STF status Feb.03,2005

H. Hayano, KEK

Technology discussion by constructing:

Superconducting RF Test Facility

Comprehensive Test Facility dedicated to ILC SC-RF R&D
(expandable to FEL, ERL)

for superconducting cavity;

fabrication, process, installation, vertical test / horizontal test, system test with beam

for cryomodule;

cavity installation, cryostat operation, heat cycle test, input coupler R&D,
tuner mechanism R&D

for power source;

modulator development, klystron development, WG components

for He plant;

High efficiency cryogenic system

for beam instrumentation;

ILC beam generation, BPM, HOM, Low-Level RF control

Issues of existing ILC-SC engineering

1. Reliability of cavity gradient >35MV/m
2. Complexity and cost of Input coupler
3. Rigidity of cavity-jacket relating to Lorentz detuning
4. Reliability of tuner mechanism, Reliability of Piezo in cold
5. Cavity alignment after cooling down
6. Cost optimization of RF Waveguide System
7. Cost optimization of cryomodule

…

etc.

Purpose of Test Facility in KEK

STF Phase 1

1. To provide stable and reliable gradient 35MV/m with reasonable yield rate.
2. To provide reliability data of 45MV/m gradient.
3. To provide a solution to issues of existing ILC-SC engineering using KEK SC engineering experience.
4. Construct cavity treatment facility in KEK.

STF Phase 2

1. Construct assembling facility of ILC cryomodule.
2. Assemble ILC cryomodule.
3. Construct cryomodule test facility.

Both

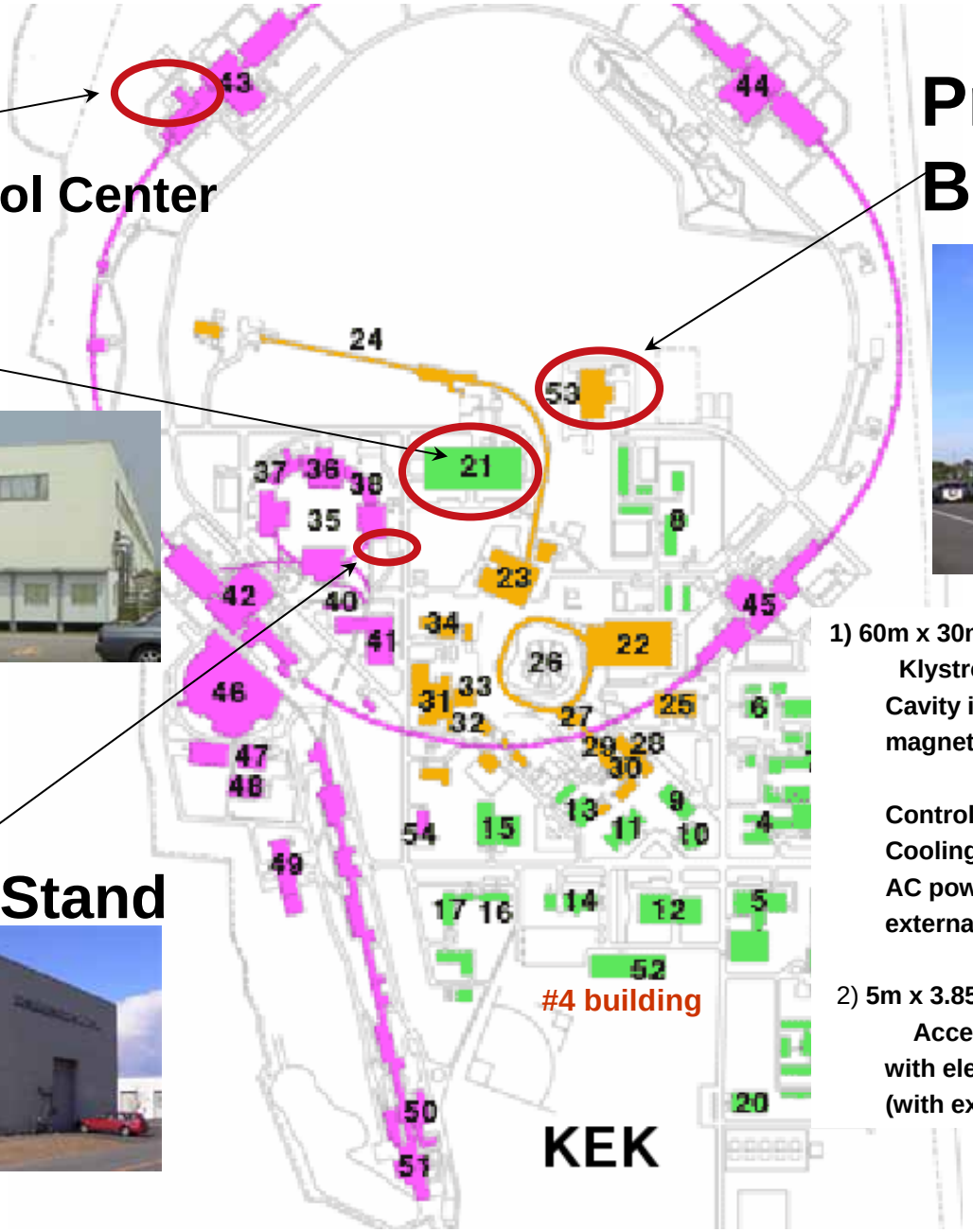
1. To be a base facility for international collaboration.
2. To provide a basis of realistic cost estimation and mass production.
3. To promote LC researchers and industries for production of SC-Cavities and cryomodules.
4. To give an opportunity to train up young researchers and students.

