

## SERIES PRODUCTION OF ACCELERATOR CAVITIES FOR THE SPALLATION NEUTRON SOURCE

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### *Abstract*

The series production of the normal conducting CCL type copper cavities as well as the superconducting elliptical cavities for the linac of the SNS project has started. Compared to previous accelerator projects at ACCEL the scope of supply has been enlarged including e.g. the tuning procedure for the CCL modules or the complete first chemical treatment of the niobium cavities. Improved manufacturing methods in view of the series production for the copper and niobium cavities will be presented.

### 1 CCL CAVITIES

In October 2001 ACCEL could win the contract on manufacture of 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 [1].

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

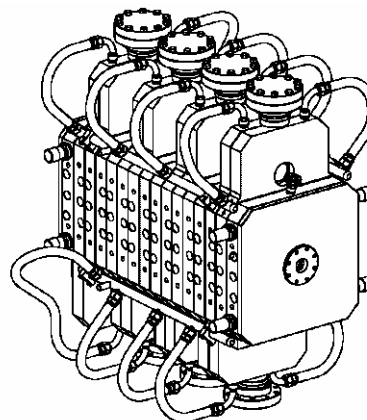


Figure 2: CCL Segment (drawing by LANL)



Figure 3: CCL Segment Plate, view on cooling channels and coupling cell

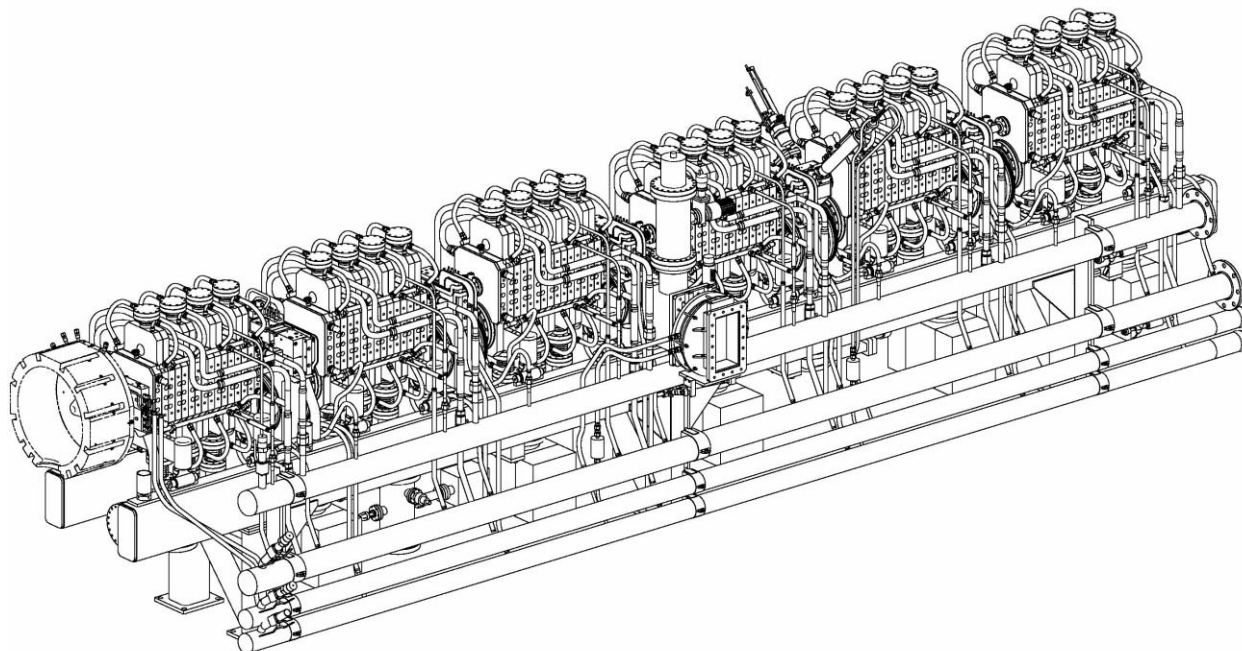


Figure 1: CCL Half Module (drawing by LANL)

The scope of work covers machining, brazing and RF tuning of all segments and bridge couplers. In addition module assembly and tuning is within ACCEL's responsibility. The logistics of handling about 90 tons of copper is finalised by the air transport of assembled and aligned half modules to Oak Ridge Laboratory.

