

# LLRF System for the Fermilab Muon g-2 and Mu2e Projects

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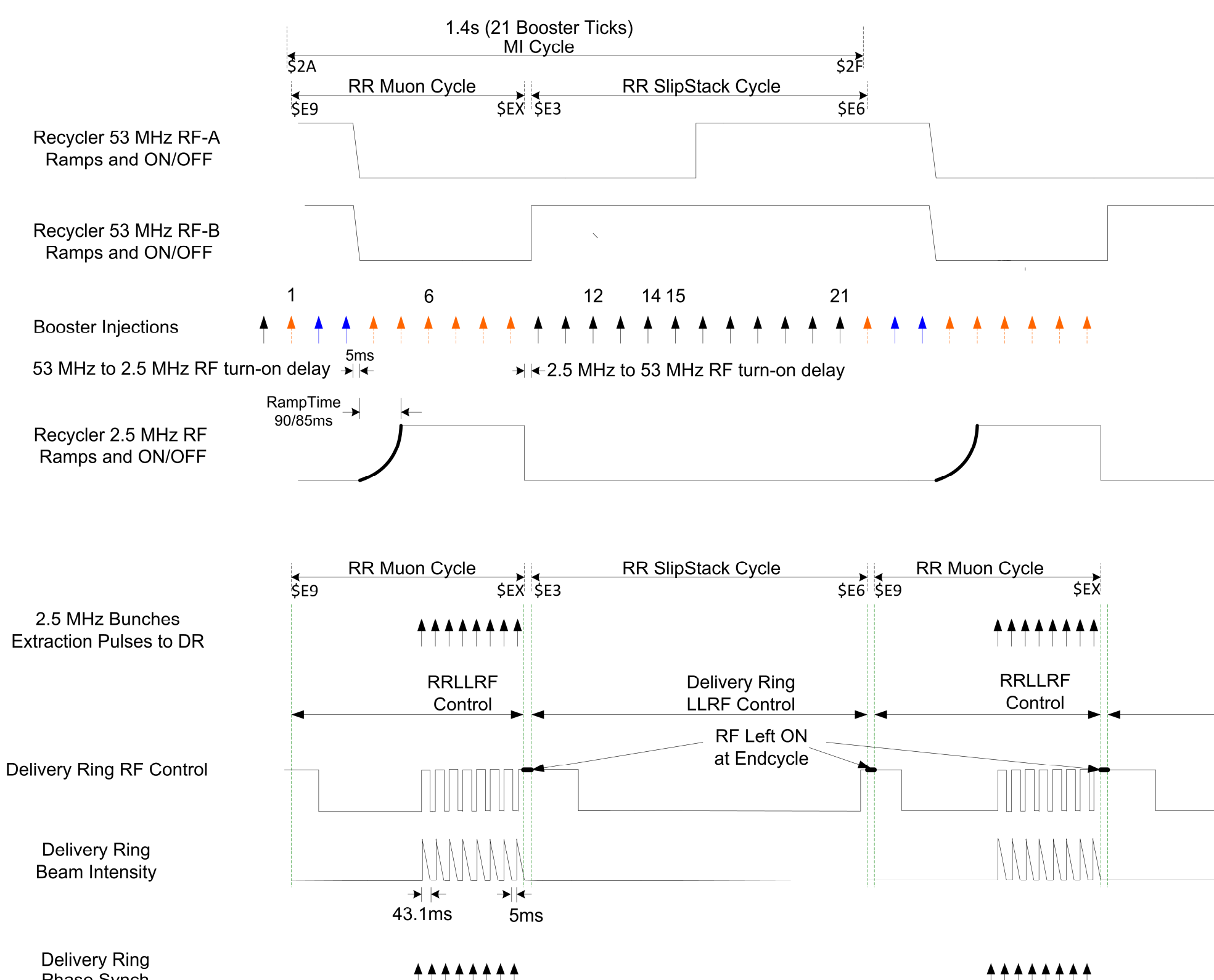
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## Introduction