Location of Test Facilities

KEK-B
He Plant Control Center

ATF

L-band R&D Stand



Proton Linac Building(STF)

1) 60m x 30m building:
- **Klystron Gallery (with extendable space)**
- **Cavity installation room**
- **magnet power supply room (with extendable space)**
- **Control room (with extendable space)**
- **Cooling water facility**
- **AC power yard**
- **external Tent House**

2) 5m x 3.85m x 93.5m tunnel:
- **Access hatch only 2m x 4.5m with elevator (with extendable space)**

JPARC Proton Linac Building

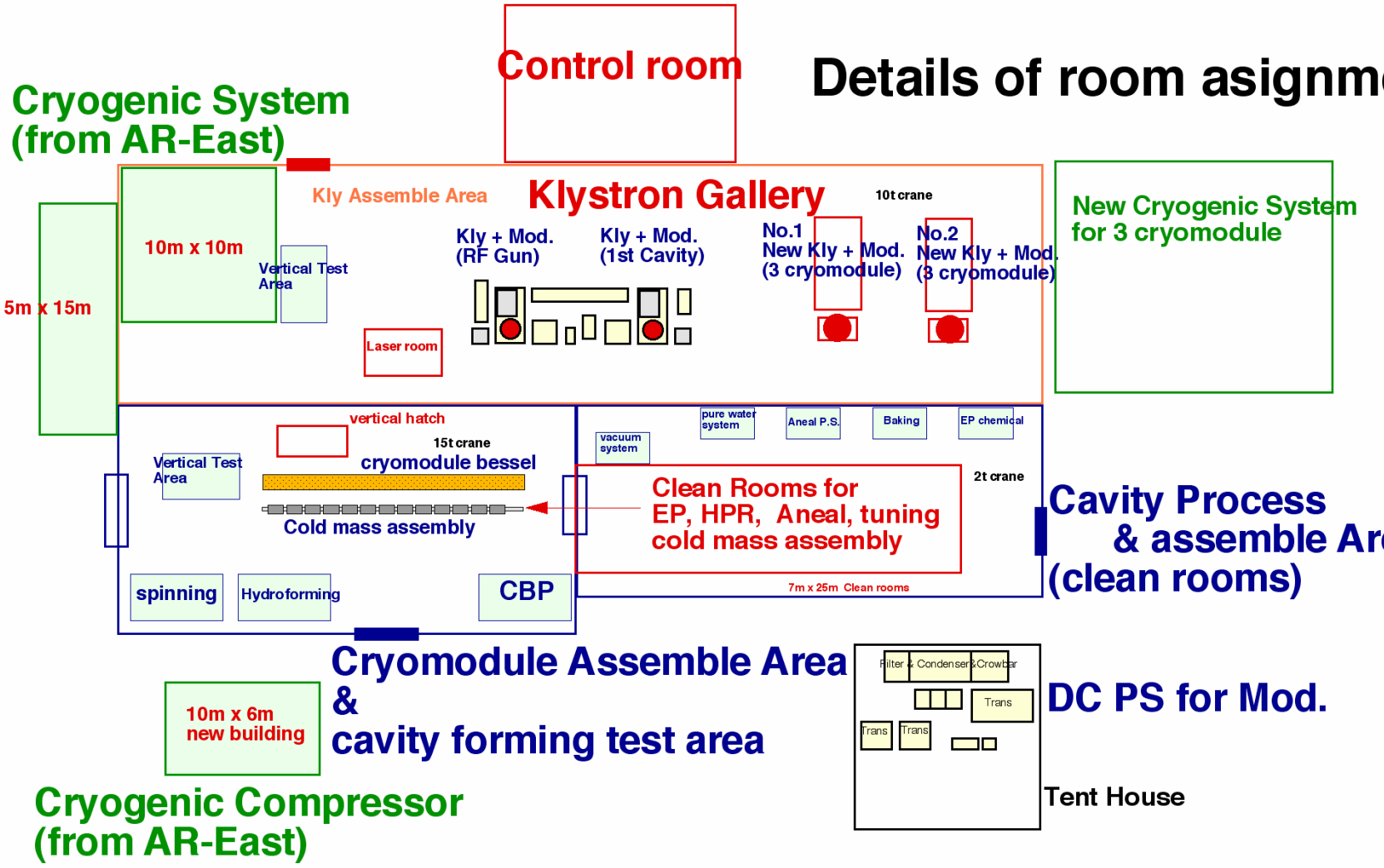
Klystron Gallery

Will be empty in August 2005

Then, STF construction.

Tunnel underground

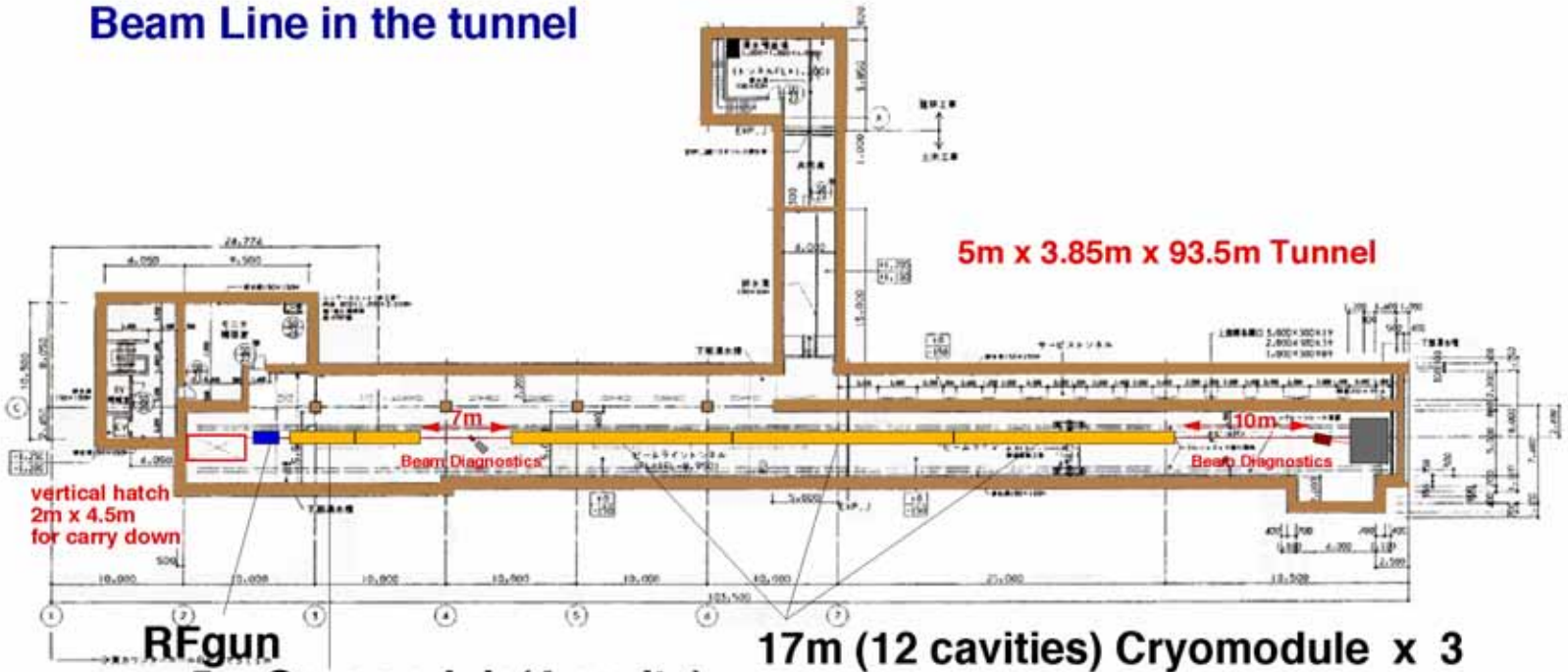
Plan of Superconducting RF Test Facility(STF)



