

STATUS OF STF FOR ILC

Hitoshi Hayano, and STF group
 High Energy Accelerator research organization (KEK), Tsukuba, Japan

Abstract

To promote R&D for the International Linear Collider (ILC) for regional production capabilities and construction share, superconducting RF test facility (STF) with the two development stages is under construction. The phase-1 plan for 2005 and 2006 is dedicated to have quick experience on all aspect of 1.3GHz SC technologies by producing 4 TESLA-shape cavities with 5m cryostat and 4 LL-shape cavities with another 5m cryostat, which are powered by 5MW klystron. In the Phase-2 plan for 2007 to 2009, we will construct a complete ILC RF unit which is compatible with ILC design and consisting of three cryomodules which contain 8 SC cavities. The role and status of the STF is reported in this paper.

1 INTRODUCTION

The development of 1.3GHz superconducting RF technologies for linear collider main linacs was conducted by DESY and TESLA collaboration. The TESLA design gradient 23.8 MV/m has been attained on average with cavities of the standard chemical treatment. By application of new EP method to 9-cell cavities, 8 cavities have reached gradients between 31 and 35 MV/m, and assembled into the cryomodule #6 which will be installed in the FLASH accelerator (former TESLA Test Facility 2 (TTF2)). The basic concept of the ILC main linac was summarized in the BCD (Base-line Configuration Document), and adopted 31.5MV/m gradient as an initial main linac operation gradient. The effort of the main linac design is now started toward making a reference design report with rough cost estimation. The current ILC configuration is illustrated in Figure 1. The 1st stage is for 250GeV+250GeV energy plan, and the 2nd stage is for 500GeV+500GeV plan.

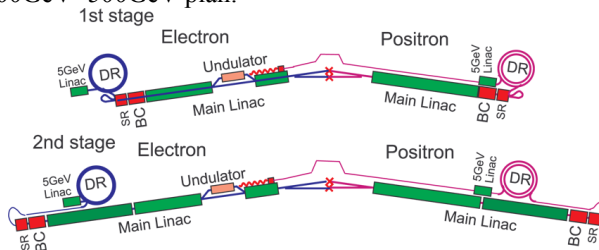


Figure 1 Baseline ILC accelerator configuration

2 RF UNIT IN ILC MAIN LINAC

The bouncer modulator and the pulse transformer generating 120kV, 140A, 1.57ms of width, 5Hz repetition pulse for the 10MW multi-beam klystron are the baseline design of RF power source. Beam is injected after filling

time of 500 μ s from the start of RF fill into the cavities. The klystron has two RF output. Each of RF output is transported by three-way waveguide system to the linear distribution system of the cryomodule. RF power branch to each cavity is done by the hybrids, which have different coupling ratio for each cavity input. The circulator of each cavity input ensures the matching condition of waveguide system. There are 8 cavities in each cryomodule. Total 24 cavities are in one RF unit. Operation gradient for these cavities are 31.5MV/m, and loaded beam current is 10mA during about 900 μ s. The configuration is illustrated in Figure 2, below.

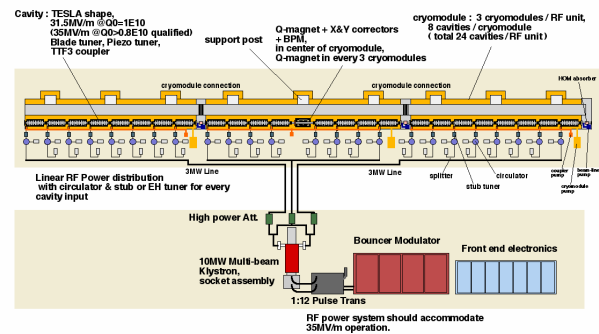


Figure 2 RF unit configuration of ILC main linac.

3 STF PHASE1 CONSTRUCTION

To promote R&D on these main linac technologies, the construction of the test facility for the ILC, STF has been started in KEK. The main role of STF is to establish the industrial design of linac unit and to promote Asian and Japanese industrial level towards ILC component production. STF will be a base of international collaboration for superconducting RF technology in Asian region. The R&D on the cavity gradient to achieve more than 31.5MV/m stably is also another urgent item of ILC.

Based on existing KEK superconducting RF technologies, the new ILC superconducting RF test facility which promote the production of high performance 9-cell cavity and an ILC-like long cryomodule assembly. The first stage (STF Phase 1) is aiming quick start up of 9-cell cavity production, having experience of assembly engineering of half-size cryomodule, and having RF power handling technologies. The infra-structure such as EP facility and clean room are constructed in parallel for preparation of cavity handling capability. The main goal of the second stage (STF Phase 2) is to build one RF unit of ILC main linac (see Figure 2) and to have long-run operation. The long term schedule

plan is shown in Figure 3, for years 2005 - 2009. And block diagram of STF phase-1 and phase-2 is shown in Figure 4.

