International Linear Collider (ILC) Status and Technical R&D Plan

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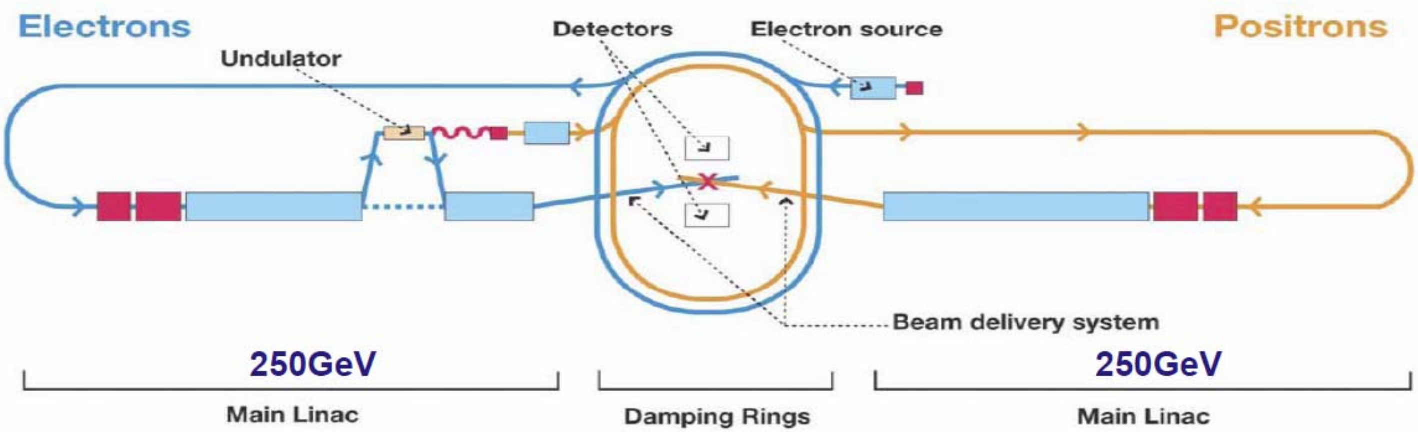
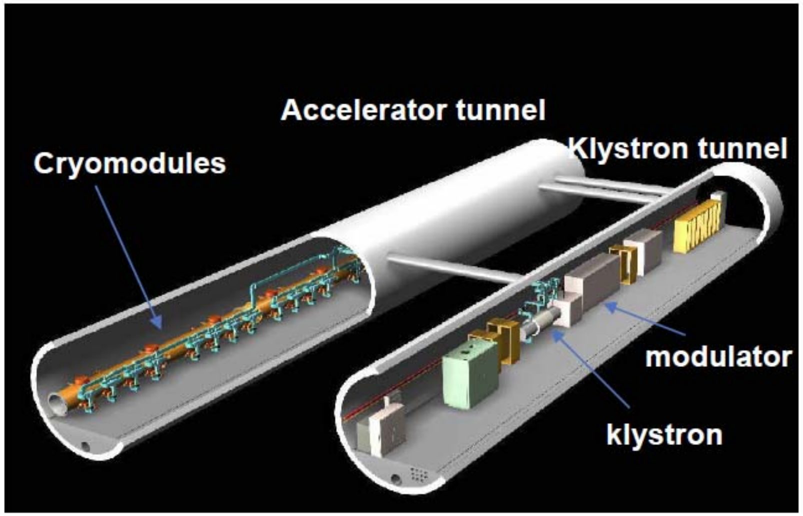
KEK

