An Automatic Measuring System Based on LabView for Resonant Cavities

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Abstract

An automatic measuring system for cavities tuning has been developed recently to improve the efficiency and accuracy. In this system, stepper motors which are positioned well and automatically controlled easily are used to drive measuring antennae. In order to measure automatically, a controlling program has been developed based on LabVIEW. Using this system, the resonant frequency, the quality factor, the coupling factor between two cavities, the pass band performance, the field distribution and the shunting impedance can be all gotten easily and quickly.

1. INTRODUCTION

Measurements of the microwave properties and the field distribution are very important during the R&D of an accelerating structure or the manufacture of an accelerator. By these measuring, we can get the resonant frequencies, the coupling factors between the adjacent accelerating cavity and coupling cavity and the distribution of the axial electric field, which are the evidences of the cavity tuning.

For X-band accelerating structures, the dimension of each cavity is so small that it is very hard to put the measuring antennae to the right positions. So the accuracy and the repeatability are not assured under manual measuring. For S-band accelerating structures, the tuning of a cavity train needs more manpower and cost more time relatively. Using a PC, the measurements and the data acquisitions can be all done automatically. The accuracy and the efficiency can be rapidly increased. So this automatic measuring system does good to the industrialization of the accelerators.

2. DESIGN PRINCIPLES

In order to solve the problem in manual measuring, stepper motors which are positioned well and automatically controlled easily are used to drive measuring components. Properties measuring and data requiring are taken by the solar network analyzer (SNA), which is controlled by a PC. Then the data is passed to Excel for analysis. Fig.1 and Fig.2 show the schematic diagrams for cavity properties measuring and axial electric field distribution measuring.

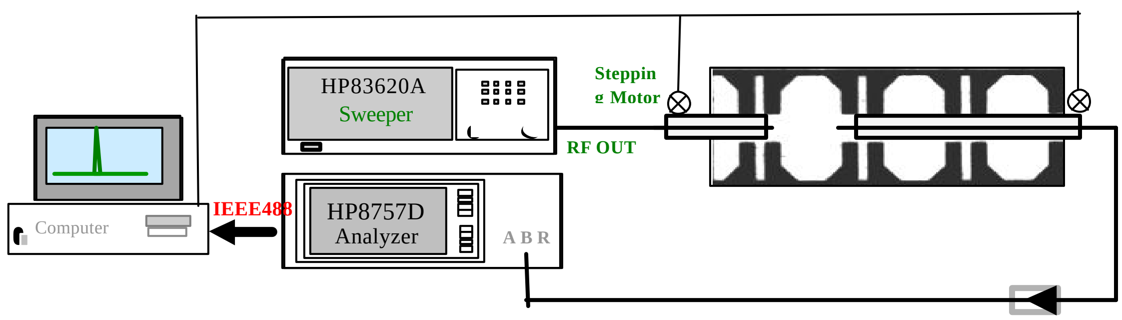

Fig.1 Cavity properties measuring

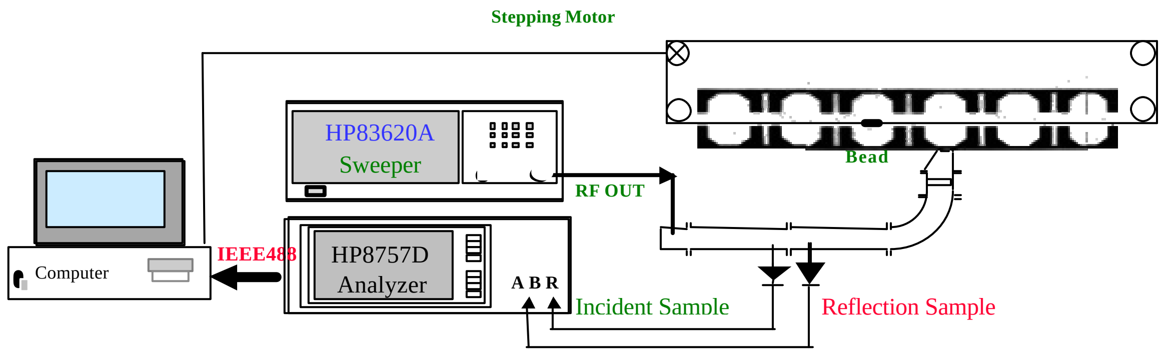

Fig.2 Axial electric field distribution measuring

3. SYSTEM COMPOSITION

3.1 Hardware

The whole system is shown in fig 3, fig 4 and fig 5.It include:

- A set of PC
- HP8757D Solar Network Analyzers
- HP83620 Sweeper
- AX5488 GPIB Card
- Two 28 series stepper motor
- One 45 series stepper motor
- 6020 steeper motor drive card
- SH series stepper motor driver
- DC24V switching power supply
- A pair of measuring antennae with their platform
- Disturbing bead with the thread and supporters

Fig.3 PC, SNA and Sweeper

Fig.4 Measuring antennae and the platforms

Fig.5 Disturbing bead with the thread and supporters

3.2 Control process and data acquisition

The system is based on NI LabVIEW. The VI control program control Stepper motors, sweeper and SNA. Stepper motors drive measuring components. Sweeper gives stimulated microwave. SNA start measuring and acquire data at the right time. Data is passed to Excel VBA for analysis. The whole process is shown as fig. 6.

