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SUPERCONDUCTING CAVITY ACTIVITIES AT DESY

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Abstract

The activities in the field of rf-superconductivity at DESY are reported.Some different multicell structures were fabricated and measured in order to gain experience in superconducting cavity technology.Strong effort was made to construct and fabricate an 18-cell structure to be tested in the PETRA storage ring. Technical developments in the fields of cavity cleaning and temperature mapping are also described.

Introduction

In 1981 the design and fabrication of elliptically shaped 1 GHz cavities was started in cooperation with the university of Wuppertal.A first series of an 1-,5- and 9-cell structure was fabricated by INTERATOM.In addition a two-cell cavity was manufactured by DORNIER using a different welding technique.Encouraging results were measured.after applying tumbling and buffered chemical polishing.Two more 9-cell structures were fabricated for the PETRA beam test, one each by INTERATOM and DORNIER. The Nb-input and output couplers were fabricated and welded to the structure by LUFTHANSA./8/
Cryogenic and microwave components for the PETRA beam test have been developed and fabricated at the same time.The preparations for the PETRA beam test are on the way and will be described in a different paper./1 /.

Cavity Measurements

The 1-,5- and 9-cell cavities were fabricated by INTERATOM-Wuppertal according to the following scheme:

1. deep drawing of shells
2. cleaning with CP
3. welding preparations
4. welding of the cells by inside equatorial weld
5. frequency measurement
6. cleaning and tuning by CP
7. welding of the structures by outside iris welds
8. grinding of the iris welds
9. structure cleaning by CP

The measured results are shown in table 1. It is evident that several repair cycles of local grinding are needed to reach fieldstrengths of well above 3 MV/m.
The two-cell structure, manufactured by DORNIER, was welded only from the outside and shows relatively broad welds (about 5 mm) Welding splutters produced a quench at .4 MV/m .Especially this experience with the droplets led to the development of a global grinding technique (tumbling, see next chapter).
This procedure was applied to the two-cell and subsequent to the nine-cell cavity and increased the maximum field to 5-6 MV/m.

The next two nine-cell structures (INTERATOM II, DORNIER) were quenchlimited by deep lying (>100um) material defects.After one repair cycle both structures reached accelerating fields of about 5 MV/m.
The productionsteps are described described in table 2.

Cleaning Procedures

Tumbling

The cavity is half filled with ceramic chips and some water and is rotated horizontally around the beam axis at 9 revolutions per minute(Fig.1). For typical tumbling time of 230 hours the global grinding rate is 14 um at the iris region and 10 um elsewhere. Tumbling generally produces an even surface. Spikes and welding splutters are ground away and sharp grooves are smoothened.The remaining surface contaminations of Si and Al disappear after cleaning by CP or BCP. For detailed information see / 2/.

Buffered Chemical Polishing(BCP).

The standard cleaning procedure using the HF,HNO3,H3PO4 in volume retios of 1:1:1 is difficult to handle with large structures because of the danger of overreaction. First we tested H2O diluted solution (table 3),however this resulted in a ruough surface due to intercrystalline corrosion (Fig.2).
Better results are gained using a buffered chemical solution with a ratio of components of 1:1:6 (Fig.3) (Table 3).A comparison with a surface exposed to the standard mixture of 1:1:1,shows no visible differences.The structure with a total volume of 50 l is filled with 5 l of acid mixture and rotated around the axis perpendicular to the beam axis fo chemical polishing(Fig.4) The etching rate is 22 um for a two-times 3o minutes polishing cycle.Further details are given in / 2 /.

Tuning Procedures

The cells were tuned individually by CP during fabrication.Nevertheless a tuning of the whole structure is necessary to correct the field profile and absolute resonance frequency.
We use a mechanical system (Fig.5),which deforms inelsticly each single cell and thus varies the distances between the respective irises

Temperature Mapping System

Two rotating arms with 147 resistors each are used for temperature mapping in the vertical test cryostat..(Figs.6 and 7)).The readout system consists of 18 multiplexers at 4.2 K and a computer controlled digital voltmeter.For improved signal to noise ratio we are using an AC-current system.
The temperature mapping system fo the horizontal beam test cryostat is similar, but a set of 900 fixed resistors is used./ 3 /.

Pipe Cooled Cavities

In order to reduce the complexity of the cryostat and to be compatible with the large HERA refrigerator system, a forced flow pipe cooling is desirable.First measurements with a Nb-Ag cavity with copper cooling pipes showed encouraging results of 3.9 MV/m.Detailed information about manufacturing and testing procedures are presented in a different talk./ 4 /.

