Status of EP single-cell cavities

(L .Lilje on behalf of D. Reschke)

History + motivation:

- statistics of single-cell cavities at KEK + CERN - Saclay -DESY collaboration shows superiority of electrolytic surface removal ("electropolishing => EP") compared to chemical etching ("buffered chemical polishing => BCP")
- obvious advantage of EP: smoother surface compared to BCP
- application to TTF nine-cell cavities requires EP system at DESY
  => under operation since March 03
  (up to now nine-cell EP at Nomura plating, Japan)
- cooperation with Henkel Elektropoliertechnik (100 km east of Hamburg)
  for single-cell treatments and future tests of alternative EP mixtures
  => first cavity polished in March 03
  no experience with SRF cavities; established processes for semi-cond. + medical industry

Status of EP single-cell cavities II

Cavity preparation:

i) degreasing (US-cleaning + pure water rinsing)

ii) electropolishing (electrolyt 1 x HF : 9 x H_2SO_4 ; horizontal set-up)

iii) rinse with diluted HNO_3 (only at Henkel)

iv) rinse with (hot) ultrapure water

v) transportation into DESY cleanroom

vi) assembly of top flange

vii) high pressure water rinse (> 2x)

viii) assembly of antenna with vacuum connection, pumping + leak check

ix) first vertical test (optional: T-mapping)

x) low temperature heat treatment between 100 C - 140 C (“bake”)

xi) second vertical test (optional: T-mapping)

EP @ DESY

- successful polishing of 4 cavities with different EP parameters (e.g. temperature of electrolyt)
- examples

  i) 1B8 of the CERN - Saclay - DESY collaboration; welded at CERN

  (best result: E_{acc} = 41MV/m after EP@CERN + bake)

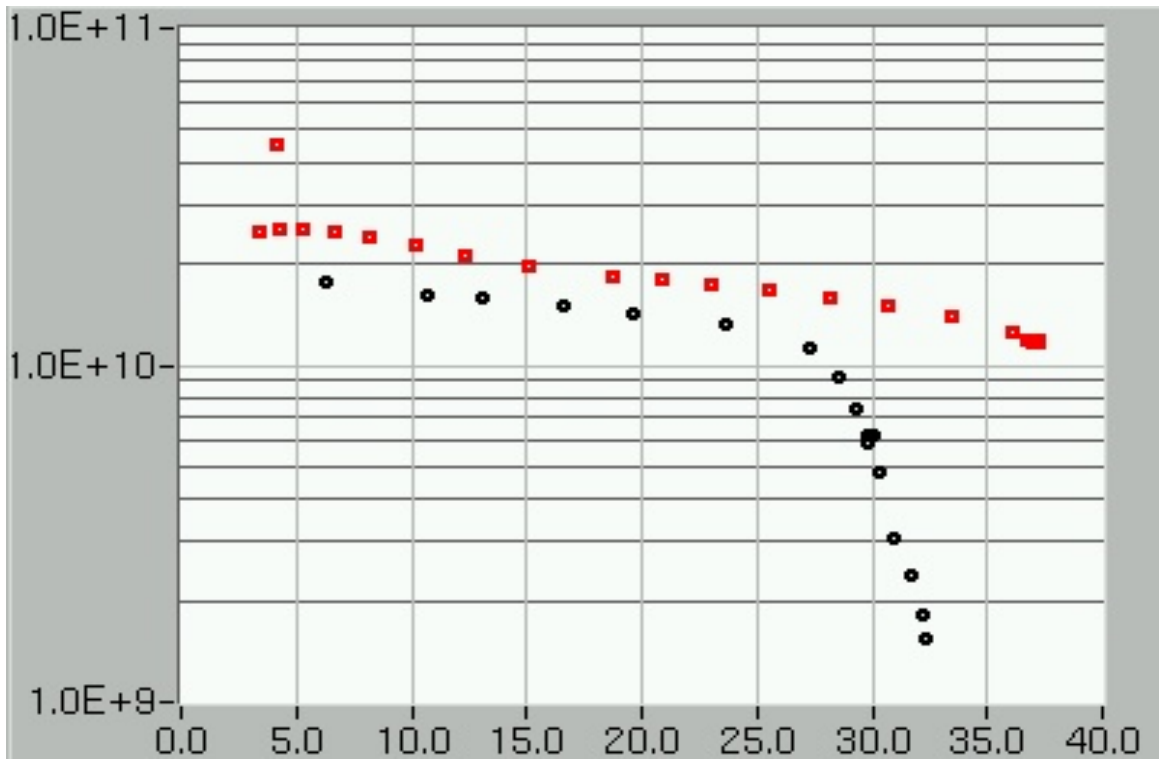
  ii) 1S2 of the CERN - Saclay - DESY collaboration; welded at ACCEL

