Determination of Resonant Frequency and External Q Values for the BESSY II HOM-Damped Cavity

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Abstract
Damping of higher order cavity modes (HOM's) is one way to increase the intensity thresholds for multibunch instabilities in B-factories and state of the art synchrotron radiation sources. Following the idea of Conciauro-Arcioni [1] one of the simplest geometries is the threefold-symmetry cavity-waveguide structure with a broadband absorber terminating the end of every guide. The iris coupling between the cavity and the waveguide has to be designed so that the fundamental cavity-mode remains nearly unperturbed. The values of the external Q und the shift resonant frequencies due to the waveguide loads is determined and tested by known methods with MAFIA.

I. INTRODUCTION
BESSY II is a 1.7 GeV third generation electron storage ring with 16 straight sections to produce highly brilliant synchrotron radiation beams in the spectral range of soft x-ray and vacuum ultraviolet. One of the design goals is a low emittance of 6: nm-rad and a maximum beam current of 200 mA [2], [3]. Therefore it is necessary to reduce all effects which potentially spoil the brilliance of the radiation beam. Especially in RF accelerating cavities, the beam induces parasitic resonant fields which can lead to coherent multibunch oscillation which results in less brilliance. A possible way to suppress the cavity higher order modes (HOM's), is to mount external waveguides on the cavities, and couple strongly to the most dangerous modes. By terminating the end of each waveguide with broadband absorbers the HOM's are damped at a rate depending on the coupling. The accelerating mode is rejected and remains undamped (if the bigger surface is not accounted for). A low power prototype cavity has been built at BESSY II (threefold-symmetry cavity waveguide structure, Fig. 1). For this preliminary investigation the cavity has a pill-box shape with three circular waveguides, distributed on the cavity coat, 120 degrees apart. In order to optimize the design of the waveguide loaded cavity, one has to know the values of the external Q and the shift resonant frequency due to the waveguide loads. These are readily determined by the method of Kroll-Yu [4], with frequencies computed by the MAFIA code [5].

II. NUMERICAL COMPUTATIONS OF Q-VALUES
For the numerical calculation of the BESSY II HOM-Damped Cavity resonance frequency and external $Q_e$, we have employed the method developed by Kroll and Yu. We will not elaborate on the method itself, rather share some general views on the method. For further details, consult [4]. Computing $Q_{e, ext}$ by numerical means is indeed no trivial task, since an infinitely long waveguide would result in an infinite mesh. Note: waveguide boundaries are unknown in frequency domain. With the Kroll-Yu method, a short is inserted into the waveguide, which of all makes the mesh size infinite. Then, resonance frequency shifts are utilized, that occur as the short position is varied. More volume always decreases resonant frequency, but the slope varies, depending on field strength at the
Figure 2. $Q_{\text{dip}}$ of the dipole mode and $Q_{\text{cond}}$ of the monopole mode versus iris radius. Conductivity is $58 \cdot 10^5 \, \text{1/(\Omega m)}$.

III. OUTLOOK

We will engage in investigations on further HOM's in due course, employing the Kroll-Yu method. Decision on the final iris size will be based on results from these investigations. A test model will be installed and measured to verify theoretical results.

References


Fig. 3 shows frequency shifts due to the iris coupling. As soon as some iris radius is chosen on the above mentioned grounds, the cavity radius has to be adapted, to keep the accelerating mode resonance frequency at its design value.
Figure 4. MAFIA mesh (500 000 mesh points) and electric field of the BESSY II cavity and the accelerating (monopole) mode.

Figure 5. MAFIA mesh (500 000 mesh points) and electric field of the BESSY II cavity and the first dipole mode.