

Main Formulas

$$W_{\parallel}^{(m)}(s) = -\sum_n \omega_n \left(\frac{R^{(m)}}{Q} \right)_n \cos\left(\omega_n \cdot \frac{s}{c}\right) \exp\left(-\frac{1}{\tau_n} \cdot \frac{s}{c}\right)$$

$$W_{\perp}^{(m)}(s) = c \sum_n \left(\frac{R^{(m)}}{Q} \right)_n \sin\left(\omega_n \cdot \frac{s}{c}\right) \exp\left(-\frac{1}{\tau_n} \cdot \frac{s}{c}\right)$$

Single modes have been calculated by *R. Wanzenberg* in
“Monopole, Dipole and Quadrupole Passbands of the TESLA 9-cell Cavity”
(September 2001)

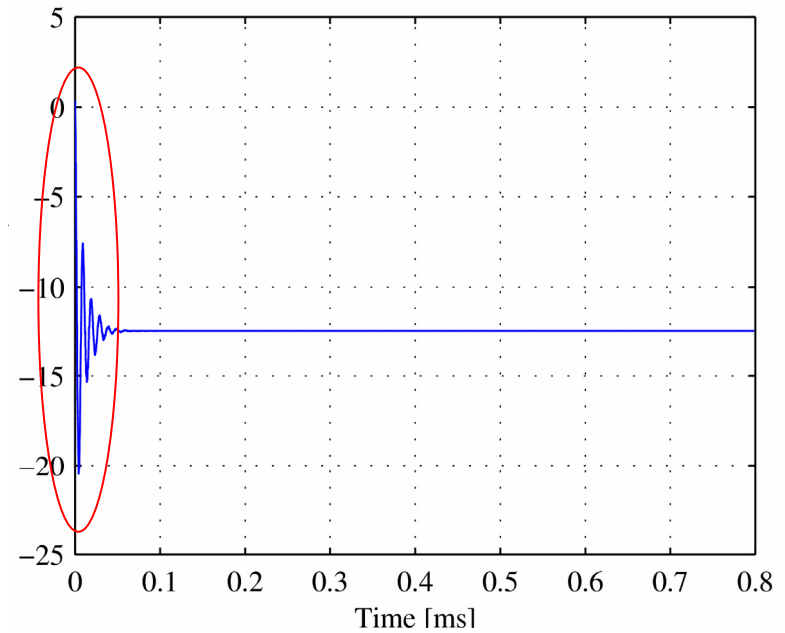
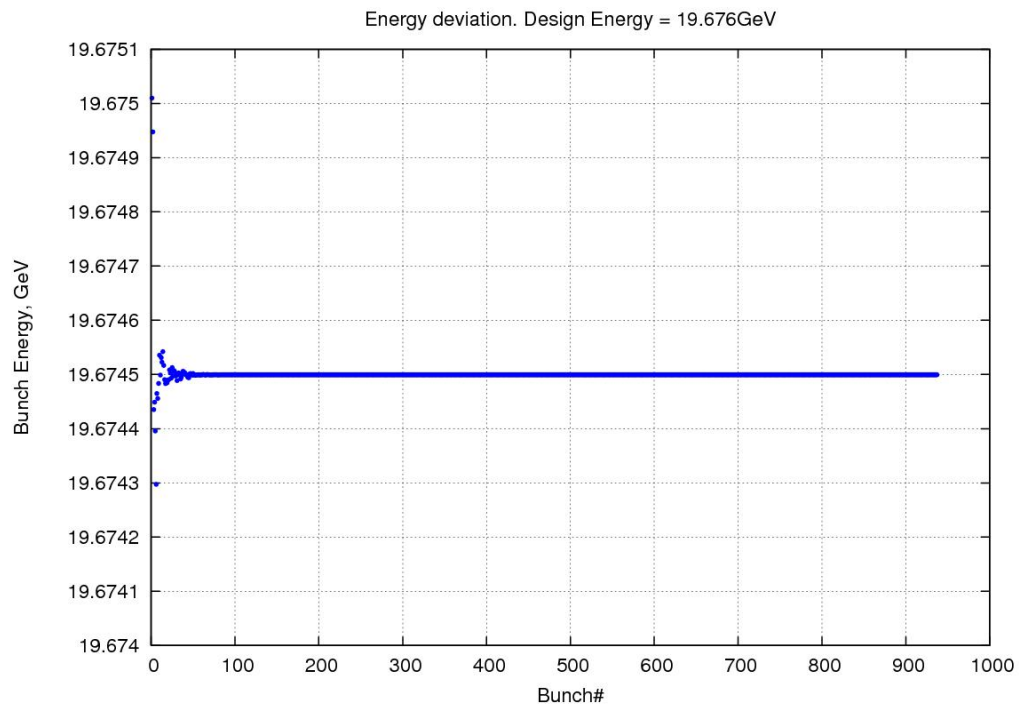
70 most prominent modes have been taken into account for the simulations

Simulations with Damping

- Inject the bunch train perfectly without any offsets
- Acceleration from 500MeV to about 20GeV → 800 cavities with 24MeV per cavity
- Bunch spacing 200ns
- Natural detuning 0.1% rms
- Cavity misalignment 500 μm rms
- Damping by order 10^{-5}
- Charge per bunch 1nC

Bunches	Energy rms, MeV	Offset rms, mm	Angle rms, μrad
0-100	0.166	0.0185	0.0217
0-500	0.074	0.0084	0.0098
0-900	0.056	0.0063	0.0073
25-900	0.0009	0.0001	0.0001

