Group Meeting Slides for Michael Ehrlichman

1) OSC Bypass Beam Envelope
2) Comments on Pinged Optics Calculation

Equation for Envelope

Beam distribution in x, x' is given by,

$$\rho\left(x, x'\right) = \frac{1}{2\pi\epsilon_x} e^{-\frac{J_x}{\epsilon_x}}$$

where,

$$J_x = \frac{\gamma_x x^2 + 2\alpha_x x x' + \beta_x x'^2}{2}$$

Beam distribution in $\bar{x} = (x, x', y, y', z, z')$ is given by,

$$\rho\left(\bar{x}\right) = \frac{1}{2\pi\epsilon_x\epsilon_y\epsilon_z} = e^{-\frac{J_x}{\epsilon_x} - \frac{J_y}{\epsilon_y} - \frac{J_z}{\epsilon_z}}$$

The N-σ beam envelope is given by $\bar{x}$ solutions to

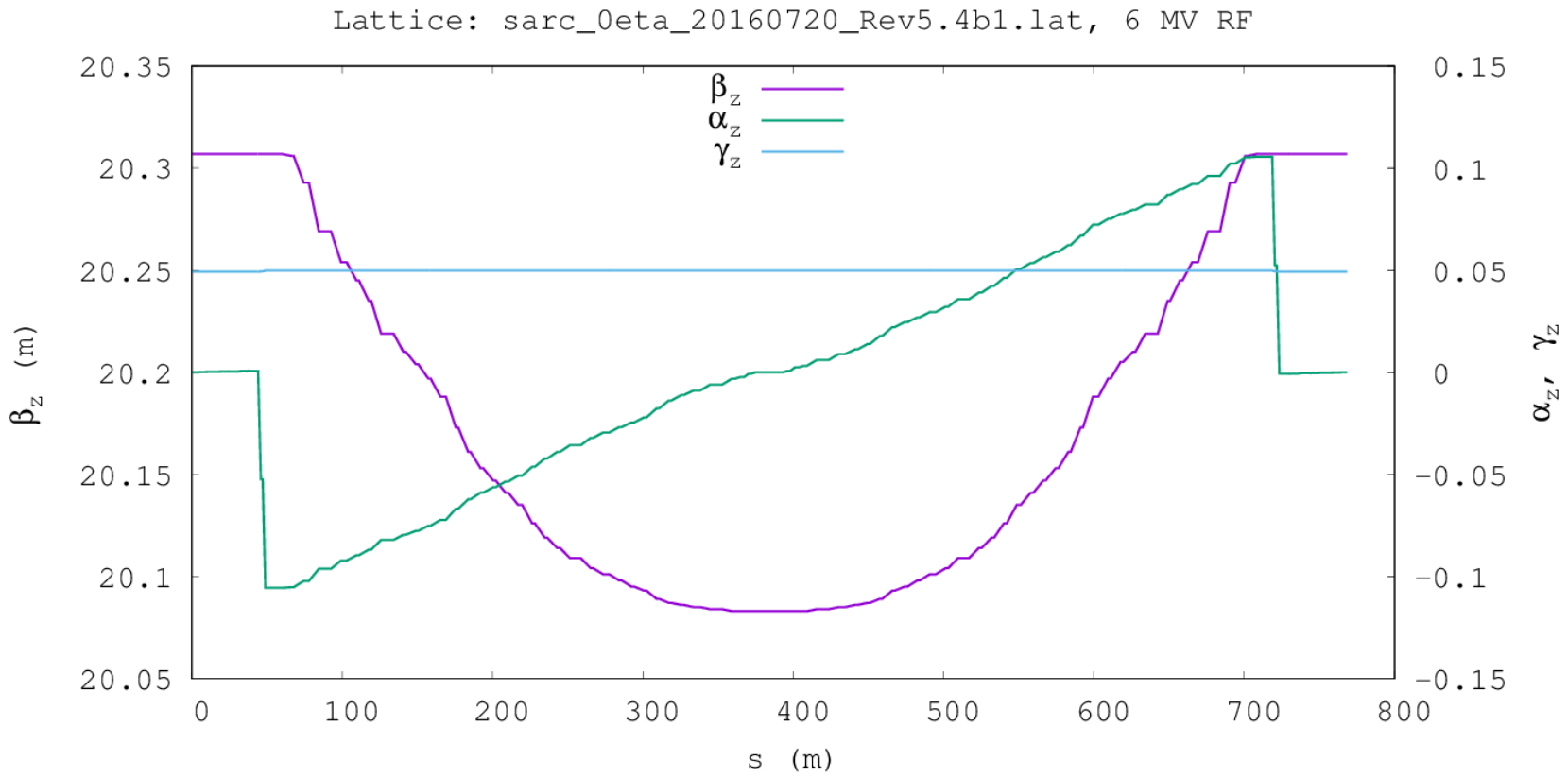
$$-\frac{J_x}{\epsilon_x} - \frac{J_y}{\epsilon_y} - \frac{J_z}{\epsilon_z} = N$$

Longitudinal Twiss Parameters

β, α, γ, and ϵ are common quantities for x and y.

