J. MacLachlan, AD/PS Wednesday 8 September 04

Energy Jitter Correction

- h=588 bunches in MI must be less than 0.7 eVs (better is 0.4)
- beam chopped at MI $f_{\mathrm{circ}} \longrightarrow \Delta E < \pm 37$ MeV
- bunch-to-bunch jitter estimated by Raparia as 6 MeV (2$\times$ desired)
- propose Cu traveling wave section about 10 m long after p collimation arc
- energy measured with BPM at center of arc
- time delay implies 1 – 2 MHz bandwidth correction

halving the number of SCRF klystrons by cutting the beam current by half and doubling the pulse length (see sect. 23.4). This scenario narrows the cavity bandwith and doubles the synchrotron phase advance across a group of cavities, both of which will reduce the performance of Vector Sum Regulation.

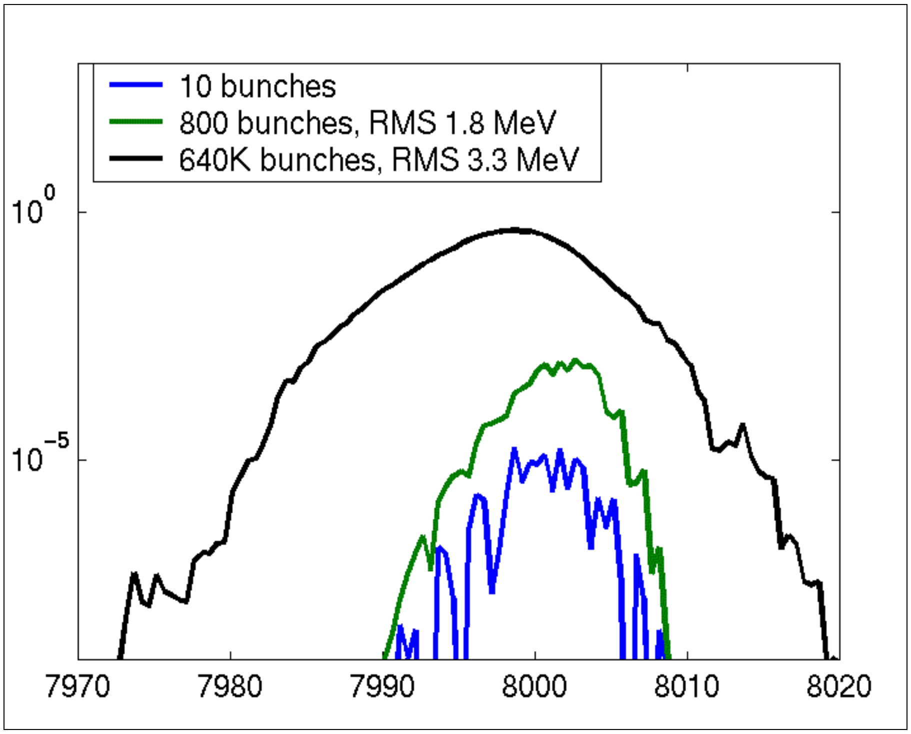

Figure 16 – Simulation of Vector-Sum Regulation with Microphonics in the 1207.5 MHz (β = 1.00) section of the 8 GeV Linac. One klystron drives 12 cavities. Microphonic resonance shifts of σ = 10 Hz were assumed, approximately 3x worse than recent measurements of SNS cavities (Figure 15). Beam was injected into the 1207.5 MHz section at 1.3 GeV with an initial emittance of 2.2π eV-s and zero energy jitter. Bottom trace: energy spread of 10 representative bunches, with a typical emittance of 2.8π eV-s (i.e. dominated by the incoming emittance). Middle trace: energy spread of 1 "macropulse" of 800 bunches. Top trace: energy spread of 800 macropulses, with an energy spread including the pulse-to-pulse fluctuations due to cavity microphonics. The output energy jitter was dominated by microphonics effects as expected, but the output energy spread was limited to σ(E)/E = 0.04% by vector sum regulation.

5.9 Resonance control in the 805 MHz (β< 1) Linac

In the β <1 (805 MHz) section of the linac, the stringent resonance control requirements for non-relativistic protons will be met by high-power, fast ferrite tuners (sect. 13.6) on the RF drive to each cavity. These provide fast modulation of phase and amplitude of the RF drive to each of the 96 cavities, while preserving the economics of the TESLA-style RF fan out.

Page 33 of TM-2169, the current draft of the 8 GeV linac concept. The caption paritially explains how the energy spreads shown were generated by various assumptions about the control of phase in the high energy modules. The spreads are the bunch centroid distributions; the bunch height is taken to be $\pm$3 MeV from Petr Ostroumov's end-to-end model results. The parameters considered are given in the following table.

Parameter Table

Parameter	Symbol	Value	Units
injection energy	E_s	8938	MeV
momentum aperture		$\gtrsim \pm 0.8$	%
betatron emittance	ϵ_r	$0.16 \cdot 10^{-6}$	m
max. energy jitter	ΔE	± 20	MeV
energy spread	δE	± 3	MeV
MI circulation period	τ	11.14	μs
MI rf harmonic number	h	588	
time chopping	T_2	10	μs/turn
barrier voltage	V_{barrier}	2	kV
barrier width	$2T_1$	1.14	μs
barrier height	$\Delta E_{\mathrm{barrier}}$	16.9	MeV

Two Basic Relations

$$\Delta\beta/\Delta\gamma = \beta^{-1}\gamma^{-3}$$

$$\Delta E_{\text{barrier}} = \sqrt{\frac{eV_{\text{barrier}}T_1 2\beta^2 E_s}{\tau|\eta|}},$$

giving the 16.9 MeV entered into the table. The parameters in the barrier height formula are defined in the table. Thus, it would be useful to increase the barrier voltage to as much as 10 kV to exploit the full momentum spread that could be accelerated through transition.

Comments or Conclusions

- If the bunch-to-bunch jitter must be corrected, the SNS solution is the only one; a long beam line and classic de-buncher are required

- If only jitter at < 2 MHz needs correcting, several ($\sim$ 5) km of beam transport can be eliminated.

- some bunch-to-bunch jitter must be expected from phase noise in reference rf