ILC WG2 (Main Linac System) status & report

H. Hayano, KEK

ILC-Working Group 2 : Main Linac System

Discussion Items

Technology aspect of

1. RF system

   Klystron, Modulator, Waveguide system, Low-level RF

2. Cryomodule*

   [Cavity itself]**, Cavity dressing(He jacket, tuner,

   HOM coupler, Input coupler, various sensor), Cryostat

3. Cryogenic system

   Refrigerator, transfer line, cold box

* :joint discussion with WG5

** :WG5 item

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.

Test Facility Background

1) KEK SC RF technology and many expert:

TRISTAN SC cavity (500MHz,CW) 1980's - 1990's

KEK-B SC cavity (500MHz,CW) 1990's - ….

KEK L-band R&D (1.3GHz, 972MHz, CW) 1990's - ….

J-PARC SC cavity R&D (972MHz, pulse) 2000's - ….

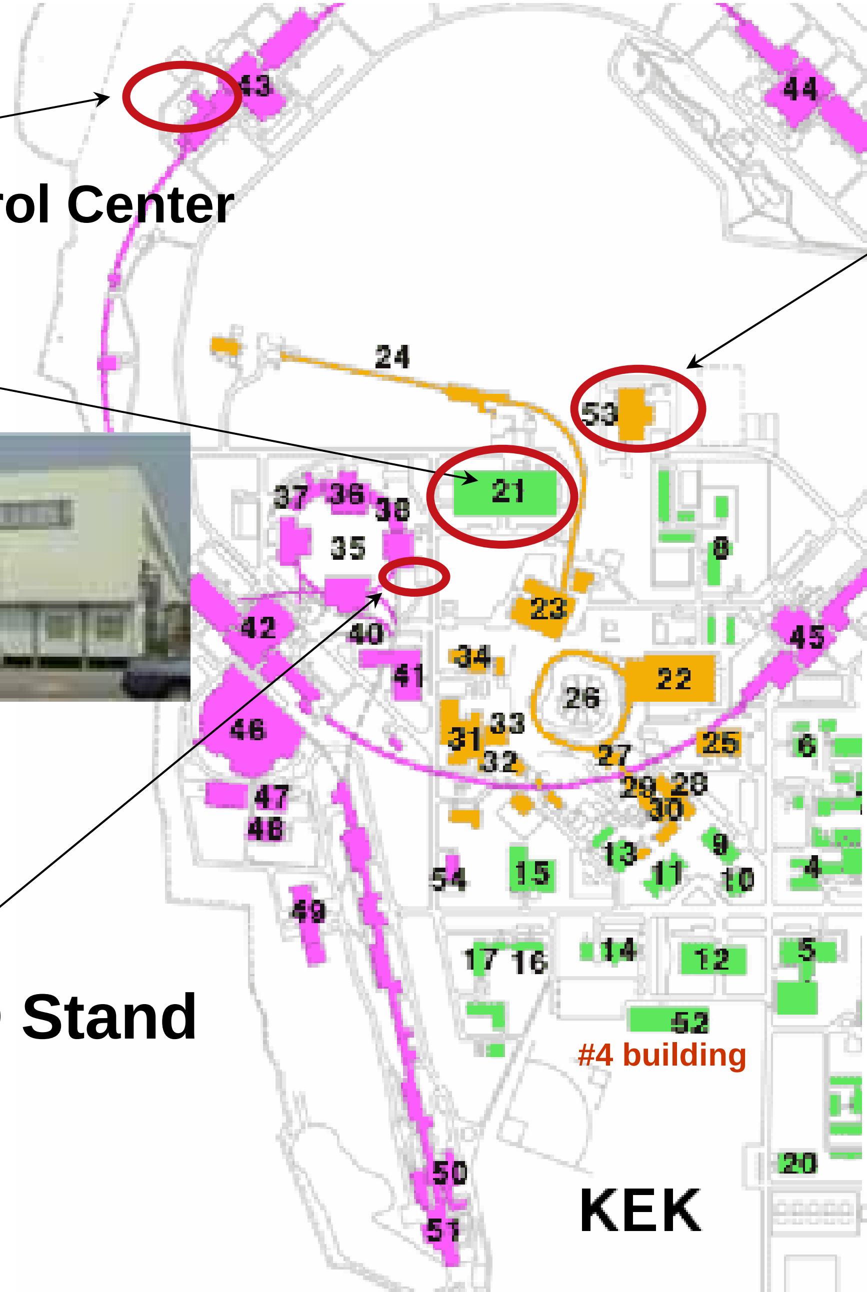
2) Existing Test Facility Infrastructure:

1. Cavity treatment, vertical test stand at KEK L-band R&D Stand
2. Spare 600W He Plant at AR-East hall (TRISTAN)
   & KEK-B Cryogenic System Operation Team
3. Proton Linac Building for J-PARC
   (DTL accelerator system will be moved
   and installed in J-PARC, Tokai by August 2005. Then,
   air conditioned building & Tunnel with cooling water
   is available.)

