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PROGRESS ON CONSTRUCTION AND TEST OF HIGH GRADIENT X-BAND STRUCTURES

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Abstract

X-band copper and molybdenum structures have been constructed at LNF and are ready to be tested at high power at SLAC. In the note we report the low power RF measurement results on the first prototypes.

1 INTRODUCTION

The sketch of the cells structure to be tested at high power is reported in Fig. 1. The device is a 3-cell structure fed by the circular waveguide. The central one is the cell under test at high gradient while the other ones are used to match the RF power from the input circular waveguide and to balance the electric field in order to have the maximum intensity in the central one. This scheme is that used at SLAC for the cell test [1]. The mode excited to test the structure is the π-mode. Its electric field profile on axis and the reflection coefficient obtained by HFSS simulations [2] are reported in Fig. 2 for a copper structure. They show the good matching at the nominal RF frequency of ~11.424 GHz and the maximum field intensity in the central cell with respect to the other ones.
The main cell dimensions for the copper structure are reported in the mechanical drawing of Fig.3.

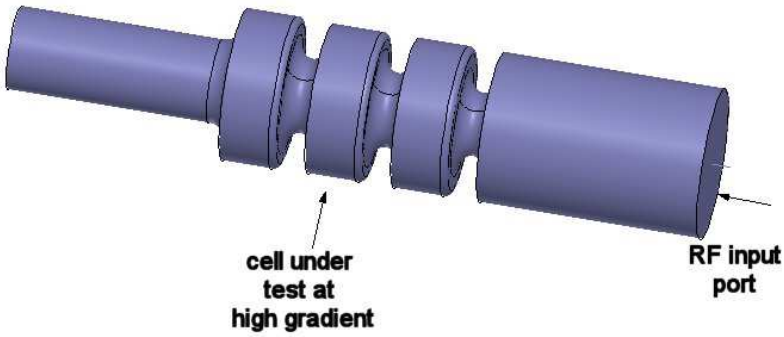

FIG. 1: sketch of the cells structure to be tested at high power.

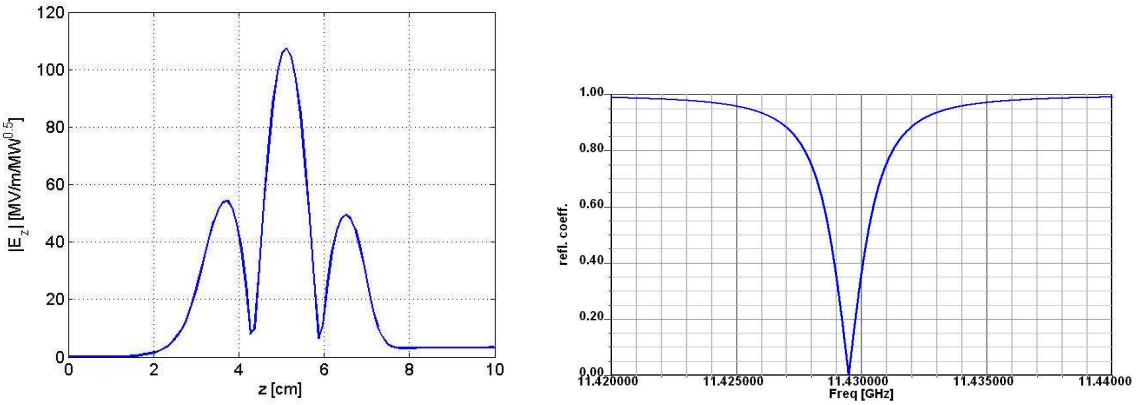

FIG. 2: electric field profile on axis and reflection coefficient at the RF input port for the π-mode (HFSS results).

