Cryomodule Test Plan in KEK-STF

KEK-STF Group

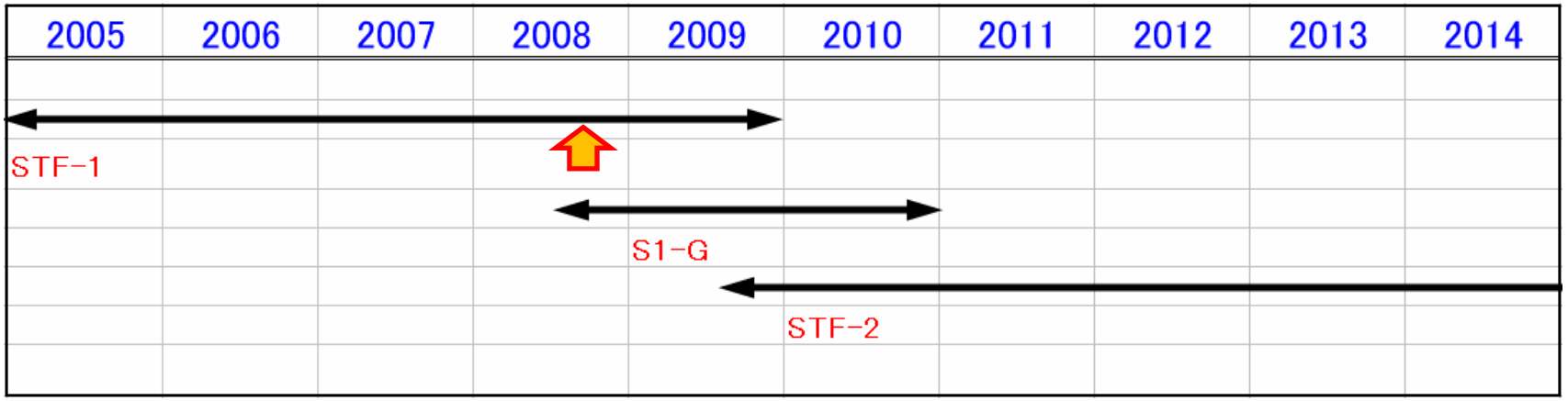
Norihito Ohuchi

Contents

- KEK General Cryomodule Test Plan for ILC
- STF1
- S1-Global
- STF2
- Summary

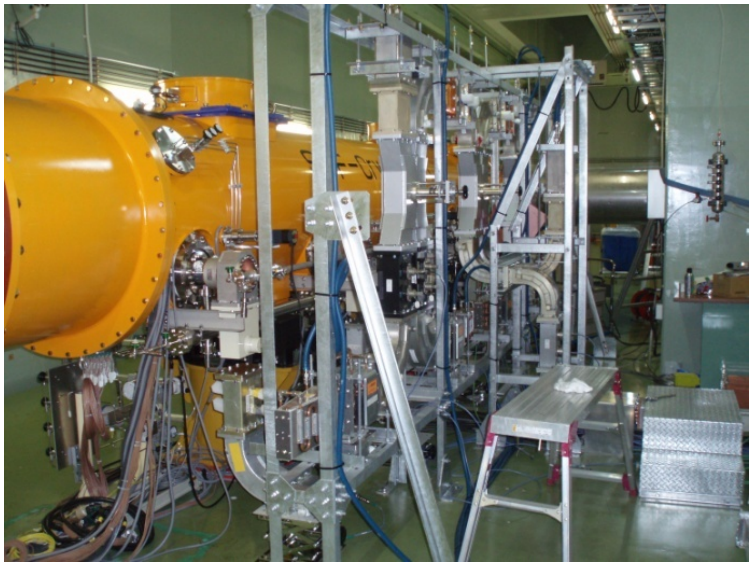
General Cryomodule Test Plan in STF

- **STF-1**
  - **Module-A: 4 BL cavities (Tesla-like) cold test from May to Dec. 2008.**
  - **Module-B: Cryostat thermal test without cavities in 2009.**
- **S1-Global**
  - **Construction and operation of the cryomodule over 31.5 MV/m**
  - **International collaboration R&D with DESY, FNAL, INFN and KEK**
- **STF-2**
  - **Construction of 1 RF unit module system**
  - **Operation of the system**



