Recent Results from Second Sound, T-Mapping and Optical Inspection of 1.3 GHz Cavities at DESY

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Abstract

DESY is preparing for the delivery of 800 superconducting 9-cell cavities for the European XFEL. The review of earlier data and the analysis of data obtained recently helped to define the rules for preparation of cavities and give guidance for the quality assessment of the expected cavity delivery. The experience gained from temperature mapping, the second sound technique and optical inspection will be compared and an overview of the results obtained so far will be given in this report.

Fundamental field modes in a 9-cell cavity

Field distribution in a 9-cell cavity for all modes, normalized to the max. field achieved. The mode measurements can be used to excite selected cells and hence reduce the cell ambiguity in locating quenches amongst various cells.

Cavity tests

Data used

Form Nov 2009 to June 2011 a total number of 69 cavity tests have been done at DESY. A few cavities do not show a clear cavity history including the current surface, and cavity production series (3 hydroformed cavities) and 9 (4 cavities in XFEL-design, test of a new fabrication process) are not included in this report. So the dataset contains test of the cavity production series 6 and 8 with fine grain large grain niobium respectively for which the number of tests amount to 30 and 18, i.e. in total 48 tests.

- For the EP cavities there are only 3 (20%) tests with gradients below 30 MV/m with strong radiation observed, leading to the assumption of field emission.
- For the different cavity series there are two "groups" in the diagram representing the BCP and the EP surface.
- 17 tests (69%) reach the XFEL specification of 23.6 MV/m in this test sample.
- The BCP cavities reach gradients up to 30 MV/m.

Example of correlation between mode measurements, quench localisation and optical inspection

The table shows the quench locations obtained with second sound of AC150 and the results of the mode measurements showing the cells with the highest fields.

<table>
<thead>
<tr>
<th>Model</th>
<th>Quench location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/9 π-</td>
<td>#1, #9</td>
</tr>
<tr>
<td>2/9 π-</td>
<td>#1, #9</td>
</tr>
<tr>
<td>3/9 π-</td>
<td>#1, #9</td>
</tr>
<tr>
<td>4/9 π-</td>
<td>#1, #9</td>
</tr>
<tr>
<td>5/9 π-</td>
<td>#1, #9</td>
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<tr>
<td>6/9 π-</td>
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<tr>
<td>7/9 π-</td>
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<tr>
<td>8/9 π-</td>
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Comparison of mode measurements with second sound data

Observation from 118 mode measurements and simultaneously running second sound measurement (13 cavities + 1 cavity with HOM feedthroughs).

Categories for failing second sound location.

- 21% defined on the 1/9 mode of AC151
- 12% no further explanation
- 33% no 2nd sound result
- 13% no correlation with field
- 44% no correlation with field
- 52% cell with maximum field
- 35% no 2nd sound result

Results:

- When measuring successfully there is good agreement between the location derived from second sound and the peak field excited in mode measurements in a given cell.
- Few datasets show quenches in cells with higher fields than in π-mode, but not in cells with highest field gradient.
- For very few datasets there is no obvious correlation between field and quench location.
- Almost half of "bad" second sound measurements are due to noise and low signals.
- AC151 had a damaged HOM coupling antenna (f-part) leading to Q-switches (local heating at the latter HOM coupler) and improper measurements.
- Some second sound measurement fail when the stored energy in the cavity is too low.

Acknowledgements

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