ILC-SCRF Project Manager

Feb. 13, 2008

ILC Layout Plan

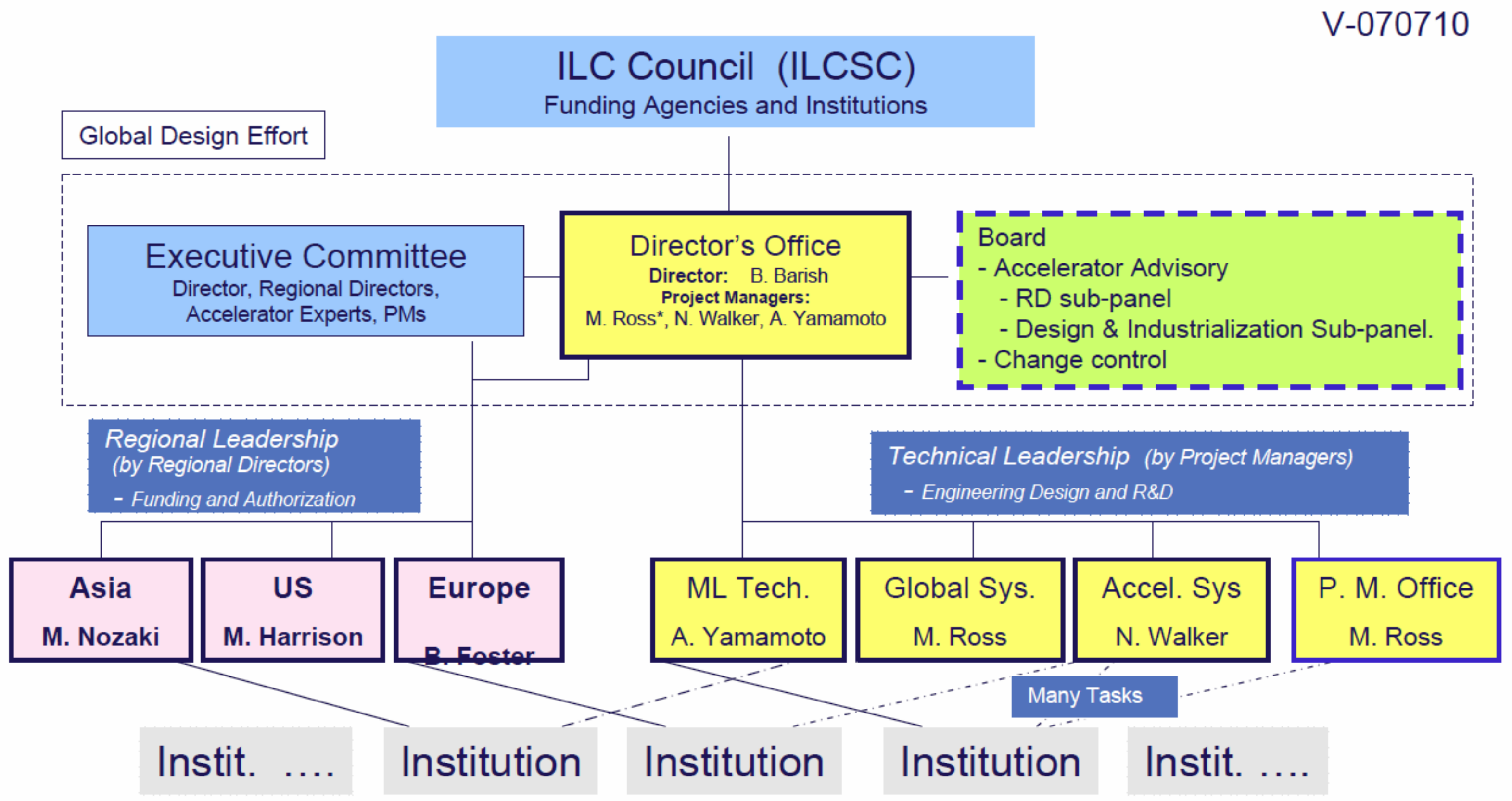




e+, e- Main Linac

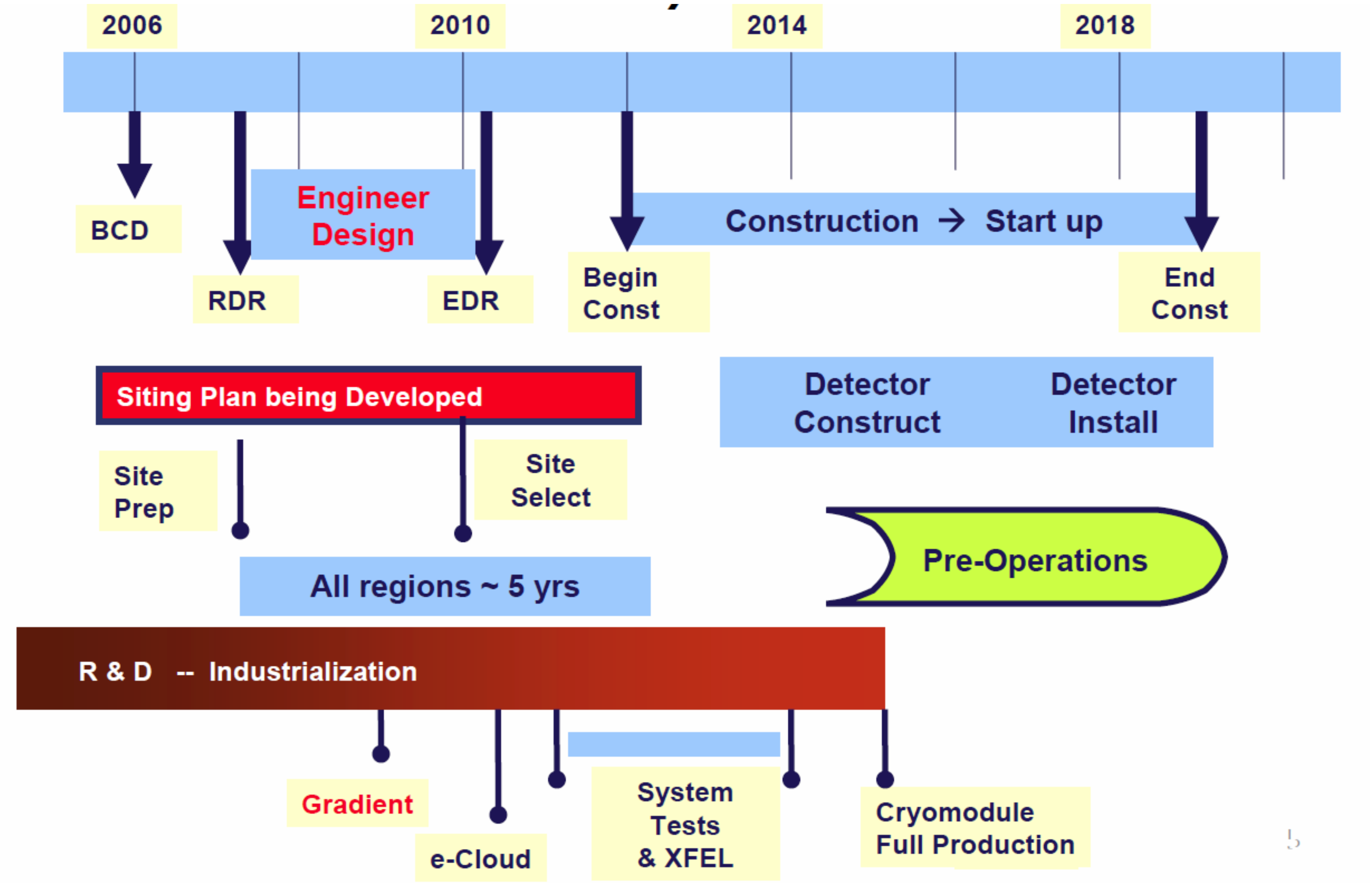
Energy : 250GeV + 250GeV
Length : 11km + 11km
# of RF unit : 560 total
# of Cryomodules : 1680 total
# of Cavities : 14560 total

3



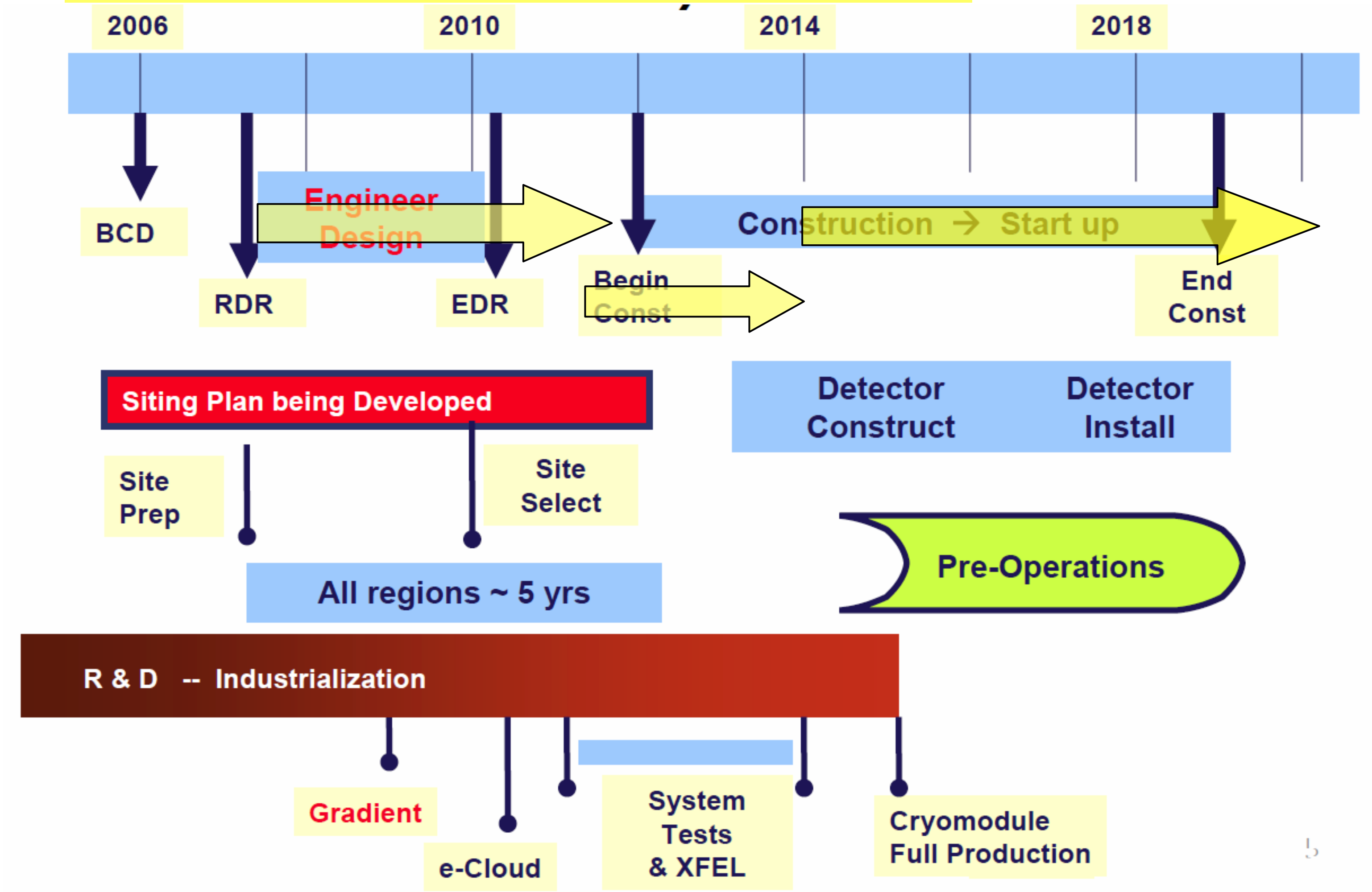
V-070710
ILC Council (ILCSC)
Funding Agencies and Institutions
Global Design Effort
Executive Committee
Director, Regional Directors, Accelerator Experts, PMs
Director's Office
Director: B. Barish
Project Managers:
M. Ross*, N. Walker, A. Yamamoto
Board
- Accelerator Advisory
- RD sub-panel
- Design & Industrialization Sub-panel.
- Change control
Regional Leadership (by Regional Directors)
- Funding and Authorization
Technical Leadership (by Project Managers)
- Engineering Design and R&D
Asia
M. Nozaki
US
M. Harrison
Europe
B. Foster
ML Tech.
A. Yamamoto
Global Sys.
M. Ross
Accel. Sys
N. Walker
P. M. Office
M. Ross
Many Tasks
Instit. ….
Institution
Institution
Institution
Instit. ….