STF1 : Cryomodule cold test with 4 BL cavities

4 BL cavities were assembled in the STF cryomodule (Module-A) and being cold-tested at 2K.

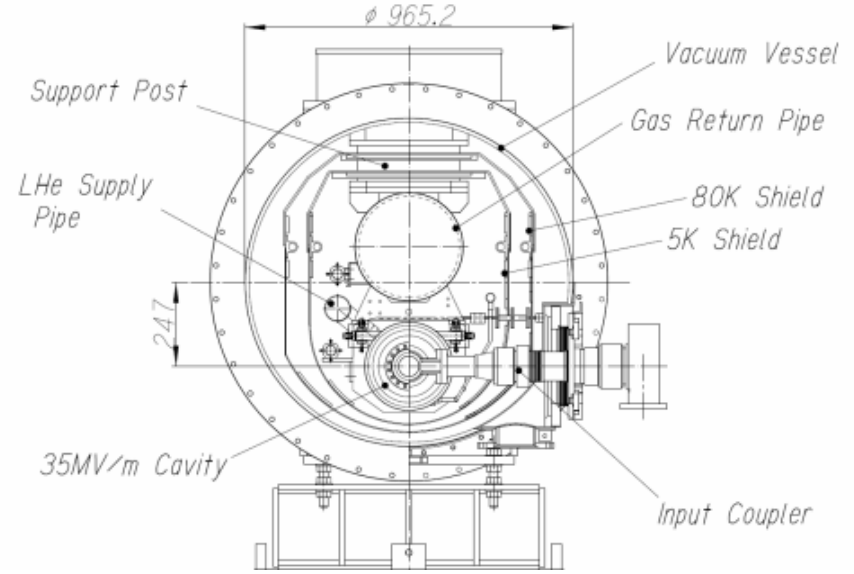


From May to Oct. 2008

1. **Low power test and RF processing at high field of 4 cavities (Reported by Eiji Kako)**
2. **Static heat load measurements**

From Nov. to Dec. 2008

3. **High power tests of 4 cavities**
   - **Q_0 measurements (dynamic loss measurements)**
   - **Detuning measurements and compensations**
4. **Operation of 4 cavities**
5. **Power distribution test**



Cross section of BL cavity-module

STF1 Cold Test: Static heat load measurements

Static Heat loads of cryogenic components

- Recalculation of the component heat load with the measured temperature distribution.

Module-A

- The sums of the heat loads of components for Module-A = the measured heat loads by the evaporation rates.
- The largest heat source = RF-cables without 5K anchors + Piezo cable = **3.6 W for four cavities.**

Module-B

- The RF cables were thermal-anchored with the 5K shield, and then the heat load was calculated to be 0.03 W.

	Module A (1 Cavity)	Module B (1 Cavity)	Module A (4 Cavities)
Measured Heat Load	5.6W	6.1 W	9.8 W
2K Cold Box	1.0 W	1.0 W	1.0 W
Transfer Tube	3.4 W	3.4 W	3.4 W
Cryomodule	1.2 W	1.7 W	5.4 W
Input Coupler	0.13 W	0.23 W	1.4 W (140K at 80K anchor position; not normal operation)
Beam Pipe	0.002 W	0.001 W	0.003 W
RF Cables	0.9 W	0.03 W	3.6 W
Signal Cables	0.05 W	0.14 W	0.05 W
Tuner	0.12 W	NA	0.48 W

STF1 : Thermal study by Module B

Measurement of heat loads with and without 5K shields by STF Module-B (scheduled at 2009)

For the study of ILC-cryomodule design;

- **The 5 K thermal shield is considered to be removed from the cost reduction of the cryomodule.**

  ILC Cryomodule Thermal Model

  5K line : cooling the input couplers, support posts and current leads

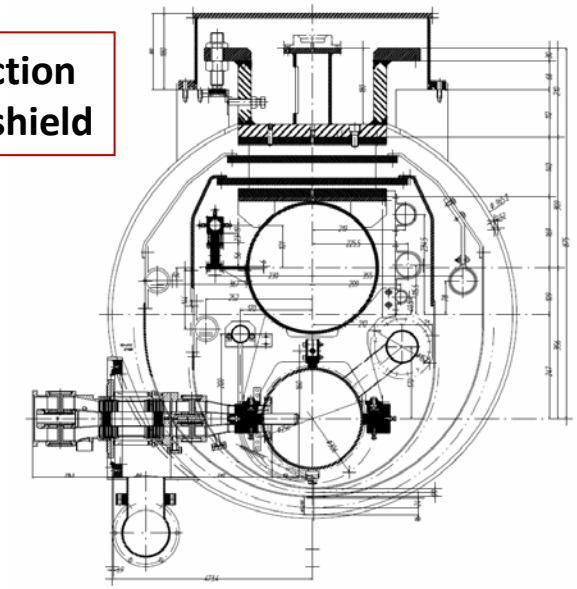
  40K line : cooling the thermal radiation shield, support posts and current leads (44K)

  cooling HOM couplers, HOM absorber and input couplers (66K)

