Stochastic Cooling Project

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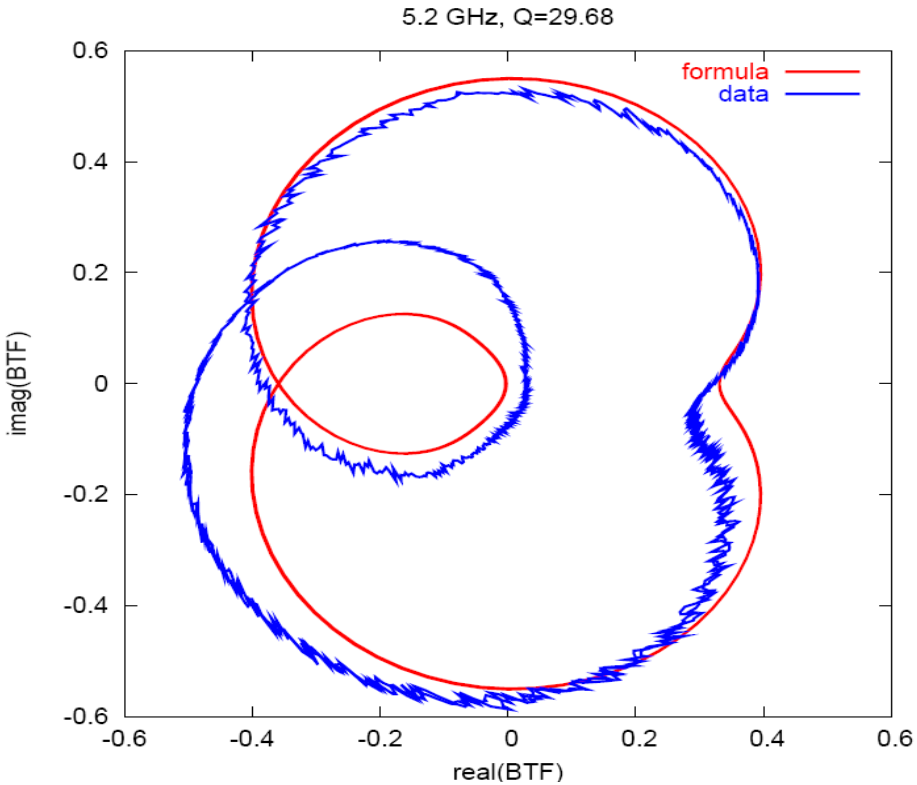
The original goal was to cool a proton test bunch like we did for longitudinal cooling.

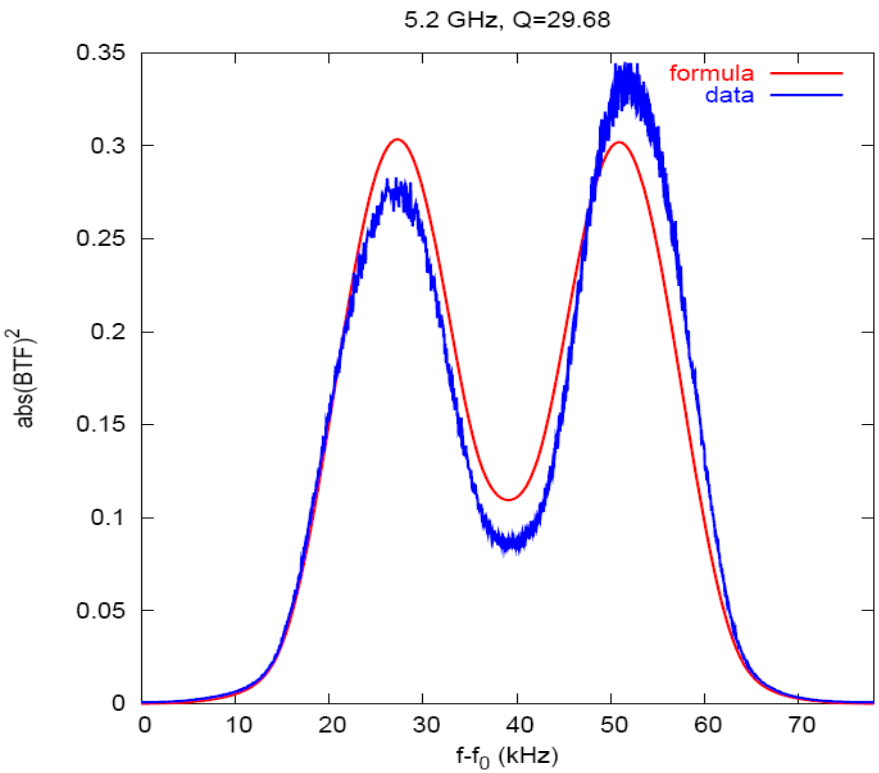
This did not pan out because of signal to noise problems.

