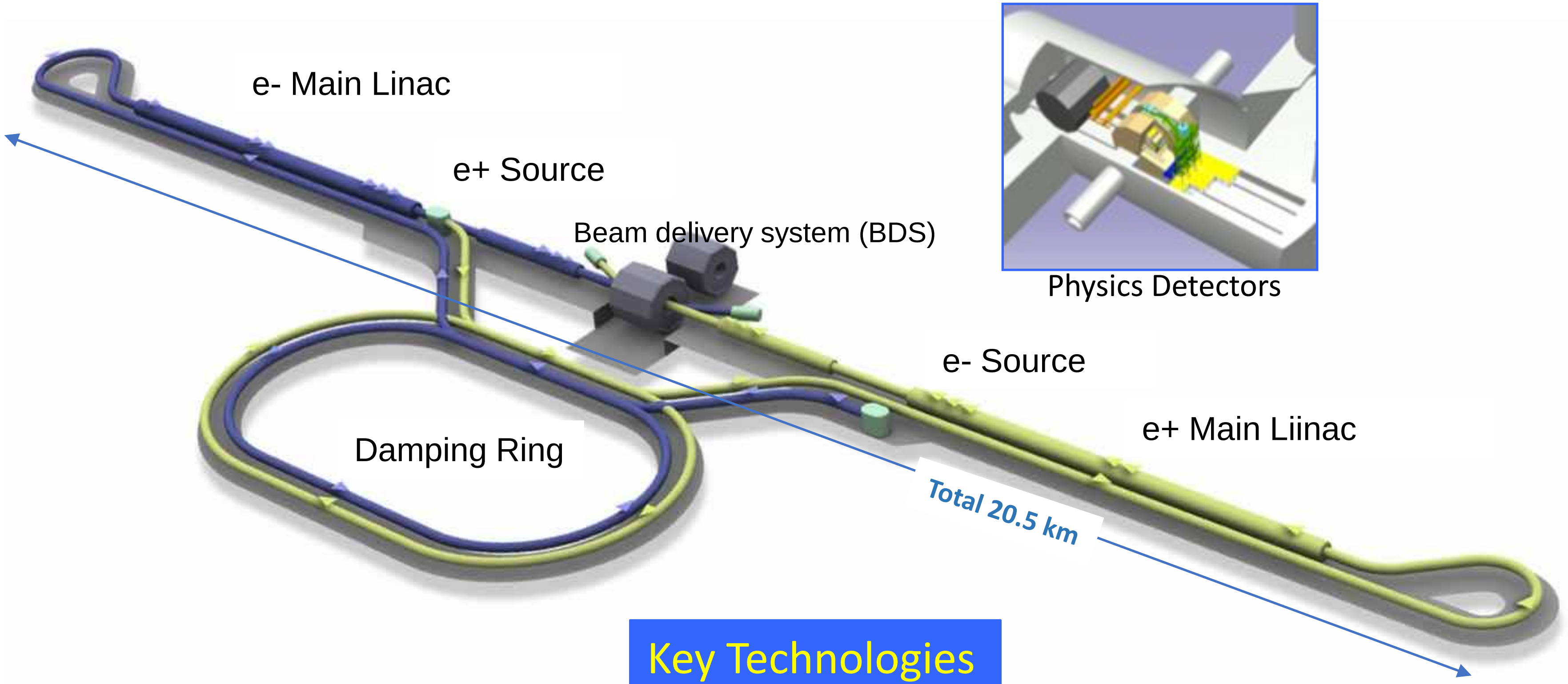
ILC status

Shin MICHIZONO

International Development Team (IDT) WG2/ KEK

- *ILC250 accelerator overview*
- *ILC area systems*
    - *Sources*
    - *Nano-beam*
    - *SRF*
- *Civil engineering*
- *International Development Team (IDT)*
- *Summary*

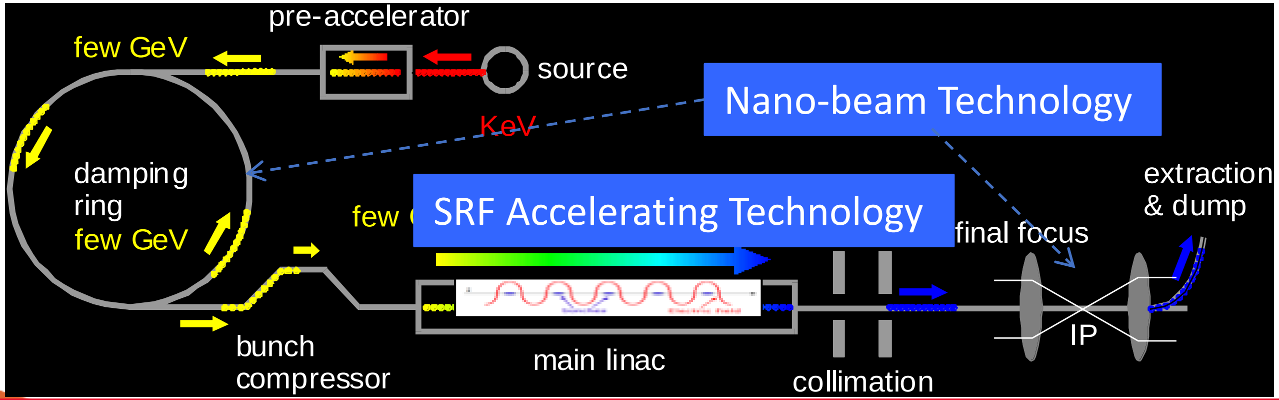
ILC250 accelerator facility



Physics Detectors

Item	Parameters
C.M. Energy	250 GeV
Length	20km
Luminosity	1.35 x10^{34} $cm^{-2}s^{-1}$
Repetition	5 Hz
Beam Pulse Period	0.73 ms
Beam Current	5.8 mA (in pulse)
Beam size (y) at FF	7.7 nm@250GeV
SRF Cavity G. Q_0	31.5 MV/m (35 MV/m) Q_0 = 1x10^{10}

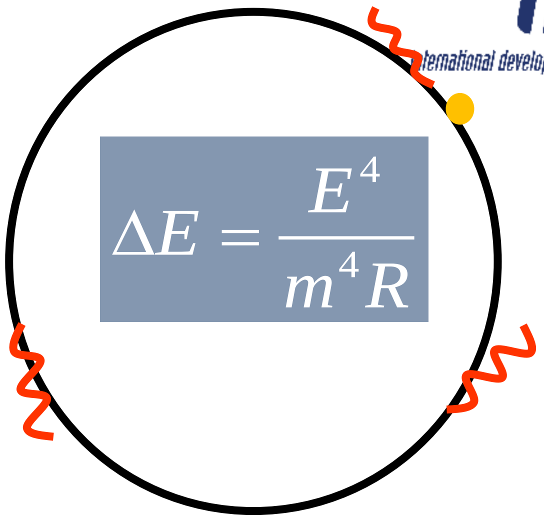
Key Technologies



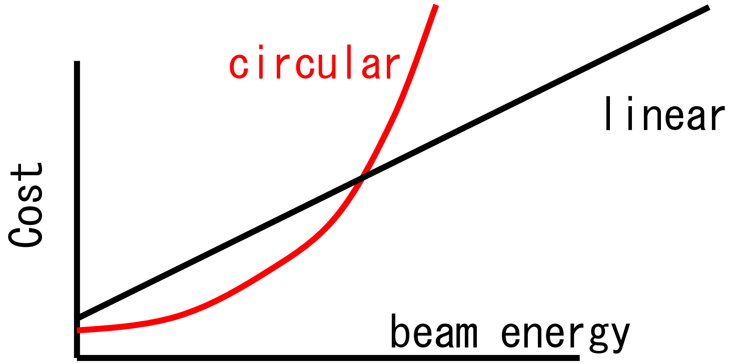

8,000 SRF cavities will be used.

Main advantages

- A linear accelerator is more advantageous for accelerating electron and/or positron beams to higher energies.
- The spin of the electron and/or positron beam can be maintained during the acceleration and collision. This can help significantly improve measurement precision.
- The small surface resistance of the SRF accelerating structure (cavity) made of Nb enables the efficient power transfer from the AC power source to the beam.
- Further energy efficiency improvements are considered as part of the of Green ILC concept, which aims to establish a sustainable laboratory.



Circulating beam loses energy by synchrotron radiation.
Linear collider can extend its collision energy by longer tunnel/ higher gradient.



Technical Maturity

- ILC based on superconducting radiofrequency (SRF) technology started its R&D from 2005 (GDE). Reference Design Report (RDR) was published in 2007 and TDR was published in 2013.
- More than 2,400 researchers contributed to the TDR.

- The SRF technology's maturity was proven by the operation of the European X-ray Free Electron Laser (X-FEL) in Hamburg, where 800 superconducting cavities (1/10 of ILC SRF cavities) were installed.
- In addition to European XFEL, LCLS-II at SLAC, SHINE in Shanghai are under construction.

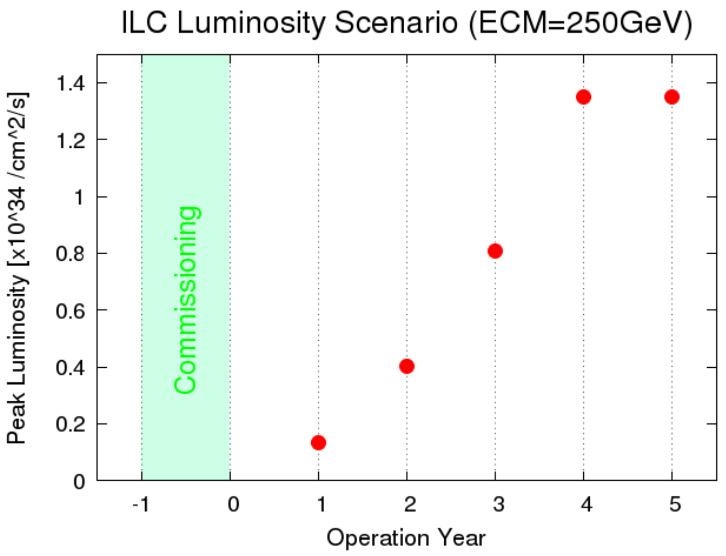
- Nano-beam technology has been demonstrated at ATF hosted in KEK under international collaboration and almost satisfied the requirements of the ILC.

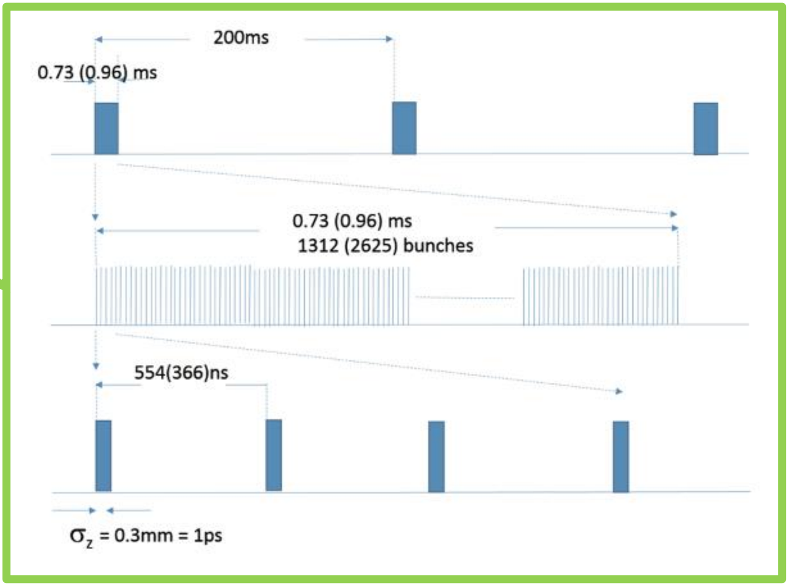
- Remaining technical preparation (such as mass-production of SRF cavities, positron source, beam dump) can be carried out during the preparation phase at Pre-lab before ILC construction. These are listed in "Recommendations on ILC Project Implementation".

ILC machine parameters

ILC	electron/positron	ILC250
Beam Energy	GeV	125 (e-) and 125 (e+)
Peak Luminosity (10^34)	cm-2 s-1	1.35
Int. Luminosity	ab-1/yr	0.24*
Beam dE/E at IP		0.188% (e-), 0.150% (e+)
Transv. Beam sizes at IP x/y	nm	515/7.66
Rms bunch length /	cm	0.03 (σ_z)
beta*	mm	bx*=13mm, by*=0.41mm
Crossing angle	mrad	14
Rep./Rev. frequency	Hz	5
Bunch spacing	ns	554
# of bunches		1,312
Length/Circumference	km	20.5
Facility site power	MW	111
Cost (value) range	$B US	~5 (tunnel and accelerator)
Timescale till operations	years	(~1) + 4(prep.) + 9(construction)

** 5,000-hour operation at peak luminosity*





Potential for upgrades

The ILC can be upgraded to higher energy and luminosity.

			Z-Pole [4]		Higgs [2,5]			500GeV [1*]		TeV [1*]
			Baseline	Lum. Up	Baseline	Lum. Up	L Up.10Hz	Baseline	Lum. Up	case B
Center-of-Mass Energy	E_{CM}	GeV	91.2	91.2	250	250	250	500	500	1000
Beam Energy	E_{beam}	GeV	45.6	45.6	125	125	125	250	250	500
Collision rate	f_{col}	Hz	3.7	3.7	5	5	10	5	5	4
Pluse interval in electron main linac		ms	135	135	200	200	100	200	200	200
Number of bunches	n_b		1312	2625	1312	2625	2625	1312	2625	2450
Bunch population	N	10^{10}	2	2	2	2	2	2	2	1.737
Bunch separation	Δt_b	ns	554	554	554	366	366	554	366	366
Beam current		mA	5.79	5.79	5.79	8.75	8.75	5.79	8.75	7.60
Average beam power at IP (2 beams)	P_B	MW	1.42	2.84	5.26	10.5	21.0	10.5	21.0	27.3
RMS bunch length at ML & IP	σ_z	mm	0.41	0.41	0.30	0.30	0.30	0.30	0.30	0.225
Emittance at IP (x)	γe^*_x	μm	6.2	6.2	5.0	5.0	5.0	10.0	10.0	10.0
Emittance at IP (y)	γe^*_y	nm	48.5	48.5	35.0	35.0	35.0	35.0	35.0	30.0
Beam size at IP (x)	σ^*_x	μm	1.118	1.118	0.515	0.515	0.515	0.474	0.474	0.335
Beam size at IP (y)	σ^*_y	nm	14.56	14.56	7.66	7.66	7.66	5.86	5.86	2.66
Luminosity	L	$10^{34}/cm^2/s$	0.205	0.410	1.35	2.70	5.40	1.79	3.60	5.11
Luminosity enhancement factor	H_D		2.16	2.16	2.55	2.55	2.55	2.38	2.39	1.93
Luminosity at top 1%	$L_{0.01}/L$	%	99.0	99.0	74	74	74	58	58	45
Number of beamstrahlung photons	n_g		0.841	0.841	1.91	1.91	1.91	1.82	1.82	2.05
Beamstrahlung energy loss	δ_{BS}	%	0.157	0.157	2.62	2.62	2.62	4.5	4.5	10.5
AC power [6]	Psite	MW			111	138	198	173	215	300
Site length	Lsite	km	20.5	20.5	20.5	20.5	20.5	31	31	40

Energy

Lumi.

Construction cost

ILC accelerator (including tunnel) construction cost is ~5 B$.