General Plan (as of Oct., 2007)



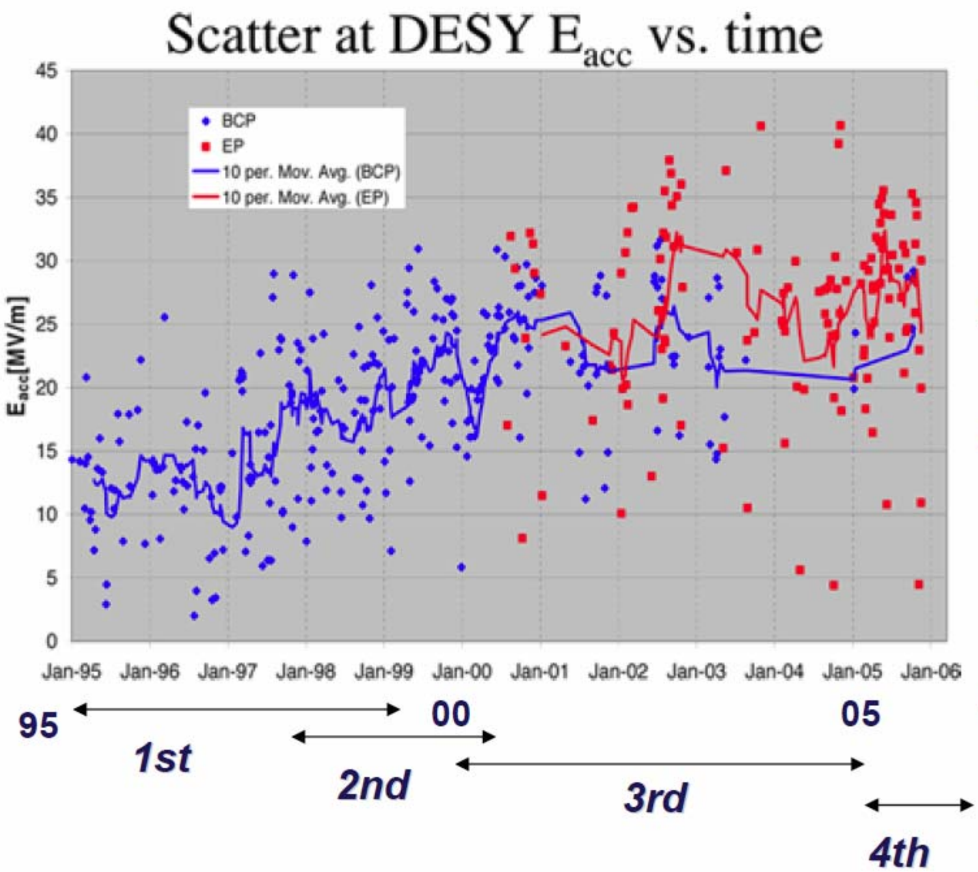
General Plan (as of Feb., 2008)

EDR to be extended, for two years



New Guideline for R&D (proposed)

- EDR with Two Phases (to be re-proposed):
  - **TDP1: technical feasibility by 2010**
    - Gradient (S0) in progress to reach 30 to 35 MV/m
    - 8-series 9-cell cavity (S1) to reach 31.5 MV/m
      - Proof-of-Principle and System Engineering
    - Cryomodule design with plug-compatible components,
  - **TDP2: technical credibility by 2012**
    - Gradient (S0) to reach 35 MV/m w/ yield 90 %
    - One-RF unit and three CM operation with beam,



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

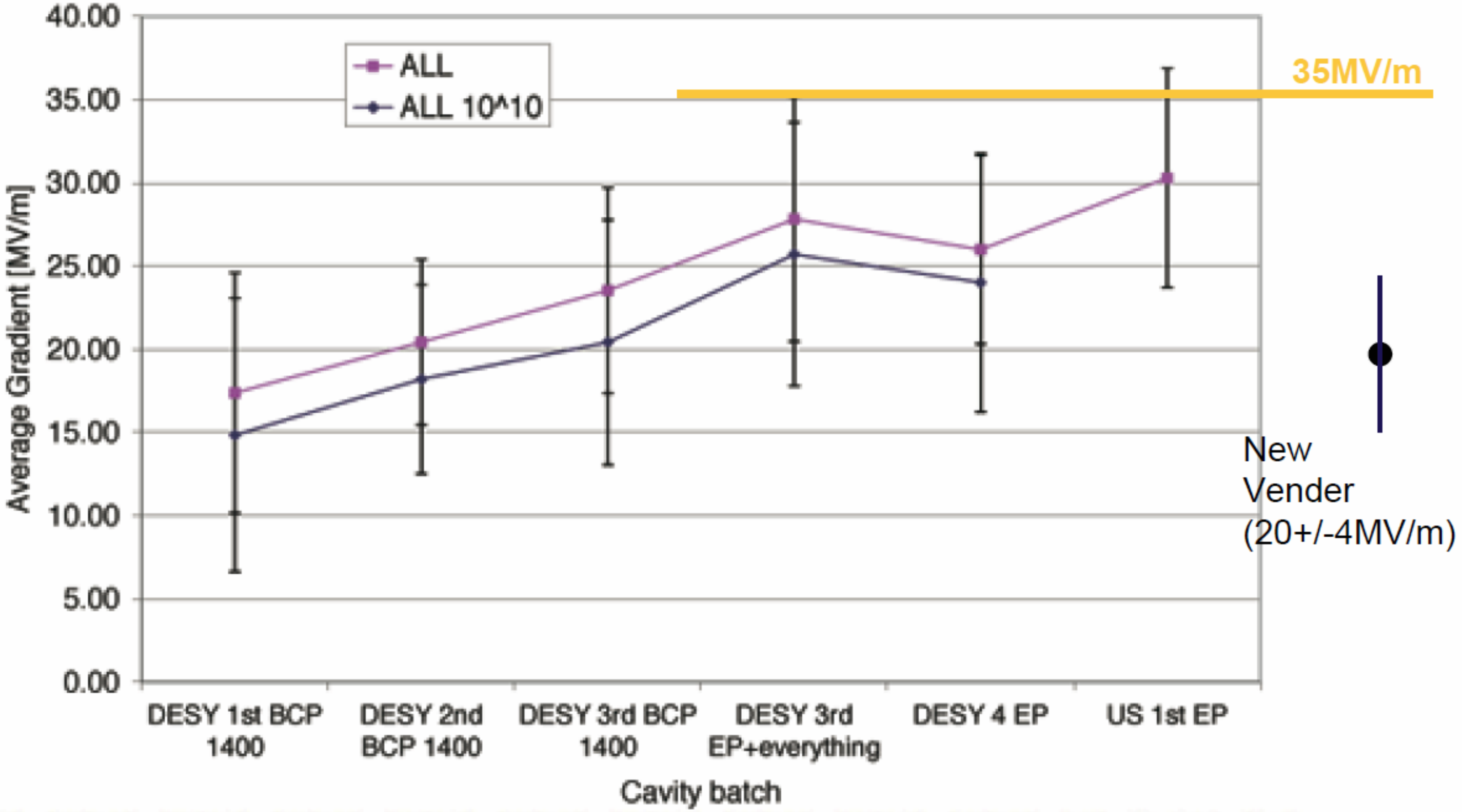
1st : no eddy-curr and BCP+1400
2~20MV/m by field emission
and defect
welding not matured

