Status of Cryomodule Development in KEK

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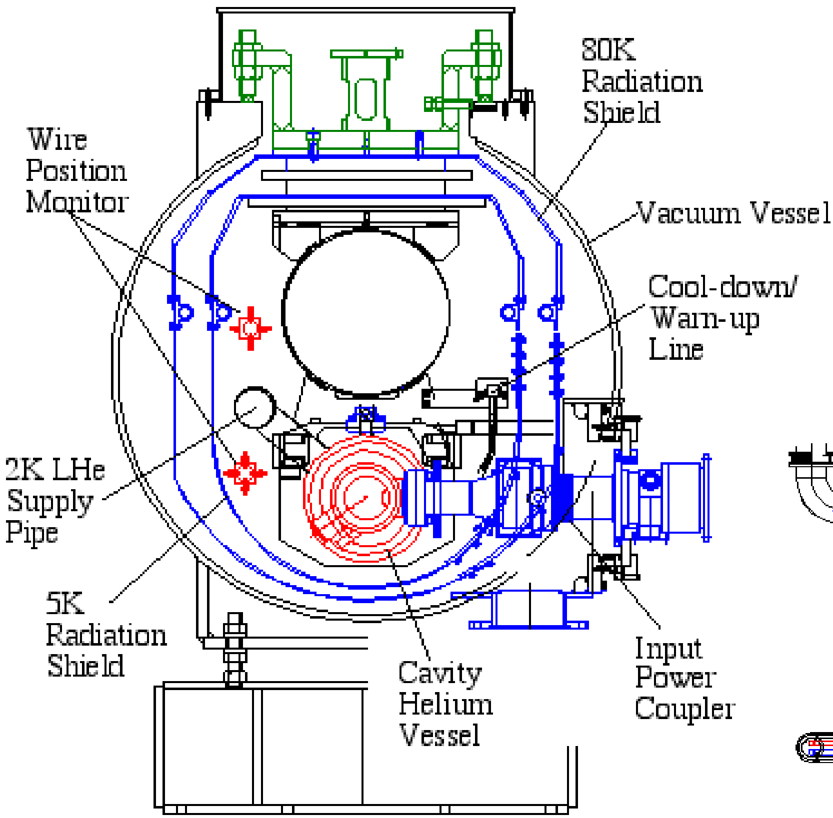
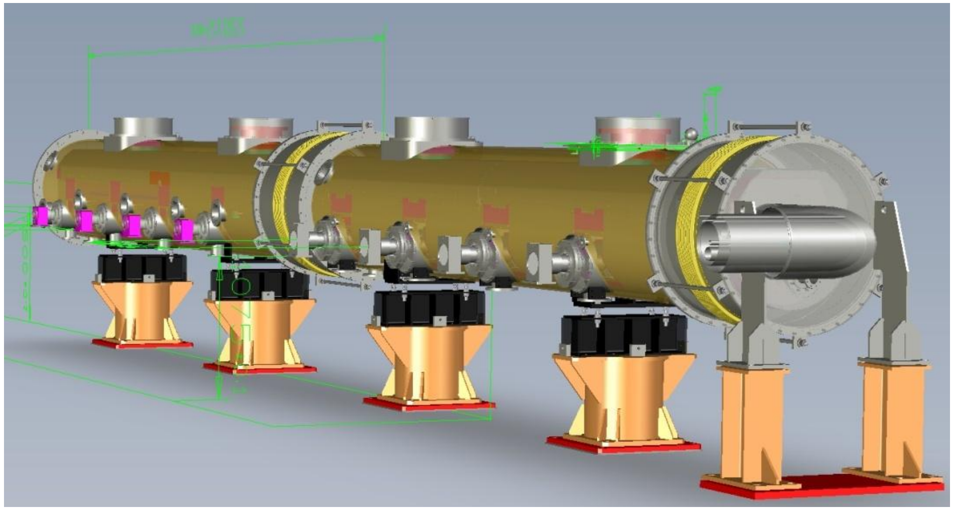
Targets of the Cryomodule Development in the KEK-STF

