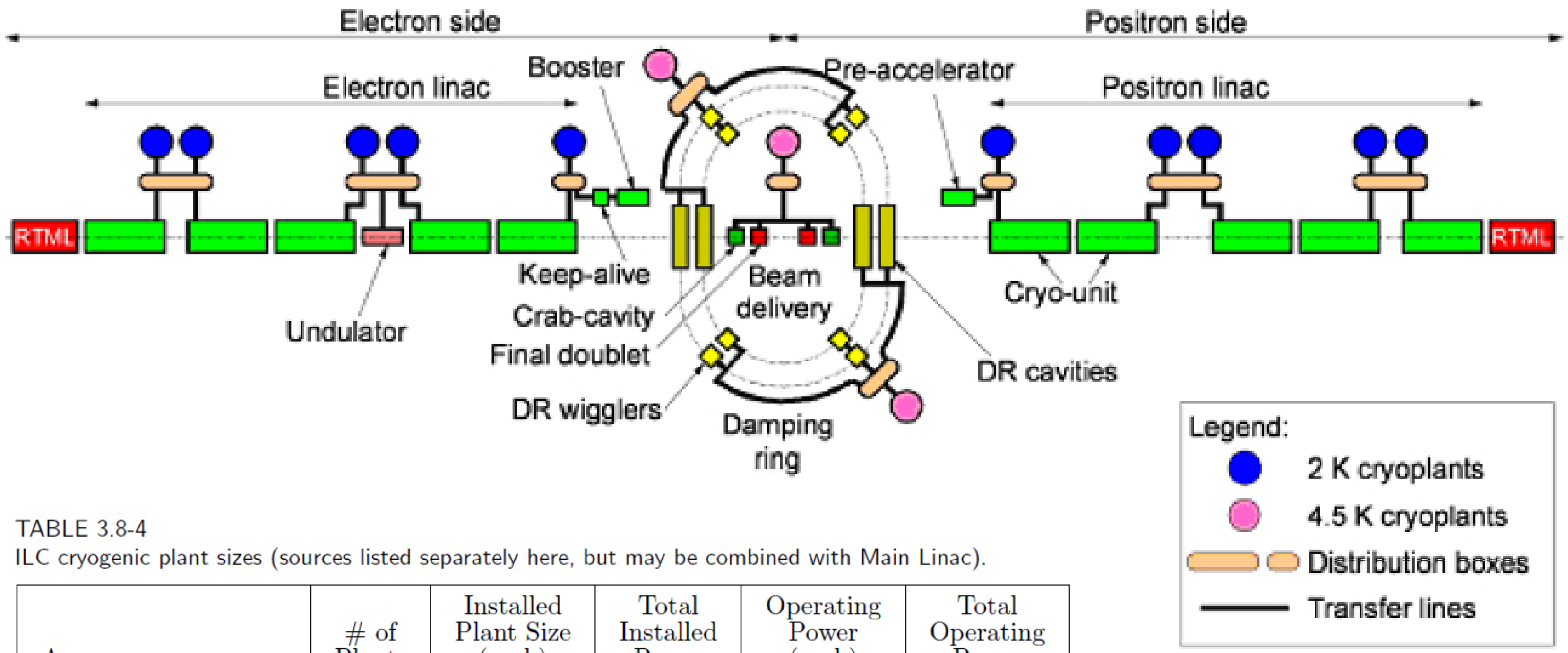
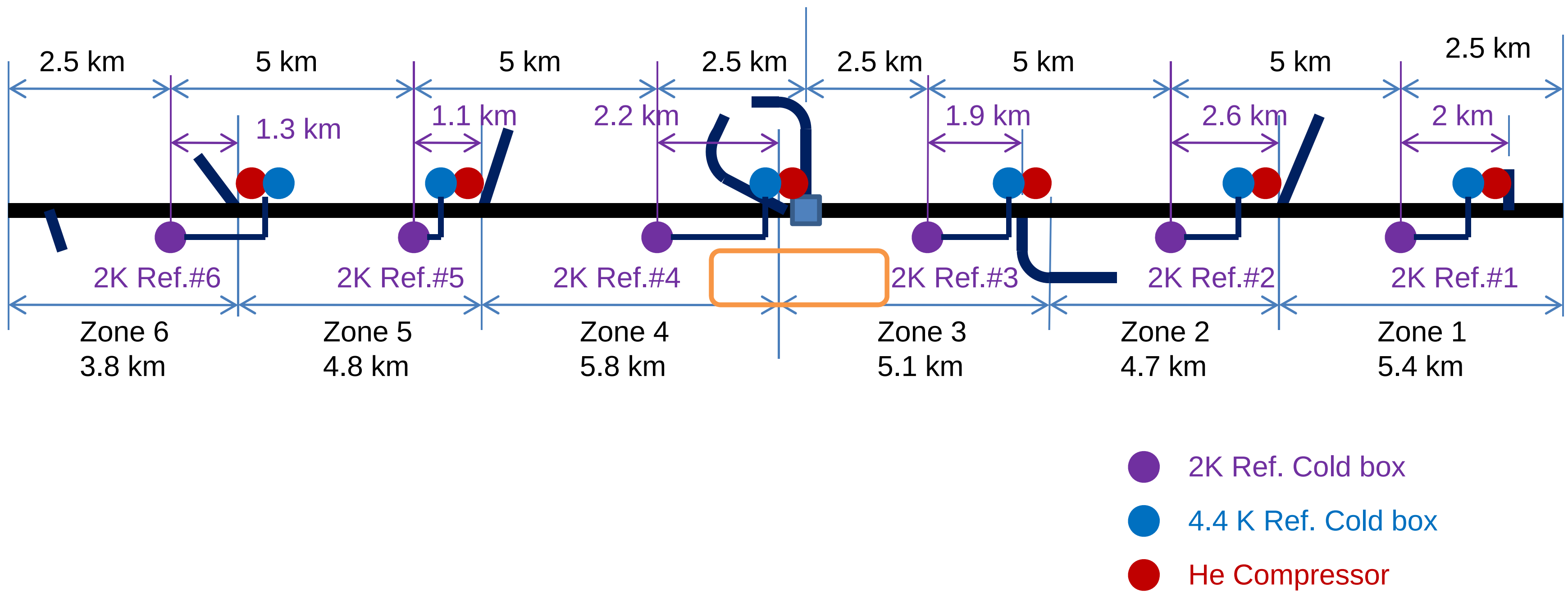


TABLE 3.8-4
ILC cryogenic plant sizes (sources listed separately here, but may be combined with Main Linac).

Area	# of Plants	Installed Plant Size (each) (MW)	Total Installed Power (MW)	Operating Power (each) (MW)	Total Operating Power (MW)
Main Linac + RTML	10	4.35	43.52	3.39	33.91
Sources	2	0.59	1.18	0.46	0.92
Damping Rings	2	1.26	2.52	0.88	1.76
BDS	1	0.41	0.41	0.33	0.33
Total			47.63		36.92

Cryogenic System in Mountainous Site

2K He Refrigerator: Main Tunnel
4.4 K He Refrigerator & He Compressor: Access Tunnel



12:00-12:30 Kenji Hosoyama, Cryogenic Requirements

Electrical / Mechanical Requirements

- Electricity in RDR -

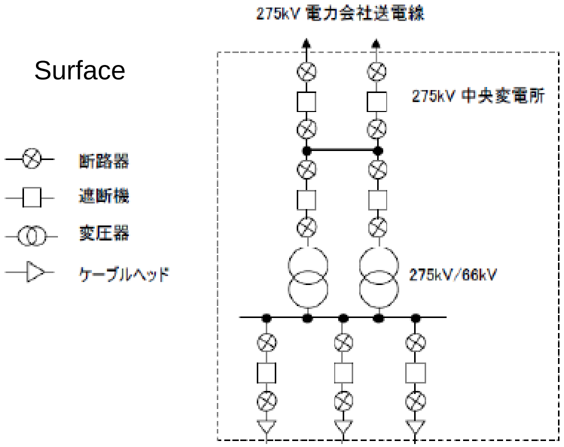
TABLE 4.3-1
Estimated nominal power loads (MW) for 500 GeV centre-of-mass operation.