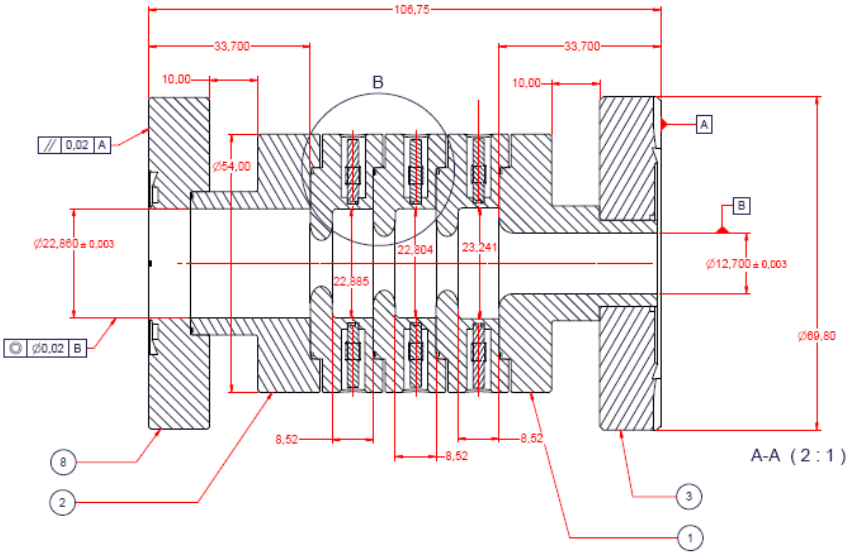

FIG. 3: mechanical drawing of copper structure with dimensions.

2 RF MEASUREMENTS RESULTS FOR THE COPPER STRUCTURE

The picture of the copper structure is reported in Fig. 4. The structure has been closed by two metallic plates and two small probes have been inserted to excite the field ([1]). With respect to the case of a circular mode launcher this configuration introduces a shift of the resonant frequencies and a perturbation of the electric field profiles. Fortunately the perturbation on the π-mode is negligible. The multi-cell mode frequencies, quality factors and the related field profiles obtained by SUPERFISH [3] are reported in Table 1 and Fig. 5. The mode number 4 corresponds to the π-mode.
The measured resonant frequencies and the quality factors of the structure simply assembled and before brazing are reported in Table 1. As an example the measured field profiles of the π-mode and of the mode number 1 (0 multi-cell mode) are reported in Fig. 6. They have been obtained by bead-pull technique.
RF measurements after brazing have been done and no significant differences have been measured with respect to the case of the structure simply assembled.

TABLE 1: mode frequencies and quality factors (given by SUPERFISH) and measurements results of copper structure before brazing.

MODE	Res. Frequency [MHz] (simul.)	Res. Frequency [MHz] (meas.)	Quality factor (simul.)	Quality factor (meas.) ([2])
1	10980	10983	8478	7700
2	11118	11127	8889	7600
3 ([3])	11211	11209	12354	--
4	11433	11429	8380	7200

[1] We have adopted this solution because we do not have coaxial-circular waveguide transitions available.
[2] After brazing the quality factors increase by ~5%.
[3] This mode is not a multi-cell mode but the mode of the circular waveguide. Its frequency is strongly depend on the circular waveguide length and strongly coupled with the probes used to characterize the other multi-cell modes.

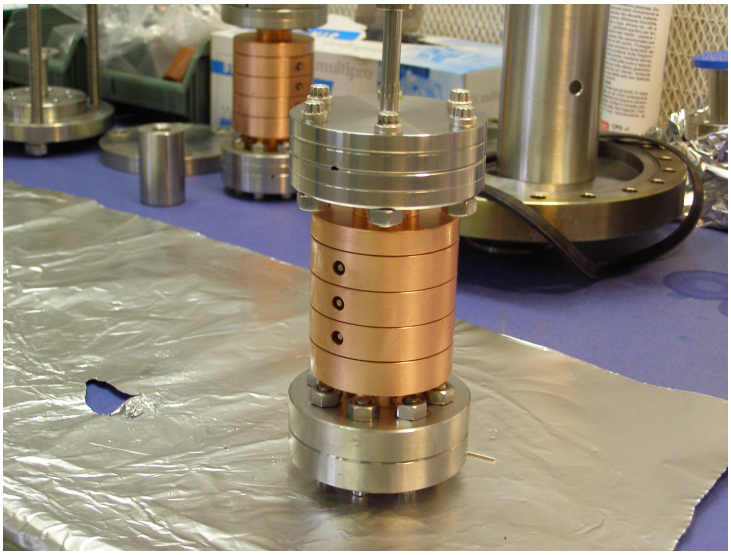

FIG. 4: picture of the copper structure under test.

