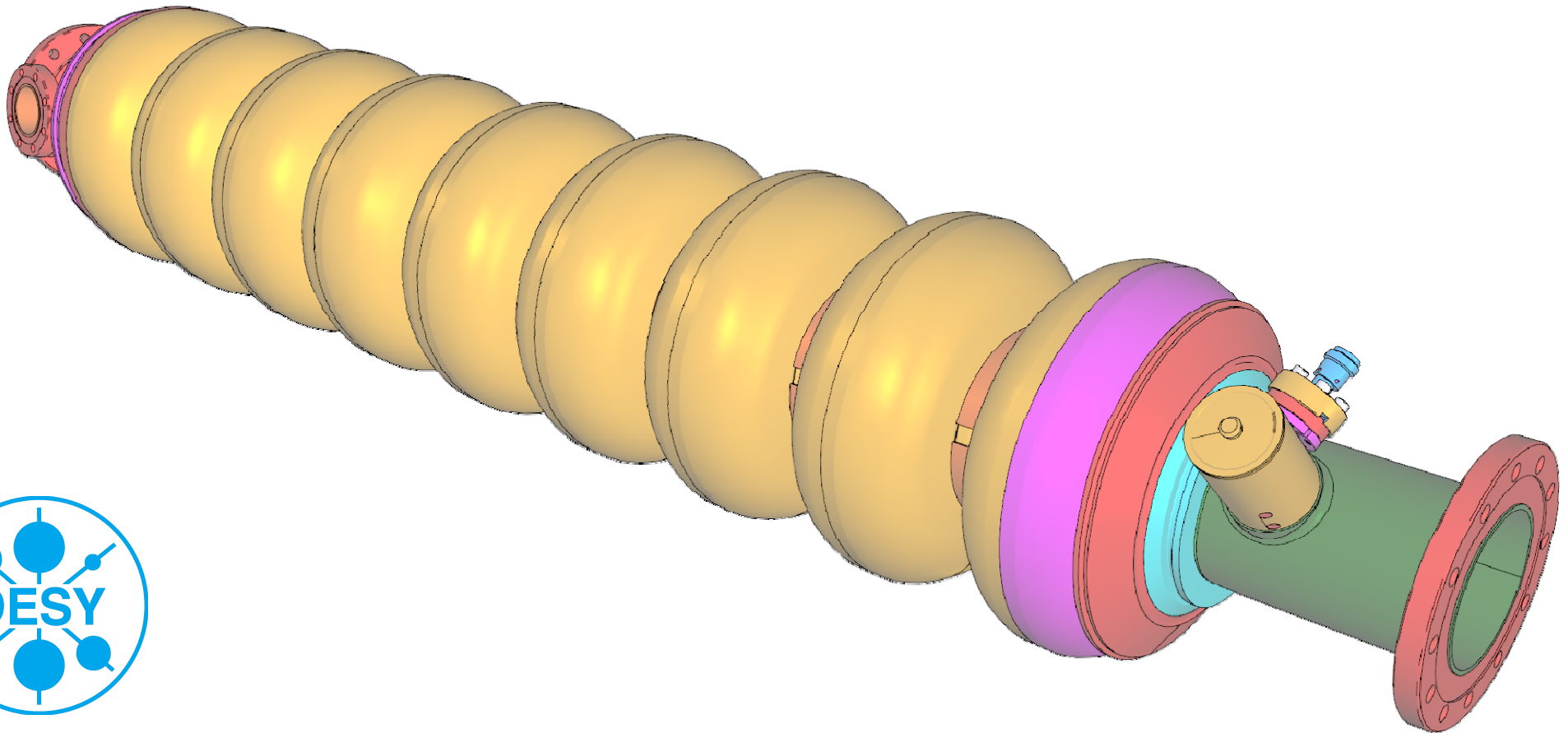


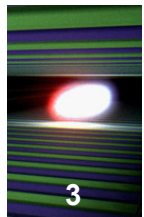
Cavity Performance Degradation during Vertical RF Test





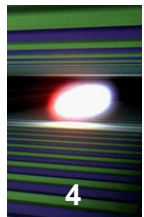
- Introduction.
- Degraded Cavities in Vertical Test.
- Statistics on tested XFEL cavities.
- Summary.
- Discussion.