Location of Test Facilities

KEK-B
He Plant Control Center

ATF



L-band R&D Stand

Proton Linac Building

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)

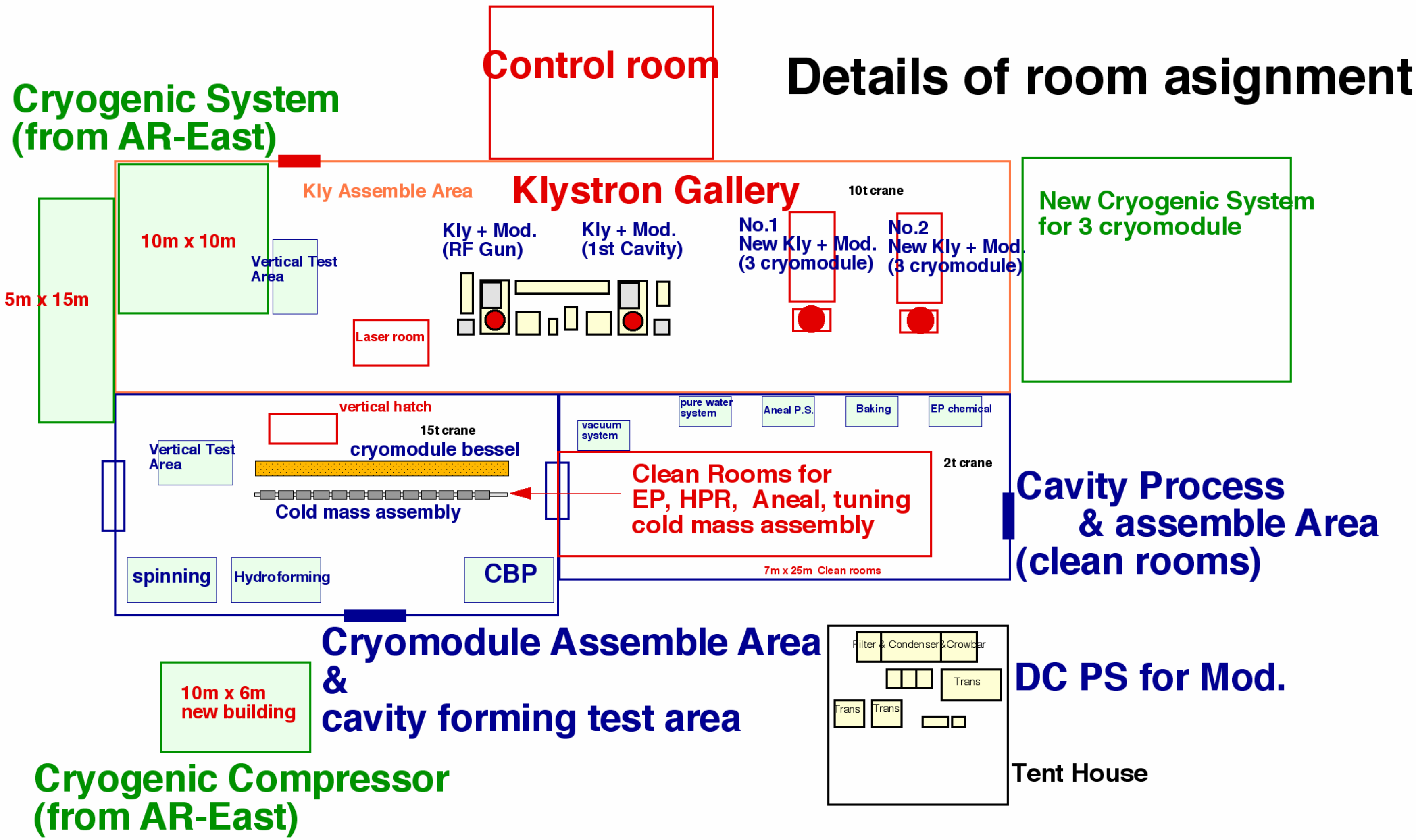
JPARC Proton Linac Building

Klystron Gallery

Will be empty in August 2005

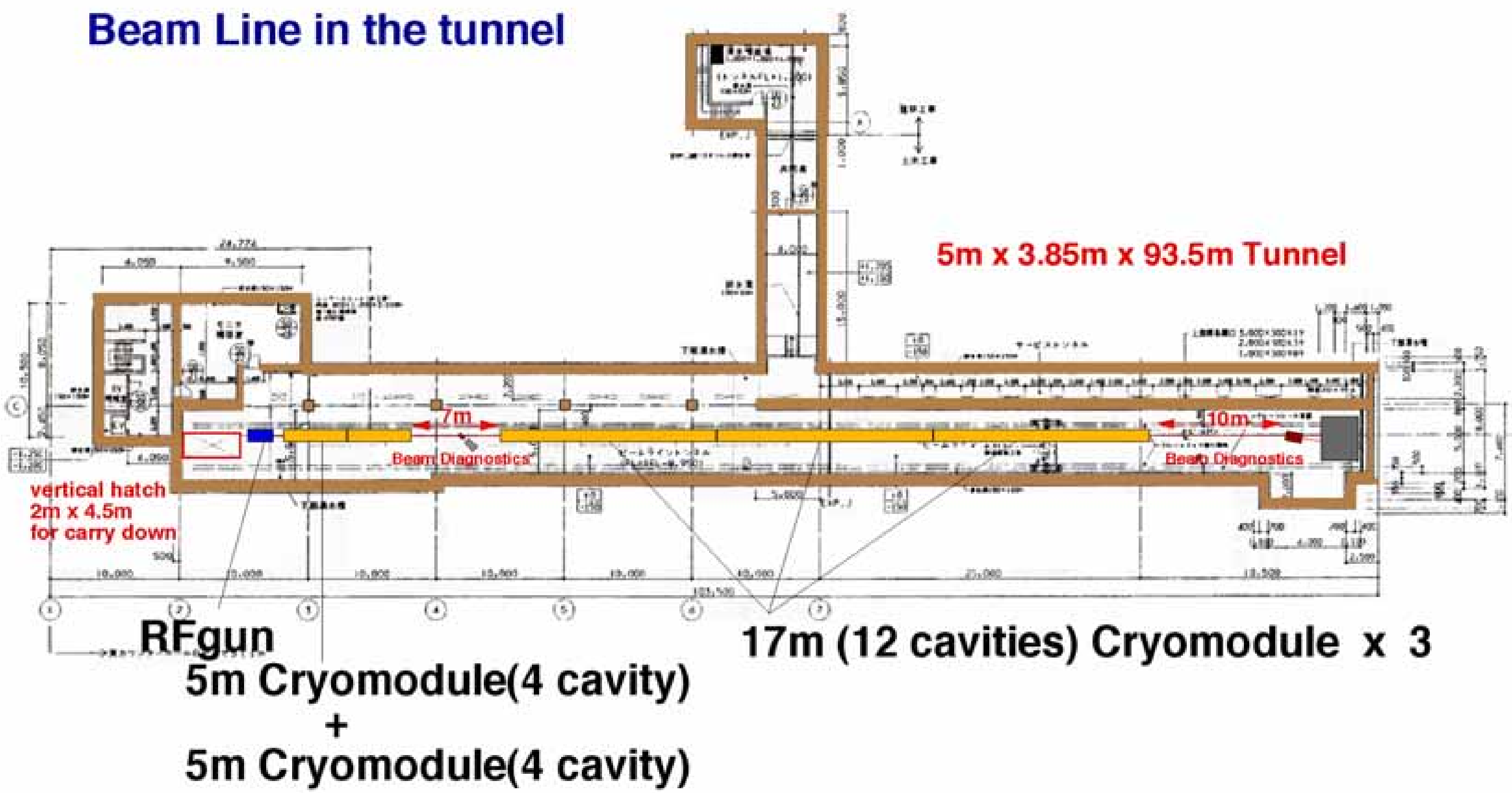
