Surface Treatment Experience of the All Superconducting Gun Cavities*.

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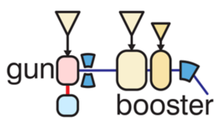
Gun cavity with cathode plug screwed into back-wall

for optimal integration of cathodes in an ultra-clean SC cavity

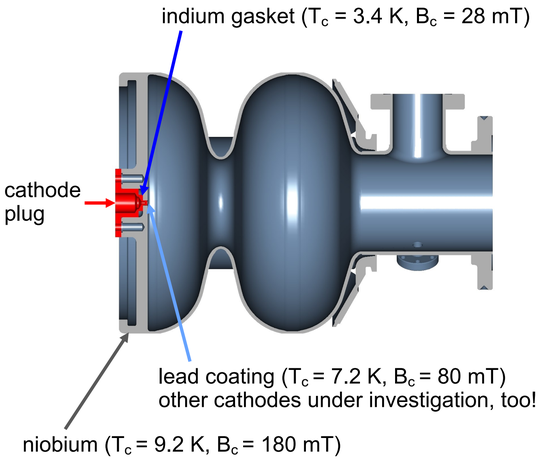
High gradient SRF gun



- ⇨ 'pancake' emission
- ⇨ direct matching of the beam into subsequent linac
- ⇨ requires peak field on axis gradient above 40 MV/m

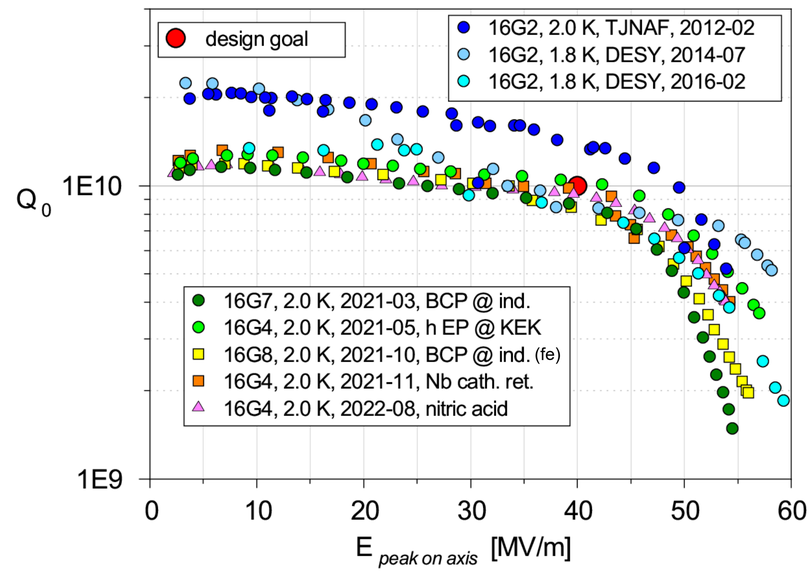
Metal cathode plug screwed into back-wall

- ☺ cleaning after cathode insertion in a clean room
- ☺ we get the high gradients required
- ☹ exchanging the cathode is complicated
- ⇨ R&D on compatible cathode



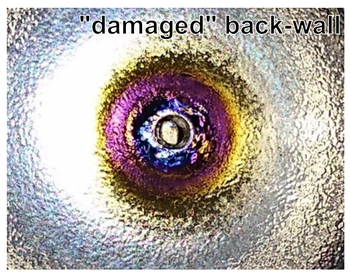
Vertical test results

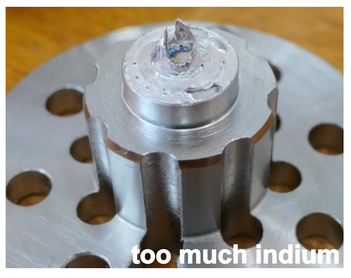
from cavities '16G2', '16G4', '16G7' and '16G8'



