# The Status of RF Superconducting Activities at Peking University

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Abstract

The development of RF superconducting technology at Peking University was reviewed. The field gradient up to 12.3 MV/m with $Qo=1.4x10^9$ was obtained for single-cell Nb cavity in the recent test. The design studies of a 1.3 GHz Nb cavity for superconducting accelerator and RF gun with photo-cathode are presented.

## 1. INTRODUCTION

A series of efforts have been made at Peking University since 1988 to establish a specialized laboratory and related conditions suitable for processing, assembling and conducting RF test of superconducting Nb cavities[1]. Recent experiments with an annealed cavity showed that field gradient Eacc=12.3 MV/m with $Qo=1.4x10^9$ was reached under 2.3K. A new task of constructing 1.3 GHz cavities with high pure Nb material was funded recently in the light of pushing forward the development of RF superconducting technology in China. Meanwhile design studies on the feasibility of a superconducting RF gun with photo cathode are to be started.

## 2. THE TEST OF 1.5 GHZ CAVITY

The 1.5 GHz single cavity sent to us from DESY has been under processing and testing since 1990 and it is interesting to recall that the performance of the cavity has been improved steadily with the number of processing and tests. The accelerating gradient of the cavity so far reaches as high as more than 11 MV/m partly due to the continuous efforts in upgrading the skill and technology of processing during a number of experiments[2].

The result of the tests showed that effect of the processing and heat treatment is long lasting for the Nb cavity, which was treated at 850°C under vacuum $p<10^{-5}$ Torr for more than one hour. After that it was cleaned by chemical process and a thin surface layer of 3-5 $\mu$m was removed. The cavity was then assembled under the protection of high pure nitrogen gas after rinsing in high pure demineralized water. It was baked afterwards for 24-36 hours before the test. No degradation of Q has been observed after a number of warming up and cooling down cycles.

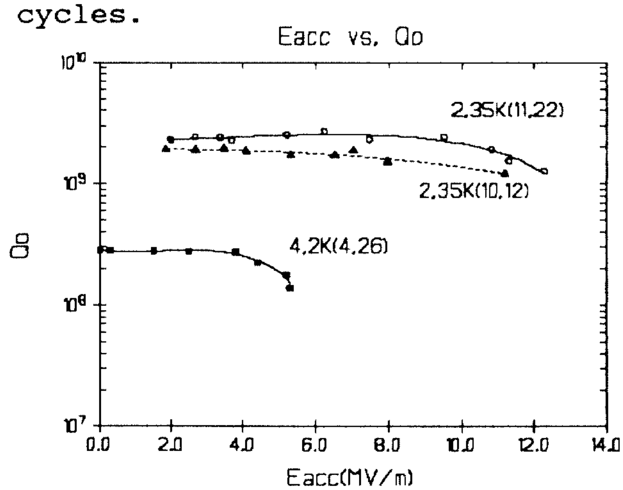


fig 1. Qo versus Eacc

The cavity also appeared to be upgraded considerably each time after a high power test. For instance the maximum field gradient reached on October 2nd 1991 was limited to 11 MV/m because of intensive X-ray radiation, however it went up to 12.3 MV/m during the test on 14th November. It seems that the previous test played a role of preconditioning for the next test. The accelerating gradient Eacc in the latest test is plotted versus Q in fig.1. So far the conditioning process is limited by the capability of the RF power amplifier. However a higher output power amplifier will be available in the near future and then the cavity will be conditioned both with and without helium.

## 3. DESIGN AND CONSTRUCTION OF 1.3 GHZ CAVITY

We have set up a new project of manufacturing a L-band cavity for the purpose of getting enough knowledge to develop superconducting electron accelerators in China[3].

