

# SUPERCONDUCTING ACCELERATOR MODULES FOR THE TAIWAN LIGHT SOURCE

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## Abstract

A machine-upgrade program is being undertaken to increase the performance capabilities of the Taiwan Light Source [1]. This program has two major goals: Provide photon beams with significant better stability and store up to 500 mA of electron beam, while maintaining the beam lifetime. In order to achieve these goals, the current DORIS cavities will be replaced by superconducting cavities of the CESR III design [2]. This cavities were chosen because of their effective damping scheme of the higher order modes, the negligible power dissipation in the cavity walls and the possibility to operate at high gradients and to transfer high power to the beam. Two turn key SRF modules each one containing one CESR III type cavity are under construction at ACCEL. One SRF module will be installed to deliver up to 100 kW of RF power to the 500 mA beam and providing a gap voltage of at least 1.6 MV. The second SRF module will be kept on readiness on a test stand. The ability to install a functional cavity on a short notice will provide maximum machine reliability.

## 1 INTRODUCTION

In February 2000 the Synchrotron Radiation Research Centre in Taiwan has contracted with ACCEL two turn key accelerator modules for the Taiwan Light Source. The modules are the main part of the above mentioned machine-upgrade program. The modules are almost identical to the CESR III accelerator modules with only small design changes. The heart of these modules is a single cell superconducting Niobium 500 MHz cavity with waveguide input coupler (see figure 1). For the delivered modules ACCEL has guaranteed the following values:

- accelerating gradient  $E_{acc}$  > 5.33 MV/m
- quality factor  $Q_0$  (at 5.33 MV/m) >  $7 \times 10^8$
- Input Coupler Power > 100 kW

Under cw operation of the cavities above values would lead to a power dissipation of 36 W in the cavity walls. The additional static heat load of the cryostat is dominated by the three big openings of the cavity (round beam pipe, fluted beam pipe and waveguide) and comparably high, but



Figure 1: Superconducting 500 MHz cavity

specified below 35 W. The total cryogenic heat load at 4.5 K is specified to be below 71 W.

## 2 MAIN FEATURES OF THE ACCELERATOR MODULE

An artist view of the CESR accelerator module can be seen in figure 2. The modules contain following sub assemblies:

- Superconducting single cell Niobium 500 MHz cavity with waveguide coupler
- Helium vessel out of 316L stainless steel
- $LN_2$  shield
- Double magnetic shielding
- Vacuum vessel
- Round beam tube and fluted beam tube thermal transitions
- Higher order mode loads with ferrite type absorbers
- Tuner
- Tapers with synchrotron radiation mask
- Sliding joint
- Gate valves
- Waveguide input coupler
- 500 MHz RF window

Detailed descriptions of these components can be found in a recent paper [2] from Cornell.