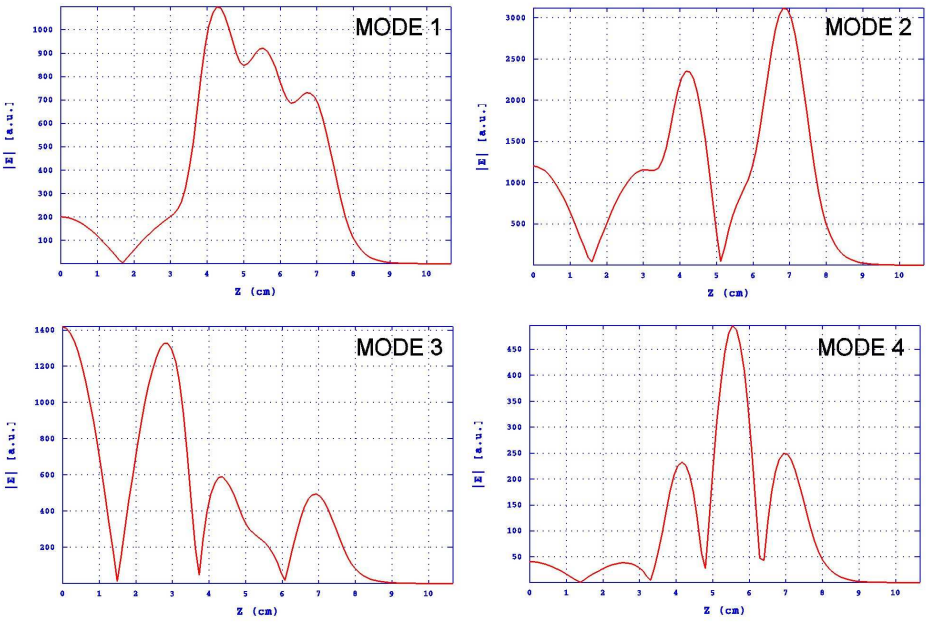

FIG. 5: field profiles of the resonant modes (SUPERFISH results).

