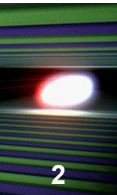


Status Jan 22, 2014: Test Results for the Testing of 800 Series Cavities for the European XFEL

Sebastian Aderhold, Detlef Reschke, Jörn Schaffran / DESY
for all colleagues working on European XFEL series cavities





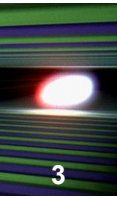
- Vertical acceptance tests of European XFEL
 - Pre-Series + Series Cavities
 - “HiGrade”-Cavities

- 800 pre-series + series cavities
- ≥ 8 cavities per week (\Rightarrow 1 module per week)

- Cavities are produced and surface treated at industry

- Status of vertical tests: **January 22, 2014**

Vertical test results: As received / 1. Pass



- 185 cavities (out of 214 delivered) tested **as received** (1. pass) with
 - 86 from Research Instruments (RI)
 - 98 from E. Zanon (EZ)

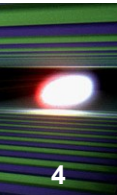
- As received: **112 cavities passed 26 MV/m => 61%**
 - 57 from RI
 - 55 from EZ

- Strict application of acceptance criteria
(Comment: Some cavities retreated though acceptance criteria formally met)

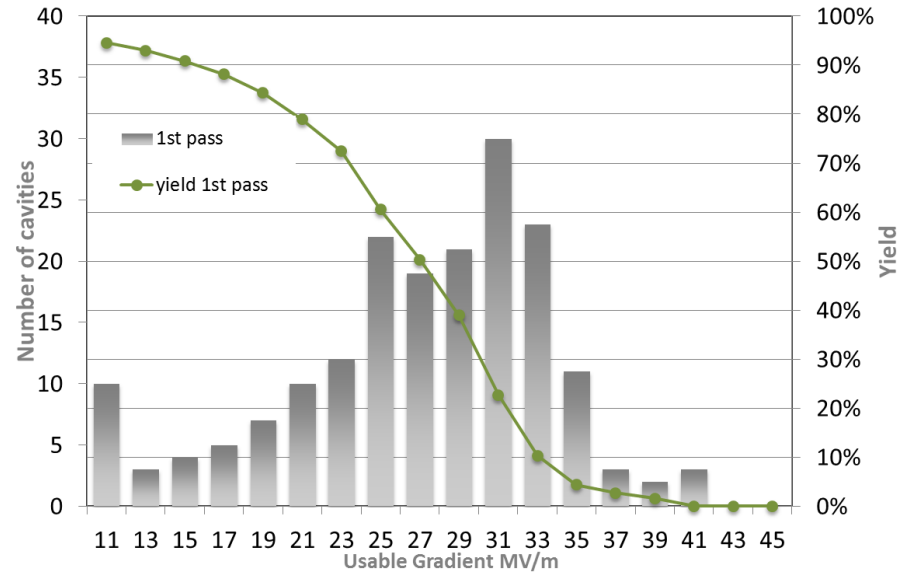
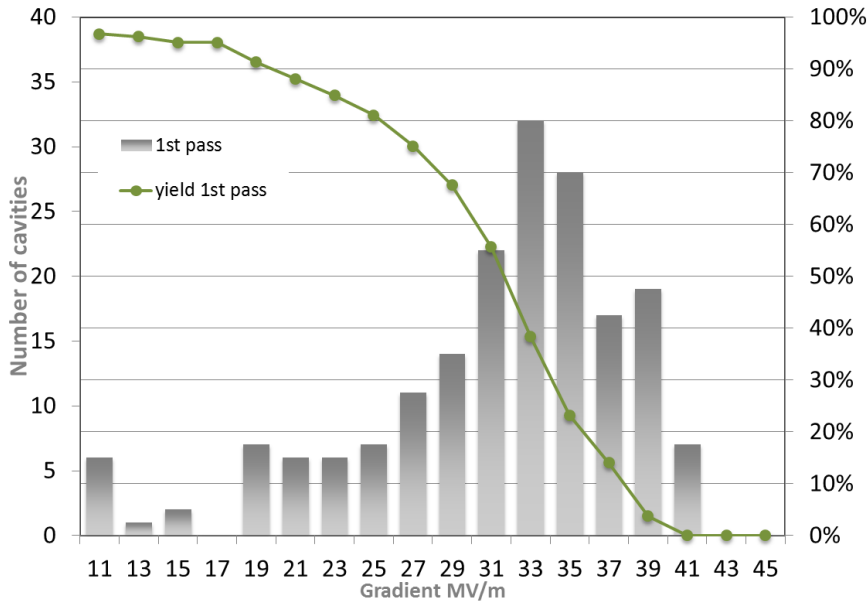
- No selection, no cut

