Results on Quality Factors of 1.3 GHz Nine-Cell Cavities at DESY.

F. Schlander*, Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany
*new affiliation: Institut für Kernphysik, Johannes Gutenberg-Universität, Mainz, Germany

Abstract

Superconducting cavities made of niobium are the basis of many accelerators, such as the linear collider. The quality factors of 1.3 GHz cavities at DESY are reported. The results allow comparison of the quality factor for the 1.3 GHz cavities with the state-of-the-art treatment taken, as marked in the table on the right.

Introduction

The minimisation of the ohmic losses in superconducting cavities is important not only because of the increasing temperature that is rising in terms of providing a really small amount of liquid helium as coolant, but it is also for the surface resistance. Hence the dissipated power is the unloaded quality factor $Q_0$. The dissipated power $P_{diss}$ is calculated by:

$$ P_{diss} = \frac{E_0^2 I^2}{R_0 Q_0} $$

The parameters are as follows (values given are for the XFEL-type cavities):

- $E_0$: accelerating field
- $I$: active length
- $R_0$: geometric factor
- $Q_0$: unloaded quality factor

Datasets are shown in the table above.

Surface treatments (large grain cavities)

This analysis shows comparison of the quality factor for all three surface treatments (EP, BCP, EP+). The surface treatments have been measured at DESY, the test results of some 50 recent cavities with state-of-the-art treatment taken are shown in the table on the right.

- Data analysis
  - Similar quality factors for all datasets
  - Quality factor requirements for XFEL easily reached
  - $Q_0 > 1.5 \times 10^8$ for accelerating fields up to 25 MV/m
  - RCA show similar performance as earlier cavities
  - Cavities surpass accelerator specifications

Surface treatments (fine grain cavities)

These are 10 EP cavities and 15 EP+ cavities, only 6 cavities have been tested with both surface treatments.

- Data analysis
  - Similar evolution of quality factor for all datasets
  - Quality factor requirements for XFEL easily reached
  - $Q_0 > 1.5 \times 10^8$ for accelerating fields up to 25 MV/m
  - RCA show similar performance as earlier cavities
  - Cavities surpass accelerator specifications

Conclusion

About 70 tests of superconducting 1.3 GHz 9-cell cavities at DESY have been examined:

- Large grain cavities feature 10-20% higher quality factors than cavities made of the grain material - expected
- Cavities made of niobium sheets with higher RRR yield slightly higher quality factors - expected
- No significant difference in quality factors for different surface treatments

The dataset available shows promising results regarding the specifications of current large scale accelerators. The dataset requires $Q_0 > 10^{10}$. Most of the cavities also meet the requirements for continuous wave accelerators at lower accelerating fields ($E_0 < 20$ MV/m = 2417 T).

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