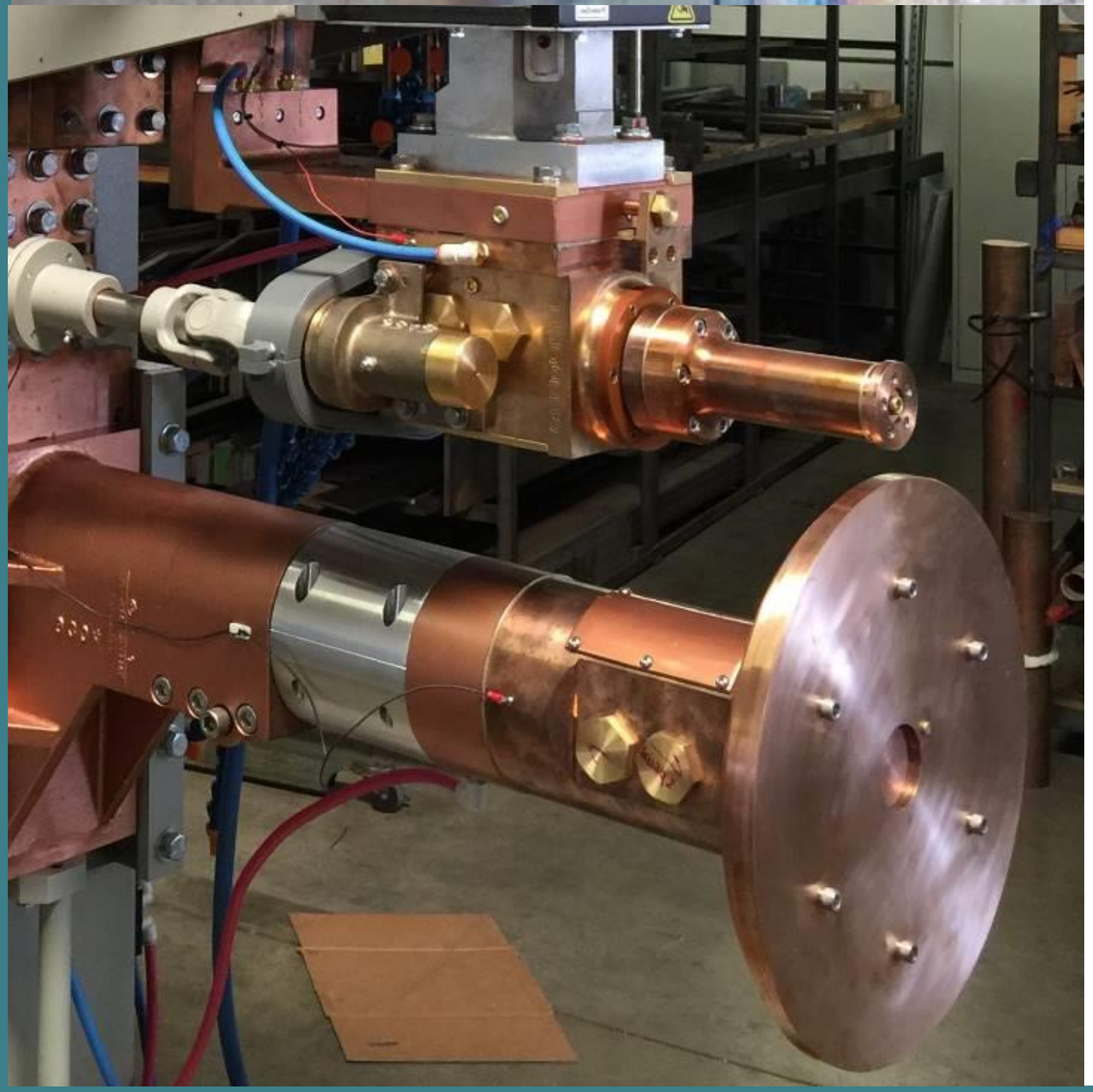


WeldComputer

The Technology Leader in Resistance Welding

Advances in Resistance Welding

How to Maximize Resistance Seam Welding Production Speeds and Improve Weld Quality

Bob Cohen
WeldComputer Corporation

How to Make a High Quality Seam

— Produce fully formed nuggets

— Free of expulsion

— For Gas Tight Requirements: Control spot spacing to make sure each nugget overlaps with the next

Use Right Machine and Control Setup for the Job

— Right material electrodes

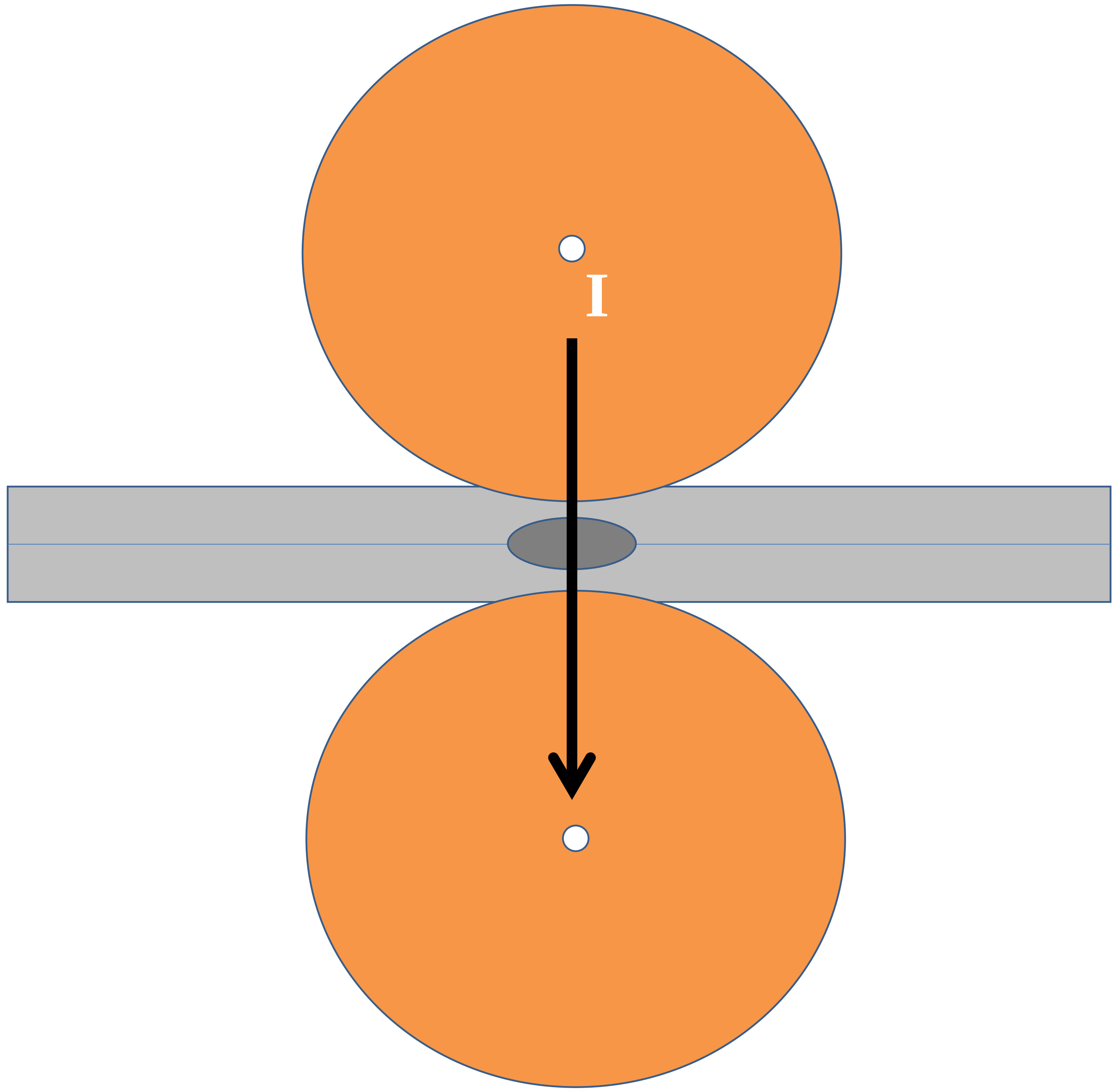
— Right electrode face diameter

— Apply right electrode force

— Apply the right current function

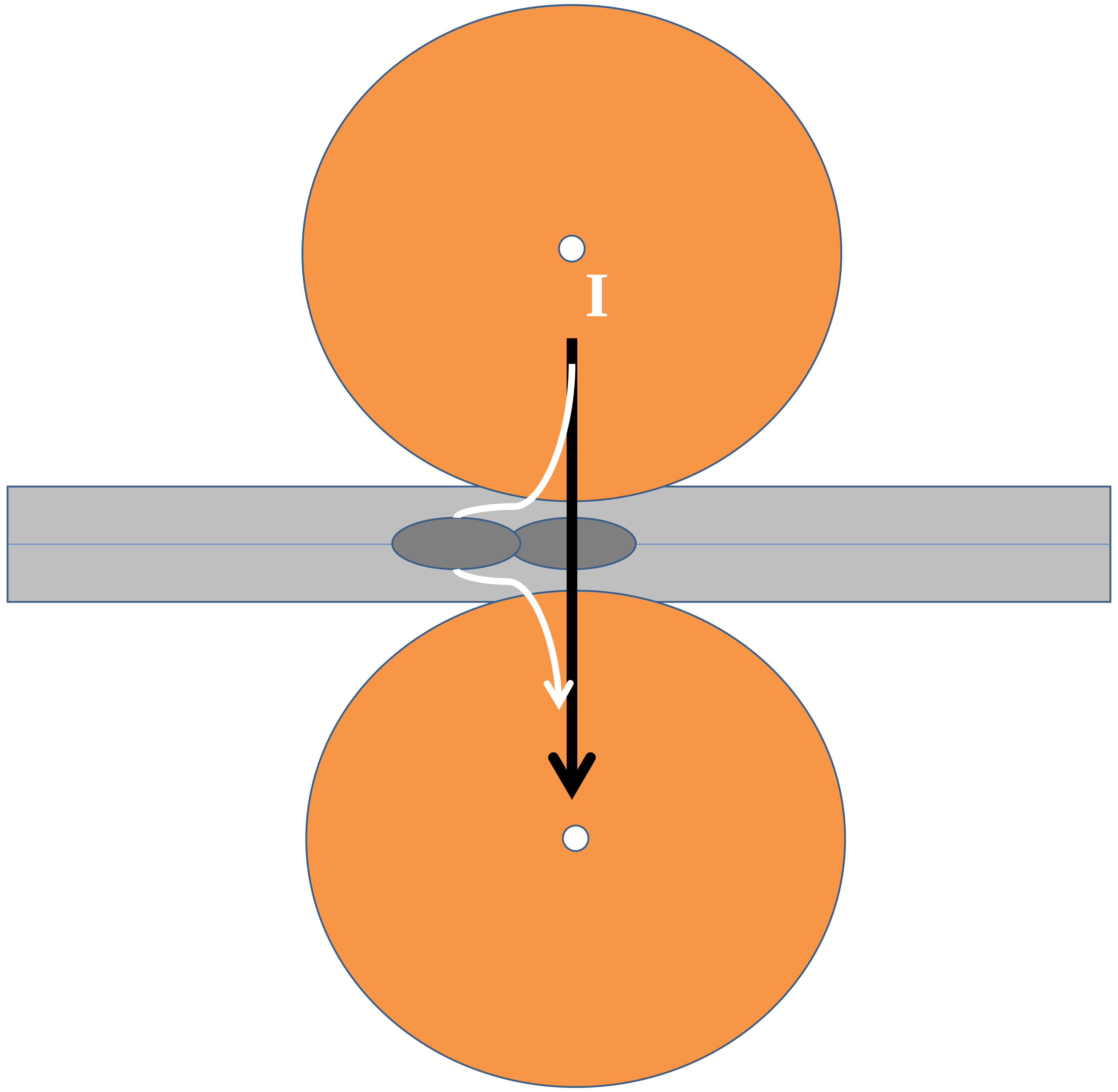
Seam Welding

Use right machine, control, electrodes, force & current to make weld.



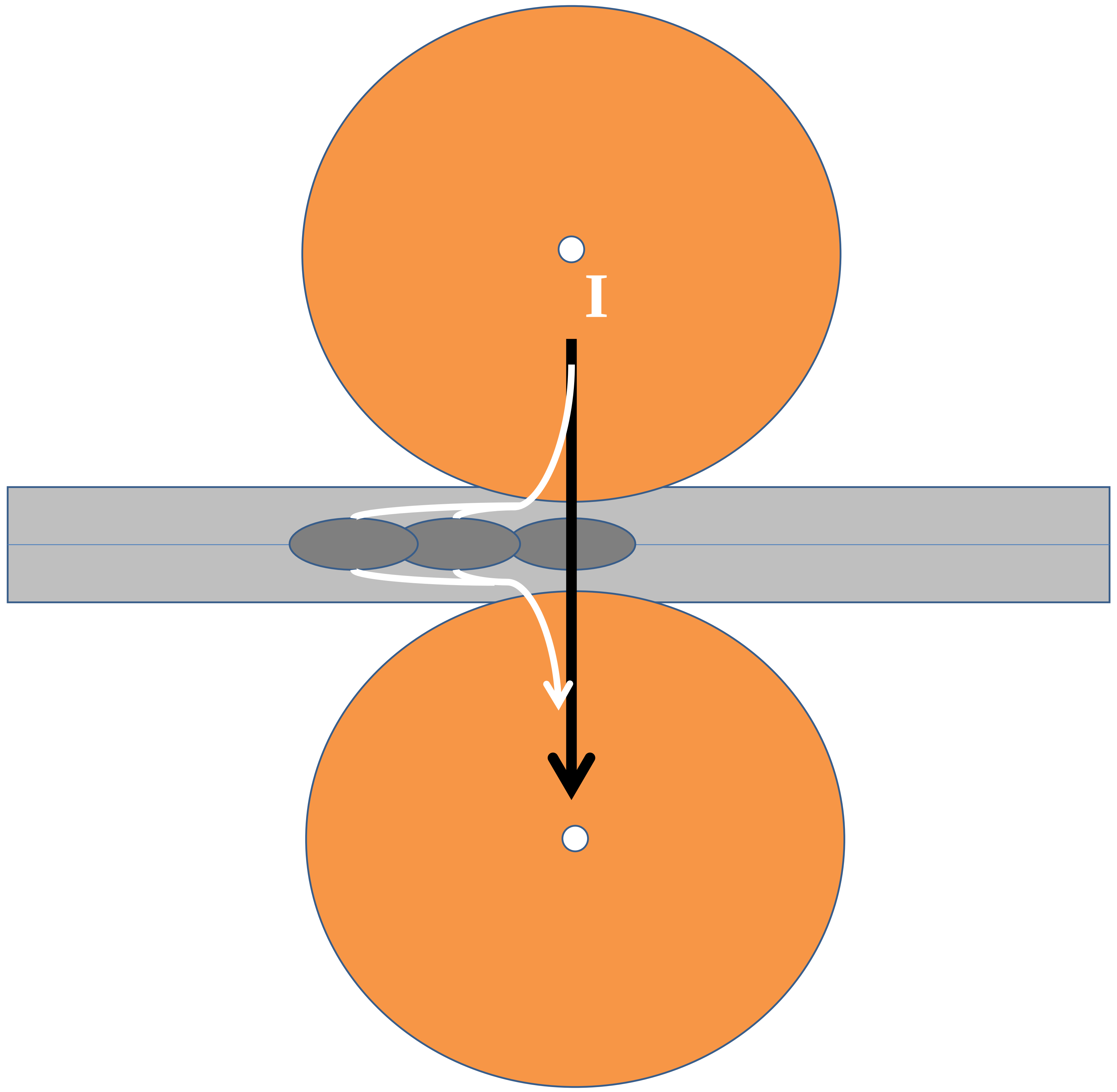
Seam Welding

2nd weld is smaller than 1st because some current shunts through 1st weld.