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

‘Qualified’ Vender Production, All Test Results



Gradient R&D Progress and Plan (S0)

Table 5.1: Projected number of superconducting RF cavities available in each region and the number of planned tests for the TD Phase (TDP1 is 2004 to mid-2010), and up to 2012.

Americas	FY06 (actual)	FY07 (actual)	FY08	FY09	FY10	TOTAL TDP1	FY11	FY12
Cavity orders	22	12	0	10	10	**52**	10	10
Total 'process and test' cycles		40	5	30	30	**98**	30	30
Asia	**FY06 (actual)**	**FY07 (actual)**	**FY08**	**FY09**	**FY10**		**FY11**	**FY12**
Cavity orders	8	7	15	25	15	**59**	39	39
Total 'process and test' cycles		21	45	75	45	**152**	117	117
Europe	**2004-06 (actual)**	**2007 (actual)**	**2008**	**2009**	**2010**		**2011**	**2012**
Cavity orders	60*			838		**898**		
Total 'process and test' cycles		14	15	30	100	**109**	354	354
Global totals								
Global totals - cavity fabrication	90	19	15	873	25	**1008**	49	49
Global totals - cavity tests	**0**	**75**	**65**	**135**	**175**	**359**	**501**	**501**

* Thirty European cavities were ordered in 2004.

As of Feb. 2008, from ILC R&D Plan for the Technical Design Phase, Release 1, Rev. 2

Gradient R&D (S0)

- Progress since technology choice
  - **27.5 MV/m w/ yield 90 % in 2006**
  - **31.5 MV/m w/ yield 90 % in 2008**
    - Based on sample population of 15 (nine-cell) cavities,

- General Goal
  - **Reach 35 MV/m w/ yield 50 % by 2010**
    - Based on a well-defined sample of ~30-40 cavities from qualified vendors
    - The total number of cavity processing cycles will be ~360 (reduced from 540)
      - Includes setup of infrastructure, vendor qualification etc.
  - **Reach 35 MV/m w/ yield 90 % by 2012**
    - Based on a well-defined sample of ~30-40 cavities from qualified vendors
    - At this time the total number of cavity processing cycles will be ~500

Gradient R&D: Key Issues

- Field emission greatly reduced with post-EP rinses
- Equator quench is a dominant limit

PLAN:

- Kyoto U/KEK inspection camera and Tmap to identify and classify flaws
  - **Tested on multi-cell; will work with single cell**
  - **Many flaws and features observed**
- *Expand and Perfect these instruments*

Goal: develop pre-VTS prediction system; provide feedback to fabrication / processing procedure

- **Reduce VTS time/cost and develop comprehensive inspection system**

Gradient R&D - Expected

- 100K$/cavity, 30 K$/ process & test cycle,
- ~ ½ test cycle per week, at the Cornell and JLab combined, in 2009-10
  - **close to table numbers – 30/year.**
  - **(3M for testing alone during the 2 years)**
- Dividing by max. number of etch & test cycles allowed per cavity (~3?),
  - **we would need 10 cavities/year.**
- Use existing cavities for some of this, need about 1M/year for cavities.
  - **development/maintenance effort must be included**
- Bulk EP should be done by fabricator
  - **cost effective and preserves our infrastructure**
- Identifying the flaws in cavities in the 20 to 32 range that are limited by quench. (TTC)
  - **relies on test / retest with tmap etc.**
- Marginally viable with less than 10 cavities and less than 30 procedures.
- Key questions –
  - **Who pays for the diagnostics (internal viewer, tmapping hardware, contaminant sampling…)?**
  - **Who develops? Mark C and TD group is interested; Fermilab focus will naturally shift to cryomodule.**

Appendix: Goal of S1 in RDR

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

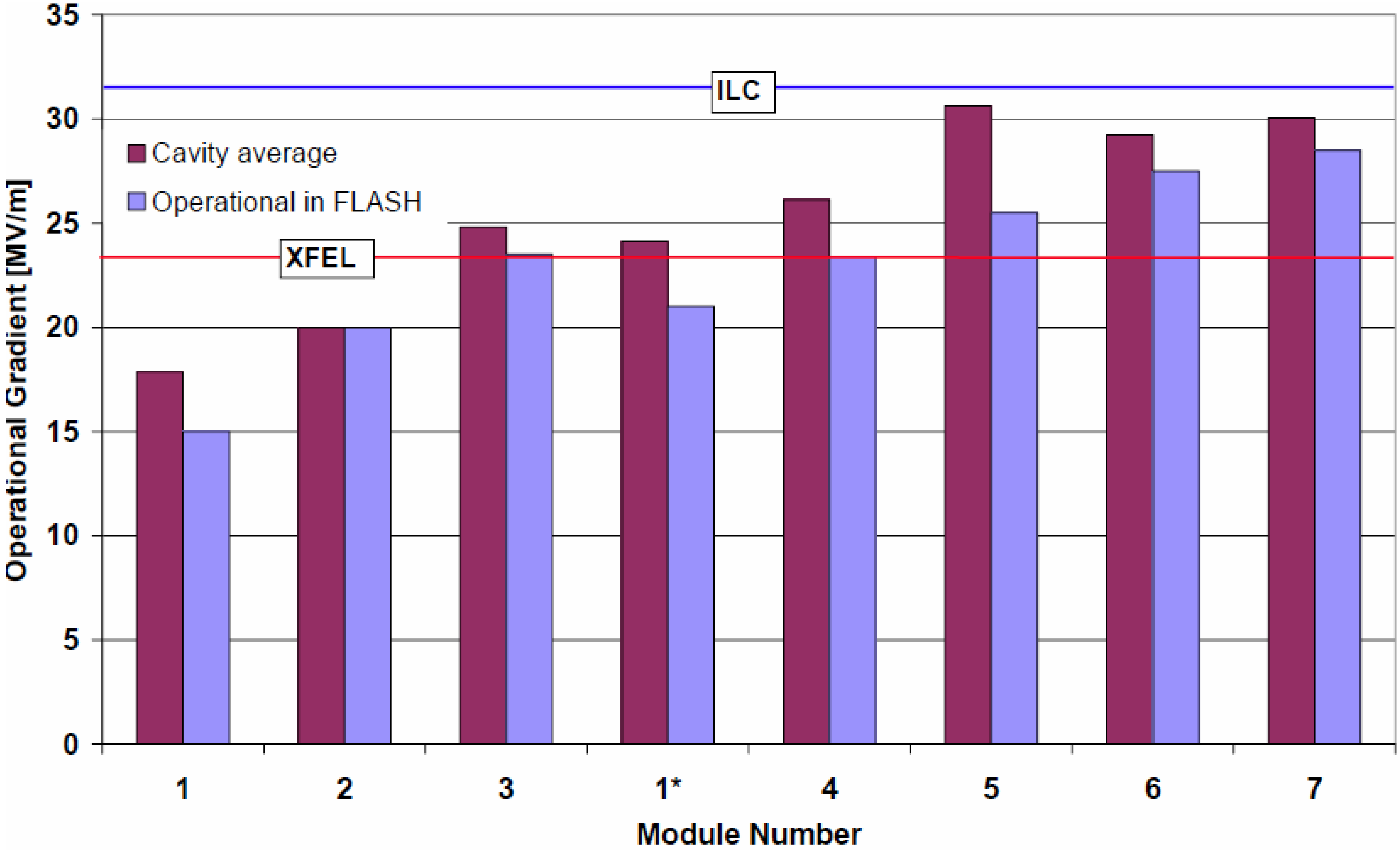
Final goal: use of 'S0' passed cavities, operation of a few weeks

