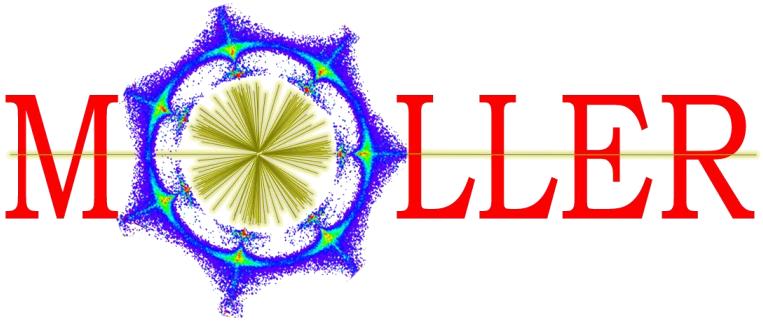
CEBAF with Low Frequency Beam

Effect of Low Frequency Beam
to Hall D on MOLLER



Summary and action items in green

Accelerator Division

March 27, 2023

Running 4-Halls during Moller and K_L

- Hall A (MOLLER):
  - 0.26 pC @ 249.5 MHz (4 ns, 65 μA average beam current) at 11 GeV
- Hall B:
  - 0.002 pC @ 249.5 MHz (4 ns, 50 nA average beam current)
- Hall C:
  - 0.12 pC @ 249.5 MHz (4 ns, 35 μA average beam current)
- Hall D (K_L):
  - 0.32 pC @ 15.6 MHz (64 ns, 5 μA average beam current)

Issues

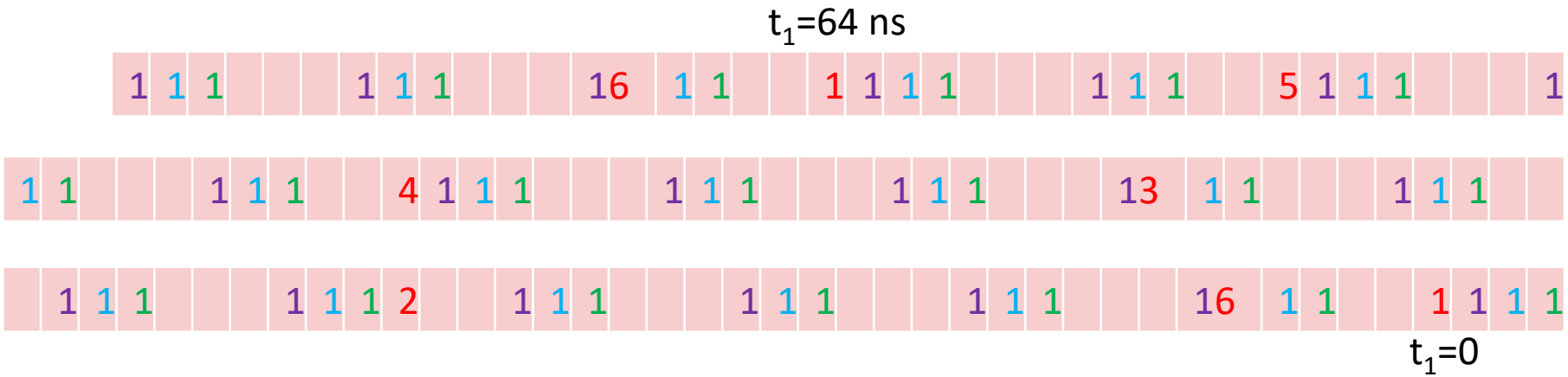
- Issues:
  - I. How would the RF system respond to such current variations? Sub-harmonic Beam loading in Buncher and SRF cavities in Linacs?
    - Any changes to beam properties (e.g., energy spread)? **Expected to be at 10^{-6} level in SRF cavities. Buncher cavities will be modeled and tested with beam**
  - II. Injector optimization for parity-quality-beam (transmission and Wien Flip) vs K_L? **Will be studied with beam**
  - III. How would the photocathode respond to such current variations?
    - Is there any time dependency in QE or polarization? **Will be studied with beam**
- Experience: G0 Forward in Hall C (2003 – 2004)
  - 1.28 pC @ 32 MHz (32 ns, 40 μA), 3rd pass (3.0 GeV)
  - Note that this was the parity-violation experiment