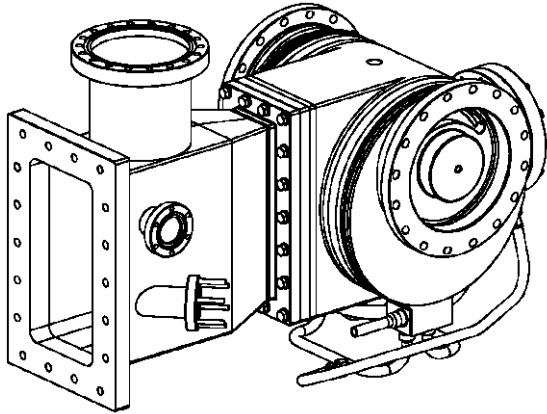


Figure 4: Bridge coupler scheme (drawing by LANL)

Series production requires a great variety of tooling for milling and turning operations (Figure 5).



Figure 5: Bridge coupler body on mill

Beside tooling a major effort is handling and logistics. For production tracing and quality assurance a labelling scheme (Figure 6) was established, which is engraved to the parts at first material inspection and kept until delivery. The numbering scheme allows at any fabrication step to identify parts as individuals and to determine their functionality in the module. The logistic of the material and component flow is supported by a computer based production planning system.

The qualification process, which is closely accompanied by LANL, will be finalised during summer

2002. In parallel to the qualification sequence rough machining has started. Series production will start this summer which allow to fulfil the contractual schedule.

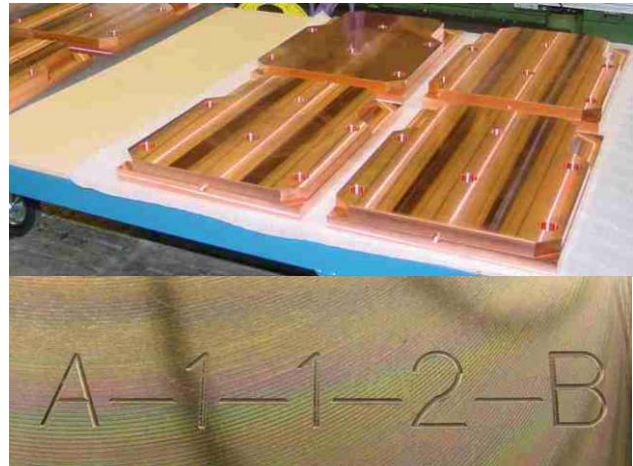


Figure 6: Rough machining of segment plates

## 2 SC ELLIPTICAL CAVITIES

In August 2001 ACCEL could win the contract for the manufacturing of all Niobium Cavities for the superconducting part of the linac for the SNS-project in Oak Ridge. The contract is concluded with Jefferson Laboratory and covers the production of 35 medium beta cavities ( $\beta=0.61$ ) and 74 high beta cavities ( $\beta=0.81$ ) (Figure 7). The production scope includes the rf-tuning as well as internal and external BCP (buffered chemical polishing).



Figure 7:  $\beta=0.81$  prototype cavity, produced by JLab courtesy Jefferson Lab

Delivery of the cavities is scheduled at rates of 4 cavities per month.

Prototypes of the cavities have been manufactured by Jefferson Lab and shown performance well above the design requirements [2].

Based on the prototype experience of JLab the following design values had been defined:

Table 1:  $\beta=0.61$  Cavities

Parameter	Value	Unit
Frequency @ 2.1 K	805	MHz
Q @ 2.1 K	5	$10^9$
$E_{acc}$	10.1	MV/m
$E_{peak}$	27.5	MV/m

Table 2:  $\beta=0.811$  Cavities

Parameter	Value	Unit
Frequency @ 2.1 K	805	MHz
Q @ 2.1 K	5	$10^9$
$E_{acc}$	12.5	MV/m
$E_{peak}$	27.5	MV/m

To manufacture niobium cavities of this quantity requires a lot of different manufacturing technologies. Beside standard technologies as milling and turning, special production sequences had been qualified as deep draw and spinning.



Figure 8: Turning fixture

EB welding is an integral and at ACCEL well established part of this project, which is accompanied by development of fixtures suitable for series production (Figure 9).



Figure 9: Welding fixture

RF measurements at different steps within the production are necessary. This was taken into account by developing RF measurement equipment and RF tuning tools as shown in Figure 10.



Figure 10: RF measurement equipment

After developing tools and equipment and qualifying sensible production steps ACCEL is now heading the series production.

### 3 CONCLUSIONS

Both projects require qualification of production sequences, development and production of tools and handling fixtures

Modern tools for handling this type of series production had been installed at ACCEL. The most important one is the installation of a production planning and control system in the engineering department and the workshop.

Based on those results ACCEL will start with the large scale series production for all contracted SNS cavities this summer.

### 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