  (best result E_{acc} = 36MV/m after EP@CERN + bake)

  removal app. 30 µm for both cavities

1B8: First successful EP at DESY

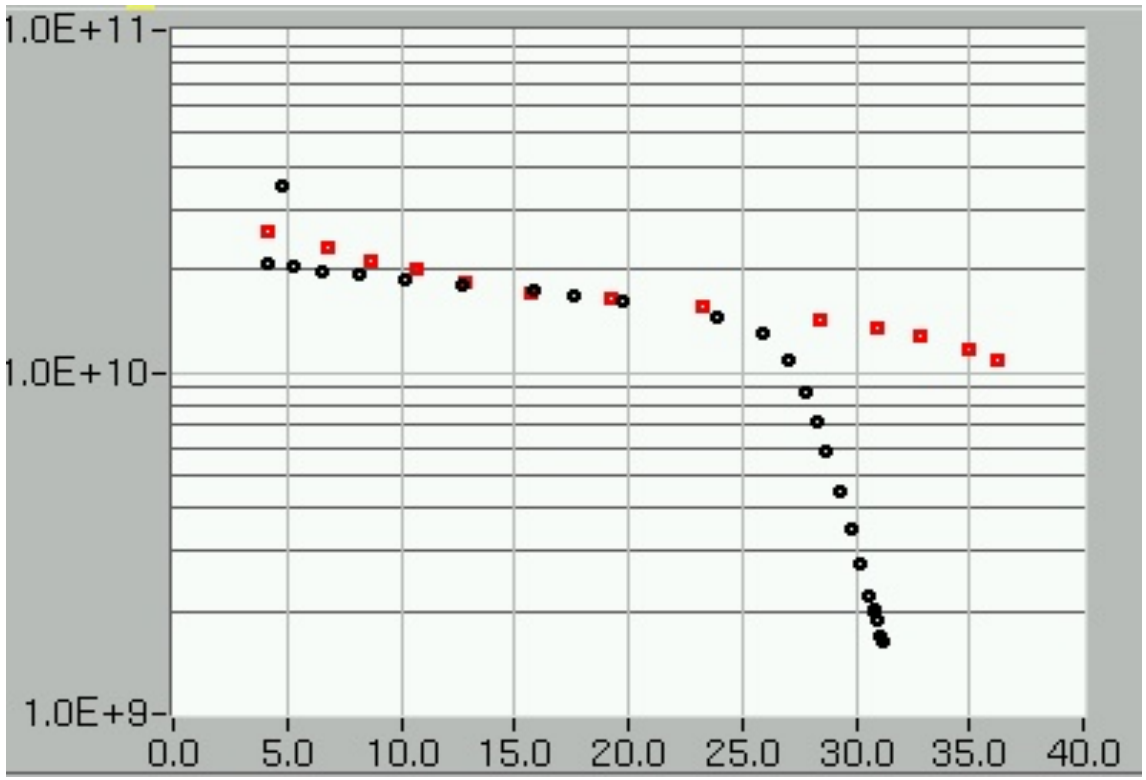
- 1. test: E_{acc} = 32 MV/m @ Q_0 = 1,6 ·10^9; no FE; limited by power
- bake at 135C
- 2. test: E_{acc} = 38 MV/m @ Q_0 = 1,2 ·10^{10} limited by breakdown; no fieldemission



T_b = 2K

1S2: EP @DESY

- 1. test: E_{acc} = 31,2 MV/m @ Q_0 = 1,6 ·10^9; no FE; limited by power
- bake at 135C
- 2. test: E_{acc} = 36,3 MV/m @ Q_0 = 1,1 ·10^{10} limited by breakdown; no fieldemission



T_b = 2K

EP @ Henkel Elektropoliturtechnik

- successful polishing of 6 single-cell cavities (1B1, 1B10, 1B11, 1B12, 1P6 + 1S1)
- removal between 40 µm and 100 µm
- all cavities show high Q-value; typical low FE-loading; sometimes multipacting
  but: up to now no gradients above 31 MV/m !!?