- 61 cavities in or after re-treatment loop => later

Yield of gradients: As received / 1. Pass



Yield of usable and maximum gradient of 185 cavities as received



Average maximum gradient:

(30.5 ± 7.4) MV/m

EZ: (28.3 ± 7.1) MV/m

RI: (32.9 ± 7.0) MV/m

Average usable gradient:

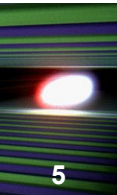
(26.2 ± 7.5) MV/m

EZ: (24.6 ± 7.2) MV/m

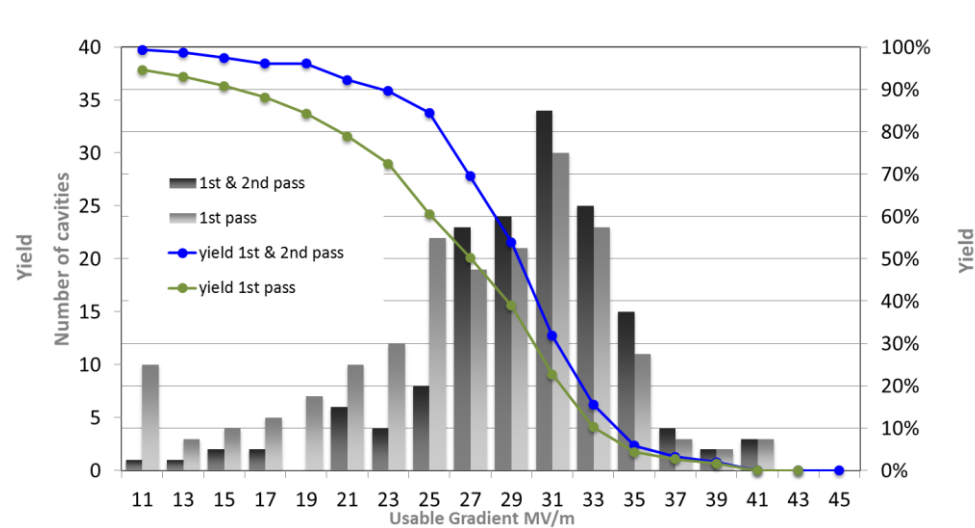
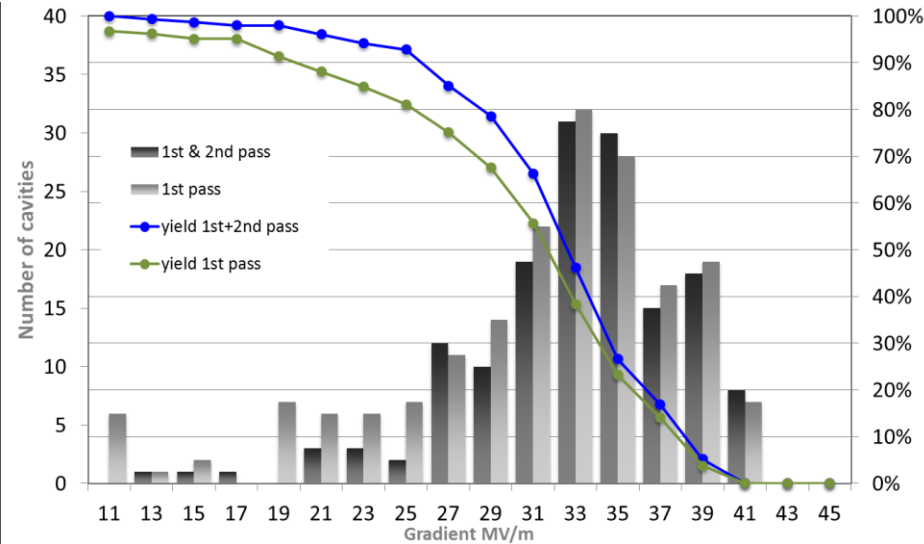
RI: (27.9 ± 7.6) MV/m

given errors are standard deviation

Yield of gradients: After re-treatment (2. pass)