Cavity Degradation Definition

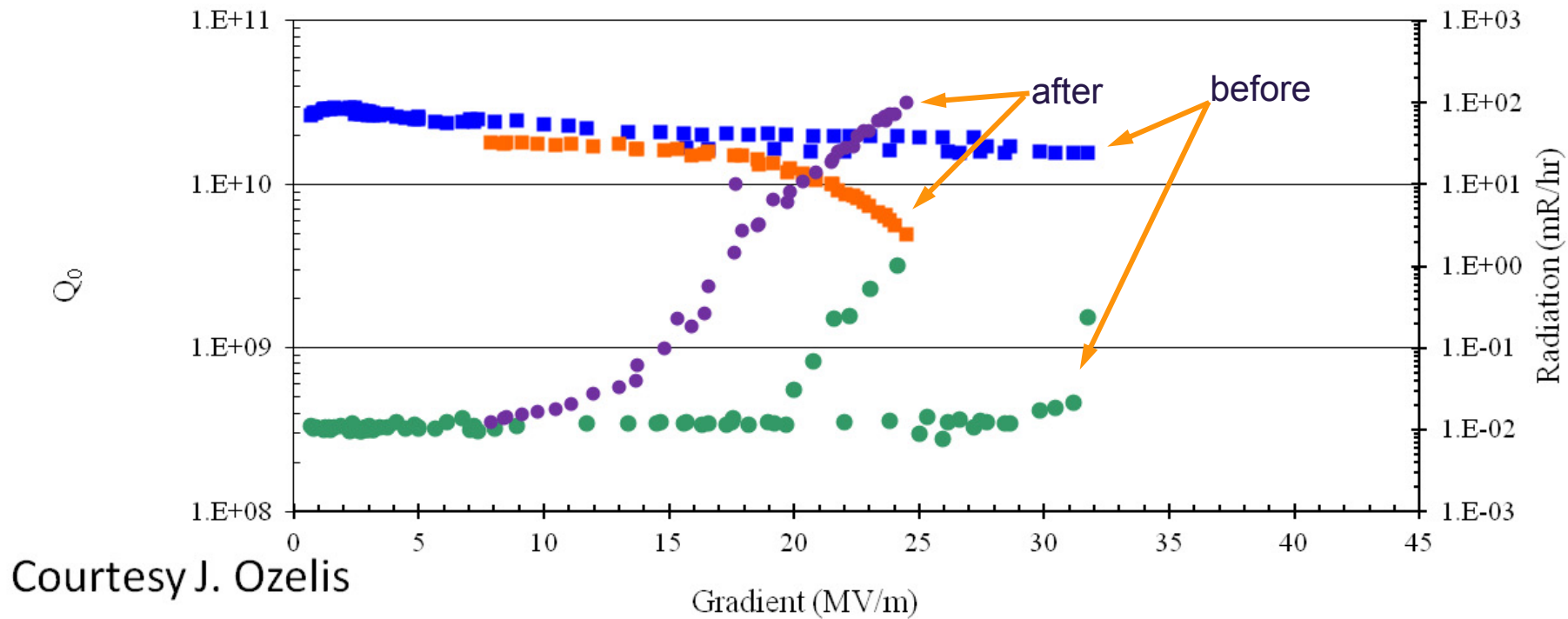


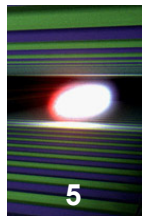
- Cavity performance was changed during the vertical cryostat RF test.
- Until certain gradient / RF power cavity performance was OK.
- At certain gradient value Q_0 drop was measured.
- At certain gradient value FE started or drastically increased.
- First breakdown initiated FE.
- Next measured $Q_0(E_{acc})$ curve has lower Q_0 and/or $E_{acc.max}$.
- During the next $Q_0(E_{acc})$ measurement FE starts earlier.
- Cavity specification (XFEL) loss.

1-cell Cavity Degradation [Hasan Padamsee] (1)

