COMPARISON OF FIELD EMISSION AT DIFFERENT CAVITY ASSEMBLY STATES AND TEST STANDS

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Abstract

RF cavity Field Emission (FE) presents a major diagnostics instrument on the cavity performance, save the FE levels differ significantly from one cavity test setup to another, making the analysis difficult. A comparison study complimented with a direct calibration of FE in the cavities tested with different auxiliaries and test stands (vertical / horizontal / module) is presented and discussed.

INTRODUCTION

TESLA type SRF accelerating 9-cell cavities for FLASH and XFEL [1] are being tested at DESY. SRF accelerating cavities FE caused gamma radiation is being measured at different cavities test stands using the "Unidos" devices with 1 l spherical gamma sensors. The "Unidos" is set to measure with 1 kHz sampling rate and 200 ms filter (integration), so with a 1 ms / 10 Hz RF pulse 1:100 peak to average ratio is to consider for the pulse measurements. There are three different cavity test stands: vertical cryostat (CW test), horizontal cryostat (pulsed test) and module test stand (pulsed test). Gamma sensors positions for different test stands are shown in Fig.1 (Gun – upstream, Dump – downstream the module).

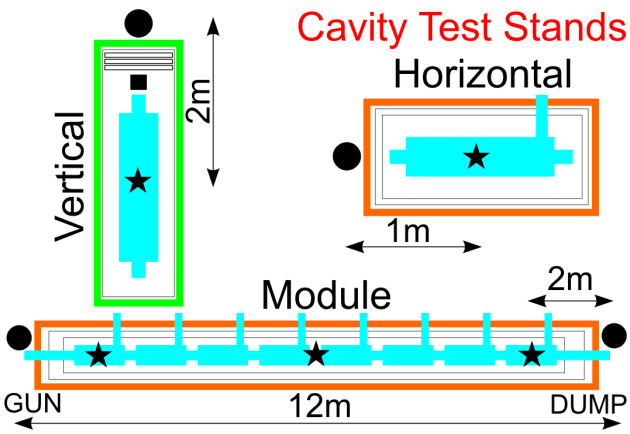

Figure 1: Cavity test stands gamma sensors (black orbs) and test Co-60 source (black stars) positions.

GAMMA RADIATION MEASUREMENTS

Gamma radiation measurements statistics for all 9-cell cavities measured so far at DESY is presented in Fig.2. The data are sorted between the three test stands and five cavity gradients values. Horizontal cryostat and module test (CMTB) [2], [3] statistics have yet a rather small data points numbers, still the comparison is possible.

