Comments on 12 GeV Klystrons

Jean Delayen and G. A. Krafft

Recently there have been discussions about the specification of the klystrons for the 12 GeV project. These discussions have been directed towards establishing a klystron specification of 13 kW for the saturated gain, as opposed to the 16 kW specification that may have been utilized in the past. This document should be regarded as a follow-up of a document compiled by the first author[1] where requirements for the rf sources and the external Q of the cavities were obtained for stiffened cavities using the standard CEBAF cell geometry (780 Ω, 15 Hz maximum detuning). At present the baseline design is based on unstiffened cavities using the low-loss cell geometry (903 Ω).

Figure 1 shows the power required at the cavity as a function of the external Q at full current, design gradient and several values of the maximum detuning. There is, at present, no data on the microphonic sensitivity of these cavities in an actual cryomodule in the accelerator environment, so it may be reasonable to use the original assumption of 25 Hz detuning. Under these conditions the optimal Q external is $2.3\ 10^7$ and the optimal power is 8.9 kW. Even allowing for an external Q misadjustment of 1.5 dB (√2) and an additional 1 dB for losses and saturation, a 13 kW rf amplifier is sufficient. The additional 1 dB assumes that a 13 kW amplifier would be able to provide 10 kW of linear power at the cavity.

Figures 2 and 3 show the rf power at gradients from 21 to 25 MV/m for maximum detuning of 25 and 15 Hz respectively. If the maximum detuning is 15 Hz (corresponding to microphonics less than 2 Hz rms), then a 13 kW amplifier would allow operation up to 25 MV/m if the external Q is between 2 and $5\ 10^7$. On the other hand, if the maximum detuning is 25 Hz (corresponding to microphonics of 3.5 Hz rms) then a 13 kW amplifier would allow operation up to 22 MV/m if the external Q is between 1.4 and $4\ 10^7$, and up to 23 MV/m if the external Q is between 1.9 and $3\ 10^7$.