$\Rightarrow$ discussion of preparation details with B. Henkel next week

- hydroformed two-cell cavity 2H2 became leak during EP
- preparation of spun three-cell cavity delayed
  (EP foreseen end of January, test in February)

EP @ Henkel: 1P6

- 1P6: older spun cavity (best result E_{acc} = 35 MV/m after EP@CERN + bake)

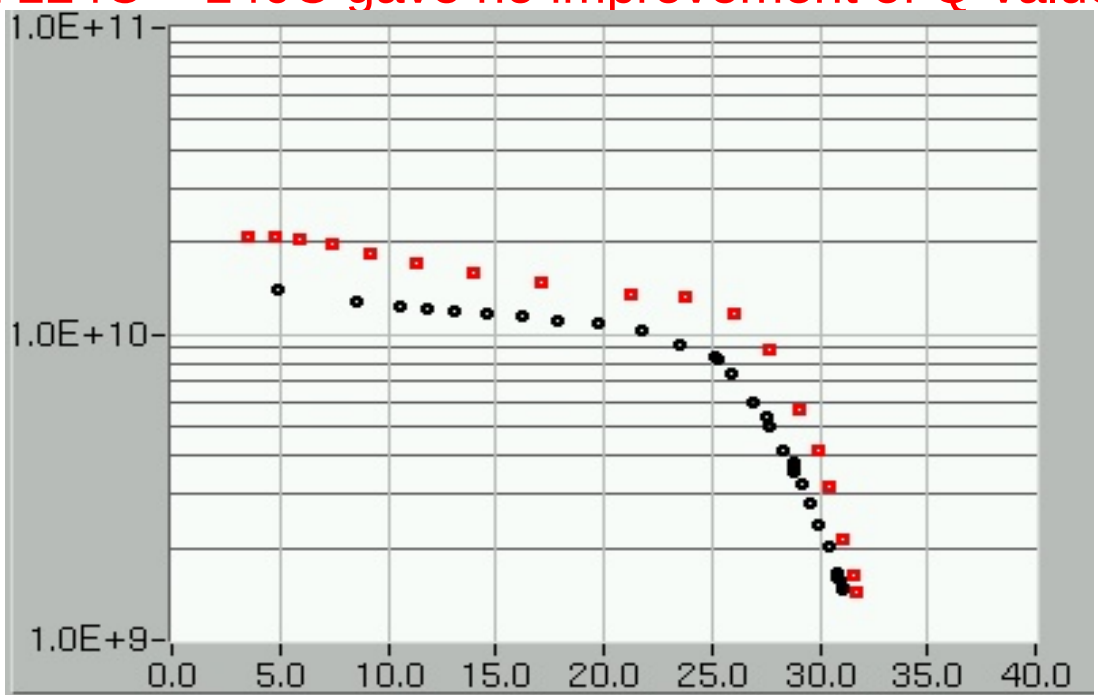
  60µm EP : E_{acc} = 31 MV/m@ Q_0 = 1,5 ·10^9; few FE