These are obtained from decomposition of 1-turn matrix, which also gives us Twiss quantities for z.

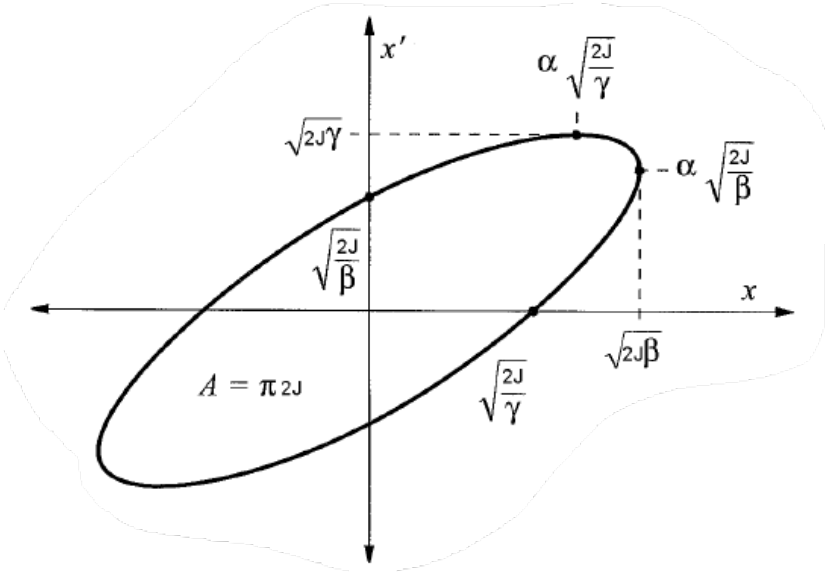
- I take $\beta_z = 20.2$, $\alpha_z = 0$, $\gamma_z = 1/\beta_z = 0.05$ as constants.
- $\epsilon_z \equiv \sigma_z \sigma_p = (1.5\text{cm})\left(7.6 \times 10^{-4}\right) = 1.17 \times 10^{-5}$ m



Build max xyz' envelope

Pick all sets of (n_x, n_y, n_z) that satisfy,

$$0.1n_x + 0.1n_y + 0.1n_z = N,$$



where the n's are positive integers.

Using

$$J_x = 0.1n_x,\ J_y = 0.1n_y, \text{ and } J_z = 0.1n_z,$$

build initial (max xyz') particle distribution from,

$$\begin{array}{cc} z = 0 & z' = \pm\sqrt{2J_z\gamma_z} \\ x = \pm\sqrt{2J_x\beta_x} + \eta_x z' & x' = \pm\alpha_x\sqrt{2J_x\gamma_x} + \eta'_x z' \\ y = \pm\sqrt{2J_y\beta_y} & y' = \pm\alpha_y\sqrt{2J_y\gamma_y} \end{array}$$

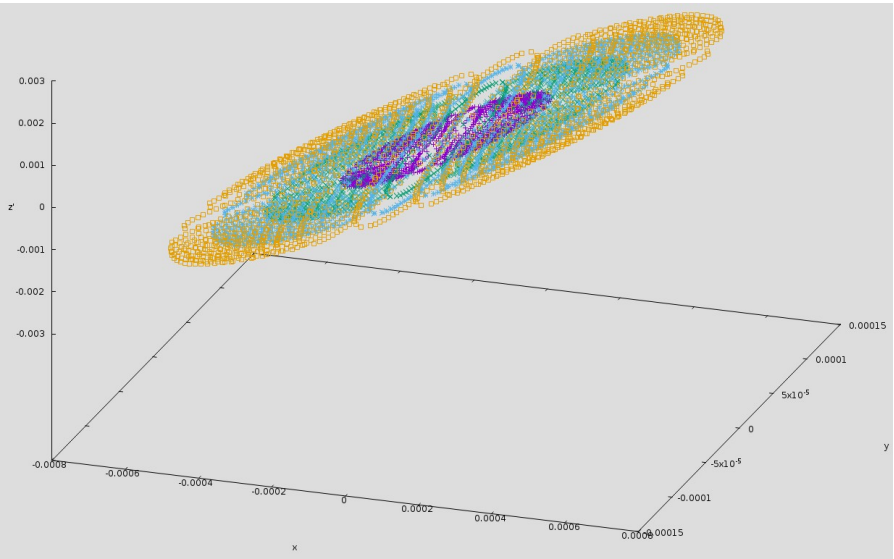
OSC Bypass Issues

- Need to consider sextupoles?
- Need to remove Quad moment from Dipoles?
- Matching into CHESS-U optics.