	TDR: ILC500 [B ILCU] (Estimated by GDE)	ILC250 [B ILCU]* (Estimated by LCC)	Conversion to: [B JPY] (Reported to MEXT/SCJ)
Accelerator Construction: sum	**n/a**	**n/a**	**635.0 ~ 702.8**
Value: sub-sum	7.98	4.78 ~ 5.26	515.2 ~ 583.0
Tunnel & building	1.46	1.01	111.0 ~ 129.0
Accelerator & utility	6.52	3.77 ~ 4.24	404.2 ~ 454.0
Labor: Human Resource	22.9 M person-hours (13.5 K person-years)	17.2 M person-hours (10.1 K person-years)	119.8
Detector Construction: sum	**n/a**	**n/a**	**100.5**
Value: Detectors (SiD+ILD)	0.315+0.392	0.315+0.392	76.6
Labor: Human Resource (SiD + ILD)	748+1,400 person-years	748+1,400 person-years	23.9
Operation/year (Acc.) : sum	**n/a**	**n/a**	**36.6 ~ 39.2**
Value: Utilities/Maintenance	0.390	0.290 ~ 0.316	29.0 ~ 31.6
Labor: Human Resource	850 FTE	638 FTE	7.6
Others (Acc. Preparation)	**n/a**	**n/a**	**23.3**
Uncertainty	**25%**	**25%**	**25%**
Contingency	**10%**	**10%**	**10%**
Decommission	**n/a**	**n/a**	**Equiv. to 2-year op. cost**

*1 ILCU= 1 US$ in 2012 prices

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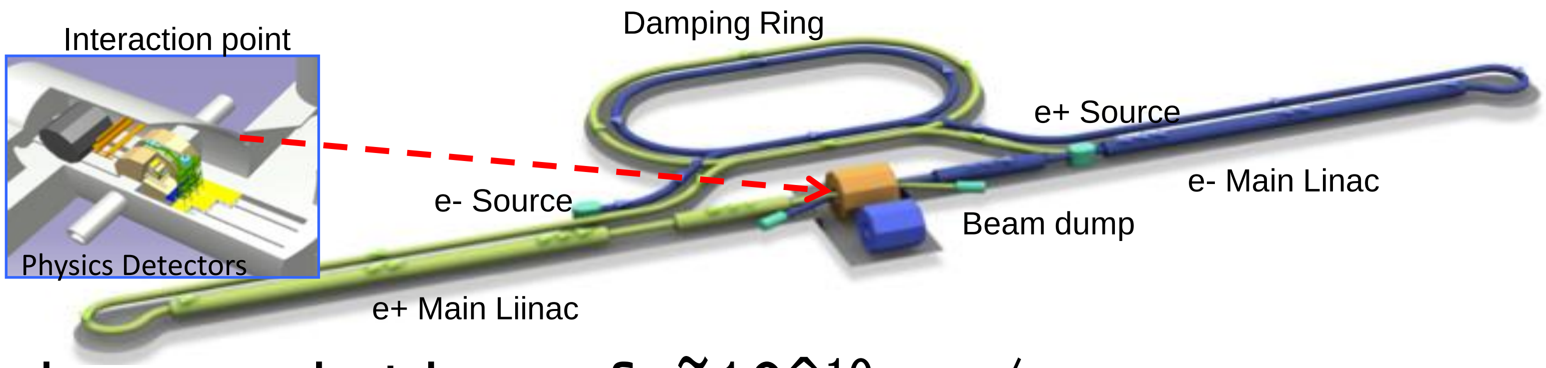
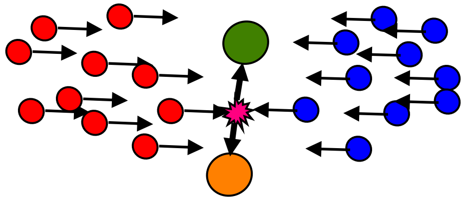
Area systems of the ILC

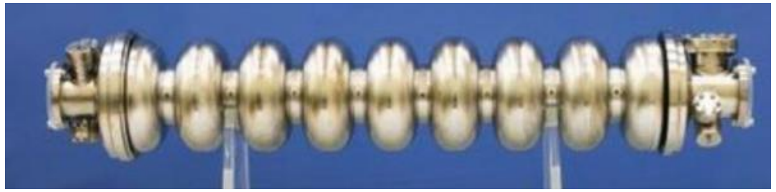


bunch, consisting of ~10^10 e+/e−

- Creating particles ***Sources***
  - polarized elections/positrons
- High quality beams ***Damping ring***
  - Low emittance beams
    - Small beam size (small beam spread)
    - Parallel beam (small momentum spread)

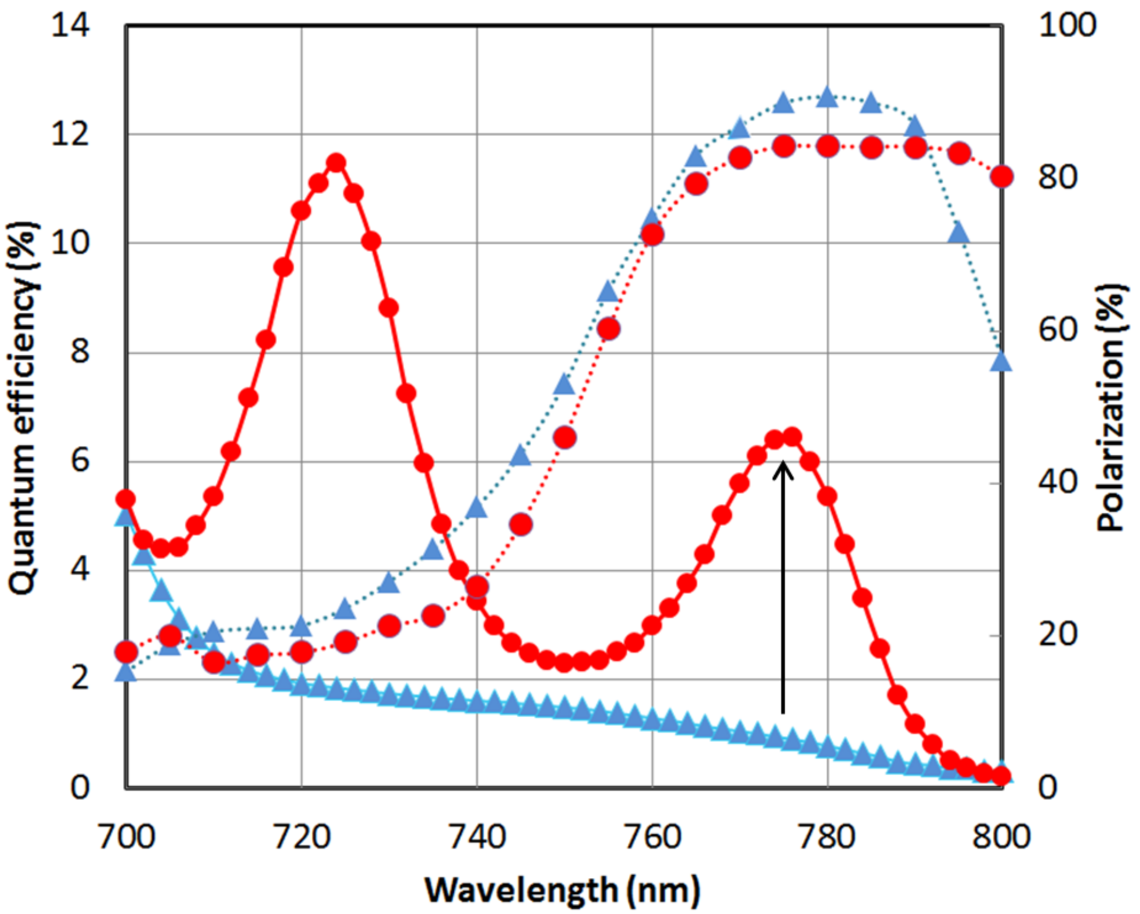


- Acceleration ***Main linac***
  - superconducting radio frequency (SRF)
- Getting them collided ***Final focus***
  - nano-meter beams
- Go to ***Beam dumps***



World record QE for high-polarization SSL GaAs photocathode

W. Liu, S. Zhang, M. Stutzman, M. Poelker, Y. Chen, W. Lu, and A. Moy, Appl. Phys. Lett. **109**, 252104 (2016)



- DBR strained-superlattice
  - **QE = 6.4%**
  - Polarization = 84%
- Standard strained-superlattice
  - QE ~1 %
  - Polarization ~90 %

- The highest reported QE of any high polarization photocathode
- Candidate for EIC, polarized positrons
- U.S. DOE SBIR partnership

ILC and JLab GaAs photogun parameters

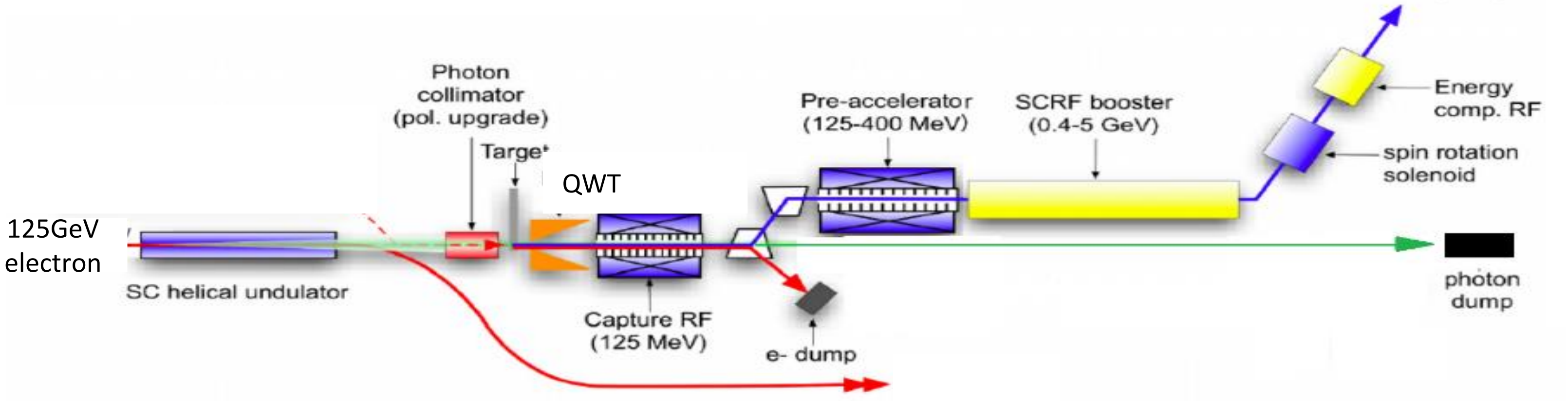
Parameter ¥ Machine =>	CEBAF	SLC	JLab/FEL	Cornell ERL	LHeC	eRHIC	CLIC	ILC	JLEIC(e+)	CEBAF (e+)
Polarization	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Number electrons/microbunch	2.5 x 10^6	1 x 10^{11}	8.3 x 10^8	4.8 x 10^8	1 x 10^9	2.2 x 10^{10}	6 x 10^9	3 x 10^{10}	1.2 x 10^{10}	2.5 x 10^8
Number of microbunches	CW	2	CW	CW	CW	CW	312	3000	900	CW
Width of microbunch	50 ps	2 ns	35 ps	2 ps	100 ps	~ 100 ps	~ 100 ps	~ 1 ns	100 ps	50 ps
Time between microbunches	2 ns	61.6 ns	13 ns	0.77 ns	25 ns	71.4 ns	0.5002 ns	337 ns	1.33 ns	4 ns
Microbunch rep rate	499 MHz	16 MHz	75 MHz	1300 MHz	40MHz	14MHz	1999 MHz	3 MHz	750 MHz	250 MHz
Width of macropulse	-	64 ns	-	-	-	-	156 ns	1 ms	1.1 ms	-
Macropulse repetition rate	-	120 Hz	-	-	-	-	50 Hz	5 Hz	50 Hz	-
Charge per micropulse	0.4 pC	16 nC	133 pC	77 pC	500 pC	3.6 nC	0.96 nC	4.8 nC	2 nC	40 pC
Charge per macropulse	-	32 nC	-	-	-	-	300 nC	14420 nC	1800 nC	-
Average current from gun	200 uA	2 uA	10 mA	100 mA	20 mA	50 mA	15 uA	72 uA	88 uA	10 mA
Average current in macropulse	-	0.064 A	-	-	-	-	1.9 A	0.0144 A	0.034 A	-
Duty Factor	2.5 x 10^{-2}	2.8 x 10^{-7}	2.6 x 10^{-3}	2.6 x 10^{-3}	4 x 10^{-3}	1.4 x 10^{-3}	0.2	3x10^{-3}	2.6 x 10^{-3}	1.2 x 10^{-2}
Peak current of micropulse	8 mA	8 A	3.8 A	38.5 A	5 A	35.7 A	9.6 A	4.8 A	20 A	0.8 A
Current density*	4 A/cm^2	10 A/cm^2	19 A/cm^2	500 A/cm^2	100 A/cm^2	182 A/cm^2	12 A/cm^2	6 A/cm^2	20 A/cm^2	16 A/cm^2
Laser Spot Size*	0.05 cm	1 cm	0.5 cm	0.3 cm	0.5 cm	0.5 cm	1 cm	1 cm	1 cm	0.10 cm

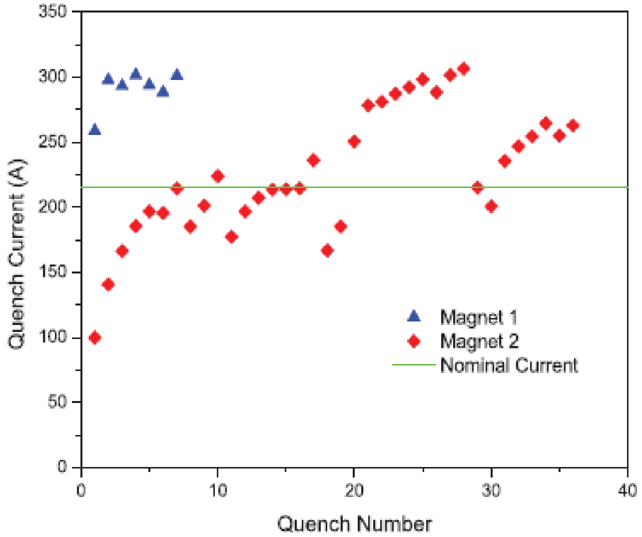
* Loose estimates

Demonstrated — Proposed (excuse outdated values) — For highest polarization

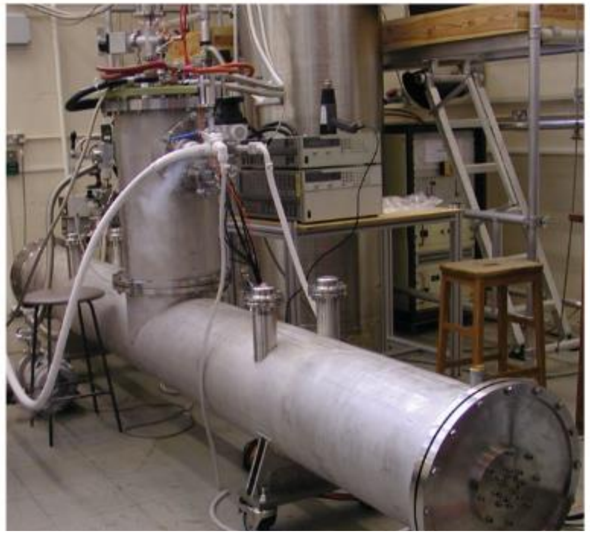
Positron Source (Undulator)

125 GeV electrons are injected to the helical undulator. The photons produced at the undulator is used for the electron/positron pair creation at the rotating target. Polarized positrons can be generated.





test at **Daresbury**

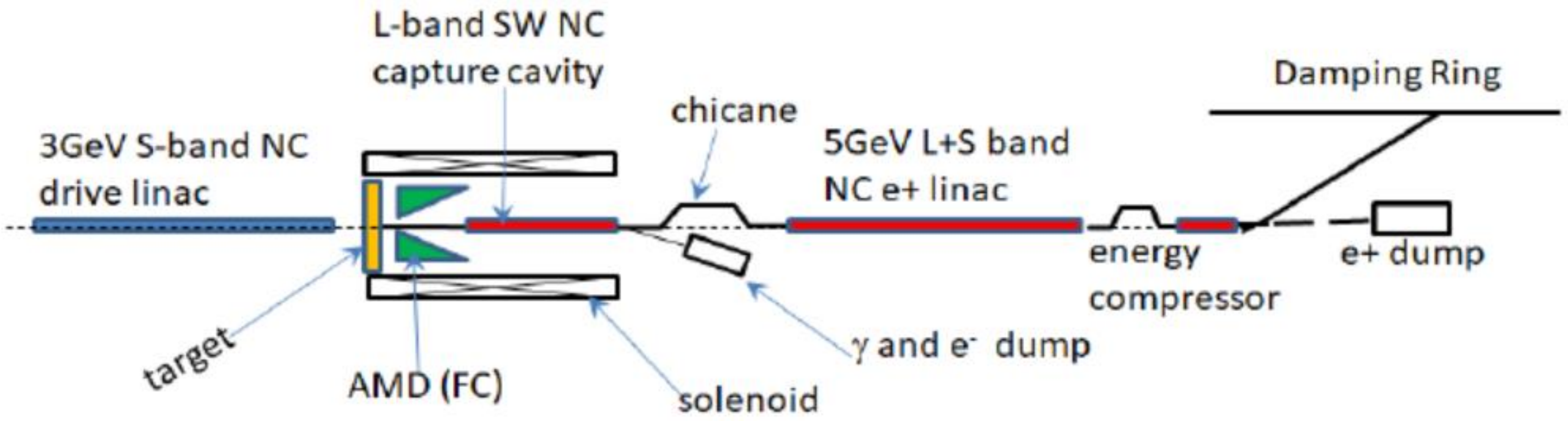


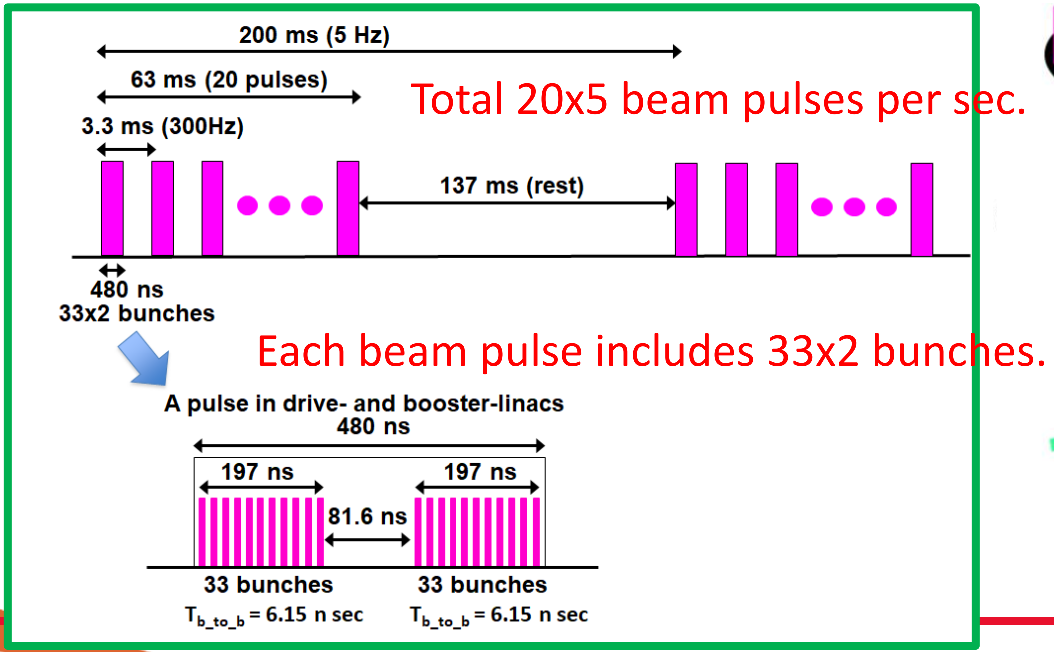
PHYSICAL REVIEW LETTERS **107** (2011) 174803

