Beam stacking study: Ramping ϕ_s

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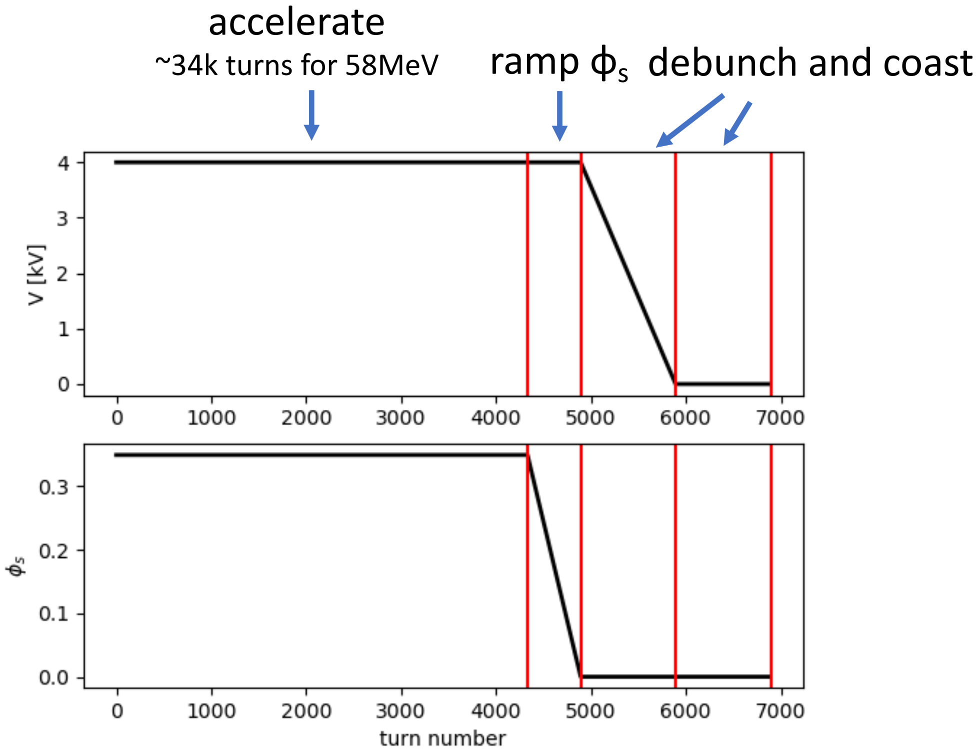
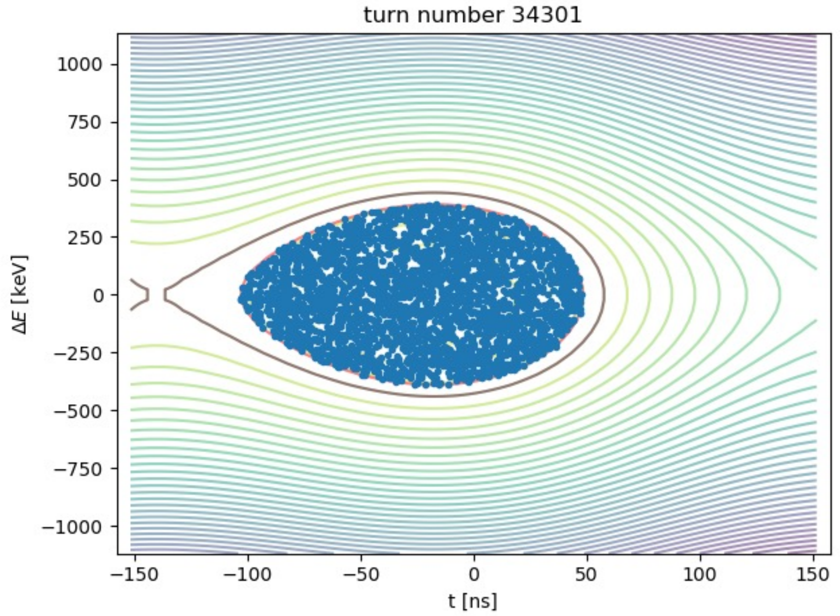
RF program – constant volts during ramp