  + bake 124C : E_{acc} = 22 MV/m@ Q_0 = 1,4 ·10^9; strong FE

  + new HPR : E_{acc} = 32 MV/m@ Q_0 = 1,5 ·10^9; no FE =>no improvement

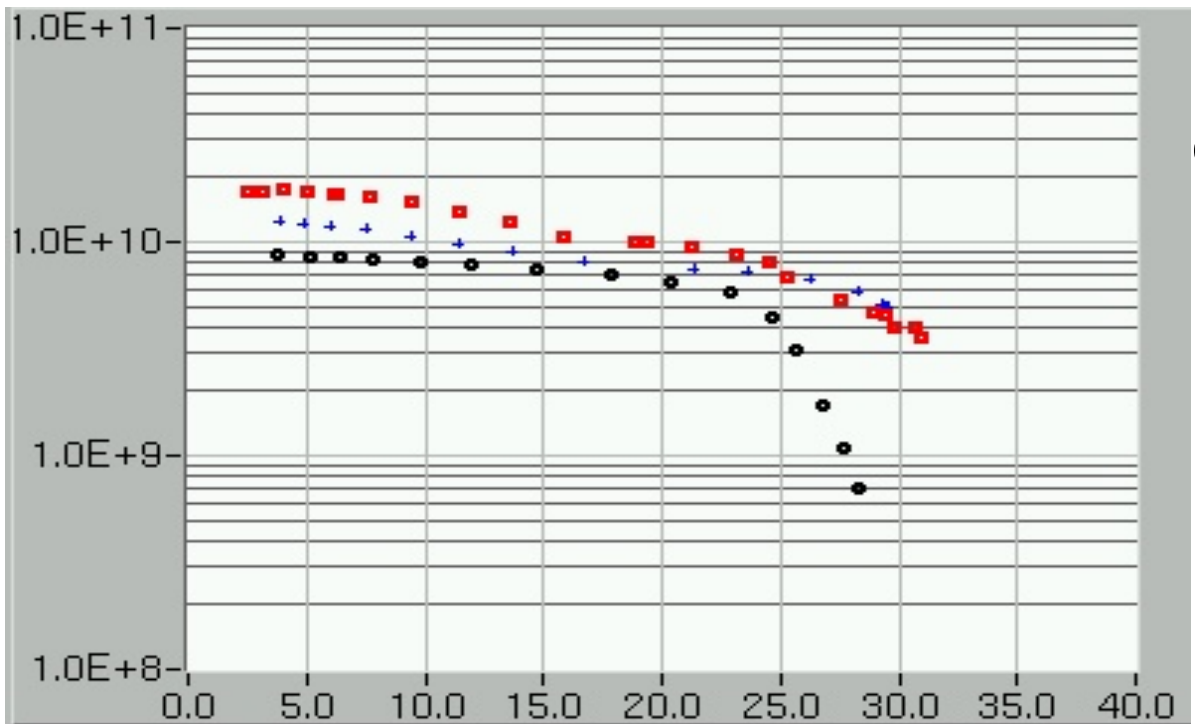
  + bake 140C : E_{acc} = 31 MV/m@ Q_0 = 1,5 ·10^9; few FE =>no improvement

=> bake at 124C + 140C gave no improvement of Q-value!!



EP @ Henkel: 1S1

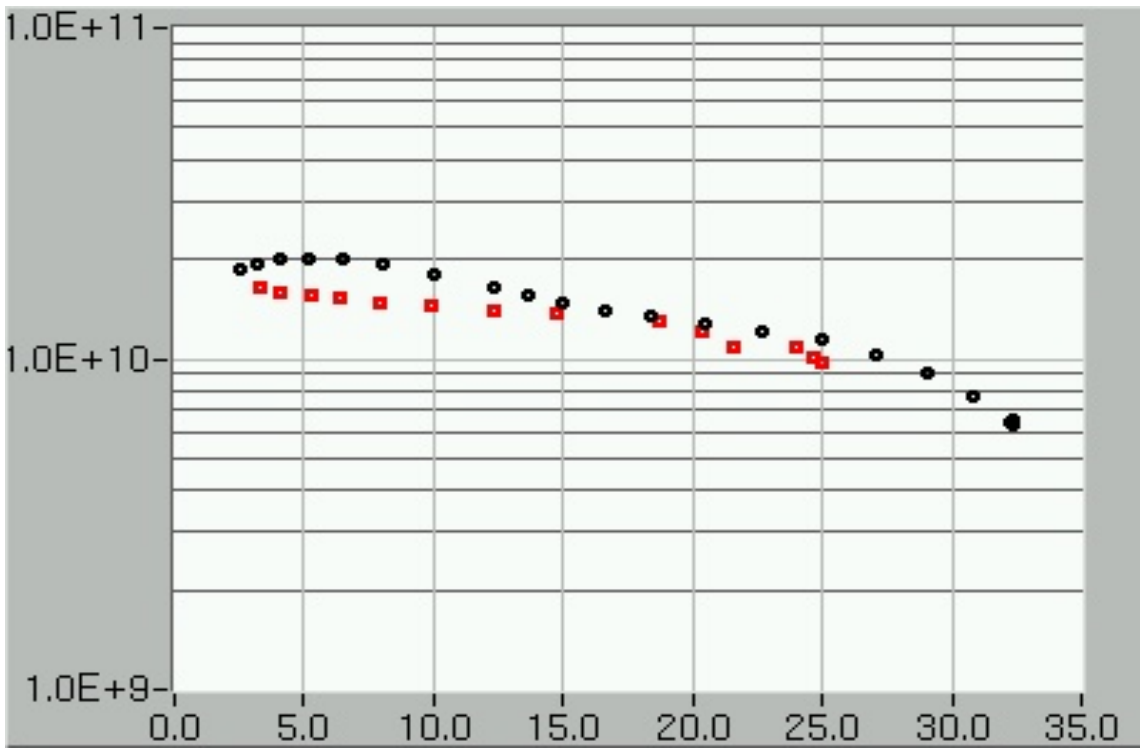
- 1S1 of the CERN - Saclay - DESY collaboration; welded at ACCEL
  800C firing + 1400C titanisation; best result E_{acc} = 35MV/m after EP@CERN + bake
- 70 µm EP@Henkel; test after bake showed leak and fieldemission:
  E_{acc} = 31 MV/m @ Q_0 = 3,6 ·10^9; strong FE; limited by vac
- new HPR: E_{acc} = 30 MV/m @ Q_0 = 4,9 ·10^9; no FE; limited by BD