Fortunately, it is possible to check phase and gain controls using Beam Transfer Functions (BTFs)

Signal suppression, or shielding, verifies that the entire cooling loop has the correct transfer function.

First consider measured and predicted Beam Transfer Functions with coasting beam approx. The difference in peak height remains to be understood.





Signal Suppression

current at pickup due to voltage at kicker

$$I_1(\tilde{\omega}) = B(\tilde{\omega})V_K(\tilde{\omega}) \propto qN$$

total current at pickup

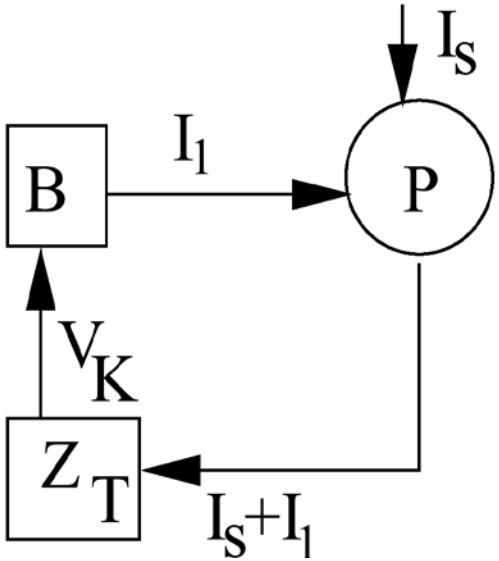
$$I_P = I_1 + I_S, \qquad I_S \propto q\sqrt{N}$$

voltage at kicker due to current at pickup

$$\begin{aligned} V_K &= -I_P Z_T \\ &= -(I_1 + I_S)Z_T \\ &= -BV_K Z_T - I_S Z_T \end{aligned}$$

net voltage at kicker due to Schottky current

$$V_K = \frac{-I_S Z_T}{1 + BZ_T} \equiv -Z_D I_S$$



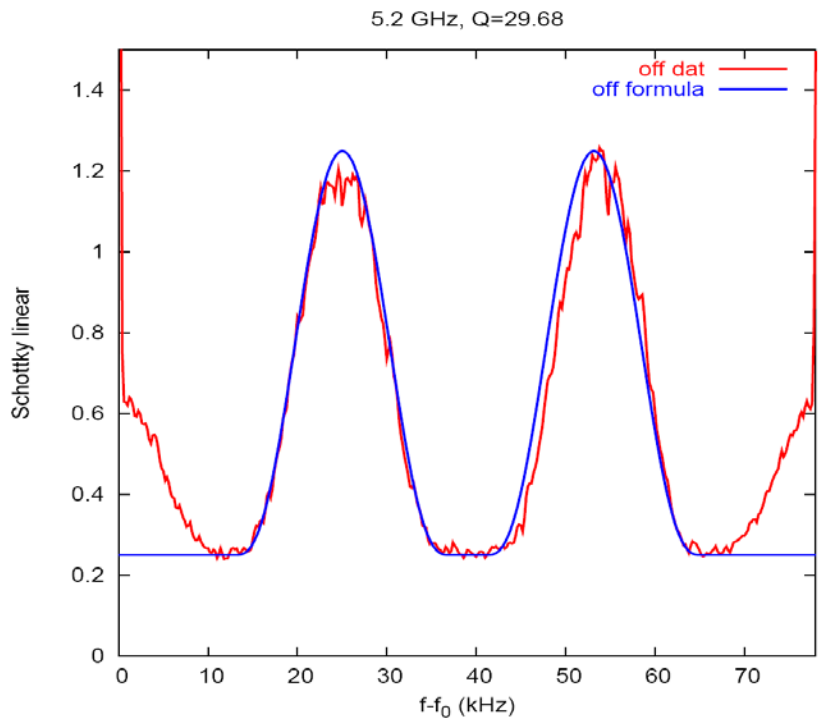
Ip is suppressed by the same factor.