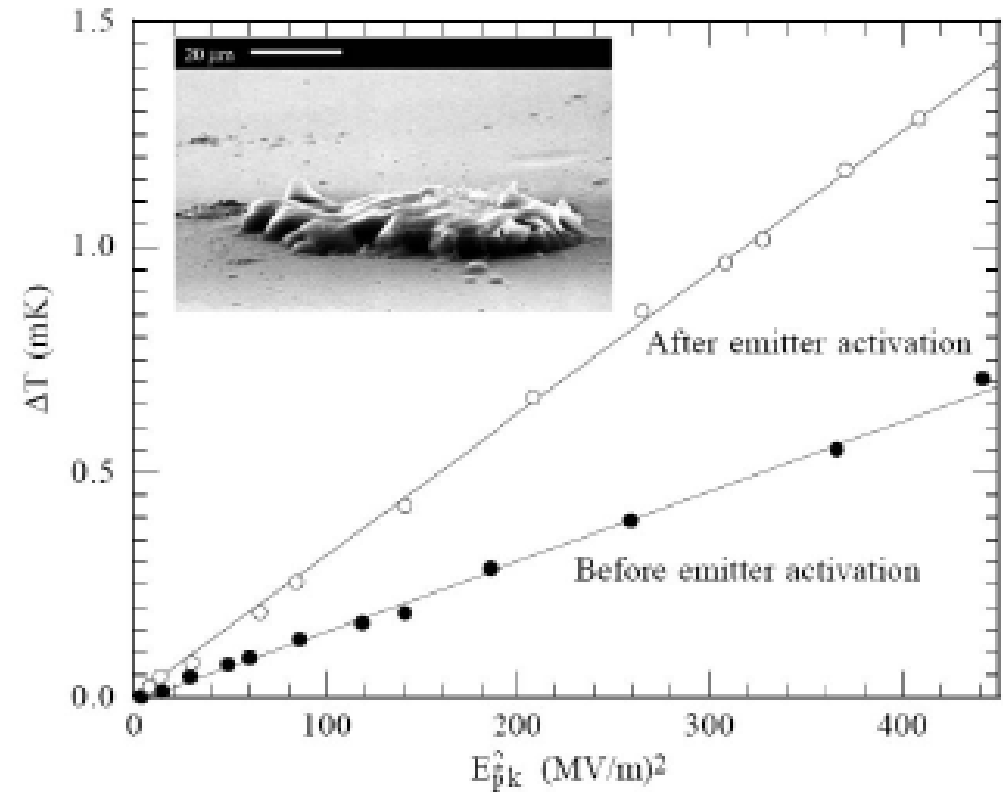
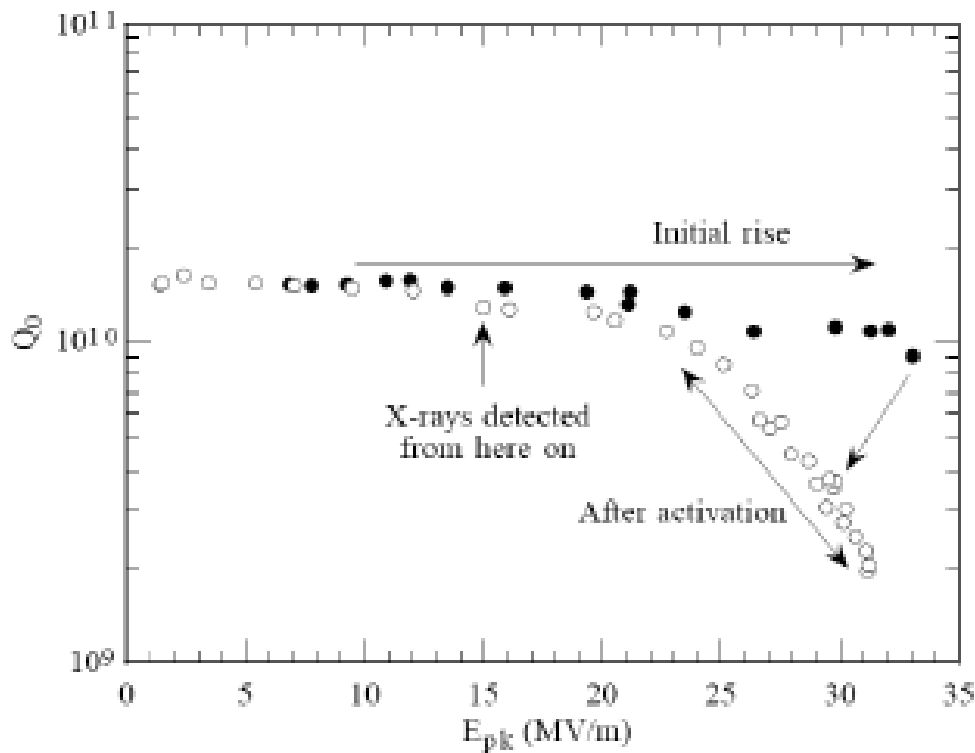


