ACTIVITIES on RF SUPERCONDUCTIVITY at DESY

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Abstract
At DESY the HERA electron storage ring is supplied with normal and superconducting cavities. The superconducting system transfers up to 1 MW klystron power to the beam. We report on the experiences on luminosity- and machine study runs. Since 1993 one major activity in the field of RF superconducting cavities is the installation of the TESLA Test Facility. We report on set up of hardware and first tests of s.c. resonators.

Introduction

Since 1992 16 superconducting (s.c.) cavities [1] are operating in the electron storage ring at HERA,. We report on the actual performance of the system after about 23,000 hours of operation. Since 1993 one main activity in the field of superconducting cavities is related to TESLA Test Facility. In order to study the application of RF superconducting cavities for linear accelerators in the TeV range, a total of 32 s.c. resonators will be installed in a testlinac section. We report on installed hardware and on the first results obtained in vertical and horizontal tests of the cavities at 1.8 K.
Experimental set ups for measurements of RRR on cavities and multipacting effects of metallic surfaces have been developed and will be briefly described.

I. HERA Superconducting Acceleration Section

I.I Set up and operation

Since 1992 the HERA electron storage ring is equipped with 16 superconducting (SRF)- and 84 normal conducting (n.c) resonators, both systems running at 500 MHz. Details of the technical set up and some operating conditions were reported in earlier papers [1, 2]. Since then no changes were done on the technical installation.
Up to now the 16 s.c. Cavities have a total of 23,000 hours in beam operation time. In beam study shift max. beam currents of 50 mA where reached. Luminosity runs have typical currents of 30 mA at 27.5 GeV.

I.II. Operation experiences

Details of operating experience, reliability and technical difficulties are described by J. Sekutowicz [3], this workshop. The major technical problem with the superconducting system is related to multipacting in the input coupler. This effect can be suppressed by high power pulse processing of the couplers. Unfortunately, multipacting reappears after about two weeks of operation. Recently, during the time of injection and ramping of a new proton fill (about once every 12 hours) multipacting was completely suppressed by short processing.
A fast data logging system was installed and used to analyse the coupler discharge problem in more detail. There is strong evidence that the primary multipactor current initiates a plasma discharge [3]. This plasma discharge shortens the coaxial guide for RF power and therefore might damage the metal or ceramic surface even during processing cycles. Therefore other means against multipacting will be tried out which eliminate the need of processing.

II. The TESLA Test Facility

II.1 General layout

In order to study feasibility and costs of the application of RF superconducting cavities for linear accelerators in the TeV range, the TESLA collaboration started to build a test facility. On a ground space of 3000 m^2 a test linac and the hardware for preparation and installation is set up. The Test Accelerator [4] will be supplied with the injector, the s.c. capture cavity, the acceleration section (4 cryomodules) and a beam-analysis experiment. The nine cell cavities, designed for TESLA [4] application, will operate at 1.8 K. Each cavity will be supplied with a separate Helium tank made from Titanium. Eight cavities and one quadrupole are housed in a cryomodule. Sixteen cavities will be powered by one 5 MW klystron. The design gradient for TTF is 15 MV/m. In order to build high performance s.c. resonators a preparation , handling and test-area is set up. We report on the actual state of the hardware and first experiences resulting from 9 resonators built by industry.

II.II Cavity design

A total of forty 9-cell cavities will be built. The TTF cavities are fabricated from niobium of quality RRR 250 and higher in standard fabrication methods (deep drawing and electron beam welding technique). Two different types of HOM couplers will be studied in the beam-performance. Type one is of coaxial design with electrical coupling and is welded to the cavity. Type two will have a magnetic coupling to the

HOM's. This coupler is connected to the beam pipe by a flange. The peak power of 208 kW is coupled to the cavity by a coaxial line. The coupling can be adjusted within a range of 10.

II.III Preparation area

A cleanroom of 300 m^2 ground space was built up in 1994 and provides assembly areas of class 10000; 100 (100 m^2) and class 10 (40m^2) quality. A chemistry area of 70m^2 (class 10000) space and a ultra high vacuum oven is built in for surface treatment and post purification of the resonators [5]. A clean water-plant (R = 18 MΩ cm P< 0.2 μm) is located outside of the cleanroom. It supplies the chemistry, the cleanroom and the high pressure rinsing stand (HPR). The HPR is located in a sluice connecting the chemistry and the class 100 assembly area inside the cleanroom. It allows to pressurise 22 l ultra pure water per minute up to 200 bar. The water jet impacting the internal cavity surface is formed by 8 nozzles on top of the spraying cane.
A ultra high vacuum furnace for post purification of niobium by Titanium solid state gettering is supplied with two cryogenic pumps of 1500 l/sec capacity each. It allows heat treatments up to 1500 C in a vacuum of 1 10^{-8} torr.
The assembly of the cavities for test , adaptation of HOM- and power-couplers is done in class 10 areas. Before installation to the module the individual cavities will be lined up in an eight cavity unit inside class 10 area as well.

II.IV Testarea

Two vertical stands and one horizontal teststand (CHECIA) are located in the testarea. The two vertical test stands are supplied with HPP couplers and allow to suppress field emission by high peak power processing (HPP) [6, 7]. Before insertion of a cavity into the module an acceptance test takes place in the CHECIA cryostat. Here the resonators are equipped with He tank, power input coupler, HOM couplers and the tuning mechanism as well.
A 5 MW klystron is located next to the test stands. It is in use for the two horizontal test stands, an input coupler training stand, the horizontal test stand and for the first linac section.

