# 178 MHz CAVITY WITH HOM DAMPING FOR THE DFELL STORAGE RING

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Design of the new cavity produced for the DUKE FELL storage ring is presented. The fundamental and higher order modes (HOMs) parameters are shown. The HOMs are substantially damped in a special load with absorbers made of conductive ceramics. Experimental studies of the absorbing material properties were carried out on models. The results are described. The cavity cold measurements results are presented as well.

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## 1. INTRODUCTION

Modern storage rings call for a beam current increase. One of the limiting factors is the instability caused by the interaction of the beam with the cavity HOMs [1]. The solution is a single-mode cavity. Such a cavity has a special absorbing load which strongly damps the HOMs while having low influence on the fundamental mode. The loading of the HOMs should provide sufficient damping of the beam induced voltage during the time between the two subsequent passages of bunches through the cavity. If this condition is not realized, the increments are so that it becomes possible to suppress the instabilities with feedback loops.

A single mode 178.5 MHz cavity is developed at BINP for the DFELL storage ring. The maximum ring energy is 1.2 GeV. The energy loss per turn is 91 keV at the maximum energy. The revolution frequency is 2.8 MHz. The simulations showed that the new cavity will allow one to store the currents of the order of 300 mA at the energy of 1 GeV and uniformly distributed over the ring perimeter 8 or 64 bunches.

## 2. CAVITY DESIGN AND PARAMETERS

The new cavity for the DUKE FELL is based on a "standard" microtron cavity [2]. A schematic drawing of the new cavity is shown in fig.1.

The cavity shell is bi-metallic (8 mm copper and 7 mm stainless steel). A coaxial input coupler with cylindrical ceramic window is located on top of the cavity. The cavity has two contactless fundamental mode tuners and two RF pick-ups (sampling loops). The HOMs are damped in a cylindrical load coupled to the cavity through a waveguide, 702 mm in diameter. The diameter is chosen so that all the HOMs propagate from the cavity to the load. The 300 mm part of the waveguide closed to the cavity is covered by copper to minimize the fundamental mode loading. The distance from the cavity to the load is chosen so that the power dissipation in the load due to the fundamental (TH010-like) mode fields is less than a few watts at maximum operating gap voltage. The cavity is pumped by two ion-getter pumps PVIG-630. The parameters of the cavity fundamental mode are shown in table.

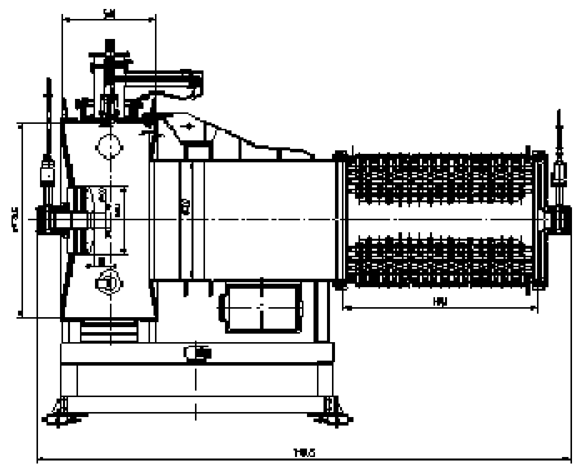

*Fig.1 Schematic drawing of the new cavity for the DUKE FELL*

Parameters of the cavity fundamental mode

| | | |
|---|---|---|
| Resonant frequency, | MHz | 178,5 |
| Frequency tuning range, | kHz | 320 |
| Unloaded quality factor, Q | | 38500 |
| Shunt impedance, R | Mom | 5,85 |
| Characteristic impedance, ρ=R/Q | Om | 152 |
| Transit time factor | | 0,757 |
| Gap voltage, U | kV | 0 - 970 |
| Cavity vacuum, | torr | $10^{-9}$ |
| Power dissipation in the walls | kW° | 80 |

## 3. ABSORBING ELEMENTS AND THEIR PROPERTIES

Absorbing elements of the load are made from conductive ceramics KT-30 at the Start Company in Fryazino. Ceramic caps are bolted (with a certain force) through a copper insertion to the water cooled wall (fig.2). The ceramics allows vacuum baking at 350°C. After baking it has low gas desorption rate (about $6.2 \cdot 10^{-12}$ torr liter/sec·cm$^2$). This allows one to achieve high vacuum in the cavity.