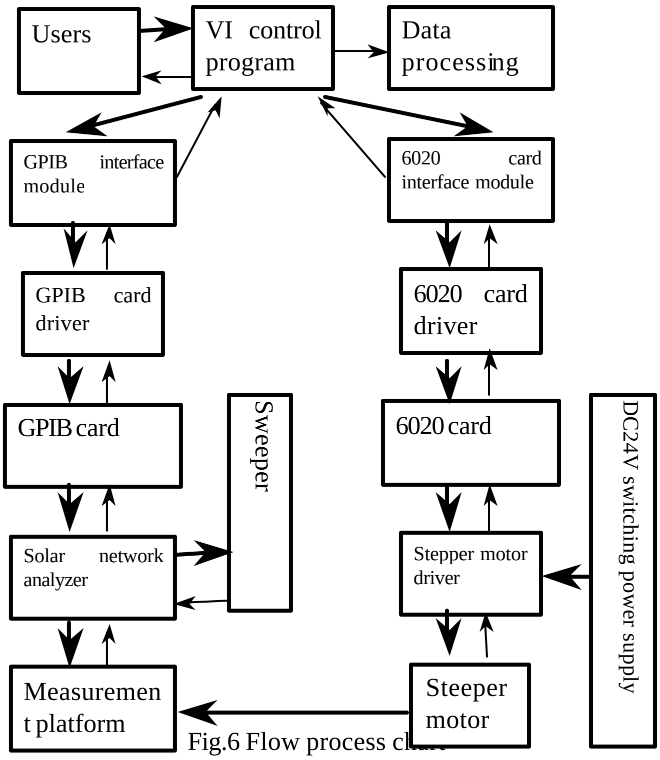

Fig.6 Flow process chart

3.3 User interface

This automatic measuring system has a user-friendly interface, which is windows style and can be mastered easily and quickly. Fig. 7 and fig. 8 are some examples.

Fig.7 Cavity properties measuring interface

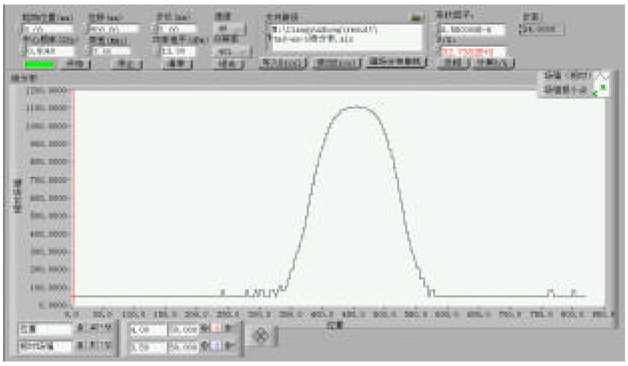

Fig.8 Field distribution measuring interface

4. SAMPLE RESULTS

The automatic measuring system has been used to the tuning of two X-band SW accelerators and an 800MHz two-cell prototype superconducting cavity with HOM couplers. Fig. 9 and Table 1 give the axial electric field distribution and the microwave properties of an X-band 2MeV guide.

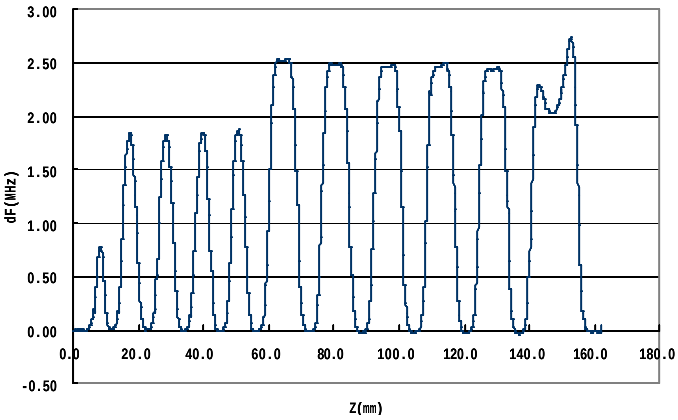

Fig.9 Axial electric field distribution

5. CONCLUSIONS

An automatic measuring system for resonant cavities tuning has been developed recently. Compared to manual measuring, this system can give more efficiency and accuracy, which is proved by a series of experiments. In the near future, the system will be applied to S-band accelerating structure which is bigger than X-band. A new type USB GPIB controller will be used to give more compatibility and portability. And the accuracy and efficiency will be increased, too.

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Table1: Microwave properties of some cavities

	Coupling factor[29]					01.12.18		
Cell--No	F1(MHZ)	F2(MHZ)	Fc(measured)	Ko(calculated)	Fa(calculated)	Fa(measured)	Ko(calculated)	Fc(calculated)
				2SQE(c1/d1)	Fc/SQR(d1)		2SQR(c/d)	Fa/SQR(d)
A1-C1	9172.34	9459.50	9296.25	0.0612	9329.04	9339.50	0.0606	9285.937
C1-A2	9206.20	9390.50	9296.25	0.0396	9297.71	9296.00	0.0396	9297.961
A2-C2	9194.54	9402.00	9298.75	0.0446	9294.32	9296.00	0.0446	9297.066
C2-A3	9195.94	9404.50	9298.75	0.0448	9298.18	9296.00	0.0448	9300.932
A3-C3	9191.19	9413.00	9305.75	0.0476	9294.48	9296.00	0.0477	9304.226
C3-A4	9193.09	9413.25	9305.75	0.0473	9296.69	9293.75	0.0472	9308.705
A4-C4	9187.61	9406.00	9298.25	0.0470	9291.52	9293.75	0.0470	9296.016
C4-A5	9193.90	9411.50	9298.25	0.0468	9303.33	9299.25	0.0468	9302.334
A5-C5	9176.70	9419.75	9296.25	0.0523	9295.44	9299.25	0.0522	9292.439
C5-A6	9219.25	9374.83	9296.25	0.0335	9295.88	9295.50	0.0335	9296.629
A6-C6	9230.15	9369.25	9301.75	0.0299	9296.09	9295.50	0.0299	9302.343
C6-A7	9230.00	9371.00	9303.00	0.0303	9296.40	9296.00	0.0303	9303.401