Analysis of „120C bake“ effect (update)

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data base:

single-cell cavity experiments at CERN, Saclay, DESY

+ nine-cell cavity tests at DESY

Introduction

- > 60 tests on EP- and “BCP after EP” - cavities before and after bake evaluated
  > 25 tests on BCP- and “EP after BCP” - cavities before and after bake evaluated (+ standard BCP treatment as comparison)
- cavity results:
  - $E_{acc,max}$
  - $E_{acc}(P_0=((100W/9)*n)$; (E_{acc}@ $Q_0 = 10^{10}$)
  - $Q_0(E_{acc,max})$
- Why $E_{acc}(P_0=((100W/9)*n)$?
  i) reasonable measure for the Q-slope
  ii) nine-cell cavity with 100 W losses in cw operation corresponds to 0,75 W losses for 10 Hz duty cycle and 1,35 ms pulse length
  => NOT related to any ILC design!!!

Introduction (ctd.)

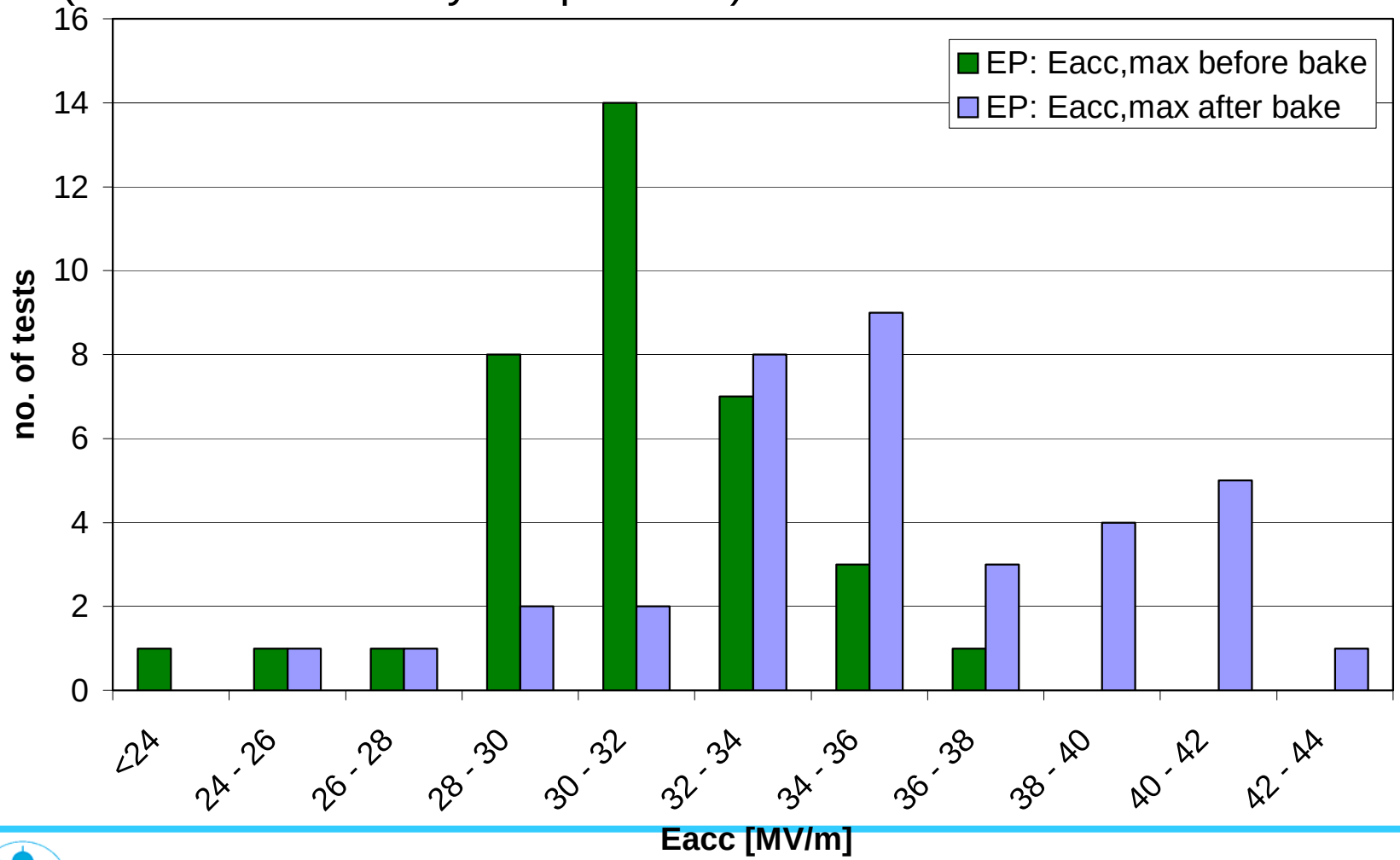
- analysed preparation + test parameters:
  - before vs. after bake
  - bake temperatures grouped:
    - (100 - 110)°C
    - (120 - 130)°C
    - (130 - 140)°C
  - He bath temperature of rf test (not complete)

