

SERIES PRODUCTION OF COPPER AND NIOBIUM CAVITIES FOR THE SPALLATION NEUTRON SOURCE

S. Bauer, K. Dunkel, B. Griep, M. Pekeler, C. Piel, P. vom Stein, H. Vogel

ACCEL Instruments, Bergisch Gladbach, Germany, accel@accel.de

Abstract

Since about one and a half year ACCEL is working on two large scale cavity series production: The normal conducting CCL type copper cavities [1] and all superconducting 6-cell cavities for the linac of the Spallation Neutron Source SNS [2]. For both projects, the prototype phase is finished and we are in the middle of the series production. Tuning results on the normal conducting cavities will be presented as well as the cold RF test results of the superconducting medium beta cavity production. Experiences gained for future large scale cavity production will be presented.

1 CCL CAVITIES

Since October 2001 ACCEL manufactures the cavity coupled linac segments for the normal conducting part of the proton linear accelerator from energies of 87 MeV to 185 MeV for the SNS project in Oak Ridge.

The contract has been concluded with Los Alamos National Laboratory and covers the production of 4 modules, each consisting out of 12 segments (Figure 2) and 11 bridge couplers (Figure 1). Each cavity coupled linac segment consists of 8 accelerating cells, coupled to each other by 7 coupling cells. Two segments are coupled by one bridge coupler, which forms together with the two endplates of the segments a three cell coupling structure.

The scope of work covers machining, brazing and RF tuning of all segments and bridge couplers. In addition module assembly, mapping and tuning is within ACCEL's responsibility.



Figure 2: Segment at final dimension control

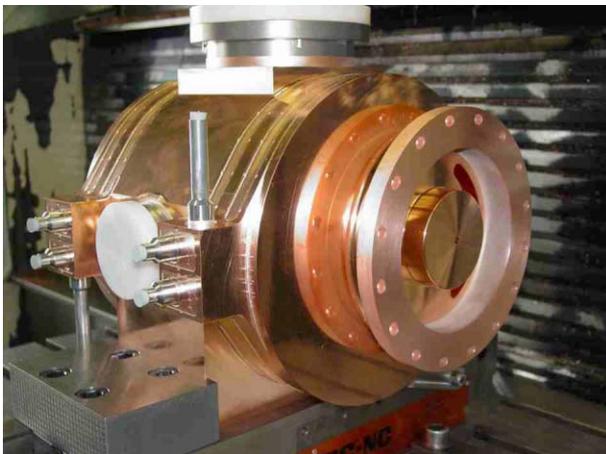


Figure 1: Bridge Coupler at final machining

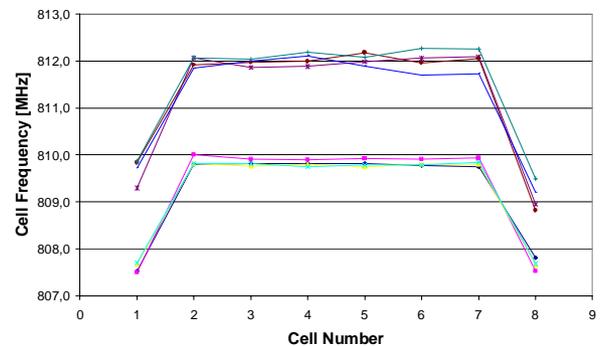


Figure 3: RF measurements before (upper curve) and after (lower curve) tuning

Comparing pre and post tuning results show RF measurement on Segment and Bridge Coupler level show good reproducibility within the entire manufacturing sequence which will allow easy tuning of brazed assemblies.

2 SC ELLIPTICAL CAVITIES

The production of the superconducting cavities of both types, medium beta ($\beta = 0,61$) and high beta ($\beta = 0,81$) is proceeding well (Figure 4). After an intense time of tooling development and establishing all the work procedures for both type of cavities, the series production was launched.

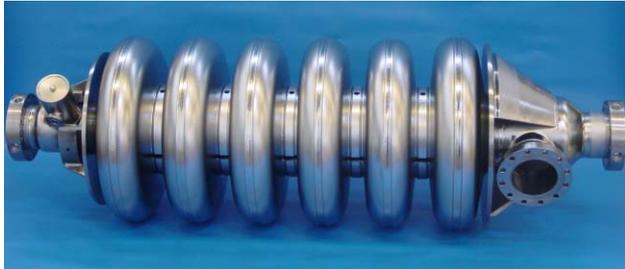


Figure 4: Series production of medium beta cavities is finalised

All 35 medium beta cavities have been delivered to Jefferson Laboratory from October 2002 until April 2003 and test results are exceeding well the design value.