Single Mode Cavity

Properties of the single mode cavity design / 5 / are investigated by URMEL calculations, and roomtemperature measurements of a single and a 9-cell cavity.The geometry of the present cell profile is shown in Fig 8 .
According to URMEL calculations all monopole modes up to the four times the fundamental frequency show strong coupling to the beam pipe.Different types of broadband beam pipe absorbers are under investigation.

Acknowledgement

The support of the technical groups at DESY during the fabrication is greatfully acknowledged.The engaged participation of members of the rf-group and the enthusiastic help provided by the F21-group during the installation and testing of the many components is greatly appreciated.
We would also like to thank all laboratories and companies who have contributed to the developement and fabrication.

Table 1

table of results

structure	Eacc [MV/m]	Q0 at Eacc [*10E8]	treatments and remarks
1-cell IA	1.5	1.2	only degreased
	3.0	5.0	grind of welds, CP
**	3.5	4.8	quenchspot ground off,CP
	5.3	3.75	grinding quench at equator weld
5-cell IA	3.2	2.5	CP
9-cell IA I	2.5	5	only degreased
	3.0	3.8	quenchspot ground away,H2O-CP
	4.9	5	tumbling, BCP, limited by available rf-power
	(5.7)	(9.0)	T=3.7 K, l.a.p.*
2-cell DO	.4	3.0	degreased,quench at welding splutter
	4.5	2.8	tumbling,H2O-CP
***	5.8	5	BCP, quench near equator,not at weld
9-cell IA II	2.5	6	tumbling, BCP, quench at material defect
	5.2	4.7	local grinding,tumbling,BCP;l.a.p.
	(6.7)	(9)	T=2.7 K,l.a.p.
9-cell DO	3.1	6.0	tumbling,BCP,quench at material defect
	4.5	5.7	local grinding,tumbling,BCP,l.a.p.
	(6.6)	(9)	T=3.1 K,quench,e- loading.

* l.a.p.=limited by available rf-power
** IA = INTERATOM /6/
*** DO = DORNIER /7/

Table 2

Production Steps

1.	Deep drawing of shells	manufacturer
2	Grinding of shells with a fan grinder and sandpaper	DESY→ manufacturer
3.	Cleaning by CP	manufacturer
4.	welding preparations	manufacturer
5.	equatorial welding (inside or outside) of the cells	manufacturer
6.	frequency measurement of cells	DESY→ manufacturer
7.	Cleaning and tuning by CP	manufacturer
8.	Welding of the structures (iris welds)	manufacturer
9.	Grinding of the welds *	manufacturer
10.	Tumbling	DESY→ manufacturer
11.	Cleaning by BCP	DESY→ manufacturer
12	Rinsing with dustfree demineralized water	DESY→ manufacturer

* not necessary for broad welding seams.

Table 3

Table of different reagents

ratio of components	HF	HNO3	H3PO4	H2O
standard CP*	1	1	1	
H2O-CP**	1	1	1	7
BCP***	1	1	6	

* The total volume of the structure is filled

** The nine-cell structure (50 l)is filled with 10 l and rotated

*** Buffered Chemical Polishing;the nine cell is filled with 5 l and rotated

Figure Captions

Fig. 1 :A nine-cell structure already equipped with input- and output-coupler,positioned on the driving rolls of the tumbling machine

Fig 2.:SEM picture of NB surface after exposure to H2O-CP

Fig. 3 :SEM picture of Nb surface after exposure to BCP

Fig. 4.:9-cell stucture already equipped with input-and output-coupler mounted on the rotating shell for chemical treatment

Fig. 5.:Tuning apparatus, one half plate just beeing inserted to enclose one cell for tuning

Fig. 6.:A nine cell structure supplied with resistor-arms for temperature mapping, mounted on the flange for a test in a vertical cryostat.