comparison of Q(E)-curves before and after bake

EP @ Henkel: 1B1

- 1B1 of the CERN - Saclay - DESY collaboration; welded at CERN
  reference cavity with BCP-treatment; 1200C titanisation;
  best result E_{acc} = 32,5 MV/m @ Q_0 = 6,5 ·10^9 after EP@CERN + bake
- 130 µm tumbling, 20µm BCP, 800C firing + 40 µm EP@Henkel:
  E_{acc} = 25 MV/m @ Q_0 = 9,5 ·10^9; no FE; limited by BD

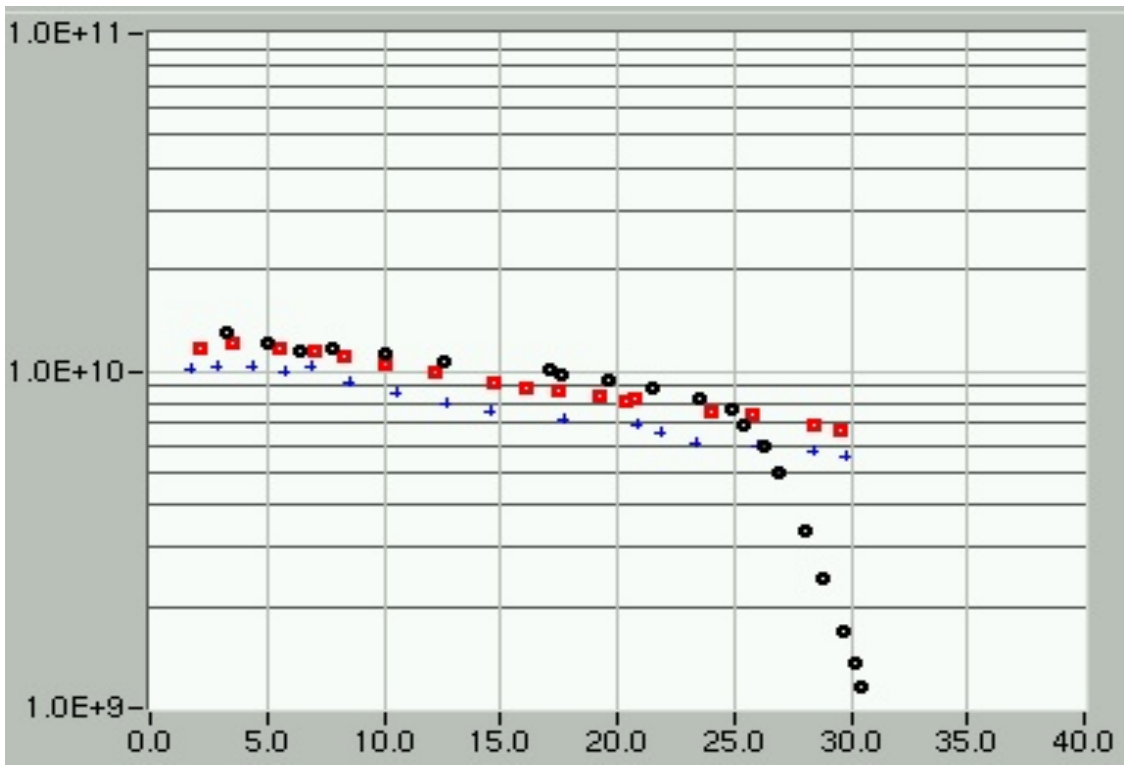


comparison of best and last Q(E)-curve

Removal not sufficient ??

