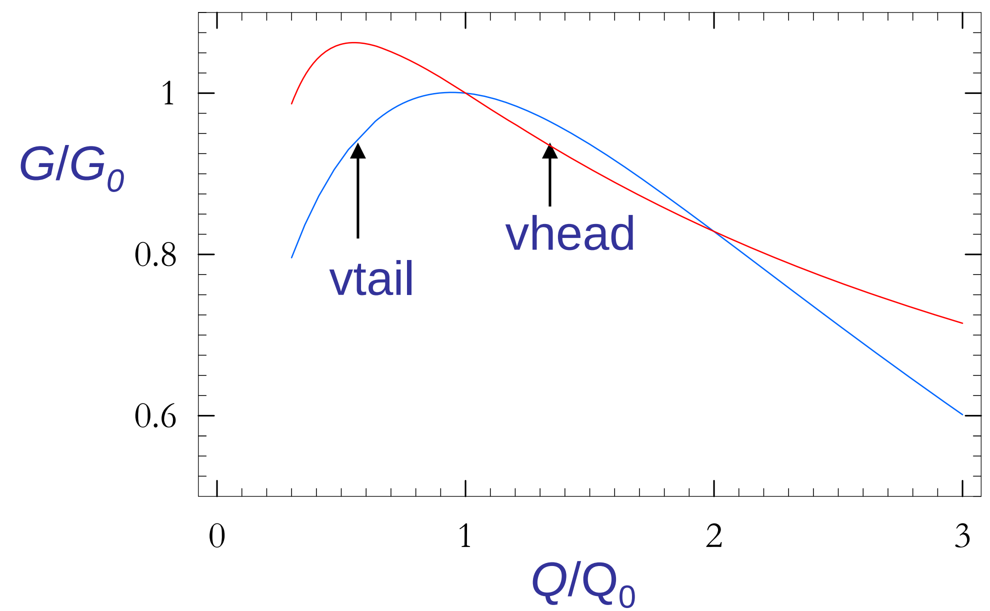
RF Distribution Management

- For a string of 26 cavities, maximize gradient, keeping gradient in cavity *i*, $\max(G)_i < (G_{lim})_i$ and *total* relative head-to-tail energy variation $< 10^{-3}$

- To optimize, vary initial beam time $T_b \ln(2)$, and some combination of the input power P_i and loaded Q, $(Q_L)_i$ for the *i* cavities

- For one overall *P* and individual *Q* adjustments, the optimized solution has $q = Q/Q_0$ (Q_0 is the matched loaded Q) mostly in the range [1, 2]

