SUPERCONDUCTING ACCELERATOR MODULES FOR STORAGE RINGS AND SYNCHROTRONS

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Abstract

We report on the production status of 6 superconducting 500 MHz accelerating modules (2 for Cornell University for upgrading CESR, 2 for the Taiwan Light Source and two for the Canadian Light Source). We focus on the test results on cavities and RF windows. The superconducting 500 MHz cavities fully prepared and assembled at ACCEL reached 12 MV/m accelerating gradient during cold vertical RF test on a regular basis. The assembly of the first module is almost completed. The cold RF test of this first module at Cornell is scheduled for June this year.[1]

1 INTRODUCTION

In the year 2000 ACCEL was contracted by Cornell University, the Taiwan Light Source and the Canadian Light Source on the production of in total 6 superconducting accelerator modules. The modules were developed at Cornell University for upgrading their storage ring CESR. The possibility to accelerate high current at high gradients together with a very effective damping scheme of the higher order modes makes such a module attractive for all kind of high current storage ring applications like for example Light Sources.

A schematic view of the superconducting module is shown in Fig. 1. More details of the superconducting module are published in [1],[2] or [3]. The modules will be delivered turn key. The major subcomponents are tested individually before module assembly:

- The cavities are tested in a vertical bath cryostat in order to demonstrate the capability to operate at fields of about 10 MV/m.
- The RF windows are processed on a separate test stand in order to demonstrate operation under at least 250 kW cw RF power in travelling wave and about 100 kW in standing wave operation with the voltage maximum at the location of the ceramic.
- Each higher order mode load of the module consist of 18 HOM panels (See Fig. 2). All HOM panels are tested individually on a separate test stand to absorb at least 600 W of RF power. This guarantees 10.8 kW absorption of HOM power for one HOM Load.
- Each cryostat is cooled to liquid helium temperature after assembly and prior delivery. During this test the leak tightness of the module at operation temperature is proven and the correct frequency of the cavity after assembly is verified.

In addition ACCEL supplies the SRF Electronics and the cryogenic distribution boxes for liquid helium and nitrogen supply to the Taiwan Light Source and to the Canadian Light Source.

2 STATUS OF PRODUCTION

The present status of production can be summarized as follows:

- All major components for the 6 modules have been produced.
- All six cavities have been tested successfully in the vertical test stand.
- All RF windows have been successfully tested.
- About 70 % of the HOM panels have been tested successfully
- One cryostat is assembled completely and the cold test at liquid helium temperature has been performed successfully. The cold RF test of the first module is scheduled for June 2002.
- Two more cryostats are pre-assembled and ready for insertion of the niobium cavity

We expect to finish the assembly of the remaining 5 modules within this year. At ACCEL we have two module assembly stands available, so that two modules can be assembled in parallel.

The valve boxes are under production and shall be completed in July.

The Electronics for the modules are under production. The first module is equipped with all necessary electronics already.

3 CAVITY TESTS

Shown in Fig. 3 are three of the six produced 500 MHz niobium cavities. The cavities are produced mainly out of RRR > 250 niobium. Only the flanges are produced out of reactor grade niobium. After production the warm frequency and the external Q of the coupler is measured. The current design of the cavity leads to an external Q of 2.5 E5.

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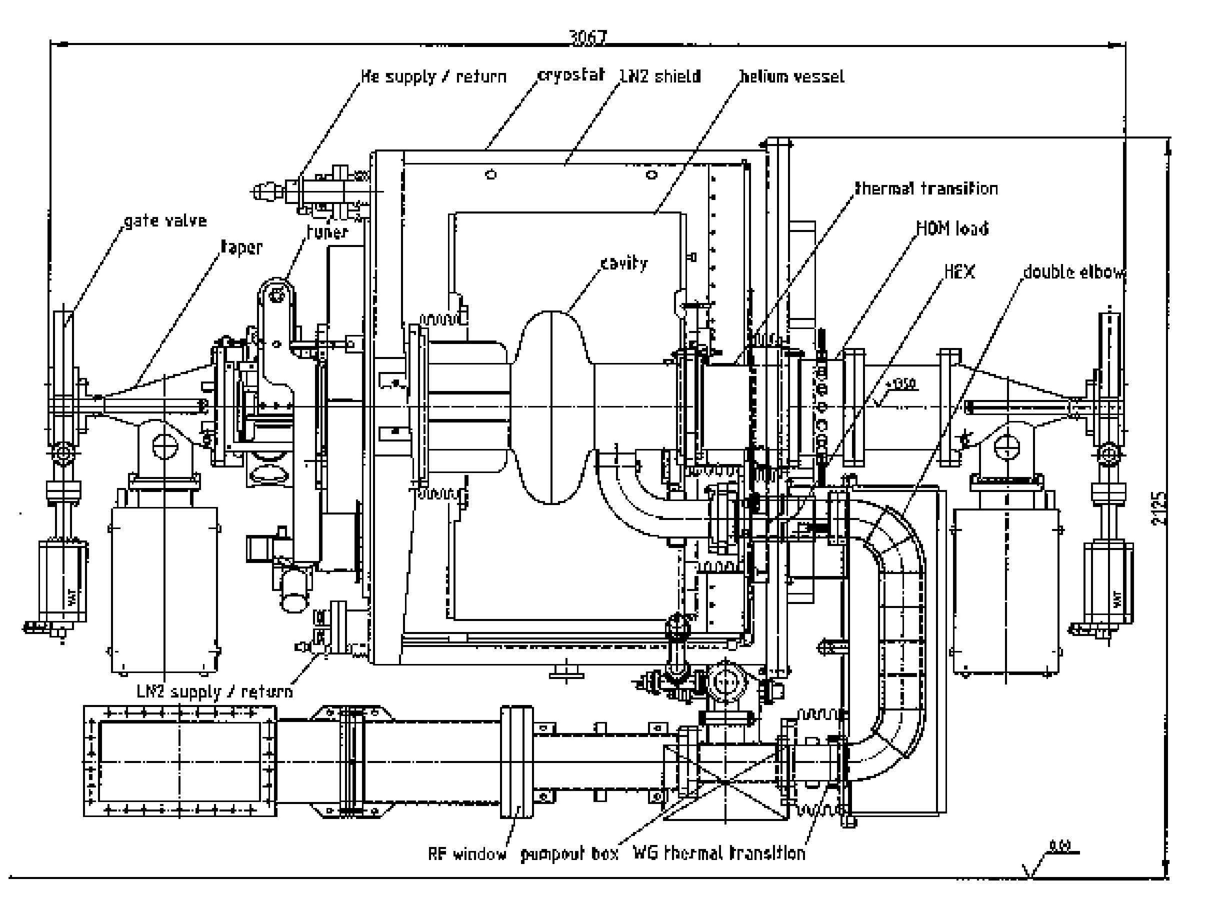

