STATUS OF THE KLYSTRONS FOR THE EUROPEAN XFEL AFTER COMMISSIONING AND FIRST USER OPERATION PHASE

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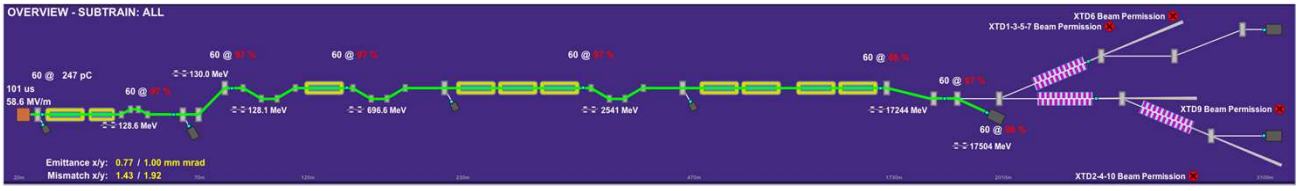
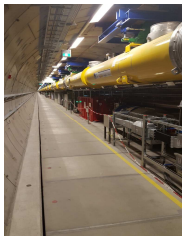
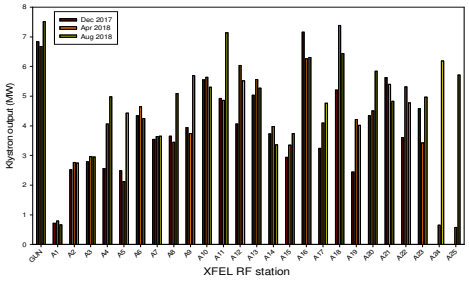
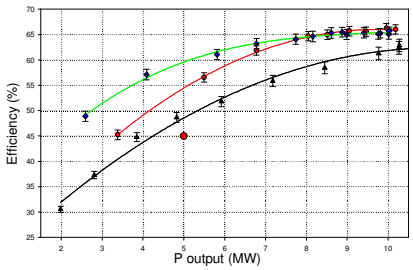
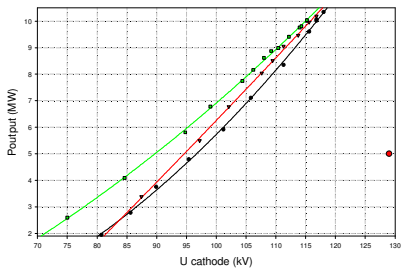
At present 26 RF stations for the European XFEL are in operation. Each of the RF stations consists of a HV modulator located on the DESY campus, up to 1600 m long 10 kV HV cables that connect the modulators and the HV pulse transformers located in the underground tunnel, the horizontal multi-beam klystron (MBK), and an air filled waveguide distribution system (WG) between the klystron and the cavities input couplers. The klystrons can produce RF power up to 10 MW, 1.5 ms RF pulse length and 10 Hz repetition rate. Two RF stations of the injector have already achieved about 30,000 hours of operation, RF stations of the XFEL bunch compressor area have operated up to 20,000 hours and the klystrons in the XFEL main linac already have about 18,000 hours of operation. To increase the lifetime of the klystrons we are using a fast protection system (KLM) that is in routine operation since July 2018 in addition to the common interlock system. In this article we will give a summary of the present klystrons operation status including the number of HV and RF arcs in the klystrons and in the WG system and operation statistics for the high power RF part of machine.

