

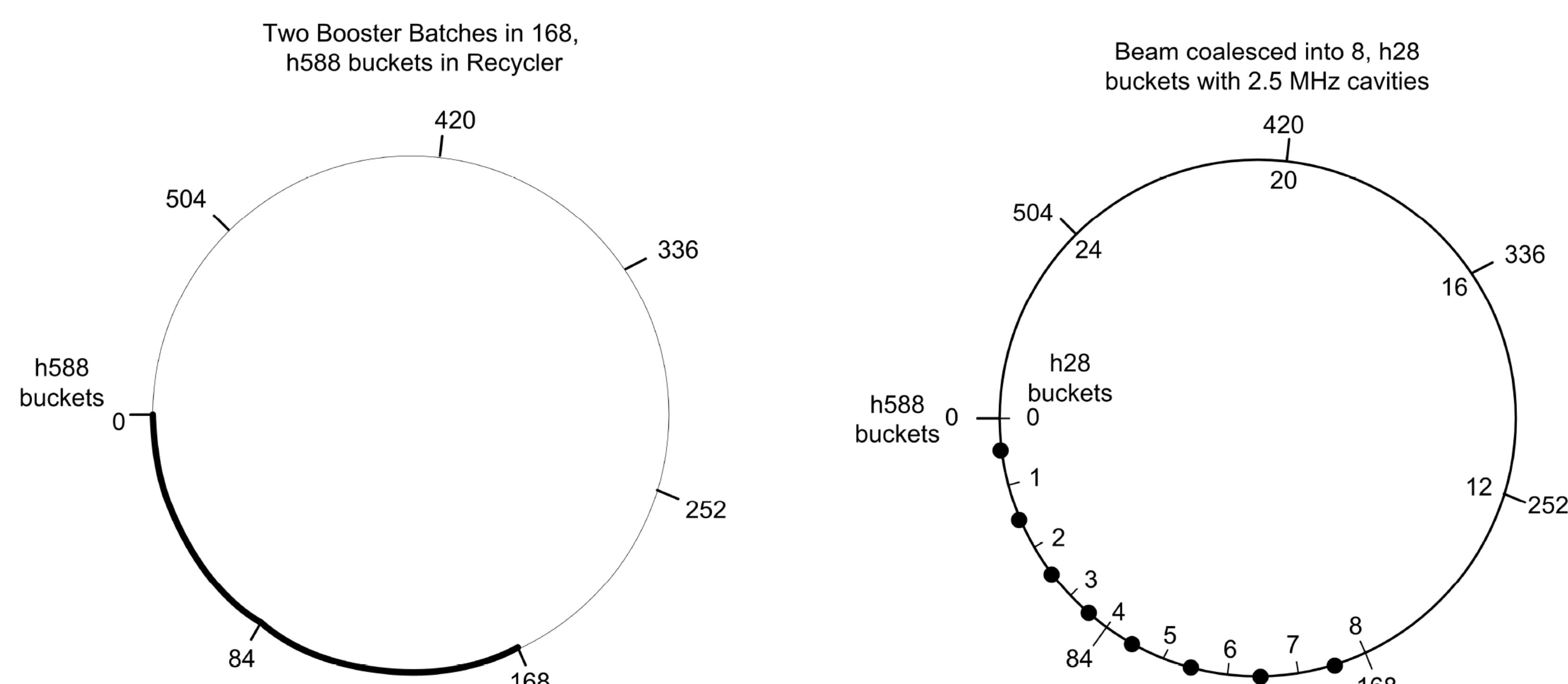
LLRF System for the Fermilab Mu2e Project – AC Dipole Extinction