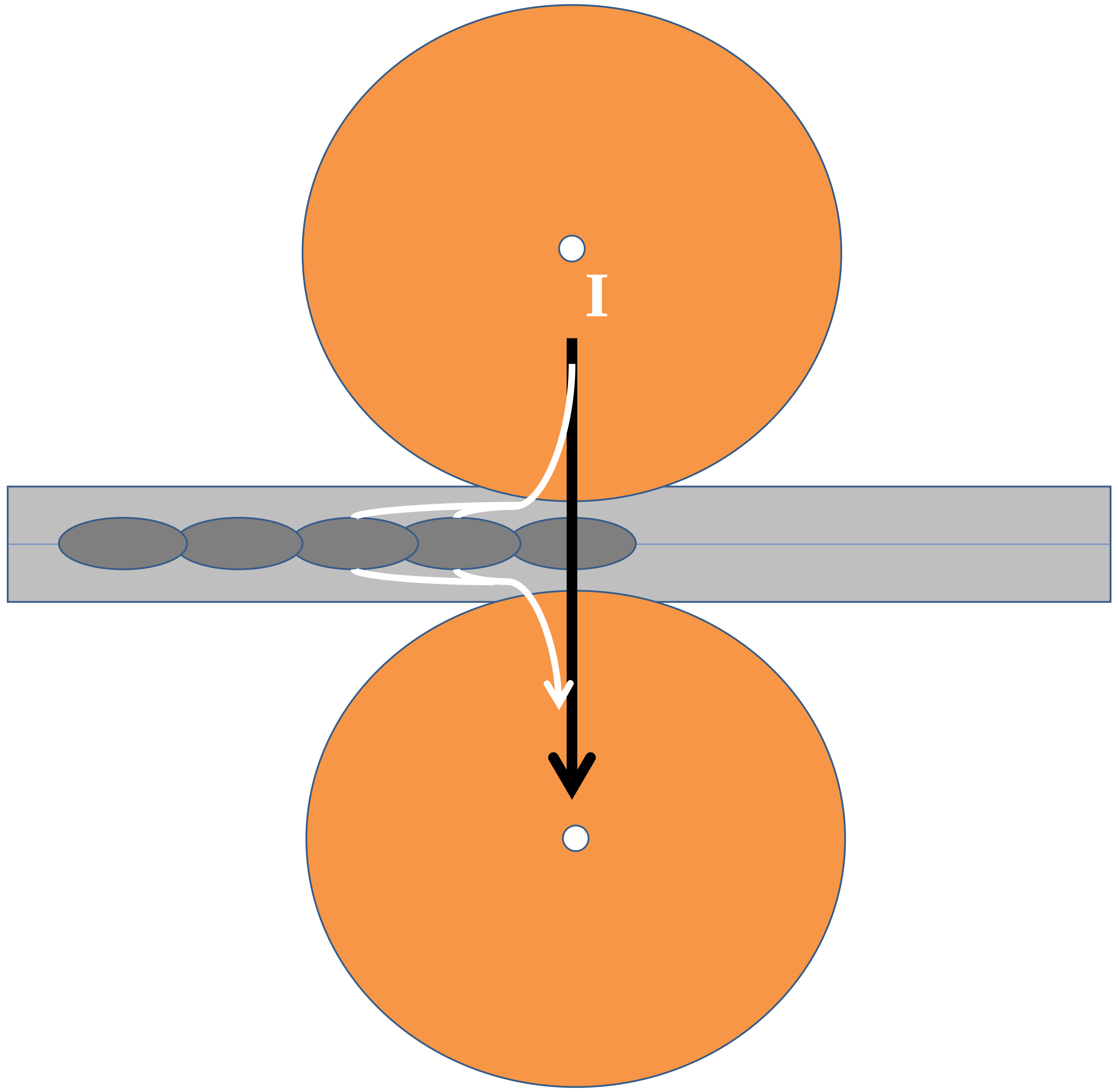
Seam Welding

3rd weld is smaller than 2nd because current shunts through 1st & 2nd welds.



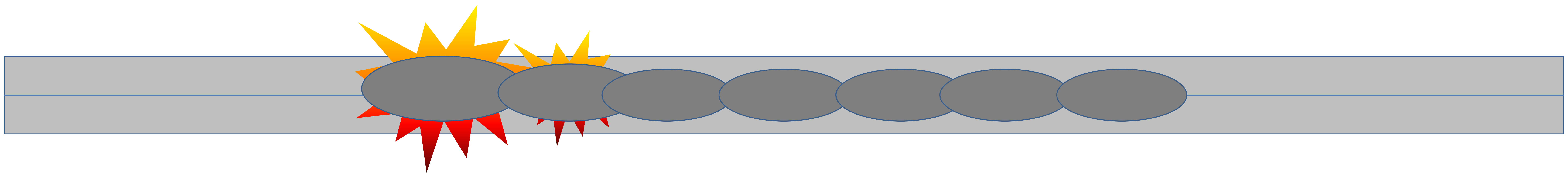
Seam Welding

Nugget size stabilizes for remaining welds in seam



Shunting

Shunting makes welds hotter at start of seam



Operations That Make All of These Welds with the Same Current Setting:

produce smaller nuggets than they really want throughout the entire length of the seam, in order to avoid having the first few welds on the seam be too hot and possibly expulse material,

or…

suffer from having the first few welds be too hot and expulse material, just so the rest of the welds in the seam are the size they want

Improve Weld Consistency by Managing Shunting at Start of Seam

— Separate heat setting for 1st spot

— Separate heat setting for 2nd spot

— Separate heat setting for remaining spots in seam

Problem: Multiple operator adjustments make process too complicated

Solution:

— Provide only a single "current adjustment" for the operator to adjust the main body welding current

— Program the control to automatically scale the heat of the 1st weld and 2nd weld, for the operator, in relation to the main body welding current adjustment that is made

— In a complex process with many parameters of control, this approach is necessary to make the process manageable by the operator

Intermittent (Roll Spot) Seam Welding

— Wheels stop to make each weld

— Welding precision is similar to spot welding. Control can take whatever time it needs to make a good weld

— This allows easy use of adaptive control to automatically correct problems like surface contamination and poor part fit-up, instantly cut off heat when expulsion occurs and automatically make a repair weld in place

— Production speed is primarily limited by how fast the wheels can be advanced to the next position and stopped so the next weld can be made

Continuous Seam Welding

— Wheels continue rolling while each weld is made

— Control has a fixed time window to make each weld

— No opportunity to vary duration of weld. All adaptive decisions and compensating actions must take place as the weld is being made

— Can achieve much higher production speed than intermittent (roll spot)

Three General Arrangements for Continuous Seam Welding

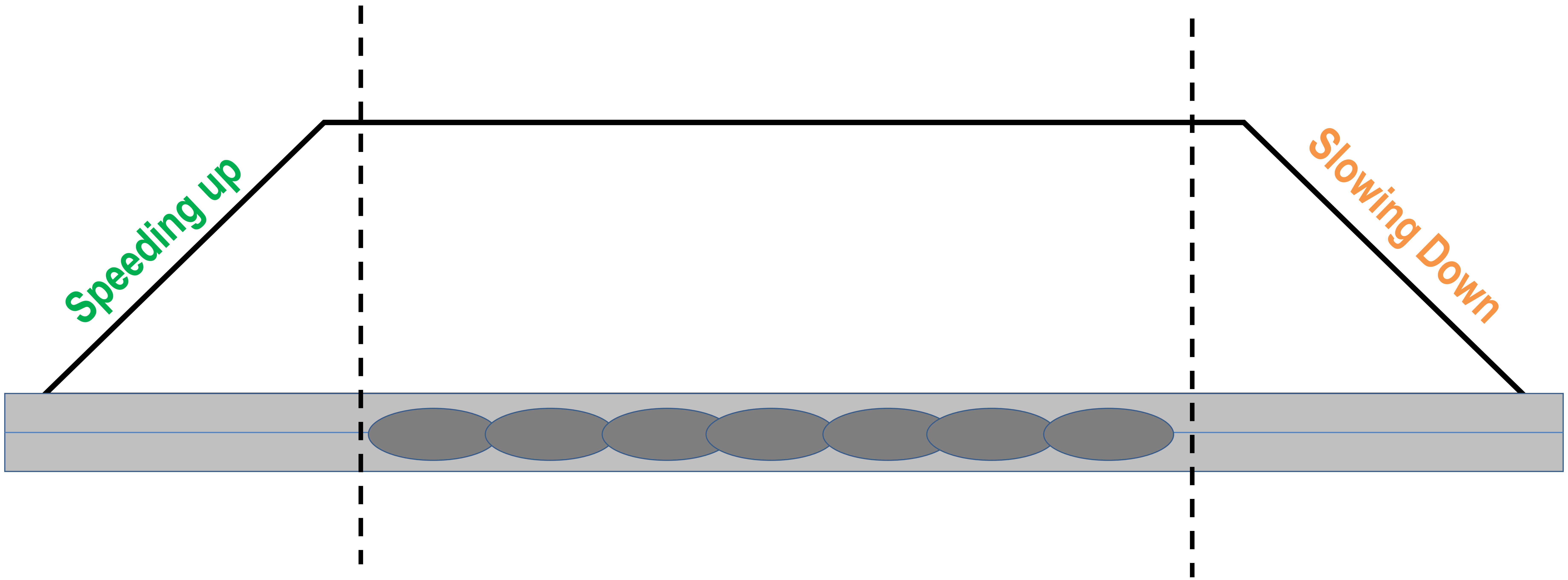
— Fast: All welds all made at constant wheel travel velocity on the same surface.

— Faster: Welding starts before wheel travel velocity is reached and continues after wheels start slowing down.

— Fastest: Welding occurs edge-to-edge across the entire part.

Wheel Velocity

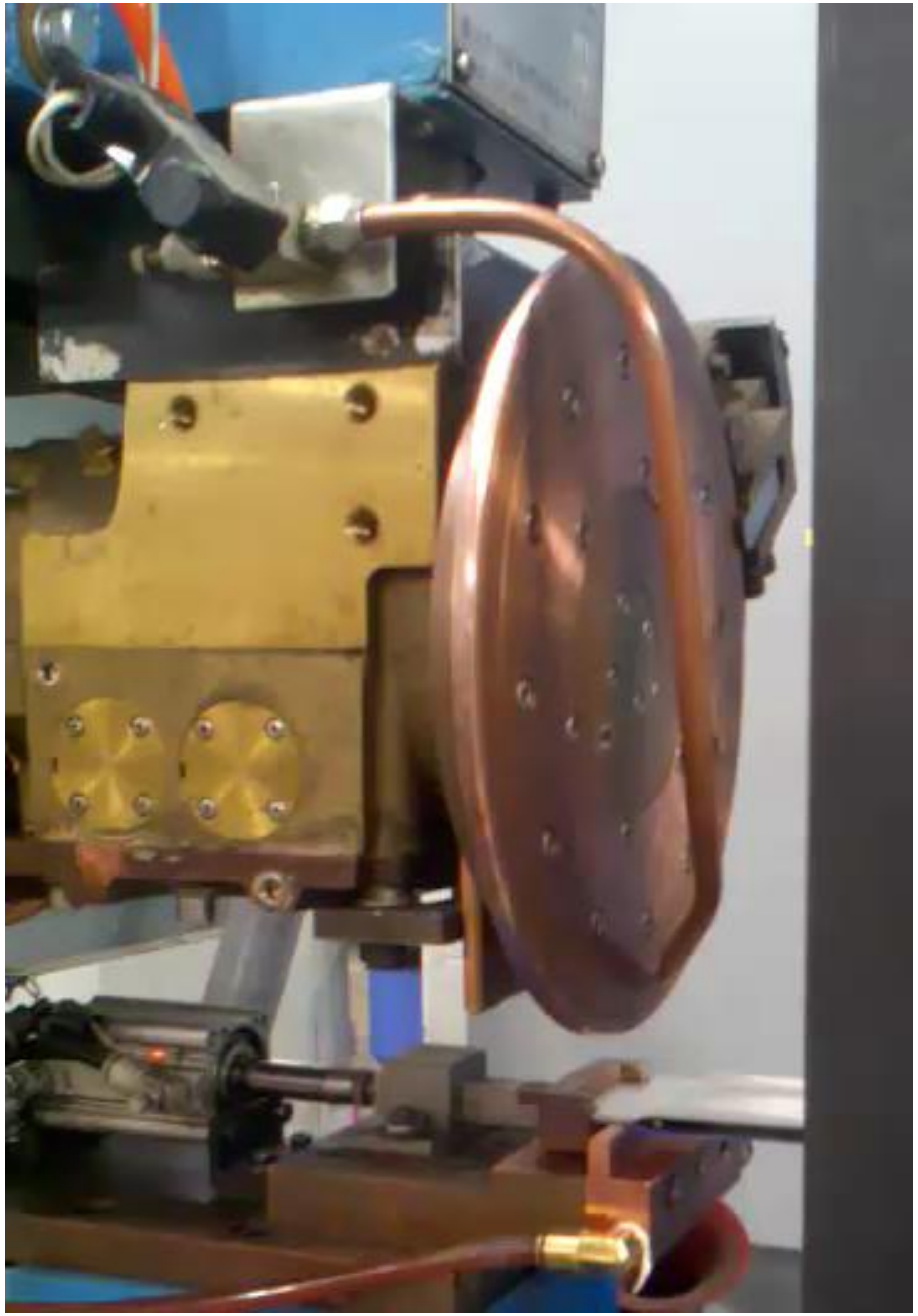
All welds occurring at same wheel speed



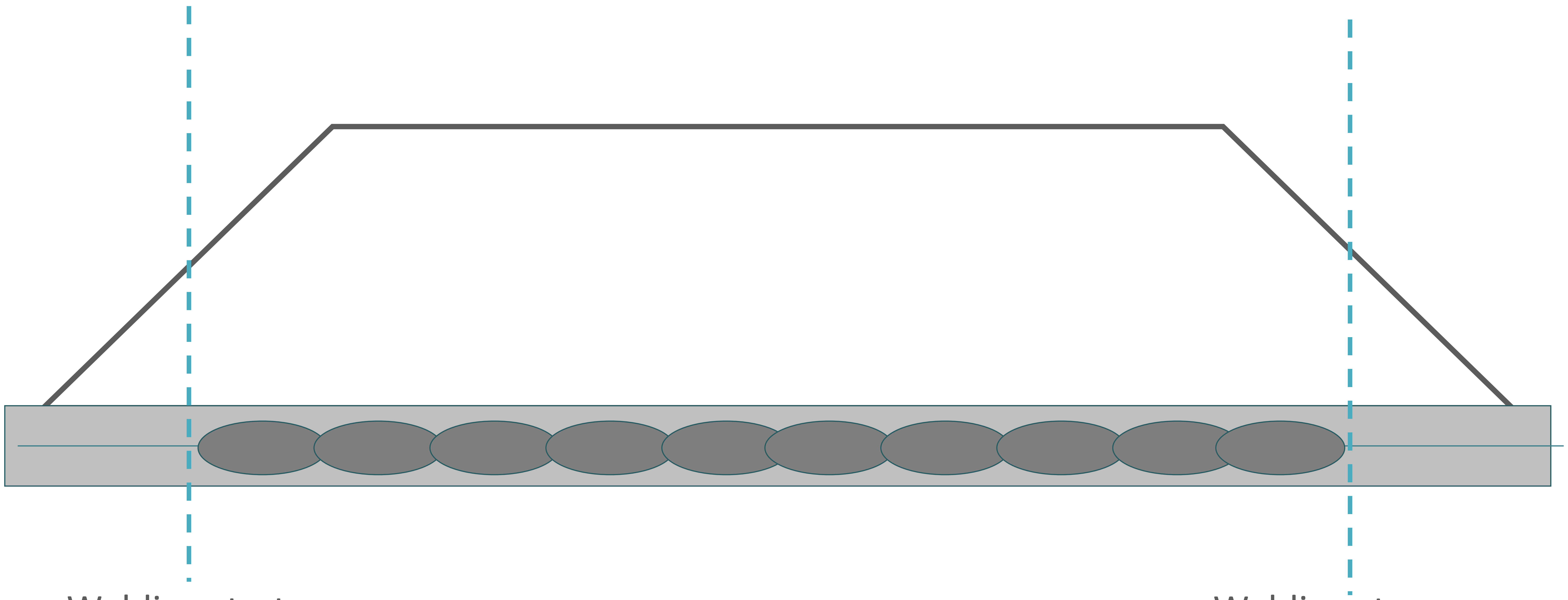
Manage Shunting at Start of Seam

- — Scale heat down for 2nd spot.
- — Scale head down more for 1st spot.