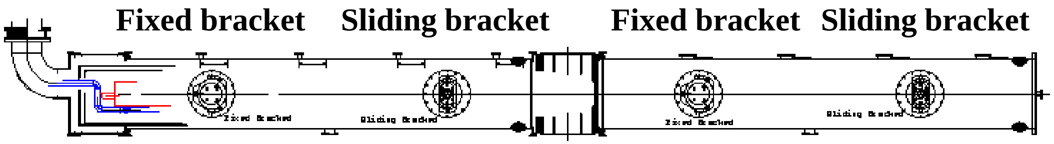
- **Design study for the STF cryomodule**
  - The cryogenic design of the STF cryomodule is based on the TTF-III cryomodule.
  - The design work of the STF cryomodule is necessary for us to understand the ILC cryomodule thermally and mechanically in detail.
- **Construction of the STF cryomodule**
  - Learning the manufacturing process of the components and the assembling process of the cryomodule.
  - Studying the cost and the required man-power for the construction of the cryomodule.
- **Tests of the cryomodule in the KEK-STF**
  - **Phase -0.5**
    - Measuring the heat loss of the cryostats with one cavity for the TESLA-like-cavity and the LL-type-cavity without and with connecting the power coupler to the room temperature.
    - Low-level and high-power tests of cavities.
    - Measuring the motion of gas return pipes during cool-down and warm-up process by WPM.
    - Establishing the cooling procedure of the STF cryogenic system.
  - **Phase-1.0**
    - Measuring the heat load of the cryostats with four cavities for the TESLA-like-cavity and the LL-type-cavity.
    - Measuring the motion of cavities and cryogenic components during cool-down and warm-up process by WPM.
    - Establishing the cooling procedure of the STF cryogenic system for 8 cavities.
    - Beam test.

Design of the KEK-STF Cryomodule

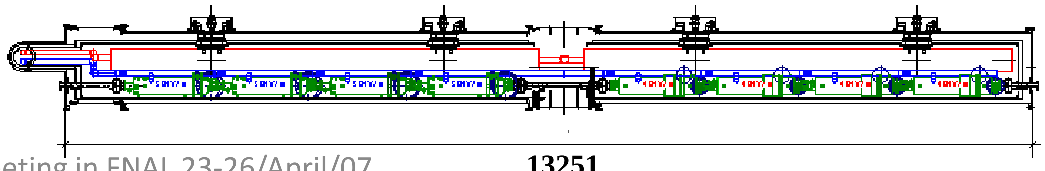
- The design of the cross section of the KEK-STF cryomodule is based on the **TTF-III** cryomodule.
- Two cryomodules for the TESLA-like-cavities and the LL-type-cavities are connected with the vacuum bellows, and the total length of the vacuum vessels is 13.25 meter.
- Each cryostat is designed to have four cavities.







Cryostat for Tesla-like-cavities **Cryostat for LL-type-cavities**



Component Dimension in the Cryostat

	STF-cryomodule	TTF-III	Material
Vacuum vessel	ϕ 965.2 , t 12	ϕ 965.2 , t 9.52	Carbon Steel
2 K He Gas return	ϕ 318.5 , t 10.5	ϕ 312 , t 6	SUS
2 K two-phase He supply	ϕ 76.3 , t 2.1	ϕ 76 , t 2.0 (ϕ 60 , t 1.5)	Ti (TTF-III) / SUS (STF)
Cool down/warm up	ϕ 27.2 , t 1.65	ϕ 42.2 , t 1.65	SUS
5 K shield supply	ϕ 30 , t 4	ϕ 60.3 , t 2.76	SUS
5 K shield return	ϕ 30 , t 4	ϕ 60 , t 5	Al
80 K shield supply	ϕ 30 , t 4	ϕ 60.3 , t 2.76	SUS
80 K shield return	ϕ 30 , t 4	ϕ 60 , t 5	Al

The material of the 2K two-phase He supply pipe is SUS.
The material of the TESLA-like-cavity helium vessel is Ti, and the SUS-Ti junction is used. For the LL-type cavity, the material of the helium vessel is SUS.

Calculated Heat Load for the STF Cryomodule (W)

STF-Phase-1 (four cavities for each cryostat)

	Cryostat Static	Tesla-Like Static	Tesla-Like Dynamic	LL-type Static	LL-type Dynamic	Total Static	Total Dynamic	Total S+D
2K	2.4	0.4	7.3	0.0	6.0	2.8	13.3	16.1
5K	6.1	4.4	0.8	2.2	11.5	12.7	12.3	25.0
80K	110	20.0	12.0	5.0	8.6	135.0	20.6	155.6

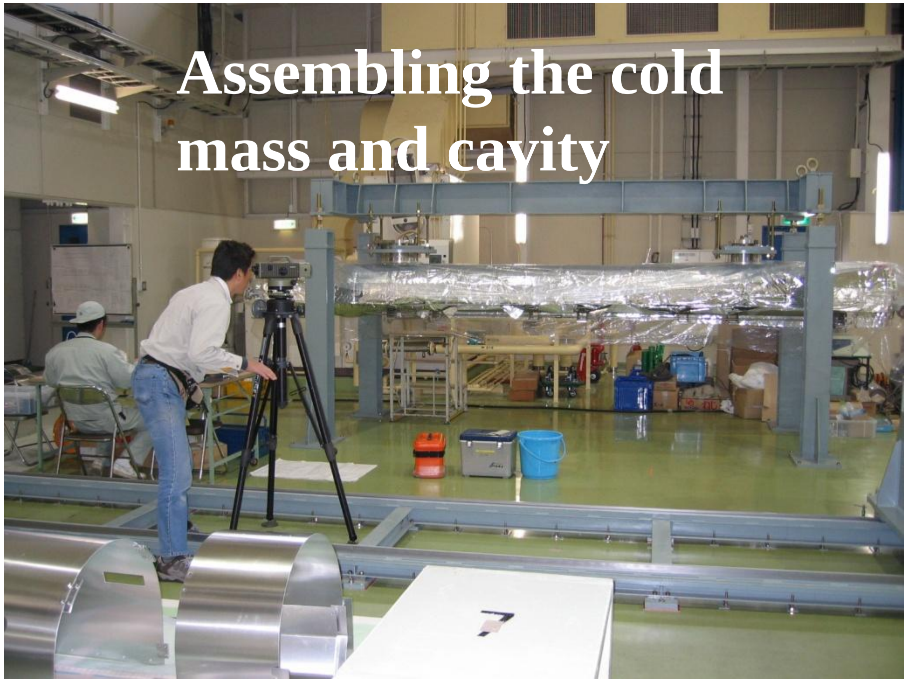
Heat losses through leads are not included.

