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Electroforming procedures applied to the construction of 11.4 GHz linear accelerating structures: status report on SALAF activity.

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Abstract

As described in the paper LNF – 05/23 Electroforming is a galvanotechnical procedure able to reproduce a structure through the deposition of a metal (usually Copper) on a core (usually Aluminium) that is chemically eliminated at the end of the process.
The idea is to apply this process to the construction of RF, 11.4 GHz multicell linear accelerating structures, taking into consideration that this process is already in use for RADAR high frequency components, as wave-guides.
The base point is that the Al core will reproduce exactly the requested inner volume of the multicell structure both as shape and as finishing.

During 2006 and beginning of 2007 the activity of the group was dedicated to explore the way to obtain the lowest roughness of the inner surface of the cells. An Ra = 0.2 – 0.3 micron is routinely reached (sufficient to start the work with RF), starting from an almost specular finishing of the core surface. The NaOH treatement, necessary to remove the Al core, gives a matt Cu surface and a roughness slightly less good, as said. In addition this process leaves the Cu surface rather dark and with a not uniform aspect.
Surely the surface roughness is considered the best parameter to predict the behavior of the accelerating structure when a high RF power is present. Anyway the presence of coloured spots could create problems, for example increasing field emission and secondary electrons emission.

As already said a study is in progress in order to find the simplest way to obtain a clean surface.
This study is made in accordance and in a continuous collaboration with the company specialized in Electroforming technique.

The first idea was to study if the Silicon content of the Al alloy (type 6082) used for the core could have a role on the quality of the surface, because Si is not eliminated by the NaOH treatement and therefore could remain on the Cu surface. Many tests with Al alloys at low Si content showed that the dark colour can not be related to the quantity of Si in the Al alloys.

A second idea was to protect Cu from the NaOH action depositing on the core firstly a thin layer of a metal able to support the NaOH treatement.
The deposition of a few micron of Silver on the core gives an increase of the quality of the Cu surface but again the Ag surface is slightly altered by NaOH.

A third idea was to deposit a layer of Gold on the core, before Cu deposition, because NaOH can not chemically react with Au. Unfortunately in our case Gold cannot be deposited on Al through an Electrolytic process. Anyway there are other procedures to obtain an Au layer, the simplest one could be the deposition by Sputtering. Just this way will be followed in the future, considering that the group has recently received a Sputtering System. Therefore the Al core will be simply covered with a sputtered Au layer, before sending it to our Company for the Cu deposition.

Finally a very simple way to obtain a brilliant Cu surface is to treat it with an acid etching. This is a typical chemical procedure: there are in commerce many products able to give a shiny and brilliant Cu surface and therefore we are in contact with our Company in order to prepare some tests.

COUPLER.
One of the cells of an Electroforming structure will have a more complicated geometry due to the presence of a window and a coupler for the connection to the external wave-guide. The core of one cell has been prepared by Electroerosion with a shape that contains the RF connection. It will be sent to the firm for Electroforming as soon as possible. Fig. 1.

MOLYBDENUM.

The use of the Molybdenum to make the irises of the accelerating structure seems to guarantee much higher RF fields. Anyway the presence of another metal along the structure creates some difficulties that we are going to cope with.

It is not easy to obtain a good finishing on Mo, especially after a high temperature thermal cycle, as it happens during brazing.
Actually the Company that usually makes for us the accelerating structures, specialized in high precision machining, has obtained good levels of roughness (Ra = 0.2 micron). This Company has obtained these results using diamond tools specially prepared for this work. The Molybdenum used for these tests did not undergo any temperature treatment before machining. This work will be completed as soon as possible with tests on thermally treated Mo.
This is a point to take into consideration when preparing brazed structures. Details on this porcess are given in another paper.

Electroforming on Molybdenum.
Some 4 cells structures with Mo irises have been prepared in collaboration with the GALVAIR Company with which we collaborate. The key point is that GALVAIR is able to prepare the Mo surface for Cu deposition with a chemical treatment, thus obtaining a very strong contact. On this base some Mo discs have been prepared with the irises already machined. Then these discs have been sent to GALVAIR for the activation of the external surface. Finally they have been mounted together with the Al cylinders (that represent the cells) in order to obtain the whole structure of the core, ready to be covered with Copper.
The picture of Fig. 2 (or Fig 3) shows one of the Mo/Cu accelerating structures cut into two halves in order to see the inner shape.
This Electroforming procedure does not require obviously thermal treatments of Molybdenum; this means, as already said before, that irises can be prepared with a very good level of finishing.
As an alternative to the electrochemical activation of the Molybdenum, as just now said, we are considering another way that consists in preparing the Mo discs with an external ribbon of brazed Cu. Therefore the external surface of the core will have only Cu and Al ready for Electroforming. This procedure will be tested as soon as a good finishing of thermal treated Mo will be obtained.

