Development and Tests of a Superconducting Cavity for High Current Electron Storage Rings[1]

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Abstract

To increase the luminosity of CESR with currents of the order of 1 amp, a superconducting cavity would be the ideal way to lower cavity impedances that cause multibunch instabilities[1]. The impedance is reduced by using a small number of high gradient superconducting cavities which have a low impedance cell shape. We have in hand components to test a SC cavity system with the CESR beam (up to 100 mA in a single beam). The niobium cavity is tested to 3 MV (gradient = 10 MV/m), the window is tested to 250 kwatt travelling wave and 125 kwatt standing wave, ferrite lined beam pipe sections damp higher order modes to Q_0 values below 100. A beam line cryostat, tuner and other components are now complete and tested with low power

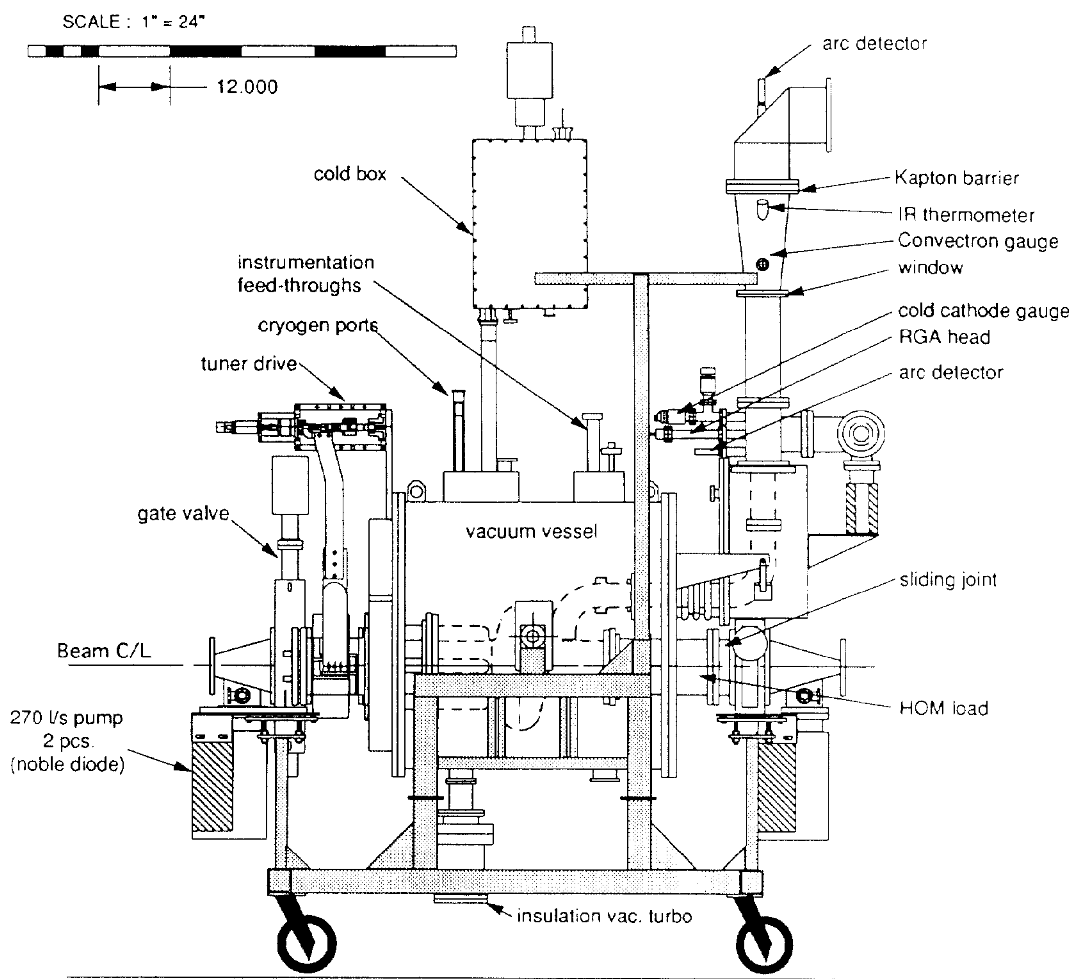

Figure 1: Layout of all components for a superconducting cavity for CESR upgrade

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Figure 1 shows the layout of the components fabricated for the planned beam test of the cavity in CESR. All the components are now complete and individually tested. These include the niobium cavity (Figure 2), the beam line cryostat (cross section Figure 3), the refrigerator interface box (cold box), thermal transitions between the cavity and the cavity and the warm ends (Figure 4), the planar waveguide window, the higher order mode loads (Figure 5), the tuner (Figure 6), the sliding joints of 24 cm diameter bore (Figure 7) and the gate valves of 24 cm bore (Figure 8)

Separate tests (previously reported) show that the niobium cavity reaches a gradient of 10 MV/m[2]. The waveguide window has been processed to 250 kwatt travelling wave power and 125 kwatt reflected power and several phases[3].