V2.1 Hitoshi Hayano, 11/03/2004

Plan of Superconducting RF Test Facility (STF)

Beam Line in the tunnel



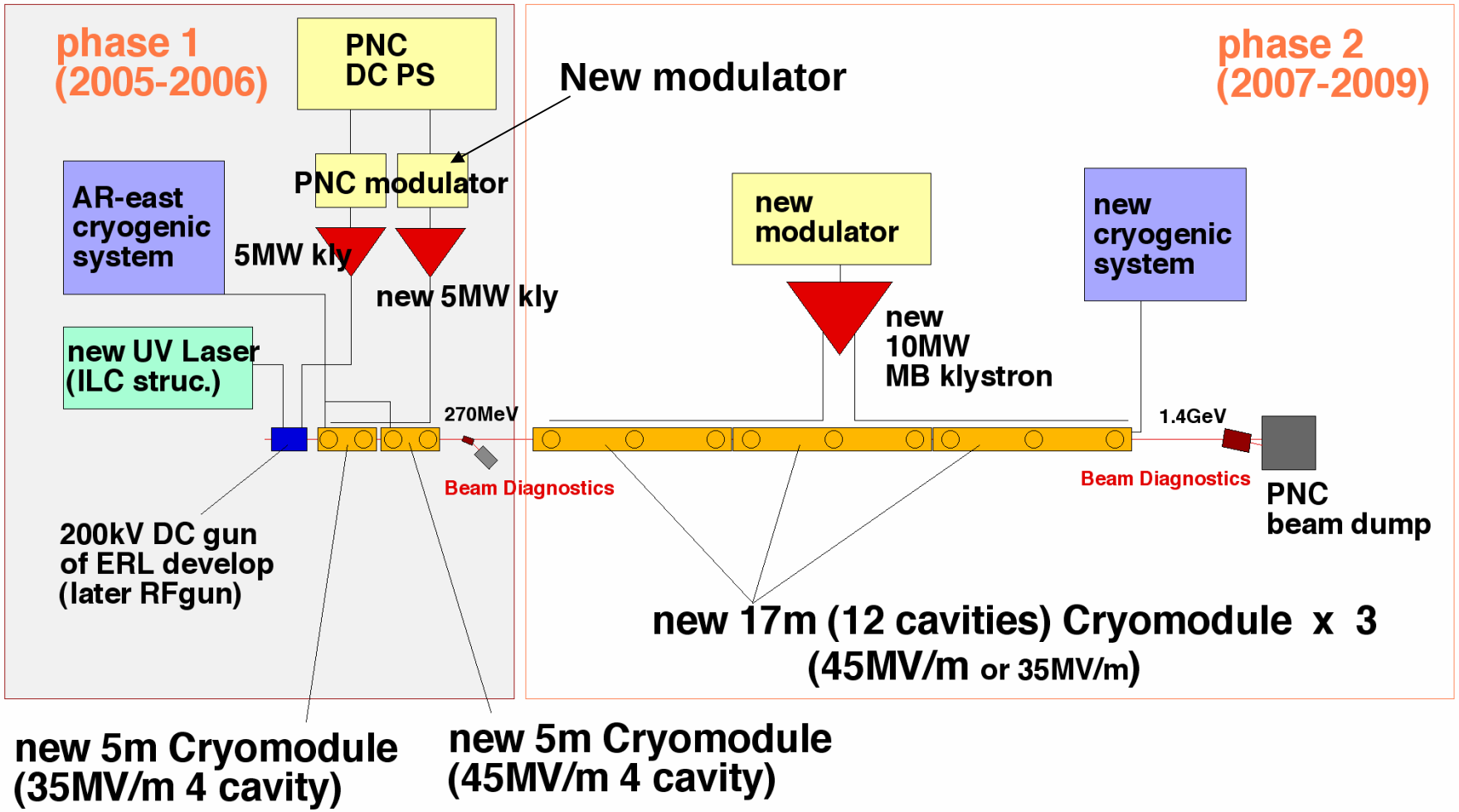
RFgun

5m Cryomodule(4 cavity)
+
5m Cryomodule(4 cavity)

17m (12 cavities) Cryomodule x 3

V2.1 Hitoshi Hayano, 11/03/2004

Plan of Superconducting RF Test Facility (STF)



V1.1 Hitoshi Hayano, 12/08/2004

STF Test Accelerator

-------- phase 1 ----------

(RF gun): 1.3GHz 1.5cell copper cavity 42MV/m, 3.2nC/bunch
3.2MW, 1ms klystron, 5Hz

DC gun : 200kV CsTe photocathode for quick start
UV(262nm) Laser (337ns spacing, 2820bunches)

Test Cryomodule
: 4x 9cell TESLA SC cavity (5m cryomodule), 35MV/m
4x 9cell LL SC cavity (5m cryomodule), 45MV/m
4x 350kW + 4x 450kW = 3.2MW, 1.5ms klystron, 5Hz