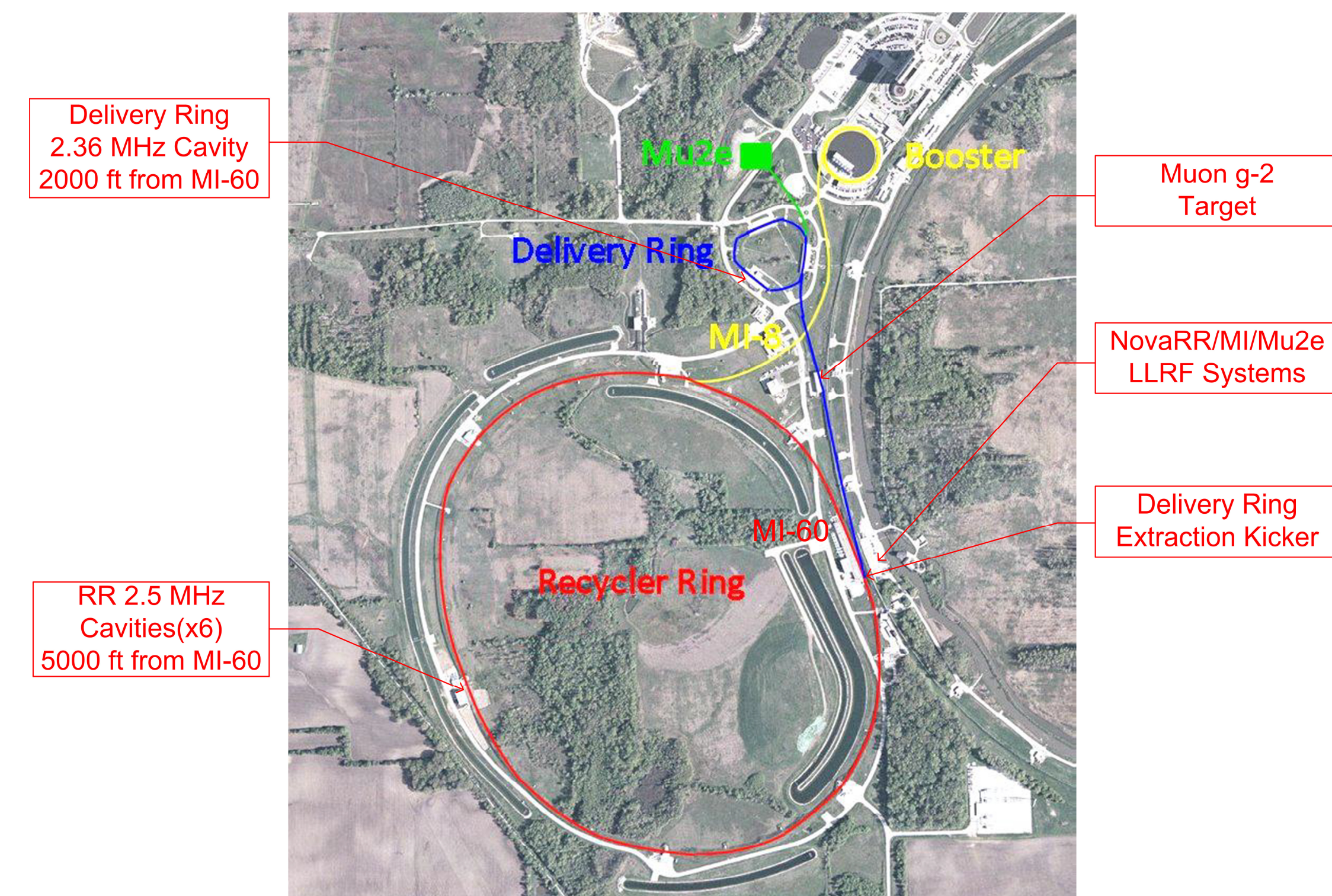
The Mu2e experiment measures the conversion rate of muons into electrons and the Muon g-2 experiment measures the muon magnetic moment. Both experiments require 53 MHz batches of 8 GeV protons to be re-bunched into 150 ns, 2.5 MHz pulses for extraction to the g-2 target for Muon g-2 and to a delivery ring with a single RF cavity running at 2.36 MHz for Mu2e.