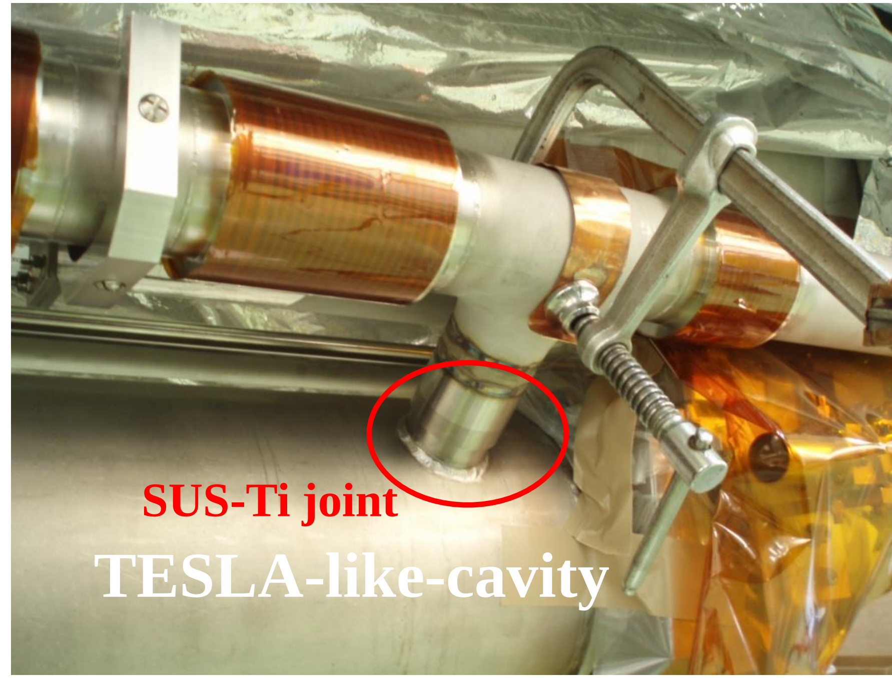
STF-Phase-0.5 (one cavity for each cryostat)

	Cryostat Static	Tesla-Like Static	Tesla-Like Dynamic	LL-type Static	LL-type Dynamic	Total Static	Total Dynamic	Total S+D
2K	2.4	0.1	1.8	0.0	1.5	2.5	3.3	5.8
5K	6.1	1.1	0.2	0.6	2.9	7.8	3.1	10.9
80K	110	5.0	3.0	1.3	2.2	116.3	5.2	121.5

Construction of the STF Cryomodule

- The design of the cryostat was started from Sept. 2005 by Hitachi.
- The manufacturing components was started from Nov. 2005.
- The assembly of the cryomodule was performed from November 2006 to February 2007.