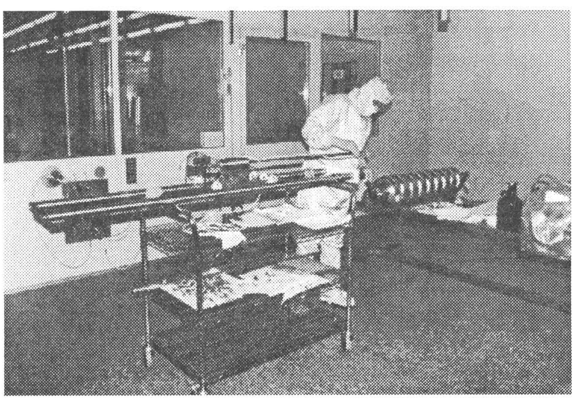

Fig. 2 Assembly of a 9-cell cavity in class 10/100 area

II.V Couplers and tuners

Two different types of input couplers are under test. Both designs for power couplers are based on two ceramic windows: one at room temperature and the second one at the 70 K level. The DESY design foresees cylindrical windows at 300 and 70 K level while the FNAL design is based on a conical ceramic at 70 K and a disc window at the 300 K level. The relative shrinkage of up to 14 mm between cryostat vessel (at 300 K level) and the cold mass (1.8 K level) is provided by bellows in both designs [4]. Tuning of the cavities is done individually by a stepping motor connected to the cavity via an elliptical gearbox and lever arm system with a resolution of 0.8 Hz per step. The total tuning range is 500 KHz.

II.VI Status

Up to now 9 cavities (6 with type 1 and 3 with type 2 HOM couplers) have been delivered by industry and are under test. One cavity is already supplied with its He tank and is tested in the horizontal test cryostat. One test stand can be supplied with a rotating T mapping system to analyse cavity limitations [8]. The sequence of preparation and handling of cavities not supplied with a He tank was tested out in 8 test runs. During these tests it is found that a second HPR at 80 bar right after assembly and with couplers on place suppresses field emission very effectively.
RRR improvement of the resonators was done in 6 test runs. Samples fired together with the resonator showed RRR of 550 to 650. The starting value of the sheet material is RRR 250.
The cavity foreseen for the injector section was supplied by Saclay. It was tested in CHECHIA under cw conditions up to Eacc = 18 MV/m [9].

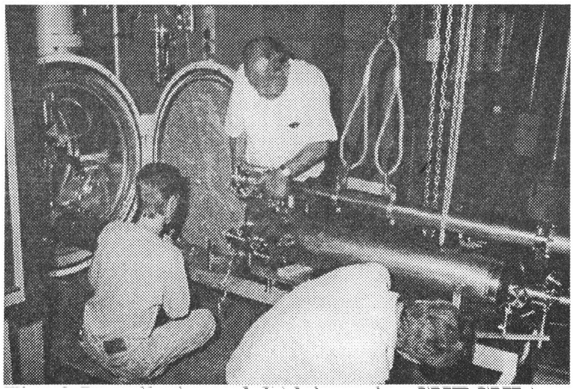

Fig. 3 Installation of C19 into the CHECHIA cryostat

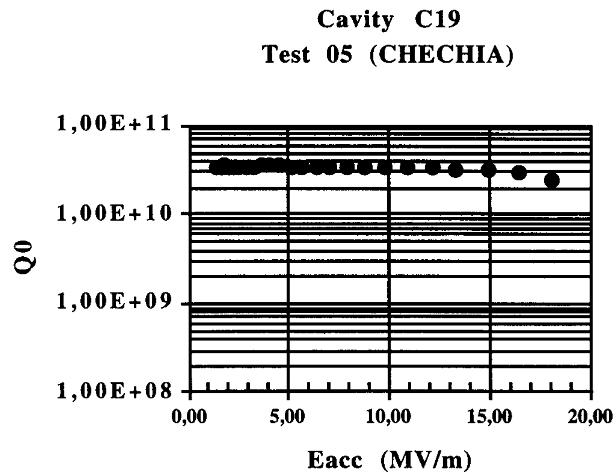

Fig. 4 Test result of cavity C19 with HOM couplers of Saclay type in place

III Inductive RRR Measurement

Usually the RRR value is measured by 4 wire DC technique. The disadvantage is that a sample has to be cut from the material under investigation. In order to measure the material property after fabrication of the cavity, a non destructive method is desirable. Therefore an inductive measurement technique has been developed. A primary coil induces eddy current in the metal surface. The induction of the eddy current is sampled by a pick up coil. The change of eddy current when passing from normal conducting to superconducting state is correlated with the RRR value. Therefore the RRR of a cavity wall can be measured during cool down by placing pairs of small drive and pick up coils at the outer cavity wall [10].

IV Multipacting Resonators

Multipacting is a phenomenon of resonant electron multiplication. Two conditions have to be fulfilled: the electron trajectories form a closed orbit and the secondary emission coefficient is larger than 1. The secondary yield has been measured by impacting the surface with a continuos electron beam in order to investigate multipacting on technical surfaces under RF fields, a resonator has been designed which shows strong multipacting current. The multipacting behaviour of different metals after different surface treatments has been investigated [11]. First measurements have been started to see the influence of condensed gases on cold surfaces. It is the aim to understand the multipacting of "cold" couplers for superconducting cavities.

Acknowledgement

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