Tunnel underground

Plan of Superconducting RF Test Facility(STF)



V2.1 Hitoshi Hayano, 11/03/2004

Plan of Superconducting RF Test Facility (STF)



Available Devices for STF

He plant : TCF200 spare plant

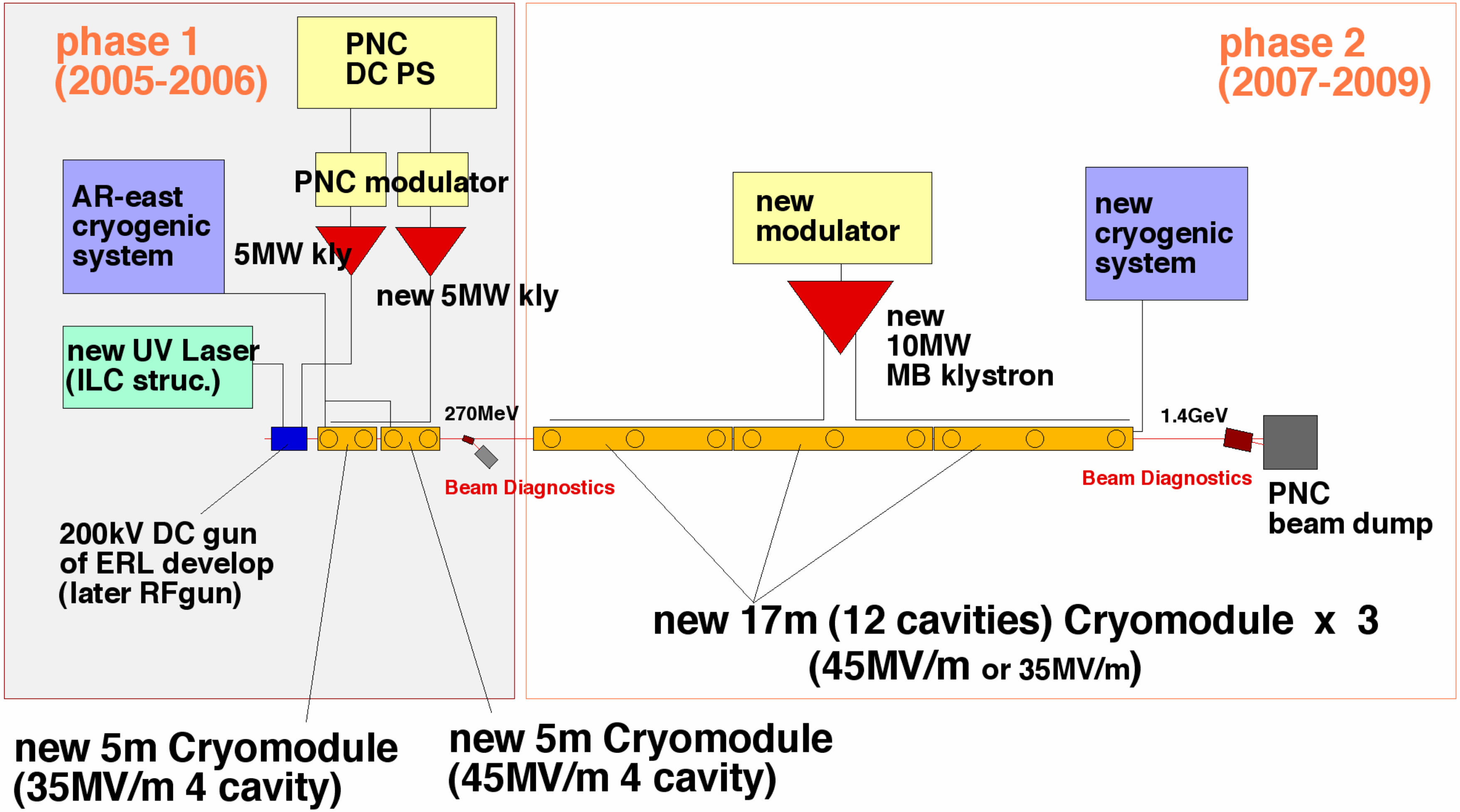
DC gun : from ERL development
(now under commissioning)

