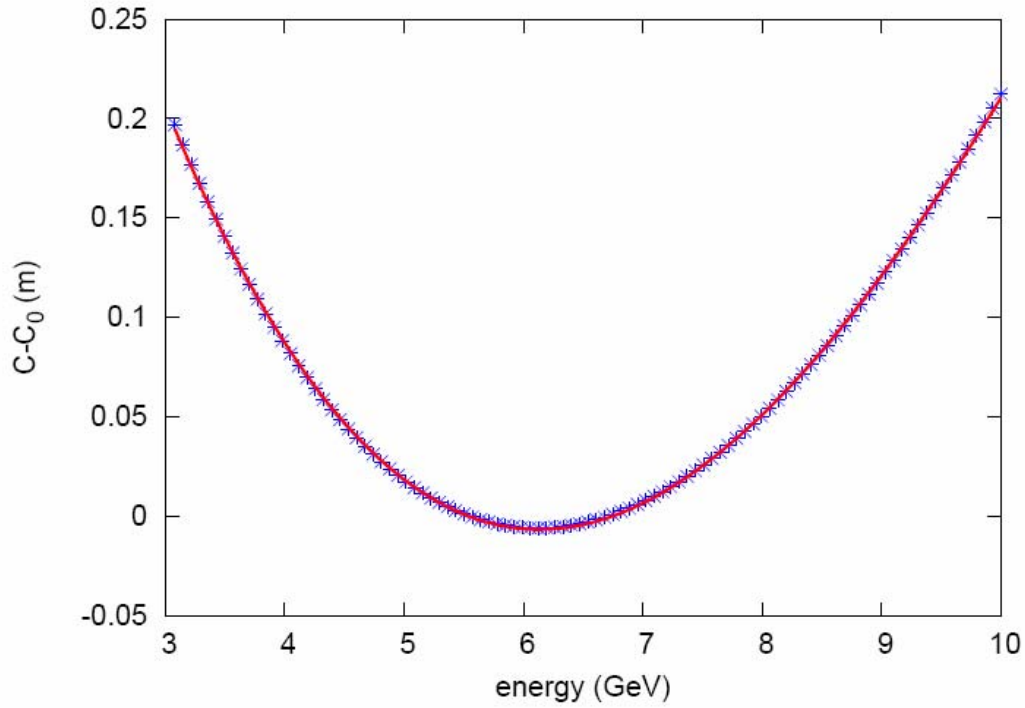
FFAG for eRHIC

The goal is to design a rapid cycling accelerator for 3 to 10 GeV. Dejan Trbojevic designed a lattice with a nominal circumference C=1277m. The variation in circumference with electron energy is



Installed Voltage

At 10 GeV an electron radiates 12.9 MeV per turn.

The reverse bends are important. For a circular path with C=1277m, an electron loses 4.3 MeV per turn.

Take an installed voltage of 20 MV/turn.

Use 2, 701 MHz cavities being designed for the e-cooling ERL.

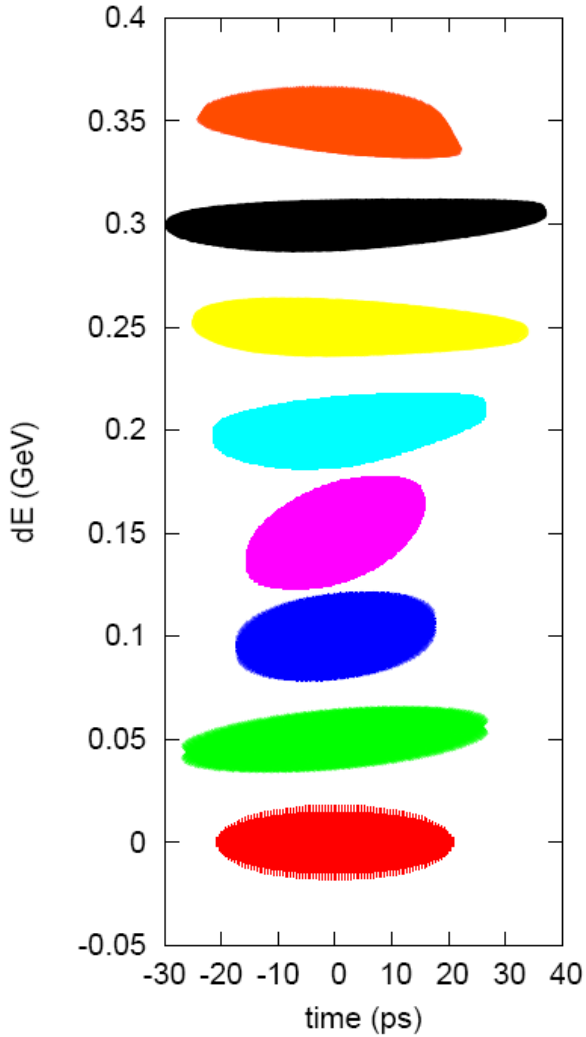
Taking 10^{11} electrons per bunch and a bunching frequency of 28.1 MHz , the DC electron beam current is 0.49 Amperes.