Area System	RF Power	Conventional Power: Conv	NC Magnets	Water Systems	Cryo	Emer Power	Total (by area)
Sources e^-	1.05	1.19	0.73	1.27	0.46	0.06	4.76
Sources e^+	4.11	7.32	8.90	1.27	0.46	0.21	22.27
DR	14.0	1.71	7.92	0.66	1.76	0.23	26.29
RTML	7.14	3.78	4.74	1.34	0.0	0.15	17.14
Main Linac	75.72	13.54	0.78	9.86	33.0	0.4	134.21
BDS	0.0	1.11	2.57	3.51	0.33	0.20	7.72
Dumps	0.0	3.83	0.0	0.0	0.0	0.12	3.95
Totals (by system)	102.0	32.5	25.6	17.9	36.9	1.4	216.3

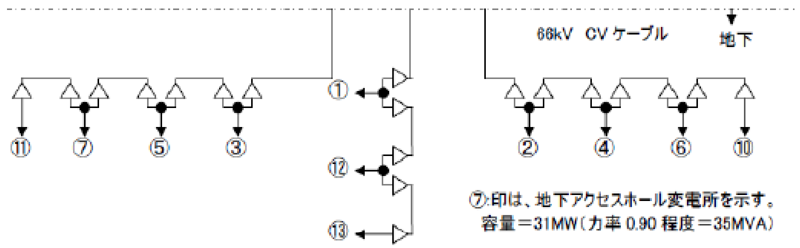
Electricity Distribution

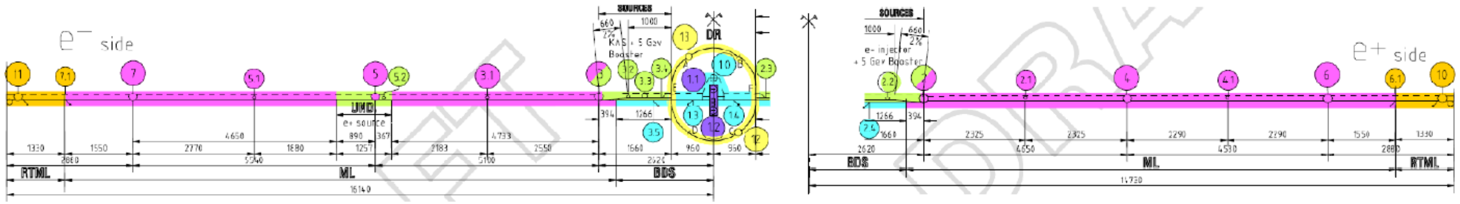
- 66 kV High Voltage Line Along The Site (Asian Regional Plan) -

Surface



Service Tunnel (RDR) / Main Tunnel (SB2009)





AREA		TOTAL	11	RTML	ML-7A	7	ML-7B	ML-5A	UND	5	ML-5B	ML-3A	3	KAS+5GV	BDS	1	BDS	13	DR	12	e-Inj+5GeV	2	ML-2A	ML-4B	4	ML-4A	ML-6B		ML-6A	RTML
Length					1550		2480	2167	1257		2246	2476		1266	960		960				1266		2476	2171		2095	2480		1550	
Total site power (max)																														
Total site power (@500GeV)		223.7		8.6	7.7	6.8	12.3	10.7	17.5	6.8	11.1	12.3	3.4	4.9	5.7	0.3	5.7	13.1	0.0	13.1	4.9	3.4	12.3	10.7	6.8	10.4	12.3	6.8	7.7	8.6
				8.6		26.7				46.2			20.6			11.7						20.6			27.9			26.7		8.6
1.3-GHz SCRF unit																														
no.				16	40		64	56			58	64		8							8		64	56		54	64		40	16
AC plug-in (max)	MW	98.3		2.59	6.47		10.35	9.06			9.38	10.35		1.29							1.29		10.35	9.06		8.73	10.35		6.47	2.59
AC plug-in (@500GeV)	MW	89.9		2.37	5.92		9.47	8.28			8.58	9.47		1.18							1.18		9.47	8.28		7.99	9.47		5.92	2.37
Conventional	MW	14.7		0.39	0.97		1.55	1.35			1.40	1.55		0.19							0.19		1.55	1.35		1.31	1.55		0.97	0.39
NC magnets	MW	0.8		0.02	0.06		0.09	0.08			0.08	0.09		0.01							0.01		0.09	0.08		0.08	0.09		0.06	0.02
Water system	MW	10.7		0.28	0.70		1.13	0.99			1.02	1.13		0.14							0.14		1.13	0.99		0.95	1.13		0.70	0.28
Emergency	MW	0.4		0.01	0.03		0.05	0.04			0.04	0.05		0.01							0.01		0.05	0.04		0.04	0.05		0.03	0.01
Cryogenic plant																														
no.						2				2			1	1		1		1		1	1	1			2			2		
Installed power (max)	MW	47.6				8.70				8.70			4.35	0.59		0.41		1.26		1.26	0.59	4.35			8.70			8.70		
Operation power (@500MeV)	MW	36.9				6.78				6.78			3.39	0.46		0.33		0.88		0.88	0.46	3.39			6.78			6.78		
Others																														
RF	MW	19.5		1.20					3.06					0.00				7.00		7.00	0.00									1.20
Conventional	MW	17.8		1.50					6.13					1.00	2.47		2.47	0.86		0.86	1.00									1.50
NC magnets	MW	24.8		2.35					8.17					0.72	1.29		1.29	3.96		3.96	0.72									2.35
Water system	MW	7.2		0.39										1.13	1.76		1.76	0.33		0.33	1.13									0.39
Emergency	MW	0.9		0.06					0.15					0.05	0.16		0.16	0.12		0.12	0.05									0.06

Area System Heat-load (RDR)

TABLE 4.5-1
Summary of heat loads broken down by Area System.

Area System	LCW (MW)	Chilled Water (MW)	Total (MW)
Sources e^-	2.880	1.420	4.300
Sources e^+	17.480	5.330	22.810
DR e^-	8.838	0.924	9.762
DR e^+	8.838	0.924	9.762
RTML	9.254	1.335	10.589
Main Linac	56.000	21.056	77.056
BDS	10.290	0.982	11.272
Dumps	36.000	0.000	36.000
Total Heat Load (MW)			182

ML Components' Heat-load (RDR)

TABLE 4.5-2
Typical Main Linac RF component heat loads.

Components	Tunnel	Total (KW)	Average (kW)	To Water (KW)	To Air (KW)
RF Charging Supply 34.5 KV AC-8 KV DC	service	4.0	4.0	2.8	1.2
Switching power supply 4kV 50kW	service	7.5	7.5	4.5	3.0
Modulator	service	7.5	7.5	4.5	3.0
Pulse transformer	service	1.0	1.0	0.7	0.3
Klystron socket tank / gun	service	1.0	1.0	0.8	0.2
Klystron focusing coil (solenoid)	service	4.0	4.0	3.6	0.4
Klystron collector/ body/windows	service	58.9	47.2	45.8	1.4
Relay racks (instrument racks)	service	10.0	10.0	0.0	-1.5
Circulators, attenuators & dummy load	beam	42.3	34.0	32.3	1.7
Waveguide	beam	3.9	3.9	3.5	0.4
Subtotal Main Linac RF unit (KW)			120		

ML Cooling System (RDR)

- Main Loops -

Process Water

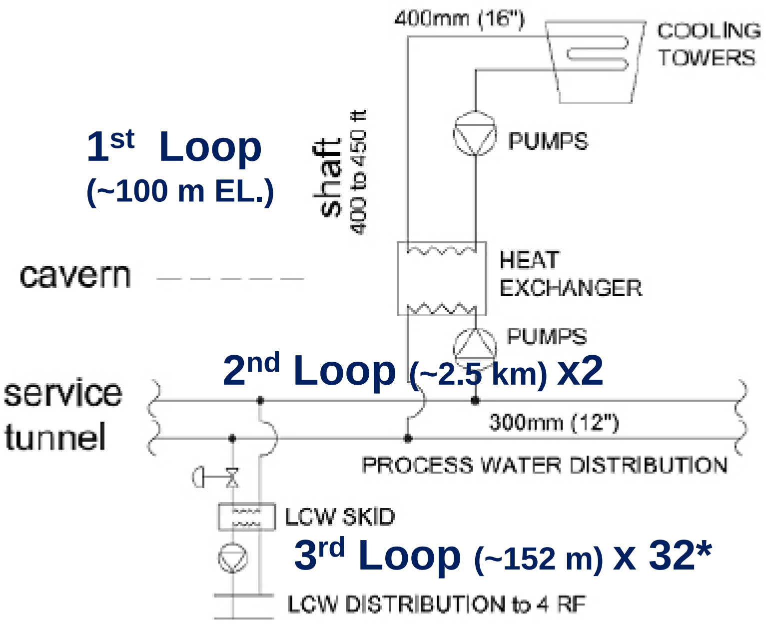


FIGURE 4.5-1. Process water system at shaft 7 plant.