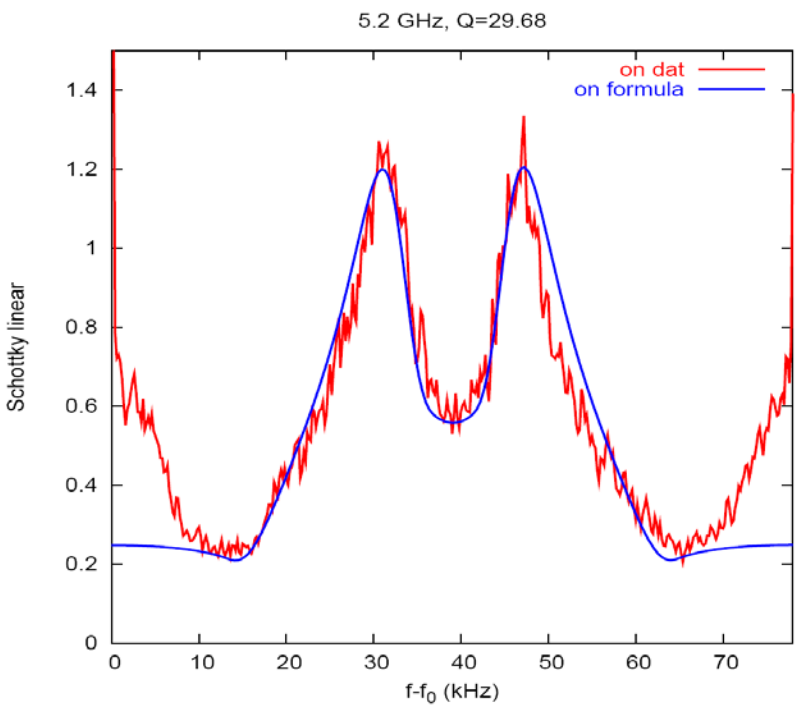
$$I_P = I_S + I_1 = \frac{I_S}{1 + BZ_T}$$

With optimal gain

$$BZ_T \approx 1$$

The effect of the feedback loop on the pickup signal can be calculated for a coasting beam.
The small shift between data and formula (left plot) seems real.
The suppressed signal is well modeled even with the errors so cooling should proceed as planned.
Suppression is non-uniform due to bad tune.