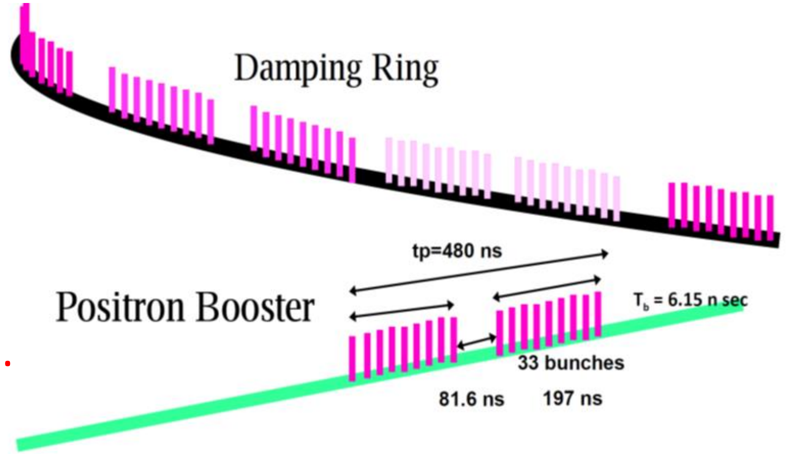
Two undulators in one cryomodule were tested. Both achieved nominal magnetic fields.

Positron Source (e-Driven)

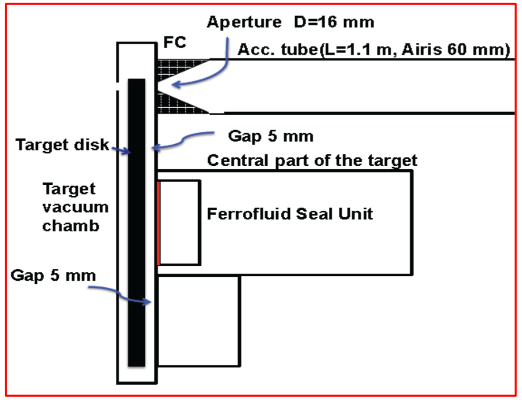
Extra 3GeV linac is used for the positron generation. High energy electrons are not necessary. (Electron independent commissioning is possible. However, polarization is not available.)

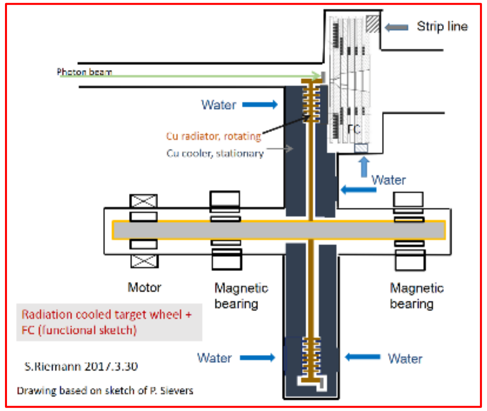






Positron rotating target





	undulator	E-Driven	Existing X-ray generator
Cooling/Seal	Radiation/ magnetic levitation	water/magnetic fluid	water/magnetic fluid
radius（ｍｍ）	500	250	160
weight（kg)	50*	65*	17
Tangential velocity（m/s)	100	5	160
rotation (rpm)	2,000	200	10,000
Beam heat load(kW)	2	20	90
Vacuum pressure（Pa)	10^{-6}	10^{-6}	10^{-4}

*The weight depends on the design of the disk part and the material

- Reliable rotating target
- Replacement of rotating target

Nano-beam R&D at ATF2

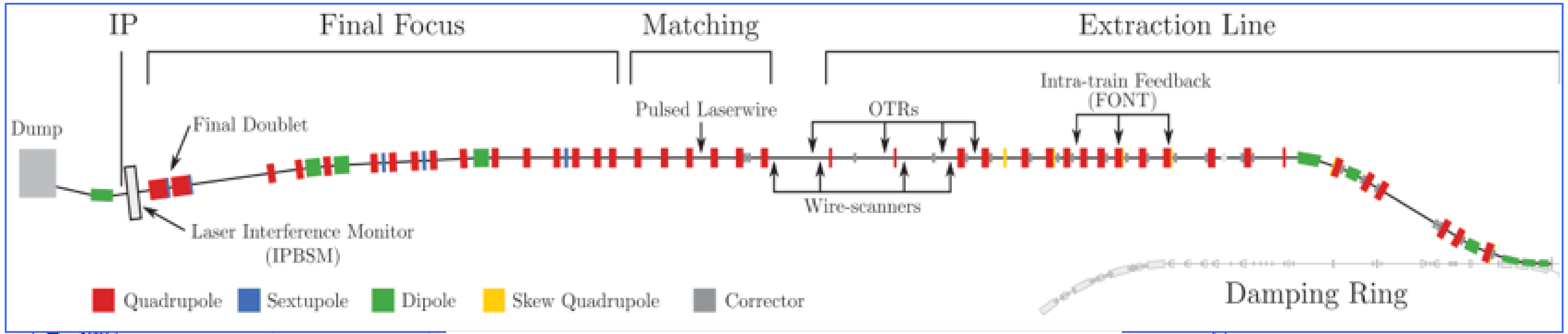
KEK · KOREA UNIVERSITY · THE UNIVERSITY OF TOKYO 東京大学 · SLAC NATIONAL ACCELERATOR LABORATORY · IFIC INSTITUT DE FÍSICA CORPUSCULAR · ROYAL HOLLOWAY UNIVERSITY OF LONDON · UNIVERSITY OF OXFORD · lapp Laboratoire d'Annecy-le-Vieux de Physique des Particules · LAL LABORATOIRE DE L'ACCÉLÉRATEUR LINÉAIRE · CERN · Institute of High Energy Physics Chinese Academy of Sciences · Fermilab

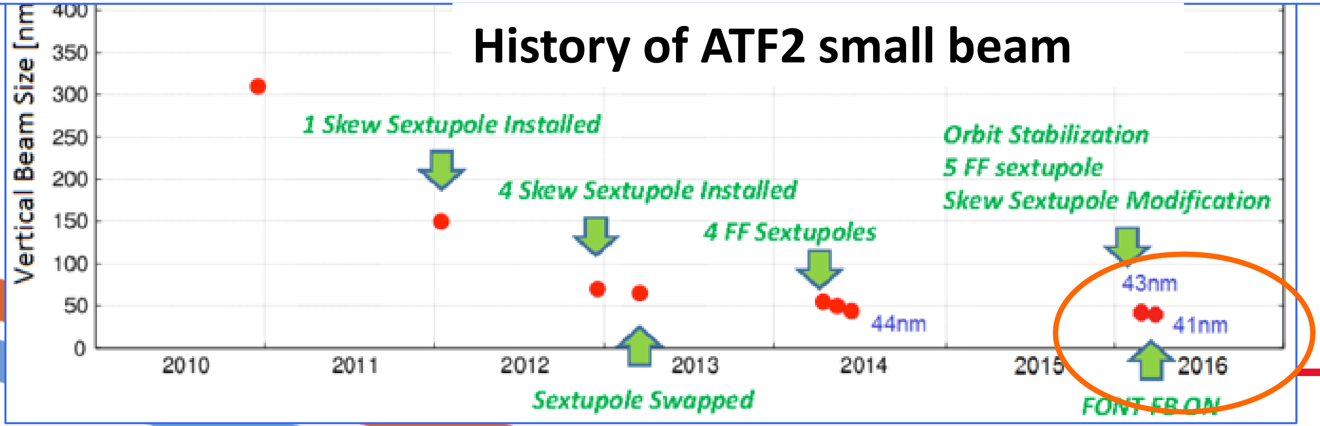
Goal 1: Establish the ILC final focus method with same optics and comparable beamline tolerances

ATF2 Goal : **37** nm → ILC **7.7** nm (ILC250); achieved **41 nm** (2016)

Goal 2: Develop the position stabilization for the ILC collision

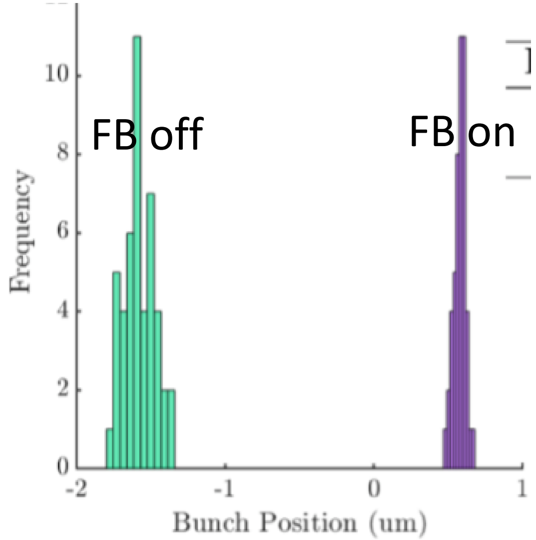
- **FB latency 133 nsec achieved** (target: < 366 nsec)
- **positon jitter at IP: 106 → 41 nm (2018)** (limited by the BPM resolution)





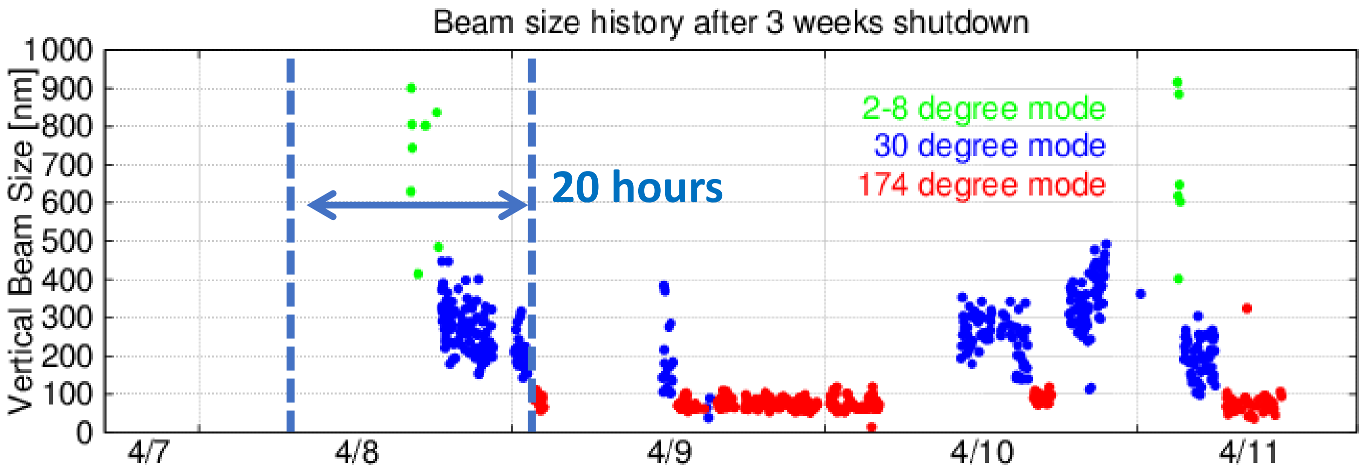
Nano-meter stabilization at IP

(2018)

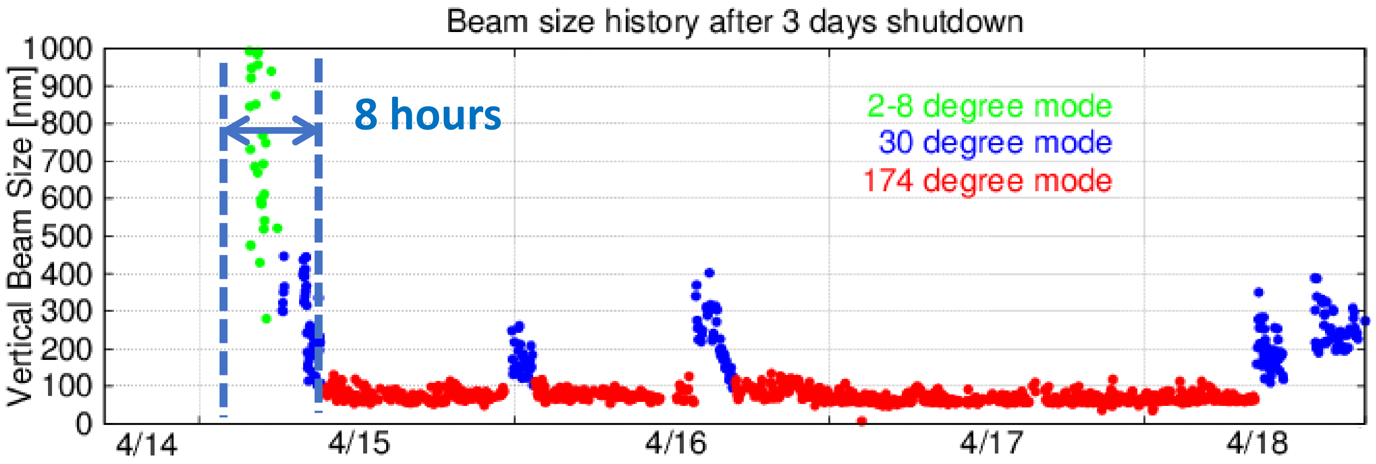


Beam tuning experience at ATF2

It takes ~20 hours (recovery time) after 3 weeks shutdown (magnet off).



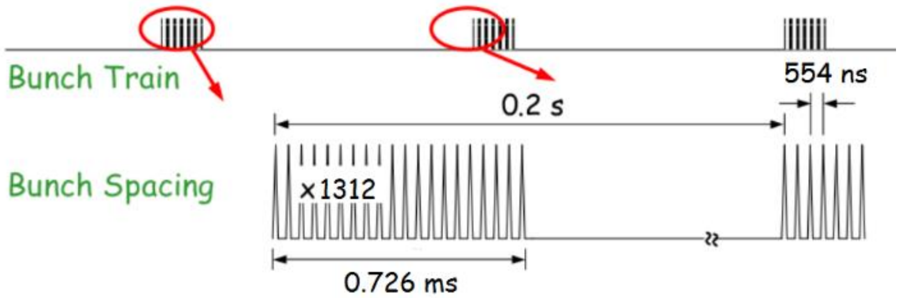
It takes ~8 hours (recovery time) after 3 days shutdown (magnet on).