Vertical Test Stand
: deep enough for superstructure cavity

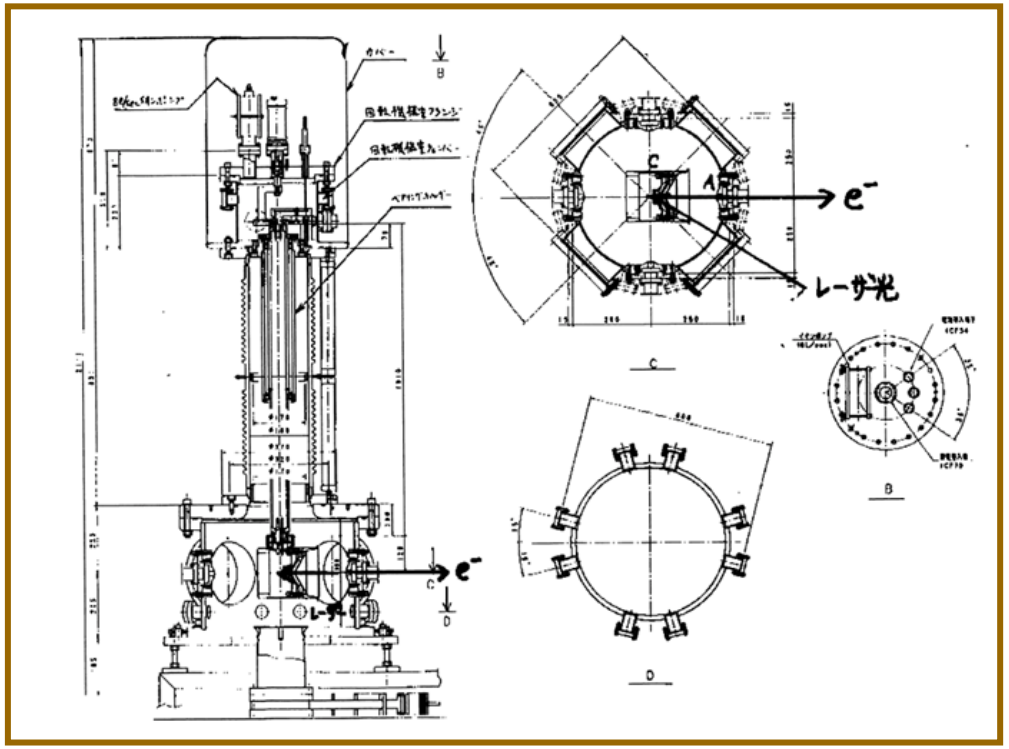
Coupler Test Stand
: 1MW, 1.5ms klystron, 5Hz
(switch use between Test Cryomodule)

-------- phase 2 ----------

Accelerating Unit
: 3 set of 17m full-size (12 cavities) cryomodule
2x 10MW, 1.5ms klystron, 5Hz

STF Beam source Plan

1. **Photo-cathode DC-gun from ERL development (Osawa, Kuriki)**



2. **RF gun cavity design (Kuriki?, SLAC?) & fabrication (KEK machine shop?)**

3. **Photo-cathode Load-lock System (extension of ATF load-lock)**

4. **Laser Development (Kuriki?, SLAC?)**

STF Modulator, klystron plan

1. Buy 5MW Thales Klystron, Build Pulse trans, Modify PNC Modulator putting bouncer circuit in it.

For driving cavities & Input coupler Test stand, later for RF-gun.

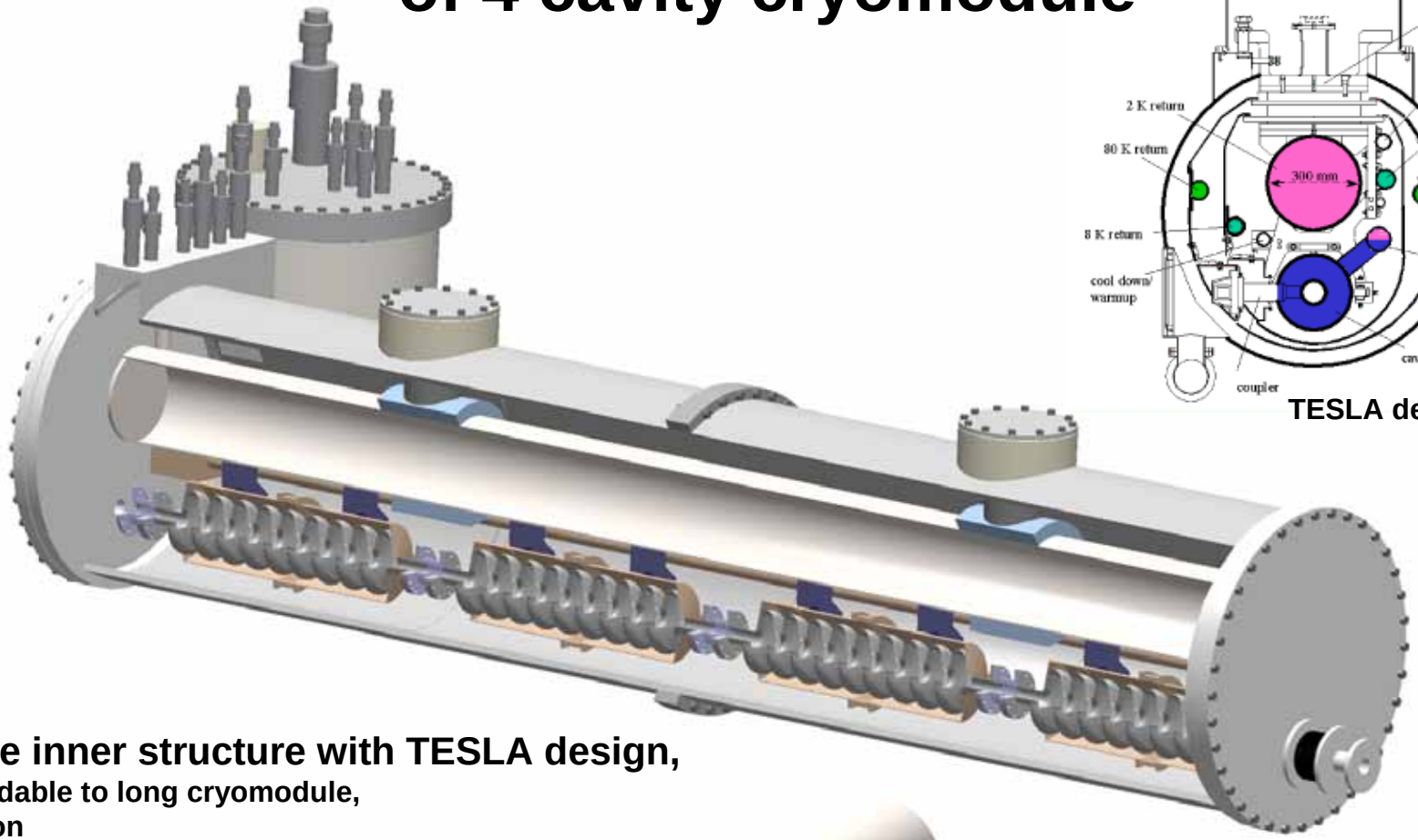
PNC modulator

TH2104C

Additional PT+Bouncer circuit
allows to use TH2104C.

