international linear collider

ILC: Goals and Progress of SRF R&D

H. Hayano, KEK

ILC goals & SRF R&D

ILC and EDR effort (2008-2010)

organization, design work, R&D, timeline

Engineering Design Report (2010.07)

ILC goal relating to SRF technology

Cavity gradient (S0 task)

Cryomodule operation (S1 task)

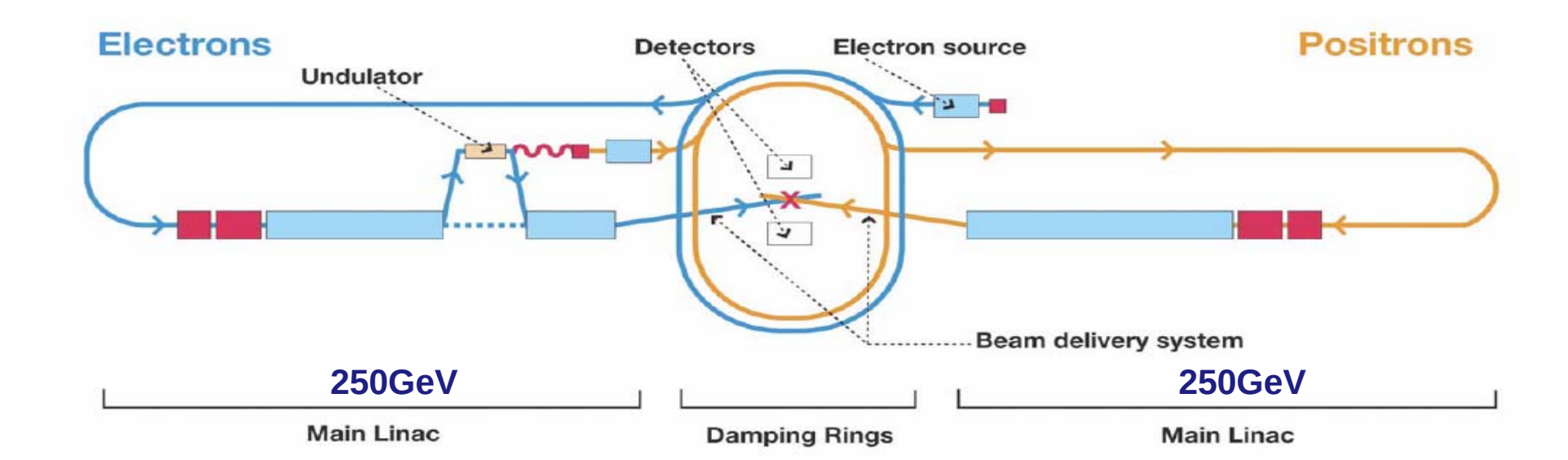
Major Facilities for R&D and demonstrations

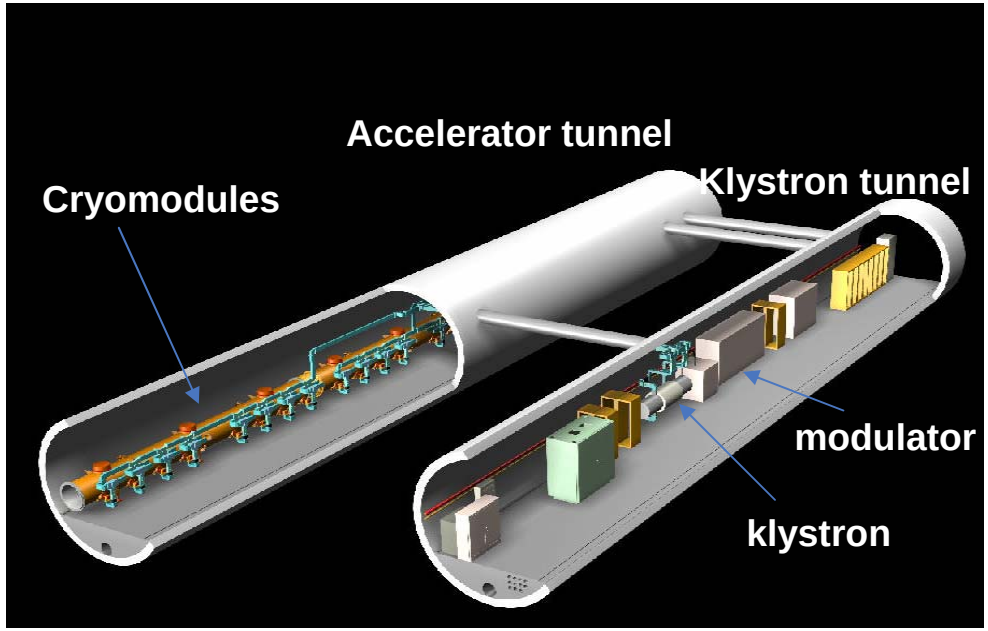
XFEL construction (already presented)

ILCTA-NML (FNAL)

STF (KEK)

ILC Accelerator Layout

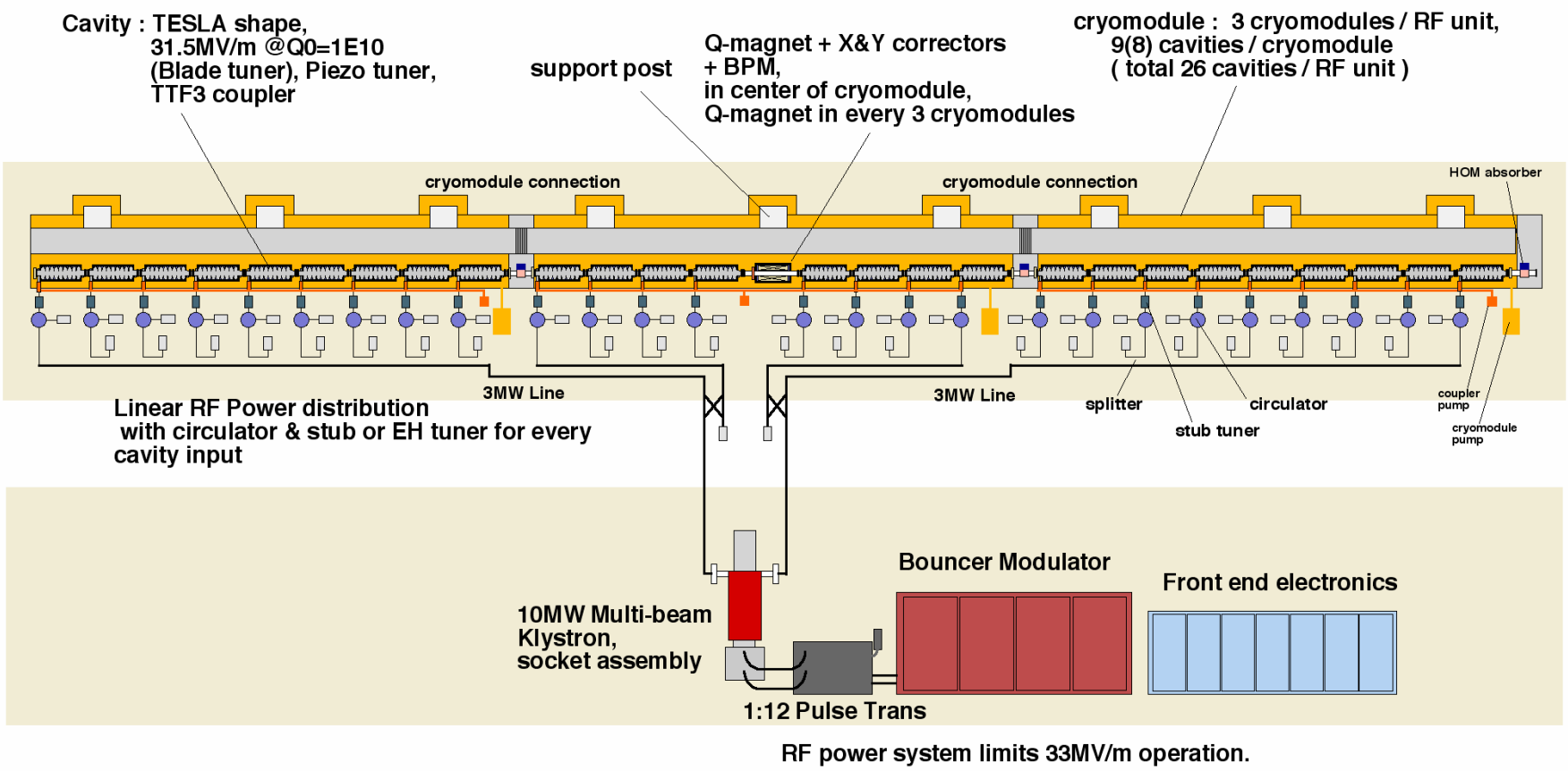




e+, e- Main Linac

Energy : 250GeV + 250GeV
Length : 11km + 11km
# of RF unit : 560 total
# of Cryomodules : 1680 total
# of Cavities : 14560 total