Seam Welder

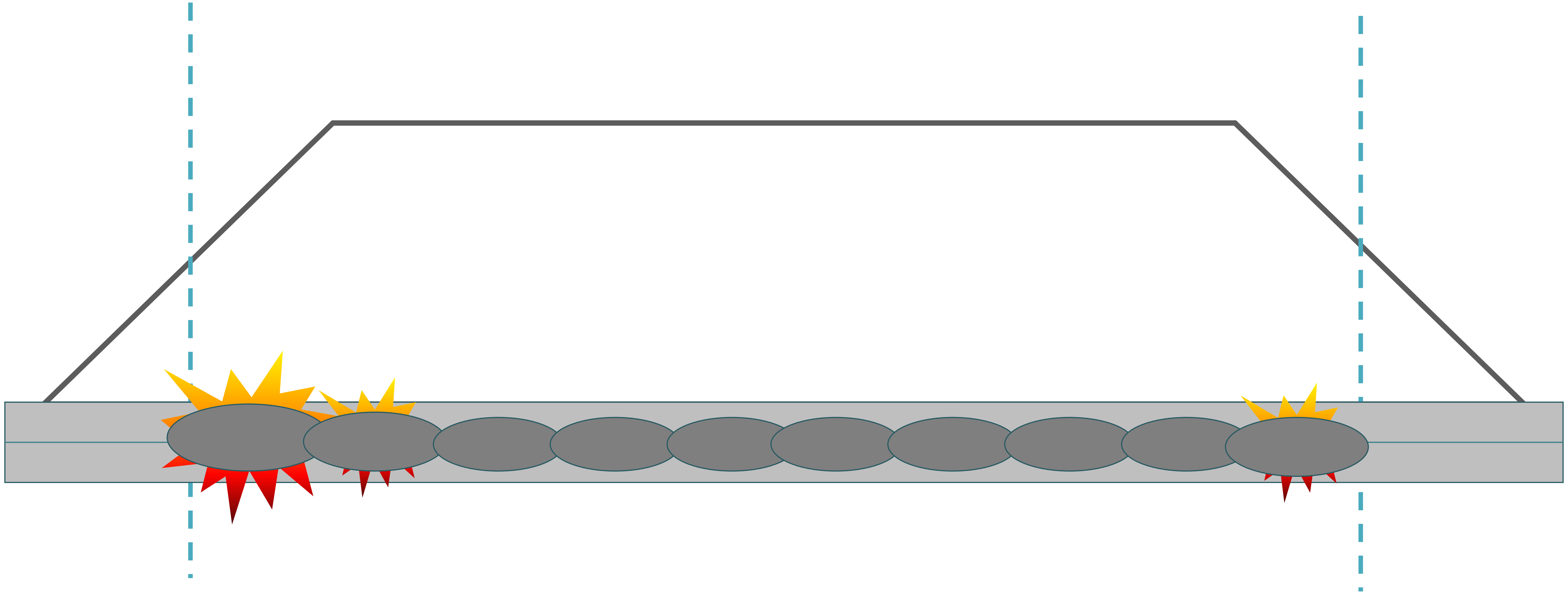


Wheel Velocity



Wheel Velocity

Welding made at slower speeds are hotter



Continuous Seam Welding

Wheel velocity is a major parameter of control, as significant as force and current

For a given applied force and current:

— Lower velocity causes hotter welds

— Higher velocity causes colder welds

Lower Wheel Velocity Requires Lower Welding Heat

Conventional Solution:

— Upslope heat at start of seam

— Downslope heat at end of seam

Disadvantage:

Hard to coordinate upslope heat and downslope heat with increasing and decreasing velocity -

Hard to synchronize heat profile with velocity profile

Lower Wheel Velocity Requires Lower Welding Heat

Adaptive Solution:

— Program the control to automatically adjust the heat up or down, in relation to instantaneous wheel velocity

Advantage:

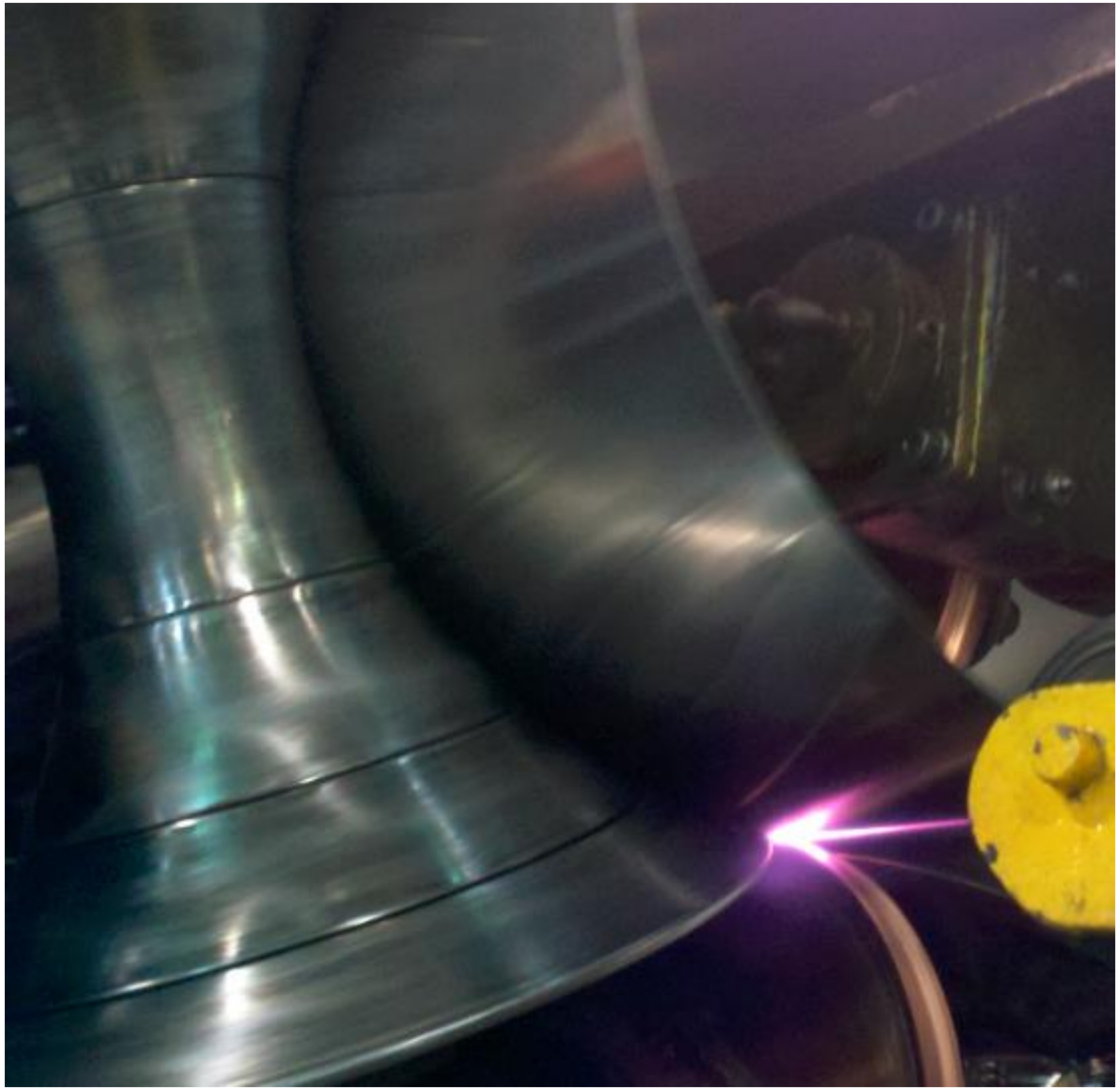
Heat: always coordinated & synchronized with wheel velocity

Easy to manage: No operator settings or proximity switches to constantly adjust

Examples of Edge to Edge Welding

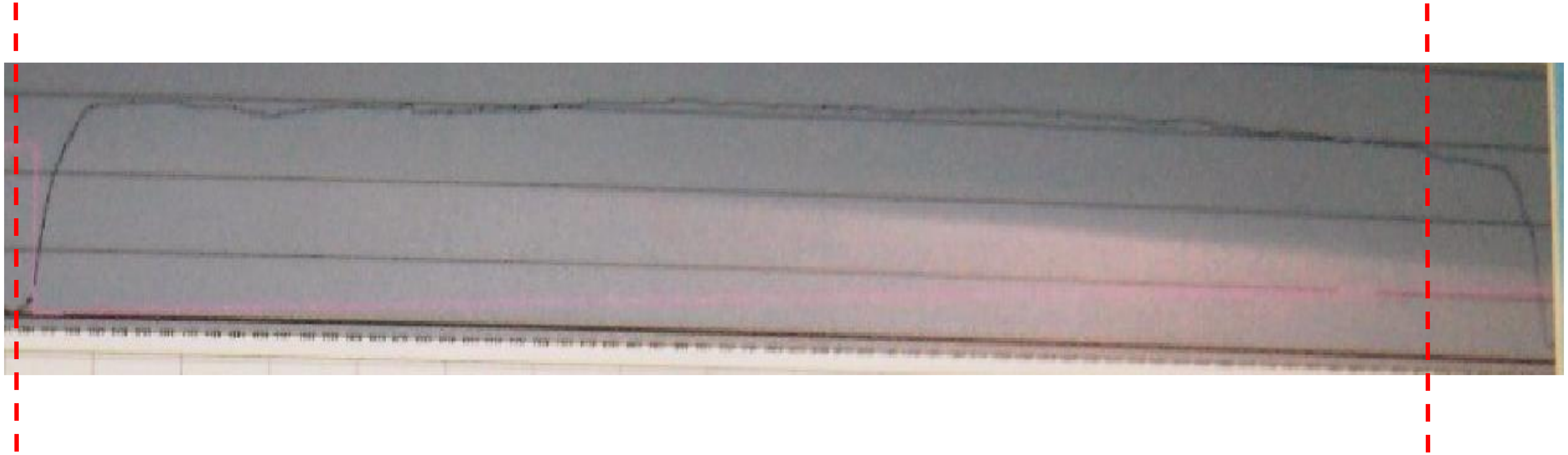
- Water heaters
- 55 Gallon drums
- Pails
- Aerosol Cans

55 Gallon Drum Welder



Typical Wheel Displacement Welding Water Heater with 0.074 Material

Plot of wheel rolling up on front tank, across tank, & off back of tank



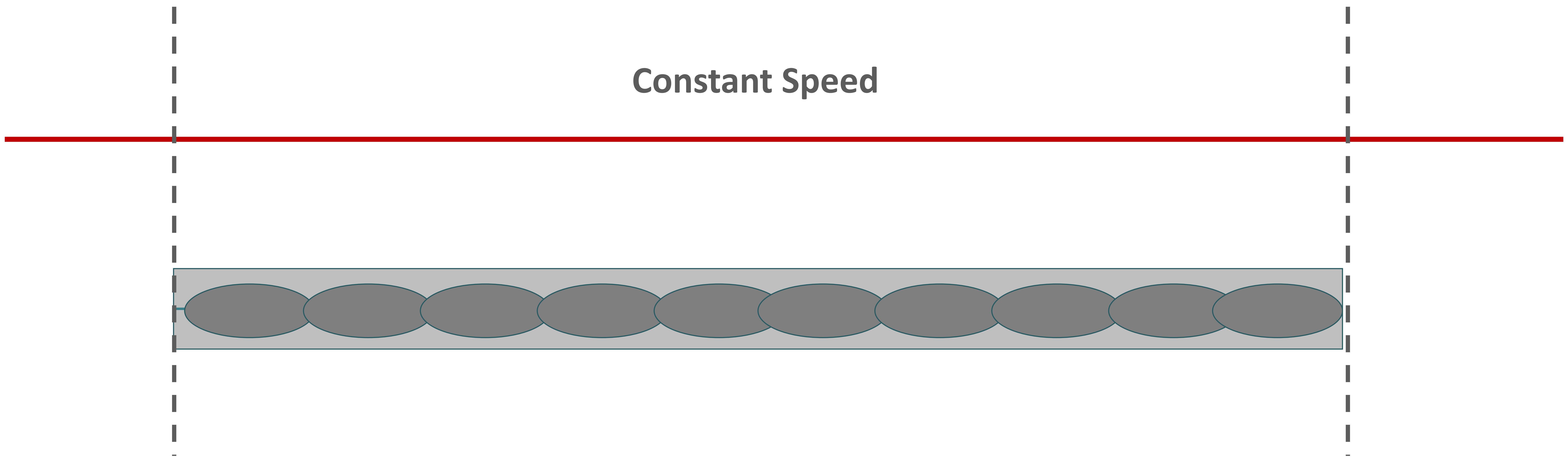
Wheel starts rolling up on front of part

Wheel starts rolling off back of part

Data collected with WeldComputer® Adaptive Control

Wheel Velocity

Edge to edge adaptive control produces gas tight welds over the entire length of seam



Typical High Speed Seam Operations Have High Scrap Rates

Inability to:

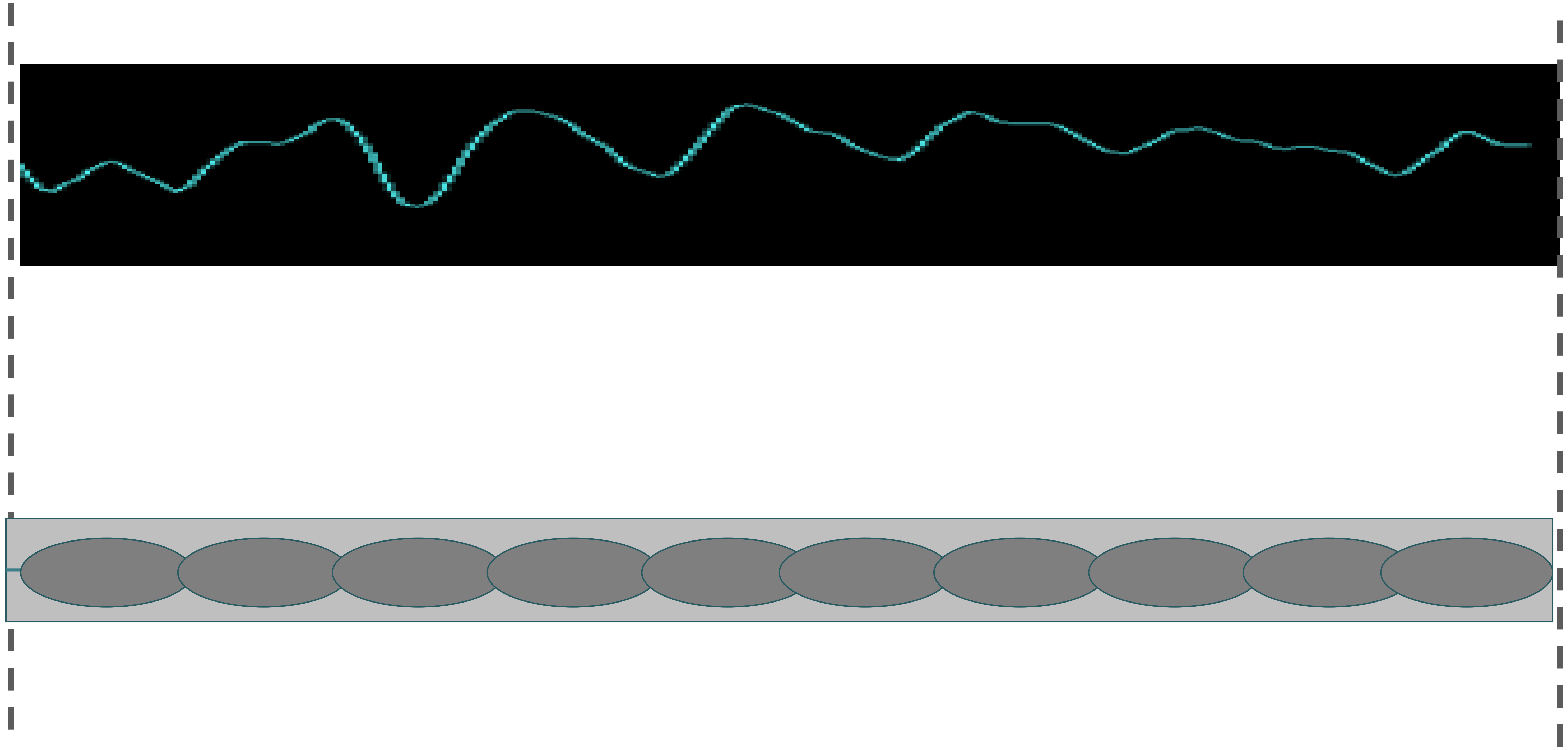
— Control welds on front and back edges

— Prevent hot and cold spots

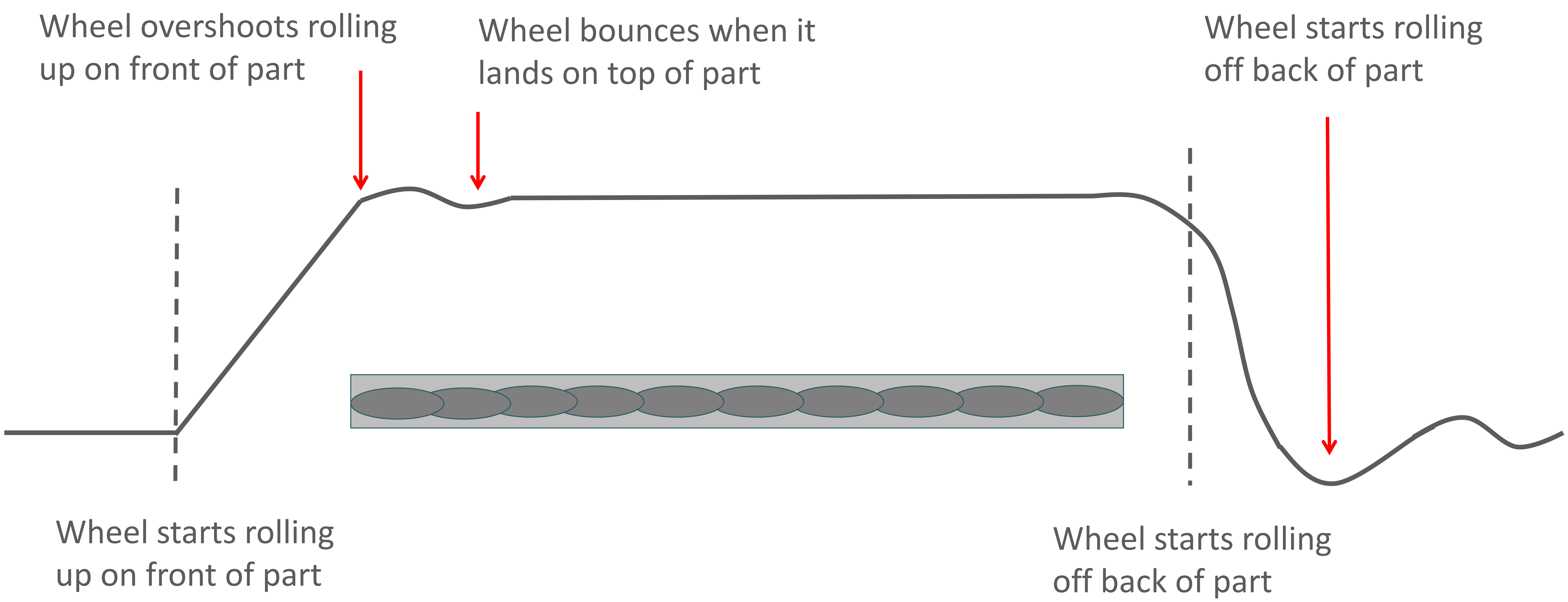
— Produce consistent current

Wheel Velocity at High Speeds

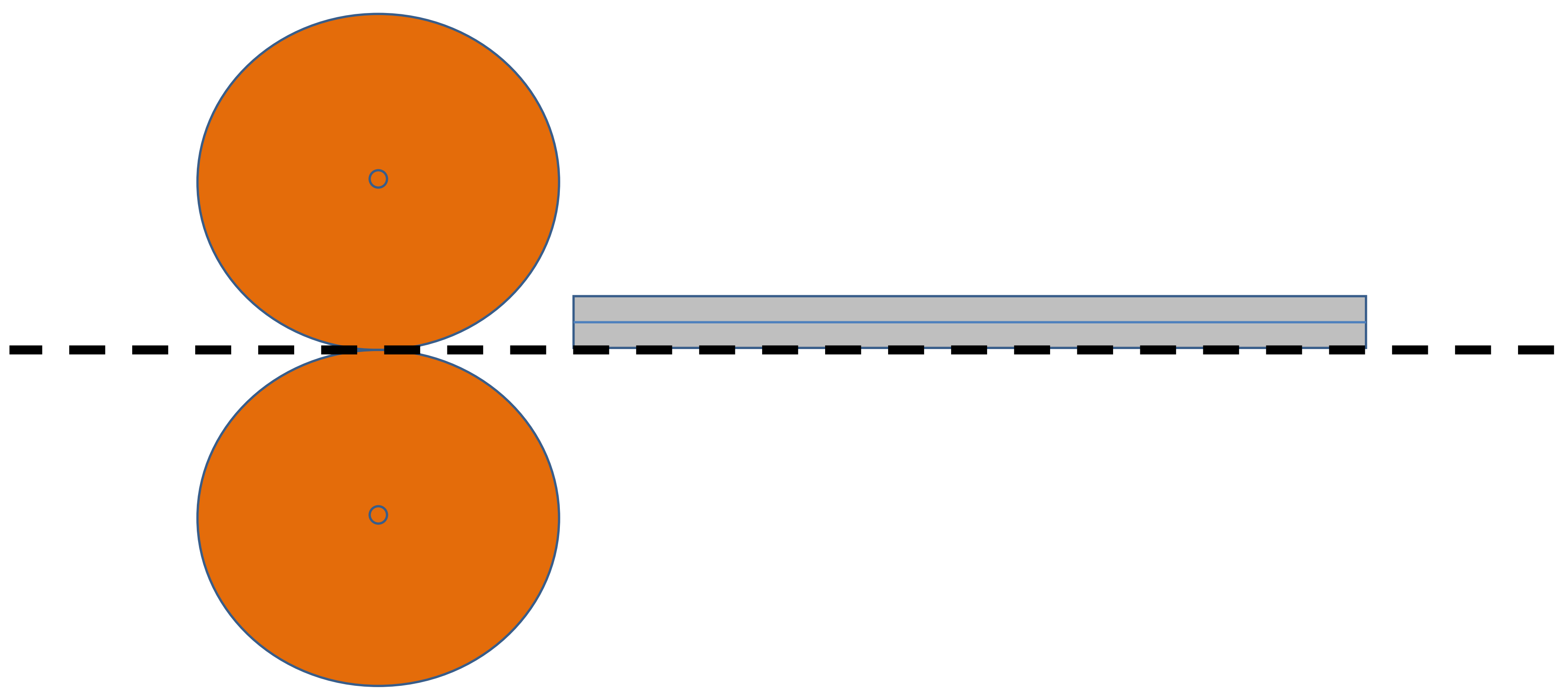
Dynamically adjusting weld heat to compensate for velocity fluctuations increases weld consistency and reduces leakers



Wheel Displacement



Wheel Displacement



For edge to edge seam welding at high speeds, conventional heat controls deliver poor performance

Part proximity sensors used to synchronize heat with front of part entering machine have too much variability to accurately control welding on the front edge

Inability to synchronize heat with back of part leaving machine

Inability to compensate for machine force and velocity variations

SCR based controls have limitations on current wave shape and regulation

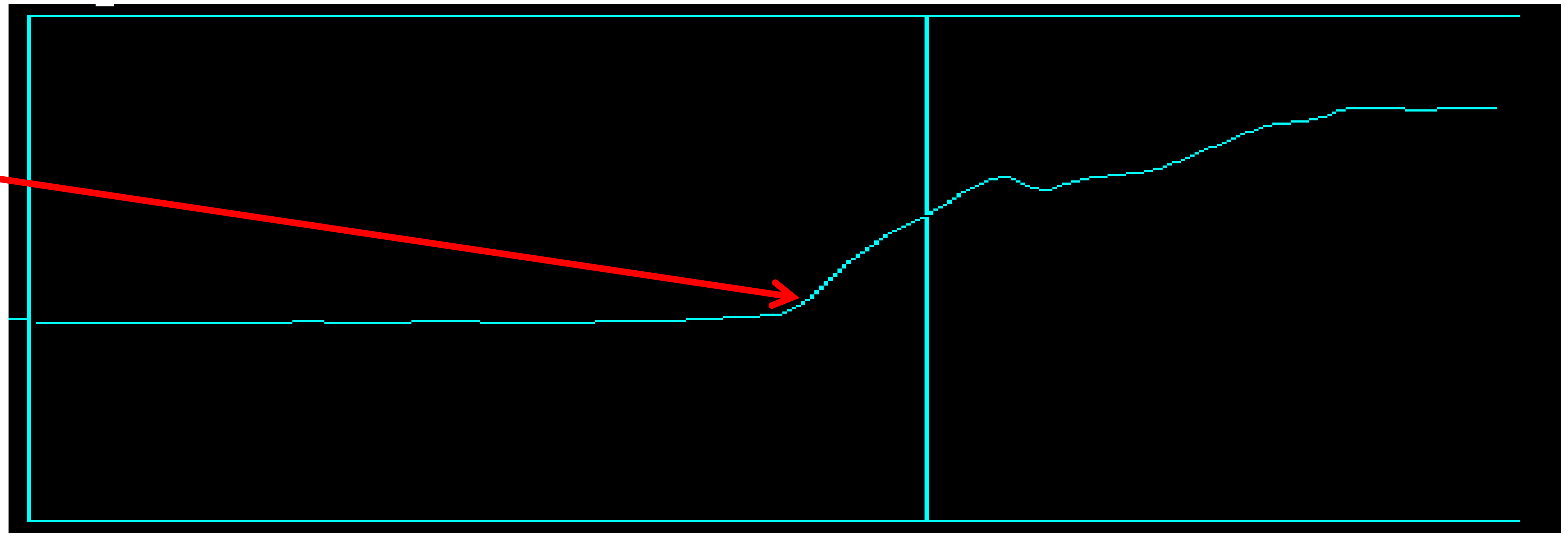
Traditional MFDC controls, provide ineffective regulation and heat repeatability, in applications requiring short duration high current pulses

Adaptive Seam Welding Water Heater with 0.074 material

Current Starting Too Late Makes Undersized Front Edge Weld

Wheel starts rolling up on part here

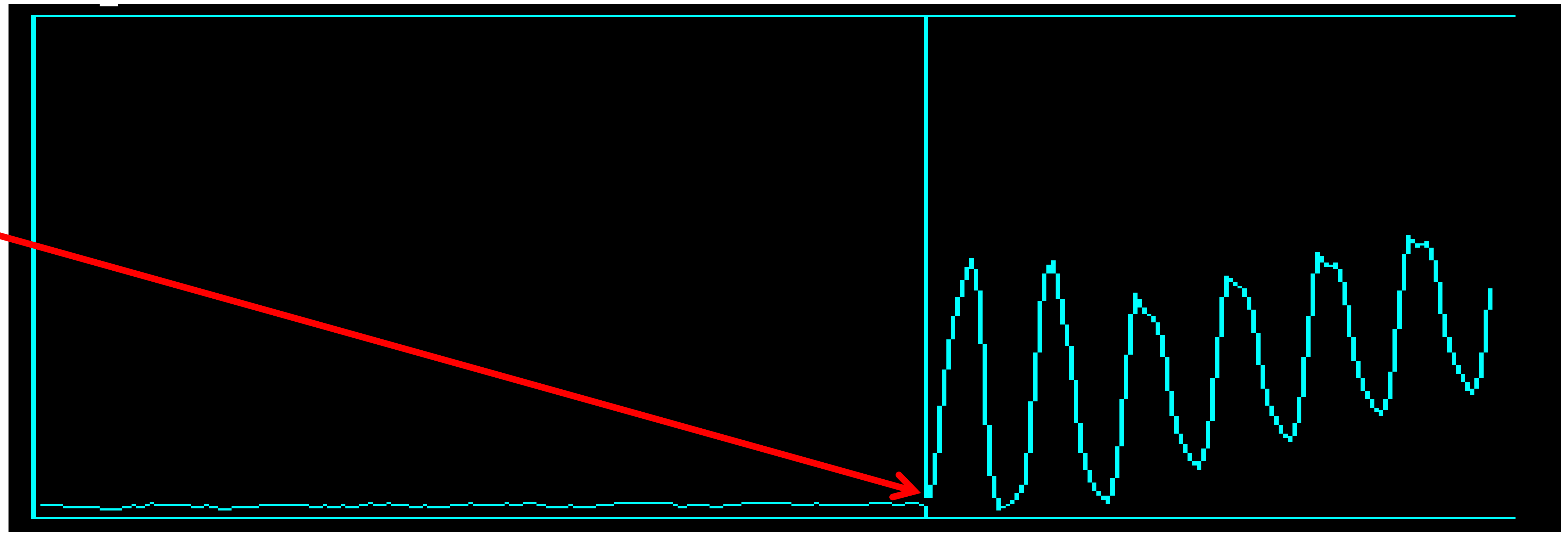
Displacement



Current starting here

after wheel is already rolling up on part results in undersized weld on front edge

