SUPERCONDUCTING RF ACTIVITIES AT ACCEL INSTRUMENTS

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Abstract

We report on highlights of SRF activities at ACCEL Instruments during the last few years. A new hydrofluoric and sulphuoric acid free electro polishing method for niobium cavities was developed. The construction and installation of a new standard electro polishing plant for 9-cell 1.3 GHz cavities was finished but is reported elsewhere [1]. For SOLEIL we manufactured a 350 MHz twin cavity accelerator module using the technology of sputtering niobium onto copper. In addition we further developed our design for 500 MHz superconducting RF modules for Light Sources and delivered three such accelerator modules for Shanghai Light Source. In our cavity business, we are working on a design of a second prototype CH mode cavity for University Frankfurt and are producing 1.3 GHz cavities on a regular basis for DESY, FNAL and BESSY. For GANIL, we are manufacturing all 16 medium beta quarter wave resonators.

DEVELOPMENT OF A NEW ELECTRO POLISHING METHOD

A new electro polishing method for superconducting cavities using an acid mixture without hydrofluoric and sulphuric acid was developed at ACCEL based on an exclusive license from Poligrat GmbH in Munich, Germany (patent pending). Two 1.3 GHz single cell cavities were built and are used for qualification of the new electro polishing method. After electro polishing at ACCEL, the cavities were transported to DESY for RF testing. At DESY no further surface removal by any means was done, but a high pressure water rinsing was carried out. Very promising test results were achieved right away. During the first RF test of the first treated cavity, Q values above $2{\cdot}10^{10}$ and accelerating gradients above 20 MV/m were measured at a helium bath temperature of 1.8 K.

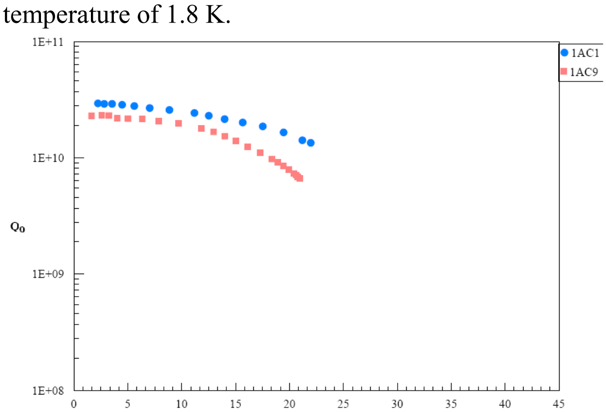

Figure 1: Test results of single cell cavities treated with new EP method.

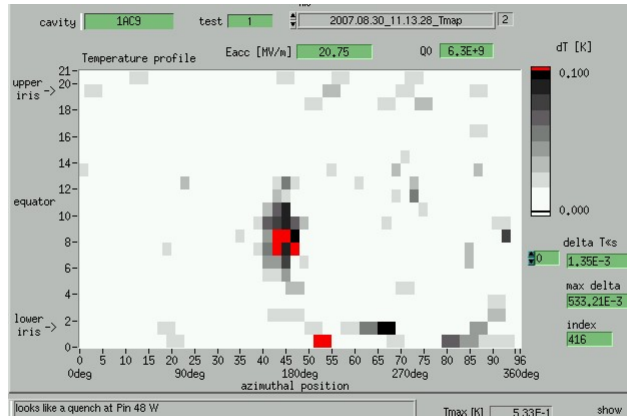

Figure 2: Temperature map of cavity 1AC1 treated with new EP and operated at about 20 MV/m accelerating gradient. It is not clear if multi pacting or quench was limiting the cavity.

We are now looking for a scientific partner, who helps us in further developing the new electro polishing method into a standard procedure for SRF cavities. To achieve this, some investment to produce better tooling and improve the currently used apparatus is necessary. We are open to share our knowledge with this partner, but can not disclose the mixture of the acid developed by Poligrat.