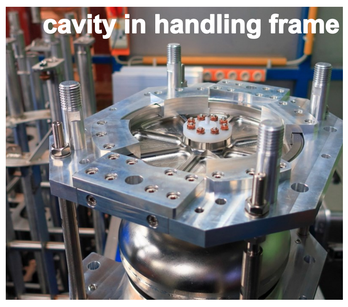
SRF gun cavity generations

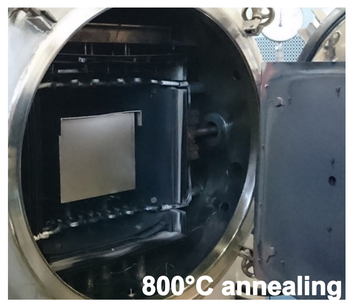
Some issues and solutions

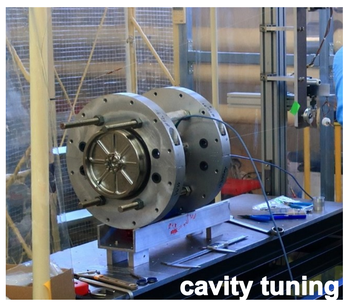


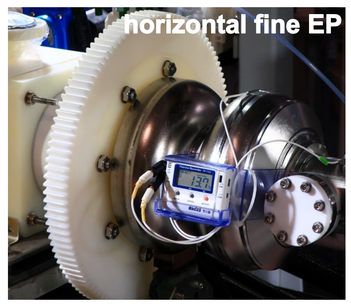


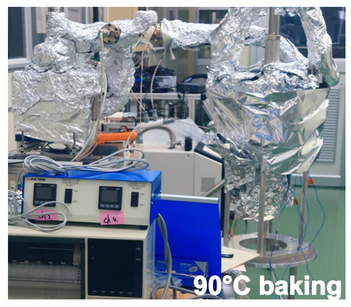
EP treatment & preparations at KEK

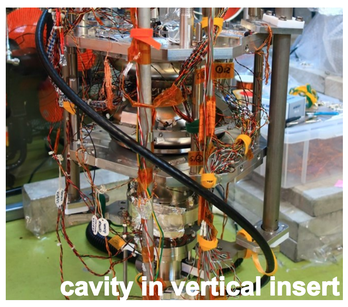












Surface treatment recipe

Well established surface treatment recipes are available for TESLA type accelerating cavities. These cavities have large beam tubes at both sides used for the treatment. The SRF gun cavity with a single beam tube requires adaptations. The main treatment and preparation steps are:

- main (BCP) treatment, 110 µm in one or more steps
- several cleaning steps applyinghigh pressure water rinsing (HPR) and ethanol rinsing
- 800°C annealing
- cavity tuning
- fine treatment by BCP of about 20 µm or horizontal EP for improved smoothness and performance
- several cleaning steps applying HPR and partially ultra-sonic cleaning (US)
- cathode plug assembly
- HPR
- 90°C baking

In the last years, we tested many variations of these steps before achieving systematically high peak field on axis gradients at the subsequent vertical tests.

Summary and outlook

In recent years we developed surface treatment procedures for the SRF gun cavities with a cathode plug screwed to the back-wall providing typical maximum peak field on axis gradients around 55 MV/m in vertical tests providing sufficient margin to the design goal of 40 MV/m. This is the case for BCP treatments. Applying EP in addition increases high gradient Q-values. We identified quite some potential for further optimizing our surface treatment processes and are working on them.

We have the first main prerequisite for a CW photoinjector for "pancake" beam emission and direct matching into the subsequent linac in hand by achieving the required high gradients on a regular basis.

The other main prerequisite are photocathodes which are robust against the exposure to air and the usual SRF cavity cleaning procedures. In contrast to the commonly used photocathode materials, our cathodes have to be out of metals. In the case of coatings, we need to improve significantly the adhesion. Other options are nanostructured metal surfaces. Plain copper cathodes may already provide the QE needed after applying RF conditioning in combination with laser cleaning.

Acknowledgements

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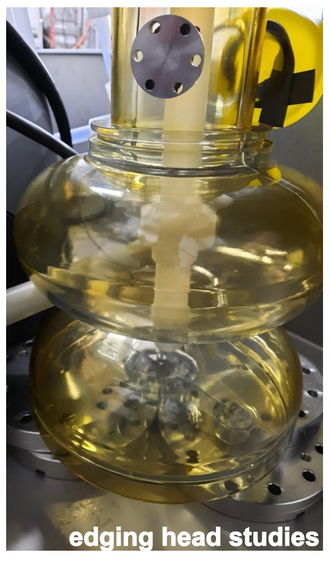
link to paper

HPR and dry-ice cleaning at DESY

Surface treatment by BCP



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‡The work at KEK presented here was carried out when T. Konomi was still employed as a scientist at KEK, Tsukuba, Japan.

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