Current

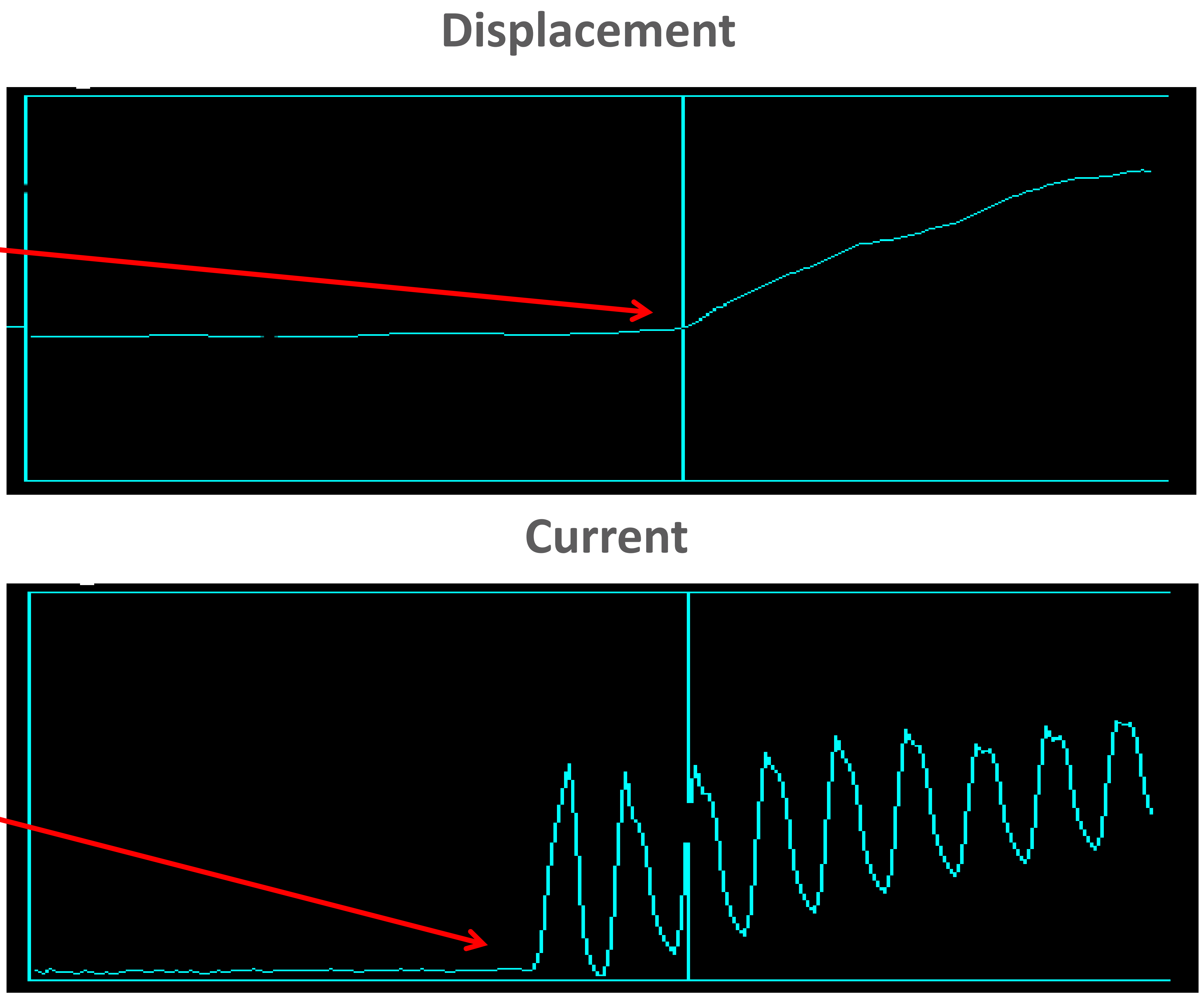


Data collected with WeldView® Monitor

Current Starting Too Early Overheats Front Edge of Part

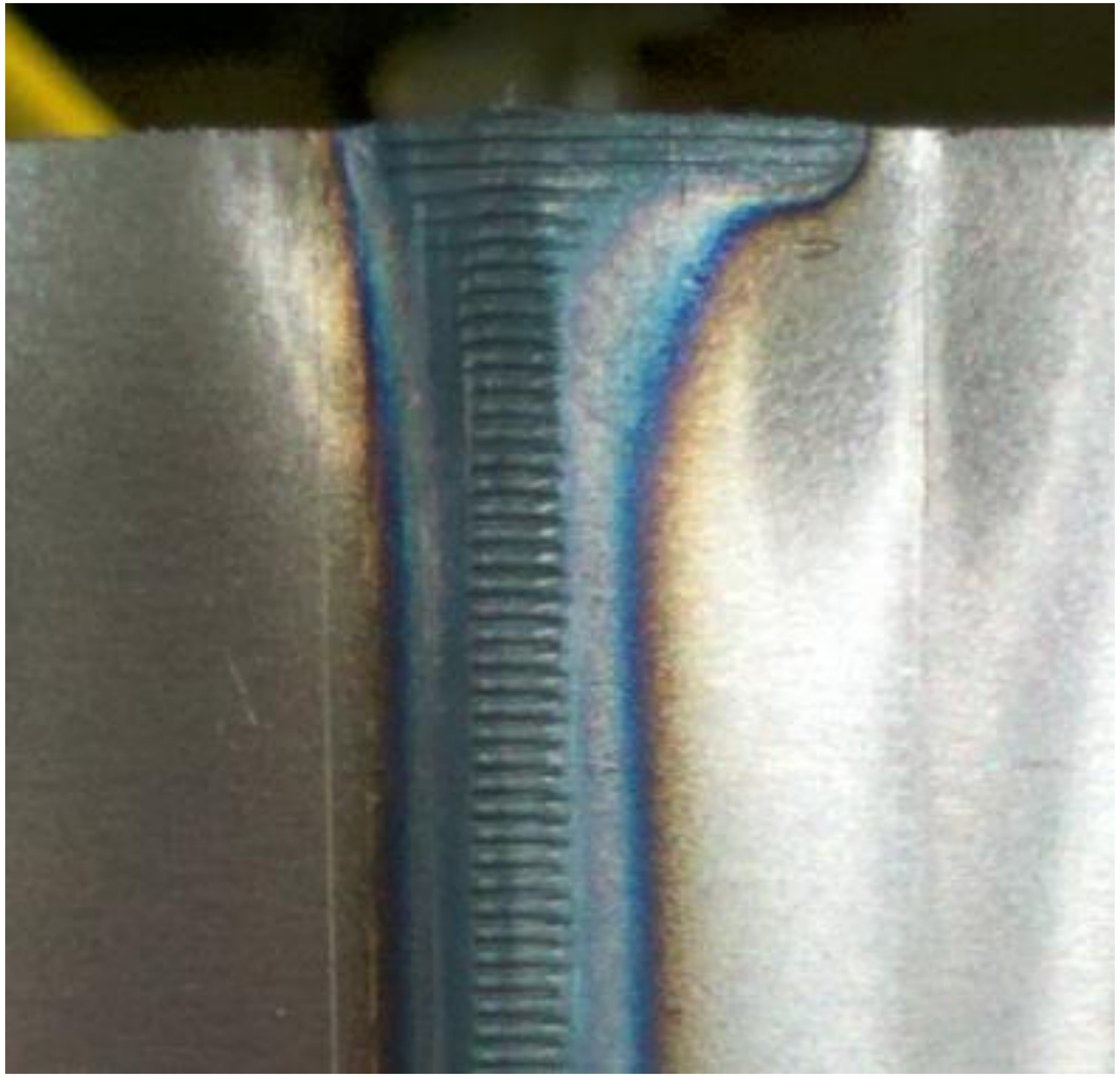
Wheel starts rolling up on part here

Current starting before wheel comes in contact with part overheats front edge of part



Data collected with WeldView® Monitor

Poorly Regulated Heat Pulses, with Uncontrolled Heat Envelope, Turning on Too Soon Overheats Front of Part



What does it take to reliably weld parts like this?

— Use control that delivers accurate repeatable heat

— Employ adaptive control to:

- Profile heat envelope rolling up on part
- Compensate for bounce of wheel landing on part
- Adjust heat for overlap & wheel contact area variations on part.
- Compensate for velocity fluctuations
- Profile heat envelope rolling off back of part
- Instantly cut off heat rolling off back edge of part

Water Heater Front Edge Adaptive Weld

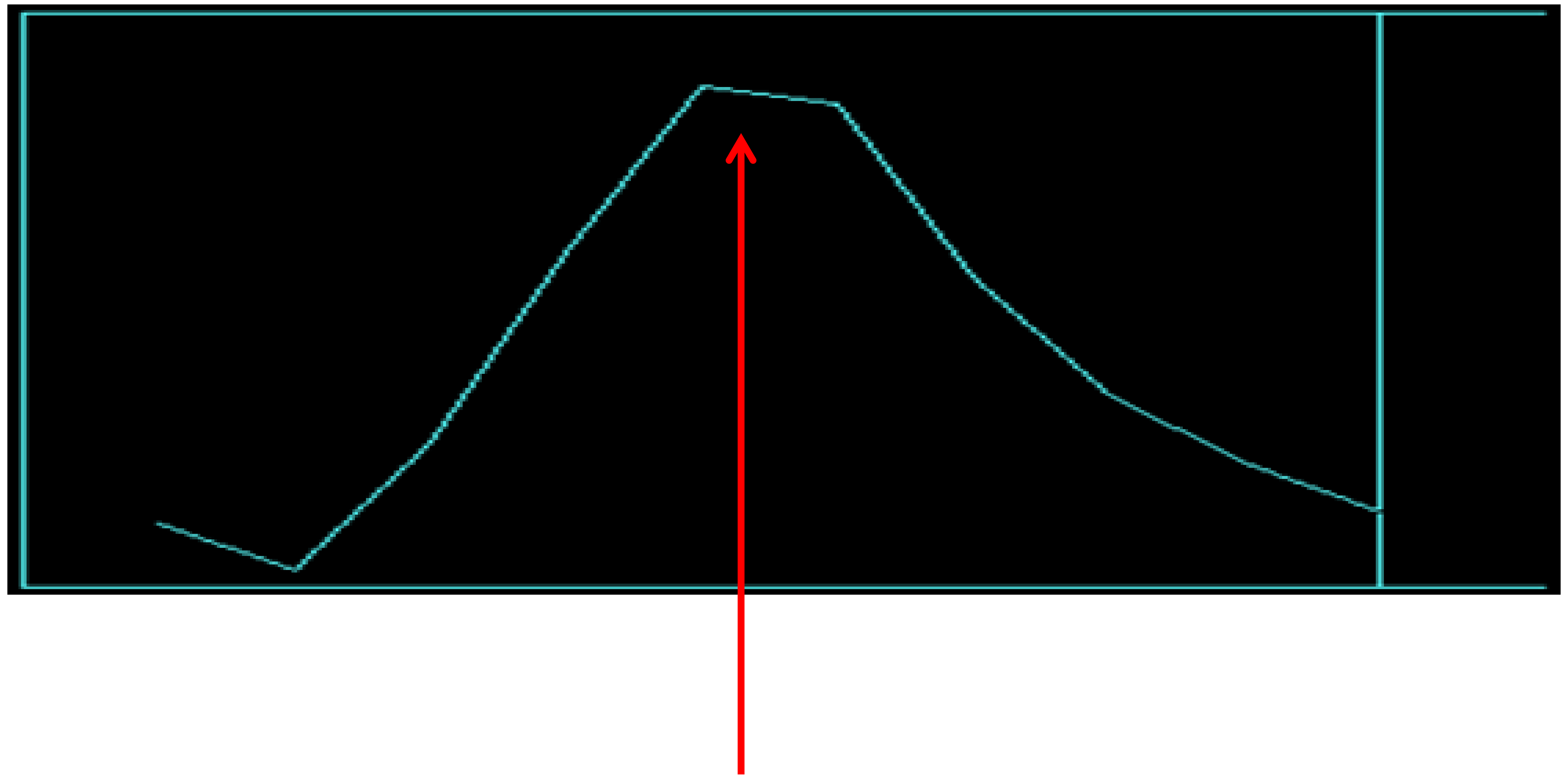
Non Adaptive – Poor heat control results in too much heat too soon

Adaptive - Heat envelop is precisely coordinated with front edge of part

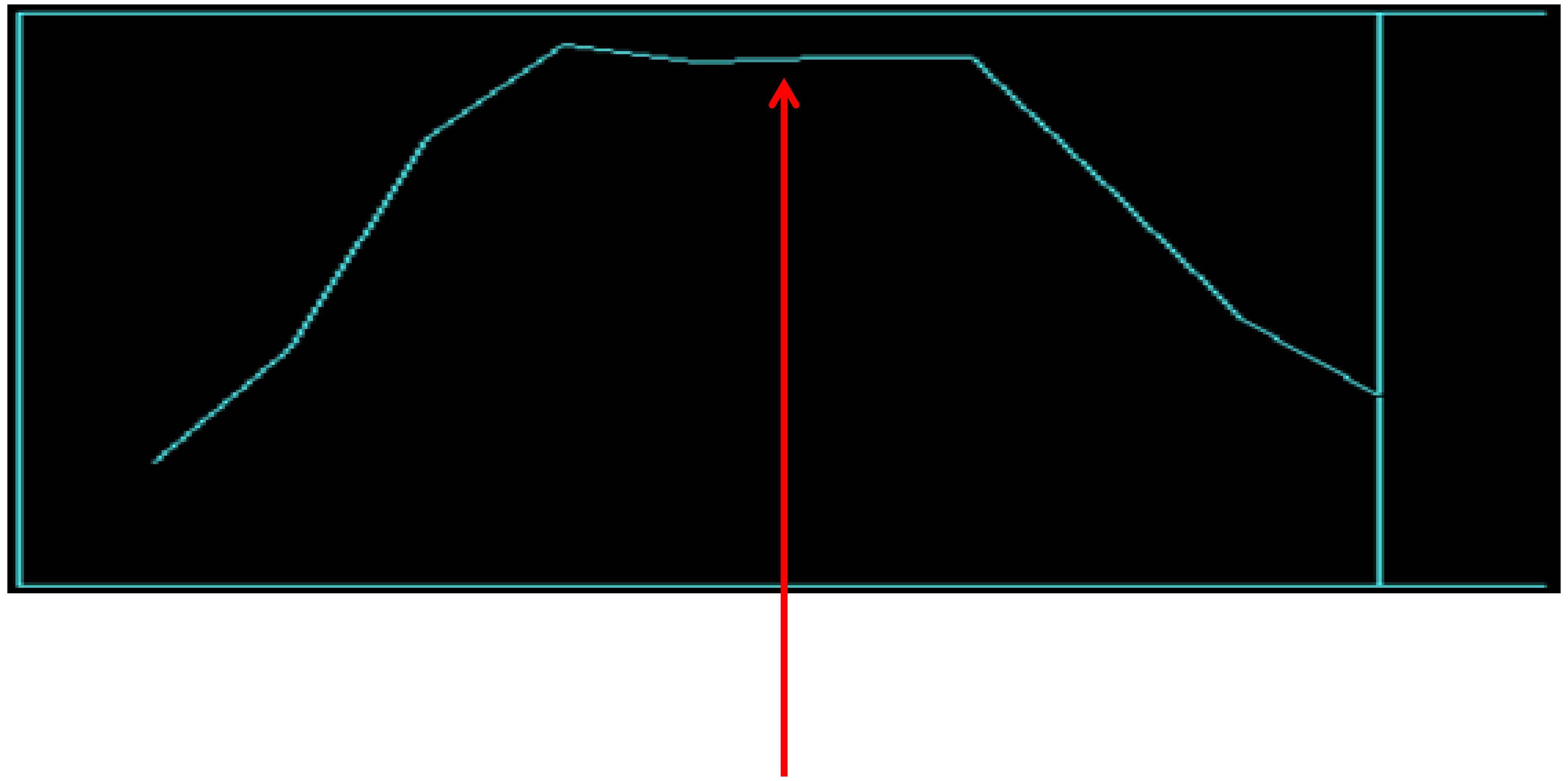
170th Weld Impulse on 55 Gallon Drum Produced with 386 Weld Current Impulses

Both of these pulses should look identical

Instead there is more than 80% variation in peak current duration



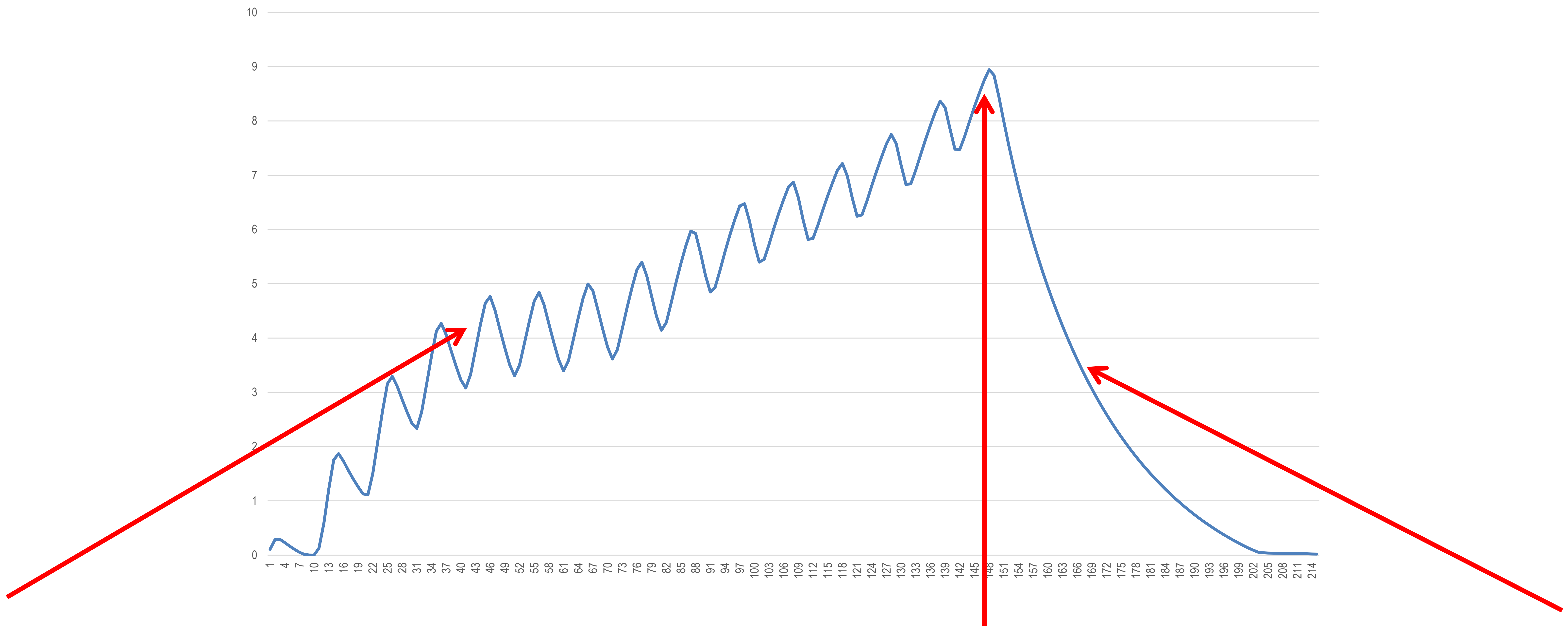
Current pulse too narrow creates leak from undersized weld