  neglected:
  - duration of bake, residual resistance, effect of warm-up above T_c

- IMPORTANT: Any effect of field emission ignored!

Effect on $E_{acc,max}$

- EP-cavities: average of E_{acc} : 31 MV/m $\Rightarrow$35,1 MV/m
  (incl. EP followed by <10µm BCP)



Effect on $E_{acc,max}$ (ctd.)

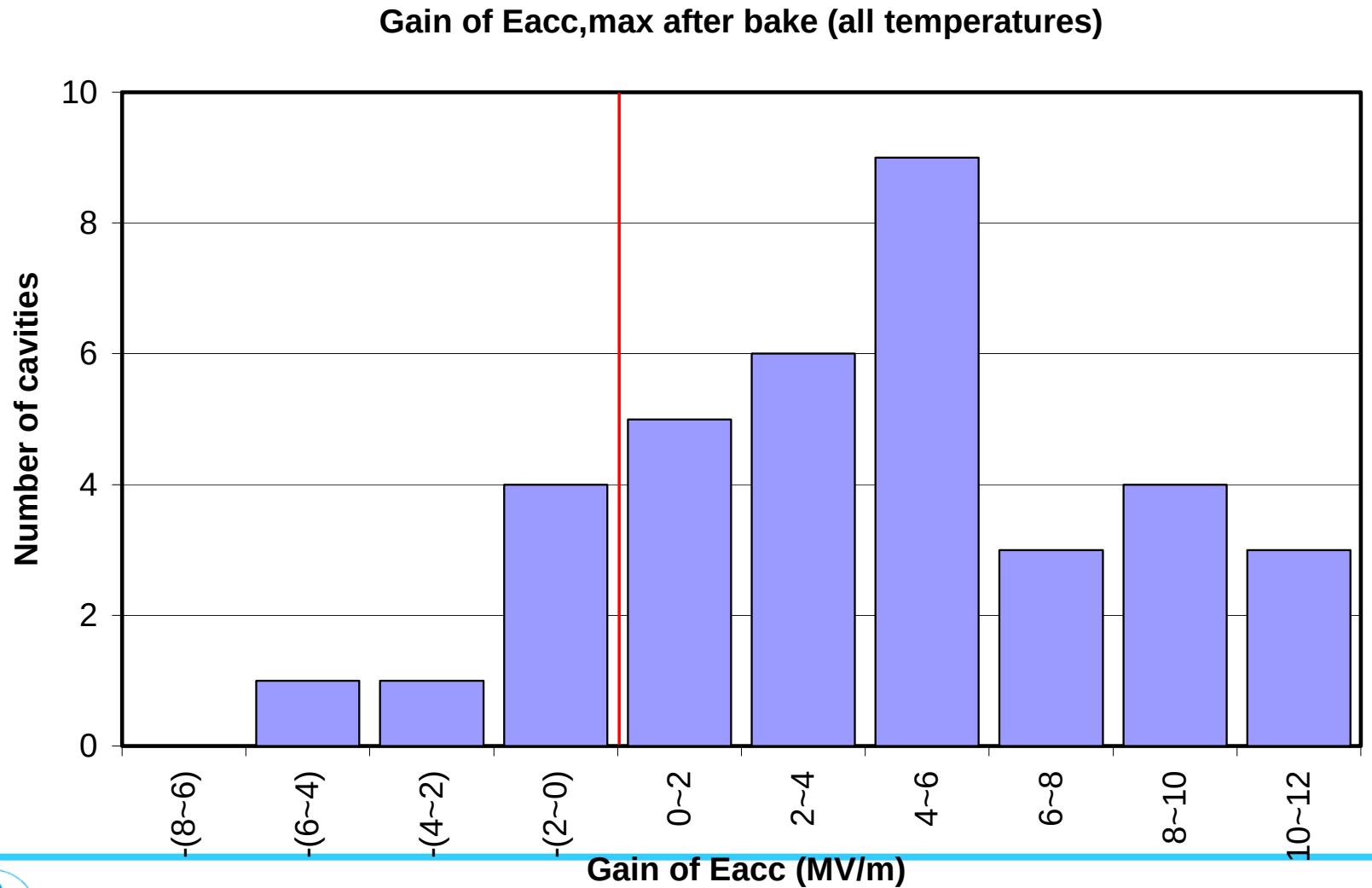
- EP-cavities:
  $\Rightarrow$ no dependency on bake temperature ($E_{acc,max} \approx 35$ MV/m)
- EP-cavities: general
  high scatter of $E_{acc,max}$: 25 MV/m to 44 MV/m
  high scatter of gain: -5 MV/m to 12 MV/m
  (experimental problems, cavity close to quench limit, not FE limited)