Figure 1: Schematic view of the SRF module

Figure 2: Three 500 MHz single cell niobium cavities ready for preparation for vertical test.

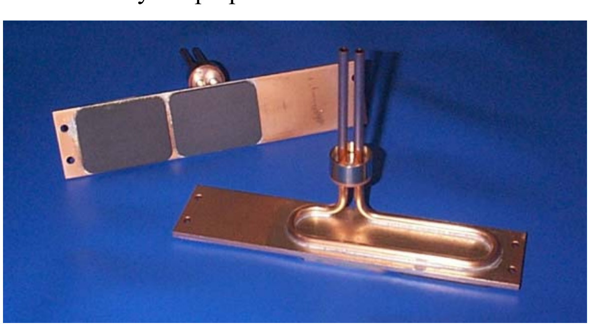

Figure 3: Two HOM panels. Each HOM Load consist of 18 such HOM panels

Figure 4: Preparation at ACCEL of a 500 MHz cavity for a vertical test. Up left: closed loop BCP, up right: high pressure rinsing, below: clean room assembly

The cavities are then prepared for the vertical RF test. For this purpose the infrastructure at ACCEL was upgraded in order to perform state of the art cavity preparation. A closed loop chemistry (BCP 1:1:2) plant and a high pressure water rinsing system is now available and shown in Fig. 4. In detail the preparation is as follows:

- 120 micron removal from the inner surface by means of closed loop chemistry. The acid is controlled to stay below 15 °C during the whole etching time.
- Rinsing with deionised water until the resistance of the water is above 18 MΩ
- Two hours high pressure water rinsing at 80 bar water pressure.
- Drying by pumping
- Assembly of vertical test equipment (antennas, pick-ups) in class 100 clean room and leak-check.
- Shipping to Cornell University for cold RF test. The test of the cavities is done by ACCEL personnel using the infrastructure at Cornell.

All test results of the cavities are summarized in Fig. 5. It is remarkable, that the cavity tests shown in Fig. 5 were reached consecutive without a unsatisfactory result in between. This means, that the cavity preparation is very reliable.

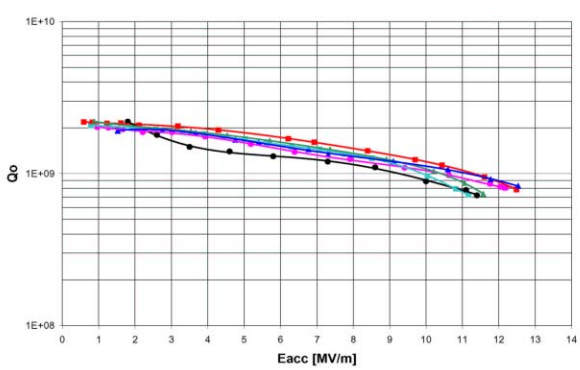

Figure 5: Q_0 versus E_{acc} measured at 4.2 K. Test results of the six cavities produced for Cornell, Taiwan Light Source and the Canadian Light Source. All Cavities reached more than 11 MV/m. The highest field observed was 12.6 MV/m. All cavities were limited by available RF power (200 W). No quenches were observed.

4 WINDOW TESTS

After arrival from THALES (window manufacturer), the windows are carefully inspected, cleaned and assembled together with an intermediate waveguide piece in a clean room (see Fig. 6). Ion pumps are connected to the intermediate waveguide to allow pumping of the desorbed gases caused from the RF processing.

After assembly, the whole assembly is baked to 200 °C in order to clean the surfaces. The assembly is shipped to Cornell University for RF processing. The processing is done by ACCEL personnel using the infrastructure of Cornell University.

All windows met the specification of transferring more than 220 kW cw in travelling wave mode and more than 100 kW in standing wave mode. The RF heating of the window ceramic was observed with a infrared camera. The maximum temperature rise observed at 220 kW cw travelling wave mode at one window was 35 °C, the temperature rise at this power level on the another window was only 5 °C, indicating, that the windows might be operated at much higher power levels.

The RF processing of the windows can be done within one week.

Figure 6: Two 500 MHz RF windows assembled and baked at ACCEL after final leak-check, ready for RF processing at Cornell

5 ACKNOWLEDGEMENTS

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