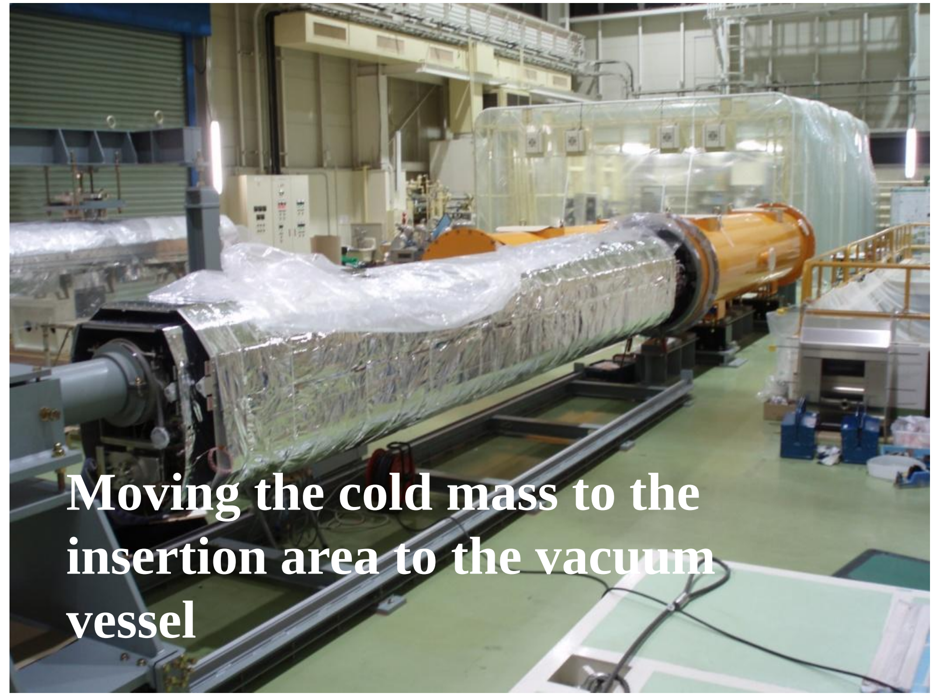

Assembling the cold
mass and cavity


SUS-Ti joint
TESLA-like-cavity

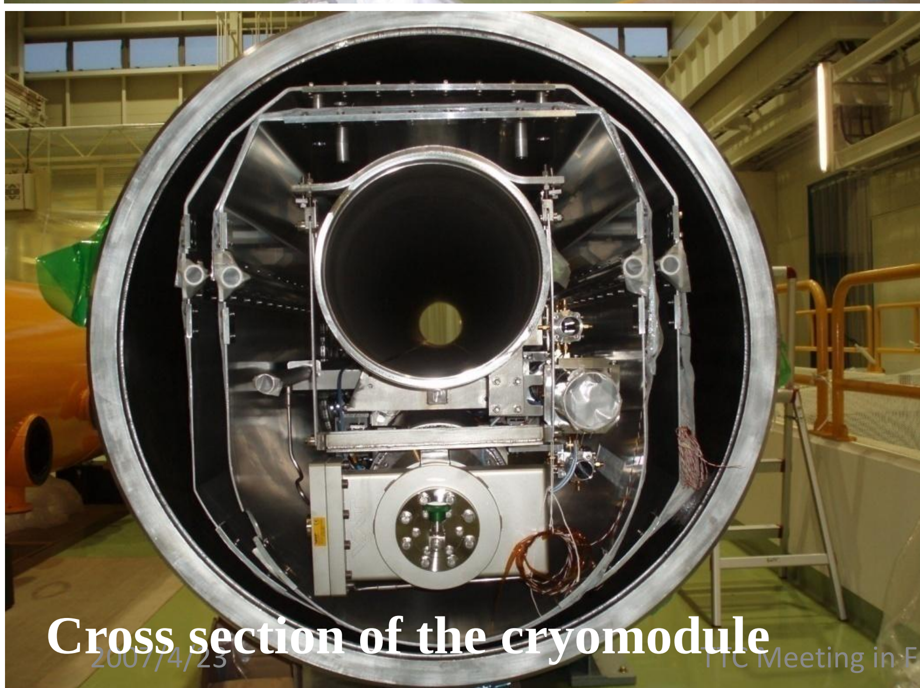

TESLA-like-cavity


5K thermal
radiation