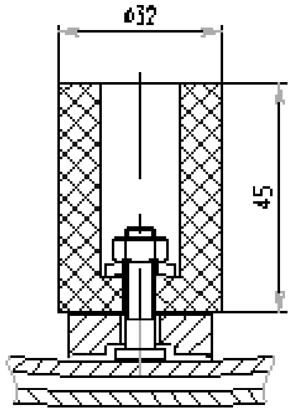


*Fig.2. HOM load absorbing element*

The absorbing characteristics of the ceramics were studied on a model cavity. The model cavity was filled with absorbing elements at different filling factors and schemes. The quality factors of the modes in the range from 500 to 2200 MHz were measured. It was found out that at frequencies below 1 GHz the quality factors of the modes do not depend on the filling scheme but only on the quantity of the absorbing caps. At frequencies above 1 GHz the caps shield each other when placed tight and so the effectiveness of the loading is decreased. This effect disappears when the distance between the caps is 3.5 cm ant more. Based on the obtained results it was decided to fill the load with 520 caps uniformly distributed over the load and keeping the distance between the caps of 3.5 cm.

The new cavity HOM spectrum simulations were carried out with the CLANS code [3]. The rows of the caps were substituted by axially symmetric rings. The width of each ring is equal the height of the cap 4.5 cm and the thickness is equal to the diameter of the cap 3.2 cm. The equivalent parameters of the rings (dielectric permittivity ε and volume conductivity σ) were chosen so that the model cavity modes measured and calculated quality factors are close to each other. It was found out that in the range of 500...2200 MHz the equivalent parameters of the rings are ε=30 and σ=0,7 1/Ohm·m (at the distance between the caps of 3.5 cm).

Also the dependence of the ceramics absorbing properties on temperature was studied on the model. It as observed that at temperature increase of 40C the HOM quality factors decrease by 10% at frequencies below 1 GHz while increasing by 20% at frequencies above 1 GHz.

## 4. CAVITY HOM SPECTRUM SIMULATION AND MEASUREMENT RESULTS

Using the above shown equivalent parameters of the rings the frequencies and quality factors of the new DUKE FELL cavity HOMs were calculated with the CLANS code in the range of 0.3...2 GHz (fig.3). When the cavity cane out from the workshop its spectrum was also measured (fig. 4).

The measurements showed that the absorbing load leads to the HOMs quality factors decrease by a factor of 100 (in average) in the frequency range of 0.3...2 GHz. The loaded HOMs quality factors lay in the range of 50-300. The fundamental mode measurements proved that the load does not affect the fundamental mode.

## 5. CONCLUSIONS

The calculations and measurements showed that the load from the KT-30 ceramics damps the HOMs quite strongly. The calculations with the MBIM code [4] showed that at the energy of 1 GeV and bunch length of 0.1 nsec the maximum beam current (limited by the beam-cavity interaction) is 374 mA for 64 bunches and 446 mA for 8 bunches. Now the cavity is being prepared for the high power tests from 140 kW RF generator.

## REFERENCES


1. M.M. Karliner. Preprint Budker INP 74-106, Novosibirsk, 1974. (in Russian).
2. N. Gavrilov, I. Kuptsov, G. Kurkin, L. Mironenko, V. Petrov, I. Sedlyarov, V.Vescherevich. Preprint Budker INP 94-92, Novosibirsk, 1994.
3. D.G. Myakishev. Preprint Budker INP 2000-55, Novosibirsk, 2000.
4. N.V. Mityanina. Preprint Budker INP 99-46, Novosibirsk, 1999.


