Analysis of RF Results of Recent Nine-Cell Cavities at DESY

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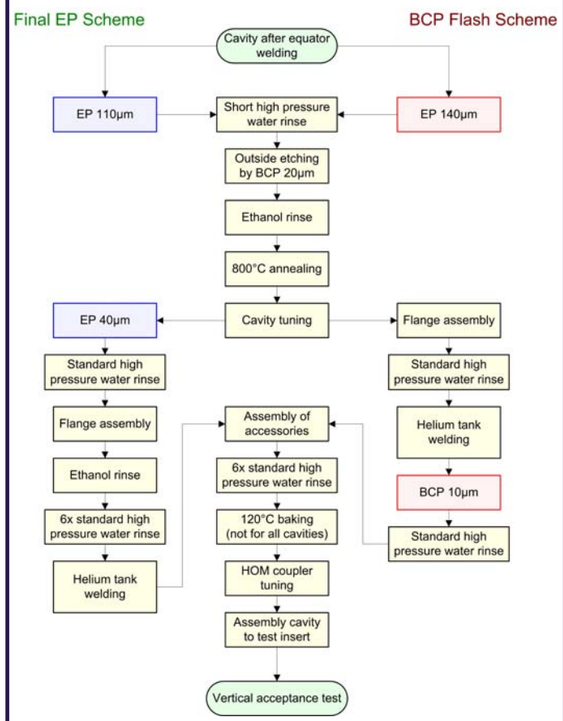
Abstract

About 50 nine-cell cavities of the recent fine-grain niobium cavity productions have been analysed with respect to maximum and usable gradient in the first and final vertical acceptance test, respectively. Parameters of the analysis were the manufacturer of the cavities, the location of the main EP (=> industry or in-house), the final surface treatment (=> final 40µm EP or short 10µm "flash" BCP) and the cavity preparation strategy (=> vertical acceptance test with or without He-Tank welded). Moreover, the effect of a re-processing of field emission loaded cavities by additional ultra pure high pressure water rinsing has been investigated.

Baseline of analysis

- About 50 cavities of 4th and 6th production analyzed
- Cavity preparation strategies:
  - **"without He-tank":** He-tank welding after preparation process + vertical RF acceptance test
  - **"with He-tank":** modified preparation strategy



- Analysis wrt. i) maximum gradient $E_{acc,max}$,
  ii) usable gradient $E_{acc,usable}$,
  iii) field emission

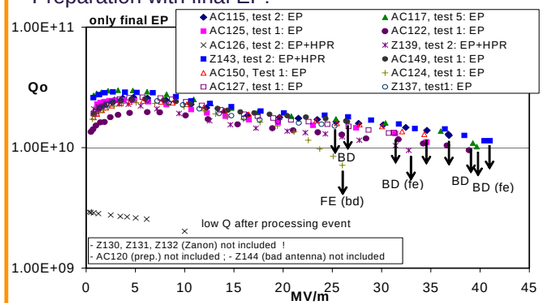
=> Definition of usable gradient:
Lowest gradient in vertical acceptance test of quench or x-rays (> 10^{-2} mGy/min) or RF losses (> 100W CW)

- Dependence on
  - cavity vendors,
  - location of main EP,
  - final EP vs. final "Flash BCP",
  - vertical RF acceptance test with or without He-tank,
  - first vertical RF test (=> goal for XFEL) and last vertical RF test (=> as used so far for FLASH modules)
  - reprocessing after field emission: additional HPR

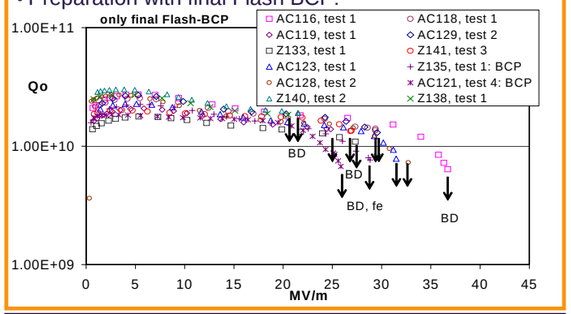
Typical Q(E)-performances

=> final EP: + gradients > 36 MV/m possible
=> final Flash BCP: - Q-slope w/o field emission not fully cured

- Preparation with final EP:



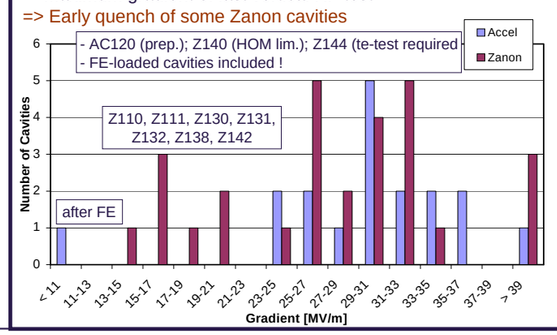
- Preparation with final Flash BCP:



Max. gradient of cavity vendors (Accel, Zanon)