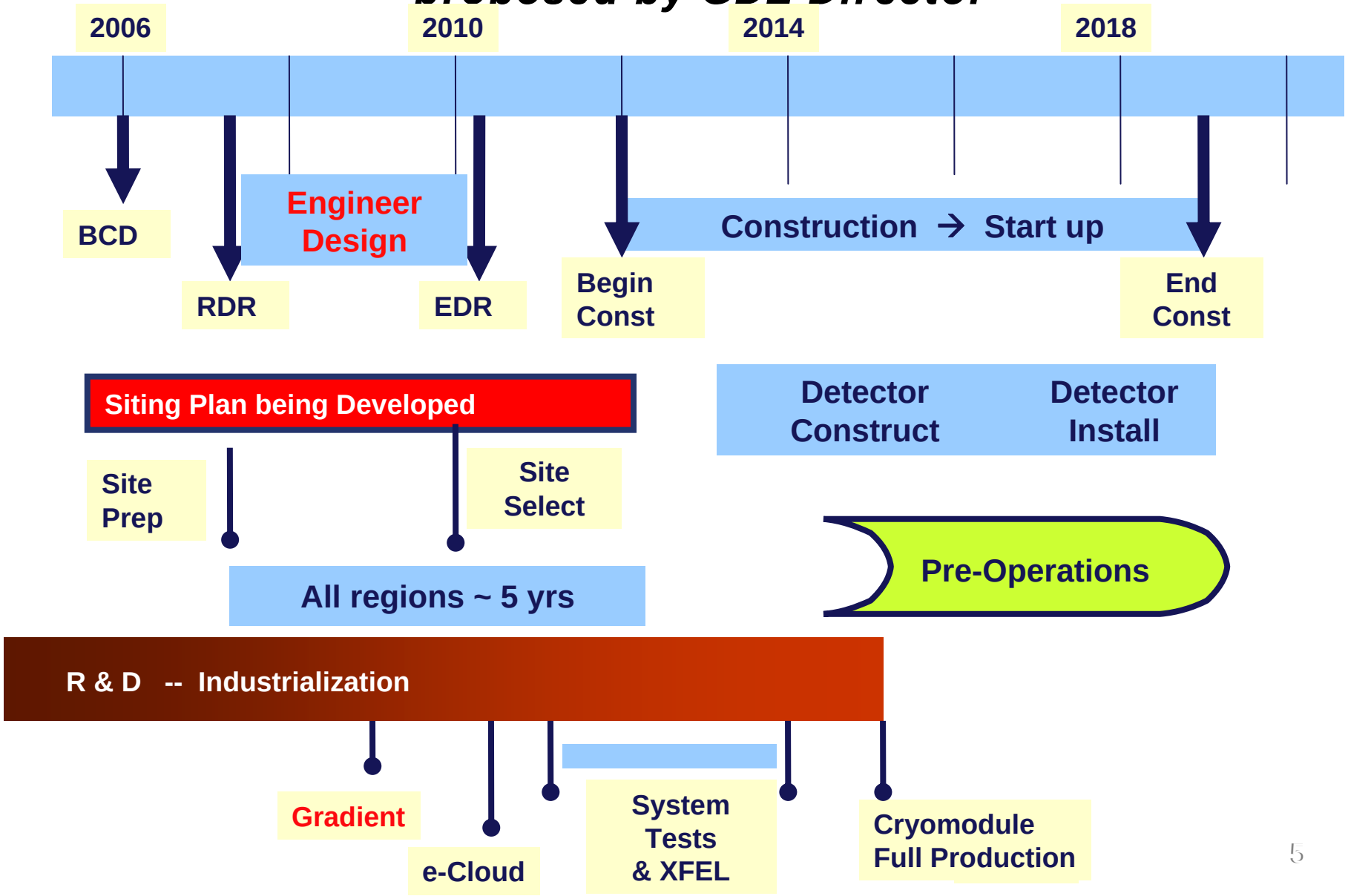
ILC Main Linac RF unit



RDR configuration

Technically Driven Timeline

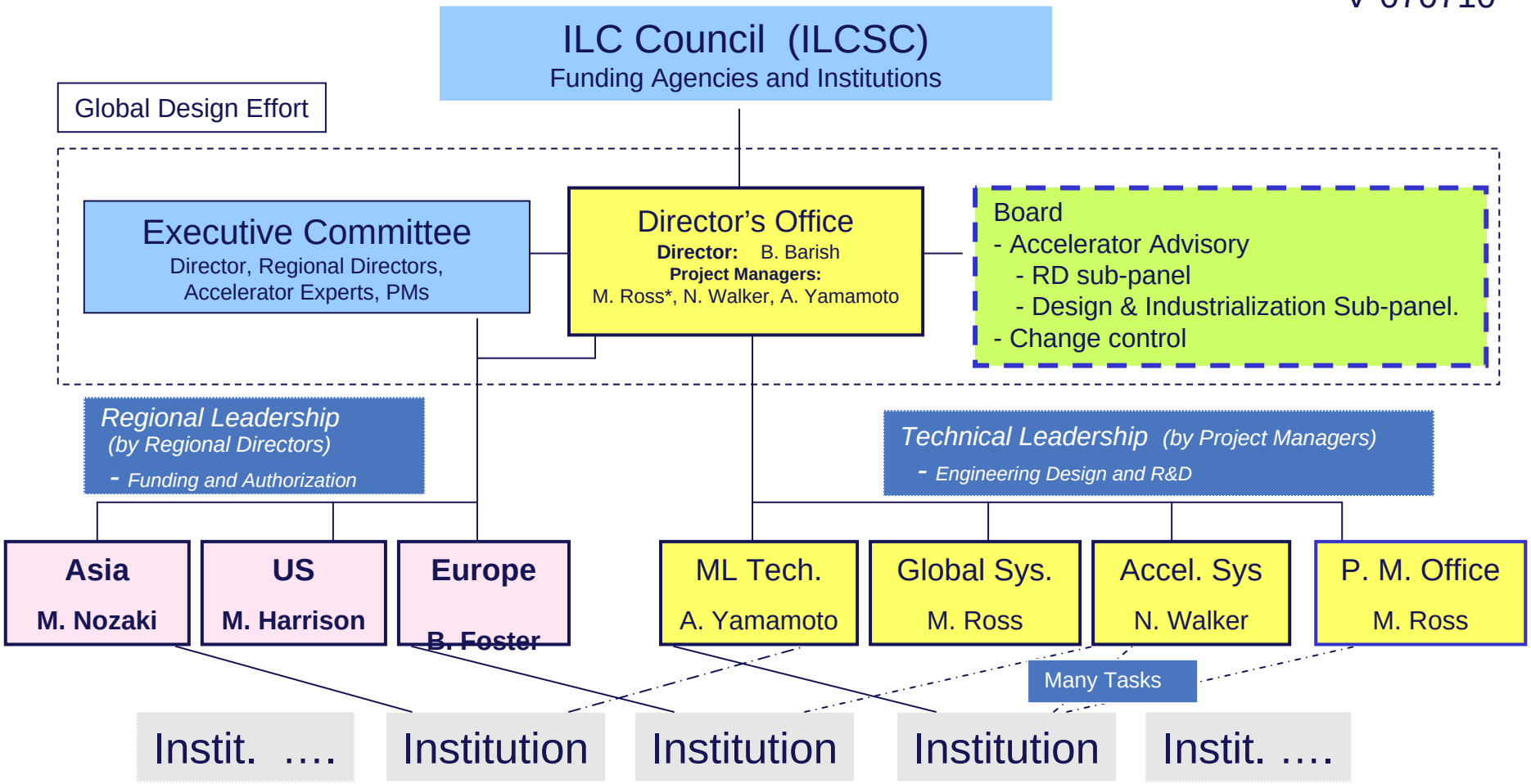
proposed by GDE Director



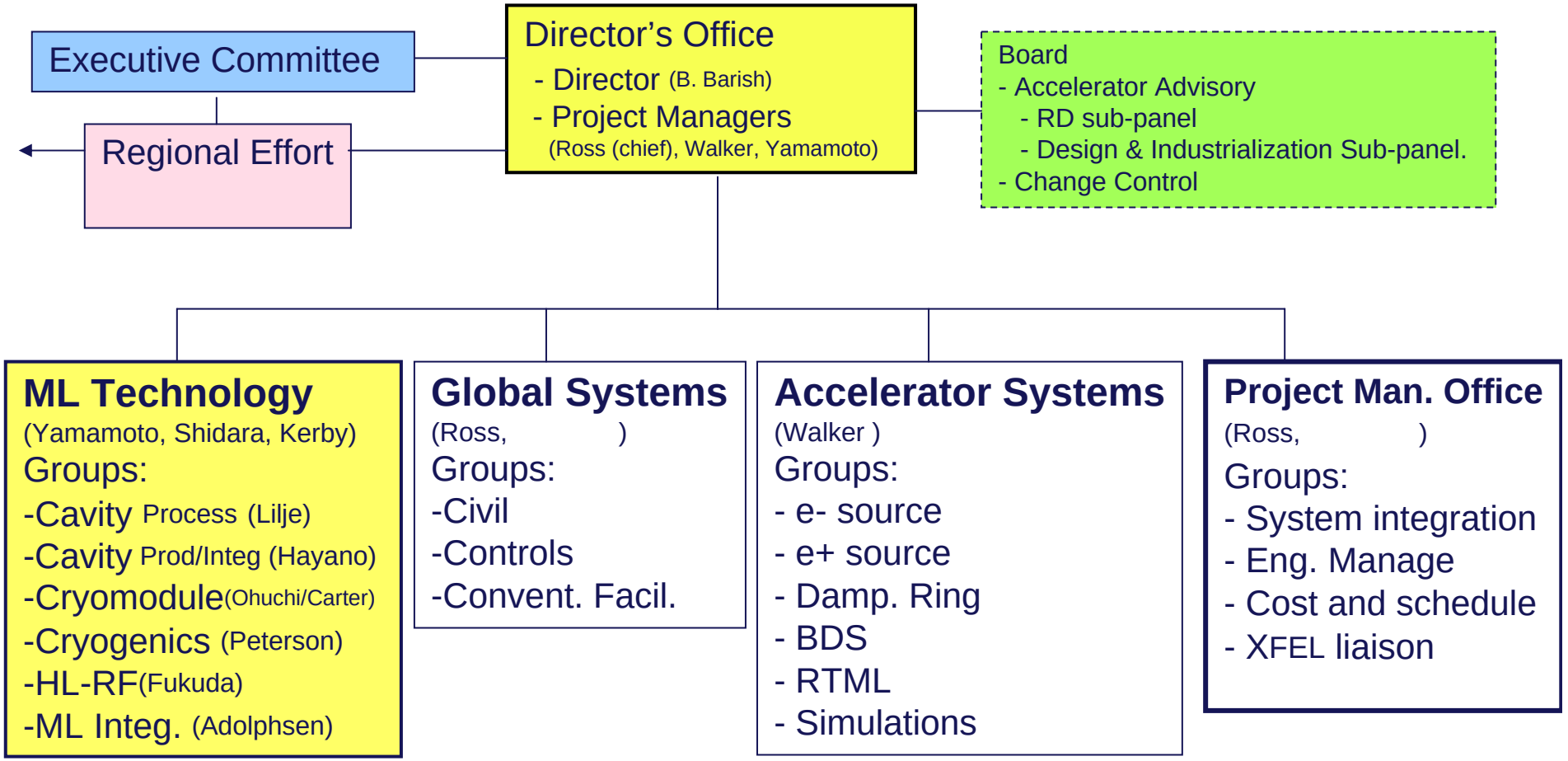
ILC Project Management

as a proposal for the organization toward EDR

V-070710



Project Management Structure (baseline)



Project Management Structure

Area: Main Linac Technology (to be completed)

Regional/Institutional Effort:

- Director-US: Mike Harrison
- Director-EU: B. Foster
- Director-AS: M. Nozaki

Technical Effort (ML (SCRF) Technology):

