ILC Technical Status Report

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ILC-GDE/KEK
in cooperation with M. Ross and N. Walker

A plenary talk at ECFA-LC2013, DESY, May 27, 2013

Outline

Technical Status reached in TDR

- Design update from Reference Design Report (RDR'07) to Technical Design Report (TDR'12)
- Results from research & development
- Recommendations given by PAC

Further Plan beyond TDR

- Further work required for detailed engineering to prepare for realization of the ILC project,

ILC Time Line

1980’ ~ Basic Study

2005 2006 2007 2008 2009 2010 2011 2012 2013

2004

ILC-GDE

LCC

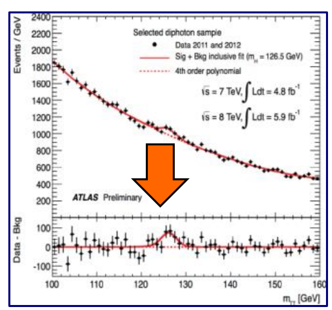
Ref. Design (RDR)

Tech. Design : TDP1

TDP 2

Selection of SC Technology

LHC

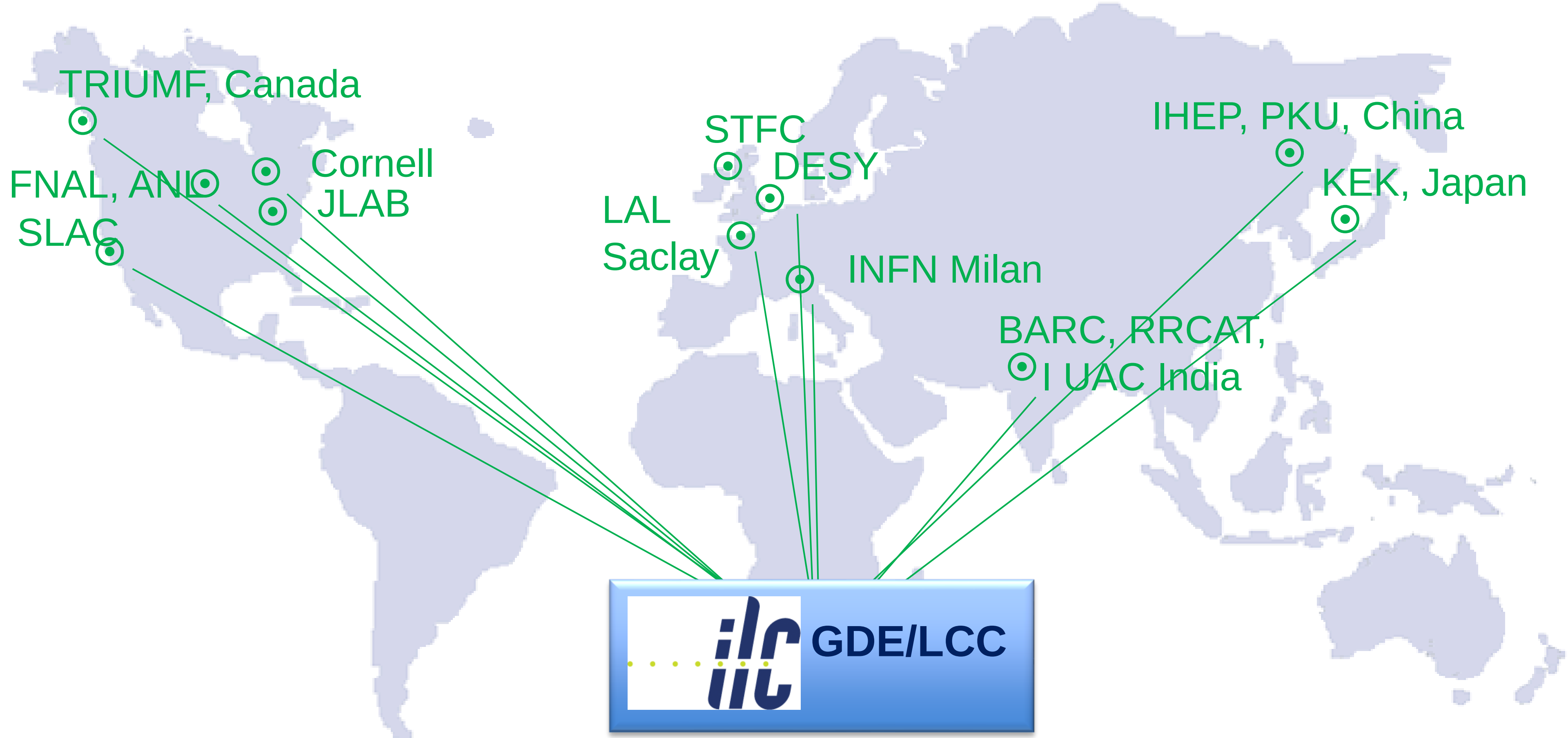


Higgs particle discovery

TDR completion

126 GeV

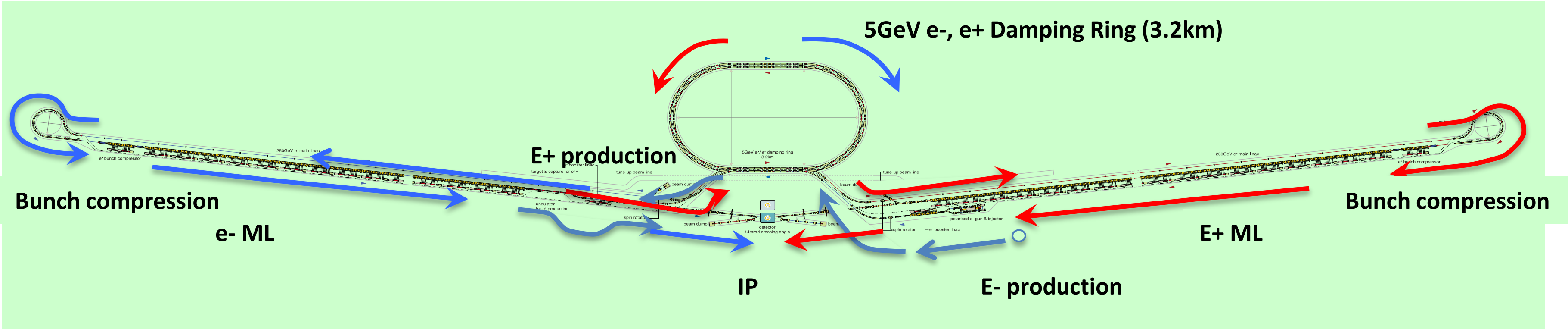
ILC R&D: Global Collaboration



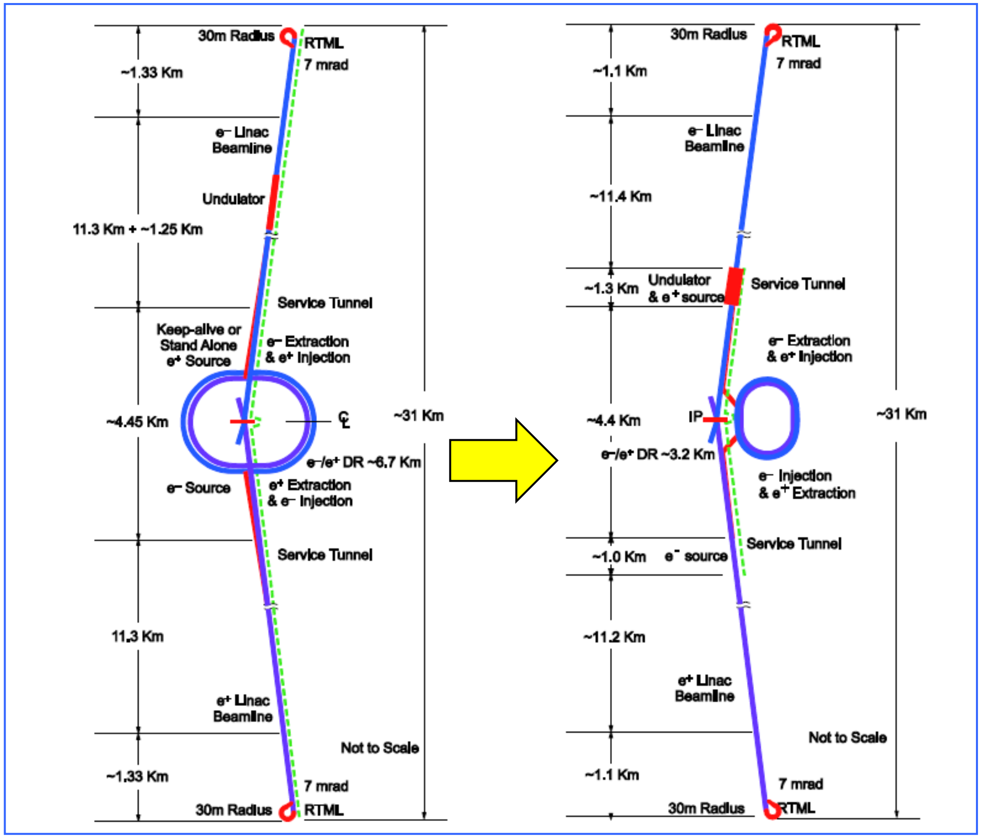
We would thank the global effort

Requirements from Physics Exp.

- **Basic requirements：**
  - Luminosity : $\int L dt$ = 500 fb^{-1} in 4 years
  - E_{cm} : 200 – 500 GeV and the ability to scan
  - E stability and precision: < 0.1%
  - Electron polarization: > 80%
- **Extension capability：**
  - Energy upgrade: 500 → 1,000 GeV

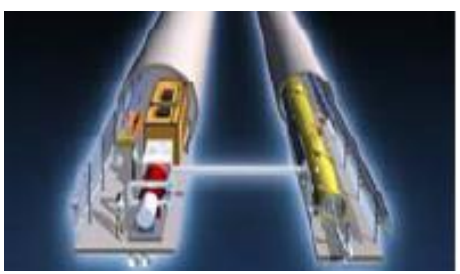


RDR (2007) to TDR (2012)

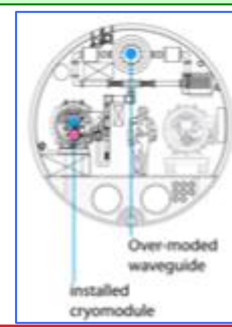


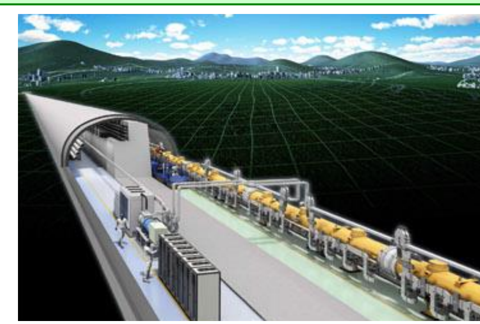
Cost Containing Effort

- **Single acc. Tunnel**
- **Reducing # bunches**
  - w/ smaller damping rings
- **Allowing gradient spread**
  - 31.5 MV/m +/- 20 %,
- **Site-dependent RF system:**
  - Clustered on surface (KCS),
  - Distributed in tunnl (DKS)



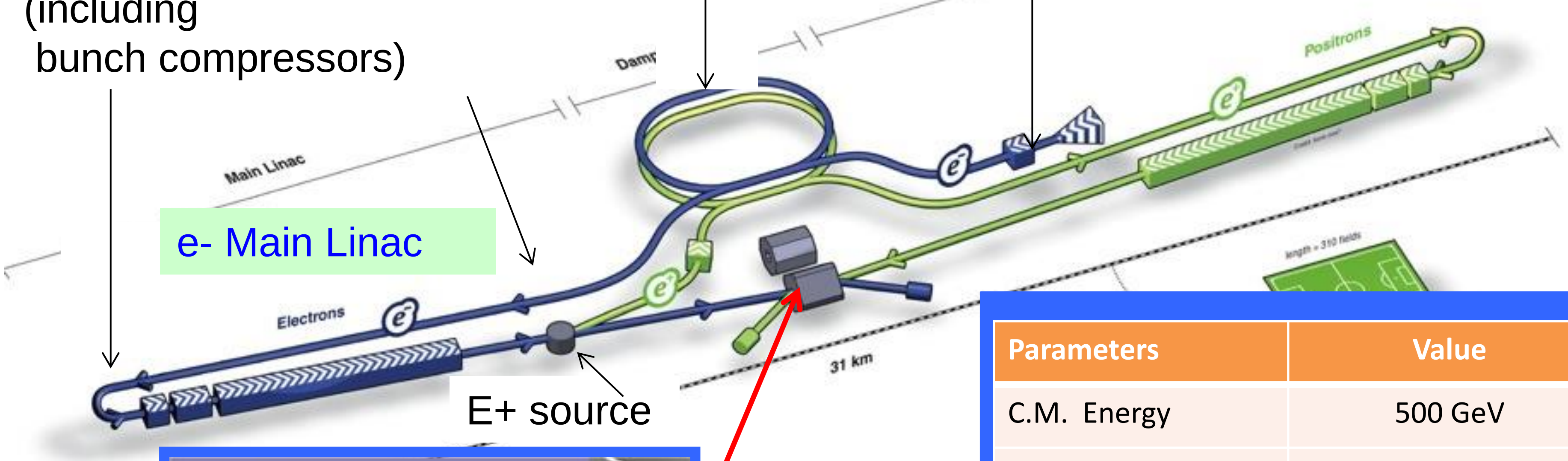
RDR'07 →
(Reference Design Rep.)
TDR'12
(Technical Design Rep.)

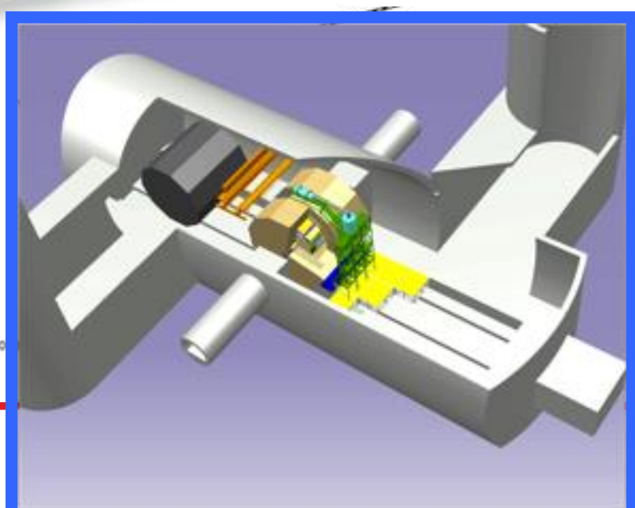




Flat-land or Mountainous Tunnel Design

ILC TDR Layout





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 independent:

Luminosity Upgrade

Collision rate	Hz	5	
Number of bunches		1312	2625
Bunch population	$\times 10^{10}$	2	
Bunch separation	ns	554	366
Pulse current	mA	5.8	8.8
Beam pulse length	ms	730	960
RMS bunch length	mm	0.3	
Horizontal emittance	mm	10	
Vertical emittance	nm	35	
Electron polarisation	%	80	
Positron polarisation	%	30	

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

ILC-TDR: Baseline Parameters

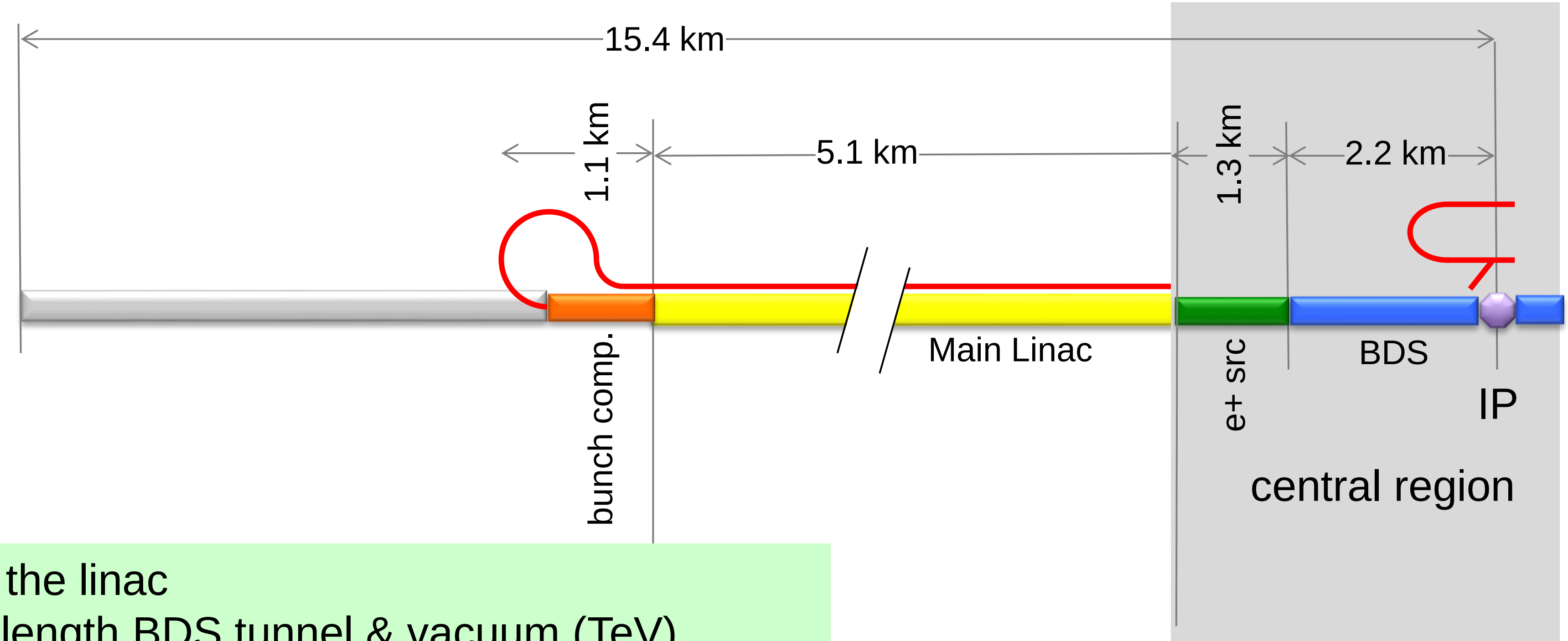
Centre-of-mass dependent:

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% DE/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

250 GeV staged (scenario 1)

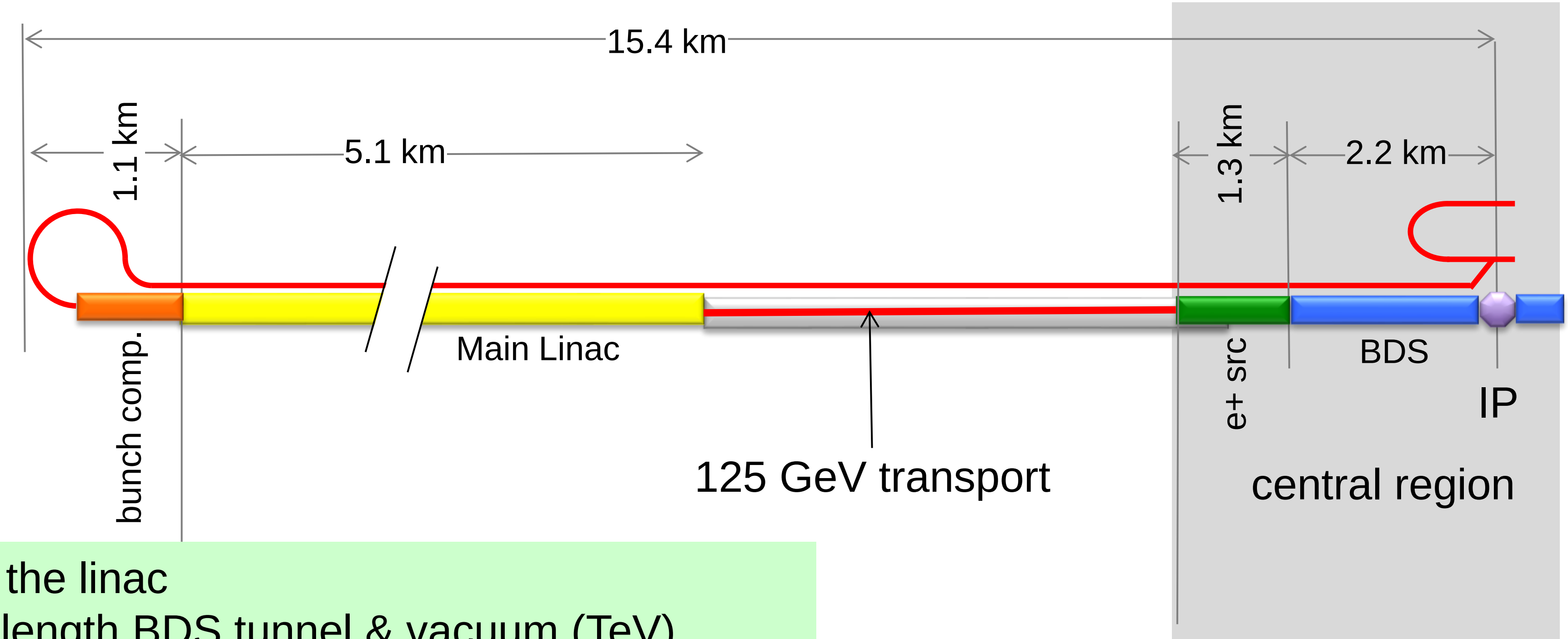


Half the linac
Full-length BDS tunnel & vacuum (TeV)
½ BDS magnets (instrumentation, CF etc)
½ RTML LTL

Extended tunnel/CFS already 500 GeV stage

10Hz mode e- linac

250 GeV staged (scenario 2)



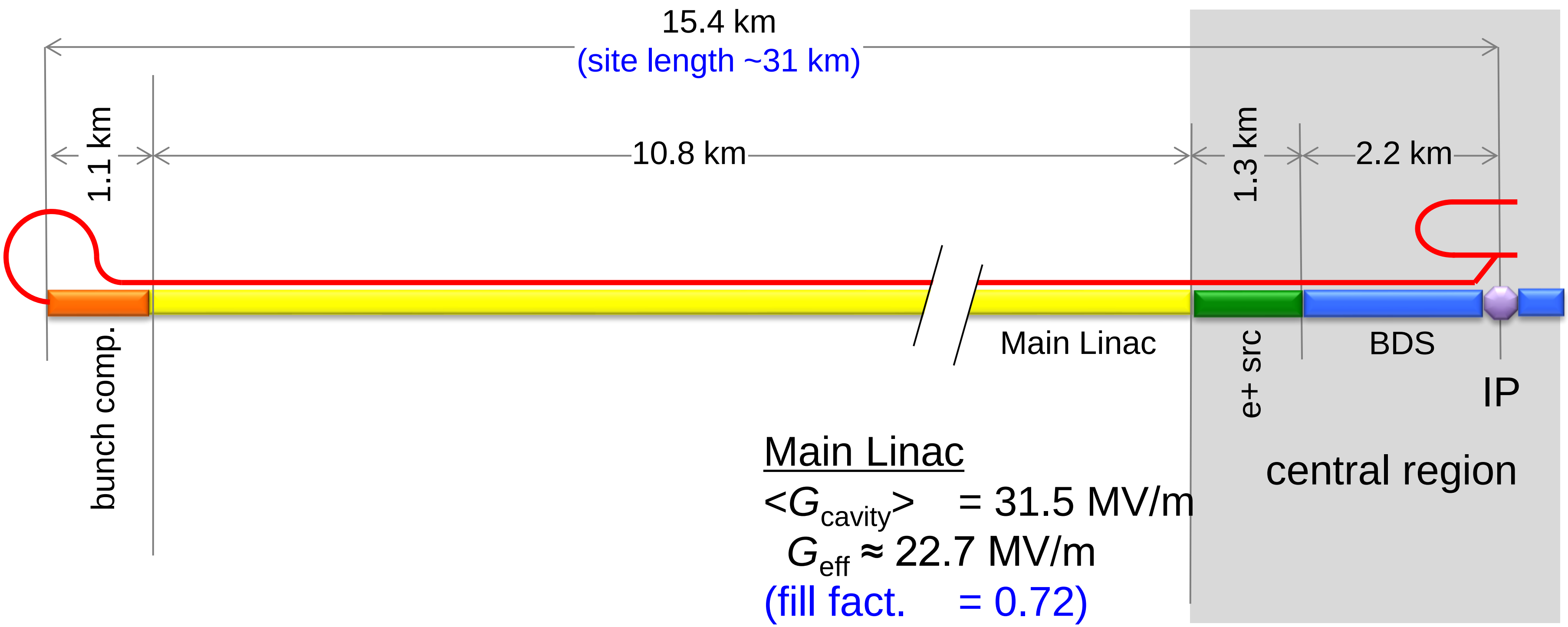
Half the linac
Full-length BDS tunnel & vacuum (TeV)
½ BDS magnets (instrumentation, CF etc)
1 RTML LTL
5km 125 GeV transport line

Extended tunnel/CFS already 500 GeV stage

10Hz mode e- linac

quasi-adiabatic energy upgrade?

TDR 500 GeV Baseline



Cost: 100%

P_{AC}: 161 MW

Major R&D Efforts in TD Phase

SCRF technology and beam acceleration :

- Cavity Gradient required : 31.5 MV/m
  - ILC SCRF cavity R&D
    - Effort for ~ 7 x Gradient (KEK-TRISTAN, CERN-LEP)
    - Gradient Progress : < 37 MV/m> （Record : 46 MV/m at DESY)
    - System engineering : S1-Global program with global effort

Electron Cloud Mitigation

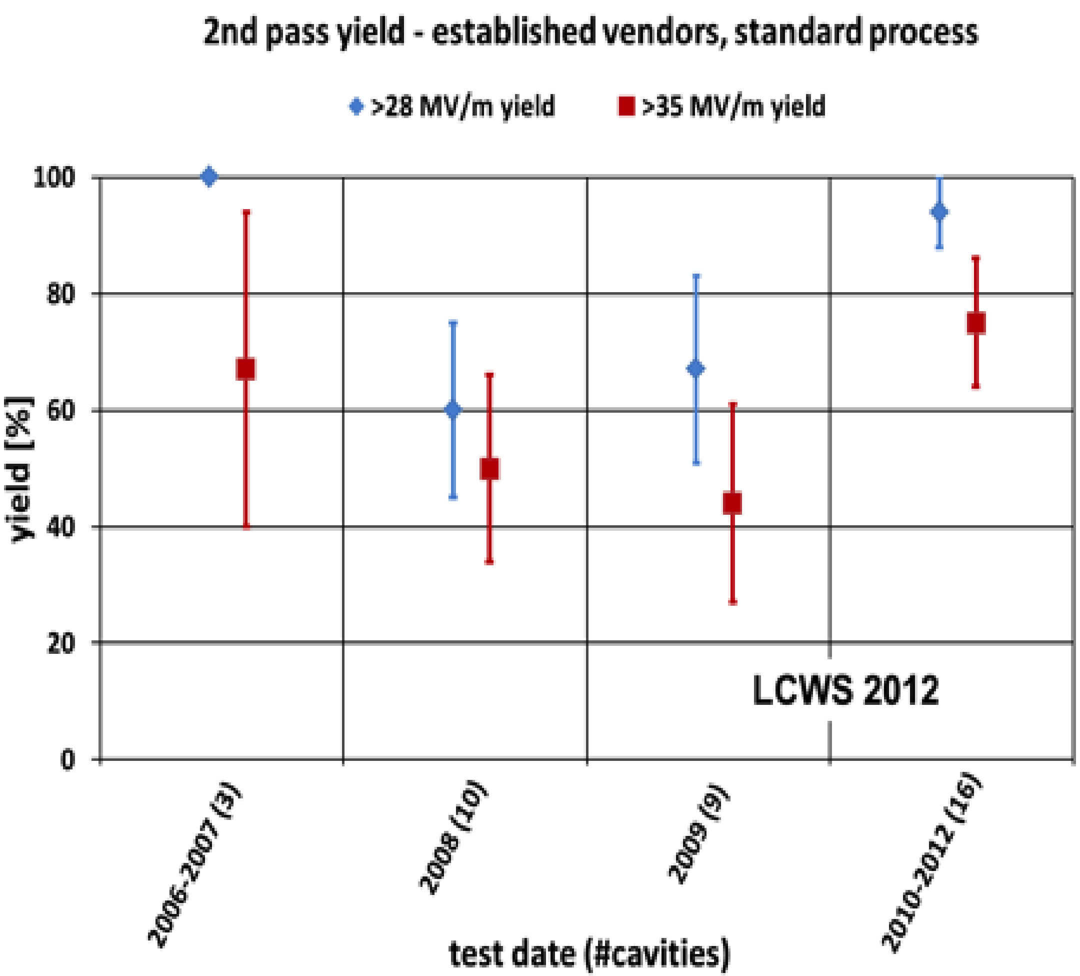
Nano-beam handling :

- ILC requiring a beam size ~ 6 nm (vertical) and stability ~2nm:
  - Progress in KEK-ATF:
    - achieving ~70 nm (at 1.3 GeV),
    - corresponding to 10 nm (at 250 GeV, ILC)

Global Plan for SCRF R&D

Year	**07**	**2008**	**2009**	**2010**	**2011**	**2012**
Phase	**TDP-1**			**TDP-2**		
Cavity Gradient in v. test to reach 35 MV/m	**→ Yield 50%**			**→ Yield 90%**		
Cavity-string to reach 31.5 MV/m, with one-cryomodule		**Global effort for string assembly and test** (DESY, FNAL, INFN, KEK)				
System Test with beam acceleration		**FLASH (DESY) , NML/ASTA (FNAL) QB, STF2 (KEK)**				
Preparation for Industrialization			**Production Technology R&D**			
Communication with industry:	1^{st} Visit Vendors (2009), Organize Workshop (2010) 2^{nd} visit and communication, Organize 2^{nd} workshop (2011) 3^{rd} communication and study contracted with selected vendors (2011-2012)					

Progress in SCRF Cavity Gradient



Production yield:
94 % at > 28 MV/m,

Average gradient:
37.1 MV/m

reached (2012)

Progress in 1.3 GHz ILC Cavity Production

year	# 9-cell cavities qualified	Capable Lab.	Capable Industry
2006	10	1 DESY	2 ACCEL, ZANON
2011	41	4 DESY, JLAB, FNAL, KEK	4 RI, ZANON, AES, MHI,
2012	(45)	5 DESY, JLAB, FNAL, KEK, Cornell	5 RI, ZANON, AES, MHI, Hitachi

- **Progress in EXFEL (800 cavity construction as of 2012/10):**

  (courtesy by D. Reschke: the 2nd EP at DESY)

  - RI: 4 reference cavities with Eacc > 28 MV/m, (~ 39 MV/m max.)
  - Zanon: 3 reference cavities with Eacc > 30 MV/m (~ 35 MV/m max.)

To be discussed by N. Walker, this aftenoon

Accelerator System Tests

2009 ~

FLASH (DESY)

- TDP focus
- 7 CM → 1.2 GeV beam
- photon user facility

NML (FNAL)

- Under construction
- Up to 6 cryomodules
- Operation: end 2012
  - (3 CM)

STF (KEK)

- "Quantum Beam" experiment 2011
- 1 CM with beam 2013
- (2 CM 2015)

Full systems integration testing

SCRF Beam Acceleration Test

DESY: FLASH

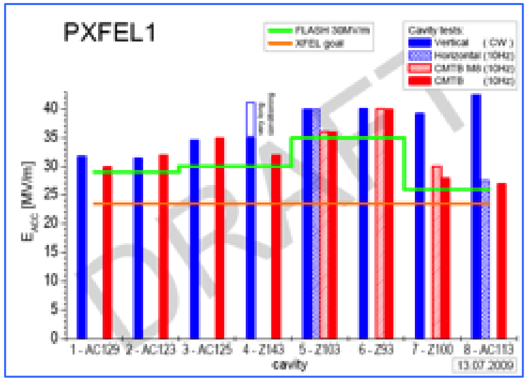
- SRF-CM string + Beam,
  - ACC7/PXFEL1 < 32 MV/m >
- 9 mA beam, 2009
- 800μs, 4.5mA beam, 2012

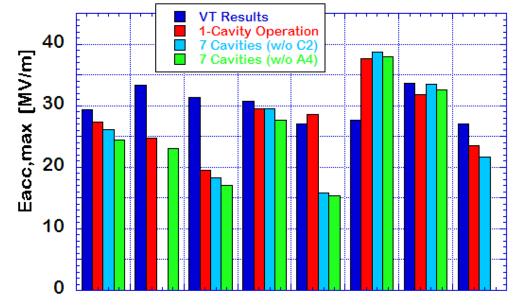
KEK: STF

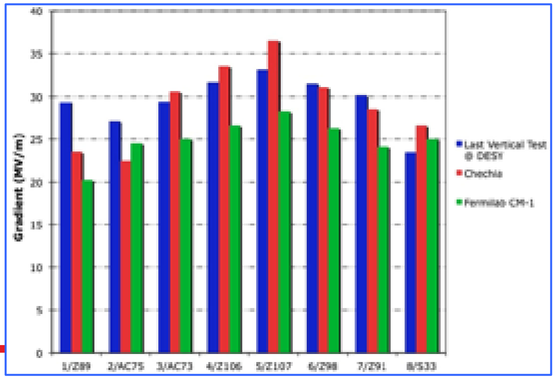
- S1-Global: complete, 2010
  - Cavity string : < 26 MV/m>
- Quantum Beam : 6.7 mA, 1 ms,
- CM1 & beam, 2014 ~2015