- BCP-cavities: general (19 tests: Saclay + DESY data)
  average gain of E_{acc} 27,6 MV/m $\Rightarrow$27,8 MV/m
  $\Rightarrow$no improvement !!

- EP-cavities preliminary: add. 2nd bake gives no improvement (3 tests)

Effect on $E_{acc,max}$ (ctd.)

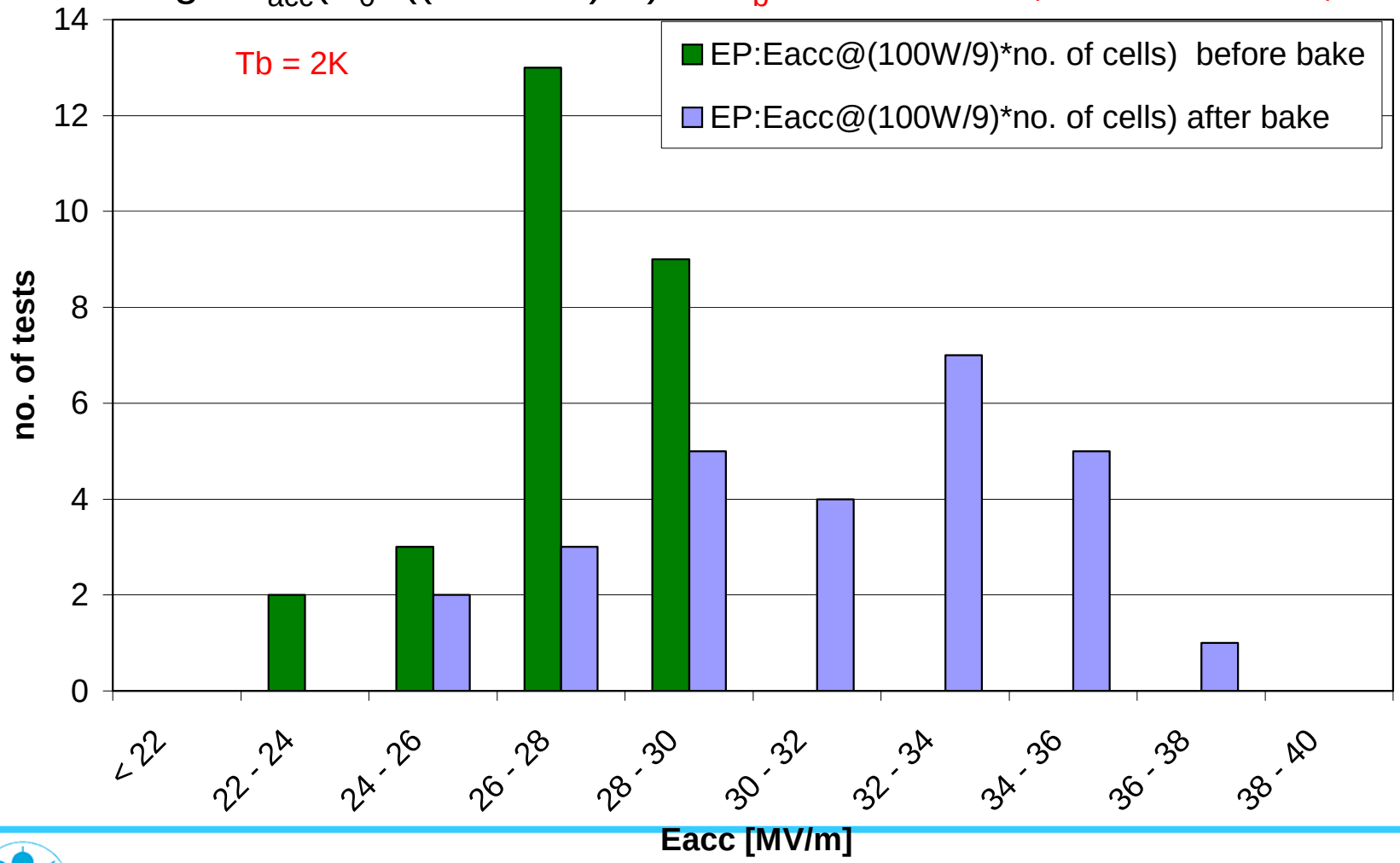
- EP-cavities: average gain of E_{acc} after bake: 4,2 MV/m