350 MHZ SRF MODULE FOR SOLEIL

SOLEIL contracted ACCEL for the manufacturing of the second accelerator module to be installed into the storage ring to achieve the design current. The module design was developed in a collaboration of CEA and CERN. The first module built by CERN and CEA is in operation at SOLEIL with very good success.

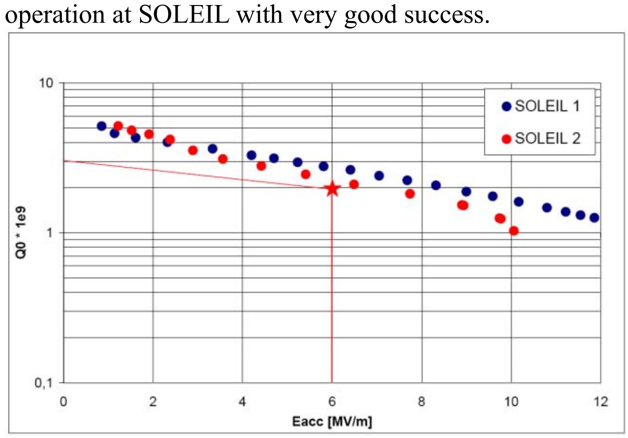

Figure 3: Vertical test result of the two SOLEIL cavities prior integration into the SRF module.

The cavities are operated at 350 MHz and manufactured by sputtering a thin niobium film inside copper cavities. This technology developed at CERN and transferred to ACCEL within the project of producing the superconducting LEP modules is still available at ACCEL.

After assembly the module was cooled down to 4 K at our premises to demonstrate the leak tightness at cryogenic temperatures and to show the correct cavity frequency and right damping of the HOM couplers. In addition the function of the temperature sensors, the level sensor and other instrumentation was tested. After warm-up, the SOLEIL module was packed and shipped to SOLEIL. The module is currently installed into the storage ring and under commissioning.

Figure 4: SOLEIL module at the final test at ACCEL. The module is cooled down to 4 K and the cavity frequency is checked and the right damping of the HOM couplers is measured.

500 MHZ SRF MODULES FOR SSRF

In the year 2000, ACCEL and Cornell agreed on a technology transfer of 500 MHz modules developed for CESR. The aim was to offer such SRF modules for other customers worldwide. Those 500 MHz modules are attractive for high current storage rings world wide. After manufacturing and installation of each two those 500 MHz modules for NSRRC, CLS and Cornell and three modules for DLS, three more modules were produced for the new Lightsource SSRF in Shanghai.

Prior integration to the module, the cavities are tested in a separate low power test at Cornell University. The test results are shown in Figure 4 and compared to the previously produced cavities.

Also the high power RF windows are tested separately on a test stand to show that they can withstand the specified RF power of typically 300 kW in cw mode. The first RF windows were tested at Cornell University. Now also RF testing at DLS is possible.

All three modules have been delivered to SSRF together with the associated valve boxes for cryogenic supply and control of liquid helium level and pressure. In addition the interlock and analogue readout electronics of the module was within our scope. The first SRF module reached already the specification; two more modules are currently under testing.

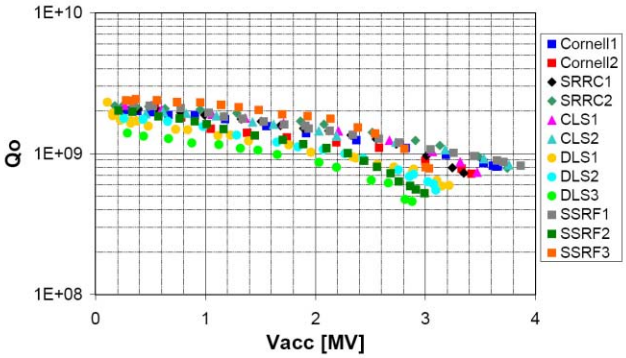

Figure 5: Vertical test results of all so far produced 500 MHz cavities prior integration into the SRF modules. Accelerating voltages of 3 MV are reached. The guaranteed values for accelerating voltage after module integration are typically 2 MV.