Fig. 7.:This detail photography shows a part of the resistor arm with the multuplexers and resistors

Fig. 8.:Geometry of "single mode cavity"

References

/1/ B.Dwersteg et al,DESY Internal Report M-84/14

/2/ D.Proch, K.Thiele,DESY Internal Report M-84/10

/3/ J.Peters,DESY Internal Report M-84/07

/4/ J.Susta ,DESY Internal Report M-84/13

/5/ T.Weiland, DESY 83-073,September1983

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/8/ Lufthansa-Werft, Postfach 300, 2000 Hamburg 63, W.Germany

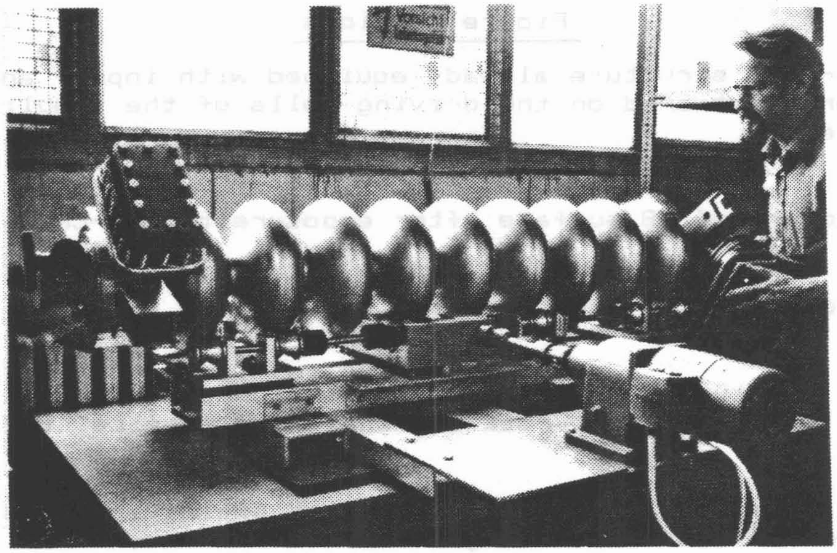


Fig. 1

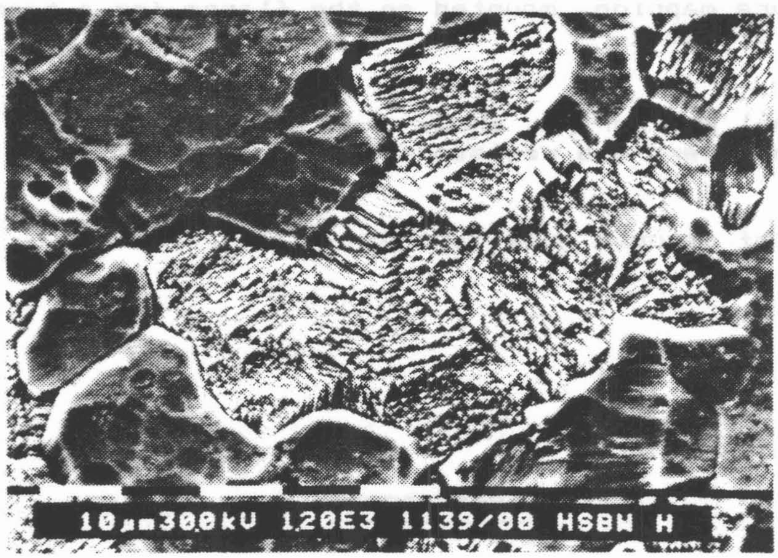


Fig. 2

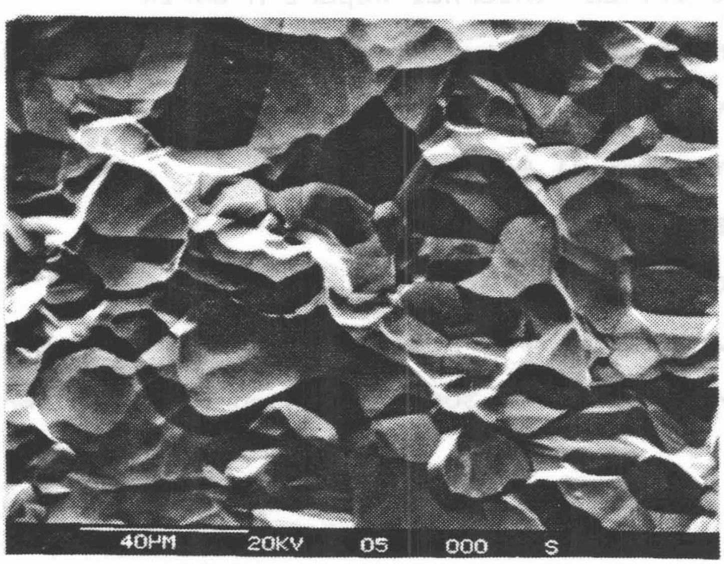
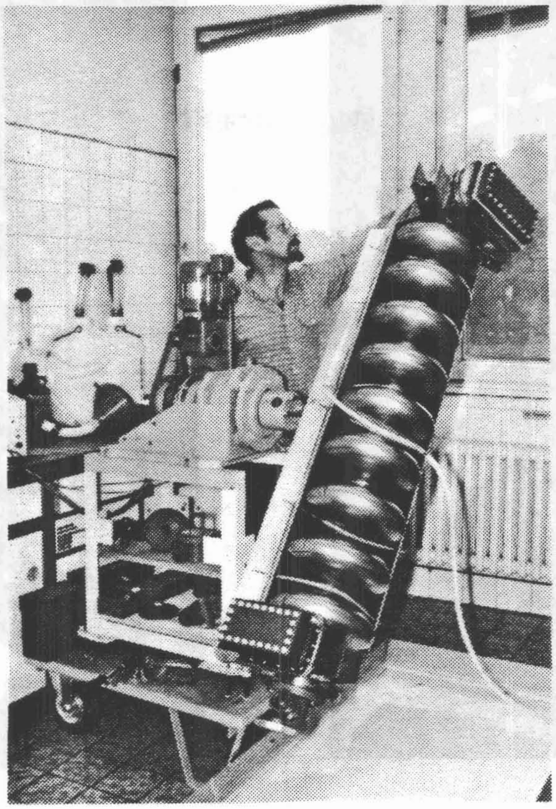


