

European XFEL: Accelerating Module Repair at DESY.



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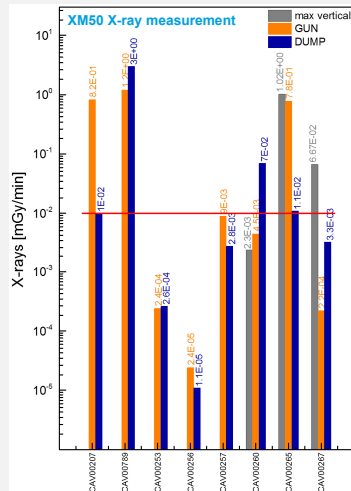
ABSTRACT

The European XFEL is in operation since 2017. The design projected energy of 17.5 GeV was reached, even with the last 4 main linac accelerating modules not yet installed. 2 out of 4 not installed modules did suffer from the strong cavity performance degradation, namely increased field emission, and required surface processing. The 1st of 2 modules is reassembled and tested. The module test results confirm a successful repair action. The module repair and test steps are described together with cavities performance evolution.

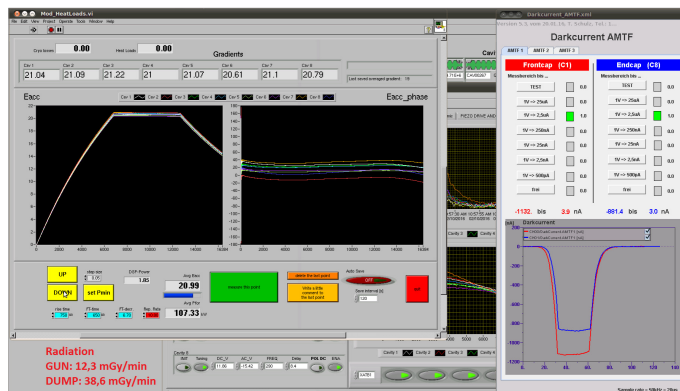


Module History

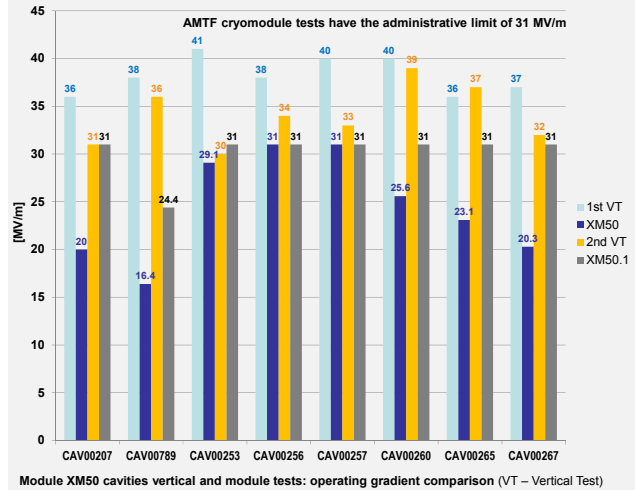
- Module XM50 was delivered to DESY in Jan. 2016 after the assembly at CEA (Saclay).
- Identified problems during the assembly:
 - Leak at angle valve;
 - Beam line leak;
 - Beam line pumped accidentally before warm coupler parts were installed.
- Module XM50 1st test in Feb. 2016 showed a degradation of the cavities' performance – mostly with strong gamma radiation – dark current caused by field emission (see the diagram →).
- Decision was taken not to install/use the module XM50 in the Eu-XFEL and re-assemble it after cavities' re-treatment.
- After disassembly XM50 cavities underwent HPR at DESY: 7 cavities after HPR and VT were accepted for XM50.1 assembly. CAV00207 had a cold leak during 2nd VT and was accepted after the exchange of the flanges, another HPR and VT.
- XM50 re-assembled at DESY to XM50.1 and tested in Apr. 2019: only one cavity (#2) degraded (without FE).



XM50 Limit: Dark Current



SRF Cavities Performance: Operating Gradient



Module XM50 cavities vertical and module tests: operating gradient comparison (VT – Vertical Test)

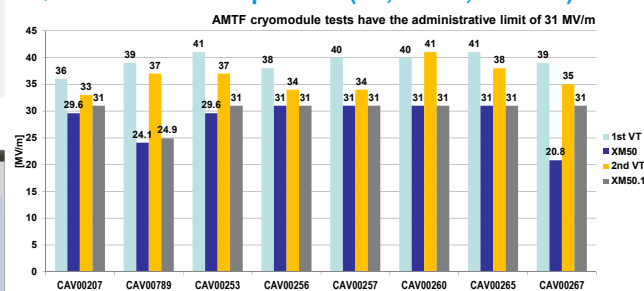
Module Test Data after 1st assembly (XM50)

XM50	pos	test	run	KT	MaxEacc	LIMIT	Oper. Grad.	LIMIT	XRAY	GUN	XRAY DUMP
CAV00207	1	1	3	1.49	29.6	BD	20	XRAY	0.82	0.01	
CAV00789	2	1	3	1.83	24.1	BD	16.4	XRAY	1.2	3	
CAV00253	3	1	3	1.61	29.62	BD	29.12	BD	0.00024	0.00026	
CAV00256	4	1	3	1.64	31	PWR	31	PWR	2.4E-5	1.1E-5	
CAV00257	5	1	3	1.46	31	PWR	31	PWR	0.009	0.0028	
CAV00260	6	1	3	1.46	31	PWR	25.59	XRAY	0.0045	0.07	
CAV00265	7	1	3	1.52	31	PWR	23.11	XRAY	0.78	0.011	
CAV00267	8	1	3	1.55	20.79	BD	20.29	BD	0	0	

Module Test Data after re-assembly (XM50.1)

XM50.1	pos	test	run	KT	MaxEacc	LIMIT	Oper. Grad.	LIMIT	XRAY	GUN	XRAY DUMP
CAV00207	1	1	2	1.54	31.0	PWR	31.0	PWR	0.00	0.00	
CAV00789	2	1	3	1.90	24.9	BD	24.4	BD	0.00	0.00	
CAV00253	3	1	2	1.59	31.0	PWR	31.0	PWR	2.8E-4	0.00	
CAV00256	4	1	2	1.65	31.0	PWR	31.0	PWR	0.00	0.00	
CAV00257	5	1	2	1.45	31.0	PWR	31.0	PWR	0.00	0.00	
CAV00260	6	1	2	1.44	31.0	PWR	31.0	PWR	8E-5	1.2E-4	
CAV00265	7	1	2	1.52	31.0	PWR	31.0	PWR	0.00	0.00	
CAV00267	8	1	2	1.78	31.0	PWR	31.0	PWR	0	1.7E-5	

Quench Limit Comparison (VT, XM50, XM50.1)



Conclusion

- The European XFEL SRF accelerator is still missing one RF-station, 4 Cryo Modules (CM) – one CM has 8 SRF cavities. 2 CM out of 4 did suffer from the cavities' performance degradation after the 1st CM assembly and must be re-assembled and re-tested at DESY.
- First CM, XM50, was re-assembled after 8 cavities HPR re-treatment and Vertical Test (VT) at DESY. VT results did show a restored cavity performance after the HPR.
- CM test after the re-assembly showed a good performance: only one cavity out of 8 did degrade after the CM assembly, but without FE and with a still usable gradient.
- Successful CM repair means a feasibility of such action to restore the CM performance.

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