R&D Plan for S1 and S1-Global

- **Purpose**
  - **E = 31.5 MV/m with system engineering (and beam)**
    - With 8 x 9-cell cavities configuration
  - **General test facilities including Cryogenics, RF and the power distribution system, diagnostics, (and electron-beam) required**

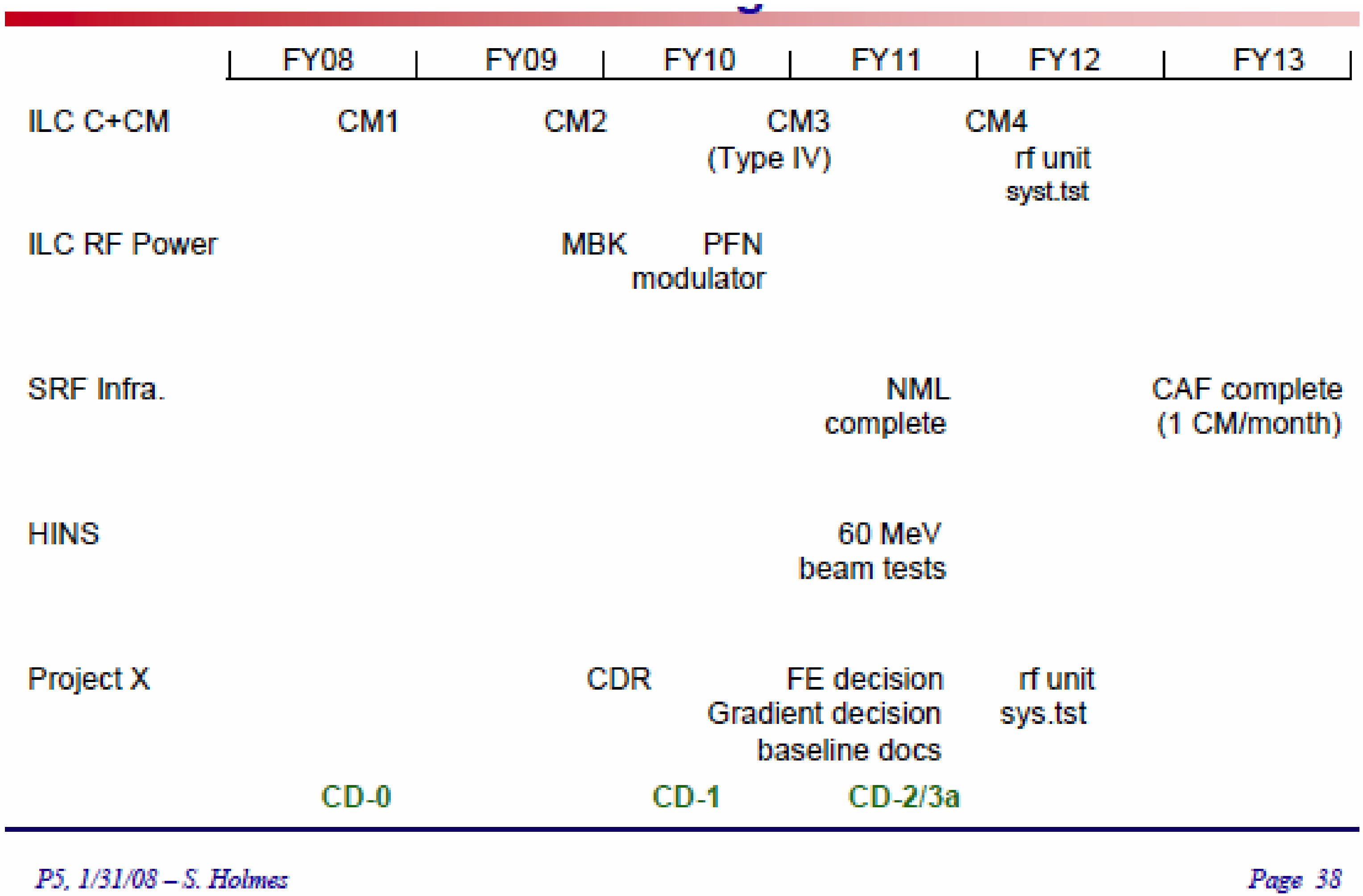
- **Where?**
  - **The primary plan at Femilab >> CM3 ~4 = Type-IV (S1)**
  - **The secondary plan proposed (S1-global/international),**
    - potentially at KEK (or DESY)
    - Qualified cavity units (cavity+vessel+tuner), couplers, quad., BPM to be gathered to the hosting lab.
  - **It may be organized as a global effort.**
    - Qualified dressed-cavities to be globally prepared.

Progress of Cavity Performance with Cryomodules at DESY



SCRF R&D Plan at Fermilab

given in a P5 talk by S. Holmes



SCRF and STF Plan at KEK
by K. Yokoya

STF0.5 for TESLA-like (done Nov.2007)

STF0.5 for ICHIRO (to finish Mar.2008)

(red color indicates different cryostat)

STF1: for TESLA-like (to finish by summer 2008)

Full STF1 : (TESLA-like + ICHIRO)