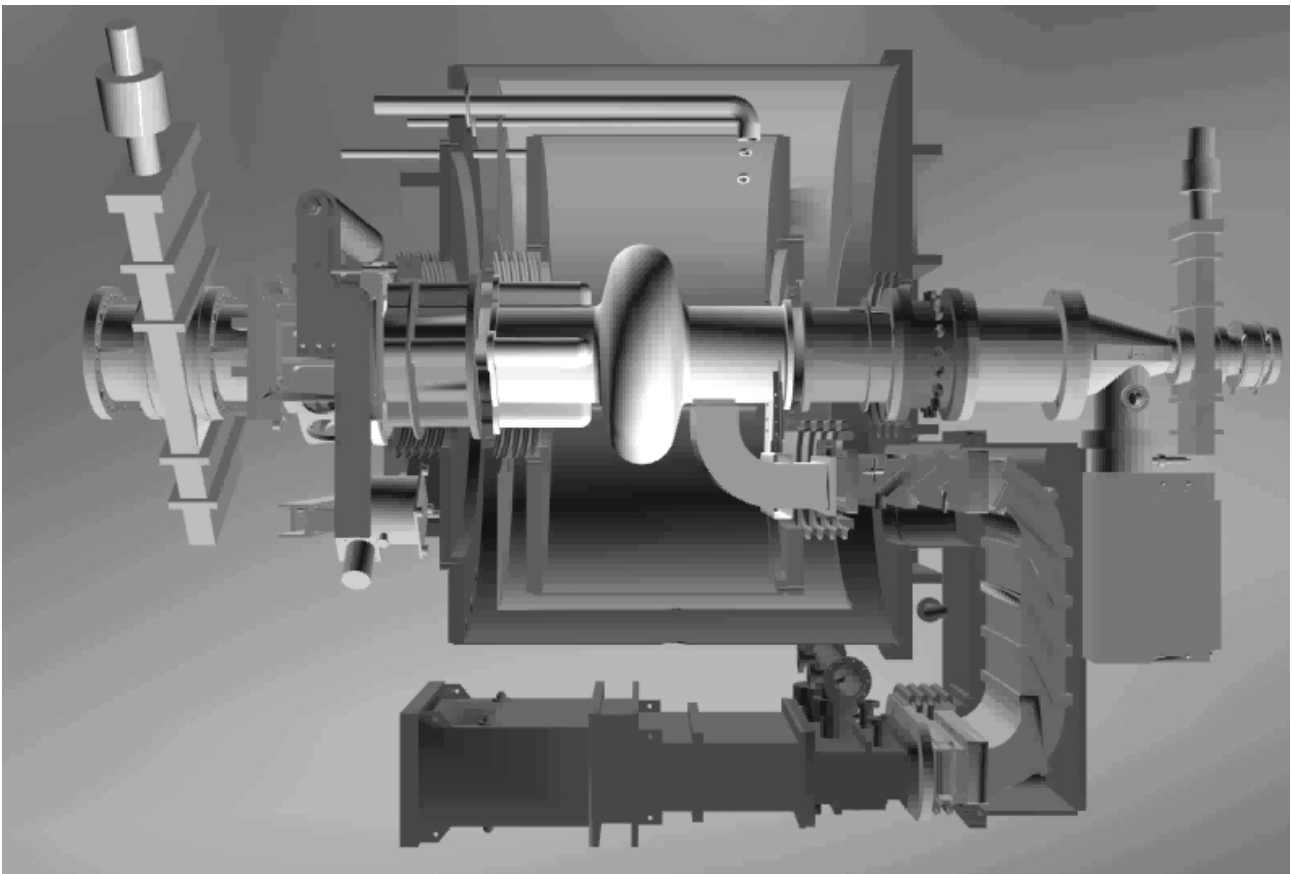


Figure 2: Artist view of the CESC III Accelerator Module (courtesy Cornell University)

In addition ACCEL will also supply:

- Complete cryostat instrumentation and Control Electronics
- Distribution valve box for LHe and LN<sub>2</sub> supply
- Cryogenic transferlines between distribution valve box and modules

### 3 TEST OF SUBCOMPONENTS AND MODULES

Major subcomponents need to be tested before they can be integrated into the module.

The cavities will be tested first in a vertical test stand at Cornell. The chemical preparation of the cavities will be done at ACCEL's premises. The chemical plant is currently being upgraded to allow closed loop buffered chemical polishing (BCP 1:1:2). The temperature is controlled in order to keep the acid below 15° C. In addition a high pressure water rinsing system (100 bar) is under construction.

The windows will be tested at Cornell at least up to 200 kW cw travelling wave RF power and up to 125 kW cw standing wave RF power. The HOM loads will also be checked on a separate test stand. The assembly of the modules will be done in a class 100 cleanroom.

The completed modules will be tested at Cornell's available module test stand. After the modules have passed the acceptance tests they will be shipped to SRRC.

One module will be installed in the storage ring, the second module will be kept on readiness on a special test stand. All tests will be performed by ACCEL personnel. The installation of the modules will be done in a common effort of ACCEL and SRRC personnel.

### 4 STATUS OF THE PROJECT / TIME SCHEDULE

Currently the cavity production is under way. Major parts of the cavities like the half cells and the waveguide coupler are already fabricated. The other components of the module design are being reviewed. The production of the RF windows is started and the cryostat production will start soon.

The time schedule foresees the vertical tests of the cavities in Spring 2001. The assembly of the modules will start in Summer 2001. The test of the assembled modules are foreseen to start in Winter 2001. It is expected, that the cryogenic plant at SRRC will be ready in Summer 2002. After that the installation of the modules at SRRC can start.

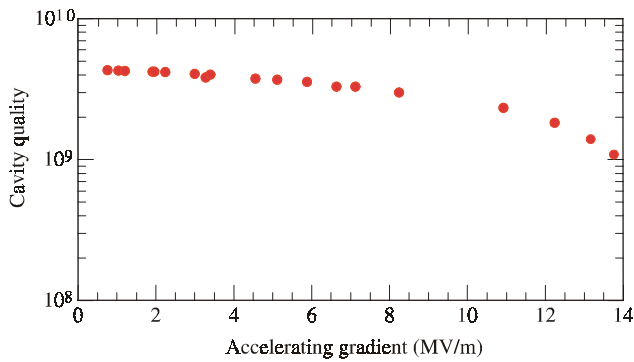


Figure 3:  $Q_0$  versus  $E_{acc}$  measurement

## 5 PERFORMANCE OF PREVIOUSLY PRODUCED CAVITIES

During the years 1994 to 1995 ACCEL already fabricated four cavities of the CESR III type for Cornell. Three modules equipped with these cavities are under

## REFERENCES

- [1] R.C. Sah, et al., "Status of the Taiwan Light Source", PAC 99, New York, April 1999.
- [2] S. Belomestnykh, et al., "Operating Experience with Superconducting RF at CESR...", 9<sup>th</sup> Workshop on RF Superconductivity, Santa Fe, Nov. 1999
- [3] H. Padamsee, "The Future of SRF in High Current Rings", 9<sup>th</sup> Workshop on RF Superconductivity, Santa Fe, Nov. 1999

operation in the CESR storage ring. One more module will be installed within the next shutdown. The cavities reached a maximum gradient of 14 MV/m in the vertical tests (see figure 3). In the ring the modules are routinely operated with a gradient of 6 MV/m and a  $Q_0 > 1 \times 10^9$ . Under operation conditions the maximum transferred power to the beam is 260 kW.

## 6 FUTURE OF SC CAVITIES FOR SYNCHROTRONS

The operating experience gained with superconducting accelerating modules for high current storage rings shows, that this technology has reached a mature status and a high reliability [2]. Several synchrotron projects are under way [3], where superconducting cavities are the first choice for the main ring accelerating sections. In the future the concept of strongly HOM damped superconducting cavities will also be applied for Landau cavities at higher frequencies.