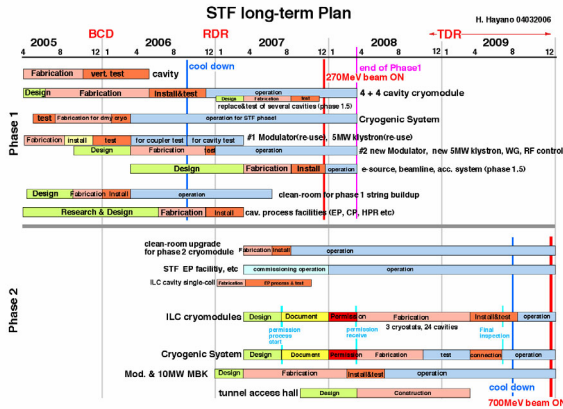


Figure 3 Schedule of STF.

Plan of Superconducting RF Test Facility (STF)

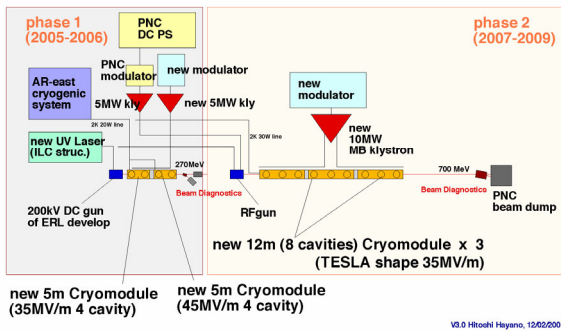


Figure 4 Two stage plan of STF construction.

STF is constructed in the building of former proton linac facility for J-PARC in KEK. The installation of He plant (cryoplant) was already done in April 2005. Towards the end of 2006, the Phase-1 of STF expects to start operation of two units of 5m-long cryostats, each containing four 9-cell cavities of LL-design and TESLA-style, which are driven by two 5MW L-band klystrons. A beam source is also installed for the purpose of cavity parameter diagnostics. Prior to this, the high-power testing and processing of fundamental mode input couplers need to be performed using the same RF power source. In preparation for such Phase-1 operation, the RF power group re-commissioned an existing 5MW L-band klystron TH2105, which had been previously built for the J-PARC project, with a modulator which have been provided by PNC laboratory and modified to have bouncer circuit. The klystron was confirmed to operate with an output pulses of 2MW, 1.5ms width, and the flatness of flattop was less than 1% in the best case. It is used for testing the input couplers for the 9-cell cavities. The cryostat design work for two units of horizontal cryostats was performed in JFY2005, and they were fabricated as shown in Figure 6.

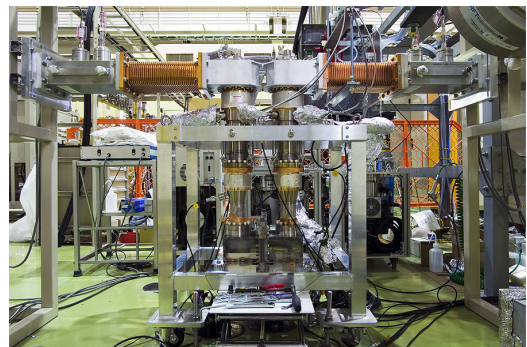


Figure 5 RF power source and input couplers for high power test.

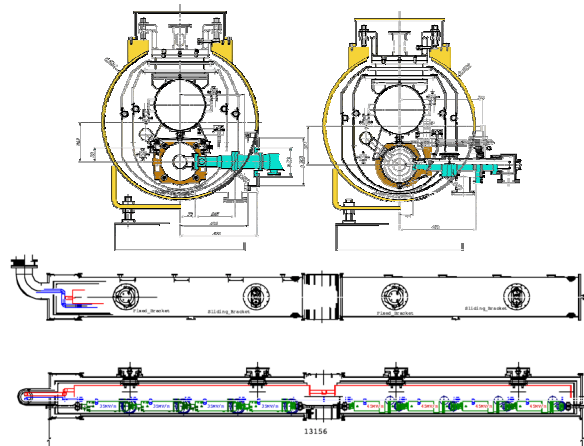


Figure 6 cross-section of STF Phase 1 cryomodule. Top-left is for TESLA-shape cavities, top-right is for LL-shape cavities. Middle is for two 5m cryostat connected. And down is the picture of cryostat.