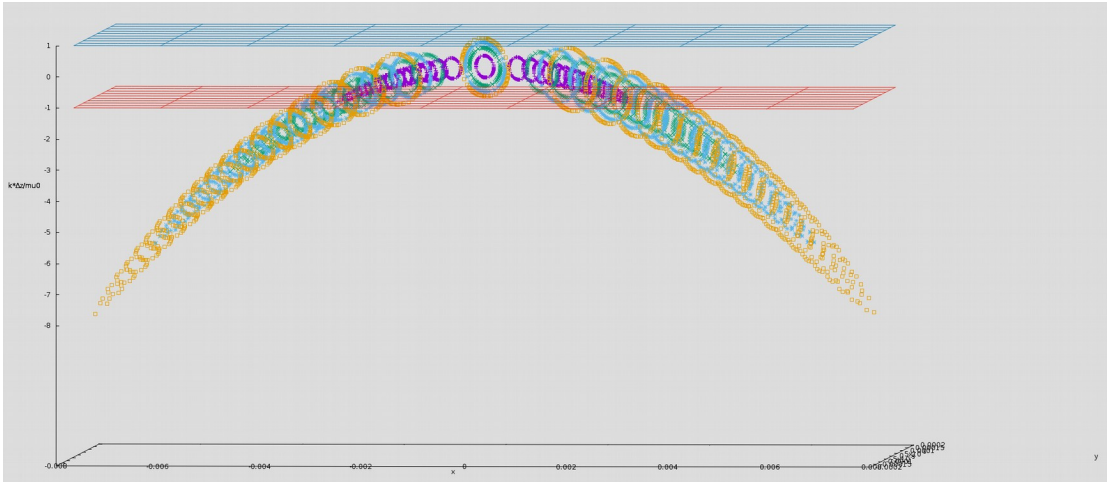
Envelope Tracking

- $\varepsilon_x = \varepsilon_y = 50$ pm
- 5.3 mm delay
- Examples are below, see accompanying gnuplot splot.

Bunch at pickup xyz' (z=0)



Bunch at kicker xyz (z' don't care)



Optics Measurement For OSC

- Tune tracker not expected to work at 500 MeV.
- Pinged beam phase measurement should work fine.
- Can develop TBT phase measurement into push-a-button tool.
  - Will require project inclusing MS shifts to develop tool and establish comparable accuracy.

Comparing apFFT to cesrv phase meas. (vert)

- CTA_2085_12W_DMTL_V15M
- Between 0.59 and 0.57 mA, one bunch
- elog entry: “qtune to (221,240) kHz” = (0.5665, 0.6152)
- cesrv phase meas 20118 (Dec 2013) (phase at 0E minus 1W)
- Bmad is ideal lattice
- apFFT measurement shown is over 2000 turns

			Full Turn (kHz)				0E minus 1W (kHz)		
	TT Dr Amp	Osc Amp @2W	TT	NAFF	apFFT	Bmad	apFFT	cesrv (data)	Bmad
15806/07	-30.7	1.6 cm	.6197	.6197	.6197		.5665		
15808/09	-33.7	1.5 cm	.6193	.6193	.6193		.5662		
15812/13	-41.0	7 mm	.6144	.6144	.6144	.6289	.5618	.5611	.5780
15820/21	-46.9	3 mm	.6134	.6134	.6135		.5605		
15834/35	-55.9	1 mm	.6130	.6130	.6139		.5602		

Comparing apFFT to cesrv phase meas. (horiz)

- CTA_2085_12W_DMTL_V15M
- 0.59-0.57 mA
- elog entry: “qtune to (221,240) kHz” = (0.5665, 0.6152)
- cesrv phase meas 20118 (Dec 2013) (phase at 0E minus 1W)
- Bmad is ideal lattice
- apFFT measurement shown is over 2000 turns

			Full Turn (unit)				0E minus 1W (unit)		
	TT Dr Amp	Osc Amp @2W	TT	NAFF	apFFT	Bmad	apFFT	cesrv (data)	Bmad
15836/37	-48.4	4.5 mm	.5688	.5688	.5687		.3548		
15840/41	-50.8	3.3 mm	.5685	.5685	.5685		.3538		
15844/45	-53.2	2.0 mm	.5683	.5683	.5683	.5639	.3550	.3546	.3631
15852/53	-58.4	1.2 mm	.5682	.5682	.5682		.3535		
15856/57	-60.9	0.9 mm	.5678	.5678	.5678		.3519		