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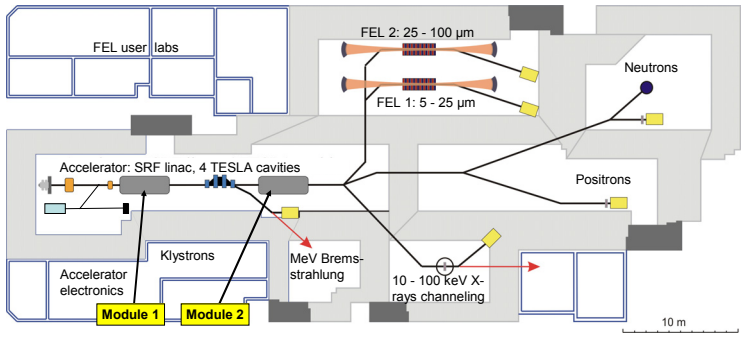
Microphonics Measurements at the ELBE Accelerator

Introduction

Microphonics measurements at the ELBE accelerator were already made in 2002 and published in [1]. The widespread use of the Rossendorf accelerator module which is manufactured in license by ACCEL and the recent development of energy recovery Linacs created new interest in microphonics measurements. With the further completion of the ELBE accelerator significant changes were made. In 2002 only one cryomodule with 2 cavities was in operation. The measurements in 2002 were done with the second cavity. Now we did quantitative measurements at the forth cavity (the second cavity in the second cryomodule) and qualitative measurements at all 4 cavities.

During the measurements the RF feedback signal of the phase lock loop was recorded in two ways. First with a data recorder and second with a sound card. Both methods have shown advantages and drawbacks. The data recorder has DC coupling and is better suited for quantitative measurements, the sound card measurements are easier to evaluate, but the frequency response needs a calibration and is only suited above 1 Hz.

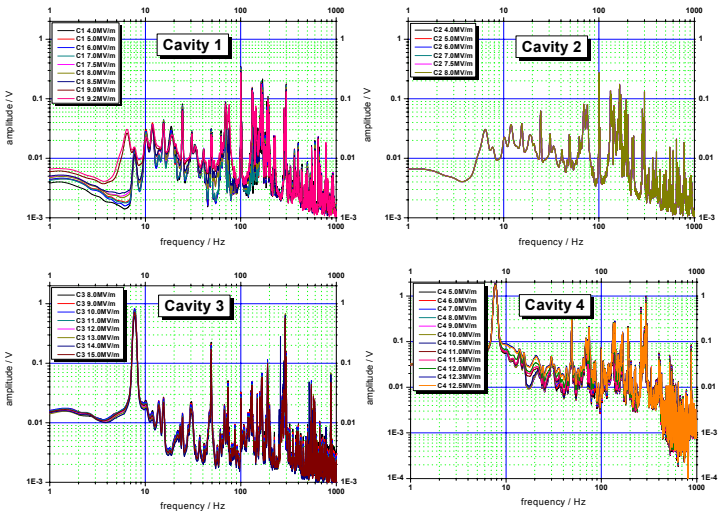


Radiation Source ELBE – 40 MeV, 1 mA CW LINAC

Measurements

Sound Card Measurements

Measurements were made for every of this 4 cavities at different gradients.



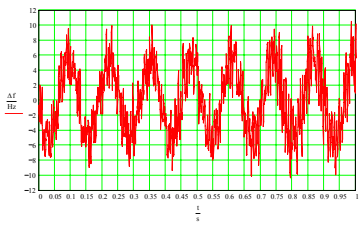
Averaged spectrum of the RF feedback signal for Cavity 1 to 4

number	cavity 1 maxima	cavity 2 maxima	cavity 3 maxima	cavity 4 maxima
1	24.6	24.4	7.7	7.0
2	69.5	69.6	49.0	49.2
3	74.2	75.6	73.3	73.2
4	99.9	100.1	259.7	259.7
5	132.2	132.2	292.4	292.0
6	164.2	164.2	--	--
7	169.6	169.2	--	--
8	193.5	193.5	--	--
9	300.1	300.1	--	--