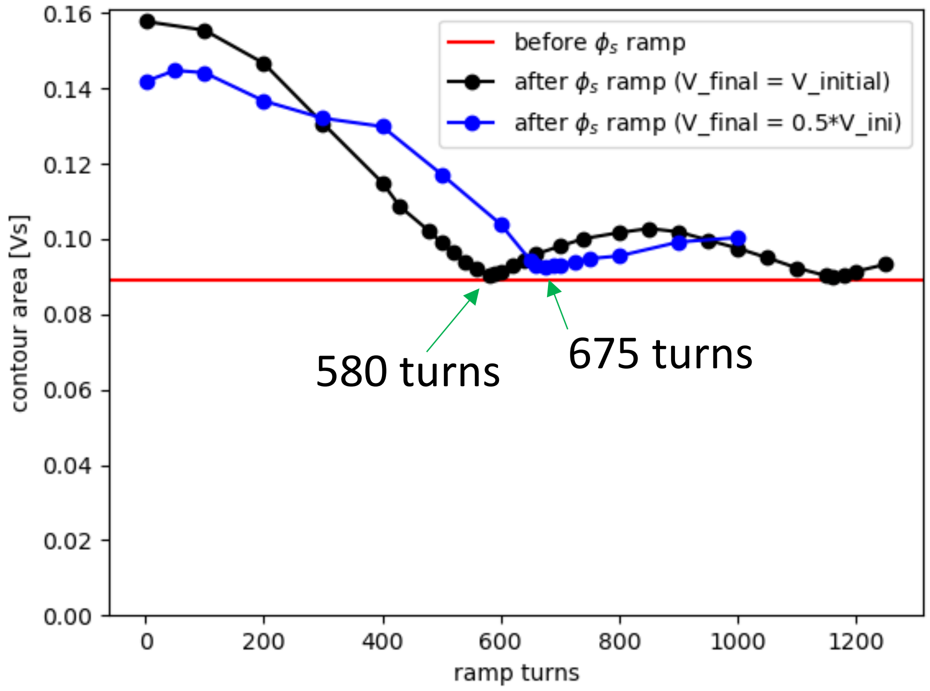


- Maintain constant voltage during ϕ_s ramp
- Synchrotron period before & after ϕ_s ramp is 495 & 481 turns, respectively at 58 MeV.
- Bucket area before & after ramp is 0.12 Vs and 0.246 Vs.

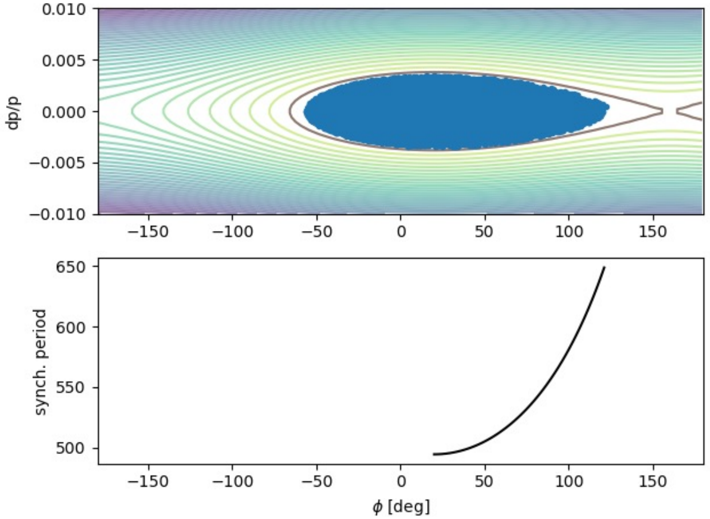


- Distribution just before ϕ_s ramp
- Red contour defines effective 100% emittance
- Contour area is 0.089 Vs