shield

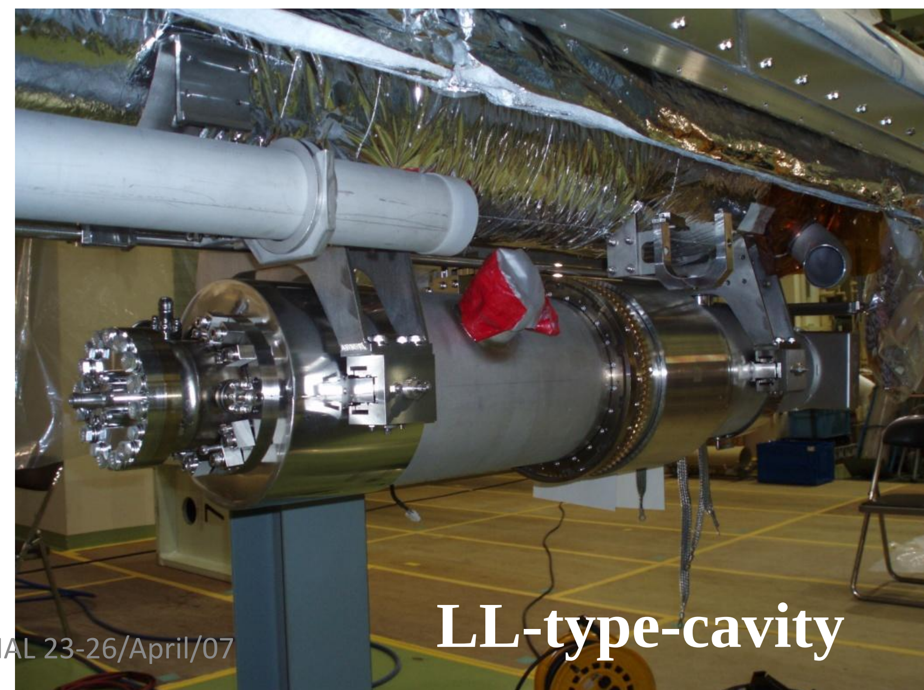
Inserting pipe into the gas return pipe



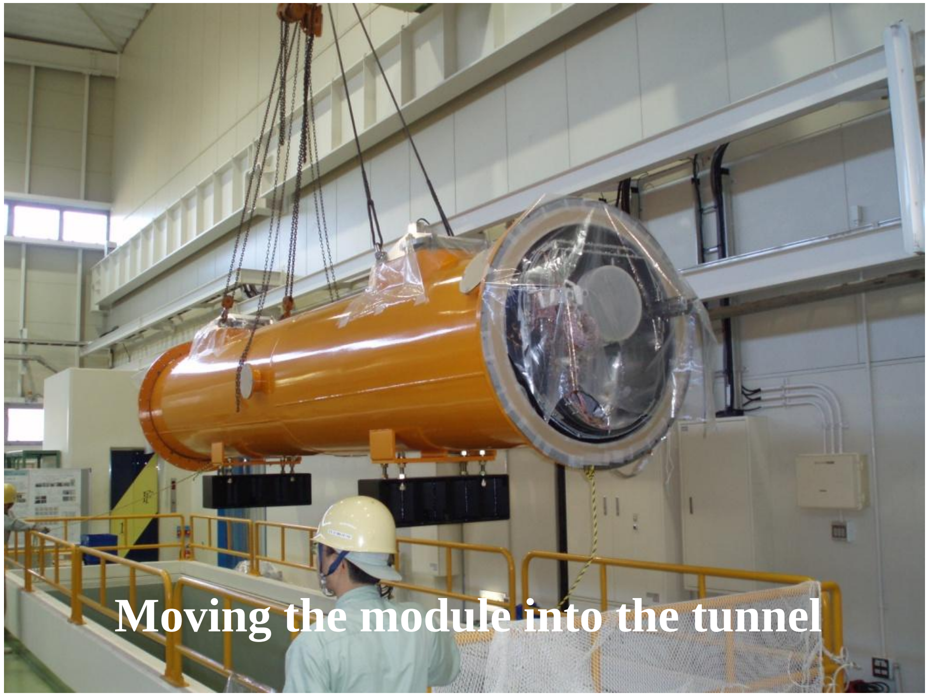
Moving the cold mass to the insertion area to the vacuum vessel



