SUPERCONDUCTING RF ACTIVITIES AT INFN MILANO-LASA

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Abstract

The ARES group at LASA (Laboratorio Acceleratori e Superconduttività Applicata, *i.e.* Laboratory for Accelerators and Applied Superconductivity), INFN Milano, is primarily engaged in the TESLA Test Facility International Collaboration. Our main responsibility in the collaboration are the design of the TTF 12 m long cryostats, manufactured by the Italian company Zanon under our supervision and the development and construction of the high brightness photocathode preparation system. The prototype TTF cryomodule has been successfully operated in DESY in 1997, and two second generation cryostats have been manufactured and sent to DESY, to be assembled and tested in 1998. The second generation cryostat has a much simpler and cheaper design than the prototype structure, and allowed a cost reduction of a factor of 2.5. A third generation design is in its final stage, in order to progress towards the stringent requirements and lower costs of the TESLA 500 cryomodules, including semi-rigid couplers and “Sekutowicz superstructures” compatibility. Six nine cell superconducting cavities, according to the Collaboration specifications, are being provided to DESY through Italian companies (Ansaldo and Zanon). Recently, a new R&D activity on RF superconducting cavities for a high current proton linac for nuclear waste transmutation and energy production has been funded in a two year program.

Cryostat activities for the TESLA TTF Collaboration (and towards TESLA 500)

Our main involvement in the superconducting RF activities of the TESLA TTF collaboration is the design, construction (with the Italian company Zanon) and installation of the eight cryostats of the TESLA Test Facility Linac. The TTF cryomodule is a unit containing eight 1.3 GHz nine-cell superconducting cavities and a superconducting quadrupole package. The whole structure is approximately 12 meters long, providing support, alignment, cooling and thermal insulation to the string of superconducting cavities.

A prototype cryostat has been designed, according to the Conceptual Design discussed and approved by the TESLA Collaboration in 1993, fabricated in Zanon, installed in DESY and successfully operated in 1997[1]. The design was very complex, due to the large amount of diagnostics in the prototype, and to the choice of a safe cryostat operation under any cooling condition. This complexity reflected in high costs. Our role, together with Zanon, has been to provide the engineering drawings of the cryostat, and to validate its behavior during the cool down procedure with an extensive numerical analysis of its thermal-mechanical properties[2]. The cryomodule has been assembled and tested at DESY under the responsibility of our group in March 1997. By the end of the year it has been cooled down twice, opened for the maintenance of the cold cavities tuning system, closed and cooled again. Another contribution of our group has been the development and installation of a stretched wire system (the Wire Position Monitor) for the online monitoring of the cold mass movements during the cool down operations. A brief summary of all these activities can be found in the References[1]-[4] or in a separate contribution to these Proceedings[5].

The extensive experience gained by the group in the design and operation of the prototype cryomodule allowed us to produce a second generation design for the cryostats number 2 and 3 of the TTF accelerator. The design was substantially revised and greatly simplified, in order to reduce dramatically the manufacturing costs of the cryostat. The design achieved a cost reduction of a factor 2.5 with respect of the prototype. The main simplifications of the second generation design are a revision of the thermal shields at 4.5 K and 70 K, which now use integrated cooling pipes, welded with a special “finger welding scheme”[4], and an improved, and noticeably simplified, specification of tolerances and procedure for alignment. In the prototype cryostat the cooling was performed through large section copper braids, which raised the costs and added complexity to the structure. Extensive simulations of the new scheme were performed to test the validity of the design. The two cryostats have been build at Zanon and shipped to DESY. Installation and operation is foreseen during 1998.

A third design is in its final stage for a further improvement of the cryomodule design, without additional increase of the manufacturing and assembling costs, in order to progress towards a design consistent with the TESLA 500 operation and costs. This design will use standardize components in order to reduce the costs of the mass production expected for the TESLA 500 collider and allows the possibility of the use of semi rigid power couplers and the “Sekutowicz superstructures”. The design is expected to be approved by the TESLA collaboration at the beginning of 1998.

The operation of the prototype cryomodule allowed us to test our Wire Position Monitor system for the movements of the cold mass during cool down and operation[3]. This system is needed in order to verify that the alignment of the cavity string is preserved during the cool down, and can be reproduced between successive cool downs. The system obtained the desired sensitivity for the TTF alignment requirement and will be installed on the two second generation cryomodules. The results obtained so far allowed us to reach a better stability for cavities and quadrupole alignment.

Superconducting cavities for TTF

As a part of the TTF Collaboration, INFN has to provide, through the Italian companies Ansaldo and Zanon, six superconducting nine cell cavities to the TTF linac. After overcoming the initial difficulties of setting the proper welding parameters, the A15 cavity has been successfully tested and showed a field limit at 23 MV/m on the DESY test stand, thus reaching the goals of the TTF linac. The industrial procedure for cavity fabrication is now under control, and the last three INFN cavities (plus the repaired A14) will be delivered during the first semester of 1998. A new batch of 6 cavities is expected to be ordered during 1998.

A proposal for a High Current Superconducting Linac for Waste Transmutation

An R&D program on an accelerator driven system (ADS) for nuclear waste transmutation has been recently approved in Italy. In this two year program, starting at the beginning of 1998, two Italian research agencies (INFN and ENEA) will be supported to study, together with other Institutions and the national industry, critical components of the accelerator driven system. Our specific task is to develop, together with the industrial partners, a design of the high energy part of the proton accelerator, along with prototype development for the most critical components.

We have set up a reference design for such a machine in References [6] and [7], and we present a separate contribution elsewhere in these Proceedings[8]. The linac will be composed of three sections of elliptical cavities at the 350 MHz LEP frequency. The three sections will use five cell cavities, designed to match the proton beam at the normalized velocities β=0.5, 0.65 and 0.85. The focusing will be provided by a quadrupole doublet structure, and the cavity cryostats will be placed in the space between two doublets.

The cavities have been optimized both in terms of their electromagnetic performances (in terms of peak electric and magnetic fields on the surface) and of their structural behavior. Stiffening structures for the lower β structures have been designed.

Based on the design of the proposed machine, our R&D activity is aimed at the construction of crucial components of the superconducting linac, and at finalizing the design of the ADS system. In particular, we will develop with the industries, niobium monocell β=0.5 cavities and a complete five cell structure for mechanical and RF warm tests. A complete copper five cell structure at β=0.85 will be built and sputtered at CERN with niobium. After the cold test at CERN, in one of the LEP2 vertical cryostats, the cavity should be operated in the horizontal cryostat prototype that we are designing for the linac.

References

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