FNAL: NML/ASTA

- CM1 test complete
- CM2 operation, in 2013
- CM2 + Beam, 2013 ~ 2014

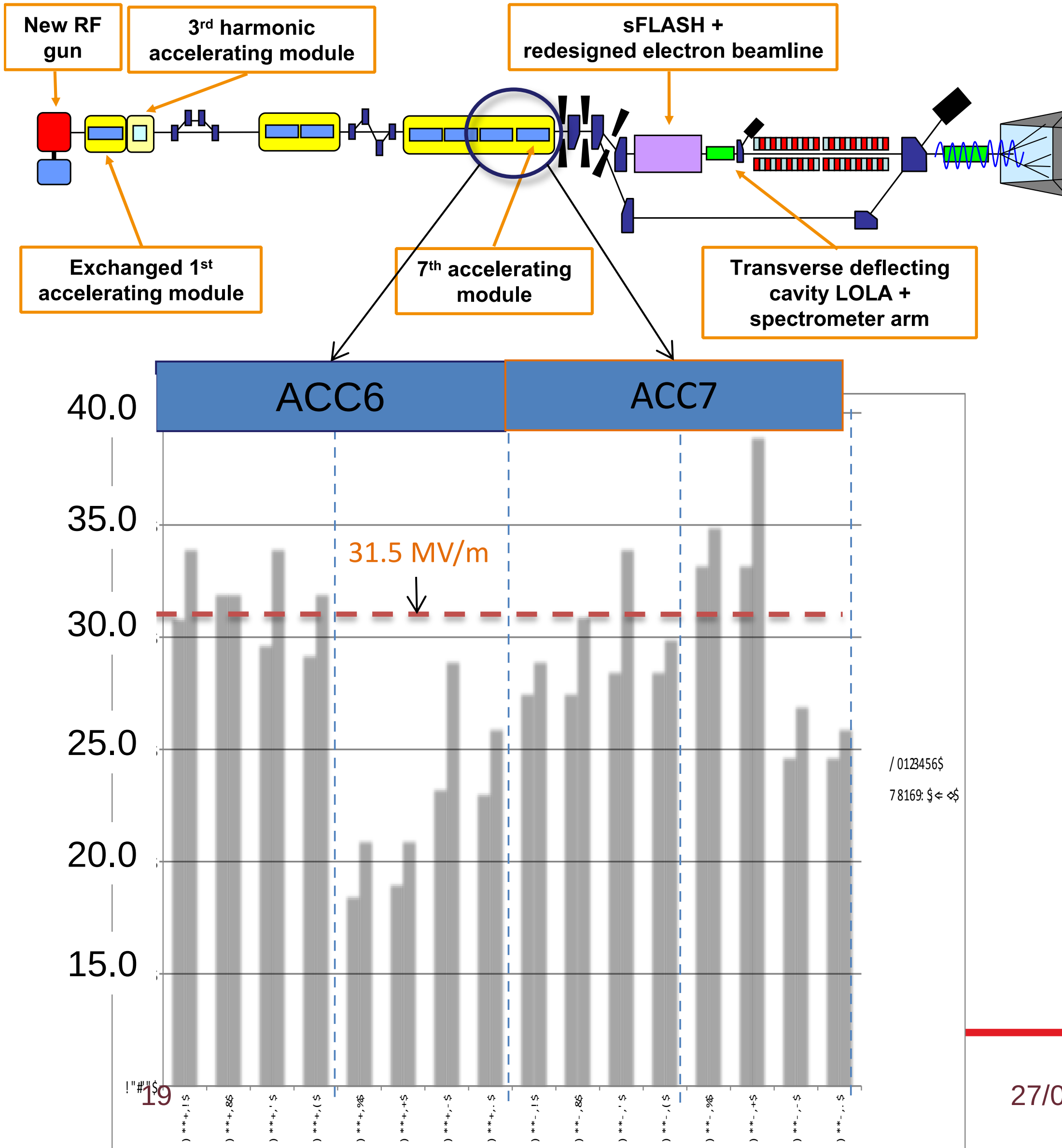






N. Walker

GDE 9mA experiment: Focus on ACC6 and ACC7



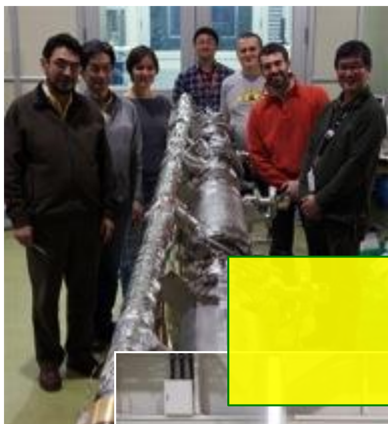
- **Operation with <u>Gradient Spread</u>**
- From single RF source
- now ILC baseline
  - Also expected for XFEL

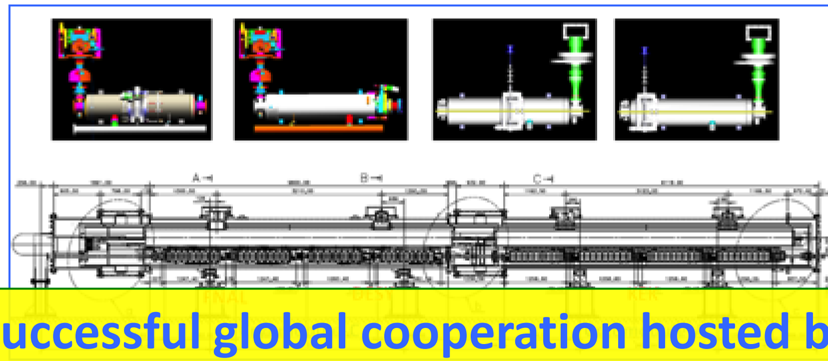
- **Specifically: achieving constant gradients <u>for each individual cavity</u> during beam pulse**
- to within few percent
- close to gradient limits

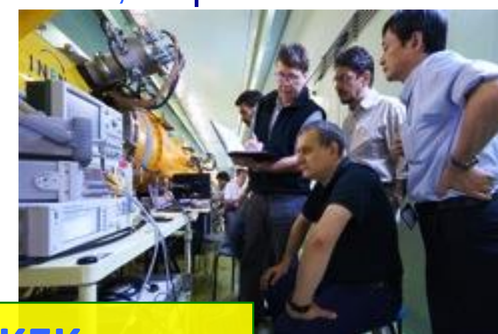
S1-Global hosted at KEK: Global cooperation to demonstrate SCRF system

DESY, FNAL, Jan., 2010

DESY, Sept. 2010







FNAL & INFN, July, 2010

Successful global cooperation hosted by KEK with variety of cavity design

INFN and FNAL Feb. 2010

March, 2010

DESY, May, 2010

June, 2010 ~

Variety of Cavity and Tuner Assembly

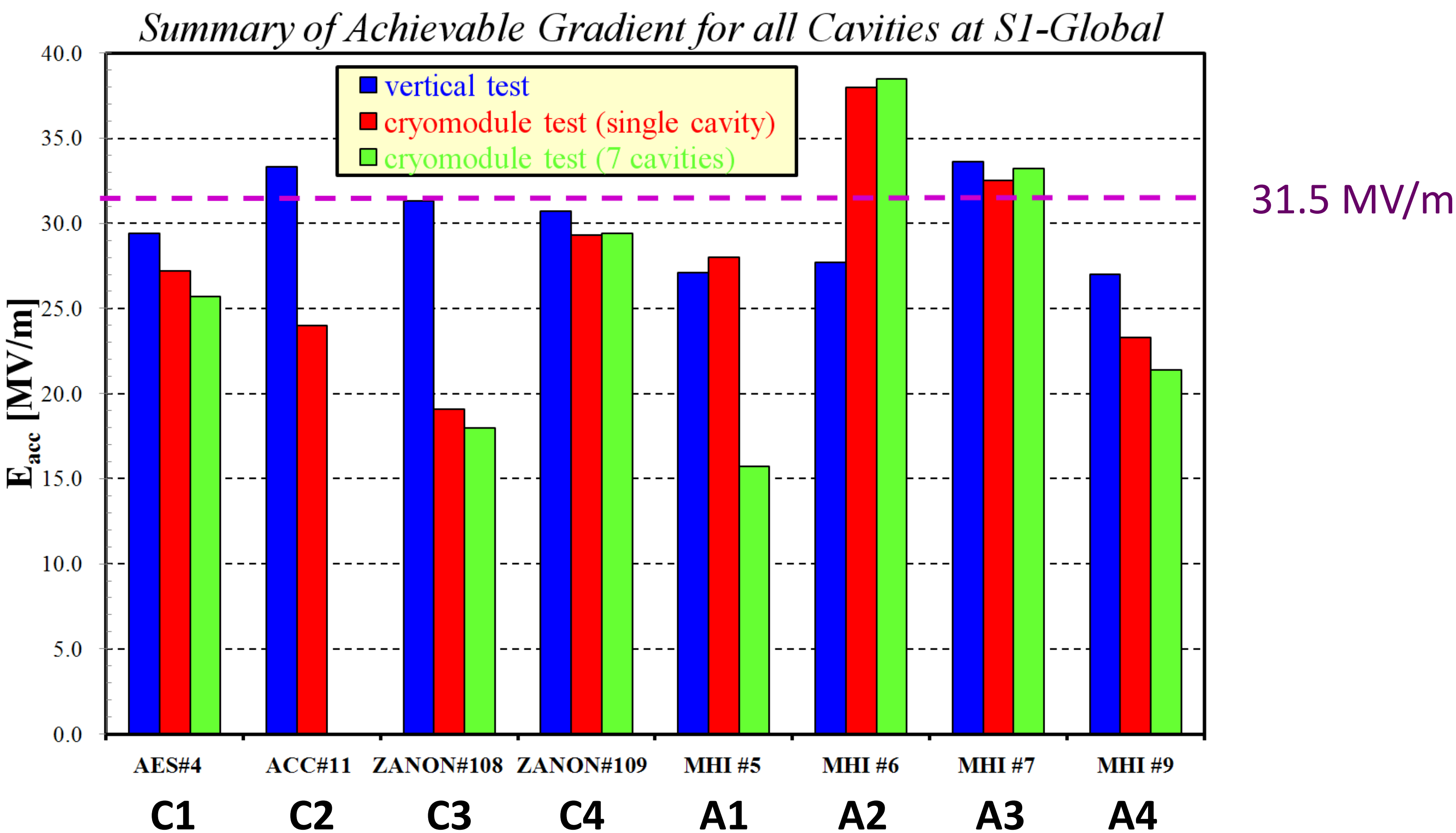
Blade Tuner (originated by INFN)

Slide-jack tuner at KEK
EXFEL tuner

An important conclusion:
These designs may meet the ILC functioning requirements.

E. Kako, H. Hayano

S1G-Cavities Gradient Performance

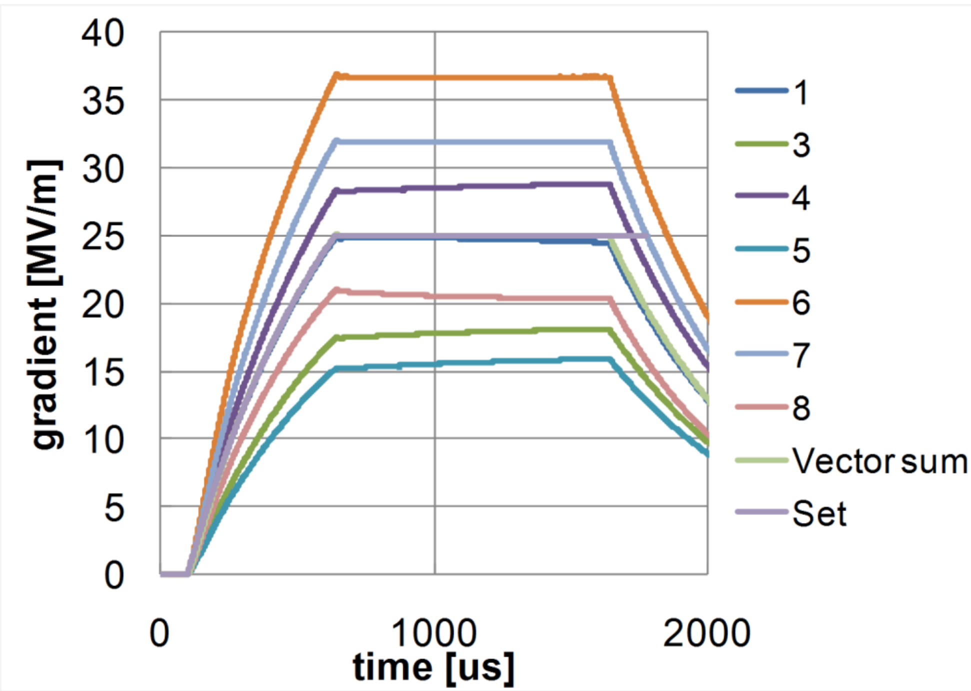


(blue)	Before cryomodule installation	Average 30.0MV/m
(red)	after cryomodule installation	Average 27.7MV/m
(green)	7 cavities combined operation	Average 26.0MV/m

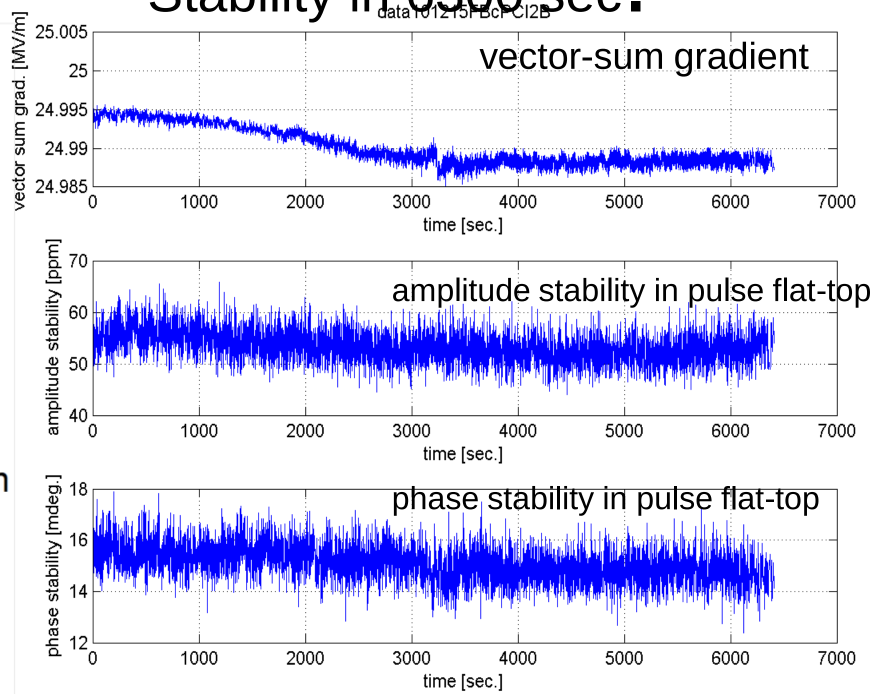
7-cavity operation by digital LLRF

LLRF stability study with 7 cavities operation at 25MV/m

Field Waveform of each cavity



Stability in 6300 sec.

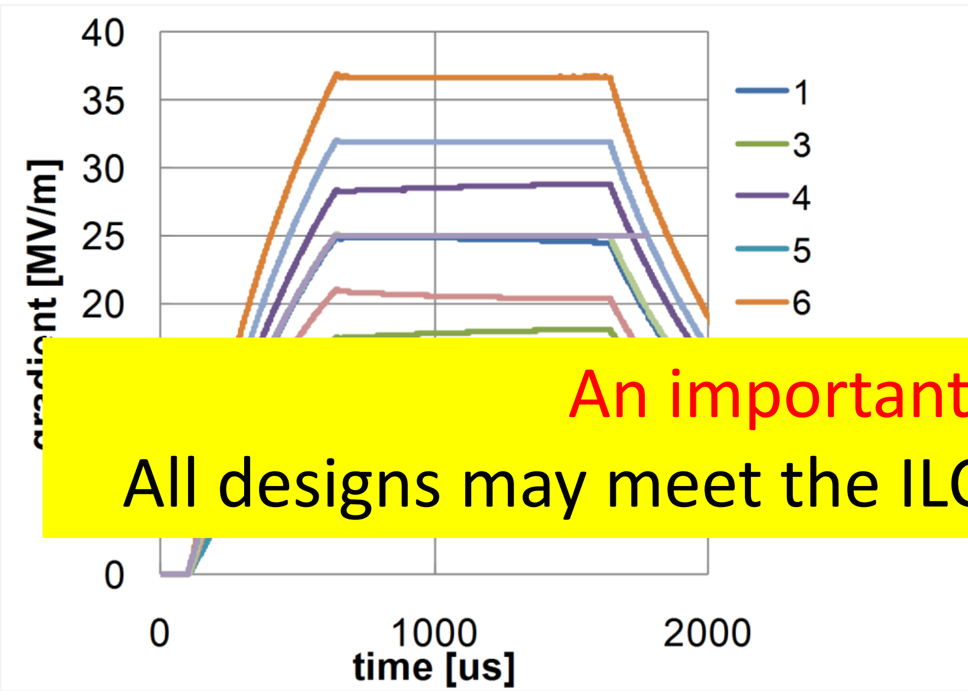


- Vector-sum stability: 24.995MV/m ~ 24.988MV/m (~0.03%)
- Amplitude stability in pulse flat-top: < 60ppm=0.006%rms
- Phase stability in pulse flat-top: < 0.0017 degree.rms