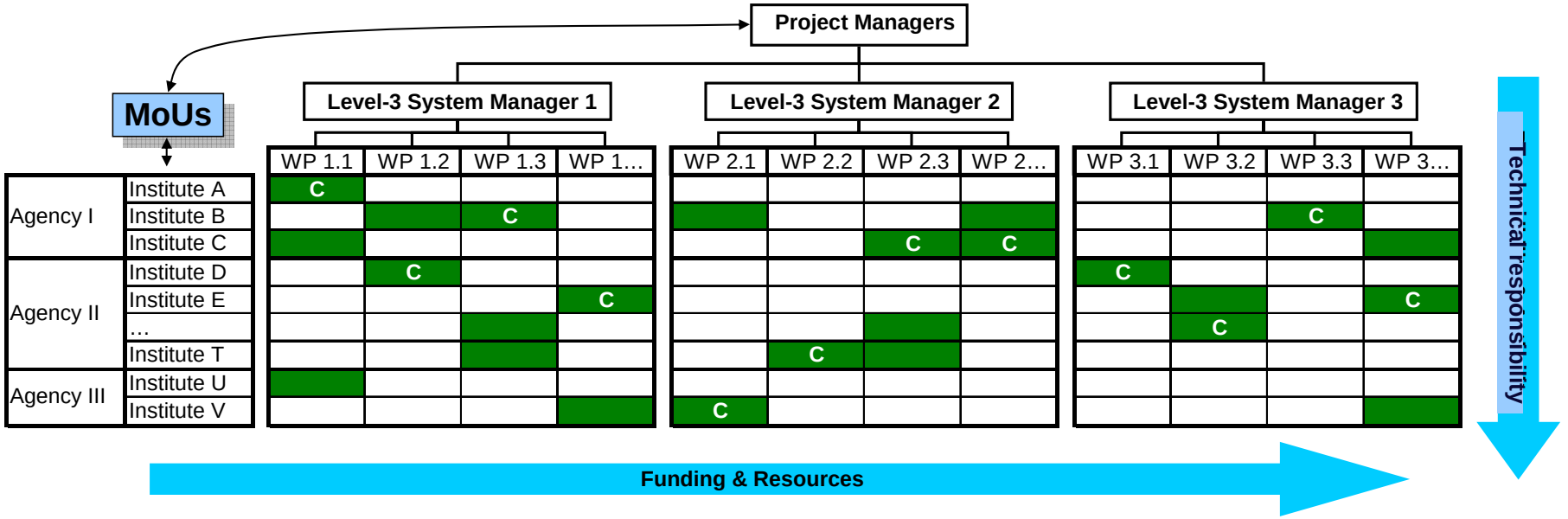
- Project Manager: A. Yamamoto
- Associate Managers: T. Shidara, J. Kerby,

* Group leader, ** Co-leader

Regions	**Institute**	**Institute Leaders**	**Cavity** (Process) L. Lilje*	**Cavity** (Prod./Int.) H. Hayano*	**Cryomodule** N. Ohuchi* -H. Carter**	**Cryogenics** T. Peterson*	**HLRF** S. Fukuda*	**ML Integr.** C. Adolphsen
US	Cornell Fermilab SLAC ANL TJNL	H.Padamsee R. Kephart T.Raubenhaimer	H.Padamsee	C.Adolphsen	H.Carter	T.Peterson	O.Nezhevenko R. Larsen /C.A.	C. Adolphsen
EU	DESY CERN Saclay Olsay INFN Spain	R.Brinkman J. Delahaye O. Napoly A.Variola C. Pagani	L.Lilje	C. Pagani	Parma Franco Pal.	Tavian	S. Choroba	
AS	KEK Korea Inst. IHEP India Inst.	K.Yokoya	Noguchi, Saito	Hayano	Tsuchiya/ Ohuchi	Hosoyama/Nakai	Fukuda	

Technical Responsibilities :

(from RDR Chapter 7)



- **Green indicates a commitment:**
  - **institute will deliver**
- **MoUs facilitate connection:**
  - **Project Management (authority and responsibility) and institutions (funding and resources).**
- **The 'C' → coordinating role in a WP**
  - **Each WP has one coordinator.**

ILC Project Management and Sharing Responsibilities

- ***Project Managers** are responsible for*
  - **Leading the world-wide technical development effort**
    - **efficiently and effectively**
  - **Setting technical direction and executing the project toward realization of the ILC**
    - **Day-to-day project execution and communication**

- ***Regional Directors and Institutional Leaders** are responsible for*
  - **Promoting, funding and authorizing the cooperation programs.**
    - **Formality to start institutional activities, and periodical oversiting the technical progress,**

Technical efforts to EDR

- ***Complete the critical R&D***
  - ***as identified by the (R & D Board and) , Prototype, DFM, Preproduction, and ..***
- ***Establish the base-line design,***
  - ***Verify the initial EDR base-line design parameters,***
  - ***Technologies to be chosen and to be demonstrated through pre-mass-production***
  - ***Learn industrialization***
    - ***Obtain the maximum benefit from the realized project***
- ***Proceed alternate design and development***
  - ***As technology back-up to achieve the ILC design goal,***
    - ***with "Plug-compatible" concept, and***
    - ***for maximizing performance/cost (value-engineering)***

S0/S1 Task Forces

Initiated by R&D Board in RDR phase(2006), will continue its mission through EDR phase as one of work-package.

Leader : ***Lutz Lilje (DESY)***

Member : ***H. Padamsee, J. Mammosser, M. Ross, K. Saito, T. Higo, H. Hayano, P. Pfund, C. Ginsburg***

Mission ***S0 :achieve ILC baseline qualification gradient 35MV/m@Q_0=1x10^{10}***

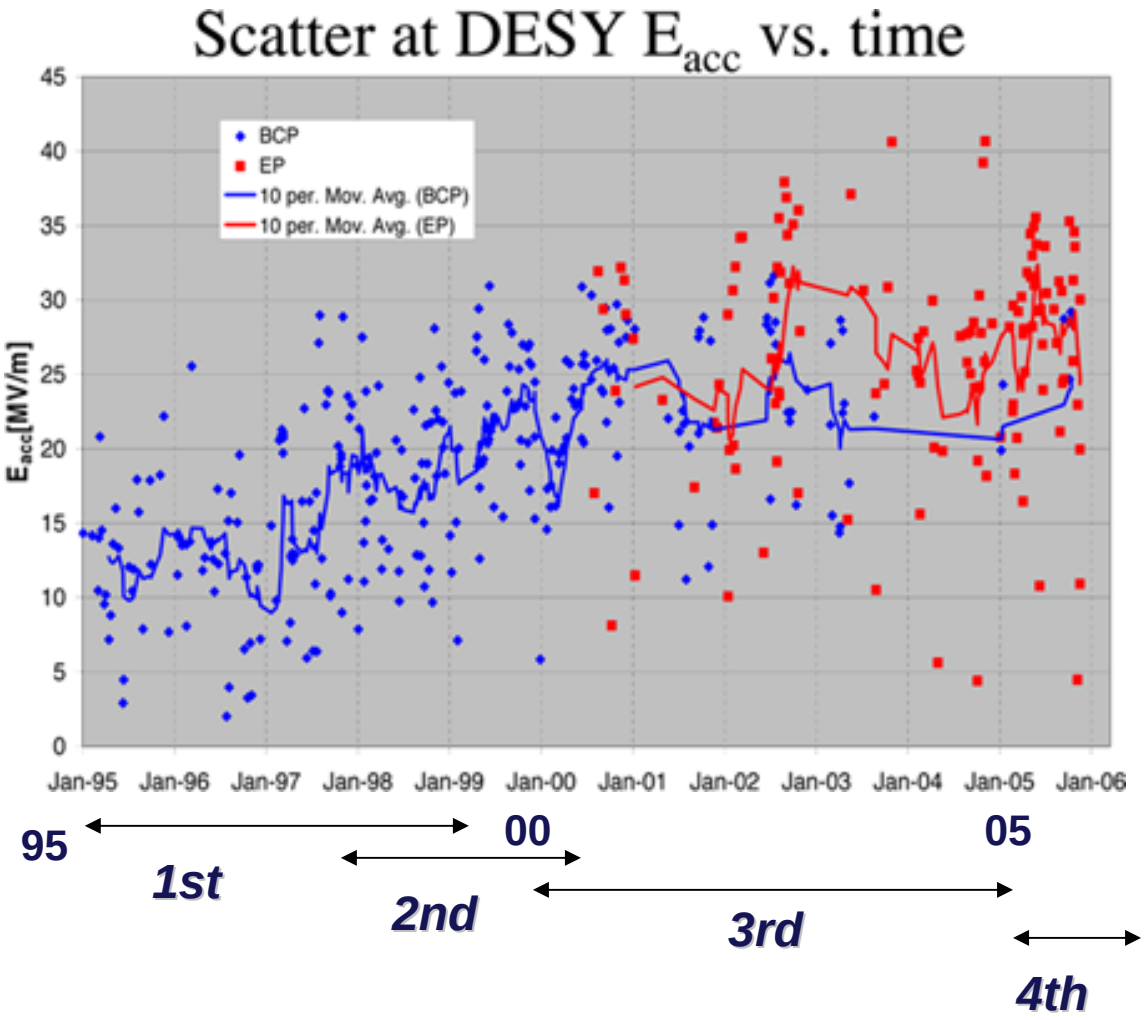
S1 :achieve 31.5MV/m operational gradient in a cryomodule

Document : http://www.linearcollider.org/wiki/doku.php?id=rdb:rdb_external:rdb_s1_home

for detail description of task force mission.

S0 Task

Gradient of SC Cavity developed by DESY



4 Production Cycles
with 26~33 cavities each;
(total >100 cavities)

1st : no eddy-curr and BCP+1400
2~20MV/m by field emission
and defect
welding not matured

2nd : eddy-curr and BCP+1400
15~30MV/m by field emission

3rd : eddy-curr scan and
22: BCP+1400, 15~32MV/m
11: EP+1400(or800) 10~40MV/m
limited by field emission
and Q-disease, etc

4th : Eddy-cur scan and EP+800
15~35MV/m by field emission
5~10MV/m by Q-disease

5th Production cycle underway

S0 Plan to Achieve Goal

Ultimate Goal;

achieve gradient 35MV/m@Q_0=1x10^{10} with 95% yield
(>35MV/m with > 80% yield at 1st test,
re-process for the rest 20%, then get >95% yield)

Plans

Tight loop test: 1st T.L., 2nd T.L.

to achieve <10% gradient spread for new 10 process
with ~3 cavities/region, ~3 successive treatment