Current pulse too wide creates leak from expulsed material

Current trace of seam with 386 current impulses recorded with WeldView® Monitor

MFDC Can Have Big Current Fluctuations and Excessive Decay Time



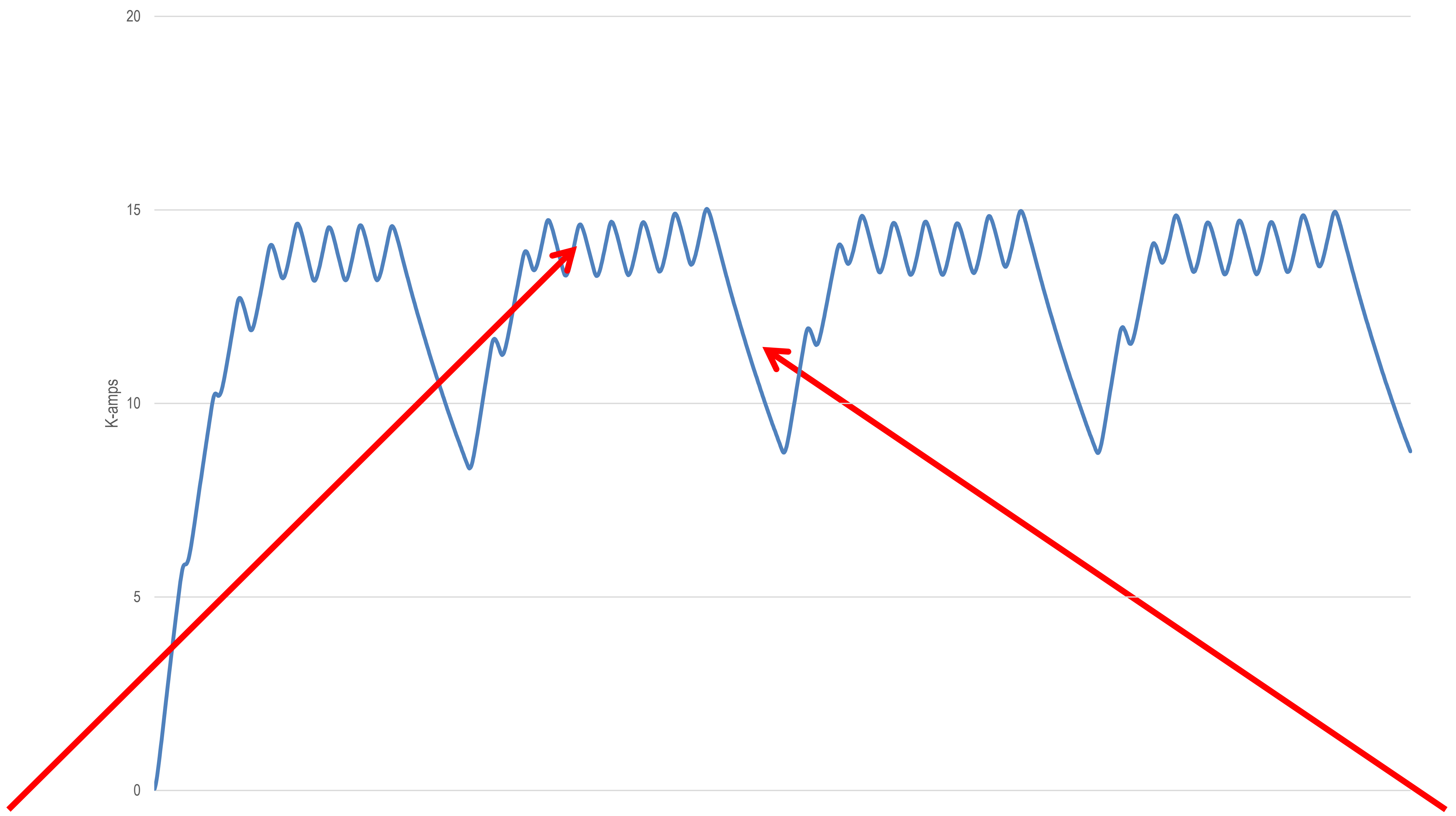
Big current fluctuations reduces stability of process

Current still rising at end of programmed heat means process is uncontrolled

Long current decay during cool time means hotter wheels

Current trace recorded with WeldView® Monitor

MFDC weld impulses with 4 ms heat 1ms cool has ineffective cooling



Big current fluctuations caused by MFDC reduces stability of process

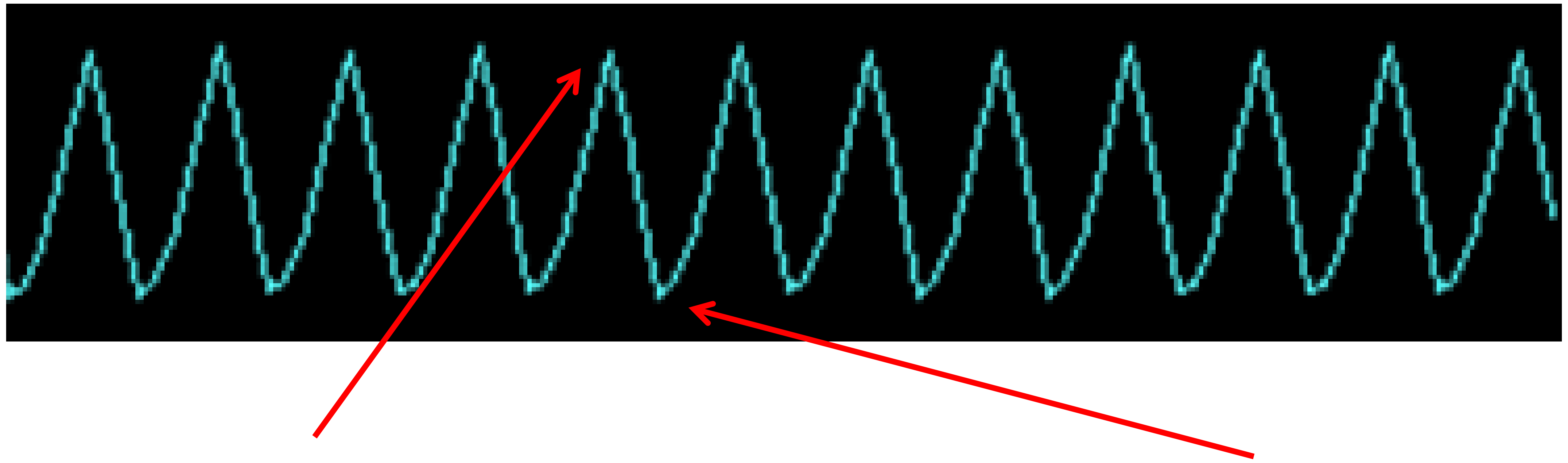
Long current decay during cool time means hotter wheels

Current trace recorded with WeldView® Monitor

MFDC Control Programmed to Produce 15.1ka for 5ms Followed by 3ms Cool Time in a Repeating Pattern

- Process is unregulated when control never reaches programmed current targets

- Seam performance is compromised when high currents persist during cool times



Current overshoots to 18kA by end of 5ms of applied heat

Current only decays to 13.5kA at end of programmed cool time

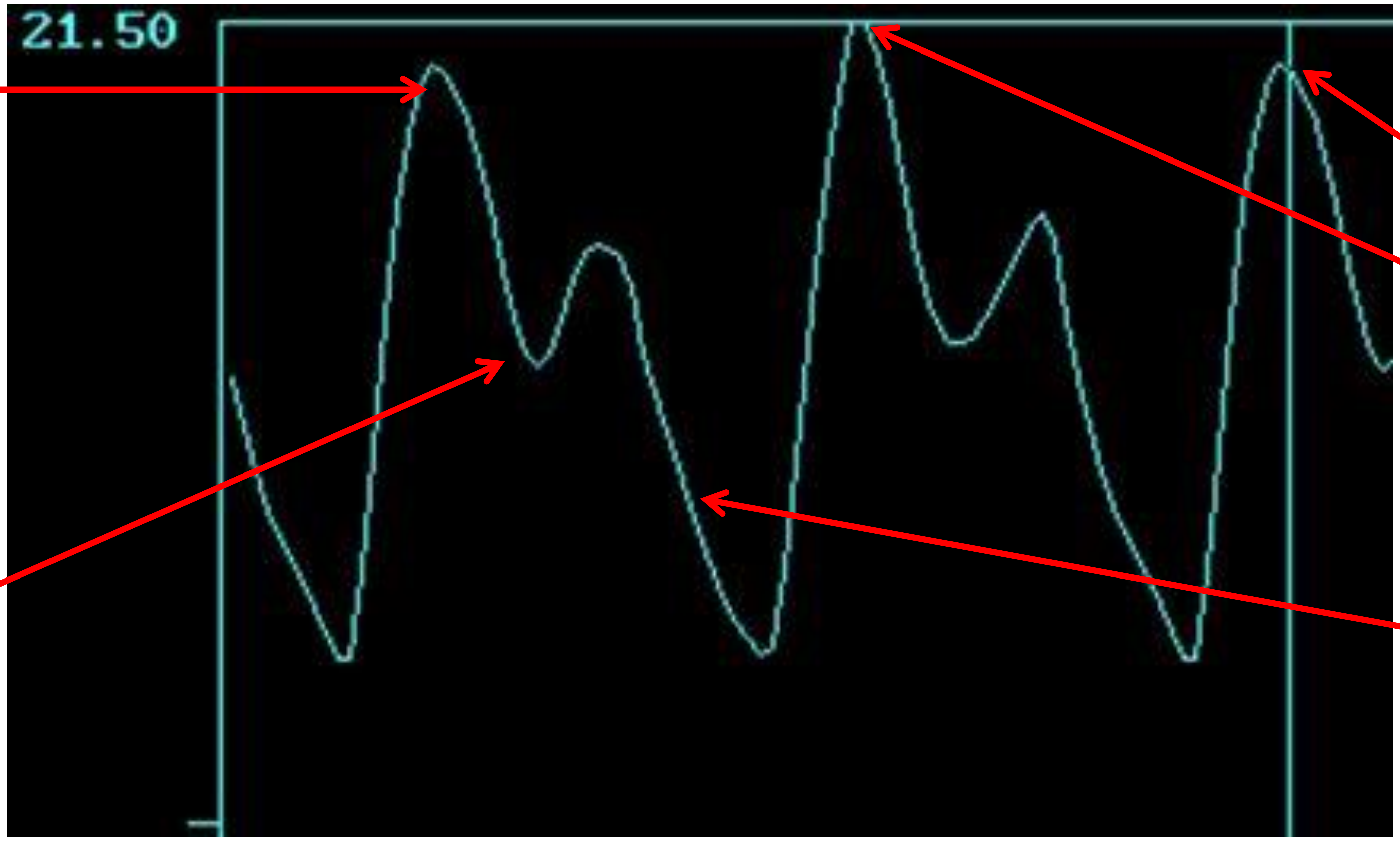
Current trace recorded with WeldView® Monitor

MFDC control programmed to produce 13kA for 24ms followed by 12ms cool time in a repeating pattern

Process is unregulated when unstable current overshoots, has oscillations, and never reaches programmed current targets

Current overshoot followed by current undershoot represents 73% current fluctuation during each weld

Undershoot occurring 8 ms after overshoot



Peak current fluctuates 15% from one impulse to the next

Current never decays to zero during cool time between impulses

Current trace recorded with WeldView® Monitor

Problems with MFDC

— Big mechanical disturbance from current fluctuations occurs twice per millisecond of applied heat

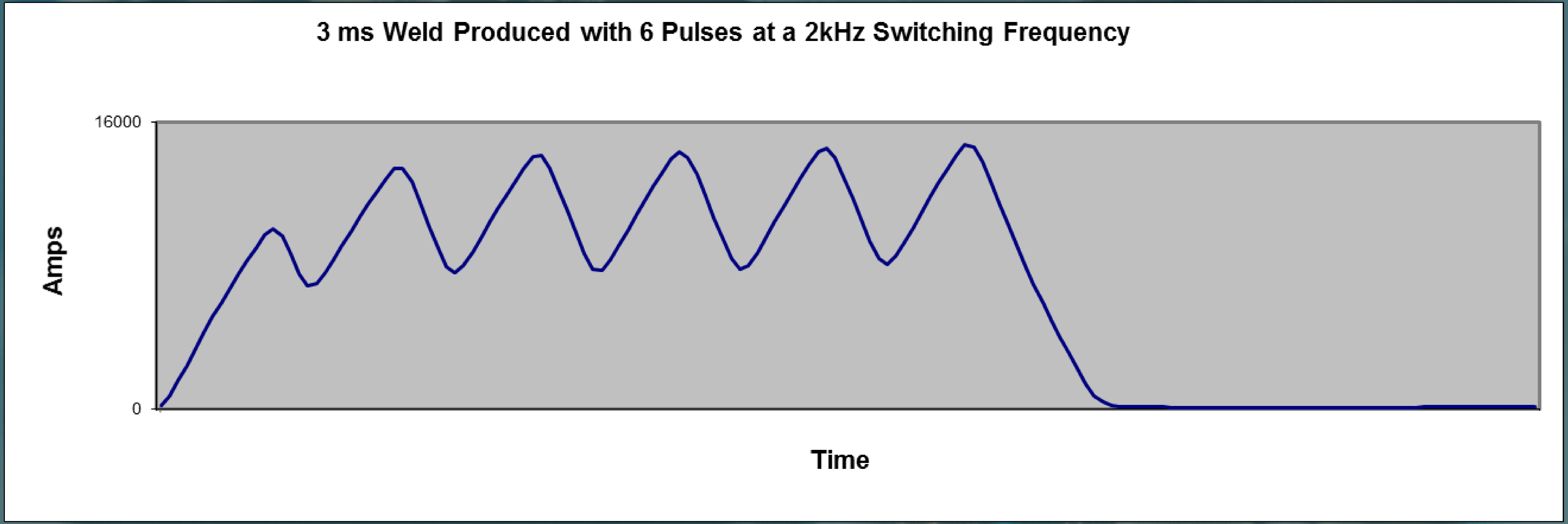
— Current decay time after each weld diminishes effectiveness of cool time & causes wheels to run hotter

— Magnetizes machine and part

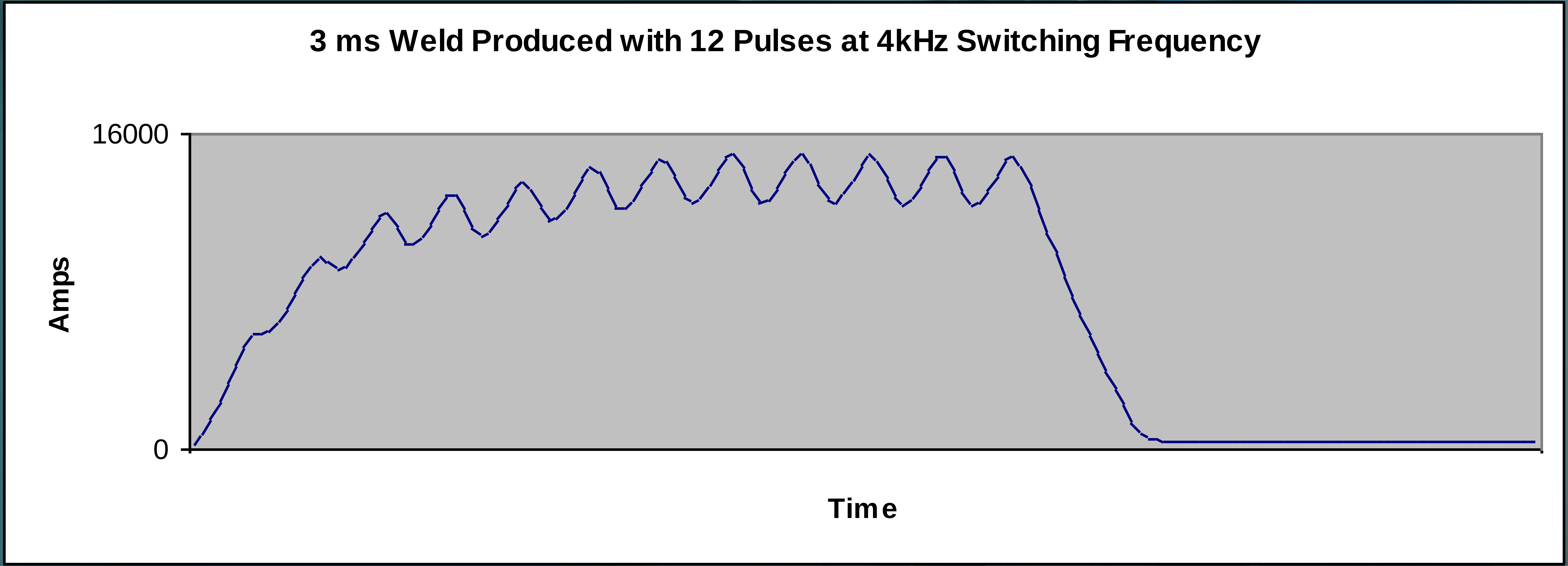
— Causes heat imbalance from Peltier Effect