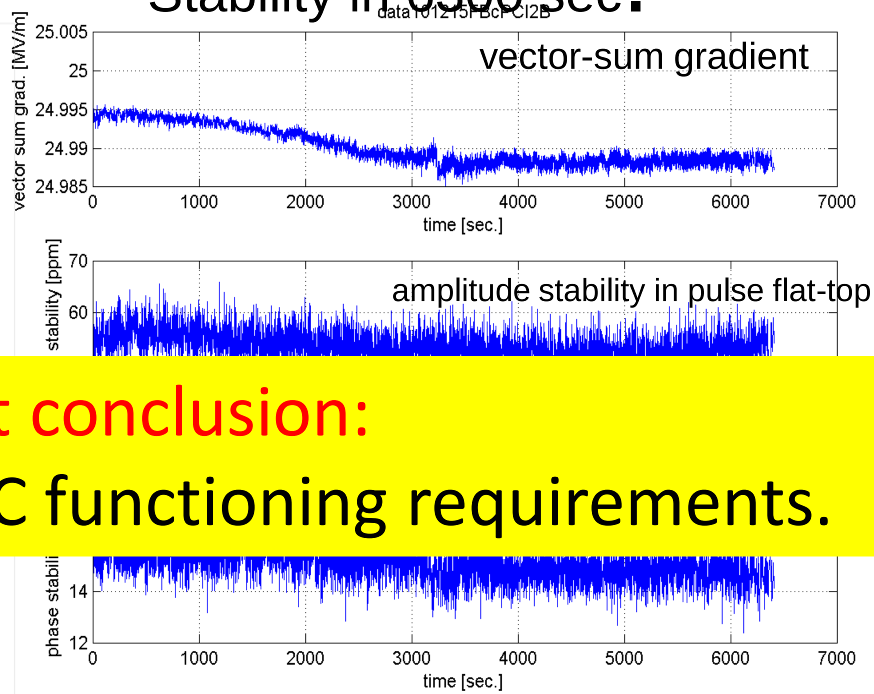
7-cavity operation by digital LLRF

LLRF stability study with 7 cavities operation at 25MV/m

Field Waveform of each cavity



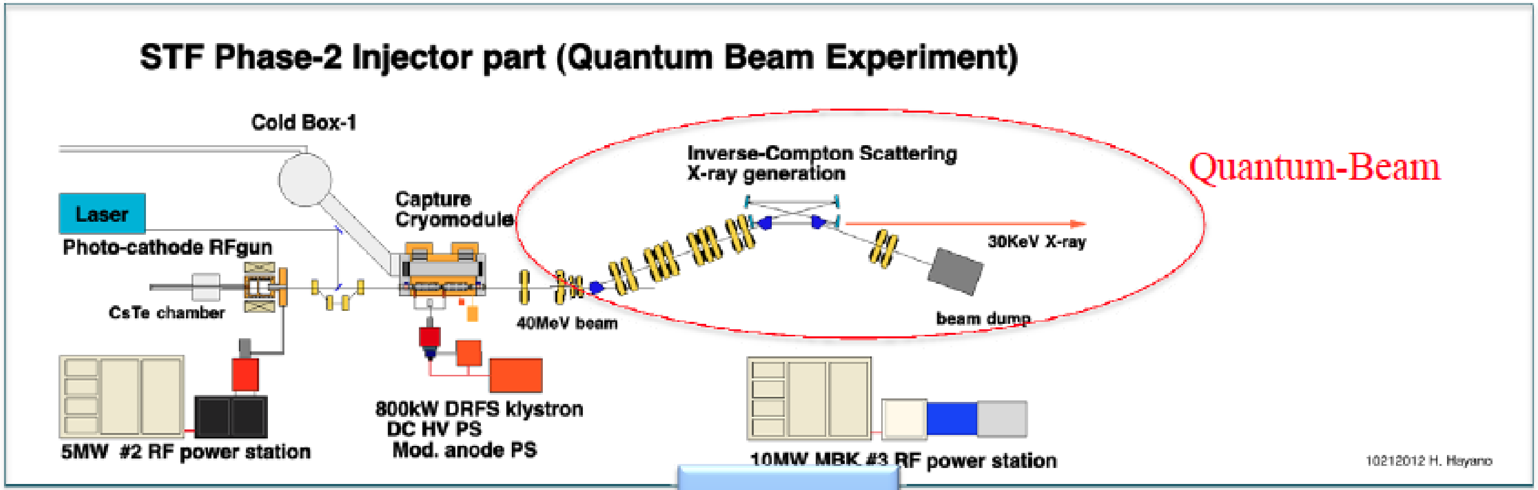
Stability in 6300 sec.

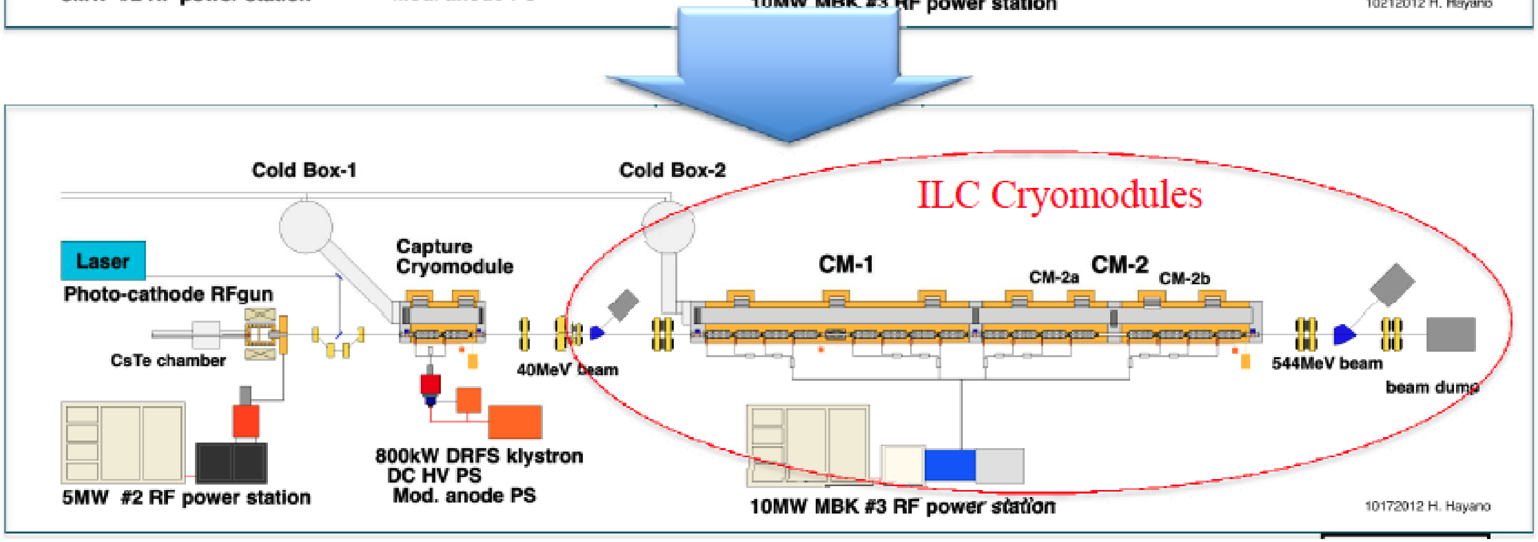


An important conclusion:
All designs may meet the ILC functioning requirements.

- Vector-sum stability: 24.995MV/m ~ 24.988MV/m (~0.03%)
- Amplitude stability in pulse flat-top: < 60ppm=0.006%rms
- Phase stability in pulse flat-top: < 0.0017 degree.rms