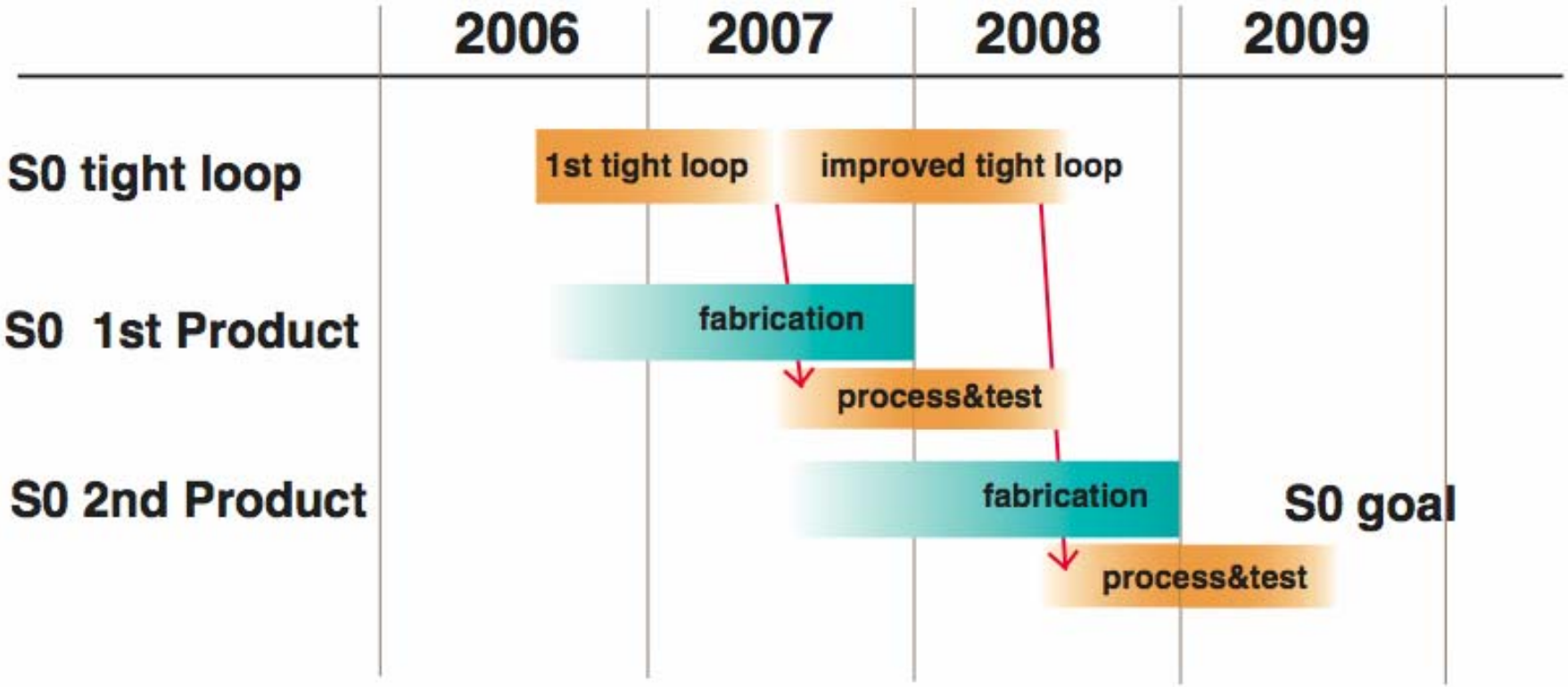
1st production-like process:

produce >20 cavities/region and
test up to 3~4 process to achieve ultimate goal

2nd production-like process:

produce another >20 cavities/region and
test to achieve ultimate goal

S0 Task Schedule



Plans: 1st production like: >60 cavities,
2nd production like: >60 cavities
Total >120 cavities / 3 - 4 years

Details to Achieve S0 Goal

Following R&D are expected during S0 work;

Realize *clean environment, clean procedure,*
selection of non-defect, no-contaminated Nb,
good welding procedure,
effective treatment & rinsing, etc

Install various diagnostics;

9-passband meas. Capability, adjustable coupler in VT,
T-map, X-ray-map, surface diagnostics, etc

Following checks are required;

hydrogen contamination check (Q-disease)

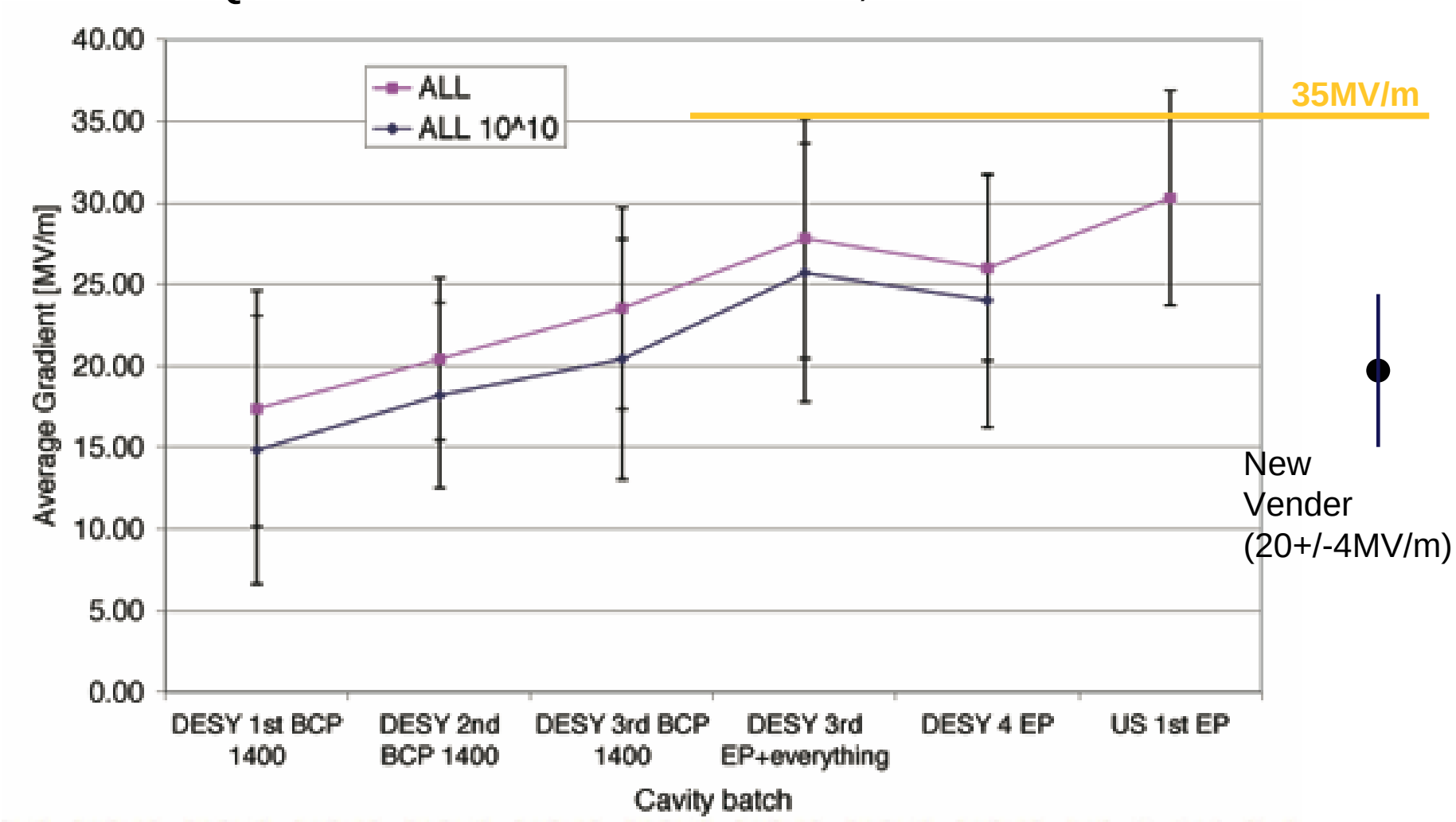
Q vs. T check (residual resistance)

9-passband spectrum check (deformation)

9-passband gradient reach (find wrong cell)

Status of gradient

‘Qualified’ Vender Production, All Test Results



Cavity production & Plan to achieve S0 goal

US cavity production

FY05 : 4
FY06 : 23
FY07 : 12
FY08 : 24 planned
FY09 : 60 planned

Total 123

KEK cavity production

JFY05 : 8
JFY06 : 0
JFY07 : 4
JFY08 : 10 planned
JFY09 : 28 planned

Total 50

XFEL cavity production : many (~120)

Global R&D cost

Total ~ 30 M$ in 2006-2009.

(28MV/m requires ~500M$ cost increase in construction for the same energy reach)

Cavity exchange status & Plan for S0 tight loop

US cavity tight loop

AC6,AC7,AC8 (Jlab)
AC5,AC8,AC9 (Cornell)
AES1,AES2,AES3,AES4 (Jlab)

→ 2 - 3 cavities are supposed to send to KEK. Under discussion.

KEK cavity tight loop

LL cavity (#0,#1, #3, New#5,New#6): 5
TESLA-shape (#1,#2,#3,#4) : 4

→ New#5 was sent to Jlab, being in process

DESY cavity tight loop

3 cavities candidates of S0 are listed

→ Go to KEK / go to US, is under discussion.

As of Oct.18, 2007

Infrastructure reinforcement to achieve S0 goal

DESY has almost all infrastructure.

- ***Material inspection: eddy-current scan** (FNAL)*
- ***BCP** (Jlab, Cornell, ANL, KEK)*
- ***EP** (Jlab, Cornell, ANL/FNAL, KEK)*
- ***Heat treatment** (Jlab, Cornell, FNAL, KEK)*
- ***Clean room** (Jlab, Cornell, ANL/FNAL, KEK)*
- ***HPR** (Jlab, Cornell, (ANL/FNAL), KEK)*
- ***Vertical test with diagnostics** (Jlab, Cornell, FNAL, (LANL), KEK)*
- ***Horizontal high power test** (FNAL)*
- ***Automated freq. tuning** (under planning at FNAL and KEK)*

Cavity Process capability (#/year)

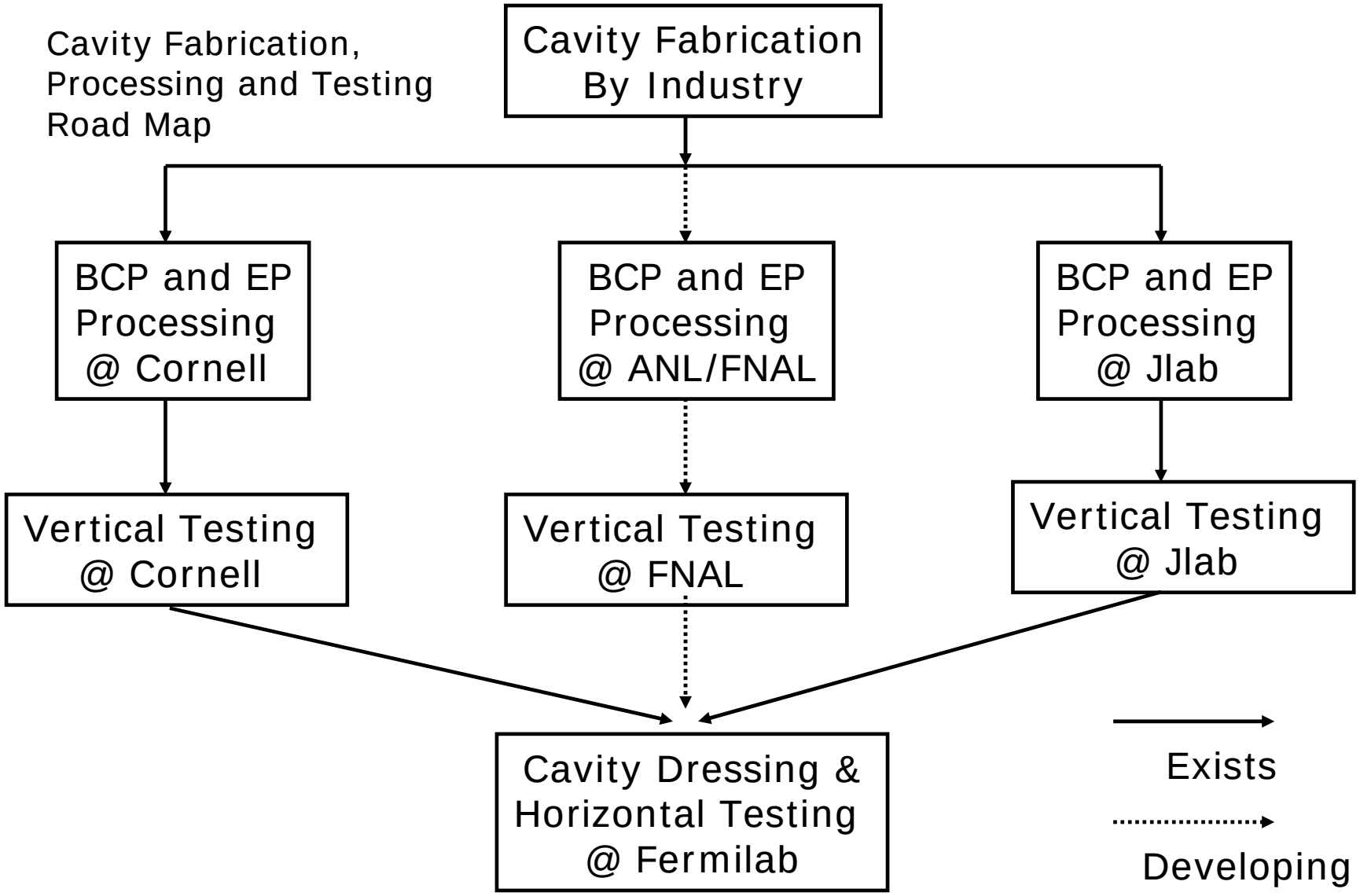
JLAB: 30(FY07), 40(FY08), 50(FY09)

