

Booster Subharmonic RF Capture

- Direct Linac to Booster Injection Benefits:
 - Direct injection eliminates PAR.
 - Subharmonic cavity allows efficient capture of long linac macropulses produced by the RF Guns.
 - Subharmonic capture makes any bunch cleaning required much easier.
 - Compatible with future booster upgrades (stacking for more uniform top-up, stored beam).
- Costs:
 - New subharmonic cavity(ies)/amplifier/low-level RF system required in the booster.

Design Goals:

- Keep booster magnet ramps the same (linear).
- Keep 325 MeV injection energy the same.
- Subharmonic rf system is powered at a constant level for the complete booster cycle.
- Determine 352 Mhz system phase and ramp profile to efficiently capture and bunch the beam at ~ 3 GeV and accelerate to 7 GeV.
- Subharmonic rf system frequency low enough to capture the complete rf gun 2 beam (~ 10 ns).

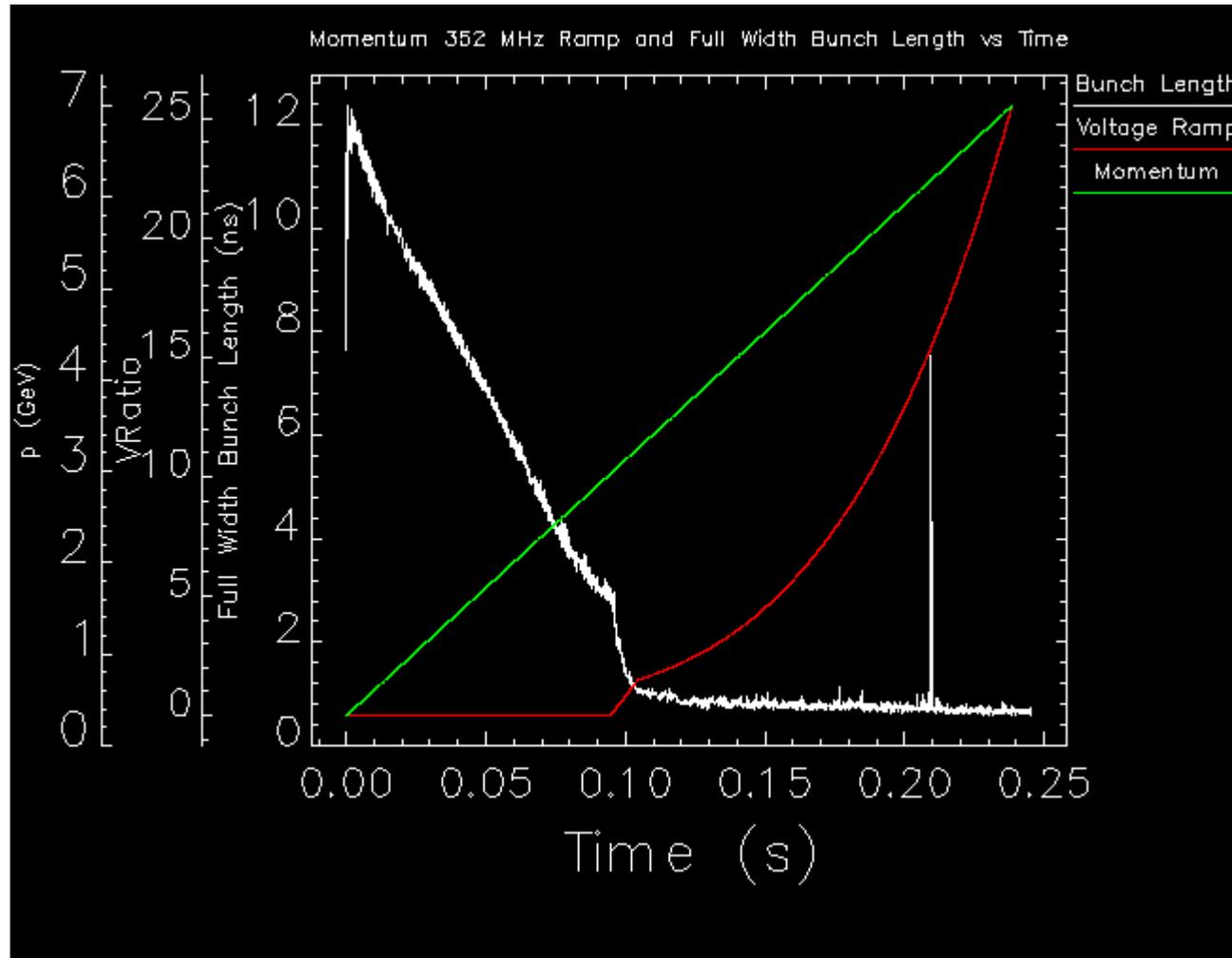
Capture Process:

- Linac macropulse is captured with the subharmonic system powered at a constant level.
- When the bunch is short enough, turn on the 352 Mhz system at the appropriate phase to accelerate and further bunch the beam.
- Adjust 352 Mhz ramp parameters to minimize beam loss (and adjacent bunch capture) at turn on.

Elegant Simulation Parameters

- Subharmonic Frequency - 8th, 9th and 12th subharmonics of 352 MHz (43.99, 39.10, 29.33 MHz)
- Gap Voltage - 350 kV for 8th and 9th, 375 kV for 12th.
- Beam loading due to 352 Mhz cavities included
 - Shunt impedance - 221 MOhms
 - $Q = 20000$
- 10000 particles 13.4 ns linac macropulse length FW (verify bunch purity). $dp/p = +/-1 \%$

Graph of Momentum, 352 Mhz system voltage ramp, and bunch length from elegant simulation.



Continuing Studies

- Optimize 352 Mhz system ramp parameters to allow a lower gap voltage for subharmonic cavity
- Study linac injection and bunch capture sensitivity to subharmonic amplitude and 352 MHz ramp parameters.
- Compare elegant simulation to analytical phase space contour computation based on difference equation of motion and energy equation.