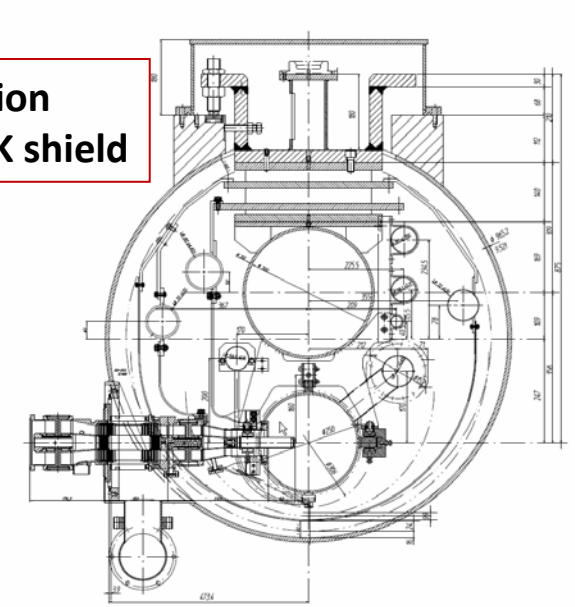
  Calculation: The difference between the required powers at 300K of two cases : 0.11 kW/Module

- **The heat load at 2K will be measured with and without 5K shields.**

Cross section with 5K shield



Cross section without 5K shield



S1- Global

As the mile-stone of ILC construction, the cryomodule over the ILC DESIGN GRADIENT is required to be realized internationally (S1).

1. The planed cryomodules for the S1

- **FNAL-CM2 [to be constructed at 2009], STF-1 (S1-Global) [to be operated at 2010].**

2. Target of the S1-Global

- **Attaining the average operating gradient over 31.5 MV/m by 8 cavities from FNAL, DESY and KEK.**

3. International research collaboration

FNAL : Two Tesla-type cavities with Blade tuner

DESY : Two XFEL cavities with Sacley tuner

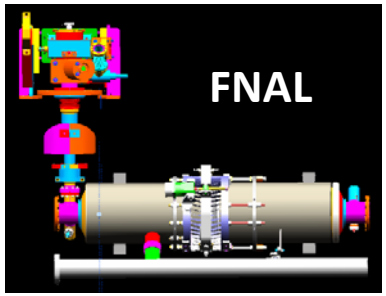
KEK and Asia : Tesla-like cavities with Slide Jack tuner or cavities compatible with the KEK type

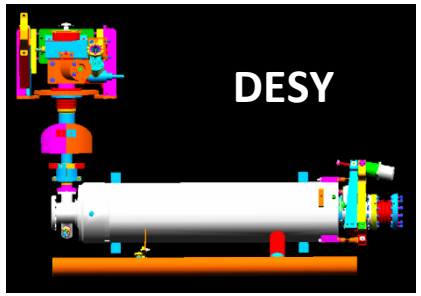
INFN : New cryostat (Module C) for FNAL and DESY cavities

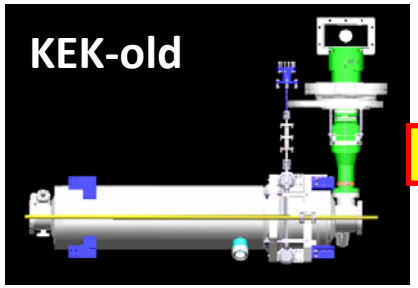
INFN and KEK have already made the MOU for developing the cryomodule (Module-C) in July.