ANL/FNAL:10-20(FY07),30(FY08),40+20(FY09), 40+100(FY10)

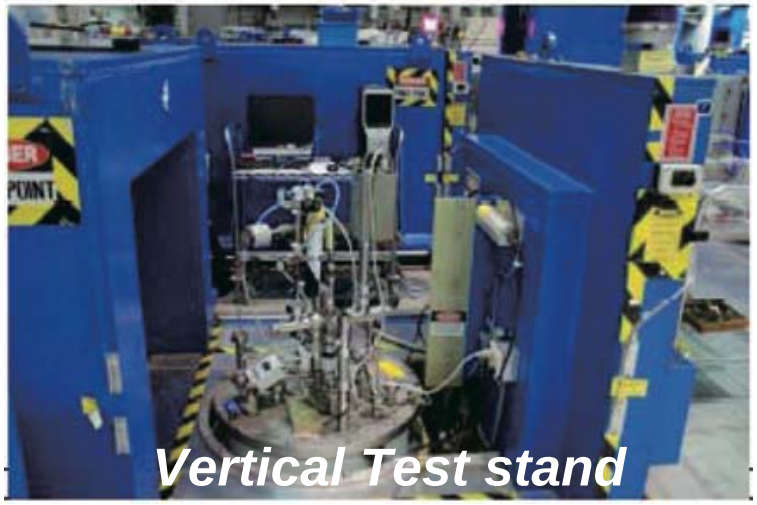
Cornell: 12

KEK:40(JFY07), 80(JFY08)

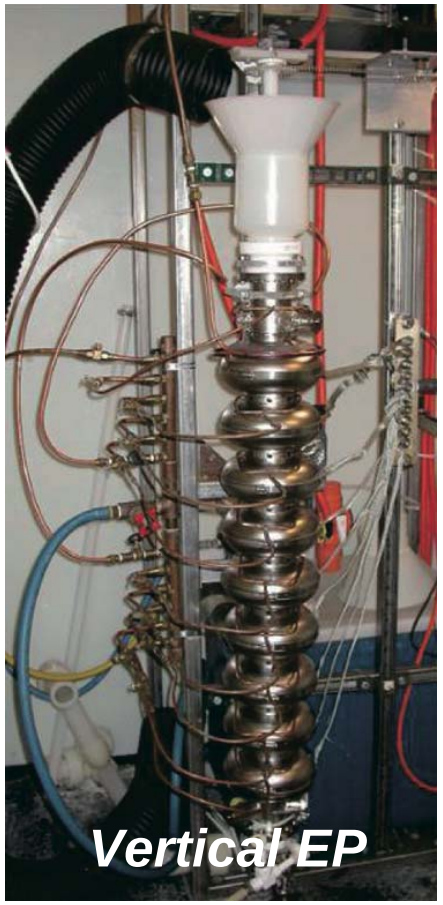
Cavity process flow in US



Cavity process at Jlab & Cornell



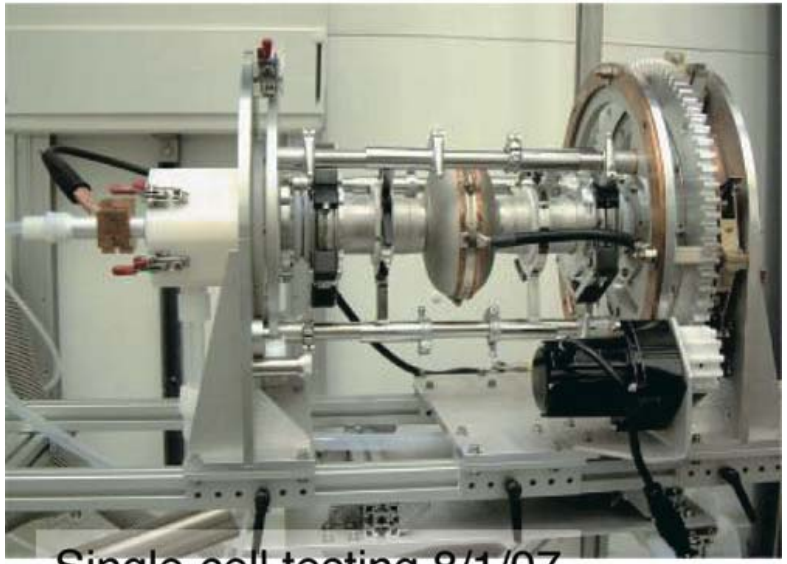
Jlab



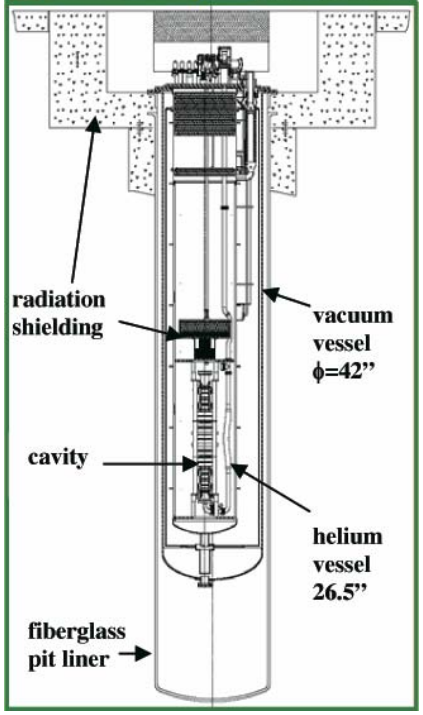
Vertical Test
Variable Coupler

Cornell

ANL/FNAL Cavity Process Facility



ANL/FNAL EP



Vertical Test at FNAL

New STF Facilities

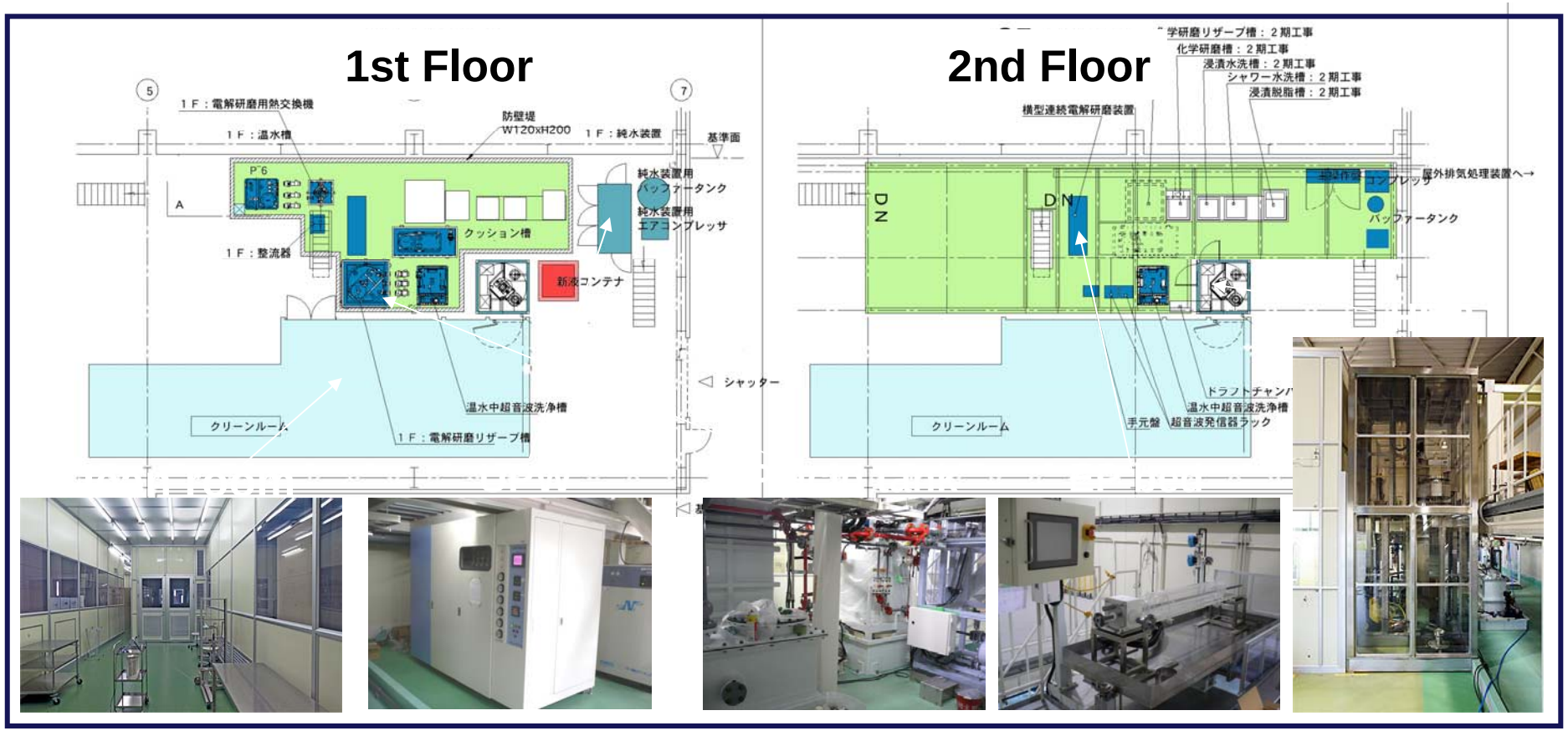
STF棟（旧陽子リニアック棟）　平面図

Control room
制御室
Cryogenic System (from AR-East)
10m x 10m
5m x 15m
Cryogenic Compressor (from AR-East)
Common Assembly/work Area
cryogenic pumping area
Kly + Mod. (coupler test, RF Gun)
Kly + Mod. (phase1 Cavity)
New 10MW Kly + Mod. (3 cryomodule)
coupler test stand
Vertical Test Area
10t crane
Klystron Gallery
vertical hatch
Laser room
HPR
EP bed
EP PS.
CP, USC, CL
pure water system
Tank
2t crane
Clean Room for cold mass assembly
7m x 25m Cleanrooms
Cold mass assembly
Cryomodule Assemble Area

