RADIATION MEASUREMENTS DURING CAVITIES CONDITIONING ON APS RF TEST STAND*

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Abstract

In order to determine the shielding structure around the Advanced Photon Source (APS) synchrotron and storage ring RF stations, the X-ray radiation has been measured in the near field and far field regions of the RF cavities during the normal conditioning process. Two cavity types, a prototype 352-MHz single-cell cavity and a 352-MHz five-cell cavity, are used on the APS and are conditioned in the RF test stand. Vacuum measurements are also taken on a prototype 352-MHz single-cell cavity and a 352-MHz five-cell cavity. The data will be compared with data on the five-cell cavities from CERN [1].

I. INTRODUCTION

The X-ray and vacuum measurements were made on various cavities with conditioning and without conditioning. The information obtained provides data for the final design of the radiation shielding on the APS RF stations.

II. EXPERIMENTAL SET-UP AND PROCEDURE

Measurements were made on the cavities that were installed in the APS RF test stand. The RF test stand block diagram and area layout are shown in Figures 1 and 2, respectively.

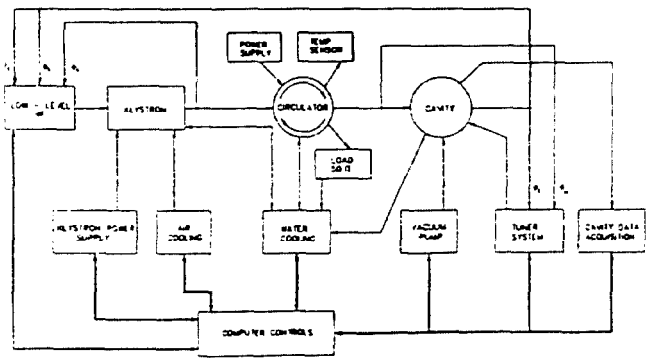

Fig. 1. RF Test Stand Block Diagram

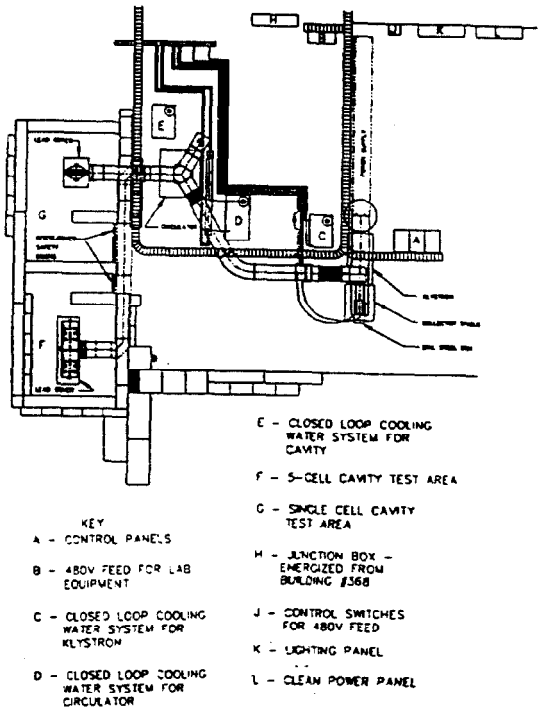

Fig. 2. RF Test Stand Area Layout

The RF system consists of a 250-kW Philips Klystron YK1350, a 351-MHz ANT circulator, a WR 2300 waveguide, directional couplers, coaxial water loads, and a 351.9-MHz single-cell [2] or a 351.9-MHz five-cell resonant cavity (LEP) type [3]. Directional couplers are located immediately after the klystron power and in each of the arms of the circulator to monitor both forward and reverse power.

The cavities are loop-excited using an input coupler from the WR2300 waveguide. The low-level RF system controls the amplitude and phase of the RF signal which drives the klystron amplifier. It also includes the phase regulation that maintains the cavity resonance point. The low-level RF system consists of an RF drive control loop for pulse or CW operation to set the operating level of the klystron in the linear or saturation region, and a frequency control loop to keep the cavity on resonance. The power supply is rated at 550 kW DC and produces 10 A at 55 kV or 8.6 A at 65 kV to feed the klystron. The cavities are tested at a vacuum limit of 5×10^{-7} and more typically about 1 to 2×10^{-7}Torr. The base pressure of the single cell cavity is 10^{-8} Torr and the five-cell cavity is 10^{-10} Torr.

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X-ray levels were measured with a Xetex Wide Area Monitor Model 510A-10 and film badges.