Child Water

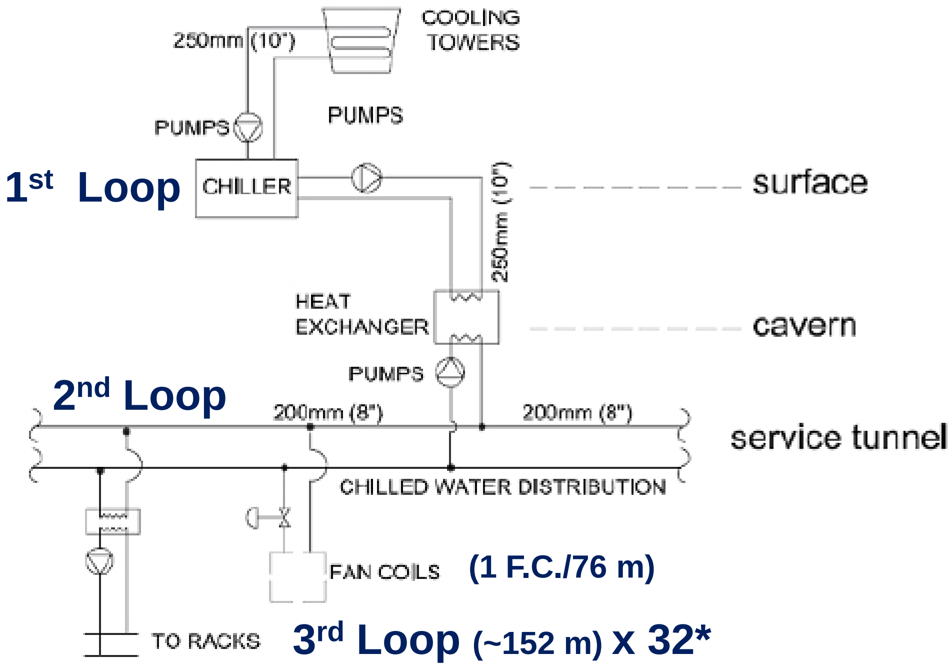


FIGURE 4.5-2. Chilled water system at shaft 7 plant.

***: max**

ML Heat-load Table (DRFS)