EP @ Henkel: 1B10

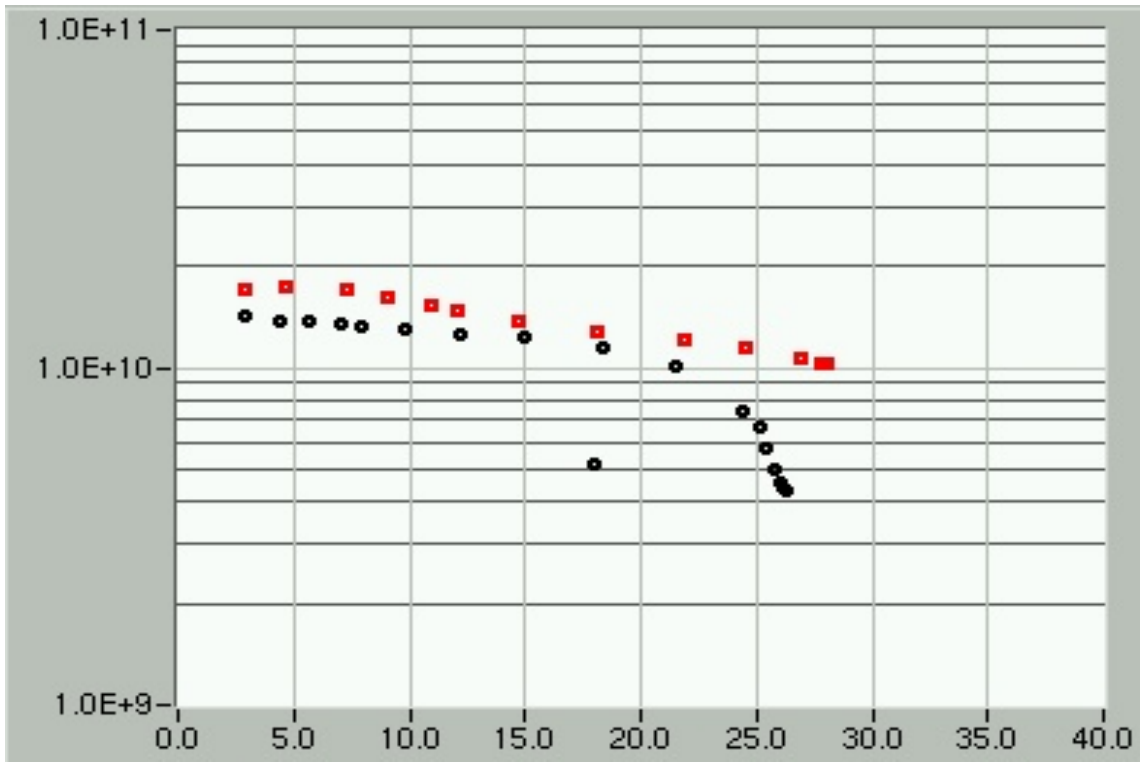
- 1B10 of the CERN - Saclay - DESY collaboration; welded at CERN
  800C firing; after EP@CERN only 17 MV/m limited by strong multipacting
- 100µm EP@Henkel; HPR + bake
  E_{acc} = 30 MV/m @ Q_0 = 5,5 ·10^9; no FE; limited by BD; strong MP



comparison of Q(E)-curves before and after bake

EP @ Henkel: 1B11

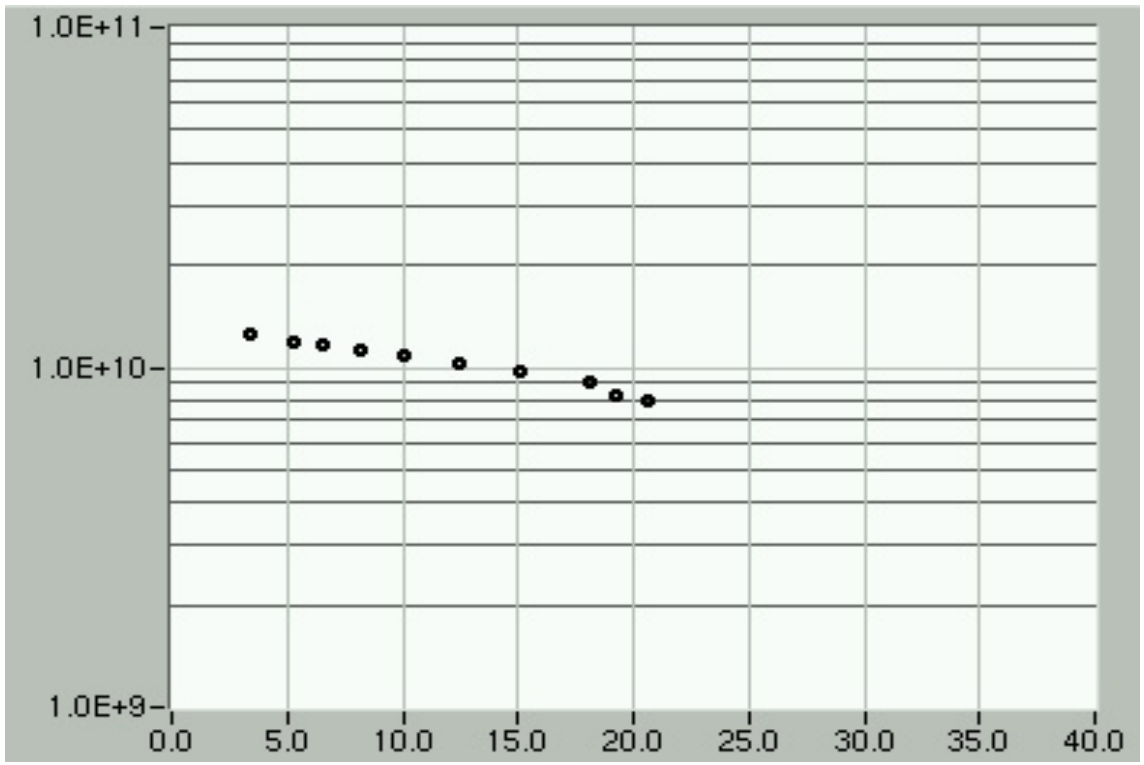
- 1B11 of the CERN - Saclay - DESY collaboration; welded at CERN
  800C firing?; no previous test
- 100µm EP@Henkel; HPR + bake
  E_{acc} = 28 MV/m @ $Q_0 = 1 \cdot 10^{10}$; no FE; limited by BD; strong MP