Time Structure in North Linac

- 64 ns pulse interval is 96 RF cycles of 1497 MHz (0.668 ns) cavity frequency
- Beam Bunches:
  - **MOLLER**
  - **Hall B**
  - **Hall C**
  - **K_L**

First Pass	1
Second Pass	2
Third Pass	3
Fourth Pass	4
Fifth Pass	5
$5\frac{1}{2}$ Pass	6

Region	RF Cycles	MOD(6)	MOD(128)
1L→3L	6554	2	26
3L→5L	6549	3	21
5L→7L	6547	1	19
7L→9L	6546	0	18
9L→BL	6545	1	17



*Showing only first pass for MOLLER and Halls B and C

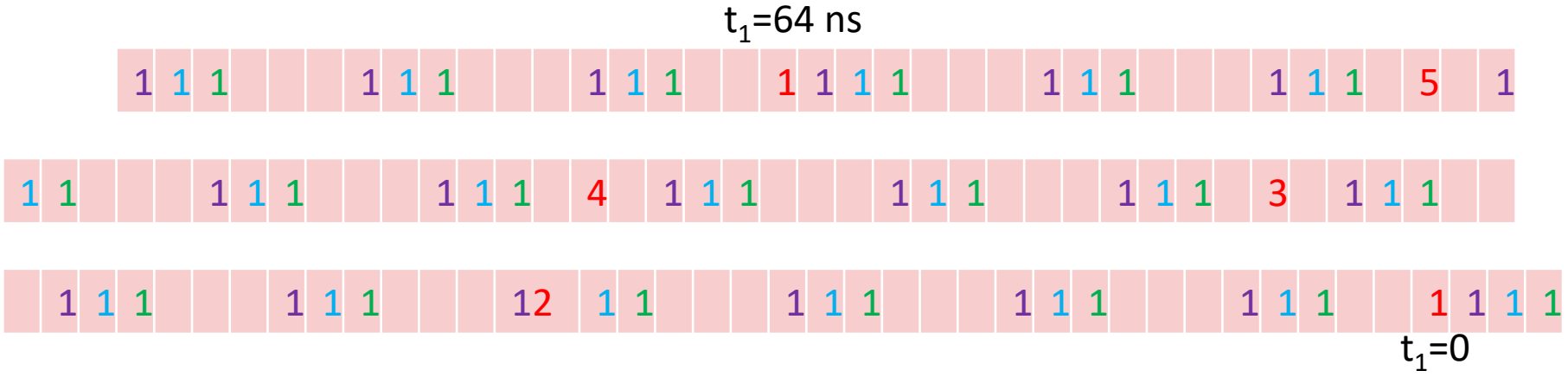
Jefferson Lab

Time Structure in South Linac

- 64 ns pulse interval is 96 RF cycles of 1497 MHz (0.668 ns) cavity frequency
- Beam Bunches:
  - **MOLLER**
  - **Hall B**
  - **Hall C**
  - **K_L**

First Pass	1
Second Pass	2
Third Pass	3
Fourth Pass	4
Fifth Pass	5

Region	RF Cycles	MOD(6)	MOD(128)
2L→4L	6551	5	23
4L→6L	6548	2	20
6L→8L	6546	0	18
8L→AL	6546	0	18



*Showing only first pass for MOLLER and Halls B and C

Jefferson Lab

Plan

- Questions to answer:
  - Impacts of delivering K_L beam in accelerator?
  - Are there conflicts between K_L and MOLLER?
- **How to test RF issue?**
  - **Can RF be sufficiently modeled? Yes. Who will do this?**
  - **Beam test in Injector**
- **Photocathode effects require beam testing**
  - **Install new Hall D Fiber Laser Amplifier with RF**
  - **Hall D at 15.6 MHz to inline dump**
  - **Beam test in Injector**
- **Conclusion – we need to perform beam studies:**
  - **CIS/RF to generate K_L beam**
  - **INJ setup to in-line dump**
  - **MOLLER/Injector/CIS to characterize beam properties**