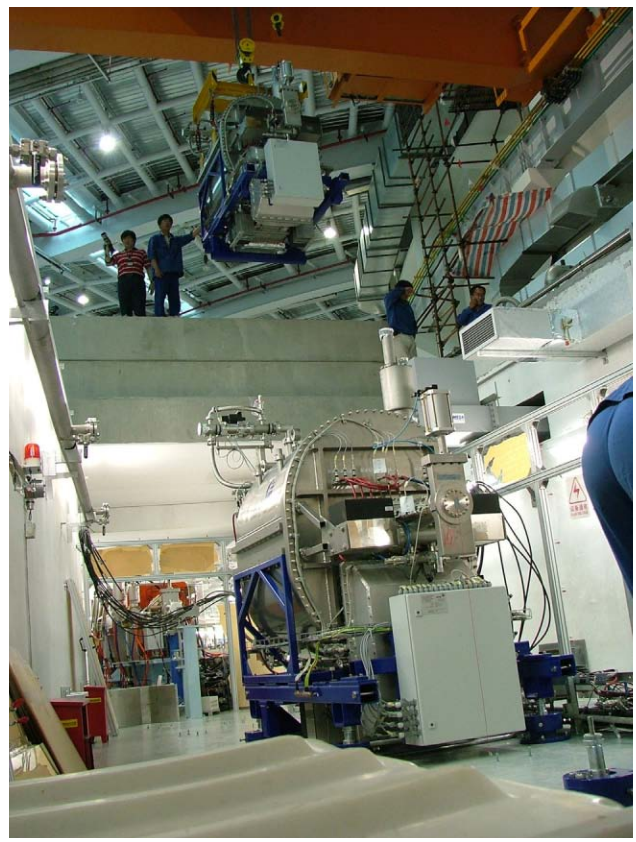

Figure 6: Installation of 500 MHz SRF modules into the storage ring at Shanghai Light Source.

SRF CAVITY DESIGN AND PRODUCTION

After successful testing of the first 350 MHz prototype CH-Mode cavity with 20 drift tubes (see Figure 6), University Frankfurt is now working on a second CH mode cavity prototype design. After the RF design, ACCEL was contracted with a study for a mechanical design of a 175 MHz CH mode cavity with 6 drift tubes. The study will be finished soon and contains the design of a titanium helium tank. It is planned to test the second prototype cavity first on a test stand and then later with beam.

Figure 7: First 350 MHz CH mode cavity with 20 drift tubes produced for University Frankfurt

After having produced 2 prototype medium beta 88 MHz quarter wave resonators for GANIL in 2007 we are now producing the 16 series medium beta cavities. The first series cavity is finished and two more are at the last welding steps. The remaining 12 cavities will be produced after GANIL has tested the first three or four series cavities.

Figure 8: Look into inside of medium beta 88 MHz quarter wave resonator for GANIL. The cavity is in the dimensional control workshop and already completed with helium vessel at this stage. Only one more weld to close the cavity at the bottom is missing.

XFEL or ILC type cavities are now standard products at ACCEL. Currently we are producing 8 XFEL cavities from large grain material for DESY and 12 ILC cavities from standard material for FNAL. Both projects will be finished this year. Typical delivery time for the first cavity lot is 6 months after complete material supply.

Besides the manufacturing of those cavities, we can also order the niobium, manufacture the helium vessel and perform the welding of the helium vessel to the cavity. The cavity surface preparation (buffered chemical polishing from outside and buffered or electro polishing from the inside) and the high pressure water rinsing and clean room assembly is also standard practice at ACCEL. For BESSY we have produced XFEL cavities furnished with helium vessel and prepared the cavities with buffered chemical polishing and high pressure water rinsing for a test in the horizontal test cryostat HOBICAT. Gradients of 20 MV/m were reached at BESSY. The test results are shown in [1].

REFERENCES

[1] M. Pekeler et al. "SRF capabilities at ACCEL in view of ILC/XFEL", this conference