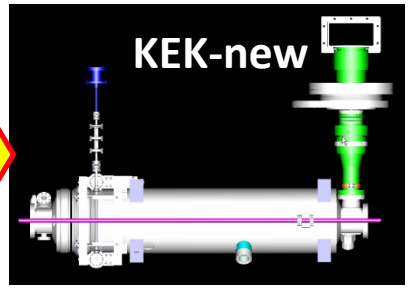
S1- Global : Cryomodule design

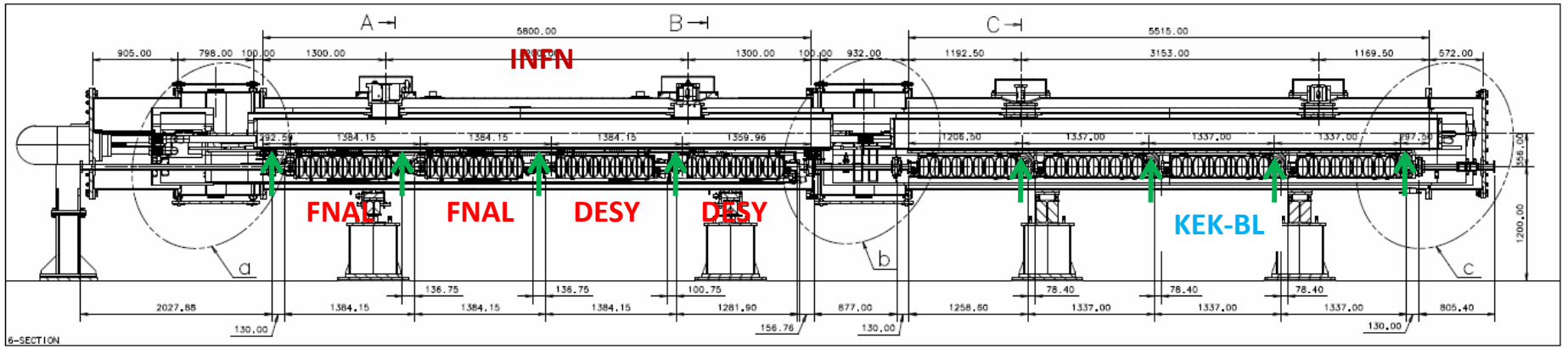
1. **The cryomodule design has started between INFN and KEK.**
   - **The general module design with 3D CAD (I-Deas) has been almost completed to confirm the interfaces between Module-A, Module-C and the cryogenic system.**
   - **KEK and DESY & FNAL input couplers locate in the opposite side with respect to the cavity packages, however, LHe supply pipes are in the same side.**
   - **Distances between input coupler axes of DESY and FNAL are 1384.15 mm (same as XFEL).**
   - **Distances between input coupler axes of KEK are 1337.0 mm.**