/ 2RF units

Sep 9 2009

WATER AND AIR HEAT LOAD for SB2009 DRFS Full Power Option

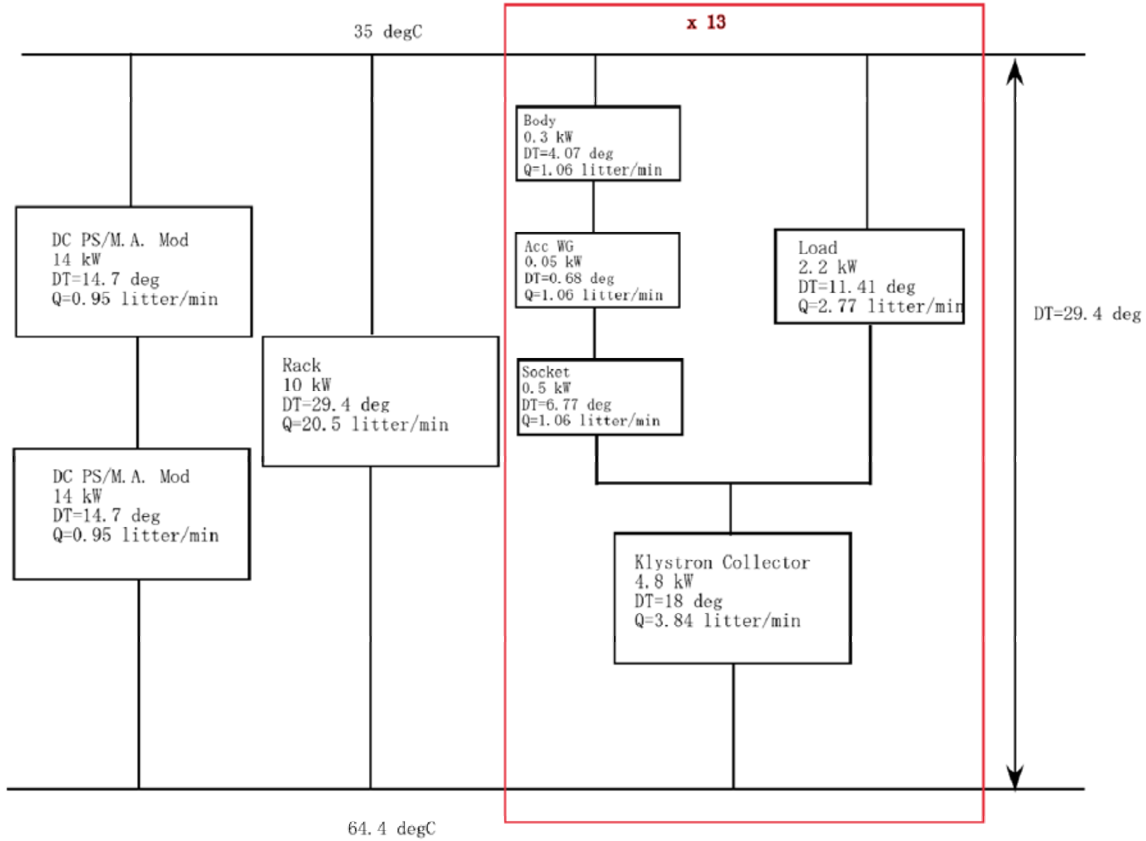
MAIN LINAC - ELECTRON & POSITRON

Components		Quantity Per 36m	Location	Total Heat Load (KW)	Average Heat Load (KW)	To Dirty Water: Heat Load to Water (KW)	To Dirty Water: Supply Temp (variation) (C)	To Dirty Water: Delta Temperature (C delta)	To Dirty Water: Water Flow (l / min)	To Dirty Water: Maximum Allowable Pressure (Bar)	To Dirty Water: Typical (water) pressure drop Bar	To Dirty Water: Acceptable Temp Variation delta C	To Low Conductivity Water: Heat Load to LCWater (KW)	Max Allowable Temperature (c)	Supply Temp (variation) (C)	Supply Temp (C)	Delta Temperature (C delta)	Water Flow (l / min)	Maximum Allowable Pressure (Bar)	Typical (water) pressure drop Bar	Acceptable Temp Variation delta C	to Chilled Water: Heat Load to Rack Chilled Water (KW)	keith Jobe load to air Nov 21 06: Power fraction to Tunnel Air (0-1)	keith Jobe load to air Nov 21 06: Power to Tunnel Air (KW)	To Fan Coil Chilled Water: Heat Load to Fan Coil Chilled Water (KW)	Max Space Temp (C)
Non-RF Components																										
LCW Skid Pump 1 per 4 rf -Motor/Feeder Loss		0.25	Service Tunnel	0.60	0.60	0.00	N/A	N/A		N/A	N/A	None	o	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	o	1.00	0.60	0.60	
I^2R Loss and Motor Loss (misc)		1	Service Tunnel	0.00	23.39								o	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	o	1.00	23.39	12.00	
Fancoils (5 ton Chilled Water) 1.5 Hp		2	Service Tunnel	2.91	2.91	0.00	N/A	N/A		N/A	N/A	None	o	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	o			2.91	
Rack Water Skid		0.25	Service Tunnel	0.20	0.20	0.00	N/A	N/A		N/A	N/A	None	o	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	o	1.00	0.20	0.20	
Lighting Heat Dissipation ~1.3W/sf			Service Tunnel	1.65	1.65	0.00	N/A	N/A		N/A	N/A	None	o	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	o	1.00	1.65	1.65	
AC Pwr Transformer 34.5-.48 kV		0.25	Service Tunnel	2.00	2.00	~~0.00~~	N/A	N/A		N/A	N/A	None	1.50			35					None	o	0.25	0.50	2.00	
Emerg. AC Pwr Transformer 34.5-.48 kV			Service Tunnel	1.00	1.00	0.00	N/A	N/A		N/A	N/A	None	o	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	o	1.00	1.00	1.00	
RF Components																										
--- High Voltage Circuit Breaker (6.6 kV) ---		1/76 m	Single Tunnel																							
DC Power Supply, 6.6 kV (In), 60 kV, 4 A (Out), 250 kW, 90% eff.	Rack 1	1/76 m	Single Tunnel		25.00								15.00	50.00								0.00	0.40	10.00	10.00	
DC Power Supply, 6.6 kV (In), 60 kV, 4 A (Out), 250 kW, 90% eff. (Backup)	Rack 2	1/76 m	Single Tunnel																							
Modulating Anode Modulator, 6.6 kV (Shunt 1.0 A, then 6 kW heat load)	Rack 3	1/76 m	Single Tunnel		6.00								3.60	50.00								0.00	0.40	2.40	2.40	
Modulating Anode Modulator, 6.6 kV (Shunt 1.0 A, then 6 kW heat load), (Back-up)	Rack 4	1/76 m	Single Tunnel																							
--- AC Transformer to Low Voltage (400/200/100 V) ---		1/152 m																								
Heater P/S, 200V,36A, 7.2kW	Rack 3	1/76 m	Single Tunnel		1.00									50.00								1.00	0.00	0.00	0.00	
Same as above (Back-up)	Rack 4	1/76 m	Single Tunnel																							
Pulse Transformer		None																								
Klystron Socket Tank / Gun 0.3 kW X 26		26/76 m	Single Tunnel		7.80								6.24	60.00								0.00	0.20	1.56	1.56	
Klystron Focusing x 26 (Permanent Magnet)		26/76 m			[illegible]																					
Klystron Collector 4.5 kW X 26		26/76 m	Single Tunnel		117.00								113.49	87.00								0.00	0.03	3.51	3.51	85 F (a)
Klystron Body & Windows		26/76 m	Single Tunnel		7.52								5.51	40.00								o				
--- LLRF Racks ---																										
LLRF+Amp +Int, 200V,2.5A /5 modules	Rack 5	1/76 m	Single Tunnel		0.35									50.00								0.35	0.00	0.00	0.00	
LLRF+Amp +Int, 200V,2.5A /5 modules	Rack 6	1/76 m	Single Tunnel		0.35									50.00								0.35	0.00	0.00	0.00	
LLRF+Amp +Int, 200V,1.5A /3 modules	Rack 7	1/76 m	Single Tunnel		0.21									50.00								0.21	0.00	0.00	0.00	
(LLRF+Amp +Int, 200V,1.5A /3 modules, for full power op.)	Rack 7	1/76 m	Single Tunnel		0.21									50.00								0.21	1.00	0.21	0.21	
(LLRF+Amp +Int, 200V,2.5A /5 modules, for full power op.)	Rack 8	1/76 m	Single Tunnel		0.35									50.00								0.35	2.00	0.70	0.70	
(LLRF+Amp +Int, 200V,2.5A /5 modules, for full power op.)	Rack 9	1/76 m	Single Tunnel		0.35									50.00								0.35	3.00	1.05	1.05	
--- Other Racks ---																										
Timing , 200V,0.5kW	Rack 10	1/76 m	Single Tunnel		0.50									50.00								0.50	0.00	0.00	0.00	
Timing , 200V,0.5kW	Rack 11	1/76 m	Single Tunnel		0.50									50.00								0.50	0.00	0.00	0.00	
Cavity , 200V,3 kW	Rack 12	1/76 m	Single Tunnel	2.95	2.05									50.00								2.05	0.00	0.00	0.00	
Cavity , 200V,3 kW	Rack 13	1/76 m	Single Tunnel	2.95	2.05									50.00								2.05	0.00	0.00	0.00	
Cryogenics, 200V, 2.1 kW	Rack 14	1/76 m	Single Tunnel		2.10									50.00								2.10	0.00	0.00	0.00	
Cryogenics, 200V, 2.1 kW	Rack 15	1/76 m	Single Tunnel		2.10									50.00								2.10	0.00	0.00	0.00	
BPM & Mag, 200V, 5 kW	Rack 16	1/76 m	Single Tunnel		5.00									50.00								5.00	0.00	0.00	0.00	
BPM & Mag, 200V, 5 kW	Rack 17	1/76 m	Single Tunnel		5.00									50.00								5.00	0.00	0.00	0.00	
--- RF Loads ---																										
Attenuator		None																								
Waveguides in service tunnel		None																								
Waveguides in penetration		None																								
Waveguides in beam tunnel		26/76 m	Single Tunnel		1.60								0.00									0.00	1.00	1.60	1.60	
Circulator with load		None																								
RF Loads		26/76 m	Single Tunnel		45.60								44.23										0.03	1.37	1.37	
--- Other Loads ---																										
Pulse motor for input coupler/tuner		(26+26)/76 m		1.79	0.00																		1.00	0.00	0.00	
Vacuum Pumps		(2+2)/76 m			1.26																		1.00	1.26	1.26	
Subtotal RF unit Only					233.90								188.07									22.12			23.66	
Total RF						0.0																				