Future work.

- An all Copper 4 – 5 cells electroformed structure will be prepared for RF tests.
- Work in progress for the Coupler structure.
- A work on the Molybdenum will continue on the fields already considered before.
- A 5 cells Mo- Cu structure will be prepared for the first RF tests. The core has been already prepared, ready to the Electroforming. See fig. 4 where is also represented another view of the Coupler
- In addition to these works a base activity is going on in order to find the best procedure to prepare good quality surfaces.

Acknowledgements.

The SALAF group is very grateful to the GALVAIR Company for its availability and collaboration in the Electroforming procedures. The same applies to the COMEB Company for the construction of the cores.

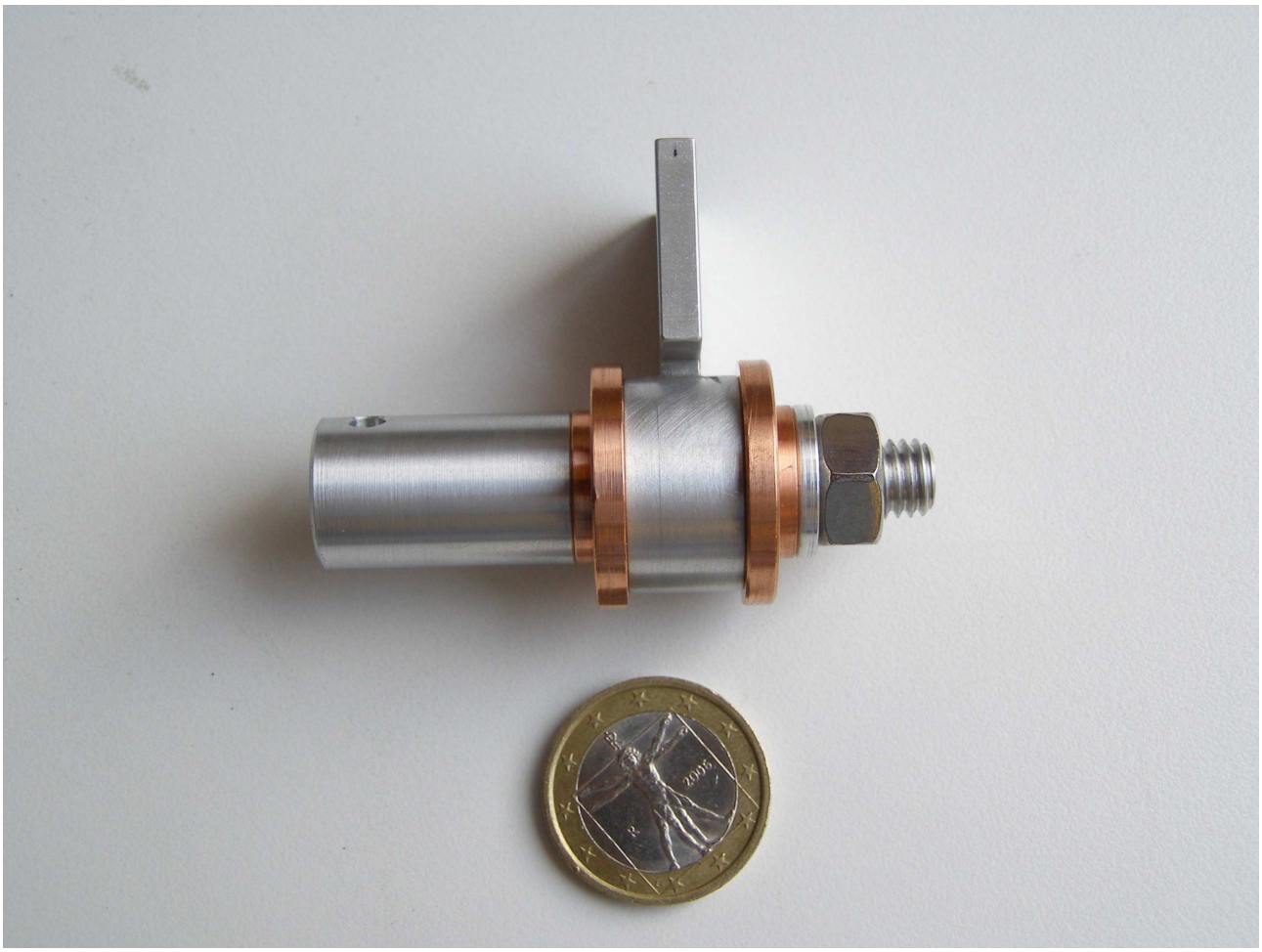
Figure captions:

Fig 1 The Al core that represents the COUPLER ready to be electroformed .

Fig 2 A Mo-Cu electroformed structure.

Fig 3 A Mo-Cu electroformed structure .The connection between Mo and Cu is based on a different geometry respect to Fig.2.

Fig 4 The core of 5 cells , Mo-Cu structure prepared for RF tests. Another view of the COUPLER core is represented .



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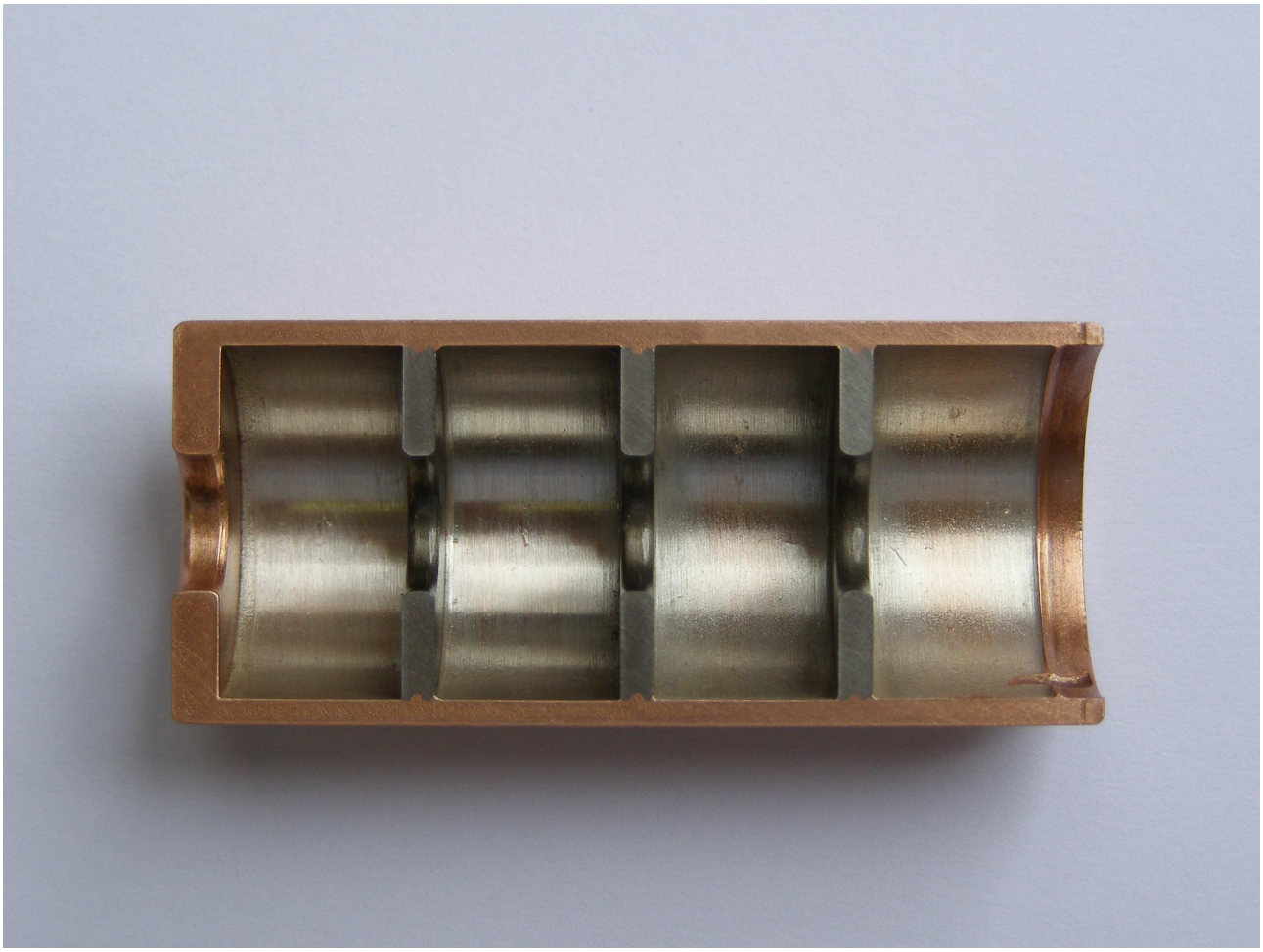