- Yield of usable and maximum gradient of 154 cavities (2.pass) => **84%** (cavities that passed in 1. pass + results of cavities after re-treatment)
- Average gradients increased + spread reduced** (standard deviation)



Average maximum gradient:

(32.6 ± 5.1) MV/m

EZ: (30.7 ± 4.6) MV/m

RI: (35.2 ± 4.4) MV/m

Average usable gradient:

(29.3 ± 5.0) MV/m

EZ: (28.0 ± 4.7) MV/m

RI: (31.0 ± 5.0) MV/m

Report on SRF R&D from DESY

- Commissioning of the CBP
- An X-ray fluorescence for defect detection in cavities
- Thermal cycling experiments
- ILC-HiGrade cavities



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January 22, 2014
3rd LCC ILC SRF Cavity Group Meeting



Bundesministe
für Bildung
und Forschung



- > CBP is an **acid-free** surface polishing technique using abrasive media
 - **reduce chemistry**, only light electropolishing (EP) ($\sim 10 \mu\text{m}$) required [1] or even **no chemistry** if **baking** done properly [2]
 - **$\sim 10\text{x}$ smaller roughness** with mirror-like surface compare to chemistry [3]
 - **better Q_0** and **E_{acc}** might be achieved
- > CBP machine **has been purchased by University of Hamburg** and is used in ILC-HiGrade Lab for:
 - **serial tests** of the polishing proc. (partially with **ILC-HiGrade cavities**) as feasibility study for meeting the ILC performance goal
 - **further optimizations/understand.** of the process (time, polishing recipes, etc.)
 - Study of CBP as **cavity repair** and **standalone preparation technique**



The machine is being commissioned based on the polishing recipes derived from best FNAL, JLAB, and previous DESY experience

[1] A. D. Palczewski et.al, WEPPC094 , IPAC2012 [2] A. Grassellino, TUP030, SRF2013, Paris

[3] C. A. Cooper et.al <http://lss.fnal.gov/archive/2011/pub/fermilab-pub-11-032-td.pdf>