DRFS Heat load estimeted in September 2009

11:30-12:00 Shigeki Fukuda, HLRF Requirements

DRFS Local Cooling Scheme

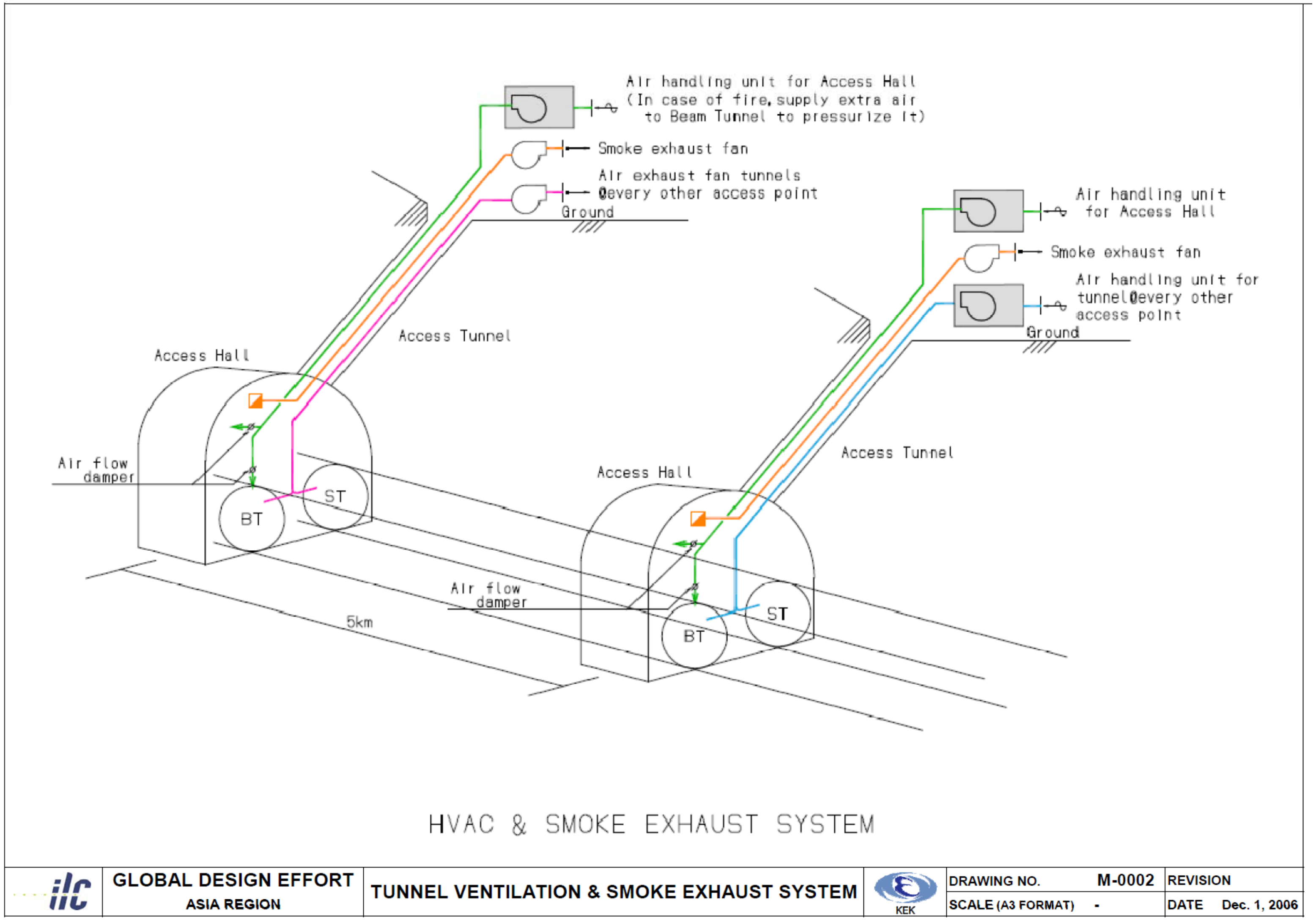


Basic configuration not changed
ΔT optimization will be done in TDP2

11:30-12:00 Shigeki Fukuda, HLRF Requirements

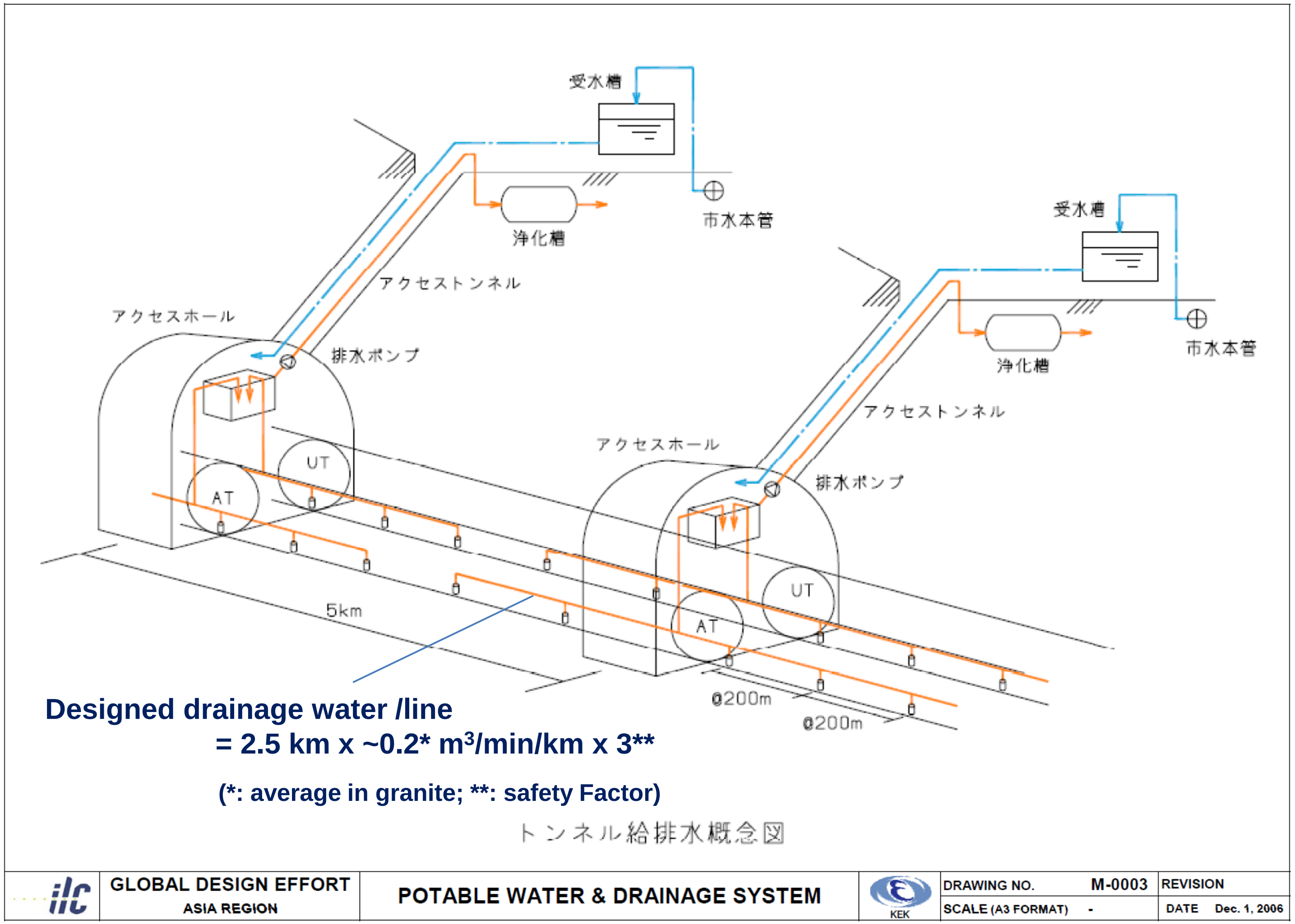
HVAC System

- Heating, Ventilation, and Air-Conditioning system design (RDR, Asia) -



Drainage System

- Drainage system design (RDR, Asia) -



Designed drainage water /line
= 2.5 km x ~0.2* m^3/min/km x 3**

(*: average in granite; **: safety Factor)

13:30-15:30 Masanobu Miyahara,

Boundary conditions and guidelines for design works

MOUNTAINOUS SITE FEATURES & CIVIL ENGINEERING

General Requirements for ILC Sites

- Uniform geology
- Tunnel depth < 600m
- Avoid residential area, because
- hard to get acknowledgement from the inhabitants from the view
- point of radiation problem and public construction
- Avoid active fault
- Avoid major epicenters (M>7) having taken place since 1,500
- Avoid large fault (W > 1m),
- especially those running parallel to the tunnel route
- Enough electric power supply
- We need about 350 MW
- Enough length to accommodate 50km tunnel
- Examined on 51 items for each candidate site

Site candidates for JLC (2000-2003)

KEK Report 2002-10, Report of JLC Site Study Group, page 9.