Fig. 3



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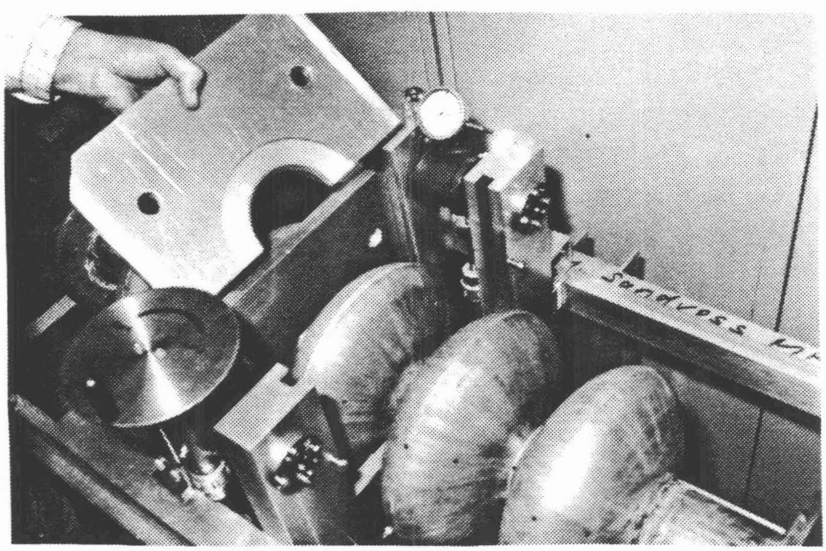


