Nb-Cu SPUTTER ACTIVITIES AT DESY

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Abstract Nb-sputtered copper cavities are considered to be an advantage over cavities formed from Nb sheet material. Motivated by the good results of the sputtered cavities by CERN we started a development program to sputter 500 MHz single cells. The sputter apparatus is designed to sputter-etch and sputter the cavity and in addition to transfer it to the cryogenic environment without breaking the cavity vacuum. Pipe cooling of the cavity is integrated from the beginning.

INTRODUCTION

Nb-sputtered Cu cavities have been developed at CERN in the last years. The results show that after a good preparation the sputtered cavities are at least equal in performance to cavities made from bulk Niobium [1]. The high thermal conductivity of the Cu material suggests to apply pipe cooling to the Nb sputtered cavities. Pipe cooling has been applied to superconducting cavities made from explosively bonded Nb-Cu sheets. A 500 MHz single cell cavity was cooled by 4 pipes and reached a field of E_{acc} = 9 MV/m limited by field emission. As compared to bath cooling the use of pipe cooling results in substantially reduced safety problems, easier cryogenic handling and in a simplified LHe distribution system.
16 4-cell cavities made from Nb bulk material are being fabricated and will be installed in HERA during the summer 1990. They are cooled in a horizontal bath cryostat. To enable the use of pipe cooling for the next generation of superconducting cavities we started a development program which will lead to a completely equipped 4-cell cavity by sputtering technique.

SPUTTER APPARATUS

Fig. 1 shows the principle layout of the planned sputter apparatus. At the beginning single cell cavities will be sputtered. The handling of 4 cell cavities is possible by extending the length of the sputter cathode.

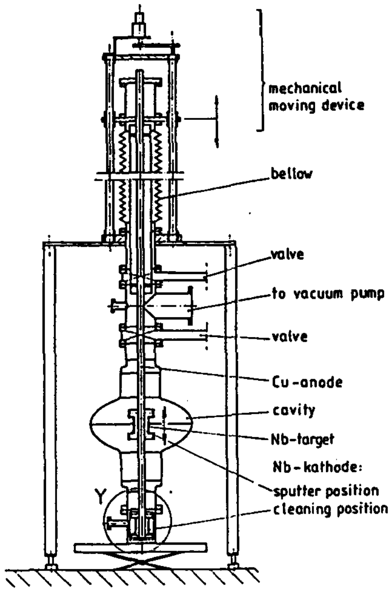

Fig. 1:
Principle layout of the planned sputter apparatus

We foresee the following sputter sequence:

- after cleaning the cavity is completed in the cleanroom with the bottom plate and the top gate valve
- the closed cavity will be attached to the sputter apparatus
- after flushing the room between both gate valves the Cu electrode is lowered to the "cleaning position"; here the Nb anode is hidden in the bottom container. The Cu-anode is used to apply diode sputter cleaning of the inner surface of the Cu cavity
- after sputter cleaning the Nb electrode is moved upwards to bring the Nb cathode with its permanent magnet inside the cavity-cell. Then the Cu cavity will be magnetron sputtered with standard parameters
- after sputtering the Cu-electrode is moved upward and the cavity is sealed by the lower gate valve

At the time of the work-shop (summer 1989) the sputter apparatus is under construction and will be used in the end of this year.

CHEMICAL CLEANING

A test series on Cu-samples has been carried out to find an easy to handle chemistry for cleaning the Cu-cavity. The best results have been achieved by the following mixture: 75 % vol H_2O, 15 % H_2SO_4 concent., 5 % vol. stabilization solution B222 and 5 % vol. H_2O_2 (product of "Peroxid Chemie", Höllriegelskreuth, FRG). The reactivity of this chemistry is rather low (1.4 µm per 1 min.). No NO and NO_2 gases develope. The surface becomes smooth and shiny.

CAVITY DESIGN

As stated earlier, the cavities will have pipe cooling from the beginning. Fig. 2 and Fig. 3 show the cross section and a picture of the cavity with the integrated pipe cooling (design and fabrication by DORNIER). As can be seen the cooling pipes are formed between the outer cavity surface and a second Cu cup with stamped grooves. The outer cup is attached to the cavity by e-beam welds. The LHe is fed in from the bottom line via gravity and the boil off GHe is collected at the top line. The amount of LHe per cell is 4 liters. The pressure sensitivity of this system is measured to be -6 Hz/1 mbar which compares to -70 Hz/1 mbar in our bath cooling cavities.

