NEW RF MEASURING SYSTEM FOR CAVITY CHARACTERIZATION

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Abstract

New computer based, mobile measuring system for both laboratory and on line characterization of superconducting cavities has been put into operation at LNL. The system covers the frequency range from 80 to 350 MHz and represents a reliable, fast and precise instrument for cavity testing. The list of automatic and semiautomatic procedures includes line calibration, frequency sweep, decay time measurement, Q (Ea) curve acquisition and pulse conditioning.

INTRODUCTION

The Q measurement and rf processing of superconducting resonator can take advantage of computer-controlled procedures, which control the devices, collect data and assist the operator during the measurements [1]. The procedures are similar for different resonators operating in a wide range of frequencies. Also most of the costly part of the equipment can be shared, the only things that differ being elements that have a small frequency range [2,3].

For this reason a new system for laboratory and on line test of the whole PIAVE-ALPI-SPES set of cavities was developed. It can also be used for room temperature resonator characterization and for bead pulling measurements.

RF MEASURING SYSTEM

The general structure of the measurement apparatus is presented in fig.1

The computer is interfaced with the signal generator, power meter, oscilloscope and frequency meter via IEEE 488 bus. He level meter, temperature sensors, and stepping motor control are instead connected by RS232 bus.

A dedicated computer board allows A/D and D/C conversion and moreover the acquisition of analog and digital inputs and the setting of digital and analog outputs.

The rf generator signal is divided into three paths. One goes through the programmable phase shifter to feed the LO mixer input. A second line goes to the frequency meter. The third one arrives at the power amplifier through a PIN diode switch and an attenuator. A bi-directional coupler allows monitoring the forward and reflected power traveling on the feeding line.

The pick-up signal passes through a computer controlled attenuator and a low noise amplifier, and then it is splitted into two parts. One of them reaches the second mixer input; the latter arrives to the digital scope, which also measures the level of forward and reflected voltage and monitors the phase error signal.

