THPP022

Efficiency of High Order Modes Extraction in the European XFEL Linac

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Abstract

The serial production of components for the European XFEL linac was started in 2011 and reached the planned level of 8 cavities (1 module) per week in 2013. The measurements of High Order Modes (HOM) characteristics under cryogenic conditions (2K) are being done at the Accelerating Module Test Facility (AMTF) by the IFJ-PAN Team in collaboration with DESY groups.

More than 50 % of the cavities have been already produced and 30 % of the whole amount were measured during either cavity vertical tests or module tests.

We present first statistics of these measurements and analyze the efficiency of HOM extraction.

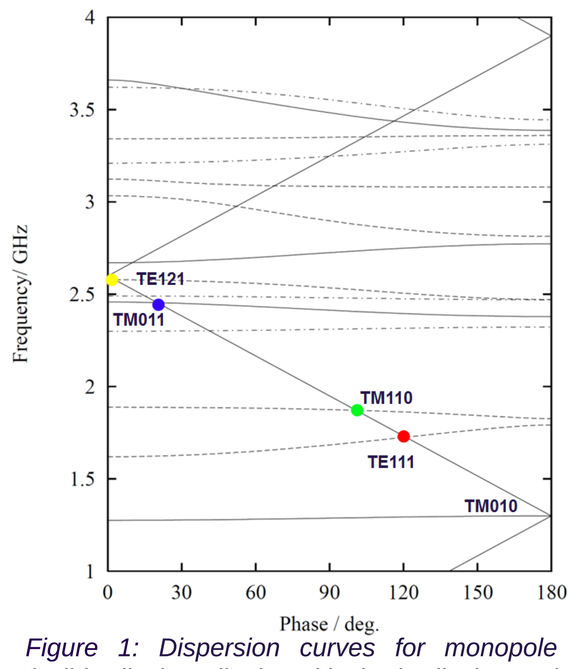

Figure 1: Dispersion curves for monopole (solid line), dipole (dashed line) and quadrupole (dash-dotted line) modes [1].
The dots mark the most critical HOM [2, 3].

TESLA HOM Damping Requirements [4]
for strongest modes (typical Q-values only!)
- **Monopole modes $Q < 10^5$**
- Dipole modes $Q < 10^5$

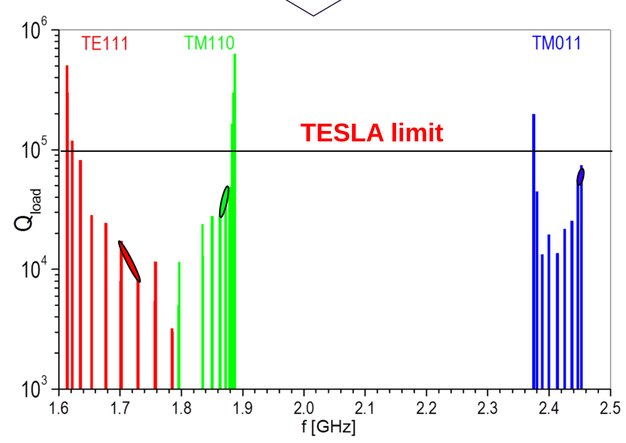

Figure 2: Example of $Q_{load}(f)$ for TE111, TM110, TM011.

