STATUS OF THE BETA 0.12 SUPERCONDUCTING CRYOMODULE DEVELOPMENT FOR THE SPIRAL 2 PROJECT

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Abstract

SPIRAL2 is a radioactive beams facility, composed of a superconducting linac driver, delivering deuterons with an energy up to 40 MeV (5 mA) and heavy ions with an energy of 14.5 MeV/u (1 mA). This facility is now fully approved by the French government.

IPN Orsay is in charge of the study and manufacture of the beta 0.12 cryomodule of the superconducting LINAC. These cryomodule, designed for an overall cryogenic power of 30 W at 4.2 K, is composed of two 88 MHz rf resonator providing a minimum of 6.5 MV/m with a quality factor of 1 10 9, two tuning systems controlling the resonator frequency in a range of 80 Hz and an alignment system allowing to adjust the cavity position within +/- 1 mm. Several tests performed on a first resonator prototype fabricated by Zanon Company, have validated the cavity and its auxiliary components design. A first cryomodule fully equipped (cavities, cryostat, tuning and alignment systems), planned to be tested at the beginning 2007, is under manufacturing. The details of the cryomodule design and the resonator's tests results are discussed in the paper.

INTRODUCTION

The Spiral 2 construction phase has officially started at the end of 2005. Works on the Beta 0.12 Cryomodule have been mainly orientated on the APD design consolidation [1] and the evaluation of the ways to manufacture and to test the 9 cryomodules with the aim to begin the installation at the GANIL Spiral 2 accelerator building from autumn 2010. Parralely tests on the first cavity prototype have been performed and should continue untill the end of the year. The APD conceptual design of the Cryomodule components, has been maintained [2]. The manufacturing of a first Cryomodule equiped with two QWR resonators, two power couplers and the assiociated cryostat sub components has started and is planed to be tested during the second 2007 trimestre.

QWR RESONATORS

Tests on a first prototype, manufactured by the Zanon Company have validated the main parameters of the QWR design [3]. The Spiral 2 nominal RF performances, Eacc = 6.5 MV with a RF loss of less than 10 W, have been measured several times during different tests with sufficient margins (figure 1). The helium vessel shape and the frequency tuning using static superconducting plungers have also been validated.

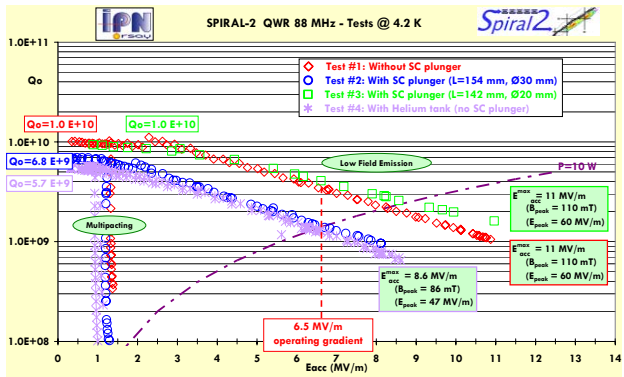

Figure 1: Q0 vs Eacc curves

The frequency shift due to the helium bath pressure variations has been measured to around 16 Hz/mbar. The two next resonators, manufactured by Accel company, are designed with a more efficient stiffener to reduce this frequency shift. This technical solution requires the use of Titanium for the helium vessel, as the first prototype was made with stainless steel. The main concern for the cavity remains the presence of a multipactor barrier at very low level, few kV, which could not be processed. The design of the next resonators includes a shape modification in order to reduce this effect. Tests show that the "100 K effect" is not negligible for our cavity. The Q0 is reduced by a factor 2 when the cavity is maintained 14 hours at around 100K.

Two power couplers prototypes, designed by the LPSC laboratory, have been successfully tested [4].

The power couplers for all the cryomodules are planned to be ordered at the beginning of 2007. Tests on the cavity prototype and the two next cavities will be performed before fixing the final design and manufacturing of the beta 0.12 cavities serial. These tests will be orientated on the frequency tuning using movable superconducting plungers, the low level multipacting study and the cavity response to microphonic perturbations.

CRYOSTAT

A first prototype cryostat is being manufactured on the basis of the general concept defined during the Spiral 2 APD [2]. The different sub components are manufactured in several firms and will be assembled at IPN in the CEA/LAL/IPN common facility named "Supratech".