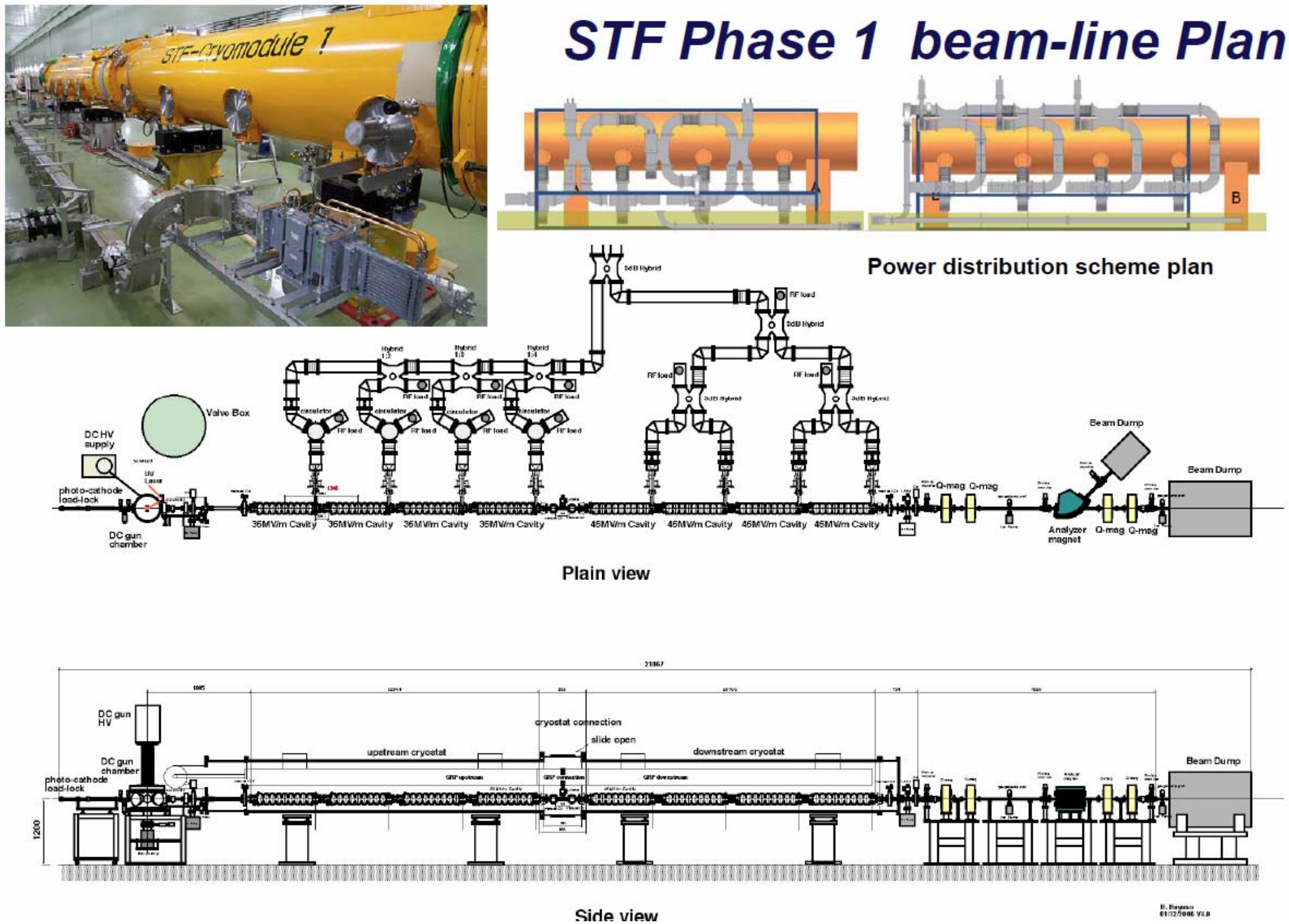
- Not yet decided
- To finish within CY2008 if to be done

>>> possible extention to **S1**, in CY2009 or later (proposed by PMs)

STF2 : design in JFY2008, construction in JFY2009-2010

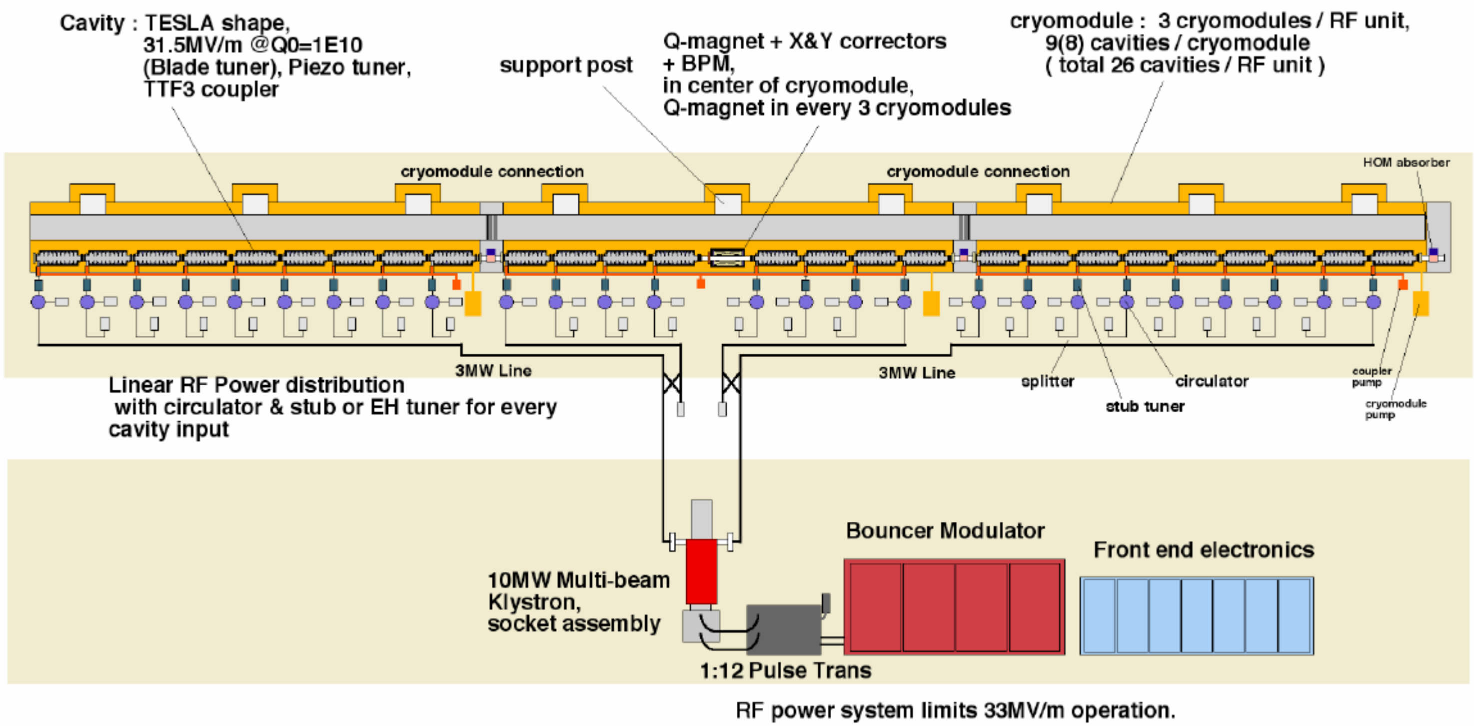
(from scratch, not extension of STF1)