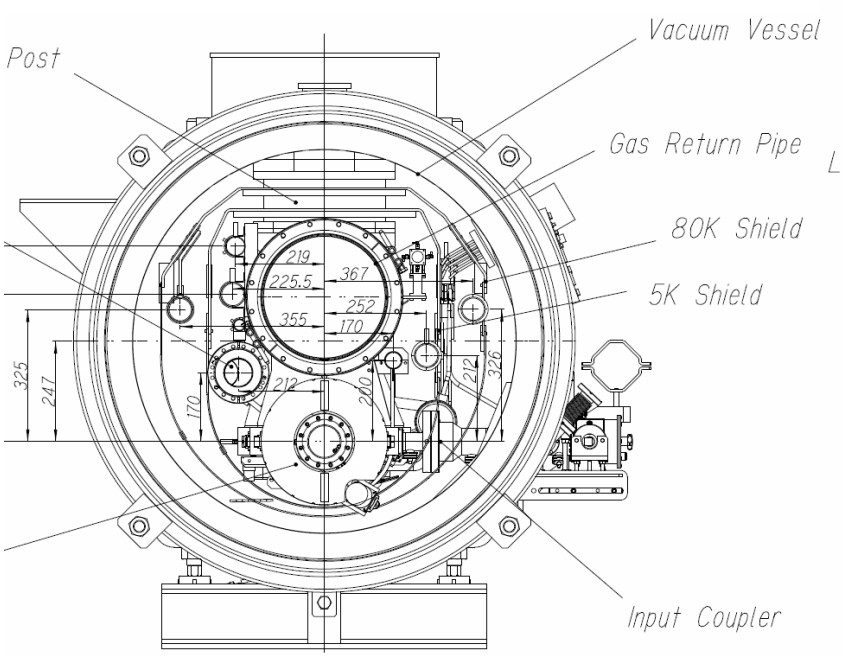


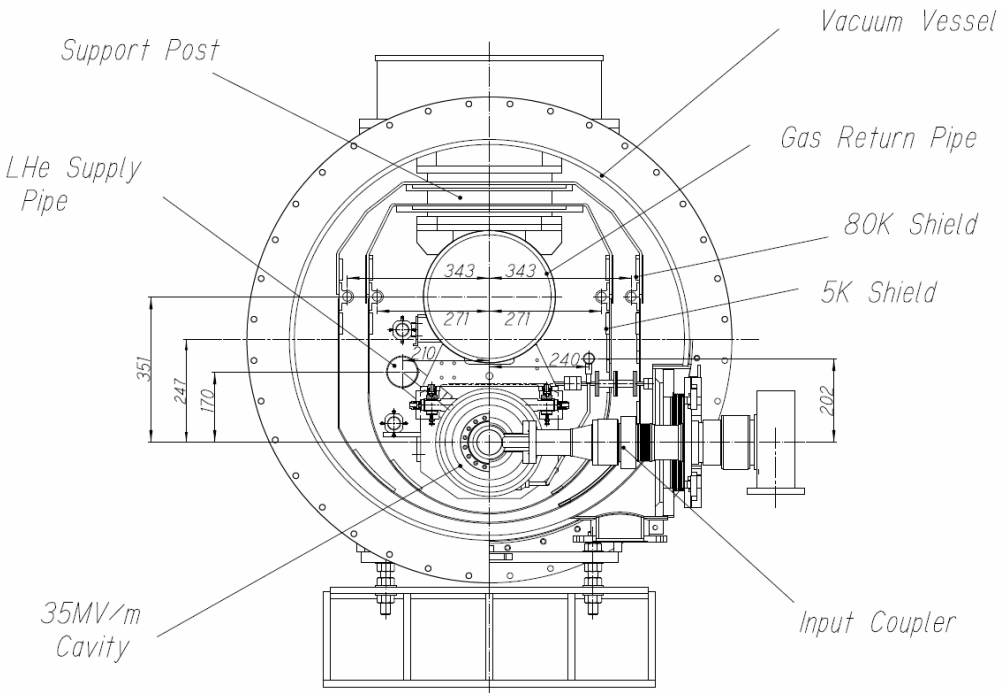


Cryogenic system **Module C** **Module A**

S1- Global : Cryomodule design

2. **The details of the cryostat components is designed from October.**
   - **The Module-C design is basically same as the XFEL cryomodule.**
   - **The length of Module-C cryostat is designed to be 5800 mm.**
   - **The interface components between KEK and INFN components are manufactured and assembled by KEK.**
3. **The design of the KEK tuner and cavity-vessel will be improved from the present configuration.**





Cross section of FNAL cavity and Module-C

Cross section of KEK-BL cavity and Module-A

S1- Global : Study subjects

1. **Attaining to the average operation gradient > 31.5 MV/m.**
2. **Information exchange of cryomodule assembly between DESY, FNAL, INFN and KEK.**