For the HOM, individual ferrite sections bonded to a water cooled copper panel have been tested to withstand power density of 15 watt/cm^2, needed for 1 amp beam current for CESR upgrade phase III.

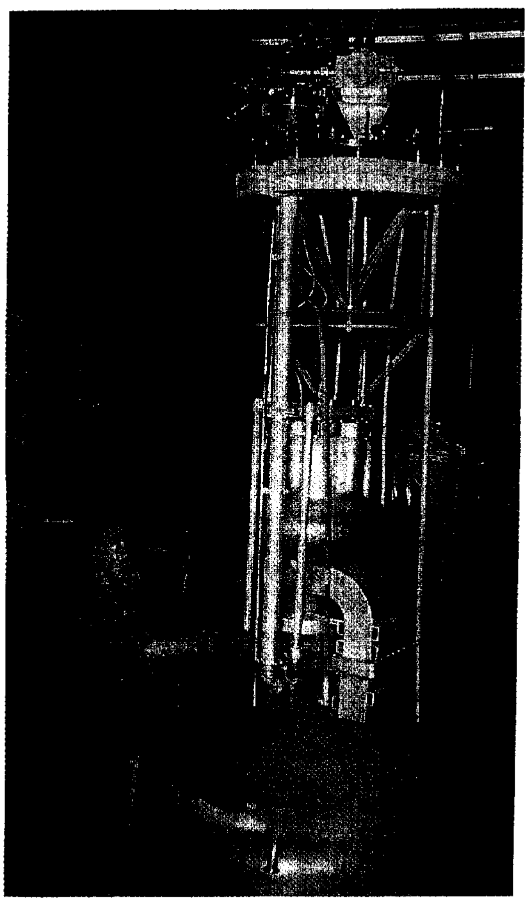

Figure 2: Niobium cavity removed from vertical test cryostat.

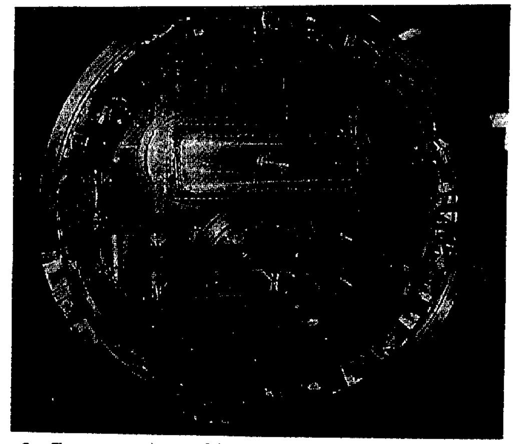

Figure 3: Cross section of horizontal cryostat

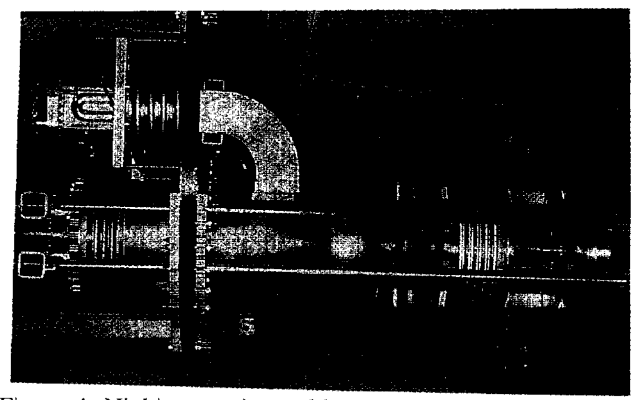

Figure 4: Niobium cavity, cold to warm transitions and He vessel bellows.

Figure 5: Higher order mode load. Ferrite tiles soldered on to water cooled panels inside a stainless steel vacuum housing.