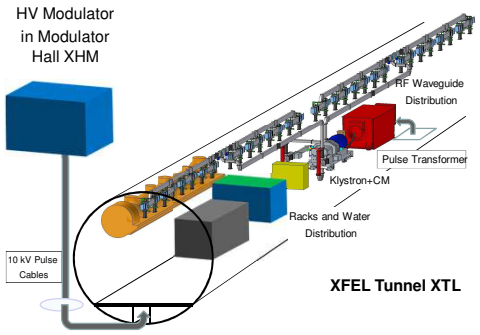


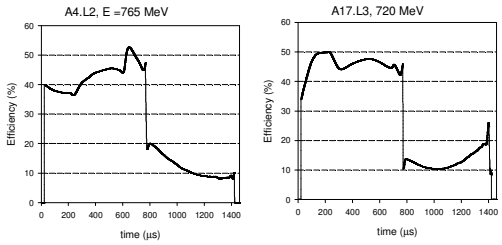




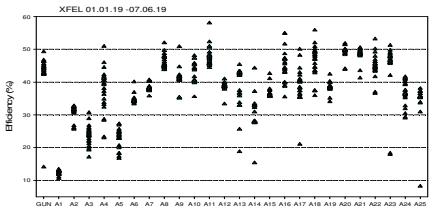






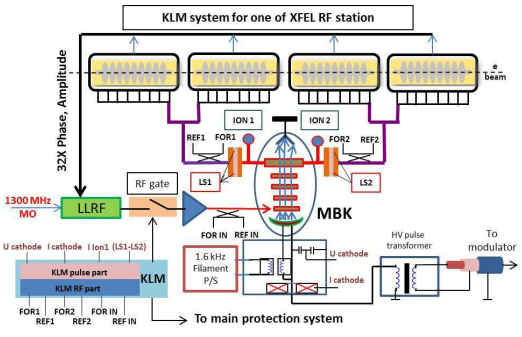


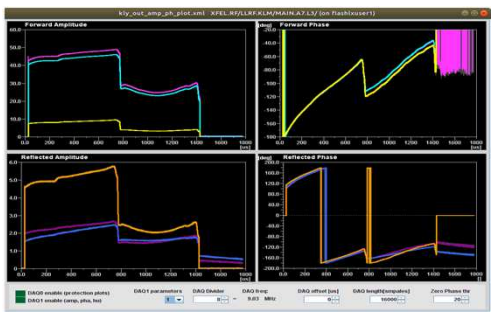
Efficiency during RF pulse



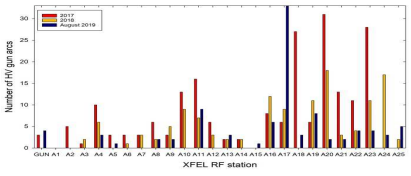
XFEL RF stations location
Efficiency during operation in 2019

Klystron Life Time Management System (KLM)

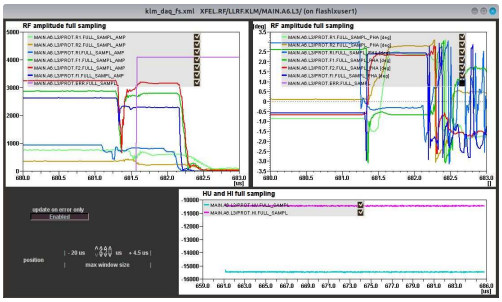




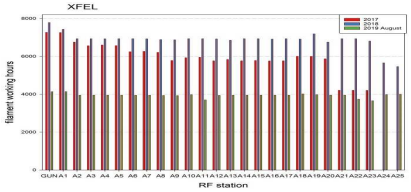
Output forward and reflection amplitudes and phases. RF station A7.L3



: Number of HV arcs in the klystrons guns



RF breakdown in the klystron, high resolution shapes, RF station A6.L3



Working hours of XFEL RF station.

Conclusion

Since August 2012 we have started a test and conditioning of the first one from 26th serial high efficiency MBKs for XFEL. The klystrons were tested together with connection modules (CM). To increase the lifetime of klystron a special fast protection system (KLM) was designed and tested. In July 2018 XFEL reached the design energy of 17.5 GeV. For the moment 26 XFEL RF stations produced in total 4.93 MW in average, the average cathode voltage is 104.5 kV; the average efficiency is 44% for the main linac and we have the plans to go step by step to higher efficiency. The breakdowns rate for the MBKs during last 8 months is 3.7 breakdowns per week for the all of XFEL klystrons. Our experience with high-performance klystrons shows that a fast protection system should be used, since the number of instabilities in high-performance klystrons is higher than in conventional klystrons.