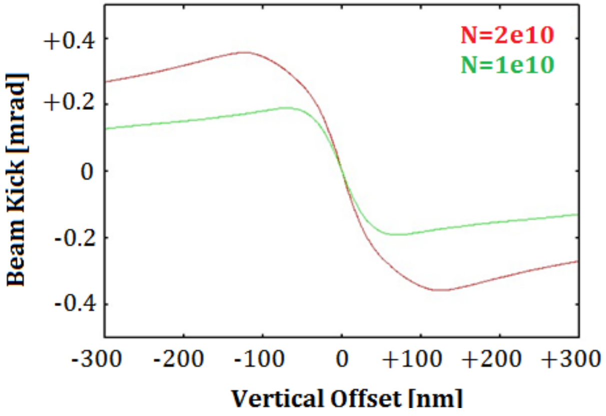
FONT* Bunch train feedback at final focus

*Feedback On Nanosecond Timescales by Oxford University
https://journals.aps.org/prab/abstract/10.1103/PhysRevAccelBeams.21.122802

ILC bunch structure

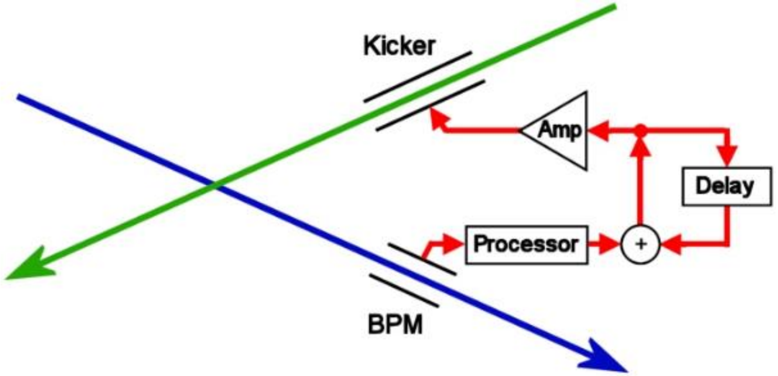


CAIN simulation

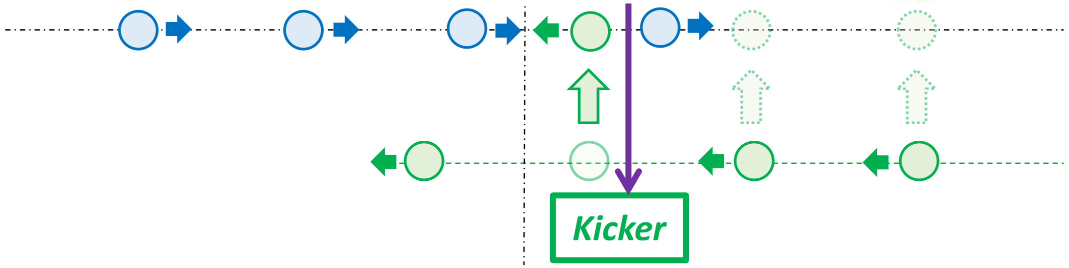


Depending on the relative position of the beam, beams are greatly scattered by the beam-beam effect.

The position of the beam between pulses shifts due to ground vibrations and equipment noise.
On the other hand, the position of the beam does not change significantly inside the bunch train.



Efficient beam collision can be achieved with high-speed feedback that measures the initial beam position of the bunch train and corrects the position of subsequent bunches in the train.
Feedback latency should be less than bunch space.



The first bunch does not collide, but the second and subsequent bunches will collide.

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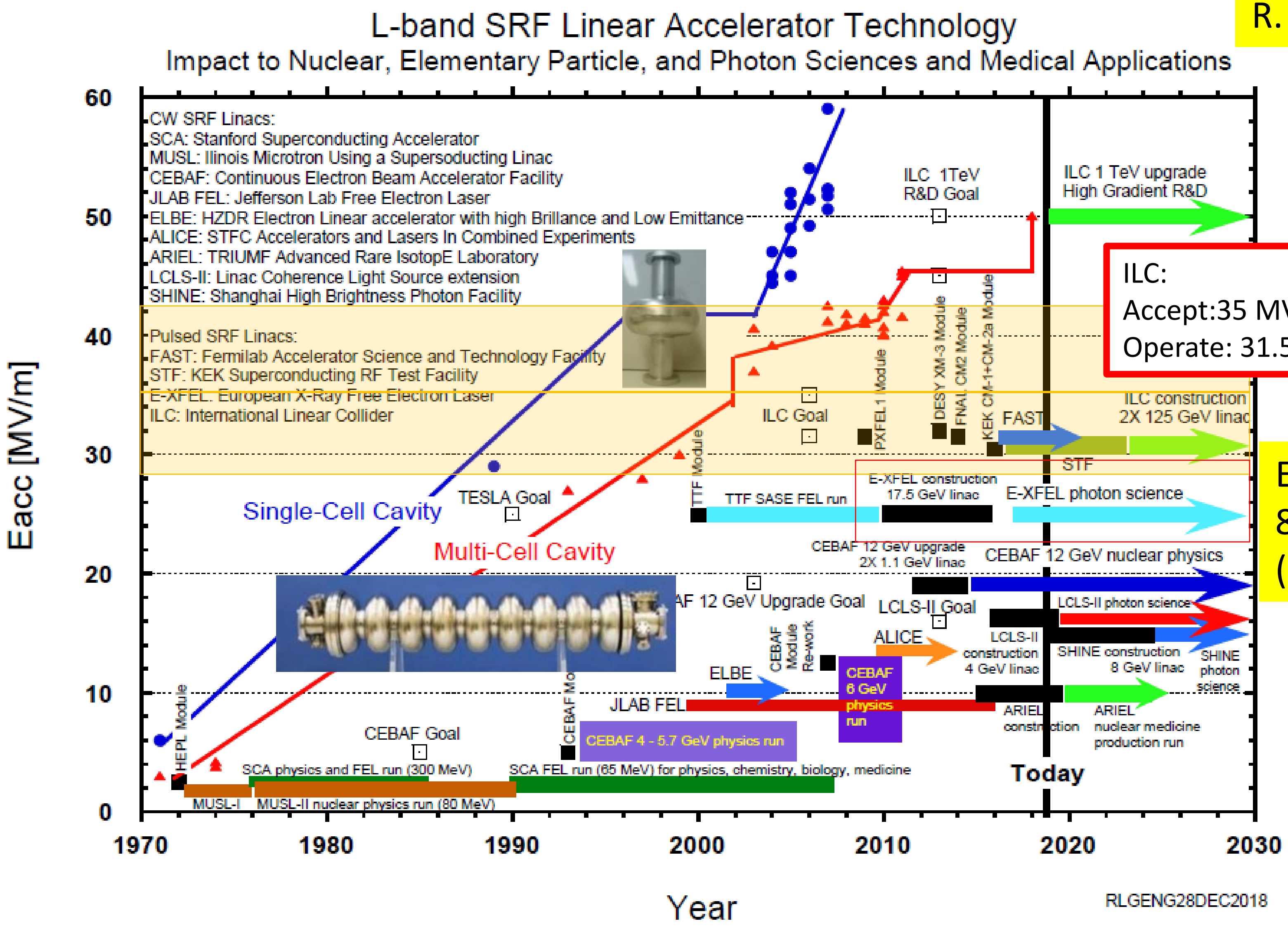
Matured SRF technologies

R. Geng (JLAB)



ILC:
Accept:35 MV/m +/-20%
Operate: 31.5MV/m +/-20%

European XFEL
800 cavities
(10% of ILC ML)

Worldwide large scale SRF accelerators

European XFEL

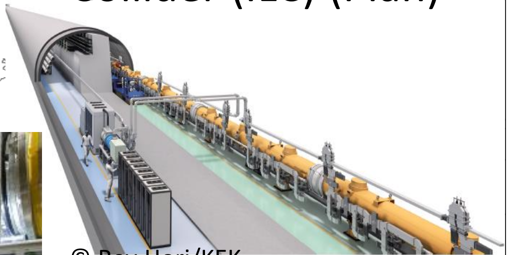
Euro-XFEL

Operation started from 2017

- -100 cyromodules
- -800 cavities
- -17.5 GeV (Pulsed)

DESY

International Linear Collider (ILC) (Plan)



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ILC

- -900 cyromodules
- -8,000 cavities
- -250 GeV (Pulsed)

KEK

LCLS-II + HE (under construction)

- -35 + 20 cyromodules
- -280 + 160 cavities
- - 4 + 4 GeV (CW)

SLAC

FNAL

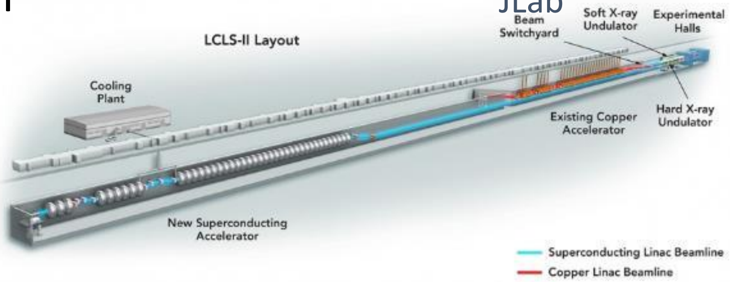
Cornell

JLab

LAL/Sacray

INFN

LCLS-II



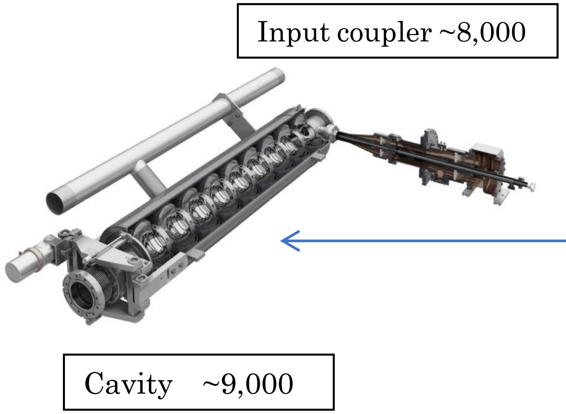
SINAP

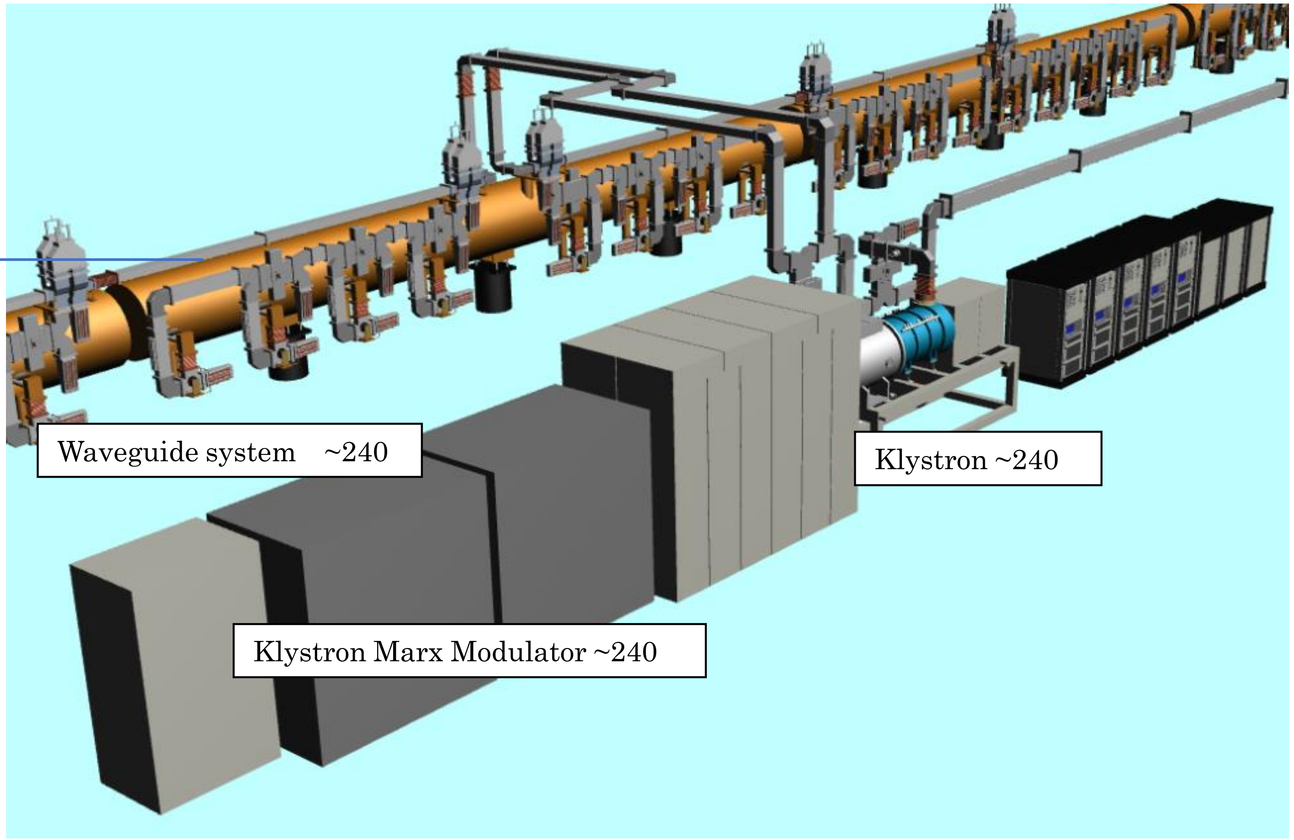
SHINE (under construction)

- -75 cyromodules
- -~600 cavities
- - 8 GeV (CW)

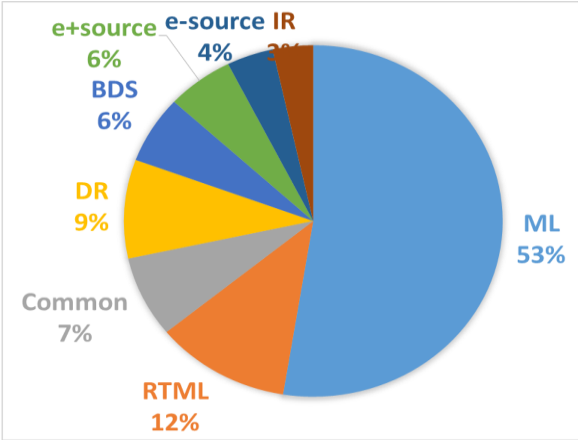
1.3GHz 9 cell cavity

ILC cost reduction R&D





(including ~10% margin)

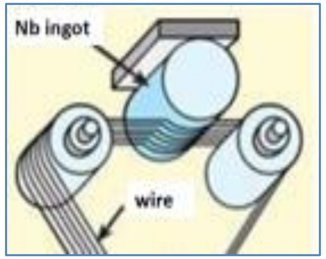


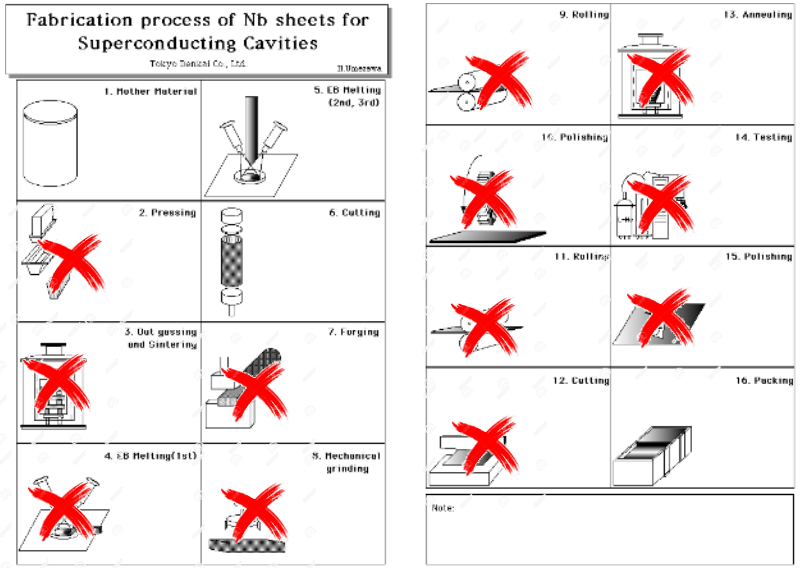
The half of the construction cost is coming from main linac (ML).
Thus we focused our cost reduction R&D into ML (superconducting RF technology)

ILC Cost-Reduction R&D in US-Japan Cooperation

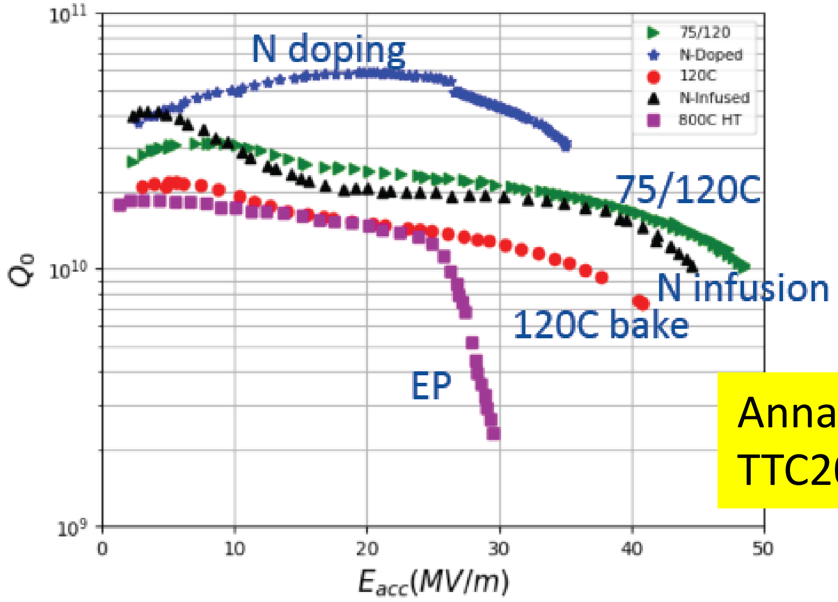
Based on recent advances in technologies;