Klystron Modulator,
Waveguide,
RF components : kept in Tent House, from PNC

Beam dump : kept in ATF space, from PNC

Concrete shield for dump : kept in Proton Linac Building

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)

Capture cavity (& Horizontal Test stand)
: 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 horizontal stand)

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

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

Accelerator Laboratory

Concept of test facility for quick and inexpensive start

Making use of power supply and waveguide component moved from PNC (**P**ower Reactor and **N**uclear Fuel **C**orp).

Power supply has 3 modes; (1)Short pulse (100μs), (2)long pulse (4ms) and (3)CW for the modulating anode type klystron.

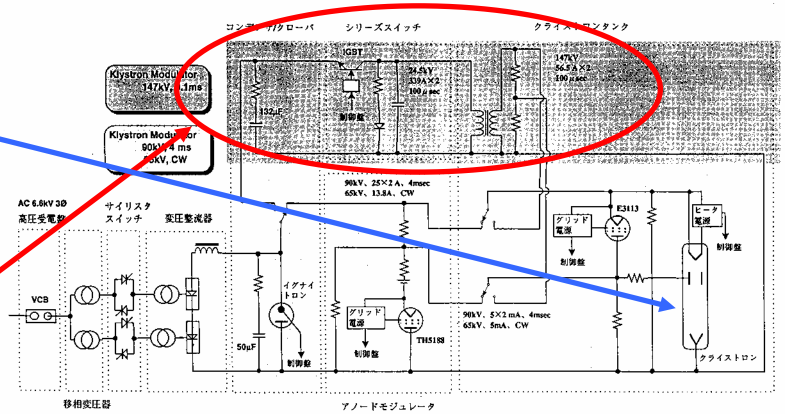
For mode(2), possible klystron is modulating anode type TH2115 (Thales). About 2MW output is possible for this case.

Reform to (PT+Bouncer) allows to use TH2104C.