Site Candidates in Japan

I. Area with good geology

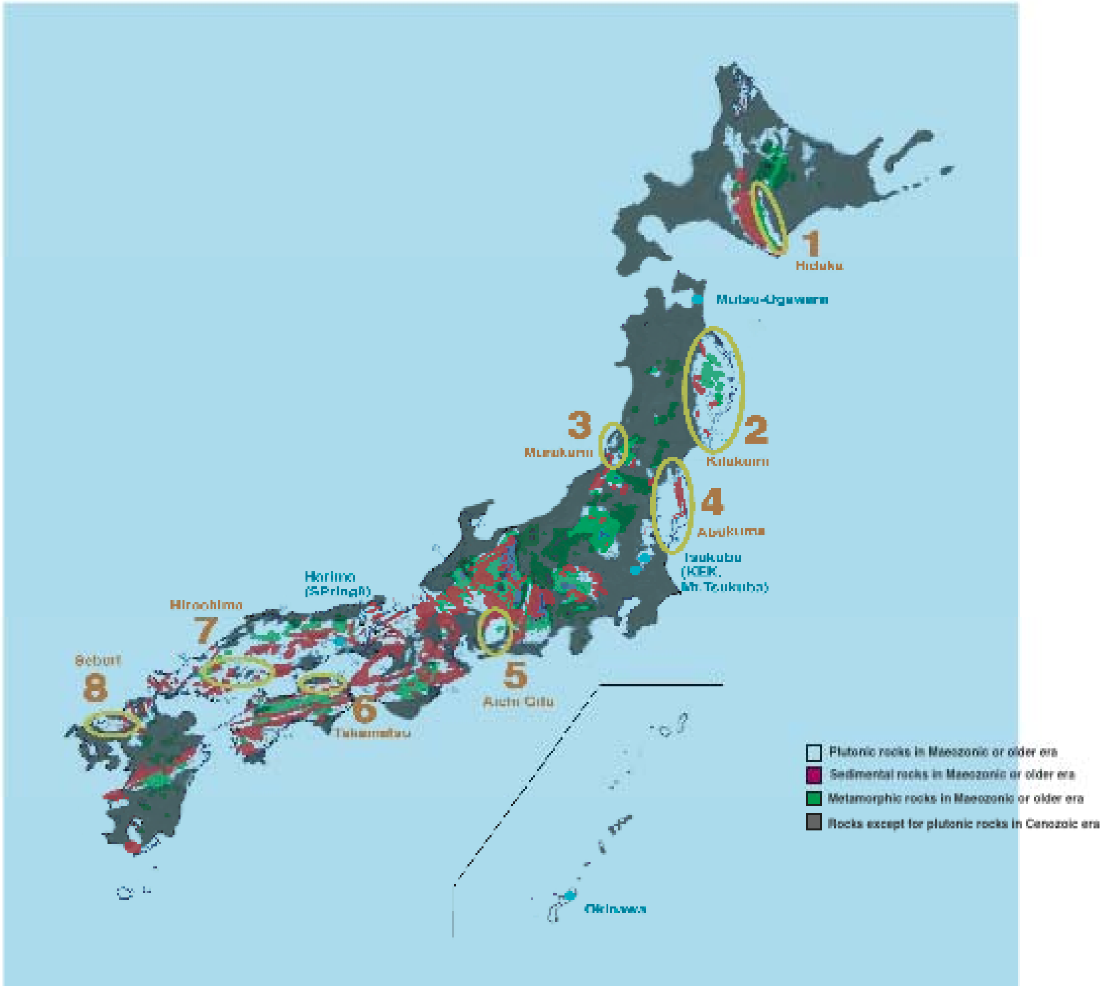
1. Hidaka
2. Kitakami
3. Murakami
4. Abukuma

4b Kita-Ibaraki

5. Aich-Gifu
6. Takamatsu
7. Hiroshima
8. Seburi

II. Research and development bases

1. Mutsu-Ogawara
2. Tsukuba (KEK)
3. Mt. Tsukuba
4. Harima (SPring-8)
5. Okinawa



KEK Report 2002-10, Report of JLC Site Study Group, page 9.

Geology

Mainly granite geology through 50-km length

Geotechnical Review 2006

- Site Assessment Working Group –

(Japan Society of Civil Engineers)

Topography

- low mountain chain -

Access to Underground Tunnel

- By Horizontal (Sloped) Tunnel s-

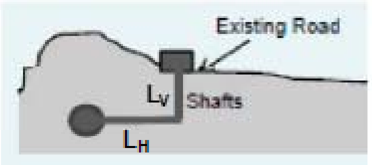
Case	Access way	Schematic Layout
RDR	Sloped Tunnel	

Sloped Tunnel Length (m) and Cost (kY)

Point ID	A	B	C	D
P11	1,215	502	1,608	1,859
P7	1,565	1,256	1,005	1,407
P5	1,577	2,161	1,507	1,708
P3	1,713	2,663	1,206	2,613
P12	1,501	2,563	904	1,960
P13	1,403	2,764	854	1,909
P2	1,157	3,467	1,005	2,311
P4	653	3,668	1,005	2,211
P6	938	3,467	1,658	2,211
P10	771	1,960	703	1,909
Total (m)	12,493	24,471	11,455	20,098

Access to Underground Tunnel

- By Shafts and Horizontal Tunnel s-



Horizontal Tunnel (L_H) and Vertical Shaft (L_V)

	A		B		C		D	
Point ID	L_H (m)	L_V (m)	L_H (m)	L_V (m)	L_H (m)	L_V (m)	L_H (m)	L_V (m)
P11	0	140	150	90	575	205	750	240
P7	560	220	50	410	300	100	80	210
P5	526	210	150	645	300	140	830	260
P3	1,330	170	150	490	0	190	450	380
P2	130	70	730	345	0	80	500	350
P4	180	100	500	430	205	140	490	260
P6	140	100	1,350	485	940	230	250	390
P10	100	80	1,375	290	240	70	480	220
P12	0	110	700	445	400	110	320	270
P13	370	130	400	445	540	100	570	260
	3,336	1,330	5,555	4,075	3,500	1,365	4,720	2,840