Cross section of the cryomodule



LL-type-cavity


Moving the module into the tunnel


Setting the module on the tunnel floor


2K cold box

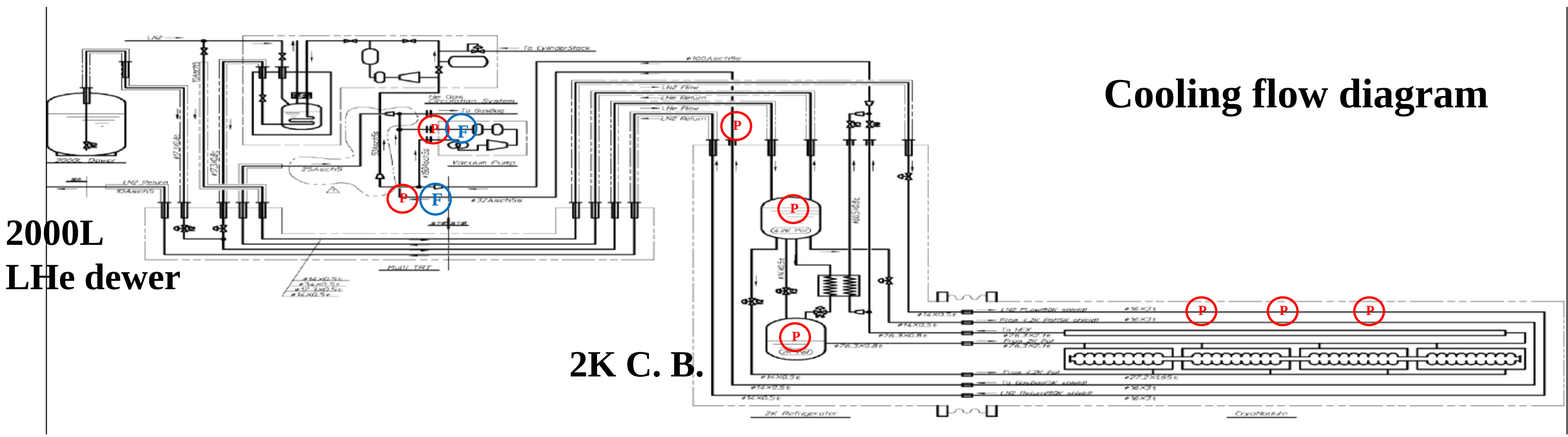

2 cryomodules are connected and aligned in the tunnel

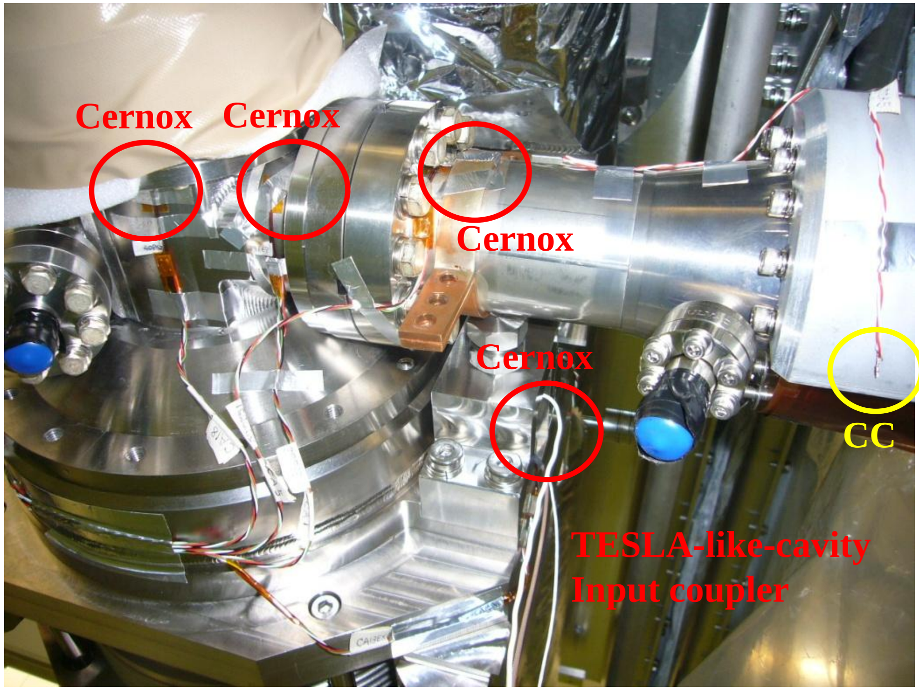
Measuring the Heat Loss of the STF Cryomodules

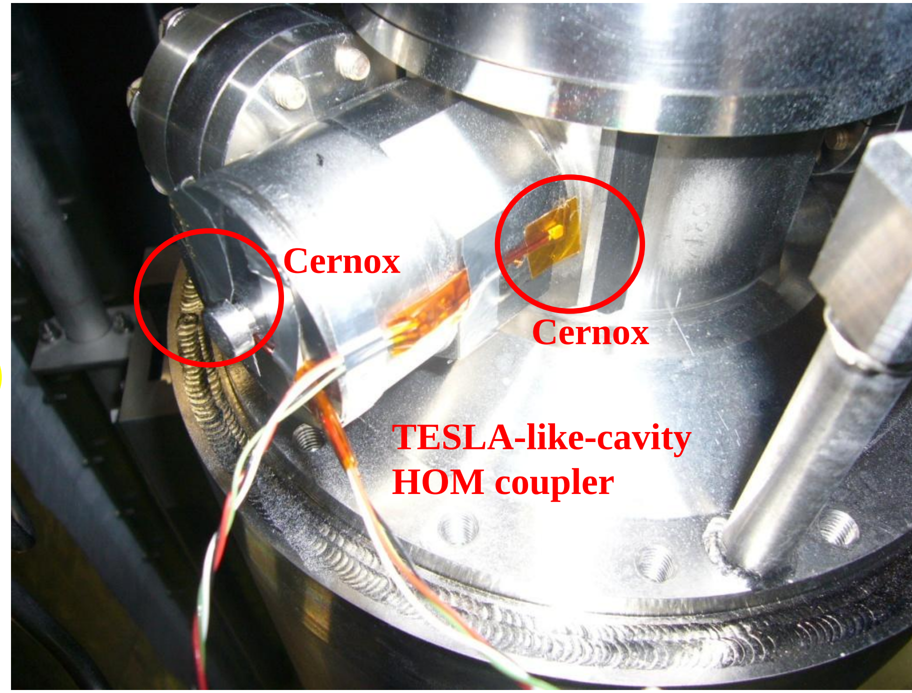
- **Heat loss measurements**
  - Heat loss at 2K
    - Evaporation rate of 2K saturated liquid helium
      - A volumetric mass flow meter, two absolute pressure sensors in the 2K liquid helium vessel and the gas return pipe.
    - Calculation of the heat loss from the actual temperature profile of the components in the cryostats.
  - Heat loss at 5K
    - All cryogenic components connecting to the 2K region is thermally anchored on the 5K thermal radiation shield.
      - Heat loss to the 5K thermal radiation shield is measured by the enthalpy change of the cooling helium gas through the cooling pipe on this shield.
      - Measurement of the temperature, the pressure and the mass flow rate of the cooling helium gas.
    - Calculation of the heat loss from the actual temperature profile of the components in the cryostats.
  - Heat loss at 80K
    - Calculation of the heat loss from the actual temperature profile of the components in the cryostats.