comparison of Q(E)-curves before and after bake

EP @ Henkel: 1B12

- 1B12 of the CERN - Saclay - DESY collaboration; welded at CERN
  800C firing?; EP@DESY ??µm, but no previous test due to accident during HPR
- 100µm EP@Henkel; HPR + bake
  E_{acc} = 20,8 MV/m @ $Q_0 = 8 \cdot 10^9$; no FE; limited by BD; some MP

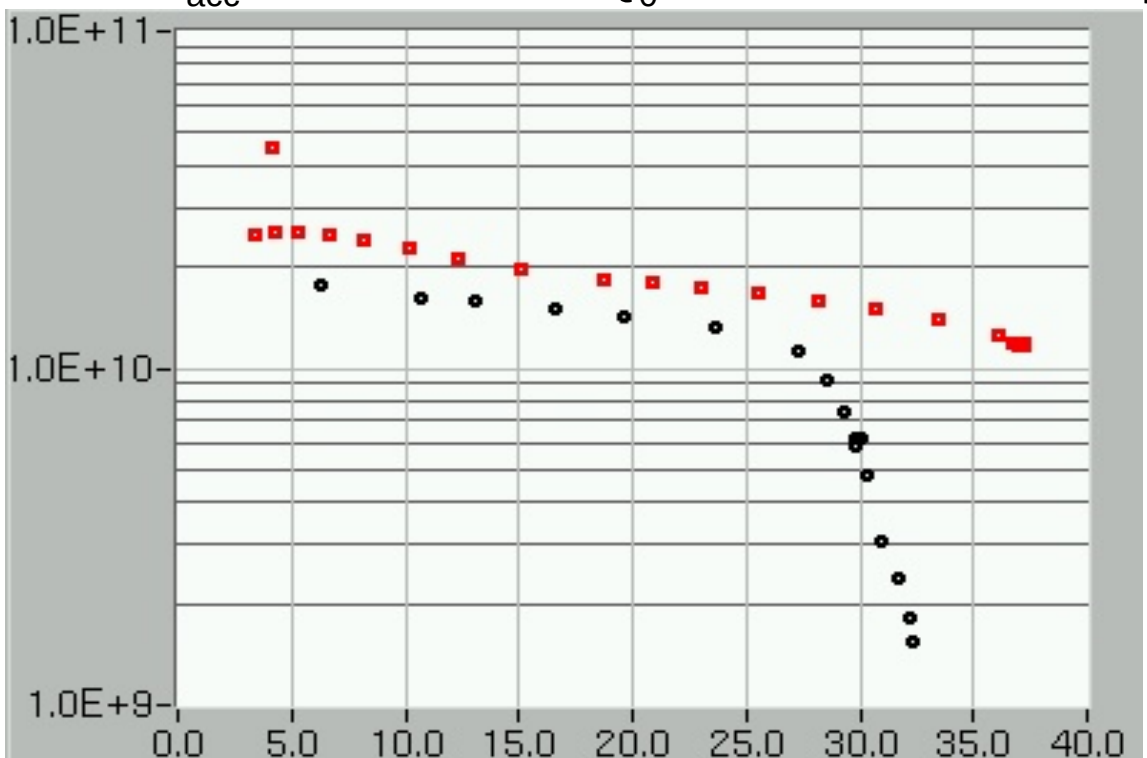


Removal not sufficient ??