## Nova/Mu2e Timeline

- 53 Mhz RF linearly ramped down over 5 ms interval
- 2.5 Mhz RF ramped adiabatically from 3 – 80 kV over 90 ms for coalescing
- 2.5 Mhz and 53 Mhz RF buckets are realigned each machine cycle



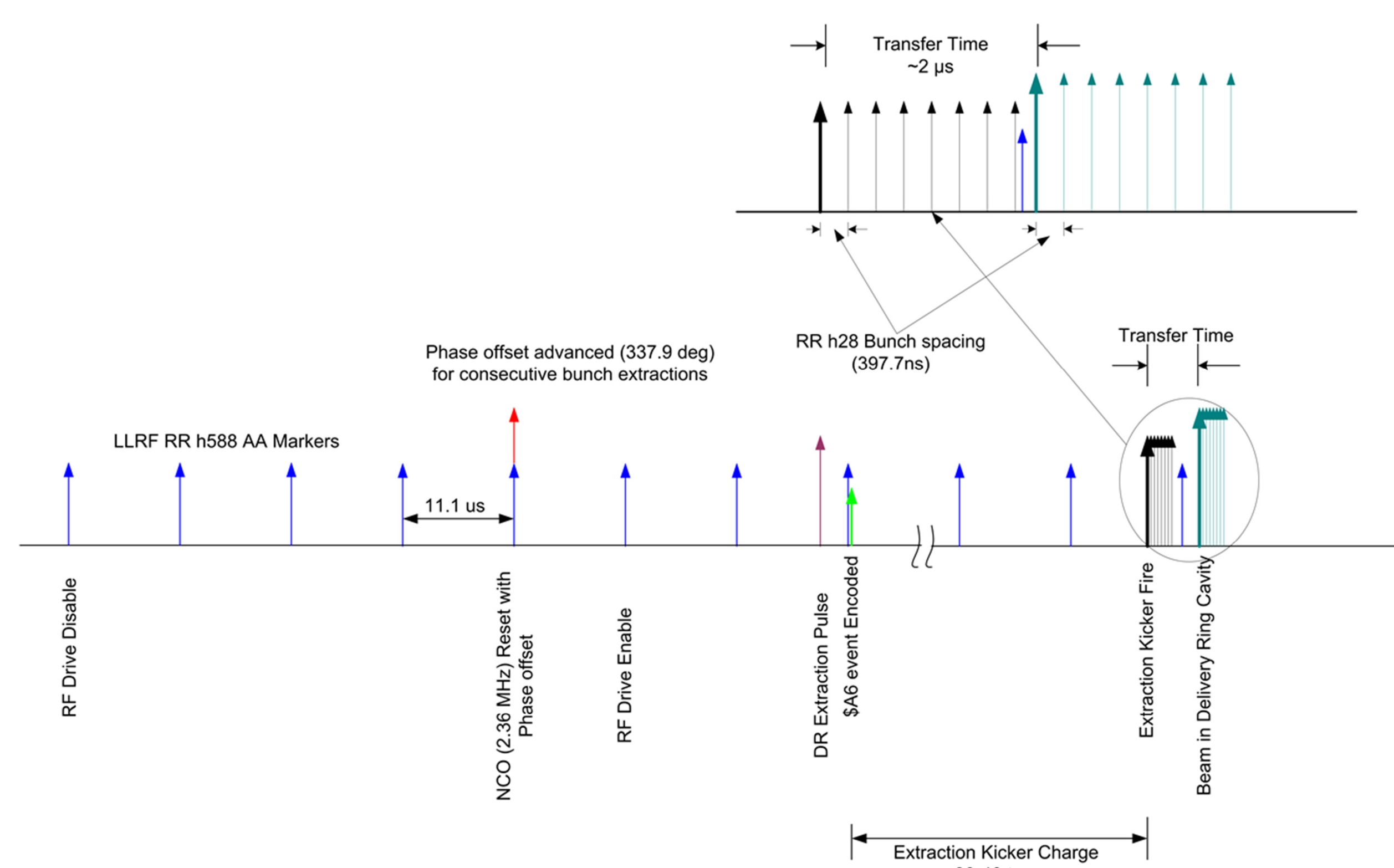