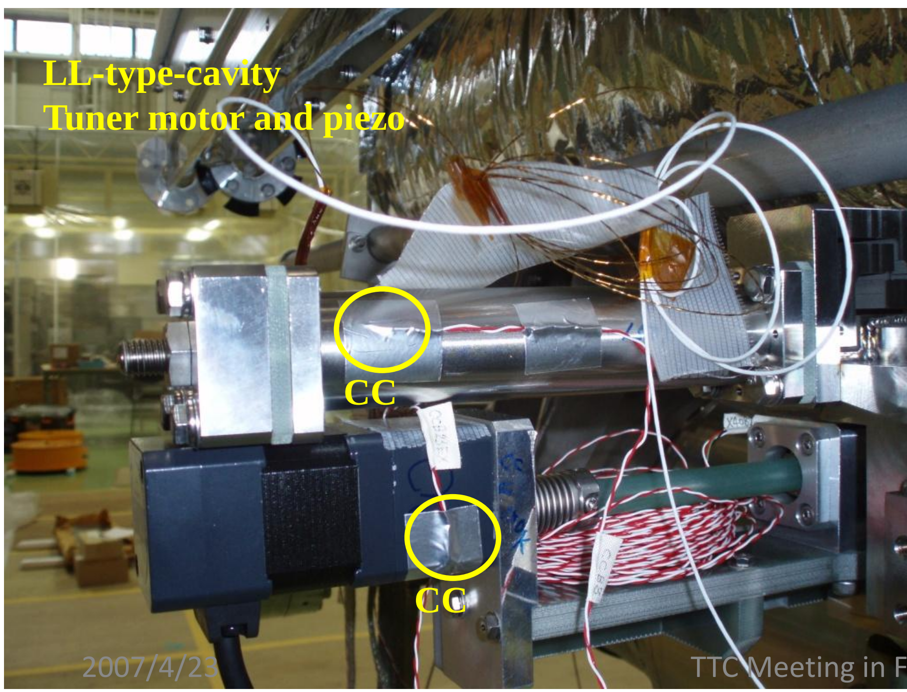
Sensors for Thermal Measurements

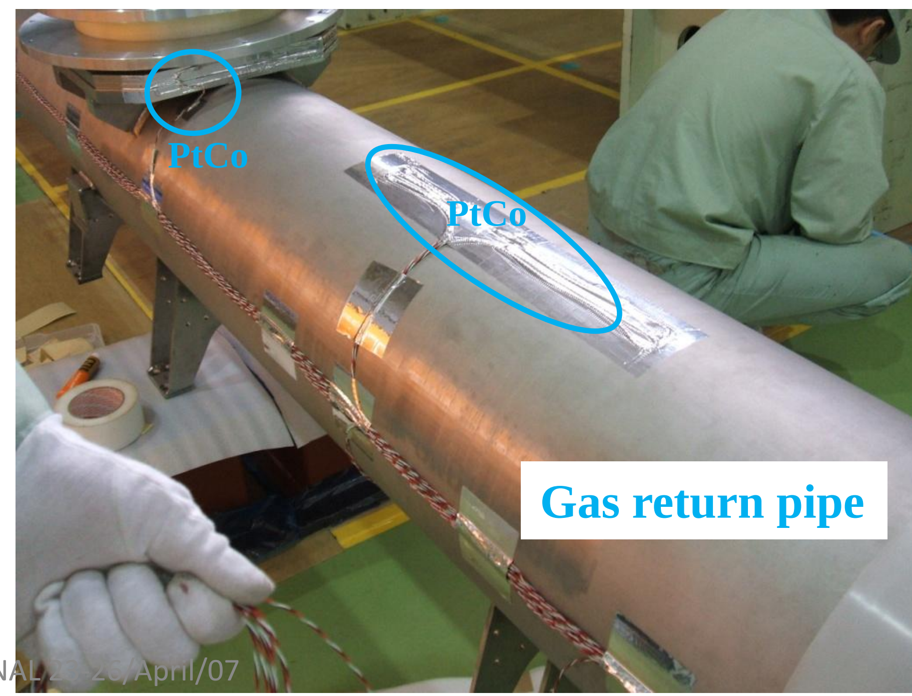
- **Pressure sensor, Mass flow meter**
  - 2 absolute pressure sensor, 6 pressure sensors
  - 2 volumetric flow meters
- **Temperature sensor (for STF-Phase-0.5)**
  - 32 Cernox temperature sensors
    - 14 sensors on two cavities, 4 sensors on 2 tuners, 14 sensors on gas return pipe (GRP)
  - 40 Pt-Co temperature sensors
    - 24 sensors on 5K thermal radiation shields, 8 sensors on 4 support posts, 4 sensors on GRP, 4 sensors on two cavity He vessels
  - 51 C-C thermo-couple temperature sensors
    - 20 sensors on 80K thermal radiation shield, 12 sensors on GRP, 12 sensors on 4 support posts, 7 sensors on the components.