Effect on $E_{acc}(P_0=((100W/9)*n)$

- EP-cavities:

  average $E_{acc}(P_0=((100W/9)*n)$ at T_b = 2K: 27,3 MV/m $\Rightarrow$31,4 MV/m



Effect on $E_{acc}(P_0=((100W/9)*n)$ (ctd.)

- Only tests at T_b = 2K taken into account !
- EP-cavities: average gain of $E_{acc}(P_0=((100W/9)*n)$

  after (100 - 110)°C (6 tests): 27,7 MV/m ⇒30,5 MV/m

  after (120 - 130)°C (15 tests): 27,2 MV/m ⇒31,6 MV/m

  after (120 - 130)°C (5 tests): 27,4 MV/m ⇒31,4 MV/m

  ⇒ no significant difference (limited statistics)

- EP-cavities:

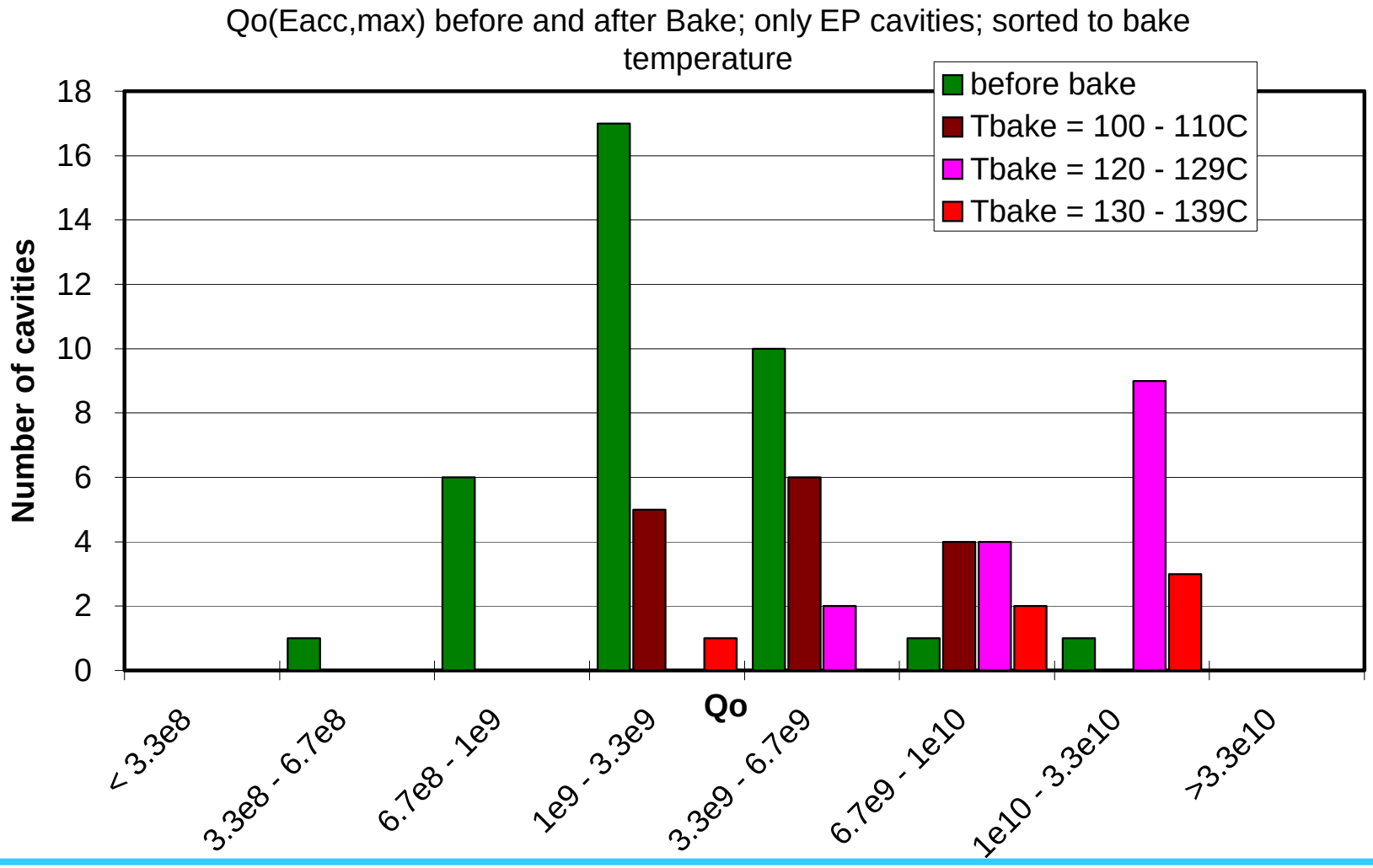
  - for some cavities multipacting leads to significant Q-degradation

  => reduced $E_{acc}(P_0=((100W/9)*n)$

  => can be cured by warm-up above T_c
- EP-cavities preliminary: add. 2nd bake gives no improvement (3 tests)
- $E_{acc}(P_0=((100W/9)*n)$ often roughly similar to E_{acc}@ $Q_0 = 10^{10}$

Effect on $Q_0(E_{acc,max})$

- EP-cavities: higher $Q_0(E_{acc,max})$ at T_{bake} = >120 °C