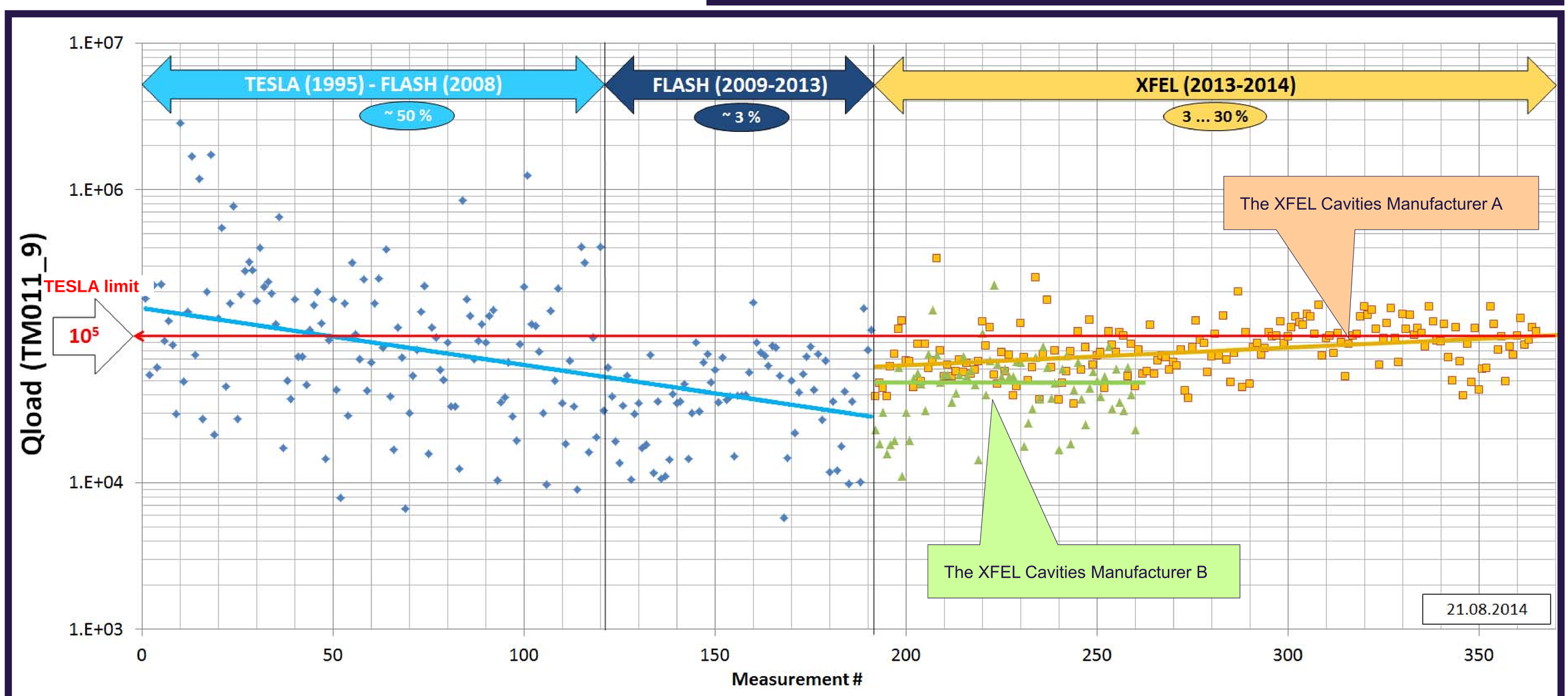

Figure 3: Measurement results of HOM damping for 9-cell TESLA shape cavities under cryogenic conditions at DESY.