TH 2104 C

5－10MW

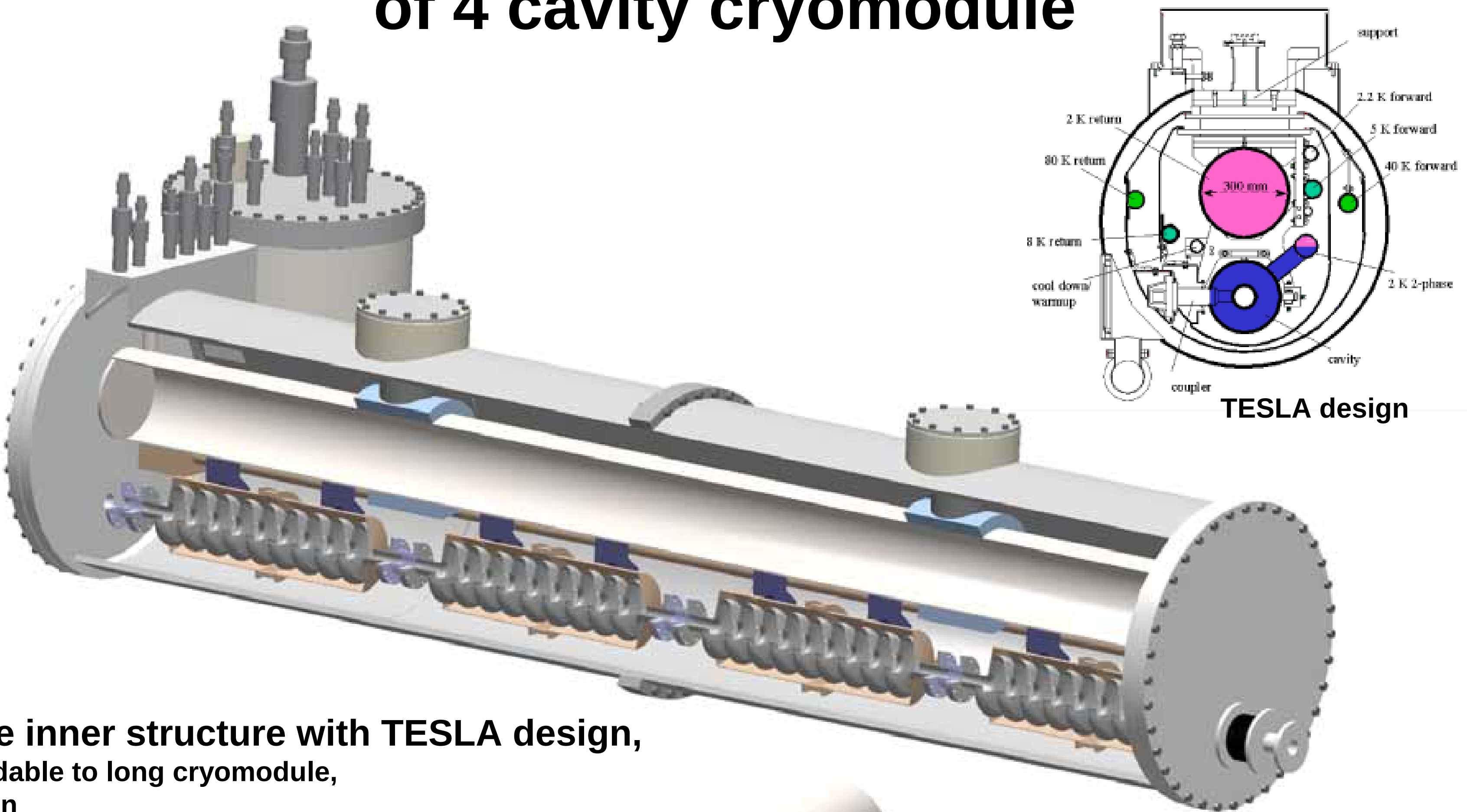
Photo of Modulator in PNC



Block diagram of PNC modulator

SF041104

Conceptual design of 4 cavity cryomodule



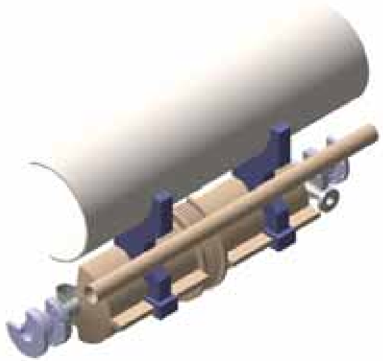
TESLA design

Same inner structure with TESLA design,