Step 1

Cutting,
~8 hours



+ Soap &
Ultrapure
Water

Step 2

Intermediate
polishing, ~15 hours



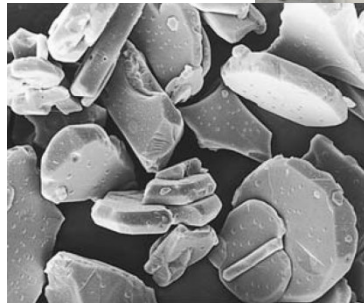
+ Soap &
Ultrapure
Water

Step 3

Intermediate polishing,
~30 hours

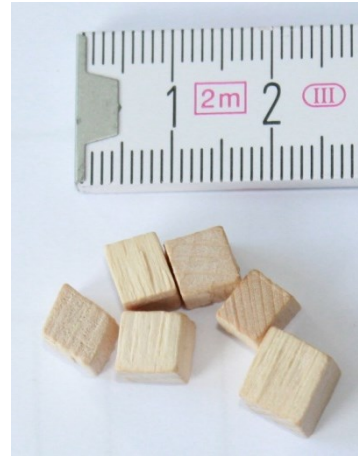


Water +
15 μm
Alumina

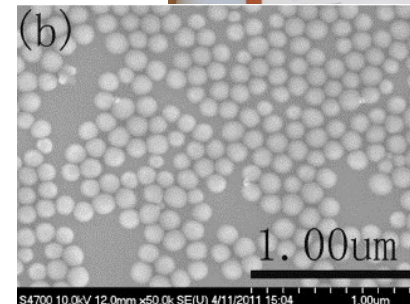


Step 4

Final polishing,
40+ hours



Colloidal
Silica –
0.04 μm



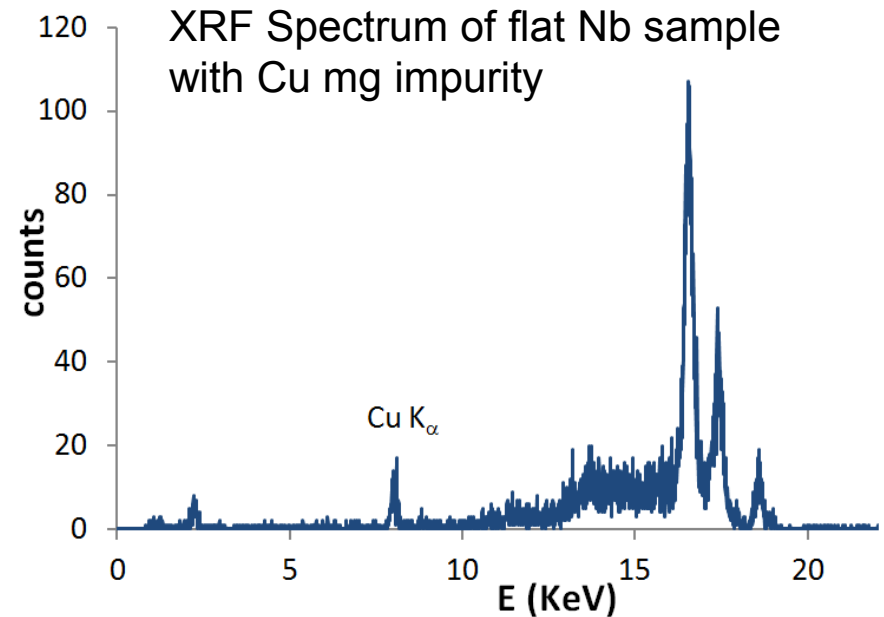
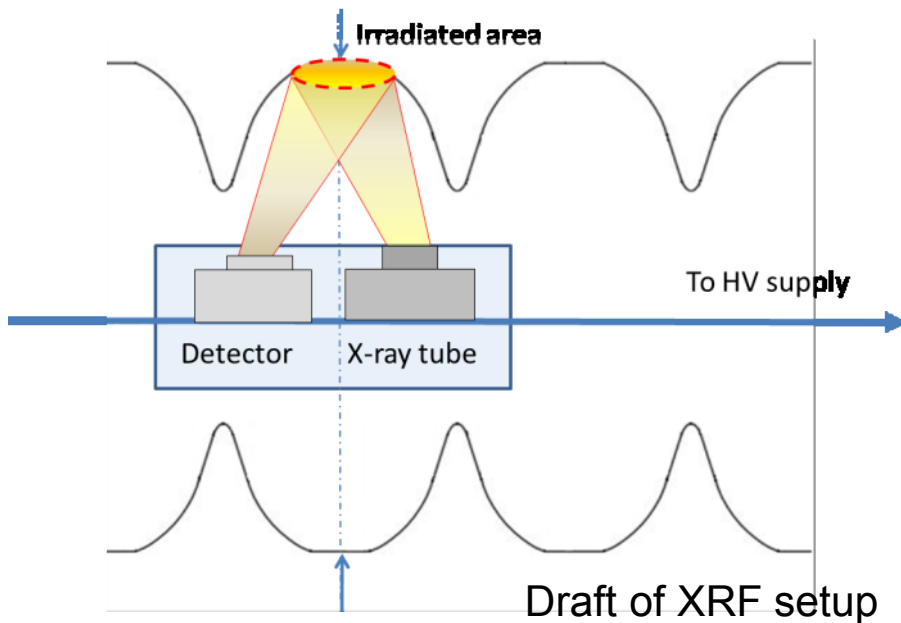
Step 5