Field emitter activation / FE turn-on event



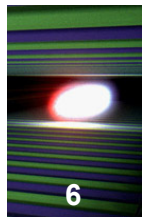


FE turn-on event

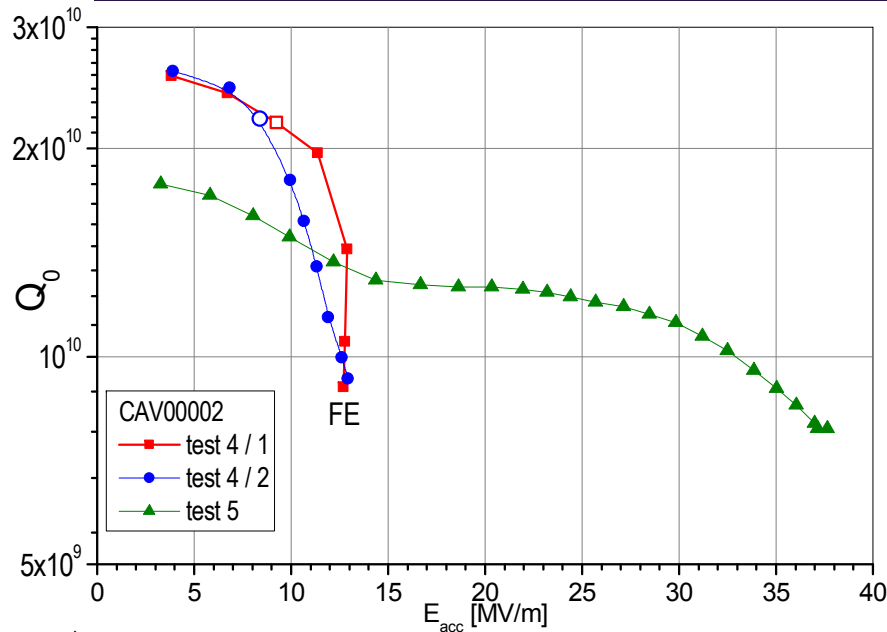


Left: Q_0 vs. E_{acc} curve, showing FE turn-on. Right: T-Map and microscopy at emission spot.

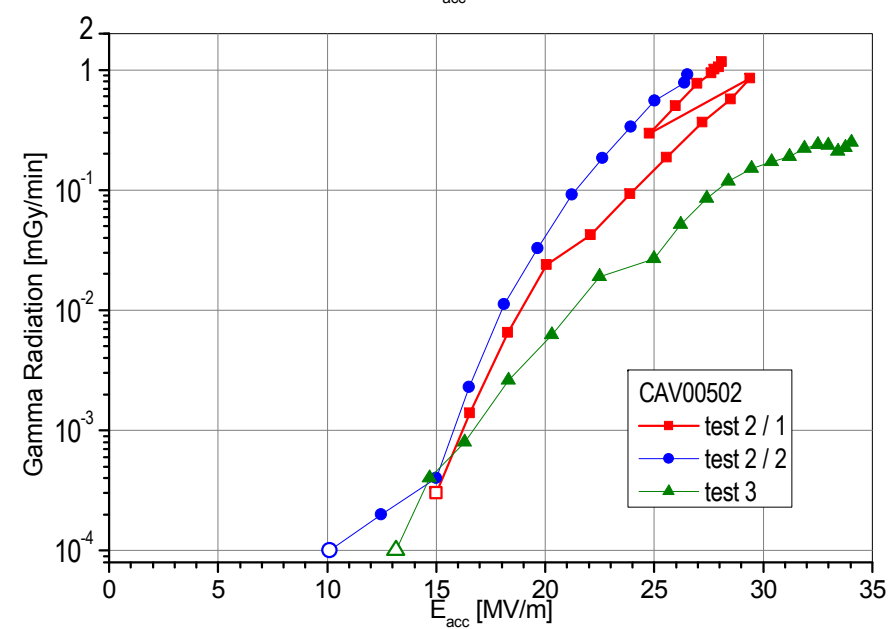
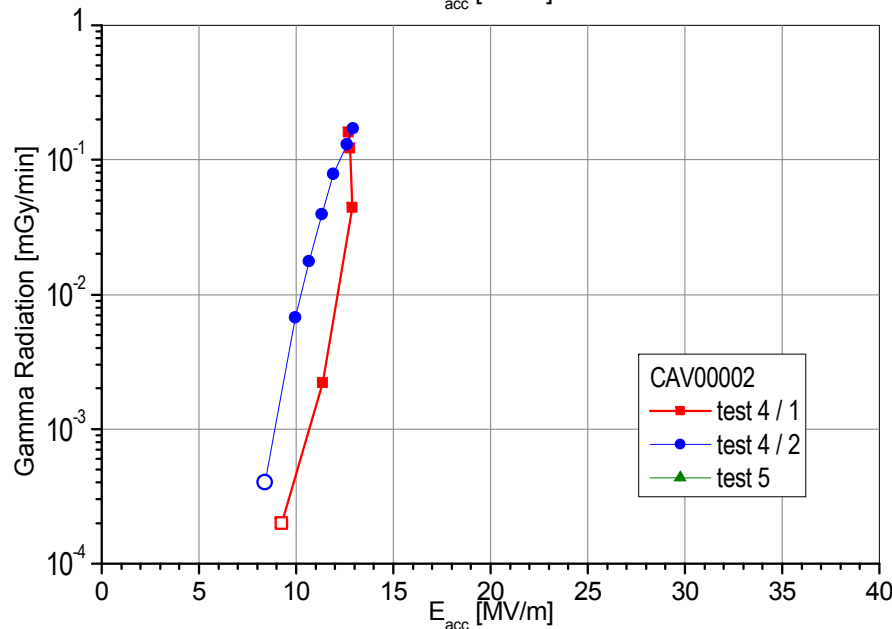
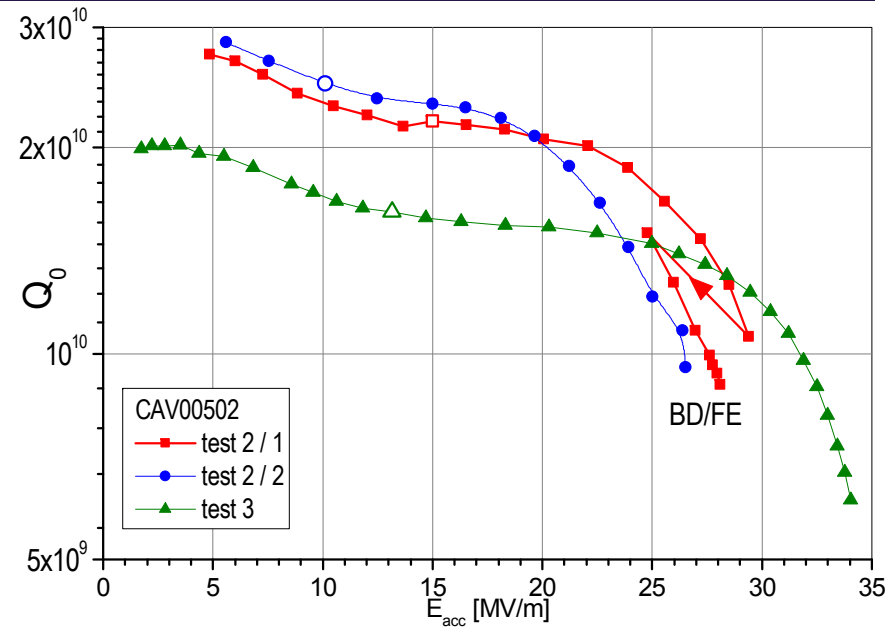
XFEL Cavities Degradation (1)