Extendable to long cryomodule,

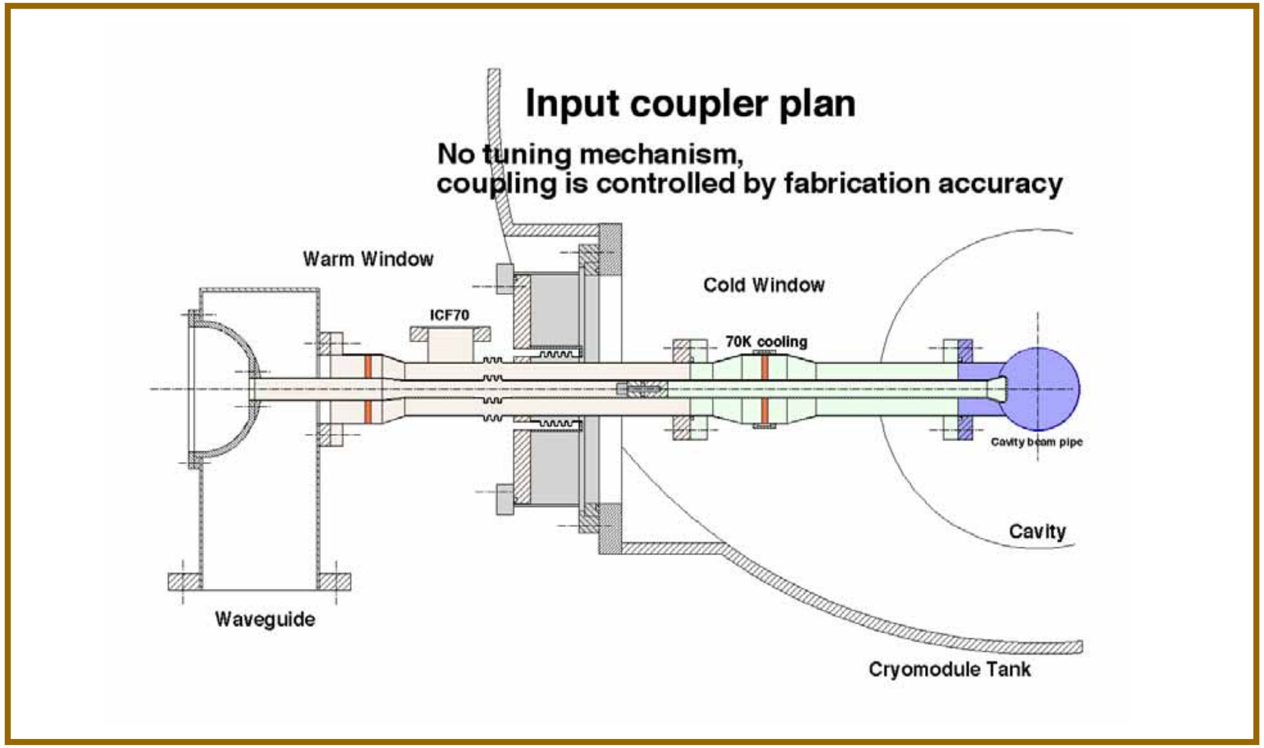
R&D on

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



Improvement Example

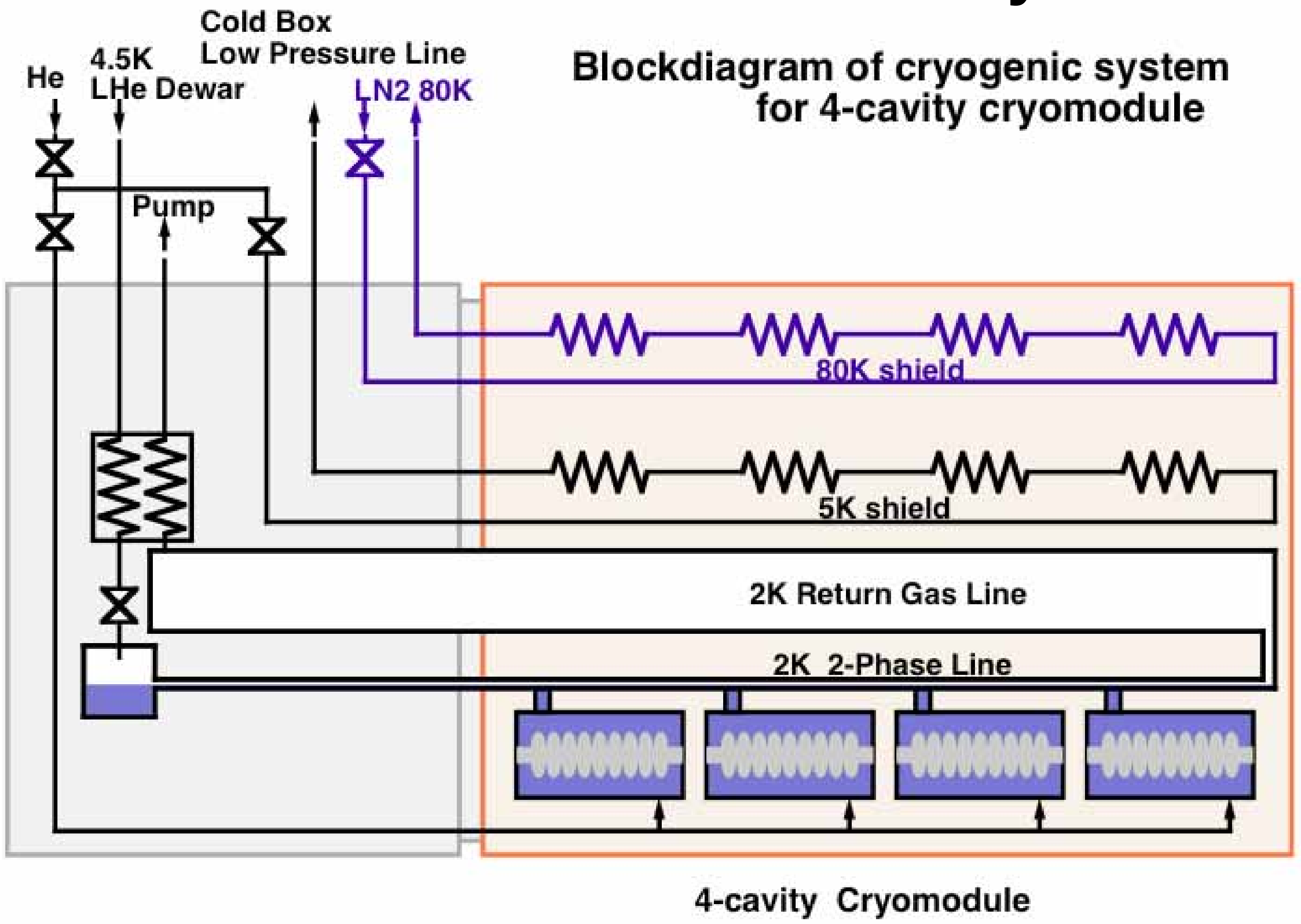
1. Input coupler improvement for simple & cost reduction
   (no tuning)