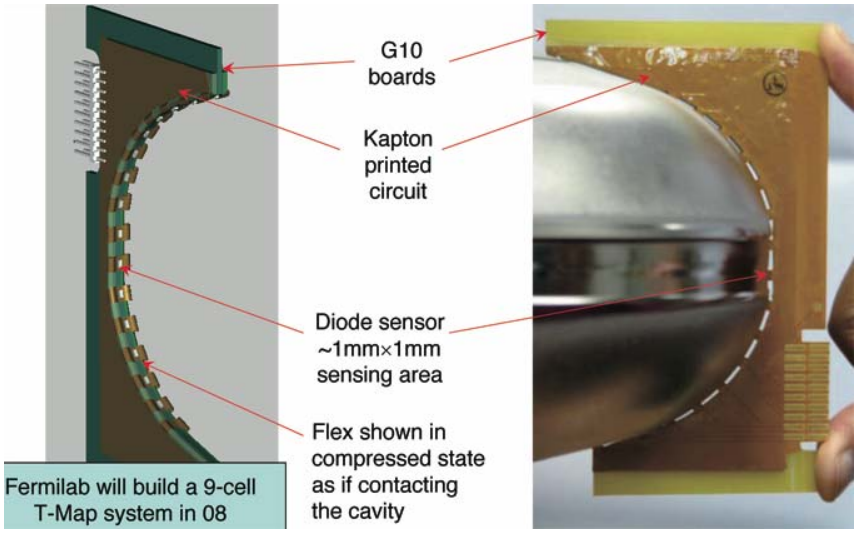
V7.2 H. Hayano, 7/10/2006

STF Cavity Surface Process Facility

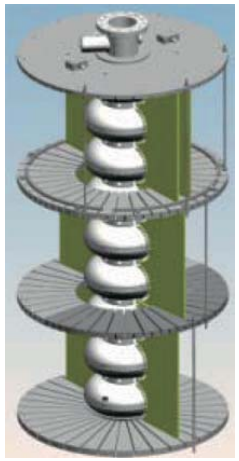
Clean room: in operation for use of short cryomodule assembly.
UPW: in operation.
HPR:under construction. almost completed.
EP : under construction. will be completed soon.
External acid tank system: will be constructed in fall 2007.
CP: will be constructed in JFY2008.

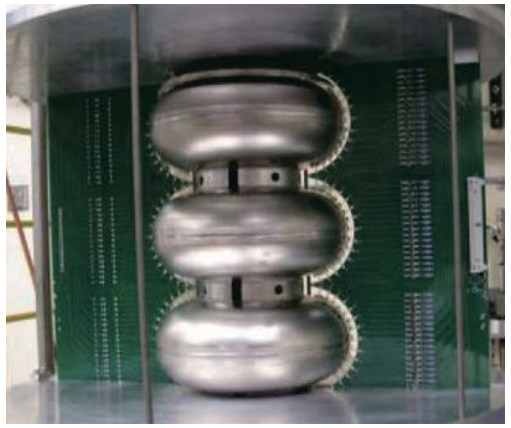


Diagnostics developments

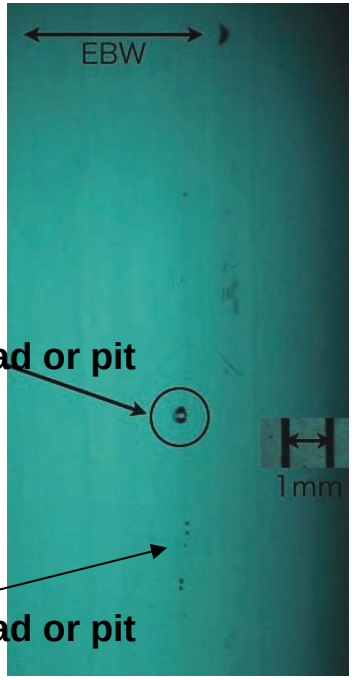


FNAL 9-cell T-map development





LANL 9-cell T-map development



Pixel resolution 15μm

KEK/Kyoto
high resolution camera,
wide illumination

S1 Task

S1 Goal and Plan to achieve

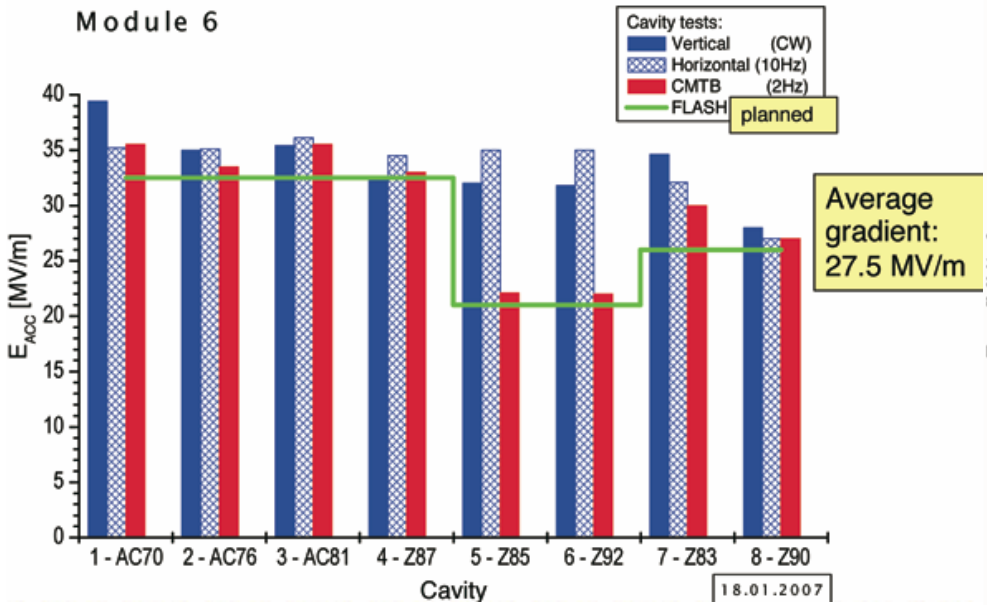
Ultimate Goal;

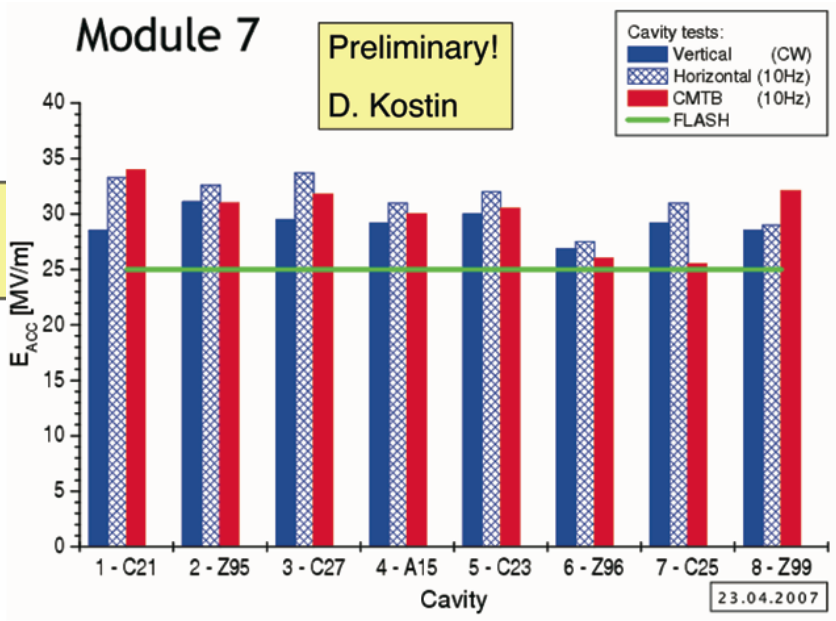
31.5MV/m@Q_0=1x10^{10} as operational gradient
at least 3 cryomodules include fast tuner, etc

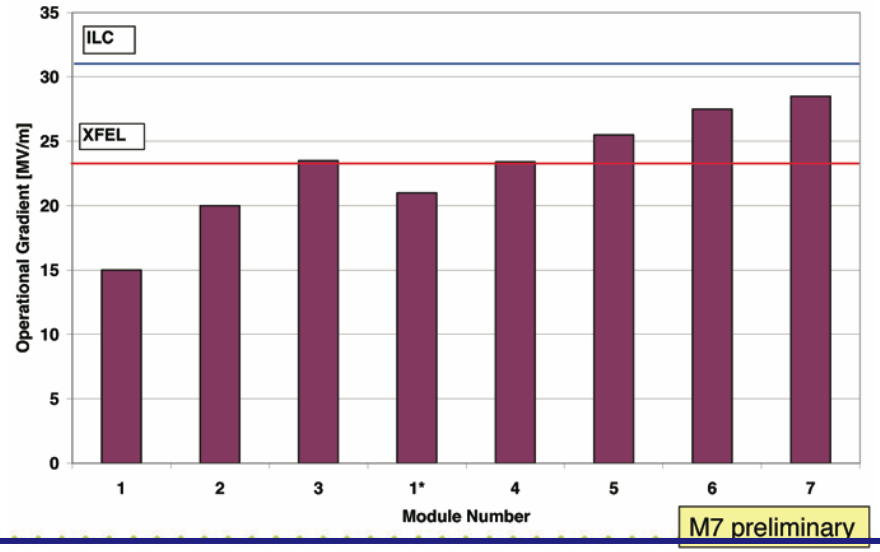
Intermediate goal: ***to achieve by single cryomodule with tweaking WG-config***

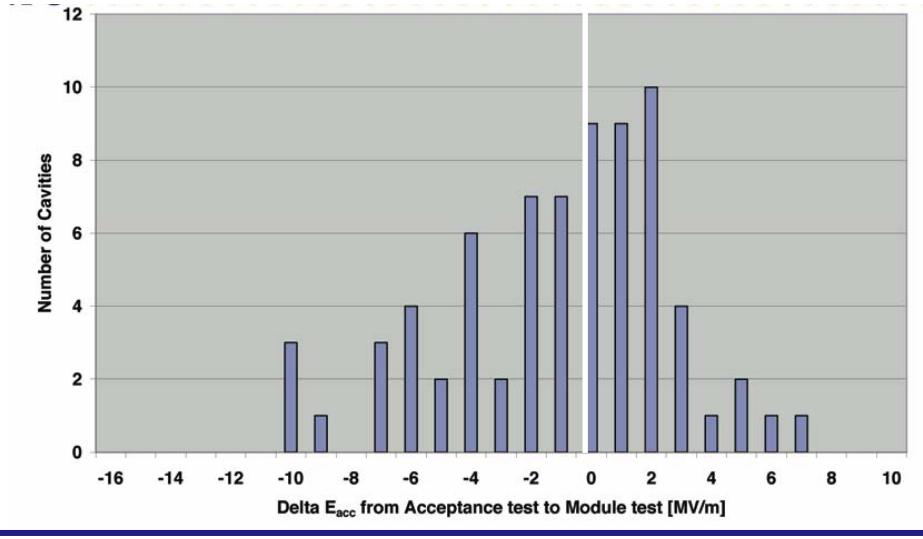
Final goal: use of 'S0' passed cavities, operation of a few weeks