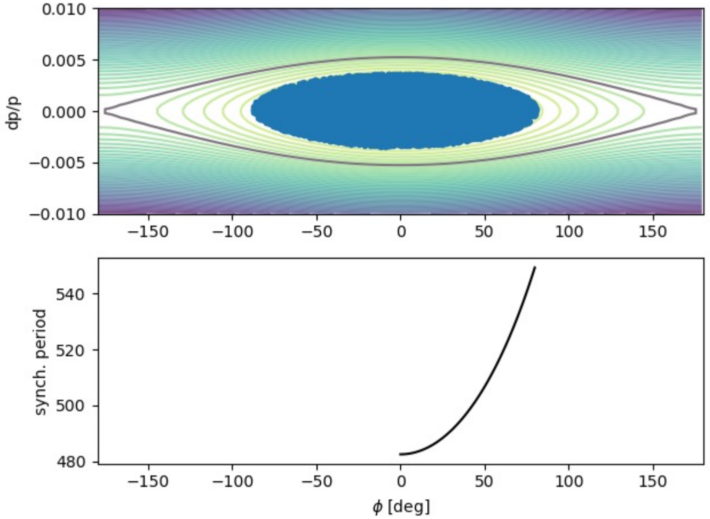
Emittance vs ramp turns



Synchrotron period vs amplitude (fix voltage)



Start of ramp, V_0 = 4kV
T_s range: 495-647 turns

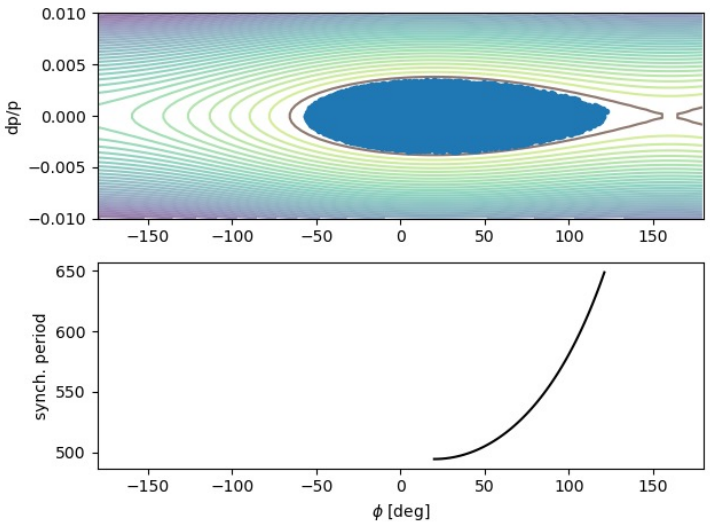


End of ramp, V_0 = 4kV
T_s range: 483-550 turns

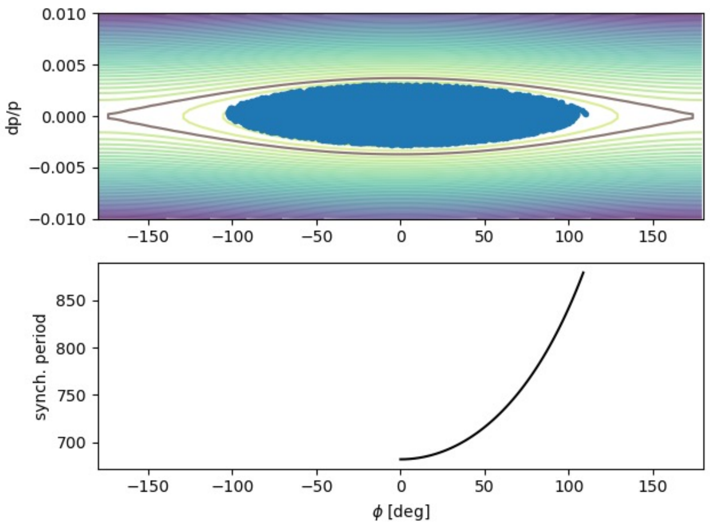
- Calculate the synchrotron period as a function of amplitude, where amplitude is given by the difference between where Hamiltonian contours cross the δ=0 line and ϕ_s.