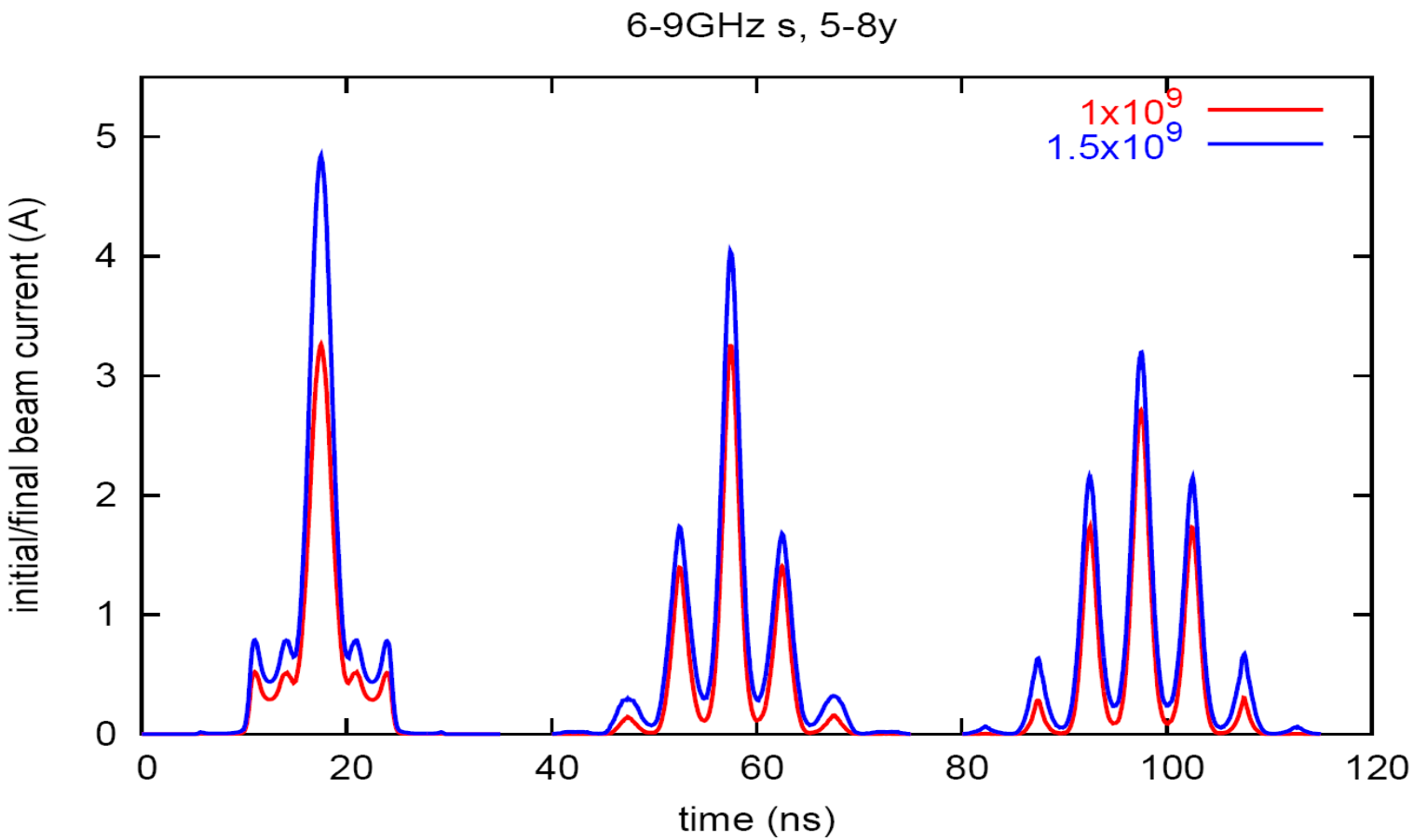


Predictions for next fall:

Current profile at 0, 2.5 and 5 hours without burnoff.