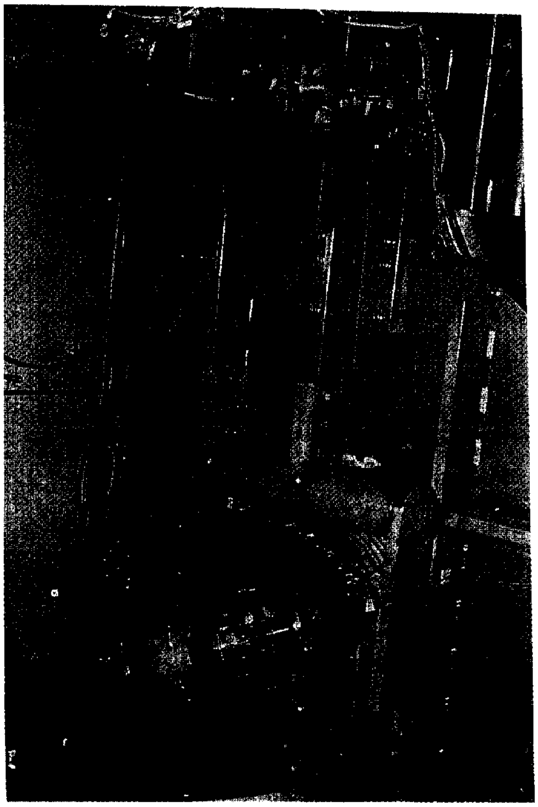

Figure 6: Mechanical tuner attached to end of vacuum vessel.

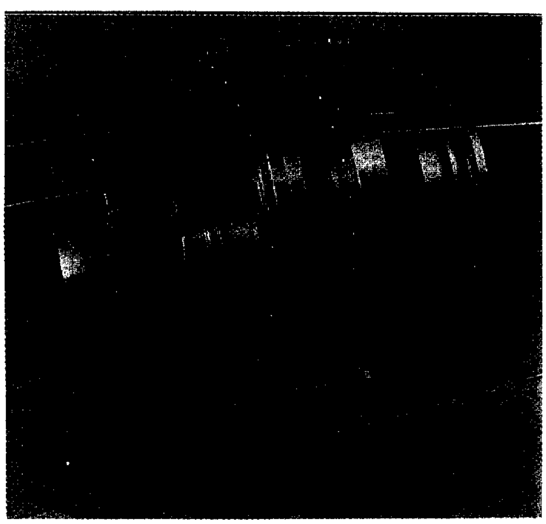

Figure 7:Twenty-four cm bore sliding joint

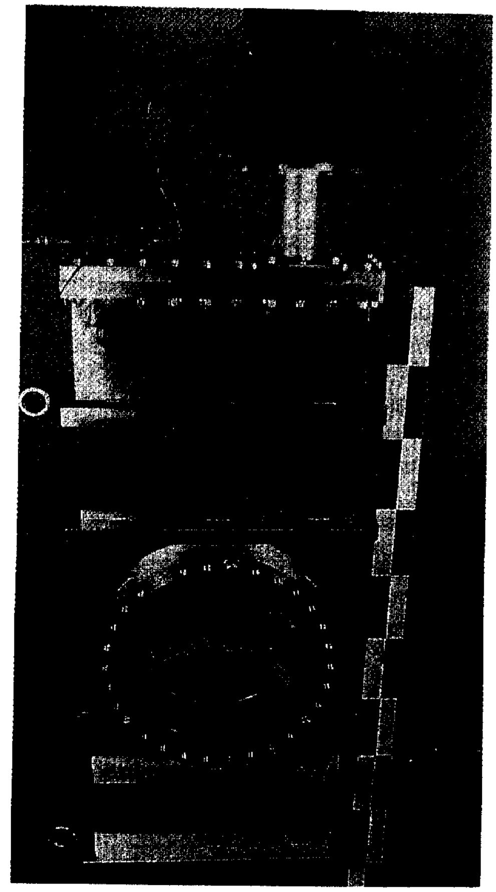

Figure 8: Twenty-four cm bore gate valve.

After assembling the components as shown in Figure 1, the niobium cavity was recently cooled down to 4.2 K and tested with low RF power (150 watt) by resonating the input waveguide to deliver the equivalent of 3.5 kwatt. The cavity reached 1.7 MV/m accelerating. The static heat leak of the beam line cryostat was 25-30 watts (in agreement with design[4]). The system is now under transport to the accelerator building which houses the high power klystron. It will first be tested with 125 kwatt of power to reach the maximum possible field level. After the high power test off-line, the cavity will be installed in CESR for high current (100 - 150 mA) operation.

REFERENCES

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