   - **For constructing the ILC-cryomodule design including the plug-compatible concept, the actual assembling process for the different cavity-packages will supply important data.**
   - **The information exchange of assembly method and tooling is very important, too.**

     Alignment strategy and tools, auto-welding machine, auto-pipe cutter, etc.
3. **Comparing the performances and the heat loads of the individual components between the collaboration laboratories.**
   - **Functional performance of the tuners and the input couplers for the operation over 31.5 MV/m.**

     Tuner: Sacley type, Blade type, Slide Jack type

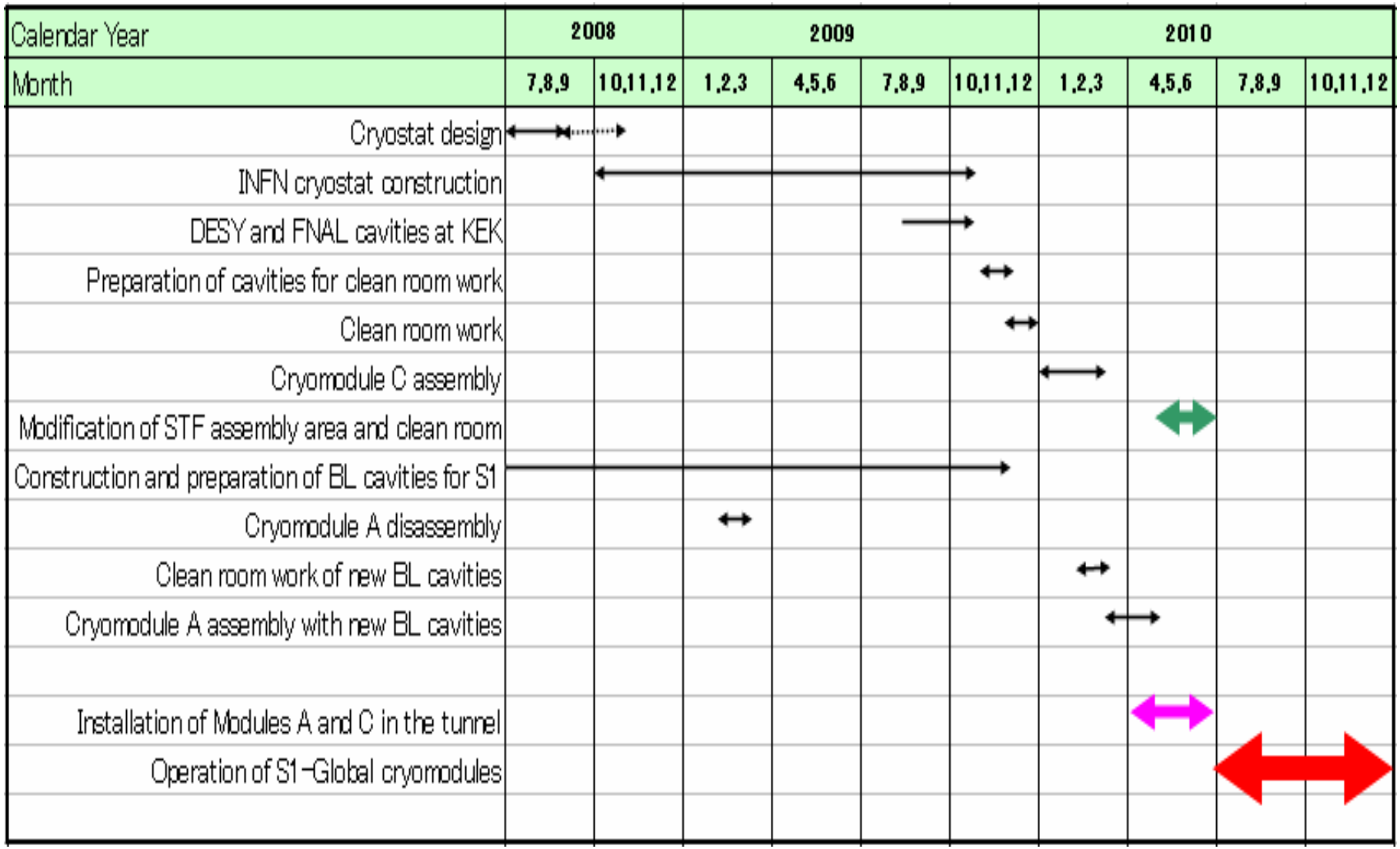
     Input coupler: TESLA input coupler, KEK coaxial window input coupler
   - **Thermal performances of the components.**