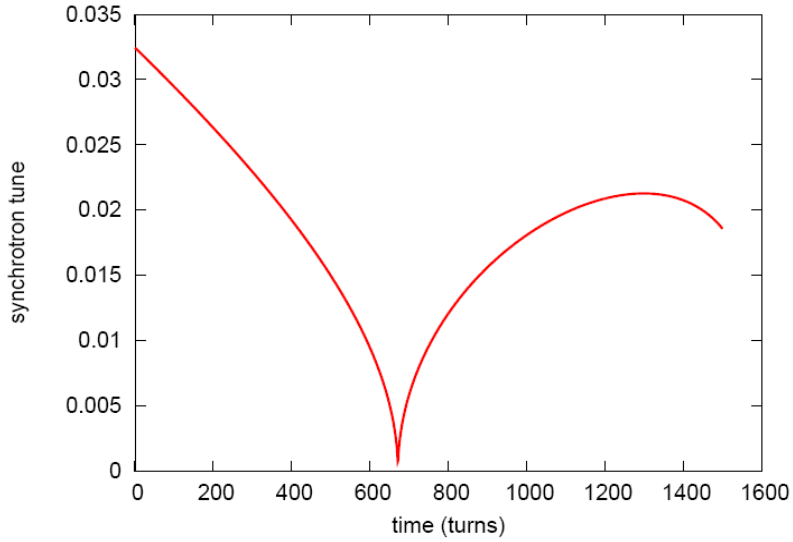
This translates to 6.3 MW of radiation power at 10 GeV, which sets the scale for the RF power supplies. The ideal cavity impedance based on radiation requirements is then

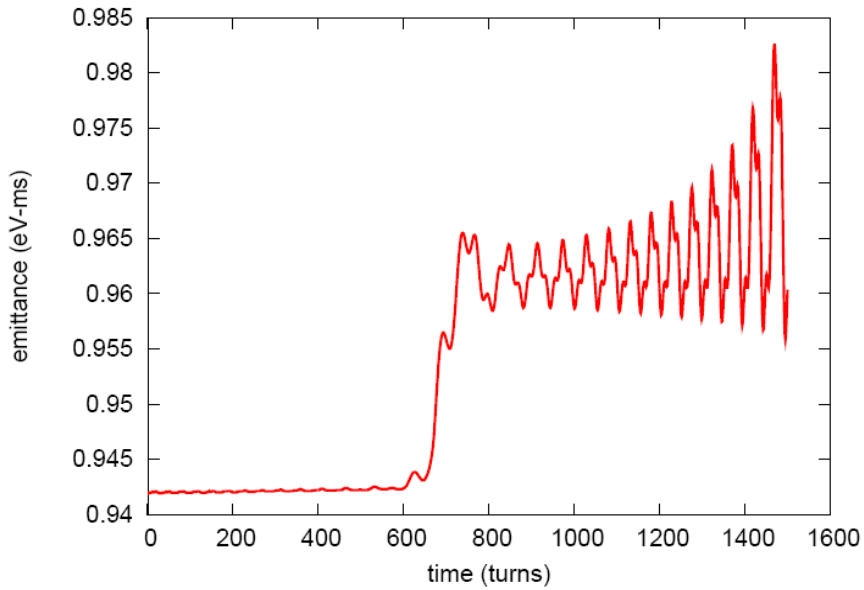
$$R_{sh} = \frac{V}{I_{beam} \sin \varphi_s} = 30 M\Omega = 200\Omega \times Q,$$