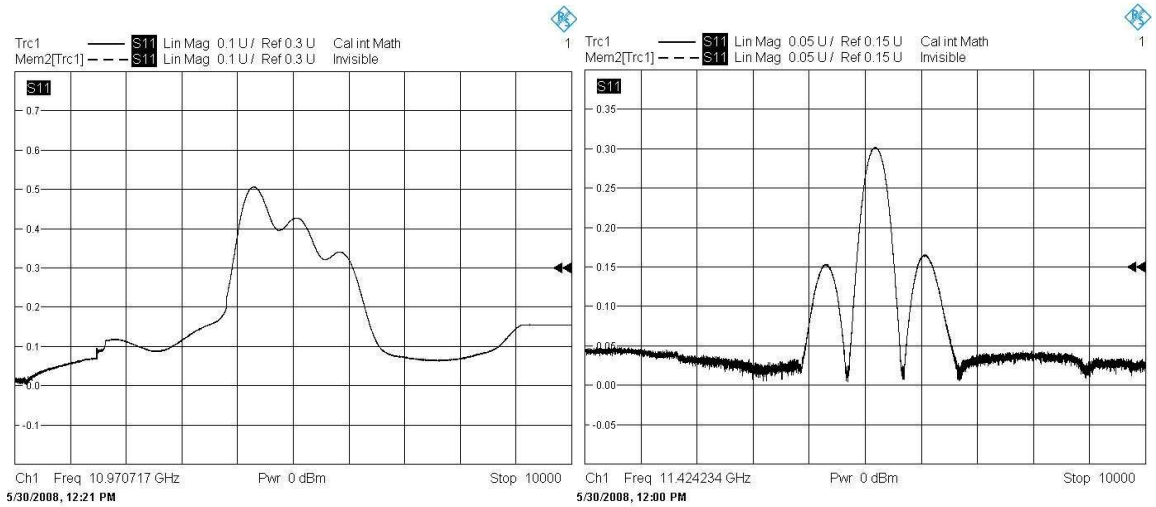

FIG. 6: measured π-mode and 0-mode field profiles (by bead-pull technique).

2 RF MEASUREMENTS RESULTS ON MOLYBDENUM STRUCTURE

The picture of the molybdenum structure is reported in Fig. 7. The structure has dimensions slightly different with respect to the copper one to take into account the different surface conductivity [1], as reported in Fig. 8. Simulations and RF measurements have been done in the case of the structure simply assembled. The results are shown in Table 2 in term of resonant frequencies and quality factors. Only the quality factor of the π-mode has been measured with accuracy and is a factor 2.65 below the theoretical one because of the bad RF contact. The field profiles measured by the bead pull technique give results similar to the case of copper structure. Tests to braze the molybdenum structure are still in progress.

TABLE 2: mode frequencies and quality factors (given by SUPERFISH) and measurements results of molybdenum structure before brazing.

MODE	Res. Frequency [MHz] (simul.)	Res. Frequency [MHz] (meas.)	Quality factor (simul.)	Quality factor (meas.)
1	10985	10968	4862	--
2	11120	11097	5144	--
3	11232	11199	6795	--
4	11430	11430	4776	1800

FIG. 7: picture of the molybdenum structure under test.

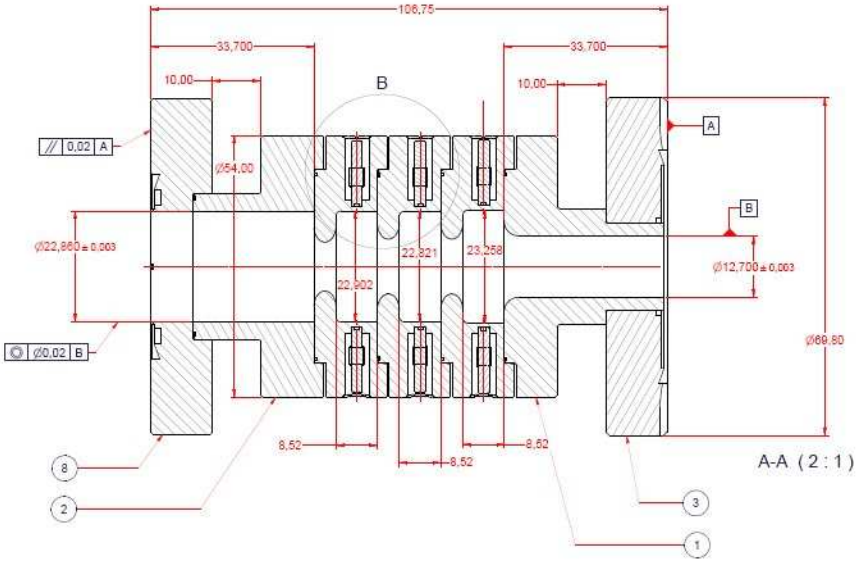

FIG. 8: mechanical drawing of molybdenum structure with dimensions.

3 CONCLUSIONS

X-band RF structures have been constructed and tested at LNF. RF measurement results of copper and molybdenum structures have been showed. The copper structure is now ready to be tested at high power at SLAC in the framework of the collaboration between LNF and the SLAC Laboratory itself.

4 ACKNOWLEDGEMENTS

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5 REFERENCES

[1] V. Dolgashev, private comunications and his seminar held at LNF
[2] www.ansoft.com
[3] J.H. Billen, L.M. Young, Part. Acceler. 7 (4) (1976) 213.