“High-gradient” cavity development and “TESLA-style” cavity development, are performed in parallel. The “high-gradient” cavity development focused

on achieving a high accelerating gradient in excess of $\sim 45\text{MV/m}$ with a cavity shape that has been optimized (“low-loss” – LL-design) to reduce the surface current near the “equator” of cavity cell. The surface magnetic field is considered to determine the ultimate gradient performance when the other issues, including dusts and surface contaminations are resolved. As an initial step, several single-cell cavities with LL-design were fabricated and tested for the goal of demonstrating an accelerating gradient of $\sim 50\text{MV/m}$ while reconfirming the parameters to use for surface treatment procedures including electro-polishing. After resolving the issues of quality degradation of hydrofluoric acid for electro-polishing and contaminations during rinsing with ultra-high purity, high-pressure water, several of the cavities have reached well above 45MV/m . Then three cavities out of six Ichiro-type cavities recorded an accelerating gradient of higher than 45MV/m in a vertical test setup.

The production of the 9 cell cavities were done. 4 TESLA-shape cavities and 4 LL-type cavities are fabricated, and some of them are processed of their inner surface and made vertical test. Three of TESLA-shape cavities (Fig. 8) were made vertical test twice, and their gradient performance reached to about 20MV/m coincidentally. The first LL-type cavity without input/HOM couplers was treated repeatedly, and reached to 30MV/m . The second LL-type cavity (Fig. 9) was reached at 17MV/m by several surface treatments, so far.

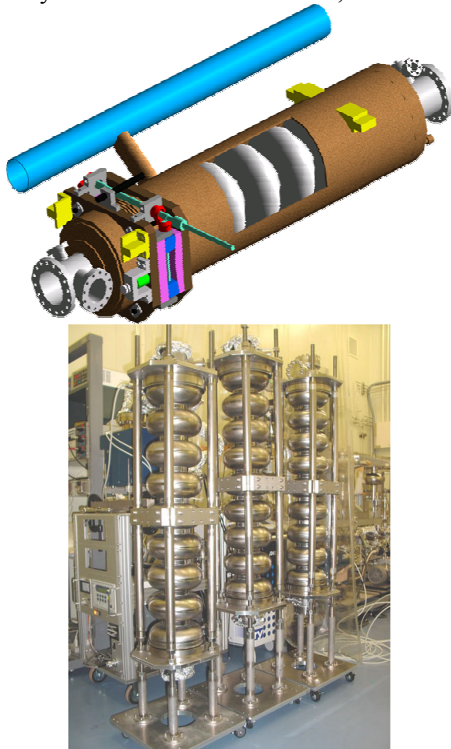


Figure 8 The cavity package configuration for TESLA-shape cavity. And the picture of the three treated cavities in stand.

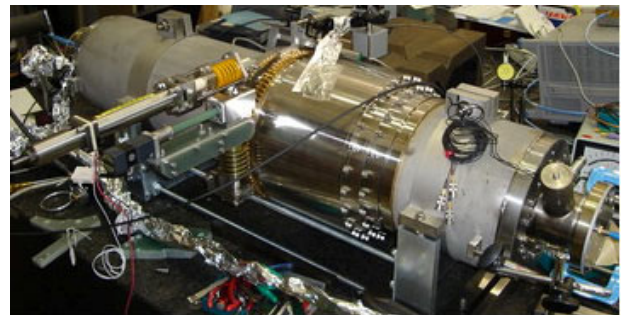


Figure 9 One of the cavity picture of high gradient LL-shape cavity. The test setup of coaxial tuner for LL-shape cavity.

Both the “high-gradient” and “TESLA-style” cavity groups will have built with required active tuners, and jackets, together with fundamental-mode power coupler and HOM absorbers. These components will be assembled into eight units of cavity packages for installation in horizontal cryostats (cryomodules). To identify the problems of gradient and to resolve them are urgent issue in ILC world-wide.

4 INFRASTRUCTURE

In addition, the half part of the STF building will incorporate an assembly area for the horizontal cryostats associated with a new electro-polishing (EP) facility and a clean room for assembling the cavity packages (Figure 10). They will be utilized for LC-related activities as well as applications of superconducting cavity technologies in other projects at KEK and in Japan. In designing of EP facility and clean room, the small committee where the member is consist from each SC cavity project in KEK discussed in detail. The clean room construction was done in March 2006. The new EP facility will be constructed until March 2007.

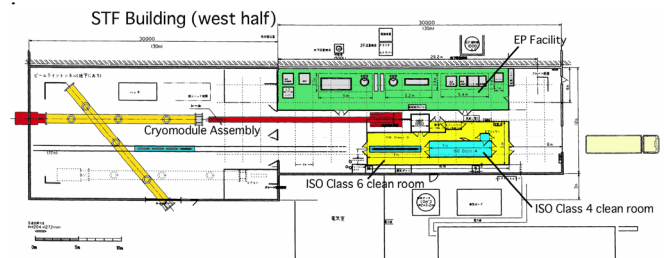


Figure 10 STF infra-structure, clean room(yellow) and EP facility(green).