For the high beta cavity production, the majority of the single part production is finished. A first article high beta cavity was delivered to Jefferson Lab in February 2003. This cavity was tested in the meantime and exceeded the design specifications. The production of the high beta cavities is now ramping up with a production rate of at least one cavity per week. This rate can be established with the current infrastructure of two electron beam welding machines. Both machines are used in a one shift operation with an occupation of about 80 % for this project. Tooling is used that allows to perform 3 similar welds within one pumpdown of the welding chamber.

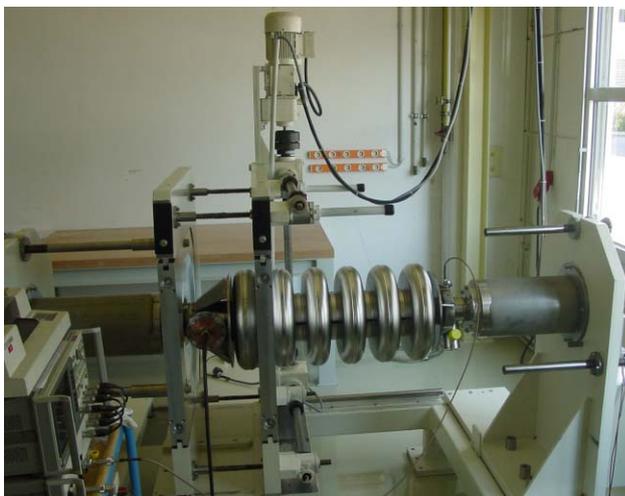


Figure 5: SNS medium beta cavity during field flatness tuning.

All cavities are delivered with guaranteed frequency and the field flatness tuned to an accuracy of 5 % in

Amplitude (Figure 5). Additionally the external Q of the fundamental mode of the HOM couplers is tuned and the cavities are chemically polished from the inside and outside in order to remove the so called damage layer. Therefore at Jefferson Laboratory only the final preparation and the cold rf-test needs to be done.

Figure 6 shows the cold RF test results of the first delivered medium beta cavities. The cold RF test was performed at Jefferson Lab after final chemical preparation and high pressure rinsing. Up to now all cavities delivered reached the specified performance.

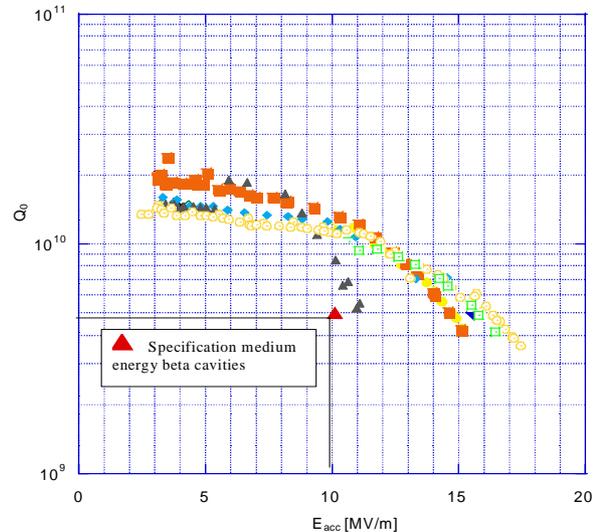


Figure 6: Cold test results of first cavities delivered (Courtesy JLab)

3 CONCLUSIONS

Both projects have been successfully started with development of tooling, optimisation of procedures and assembly deliveries. The series production of a total number of 109 s.c. cavities and 48 n.c. cavities is well on track for the SNS project.

Based on this experience (completion of 4 to 6 cavities per month) we conclude that production rates of about 40 sc. cavities per month as may be required e.g. DESY X-FEL project can be handled. An analysis in view of such future projects shows that production rates can be easily handled with specially designed electron beam welding machines and the surrounding appropriate infrastructure for chemical processing within the frame of existing infrastructure.

REFERENCES

- [1] N. Bultman, MECHANICAL DESIGN OF THE SNS COUPLED CAVITY ACCELERATOR, Proceedings of the 2001 Particle Accelerator Conference, Chicago
- [2] G. Ciovati et al., "Superconducting Prototype Cavities for the Spallation Neutron Source (SNS) Project," Proceedings of the 2001 Particle Accelerator Conference, Chicago