DESY FLASH modules: operational gradient









Cryomodule Plan to achieve S1 goal

DESY: module 6 was a candidate.
(next will be XFEL module production)

FNAL: 1 type III+ (from DESY) in 2007
1 type III+ in 2008
3 type IV in 2009-2010

KEK: 1 connected cryomodule (STF phase 1)
in 2007-2008
3 ILC modules (STF phase 2) in 2009-2010

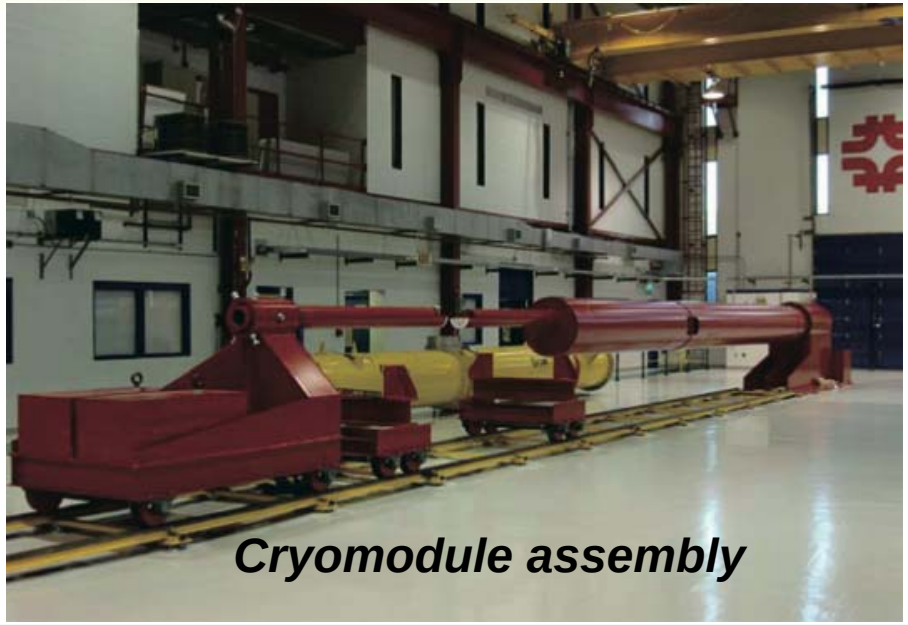
Candidates of S1 intermediate goal:
FNAL type III+, type IV
KEK STF phase 2 cryomodule,
plan of 'dream module' is under discussion.