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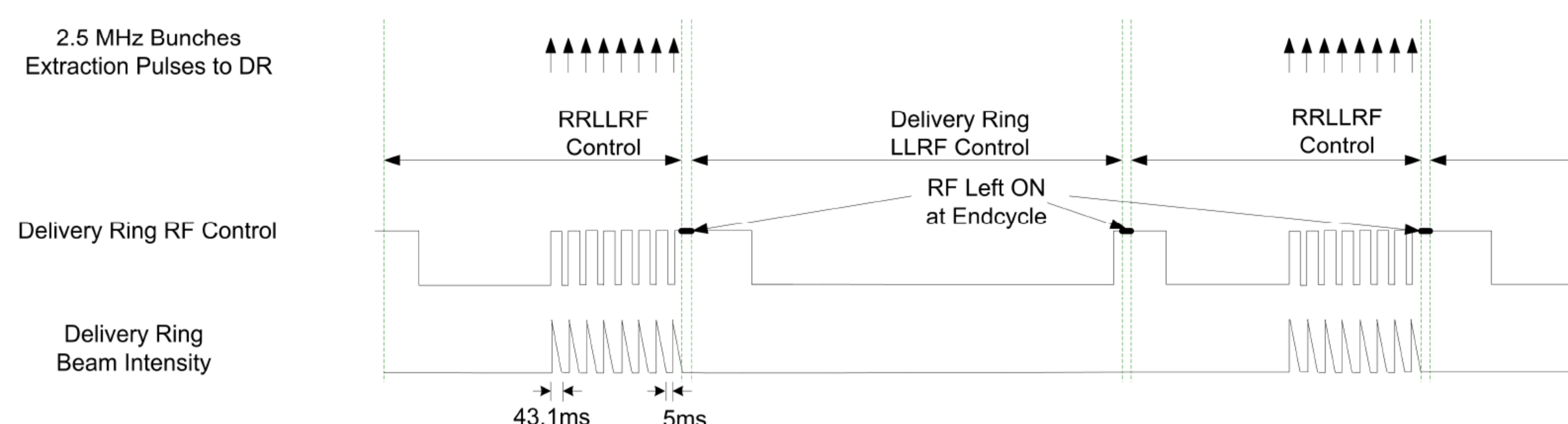
Introduction

The Mu2e experiment measures the conversion rate of muons into electrons. The experiments requires 53 MHz batches of 8 GeV protons to be re-bunched into 150 ns, 2.5 MHz pulses for extraction to a single RF cavity running at 2.36 MHz. To meet stringent limits on the amount of beam between pulses, an Extinction System is used comprising of 2 AC dipole magnets (4.4MHz, 296Khz) and a collimator.