Cernox
Cernox
Cernox
Cernox
CC
TESLA-like-cavity
Input coupler

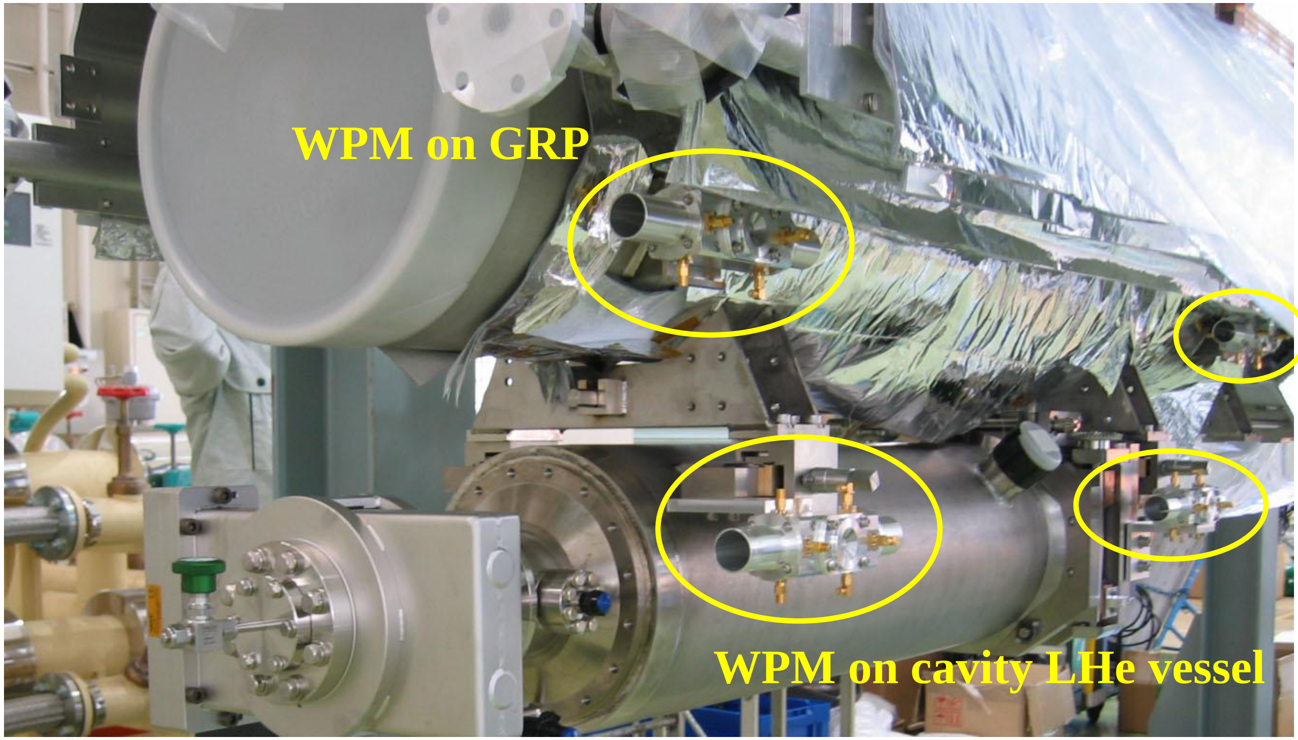

Cernox
Cernox
TESLA-like-cavity
HOM coupler


LL-type-cavity
Tuner motor and piezo
CC
CC


PtCo
PtCo
Gas return pipe

Measurement of Cavity and GRP Movement by WPM

- **Position changes of GRPs and cavity helium vessels** during cool-down and warm-up will be measured by Wire Position Monitors (**WPM**).
  - 5 WPMs are assembled on the GRP for each cryomodule (total 10 WPMs).
  - 2 WPMs on one cavity helium vessel (total 16 WPMs).
- **STF-Phase-0.**5
  - Position changes of GRPs will be measured by 10 WPMs.
- **STF-Phase-1.0**
  - Position changes of GRPs and cavities will be measured by 26 WPMs.



Summary

- The STF cryomodule was designed with based on the TTF-III design and the construction has been already completed.
- The cool-down of this cryomodule is scheduled to start on May 14. **(STF0.5)**
  - In the first cool-down, the main subjects are heat loss measurements of cryomodule without connecting the cold couplers to the warm couplers, and the cooling procedure will be confirmed.
  - After the warm-up of the cryomodule and connecting the cold and warm couplers, the cryomodule will be cooled to 2K again, and the high power tests of cavities and the heat loss measurements will be performed.