DEVELOPMENT OF STF CRYOGENIC SYSTEM IN KEK

*Jun Yoshida (Hitachi Plant Technologies, Ltd.),
Kenji Hosoyama (KEK),
Hirotaka Nakai, Kazufumi Hara, Yuuji Kojima, Kota Nakanishi (KEK),
Masato Noguchi (Mayekawa MFG. Co., Ltd.),
Takashi Ichitani, Satoshi Kaneda (Taiyo Nippon Sanso Corporation),
Shigemitsu Sakuma, Kouichi Suzuki (Taiyo Nippon Sanso Higashikanto Corporation),
Takayuki Kanekiyo (Hitachi Technologies and Services Co., Ltd.)

[KEK: High Energy Accelerator Research Organization]

Abstract

Under the leadership of KEK (High Energy Accelerator Research Organization), the collaborating design and construction activity has been performed in KEK in order to develop the STF (Superconducting RF Test Facility) cryogenic system, together with some positive Japanese industrial members.

As the first activity of the collaboration, the initial plant of STF cryogenic system with cooling capacity of 30W at 2.0K has been constructed for the testing of STF Cryomodule, and been ready for its operation in KEK.

In this session, the present status and schedule of STF cryogenic system in KEK will be briefly reported.

INTRODUCTION

In KEK, the STF (Superconducting RF Test Facility) project has been promoted in order to develop super conducting RF cavities for ILC (International Linear Collider).

Its detail progress and status of STF will also be reported in other sessions.

For design and construction of the cryogenic system of STF, the “STF cryogenic collaboration team” had established in KEK, and started to design a cryogenic test facilities in 2005, which is operated for cooling the STF Cryomodule.

The STF cryogenic collaboration team is composed of KEK staff and industries. The team plans to promote further R&D of cryogenic components. [1-2]

KEK plans to develop some cryogenic systems not only for STF Cryomodule experiment but also further systems for evaluating cryogenic components. This proceeding describes the prototype cryogenic system for STF.

COLLABORATION TEAM MEMBERS

Under the leadership of KEK, the following five Japanese companies have joined to attend STF cryogenic collaboration team for designing and fabricating STF cryogenic system.

1) Hitachi Plant Technologies, Ltd (HPT) Tokyo (Former industrial plant section of Hitachi, Ltd)
2) Taiyo Nippon Sanso Corporation, Tokyo
3) Mayekawa MFG. Co., Ltd., Tokyo
4) Taiyo Nippon Sanso Higashikanto Corporation
5) Hitachi Technologies and Services Co., Ltd.

These are some of principal Japanese industries related to cryogenics, which have experience of engineering, fabricating, procurement, construction, and commissioning of cryogenic plants or machines in Japan. They are interested in construction of ILC cryogenic systems, related to main cryogenic plant facilities, including other cryogenic components.

STF CRYOGENIC SYSTEM

STF cryogenic system was designed to ensure testing of STF Cryomodule, which is installed in the underground of the building, supplying 2.0K superfluid helium to RF cavity inside the STF Cryomodule.

For this initial plant, cooling capacity was selected 30W at 2.0K. These figures are only for this prototype, since existing helium refrigerator has been adopted to this system, decided at basic engineering stage.

Main feature of STF cryogenic system is shown in Table 1 and Table 2.

Table 1: Specifications of STF cryogenic system

Item	Specification	Remarks
Cooling Capacity	30 W	At 2.0K Dewar
Cooling Temperature	2.0 K	Saturated
Thermal Shield 5K	LHe, GHe	Supplied from 4.5K Dewar
Thermal Shield 80K	GHe	Precooled GHe, from precooler
Pumping System	Vacuum Pumps	MBP.+RP. (at Room Temperature)
Pipe for Pumping	35m, 100A	

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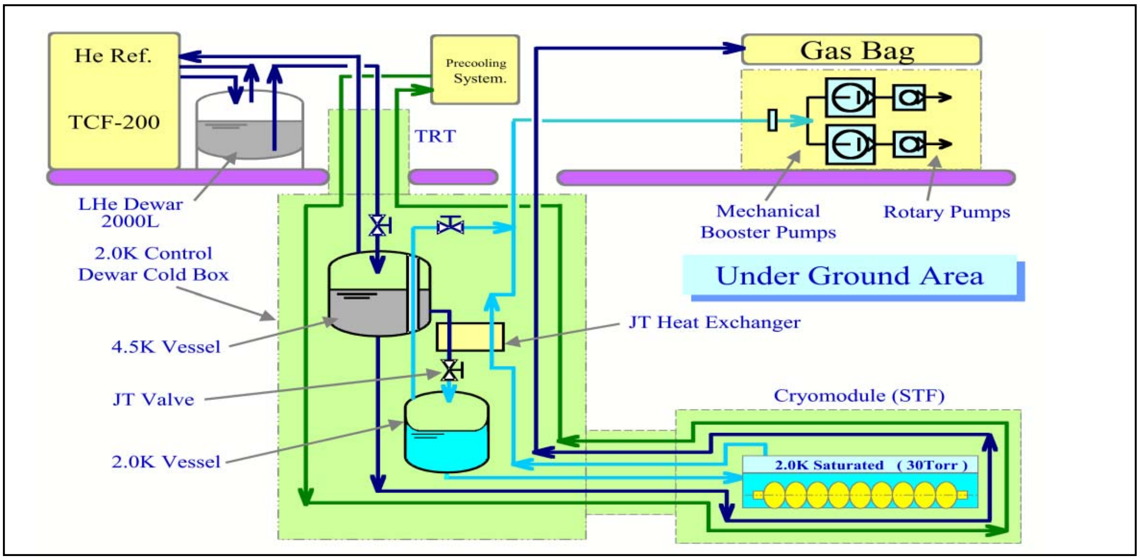

Figure 1: Schematic Flow Diagram of STF Cryogenic System

Existing helium refrigerator/ liquefier of TCF-200 (former Sulzer) is restored for this system, which was operated as test stand refrigerator for KEKB prototype superconducting cavity, more than ten years ago. Plant capacity of this helium refrigerator is reconfirmed as around 600W at 4.5K or 280L/h after reinstallation.