2. Build one more modulator (ILC spec.) for cavity driving (in 2006).
start investigation of technology for bouncer modulator/IGBT modulator.

Conceptual design of 4 cavity cryomodule



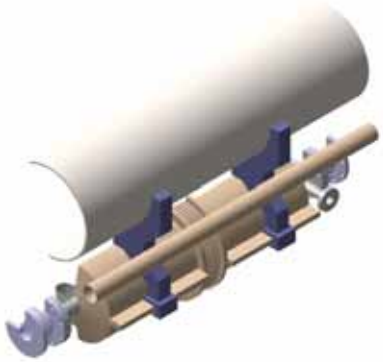
TESLA design

Same inner structure with TESLA design,

Extendable to long cryomodule,

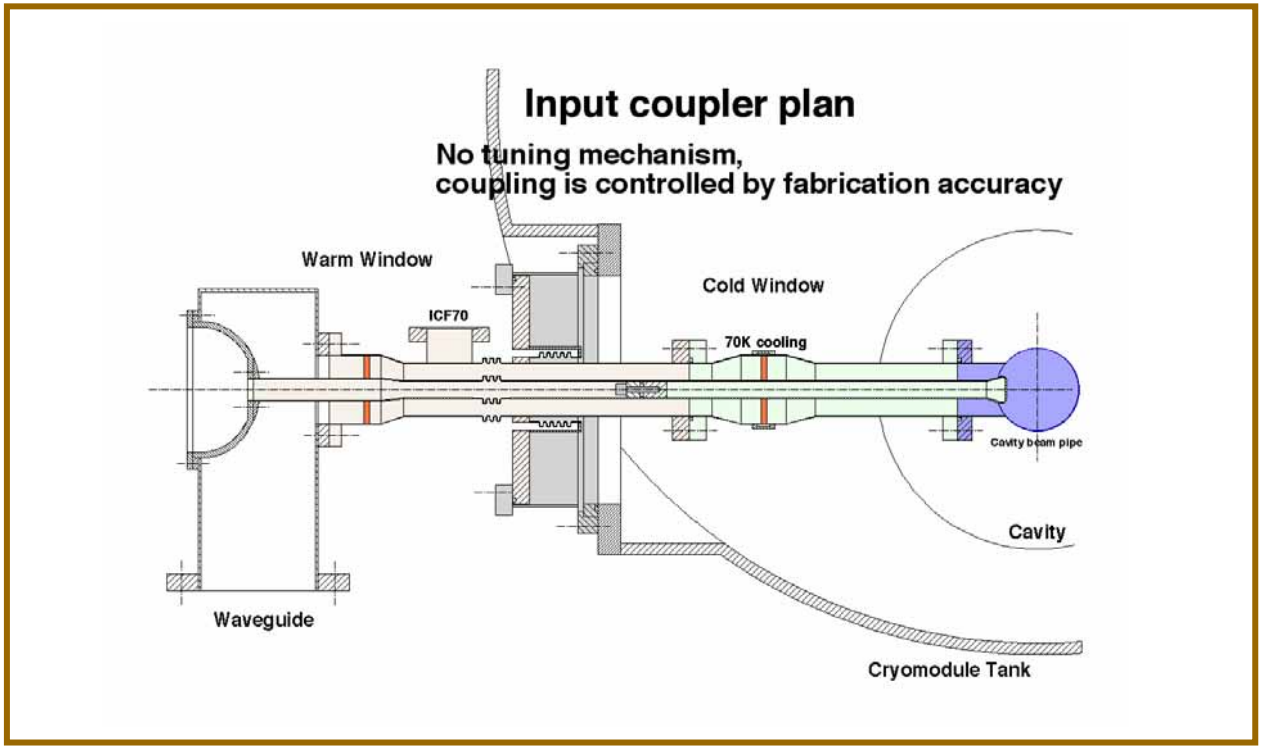
R&D on

- **Input coupler improvement,**
- **Cavity rigidity improvement,**
- **Tuner mechanism improvement,**
- **Alignment accuracy improvement,**
- **Maintainability improvement,**
- **Cost reduction,**
- **Industrialization …….**