Final EP
>10 μm after
800°C bake

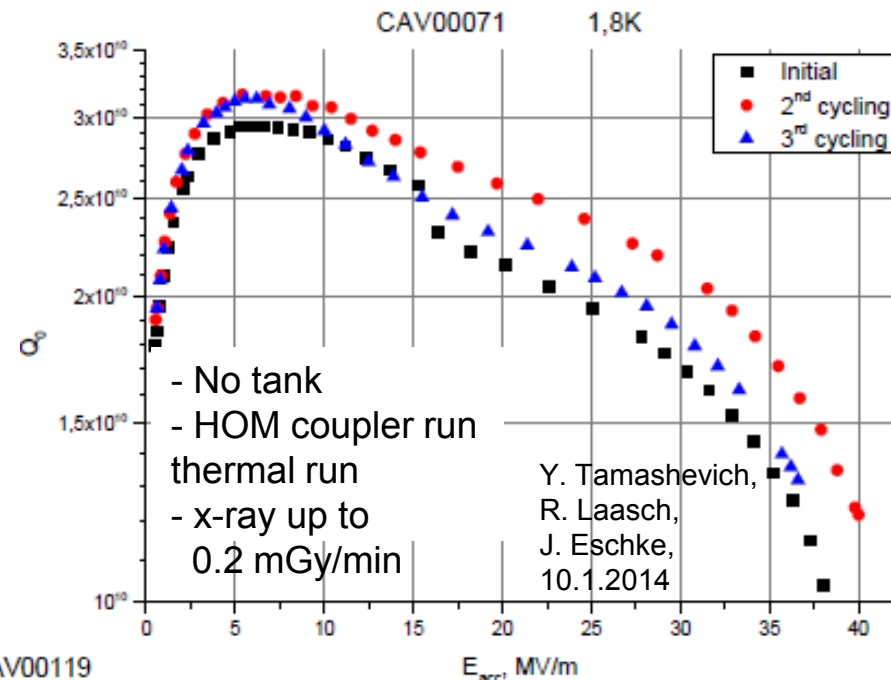
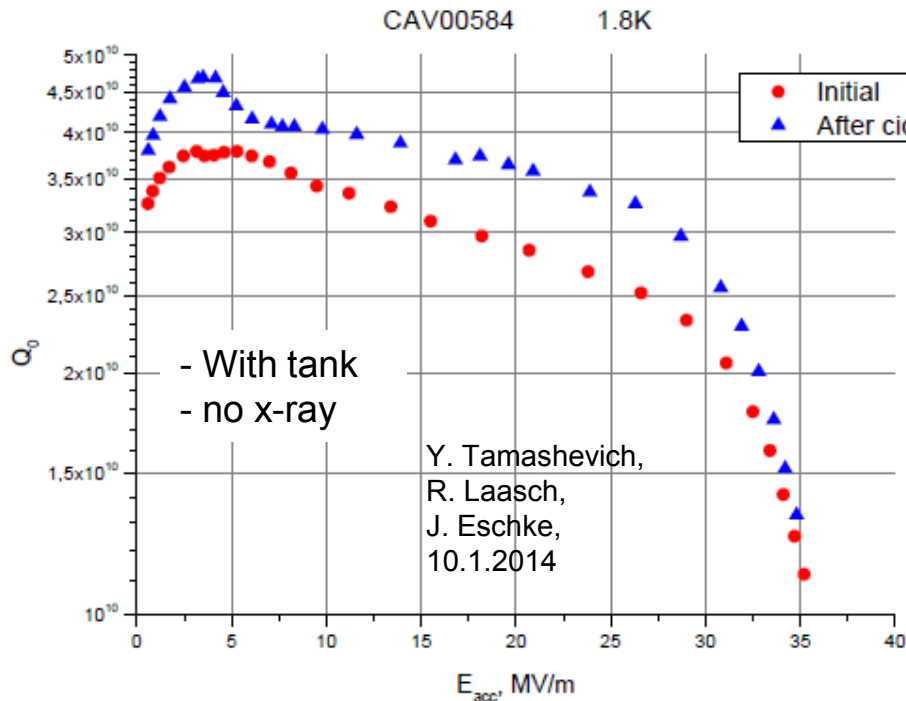
HF : H₂SO₄
1 : 9

119 nm SiO₂,
Example from
L. Zhang et.al. ASS,
258, (2011) p.1217.