STF：Quantum Beam → ILC full-cryomodule Test

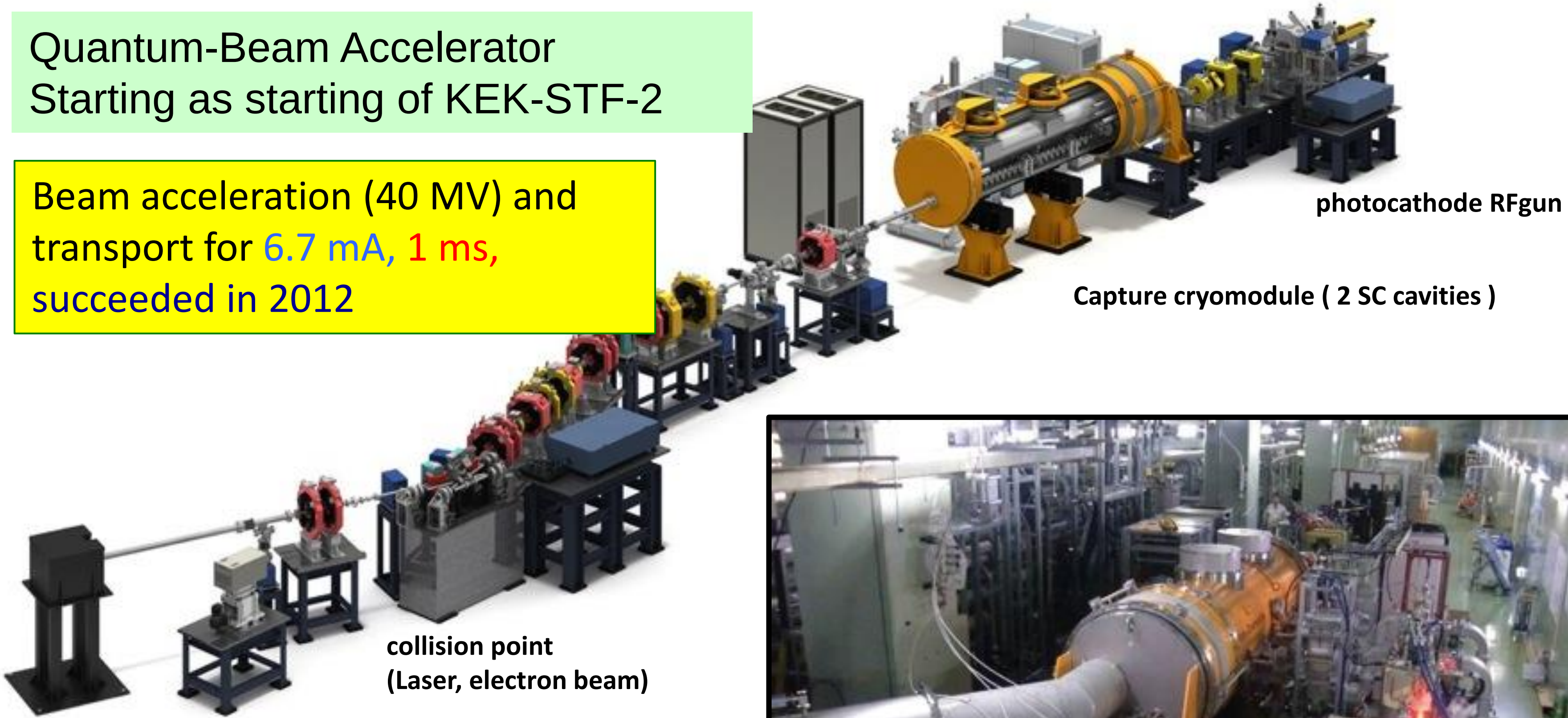


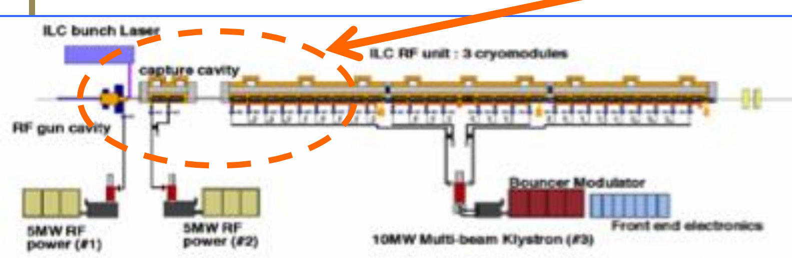


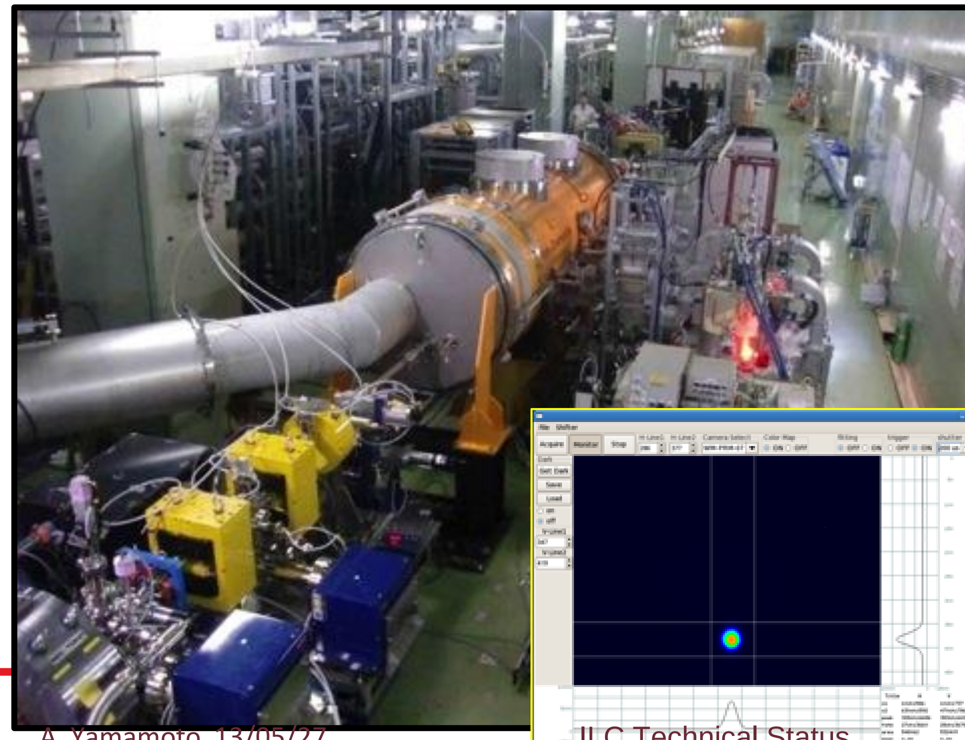
ILC beam condition demonstrated at QB

Quantum-Beam Accelerator
Starting as starting of KEK-STF-2

Beam acceleration (40 MV) and transport for 6.7 mA, 1 ms, succeeded in 2012

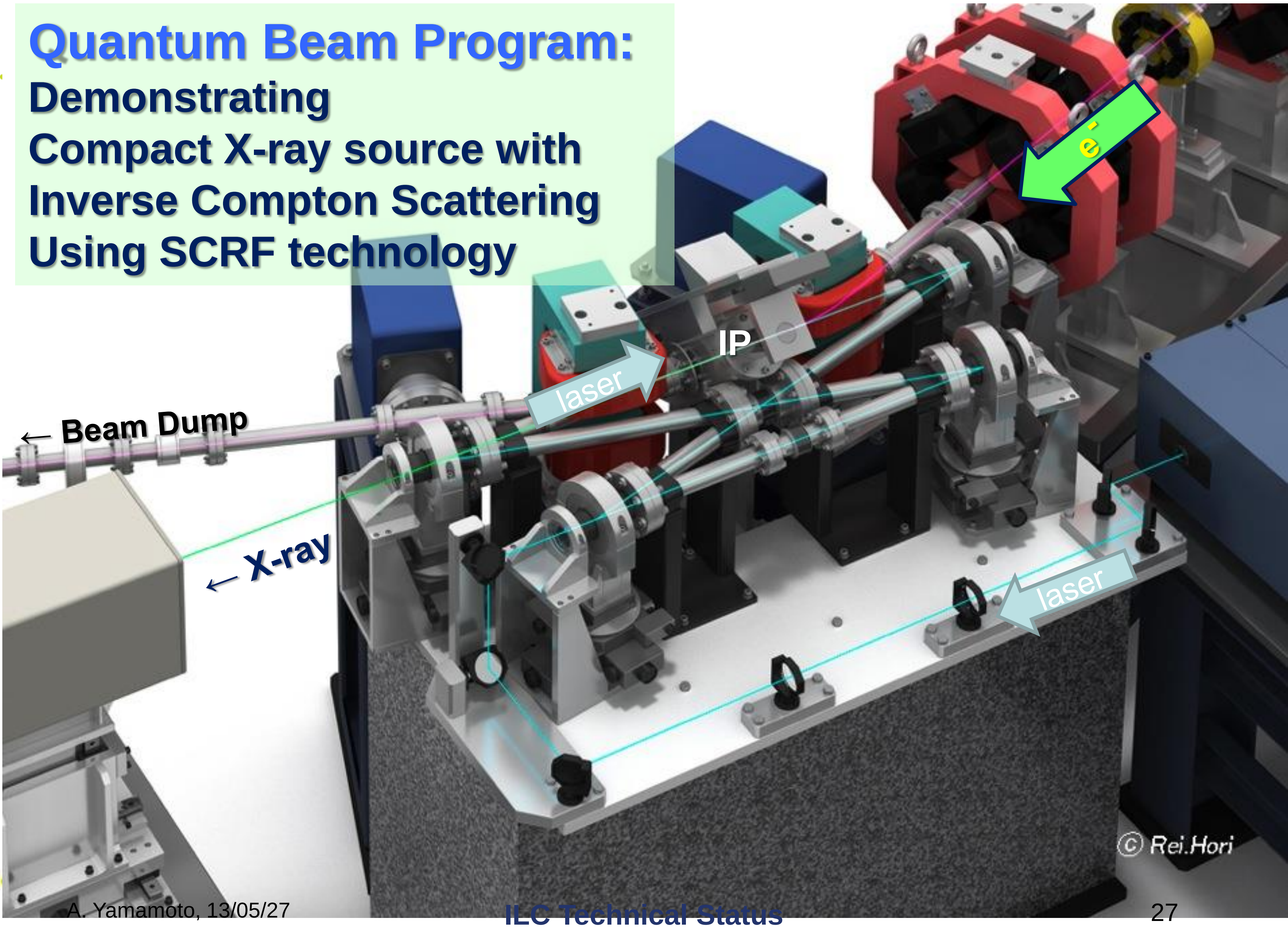




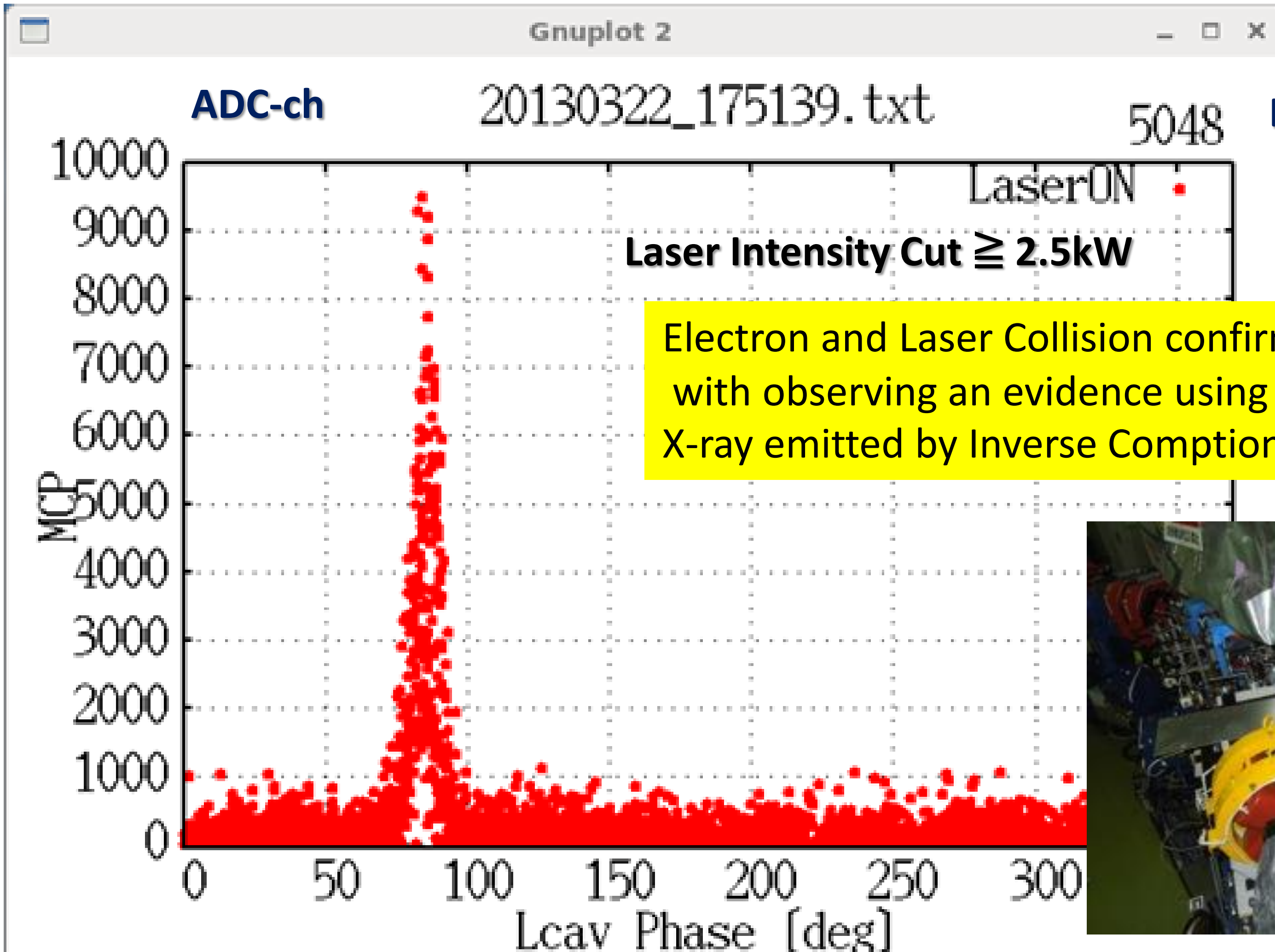


Quantum Beam Program:

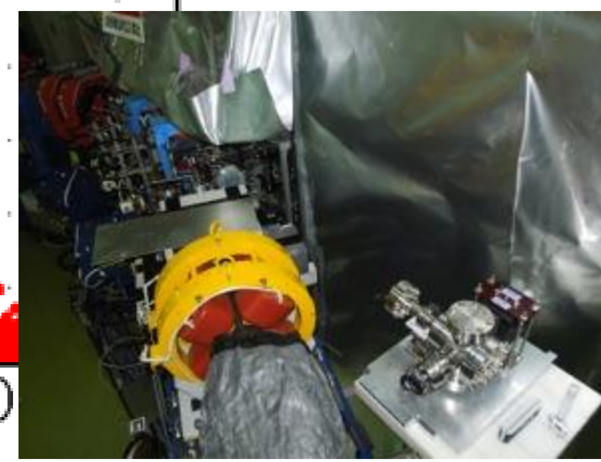
Demonstrating Compact X-ray source with Inverse Compton Scattering Using SCRF technology



X-ray observed (w/ MCP, 22nd Mar.2013)



Electron and Laser Collision confirmed
with observing an evidence using MCP :
X-ray emitted by Inverse Comption scattering



Global Cooperation for ILC Accelerator Beam Demonstration

LINEAR COLLIDER

TTF/FLASH (DESY) ~1 GeV
ILC-like beam ILC RF unit
(* lower gradient)

STF (KEK) operation/construction
ILC Cryomodule test : S1-Gloabal
Quantum Beam experiment

CesrTA (Cornell)
electron cloud
low emittance

DESY

INFN Frascati

KEK, Japan

FNAL

Cornell

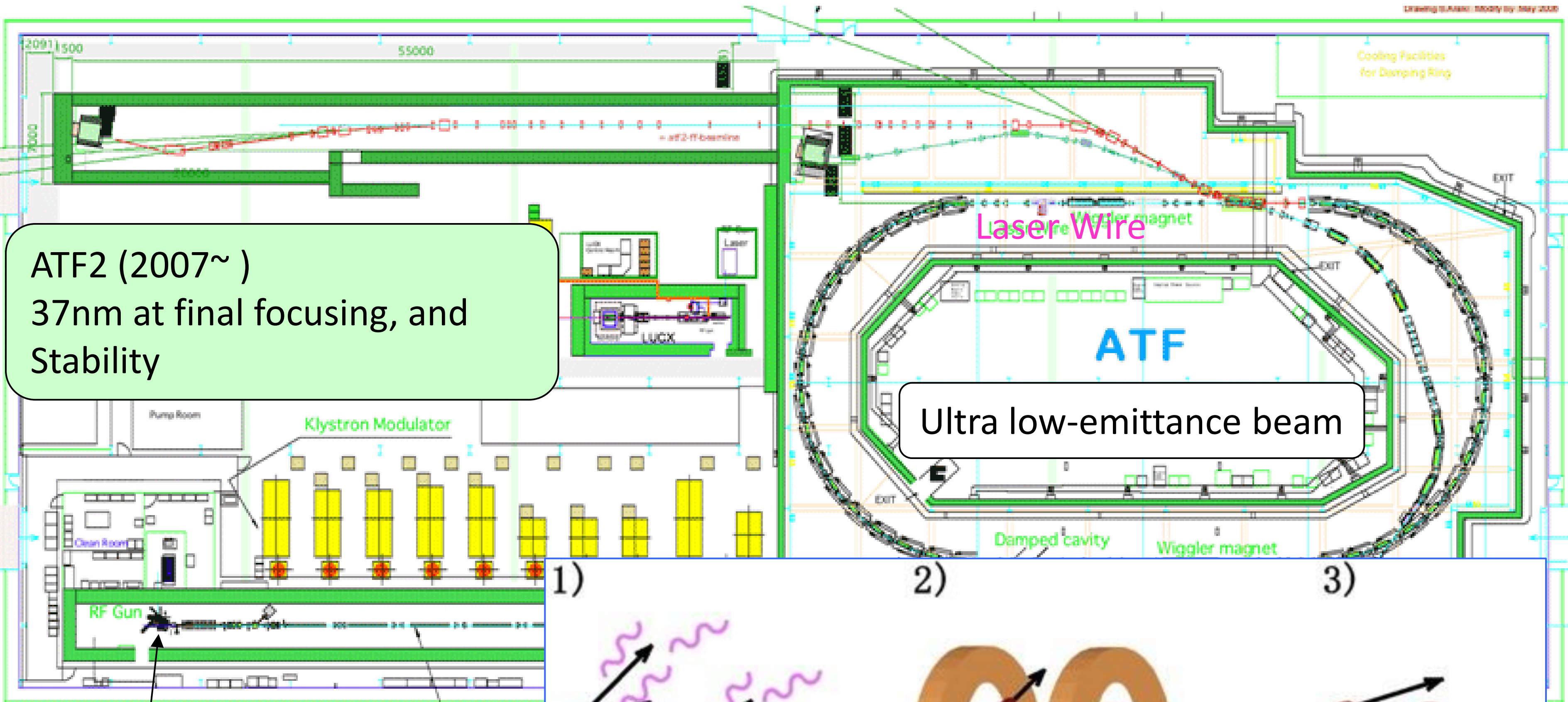
NML facility ILC RF unit test
Under construction

DA^{f}NE (INFN Frascati)
kicker development
electron cloud

ATF & ATF2 (KEK)
ultra-low emittance
Final Focus optics
KEKB electron-cloud

KEK-ATF Effort:

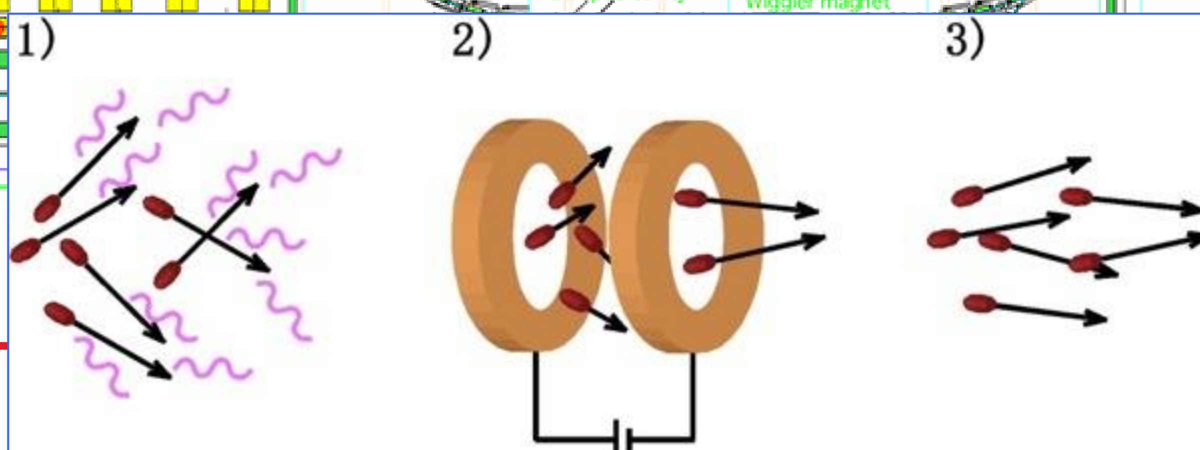
Ultra low emittance and nano-beam handling at final focusing



ATF2 (2007~)
37nm at final focusing, and Stability

Ultra low-emittance beam

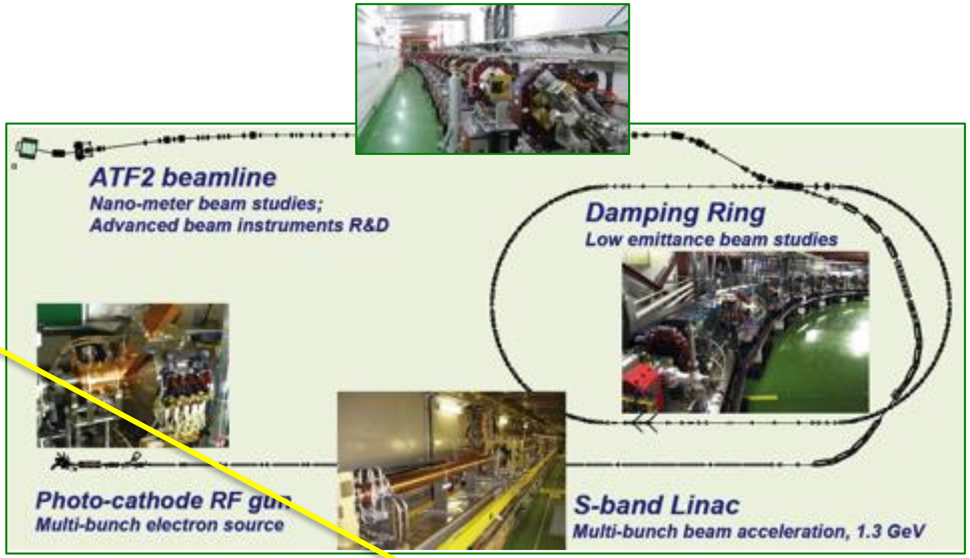
Photocathode RF gun

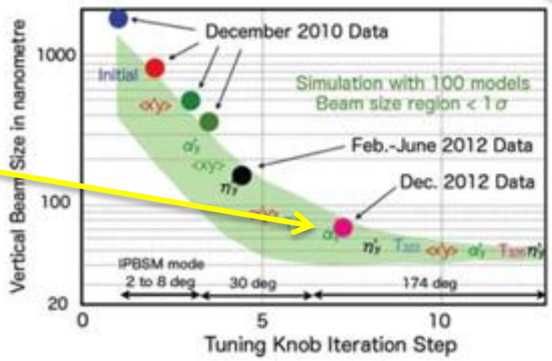


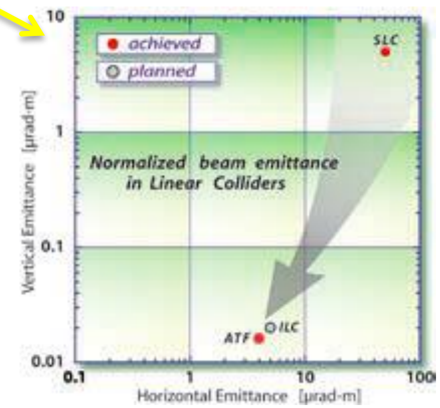
KEK-ATF : Progress

Ultra-small beam

- **Low emittance : KEK-ATF**
  - Achieved the ILC goal (2004).
- **Small vertical beam size : KEK ATF2**
  - Goal = 37 nm,
    - – 160 nm (spring?, 2012)
    - – ~70 nm (Dec. 2012) at low beam current







Technical Design Report Completed

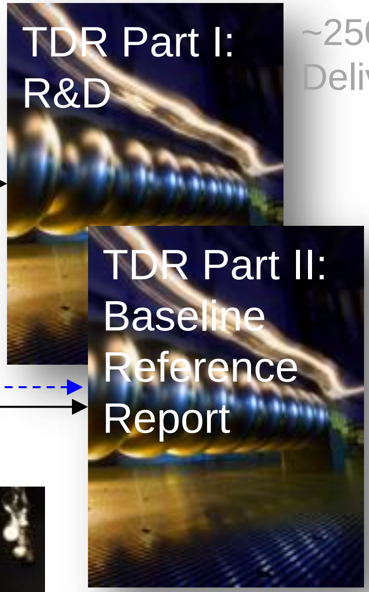
2007

2011

2013*

ILC Technical Progress Report (“*interim report*”)