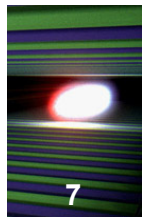
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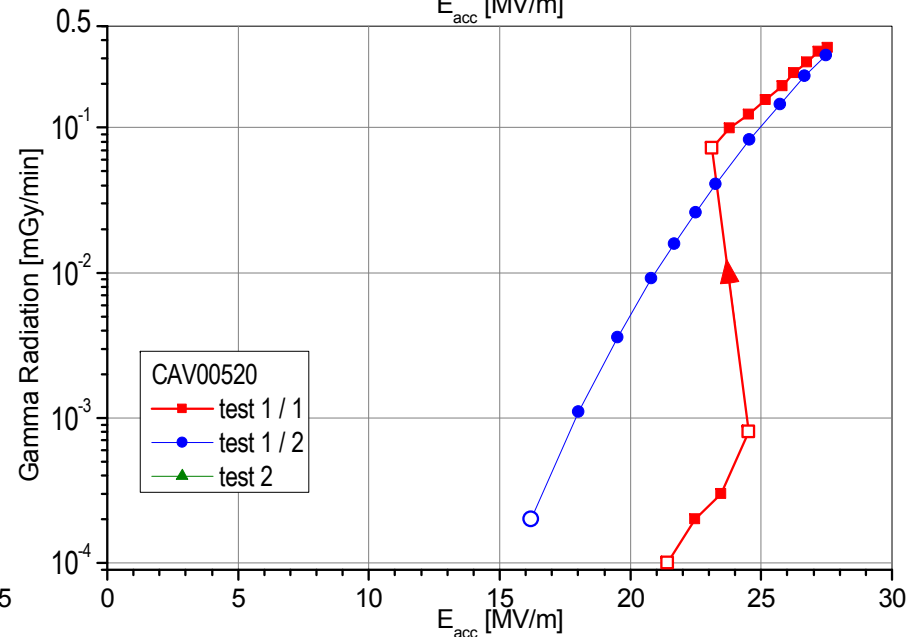