Improvement Example

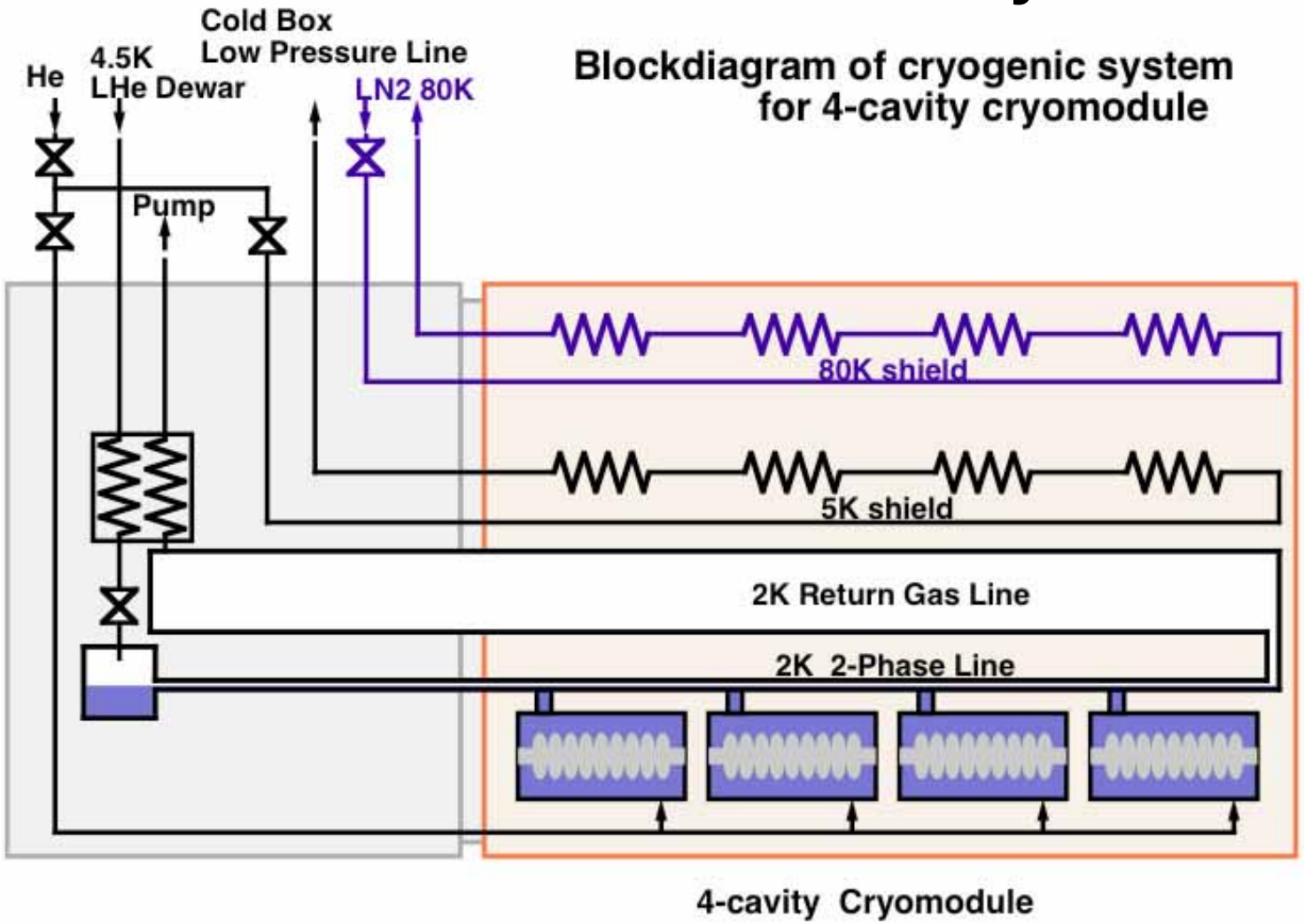
1. Input coupler improvement for simple & cost reduction (no tuning)



2. cavity and He jacket rigidity improvement for small Lorentz detuning

3. Simplification of Tuner mechanism, exchangeability of Piezo Element, Pulse Motor outside, etc

Cryogenic System Plan
similar to TESLA cryomodule



Conceptual design of cryomodule connection

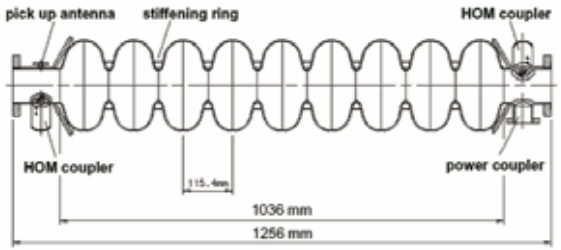
Valve Box

STF Phase 1

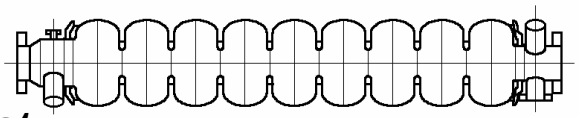
Why two module and connection?
5m carry hatch,
Establish weld connection in tunnel.

Weld connection

35MV/m TESLA design cavities

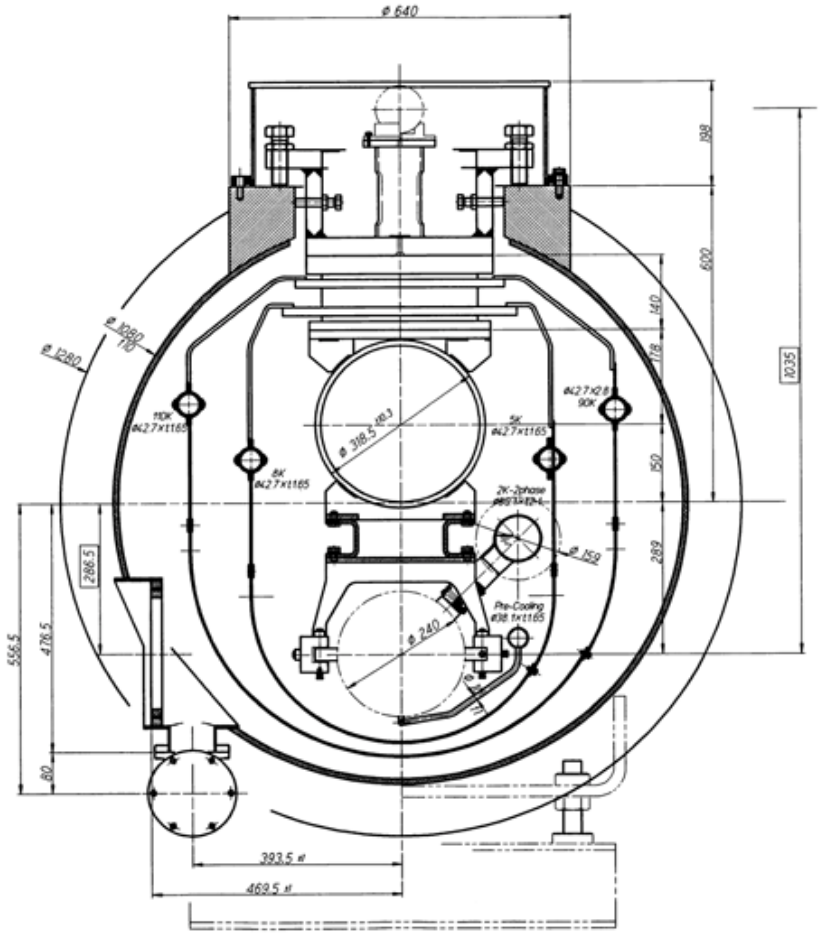


45MV/m Low-loss cavities



Become to 8 cavities in one cryostat
Like TTF cryomodule

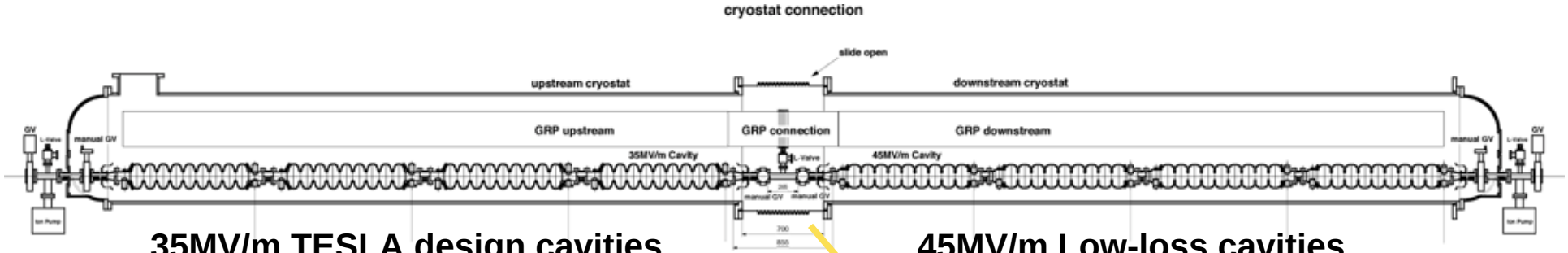
Preliminary design of cryomodule cross-section