- Nb material/sheet preparation
  - w/ optimum Nb purity and clean surface

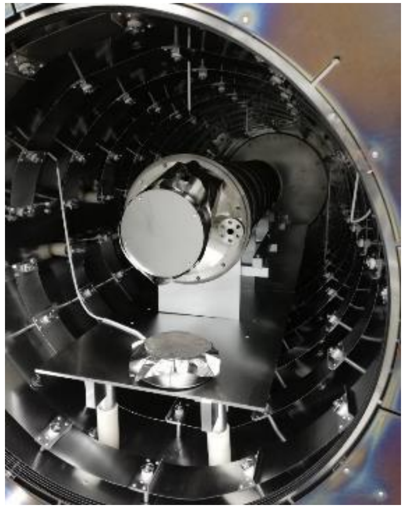




- Surface treatments for high-Q and high-G



Anna Grassellino
TTC2019 Vancouver



ILC status

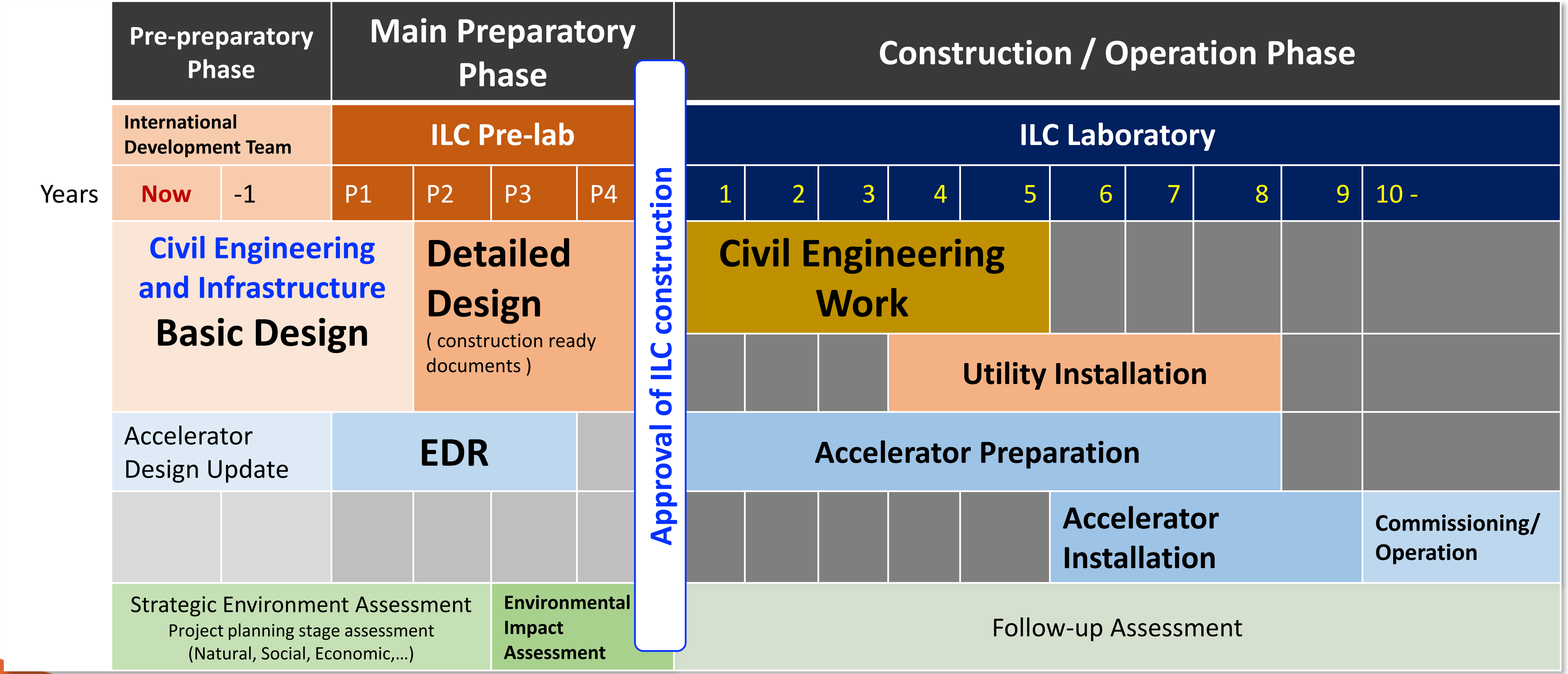
Shin MICHIZONO

International Development Team (IDT) WG2/ KEK

- *ILC250 accelerator overview*
- *ILC area systems*
  - *Sources*
  - *Nano-beam*
  - *SRF*
- *Civil engineering*
- *International Development Team (IDT)*
- *Summary*

Civil Engineering related Schedule for ILC-250GeV

N.Terunuma, AWLC2020

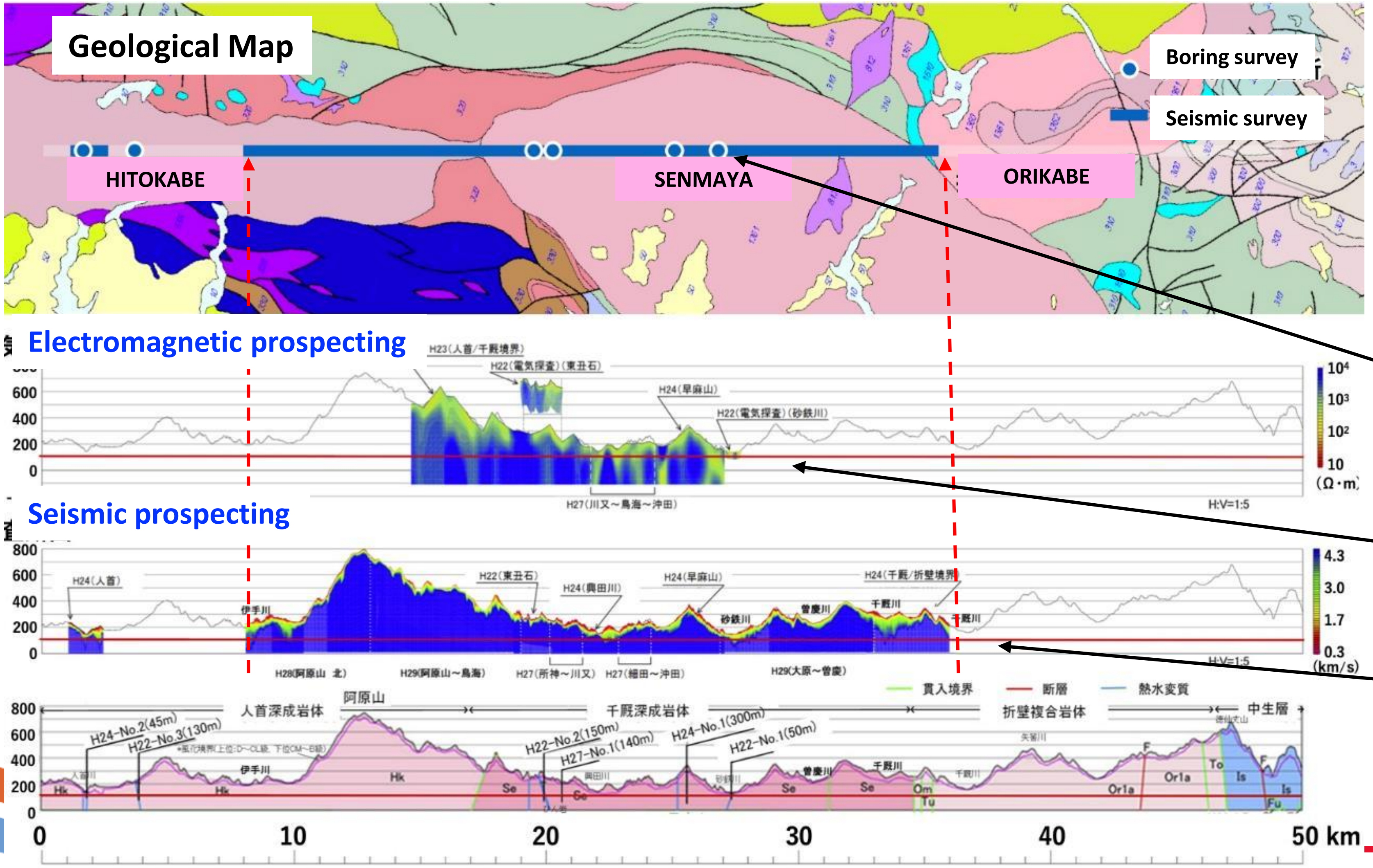


References; (1) TDR, (2) Recommendations on ILC Project Implementation, 2019.

Geological Surveys for ILC: Kitakami Mountains

international development team

ILC-250 (20.5 km)



- Continuous **granite region**

  HITOKABE, **SENMAYA** and **ORIKABE** bedrock

- **Have capability to extend the ILC up to 50 km in future**

- **Boring geological survey**

  → Direct sampling down to the accelerator depth

- **Electromagnetic prospecting**

  → Cracks in the rock

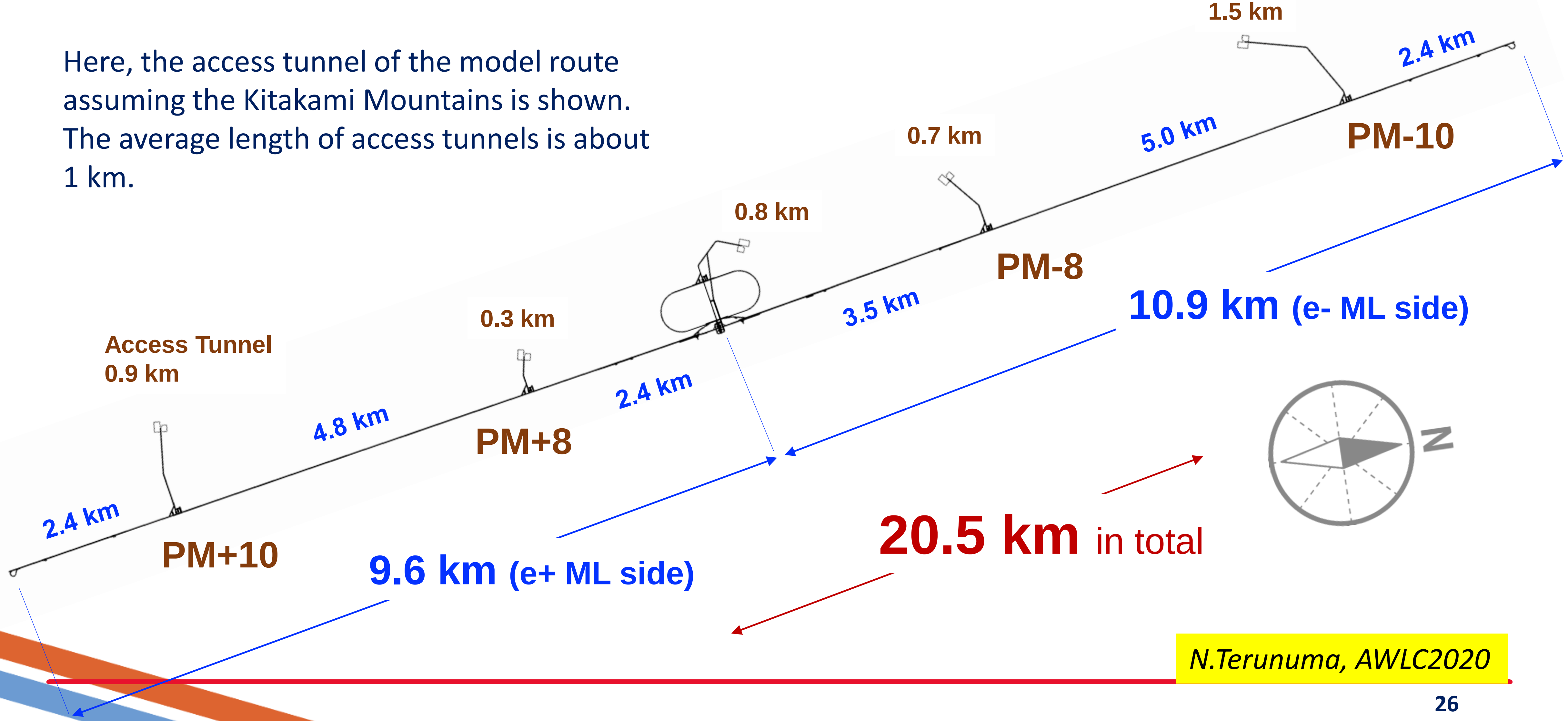
- **Seismic prospecting**

  → Rock hardness

N.Terunuma, AWLC2020

Scale of the ILC-250GeV

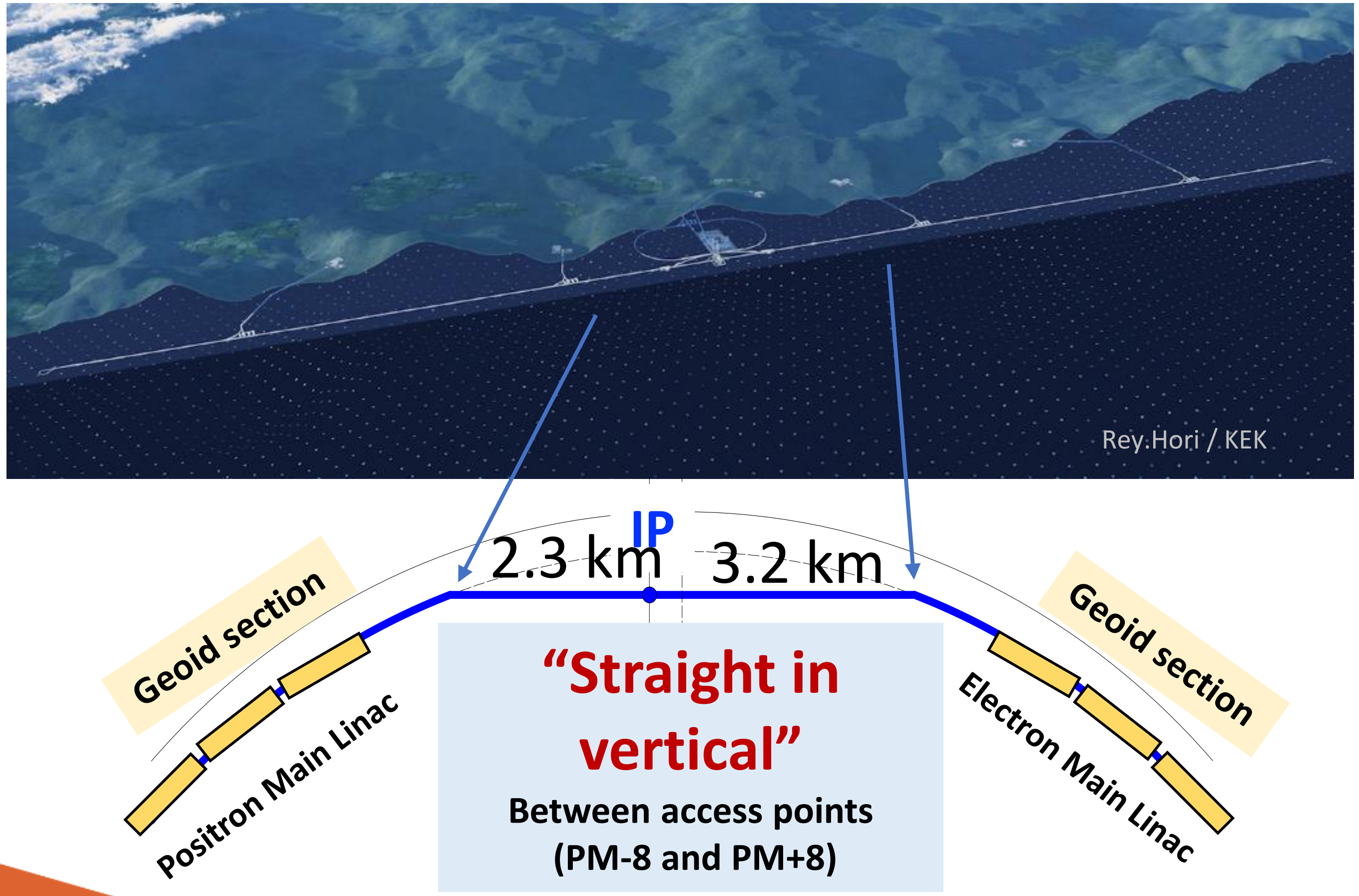
Here, the access tunnel of the model route assuming the Kitakami Mountains is shown. The average length of access tunnels is about 1 km.



N.Terunuma, AWLC2020

Laser Straight Section

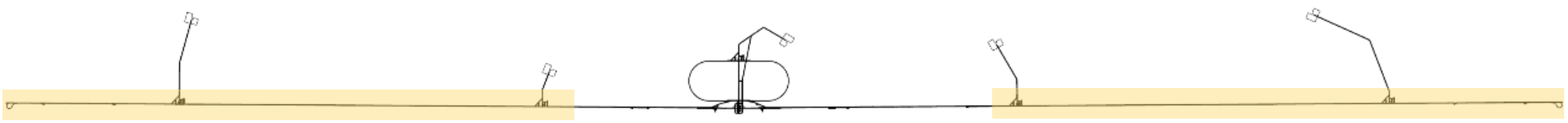
- BDS: “laser straight” in vertical
- ML: Cryomodule will be aligned to the geoid.