Module Infrastructure at FNAL

Cold mass assembly

The first type III+ is under assembly in ICB-FNAL. will be finished in Nov. 2007

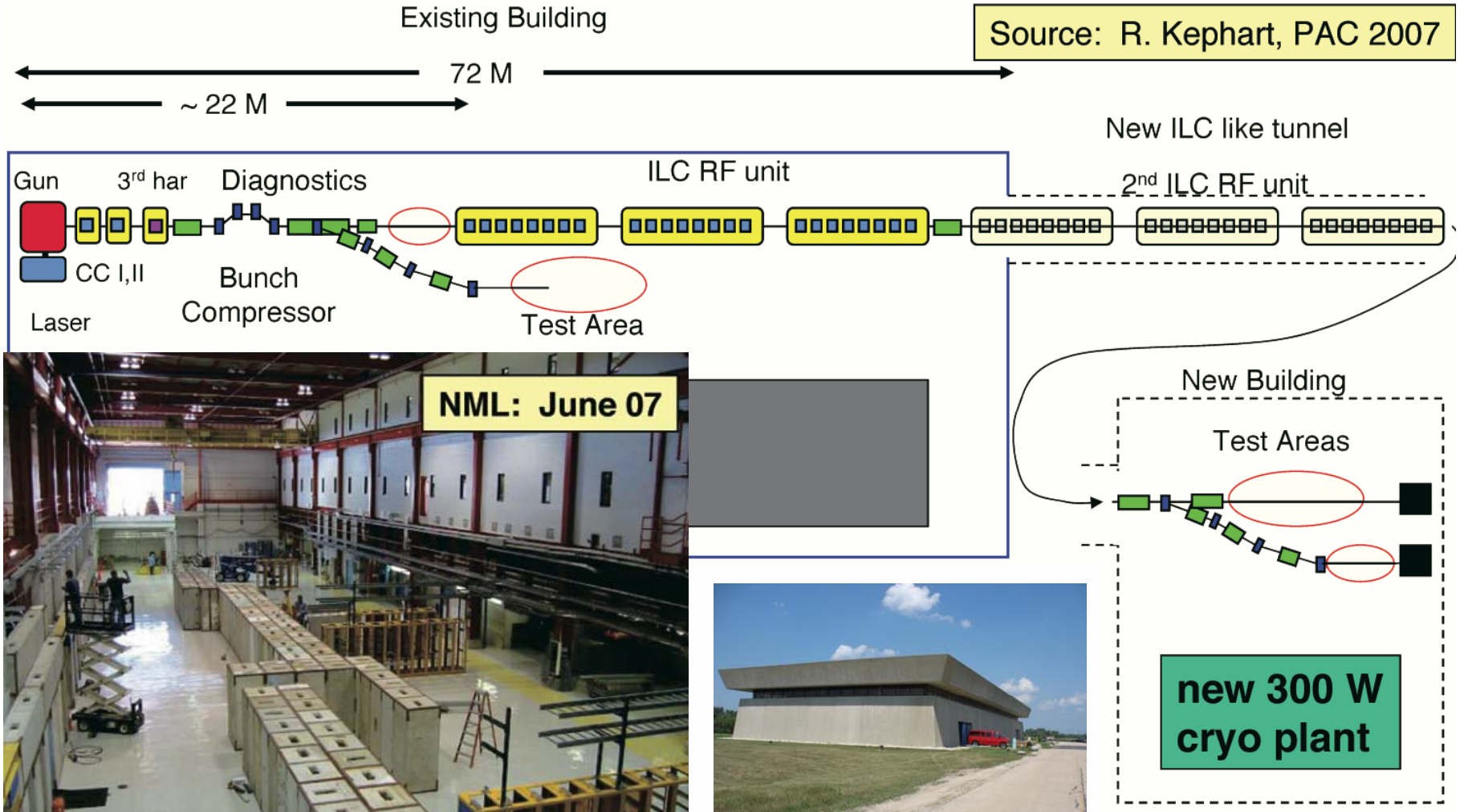
Clean room For cavity assembly



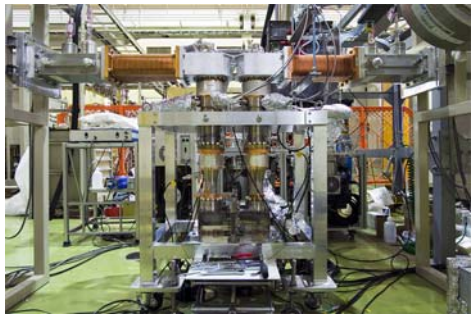
Cryomodule assembly

ILCTA-NML at FNAL

Test Accelerator for Cryomodule test



Cryomodule Activity in KEK



Coupler process

Cold-mass Insertion

Installation in tunnel

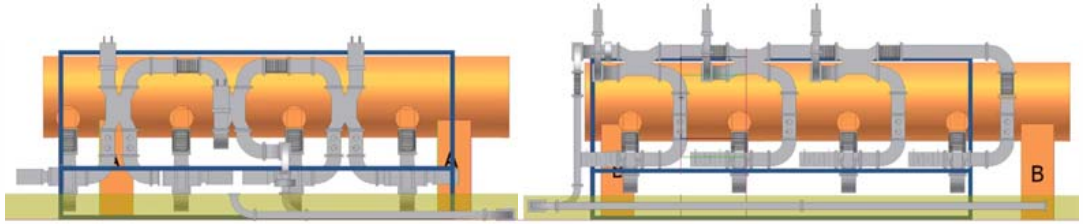
1 TESLA-shape cavity

1 LL-shape cavity

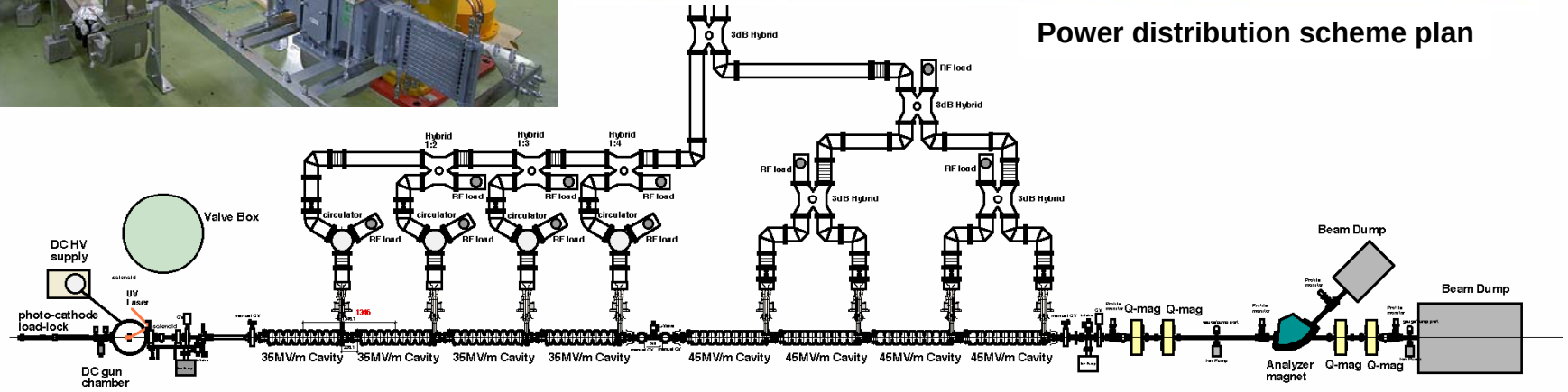
Cold-box cool-down test

Assembly in tunnel

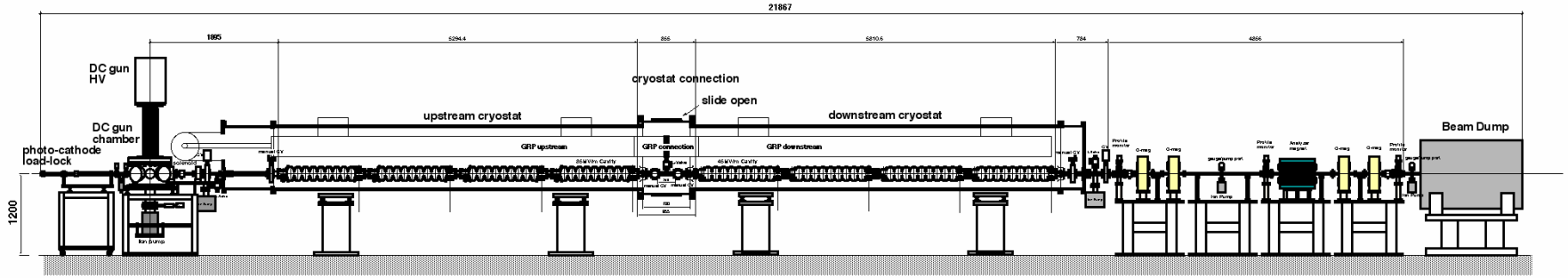
STF Phase 1 beam-line Plan



Power distribution scheme plan



Plain view



Side view

H. Hayano
01/12/2006 V4.0

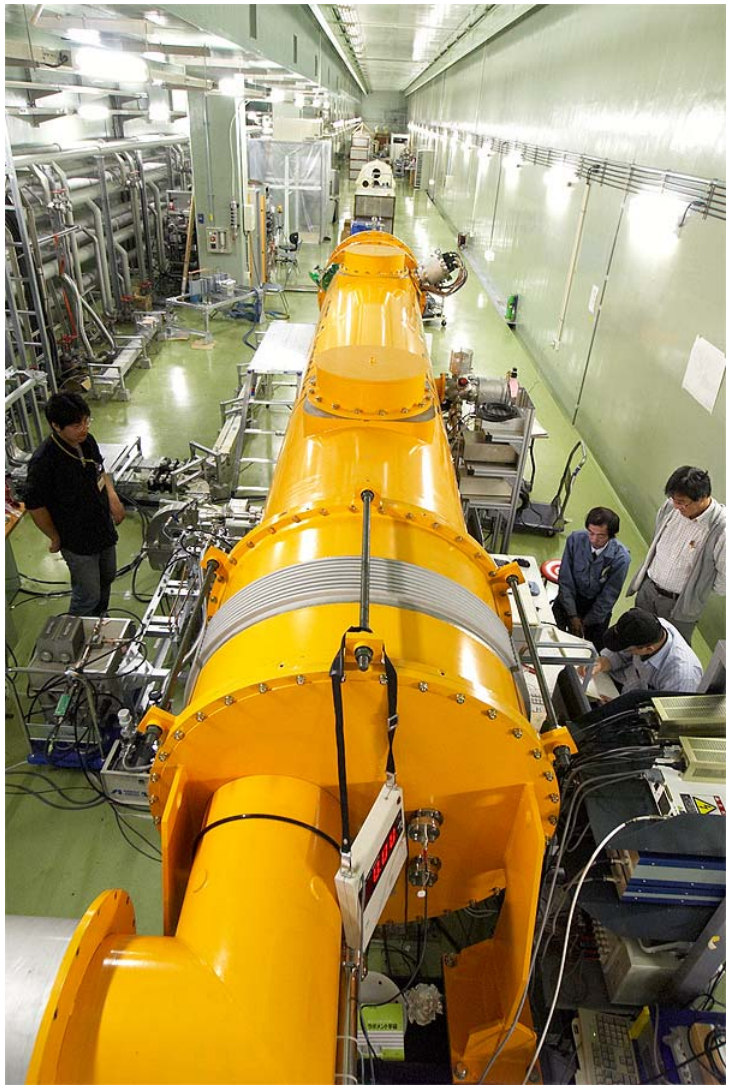
Pre-test of STF1.0 (STF0.5)

During assembly of cryomodule;
leak at cavity vessel was found
-> dismount downstream half cryomodule.
leak at cold box was found
-> repair the cold box.

From the beginning of October,
cool-down test was started,
reached 4K and stay there for data taking.

STF1.0(module cool-down test)
is scheduled in middle of 2008

Remove cold mass of
the downstream half cryomodule



Cool down test of half-cryomodule
with one TESLA-shape cavity inside.

Plan of STF Phase 2

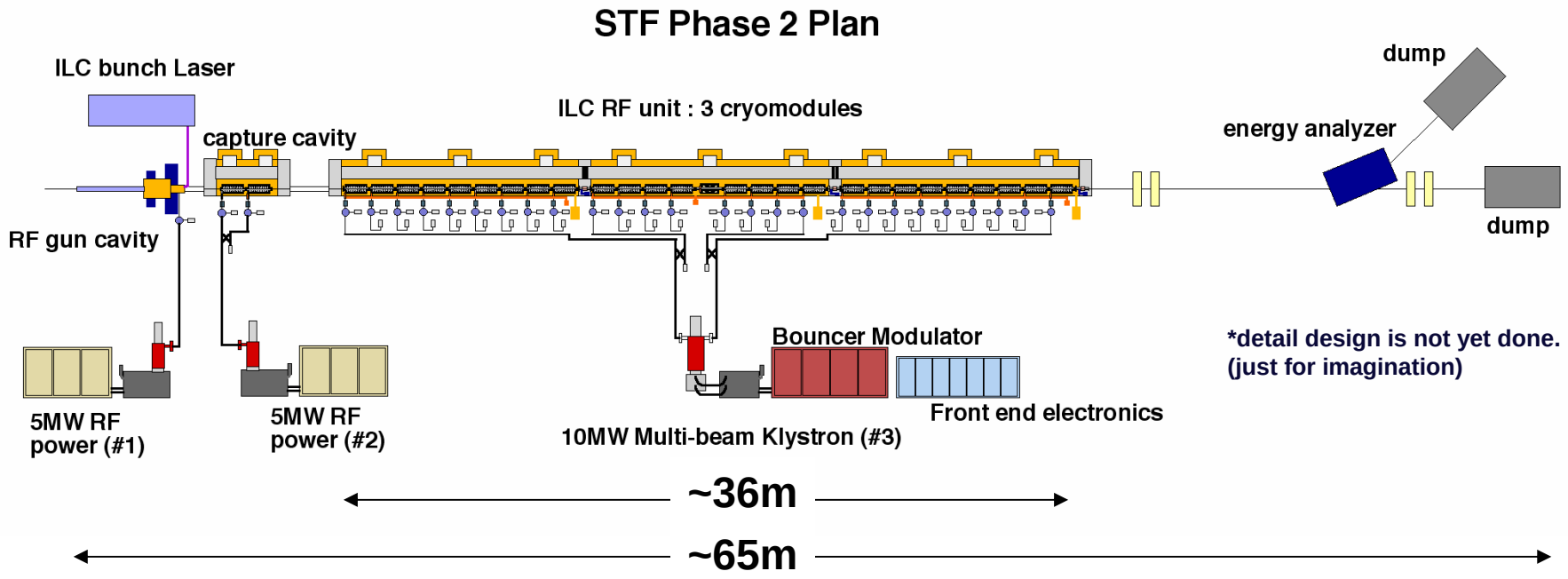
ILC RF unit test, in the existing STF tunnel,

With ILC beam by L-band RF-gun.

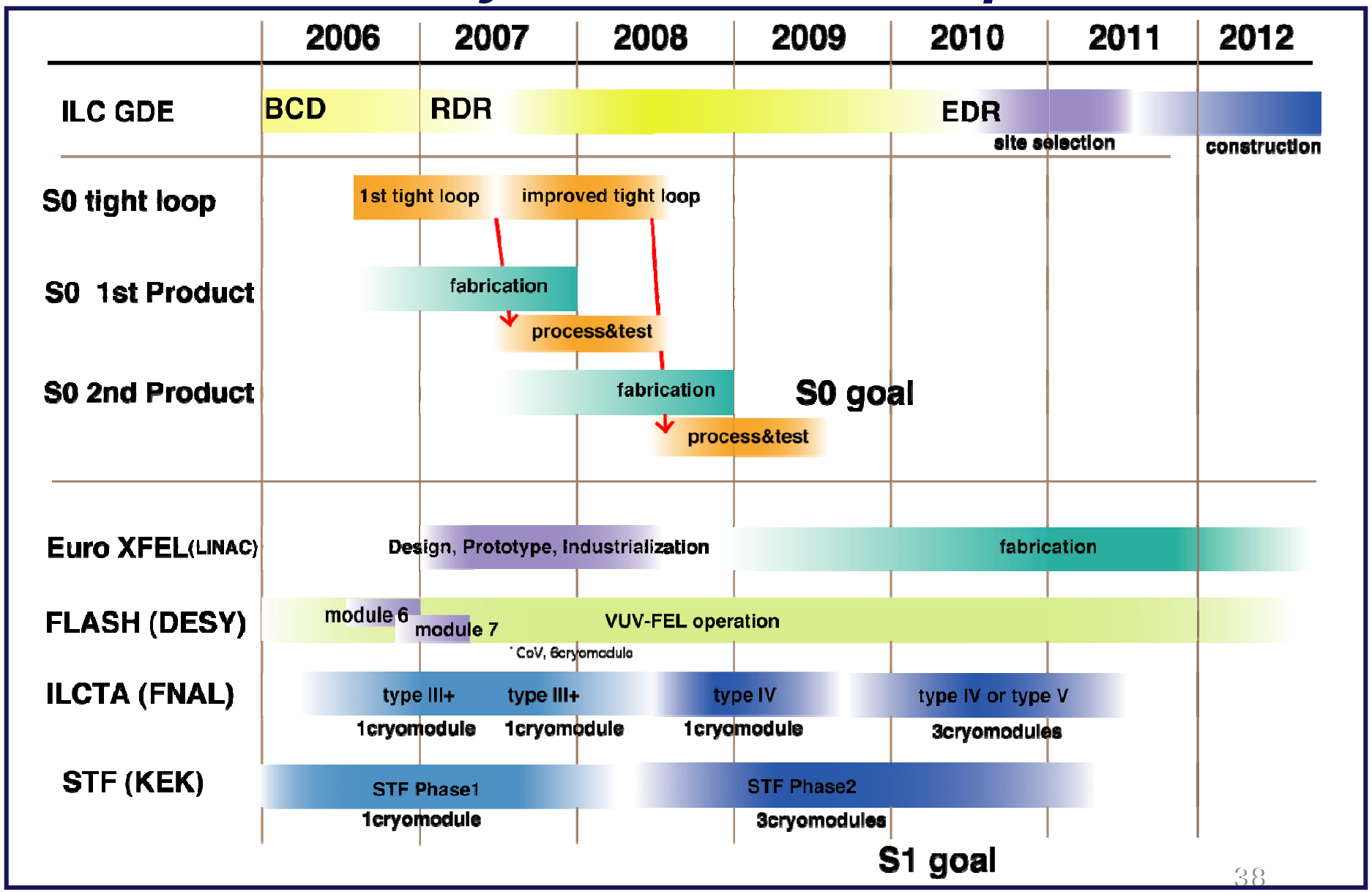
design and preparation of vessel code : 2008

fabrication : 2009 - 2010

operation : 2011



Summary of ILC SC R&D plan



end