KEK cryomodule

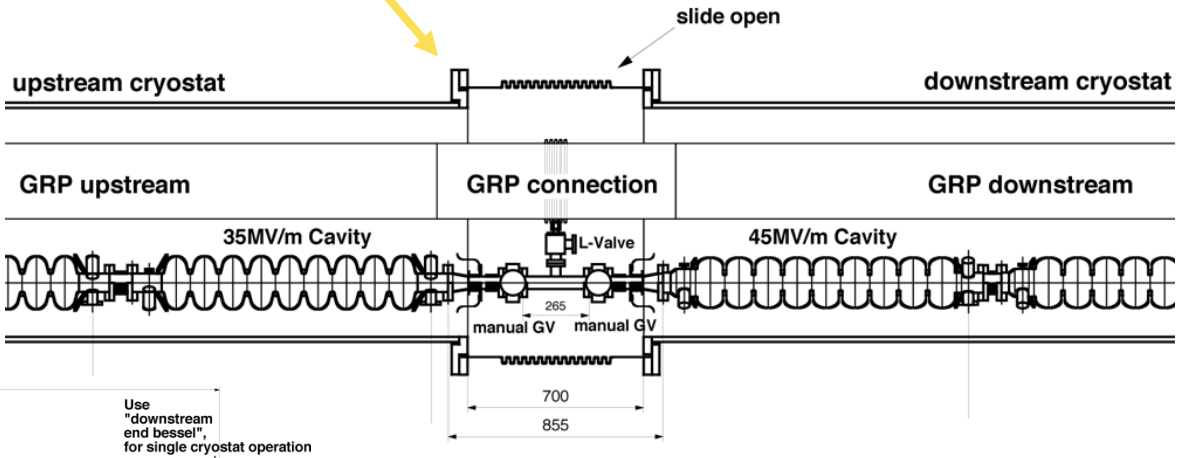
Design is underway

Preliminary design of cryomodule whole assembly

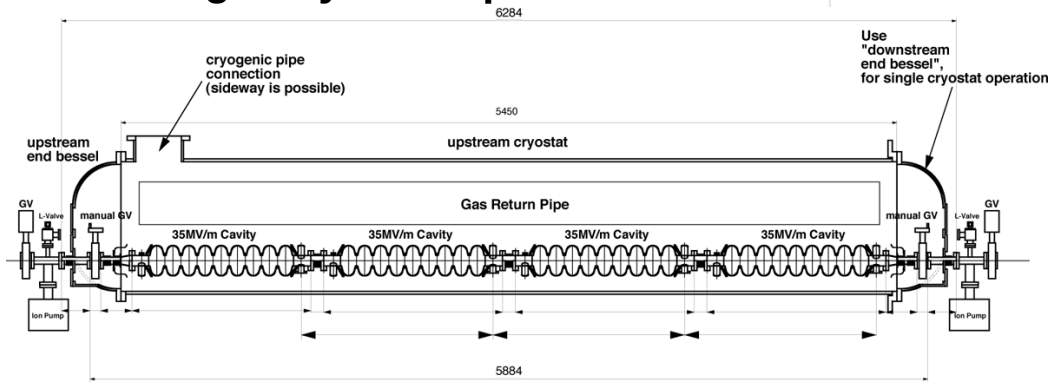


35MV/m TESLA design cavities

45MV/m Low-loss cavities



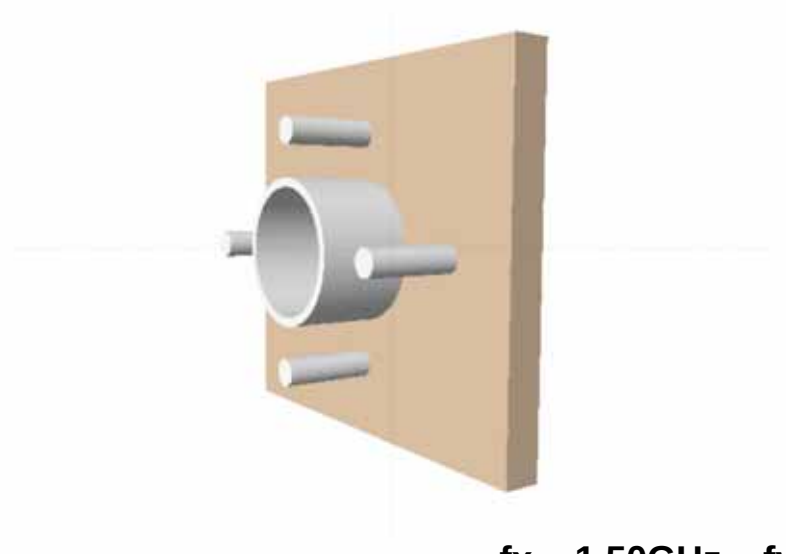
Single cryostat operation



Instrumentation Example

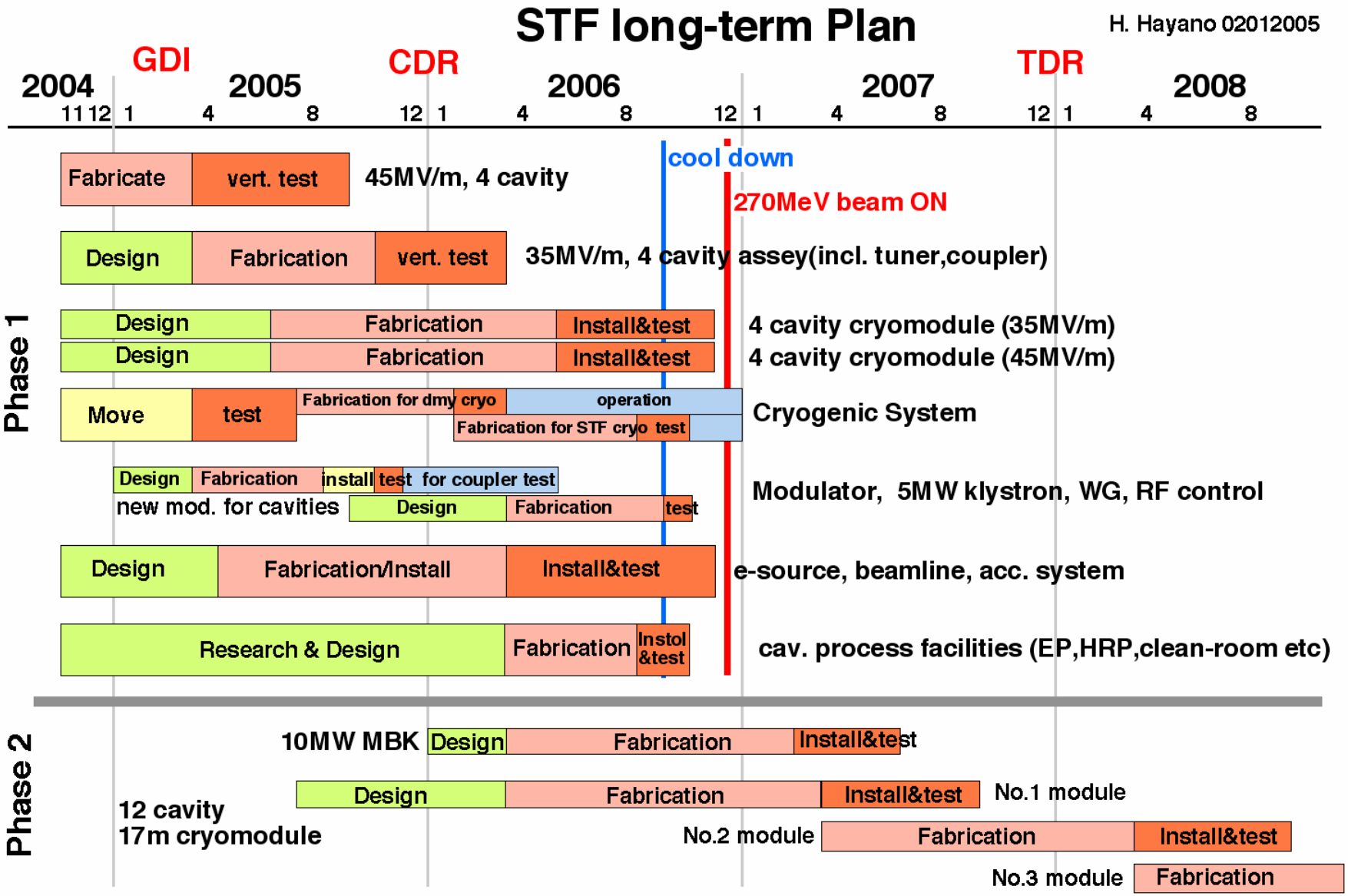
ILC cavity BPM

230mm x 200mm x10mm rectangular cavity



fx ~ 1.50GHz, fy ~ 1.63GHz
df ~ 130MHz

Resonant frequency for X, Y are different for no mixing X-Y.
Frequency ~1.5GHz, beam pipe 70mm dia.,


STF long-term Plan
H. Hayano 02012005
GDI
CDR
TDR
2004
2005
2006
2007
2008
11 12 1 4 8 12 1 4 8 12 1 4 8 12 1 4 8
cool down
270MeV beam ON
Phase 1
Fabricate
vert. test
45MV/m, 4 cavity
Design
Fabrication
vert. test
35MV/m, 4 cavity assey(incl. tuner,coupler)
Design
Fabrication
Install&test
4 cavity cryomodule (35MV/m)
Design
Fabrication
Install&test
4 cavity cryomodule (45MV/m)
Move
test
Fabrication for dmy cryo
operation
Fabrication for STF cryo
test
Cryogenic System
Design
Fabrication
install
test
for coupler test
new mod. for cavities
Design
Fabrication
test
Modulator, 5MW klystron, WG, RF control
Design
Fabrication/Install
Install&test
e-source, beamline, acc. system
Research & Design
Fabrication
Instol &test
cav. process facilities (EP,HRP,clean-room etc)
Phase 2
10MW MBK
Design
Fabrication
Install&test
Design
Fabrication
Install&test
No.1 module
12 cavity
17m cryomodule
No.2 module
Fabrication
Install&test