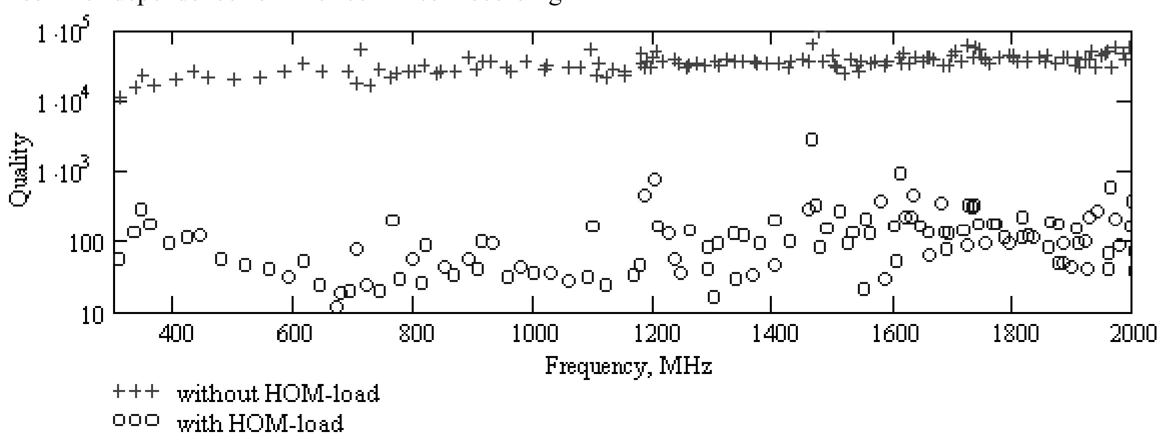

*Fig. 3. Calculated cavity HOMs quality factors in the frequency range of 0.3-2 GHz*

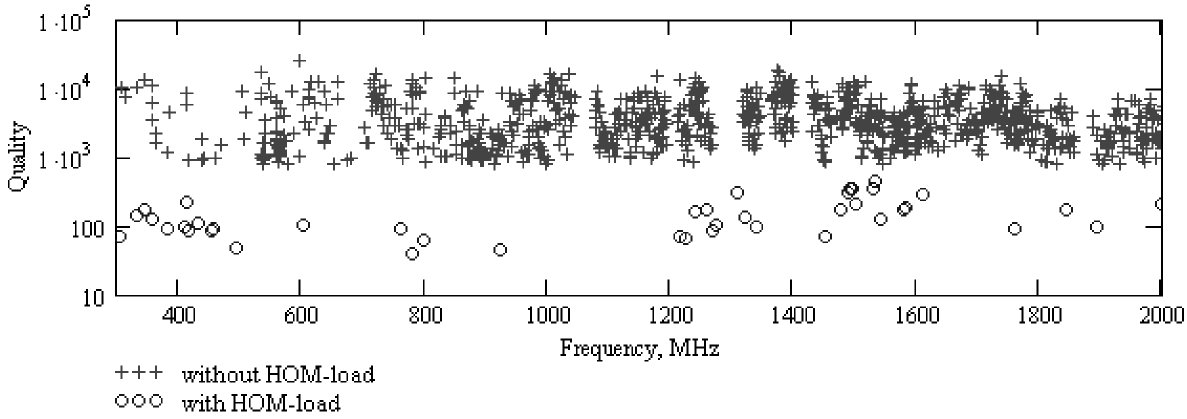


*Fig.4. Measured cavity HOMs quality factors in the frequency range of 0.3-2 GHz*

## РЕЗОНАТОР 178 МГц С ПОДАВЛЕНИЕМ ВЫСШИХ МОД ДЛЯ НАКОПИТЕЛЯ УНИВЕРСИТЕТА ДЮКЕ (США)

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Представлена конструкция, параметры и результаты расчета спектра высших мод резонатора, изготовляемого для накопительного кольца лазера на свободных электронах в университете ДЮКЕ (США). В этом резонаторе высшие моды сильно подавлены с помощью специальной нагрузки, использующей проводящую керамику. Описаны результаты исследований свойств поглощающего материала, проведенных на макете. Приведены результаты холодных измерений резонатора и его испытаний на высоком уровне мощности.

## РЕЗОНАТОР 178 МГц ІЗ ЗАГЛУШЕННЯМ ВИЩИХ МОД ДЛЯ НАКОПИЧУВАЧА УНІВЕРСИТЕТУ ДЮКЕ (США)

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Представлено конструкцію, параметри, і результати розрахунку спектра вищих мод резонатора, виготовленого для накопичувального кільця лазера на вільних електронах в університеті ДЮКЕ (США). У цьому резонаторі вищі моди сильно подавлені за допомогою спеціального навантаження, що використовує провідну кераміку. Описано результати досліджень властивостей поглинаючого матеріалу, проведених на макеті. Приведено результати холодних вимірів резонатора і його іспитів на високому рівні потужності.