Effect on $Q_0(E_{acc,max})$

- EP-cavities:

  $Q_0(E_{acc,max})$ at T_{bake} = (100 - 110) °C: $(5,3 \pm 2,4) \cdot 10^9$ (15 tests)

  (120 - 130) °C: $(11,3 \pm 3,5) \cdot 10^9$ (15 tests)

  (130 - 140) °C: $(9,8 \pm 3,8) \cdot 10^9$ (6 tests)

  $\Rightarrow$ significant improvement by enhanced bake temperature

- BCP-cavities:

  $Q_0(E_{acc,max})$ improves systematically to $1 \cdot 10^{10}$

Summary

- average gradient after EP + bake: 35,1 MV/m
  average $E_{acc}(P_0=((100W/9)*n)$ after EP +bake: 31,4 MV/m
- bake at > 120 °C results in higher $Q_0(E_{acc,max})$ then (100 - 110) °C
  => > $1 \cdot 10^{10}$
- multipacting of EP-cavities needs more investigation

- E_{acc}@ $Q_0 = 10^{10}$ (BCP without bake)/ E_{acc}@ $Q_0 = 10^{10}$ (EP +bake) =
  + 6,4 MV/m

- further studies of the Q-slope (bake parameters, anodizing + oxipolishing) necessary

Thank you!

- Thanks to D.G. Gall, L. Lilje, B. Visentin, Feng Zhu