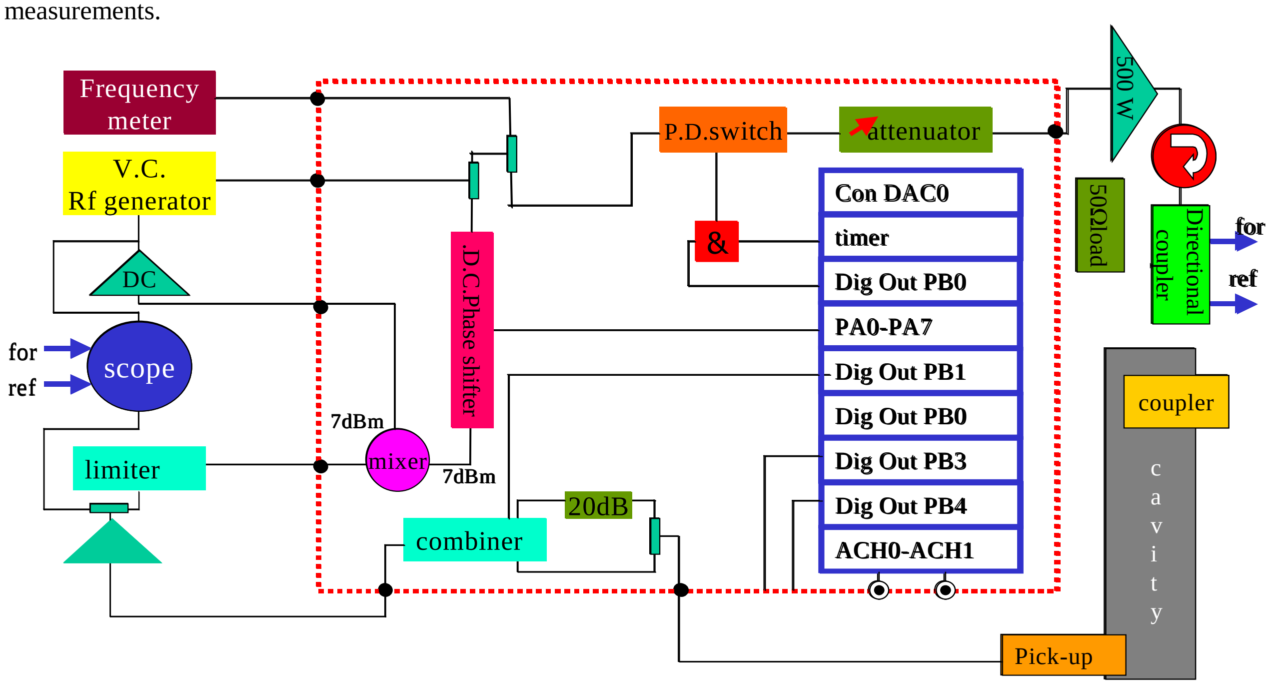

Figure 1: Example of a full width figure showing the distribution of problems commonly encountered during paper processing.

SOFTWARE

The control program, developed in Visual Basic, allows to calibrate the rf lines, to find the resonant frequency, to set the loop phase, to lock the generator to the resonator frequency, to adjust suitable coupling conditions and the forward power level. It measures the levels of pick-up, forward and reflected power signal, allows pulse length and period setting to optimize the cavity conditioning. The program computes the Q, plots Q as a funtion of the accelerating field allowing both a fast data analysis and recording (fig.1).

Another set of similar programs controls the motion of the coupler and tuner and monitors the cavity temperature, the level of liquid He and other useful parameters.

It is always possible to stop the automatic procedure and to operate manually the devices if necessary, resuming the automatic process later if required.

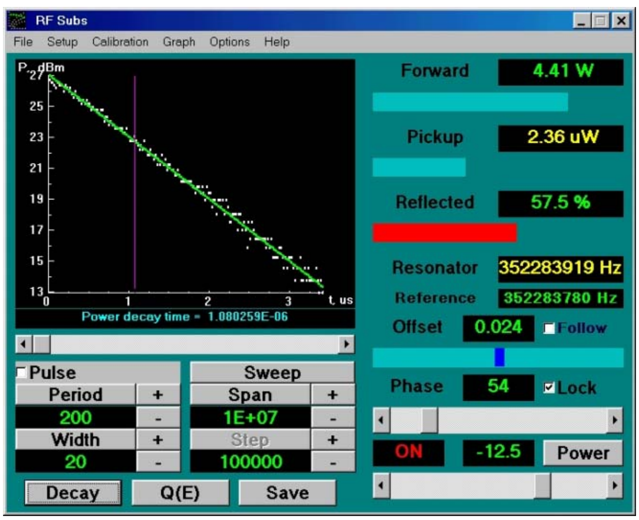

Fig 2. Control pannel view during the measurement of the decay time.

COMPUTER ASSISTED MEASUREMENT

We developed also a sort of computer-assisted device, consisting in a very simple calculation tool (developed in Visual Basic), which makes the cavity measurement easier and more reliable in case of manual Q-curve measurement.

It can be used for all kinds of normal and superconducting cavities and it is compatible with Windows from 3.1 to XP versions.

When the low field decay time of the resonators or the band is measured, the following data must be known: rf input line and pick-up line attenuations, frequency, ratio between stored energy and square of the accelerating field.

Choosing on the panel the coupling condition (under, critical or over-coupling) and suitably introducing the value of resonator decay time and the amplitude of pick-up, forward and reflected voltage (or power) when the decay time was measured, it is possible to determine the calibration parameter (fig. 3). Pushing the SHOW button, the program determines the accelerating field value and the correspondent Q value and shows it on the plot (fig. 4). For the next points, only the three values of peak-to-peak voltages or powers are sufficient, to show and save the measured points: the Q curve, manually taken, is drawn "on-line".