— Asymmetrical electrode wear

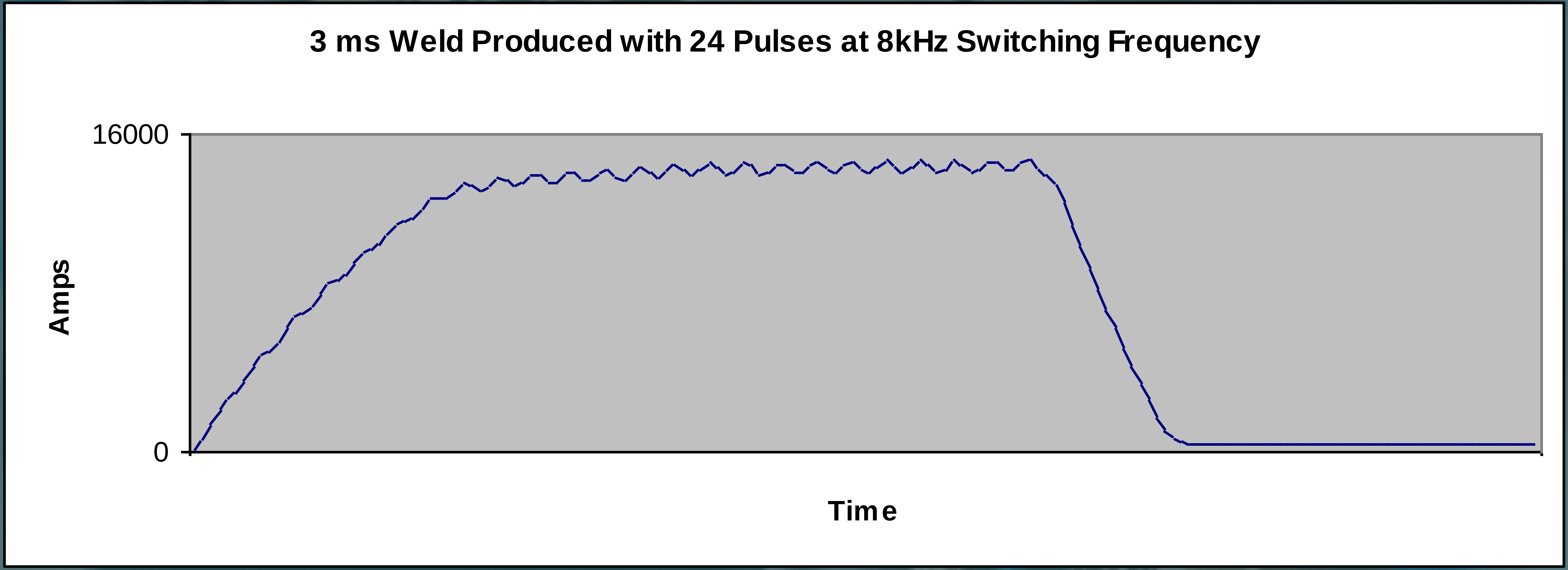
— Limited current adjustment rate

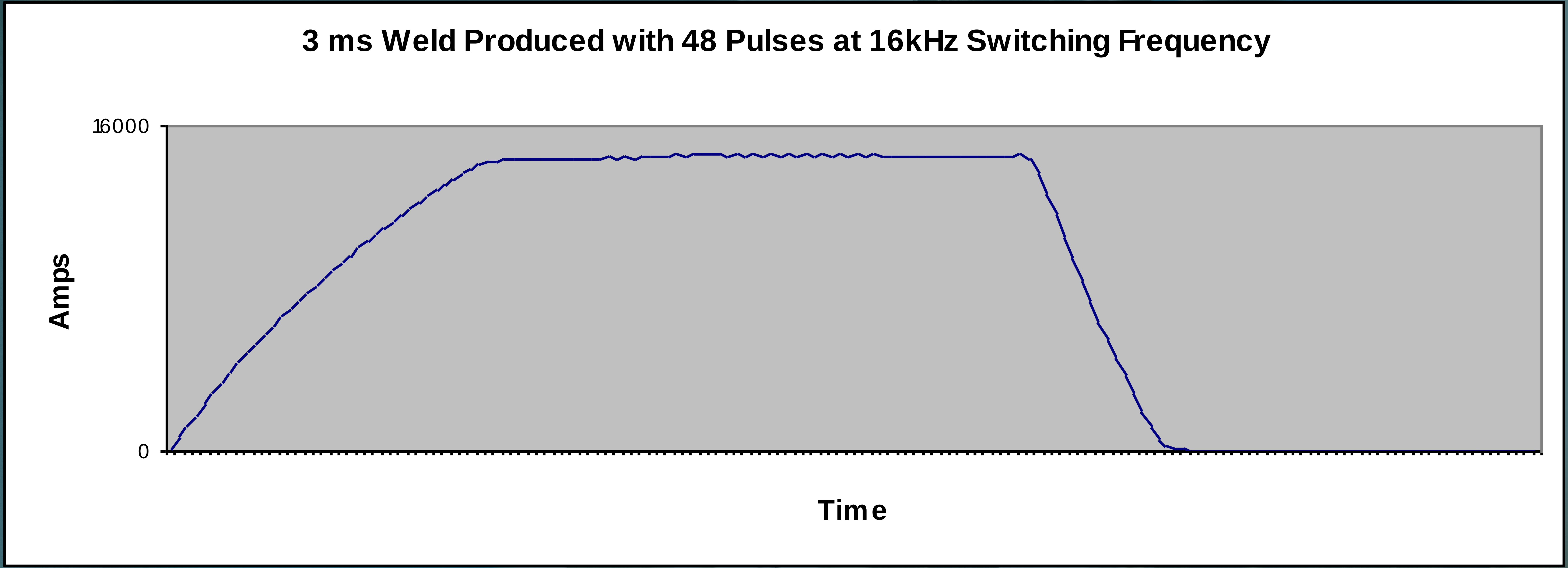


3 ms Weld Produced with 6 Pulses at a 2kHz Switching Frequency
16000
0
Amps
Time

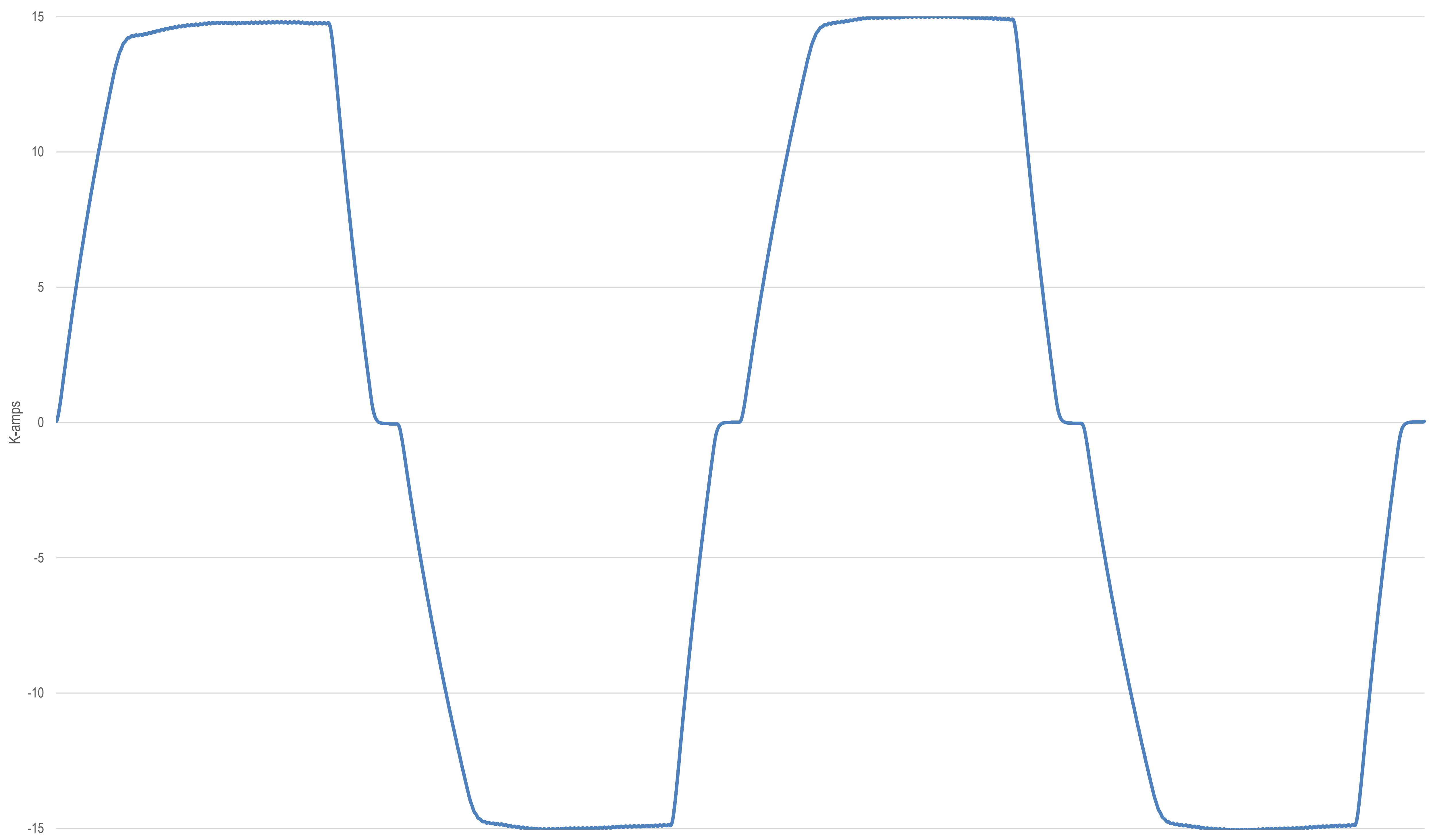


3 ms Weld Produced with 12 Pulses at 4kHz Switching Frequency
16000
0
Amps
Time


3 ms Weld Produced with 24 Pulses at 8kHz Switching Frequency
16000
0
Amps
Time

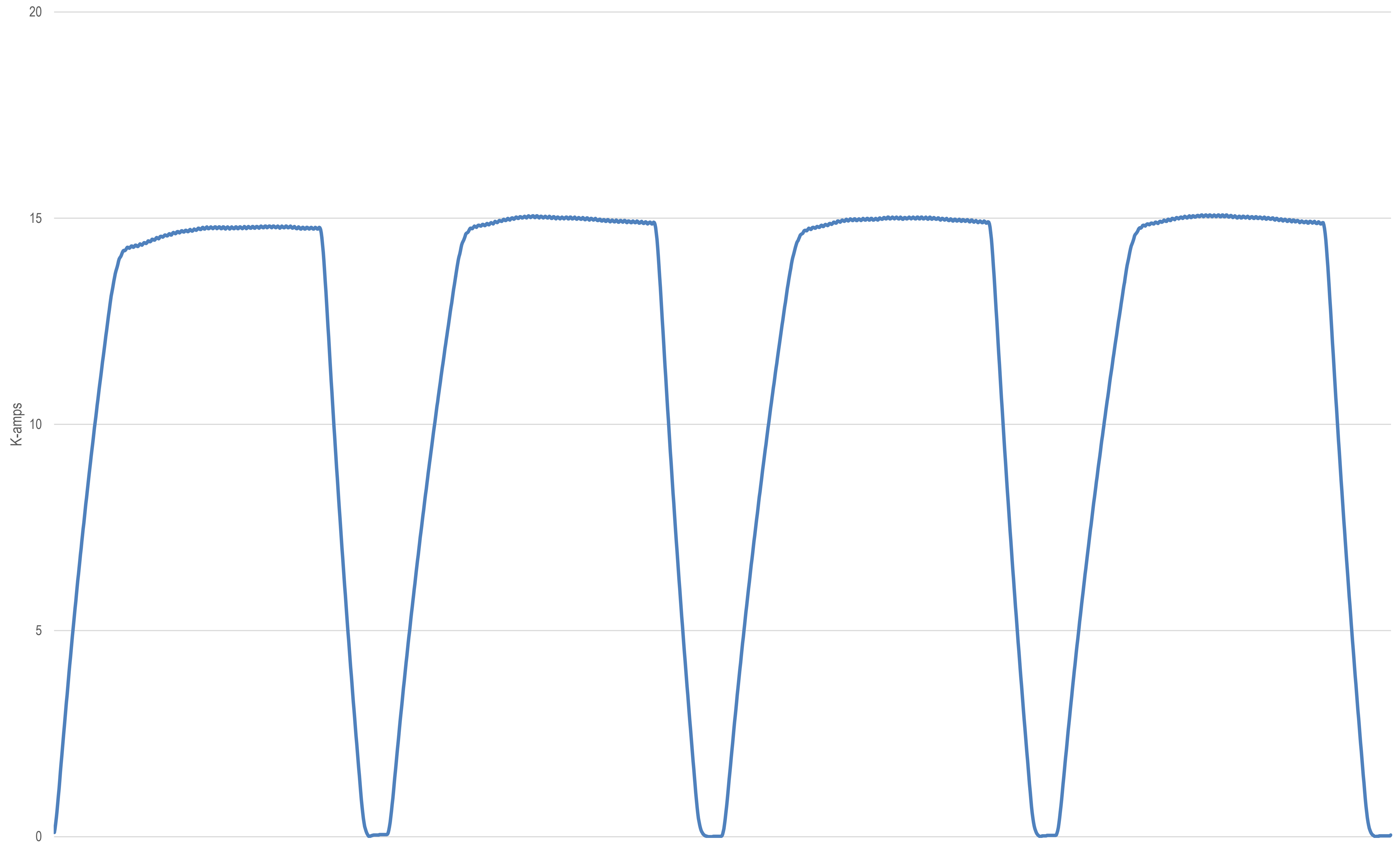

3 ms Weld Produced with 48 Pulses at 16kHz Switching Frequency
16000
0
Amps
Time

Instantaneous current waveform of 4 ms heat 1ms cool weld impulses produced with WeldComputer® Wave Synthesis Control and 60 Hz AC transformer



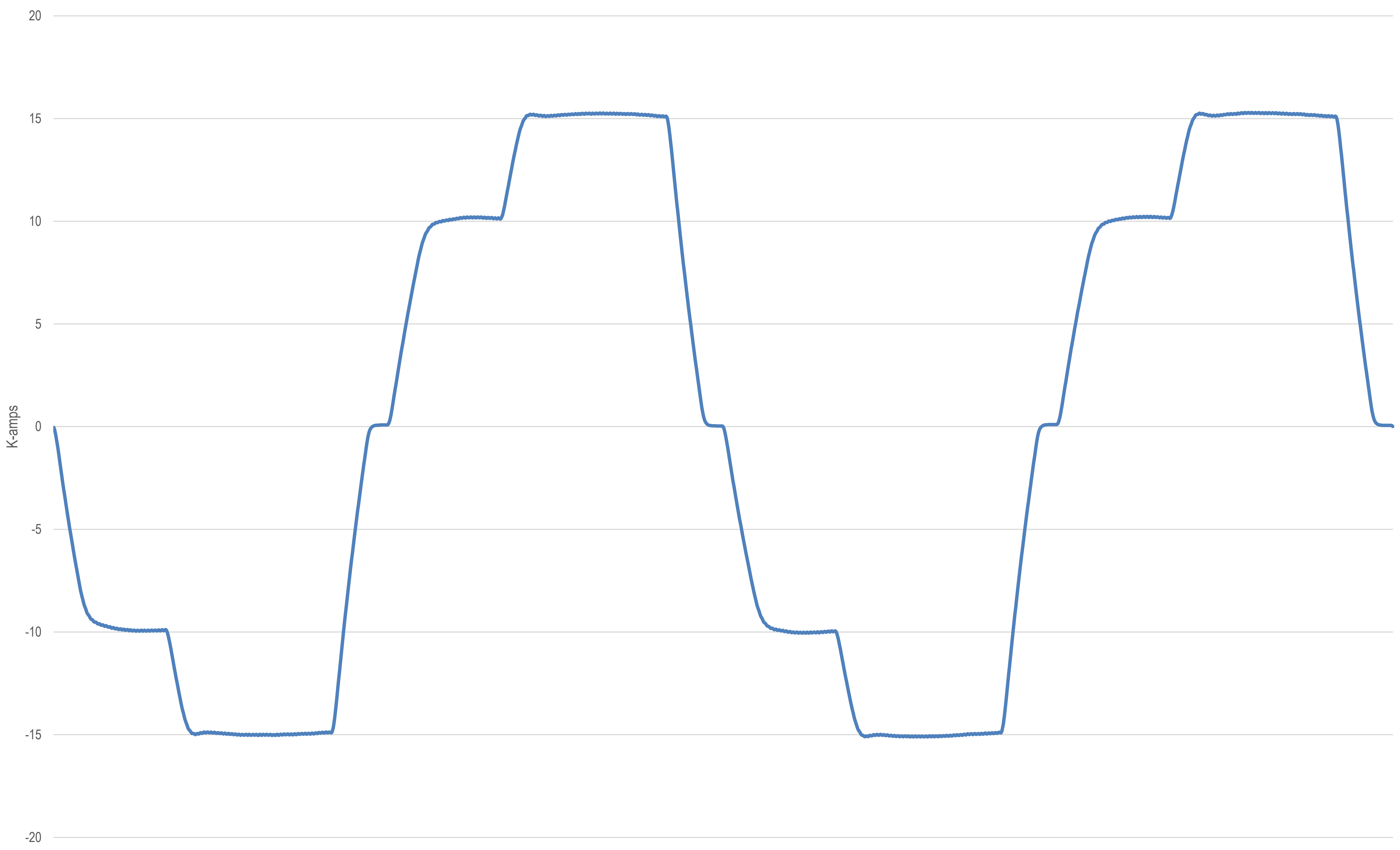
Current trace recorded with WeldView® Monitor

RMS current trace of 4 ms heat 1ms cool weld impulses produced with WeldComputer® Wave Synthesis Control and 60 Hz AC transformer