$$Q_s(\hat{\phi}) \simeq Q_{s0}\left(1 - \frac{1}{16}(1 + \frac{5}{3}\tan^2\phi_s)\hat{\phi}^2\right)$$

Synchrotron period vs amplitude (halve RF voltage)

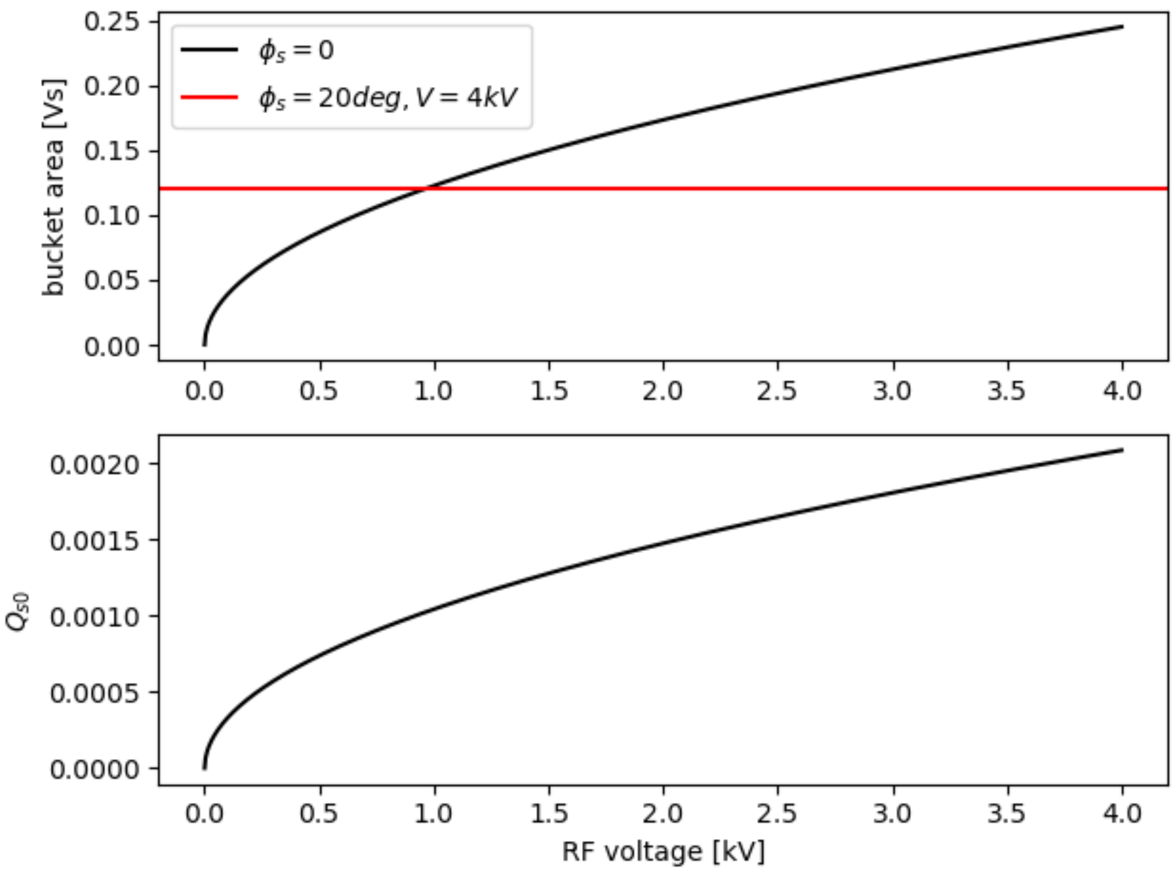


Start of ramp, V_0 = 4kV
T_s range: 495-647 turns



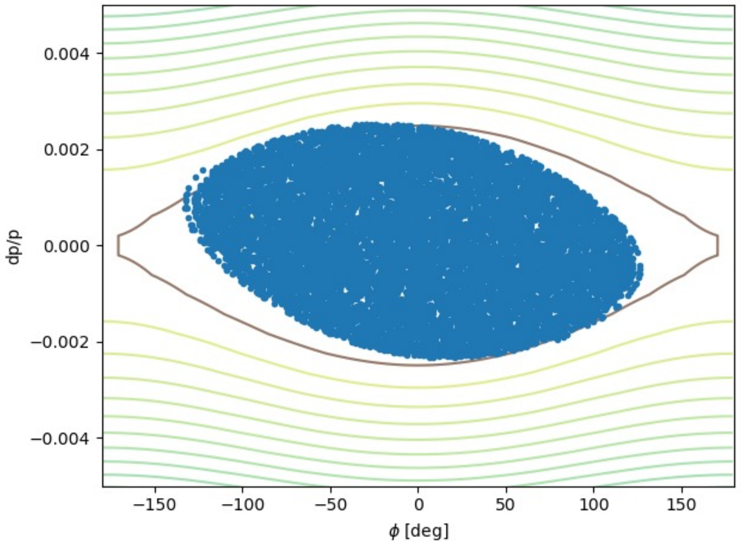