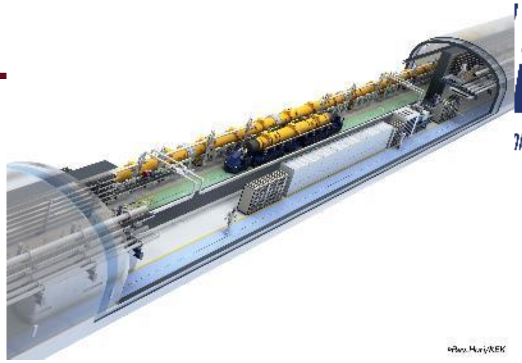


- ILC optics DECK has been updated to incorporate corrections for **geoid** and **straight sections** around the IP.
- Asymmetric straight sections
  - The e- side is longer to include undulator and dog-leg.
  - If e+ and e- MLs are at the same altitude, the IP is tilted by 0.1 mrad.
  - If e- ML is placed 0.6 m higher than e+, the IP has no tilt and BDSs are symmetrically sloped to the IP.

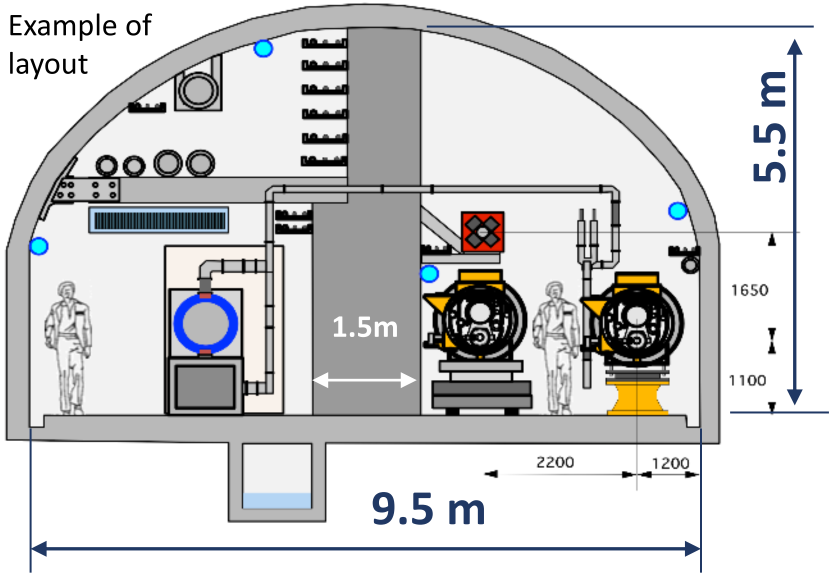
N.Terunuma, AWLC2020

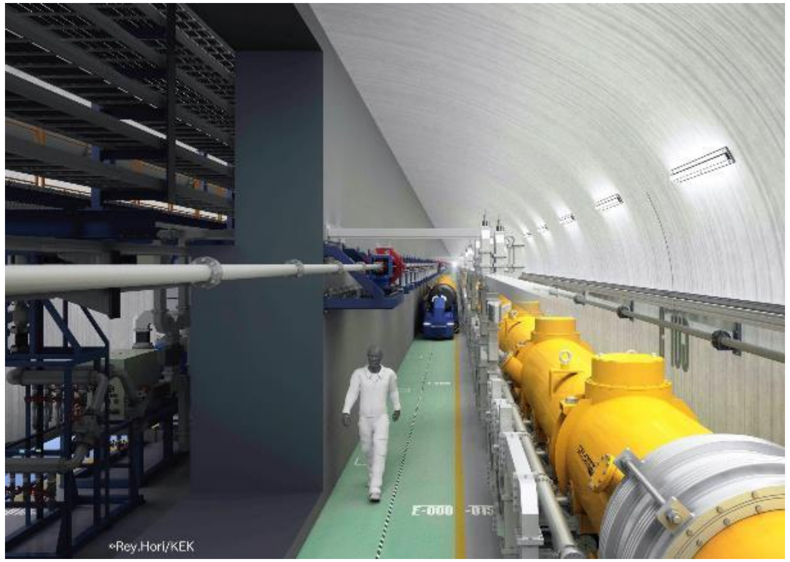
Main Linac (ML) tunnel





- 15 km in (e+e-) total
- follow the geoid in vertical
- **Kamaboko 9.5m X 5.5m**
- **1.5m central radiation shield**
- Further optimization will be done.





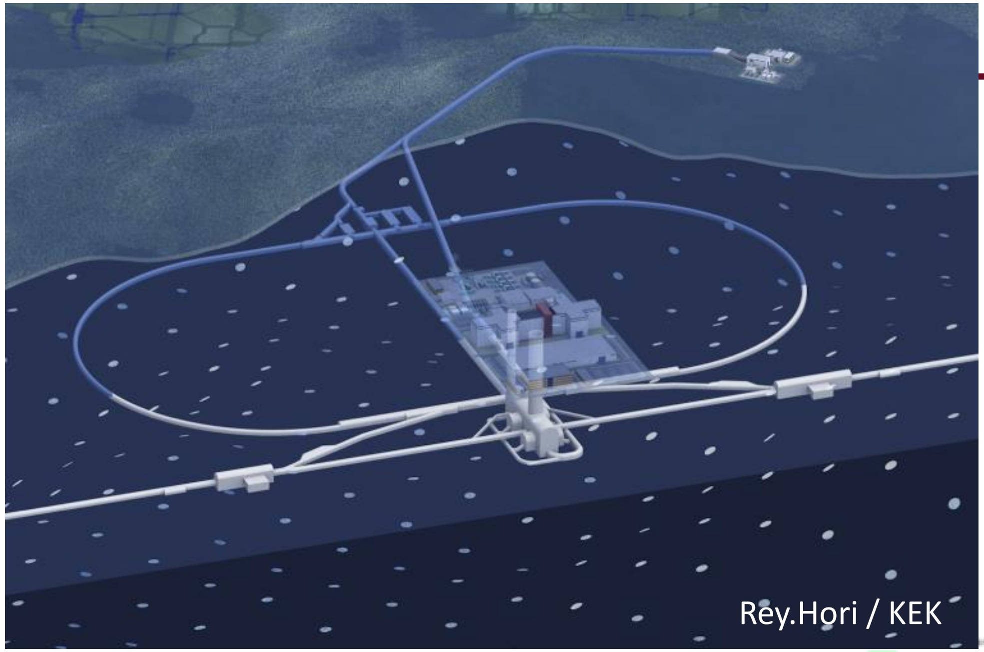
- **66 kV distribution cables**
- **Colling water pipes**
- Fan Coil Units
- Low power and signal cables
- **RF klystrons and modulators**
- **Electric Power Stations**

- **ML Cryomodules**
- **RTML**
- Low power and signal cables

N.Terunuma, AWLC2020

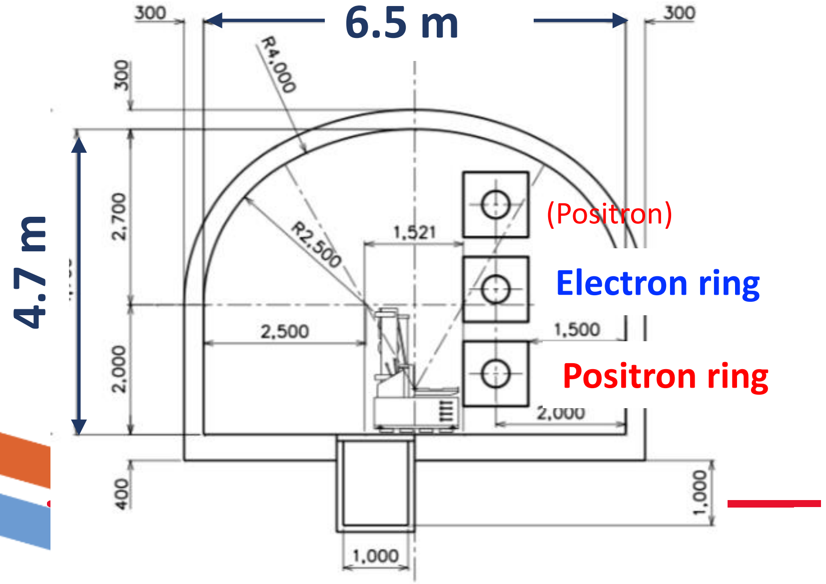
Damping Ring

N.Terunuma, AWLC2020

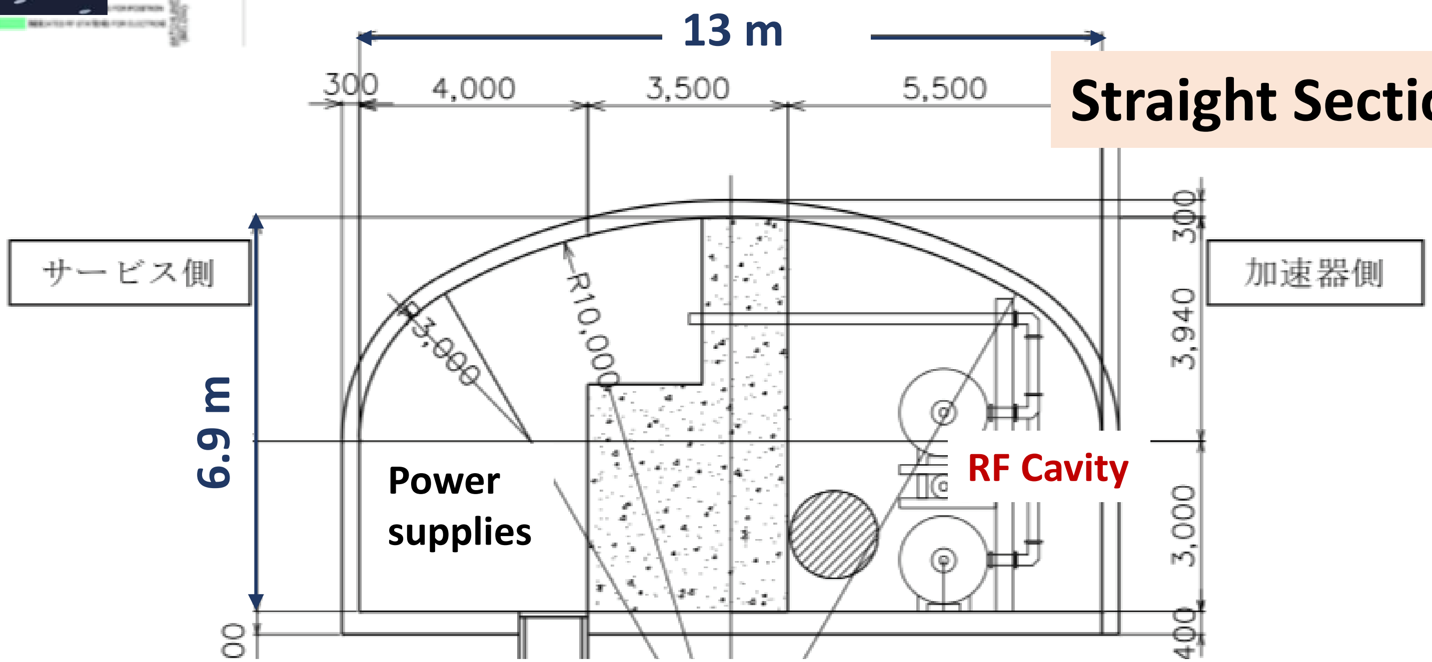


- Circumference: 3.2km
- Start with two rings
- Arc section: **single tunnel, no central shield.**
- Straight section: **Kamaboko with a central shield** (3.5m in TDR).

Arc Section



Straight Section



Interaction Point (IP)

N.Terunuma, AWLC2020

IP surface area

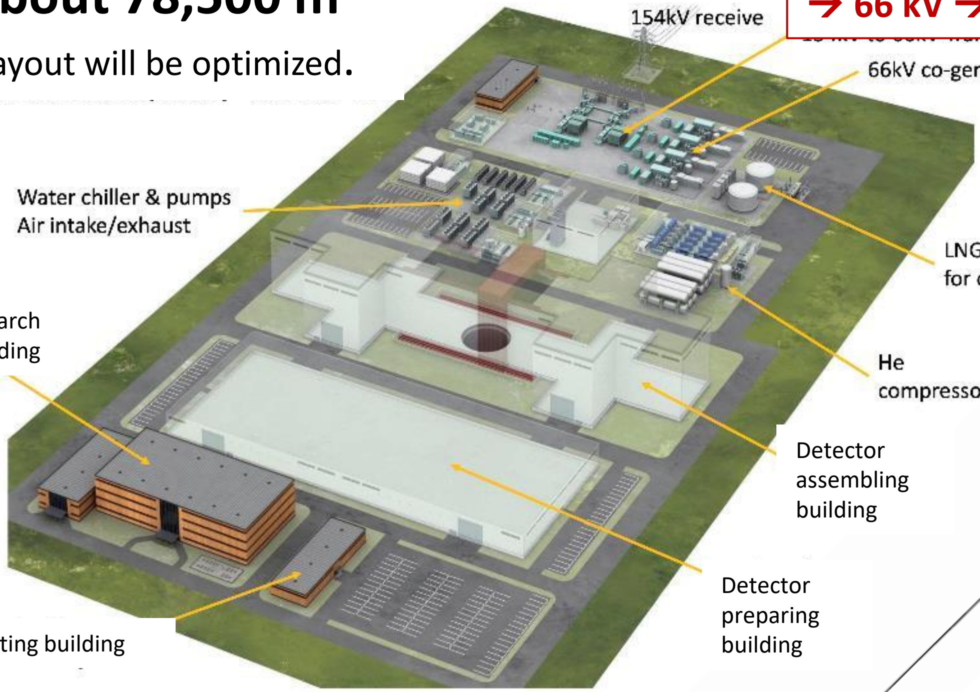
about 78,500 m^2

Layout will be optimized.

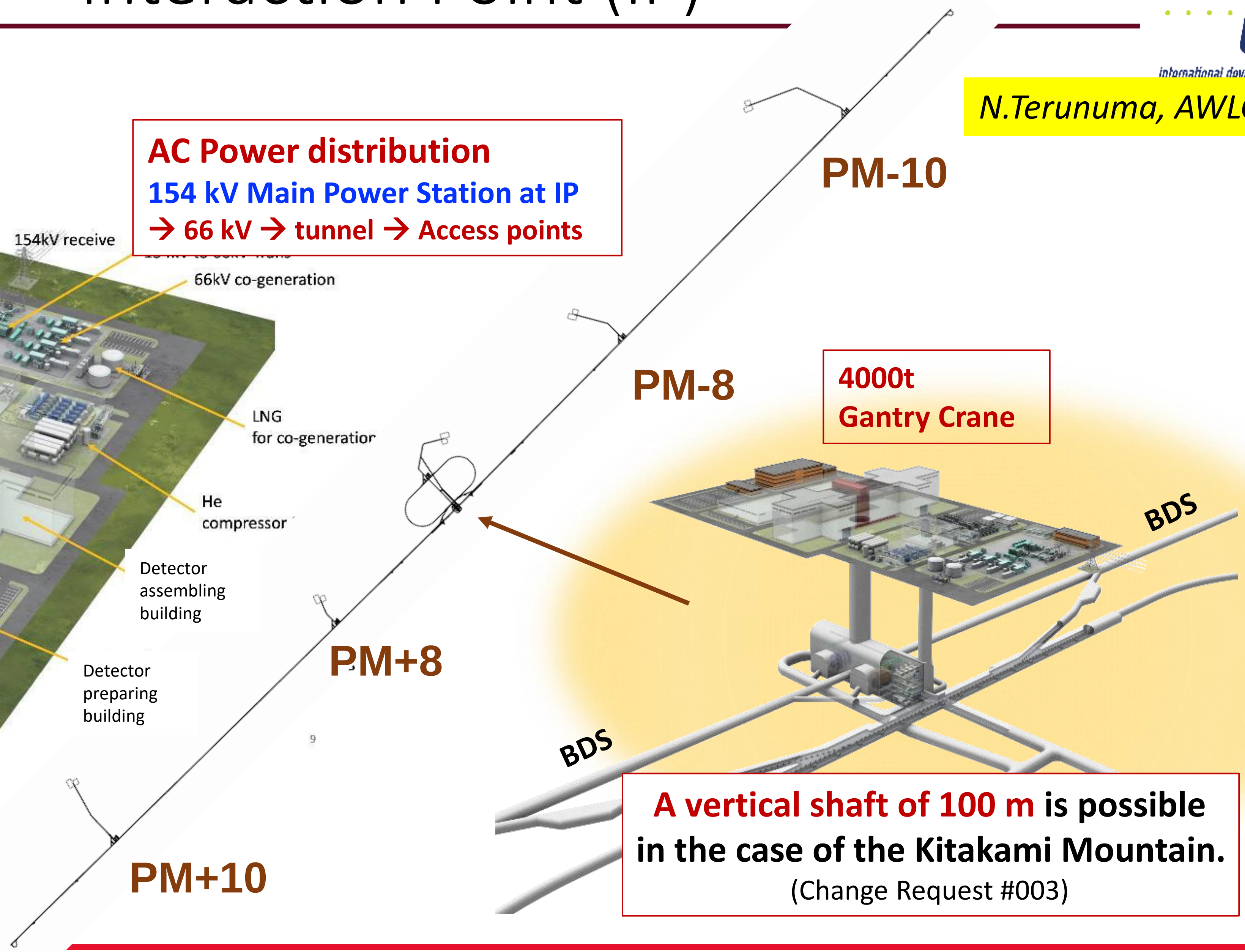
AC Power distribution

154 kV Main Power Station at IP

→ 66 kV → tunnel → Access points



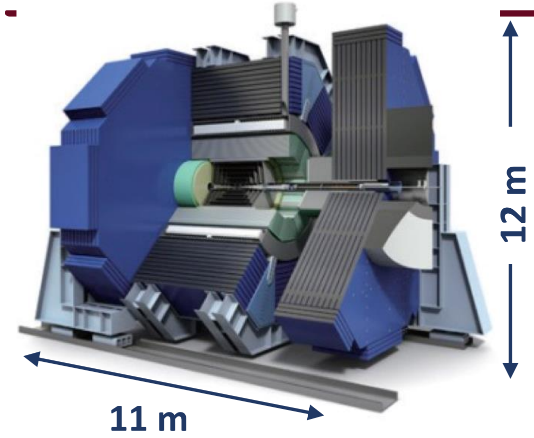
4000t
Gantry Crane



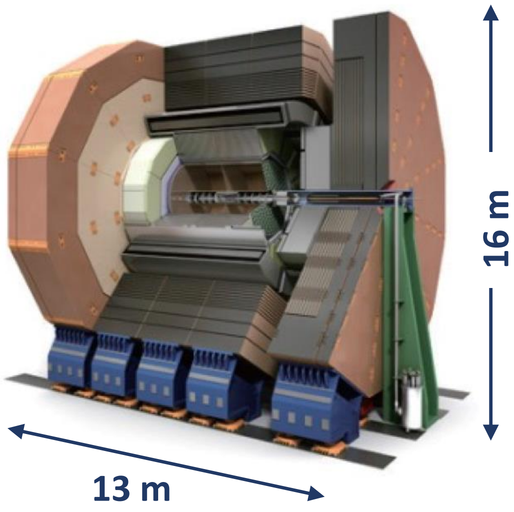
A vertical shaft of 100 m is possible in the case of the Kitakami Mountain.