Fig 2 A Mo-Cu electroformed structure.

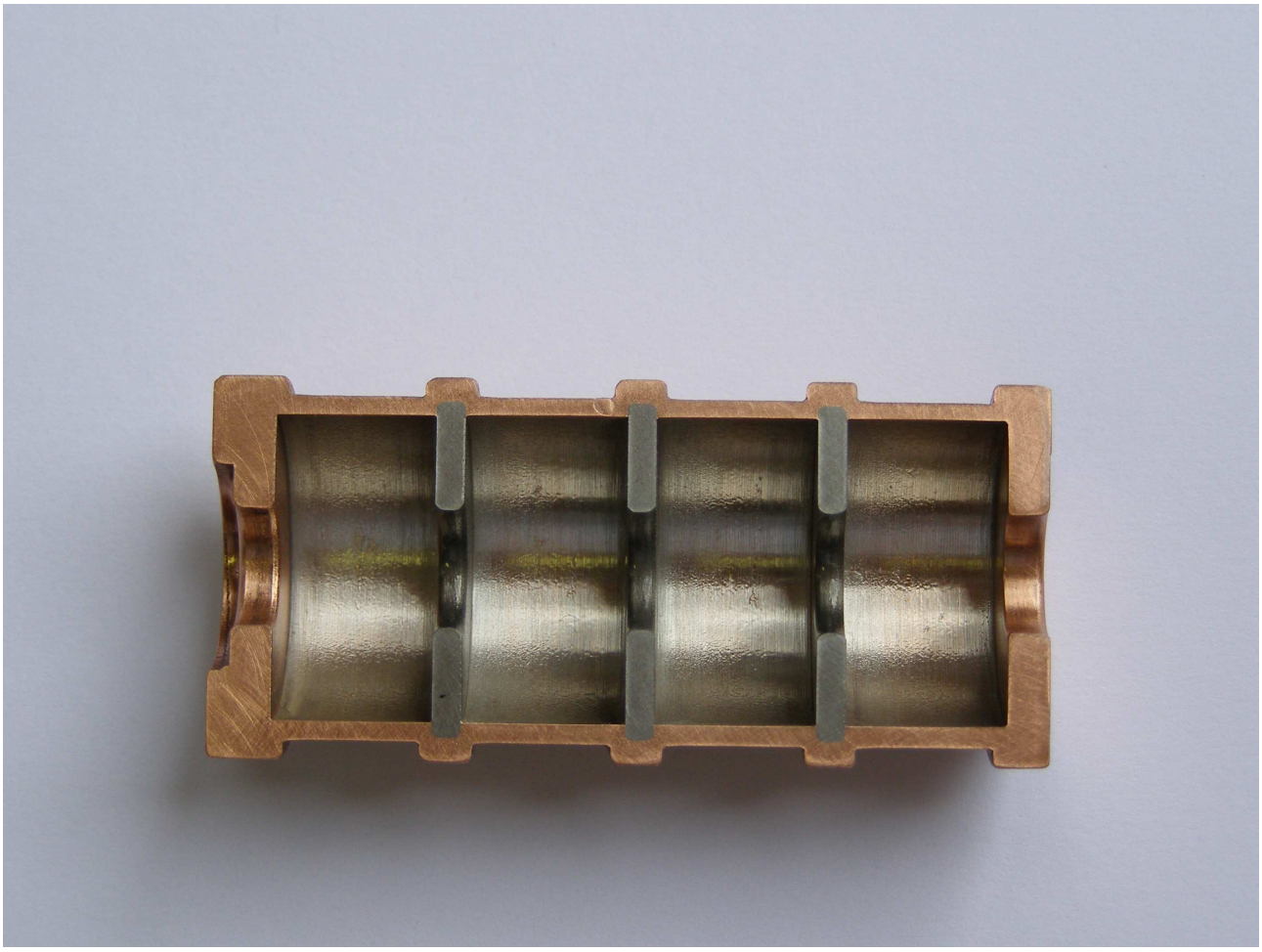
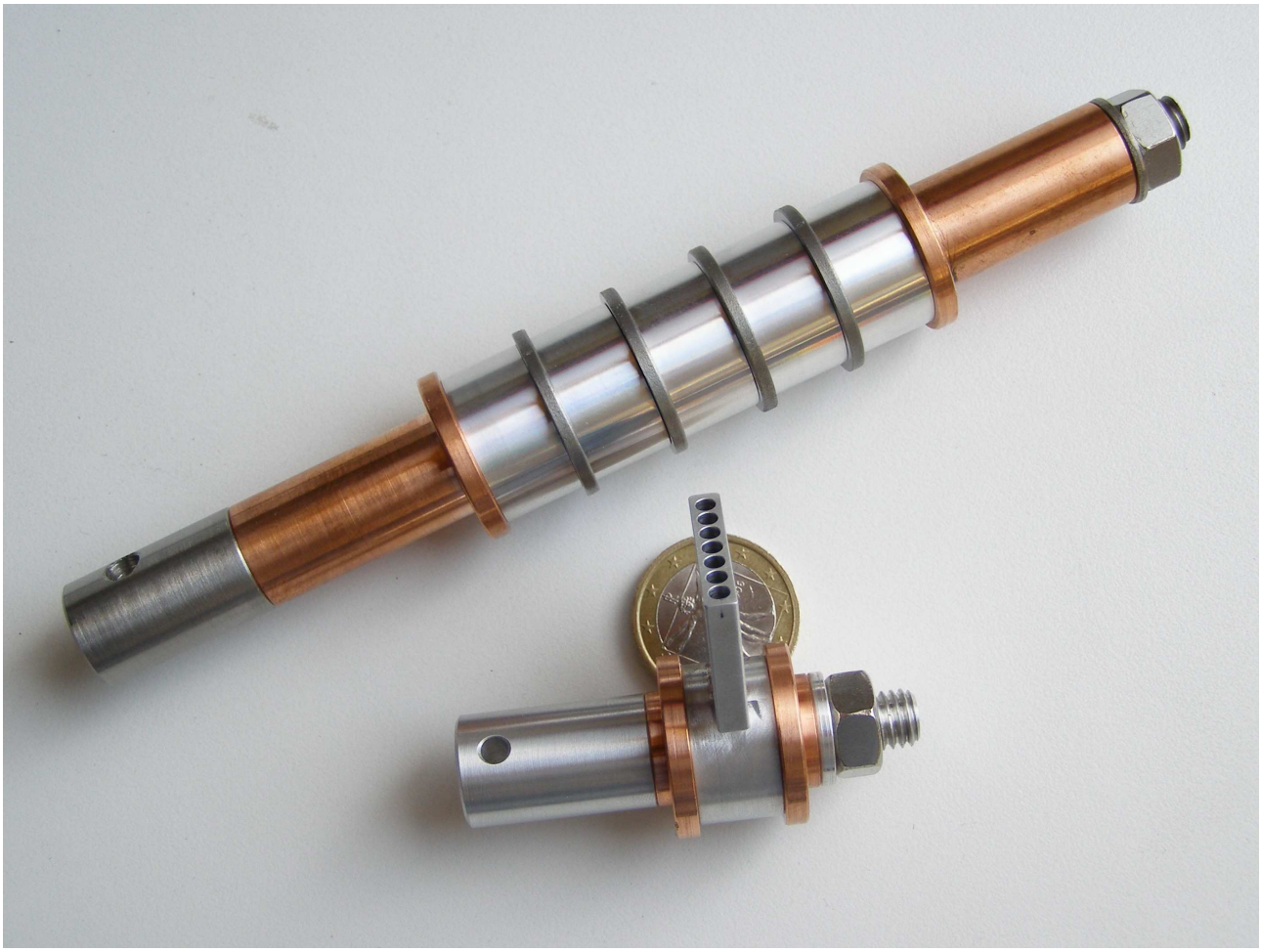


Fig 3 A Mo-Cu electroformed structure .The connection between Mo and Cu is based on a different geometry respect to Fig 2



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