Fast Grid Pulse Modulation

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Purpose of Pulse Modulator

- Electron gun operates in same manner as a vacuum tube triode
- Pulse modulator will control the duration and amount of electron beam current by applying voltage to the grid
- HeatWave gun will be operated near -2KV with 600V square pulses.
Transformer Core Properties

There are two ways to avoid core saturation. The core can be biased to the negative saturation region with a DC source. Alternatively, each square pulse may be followed by an equal and opposite negative pulse to reset the core.
With active reset of the core, two switching circuits are attached to the primary side of the transformer. The core is pulsed with a positive voltage, then an equal and opposite voltage.
The purpose of an inductive adder is to sum voltages while maintaining a rapid rise and fall time.
Overall Pulse Form

Option 1: Active Core Reset

\[ V_{12} = V_1 - V_2 \]

\[ V_{34} = V_3 - V_4 \]

\[ V_{OUT} = V_{12} + V_{34} \]

Option 2: Passive Core Reset

Overall pulse combines signal to reset core and inductive adder concept
Capacitors will be utilized with a 100-pulse burst to reduce power consumption to levels appropriate for the HeatWave gun.
**Initial Results**

**Test:** 50V input  
1 MHz Pulse  
100ns Width  
10 Hz Burst  
Without Snubber

**Notes:** The two issues here are the voltage overshoot and oscillations during and after the pulse.
Modified Circuit Results

Test: 50V input
1 MHz Pulse
200ns Width
100 Hz Burst
With Voltage Clamp

Notes: Adding voltage clamp and snubber capacitor provides a smoother output. Additional circuit design modification should further smooth out oscillations.
Conclusion Slide

• Inductive Adder concept is well established through testing at LLNL and University of Rochester
• This project is unique in that it utilizes the inductive adder concept for a gridded accelerator
• Main challenge removing ripples in the pulse waveform
• Next step is to develop a DC reset circuit