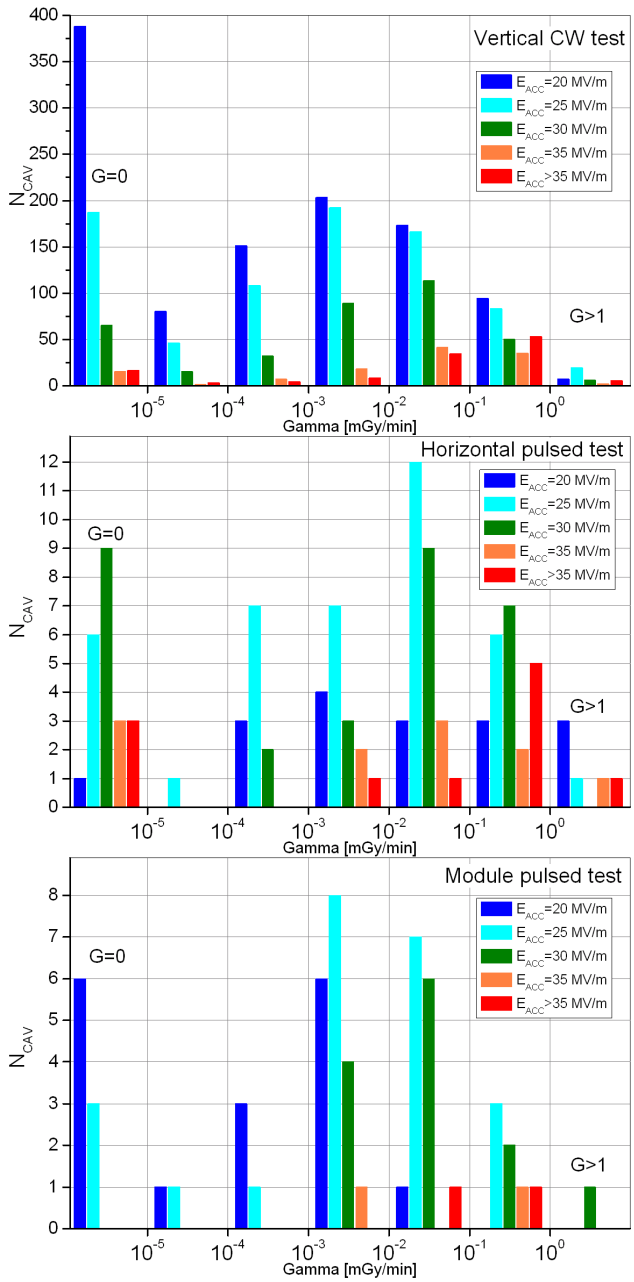

Figure 2: 9-cell SRF accelerating cavities tests at DESY: gamma radiation measurements statistics.

Module PXFEL3 was tested on the CMTB [4]. After the test module was disassembled and all cavities were tested separately on vertical and horizontal cryostat cavity test stands. Gamma radiation measurement data for module PXFEL3 cavities is shown in Fig.3.