- XRF is a high sensitivity spectroscopy technique which may allow the detection of trace element content, such as the **few μg impurities**, responsible for low cavity performances

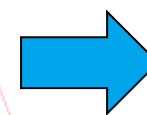
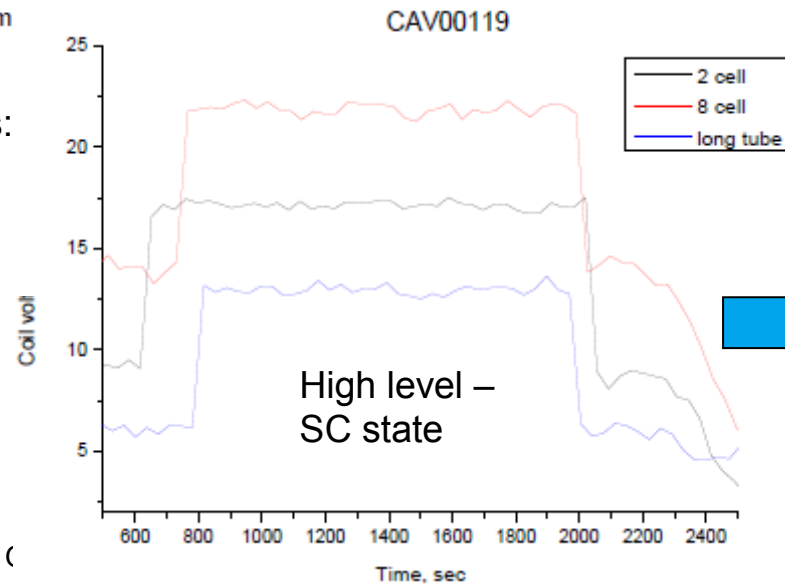


- Preliminary tests confirmed the feasibility of low-size defect detection on cavity surface
- The development of experimental setup is now in progress and further tests have to be done to work out the best experimental arrangement