(Change Request #003)

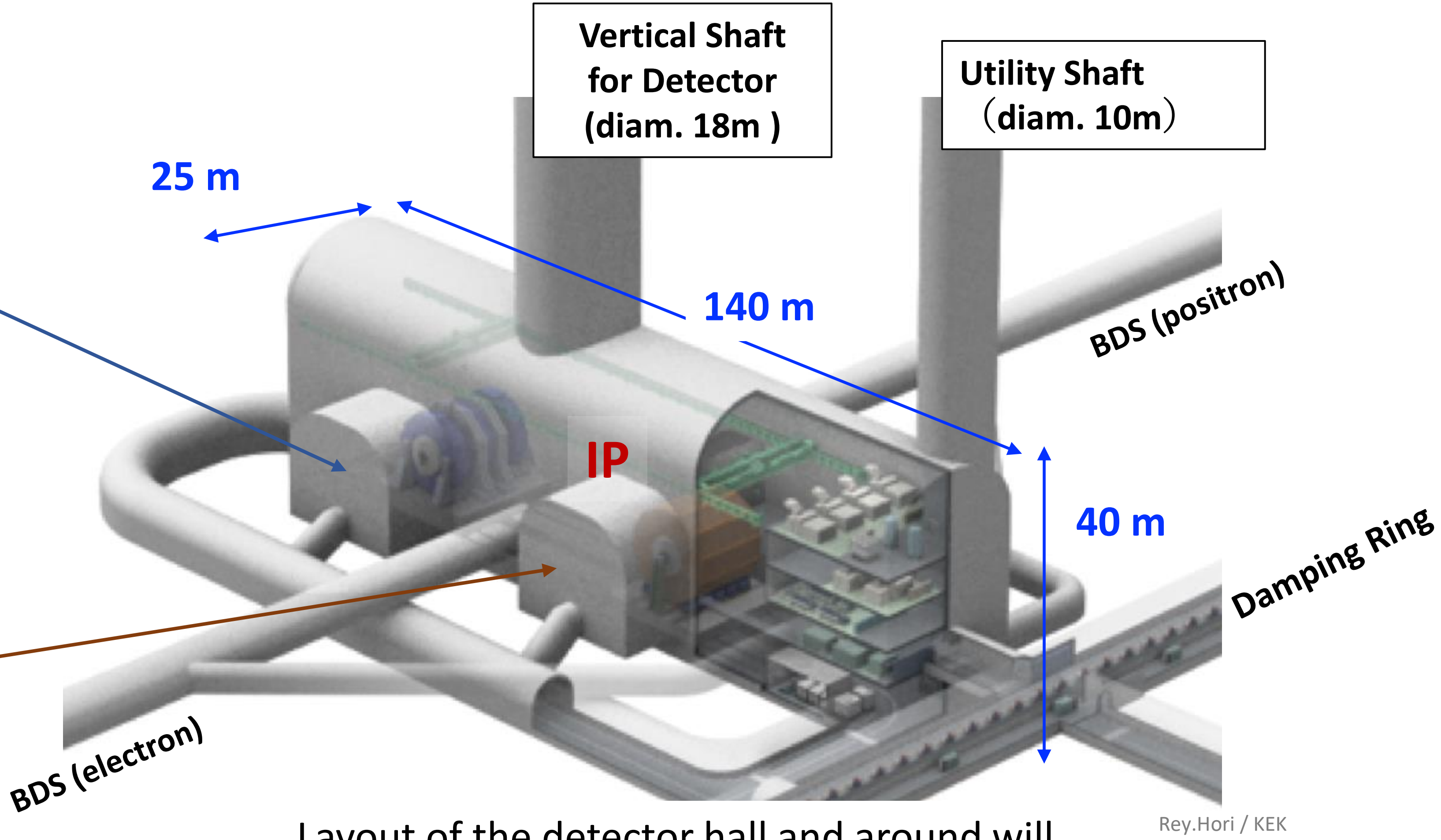
Detector Hall



SiD, 8,000 t



ILD, 15,000 t



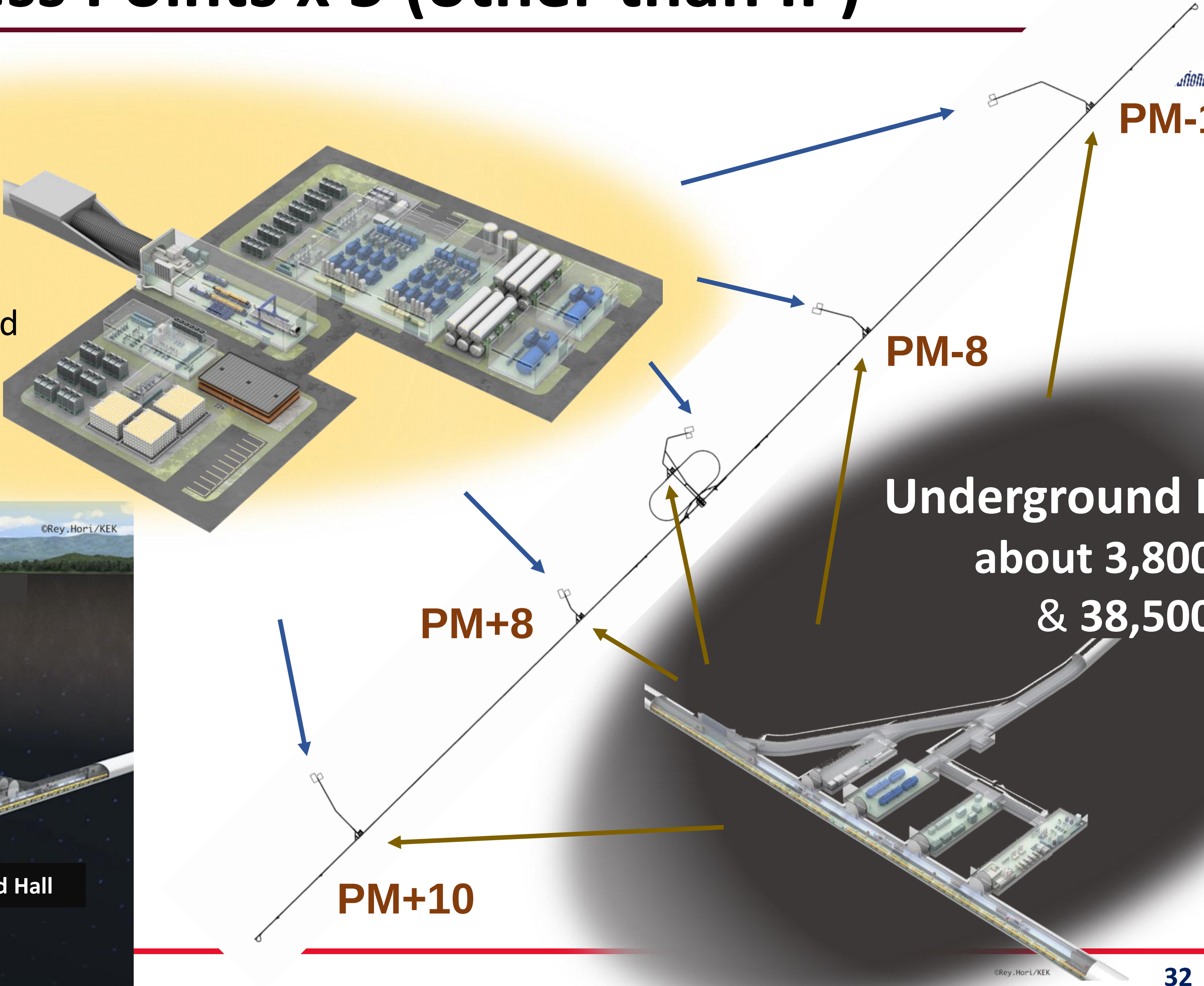
Layout of the detector hall and around will be optimized with detector groups.

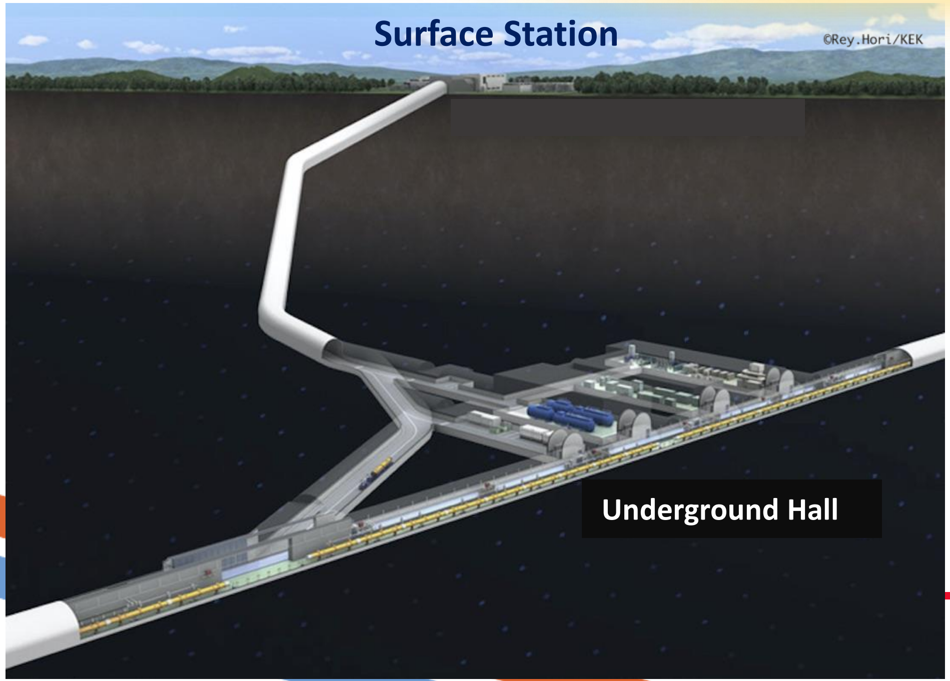
Access Points x 5 (other than IP)

Surface Station

about 16,600 m^2

The ground layout is optimized by the station.