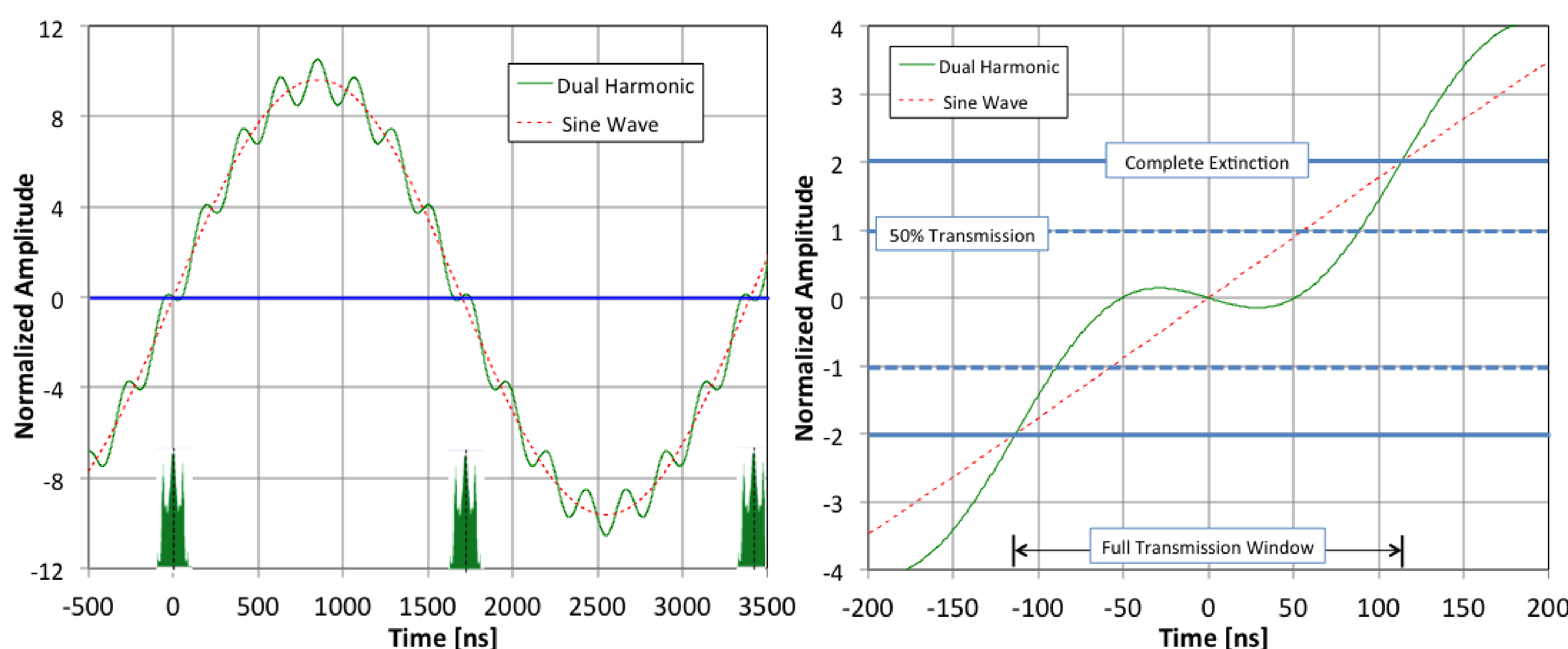
Booster to Recycler Ring



Recycler Ring to Delivery Ring

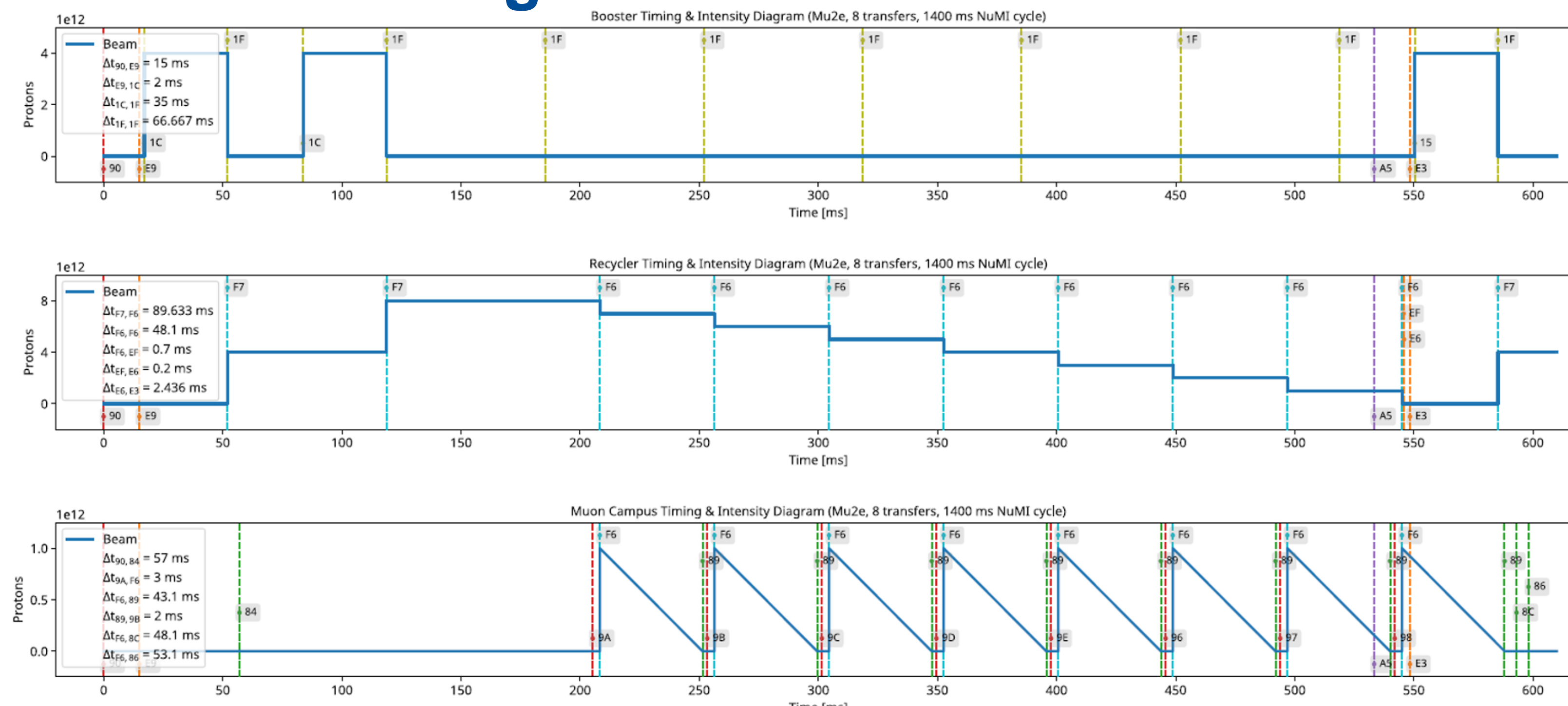


AC Dipole driven by dual harmonic

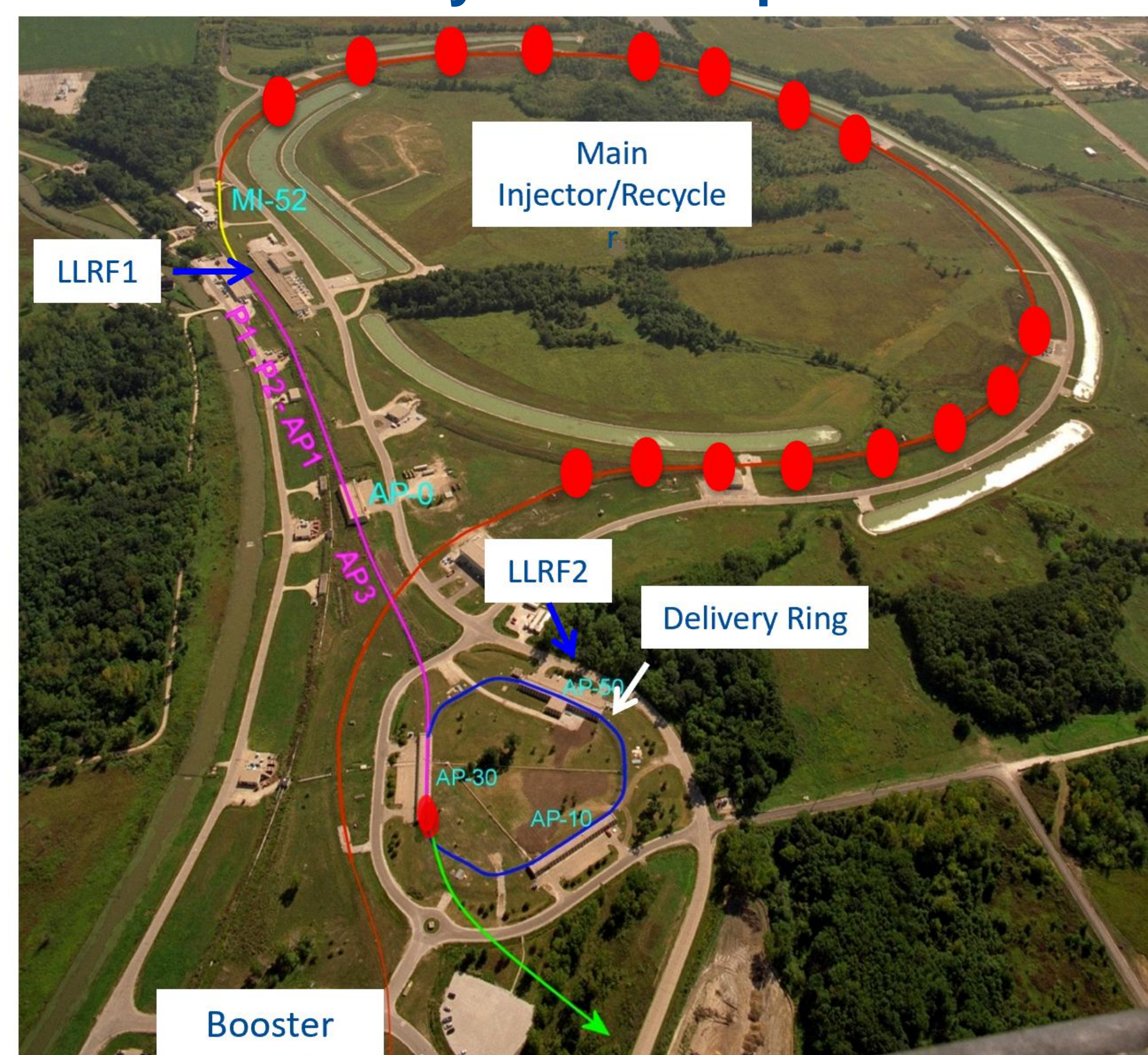


- Extinction of out-of-time protons is necessary to eliminate radiative pion capture, ensuring accurate measurement.
- The 295KHz AC Dipole is set to 1/2 of the Delivery Ring revolution frequency (590kHz) revolution frequency and ensures all out-of-time protons receive a kick.