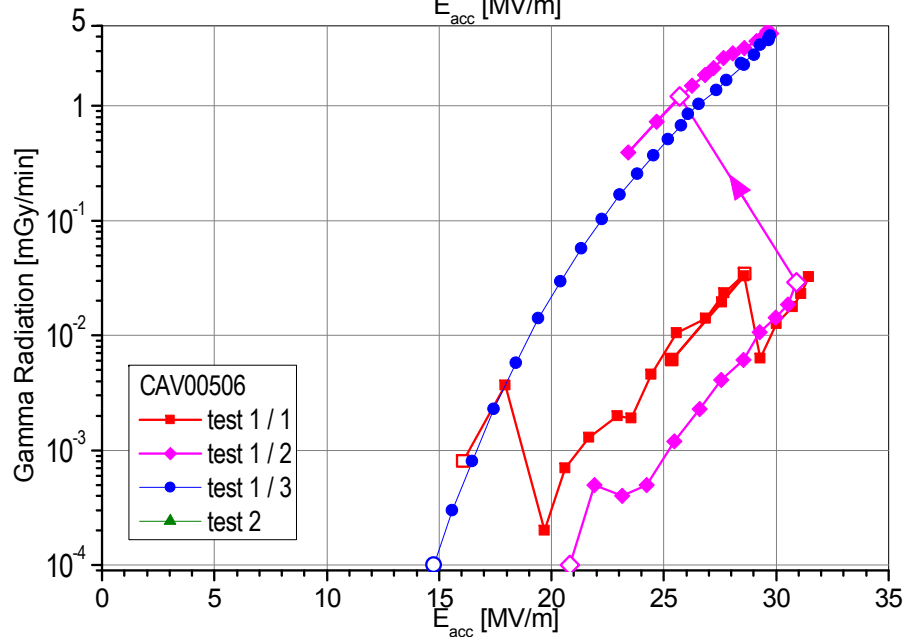
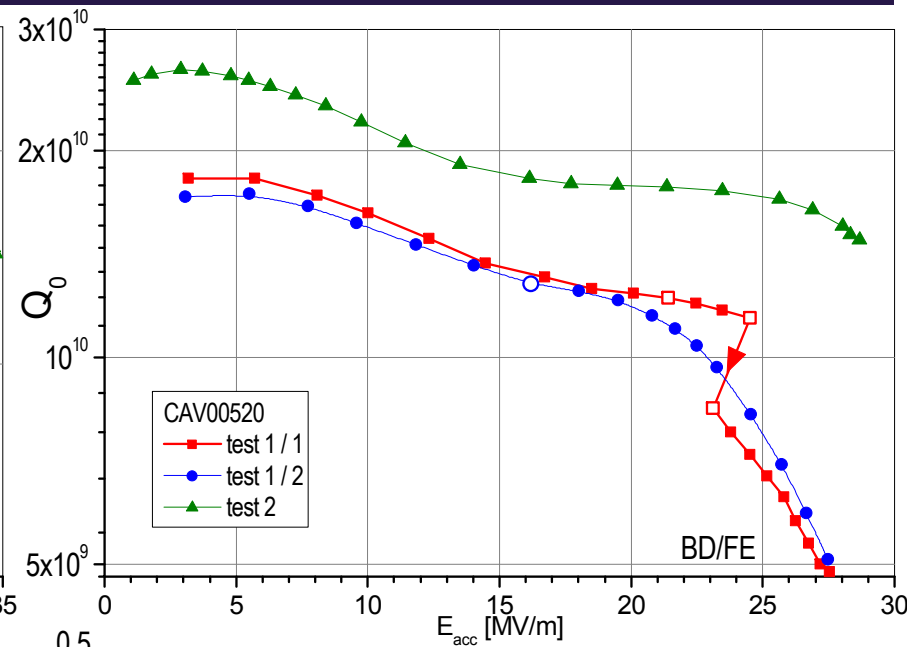
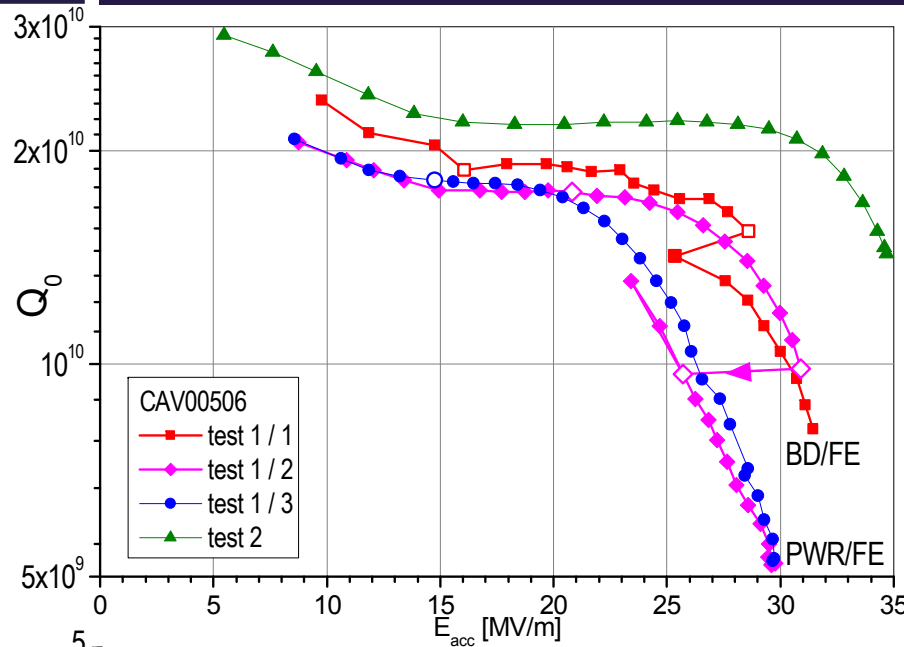