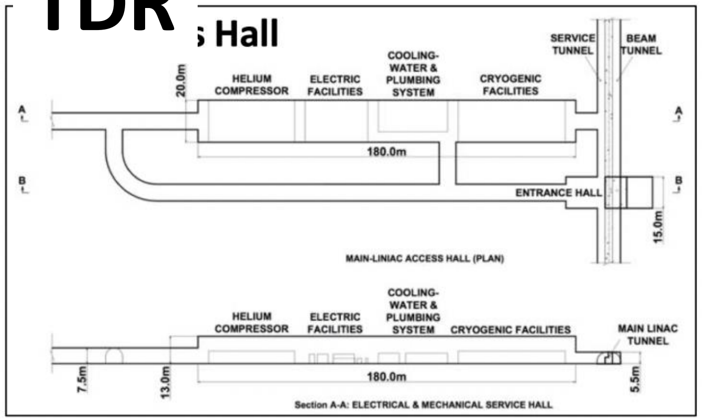
Underground Hall

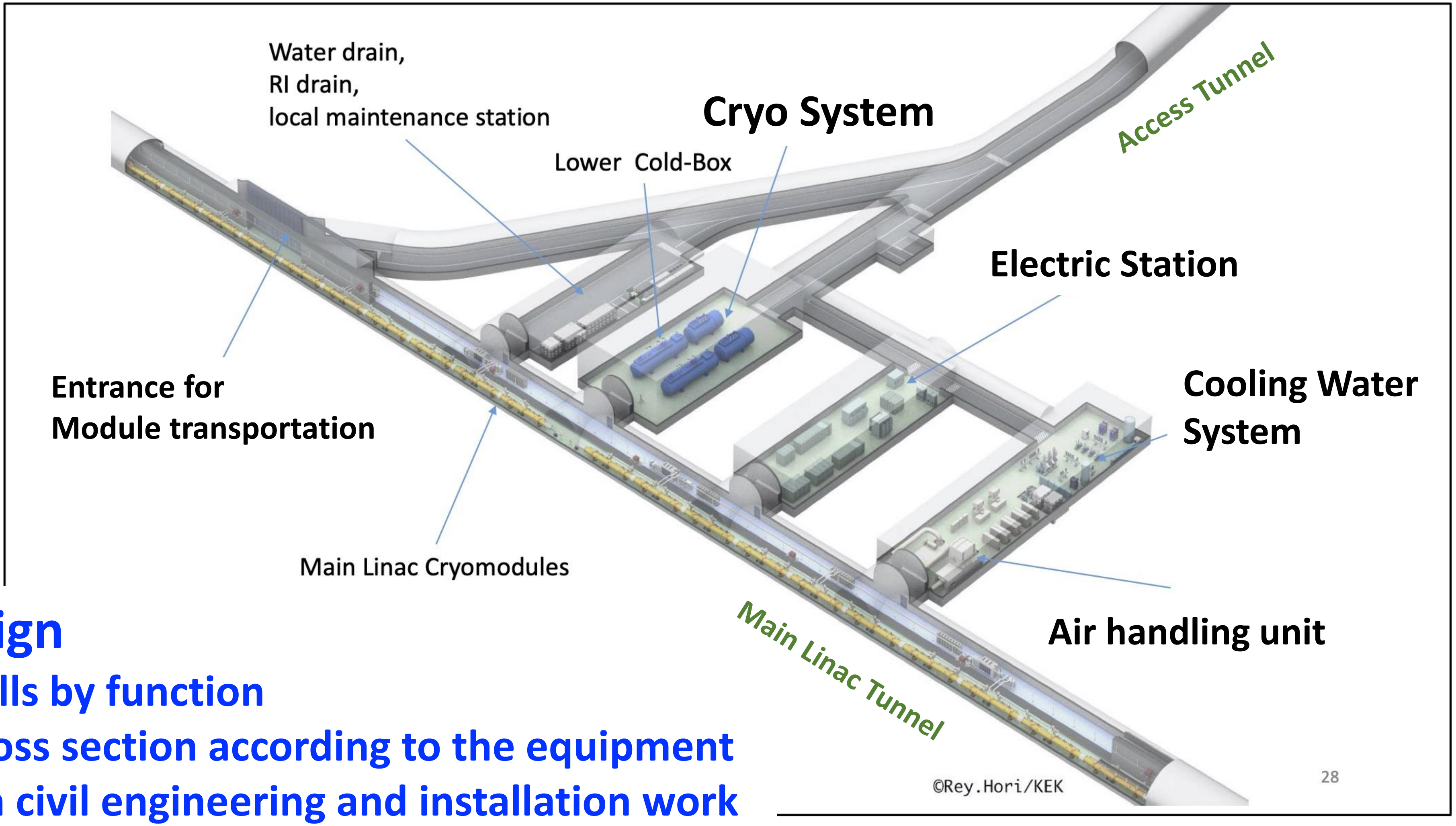
about 3,800 m^2

& 38,500 m^3

Underground Access/utility Halls

TDR

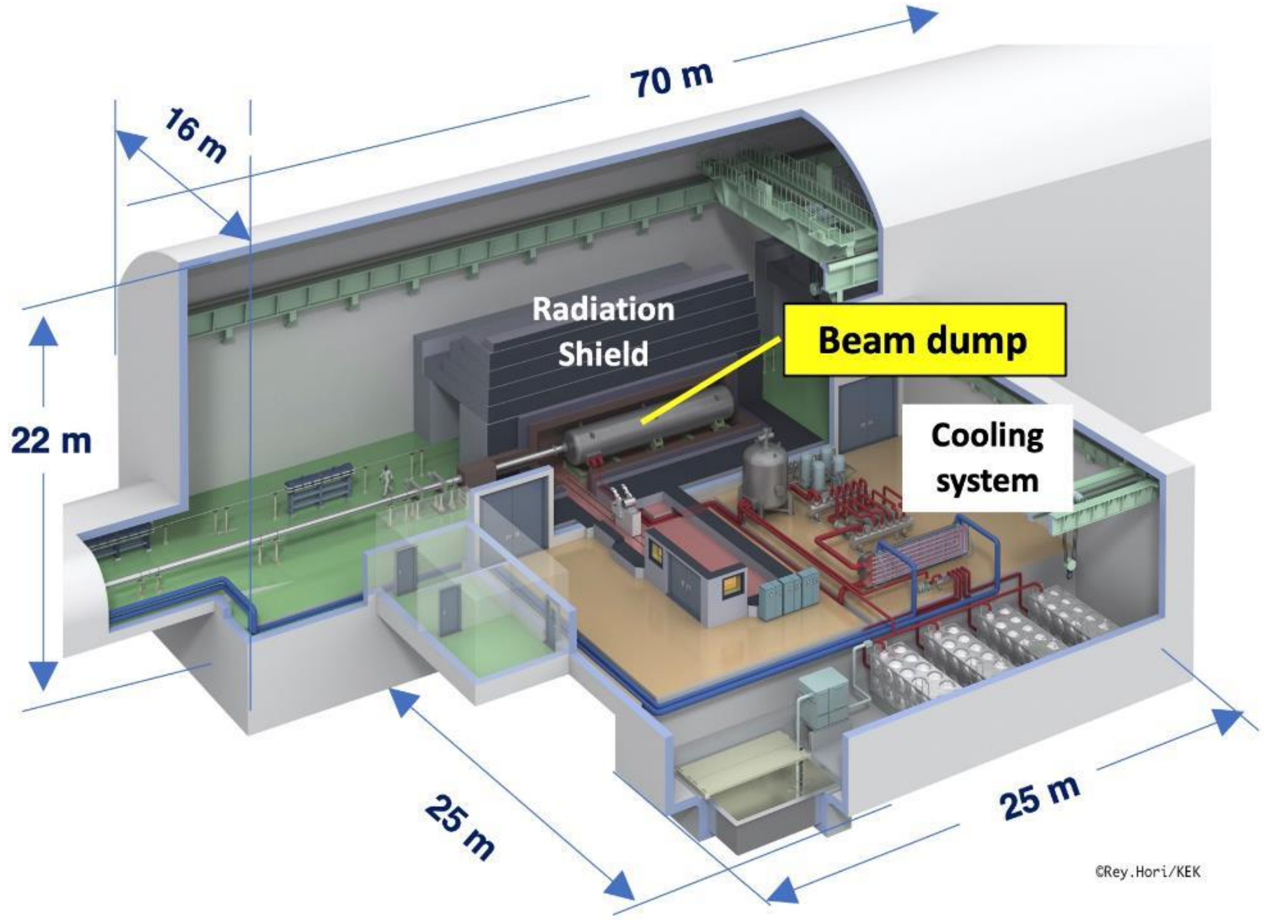




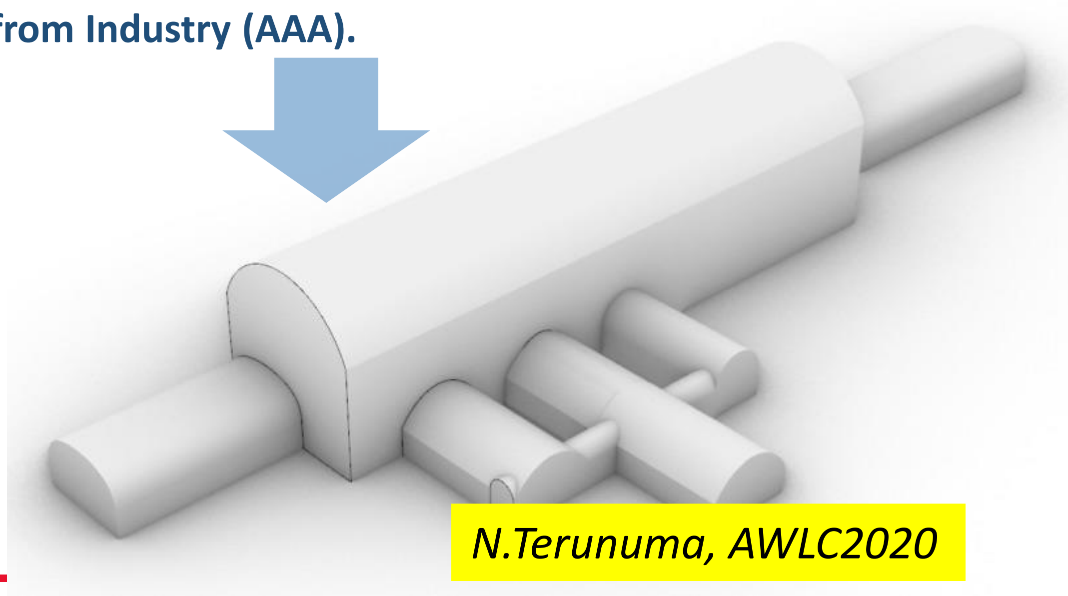
Updated Design

- Separated halls by function
- Optimized cross section according to the equipment
- advantage on civil engineering and installation work

Cavern for Main Beam Dump



- **Three big caverns**
  - Two main beam dumps
  - e- dump for undulator, low energy collision (5 x 5 Hz)
- The main beam dump has been designed for **1 TeV collisions.**
  - **5 m thick concrete shield in all directions**
  - **17 MW power cooling (wider utility hall)**
  - **¼ volume of detector hall**
- **The civil engineering design is updating with experts from Industry (AAA).**



N.Terunuma, AWLC2020

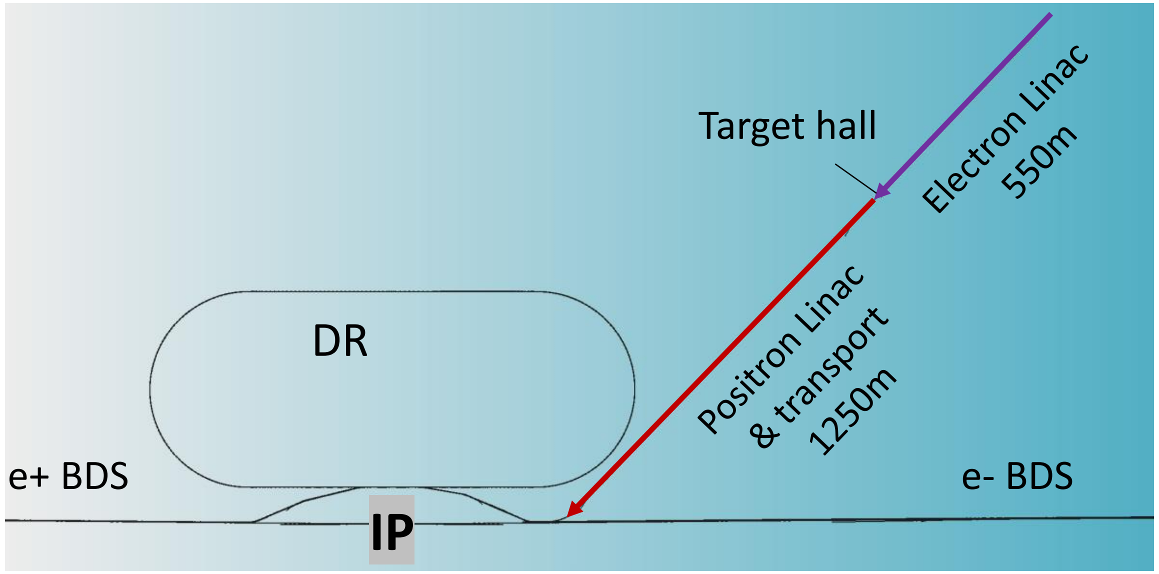
Civil Engineering Design for Positron Source

Since civil engineering (CE) work will start immediately after the preparation period, a lot of detailed design work is expected during the preparation period, so the CFS Group will proceed with the basic design of the CE for the positron source in advance.

- Have the CE design to **include the undulator scheme in any scenarios.**
  - **TDR based layout**
  - and have **Photon dump line** in the BDS tunnel
- **E-driven source** will be in **separated dedicated tunnel.**
  - **add on to the TDR based design**
  - From the CE view, sharing of BDS tunnel is not realistic.
  - e-driven study group is developing this design.
  - Access tunnel should be considered.

Design study for e-driven positron source

- Figure shows the length of the linac, taking into account the size and placement of devices.
- Positron injection into the DR uses RTL.
- Joint angle to the BDS tunnel will be optimized for local conditions.



ILC status

Shin MICHIZONO

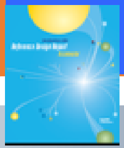
International Development Team (IDT) WG2/ KEK

- *ILC250 accelerator overview*
- *ILC area systems*
    - *Sources*
    - *Nano-beam*
    - *SRF*
- *Civil engineering*
- *International Development Team (IDT)*
- *Summary*

Brief History of ILC Collaboration

2004

2006 ‘07 ‘08 ‘09 ‘10 ‘11 ‘12 ‘13 ‘14 ‘15 ‘16 ’17 ’18 ’19 ’20



SC Technology selected

ILC-GDE

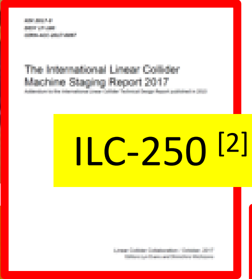
TDR

LCC

RDR)

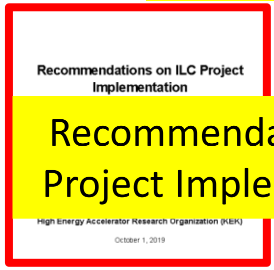
Technical Design Phase

TDR [1] :
49 countries
392 institutions
>2400 researchers

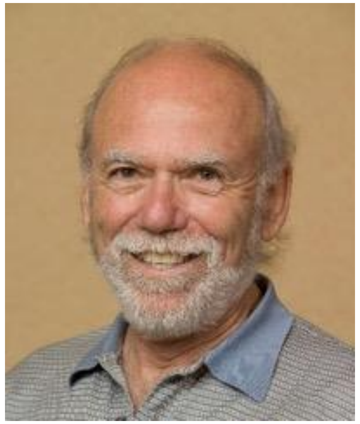


ILC-250 [2]

*I*nternational *D*evelopment *T*eam



Recommendations on ILC Project Implementation [3]



Barry Barish
GDE director
(the Nobel Prize winner for physics in 2017)

Lyn Evans
LCC director
(former LHC project manager)

LHC

European XFEL

LCLS-II

From IDT to Pre-Lab, ILC construction phase

IDT is formed under ICFA. KEK serves as its host.

Stage 1 International Development Team (~1.5 years)

ILC Pre-Lab. is established by MOU's among the laboratories.

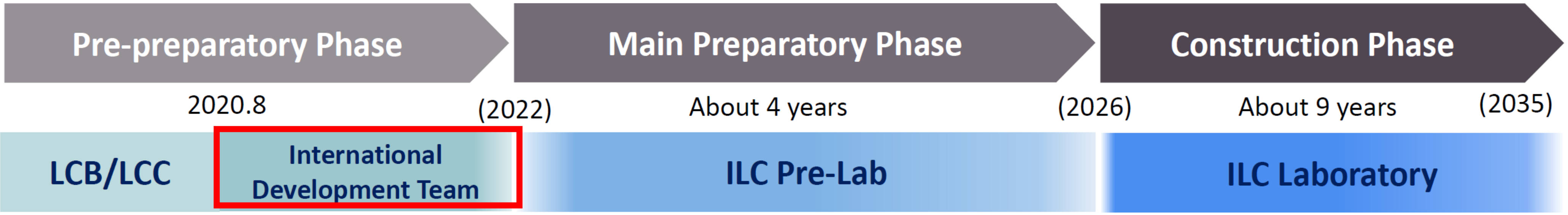
Stage 2 ILC Pre-Laboratory (4 years)

ILC Lab. is established by governmental agreement.

Stage 3 ILC Laboratory (10 years for construction)

Stage 4 Experiment at ILC!

International Development Team (IDT)



IDT: to prepare for smooth transition to the ILC Pre-lab

- Prepare a proposal for the organization and governance of the ILC Pre-Lab
- Prepare the work and deliverables of the ILC Pre-laboratory and workout a scenario for contributions with national and regional partners

KEK's role at IDT and beyond

- The next focus will be when ILC Pre-Lab can be started following the IDT.
- The function of the ILC Pre-lab is to do the remaining works in four years.
  - Solve remaining technical issues of the accelerator.
  - Design of the organization and functions of the ILC laboratory
  - and launch the ILC laboratory
- Since the start of the ILC Laboratory is the official start of the ILC project, it is necessary to reach an international agreement including cost sharing before its start. The ILC Pre-Lab also plays an important role in supporting such international negotiations
- KEK is making every possible effort to start the ILC Pre-Lab soon after the IDT completes its mandate, and to realize the ILC together with the Japanese physics community and supporting groups in the political sector, industrial sector and Tohoku region.

M. Yamauchi, AWLC2020

Accelerator activities at ILC Pre-lab phase

Technical preparations & SRF R&D for cost reduction [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 office in Japan with a support from other labs]

- 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 coordinated by the central office]

- 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 [mainly by the Japanese institutions]

- 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

ILC construction human resources

KEK ILC action plan

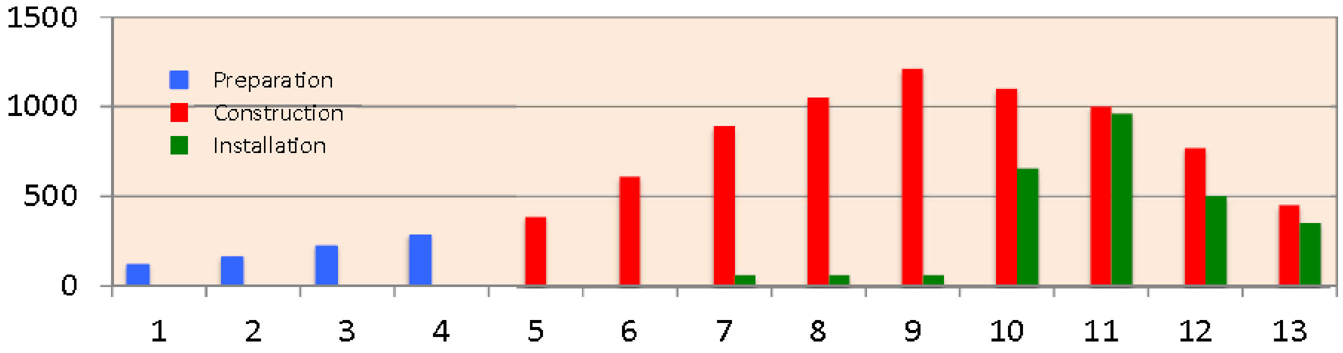
https://www.kek.jp/en/newsroom/KEK-ILC_ActionPlan_Addendum-EN%20%281%29.pdf

Overview of Human Resources during the ILC Construction

Preparation stage (4 years) ~ Construction stage (9 years) ILC-500 → ILC-250

unit: person

Stage	Preparation				Construction									Total
	1	2	3	4	1	2	3	4	5	6	7	8	9	
Prep.	118	161	222	282										
TDR							TDR, ILC-500 Ann. average: ~ 1,100 persons							
Constr.					410	922	1208	1350	1589	1480	1374	1106	679	10,118
Install.							80	80	80	768	1140	683	522	3,353
Total					410	922	1288	1430	1669	2248	2514	1789	1201	13,471
ILC-250							ILC-250: Ann. average: ~ 830 persons							
Constr.					385	610	890	1050	1210	1100	1000	770	450	7,465
Install.							60	60	60	655	960	500	350	2,645
Total					385	610	950	1110	1270	1755	1960	1270	800	10,110



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Summary

- *ILC250 accelerator is 20 km long e-/e+ collider for the Higgs factory.*
- *The ILC is upgradable in energy and luminosity.*
- *Key technologies at the ILC are superconducting rf (SRF) and nano-beam.*
  - *SRF technology has been widely adopted at XFELs such as European XFEL.*
  - *Nano-beam technology has been demonstrated at ATF hosted by KEK*
- *Tunnel design and civil overview are shown.*
- *We assume 4-year preparation and 9-year construction.(now we are at pre-preparation phase (IDT))*
- *Preparation phase activities are*
  - *Technical preparation*
  - *Final engineering design*
  - *Planning and preparation of Hub lab.*
  - *Human resources for ILC construction …*

Thank you for your attention