4 MV on storage system, IBS suppression lattice

Vertical cooling only dQmin=0.01, dQbare=0



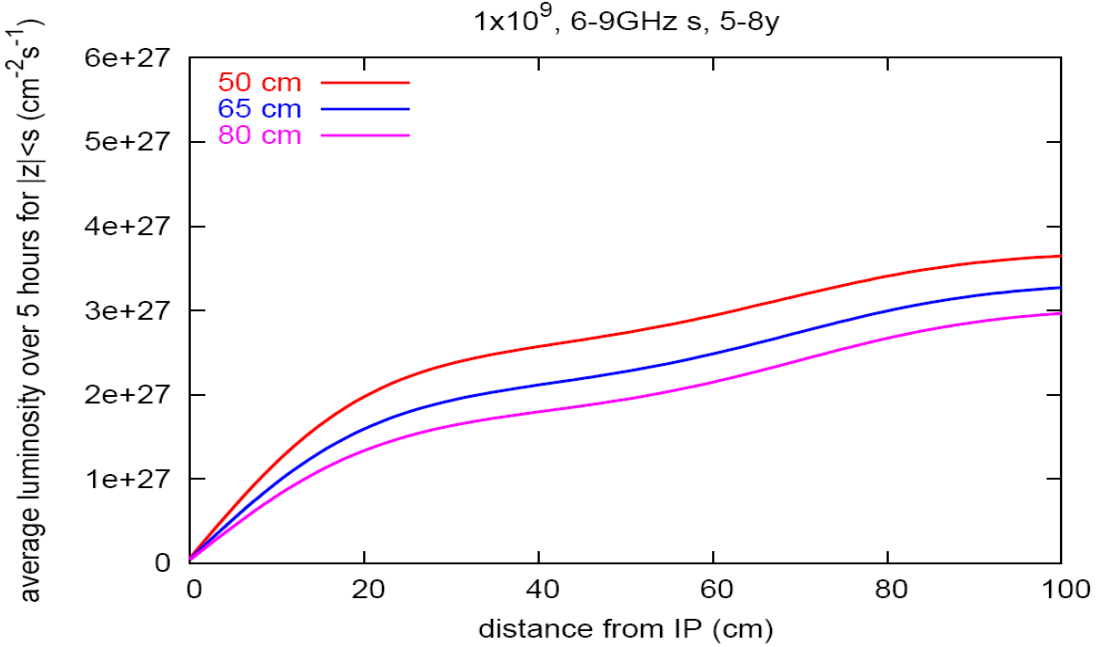
Expected luminosity for different β* and intensities.

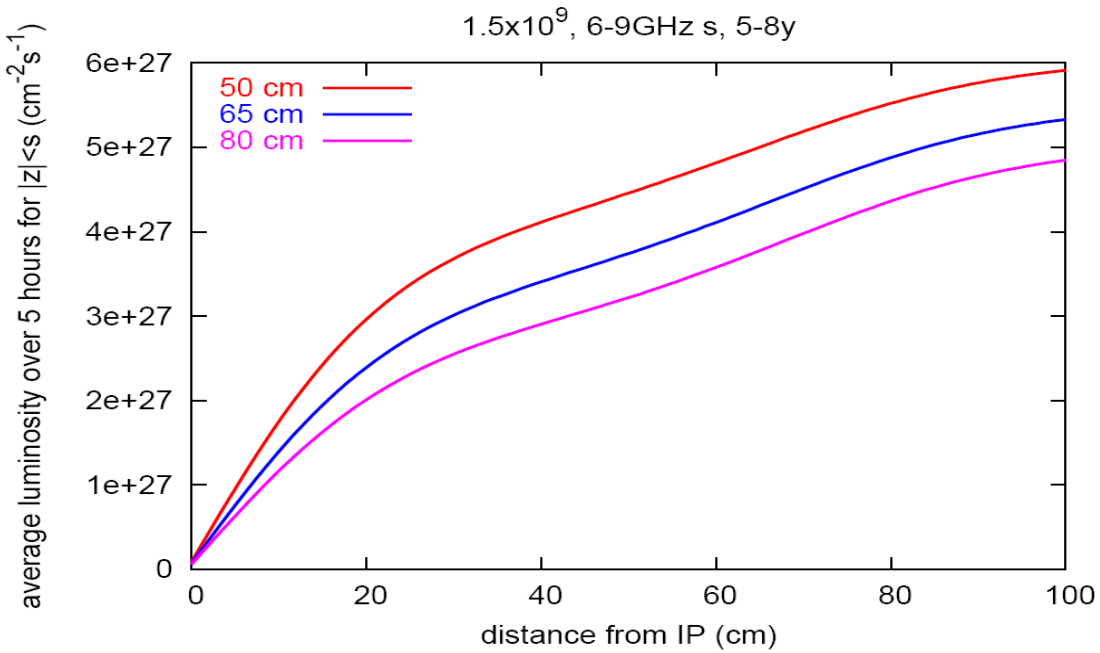
For small distance from the IP the luminosity scaling is linear in β*

