

TDR Part 1:

3.5 The S1-Global experiment

(15pages)

Write-up is concise summary from S1-Global report, but plans are presented.

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Write-up contents will be;

3.5 The S1-Global experiment

introduction

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3.5 The S1-Global experiment

The GDE's R&D board launched an S-series task force in 2005 to sort out the outstanding R&D tasks for the ILC. The S1 is one of the identified tasks, where an RF operation of a cryomodule with an average accelerating gradient of 31.5MV/m is to be demonstrated. The S1-global experiment was the world's first program of building a segment of a superconducting linac system and testing a string of superconducting RF cavities by a global collaboration in the Technical Design phase of the ILC project. The proposal was to bring eight 9-cell superconducting cavities and associate hardware components from institutions in the world, install them in common cryomodules, and demonstrate their operation by a global collaboration. Two TESLA type cavities with blade tuners were provided by Fermilab, two TESLA type cavities with Saclay-tuners by DESY, and four TESLA-like cavities with slide-jack tuners by KEK. All of these cavities are industry-made: Zanon in Italy, ACCEL/RI in Germany, AES in the United States, and MHI in Japan. Prior to being brought to assembly into cryomodules of the S1-Global program, all these cavities had been individually cold-tested in each contributing laboratory. The cryomodules were provided by KEK and INFN, who closely collaborated in all aspects of design, engineering and assembly. A half of cryomodule was manufactured by Zanon, and another half by Hitachi in Japan. Input-power couplers for the cavities were contributed by SLAC, DESY and KEK. They were manufactured by CPI and Toshiba (Electron Tube). Components of the RF waveguides were provided by KEK and SLAC. The participating institutions contributed their hardware and human resources on an equal footing, and closely shared the experiences of how it would be like to assemble a complex superconducting linac whose component designs and manufacturing are remotely coordinated. While the S1-Global program lacked beam operation, it involved all the essential steps that are required prior to beam acceleration. The program successfully addressed numerous critical issues such as the plug-compatibility (i.e. compatible but not identical) of hardware components, as well as single- and multiple-cavity operation with pulsed microwave power and associated LLRF controls.

Major contributions made by the participating institutes in the S1-Global are summarized as follows:

INFN: Design and construction of the Module-C and production of the INFN blade tuners for the FNAL cavities. Assembly work of tuners, magnetic shield and test of tuners.

FNAL: Two TESLA type cavities [5], TTF-III power couplers. Integration and installation work of the power couplers, cavity connection, INFN blade tuners, and the magnetic shields.

DESY: Two TESLA type cavities, together with Saclay-type tuners, and TTF-III power couplers. Integration and installation work of the power couplers, cavity connection, and RF processing of the power couplers and cavities.

SLAC: Two sets of variable tap-offs (VTOs) to use in the RF power distribution for Module-C, and RF processing of FNAL couplers.

KEK: Four TESLA-like cavities, KEK power couplers, integrated with two types of slide-jack tuners, their assembly into the Module-A [6], the RF power distribution for Module-A, and infrastructure for the S1-Global experiment in general. Remaining part of assembly work, cooling-down and the various aspect of RF testing were coordinated or conducted by KEK.

The chronology of S1-Global experiment is summarized as follows;

Dec. 4, 2009: Arrival of two DESY cavities at KEK.

Dec. 25, 2009 and Jan. 8, 2010: Arrival of two FNAL cavities at KEK.

Jan. - March, 2010: Cavity stringing of DESY and FNAL cavities by members from DESY, FNAL and INFN for Cryomodule C.

March, 2010: Installation of Cryomodule C in the STF tunnel.

March - May, 2010: Cavity stringing of KEK cavities by members from KEK for Cryomodule A.

May, 2010: Installation of Cryomodule A in the STF tunnel. Connection of Cryomodules A and C.

June 6 - July 23, 2010: 1st cooling-down. Low power test of cavities, cold-test of tuners, and measurement of static heat load.

Sept. 6 - Dec. 24, 2010: 2nd cooling-down. High-power test of cavities. Test of compensation of Lorentz-force detuning (LFD). LLRF test of vector-sum field control. Measurement of dynamic heat load.

Jan. 17 - Feb. 25, 2011: Testing of the Distributed RF scheme (DRFS) with S1-Global cavities.

Late Apr., 2011: Began disassembly of S1-Global Cryomodules.

June, 2011: Cryomodules A and C were taken out of the STF tunnel. Disassembly of the cold mass for the Cryomodule A.

Dec., 2011: Disassembly of the cold mass for the Cryomodule C. Components were shipped back to their home institutions (DESY and FNAL).

While the cooling-down tests were all completed by the end of February, 2011, disassembly of the S1-Global cryomodules was delayed until the end of April due to the impact of the 311 earthquake. However, toward the end of the year 2011, practically all of the contributed cavity components were brought back to their home institutions for post-mortem diagnosis studies.

3.5.1 Cavities and Couplers

DESY cavities, coupler

Module S1-Global has 2 DESY cavities, C3 – Z108 and C4 – Z109. Both cavities were manufactured by Zanon on 2005 using Tokyo Denkai niobium ingot N21. Both cavities were processed with the DESY EP treatment and had been previously installed in module 8 and tested on the CMTB at DESY. Before shipment to KEK, Z108 and Z109 underwent 6 HPR cycles and were tested in the DESY vertical cryostat. Full treatments and test history of the cavities is presented below. The cavities are equipped with TTF3 type main input couplers made by CPI and Saclay type cavity tuners.

FNAL cavities, coupler

Module-C S1-Global has 2 FNAL cavities, C1 – TB9AES004 and C2 – TB9ACC011. Cavity TB9AES004 was fabricated by Advanced Energy Systems (AES) in USA and cavity TB9ACC011 was fabricated by ACCEL (now Research Instruments) in Germany. TB9AES004 was last tested in the horizontal test stand at Fermilab before shipment, while