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

3. Simplification of Tuner mechanism, exchangeability of Piezo Element

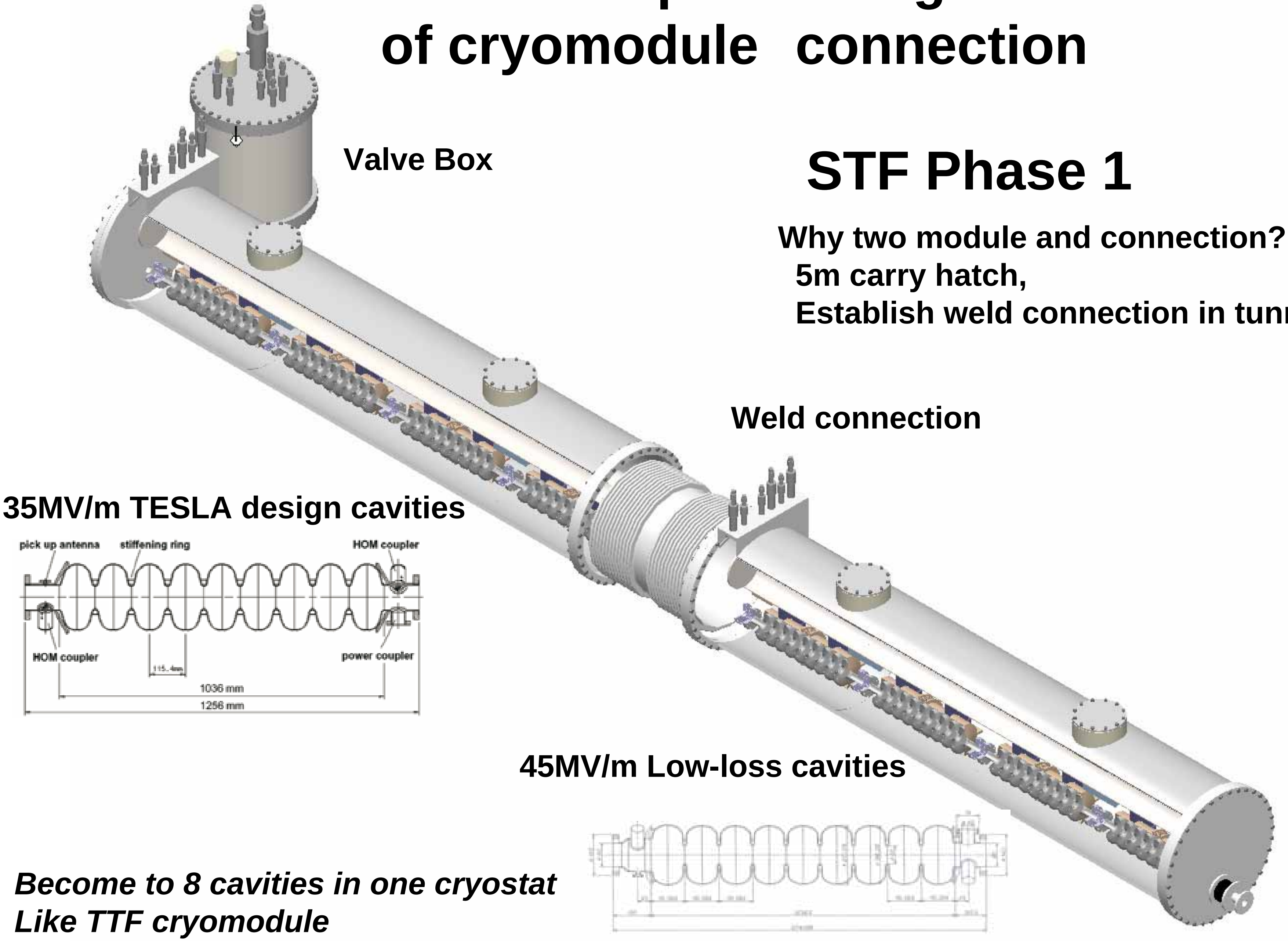
Cryogenic System Plan
similar to TESLA cryomodule



Conceptual design of cryomodule connection

STF Phase 1

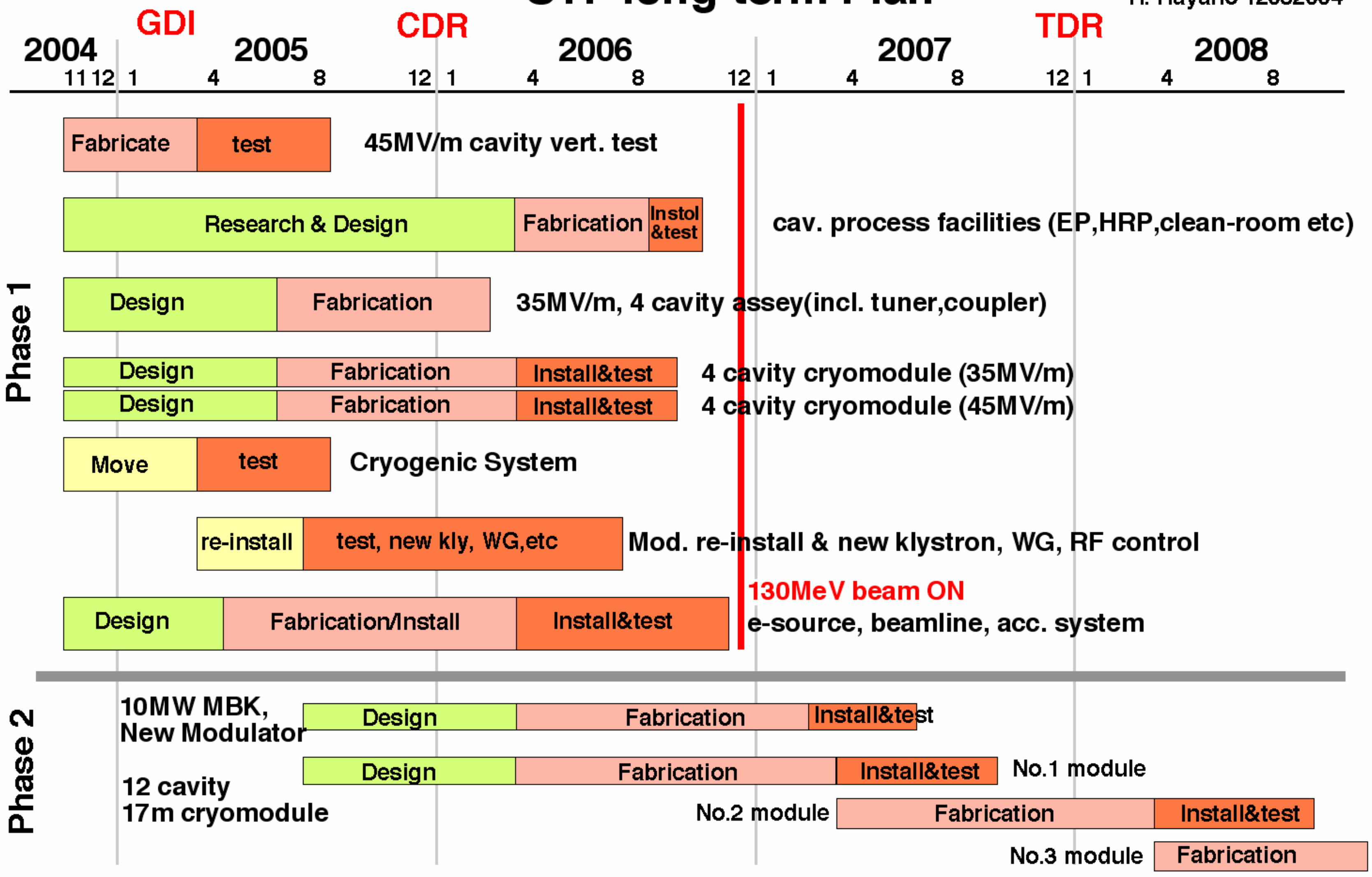
Why two module and connection?
5m carry hatch,
Establish weld connection in tunnel.