III. MEASUREMENTS

1) *Single-Cell Prototype Cavity*

After assembly the cavity was not baked. X-ray measurements were done with five film badges placed around the cavity. The radiation levels in millirads are shown in Table 1. The measurements were performed for two hours at power levels of 30 kW and 60 kW.

Table 1. Radiation measurements around a single-cell cavity (in mrd).

Radiation badge #	Position from the center of the cavity in the directions x	y	z	30kW	60kW
1	-0.84	-0.28	+0.39	min	410
2	-0.84	+0.28	+0.39	min	400
3	-0.66	+0.28	+0.39	min	260
4	-0.66	-0.28	+0.39	min	260
5	0	0	+0.39	min	20

The single-cell cavity vacuum as a function of RF power is shown in Fig. 3.

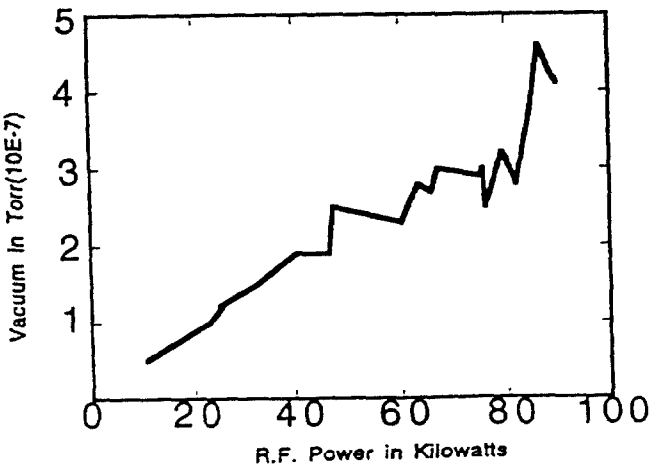

Fig. 3. Cavity vacuum as a function of RF power after 122 hours of conditioning.

2) *Five-Cell Cavity #1*

After assembly, the cavity was baked out at 150° C for 24 hours and then conditioned with RF power up to 100 kW in the RF test stand.

An X-ray radiation level of .14 mrd/h was found around the blockhouse at a 40-kW power level. Nothing was observed for low power levels. About this same level was observed on an Xetex X-ray monitor with its head sensor located in the blockhouse (Fig. 2). The radiation levels in millirads are listed in Table 2. At 100 kW measurements were taken for three hours with ten film badges placed around the cavity. This cavity was pumped with two 400-l/s turbo pumps.

Table 2. Radiation measurements around a five-cell cavity at 100 kW.

Radiation badge #	Position from the center of the cavity in the directions in m x	y	z	Radiation level in mrd
1	-1.4	0	0	895
2	-1.1	-0.4	+0.4	95
3	0	-0.4	+0.4	50
4	+1.1	-0.4	+0.4	35
5	+1.4	0	0	120
6	+1.1	+0.4	+0.4	30
7	0	+0.4	+0.4	85
8	-1.1	+0.4	+0.4	125
9	-2.0	-2.0	-2.0	35
10	+2.0	+2.0	+2.0	15

The radiation level in mrd/h, the cavity vacuum in Torr, and RF power in kW are shown in Fig. 4.

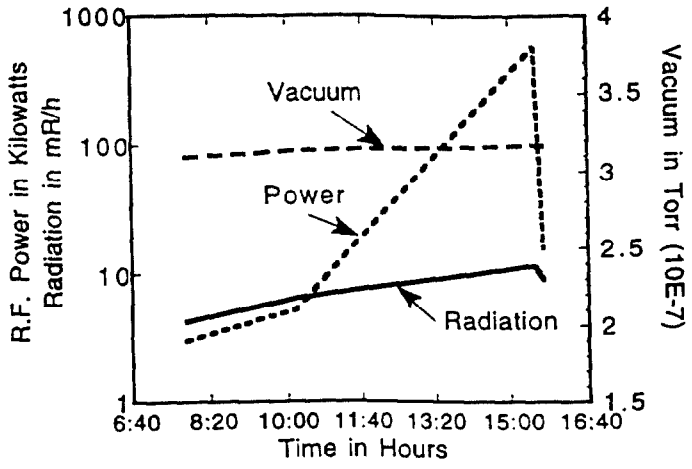

Fig. 4. Radiation level, cavity vacuum level, and RF power level as a function of time.

The five-cell cavity vacuum as a function of RF power after 42 hours of conditioning is shown in Fig. 5.