No.3 module
Fabrication

Man-power (& contact person) for STF

Cryogenic plant : Team K. Hosoyama (7)

High Power RF (inc.LLRF) : Team S. Fukuda(11)

Cryomodule (exc. Cavity) : Team S. Noguchi(3) &
Team K. Tsuchiya(2)

SC-Cavity : Team K. Saito(14)

Electron Gun : Team S. Osawa(4)

Control & Operation : Team ATF(9) & Team XTF(5)
contact: H. Hayano & N. Terunuma

Surface Process Facility : Team K. Saito(14) &
Team K. Ueno (Mec. Eng. Center)

Total 52 (excl. double count), ~23 FTE

STF phase 1 start-up status

JFY 2004 budget

Cryogenic plant movement: March 2005
45MV/m cavity fabrication

JFY 2005 budget

2005, 2006 plan still under planning for detail.
need input from collaborator (Asia, US, Europe)

Construction

responsible person has fixed.
detail scheduling has started (making Excel sheet).
interaction with collaborators has just started.
interaction with Industry has just started.
items: cryogenic system, cryostat, cavity, power source…
Detail design has just started.

Collaboration Plan with Overseas

Asia: mainly on design works, people,
power source, SC peripherals, magnets,
instrumentation etc.

Europe: collaboration on
TESLA/TTF designs and engineering information,
provide KEK SC technologies,
exchange people,
obtain other technologies(power source,
control, beam generation, instrumentation)

US: done by US-Japan collaboration mainly,
provide KEK SC technologies,
exchange people,
obtain other technologies(power source,
control, beam generation, instrumentation)

end