Become to 8 cavities in one cryostat
Like TTF cryomodule

STF long-term Plan

H. Hayano 12082004



Man-power 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)

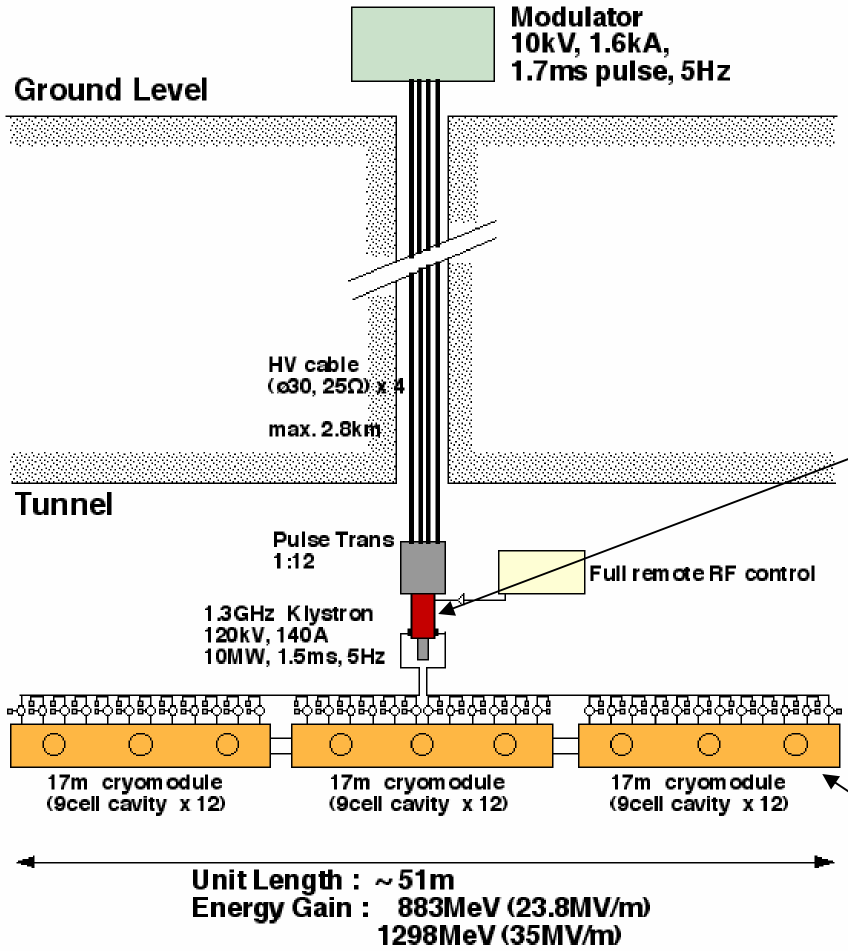
Control & Operation : Team ATF(9) & Team XTF(5)

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

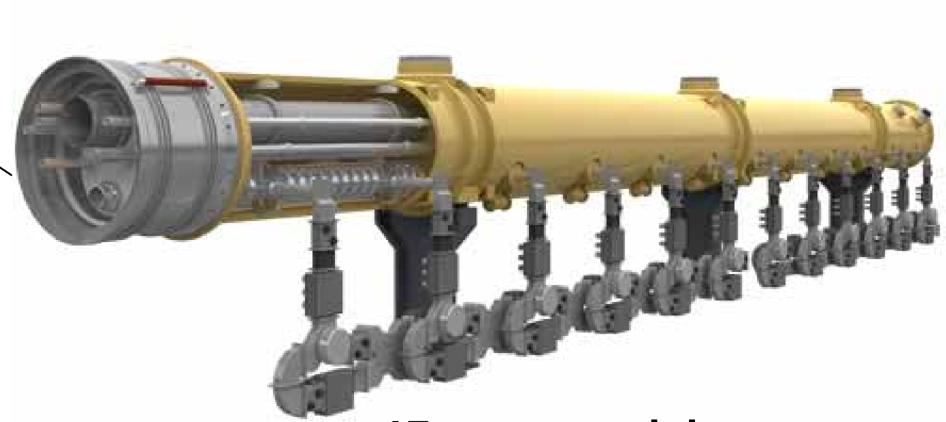
Total 52 (excl. double count), ~23 FTE

STF phase 2

1 full unit of ILC Main Linac



Multi-beam Klystron



17m cryomodule

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STF phase 1 start-up status

FSY 2004 budget

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

FSY 2005 budget

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

Construction

- responsible person has fixed.
- detail scheduling has started.
- 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 SC technologies,
exchange people,
obtain other technologies(power source,
control, beam generation, instrumentation)

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