     The heat load measurements will be done under the completely same conditions.

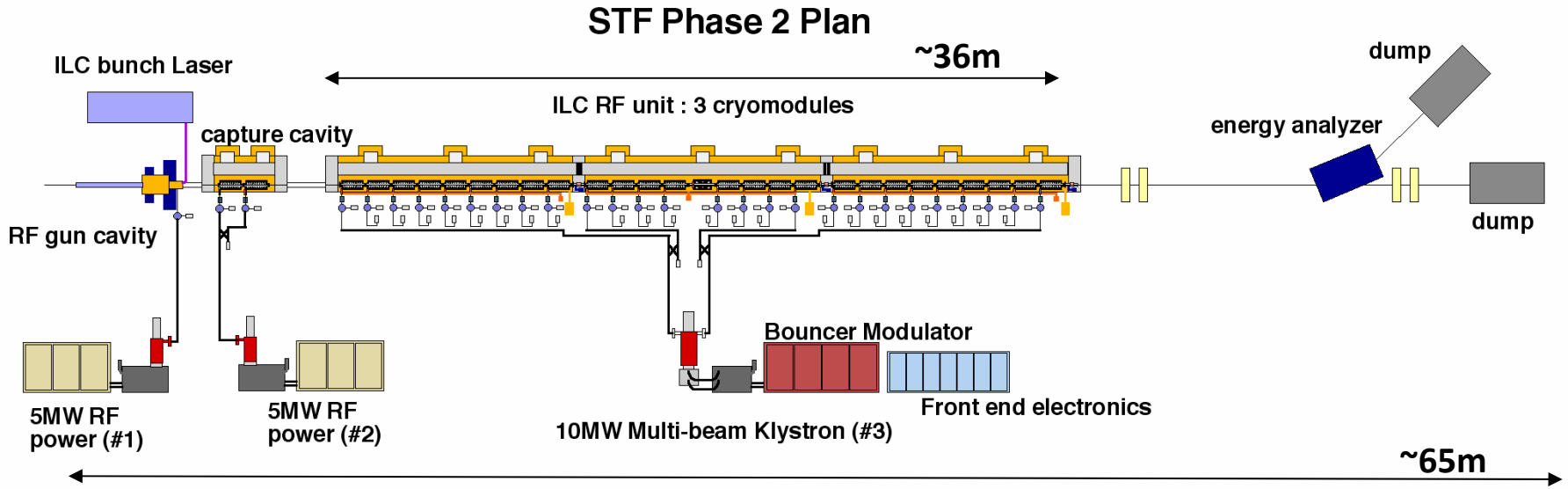
     Static heat loads

     Dynamic heat loads at 31.5 MV/m
   - **Heat load data will lead to the confirmation of the specification of the ILC cryogenic system.**

S1- Global : Schedule (detail)