XFEL Cavities Degradation (2)

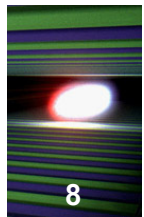


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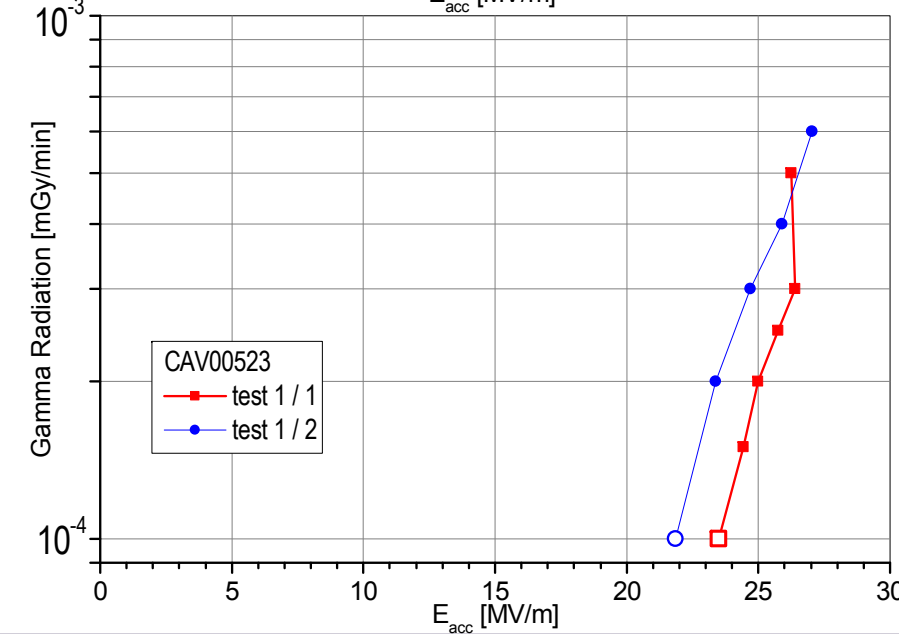
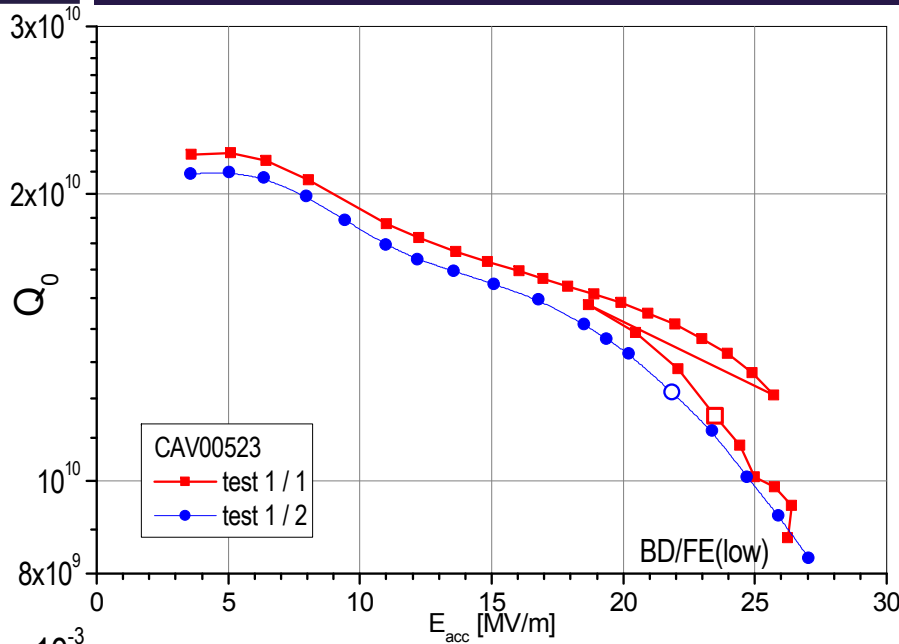
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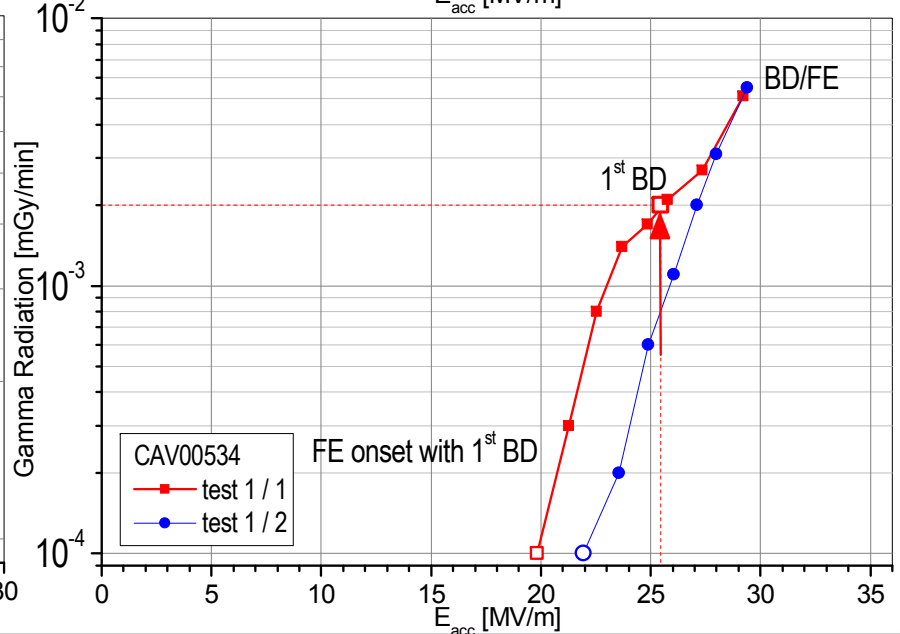
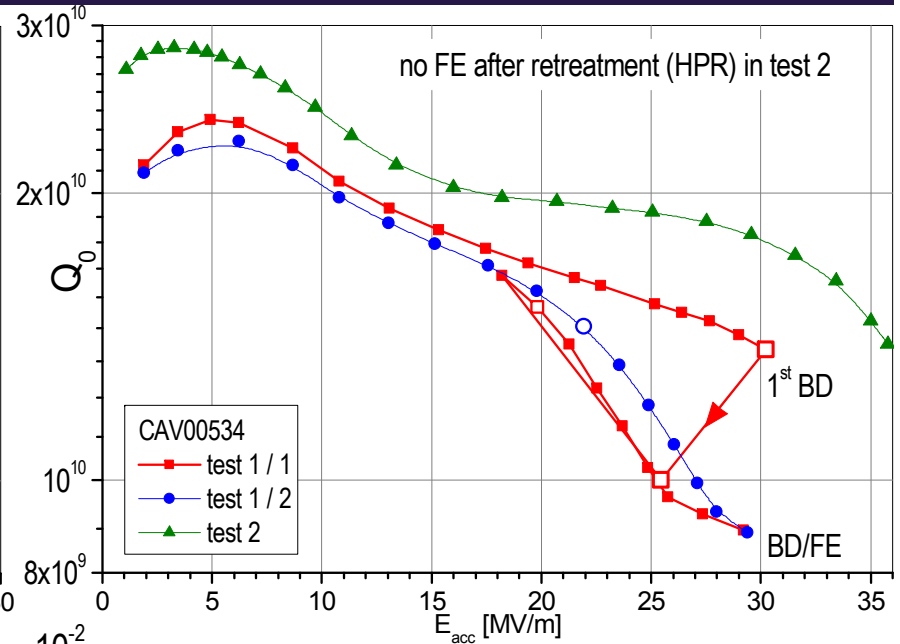
XFEL Cavities Degradation (3)