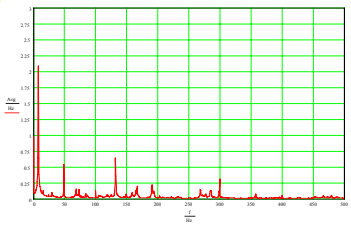
Peaks in spectrum of the RF feedback signal for Cavity 1 to 4

Data Recorder Measurements

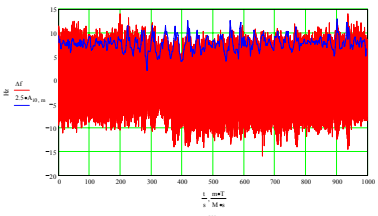
Measurements were made only for cavity 4 at different gradients.



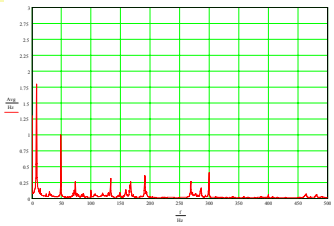
Frequency deviation for 10 MV / m, 31 mBar



Averaged spectrum of the frequency deviation for 10 MV / m, 31 mBar



Long time frequency deviation for 10 MV / m, 31 mBar overlayed with the amplitude of the 7.7 Hz component



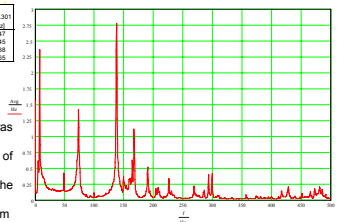
Averaged spectrum of the frequency deviation for 10 MV / m, 20 mBar

		total	pk-pk	5.11	46.50	69.77	130.137	163.169	188.196	223.226	265.272	292.295	298.301
		[Hz]	[Hz]	[Hz]	[Hz]	[Hz]	[Hz]	[Hz]	[Hz]	[Hz]	[Hz]	[Hz]	[Hz]
20 mBar	10 MV/m	3.8	33.0	2.73	1.54	0.46	0.40	0.51	0.64	0.04	0.43	0.08	0.47
	12 MV/m	4.0	36.8	2.47	0.51	0.33	1.82	0.61	0.49	0.21	0.39	0.21	0.45
31 mBar	10 MV/m	3.8	30.2	3.07	0.58	0.35	0.84	0.39	0.46	0.04	0.28	0.05	0.38
	12 MV/m	3.3	134.8	3.62	0.53	3.19	2.36	2.05	1.05	0.45	0.43	0.60	0.65

Total, peak to peak and RMS frequency deviations for the 10 biggest components

Results:

- No significant correlation between the frequency components was found
- The 7.7 Hz component changes strongly over time with a period of ~ 45 seconds
- Working at the limit of the Helium machine increases mainly the 135 Hz and 75 Hz components
- No influence on microphonics was seen by using the tuning system
- No influence was seen by switching off a membrane pump at the module



Averaged spectrum of the frequency deviation for 12 MV / m, 31 mBar

Conclusions

Cavity 1 shows significant energy dependency for low frequencies at energies from 9 MeV and above. Cavity 1 / 2 and also cavity 3 / 4 have very similar peaks. The peaks are not corresponding to calculated values for the self resonances of the cavities [2] without housing. In Module 2 a significant component at 7.7 Hz could be observed. It would be useful to reduce this to the levels of module 1 and to reduce the hum components at 50 and 100 Hz.

The next step in research would be to identify the sources of excitation by using real time cross-spectra.

Acknowledgement

This work has been partially supported by the EU Commission in the Sixth Framework Program, Contract No. 011935-EUROFEL and Contract No. RII3-CT-2003-506395-CARE. And we acknowledge the support of the German Federal Ministry of Education and Research grant 05 ES4BR1/8.

References

[1] A. Büchner, F. Gabriel, H. Langenhagen, “Noise Measurements at the RF System of the ELBE Superconducting Accelerator” EPAC’2002, Paris, June 2002.
[2] T. Schilcher, “Vector Sum Control of Pulsed Accelerating Fields in Lorentz Force Detuned Superconducting Cavities” TESLA Report 98-20, DESY, August 1998.

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