Measurements

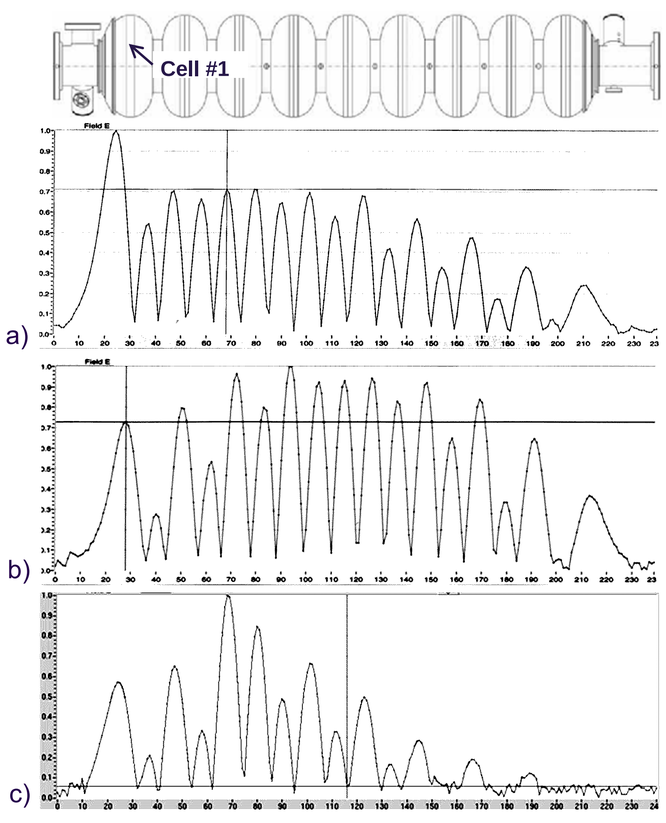

Figure 4:Field distribution of TM011_9 |E| (r=0, z) for:
a) optimal HOM damping efficiency (Qload = 70 000);
b) reduced HOM damping efficiency (Qload = 252 000);
c) TM011 (zero) is trapped in the cavity (Qload = 339 000).

Computer Simulations [6]

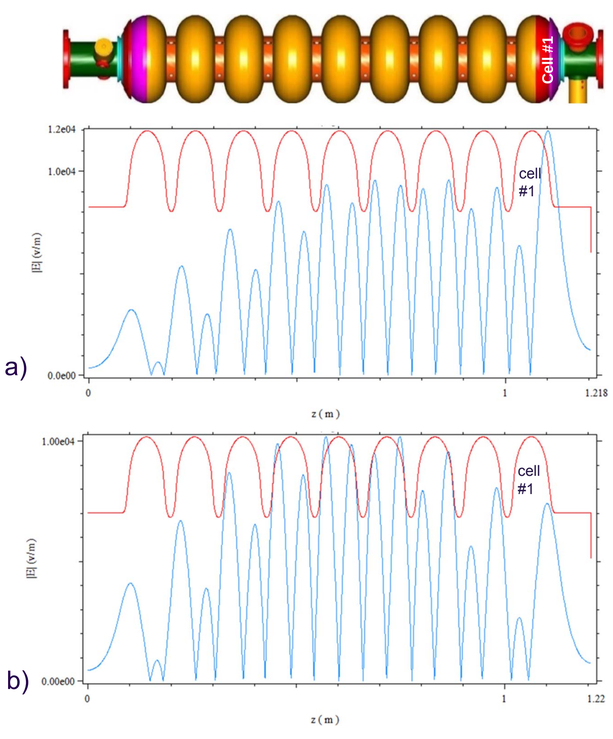

Figure 5: Simulated TM011 (zero-mode) |E| (r=0, z) for:
a) planned geometry;
b) elongation of cell#1 (about 1.5 mm) compensates increasing of the equator radius by 0.2 mm.

Summary

- The reduction of a HOM damping efficiency for the European XFEL cavities is caused by some critical changes in the field distribution on TM011 (zero mode).
- RF simulations show that these changes are possible even for geometry deviations of about ± 0.2 mm in the equator radius within specific cells.
- Some geometry deviation influences could be reduced by an algorithm of parts sorting during cavity fabrication. However, such shape errors, generated during cavity welding, could not be compensated without expensive and time-consuming actions.
- Based on the European XFEL beam parameters, the HOM damping is not as critical as for the TESLA linac. Therefore it was decided to relax the HOM damping requirements for the monopole mode TM011_9: Q_{load} limit from 1×10^5 to 2×10^5.
- The further work on the HOM damping improvement is going on in collaboration with cavities manufacturers

References:
[1] R. Wanzenberg, “Monopole, Dipole and Quadrupole Passbands of the TESLA 9-cell Cavity”, TESLA 2001-33,
[2] N. Baboi et al., “Preliminary Study on HOM-Based Beam Alignment in the Tesla Test Facility”, LINAC 2004, Lübeck,
[3] N. Baboi et al., Investigation of a High-Q Dipole Mode at the TESLA Cavities, EPAC 2000, Vienna, Austria
[4] TESLA Technical Design Report, DESY, 2001
[5] J. Iversen et al., “Development and Design of an RF measurement Machine for the European XFEL Cavity Fabrication”, 14th SRF Conference, Berlin, 2009, p.786.
[6] J. Sekutowicz, “2D FEM Code with Third Order Approximation for RF Cavity Computation”, Proceed. Linear Accelerator Conference, Tsukuba, Japan, 1994, p. 284
[7] http://tesla new.desy.de/cavity_database/homs_pickups/
[8] http://xfel.desy.de/cavity_database/rf_measurements/

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