Compare with results of Nicoleta



→ Different numbers but the same story

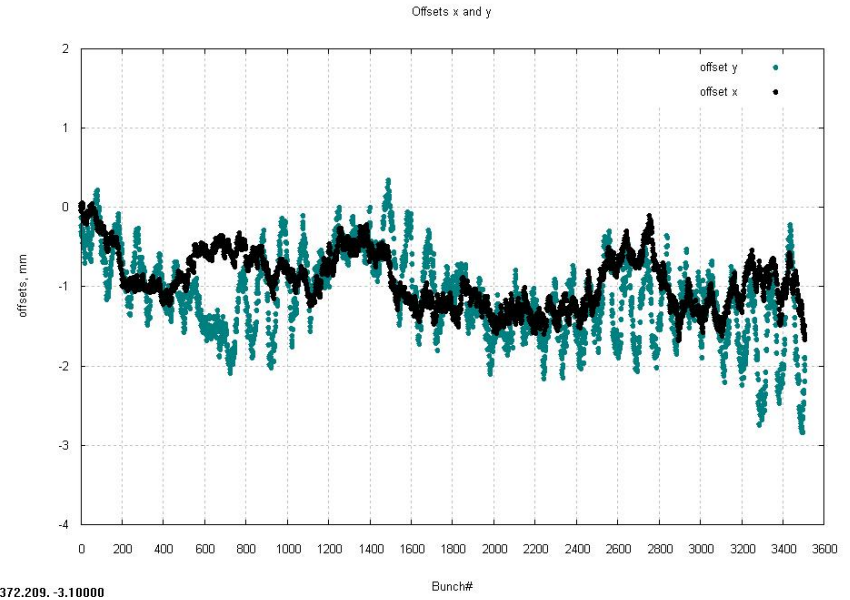
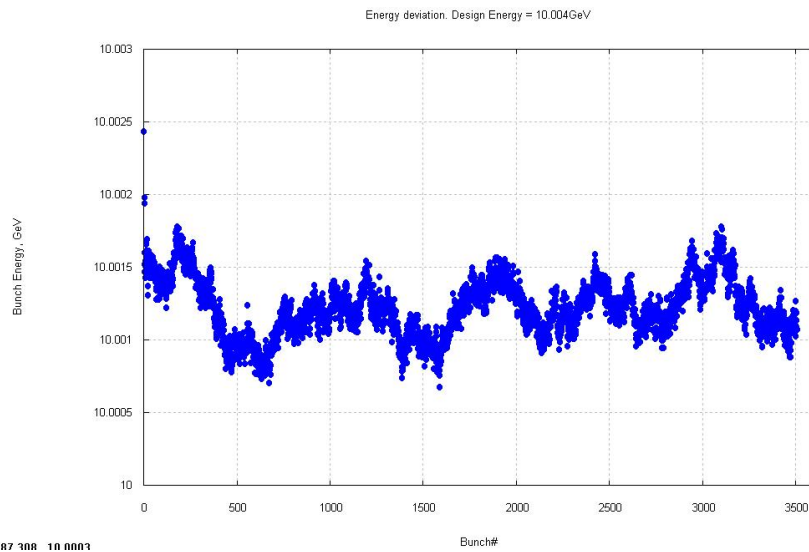
Simulations without damping I with and without detuning

- Inject the bunch train perfectly without any offsets
- Acceleration from 500MeV to about 10GeV → 397 cavities with 24MeV per cavity
- Bunch spacing 200ns
- Cavity misalignment 500 μm rms
- Charge per bunch 1nC

Detuning	Bunches	Energy rms, MeV	Offset rms, mm	Angle rms, μrad
no detuning	0-500	4.03	13.28	167
0.1% rms	0-500	0.23	0.38	1.08
0.2% rms	0-500	0.47	0.78	2.40
0.1% rms	0-3500	0.19	0.53	1.73
0.1% rms	500-3500	0.18	0.52	1.72
0.2% rms	0-4000	2.01	1.03	5.15

Energy deviation and offsets

Bunch spacing = 200ns, detuning 0.1%, cavity offsets rms 0.05cm
Charge per bunch 1nC, accelerated by means of 397 cavities from
500MeV to 10.004GeV



Simulations without damping II different bunch spacings

- Inject the bunch train perfectly without any offsets
- Acceleration from 500MeV to about 10GeV → 397 cavities with 24MeV per cavity
- Natural detuning 0.1% rms
- Cavity misalignment 500 μm rms
- Charge per bunch 1nC

Bunch spacing, ns	bunches	Energy rms, MeV	Offset rms, mm	Angle rms, μrad
200	0-500	0.23	0.38	1.08
400	0-500	0.38	0.36	0.86
1000	0-500	0.93	0.37	1.50

*→ If no damping by HOM couplers provided,
it doesn't matter which bunch spacing to choose*

Simulations without damping III

different initial emittance

- Inject the bunch train perfectly without any offsets
- Acceleration from 500MeV to about 10GeV → 397 cavities with 24MeV per cavity
- Bunch spacing 400ns
- Natural detuning 0.1% rms
- Cavity misalignment 500 μm rms
- Charge per bunch 1nC

Initial bunch size	Bunches	Energy rms, MeV	Offset rms, mm	Angle rms, μrad	Emittance growth, %
Point bunch	0-1000	0.50	0.40	1.30	Infinity
1 μm x 1 μrad	0-1000	0.50	0.51	1.52	77400
50 μm x 5 μrad	0-1000	0.50	1.70	4.46	2933