$$Q = 1.5 \times 10^5$$

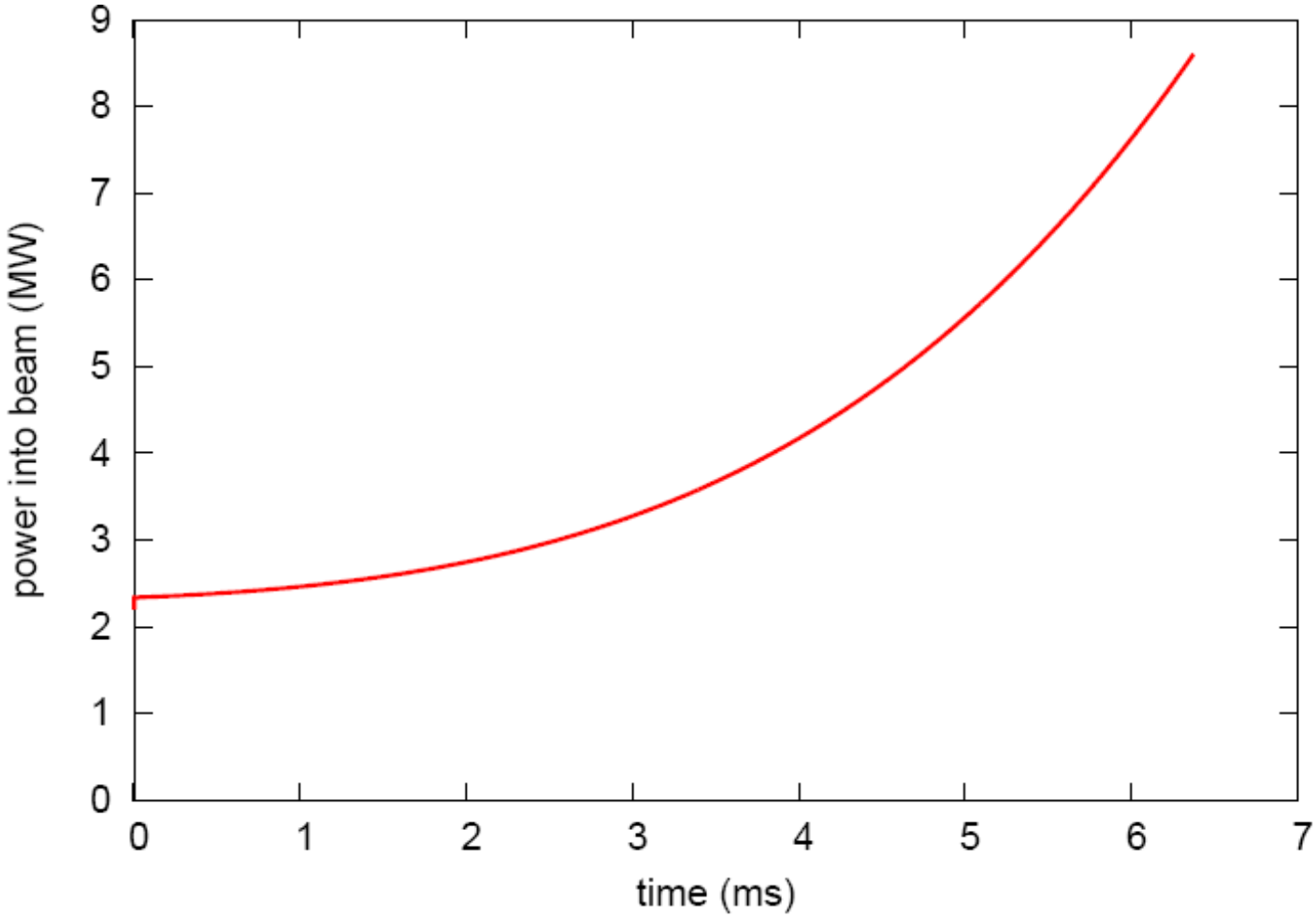
Simulations



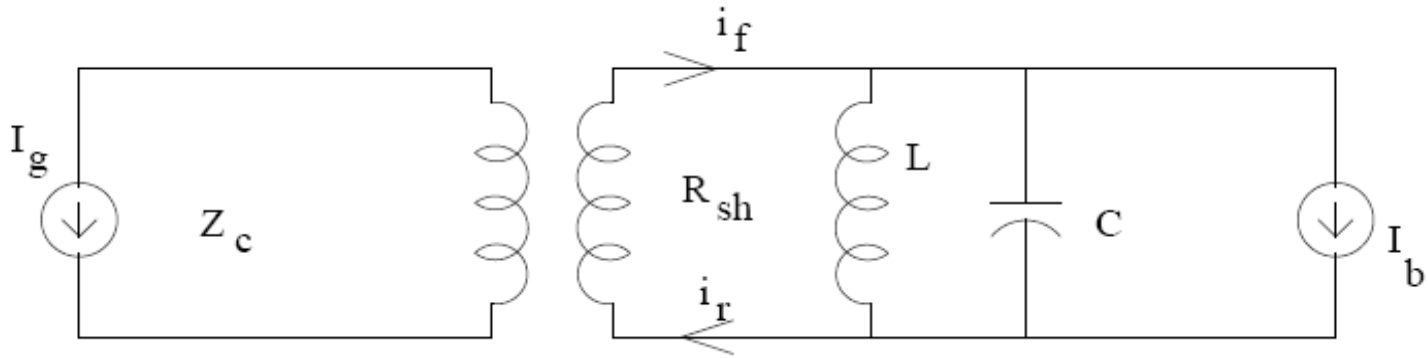




power budget with constant dE/dt



Installed power might need to be significantly larger



$$i_f - i_r - I_b = \frac{V}{Z_{cav}(\omega)}, \qquad \frac{1}{Z_{cav}(\omega)} = j\omega C + \frac{1}{j\omega L}$$

$$i_f + i_r = \frac{V}{R_{sh}}$$

$$2i_f - I_b = V\left(\frac{1}{R_{sh}} + \frac{1}{Z_{cav}(\omega)}\right)$$

Ideally, Zcav is chosen to cancel the reactive beam current. (SC cavity!) This requires a stepwise change in resonant frequency at transition. Additionally, the optimal Q changes with input power.