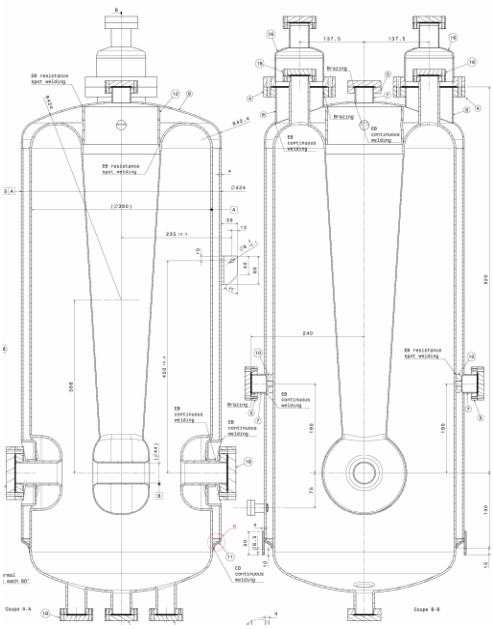

Figure 1: Spiral 2 beta 0.12 QWR

The beginning of the assembly is planned for february 2007. The cryogenic validation tests of the fully equiped cryomodule (cavities, power couplers, cold tuning systems, alignement set up…)will be performed from April 2007 to june 2007. The cryomodule test bench is under manufacturing at IPN. It will also allow to validate the 10 kW and 20 kW solid state RF amplifiers prototypes and a Spiral 2 cryogenic cold valves box prototype. The aim of these tests will be the technical validation of the cryomodule as well as to determine the mounting and the alignement procedures and the cryogenic and cavity tuning command controls parameters. The tests and assembly "supratech" facilities will be used for the production of the 9 beta 0.12 cryomodules. This facility will be equipped with a 85 m2 clean room, featuring an HPR installation in a 45 m2 class 10 area.

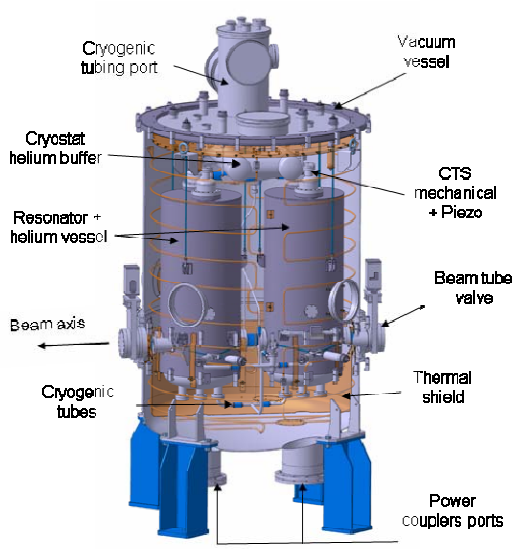

Figure 2: Spiral 2 beta 0.12 Cryomodule

The clean room has been ordered and is planned to be operationnal in december 2006. A chemical etching installation, as well as a 20l/h liquefier are respectively forseen for the middle of 2007 and the beginning 2008.

CRYOMODULE INDUSTRIALIZATION

Studies on the Cryomodule manufacturing sequences and tasks distribution between labs and industries have started.

from the folowing chart (figure 3), we consider a total period of approximatively 30 months to mount and test the 9 beta 0.12 cryomodules.

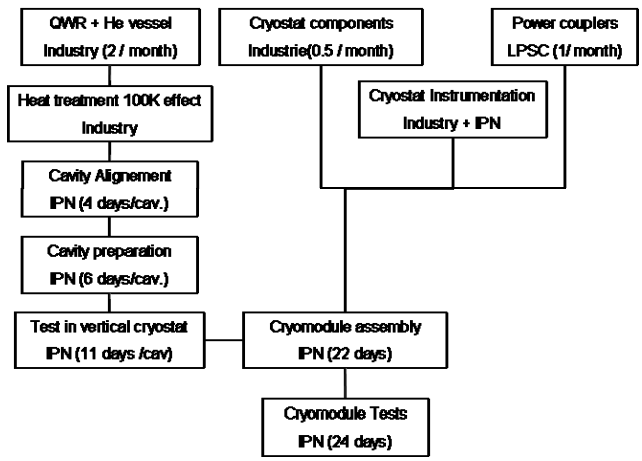

Figure 3: Manufacturing chart for 1 cryomodule

Currently, the industrialization option for IPN is to have all the mechanical cryostat sub components supplied by only one firm and to mount and test the cryomodule at IPN. However assembly of a part of the cryomodule serial in industry, is investigated in order to cope with eventual delays and lack of manpower during the serial production.

SCHEDULE

The milestones for the beta 0.12 cryomodule manufacturing are summarized below.

- November 2006: High RRR Niobium contract signature for 12 beta 0.07 and 20 beta 0.12 cavities.
- December 2006: contract signature for manufacturing of 20 beta 0.12 QWR with helium vessel. A stop in the serial manufacture schedule is planned to take into account the next tests on the QWR prototype.
- From April 2007 to June 2007 : tests of the completely equipped beta 0.12 prototype cryomodule

- September 2007: contract signature of the cryostat components manufacturing for 9 beta 0.12 cryomodules.
- February 2008 to September 2010: manufacture and acceptance tests of the 9 beta 0.12 cryomodules.

In parralel, R&D tests at 300K will be performed to study the multipacting at low field and the microphonics effetcs on the resonnator frequency. Two cryogenic tests, one with a prototype movable tuning plunger and one with a prototype power coupler, are forseen on the first cavity prototype for the end of 2006.

REFERENCES

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