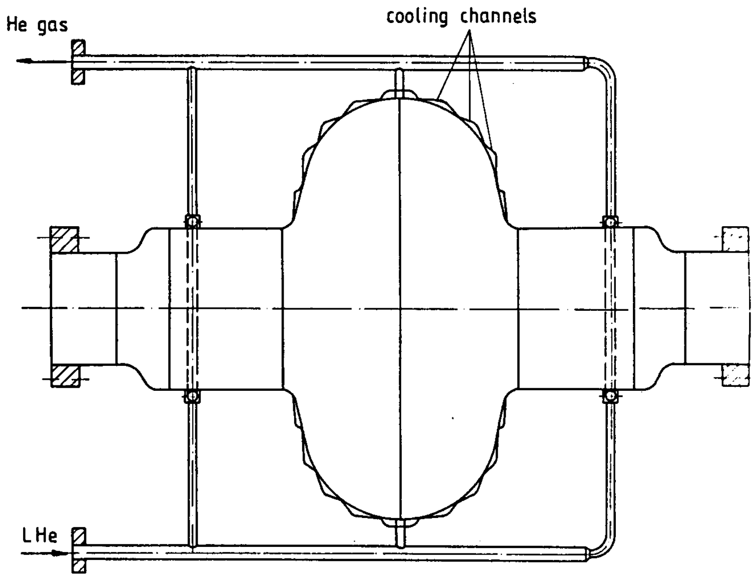

Fig. 2
Cross section of the copper cavity with integrated cooling channels

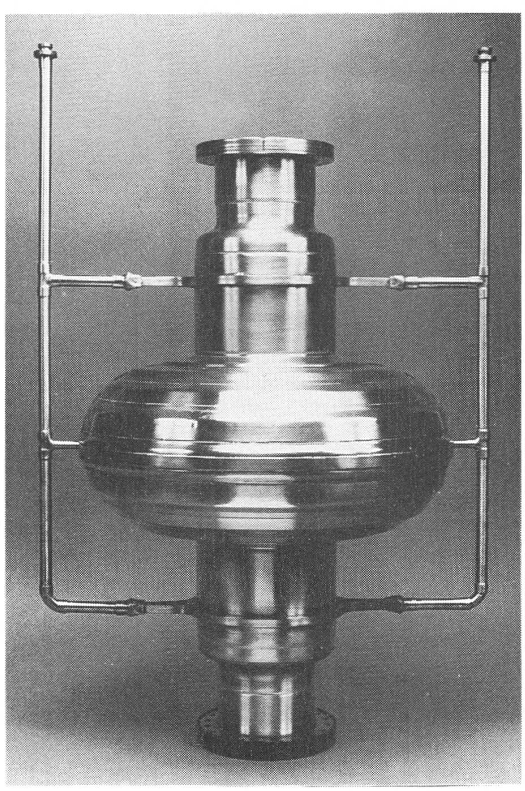

Fig. 3
Picture of the copper cavity

CRYOGENIC MEASUREMENT

Fig. 4 shows the horizontal cryostat during assembly and cool down of a cavity. Originally this test cryostat is designed for diagnostic superconductivity measurements of the 16 4-cell cavities (integrated bath cooling). The first cool down of the single cell cavities were done without a phase separator for the liquid helium. I.e. the cavity was cooled by two phase forced flow from the refrigerator. Using facilities outside DESY (DORNIER) we started to sputter cavities before our own sputter apparatus is in operation. These data are used to gain time in finding optimum cleaning, handling and sputter parameters. A first coating showed a low field Q value of 2×10^9 at 4.2 K. With increasing field, however, the Q dropped rapidly (3×10^8 at 3 MV/m). We contribute this moderate result to the very rough Nb surface and to the not optimized sputter parameters. Single cell cavities sputtered by the described apparatus are expected at the end of this year.

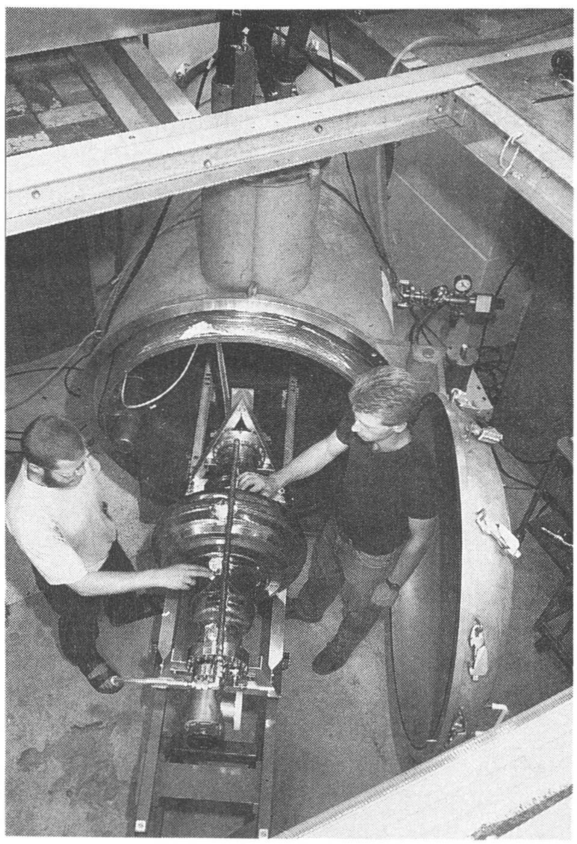

Fig. 4
The horizontal cryostat during assembly of a cavity

ACKNOWLEDGEMENT

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REFERENCES

1. C. Benvenuti et al., Proc. of the European Particle Accelerator Conference, Rom 1988, 37