## Location of RF system components



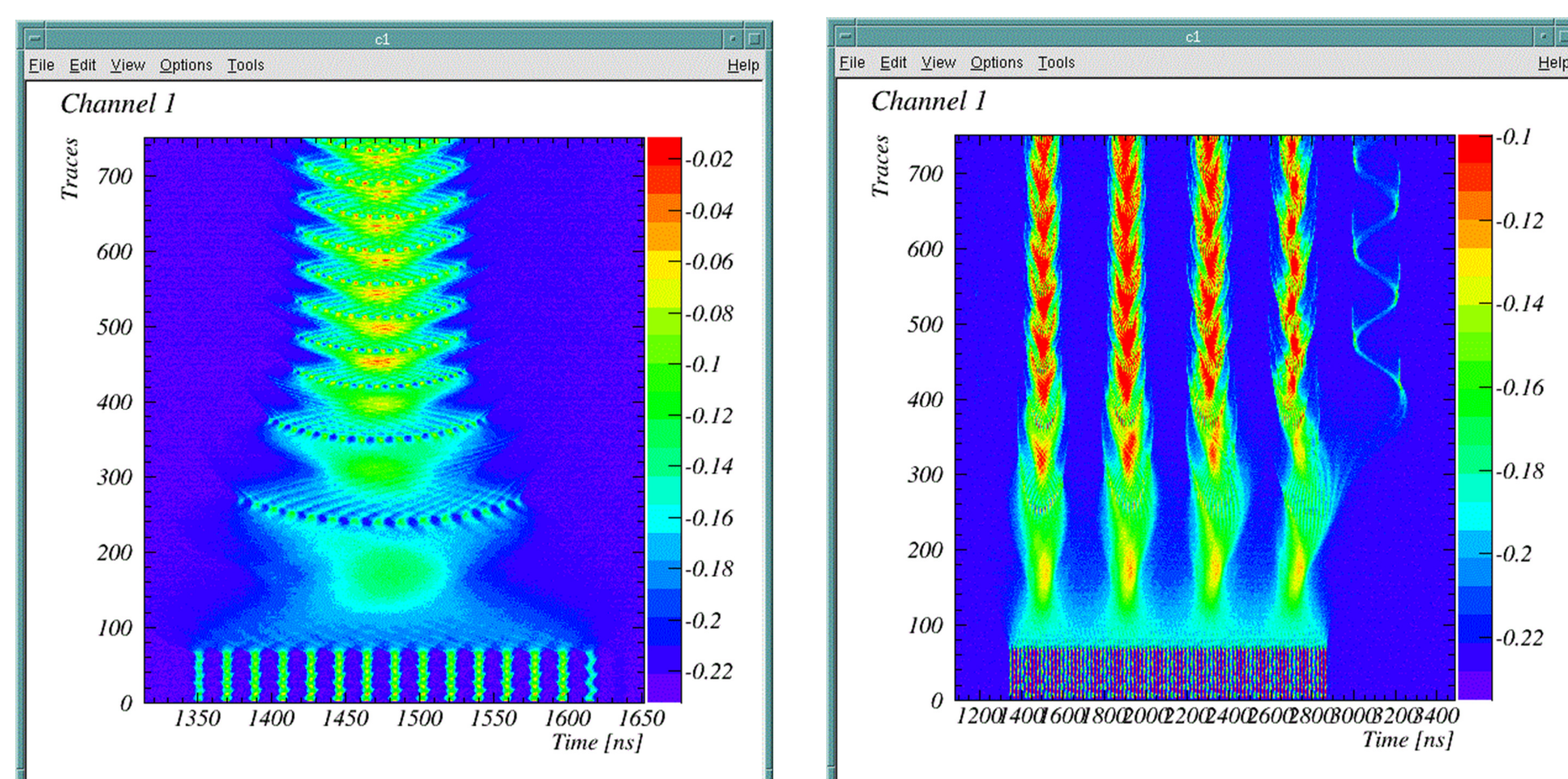
## LLRF Requirements

- 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 Muon Target
- Delivery Ring frequency of 2.36 MHz is non-harmonically related to the RR 2.5 MHz.