Boundary conditions and guidelines for design works

PRELIMINARY STUDY FOR TDP2

BY

CONVENTIONAL FACILITY WORKING GROUP

ADVANCED ACCELERATOR ASSOCIATION PROMOTING SCIENCE AND TECHNOLOGY

Single-Tunnel Accelerator Configuration

- Guideline for Design in Asian Region -

Keypoints for TDP2 Design Concepts

Cost Reduction from RDR

- (Deep) Single-Tunnel Accelerator Configuration

Should be harmonized with

Applicability to Site and Environmental Conservation

- Less surface facilities and plants

Life Safety / Accessibility to Underground Accelerator

- Enough evacuation / access passages

Risk reduction for tunnel excavation

- Heading for the main accelerator tunnel

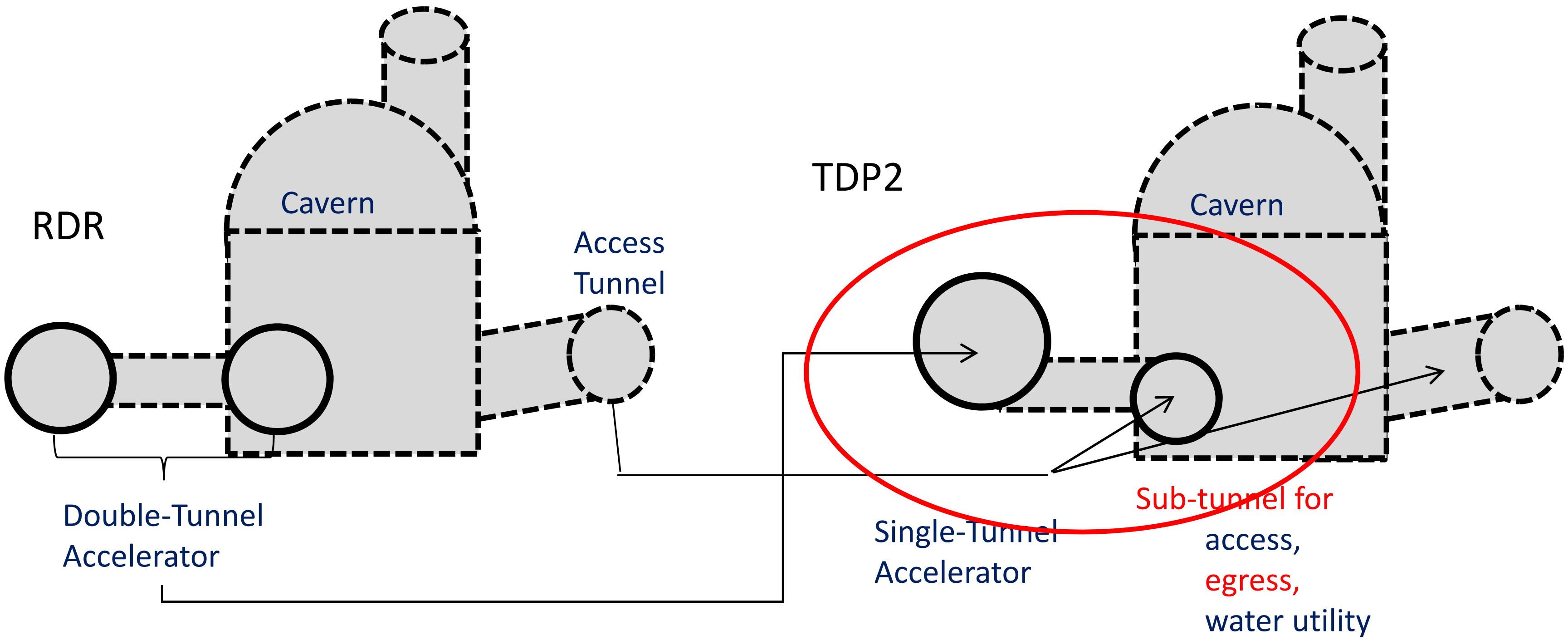
Advantage of Topology

- Spontaneous drainage of sump water

10:30-11:00 Masakazu Yoshioka, CF Concepts

Single-Tunnel Accelerator Configuration

- Basic Design Concepts in Asian Region -

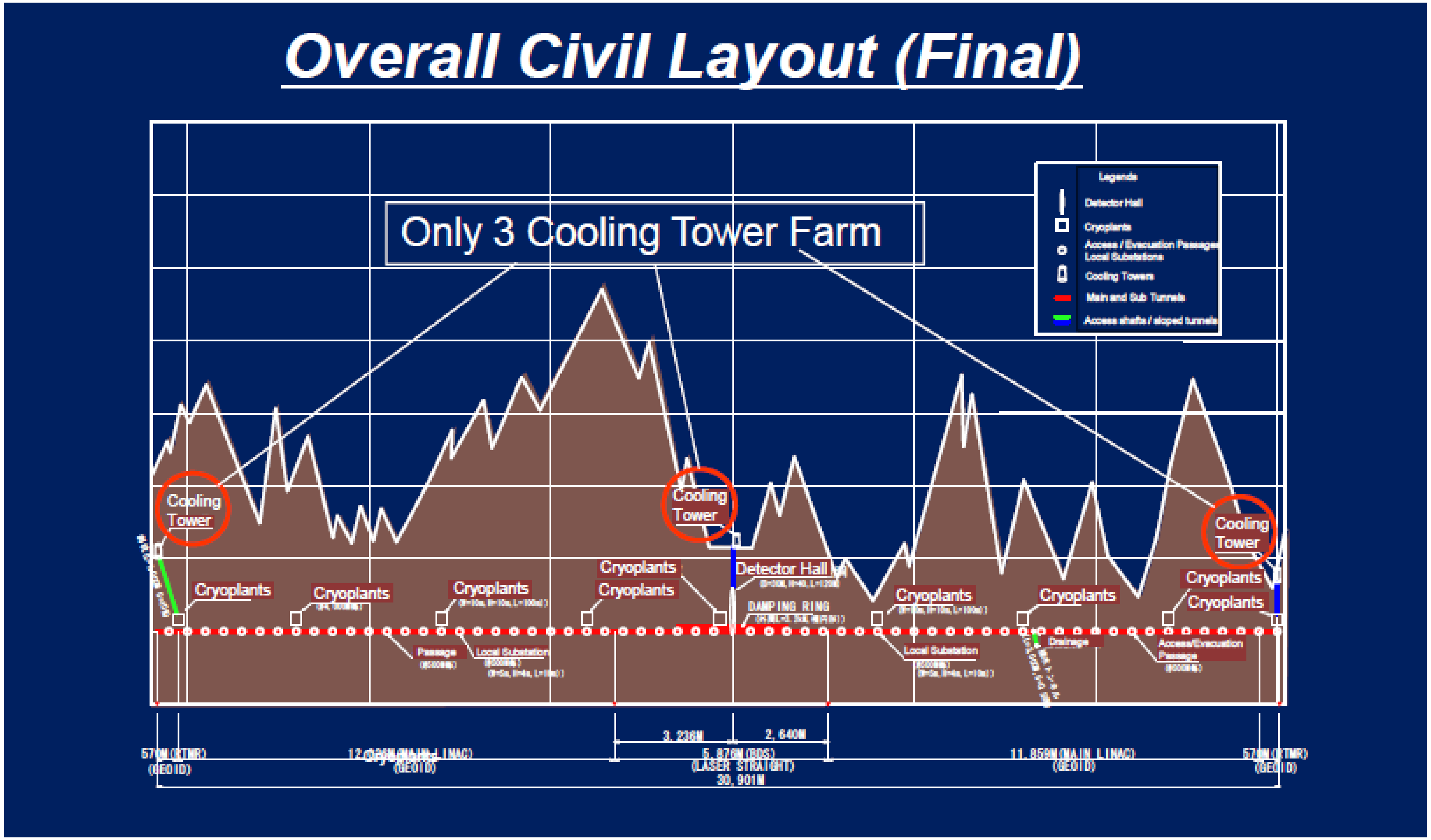


RDR
2-Tunnel + Access Tunnel/Shaft Configuration

SB2009
1.5-Tunnel + Access Tunnel/Shaft Configuration

Site Layout Example

- Asian Region-



13:30-15:30 **Masanobu Miyahara**

Boundary conditions and guidelines for design works

SUMMARY

Summary

- RDR demonstrated a realistic ILC design based on a sample site and a construction cost.
- Cost containment is a primary concept in TDR.
- Single-tunnel accelerator configuration is one of the working assumptions for such a request.
- A single-tunnel accelerator configuration which meets the Asian potential sites' conditions is under investigation.