Voltage of head and tail of train; $t_b = T_b/\tau_0 = 1$, $P/P_0 = 1$

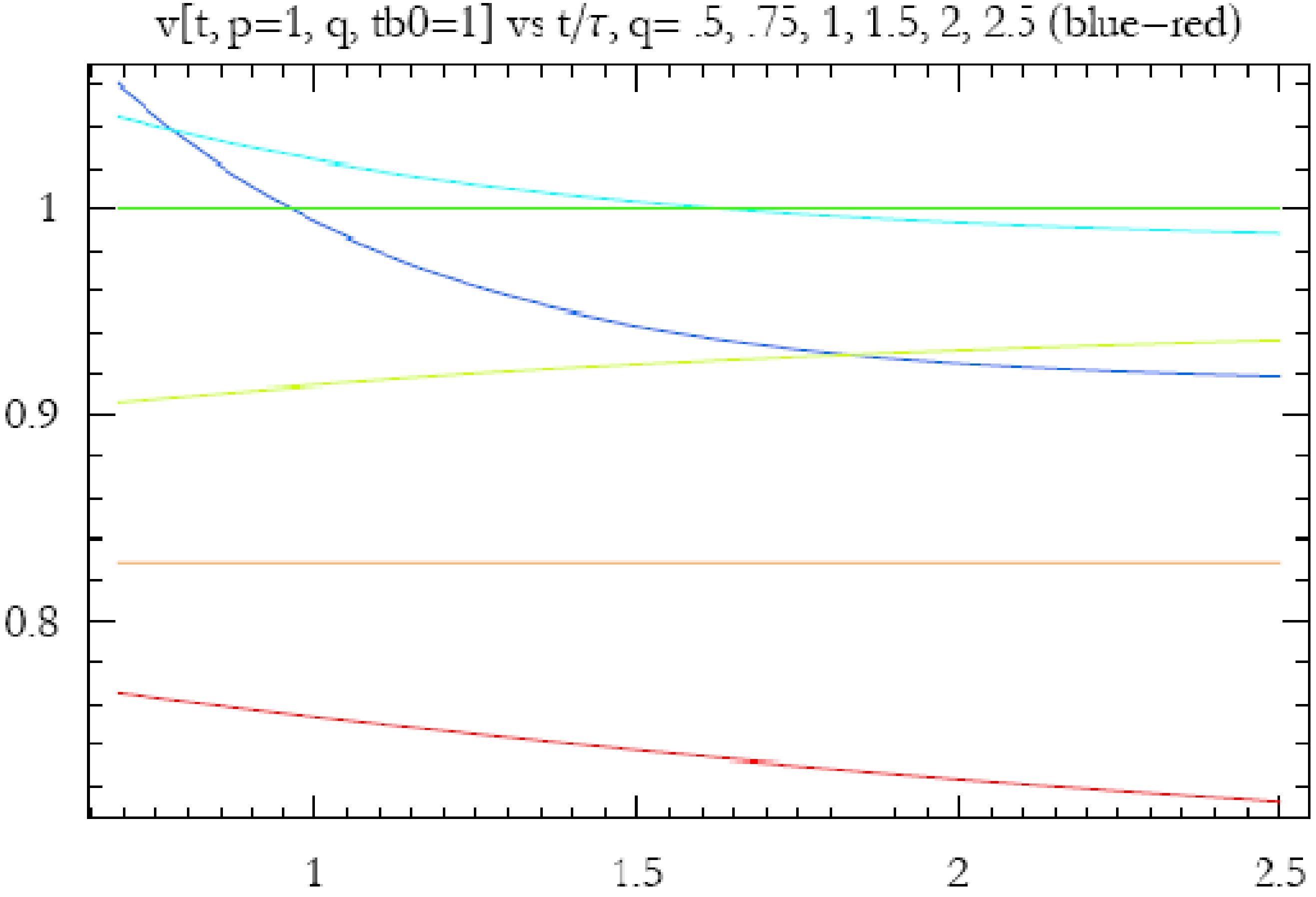


$[\tau_0 = 2Q_0/\omega]$

[train length= $1.8\tau_0$]

Karl Bane, SLAC

Gradient vs Time for Various Q's



Gradient Optimization

Consider uniform distribution of gradient limits $(G_{lim})_i$ from 22 to 34 MV/m in a 26 cavity rf unit - adjust cavity Q's and/not cavity power (P) to maximize overall gradient while keeping gradient uniform (< 1e-3 rms) during bunch train

Optimized $1-\langle G\rangle/\langle G_{lim}\rangle$; results for 100 seeds

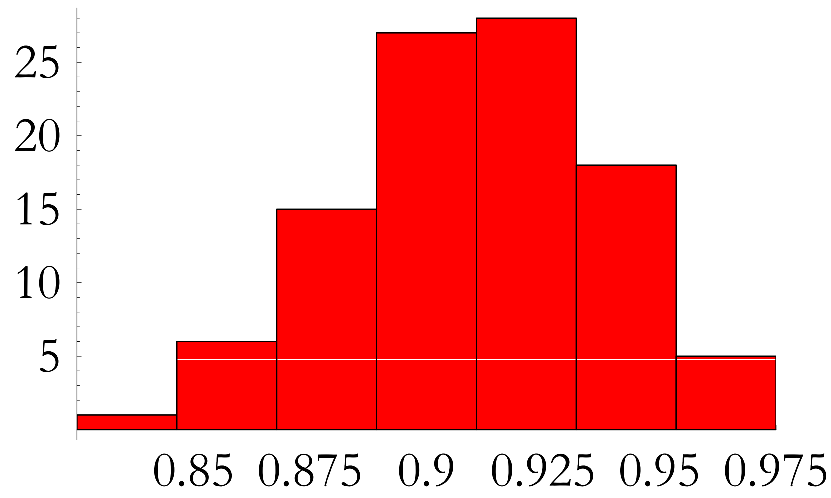
Case	Not Sorted [%]	Sorted [%]
Individual P's and Q's (VTO and Circ)	0.0	0.0
1 *P*, individual *Q*'s (Circ but no VTO)	2.7 ± 0.4	2.7 ± 0.4
P's in pairs, *Q*'s in pairs (VTO but no Circ)	7.2 ± 1.4	0.8 ± 0.2
1 *P*, *Q*'s in pairs (no VTO, no Circ)	8.8 ± 1.3	3.3 ± 0.5
G_i set to lowest G_{lim} (no VTO, no Circ)	19.8 ± 2.0	19.8 ± 2.0

"Sorted" means cavities are arranged in pairs of nearly equal G_{lim}

The number after "±" is the rms value

Beam Turn-On Time

1 p, individual q's, not sorted: distribution of beam turn-on times



t_b

• Remember: beam turn-on time is T_b ln(2), and $t_b = T_b/\tau_0$, $\tau_0 = 2Q_0/\omega$, with Q_0 the matched loaded Q at G= 34 MV/m