STF (1) at KEK

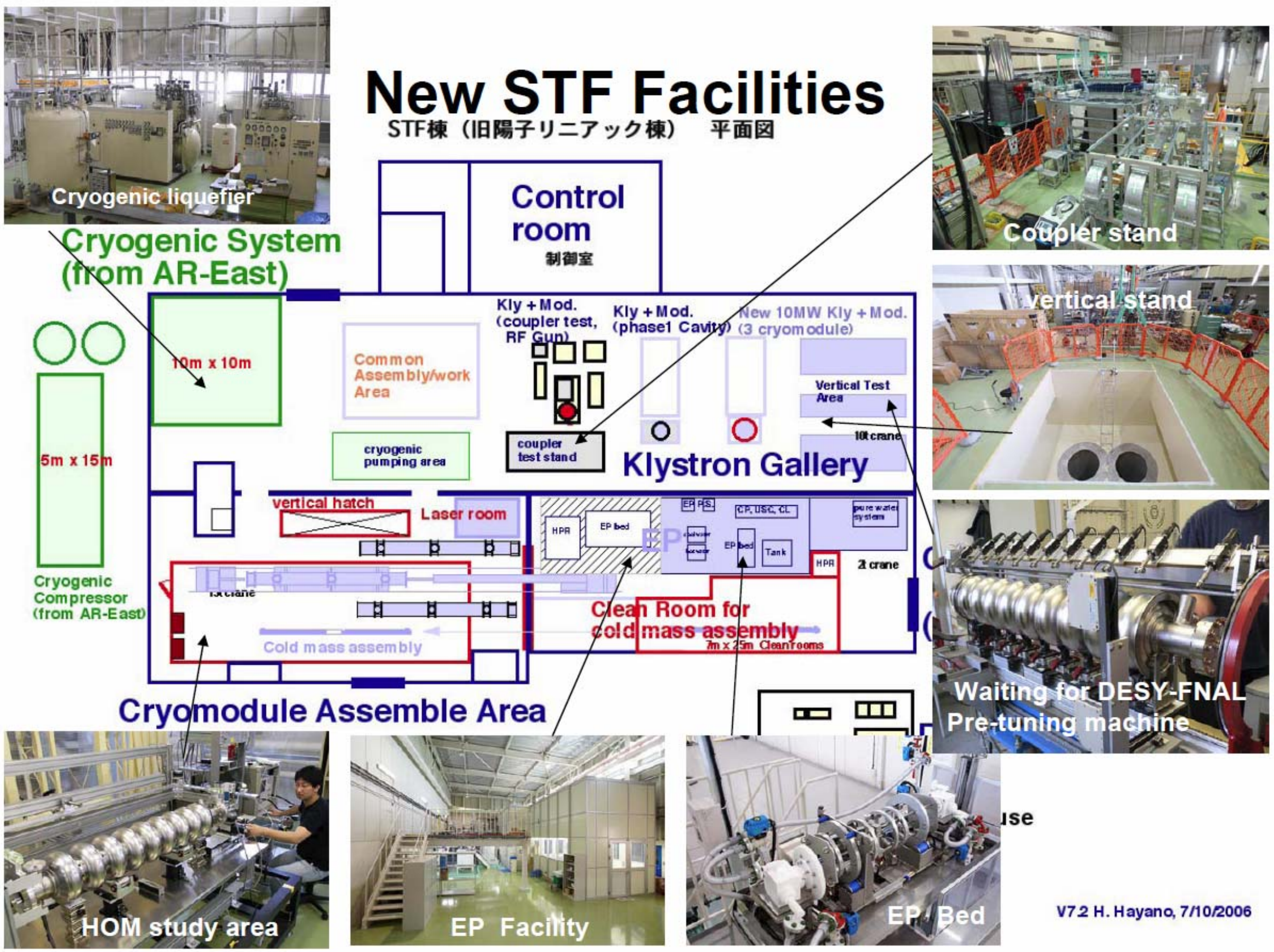

STF-Cryomodule 1
STF Phase 1 beam-line Plan
Power distribution scheme plan
Valve Box
DC HV supply
photo-cathode load-lock
DC gun chamber
35MV/m Cavity
45MV/m Cavity
Q-mag
Beam Dump
Analyzer magnet
Plain view
DC gun HV
DC gun chamber
cryostat connection
slide open
upstream cryostat
downstream cryostat
Side view

S2 Concept (one RF unit)

ILC Main Linac RF unit



RDR configuration



New STF Facilities
STF棟（旧陽子リニアック棟） 平面図
Cryogenic liquefier
Cryogenic System
(from AR-East)
Control room
制御室
10m x 10m
5m x 15m
Common Assembly/work Area
Kly + Mod. (coupler test, RF Gun)
Kly + Mod. (phase1 Cavity)
New 10MW Kly + Mod. (3 cryomodule)
Vertical Test Area
10t crane
cryogenic pumping area
coupler test stand
Klystron Gallery
vertical hatch
Laser room
Cryogenic Compressor (from AR-East)
Cold mass assembly
Clean Room for cold mass assembly
7m x 25m Cleanrooms
2t crane
Cryomodule Assemble Area
Coupler stand
Vertical stand
Waiting for DESY-FNAL Pre-tuning machine
HOM study area
EP Facility
EP Bed
V7.2 H. Hayano, 7/10/2006

Possible Global R&D Plan

		CY08		CY10		CY12
EDR	TDP1				TDP-II	
S0: Cavity Gradient (MV/m)	30					35 (>90%)
KEK-STF-0.5a: 1 Tesla-like						
KEK-STF-0.5b: 1 LL						
KEK-STF1: 4 cavities						
S1-Global (AS-US-EU) 1 CM (4+2+2 cavities)			CM ($4_{AS}+2_{US}+2_{EU}$) <31.5 MV/m>			
S2 & STF2: One RF unit & 3 CM with beam		design	Fabrication in industries	Assembled and test at STF		
S1-Fermilab/US ILC-CM-3 or -4		CM1	CM2	CM3(Type-IV)	CM4	

R&D Goals in EDR

- **Cavity: Basic Performance (S0)**
  - **High-gradient 9-cell Cavity R & D for the preparation process & vertical test to achieve 35 MV/m at $Q_0 = 10^{10}$ with yield > 90% (> 80% at 1st test, and > 90 % after re-processing remaining 20%) ,**
- **Cavity: System Performance with Cryomodule (S1)**
  - **Cryomodules containing eight 9-cell, full-dressed cavities, achieving an average gradient of 31.5 MV/m ($Q_0 = 10^{10}$),**
- **Cryomodule**
  - **Optimum design and establish the technology with plug compatible interface and components.**
- **Cryogenics**
  - **Cost effective design of the integrated cryogenics system, both in terms of construction and operation;**
- **HLRF**
  - **Cost effective design of the RF power and distribution system.**
- **Integration/Layout**
  - **Optimization of the cryomodule and component layout design with respect to beam dynamics issues**