Boundary conditions and guidelines for design works

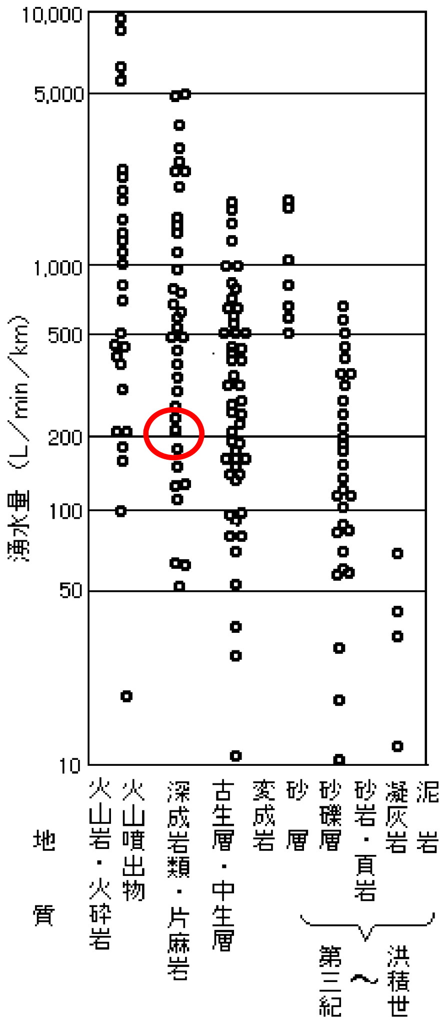
APPENDIX

Drainage System

- Sump water and Geology in Japan-

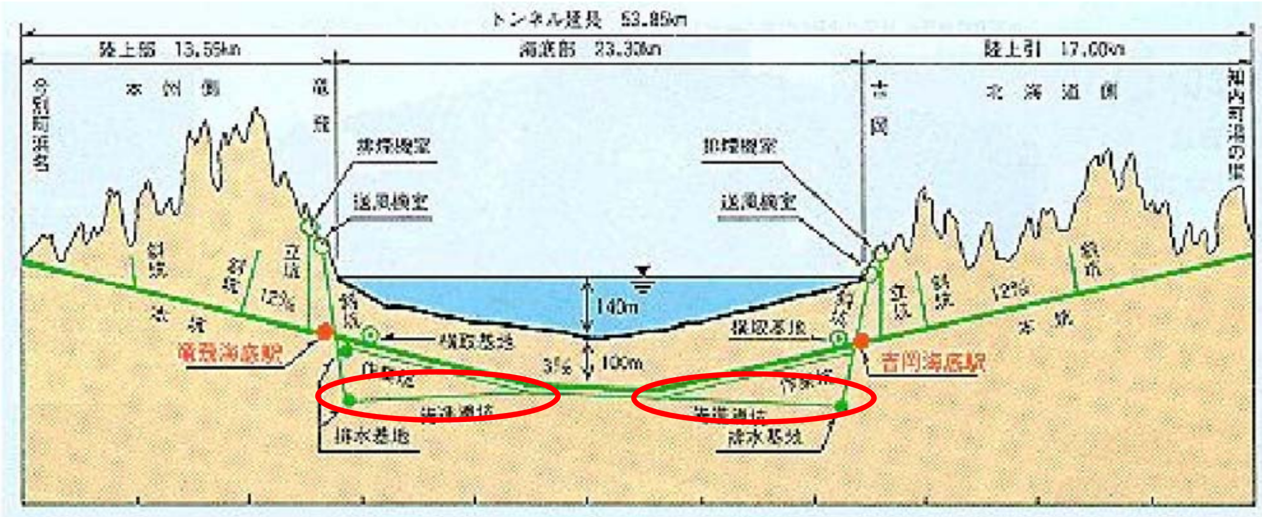
地質分類		比湧水量の範囲 m^3/min/km	平均比湧水量 m^3/min/km
火山岩、火山砕屑岩		0.85 ～ 10	3.71
		0.035 ～ 0.9	0.30
深成岩類（含片麻岩）		0.17 ～ 3.8	1.38
		0.018 ～ 0.84	0.20
古生層、中生層		0.10 ～ 4.5	0.79
		0.0 ～ 0.95	0.17
第三紀—洪積世	砂礫層	0.02 ～ 3.6	0.84
	砂岩・頁岩・凝灰岩	0.014 ～ 0.95	0.25
	泥岩	0.0 ～ 0.26	0.07

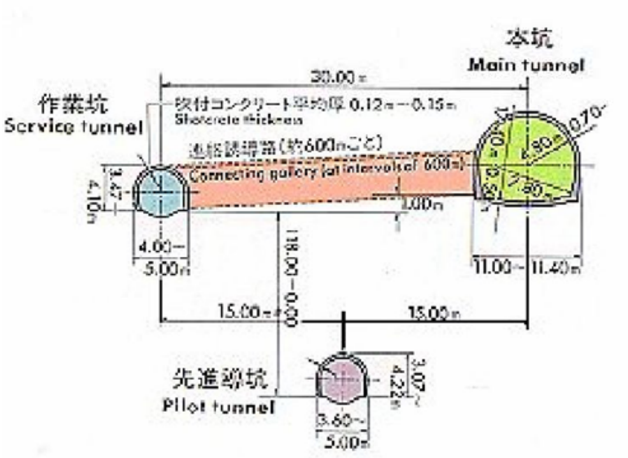
（出典：（社）日本トンネル技術協会『トンネル施工に伴う湧水渇水に関する調査研究（その２）報告書』昭和 58 年 2 月）



Drainage System

- An Example of Drainage Tunnel in Japan-





海底部標準断面図(単位:m)

排水設備

名称	ポンプ1	ポンプ2	ポンプ3
位置	竜飛 作業坑	竜飛 斜坑	吉岡 斜坑
排水量(ポンプ室への流水量)	19m3/分	8m3/分	16m3/分
ポンプ台数	10m3/分×3	9m3/分×3	12m3/分×6

Tunneling

- Rock hardness and Geology-

表－　岩の分類と判定基準

metamorphic　sedimentary　igneous

Paleozoic　Mesozoic

sandstone　limestone　granite

weathered　fresh

~40 MPa　~80 MPa　~120 MPa　~160 MPa　~200 MPa

名称 A	名称 B	名称 C	説明	適用	国土交通省岩分類	岩種グループ別
岩または石	岩塊玉石	岩塊玉石	岩塊、玉石が混入して掘削しにくく、バケット等に空隙のでき易いもの 岩塊、玉石は粒形7.5cm以上としまるみのあるものを玉石とする。	玉石まじり土 岩塊起砕された岩 ごろごろした河床		
	軟岩	軟岩Ⅰ	第三紀の岩石で固結の程度が弱いもの、風化がはなはだしくきわめて脆いもの、指先で離しうる程度のもので亀裂の間隔は1～5cmくらいのもの及び第三紀の岩石で固結の程度が良好なもの、風化が相当進み多少変色を伴い軽い打撃で容易に割れるもの、離れやすいもので、亀裂間隔は5～10cm程度のもの	地山弾性波速度 700～2800m/sec	軟岩Ⅰ	A / B
		軟岩Ⅱ	凝灰質で堅く固結しているもの、風化が目にそって相当進んでいるもの、亀裂間隔が10～30cm程度で軽い打撃により離しうる程度、異質の硬い異層をなすもので層面を楽に離しうるもの		軟岩Ⅱ	A / B
	硬岩	中硬岩	石灰岩、多孔質安山岩のように、特にち密でなくても相当な堅さを有するもの、風化の程度があんまり進んでいないもの、硬い岩石で間隔30～50cm程度の亀裂を有するもの	地山弾性波速度 2000～4000m/sec	中硬岩	A / B
		硬岩Ⅰ	花崗岩、結晶変岩等で全く変化していないもの、亀裂間隔が1m内外で相当密着しているもの、硬い良好な石材を取り得るようなもの	地山弾性波速度 3000m/sec以上	硬岩Ⅰ	A / B
		硬岩Ⅱ	けい岩、角岩などの石英質に富む岩石で最も硬いもの、風化していない新鮮な状態のもの、亀裂が少なく、よく密着しているもの		硬岩Ⅱ	A

国土交通省岩分類	岩種グループ別	変成岩および堆積岩										堆積岩								火成岩									
		主として古生代										中世代				第三紀				深成岩					火山岩				
		片麻岩	砂質片岩	黒色片岩	緑色片岩	千枚岩	珪岩・角岩	石灰岩	砂岩	粘板岩	輝緑凝灰岩	粘板岩	頁岩	砂岩	れき岩	頁岩泥岩	砂岩	凝灰岩	凝灰角礫岩	花こう岩	せん緑岩	ハンレイ岩	カンラン岩	蛇紋岩	流紋岩	ヒン岩	安山岩	玄武岩	集塊岩
軟岩Ⅰ	A	●			●			●	●		●			●	●		▲ △			● ▲	●			● ▲	●		●	●	
軟岩Ⅰ	B			△		●				● ▲		● ▲	▲			△ ○		● ▲	● ▲										▲ △
軟岩Ⅱ	A	▲	● ▲		● ▲		●	▲ △	▲		▲			▲	▲ △		○ ◎			▲ ▲	▲	● ▲	● ▲	△ ○	▲	● ▲	▲	▲	
軟岩Ⅱ	B			○		▲				▲ △	△	▲ △	△			◎		△ ○	△ ○										○ ◎
中硬岩	A	△	▲ △		△		▲	○ ◎	△		△	△	○	△	○ ◎					▲ ○	△ ○	△ ○	△ ○	◎	△	△	△	△	
中硬岩	B			◎		△				△ ○	○	◎	◎					◎	◎										
硬岩Ⅰ	A	○ ◎	△ ○		○ ◎		○		○		○			○ ◎						◎	◎	◎	◎		○ ◎	○ ◎	○ ◎	○ ◎	
硬岩Ⅰ	B					○ ◎				◎																			
硬岩Ⅱ	A		◎				○ ◎		◎																				

● 全体に変化が進み変色しているもの。
▲ 割れ目に沿って幅広く風化しているが球状、レンズ状に未風化部を残すもの。
△ 割れ目に沿って風化変色が少なく、岩片内部は新鮮なもの。
○ 割れ目が少なく風化変色がほとんどなく新鮮で硬いもの。
◎ 岩石が特に硬く全く新鮮なもの。

＊　Aグループは、花崗岩・安山岩・砂岩・珪岩のように、造岩物質、固結度共に固く、風化が進み、亀裂が入って、弾性波速度が遅くても、岩片耐圧強度の高い岩種類。
＊　Bグループは、頁岩・粘板岩・黒色片岩のように、造岩物質が軟らかく、風化が進むと泥化し新鮮なもので弾性波速度が早くても、岩片耐圧強度の低い岩種類。
注)　輝緑凝灰岩は、地質資料によっては玄武岩質火山噴出物（火砕岩、溶岩）と呼称される。