AD&I



~250 pages
Deliverable 2

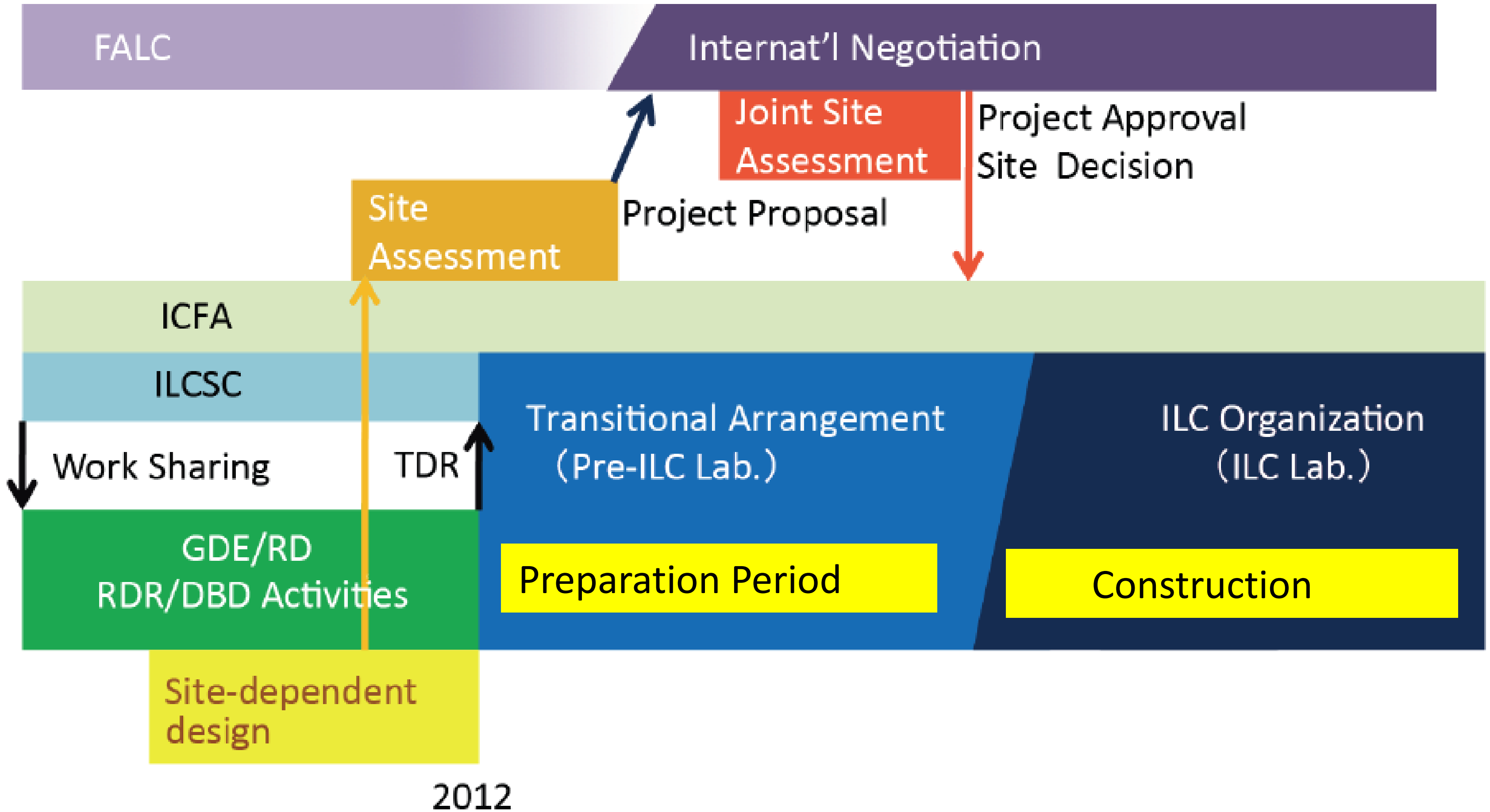
~300 pages
Deliverables 1,3 and 4

Reference Design Report

Technical Design Report

* end of 2012 – formal publication early 2013

ILC Road Map


FALC
Internat'l Negotiation
Joint Site
Assessment
Project Approval
Site Decision
Site
Assessment
Project Proposal
ICFA
ILCSC
Work Sharing
TDR
Transitional Arrangement
（Pre-ILC Lab.）
ILC Organization
（ILC Lab.）
GDE/RD
RDR/DBD Activities
Preparation Period
Construction
Site-dependent
design
2012

Outline

Technical Status reached in TDR

- Design update from Reference Design Report (RDR'07) to Technical Design Report (TDR'12)
- Results from research & development
- Recommendations given by PAC

Further Plan beyond TDR

- Further work required for detailed engineering to prepare for realization of the ILC project,

Report given by PAC

REPORT OF THE NINTH MEETING OF THE ILC PROJECT ADVISORY COMMITTEE (PAC)

13/14 December 2012; KEK

Augmented Committee: Jon Bagger, Johns Hopkins; Jia-Er Chen, IHEP/Beijing; Stefan Choroba, DESY; Michel Davier, LAL; Lyn Evans, CERN (Chair); Paul Grannis, Stony Brook; Lutz Lilje, DESY; Tomio Kobayashi, Tokyo; Masao Kuriki, Hiroshima; Wolf-Dietrich Moeller, DESY; Katsunobu Oide, KEK; Robert Orr, Toronto; Roy Rubinstein, Fermilab (Secretary); John Seeman, SLAC; Hans Weise, DESY

Apologies: Enrique Fernandez, Barcelona; Stuart Henderson, Fermilab; John Mammosser, JLab; Raj Pillay, TIFR

PAC Summary and Recommendations (1/3)

1. The PAC was very impressed by the GDE presentations to the Committee, and supports the TDR. What follows are recommendations by the Committee on items that need to be addressed in the future; however, the PAC recommends no changes to the TDR.
2. The lack of progress towards the 37 nm ATF2 IP goal is a concern. Several issues have already been resolved, and the currently scheduled modifications should lead to significant progress towards the goal.
3. Sufficient progress has been made on SCRF that the TDR sections on cavity gradient can be defended. The desired gradient is well within reach, and several manufactures have been validated. XFEL industrialization will give valuable information.
4. The Japanese power coupler appears to be a good design, and should be pursued further to be adaptable to the TESLA-type cavity (having the smaller cold-end interface flange).
5. It would be valuable to obtain more operational statistics on the Marx modulator.

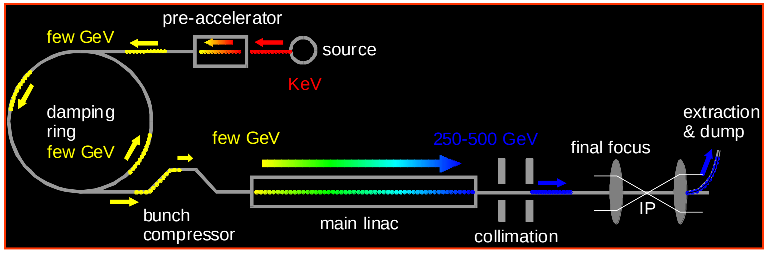
PAC Summary and Recommendations (2/3)

6. The Klystron Cluster Scheme (KCS) appears to solve several important problems, but several issues remain currently open:
   a) More test time of the system is needed
   b) It is not clear how well the current LLRF system will operate with KCS
   c) Can the system be aligned well enough that no other modes are excited?
   d) The effects of a fault in the power line should be studied further to ensure that no damage will be caused by the high power levels involved.
   e) A coupler breakdown in KCS could lead to availability issues.
   f) It is not clear how precise adjustment of the coaxial tap-offs (CTOs) can be achieved and maintained at high power operation to ensure the right coupling ratio and matching.
7. More evaluation is needed of cavity tuner designs.
8. Alternate cavity designs producing higher gradients could be valuable for future upgrades, but the current design is appropriate for a linear collider proposal.
9. Are there any advantages to having a 1.9 K liquid helium system?

PAC Summary and Recommendations (3/3)

10. More R&D appears to be needed on the positron source:
    a) A technical design of the rotating target should be established; it has to be compatible with ultra-high vacuum; enable fast rotation; and be robust to radiation damage.
    b) The flux concentrator as a matching device should be demonstrated
    c) A realistic scenario of installation and path-length adjustment for positron operation should be established.
11. The overall ILC cost was reduced a few years ago by shortening the damping ring from 6 km to 3 km. To keep the luminosity constant the beam sizes etc. at the IP were reduced. Thus, tolerances in several parts of the system became tighter. The recommendation is to complete a new overall tolerance study.
12. The IDAG presentation to the PAC meeting summarizes the recommendations on the ILC detectors, with an additional PAC comment below.
13. The two ILC detector designs have different L*s (distance to the IP from 1st quad). These were requested by the detector groups. If these two L*s were made the same, the retuning time between push-pull detector set-ups could be made shorter.

Further R&D/Engineering Study required



- Positron source: Rotating target, alternate solution/backup
- Damping ring: Undulators, 650 MHz SCRF
- RTML: Quadrupole magnet with HTS?
- ML: Cavity integration, CM design, HLRF demonstration…
- BDS: Final focusing, alignment w/ tighter tolerance
- Beam Dynamics: Accurate lattice design based on the specific site
- CFS: Site specific work including Central Campus design and others
- General engineering: such as drawing coordination (rules)

Positron Source

- Current design: Rotating target w/ vacuum sealing,
  - LLNL target and capture R&D: need to restart
- Alternative options, or conventional design as back-up?,
  - Any valuable candidates?
- Short-period undulator,
  - RHUL and/or ANL could do it?

Main Linac

- Cavity gradient
  - Surface process: Vertical EP w/ He-tank, and further optimization
  - Cavity material (RRR, grain-size), shape,
  - Diagnostics and repair technology
- Cavity integration
  - Coupler, tuner, and He-tank to be revisited for further efficient and cost-effective production/industrialization
- Cryomodule assembly
  - Mitigation of gradient degradation during the CM assembly process
  - Further engineering work for the best optimum CM design
  - Pre-Assembly of power distribution wave-guide) w/ CM, on surface
- Cryogenics
  - Demonstration of cooling performance with tilted CM installation to adapt possible tunnel slop (~0.5 %)
  - Operation temperature down to 1.9 K (instead of 2.0 K)
- HLRF/LLRF
  - More statics for the Marx generator operation loaded by Klystron

Cavities, Tuners, Couplers in S1-G Cryomodule

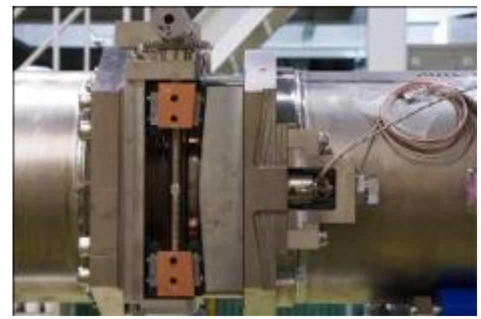
TESLA Cavity (DESY/FNAL)

Blade Tuner (INFN/FNAL)

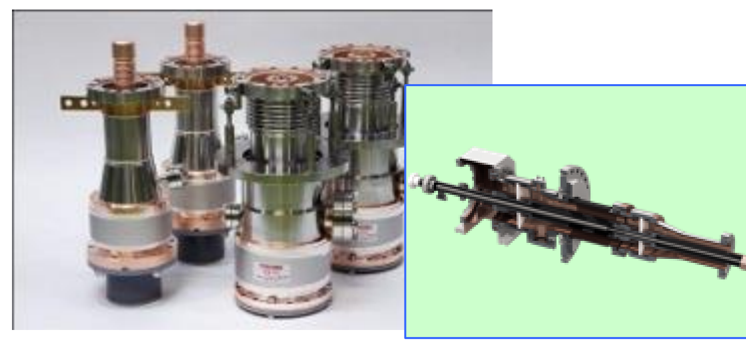
Saclay Tuner (DESY)

TTF-III Coupler (DESY/FNAL/SLAC)

Tesla-like Cavity (KEK)



Slide-Jack Tuner (KEK)



STF-II Coupler (KEK)

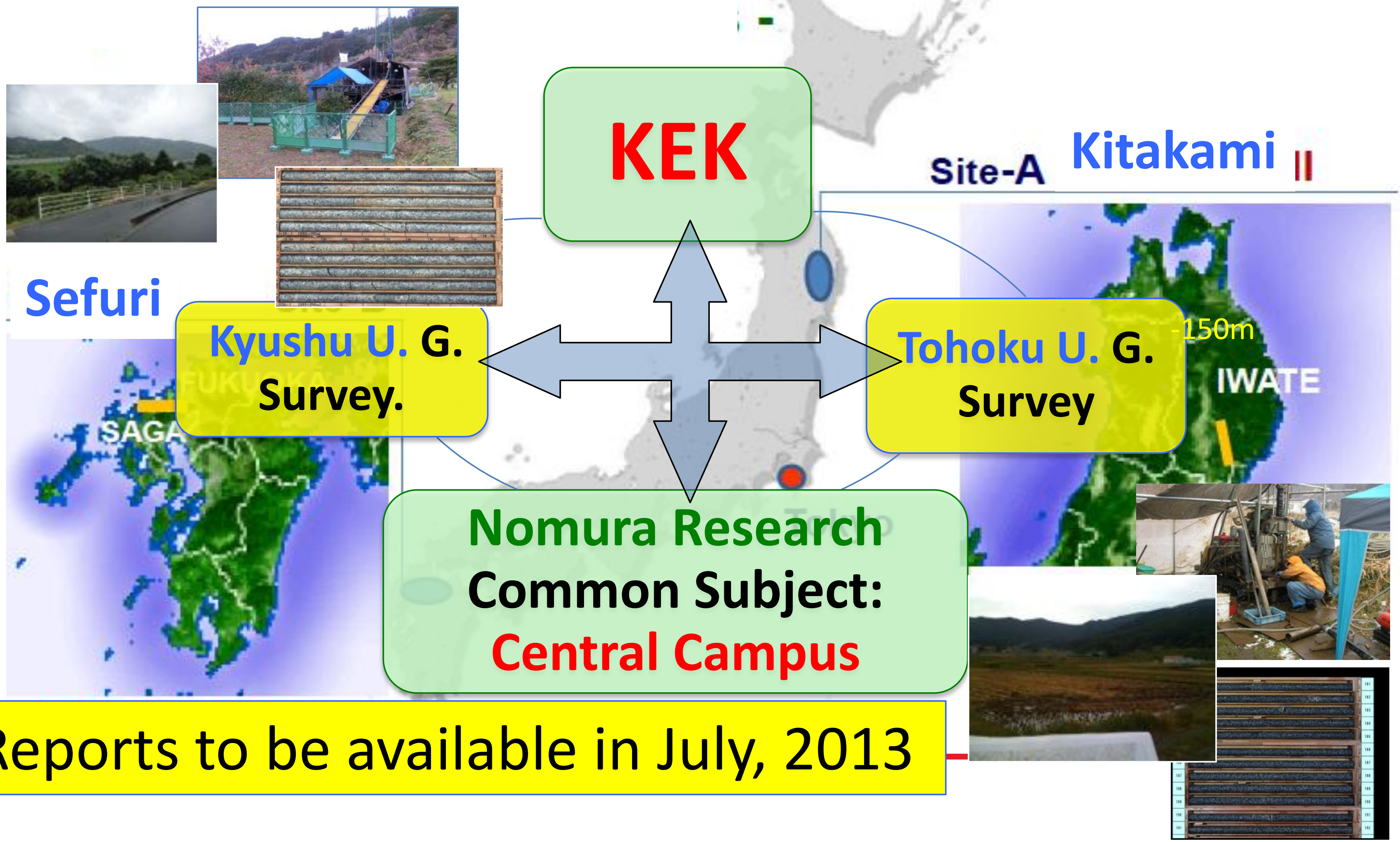
BDS and Beam Dynamics

- **BDS**
  - Final focusing with superconducting quadrupoles
  - Tighter tolerance to achieve nominal luminosity with reduced beam-power
- **Beam Dynamics**
  - Re-evaluation of the beam dynamics with matching of the damping ring circumference and main linac length.
  - Re-evaluation of acceptable tolerances

CFS and General Engineering

- **Site specific CFS works after the site selection established**
  - Access/approach to tunnel and transportation
  - Tunnel slope to be optimized in relation with cryogenics and water handling
- **General Engineering**
  - Such as drawing coordination rules
    - It was once fixed to writer electron ML at left and positron ML right
      - » In this way, CM lower/right and RFs upper/left in case of CAMABOKO tunnel in mountain site.

Geological Survey and Common-Subject Study, going on, in japan



Reports to be available in July, 2013

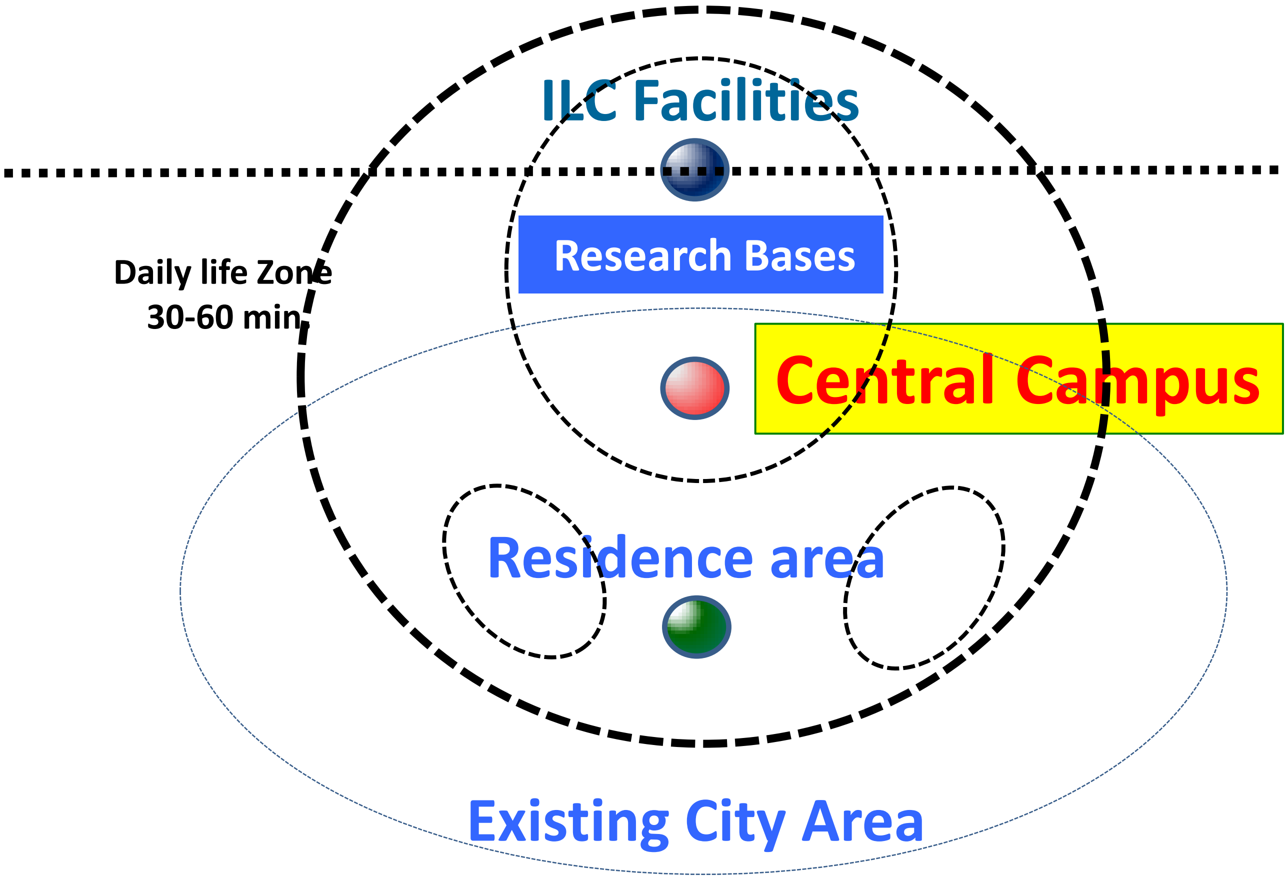
Study of a Common Subject:
the ILC Central-Campus Design

- **Functions?:**
- As the headquarters and a hub-laboratory
- **Location?:**
- with adequate distance to the ILC facility and to public-city/living area
- **How many Persons to work/live ?:**
- as employees, sub-contractors, scientific/technical user, families, and others,
- to dynamically change according to the project stages,
- **Which kind of facilities and buildings ?:**
- For facilities/building, and area/environment design

Functions

- **Headquaters' function:**
  - Center for Research and Administration including international cooperation
  - Offices for employees and visitors/users
  - Rooms for Conferences/seminars/lectures
- **Hub-laboratory's function:**
  - Technical laboratories
    - SCRF assembly and test stations, as an example
      - (Detector main assembly may be located near ILC main-site)
- **Residence function**
  - For visitors in some fraction

Relative Location ?