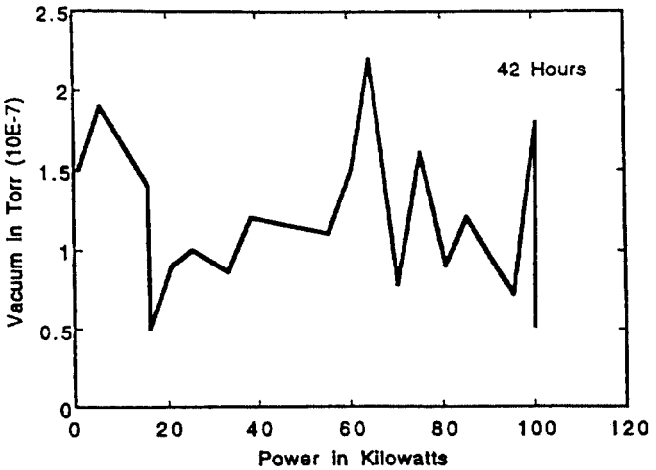

Fig. 5. Cavity vacuum as a function of RF power after 42 hours of conditioning.

3) *Five-Cell Cavity #2*

After assembly, the cavity was baked out at 150° C for 24 hours and then conditioned with RF power up to 100 kW in the RF test stand. At a power level of 100 kW measurements were taken for three hours with ten film badges placed around the cavity. This cavity was pumped one 400-l/s turbo pump.

Table 3 shows the radiation level in millirads.

Table 3. Radiation measurements around a five-cell cavity at 100 kW.

Radiation badge #	Position from the center of the cavity in the directions in m x	y	z	Radiation level in mrd
1	-1.4	0	0	140
2	-1.1	-0.4	+0.4	40
3	0	-0.4	+0.4	60
4	+1.1	-0.4	+0.4	45
5	+1.4	0	0	500
6	+1.1	+0.4	+0.4	85
7	0	+0.4	+0.4	40
8	-1.1	+0.4	+0.4	70
9	-2.0	-2.0	-2.0	15
10	+2.0	+2.0	+2.0	Min

The radiation level in mrd/h, the cavity vacuum in Torr, and RF power in kW as a function of time are shown in Fig. 6 and the cavity vacuum as a function of RF power is shown in Fig. 7.

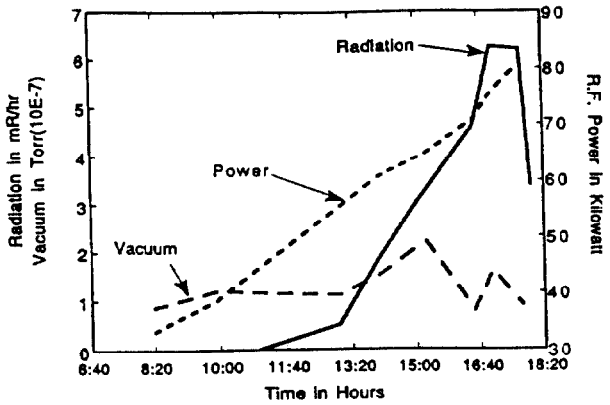

Fig. 6. Radiation level, cavity vacuum level, and RF power level as a function of time.

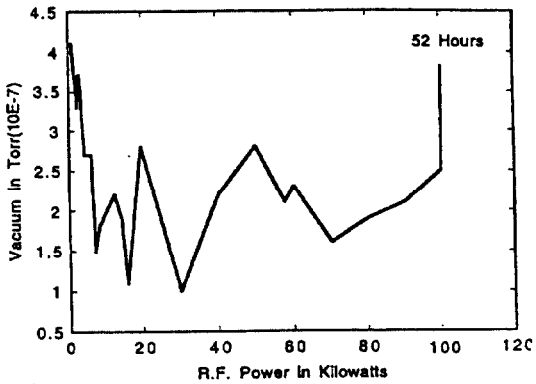

Fig. 7. Cavity vacuum as a function of RFpower after 52 hours of conditioning.

IV. CONCLUSIONS

Since the prototype single-cell cavity was not baked out after assembly, the conditioning process wasapproximately two months long. High radiation levels of 895 and 500 mrd were measured on badges positioned close to the beam ports of the five-cell cavities.

V. ACKNOWLEDGMENTS

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VI. REFERENCES

[1] P. Brown, G. Geshonke, H.Henke and I. Wilson, *Procee dings 1989 Particle Accelerator Conf.*, pp. 1128-1130, (1989).

[2] J.F. Bridges, J.M. Cook, R.L. Kustom, J.J.Song, "*Proceedings 1991 Particle Accelerator Conf.*, pp. 639-641 (1991).

[3] Ian Wilson, H. Henke, "The LEP Main Ring Accelerating Structures," *CERN 89-09*, Nov. 8, 1989.