Plan for STF-2

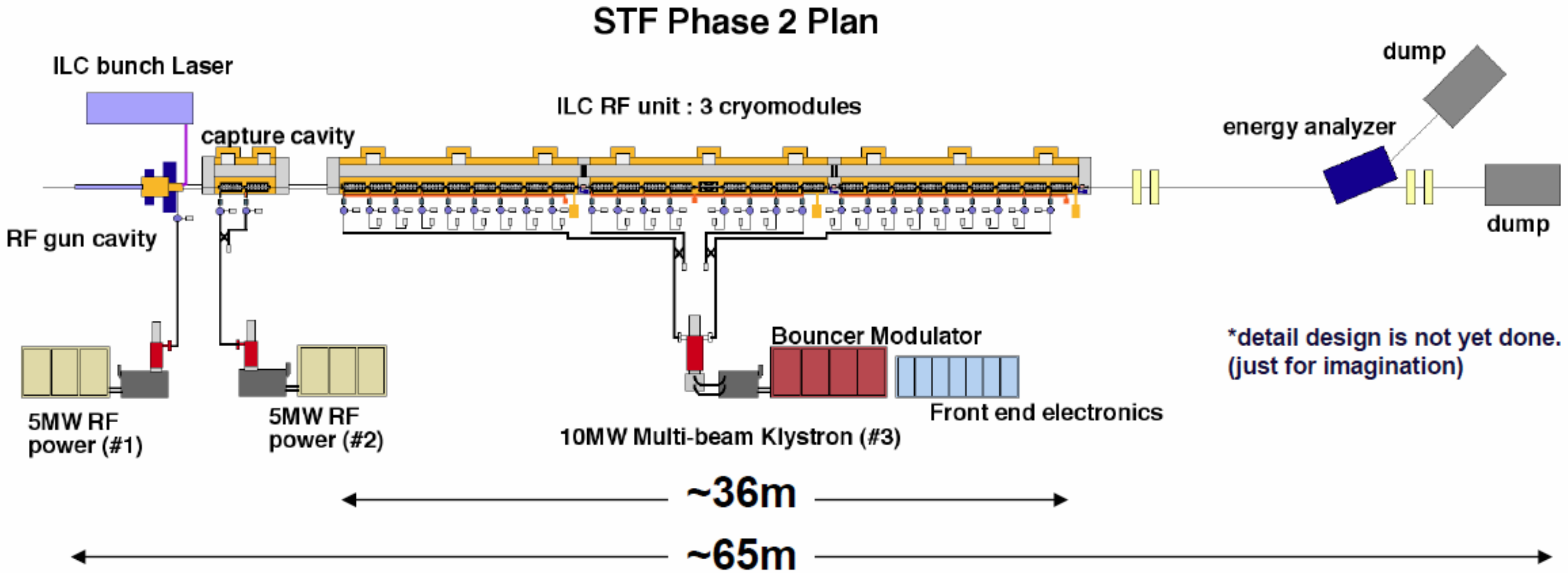
ILC RF unit test, in the existing STF tunnel,

With ILC beam by L-band RF-gun.

design and preparation of vessel code : 2008

fabrication : 2009 - 2010

operation : 2011



Summary

- ILC engineering design phase to be proceeded with
  - **TDP-1: technical feasibility by 2010, and**
  - **TDP-2: technical credibility by 2012,**
- Key technologies to be demonstrated are:
  - **Beam acceleration field <31.5 MV/m>**
    - with SCRF cavities associated with RF power distribution, cryogenics,
  - **Beam handling**
    - Superconducting magnets and diagnostics,
  - **Alignment**
    - static (10^{-1} mm) and dynamic (< 100 nm)

- *Thanks for expert's cooperation to meet these technical goals.*

Cryomodule Design

with plug-compatible components

	Cost fraction
• **CM with 6 modular sub-assemblies**	
– **Cavity unit (cavity + helium vessel + tuner)**	**64%**
– **Coupler**	**12%**
– **Quad package (quad + corrector)**	**4%**
– **BPM**	**2%**
– **Cold-mass (cold-piping)**	**x/19%**
– **Vacuum vessel**	**y/19%**

- **Plug-compatible, Interface specifications (IS)**
  - **To be fixed at Fermilab meeting, in April, 2008**

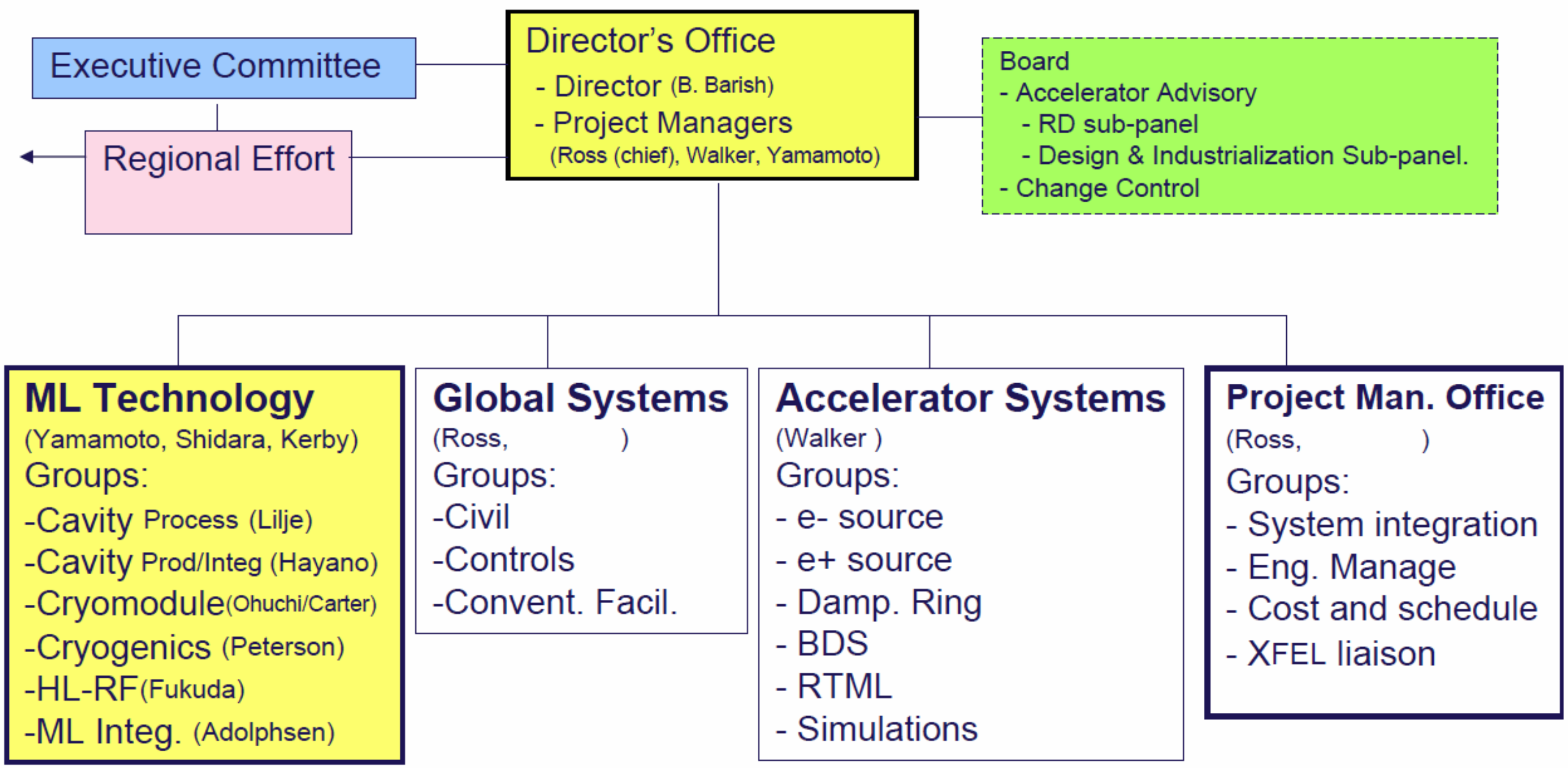
- **Plug-compatible IS** enables parallel development toward a single goal

backup

A possible plan at KEK-STF
as a proposal

- STF-1 extension to meet S1 plan
  - **2 x STF1 (2 x 4-series cavities) to become S1**
  - **Re-use of vacuum vessels (w/ modification)**
  - **Gather, globally, qualified cavities**
    - Plug compatibility is essentially required,
  - **S1 test constraint in high pressure system operation (i.e. temporary test),**
  - **The program may become feasible after the current STF-0.5 and STF-1 program at KEK,**
    - JFY-09 and later, and before STF-2 assembly work at the KEK-STF site.

ILC Technical Coordination



- ***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)*