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## Roadmap on the Development of Klystron Modulators for ESS

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The European Spallation Source will require, by its completion, a pulsed Linac capable of delivering a proton beam with a peak power of 125MW and a pulse width of 2.86ms and a pulse repetition rate of 14Hz. The required klystrons are fed by 33 high power long pulse modulators, each rated for 115kV/100A;3.5ms/14Hz. Due to their high power levels, not only the quality of the pulses delivered is of great concern, but also the power quality on the AC grid is a challenge. Additional constraints like cost, footprint, efficiency, reliability/maintainability made it impossible procuring a solution already available in the market by the time of decision.

This contribution will focus on the modulator development roadmap for ESS. It will describe the obtained results and lessons learned from the first phase of the project, where two commercial solutions were procured and tested leading to unsatisfactory results.

Concurrent to the commercial approach, ESS decided to launch an internal R&D project aiming at developing a new class of modulators, particularly suited for long pulse and high power applications. The topology (Stacked Multi-Level) is modular and based on several HV modules connected in series using High Frequency Transformers, fed from a primary low voltage inverters. In order to cope with power quality requirements, Active Front Ends are used at the first stage of the capacitor chargers. A reduced scale prototype, capable of powering one klystron, was built and successfully validated on a dummy load and on the real load. The series production of the first batch of 12 full scale units was outsourced on a built-to-print basis. The first series unit, capable of feeding 4 klystrons in parallel, was recently tested at full power on a HV dummy load. Experimental results of both the prototype and first series unit will be presented and discussed.

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