Schematic flow diagram of STF cryogenic system is shown in Fig. 1. The helium refrigerator liquefy helium and storage into existed 2000L liquid helium dewar at 0.12MPa (1.2atm), 4.5K. The helium refrigerator and dewar are equipped on ground level of the STF building.

2.0K Control Dewar Cold Box was designed for STF cryogenic system, containing 4.5K vessel connected to the 2.0K vessel vertically. JT heat exchangers and JT valves are also equipped in the 2.0K Control Dewar Cold Box. The 2.0K Control Dewar Cold Box is installed on underground level of the STF building. The helium dewar and the 2.0K Control Dewar Cold Box is connected with high performance transfer lines with 35m long.

Stored liquid helium is supplied from liquid helium dewar to 4.5K vessel in 2.0K Control Dewar Cold Box.

From 4.5K vessel, liquid helium is induced to JT heat exchanger to decrease its temperature by returning helium gas before JT expanding into 2.0K vessel. This 2.0K vessel is horizontally connected to cavity cooling channel of STF Cryomodule on the underground level.

The cavity cooling channel is evacuated down to around 3.1kPa (23Torr) to generate 2.0K superfluid helium.

Table 2: Specifications of helium refrigerator for STF cryogenic system

Item	Specification	Remarks
Helium Refrigerator	280L/h or 600W at 4.5K	TCF-200 (Restored at KEK)
Helium Dewar	2000 litter	4.5K, 1.2 atm

Pump unit is installed on ground floor level working at warm temperature. Pump unit, which is consisted of two units of a mechanical booster pump and a rotary pump in parallel, pumps helium from cavities and vessels through the pipe size of 100A, 35m.

Equipment between ground level and underground level is connected with high performance transfer lines developed by KEK. [3]

5K and 80K shield lines are also equipped independently. 5K shield helium is supplied from 4.5K vessel to the cryomodule, 80K helium is supplied from precooling system cooled by liquid nitrogen.

Figure 2 shows installed 2.0K control dewar Cold Box beside STF Cryomodule on underground level.

In this STF cryogenic system, the following developed components or techniques are adopted.

1) JT-Heat Exchanger
   (Laminated finned type)
2) Transfer lines
   (High performance transfer line designed by KEK)
3) Precooling System
   (80K helium gas supplying system)

Figure 2: 2.0K Control Dewar Cold Box.

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Figure 3 shows a cross sectional view of high performance transfer line.

For controlling pressure and liquid level of vessels and for several data acquisitions, PC-DCS system with PLC is equipped.

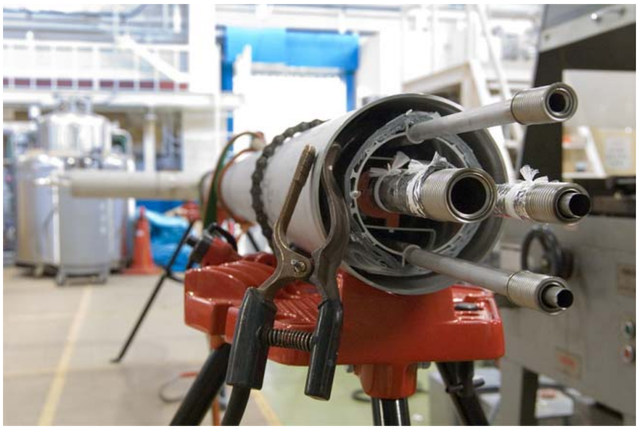


Figure 3: High Performance Transfer Line Designed by KEK.

DESIGN AND CONSTRUCTION SCHEDULE

Table 2 shows project schedule of STF cryogenic system.

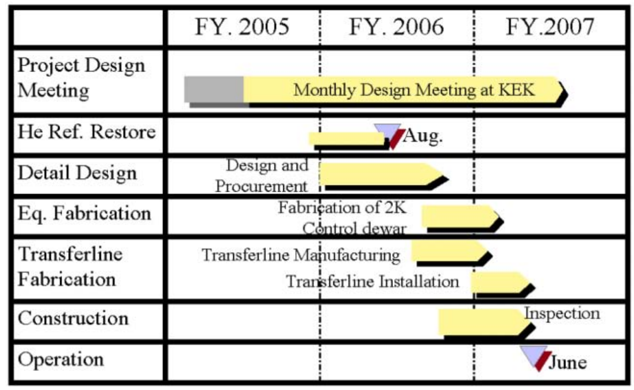
Basic design and engineering work was started in winter 2006, and progressed with reviewing monthly design meeting of STF cryogenic collaboration team.

Project control and management was fully done by KEK.

At present, construction of STF cryogenic system has been completed successfully, and final inspection for initial cooling down has been also completed.

Initial cooling-down will be performed in June 2006.

Table 3: Design and Construction Project Schedule of STF Cryogenic system



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