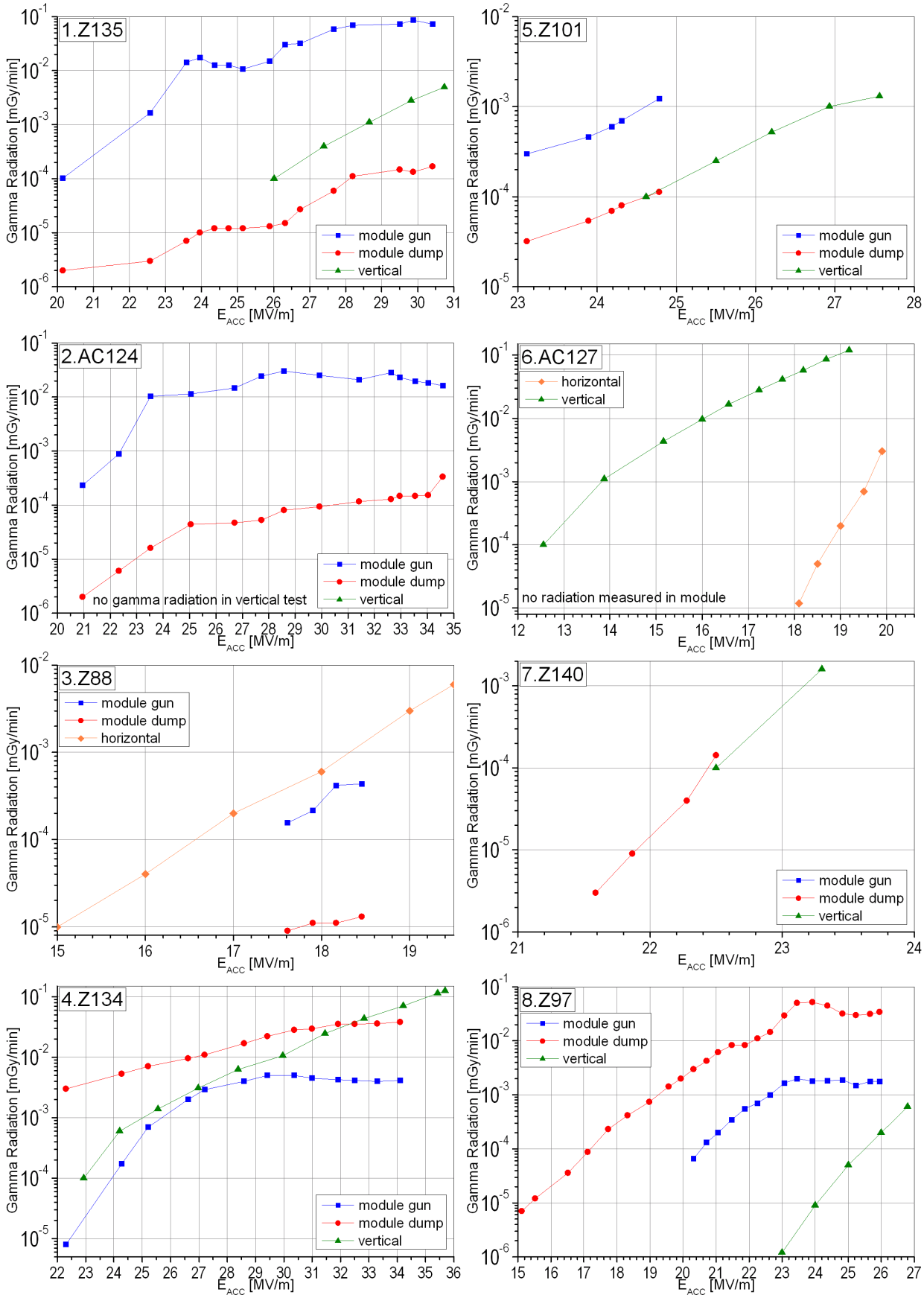

Figure 3: Module PXFEL3 cavities gamma radiation measurements (raw data).

GAMMA RADIATION DAMPING

Direct calibration measurements using the thermo luminescent detectors (TLD) during the cavity test and radiation measurements with a gamma source are done. As a test gamma radiation source 47 MBq Co-60 with 4.5 mSv/h was used. The test source positions on the cavity test stands are marked with a star in the Fig.1. Measurement with a gamma source on the vertical cavity test stand was not successful because of reaching the device precision limit. Vertical test stand is equipped with an additional lead shielding (black square in Fig.1) yielding bigger radiation damping. TLD measurement data is used for calibration for vertical test stand. Fig.4 summarizes the gamma radiation damping measurements on different cavity test stands at DESY.

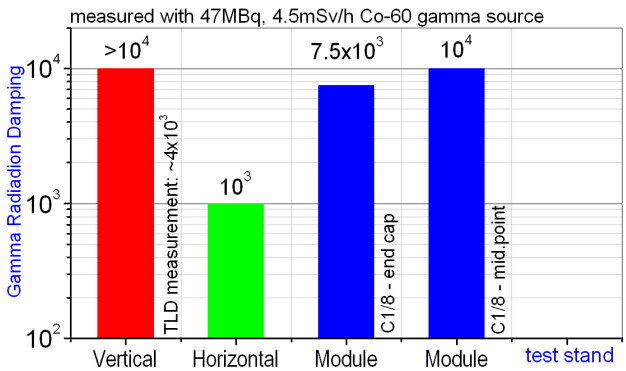

Figure 4: Gamma radiation damping measurements.

SUMMARY

- Cavity Field Emission (FE) caused gamma radiation was measured on three different test stands: vertical test (1 cavity, CW), horizontal (1 cavity, pulsed) and module test (8 cavities, pulsed), Fig.1 shows the sensors positions outside the test stands.
- Pulsed (1 ms / 10 Hz) to CW integrated gradient ratio is 100, so the CW test must have 100 times higher direct on-cavity measured radiation level. Measurements with module PXFEL3 (Fig.3) cavities 1 and 6 give agreeable results. For direct comparison of the data not only the pulse/CW ratio, but also the test stand infrastructure (shielding) and cavities positions (see Fig.1) must be taken into account.
- Direct gamma radiation damping measurements results are presented in Fig.4.
- Cavities test gamma radiation measurements statistics (Fig.2) shows no significant difference between the test stands, still the vertical test statistics has much more data.
- Module PXFEL3 cavities were tested together in the module test stand, as well as separately after the disassembly without cavities treatment. Measurement results acquired from module, horizontal and vertical tests (Fig.3) are mostly close. The pulse/CW ratio, infrastructure damping, cavities positions and measurements errors must be compensating each other in given measurement range and precision.
- Directly comparable with other test stands module test gamma radiation data are only end cavities data.
- Common FE high/low threshold can be set for all test stands, in our case 10^{-2} mGy/min. This can not be used as a strict criterion, still a usable one.
- Further tests aimed to gamma radiation measurement calibration between three cavity test stands are in preparation.

ACKNOWLEDGEMENTS

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