DAMPING ANTENNAS FOR SPURIOUS RF-MODES IN ELECTRON-POSITRON STORAGE RINGS

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The maximum beam currents in DORIS were limited mainly by instabilities induced by the rf-cavities. To overcome this difficulty, the higher cavity modes must be damped. Special damping antennas were developed for this purpose.

1. Introduction

A study of maximum beam currents stored in DORIS showed that transverse and longitudinal instabilities limited the electron and positron beam currents. It was found, that by randomly changing the rf-cavity tuning one obtained a maximum stored beam current of 200 mA, while the thresholds of instabilities were in the range of 1 to 5 mA. With a wide-band microwave detecting equipment it could be shown on a spectrum analyser that the thresholds and maximum currents are correlated to the rf-cavities and furthermore, that the instabilities were caused by the excited parasitic cavity modes. The analysis identified the most harmful modes:

- transverse instability: TM_{111} (927 MHz)
- longitudinal instabilities: TM_{011} (743 MHz), TM_{012} (1150 MHz), TM_{022} (1585 MHz) - mode and others.

2. Damping antenna

The theoretical calculations[1,3] show that one of the parameters which influences the instabilities is the shunt impedance of the rf-cavities. A new kind[2] of antennas was developed to reduce the characteristic impedance of these parasitic modes.

The energy of the dangerous modes such as TM_{011}, TM_{012}, TM_{111} is coupled into quarter-wave length coaxial resonators and absorbed in kanthal wire loops ($\rho = 1.45 \frac{\Omega mm^2}{m}$) fitted at the short circuit end of the antenna resonator (Fig.1).

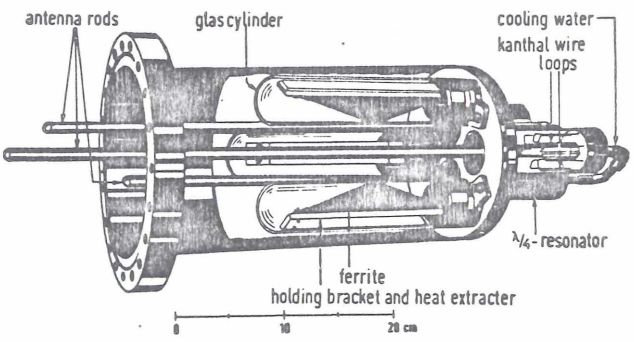

Fig.1 Sectional view of the damping antenna

The water cooled copper antenna rods are calibrated in length, diameter and coupling to a maximum power loss of the corresponding mode and to a minimum loss of the fundamental mode. The fundamental mode loss in the antenna is less than 100 W at 80 kW rf-power in the cavity.

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The 3 ferrite slabs give wide-band damping effects in the frequency range above 1200 MHz. The fundamental mode power loss per slab is less than 10 Watt. To eliminate outgassing of the ferrite slabs in the vacuum they are enclosed in glas cylinders which were first evacuated and then filled with 100 torr of hydrogen.

Each rf-cavity in DORIS is equipped with this kind of damping antenna (Fig.1).

The effect of the damping antenna was a decrease of the shunt impedance of most of the dangerous spurious modes in the cylindrical cavity (Fig.2).

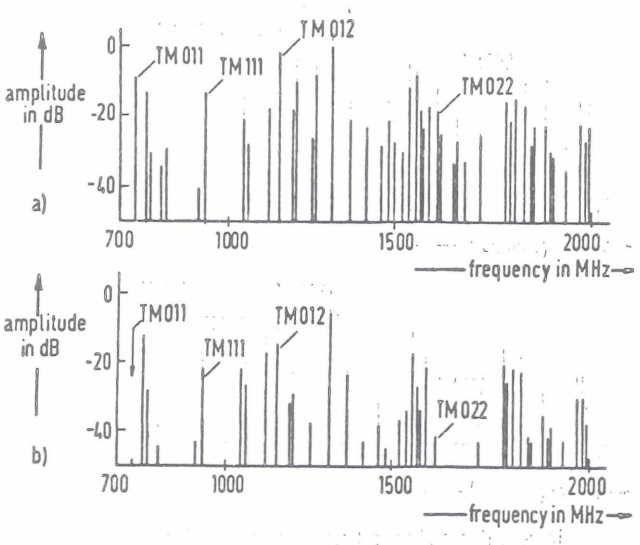

Fig. 2 Diagram 2a shows the parasitic mode amplitudes of a DORIS rf-cavity without damping antenna. Diagram 2b shows the remaining mode amplitudes after installing the damping antenna.

3. Experimental results

Preliminary experimental results with an e^+- and e^--beam show:

- an increase from a few mA stored current to 100 mA and more before reaching the beam instability thresholds
- the single beam current could be increased to $I \geq 500$ mA at an energy of $E = 2.5$ GeV
- the TM_{022} - 1585 MHz instability could no longer be observed.

References

1) R. D. Kohaupt: Single beam instabilities in DORIS. Proceedings of IV All-Union National Conference on Accelerators, Nov.18-20, 1974, Moscow, USSR
2) N. Lehnart, H. Petersen: Ferrit-Dämpfungsantennen gegen parasitäre Cavity-Modes in den DORIS-Hohlraum-Resonatoren. DESY, Technische Notiz H2-77/12, 1977
3) R. D. Kohaupt: Excitation of a transverse instability by parasitic cavity modes. Interner Bericht DESY H1-74/2, 1974.