- Maximum gradient of last vertical RF test

=> Early quench of some Zanon cavities

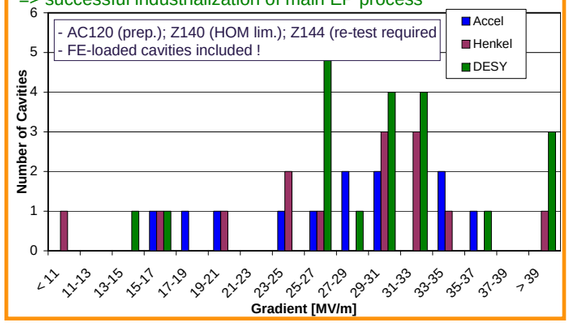


Max. gradient depending on Main EP location

(Accel, Henkel, DESY)

- Maximum gradient of last vertical RF test

=> no dependence on main EP location
=> successful industrialization of main EP process

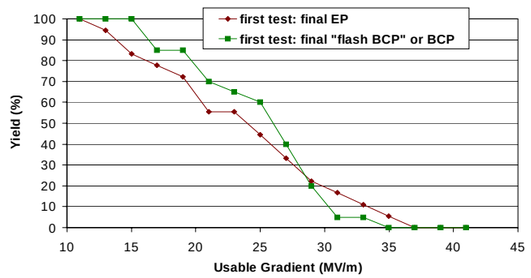


Maximum and usable gradient depending on final treatment (final EP vs. final "Flash BCP")

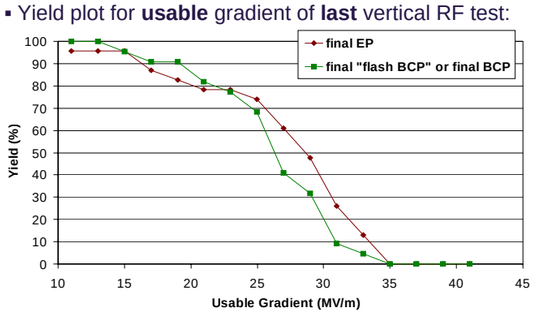
- analysis of about 18 – 25 cavities **per treatment**
- for 10 cavities only one test done => first + last test identical

=> yield for 23.6 MV/m (usable): (70 – 80)% in last test
(50 – 65)% in first test
(limited by Zanon cavities + field emission)
=> Max gradient: Final EP with obvious high potential for gradients > 30-35 MV/m
=> Usable gradient: Field emission at high gradients levels advantage of final EP

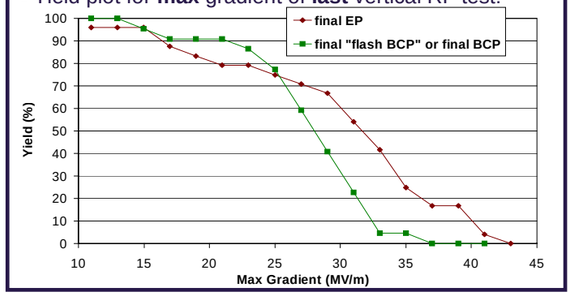
- Yield plot for **usable** gradient of **first** vertical RF test:



- Yield plot for **usable** gradient of **last** vertical RF test:



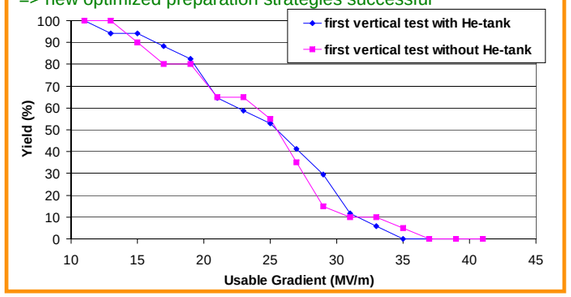
- Yield plot for **max** gradient of **last** vertical RF test:



Preparation strategies "with He-tank" and "without He-tank"

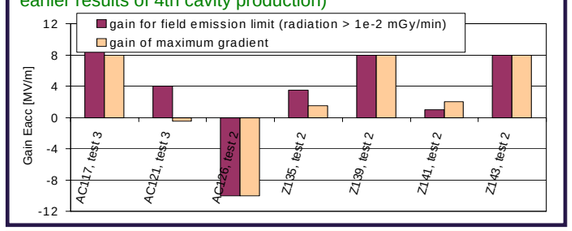
- Yield plot of **usable** gradient of **first** vertical RF test

=> new optimized preparation strategies successful



Re-processing of field emission loaded cavities by HPR

=> successful for 6 of 7 cavities of 6th cavity production (confirms earlier results of 4th cavity production)



Summary

- **Broad scatter of max. and usable gradient in vertical acceptance test:**
  - **=> some Zanon cavities with early quench**
  - **=> field emission limits in about 1/3 of tests**
  - **=> yield of usable gradient at 23.6 MV/m: 50 – 80 %**
  - **=> higher yield of final EP for gradients > 30 MV/m**
- **Industrialization of Main EP successful**
- **Re-processing with only HPR effective against field emission**
- **Optimized preparation scheme "with He-tank" successful**
- Q-slope w/o field emission not fully cured by "120C bake" for final "Flash BCP"

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