Reference

[1] Jean Delayen, JLAB-TN-05-044

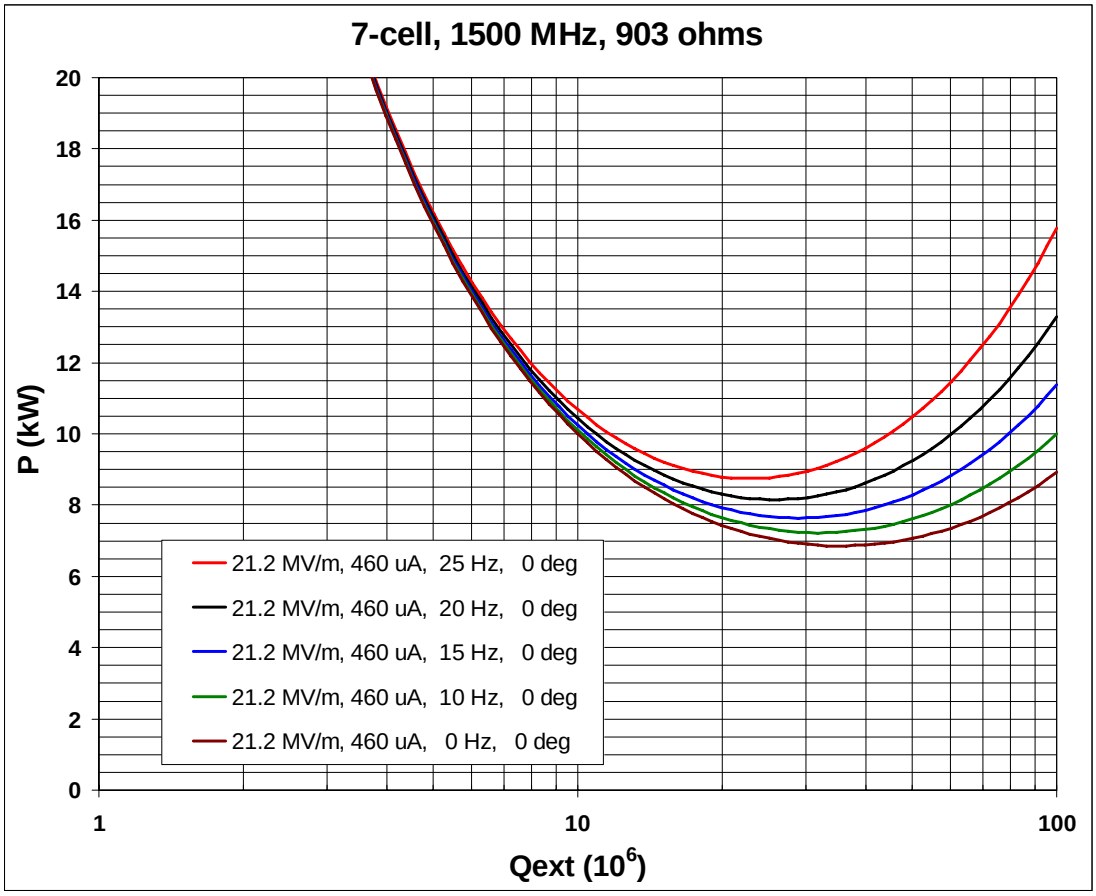

Figure 1: Power curves at design gradient of 21.2 MV/m for several detuning assumptions

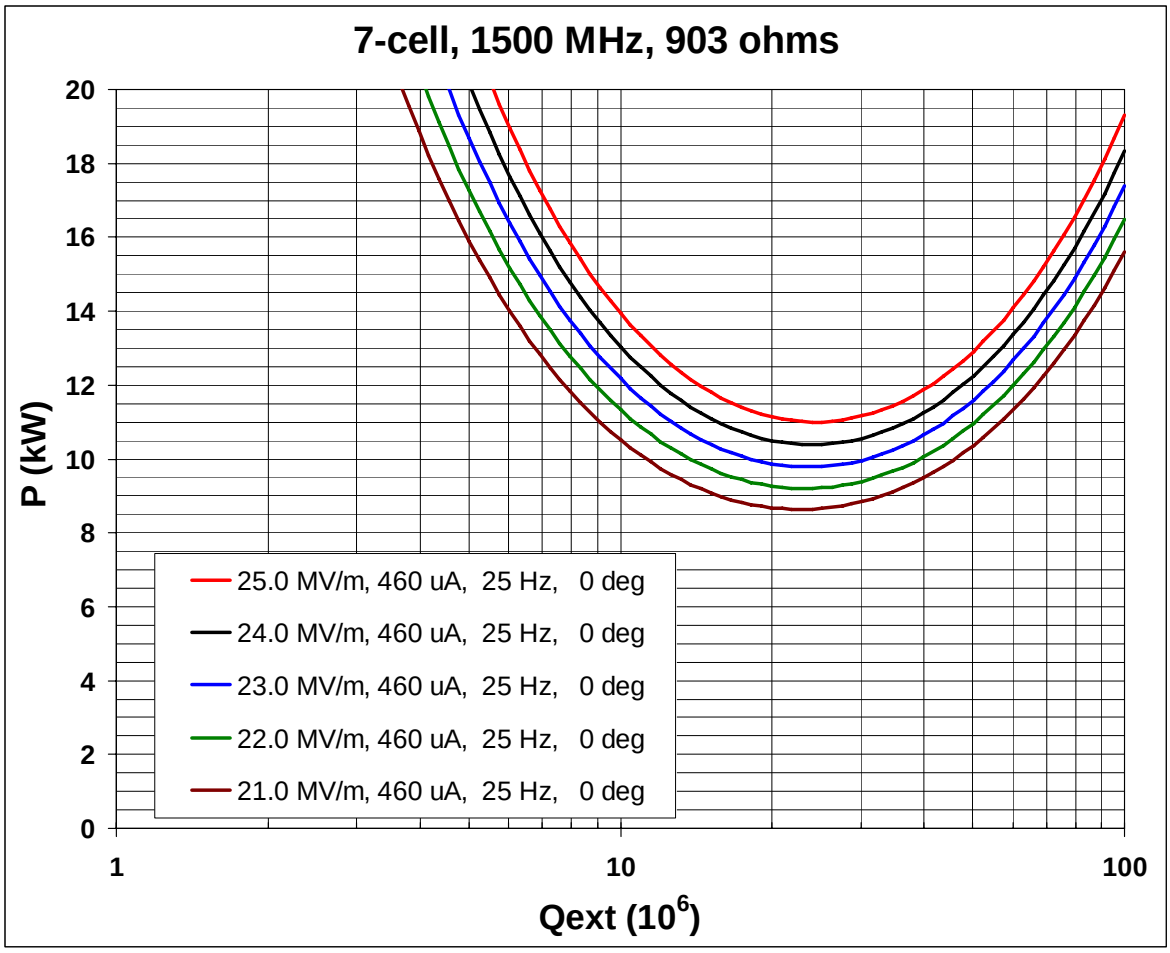

Figure 2: Power curves for 15 Hz total detuning and gradients from 21 to 25 MV/m.