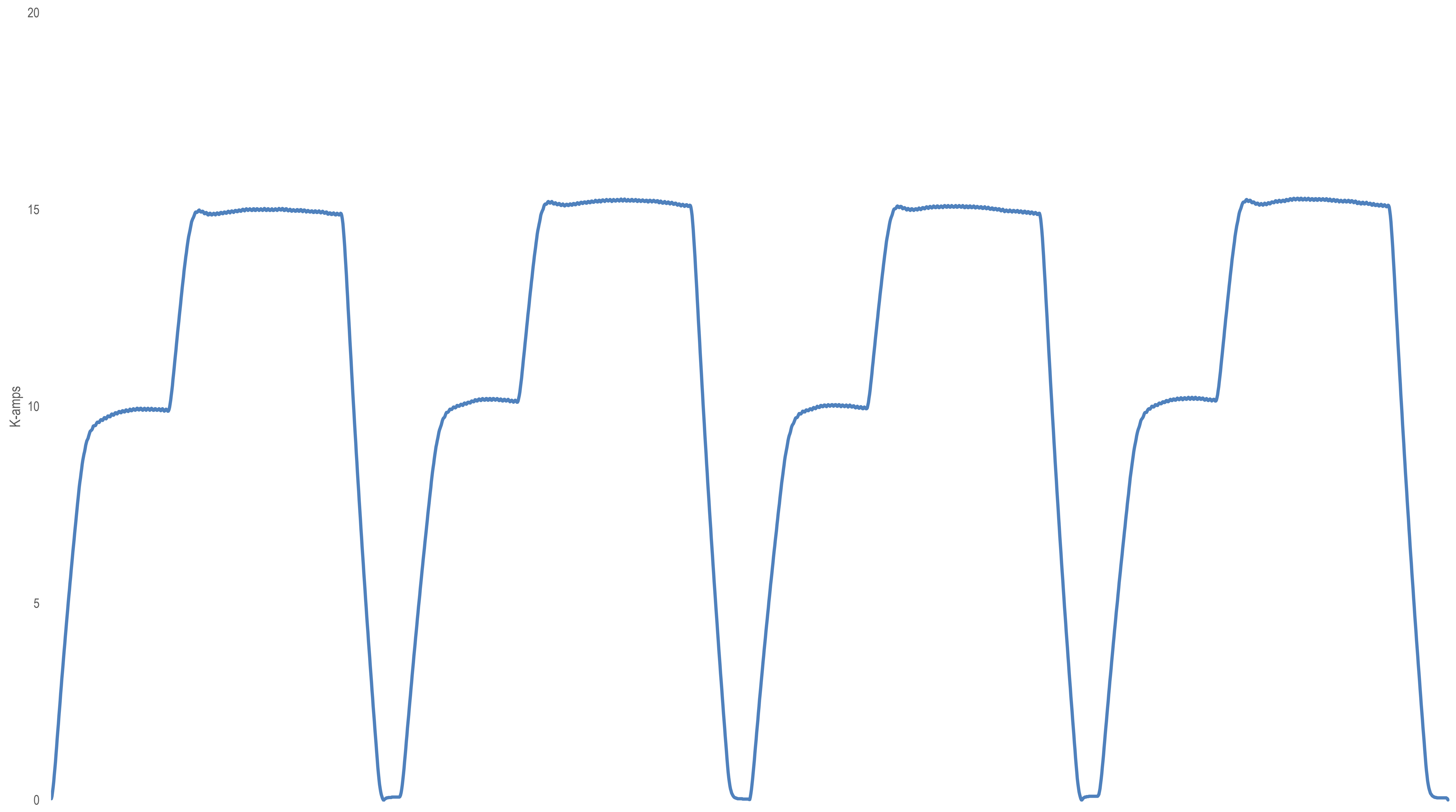
Current trace recorded with WeldView® Monitor

Instantaneous current waveform of 2 ms preheat, 3 ms weld heat, 1ms cool weld impulses produced with WeldComputer® Wave Synthesis Control and 60 Hz AC transformer



Current trace recorded with WeldView® Monitor

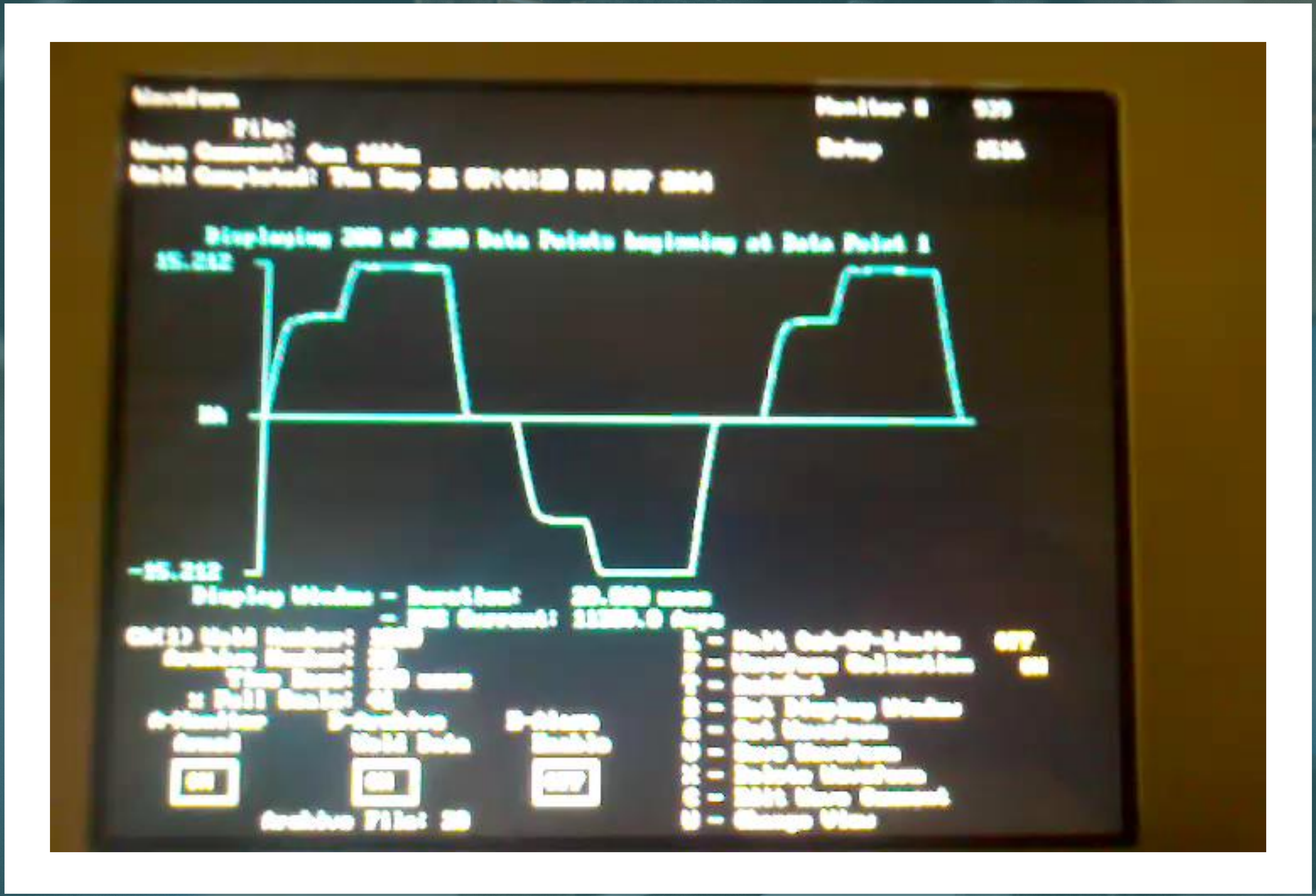
RMS current trace of 2 ms preheat, 3 ms weld heat, 1ms cool weld impulses produced with WeldComputer® Wave Synthesis Control and 60 Hz AC transformer



Current trace recorded with WeldView® Monitor

60 Hz AC fixture type transformer used to produce 200 welds per second

2 ms preheat, 3 ms weld heat, 1ms cool weld impulses produced with WeldComputer® Wave Synthesis Control and 60 Hz AC transformer



Current trace recorded with WeldView® Monitor

Machine Stability

— Velocity fluctuations: can be compensated for with adaptive control

— Force fluctuations: can be compensated for with adaptive control

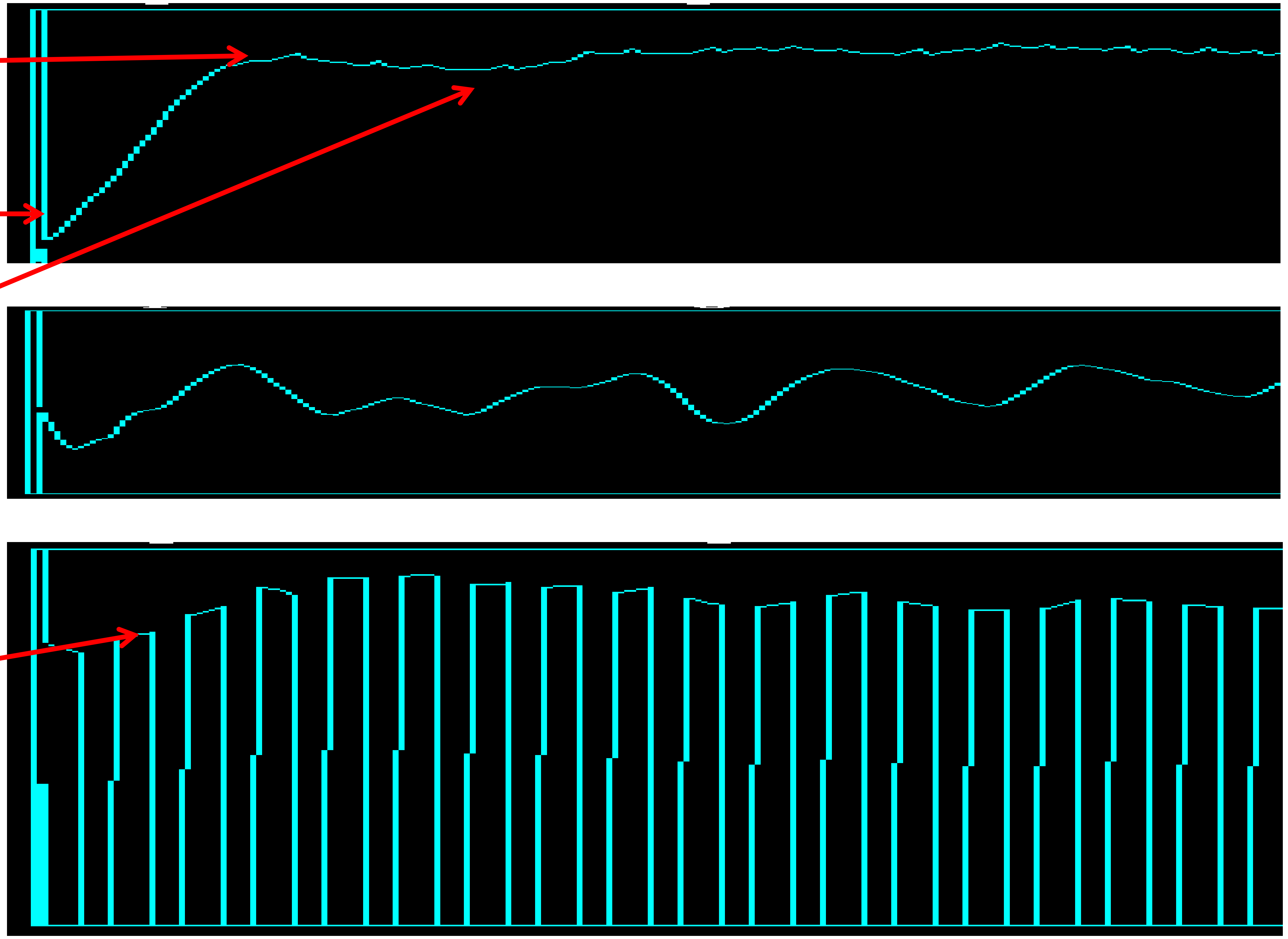
Adaptive Seam Welding at 22.5 in/sec - Front End of Part

Wheel overshoots rolling up on front of part

Displacement of wheel rolling up on front of part triggers current

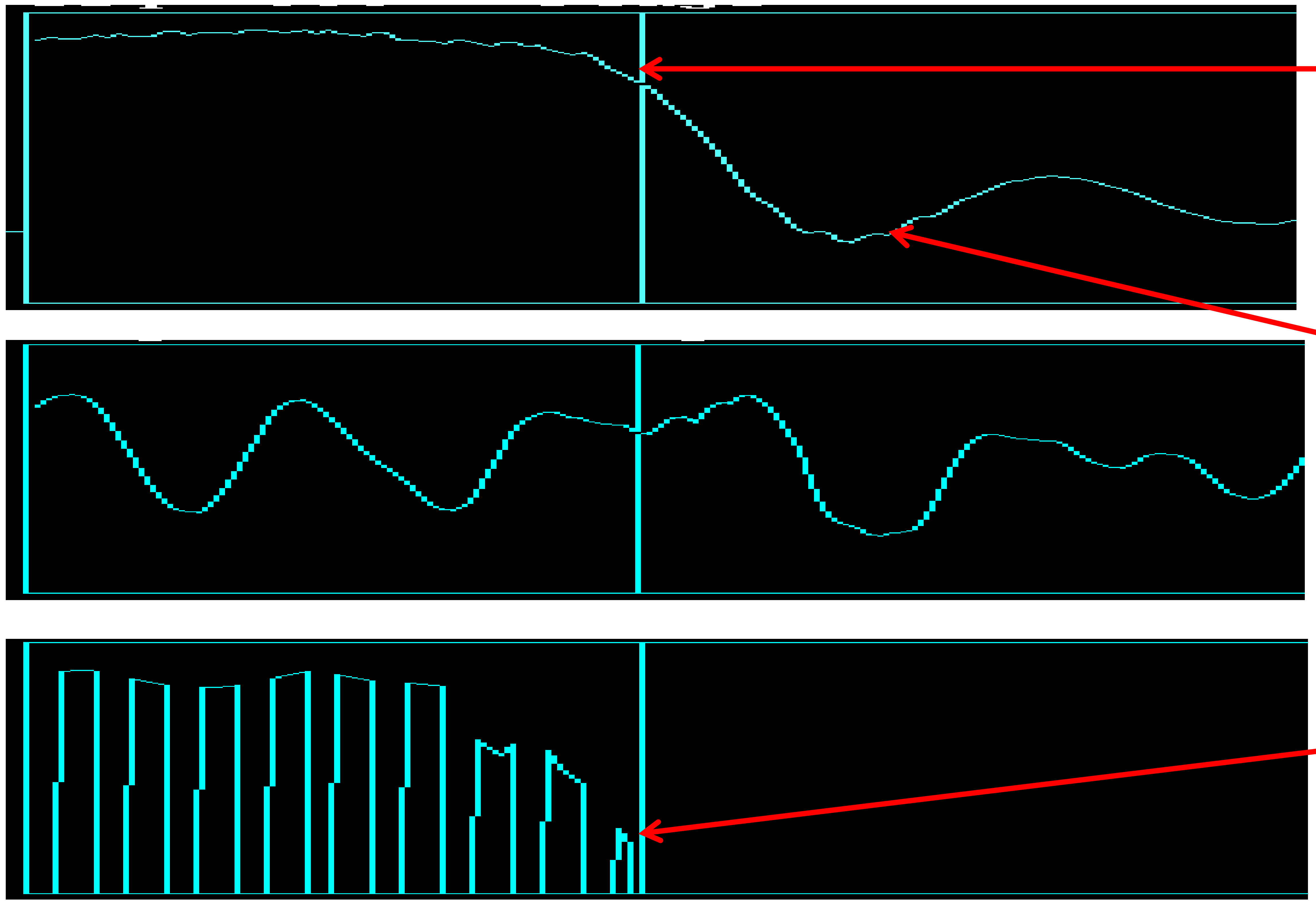
Wheel bounces when it lands on top of part

Each 5ms duration weld current pulse (below) is adjusted each 1ms to control weld based on displacement, velocity & force



Data collected and current synthesized with WeldComputer® Adaptive Control

Adaptive Seam Welding at 22.5 in/sec Back End of Part



Wheel starts rolling off back of part

Wheels bounce against each other after rolling off back of part

Heat automatically reduces itself and shuts off as wheel rolls off part

Data collected and current synthesized with WeldComputer® Adaptive Control

Continuous Welding Speed Limiting Factors:

— Current

— Force

— Wheel/Electrode Cooling

Reach out today to speak with one of our seam welding experts.

WeldComputer
The Technology Leader in Resistance Welding

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