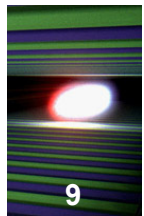
5



6



Degraded XFEL Cavities Statistics

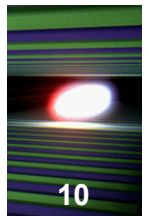


■ Cavity performance change / XFEL specification loss

cavity N	XFEL spec. at start	XFEL spec. loss	initially >15MV/m	initially > 25MV/m	Q ₀ drop	E _{acc} drop	X-rays increase	FE onset 1 st BD	FE onset earlier after	X >10 ⁻² mGy/min at end	retreated	retreated OK
1	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	YES	YES
2	NO	NO	YES	YES	YES	YES	NO	NO	YES	YES	YES	NO
3	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES
4	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
5	YES	NO	YES	YES	YES	NO	YES	YES	YES	NO	NO	
6	YES	NO	YES	YES	YES	NO	YES	YES	NO	NO	YES	YES
Σ	4	2	5	5	5	2	4	2	4	3		
%		5			12	5	11	5	10			

■ 40 XFEL cavities tested

Summary



- Cavity performance degradation was observed during some vertical cryostat RF tests.
- From measured 37 XFEL cavities 2 lost the XFEL specs in test (5%) and 5 got the Q_0 drop (12%).
- Performance deterioration was achieved at first breakdown in some cases (2 XFEL cavities).
- In most cases retreatment was a solution.
- There is no definite gradient limit to stop the test before degradation.
- Field emission starts often before the event, but also is starts at the first breakdown in some cases.
- Limiting the test gradient will not let to characterise the cavity.
- It is close to impossible to limit the gradient in the accelerator, LLRF control errors (linac/beam tuning) are not avoidable from FLASH experience: we did quench most of the cavities at some point. Quenching such a cavity in the accelerator will yield bigger problem.