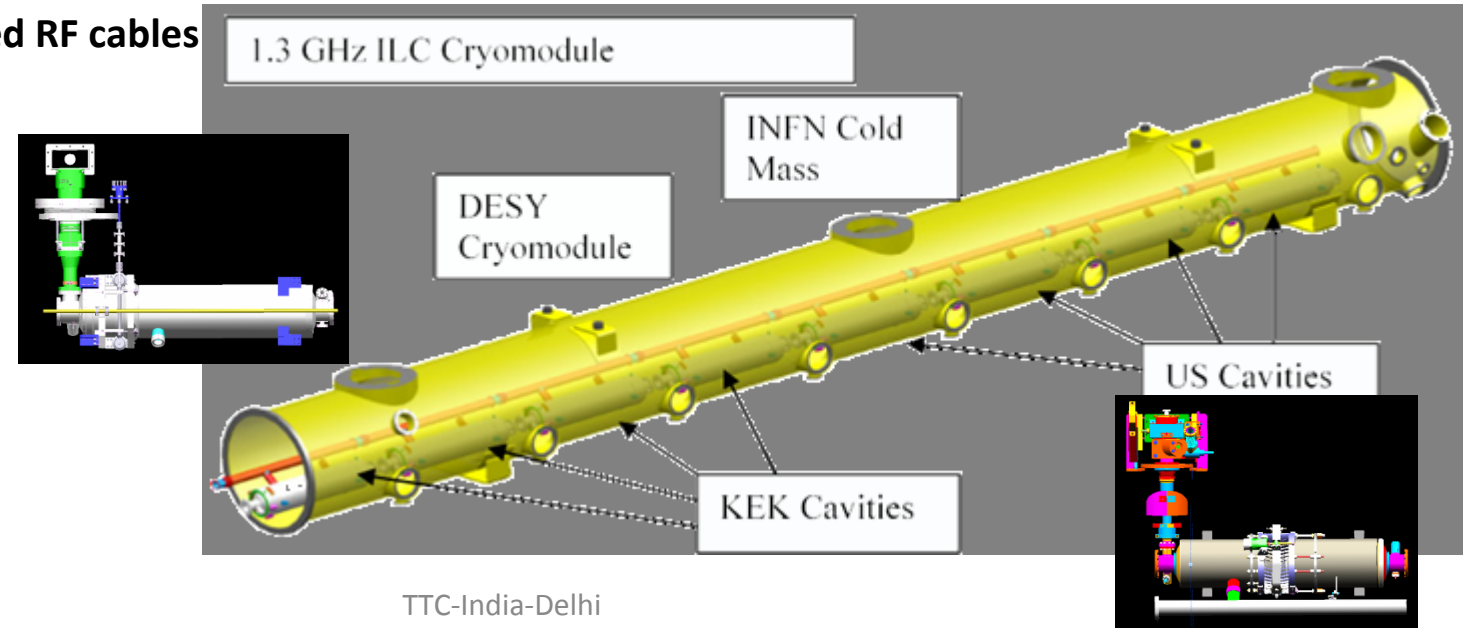
STF2



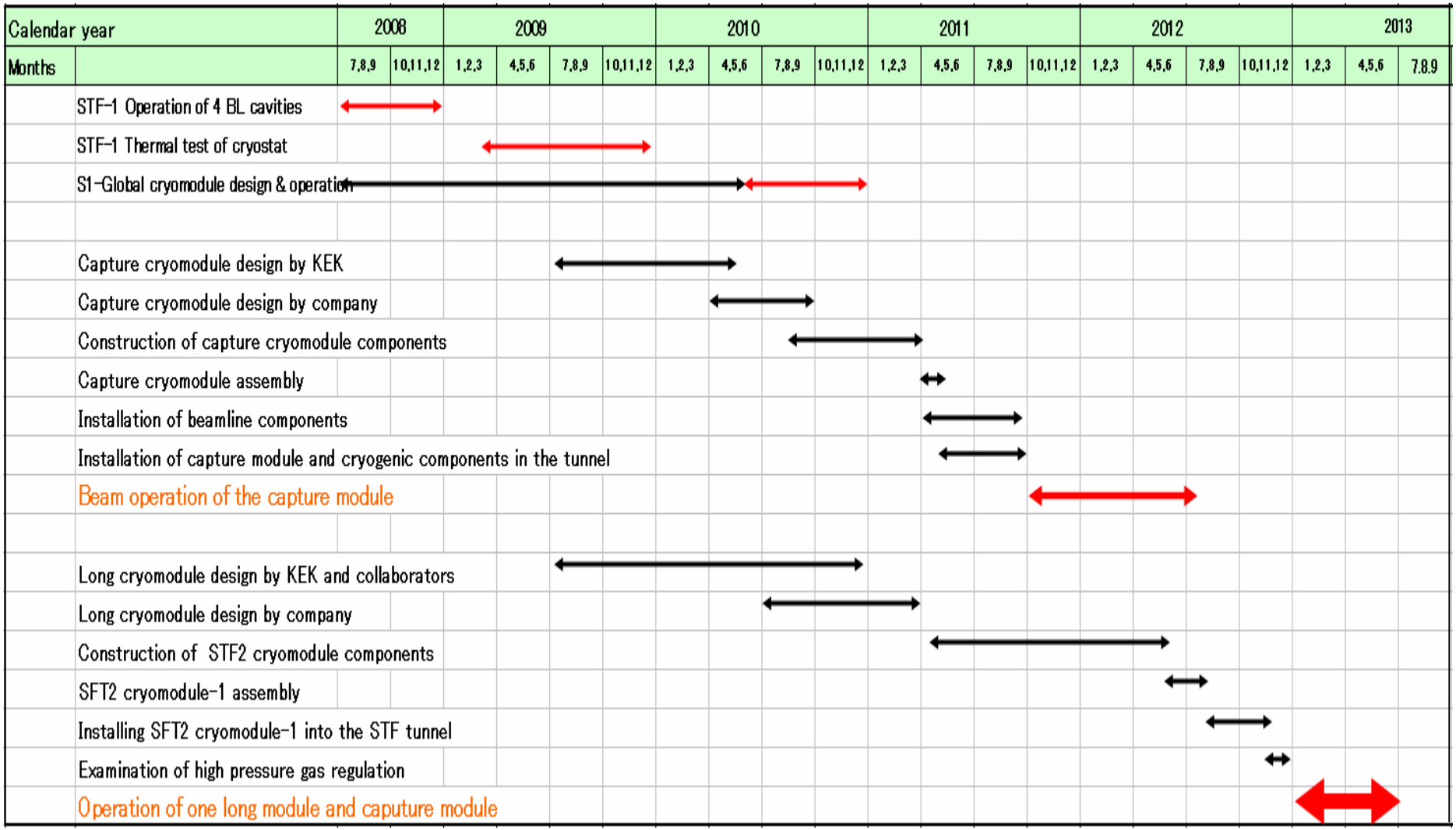
- **Construction of 1 RF unit of ILC**
  - **Cryomodule: 2 modules (9 cavities) + 1 module (8 cavity + 1 quadrupole)**
    - **Design of cryomodule (CM-Type 5 or ILC-prototype)**
  - **RF system of 10MW Multi-beam Klystron**
  - **Reinforcement of the cryogenic system**
  - **Expansion of the clean room**
    - **Enable assembly of 9 cavities in a string**
      - **The present clean room was designed for assembly of 4 cavities.**

STF2 : Cryomodule design

- **Design concept**
  - **The module is designed in order to get the ILC proto-type module design.**
  - **Plug compatibility**
    - **Accepting the different type of cavity-packages**
      - **DESY, FNAL and KEK cavity-packages**
  - **Improving the thermal model including the cost effect**
    - **Re-designing the thermal shield system**
      - **removing 5K shield + 40 K shield**
    - **Thermal intercept design**
      - **5 K and 60 K thermal interceptors**
    - **Optimized RF cables**



STF2 : Schedule (cryomodule development)

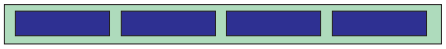


(Details and operation are still under discussion.)

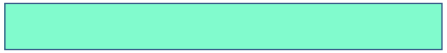
Summary: STF Module Plan and Schedule

STF1

May-Dec. 2008 Cryomodule-A with 4 base-line cavities: 2K cold test is now continuing.



Jan-Dec. 2009 Cryomodule-B without cavities: Thermal measurement at 2K



S1-Global

May 2008 – Dec.2010 Cryomodule with 8 cavities (FNAL, DESY and KEK cavities, INFN cryostat and STF cryostat)

STF-Module A + Module-C

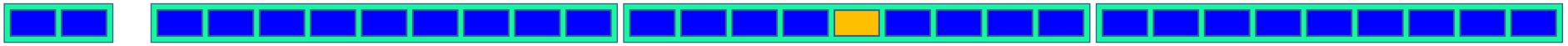
Operation: June-Dec. 2010

Target:31.5MV/m

STF2（ILC 1 RF unit + 1 capture module）

2009-2010 Design work（SC cavity, Cryomodule, Cryogenic system, RF system, etc）

2010- Construction of the components and infrastructure



Quadrupole