- The 4.4MHz AC Dipole is set to the 15th harmonic and is used to flatten/extend the zero-cross portion of the waveform.

Mu2e Timing



Location of RF system components

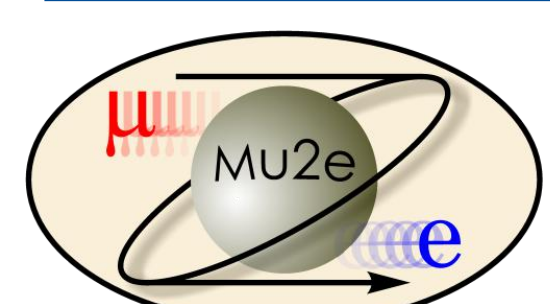


LLRF Requirements

- 8/21 booster cycles in machine cycle used to provide beam to Delivery Ring
- Two batches are captured in 53 MHz buckets. 53 MHz RF is ramped off and 2.5 MHz RF is ramped to 80 kV over 90ms
- 8, 2.5 MHz bunches are transferred - one bunch at a time to the Delivery Ring for resonant extraction to the Muon Target.
- Delivery Ring RF frequency of 2.36 MHz is non-harmonically related to the RR 2.5 MHz.
- 295KHz and 4.4MHz phase signal in sync with the Delivery Ring RF.

Summary

- Delivery Ring LLRF and the Recycler 2.5 MHz LLRF systems are implemented in an upgraded SoC FPGA card located in the same VXI crate as the Recycler 53MHz LLRF system
- The Mu2e Extinction task requires an additional LLRF chassis to provide feedback control signals to the 295KHz and 4.4MHz AC dipole magnets power supplies.



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