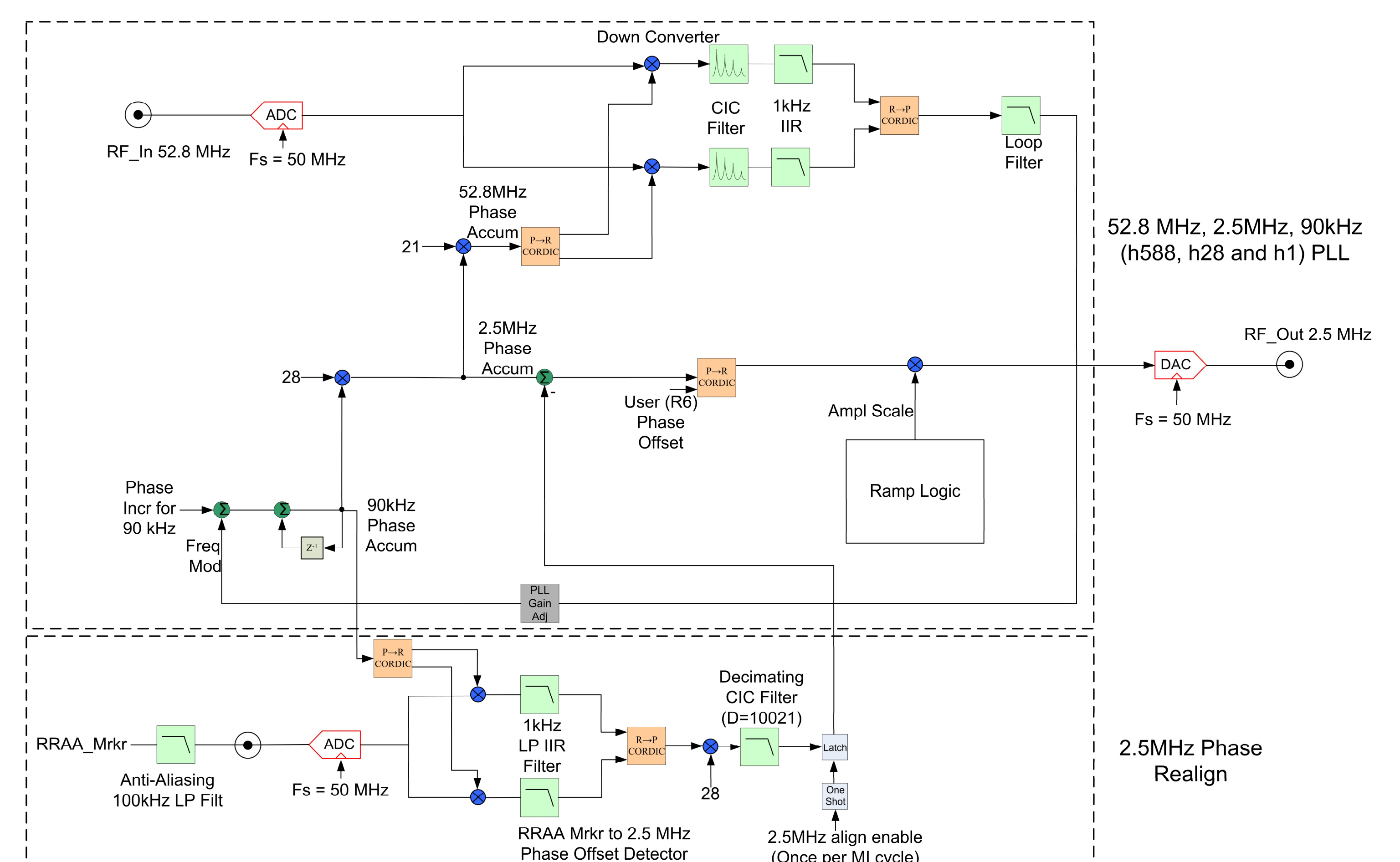
## Beam Transfer Timing with Phase Alignment



## Beam Coalescing

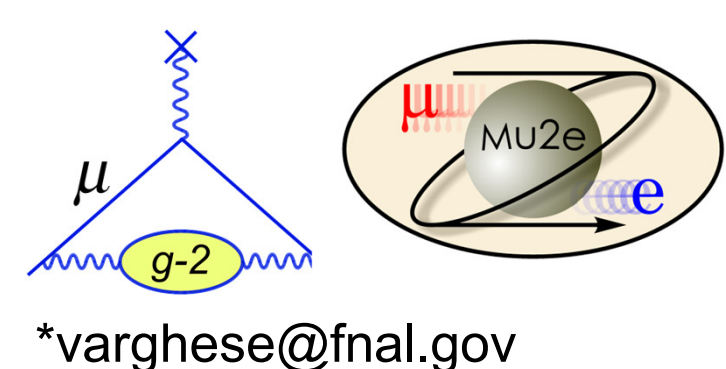


## Digital PLL with Phase Alignment for 2.5 MHz RF



## Summary

- Delivery Ring LLRF and the Recycler 2.5 MHz LLRF systems are implemented in one SoC FPGA card located in the same VXI crate as the Recycler 53MHz LLRF system
- The Recycler 53MHz, Recycler 2.5 MHz and Delivery Ring LLRF systems are tightly integrated allowing for various operational sequences to be supported.



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