Fig. 5

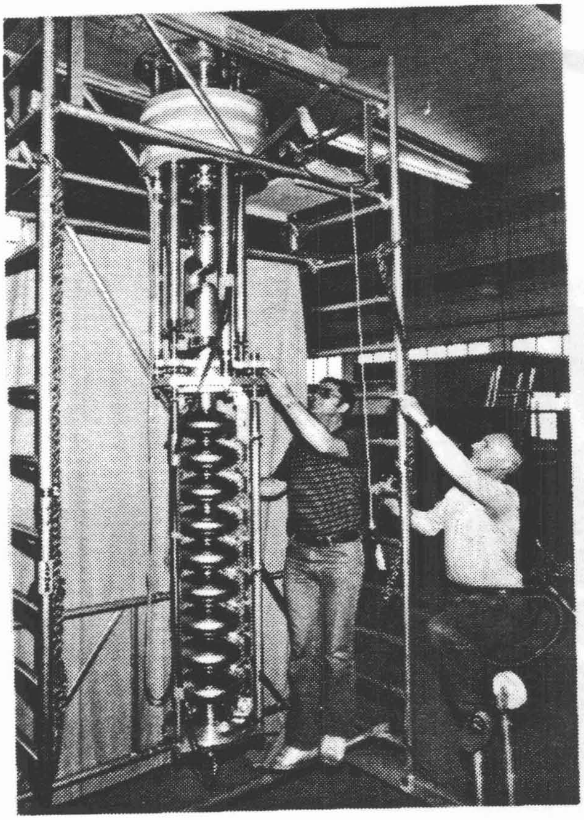


Fig. 6

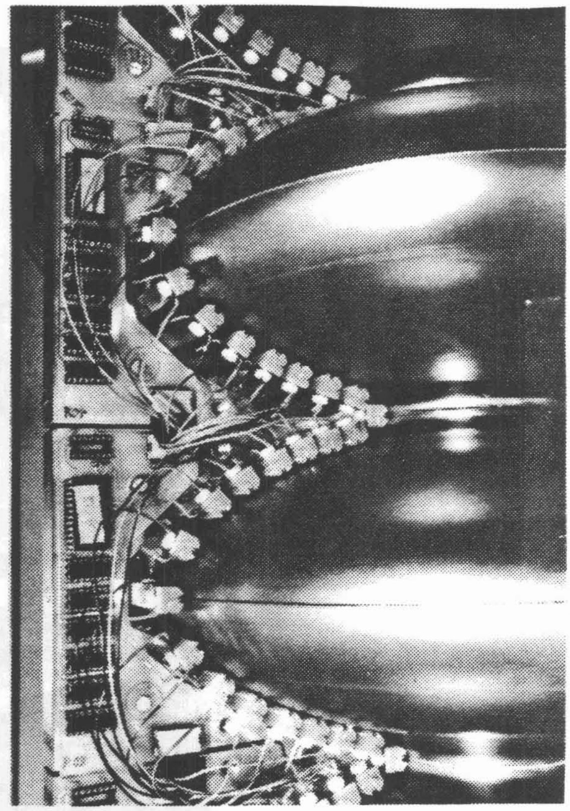
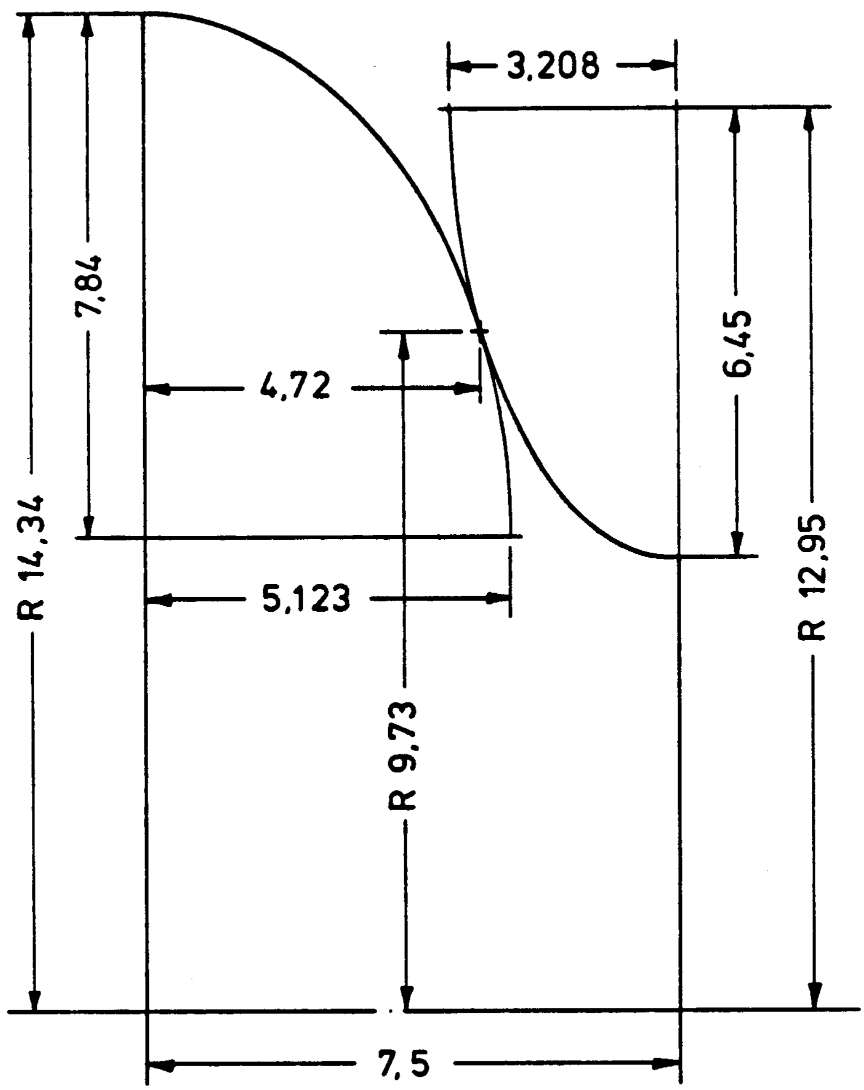


Fig. 7



Alle Maße in cm

Fig. 8