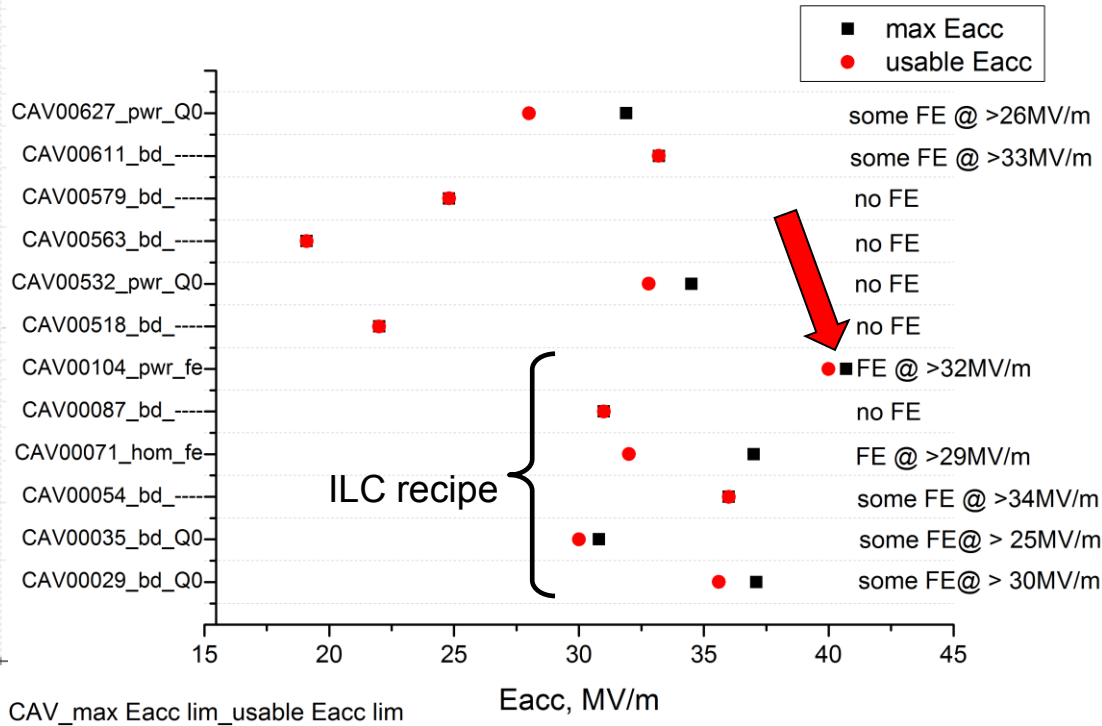
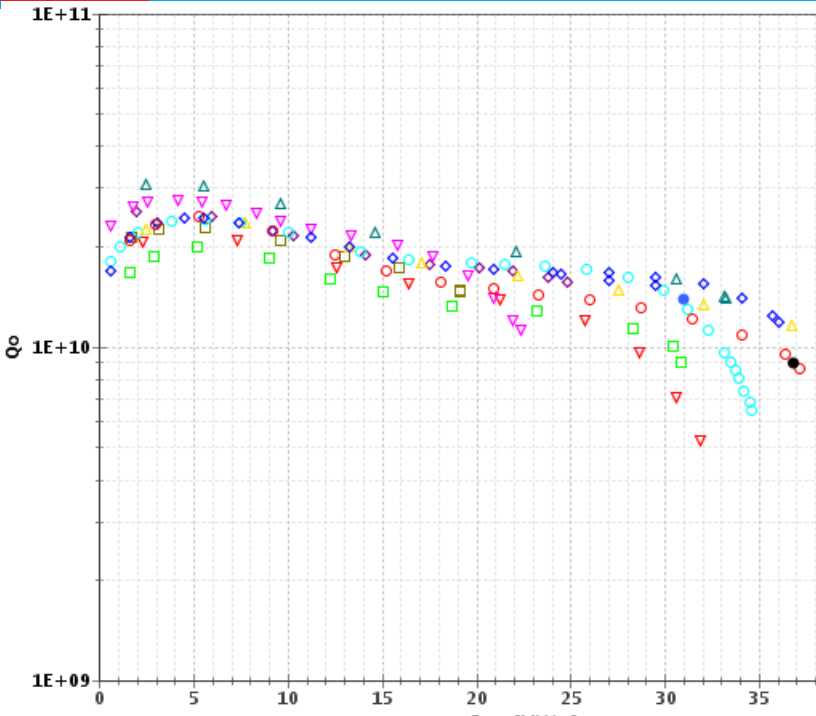


RRR Eddy-current measurements:

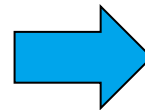
- determination of the transition point
- Determination of the Rres
- Better understanding/control of the cycling



More systematic tests are ongoing



- CAV00029 Test:1.2 AMTF 09/09/13 2[K] bd
- CAV00035 Test:1.2 AMTF 09/09/13 2[K] bd_fe
- ◇ CAV00054 Test:1.2 Hall 3 24/09/13 2[K] bd
- CAV00071 Test: 6.12 Hall 3 24.10.2013 2 [K] no self pulsing quench, Emax = 37 MV/m, usable 32 MV/m FE limited by HOM heating
- CAV00087 Test: 2.3 Hall 3 18.11.2013 2 [K] Emax= 31 MV/m, usable 31 MV/m, BD limited
- △ CAV00104 Test:1.2 AMTF 04/12/13 2[K] pwr_fe
- ▽ CAV00518 Test:2.2 Hall 3 25/06/13 2[K] bd_fe
- CAV00532 Test:1.2 Hall 3 16/04/13 2[K] pwr
- CAV00563 Test:1.2 AMTF 19/09/13 2[K] bd
- ◇ CAV00579 Test:1.2 Hall 3 08/10/13 2[K] bd
- △ CAV00611 Test:1.2 AMTF 18/11/13 2[K] bd
- ▽ CAV00627 Test:1.2 AMTF 05/12/13 2[K] pwr



- ILC recipe provides gradient above 30 MV/m, some achieve **>40 MV/m usable gradient**
- Main limitation is FE