End of ramp, V_0 = 2kV
T_s range: 680-843 turns

Bucket area & tune dependence on final voltage

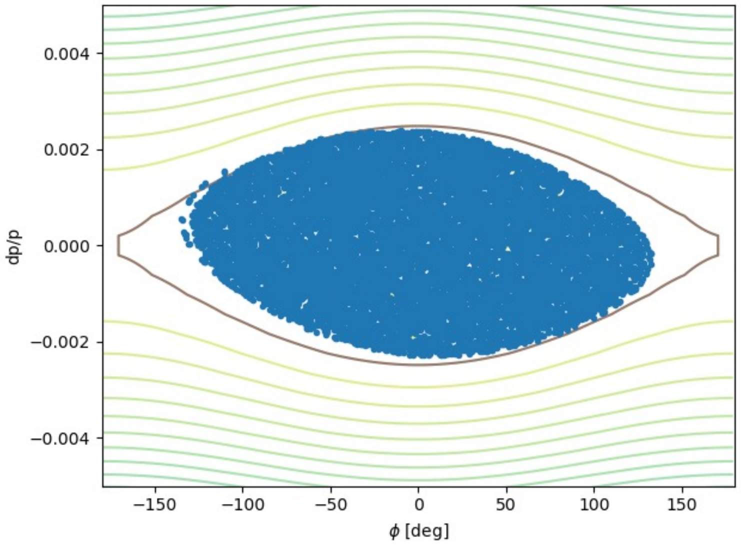


Reduce RF voltage to 0.9kV

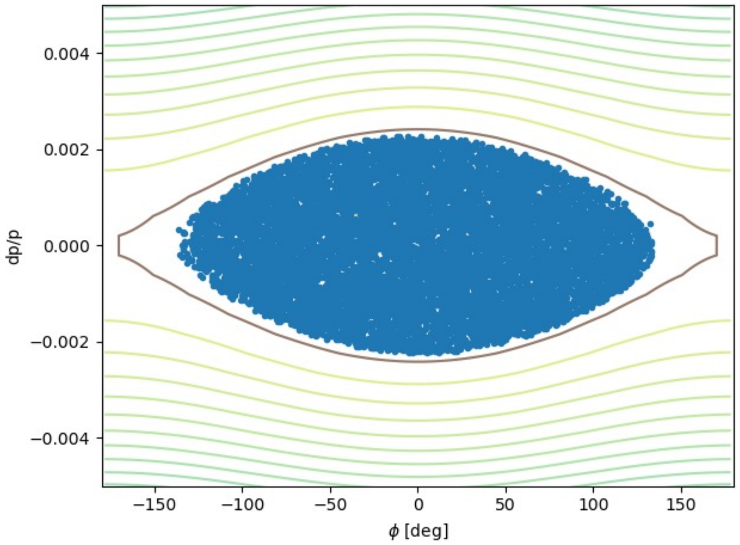
Bucket area at start & end of ramp: 0.12Vs & 0.117 Vs
Synchrotron period at end of ramp: 1018



