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Optimization in the Structure of Klystron Drive Signal to Extend RF Pulse Flattop Length at the European XFEL

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Currently 26 RF stations are in operation at the European X-ray Free Electron Laser (XFEL) and all RF stations can deliver sufficient power to reach maximum gradients in the accelerating modules, limited only by cavity and coupler properties. It was demonstrated that by activating a dynamic frequency shift (DFS) of the RF drive signal, the requested klystron power can be reduced by up to 20%, keeping the gradient levels unchanged. Currently the high voltage (HV) pulse has a length of 1.7ms and the RF pulse a length of 1.42ms, out of which only 0.6ms can be used for beam acceleration. Currently, the RF pulse starts when the level of klystron HV reaches 99% of the nominal voltage. If one allows the RF pulse to start at the 80% level of the nominal voltage, then the RF pulse length can be increased. In this article we will present a proposal for increasing the XFEL RF pulse flattop length using phase and amplitude compensation during the rise and fall of the HV, as well as applying DFS when filling the cavities of the accelerator. The first demonstration of the proposed procedure with the 10MW multi-beam klystrons (MBK) at the klystron test stand and at the XFEL RF station A10.L3 will be presented as well. The described procedure can be used both to increase the duration of the RF flat top as well as to shorten the duration of the HV, which could lead to energy savings.

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