A concept: Relative distance from main campus, for moving time: ≤ ~ 30 min.

An Assumption for Numbers of Persons at ILC (whole) Laboratory

(more than the number in TDR)

	Under construction Peak (8Th year.)	Operation start (11Th year.)	In operation (15Th year.)	In operation (20Th year.)
Laboratory Staffs *#1*	1,600	1,200	1,200	1,200
Experiment participants *#2*	500	700	800	1,000
Laboratory Supporters *#3*	300	300	400	500
Total	2,400	2,200	2,400	2,700

***#1*: including the regular/permanent staff and temporary staff (Post-Doc),**
#2: including researchers, engineers and students for two experiments,
#3: including subcontracted specialist to support acc. & exp. activities

Estimate Breakdown of the Numbers of Persons

	Construction period										Operational Period									
Annual	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Fiscal year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
■ Researcher, Engineer, Office worker Subtotal	500	600	800	1,203	1,605	2,049	2,267	2,388	2,282	2,362	2,200	2,251	2,303	2,358	2,415	2,476	2,540	2,606	2,677	2,751
(1) ILC Laboratory staff (parmanent+temporary)	500	600	800	1,000	1,200	1,400	1,600	1,600	1,400	1,400	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
①Permanent staff	400	500	600	700	800	900	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
−Research staff	200	250	300	350	400	450	500	500	500	500	500	500	500	500	500	500	500	500	500	500
−Technical staff	140	175	210	245	280	315	350	350	350	350	350	350	350	350	350	350	350	350	350	350
−Management staff	60	75	90	105	120	135	150	150	150	150	150	150	150	150	150	150	150	150	150	150
②Temporary staff (postdoctoral)	100	100	200	300	400	500	600	600	400	400	200	200	200	200	200	200	200	200	200	200
(2) Experiment participant Subtotal				203	405	649	667	788	882	962	1,000	1,051	1,103	1,158	1,215	1,276	1,340	1,406	1,477	1,551
①Reseacher				91	182	292	300	354	397	433	450	473	496	521	547	574	603	633	665	698
②Student (graduaite student)				71	142	227	234	276	309	337	350	368	386	405	425	447	469	492	517	543
③Experiment supporter				41	81	130	133	158	176	192	200	210	221	232	243	255	268	281	295	310
■ Construction, Maintenance worker Subtotal	2,730	3,835	3,180	3,240	2,630	2,550	2,610	2,610	2,550	2,360	360	360	360	360	360	360	360	360	360	360
(3) Construction worker (Including supervisor)	2,580	3,655	2,940	2,940	2,270	2,130	2,130	2,130	2,130	2,000	0	0	0	0	0	0	0	0	0	0
(4) Maintenance outsourcing workers	150	180	240	300	360	420	480	480	420	360	360	360	360	360	360	360	360	360	360	360
■ Incidental family Subtotal	782	956	1,215	1,571	1,927	2,303	2,570	2,668	2,580	2,481	2,536	2,599	2,662	2,728	2,996	2,866	2,940	3,015	3,094	3,175
(1) Family of ILC staff	710	870	1,100	1,330	1,560	1,790	2,020	2,050	1,936	1,818	1,844	1,871	1,897	1,923	1,949	1,975	2,001	2,027	2,053	2,079
(Parmanent staff with family)	320	400	480	560	640	720	800	800	800	800	800	800	800	800	800	800	800	800	800	800
(Temporary staff with family)	35	35	70	105	140	175	210	210	140	70	70	70	70	70	70	70	70	70	70	70
(2) Family of experiment participants	0	0	0	97	194	311	320	384	436	482	509	542	577	614	853	695	740	787	837	890
Experiment participants with family	0	0	0	49	97	156	160	189	212	231	240	252	265	278	292	306	322	338	355	372
(3) Family of construction worker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(4) Family of maintenance outsourcing workers	72	86	115	144	173	202	230	234	208	181	183	186	188	191	194	196	199	201	204	206
■ Total	4,012	5,391	5,195	6,014	6,162	6,902	7,447	7,666	7,412	7,203	5,096	5,210	5,325	5,446	5,771	5,702	5,840	5,981	6,131	6,286

General Plan for ILC Central Campus
(major fraction of persons having working spaces there)

Major facilities:

- Offices
- Laboratory
- Meeting rooms
- Visitor's accommodation
- General services
- Parking
- Utility plant, etc.

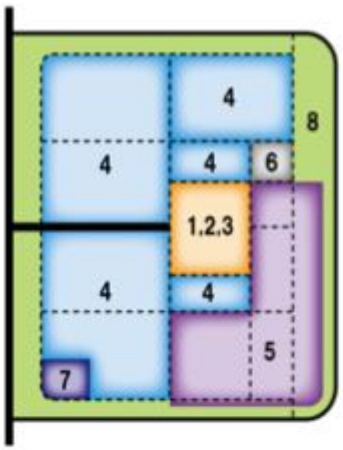
Assuming:

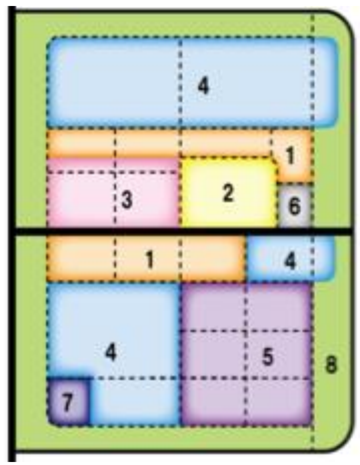
~ 100,000 m^2
in total floor area

Classification	Assuming facilities	
	Facilities	Area(m^2)
Offices	Research office University & Institute	35,000
laboratory facilities	Control center Assembly hall Technology development hall	33,000
meeting and exchange	Lecture hall Meeting room	3,500
Accommodation	Dormitory Visitor accommodation	23,000
Service facilities	Reception, Users office Library, exhibition hall Cafeteria, Convenient store Health care & Training center	3,200
Transportation	Parking, Bus Terminal	-
Energy plant, etc.		1,100
Total		99,800

Case studies : Zoning and Facility Layout

High-Rise Type





Flatter Type

More spatial design

Area: ~ 30,000 m^2 ~ 40,000 m^2 ~ 80,000 m^2

(Floor area: commonly ~10,000 m^2)

To be more discussed in the ADI/CFS session

Summary

Progress and Status :

- TDR completed
- Technical- and Cost-Review proceeded
- ILC can be built from a technical view point, based on the TDR technology.

Further Technical Process Required :

- Detailed engineering, system demonstration, and preparation for industrialization
- Global participation and human-resource are critically required to prepare for the project realization.

backup

ILC Time Scale required

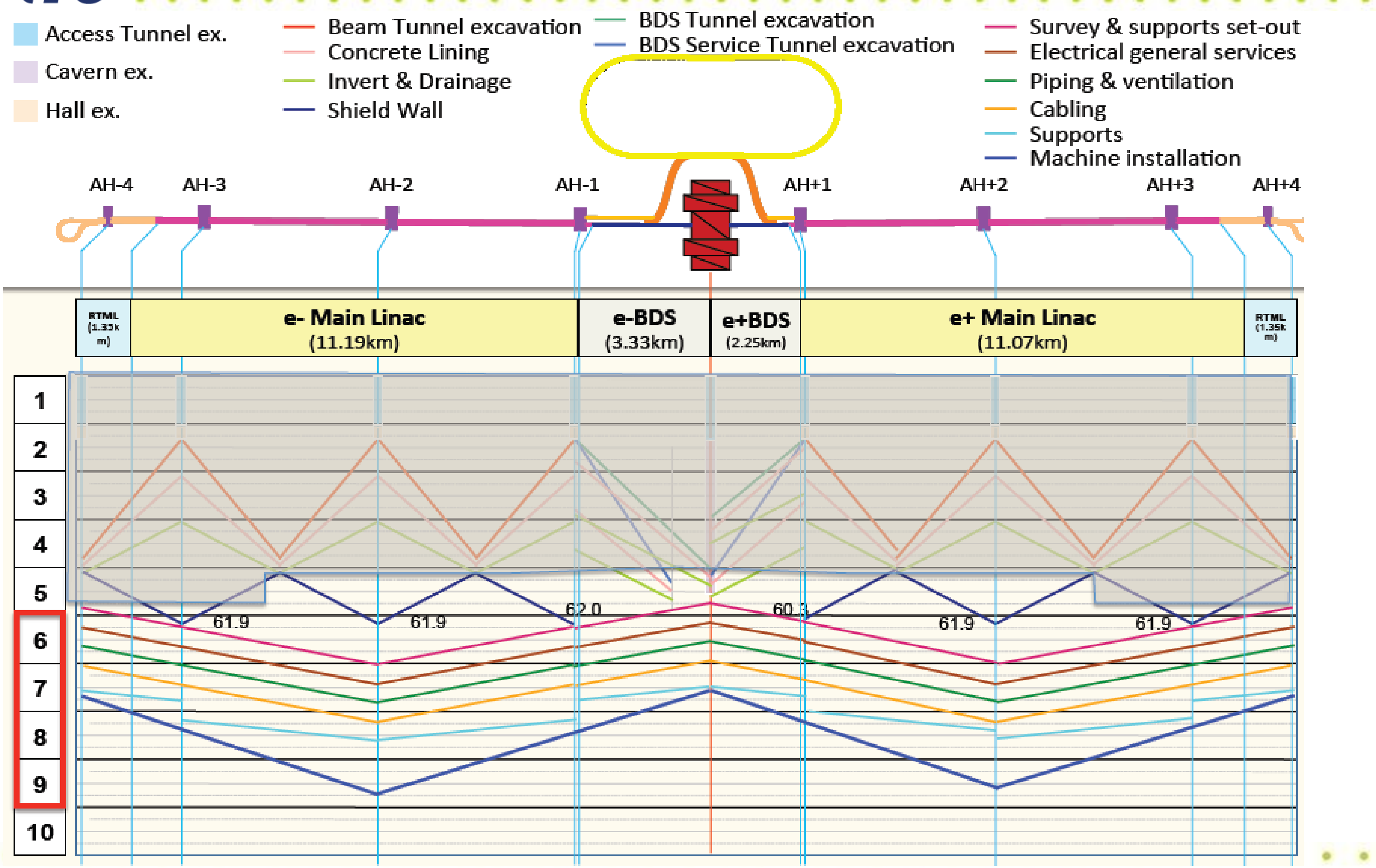
	12	13	14	15	16	17	18	19	20	21	22	23	24	25
ILC TDP/TDR														
ATF-II	Beam test													
ATF-future			Extended program											
STF														
QB	Beam test													
STF2-CM1+CM2a			Beam test											
STF-Future				Extended program										
CFS														
Civil eng.														
Site-survey														

After getting Green Sign、
- Preparation for contract : ~ 2 years
- Construction period : ~ 10 years

- If the green sign given in 5 years、 ILC to be realized by 2030

			14 19		16 21			19 24						25 30
ILC constr.														Commissioning
Fabrication			Preparation for the project		Preparation for industrialization		Fabrication and tests, preparation for installation							
Inst/commissio											Installation			

Schedule for 500 GeV Machine



ILC-TDR evaluation (2013-2)

	M&S Value (Ratio)	M&S Value (GILCU)	M&S Value converted (GJY)	M&S Prem.:	Labor (M person-hr)	Labor Prem.:
RDR-2007	1	6.31 1)	---		24.4	
RDR-2012 (15% inflation)	1.15	7.27 1)	---		24.4	
TDR-2012 average for 3 region	1.23	7.78 1)	---		22.6	
TDR- (Asia) mountain site	1.26	7.98 1)	830 2)	26 %	22.9	24 %

1) Estimated by using PPP (purchasing power parity) methodology established by OECD
2) Conversion to Japanese Yen: using currency exchange rates
- assuming a model with 100JYen/USD, 115 Jyen/Ero

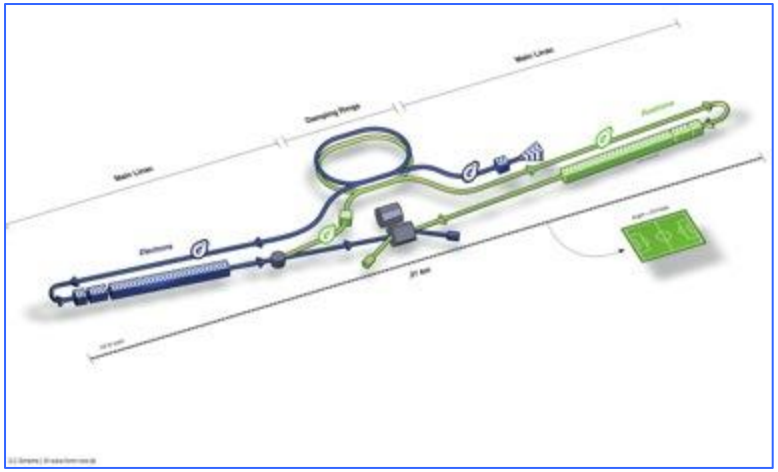
* Budget not inclcued, above :
- Project preparation, Operation (0.39GILCU, 850 FTE) 、Detectors (~ 2 x 0.4 GILCU

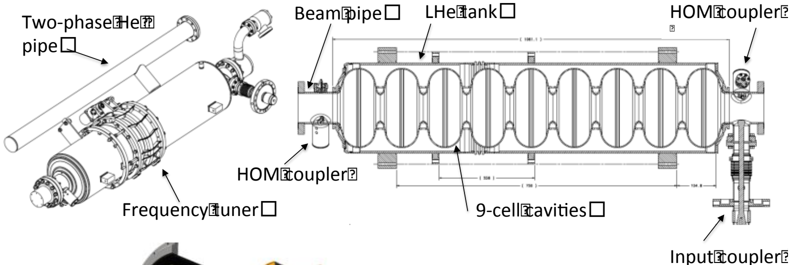
Base for Uncertainty Estimates

	Value basis	Premium
1	COTS or equivalent	5%
2	Procurement	8%
3	Vendor quote	10%
4	Industrial Study, mass production	20%
5	Engineering estimate: conventional technology	15%
6	Engineering estimate: R&D needed	30%