Considering the specifications of the power amplifiers available in the domestic market as well as possible future applications of L band superconducting cavity in

Table 1 Parameters of the 1.3 GHz Cavity

| Item | Cavity1 | Cavity2 |
|---|---|---|
| Frequency | 1.5GHz | 1.3GHz |
| Beam aperture | 7.0cm | 7.6cm |
| R/Q | 47.9Ω | 56.1Ω |
| $E_{peak}/E_{acc}$ | 1.03 | 1.09 |
| $H_{peak}/E_{acc}$(A/MV) | 1.97E3 | 2.00E3 |

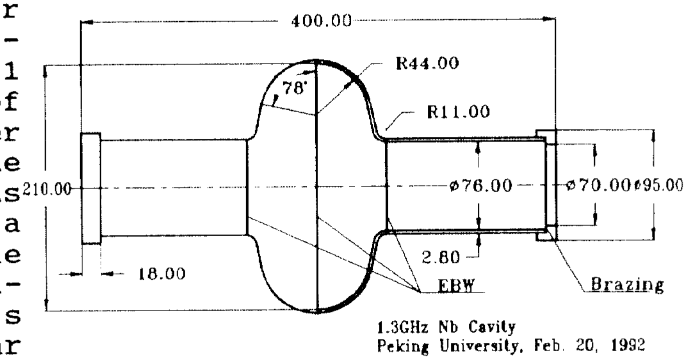


Fig. 2 The Geometry of the 1.3GHz Cavity

China, an operating frequency of 1.3 GHz is preferred. In referring to parameters of the cavities with the same frequency in other countries, the geometry of a 1.3 GHz cavity was optimized and determined by using codes of URMELT and SUPERFISH. The results are shown in the table 1 and illustrated in fig.2 as well.

The 1.3 GHz cavity will be made of pure bulk Nb, for this purpose the production of high purity Nb material is started in the factory. We are aware of eliminating the carbon content from the beginning of smelting so as to minimize the content of impurities as C, N, O, H etc. High purity material can be obtained by electron beam smelting and regional beam refining. The chemical contents of a sample obtained by a number of metallurgical treatments are listed in Table 2 , the measured RRR of which is 20. Having been heated in a high vacuum furnace, the RRR value of the very sample raised up to 125 and eventually reached as high as more than 250 after further annealing with degas in an ultrahigh vacuum furnace. The rolling of the Nb material will be under careful control so as to avoid scrapping and contamination. The construction of the Nb cavity is well in progress.

Table 2. Chemical Content of a Sample(made by the end of 1991)

| | | | |
|---|---|---|---|
| Ta | <0.004% | C | 0.005% |
| W | ≤0.0005% | N | 0.004% |
| Mo | <0.0002% | O | 0.005% |
| Fe | 0.0005% | H | <0.001% |
| Cu | 0.00025% | * | <0.00005% |
| Ni | 0.0001% | | |

*: others content

## 4. THE FUTURE PLAN OF A SC PHOTO-CATHODE RF GUN

High quality electron beam is essential for the Free Electron Laser. The brightness accelerated beam brightness is usually determined by the starting condition of the gun[4]. The realization of a superconducting photo-cathode RF gun is very attractive. The photo-cathode can supply ultra-short electron beam pulses with high brightness. The super-conducting cavity could provide a suitable environment for prolonging life-time of the photo-cathode due to low temperature. Optimizing the cavity geometry for minimum beam emitance is possible because the RF loss on cavity wall can be neglected. Moreover, it is favorable for a high duty cycle or C.W. operation.

The design studies on the 1.3 GHz 1+1/2 SC cavity for gun is started and in progress. The work of optimizing the 1/2 SC cavity is carried out on VAX-Station 3100 computer.

The photo-cathode is being developed with the collaboration of Dept. of Radio Electronics of Peking University. We are particularly interested in developing semiconductor photo-cathodes suitable for SC RF gun. A series of work on the design of cryostat, ultrahigh vacuum chamber etc. are in progress.

## 5. ACKNOWLEDGE

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## 6. REFERENCE

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