ramp turns: 675
ramp turns: 0.2ms

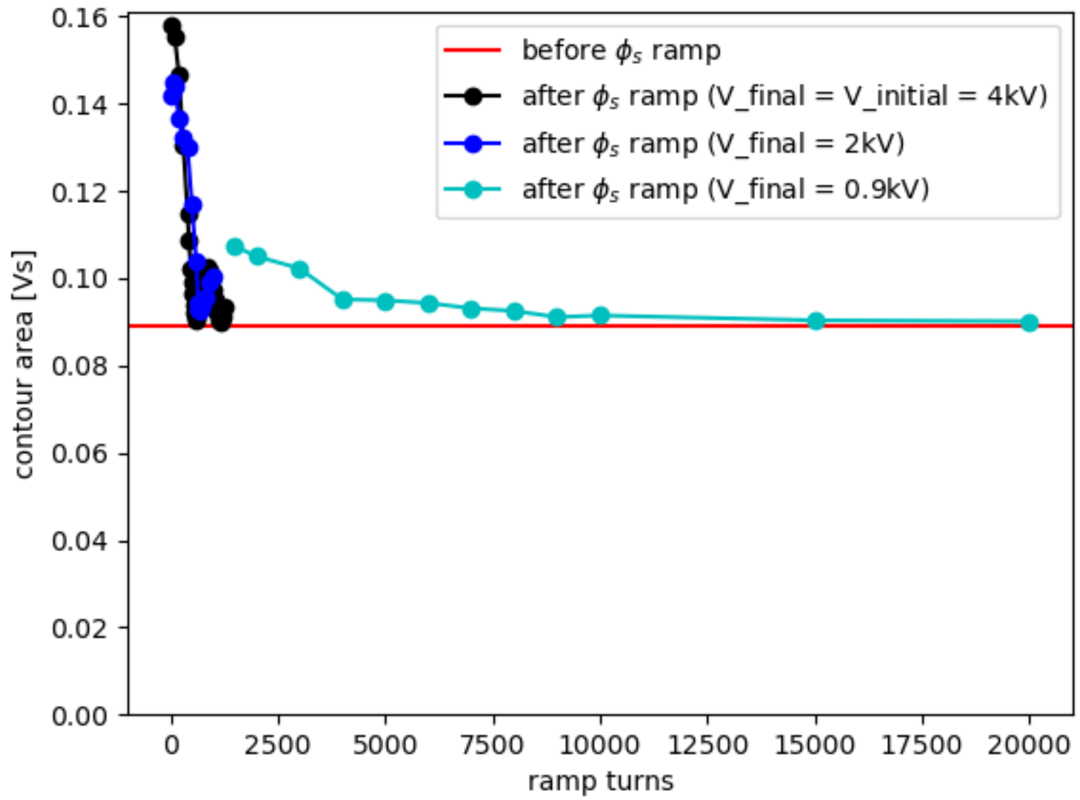


ramp turns: 1500
ramp turns: 0.5ms



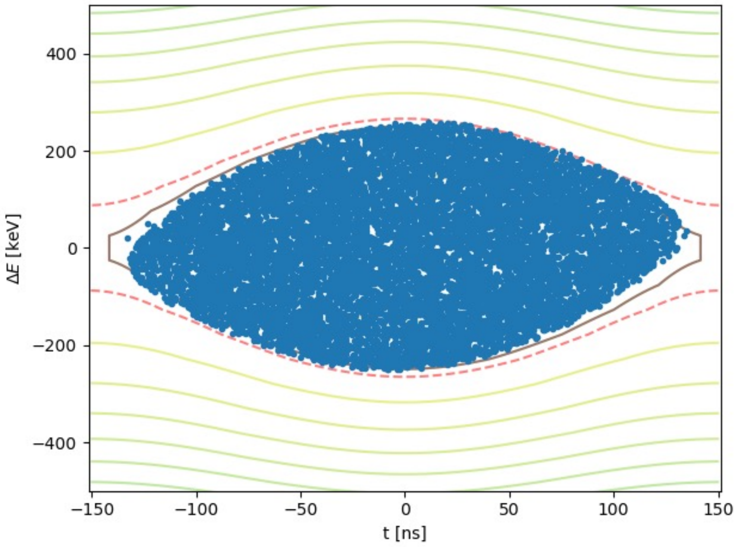
ramp turns: 10000
ramp time: 3.1ms

Emittance vs ramp turns

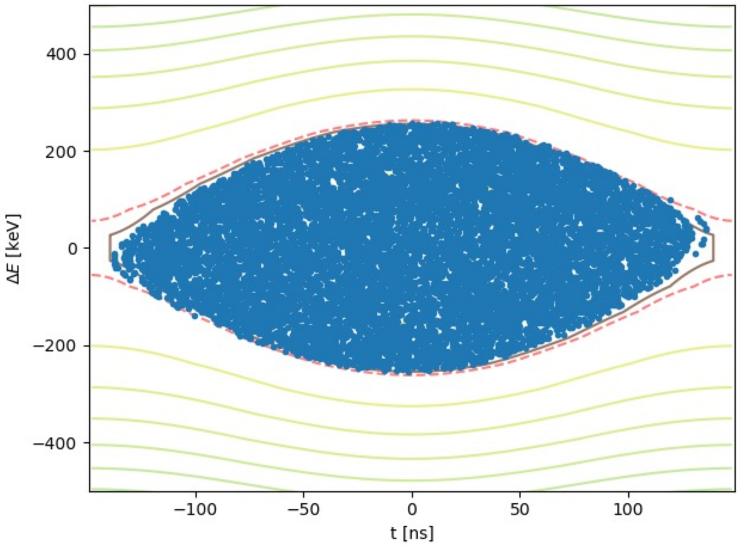


Reduce RF voltage to 0.6kV

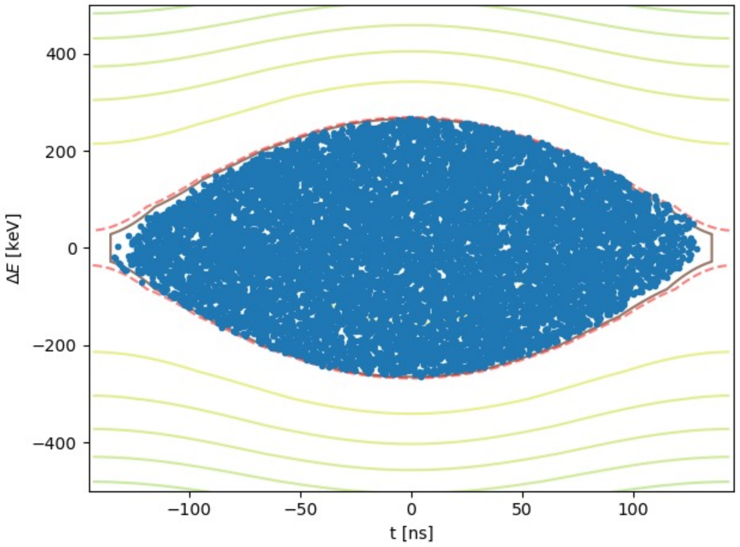
Bucket area at start & end of ramp: 0.12Vs & 0.096 Vs
Synchrotron period at end of ramp: 1267



ramp turns: 5000
ramp time: 1.6ms



ramp turns: 10000
ramp time: 3.1ms



ramp turns: 20000
ramp time: 6.0ms

Emittance evolution example

- Phase 1: Linearly decrease ϕs from 20 degrees to zero in 10,000 turns. At the same time linearly decrease voltage from 4kV to 0.9kV.
- Phase 2: Linearly decrease voltage to zero in 5000 turns.