Anodizing

1B8: First successful EP at DESY

- single-cell cavity of the CERN - Saclay - DESY collaboration welded at CERN (best result E_{acc} = 41MV/m after EP + bake at CERN)
- first EP @ DESY:
  before bake: E_{acc} = 32 MV/m @ Q_0 = 1,6 ·10^9, no FE; limited by power
  + bake 135C: E_{acc} = 38 MV/m @ Q_0 = 1,2 ·10^{10}, limited by BD; no FE



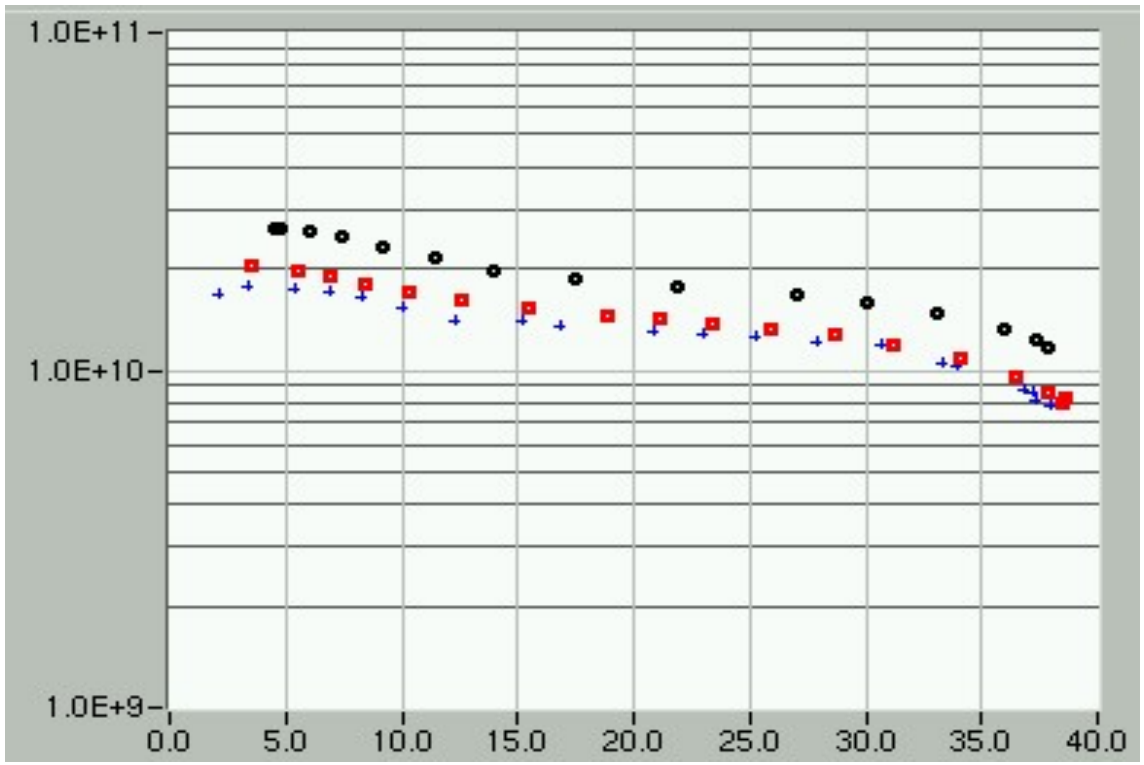
1B8: Anodizing

- anodizing with 30 V (≈ ??? nm Nb_2O_5-layer) + HPR

  E_{acc} = 39 (42) MV/m @ Q_0 = 8 ·10^9, limited by BD; no FE

- bake at 130C

  E_{acc} = 38 (42) MV/m @ Q_0 = 8e9, limited by BD; no FE



black: after EP + bake
red: after anodizing
blue: after add. bake

Summary + Outlook

- EP @ Henkel Elektropoliertechnik still needs final confirmation of full EP performance
  - detailed discussion of processes necessary
  - EP of spun three-cell cavity and more single-cell cavities in near future

- Anodizing for further understanding of the bakeout