

The ALS Storage Ring RF System*

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Abstract

The ALS Storage Ring RF System is characterized by the use of the following features:

1. High power loading of two single cell cavities.
2. The use of a tubular ceramic input window employing aperture coupling.
3. The use of waveguide filters and matchers designed for HOM absorption.
4. A comprehensive HOM monitoring system.
5. The use of waveguide water-wedge loads for the magic tee and circulator loads.

The results of cavity measurements and high power tests are reported together with the performance of the system during the commissioning and operation phases of the ALS project. Plans for future window development are discussed.

I. INTRODUCTION

The ALS Storage Ring RF system employs two single cell cavities fed via a magic "T" from a circulator protected high power 500 MHz klystron. The system is capable of delivering 150 kW cw at each cavity input window. Some unusual features of the system are the use of tubular ceramic cavity coupling windows and the use of water wedge waveguide loads for the circulator and magic tee[1].

II. RF CAVITIES DESIGN AND CONSTRUCTION

The RF cavities are a further adaptation, progression and development of the aperture coupled toroidal cavities used at the "SRS" Daresbury Laboratory machine. Firstly, the cooling system of the cavity was redesigned by the manufacturer to dissipate 70 kW employing a turbulent flow of ~130 gpm (US) and a Δt of 2°C. Extra cooling was also added to the waveguide connecting flange and the tuner neck area. Secondly, the disc ceramic input window of the SRS design was replaced by a ceramic cylinder which extends the full 18" of the WR1800 waveguide greater dimension. The cavity will, however, still accommodate disc windows. Thirdly, a hybrid SRS/LEP tuner was designed using a LEP drive system but retaining the SRS-style non-contacting tuner and tuner well arrangement. Fourthly, the manufacturer[2], who also made the SRS cavities, chose an inside out arrangement as compared to the SRS construction method. The inner shell of the ALS cavity is machined and welded whereas the complex outer shell and water passages are electroformed. The general arrangement of the bare cavity is shown in Figure 1. The higher order mode damping port is at the right of the picture.

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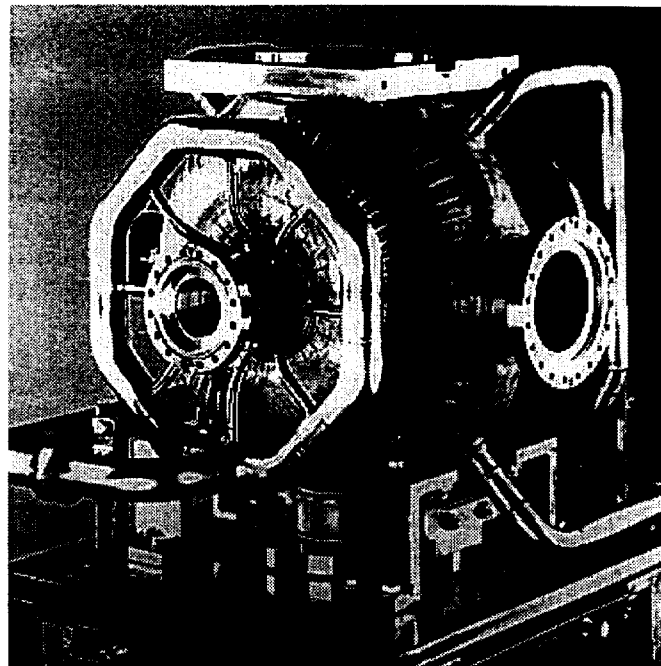


Figure 1. Single Cell Cavity [2]

III. CAVITIES MEASUREMENT AND PERFORMANCE

Table 1
Shows the Measured Performance of Each Cavity

Unloaded Q	= 40,000
Shunt Impedance	= 10 MΩ ($2ZT^2L$)
Design Peak Effective Volts V _{PT}	= 750 kV
Mechanical Tuner Range	= -0.6 MHz to +3 MHz
Coupling Factor β	= 1 to 3 with tubular window
Max Power Dissipation Test	= 70 kW cw Δt 2°C inlet to outlet
Normal Controlled Water Temperature	= 40°C ± 0.5°C
Highest Outer Envelope Spot Temperature	= 50°C (70 kW input water at 40°C)
Ceramic Window Temperature Rise	= ~0.2°C/kW (at mid point of tube)

Cavities were tested under vacuum to 70 kW cw in the LBL cavity test facility. Some instances of sparking due to dc charging of the ceramic were encountered at ~50 kW. This effect was either traced to inadequate window antimultipactor coating, or the problem conditioned out with prolonged

running. This exercise proved the excellence of the window are detectors designed by C.C. Lo. A conditioning period of about 20-30 hrs was normally adequate for the cavities.

At the time of writing, two cavities have operated in the ALS storage ring with a total input of ~110 kW producing a 400mA (250 Bunch) stored beam at 1.5 GeV, lifetime being vacuum limited at this stage.

IV. WAVEGUIDE SYSTEM AND HOM ABSORBERS

The basic waveguide HOM filters and HOM monitoring devices follow the proposals made in the authors' original ALS RF paper[1] of 1989. The actual layout of the waveguide system is shown in Figure 3.