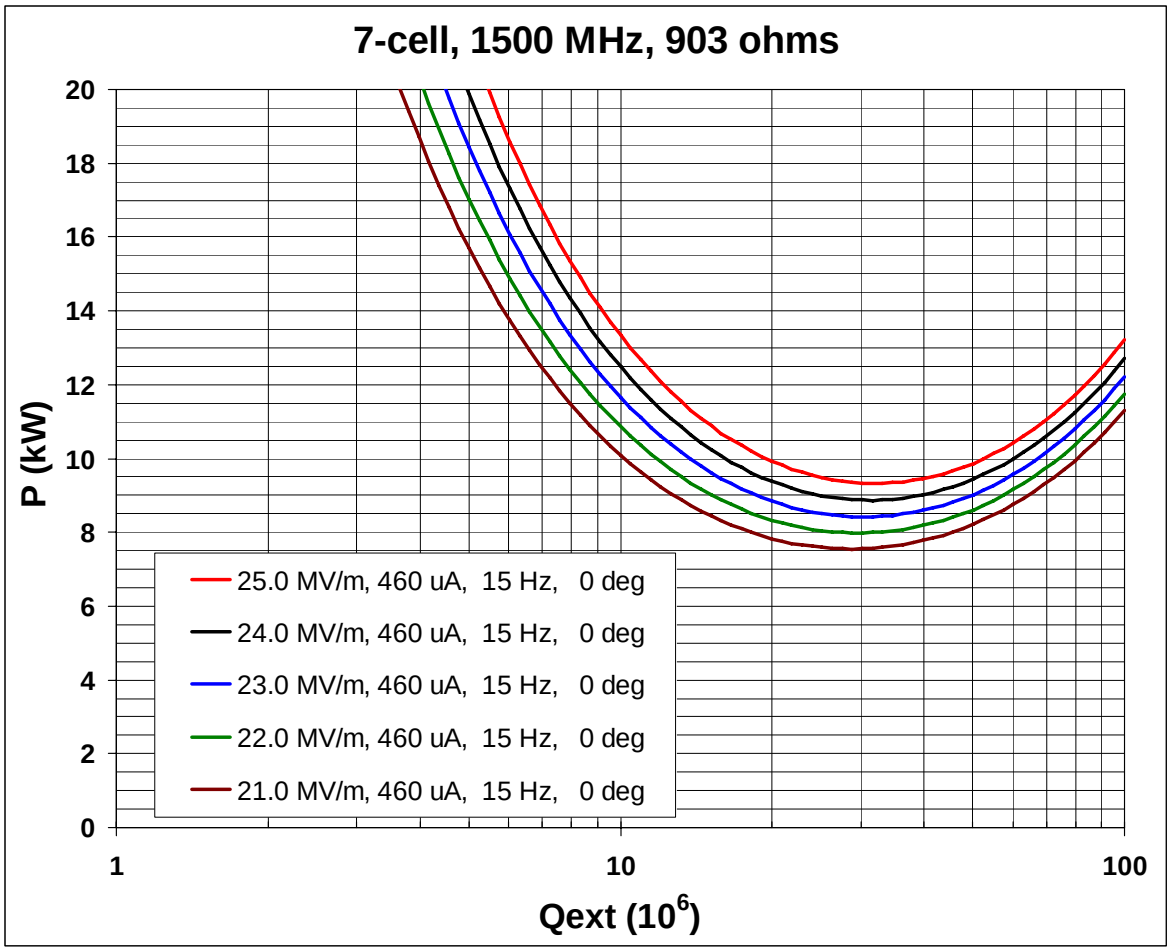

Figure 3: Power curves for 25 Hz detuning and gradients from 21 to 25 MV/m.