INTRODUCTION

During 2014 the working activities were mainly focused on two objectives: the production of 5 accelerating modules for the IFMIF/EVEDA RFQ [1], and the production of components for the IFMIF RF power test [2]. The latter production regarded in particular the RF couplers (see Fig. 1) and the end-plates for the testing cavity. Additional thermal cycles was dedicated to the brazing of the first prototypes for the ESS project [3].

REPORT OF THE WORK

The working plan was very dense at the beginning of the year (see Fig. 2) when the fabrication of the couplers partially overlapped on the assembly of the RFQ module #8. Another intense period was in July when two modules were assembled and brazed in one month. Typically the assembly phase spans over three weeks.

The second part of the year featured the brazing of the RFQ module #11, the reparation of an incomplete brazing external flange of the module #08, and a test of a new brazing set-up for the module #07. Finally in the early weeks of 2015 some leaking cooling channels were rebrazed on the modules #5 and #6.

All the thermal cycles took advantages of the upgrading program made on the new control system of the vacuum furnace [4].

The brazing activities shown in Fig. 2 were always preceded by the chemical cleaning of the copper parts and stainless steel parts. This task was carried out internally by the LNL Chemical Treatment Section, using the cleaning procedures obtained in a past investigation [5]. The nickel plating of the stainless steel components was instead done by an external company, following the qualification of the deposition [6].

Fig. 1. Picture of the last brazing phase for the IFMIF couplers inside the LNL furnace.

Fig. 2. Sketch of the production timeline in 2014 and early 2015. The red diamond are related to the IFMIF project. Text in red is the one step brazing of the RFQ modules. The blue diamonds represents the brazing for the ESS project, whereas in green additional brazing for the production of the power test stand and reparations.
MATERIAL STUDIES

Additional research activities were dedicated to the studying of the brazing joints made on copper parts and stainless steel parts formerly nickel plated.

The test sample was extracted from a brazing assembly test my means of two EBW cuts, made at the LNL machine shop. The specimen consist of a slice of the original assembly with a thickness of 2 mm. This sample was then polished in several passages and analyzed in with a SEM.

The images in Fig. 3 shows the copper portion on the left and the stainless steel portion on the right, joined by a heterogeneous phase composed by the brazing filler metal. The joint is characterized by the typical eutectic structure [7] made of alternating portion of Copper rich solid solution and Silver rich solid solution. Looking at the distribution of the chemical elements, it is possible to recognize the nickel layer at the boundary of the stainless steel portion, and the palladium contained in the brazing filler metal. The migration of the elements between the joint does not appear to be marked, except for the Palladium which is found on both sides and at the grain boundaries of the copper.

Further research on the material regarded the influence of the annealing temperature of the Copper parts. Preliminary work on forged and annealed samples were done accordingly to the literature [8] using LNL internal equipment. A results is shown in Fig. 4 after a mechanical polishing and a chemical etching to accentuate the grain boundaries.

CONCLUSIONS AND FUTURE WORKS

The production sequence for brazing components was extensively validated during 2014. This organization will also be used in future projects, such as the production of the RFQ for the SPES project and the production of the drift tube for the ESS DTL accelerator.