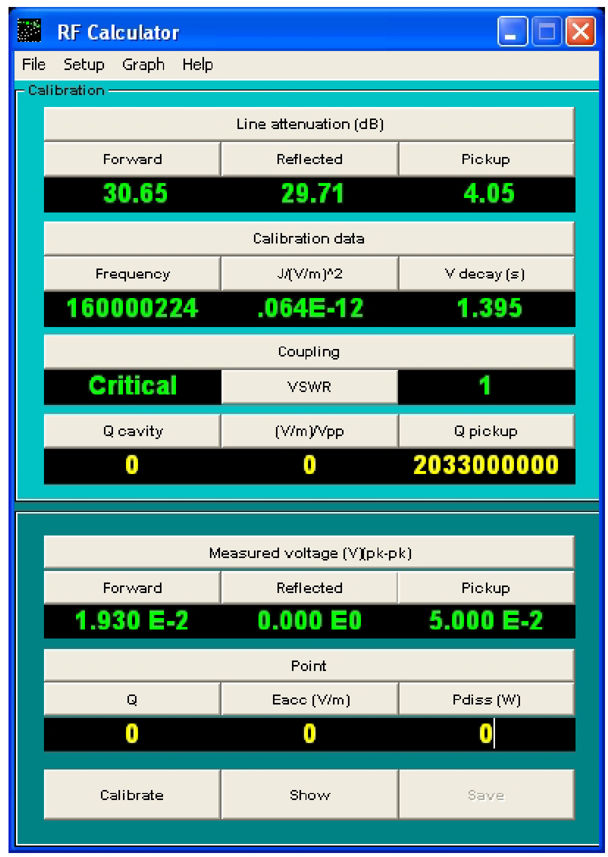

Fig.3. Calibration panel.

CONCLUSIONS

New computer based mobile measuring system for laboratory and online characterization of superconducting cavities has been put into operation at LNL. The system covers the frequency range from 80 to 350 MHz. It was used to test 80 MHz SRFQs of PIAVE, 160 MHz QWRs in ALPI and for bead pulling measurement at 350 MHz of ladder cavity prototype. Universal calculation tool for manual measurements has been developed and tested.

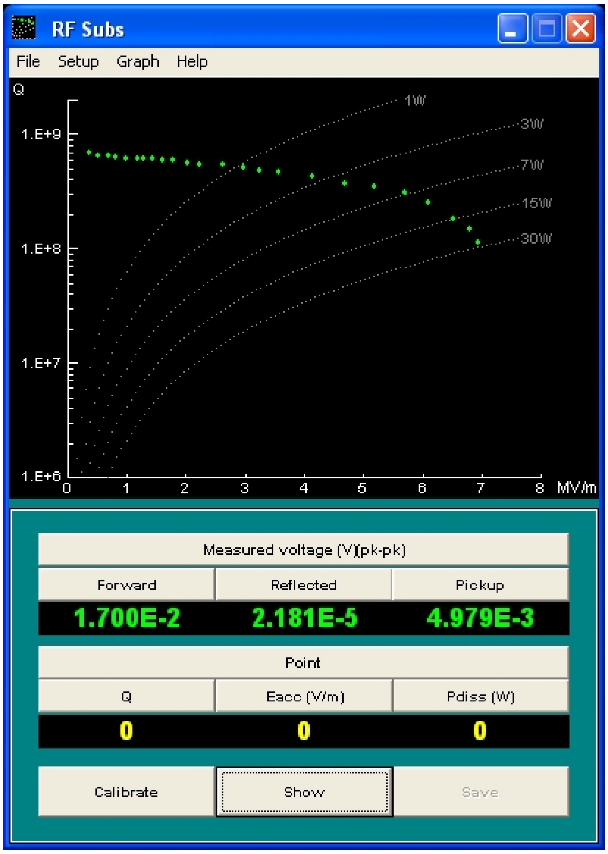

Figure 4: Measurement panel.

CONCLUSIONS

New computer based mobile measuring system for laboratory and on line characterization of both normal and superconducting cavities has been put into operation at LNL. The system covers the frequency range from 80 to 350 MHz. It was used to test 80MHz SRFQs of Piave, 160MHz QWRs in ALPI and for bead pulling measurement at 350MHz of ladder cavity prototype. Universal calculation tool for manual measurements has been developed and tested.

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