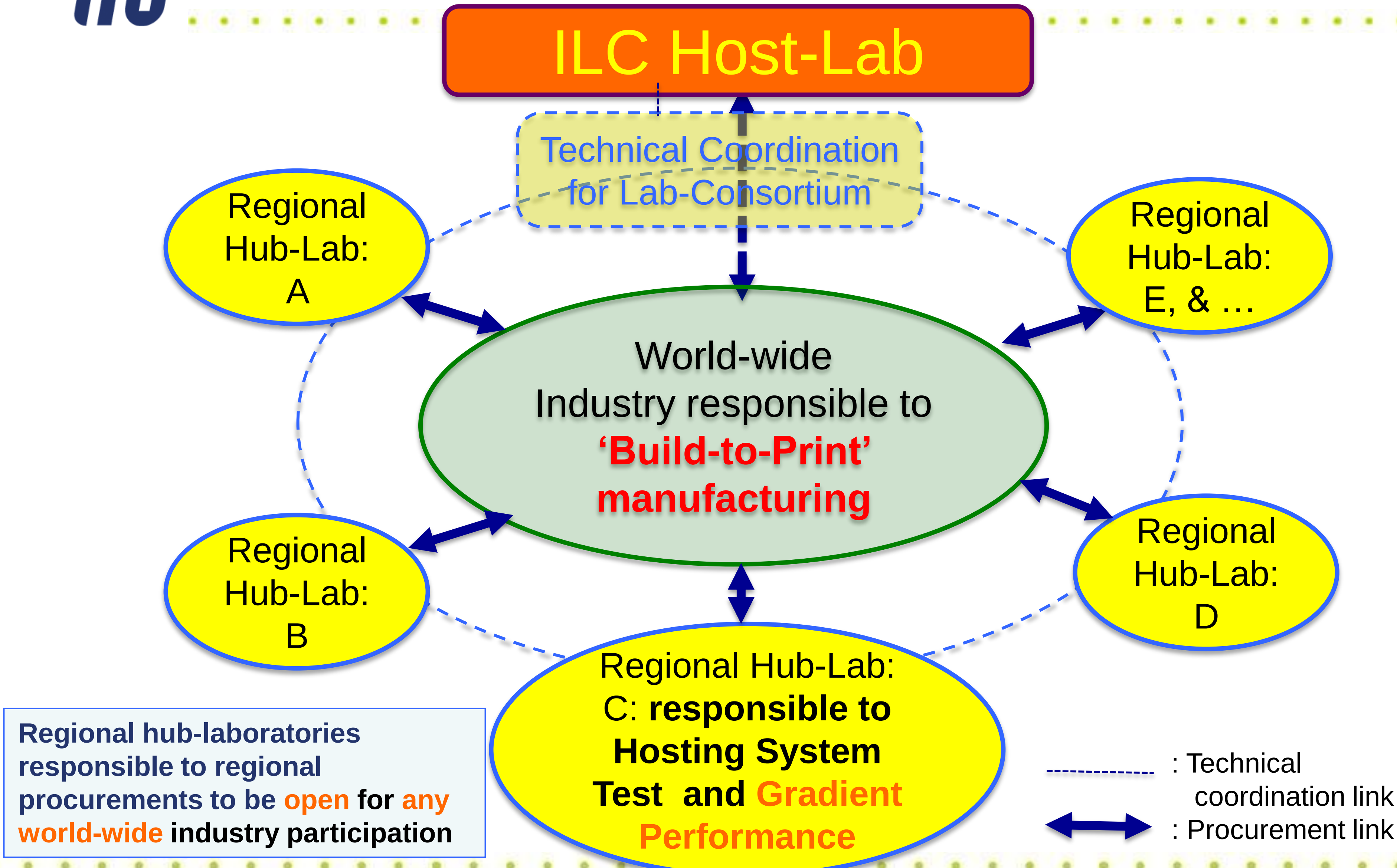
SCRF Industrialization required

Parameters	Value
C.M. Energy	500 GeV
Peak luminosity	1.5 x10^{34} cm^{-2}s^{-1}
Beam Rep. rate	5 Hz
Pulse duration	0.73 ms
Average current	5.8 mA (in pulse)
Av. field gradient	31.5 MV/m +/-20% Q_0 = 1E10
# 9-cell cavity	16024 (x 1.1)
# cryomodule	1,855
# Klystron	~400





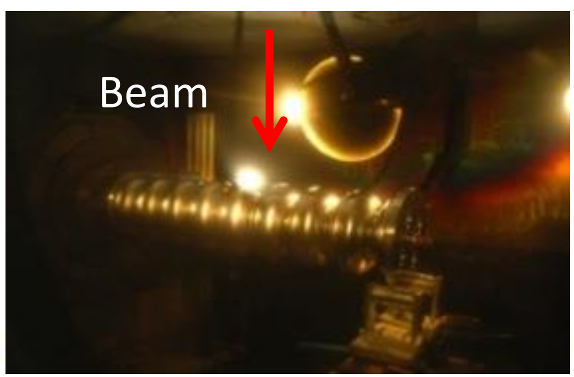
Cooperation of ILC host- and hub-laboratories with worldwide industry (proposed)



KEK' Own Effort for Industrialization

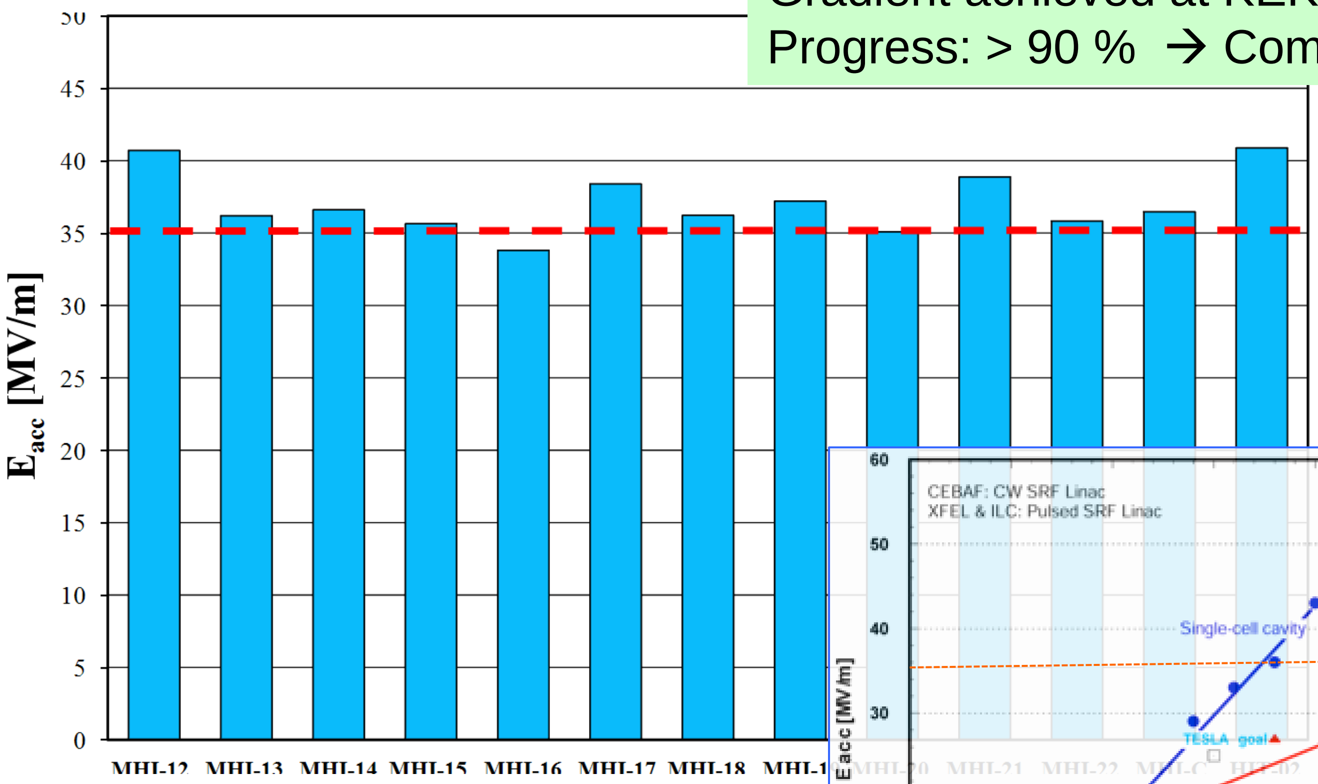
best cost-effective fabrication technology

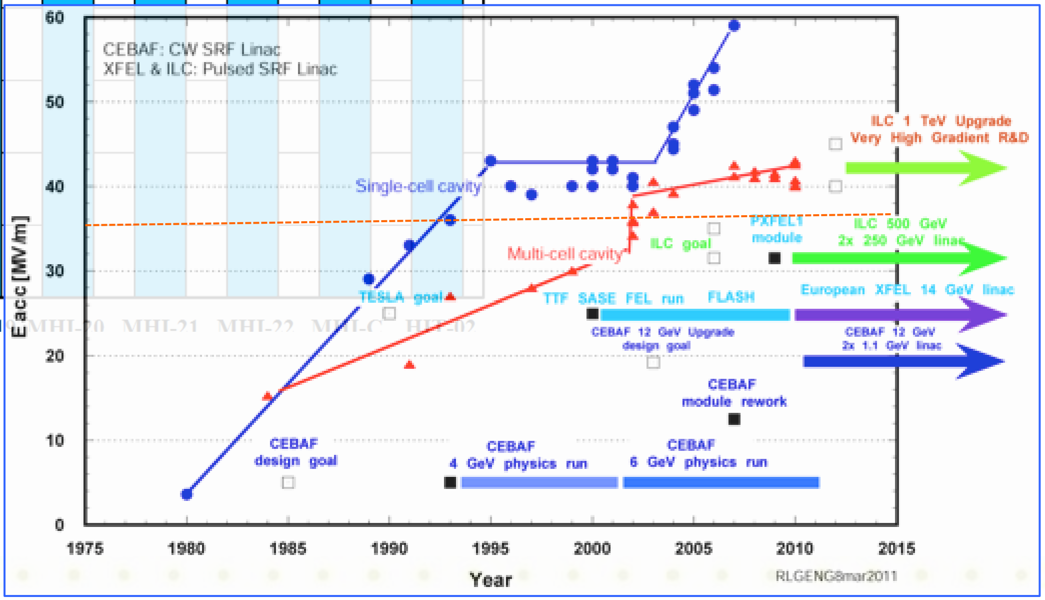
KEK is preparing for SCRF Industrial technology R&Ds to provide the facility and to cooperate with industry in coming years.



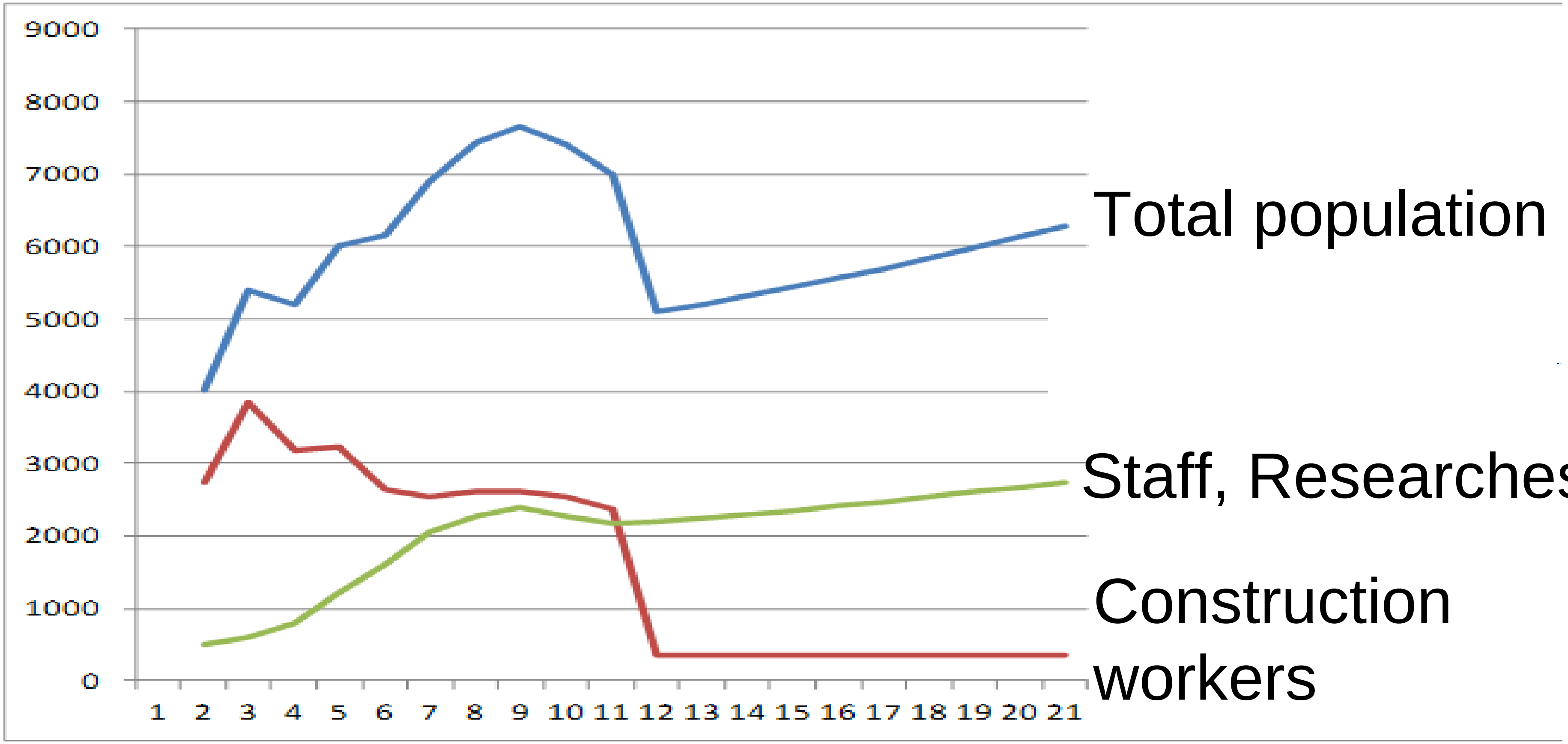
Further Effort for Gradient for Effective Perfromance/cost

Gradient achieved at KEK-STF: > ~ 35 MV/m
Progress: > 90 % → Coming 5 years: ~ 100 %





Annual Profile of Persons Involved



- **5,100 people (11 years) ILC start of operations**
- **Foreigner's fraction, assumed to be ~ 50 %**

Social infrastructure conditions of ILC central campus

Infrastructure	Requirements
Electric Power	・ Required Electric capacity: about 10,000kwh (26ha: Site area)
Traffic	・ Traffic base reinforcement: Improvement of international airport ・ Public Transport reinforcement: between airport, nearest station ~ campus
Water Supply	・
Waste	・
Infrastructure development	

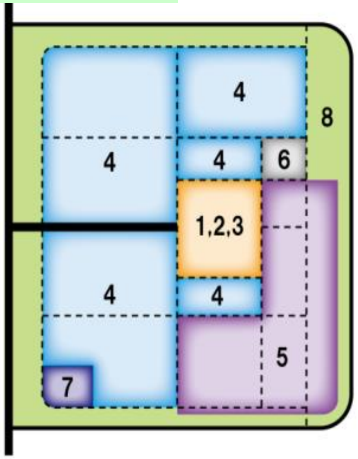
Living environment infrastructure	On- Campus	Off-Campus
Childcare, Education	○（ Nursery)	○(International School)
Medical care, Healthcare	△(Healthcare office)	○(Hospital, Drugstore)
Life Support	○(Users Office)	○(Regional Service)
Finance, Settlement	△(ATM, UO-support)	○(Bank, Insurance)
Shopping, Eating	△(Café ,Stand)	○(Super, Restaurant)
Culture, Art, Information	△(UO-support)	○(Hall, Religion relation)
Recreation, Sport	△(Jim, Swimming Pool)	○(Regional Service)

■Assumption of the Building area and Site area

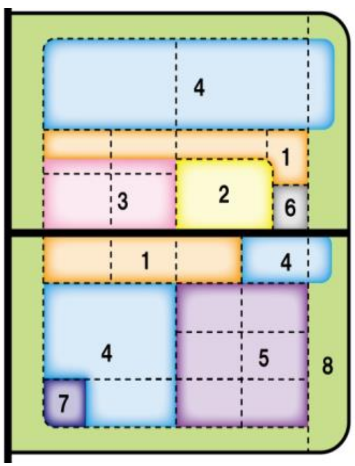
Function	Facilities		Floor area Gross (m²)	High-rise type		Low-rise type	
				Stories	Area (m²)	Stories	Area (m²)
■Research function Function	Research Building	–	18,000	1 building 16-stories	12,850	3 stories	38,550
		–	9,000				
		–	9,450				
	Administration building	–	2,100				
	Facility	Number	25,000	1 floor	110,000	1 story	110,000
			5,000				
	Control center	1	3,000				
■Conference function	Lecture hall	1	1,500	1 building 16-stories	1,300	1 story	13,000
		1	600				
	Meeting	2	900				
		4	900				
■Residence function	Visitor accommodation	300	27,000	3 stories	34,500	3 stories	34,500
	Guest house	50	7,500				
■Service function	Reception facility	1	375	1 building 16-stories	2,008	1 story	20,083
	Exhibition facilities		900				
	Library center		450				
	Cafeteria	1	1,300				
	Medical care room		150				
	Child care facility		600				
	Recreation・ Sport		750				
	Users service center	1	1,000				
	Convenience shop		500				
■Traffic function	Parking tower		3,000	–	3,000	–	3,000
■Supply function	Electric room	1	200	1 story	3,667	1 story	3,667
	Machine room	1	700				
	Disaster control room	1	200				
Total			120,075		167,325		222,800
Green area	Park, Open space, Green belt	25.0 %	25%		79,226		105,492
Outer road	Road	20.0 %	20%		63,381		84,394
Adjust pond		2.2 %	2.2%		6,972		9,283
Site area					316,903		421,970
					Around 32ha		Around 42ha

■ Case study： Zoning and Facility Layout

High-Rise Type



Flatter Type



Zoning **Layout Plan**

Image of ILC Central Campus, suggested

Model plan of assuming the site area 80ha

More detail will be discussed during this workshop