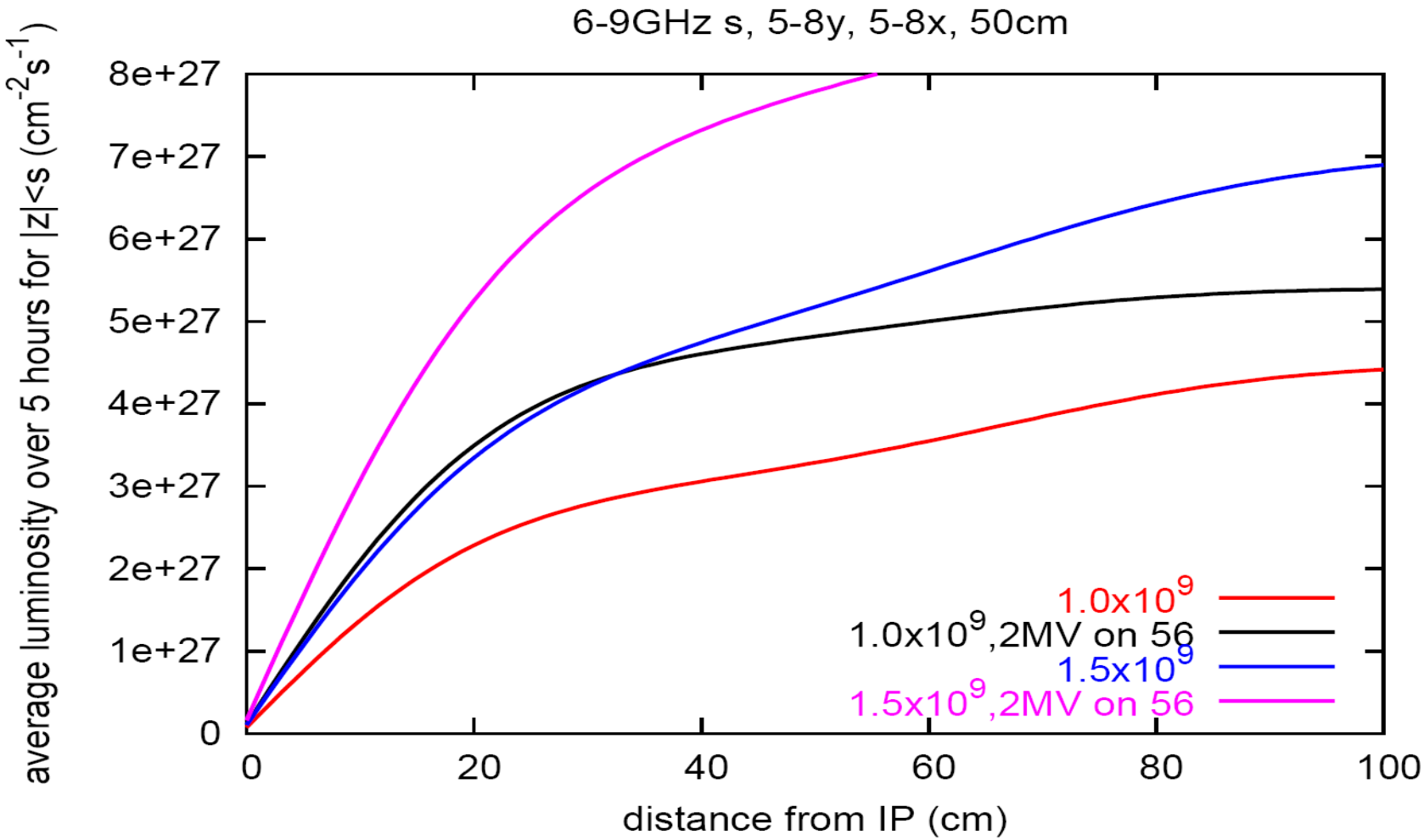
Burn-off with 50cm is:

20% for 1.0×10^{9}

30% for 1.5×10^{9}





For FY11 we will also have horizontal cooling.

Adding the 56 MHz RF cavity gives a 50% boost near the IP