The magic tee dual H plane and E plane HOM filters and tee wedge water load are accommodated on the shield tunnel roof, feeding downwards to the cavities.

The waveguide 300 kW circulator and load are also on the tunnel roof. This layout has proved very compact and has released valuable real estate at ground level for experimenters' use. The waveguide wedge loads although large have worked well providing an excellent match and acting as power absorbers over a wide range of frequencies. Quiet in operation the loads share one 3/4 HP pump for water circulation

Numeric data on the power absorbed by the HOM filters and "transparent" matchers, when the cavities are beam excited, has not yet been collected. The fact, however, that a 400mA 250 bunch beam of 1.5 GeV can be rapidly and smoothly accumulated is significant. Plentiful evidence of

HOM excitation is visible on all of the 30 pick up antennae available in the HOM damping systems. When running a 40mA mean, 4 bunch beam, HOM power interference was experienced by ion gages and IR temperature monitors mounted on the cavity. No gross beam effects however, were noticed. An examination of the ALS cavity HOM characteristics is presented in a companion paper[3].

V. FUTURE DEVELOPMENTS

The presence of a ceramic disc window in the coupling port of a cavity lowers the cut off frequency of that port. As a result, for the same size coupling port, a higher coupling factor β may be obtained with a disc window than with a tubular window. The relative figures for an ALS cavity are, $\beta_{\text{max disc}} \sim 5.0$, $\beta_{\text{max tubular}} \sim 3.0$. Experiments have been conducted showing that the coupling factor of a tubular window may be increased by providing ridges on the coupling aperture in the manner of a ridged waveguide. Such a shaped aperture may also be effective in increasing the coupling out of lower frequency HOM components, both from the input coupling port and other ports.

A problem sometimes encountered with ceramic windows of all kinds is the phenomenon of dc charging of the ceramic, the attendant dc sparking leading to RF arcing. The ALS tubular window has been designed with a central access/inspection port in the top cap. The effect of a biased collector electrode coaxial with the window ceramic will be explored in order to diagnose or possibly suppress the charging action.

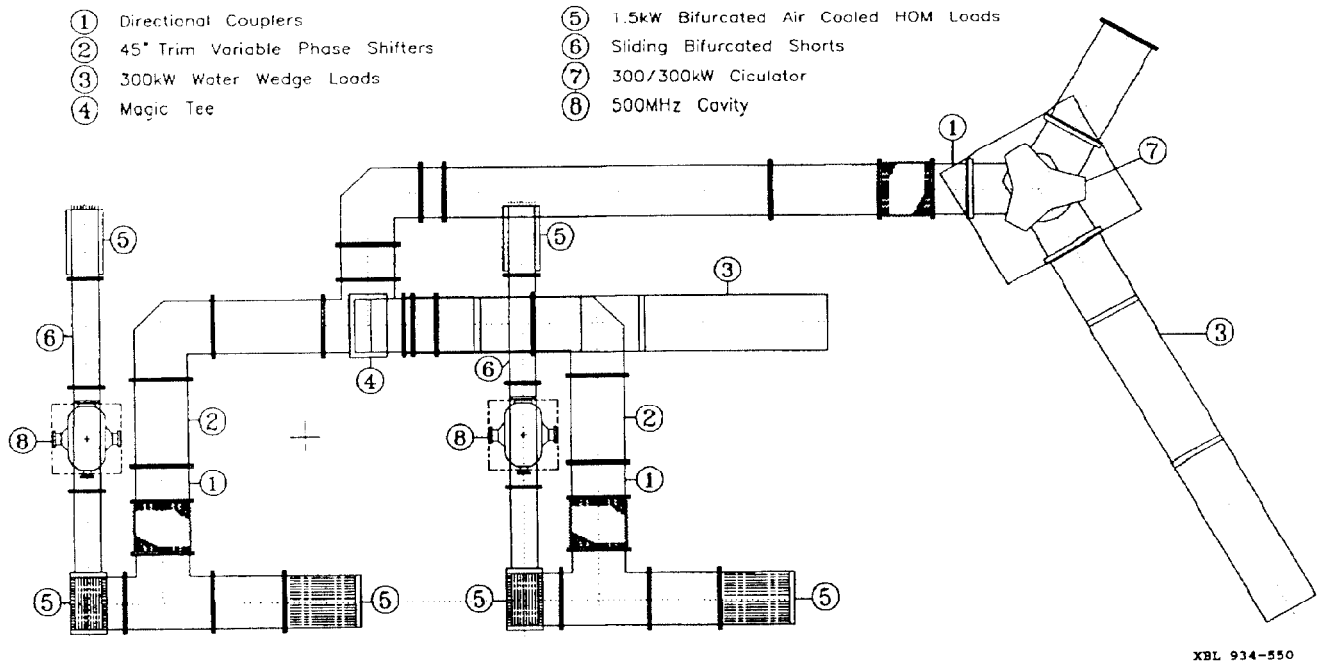


Figure 2. Storage Ring Roof Waveguide Layout

VI. ACKNOWLEDGMENTS

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VII. REFERENCES

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